



# **Year-in-Review: 2010**

## **Energy Infrastructure Events and Expansions**



**Infrastructure Security and Energy Restoration  
Office of Electricity Delivery and Energy  
Reliability**

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## For Further Information

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## Background

The Year-in-Review provides an overview of the events that occurred in 2010: disruptions and additions to energy infrastructure in the United States as well as international events of importance to U.S. energy supplies. The report is organized like the *Energy Assurance Daily*.

### Energy Assurance Daily

The [\*Energy Assurance Daily\*](#) (EAD) is a web-based publication of the Infrastructure Security and Energy Restoration (ISER) Division of the Office of Electricity Delivery and Energy Reliability (OE). It summarizes public information about significant changes in:

- U.S. energy infrastructure
- Energy flows within and into the United States
- Oil and gas exploration, production, movement, and demand worldwide

Published daily, excluding Federal holidays, it provides highlights of events in energy systems, flows, and markets rather than a comprehensive coverage of all energy-related issues. It functions as a tool for energy planners, policy makers, and other stakeholders to keep abreast of the constantly changing conditions in the energy sector.

EAD stories are organized into four types: Major Developments; Energy Stories (which are further categorized into sections called Electricity, Petroleum, Natural Gas, and Other); Energy Notes (which are very brief entries); and Energy Prices. Whether an energy event is covered as a Major Development, an Energy Story, or an Energy Note depends on the size of its impact. The specific parameters for categorizing EAD stories are provided in Appendix A. Guidelines and Criteria for EAD Story Selection. Because these parameters are static, the Major Developments are published in the EAD only when a story of national significance occurs. To put the day's stories into context, each EAD closes with a table of petroleum and natural gas spot prices.

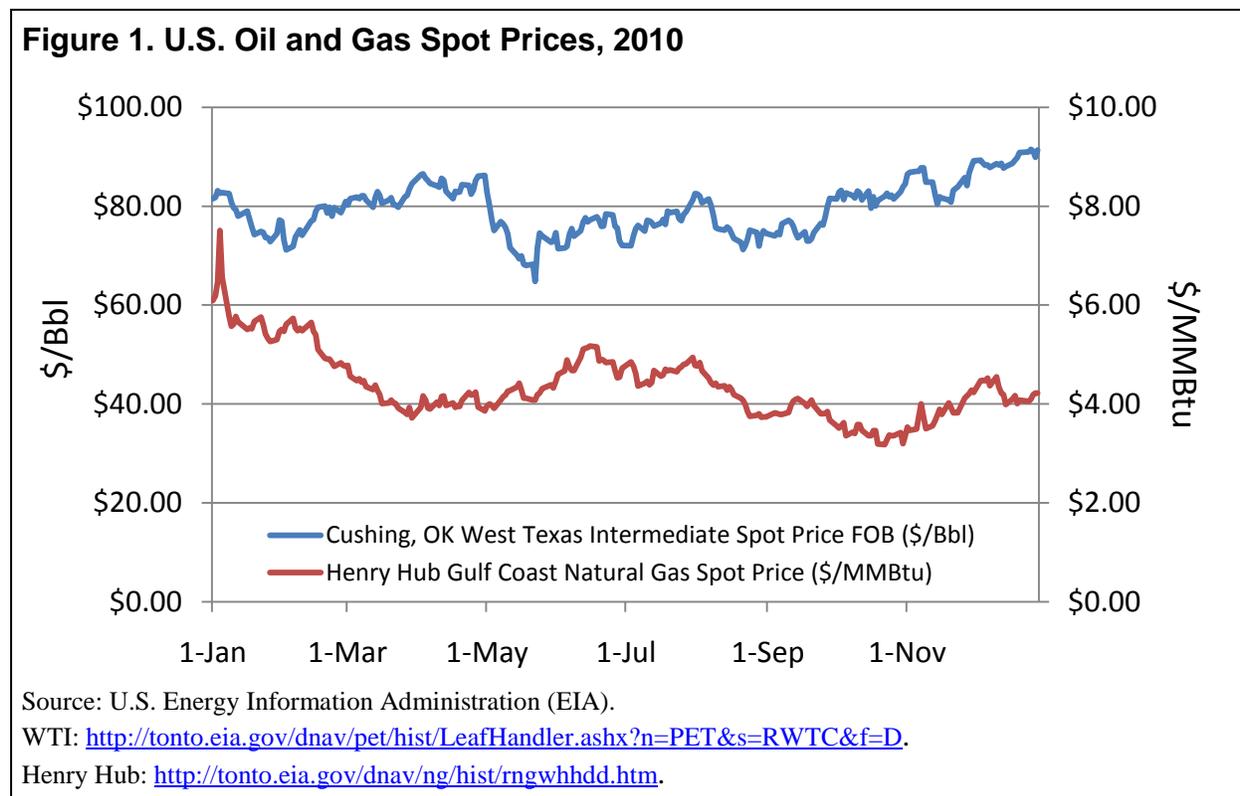
### Focus and Limitations of the Report

This Year-in-Review report is the culminating analysis of all of the 2010 issues of the EAD. It is worth noting here that because the EAD is derived entirely from publicly available information, the resulting report is limited in its scope. Classified or business-confidential data are not factored into the analysis, nor is information that is accessible only through subscription services. EAD data collection cannot be considered exhaustive, as public availability depends on regulatory, corporate, or media disclosure. And due to differences in the regulatory regimes across energy types and indeed across different States, certain areas of the energy sector and certain parts of the country report more heavily than others. For example, California and Texas support very thorough energy reporting mechanisms, while some other States do not. The Nuclear Regulatory Commission reports daily on the status of all nuclear plants in the country, but there is no such equivalent in any other generation sector. For that reason, it would be inadvisable to attempt an “apples to apples” comparison of certain elements of the sector, such as outages across States or across generation types. Instead, this report provides a snapshot of newsworthy events and broad trends that shaped the U.S. energy outlook in 2010.

