Study to Assess Widespread Electricity System Outage Risks on Gasoline and Diesel Supply and Distribution Systems in Upstate New York

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Abstract

This report was authorized in response to the impacts of recent storms such as Superstorm Sandy, Hurricane Irene, and Tropical storm Lee. It examines the petroleum supply pathways of the Upstate regions of New York, including the Hudson Valley Region (supplied by marine) and the Central and Western portions of the State (supplied primarily by pipelines). This study also assesses the frequency and duration of power outage events affecting Upstate New York, and the impact of past events on the region's fuel supply and distribution systems. Finally, this study examines the existing storm-hardening and resiliency measures at Upstate petroleum supply terminals and identifies the relative benefits of expanding these measures to strengthen the Upstate supply chain.

Keywords

Transportation Fuels, Petroleum Terminals, Hardening, Resiliency, Superstorm Sandy, Hurricane Irene, Power Outages, Upstate New York, Gasoline, Diesel

TABLE OF CONTENTS

Table of Contents ..... **ii**

Table of Figures iii

Table of Tables iv

Executive Summary ..... **v**

Introduction **1**

Analysis of Upstate Fuel Supply Pathways **2**

Hudson Valley Region 4

Hudson River 5

Rail 6

Truck 6

Central & Western Region 6

Buckeye Pipeline System 8

Sunoco Logistics Pipeline System 8

United Refinery 9

Truck 9

Assessment 9

Analysis of Power Outage Events **11**

Electric Service Reliability 11

Average Outages from Major Storms 12

Average Outages from Major Storm Outages by Utility 13

Widespread Power Outage Events 14

August 2003 Northeast Blackout 15

North Country Ice storm 16

Hurricane Irene 17

Tropical Storm Lee 19

Superstorm Sandy 19
Assessment 20
Analysis of Hardening and Resiliency Measurses 22
Pre-Storm Activities 22
Flood Protection Measures 24
Backup Generation 24
Backup Generation by Load Capability 26
Assessment 27
Conclusion 28

TABLE OF FIGURES

Figure 1. Upstate New York Regions of Analysis and Petroleum Supply Infrastructure 3
Figure 2. Frequency of Storm-Related Outage Events by Upstate Utility (2008-2012) 13
Figure 3. Duration of Storm-Related Outage Events by Upstate Utility in hours (2008-2012) 14
Figure 4. New York Customers Restored from August 2003 Blackout by Utility 16
Figure 5. NYS Investor-Owned Utility Customers without Power Following Hurricane Irene 18
Figure 6. Percentage of Upstate Terminals Conducting Pre-Storm Activities 23
Figure 7. NYS Terminals that Have or Obtain Backup Generators, Upstate vs. Downstate 25
Figure 8. Upstate Terminals that Have or Obtain Backup Generators by Region 25
Figure 9. Terminals with Backup Generators Capable of Powering Throughput Operations by Region 26

TABLE OF TABLES

Table 1. Hudson Valley Region Terminals....4

Table 2. Hudson Valley Region [A] Terminal Storage Capacity by Product (Barrels) 5

Table 3. Central & Western Region Terminals....7

Table 4. Investor-Owned Electric Utilities Serving Upstate New York....11

Table 5. Reliability Measures for Upstate Utilities Excluding Interruptions Caused by Major Storms (2008-2012) 12

Table 6. Storm-Related Reliability Measures for Upstate Utilities (2008-2012) 12

Table 7. Peak Upstate Customer Outages Caused by 2003 Blackout by Utility....15

Table 8. Peak Upstate Customer Outages Caused by Hurricane Irene by Utility 18

Table 9. Peak Upstate Customer Outages Caused by Superstorm Sandy by Utility 20

EXECUTIVE SUMMARY

Upstate New York petroleum markets are less at risk to widespread power outage events than Downstate markets. In addition to primary supply sources, Upstate NY petroleum markets have several alternative fuel supply sources allowing for a measure of diversification. Upstate markets also tend to hold higher inventories than their Downstate counterparts and Upstate supply systems have a greater ability to make up lost volumes after a disruption event has ended. Furthermore, Upstate markets do not experience major power outage events with a high frequency or duration, and recent outage events have had limited (and manageable) impacts on the Upstate petroleum supply chain and end-use consumers. Few Upstate petroleum terminals have implemented additional hardening or resiliency measures above which are already in place – such as elevating critical equipment or installing backup generators – to ensure continuity of operations during major storm events. This is because the recent major storm events have not significantly impacted these terminals. While future storms and widespread power outage events could hypothetically cause greater disruptions to Upstate supply and distribution systems, these systems have largely withstood historic worst case scenarios without experiencing major supply impacts. Key findings from this study are summarized below:

1. **Supply pathways to Upstate New York petroleum markets have limited diversity but supply security is enhanced by higher storage inventories at Upstate terminals (than Downstate) and the ability of supply systems to ramp up deliveries after a disruption to make up for lost volumes.** Terminals in the Hudson Valley Region of Upstate New York are dependent on marine deliveries from the New York Harbor area via the Hudson River for essentially all of their supply of gasoline and diesel. The Central & Western Region of Upstate New York receives supply along more pathways, but is heavily dependent on the Buckeye Pipeline system. Although neither region could fully compensate for lost supplies along these primary pathways, terminals in Upstate New York typically hold higher inventories than Downstate terminals, and can consequently withstand longer supply disruptions before running out of fuel. For instance, Upstate terminals supplied by pipeline hold more than 10 days of supply on average compared with 2-3 days of supply for terminals with less storage capacity in the Downstate area. Furthermore, Upstate fuel pathways tend to have some spare capacity, thus making it possible for operators to ramp up throughput to make up for lost volumes after a supply disruption (or in preparation for a disruption). The Buckeye Pipeline to Upstate New York, for instance, typically runs at 75 to 80 percent of capacity and is shut for 3 to 4 days per month due to low demand, so an outage could be managed by higher pipeline throughputs after power was restored.

2. **Widespread power outage events in Upstate markets are relatively rare, short-lived, and have historically had limited impacts on Upstate supply facilities.** Over the past five years, Upstate power customers, have on average experienced one major storm-related power outage every two years with an average duration of 14 hours – not long enough to cause a significant disruption to most fuel supply systems due to availability of storage at multiple levels of the fuel supply chain. Five widespread power outage events – the 1998 North Country Ice Storm, the August 2003 Northeast Blackout, Hurricane Irene, Tropical Storm Lee, and Superstorm Sandy – appear to have had limited direct power outage impacts on petroleum supply infrastructure located in Upstate New York. Although, storm-related damage and power outages to key supply facilities in the New York Harbor area have had a significant impact on fuel supply to Upstate markets, these problems would not have been alleviated by greater hardening or resiliency measures at Upstate New York facilities.

3. **Few Upstate petroleum terminals have put in place additional hardening and resiliency measures because they have not historically experienced significant storm-related disruptions.** While terminals representing 40 percent of fuel throughput surveyed by NYSERDA in the Hudson Valley Region reported having backup generators capable of powering throughput operations, terminals representing only 6 percent throughput in the Central & Western Region reported having operational backup. This divergence is due to higher frequency of severe storms and power outage events in the Hudson Valley Region, particularly in the Newburgh area, which is in close proximity to Downstate New York. Companies operating terminals in the Upstate area noted they had the ability to rapidly deploy backup generators in the event of a long-term outage.

While the Upstate petroleum markets have not experienced severe weather or widespread power outage events as frequently as Downstate, there always remains potential for more significant outages than have occurred historically. The North Country Ice Storm of 1998 had a crippling impact on the northern upstate markets from Watertown to Massena and into the Adirondacks and Canada. The impact on gasoline and heating oil supply was significant, but was focused on a small, geographically dispersed population. Should a similar storm impact the Buffalo to Albany areas, the extent of power outages and impact on petroleum markets could be significantly disrupted with more extended recovery times. Offsetting these impacts would be the ability of terminals located outside the impact area to supplement fuel supplies.

ICF International recommends that NYSERDA consider working with terminals in the Upstate markets to encourage that appropriate backup generation capability is in place or could be made available in a worst-case scenario, and that weather contingency plans are in place to assure access to petroleum delivery trucks. While it does not appear critical that a broad service station backup generator program is required (similar to the program in place Downstate), it would be prudent to encourage a limited number of service stations on key arteries in metropolitan areas and some rural stations in county seats or population centers to either obtain generators or pre-wire for quick access in the event of severe outages.

INTRODUCTION

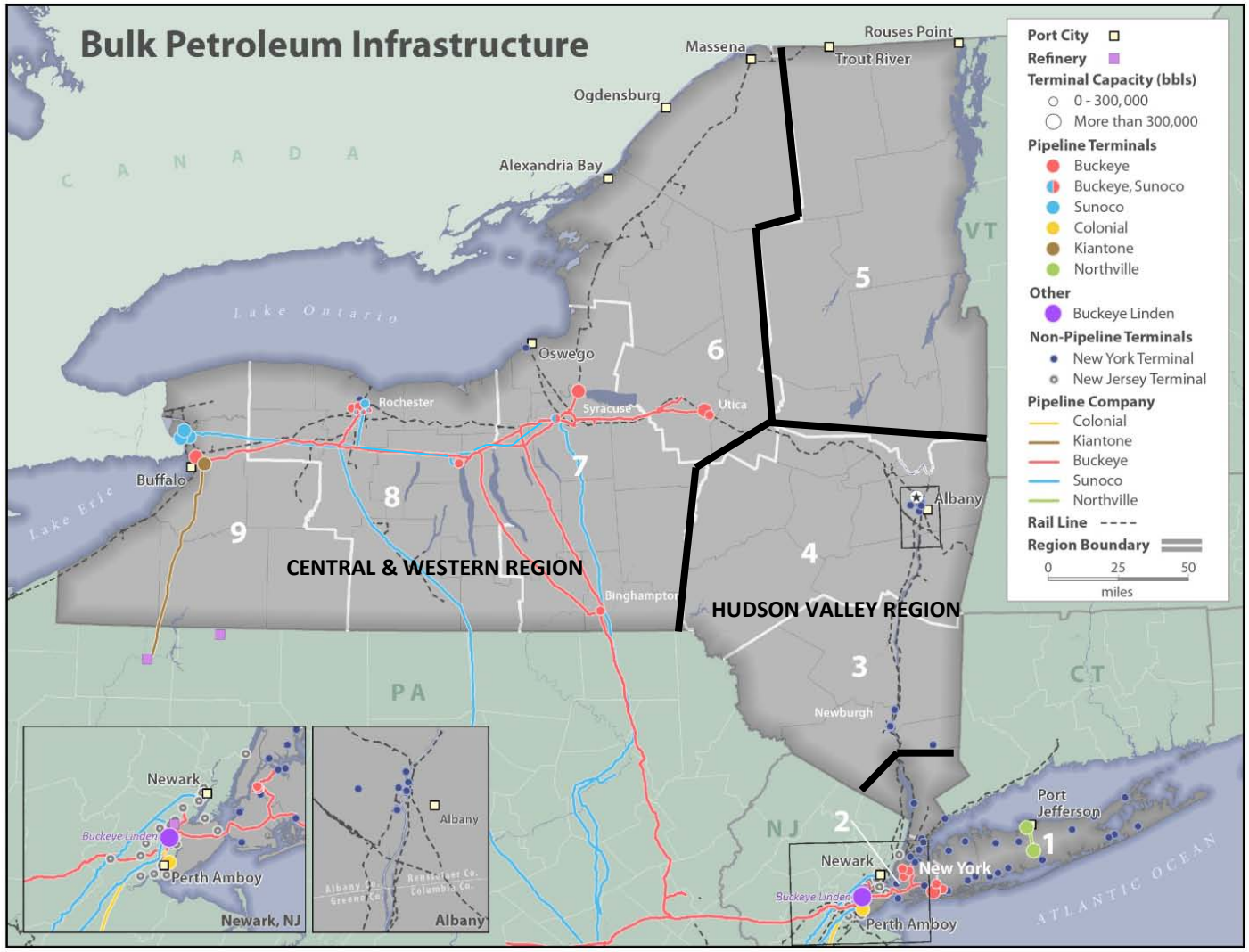
NYSERDA and New York State have implemented a number of initiatives stemming from the impacts of recent storms such as Superstorm Sandy, Hurricane Irene, and Tropical storm Lee. These storms primarily impacted the Downstate portion of the State (New York City and Long Island) with storm surge, power outages and waterway blockages severely affecting the fuel supply chain. The purpose of this study is to examine the petroleum supply pathways of the Upstate regions of New York, including the Hudson Valley Region (supplied by marine) and the Central and Western portions of the State (supplied primarily by pipelines). This study will also examine the frequency and duration of power outage events affecting Upstate New York, and the impact of past events on the region's fuel supply and distribution systems. Finally, this study will examine the existing storm-hardening and resiliency measures at Upstate petroleum supply terminals and assess the relative benefits of expanding these measures to strengthen the Upstate supply chain.

