2012

Maryland Energy Assurance Plan

Maryland Energy Administration

Maryland Emergency Management Agency

Maryland Public Service Commission

Prepared with assistance from:

University of Maryland Center for Health and Homeland Security
University of Maryland Center for Integrative Environmental Research
National Center for Smart Growth Research & Education

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Executive Summary

In 2009, Maryland received American Recovery and Reinvestment Act (ARRA) funding from the U.S. Department of Energy (DOE) to enable the creation of an energy assurance plan. Three State agencies—Maryland Energy Administration (MEA), Maryland Emergency Management Agency (MEMA) and Maryland Public Service Commission (PSC)—collaborated to develop the Maryland Energy Assurance Plan (EAP). The broad purpose of the EAP is four-fold:

1. To provide an overview of Maryland's interdependent energy landscape as a means to enhance reliability and facilitate recovery from disruptions to the State's energy supply.
2. To provide background information that will help to guide investments in energy infrastructure going forward.
3. To provide an analysis of the pre- and post- emergency roles, responsibilities and relationships between the various actors in the State's energy supply.
4. To provide background information to aid public agencies and private entities as they develop specific procedural energy emergency plans.

These four purposes define the over-arching goal of creating in Maryland a more resilient energy infrastructure that recovers quickly from disruption.

This Plan recognizes that a steady stream of reliable energy provides the foundation of a functioning modern society, and that residents of Maryland have come to expect minimal interruptions in their supply of electricity, transportation fuels and heating products. Energy supplies are not just a convenience, but have become a necessity for individuals and businesses. A prolonged interruption of the supply of basic energy or fuel—petroleum products, electricity, or natural gas—would likely result in significant harm to Maryland's public health, safety, economy and security. Although energy commodities are supplied by private firms, the State's interest in providing for the welfare of its citizens gives it a role to play in helping firms assure the continued provision of energy and fuel. This Plan points the way to improving energy assurance in Maryland and is intended to help mitigate the impacts of an energy supply interruption and to help the State return to normal conditions as quickly as possible.

This Plan also recognizes that energy emergency procedural plans are the life-blood of energy emergency response activities, but that *procedural plans are not created in a vacuum*. Procedural plans are created based on a thorough understanding of existing conditions in the sectors they cover. The Maryland Energy Assurance Plan provides the background necessary to understand the existing conditions of the energy sector in the State so that effective emergency procedural response plans can be created. The EAP is a reference to be used by public agencies and private energy firms in the development of their specific procedural energy emergency plans.

The EAP encompasses several key components that address the multifaceted and interconnected landscape of energy in the State. The EAP provides:

- An overview of the State's energy infrastructure, Maryland's Energy Profile, and system interdependencies;
- An assessment of potential risks and hazards threatening the State's critical energy infrastructure;
- An analysis of short- and long-term mitigation measures to reduce risk and vulnerability;
- Background information for the creation of effective plans and procedures to minimize the impacts of an energy supply interruption;
- Information to enable the rapid restoration of the energy infrastructure after an energy emergency; and
- Tools to increase public awareness before and during an energy emergency.

The EAP is not an emergency response plan. Energy emergency response plans contain specific details and provide procedures and checklists prescribing how decision-makers and emergency responders shall:

- Accomplish pre-identified tasks and objectives to make emergency notifications;
- Monitor and assess the severity of an energy emergency;
- Issue protective actions and decisions;
- Provide situational awareness reports;
- Provide emergency information to the news media and the public;
- Activate, staff, and operate an Emergency Operations Center; and
- Engage in other critical tasks to effectively recover from energy emergencies and restore the energy infrastructure.

The EAP provides a high-level view of how Maryland prepares for, responds to, and recovers from energy emergencies. Effective energy emergency procedural response plans are generated based on the information supplied within the EAP.

The EAP was developed using the National Association of State Energy Officials (NASEO) State Energy Assurance Guidelines, the NASEO Energy Assurance Planning Framework, the National Response Framework (NRF), the National Infrastructure Protection Plan (NIPP), and the National Incident Management System (NIMS) as platforms for development. The EAP is also consistent with the Maryland Core Plan for Emergency Operations and the State's duty under Maryland Public Safety Article, § 14-102(b) to "coordinate the activities of all public and private organizations providing emergency services within this State." MEA, MEMA and PSC should review and update the EAP annually or as needed to reflect changing response trends and strategies and to incorporate lessons learned from exercises or responses to actual energy emergencies.

List of Acronyms

ACEEE: American Council for an Energy Efficient Economy

ACP: Alternative Compliance Payment

AGA: American Gas Association

AMI: Advanced Metering Infrastructure

AP: Allegheny Power

API: American Petroleum Institute

ARRA: American Recovery and Reinvestment Act

ATAC: Anti-Terrorism Advisory Council of Maryland

Bcf: Billion cubic feet

BGE: Baltimore Gas & Electric Company

BOC: Business Operations Center

BOEMRE: Bureau of Ocean Energy Management, Regulation and Enforcement

Btu: British Thermal Unit

BWI: Baltimore Washington International Airport

CAD/RMS: Computer Aided Dispatch / Records Management System

CCHP: Combined Cooling Heat and Power

CCTV: Closed Circuit Television

CEG: Constellation Energy Group

CEMP: Comprehensive Emergency Management Program

CEO: Chief Executive Officer

CHP: Combined heat and power

CHHS: University of Maryland Center for Health and Homeland Security

CIA: Central Intelligence Agency

CIER: University of Maryland Center for Integrative Environmental Research

CI: Critical Infrastructure

CII: Critical Infrastructure Information

CIKR: Critical Infrastructure and Key Resource

CIPAC: Critical Infrastructure Protection Advisory Council

CIPC: Critical Infrastructure Protection Committee

CNG: Compressed Natural Gas

COOP: Continuity of Operations

CSP: Corporate Security Program

DelMarVa: Delaware, Maryland, Virginia

DCS: Distributed Control System

DETF: Delmarva Emergency Task Force

DGS: Maryland Department of General Services

DHCD: Department of Housing and Community Development

DHHS: Department of Health and Human Services

DHMH: Maryland Department of Health & Mental Hygiene

DHR: Maryland Department of Human Resources

DHS: U.S. Department of Homeland Security

DNR: Maryland Department of Natural Resources

DPL: Delmarva Power & Light

DPW: Department of Public Works

DoD: U.S. Department of Defense

DOE: U.S. Department of Energy

DOI: U.S. Department of the Interior

DOS: Department of State

DSM: Demand-side Management

EAP: Energy Assurance Plan

EAS: Emergency Alert System

EEAC: Energy Emergency Assurance Coordinator

EEI: Edison Electric Institute

EGS: Enhanced Geothermal Systems

EIA: U.S. Energy Information Administration

EIAC: Energy Industry Assurance Coordinators

EM: Emergency Manager

EMA: Emergency Management Agency

EMMA: Emergency Mapping Management Application

EOB: Electric Operations Building

EOC: Emergency Operations Centers

EOP: Emergency Operations Plans

EPA: U.S. Environmental Protection Agency

ERO: Electric Reliability Organization

ESF: Emergency Support Functions

ESISAC: Electricity Sector Information Sharing and Analysis Center

ESNG: Eastern Shore Natural Gas

ESSP: Energy Sector Specific Plan

EUSP: Electric Universal Service Program

FBI: Federal Bureau of Investigation

FEMA: Federal Emergency Management Agency

FERC: Federal Energy Regulatory Commission

FISMA: Federal Information Security Management Act

FPA: Federal Power Act

FPC: Federal Power Commission

GCC: Government Coordinating Council

GIS: Global Information System

GOHS: Governor's Office of Homeland Security

GTP: Geothermal Technologies Program

GW: Gigawatt

GWh: Gigawatt Hour

HSA: Homeland Security Act

HIRA: Hazard Identification Risk Assessment

HSIN: Homeland Security Information Network

HSPD-5: Homeland Security Presidential Directive-5

HSPD-7: Homeland Security Presidential Directive-5

IAP: Incident Action Plan

IC: Incident Command

ICS: Incident Command Structure

IECC: International Energy Conservation Code

IMMA: InfraGard Maryland Members Alliance

ISER: Infrastructure Security and Energy Restoration Division

ISO: Independent system operator

JIC: Joint Information Center

JIS: Joint Information System

KR: Key Resources

LDCs: Local Distribution Companies

LDV: Low Duty Vehicle

LNG: Liquefied Natural Gas

LPG: Liquefied Petroleum Gas

MEA: Maryland Energy Administration

MACS: Multiagency Coordination System

MAGNet: Mid-Atlantic Gas Network

MAMA: Mid-Atlantic Mutual Assistance

MAPGA: Mid-Atlantic Propane Gas Association

MAPP: Mid-Atlantic Power Pathway

MARAD: Maritime Administration

MARC: Maryland Area Regional Commuter Train

MARUC: Mid-Atlantic Conference of Regulatory Utilities Commissioners

MCAC: Maryland Coordination and Analysis Center

MDE: Maryland Department of Environment

MDOD: Maryland Department of Disabilities

MDOT: Maryland Department of Transportation

MdTA: Maryland Transportation Authority

MEAP: Maryland Energy Assistance Program

MEMA: Maryland Emergency Management Agency

MESIN: Maryland Eastern Shore Interoperability Network

MIEMSS: Maryland Institute for Emergency Medical Services Systems

MJOC: Maryland Joint Operations Center

mmcf: million cubic feet

MMSSP: Maryland Maritime Strategic Security Plan

MNG: Maryland National Guard

MOU: Memoranda of Understanding

MPA: Maryland Port Administration

MSP: Maryland Department of State Police

MTA: Maryland Transit Administration

MUGMA: Maryland Utilities Group for Mutual Assistance

MW: Megawatts

MWh: Megawatt hour

MWCOG: Metropolitan Washington Council of Governments

NARUC: National Association of Regulatory Utility Commissioners

NASEO: National Association of State Energy Officials

NCR: National Capital Region

NCR-CIP: National Capital Region's initiative on Critical Infrastructure Protection

NCRC: National Capital Region Coordination

NCSG: University of Maryland National Center for Smart Growth

NCSL: National Conference of State Legislatures

NECP: National Emergency Communications Plan

NERC: North American Electric Reliability Corporation

NERC CIPC: North American Electric Reliability Corporation Critical Infrastructure Protection Committee

NGA: National Governors Association

NGO: Non-Governmental Organization

NIMS: National Incident Management System

NIPP: National Infrastructure Protection Plan

NIST: National Institute of Standards and Technology

NOAA: U.S. National Oceanic and Atmospheric Administration

NRC: Nuclear Regulatory Commission

NRF: National Response Framework

NSF: National Science Foundation

NSA: National Security Agency

NTD: National Transit Database

OEC: Office of Emergency Communications

OHEP: Office of Home Energy Programs

OPC: Maryland Office of People's Counsel

PAD: Petroleum Administration for Defense

PADD: Petroleum Administration for Defense Districts

PATH: Potomac-Appalachian Transmission Highline

PCII: Protected Critical Infrastructure Information

PEPCO: Potomac Electric Power Company

PHEVs: Plug-in Hybrid Electric Vehicles

PHMSA: Pipeline and Hazardous Materials Safety Administration

PIO: Public Information Officer

PJM: Pennsylvania-New Jersey-Maryland Interconnection

PJM-GATS: PJM Generation Attribute Tracking System

PMU: Phasor Measurement Units

PSC: Maryland Public Service Commission

PSINet: Maryland Public Safety Intranet

REC: Renewable Energy Credits

RECCWG: Regional Emergency Communications Coordination Working Group

RFG: Reformulated Gasoline

RFI: Request for Interest

RGGI: Regional Green House Gas Initiative

RPS: Renewable Portfolio Standard

RTEP: Regional Transmission Expansion Plan

RTO: Regional Transmission Organization

SAIDI: System Average Interruption Duration Index

SAIFI: System Average Interruption Frequency Index

SALP: State Agency Loan Program

SAVs: Site Assistance Visits

SCADA: Supervisory Control and Data Acquisition

SCC: Sector Coordinating Councils

SCIP: Statewide Communication Interoperability Plan

SEE: Southeastern Electric Exchange

SEIF: State Energy Investment Fund

SEOC: State Emergency Operations Center

SHA: Maryland State Highway Administration

SLTTGCC: State Local, Tribal and Territorial Government Coordinating Council

SMAG: Salisbury Mutual Assistance Group

SMECO: Southern Maryland Electric Cooperative

SOPs: Standard Operating Procedures

SPIA Index: Sperry-Piltz Ice Accumulation Index

SREC: Solar Renewable Energy Credit

SWMAAC: Southwestern Mid-Atlantic Area Council

Tcf: Trillion Cubic Feet

T&D: Transmission and Distribution

TOD: Transit Oriented Development

TSA: Transportation Security Administration

TrAIL: Trans-Allegheny Interstate Line

UC: Unified Command

UMBC: University of Maryland, Baltimore County

USCG: United States Coast Guard

USDA: United States Department of Agriculture

USPP: Utility Service Protection Program

VoIP: Voice over internet protocol

WAP: Weatherization Assistance Program

WGL: Washington Gas & Light

WMATA: Washington Metropolitan Area Transit Authority

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Introduction

The Maryland Energy Assurance Plan (EAP) sets forth how the State of Maryland prepares for, responds to, and recovers from energy emergencies. The EAP accomplishes this by providing a detailed look at emergency functions on the local, State and federal level and looks at these functions through the lens of energy infrastructure and operations. The Plan was written for emergency managers and energy assurance planners alike, and knowledge of the Plan should help emergency and energy personnel facilitate recovery from disruptions to Maryland's energy supply. Beyond aiding recovery, the Plan also acts as a resource for energy assurance planners as they determine how to increase the State's energy sector resiliency. In effect, the EAP functions as the State's central storehouse of energy emergency information and as a resource for the creation of procedural documents for energy emergency events. The EAP is a "one stop shop" for energy assurance in Maryland.

State agencies interested in creating their own energy emergency procedural manual will find the EAP a useful source of background material. Unlike the EAP, which provides a high-level view of energy and emergency planning, an energy emergency procedural manual can provide an agency with a step-by-step process to prepare for and recover from energy disruptions. Energy emergency procedural manuals, when combined with continuity of operations plans (COOP) provide agencies with tools that make them more resilient to disruptive events.

Energy Assurance Plan Approach and Format

Energy assurance planning includes a large array of activities that fall into three main phases:

I-Planning and Preparedness,
II-Mitigation and Response, and
III-Education and Outreach.

Planning and Preparedness involves understanding the interdependencies of the State's energy infrastructure and identifying key assets; designing and updating energy emergency response plans; training personnel; and conducting exercises that test the effectiveness of response plans. Mitigation and Response includes monitoring events that may affect energy supplies; assessing the severity of disruptions; providing situational awareness; coordinating restoration efforts; and tracking recoveries. Education and Outreach includes communicating and coordinating with key stakeholders; increasing public awareness; and forming partnerships across sectors and jurisdictions. These phases are addressed throughout this Plan as they are encountered and practiced by both public and private stakeholders.

Section I-Planning and Preparedness

Chapter 1: Energy Infrastructure Overview organizes and broadly describes the infrastructure of the energy sector according to the sector's three basic components: electricity, petroleum and natural gas. The purpose of the chapter is to provide a primer on basic energy infrastructure at the national level.

Chapter 2: Maryland Energy Profile delves deeper into the infrastructure and operations of the energy sector and takes Maryland as its point of focus. The chapter breaks down the State's energy sector into three primary sub-sectors: Electricity, Natural gas and Petroleum and looks at each in relation to energy assurance.

Chapter 3: Organizations and Responsibilities lists the Maryland State agencies that have various regulatory, advocacy and/or assistance roles in the energy sector and briefly describes the role of each agency.

Chapter 4: Maryland Energy Efficiency, Conservation, and Renewable Energy focuses on the roles played by energy efficiency, conservation and distributed generation in energy assurance.

Chapter 5: Foundations of Emergency Response Planning in Maryland addresses the importance of coordination between governmental agencies from several jurisdictions, and between these agencies and private firms and how Maryland has adopted federal emergency management guidelines and procedures in an effort to bring consistency to emergency-response activities in the State. This chapter also provides energy professionals an overview of emergency management in the State of Maryland.

Section II-Mitigation and Response

Chapter 6: Energy Disruptions explains the types of hazards in the Middle Atlantic Region that can impact Maryland's critical energy infrastructure. The chapter analyzes the causes of, and solutions to, energy disruptions and provides an overview of energy disruptions, the causes of disruptions in Maryland, the potential effects of such disruptions, and recovery efforts that may be needed.

Chapter 7: Managing Information for Energy Assurance Planning manages energy information by providing a reference list of essential information sources and published reports for the State. Resources that provide current data and those that provide forecasts are enumerated. Specific reports are organized according to the authoring agency and each report is briefly described and includes a bulleted list of the report's central topics.

Chapter 8: Critical Energy Infrastructure Protection focuses on the components of the energy infrastructure that are determined to be "critical" and discusses the forces involved in their protection. Topics covered are: "Roles and Responsibilities of Agencies Involved with Critical Infrastructure Protection" and "Public and Private Sector Plan Coordination".

Section III-Education and Outreach

Chapter 9: Emergency Communications describes emergency communications structures and procedures in the State. The first two sections focus on State and local interagency communications, while the last section focuses on a discussion of government communications with the public. Topics covered include: interoperable communications, unified messaging, personnel (public information officers), communication technologies and emerging social media.

Appendix A: Key Terms Defined

The Maryland EAP follows the format and recommendations of the National Association of State Energy Officials' (NASEO's) guidelines for energy assurance planning.[1] These guidelines were developed by NASEO in collaboration with the National Association of Regulatory Utility Commissioners (NARUC) and funded by the U.S. Department of Energy Office of Electricity Delivery & Energy Reliability (OE).

[1] National Association of State Energy Officials, State Energy Assurance Guidelines (Version 3.1 2009).

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Chapter 1. Energy Infrastructure Overview

Introduction

This chapter organizes and broadly describes the infrastructure of the energy sector according to the sector's three basic components: electricity, petroleum, and natural gas. Each of these components is analyzed according to its inherently unique set of supporting activities and assets, as shown in Table 1-1: Segments of the Energy Sector. Following the analysis of the energy sector's infrastructure, the chapter concludes with a brief description of the interdependencies of each component within the sector. The purpose of this chapter is to provide a primer on basic energy infrastructure as a first step in explaining how to make the energy sector more resilient to threats and to implementing methods of quick recovery from disruptions.

Table 1-1: Segments of the Energy Sector

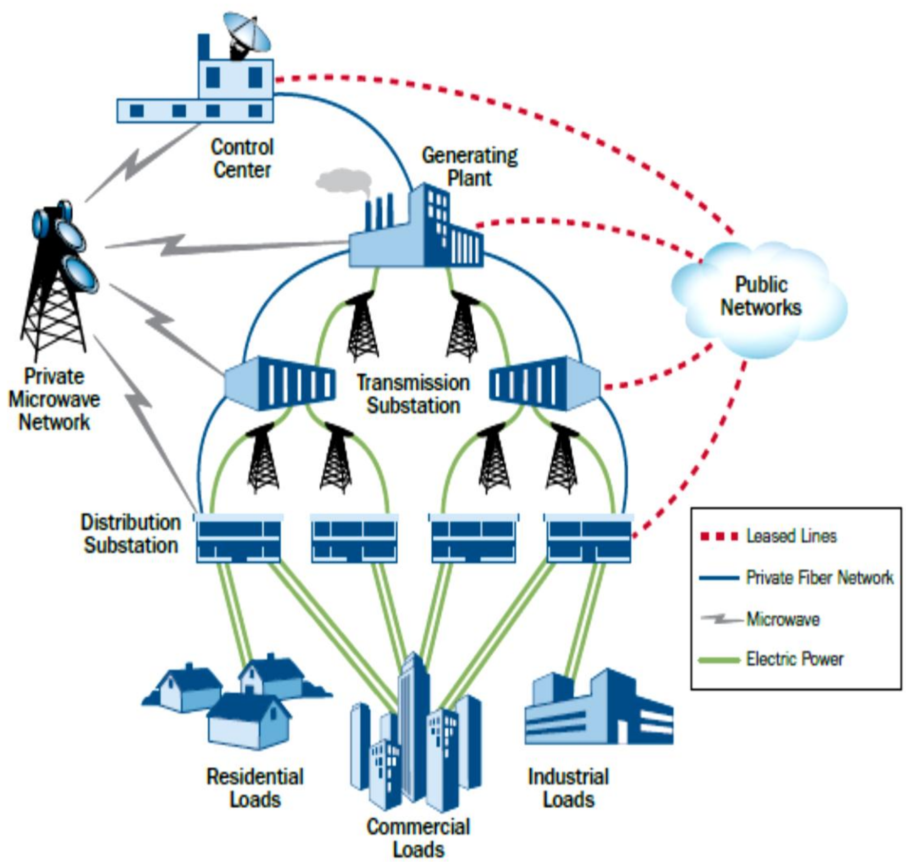
Electricity	Petroleum	Natural Gas
• Generation – Fossil Fuel Power Plants » Coal » Natural Gas » Oil – Nuclear Power Plants – Hydroelectric Dams – Renewable Energy – Transmission – Substations – Lines – Control Centers – Distribution – Substations – Lines – Control Centers – Control Systems – Electricity Markets	• Crude Oil – Onshore Fields – Offshore Fields – Terminals – Transport (pipelines) – Storage • Petroleum Processing Facilities – Refineries – Terminals – Transport (pipelines) – Storage – Control Systems – Petroleum Markets	• Production – Onshore Fields – Offshore Fields • Processing • Transport (pipelines) • Distribution (pipelines) • Storage • Liquefied Natural Gas Facilities • Control Systems • Gas Markets

Electricity

The use of electricity is ubiquitous, spanning and supporting all sectors of the U.S. economy. Electricity accounts for 40 percent of all energy consumed in the United States,[1] with more than 98 percent being generated domestically. On a regional basis, some states are net importers and some net exporters. Maryland is a net importer of approximately 30 percent of its electricity. On the national and regional levels, the fuels for generating electricity are often imported either from other states or nations.

Electricity is generated at plants throughout the country using several types of fuel. Once produced, electric current flows through large overhead transmission lines that feed into a network of smaller distribution lines that bring current to end use customers (see Figure 1-1). The electric power industry is diverse in its ownership, geography and asset type. Moreover, several levels of government have roles in regulating the distribution and/or generation of electricity.

Figure 1-1: Overview of the Electric Power System and Control Communications



[1] U.S. Dep't of Homeland Sec. & U.S. Dep't of Energy, *Energy Sector-Specific Plan- An Annex to the National Infrastructure Protection Plan* 10 (2010) [hereinafter *Energy Sector-Specific Plan*], *available at* http://www.dhs.gov/xlibrary/assets/nipp-ssp-energy-2010.pdf.

Electricity Supply, Generation, Transmission, Distribution, and Control Systems

The electricity sector consists of several interconnected and equally important pieces. There is varying oversight and responsibility for generation, transmission, distribution, reliability and fuel supply. Although most assets are privately owned, no single organization represents the interests of the entire sector.[2]

Electricity Generation

More than 70 percent of the electricity generated in the United States comes from burning fossil fuels—coal, natural gas, and oil.[3] A very high percentage of coal consumed in the U.S. is mined domestically. It is transported to power plants by rail and barge, where it produces 45 percent of the nation's electricity. Recently, imports of low sulfur coal from South America and elsewhere increased in order to meet Federal environmental guidelines. Coal imports peaked in 2007 at 36,347 thousand short tons (four percent of the supply) but have fallen to 19,353 thousand short tons in 2010.[4]

Approximately 23 percent of electricity in the U.S. is generated by burning natural gas, and one percent is generated by burning oil. Natural gas and oil are transported to power plants by pipeline. Additional sources of electricity generation include nuclear and hydropower. Renewable energy sources—including solar, wind, and geothermal—account for three percent of national electricity generation, but are being used more frequently.[5]

Oversight

Once electricity is generated it enters the national electrical grid. The amount of electricity entering the grid is overseen by The North American Electric Reliability Corporation (NERC). Through NERC's eight Regional Reliability Councils, it provides a platform for ensuring reliable, adequate, and secure supplies of electricity through coordination with many asset owners (see Figure 1-2). NERC develops and enforces mandatory reliability standards for the bulk electric power system in the United States, Canada and a portion of Baja Mexico.[6]

[2] *Energy Sector-Specific Plan*, supra note 1, at 10.
[3] *Energy Sector-Specific Plan*, supra note 1, at 10.
[4] U.S. Energy Information Administration, *U.S. Coal Imports* (2011) [hereinafter *U.S. Coal Imports*], *available at* http://www.eia.gov/cneaf/coal/quarterly/html/t4p01p1.pdf.
[5] *Energy Sector-Specific Plan*, supra note 1, at 12.
[6] *Energy Sector-Specific Plan*, supra note 1, at 10.

Figure 1-2: NERC Territories[7]

Transmission Lines

Transmission lines serve two primary purposes: moving electricity from generation sites to customers and interconnecting adjacent systems. Interconnection between systems is important given that three regions of the United States operate on regional systems that create the national electrical grid (see Figure 1-3).

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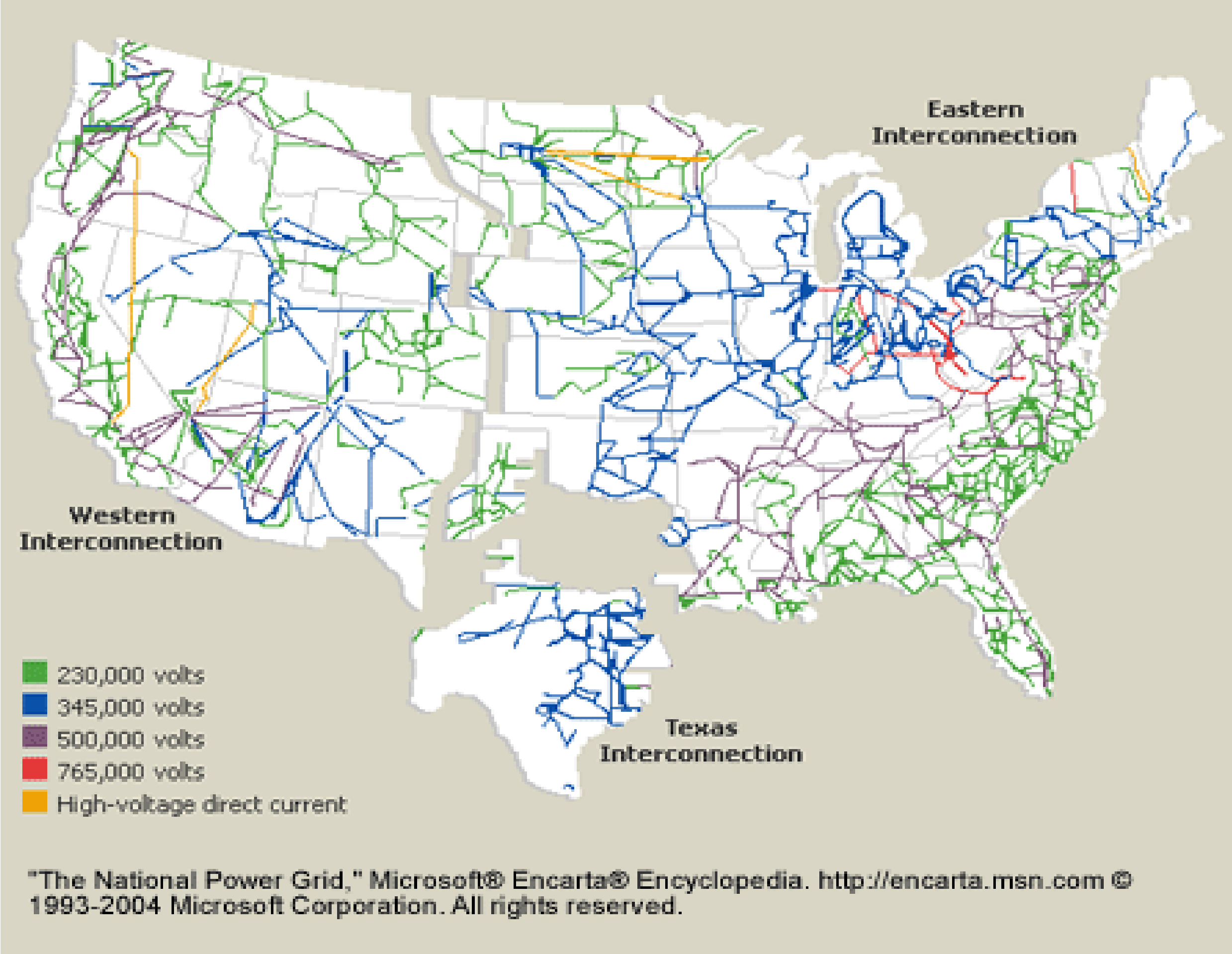
[7] North American Electric Reliability Corporation, *Key Players: Regional Entities* (2011) [hereinafter *Key Players: Regional Entities*], *available at* http://www.nerc.com/page.php?cid=1|9|119.

Figure 1-3: United States Electrical Grid and Transmission[8]



Voltages in the transmission system range from 69 kilovolts (kV) to 765 kV,[9] which makes it possible to carry electric power efficiently over long distances and deliver it to substations near customers.[10]

Transmission and Distribution Substations

Substations are located at the ends of transmission lines. A transmission substation located near generation uses transformers to increase the voltage. At the other end of a transmission line, a substation uses transformers to step transmission voltages back down so the electricity can be distributed to customers.[11]

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[8] U.S. Energy Information Administration, *Energy in Brief: What Everyone Should Know About Energy*, [hereinafter *Energy in Brief*] *available at* http://www.eia.gov/energy_in_brief/power_grid.cfm (last visited Dec. 24, 2011).
[9] Occupational Safety & Health Administration, U.S. Department of Labor, *Illustrated Glossary: Transmission Lines,* [hereinafter *Illustrated Glossary*] *available at* http://www.osha.gov/SLTC/etools/electric_power /illustrated_glossary/transmission_lines.html (last visited Dec. 24, 2011).
[10] *Energy Sector-Specific Plan*, supra note 1, at 12.
[11] *Energy Sector-Specific Plan*, supra note 1, at 12.

Distribution Lines

Distribution lines are relatively low voltage (50 kV or lower)[12] and carry electricity from substations to end users.

Control Centers

Control centers have sophisticated monitoring and control systems and are staffed by operators 24 hours per day, 365 days per year. These operators are responsible for several key functions, including: balancing power generation and demand; monitoring flows over transmission lines to avoid overloading; planning and configuring systems to operate reliably; maintaining system stability; preparing for emergencies; and placing equipment in and out of service for maintenance and during emergencies.[13]

Control Systems

Supervisory Control and Data Acquisition Systems (SCADA) and Distributed Control Systems (DCS) monitor the flow of electricity from generators through transmission and distribution lines. These electronic systems enable efficient operation and management of electric systems through the use of automated data collection and equipment control.[14]

Smart Grid Technologies

Under the American Recovery and Reinvestment Act (ARRA) of 2009, funds became available to utilities to incorporate "smart technologies" into electricity distribution systems. These technologies are intended to improve end-use efficiency and increase the reliability of the grid.[15] Two Maryland utilities have been authorized to proceed with the installation of a system of advanced meters, which are intended as the first step towards developing a smart grid in the State. Smart Grid Technology is explored more fully in Chapter 4.

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[12] Electrical Safety Authority, *Powerline Safety Facts & Myths*, *available at* http://www.powerlinesafety.info/ RightPanel-001.php [hereinafter *Powerline Safety Facts & Myths*] (last visited Dec. 24, 2011).

[13] *Energy Sector-Specific Plan*, supra note 1, at 12.

[14] *Energy Sector-Specific Plan*, supra note 1, at 12.

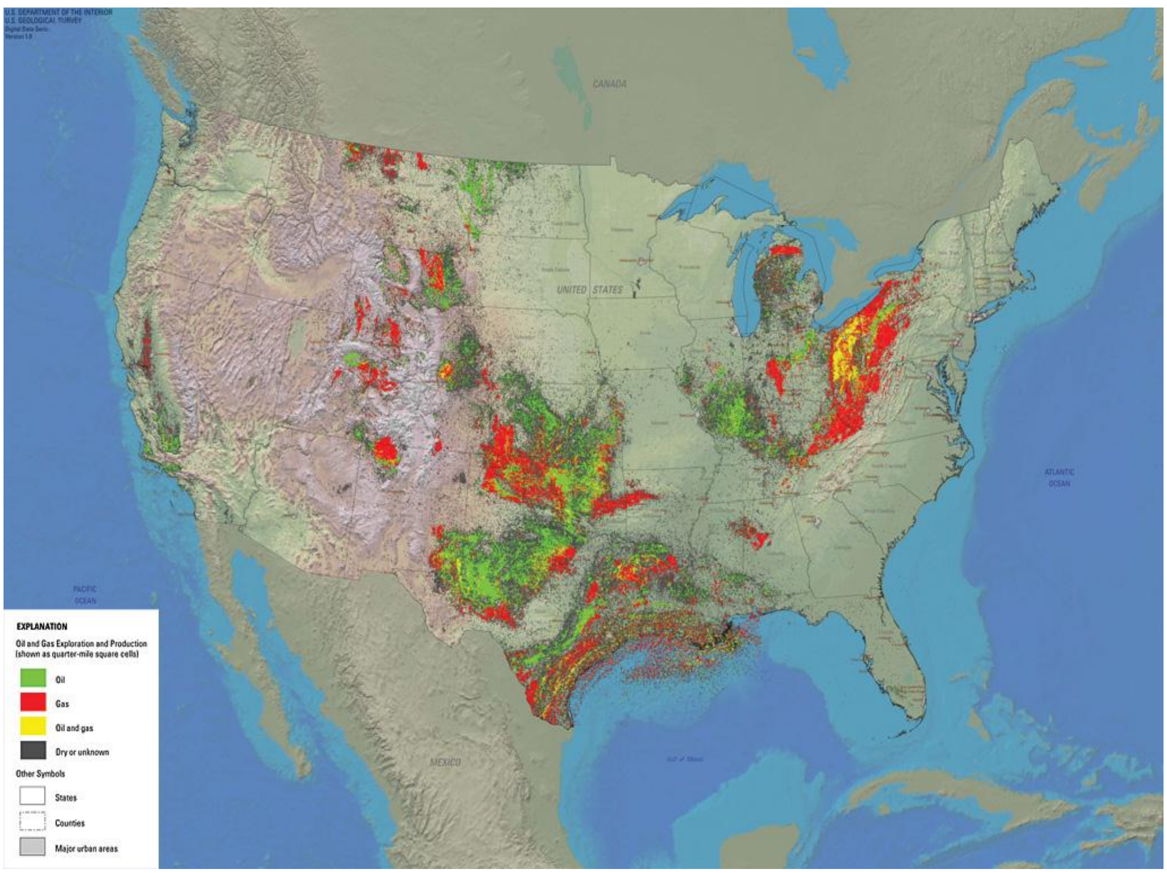
[15] *Energy Sector-Specific Plan*, supra note 1, at 12.

Petroleum

The petroleum portion of the energy sector consists of production, transportation, and storage of crude oil; processing of crude oil into petroleum products; transportation and storage of petroleum products; and management of sophisticated control systems to coordinate storage and transportation.[16]

The petroleum supply and distribution system includes onshore and offshore oil fields. Specifically, U.S. crude oil production is concentrated onshore and offshore along the Texas-Louisiana Gulf Coast, extending inland through western Texas, Oklahoma, and eastern Kansas. There are also significant oil fields in Alaska along the central North Slope and along the California coastline (Figure 1-4).[17] The U.S. also imports nearly 60 percent of the petroleum it consumes from Canada, Mexico, the Middle East, South America and Africa.

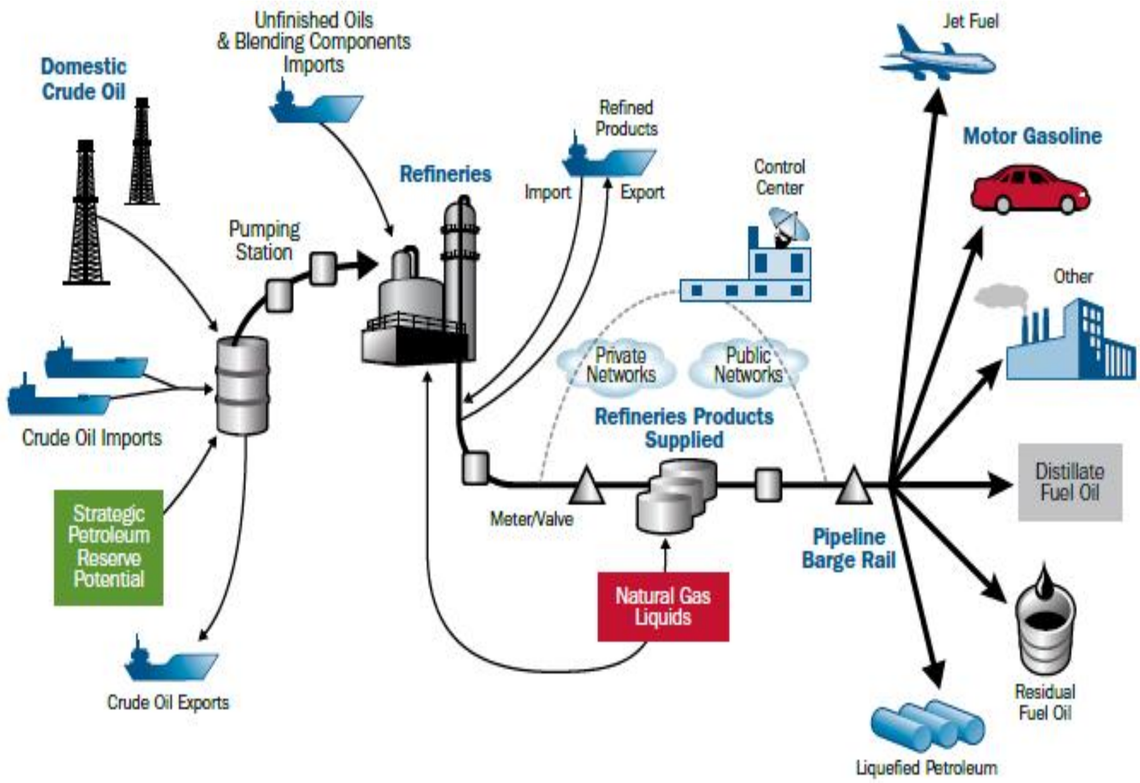
Figure 1-4: Oil and Gas Exploration and Production[18]



[16] *Energy Sector-Specific Plan*, supra note 1, at 13.
[17] *Energy Sector-Specific Plan*, supra note 1, at 14.
[18] Laura R.H. Biewick, U.S. Geological Survey, *Areas of Historical Oil and Gas Exploration and Production in the United States (2008)* [hereinafter *Areas of Historical Oil and Gas Exploration*], *available at* http://www.esri.com/mapmuseum/mapbook_gallery/volume24/images/petroleum3_lg.jpg.

Pipelines are critical for gathering, transmitting, and distributing petroleum. The Department of Homeland Security's (DHS's) Transportation Security Administration (TSA) is responsible for the oversight of pipeline security.[19] Figure 1-5 provides a graphical representation of the petroleum sector.

Figure 1-5: Overview of the Petroleum System



Crude Oil Drilling, Gathering and Processing

This sector of the petroleum industry includes a large number of facilities, such as wellheads, gas and oil separation plants, compressor stations and water treatment units, for both onshore and offshore areas.[20] U.S. oilfields currently produce over two billion barrels of oil per year.[21]

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[19] *Energy Sector-Specific Plan*, supra note 1, at 14.

[20] *Energy Sector-Specific Plan*, supra note 1, at 14.

[21] U.S. Energy Information Administration, *Independent Statistics & Analysis: Petroleum & Other Liquids* (2011) [hereinafter *Petroleum & Other Liquids*], *available at* http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=MCRFPUS1&f=A.

Import Marine Terminals

Crude oil is received into the United States at import terminals, which usually consist of a berth or port facility for the tankers, unloading facilities, storage facilities and a system of pipelines to move the crude. [22] Maryland has an import terminal in the Port of Baltimore which includes the importation of petroleum products,[23] "petrol, ethanol, and distillate".[24]

Oil Transport

Privately owned pipelines, such as the Colonial Pipeline, reaching from Houston, Texas to New York Harbor, transport most of the refined petroleum products in the United States. Waterborne transportation modes, including ocean tankers and barges, are also used. [25]

Oil Storage

Import terminals always incorporate storage facilities. In addition, the Strategic Petroleum Reserve has huge underground salt caverns along the coastline of the Gulf of Mexico. The reserve has the capacity to hold 727 million barrels and is the world's largest supply of emergency crude oil.[26]

Refineries

Refineries process crude oil into petroleum products such as gasoline, diesel fuel, jet fuel and home heating oil. The Gulf Coast has more than twice the crude oil refining capacity of any other U.S. region (see Table 1-2 on the following page).[27]

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[22] *Energy Sector-Specific Plan*, supra note 1, at 14.

[23] Maryland Port Administration, *The Economic Impacts of the Port of Baltimore* (2008) [hereinafter *The Economic Impacts of the Port of Baltimore, available at* http://mpa.maryland.gov/_media/client /planning/EconomicImpactReport-revisedJan'08.pdf.

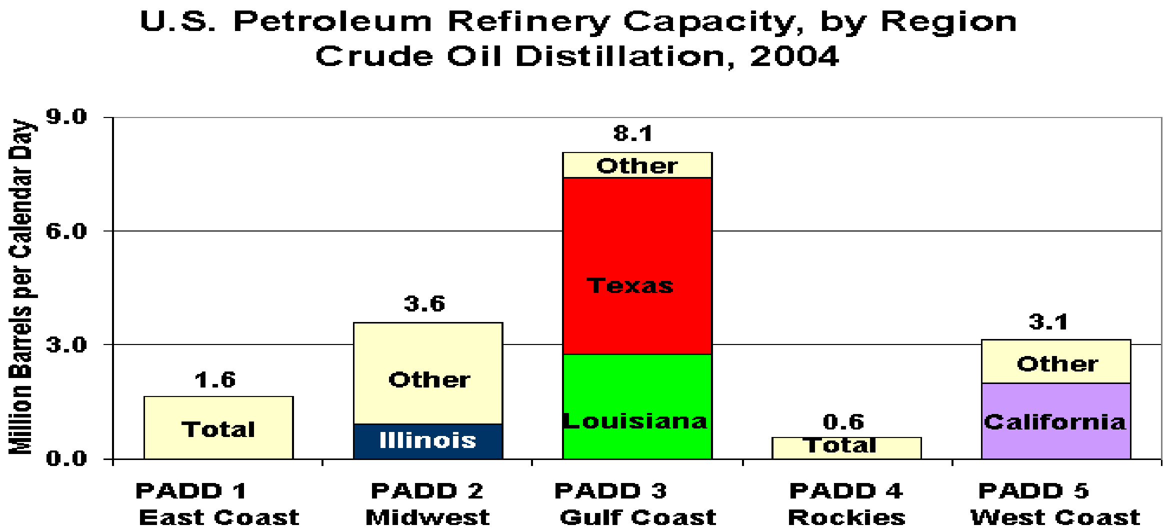
[24] Luke Buxton, Tank Storage, *Tank Terminal Update – US (2010)* [hereinafter *Tank Terminal Update – US*], *available at* http://www.blackwatermidstream.com/tankupdate.pdf.

[25] *Energy Sector-Specific Plan*, supra note 1, at 15.

[26] *Energy Sector-Specific Plan*, supra note 1, at 15.

[27] *Energy Sector-Specific Plan*, supra note 1, at 15.

Table 1-2: Petroleum Refinery Capacity[28]



Refined Petroleum Product Transport

Refined petroleum products are mainly transported by pipelines, tankers, barges, railroad tank cars, and trucks. The products are shipped to terminals for temporary storage before transport to smaller petroleum delivery stations in market areas.[29]

Refined Petroleum Product Storage

Refined Petroleum products are stored both above and below ground in tank farms and storage fields to minimize unwanted fluctuations in pipeline throughput and product delivery. As an example, DOE's Northeast Home Heating Oil Reserve stores two million barrels of home heating oil at commercial terminals in the Northeast. This oil is intended for distribution during severe heating-oil supply disruptions in that part of the country.[30]

Refined Petroleum Control Systems

Control systems, like SCADA,[31] continuously monitor, transmit, and process pipeline data. This includes flow rate, pressure, and speed. The SCADA systems monitor and control pumping stations and track terminal inventories. SCADA gathers information, such as where a leak on a pipeline has occurred, and transfers the information back to a central site. This alerts the home station that the leak has occurred, analyzes its importance, and displays the information in a logical and organized fashion. [32]

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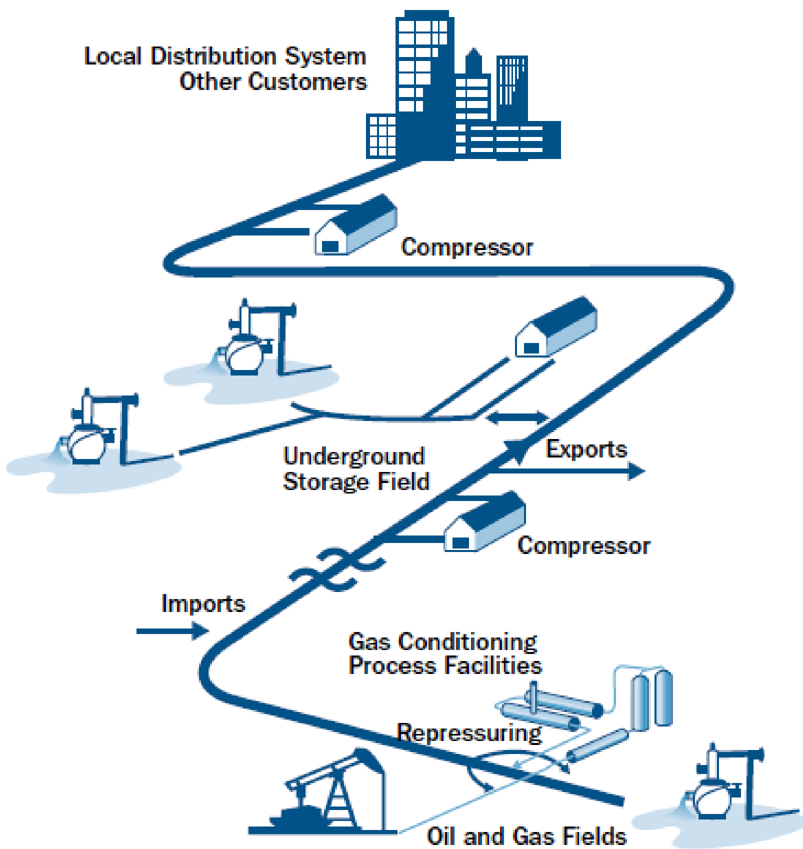
[28] U.S. Energy Information Administration, *U.S. Petroleum Refinery Capacity, by Region Crude Oil Distillation, 2004, available at* http://www.eia.gov/pub/oil_gas/petroleum/analysis_publications/oil_market_basics/ref_image_usr egl_cap.htm.
[29] *Energy Sector-Specific Plan*, supra note 1, at 15.
[30] *Energy Sector-Specific Plan*, supra note 1, at 15.
[31] See Electricity, supra, for additional information on SCADA.
[32] *Energy Sector-Specific Plan*, supra note 1, at 15.

Natural Gas

The natural gas portion of the energy sector includes the production, processing, transportation, distribution, and storage of natural gas; liquefied natural gas (LNG) facilities; and gas control systems (see Figure 1-6). Natural gas provided 24 percent of U.S. energy needs in 2008, and thanks in part to the discovery of new reserves, coupled with new extraction technologies, its use is growing.[33] In particular, power producers and industrial facilities are opting for gas-powered equipment, and residential customers use natural gas for space heating, hot water and cooking.

Figure 1-6: Flow of Natural Gas[34]



Natural Gas Production, Processing, Transport, Distribution and Storage

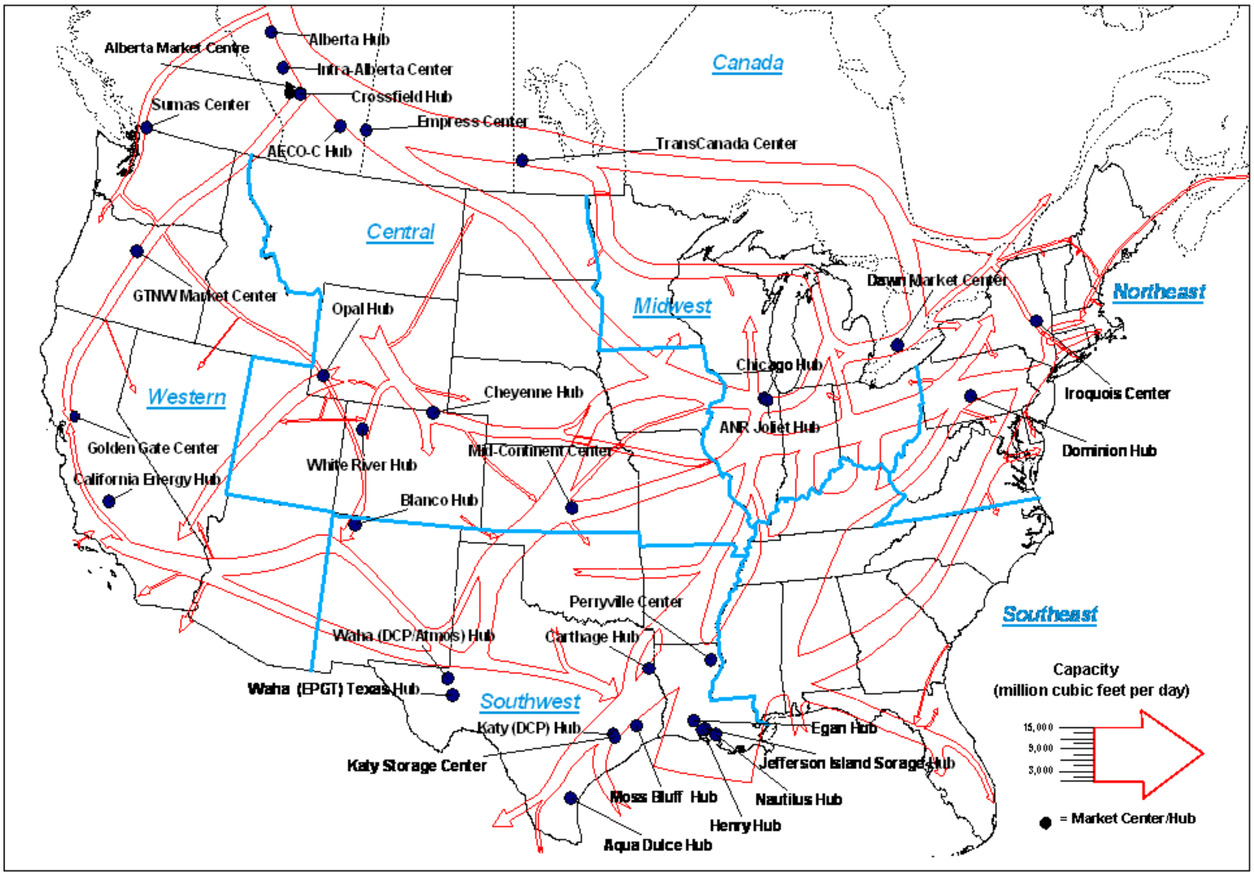
Natural Gas Production

The Gulf of Mexico and Texas are the largest gas-producing regions in the United States, at approximately 6.4 billion and 17.9 billion cubic feet per day, respectively (see Figure 1-7).[35] The two

[33] *Energy Sector-Specific Plan*, supra note 1, at 15.
[34] *Energy Sector-Specific Plan*, supra note 1, at 17.
[35] *Energy Sector-Specific Plan*, supra note 1, at 15.

regions account for almost 45 percent of all U.S. natural gas production. The United States had 245 trillion cubic feet of dry natural gas reserves as of December 31, 2008.[36] For movement of natural gas in the United States, see Figure 1-7, below.

Figure 1-7: Movement of Natural Gas in the United States[37]



Natural Gas Processing

Natural gas processing consists of separating all the various hydrocarbons and fluids from pure natural gas to produce pipeline-quality dry natural gas. Most U.S. natural gas processing plants are located near production facilities in the Southwest and Rocky Mountain States. The natural gas extracted from a well is transported to a processing plant through a network of gathering pipelines.[38]

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[36] *Energy Sector-Specific Plan*, supra note 1, at 16.

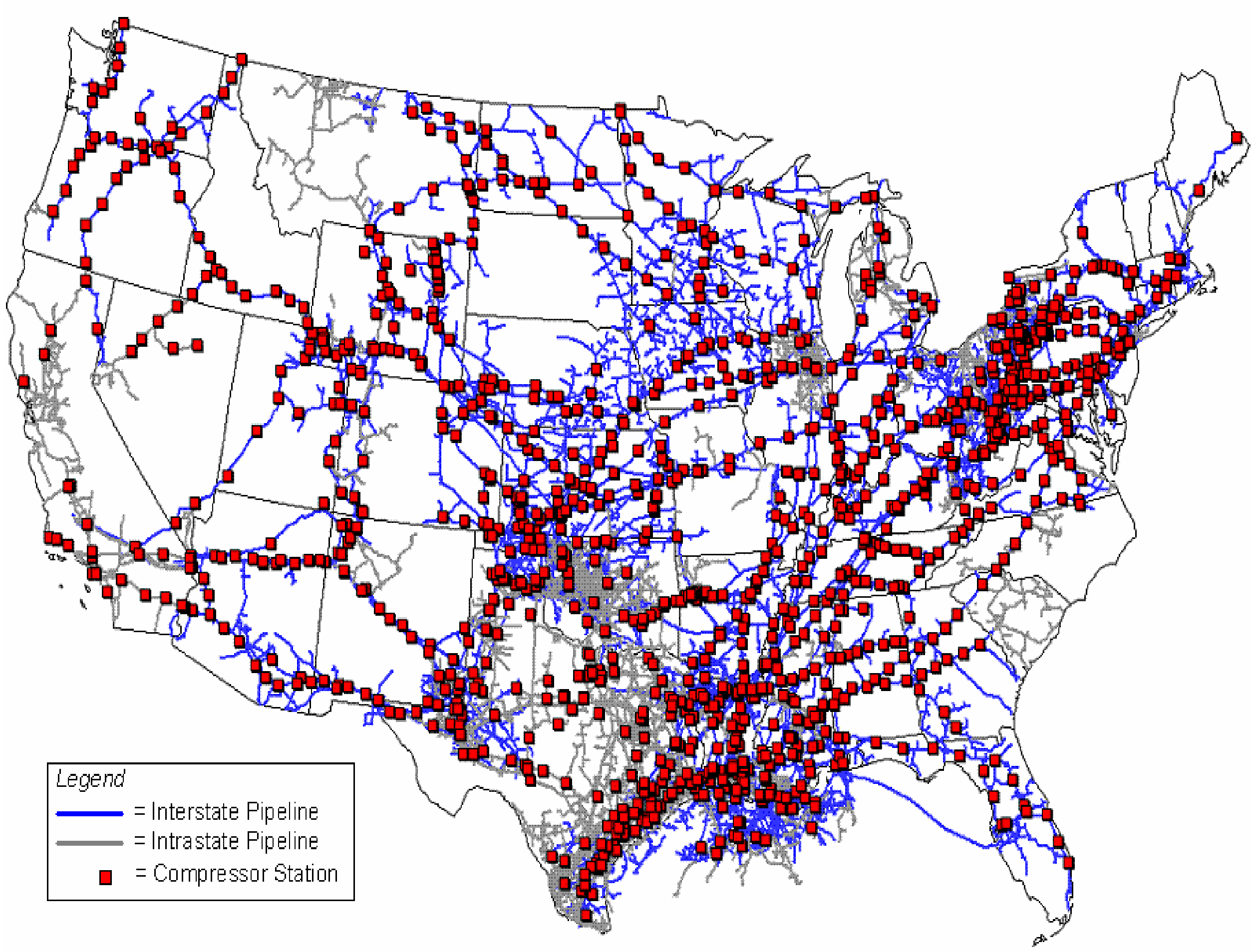
[37] U.S. Energy Information Administration, *Independent Statistics & Analysis: Natural Gas Market Centers and Hubs in Relation to Major Natural Gas Transportation Corridors* (2009) [hereinafter *Natural Gas Market Centers and Hubs*], *available at* http://www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/ngpipeline/MarketCenterHubsMap.html.

[38] *Energy Sector-Specific Plan*, supra note 1, at 16.

Natural Gas Transportation

The interstate natural gas pipeline network transports natural gas from processing plants in producing regions to market areas with high natural gas requirements, particularly large urban areas. Compression stations along the pipeline transmission route keep the gas moving at the desired volume and pressures (see Figure 1-8).[39]

Figure 1-8: Natural Gas Pipelines and Compressor Stations[40]

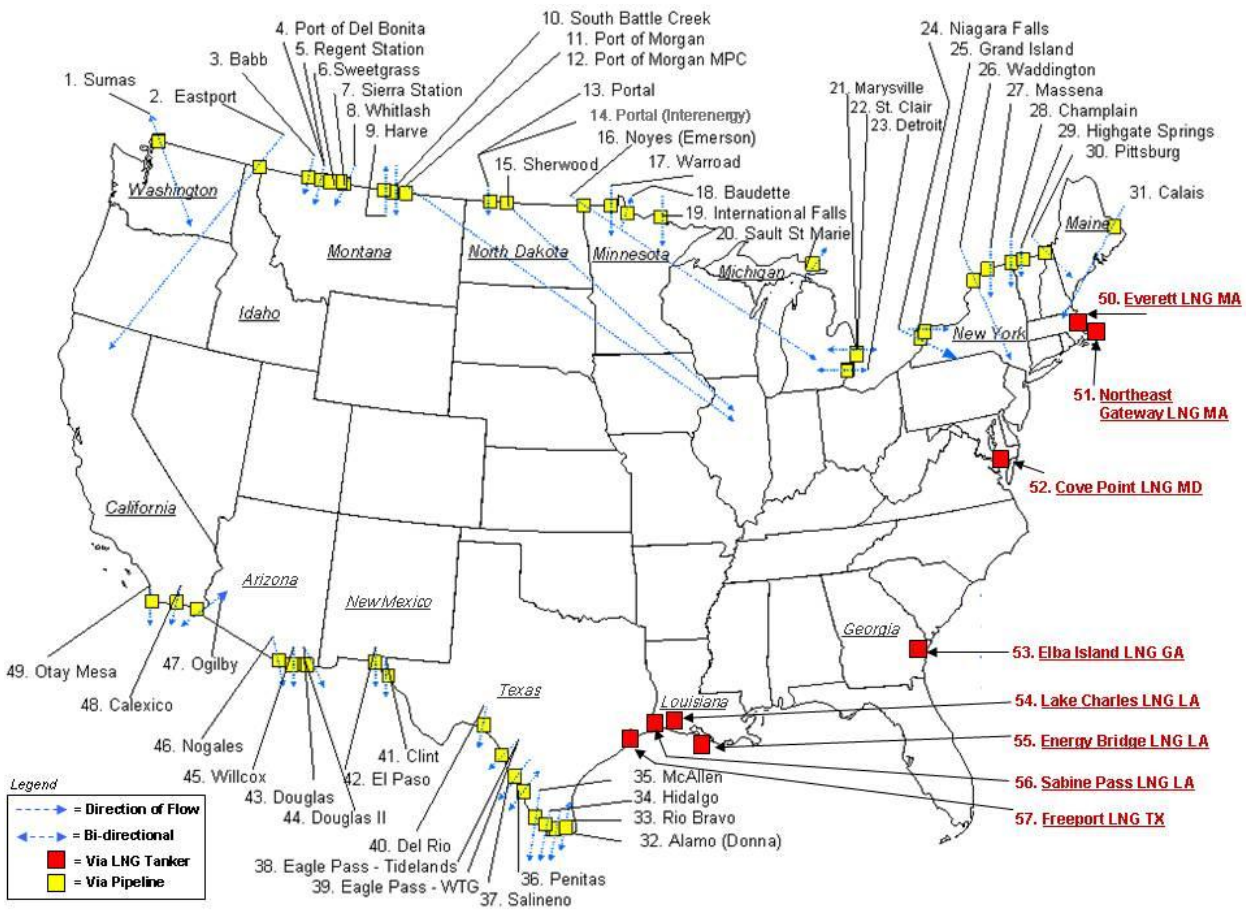


In addition, the United States imports and exports natural gas through a series of pipelines and terminals nationwide (see Figure 1-9 on the following page).

[39] *Energy Sector-Specific Plan*, supra note 1, at 16.

[40] U.S. Energy Information Administration, *Independent Statistics & Analysis: U.S. Natural Gas Pipeline Compressor Stations Illustration,* [hereinafter *U.S. Natural Gas Pipeline Compressor Stations Illustration*] *available at* http://www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/ngpipeline/compressorMap.html (last visited Dec. 24, 2011).

Figure 1-9: Natural Gas Import/Export Locations (2008) [41]



Natural Gas Distribution

Local distribution companies typically transport natural gas from interstate pipeline delivery points to end users through millions of miles of distribution pipe. Delivery points to local distribution companies are often termed city gates, especially for large municipal areas, and are important market centers for the pricing of natural gas.[42]

Natural Gas Storage

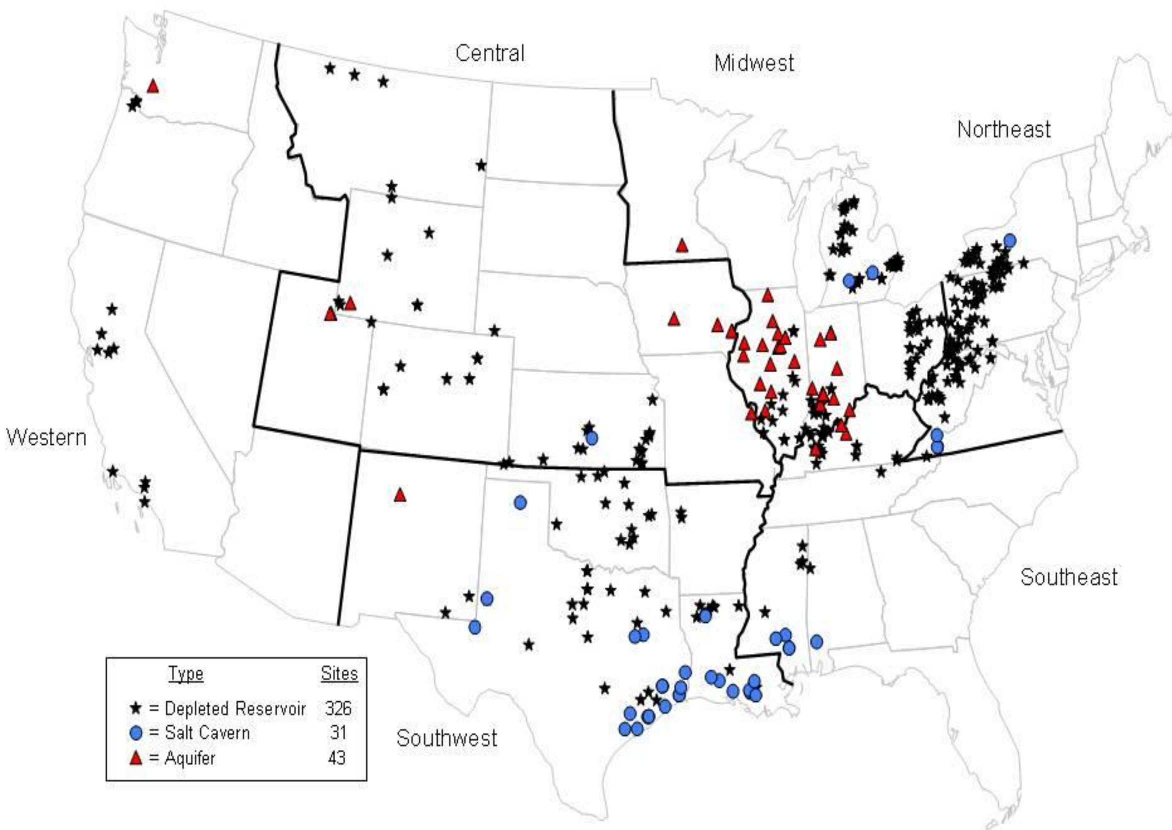
Gas is typically stored underground and under pressure as an efficient way to balance variations between supply input and market demand (see Figure 1-10). Three types of facilities are used for underground gas storage: depleted reservoirs in oil and/or gas fields, aquifers and salt caverns. Facilities

[41] U.S. Energy Information Administration, *Independent Statistics & Analysis: U.S. Natural Gas Import/Export Locations, as of the end of 2008,* [hereinafter *U.S. Natural Gas Import/Export Locations*] *available at* http://www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/ngpipeline/impex_map.html (last visited Dec. 24, 2011).

[42] *Energy Sector-Specific Plan*, supra note 1, at 16.

serving the interstate market are subject to Federal Energy Regulatory Commission (FERC) regulations; otherwise they are state-regulated. Most working gas held in storage facilities is held under lease with shippers, local distribution companies or end users who own the gas.[43]

Figure 1-10: Storage of Natural Gas in the United States (2007) [44]



Source: Energy Information Administration, Office of Oil & Gas, Natural Gas Division Gas, Gas Transportation Information System, December 2008.

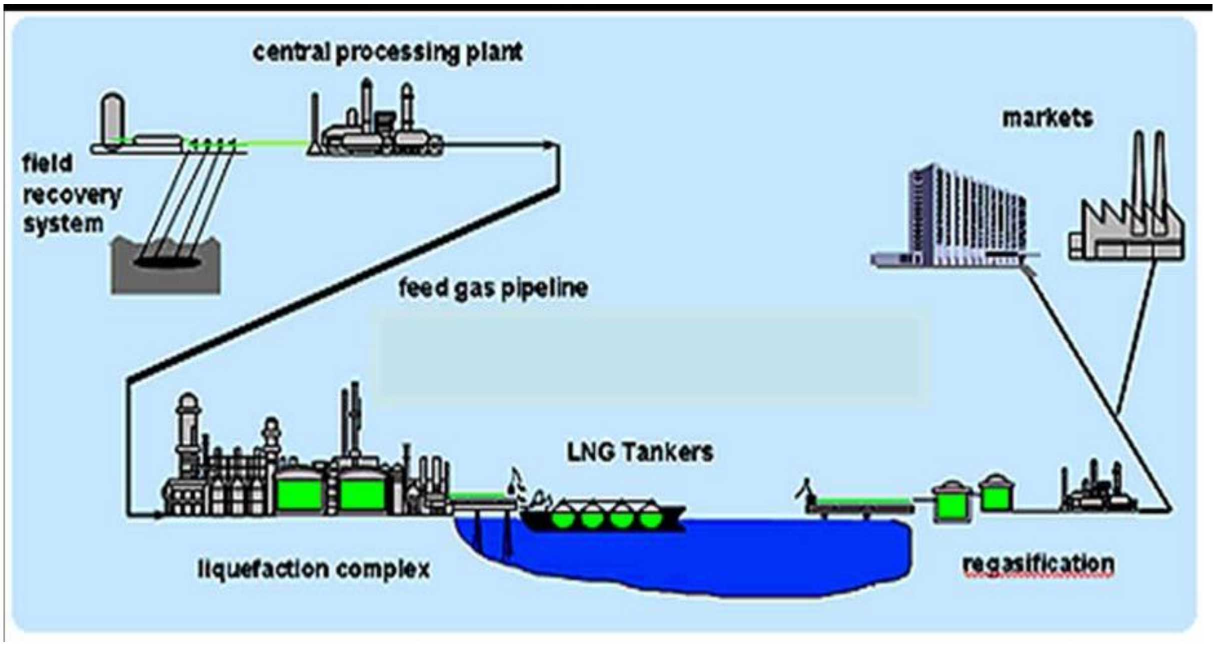
[43] *Energy Sector-Specific Plan*, supra note 1, at 16.

[44] U.S. Energy Information Administration, *Independent Statistics & Analysis: U.S. Underground Natural Gas Storage Facilities, Close of 2007,* [hereinafter *U.S. Underground Natural Gas Storage Facilities*] *available at* http://www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/ngpipeline/undrgrndstor_map.html (last visited Dec. 24, 2011).

Liquefied Natural Gas Facilities

Liquefied Natural Gas (LNG) is produced by cooling natural gas to −260 degrees Fahrenheit (−160 degrees Centigrade).[45] In its liquid state, natural gas occupies 618 times less volume than the same mass of gaseous methane at standard conditions. Volume reduction allows the product to be transported by specially designed ships or tankers.[46] The process of supplying and distributing LNG is described in Figure 1-11.

Figure 1-11: LNG Supply and Distribution Chain[47]



The lower 48 States have eight marine terminals, which includes Cove Point in Southern Maryland, for receiving, storing, and re-gasifying LNG for delivery into the pipeline network. Furthermore, there are more than 50 above-ground LNG storage tanks for meeting peak-day demand (see Figure 1-12).[48] In addition, there is an LNG export terminal in Kenai, Alaska and another LNG import facility in Peñuelas, Puerto Rico.[49]

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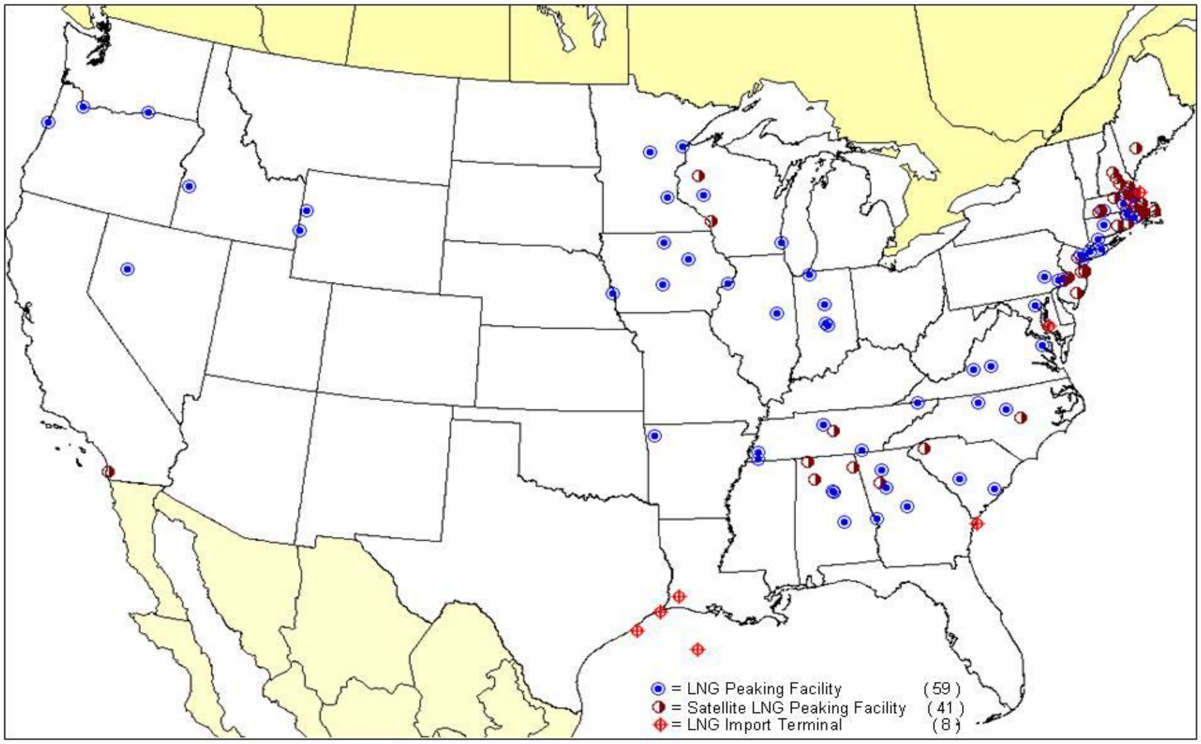
45 *Energy Sector-Specific Plan*, supra note 1, at 17.
46 *Energy Sector-Specific Plan*, supra note 1, at 17.
47 Oregon Department of Energy & Oregon Public Utility Commission, *Oregon State Energy Assurance Plan* at 9 (2011) [hereinafter O*regon State Energy Assurance Plan*], *available at* http://www.oregon.gov/ENERGY/docs/OregonStateEnergyAssurancePlan.pdf?ga=t.
48 *Energy Sector-Specific Plan*, supra note 1, at 17.
49 *Energy Sector-Specific Plan*, supra note 1, at 17.

Figure 1-12: Liquefied Natural Gas Peaking and Import Facilities (2007) [50]



Note: Satellite LNG facilities have no liquefaction facilities. All supplies are transported to the site via tanker truck.
Source: Energy Information Administration, Office of Oil & Gas, Natural Gas Division Gas, Gas Transportation Information System, December 2008.

Energy Sector Interdependencies

The generation of electricity relies in large part on the transportation of coal and natural gas, and both coal and natural gas rely on electricity to transport them to generating stations. Coal gets from mine to generating station by rail, barge and truck, and all three are powered by refined petroleum products which are pumped through pipelines and offloaded to tankers with equipment that relies on electricity. Natural gas is transported through interstate pipelines to generating stations and many of the pumps that push natural gas along the length of its pipeline are powered by electricity. A disruption in any one of these energy sectors can have dramatic and immediate effects on the others (see Figure 1-13).

A perfect example of the interconnectedness of energy sectors in Maryland occurred during Hurricane Irene. At the height of the storm power was knocked out to the Curtis Bay petroleum storage and offloading facility south of Baltimore. Curtis Bay, which is connected to a stub line of the Colonial Pipeline from the Dorsey Pumping Station, was unable to offload product for several days. Had the interruption in pipeline operations lasted too much longer, Colonial would have experienced a back-up

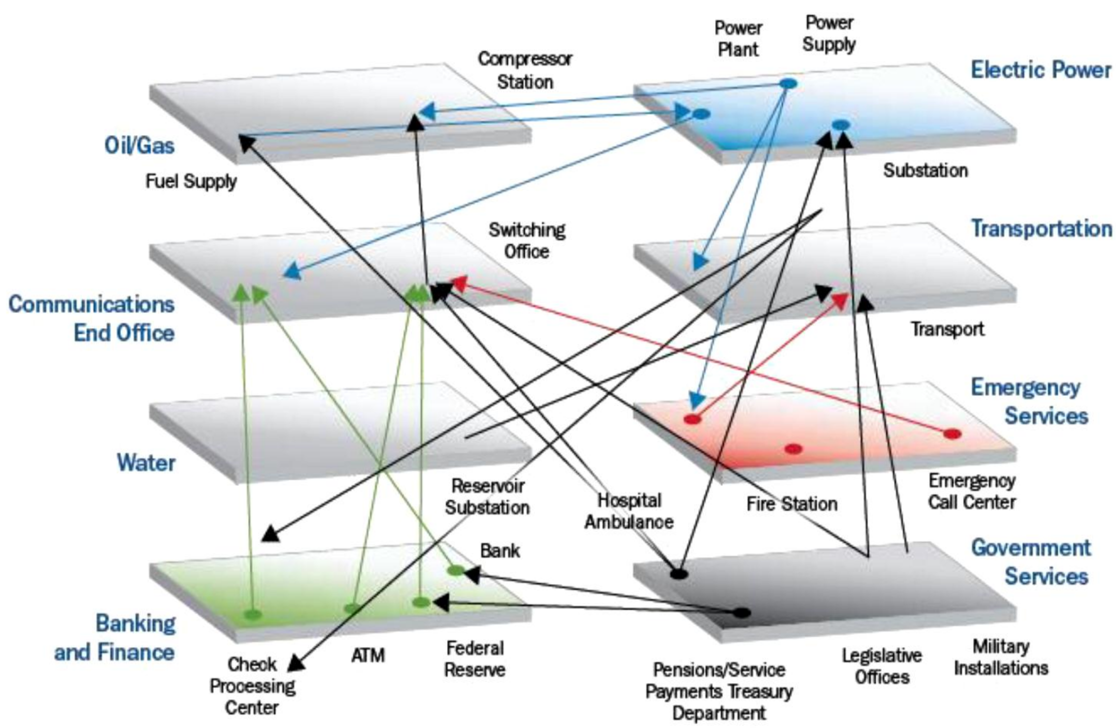
[50] U.S. Energy Information Administration, *Independent Statistics & Analysis: U.S. LNG Peak Shaving and Import Facilities* (2008) [hereinafter*: U.S. LNG Peak Shaving and Import Facilities*]*, available at* http://www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/ngpipeline/lng peakshaving_map.html.

along its entire Gulf Coast to New York system, affecting the supply of transportation and fuel oils along the entire East Coast.

During the last half of the 20th century, technical innovations and developments in automated controls and digital telecommunications dramatically increased interdependencies among the nation's critical infrastructures.[51]

Electricity and natural gas suppliers have come to rely heavily on data collection systems to ensure accurate billing.[52] Supervisory Control and Data Acquisition Systems (SCADA) and the information and communications technologies on which they rely have come to play a key role in the North American energy infrastructure.[53] SCADA systems have become an essential element in monitoring and controlling the production and distribution of energy.[54] Coupled with digital communications systems, they have helped to create the level of reliability and flexibility that exists today in the energy infrastructure in the United States.[55]

Figure 1-13: Interdependencies across the Economy[56]



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[51] *Energy Sector-Specific Plan*, supra note 1, at 18.
[52] *Energy Sector-Specific Plan*, supra note 1, at 18.
[53] *Energy Sector-Specific Plan*, supra note 1, at 18.
[54] *Energy Sector-Specific Plan*, supra note 1, at 18.
[55] *Energy Sector-Specific Plan*, supra note 1, at 18.
[56] *Energy Sector-Specific Plan*, supra note 1, at 18.

Conclusion

Three key energy sources – electric power, petroleum, and natural gas – comprise the energy sector's primary assets. Each energy source requires an individualized framework of supporting activities and assets, but some, such as petroleum and natural gas, utilize similar methods of extraction, fuel cycles and transport. Despite these similarities, the three key sources are diverse in ownership and geography, and are generally separately regulated. Energy Assurance Planning relies on an understanding of the operational characteristics, complexity, magnitude, and scope of the United States' energy assets and critical infrastructure. Coupling this knowledge with an understanding of emergency preparedness and response procedures will assist decision makers and emergency managers to protect against threats and recover from energy interruptions.

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Chapter 2. Maryland Energy Profile

Introduction

Maryland's energy sector is a complex network of interdependent systems, which in 2008 provided 1,449 trillion BTU's of energy to Maryland consumers. A detailed analysis of this system is an essential element to the State's energy assurance planning process. Elements of the analysis include details specific to Maryland, with the following topics being covered in this chapter:

- The infrastructure of energy supply and delivery,
- Energy industry and government interactions,
- The relationship between supply and demand,
- System strengths and weaknesses.

During emergencies, having easy access to information on the location of fuel pipelines, electric transmission and distribution lines, fuel storage facilities, loading terminals, delivery routes and related facilities, better equips the State to recover from a disruptive event. What's more, to be useful for assurance planning, these physical realities of the energy sector must be analyzed in light of the economic and regulatory realities of the State. Maryland's energy infrastructure must also be analyzed as part of a much larger regional, national and global energy supply and distribution system. In light of these requirements, this chapter attempts to provide an analysis of energy infrastructure and energy sector interactions within the Maryland economic and regulatory environment as they relate to energy assurance planning.

In an effort to succinctly describe such a complex system, Chapter 2 breaks down the State's energy sector into three primary sub-sectors: **Electricity**, **Natural gas** and **Petroleum**. Each sub-sector is described in detail including the sources of primary fuel, delivery systems and consumption information.

Electricity Sector

Industry Overview

The electricity sector is composed of two distinct operations; *generation* (the creation of electricity from a primary fuel source) and *transmission/distribution* (T&D) (the delivery of electricity from generators to end-use customers). In Maryland, there are approximately 40 large generating facilities, and 13 companies that provide transmission and distribution services to end-user customers. Prior to 1999, generation could be provided by the same company that provided T&D services, but in 1999 Maryland deregulated portions of the electric industry, which forced utilities to sell or transfer ownership of their generating plants. The end result is that electricity generation pricing is unregulated, whereas the 13 companies that provide T&D services in the State are regulated by the Maryland Public Service

Commission (PSC).[1] The differences between generation, transmission, and distribution are described in more detail below.

The purpose behind PSC's regulation of the T&D utilities is to ensure the provision of reliable, cost effective service to customers in the State. To accomplish this goal, T&D utilities must receive PSC acceptance of proposed rate changes to re-coup the costs of certain capital and operating expenditures; including investments in reliability. In addition the PSC ensures that the utilities' profits are closely monitored while overseeing utility reliability, security, customer privacy, investment, and others. With its regulatory powers, PSC has a large impact over electric assurance.

Unlike profits associated with T&D, profits associated with generation have been left unregulated in the State in an effort to create a competitive marketplace which in turn reduces prices for consumers. Because of this, Maryland utilities buy their electricity from independent generators or electric wholesalers at bi-yearly wholesale auctions held by Pennsylvania-New Jersey-Maryland Interconnection LLC (PJM). To insure that there is enough supply to meet expected demand, utilities purchase the capacity a year ahead of when the electricity will be needed. The utilities then supply this electricity to each company's end users in their service territory. Customers pay for generation and T&D as separate line items on their bills.

Maryland's transmission and distribution network is connected to and interacts with the regional electric power grid in the PJM interconnection, and out-of-state generators supply about 30 percent to 35 percent of the State's electricity. This far-flung system of systems is exposed to possible interruption at every point along its extensive multi-state and international supply chain. Electricity is the State's dominant energy source for residential and commercial energy needs; and as such it is critical that secure and reliable facilities exist to provide electricity to Maryland.

Electricity Generation

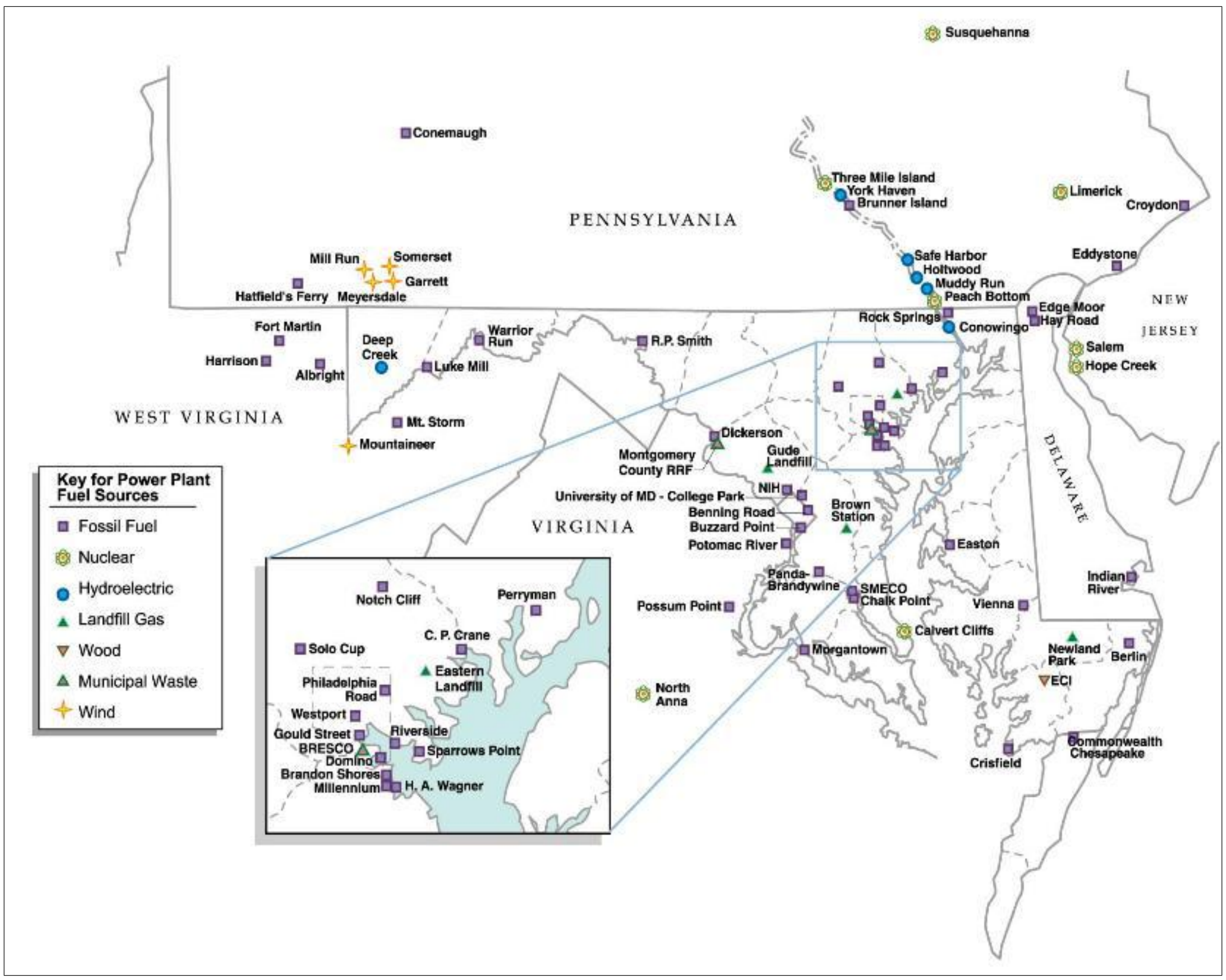
The generation of electricity from power plants can be thought of in terms of either the plant's capacity or its actual production. Power plants are rated at a certain capacity, or megawatts (MW), but the actual amount of electricity a plant produces is measured in megawatts generated per hour (MWh). Further, there are two general classifications of plants; base load and peaking load. Base-load plants operate near their capacity at all times, and peaking plants operate infrequently and only supply electricity during times of high demand. The combination of all plants based in Maryland provides about two-thirds of both the generating capacity the State needs and the electricity the State consumes.

Most base-load generation capacity in Maryland comes from coal and nuclear (via Calvert Cliffs Power Plant), while peaking plants operate on natural gas and oil. Due to comparatively higher operating costs,

[1] The PSC regulates transmission systems for only those portions of interstate lines that are in Maryland. See the discussion on the MAPP transmission line below as an example. In addition, the Federal Energy Regulatory Commission regulates the interstate portions of transmission.

the oldest oil and gas generators operate infrequently, generating only during periods of peak demand—i.e. "peaking units." Base load is primarily provided by facilities with comparatively lower operating costs, such as large coal and nuclear facilities. Because of this, the proportion of generation by fuel type differs from the proportion of capacity by fuel type. Most Maryland-generated electricity (MWh) comes from coal (55 percent) and nuclear power (33 percent) whereas the state-wide generation capacities of plants using these two fuels are 39.7 percent and 13.9 percent respectively.[2] Two companies, Mirant and Constellation Energy Group (CEG), own over 80 percent of the Maryland-generation capacity (see Table 2-1), which is concentrated in four counties: Anne Arundel, Calvert, Charles, and Prince George's (see Figure 2-1).[3]

Figure 2-1: Location of Power Plants in Maryland



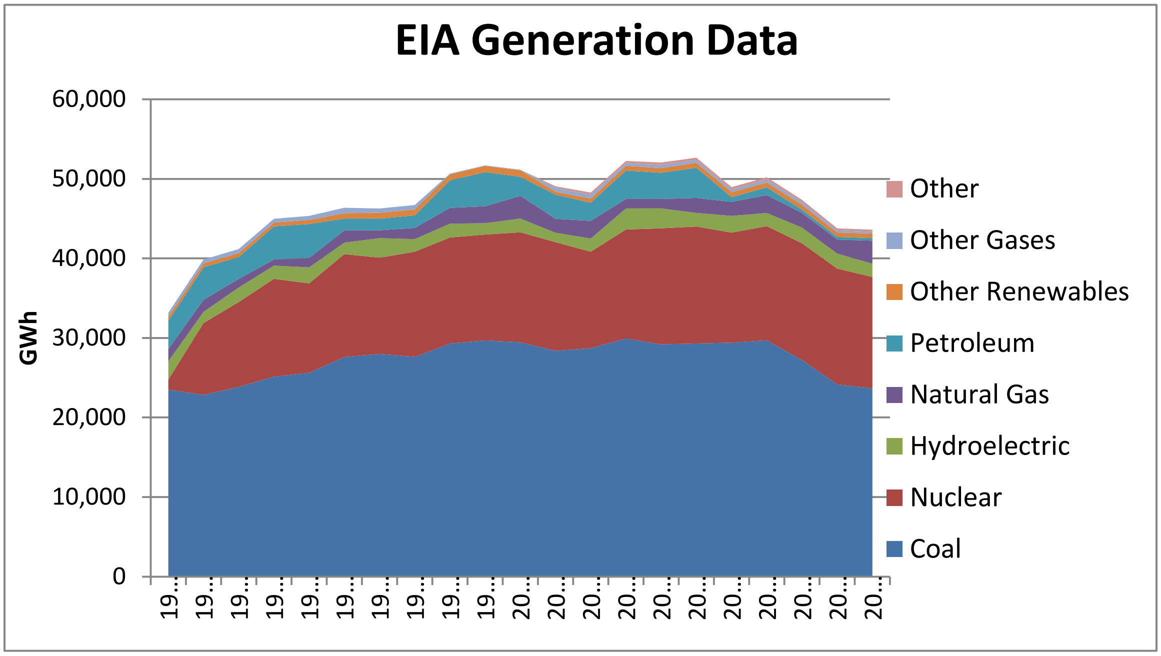
[2] Maryland Public Service Commission, *Ten-Year Plan (2009-2018)* 11 (2010) [hereinafter *Ten-Year Plan (2009-2018)*], *available at* http://webapp.psc.state.md.us/intranet/Reports/2009-2018%20Ten%20Year%20Plan.pdf.
[3] *Ten-Year Plan (2009-2018)*, *supra* note 2 at 11.

Table 2-1: Power Plants in Maryland[3]

Owner Name/Plant Name	County	Capacity Statistics			Primary Fuels
		Nameplate	Summer	Pct	
A & N Electric Coop/Smith Island	Somerset	1.7	1.6	0.013	Distillate Fuel Oil
AES Warrior Run Inc/AES/Warrior Run Cogen	Allegheny	229	180	1.442	Coal
Allegheny Energy Supply Co LLC/R. Paul Smith	Washington	109.5	115	0.921	Coal
Alternative Energy Associates/Brighton Dam	Montgomery	0.5	0.5	0.004	Water
Berlin MD (Town of)/Berlin	Worcester	9	9	0.072	Distillate Fuel Oil
Brookfield Asset Management Inc/Deep Creek	Garrett	20	18	0.144	Water
ConEd Inc./Rock Springs Generating Facility	Cecil	772.6	632	5.063	Nat. Gas
CEG/Calvert Cliffs Nuclear Power Plant	Calvert	1828.7	1735	42.983	Nuclear
CEG/Brandon Shores	Anne Arundel	1370	1283		Coal
CEG/C P Crane	Baltimore	415.8	378		Coal & Dist. Fuel Oil
CEG/Gould Street	Baltimore City	103.5	101		Nat. Gas
CEG/Herbert A Wagner	Anne Arundel	1058.5	963		Coal, NG, DFO
CEG/Notch Cliff	Baltimore	144	120		Nat. Gas
CEG/Perryman	Harford	404.4	370		Dist. Fuel Oil & Nat Gas
CEG/Philadelphia Road	Baltimore City	82.8	64		Distillate Fuel Oil
CEG/Riverside (MD)	Baltimore	257.2	237		Dist. Fuel Oil & Nat Gas
CEG/Westport	Baltimore City	121.5	116		Nat. Gas
Easton Utilities/Easton; Easton 2	Talbot	72.4	69	0.552	Dist. Fuel Oil & Residual Fuel Oil
Exelon Corp./Conowingo	Harford	506.8	572	4.581	Water
Florida Crystals Corp./Domino Sugar Baltimore	Baltimore City	20	20	0.16	Nat. Gas
MD Dept of Pub Safety & Corr Svc/Eastern Corr. Inst	Somerset	5.8	4.6	0.037	Wood Waste & Dist. Fuel Oil
MeadWestvaco Corp (The)/Luke Mill	Allegheny	65	60	0.481	Coal
Mirant Corp/Chalk Point	Prince Georges	2647	2417	38.138	Dist. Fuel Oil, Res. Fuel Oil, Coal
Mirant Corp./Dickerson	Montgomery	930	853		Nat. Gas, Coal, Dist. Fuel Oil
Mirant Corp/Morgantown Generating Station	Charles	1548	1492		Dist. Fuel Oil & Coal
Mittal Steel Co. N V/Sparrows Point	Baltimore	120	152	1.22	Blast Furnace Gas
NRG Energy Inc./Vienna	Dorchester	183	170	1.362	Dist. Fuel Oil & Residual Fuel Oil
Panda Energy Intl Inc/Panda Brandywine LP	Prince Georges	288.8	230	1.842	Nat. Gas
Pepco Holdings Inc/Crisfield	Somerset	11.6	10	0.104	Distillate Fuel Oil
Pepco Holding Inc/Eastern Sanitary Landfill	Baltimore	3	3		Landfill Gas
Prince Georges County/Brown Station Road I and II	Prince Georges	6.7	6	0.045	Landfill Gas
TriGen Cinergy Sol. Balto/Inner Harbor East Heat	Baltimore City	2.1	2	0.0331	Nat. Gas
TriGen Cinergy Sol. Balto/Millennium Hawkins Pt.	Baltimore	10.5	7		Nat. Gas
Trigen Cinergy Sol. College Park/UMCP CHP Plant	Prince Georges	27.4	20		Nat. Gas
Trigen Cinergy Sol. Sweetheart Cup/Owings Mills	Baltimore	11.2	11		Nat. Gas
Waste Energy Partners LP/Waste Energy Partners LP	Harford	1.2	1	0.009	Municipal Solid Waste
Waste Management/Wheelabrator Baltimore Refuse	Baltimore City	64.5	61	0.491	Municipal Solid Waste
Worcester County Renewable	Worcester	1	0.9	0.007	Landfill Gas
Total		**13,454.7**	**12,486**	**100%**	

Maryland's total contribution to PJM generation capacity in 2008 amounted to 12,486 MW—less than Maryland's summer peak load demand, net of demand side management measures. Consequently, Maryland imports approximately one-third of its electricity.[4] Pennsylvania, West Virginia and Kentucky provide most of the out-of-state generation capacity. When taking into account the one third of Maryland's electricity that comes from imports, coal and nuclear power are the predominate fuels used to generate the electricity consumed in Maryland (see Figure 2-2).