## Financial and Economic Context

There were 245 issues of the EAD produced in 2010 and posted to OE's public [website](#).<sup>1</sup> Over 8,000 stories were prepared in these issues. As noted earlier, fuel prices play an important role in setting the context for these stories.

In the Energy Prices section of the EAD, petroleum prices are represented by West Texas Intermediate (WTI) crude oil at Cushing, Oklahoma. WTI spot prices started the year at just over \$80 per barrel. After a tumble in May to below \$70 per barrel, prices slowly recovered and ended the year higher than they began, at over \$90 per barrel (see Figure 1).



The May drop in crude oil spot prices was due to uncertainty over the pace and extent of economic recovery, particularly given European economic issues (e.g., the debt crisis in Greece) and Chinese money policy tightening, reportedly contributing to the decline. By the end of May, oil prices had reversed course, supported by continuing strength in Chinese demand and growing signs of demand recovery in the United States.<sup>2</sup>

Natural gas spot prices at Henry Hub started the year at just over \$6 per million Btu (MMBtu). After a spike to \$7.51 on January 7, prices declined and settled to between \$3 and \$5 per MMBtu for the rest of the year. At year end, natural gas spot prices hovered at just over \$4 per MMBtu. The gap between U.S. oil and gas prices appears to have widened during 2010.

<sup>1</sup> Monthly archives of all EAD issues dating back to November 17, 2003 appear on <http://www.oe.netl.doe.gov/ead.aspx>.

<sup>2</sup> EIA, This Week in Petroleum, June 16, 2010, <http://www.eia.gov/oog/info/twip/twiparch/100616/twipprint.html>.

Much of the year's financial climate was characterized by turmoil, particularly as the European Union struggled with sovereign debt crises in multiple countries. The U.S. dollar, however, maintained a fairly stable exchange rate with the euro. At the start of the year, the U.S. dollar was worth approximately 0.7 euro, strengthening to a peak of nearly 0.84 euro in May, before ending the year at approximately 0.76 euro.<sup>3</sup> This was good news as the United States had just recovered from an 18-month recession in mid-2009. Unemployment in the United States remained high, however, hovering between 9.5 and 9.8 percent all year.<sup>4</sup>

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<sup>3</sup> European Central Bank, <http://www.ecb.int/stats/exchange/eurofxref/html/eurofxref-graph-usd.en.html>.

<sup>4</sup> Bureau of Labor Statistics, [http://www.bls.gov/news.release/archives/empsit\\_02042011.pdf](http://www.bls.gov/news.release/archives/empsit_02042011.pdf).

## Major Developments

Most years, hurricanes and other weather events are the primary cause for major disruptions to energy infrastructure in the United States. In 2010, however, the hurricanes and tropical storms were less severe, resulting in minor damage and disruption. Instead, the Deepwater Horizon disaster was the most pervasive major development of 2010.

After the explosion on the rig the night of April 20, 2010, the Deepwater Horizon crisis dominated energy news coverage, even after the well was finally sealed off on September 19, 2010. The related EAD stories – 128 of them from April 21 through December 22, 2010 – are almost uniformly classified as Major Developments. Built in 2001, Deepwater Horizon, a semi-submersible rig, drilled wells as deep as 35,000 feet in the Gulf of Mexico. The platform was operated by Transocean, under contract to BP. The explosion resulted in the evacuation of all personnel; 17 were injured and 11 were killed. Within two days, the rig sank and the environmental and political fallout lasted through the rest of the year. The financial impacts have yet to be fully calculated.<sup>5</sup> Oil and gas extraction operations in the Gulf of Mexico near the Louisiana border were affected, and tankers bringing petroleum imports were diverted for the first few weeks. There were restrictions on Mississippi River traffic as special precautions were put into place to stop the flow of oil. However, no refineries experienced reduced crude oil supplies or restricted their product yield.

Although Deepwater Horizon became a regular fixture on the evening news, other major incidents did occur at U.S. energy infrastructure (see Table 1).

**Table 1. Major U.S. Energy Incidents, 2010**

Date	Crude and Natural Gas Supply Issues
2/7/10	Explosion at the Kleen Energy power plant in Connecticut
4/5/10	Explosion at the Massey coal mine in West Virginia
4/21/10	Explosion on the Deepwater Horizon rig that initiated a massive five-month oil leak
5/25/10	Leak/spill along the Trans-Alaska Pipeline System that resulted in a three-day outage
6/7/10	Explosion on the Enterprise natural gas pipeline
7/27/10	Spill in Michigan along the Enbridge 6B crude pipeline
7/27/10	Waterborne vessel collision that resulted in a wellhead leak lasting several weeks in Barataria Bay, Louisiana
9/2/10	Fire and explosion that shut down service for one week at the Mariner Energy platform in the Gulf of Mexico
9/9/10	Explosion on the gas pipeline operated by Pacific Gas & Electric in San Bruno, California, shutting it indefinitely
9/9/10	Spill in Illinois along the Enbridge 6A crude oil pipeline