ANALYSIS OF UPSTATE FUEL SUPPLY PATHWAYS

New York State (NYS) does not have any petroleum refineries and, as a result, the State relies entirely on the movement of petroleum products (e.g., motor gasoline, diesel fuel, jet fuel, etc.) produced in other markets. Petroleum products are transported to Upstate New York terminals from regional production and import hubs by pipeline, marine vessel, and – to a lesser extent – by rail and truck. Products move from Upstate receipt terminals to end-users (retail gas stations, power plants and individual homes and businesses) by tanker truck. This section identifies the major infrastructure supporting the supply and distribution of petroleum fuels to consumer markets throughout NYS, with an emphasis on the Upstate market.

For the purposes of this study, the Upstate New York market has been divided into two distinct regions based on primary fuel supply routes: the Hudson Valley Region, which is supplied by marine barges along the Hudson River from New York Harbor; and the Central & Western Region, which is supplied by pipelines originating in New York Harbor and the Philadelphia refining center. The Hudson Valley Region has been defined as New York Department of Environmental Conservation (DEC) Region 4 and the northern portion of DEC Region 3 (all counties north of Rockland and Westchester counties), including the major terminal network in Newburgh. The Central & Western Region of NYS has been defined as DEC Regions 6-9. Region 5 was not included in this analysis as it is sparsely populated and only has one smaller terminal in Plattsburgh, which is not supplied by the Hudson River or the pipeline systems. Figure 1 identifies the nine DEC Regions, the two Upstate Regions defined for this study (Hudson Valley and Central & Western), and the major petroleum infrastructure supplying the State, including refineries, pipelines, terminals, ports, and railways. The sections that follow describe the Hudson Valley and Central & Western Regions and identify the fuel infrastructure supplying each Region.

Figure 1. Upstate New York Regions of Analysis and Petroleum Supply Infrastructure



Source: OPIS/Stalsby. "Petroleum Terminal Encyclopedia." 2012 Edition.

HUDSON VALLEY REGION

No pipelines supply gasoline or distillate fuel to terminals in the Hudson Valley Region.[1] All 11 terminals in the Hudson Valley Region reported being supplied by marine, according to the OPIS Terminal Encyclopedia. Most of these terminals also report being supplied by truck, though truck supply is primarily ethanol delivered from bulk ethanol terminals in Albany. Two terminals reported receiving supply of crude oil and ethanol by rail (Buckeye Albany and Global Albany) for transshipment to East Coast refineries. The absence of supply pipelines and the limited use of other bulk transportation modes underscore the importance of marine supply to the Region. Table 1 lists all the petroleum terminals and their storage capacities in the Hudson Valley Region.

Table 1. Hudson Valley Region Terminals

Company	Location	Capacity (bbl)
Buckeye Terminals, LLC	Albany	1,978,312
Global Companies, LLC	Albany	1,376,993
International Petroleum Terminal LLC	East Greenbush	370,846
CITGO Petroleum Corp.	Glenmont	1,225,634
North Albany Terminal Co.	Glenmont	1,931,649
Getty Terminals Corp.	Rensselaer	712,643
Buckeye Hess Corp.	Rensselaer	871,140
Petroleum Fuel & Terminal Co.	Rensselaer	642,171
Sprague Energy Corp.	Rensselaer	2,684,931[A]
Albany Subtotal		**11,794,319**
Global Companies, LLC	New Windsor	1,359,550[B]
Buckeye Hess Corp.	Newburgh	1,365,582
Newburgh Subtotal		**2,725,132**
Hudson Valley Total		**14,519,451**

[A] Sprague owns two terminals in Rensselaer, NY. The capacity shown is combined capacity.
[B] Global owns four terminals in New Windsor, NY. The capacity shown is combined capacity.
Source: OPIS/Stalsby. "Petroleum Terminal Encyclopedia." 2012 Edition.

The terminals listed in Table 1 have a combined storage capacity of 14.5 million barrels but not all of this capacity is dedicated to transportation fuels (gasoline, ethanol, and diesel). Other petroleum products, including jet fuel (used in aircraft) and residual fuel oil (used in power plants, industrial boilers, and for marine bunkering) are also stored at terminals in the Hudson Valley Region. Table 2 below lists the total storage capacity by product at terminals in the Hudson Valley Region with more than 400,000 gallons (9,524 barrels) of storage capacity. The total capacity listed in this table differs from the total capacity listed in Table 1 for two reasons: first, the data in Table 2 is from New York DEC as opposed to OPIS; and second, only a portion of Table 2 includes the storage capacity from two counties (Westchester and Rockland) that are outside the Hudson Valley Region.

[1] Enterprise Products Partners L.P. operates an LPG pipeline to Selkirk, NY south of Albany.

Table 2. Hudson Valley Region [A] Terminal Storage Capacity by Product (Barrels)

Product	Region 3	Region 4	Total
Gasoline	528,581	2,326,912	2,855,493
Distillate	2,712,622	5,220,991	7,933,613
Jet Fuel	59,585	73,457	133,042
Ethanol	--	1,073,619	1,073,619
Crude Oil	--	186,031	186,031
Residual	2,320,122	943,403	3,263,525
Other[B]	299,632	1,438,640	1,738,272
Total	**5,920,542**	**11,263,053**	**17,183,595**

[A] This table includes storage capacity at terminals in Westchester and Rockland counties.
[B] "Other" includes hydraulic oil, white/mineral spirits, motor oil, transmission fluid, waste oil/used oil, turbine oil, mineral oil, and used oil (heating).
Source: DEC Regional Capacity Database

Using the information in Table 2, it is estimated that the Hudson Valley Region has roughly 2.6 million barrels of gasoline storage capacity (not including ethanol) and 6.5 million barrels of distillate capacity. A general rule of thumb in the petroleum industry is that inventory levels average 40 percent of capacity (more than 40 percent immediately after receipt of shipment and below 40 percent just prior to receipt of a shipment). Using this rule, it is estimated that terminals in the Hudson Valley Region collectively hold roughly 1.1 million barrels of gasoline and 3.2 million barrels of distillate in inventory at any given time.

HUDSON RIVER

The Hudson Valley Region is primarily supplied by marine movements of petroleum products north along the Hudson River from New York Harbor (NYH), which is a major transshipment hub for product distribution throughout the Northeast. Products typically arrive into NYH bulk terminals in Northern New Jersey and Staten Island from domestic and foreign sources via large, oceangoing marine vessels and high-volume interstate pipeline systems. From these bulk terminals, products are loaded onto barges or smaller vessels to supply marine terminals along the Hudson River at Newburgh and Albany as well as some small capacity terminals at other locations along the river. According to the Federal Highway Administration's Freight Analysis Framework (FAF), in 2011 roughly 10,000 barrels per day (b/d) of gasoline were shipped into the Albany metropolitan area from the New York Harbor region.[2]

Some domestic and foreign-sourced products imported to the Hudson Valley Region also bypass the NYH terminal hub and are delivered directly to terminals along the Hudson River, though the River's dimensions and dimensions of berthing facilities at terminals along the river (e.g., maximum draft, maximum length overall, etc.) are not conducive for the navigation of large, ocean-going vessels. Foreign imports primarily arrive from refineries on Canada's East Coast. In 2012, roughly 1,400 b/d arrived in Albany from foreign sources, all of which were from Canada. Of these imports, 275 b/d was gasoline and 330 b/d was distillate fuel oil, with the balance being primarily

[2] "Freight Analysis Framework Data Tabulation Tool." Federal Highway Administration. http://faf.ornl.gov/fafweb/Extraction0.aspx

residual fuel oil. In 2013 through August, imports into Albany were 3,500 b/d, all of which came from Canada except one cargo from Portugal. Again, the vast majority of imports were residual fuel oil.[3]

RAIL

Two Albany terminals act as a major hub for rail supply into New York. While gasoline and diesel are essentially all supplied to Albany by marine from New York Harbor, ethanol is delivered into Albany by "unit trains" from the Midwest. These unit trains are dedicated rail trains of 60-100 railcars (which can carry an estimated 43,000-72,000 barrels[4]) that transport ethanol into major distribution hubs in Albany. From these receipt terminals, ethanol moves primarily by barge and local rail lines (short lines), into New York Harbor ethanol storage facilities, as well as by truck into primary distribution terminals in the Hudson Valley Region where the ethanol is rack blended with reformulated blendstock for oxygenate blending (RBOB) or conventional blendstock for oxygenate blending (CBOB) gasoline for delivery as E10 gasoline to service stations.[5]

In addition, several terminals in Albany receive rail shipments of crude oil, primarily from the Bakken region in North Dakota. Similar to ethanol, the receipts are via unit trains. From Albany, the crude oil is loaded out into barges or small marine tanker vessels for shipment to refiners such as Phillips 66 in Linden, NJ and Irving Oil in St. John, NB, Canada.