Figure 2-2: Maryland's Energy Mix (1990-2010)[5]



In 2010, the PJM system-wide fuel mix included coal (54.3 percent), nuclear (32.1 percent), natural gas (6.6 percent) and renewables including hydro (5.1 percent), among others.[6] Renewable power accounts for a small fraction of the total amount of electricity generated, although this is expected to increase as the State's Renewable Portfolio Standard (RPS) progresses (see below).

Approximately 67 percent of Maryland's electricity generating infrastructure is over 30 years old, while less than eight percent is ten years old or newer (see Table 2-3). While no generating facilities in Maryland are scheduled for retirement, a few of the older generating units in the PJM region near Maryland have requested deactivation.[7] Generator deactivations scheduled for 2012 will reduce local capacity and may increase the need to import more electricity from other states in the PJM interconnection.[8] From 2007 to 2012, the Mid-Atlantic region lost 1,265 MW of generating capacity (see

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[4] *Ten-Year Plan (2009-2018)*, *supra* note 2 at 8.

[5] Maryland Energy Administration, *Maryland Smart Green and Growing,* at 11, *available at* http://www.gov.state .md.us/documents/110513Energy.pdf.

[6] PJM Environmental Information Services, *PJM System Mix*, [hereinafter *PJM System Mix*] *available at* https://gats.pjm-eis.com/myModule/rpt/myrpt.asp?r=226&TabName=System%20Mix%20By%20Fuel (last visited Dec. 28, 2011).

[7] *Ten-Year Plan (2009-2018)*, *supra* note 2 at 7.

[8] PJM, *Regional Transmission Expansion Plan* 311 (2011) [hereinafter *Regional Transmission Expansion Plan*], *available at* http://pjm.com/documents/reports/~/media /documents/reports/2010-rtep/2010-rtep-report.ashx.

Table 2-2). Working against this trend is the State's effort to reduce demand through utility and MEA sponsored programs, as discussed later in this section.

Table 2-2: Power Plant Retirements[9,10]

Name	Location	Size (MW)	Year Deactivated (or expected)
Gude Landfill #1 and 2	Maryland	2.2	2006
Martin's Creek	New Jersey	280	2007
Buzzard Point East Bank 3	D.C.	16	2007
Benning 15	D.C.	275	2012
Benning 16	D.C.	275	2012
Buzzard Point East Banks 1, 2, 4 - 8	D.C.	112	2012
Buzzard Point West Banks 1 - 8	D.C.	128	2012
Indian River	Delaware	177	2013

Table 2-3: Maryland Generating Capacity[11]

		Capacity		Age of Plants, by % of Fuel Type		
Primary Fuel Type	**Summer (MW)**	**Pct. Of Total**	**1-10 Years**	**11-20 Years**	**21-30 Years**	**31+ Years**
Coal	4,958	39.7%	3.6%	13.0%	13.6%	69.8%
Dual-Fired*	3,066	24.6%	2.3%	35.7%	18.7%	43.4%
Nuclear	1,735	13.9%	0.0%	0.0%	0.0%	100.0%
Other Gas	1,236	9.9%	57.4%	0.0%	0.2%	42.6%
Petroleum	766	6.1%	1.4%	2.5%	0.2%	95.8%
Hydroelectric	590	4.7%	0.0%	0.0%	0.1%	99.8%
Other & Renewables	135	1.1%	12.2%	40.9%	47.1%	0.0%
Total	**12,486**	**100%**	**7.3%**	**14.9%**	**10.7%**	**67.1%**

*** Dual-fired generation capacity able to use two fuel types, typically oil and gas**

9 *Ten-Year Plan (2009-2018)*, *supra* note 2.
10 *Regional Transmission Expansion Plan*, *supra* note 8 at 311.
11 *Ten-Year Plan (2009-2018)*, *supra* note 2.

Maryland is likely to see additional in-State generation added over the coming decade, though economic and environmental barriers exist. For example, independent power producers frequently lack the financial assurance, such as long-term power purchase agreements, needed from utilities to finance new projects. Recently, most new generation occurred at existing generation sites via expansion or through the addition of small, distributed capacity (e.g., solar).[12] According to PJM, as of spring 2010 there was 234 MW of forthcoming but not-yet-approved capacity in the State's generation queue.[13] Renewable sources are likely to supplement new in-state capacity in order to comply with Maryland's Renewable Portfolio Standard (RPS) (discussed below).

Electricity Transmission and Distribution – Import and Export

After electricity is generated, it needs to get to end-use customers and does so by way of different types of wires and associated equipment.[14] The two broad systems used are transmission systems and distribution systems. PJM monitors the flow of electricity on these systems in order to balance supply and demand (load). Both systems are prone to disruptions or service reductions.

Transmission: In order to minimize line losses, very high voltages are used when electricity is transmitted long distances. Therefore the transmission system has operating voltages that exceed 230 kV and use overhead lines to connect generating stations to large substations near load centers.[15] In Maryland, BGE estimates that it runs 1,300 miles of electric transmission lines,[16] PEPCO approximates 1,596 miles[17] and SMECO reports over 400 miles.[18] PJM directs the operation of the region's transmission grid, spanning 211,000 square miles, which includes 6,145 substations and 61,200 miles of

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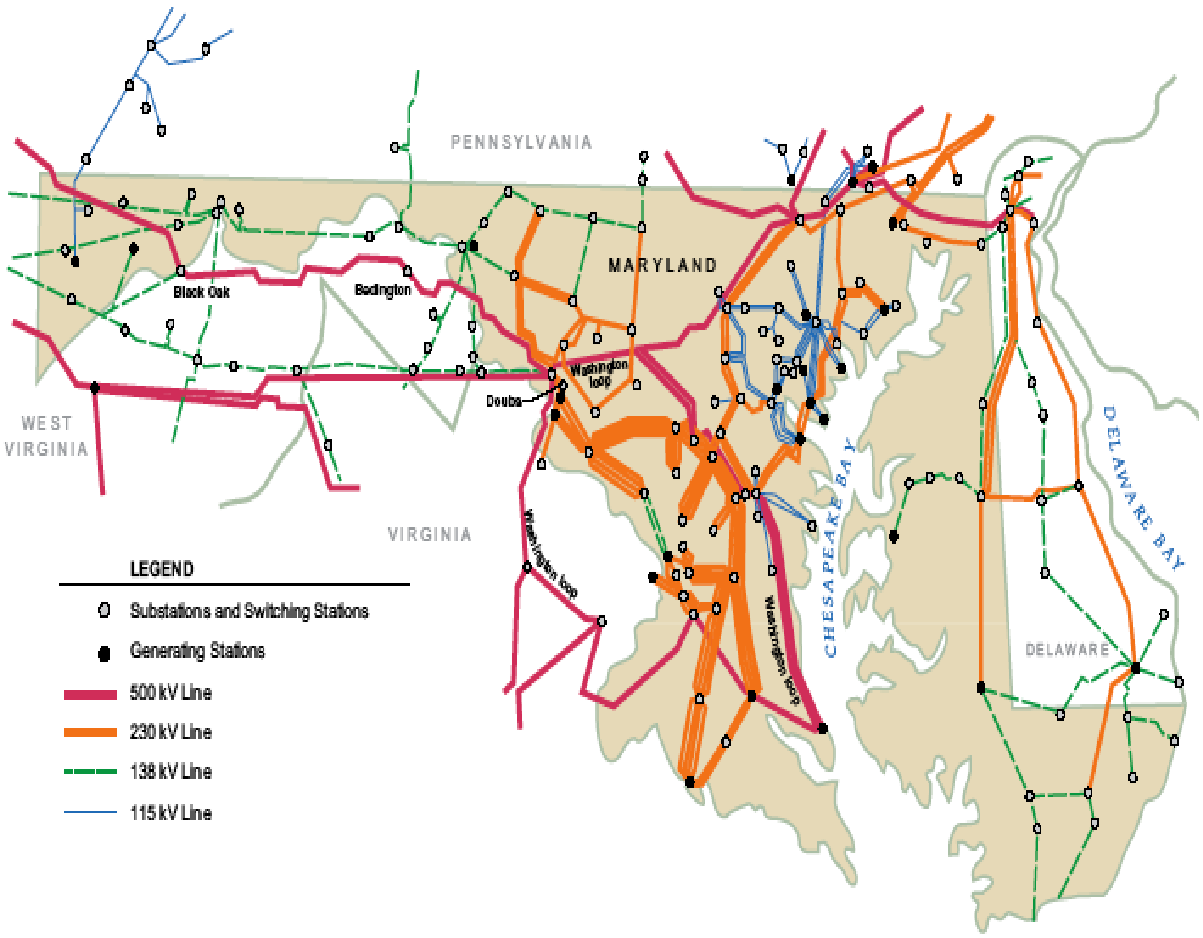
[12] *Ten-Year Plan (2009-2018)*, *supra* note 2 at 11.
[13] PJM, *Generation Queues: Active*, [hereinafter *Generation Queues: Active*] *available at* http://pjm.com/planning/generation-interconnection/generation-queue-active.aspx (last visited Dec. 28, 2011).
[14] An in-depth discussion of the various components of transmission, distribution, and generation occurs later in this chapter.
[15] The McGraw-Hill Companies, *Electric Power Transmission*, McGraw-Hill Science & Technology Encyclopedia (5th ed. 2004).
[16] Testimony of Albert E. Alford, BGE Graceton to Conastone Transmission Line Application Case, M.P.S.C. 9246 (2011) [hereinafter *Albert E. Alford*], *available at* http://www.google.com/url?sa=t&source=web&cd=1&ved=0CBYQFjAA&url=http%3A%2F%2Fwebapp.psc.state.md.us%2Fintranet%2Fmaillog%2Fcontent.cfm%3Ffilepath%3DC%3A%255CCasenum%255CAdmin%2520Filings%255C110000-159999%255C128702%255C9246_AlfordDirectTestimony_Final.pdf&ei=t4vvTff7Luay0AGbspXyDA&usg=AFQjCNF9GwwkMTU1vnhMJ-EkCs-jcqEkug.
[17] PEPCO, *Maryland Factsheet* (2011), *available at* www.pepco.com/_res/documents/PEPCO_MD_LEG_FACT_SHEET.pdf.
[18] Mark A. MacDougall, SMECO, report to Maryland Office of People's Counsel (Apr. 25, 2011) [hereinafter MacDougall Report], *available at* http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=10&ved=0CGAQFjAJ&url=http%3A%2F%2Fwebapp.psc.state.md.us%2FIntranet%2FCaseNum%2FNewIndex3_VOpenFile.cfm%3Ffilepath%3D%255C%255CColdfusion%255CEWorkingGroups%255CRM43%255C%255COPC%2520DR%25201%255CSMECO%2520Response%2520to%2520OPC%2520DR%25201.pdf&ei=obAET56KOqru0gHgws2LBA&usg=AFQjCNGpUVK7GYd6SgPkdrYd5hm0eYZ4iQ.

transmission lines in portions of 13 states and the District of Columbia.[19] Maryland's electricity transmission is subject to congestion, or an inability of the lowest-cost electricity to reach markets due to limited transmission capacity.

Figure 2-3 is a map of major transmission lines in Maryland (>115 kilo-volts). Electricity congestion is prominent in central Maryland and the Delmarva Peninsula, both areas of dense populations. As a result, energy and capacity costs in Maryland are higher than they would be otherwise.

Figure 2-3: Major Electric Transmission Lines in M.D.[22]



[19] PJM, *PJM's Role as an RTO* (2011) [hereinafter *PJM's Role as an RTO*], *available at* http://www.pjm.com/~/media/about-pjm/newsroom/downloads/pjms-role-as-an-rto-fact-sheet.ashx.

Figure 2-4 displays the added costs per region due to congestion.

Figure 2-4: Costs of Electric Transmission Congestion in Maryland[20]

Zone	2009 Total Annual Zonal Congestion Costs ($ million)
Potomac Edison[21]	$95.3
Baltimore Gas & Electric	$33.5
Delmarva Power	$31.1
Potomac Electric Power	$58.4

Transmission operation and planning is coordinated by PJM through annual development of a Regional Transmission Expansion Plan (RTEP). In the 2010 RTEP, PJM identified a need for new, high-voltage backbone transmission lines in Maryland, as well as modifications and upgrades to existing Maryland transmission infrastructure. PJM also confirmed the need for the Mid-Atlantic Power Pathway (MAPP) line. The MAPP line is expected to be more effective at improving electricity transmission relative to alternative options. The MAPP line was planned to be in service by June 2015, but recent reductions in energy use due to economic conditions has pushed that date back. When built, it will connect the Eastern and Western shores of the Chesapeake Bay via a submarine high-voltage DC line.[22] The Trans-Allegheny Interstate Line (TrAIL) will be completed in 2011 and will serve the Potomac Edison (PE) service area.[23] Both the MAPP and TrAIL lines are expected to reduce congestion costs and improve system reliability, see Figure 2-7 below: Maryland Transmission Network and Planned Upgrades, for proposed locations.

Distribution: Sub-transmission system lines with operating voltages of 69-138 kV, distribute energy across an entire district, through overhead lines.[24] When electricity nears end users (load centers) the voltage is reduced to under 34.5 kV and sent to residences and commercial customers by way of electric distribution lines. With respect to local electric distribution lines, BGE has about 22,500 miles,[25] PEPCO

[20] Maryland Public Service Commission, *Ten-Year Plan (2010-2019)* (2011) [hereinafter *Ten-Year Plan (2010-2019)*].
[21] Potomac Edison is formerly Allegheny Power Company.
[22] Power Plant Research Program, Maryland Department of Natural Resources, *Electricity in Maryland: Factbook* (2008) [hereinafter *Electricity in Maryland: Factbook*], *available at* esm.versar.com/pprp/factbook/fb 08 1-22-09 spreads.pdf.
[23] *Ten-Year Plan (2009-2018)*, *supra* note 2 at 29.
[24] The McGraw-Hill Companies, *supra note* 15.
[25] *Albert E. Alford*, *supra note* 16.

provides 18,958 miles,[26] SMECO lines total 3,618 miles[27] and Choptank Electric Cooperative reports 6,218 miles.[28]

Maryland Electricity Customers

Maryland electricity customers can buy electricity from an independent competitive supplier or take Standard Offer Service from their local electric company.[29] Standard Offer Service is the default electricity rate determined by the utility service area in which the customer resides and approved by the PSC. As discussed previously in this chapter, the Maryland General Assembly deregulated electric generation prices and opened retail markets to competition when it passed the Electric Customer Choice and Competition Act of 1999.[30] PSC, however, still regulates transmission and distribution costs. As of December 2009, PSC issued 47 electricity supplier licenses and 59 electricity broker licenses.[31]

Switching to alternative suppliers with the prospect of savings over the Standard Offer Service rates has become an increasingly attractive option for residential customers.[32] In some cases, residential electricity offers are up to 10 percent below the Standard Offer Service rate.[33] In 2009, the number of Customer Choice participants increased by 79 percent statewide (see Table 2-4).[34]

Table 2-4: Residential Customers Enrolled in Retail Supply at Year End[35]

	2008	2009	Annual % Increase
BGE	26,944	53,126	97%
Pepco	27,001	40,267	49%
DPL	1,039	2,463	137%
PE	40	2,743	6,758%
MD Total	55,024	98,599	79%

From December 2005 to December 2009, the total number of customers in Maryland served by competitive, non-utility electricity suppliers rose from 39,527 to 169,908.[36] Notably, the total number of

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[26] PEPCO, *supra note* 17.
[27] MacDougall Report, *supra* note 18.
[28] Choptank Electric Cooperative, *About Us*, *available at* http://www.choptankelectric.com/aboutus/index.html (last visited June 6, 2011).
[29] *Ten-Year Plan (2009-2018)*, *supra* note 2 at 76.
[30] *Ten-Year Plan (2009-2018)*, *supra* note 2 at 76.
[31] *Ten-Year Plan (2009-2018)*, *supra* note 2 at 76.
[32] *Ten-Year Plan (2009-2018)*, *supra* note 2 at 76.
[33] *Ten-Year Plan (2009-2018)*, *supra* note 2 at 76.
[34] *Ten-Year Plan (2009-2018)*, *supra* note 2 at 76.
[35] *Ten-Year Plan (2009-2018)*, *supra* note 2 at 76.

customers served by a competitive, non-utility supplier in BGE's service territory increased from 3,932 to 93,469 during the same period.[37] Medium and large commercial and industrial firms, as measured by a percentage of peak load obligation, are predominately served by competitive electricity suppliers.[38]

Electricity Demand, Consumption and Expenditures

Demand

The movement of electricity through the grid can be described either in terms of its peak demand (gigawatts, megawatts, or kilowatts), or its flow over time (gigawatts, megawatts or kilowatts per unit of time). Peak demand is an instantaneous measurement of the maximum amount of electricity demanded by customers. Customer demand can be graphed, and the "peaks" in the graph reflect peak demand and display a customer's electric use "load shape". As additional electric appliances and equipment add demand on the grid, the peak increases. The highest peaks in Maryland's population centers are typically in the summer months when air conditioning use is highest. When peak demand exceeds the capacity of base load plants, peaking plants come online and provide the added capacity.

Peak electricity demand in Maryland is expected to increase between 2011 and 2021. The greatest annual growth is predicted to occur in municipal and cooperative electric utilities (e.g., Choptank and SMECO) (see Table 2-5 on the following page). The Maryland-wide annual demand growth in peak electricity is forecast to be 0.3 percent from 2009 until 2023, but Maryland's growth is lower than the 1.5 percent PJM area-wide forecast for annual growth in peak demand for the same period. The comparatively lower growth in peak demand in Maryland is likely the result of EmPOWER Maryland utility programs. EmPOWER programs have goals to reduce both peak demand and overall consumption.[39]

[36] *Ten-Year Plan (2009-2018)*, *supra* note 2 at 77.
[37] *Ten-Year Plan (2009-2018)*, *supra* note 2 at 77.
[38] *Ten-Year Plan (2009-2018)*, *supra* note 2 at 78.
[39] *See infra* "Demand-Side Management."

Table 2-5: Maryland Peak Demand Forecast (Net of DSM Programs; MW) [40]

Year	Berlin	BGE	Choptank	DPL	Easton	Hagerstown	PE/AP	Pepco	SMECO	Thurmont	Williams-port	Total
2009	3	7,044	219	891	67	64	1,529	3,589	801	20	5	14,230
2010	3	6,790	221	875	68	62	1,534	3,511	824	20	5	13,913
2011	3	6,653	227	813	70	60	1,544	3,240	842	20	5	13,476
2012	3	6,392	233	811	71	60	1,557	3,175	860	20	5	13,187
2013	3	6,220	238	803	72	60	1,566	3,189	878	20	5	13,054
2014	3	6,250	247	804	74	61	1,571	3,190	894	20	5	13,119
2015	4	6,252	253	809	75	61	1,584	3,189	912	20	5	13,162
2016	4	6,344	256	826	76	61	1,608	3,223	929	20	5	13,352
2017	4	6,439	262	845	78	61	1,632	3,265	945	20	5	13,555
2018	4	6,536	268	863	79	61	1,653	3,306	963	20	5	13,758
2019	4	6,634	273	884	80	62	1,677	3,352	979	20	5	13,970
2020	4	6,736	278	904	82	62	1,696	3,398	996	20	5	14,181
2021	5	6,844	283	925	83	62	1,721	3,438	1,013	20	5	14,398
2022	5	6,957	288	944	84	62	1,751	3,478	1,029	20	5	14,623
2023	5	7,074	292	964	86	62	1,783	3,519	1,045	20	5	14,855
Change (2009-2023)	2	30	73	73	19	-2	254	-70	244	1	0	625
Percentage Change	75%	0.4%	33.3%	8.2%	28.1%	-2.5%	16.6%	-2.0%	30.5%	4.3%	0.0%	4.4%
Annual Growth Rate	4.1%	0.0%	2.1%	0.6%	1.8%	-0.2%	1.1%	-0.1%	1.9%	0.3%	0.0%	0.3%

Demand Side Management

The EmPOWER Maryland Energy Efficiency Act of 2008 promulgated demand side management programs across Maryland utilities. The EmPOWER Maryland legislation calls for each electric company in the State to cost-effectively reduce per capita electricity consumption and peak demand by 15 percent by the end of 2015. Utilities have complied with the law through development of direct load reduction programs, which are expected to continuously reduce peak load over the coming decade (see Table 2-6). Utilities have also developed and begun to implement energy efficiency and conservation programs. Most utilities are compliant with interim 2011 goals, though utilities vary in the maturity of their programs. According to annual utility filings with the PSC through the second quarter of 2011, utility programs achieved less than 25 percent of the 2011 EmPOWER goal and one-tenth of the 2015 EmPOWER goal. The economic recession beginning in late 2007 also lowered total electricity consumption and peak demand.[41]

[40] *Ten-Year Plan (2009-2018)*, *supra* note 2 at 92.
[41] *Ten-Year Plan (2009-2018)*, *supra* note 2 at 38.

Table 2-6: Peak Load Reduction Forecast in Maryland (MW), 2009-2023[42]

Year	BGE	Choptank	DPL	PE/AP*	Pepco	SMECO	Total
2009	301	10	21	6	67	11	416
2010	583	10	44	17	179	11	844
2011	878	10	137	31	511	11	1578
2012	1335	10	174	43	634	11	2207
2013	1648	11	206	56	676	11	2608
2014	1765	10	225	68	716	11	2795
2015	1892	10	237	78	757	11	2985
2016	1927	11	237	76	757	11	3019
2017	1956	10	237	74	757	11	3045
2018	1982	10	237	72	757	11	3069
2019	2006	10	237	69	757	11	3090
2020	2025	10	237	66	757	11	3106
2021	2039	10	237	60	757	11	3114
2022	2051	10	237	51	757	11	3117
2023	2060	10	237	41	757	11	3116
Change	**1,759**	**0**	**216**	**35**	**690**	**0**	**2,700**
Percentage Change	**584.4%**	**0.0%**	**1028.6%**	**583.3%**	**1029.9%**	**0.0%**	**649.0%**
Annual Growth Rate	**14.7%**	**0.0%**	**18.9%**	**14.7%**	**18.9%**	**0.0%**	**15.5%**

Further reductions in the growth of peak demand are expected as a result of DSM programs run by PJM. Economic Load Demand Response is a region-wide, voluntary DSM program run by PJM where customers are compensated for temporarily reducing their electricity load. PJM also has an Emergency Load Response Program that allows PJM to curtail electricity load to willing customers during emergency events. The PJM Economic Load Demand Response program is available to all retail electricity customers in the PJM region, but typical participants include large industrial and commercial electricity customers. Total demand response capacity in PJM available through these programs increased by 400.6 MW between 2011 and 2012.[43]

While the State as a whole has a lower than average growth in demand, increases in some Maryland service areas (such as Choptank and SMECO) may exceed the PJM average.[44] Depending on the utility service area, peak demand occurs at different times of the year. BGE, DPL and PEPCO service areas all experience peak demand during the summer months when air conditioning requirements are the greatest. In contrast, the Potomac Edison (PE) service area in the Western portion of the State experiences peak demand during the winter months.

Consumption

Whereas electricity demand represents the instantaneous load for electricity (e.g., megawatts, or MW), electricity consumption represents electricity demand over a period of time (e.g., megawatt hours, or

[42] *Ten-Year Plan (2009-2018)*, *supra* note 2 at 37.
[43] *Ten-Year Plan (2009-2018)*, *supra* note 2 at 17.
[44] *Ten-Year Plan (2009-2018)*, *supra* note 2 at 4.

MWh). Electricity consumption in Maryland has grown steadily since the 1960s, with periodic decreases resulting from economic slow-downs.[45] The commercial and residential sectors use more than 90 percent of all electricity in Maryland. In addition, the utility areas with the greatest number of customers consume the greatest quantity of electricity (see Table 2-7).[46] In 2008, consumption in Maryland was 11,242 kWh per person—lower than the U.S. as a whole. From 2010-2022, electricity consumption in Maryland, as measured by sales, is expected to grow by about 1 percent per year.[47]

Table 2-7: Average Sales by Customer Class (As of December 31, 2008; GWh)[48]

Utility Co.	System-wide						Maryland					
	Residential	Commercial	Industrial	Other	Sales for Resale	Total	Residential	Commercial	Industrial	Other	Sales for Resale	Total
A&N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Berlin	2	0	1	0	0	3	2	0	1	0	0	3
BGE	1,085	1,308	270	0	0	2,664	1,085	1,308	270	0	0	2,664
Choptank	54	18	6	0	0	78	54	18	6	0	0	78
DPL	420	440	222	4	0	1,087	175	145	35	1	0	357
Easton	9	13	0	1	0	22	9	13	0	1	0	22
Hagerstown	13	6	10	0	0	29	13	6	10	0	0	29
PE	523	298	274	2	62	1,159	271	171	129	1	39	610
PEPCO	642	1,467	60	61	0	2,230	483	719	38	27	0	1,267
SMECO	169	93	16	0	0	279	169	93	16	0	0	279
Somerset	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thurmont	3	1	2	0	0	7	3	1	2	0	0	7
Williamsport	1	0	1	0	0	2	1	0	1	0	0	2
Total	2,921	3,644	864	68	62	7,560	2,266	2,473	510	31	39	5,319

[45] U.S. Energy Information Administration, *State Energy Data System* (2009) [hereinafter *State Energy Data System*], *available at* http://www.eia.gov/states/_seds.html.
[46] *State Energy Data System*, *supra note* 45.
[47] *Ten-Year Plan (2009-2018)*, *supra* note 2 at 95.
[48] *Ten-Year Plan (2009-2018)*, *supra* note 2 at 87.

Electricity rates are influenced by multiple factors including, but not limited to, fuel costs, proximity to low-cost generation sources, system maintenance costs and weather conditions. As of spring 2011, Maryland's average electricity rates are $0.123/kWh. Average Maryland residential, commercial and industrial electricity rates are 0.134, 0.116, and 0.088 $/kWh, respectively.[49] Moreover, Maryland's average electricity rates increased approximately $0.06/kWh between 1999 and 2011. Among the PJM states, Maryland's electricity rates are the third highest, behind Washington, D.C. and New Jersey.[50] Between 2009 and 2035, the U.S. Energy Information Administration (EIA) forecasts electricity rates to decrease by .1, .2 and .1 percent for residential, commercial and industrial customers, respectively.[51]

Expenditures on electricity are a function of rates and consumption. In 2008, Maryland electricity customers spent roughly $8.2 billion on electricity, the 15th highest among all states. That year, each Marylander contributed about $1,450 to the statewide electricity bill, and electricity expenditures accounted for 3.2 percent of the State's $258 billion GDP. In 2008, in the U.S. as a whole, each citizen contributed approximately $1,185 to the nationwide electricity bill, and electricity expenditures accounted for 2.5 percent of the $14.3 trillion U.S. GDP.

Renewable Electricity

Renewable electric generation facilities have both positive and negative impacts on energy assurance. Positively, renewable generation facilities are often widely dispersed small installations, and the loss of power from one facility does not greatly impact the grid's reliability. Renewable installations also rely on fuels (wind and sun) that supplant other, more difficult to acquire fuel supplies. Negatively, renewable fuel supplies such as wind and sun are by their nature intermittent commodities. Intermittent generation entering and leaving the grid can create imbalances in the entire system, leading to failures. As the number of renewable energy facilities increases, measures must be implemented to counteract the effect of intermittent supply. One hope is that the development of "smart" meters and control devices in conjunction with smart grid technologies will have the capability to overcome intermittent supply problems.

Maryland's Renewable Portfolio Standard (RPS), last updated in 2010, requires that by 2022, 20 percent of power sold in-state comes from renewable resources. This would result in almost 14 million MWh of renewable generation by 2022. Moreover, at least 2 percent of electricity sold must come from solar power. As of April 2011, over 1,000 renewable energy facilities exist in Maryland, a majority of which are solar facilities. Solar capacity in Maryland currently accounts for a little over 1 percent of total renewable capacity. Most of the solar capacity is not commercial scale, but comes from small home

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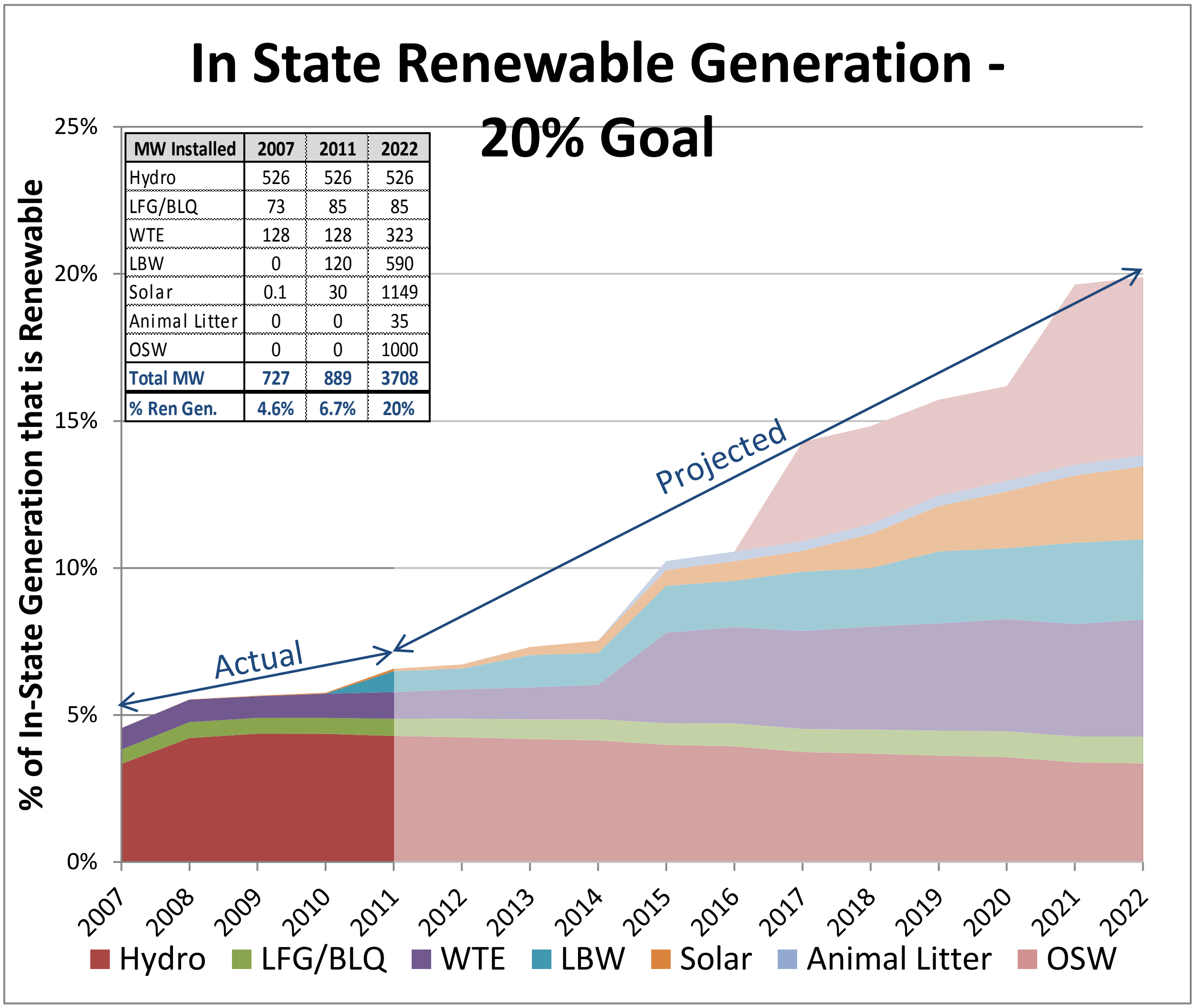
[49] U.S. Energy Information Administration, *Electric Power Monthly - April 14, 2011* (2011) [hereinafter *Electric Power Monthly - April 14, 2011*].
[50] *Electric Power Monthly - April 14, 2011*, *supra note* 49.
[51] U.S. Energy Information Administration, *Annual Energy Outlook 2011* [hereinafter *Annual Energy Outlook 2011*], *available at* http://www.eia.doe.gov/forecasts/aeo/pdf/0 383(2011).pdf (last visited December 29, 2011).

units (<50 kW of capacity).[52] In 2009, renewable resources, primarily hydroelectric, generated approximately 2.5 million MWh, or 5.5 percent, of Maryland's electricity generation.

Over the coming decade, Maryland will continue to develop its domestic sources of renewable energy and will continue to increase its consumption of renewable electricity imported from PJM. These sources could include wind power potential in Western Maryland, offshore wind resources in the Atlantic Ocean, commercial-scale solar installations, and renewable generation contributed by sources elsewhere in PJM (see Figure 2-5).

Figure 2-5: Projected Sources of Maryland RPS Compliance[53]



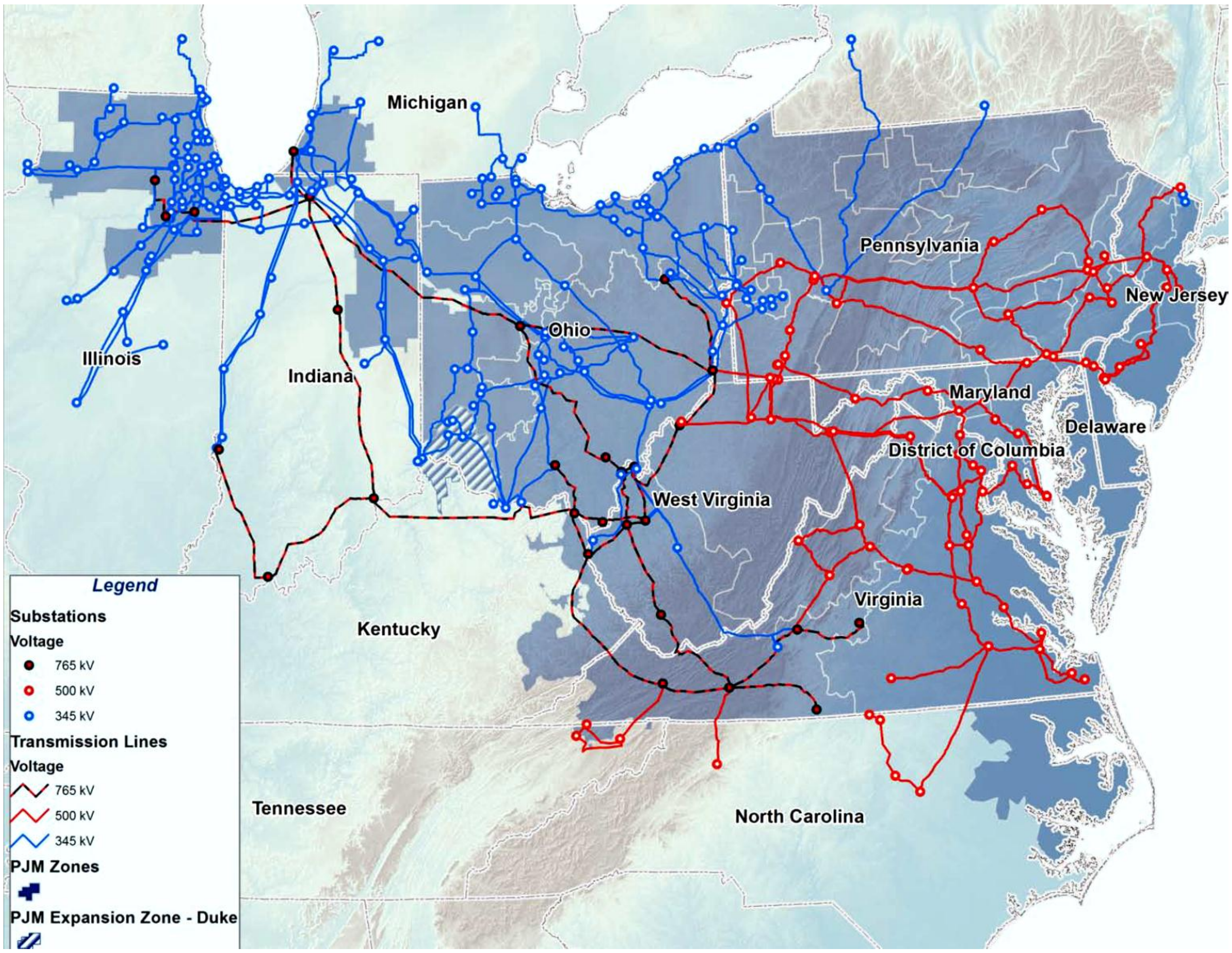
MW Installed	2007	2011	2022
Hydro	526	526	526
LFG/BLQ	73	85	85
WTE	128	128	323
LBW	0	120	590
Solar	0.1	30	1149
Animal Litter	0	0	35
OSW	0	0	1000
Total MW	**727**	**889**	**3708**
% Ren Gen.	**4.6%**	**6.7%**	**20%**

[52] PJM Environmental Information Services, *About GATS* [hereinafter *About GATS*], *available at* http://www.pjm-eis.com/getting-started/about-GATS.aspx (last visited Dec. 31, 2011).
[53] Public Service Commission of Maryland Ten Year Plan (2011-2020) of Electric Companies in Maryland

PJM and Electric Utility Interconnection

The wholesale electricity market that includes Maryland operates across 13 states and the District of Columbia. This market is coordinated by a regional transmission organization (RTO) called PJM Interconnect (PJM) (see Figure 2-6).

Figure 2-6: PJM Territory[54]



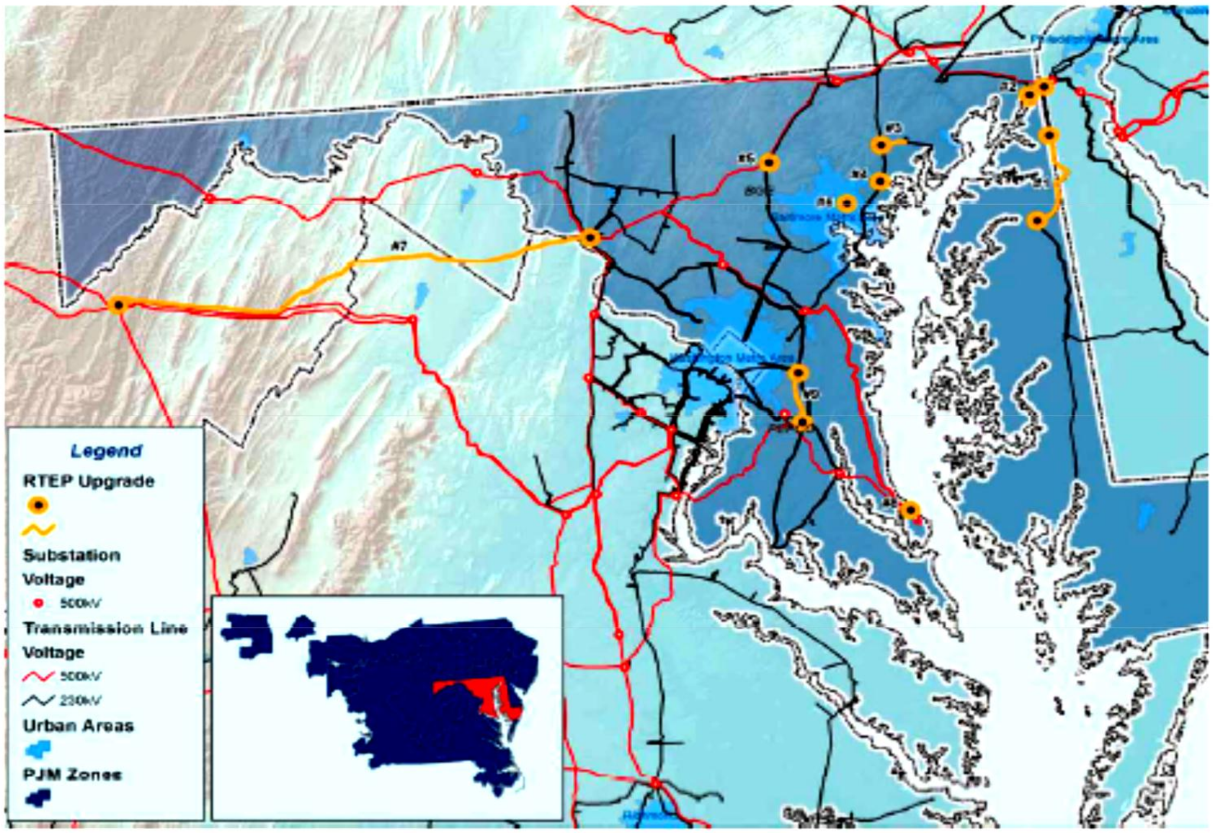
PJM coordinates both the buying and selling of wholesale electricity, and the delivery of high-voltage electricity throughout the region (electricity transmission). Through the process of coordinating the buying and selling of wholesale electricity, PJM ensures sufficient generation capacity for the entire region.

All generation sources in PJM, including those located in Maryland, participate in regular capacity auctions to become eligible to generate and sell electricity on the wholesale market. In conducting its capacity auctions, PJM ensures enough capacity, plus a 15 to 20 percent margin, is acquired to meet expected peak load demand across the entire region. PJM also coordinates the regional transmission

[54] *Regional Transmission Expansion Plan*, *supra* note 8 at 311.

network through a regular planning process, which analyzes and determines the necessity of transmission additions or enhancements as a means for providing reliable and economic electricity service. There are multiple transmission lines that connect Maryland to Delaware, Pennsylvania, West Virginia and Virginia (see Figure 2-7).

Figure 2-7: Maryland Transmission Network and Planned Upgrades



In addition to PJM's coordinating efforts, the Federal Energy Regulatory Commission (FERC) regulates both the legal issues associated with the wholesale electricity markets, and any modifications to the electricity transmission network.[55]

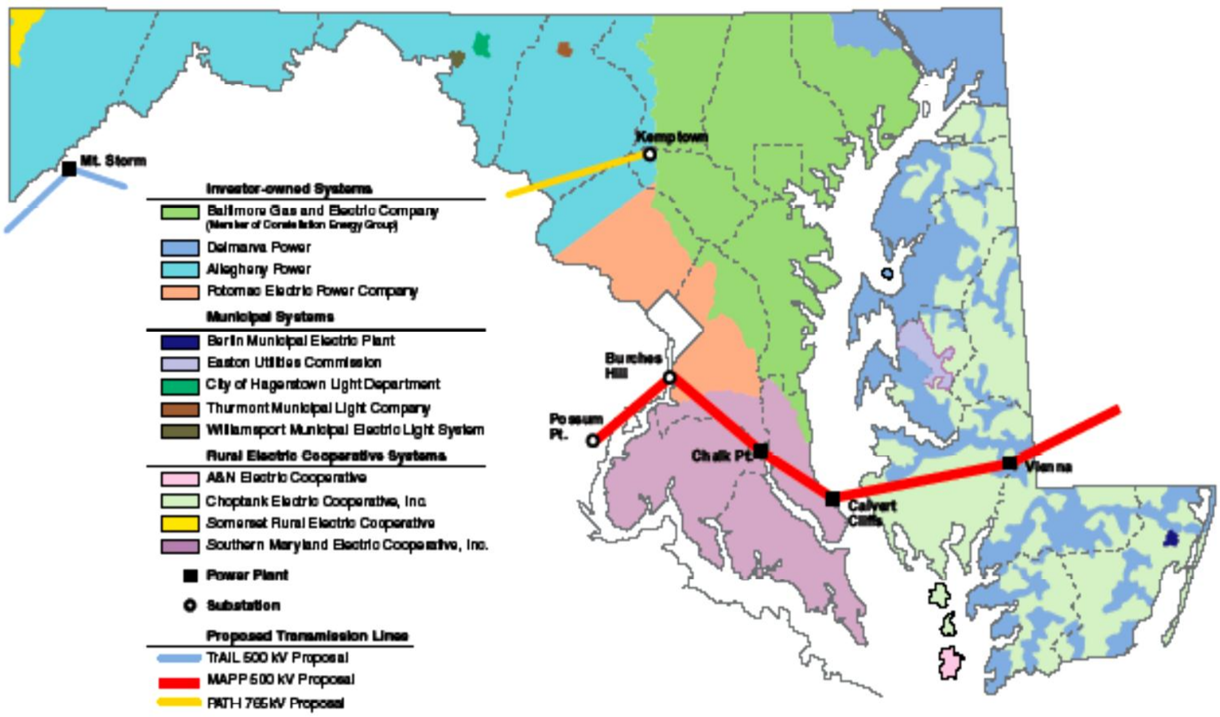
Electricity is ultimately delivered to and used by consumers via the retail market. At this level, electricity suppliers purchase electricity from the wholesale market or directly from generators via a Power Purchase Agreement and sell it to customers at retail rates. Because of Maryland's 1999 electricity market deregulation, some, but not all retail electricity suppliers are public utilities. Independent, non-utility electricity suppliers coordinate the sale of electricity to customers and pay utilities for the right to use distribution lines. Thirteen utilities deliver electricity to customers in Maryland over thirteen separate service areas (see Figure 2-8). Despite the independent electricity suppliers selling retail

[55] Federal Energy Regulatory Commission, *Transmission Line Siting* (2010) [hereinafter *Transmission Line Siting*], *available at* http://www.ferc.gov/industries/electric/indus-act/siting.asp.

electricity, utilities coordinate low voltage electricity distribution over shorter distances and repair and maintain the distribution network (e.g., downed lines and investments in new technology at substations).

Maryland's largest electric utilities, in terms of average sales to customers are, in order: BGE, PEPCO, PE, DPL, and SMECO (see Table 2-7). PSC oversees retail electricity markets and modifications to the electricity distribution network in Maryland.[56]

Figure 2-8: Electricity Service Areas in Maryland[57]



[56] *Ten-Year Plan (2009-2018)*, *supra* note 2.
[57] *Electricity in Maryland: Factbook*, *supra note* 22.

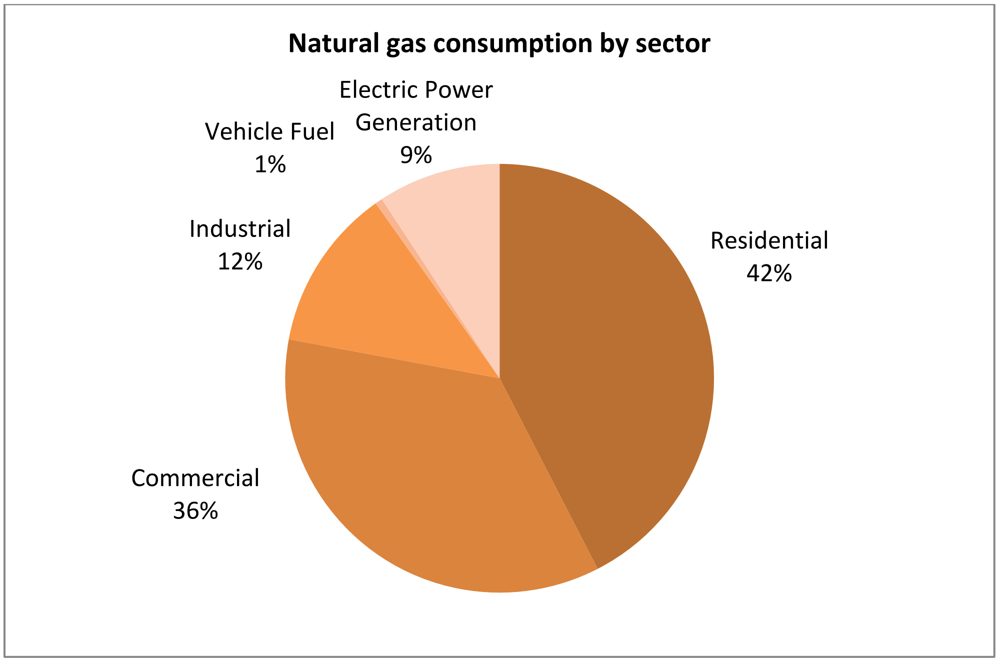
Natural Gas

Natural gas is mainly used for space heating, generating electricity, and as a fuel or feedstock for industrial processes. In Maryland over a million households and 77,000 businesses depend on natural gas for heating and other services. Maryland does not (yet) produce natural gas, and relies on imports from other states and countries. Three FERC-regulated interstate transmission pipelines transport gas to Maryland on their way to their terminus in the Northeast: two run from the Gulf of Mexico and Texas production regions to the Northeast, and one transports gas from the Cove Point LNG terminal owned by Dominion Energy (Cove Point) to storage fields in Pennsylvania and other interstate transmission lines. Most LNG arrives at Cove Point from Trinidad and Tobago followed by lesser amounts from Norway, Egypt and Nigeria. Maryland's PSC-regulated natural gas distribution utilities (the largest of which are BGE, Washington Gas and Light (WGL) and Columbia Gas of Maryland) tap gas from the interstate pipelines at multiple "city gate" stations, and transport the gas to customers throughout their service areas.

Gas utilities contract or operate base and peak load storage facilities, which they fill up prior to the winter heating season to assure service during peak demand periods. In the coldest months, demand can be 4-5 times higher than during summer lows.

Of the 1,449 trillion BTU of energy Maryland consumed in 2008, natural gas accounted for 14 percent. By comparison, natural gas makes up 22 percent of total U.S. energy consumption. Maryland's natural gas consumption is dominated by the residential and commercial sectors, which account for 78 percent of the State's total demand (see Figure 2-9). This is in contrast with the total U.S. natural gas consumption, where residential and commercial sectors together account for approximately one-third of total consumption, and the industrial and power generation sectors account for the remaining two-thirds (each sector alone accounts for about one-third of total consumption). In 2010, there were approximately 1,000,000 residential, 75,000 commercial and 1,200 industrial consumers. On an annual basis, total industrial consumption was 23,106 (mmcf),commercial consumption was 67,555 mmcf, and residential consumption was 83,830 mmcf. Per-consumer consumption for industrial customers was 19,250 mmcf, for commercial-.901 mmcf, and for residential .084 mmcf, with another 18,039 mmcf consumed to produce electricity.

Figure 2-9: Natural Gas Consumption by Sector, 2009[58]



Residential uses

Since the mid-1990s, the number of residential natural gas customers has been growing roughly two percent annually. In 2009, approximately 46 percent of Maryland households used natural gas. The most common residential uses are space and water heating, accounting for 68 percent and 23 percent, respectively. Eight percent accounts for other uses, such as cooking.[59]

Commercial uses

Commercial uses of natural gas are similar to residential uses; however, end users are organizations such as office buildings, schools, churches, hotels, restaurants, and government buildings.[60] The primary uses of natural gas in the commercial sector include space heating, water heating and cooling. In commercial buildings with cooking facilities, such as restaurants, natural gas is typically the fuel of choice.

Industrial uses

In 2009, 1,100 of the 1,234 industrial natural gas customers in Maryland were in the BGE service territory, which includes Baltimore and its surrounding areas.

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[58] U.S. Energy Information Administration, *Natural Gas Consumption By End Use available at* http://www.eia.gov/dnav/ng/ng_cons_sum_dcu_SMD_a.htm (last visited Jan. 5, 2012).

[59] Center for Integrative Environmental Research (CIER) University of Maryland, *Strategies for Carbon Dioxide Emissions Reductions: Residential Natural Gas Efficiency, Economic and Ancillary Health Impacts in Maryland*, (Dec. 2009) *available at* http://www.cier.umd.edu/documents/Residential_Natural_Gas_Efficiency_in_Maryland.pdf.

[60] Natural Gas Supply Association, *Commercial Uses* [hereinafter *Commercial Uses*], *available at* http://www.naturalgas.org/overview/uses_commercial.asp (last visited Dec. 31, 2011).

In the United States, 84 percent of all industrial consumption of natural gas is concentrated in the pulp and paper, metal, chemical, petroleum refining, stone, clay and glass, plastic and food processing industries.[61] Similar to the commercial and residential sectors, the industrial sector uses natural gas for heating, cooling, and cooking. In addition, natural gas can play an important role in industrial processes when used as fuel or feedstock. It is already used for waste treatment and incineration, preheating metals in iron and steel manufacturing, drying and dehumidification, melting glass, processing food, and fueling industrial boilers. When used as a feedstock, natural gas can be used to manufacture chemicals, fertilizers, pharmaceuticals and other products.[62]

Electric power generation

In 2009, 12.2 billion cubic feet (bcf) of Maryland's gas consumption was used for electric power generation,[63] generating 1,768 GWh of electricity in-state, approximately 4 percent of the 63,647 GWh of electricity consumed in Maryland.[64] In the PJM service area, natural gas provided for 11.5 percent of electricity generation in 2010.[65] Consequently, most of the electricity from gas-fired generators that is consumed in Maryland is imported from states in the PJM service area (see below for more detail on sourcing).

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Yearly natural gas demand cycle dominated by space heating needs

Because residential and commercial sectors account for more than three-quarters of Maryland's consumption, these sectors drive the yearly cycle. Gas use is highest in winter months, when the need for space heating drives up demand. In the summer, gas use for electricity generation is higher, creating small spikes in gas demand. These spikes do not offset the reduced heating demands, and do not have a significant effect on the yearly consumption cycle (shown in Figure 2-10 on the following page).

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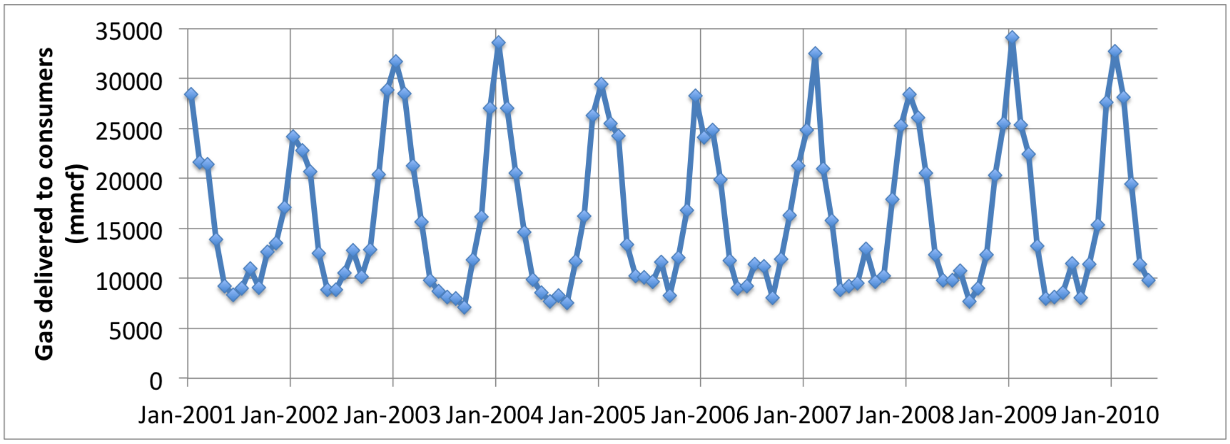
[61] *Commercial Uses*, *supra note* at 60.
[62] *Commercial Uses*, *supra note* at 60.
[63] *State Energy Data System*, *supra note* 45.
[64] U.S. Energy Information Administration, Maryland Electricity Profile, (2009), *available at* http://38.96.246.204/cneaf/electricity/st_profiles/maryland.html edition.
[65] Monitoring Analytics LLC, *State of the Market Report for PJM* (2011) [hereinafter *State of the Market Report*].

Figure 2-10: Natural Gas Delivered to Maryland Consumers (Including Vehicle Fuel)[66]



Natural Gas Sourcing

In 2009, Maryland consumed 197,313 million cubic feet (mmcf) of natural gas.[67] Only 43 mmcf of natural gas was produced in-state from seven gas wells located in the Southwestern tip of Garrett County.[68] Accordingly, nearly all of the natural gas consumed in Maryland is imported.

As mentioned above, most of the natural gas for consumption in Maryland is delivered to the State through interstate transmission pipelines that run from the Texas/Gulf Coast area to New Jersey and New England. Some natural gas enters Maryland through distribution pipelines running across borders with neighboring states. Alternatively, some natural gas arrives from Egypt, Trinidad, Tobago, Nigeria, and Norway by ship as liquefied natural gas (LNG) at the Cove Point LNG terminal in Calvert County (see Table 2-8 on the following page).

Maryland is a transit state for natural gas. The volume of gas flowing through Maryland is approximately 10 times larger than the volume of gas Maryland consumes. In 2009, 1,045,712 mmcf entered the State through pipelines; 72,339 mmcf of natural gas came through the LNG terminal; and 917,426 mmcf exited the State. Maryland's own consumption was only 197,313 mmcf.

[66] U.S. Energy Information Administration, *Natural Gas* (2011) [hereinafter *Natural Gas*], *available at* http://205.254.135.24/dnav/ng/hist/n3060md2m.htm.
[67] U.S. Energy Information Administration, *Natural Gas Annual Report 2009* [hereinafter *Natural Gas Annual Report*], available at http://www.eia.gov/pub/oil_gas/natural_gas/data_publications/natural_gas_annual /current/pdf/nga09.pdf.
[68] *Natural Gas Annual Report*, *supra note* 67.

Table 2-8 tracks Maryland's interstate and international movement of natural gas in 2009.

Table 2-8: Interstate and International Movements of Maryland Natural Gas, 2009 (mmcf)[69]

State or Country From/To	Volume (MMCF)		
	Receipts/Imports From	**Deliveries/Exports To**	**Net**
District of Columbia	0	902	-902
Delaware	4,365	0	4,365
Egypt	5,932	0	5,932
Nigeria	2,490	0	2,490
Norway	29,327	0	29,327
Pennsylvania	66,715	843,505	-776,790
Trinidad/Tobago	34,590	0	34,590
Virginia	974,632	73,019	901,614
Total	**1,118,051**	**917,426**	**200,625***
**This is not the annual consumption in Maryland. The difference with actual consumption can be explained by net additions to storage.*			

Interstate pipelines

Interstate pipelines transport natural gas from processing plants in producing regions or LNG import terminals to areas with high natural gas demand, usually large urban areas, such as the Washington D.C.—Boston urban corridor.

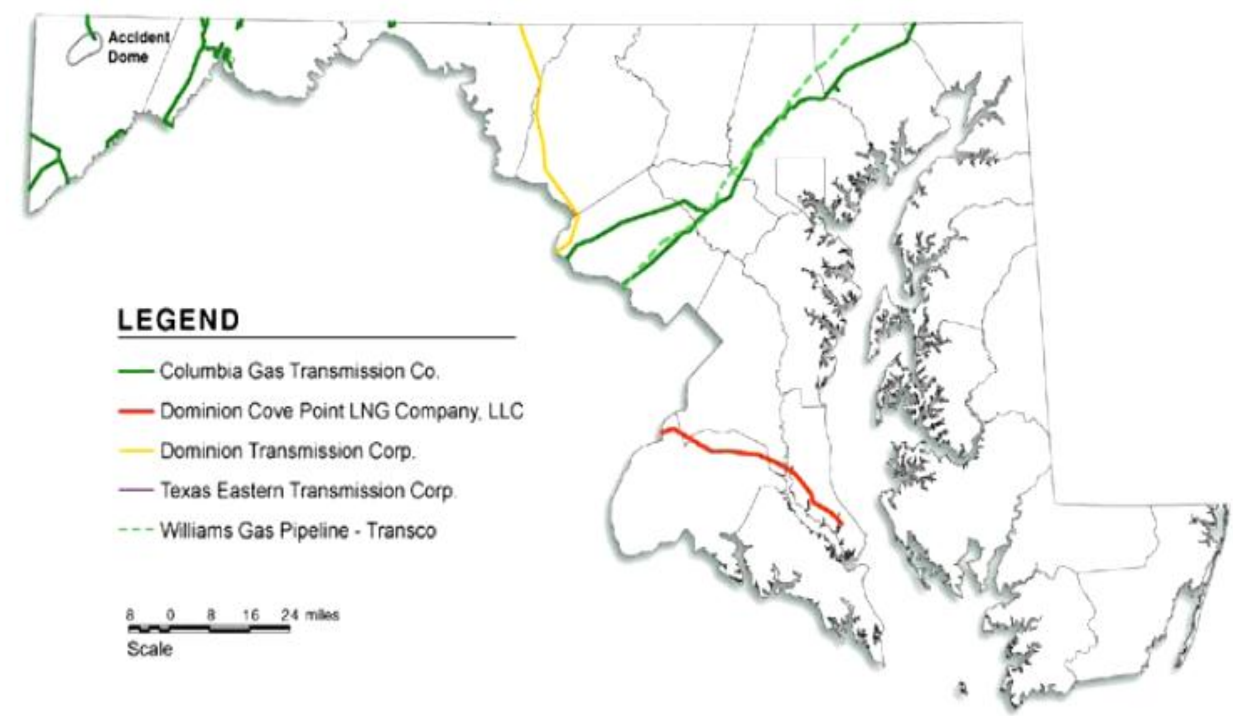
Most major interstate pipelines measure between 24 and 36 inches in diameter and transport gas at high pressures, typically between 200 and 1,500 psi. The pipeline itself is made of a strong carbon steel material, which is engineered to meet standards set by the American Petroleum Institute (API).[70] (Distribution pipes are sometimes made of advanced plastic, because of the need for flexibility, versatility, and the ease of replacement.)[71]

[69] *Natural Gas Annual Report*, *supra note* 67.
[70] *Natural Gas*, *supra note* 66.
[71] *Natural Gas*, *supra note* 66.

Every 40 to 100 miles along the route of the transmission pipes, compressor stations re-pressurize the gas to keep it flowing and maintain its pressure.[72] Compressor stations may be electrically powered or they may be powered by gas from the pipeline.

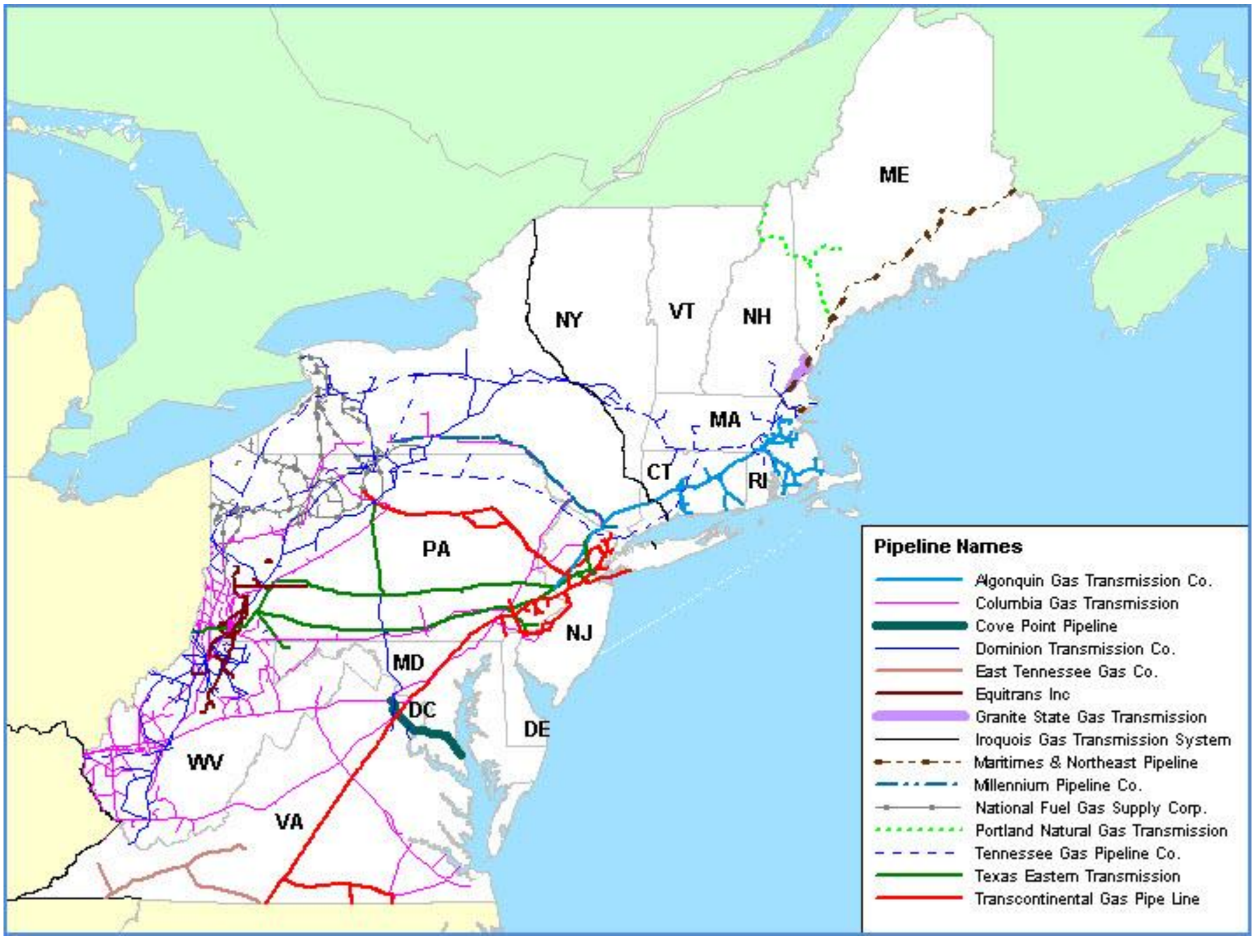
Three interstate transmission pipelines deliver gas to Maryland (see Figure 2-11). 1,022 miles of those natural gas transmission pipelines run over Maryland territory.[73]

Figure 2-11: Interstate Natural Gas Pipelines in Maryland[74]



[72] *Natural Gas*, *supra note* 66.
[73] According to 2008 end data. See U.S. Energy Information Administration, *About U.S. Natural Gas Pipelines* [hereinafter *About U.S. Natural Gas Pipelines*], *available at* http://www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/ngpipeline/mileage.html (last visited Dec. 31, 2011).
[74] Maryland cumulative environmental impact report, 15th edition, 2010, *available at* http://www.esm.versar.com/PPRP/ceir15/CEIR15.pdf.

Figure 2-12: Interstate Natural Gas Pipelines in Northeast Including Maryland[75]



Columbia Gas Transmission (FERC code 021),[76] operated by the Columbia Gas Transmission Company and owned by NiSource, collects gas in the Gulf of Mexico and transports it to New York.[77] It crosses the Potomac River from Virginia into Maryland at two locations: near Leesburg, VA, and close to Rockville, MD. The pipelines run toward the Northeast and rejoin as one pipeline in Cecil County before entering Pennsylvania. BGE taps gas from the Columbia pipeline at eight locations.

Williams Gas Pipeline-Transco Pipeline (FERC code 029), run by the Transcontinental Gas Pipeline Corporation, is a natural gas pipeline that brings gas from the Gulf Coast region through Georgia, South Carolina, North Carolina, Virginia, Maryland and Pennsylvania, to deliver gas to the New Jersey and New

[75] Maryland cumulative environmental impact report, 15th edition, 2010, *available at* http://www.esm.versar.com/PPRP/ceir15/CEIR15.pdf

[76] For identification purposes, FERC assigns interstate pipelines a three-digit pipeline code.

[77] NiSource Gas Transmission & Storage, *NiSource Gas Transmission & Storage Home Page* [hereinafter *NiSource Gas Transmission & Storage Home Page*], *available at* http://www.ngts.com/en/home.aspx (last visited Dec. 31, 2011).

York City areas.[78] It is owned by the Williams Companies. The Transco pipeline consists of two 30-inch pipes and one 36-inch pipe. It crosses the Potomac River into Maryland about two miles upstream from Great Falls National Park and exits into Pennsylvania from Harford County.

The Dominion Line (FERC code 022), run by Dominion Cove Point LNG Company, brings gas from the Dominion Cove Point LNG terminal in Maryland to extensive natural gas storage fields in Pennsylvania. It also carries gas into New England.[79] From Cove Point, the pipeline runs westward into Virginia, where it branches off twice toward local distribution systems, before re-entering Maryland near Leesburg, VA. It then runs north through Frederick and Washington Counties, as the Dominion Transmission Corporation, toward Pennsylvania. BGE taps gas from the Dominion line near Tuscarora in Frederick County.

Imports Through Distribution Pipelines

In Western Maryland and on the Eastern Shore, natural gas is delivered to Maryland consumers from Pennsylvania and Delaware, respectively. In Allegany and Washington Counties, Columbia Gas pipelines enter the State from Pennsylvania.

On the Eastern Shore, Eastern Shore Natural Gas (ESNG), a subsidiary of Chesapeake Utilities, operates the only transmission line on the peninsula, running north-south through Delaware (see Figure 2-13). Two branches deliver gas to Maryland: one branch enters Wicomico County and runs to Salisbury; a second branch enters Dorchester County and supplies Dorchester, Talbot (Easton Utilities), and Caroline Counties. ESNG is directly interconnected with the Transcontinental and Columbia pipelines, which run through Maryland, and the Texas Eastern Transmission, which passes Maryland on the West.

[78] Williams TRANSCO, *Williams TRANSCO Home Page* [hereinafter *Williams TRANSCO Home Page*], *available at* http://www.1line.williams.com/Transco/index.html (last visited Dec. 31, 2011).
[79] Dominion Transmission, Inc., *available at* http://www.dom.com/business/gas-transmission/index.jsp (last visited Jan. 4, 2011).

Figure 2-13: Chesapeake Utilities Service Area and Eastern Shore Transmission Lines

LNG Imports

LNG arrives in Maryland from overseas by ship at the Dominion Cove Point LNG terminal, in Lusby, Calvert County. Re-gasified natural gas from the terminal is fed into the Dominion Line (see above). Another pipeline from the terminal directly supplies the WGL distribution system, serving retail customers in Prince George's and Montgomery Counties.

Imports can fluctuate significantly from year to year (see Table 2-9). In 2009, Dominion Cove point received 72 Bcf of LNG, primarily from Trinidad, Tobago and Norway, and less from Egypt and Nigeria. LNG is a marginal supplier, and its volumes swing with changing demand and price. However LNG tanker ships, unlike pipelines carrying natural gas, are not bound to one fixed route and can be directed to various ports to take advantage of the market that offers the best price.

Table 2-9: LNG Arriving at Dominion Cove Point LNG Terminal[80]

Year	2005	2006	2007	2008	2009
LNG arrived (BCF)	222	117	148	26	72

[80] *Natural Gas Annual Report*, *supra note* 67.

Dominion Cove Point has a storage capacity of 14.6 Bcf and a daily send-out capacity of 1.8 Bcf. In recent years the terminal's capacity has been dramatically underused. The decline since 2005 is probably due to a combination of factors that includes a sharp increase in domestic production from shale, and reduced demand due to the 2008 economic downturn.

Natural Gas In-flows and Out-flows

Table 2-10 presents an overview of natural gas pipelines (capacity and flows) that cross Maryland's state borders, including Cove Point LNG. The data can be mapped to the pipelines shown in Figure 2-12.

Table 2-10: Natural Gas Pipeline in- and outflow Capacities and Flows[81]

Delivering Pipeline	State To	County To	State From	County From	Average Operating Pressure (PSIA)	Bi-directional Line?	Estimated Bi-directional Capability at this Point (MMcf/d)	Capacity as of end of 2008 (MMcf/d)	Capacity as of end of 2007 (MMcf/d)	Capacity as of end of 2006 (MMcf/d)	Capacity as of end of 2005 (MMcf/d)	Average Daily Flow in 2007 (MMcf/d)	Average Daily Flow in 2006 (MMcf/d)	Average Daily Flow in 2005 (MMcf/d)
To Maryland:														
Eastern Shore Nat Gas Co	MD	Wicomico	DE	Sussex	500	N	0	6	6	6	6	3	2	2
Eastern Shore Nat Gas Co	MD	Dorchester	DE	Sussex	500	N	0	16	16	16	16	6	6	7
Subtotal	**MD**		**DE**					**22**	**22**	**22**	**22**	**9**	**8**	**9**
Columbia Gas Trans Corp	MD	Allegany	PA	Bedford	550	N	0	34	34	34	34	0	0	0
Columbia Gas Trans Corp	MD	Allegany	PA	Bedford	550	N	0	0	0	0	0	0	0	0
Columbia Gas Trans Corp	MD	Washington	PA	Fulton	550	N	0	23	23	23	23	0	0	0
Dominion Transmission Co	MD	Washington	PA	Franklin	850	Y	700	769	769	769	769	136	119	118
Eastern Shore Nat Gas Co	MD	Cecil	PA	Chester	600	N	0	145	134	123.8	97.6	15	0	0
Texas Eastern Trans Corp	MD	Garrett	PA	Fayette	0	Y	300	300	300	300	300	56	41	49
Subtotal	**MD**		**PA**					**1,271**	**1,260**	**1,250**	**1,224**	**206**	**160**	**167**
Columbia Gas Trans Corp	MD	Montgomer	VA	Loudoun	750	N	0	642	642	642	642	228	236	214
Columbia Gas Trans Corp	MD	Montgomer	VA	Fairfax	350	N	0	538	538	538	538	191	198	180
Dominion Transmission Co	MD	Montgomer	VA	Loudoun		Y	769	700	0	0	0	0	0	0
Cove Point LNF LP	MD	Charles	VA	Fairfax	1200	Y	2,233	2,233	1,433	1,433	1,433	55	49	10
Transcontinental Gas P L Co	MD	Montgomer	VA	Fairfax	770	N	0	2265	2265	2100	2100	1,804	1,728	1,791
Subtotal	**MD**		**VA**					**6,378**	**4,878**	**4,713**	**4,713**	**2,278**	**2,211**	**2,195**
Columbia Gas Trans Corp	MD	Garret	WV	Mineral	550	N	0	4	4	4	4	0	0	0
Subtotal	**MD**		**WV**					**4**	**4**	**4**	**4**	**0**	**0**	**0**
Dominion Cove Point LNG	MD	Calvert										406	319	607
Total into Maryland (mmcf/d)								7,676	6,165	5,989	5,963	2,899	2,699	2,978
in bcf/year												*1,058,121*	*984,966*	*1,087,130*
From Maryland:														
Columbia Gas Trans Corp	PA	Lancaster	MD	Cecil	730	N	0	206	206	206	206	91	70	46
Dominion Transmission Co	PA	Franklin	MD	Washingto		Y	769	700	0	0	0	0	0	0
Texas Eastern Trans Corp	PA	Fayette	MD	Garrett	1100	Y	300	300	300	300	300	58	36	42
Transcontinental Gas P L Co	PA	York	MD	Harford	770	N	0	2,050	2,050	2,050	2,050	1,746	1,667	1,622
Subtotal	**PA**		**MD**					**3,256**	**2,556**	**2,556**	**2,556**	**1,894**	**1,773**	**1,710**
Cove Point LNG LP	VA	Fairfax	MD	Charles	1200	Y	1,433	2,233	1,433	1,433	1,433	336	276	481
Dominion Transmission Co	VA	Loudoun	MD	Frederick	850	N	0	467	467	467	467	158	124	142
Subtotal	**VA**		**MD**					**2,700**	**1,900**	**1,900**	**1,900**	**493**	**401**	**623**
Washington Gas Light Co	DC	District Colu	MD	Montgome	0	N	0	80	80	80	80	4	4	10
Subtotal	**DC**		**MD**					**80**	**80**	**80**	**80**	**4**	**4**	**10**
Eastern Shore Nat Gas Co	DE	New Castle	MD	Cecil	600	N	0	145	134	123.8	97.6	15	0	0
Subtotal	**DE**		**MD**					**145**	**134**	**124**	**98**	**15**	**0**	**0**
Columbia Gas Trans Corp	WV	Mineral	MD	Allegany	550	N	0	5	5	5	5	0	0	0
Subtotal	**WV**		**MD**					**5**	**5**	**5**	**5**	**0**	**0**	**0**
Total from Maryland (mmcf/d)								6,186	4,675	4,665	4,639	2,406	2,178	2,344
in bcf/year												*878,358*	*795,047*	*855,599*
Flow balance (bcf/year)												179,763	189,920	231,530

[81] U.S. Energy Information Administration, *Interstate Pipeline Capacity on a State-to-State Level, available at* http://www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/ngpipeline/StatetoState.xls.

Natural Gas Utilities and Distribution

Once natural gas arrives in Maryland, it is distributed to customers by local distribution companies (LDCs) or "utilities". Along the interstate transmission pipelines are multiple gate stations where natural gas is tapped from the interstate transmission line, depressurized, odorized and then fed into the utilities' network of local transmission and distribution pipes at lower pressures. Maryland has approximately 15,130 miles of gas pipelines used for distribution and transmission.[82] The pipelines in the distribution network are 6 to 16 inches in diameter, with certain segments as narrow as half an inch. Pipeline pressure decreases as it moves further away from the interstate transmission line. For example, BGE's transmission lines use pressures ranging from 200-720 psi; its lowest pressure distribution line decreases to ¼ psi. The majority (67 percent) of its lines are "high-pressure," operating at 99 psi or higher.

Unbundled market

The natural gas distribution market in Maryland is largely deregulated. All commercial and industrial customers may choose their gas suppliers. Almost all Maryland residential customers may choose their supplier as well, if they reside in the service territory of one of the State's three largest local distribution companies (LDCs): BGE, WGL and Columbia Gas of Maryland, Incorporated (Columbia).[83]

As of December 2009, 11 companies have licenses to sell and/or market natural gas to residential consumers in the State. Six suppliers serve residential customers in BGE's service area, two suppliers serve customers in Columbia's area, and four serve customers in WGL's area.[84]

Together, BGE, WGL and Columbia serve 98 percent of all of Maryland's 1.14 million natural gas customers. The remaining share is served by smaller utilities, including Chesapeake Utilities in Wicomico, Dorchester, and Caroline Counties on the Eastern Shore; Easton Utilities Commission in Easton and its surrounding area in Talbot County; Pivotal Utilities DBA Elkton Gas in Elkton, Cecil County; and UGI Central Penn Gas Incorporated, in Emmittsburg, Frederick County.

Three Major Natural Gas Utilities: BGE, WGL, and Columbia

BGE's gas service area is approximately 800 square miles and includes Baltimore City. In 2010, BGE served 608,600 residential, 42,900 commercial and 1,100 industrial customers—or 57 percent of residential and commercial gas customers and 89 percent of industrial gas customers in Maryland.[85] BGE receives gas from all three interstate pipelines described above. Its main source is the Columbia Transmission pipeline, where it taps gas at eight gate stations along its Maryland trajectory.

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[82] American Gas Association, *Maryland State Profile, available at* http://www.aga.org/Kc/analyses-and-statistics/state_profiles/Documents/1002Maryland.pdf.

[83] U.S. Energy Information Administration, *Retail Unbundling – Maryland* [hereinafter *Retail Unbundling – Maryland*], *available at* http://www.eia.doe.gov/oil_gas/natural_gas/restructure/state/md.html (last visited Dec. 31, 2011).

[84] *Retail Unbundling – Maryland*, *supra note* 83.

[85] Constellation Energy, *2010 Annual Report, available at* http://files.shareholder.com/down loads/CEG/1603390128x0x460644/70872692-8CCD-479A-8DD8-32CA988D726F/2010AR.pdf.

WGL serves the suburban Washington D.C. area, including parts of Virginia and Maryland. Its Maryland service area includes Frederick, Montgomery, Prince George's, Charles, St. Mary's and Calvert Counties. WGL has approximately one million customers in its three-state service area; of these, about half (435,000) are in Maryland, and approximately 29,000 are commercial customers. WGL is the State's biggest supplier to electric power generation, and has service agreements with numerous pipeline companies to provide firm transportation and/or storage services directly to WGL's city gate.[86] WGL also gets supplied directly from the Cove Point LNG terminal to a dedicated gateway station in Prince George's County. As of September 2010, WGL's tri-state service area had approximately 664 miles of transmission mains, 12,414 miles of distribution mains and 13,453 miles of distribution services.[87]

Columbia Gas serves Garrett, Allegany, and Washington Counties in Western Maryland. It has over 33,000 residential and commercial customers in the State. Columbia serves a large part of Pennsylvania, as well as other states. Columbia's Maryland network is connected to its Pennsylvania system, sourcing gas through one distribution system.

Minor Utilities

In addition to the three major natural gas utilities, a handful of local utilities serve areas with a smaller customer base, ranging from several hundred to several thousand customers. PSC grants these local utilities a franchise to operate a distribution pipeline and provide gas service within PSC jurisdiction.[88] Key utilities are discussed below.

Chesapeake Utilities serves 50,000 consumers in Delaware and Maryland. Chesapeake is one of two gas distributers on Maryland's Eastern Shore. Based on State average per customer consumption, Chesapeake is estimated to serve close to 7,000 residential and approximately 2,000 commercial customers in Maryland (including those served by its subsidiary, ESNG (discussed above)).

The Easton Utilities Commission serves 4,500 residential and commercial customers in the city of Easton and surrounding areas. Easton Utilities purchases its gas supply from ESNG, which is directly connected to interstate transmission pipelines coming from the Gulf Coast area.

Pivotal Utilities DBA Elkton Gas serves approximately 5,100 residential and commercial customers in the greater Elkton area in Cecil County, in the utmost Northeastern tip of Maryland.

UGI Central Penn Gas Incorporated serves several hundred customers in Frederick County, Maryland. However, it is a Pennsylvania utility also serving 568,000 customers in Eastern and Central Pennsylvania.

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[86] A city gate, or "citygate," is "the delivery point where the natural gas is transferred from a transmission pipeline to the local gas utility." *See Natural Gas Annual Report*, *supra note* 67.

[87] WGL Holdings, Inc., *Clean and Efficient Energy Solutions* (2010) [hereinafter *Clean and Efficient Energy Solutions*], *available at* http://www.washgas.com/FileUpload/File/About%20Us/WGLHoldings2010FinancialReport.pdf.

[88] Maryland's Office of People's Counsel, *Consumer Corner – Natural Gas* [hereinafter *Consumer Corner – Natural Gas*], *available at* http://www.opc.state.md.us/ConsumerCorner/NaturalGas.aspx (last visited Jan. 1, 2012).

Eastern Shore Gas Company in Ocean City (not affiliated with Chesapeake Utilities' Eastern Shore Natural Gas) currently provides underground propane pipeline/metered gas service to residents and businesses in Ocean City, West Ocean City, Ocean Pines, Berlin, Snow Hill and Pocomoke City. However, it is planning to provide natural gas to Worcester County soon.

Storage Capacity

Natural gas can be stored indefinitely. Utility companies' access to storage is important because it allows those utilities to be less dependent on direct pipeline transportation, as well as hedge against short-term gas price fluctuations in order to lower cost. Storage facilities can also act as a back-up supply when there are unforeseen supply disruptions. Natural gas stored in facilities is used either to meet base load requirements or peak load requirements. Both types of storage are discussed below (see Chapter 1 for a map of storage locations).

Base Load Storage

Because base load storage capacity is used to meet seasonal demand increases, such facilities should be capable of holding enough natural gas to meet long-term seasonal demand. This type of facility is most often a depleted natural gas field.

Within Maryland's region,[89] base load storage facilities are almost all depleted natural gas fields in West Virginia, Eastern Pennsylvania, New York, and Western Ohio. Maryland itself has gas storage fields in Accident, Garrett County. These fields have a capacity of 64 Bcf and are owned and operated by Spectra Energy, which also owns the Texas Eastern Transmission line.[90]

Natural gas utilities arrange for base load storage. BGE has a reported 0.30 Bcf in current maximum storage entitlements.[91] WGL purchases storage services from Hampshire, a wholly owned subsidiary of Washington Gas Light Holdings. Hampshire owns and operates full and partial interests in underground natural gas storage facilities. For the 2011 fiscal year, Hampshire storage facility had the estimated capacity to supply approximately 2.5 Bcf to WGL's system for meeting winter season demands.[92] Chesapeake Utilities' Maryland division has contracted for storage capacity with its own ESNG pipeline subsidiary, as well as Columbia and Transcontinental transmission companies.[93]

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[89] Although typically thought of as belonging to the Mid-Atlantic, DOE EIA identifies Maryland as belonging to the "Northeast" region. See http://www.eia.doe.gov/pub/oil_gas/natural_gas/analysis_publications/ngpipeline/undrgrnd_storage.html.

[90] The gas storage fields are connected to the Texas Eastern Transmission pipeline; however, this pipeline does not run through Maryland.

[91] Constellation Energy, *2010 Annual Report, available at* http://files.shareholder.com/downloads/CEG/1603390128x0x460644/70872692-8CCD-479A-8DD8-32CA988D726F/2010AR.pdf.

[92] *Clean and Efficient Energy Solutions*, *supra note* 87.

[93] Chesapeake Utilities Corporation, *Annual Report* (2010) [hereinafter *Chesapeake Annual Report*].

Peak Load Storage

Peak load storage facilities are intended to meet sudden, short-term demand increases, and subsequently are designed to allow quick natural gas withdrawal. Peak load storage facilities do not have as large a capacity as base load facilities, but they are capable of delivering small amounts of natural gas quickly. For example, in addition to its base load storage entitlements, BGE also operates three peak shaving facilities:

- Spring Gardens is an LNG plant located in the Baltimore harbor. Spring Gardens has a storage capacity of 1 Bcf (12 million gallons LNG), and deliverability of 0.312 Bcf/d.
- North Cliff is a propane-air plant near Gunpowder River in Baltimore County. North Cliff has a capacity of 0.5 Bcf and deliverability of 0.085 Bcf/d. In non-peak times (summer), propane is trucked in as liquid propane gas (LPG).
- Westminster LNG plant is a satellite location in Carroll County with a capacity of 5.6 mmcf, and deliverability of 6 mmcf/d. Spring Gardens supplies Westminster with LNG delivered by truck.

To enhance deliverability during winter's peak demand periods, WGL has two peaking facilities. Both are propane-air plants: one is located in Springfield, Virginia (Ravensworth Station) and the other is in Rockville, Maryland (Rockville Station). Together, they have the capacity for approximately 15 million gallons (approximately 1.2 Bcf) of propane for peak shaving. Propane, when mixed with air, will duplicate the burning characteristics of natural gas and allow the user to utilize existing natural gas burners, piping and controls. WGL is currently working to enhance its peaking capacity with the construction of an LNG peaking facility that is forecast to be in service by the 2015-2016 winter heating season. The facility will provide two million therms (200 mmcf/d) of deliverability and ten million therms (1 Bcf) of annual storage capacity.[94]

[94] *Clean and Efficient Energy Solutions*, *supra note* 87.

Natural Gas Prices and Expenditures

Natural Gas Expenditures

Table 2-11 derives natural gas expenditures by Maryland residential, commercial, and industrial consumers from consumption and price data for the years 2007-2009. It shows that natural gas consumption decreased during the economic downturn, but started rising again in 2009. Prices peaked in 2008 and decreased sharply into 2009. The expense pattern follows the price pattern. The aggregate numbers show that natural gas is a 2-3 billion dollar business in Maryland.

Table 2-11: Maryland Residential, Commercial and Industrial Natural Gas Expenses[95]

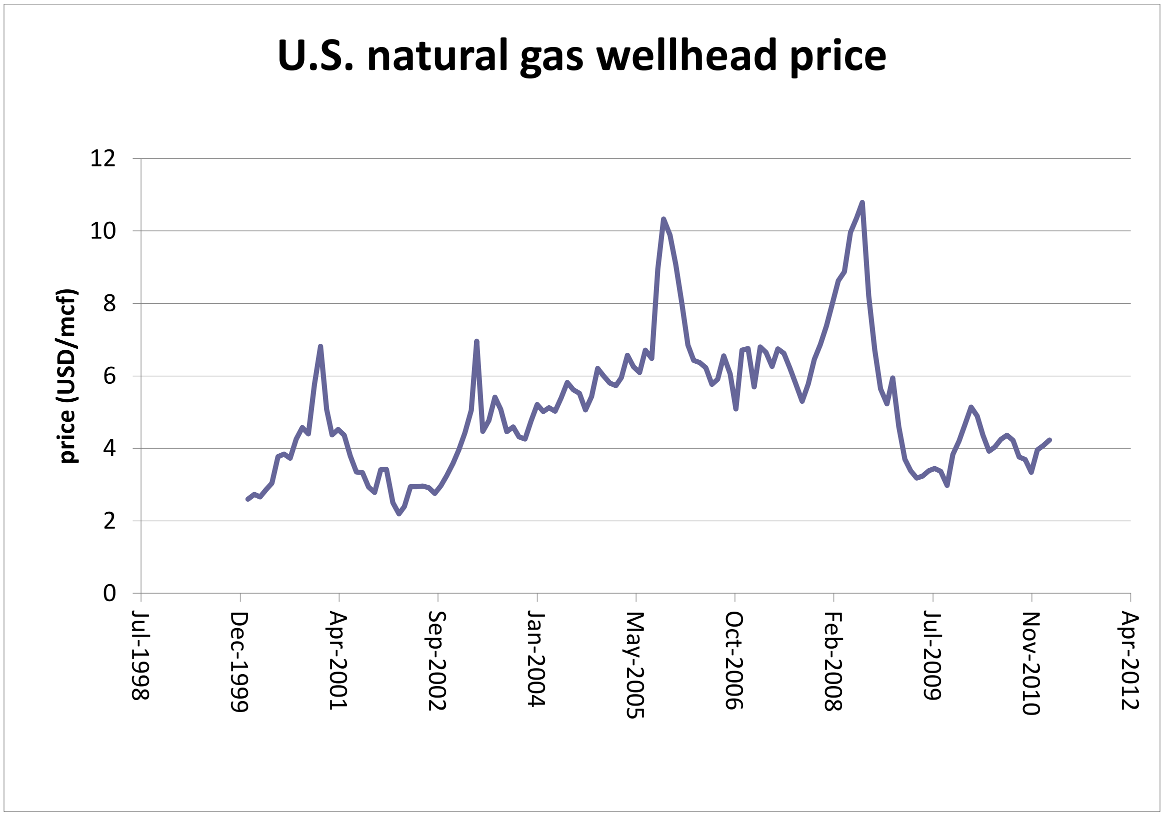
	2007	2008	2009
Residential			
consumption (mmcf)	83,457	81,180	82,699
average price ($/mcf)	15.17	16.07	13.73
expenses (million $)	1,266	1,305	1,135
Commercial			
consumption (mmcf)	70,852	70,411	69,119
average price ($/mcf)	12.3	13.12	10.87
expenses (million $)	871	924	751
Industrial			
consumption (mmcf)	20,413	21,153	23,926
average price ($/mcf)	11.59	13.46	10.7
expenses (million $)	237	285	256
Total*			
consumption (mmcf)	174,722	172,744	175,744
expenses (million $)	2,374	2,513	2,143
**excludes consumption as vehicle fuel and for power generation*			

[95] U.S. Energy Information Administration, *Natural Gas* Monthly (April 2011) [hereinafter *Natural Gas Monthly*], *available at* http://www.eia.doe.gov/natural_gas/data_publications/natural_gas_monthly/ngm.html.

Natural gas prices

The pattern that wholesale natural gas market prices followed over the past several years is displayed in Figure 2-14.

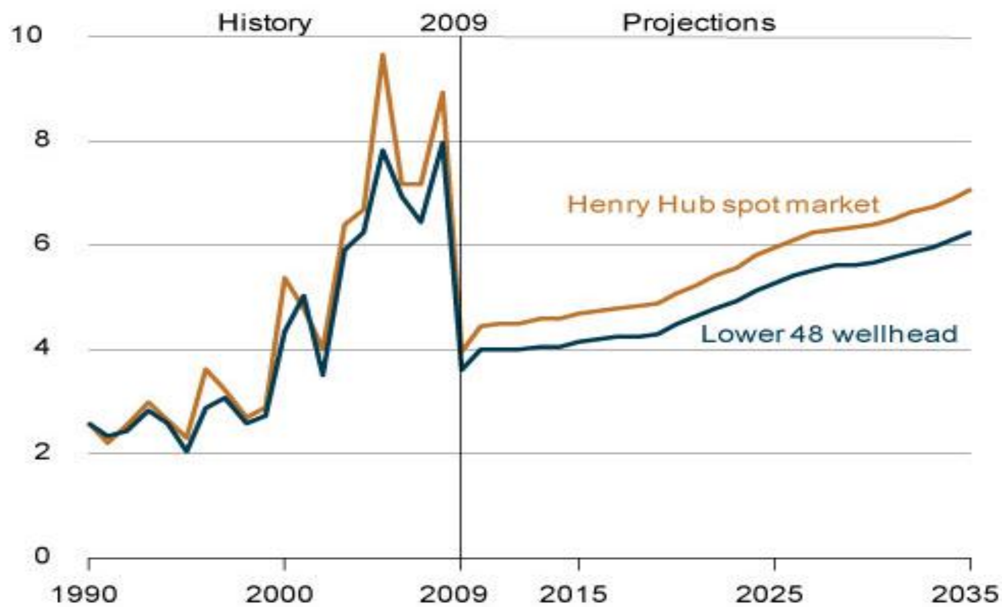
Figure 2-14: U.S. natural gas wellhead price since 2000[96]



Natural gas prices were rising until, in 2008, the wellhead price dropped sharply to around $4 per mcf. It has remained low since then. Three factors contributed to the price drop and the sustained low level thereafter: (1) due to the economic crisis, demand sharply declined; (2) large volumes of unconventional (mostly shale) gas entered the market; and (3) LNG capacity overseas came online. The slow economic recovery and continued growth of shale gas production have kept prices low and changed the long-term outlook for natural gas prices. The EIA now foresees shale gas production growing to 47 percent of domestic natural gas production in 2035 and natural gas wellhead prices staying in the $4-7 per mcf range until 2035 (see Figure 2-15 on the following page).

[96] *Natural Gas Monthly*, *supra note* 95.

Figure 2-15: Annual average lower-48 wellhead and Henry Hub spot market prices for natural gas in seven cases, 1990-2035 (2009 dollars per million Btu)[97]



Maryland natural gas consumer prices

Natural gas prices for Maryland's consumers historically followed the trend of the wholesale market, rising until 2008 and sharply declining thereafter. There are different price structures for residential, commercial and industrial consumers. Table 2-12 lists the average annual prices for residential consumers in Maryland and its neighboring states, as well as the U.S. average.

Table 2-12: Annual average natural gas prices for residential consumers (in dollars per thousand cubic feet)[98]

	2005	2006	2007	2008	2009
United States avg.	*12.70*	*13.73*	*13.08*	*13.89*	*12.14*
Delaware	14.58	16.93	16.21	16.07	17.79
DC	16.87	16.96	15.67	16.49	13.92
Maryland	**14.80**	**16.36**	**15.17**	**16.07**	**13.73**
Pennsylvania	14.21	16.45	14.66	16.22	14.74
Virginia	15.15	16.20	15.42	16.19	13.83
West Virginia	13.00	15.74	14.59	14.51	14.75

Maryland's residential prices are comparable to those of its neighbors (with Delaware an outlier in 2009), but the region as a whole is significantly more expensive than the national average. Residential consumer prices follow a yearly cycle; with a peak in the winter months and a low in summertime (see Figure 2-16 on the following page). The cycle is more pronounced in the Mid-Atlantic region than in the U.S., on average.