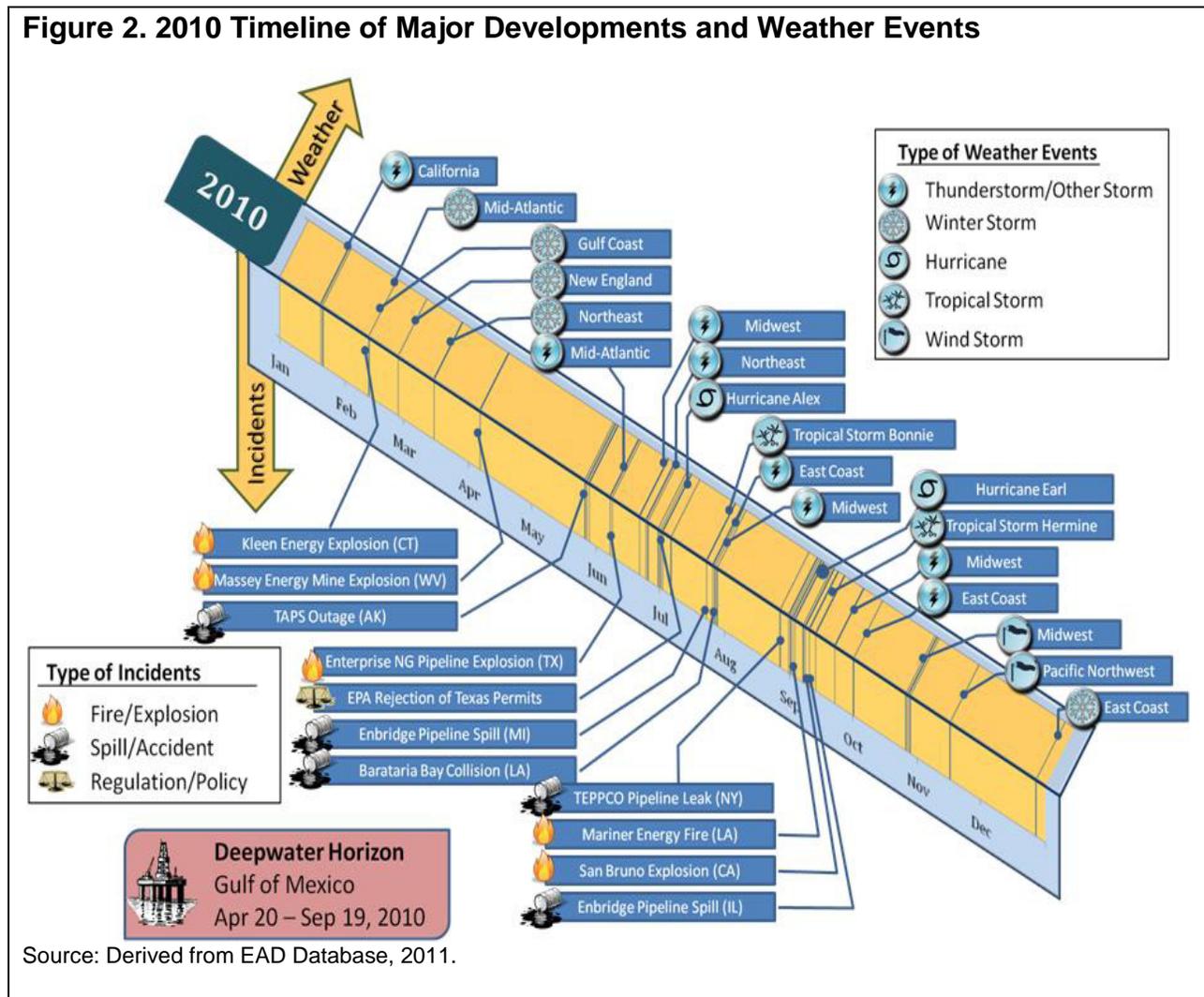
Source: Derived from EAD Database, 2011.

<sup>5</sup> The liability for Deepwater Horizon was capped at \$75 million for the owner, BP, and \$65 million for the operator, Transocean, but could be higher if gross negligence is proven, as indicated in Rawle O. King, “Deepwater Horizon Oil Spill Disaster: Risk, Recovery, and Insurance Implications,” Congressional Research Service R41320, July 12, 2010, <http://www.cnie.org/NLE/CRSreports/10Aug/R41320.pdf>.

Most of these incidents lasted only a few days as EAD Major Developments. A select few continued on as Energy Stories and Energy Notes in subsequent EAD issues.

Though at a lower-than-usual level, weather-related events did impact U.S. energy infrastructure in 2010 (see Figure 2). The hurricane season started early with the formation of Hurricane Alex in June, interrupting Deepwater Horizon cleanup operations. Before reaching hurricane strength, Alex had forced offline 421,350 barrels per day (b/d) of oil production and 919 million cubic feet per day (MMcf/d) of natural gas output in the Gulf of Mexico by June 30. The Louisiana Offshore Oil Port (LOOP) and production platforms in the vicinity were shut-in and evacuated for a few days; the Houston ship channel was also impacted as Hurricane Alex moved through the Gulf, finally making landfall on July 1 in Mexico, 100 miles south of Brownsville, Texas. Tropical Storm Bonnie appeared a month later in the Gulf of Mexico, forcing offline more than 450,000 b/d of oil production and 667 MMcf/d of natural gas output by July 23. Companies evacuated workers from platforms and rigs in the path of Tropical Storm Bonnie, but the storm quickly made landfall and never acquired hurricane strength.

**Figure 2. 2010 Timeline of Major Developments and Weather Events**



Hurricane Earl was the most significant single weather event of 2010, knocking out power to 200,000 customers in Puerto Rico, and about 90 percent of customers in the U.S. Virgin Islands by August 31. Hurricane Earl forced the U.S. Coast Guard to order shut all ports in the U.S. Virgin Islands on August 30, including a Hovensa LLC-controlled harbor. The storm never entered the Gulf of Mexico, tracking instead the Atlantic Coast, closing the Port of Wilmington, North Carolina on September 2, and causing refiners to activate emergency response plans in Virginia and New Jersey. By September 5, Hurricane Earl made landfall in Canada, knocking out power to more than 229,000 customers in Nova Scotia and Prince Edward Island and causing the pre-storm shut-in of the Imperial Oil refinery.