Albany also serves as a source of gasoline and distillate supply into Vermont via CP railroad unit trains to the Burlington, Vermont terminal. Data from 2011 indicate as much as 12,000 b/d moves by rail into Vermont.[6]

TRUCK

The Hudson Valley Region also brings in petroleum products by truck from other parts of New York, from neighboring states, and from Canada. According to the U.S. Department of Transportation, approximately 3,000 b/d of petroleum products moved into the Albany metropolitan area. All of these products were fuel oils and nearly all of it came from the New York Harbor area. Occasional truck deliveries are made from nearby States (other than New Jersey), including Massachusetts, Connecticut, and Vermont.

CENTRAL & WESTERN REGION

The Central & Western Region is more diversified in its supply than the Hudson Valley Region. Products enter this portion of the State through major pipeline networks owned and operated by Buckeye Partners, L.P. and Sunoco Logistics. In addition, United Refining Co. supplies fuel to the Central & Western Region by truck from their refinery in Warren, PA, and the Region receives occasional imports from Ontario into the Buffalo area and from Quebec into the Adirondacks. These supply sources are described here in greater detail.

Table 3 provides a comprehensive summary of all terminals in the Central & Western New York market gathered by regional clusters, identifying terminal capacities, pipelines which access the terminals, and terminal owners.

[3] EIA. "Petroleum & Other Liquids—Company Level Imports." 2012. Available at: http://www.eia.gov/petroleum/imports/companylevel/

[4] *This assumes a rail car capacity of 30,000 gallons (714 bbl).*

[5] *E10 is a gasoline formulation comprised of 90% petroleum gasoline and 10% ethanol.*

[6] "Freight Analysis Framework Data Tabulation Tool." Federal Highway Administration. http://faf.ornl.gov/fafweb/Extraction0.aspx

Table 3. Central & Western Region Terminals

Company	Location	Cluster	Capacity (bbl)	Pipeline(s)
Buckeye Terminals, LLC	Vestal	Binghamton/Vestal	132,485	Buckeye
Buckeye Terminals, LLC	Vestal	Binghamton/Vestal	475,001	Buckeye
CITGO Petroleum Corp.	Vestal	Binghamton/Vestal	122,106	Buckeye
Binghamton/Vestal Total			**729,593**	
Buckeye Terminals, LLC	Buffalo	Buffalo	488,839	Buckeye
Marathon Petroleum LLC	Tonawanda	Buffalo	116,555	--
NOCO Energy Corp.	Tonawanda	Buffalo	1,062,043	Sunoco
Sunoco Logistics	Tonawanda	Buffalo	346,210	Sunoco
United Refining	Tonawanda	Buffalo	543,019	Sunoco
Buffalo Total			**2,556,666**	
Buckeye Terminals, LLC	Rochester	Rochester	180,708	Buckeye
Buckeye Terminals, LLC	Rochester	Rochester	285,484	Buckeye, Sunoco
Griffith Energy, Inc.	Rochester	Rochester	281,818	--
Buckeye Hess Corp.	Rochester	Rochester	195,191	Buckeye
North Albany Terminal Co.	Rochester	Rochester	271,788	Buckeye, Sunoco
Sunoco Logistics	Rochester	Rochester	169,976	Sunoco
United Refining	Rochester	Rochester	190,972	Buckeye, Sunoco
Rochester Total			**1,575,937**	
Buckeye Terminals, LLC	Brewerton	Syracuse	417,846	Buckeye
Buckeye Hess Corp.	Warners	Syracuse	589,806	Buckeye, Sunoco
Syracuse Total			**1,007,652**	
Buckeye Terminals, LLC	Marcy	Syracuse East	459,666	Buckeye
Buckeye Terminals, LLC	Utica	Syracuse East	270,188	Buckeye
Syracuse East Total			**729,854**	
Buckeye Terminals, LLC	Geneva	Geneva	111,849	Buckeye
Sprague Energy Corp.	Oswego	Oswego	340,569	--
Other Total			**452,418**	
Total			**7,052,120**	

Source: OPIS/Stalsby. "Petroleum Terminal Encyclopedia." 2012 Edition.

The Buckeye and Sunoco pipeline systems combined have access to 18 terminals with over 6.3 MMbbl of capacity. This represents 90% of the Central & Western Region's terminal capacity and 86% in terms of count, taking into account the overlap in access capacity by the two pipelines as four terminals are supplied by both. This underscores the criticality of the pipelines to petroleum supply in the region.

BUCKEYE PIPELINE SYSTEM

Buckeye Partners, LP operates three pipelines that enter Upstate New York from Pennsylvania: Line 701 (14-inch) and Line 702 (16-inch) are operated by Buckeye Pipe Line Company LP; and Line 751 (8-inch) is operated by Buckeye Pipe Line Transportation, LLC. All three of these lines originate from the Buckeye Partners, LP terminal in Macungie, PA. The Macungie terminal is supplied via 16-inch and 20-inch pipelines from Buckeye Pipe Line Company LP's origination terminal in the New York Harbor area; and via an 8-inch pipeline from Buckeye Pipe Line Transportation LLC's origin in the Philadelphia area. From the Macungie terminal, the three pipelines (701, 702, and 751) run to Binghamton. In Binghamton, Line 702 terminates, while Line 701 continues north to the Auburn Tank Farm and junction, where product movement is split east to destination markets near Syracuse, Brewerton, and Utica; and west to destination markets in Geneva and Rochester. Buckeye has indicated that Lines 701 and 702 run at roughly 75 percent of maximum pumping capacity. Line 751 continues north from Binghamton and splits at Waterloo Station, with product running east via a 6-inch pipeline to Syracuse and west via another 6-inch pipeline to Rochester and Buffalo. This system runs near 95 percent of capacity. In the event that Line 751 shuts down, Buckeye has the ability to shift some of this volume onto the Line 701 at Macungie and can reach all 751 destination points except Buffalo. Buckeye's Upstate systems are connected to 14 terminals with a total storage capacity of over 4.2 million barrels. Of these 14 terminals, nine are owned by Buckeye with a combined capacity of 2.8 million barrels.[7,8]

SUNOCO LOGISTICS PIPELINE SYSTEM

The Sunoco Logistics system moves product from the Philadelphia area refineries through Pennsylvania into Upstate New York via two pipelines: the Reading/Buffalo segment, which supplies terminals in Western New York, splits in Caledonia into two lines with one line terminating in Rochester and one line supplying three terminals in Tonawanda (near Buffalo); and the Philadelphia/Syracuse segment, which supplies terminals in Central New York, including the Syracuse area.[9] Sunoco's Reading/Buffalo pipeline segment is connected to eight terminals in NYS with a total access capacity of 3.5 MMbbl. Of these terminals, two are owned by Sunoco Logistics with a total NYS capacity of 0.5 MMbbl.[10] Sunoco has indicated that this segment typically operates near capacity. Sunoco's Philadelphia/Syracuse segment is no longer in operation.

It is important to note that although the Sunoco Logistics system is critical to Upstate supply; it is much smaller in capacity than the Buckeye system. Table 3 indicates that both systems feed terminals with large aggregate capacity, but according to industry sources, it is not believed that the Sunoco system would be able to fully offset lost capacity in the event Buckeye suffered a disruption. Conversely, it is believed that Buckeye may be large enough with enough unsubscribed capacity to fill gaps (at least temporarily) in the event the Sunoco system suffered a disruption.

[7] OPIS/Stalsby. "Petroleum Terminal Encyclopedia." 2012 Edition.
[8] http://www.buckeye.com/LinkClick.aspx?fileticket=idzFY8SvuAA%3D&tabid=36
[9] Sunoco Logistics. "Asset Map." Available at: http://www.sunocologistics.com/Customers/Business-Lines/Asset-Map/130/
[10] OPIS/Stalsby. "Petroleum Terminal Encyclopedia." 2012 Edition.

UNITED REFINERY

United Refining Co. owns a 65,000 b/d refinery in Warren, PA that directly supplies and markets petroleum fuels in Western New York as well as Pennsylvania and eastern Ohio. All of the crude oil processed at this refinery is shipped via United's 78-mile, dedicated 70,000 b/d Kiantone Pipeline, which originates at United's 485,000 bbl tank farm in West Seneca, NY. [11] The West Seneca terminal receives crude oil imported from Canada via the Enbridge Pipeline. The refinery processes over 50 percent Canadian heavy crude and the balance is lighter grades of Canadian crude. It is a full upgrading refinery although it produces asphalt in lieu of coking the residual component of crude oil. Product is out-loaded primarily by truck for delivery to destination markets. As shown in Table 3, United also owns two terminals that are supplied by Sunoco (one of which also has access to the Buckeye system).

TRUCK

The Central & Western Region of Upstate New York receives some supply by truck from other parts of Downstate New York, the Hudson Valley Region, from neighboring States, and from Canada. Typically the maximum radius for normal trucking of petroleum products is 200 miles. This puts Utica, Syracuse, and Binghamton within trucking distance of Albany terminals. According to U.S. Department of Transportation data, volumes of petroleum products from the Hudson Valley Region to Central & Western New York could be as high as 12,500 b/d. Movements from Pennsylvania into the Central & Western Region could be as high as 21,000 b/d, with at least 14,000 b/d moving from Pennsylvania to the Buffalo and Rochester metropolitan areas. These movements include volumes from the United Refinery in Warren, PA. In addition, roughly 1,000 b/d moves into the Region from the New York Harbor area.

In addition to movements of petroleum products, ethanol, which is railed into Albany terminals from the Midwest, is trucked to a variety of markets in NYS. In fact, one terminal in the Vestal/Binghamton area suffered short-term delays in receiving truck deliveries of ethanol from Albany due to weather that affected road conditions according to a recent survey administered by NYSERDA.

ASSESSMENT

In addition to primary supply sources, Upstate NY petroleum markets have several alternative fuel supply sources allowing for a measure of diversification. Terminals in the Hudson Valley Region are dependent on marine deliveries from the New York Harbor area via the Hudson River for essentially all of their supply of gasoline and diesel fuel (although ethanol, which is splash blended into gasoline, arrives to the Region by rail). In the event that shipping is shut down on the Hudson River or the New York Harbor, the Region could receive some fuel deliveries by truck from the NYH area, Central New York, or neighboring states but it would not be possible to fully replace marine volumes on short notice. The Central & Western Region of Upstate New York is more diversified, with fuel deliveries possible by two pipeline systems and by truck from Pennsylvania and Canada. However, the Region is heavily dependent on the Buckeye Pipeline system and it would be difficult to completely compensate for the loss of this system with deliveries along other pathways.