[97] *Annual Energy Outlook 2011*, *supra note* 51.
[98] *Natural Gas Monthly*, *supra note* 95.

Figure 2-16: Monthly residential natural gas price time history, showing the winter-summer cycle.[99]

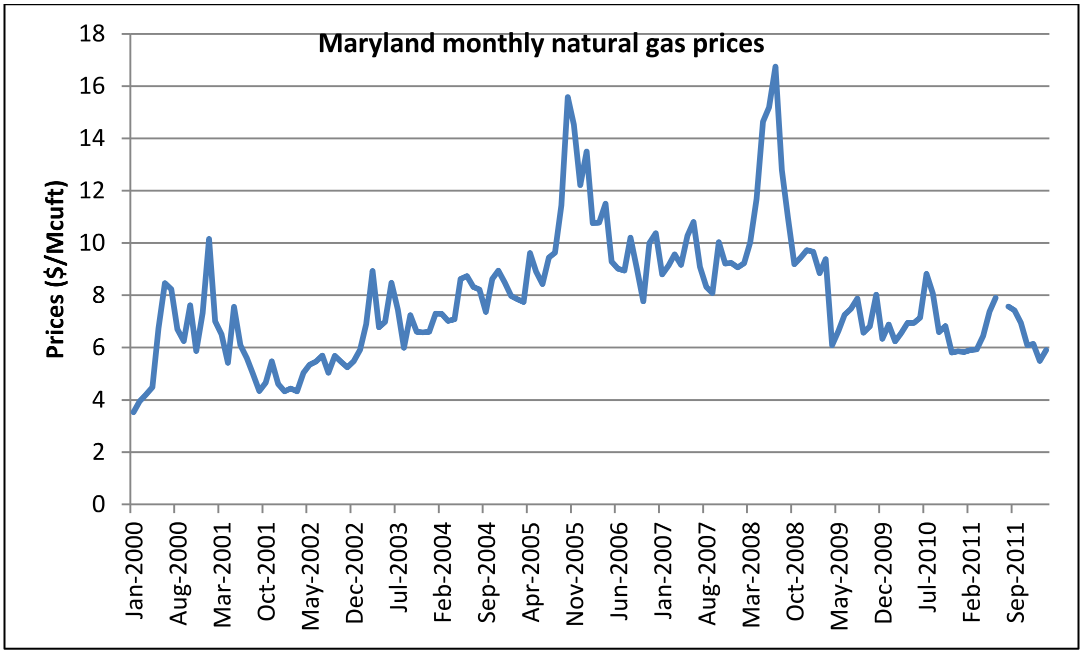


Table 2-13 and Table 2-14 list the historic annual average natural gas prices for commercial and industrial consumers, respectively.

Table 2-13: Annual average natural gas prices for commercial consumers (USD/mcf)[100]

	2005	2006	2007	2008	2009
United States avg.	*11.34*	*12.00*	*11.34*	*12.23*	*10.06*
Delaware	12.98	15.33	14.48	14.24	15.87
DC	13.17	14.67	13.69	13.90	12.99
Maryland	**11.97**	**13.28**	**12.30**	**13.12**	**10.87**
Pennsylvania	13.04	14.30	12.77	14.29	11.83
Virginia	11.85	12.46	11.99	12.81	10.31
West Virginia	12.22	14.38	13.37	13.54	14.24

Table 2-14: Annual average natural gas prices for industrial users (USD/mcf)[101]

	2005	2006	2007	2008	2009
United States avg.	*8.56*	*7.87*	*7.68*	*9.65*	*5.33*
Delaware	10.86	11.94	8.93	12.54	13.99
Maryland	**12.17**	**12.86**	**11.59**	**13.46**	**10.70**
Pennsylvania	11.25	12.30	10.64	12.09	9.42
Virginia	10.83	9.98	9.33	11.49	7.14
West Virginia	10.50	8.98	8.51	10.94	5.55

[99] *Natural Gas Monthly*, *supra note* 95.
[100] *Natural Gas Monthly*, *supra note* 95.
[101] *Natural Gas Monthly*, *supra note* 95.

For both commercial and industrial consumers, natural gas prices for Maryland and its neighbors are more expensive than the U.S. average, but there is less of a difference for residential consumers. Furthermore, Maryland offers competitive prices for commercial users – only Virginia is cheaper – but is the most expensive of its neighbors for industrial users, except for Delaware in 2009. Delaware witnessed a rise in natural gas prices from 2008 to 2009, whereas prices in other states sharply declined during that same timeframe. The increase in Delaware is probably due to hedging strategies.

Price volatility

Natural gas prices depend on market supply and demand. In the 1990s, when supplies were ample, the wholesale price of natural gas was relatively stable at $2 per mcf.[102] But in the 2000s, as shown in Table 2-12, when domestic production declined while economic growth spurred demand, "wellhead" or "wholesale" prices rose and became much more volatile. Peaks of $10.3 and $10.8 per mcf (monthly average) were experienced in 2005 (following Hurricane Katrina) and 2008, respectively.[103] In 2009, wellhead prices dropped sharply to close to $3 per mcf.[104] In 2011, the wholesale price has hovered close to $4 per mcf.[105]

Due to limited alternatives for natural gas consumption or production in the short run, natural gas prices are susceptible to changes in supply or demand over a short period, which can result in large price movements to rebalance supply and demand.

Supply side factors that can affect prices include variations in natural gas production, net imports, or storage levels. On the demand side, economic growth, winter and summer weather, and oil prices may affect prices. Additionally, the system can experience delays in responding to changing demand or supply, which may exacerbate cyclical behavior or price volatility.

Natural gas utilities can use the following strategies to keep prices affordable and stable for Maryland consumers:[106]

- **Billing plans**: allowing customers to spread annual aggregate natural gas costs over many months, keeping winter bills in check (Revenue Normalization Adjustment billing).
- **Storage**: purchasing extra natural gas during the cheaper summer months and storing it for use in the winter. According to the American Gas Association (AGA), gas withdrawn from storage can account for half of a utility's natural gas supply on very cold winter days.
- **Hedging**: using financial instruments, such as futures contracts and weather risk insurance, to hedge against quickly changing prices.

[102] American Gas Association, *Natural Gas Supply and Prices: Frequently Asked Questions* (2011) [hereinafter *Natural Gas Supply and Prices: Frequently Asked Questions*].
[103] *Natural Gas Monthly*, *supra note* 95; *Natural Gas Supply and Prices: Frequently Asked Questions*, *supra note* 101.
[104] *Natural Gas Monthly*, *supra note* 95.
[105] EIA Natural Gas Weekly Update, May 25, 2011, http://www.eia.gov/oog/info/ngw/ngupdate.asp
[106] *Natural Gas Supply and Prices: Frequently Asked Questions*, *supra note* 102.

- **Contract terms**: gas suppliers can 'shop around' and negotiate different contracts with different terms with a variety of suppliers. This protects a utility's gas receipts from being curtailed by such events as financial difficulties of a single supplier, natural disasters, etc.[107]
- **Programs for low-income households**: discounts, fee waivers, efficiency and weatherization programs, and arrearage forgiveness funded by customers and stockholders. According to AGA, utilities provided $2.4 billion in assistance to low-income households in 2009.

Utility plans and strategies for billing, hedging and storage are subject to authorization by PSC.

Outlook for Natural Gas Demand and Supply

The EIA's projection for natural gas demand by sector in the Mid- and South-Atlantic census divisions shows a slow growth in the next 25 years (see Table 2-15 on the following page).[108] However, in the EIA's Annual Outlook's reference case, domestic U.S. natural gas production is forecast to increase, resulting in a decrease of the amount of natural gas imported. In the EIA's Annual Outlook, by 2035, U.S. imports of Canadian natural gas fall to 2.8 trillion cubic feet, while U.S. natural gas exports to both Canada and Mexico increase. Natural gas demand is expected to increase: for example, natural-gas-fired power plants are forecast to account for 60 percent of capacity additions between 2010 and 2035.

Several factors influence demand prospects for natural gas in Maryland. These include:

- Population change
- Economic growth
- Appliance technology
- Grid expansion
- Energy efficiency (especially of houses/buildings)
- Structural change: shift toward service economy
- Prices for natural gas
- Energy policy (e.g., CO2 emission constraints)

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[107] *Clean and Efficient Energy Solutions*, *supra note* 87.
[108] For purposes of the EIA Energy Outlook Report 2011, Maryland is at the border of the Mid- and South- Atlantic census divisions.

Table 2-15: Natural Gas Consumption by End-use Sector & Census Division, Reference Case (trillion cubic feet)[109]

Sector and Region	2010	2015	2020	2025	2030	2035	Growth Rate (2009-2035)
Residential							
Middle Atlantic	0.83	0.87	0.88	0.88	0.89	0.88	0.10%
South Atlantic	0.47	0.46	0.47	0.48	0.49	0.49	0.40%
Commercial							
Middle Atlantic	0.6	0.68	0.7	0.72	0.75	0.79	1.00%
South Atlantic	0.38	0.4	0.43	0.44	0.46	0.48	1.00%
Industrial							
Middle Atlantic	0.34	0.43	0.46	0.48	0.5	0.53	2.00%
South Atlantic	0.48	0.59	0.59	0.57	0.56	0.55	0.80%
Electric Power							
Middle Atlantic	0.77	0.77	0.71	0.75	0.83	0.91	0.70%
South Atlantic	1.17	0.87	0.87	0.94	1.09	1.21	-0.30%
Transportation							
Middle Atlantic	0	0.01	0.01	0.02	0.02	0.03	9.40%
South Atlantic	0	0.01	0.01	0.02	0.02	0.03	7.70%
All Sectors							
Middle Atlantic	2.54	2.75	2.76	2.85	3	3.14	0.80%
South Atlantic	2.5	2.32	2.37	2.45	2.61	2.75	0.30%

Population

Maryland's population is expected to keep growing, from approximately 5.7 million[110] in 2010 to 6.2 million in 2020,[111] or at a rate that is slightly less than 1 percent per year. During that same period, households are expected to grow at a rate of a little over 1 percent per year. This data suggests that household size is decreasing, although certain high-growth areas are identified—such as Southern Maryland, the Upper Eastern Shore, and Frederick County. An overall trend of decreasing household size, however, will likely negatively impact space heating demand.

Technology

Technology affects every aspect of natural gas supply and demand—from identification and extraction, to consumer-side consumption. Advancements in technology and efficiency have helped fuel a resurgence of interest in natural gas air conditioning. Additionally, natural gas appliances are rising in popularity. While more expensive to purchase, they are often cheaper to operate. Examples include space heaters, clothes dryers, pool and jacuzzi heaters, fireplaces, barbecues, garage heaters and outdoor lights.[112]

[109] *Annual Energy Outlook 2011*, *supra note* 51.
[110] U.S. Census Bureau, *Census 2010* (2011) [hereinafter *Census 2010*].
[111] Maryland Department of Planning, State Data Center, Projections 2010-2040
[112] Natural Gas Supply Association, *Natural Gas Supply Association Home Page* [hereinafter *Natural Gas Supply Association Home Page*], *available at* http://www.naturalgas.org (last visited Dec. 31, 2011).

In-state Production from Shale

New technologies have reduced the cost of extracting natural gas from shale formations; in addition, the estimated amount of recoverable U.S. shale gas resources has more than doubled.[113] Yet recent research by the U.S. Geological Survey (USGS) caused the EIA to slash its official estimate for the Marcellus Shale by nearly 80 percent.[114] Significant increases in shale gas production are specifically predicted for the Northeast region, which includes the Marcellus Shale. In Maryland, Garrett County and parts of Allegany County lie on top of the Marcellus Shale, where an estimated 1 to 8 trillion cubic feet (Tcf) of gas is technically recoverable from the Maryland-side Marcellus Shale. If such predictions prove accurate, Maryland could become a gas-producing state, exporting more natural gas than it consumes.[115]

Although Maryland-side Marcellus Shale exploratory drilling has yet to occur, the Maryland Geological Survey notes increased interest from companies in the Marcellus Shale.[116] However, State government has yet to determine its position on whether or not, and under what conditions, exploitation of the shale resources should be allowed. In the spring of 2011, the House of Delegates adopted HB852 (Marcellus Shale Safe Drilling Act), a bill that required a two-year study of the environmental impacts of shale gas production before any permits could be granted. The Senate failed to adopt the cross-filed bill (SB634) before the end of the 2011 legislative session. Meanwhile, the O'Malley Administration, warned by a series of incidents and problems related to shale gas production in neighboring Pennsylvania, is taking a cautious approach to ensure that shale gas extraction will be done in a responsible, safe manner. It remains uncertain whether Maryland will become a gas-producing state anytime in the near future.

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[113] See *Annual Energy Outlook 2011*, *supra note* 51.

[114] Ian Urbina, *Geologists Sharply Cut Estimate of Shale Gas*, N.Y. Times A16 (Aug. 24, 2011), *available at* http://www.nytimes.com/2011/08/25/us/25gas.html.

[115] David K. Brezinsk, *Geology of the Marcellus Shale In Maryland* (Maryland Geological Survey) (n.d.) [hereinafter *Geology of the Marcellus Shale In Maryland*], *available at* http://www.mgs.md.gov/geo/pub /MarcellusShaleGeology.pdf.

[116] *Geology of the Marcellus Shale In Maryland*, *supra note* 115.

Petroleum

Maryland has no proven reserves of petroleum, and no rigs, oil wells or refineries. Maryland also does not maintain reserves of crude oil or motor oil. Consequently, Maryland relies entirely on imported petroleum to fuel its transportation system and to provide what heating and heavy fuel oil is consumed in the State. Due to the State's reliance on imported petroleum products, Maryland is particularly vulnerable to disruptions in the supply of petroleum.

Production, Supply, and Distribution

During World War II, to facilitate wartime oil allocation, the nation was divided into 5 Petroleum Administration for Defense Districts (PADD). EIA defines the 5 PADDs as: I-East Coast, II-Midwest, III-Gulf Coast, IV-Rockies, and V-West Coast (see Figure 2-17). The East Coast PADD is composed of three sub districts: 1A-New England, 1B- Central Atlantic, and 1C-Lower Atlantic. Maryland lies within PADD 1 (East Coast Sub district 1B), along with Pennsylvania, West Virginia, Virginia, Delaware and New Jersey. Some of Maryland's neighboring states in PADD 1 have oil rigs, oil wells, refineries and/or reserves (see Figure 2-17) which can be called upon during shortages.

Figure 2-17: PADD Districts[117]

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[117] U.S. Energy Information Administration, *Petroleum Administration for Defense Districts, available at* http://www.eia.gov/pub/oil_gas/petroleum/analysis_publications/oil_market_basics/paddmap.htm

Table 2-16: Reserves, Supply, Capacity, and Distribution in Petroleum Sector[118]

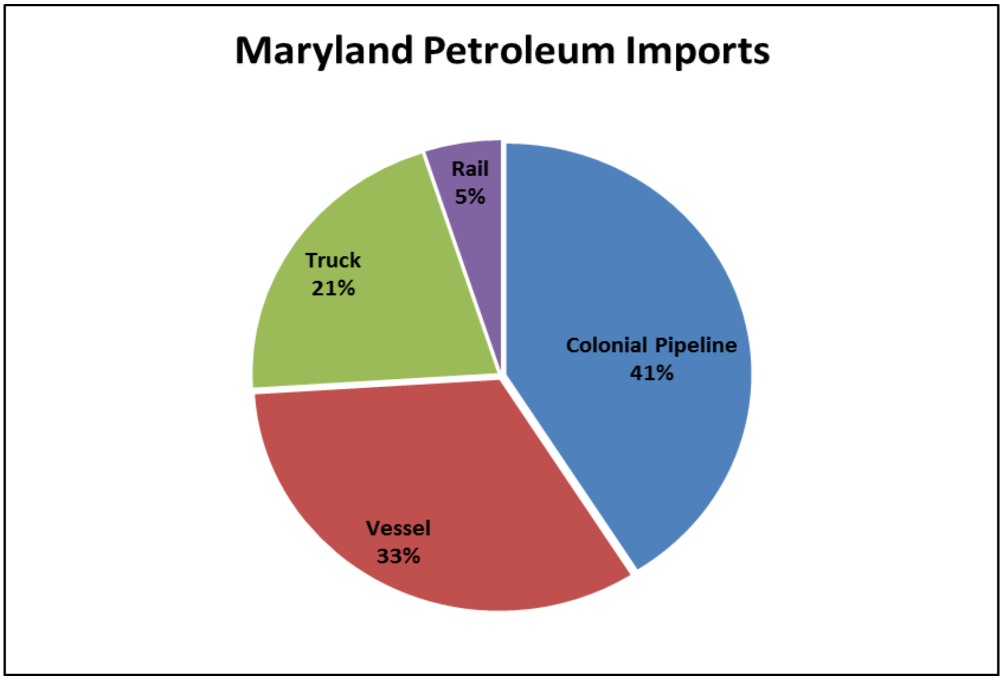
Metric	Period	MD	U.S. Rank	DE	NJ	VA	PA	D.C.	WV	U.S.
Reserves and Supply										
Reserves										
Proved nonproducing Reserves	2009	-	-	-	-	-	-	-	-	6,015
Crude Oil (million barrels)	2009			-	-	-	10	-	19	20,682
Wells										
Rotary Rigs in Operation	2009	-	-	-	-	4	42	-	22	1,546
Crude Oil Producing Wells	2009	-	-	-	-	3	19,841	-	3,965	363,459
Production										
Crude Oil Production (Annual-thousand barrels)	2009	-	-	-	-	14	3,541	-	1,864	2,011,855
Capacity										
Crude Oil Refinery Capacity (Annual-thousand barrels)	2010	-	-	-	510,00	66,300	773,000	-	20,000	178,518
Net Electricity Generation										
Petroleum-Fired (Megawatts)	2009	3,302	5	573	1,361	2,851	5,132	850	19	63,254
Stocks										
Motor Gasoline (thousand barrels)		-	-	-	731	358	709	-	72	219,473
Distillate Fuel Oil (thousand barrels)		3,190	10	514	14,339	2,370	5,768	-	156	164,452
Petroleum Stocks at Electric Power Producers (thousand barrels)	2011	1,463*	-	1463*	-	2,075	1,287	1463*	139	35,578

118 U.S. Energy Information Administration, *U.S. States, available at* http://www.eia.gov/state/.

Metric	Period	MD	U.S. Rank	DE	NJ	VA	PA	D.C.	WV	U.S.
Production Facilities										
Petroleum Refineries	2010	-	-	1	5	1	5	-	1	148
Distribution and Marketing										
Distribution Centers										
Oil Seaports/ Oil Import Sites		Baltimore		Wilmington	Newark, Paulsboro, Perth Amboy	Newport News, Norfolk	Philadelphia, Marcus Hook	None	None	Not known
Major Pipelines										
Crude Oil		None		None	None	None	None	None	Eureka	Not known
Refined Petroleum Product		Colonial Pipeline		Motiva Pipeline	Buckeye, Colonial, Sun.	Colonial-Plantation	Atlantic, Buckeye, Colonial,	None	Consolidated Natural Gas, Koch	Not known
LPG		None		None	None	None	TEPPCO	None	Consolidated Natural Gas, Koch.	Not known
Fueling Stations										
Motor Gasoline	2007	2,182	Not known	373	3,142	4,140	4,713	118	1,450	Not known
LPG	2011	22	35	3	10	38	70	-	8	2,585
CNG	2011	6	29	1	19	9	24	2	-	875
Ethanol	2011	19	26	1	5	14	36	3	2	2,357
Other Alternative Fuels	2011	65	17	3	14	24	10	7	3	1,666

According to the Maryland Department of Environment (MDE), oil is transported into and through the State in the following ways: pipeline (41 percent), vessel (33 percent), truck (21 percent) and rail (5 percent) (see Figure 2-18 below).[119]

Figure 2-18: Maryland Petroleum Imports



Maryland imports petroleum products from other states and countries via tanker ship into the Port of Baltimore and Salisbury, through the Colonial Pipeline, and over land by rail and truck (see Figure 2-20). Central Maryland is directly connected to the pipeline distribution network, while the Eastern Shore obtains its fuel by barges operated by the Cato Oil Company. Petroleum products for six counties on the Eastern Shore are transported to Salisbury, Maryland (in Wicomico County) by barges from a refinery in Yorktown, Virginia.

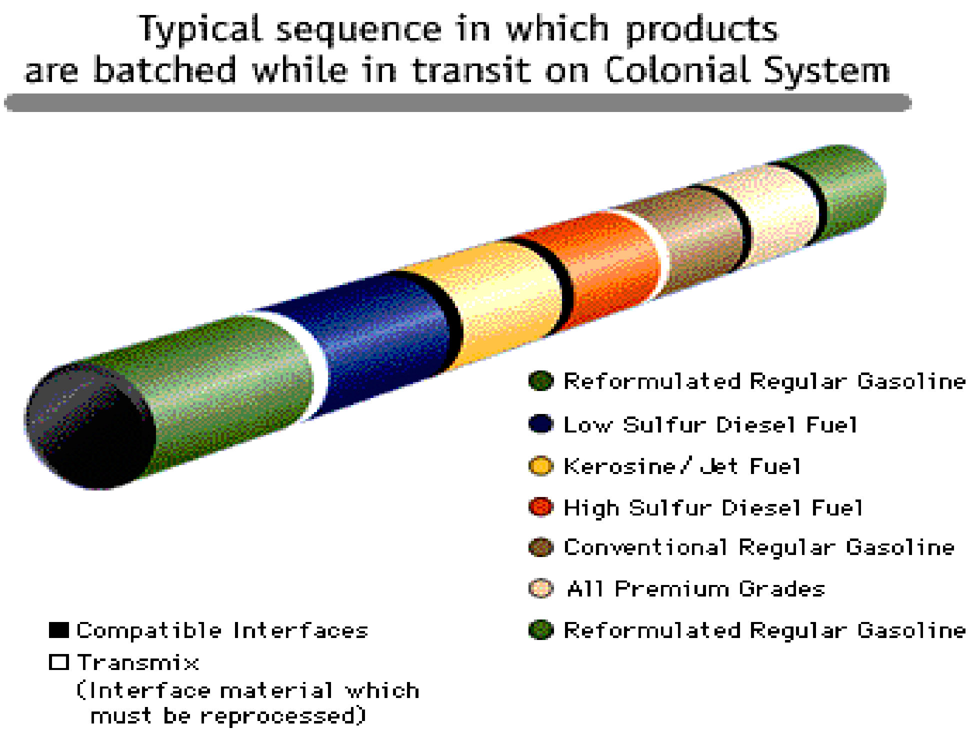
Western Maryland obtains most of its fuel by trucks. Ewing Oil distributes petroleum to service stations and commercial customers in Western Maryland and the Washington, D.C. region, providing petroleum to major filling stations like BP, Citgo, Gulf, Liberty and Shell. Apex Oil Company operates two petroleum fuel and terminal facilities in Baltimore, providing a variety of petroleum products, including kerosene, fuel oil, diesel oil, heavy oil and gasoline.

[119] Maryland Department of Environment, *Maryland's Oil Spill Response Capabilities* (n.d.) [hereinafter *Maryland's Oil Spill Response Capabilities*], *available at* http://www.mde.state.md.us/assets/document/MDE_OC_oils pillcapablities_factsheet.pdf.

Colonial Pipeline

Colonial Pipeline is an "interstate common carrier of petroleum products", including thirty-eight grades of gasoline, seven grades of kerosene, sixteen grades of home heating oil and diesel fuel, several national defense fuels and one grade of transmix.[120] The 5,519 mile pipeline system, originating from facilities in Texas, Louisiana, Mississippi and Alabama, averages 100 million gallons of petroleum products delivered per day, utilizing its 267 marketing terminals throughout the South and Eastern United States. The smallest batch could consist of three 25,000-barrel batches of fungible (or generic, non-segregated) products, while the largest batch could consist of 3,200,000 barrels of product.[121] Typical separation of products is as follows:

Figure 2-19: Typical Colonial Pipeline Batch[122]



Batches are traditionally separated by a "turbulent flow condition" rather than physically by a mechanical separator or pig.[123] The sequence of batches promotes downgrading of premium gasoline to regular if the batches happen to mix. If gasoline and distillates mix, the product is sold as transmix for re-refining. The products are transported at a three-to-five mile per hour rate.

The Colonial Pipeline operates approximately 250 miles of interstate pipeline in Maryland, while Pepco and ST Services operate 52 miles of intrastate pipeline in Southern Maryland, and Apex Oil operates

[120] Colonial Pipeline Company, *Frequently Asked Questions* [hereinafter *Colonial Pipeline FAQ*], *available at* http://www.colpipe.com/ab_faq.asp (last visited Jan. 1, 2012).
[121] *Colonial Pipeline FAQ*, *supra note* 118.
[122] *Colonial Pipeline FAQ*, *supra note* 118.
[123] *Colonial Pipeline FAQ*, *supra note* 118.

three miles of intrastate pipeline in Baltimore. The Pepco pipeline in Southern Maryland transports fuel from ST Storage in St. Mary's County to a Pepco electric generating facility at Chalk Point in Prince George's County. The Apex Oil pipeline carries gasoline, kerosene and heating oil.[124] The Colonial Pipeline has six delivery facilities in Maryland, all of which are located near Baltimore in Central Maryland: North Baltimore, South Baltimore, Curtis Bay Junction, Curtis Bay, Dorsey Junction, Aberdeen Junction and Baltimore Washington International Airport (see Figure 2-20).

Figure 2-20: Colonial Pipeline

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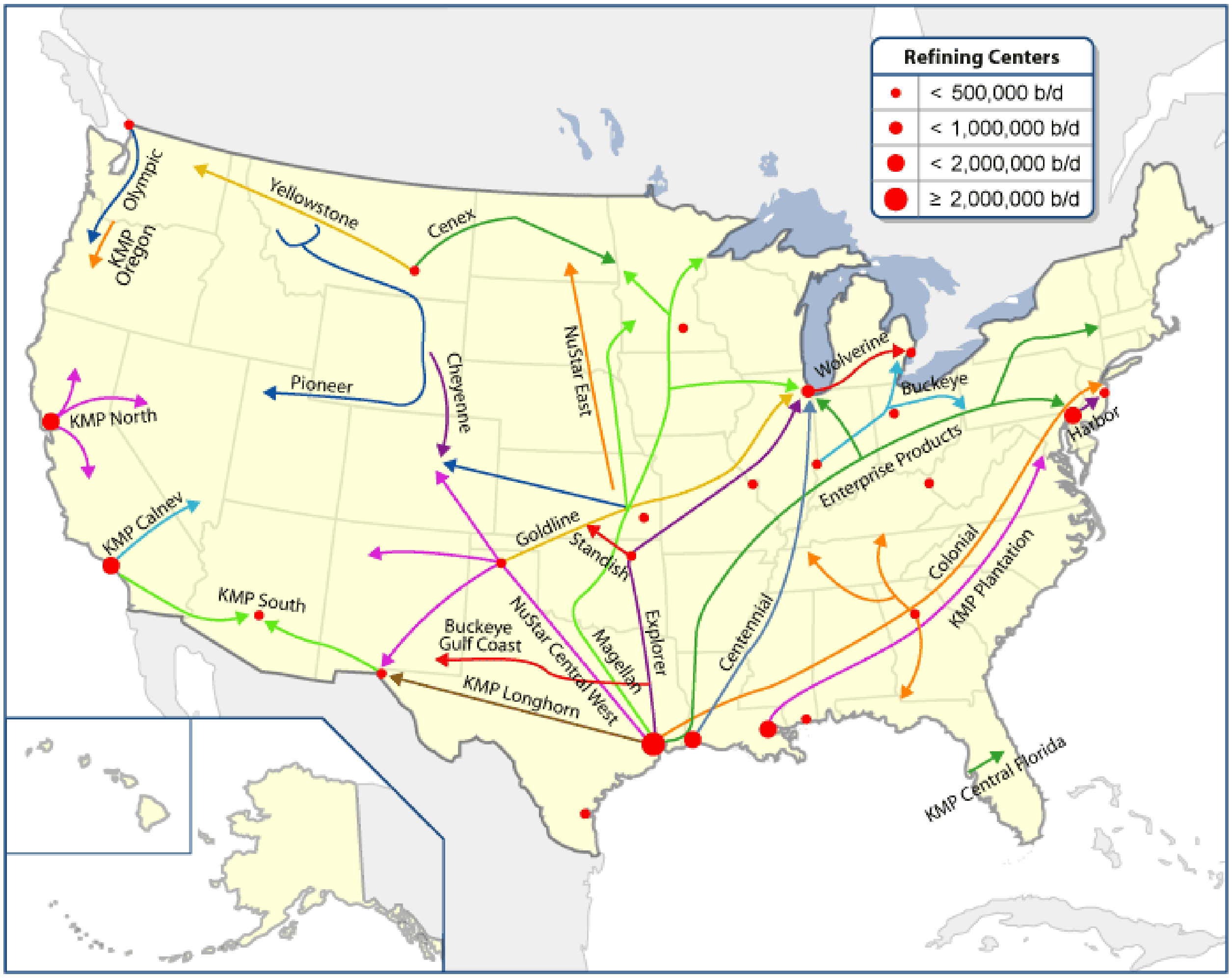
124 Dan Thanh Dang, *Authority Over City Pipeline in Dispute By Oil Company*, *Baltimore Sun* (May 23, 2002) [hereinafter *Dang*], *available at* http://articles.baltimoresun.com/2002-05-23/news/0205230074_1_pipeline-public-service-commissi on-apex.

Figure 2-21: National Refined Petroleum Pipeline System



Delivery Chokepoints

EIA identifies international oil chokepoints. The two most strategic chokepoints are the Strait of Hormuz leading out of the Persian Gulf, and the Strait of Malacca which connects the Indian and Pacific Oceans. According to EIA, the blockage of these two chokepoints would cause substantial impacts on world oil prices. Blockages of these chokepoints, in addition to other important waterways like the Suez Canal (Egypt), Bab el-Mandab (Djibouti/Yemen), Bosporus (Turkey) and Panama Canal (Panama), would likely have downstream impacts on Maryland.

Within Maryland, the use of several different methods of petroleum distribution protects the State as a whole in the case of a crisis at a single chokepoint. However, some geographic regions of Maryland are more susceptible to impacts because of limited distribution points. Specifically, all of the oil used by the Eastern Shore is delivered by barge to Salisbury over the Chesapeake Bay and the Wicomico River, and petroleum trucks are not permitted in the Chesapeake Bay Tunnel. In the case of a disruption to shipping in Chesapeake Bay, petroleum would need to be trucked across the Chesapeake Bay Bridge. Similarly, a blockage of the Port of Baltimore would have severe implications for central Maryland.

Distillate Fuel Oils

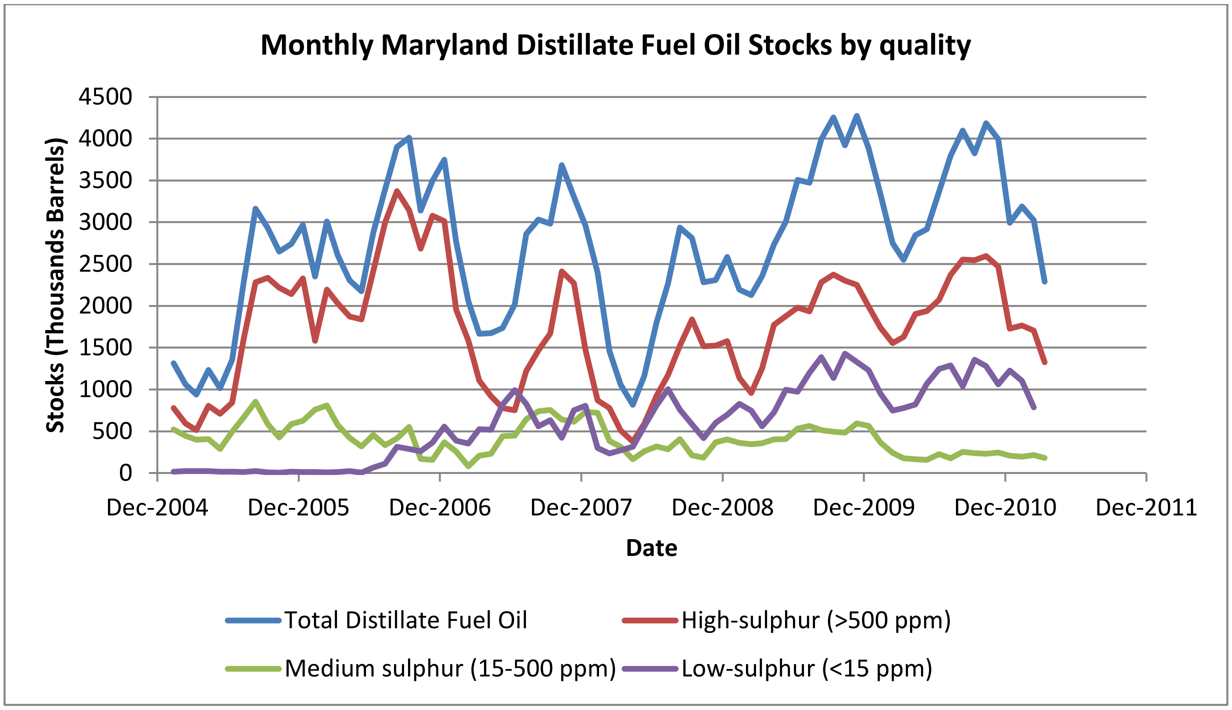
Distillate fuel oils are a product, or *fraction*, of petroleum distillation and include home heating oils and diesel motor fuel. From one 42-gallon barrel of crude oil, refineries produce approximately 11 gallons of distillate, of which 2 gallons are heating oil and 9 are diesel.[125] Heating oil is less processed than diesel and is allowed to contain more sulphur, which makes heating oil cheaper than diesel.[126] Over the last few years most States in New England have implemented more stringent fuel standards that require replacement of high sulfur (2,000 parts per million) heating oil to ultra low sulfur heating oil (15 parts per million). In February of 2011, DOE replaced all of the heating oil in the Northeast Heating Oil Reserve with ultra low sulfur oil. Although Maryland has not yet legislated the use of ultra low sulfur heating oil, the switch in the Northeast will likely affect the supply and prices in the State. As it now stands, consumers may use ultra low sulfur diesel fuel in their furnaces, which burns cleaner and necessitates less furnace maintenance than the current high sulfur heating oil.

Annually, as the weather grows colder, refineries manufacture most— about 90 percent — of the heating oil consumers need. In the winter months, demand for heating oil is highest and demand for gasoline is slightly reduced, as people drive less. Some heating oil is produced and stored during the summer and fall months to supplement winter production and high consumer demand.[127]

All home heating oil consumed within Maryland is imported, and can be stored between receipt of supplies and distribution to customers. Figure 2-22 shows monthly distillate fuel stocks in Maryland by sulphur content since 2005. Home heating fuel has higher sulphur content and is tracked in Figure 2-22 by the red line. Heating oil is primarily required during the winter and largely unneeded during the summer and a seasonal pattern emerges in the supply.

[125] U.S. Energy Information Administration, *Heating Oil Explained* [hereinafter *Heating Oil Explained*], *available at* http://www.eia.gov/energyexplained/index.cfm?page=heating_oil_home (last visited Jan. 1, 2012).
[126] *Heating Oil Explained*, *supra note* 125.
[127] American Petroleum Institute, *Heating Oil* (2011) [hereinafter *Heating Oil*], available at http://www.api.org/aboutoilgas/heatingoil/.

Figure 2-22: Monthly Maryland Distillate Fuel Oil Stocks since 2005.[128]



Maryland receives its supplies of distillate fuel oil from several sources (similar to sources of other refined petroleum products):[129]

1. shipments from Gulf Coast refineries via the Colonial Pipeline and to a smaller extent via barges,
2. shipments from (out-of-state) Central Atlantic refineries distributed throughout the Northeast by barges and to inland Pennsylvania and New York (not Maryland) via the Buckeye pipeline system,[130] and
3. imports from offshore or foreign areas (mostly Canada, the U.S. Virgin Islands, and Venezuela).

Imports from offshore or foreign areas arrive at central distribution centers such as New York Harbor and Boston, from which they are redistributed. Figure 2-23 displays the three sources of distillate fuel oil supply for the Northeast.

[128] U.S. Energy Information Administration, *Refinery, Bulk Terminal, and Natural Gas Plant Stocks by State* (2011) [hereinafter *Refinery, Bulk Terminal, and Natural Gas Plant Stocks by State*], *available at* available at http://www.eia.gov/dnav/pet/pet_stoc_st_a_EPD0_STR_mbbl_m.htm.

[129] *Refinery, Bulk Terminal, and Natural Gas Plant Stocks by State*, *supra note* 128.

[130] A system map of the Buckeye pipeline system can be viewed here: http://www.buckeye.com/About Us/SystemMap/tabid/57/Default.aspx.

Figure 2-23: Northeast Distillate Fuel Oil Supply Sources[131]

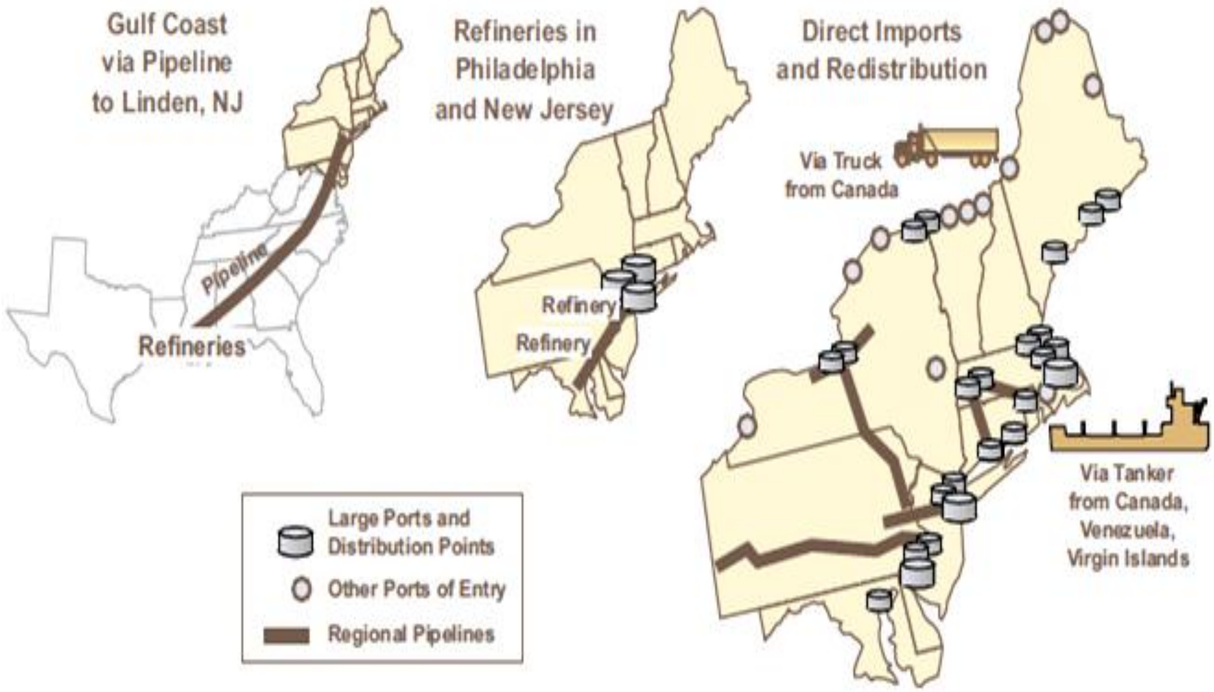


Figure 2-23 displays the points of origin of distillate fuel oil supplied to PADD 1 states. Most of the PADD 1 supply (in terms of "all grades combined") comes from Gulf Coast refineries. In 2010, 65 percent of East Coast distillate came from the Gulf Coast, 19 percent from East Coast refineries and 16 percent was imported from other countries, with most products coming from Canada and the Virgin Islands (see Table 2-17). For high-sulphur distillate fuel oil (Figure 2-25), used primarily for heating purposes, supplies from Gulf Coast refineries have a much smaller share and more is produced within the region itself from crude oil imports (40 percent in 2010).

[131] U.S. Energy Information Administration, *The Northeast Heating Fuel Market: Assessment and Options* (2000) [hereinafter *Northeast Heating Fuel Market*], *available at* http://www.eia.gov/oiaf/servicerpt/nehfuel/index.html.

Figure 2-24: East Coast (PADD 1) total distillate fuel oil supply by source (see Figure 2-25 for legend)[132]

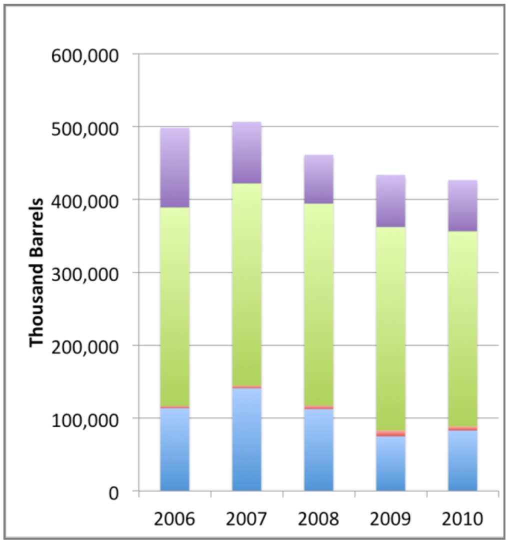


Figure 2-25: East Coast (PADD 1) high-sulfur distillate fuel oil supply by source[133]

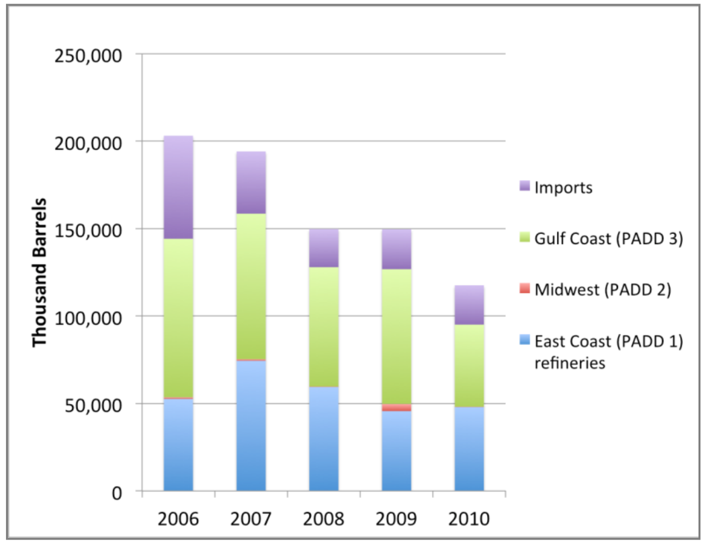


Table 2-17: East Coast yearly distillate fuel oil imports by origin (in thousands of barrels). Order based on highest yearly average over 2005-2010.[134]

Origin	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*
East Coast total	**106,151**	**109,232**	**84,543**	**67,015**	**71,562**	**70,297**
Non-OPEC	87,164	92,932	79,176	64,743	68,188	69,527
OPEC	18,987	16,300	5,367	2,272	3,374	770
Canada	33,072	34,031	36,372	33,060	36,831	40,660
U.S. Virgin Islands	34,369	34,702	30,882	24,999	24,484	20,499
Venezuela	18,006	16,300	4,552	576	2,366	560
Russia	2,616	8,200	6,042	2,308	3,449	4,344
Aruba	5,488	1,547	525	2,064	905	
Netherlands	3,659	5,153	275	352	661	746

[132] U.S. Energy Information Administration, *Petroleum & Other Liquids Data* [hereinafter *Petroleum & Other Liquids Data*], *available at* http://www.eia.gov/petroleum/data.cfm (last visited Jan 1, 2012).
[133] *Petroleum & Other Liquids Data*, *supra note* 132.
[134] *Petroleum & Other Liquids Data*, *supra note* 132.

During particularly cold weather or prolonged cold spells, heating oil in storage is used much faster than it can be replenished, and refineries may not keep up with demand. Because there is a delay from days to weeks in the delivery of new product, wholesale resellers are able to bid up prices for the product in regional storage. In the Northeast, additional supplies may have to come from great distances, such as the Gulf Coast or overseas, which also adds to the cost.

Alternative Fuels and Modes

Broadly speaking, an alternative fuel vehicle is any vehicle that is powered by a fuel that is not refined from crude oil. Popular alternative fuels include bio-diesel, ethanol, hydrogen, electricity, and compressed natural gas. Alternative fuel vehicles and fueling stations are becoming increasingly popular in Maryland. In 2008, there were approximately 18,000 alternative fuel vehicles in the State and they constituted 0.4 percent of the 4,525,000 automobile registrations in Maryland in that year.[135] As alternative fuels displace traditional crude oil based fuels, new concerns with their supply and distribution of their fuel will arise.

Ethanol has become an increasingly common additive to gasoline (called reformulated gasoline), and up to 10 percent is commonly added to gasoline at pumps in Maryland. Adding ethanol to gasoline lowers emissions, and consequently service stations in central Maryland are required by the federal government to sell only reformulated gasoline.[136] Ethanol consumption in Maryland is relatively high (see Table 2-18) and all ethanol is imported from other states. During emergency events, the State, via MDE can petition USEPA to suspend the requirement for reformulated gasoline.

Table 2-18: Alternative Fuels[137]

	Period	Maryland	US Rank	Delaware	New Jersey	Virginia	Pennsylvania	DC	West Virginia	US
Alternative Fuel Vehicles	2008	16,278	14	2,397	18,742	21,505	13,307	6,415	2,256	775,667
Percentage		2.1%		0.3%	2.4%	2.8%	1.7%	0.8%	0.3%	
Ethanol consumption (thousand barrels)	2009	5,233	22	880	9,341	8,616	10,726	163	1,667	262,776
Percentage		2.0%		0.3%	3.6%	3.3%	4.1%	0.1%	0.6%	
Ethanol Plants	2011	-		-	-	1	1	-	-	204
Percentage		-		-	-	0.5%	0.5%	-	-	
Ethanol Plant Capacity (million gallons)	2011	-		-	-	65	110	-	-	13,508
Percentage		-		-	-	0.5%	0.8%	-	-	

135 U.S. Census Bureau, *US Statistical Abstract Table 1097: State Motor Vehicle registrations 1990-2008* (2011) [hereinafter *US Statistical Abstract Table 1097*], available at http://www.census.gov/compendia /statab/2011/tables/11s1097.pdf.
136 U.S. Environmental Protection Agency, *Reformulated Gas*, *available at* http://www.epa.gov/otaq/fuels/gasoline fuels/rfg/areas.htm.
137 U.S. Energy Information Administration, *Alternatives to Traditional Transportation Fuels 2008* (April 2010), *available at* http://www.eia.gov/cneaf/alternate/page/atftables/afv-atf2008.pdf.

Using ethanol as a fuel source has become easier in recent years as more E85 models that can operate on up to 85 percent ethanol become available. Currently nearly 50 percent of the cars produced by General Motors, Ford and Chrysler are FFV's that can use up to 85 percent ethanol. There are currently about 250,000 E85 vehicles in Maryland with more expected in the future.[138] There are also 18 service stations in the State that offer E85 fuel with 10 more in the planning stages. As ethanol based fuel increases its market in Maryland, it will displace petroleum as a fuel and should in effect decrease the State's reliance on imported oil products.

Maryland has several alternative fueling stations available, including 22 Liquefied Petroleum Gas (LPG), 6 Compressed Natural Gas (CNG) and 18 ethanol (E85) stations. Maryland received stimulus funding in 2010 to install approximately 65 electric charging stations.

Energy Demand by Transportation

The transportation sector is responsible for nearly one-third of all energy used in Maryland, and nearly all of the energy used in transportation comes from petroleum products. More than 84 percent of all petroleum in Maryland is used for transportation, compared to 71 percent nationwide (see Figure 2-26 on the following page). Even though Maryland ranks 41st in overall per capita energy use in the nation, it ranks 16th for per capita gasoline consumption.

Data on petroleum use by transportation mode is only available at the national level, and is published in the Transportation Data Energy Book.[139] In the United States, over two-thirds of petroleum is used for light vehicles, including automobiles, light trucks, and vans. Nearly 20 percent is used by medium and heavy trucks, and less than 10 percent of petroleum is used by airlines.

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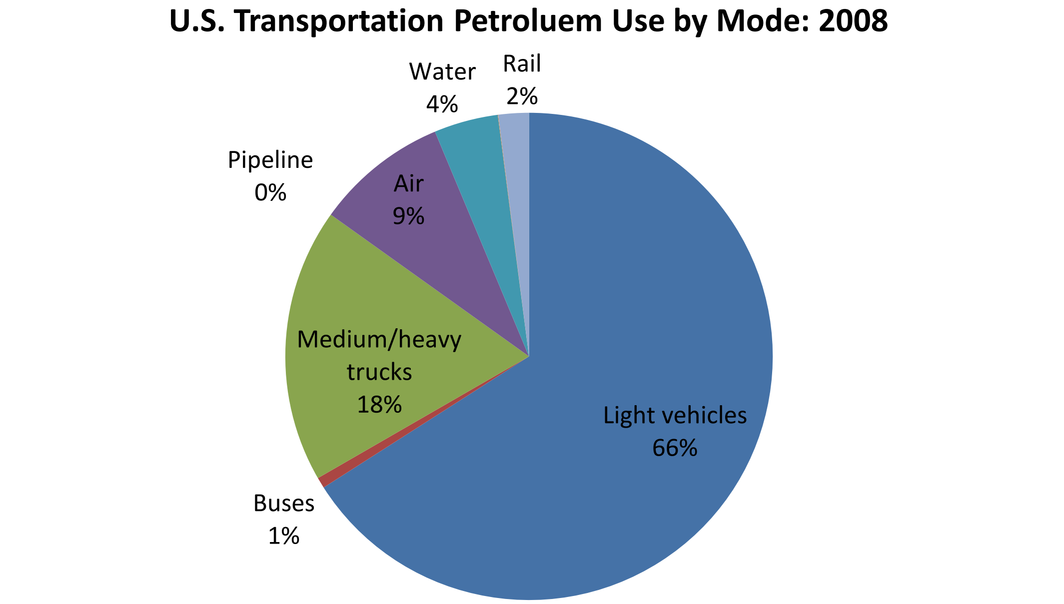
[138] Biofuels Journal, *MD Grain Producers Utilization Board Joins Clean Fuels Foundation Flex Fuel Vehicle Awareness Campaign* (2011) [hereinafter *MD Grain Producers Utilization Board*], *available at* http://www.biofuelsjournal.com/articles/MD_Grain_Producers_Utilization_Board _Joins_Clean_Fuels_Foundation_Flex_Fuel_Vehicle_Awareness_Campaign-103850.html.

[139] Oak Ridge National Laboratory, Transportation Data Energy Book, Edition 29 (2010), *available at* http://info.ornl.gov/sites/publications/files/pub24318.pdf.

Figure 2-26: Petroleum Use by Mode in the United States-2008



Data Source:Transportation Energy Data Book, 2009 Table 1.16

Table 2-19: Petroleum Consumption in the Transportation Sector of Maryland[140]

	Period	Maryland	Share	US Rank	US
Consumption					
Per Capita					
Total Energy (million Btu)	2009	256		41	327
By Source					
Total Energy (trillion Btu)	2009	1,447			99,382
Total Petroleum (million barrels)	2009	102		24	6,852
Motor Gasoline (million barrels)	2009	70	68%	16	3,284
Distillate Fuel Oil (million barrels)	2009	20	19%	29	1,325
LPG (million barrels)	2009	3	3%	28	749
Jet Fuel (million barrels)	2009	3	3%	29	509
By End Use Sector (Petroleum)					
Residential (thousand barrels)	2009	5,465	5%	17	250,770
Commercial (thousand barrels)	2009	2,520	2%	17	130,140
Industrial(thousand barrels)	2009	7,325	7%	36	1,560,102
Transportation (thousand barrels)	2009	85,728	84%	19	4,846,677
Electric Power (thousand barrels)	2009	630	1%	17	63,871
Total (thousand barrels)	2009	101,668	100%	24	6,851,560

[140] U.S. Energy Information Administration, *Maryland Energy Fact Sheet*, *available at* http://www.eia.gov/state/state-energy-profiles-print.cfm?sid=MD.

Table 2-20: Petroleum end uses

	Period	Maryland	U.S.
Total Petroleum (million barrels)	2009	100%	100%
Share Motor Gasoline (million barrels)	2009	68%	48%
Share Distillate Fuel Oil (million barrels)	2009	19%	19%
Share LPG (million barrels)	2009	3%	11%
Share Jet Fuel (million barrels)	2009	3%	7%
By End Use Sector (Petroleum)			
Share Residential (thousand barrels)	2009	5%	4%
Share Commercial (thousand barrels)	2009	2%	2%
Share Industrial(thousand barrels)	2009	7%	23%
Share Transportation (thousand barrels)	2009	84%	71%
Share Electric Power (thousand barrels)	2009	1%	1%
Total (thousand barrels)	2009	100%	100%

Travel in Maryland

Maryland's transportation sector energy use is reflected in its choice of travel mode. According to the 2010 Census, Maryland's travel statistics echo the national average (see Table 2-21) but with a slightly higher use of public transportation. About 84 percent of commuters drive to work, and approximately 3.6 percent of Maryland workers use non-motorized transportation (walking or bicycling). Maryland's Smart Growth program, which represents a package of legislative programs enacted between 1997 and 2001, encourages moving away from auto-dependency toward alternative modes of transportation. Governor Martin O'Malley established a goal to double transit ridership by 2020 by expanding services and promoting Transit Oriented Development (TOD.)[141] However, in a 2011 report, the National Center for Smart Growth Research and Education found that, while Maryland had higher transit ridership than many states, the relatively higher rates were attributable to its proximity to Washington, D.C. and historical investments by the state of Maryland rather than its specific policy initiatives like the Smart Growth program.[142]

[141] Martin O'Malley webpage, *Leadership and Innovation* [hereinafter *O'Malley Leadership and Innovation*], *available at* http://www.martinomalley.com/issue/issue/leadership_and_innovation/#leadership_and_innovation_11 (last visited Jan. 1, 2012).

[142] The National Center for Smart Growth Research and Education at the University of Maryland, *Indicators of Smart Growth in Maryland* [hereinafter *Indicators of Smart Growth in Maryland*], *available at* http://www.smartgrowth.umd.edu/research/pdf/SartoriMooreKnaap_MD Indicators_010611.pdf.

Table 2-21: Travel Mode in 2010 (by percentage)[143]

	Drive Alone	Carpooled	Public Transportation	Bicycle, Walk, & Others	Work at Home
Maryland	73.2	10.8	8.5	3.6	3.8
Delaware	78.6	10.6	3.8	4.1	3
District of Columbia	37.2	6.6	35.7	15.8	4.7
New Jersey	71.7	9.1	10.3	5.5	3.3
Pennsylvania	76.2	9.7	5.3	5.3	3.4
Virginia	76.7	10.9	4.3	3.8	4.3
West Virginia	80.9	10.9	.8	4.5	3
Nation	75.5	10.7	5	4.6	4

Energy Use by Transit Providers

Mass transit is a vital component in Maryland's transportation system. Transit systems are large consumers of petroleum and other fuels, although their share of total fuel consumption is small, and the amount of fuel use per passenger is small compared to using personal vehicles. Rail transit is primarily located in Central Maryland in the Baltimore-Washington corridor. The Maryland Transit Administration (MTA) operates three types of train systems—MARC Train, Metro rail (Baltimore subways system) and light rail—that, together, consumed a total of 92 million kWh in 2009 (see Table 2-22).

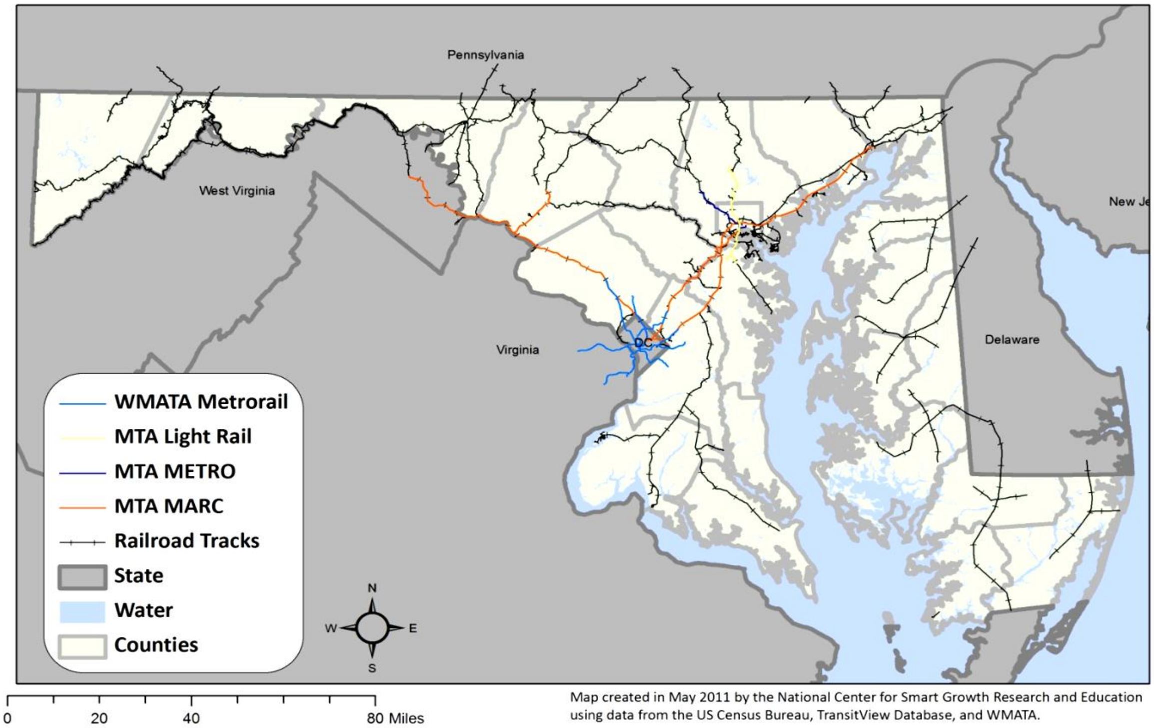
Table 2-22: Energy Consumption by Transit Agencies in Maryland, 2009[144]

2009 Annual Use by Transit Agencies (Excludes WMATA)	
Type of Energy	**Amount Consumed**
kWh Propulsion	92,612,613
Gallons of Diesel	16,252,770
Gallons of Gas	1,472,108
Gallons of CNG	1,114,680
Gallons of Biodiesel	61,721

[143] U.S. Census Bureau, *Census 2010: Workers 16 Years and Over, Means of Transportation to Work* [hereinafter *Census 2010: Workers 16 Years and Over*], *available at* http://www.census.gov/compendia/statab/2011/tables/11s1099.pdf.

[144] American Public Transportation Association, *National Transit Database 2009* (n.d.) [hereinafter *National Transit Database 2009*], *available at http://www.apta.com/resources/statistics/Documents/NTD_Data/2009_NTD/T17_Energy_Consumption.xls.*

Figure 2-27: Transit and Railroad Network in Maryland



Other transit modes are motor bus and demand response service, which rely heavily on three types of fuel: diesel, gasoline, and CNG. Demand response services, like MetroAccess in the Washington Region, provide transportation to populations in need, often carrying several passengers at once along flexible routes. Table 2-23 provides energy consumption by transit agency in Maryland, combining all modes, compared to all U.S. transit providers. Diesel fuel comprises 85 percent of fuel consumed to provide on-road transit services, as compared to the national rate of 69 percent. The use of alternative fuels such as ethanol, methanol, kerosene, LNG and LPG in Maryland transit systems is negligible. Additionally, Maryland's use of CNG and biodiesel fuel is also significantly lower than national figures.

Most buses in Maryland run on diesel fuel, which constitutes approximately 86 percent of all fuel consumed for providing bus services. The Annapolis Department of Transportation and Montgomery County Transit Ride On use CNG for a portion of their fleets, while the Tri-County Council for the Lower Eastern Shore of Maryland uses biodiesel buses for a portion of its fleet.

Table 2-23: Energy Consumption by Maryland Transit Agencies and the U.S., All Modes Combined[145]

	Propulsion Powe	Charge Batteries	Diesel Fuel	Gasoline	LPG	LNG	CNG	Kerosene	Other fuel	Biodiesel
	(kWh)	(kWh)	(gl)	(gl)	(gl)	(gl)	(gl)	(gl)	(gl)	(gl)
Maryland Transit Administration	92,612,613	-	11,963,086	1,138,029	-	-	-	-	-	-
Annapolis Department of Transportation	-	-	101,019	-	-	-	2,295	-	-	-
Allegany County Transit	-	-	28,476	32,789	-	-	-	-	-	-
Washington County Transit	-	-	97,163	-	-	-	-	-	-	-
Howard Transit	-	-	209,963	3,095	-	-	-	-	-	-
Ride-On Montgomery County Transit	-	-	2,513,813	71,016	-	-	1,112,385	-	-	-
Transit Services of Frederick County	-	-	213,039	7,214	-	-	-	-	-	-
Harford Transit	-	-	102,956	11,303	-	-	-	-	-	-
Prince George's County Transit	-	-	673,748	-	-	-	-	-	-	-
County Commissioners of Charles County, MD	-	-	37,060	164,914	-	-	-	-	-	-
Carroll County Planning Department	-	-	79,751	15,902	-	-	-	-	-	-
The Tri--County Council for the Lower Eastern Shore of Maryland	-	-	232,696	27,846	-	-	-	-	-	61,721
Maryland Total	92,612,613	-	16,252,770	1,472,108	-	-	1,114,680	-	-	61,721
Maryland Percentage (kWh)	100%	0%								
Maryland Percentage (gl)			85.99%	7.79%	0.00%	0.00%	5.90%	0.00%	0.00%	0.33%
National Total	6,491,593,620	855,743	614,433,404	65,351,373	4,804,592	25,195,388	142,156,164	502,151	2,131,777	43,682,897
National Percentage (kWh)	99.99%	0.01%								
National Percentage (gl)			68.40%	7.28%	0.53%	2.80%	15.83%	0.06%	0.24%	4.86%

Note that Table 2-23 excludes the Washington Metropolitan Area Transit Authority (WMATA), although WMATA provides both rail and bus services to Maryland.

[145] *National Transit Database* 2009, *supra note* 141. Transit Fact Book gives a slightly different look of the consumption of energy in the U.S. transit systems. It counts 7,200 transit systems, including about 5,300 services for the elderly and persons with disabilities. U.S. transit systems consumed 660.6 million gallons of diesel fuel, 348.7 million gallons of other fossil fuel, and 6,542.7 million kWh of electricity in 2009.

Table 2-24 presents WMATA fuel consumption for buses and service vehicles.

Table 2-24: Fuel Consumption by WMATA- 2010[146]

2010 Usage by WMATA	
Type of Energy	**Amount Consumed**
Kwh Propulsion	499,362,474
Gallons of Diesel	9,933,549
Gallons of Gas	3,140,116
Gallons of CNG	5,560,049

Energy Expenditures

Ten transit agencies in Maryland that report to the National Transit Database spent $4.38 billion for fuel and lubricants in 2009 to provide services in-house, not including the cost of services outsourced to other public and private transit providers. Two agencies did not report operating expenses for in-house services. The proportion of fuel and lubricant expenses in the total operating costs for in-house services varies from 5 percent to 24 percent.

Petroleum Product Demand - Non-Transportation

Excluding fuels used in the transportation sector (e.g., diesel fuel and jet fuel), petroleum products are a minor, but not insignificant source of energy in Maryland relative to natural gas and electricity (see Table 2-25).

Table 2-25: Maryland fuel consumption by sector (transportation excluded), 2008 (Measured in trillion BTU)[147]

	Natural Gas	Distillate Fuel Oil	Kerosene	Liquid Propane Gas	Residual Fuel Oil
Residential	84.2	17.7	.6	6.7	N/A
Commercial	73.1	7.0	.1	3.0	.1
Industrial	21.9	9.9	N/A	1.5	3.3

[146] National Transit Database 2009, Energy Consumption File.
[147] *State Energy Data System*, *supra note* 45.

Within the Mid-Atlantic region, reliance on petroleum products for non-transportation purposes is expected to remain constant or decrease in the coming two decades. Decreased reliance on petroleum products will be driven in part by increased dependence on natural gas (see Table 2-26).

Table 2-26: Historical and forecasted consumption of primary fuels and electricity across major sectors (transportation-excluded) in Mid-Atlantic region (Measured in quadrillion BTU)[148]

Sector and Source	2008	2009	2010	2015	2020	2025	2030	2010-2030 Change
Residential								
Liquefied Petroleum Gases	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.0%
Distillate Fuel Oil	0.28	0.27	0.27	0.25	0.22	0.2	0.19	-2.2%
Natural Gas	0.87	0.88	0.85	0.89	0.9	0.91	0.91	5.1%
Electricity	0.45	0.44	0.47	0.42	0.43	0.46	0.48	0.5%
Commercial								
Liquefied Petroleum Gases	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.0%
Distillate Fuel Oil	0.12	0.11	0.1	0.09	0.09	0.08	0.08	-0.2%
Residual Fuel Oil	0.05	0.04	0.03	0.05	0.05	0.05	0.05	0.1%
Natural Gas	0.62	0.62	0.62	0.69	0.72	0.74	0.77	9.3%
Electricity	0.56	0.55	0.57	0.59	0.62	0.64	0.67	5.7%
Industrial								
Liquefied Petroleum Gases	0.04	0.02	0.02	0.03	0.03	0.03	0.03	0.0%
Distillate Fuel Oil	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.0%
Residual Fuel Oil	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.0%
Natural Gas	0.34	0.33	0.35	0.44	0.47	0.49	0.52	6.0%
Electricity	0.25	0.23	0.25	0.28	0.27	0.26	0.24	-0.3%

[148] *Annual Energy Outlook 2011*, *supra note* 51.

After natural gas and electricity, oil is the third-most important fuel source for home heating in Maryland. The EIA estimates that in 2009, around 266,000 or about 13 percent of Maryland homes were heated with petroleum products, such as fuel oil and kerosene (see Table 2-27).

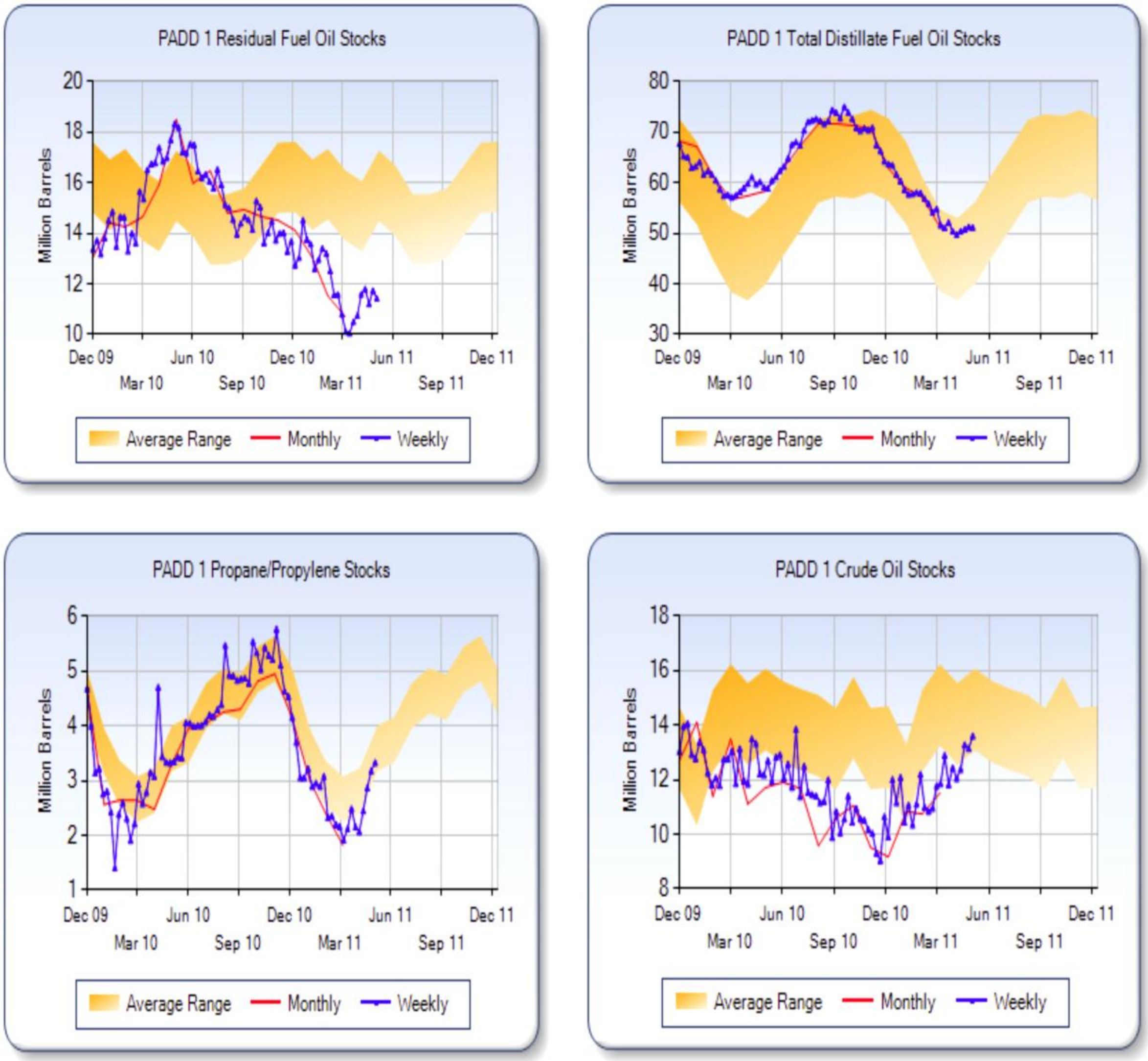
Table 2-27: Maryland housing units and primary heating fuel, 2009 (Measured in number of housing units)[149]

	Estimate	Percent
Occupied housing units	**2,092,538**	**2,092,538**
Natural gas	946,059	45.2%
Bottled, tank, or LP gas	72,711	3.5%
Electricity	769,362	36.8%
Fuel oil, kerosene, etc.	266,013	12.7%
Coal or coke	2,574	0.1%
Wood	22,923	1.1%
Solar energy	292	0.0%
Other fuel	7,655	0.4%
No fuel used	4,949	0.2%

The capacity of a home to store heating oil, as dictated by the size of a storage tank, is limited. As a result, homes will often need to have their storage tanks filled multiple times during the course of a winter season. Propane and distillate fuels are common heating fuels subject to high demand during the winter and low demand during the summer. As a result, the supply and price of these fuels tends to be more seasonal relative to crude oil and residual oil, which are often used for purposes other than space heating (see Figure 2-28).

[149] U.S. Census Bureau, *2005-2009 American Community Survey* (n.d.) [hereinafter *2005-2009 American Community Survey*].

Figure 2-28: Stock of four petroleum products in PADD 1 (includes Maryland) during period December 2009-May 2011[150]

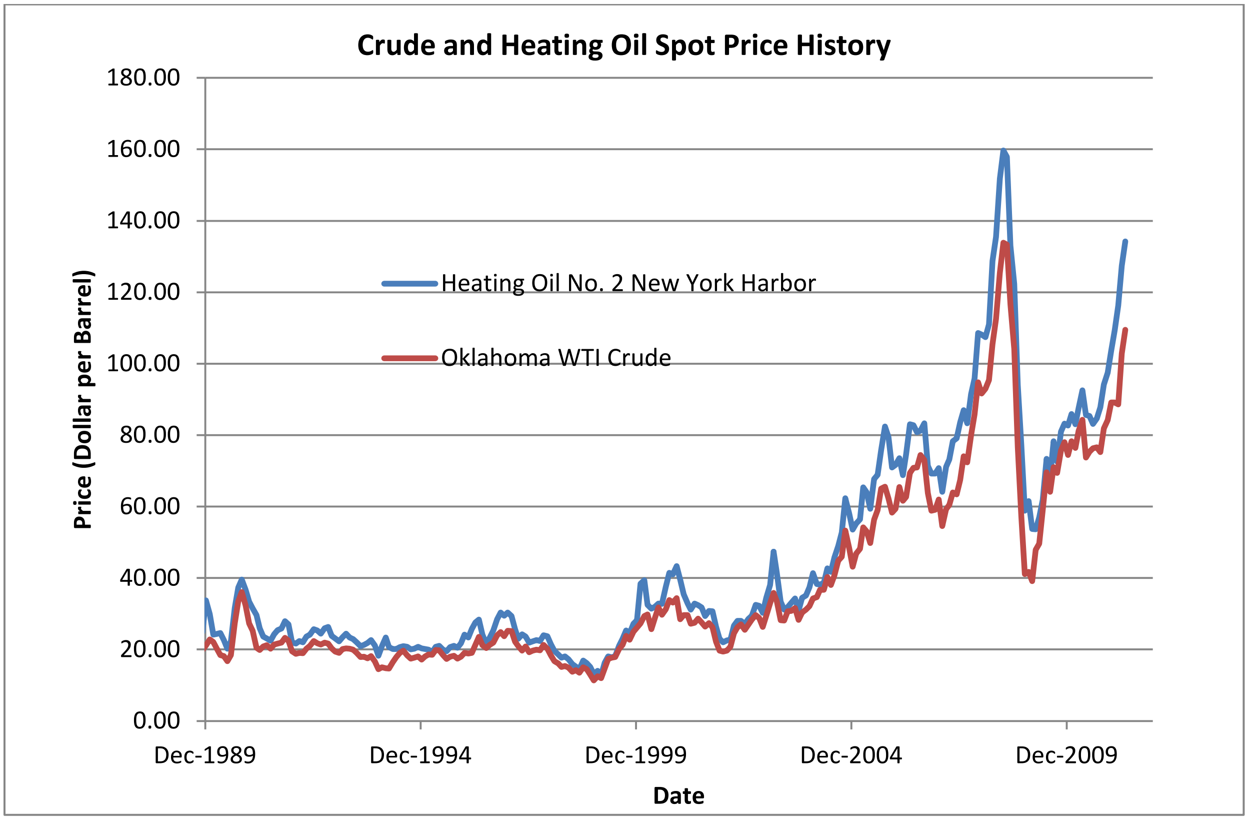


Seasonal price changes in heating fuel occur as demand rises during the winter and decreases during the summer. Between 1992 and 2012, the price for number 2 heating oil, a common home heating fuel, ranged between .98 and 4.11 $/gallon (not adjusted for inflation) (see Figure 2-29).[151] The highest prices occurred during spring months and the lowest prices were during the early fall months. Prices are also subject to global changes in crude oil markets, local competition from suppliers of heating fuel and other geographic-specific factors such as the cost of labor. In the event of an energy disruption such as a pipeline rupture or a frozen waterway that impedes entry for oil-carrying ships, supply will be constrained and heating fuel prices can escalate. Depending on when consumers purchase heating fuels,

[150] U.S. Energy Information Administration, *Weekly Petroleum Status Report* [hereinafter *Weekly Petroleum Status Report*], *available at* http://www.eia.gov/oil_gas/petroleum/data_publications/weekly_petroleum_status_report /wpsr.html (last visited Jan 1, 2012).
[151] *Weekly Petroleum Status Report*, *supra note* 150.

they may be able to achieve lower prices, for example, by scheduling delivery during the summer or fall. Suppliers of heating fuel also provide contracts that spread the cost of fuel over the course of a year or install a cap, which fixes the maximum price.[152] Conservation and energy efficiency are valid options for reducing costs as is participation in Maryland or Federal assistance programs (see Chapter 4).

Figure 2-29: Crude Oil and Heating Oil spot price history[153]



A typical homeowner in Maryland who relies on heating oil consumes around 630 gallons per year (nearly all of which is consumed between October and March).[154] The typical aboveground tank size is around 300 gallons with below-ground tanks holding around 500 gallons on average. Depending on the size of the tank and demand, a homeowner might fill a tank multiple times. Taking heating oil prices into account, it is possible to estimate average annual expenditures on heating oil for a Maryland family. The New York Harbor price for number 2 heating fuel oil was $2.02/gallon on September 1, 2010; on March 1, 2011, the price at the same location was $3.03/gallon. Assuming a homeowner with a 500 gallon tank purchased 450 gallons of fuel oil at each corresponding day and price (900 gallons/year), the individual would spend around $2,300/year for home heating, which would represent a high estimate.[155]

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[152] *Heating Oil Explained*, *supra note* 125.
[153] *Petroleum & Other Liquids Data*, *supra note* 132.
[154] Maryland Energy Administration*, Maryland Energy Emergency Contingency Plan* (January 2001), *at* 9.
[155] This estimate does not consider cost of delivery from local supplier; also tanks should not be filled to capacity to allow the fuel to expand.

Conclusion

Maryland, like many states, is on the cusp of an energy transformation. It faces a number of significant energy challenges, including growing power demands, volatile energy prices, increasing dependence on imported fuels, and climate change. The continued expansion and diversification of Maryland's energy portfolio, continued efforts to enact conservation and efficiency measures (discussed in Chapter 4) and development of energy sector-specific emergency plans (discussed in Chapter 5) will significantly contribute to Maryland's energy assurance.

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Chapter 3. Organizations and Responsibilities

Introduction

Maryland State agencies play various regulatory, advocacy and/or assistance roles in the energy sector. Agencies run programs with goals that range from increasing energy efficiency and conservation, to providing power and heating for outdoor recreation and activities, to ensuring low-income populations have electricity and heating/cooking fuels in the coldest and hottest months of the year. Other agencies ensure that energy supply and distribution routes remain open and secure to enhance swift recovery from an energy interruption.

The State of Maryland, through the Department of General Services also contracts with suppliers of liquid petroleum products to provide 104 State-use filling stations with gasoline, diesel and other fuels. In 2010, the State contracted for and used nearly 11 million gallons of refined petroleum products, including transportation fuels and heating oil. Gasoline throughput alone associated with these contracts was 116,000 gallons per week in 2010, which was 4 percent of the State's total consumption of gasoline from all sectors for that year. Due to these contracts, at any moment in time, the State has tens of thousands of gallons of petroleum in reserve at these filling stations.

This chapter discusses the many roles of several State agencies in assuring the resiliency and post-interruption recovery of Maryland's energy sector. The State of Maryland Core Plan for Emergency Operations includes an energy specific Emergency Support Function 12 (ESF-12) that further describes the roles of specific State agencies during an energy emergency. By establishing well-defined roles for agencies, and practicing those roles, a more efficient response to emergencies is achieved.

Authority

Maryland's Constitution[1] and statutes grant the Governor of Maryland primary responsibility for preparing for and responding to a wide range of emergencies. In addition to the powers it has conferred on the Governor directly, the General Assembly has given some of the Governor's subordinate officers and agencies specific responsibilities and powers to prepare for and respond to emergencies.

[1] Article II, Section 1 of Maryland Constitution provides that "[t]he executive power of the State shall be vested in a Governor[.]" Article II, Section 9 further provides that the Governor "shall take care that the Laws are faithfully executed." Article II, Section 8 of the Maryland Constitution provides that "[t]he Governor shall be the Commander-in-Chief of the land and naval forces of the State[,]" including the Maryland Militia.

The Governor of Maryland has the authority, under Public Safety § 14-304(a), to declare a state of emergency if he or she has a "reasonable apprehension that an energy emergency exists."[2] Once the Governor proclaims a state of emergency, the Governor may then "promulgate orders, rules, or regulations" that:

1. establish and implement programs, controls, standards, priorities and quotas for the allocation, conservation and consumption of energy resources;
2. suspend and modify existing standards and requirements affecting or affected by the use of energy resources, including those that relate to air quality control, the type and composition of various energy resources, the production and distribution of energy resources and the hours and days during which public buildings and commercial and industrial establishments are authorized or required to remain open; and
3. establish and implement regional programs and agreements to coordinate the energy resource programs and actions of the State with those of the federal government and of other states and localities.[3]

Moreover, the Governor may "exercise fully the authority necessary to implement any federal mandatory energy emergency program as set forth in any federal programs, laws, orders, rules, or regulations that relate to the allocation, conservation, or consumption of energy resources."[4] The only explicit limitation on the Governor's energy emergency power is that the Governor may not authorize the "establishment of oil refineries, deep water ports, offshore drilling facilities, or other similar major capital facilities."[5]

Governor:

http://www.governor.maryland.gov/

Governor Martin O'Malley established four main energy objectives to prevent environmental neglect and to help secure Maryland's energy supply. The four objectives are:

- reducing per capita energy use;
- increasing renewable energy resources;
- reducing greenhouse gas emissions; and
- creating "green" jobs.[6]

Acting through the State's administrative agencies, as set forth in detail below, the Governor takes a role in addressing most energy issues in the State.

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[2] Md. Code Pub. Safety § 14-304(b).
[3] Md. Code Pub. Safety § 14-304(b).
[4] Md. Code Pub. Safety § 14-304(f).
[5] Md. Code Pub. Safety § 14-304(b).
[6] Maryland Energy Administration, *Maryland's Goals* [hereinafter *Maryland's Goals*], *available at* http://energy.maryland.gov/mdgoals.html (last visited Dec. 24, 2011).

During emergencies as promulgated under section 14-304(a) of the Maryland Public Safety Code, the Governor has the authority to declare a state of emergency if he or she has a "reasonable apprehension that an energy emergency exists."[7] Once the Governor proclaims a state of emergency, he or she may issue orders to address specific concerns. For example, the Governor is authorized to implement programs "for the allocation, conservation, and consumption of energy resources."[8] The Governor's broad authority to take these steps during a declared energy emergency is critical to minimizing the harm to Maryland's public health and safety, economy, and security.

State Agencies

Maryland Energy Administration (MEA):

http://www.energy.state.md.us/

The Maryland Energy Administration is committed to promoting affordable, reliable, and clean energy in Maryland.

By making smart investments in clean energy and energy efficiency, MEA is reducing Maryland's dependence on foreign energy sources, reducing energy demand, promoting development of Maryland's green economy and improving our environment.

While monitoring the energy markets and sectors critical to Maryland's growth and prosperity, MEA advises the Governor on energy policy and helps to promote a clean energy future. MEA encourages smart investments in renewable energy and helps make energy efficient improvements more affordable for Maryland homes and businesses. MEA also works closely with the Public Service Commission (PSC) on how to best evaluate the energy conservation programs that Maryland utilities offer their customers.

MEA has published a comprehensive report, the *2010 Maryland Energy Outlook*, which is a critical analysis of how the State is meeting its energy goals. The *Outlook* not only focuses on how Maryland can achieve its energy aspirations, but also shows how Maryland can meet these standards even sooner.

MEA's strategic goals make it a national leader in the emerging green economy. Under Governor O'Malley's leadership, the Maryland Energy Administration has set the following strategic goals:

- Generate 20 percent of Maryland's consumed energy from renewable sources by 2022, with at least 2 percent of Maryland's energy consumption coming from solar power;
- Reduce per capita energy consumption and peak demand 15 percent by 2015 (relative to 2007);
- Create 100,000 new green jobs by 2015 (relative to 2009);
- Reduce our State's greenhouse gas emissions 25 percent by 2020 (relative to 2006);
- Make Maryland industries more competitive through leveraging public/private partnerships; and

7 Md. Code Ann., Pub. Safety §§ 14-304(a) (2011).
8 Md. Code Ann., Pub. Safety §§ 14-304(a) (2011).

- Show that our government leads by example by reducing the energy usage and operating costs of Maryland's public buildings.

As outlined in the *State of Maryland Core Plan for Emergency Operations*, MEA works with the PSC in times of state-wide energy emergencies to ensure that all Marylanders have the energy resources they need and the State can quickly respond and recover from whatever challenges may arise. Specifically, MEA is responsible for the following key items:

- serve – alongside the PSC – as the primary State agency on energy issues;
- coordinate with fuel suppliers to arrange for emergency deliveries of commodities to local distributors;
- allocate scarce energy resources, such as fuel, and develop contingency plans for energy supply emergencies declared by the Governor;
- participate in any long-term recovery efforts; and
- coordinate response and restoration strategies with the PSC.

To facilitate these activities, MEA and PSC share responsibilities under Emergency Support Function 12 (ESF-12), the formal procedure for the restoration of energy services, which is discussed more fully in Chapter 5.

Maryland Emergency Management Agency (MEMA):

http://www.mema.state.md.us

MEMA exists to ensure that the State is capable of dealing with large-scale emergencies, including an energy emergency.[9] MEMA is responsible for the coordination of public and private entities before, during, and after an emergency.[10] MEMA provides support to local governments when needed or requested, and coordinates State responses with the Federal Emergency Management Agency (FEMA) and other federal agencies.[11]

MEMA utilizes the Maryland Joint Operations Center (MJOC) as a communications hub for emergency responders and local support agencies as well as a monitoring station when there are emergencies from the local to the international level.[12] Local emergency management offices exist in all 23 Maryland counties and the cities of Annapolis, Baltimore, and Ocean City.[13]

[9] Maryland Emergency Management Agency, *About MEMA* [hereinafter *About MEMA*], *available at* http://www.mema.state.md.us/MEMA/content_page.jsp?TOPICID=about# (last visited Dec. 29, 2011).
[10] *About MEMA*, *supra note* 9.
[11] *About MEMA*, *supra note* 9.
[12] *About MEMA*, *supra note* 9.
[13] *About MEMA*, *supra note* 9.

MEMA is responsible for the implementation of energy emergency response and recovery activities, as well as coordination of activities and resources at an operational level.[14] MEMA has authority to activate the State's Emergency Operations Center (SEOC) during an energy emergency.[15] The SEOC is an incident command center for the "coordination of personnel and equipment for protective actions as well as management of the incident."[16] MEMA also notifies local jurisdictions and private organizations within the State of an impending energy emergency, and works with State agencies and local jurisdictions to maintain the Joint Information Center (JIC), a public information system used to respond to media requests for access to, and information regarding, an incident site.[17]

Maryland Public Service Commission (PSC):

http://www.psc.state.md.us

As the agency responsible for regulating electric utilities, gas utilities, and combination gas and electric utilities, PSC plays a significant role in helping to shape Maryland's energy landscape, both long-term and during an emergency.

PSC conducts hearings and makes decisions on the following: 1) utility company customer rate adjustments; 2) applications to exercise or abandon franchises; 3) applications to modify the type or scope of service; 4) approval of issuance of securities; 5) promulgation of new rules and regulations; and 6) quality of utility and common carrier service.[18] Furthermore, PSC must issue a Certificate of Public Convenience and Necessity (CPCN) prior to construction or modification of new generating stations or high-voltage transmission lines.[19] In addition, MEA and PSC share responsibilities in the State of Maryland Core Plan for Emergency Operations, ESF 12.[20] As the primary agency for utility issues,[21] PSC acts as the State liaison to providers of emergency electricity and natural gas.[22] Additionally, PSC must notify the emergency management community of public service company plans for restoring services.[23] All of these core functions allow PSC to improve Maryland's energy assurance efforts.

The PSC, under 49 U.S.C. 60105 Certification, has statutory authority to establish and enforce safety standards for intrastate hazardous liquid, natural gas and LPG pipelines. Pipeline facilities and procedures are inspected based on a Risk Based Inspection Program that uses several specific criteria to

[14] Maryland Emergency Management Agency, *State of Maryland Core Plan for Emergency Operations* [hereinafter *State of Maryland Core Plan for Emergency Operations*], *available at* http://www.mema.state.md.us/MEMA/content/pdf/The_State_of_Maryland_Emergency_Operations_Plan_26Aug09.pdf (last visited Dec. 29, 2011).

[15] *State of Maryland Core Plan for Emergency Operations*, *supra note* 14.

[16] *State of Maryland Core Plan for Emergency Operations*, *supra note* 14.

[17] *State of Maryland Core Plan for Emergency Operations*, *supra note* 14.

[18] Public Service Commission of Maryland, *Background Information* [hereinafter *Background Information*], *available at* http://webapp.psc.state.md.us/intranet/psc/generalinfo_new.cfm (last visited Dec. 29, 2011).

[19] *Background Information*, *supra note* 18.

[20] *State of Maryland Core Plan for Emergency Operations*, *supra note* 14.

[21] *State of Maryland Core Plan for Emergency Operations*, *supra note* 14.

[22] *State of Maryland Core Plan for Emergency Operations*, *supra note* 14.

[23] *State of Maryland Core Plan for Emergency Operations*, *supra note* 14.

determine need. After an inspection, if the Commission finds a particular facility to be hazardous to life or property, it is empowered to require the person operating such facility to take those steps necessary to remove such hazards. There are currently three intrastate trunklines for petroleum products that come under PSC jurisdiction: Mirant Piney Point LLC, Nu Star and Petroleum Fuel and Terminal Company. There are dozens of natural gas and LPG facilities that come under PSC jurisdiction, including master meters for natural gas on multi-family buildings, private pipelines owned by distribution companies and LPG and fuel oil retailers.

The Governor's Office of Homeland Security (GOHS):

http://www.gohs.maryland.gov/

GOHS is a coordinating office for the state's homeland security initiatives. GOHS' role is to advise the Governor, lead the development of policies, priorities, and strategy for homeland security in Maryland, and assist state agencies and local government in the implementation of their core homeland security and public safety missions. GOHS is also the primary liaison to the U.S. Department of Homeland Security and other federal partners, and oversees coordination of federal homeland security grant funding in the state.

In 2007, GOHS established the Governor's 12 Core Goals for a Prepared Maryland to enhance the safety and security of the State. The 12 Core Goals represent "basic, core capacities" that Maryland should develop and maintain to improve the state's homeland security capabilities. The Governor's 12 Core Goals directly relate to the protection of critical energy infrastructure and resources (CIKR) and energy emergency response. The relevance of the Governor's 12 Core Goals on the energy sector is discussed more fully in Chapter 5.

Maryland Department of Human Resources (DHR):

http://www.dhr.maryland.gov/

DHR has an important role in energy assurance through its oversight of a variety of energy sector programs. The Maryland Energy Assistance Program (MEAP), operated by the Office of Home Energy Programs (OHEP), assists low income individuals in paying their utility bills. [24] For example, through MEAP, limited assistance may be available to replace broken or inefficient furnaces.[25] The Electric Universal Service Program (EUSP) assists in paying electric bills for eligible low-income individuals.[26] Under the EUSP, assistance is available in three ways: 1) payment of current electric bills; 2) payment of past due electric bills; and 3) assistance with adding energy efficient measures to lower future bills.[27]

[24] Maryland Department of Human Resources, *About Us* [hereinafter *DHR About Us*], *available at* http://www.dhr.maryland.gov/AboutUs.php (last visited Dec. 29, 2011).

[25] Maryland Department of Human Resources, *Office of Home Energy Programs* [hereinafter *Office of Home Energy Programs*], *available at* http://www.dhr.maryland.gov/ohep/index.php (last visited Dec. 29, 2011).

[26] *Office of Home Energy Programs*, *supra note* 25.

[27] *Office of Home Energy Programs*, *supra note* 25.

The Utility Service Protection Program (USPP) prevents utility cut-offs to low-income individuals.[28] MEAP-eligible homes also may enter into a year-round, equal monthly payment plan through their utility provider.[29] These programs enable DHR to help establish energy assurance directly for Maryland citizens.

Department of Housing and Community Development (DHCD):

http://www.dhcd.maryland.gov

DHCD creates energy crisis intervention programs to assist low-income households with fuel and utility costs.[30] In addition, DHCD operates the Weatherization Assistance Program (WAP), which helps with the installation of energy efficiency and conservation materials into eligible homes.[31] If eligible, and the building allows, the following improvements to building energy efficiency may be made: blower door air infiltration reduction; insulation in the attic, floors and walls; hot water system improvements; lighting retrofit; furnace clean/tune, safety repairs and burner retrofit or replacement; and/or health and safety items.[32] Weatherization training courses are also available through WAP.[33]

DHCD also runs the Be SMART Home Program, which provides financing for home energy efficiency improvements in fifteen Maryland communities.[34] Two loan types are available: "Be SMART Home ENERGY STAR" and "Be SMART Home Complete."[35] Energy efficiency professionals are selected from a list of eligible providers with some availability of free home energy audits.[36] Program eligibility is limited to the fifteen targeted communities, and credit worthiness must be verified.[37] The programs allow up to $15,000 in financing for energy efficient improvements.[38] All of these DHCD efficiency and conservation programs are instrumental in helping Maryland meet its energy needs in a cost-effective manner.

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[28] *Office of Home Energy Programs*, *supra note* 25.

[29] *Office of Home Energy Programs*, *supra note* 25.

[30] *See generally*, Md. Human Services Code Ann. § 5-5A-06 (2011).

[31] Department of Housing and Community Development, *Weatherization Assistance Program* [hereinafter *Weatherization Assistance Program*], *available at* http://www.dhcd.state.md.us/Website/Programs/wap/Default.aspx (last visited Dec. 29, 2011).

[32] *Weatherization Assistance Program*, *supra note* 31.

[33] *Weatherization Assistance Program*, *supra note* 31.

[34] Department of Housing and Community Development, *Be SMART Home* [hereinafter *Be SMART Home*], *available at* http://www.dhcd.state.md.us/Website/programs/BeSmart/Home.aspx (last visited Dec. 29, 2011).

[35] *Be SMART Home*, *supra note* 34.

[36] *Be SMART Home*, *supra note* 34.

[37] *Be SMART Home*, *supra note* 34.

[38] *Be SMART Home*, *supra note* 34.

Maryland Office of People's Counsel (OPC):

http://www.opc.state.md.us/

OPC represents Maryland residential consumers of electricity, natural gas, water, and some transportation services before PSC, federal regulatory agencies, and the courts.[39] OPC involves itself in issues relating to cost, quality of service and adequacy of supply for utility services.[40] OPC attorneys also represent Maryland residents on matters regarding rates, services and practices.[41] As indicated above, proceedings before PSC involve cases, rulemakings, public conferences and working groups regarding utility services.[42] OPC also intervenes in cases before the Federal Energy Regulatory Commission (FERC), which oversees wholesale electricity markets, interstate electricity transmission and interstate gas transportation when appropriate.[43] OPC also acts as consumer representative in PJM Interconnection stakeholder groups concerning PJM Interconnection operation.[44] By giving a voice to Maryland residents on energy issues, OPC helps to ensure that utilities adequately provide reliable and affordable energy to the residents of Maryland.

Maryland Department of Disabilities (MDOD):

http://www.mdod.maryland.gov

MDOD is responsible for improving delivery of services, including services during an energy emergency, to individuals with functional needs through the development of collaborative partnerships with other State agencies.[45] MDOD also administers the State Disabilities Plan, which includes a section entitled "Emergency Preparedness." This part of the Plan aims to prepare people with disabilities for "any natural or man-made disaster or emergency."[46] Additionally, it focuses on training emergency personnel, employers, and others to effectively assist those disabled individuals.[47] The State Disabilities Plan markedly improves this vulnerable group's prospects in an energy emergency.