The next storm to threaten the Gulf was Tropical Storm Hermine, which flooded parts of Texas and knocked out power to more than 320,000 customers in Texas on September 7-8. By mid-September, Hurricanes Igor and Karl targeted Canada and Mexico, respectively. Hurricane Igor brought heavy winds over parts of Newfoundland, Canada, and caused a few evacuations, but did not impact energy production. Hurricane Karl forced the Mexican national petroleum company, Pemex, to shut two of its three main oil ports in the Gulf of Mexico, but the storm did not cause any damage to Mexico's offshore oil platforms. With this final storm, the Atlantic hurricane season ended.

## Electricity

In any given year, weather events can be expected to be the main source of customer electricity outage. However, the 2010 hurricane season was unusually mild (at least in terms of U.S. infrastructure damage) and the major outages caused by winter storms were more numerous than those caused by tropical storms. And although small outages outnumbered large ones by far, the greatest cumulative loss of electricity during the year stemmed from the relatively few large outages rather than the many small ones.

For both nuclear and natural gas generation, plant outages that were planned (for maintenance and improvements) accounted for significantly more down-time than unplanned outages. Because planned outages are normally scheduled for low-demand times of year – mainly spring and fall – power plant outages tend to peak in predictable cycles, and indeed did so in 2010.

Although cyber security continued to be a hot-topic issue in 2010, and its importance has only increased in urgency with the advancement of smart grid, there was relatively little coverage of it in the EAD. Copper theft was on the increase, but that too was underreported. A topic that received far more coverage was the expansion of renewables in electricity generation. Led by investor owned utilities (IOUs), power companies either proposed or built a renewable power generation facility in every geographic region of the United States in 2010. Overall, solar and wind projects represented the largest number of proposals.

## Electricity Customer Outages

Every issue of the 2010 EAD reported multiple electric outages, all of which impacted more than 10,000 customers.<sup>6</sup> Over the course of the year, these outages were reported in the EAD by a total of 248 utilities; of those, 167 were IOUs, and 81 were cooperatives and municipals. The utilities were spread across 49 States, the District of Columbia, nine Canadian provinces, and Puerto Rico. Hawaii was the only State not represented in the data. Of these reporting utilities, the ones that ended the year with the highest numbers of individual outages of any size were Dominion, BG&E, and DTE Energy.

It is worth noting, however, that there are several ways to measure the impact of electricity outages over the course of a year, including the number of distinct outage events, the duration of each event, and the number of customers out. The latter two figures can be used to calculate lost gigawatt-hours (GWh), or the amount of electricity that consumers would have used, but could not due to the outage. The different impact measurements are significant because large outages tend to have different characteristics from small ones (see Figure 3 and Figure 4). The EAD defines a large outage as one that cuts off power to at least 250,000 customers overall. The customer counts in EAD outage figures can, and often do involve multiple utilities. In 2010, as in most years, the large outages were almost always weather related. The largest of the large outages, for example, included the following events:

- A chain of snowstorms in February caused an outage that affected more than 1 million customers across the mid-Atlantic, and shut down the Federal government for four-and-a-

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<sup>6</sup> To merit inclusion in the EAD, an electricity customer outage must impact a minimum of 10,000 customers. See Appendix A for an outline of EAD story selection guidelines.

half days. The weather impacted numerous utilities, particularly Dominion, Pepco, and Allegheny. Within days, another snowstorm hit the Gulf Coast, cutting off power to more than 260,000 customers.

- On March 12, heavy wind and rain pummeled the Northeast, leaving customers without power in New Jersey, New York, Pennsylvania, Connecticut, and Massachusetts. The number of affected customers peaked at 1.2 million; the hardest-hit utility was Public Service Electric & Gas (PSE&G).
- Storms with high winds in late October cut power to 1.3 million customers in the Midwest, with Consumers, ComEd and Xcel the hardest-hit utilities.

### **Electric Outage Duration**

Due to winter storms, ice/snowstorms, and windstorms, customer outages overall had longer durations in the first half of the year. However, the largest outages (affecting more than 250,000 customers) appear to have lasted more days during the second and third quarters due to severe spring and summer storms. The average duration for medium-sized outages was higher in the first quarter (2.8 days) than in the other quarters (closer to 1.7 days). Smaller outages averaged just over one day for the whole year.

### **Electric Outages by Quarter and Magnitude**

Simply counting electricity outages does not provide a true sense of their relative impact. For example, small outages occur much more frequently than large outages, but they also tend to have shorter durations. To determine the overall energy impact of numerous outages over time, it is necessary to convert the number of customers affected to a unit of energy. Consumption data from EIA reveals that the average household consumes 31 kWh per day. Applying that factor to the average outage (number of customers affected and duration) yields a rough estimate of GWh losses from the outages. In 2010, although smaller outages were the most frequent, larger outages resulted in greatest GWh lost (except in the third quarter, see Figure 3).

The few large outages that occurred each quarter tended to be responsible for the greatest loss of electricity, with as much as 250 GWh lost in the first quarter of 2010. Small outages totaled 40 GWh in the first and fourth quarters, jumping to 67 GWh lost in the third quarter.