[11] United Refining Company 2010 and 2011 SEC 10-K Filing. Year ended August 31, 2011. Available at: http://www.sec.gov/Archives/edgar/data/101462/000119312511324609/d257760d10k.htm

The limited supply diversification in Upstate New York is mitigated to some degree by the relatively higher levels of inventory held at Upstate terminals. While companies do not report their specific inventory levels (as that is confidential business information), it is possible to estimate volumes using industry rules of thumb. On average, terminals supplied by marine (such as those in the Hudson Valley Region) hold inventories equal to roughly 40 percent of storage capacity because capacity utilization is planned around the timing of marine cargoes. This means that terminals in this region typically hold several days of supply in inventory. In the Central & Western Region, pipeline deliveries along the main pathway – the Buckeye Pipeline – run on a 10-day delivery cycle, which means that terminals in this Region typically hold more than 10 days of supply on hand following pipeline deliveries. Inventory levels in the Upstate markets contrast starkly with inventory at terminals in the Downstate New York area, which may hold as little 2-3 days of supply at any given point. The higher inventory levels in Upstate markets mean these areas can withstand longer disruptions to critical fuel supply pathways.

ANALYSIS OF POWER OUTAGE EVENTS

The need for greater power resiliency at Upstate petroleum infrastructure components depends in part on the frequency and magnitude of major power outage events historically experienced in Upstate markets. This section provides an analysis of the average frequency and duration of power outage events affecting the utilities serving Upstate New York – Central Hudson Gas & Electric (CHGE), National Grid, New York State Electric & Gas (NYSEG), Orange and Rockland Utilities (O&R), and Rochester Gas & Electric (RG&E). These companies and the number of customers they served in 2012 are listed in Table 4 below.

Table 4. Investor-Owned Electric Utilities Serving Upstate New York

Company	Customers Served ('12)
Central Hudson Gas & Electric	299,593
National Grid	1,632,533
New York State Electric & Gas	879,534
Orange & Rockland	225,280
Rochester Gas & Electric	369,064
Total	**3,406,004**

Source: New York DPS

In addition, this section looks in-depth at five historic power outage events: the 1998 North Country Ice Storm, the August 2003 Northeast Blackout, Hurricane Irene (2011), Tropical Storm Lee (2011), and Superstorm Sandy (2012). For each event, the impact on Upstate electricity customers and the impact on Upstate petroleum markets are summarized.

ELECTRIC SERVICE RELIABILITY

The New York State Department of Public Service (NYSDPS) collects outage and reliability information from New York utilities each year, including the number of interruptions (loss of service for five minutes or more); number of customer-hours lost; number of customers affected; and total number of customers served. NYSDPS uses this data to calculate two key electric service reliability performance measures: the System Average Interruption Frequency Index (SAIFI or frequency) and the Customer Average Interruption Duration Index (CAIDI or duration). Frequency measures the average number of interruptions experienced by customers served by the utility and is influenced by factors such as system design, capital investment, maintenance, and weather. Duration measures the average time that an affected customer is out of electric service and is affected by work force levels, management of the workforce, and geography.[12] NYSDPS reports these items for all service interruptions and for all interruptions excluding those caused by major storms (defined as any storm which causes service interruptions of at least ten percent of customers in an operating area, or if the interruptions last for 24 hours or more). Table 5 presents key aggregated reliability measures for electric service interruptions excluding interruptions caused by major storms in

[12] "2012 Electric Reliability Performance Report." New York State Department of Public Service. Electric Distribution Systems Office of Electric, Gas, and Water. June 2013. http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7B8D094296-7013-425D-9287-043D8860D0CF%7D

the Upstate area from 2008 to 2012. The cause of interruptions in Table 5 includes equipment failures, accidents, and vegetation issues.

Table 5. Reliability Measures for Upstate Utilities Excluding Interruptions Caused by Major Storms (2008-2012)

	2008	2009	2010	2011	2012	5-Year Avg.
Number of Interruptions (Excluding Storms)	35,623	38,200	37,130	36,790	34,202	36,390
Number of Customer-Hours Lost	6,232,566	6,158,169	6,292,125	6,909,032	6,141,341	6,346,646
Number of Customers Affected	3,054,021	3,154,769	3,150,860	3,476,872	3,047,433	3,176,790
Number of Customers Served	3,322,136	3,334,327	3,329,769	3,336,260	3,349,413	3,334,381
Average Duration Per Customer Affected (hrs) (CAIDI)	2.04	1.95	2	1.99	2.02	2
Average Duration Per Customers Served (hrs)	1.88	1.85	1.89	2.07	1.83	1.9
Number of Customers Affected Per Customer Served (SAIFI)	0.92	0.95	0.95	1.04	0.91	0.95

Note: Upstate utilities are CHGE, National Grid, NYSEG, O&R, and RG&E. The number of affected customers may be higher than number of total customers as some customers experience multiple outages each year.
Source: New York State Department of Public Service

Table 5 shows that Upstate utilities experienced an average of 36,000 interruptions per year from 2008 to 2012 (excluding storm-related outages). These interruptions affected an average of 3.2 million customers each year and led to more than 6 million customer hours lost per year. On average Upstate customers experienced one outage event per year with an average duration of 2 hours for affected customers.

AVERAGE OUTAGES FROM MAJOR STORMS

Outage events caused by major storms are less frequent but typically last longer than service interruptions due to other causes. Table 6 presents outage data and key reliability data for outage events caused by major storms for Upstate utilities.

Table 6. Storm-Related Reliability Measures for Upstate Utilities (2008-2012)

	2008	2009	2010	2011	2012	5-Year Avg.
Number of Interruptions (Major Storms)	17,056	4,638	12,138	23,428	15,572	14,566
Number of Customer-Hours Lost	22,731,432	2,643,831	15,048,759	46,403,552	38,393,033	25,044,122
Number of Customers Affected	2,443,101	702,784	1,437,062	2,633,915	1,618,092	1,766,991
Number of Customers Served	3,322,136	3,334,327	3,329,769	3,336,260	3,349,413	3,334,381
Average Duration Per Customer Affected (hrs) (CAIDI)	9.3	3.76	10.47	17.62	23.73	14.17
Average Duration Per Customers Served (hrs)	6.84	0.79	4.52	13.91	11.46	7.51
Number of Customers Affected Per Customer Served (SAIFI)	0.74	0.21	0.43	0.79	0.48	0.53

Note: Upstate utilities are CHGE, National Grid, NYSEG, O&R, and RG&E. The number of affected customers may be higher than number of total customers as some customers experience multiple outages each year.
Source: New York State Department of Public Service

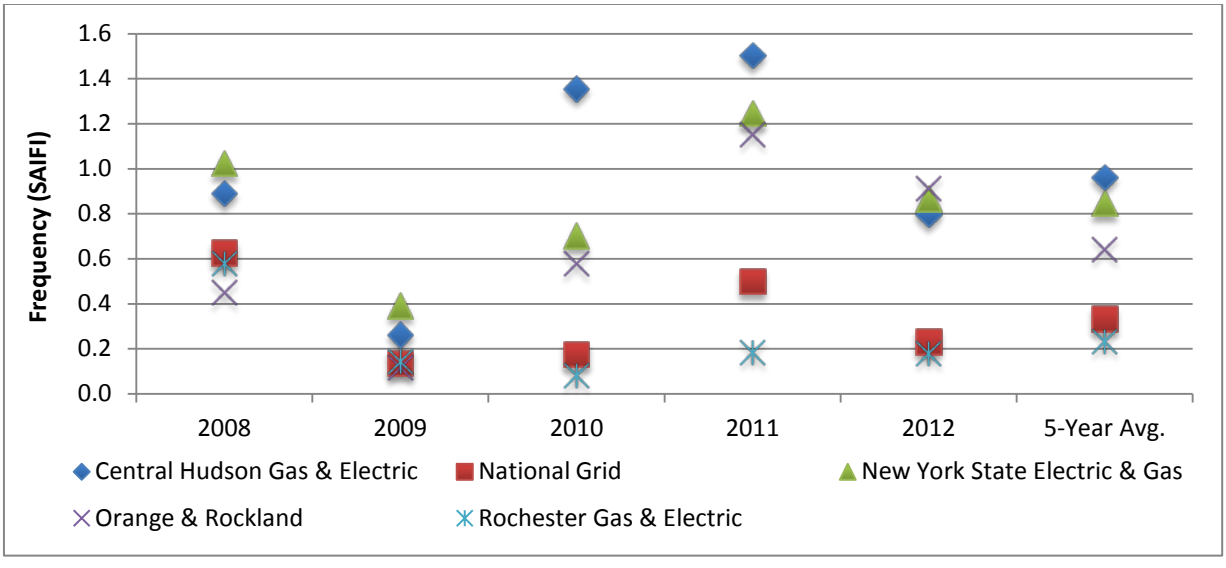
Table 6 shows that Upstate customers experience an average of nearly 15,000 interruptions due to major storms each year, affecting 1.8 million customers each year and leading to a 25 million customer-hours lost per year from 2008 to 2012. On average, Upstate customers experience one major storm-related power outage event every two years with average outage duration of more than 14 hours. Over this 5-year span, the most Upstate customers (2.6 million) were affected by service interruptions in 2011, due in large part to Hurricane Irene and Tropical Storm Lee, leading to a frequency of 0.79 outages per customer served. Due in large part to Superstorm Sandy, the longest average duration of storm-related power outages for affected customers (nearly 24 hours) was reported in 2012.

This average frequency and duration of power outage events is an acceptable level for petroleum terminals as operators are typically able to ramp up out-bound deliveries to customers to make up for interruptions lasting 24 hours or less. In addition, Upstate terminals that rely on in-bound deliveries via pipeline typically have enough product in on-site storage tanks to continue operating in the event that a pipeline system cannot operate for 24 hours due to loss of power. As noted earlier in this report, Upstate terminals connected to major pipeline systems run on 10 day delivery cycles, meaning the average pipeline-connected terminal has 5 days or more of supply in storage at any given time during the cycle. In addition, Upstate terminals are likely to obtain backup generators during outage events lasting longer than 48 hours as the companies operating these facilities have backup generator capacity at offsite locations.

AVERAGE OUTAGES FROM MAJOR STORM OUTAGES BY UTILITY

Within the Upstate New York area, the average frequency and duration of major storm-related power outages varies by utility. There are five utilities that primarily serve the Upstate area: Central Hudson Gas & Electric (CHGE), National Grid, New York State Electric & Gas (NYSEG), Orange & Rockland Utilities (O&R), and Rochester Gas & Electric (RGE). Figure 2 presents the frequency of storm-related power outage events by Upstate utility from 2008 to 2012.