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[39] Maryland Office of People's Counsel, *About Us* [hereinafter *OPC About Us*], *available at* http://www.opc.state.md.us/Home/AboutUs.aspx (last visited Dec. 29, 2011).

[40] *OPC About Us*, *supra note* 39.

[41] Maryland Office of People's Counsel, *Regulatory Activities* [hereinafter *OPC Regulatory Activities*], *available at* http://www.opc.state.md.us/opc/RegulatoryActivities.aspx (last visited Dec. 29, 2011).

[42] *OPC Regulatory Activities*, *supra note* 41.

[43] *OPC Regulatory Activities*, *supra note* 41.

[44] *OPC Regulatory Activities*, *supra note* 41.

[45] Maryland Department of Disabilities, *Maryland State Disabilities Plan* [hereinafter *Maryland State Disabilities Plan*], *available at* http://www.mdod.maryland.gov/uploadedFiles/Publications/2009%20State%20Disabilities%20Plan.pdf (last visited Dec. 29, 2011).

[46] *Maryland State Disabilities Plan*, *supra note* 45.

[47] *Maryland State Disabilities Plan*, *supra note* 45.

Maryland Department of Natural Resources (DNR):

http://www.dnr.state.md.us/

DNR focuses on the preservation and enhancement of Maryland's natural resources and access to outdoor recreational opportunities. The agency works to promote the efficient use of energy and energy resources to secure a sustainable future for Maryland's natural resources. On the supply side, among DNR's responsibilities are ice-breaking operations on the State's navigable waterways. Its ice-breaking operations significantly contribute to energy assurance through tools and machines that allow petroleum and coal-carrying barges to reach the ports to which they are delivering oil supplies. In addition, DNR cooperates with the Maryland Department of the Environment (MDE) to respond to petroleum releases in water. Also, DNR manages State Forests and works with private foresters to support the wood industry in Maryland. Wood and other renewable services (wind, solar and geothermal) are actively promoted and utilized by DNR on State lands and facilities. Regarding demand, DNR also secures a variety of energy sources at a number of Maryland's State Parks, which include heating and cooking at cabins and RV electrical hookups.

Maryland Coordination and Analysis Center (MCAC):

http://www.mcac-md.gov

MCAC analyzes and disseminates information to federal, State, and local agencies in support of law enforcement, public health and welfare, public safety, and homeland security statewide. MCAC is one of four components of the Anti-Terrorism Advisory Council (ATAC).[48] During an emergency, MCAC facilitates the continued communication between responders and customers, which is critical for an accurate assessment of damage and response to the emergency. Chapter 5 further discusses MCAC's role in an energy emergency.

Maryland Department of Environment (MDE):

http://www.mde.state.md.us

MDE oversees the Oil Control Program, which regulates oil-related activities in the State of Maryland, including storage tank usage and transportation of oil both within Maryland and across State borders.[49] Permits are required for above ground storage tanks exceeding 10,000 gallons of capacity of oil intended for use as motor fuel, lubricant or fuel source. Permits are also required for used oil tanks with capacity exceeding 1,000 gallons and for transporting oil within, into, or out of the State.[50] These permitting

[48] Anti-Terrorism Advisory Council of Maryland, *The Maryland Coordination and Analysis Center* (2006) [hereinafter *The Maryland Coordination and Analysis Center*], *available at* http://www.justice.gov/usao/md/Anti-Terrorism/Files/THE%20MARYLAND%20ATAC%20COORDINATION%20AND%20ANALYSIS%20CENTER011.word.pdf.
[49] Maryland Department of Environment, *Oil Control Program* [hereinafter *Oil Control Program*], available at http://www.mde.state.md.us/programs/Land/OilControl/Pages/Programs/LandPrograms/Oil_Control/index.aspx (last visited Dec. 29, 2011).
[50] *Oil Control Program*, *supra note* 49.

regulations impact the distribution of petroleum across the State. MDE also plans for and responds to oil spills in the State of Maryland by placing spill response trailers and boom trailers at various locations throughout the State.[51]

The Oil Control Program within the Land Management Administration of the Maryland Department of the Environment regulates all oil-related activities, such as aboveground and underground oil storage facilities, oil-contaminated soil treatment facilities, and oil transportation. The Program oversees the installation, maintenance, operation and removal of oil storage tanks. The Program maintains a strong field presence. Inspectors investigate complaints of illegal dumping and the improper handling of oil as well as non-compliance with State and federal regulations.

Any person who transfers any volume of non-edible oils into Maryland requires an oil transfer license. The licensee must submit quarterly reports indicating the volume and method of oil transferred into the State. A fee per barrel of oil transferred into the State is assessed at the first point of transfer and paid quarterly. Funds received as oil transfer fees are used to fund the State's oil control and spill response activities.

State Transportation Agencies:

Maryland Department of Transportation (MDOT):

http://www.mdot.maryland.gov/

MDOT is responsible for building, operating, and maintaining the Maryland transportation sector. MDOT directs and oversees the planning, construction, and operation of Maryland's highway, transit, maritime and aviation facilities, as well as the Maryland Motor Vehicle Administration (MVA).[52] It manages transportation issues such as debris removal from State-managed roadways and establishes checkpoints for vehicles transporting resources and goods such as gasoline.[53] MDOT has the delegated authority from the Governor to declare a transportation or utility emergency, allowing for commercial driver hour waivers.[54]

MDOT has three particularly important support roles to play during energy emergencies.

1. MDOT focuses on ensuring that State-maintained roads are operating free from significant problems by working with utility companies to clear fallen utility lines from roads after

[51] Maryland Department of Environment, *Maryland's Oil Spill Response Capabilities* (n.d.) [hereinafter *Maryland's Oil Spill Response Capabilities*], *available at* http://www.mde.state.md.us/assets/document/MDE _OC_oilspillcapablities_factsheet.pdf.

[52] Maryland Department of Transportation, *Home Page* [hereinafter *MD DOT Home Page*], *available at* http://www.mdot.maryland.gov (last visited Dec. 29, 2011).

[53] *State of Maryland Core Plan for Emergency Operations*, *supra note* 14.

[54] *State of Maryland Core Plan for Emergency Operations*, *supra note* 14.

major storms. MDOT also ensures that roads are cleared of debris for the transportation and delivery of fuel, which occasionally requires a police escort.

2. In the case of energy shortages or crises, MDOT ensures that fuel is available for State agencies. MDOT maintains roughly one week's supply at all State Highway Administration District fueling stations, and refuels in anticipation of weather events. Additionally, State facilities are equipped with backup generators to pump gas in the case of an electricity outage. The State has a contract with the private firm Commercial Fueling Services, to distribute gas across the State to State-owned fueling stations. Commercial Fueling Services is able to fill some response vehicles directly from tanker trucks, which helps sustain operations during weather emergencies.

3. MDOT issues driver hour waivers for its own personnel and private firm employees during an emergency. Driver hour waivers exempt drivers from federal laws limiting the number of hours that drivers can be on duty. Weight and width restrictions may also be waived. These waivers can be granted for up to one week, and can be used for State employees, utility companies, or petroleum distributors. While the main authority to grant waivers rests with the Secretary of Transportation, the authority is routinely delegated to other staff, including the Director of Emergency Planning at MDOT and the head of Maintenance at SHA.

A "transportation emergency" is a "natural or man-made emergency that disrupts or hinders the free flow of traffic on the State's highways and local streets and roads for more than 8 hours so that public safety is or may be threatened as a result."[55] A "utility emergency" is "any natural or man-made emergency that disrupts or severs or has the potential to disrupt or sever gas, electric, telephone, water, sewer, cable, or other utility service" to a "large number of residential or commercial customers" or "public or private institutions" in the State and threatens public health, welfare, or safety.[56] The availability of driver hour waivers is essential to energy assurance. If, for example, there were a severe winter storm, leading to an increase in natural gas demand to heat residents' homes, Maryland would need to rely more heavily on tanker trucks to deliver more natural gas to meet that increased demand. This would increase the number of hours worked by tanker truck drivers. At some point, it is likely that the driver or employing company would need a driver hour waiver to be able to continue making deliveries. MDOT's role in facilitating the driver hour waiver process helps bolster Maryland's energy emergency response efforts. See Chapter 6 for additional detail on driver hour waivers.

[55] Md. Code, Trans. § 25-111(a)(6).
[56] Md. Code, Trans. § 25-111(a)(7).

Maryland State Police (MSP):

http://www.mdsp.org

MSP works with MDOT to establish checkpoints and access for vehicles transporting resources and goods such as gasoline.[57] Moreover, because an energy emergency has the potential to generate a public disturbance, law enforcement may be necessary to prevent any unlawful activity.

Maryland Transportation Administration (MTA):

http://mta.maryland.gov/

MTA provides local bus, metro subway, light rail, MARC commuter rail, and commuter bus services across central Maryland. The MARC commuter rail and MTA commuter bus systems provide service between Baltimore and Washington. MTA runs the Commuter Choice Program, which provides incentives to individuals for using mass transit or vanpools instead of driving to work.[58] Reduced fares are available through the Commuter Choice Program for use on MTA Local Bus, Commuter Bus, Light Rail, Metro Subway, and MARC Train.[59] Employers receive additional benefit through special federal tax deductions, State tax deductions and credits, and savings on certain payroll taxes.[60] The development and maintenance of mass transit systems may have a positive impact on energy assurance goals. For example, in the case of a fuel shortage, the electric rail system provides an alternative method of transportation. MTA's programs are explored in Chapter 6.

Maryland State Highway Administration (SHA):

http://sha.md.gov/

SHA, as the State agency charged with maintaining State highways, is responsible for ensuring highways are clear of debris.[61] In an emergency that deposited debris on the highways, SHA's debris removal operations must occur before utilities could access the power lines and restore them. SHA's prompt response would be key to minimizing the length of a power outage. Additionally, SHA clears roads for petroleum distribution vehicles in the case of emergency and uses SHA vehicles to escort petroleum distribution vehicles during emergencies.[62] The Maryland Joint Operations Center (MJOC) at SHA offers real-time monitoring of the volume and speed of traffic on State and county roads. This monitoring would be useful in assessing the impacts of a petroleum emergency.[63] The MJOC has plans and

[57] State of Maryland Core Plan for Emergency Operations, supra note 14.

[58] Maryland Transit Administration, *What is Commuter Choice?* [hereinafter *What is Commuter Choice*], *available at* http://www.commuterchoicemaryland.com/ (last visited Dec. 29, 2011).

[59] *What is Commuter Choice*, *supra note* 58.

[60] *What is Commuter Choice*, *supra note* 58.

[61] Maryland Department of Transportation State Highway Administration, *SHA Home Page* [hereinafter *SHA Home Page*], *available at* http://sha.md.gov/Home.aspx (last visited Dec. 29, 2011).

[62] Interview with Alvin Marques, Maryland State Highway Administration, (May 26, 2011) [hereinafter *Alvin Marques*].

[63] *Alvin Marques*, *supra note* 62.

communication strategies in place to facilitate coordination among agencies within Maryland and across the National Capital Region in the case of an emergency.[64]

Maryland Port Administration (MPA):

http://mpa.maryland.gov/

MPA supervises and manages Maryland's public marine terminals.[65] MPA's provision of security for State ports enables the importation of various energy supplies such as coal, liquefied natural gas, and petroleum. Additionally, MPA dredging operations keep waterways open and accessible to marine vessels.[66]

Maryland Transportation Authority Police (MdTA):

http://www.mdta.maryland.gov/Police/policeMain.html

MdTA Police provide security for Maryland ports, bridges, highways, and tunnels.[67] The presence of MdTA Police security at these various locations allows energy supplies to pass securely through Maryland.[68]

Maritime Security

Maryland imports a variety of energy resources through use of public and private ports. The protection of the State's navigable waterway safety and security zones are carried out using Memoranda of Agreement (MOAs) with the United States Coast Guard and the following agencies: MdTA Police, the Baltimore Police Department, the Anne Arundel County Police Department, the Calvert County Sheriffs' Office, the Charles County Sheriffs' Office and the Prince George's County Police Department.[69] A secure and prepared Maryland maritime region helps ensure that the ships transporting energy-related cargo are able to reach Maryland's ports and citizens.

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[64] *Alvin Marques*, *supra note* 62.
[65] Maryland Port Administration, Maryland Department of Transportation, *Port of Baltimore Home Page* [hereinafter *Port of Baltimore Home Page*], *available at* http://mpa.maryland.gov/ (last visited Dec. 29, 2011).
[66] *Port of Baltimore Home Page*, *supra note* 65.
[67] Maryland Transportation Authority, *Maryland Transportation Authority Home Page* [hereinafter *MTA Home Page*], *available at* http://www.mdta.maryland.gov/Police/policeMain.html (last visited Dec. 29, 2011).
[68] *MTA Home Page*, *supra note* 67.
[69] Maryland Governor's Office of Homeland Security, *Maryland Maritime Strategic Security Plan* (2010) [hereinafter *Maryland Maritime Strategic Security Plan*], *available at* http://www.gov.state.md.us/gohs/pdfs/MarlyandMaritimeStrategicSecurityPlan.pdf.

Conclusion

State agencies perform a variety of roles, from regulation to advocacy, in Maryland’s energy sector. State agency programs seek to achieve a number of goals, such as improving energy efficiency and conservation in the State and ensuring that all Maryland citizens have sufficient electrical power throughout the year to meet their daily needs. Several Maryland agencies assist the State in achieving its energy goals by ensuring that supply and distribution routes for energy resources remain open and secure at all times. These agencies work in coordination to provide Maryland with a resilient energy sector that is able to quickly recover following an emergency.

Chapter 4. Maryland Energy Efficiency, Conservation and Renewable Energy

Overview: Energy Efficiency, Conservation and Renewable Energy

Mitigating risk and threats to Maryland's energy supply is a vital component of the State's energy assurance efforts. One potential systemic and ongoing threat that Maryland faces, due in large part to the high percentage of power imported into the State, is a possible energy supply shortfall. According to a 2007 report from the Maryland Public Service Commission (PSC), "the margin for error in electricity supply adequacy is getting precariously thin, particularly in areas such as the Baltimore-Washington region, southern Maryland, [and] the Delmarva Peninsula."[1] This shortfall can be partially mitigated through the increased use of distributed generation within the State from renewable sources and from the increased use of energy efficiency measures through demand side management (DSM) programs. But these measures carry their own set of challenges to grid security. Many sources of renewable power, including wind and solar, are intermittent and must be managed differently than conventional energy facilities. Furthermore, demand side management programs may not meet their predicted savings targets, with the result being that other, possibly more expensive generation sources would need to be brought online to supplement DSM program shortfalls. Distributed generation from renewable energy and DSM programs must be appropriately monitored, managed and balanced to avoid potential negative impacts on the Maryland electrical grid.

Energy Efficiency in Maryland

In 2008, driven in part by a desire to stave off predicted shortfalls in the supply of electricity, the Maryland legislature passed the EmPOWER Maryland (EmPOWER) act which set targets to both reduce per capita energy consumption and per capita peak demand by 15 percent by the end of 2015 (based on a 2007 baseline). Most of the demand reduction resources (kW) are expected to come from the residential sector, the commercial sector and government buildings and will be gathered through electric utility run programs.[2] Each electric utility works with the Maryland Energy Administration (MEA) to develop plans to reach EmPOWER goals, and these plans are reviewed and modified every three

[1] Maryland Public Service Commission, *Electric Supply Adequacy Report of 2007* (2007) [hereinafter *Electric Supply Adequacy Report of 2007*] *available at http://webapp.psc.state.md.us/Intranet/Reports/2007SupplyAdequacy Report_01172007.pdf*.

[2] *See* Ruth. M., Williamson et al., Center for Integrative Environmental Research, University of Maryland, College Park, *Meeting Maryland's Greenhouse Gas Reduction Goals: Manufacturing Costs Employment and Economic Effects from Maryland's Climate Action Plan*, 34 (2011) [hereinafter *Meeting Maryland's Greenhouse Gas Reduction Goals*].

years by the PSC.[3] As of 2011, implementation of the energy conservation and peak demand reduction requirements of the EmPOWER goals were underway with varying degrees of success.[4]

Maryland EmPOWER programs target individual residences, multifamily housing complexes, commercial and industrial facilities and State agencies. Programs to help lower consumption and reach the EmPOWER goals have included measures to replace old and inefficient lighting and appliances with more efficient units, upgrade inefficient HVAC systems with Energy Star models, train home performance workers and provide weatherization services. Utilities total their respective energy savings and compare them with past consumption for each sector. According to PSC, as of 2010, "energy savings and demand reductions remain considerably lower than targeted in the utilities' plans, and even more modest against the EmPower Maryland 2011 and 2015 goals."[5] From the inception of the EmPOWER programs, the utilities have saved a total of 661,290 MWh and 672 MW.[6]

Maryland utilities are able to bid the DSR program savings of EmPOWER into the PJM generation market. PJM looks at avoided peak power and energy consumption through these programs as being comparable to generation at the same level. In other words, if a utility expects that its DSR programs will avoid consuming 500 megawatts (MW) of peak and 500 megawatt-hours (MWh) of energy, then PJM counts these resources as equal to generation resources. If a utility fails to deliver the amount of DSR resources that cleared the PJM capacity market auction, they will be subjected to fines and penalties.

Renewable Energy in Maryland

Maryland's Renewable Portfolio Standard (RPS) requires that by 2022 a minimum of 20 percent of the electricity sold in Maryland must come from renewable sources.[7] In addition, at least two percent of the renewable resources must come from solar installations.[8] As discussed in Chapter 2, significant new capacity will need to be brought online in order to meet RPS benchmarks.[9]

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[3] For information on each utility's program see: Maryland Energy Administration, *EmPOWER Maryland* (n.d.) [hereinafter *EmPOWER Maryland*], *available at* http://energy.maryland.gov/facts/empower.html.

[4] *See EmPOWER Maryland*, *supra note* 3.

[5] Public Service Commission of Maryland, *The EmPOWER Maryland Energy Efficiency Act Standard Report of 2011: With Data for Compliance Year 2010* (March 2011) [hereinafter *EmPOWER Maryland Energy Efficiency Act Standard Report of 2011*].

[6] *EmPOWER Maryland Energy Efficiency Act Standard Report of 2011*, *supra note* 5.

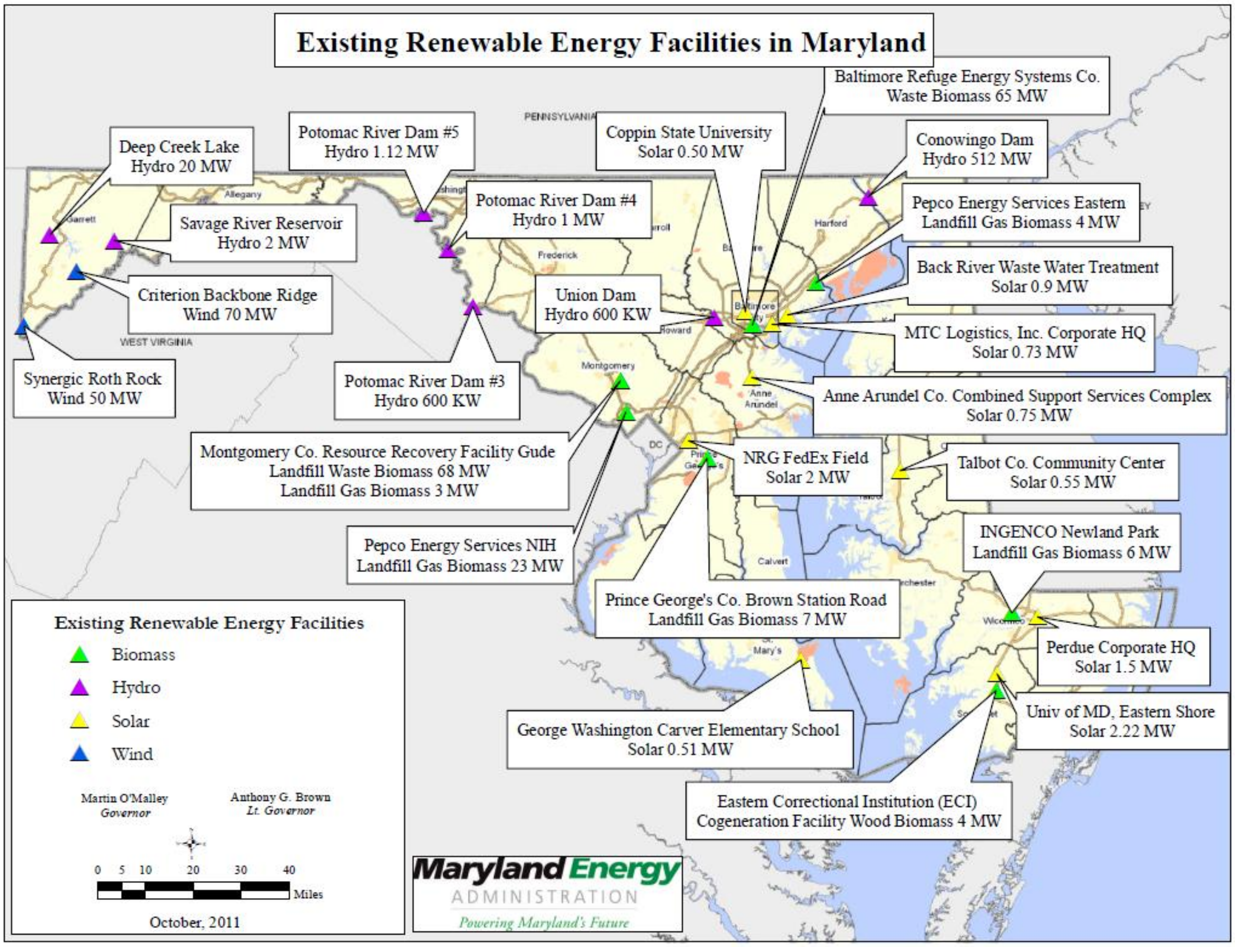
[7] Maryland Energy Administration, *Maryland's Goals* (n.d.) [hereinafter *Maryland's Goals*], *available at* http://www.energy.state.md.us/mdGoals.html (last visited Jan. 23, 2012).

[8] *See Maryland's Goals*, *supra note* 7. In addition, the RPS requires that beginning in 2012, requires that solar REC facilities be located in Maryland while other RPS-eligible capacity may still be generated within the PJM region. *See* Md. Code Ann., Pub. Util. Cos. § 7-703 (West). The requirement to increase solar electricity-generating capacity to sites in Maryland is anticipated to improve the State's electricity reliability in small ways.

[9] See Chapter 2.

Maryland is pursuing alternative energy sources through various initiatives. At the end of 2011, Maryland had over 41.8 MW of installed solar energy, over 120 MW of installed wind capacity, and over 80 electric vehicle charging stations.[10] This installed renewable energy capacity, which increases monthly, helps Maryland reduce the impacts of energy disruptions from conventional generation sources.

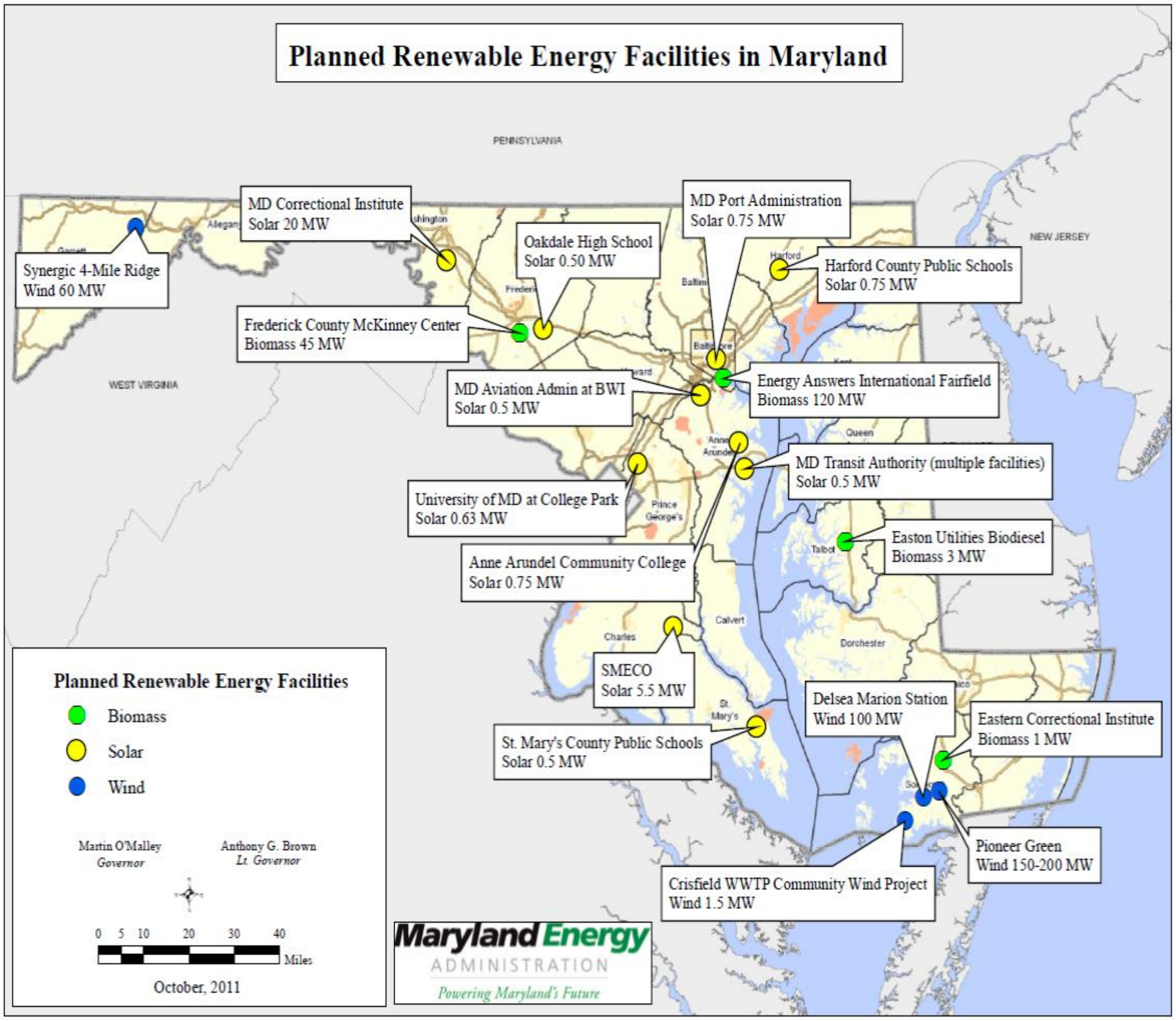
Figure 4-1: Existing Renewable Facilities in Maryland (October 2011)



In addition, several more renewable energy facilities are planned for development in Maryland. As more renewable energy is developed, Maryland's electric energy sector becomes more resilient to disruptions to conventional energy generation and long-distance transmission. However, as explained below, increased use of distributed and renewable generation raises its own potential concerns.

[10] For EV locations, *see*: http://maps.google.com/maps/ms?msid=202311883840557563300.00049fba01e8199 5e9aa7&msa=0&ll=38.653343,-76.890564&spn=1.156084,2.518616.

Figure 4-2: Planned Renewable Energy Facilities in Maryland (October 2011)



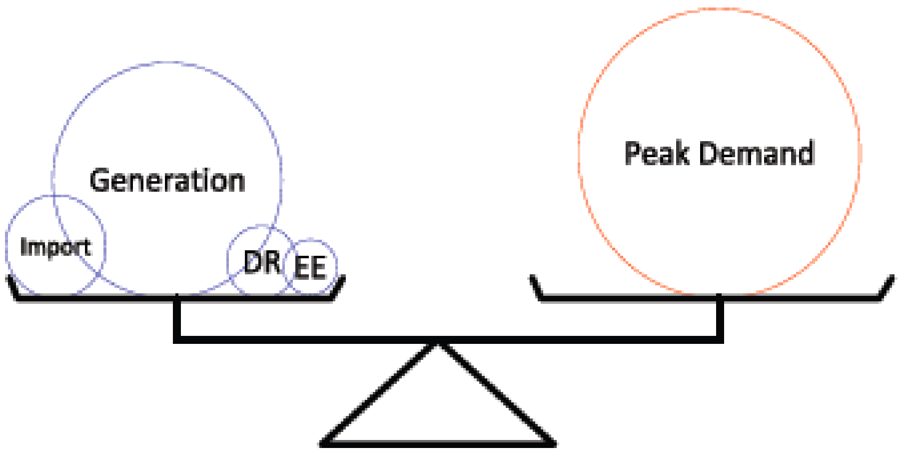
Increased amounts of renewables can potentially provide increased energy security and resiliency but must be properly integrated into the transmission grid to ensure continued reliable operation. Studies performed by the Department of Energy[11] show that existing control technologies paired with new transmission facilities can accommodate renewable energy penetration up to 20%, particularly when dispersed over a larger geographic area such as PJM. However, even at more moderate rates of intermittent renewable generation, grid operators must adapt their procedures to properly account for the changes in energy. Advances in wind energy forecasting has increased the accuracy of hour-ahead and day-ahead forecasts. PJM actively monitors wind generators and is improving their capabilities to incorporate the increasing RPS requirements of PJM states.

[11] http://www.nrel.gov/wind/systemsintegration/ewits.html

Balancing Supply and Demand through the RPS and EmPOWER

An important role of PJM is to plan for the balance of supply and demand (see Figure 4-3). While Maryland's RPS aims to increase the amount of supply through distributed generation, EmPOWER aims to reduce demand through increases in demand response resources. Working together they improve the net balance of electricity in the State.[12] (For more information on the effects of the RPS and EmPOWER, see Chapter 2.)

Figure 4-3: Electricity Supply Demand-Balance[13]



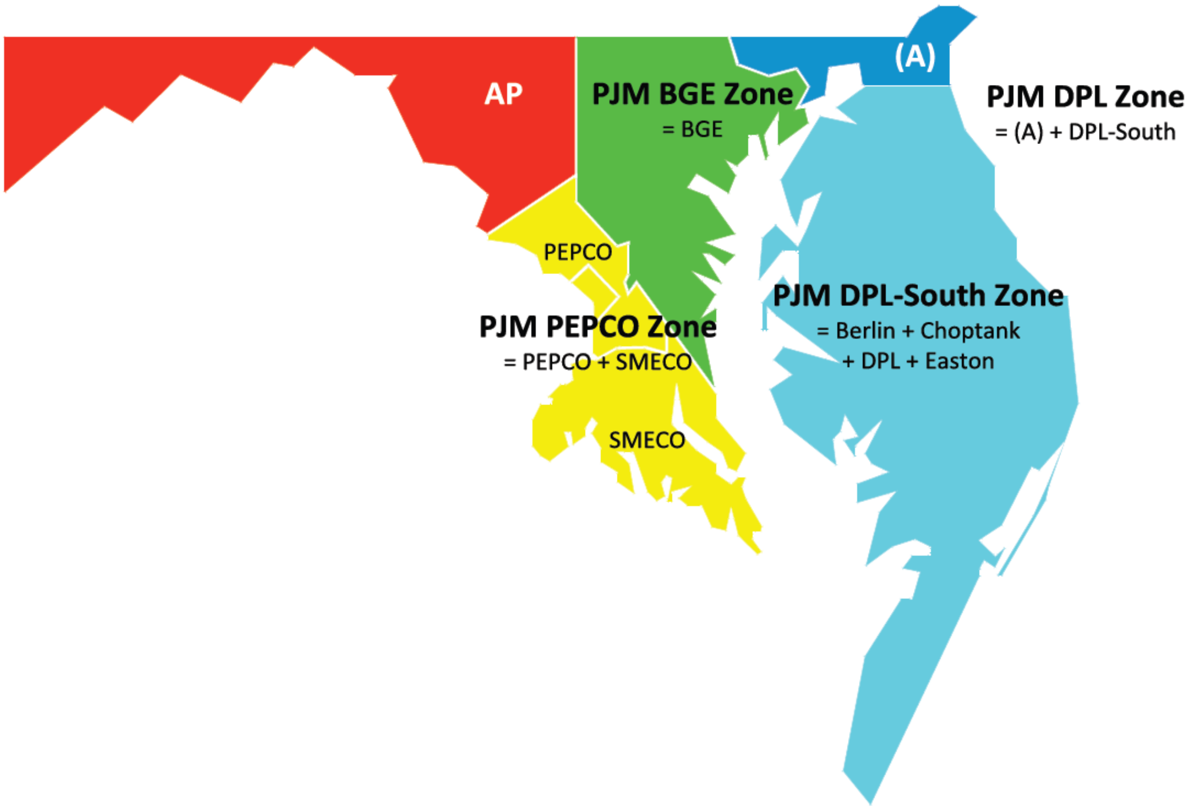
A 2011 study from the Center for Integrative Environmental Research (CIER) evaluated the impact of Maryland's energy policies and efforts, including EmPOWER and the RPS on the State's electricity reliability. The study found that the Southwestern Mid-Atlantic Area Council (SWMAAC) (see

Figure 4-4) region, consisting of the BGE, Pepco (including Washington, D.C.) and SMECO service territories,[14] absent EmPOWER and RPS achievements, is anticipated to face an electricity imbalance by

[12] *Meeting Maryland's Greenhouse Gas Reduction Goals*, *supra note* 2, at 55.
[13] *See Meeting Maryland's Greenhouse Gas Reduction Goals*, *supra note* 2, at 55.
[14] For geographic information on these service territories, see Chapter 2, Maryland Energy Profile.

2019.[15] In an alternative scenario, which introduces the effects of EmPOWER and the State's RPS, the net balance of electricity improves and no capacity deficits are identified for the period 2011-2020.[16]

Figure 4-4: PJM Zones in Maryland and Delaware
(large text indicates PJM Zone; normal text indicates utility service areas)



Circumstances on the Delmarva Peninsula are distinct from the SWMAAC region because the peninsula is isolated and there are few transmission lines entering the region. The southern Delmarva Peninsula region, known as DPL-South, which includes Delmarva Power, Berlin Municipal Electric, Choptank Electric Cooperative and Eason Utilities, is not expected to face any electricity balance deficits from 2011-2020 in the absence of EmPOWER or RPS achievements.[17] Although the DPL-South region is constrained, current demand and forecasted demand growth are modest relative to the densely populated western shore. In the alternative scenario, which introduces the effects of EmPOWER and the State's RPS, the net balance of electricity improves in the DPL-South region.[18] If offshore wind resources are developed in the Atlantic Ocean off of Maryland's coast, and the transmission network is upgraded

[15] *See Meeting Maryland's Greenhouse Gas Reduction Goals*, *supra note* 2, at 54.For the specific forecasts and outlooks, please refer to the source material. The specific predictions contained the report are beyond the scope of this Plan.
[16] *See Meeting Maryland's Greenhouse Gas Reduction Goals*, *supra note* 2, at 41.
[17] *See Meeting Maryland's Greenhouse Gas Reduction Goals*, *supra note* 2, at 55.
[18] *See Meeting Maryland's Greenhouse Gas Reduction Goals*, *supra note* 2, at 55.

to accommodate the westward flow of power, then the DPL-South region will have a positive outlook for electricity reliability (see below for additional information on offshore wind impacts).[19]

Clean Energy and EmPOWER Programs

Residential Renewable Energy Grants

Use of residential solar, geothermal, and wind power can significantly reduce energy bills for consumers while increasing familiarity and knowledge of renewable energy systems.[20] The residential grant program provides financial assistance connected with installing renewable energy systems, such as solar, wind and geothermal at residences.[21] Through the residential grant program, Maryland has increased its use of distributed generation by residences, thereby reducing the demand on conventional energy resources. In addition, many installations have the ability to return energy to the grid through arrangements with the local utility.

Increased demand for MEA's grant program resulted in hundreds of Maryland households engaging in the Residential Renewable Energy Grants program.[22] MEA utilizes Strategic Energy Investment Fund (SEIF) resources to serve applications as they come forward. As prices for renewable technologies, particularly solar PV, continue to fall, , demand for renewable grants continues to rise.[23] In FY 2009, MEA's Residential Renewable Grants Program reduced fossil fuel-based energy consumption by 1,420 MWh, the savings equivalent to the energy consumption of 115 Maryland homes.[24] In FY 2010, 500 Maryland households and small businesses received SEIF-funded grants.[25] That year, the program reduced Maryland's fossil fuel-based energy consumption by 2,580 MWh, the savings equivalent to the energy consumption of 208 homes.[26] In FY 2011, MEA awarded 1,956 residential renewable grants, reducing conventional energy consumption by 11,126 MWh, the savings equivalent to over 900 homes. The program helps with energy assurance by reducing the demand on the electric grid, thereby limiting outage possibilities.

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[19] *See Meeting Maryland's Greenhouse Gas Reduction Goals*, *supra note* 2, at 56.

[20] *See* Maryland Energy Administration, *Maryland State Energy Investment Fund-Clean Energy Accomplishments FY 2009 and 2010* (n.d.) [hereinafter *Md. St. Energy Investment Fund-Clean Energy Accomplishments FY 2009 and 2010*], *available at* http://energy.maryland.gov/documents/FY09andFY10SEIFAccomplishmentsbook.pdf.

[21] *See* Maryland Energy Administration, *Residential Clean Energy Grant Program* (n.d.) [hereinafter *Residential Clean Energy Grant Program*], *available at* http://www.energy.state.md.us/Residential/cleanenergy grants/index.html (last visited Jan. 23, 2012).

[22] *See Md. St. Energy Investment Fund-Clean Energy Accomplishments FY 2009 and 2010*, *supra note* 21.

[23] *See Md. St. Energy Investment Fund-Clean Energy Accomplishments FY 2009 and 2010*, *supra note* 21.

[24] *See Md. St. Energy Investment Fund-Clean Energy Accomplishments FY 2009 and 2010*, *supra note* 21.

[25] *See Md. St. Energy Investment Fund-Clean Energy Accomplishments FY 2009 and 2010*, *supra note* 21.

[26] *See Md. St. Energy Investment Fund-Clean Energy Accomplishments FY 2009 and 2010*, *supra note* 21.

Biomass Programs

"Biomass" energy is "any plant-derived organic matter available on a renewable basis."[27] Bioenergy technologies utilize renewable biomass resources to produce an array of products, including electricity. Bioenergy is ranked "second in renewable primary energy production and accounts for three percent of the primary energy production in the United States."[28] In Maryland, nearly three million tons of biomass are produced annually, co-producing 462 gigawatt hours (GWh) of electricity.[29] The Maryland Clean Energy Center lists the following types of biomass:[30] energy crops, trees, grasses, food crops, algae, biomass residues and human wastes. Human wastes include biomass energy, which encompasses the following:

- Organic and biodegradable garbage (paper, food, leather, yard waste and woody waste from packaging and cardboard);
- Landfill gases given off by decomposition; and
- Sewage, in the form of methane greenhouse gas, which is captured and burned for heat and power by sewage treatment plants.

Biofuels provide opportunities for Maryland to become less dependent on fossil fuels by using materials that would otherwise go to a landfill. Additionally, biomass does not have the same issues of intermittency other renewable energy sources may encounter. Because biomass sources, such as animal manure and municipal solid waste, can be used in a constant stream for electricity generation, it can be a more consistent source of electricity. As of 2011, Maryland has approximately 180 MW of biomass energy in service with another 170 MW expected to come on line in subsequent years.

Wind Energy

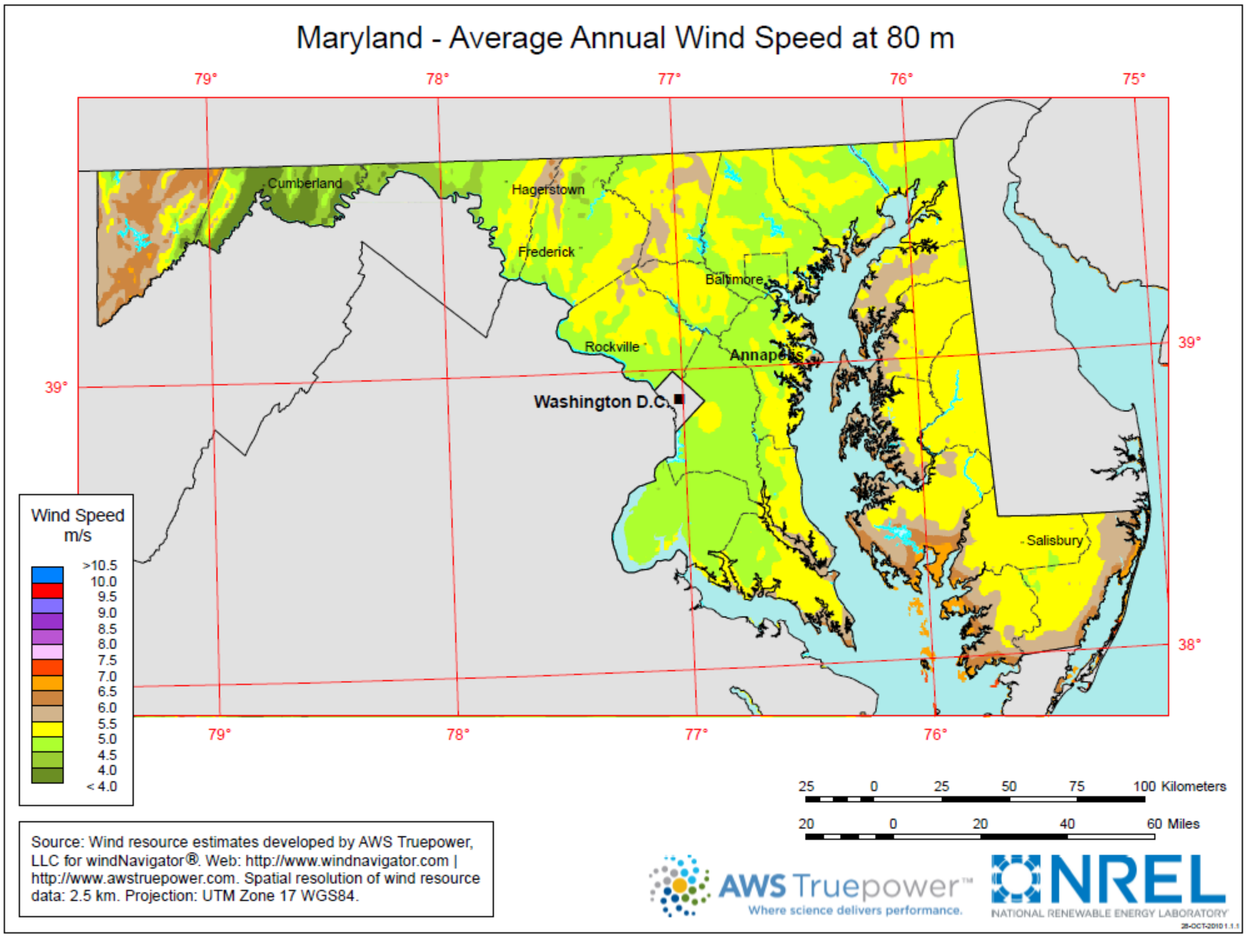
Maryland has significant wind resources available for energy production. In addition to the traditional, land-based wind resources, the State is also attempting to tap the larger, off-shore wind in the Atlantic Ocean.

Land Based Wind

As of 2011, Maryland has over 120 MW of wind capacity. In addition, there are further opportunities for development, and as shown above, additional projects expected in the near future (see Figure 4-5).

[27] *See* Maryland Energy Administration, *Solar Renewable Energy Credits* (2011) [hereinafter *Solar Renewable Energy Credits*], *available at* http://energy.maryland.gov/Business/cleanenergygrants/documents/SRECInformationv2.1.pdf.
[28] *See* Maryland Clean Energy Center, *Clean Technologies-Biomass* (n.d.) [hereinafter *Clean Technologies-Biomass*], *available at* http://mdcleanenergy.org/clean_technologies/bio_mass.
[29] *See Clean Technologies-Biomass*, *supra note* 29.
[30] *See Clean Technologies-Biomass*, *supra note* 29.

Figure 4-5: Average Annual Wind Speed at 80 Meters



Maryland is supporting the development of land-based wind generation at the residential and commercial scales.[31] As of November 29, 2011, Maryland issued 95 grants for wind energy.[32] In addition, through the Generating Clean Horizons program, Maryland entered into 20-year contracts to purchase 65 MW of wind power to supplement State government's energy demand.[33] Additional, utility scale wind installations are also in development without Maryland financial support.

[31] *See* Maryland Energy Administration, *Wind Energy* (n.d.) [hereinafter *Wind Energy*], *available at* http://energy.maryland.gov/wind.html (last visited Jan. 23, 2012).

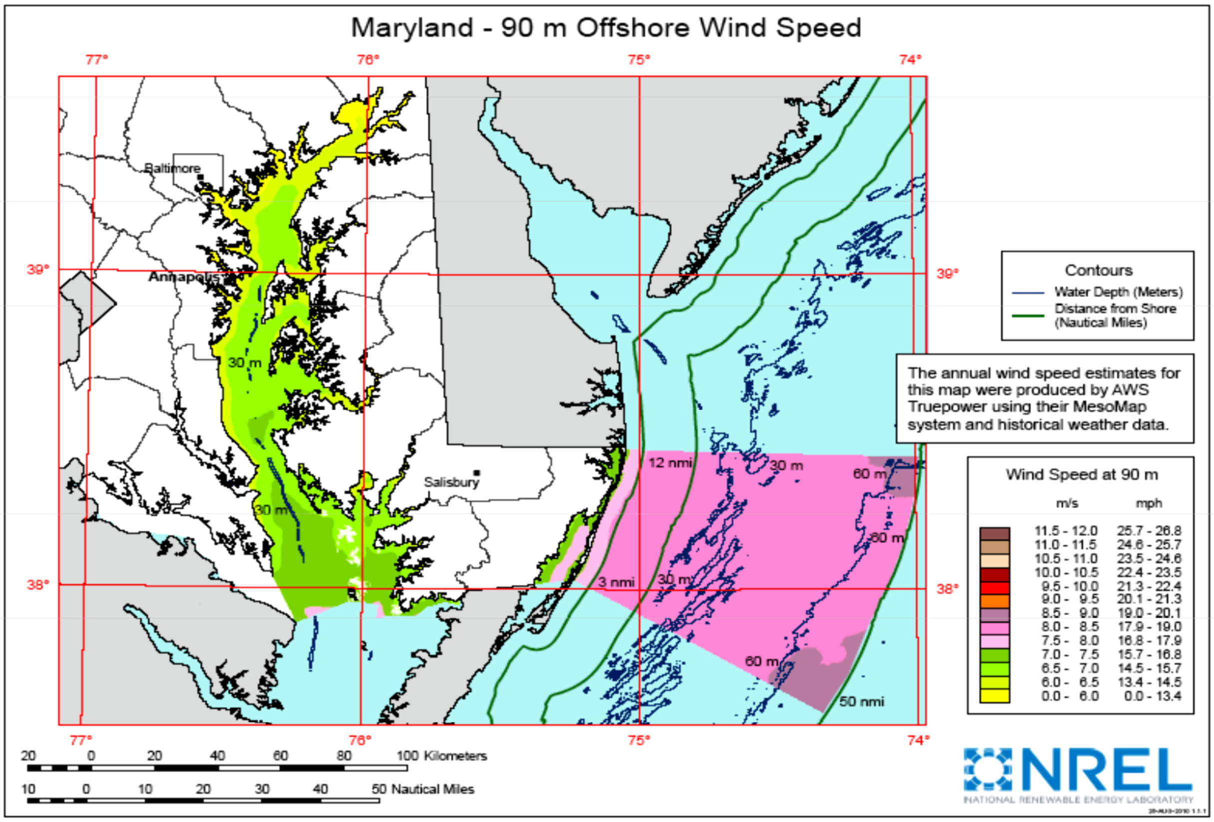
[32] *See* Maryland Energy Administration, *Historic Award Data* (n.d.) [hereinafter *Historic Award Data*], available at: http://www.energy.state.md.us/Business/cleanenergygrants/documents/status/Historic%20Award%20Data%20Report%20-%2020120120.xls (last visited Jan. 23, 2012).

[33] *See* U.S. Windforce, *Pinnacle Wind Farm at NewPage – Prjoect Overview* (n.d.) [hereinafter *Pinnacle Wind Farm at NewPage*], *available at* http://web.uswindforce.com/index.php?option=com_content&view=article&id=43&Itemid=17 (last visited Jan. 23, 2012); Gestamp Wind, *Roth Rock* (2011) [hereinafter *Roth Rock*], *available at* http://www.gestampwind.com/en/business/innovating-projects/roth-rock (last visited Jan, 23, 2012).

Off-Shore Wind

DOE classifies off-shore wind resources in Maryland as "outstanding"[34]—areas of the Outer Continental Shelf off the coast of Maryland are ideal for development of offshore wind energy (see Figure 4-6).[35] The shelf here slopes gradually and contains vast areas below 30 meters in depth, which makes Maryland's coast ideal for deployment of turbines.[36]

Figure 4-6: Offshore Wind Speed at 90 Meters[37]



While there are currently no operating offshore wind farms in North America, commercial scale facilities have been operating in Europe since 1991.[38] An estimated 3,160 MW of capacity are currently operating worldwide, with another 15,000 MW expected to be deployed by 2014.[39]

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[34] *See* U.S. Department of Energy, *Wind Resource Map* (2009) [hereinafter *Wind Resource Map*], *available at* http://www.windpoweringamerica.gov/pdfs/wind_maps/us_windmap.pdf.

[35] *See* Maryland Energy Administration, *Maryland Offshore Wind Energy Act of 2011: Facts & Figures* (n.d.) [hereinafter *Maryland Offshore Wind Energy Act of 2011*], *available at* http://www.energy.state.md.us/documents/offshorewindfactsheet.pdf.

[36] *See Maryland Offshore Wind Energy Act of 2011*, *supra* note 37.

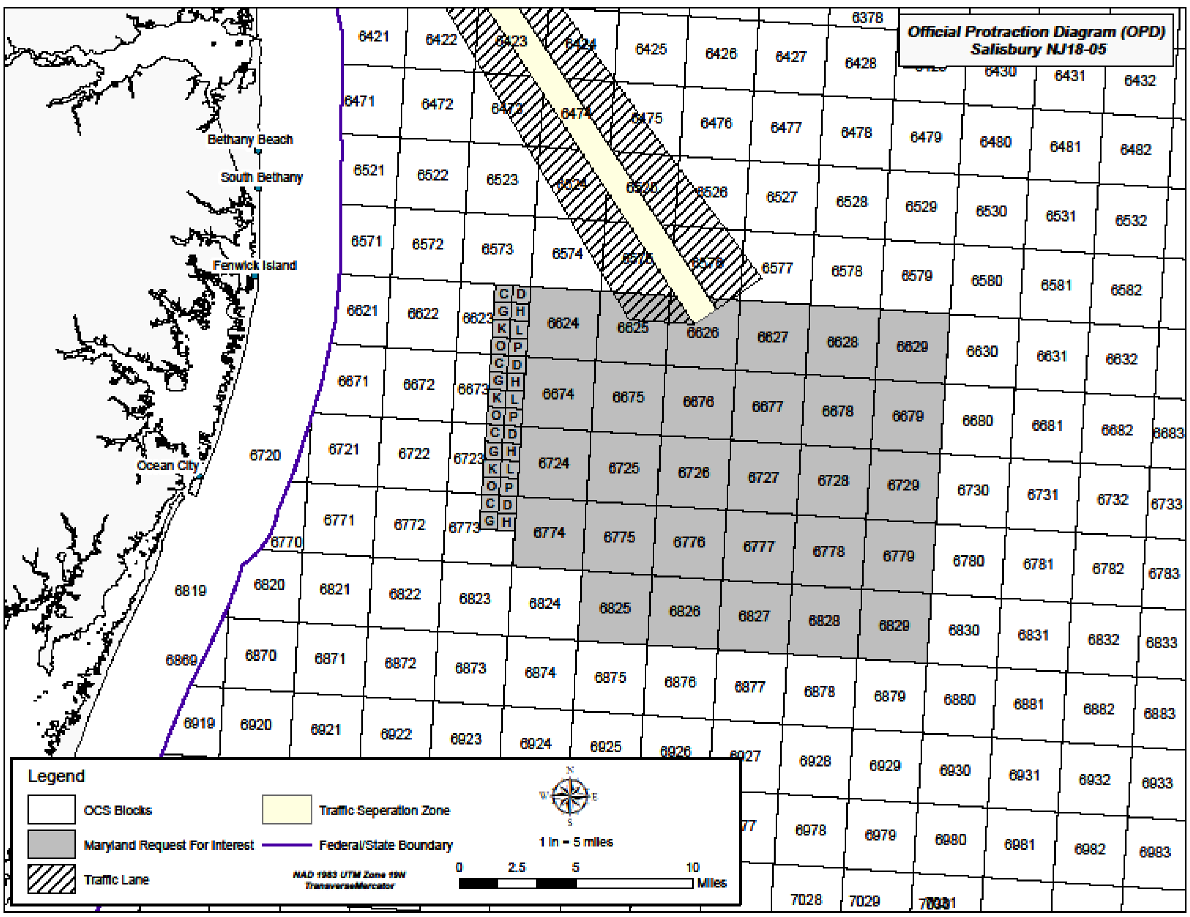
[37] *See* U.S. Department of Energy, *Maryland Offshore Wind Map and Resource Potential*, *available at* http://www.windpoweringamerica.gov/windmaps/offshore_states.asp?stateab=MD

[38] *See Maryland Offshore Wind Energy Act of 2011*, *supra* note 37.

[39] *See Maryland Offshore Wind Energy Act of 2011*, *supra* note 37.

At the request of Governor O'Malley, in 2010, the Department of the Interior's (DOI) Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) created the Maryland State/Federal Offshore Wind Task Force (Task Force). The Task Force is composed of officials from Maryland and federal agencies, as well as elected officials from Maryland's coastal communities. The Task Force developed recommendations for offshore wind deployment. BOEMRE accepted these recommendations, making Maryland the second state in the nation to have a Request for Interest (RFI) issued for wind leases off its shores.[40] Eight offshore wind developers responded with development proposals, and twelve stakeholders submitted comments.[41] The map below (Figure 4-7) indicates the proposed leasing area in the State. Each numbered block represents a potential of 100-180 megawatts (MW) power capacity.[42]

Figure 4-7: Federal RFI Planning Area[43]



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[40] *See Maryland Offshore Wind Energy Act of 2011*, *supra* note 37.
[41] *See Maryland Offshore Wind Energy Act of 2011*, *supra* note 37.
[42] *See Maryland Offshore Wind Energy Act of 2011*, *supra* note 37.
[43] *See Maryland Offshore Wind Energy Act of 2011*, *supra* note 37.

Further planning will develop an approach to mitigate potential impacts on marine navigation, ecology, fisheries, and other uses. Maryland continues to work with regional and federal partners, including the Obama Administration and the U.S. Department of the Navy, to develop additional procurement strategies to leverage State efforts. The Maryland regional and federal partnership promises additional economic development benefits.[44]

Maryland agencies began planning for offshore wind development in 2009.[45] MEA collaborated with the Department of Natural Resources (DNR) and other stakeholders, such as the Nature Conservancy, CIER, and Towson University, to develop the *Maryland Coastal Atlas*—an online interactive tool for advanced marine spatial planning.[46] The *Maryland Coastal Atlas* allows State agencies, offshore wind developers and affected stakeholders to determine areas of potential conflict due to ecological, navigational, military, fisheries and other uses.[47]

While still speculative, the development of wind power in Maryland can contribute to the lowering of the State's dependence on imported energy sources, increasing Maryland's energy security. Because offshore wind is a more dependable resource than its land-based counterpart, it has large potential for addressing Maryland's long-term energy needs. However, the high cost of offshore wind energy with respect to conventional energy in the short term remains an impediment to full deployment.

Solar Installations

Solar energy in Maryland is providing both utility scale generation and increased distributed generation at the residential level. Maryland has measureable solar resources at an annual average of 5.3 kilowatt-hours (kwh)/m^2 (see Figure 4-8).[48] As of 2011, Maryland had over 41.8 MW of installed solar capacity, with at least 30 MW of additional capacity expected to come on-line in the near future. Maryland is actively pursuing additional solar resources through the RPS, which requires at least 2% of the electricity sold in Maryland by 2022 come from solar resources.[49] Further, beginning in 2012, all solar resources used for RPS compliance must be connected to the distribution grid serving the State.

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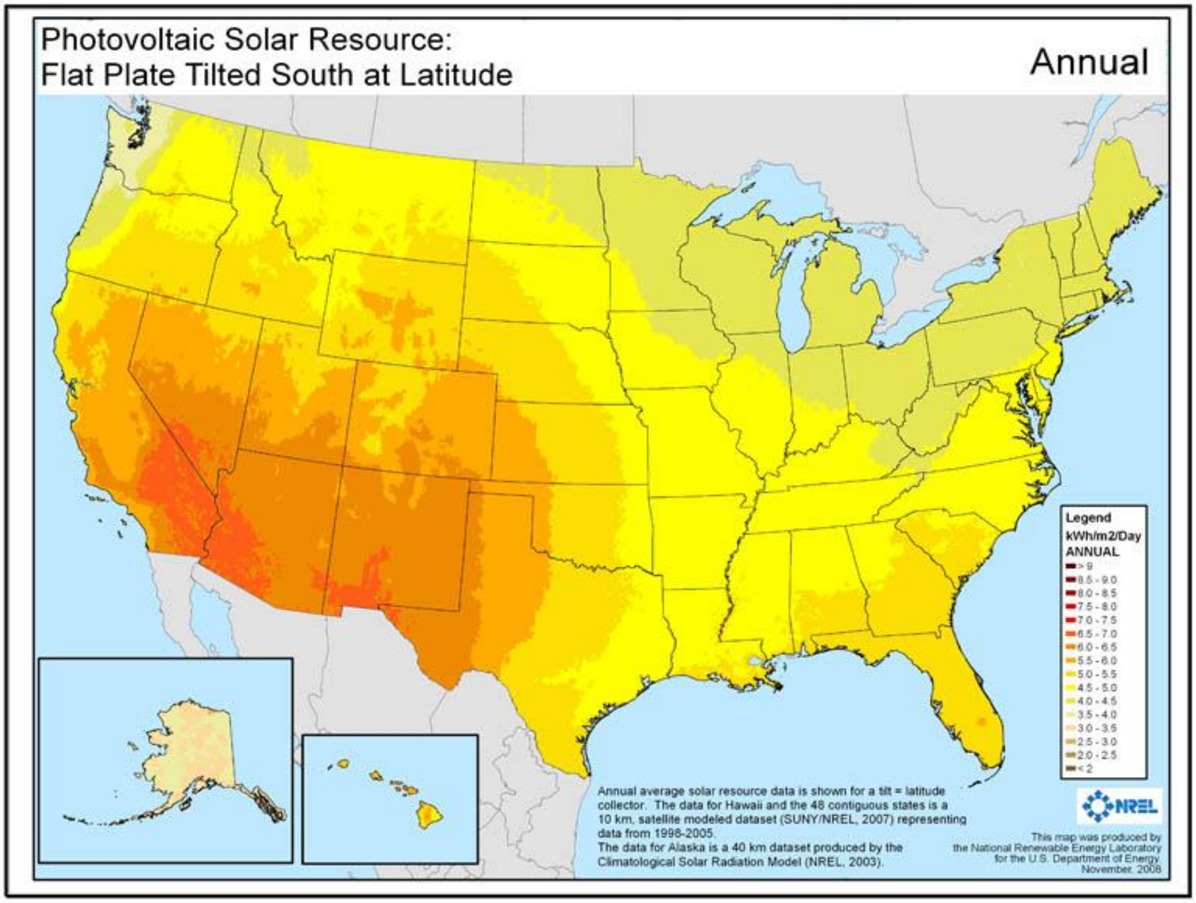
[44] *See Maryland Offshore Wind Energy Act of 2011*, *supra note* 37.
[45] *See Maryland Offshore Wind Energy Act of 2011*, *supra note* 37.
[46] *See Maryland Offshore Wind Energy Act of 2011*, *supra note* 37.
[47] *See Maryland Offshore Wind Energy Act of 2011*, *supra note* 37. *See also* Maryland Department of Natural Resources, *Coastal Atlas: Ocean* (n.d.) [hereinafter *Coastal Atlas: Ocean*], *available at* http://www.dnr.state.md.us/ccp/coastalatlas/ocean.asp, (last visited Jan. 23, 2012).
[48] *See* National Renewable Energy Laboratory, *Solar Maps* (2012) [hereinafter *Solar Maps*], *available at* http://www.nrel.gov/gis/solar.html (last visited December 9, 2011). *See also* Maryland Energy Administration, *Solar Energy* (n.d.) [hereinafter *Solar Energy*], *available at* http://energy.maryland.gov/solar.html (last visited Jan. 23, 2012).
[49] *See* Maryland Energy Administration, *Maryland's Goals* (n.d.) [hereinafter *Maryland's Goals*], *available at* http://www.energy.state.md.us/mdGoals.html (last visited Jan. 23, 2012).

Figure 4-8: Photovoltaic Solar Resource



Solar energy is used in Maryland to produce both electricity (photovoltaic) and heat (thermal). Both uses reduce reliance on conventional energy resources and increase distributed generation throughought the State.[50] In addition to the residential grants discussed above, Maryland also offers grant assistance to commercial[51] and government scale projects.[52] These efforts have directly resulted in the development of over 10 MW of solar generation through approximately 50 projects. Moreover, Maryland is purchasing 16 MW of solar capacity to serve its own electrical load in the third of three projects in Generating Clean Horizons.[53] Additional commercial scale installations are in development without MEA

[50] *See Solar Energy*, *supra note* 50.

[51] *See* Maryland Department of Energy, *Commercial Clean Energy Grant Program* (n.d.) [*Commercial Clean Energy Grant Program*], *available at* http://www.energy.state.md.us/Business/cleanenergygrants/index.html (last visited Jan. 24, 2012).

[52] *See* Maryland Energy Administration, *Project Sunburst* (n.d.) [hereinafter *Project Sunburst*], *available at* http://energy.maryland.gov/Govt/sunburst.html (last visited Jan. 23, 2012).

[53] *See* Constellation Energy, *Emmitsburg Solar* (n.d.) [hereinafter *Emmitsburg Solar*], *available at* http://www.constellation.com/energymatters/renewableenergy/emmitsburgsolar/pages/emmitsburgsolar.aspx (last visited Jan. 24, 2012).

involvement, thereby further increasing solar capacity. These resources are located in all areas of the State, lessening the need for large scale generation and transmission.

Geothermal Heat Pumps

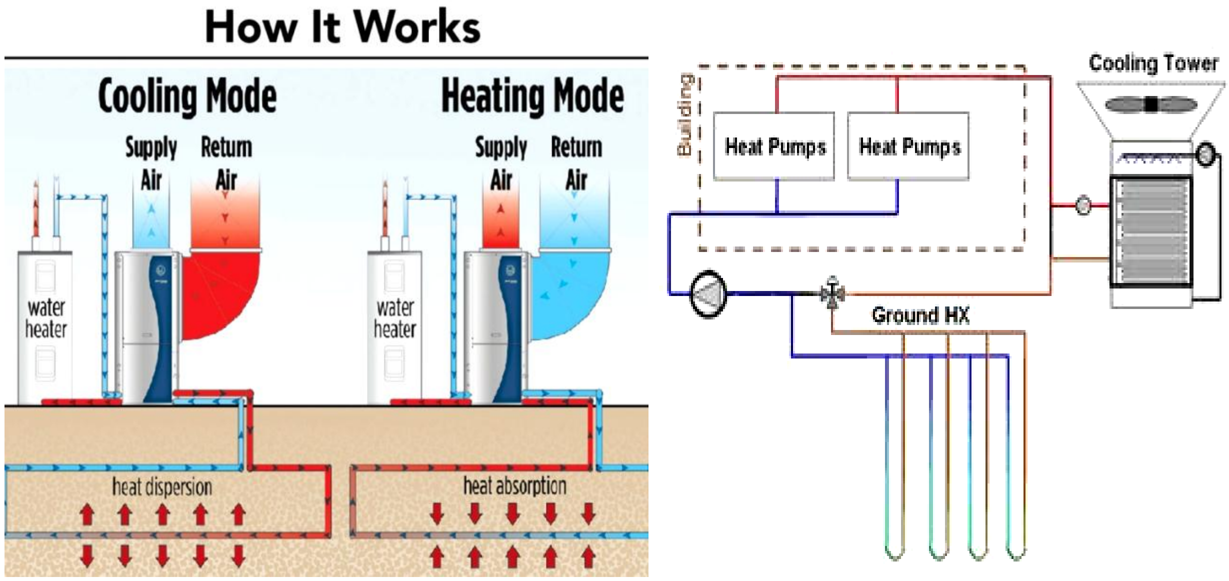
Geothermal heat pumps are used for space heating and cooling, as well as water heating. Their greatest advantage is that the technology works by concentrating naturally existing heat, rather than producing heat through combustion of fossil fuels.[54] One of the key benefits to using geothermal heat pumps is that they "[u]se 25 percent–50 percent less electricity than conventional heating or cooling systems: up to 44 percent compared to air-source heat pumps and up to 72 percent compared to electric resistance heating with standard air-conditioning equipment."[55]

The DOE's Geothermal Technologies Program (GTP) partners with industry, academia, and DOE's national laboratories to help geothermal energy become "an economically competitive contributor to the U.S. energy supply."[56] Geothermal energy production is a $1.5 billion per year industry, and it "generates electricity or provides heat for direct applications including aquaculture, crop drying, and district heating, or for use in heat pumps to heat and cool buildings."[57]

(See Figure 4-9 on the following page for diagram of Geothermal Heat Pumps in operation.)

[54] *See* Maryland Energy Administration, *Geothermal,* (n.d.) [hereinafter *Geothermal*] *available at* http://www.energy.state.md.us/renewable/geothermal.html (last visited Jan. 24, 2012).
[55] *See* U.S. Department of Energy, *Energy Savers: Benefits of Geothermal Heat Pump Systems* (n.d.) [hereinafter *Energy Savers*]*, available at* http://www.energysavers.gov/your_home/space_heating_cooling/index.cfm/mytopic=12660 (last visited Jan. 24, 2012).
[56] U.S. Department of Energy, *Geothermal Technologies Program: About the Program* (n.d.) [hereinafter *Geothermal Technologies Program*], *available at* http://www1.eere.energy.gov/geothermal/about.html (last visited Jan. 24, 2012).
[57] *Geothermal Technologies Program*, *supra note* 58.

Figure 4-9: Geothermal Heat Pumps, How It Works



As part of MEA's Commercial Clean Energy Grant Program, businesses, nonprofits and government entities who install geothermal heat pumps will receive financial assistance.[58] In addition, MEA administers a Residential Clean Energy Grant Program that provides financial assistance to residents who make those installations.[59]

Because geothermal energy comes from the heat of the earth, it has the ability to produce energy consistently, regardless of time of day or weather factors, helping assure that Maryland's energy supply is resilient.

Residential Energy Efficiency

The five Maryland EmPOWER utilities (BGE, Pepco, SMECO, Delmarva and Potomac Edison) run several programs aimed at both reducing energy consumption and peak demand of residential housing. Energy consumption is targeted through programs such as the Home Performance with Energy Star program that offers whole house energy retrofits based on the Energy Star platform, while peak demand is addressed through remote cycling of HVAC equipment and water heaters. Utilities offer rebates for specific Energy Star appliances and HVAC systems, as well as for participation in the remote cycling program. Each utility has the effectiveness of its programs reviewed every three years by the PSC and MEA works with the utilities to design new programs and make improvements to existing ones.[60]

[58] *See Commercial Clean Energy Grant Program*, *supra note* 51.
[59] *See Commercial Clean Energy Grant Program*, *supra note* 51.
[60] *See EmPOWER Maryland*, *supra note* 3.

Commercial Energy Efficiency

MEA works with industry and utility partners to design new methods for reducing the consumption and peak demand of Maryland's commercial and industrial sector. Areas targeted include motors and industrial drives, building efficiency, lighting and HVAC systems. Grants and loans are available to commercial establishments to pursue different avenues of bringing efficiency to the workplace. Larger commercial establishments also work with energy service companies in the State and develop plans based on energy savings contracts to lower energy consumption.[61]

Government Sector Energy Efficiency

Senate Bill 267 requires the Department of General Services, in cooperation with MEA, to set energy performance standards that require energy consumption reductions in State buildings. MEA offers advice and low interest loans to other State agencies to accomplish goals laid out in the bill.[62]

Supplemental Energy Resources

Much like renewable energy sources, supplemental energy resources add a layer of reliability to the existing energy infrastructure. These resources can be added to the overall energy assurance efforts in Maryland.

Combined Heat and Power & Combined Cooling Heat and Power

Combined Heat and Power (CHP) and Combined Cooling Heat and Power (CCHP) are supplemental energy resources that can be used to enhance energy assurance in the State. The terms CHP and CCHP are used interchangeably; it is "an integrated system located at or near a building or facility, satisfying at least a portion of the facility's electrical demand, utilizing the heat generated by the electric power generation equipment to provide heating, cooling and/or dehumidification to a building and/or industrial process."[63]

According to the State Energy Assurance Guidelines issued by the National Association of State Energy Assurance Officials (NASEO) in December 2009, CHP provides the "capability, under certain configurations, to continue to safely operate and provide electric service to a facility during emergency situations."[64] Moreover, CHP systems are far more efficient than traditional methods of producing heat

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[61] *See EmPOWER Maryland*, *supra note* 3.

[62] *See EmPOWER Maryland*, *supra note* 3.

[63] Midwest CHP Application Center, *Combined Heat & Power (CHP) Resource Guide* 1 (2nd ed. 2004).

[64] *See* National Association of State Energy Officials, *State Energy Assurance Guidelines* Appendix G – 135 (version 3.1 2009).

and power separately—traditional methods have a combined efficiency of 45 percent, in comparison to CHP systems that can reach 80 percent efficiency levels.[65]

Maryland has a number of CHP units located across the State, including units in Baltimore, Bethesda, Brandywine, College Park, Cumberland, Indian Head, Joppa, Lexington Park, Luck, Owings Mills, Princess Anne, Silver Spring, Sparrows Point and Upper Marlboro.[66]

While these facilities may be available during an emergency situation, the State must make a determination as to which of these sites meet criteria for operating during times of an emergency. Additionally, a decision must be made as to which units can be utilized to meet the needs of specific facilities during an emergency. Finally, the State should determine the ease and cost of modifying existing units to meet grid reliability and energy assurance needs.

Energy Storage

Energy storage is the process by which energy is developed, but not released until needed. Simple examples of energy storage include batteries and pump-storage hydroelectric generation, where water is pumped uphill and then released downhill through generating turbines when the electricity is needed. Electric energy storage (EES) "can be used to accumulate excess electricity generated at off-peak hours and discharge it at peak hours."[67] Thus, using EES effectively would reduce the need for costly generation during peak hours. Further, EES can provide additional benefits such as grid frequency regulation, voltage support and operating reserves.[68]

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[65] *See* Maryland Energy Administration, *Save Energy Now for Maryland Industry: Combined Heat and Power* (n.d.) [hereinafter *Save Energy Now for Maryland Industry*], *available at* http://www.energy.state.md.us/SEN/CHP.html (last visited Jan. 24, 2012).

[66] *See* U.S. Department of Energy, *Combined Heat and Power Installation Database* (n.d.) [hereinafter *Combined Heat and Power Installation Database*], *available at* http://www.eea-inc.com/chpdata/States/MD.html (last visited Jan. 24, 2012).

[67] *See* National Energy Technology Laboratory, *Market Analysis of Emerging Electric Energy Storage Systems, Final Report* 1 (2008) [hereinafter *Market Analysis of Emerging Electric Energy Storage Systems*], *available at* http://www.netl.doe.gov/energy-analyses/pubs/Final%20Report-Market%20Analysis%20of%20Emerging%20Electric%20Energy%20Sto.pdf.

[68] *See Market Analysis of Emerging Electric Energy Storage Systems*, *supra note* 69.

There are two main categories of EES technologies – electrochemical and non-electrochemical. Specific examples in each of these categories include:

- Electrochemical EES:
    - Lead Acid Battery
    - Sodium-Sulfur battery (NaS)
    - Flow Batteries
        - Vanadium Redox Battery (VRB)
        - Zinc Bromine Battery (ZnBr)
    - Nickel Cadmium (NiCd) Battery
    - Nickel Metal Hydride (NiMh) Battery
    - Lithium Ion (Li-ion) Battery
- Non-Electrochemical EES:
    - Pumped Hydroelectric
    - Compressed Air Energy Storage (CAES)
    - Flywheel
    - Ultra-Capacitor
    - Superconducting Magnetic Energy Storage (SMES) [69]

Although these technologies exist, they are not yet commonly employed in the United States. As of 2008, the United States only had one CAES system, several plants based on lead-acid batteries, and one based on nickel-cadmium batteries.[70] Moreover, since 2003, only 2.5 percent of the total electric power delivered in the United States passed through energy storage at all, and much of that was largely through pumped hydroelectric.[71] Because hydroelectric and CAES systems are geographically constrained and less flexible, other systems have taken the lead as EES technologies have become more attractive in the electricity industry—two of the leading technologies are batteries and flywheel systems.[72]

Adding effective storage capabilities to the State's current energy infrastructure would provide greater resiliency and help compensate for the variability in some renewable energy sources, such as wind and solar.[73] At the same time, storage will alleviate grid stability concerns associated with intermittent renewable energy sources. At this time, Maryland does not have any large scale energy storage capacity. However, the overall, the technical benefits of energy storage, such as grid stabilization, operational support, power quality and reliability, load shifting and supporting the integration of intermittent renewable energy sources, make it an option for creating greater energy assurance in the State.

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[69] *See Market Analysis of Emerging Electric Energy Storage Systems*, *supra note* 69.
[70] *See Market Analysis of Emerging Electric Energy Storage Systems*, *supra note* 69.
[71] *See Market Analysis of Emerging Electric Energy Storage Systems*, *supra note* 69.
[72] *See Market Analysis of Emerging Electric Energy Storage Systems*, *supra note* 69.
[73] *See Market Analysis of Emerging Electric Energy Storage Systems*, *supra note* 69.

The Smart Grid: An Overview and Analysis

At its most basic level, the Smart Grid combines digital information and communication technology with electric distribution and generation systems. Smart Grid components placed along transmission and distribution lines, as well as at customer locations, facilitate the movement and management of power along the grid. Smart Grid components can regulate power both on the utility side and customer side of electric meters. On the utility side, digital communications can inform control operations and help to balance supply and demand. On the customer side, digital meters provide data that can help customers control consumption, and coupled with real time pricing, provide an incentive and a means to control consumption and peak demand. In a fully realized Smart Grid, customers will be able to control systems, such as HVAC and appliances located within their residences or businesses, through remote operations such as smart phones and internet capable devices.

The Smart Grid:

> is an interconnected system of information and communication technologies and electricity generation, transmission, distribution and end-use technologies that will: enable consumers to manage their usage and choose the most economically efficient offering, maintain delivery system reliability and stability enhanced by automation, and use the most environmentally benign generation alternatives including renewable resources and energy storage.[74]

There are three categories of smart grid technology:

1. Advanced information and communications technologies, including sensors and automation capabilities, which improve the operation of transmission and distribution systems;
2. Advanced metering solutions, which improve on or replace legacy metering infrastructure; and
3. Technologies, devices and services that access and leverage energy usage information, such as smart appliances that can use energy data to turn on when energy is cheaper or renewable energy is available.[75]

Further, the Smart Grid offers several benefits, both to consumers and to utility/energy companies. The benefits to consumers include:

- The ability to make informed usage decisions;
- A direct, real-time connection to the electricity market;
- The motivation to participate in that market; and
- Reduced energy costs.[76]

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[74] *See* Richard Sedano, *Smart Grid Briefing to Renewable Fund Managers* (2009) [hereinafter *Smart Grid Briefing*], *available at* http://www.sgiclearinghouse.org/node/2306&lb=1.

[75] *See* Executive Office of the President, *A Policy Framework for the 21st Century Grid: Enabling Our Secure Energy Future*, 1 (2011) [hereinafter *Policy Framework for the 21st Century Grid*].

[76] *See* National Energy Technology Laboratory, *A Systems View of the Modern Grid* (vol. 2.0 2007) [hereinafter *Systems View of the Modern Grid*].

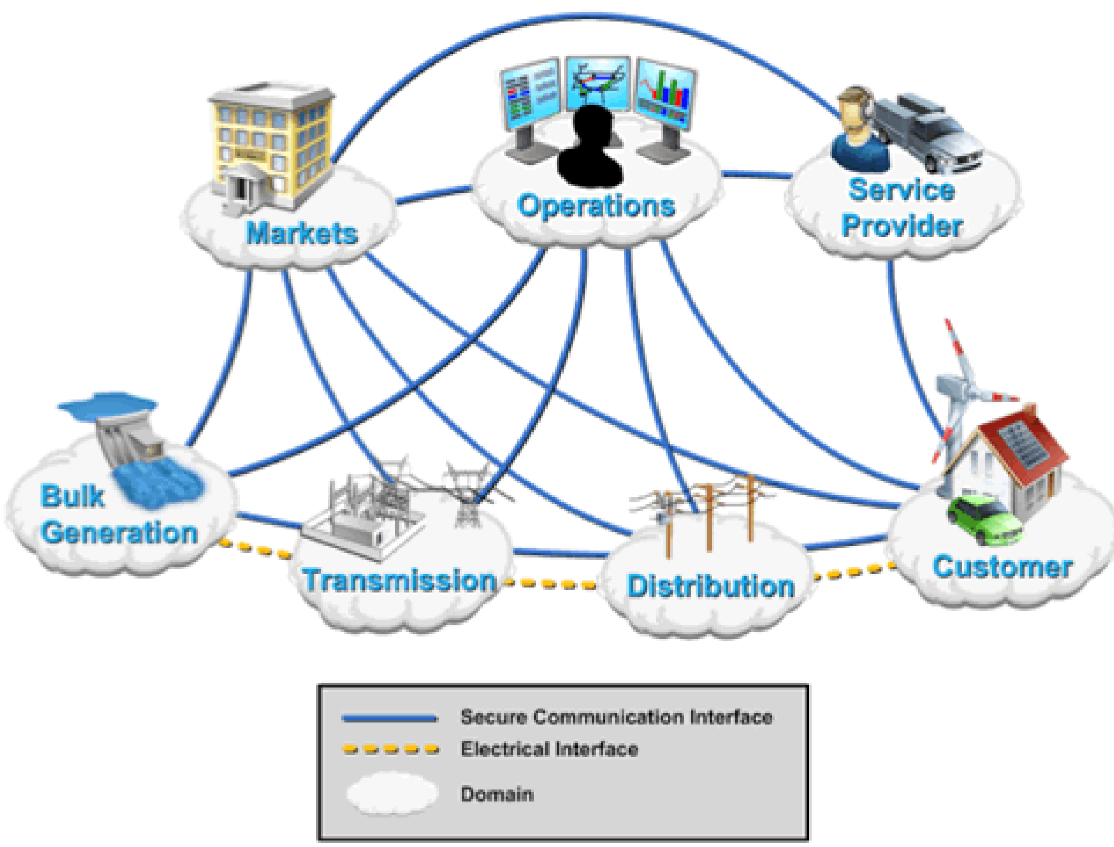
The benefits to utilities include:

- Greater load control;
- Reduced operational costs;
- Congestion relief; and
- Reduced energy theft.[77]

The Smart Grid as a Nucleus

The Smart Grid serves as an enabler/facilitator for energy efficiency, energy conservation, renewable energy, and distributed generation. In other words, it is a unifying capability that allows for enhanced energy reliability across demand and supply side users and providers. The relationship amongst these concepts is depicted and described below (see Figure 4-10):[78]

Figure 4-10: National Institute of Standards and Technology (NIST) conceptual model of the SmartGrid[79]



[77] *See Systems View of the Modern Grid*, *supra note* 78.
[78] *See* PJM, *Smart Grid* (n.d.) [hereinafter *Smart Grid*], *available at* http://www.pjm.com/about-pjm/exploring-tomorrows-grid/smart-grid.aspx (last visited Jan. 24, 2012).
[79] *See* Smartgrid Information Clearinghouse, *NIST Smart Grid Conceptual Model* (n.d.) [hereinafter *NIST Smart Grid Conceptual Model*], *available at* http://www.sgiclearinghouse.org/ConceptualModel (last visited January 17, 2012).

The Smart Grid enables the use of several energy sources, to include renewable energy sources like the sun and wind. The generation of energy that the Smart Grid can leverage is distributed – some of it comes from a centralized energy plant, others come from renewable energy sources (distributed generation). Also depicted in Figure 4-10 are "smart" appliances and interval meters. As the existence and use of these appliances and meters become more pervasive, consumers will be able to further manage their energy consumption by "programming" their appliances to operate in the most efficient manner and at the most efficient times of the day.

Smart Grid Integration with Interval Meters and "Smart" Appliances

Developing alongside the Smart Grid are interval meters and "smart" appliances. Interval meters are energy meters that allow for data to be collected in minute-intervals (e.g., 5 minutes, 10 minutes, etc.), thereby providing more insight into how much energy is consumed at different times during the billing period; this is different from simply totaling the amount consumed during a certain billing period.[80] A letter from the Environmental Protection Agency (EPA) to the Association of Home Appliance Manufacturers states that "consumers can save money when time-of-use or real-time electricity prices and smart meters are in place and when grid savings are reflected through lower electricity rates for consumers."[81] The greatest benefit to consumers in having interval meters is the ability to dynamically manage their energy costs. If the consumer is on a fixed budget and knows how much they can afford each month for an energy bill, they can better manage consumption by reducing their usage of some appliances or programming their "smart" devices to automatically turn off after some predefined threshold is met.

Smart appliances are an important element in realizing the benefits of smart grid technologies. They have the potential to significantly improve the stability and operational efficiency of the electrical grid with limited impact on the lives of energy users. Because they can manage discrete device components to reduce energy consumption at a moment in time, smart appliances connected to the grid offer extensive load management options. Whether it is the use of renewable sources or load management, smart appliances allow energy consumers to contribute to more efficient management of energy resources while at the same time reducing carbon emissions.[82]

Consumers and utility/energy companies alike can benefit from the utilization of smart appliances and interval meters. Additionally, the energy market (e.g., PJM Market), which fluctuates based upon supply

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[80] *See* Larry E. Sandre, *Power Metering, Monitoring, and Control: An Interval Meter…Watt?* (n.d.) [hereinafter *Power Metering, Monitoring, and Control*], *available at* http://www.electricity-today.com/et/issue0801/i08_metering.htm (last visited Jan. 24, 2012).

[81] *See* U.S. Environmental Protection Agency, *E.P.A. Response Letter to Petition* (2011) [hereinafter *E.P.A. Response Letter to Petition*], *available at* http://www.energystar.gov/ia/partners/prod_development/revisions/downloads/room_air_conditioners/EPA_Response_Letter_to_Petition.pdf.

[82] *See* Pike Research, *Smart Appliances* (n.d.) [hereinafter *Smart Appliances*], *available at* http://www.pikeresearch.com/research/smart-appliances (last visited Jan. 24, 2012).

and demand, could also leverage the "closer to real-time" (e.g., 5 minute intervals) insight provided by interval meters to dynamically increase and decrease energy market prices.

Security and the Smart Grid

Even with all the benefits offered by the Smart Grid, it still gives rise to a major concern as well—security. Security in the context of the Smart Grid refers primarily to securing the control systems (transmission upgrades, substation automation and distribution automation) and the smart meter, also referred to as the Advanced Metering Infrastructure (AMI).[83] Generally speaking, there are the same security concerns inherent in the Smart Grid that exists with any system, data or infrastructure connected to the internet (cyberspace): confidentiality, integrity, availability and authentication. The Smart Grid is designed to provide increased reliability, accessibility and visibility into energy production, distribution and use for utility companies and consumers. However, the information technology that enables this increased reliability, accessibility and visibility can also be exploited by illegitimate users and/or for illegitimate purposes. For these reasons, security "must address not only deliberate attacks, but also inadvertent compromises of the information infrastructure due to user errors, equipment failures, and natural disasters. Vulnerabilities might allow an attacker to penetrate a network, gain access to control software, and alter load conditions to destabilize the grid in unpredictable ways."[84]

The National Institute of Standards and Technology (NIST) Interagency Report providing Guidelines for Smart Grid Cyber Security ("NIST Report") lists some of the risks associated with making our grid "smarter":

- Greater complexity increases exposure to potential attackers and unintentional errors;
- Networks that link more frequently to other networks introduce common vulnerabilities that may now span multiple Smart Grid domains and increase the potential for cascading failures;
- More interconnections present increased opportunities for "denial of service" attacks, introduction of malicious code (in software/firmware) or compromised hardware, and related types of attacks and intrusions;
- As the number of network nodes increases, the number of entry points and paths that potential adversaries might exploit also increases; and
- Extensive data gathering and two-way information flows may broaden the potential for compromises of data confidentiality and breaches of customer privacy, and compromises of personal data and intrusions of customer privacy. [85]

According to the "Energy Independence and Security Act (EISA) of 2007, NIST has the 'primary responsibility to coordinate development of a framework that includes protocols and model standards

[83] *See* Pike Research, *Research Report: Utility Cyber Security: Seven Key Smart Grid Security Trends to Watch in 2012 and Beyond*, 1; 3-4 (2011) [hereinafter *Research Report: Utility Cyber Security*].
[84] *See* The Smart Grid Interoperability Panel Cyber Security Working Group, *NIST Interagency Report 7268 – Guidelines for Smart Grid Cyber Security*, 6-7 (2010), *available at* http://csrc.nist.gov/publications/nistir/ir7628/introduction-to-nistir-7628.pdf.
[85] *See NIST Interagency Report 7268*, *supra note* 86.

for information management to achieve interoperability of smart grid devices and systems . . . .'"[86] While there is an advantage to having a centralized body for establishing Smart Grid cybersecurity standards, the challenge is that "over 80 percent of the physical assets that make up the grid (generating plants, transmission and distribution lines, meters, and more) are privately owned." [87]

Further security guidance is available in the Energy Sector-Specific Plan (ESSP) Annex to the National Infrastructure Protection Plan. Issued in 2010, the ESSP Annex discusses protective measures related to physical and cyber security.[88] According to the ESSP Annex, protective measures should include: further developing contingency plans; continuing to conduct asset, system and network assessments; continuing to analyze current security risks and provide needed information to appropriate sector partners; and enhancing access controls, surveillance and hardening of assets, systems and networks.[89] The ESSP also addresses cybersecurity protective measures, including defining protocol for securing infrastructure against cyber attacks, as well as improving protection of Supervisory Control and Data Acquisition (SCADA) networks.[90] ESSP cites several enhanced security measures, including:

- Attack-resistant platforms, hardened systems, platforms, devices and equipment, and built-in security appliances with each asset or device;[91]
- Secure communication architectures able to continue operating in a degraded condition during a cyber attack are equally important to develop;[92]
- Non-bootable (hot) patching capabilities, which can be applied system-wide and without harming operations;[93] and
- Secure operating systems as part of a real-time platform.[94]

Finally, with regard to Smart Grid technology, the ESSP finds that "risk assessment, modeling, and simulation tools that have dynamic automated capabilities are needed to discover the implication of new complexities, design and implement a smart grid with built-in security, and inform engineering decisions to optimize security."[95]

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[86] *See NIST Interagency Report 7268*, *supra note* 86.
[87] *See NIST Interagency Report 7268*, *supra note* 86.
[88] *See* U.S. Department of Energy & Department of Homeland Security, *Energy Sector Specific Plan*, 53-54 (2010) [hereinafter *DOE & DHS Energy Sector Specific Plan*], *available at* http://www.dhs.gov/xlibrary/assets/nipp-ssp-energy-2010.pdf.
[89] *See DOE & DHS Energy Sector Specific Plan*, *supra note* 90.
[90] *See DOE & DHS Energy Sector Specific Plan*, *supra note* 90.
[91] *See* Energy Sector Control Systems Working Group, *Roadmap to Secure Energy Delivery Systems Draft*, 40-41 (2011), *available at* http://www.oe.energy.gov/DocumentsandMedia/2011_EDS_Roadmap_DRAFT_11111.pdf.
[92] *See Roadmap to Secure Energy Delivery Systems Draft*, *supra note* 93, at 40.
[93] *See Roadmap to Secure Energy Delivery Systems Draft*, *supra note* 93, at 40.
[94] *See Roadmap to Secure Energy Delivery Systems Draft*, *supra note* 93, at 40.
[95] *See Roadmap to Secure Energy Delivery Systems Draft*, *supra note* 93, at 40.

Distributed Generation, Electric Vehicles, and the Smart Grid

The electricity grid is designed to meet the rare occasions of maximum load (e.g., peak summer demand in Maryland) and as such, there is unused transmission and generation capacity for much of the year. In the context of the Smart Grid, this excess capacity, if utilized by plug-in hybrid electric vehicles (PHEVs), could lower electricity rates and lead to environmental benefits.[96] Despite the potential benefits of PHEVs, the possibility for negative impacts exist without proper infrastructure growth, maintenance and carefully designed PHEV charging regulations.

For the coming decade, the risk of PHEVs creating a significant reliability-disrupting source of power demand is unlikely, as adoption of the technology by consumers is currently slow. As PHEVs become more prevalent, however, the risk of power demand exceeding supply would grow in the absence of appropriate measures. A 2007 study from the Pacific Northwest National Laboratory, found that assuming a very high use rate of PHEVs where 73 percent of the daily energy requirements for U.S. low-duty vehicles (LDV) are met by electricity, grid reliability concerns could arise.

Such concerns include:

- Planned outages for plant maintenance would likely need to occur more frequently, making it more difficult to schedule maintenance;
- Overall system reliability could be reduced in this high-use scenario, as less reserve capacity is available to system operators for managing system emergencies;
- As loads become less cyclical (e.g., with peaks and troughs), and more constant across time, "intra-regional transmission constraints" could occur more frequently;
- System components (e.g., transformers) may impose additional constraints on the delivery limit because they may not be designed to sustain a constant high-load without a period of lower load conditions, during which equipment can cool down. [97]

Despite these concerns, grid reliability challenges can be overcome. First, the quality and capacity of the bulk and retail electricity networks would need to be upgraded in a manner that meets PHEV-driven consumption patterns. Specifically, adoption of smart meters and high-capacity transformers and distribution feeders would help meet PHEV demand. Second, "grid-operating procedures would need to be changed to shift some of the ancillary services to load resources to free up generation capacity for energy production."[98] Third, regulators should mandate or incentivize adoption of smart PHEV charging systems capable of recognizing grid emergencies. Smart PHEV charging stations would have two functions: (1) not drawing power at critical times, and (2) supplying the grid with excess power during

[96] Michael Kinter-Meyer, M et. al., Pacific Northwest National Laboratory, *Impacts Assessment of Plug-in Hybrid Vehicles on Electric Utilities and Regional U.S. Power Grids, Part 1: Technical Analysis* (2007) [hereinafter *Impacts Assessment of Plug-in Hybrid Vehicles*], *available at* http://citeseerx.ist.psu.edu/viewdoc/download ?doi=10.1.1.105.663&rep=rep1&type=pdf.

[97] *Impacts Assessment of Plug-in Hybrid Vehicles*, *supra note* 98.

[98] *Impacts Assessment of Plug-in Hybrid Vehicles*, *supra note* 98.

emergencies. Collectively, these steps and others would diminish the likelihood for grid electricity reliability risks as PHEVs become more prevalent.[99]

Additionally, increased use of PHEVs could impact the electricity fuel-mix, and consequently, regional fuel demand, prices and the supply chain. As the cyclical load profile transforms to a relatively flat profile, load following fuels such as natural gas and oil may be in less demand; conversely, base load resources such as coal and nuclear could be in greater demand. However, growth of intermittent wind and solar could require that a significant amount of load-following capacity remain in-service. Also, studies show PHEVs and intermittent renewable resources could jointly improve grid reliability; PHEVs provide a ready source of demand (and storage) when power is being generated, and a ready source of supply when the system is at maximum capacity. Last, PHEVs would displace oil consumption – relying on PHEVs for 73 percent of light duty vehicle (LDV) transportation needs would result in a 52 percent reduction in foreign petroleum imports.[100] Overall, there remains significant uncertainty regarding how PHEV adoption in Maryland and the Mid-Atlantic region would impact fuel consumption patterns and energy assurance.

Maryland Smart Grid Projects

The American Recovery and Reinvestment Act of 2009 helped to fund a number of smart grid projects in Maryland. Below are brief summaries of each project as described on the smartgrid.gov website.