### **Electric Outage Causes**

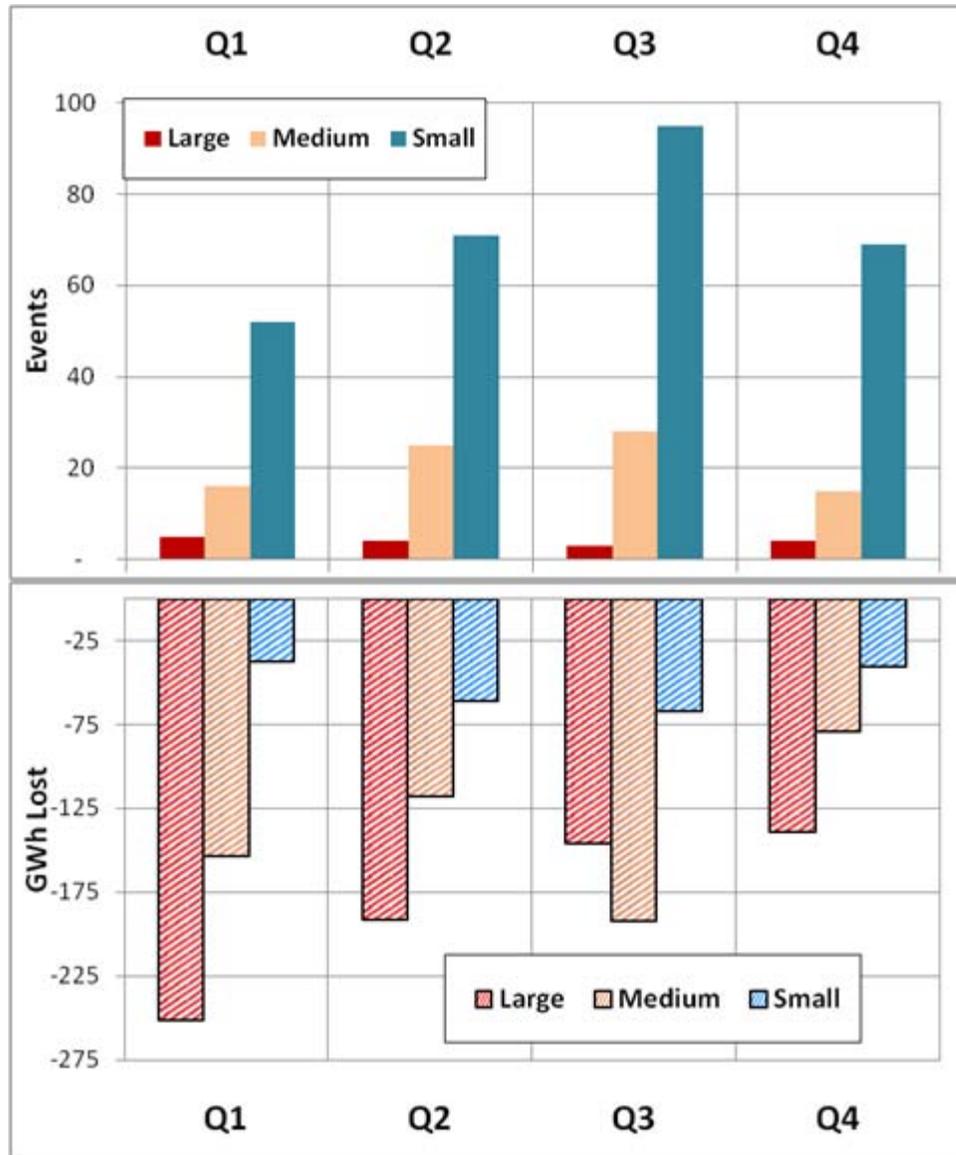
For analysis of the causes of customer electricity outages, incidents were grouped into four categories: accident/human error, weather, natural events, and other/unknown.

- Accidents/human error include incidents such as an animal interference, equipment failure, human error or other man-made cause, theft, vandalism, sabotage, or fire, explosion, or smoke event.
- Weather-related outages can include hurricanes, tropical storms, ice or snow storm, lightning, thunderstorms, wind storms, other storms, tornadoes, or extreme temperatures.
- Natural events include earthquakes, tsunamis, flooding, or other natural events.

Approximately 60 percent of the electricity outages reported in the EAD in 2010 are due to weather events, regardless of the time of year (see Figure 4). Accident/human error is the second-most frequent cause for unscheduled outages. The data show far more variability, however, when viewed in terms of magnitude of the outage. For example, the largest electricity

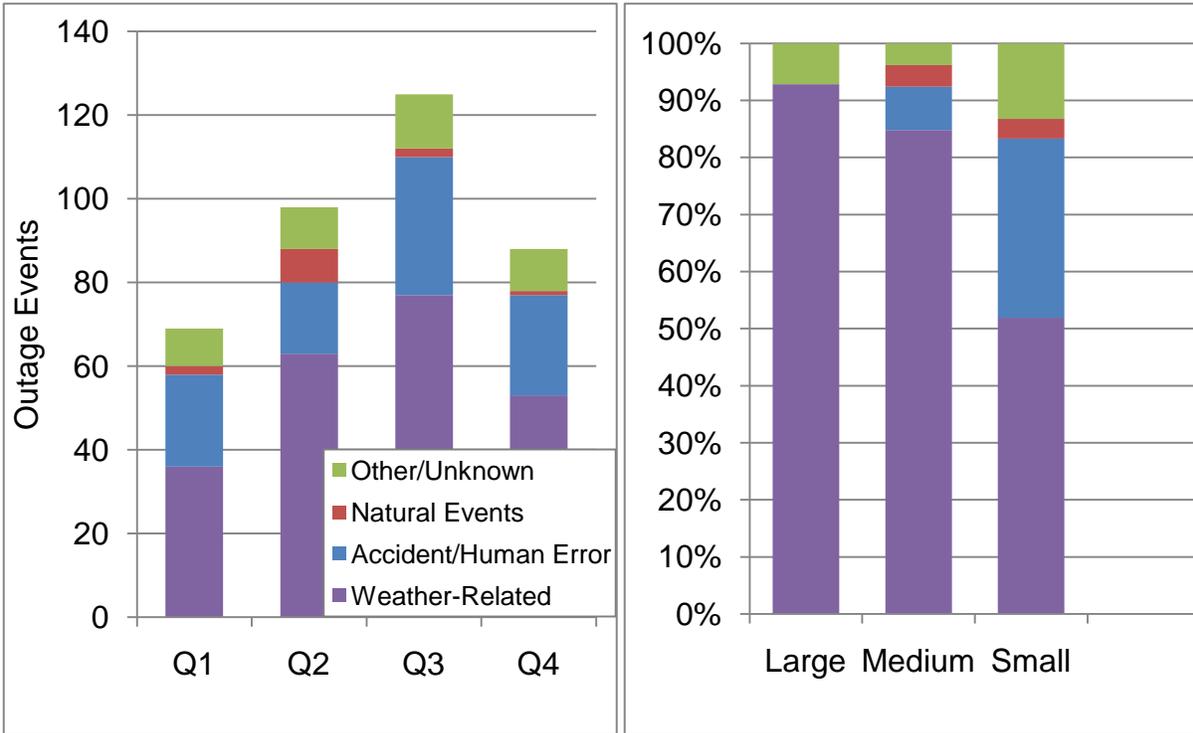
outages (>250,000) were almost exclusively due to weather-related causes. Weather events still contributed to 85 percent of all medium-sized outages (50,000-250,000) reported in the EAD in 2010, but the other causes are somewhat more relevant. The smallest outages (<50,000) were caused by weather events only 52 percent of the time. Accidents/human error accounted for 31 percent of the smaller-magnitude outages.