Figure 2. Frequency of Storm-Related Outage Events by Upstate Utility (2008-2012)

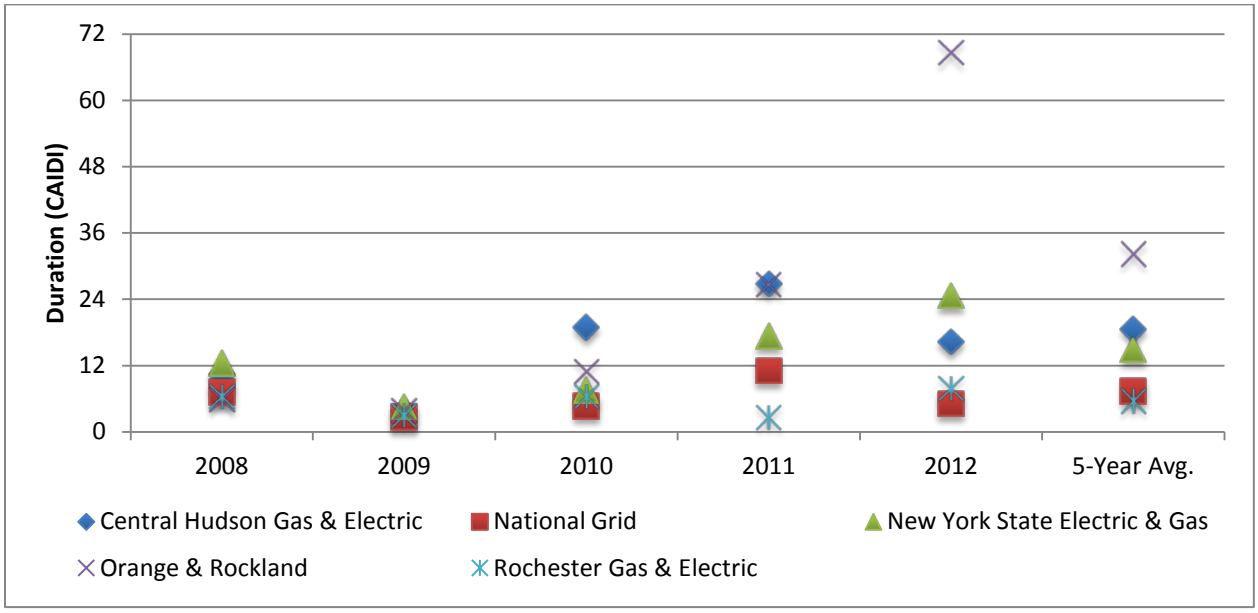


Source: New York State Department of Public Service

Figure 2 shows that, on average, CHGE had the highest 5-year average frequency of major storm outage events (0.96), followed by NYSEG (0.84), O&R (0.64), National Grid (0.33), and RGE (0.23) respectively.

The average duration of power outages from major storms has also varied over the past five years. Figure 3 presents the average duration (CAIDI) of storm-related power outage events by utility from 2008 to 2012.

Figure 3. Duration of Storm-Related Outage Events by Upstate Utility in hours (2008-2012)



Source: New York State Department of Public Service

Figure 3 shows that for the majority of the Upstate region, the 5-year average duration of storm-related power outage events ranged from 6 to 32 hours for Upstate utilities from 2008 to 2012. Some utilities reported the highest duration in 2011 due to Hurricane Irene and Tropical Storm Lee, and some utilities reported the highest duration in 2012 due to Superstorm Sandy. The highest average storm-related outage duration (67 hours) was reported by Orange & Rockland (O&R) Utilities in 2012. O&R's service territory is located in the southernmost portion of Upstate New York, just outside the New York City metropolitan area and was heavily affected by Hurricane Sandy. Other utilities in 2012 reported average durations of 24 hours or less.

WIDESPREAD POWER OUTAGE EVENTS

Widespread power outage events – those impacting a large number of customers – are the most likely to impact petroleum supply infrastructure to Upstate New York. Over the past 15 years several widespread power outage events have affected Upstate New York: the North Country Ice Storm in 1998; the Northeast Blackout in 2003; Hurricane Irene in 2011; Tropical Storm Lee in 2011; and Superstorm Sandy in 2012. These events and their impacts on Upstate electricity customers and petroleum markets are summarized in the following sections.

AUGUST 2003 NORTHEAST BLACKOUT

On August 14, 2003, Upstate New York was impacted by a major cascading blackout that affected millions of electric power customers across the Northeastern United States and Canada. The event, which was the result of a series of electric system failures outside New York, affected a total of 6.3 million customers in New York State, or more than 83 percent of statewide customers.[13] Of the five utilities serving the Upstate New York region (listed in Table 7), nearly 2.1 million customers lost power, representing nearly 63 percent of total customers in Upstate New York.

Table 7. Peak Upstate Customer Outages Caused by 2003 Blackout by Utility

Company	Customers Served ('03)	Customers Affected	% Customers Affected
Central Hudson Gas & Electric	282,814	255,438	90.3%
Niagara Mohawk (National Grid)	1,580,395	840,137	53.2%
New York State Electric & Gas	844,912	470,267	55.7%
Orange & Rockland	210,235	210,235	100.0%
Rochester Gas & Electric	362,975	287,256	79.1%
Total	**3,281,331**	**2,063,333**	**62.9%**

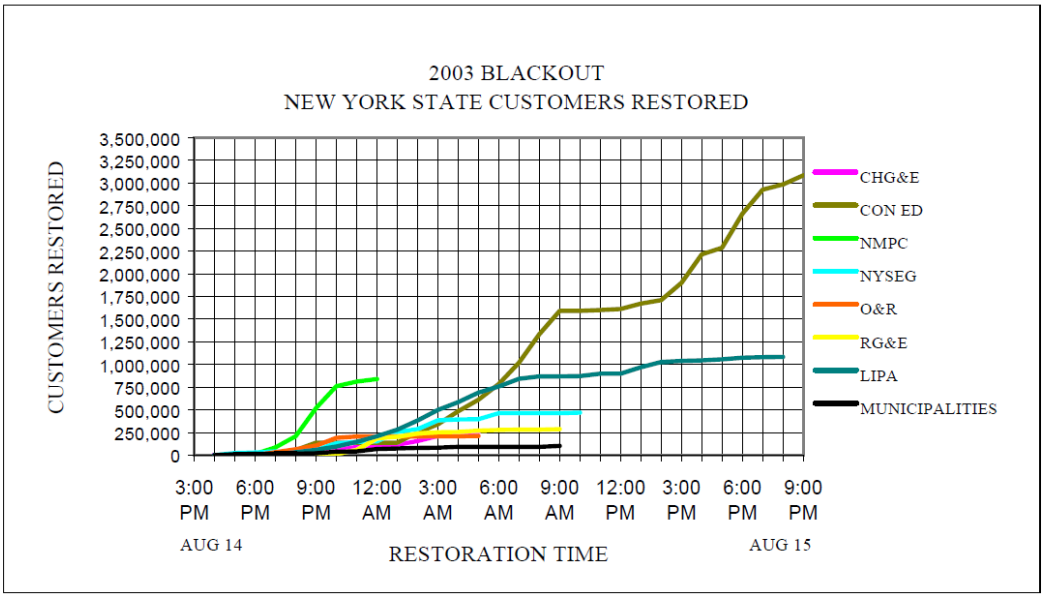
Source: New York State DPS

Outages affecting Upstate New York customers began around 4:00 p.m. on August 14, 2003, and most customers had power restored by 9:00 a.m. on August 15. However, some customers were forced to wait for longer periods including some who waited up to two days.

Figure 4 shows the restoration status of New York utilities that were affected by the 2003 blackout from the start of the event until full restoration was achieved.

[13] New York State Department of Public Service. "Initial Report by the New York State Department of Public Service on the August 14, 2003 Blackout." February 2004.
http://www3.dps.ny.gov/pscweb/WebFileRoom.nsf/Web/5FA2EC9B01FE415885256E69004D4C9E/$File/doc14463.pdf?OpenElement

Figure 4. New York Customers Restored from August 2003 Blackout by Utility



Source: New York DPS

Impacts to Petroleum Markets

The August 2003 Blackout knocked out power to eight oil refineries in Ohio, Michigan, and Ontario, however, the Upstate New York area does not regularly receive supply from these sources.[14] It is likely that operations in New York were disrupted to pipelines; terminals, gas stations, and other petroleum infrastructure served that rely on grid power. However, the short duration of the outage likely mitigated any impacts on end-use customers. A report by the U.S. Energy Information Administration found that although parts of the Northeast region, including essentially all of New York State, were affected by the August 2003 blackout, that event appeared to have had relatively little impact on gasoline prices or on the petroleum industry in general, in the region.[15]

NORTH COUNTRY ICE STORM

In January 1998, a powerful ice storm struck Canada, northern New York, and parts of northern New England. A dense layer of cold air coupled with heavy rain created ice accumulations in excess of three inches. The storm dumped freezing rain on the region for an unprecedented 5 days. Flooding from heavy rains and significant runoff from melting snow forced the evacuation of more than 1,000 homes and caused widespread damage across the region. The ice coated all outdoor surfaces, destroying electric power infrastructure and more than 3 million people in four states and two Canadian provinces were affected by widespread power outages. Due to the severity of damage to roads and bridges from downed trees and flooding, power was not restored in many areas for up to two weeks.

[14] "The Economic Impacts of the August 2003 Blackout." Electricity Consumers Resource Council (ELCON). February 9, 2004. http://www.elcon.org/Documents/EconomicImpactsOfAugust2003Blackout.pdf

[15] "Inquiry into August 2003 Gasoline Price Spike." U.S. Energy Information Administration. Office of Oil and Gas. November 2003. http://www.eia.gov/pub/oil_gas/petroleum/analysis_publications/gasps/gasps.pdf

In Maine, 80 percent of the state's population lost electrical service, some for more than two weeks.[16] In New York, heavy freezing rain and subsequent icing caused damage to transmission and distribution facilities of New York State Electric & Gas Corporation, Niagara Mohawk Power Corp, Bell Atlantic, and numerous small private and municipal utilities. During the five-day duration of the storm, weather and road conditions prevented utilities from making significant progress in restoring service.[17] Niagara Mohawk (now National Grid) reported that 100,000 of its customers were without power on January 8, and estimated that it would take 5 to 6 days to restore power to most customers. A small number of homes remained without power for more than three weeks after the storm. According to media reports, at the worst point, all the distribution lines into the North Country had been down, and utilities from across the Eastern United States and Canada sent trucks and linemen to assist in power restoration. Utility repair crews were mobilized and the National Guard was called in to assist in the recovery effort. In the end, fourteen hundred line crews set 10,000 new poles and strung hundreds of miles of wire.[18]

Impacts to Petroleum Markets

The 1998 ice storm knocked out power to virtually all of northern New York. Petroleum terminals and gas stations that rely on grid-supplied electric power to run pumps would not have been able to operate without backup generation, thus disrupting the supply of transportation fuels and heating oil to customers in the affected region. The impact on transportation fuel supply was likely to have been significantly mitigated by the large drop in demand for transportation fuels as motorists stayed off the icy and dangerous roads. Demand for heating oil continued during the storm, but heating oil distributors may not have been able to deliver fuel to customers due to road blockages even if power had been available to terminals.