Baltimore Gas and Electric Company (BGE) received $200M in funding to initiate a Smart Grid project to install 1.25 million residential and commercial smart meters that could potentially save BGE electric and gas customers in excess of $2.6 billion over the life of the project. BGE's Smart Grid Initiative consists of a territory-wide deployment of AMI, implementation of a customer Web portal and home energy management reports, deployment of a direct load control program, and installation of a new customer care and billing system. BGE will replace or upgrade more than 1.25 million electric meters to improve customer service, reduce BGE operation and maintenance costs, and offer customers a critical peak rebate program to help reduce peak demand and lower customer bills. Through a Web portal, energy management reports, emails, texts, and phone messaging, BGE delivers usage information to help customers better manage their energy consumption. A direct load control program offers customers a rebate to enable cycling of central air conditioners and electric hot water heaters. In addition, a new billing system enables optimal utilization of the new technologies offered by these programs.[101]

Pepco Holdings, Inc.-DC (Pepco) Smart Grid project in Washington, DC, includes distribution automation, AMI, and demand response programs that involve load control devices and time-based rate programs. The AMI installation is designed to provide customers and Pepco with detailed electricity usage information, which, when combined with the demand response programs, helps customers

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[99] As of the end of 2011, Maryland has over 80 electric vehicle charging stations installed throughout the state.
[100] *Impacts Assessment of Plug-in Hybrid Vehicles*, *supra note* 98.
[101] U.S. Department of Energy, *Baltimore Gas and Electric Company Smart Grid Project* (n.d.) [hereinafter *BGE Smart Grid Project*], *available at* http://www.smartgrid.gov/project/baltimore_gas_and_electric_companysmart_ grid_project/latest_data (last visited Jan. 24, 2012).

reduce electricity usage and peak demand. The distribution automation deployment includes automated distribution circuit switches and transformer monitors that improve the reliability of the distribution system while decreasing operations and maintenance costs. Pepco received over $44.5M for this project, which covers both Maryland and Washington, DC.[102]

Atlantic City Electric Company's (ACE) SGIG Distribution Automation project received $18.7M for its Smart Grid project. Under this project, ACE will be deploying distribution automation assets, direct load control devices, and a wireless communications network. Direct load control devices are being offered that provide financial incentives for customers for allowing ACE to cycle air-conditioners or control thermostats during peak periods. Distribution automation devices, which include feeder monitors, equipment condition monitors, and automated feeder switches, improve the reliability and power quality of the distribution system. These systems also reduce operation and maintenance costs as well as distribution line losses. Benefiting states include: Maryland, New Jersey, and Washington, DC.[103]

PJM Interconnection's (PJM) Smart Grid project received over $13.6M in federal funding. Under this project, PJM and 12 of its member transmission owners are deploying synchrophasor measurement devices in 81 of its high-voltage substations and are implementing a robust data collection network. This project complements existing equipment to provide the necessary information technology infrastructure and wide-area monitoring and coverage of the PJM system to support further development of more advanced applications. The project is aimed at improving electric system reliability and restoration procedures, and preventing the spread of local outages to neighboring regions. The project deploys phasor measurement units, phasor data concentrators, communication systems and advanced transmission software applications. These devices increase grid operators' visibility of bulk power system conditions in near real time, enable earlier detection of problems that threaten grid stability or cause outages, and facilitate information sharing with neighboring control areas. Access to better system operating information allows PJM engineers to improve power system models and analysis tools for better reliability and operating efficiency. This project covers a number of states and territories, including Maryland.[104]

Princeton Energy Resources International (PERI) received $750,000 in federal funds for its Smart Grid project which teams PERI with a local a community college and two rural electric cooperatives to provide training and workforce development to accelerate the use of sustainable energy resources in the Mid-Atlantic region. Working with Worchester and Wicomico Community College, PERI is developing and implementing an Associate degree program in Electrical Engineering, an Associate of Applied Sciences degree in Environmental Engineering Technology and a certificate program in alternative

[102] U.S. Department of Energy, *Pepco Holding, Inc. – DC: Smart Grid Project* (n.d.) [hereinafter *Pepco Holding, Inc. – DC: Smart Grid Project*], *available at* http://www.smartgrid.gov/project/pepco_holdings_inc_dc_smart_grid_project (last visited Jan. 24, 2012).
[103] U.S. Department of Energy, *Atlantic City Electric Company: SGIG Distribution Automation Project* (n.d.) [hereinafter *Atlantic City Electric Company*], *available at* http://www.smartgrid.gov/project/atlantic_city_electric_company_sgig_distribution_automation_project (last visited Jan. 24, 2012).
[104] U.S. Department of Energy, *Princeton Energy Resources International: Mid-Atlantic Renewable Energy Education Program for Rural Electric Power Sector* (n.d.) [hereinafter *Princeton Energy Resources International*], *available at* http://www.smartgrid.gov/project/princeton_energy_resources_international (last visited Jan. 24, 2012).

energy. A distance learning component will be added to the program to provide further outreach to electric cooperatives. The PERI team is also assisting Salisbury University in the development of a Rural Energy Business Administration Certificate program that focuses on business issues related to sustainable and renewable energy. To further enrich the learning experience, Choptank Electric Cooperative is implementing hands-on training at their wind and solar data collection laboratory. Mentorships and scholarships are supported by MEA and the Old Dominion Electric Cooperative.[105]

Conclusion

Maryland continues to maximize the use of energy conservation and efficiency programs as well as pursuing alternative energy sources to reduce overall energy consumption and peak demand. By decreasing energy consumption and peak demand and increasing use of renewable and supplemental energy resources, the State will be able to lessen the likelihood of brownouts and blackouts. Further, implementation of the Smart Grid in Maryland provides the State with a unified system for taking advantage of new technologies and increasing energy reliability.

[105] U.S. Department of Energy, *PJM Interconnection, LLC: PJM SynchroPhasor Technology Deployment Project* (n.d.) [hereinafter , *PJM Interconnection, LLC*], *available at* http://www.smartgrid.gov/project/pjm_interconnection_llc_pjm_synchrophasor_technology_deployment_project (last visited Jan. 24, 2012).

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Chapter 5. Foundations of Emergency Response Planning in Maryland

Introduction

Energy disruptions play a critical role in a majority of emergency events in Maryland, and the causes and effects of the disruptions often span jurisdictional boundaries. To effectively respond to the wide variety of energy disruptions, energy assurance in Maryland requires the coordination of State, local, federal and industry emergency response plans and procedures. In this respect, Maryland's emergency planning and response is ultimately based on a number of federal plans and policies that stress coordination between stakeholders, responders and planners.

Coordination between governmental agencies from several jurisdictions, and between these agencies and private firms, requires individual plans to have similar fundamental aspects, including recognizing the need for effective inter-agency communication and plan coordination. The first step in harmonizing these various plans and procedures is to compile them and provide an overview in a single master planning document. This chapter addresses how Maryland has adopted federal emergency management guidelines and procedures in an effort to bring consistency to emergency-response activities in the State. This chapter also provides energy professionals an overview of emergency management in the State of Maryland.

State Energy Emergency Management

Overview of Emergency Response in Maryland[1]

In Maryland, emergency management is the purview of the Maryland Emergency Management Agency (MEMA), and MEMA's first defense against, and recovery from, catastrophic events is the Maryland Joint Operations Center (MJOC). MJOC is a continuously staffed communications and information gathering operations center at the Camp Fretterd Military Reservation facility outside of Reisterstown. The staff at MJOC tracks national and regional news, weather, and other information sources for pre-event informational awareness. In the event of an approaching or immediately apparent emergency (such as an approaching hurricane), the MJOC coordinates communications with State agencies and

[1] For specifics on Maryland's efforts, Maryland Emergency Management Agency, *State of Maryland Core Plan for Emergency Operations* (2009) [hereinafter *State of Maryland Core Plan for Emergency Operations*], *available at* http://www.mema.state.md.us/MEMA/content/pdf/The_State_of_Maryland_Emergency_Operations_Plan_26Aug09.pdf.

emergency responders who take a variety of actions depending on the type and severity of the threat or event.

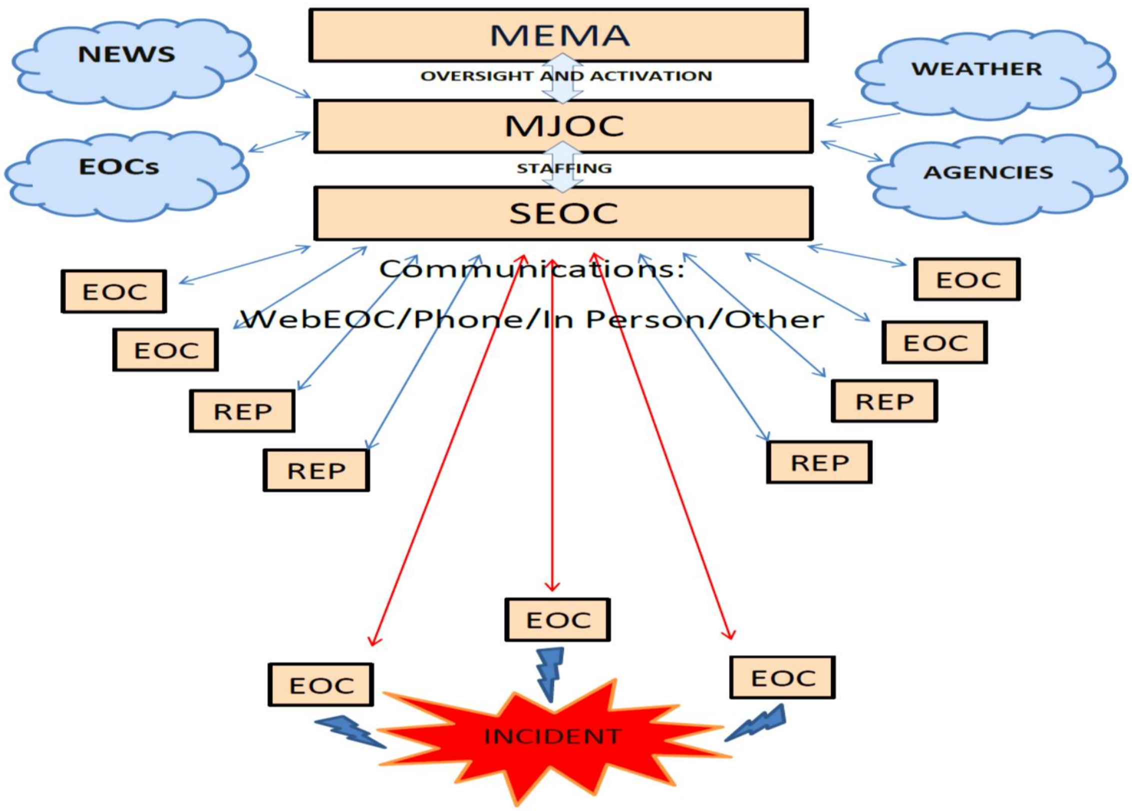
When an emergency rises to a widespread or serious level, MEMA activates the State Emergency Operations Center (SEOC) which is housed in the same facility as the MJOC. The SEOC functions as a communications hub for State and some private sector stakeholders during a declared emergency. During an emergency MEMA requests that State agencies, federal agencies and private firms staff the SEOC as appropriate for the event. The SEOC gathers and manages information arriving from local Emergency Operations Centers (EOC), first responders, State agencies and others. Those called in to staff the SEOC work together, using the information specific to their agency or firm, to develop responses and coordinate field activities.

An integral conduit for communications and information used at the SEOC and in the field is an internet based application; WebEOC. WebEOC allows emergency personnel to communicate and track recovery operations in real time while compiling a record of response. Access to WebEOC is restricted, yet wide-spread and is used by first responders, State agency personnel and some private firms. All WebEOC communications are funneled through an administrator at the SEOC, making it an essential tool for developing a coordinated response. (For additional information on WebEOC see Chapter 9.)

Energy emergencies are typically tied to general emergencies, such as a weather event, and as such are only a single aspect of the overall situation. Although it is possible that SEOC activation could center on energy, such as a wide-scale blackout, the State has yet to experience an energy specific event that required full SEOC activation. In any case, energy is often an important aspect in SEOC activations and appropriate personnel are called in to staff the center. At these times staff from PSC, MEA, MDOT, utility firms and others offer advice and expertise to aid in restoring power.

Figure 5-1 displays the interactions that commonly occur before and during an emergency. Starting from the top of the graphic, MEMA oversees the MJOC and activates and oversees the SEOC. MJOC continuously monitors the "clouds" of information coming from broadcast news, local EOC's, weather forecasters and State and federal agencies. When an emergency arises, MEMA activates the SEOC and the MJOC sends out notifications to SEOC representatives (REP) to staff the SEOC. When the SEOC is staffed, local EOC's throughout the State communicate through the SEOC with agency and industry representatives (REP) who are staffing the SEOC. Communications are filtered and vetted through the SEOC and disseminated to the local EOC responders at an incident (red lines) who are on the scene responding (lightning bolts).

Figure 5-1: Overview of Emergency Activation and Response



Defining States of Energy Emergencies

The National Association of State Energy Officials (NASEO) and the National Association of Regulatory Utility Commissioners (NARUC) have compiled a set of guidelines that provide a mechanism to measure the severity of an energy crisis. The guidelines describe a range of conditions from normal operations (Level 1) to severe shortage (Level 4) (see Table 5-1 on the following page). The guidelines provide suggestions for appropriate governmental response measures according to the seriousness of the emergency.

Maryland similarly has levels of responses ranging from "Alert" (no discernible shortage in the State) to "Beyond Severe."[2] Each of these levels of severity are characterized by identifiable conditions and observed probable impacts. These well-defined categories assist the State in formulating the proper responses to an energy shortage.

[2] Maryland Energy Administration, *Energy Emergency Contingency Plan* 13-17 (2001) [hereinafter *Energy Emergency Contingency Plan*].

Table 5-1: Levels of Shortage[3]

Shortage Level	Reduction Percentage and/or Transmission/Distribution Damage Severity
Normal Conditions Level 1 ***Monitor and Alert***	• No discernable shortage. • Possible shortages elsewhere.
Shortage Level 2 ***Mild Shortage***	• 5-10%* reductions in petroleum supply for a week or more, estimated by the days a port or terminal is closed or the number of substitutions of truck deliveries instead of normal pipeline supply • 5-10%* reduction in natural gas nominations on interstate pipelines or pipelines on allocation for up to two weeks • Localized storm damage causing short-term electric transmission/distribution loss.
Shortage Level 3 ***Moderate Shortage***	• 10-15%* reductions in petroleum products for 3 weeks or more. • 10-15% reductions in natural gas nominations on interstate pipelines plus inside City Gate (the point at which gas moves from the pipeline to local distribution lines). • Curtailments by local gas distribution companies for two weeks or more. • Severe storm damage to electric transmission/distribution infrastructure.
Shortage Level 4 ***Severe Shortage***	• Greater than 15%* reduction in availability of petroleum products and/or natural gas for more than two weeks. • Natural gas nominations fall severely due to weather, interstate pipeline failure, or production problems. • Electricity outages extend for several weeks.

***Percentage reductions are illustrative only and power outage severity is often based on the number of effected customers.**

Emergency Management in Maryland: Adoption of the National Response Framework and National Incident Management System

Emergency management in Maryland mirrors the federal emergency management framework set forth in the Federal Emergency Management Agency (FEMA) National Response Framework (NRF) and National Incident Management System (NIMS). NIMS provides a template for the management of incidents, while the NRF provides the overall structure and specific mechanisms for national-level incident management. Maryland's Comprehensive Emergency Management Program (CEMP) parallels

[3] National Association of State Energy Officials & National Association of Regulatory Utility Commissioners, *State Energy Assurance Guidelines* 46 (Version 3.1 2009) [hereinafter *State Energy Assurance Guidelines*].

federal activities set forth in the NRF. The CEMP is consistent with NIMS and aligns with the NRF. Furthermore, the SEOC (and local EOC's) use the Incident Command Structure (ICS) under NIMS.[4]

Emergency management plans, annexes, and documents in Maryland are housed within the CEMP. These plans use an all-hazards approach to emergency management that has been adopted by MEMA and local jurisdictions. The CEMP:

- Outlines the roles and responsibilities of State agencies and local governments;
- Coordinates response and recovery activities; and
- Describes a system for effective use of federal, State and local government and private resources.[5]

The CEMP forms an umbrella for emergency planning that unifies actors within the State and creates a comprehensive approach to mitigating energy emergencies.

The National Response Framework (NRF)

Adopted by Maryland, the NRF guides the State's all-hazards response from the smallest incident to the largest catastrophe. The NRF:

> …identifies the key response principles, as well as the roles and structures that organize national response. It describes how communities, States, the Federal Government and private-sector and nongovernmental partners apply these principles for a coordinated, effective national response. In addition, it describes special circumstances where the Federal Government exercises a larger role, including incidents where Federal interests are involved and catastrophic incidents where a State would require significant support. It lays the groundwork for first responders, decision-makers and supporting entities to provide a unified national response.[6]

In addition to the NRF, there are twenty-three Emergency Support Function (ESF) Annexes and Support Annexes. The Annexes create response directives for those acting under the NRF by providing a concept of operations, procedures and structures.[7] In the context of an energy emergency, the NRF applies to energy disruption, mitigation and response actions ranging from small-scale localized incidents to large-scale regional or statewide power outages. The all-hazards unified response of the NRF enables it to be used in any energy emergency.

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[4] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1, at 29.

[5] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1.

[6] U.S. Department of Homeland Security, *National Response Framework Fact Sheet* (n.d.) [hereinafter *National Response Framework Fact Sheet*], *available at* http://www.fema.gov/pdf/emergency/nrf/NRFOnePage FactSheet.pdf (last visited Jan. 10, 2012).

[7] *National Response Framework Fact Sheet*, *supra note* 6.

For example, Maryland's experience during Hurricane Irene in the summer of 2011 was that the federal ESFs of FEMA Region 3 were activated and staffed in Philadelphia and were available for consultation and aid in the coordination of energy restoration. Personnel from DOE and DOT were instrumental in interpreting the Governor's Executive Order in Maryland as it related to hours of service waivers for the federal interstate system. Staff in Philadelphia remained in regular contact by email and telephone with MEMA and MEA emergency coordinators throughout the event.

National Incident Management System (NIMS)

Homeland Security Presidential Directive-5 (HSPD-5) of February 28, 2003, requires the Secretary of Homeland Security to create a national incident management system (NIMS) to facilitate a "consistent nationwide approach for Federal, State, and local governments to work effectively and efficiently together to prepare for, respond to, and recover from domestic incidents, regardless of cause, size or complexity."[8] Maryland has adopted NIMS as the statewide framework for incident management. NIMS focus is on communication and information management.[9] NIMS is the "doctrine, principles, terminology, and organizational processes to enable effective, efficient and collaborative incident management at all levels."[10] NIMS attempts to balance flexibility and standardization, while enabling a structured framework for interoperability and compatibility.[11]

Preparedness is essential to NIMS and is achieved through continued planning, organizing, training, equipping, exercising, evaluating and taking corrective action.[12] Preparedness actions ensure coordination during an incident and facilitate efficient and effective emergency management and incident response activities.[13]

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[8] Homeland Security Presidential Directive/HSPD-5, 2003 WL 604606 (2003) [hereinafter *Homeland Security Presidential Directive*], *available at http://www*.training.fema.gov/EMIWeb/IS/ICSResource/assets/HSPD-5.pdf.

[9] Federal Emergency Management Agency, U.S. Department of Homeland Security, *Communications and Information Management* (n.d) [hereinafter *Communications and Information Management*], *available at* http://www.fema.gov/emergency/nims/CommunicationsInfoMngmnt.shtm (last visited Jan. 10, 2012).

[10] Federal Emergency Management Agency, *NIMS and the Incident Command System* (2004) [hereinafter *NIMS and the Incident Command System*], *available at* http://www.fema.gov/txt/nims/nims_ics_position_paper.txt.

[11] *NIMS and the Incident Command System*, *supra note* 10.

[12] Federal Emergency Management Agency, U.S. Department of Homeland Security, *Preparedness* (n.d.) [hereinafter *Preparedness*], *available at* http://www.fema.gov/emergency/nims/Preparedness.shtm#item1 (last visited Jan. 10, 2012).

[13] *Preparedness, supra note* 12.

Figure 5-2: NIMS Preparedness Cycle[14]

To ensure accessibility and interoperability, communication and information management utilize a common operating picture for emergency management and response personnel. Interoperable communications are essential for effective incident management because they allow emergency managers and responders to work across agencies and jurisdictions as needed and authorized during an incident.[15] NIMS Command and Management consists of the following three elements:

1. Incident Command System (ICS),
2. Multiagency Coordination System (MACS), and
3. Public Information.[16]

Incident Command System

ICS is the "standardized, on-scene, all-hazards incident management approach" that integrates facilities, equipment, personnel, procedures, and communications within a common organization structure.[17] ICS is used at all levels of government, in nongovernmental organizations and in the private sector; State agencies, counties and local governments have all adopted ICS. ICS facilitates coordinated response between agencies, both public and private, and creates standardized processes for planning and managing resources.[18] ICS covers five major functional areas: Command, Operations, Planning, Logistics and Finance/Administration.[19] ICS's scalability allows it to be used during single or multiple incidents and

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[14] *Preparedness*, *supra note* 12.

[15] *Communications and Information Management*, *supra note* 9.

[16] *Communications and Information Management*, *supra note* 9.

[17] Federal Emergency Management Agency, U.S. Department of Homeland Security, *Incident Command System* (n.d.) [hereinafter *Incident Command System*], *available at* http://www.fema.gov/emergency/nims/IncidentCommandSystem.shtm (last visited Jan. 10, 2012).

[18] *Incident Command System*, *supra note* 17.

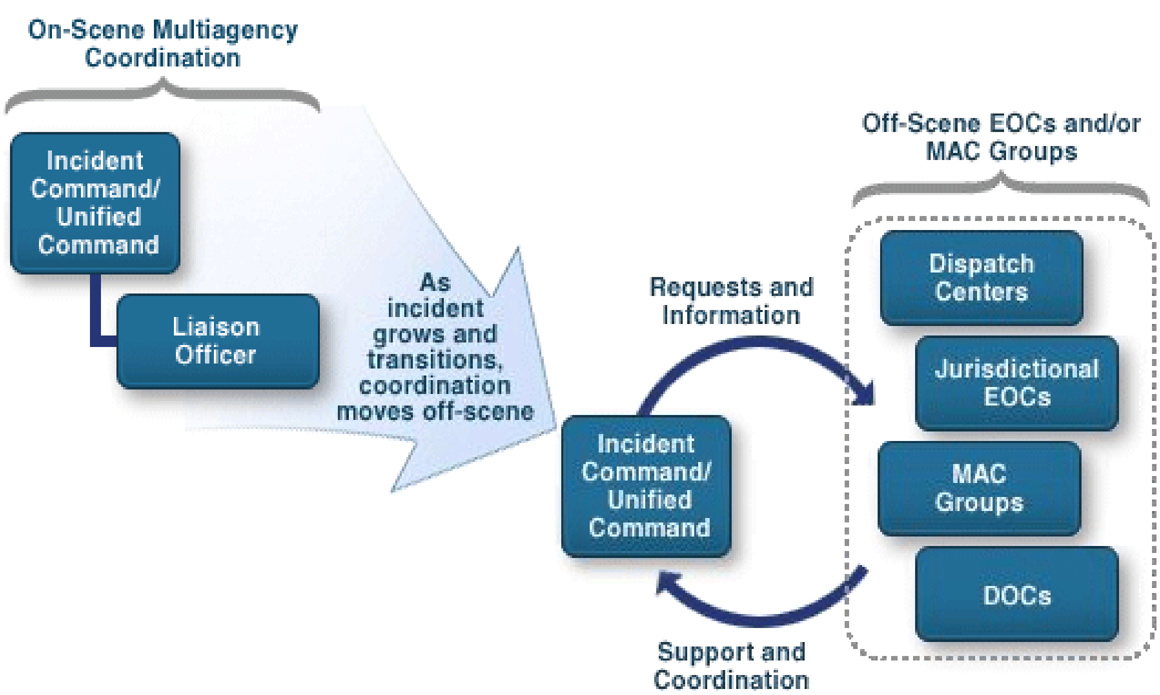
[19] *Incident Command System*, *supra note* 17.

for varying incident types, scopes, and complexities.[20] Depending on the nature of an incident, one or all of the ICS functional areas can be used as necessitated by the incident.[21]

Multiagency Coordination System

Agencies develop Multiagency Coordination Systems (MACS) to enable interagency cooperation and to accomplish a coordinated and efficiently defined work protocol.[22] In Maryland, MACS enables various State and local agencies to work with one another across jurisdictions during an incident to effectively respond to regional or statewide incidents.[23] Figure 5-3 demonstrates the growth of coordination between agencies as an emergency incident evolves.

Figure 5-3: Multiagency Coordination Systems[24]



[20] *Incident Command System*, *supra* note 17.

[21] *Incident Command System*, *supra* note 17.

[22] Federal Emergency Management Agency, U.S. Department of Homeland Security, *Multiagency Coordination Systems* (n.d.) [hereinafter *Multiagency Coordination Systems*], *available at* http://www.fema.gov/emergency/nims/MultiagencyCoordinationSystems.shtm (last visited Jan. 10, 2012).

[23] *Multiagency Coordination Systems*, *supra* note 22.

[24] *Multiagency Coordination Systems*, *supra* note 22.

Public Information
Public Information under NIMS:

> . . . consists of the processes, procedures, and systems to communicate timely, accurate, and accessible information on the incident's cause, size, and current situation to the public, responders, and additional stakeholders (both directly affected and indirectly affected). Public information must be coordinated and integrated across jurisdictions, agencies, and organizations; among Federal, State, tribal, and local governments; and with NGOs and the private sector.

Well-developed public information, education strategies, and communications plans help to ensure that lifesaving measures, evacuation routes, threat and alert systems and other public safety information are coordinated and communicated to numerous audiences in a timely, consistent manner.[25] Public information plans help ensure that public safety and incident information is consolidated and conveyed to the public in a consistent, clear and effective way.[26]

Continued NIMS/ICS Training
The Maryland Emergency Management Agency (MEMA) continuously offers NIMS and ICS courses throughout Maryland to public and private institutions to ensure that the State remains up-to-date on emergency training and procedures.[27] MEMA produces a list of individuals who should receive NIMS and ICS training because they are likely to be the first responders to an incident. These individuals come from the following core disciplines as defined by DHS: fire service, emergency medical services, government administration, law enforcement, health care, hazardous material personnel, emergency management, public works, public safety communications and public health.[28] MEMA's website contains a regularly updated list of the available NIMS and ICS courses offered in Maryland.

State of Maryland Core Plan for Emergency Operations

Maryland Executive Order 01.01.1991.02 mandates that MEMA create an Emergency Operations Plan for "the disaster and emergency response of the State of Maryland."[29] In response to this Order, MEMA created and published the State of Maryland Core Plan for Emergency Operations (Core Plan), the most

[25] Federal Emergency Management Agency, U.S. Department of Homeland Security, *Public Information*, (n.d.) [hereinafter *Public Information*], *available at* http://www.fema.gov/emergency/nims/PublicInformation.shtm (last visited Jan. 10, 2012).
[26] *Public Information*, *supra note* 25.
[27] Maryland Emergency Management Agency, *National Incident Management System – ICS* (n.d.) [hereinafter *NIMS*]*, available at* http://www.mema.state.md.us/NIMS/index.jsp#.
[28] *NIMS*, *supra note* 27.
[29] Md. Code Regs. 01.01.1991.02 (1991), *available at* http://www.dsd.state.md.us/comar/comarhtml/01/01.01.1991.02.htm.

recent version of which went into effect June 1, 2009.[30] The Core Plan denotes the "policy and systems, scope and the roles and responsibilities of State departments and agencies with regard to disaster and emergency response and is consistent with Federal plans, procedures and guidelines. Further, it provides for the coordination of State resources to manage emergencies and disasters effectively."[31] The Core Plan represents an all-hazards approach to emergency response and outlines sixteen separate ESFs.[32]

The Core Plan framework follows CEMP (discussed previously in this chapter).[33] In Volume I, the Core Plan focuses on the "interrelationship of activities, functions, and expertise needed to deal with emergencies and disasters;" Volume II includes Hazard Specific Annexes, Support Annexes, Administrative and Continuity of Operations (COOP) plans.[34]

The Core Plan has four primary purposes:

1. Ensure a coordinated emergency management response by local, State and federal governments to protect public health and safety and to preserve the lives and property of the people of the State;
2. Identify the roles, responsibilities and actions required of State departments and agencies in preparing for and responding to major emergencies and disasters;
3. Provide a framework of policies and objectives for coordinating, integrating and administering the emergency operations plan and related programs of local, State and federal governments; and
4. Provide a platform for the integration and coordination of volunteer agencies and private organization involved in emergency response and relief efforts.[35]

The Core Plan is the foundational document for development of Standard Operating Procedures (SOPs) for ESFs which facilitate the efficient and effective implementation of State response and recovery activities.[36] The CEMP endorses four phases in an emergency management cycle: mitigation, preparedness, response, and recovery, with each having associated policies, plans, and procedures.[37] Therefore, the Core Plan's "Comprehensive Approach" to handling disasters includes: 1) preparedness before a disaster or emergency, 2) response in a timely and effective manner during an event, 3) post-event recovery for both short- and long-term periods, and 4) mitigation to lessen the impact of the event.[38]

[30] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1.
[31] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1.
[32] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1.
[33] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1.
[34] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1.
[35] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1.
[36] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1.
[37] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1.
[38] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1.

Figure 5-4: Maryland Core Plan's Comprehensive Approach[39]

Maryland is regularly refining emergency plans and procedures to accommodate changes and to "promote preparedness for emergency situations."[40] To enhance preparedness at a local level, all twenty-three Maryland counties, Baltimore City, The City of Annapolis and Ocean City have individual Emergency Operations Plans (EOPs) and EOCs. The Core Plan dictates that the SEOC is the command center with primary responsibility for the coordination of personnel and equipment for protective actions in incident management.

Variables such as traffic and lack of sufficient law enforcement resources can stress, or even exceed, local jurisdictional capabilities to manage an incident, thereby necessitating cross-jurisdictional resource coordination.[41] State agencies, through the SEOC, step in and provide supplemental assistance to local jurisdictions when an incident overwhelms a jurisdiction's available resources. Each State agency appoints a public information officer (PIO) to coordinate the release of information during and after an emergency and to participate in the Joint Information Center (JIC) (further described in Chapter 9).

[39] Adapted from, *State of Maryland Core Plan for Emergency Operations*, *supra note* 1.

[40] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1.

[41] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1.

Agencies pre-position personnel, supplies, equipment and resources when possible and are ready to reallocate equipment to other areas with limited notice.[42] To further this goal, MEMA solicits broad participation from government agencies throughout the State as well as the private sector.[43]

The Core Plan identifies weather situations that may cause varying degrees of energy interruptions, for example:

- **Hurricane/Tropical Storms**: In addition to causing severe flooding, when a tropical storm moves inland, it can knock down trees and power lines and force evacuations which stress fuel resources.[44] Tropical storms or hurricanes can also create impassible roadways which may hinder distribution of energy resources, delay vessels delivering energy supplies and damage energy infrastructure.
- **Snow**: The largest snowstorms in Maryland, which typically occur in January and February, have accumulated between 12-28 inches of snow.[45] Prior preparation for such significant snow accumulation will help mitigate any potential interruptions to the energy supply distribution network that requires use of roadways.
- **Ice**: Small ice accumulations can inhibit safe driving, while significant accumulation can lead to "[fallen] trees and utility lines, resulting in loss of power and communication." Ice accumulation of this magnitude results from several hours of freezing rain.[46] (For additional information on weather related damage, see the Historical Events Chart in Chapter 6.)

Hazard and Vulnerability Mitigation Plans

Plans for emergency management are prioritized based on Hazard Identification Risk Assessment (HIRA), as demonstrated in MEMA's State of Maryland Hazard Mitigation Plan 2008.[47] The 2008 State of Maryland Hazard Mitigation Plan's purpose is to help the State of Maryland and its local governments reduce the "human and economic costs of disasters . . . ."[48] Local jurisdictions have identified locations and facilities with known vulnerabilities to particular hazards, which may require protective actions, such as coastal areas, critical facilities and infrastructure, nuclear power reactors and other hazards identified in the Maryland Hazard Vulnerability Analysis, 2008.[49]

Emergency Support Functions (ESF's)

There are sixteen ESF's described in the Core Plan. Each ESF describes a specific role or roles that one or more State agencies assume during a particular emergency event. Each ESF has a designated ESF

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[42] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1.
[43] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1.
[44] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1.
[45] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1.
[46] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1.
[47] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1.
[48] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1.
[49] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1.

Primary Agency, which is the "State agency with significant authorities, roles, resources, or capabilities for a particular function within an ESF and has coordinating oversight for the particular ESF" through use of a unified command structure.[50] The ESF Support Organizations/Agencies are State agencies with the capabilities and resources to support the ESF Primary Agency during an incident.[51]

Maryland ESF-12, "Energy"

ESF-12 of the Core Plan focuses on energy and correlates directly with the Federal ESF-12. This portion of the Maryland Core Plan for Emergency Support mandates State coordination "with the private sector [for] the emergency repair and restoration of critical public energy utilities (i.e., gas, electricity, etc.)" and "[c]oordinates the rationing and distribution of emergency power and fuel."[52]

The purpose of ESF-12 is to delineate State coordination with private energy firms to ensure the integrity of power supply systems during emergency situations, and when damage occurs, to ensure the repair of systems and restoration of services as quickly and efficiently as possible. ESF-12 describes State agency roles in support of communications and coordination between State energy emergency response organizations and private energy suppliers. Energy suppliers include the electric industry, petroleum trade organizations, transportation fuel distributors and suppliers of heating fuels. The Core Plan lists the Maryland Energy Administration (MEA) and the Maryland Public Service Commission (PSC) as the primary agencies in Maryland.[53] Support agencies include MEMA, Maryland Department of Natural Resources (DNR), Maryland Department of Environment (MDE) and Maryland Department of Transportation (MDOT).

As the primary agencies for ESF-12, MEA and PSC are responsible for coordinating response and restoration strategies with one another. MEA and PSC are jointly responsible for monitoring utility and energy resources and for the coordination of strategic restoration or delivery solutions, in cooperation with team members. MEA also acts as the Team Leader as well as the team's representative in policy discussions and negotiations with other ESF teams. Both MEA and PSC participate in long-term recovery efforts as needed. PSC is responsible for acting as the State's liaison to providers of electricity, natural gas and telephone services, whereas MEA's areas of responsibility are liquid petroleum fuels; including heating oil, propane, petroleum and ethanol based transportation fuels. PSC also must communicate to emergency management officials what plans utility companies have in place for restoring service.

The strategy for restoration operations is based upon an assessment of the damage to the energy infrastructure for a particular area in light of the public health hazards associated with compromised transmission lines, pipelines or distribution equipment. Road conditions are also taken into account so that restoration is properly coordinated, minimizing the risk of injury to first responders and utility

[50] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1.
[51] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1.
[52] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1.
[53] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1.

workers. Assessments are made of system damage, resource requests, needs, supply, and overall capabilities, so that restoration projects, resource assignment and aid requests can be prioritized.

Other Maryland ESFs with Energy Implications in Brief

- **ESF-1 Transportation** "provides for coordination, control, and allocation of transportation assets in support of the movement of emergency resources including the evacuation of people and the redistribution of food and fuel supplies."[54]
- **ESF-2 Communications** "provides a coordinated use of the State's communications resources by facilitating the procurement of communications related goods and services; identifying and redistributing existing goods and services; providing recommendations on the level of communications needs to respond to a request; identifying and redistributing qualified personnel to support the resolution related to the requests."[55]
- **ESF-5 Information, Intelligence, and Planning "**collects, analyzes, creates and disseminates critical information on emergency operations for decision-making purposes. Identifies the roles and responsibilities of State government in coordinating Federal assistance to local government."[56]
- **ESF-7 Resource Support** "secures resources through mutual aid agreements and procurement procedures for all ESFs, as needed. Provides for coordination and documentation of personnel, equipment, supplies, facilities, and services used during disaster response and initial relief operations."[57]
- **ESF-10 Oil and Hazardous Materials** "provides response, inspection, containment, and cleanup of oil and hazardous materials accidents or releases."[58]

(See Chapter 3 for additional information on specific State agency roles in energy emergencies.)

[54] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1.
[55] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1.
[56] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1.
[57] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1.
[58] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1.

Governor Martin O'Malley's Core Goals for Maryland

In a July 27, 2007 letter,[59] Governor O'Malley established 12 Core Goals for a Prepared Maryland to enhance the safety and security of the State.[60] The 12 Core Goals operate as "basic, core capacities" that should be implemented throughout the State.[61]

Figure 5-5: Governor's 12 Core Goals[62]

Of the Governor's 12 Core Goals, seven directly relate to the protection of critical energy infrastructure and resources (CIKR) and energy emergency response. The impact of the Governor's 12 Core Goals on the energy sector is discussed below.

- **Interoperable Communications** assist emergency response personnel in information sharing and coordination of response efforts, which are essential to an efficient and effective response to and recovery from an emergency. Interoperable communications also help facilitate information sharing between law enforcement officers and emergency responders throughout the State. (For a more detailed discussion of interoperable communications see Chapter 9.)

- **Intelligence/Information Sharing** is important for ensuring the safety of our critical energy infrastructure and resources. The Maryland Coordination and Analysis Center (MCAC), the

[59] Governor's Office of Homeland Security, *Goals for a Prepared Maryland* (2007) [hereinafter *Goals for a Prepared Maryland*]*, available at* http://gohs.maryland.gov/pdfs/GOHS_GovGoalsLetter.pdf.
[60] The Office of Maryland Governor Martin O'Malley, *Maryland's Strategic Goals and Objectives for Homeland Security* (2009) [hereinafter *Maryland's Strategic Goals and Objectives for Homeland Security*], *available at* http://www.governor.maryland.gov/documents/HSgoals&objectives090115.pdf.
[61] *Maryland's Strategic Goals and Objectives for Homeland Security*, *supra note* 60.
[62] http://www.gohs.maryland.gov/ (last visited Feb. 22, 2012).

State's communications fusion center, assists in facilitating information sharing and dissemination to first responders to enhance the protection of critical energy infrastructure in Maryland. MCAC expanded its scope to include all crimes that pose a potential threat to critical infrastructure and key resources, and increased the number of analysts employed to accommodate its growth. The opening of three Regional Information Centers (RICs) in Southern, Eastern, and Western Maryland increased overall data collection throughout the State. "The State has committed to adding additional License Plate Reader (LPR) units at the State and local level and networking these system[s] throughout the State. About 200 fixed and mobile LPRs are being used in multiple projects throughout the State and are now connected to MCAC with a fiber-optic connection to network Maryland."[63]

- **Vulnerability Assessments**: "The State's efforts have focused on developing a common set of definitions for critical infrastructure, a standardized site assessment tool, and a common database accessible to all critical stakeholders. Through a partnership between state, local, and federal government and the private sector, assessments are underway on infrastructure and key resources . . . These assessments are being used to provide information to assist in implementing new protective measures to harden key facilities and critical systems. The program's priority is to continue to complete an inventory of all public and private critical infrastructures in Maryland . . ."[64]

- **Training and Exercises**: Continued training and preparedness exercises are necessary in order to properly prepare emergency response personnel, law enforcement, and security personnel, both public and private, to more effectively prevent or respond to an energy emergency. The accomplishments to date include: the development of the first statewide multi-year exercise and training plan that includes all exercises occurring within Maryland between 2011 and 2013 and outlines training and exercise needs, a statewide database of exercises, after-action reports and the creation of improvement plans accessible to local jurisdictions. MEMA publishes a Quarterly Exercise Report which combines lessons learned from previous exercises to help assess areas which require additional improvement. MEMA also makes training and exercises available to first responders statewide.[65] MEMA maintains a list of training opportunities on its website for reference and registration.[66]

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[63] *The Governor's 12 Core Goals for a Prepared Maryland*, *supra note* 62; *see also* Maryland Department of Information Technology, *networkMaryland* (n.d.) [Hereinafter *networkMaryland*], *available at* http://doit.maryland.gov/support/Pages/networkMaryland.aspx (last visited Jan. 10, 2012) (*networkMaryland* is the statewide high-speed network for public sector use. The network was created from an initiative to utilize resource shared fiber optic cable assets throughout the state to provide affordable, high-speed bandwidth to all areas of the State and to provide a cost savings to the citizens of the State of Maryland).

[64] *The Governor's 12 Core Goals for a Prepared Maryland*, *supra note* 62.

[65] *The Governor's 12 Core Goals for a Prepared Maryland*, *supra note* 62.

[66] Maryland Emergency Management Agency, *Exercise and Training Course Calendar* (n.d.) [hereinafter *Exercise and Training Course Calendar*], *available at* http://www.mema.state.md.us/calendar/index.asp (last visited Jan. 10, 2012).

- **Closed Circuit Television (CCTV)**: CCTV assists in securing Maryland's critical energy infrastructure and aids in monitoring energy sector events that are in the CCTV coverage area. Maryland is developing a "statewide CCTV system by identifying and cataloging cameras and capabilities, networking those cameras, and providing an interface so that necessary video can be disseminated where it is needed." [67] The CCTV system includes integration of State, local, and private CCTV systems. [68] "The State has also continued to build-out new state-of-the-art CCTV systems at critical infrastructure and other locations and is pursuing pairing cameras with companion technologies such as license plate recognition and radiation sensors."[69] (For a more detailed discussion on CCTV see Chapter 8.)

- **Planning**: On August 26, 2009, Governor O'Malley signed the Core Plan which completely revised the previous plan that served as the basis for emergency response and coordination between State agencies. In the event of mass evacuation, additional transportation fuel resources are made available along evacuation routes as needed. The Maryland State Highway Administration (SHA) with the University of Maryland, College Park (College Park), "[d]eveloped a dynamic evacuation planning tool using real-time traffic data to enhance evacuation planning around Baltimore City and the District of Columbia." [70] SHA, with College Park, used the system "to retrieve data on traffic flow around the National Capital Region and Baltimore City to make constant changes to evacuation plans for both regions . . . [to develop] a sheltering and evacuation checklist that would streamline the evacuation and sheltering process at the State level . . . [and to write] the Hurricane/Tropical Storm Plan, an annex of the State's core emergency operations plan."[71]

- **Back-Up Power and Communications**: Certain energy infrastructure requires back-up generators or the ready availability of backup generators to ensure continued operation. Depending on the event, if a main power source is lost, immediate restoration of power may not be possible. Recent incidents in Japan related to their nuclear facility infrastructure demonstrate the need for back-up generator availability, infrastructure security and resiliency. "The State's efforts have focused on continuity of power and redundant means of communication as two of the most basic capacities necessary for any operation . . . on inventorying and identifying gaps in backup power and communications resources and in planning to ensure continuity of service and government during times of need." [72] Also, all executive departments and agencies have updated and revised their COOP plans, and MEMA is advising local jurisdictions to similarly update their COOP plans. MEMA assesses and divides critical facilities and their back-up power needs into four tiers based on priority of continued operations. The State's Public Safety

[67] *The Governor's 12 Core Goals for a Prepared Maryland*, *supra note* 62.
[68] *The Governor's 12 Core Goals for a Prepared Maryland*, *supra note* 62.
[69] *The Governor's 12 Core Goals for a Prepared Maryland*, *supra note* 62.
[70] *The Governor's 12 Core Goals for a Prepared Maryland*, *supra note* 62.
[71] *The Governor's 12 Core Goals for a Prepared Maryland*, *supra note* 62.
[72] *The Governor's 12 Core Goals for a Prepared Maryland*, *supra note* 62.

Intranet (PSINet), which provides backup and redundancy to communications through voice over internet protocol (VoIP), connects twenty-two local 911 centers, local EOCs, the Department of Health and Mental Hygiene (DHMH), the Maryland Institute for Emergency Medical Services Systems (MIEMSS) and MEMA.[73] Maryland completed a new State Emergency Alert System (EAS) plan which would allow the Governor or a designee to use the system during an emergency. Furthermore, RoamSecure was purchased to allow the MJOC to provide essential employees with emergency alerts.[74]

The continued implementation and success of the Governor's 12 Core Goals directly impacts the resilience of Maryland's CIKR and energy emergency response.

State Efforts on Cyber Security

In Maryland, Governor O'Malley indicated his desire to make the State the national "epicenter of cyber security."[75] As part of this statewide effort, the Maryland Department of Business and Economic Development created *CyberMaryland*,[76] the "first comprehensive inventory of any State's cyber security assets."[77] A large portion of the State's critical energy infrastructure is computer-controlled and remotely operated; therefore, it is vulnerable to cyber attacks. Implementation of Smart Grid technology requires ongoing installation of smart-metering systems that, if installed without proper security protocols, may increase the risk of cyber attack to Maryland's electricity infrastructure. (Cyber security is addressed further in Chapter 8.)

Maryland Maritime Strategic Security Plan

The Maryland Maritime Security Team wrote the Maryland Maritime Strategic Security Plan (MMSSP)[78] and works to coordinate the various maritime entities, inclusive of federal, state, local, and private, in

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[73] *The Governor's 12 Core Goals for a Prepared Maryland*, *supra note* 62.

[74] *The Governor's 12 Core Goals for a Prepared Maryland*, *supra note* 62; for more information about RoamSecure *see* Roam Secure Alert Network, *Roam Secure Alert Network Home Page* (n.d.) [hereinafter *Roam Secure Alert Network Home Page*], *available at* https://www.rsalert.net (last visited Jan. 10, 2012).

[75] Press Release, The Office of Maryland Governor Martin O'Malley, *Governor Martin O'Malley Releases Plan to Make Maryland Nation's Epicenter for Cyber Security* (Jan. 11, 2011) [hereinafter *Governor Martin O'Malley Releases Plan to Make Maryland Nation's Epicenter for Cyber Security*], *available at* http://www.gov.state.md.us/pressreleases/100111.asp; see also Editorial, Geeks 'R' Us, THE BALTIMORE SUN, Jan. 13, 2010 [hereinafter Geeks 'R' Us], available at http://articles.baltimoresun.com/2010-01-13/news/bal-op.cybersecurity0113_1_cyber-security-cyber-command-national-security-agency.

[76] Maryland Department of Business and Economic Development, Cyber Maryland [hereinafter *Cyber Maryland*], available at, http://issuu.com/CyberMaryland/docs/cyberreport (last visited Jan. 10, 2012).

[77] *Governor Martin O'Malley Releases Plan to Make Maryland Nation's Epicenter for Cyber Security, supra note* 75.

[78] The Office of Maryland Governor Martin O'Malley, *Maryland Maritime Strategic Security Plan* (ver. 1.0 2010) [hereinafter *Maryland Maritime Strategic Security Plan*], *available at* http://www.gohs.maryland.gov/ pdfs/MarlyandMaritimeStrategicSecurityPlan.pdf.

order to streamline their response to emergencies. The Maryland Department of Transportation Homeland Security Advisor is the designated responsible party for the "maintenance and updating of the Plan every three years or as conditions dictate."[79] Federal, State, local and private sector contributors include, but are not limited to:

- Federal:
  - United States Coast Guard, Sectors Baltimore, National Capital Region and Hampton Roads
  - Federal Bureau of Investigations, Baltimore Office
  - United States Army Corps of Engineers
- State:
  - MEMA
  - Maryland State Police
  - Maryland Department of Transportation
- Local:
  - Anne Arundel County Police
  - Calvert County Sheriff's Office
  - Hartford County Sheriff's Office
- Private:
  - Dominion Cove Point LNG facility
  - Calvert Cliffs Nuclear Power Plant
  - Chesapeake Energy Services

The MMSSP covers "all vessels and facilities located on, under, or adjacent to the waters of the Chesapeake Bay and its tributaries subject to the jurisdiction of the State of Maryland" and includes the laws, guidelines, and authorities that impact maritime response[80] and corresponding implementation plans.[81] Response to events outlined in the MMSSP generally requires use of NIMS/ICS, but also denotes special situations where specific State or federal agencies take the lead.[82]

The MMSSP adopts and utilizes many of the Governor's Core Goals including Interoperable Communications, Training and Exercises, CCTV and Vulnerability Assessments. The Vulnerability Assessment as it pertains to the Maryland maritime domain includes portions of two different United States Coast Guard Captain of the Port Zones, Sector Baltimore and Sector Hampton Roads.

> All of Maryland's maritime partners should conduct regular all-hazards threat and vulnerability assessments, including an assessment and inventory of critical infrastructure (CI) and key resources (KR). These assessments will include both CI and KR owned by the private sector, local government, State government and federal government. Finally, regulated facilities who have conducted their facility security

[79] *Maryland Maritime Strategic Security Plan*, *supra note* 78.
[80] *Maryland Maritime Strategic Security Plan*, *supra note* 78.
[81] *Maryland Maritime Strategic Security Plan*, *supra note* 78.
[82] *Maryland Maritime Strategic Security Plan*, *supra note* 78.

assessments in compliance with United States Coast Guard mandates and guidelines should review those findings, address the gaps, and share findings with the proper authorities when necessary.[83]

The MMSSP acts as a unifying document for operations plans and response strategies, thereby increasing security and preparedness and improving response to maritime incidents.[84] The MMSSP helps protect publicly- and privately-owned critical energy infrastructure on Maryland's waterways and governs response to an energy emergency at those locations. Likewise, the MMSSP helps ensure the safety of the 33 percent of Maryland's oil that is transported by vessel.[85]

The MMSSP represents a concerted effort by many of the State's and local government agencies working together with non-governmental members of Maryland's maritime community to achieve the common goals of increased security and preparedness and improved response to maritime incidents. The maritime region of Maryland encompasses a large area as demonstrated above. Continued use of the MMSSP will assist in the assurance of the Maryland energy sector. A secure and prepared Maryland maritime region helps ensure the resiliency of the energy infrastructure and resources imported and contained in maritime districts.

Federal Bureau of Investigation (FBI) InfraGard

InfraGard is an informational and partnership arrangement designed to facilitate continued dialogue and timely communication between the FBI and various public and private entities. InfraGard membership consists of businesses, academic institutions and State and local law enforcement agencies, among others.[86] InfraGard allows the FBI to work with DHS to protect critical infrastructure from physical and cyber threats.[87] Information on threats to critical infrastructure, vulnerabilities, and interdependencies are reported to promote counterterrorism, cyber crime and other crime program capabilities.[88]

Maryland is home to the InfraGard Maryland Members Alliance (IMMA), headquartered at the FBI's Baltimore field office.[89] IMMA is one of the most active InfraGard Chapters in the nation with over 700 actively registered members.[90] IMMA works with law enforcement, first responders, and other officials, in particular the Maryland Coordination and Analysis Center (MCAC).[91]

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[83] *Maryland Maritime Strategic Security Plan*, *supra note* 78.
[84] *Maryland Maritime Strategic Security Plan*, *supra note* 78.
[85] *Maryland Maritime Strategic Security Plan*, *supra note* 78.
[86] InfraGard, *About InfraGard* (n.d.) [hereinafter *About InfraGard*], *available at* http://www.infragard.net/about.php?mn=1&sm=1-0 (last visited Jan. 10, 2012).
[87] *About InfraGard*, *supra note* 86.
[88] *About InfraGard*, *supra note* 86.
[89] *About InfraGard*, *supra note* 86.
[90] *About InfraGard*, *supra note* 86.
[91] *About InfraGard*, *supra note* 86.

Federal Plans

Federal ESF-12 (Energy)

The Department of Energy (DOE) is the lead Federal agency for ESF-12 whose purpose is to "facilitate the restoration of damaged energy systems and components" when the Secretary of Homeland Security activates it as part of a coordinated federal response.[92] DOE estimates the impact of outages, and collects, evaluates, and shares that information when energy systems are damaged. DOE also provides expertise and assistance to government and private sector stakeholders in energy system recovery planning and efforts. In the context of ESF-12, "'energy' includes producing, refining, transporting, generating, transmitting, conserving, building, distributing, maintaining, and controlling energy systems and system components. All energy systems are considered critical infrastructure."[93] (Listing and monitoring energy infrastructure is addressed in Chapter 8.) ESF-12 addresses any disruptions in energy supplies and impacts from disruptions on an intrastate to international level.

As the ESF-12 primary agency, DOE is the primary federal point of contact for the energy industry for information and requests for assistance. Natural gas and petroleum pipeline safety and reliability is also addressed in ESF-12 and requires the involvement of the Department of Transportation (DOT) Pipeline and Hazardous Materials Safety Administration (PHMSA). ESF-12 also establishes policies and procedures for preparedness in the event of attacks on energy infrastructure and recovery caused by shortages and disruptions in supply and delivery of energy sources. However, individual facility owners are ultimately responsible for restoration to normal operations.

DOE, with cooperation from the private energy sector, continues to develop the best practices for:

- infrastructure design and operations,
- standards for physical, operational, and cyber security, and
- energy emergency exercises prior to an incident.

When ESF-12 is activated, DOE utilizes its disaster response procedures, which includes assigning an Emergency Management Team to coordinate with State, tribal, and local governments and private entities. ESF-12 details coordination procedures for assessing energy infrastructure damage and reporting CIKR damage and operating status. Language in ESF-12 enables DOE and other federal agencies, through legal authorities and waivers, to restore energy supplies. Examples of these waivers include:

- Environmental Protection Agency (EPA) waiver of environmental requirements for motor vehicle fuel;

[92] U.S. Department of Energy, *Federal Emergency Support Function #12-Energy Annex* (2008) [hereinafter *Federal Emergency Support Function #12-Energy Annex*].
[93] *Federal Emergency Support Function #12-Energy Annex*, *supra note* 92.

- DOT PHMSA responding to waiver of restriction requests for pipeline transportation of natural gas, hazardous liquid, and liquefied natural gas; and
- DOT Maritime Administration (MARAD) waiver of the U.S. Cabotage law for the movement of energy supplies.[94]

After an incident, ESF-12 active agencies participate in post-incident hazard mitigation studies and best practices and lessons learned forums. Involved agencies then discuss disaster-related expenses with DHS/FEMA.

Department of Energy, Energy Sector-Specific Plan: An Annex to the National Infrastructure Protection Plan, 2010

In 2010, DOE, with DHS and stakeholder assistance, created the Energy Sector Specific Plan (ESSP) to facilitate the enhancement of the nation's energy infrastructure.[95] The ESSP was developed as an Annex to the broader National Infrastructure Protection Plan (NIPP).[96] The ESSP assists federal, state, and private entities in preparing for, responding to, recovering from, and mitigating events affecting the nation's energy supply. The ESSP addresses a wide-range of energy disruption events including physical damage to the energy infrastructure, cyber security, and the effects of a pandemic on energy service personnel. The ESSP enhances information sharing between government agencies and energy asset owners and operators. It also places great importance on information sharing and coordination, which builds and enhances relationships, to assist in the protection and recovery of key energy infrastructure and resources.

[94] *Federal Emergency Support Function #12-Energy Annex*, *supra note* 92.
[95] U.S. Department of Energy, *Energy Sector-Specific Plan: An Annex to the National Infrastructure Protection Plan* (2010) [hereinafter *Energy Sector-Specific Plan*].
[96] U.S. Department of Homeland Security, *National Infrastructure Protection Plan* (2009) [hereinafter *National Infrastructure Protection Plan*], available at http://www.dhs.gov/xlibrary/assets/NIPP_Plan.pdf.

The ESSP determined that:

> . . . [h]istorically, the Energy Sector has been proactive in developing and applying vulnerability assessment methodologies tailored to its assets and systems. However, no single vulnerability tool or assessment methodology is universally applicable. Individual energy companies use assessment tools that are developed by professional and trade associations, Federal organizations, government laboratories, and private sector firms. The number of tools in use is large, and the vast majority of significant facilities in the Energy Sector have already undergone assessments using one or more of these tools.[97]

Energy Sector Employee Health

The energy sector requires the continuous work of highly trained technical personnel; as a result, year-round illnesses, specifically pandemic illness, have the ability to widely impact the energy sector. As noted in the ESSP, "the Energy Sector has worked through its trade organizations to improve pandemic planning. It has developed guides, exercises, working groups, and points-of-contact. Examples of pandemic reference guides include:

- The Electricity Subsector Pandemic Influenza Guideline (DHS)
- The Oil and Natural Gas Subsector Pandemic Influenza Guideline (DHS)
- Electricity Subsector Influenza Pandemic Planning, Preparation, and Response Reference Guide (NERC)."[98]

ESSP acknowledges a pandemic's potential adverse effects on energy supply and delivery, and it recognizes that planning and preparation for a pandemic event will mitigate its harmful impact on the energy sector.

Protected Critical Infrastructure Information (PCII) Program of the Critical Infrastructure Information (CII) Act of 2002

The PCII Program, established pursuant to the CII Act, allows private sector energy infrastructure owners and operators to voluntarily provide sensitive information to DHS regarding their infrastructure with the assurance that the information will be protected from public disclosure.[99] Ongoing activities within the PCII Program include energy infrastructure owners and operators participation in DHS- and DOE-led facility vulnerability assessments and site assistance visits (SAVs), which are used to identify security gaps and recommend protective measures. In Maryland, these assessments are conducted by a combination of federal, State and private infrastructure security experts who later brief the owners and operators on their findings.

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[97] *Energy Sector-Specific Plan*, *supra note* 95.

[98] *Energy Sector-Specific Plan*, *supra note* 95.

[99] *State Energy Assurance Guidelines*, *supra note* 3; *see also* U.S. Department of Homeland Security, *How Protected Critical Infrastructure Information Is Protected* (n.d.) [hereinafter *How Protected Critical Infrastructure Information Is Protected*]*, available at* http://www.dhs.gov/files/programs/gc_1193088517704.shtm.

Cyber Security

Homeland Security Presidential Directive-7 (HSPD-7) and the Homeland Security Act (HSA) of 2002[100] charged DHS with assessing cyberspace vulnerabilities and encouraging appropriate protective action and contingency plans in and out of the cyber domain. The HSA further authorized DHS to provide members of the private sector analyses and warnings of vulnerabilities and threats to computer systems as well as technical or administrative support in response to such threats upon request.[101]

The recent "STUXNET" virus attack[102] that targeted the Supervisory Control and Data Acquisition (SCADA) systems of Iran's nuclear enrichment program, demonstrates the devastating effects of cyber attacks on industrial control systems that many power generation and energy delivery systems rely on. At the federal level, virtually every government, military and law enforcement institution concerned with homeland security agrees that cyber-based threats "pose a potentially devastating impact to [technological] systems and operations and the critical infrastructures they support."[103]

As part of broader homeland security efforts, DHS and DOE established various security plans. DHS developed the NIPP[104] with the aim of "enhanced protection and resiliency of the nation's critical infrastructure and key resources."[105] DOE established the National SCADA Test Bed to "combine the expertise and resources of several national laboratories into a multi-lab partnership that helps to

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[100] Homeland Security Act of 2002, Pub. L. No. 107-296, 116 Stat. 2135, *available at* http://www.dhs.gov/xlibrary/assets/hr_5005_enr.pdf.

[101] Homeland Security Act of 2002.

[102] The "STUXNET" attack was widely covered by the popular press in late 2010 and early 2011. *See e.g.,* William J. Broad et al., *Israeli Test on Worm Called Crucial in Iran Nuclear Delay*, NY TIMES, Jan. 15, 2011*, available at* http://www.nytimes.com/2011/01/16/world/middleeast/16stuxnet.html.

[103] *See* Government Accountability Office, *Critical Infrastructure Protection* (2010) [hereinafter *Critical Infrastructure Protection*], *available at* http://www.gao.gov/new.items/d10628.pdf ("Pervasive and sustained computer-based (cyber) attacks against federal and private-sector infrastructures pose a potentially devastating impact to systems and operations and the critical infrastructures that they support."); *see also* Press Release, The White House*, Remarks by the President on Securing Our Nation's Cyber Infrastructure* (May 29, 2010) [hereinafter *Remarks by the President on Securing Our Nation's Cyber Infrastructure*], *available at* http://www.whitehouse.gov/the_press_office/Remarks-by-the-President-on-Securing-Our-Nations-Cyber-Infrastructure/ (*quoting* President Obama, "It's the great irony of our Information Age -- the very technologies that empower us to create and to build also empower those who would disrupt and destroy."); Government Accountability Office, *Cybersecurity: Continued Attention is Needed to Protect Federal Information Systems from Evolving Threats* (2010) [hereinafter *Cybersecurity: Continued Attention is Needed to Protect Federal Information Systems from Evolving Threats*], *available at* http://www.gao.gov/new.items/d10834t.pdf ("Cyber-based threats to federal systems and critical infrastructure are evolving and growing.").

[104] *National Infrastructure Protection Plan, supra note* 96.

[105] U.S. Department of Homeland Security, *Critical Infrastructure* [hereinafter *Critical Infrastructure*] (n.d.), available at http://www.dhs.gov/files/programs/gc_1189168948944.shtm (last visited Jan. 10, 2012).

identify and correct critical security flaws in control systems and equipment."[106] The Federal Government also passed several statutes that relate to energy sector cyber security, including:

- Atomic Energy Act of 1954;
- Computer Fraud and Abuse Act of 1986;
- Computer Matching and Privacy Protection Act of 1988;
- Computer Security Act of 1987;
- Electronic Communications Privacy Act of 1986;
- Federal Information Security Management of 2002;
- National Homeland Security Act of 2001; and
- USA Patriot Act of 2001.

To stimulate private cyber security research and development, DHS's National Strategy to Secure Cyberspace[107] recommends the advanced training and certification of cyber security professionals. Accordingly, the Federal Information Security Management Act of 2002 (FISMA) and National Security Directive (NSD)-42 authorized the National Science Foundation (NSF), National Security Agency (NSA), National Institute of Standards and Technology (NIST) and DHS to develop the nation's expertise in this area. In addition, the HSA[108] established the Office of Science and Technology (OST) within the Department of Justice (DOJ) and authorized OST to conduct cyber-forensic research and development.[109] The HSA also authorized DHS to establish research centers in the area of information security at universities with nationally recognized programs in this specialty.[110] For example, the University of Maryland, Baltimore County's (UMBC) Center for Cybersecurity Training "delivers high quality non-credit Cybersecurity education and training programs to individuals and organizations."[111]

Federal Power Act (FPA)

The Federal Power Act provides statutory authority for FERC to oversee power markets. FERC primarily manages wholesale purchases and interstate transportation, and does not have oversight of generation siting, intrastate transportation, or retail sales which are typically regulated by State or local entities. One of FERC's goals is to provide oversight of energy markets in transition through the creation of a pro-competitive market structure. Consequently, FERC is responsible for determining the competitive

[106] U.S. Department of Energy, *National SCADA Test Bed* (2007) [hereinafter *National SCADA Test Bed*].
[107] U.S. Department of Homeland Security, *National Strategy to Secure Cyberspace* (2003) [hereinafter *National Strategy to Secure Cyberspace*], *available at* http://www.us-cert.gov/reading_room/cyberspace_strategy.pdf.
[108] § 231.
[109] Homeland Security Act § 232.
[110] § 308.
[111] University of Maryland Baltimore County, *UMBC Center for Cybersecurity Training* (n.d.) [*UMBC Center for Cybersecurity Training*], *available at* http://www.umbc.edu/trainctr/it/infosec.html (last visited Jan. 10, 2012).

performance and efficiency of wholesale natural gas and electricity markets, including those that provide energy to Maryland.[112]

Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended, 42 U.S.C. 5121 et seq.

In the event of an energy emergency within the State of Maryland, the Robert T. Stafford Disaster Relief and Emergency Assistance Act ("Stafford Act")[113] permits a State Governor to request assistance from the Federal Government when the situation exceeds the State's response capabilities. The Governor's request prompts the President to make an emergency or disaster declaration.[114] After the President declares an emergency or disaster area, FEMA may begin to provide resources and personnel to support State and local disaster recovery efforts.[115] DOE supports federal, state, and local government and private industry efforts in restoring energy infrastructure and services in disaster areas.[116]

Department of Energy Organization Act, Section 205 and Federal Energy Administration Act of 1974, Sections 51 to 59

States must provide timely assessments of their energy markets to DOE and other states when an energy supply disruption occurs. To accomplish this, each state identifies at least one primary and one alternate Energy Emergency Assurance Coordinator (EEAC) per energy source (petroleum, natural gas and electricity).[117] In Maryland, MEA, PSC and MEMA each have at least one EEAC in their respective offices. EEACs have a coordinated website with e-mail, allowing dissemination of information including emergency situation reports, lessons learned, and outage and curtailment information. The website enables local government personnel to access information on energy supply, demand, pricing, and infrastructure. EEAC's are typically "representatives from state energy offices, public utility organizations, state legislators, emergency management agencies, homeland security agencies, local governments, and Governors' offices."[118]

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[112] Federal Emergency Management Agency, U.S. Department of Homeland Security, *Public Information* (n.d.) [hereinafter *Public Information*], *available at* http://www.fema.gov/emergency/nims/PublicInformation.shtm (last visited Jan. 12, 2012).

[113] Robert T. Stafford Disaster Relief and Emergency Assistance Act, 42 U.S.C.A § 5121 (West 2010), *available at* http://www.law.cornell.edu/uscode/42/usc_sec_42_00005121----000-.html.

[114] Robert T. Stafford Disaster Relief and Emergency Assistance Act § 5121.

[115] Robert T. Stafford Disaster Relief and Emergency Assistance Act § 5121. One example of such a declaration in Maryland was the follow-up to Hurricane Irene in 2011. Maryland and the Federal Government worked together to mutually declare disaster areas in Maryland allowing for FEMA assistance in recovery efforts.

[116] Robert T. Stafford Disaster Relief and Emergency Assistance Act § 5121.

[117] National Association of State Energy Officials, *The Role of Energy Emergency Assurance Coordinators* (n.d.) [hereinafter *The Role of Energy Emergency Assurance Coordinators*], *available at* https://www.naseo.org/energyassurance/coordinators.htm (last visited Jan. 12, 2012).

[118] *The Role of Energy Emergency Assurance Coordinators*, *supra note* 117.

Private and Public Coordination

The preceding sections of this chapter describe in detail how State and federal agencies prepare for and respond to energy and other emergencies. As we move into private sector plans, we find that the importance of the interactions between government and private sector actors are a unique aspect of energy disruptions. Private firms own and operate the systems that supply energy, and have plans in place to recover from disruptions. The State on the other hand maintains and operates shelters, clears roads, maintains order, disseminates information, and creates and maintains its own plans for dealing with emergencies. Close coordination between these two sectors is vital to timely and effective restoration.

The second half of this chapter examines how private energy firms in Maryland plan for and respond to energy emergencies. We look at the emergency planning of nuclear and non-nuclear electric utilities as well as the natural gas and petroleum industries. Particular emphasis is on the intersection between private and government planning.

Calvert Cliffs and Peach Bottom Emergency Planning: Nuclear Generation Issues

Located in Calvert County, Calvert Cliffs Nuclear Power Plant is Maryland's only nuclear power plant;[119] however, Pennsylvania's Peach Bottom Atomic Power Station is only three miles from the Maryland-Pennsylvania border.[120] The plume exposure zones of both facilities (a ten mile radius from the plant) are in Maryland. Additionally, Maryland is within the fifty mile "ingestion zone" radius of four other nuclear facilities: Three Mile Island Nuclear Station (PA), Limerick Generating Station (PA), Salem/Hope Creek Generating Stations (NJ) and North Anna Power Station (VA).[121]

The State's Radiological Event Plan, which is an update of the document formerly known as "Annex Q", details emergency response procedures in the event of radiation leaking from either Calvert Cliffs or Peach Bottom. The Maryland Department of the Environment (MDE) is the primary State agency responsible for reacting to a radiological event from a nuclear facility. In the event of a nuclear power accident, MDE receives assistance from other State and local agencies.[122]

The Calvert County Emergency Management Division provides emergency planning for the Calvert Cliffs Nuclear Power Plant and maintains an evacuation plan for the plume zone surrounding the facility (see

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[119] Maryland Emergency Management Agency, *Nuclear and Radiological* (n.d.) [hereinafter *Nuclear and Radiological*], *available at* http://www.mema.state.md.us/MEMA/jsp/portlets/nukes.jsp (last visited Jan. 12, 2012).
[120] *Nuclear and Radiological*, *supra note* 119.
[121] *Nuclear and Radiological*, *supra note* 119.
[122] *Nuclear and Radiological*, *supra note* 119.

Figure 5-6).[123] The area within the plume zone includes part of Calvert County, a portion of St. Mary's County along the Patuxent River between the towns of California and Sandgates, the northern tip of the Patuxent River Naval Air Station, and the Taylors Island area of Dorchester County.[124] In the case of a radiological emergency, sirens alert individuals within a ten mile radius of the plant.[125] Calvert County residents are provided with a yearly calendar that outlines emergency procedures and siren test dates.[126] When a siren goes off, individuals are instructed to tune into the EAS for information and instructions on how and where to proceed.[127] Individuals are told to either seek shelter at home or evacuate their premises following marked evacuation routes.[128] If staying home, residents are instructed to close any open windows and doors, keep telephone lines open and turn off air conditioners.[129]

The U.S. Nuclear Regulatory Commission (NRC) Office of Nuclear Security and Incident Response is responsible for reviewing nuclear facilities' emergency preparedness programs.[130] The NRC oversees nuclear power plant operators and conducts thorough facility inspections. Full-scale exercises are conducted every two years. NRC develops the exercises in conjunction with FEMA.[131] State agencies, local responders and private sector stakeholders participate in the exercises. Maryland agencies participate in the exercises at Calvert Cliffs Nuclear Power Plant and Peach Bottom Atomic Power Station conducted every other year.

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[123] Maryland Emergency Management Agency, *Area Nuclear Emergency Plan* (2008) [hereinafter *Area Nuclear Emergency Plan*], *available at* http://www.mema.state.md.us/MEMA/content/pdf/disaster_preparedness/ Calvert_Cliffs_emergency.pdf.

[124] *Area Nuclear Emergency Plan*, *supra note* 124.

[125] *Area Nuclear Emergency Plan*, *supra note* 124.

[126] Calvert County, *Welcome to Calvert County: Calvert Cliffs Nuclear Power Plant* (n.d.) [hereinafter *Welcome to Calvert County: Calvert Cliffs Nuclear Power Plant*], *available at* http://www.co.cal.md.us/residents/safety /emergency/calvertcliffs/ (last visited Jan. 12, 2012).

[127] *Area Nuclear Emergency Plan*, *supra note* 124.

[128] *Area Nuclear Emergency Plan*, *supra note* 124.

[129] *Area Nuclear Emergency Plan*, *supra note* 124.

[130] U.S. Nuclear Regulatory Commission, *Emergency Preparedness & Response* (n.d.) [hereinafter *Emergency Preparedness & Response*], *available at* http://www.nrc.gov/about-nrc/emerg-preparedness.html (last visited Jan. 12, 2012).

[131] U.S. Nuclear Regulatory Commission, *Exercise Schedules* (2011) [hereinafter *Exercise Schedules*], *available at* http://www.nrc.gov/about-nrc/emerg-preparedness/about-emerg-preparedness/exercise-schedules.html.

Figure 5-6: Ingestion Zones for Maryland[132]

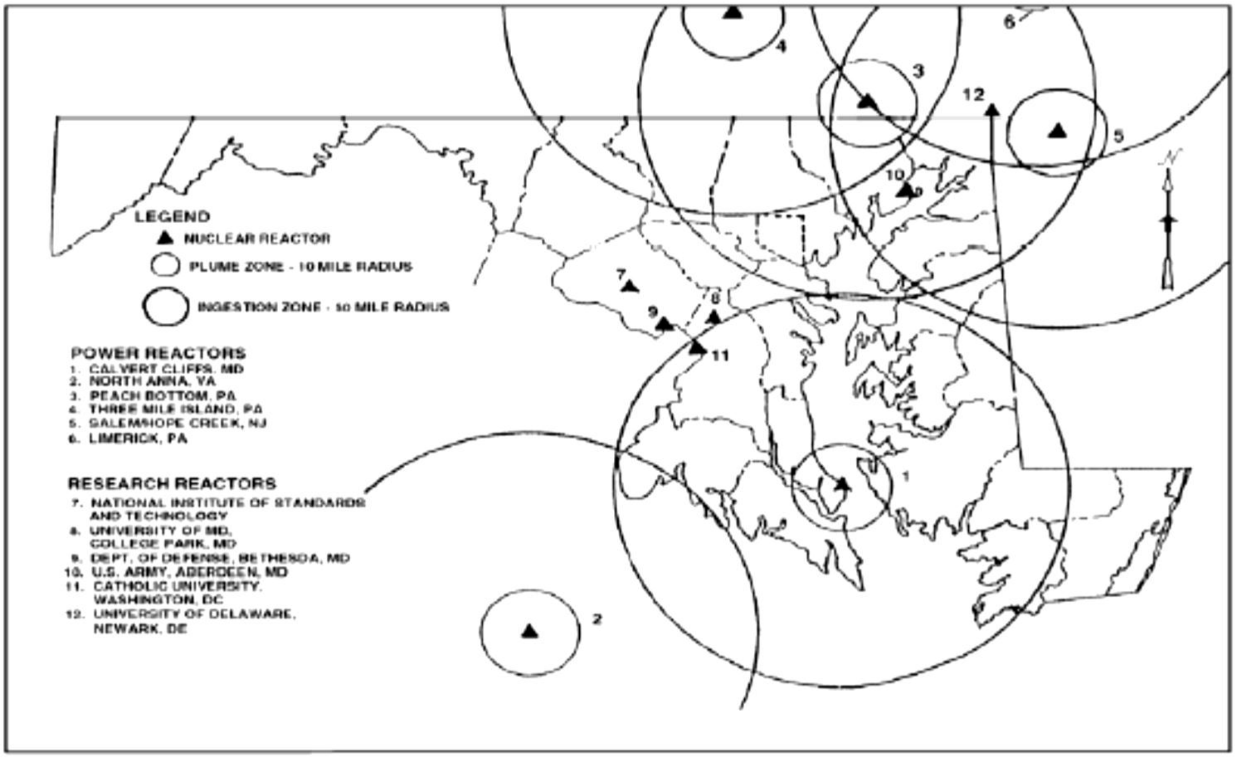

Figure 5-7 and Figure 5-8 on the following page show the evacuation routes for Calvert Cliffs and Peach Bottom plume zones.

[132] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1.

Figure 5-7: Calvert Cliffs Evacuation Route

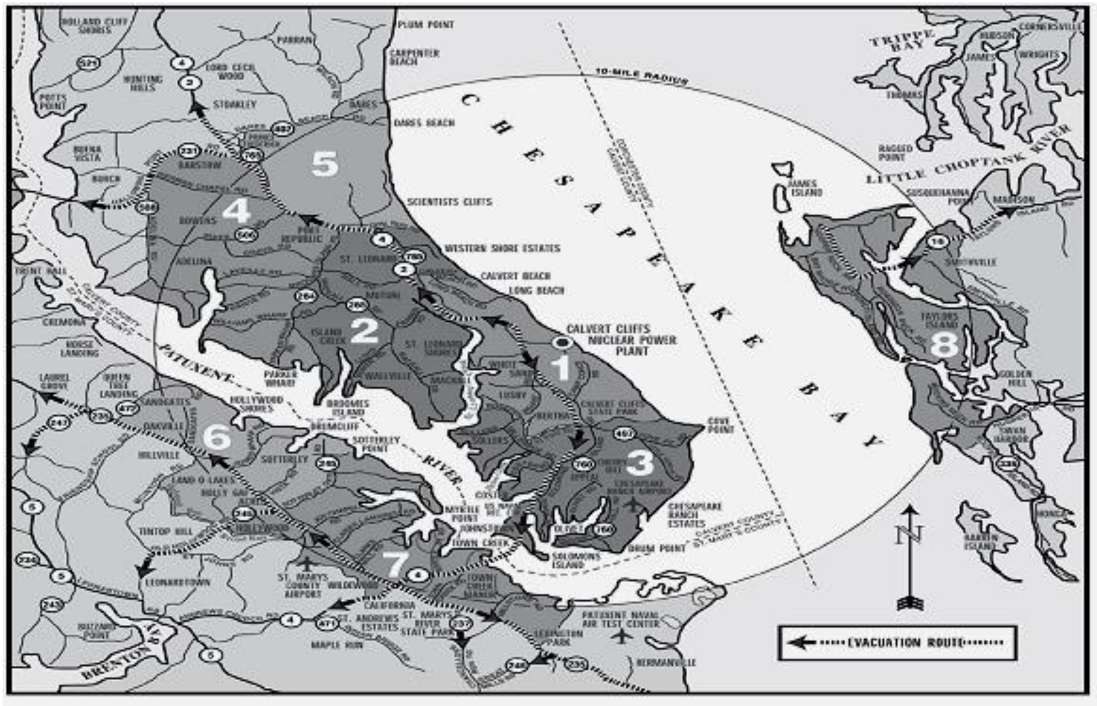

Figure 5-8: Peach Bottom Evacuation Route[133]

133 Maryland Emergency Management Agency, *Emergency Planning for the Peach Bottom Area* (2009) [hereinafter *Emergency Planning for the Peach Bottom Area*], *available at* http://www.mema.state.md.us /MEMA/content/pdf/disaster_preparedness/YEL_PB_FOB_EMER_3col-2009-2010.pdf.

A major emergency incident requiring mass evacuations (such as what would take place in the event of a radiological emergency) will likely stress energy resources in the areas along marked evacuation routes. Additionally, evacuation routes from other states that lead through Maryland can also potentially strain fuel resources along those routes. Regional coordination and an analysis of Maryland's evacuation routes help guide planning efforts for additional emergency evacuation fuel resources.

Non-Nuclear Utilities (Natural Gas and Electric)

Maryland's government agencies have historically coordinated and collaborated with utility partners to prepare for, respond to, and recover from incidents that impact the energy sector. Currently, MEMA and Constellation Energy are engaged in efforts to establish a plan that will facilitate collaborative efforts to restore power to critical areas. Private energy sector partners also coordinate and collaborate with each other to prepare, respond to and recover from such incidents. Further, utilities are required under Code of Maryland Regulations ("COMAR") 20.50.07.07, to file a written report with PSC within three weeks of the end of a major storm. Maryland's public and private energy sector partners share many of the same goals and interests, namely the restoration of services and a return to normal operations. Further progress regarding these goals and interests relies on planning and operations, resource sharing and communication.

Utility coordination with local and State emergency response personnel is of primary importance. Utilities traditionally participate in meetings and conference calls with State agencies regarding the utilities' emergency plans. In preparation for an emergency, utilities update contact lists and emergency plans prior to the summer and winter months each year. Utilities maintain contact information for key government officials and all State and local emergency management agencies. Baltimore Gas & Electric (BGE) specifically states that it works to establish relationships prior to emergencies with newly elected county officials and holds annual meetings with local emergency management officials. Relationship building prior to an emergency results in better coordination and communication in the event of an emergency.

In order to prevent, mitigate and respond to emergency events, utilities in Maryland participate in working groups and respond to inquiries that have included the following topics and venues:

- Maryland Emergency Management Agency meetings,
- Maryland Electric Reliability Tree Trimming (MERTT) Council,
- Selective undergrounding of electric circuits,
- Life support / vulnerable customer programs descriptions,
- Customer Call Centers, and
- Mutual Assistance.

Utility Emergency Response Plans

Emergency response plans for utilities are confidential documents that address the protection of Maryland's critical energy infrastructure and resources. For security reasons, this plan addresses the existence of utility emergency response plans without divulging confidential information in the plans that may expose Maryland's energy infrastructure to harm. The emergency response plans of utilities operating in Maryland take into consideration the following scenarios:

- Evacuation of the East Coast (the Baltimore and Washington D.C. areas),
- Cyber and/or Physical attacks,
- Pandemics,
- Geomagnetic Disturbance/Electro-magnetic pulse risks,
- Facility loss, and
- Natural Disasters.

An example of a scenario that is addressed in the utilities' plans is an incident that involves a natural gas emergency. In the event of a natural gas emergency that meets certain pre-defined criteria, utilities share information with PSC. In extreme situations, a utility's internal gas curtailment plan designates a personnel hierarchy for the restoration of services. BGE maintains contact information for current key employees and defines BGE personnel rotations at the BGE Electric Operations Building (EOB) and Spring Gardens facility as well as local EOCs (when and if BGE staffing is requested).

Utility Pre-event Activities:

Prior to a weather event (e.g., hurricane or severe winter weather), utilities begin monitoring forecasts as well as contacting and securing mutual assistance resources. Utilities begin making daily press releases, conducting media interviews and placing messages on social media platforms to inform the media and customers of an impending storm's severity. Utility websites are converted from a standard homepage to a "storm homepage" with storm-related information, including outage reporting and maps. Predictive dialers are used days prior to a storm's projected impact to further warn customers of the possibility of extended outages. Predictive dialers also serve as a method to notify individuals with functional needs that arrangements should be made in case of an extended outage. Additionally, the availability of resources is determined and reviews are made of pre-event checklists, work schedules, and damage assessments.

Utility Restoration Priorities List: Post-event recovery requires utilities to prioritize their restoration activities. An example of a utility restoration priority list includes, in order of restoration:

1. Public safety issues including downed wires or other life-threatening situations,
2. Critical facilities (e.g., hospitals and 911 call centers),
3. Electric system "backbone" including sub-transmission feeders, substation and distribution feeders,
4. Large outages affecting the most customers,
5. Secondary lines serving neighborhoods, and finally
6. Service lines to individual homes and businesses.

Utilities maintain Transmission System Operator Emergency Response Plans that describe actions to restore a partial or total collapse of the transmission system and communications to critical facilities. Local Distribution Utility Emergency Response Plans contain procedures in case of a service interruption for diagnosing the local distribution interruption and the dispatch of personnel to repair facilities.

Utilities support each other during large emergency events that are beyond the capacity of a single utility. This cooperative support is often focused on assisting with emergency response and the recovery of customer energy services. Cooperative emergency assistance is coordinated through regional planning groups in the natural gas and electricity industries, who plan for and conduct exercises in preparation for energy emergencies;[134] for instance, the Mid-Atlantic Mutual Assistance Group is one such regional planning group. Utility providers have long been part of Mutual Assistance Groups, which are called upon when the resources of a particular utility are unable to adequately respond to an incident. The Maryland Utilities Group for Mutual Assistance is the intrastate mutual assistance group for Maryland utilities. Maryland utilities belong to the following Mutual Assistance Groups:

- Electricity Mutual Assistance:
  - Mid-Atlantic Mutual Assistance (MAMA) Group
  - Southeastern Electric Exchange (SEE)
  - Maryland Utilities Group for Mutual Assistance (MUGMA)
  - Edison Electric Institute (EEI)[135]
- Natural Gas Mutual Assistance:
  - AGA Natural Gas Mutual Aid Resource Center
  - Mutual Aid Database
  - Local Mutual Assistance Agreements
  - Mid-Atlantic Contingency Planning Group
  - Mid-Atlantic Gas Network (MAGNet)[136]

Mutual Assistance Groups produce guidelines that address the request of emergency assistance. The Joint Mobilization process establishes procedures for the initiation of Mutual Assistance Conference Calls. Mutual Assistance Conference Calls allow a company in need of assistance to contact all members with one phone call. After each call, all members receive summary notes and a "Resource Summary Sheet" that details the resources needed and available, including companies and contract personnel. The most commonly requested and identified resources include distribution linemen, transmission linemen, vegetation management personnel, and damage assessment personnel.[137] Mutual Assistance

[134] *Energy Sector-Specific Plan*, *supra note* 95.
[135] List provided from BGE Presentation, April 2011.
[136] List provided from BGE Presentation, April 2011.
[137] *Energy Sector-Specific Plan*, *supra note* 95.

Conference Calls are not a limitation on requests for assistance; in fact, "additional requests are often made outside of mutual assistance calls."[138]

Monitoring Natural Gas Supply and Demand

According to NASEO's guidelines, adequate monitoring of natural gas requires collecting information that addresses:

- the quantity of interstate deliveries to LDCs;
- storage levels;
- gas injection rates into storage;
- projected system send-outs;
- spot market and contract prices;
- curtailment notices; and
- heating degree days. [139]

Monitoring natural gas supplies alerts actors in the private sector to changes in supply levels, and predefined supply-level dependent trip points trigger certain responses as described below (as defined by NASEO):

Level 1*: Normal conditions*

At Level 1 conditions are normal – there is no disruption, shortage or reduced reliability of supply. However, monitoring by the private sector is ongoing and alert systems are on stand-by. There may, however, be reports of shortages, or the potential for shortages in gas producing countries that could affect natural gas prices.

Lead State agency: PSC
State agency lead actions include:

- Receive notices of reportable outages or incidents from natural gas system operators;
- Evaluate reportable outages or incident notices received to anticipate impact on natural gas supply, relying on company experts;
- Maintain a readily accessible contact list to aid in contacting individuals in the various public and private industries;
- Conduct regular (e.g., annual) inspection of intrastate[140] natural gas operations, facilities, and pipeline systems according to State statute[141] and federal code regulations[142] to ensure reliable service delivery;

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[138] Maryland Public Service Commission, *Potomac Edison Company d/b/a Allegheny Power – Major Storm Report: Case No. 9220* (2010) [hereinafter *Major Storm Report: Case No. 9220*], *available at* http://webapp.psc.state.md.us/Intranet/casenum/NewIndex3_VOpenFile.cfm?ServerFilePath=C:\Casenum\9200-9299\9220\\4.pdf.

[139] *State Energy Assurance Guidelines*, *supra note* 3, at Appendix D, 94-95.

[140] *See* 49 U.S.C.A. § 60105 (West 2012) (Certification, assumes safety responsibility with respect to intrastate gas facilities).

[141] *See* 49 U.S.C.A. § 16451 et seq. (West 2012).

[142] *See* 49 C.F.R. §§ 191-193, 195, 198, 199 (2012), *available at* http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?sid=a18284207826e9ca6ac521421a9d9d5d&c=ecfr&tpl=/ecfrbrowse/Title49/49cfrv3_02.tp.

- Review previous situations reports to evaluate adequacy of State response practices;
- Review previous exercises, evaluate lessons learned and implement into response plan procedures;
- Update emergency response plan as needed;
- Participate in collaborative efforts with State and local government and utility operators; and
- Identify response vulnerabilities in cross-coordination between industries and State agencies.

Level 2*: Mild natural gas shortage*

A "mild shortage" situation means there is a mild outage or incident, or an identifiable event that could potentially cause a disruption, shortage, or affect reliability of natural gas service. NASEO State Energy Assurance Guidelines describe a Level 2 situation as one where there is "5-10 % reduction in natural gas nominations on interstate pipelines for up to 2 weeks." [143]

Lead response actors: Natural Gas Companies
State Agency Lead: PSC
Support: MEA, MEMA

Level 2 situations can be triggered by:

- Significant storms or similar incidents, without a declaration of "emergency";
- Activation of the natural gas utility EOC; and
- The Energy Information Administration or other sources report a decrease in the availability of product.

State agency lead response measures include:

- Receive update notices from utility operator as required;
- Monitor State, regional and world events and weather forecasts that may impact Maryland natural gas supplies and service delivery; and
- Keep informed by utility operator public affairs team as they perform emergency response operations, procedures, and distribution of accurate event information to the public.

Level 3*: Moderate natural gas shortage*

A Level 3 moderate shortage situation arises when there is an identifiable event that is known to have the potential to lead to a natural gas disruption, shortage, or jeopardizes reliable natural gas service lasting 2-4 weeks. NASEO suggests defining a level 3 event as one where there is "10-15 %[144] reduction in natural gas supply nominations on interstate pipelines, plus inside "City Gate" and "Curtailments by [natural gas utilities] for 2 weeks or more."[145]

Lead response actors: Natural Gas Companies
State Agency Lead: PSC

[143] Illustrative percentages. The MEA Energy Emergency Contingency Plan of 2001 defines a mild shortage as "10-15% reduction in natural gas nominations on interstate pipelines for up to two weeks."
[144] Illustrative percentages. To be decided upon by State authorities. The MEA Energy Emergency Contingency Plan of 2001 defines a moderate shortage as 15 to 20%.
[145] *State Energy Assurance Guidelines*, *supra note* 3.

Support: Governor's Office, MEMA, MEA, MDOT, Maryland Department of Human Resources (MDHR), American Red Cross, Civil Air Patrol

Level 3 situations can be triggered by events, such as:

- Moderate shortage, escalating incident, or disruption;
- Utility operator requests for limited assistance; and
- Impact extends to interdependent utilities (those that rely on the impacted energy resource).

State agency lead response measures include:

- Serve as liaison (in level 3 and 4 situations) between natural gas operators and other State agencies to assist the operator in procuring State resources to meet its needs;
- Implement in-house Situation Report to define the source and details of the outage or incident. The Situation Report includes information on the operator involved, area impacted, cause (if known), and expected duration;
- Maintain communication with natural gas operator for frequent updates;
- Notify PSC, Executives and the PIO with initial and interim situation reports, as necessary;
- Send courtesy notifications to other utility operators, MEA, MEMA and other State support agencies related to ESF 12 (previously described in this Chapter);[146]
- Update MEMA with utility situation reports;
- Evaluate geographical areas affected by the cascading effects of the event and notify stakeholders;
- Support necessary reconnaissance efforts to aid in evaluating energy infrastructure;
- Consider issuing public appeal for voluntary reduction of natural gas in accordance with curtailment plans;
- Implement voluntary reduction of natural gas consumption in accordance with curtailment plans, as necessary, by consumers, businesses, schools, institutions and State-owned facilities; and
- Escalate to Level 4 status, as appropriate.

Level 4: *Severe natural gas shortage*

Level 4 is a severe shortage; a real "emergency" situation with serious risks for public health and safety. A disruption, shortage, or constraint has occurred that causes a larger than "15%[147] reduction in availability of natural gas for more than 2 weeks."[148]

Lead response actors: Natural gas companies

State Agency Lead: PSC

Support: Governor's Office, MEMA and SEOC, MEA, Civil Air Patrol, MDOT, MDHR, American Red Cross and DOE.

[146] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1, at 26.

[147] Illustrative percentage. To be decided by State authorities. The MEA Energy Emergency Contingency Plan of 2001 uses "20% to 30% and upwards."

[148] *State Energy Assurance Guidelines*, *supra note* 3.

A Level 4 status is triggered by:

- Declaration of State of Emergency by the Governor;
- Escalation of a high frequency, low impact outage or incident estimated to last a period of months, precluding the reliability of natural gas service delivery;
- Natural gas companies recognizing that either company resources (e.g., staff experts, materials, and equipment) are being exhausted or a multi-jurisdictional emergency is occurring;
- A devastating natural or deliberate disaster that immediately impacts natural gas infrastructure with little or no warning; or
- Energy demand exceeds supply such that a natural gas shortage occurs, and the situation becomes unmanageable by natural gas operators, balancing authorities and excess market supply.

Under such conditions, the State's emergency response capability will be activated on determination that multiple State agencies have operational responsibilities and that a need for resource coordination exists.[149] The SEOC will be activated under standby, limited, or full activation status determined by the Director of MEMA. The PSC works with the MEMA team and others at the SEOC to provide subject matter expertise.

State agency lead response measures include:

- Present initial situation report to SEOC and MEMA's PIO consolidates information for public media release;
- Notify SEOC with appropriate updates;
- Notify DOE, if necessary;
- Maintain communication with natural gas operator for updates and continue providing resource support;
- Update MEMA/SEOC with interim situation report;
- Evaluate geographical areas affected by cascading effects of the event and notify SEOC State Support Functions 1-13;
- Advise Governor and MEMA Director to implement curtailment of natural gas and electric usage in accordance with advanced stages of the curtailment plans;
- Identify interdependencies between the natural gas, electric power, and petroleum sector to minimize impact upon sectors outside of the natural gas industry; and
- Facilitate utility operators with possible resources from various State agencies.

Following event:

- Demobilize response-recovery as emergency abates and return to normal operational conditions; and
- Return borrowed assets to originating agency.

[149] *State of Maryland Core Plan for Emergency Operations*, *supra note* 1, at 26.

"Beyond Severe" Shortage

On top of Levels 1-4, the MEA's Energy Emergency Contingency Plan of 2001[150] defines a "beyond severe" shortage level for very low frequency/high impact situations. Additional conditions include war, widespread natural disasters or other calamities that cause a long-term reduction in fuel availability, evident health and safety issues for people with functional needs or price and/or consumption reductions do not readily impact supply.

Natural Gas Utility Actions

Natural gas utilities employ multiple strategies to prevent a shortage of supply, including contracting sufficient firm transmission capacity and base load storage capacity, and building peak load storage facilities. Gas utilities are required by federal law to have emergency plans for dealing with disruptions. The emergency steps that gas companies generally take during a shortage include:

- Purchase and transport additional gas and/or exchange agreements with other gas companies;
- Increase withdrawals from storage;
- Increase withdrawals from other operating system sources;
- Increase pipeline pressure;
- Request that customers voluntarily reduce gas demand;
- Arrange for import of CNG or LPG;
- Interrupt selected customers; and
- Implement gas cut-offs.[151]

If, despite preventive measures, a utility comes to face a shortage of supply, PSC-approved contingency plans (related to bulleted items 5, 7 and 8 of the list above) provide guidance for reducing demand in a way that safeguards critical functions, the public health, safety and property and maximizes the number of customers served.

Contingency Plans

Under supply shortage conditions, utilities may implement contingency plans in order to maximize the number of customers served and sustain priority services. Contingency plans include requests to conserve and curtail specific sections of the systems, such as interruptible customers. The plans specify the hierarchy of gas service and use during extraordinary situations, and are required to be consistent with PSC regulations, MEMA requirements, the utility's own emergency standards and the Maryland Natural Gas Supply Contingency Plan.[152]

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[150] *Emergency Contingency Plan*, *supra note* 2.

[151] *State Energy Assurance Guidelines*, *supra note* 3.

[152] Interview with Ruth Kiselwich, Dir. of Demand-Side Mgmt. Programs, BGE; Gary Hildebeidel, Sr. Project Manager, BGE; Mike Fowler, Manager of Local Affairs, BGE; Linda Foy, Manager of Corporate Commc'n, BGE; Blake Gardner, Dir. of Gas Sys. Operations, BGE; Andy Dodge, VP of Transmission, BGE; Frank Tiburzi, Principle Eng'r; and Dan Sadler, Supervisor of Bus. Continuity, Constellation Energy in Baltimore, Md. (Apr. 29, 2011) [hereinafter *BGE Interview*].

The curtailment hierarchy determines the order in which gas supply to specific sections of the system is discontinued in emergency situations when curtailment of interruptible customers is insufficient. ”Critical uses” are last in line to have service interruptions, and include gas for pilot lights or to protect life, health, and public safety (schools, hospitals, etc.), or where a gas outage of up to 24 hours would irreparably damage the environment and/or property.[153] The last time BGE had to invoke the plan was in 1995.[154]

Natural gas utilities are expected to follow their PSC-approved plans, which are on file with the PSC. A common sequence of curtailment requires is as follows:

1. Call for voluntary reduction of use by all customers before issuing mandatory curtailment;
2. Interruption of all interruptible service customers;
3. Issue operational flow orders; and
4. Implementation of penalties for violations or a failure to curtail use. [155]

Interruptible customers are large commercial customers whose service can be temporarily interrupted in order for the regulated utility to sustain vital services for critical customers. The interruptible customers pay a lower delivery rate, and they must be able to readily substitute an alternate fuel for natural gas.[156] BGE has 163 interruptible service customers; WGL had 262 in Maryland as of September 30, 2010. Contingency plans are tested regularly to make sure that alternative fuel capability is on hand.

Natural Gas for Electricity Generation

PJM has a procedure to avert natural gas supply problems for power generation.[157] During periods of extremely cold weather, the natural gas supply to gas-fired generators may become negatively impacted. ISO New England, New York ISO and PJM (the RTOs) will jointly act to communicate with interstate natural gas pipeline operators, and coordinate actions to be taken to manage potential gas supply inadequacy situations during normal operations and when extremely cold weather is expected in any or all parts of the Northeast. To facilitate this process, PJM has developed:

- A database of natural gas-fired generation on its system, including its interstate pipeline supplier or LDC, connection point on the gas pipeline system and contract arrangements for gas supply and transmission;
- A complete set of maps of the interstate gas pipelines serving units on its system; and
- A contact list for people at the gas pipelines or LDC.

This information will be shared among the RTOs and combined such that each RTO has a complete set of information for facilities in the combined area.