**Figure 3. 2010 Customer Electricity Outages: Magnitude, Frequency and GWh Lost**



Notes: Magnitude: Large >250,000; Medium 50,000-250,000; and Small <50,000.  
 Quarters: Q1=Jan, Feb, Mar; Q2=Apr, May, Jun; Q3=Jul, Aug, Sep; Q4=Oct, Nov, Dec.  
 Sources: Derived from EAD Database and OE 417 reports, 2011.

**Figure 4. U.S. Electric Customer Outage Events by Cause and Magnitude, 2010**



Notes: Quarters: Q1=Jan, Feb, Mar; Q2=Apr, May, Jun; Q3=Jul, Aug, Sep; Q4=Oct, Nov, Dec.  
 Magnitude: Large >250,000; Medium 50,000-250,000; and Small 10,000-50,000 customers without power.  
 Source: Derived from EAD Database, 2011.

### Power Plant Outages

Of all the publicly available information on power plant outages, the California Independent System Operator (CAISO), and the Texas Commission on Environmental Quality (TCEQ) provide the most comprehensive data on plants operating in their States. And of all the outages that occur across the Nation for any one specific energy source, the Nuclear Regulatory Commission provides the most comprehensive data. As a result, power plant outage reporting is skewed toward nuclear plants, and non-nuclear power plants in California and Texas.

### Cyber Security Issues

The most visible cyber security event that happened in 2010 was the July discovery of the Stuxnet worm. This malware had the ability to spy on and subvert industrial systems such as power plants in order to gain control of plant operations. The worm initially spread indiscriminately, but was designed to target the Siemens Supervisory Control and Data Acquisition (SCADA) systems that are configured to control and monitor specific industrial processes. Most of the known infections occurred in Iran, but there has been no hard evidence pointing to the source of the malware.

The NRC and North American Electric Reliability Corporation (NERC) have established their respective organizations' responsibility for cyber security requirements at nuclear power plants.

The Department of Homeland Security (DHS) formed expert teams to test power plant systems for vulnerability to cyber attacks. DOE announced plans in 2010 to invest \$30 million in projects that address electric grid cyber security. The Department of Defense and the National Security Agency are developing programs and technology to boost cyber security. Even the International Instrument Users Association has released a cyber security standard, the first international standard that outlines a set of specific requirements focusing on cyber security best practices.

Because the government has increased incentives for utilities to install smart grids and meters, interest in cyber security as it relates to smart grid has also been on the rise. Currently utilities in 33 States have some sort of smart grid project either planned or in progress. The National Institute of Standards and Technology issued a set of guidelines for smart grid cyber security on September 2, 2010.<sup>7</sup> Research groups have estimated that utility companies worldwide will spend over \$20 billion by 2015 to improve cyber security for smart grids.

### **Copper Theft**

In addition to increased concerns about cyber security, 2010 also saw an increase in copper wire theft from electric utilities. Although the problem is chronically underreported, evidence from a variety of sources indicates that after seeing a drastic reduction in 2009, theft of copper rose in 2010 in most areas. This resurgence in theft was predictable, given the year's spike in copper prices to record levels.<sup>8</sup>

### **New and Expanded Power Generation Capacity**

As a matter of procedure, the EAD reports only on the new and proposed power plants and capacity expansions that exceed 10 MW; smaller facilities are not reported. In 2010, the majority of the proposed new generation capacity was for renewable energy.<sup>9</sup>

The year saw a significant increase in the number of solar and wind facilities proposed and built. Almost twice as many solar facilities were proposed/built than wind facilities (see Figure 5). However, during 2010, a greater number of States were involved in new wind projects (26 States) than solar (19 States).

Only two stories mentioned smaller-scale projects in 2010, one at a college and the other located at 15 Kaiser Permanente facilities, all of which were in California. As noted, projects that generate less than 10 MW are not reported in the EAD; therefore it is likely that many of the smaller facilities fall below the threshold for EAD publication.