HURRICANE IRENE

Hurricane Irene, which moved up the U.S. East Coast in late August 2011, disrupted electricity transmission and distribution infrastructure and knocked out power to 6.69 million utility customers from South Carolina to Maine.[19] Irene initially made landfall as a Category 3 hurricane in North Carolina on August 27, but weakened to a tropical storm before reaching NYS. Irene brought high winds and heavy rainfall causing power outages, road closures, and flooding in low lying areas around the state. The sum of the peak outages from each NYS utility affected by Irene was 1.1 million customers.[20] Of these outages, 461,000 were reported by Upstate utilities (see Table 8). After the storm had passed, delays due to bridge closings, impassable roads, and flooding made the restoration effort challenging.

[16] "The Ice Storm and Flood of January 1998." NOAA. June 1998. http://www.nws.noaa.gov/os/assessments/pdfs/iceflood.pdf
[17] http://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/f2b657511ffeaed885257687006f3a95/$FILE/ATTY0FF0.pdf/
[18] "Ice Storm of '98: A Retrospective." North Country Public Radio. http://www.northcountrypublicradio.org/news/icestorm.html
[19] "Comparing the Impacts of Northeast Hurricanes on Energy Infrastructure." U.S. Department of Energy. Office of Electricity Delivery and Energy Reliability. April 2013. http://www.oe.netl.doe.gov/docs/Northeast%20Storm%20Comparison_FINAL_041513c.pdf
[20] "Utility Performance Report Following Hurricane Irene and Tropical Storm Lee." New York State Department of Public Service. June 2012. http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={AD5B750D-A5DC-4ABB-972F-EB0557269D9F}

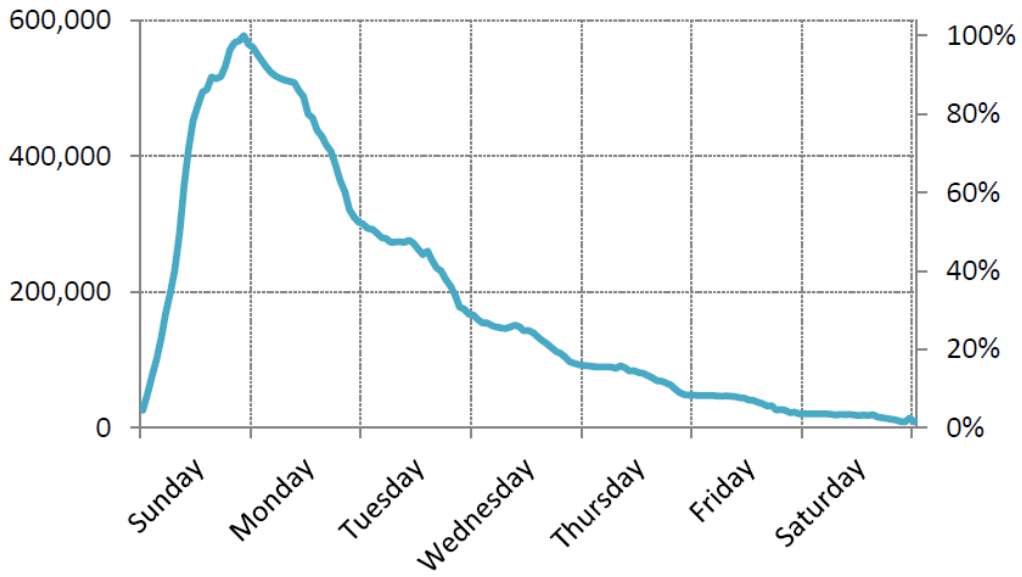
Table 8. Peak Upstate Customer Outages Caused by Hurricane Irene by Utility

Company	Customers Affected
Central Hudson Gas & Electric	118,000
National Grid	156,000
New York State Electric & Gas	131,000
Orange & Rockland	56,000
Total	**461,000**

Source: New York DPS

Figure 5 shows the number of customer outages from investor owned utilities (the four utilities listed in Table 8 plus Con Edison) without power beginning on Sunday, August 28, 2011.

Figure 5. NYS Investor-Owned Utility Customers without Power Following Hurricane Irene



Source: New York DPS

Figure 5 shows that customer outages peaked at close to 600,000 late Sunday August 28, 2011. By midnight Tuesday, less than 300,000 customers (or about 50 percent of peak outages) remained without power and by midnight Wednesday, less than 200,000 (or about 33 percent of peak outages) were still without power. Nearly all customers were restored within six days of the storm.

Impacts to Petroleum Markets

Direct damage (wind and flooding) from Hurricane Irene, and power outages had significant impacts on Downstate New York and regional petroleum supply infrastructure. ConocoPhillips's (now Phillips 66) 238,000 b/d refinery in Linden, NJ was shut for four days following Hurricane Irene, and other regional refineries in New Jersey, Pennsylvania, and Delaware operated at reduced rates as a result of the storm. Terminals in the New York Harbor transshipment hub were also affected, and Buckeye Pipeline shut segments of its pipeline system, part of which

feeds Upstate New York markets. The Harbor itself was closed for 4 days as a result of the storm, and five Upstate terminals, all located along the Hudson River in the Hudson Valley Region, reported having marine shipments disrupted due to the storm.

Upstate markets were affected by power outages caused by Irene but to a lesser degree than Downstate. According to a recent survey conducted by NYSERDA, only 4 of 26 Upstate New York terminals (15 percent) reported losing power as a result of Hurricane Irene.[21] All of these terminals were located in the Hudson Valley Region, which includes the terminal clusters near Albany and Newburgh. Two of the terminals that lost power were located in the Newburgh area and were served by CHGE and two were located in the Albany area and were served by National Grid. One Newburgh-area terminal reported losing power for 3 days and one Albany- area terminal reported losing power for two days, while the other two terminals reported outages of less than 24 hours. Terminals located in the Central & Western Region and connected to the Buckeye and Sunoco pipeline systems remained operational.

TROPICAL STORM LEE

Tropical Storm Lee made landfall in Louisiana on September 4, 2011 before moving north across the Eastern United States. The storm reached NYS by September 5, as a Tropical Depression. From September 5 through September 10, heavy rains soaked portions of central and eastern New York. While Lee did not possess high winds, the storm delivered between 8 to 12 inches of rainfall to NYS, as the state was still recovering from flooding caused by Hurricane Irene. Lee brought rain for several days causing widespread flood damage. NYSEG and National Grid were the only utility companies to be severely impacted by Lee. These utilities experience peak outages of 68,000 customers. Severe flooding impacted nine substations in NYSEG's Binghamton Division, one substation in the NYSEG's Oneonta Division, and one National Grid substation in Amsterdam. In addition, erosion due to high water in the Mohawk River compromised a National Grid utility tower supporting transmission lines across the river.[22]

Impacts to Petroleum Markets

Buckeye Partners operates petroleum terminals in Binghamton and Vestal, as well as two pipelines that run north from these terminals to supply other Upstate markets. Buckeye reports that it did not experience any power loss or supply issues from Tropical Storm Lee.

SUPERSTORM SANDY

Superstorm Sandy made landfall as a post-tropical cyclone near Atlantic City, New Jersey on October 29. Sandy brought strong winds and a record storm surge, severely damaging electric transmission and distribution infrastructure along the New Jersey and New York coastlines. At time of peak outage, there were more than 2 million customers without power in NYS, or more than 23 percent of all customers statewide. The magnitude and severity of the damage, in addition to the November 2012 Nor'easter that followed a week after the storm had passed, slowed restoration efforts and led to extended outages for many New York customers. Ninety-nine percent service restorations in New York were not achieved until two weeks after the storm had passed. According

[21] Upstate New York is defined as anything north of Westchester and Rockland counties.
[22] New York State Department of Public Service

to the New York State DPS, of the more than 726 million hours of customer interruptions that have occurred since 1989, more than 23 percent (168 million hours) can be attributed to Superstorm Sandy. Sandy's effects were focused on the Downstate region, although several Upstate markets in the Lower Hudson and Albany areas were also impacted. As shown in Table 9, Upstate New York utilities reported that a total of 432,000 customers lost power as a result of Superstorm Sandy.

Table 9. Peak Upstate Customer Outages Caused by Superstorm Sandy by Utility

Company	Customers Affected
Central Hudson Gas & Electric	80,286
National Grid	37,000
New York State Electric & Gas	116,668
Orange & Rockland	171,428
Rochester Gas & Electric	26,635
Total	**432,017**

Source: New York State DPS

Impacts to Petroleum Markets

Superstorm Sandy caused extensive damage to Downstate petroleum supply infrastructure. Flooding and power outages shut refineries and numerous bulk terminals in the New York Harbor area and some facilities remained shut for weeks after the storm had passed. The Buckeye Pipeline pump station in Linden, NJ, which supplies multiple markets in the Northeast, including markets in Upstate New York, lost power during the storm and was down for 3 days after the storm had passed. As noted previously in this report, the Buckeye Pipeline system is the primary fuel supply pathway to the Central & Western Upstate New York Region. Additionally, debris in New York Harbor shut down shipping operations for 3 days after the storm had passed, and part of New York Harbor – the Arthur Kill waterway between Staten Island and northern New Jersey – was shut down for 10 days due to an oil spill from a terminal in Sewaren, NJ. The New York Harbor and Hudson River make up the key pathway supplying the Hudson River Region of Upstate New York. Six of 26 Upstate terminals surveyed reported experiencing supply disruptions as a result of Superstorm Sandy: three terminals supplied by the Buckeye Pipeline system in the Central and Western Upstate New York Region, and three terminals along the Hudson River in the Hudson River Region.

Although Upstate terminals were affected by disruptions to supply infrastructure in the New York Harbor area caused by Superstorm Sandy, only 3 of 26 Upstate New York terminals reported directly losing power as a result of the storm. All of the Upstate terminals that lost power were in the Hudson River Region: two were in the Newburgh terminal cluster served by CHGE and one was located in the Albany area served by National Grid. Each of these terminals reported losing power for 24 hours or less. All of the terminals that lost power during Sandy also lost power during Irene.

ASSESSMENT

Over the past five years, Upstate power customers, have on average experienced one major storm-related power outage every two years with an average duration of 14 hours. This is not long enough to cause a significant disruption to most fuel supply systems due to availability of storage at multiple levels of the fuel supply chain and

to the ability of pipeline and terminal operators to make up lost volumes by ramping up rates after power has been restored. Five widespread power outage events – the 1998 North Country Ice Storm, the August 2003 Northeast Blackout, Hurricane Irene (2011), Tropical Storm Lee (2011), and Superstorm Sandy (2012) - appear to have had limited direct power outage impacts on petroleum supply infrastructure located in Upstate New York. However, storm-related damage to key supply facilities in the New York Harbor area (in Northern New Jersey and Downstate New York) has had a significant impact on fuel supply to Upstate markets. In particular, recent storms have cut power to Buckeye Pipeline's pump station in Linden, NJ, which helps supply Central and Western Upstate New York markets; and have shut down shipping in New York Harbor and caused power outages to marine terminals that supply product to the Hudson Valley Region via the Hudson River. These past problems may have been alleviated by greater power resiliency at petroleum infrastructure in the New York Harbor area but would not have been alleviated by greater resiliency at Upstate facilities.