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[153] *BGE Interview, supra note* 152.
[154] *BGE Interview, supra note* 152.
[155] National Association of Regulatory Utility Commissioners, *Technical Assistance Brief: NARUC Inventor on Gas Curtailment Planning* [hereinafter *NARUC Technical Assistance Brief*] (2005).
[156] WGL Holdings, *Annual Report* 3 (2010).
[157] PJM, *PJM Manual 13: Emergency Operations* (Rev. 43 2011) [hereinafter *PJM Manual 13: Emergency Operations*], *available at* http://pjm.com/~/media/documents/ manuals/m13.ashx.

Colonial Pipeline Company (Colonial)

Emergency Response Preparation

Colonial maintains procedures and devices to protect its pipelines from incidents. Colonial developed, and annually updates, area-focused Emergency Response Plans (ERPs) which are specific to the district for which each plan is created.[158] The plans outline the independent duties of work personnel during an emergency. In addition to developing ERPs, Colonial provides emergency response training that involves tabletop and functional exercises for emergency responders.[159]

Safety Preparedness and Maintenance Operations

DOT PHMSA sets pipeline operation safety standards.[160] The pipe itself is composed of "improved steels" and undergoes quality control testing when manufactured and installed.[161] "Heavier-wall pipe" is installed at waterways, river crossings and other sensitive areas as needed. The pipeline is coated with a corrosion-resistant waterproofing and cathodic protection is employed.[162] All pipelines are installed at least three to four feet underground, reducing the potential for accidental damage to the pipeline from digging or other activities, but remaining accessible if maintenance is required.

The Alpharetta Georgia pipeline control center monitors flow rates, pressures, pump operation status and valve positions.[163] Controllers are able to shut down pipelines within seconds from this location. In case of emergency, Colonial has available on its website an emergency contact number which is 800-926-2728.

Inspections are also conducted using electronic devices, known as smart pigs, which are used on each section of pipeline on two, three or five year intervals.[164] There are three types of pigs: deformation pig, magnetic flux leakage pig and elastic wave tool. The deformation pig is regularly used in "large-diameter" pipelines. It identifies dents and buckles in the pipeline. The magnetic flux leakage pig detects corrosion down to a half-inch.[165] It also locates thin areas of steel or gouges.[166] The third pig, known as the elastic wave tool, detects cracks in the pipeline.[167] Colonial also uses airplanes to conduct aerial patrols of pipeline easements to detect vegetation overgrowth and other threats. Federal regulations require twenty-six inspections of all easements a year. DHS, TSA and FBI also work with

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[158] Colonial Pipeline Company, *Working with the Communities We Serve: Emergency Response Training* (n.d.) [hereinafter *Working with the Communities We Serve: Emergency Response Training*], *available at* http://www.colpipe.com/en_com.asp (last visited Jan. 15, 2012).

[159] *Working with the Communities We Serve, supra note* 158.

[160] *Working with the Communities We Serve, supra note* 158.

[161] *Working with the Communities We Serve, supra note* 158.

[162] *Working with the Communities We Serve, supra note* 158.

[163] *Working with the Communities We Serve, supra note* 158.

[164] *Working with the Communities We Serve, supra note* 158.

[165] *Working with the Communities We Serve, supra note* 158.

[166] *Working with the Communities We Serve, supra note* 158.

[167] *Working with the Communities We Serve, supra note* 158.

Colonial to monitor threats to the pipeline. The Colonial pipeline is not always easily detectable, and a national 811 One-Call Center is available for homeowners, excavators and others to report digging projects. When a call is made, a utility representative arrives to mark the buried pipeline to prevent accidental damage.[168]

Dominion Cove Point Liquefied Natural Gas Facility

Security and Emergency Planning

The United States Coast Guard (USCG), FERC and DOT routinely inspect Dominion Cove Point's (Cove Point) security procedures and plans. Cove Point security must meet federal maritime security regulation, CFR 33-105. USCG's jurisdiction over shipping begins when a vessel enters the Chesapeake Bay. The USCG focuses particularly on the offshore platform where vessels dock and the fuel pipeline leading to shore. A USCG security zone is maintained around the offshore platform even when a ship is not present. When a vessel is docked, the Calvert County Sheriff Department enforces the security zone. DOT Office of Pipeline Safety has jurisdiction for the safety inspections of the storage tanks, facility process equipment and pipeline. FERC also monitors Cove Point. Cove Point's "security organization plays a leadership role in law enforcement meetings with local, federal, and State law enforcement agencies, local businesses, and private sector critical infrastructure workgroups."[169]

Safety equipment used at onshore facilities "include[s] methane detectors, Ultraviolet or Infrared (UV/IR) fire detectors, and closed-circuit TV."[170] Offsite monitoring, personnel training, and restricted access to the facility all enhance safety. Cove Point was designed and maintained according to DOT PHMSA regulations for a Liquefied Natural Gas (LNG) terminal that require adequate safety measures to mitigate damages resulting from a spill or equipment failure.

Additionally, pipeline resiliency is tested in the same manner as the Colonial Pipeline through the use of "pigs." While LNG passes through the pipeline, ice can form where leaks occur or insulation is insufficient for particular pieces of the pipeline. The ice formations help notify Cove Point which portions of pipeline receive priority for maintenance or replacement. The Calvert County Emergency Management Division, in working with Cove Point, develops emergency response plans to respond to an incident at Cove Point. These plans include emergency response and evacuation procedures in the event of an on-site, off-site, or off-shore accident. The use of sirens alert residents of an incident and notify them to listen to the local EAS. Public notification also includes the use of:

- An Emergency Telephone Mass Notification System, which informs individuals if they are in the evacuation zone;
- A Rout-Alerting Process, which assigns emergency vehicles to each street in the evacuation zone to provide each household notification; and

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168 *Working with the Communities We Serve*, *supra note* 158.

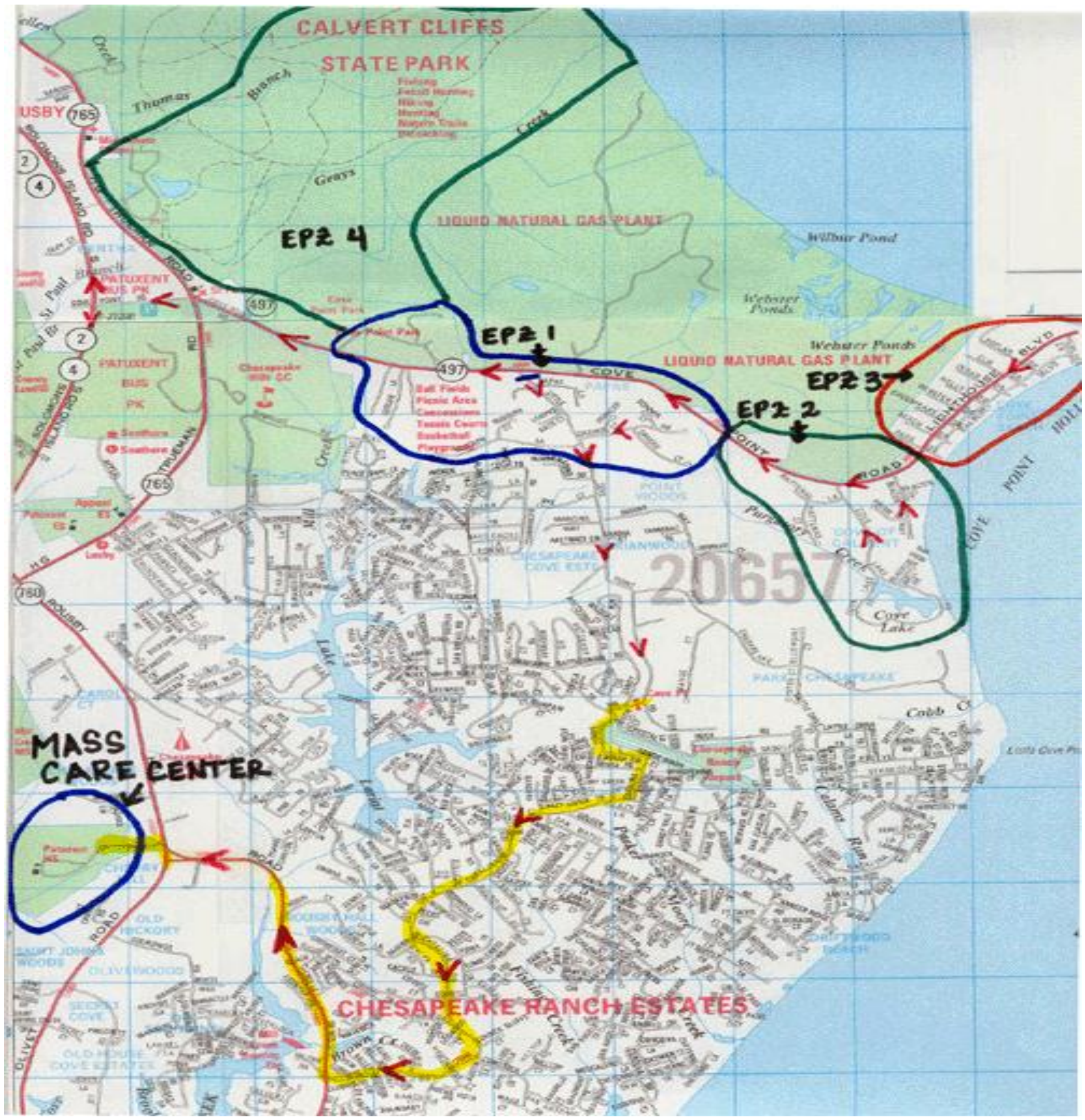
169 Dominion, *Cove Point LNG: Safety and Security* (n.d.) [hereinafter *Cove Point LNG: Safety and Security*], *available at* http://www.dom.com/business/gas-transmission/cove-point/safety-and-security.jsp (last visited Jan. 15, 2012).

170 *Cove Point LNG: Safety and Security*, *supra note* 169.

- Media announcements on Comcast Channel 6 and local EAS stations.

The emergency evacuation map in Figure 5-9 is available online and designates four Emergency Protective Zones, evacuation routes, and a Mass Care Facility (Patuxent High School) used in the event of an evacuation.

Figure 5-9: Emergency Evacuation Route for Dominion Cove Point LNG Facility[171]



[171]Calvert County Public Safety, *Cove Point LNG Emergency Preparedness* (n.d.) [hereinafter *Cove Point LNG Emergency Preparedness*], *available at* http://www.co.cal.md.us/residents/safety/emergency/covepoint/.

Examples of Lessons Learned

Post-incident emergency response plan reviews are an important aspect of effective emergency management. Incorporation of lessons learned into emergency plans helps ensure that Maryland is as prepared as possible for an event and that emphasis is placed upon constant improvement. In-so-doing, emergency plans become living documents, subject to frequent change and update. After an emergency event, debriefings are held to evaluate the overall system, response times and emergency plans in general.

The following information is included from publicly available self-assessments from two utility providers: Allegheny Power (now Potomac Edison) and Potomac Electric Power Company (PEPCO). The assessments are part of PSC filings for Case Number 9220, which occurred after the Maryland winter storms of 2010.

Allegheny Power: Allegheny Power's assessment included lessons learned and plans for future improvement of power restoration. Allegheny Power looked into the following:

> (a) improving field communications to compensate for lack of cell phone service in some areas; (b) having more hard copy maps available ready for use by external contractors; (c) obtaining GPS devices for external resources; (d) possible acquisition of additional lighting to be used by contractors for work at night; and, (e) exploring ways to improve communications with local Department of Highway officials.[172]

PEPCO: A portion of the PEPCO assessment identifying communication and coordination lessons learned include that:

> Pepco will continue to seek support from communications utilities prior to and during major storm outage events to augment Pepco first-responder resources assigned to identify downed wires to distinguish electric lines from communications wires. Pepco would suggest that the Commission convene a working group of key stakeholders to address this issue; Pepco will solicit updated contact information from customers in order to facilitate better communication during storm emergencies; Pepco will evaluate telephone menu options for modifications to facilitate easier access to outage and restoration functions during storm emergencies; Pepco will continue to coordinate with appropriate local agencies to develop snow plowing plans that work in conjunction with the Company's service restoration priorities; and Pepco will continue the use of mutual assistance personnel for customer service and outreach.[173]

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[172] Maryland Public Service Commission, *The Potomac Edison Company d/b/a Allegheny Power - Major Storm Report. Case No. 9220* (2010), *available at* http://webapp.psc.state.md.us/.

[173] Maryland Public Service Commission, *Potomac Electric Power Company - Supplemental Report Case No. 9220* (2010) [hereinafter *Potomac Electric Power Company - Supplemental Report*], *available at*

As demonstrated by the Allegheny Power and PEPCO filings, there were communication issues with response personnel and customers during the 2010 winter weather event. Improved coordination was also needed between those State and local agencies responsible for road clearing to assist in facilitating power restoration. The 2010 winter weather event further demonstrated the importance of continued use of mutual aid agreements and pre-emergency coordination between the private sector and government agencies responsible for emergency response. Continued implementation of lessons learned into response plans and procedures remains an important aspect in Maryland's ability to mitigate the impact of an energy emergency.

Conclusion

A statewide energy emergency plan cannot exist in a vacuum. Instead, State representatives must be sure they are working with, and not against, private parties who also have an interest in energy restoration. By coordinating energy emergency efforts, restoration can be efficient and proceed as quickly as possible. In many instances, energy assets are owned and operated by the private sector; they must be permitted to lead restoration efforts. The State should ensure a level of coordination necessary to ensure all parties are working in concert.

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http://webapp.psc.state.md.us/intranet/casenum/NewIndex3_VOpenFile.cfm?ServerFilePath=C%3A%5CCasenum%5C9200%2D9299%5C9220%5C24%2Epdf.

Chapter 6. Energy Disruptions

Introduction

An energy disruption can be defined as a failure, or a partial failure as in the case of a brownout, of the energy supply to meet demand. Energy disruptions may occur anywhere along the global energy supply chain and may result from frequent or infrequent, human-made or natural events. Human-made events include use of faulty energy infrastructure along with a failure to identify, repair, maintain and properly site infrastructure (e.g., pipelines, transmission lines and generating stations). Human-made disruptions also include physical or cyber attacks, as well as accidental damage (e.g., digging). Natural catastrophes include weather events such as tornadoes, hurricanes, floods, substantial snow and ice accumulation, extreme heat and cold and earthquakes. Human-made and natural events can happen in tandem to cause an energy disruption that makes it difficult to assign a singular cause. Additionally, due to dynamic interconnections in the energy infrastructure and marketplace, disruptions to domestic or international energy supplies can have significant impacts on Maryland's energy availability.

Marylanders have come to increasingly rely on an uninterrupted supply of energy. Without a steady supply of energy, food rots, cars sit idle, houses get too hot or too cold, water stops flowing and lights go dim. Given this reliance, an energy disruption may easily rise to the level of an energy emergency. When end-users do not have energy for prolonged periods of time, public health, safety, economy and security are all negatively affected. Maryland's reliance on energy has also tracked its citizens' increased use of energy over time. Analyzing the causes of, and solutions to, energy disruptions enables us to create strategies for resilience to, and recovery from, future disruptive events. This chapter provides an overview of energy disruptions, the causes of disruptions in Maryland, the potential effects of such disruptions and recovery efforts that may be needed.

Characterizing Energy Disruptions

Energy systems – including fuel and infrastructure – are often threatened on both the supply and demand side. Disruptions may arise as a result of high demand (e.g., high electricity load during heat events), generation unavailability (e.g., a power plant fails) or supply constraints (e.g., a shortage of gasoline due to a hurricane on the Gulf Coast). As a consequence, the multiple drivers of energy disruptions necessitate expanding the scope of monitoring, assessing and responding to such disruptions.

As disruptions persist and possibly expand over larger geographic regions, the cumulative event may be categorized as an energy emergency, though the distinction between disruption and emergency is not always clear. Energy emergencies arise as the result of non-functioning energy infrastructure (e.g., transmission network, pipelines and electrical generation capacity) or lack of primary fuels (e.g., coal, natural gas and oil). The root causes of these energy emergencies, however, stem from a common set of human-made or natural events, including:

- *Severe Weather Conditions* – Extreme heat and cold over consecutive days, high winds, severe lightning storms, winter storms and excessive precipitation can lead to fuel shortages and infrastructure failure. In the case of extreme heat and cold, electricity demand is elevated, which necessitates deploying more generation and transmission capacity during a time when electricity resources are already stressed (e.g., some electricity generators require an additive to burn fuel under colder temperatures).
- *Natural Disasters* – Sudden, high-impact natural events with severe consequences, such as hurricanes, flooding, earthquakes, geo-magnetic events and tsunamis, may cause a substantial increase in energy demand, while limiting ability to supply and transport energy resources. Maryland's weather patterns in particular, with its history of hurricanes (e.g., Isabel in 2003 and Irene in 2011), presents a potentially serious threat to the State's energy resources. Disasters may also cascade across neighboring economies and geographies, indirectly impacting Maryland. For example, as recently as 2006, major hurricanes with landfalls in the Gulf of Mexico significantly influenced gasoline and natural gas supply and prices.[1] After hurricanes Katrina and Rita in 2005, approximately 5 billion cubic feet (Bcf) of natural gas production per day was curtailed and prices rose from $ 10 to $ 15 per one million British thermal units (MMBtu), a 50 percent increase in the price of natural gas.[2]
- *Systemic or Infrastructure Events* – Critical energy infrastructure may fail (short- or long-term) as a result of either natural or human-caused events that affect either the demand-side or supply-side. High load demand from consumers may place stress on electricity transmission systems, resulting in automatic load shedding. Conversely, plant mismanagement or water-damaged equipment may cause electrical generation failures. Systemic events include a persistent inability to properly protect infrastructure from weather-related events (e.g., not maintaining tree trimming on rights of way or allowing for downed trees on power lines). For more information on critical infrastructure specifically, see Chapter 8.
- *National Security/Sabotage Events* – Human-made disasters intended to disrupt the energy supply or infrastructure may result from terrorist acts, cyber attacks or acts of war.
- *Geopolitical and Market Events* – Fuel supplies may be disrupted or severely constrained as a result of domestic or international events such as labor strikes or civil unrest. These events may stimulate shifts in both the demand and supply of fuels to meet national defense priorities or satisfy market dynamics.

Protecting Energy Infrastructure

For information regarding the protection of Maryland's critical energy infrastructure, see Chapter 8.

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[1] Telephone Interview with Sam Whitehead, Public Affairs Manager, Colonial Pipeline (Mar. 28, 2011) [hereinafter *Whitehead Telephone Interview*].

[2] Energy and Environmental Analysis, Inc., *Hurricane Damage to Natural Gas Infrastructure and its Effect on the U.S. Natural Gas Market* (2005) [hereinafter *Hurricane Damage to Natural Gas Infrastructure and its Effect on the U.S. Natural Gas Market*], *available at* http://www.ef.org/documents/hurricanereport_final.pdf.

Vulnerabilities to Energy Disruptions

Certain characteristics of Maryland's energy infrastructure, geography and weather may make the State particularly susceptible to an energy disruption. The following vulnerabilities exist in Maryland:

- *Eastern Shore Load Pocket* – A load pocket is a geographic area with limited transmission capacity resulting in a less than optimal redundancy in electricity supply. The Delmarva Peninsula, for example, is geographically constrained by the Chesapeake Bay and the Atlantic Ocean. Most of the peninsula's electricity comes from local generation or transmission lines running from the north of the Peninsula. When there are transmission outages in the northern portion of the Peninsula (potentially caused by high winds or high load demand), the Eastern Shore has limited options for importing electricity. Two proposed transmission lines to the Eastern Shore, the Mid-Atlantic Power Pathway (MAPP) and the Atlantic Wind Connection, should alleviate the load pocket. The MAPP line, currently in the Pennsylvania-New Jersey-Maryland independent system operator (PJM) queue for new transmission projects and subject to the PJM Regional Transmission Expansion Planning (RTEP) process, is scheduled for completion by 2015.[3] The Atlantic Wind Connection, a proposed transmission line for use with potential off-shore wind developments will not be complete until 2016 at the earliest, has secured funding from multiple companies and filed for a right-of-way permit.[4]

- *Growing Load Demand, Reliance on Out-of-State Capacity and Transmission, and Generation Retirement* –PJM Interconnection notes that these 3 factors will continue to impact electricity reliability in Maryland.[5] As the State's population and urban centers grow, particularly in the central corridor region between Baltimore and Washington, D.C., increased load demand during high-heat events will inevitably strain the transmission network. In particular, Maryland is expecting an additional 28,000 new households to locate in the central part of the State over the next few years due to the Base Realignment and Closure (BRAC) process at the Department of Defense.[6] One economic consequence of the central corridor's current load demand is high congestion pricing for electricity in Maryland.

- *Natural Gas Pipeline Damage* – The most frequent cause of damage to Maryland's natural gas infrastructure results from machines striking natural gas pipelines while digging.[7] Gas pipelines

[3] Mid-Atlantic Power Pathway, *MAPP Home Page* (n.d.) [hereinafter *MAPP Home Page*], *available at* http://webapps.powerpathway.com/mapp (last visited Jan. 17, 2012).
[4] Atlantic Wind Connection, *Atlantic Wind Connection Home Page*, (n.d.) [hereinafter *AWC Home Page*], *available at* http://atlanticwindconnection.com/ (last visited Jan. 17, 2012).
[5] PJM, *Regional Transmission Extension Plan 35* (2010) [hereinafter *RTEP*], *available at http://pjm.com/documents/reports/~/media/documents/reports/2010-rtep/2010-rtep-report.ashx*.
[6] Maryland Base Realignment & Closure, *Maryland Base Realignment & Closure Home Page* (n.d.) [hereinafter *BRAC Home Page*], *available at* http://www.brac.maryland.gov (last visited Jan. 17, 2012).
[7] Interview with Ruth Kiselwich, Dir. of Demand-Side Mgmt. Programs, BGE; Gary Hildebeidel, Sr. Project Manager, BGE; Mike Fowler, Manager of Local Affairs, BGE; Linda Foy, Manager of Corporate Commc'n, BGE; Blake Gardner, Dir. of Gas Sys. Operations, BGE; Andy Dodge, VP of Transmission, BGE; Frank Tiburzi, Principle Eng'r; and Dan

are buried, and although high-capacity transmission pipeline rights-of-way are marked, the low-capacity distribution portion of gas pipeline infrastructure is not. As a result, digging operations frequently cause leaks. In 2008, the federal government responded to the accidents caused by digging operations by establishing a national "Call Before You Dig" number (811) that mandated that every person call prior to digging "even [for] small projects like planting trees or shrubs."[8]

- *Insufficient Heating Fuel Storage Capacity and Infrastructure* – Natural gas storage and delivery capacity is inadequate to meet the growing demand of an increasing population.[9] However, other fuels such as home heating oil and propane are expected to have sufficient capacity into the foreseeable future to satisfy the State's expected increase in consumption. As demand increases, suppliers will find themselves competing for existing pipeline and storage capacity, or will be investing in their own storage facilities. Washington Gas and Light (WGL) already has plans to construct additional natural gas storage capacity in Chillum, Maryland. This storage facility would add 1 bcf of storage capacity to meet forecasted peak demand and is projected to be in service by 2015 or 2016.[10] Additionally, infrastructure deterioration (e.g., aging equipment, failure to repair faulty or defective pipes) may cause leaks throughout the natural gas distribution system. WGL adds that additional stress on the natural gas system ensues when there is an increase in volume in LNG imports from the Dominion Cove Point Terminal. Pressure associated with the higher volume of natural gas travelling through the pipeline system could lead to "a significantly greater number of leaks in Washington Gas's distribution system, unless efforts to mitigate are taken."[11] When natural gas supplies are tight and prices are high, demand from electric generators will often shift to fuel oil, which will constrain supply and also raise prices of home heating oil. Having sufficient storage capacity and infrastructure for one type of heating fuel has spillover benefits for other fuels, for energy reliability, and for Maryland citizens.

- *Gasoline Price Spike* – Precipitous increases in the price of gasoline, frequently caused by supply shortages, will directly impact transportation patterns in Maryland. While gasoline prices have steadily increased over the last decade, citizens and markets are generally able to respond to these changes over time. Sudden price spikes, on the other hand, create a real risk to the State's economy and public welfare.[12] Gas prices in the Central Mid-Atlantic region generally rise at a rate equal to or slightly greater than the national average. Increases in gas price will indirectly

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Sadler, Supervisor of Bus. Continuity, Constellation Energy in Baltimore, Md. (Apr. 29, 2011) [hereinafter *BGE Interview*].

[8] 811, *About Us* (n.d.) [hereinafter *811 About Us*], *available at http://www.call811.com/about-us/default.aspx* (last visited Jan. 17, 2012).

[9] WGL Holding, Annual Report (2010) [hereinafter *WGL Holding 2010 Annual Report*], *available at* http://files.shareholder.com/downloads/WGL-II/1635274434x0x435990/f57189f7-f6c1-42fd-9e71-6dc030a4c5f9/WGL2010AR.pdf.

[10] *WGL Holding 2010 Annual Report*, *supra note* 9.

[11] *WGL Holding 2010 Annual Report*, *supra note* 9.

[12] U.S. Energy Information Administration, Petroleum and Other Liquids *available at* http://www.eia.gov/petroleum/gasdiesel/.

impact the State transportation system by increasing demand for alternative and mass transit modes. Public response to gas price increases varies over time and geographic location (e.g., rural or urban setting). (For additional information on Maryland's gasoline supply, see Chapters 2 and 8.)

- *Major Hurricane Strikes Mid-Atlantic or Gulf Coast* – The landfall of a major hurricane or tropical storm in the Mid-Atlantic region, such as Hurricane Isabel in 2003, may have serious consequences for energy provision in Maryland. The electricity transmission and distribution networks may experience outages caused by high winds, fallen trees or other energy interdependencies as referenced in Chapter 1, throughout the coastal portions of the State. Storm surges in low-lying areas (e.g., portions of Baltimore and much of the Eastern Shore) may lead to flooding and inhibit local transportation of fuel and utility repair efforts.[13] Moreover, importation of refined oil and liquefied natural gas via terminals in the Chesapeake Bay may be interrupted for a prolonged period as a result of serious damage. While a hurricane that takes a path through, or near Maryland has a limited likelihood of occurring, such an event poses severe consequences making it a high-risk event. Hurricane landfall in the Gulf Coast region, where such storms occur more frequently than in the Mid-Atlantic, poses a similar risk to Maryland due to the oil and gas interconnections between the two regions. Any major hurricane event along the Gulf Coast will likely disrupt oil and gas extracting, refining and transmission, and place constraints on supply and price. After Hurricane Katrina, for example, Mid-Atlantic gasoline prices increased by 22 percent from $2.47 to $3.03 per gallon.[14]

Energy Disruptions: Historical and Ongoing

Energy disruptions can impact all parts of the State. This section outlines major historical energy disruption events as well as ongoing events that are less significant in the scope of their impact, but recognizing them, remains critical to Maryland's overall energy reliability.

Major Historical Human-Caused Events

Severe Gasoline Shortages and Price Spikes

Historically, international incidents have contributed to gasoline price increases. The most notable of these includes the oil crisis caused by the Organization of Petroleum Exporting Countries' (OPEC's) oil embargo in 1973; the 1979 Iranian Revolution; and the 1981 Iran-Iraq War. In 1973, imports of oil to the

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[13] Baltimore Gas and Electric Company, *Reports on the Electric Service Interruptions due to Hurricane/Tropical Storm Isabel and the Thunderstorms of August 26-28, 2003 – Case No. 8977* (2003) [hereinafter *BGE Reports on the Electric Service Interruptions*], *available at* http://webapp.psc.state.md.us/Intranet/casenum/s ubmit.cfm?DirPath=C:\Casenum\8900-8999\8977\Item_007\&CaseN=8977\Item_007 (last visited Jan. 17, 2012).
[14] U.S. Energy Information Administration, Petroleum and Other Liquids *available at* http://www.eia.gov/petroleum/gasdiesel/.

United States dropped from 6 million barrels/day in September to 5 million barrels/day in the following months. By December 1973, the price per barrel of oil rose 130 percent.

In 1973 and 1979, the Metropolitan Washington Council of Governments (MWCOG) worked with Virginia, Maryland and Washington, D.C. to coordinate and establish emergency actions during oil shortages. Within eight days, MWCOG developed and enacted an area-wide gasoline allocation plan for the region calling for “odd-even” fueling: owners of cars with even-numbered license plates purchased gas on even-numbered days of the month and those with odd-numbered plates bought gas on odd-numbered days. In further response to the fuel crisis, in 1974 the MWCOG developed the Commuter Connections program, which maintains a database of 30,000 commuters in the region who participate in carpooling and vanpooling. MWCOG subsequently published the *Metropolitan Washington Energy Conservation and Management Plan*, which outlined the need for employer-sponsored ridesharing and limited purchases of gasoline.[15]

During the 1979 oil shortage, many State politicians, including Maryland Governor Harry Hughes, proposed gas rationing, but this suggestion was unpopular. It is likely that rationing was not ultimately utilized due to its unpopularity and the lengthy administrative process needed for implementation.[16] Responses and implementation of odd-even rationing happened at the state level rather than the federal level in both 1973 and 1979. Though the Federal Energy Administration, the precursor to the U.S. Department of Energy (DOE), ordered gas rationing coupons in 1974 and 1975, these coupons ultimately were not used because the embargo ended and the shortage subsided.[17] The coupons were destroyed in 1984.[18] (For information on fuel sourcing see Chapter 2.)

(For historic gas prices see Figure 6-1: Historic Gasoline Prices in the Central Atlantic Region and the U.S. (1976-2012) , on the following page.)

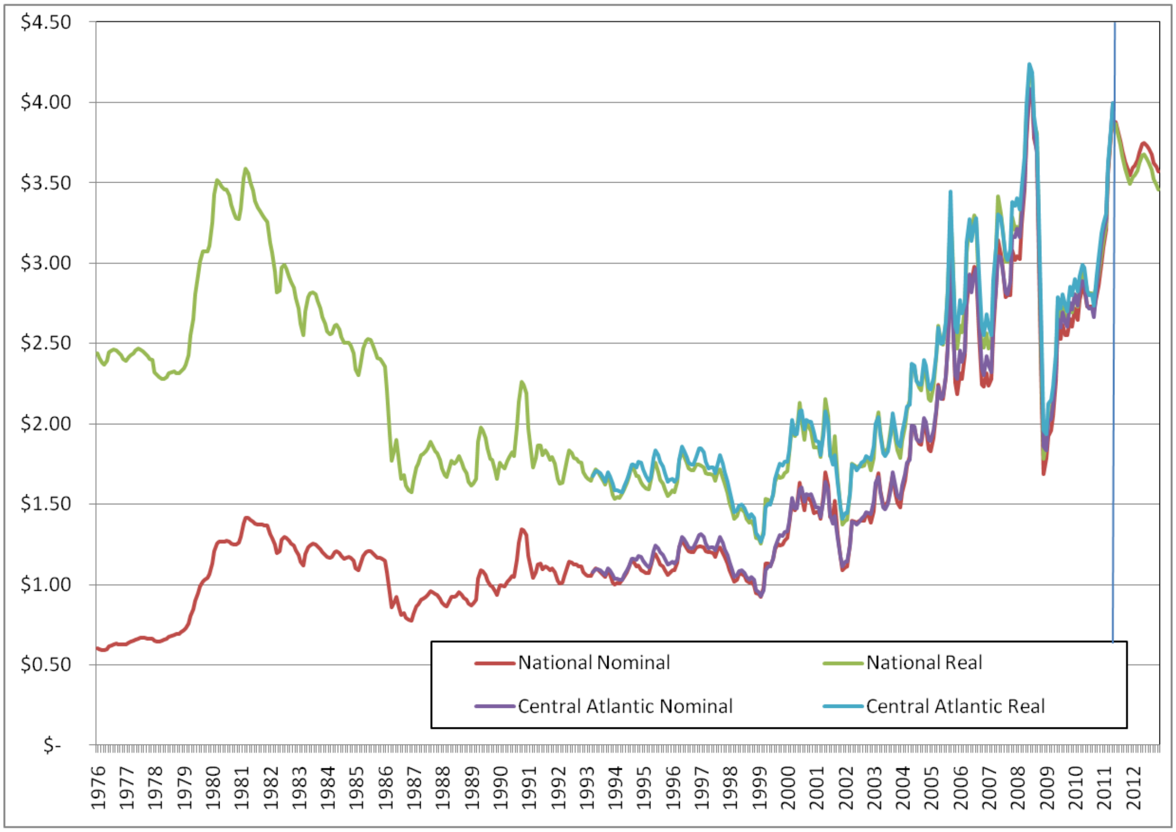
[15] Additional information on Commuter Connections can be found at http://www.mwcog.org/commuter2/.

[16] *See RATIONING: Spotty Local Starts*, TIME MAGAZINE, Feb. 25, 1974. *See also* David Donadio, *Learning From American's Mistakes*, *The American* Spectator, Dec. 4, 2007, *available at* http://spectator.org/archives/2007/12/04/learn-from-americas-mistakes (last visited Jan. 17, 2012).

[17] See National Postal Museum, *About the Museum: Gasoline Rationing Coupons* (n.d.) [hereinafter *About the Museum: Gasoline Rationing Coupons*], *available at* http://www.postalmuseum.si.edu/museum/1d_gas_coupons.html (last visited Jan. 17, 2012).

[18] *See Rationing Coupons Shredded*, N.Y. TIMES, Feb. 6, 1984, *available at* http://query.nytimes.com/gst/fullpage.html?res=9F06E0DD153BF931A35755C0A962948260&sec=&spon=&pagewanted=print.

Figure 6-1: Historic Gasoline Prices in the Central Atlantic Region and the U.S. (1976-2012) [19]



Accidental Oil Leaks

Accidental oil leaks can result in two distinct issues: environmental impacts and economic impacts. The size of the leak will determine the reach of either event; however both are real possibilities if a pipeline ruptures. Maryland has seen examples of both.

- *Environmental Impact*: In 2000, a pipeline in southeastern Prince George's County ruptured, releasing approximately 126,000 gallons of fuel oil into Swanson Creek and the Patuxent River. The pipeline, then owned by PEPCO, burst while transporting oil between a terminal in St. Mary's County and the Chalk Point Generating Station. Following the incident, "The US EPA issued PEPCO an Administrative Order pursuant to Section 311 (c) of the Clean Water Act (CWA) to conduct emergency response actions to contain and recover the oil."[20] A clean-up command structure was organized and over 800 workers from 12 local, state, and national agencies worked around the clock to stop the leak, contain the oil and minimize damage to wildlife. Among the agencies involved were the Maryland Department of Natural Resources (DNR),

[19] U.S. Energy Information Administration, Petroleum and Other Liquids *available at* http://www.eia.gov/petroleum/gasdiesel/.

[20] Mid-Atlantic Superfund, U.S. Environmental Protection Agency, *Swanson Creek Oil Spill* (n.d.) [hereinafter *Swanson Creek Oil Spill*], *available at* http://www.epa.gov/reg3hwmd/super/MD/swanson-pepco/pad.htm (last visited Jan. 17, 2012).

Maryland Department of the Environment (MDE) and the U.S. National Oceanic and Atmospheric Administration (NOAA).

- *Economic Impact*: The British Petroleum oil spill in the Gulf of Mexico in 2010 will have near-term impacts on Maryland's economy. Namely, the 2010 oil spill had an observed influence on crude oil future contracts. The spill persuaded investors that prices would rise as a result of supply constraints.[21] Anticipated increases in oil prices will have direct effects for Maryland's oil transmission market as well as consumers at-large.

Deliberate Attacks

Deliberate attacks include terrorist acts by foreign nationals as well as criminal acts by U.S. residents. Maryland has not directly experienced a major terrorist attack, but the events of September 11, 2001, compelled the Maryland Department of Transportation (MDOT), and in particular the State Highway Administration (SHA) and Maryland Transportation Authority (MDTA) divisions, to reexamine their current response plans to terrorist threats and an attack's after-effects. Maryland's large and highly visible military and intelligence community presence creates unusual security and access issues during times of high alert. Additionally, substantial regional integration of infrastructure in Maryland, Virginia and the District of Columbia, particularly around the Potomac River crossings, Baltimore/Washington Parkway, and property owned by the federal government, results in complex issues of jurisdiction.

Accordingly, MDOT's responses to September 11th were narrowly focused and anticipatory. Specifically, MDOT:

- Increased monitoring of roadways, bridges, and tunnels,
- Enhanced infrastructure security,
- Managed plans to address extraordinarily heavy traffic during an evacuation, particularly in the Washington/Baltimore area,
- Assisted with communications and traffic alerts along the I-95 corridor, and
- Lent assistance to Virginia DOT in the wake of the Pentagon attack.[22]

One major lesson MDOT learned in the wake of the September 11th events is that SHA and MDTA maintain an appropriate set of protocols to respond to such events, and that they possess the necessary authority to act efficiently and effectively, while retaining flexibility at the operations level. However, MDOT also identified a striking weakness that extended across all Maryland regions: inadequate communication interoperability. (For additional information regarding interoperability see Chapter 9.)

The September 11th terrorist attacks on the Pentagon affected the entire transportation system in the Washington metropolitan area. Although it was not a sustained attack, the public's response to the events of September 11th created gridlock on the region's major roadways. In response to the gridlock

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[21] Brian Baskin, *Curbs on Oil Drilling Lurk as Long-Term Wild Card*, WALL ST. J. (June 3, 2010), *available at* http://online.wsj.com/article/SB10001424052748704515704575282871418108164.html?mod=WSJ_latestheadlines.

[22] Transportation Security and Emergency Management, *Maryland's Reaction and Response to the Events of September 11th: A Case Study* (n.d.) [hereinafter *Maryland's Reaction and Response to the Events of September 11th*], *available at* http://www.transportation.org/sites/security/docs/MD911Final.pdf (last visited Jan. 17, 2012).

the Washington Metropolitan Area Transit Authority (WMATA) allowed the metro system to continue operating. The system served as an effective alternative to the road network.

Increased vigilance and security in the hours and days following the 2001 terror attacks served as a necessary precaution to secure energy provisions throughout Maryland, and no immediate impact on natural gas or electricity has been identified.

Disruption in Generation or Transmission (Blackouts)

Wide-spread blackouts traced back to problems with transmission or generation are frequently caused by a combination of human error and infrastructure problems (e.g., miscommunication or poor coordination across Regional Transmission Organizations) and natural drivers (e.g., extreme heat events place significant load demand on the electricity transmission network). Over the past decade, Maryland has not experienced any substantial generation or transmission disruptions resulting in wide-scale outages. Maryland directly benefits from PJM's assistance in providing a consistent and adequate electric supply to the State, and from PJM's use of multiple supply modes to meet Maryland's electricity demand. As the Northeast Blackout of 2003 demonstrated however, electric grid interconnectivity can have negative consequences. Failed attempts to identify and understand system inadequacies in the Cleveland-Akron area, among other problems, resulted in cascading blackouts throughout the entire Northeast region in 2003.

More recently the Office of Electricity Delivery and Reliability, a branch of the U.S. DOE, instituted a program to address the problem of wide-spread cascading blackouts by funding and encouraging the increased installation of transmission line synchrophasors through the North American SynchroPhasor Initiative. Synchrophasors allow for wide area high speed measurement and control of power on the grid. Synchrophasors from different utilities are time-aligned (or "synchronized") and combined together to provide a precise and comprehensive view of the entire interconnection. Synchrophasors enable a better indication of grid stress, and can be used to trigger corrective actions to maintain reliability. Important applications today include wide-area monitoring, real-time operations, power system planning and forensic analysis of grid disturbances. Phasor technology is expected to offer great benefit for integrating renewable and intermittent resources, automated controls for transmission and demand response, increasing transmission system throughput and improving system modeling and planning.[23]

[23] North American SynchroPhasor Initiative, *North American SynchroPhasor Initiative Home Page* (n.d.) [hereinafter *NASPI Home Page*], *available at* https://www.naspi.org/ (last visited Jan. 17, 2012).

Major Historical Natural Events

Weather events, both extreme and ordinary, can interrupt Maryland's energy supply, which then negatively impacts a variety of related sectors. Common summer thunderstorms frequently knock out electric distribution lines and transformers, resulting in a loss of power, which in turn impacts the transportation sector. Downed wires block roadways and widespread outages stall electric trains. Heavy rain and flooding closes roads and isolates populations, and can keep repair crews from reaching downed power lines.

With the exception of storm surges and sea level changes, discussed below, Maryland's gas supply infrastructure is relatively shielded from weather events. Maryland has two supply routes for refined petroleum, pipeline and port, reducing the State's reliance on any single supply chain. Further, petroleum transmission and distribution lines, and base-load storage fields are protected underground. Still, cold spells that cause demand peaks strain the natural gas and heating oil supply and distribution systems. Heating oil shortages in 1989-1990 and 1994 were the result of extreme cold in Maryland.[24] Additionally, Maryland sporadically experiences severe snowstorms, tornadoes, tropical depressions, rainstorms and hurricanes. Major weather events are discussed in more detail below.

Hurricanes

Maryland has only experienced two hurricane landfalls since 1851, with the most recent being hurricane Isabel in 2003, which resulted in $410 million in state-wide property damage. Hurricane Irene in August 2011 did not land in Maryland, but passed within a few miles of Ocean City and was responsible for over 800,000 electrical outages. Hurricane season in Maryland is from June 1 to November 30 and coincides with three of the heaviest months for peak electric demand in the State (June, July and August). Numerous powerful storms have also adversely affected the State,[25] including tropical storm Agnes in 1972 which resulted in the death of 21 people and $62 million in property damage[26].

Over the last decade, Maryland experienced two significant electricity disruption events as a result of Hurricane Isabel in September 2003 and Hurricane Irene in 2011. Both Isabel and Irene disrupted electrical service for millions of Mid-Atlantic customers. The two hurricanes had remarkably similar effects on Maryland's electricity infrastructure. The densely populated Baltimore-Washington Corridor accounted for the greatest number of outages in both storms, with outages caused primarily by dead or damaged trees hitting overhead distribution wires. A comparison of the two hurricanes is in Table 6-1.

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[24] Maryland Energy Administration, *Maryland Energy Emergency Contingency Plan*, (2001).

[25] Atlantic Oceanographic and Meteorological Laboratory, *Chronological List of All Hurricanes which Affected the Continental United States: 1851-2007* (2008) [hereinafter *AOML Chronological List*], *available at* http://www.aoml.noaa.gov/hrd/hurdat/ushurrlist18512007.txt.

[26] Fred Rasmussen, *Remember When: Hurricane Agnes Roared Across the State*, BALTIMORE SUN, June 22, 1997.

Table 6-1: BGE Service Territory Hurricane Impacts

Hurricane	Date	Category at Landfall or at largest impact to Maryland	Number of Outages	Customer Interruption Hours	Number of Days Until Full Restoration
Isabel/BGE	8/03	2	790,000	36,648,956	8
Irene/BGE	8/11	1-2	756,000	27,697,518	8
Isabel/Pepco	8/03	2	394,988	30,599,650	10
Irene/Pepco	8/11	1-2	194,516	4,989,481	6

Maryland's heavy reliance on energy imports makes the State vulnerable to hurricanes that affect other parts of the country. For example, Maryland depends on a sustained supply of petroleum products from the Gulf Coast which necessitates that Maryland remains cognizant of natural catastrophes that substantially disrupt the energy industry in the Gulf. As a consequence of Hurricane Katrina in 2005, Colonial Pipeline (which carries gasoline, kerosene, home heating oil, diesel fuel, jet fuel and national defense fuels to Maryland) suffered an outage, which resulted in higher gas prices along its entire route, driving prices in Maryland to historic levels.[27] Because Colonial Pipeline carries 40 percent of the petroleum imported into the State, the outage had a significant impact on Maryland consumers. (For additional information regarding the Colonial Pipeline see Chapters 2 and 5.)

In 2008, the arrival of Hurricanes Ike and Gustav on the Gulf Coast once again disrupted refinery operations and caused power outages; which ultimately shut down transportation pipelines and significantly reduced the supply of petroleum products in Maryland (e.g., gasoline, jet-fuel, heating oil and propane). It is worth noting that hurricane season does not coincide with peak demand for heating fuels, though summer/late-fall storage opportunities may be disrupted by limited supplies and higher prices. The reduced fuel supply prompted the Environmental Protection Agency (EPA) to grant Maryland's request to waive reformulated gas requirements.[28] Reformulated gasoline is required in 12 Maryland counties due to non-attainment of Clean Air Act standards on PM2.5 (particulate matter).

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[27] Lawrence Kumins & Robert Bamberger, Congressional Research Service, Library of Congress, *CRS Report for Congress: Oil and Gas Disruption From Hurricanes Katrina and Rita* 6 (2006) [hereinafter *Oil and Gas Disruption From Hurricanes Katrina and Rita*], *available at* http://www.au.af.mil/au/awc/awcgate/crs/rl33124.pdf. *See also* Press Release, Colonial Pipeline Company, *Colonial Pipeline Plans to Restore Partial Service by This Weekend* (Aug. 30, 2005) [hereinafter *Colonial Pipeline Plans to Restore Partial Service by This Weekend*], *available at* http://www.colpipe.com/press_release/pr_72.asp; Paul Adams, *Storm Tightens U.S. Supply*, BALTIMORE SUN, Aug. 30, 2005 ("The record high gasoline prices reached just a week ago in Maryland…"), *available at http://articles.baltimoresun.com/2005-08-30/news/0508300013_1_gasoline-prices-hurricane-katrina-natural-gas.*

[28] Letter from Stephen L. Johnson, Administrator, U.S. Environmental Protection Agency, to Governors Martin O'Malley, Governor, State of Maryland; Governor Kaine, Governor, Commonwealth of Virginia; Mayor Fenty, Mayor, District of Columbia (Sept. 18, 2008), *available at* http://www.epa.gov/compliance/resources/policies/civil/caa/mobile/dc-md-va-fuelwaiver091808.pdf.

Reformulating gasoline requires blending fuel with additives. At the request of the MDE during events that affected Gulf refineries, the EPA waived these requirements to prevent a significant impact on the supply of gasoline to Maryland and other Mid-Atlantic states.

Following Hurricane Katrina, it became "clear that [Maryland's] petroleum fuel supply is vulnerable to disruptions and shortages because most of it is processed in one geographic location."[29] Hurricanes Katrina and Rita shutdown large natural gas production and processing facilities in the Gulf, increasing prices from under $10 to over $14 per MMBtu, more than a 40% change in the price of natural gas.[30] Damage to gas processing facilities disabled necessary petroleum treatment operations, and extended the delay of getting gas to customers.[31] Supply shortages from production losses in the Gulf could not be mitigated by increased supply from production areas in the Western U.S. because of inadequate east to west pipeline capacity.[32] Natural gas supply shortages due to hurricanes in the Gulf are partially curtailed because refineries and chemical companies reduce consumption, while demand to fuel power generation decreases from power outages.[33]

A hurricane of similar magnitude to Katrina, making landfall in Maryland, would severely impact the State's transportation network on the Eastern Shore. Intense storms, such as "nor'easters" originating in the South and traveling north along the East Coast, often inhibit the shipment of petroleum through the Chesapeake Bay and Wicomico River to ports on the Eastern Shore. In Maryland, 33 percent of petroleum is shipped by vessel and in the event of an evacuation, a shortage of petroleum products could result in a severe crisis for displaced populations and those situated along the Eastern Shore.

Winter Storms

The twin snowstorms and high wind that struck Maryland on February 5, 2010, and February 10, 2010, dumped nearly four feet of snow on Central Maryland and caused major power outages.[34] BWI Thurgood Marshall Airport recorded 26 inches of snow, and Reagan National Airport reported over 17 inches.[35] At its peak, PEPCO experienced 97,651 outages system-wide, 90,858 of which were in Maryland. About 6,100 Allegheny Power customers experienced a sustained interruption in power.[36]

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[29] Maryland Energy Administration*, A Practical Guide to Using B20 in Your Fleet (April 2007)* [hereinafter *A Practical Guide to Using B20 in Your Fleet*].

[30] U.S. Energy Information Administration, *EIA Report on the Hurricane Impacts on U.S. Economy*, (n.d.) [hereinafter *EIA Report on the Hurricane Impacts on U.S. Economy*], *available at* http://www.eia.gov/oog/special/eia1_katrina_111505.html (last visited Jan. 20, 2012).

[31] *EIA Report on the Hurricane Impacts on U.S. Economy*, *supra note* 30.

[32] Energy and Environmental Analysis, Inc., *Hurricane Damage to Natural Gas Infrastructure and its Effect on the U.S. Natural Gas Market* (2005) [hereinafter *Hurricane Damage to Natural Gas Infrastructure*].

[33] *Hurricane Damage to Natural Gas Infrastructure*, *supra note* 32.

[34] Baltimore Gas and Electric Company, *Major Storm Report – February 5-12, 2010* (2010) [hereinafter *BGE Major Storm Report*].

[35] Pepco, *State of Maryland Major Storm Report February 5 - 12, 2010* (2010) [hereinafter *Pepco State of Maryland Major Storm Report*].

[36] Allegheny Power, *Report re Case No. 9220* (2010) [hereinafter *Allegheny Power Report re Case No. 9220*].

The number of BGE customers who experienced a sustained interruption was 45,158.[37] The amount of customer-interruption hours due to the storms were as follows:

- PEPCO, 3,735,072 hours system-wide and 3,591,156 hours in Maryland;
- Allegheny Power 110,002 hours;[38] and
- BGE, 1,145,347 hours.

All major storm-related interruptions were restored soon after the storms: Allegheny Power restored full service to consumers by February 9th,[39] BGE restored full service to consumers by February 10th,[40] and PEPCO restored full service to Maryland consumers by February 12th.[41]

The historic 2010 snow storms significantly impacted the State's transportation system, but they did not disrupt the State's petroleum distribution system or lead to an increase in fuel price. There was no state-wide shortage of fuel; supply and demand were both curtailed due to the inaccessible roads. Government agencies filled fuel tanks in anticipation of severe weather and worked with their own fueling suppliers to ensure that petroleum stocks were adequate to continue snow removal efforts.[42] State vehicles assisting with snow removal and safety operations were able to obtain the fuel necessary to continue operations. In the future, State agencies plan to use similar preparation methods to ensure the adequacy of fuel supplies necessary to keep roads safe and clear. In the event of a long term interruption of transportation fuels, the governor has the authority to "establish and implement programs, controls, standards, priorities, and quotas for the allocation, conservation, and consumption of energy resources" (see, MD Code, Public Safety 14-304. Energy Emergencies).

These events provide examples of complete shut-downs of the regional road system and demonstrate the vulnerability of the transportation system to winter weather. Two positive signs from these events were: 1) the WMATA Metro system was able to effectively transport passengers when driving was not a feasible option; and 2) the effectiveness of teleworking for employers when roadways are shut down. The Federal government has found that its telework policies can be quite effective in situations where employees are unable to safely report to work. Though not all employees are eligible to telework, agencies such as the United States Patent and Trademark Office are aggressive in utilizing telework.[43] Private companies are not required by the State to have telework policies, however, many private companies do make telework available. Maryland has formal policies for State employee telework,

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[37] *BGE Major Storm Report*, *supra note* 34.
[38] *Allegheny Power Report re Case No. 9220*, *supra note* 36.
[39] *Allegheny Power Report re Case No. 9220*, *supra note* 36.
[40] *BGE Major Storm Report*, *supra note* 34.
[41] *Pepco State of Maryland Major Storm Report*, *supra note* 35.
[42] Meeting with Mark Harris, Emergency Response Manager & Grants Coordinator. Maryland Department of Transportation, May 2, 2011.
[43] Joe Davidson, *Snowstorm's Possible Plus: Advancing Cause of Telework*, WASHINGTON POST, February 11, 2010, *available at* http://www.washingtonpost.com/wp-dyn/content/article/2010/02/10/AR2010021003715.html?sid=ST2010021004217.

including requirements that employees telework during crises and specific provisions if employees are not authorized to do so prior to an event.[44]

Extreme Cold

Winter storms and extreme cold weather may disrupt the provision of the non-transportation petroleum products, propane and heating oil.

- *Propane* is transported via underground pipeline to distribution terminals. Railroads, barges, trucks, and supertankers also ship propane to bulk distributors, where local propane dealers fill small tank trucks (called "bobtails") for delivery to the more than 72,000 households that rely on propane for home heating. The average residential propane tank holds between 500 and 1,000 gallons of liquid fuel, with typical refueling needed every 30 days, but capable of lasting for 45 days under normal winter conditions.[45]
- *Heating oil* arrives in the Northeast by pipelines and ship from Gulf Coast refineries or is piped or shipped as crude to refineries in New Jersey and Philadelphia. Heating oil is also shipped to large terminals in Boston and New York from overseas. Baltimore acts as a large coastal entry point for the mid-Atlantic region. Once delivered to one of the aforementioned ports, barges and trucks distribute to smaller terminals along the coast after which, local distributer trucks deliver to customers. In Maryland, 266,000 households use heating oil as their primary fuel for heating.[46]

Cold weather increases consumer demand for heating fuels, while limited pipeline capacity, frozen harbors and rivers, and snow-blocked roads potentially limit delivery of additional supply. In the event of a severe storm (or specifically heavy snow coverage), heating oil and propane fuels may arrive undeterred in Maryland's receiving terminals, but local level distribution by rail or truck will be constrained. Storms may also prohibit tankers and barges from docking, which happened along the Northeast coast in the winter of 1999-2000.[47]

There were multiple home heating fuel shortages from 1973-1994 as a result of extreme winter weather.[48] During cold spells, propane and heating oil in storage is used much faster than it can be

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[44] Information on Maryland state employee telework policies are provided in the State of Maryland Teleworker's Manual. See Maryland Department of Budget and Management, *Teleworker's Manual* (2007) [hereinafter *Maryland Teleworker's Manual*], *available at* http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source =web&cd=1&ved=0CCQQFjAA&url=http%3A%2F%2Fwww.dbm.maryland.gov%2Femployees%2Ftelework%2FDocuments%2Fteleworkers_manual_may_2007.doc&ei=R3EbT_ecGYHo0QHz2cS8Cw&usg=AFQjCNEK95vVmXpdKnpWyIi2p58hz2v05g&sig2=D_noNscn8fkFPKn1MWicfA.

[45] U.S. Census Bureau, *2005-2009 American Community Survey* (2010) [hereinafter *American Community Survey*]. *See also* Harry Hunter Hanger Jr., Pennsylvania Public Utility Commission Winter Meeting: *Propane Supply and Logistics Overview* (Nov. 9, 2006).

[46] *American Community Survey*, *supra note* 45. See also, U.S. Department of Energy, *The Northeast Heating Fuel Market: Assessment and Options* 51-59 (2000) [hereinafter *The Northeast Heating Fuel Market*], *available at http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CCEQFjAA&url=http%3A%2F%2Fwww.fe.doe.gov%2Fprograms%2Freserves%2Fpublications%2FPubs-HeatingOil%2F60daystudy.pdf&ei=dnMbT9mFBoHm0QHxvJWwCw&usg=AFQjCNGPc3fKSbrfUbkYcu5nH90i-eecEg&sig2=GcCLidu3dTazzWVIrUmllA*.

[47] *The Northeast Heating Fuel Market*, *supra note* 46.

[48] *The Northeast Heating Fuel Market*, *supra note* 46.

replenished, and refineries normally cannot keep up with demand during cold periods.[49] Winter demand can exceed summer demand by six times and pipelines cannot deliver more than double summer capacity during winter. Moreover, pipeline shipments from the Gulf Coast have transit times of 14 to 20 days; imports over water from Venezuela or the Virgin Islands take 5 to 7 days. As a result, immediate incremental supplies are only available from local inventories.

Supplier behavior can exacerbate the situation as follows:

- Wholesale buyers, predicting that supplies are not adequate to cover short-term demand, bid up prices for available product.
- Deliveries can be delayed days to weeks.
- Additional supplies may have to come long distances, driving up prices for end-use consumers.

Due to the delay in resupply, sellers in the region may see reserves drop further, increasing buyers' anxiety, while inflating prices. [50] In addition, during very cold periods, prices of other heating fuels (such as natural gas or kerosene) may increase beyond heating oil prices, compelling some industrial consumers to switch from their normal heating fuel to heating oil, further increasing demand. [51]

Geo-magnetic Events

Electromagnetic radiation stemming from solar storms and nuclear blasts carry the potential to interrupt communications, GPS navigation systems and the supply of electricity in a wide region that includes Maryland and the states that supply Maryland with electricity. Occurring in eleven year cycles, solar storms create electromagnetic disturbances that, due to the geological formations common in the Northeast U.S. and in Western Maryland, are powerful enough to destroy transmission and distribution transformers; leading to a complete collapse or blackout of the grid system.[52]

The effects of electromagnetic disturbances include:

- Tripping of capacitors,
- Operation and non-operation of relays,
- Overheating in transformers,
- Phase voltage imbalances,
- Cyclic levels of generation excitation,
- Power swings, and
- Decaying voltage profiles.

[49] U.S. Energy Information Administration, *Heating Oil Explained – Factors Affecting Heating Oil Prices* (2011) [hereinafter *Heating Oil Explained*], *available at* http://www.eia.gov/energyexplained/index.cfm?page=heating_oil_factors_affecting_prices (last visited Jan. 22, 2012).

[50] *Heating Oil Explained*, *supra note* 49.

[51] *Heating Oil Explained*, *supra note* 49.

[52] PJM, *Weather and Environmental Emergencies Training* (2010) [hereinafter *Weather and Environmental Emergencies Training*], *available at* http://pjm.adobeconnect.com/p37769123.

On March 13, 1989, a geomagnetic event centralized in eastern Canada caused extensive damage to equipment on the Hydro Quebec system which led to further damage and blackouts in Canada and the Northeast U.S. Some damaged parts from this event took six weeks to replace.[53]

Nuclear detonations can have very similar impacts, but are not at all predictable in time or location. Nuclear weapons emit a slightly different kind of electromagnetic pulse that can affect different types of equipment. However, the end result is very similar in terms of disruptions to electricity transmission and communications.

Earthquakes

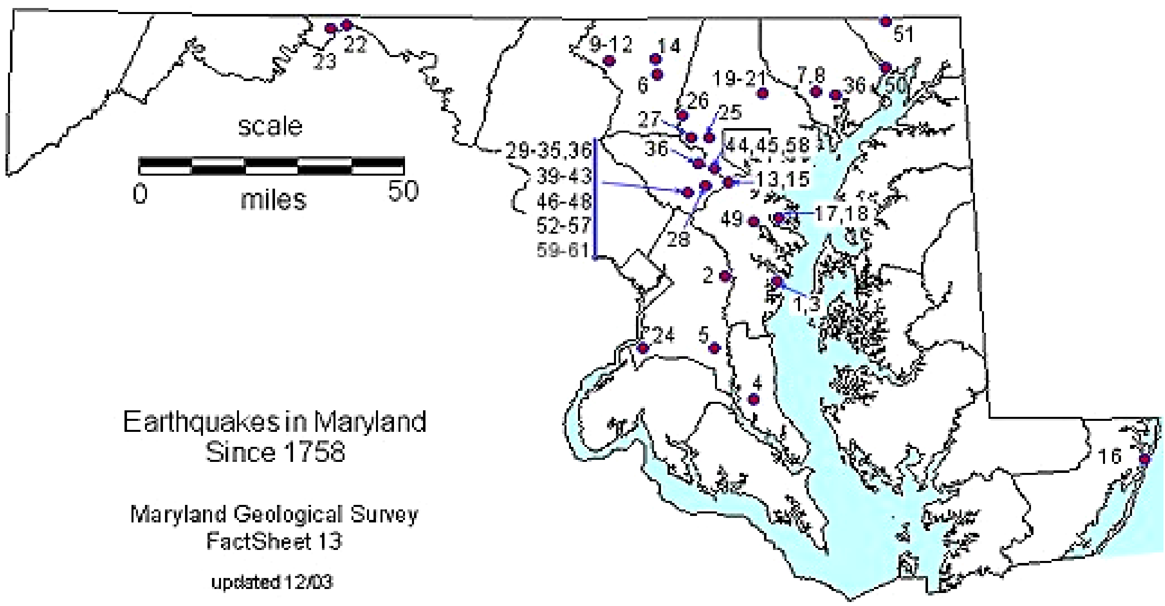
The most recent earthquake felt in Maryland occurred on August 23, 2011. The 5.8 magnitude earthquake's epicenter was in Virginia, and fortunately had limited destructive impact in Maryland. Nevertheless, petroleum pipeline companies, the Calvert Cliffs nuclear power plant and other owners of critical energy infrastructure found it necessary to perform extensive inspections after the quake which at times interrupted their normal operations. Earthquakes are capable of causing extreme damage to infrastructure, the extent of which may be determined from the following interrelated factors:

- Amount of seismic energy released;
- Duration of shaking;
- Depth of focus, or hypocenter;
- Distance from epicenter;
- Geologic setting;
- Population and building density; and
- Geographic and topographic setting: this characteristic relates more to secondary effects of earthquakes than to primary effects such as ground shaking, ground rupture, and local uplift and subsidence. Secondary effects include landslides (generally in hilly or mountainous areas), seismic sea waves or tsunamis (mainly restricted to oceans and coastal areas) and fires (from ruptured gas lines and downed utility lines).[54]

Although Maryland experiences earthquakes, those that pose the greatest threat of damage will most likely have an out-of-state epicenter.[55]

[53] *Weather and Environmental Emergencies Training*, *supra note* 52.
[54] James P. Reger, Maryland Geological Survey, *Earthquakes and Maryland* (2011) [hereinafter *Earthquakes and Maryland*], *available at* http://www.mgs.md.gov/esic/brochures/earthquake.html.
[55] *Earthquakes and Maryland*, *supra note* 54.

Figure 6-2: Earthquakes in Maryland Since 1758[56]



Maryland specific seismic risk maps are available from the Maryland Geological Survey and can be used to conduct a risk assessment of earthquake hazards. These maps are based on either relative risk or probability of a "certain seismic event at a particular time and place."[57] Figure 6-3 is a historical map of earthquakes in the State for the last 250 years. Figure 6-3 displays a "relative risk of damage, based to a large extent on known earthquake history." Figure 6-4 is a probabilistic risk map showing maximum horizontal ground acceleration with a 90 percent probability of not being exceeded in 50 years. The relative risk map:

> . . . is based on the known occurrence of damaging earthquakes in the past, evidence of strain release, and consideration of major geologic structures and provinces believed to be associated with earthquake activity. For years, this map was widely used, because it was the best risk map available. However, this type of risk map has several drawbacks. For one thing, it does not consider frequency of occurrence. Furthermore, there is no justification for assuming that events larger than those observed historically, especially in the East, will not occur in the future. It is also known that ground-motion attenuation ("dying out" of the shock waves) with distance is far less in the eastern U.S. than in the western states. Felt areas are, in general, one order of magnitude greater in the East than for similar earthquakes in the West. Nonetheless, according to this map, Maryland is appropriately placed into a zone of minor expected damage, corresponding to Mercalli intensity V to VI. . . . [58]

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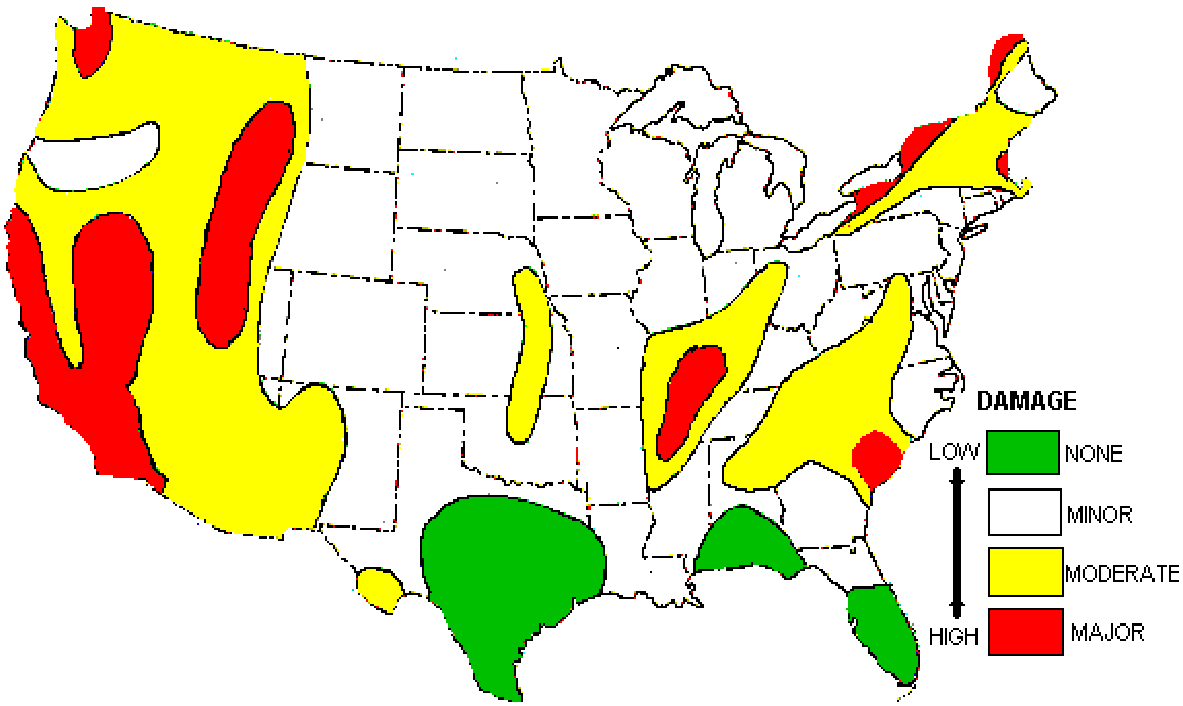
[56] *Earthquakes and Maryland*, *supra note* 54.
[57] *Earthquakes and Maryland*, *supra note* 54.
[58] *Earthquakes and Maryland*, *supra note* 54.

Figure 6-3: United States Earthquake Map, Relative Risk of Damage

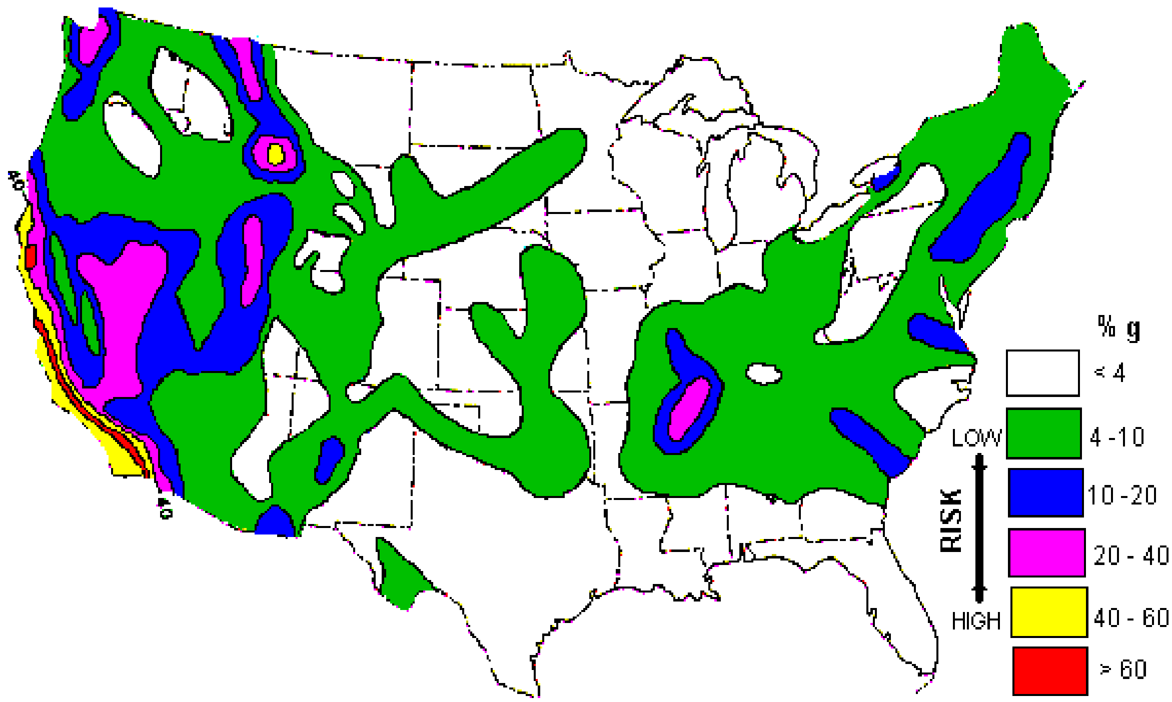


In contrast, the probabilistic risk map, Figure 6-4 shows:

> . . . the expected maximum horizontal ground acceleration (as a percentage of g, the acceleration due to gravity, 32.2 ft/sec^2) on rock sites. These ground accelerations, which are one measure of ground shaking, have a 90-percent probability of not being exceeded in 50 years . . . . Damage begins to occur at about 10-15% g. Below 4% g, which is the lowest contour on this map, shaking effects are controlled by earthquakes of magnitude 4.0 or less in other words, minor earthquakes . . . . According to Figure [6-] 4, Maryland has a very low chance of experiencing a damaging earthquake in a 50-year period. For moderate exposure times (10-100 years), the expected ground motion associated with earthquakes in this region would be of marginal interest . . . . The difficulty in assigning maximum magnitudes is most acute where no faults are known, where seismicity is low, and where near-maximum earthquakes may not have occurred in historical times. This is true for most of the eastern United States.[59]

[59] *Earthquakes and Maryland*, *supra note* 54.

Figure 6-4: United States Earthquake Map, Probabilistic Map



Though earthquakes can cause severe damage to energy infrastructure, Maryland's risk of a high-magnitude earthquake is relatively low based on current available data. Still, the possibility of a severe earthquake exceeding historical levels exists.

(For additional information on events impacting Maryland, see the Historical Events Chart beginning on the following page.)

Historical Events Chart

Event	Impacts	Restoration Time	SEOC Level	Agency Staffing[60]
2011-Hurricane Irene	Over one million electrical outages centered in BGE, Pepco and SMECO service territories (Table 1, page 10). Unit I reactor at Calvert Cliffs is shut down due to windblown debris. Curtis Bay petroleum facility is without power for 3 days.	Impacts begin on Saturday evening, August 27. Maximum outages occur between 2:00 AM and 8:30 AM Sunday, August 28. Restoration for Pepco is complete by Thursday afternoon, and BGE is restored by Sunday morning September 4.	Activated Level 3	DoIT, PSC, MEA (remotely), MEIMSS, DHMH, DMIL, Fire Desk, DHR, DNR, DGS, GOHS, MDOT, MSP, and MdTAP, SHA, MTAP, USCG, C.A.P., Dept. of Agriculture, MDE, OSFM, DOA, ARC, VOAD, Army Corp of Engineers, RACES, ARMY MARS
2010 - Twin Snow Storms	Approximately 150,000 electrical outages (heating and transportation fuels did not experience state-wide shortage) -*PEPCO*, 3,735,072 hours system-wide and 3,591,156 hours in Maryland; -*Allegheny Power* 110,002 hours;[61] and -*BGE,* 1,145,347 hours. Nearly 5 million interruption hours across Maryland	All major storm-related interruptions were restored soon after the storms: Allegheny Power restored full service to consumers by February 9th,[62] BGE restored full service to consumers by February 10th,[63] and PEPCO restored full service to Maryland consumers by February 12th.[64]	Activated – Level 3	MDOT MSP DNR DMIL MDTAP DGS SHA MFCA (Fire Desk) DHMH DHR MTA-Police PSC and MEA did not staff SEOC

[60] Source: WebEOC Incident Logs. Partial activation of the SEOC, such as a Level 3 activation, means that depending on the nature of the emergency different departments and agencies will be notified and summoned to the SEOC. Because each activation is different, it is difficult to tell which departments or agencies were present at a given time.
[61] *Allegheny Power Report re Case No. 9220, supra note* 36.
[62] *Allegheny Power Report re Case No. 9220, supra note* 36.
[63] *BGE Major Storm Report*, *supra note* 34.
[64] *Pepco State of Maryland Major Storm Report*, *supra note* 35.

2006 - Hurricanes Katrina and Rita	Colonial Pipeline disruption and stoppage of oil flow from gulf; stoppage of natural gas production and estimated 40% increase in prices	1 week - approximately 5 billion cubic feet (Bcf) of natural gas production per day was curtailed and prices rose 50 percent, from $ 10 to $ 15 per one million British thermal units (MMBtu)	Activated – Level 3	Unknown
2003 - Hurricane Isabel	$410 million in damage; 2 million Mid-Atlantic elect. customers w/o power, 790,000 from BGE and 395,000 from PEPCO;	Eight days after Hurricane Isabel made landfall, BGE restored service to the remaining customers affected by the outage who had not also experienced flood damage. PEPCO restored full service to its customers within ten days of Isabel's landfall	Activated – Level 3	MEA staffed SEOC according to veteran MEA staff Other agency staffing unknown
Geomagnetic Event March 13, 1989 in eastern Canada	Caused extensive damage to equipment on the Hydro Quebec system which led to further damage and blackouts in Canada and the Northeast U.S.	Some of the damaged parts from this event took six weeks to replace[65].	Activation unknown	Unknown
1972 – Hurricane Agnes	$62 million in damage, 21 deaths		MEMA was not in existence at the time; MD Civil Defense was its predecessor and probably did not "activate."	

[65] *Weather and Environmental Emergencies Training*, *supra note* 52.

Ongoing Energy Events - Natural Gas Disruptions

Design differences between the distribution systems of natural gas and electricity lead to fewer disruptions in the delivery of natural gas. Natural gas delivery systems are mainly buried underground and in the event of an accidental rupture have multiple pipeline interconnection rerouting capabilities. The requirement that contractors check for pipelines prior to digging reduces, but does not eliminate, the likelihood of pipeline ruptures. Problems with the natural gas system generally develop over time, thus allowing more opportunity to facilitate repairs and prevent ruptures.[66] An accidental total loss of gas supply from a major pipeline can take weeks or months to restore. Crews must purge air from the entire system, re-pressurize the pipes and manually restore service to all customers that have been shut off. A loss of gas during winter poses a serious and immediate threat to public health. Additionally, a break in a natural gas pipeline makes the system susceptible to fires and explosions.[67]

Maryland imports almost all of its natural gas. The State must remain cognizant of natural gas supply disruptions along its entire supply chain; including gas piped in from the Gulf of Mexico, and liquefied natural gas (LNG) supply routes originating in Europe, Africa and the Caribbean. (For additional information on Maryland's natural gas supply see Chapter 2.)

Electricity Disruption

Some natural gas compressor stations rely on electricity to function and a disruption in electricity supply affects the natural gas pipeline delivery system. Many electric peaking plants that supply electricity during high demand periods rely on natural gas as a fuel. When power is disrupted to natural gas compressor stations, a feedback loop is created. Compressor stations overcome this feedback loop by having backup generators available to substitute for grid electricity.

Shortage of Supply and Interruptible Service

Gas utilities doing business in Maryland file annual capacity procurement plans with the Maryland Public Service Commission (PSC). PSC reviews the capacity plans to assure adequate storage capacity for the State.[68] In unlikely events, such as intense or prolonged cold spells, natural gas demand may exceed the system's capacity. When the possibility of a shortage is looming, gas utilities execute State-approved contingency plans and curtail supply to "interruptible service customers," who are usually large commercial consumers with access to alternative fuel sources. During severe shortage situations, supply to additional customers or areas is curtailed according to a pre-approved hierarchy[69] to ensure the continued operation of essential services provided by homes, schools, and hospitals. (See Chapter 5 for details on contingency and curtailment plans.)

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[66] National Association of State Energy Officials, *State Energy Assurance Guidelines: Version 3.1*. 56 (2009) [hereinafter *NASEO State Energy Assurance Guidelines*, *available at* http://www.naseo.org/eaguidelines/.

[67] *NASEO State Energy Assurance Guidelines*, *supra note* 66, at 56.

[68] Maryland Public Service Commission, *Commission Reports available at* http://webapp.psc.state.md.us/Intranet/psc/Reports_new.cfm.

[69] Utilities file contingency plans with PSC, which include targeted curtailments consistent with PSC-approved curtailment tariffs.

The natural gas system must keep up with constantly changing demand. Population growth, economic growth, and structural changes are factors that affect volume and distribution of base demand. Climate variability affects the frequency and intensity of peak demand. Gas utilities must demonstrate to PSC that their systems can adapt to demand trends five years into the future, and must contract or construct sufficient base and peak storage capacity and transmission capacity to meet future demand.

Factors that require capacity expansion also create barriers to capacity expansion. When population growth creates competing land uses, sighting natural gas facilities in or around densely populated areas is difficult and controversial. Additionally, in its 2010 annual report, WGL warned:

> Washington Gas needs to acquire additional capacity to deliver natural gas on the coldest days of the year and it may not receive the necessary authorizations to do so in a timely manner. Washington Gas plans to construct a one billion cubic foot liquefied natural gas (LNG) storage facility in Chillum, Maryland, to meet its customers' forecasted demand for natural gas. The new storage facility is expected to be completed and in service by the 2015-2016 winter heating season. If [it] is not permitted or not able to construct this planned facility on a timely basis (…), the availability of the next best alternative (which is to acquire additional interstate pipeline transportation or storage capacity) may be limited by market supply and demand, and the timing of Washington Gas's participation in new interstate pipeline construction projects. This could cause an interruption in Washington Gas's ability to satisfy the needs of some of its customers.

Ongoing Energy Events - Oil and Gasoline Disruptions

Rising Cost of Gasoline and Oil

Oil and gasoline are subject to market dynamics, which include increasing demand from developing countries, changes in available supply as stimulated by OPEC, and geopolitical events such as the 2011 Libyan civil war. The past twelve years have demonstrated an unprecedented increase in U.S. gasoline prices. Brief spikes in gasoline prices have occurred due to specific events such as the September 11, 2001, terrorist attacks, the Iraq War and Hurricane Katrina. In July 2008, gasoline prices exceeded $4.00/gallon in nominal value. In response, drivers reported adjusting their travel behavior by driving less, using public transportation and shifting to more fuel-efficient vehicles. In April 2011, gasoline prices in many urban areas surpassed the $4.00/gallon mark again.[70] Though average consumers witnessed fluctuating prices from 2006 to 2010, WMATA noted no material increase in ridership.

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[70] *See* Catharine Schaidle, *Drivers Changing Habits, Vehicles As Gas Prices Rise*, JOURNAL STAR (2011) [hereinafter *Drivers Changing Habits*], *available at* http://www.istockanalyst.com/business/news/5094524/drivers-changing-habits-vehicles-as-gas-prices-rise. *See also* Andrew M. Seder, *The Fear of Going Over Four Dollars*, TIMES LEADER (2011) [hereinafter *The Fear of Going Over Four Dollars*], *available at* http://www.timesleader.com/news/The_fear_of_going_over_four_dollars_05-01-2011.html; *See also* John Burgeson, *Motorists Seek Relief As Gas Soars Above $4 Per Gallon*, GREENWICHTIME.COM (2011) [hereinafter *Motorists Seek Relief As Gas Soars Above $4 Per Gallon*], *available at* http://www.greenwichtime.com/local/article/Motorists-seek-relief-as-gas-soars-above-4-per-1357454.php.

In theory, an increase in gasoline prices has three main impacts on the transportation system.[71] Higher gas prices increase:

- the cost of driving, which should induce a shift from personal automobile use to public transit;[72]
- the demand for alternative modes of transportation such as biking and walking; and
- fare revenues to mass transit from the increase in ridership.[73]

In reality, however, the magnitude of travel mode shift, reduction in automobile traffic and increase in transit ridership in relation to gasoline price increases are a function of many different factors, including regional economy, socio-economic demographics of population, travel patterns (trip origins and destinations, and time of travel), availability of viable alternative modes of travel and relative costs and level of convenience of alternative travel modes. Therefore, the effect of gasoline price changes on transit ridership must be examined in a larger context, taking into account the factors above.[74]

In its simplest form, the price elasticity of demand—the percentage change in the quantity of gasoline demanded divided by the percentage change in the price of gas—is used to assess the extent of the response to rising gasoline prices. The price elasticity of demand depends on the availability of substitutes, the share of consumers' budgets spent on gas, and how long prices remain high. Gasoline has a limited number of substitutes and does not represent a large share of consumer budgets (in a range of 3.5 to 4.9 percent across all income groups),[75] making the overall price elasticity of demand generally low, however, lower income households directly feel the budgetary impact resulting from an increase in motor fuel expenses. Generally, the price elasticity of demand for gasoline increases over time, as consumers gradually adjust their driving behavior.

In practical terms, when the price of gasoline goes up by 10%, two results have been observed:

- The volume of traffic goes down by about 1% within about a year, increasing to a reduction of about 3% in about five years.
- The amount of gasoline consumed will go down by about 2% in a year, increasing to a greater than 5% reduction over time.

Heating oil prices are subject to the same upstream dynamics, as they closely follow crude oil prices (see Table 6-2). Short-run factors that can cause divergences from this correlation include: supply shortages resulting from refinery outages, transportation issues, adverse weather conditions and pipeline problems.[76] EIA only publishes heating oil price updates during the heating season from October to March. At the end of the 2010-2011 heating season, the price of heating oil had risen to $3.88 per

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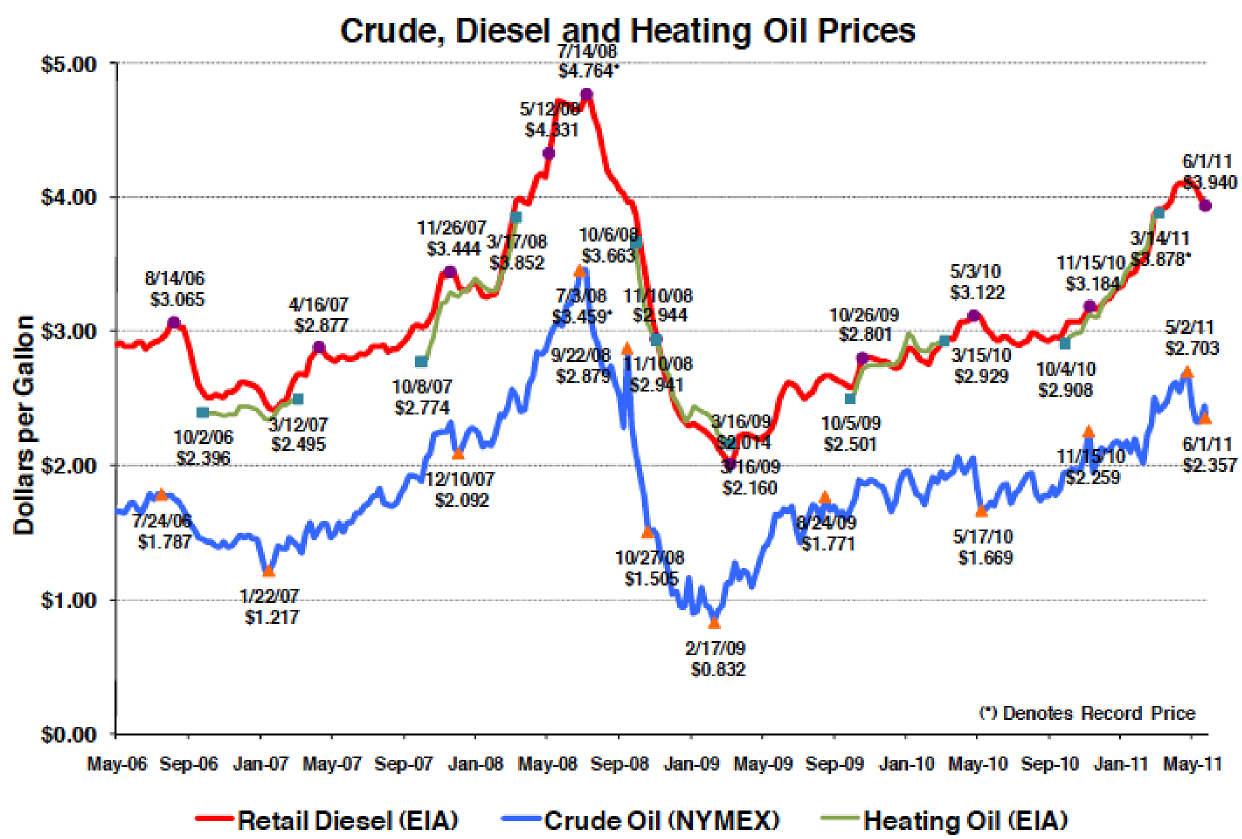
[71] Johan Holmgren, *Meta-analysis of Public Transport Demand*, 41 TRANSPORTATION RESEARCH PART A: POLICY AND PRACTICE 1021, 1021-1035 (2007) [hereinafter *Meta-analysis of Public Transport Demand*].
[72] *Meta-analysis of Public Transport Demand*, *supra note* 71.
[73] *Meta-analysis of Public Transport Demand*, *supra note* 71.
[74] B.D. Taylor et al., *Nature And/Or Nurture: Analyzing The Determinants of Transit Ridership Across US Urbanized Areas* 43 TRANSPORTATION RESEARCH PART A: POLICY AND PRACTICE 60, 60-77 (2009).
[75] Bureau of Labor Statistics, U.S. Department of Labor, *Table 2. Income Before Taxes: Average annual Expenditures and Characteristics, Consumer Expenditure Survey* (2010) [hereinafter *Table 2. Income Before Taxes*], *available at* http://www.bls.gov/cex/2010/Standard/income.pdf.
[76] American Petroleum Institute, *U.S. Distillate Fuel Oil Update* (2011) [hereinafter *U.S. Distillate Fuel Oil Update*].

gallon. At the beginning of the 2011-2012 season, nationally, residential heating fuel prices averaged $3.68/gallon for No. 2 heating oil and $2.76/gallon for propane.[77]

Table 6-2 Crude Oil, Retail Diesel and Heating Oil spot price history[78]



Elasticity of Transit Ridership to Gasoline Prices

The effect of gasoline prices on transit ridership depends on the cross-price elasticity of demand between gasoline and transit ridership. Cross-price elasticity is defined as the ratio of a percentage increase in transit ridership to a percentage increase in gasoline prices. For example, if the current gas price and transit ridership in one region are $3.80 and 39,000 people a day, and these numbers increase to $4.20 and 41,000, respectively, elasticity is 0.5[=((41,000-39,000)/(39,000+41,000)) / (($4.20-$3.80)/($3.80+$4.20))]. In other words, a 10 percent increase in gas prices induces a 5 percent increase in transit ridership.

In general, inelastic cross-elasticity of ridership to gasoline price generally ranges from 0.1 to 0.5. Cross elasticity varies based on: (1) modes, (2) cities, metropolitan areas, city sizes, locations within metropolitan areas (urban, suburban and rural), (3) trip purposes, and (4) short- and long-term effects.

[77] U.S. Energy Information Administration, *Heating Oil and Propane Update* (Jan. 19, 2012) [hereinafter *Heating Oil and Propane Update*], *available at* http://www.eia.gov/petroleum/heatingoilpropane/ (last visited Jan. 22, 2012).
[78] American Petroleum Institute, *U.S. Distillate Fuel Oil Update* (June 8, 2011).

The table below reports the following price elasticities of demand for transit ridership:[79]

Table 6-3: Elasticity of Demand for Transit Ridership

	Market Segment	Short Term	Long Term
Transit Ridership with regard to transit fares	Overall	-0.2 to -0.5	-0.6 to -0.9
Transit Ridership with regard to transit fares	Peak	-0.15 to -0.3	-0.4 to -0.6
Transit Ridership with regard to transit fares	Off-peak	-0.3 to -0.6	-0.8 to -1.0
Transit Ridership with regard to transit fares	Suburban Commut	-0.3 to -0.6	-0.8 to -1.0
Transit Ridership with regard to transit service	Overall	0.5 to 0.7	0.7 to 1.1
Transit Ridership with regard to auto operating costs	Overall	0.05 to 0.15	0.2 to 0.4
Automobile Travel with regard to transit costs	Overall	0.03 to 0.1	0.15 to 0.3

In a short-term gas-supply emergency, price elasticities and cross-price elasticities—and therefore consumer responses—are difficult to predict. As demonstrated by the oil shocks in the 1970's, gas prices escalate rapidly when supplies diminish. Although the State is not allowed by statute to undertake any rationing or set-aside actions based solely on price, the supply shortage—an original cause of gas price hikes—leads to an emergency. In such an emergency, policy makers may have to adopt alternative rationing systems—such as odd-even license plate plan to curtail demand.

Ongoing Energy Events - Electricity

Disruptions in Electricity Distribution (Electricity Outages)

Temporary electricity outages are most often located in the distribution portion of electric supply. Most short-lived electricity outages in Maryland occur as a result of weather effects, including high winds, snow accumulation, and lightning strikes; which lead to fallen trees and limbs that cause electricity distribution failures. Outages due to the vulnerability of overhead distribution lines to storm-damaged trees are an ongoing concern to the PSC and the State's utilities. Power supply outages vary geographically, by number of customers impacted and by the average duration of an outage. The average frequency and duration of Maryland system-wide electricity outages can be measured via the System Average Interruption Frequency Index (SAIFI) (Table 6-4 and Table 6-5 on the following page).

[79] Todd Litman, Victoria Transport Policy Institute 2011, *Transit Price Elasticities and Cross-Elasticities* (2011).

Table 6-4: Five-year, System-wide SAIFI (All Weather Included) Average Number of Sustained Power Interruptions per Customer[80]

	Potomac Edison	BGE	Choptank	DPL	PEPCO	SMECO
2005	1.23	1.56	2.38	2.07	2.01	.97
2006	1.28	1.93	1.93	2.57	2.61	.72
2007	1.22	1.64	2.04	2.29	2.23	1.63
2008	1.33	1.83	2.69	2.47	2.85	1.95
2009	.97	1.28	2.13	2.07	2.06	1.64

Table 6-5: Five-year, System-Wide SAIDI (All Weather Included) Average Duration (in Hours) of Sustained Power Outage per Customer[81]

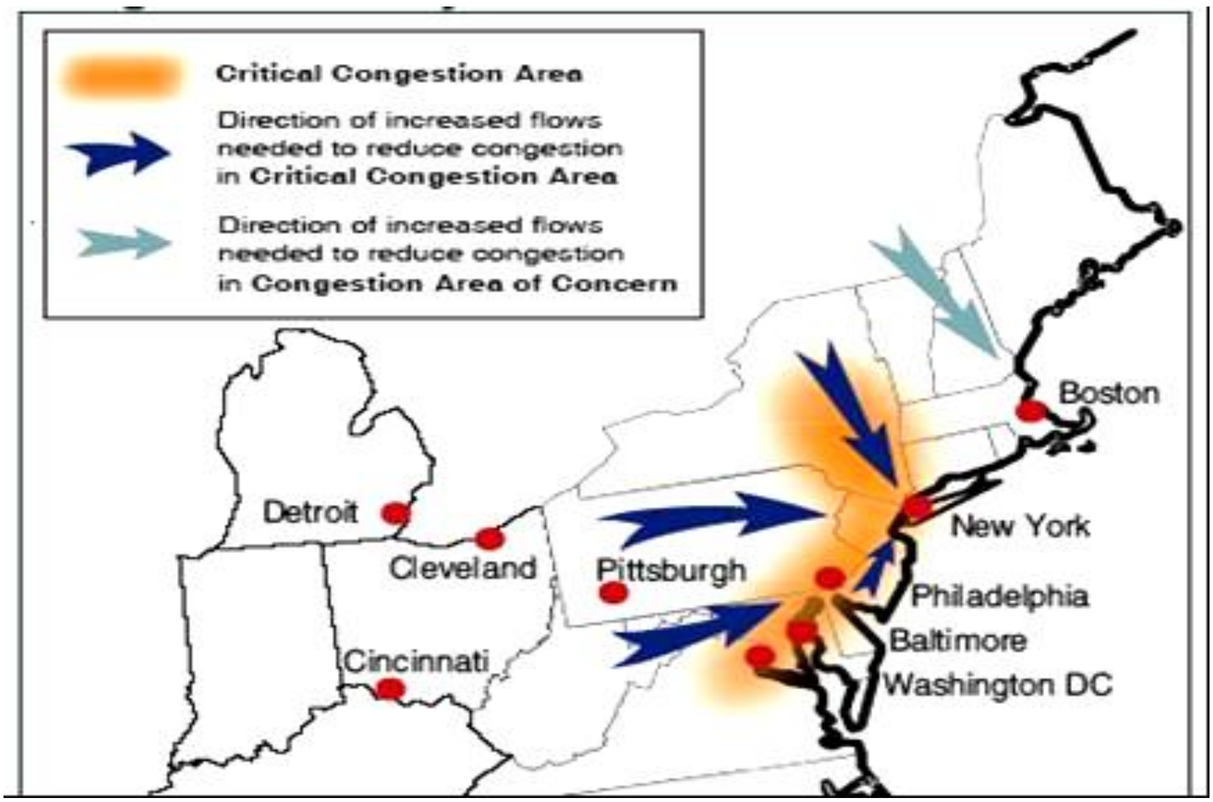
	Potomac Edison	BGE	Choptank	DPL	PEPCO	SMECO
2005	6.47	4.02	4.27	4.35	7.15	2.02
2006	3.92	8.00	4.42	10.20	9.95	2.35
2007	5.30	5.87	3.49	5.17	5.97	6.73
2008	5.63	6.40	5.90	6.52	11.82	5.42
2009	3.02	3.60	3.20	5.18	3.42	4.46

Electricity Congestion

Portions of Maryland lie in a national interest electric transmission corridor, which is a geographic area that has historically experienced capacity constraints or congestion (see Figure 6-5). Transmission congestion is defined as "the condition that occurs when transmission capacity in a specific location is not sufficient to enable safe delivery of all scheduled or desired wholesale electricity transfers simultaneously."[82] The consequence of congestion is a failure to deliver the least expensive available energy and the subsequent creation of new consumer costs. In 2008, PJM-wide congestion costs totaled $2.12 billion or about 6 percent of total electricity billings.[83]

[80] Email from James Boone, Maryland Public Service Commission to Sean Williamson, Center for Integrative Environmental Research (Apr. 29, 2011) (on file with author) [hereinafter *Email from James Boone*].
[81] *Email from James Boone*, *supra note* 80.
[82] U.S. Energy Information Administration, *Glossary* (n.d.) [hereinafter *EIA Glossary*], *available at* http://www.eia.gov/tools/glossary/index.cfm?id=C (last visited Jan. 22, 2012).
[83] Monitoring Analytics, *2008 State of the Market Report for PJM* (2009) [hereinafter *2008 State of the Market Report for PJM*], *available at http://www.monitoringanalytics.com/reports/PJM_State_of_the_Market/2008/2008-som-pjm-volume2.pdf*.