Most of the companies that reported new power generation capacity and expansion were investor-owned utilities (IOUs). A solid majority of the renewable facilities that were proposed or built in 2010 were located in the Southwest (California, Arizona, Nevada, and New Mexico). These included geothermal, biomass, solar, and wind projects. Furthermore, all of the proposed

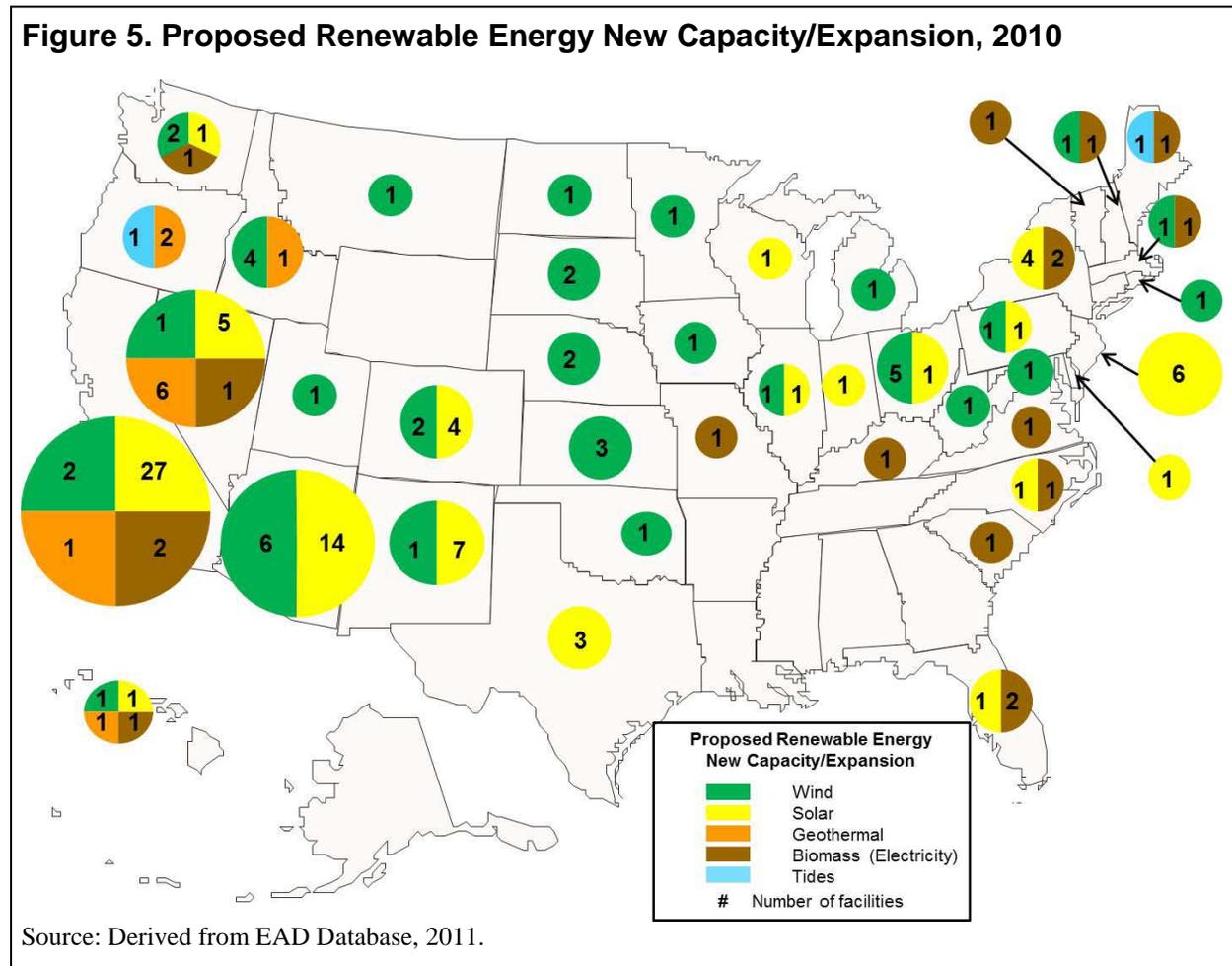
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<sup>7</sup> National Institute of Standards and Technology, *Introduction to NISTIR 7628 Guidelines for Smart Grid Cyber Security*, September 2010, <http://csrc.nist.gov/publications/nistir/ir7628/introduction-to-nistir-7628.pdf>.

<sup>8</sup> DOE/OE, *An Updated Assessment of Copper Wire Thefts from Electric Utilities*, October 12, 2010, <http://www.oe.netl.doe.gov/outreach.aspx>.

<sup>9</sup> Excludes hydropower and pumped storage.

geothermal facilities were located in four western states (California, Nevada, Oregon, and Idaho) plus Hawaii. The Midwest and Northeast also had a significant number of proposals, particularly for solar, wind and biomass projects. In 2010 there were relatively few renewable projects proposed in the Southeast, and none at all in Tennessee, Georgia, Mississippi, Alabama, Louisiana, or Arkansas. Overall, solar and wind projects represented the largest number of proposals in the United States in 2010, with every geographic region proposing at least one of each.



The large number of renewable energy project proposals in California likely stems from the Energy Action Plan that proposed a generation portfolio with 20 percent renewable energy by 2010. The massive expansion in renewable proposals, particularly solar, could be part of the attempt to meet this goal.

Since it was passed in 2009, the American Recovery and Reinvestment Act (ARRA) has greatly affected renewable energy in the United States. Overall, the Energy Information Administration (EIA) estimates that U.S. renewable generation capacity will increase 32 percent more than it would have without ARRA support – reaching 155 GW in 2015.

## **Petroleum**

Although petroleum disruptions are a major source of news for the EAD in any year, 2010 was exceptional in that the petroleum disruptions that did occur had relatively mild impacts. The main petroleum story of the year was the Deepwater Horizon disaster, and while that had a catastrophic environmental impact, it had little effect on the delivery of fuel to end-users. 2010 was also noteworthy as a year of planning for new or expanded fuel production facilities. For the first time in several decades, the construction of a new conventional refinery was proposed. But although the year saw a number of proposals to expand refineries across the United States, only a few expansions were actually under construction. Just as significant were the numerous proposals to construct new facilities to produce unconventional fuels, such as ethanol and biofuels. In all, there were about 60 proposals concerning either the expansion or construction of ethanol and biofuel refineries in 2010.