ANALYSIS OF HARDENING AND RESILIENCY MEASURSES

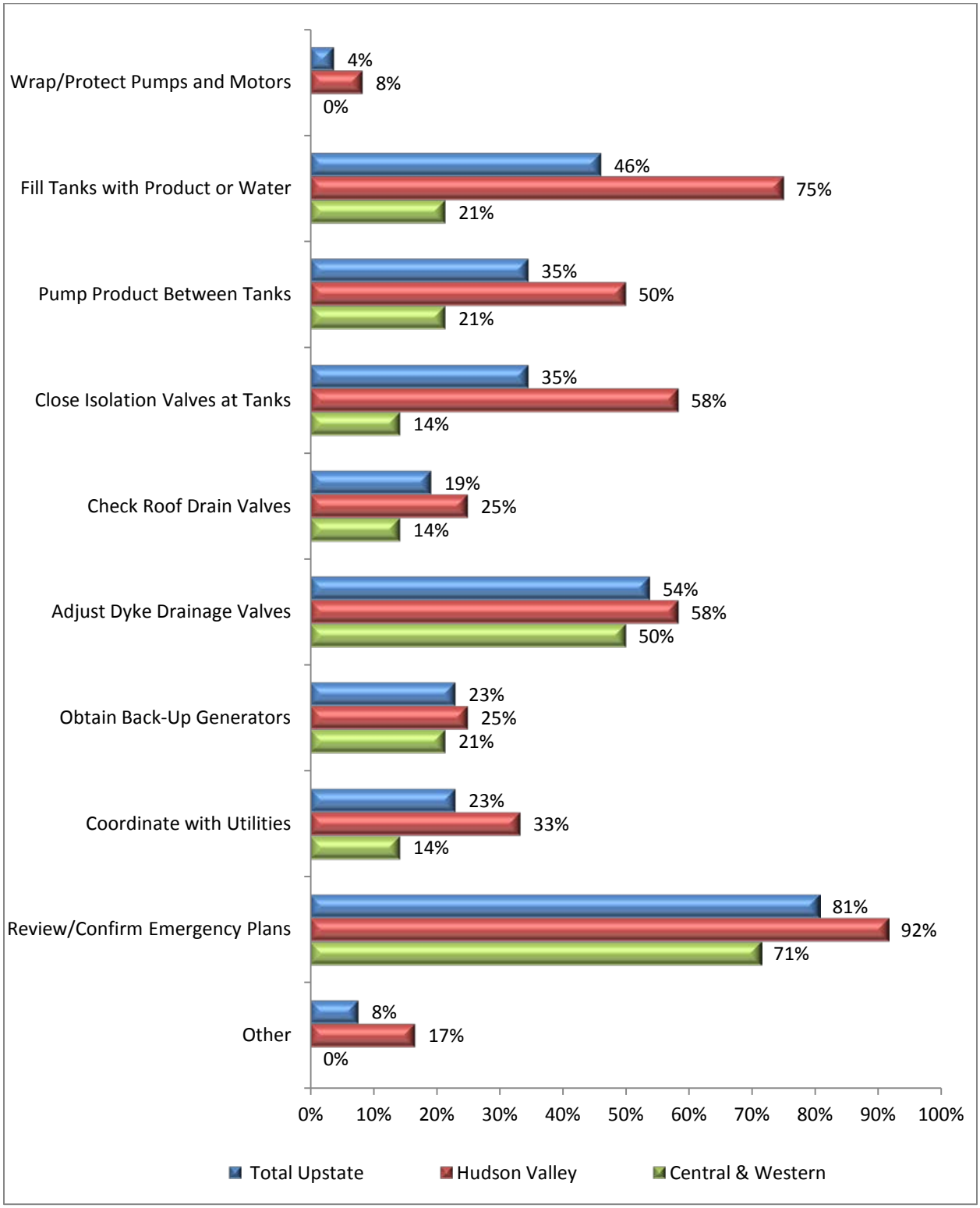
Operators of petroleum supply infrastructure in NYS continuously assess and improve hardening and resiliency measures to protect against or mitigate the effects of hurricanes, tropical storms, and other major weather events. This includes implementing best practices to secure facilities prior to a storm making landfall, flood protection measures to keep critical equipment dry, and power resiliency measures to ensure that the power supply remains available during major outage events. Many of these measures have been in place for years, while others have been initiated recently as a response to experiences learned during Superstorm Sandy (October 2012), Tropical Storm Lee (2011), and Hurricane Irene (August 2011).

It is important to note that hardening and resiliency investments are fundamental business decisions; operators weigh the monetary benefits of protecting equipment and expediting restoration of operations against the monetary costs of specific hardening and resiliency measures. There is no specific level of hardening that applies to all terminals. Decisions to undertake hardening and resiliency investments will depend on site-specific assessments of threats and vulnerabilities at each facility. For instance, terminals that have critical equipment (e.g., electrical switchgear, motor control centers, product pumps) located in low-lying coastal areas, or within river floodplains, will find greater benefits for investing in flood protection measures than terminals located on higher ground.

PRE-STORM ACTIVITIES

In preparation for major storms, NYS terminals undertake pre-storm activities designed to protect vulnerable parts of their facilities and to expedite the terminal's ability to restore operations after the storm has passed. The terminals surveyed by NYSERDA reported taking a variety of protection and preparedness measures prior to major hurricanes and tropical storms including; wrapping/protecting pumps and motors against potential flood damage; filling or pumping water or product between tanks to ensure adequate weight in each tank to prevent floating; closing isolation valves at tanks to prevent unintended product releases; checking roof drain valves for storm water; adjusting valve configurations for storm water drains; obtaining or pre-positioning backup generators if permanent generators are not already in place; coordinating with utilities for priority power restoration; and reviewing/confirming emergency plans. Figure 6 shows the percentage of Total Upstate terminals, Hudson Valley Region terminals, and Central & Western Region terminals surveyed by NYSERDA that reported undertaking each of these pre-storm activities.

Figure 6. Percentage of Upstate Terminals Conducting Pre-Storm Activities



Source: NYSERDA Terminal Survey

FLOOD PROTECTION MEASURES

Flooding is a serious threat for terminals located in low-lying areas along large bodies of water. Rising waters can put immense pressure on docks, tanks, and other terminal structures, and even short-term exposure to water can cause severe damage to pumps, motors, and electrical systems. Terminals that have saltwater damage to their electrical systems may experience long-term power outages disruptions to terminal operations.

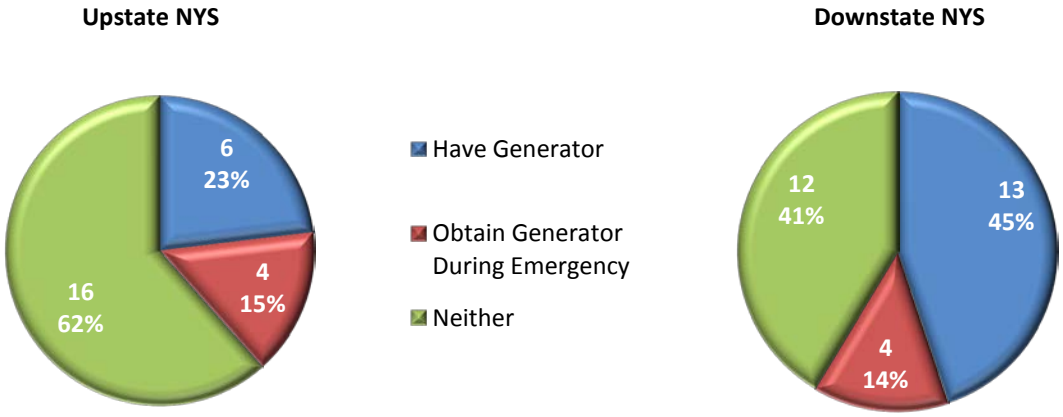
Eleven of the 26 Upstate New York terminals included in the survey, all in the Hudson Valley Region, are located along bodies of water; however, not all of these terminals may be located in a floodplain and not all may be at high risk of flooding. Of these 11 terminals, none reported installing enhanced berms, levees, or floodwalls along their waterfronts to protect onshore equipment in addition to what is already in place; two reported elevating transformers, and one reported protecting cabling.

BACKUP GENERATION

Some Upstate terminals have undertaken measures to obtain backup power equipment to ensure that power supply is available to run terminal operations in the event of an extended loss of grid-supplied power. The need for backup generation varies depending on the frequency and duration of grid power outage events that a terminal experiences. Some terminals that supply fuel to emergency responders are designated by the local utilities for priority restoration, and may be restored quickly following a major outage event. Even if power cannot be restored quickly, priority terminals may receive emergency resources from Federal, State, and local government agencies. For instance, terminals that supply emergency responder contracts may receive generators from city governments, the Federal Emergency Management Agency, and other governmental entities during emergencies. Similarly, one terminal in the Upstate region lies along the same electrical connection as the regional airport. Since the airport receives priority in electrical restoration, the terminal also regains power more quickly after an outage as a result.

NYSERDA recently administered a Terminal Resiliency Survey to 55 terminals in NYS, including 26 terminals that are defined as Upstate terminals for the purpose of this study (all counties north of Westchester and Rockland). Figure 7 presents the number and share of Upstate (comprised of the Hudson Valley Region and the Central & Western Region) and Downstate terminals that reported having backup power generators or obtaining them during emergency events.

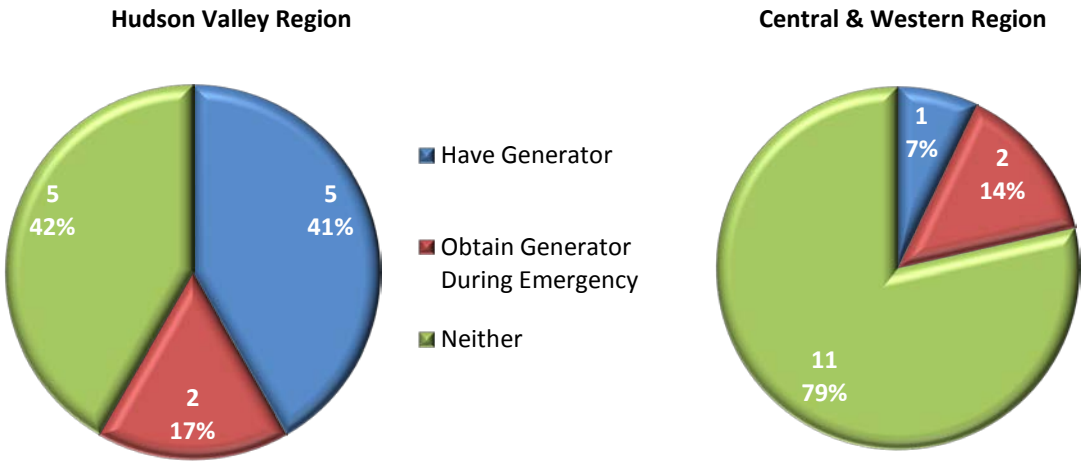
Figure 7. NYS Terminals that Have or Obtain Backup Generators, Upstate vs. Downstate



Source: NYSERDA Terminal Survey

Figure 7 shows Upstate terminal are less likely to have backup generators than Downstate terminals. Whereas 59 percent of Downstate terminals reported having some ability to access and utilize backup generators when needed, only 38 percent of their Upstate counterparts reported the same ability. Of the Upstate terminals with access to backup generators, the vast majority is located in the Hudson Valley Region. The survey shows that 58 percent of Hudson Valley terminals have access to back up generation, compared with only 21 percent of Central & Western Region terminals (see Figure 8).