Figure 6-5: Mid-Atlantic Critical Congestion Area[84]



The costs of electricity congestion vary both daily and seasonally. Moreover, the location of congestion differs depending on new transmission line development, local weather conditions, and long-term changes in the proximity of generation capacity and load demand. In 2009, PJM estimated that 90 percent of regional congestion costs could be eliminated with the development of five major backbone lines in the region, including two in Maryland: the Mid-Atlantic Power Pathway (MAPP), and the TrAIL lines. Proposed construction of a third line, the Potomac Appalachian Transmission Highline (PATH), was suspended as of February 2011.[85]

[84] U.S. Department of Energy, *National Electric Transmission Congestion Study* (2009), *available at http://congestion09.anl.gov/documents/docs/Congestion_Study_2009.pdf*.

[85] Press Release, Potomac-Appalachian Transmission Highline, *PATH Seeks to Withdraw Application for Electric Transmission Project: Regional Grid Operator Directs Suspension of PATH Project* (2011) [hereinafter *PATH Seeks to Withdraw Application for Electric Transmission Project*], *available at* http://www.pathtransmission.com/.

Ongoing Energy Events - Marketplace

Supply Chain Dependency

Maryland is a net importer of electricity and primary fuels, and as such is susceptible to socioeconomic, labor and political events that may arise in locations that provide energy to the State.

- Maryland imports approximately 30 percent of its electricity from surrounding states.[86]
- Maryland is home to one of the nation's nine liquefied natural gas (LNG) import terminals at Cove Point, which primarily receives natural gas from Trinidad, Tobago, Egypt and Norway.[87]
- Coal is shipped to Maryland primarily from West Virginia and Pennsylvania; Kentucky, Columbia, Maryland and Wyoming are secondary sources for coal.[88]
- Natural gas is delivered through several pipelines from the Gulf Coast.[89]
- Refined transportation fuels are delivered through the Colonial Pipeline, shipped by barge and transported by rail and truck.
- Home heating oil is delivered from the Gulf Coast via the Colonial Pipeline and is also shipped by sea from Canada, Venezuela and the Virgin Islands. It is then deposited in Northeast storage and distribution facilities.
- Propane is 85-90 percent domestic. 10-15 percent is imported from Canada by rail or pipe, or arrives from overseas at waterborne import terminals. About half of all propane is produced from crude oil in refineries and half from natural gas in fractionation plants. Distribution supply points include waterborne import terminals, major storage and pipeline terminal facilities, refineries (in New Jersey and Delaware) and rail terminals. From these supply points, trucks transport propane to local dealer bulk plants, and then again to end user tanks.

Nearly 60 percent of the electricity generated in Maryland is produced by burning coal. In 2009, 2.3 million short tons of coal were mined in Maryland compared to 107 million in Kentucky and 137 million in West Virginia.[90] Maryland is a net importer of coal. In 2008, just 6.5 percent of the coal used to generate electricity in Maryland actually originated in Maryland; the Warrior Run electricity generating facility primarily depends on Maryland coal.[91] Accordingly, a natural or human-made catastrophic event along the coal supply route to Maryland or at sources of production (e.g., Pennsylvania, Kentucky and

[86]Maryland Energy Administration, *Energy 101* (n.d.) [hereinafter *MEA Energy 101*], *available at* http://energy.maryland.gov/energy101/index.html (last visited Jan. 22, 2012).

[87] Institute for Energy Research, *Maryland Energy Facts* (n.d.) [hereinafter *Maryland Energy Facts*], *available at* http://www.instituteforenergyresearch.org/state-regs/pdf/Maryland.pdf.

[88] Maryland Power Plant Research Program, Maryland Department of Natural Resources, *Power Plants and the Environment CEIR-15: Chapter 2 - Power Generation, Transmission, and Use* (2010) [hereinafter *Power Generation, Transmission, and Use*], *available at* http://esm.versar.com/pprp/ceir15/CEIR15_Chap2.pdf/ceir15/ Report_2_1_1.htm.

[89] Maryland Energy Facts, Institute for Energy Research, *available at* http://www.instituteforenergy research.org/state-regs/pdf/Maryland.pdf.

[90] U.S. Energy Information Administration, *Coal Production and Number of Mines by State and Mine Type* (2010) [hereinafter *Coal Production and Number of Mines*], *available at* http://www.eia.gov/cneaf/coal/page/ acr/table1.html (last visited Jan. 22, 2012).

[91] *Power Generation, Transmission, and Use*, *supra note* 88.

West Virginia), may adversely affect the delivery of coal used to generate electricity. Coal is typically transported by rail, which could be inhibited by inclement weather (e.g., snow storms), physical or cyber attacks or energy failures (e.g., electricity outages would prevent track signaling and communication). Furthermore, it should be emphasized that as a result of new air quality standards under Maryland's Healthy Air Act (HAA), it is expected that sub-bituminous coal, found in Wyoming and Montana, will be increasingly used to generate electricity in State.[92]

Maryland's two nuclear reactors at Calvert Cliffs provide 29 percent, or a total of 1,829 MW (megawatts) of the electricity produced in the State. Renewable resources, including hydroelectric plants, wind farms and solar cells contribute 6.6 percent, or roughly 900 MW of electricity generated inside Maryland. Maryland is included in the PJM system, which encompasses 13 states and the District of Columbia. Maryland electricity customers are supplied by the 163,000 MW of electricity capacity generated within PJM.[93]

Market and Political Impacts

In addition to supply and demand disruptions, market distortions, including excessive speculation and manipulation, can have a powerful effect on energy prices. The rates that Maryland customers pay for electricity are regulated by PSC. Utilities are allowed to recover the prudent costs of supplying electricity, and these costs are determined in-part by fuel prices. Fuels, including natural gas and oil, are particularly susceptible to speculation as regularly traded commodities. Gasoline or natural gas prices may respond to speculation relatively quickly (e.g., months) under fuel market mechanisms; wholesale and retail electricity rates are similarly responsive to increases in fuel costs, but over the long-term (e.g., 1-2 years).

Although most electricity is generated by coal and nuclear to meet regular demand or base load, natural gas and oil are often required to meet high demand or peak load. As the demand for electricity spikes the value of electricity increases, and it becomes increasingly economical for power plants with high fuel costs (e.g., oil and natural gas) to begin generating. These peak demand plants, or peaking plants, tend to follow fluctuating demand and add valuable reliability to the electricity market. However, because peaking plants rely on fuels more susceptible to price spikes and speculation, electricity rates are not immune from market-driven price increases. It should be noted that fuel prices are a single factor in determining electricity rates; customer load, seasonal variation, capital costs and ancillary costs, among other factors, contribute to electricity rates. Depending on the type of generating technology, the lifetime of that technology, and multiple other assumptions, the portion of fuel costs that contribute to electricity costs varies. One study estimates that fuel accounts for 45 percent of the cost for coal-fired generation, 73 percent of natural gas fired generation and 10 percent for nuclear generation. Electricity generation from solar and wind sources have zero fuel cost.[94]

[92] *Power Generation, Transmission, and Use*, *supra note* 88.
[93] *MEA Energy 101*, *supra note* 86.
[94] International Energy Agency, *et. al.*, *Projected Costs of Generating Electricity* (2005). Executive Summary *available at www.iea.org/textbase/npsum/ElecCostSUM.pdf.*

Because electricity rates are a function of so many factors and rates are overseen by PSC, changes in fuel prices driven by speculation are unlikely to drastically or immediately influence electricity rates. On the other hand, speculation can unmoor fuel prices from market fundamentals, which could impact the transportation sector or households dependent on heating fuels.[95] In essence, fuel prices are determined by a healthy tension between customers seeking low prices and high value and profit-seeking producers. Speculators, on the other hand, are not concerned with the fair market value of a commodity; rather, they want prices to move dramatically in the direction of their bets.[96] (See Chapter 2 for information on electricity deregulation in Maryland.)

The impact of speculation on oil pricing was evident between 2007 and 2009, when prices rose from $65 per barrel in June 2007 to $145 in July 2008 to $30 in the winter of 2008-09 and back to $60 and $70 in 2009.[97] Recently, with no fundamental underlying change in supply and demand, the price of crude oscillated from $73 per barrel in September 2010 to $119 in April 2011, an increase of over 63 percent.[98] According to International Energy Agency's Oil Market Report, during the third and fourth quarters of 2011, the world oil demand increased by 0.2 million barrels per day (mb/d)[99] and, notably, the world oil supply increased by 0.7 mb/d.[100]

While it is true that political destabilization within oil producing countries cause market "fears," speculators vastly amplify the price volatility by taking advantage of this "fear." For example, the recent surge in the oil price defies market fundamentals because Saudi Arabia, the largest world oil supplier, offered to "make up for supplies lost because of unrest in Libya."[101] The International Energy Agency agreed to "release emergency stockpiles, if needed."[102] These market and political disruptions, as noted

[95] Gerald P. O'Driscoll Jr., *The Fed Can't Solve Our Economic Woes*, WALL ST. J., Aug. 16, 2010, at A15.
[96] *See* Permanent Subcommittee on Investigations, U.S. Senate, *Excessive Speculation in the Wheat Market: Majority and Minority Staff Report* 152–57 (2009) [hereinafter *Excessive Speculation in the Wheat Market*]; *See* Permanent Subcommittee on Investigations, U.S. Senate, *Excessive Speculation in the Natural Gas Market* 29 (2007); Ke Tang & Wei Xiong, NBER Summer Institute Workshop on Capital Markets and the Economy, *Index Investing and the Financialization of Commodities* 2 (2009) [hereinafter *Index Investing and the Financialization of Commodities*], *available at* http://www.princeton.edu/~wxiong/papers/commodity.pdf.
[97] Ianthe Jeanne Dugan & Alistair MacDonald, *Traders Blamed for Oil Spike — CFTC Will Pin '08 Price Surge on Speculators, in a Reversal From Bush Findings*, WALL ST. J., July 28, 2009, at A1.
[98] *See* U.S. Energy Information Administration, *Petroleum & Other Liquids* (n.d.) [hereinafter *Petroleum & Other Liquids*], *available at* http://www.eia.gov/petroleum/index.cfm (last visited Jan. 22, 2012).
[99] *See* International Energy Agency, *Oil Market Report* (May 19, 2011) [*IEA Oil Market Report*], *available at* http://omrpublic.iea.org/World/Wb_all.pdf.
[100] *See Oil Mark Report*, *supra note* 99.
[101] Ben Sharples, *Oil Trades Near One-Week Low After Saudi Arabia Offers to Cover Supplies*, BLOOMBERG (Feb. 28, 2011) [hereinafter *Oil Trades Near One-Week Low After Saudi Arabia Offers to Cover Supplies*], *available at* http://www.bloomberg.com/news/2011-02-28/oil-trades-near-one-week-low-after-saudi-arabia-offers-to-make-up-supplies.html.
[102] *Oil Trades Near One-Week Low After Saudi Arabia Offers to Cover Supplies*, *supra note* 101.

by many economists and market watchers, cannot be fully explained by either market realties or fears, and can only be understood in the light of excessive speculation.[103]

The U.S. Energy Information Administration publishes a Short-Term Energy Outlook (see Chapter 7) which projects consumption, inventories, and production of oil, electricity, coal and natural gas. Additionally, the report outlines major uncertainties that may cause prices to move above or below their forecast. Uncertainties include political unrest, OPEC decisions and fiscal issues faced by governments across the world.[104] While these Short Term Energy Outlooks are beneficial to a certain extent, there is a high level of uncertainty in predicting market and political factors.

Electric Vehicles (hybrid-electric or electric only)

Volatile and increasing gasoline prices have pushed consumers and automobile manufacturers towards more efficient gas only and hybrid-electric vehicles. Electric vehicles (hybrid or electric only) are a growing market in Maryland. With future technological improvements in battery technology, electric vehicles may become a viable alternative to gasoline vehicles not just for intra-city travel but also for inter-city travel. In May 2011, the Maryland General Assembly and Governor approved the formation of the Maryland Electric Vehicle Council, which will have responsibilities for overseeing the development of electric vehicle infrastructure in the State.[105] The emergence of electric vehicles in Maryland will result in more electricity consumption and load demand. Charging a plug-in hybrid electric vehicle with 5–10 kWh of useable battery capacity once a day could add an additional 21–43 percent (2,200-4,600 kWh) of the 11,000 kWh annual consumption of a typical U.S. household, a consumption level comparable to the average annual use of central air conditioning.[106] (One study in the UK found that the national power grid capacity would be adequate for up to 10 percent market penetration of electric vehicles in the short and medium terms.)[107]

Charging electric vehicles during periods of peak demand would strain the electricity system. However, the impact of increased demand on the electric grid can be mitigated by treating electric vehicle batteries as small power stations. If managed intelligently, electric vehicles can actually improve reliability by controlling charging and discharging to match supply and demand in the entire grid system. Furthermore, development of a smart grid will facilitate the introduction of electric vehicles by improving the return on investment. This will be accomplished through vehicle-to-grid electricity flows as directed by the smart grid communication infrastructure; the financial incentive for electric vehicle owners to make their batteries available for grid withdrawal could be lucrative, particularly if real-time

[103] Commodity Markets Oversight Coalition, *Evidence of the Impact of Commodity Speculation by Academics* (2011), *available at* http://www.nefiactioncenter.com/PDF/evidenceonimpactofcommodityspeculation.pdf.
[104] U.S. Energy Information Administration, *Short Term Energy Outlook* (n.d.) [hereinafter *Short Term Energy Outlook*], *available at* http://www.eia.gov/emeu/steo/pub/contents.html#Overview (last visited Jan. 22, 2012).
[105] S.B. 176, 2011 Reg. Leg. Sess. (Md. 2011), *available at* http://mlis.state.md.us/2011rs/billfile/sb0176.htm.
[106] Christopher Yang & Ryan W. McCarthy, Environmental Management, *Electricity Grid: Impacts of Plug-In Electric Vehicle Charging* 16 – 20 (2009) [hereinafter *Electricity Grid*].
[107] A. Harris, *Charge of the Electric Car*, 4 INSTITUTE OF ENGINEERING AND TECHNOLOGY 52, 52-53, (2009) [hereinafter *Charge of the Electric Car*].

pricing schemes are established. A large-scale system incorporating one million plus electric vehicles and a smart grid is not expected in the United States until at least 2020.[108]

Ongoing Energy Events - Climate Change

Today, energy issues are inseparably linked to climate change concerns. Over the coming decades, Maryland will face temperature, sea level and other weather changes as a result of increasing carbon dioxide concentrations in the lower atmosphere. As a coastal State with 7,000 miles of shoreline, Maryland will experience the effects of sea rise as oceans warm and Polar Regions melt. These physical changes are likely to impact all segments of the State's economy. The production of fossil fuel based energy is a source of atmospheric carbon dioxide which leads to climate change, and the provision and need for energy will be altered as a result of increasing levels of carbon dioxide in the atmosphere. Maryland is in the beginning stage of planning for these physical changes. The Maryland Climate Action Plan (CAP), which contains both GHG mitigation and adaptation measures, addresses energy use in the State. The CAP recognizes that reducing energy use, and promoting substitutes for high carbon fuels, will help to forestall some effects of climate change while creating a more resilient energy sector.[109]

Rising Temperatures and Climate Change

Climate change, coupled with an increasing demand for energy, will complicate the task of reliably achieving the State's energy capacity needs. Maryland's average annual temperature has increased about 2° F (1° C) since 1900. Average yearly temperatures are expected to increase by 3-6° F (2-4° C) in the winter and by 4-8° F (2.2-4.4°C) in the summer by 2100.[110] Higher winter temperatures will reduce the demand for heating fuels during winter months. However, more frequent and longer-lasting heat waves in summers, accompanied by higher peak temperatures will increase the need for peak electric power generation; which currently relies on natural gas, and other fossil fuels. Additionally, the availability of water will shift along with precipitation, snowmelt, and increased average summer water temperatures. Electric generating facilities requiring water as a coolant may find that they need more water than is readily available, and that they will need to compete with municipalities and agriculture for the remaining supply.

Sea Level Rise and Storm Surges

There is an increasing threat to coastal energy infrastructure due to sea level rise and heightened storm surges. The 20th century saw the Mid-Atlantic region experience a 12-20 percent increase in major weather events from the previous century. The sea level along the Maryland coastline rose at the average rate of 3-4 mm/year (0.14 inch/year) over the last century – nearly twice the global average of 2

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108 K. Galbraith, *Electric Cars and a Smarter Grid*, N.Y. TIMES, February 17, 2009 [hereinafter *Electric Cars and a Smarter Grid*], *available at* http://green.blogs.nytimes.com/2009/02/17/electric-cars-and-a-smarter-grid/.
109 Maryland Department of the Environment, *Maryland Climate Action Plan* (2012) [hereinafter *Maryland Climate Action Plan*], *available at* http://www.mdclimatechange.us/ (last visited Jan. 22, 2012).
110 Center for Integrative Environmental Research, *Climate Change Impacts on Maryland and the Cost of Inaction* (2008) [hereinafter *Climate Change Impacts on Maryland and the Cost of Inaction*].

mm/year (0.08 inch/year).[111] The aforementioned trends are predicted to continue or worsen if climate change continues unabated, possibly adding 1.3 feet by mid-century.[112] If these predictions prove accurate, Maryland can expect significant coastal impacts. Major coastal storms will be more intense and more frequent. By the century's end, there will be an increase of 5-15 percent of late-winter storms in the Northeast as storm systems move further north in response to warmer ocean surface temperatures.[113] An increase in major storms will only exacerbate energy disruptions already being experienced as a result of weather.

Along the Maryland coast, natural gas infrastructure includes the Dominion Cove Point liquefied natural gas (LNG) terminal and BGE's Spring Garden LNG peaking facility, located at the lowest point in Baltimore.[114] Changing weather patterns and rising sea levels will likely affect LNG shipping routes; offsetting Maryland's reliance on imported LNG from an expected increase of domestic gas supply from deep shale sources such as the Marcellus Shale.[115]

Out-of-state, upstream portions of Maryland's energy supply chain are more vulnerable to climate change impacts. Much of Maryland's oil and gas comes from the U.S. Gulf Coast region. The Global Change Research Program 2009 report *Climate Change Impacts on the United States* [116] explains the following climate change risks to upstream U.S. energy supply:

> The Gulf Coast is home to the U.S. oil and gas industries, representing nearly 30 percent of the nation's crude oil production and approximately 20 percent of its natural gas production. One-third of the national refining and processing capacity lies on coastal plains adjacent to the Gulf of Mexico. Several thousand offshore drilling platforms, dozens of refineries, and thousands of miles of pipelines are vulnerable to damage and disruption due to sea-level rise and the high winds and storm surge associated with hurricanes and other tropical storms. For example, hurricanes Katrina and Rita halted all oil and gas production from the Gulf, disrupted nearly 20 percent of the nation's refinery capacity, and closed many oil and gas pipelines. Relative sea-level rise in parts of the Gulf Coast region (Louisiana and East Texas) is projected to be as high as 2 to 4 feet by 2050 to 2100, due to the combination of global sea-level rise caused by warming oceans and melting ice and local land sinking. Combined with onshore and offshore

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[111] *Climate Change Impacts on Maryland and the Cost of Inaction*, *supra note* 110.

[112] Report of the Scientific and Technical Working Group of the Maryland Commission on Climate Change, University of Maryland Center for Environmental Science, *Global Warming and the Free State: Comprehensive Assessment of Climate Change Impacts in Maryland* (2008) [hereinafter *Global Warming and the Free State*].

[113] Global Change Research Program, Climate Impacts on the US, 2009 (2009) [hereinafter *Climate Impacts on the US*], *available at* http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf.

[114] *BGE Interview, supra note* 7.

[115] Geology.com, *Marcellus Shale - Appalachian Basin Natural Gas Play* (n.d.) [hereinafter *Marcellus Shale*], *available at* http://geology.com/articles/marcellus-shale.shtml.

[116] *Climate impacts on the US, supra note* 113.

storm activity, this would represent an increased threat to this regional energy infrastructure.[117]

The report indicates that “some adaptations to these risks are beginning to emerge.”[118]

Conclusion

Maryland is subject to potential energy disruptions caused by natural or human-made events. Some disruptions are very brief (e.g., downed power lines), while others are long-term (e.g., OPEC oil embargo). International political and market events outside Maryland’s control may also cause disruptions due to Maryland’s status as a net importer of energy supplies. Previous events may be the best indication of potential future disruptions, and may serve as a foundation for developing methods to prevent or mitigate the impact of such events.

[117] *Climate impacts on the US, supra note* 113, *at* 57.
[118] *Climate impacts on the US, supra note* 113, *at* 57.

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Chapter 7. Managing Information for Energy Assurance Planning

Introduction

Information about energy is constantly being exchanged between private firms and public agencies. Energy assurance planners must keep abreast of this information in order to anticipate disruptions of supply, and avoid their worst consequences. But separating useful information from superfluous data in such a complex, ever-changing, and far-reaching field can be a daunting task. Reports on energy facts and figures, and forecasts on local, regional, national and global energy trends are widespread. It is far too easy to get lost in a sea of data. Energy assurance planners must know where to find information on energy and must know which information is relevant, and which is superfluous. Planners must have access to a manageable overview and survey of the sources of information that impact energy assurance in Maryland.

Information gathered from the real-time monitoring of Maryland's energy supply and demand can forestall many energy emergencies, but State agencies are generally not equipped to continually monitor energy reserves and drawdowns in real time, so the responsibility falls to the private sector. Petroleum distributors, pipeline operators, and individual oil companies monitor the distribution of petroleum products in Maryland. The Mid-Atlantic Petroleum Distributors Association lists over 20 member distributors that service the State. Distributors, whose job involves moving petroleum from wholesale storage tanks to retailers, monitor local and regional supply on a daily basis, and increase reserves when severe weather is predicted.[1]

This chapter manages energy information by providing a reference list of essential information sources and published reports for the State. Energy information is generally recognized as falling into two broad categories, data and forecasts: data on what is currently in place, and forecasts on what may be, or should be, in place in the future. Chapter 7 points to several sources for both of these categories. Regularly updated reports that describe current conditions in the State can be used to supplement Chapter 2: "Maryland Energy Profile." Chapter 7 also provides sources that present energy forecasts to help energy assurance planners anticipate and plan for future scenarios. Specific reports are organized according to the authoring agency and each report is briefly described and includes a bulleted list of the report's central topics.[2]

[1] Telephone Interview with Tim Emge, Facility Security Officer, Cato Oil (May 27, 2011).

[2] Although private entities collect and analyze energy information, information concerning such collection efforts and analysis products is generally unavailable and, therefore, is not discussed in this document.

Maryland Public Service Commission (PSC)

http://webapp.psc.state.md.us/Intranet/home.cfm

The Maryland Public Service Commission (PSC) is an important resource when researching energy provision in Maryland. The PSC has two important functions in providing energy information: (1) making regulatory decisions publicly available and (2) collecting, compiling and analyzing data via formal summary and planning reports.[3] Regarding the former function, many of the decisions made by the PSC are never published in report form, instead appearing as individual orders and opinions, but the information may provide important insights for Maryland energy assurance. For example, the PSC presides over rate adjustment matters, promulgates rules and regulations related to the energy sector, and decides utility quality and common carrier service issues.[4] Such decisions could have a considerable impact on energy provision and must generally be considered when creating energy forecasts.[5] Case decisions made by the PSC are publicly available and may be found through the docket on the PSC's website.[6] Regarding the latter function above, the PSC compiles utility-provided information into regular reports including annual reports, ten-year plans, and renewable energy portfolio standard updates. Additionally, annual reports from electric service providers, which cover utility planning, may be found at the PSC website.[7] The PSC also publishes information at irregular intervals on special topics including updates on the status of electric restructuring, wind generation and consumer education.[8] Three PSC reports are particularly relevant to energy assurance:

Analysis of Resource and Policy Options for Maryland's Energy Future

http://efile.mpsc.state.mi.us/efile/docs/16000/0065.pdf

During consideration of regulations for the introduction of new technologies such as wind turbines, PSC engaged consulting companies in 2007 to study Maryland's long-range energy options. The resulting report presents eight case studies that analyze various issues, including:

- The benefits and potential risks of demand-side management (DSM);

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[3] Maryland Public Service Commission, *Background Information* (n.d.) [hereinafter *MPSC Background Information, available at* http://webapp.psc.state.md.us/Intranet/psc/GeneralInfo_new.cfm (last visited Jan. 30, 2012).

[4] *MPSC Background Information*, *supra note* 3.

[5] Reports and Orders may be found on PSC website at Maryland Public Service Commission, *Home Page* (n.d.) [hereinafter *MPSC Home Page*]*, available at* http://webapp.psc.state.md.us/Intranet/home.cfm (last visited Jan. 30, 2012).

[6] Maryland Public Service Commission, *Search Case Files* (n.d.) [hereinafter *MPSC Search Case Files*, *available at* http://webapp.psc.state.md.us/Intranet/Casenum/caseform_new.cfm? (last visited Jan. 30, 2012).

[7] Maryland Public Service Commission, *Utility Company Annual Reports* (n.d.) [hereinafter *MPSC Utility Company Annual Reports*], at http://webapp.psc.state.md.us/Intranet/utility/Utilityreport_new.cfm (last visited Jan. 30, 2012).

[8] Maryland Public Service Commission*, Commission Reports* (n.d) [hereinafter *MPSC Commission Reports*], *available at* http://webapp.psc.state.md.us/Intranet/psc/Reports_new.cfm (last visited Jan. 30, 2012).

- Energy conservation and efficiency initiatives that are consistent with the EmPOWER Maryland *15 by 15* initiative;[9]
- On- and off-shore wind power introduction;
- Solar energy options; and
- Long-term power purchase agreements.[10]

Some of the information provided in the *Analysis of Resource and Policy Options for Maryland's Energy Future* has been updated by the Maryland Energy Administration (MEA) in the *Maryland Energy Outlook of 2010*, discussed below.[11] PSC will publish future reports concerning long-range energy options.

Ten-Year Plans of Electric Companies in Maryland

http://webapp.psc.state.md.us/Intranet/psc/Reports_new.cfm

The *Ten Year Plan of Electric Companies*, published annually by PSC, projects service-area-specific electricity consumption and generation data and includes "long-range plans of Maryland electric utilities."[12] The plan discusses Maryland's energy market, how PSC works to promote reliability and specifically covers:

- Maryland peak demand load forecasts and projected "baseline load requirements";
- Forecasts of the availability of energy generation;
- Transmission issues that impact Maryland;
- Energy efficiency, conservation and demand response options for Maryland;
- Maryland's climate change goals through 2050, Maryland's role in the Regional Greenhouse Gas Initiative, and promotion of renewable energy options;
- Distribution reliability issues, past response efforts of utilities to power outages, and future plans to "meet load requirements";
- The Maryland Utility and Pennsylvania-New Jersey-Maryland Interconnection (PJM) zonal load and the regional and statewide influences that market rule changes have had on supply; and
- The influence of Federal Energy Regulatory Commission (FERC) rulings as well as Department of Energy (DOE) actions on supply and demand. [13]

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[9] The EmPOWER Maryland *15 by 15* initiative is Governor O'Malley's goal of reducing the state's peak energy consumption 15 percent by 2015.

[10] Levitan & Associates, Inc. & Haye Scholer LLP, *Analysis of Resource and Policy Options for Maryland's Energy Future* (2008) [hereinafter *Analysis of Resource and Policy Options for Maryland's Energy Future*], *available at* http://webapp.psc.state.md.us/Intranet/sitesearch/Levitan%20&%20Associates_Final%20Report_Analysis%20of20Resource%20and%20Policy%20Options%20for%20Maryland's%20Energy%20Future%20for%20the%20MD%20PSC.pdf.

[11] Maryland Energy Administration, *Maryland Energy Outlook* (2010) [hereinafter *MEA Energy Outlook*], *available at* http://www.energy.maryland.gov/documents/MEOFINALREPORTJAN2010.pdf.

[12] Public Service Commission of Maryland, *Ten Year Plan (2009-2018) of Electric Companies in Maryland* 1 (2010) [hereinafter *PSC Ten-Year Plan (2009-2018)*, *available at* http://webapp.psc.state.md.us/Intranet/Reports/2009-2018%20Ten%20Year%20Plan.pdf.

[13] *PSC Ten-Year Plan (2009-2018)*, *supra note* 12.

Renewable Energy Portfolio Standard Reports
http://webapp.psc.state.md.us/Intranet/psc/Reports_new.cfm

The *Renewable Energy Portfolio Standard Report* is another annual publication produced by PSC.[14] This report documents the compliance measures that electricity suppliers have enacted to meet a "minimum portion of . . . electricity sales with various renewable energy sources."[15] Progress towards meeting the Renewable Portfolio Standard (RPS) will influence electricity generation capacity and electric service reliability. Topics covered in the annual RPS report include:

- Summary of the current RPS rules, which have been subject to frequent revision since first adopted;
- Processes for registering renewable energy facilities in PJM and Maryland;
- Detailed figures summarizing utility RPS obligations and compliance including costs;
- Data on the type and geographic distribution of renewable energy facilities in Maryland.

An additional report discussing progress towards meeting Maryland's RPS is the *Inventory of Renewable Energy Generators Eligible for the Maryland Renewable Portfolio Standard*. This annual report from the Maryland Power Plant Research Program complements the annual PSC report as it provides greater detail on renewable capacity growth in the PJM region.[16]

Maryland Energy Administration (MEA)

http://energy.maryland.gov/

The Maryland Energy Administration (MEA) advises the Governor on energy-related issues.[17] In furtherance of its mission to "maximize energy efficiency while promoting economic development, reducing reliance on foreign energy supplies, and improving the environment,"[18] MEA has published *The Maryland Energy Outlook of 2010*[19] and *The Maryland Energy Outlook: Energy Demand and Supply Information*.[20] Together, these two documents highlight Maryland's energy goals, demonstrate how those goals are currently being achieved, provide recommendations on greater promotion of those goals in the future, and provide an in-depth analysis and projection of the supply and demand structures from 2009 to 2018. These two documents further address the goals from three legislative initiatives

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[14] Public Service Commission of Maryland, *Renewable Energy Portfolio Standard Report of 2011* (2011) [hereinafter *Renewable Energy Portfolio Standard Report of 2011*], *available at* http://webapp.psc.state.md.us /Intranet/Reports/MD%20RPS%202011%20Annual%20Report.pdf.

[15] *Renewable Energy Portfolio Standard Report of 2011*, *supra note* 14.

[16] Maryland Power Plant Research Program, *Inventory of Renewable Energy Generators for the Maryland Renewable Portfolio Standard*, 2010, available at: http://esm.versar.com/pprp/pprac/Docs/ *2010_MD__RPS__Inventory__Draft_Nov_2010.pdf.*

[17] Maryland Energy Administration, *About Us* (n.d.) [hereinafter *MEA About Us*], *available at* http://www.energy.state.md.us/ABOUTUS.HTML (last visited Jan. 30, 2012).

[18] *MEA About Us*, *supra note* 17.

[19] *MEA Energy Outlook*, *supra note* 11.

[20] Maryland Energy Administration, *Maryland Energy Outlook: Energy Demand and Supply Information* (Revised November 17, 2009) [hereinafter *Maryland Energy Outlook: Energy Demand and Supply Information*], *available at* http://energy.maryland.gov/documents/MDEnergySupplyandDemandOutlookREVISEDNov09.pdf.

that the General Assembly enacted in 2008: *EmPOWER Maryland Energy Efficiency Act of 2008*, which aims to reduce Maryland's energy demand by 15 percent in 2015; the revised Renewable Portfolio Standard (RPS), which aims to increase renewable energy by 20 percent by 2022; and the *Greenhouse Gas Emissions Reduction Act*, which directs the Maryland Department of the Environment (MDE) to publish a plan that directs the reduction of greenhouse gas emissions by 25 percent by 2020.[21]

Maryland Energy Outlook of 2010

http://energy.maryland.gov/documents/MEOFINALREPORTJAN2010.pdf

The Maryland Energy Outlook of 2010 Incorporates updated recommendations similar to those made in PSC's *Analysis of Resource and Policy Options for Maryland's Energy Future*. These recommendations include a number of clean energy suggestions, such as: promoting increased use of biofuels to protect the environment; increasing domestic fuel use; reducing dependence upon foreign oil; complying with the *Energy Independence and Security Act of 2007*, which requires increased use of biodiesel over the next 10 years; employing lead-by-example initiatives by introducing hybrid vehicles into Maryland's fleet; and continuing the tax incentive for energy-efficiency efforts such as rehabilitating buildings of at least 200,000 square feet to meet Leadership in Energy Efficiency Design (LEED) criteria.[22]

The Maryland Energy Outlook: Energy Demand and Supply Information

http://energy.maryland.gov/documents/MDEnergySupplyandDemandOutlookREVISEDNov09.pdf

The Maryland Energy Outlook provides energy supply and demand data and information for various energy sectors, including current and projected energy use as it relates to direct use, transportation and electricity. The data allows energy providers to estimate Maryland's future energy consumption requirements. The report compiles data from various sources, including:

- The PSC (e.g., *Ten Year Plan*, "Gap RFP", BG*E EmPOWER MD Staff Initial Comments),* the U.S. Energy Information Administration (EIA) (e.g., *Annual Energy Outlook*)
- PJM (e.g., *PJM Load Forecast Report)*, American Council for Energy Efficient Economy,
- Maryland Department of Natural Resources (DNR), and
- Maryland Commission on Climate Change.[23]

PJM Interconnection LLC

http://www.pjm.com/

PJM Interconnection is a regional transmission organization coordinating wholesale electricity movement for 13 states (including Maryland) and the District of Columbia, and is instrumental in providing electricity for Maryland's citizens. PJM hosts a very functional, user-friendly website with publicly available real-time data, historical reports and data and planning documents. The quantity and quality of information available through PJM acts as a valuable resource for Maryland energy assurance planners. The PJM resources most likely to be of value to Maryland's energy assurance are as follows:

[21] *MEA Energy Outlook*, *supra note* 11.
[22] *MEA Energy Outlook*, *supra note* 11.
[23] *Maryland Energy Outlook: Energy Demand and Supply Information*, *supra note* 20.

Regional Transmission Expansion Plan (RTEP)

http://pjm.com/planning/rtep-upgrades-status.aspx

The *Regional Transmission Expansion Plan* (RTEP) is an annual publication forecasting PJM system growth and necessary transmission upgrades or construction. Findings of the RTEP are critical to transmission expansion; without the demonstrated necessity of a particular project in the RTEP, construction will not proceed.[24] The RTEP includes:

- Identification of potential transmission overloads, voltage limitations, and other reliability standard violations over a 15-year outlook;
- Anticipated system-wide reliability and economic impacts from new backbone transmission projects (e.g., Mid-Atlantic Power Pathway (MAPP));
- A selected course of action for transmission expansion within the PJM footprint;
- Summary of Maryland electricity system including expected growth in load, status of planned transmission projects and critical issues and upgrades.

PJM Manuals

http://pjm.com/documents/manuals.aspx

The *PJM Manuals* are a series of more than 40 detailed reference manuals containing information about PJM operations, planning, and financing. Manuals are regularly updated to reflect the best available practices. PJM Manuals relevant to electricity reliability and energy assurance include Manuals 12, 13, and 36:

- Manual 12, "Balancing Operations," describes the day-to-day processes necessary to balance electricity supply and demand as well as the communication and management tools used;
- Manual 13, "Emergency Operations," describes types of emergencies, emergency preparation and event planning, and protocols for returning to normal operations;
- Manual 36, "System Restoration," describes protocol for restoring operations including communication processes, system requirements and contingency plans.

PJM System Status Information

https://edata2007.pjm.com/eData/index.html

PJM provides real-time data and near-term forecasts of system load, outages (existing and planned) and other critical system information. Information of value to Maryland energy planners includes:

- The PJM load forecast model estimates future monthly and seasonal peak demand, which serves as an important signal for generators; and
- eData, a tool on the PJM website, describes current PJM emergencies, current load, week-day-hour-ahead load forecasts and scheduled generation and transmission outages or constraints.

[24] PJM, *RTEP Development* (n.d.) [hereinafter *RTEP Development*], *available at* http://pjm.com/planning/rtep-development.aspx (last visited Jan. 30, 2012).

Eastern Interconnection Planning Collaboration
http://www.eipconline.com/Resource_Library.html

PJM participates in the *Eastern Interconnection Planning Collaboration* (EIPC), which is a coalition of regional electricity planning authorities in the Eastern U.S. PJM's collaboration with EIPC has a long-term impact on Maryland electricity reliability, as the EIPC publishes long-term planning documents and results from models of future electricity transmission reliability in the region. Specific documents of interest include:

- The Business-As Usual (BAU) Sensitivity 3 Output Report, which provides modeling results for EIPC capacity expansion modeling based on alternative Environmental Protection Agency (EPA) regulations; and
- The Future 1 Sensitivities 4-16 presentation, which provides data and projections on the capacities and needs for coal and nuclear energy sources in 2015, 2020 and 2030s.[25]

Additional PJM Information

Information available through PJM is not limited to the above resources. The PJM website should serve as a first stop for high-quality historical data for energy planners. Useful summary documents of historical data include the annual and quarterly *State of the Market* reports published by Monitoring Analytics, a PJM spin-off that acts as its independent market monitor.[26]

U.S. Energy Information Administration (EIA)

http://www.eia.gov/

The U.S. Energy Information Administration (EIA) is the agency within the DOE responsible for providing "impartial energy information."[27] EIA collects, analyzes and disseminates the information in order to increase the efficiency of the markets, broaden public understanding, and assist policymakers in making sound decisions.[28] The materials the EIA distributes include an overview of Maryland's energy infrastructure,[29] energy source-specific projections, short-term energy outlooks and long-term energy outlooks. Regularly updated reports of value to Maryland energy planners include:

[25] EIPC model results are available at: Eastern Interconnection Planning Coorperative, *Modeling Results: Futures and Sensitivities* (n.d.) [*EIPC Modeling Results*], *available at* http://www.eipconline.com/Modeling_Results.html (last visited Jan. 30, 2012).

[26] Monitoring Analytics, *Reports: PJM State of the Market – 2010* (n.d.) [hereinafter *Reports: PJM State of the Market*] *, available at* http://www.monitoringanalytics.com/reports/PJM_State_of_the_Market/2010.shtml (last visited Jan. 30, 2012).

[27] U.S. Energy Information Administration, *About EIA* (n.d.) [hereinafter *About EIA*]*, available at* http://www.eia.gov/about/ (last visited Jan. 30, 2012).

[28] *About EIA*, *supra note* 27.

[29] U.S. Energy Information Administration, *Maryland* (n.d.) [hereinafter *EIA Maryland*]*, available at* http://www.eia.doe.gov/state/state-energy-profiles.cfm?sid=MD (last visited Jan. 30, 2012).

International Energy Outlook
http://www.eia.gov/oiaf/ieo/

The *International Energy Outlook* is an annual report of international markets with broad geographic information on patterns of fuel consumption and production. Topics include:

- World energy demand and economic outlook with high and low economic growth scenarios;
- Fuel-by-fuel analysis including geographic consideration of production and consumption;
- Industry and transportation related energy consumption;
- Energy related carbon dioxide emissions.

Annual Energy Outlook
http://www.eia.gov/forecasts/aeo/

The *Annual Energy Outlook* is an annual report forecasting U.S.-wide and regional energy markets, changes in consumption and production, and impacts of legislation and regulation. Topics include:

- Forecasts of regional energy demand based on variable estimates of economic growth;
- Fuel-by-fuel projections of prices and consumption as distributed over economic sectors;
- Estimated improvements in energy efficiency and intensity across the economy.

Short-Term Energy Outlook
http://www.eia.gov/steo/

The *Short-Term Energy Outlook* is a monthly projection of U.S. future fuel prices and energy consumption and production. Specific topics include:

- Forecasts of regional and national fuel prices, supply, and expected consumption;
- Regional macroeconomic and weather information.

Petroleum Reports
http://www.eia.gov/petroleum/

The *Weekly Petroleum Status Report*[30] and *Petroleum Supply Monthly* Reports[31] provide information about current stocks of crude oil and petroleum by Petroleum Administration for Defense District (PADD). The *Petroleum Supply Monthly* report provides information by country of origin for crude oil by PADD.[32] This information is critical to domestic petroleum suppliers especially in light of political volatility in petroleum-exporting countries.

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[30] U.S. Energy Information Administration, *Weekly Petroleum Status Report* (n.d.) [hereinafter *EIA Weekly Petroleum Status Report*], *available at* http://tonto.eia.doe.gov/oil_gas/petroleum/data_publications/weekly_petroleum_status_report/wpsr.html (last visited Jan. 30, 2012).

[31] *EIA Weekly Petroleum Status Report*, *supra note* 30.

[32] U.S. Energy Information Administration, *Petroleum Supply Monthly* (n.d.) [hereinafter *EIA Petroleum Supply Monthly*], *available at* http://tonto.eia.doe.gov/oil_gas/petroleum/data_publications/petroleum_supply_monthly/psm.html (last visited Jan. 30, 2012).

Natural Gas Reports
http://www.eia.gov/naturalgas/

The EIA publishes the Natural Gas Monthly, which has monthly supply, disposition, and price data for all 50 states and the District of Columbia, and includes data from the prior two months.[33] Also, the EIA publishes two weekly natural gas sector releases: the *Weekly Natural Gas Storage Report*[34] and the *Natural Gas Weekly Update*.[35] The former contains estimates of natural gas in underground storage for the United States and three regions of the United States. The estimates are for the current and prior weeks and are compared to previous periods. The latter is a current analysis of the natural gas industry each week with information on natural gas spot and futures prices and storage activities.

Additional Information

Information available through the EIA is not limited to the resources above. Maryland-level historical data can be found at the State Energy Data System.[36] Additionally, Forms EIA-782C and EIA C-007 are two monthly surveys that report monthly statistics on petroleum delivery volumes and projected volumes for the upcoming month. These forms also include wholesale and retail prices for various types of fuel including gasoline, No.2 Distillate, Propane, and Residual Fuel Oil, which are also provided monthly for the U.S. PADD and State.[37] Last, sector-specific energy information is available through the Manufacturing Energy Consumption Survey[38] and the Residential Energy Consumption Survey,[39] which are conducted every 5 years.

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[33] U.S. Energy Information Administration, *Natural Gas Monthly* (n.d.) [hereinafter *EIA Natural Gas Monthly*], *available at* http://www.eia.doe.gov/natural_gas/data_publications/natural_gas_monthly/ngm.html (last visited Jan. 30, 2012).

[34] U.S. Energy Information Administration, *Weekly Natural Gas Storage Report* (n.d.) [hereinafter *EIA Weekly Natural Gas Storage Report*], *available at* http://ir.eia.gov/ngs/ngs.html (last visited Jan. 30, 2012).

EIA Natural Gas Monthly, *supra note* 33.

[36] U.S. Energy Information Administration, *State Energy Data System* (n.d.) [hereinafter *EIA SEDS*], *available at* http://www.eia.gov/state/seds/ (last visited Jan. 30, 2012).

[37] U.S. Energy Information Administration, *Petroleum & Other Liquids* (n.d.) [hereinafter *EIA Petroleum & Other Liquids*], *available at* http://www.eia.doe.gov/petroleum/data.cfm#prices (last visited Jan. 30, 2012).

[38] U.S. Energy Information Administration, *Manufacturing Energy Consumption Survey* (n.d.) [hereinafter *EIA Manufacturing Energy Consumption Survey*], *available at* http://www.eia.gov/emeu/mecs/ (last visited Jan. 30, 2012).

[39] U.S. Energy Information Administration, *Residential Energy Consumption Survey* (n.d.) [hereinafter *EIA Residential Energy Consumption Survey*], *available at* http://www.eia.gov/consumption/residential/ (last visited Jan. 30, 2012).

The Federal Energy Regulatory Commission (FERC)

http://www.ferc.gov/

The Federal Energy Regulatory Commission (FERC) is an independent U.S. agency formed in 1977 to regulate transmission of electricity, natural gas and oil.[40] FERC's duties aim to promote its mission to "[a]ssist consumers in obtaining reliable, efficient and sustainable energy services at a reasonable cost through appropriate regulatory and market means."[41] FERC publishes a number of data-laden reports that assist providers and consumers in understanding the energy market and forecasting future needs. Resources useful to Maryland energy planners include:

- *State of the Markets* report,
- *Seasonal Energy Market Assessments*, and
- FERC decisions and notices.

State of the Markets

http://www.ferc.gov/market-oversight/st-mkt-ovr/st-mkt-ovr.asp

State of the Markets is an annual report of U.S. energy markets that uses historical data to evaluate system reliability and inform future assessments. Topics include:

- Natural gas market trends;
- Physical and financial trade balance for electricity; and
- Market implications of adding natural gas and electricity infrastructure.

Seasonal Energy Market Assessments

http://www.ferc.gov/market-oversight/reports-analyses/overview.asp

Seasonal reports project near-term supply and demand as well as potential shortages or constraints for weather-dependent fuels. Seasonal energy assessments provide the following information:

- Amount of fuel in storage relative to potential demand based on forecasted weather;
- Expected impact from recent infrastructure changes (e.g., additions, retirements); and
- Regionally specific fuel prices relative to previous years.

FERC Decisions and Notices

http://www.ferc.gov/docs-filing/dec-not.asp

One of FERC's primary responsibilities is to "regulate the interstate transmission of electricity, natural gas and oil."[42] In meeting this obligation, FERC interacts with electric service providers, ISOs and fuel distributers to attain information, review projects and permit projects (e.g., siting of interstate transmission lines). All of the decisions and notices related to FERC-regulated entities are available

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[40] Federal Energy Regulatory Commission, *What FERC Does* (2010) [hereinafter *What FERC Does*]*, available at* https://www.ferc.gov/about/ferc-does.asp (last visited Jan. 30, 2012).

[41] Federal Energy Regulatory Commission, *About FERC* (2011) [hereinafter *About FERC*]*, available at* https://www.ferc.gov/about/about.asp (last visited Jan. 30, 2012).

[42] *About FERC*, *supra note* 41.

online at FERC's website. For example, notice of curtailment from interstate pipelines would warrant a FERC notification.

The North American Electric Reliability Corporation (NERC)

http://www.nerc.com/

The North American Electric Reliability Corporation (NERC) is a non-profit international regulatory agency whose "mission is to ensure the reliability of the North American bulk power system."[43] NERC promotes reliability of the bulk power system by developing and enforcing reliability standards.[44] To develop these standards, NERC collects data from numerous sources and publishes its own reports, such as the *2010 Long-Term Reliability Assessment.*[45] The *2010 Long-Term Reliability Assessment* includes:

- A 2010-2019 forecast of electricity demand and generation projections;
- Transmission reliability assessment, potential reliability issues and power risks; and
- Regional reliability self-assessments performed by NERC's regional entities.

Interpreting Information and Responding Through Operations

Data about current energy conditions can be used to improve energy delivery operations, identify energy infrastructure vulnerabilities and direct investment decisions. For example, current data on energy usage can help determine short-term demand load and Maryland's ability to meet that demand. Reports detailing prior infrastructure vulnerabilities can be used to identify similar vulnerabilities elsewhere in Maryland's energy infrastructure, and provide guidance on enhancing its resilience. Weather information—including historical data, statistical data, real-time monitoring and the impact of weather events on energy supply, demand and delivery—enables energy providers to examine the number, type and frequency or various types of weather events, pinpoint lessons learned from past weather events and enhance contingency plans regarding future weather events.

Similarly, forecast information can be used to help determine the supply and demand of different kinds of energy, and future energy operations and delivery. Energy forecasts enable energy providers to anticipate demand-loads and generation and transmission capacity needs, which enables energy providers to better ensure reliability and efficiency with enough energy supply to meet demand while limiting excess generation. Forecasting also enables energy providers to better coordinate energy transmission regionally. As Maryland incorporates more renewable energy resources, forecasting not only enables planners to model how much energy will be generated from renewable resources; weather forecasting allows energy planners to predict the impact of weather patterns and events on the intermittent supply of that energy, such as solar- and wind-powered energy. Managing energy

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[43] North American Electric Reliability Corporation, *North American Electric Reliability Corporation Home Page* (n.d.) [hereinafter *NAERC Home Page*]*, available at* http://www.nerc.com/ (last visited Jan. 30, 2012).
[44] North American Electric Reliability Corporation, *2010 Long-Term Reliability Assessment* (2010) [hereinafter *2010 Long-Term Reliability Assessment*]*, available at* http://www.nerc.com/files/2010_LTRA_v2-.pdf.
[45] *2010 Long-Term Reliability* Assessment, *supra note* 44.

information better enables energy providers to reduce disruptions in energy provision, and to better prepare to respond to any disruptions.

Conclusion

Access to accurate and current information is critical in determining the condition of Maryland's energy sector. Uses for reliable data include infrastructure planning, policy creation, and emergency response. No single source will likely have all applicable information. Consequently, multiple sources will be needed to provide the most complete picture of Maryland's energy sector. Energy professionals must also be aware of the release of new resources as well as the discontinuation or modification of existing sources.

Chapter 8. Critical Energy Infrastructure Protection

Introduction

Energy infrastructure in Maryland is similar to the energy infrastructure of the nation at large; it is distributed across a wide geography, is made of diverse components, is exposed to natural and man-made threats, is in different stages of age and disrepair and is widely interconnected and interdependent. Maryland's energy infrastructure also includes vastly different scales, from 120v residential pole drops to 765kv high power transmission lines; from a 2kw windmill in a homeowner's backyard to a 1,800MW nuclear power plant. Even more, it is overseen by a wide range of stakeholders, from private industry to federal, state and local agencies. Some elements of the State's energy infrastructure are localized and can be easily replaced, while other elements serve wide areas and are more critical. This chapter focuses on the components of the energy infrastructure that are determined to be "critical" and discusses the forces involved in their protection.

Critical Infrastructure and Key Resources

Critical Infrastructure and Key Resources (CIKR) are "the assets, systems, and networks that provide vital services to the United States."[1] In the energy sector, as defined by Homeland Security Presidential Directive-7 (HSPD-7),[2] CIKR consists of thousands of electricity, oil and natural gas assets that are connected by geographically dispersed systems and networks. Primary assets in Maryland include electric generators, transmission and local distribution facilities, gas processing plants, pipelines and storage, as well as petroleum delivery systems and storage.[3] In addition to many retail fuel and propane locations, Maryland is home to six major utility companies, several liquid petroleum gas stations, petroleum offloading ports, compressed natural gas stations, E85 fuel and biodiesel fuel stations, propane locations, a nuclear power plant, an LNG facility and other energy assets. For information regarding Maryland's energy profile, see Chapter 2.

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[1] U.S. Department of Homeland Security, *Critical Infrastructure* (2010) [hereinafter *DHS Critical Infrastructure*], *available at* http://www.dhs.gov/files/programs/gc_1189168948944.shtm (last visited Jan. 3012).

[2] Homeland Security Presidential Directive 7 "establishes a national policy for Federal departments and agencies to identify and prioritize critical infrastructure and to protect them from terrorist attacks." *See* U.S. Department of Homeland Security, *Homeland Security Presidential Directive 7: Critical Infrastructure Identification, Prioritizations, and Protection* (2003) [hereinafter *DHS Homeland Security Presidential Directive 7*], *available at* http://www.dhs.gov/xabout/laws/gc_1214597989952.shtm (last visited Jan. 30, 2012).

[3] National Association of State Energy Officials, *State Energy Assurance Guidelines* 12 (version 3.1 2009) [hereinafter *NASEO State Energy Assurance Guidelines*], *available at* http://www.naseo.org/eaguidelines/ State_Energy_Assurance_Guidelines_Version_3.1.pdf.

Maryland's critical energy infrastructure is protected through the State's Critical Infrastructure Protection (CIP) Program. The CIP Program began in 2005, and in May of 2007 became the responsibility of the Maryland Coordination and Analysis Center (MCAC), Intelligence Analysis Division, a subdivision of the Maryland State Police (MSP). The CIP is currently headed by a lieutenant from the MSP and consists of two operations staffers (one from the Maryland Emergency Management Agency (MEMA) and the other from MSP), an MSP administrator, a TSA transportation specialist, a transit specialist and an intelligence analyst.[4] MCAC partners with MEMA and the Governor's Office for Homeland Security (GOHS), as well as numerous federal agencies including the Federal Bureau of Investigation (FBI), the Bureau of Alcohol, Tobacco, and Firearms (ATF), Department of Homeland Security (DHS), Transportation Security Administration (TSA) and the United States Secret Service (USSS).

MCAC also coordinates with twenty-seven local partners to collect information on all privately and publicly owned critical infrastructure in the State. The information is input into a secure DHS-sponsored database that is controlled by MCAC's CIP Branch and is available to utility providers, local, State and federal entities as well as first responders who need access to information during an energy emergency. Anyone with access to the information must have training on the system and hold a Protected Critical Infrastructure Information (PCII) certificate. The database is structured to allow local jurisdictions access only to facilities within their city or county, with access for private or public sector asset owners limited, through separate login requirements, to information regarding only their respective facilities.

In addition to providing necessary information on critical infrastructure, the CIP Program locates grant opportunities to assist private, State and local agencies to promote the protection of critical infrastructure.[5] Trainings for the CIP Program with a DHS liaison are available which include the PCII certification classes mentioned above, as well as Risk Analysis and Management for Critical Assets Protection (RAMCAP) and Criticality, Accessibility, Recuperability, Vulnerability, Effect and Recognizability (CARVER) trainings, in addition to Automated Critical Asset Management System (ACAMS) training.

Maryland has also been involved in numerous critical infrastructure protection initiatives, including participating in the Maryland Chapter of InfraGard (since 1999) and serving as a key stakeholder in the National Capital Region's initiative on Critical Infrastructure Protection (NCR-CIP). The State's involvement in these organizations and programs is discussed in-depth later in this chapter.

[4] Interview with Jeremy Scheinker, Critical Infrastructure Protection Liaison, Maryland Emergency Management Agency (June 7, 2011) [hereinafter *Interview with Jeremy Scheinker*].
[5] *Interview with Jeremy Scheinker*, *supra note* 4.

Identification and Description of Critical Energy Infrastructure

The first aspect of CIP is the identification and description of Maryland's critical energy infrastructure. As stated above, Maryland collects, stores and uses data on the State's critical energy infrastructure through the efforts of MCAC (http://www.mcac-md.gov/), which is designed to share information on CI as appropriate with federal, State, local and private entities. Currently, MCAC has inventoried approximately 4,000 critical infrastructure sites into ACAMS, run by DHS.[6]

ACAMS allows states to catalog and manage CIKR information, including the ability to receive and share statewide, threat-based information concerning critical infrastructure protection issues. In 2006, Maryland became the second state to integrate its critical infrastructure assessment database with ACAMS. Interdisciplinary assessment teams, which include public and private entities, are conducting site assessments of the approximately 4,000 critical infrastructure sites in Maryland already inventoried in ACAMS. In addition, CIP Program has used ACAMS to conduct vulnerability assessments and provide threat briefings to more than 70 of the State's critical infrastructure facilities. A continuing CIP Program priority is to complete an inventory of all publicly- and privately-owned critical infrastructure in Maryland. The information will then be used to implement new security measures. MCAC is also now producing sector-specific vulnerability assessments on a yearly basis.

Identifying, assessing, mitigating and managing risks to critical energy infrastructure helps to ensure the infrastructure's resilience, as well as the continuity of a State's energy services and business operations. The primary aspects of critical energy infrastructure protection include:

- criticality assessment;
- threat, vulnerability and consequence assessment;
- prioritization of critical energy infrastructure; and
- identification and development of protective measures.[7]

These aspects of critical energy infrastructure protection cut across all energy sub-sectors (electricity, oil and natural gas). Protective measures address several aspects of security: information-sharing and communication; physical and cyber security; coordination and planning; and ensuring public confidence.[8]

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[6] Governor's Office of Homeland Security, *Vulnerability Assessment: Accomplishments for Core Goal #6 Vulnerability Assessment* (2011) [hereinafter *Vulnerability Assessment*], *available at* http://www.gohs.maryland.gov/va_accomplishments.html (last visited Jan. 30, 2012).

[7] Transportation Security Administration, U.S. Department of Homeland Security, *Pipeline Security Guidelines* 7 (2011) [hereinafter *Pipeline Security Guidelines*], *available at* http://www.tsa.gov/assets/pdf/guidelines _final_apr2011.pdf.

[8] U.S. Department of Energy & U.S. Department of Homeland Security, *Energy Sector Specific Plan* 8 (2010) [hereinafter *Energy Sector Specific Plan*], *available at* http://www.dhs.gov/xlibrary/assets/nipp-ssp-energy-2010.pdf.

Prioritization of Critical Energy Infrastructure

After identifying and describing critical energy infrastructure, each element must be ranked in a prioritization schedule. Prioritization is determined through a number of methodologies that assess risk (threats, vulnerabilities and consequences) across the various energy assets, systems and networks. The results of this assessment are then examined in the context of a variety of variables and circumstances. Prioritization of infrastructure and assets is based upon flexible sector-developed protocols that best ensure continuity and reliability of operations.[9] Critical decision-making should not be based on a static prioritization of assets that uses outdated or erroneous information. Efforts to direct scarce resources to assets, systems and networks must be flexible enough to respond to the most critical area at any point in time.[10]

Energy asset, system and network characteristics that inform assessment of risk and determination of priorities include:

- physical and location attributes;
- cyber attributes (protection, monitoring and control systems);
- throughput attributes (utilized capacity or capacity-constraint points);
- time- or load-dependent attributes (time of year or day, volume of energy);
- human attributes (knowledge, skills, and training); and
- the importance of an asset or system regarding the impact of its disruption and its relation to other critical infrastructure.[11]

Federal, State and local government programs that prioritize the allocation of CIP resources supplement and support industry efforts to assess the relative risk and importance of the critical infrastructure at issue. The dynamic between government and sector responsibilities and efforts requires that governments develop working relationships and coordinate with sector owners and operators to better understand the relative risk and importance of critical energy infrastructure and assets, and to address any legal, policy or practical impediments of enhancing CIP.[12]

Assessing Risks to Critical Energy Infrastructure: Threats, Vulnerabilities and Consequences

The EAP relies on updated, continual risk assessments of critical energy infrastructure, which include screening infrastructure, assessing threats, assessing vulnerabilities and assessing consequences. Since 2007, MCAC has conducted approximately 140 assessments of critical infrastructure sites.

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9 *Energy Sector Specific Plan*, *supra note* 8, at 39-40.
10 *Energy Sector Specific Plan*, *supra note* 8, at 40.
11 *Energy Sector Specific Plan*, *supra note* 8, at 27.
12 *Energy Sector Specific Plan*, *supra note* 8, at 40.

Following federal guidelines, Maryland's critical energy infrastructure is screened to determine which networks, systems, and assets are sufficiently significant to necessitate a further, more comprehensive assessment of risk: threats, vulnerabilities and consequences.[13]

In assessing Maryland, or any state's critical energy infrastructure, a broad range of threats must be considered, including natural incidents, terrorist incidents, criminal incidents and insider threats.[14] A threat assessment determines the likelihood that a network, system or asset will be disrupted or attacked.[15] As threat information is essential to vulnerability and risk assessments, the timely sharing and dissemination of this information should take place regularly among appropriate public and private energy sector partners, and in Maryland is conducted through MCAC.

For critical energy infrastructure,

> vulnerabilities are the characteristics of an asset, system, or network's design, location, security posture, process, or operation that render it susceptible to destruction, incapacitation, or exploitation by mechanical failures, natural hazards, terrorist attacks, or other malicious acts. Vulnerability assessments identify areas of weakness that could result in consequences of concern, taking into account intrinsic structural weaknesses, protective measures, resilience, and redundancies.[16]

Meanwhile, in assessing risk to critical energy infrastructure, the potential consequence of an incident is measured as the range of expected loss or damage, and includes:

- human impact (effect on human life and physical well-being);
- economic impact (direct and indirect effects on the economy, including short- and long-term costs associated with damage/disruption, response and recovery);
- impacts on public confidence; and
- on the government's ability to provide essential services and maintain the public's health and safety.[17]

Depending on the specific infrastructure, only certain aspects of consequence may be relevant to an assessment and factors of network, system or asset redundancy, resilience and interdependency also may affect the assessment of consequence.[18]

[13] *Energy Sector Specific Plan*, *supra note* 8, at 33.
[14] *Energy Sector Specific Plan*, *supra note* 8, at 35.
[15] *Energy Sector Specific Plan*, *supra note* 8, at 35.
[16] *Energy Sector Specific Plan*, *supra note* 8, at 36.
[17] *Energy Sector Specific Plan*, *supra note* 8, at 34.
[18] *Energy Sector Specific Plan*, *supra note* 8, at 34.

Identifying and Developing Protective Measures

After categorizing critical energy infrastructure, and assessing and prioritizing the potential risks, it is necessary to identify, develop and implement protective programs and resilience strategies.[19] All protective measures should focus on "reliable information sharing[,] effective physical and cyber security, and . . . coordinated response capabilities," determined through the careful consideration, and extensive experience and expertise, of public and private sector stakeholders and partners.[20] Protective measures address several aspects of security: information-sharing and communication, physical and cyber security, coordination and planning and public confidence.[21]

Protective measures which are identified should be developed to address the following issues, as appropriate:

- building resiliency;
- diversifying energy sources and integrating renewable resources;
- enhancing reliability;
- increasing efficiency; and
- developing smart or intelligent-power grids, including cyber security programs and initiatives.[22]

Maryland's Protective Measures

To enhance surveillance, one of the key protective measures Maryland and its local jurisdictions continue to develop and implement is closed circuit television (CCTV), which is one of the Governor's Core Goals.[23] In this regard, the State continues to enhance its CCTV network, systems and equipment through the acquisition of thousands of CCTV cameras, which it integrates through its Intelligent CCTV (ICCTV) Program.[24] This integration allows State, local, and federal systems to share camera feeds with public and private sector critical infrastructure protection partners as necessary and appropriate. Currently, the State has an inventory of over 8,400 CCTV components, the capabilities of which continue to be improved by the efforts of the Maryland Department of Transportation (MDOT) and the Maryland Department of Information Technology (DoIT).[25] CCTV surveillance continues to enable greater real-time information-sharing and situational awareness regarding the State's critical infrastructure, including energy and transportation infrastructure, which in turn enhances protection, prevention, response and recovery capabilities (see Figure 8-1 on following page).

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[19] *Energy Sector Specific Plan*, *supra note* 8, at 41.

[20] *Energy Sector Specific Plan*, *supra note* 8, at 41.

[21] *Energy Sector Specific Plan*, *supra note* 8, at 8.

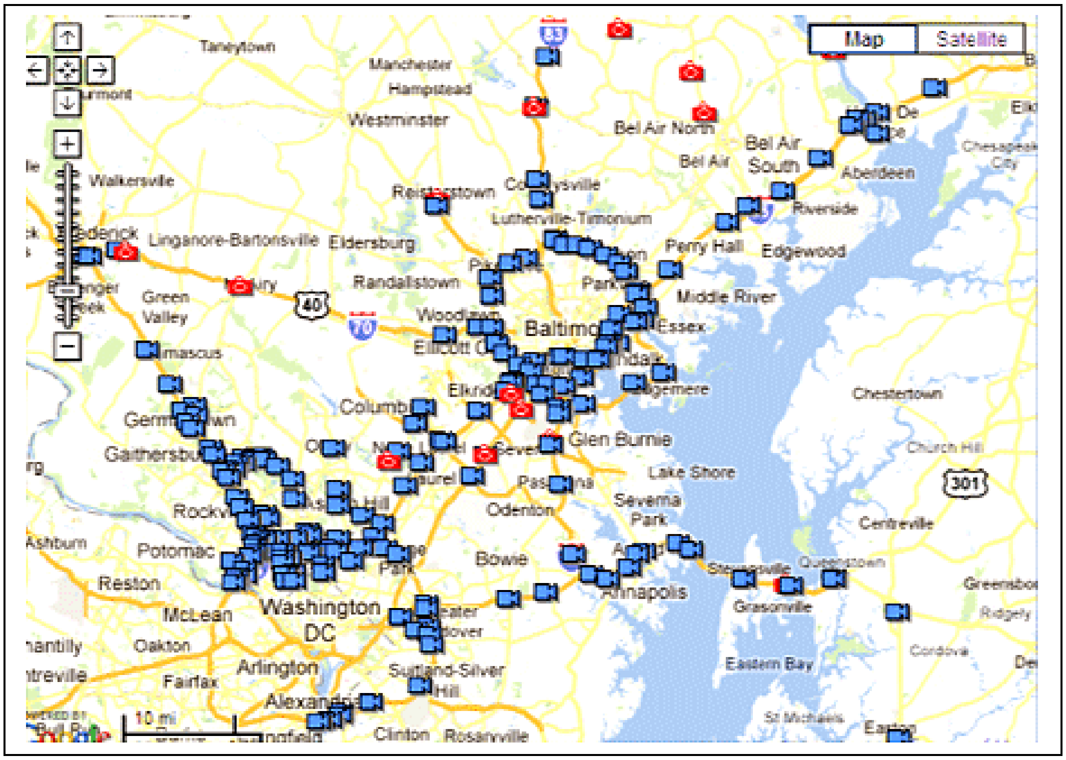
[22] *Energy Sector Specific Plan*, *supra note* 8, at 41.

[23] Governor's Office of Homeland Security, *CCTV (Closed Circuit Television): Accomplishments for Core Goal #8 Closed Circuit Television (CCTV)* (2011) [hereinafter *Accomplishments for Core Goal #8*], *available at* http://gohs.maryland.gov/cctv_accomplishments.html (last visited Jan. 30, 2012).

[24] *Accomplishments for Core Goal #8*, *supra note* 23.

[25] *Accomplishments for Core Goal #8*, *supra note* 23.

Figure 8-1: Publically Available CCTV Traffic Cameras[26]



Additionally, MCAC's CIP Program, discussed earlier in this chapter, provides a secure critical infrastructure database that is available only to those with the proper PCII training and certifications. Information is provided on a case-by-case basis, with access to only the applicable utility or locality necessary. Also, MCAC conducts assessments of critical infrastructure and identifies protective measures.[27]

Coordination and Planning Security

Protective measures addressing coordination and planning should include agreements to share resources in an emergency, as well as plans, training and exercises for coordinating incident response among public and private energy sector partners. These measures also should include enhancing coordination to further develop and sustain security, reliability and recovery capabilities.[28] Examples of measures already being taken include emergency planning for the Calvert Cliffs Nuclear Power Plant that

[26] *Accomplishments for Core Goal #8*, *supra note* 23. For more information on CCTV cameras, *see* Coordinated Highways Action Response Team, Maryland Department of Transportation, *Coordinated Highways Action Response Team Home Page* (n.d.) [hereinafter *CHART Home Page*], *available at* http://www.chart.state.md.us/ (last visited Jan. 30, 2012).

[27] Governor's Office of Homeland Security, *Vulnerability Assessment: Accomplishments for Core Goal #6 Vulnerability Assessment* (2011) [hereinafter *Accomplishments for Core Goal #6*], *available at* http://www.gohs.maryland.gov/va_accomplishments.html (last visited Jan. 30, 2012).

[28] *Energy Sector Specific Plan*, *supra note* 8, at 54-55.

is provided by the Emergency Management Division of Calvert County.[29] Full-scale exercises are carried out every two years. These exercises are developed by the Nuclear Regulatory Commission (NRC) in conjunction with the Federal Emergency Management Agency (FEMA).[30] This includes government agencies and State and local responders, as well as licensees. Also, for the Dominion Cove Point LNG facility, there is an agreement between the Calvert County Police Department and Dominion for the police department to provide additional security for the facility. Similarly, individuals from Colonial Pipeline meet with local emergency response personnel to ensure and improve pipeline safety.[31] These meetings serve as a question and answer session to assist emergency responders in knowing what is happening with regard to pipeline operations.[32] In addition to internal monitoring of the pipeline, Colonial developed an in-house aerial patrol of the pipeline easements in 1991. Federal regulations require twenty-six inspections of all easements per year. Sections of the easements are inspected by Colonial on a weekly basis, weather permitting.[33]

Roles and Responsibilities of Agencies Involved with Critical Infrastructure Protection

A variety of federal, State and local government agencies coordinate with each other to protect Maryland's critical energy infrastructure resources.

Roles and Responsibilities of Federal Agencies

A number of federal agencies have CIKR protection roles that affect a state's CIKR protection. These agencies coordinate among themselves, with state and local agencies and the private sector. The primary federal coordinating agency is the Department of Energy (DOE), which spearheads agency organization and provides sector specific National Infrastructure Protection Plan (NIPP) guidance in its Energy Sector Specific Plan (ESSP). Additional agencies with energy-related critical infrastructure roles are discussed in DOE's ESSP, and are briefly described on the following page:

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[29] Calvert County Government, *Calvert Cliffs Nuclear Power Plant* (n.d.) [hereinafter *Calvert Cliffs Nuclear Power Plant*], *available at* http://www.co.cal.md.us/residents/safety/emergency/calvertcliffs/ (last visited Jan. 30, 2012).
[30] United States Nuclear Regulatory Commission, *Emergency Exercise Schedule* (2011) [hereinafter *Emergency Exercise Schedule*], *available at* http://www.nrc.gov/about-nrc/emerg-preparedness/about-emerg-preparedness /exercise-schedules.html (last visited Jan. 30, 2012).
[31] Colonial Pipeline Company, *Safety and the Environment: Working with the Communities We Serve* (n.d.) [hereinafter *Safety and the Environment: Working with the Communities We Serve*], *available at* http://www.colpipe.com/en_com.asp (last visited Jan. 30, 2012).
[32] *Safety and the Environment: Working with the Communities We Serve*, *supra note* 31.
[33] Colonial Pipeline Company, *Safety and the Environment: Aerial Patrol* (n.d.) [hereinafter *Safety and the Environment: Aerial Patrol*], *available at* http://www.colpipe.com/en_ap.asp (last visited Jan. 30, 2012).

- **Department of Agriculture (USDA)** (http://www.rurdev.usda.gov/UEP_HomePage.html): The Rural Utilities Service provides funding and support for rural electric utilities.
- **Department of Defense (DoD)** (http://www.usace.army.mil/Pages/default.aspx): The U.S. Army Corps of Engineers (USACE) maintains the nation's dams, including those used for hydroelectric power and shipping channels, ensuring transportation of petroleum and other products.
- **Department of Homeland Security (DHS)** (http://www.dhs.gov/files/programs/gc_1189013411585.shtm): DHS, in coordination with DOE, which serves as the Sector-Specific Agency (SSA) for energy, leads, integrates and coordinates CIP activities across the federal government. In addition, DHS is responsible for implementing chemical security regulations that will impact some important energy sector assets. DHS directly coordinates security for certain segments of the energy sector, including nuclear power and hydroelectric power (dams). Other entities within DHS have specific roles regarding CIP:
  - **Transportation Security Administration (TSA)** (http://www.tsa.gov/what_we_do/tsnm/pipeline.shtm): oversees pipeline security and works closely with the Department of Transportation (DOT) and DOE on matters where pipeline safety and security overlap. In 2011, TSA released guidelines for pipeline security and recommended that a risk-based Corporate Security Program (CSP) plan be established and employed by each pipeline industry.[34]
  - **Federal Emergency Management Agency (FEMA)** (http://www.fema.gov/): works closely with DOE to address natural disasters and security issues related to the provision of energy and public safety.
  - **U.S. Coast Guard (USCG)** (http://www.uscg.mil/hq/cg5/cg532/pwcs.asp): has responsibility for safety and vessel management in U.S. terminals and waterways. The Maritime Transportation Security Act of 2002 designated the Coast Guard Captains of the Port as the Federal Maritime Security Coordinators, thus making the Coast Guard the lead agency for managing all maritime security planning and operations in ports and waterways. As such, the Coast Guard is also responsible for protecting offshore oil and gas facilities, and most likely[35] will be responsible for protecting future wind farms that probably will be placed in high-density navigational areas that are currently overseen and regulated by the U.S. Coast Guard.[36]

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[34] *Pipeline Security Guidelines*, *supra note* 7, at 3.

[35] Note: USCG safety and security regulations do not currently cover off-shore wind production. However, it is possible that off-shore wind might be covered under 33CFR103, Area Maritime Security, placing the Area Maritime Security Committee (AMSC) with the responsibility of identifying the risks and determining the mitigation strategies in an Area Maritime Security Plan (AMSP).

[36] World Shipping Council, *Comments of the World Shipping Council Submitted to the Bureau of Ocean Energy Management, Regulation, and Enforcement in the Matter of Commercial Leasing for Wind Power on the Outer Continental Shelf (OCS) Offshore Maryland – Request for Interest* 6 (2011) [hereinafter *WSC Comments*], *available at* http://www.boemre.gov/offshore/renewableenergy/PDFs/stateactivities/MD/WorldShippingCouncil.pdf.

- **Office of Cyber Security and Communications** (http://www.dhs.gov/xabout/structure/gc_1185202475883.shtm): works to address and enhance the security of critical sectors' cyber infrastructure through such efforts as the Control Systems Security Program.

- **Department of the Interior (DOI)** (http://www.doi.gov): DOI's U.S. Geological Survey monitors coal mines and geothermal production areas and power plant siting. DOE works with DOI's Bureau of Reclamation to coordinate power generation and river operations; it also coordinates with DOI's Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE), which manages the nation's natural gas, oil and other mineral resources on the Outer Continental Shelf. Any offshore wind effort will necessarily include BOEMRE.
- **Department of State (DOS)** (http://www.state.gov/e/eeb/esc/index.htm): Under international agreements led by DOS and DHS, energy is exported and imported across U.S. borders with Canada and Mexico.
- **Department of Transportation (DOT)** (http://www.dot.gov/): The energy sector relies on pipelines, barges, tankers, railways and highways to transport all raw and refined energy products. DOT's Pipeline and Hazardous Materials Safety Administration (PHMSA) coordinates activities regarding oil and natural gas pipelines. PHMSA is a member of the interagency committee charged with developing a memorandum of understanding (MOU) to facilitate prompt repair of oil and natural gas transmission pipelines. DOT's Maritime Administration (MARAD) programs promote waterborne transportation and its integration into other transportation system segments. MARAD also ensures that reserve shipping capacity is available in times of national emergency.
- **Environmental Protection Agency (EPA)** (http://www.epa.gov/): EPA coordinates with DOE during energy emergencies and supply disruptions to assess the availability of transportation and boutique fuels and the need for environmental fuel waivers.
- **Federal Energy Regulatory Commission (FERC)** (http://www.ferc.gov/): FERC regulates the interstate transmission of natural gas, oil, electricity and natural gas and hydropower projects. DOE coordinates with FERC on energy security issues. FERC oversees the approval and enforcement of electric reliability standards, which it also develops. FERC also ensures or enhances the operational reliability of LNG facilities within its jurisdiction by imposing safety requirements.
- **Nuclear Regulatory Commission (NRC)** (http://www.nrc.gov/): Energy partners continue to coordinate with NRC on energy security issues related to electricity generated by nuclear fission, relying on the experience gained from DOE's own operation of numerous nuclear facilities.

In addition to these agencies, DOE's Office of Electricity Delivery and Energy Reliability (OE) Infrastructure Security and Energy Restoration Division (ISER) plays a prominent role in coordinating collaboration and information sharing efforts. OE established ISERnet, which is a restricted-access online community of federal and state officials and industry professionals who have a role in protecting energy-sector CIKR. The site provides an environment to address energy emergencies and supply disruptions, as well as to share information. It also contains the Energy Emergency Assurance Coordinators (EEAC) system, a database and platform for state-level personnel to share information and coordinate with each other and with DOE before, during and after energy emergencies.

Roles and Responsibilities of State Agencies and Governments

In 2006, DHS released the NIPP, noting that "state governments are responsible for establishing security partnerships, facilitating coordinated information sharing, and enabling planning and preparedness for CIKR protection within their own jurisdiction." Maryland's role in establishing effective protection of CIKR is to facilitate cooperation and coordination with the federal government and to support implementation of the NIPP at the State and local levels. In addition, DOE's Sector Specific Energy Annex identifies "defin[ing] critical infrastructure protection roles and responsibilities among all federal, state, local, and private sector partners" as one of its main goals. The NIPP recognizes that "non-federal efforts are the most visible and tangible to many of the owners and operators—as well as to the public in general,"[37] and sets out a number of responsibilities for state actors.[38]

State governments and related agencies serve as crucial coordination hubs, bringing together prevention, protection, response and recovery authorities, capacities and resources among local jurisdictions, across sectors and between regional entities. In working with federal authorities and Maryland's CIP Program, Maryland agencies play a significant role in preventing an energy supply crisis and mitigating a potential emergency's impact.

Federal homeland security funding provisions require Maryland to implement programs similar to the NIPP, National Response Framework (NRF) and National Incident Management System (NIMS).[39] Maryland's CIP Program, under the direction of MCAC reflects the State's implementation of a full range of NIPP-related activities. The CIP Program addresses all relevant aspects of CIKR protection, from leveraging support from homeland security assistance programs that apply across the homeland security mission area to reflecting priority activities in its strategy to ensure effectively allocated resources.[40] MCAC incorporated the use of DHS's ACAMS to catalogue and manage critical infrastructure and key resource vulnerability information, as well as share and receive statewide information concerning critical infrastructure protection issues.[41] Maryland agencies also act as conduits for requests for federal assistance when a threat or incident exceeds the capabilities of public and private sector CIKR partners at lower jurisdictional levels.

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[37] *State Energy Assurance Guidelines*, *supra note* 3, at 16.

[38] For a complete list of recommended state-level CIKR activities, *see State Energy Assurance Guidelines*, *supra note* 3.

[39] 6 U.S.C.A. § 609 (West 2011).

[40] Under CIPP, critical infrastructure sites are assessed and inventoried. Then, program personnel identify existing vulnerabilities and provide recommendations to key stakeholders to enhance overall security.

[41] Ken Mallette, James Lee Witt Assocs., *Phase II Assessment: Emergency Preparedness in the State of Maryland* 28 (rev. rep. 2010) [hereinafter *Phase II Assessment*], *available at* www.gov.state.md.us/gohs/pdfs/witt_report.pdf.

In addition to Maryland State Police (MSP) CIP Program implementation, various other State agencies have a critical role in CIKR protection. These agencies include:

- **Governor's Office of Homeland Security (GOHS)** (http://www.gohs.maryland.gov/): The Governor's Office of Homeland Security is a coordinating office that advises the Governor and leads the development of policies, priorities and strategy for homeland security in Maryland. GOHS also assists State agencies and local governments as they implement their core homeland security missions. GOHS is the primary liaison to DHS and other federal partners, and oversees coordination of federal homeland security grant funding in the State. GOHS has encouraged State agencies to make resources available to support Maryland's CIP Program. GOHS has also been responsible for MCAC's growth and streamlined movement into MSP, overseeing the Maryland Maritime Strategic Security Plan, and the State's Core Goals.
- **Maryland Energy Administration (MEA)** (http://energy.maryland.gov/): As the State energy office, MEA interacts with DOE's Office of Electricity Delivery and Energy Reliability (OE) in formulating and enacting Maryland's Energy Assurance Planning efforts. The OE is the primary DOE office that deals with energy emergency planning and response, and is also responsible under the NIPP for formulating strategies to protect energy CIKR as described in the ESSP. It shares responsibility with the Public Service Commission (see below) for ESF-12 implementation, which involves coordinating with the private sector for the emergency repair and restoration of critical public energy utilities.
- **Maryland Emergency Management Agency (MEMA)** (http://www.mema.state.md.us): MEMA was created by the Maryland legislature to prepare the State for large-scale emergencies. MEMA is responsible for coordinating the State's response in any major emergency or disaster, which includes supporting local governments as needed or requested, and coordinating assistance with FEMA and other federal partners. In addition to working with first responders around the State, MEMA works with State agencies, the Maryland National Guard, local emergency management directors and partners in neighboring states to plan for, respond to and recover from any emergency that could threaten Maryland's residents.
- **Maryland Department of Transportation** (MDOT) (http://www.mdot.maryland.gov/): MDOT directs and oversees the planning, construction, and operation of Maryland's highway, transit, maritime, and aviation facilities, as well as the Maryland Motor Vehicle Administration. MDOT is primarily responsible for specific emergency support functions related to transportation (ESF-1), which includes coordinating the use of necessary transportation resources and services to support emergency response or recovery operations or other emergency assistance initiatives (e.g., providing land, air, rail or water crafts for emergency response or assistance operations).
- **Maryland State Police (MSP)/MCAC** (http://www.mcac-md.gov/)**:** MSP coordinates and oversees MCAC. MCAC partners with MEMA, GOHS and FBI, as well as local partners. As discussed earlier, the CIP Program of MCAC collects and disseminates critical infrastructure information to the appropriate organizations and agencies in a controlled and secure manner. In addition to MCAC, Maryland opened three Regional Information Centers (RICs) in southern, eastern and western Maryland, developing a "hub and spoke" information sharing model.

Specific to CIKR, MSP/MCAC seeks to establish relationships with CIKR owners and operators to increase information sharing between private and public sectors.

- **Public Service Commission (PSC)** (http://webapp.psc.state.md.us/Intranet/home.cfm): PSC regulates gas, electric, telephone, water and sewage disposal companies. PSC also has jurisdiction over other regulatory activities that may affect CIKR. It shares responsibility with MEA for ESF-12 implementation, which involves coordinating with the private sector for the emergency repair and restoration of critical public energy utilities.

These Maryland agencies also are able to participate in CIKR protection through the Energy Government Coordinating Council (GCC), DOE's government counterpart for Sector Coordinating Councils (SCC). The Energy GCC was established in early 2004 and is co-chaired by representatives from DOE and DHS. It is composed of all relevant federal, State, local, tribal, and territorial government agencies (or their representative bodies) that are concerned with the security of the energy sector.

In addition, these Maryland agencies work collaboratively with regional CIKR efforts, such as FEMA Region III or the National Capital Region (NCR)-CIP. NCR-CIP partners include Maryland, the District of Columbia and Virginia, as well as select counties and municipalities from Maryland and Virginia. NCR-CIP promotes collaboration across jurisdictional boundaries by conducting regional planning efforts, encouraging partnership agreements, facilitating information sharing and data collection and coordinating regional exercises and training programs.

Roles and Responsibilities of Local Agencies and Governments

Local emergency management agencies and first responders prepare for and respond to all emergencies, including those with implications for the energy infrastructure. Local governments represent the front lines for CIKR protection and NIPP framework and sector partnership model implementation. Maryland's local governments drive emergency preparedness, lead and support NIPP and ESSP implementation activities and encourage the participation of local CIKR partners, including government agencies, owners and operators, as well as private citizens in the communities they serve.

Although local governments have a role in supporting statewide CIP Program implementation efforts, most events that impact CIKR are localized. Local authorities typically "shoulder the weight of initial prevention, response, and recovery operations until coordinated support from other sources becomes available, regardless of who owns or operates the affected asset, system, or network."[42]

Local governments, through their emergency plans or public-private partnerships, contribute significantly to CIKR protection. For example, by using memoranda of understanding (MOUs), local law enforcement can partner with energy-sector CIKR owners. Agreements, such as the one between Calvert County's Police Department and the Dominion Cove Point LNG facility, in which the police department provides additional facility security, allow county officers to protect CIKR during an emergency.

[42] *State Energy Assurance Guidelines*, *supra note* 3, at 18.

Local governments and the associations that represent them, such as the Public Technology Institute (PTI), comprise an extremely large set of stakeholders. These entities represent the interests of cities, towns and municipalities in energy sector security, protection and emergency preparedness.

CIKR protection at the local level should focus on, but is not limited to:

- "Acting as a focal point for and promoting the coordination of protective and emergency response activities, preparedness programs, and resource support among local agencies, businesses, and citizens;
- Developing a consistent approach at the local level to CIKR identification, risk determination, mitigation planning, and prioritized security investment, and exercising preparedness among all relevant CIKR partners within the jurisdiction;
- Facilitating the exchange of security information, including threat assessments, attack indications and warnings, and advisories among CIKR partners within the jurisdiction;
- Participating in the NIPP sector partnership model, including GCCs, SCCs, State, Local, Tribal and Territorial Government Coordinating Council (SLTTGCC) and other CIKR governance efforts and SSP planning efforts relevant to the given jurisdiction, through direct participation, coordination, or establishment of local coordinating councils as appropriate;
- Sharing information with CIKR partners, as appropriate through Homeland Security Information Network (HSIN) and other channels, on CIKR deemed critical from the local perspective to enable prioritized protection and restoration of critical public services, facilities, utilities, and processes within the jurisdiction;
- Integrating CIKR protection into existing plans, such as hazard mitigation plans, emergency operations plans, and contingency plans;
- Documenting lessons learned from pre-disaster mitigation efforts, exercises, and actual incidents, and applying that learning, where applicable, to the CIKR protection context;
- Conducting CIKR protection public awareness activities; and
- Assuring energy resilience through energy self reliance."[43]

[43] *State Energy Assurance Guidelines*, *supra note* 3, at 18-19.

Public and Private Sector Plan Coordination

Energy-sector infrastructure protection is particularly complex because physical energy assets—those that would be considered critical infrastructure—are generally privately-owned, but subject to State regulation. Consequently, public-private partnerships are vital to effective CIKR protection and resilience because over 85 percent of critical infrastructure in the U.S. is privately owned.[44] Owners and operators of energy sector assets have well-developed protocols that identify high-priority assets at any given time and ensure business continuity and operational reliability.

The DOE ESSP identifies three major areas that can help a state's preparedness and ability to respond:

1. Knowledge of major assets;
2. Assets locations; and
3. Impact on the delivery of energy.

MCAC expanded and integrated the State's plan in part to improve this kind of information sharing between law enforcement and the private sector.

CIKR protection has become a highly collaborative effort involving federal, state and local governments, and private sector owner/operators. The following sections describe key players in each area, as well as their roles and responsibilities. Public-private partnerships and NIPP's Partnership Framework are discussed later in this section.

Frameworks to Support NIPP-Envisioned Public- Private Partnerships

As mentioned earlier, the large amount of critical infrastructure that is privately owned necessitates strong public-private partnerships to effectively protect the CIKR.

Department of Energy (DOE)

As part of the NIPP and ESSP, DOE created an organizational structure for public-private partnerships, to complement existing activities and programs, which will benefit both sectors and provides energy sector owners and operators with an efficient partnership model.[45] DOE's structure calls for sector coordinating councils (SCCs), a government coordinating council and sector working groups. The GCC is to be composed of representatives from federal, state, local, tribal and territorial levels of government, and it is to develop and prioritize security programs and initiatives supporting the NIPP and ESSP. The SCCs (one in electricity and another in oil and natural gas) are to be composed of energy sector-specific owners, operators, associations and other entities, and they are to coordinate with the government on a wide range of CIKR protection activities and issues, including policy and planning.

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[44] Office of Homeland Security, White House, *National Strategy for Homeland Security* 33 (2002) [hereinafter *National Strategy for Homeland Security*], *available at* http://www.dhs.gov/xlibrary/assets/nat_strat_hls.pdf.

[45] DOE's commitment to a mutually beneficial partnership is evident in its ESSP, where it outlines the value private sector members gain by participating in NIPP/ESSP initiatives, which are largely voluntary. *See Energy Sector Specific Plan*, *supra note* 8, at 19, 24, 75.

North American Electric Reliability Corporation (NERC)

NERC is the electric reliability organization (ERO) certified by FERC to establish and enforce reliability standards for the bulk-power system. DOE designated NERC as the electricity sector coordinator for critical infrastructure protection. NERC's Critical Infrastructure Protection Committee (CIPC) coordinates all of NERC's efforts to improve physical and cyber security for the bulk of America's power system. The CIPC Executive Committee and NERC's President and CEO serve as the ESCC and collaborate with DOE and DHS on critical infrastructure and security matters. NERC also serves as the electricity sector for Information Sharing and Analysis Center.

NERC oversees eight regional reliability entities in the U.S. and Canada. Maryland is part of the Reliability*First* Corporation, a regional electricity reliability council under NERC, which services thirteen states and the District of Columbia. Reliability*First* develops and enforces regional reliability standards which define the reliability requirements for planning and operating regional bulk power systems.[46] It has its own CIP Committee.[47]

Other NIPP Framework Collaborative Efforts

In addition to SCCs, NERC CIPC, and their respective working groups, the ESSP/NIPP partnership framework includes other collaborative CIKR protection and information sharing efforts that impact Maryland and its CIP Program. These are the Critical Infrastructure Protection Advisory Council (CIPAC), the Electricity Sector Information Sharing and Analysis Center (ESISAC) and HSIN. As part of the NIPP, DHS established CIPAC, which works with DOE and facilitates interaction among government representatives and representatives of CIKR owners and operators in each sector. ESISAC and HSIN provide ways for the energy industry to share and analyze important information about vulnerabilities, threats, intrusions and anomalies. These also enable the energy industry to communicate with and provide support to the federal government, primarily through collaborating with DOE. Both ESISAC and DHS-HSIN can be used to share information about other critical infrastructures, and complement information sharing efforts accessible through DOE's secure ISERnet website (discussed above).

Other CIKR-Related Energy Sector Organizations

In addition to DOE's energy sector organizational structure, a number of public-private partnerships and organizations exist that can enhance Maryland's CIP Program efforts.

[46] North American Electric Reliability Corporation, *Standards: Regional Reliability Standards* (n.d.) [hereinafter *Standards: Regional Reliability Standards*], *available at* http://www.nerc.com/page.php?cid=2|97 (last visited Jan. 30, 2012).

[47] Maryland Public Service Commission of Maryland, *Ten Year Plan (2009-2018) of Electric Companies in Maryland* 1 (2010) [hereinafter *PSC Ten-Year Plan (2009-2018)*, *available at* http://webapp.psc.state.md.us/Intranet/ Reports/2009-2018%20Ten%20Year%20Plan.pdf.

InfraGard

InfraGard is a partnership between the FBI and the private sector that facilitates information sharing and analysis efforts. Association members include businesses, academic institutions, state and local law enforcement agencies and other participants.

Maryland participates in InfraGard through the InfraGard Maryland Members Alliance (IMMA), headquartered at the FBI's Baltimore field office.[48] IMMA is one of the most active InfraGard chapters in the nation with over 700 actively registered members.[49] The MCAC Executive Director is considering having a representative from InfraGard assist with providing resources during an emergency.[50]

American Petroleum Institute (API)

Since September 11th, 2001, API has been partnering with the natural gas industry and federal government to continuously evaluate and strengthen energy industry CIKR security. As an active participant in public-private partnerships, API has collaborated with federal authorities to produce several security guidelines that have become industry standards, such as the *Security Guidelines for the Petroleum Industry*.

API has a State Petroleum Council Network, through which state offices can address legislative and regulatory issues. Maryland is part of the Eastern Region, along with 11 other states and the District of Columbia. There is also the Maryland Petroleum Council in Annapolis, which has its own working group that directs State efforts.

National Association of State Energy Officials (NASEO)

The National Association of State Energy Officials (NASEO) is a national non-profit organization that represents state government energy offices. NASEO coordinates a number of state-level energy related functions, including coordinating energy emergency response, developing energy emergency plans and developing best practices for energy security and reliability. MEA is NASEO's Maryland affiliate, and MEA's Director is the 2011-2012 Board Chairman.

Regional Consortium Coordinating Council (RCCC)

Formed by DHS in 2008, the RCCC brings together "established regional entities into a unified forum for coordination with DHS and the established CIKR sector framework."[51] The RCCC coordinates CIKR protection efforts within geographic areas and across jurisdictional boundaries so that best practices, lessons learned and other means of support can be shared.

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[48] InfraGard Maryland Members Alliance, *About InfraGard* (n.d.) [hereinafter *About InfraGard*], *available at* http://www.mdinfragard.net/beta/about (last visited Jan. 30, 2012).

[49] *About InfraGard*, *supra note* 48.

[50] *Phase II Assessment*, *supra note* 41, at 28.

[51] Regional Consortium Coordinating Council, *Home Page* (n.d.) [hereinafter *RCCC Home Page*] *available at* http://www.r-ccc.org/ (last visited June 7, 2011).

National Association of Regulatory Utility Commissioners (NARUC)

Similar in function to NASEO, NARUC, composed of commissioners from utility regulatory bodies in each state, regulates utilities (energy, water, and telecommunications) at the state level. NARUC's Committee on Critical Infrastructure is the focal point for public utilities' CIKR protection efforts, and provides "state regulators a forum to analyze solutions to utility infrastructure security and delivery concerns."[52]

PSC is a member of NARUC.[53] PSC's responsibility as a member of NARUC is to assure reliable utility service at a fair and reasonable rate.[54] The regional association for public utility regulation, the Mid-Atlantic Conference of Regulatory Utilities Commissioners (MACRUC), advances region-wide public interest by ensuring proper adherence to public utility regulation, competitive rates and exchange of information between MARCUC, regional state public utility commissions and federal commissions and departments that are represented in the NARUC.[55] Lawrence Brenner from PSC serves as Co-Chair of the Committee on Electricity, and Michael Krauthamer from PSC sits as Co-Chair of the Staff Subcommittee on Electricity within MARCUC.[56]

The National Governors Association (NGA)

The National Governors Association (NGA) represents governors' offices and state legislators. Its Center for Best Practices and the National Conference of State Legislatures (NCSL), respectively, develop energy security policies and play major roles in responding to energy emergencies. The Center also works with DOE-OE to raise awareness among governors about energy assurance issues, and to increase coordination and cooperation among state-level homeland security officials, state energy officials and private-sector energy players.

Regional CIKR-Related Energy Sector Organizations

All-Hazards Consortium (AHC)

AHC is a non-profit organization guided by the states of Delaware, Maryland, New Jersey, New York, North Carolina, Pennsylvania, Virginia, West Virginia and the District of Columbia. AHC's mission is to "help create new resources and funding opportunities for the states to support regional multi-state collaboration efforts among our stakeholders from government, private sector, higher education and

[52] National Association of Regulatory Utility Commissioners, *Committee on Critical Infrastructure* (n.d.) [hereinafter *Committee on Critical Infrastructure*], *available at* http://www.naruc.org/committees.cfm?c=46# (last visited Jan. 30, 2012).

[53] National Association of Regulatory Utility Commissioners, *Home Page* (n.d.) [hereinafter *NARUC Home Page*], *available at* http://www.naruc.org/ (last visited Jan. 30, 2012).

[54] *NARUC Home Page*, *supra note* 53..

[55] Mid-Atlantic Conference of Regulatory Utilities Commissioners, *About* (n.d.) [hereinafter *MACRUC About*], *available at* http://macruc.narucmeetings.org/about.cfm (last visited Jan. 30, 2012).

[56] *MACRUC About*, *supra note* 54.

non-profit/volunteer organizations."[57] The State of Maryland utilizes its membership in AHC to facilitate interstate partnerships for coordination in a number of areas, including CIKR protection.