Figure 8. Upstate Terminals that Have or Obtain Backup Generators by Region



Source: NYSERDA Terminal Survey

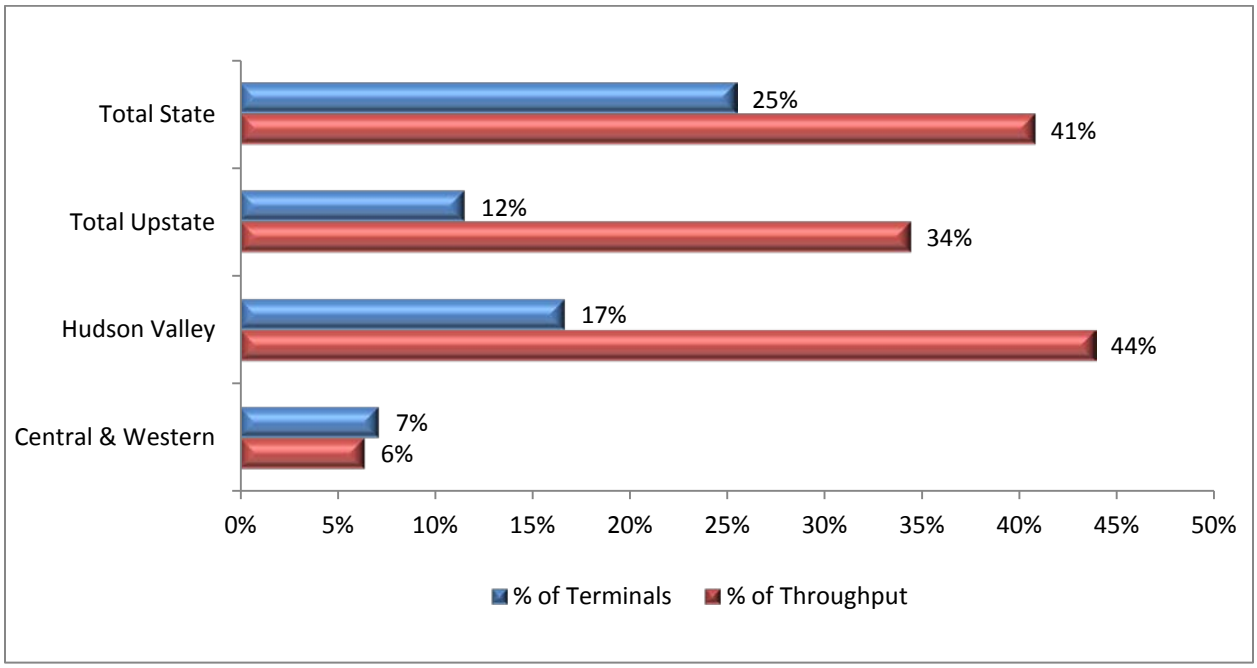
Of the seven terminals in the Hudson Valley Region that have or obtain backup generators, five are located near Newburgh in the southern portion of the Region, which has been adversely impacted by recent storms. In the Central & Western Region, the three terminals with generators are spread throughout the State with one in the Buffalo area, one in the Binghamton/Vestal area, and one in the Syracuse area.

Buckeye Partners, which operates two of the Upstate terminals that reported obtaining backup generators during an emergency, reported that prior to a major storm, they pre-position several backup generators at a central location outside of the storm's impact radius. Prior to Hurricane Irene and Superstorm Sandy, Buckeye staged generators at its terminal in Macungie, PA. After the storms, the generators were sent to pipeline booster stations and terminals that had lost grid power.

BACKUP GENERATION BY LOAD CAPABILITY

Backup power generators in NYS vary in size and capability. Some terminals have large generators capable of supplying the terminal's full power load, allowing the terminal to power 100 percent of throughput operations, including product loading and unloading, heating of viscous products, and running emergency alarm and fire suppression systems. Other facilities have generators that are only capable of powering throughput operations at a reduced rate, while still other terminals have generators that are only capable of powering office and/or emergency systems, and are not capable of running any throughput operations. Figure 9 shows the percentage of terminals that have backup generators capable of fully or partially powering throughput operations and the estimated aggregate throughput that can be powered by those generators by region.

Figure 9. Terminals with Backup Generators Capable of Powering Throughput Operations by Region



Source: NYSERDA Terminal Survey

Figure 9 shows that statewide, one-fourth of the terminals have backup generators capable of fully or partially powering throughput operations. Based on each terminal's throughput and the reported level of throughput that can be carried out with backup power, it is estimated that nearly 350,000 b/d of terminal throughput can be carried out with backup power generators statewide, representing more than 40 percent of the total throughput at NYS terminals. Although only 12 percent of the Upstate terminals have backup generation capabilities, these terminals tend to be larger on average so an estimated 34 percent of throughput can be sustained on backup

generation (160,000 b/d). Breaking down the Upstate Region reveals differences between the Hudson Valley and Central & Western Regions. For the Hudson Valley Region, an estimated 44 percent of throughput can be sustained with backup generation whereas only 6 percent can be maintained in the Central & Western Region.

ASSESSMENT

Upstate New York terminals are less prepared for hurricanes and tropical storms that bring high winds and flooding than their Downstate counterparts. This is because these storms rarely impact Upstate markets, and when they do they are much weaker than when they impact the coastal Downstate area. Upstate terminals that have hardened their facilities against storms and taken power resiliency measures are located near Newburgh in the southern portion of the Hudson Valley Region. Terminals in this area were impacted by Superstorm Sandy and Hurricane Irene. As noted in the *Analysis of Power Outage Events* chapter of this report, widespread power outage events occur less frequently and with shorter durations in Upstate New York. The outages that do impact the Upstate area are typically short enough in duration that they do not cause supply disruptions to end users due to storage inventory at multiple levels of the supply chain and because of the ability of operators to ramp up throughput to make up lost deliveries after power has been restored. While power resiliency measures, such as installing backup generators, could prevent supply disruptions in some hypothetical situations where grid power is lost for an extended period, it is not clear that Upstate New York fuel supply chain would significantly benefit from increased use of backup generators at petroleum terminals under historical worst-case scenarios.

CONCLUSION

Upstate New York petroleum markets are less at risk to widespread power outage events than Downstate markets. Although Upstate markets have limited diversification of fuel supply pathways, they tend to hold higher inventories than their Downstate counterparts and Upstate supply systems have a greater ability to make up lost volumes after a disruption event has ended. Furthermore, Upstate markets do not experience major power outage events with a high frequency or duration, and recent outage events have had limited (and manageable) impacts on the Upstate petroleum supply chain and end-use consumers. Few Upstate petroleum terminals have implemented hardening or resiliency measures – such as elevating critical equipment or installing backup generators – to ensure continuity of operations during major storm events. This is likely because major storm events have not significantly impacted these terminals. While future storms and widespread power outage events could hypothetically cause greater disruptions to Upstate supply and distribution systems, these systems have withstood largely historic worst case scenarios without experiencing major supply impacts.

In addition to primary supply sources, Upstate NY petroleum markets have several alternative fuel supply sources allowing for a measure of diversification. Terminals in the Hudson Valley Region of Upstate New York are dependent on marine deliveries from the New York Harbor area via the Hudson River for essentially all of their supply of gasoline and diesel. In the event that shipping is shut down on the Hudson River or the New York Harbor, the Region could receive some fuel deliveries by truck from the NYH area, Central New York, or neighboring states but it would not be possible to fully replace marine volumes on short notice. The Central & Western Region of Upstate New York is more diversified, with fuel deliveries possible by two pipeline systems and by truck from Pennsylvania and Canada. However, the Region is heavily dependent on the Buckeye Pipeline system and it would be difficult to compensate for the loss of this system with deliveries along other pathways.

The limited amount of diversification in Upstate New York is mitigated to some degree by the relatively higher levels of inventory held at Upstate terminals. While companies do not report their specific inventory levels, on average, terminals supplied by marine (such as those in the Hudson Valley Region) hold inventories equal to roughly 40 percent at any given time, meaning marine terminals in the Hudson Valley Region typically have several days of supply on hand at any given time, depending on the timing of deliveries. In the Central & Western Region, pipeline deliveries along the main pathway – the Buckeye Pipeline – run on a 10-day delivery cycle, and hold more than 10 days of supply on average. Inventory levels in these Upstate markets contrast starkly with inventory at terminals in the Downstate New York area, which may hold as little as 2-3 days of supply at any given point. The higher inventory levels in Upstate markets mean these areas can withstand longer disruptions to critical fuel supply pathways.

Furthermore, systems supplying Upstate markets have a greater ability to make up lost deliveries after a disruption event has ended. In the Hudson Valley Region, additional barges can be contracted from the New York Harbor shipping market to make up for lost deliveries, and supplemental deliveries can be made by tanker truck (the distance between Linden, NJ and Albany is roughly 160 miles). The Buckeye Pipeline system, which supplies markets in the Central & Western Region, typically runs at 75 to 80 percent of capacity and is out of operation 3 to 4 days per month due to lack of demand for volumes. This means that deliveries along this system can be ramped up after a disruption event to compensate for lost supply.

Upstate markets have not historically experienced major power outage events impacting Upstate supply facilities. Over the past five years, Upstate power customers, have on average experienced one major storm-related power

outage every two years with an average duration of 14 hours – not long enough to cause a significant disruption to most fuel supply systems due to availability of storage at multiple levels of the fuel supply chain and to the ability of pipeline and terminal operators to make up lost volumes by ramping up rates after power has been restored. Five widespread power outage events – the 1998 North Country Ice Storm, the August 2003 Northeast Blackout, Hurricane Irene (2011), Tropical Storm Lee (2011), and Superstorm Sandy (2012) – appear to have had limited direct power outage impacts on petroleum supply infrastructure located in Upstate New York. Although, storm-related damage to key supply facilities in the New York Harbor area have had a significant impact on fuel supply to Upstate markets, these problems would not have been alleviated by greater hardening or resiliency measures at Upstate New York facilities. As a result, few Upstate terminals have made such investments.