Conclusion

Critical infrastructure protection requires the participation and efforts of many different agencies across all levels of government and private stakeholders. By effectively tracking, monitoring and sharing necessary information concerning CIKR, infrastructure will be more secure, and energy disruptions will be minimized. Similarly, fast and efficient recovery from energy disruptions is made possible when impacted sectors understand which assets are necessary and share information as appropriate. CIKR protection is a continuing effort that will necessarily change and evolve as new threats are discovered and technology changes.

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[57] *See* All-Hazards Consortium, *Who Is the AHC* (n.d.) [hereinafter *Who Is the AHC*], *available at* http://www.ahcusa.org/whoIs.htm (last visited Jan. 30, 2012).

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Chapter 9. Emergency Communications

Introduction and Overview of Emergency Communications

Maryland is susceptible to many natural and manmade emergency events, and communications systems and plans have been established and tested in anticipation of these events. Depending on the type and scale of an emergency, fast and reliable communications are often required between Maryland State agencies, local municipalities and agencies, private entities, bordering state agencies and the federal government.[1] The Maryland Emergency Management Agency (MEMA) is the primary State agency for emergency communications and planning, is subject to federal guidance, engages in regional coordination and planning and interacts with local jurisdictions regarding emergency response.

At the federal level, Maryland's emergency communications follows the National Incident Management System/Incident Command System (NIMS/ICS). In addition, Maryland is part of the Federal Emergency Management Agency's (FEMA's) Region III, which also includes Pennsylvania, the District of Columbia, Virginia, Delaware, and West Virginia.[2] Based in Philadelphia, FEMA Region III consists of 140 full-time employees, as well as 500 on-call Disaster Assistance Employees able to assist during a Presidential disaster declaration.[3] In order to "prepare for, protect against, respond to, recover from and mitigate all hazards," FEMA Region III maintains strong communication with a Regional Advisory Council, whose membership includes the Executive Director of MEMA, the Director of Baltimore City's Mayor's Office of Emergency Management, a Maryland law enforcement representative, one Maryland Mayor, and the Regional Emergency Communications Coordination Working Group (RECCWG). The RECCWG provides a "regional [emergency] coordination point" for federal, state, and local governments within Region III.[4]

As a member of FEMA Region III, Maryland works closely with the Department of Homeland Security (DHS) Office of Emergency Communications (OEC). OEC was created by Congress, in response to the communications challenges witnessed during Hurricane Katrina, to improve emergency responders' and government officials' ability to continuously communicate and to enhance interoperability during a natural disaster, act of terrorism, or other emergency.[5]

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[1] Maryland Emergency Management Agency, *State of Maryland Core Plan for Emergency Operations* (2009) [hereinafter *State of Maryland Core Plan for Emergency Operations*], *available at* http://www.mema.state.md.us/MEMA/content/pdf/The_State_of_Maryland_Emergency_Operations_Plan_26Aug09.pdf.

[2] *State of Maryland Core Plan for Emergency Operations, supra note* 1, at 12-13 .

[3] Federal Emergency Management Agency, *Region III,* [hereinafter *FEMA Region III*], *available at* http://www.fema.gov/about/regions/regioniii/#2 (last visited May 27, 2011).

[4] FEMA, *Region III*, *supra note* 2.

[5] Department of Homeland Security, *About the Office of Emergency Communications, available at* http://www.dhs.gov/xabout/structure/gc_1189774174005.shtm (last visited June 6, 2011).

Maryland (through MEMA) also participates in regional emergency communications planning as a part of the National Capital Region (NCR), as well as with Delaware and Virginia on the Delmarva Emergency Task Force (DETF).[6]

The NCR consists of the cities of Alexandria and Falls Church, counties of Arlington, Fairfax, Loudon and Prince William in Virginia, the District of Columbia and the Counties of Montgomery and Prince George's in Maryland.[7] Together, along with the DHS Office for National Capital Region Coordination (NCRC), non-profit organizations and private sector interests, these partners develop guidelines, a governance structure, and preparedness plans to "reduce the vulnerability of the National Capital Region (NCR) from terrorist attacks."[8] The NCR governance structure includes regional working groups as well as regional emergency support function committees.

The Delmarva Emergency Task Force consists of Maryland's nine counties east of the Chesapeake Bay, along with Ocean City, Maryland, which comprise the Eastern Shore; the entire State of Delaware; and the two Virginia counties on the Eastern Shore.[9] DETF meets within five work-groups to coordinate a regional response to emergencies,[10] including one work group specifically focused on communications.[11]

Within Maryland, communications plans are guided by the National Emergency Communications Plan (NECP). In addition, Maryland has five interoperability regions, with which the State, through MEMA and the Statewide Interoperability Program Management Office, coordinates emergency communications planning and operation, as well as interoperable communications programs, systems and planning. A touchstone of this coordination is the annually-updated Statewide Communications Interoperability Plan (SCIP), which is a locally-driven, multi-jurisdictional and multidisciplinary statewide plan to enhance emergency communications interoperability and enable seamless communication throughout participating locations.[12]

This chapter first addresses statewide and federal emergency communications, followed by local jurisdictions' emergency communications.

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[6] *State of Maryland Core Plan for Emergency Operations, supra note* 1, at 8-9.

[7] National Capital Region Homeland Security Program, *About the NCR Program*, [hereinafter *About the NCR Program*] *available at* http://www.ncrhomelandsecurit y.org/overview.asp (last visited Jan. 20, 2012).

[8] *About the NCR Program, supra note* 7.

[9] *State of Maryland Core Plan for Emergency Operations, supra note* 1, at 5.

[10] Maryland State Archives, *Interstate Agencies*, *Delmarva Emergency Task Force* [hereinafter *Delmarva Emergency Task Force*], *at* http://www.msa.md.gov/msa/mdmanual/38inters/html/07delmar.html (last visited Jan. 20, 2012).

[11] *Delmarva Emergency Task Force, supra note* 10.

[12] U.S. Department of Homeland Security, *National Emergency Communications Plan* (Aug. 2008), at 1-2, *available at* http://www.dhs.gov/xlibrary/assets/national_emergency_communications_plan.pdf (last visited Jan. 20, 2012).

Statewide Communications

MEMA is responsible for the State's emergency communications operations and planning, and, in doing so, coordinates with the Statewide Interoperability Coordinator, Statewide Interoperability Program Management Office, the State's interoperability regions and local jurisdictions.

MEMA coordinates emergency communications through its Maryland Joint Operations Center (MJOC),[13] which operates twenty-four hours a day, seven days a week[14] and is the central hub for emergency communications within the State Emergency Operations Center (SEOC).[15] Created in 2004, the MJOC monitors emergency responders in the State, as well as military activities and potential weather or disaster threats throughout the country. MJOC personnel are in constant communication using radios, email, landline and cellular phones, WebEOC and other modes of communication.[16] The MJOC works in conjunction with the Maryland Coordination and Analysis Center (MCAC) and uses communications networks to coordinate with local, State, and federal agencies. The MCAC is the State's fusion center for information collection, analysis, and dissemination related to crimes and homeland security.[17] MCAC "provide[s] analytical support for federal, state and local agencies involved in law enforcement, fire, emergency medical and response services, public health and welfare, public safety and homeland security."[18] When necessary, the MJOC and MCAC communicate and coordinate with appropriate federal agencies including FEMA, DHS, the Department of Health and Human Services (DHHS), the Federal Bureau of Investigation (FBI), and the Central Intelligence Agency (CIA).

NIMS/ICS and Maryland Communications

NIMS and ICS are discussed in Chapter 5; however, NIMS and ICS affect emergency communications primarily in two ways. Two focal points of NIMS are communication and information management.[19] The communications component of NIMS is to have a flexible yet constant flow of information.[20] This involves maintaining a "common operating picture; interoperability; reliability, scalability, and

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[13] *State of Maryland Core Plan for Emergency Operations, supra note* 1, at 27.

[14] *State of Maryland Core Plan for Emergency Operations, supra note* 1, at 27.

[15] *State of Maryland Core Plan for Emergency Operations, supra note* 1, at 27.

[16] Maryland Joint Operations Center, *available at* http://www.mema.state.md.us/MEMA/jsp/portlets/mjoc.jsp (last visited Jan. 20, 2012).

[17] University of Maryland. *Maryland Communication and Analysis Center Project* [hereinafter *Maryland MCAC Project*] *available at* http://www.psttap.org/MCAC.asp (last visited Jan. 20, 2012).

[18] *Maryland MCAC Project, supra note* 17.

[19] Federal Emergency Management Agency, *Communications and Information Management Overview*, *available at* http://www.fema.gov/emergency/nims/CommunicationsInfoMngmnt.shtm (last visited Jan. 20, 2012).

[20] U.S. Department of Homeland Security, *National Incident Management System,* 23 (December 2008) [hereinafter *National Incident Management System*], *available at* http://www.fema.gov/pdf/emergency/nims /NIMS_core.pdf (last visited Jan. 20, 2012).

portability; and resiliency and redundancy of any system and its components."[21] These are discussed below.

Common Operating Picture

In order to create and maintain a common operating picture, information is gathered from various on-scene, off-scene, and web-based sources.[22] The information gathered includes weather reports, updates on damage, power outages, responder and community needs and available resources.[23] Information is relayed by phone calls, radio contact, standardized forms that are faxed or emailed, fact-checked media reports or individual emails. Once the information is collated, synthesized and vetted, it is disseminated by Incident Command (IC).[24]

Interoperability

In order to effectively manage an energy emergency, coordinated decision-making is essential between jurisdictions and agencies, as well as between government agencies and private firms.[25] Recognizing this necessity, Governor Martin O'Malley placed interoperable communications as the State's top preparedness priority.[26] Operationally, interoperability means that emergency responders and their affiliated agencies have the ability to seamlessly communicate via voice, data or video communications systems during a declared emergency.[27] Communications interoperability is achieved when:

1. Radios and computer programs are compatible,
2. Communications policies between agencies and jurisdictions are standardized,
3. Inter-jurisdictional agreements for promoting interoperable communication exist,
4. Equipment is up to date and maintained, and
5. Personnel are trained to use the interoperable communication devices.[28]

Additionally, standardized incident reporting methods and procedures must be in place, data collection and monitoring (including geospatial data collection) must follow techniques that are standard in the industry, and personnel must be trained in these standards.[29]

To guide and coordinate the State's interoperability efforts, the State's Interoperability Program Management Office in the Department of Information and Technology (DoIt) implements the SCIP, which involves updating outdated first responder voice and data communications systems and

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[21] *National Incident Management System, supra note* 20*,* at 23.
[22] *National Incident Management System, supra note* 20*,* at 23.
[23] *National Incident Management System, supra note* 20*,* at 23.
[24] *National Incident Management System, supra note* 20*,* at 23-24.
[25] *National Incident Management System, supra note* 20*,* at 24.
[26] Office of Governor Martin O'Malley, *Maryland's Strategic Goals and Objectives for Homeland Security,* 4 (Jan. 15, 2009), *available at* http://www.governor.maryland.gov/documents/hsgoals&objectives090115.pdf (last visited Jan. 20, 2012). *See also* The Governor's Office of Homeland Security, *The Governor's 12 Core Goals for a Prepared Maryland, available at* http://www.gohs.maryland.gov/ (last visited Jan. 20, 2012).
[27] *National Incident Management System, supra note* 20*,* at 24.
[28] *National Incident Management System, supra note* 20*,* at 25-26.
[29] *National Incident Management System, supra note* 20*,* at 27-28.

equipment, participating in common language communications protocols, signing Memoranda of Understanding (MOUs) among agencies and jurisdictions and instituting training programs that teach user-skills for the new systems and equipment.

Reliability, Portability and Scalability

Maryland's implementation of its SCIP will improve communications reliability by employing new voice and data communications systems and equipment, including the new statewide 700 MHz radio communications system and statewide computer-aided-dispatch/records-management/automatic-vehicle-locator/automated-field- reporting systems (CAD/RMS/AVL/AFR). These systems are to provide enhanced communications capabilities and resources among State agencies and local jurisdictions. In addition, these systems will enhance portability by further enabling new and existing voice and data communications systems and equipment to function efficiently and effectively across state agencies, interoperability regions, and local jurisdictions. Also, these systems will enhance the scalability of communications by allowing for increasing numbers of users.[30] All of these attributes improve emergency communications by creating a system that is versatile and able to adapt to the responders' needs during an energy emergency.

Resiliency and Redundancy

A resilient communications system is not only resistant to fire, water, accidental drops and other physical damage, but is also robust enough to operate during a power outage.[31] Radios must be strong, have long battery lives, back-up chargers and/or batteries, and communications centers must have independent generators to ensure that batteries can be charged and that computers, phones, lights, and other essential communications devices can be used.

[30] *National Incident Management System, supra note* 20*,* at 24.

[31] *National Incident Management System, supra note* 20, at 24.

Local Communications

Local emergency operations centers (EOCs) serve as the primary jurisdictional communications centers during an emergency and initially use available resources from their respective jurisdictions.[32] In Maryland, there are a total of twenty-six local EOCs composed of twenty-three county EOCs and three city EOCs.[33] When local resources are exhausted, local emergency management agencies notify the MJOC. MEMA then determines whether to activate the SEOC and offer available resources from the State.[34]

Common Operating Picture

The majority of local EOCs in Maryland use the WebEOC system to collect, collate and synthesize needed information.[35] WebEOC is a "web-enabled crisis information management system" that allows emergency responders to communicate in near real time and to pull information from government, private and public websites and databases to aid coordinated response efforts.[36] All entries to WebEOC are vetted through the SEOC before being posted to the wider incident board. Much like a physical EOC, WebEOC becomes the Internet-based situational awareness nexus where situational updates, needs and available resources are entered, information is collated and tasks are prioritized and assigned.

WebEOC includes a geographic information system (GIS) component, known as the Emergency Management Mapping Application (EMMA), which has the capability to develop and update static and real-time incident maps.[37] EMMA is used in conjunction with the incident board function of WebEOC to locate power outages, determine who is on the scene, what needs and resources are available and what level of priority is assigned to those needs. WebEOC also provides a consolidated method of information gathering and allows for time-stamping and tracking that are important not only during an incident, but in post-incident assessments.

When an energy emergency occurs, the designated local emergency manager (EM) opens a named "incident" window in WebEOC. The incident window is a compilation of data entry and provision screens where status boards, task lists and real-time maps may be created for the energy emergency. The applicable local, State and federal agencies, in addition to the local emergency manager, emergency liaison officers and private utility companies, are granted varying levels of access to the site based upon

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[32] *State of Maryland Core Plan for Emergency Operations, supra note* 1, at 34.

[33] Maryland Emergency Management Agency, *Local Emergency Management Directors, available at* http://www.mema.state.md.us/MEMA/content_page.jsp?TOPICID=emmgrs (last visited Jan. 20, 2012).

[34] *State of Maryland Core Plan for Emergency Operations, supra note* 1, at 12.

[35] Many state agencies utilize the WebEOC system. *See e.g.* Inland Area Committee Meeting in Richmond, VA (Sept. 18, 2007), *available at* www.nrt.org/...nsf/.../2007_Meetings/.../Inland_Area_Committee_Meeting.doc.

[36] Esi911, *WebEOC, available at* http://www.esi911.com/esi/index.php?option=com_content&task=view&id =14&Itemid=30 (last visited Jan. 20, 2012).

[37] EMMA will soon be replaced by a newer system, OSPREY, which is partially available on MEMA's website, *available at* http://www.mema.state.md.us/mema2/map2.html.

need and level of involvement. The level of WebEOC access dictates whether the designee is allowed to post or simply view the information on the site. Designees with rights to full access have the ability to cross-post necessary information across the WebEOC system to all users. In addition, the Public Service Commission (PSC) is granted the ability to post information such as power outages. Other organizations are granted specific access and posting rights on a case-by-case basis. In an energy emergency, other applicable organizations might be granted access and/or posting ability to the WebEOC system.

Interoperability

Maryland's local jurisdictions and regional communications entities have implemented, and continue to implement, voice and data communications systems and equipment to further enhance interoperability, as well as efficient and effective emergency communications. In this regard, a number of jurisdictions have implemented enhanced intra-jurisdictional communications systems, such as Prince George's County's 700 MHz radio system, Baltimore City's 800 MHz radio system and the Salisbury Mutual Assistance Group's (SMAG) updating of its radio inventory to 700 MHz radios, which allows SMAG to patch in with the local fire department and other first responders. Also in this regard, Maryland's regional communications entities continue to implement interoperable communications systems, such as the Central Maryland Area Radio Communications system. In terms of coordination with the State to further enhance interoperable communications, local jurisdictions can choose to participate in the upcoming Statewide 700 MHz radio and CAD/RMS/AVL/AFR systems.

Resiliency and Redundancy

In addition to voice and data communications systems, local jurisdictions have resilient and redundant communications via mobile communications units, backup power sources and alternative communications locations. In Maryland, local EOCs are equipped with generators and enough fuel to supply 24 to 96 hours of electricity. Many local EOCs also have alternate locations and mobile communications units to ensure communications operability when the primary EOC loses power. The mobile communications units are vehicles or trailers, housing computers, radios, telephones, and other communications equipment, which can be driven to the site of an incident if needed.

In addition, current and upcoming communications systems have built-in redundancies, as many of the components (e.g., base stations, transmitters and receivers) have built-in redundant circuitry to maintain functionality if one component fails. Communications networks themselves have dual paths between transmission sites to reduce the possibility of having one single point of failure. In addition, many new radios are programmed with a "talk around" function that allows for limited communications within an immediate area, should towers be lost in severe weather events or other adverse conditions.

Communication with the Public

When MEMA is notified of an energy emergency, a determination is made as to whether public information regarding the emergency will originate from the Public Information Officers (PIOs) of the utility involved, from the media, or from MJOC. If the emergency is deemed to require activating the SEOC, the dissemination of public information follows the Joint Information Center (JIC) structure,[38] as defined by the National Response Framework (NRF), NIMS and Emergency Support Function (ESF) 15.[39] When an emergency is imminent, MEMA's public information officer (PIO) and MJOC assume responsibility for developing clear, concise and uniform messages ready for distribution to public and private entities, the media and the public.

On-site PIOs at MJOC, collect information about a potential event and draft a uniform message that is disseminated to local radio and television stations. In addition, PIOs are recruited from specified organizations to assist with news-gathering and message-control. The PIOs are designated based upon the jurisdiction in which the emergency occurs and the PIOs respective areas of expertise and other relevant criteria. These PIOs monitor the media, work on rumor control, gather and verify facts, vet[40] information with appropriate government officials or other entities and give interviews to the media.

A single PIO is sent to the utility site of the incident, if a particular utility is involved, and two PIOs report to the local EOC where the event has occurred to gather on-site information and relay that information back to MJOC. MJOC then develops and disseminates coordinated public statements. Statements from MJOC are in the form of situation reports, press releases and other public information documents. In addition, MJOC develops talking points for government officials, as well as a general list of emergency preparedness talking points for officials and PIOs.

Some emergencies call for instant information dissemination. The most immediate type of message that MEMA disseminates is an emergency alert. If an event requiring immediate evacuation or sheltering is likely to occur, MEMA's emergency alert system (EAS) is engaged. MJOC prepares and disseminates a succinct message of less than fifteen seconds in duration to local broadcasters who, in turn, immediately post the warning. Tornadoes, hurricanes and severe winter storms are among the potentially life-threatening weather events that could have a significant impact on the energy grid and would most likely prompt activation of the EAS.

Local jurisdictions also have the ability to notify citizens through EAS notifications. For example, Montgomery County offers an emergency alert that is texted to an individual's cellular phone, emailed

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[38] The JIC structure as applied in Maryland is discussed in further detail below in the "Unified Messaging and Coordination" section of this chapter.

[39] U.S. Department of Homeland Security, *Public Affairs Support Annex,* 1 (Jan. 2008), *available at* http://www.fema.gov/pdf/emergency/nrf/nrf-support-pa.pdf (last visited Jan. 20, 2012). *See also National Incident Management System, supra note* 20, at 29 (Describes JIS and JIC).

[40] Note that the vetting process is extremely important to MEMA as it does not exercise ultimate authority or control when stepping onto a scene. The purpose of the MJOC at MEMA is, rather, to serve as a support and guidance team for the local authorities.

to their personal or business email address, tweeted or instant messaged on Twitter and Facebook or broadcast on XM Radio.[41] A number of other local jurisdictions also have the capabilities to send emergency alert notifications through a variety of media.

Public Information Campaigns

During an energy emergency, Maryland must deliver a message that speaks effectively to the public, stakeholders and the media. An informed public helps avoid the misallocation of limited resources, prevents those resources from being wasted and allows response and recovery plans to be executed as efficiently as possible, all of which helps to minimize the potential public harm caused by an energy emergency. A primary component of the NIMS is "Public Information." FEMA explains that:

> Public Information consists of the processes, procedures, and systems to communicate timely, accurate, and accessible information on the incident's cause, size, and current situation to the public, responders, and additional stakeholders (both directly affected and indirectly affected). Public information must be coordinated and integrated across jurisdictions, agencies, and organizations; among Federal, State, tribal, and local governments; and with NGOs [non-governmental organizations] and the private sector.
>
> Well-developed public information, education strategies, and communications plans help to ensure that lifesaving measures, evacuation routes, threat and alert systems, and other public safety information are coordinated and communicated to numerous audiences in a timely, consistent manner.[42]

The National Association of State Energy Officials (NASEO) recognizes that during an energy emergency, two types of public information campaigns, informational and educational, should be used: "The first is to help the public understand the nature of the problem and prevent panic. The second is to encourage appropriate responses including conservation and energy use reduction programs."[43]

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[41] Montgomery County Maryland, *Welcome to Alert Montgomery, available at* https://alert.montgomerycountymd.gov/ (last visited on May 16, 2011).

[42] Federal Emergency Management Agency, *Public Information Overview* [hereinafter *Public Information Overview*], *available at* http://www.fema.gov/emergency/nims/PublicInformation.shtm (last visited Jan. 23, 2012).

[43] National Association of State Energy Officials: *State Energy Assurance Guidelines* (Dec. 2009), *available at* http://www.naseo.org/eaguidelines/State_Energy_Assurance_Guidelines_Version_3.1.pdf (last visited Jan. 23, 2012).

Both informational and educational campaigns are discussed in greater detail below and share the following elements:

- Using the internet and social media, in addition to other media, to expand coverage;
- Directly providing emergency information to customers from utilities;
- A unified message with coordination between the public relations efforts of the utilities, PSC and MEMA;
- Use of a designated State PIO from MEA, PSC, MEMA or the Governor's Office of Homeland Security (GOHS), when State action is necessary.

Informational Campaign

An informational campaign should be designed to provide "clear and concise updates of the situation" and the steps being taken to provide relief. Elements of an effective campaign include:

- Timely updates from a single source;
- Tailored information for at-risk communities (including the elderly and individuals with functional needs);
- Contact information for emergency response agencies;
- Requests and tips for energy conservation;
- Location of shelters; and
- Other important information.

It is important to avoid assigning blame, while at the same time being direct about what is occurring. Whether the emergency is natural (e.g., a hurricane) or man-made (e.g., a terrorist attack), people need enough information to understand what is happening and to become motivated to respond appropriately. Because of the widespread types of possible scenarios that may prompt an energy emergency, most of this messaging cannot be crafted in advance.

Local officials should receive at least as much information as the media and public (through the various modes explained previously). For public information purposes, the most common practice is for a PIO from the applicable government office to report to MJOC to collect critical information and assist in crafting a coordinated message for the public. In addition, a designated PIO or other communications representative at Incident Command would be tasked with the duty to contact local officials and keep them abreast of events as they occur. This might be done via telephone, fax, email or WebEOC.

Educational Campaign

An educational campaign advises the public on ways to minimize energy consumption and to limit the inconvenience an energy disruption causes. Many elements of an educational campaign can be borrowed from energy efficiency and emergency preparedness campaigns. The key is to focus on concrete, actionable steps that members of the public can take. Besides providing direct assistance to resolve an emergency, effective action messages can help mitigate the negative emotions segments of the public may likely experience.

MEMA is the Primary Agency for ESF-5 (Emergency Management), which involves collecting, analyzing, crafting and distributing "critical information" regarding emergency operations during an energy emergency. If coordinated communications are required of the State, DoIT is involved as the Primary Agency for ESF-2 (Communications). Throughout the process, Maryland's Department of Natural Resources (DNR), Maryland Department of Transportation (MDOT), MEA and PSC, as the Support Agencies, provide subject matter and status support for those communications. Together with other designated PIOs, these organizations would collect pertinent information and craft coordinated messages to inform the public regarding topics such as:

- The potential impacts of energy shortages or disruptions to the community;
- Preventive measures to help avoid or reduce the impacts if energy supply shortages or disruptions were to occur; and
- Conservation measures to be taken before, during and after energy emergencies to help the State recover from supply shortages and disruptions.

Guide for Crafting and Delivering an Effective Message

Understanding how to craft a message that effectively speaks to the public, stakeholders, and media covering a crisis is a necessary skill for successfully managing any emergency. Accordingly, great care must be taken prior to releasing any message to ensure its accuracy, which is essential to maintaining the public's trust. "In a serious crisis, all affected people take in information differently, process information differently, and act on information differently."[44] Both informational and educational public message campaigns should:

- Focus on one or two key topics;
- Have background information pre-scripted;
- Use talking points;
- Designate a spokesperson(s) for media interviews;
- Avoid talking about other agencies' activities; and
- Address rumors and inaccurate information.

Messages in a crisis should follow the "STARCC" principle: simple, timely, accurate, relevant, credible and consistent.

Simple: We live in an era of media sound bites. While people want a detailed account of what is going on, they generally expect the news/message to be delivered in an efficient, easily understandable manner. One way to deliver a simple message is to create action steps in threes, rhymes or acronyms. Technical jargon should be avoided if possible.[45]

Timely: During an energy emergency, it is important that the State take prompt action to communicate its messages to the public. The longer the public is deprived of a clear message, the more likely it is that

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[44] Centers for Disease Control, *Crisis & Emergency Risk Communication*, [hereinafter *CERC*], *available at* http://www.bt.cdc.gov/CERC/ (last visited Jan. 23, 2012); *see also* Center for Disease Control, CERC PANDEMIC INFLUENZA (Oct. 2007) [hereinafter *CERC Pandemic Influenza*], *available at* http://www.bt.cdc.gov/cerc/pdf/CERC-PandemicFlu-OCT07.pdf.

[45] *Crisis & Emergency Risk Communication, supra note* 44; see also *CERC Pandemic Influenza, supra note* 44.

rumors containing misinformation will spread. False rumors or misinformation must be countered in real time.[46]

Accurate: The need to deliver a timely message must be balanced against the need to deliver an accurate message. There should also be a mechanism to verify the accuracy of all messages. Rushing the delivery of a message increases the probability of an error, which will create confusion and cause increased anxiety or panic.[47]

Relevant: Each message should relate directly to the goals of the associated informational or educational campaigns. Messages that address other issues risk losing the public's attention or redirecting the course of the public discussion. By staying on-point, the State can deliver to the public the information necessary to weather the emergency.[48]

Credible: Messages need to be credible about the scope of the problem and response. The public needs to be assured that responders understand the magnitude of the problem, and to trust that those responders will do what they say. If the public finds either message not credible, then it will likely lose confidence in the response. The focus should be on what is known, and what the responders are doing based on that knowledge as well as what remains unknown, and the steps being taken to answer those questions. The message should emphasize positive steps taken by responders to rectify the situation, without ignoring the negatives. Do not get trapped into promising achievement of specific goals or benchmarks that rely on factors beyond direct control. Failure to deliver on these commitments will undermine all future credibility.[49]

Consistent: All agencies involved should work together to deliver a unified, consistent message. Conflicting reports from a variety of sources can undermine the public's trust and receptiveness. While repetition can be a useful technique for message delivery, it is important that repetition not become paternalistic or condescending. The message should reach as many citizens as possible, convey the necessary information in a clear manner and use accessible language.[50]

Empathy

In addition to employing STARCC, it is important to express empathy early, without appearing to patronize. In an emergency situation, the public wants to know that those in charge, whether from the government or other stakeholders, care about them. To the extent responders can convey that they understand the burdens imposed on people by the emergency, the more receptive the public will be to pleas to conserve energy.

Part of this is setting the right tone. Perhaps the worst instruction is, "Don't panic!," as this will likely only increase the collective panic. The public seeks a message that promises hope through a description

[46] *Crisis & Emergency Risk Communication, supra note* 44; see also *CERC Pandemic Influenza, supra note* 44.
[47] *Crisis & Emergency Risk Communication, supra note* 44; see also *CERC Pandemic Influenza, supra note* 44.
[48] *Crisis & Emergency Risk Communication, supra note* 44; see also *CERC Pandemic Influenza, supra note* 44.
[49] *Crisis & Emergency Risk Communication, supra note* 44; see also *CERC Pandemic Influenza, supra note* 44.
[50] *Crisis & Emergency Risk Communication, supra note* 44; see also *CERC Pandemic Influenza, supra note* 44.

of real and concrete steps that will be taken. Humor should be avoided, as should condescending and judgmental phrases. Using these rhetorical devices undercuts the government's credibility in understanding the scope of the emergency and the extent of people's suffering.

Unified Messaging and Coordination

Coordinating public information requires a mechanism for interagency cooperation and procedures to assure that public statements are "timely, accurate, and consistent."[51] Accordingly, "a specific office should be assigned the responsibility for the public information program."[52] Pursuant to Executive Order 01.01.1991.02, effective June 1, 2009, Governor O'Malley approved and promulgated the State of Maryland Emergency Operations Core Plan, as part of the Comprehensive Emergency Management Program.[53] The Core Plan sets forth "the policy and systems, scope and the roles and responsibilities of State departments and agencies with regard to disaster and emergency response and is consistent with Federal plans, procedures and guidelines."[54] The Core Plan requires each "department or agency" to choose a PIO "to coordinate announcements and the release of information during and after an emergency and to participate in the [JIC]."[55]

A JIC is a centralized location to facilitate the cooperation of multiple partners in a joint information system (JIS). A JIS allows the State to speak with one voice. As FEMA states, it:

> provides the mechanism to organize, integrate, and coordinate information to ensure timely, accurate, accessible, and consistent messaging across multiple jurisdictions and/or disciplines with nongovernmental organizations and the private sector. . . . A JIS includes the plans, protocols, procedures, and structures used to provide public information. Federal, State, tribal, territorial, regional, or local Public Information Officers and established . . . JICs . . . are critical supporting elements of the JIS.[56]

The number of PIOs involved depends upon the type, extent, and affected area of a disaster. All State agencies involved designate a PIO, as do local governments who are affected. Additionally, affected utility providers provide at least one PIO to work with the JIC. MEMA is responsible for "[c]ooperat[ing] with State agencies and local jurisdictions to maintain the JIC."[57]

When the SEOC is activated, a JIC is opened and State, tribal, non-profit and private organizations provide PIOs to assist at the JIC. In addition to outside PIOs, the JIC is composed of at least three internal PIOs – one focused on print media, another for electronic media such as radio and television and one

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[51] Governor Martin O'Malley's Exec. Order No. 01.01.1991.02 (June 1, 2009).

[52] Governor Martin O'Malley's Exec. Order No. 01.01.1991.02 (June 1, 2009).

[53] Governor Martin O'Malley's Exec. Order No. 01.01.1991.02 (June 1, 2009).

[54] *State of Maryland Core Plan for Emergency Operations, supra note* 1, at 12.

[55] *State of Maryland Core Plan for Emergency Operations, supra note* 1, at 12.

[56] *Public Information Overview*, *supra note* 42.

[57] *State of Maryland Core Plan for Emergency Operations, supra note* 1, at 12.

that is deployed to the field, but who communicates directly with State, local and internal JIC PIOs. The JIC also houses the JIC Team Leader, who assigns duties and manages JIC staff, an Assistant Team Leader, State agency and local government liaisons, a Governor's Press Office Liaison, a Rumor Control Officer, a Media Monitor, a WebEOC Records Monitor and Administrative Support. The JIC provides a public hotline and monitors traditional and social media. While a single JIC location is preferable in most emergencies, "the system is flexible and adaptable enough to accommodate virtual or multiple JIC locations, as required."[58] The JIC follows a four step process:

- Gathering information: information is gathered from field PIOs, field command, emergency operations center (EOC) staff/briefings, public hotline, social media and traditional media.
- Verifying information: information is verified by comparing notes with other PIOs in the JIC, checking with EOC sources and checking with field PIOs.
- Coordinating information: information is coordinated by jointly identifying key messages, obtaining approval and clearance from entities participating in the messaging and through a final review.
- Disseminating information: information is disseminated through multiple methods, after which EOC and field command are notified that the messaging has been sent, and traditional and social media are monitored for any reporting on that messaging.[59]

In support of its JIC and SEOC operations, MEMA maintains a list of off-hour contact information for federal agency, State agency and local government representatives, and coordinates with PSC and MEA to have similar access to key stakeholders in industry. MEMA is also responsible for coordinating similar communication with cross-jurisdictional entities, such as in the NCR.[60]

Maryland PIO Awareness Course

MEMA, as the Governor's designated ICS/NIMS trainer and the primary provider of FEMA-approved PIO trainings in Maryland, offers a four-day PIO Awareness Course. The course, which is composed of three parts, is designed to train PIOs and other individuals with public information roles in effective public communication skills through written, oral and media outreach. Courses like this further Maryland's goal of providing the best possible public information program.

Social Media

Social media uses web-based and mobile technologies such as Facebook, Twitter and YouTube to facilitate interactive communication. Government and utilities can both disseminate information to as well as gather information from the public using these technologies. According to an August 2010 Red Cross survey, one out of every five adults would use digital means to contact responders if they needed help and could not reach an emergency call center. In addition, 69 percent of adults think first

[58] *State of Maryland Core Plan for Emergency Operations, supra note* 1, at 12.
[59] *State of Maryland Core Plan for Emergency Operations, supra note* 1, at 12.
[60] *State of Maryland Core Plan for Emergency Operations, supra note* 1, at 12.

responders should be monitoring social media sites in order to quickly answer requests for help. Moreover, 35 percent indicated they would post a request for help directly on a response agency's Facebook page. As FEMA Administrator Craig Fugate has said, "[r]ather than trying to convince the public to adjust to the way we . . . communicate, we must adapt to the way the public communicates by leveraging the tools that people use on a daily basis."[61]

Many Maryland agencies are developing or already use social media such as Twitter and Facebook. For example, MEMA, MEA, the Maryland Transit Authority (MTA), the Baltimore Police Department, Anne Arundel County Police Department, and Montgomery County Fire Department may be followed on Twitter. Also, a non-exhaustive list of Maryland agencies with Facebook accounts includes MEA, MEMA, the Maryland State Police (MSP), MDOT, and the Maryland Transportation Authority (MdTA) Police. MEMA also posts to a micro-blog as part of its efforts to disseminate information. During activations of the SEOC, the JIC regularly monitors social media sites for relevant information.

Conclusion

Past experience during emergency response has shown the value of coordinated, interoperable and unified communications. As the State's central command for emergency response, MEMA is responsible for distributing a single, clear message to the media, the public and to other State and federal agencies. MEMA is aided in this effort by local and agency PIOs that gather and feed information to MEMA's PIO at the MJOC. Ignoring this system, while disseminating conflicting, partial and confusing information through many different sources slows response time, increases panic and interferes with efficient emergency response.

[61] Craig Fugate, Federal Emergency Management Agency, Administrator, *Understanding the Power of Social Media as a Communication Tool in the Aftermath of Disasters*, Testimony before the Senate Committee on Homeland Security and Governmental Affairs, (May 5, 2011), *available at* http://www.fema.gov/pdf/about /programs/legislative/testimony/2011/5_5_2011_use_of_social_media_in_disasters.pdf (last visited Jan. 23, 2012).

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Appendix A. Glossary

Actual peak reduction: The actual reduction in annual peak load (measured in kilowatts or megawatts) achieved by customers that participate in a utility demand-side management (DSM) program. It reflects the changes in the demand for electricity resulting from a utility DSM program that is in effect at the same time the utility experiences its annual peak load, as opposed to the installed peak load reduction capability (i.e., potential peak reduction). It should account for the regular cycling of energy efficient units during the period of annual peak load.

Alternative-fuel vehicle (AFV): A vehicle designed to operate on an alternative fuel (e.g., compressed natural gas, methane blend, electricity). The vehicle could be either a dedicated vehicle designed to operate exclusively on alternative fuel or a non-dedicated vehicle designed to operate on alternative fuel and/or a traditional fuel.

American Recovery and Reinvestment Act (ARRA) of 2009: Legislation aimed at creating new jobs, saving existing jobs, spurring economic activity, and promoting transparency in government spending. Part of the ARRA provided $275 billion for federal contracts, grants, and loans. This is what is funding development of Energy Assurance Plans around the United States, including Maryland.

Aviation gasoline (finished): A complex mixture of relatively volatile hydrocarbons with or without small quantities of additives, blended to form a fuel suitable for use in aviation reciprocating engines. Fuel specifications are provided in ASTM Specification D 910 and Military Specification MIL-G-5572. *Note:* Data on blending components are not counted in data on finished aviation gasoline.

Backup fuel: In a central heat pump system, the fuel used in the furnace that takes over the space heating when the outdoor temperature drops below that which is feasible to operate a heat pump.

Backup Generator: A generator that is used only for test purposes, or in the event of an emergency, such as a shortage of power needed to meet customer load requirements.

Backup power: Electric energy supplied by a utility to replace power and energy lost during an unscheduled equipment outage.

Base load: The minimum amount of electric power delivered or required over a given period of time at a steady rate.

Base load capacity: The generating equipment normally operated to serve loads on an around-the-clock basis.

Base load plant: A plant, usually housing high-efficiency steam-electric units, which is normally operated to take all or part of the minimum load of a system, and which consequently produces electricity at an essentially constant rate and runs continuously. These units are operated to maximize system mechanical and thermal efficiency and minimize system operating costs.

Base rate: A fixed kilowatt hour charge for electricity consumed that is independent of other charges and/or adjustments.

Biodiesel: Any liquid biofuel suitable as a diesel fuel substitute or diesel fuel additive or extender. Biodiesel fuels are typically made from oils such as soybeans, rapeseed, or sunflowers, or from animal tallow. Biodiesel can also be made from hydrocarbons derived from agricultural products such as rice hulls.

Biofuels: Liquid fuels and blending components produced from biomass (plant) feedstocks, used primarily for transportation.

Biomass: Organic non-fossil material of biological origin constituting a renewable energy source.

British thermal unit (Btu): The quantity of heat required to raise the temperature of 1 pound of liquid water by 1 degree Fahrenheit at the temperature at which water has its greatest density (approximately 39 degrees Fahrenheit).

Btu: The abbreviation for British thermal unit(s).

Btu conversion factors: Btu conversion factors for site energy are as follows:

Electricity	3,412 Btu/kilowatthour
Natural Gas	1,031 Btu/cubic foot
Fuel Oil No.1	135,000 Btu/gallon
Kerosene	135,000 Btu/gallon
Fuel Oil No.2	138,690 Btu/gallon
LPG (Propane)	91,330 Btu/gallon
Wood	20 million Btu/cord

Coal: A readily combustible black or brownish-black rock whose composition, including inherent moisture, consists of more than 50 percent by weight and more than 70 percent by volume of carbonaceous material. It is formed from plant remains that have been compacted, hardened, chemically altered, and metamorphosed by heat and pressure over geologic time.

Consumption (Electricity): The electricity demand over a period of time (Megawatt hours, MWh).

Code of Federal Regulations: A compilation of the general and permanent rules of the executive departments and agencies of the Federal Government as published in the Federal Register. The code is divided into 50 titles that represent broad areas subject to Federal regulation. Title 18 contains the FERC regulations.

Crude oil: A mixture of hydrocarbons that exists in liquid phase in natural underground reservoirs and remains liquid at atmospheric pressure after passing through surface separating facilities. Depending upon the characteristics of the crude stream, it may also include:

1. Small amounts of hydrocarbons that exist in gaseous phase in natural underground reservoirs but are liquid at atmospheric pressure after being recovered from oil well (casing head) gas in lease separators and are subsequently commingled with the crude stream without being separately measured. Lease condensate recovered as a liquid from natural gas wells in lease or field separation facilities and later mixed into the crude stream is also included;

2. Small amounts of non-hydrocarbons produced with the oil, such as sulfur and various metals;

3. Drip gases, and liquid hydrocarbons produced from tar sands, oil sands, gilsonite, and oil shale.

Liquids produced at natural gas processing plants are excluded. Crude oil is refined to produce a wide array of petroleum products, including heating oils; gasoline, diesel and jet fuels; lubricants; asphalt; ethane, propane, and butane; and many other products used for their energy or chemical content.

Crude oil input: The total crude oil put into processing units at refineries.

Crude oil production: The volume of crude oil produced from oil reservoirs during given periods of time. The amount of such production for a given period is measured as volumes delivered from lease storage tanks (i.e., the point of custody transfer) to pipelines, trucks, or other media for transport to refineries or terminals with adjustments for (1) net differences between opening and closing lease inventories, and (2) basic sediment and water (BS&W).

Deliverability: Represents the number of future years during which a pipeline company can meet its annual requirements for its presently certificated delivery capacity from presently committed sources of supply. The availability of gas from these sources of supply shall be governed by the physical capabilities of these sources to deliver gas by the terms of existing gas-purchase contracts, and by limitations imposed by State or Federal regulatory agencies.

Delivered cost: The cost of fuel, including the invoice price of fuel, transportation charges, taxes, commissions, insurance, and expenses associated with leased or owned equipment used to transport the fuel.

Delivered energy: The amount of energy delivered to the site (building); no adjustment is made for the fuels consumed to produce electricity or district sources. This is also referred to as net energy.

Delivered (gas): The physical transfer of natural, synthetic, and/or supplemental gas from facilities operated by the responding company to facilities operated by others or to consumers.

Deliveries (electric): Energy generated by one system and delivered to another system through one or more transmission lines.

Diesel-electric plant: A generating station that uses diesel engines to drive its electric generators.

Diesel fuel: A fuel composed of distillates obtained in petroleum refining operation or blends of such distillates with residual oil used in motor vehicles. The boiling point and specific gravity are higher for diesel fuels than for gasoline.

Diesel fuel system: Diesel engines are internal combustion engines that burn diesel oil rather than gasoline. Injectors are used to spray droplets of diesel oil into the combustion chambers, at or near the top of the compression stroke. Ignition follows due to the very high temperature of the compressed intake air, or to the use of "glow plugs," which retain heat from previous ignitions (spark plugs are not used). Diesel engines are generally more fuel-efficient than gasoline engines but must be stronger and heavier because of high compression ratios

Distillate fuel oil: A general classification for one of the petroleum fractions produced in conventional distillation operations. It includes diesel fuels and fuel oils. Products known as No. 1, No. 2, and No. 4 diesel fuel are used in on-highway diesel engines, such as those in trucks and automobiles, as well as off-highway engines, such as those in railroad locomotives and agricultural machinery. Products known as No. 1, No. 2, and No. 4 fuel oils are used primarily for space heating and electric power generation.

EIA: The Energy Information Administration. An independent agency within the U.S. Department of Energy that develops surveys, collects energy data, and analyzes and models energy issues. The Agency must meet the requests of Congress, other elements within the Department of Energy, Federal Energy Regulatory Commission, the Executive Branch, its own independent needs, and assist the general public, or other interest groups, without taking a policy position. See more information about EIA at http://www.eia.doe.gov/neic/aboutEIA/aboutus.htm.

Electric Customer Choice and Competition Act of 1999: Act that deregulated electric generation prices and opened retail markets to competition.

Electric generation industry: Stationary and mobile generating units that are connected to the electric power grid and can generate electricity. The electric generation industry includes the “electric power sector” (utility generators and independent power producers) and industrial and commercial power generators, including combined-heat-and-power producers, but excludes units at single-family dwellings.

Electric generator: A facility that produces only electricity, commonly expressed in kilowatt hours (kWh) or megawatt hours (MWh). Electric generators include electric utilities and independent power producers.

Electric hybrid vehicle: An electric vehicle that either (1) operates solely on electricity, but contains an internal combustion motor that generates additional electricity (series hybrid); or (2) contains an electric system and an internal combustion system and is capable of operating on either system (parallel hybrid).

Electric industry restructuring: The process of replacing a monopolistic system of electric utility suppliers with competing sellers, allowing individual retail customers to choose their supplier but still receive delivery over the power lines of the local utility. It includes the reconfiguration of vertically-integrated electric utilities.

Electric motor vehicle: A motor vehicle powered by an electric motor that draws current from rechargeable storage batteries, fuel cells, photovoltaic arrays, or other sources of electric current.

Electric power: The rate at which electric energy is transferred. Electric power is measured by capacity and is commonly expressed in megawatts (MW).

Electric power grid: A system of synchronized power providers and consumers connected by transmission and distribution lines and operated by one or more control centers. In the continental United States, the electric power grid consists of three systems: the Eastern Interconnect, the Western Interconnect, and the Texas Interconnect. In Alaska and Hawaii, several systems encompass areas smaller than the State (e.g., the interconnect serving Anchorage, Fairbanks, and the Kenai Peninsula; individual islands).

Electric power plant: A station containing prime movers, electric generators, and auxiliary equipment for converting mechanical, chemical, and/or fission energy into electric energy.

Electric power sector: An energy-consuming sector that consists of electricity only and combined heat and power (CHP) plants whose primary business is to sell electricity, or electricity and heat, to the public--i.e., North American Industry Classification System 22 plants.

Electric power system: An individual electric power entity--a company; an electric cooperative; a public electric supply corporation as the Tennesse Valley Authority; a similar Federal department or agency such as the Bonneville Power Administration; the Bureau of Reclamation or the Corps of Engineers; a municipally owned electric department offering service to the public; or an electric public utility district (a "PUD"); also a jointly owned electric supply project such as the Keystone.

Electricity Demand: Instantaneous electricity load requirement (Megawatts, MW).

Emergency: The failure of an electric power system to generate or deliver electric power as normally intended, resulting in the cutoff or curtailment of service.

Emergency backup generation: The use of electric generators only during interruptions of normal power supply.

Emergency energy: Electric energy provided for a limited duration, intended only for use during emergency conditions.

EmPOWER Maryland Energy Efficiency Act of 2008: Legislation that, among other things, calls for each electric company in the state to cost effectively reduce: (1) per capita overall electricity consumption by 10 percent by the end of 2015; and (2) per capita peak electricity demand by 15 percent by 2015. *See* http://energy.maryland.gov/facts/empower.html for additional information.

Energy demand: Instantaneous energy load need; the requirement for energy as an input to provide products or services.

Energy reserves: Estimated quantities of energy sources that are demonstrated to exist with reasonable certainty on the basis of geologic and engineering data (proved reserves) or that can reasonably be expected to exist on the basis of geologic evidence that supports projections from proved reserves (probable/indicated reserves). Knowledge of the location, quantity, and grade of probable/indicated reserves is generally incomplete or much less certain than it is for proved energy reserves. *Note:* This term is equivalent to "Demonstrated Reserves" as defined in the resource/reserve classification contained in the U.S. Geological Survey Circular 831, 1980. Demonstrated reserves include measured and indicated reserves but exclude inferred reserves.

Energy service provider: An energy entity that provides service to a retail or end-use customer.

Energy source: Any substance or natural phenomenon that can be consumed or transformed to supply heat or power. Examples include petroleum, coal, natural gas, nuclear, biomass, electricity, wind, sunlight, geothermal, water movement, and hydrogen in fuel cells.

Energy supply: Energy made available for future disposition. Supply can be considered and measured from the point of view of the energy provider or the receiver.

Energy supplier: Fuel companies supplying electricity, natural gas, fuel oil, kerosene, or LPG (liquefied petroleum gas) to the household.

Federal Energy Regulatory Commission (FERC): The Federal agency with jurisdiction over interstate electricity sales, wholesale electric rates, hydroelectric licensing, natural gas pricing, oil pipeline rates, and gas pipeline certification. FERC is an independent regulatory agency within the Department of Energy and is the successor to the Federal Power Commission.

Federal Power Act: Enacted in 1920, and amended in 1935, the Act consists of three parts. The first part incorporated the Federal Water Power Act administered by the former Federal Power Commission, whose activities were confined almost entirely to licensing non-Federal hydroelectric projects. Parts II and III were added with the passage of the Public Utility Act. These parts extended the Act's jurisdiction to include regulating the interstate transmission of electrical energy and rates for its sale as wholesale in interstate commerce. The Federal Energy Regulatory Commission is now charged with the administration of this law.

Federal Power Commission (FPC): The predecessor agency of the Federal Energy Regulatory Commission. The Federal Power Commission was created by an Act of Congress under the Federal Water Power Act on June 10, 1920. It was charged originally with regulating the electric power and natural gas industries. It was abolished on September 30, 1977, when the Department of Energy was created. Its functions were divided between the Department of Energy and the Federal Energy Regulatory Commission, an independent regulatory agency.

Federal region: In a Presidential directive issued in 1969, various Federal agencies (among them the currently designated Department of Health and Human Services, the Department of Labor, the Office of Economic Opportunity, and the Small Business Administration) were instructed to adopt a uniform field system of 10 geographic regions with common boundaries and headquarters cities. The action was taken to correct the evolution of fragmented Federal field organization structures that each agency or component created independently, usually with little reference to other agencies' arrangements. Most Federal domestic agencies or their components have completed realignments and relocations to conform to the Standard Federal Administration Regions (SFARs).

Fleet vehicle: Any motor vehicle a company owns or leases that is in the normal operations of a company. Vehicles which are used in the normal operation of a company, but are owned by company employees are not fleet vehicles. If a company provides services in addition to providing natural gas, only those vehicles that are used by the natural gas provider portion of a company should be counted as fleet vehicles. Vehicles that are considered "off-road" (e.g., farm or construction vehicles) or demonstration vehicles are not to be counted as fleet vehicles. Fleet vehicles include gasoline/diesel powered vehicles and alternative-fuel vehicles.

Fossil fuel: An energy source formed in the earth's crust from decayed organic material. The common fossil fuels are petroleum, coal, and natural gas.

Fossil-fuel electric generation: Electric generation in which the prime mover is a turbine rotated by high-pressure steam produced in a boiler by heat from burning fossil fuels.

Fossil fuel plant: A plant using coal, petroleum, or gas as its source of energy.

Fuel: Any material substance that can be consumed to supply heat or power. Included are petroleum, coal, and natural gas (the fossil fuels), and other consumable materials, such as uranium, biomass, and hydrogen.

Fuel cell: A device capable of generating an electrical current by converting the chemical energy of a fuel (e.g., hydrogen) directly into electrical energy. Fuel cells differ from conventional electrical cells in that the active materials such as fuel and oxygen are not contained within the cell but are supplied from outside. It does not contain an intermediate heat cycle, as do most other electrical generation techniques.

Fuel cycle: The entire set of sequential processes or stages involved in the utilization of fuel, including extraction, transformation, transportation, and combustion. Emissions generally occur at each stage of the fuel cycle.

Fuel emergencies: An emergency that exists when supplies of fuels or hydroelectric storage for generation are at a level or estimated to be at a level that would threaten the reliability or adequacy of bulk electric power supply. The following factors should be taken into account to determine that a fuel emergency exists:

1. Fuel stock or hydroelectric project water storage levels are 50 percent or less of normal for that particular time of the year and a continued downward trend in fuel stock or hydroelectric project water storage level is estimated; or

2. Unscheduled dispatch or emergency generation is causing an abnormal use of a particular fuel type, such that the future supply of stocks of that fuel could reach a level that threatens the reliability or adequacy of bulk electric power supply.

Fuel ethanol (C_2H_5OH): An anhydrous denatured aliphatic alcohol intended for gasoline blending.

Fuel oil: A liquid petroleum product less volatile than gasoline, used as an energy source. Fuel oil includes distillate fuel oil (No. 1, No. 2, and No. 4), and residual fuel oil (No. 5 and No. 6).

Fuel oil supplier: See Energy supplier.

Gas plant operator: Any firm, including a gas plant owner, which operates a gas plant and keeps the gas plant records. A gas plant is a facility in which natural gas liquids are separated from natural gas or in which natural gas liquids are fractionated or otherwise separated into natural gas liquid products or both.

Gas processing unit: A facility designed to recover natural gas liquids from a stream of natural gas that may or may not have passed through lease separators and/or field separation facilities. Another function of natural gas processing plants is to control the quality of the processed natural gas stream. Cycling plants are considered natural gas processing plants.

Gas turbine plant: A plant in which the prime mover is a gas turbine. A gas turbine consists typically of an axial-flow air compressor and one or more combustion chambers where liquid or gaseous fuel is burned and the hot gases are passed to the turbine and where the hot gases expand drive the generator and are then used to run the compressor.

Gas well: A well completed for production of natural gas from one or more gas zones or reservoirs. Such wells contain no completions for the production of crude oil.

Gasoline grades: The classification of gasoline by octane ratings. Each type of gasoline (conventional, oxygenated, and reformulated) is classified by three grades - Regular, Midgrade, and Premium. *Note:* Gasoline sales are reported by grade in accordance with their classification at the time of sale. In general, automotive octane requirements are lower at high altitudes. Therefore, in some areas of the United States, such as the Rocky Mountain States, the octane ratings for the gasoline grades may be 2 or more octane points lower.

> **Regular gasoline:** Gasoline having an antiknock index, i.e., octane rating, greater than or equal to 85 and less than 88. *Note:* Octane requirements may vary by altitude.
>
> **Midgrade gasoline:** Gasoline having an antiknock index, i.e., octane rating, greater than or equal to 88 and less than or equal to 90. Note: Octane requirements may vary by altitude.
>
> **Premium gasoline:** Gasoline having an antiknock index, i.e., octane rating, greater than 90. *Note:* Octane requirements may vary by altitude. s or fluids at various depths beneath the surface of the earth. The energy is extracted by drilling and/or pumping.

Gasoline motor, (leaded): Contains more than 0.05 grams of lead per gallon or more than 0.005 grams of phosphorus per gallon. The actual lead content of any given gallon may vary. Premium and regular grades are included, depending on the octane rating. Includes leaded gasohol; blendstock is excluded until blending has been completed; and alcohol that is to be used in the blending of gasohol is also excluded.

Gate station or City Gate: Location where the pressure of natural gas being transferred from the transmission system to the distribution system is lowered for transport through small diameter, low pressure pipelines.

Generating facility: An existing or planned location or site at which electricity is or will be produced.

Generating station: A station that consists of electric generators and auxiliary equipment for converting mechanical, chemical, or nuclear energy into electric energy.

Generating unit: Any combination of physically connected generators, reactors, boilers, combustion turbines, and other prime movers operated together to produce electric power.

Generation: The process of producing electric energy by transforming other forms of energy; also, the amount of electric energy produced, expressed in kilowatt-hours.

Generation company: An entity that owns or operates generating plants. The generation company may own the generation plants or interact with the short-term market on behalf of plant owners.

Generator capacity: The maximum output, commonly expressed in megawatts (MW), that generating equipment can supply to system load, adjusted for ambient conditions.

Geothermal energy: Hot water or steam extracted from geothermal reservoirs in the earth's crust. Water or steam extracted from geothermal reservoirs can be used for geothermal heat pumps, water heating, or electricity generation.

Geothermal plant: A plant in which the prime mover is a steam turbine. The turbine is driven either by steam produced from hot water or by natural steam that derives its energy from heat found in rock

Greenhouse Gas Emissions Reduction Act of 2009: Legislation requiring a 25 percent reduction in greenhouse gas emissions by 2020, from 2006 levels.

Heat pump: Heating and/or cooling equipment that, during the heating season, draws heat into a building from outside and, during the cooling season, ejects heat from the building to the outside. Heat pumps are vapor-compression refrigeration systems whose indoor/outdoor coils are used reversibly as condensers or evaporators, depending on the need for heating or cooling.

Heat pump (air source): An air-source heat pump is the most common type of heat pump. The heat pump absorbs heat from the outside air and transfers the heat to the space to be heated in the heating mode. In the cooling mode the heat pump absorbs heat from the space to be cooled and rejects the heat to the outside air. In the heating mode when the outside air approaches 32o F or less, air-source heat pumps loose efficiency and generally require a back- up (resistance) heating system.

Heat pump (geothermal): A heat pump in which the refrigerant exchanges heat (in a heat exchanger) with a fluid circulating through an earth connection medium (ground or ground water). The fluid is contained in a variety of loop (pipe) configurations depending on the temperature of the ground and the ground area available. Loops may be installed horizontally or vertically in the ground or submersed in a body of water.

Heating equipment: Any equipment designed and/or specifically used for heating ambient air in an enclosed space. Common types of heating equipment include: central warm air furnace, heat pump, plug-in or built-in room heater, boiler for steam or hot water heating system, heating stove, and fireplace. *Note:* A cooking stove in a housing unit is sometimes reported as heating equipment, even though it was built for preparing food.

Housing unit: A house, an apartment, a group of rooms, or a single room if it is either occupied or intended for occupancy as separate living quarters by a family, an individual, or a group of one to nine unrelated persons. Separate living quarters means the occupants (1) live and eat separately from other persons in the house or apartment and (2) have direct access from the outside of the buildings or through a common hall--that is, they can get to it without going through someone else's living quarters. Housing units do not include group quarters such as prisons or nursing homes where ten or more unrelated persons live. A common dining area used by residents is an indication of group quarters. Hotel and motel rooms are considered housing units if occupied as the usual or permanent place of residence.

Incentives Demand-Side Management (DSM) program assistance: This DSM program assistance offers monetary or non-monetary awards to encourage consumers to buy energy-efficient equipment and to participate in programs designed to reduce energy usage. Examples of incentives are zero or low-interest loans, rebates, and direct installation of low cost measures, such as water heater wraps or duct work for distributing the cool air; the units condition air only in the room or areas where they are located.

Independent power producer: A corporation, person, agency, authority, or other legal entity or instrumentality that owns or operates facilities for the generation of electricity for use primarily by the public, and that is not an electric utility.

Independent system operator (ISO): An independent, federally regulated entity established to coordinate regional transmission in a non-discriminatory manner and ensure the safety and reliability of the electric system.

Indicated resources (Coal): Coal for which estimates of the rank, quality, and quantity are based partly on sample analyses and measurements and partly on reasonable geologic projections. Indicated resources are computed partly from specified measurements and partly from projection of visible data for a reasonable distance on the basis of geologic evidence. The points of observation are 1/2 to 1-1/2 miles apart. Indicated coal is projected to extend as a 1/2-mile-wide belt that lies more than 1/4 mile from the outcrop, points of observation, or measurement.

Insulation: Any material or substance that provides a high resistance to the flow of heat from one surface to another. The different types include blanket or batt, foam, or loose fill, which are used to reduce heat transfer by conduction. Dead air space is an insulating medium in storm windows and storms as it reduces passage of heat through conduction and convection. Reflective materials are used to reduce heat transfer by radiation.

Insulation around heating and/or cooling ducts: Extra insulation around the heating and/or cooling ducts intended to reduce the loss of hot or cold air as it travels to different parts of the residence.

Insulation around hot-water pipes: Wrapping of insulating material around hot-water pipes to reduce the loss of heat through the pipes.

Insulation around water heater: Blanket insulation wrapped around the water heater to reduce loss of heat. To qualify under this definition, this wrapping must be in addition to any insulation provided by the manufacturer.

Interruptible gas: Gas sold to customers with a provision that permits curtailment or cessation of service at the discretion of the distributing company under certain circumstances, as specified in the service contract.

Interruptible load: This Demand-Side Management category represents the consumer load that, in accordance with contractual arrangements, can be interrupted at the time of annual peak load by the action of the consumer at the direct request of the system operator. This type of control usually involves large-volume commercial and industrial consumers. Interruptible Load does not include Direct Load Control.

Interruptible or curtailable rate: A special electricity or natural gas arrangement under which, in return for lower rates, the customer must either reduce energy demand on short notice or allow the electric or natural gas utility to temporarily cut off the energy supply for the utility to maintain service for higher priority users. This interruption or reduction in demand typically occurs during periods of high demand for the energy (summer for electricity and winter for natural gas).

Interruptible power: Power and usually the associated energy made available by one utility to another. This transaction is subject to curtailment or cessation of delivery by the supplier in accordance with a prior agreement with the other party or under specified conditions.

Interstate companies: Natural gas pipeline companies subject to Federal Energy Regulatory Commission (FERC) jurisdiction.

Interstate pipeline: Any person engaged in natural gas transportation subject to the jurisdiction of Federal Energy Regulatory Commission (FERC) under the Natural Gas Act.

Jet fuel: A refined petroleum product used in jet aircraft engines. It includes kerosene-type jet fuel and naphtha-type jet fuel.

Kerosene: A light petroleum distillate that is used in space heaters, cook stoves, and water heaters and is suitable for use as a light source when burned in wick-fed lamps. Kerosene has a maximum distillation temperature of 400 degrees Fahrenheit at the 10-percent recovery point, a final boiling point of 572 degrees Fahrenheit, and a minimum flash point of 100 degrees Fahrenheit. Included are No. 1-K and No. 2-K, the two grades recognized by ASTM Specification D 3699 as well as all other grades of kerosene called range or stove oil, which have properties similar to those of No. 1 fuel oil. Also see Kerosene-type jet fuel.

Kerosene-type jet fuel: A kerosene-based product having a maximum distillation temperature of 400 degrees Fahrenheit at the 10-percent recovery point and a final maximum boiling point of 572 degrees Fahrenheit and meeting ASTM Specification D 1655 and Military Specifications MIL-T-5624P and MIL-T-83133D (Grades JP-5 and JP-8). It is used for commercial and military turbojet and turboprop aircraft engines.

Commercial: Kerosene-type jet fuel intended for use in commercial aircraft.

Military: Kerosene-type jet fuel intended for use in military aircraft.

Kilowatt (kW): One thousand watts.

Kilowatt-electric (kWe): One thousand watts of electric capacity.

Kilowatt hour (kWh): A measure of electricity defined as a unit of work or energy, measured as 1 kilowatt (1,000 watts) of power expended for 1 hour. One kWh is equivalent to 3,412 Btu.

Leaded gasoline: A fuel that contains more than 0.05 gram of lead per gallon or more than 0.005 gram of phosphorus per gallon.

Leaded premium gasoline: Gasoline having an antiknock index (R+M/2) greater than 90 and containing more than 0.05 grams of lead or 0.005 grams of phosphorus per gallon.

Leaded regular gasoline: Gasoline having an antiknock index (R+M/2) greater than or equal to 87 and less than or equal to 90 and containing more than 0.05 grams of lead or 0.005 grams of phosphorus per gallon.

Load (electric): The amount of electric power delivered or required at any specific point or points on a system. The requirement originates at the energy-consuming equipment of the consumers.

Load control program: A program in which the utility company offers a lower rate in return for having permission to turn off the air conditioner or water heater for short periods of time by remote control. This control allows the utility to reduce peak demand.

Local distribution company (LDC): A legal entity engaged primarily in the retail sale and/or delivery of natural gas through a distribution system that includes mainlines (that is, pipelines designed to carry large volumes of gas, usually located under roads or other major right-of-ways) and laterals (that is, pipelines of smaller diameter that connect the end user to the mainline). Since the restructuring of the gas industry, the sale of gas and/or delivery arrangements may be handled by other agents, such as producers, brokers, and marketers that are referred to as "non-LDC."

Loss of service (15 minutes): Any loss in service for greater than 15 minutes by an electric utility of firm loads totaling more than 200 MW, or 50 percent of the total load being supplied immediately prior to the incident, whichever is less. However, utilities with a peak load in the prior year of more than 3000 MW are only to report losses of service to firm loads totaling more than 300 MW for greater than 15 minutes. (The DOE shall be notified with service restoration and in any event, within three hours after the beginning of the interruption.)

Main heating fuel: The form of energy used most frequently to heat the largest portion of the floor space of a structure. The energy source designated as the main heating fuel is the source delivered to the site for that purpose, not any subsequent form into which it is transformed on site to deliver the heat energy (e.g., for buildings heated by a steam boiler, the main heating fuel is the main input fuel to the boiler, not the steam or hot water circulated through the building.) *Note:* In commercial buildings, the heating must be to at least 50 degrees Fahrenheit.

Mains: A system of pipes for transporting gas within a distributing gas utility's retail service area to points of connection with consumer service pipes.

Megawatt (MW): One million watts of electricity.

Megawatt electric (MWe): One million watts of electric capacity.

Megawatt hour (MWh): One thousand kilowatt-hours or 1 million watt-hours.

Mutual Assistance Agreement: Enables state agencies to share fuel with emergency services personnel, such as police and fire, at the state and local levels.

National Association of Regulatory Utility Commissioners (NARUC): An affiliation of the public service commissioners to promote the uniform treatment of members of the railroad, public utilities, and public service commissions of the 50 states, the District of Columbia, the Commonwealth of Puerto Rico, and the territory of the Virgin Islands.

National Association of State Energy Officials (NASEO): An affiliation of the state energy offices and federal government to improve the effectiveness and quality of state energy programs and policies, provide policy input and analysis, share successes among the states, and to be a repository of information on issues of particular concern to the states and their citizens.

Natural gas: A gaseous mixture of hydrocarbon compounds, the primary one being methane.

Natural gas field facility: A field facility designed to process natural gas produced from more than one lease for the purpose of recovering condensate from a stream of natural gas; however, some field facilities are designed to recover propane, normal butane, pentanes plus, etc., and to control the quality of natural gas to be marketed.

Natural gas gross withdrawals: Full well-stream volume of produced natural gas, excluding condensate separated at the lease.

Natural gas hydrates: Solid, crystalline, wax-like substances composed of water, methane, and usually a small amount of other gases, with the gases being trapped in the interstices of a water-ice lattice. They form beneath permafrost and on the ocean floor under conditions of moderately high pressure and at temperatures near the freezing point of water.

Natural gas liquids (NGL): Those hydrocarbons in natural gas that are separated from the gas as liquids through the process of absorption, condensation, adsorption, or other methods in gas processing or cycling plants. Generally such liquids consist of propane and heavier hydrocarbons and are commonly referred to as lease condensate, natural gasoline, and liquefied petroleum gases. Natural gas liquids include natural gas plant liquids (primarily ethane, propane, butane, and isobutane; see Natural Gas Plant Liquids) and lease condensate (primarily pentanes produced from natural gas at lease separators and field facilities).

Natural gas liquids production: The volume of natural gas liquids removed from natural gas in lease separators, field facilities, gas processing plants, or cycling plants during the report year.

Natural gas marketed production: Gross withdrawals of natural gas from production reservoirs, less gas used for reservoir re-pressuring, non-hydrocarbon gases removed in treating and processing operations, and quantities vented and flared.

Natural gas plant liquids: Those hydrocarbons in natural gas that are separated as liquids at natural gas processing plants, fractionating and cycling plants, and, in some instances, field facilities. Lease condensate is excluded. Products obtained include ethane; liquefied petroleum gases (propane, butanes, propane-butane mixtures, ethane-propane mixtures); isopentane; and other small quantities of finished products, such as motor gasoline, special naphthas, jet fuel, kerosene, and distillate fuel oil.

Natural Gas Policy Act of 1978 (NGPA): Signed into law on November 9, 1978, the NGPA is a framework for the regulation of most facets of the natural gas industry.

Natural gas processing plant: Facilities designed to recover natural gas liquids from a stream of natural gas that may or may not have passed through lease separators and/or field separation facilities. These facilities control the quality of the natural gas to be marketed. Cycling plants are classified as gas processing plants.

Natural gas utility demand-side management (DSM) program sponsor: A DSM (demand-side management) program sponsored by a natural gas utility that suggests ways to increase the energy efficiency of buildings, to reduce energy costs, to change the usage patterns, or to promote the use of a different energy source.

Natural gasoline: A term used in the gas processing industry to refer to a mixture of liquid hydrocarbons (mostly pentanes and heavier hydrocarbons) extracted from natural gas. It includes isopentane.

Natural Gasoline and Isopentane: A mixture of hydrocarbons, mostly pentanes and heavier, extracted from natural gas, that meets vapor pressure, end-point, and other specifications for natural gasoline set by the Gas Processors Association. Includes isopentane which is a saturated branch-chain hydrocarbon, (C_5H_{12}), obtained by fractionation of natural gasoline or isomerization of normal pentane.

Net generation: The amount of gross generation less the electrical energy consumed at the generating station(s) for station service or auxiliaries. *Note*: Electricity required for pumping at pumped-storage plants is regarded as electricity for station service and is deducted from gross generation.

Nonattainment area: Any area that does not meet the national primary or secondary ambient air quality standard established by the Environmental Protection Agency for designated pollutants, such as carbon monoxide and ozone.

North American Electric Reliability Council (NERC): A council formed in 1968 by the electric utility industry to promote the reliability and adequacy of bulk power supply in the electric utility systems of North America. NERC consists of regional reliability councils and encompasses essentially all the power regions of the contiguous United States, Canada, and Mexico. See the various NERC Regional Reliability Councils here: http://www.nerc.com/regional/ .

North American Industry Classification System (NAICS): A new classification scheme, developed by the Office of Management and Budget to replace the Standard Industrial Classification (SIC) System, that categorizes establishments according to the types of production processes they primarily use.

Nuclear electric power (nuclear power): Electricity generated by the use of the thermal energy released from the fission of nuclear fuel in a reactor.

Nuclear fuel: Fissionable materials that have been enriched to such a composition that, when placed in a nuclear reactor, will support a self-sustaining fission chain reaction, producing heat in a controlled manner for process use.

Nuclear reactor: An apparatus in which a nuclear fission chain reaction can be initiated, controlled, and sustained at a specific rate. A reactor includes fuel (fissionable material), moderating material to control the rate of fission, a heavy-walled pressure vessel to house reactor components, shielding to protect personnel, a system to conduct heat away from the reactor, and instrumentation for monitoring and controlling the reactor's systems.

OPEC (Organization of the Petroleum Exporting Countries): An organization founded in Baghdad, Iraq, in September 1960, to unify and coordinate members' petroleum policies. OPEC members' national oil ministers meet regularly to discuss prices and, since 1982, to set crude oil production quotas. Original OPEC members include Iran, Iraq, Kuwait, Saudi Arabia, and Venezuela. Between 1960 and 1975, the organization expanded to include Qatar (1961), Indonesia (1962), Libya (1962), the United Arab Emirates (1967), Algeria (1969), Nigeria (1971), Ecuador (1973), and Gabon (1975)**.** Ecuador withdrew in December 1992, and Gabon withdrew in January 1995. Although Iraq remains a member of OPEC, Iraqi production has not been a part of any OPEC quota agreements since March 1998. For more information, go to OPEC's website at http://www.opec.org/aboutus/history/history.htm.

Operable capacity: The amount of capacity that, at the beginning of the period, is in operation; not in operation and not under active repair, but capable of being placed in operation within 30 days; or not in operation but under active repair that can be completed within 90 days. Operable capacity is the sum of the operating and idle capacity and is measured in barrels per calendar day or barrels per stream day.

Operable generators/units: Electric generators or generating units that are available to provide power to the grid or generating units that have been providing power to the grid but are temporarily shut down. This includes units in standby status, units out of service for an indefinite period, and new units that have their construction complete and are ready to provide test generation. A nuclear unit is operable once it receives its Full Power Operating License.

Operable nuclear unit (U.S.): A U.S. nuclear generating unit that has completed low-power testing and is in possession of a full-power operating license issued by the Nuclear Regulatory Commission.

Operating capacity: The component of operable capacity that is in operation at the beginning of the period.

Operating day: A normal business day. Days when a company conducts business due to emergencies or other unexpected events are not included.

Operator, gas plant: The person responsible for the management and day-to-day operation of one or more natural gas processing plants as of December 31 of the report year. The operator is generally a working-interest owner or a company under contract to the working-interest owner(s). Plants shut down during the report year are also to be considered "operated" as of December 31.

Operator, oil and/or gas well: The person responsible for the management and day-to-day operation of one or more crude oil and/or natural gas wells as of December 31 of the report year. The operator is generally a working-interest owner or a company under contract to the working-interest owner(s). Wells included are those that have proved reserves of crude oil, natural gas, and/or lease condensate in the reservoirs associated with them, whether or not they are producing. Wells abandoned during the report year are also to be considered "operated" as of December 31.

Organization for Economic Cooperation and Development (OECD): An international organization helping governments tackle the economic, social and governance challenges of a globalized economy. Its membership comprises about 30 member countries. With active relationships with some 70 other countries, NGOs and civil society, it has a global reach. For details about the organization, visit http://www.oecd.org.

Payment method for utilities: The method by which fuel suppliers or utility companies are paid for all electricity, natural gas, fuel oil, kerosene, or liquefied petroleum gas used by a household. Households that pay the utility company directly are classified as "all paid by household." Households that pay directly for at least one but not all of their fuels used and that has at least one fuel charge included in the rent were classified as "some paid, some included in rent." Households for which all fuels used are included in rent were classified as "all included in rent." If the household did not fall into one of these categories, it was classified as "other." Examples of households falling into the "other" category are: (1) households for which fuel bills were paid by a social service agency or a relative, and (2) households that paid for some of their fuels used but paid for other fuels through another arrangement.

Peak day withdrawal: The maximum daily withdrawal rate (Mcf/d) experienced during the reporting period.

Peak demand: The maximum load during a specified period of time.

Peak kilowatt: One thousand peak watts.

Peak load: The maximum load during a specified period of time.

Peak load month: The month of greatest plant electrical generation during the winter heating season (Oct-Mar) and summer cooling season (Apr-Sept), respectively.

Peak load plant: A plant usually housing old, low-efficiency steam units, gas turbines, diesels, or pumped-storage hydroelectric equipment normally used during the peak-load periods.

Peak megawatt: One million peak watts.

Peak watt: A manufacturer's unit indicating the amount of power a photovoltaic cell or module will produce at standard test conditions (normally 1,000 watts per square meter and 25 degrees Celsius).

Peaking capacity: Capacity of generating equipment normally reserved for operation during the hours of highest daily, weekly, or seasonal loads. Some generating equipment may be operated at certain times as peaking capacity and at other times to serve loads on an around-the-clock basis.

Petroleum: A broadly defined class of liquid hydrocarbon mixtures. Included are crude oil, lease condensate, unfinished oils, refined products obtained from the processing of crude oil, and natural gas plant liquids. *Note:* Volumes of finished petroleum products include non-hydrocarbon compounds, such as additives and detergents, after they have been blended into the products.

Petroleum imports: Imports of petroleum into the 50 states and the District of Columbia from foreign countries and from Puerto Rico, the Virgin Islands, and other U.S. territories and possessions. Included are imports for the Strategic Petroleum Reserve and withdrawals from bonded warehouses for onshore consumption, offshore bunker use, and military use. Excluded are receipts of foreign petroleum into bonded warehouses and into U.S. territories and U.S. Foreign Trade Zones.

Petroleum products: Petroleum products are obtained from the processing of crude oil (including lease condensate), natural gas, and other hydrocarbon compounds. Petroleum products include unfinished oils, liquefied petroleum gases, pentanes plus, aviation gasoline, motor gasoline, naphtha-type jet fuel, kerosene-type jet fuel, kerosene, distillate fuel oil, residual fuel oil, petrochemical feedstocks, special naphthas, lubricants, waxes, petroleum coke, asphalt, road oil, still gas, and miscellaneous products.

Petroleum refinery: An installation that manufactures finished petroleum products from crude oil, unfinished oils, natural gas liquids, other hydrocarbons, and alcohol.

Pipeline, distribution: A pipeline that conveys gas from a transmission pipeline to its ultimate consumer.

Pipeline freight: Refers to freight carried through pipelines, including natural gas, crude oil, and petroleum products (excluding water). Energy is consumed by various electrical components of the pipeline, including, valves, other, appurtenances attaches to the pipe, compressor units, metering stations, regulator stations, delivery stations, holders and fabricated assemblies.

Pipeline fuel: Gas consumed in the operation of pipelines, primarily in compressors.

Pipeline, gathering: A pipeline that conveys gas from a production well/field to a gas processing plant or transmission pipeline for eventual delivery to end-use consumers.

Pipeline (natural gas): A continuous pipe conduit, complete with such equipment as valves, compressor stations, communications systems, and meters for transporting natural and/or supplemental gas from one point to another, usually from a point in or beyond the producing field or processing plant to another pipeline or to points of utilization. Also refers to a company operating such facilities.

Pipeline (petroleum): Crude oil and product pipelines used to transport crude oil and petroleum products, respectively (including interstate, intrastate, and intracompany pipelines), within the 50 states and the District of Columbia.

Pipeline purchases: Gas supply contracted from and volumes purchased from other natural gas companies as defined by the Natural Gas Act, as amended (52 Stat. 821), excluding independent producers, as defined in Paragraph 154.91(a), Chapter I, Title 18 of the Code of Federal Regulations.

Pipeline quality natural gas: A mixture of hydrocarbon compounds existing in the gaseous phase with sufficient energy content, generally above 900 British thermal units, and a small enough share of impurities for transport through commercial gas pipelines and sale to end-users.

Pipeline, transmission: A pipeline that conveys gas from a region where it is produced to a region where it is to be distributed.

Pipelines, rate regulated: FRS (Financial Reporting System Survey) establishes three pipeline segments: crude/liquid (raw materials); natural gas; and refined products. The pipelines included in these segments are all federally or State rate-regulated pipeline operations, which are included in the reporting company's consolidated financial statements. However, at the reporting company's option, intrastate pipeline operations may be included in the U.S. Refining/Marketing Segment if: they would comprise less than 5 percent of U.S. Refining/Marketing Segment net PP&E, revenues, and earnings in the aggregate; and if the inclusion of such pipelines in the consolidated financial statements adds less than $100 million to the net PP&E reported for the U.S. Refining/Marketing Segment.

Potential peak reduction: The potential annual peak load reduction (measured in kilowatts) that can be deployed from Direct Load Control, Interruptible Load, Other Load Management, and Other DSM Program activities. (Please note that Energy Efficiency and Load Building are not included in Potential Peak Reduction.) It represents the load that can be reduced either by the direct control of the utility system operator or by the consumer in response to a utility request to curtail load. It reflects the installed load reduction capability, as opposed to the Actual Peak Reduction achieved by participants, during the time of annual system peak load.

Power (electrical): An electric measurement unit of power called a voltampere is equal to the product of 1 volt and 1 ampere. This is equivalent to 1 watt for a direct current system, and a unit of apparent power is separated into real and reactive power. Real power is the work-producing part of apparent power that measures the rate of supply of energy and is denoted as kilowatts (kW). Reactive power is the portion of apparent power that does no work and is referred to as kilovars; this type of power must be supplied to most types of magnetic equipment, such as motors, and is supplied by generator or by electrostatic equipment. Voltamperes are usually divided by 1,000 and called kilovoltamperes (kVA). Energy is denoted by the product of real power and the length of time utilized; this product is expressed as kilowathours.

Power production plant: All the land and land rights, structures and improvements, boiler or reactor vessel equipment, engines and engine-driven generator, turbo generator units, accessory electric equipment, and miscellaneous power plant equipment are grouped together for each individual facility.

Power transfer limit: The maximum power that can be transferred from one electric utility system to another without overloading any facility in either system.

Powerhouse: A structure at a hydroelectric plant site that contains the turbine and generator.

PP&E, additions to: The current year's expenditures on property, plant, and equipment (PP&E). The amount is predicated upon each reporting company's accounting practice. That is, accounting practices with regard to capitalization of certain items may differ across companies, and therefore this figure in FRS (Financial Reporting System) will be a function of each reporting company's policy.

Premium gasoline: Gasoline having an antiknock index (R+M/2) greater than 90. Includes both leaded premium gasoline as well as unleaded premium gasoline

Primary coal: All coal milled and, when necessary, washed and sorted.

Primary energy: All energy consumed by end users, excluding electricity but including the energy consumed at electric utilities to generate electricity. (In estimating energy expenditures, there are no fuel-associated expenditures for hydroelectric power, geothermal energy, solar energy, or wind energy, and the quantifiable expenditures for process fuel and intermediate products are excluded.)

Primary energy consumption: Primary energy consumption is the amount of site consumption, plus losses that occur in the generation, transmission, and distribution of energy.

Primary energy consumption expenditures: Expenditures for energy consumed in each of the four major end-use sectors, excluding energy in the form of electricity, plus expenditures by the electric utilities sector for energy used to generate electricity. There are no fuel-associated expenditures for associated expenditures for hydroelectric power, geothermal energy, photovoltaic and solar energy, or wind energy. Also excluded are the quantifiable consumption expenditures that are an integral part of process fuel consumption.

Primary fuels: Fuels that can be used continuously. They can sustain the boiler sufficiently for the production of electricity.

Primary metropolitan statistical area (PMSA): A component area of a consolidated metropolitan statistical area consisting of a large urbanized county or cluster of counties (cities and towns in New England) that demonstrate strong internal economic and social links in addition to close ties with the central core of the larger area. To qualify, an area must meet specified statistical criteria that demonstrate these links and have the support of local opinion.

Probable (indicated) reserves, coal: Reserves or resources for which tonnage and grade are computed partly from specific measurements, samples, or production data and partly from projection for a reasonable distance on the basis of geological evidence. The sites available are too widely or otherwise inappropriately spaced to permit the mineral bodies to be outlined completely or the grade established throughout.

Production, natural gas: The volume of natural gas withdrawn from reservoirs less (1) the volume returned to such reservoirs in cycling, repressuring of oil reservoirs, and conservation operations; less (2) shrinkage resulting from the removal of lease condensate; and less (3) nonhydrocarbon gases where they occur in sufficient quantity to render the gas unmarketable. Volumes of gas withdrawn from gas storage reservoirs and native gas, which has been transferred to the storage category, are not considered production. Flared and vented gas is also considered production. (This differs from "Marketed Production" which excludes flared and vented gas.)

Production, natural gas, dry: The volume of natural gas withdrawn from reservoirs during the report year less (1) the volume returned to such reservoirs in cycling, repressuring of oil reservoirs, and conservation operations; less (2) shrinkage resulting from the removal of lease condensate and plant liquids; and less (3) nonhydrocarbon gases where they occur in sufficient quantity to render the gas unmarketable. Volumes of gas withdrawn from gas storage reservoirs and native gas, which has been transferred to the storage category, are not considered production. This is not the same as marketed production, because the latter also excludes vented and flared gas, but contains plant liquids.

Production, natural gas liquids: Production of natural gas liquids is classified as follows:

<u>Contract Production</u>. Natural gas liquids accruing to a company because of its ownership of liquids extraction facilities that it uses to extract liquids from gas belonging to others, thereby earning a portion of the resultant liquids.

<u>Leasehold Production</u>. Natural gas liquids produced, extracted, and credited to a company's interest.

<u>Contract Reserves</u>. Natural gas liquid reserves corresponding to the contract production defined above.

<u>Leasehold Reserves</u>. Natural gas liquid reserves corresponding to leasehold production defined above.

Production, natural gas, wet after lease separation: The volume of natural gas withdrawn from reservoirs less (1) the volume returned to such reservoirs in cycling, repressuring of oil reservoirs, and conservation operations; less (2) shrinkage resulting from the removal of lease condensate; and less (3) nonhydrocarbon gases where they occur in sufficient quantity to render the gas unmarketable. *Note:* Volumes of gas withdrawn from gas storage reservoirs and native gas that has been transferred to the storage category are not considered part of production. This production concept is not the same as marketed production, which excludes vented and flared gas.

Production, oil and gas: The lifting of oil and gas to the surface and gathering, treating, field processing (as in the case of processing gas to extract liquid hydrocarbons), and field storage. The production function shall normally be regarded as terminating at the outlet valve on the lease or field production storage tank. If unusual physical or operational circumstances exist, it may be more appropriate to regard the production function as terminating at the first point at which oil, gas, or gas liquids are delivered to a main pipeline, a common carrier, a refinery, or a marine terminal.

Propane (C_3H_8): A normally gaseous straight-chain hydrocarbon. It is a colorless paraffinic gas that boils at a temperature of -43.67 degrees Fahrenheit. It is extracted from natural gas or refinery gas streams. It includes all products designated in ASTM Specification D1835 and Gas Processors Association Specifications for commercial propane and HD-5 propane.

Propane air: A mixture of propane and air resulting in a gaseous fuel suitable for pipeline distribution.

Propane, consumer grade: A normally gaseous paraffinic compound (C3H8), which includes all products covered by Natural Gas Policy Act Specifications for commercial and HD-5 propane and ASTM Specification D 1835. Excludes: feedstock propanes, which are propanes not classified as consumer grade propanes, including the propane portion of any natural gas liquid mixes, i.e., butane-propane mix.

Public utility: Enterprise providing essential public services, such as electric, gas, telephone, water, and sewer under legally established monopoly conditions.

Public utility district: Municipal corporations organized to provide electric service to both incorporated cities and towns and unincorporated rural areas.

Public Utility Holding Company Act of 1935 (PUHCA): This act prohibits acquisition of any wholesale or retail electric business through a holding company unless that business forms part of an integrated public utility system when combined with the utility's other electric business. The legislation also restricts ownership of an electric business by non-utility corporations.

Public Utility Regulatory Policies Act (PURPA) of 1978: One part of the National Energy Act, PURPA contains measures designed to encourage the conservation of energy, more efficient use of resources, and equitable rates. Principal among these were suggested retail rate reforms and new incentives for production of electricity by cogenerators and users of renewable resources. The Commission has primary authority for implementing several key PURPA programs.

Publicly owned electric utility: A class of ownership found in the electric power industry. This group includes those utilities operated by municipalities and State and Federal power agencies.

PVCs that convert sunlight directly into energy: A method for producing energy by converting sunlight using photovoltaic cells (PVCs) that are solid-state single converter devices. Although currently not in wide usage, commercial customers have a growing interest in usage and, therefore, DOE has a growing interest in the impact of PVCs on energy consumption. Economically, PVCs are competitive with other sources of electricity.

Quality or grade (of coal): An informal classification of coal relating to its suitability for use for a particular purpose. Refers to individual measurements such as heat value, fixed carbon, moisture, ash, sulfur, major, minor, and trace elements, coking properties, petrologic properties, and particular organic constituents. The individual quality elements may be aggregated in various ways to classify coal for such special purposes as metallurgical, gas, petrochemical, and blending usages.

R-value: A measure of a material's resistance to heat flow. The higher the R-value of a material, the greater its insulating capability. The R-value of some insulating materials is 3.7 per inch of fiberglass and cellulose,2.5 per inch of vermiculite, and more than 4 per inch for some types of insulating foam. All building materials have some R-value. For example, a 4-inch brick has an R-value of 0.8, and half-inch plywood has an R-value of 0.6.

Rack sales: Wholesale truckload sales or smaller of gasoline where title transfers at a terminal.

Reformulated gasoline: Finished gasoline formulated for use in motor vehicles, the composition and properties of which meet the requirements of the reformulated gasoline regulations promulgated by the U.S. Environmental Protection Agency under Section 211(k) of the Clean Air Act. It includes gasoline produced to meet or exceed emissions performance and benzene content standards of federal-program reformulated gasoline even though the gasoline may not meet all of the composition requirements (e.g. oxygen content) of federal-program reformulated gasoline. *Note:* This category includes Oxygenated Fuels Program Reformulated Gasoline (OPRG). Reformulated gasoline excludes Reformulated Blendstock for Oxygenate Blending (RBOB) and Gasoline Treated as Blendstock (GTAB).

Renewable Portfolio Standard (RPS): Maryland state policy requiring that 20 percent of all electric retail sales in Maryland be from renewable sources, as defined, by 2022. In addition, the policy requires that at least 2 percent of all electric retail sales be supplied from solar energy resources.

Reseller: A firm (other than a refiner) that is engaged in a trade or business that buys refined petroleum products and then sells them to a purchaser who is not the ultimate consumer of those refined products.

Reserves, coal: Quantities of un-extracted coal that comprise the demonstrated base for future production, including both proved and probable reserves.

Reserves, net: Includes all proved reserves associated with the company's net working interests.

Reserves changes: Positive and negative revisions, extensions, new reservoir discoveries in old fields, and new field discoveries that occurred during the report year.

Residential propane price: The "bulk keep full" price for home delivery of consumer-grade propane intended for use in space heating, cooking, or hot water heaters in residences.

Residual fuel oil: A general classification for the heavier oils, known as No. 5 and No. 6 fuel oils, that remain after the distillate fuel oils and lighter hydrocarbons are distilled away in refinery operations. It conforms to ASTM Specifications D 396 and D 975 and Federal Specification VV-F-815C. No. 5, a residual fuel oil of medium viscosity, is also known as Navy Special and is defined in Military Specification MIL-F-859E, including Amendment 2 (NATO Symbol F-770). It is used in steam-powered vessels in government service and inshore powerplants. No. 6 fuel oil includes Bunker C fuel oil and is used for the production of electric power, space heating, vessel bunkering, and various industrial purposes.

Retail motor gasoline prices: Motor gasoline prices calculated each month by the Bureau of Labor Statistics (BLS) in conjunction with the construction of the Consumer Price Index.

Scheduled outage: The shutdown of a generating unit, transmission line, or other facility for inspection or maintenance, in accordance with an advance schedule.

Set-Aside Program: A program that requires petroleum suppliers to set aside a specified percentage of products. Often the cost of doing this is off-set by a state agency.

Spot market (natural gas): A market in which natural gas is bought and sold for immediate or very near-term delivery, usually for a period of 30 days or less. The transaction does not imply a continuing arrangement between the buyer and the seller. A spot market is more likely to develop at a location with numerous pipeline interconnections, thus allowing for a large number of buyers and sellers. The Henry Hub in southern Louisiana is the best known spot market for natural gas.

Stand-alone generator: A power source/generator that operates independently of or is not connected to an electric transmission and distribution network; used to meet a load(s) physically close to the generator.

Standby electricity generation: Involves use of generators during times of high demand on utilities to avoid extra "peak-demand" charges.

Standby facility: A facility that supports a utility system and is generally running under no-load. It is available to replace or supplement a facility normally in service.

Station (electric): A plant containing prime movers, electric generators, and auxiliary equipment for converting mechanical, chemical, and/or nuclear energy into electric energy.

Station use: Energy that is used to operate an electric generating plant. It includes energy consumed for plant lighting, power, and auxiliary facilities, regardless of whether the energy is produced at the plant or comes from another source.

Strategic Petroleum Reserve (SPR): Petroleum stocks maintained by the Federal Government for use during periods of major supply interruption

Subbituminous coal: A coal whose properties range from those of lignite to those of bituminous coal and used primarily as fuel for steam-electric power generation. It may be dull, dark brown to black, soft and crumbly, at the lower end of the range, to bright, jet black, hard, and relatively strong, at the upper end. Subbituminous coal contains 20 to 30 percent inherent moisture by weight. The heat content of subbituminous coal ranges from 17 to 24 million Btu per ton on a moist, mineral-matter-free basis. The heat content of subbituminous coal consumed in the United States averages 17 to 18 million Btu per ton, on the as-received basis (i.e., containing both inherent moisture and mineral matter).

Supervisory Control and Data Acquisition Systems (SCADA) and Distributed Control Systems (DCS): http://www.dhs.gov/xlibrary/assets/nipp-ssp-energy-2010.pdf, p. 12.

Tanker and barge: Vessels that transport crude oil or petroleum products. **Note:** Data are reported for movements between PAD Districts; from a PAD District to the Panama Canal; or from the Panama Canal to a PAD District.

Three-phase power: Power generated and transmitted from generator to load on three conductors.

Transformer: An electrical device for changing the voltage of alternating current.

Transmission and distribution loss: Electric energy lost due to the transmission and distribution of electricity. Much of the loss is thermal in nature.

Transmission (electric) (verb): The movement or transfer of electric energy over an interconnected group of lines and associated equipment between points of supply and points at which it is transformed for delivery to consumers or is delivered to other electric systems. Transmission is considered to end when the energy is transformed for distribution to the consumer.

Transmission circuit: A conductor used to transport electricity from generating stations to load.

Transmission line: A set of conductors, insulators, supporting structures, and associated equipment used to move large quantities of power at high voltage, usually over long distances between a generating or receiving point and major substations or delivery points.

Transmission network: A system of transmission or distribution lines so cross-connected and operated as to permit multiple power supply to any principal point.

Transmission system (electric): An interconnected group of electric transmission lines and associated equipment for moving or transferring electric energy in bulk between points of supply and points at which it is transformed for delivery over the distribution system lines to consumers or is delivered to other electric systems.

Transmission type (engine): The transmission is the part of a vehicle that transmits motive force from the engine to the wheels, usually by means of gears for different speeds using either a hydraulic "torque-converter" (automatic) or clutch assembly (manual). On front-wheel drive cars, the transmission is often called a "transaxle." Fuel efficiency is usually higher with manual rather than automatic transmissions, although modern, computer-controlled automatic transmissions can be efficient.

Transmitting utility: A regulated entity which owns and may construct and maintain wires used to transmit wholesale power. It may or may not handle the power dispatch and coordination functions. It is regulated to provide non-discriminatory connections, comparable service, and cost recovery. According to the Energy Policy Act of 1992, it includes any electric utility, qualifying cogeneration facility, qualifying small power production facility, or Federal power marketing agency which owns or operates electric power transmission facilities which are used for the sale of electric energy at wholesale.

Underground storage: The storage of natural gas in underground reservoirs at a different location from which it was produced.

Vehicle fuel consumption: Vehicle fuel consumption is computed as the vehicle miles traveled divided by the fuel efficiency reported in miles per gallon (MPG). Vehicle fuel consumption is derived from the actual vehicle mileage collected and the assigned MPGs obtained from EPA certification files adjusted for on-road driving. The quantity of fuel used by vehicles.

Vehicle fuel expenditures: The cost, including taxes, of the gasoline, gasohol, or diesel fuel added to the vehicle's tank. Expenditures do not include the cost of oil or other items that may have been purchased at the same time as the vehicle fuel.

Vehicle identification number (VIN): A set of codes, usually alphanumeric characters, assigned to a vehicle at the factory and inscribed on the vehicle. When decoded, the VIN provides vehicle characteristics. The VIN is used to help match vehicles to the EPA certification file for calculating MPGs.

Wet natural gas: A mixture of hydrocarbon compounds and small quantities of various nonhydrocarbons existing in the gaseous phase or in solution with crude oil in porous rock formations at reservoir conditions. The principal hydrocarbons normally contained in the mixture are methane, ethane, propane, butane, and pentane. Typical nonhydrocarbon gases that may be present in reservoir natural gas are water vapor, carbon dioxide, hydrogen sulfide, nitrogen and trace amounts of helium. Under reservoir conditions, natural gas and its associated liquefiable portions occur either in a single gaseous phase in the reservoir or in solution with crude oil and are not distinguishable at the time as separate substances. *Note*: The Securities and Exchange Commission and the Financial Accounting Standards Board refer to this product as **natural gas**.