As with all EAD data, the petroleum outage and asset information reported here comes from open-source data, and does not reflect proprietary or subscription-based sources. As a result, the total number of disruption events experienced by refiners is likely much higher than what can be counted by the EAD. It is also important to note that EAD analysis is only focused on petroleum outages that are unscheduled; for petroleum assets, planned maintenance is not tracked in EAD stories.

### **Petroleum Disruptions**

In the shadow of the Deepwater Horizon crisis of 2010, other petroleum disruptions appeared very minor. However, two Enbridge pipeline disruptions in the Midwest had a significant impact, affecting multiple U.S. refineries. In addition to the Enbridge shutdowns, there were six other EAD stories reporting pipeline disruptions that lasted a week or longer.

Another issue in 2010 was the permanent shutdown of four refineries across the United States. One of these, the Yorktown, Virginia refinery, was the last refinery operating in the State of Virginia; it was shut down due to a weak outlook for East Coast refining margins.

### **Refineries**

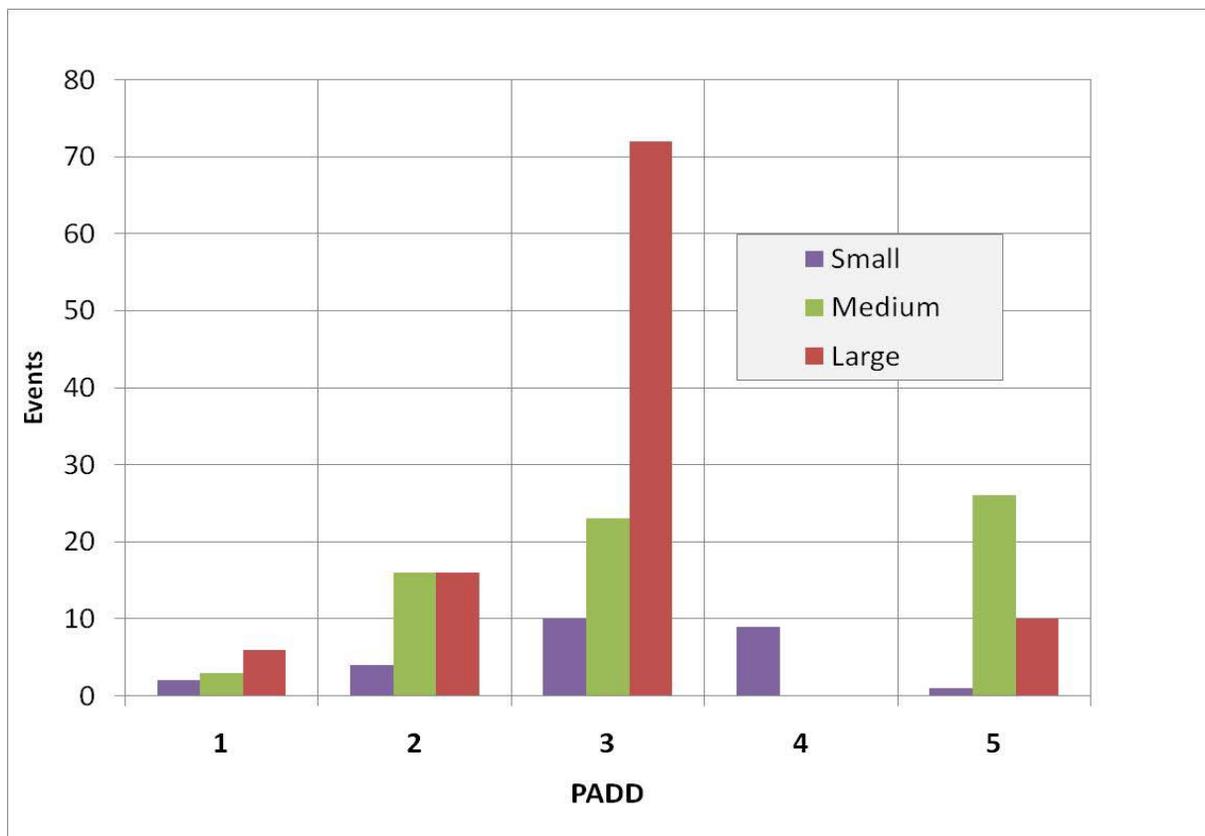
As noted earlier, the EAD tracks reports of unplanned outage or disruption events at U.S. refineries. According to EIA, there are 142 refineries operated by 65 unique refiners across 31 States and the U.S. Virgin Islands. In 2010, the EAD covered disruption events at 78 refineries operated by 33 refiners in 21 States and the Virgin Islands.

That year, four refineries shuttered their operations completely due to economic reasons:

- Foreland Eagle Springs, Wyoming
- Somerset Refinery, Somerset, Kentucky
- Western Refining, Bloomfield, New Mexico
- Western Refining, Yorktown, Virginia

Refineries can be classified as small (having a capacity of under 75,000 b/d), medium (75,000 to 200,000 b/d), or large (over 200,000 b/d). Larger refineries were more likely than smaller refineries to have at least one unscheduled disruption reported in the EAD (see Figure 6). There was at least one disruption event story for nearly all large refineries and most medium refineries, but only about one-fifth of small refineries. Geographically, the smallest number of disruption events per refinery was in the Petroleum Administration for Defense District (PADD) 4 (the Rocky Mountain region), the only PADD to contain exclusively small refineries. However, PADD 4 also contained the highest reported number of disruption events per barrel produced each day at its refineries. When disruption events are considered in proportion to production capacity, therefore, it may be that small refineries are relatively more prone to disruption than it might otherwise appear. Not surprisingly, because most of the largest refineries are located in PADD 3 (the Gulf Coast), half of the disruption events in 2010 affected PADD 3 (Gulf Coast) refineries.

**Figure 6. Disruption Events by Refinery and Location, 2010**



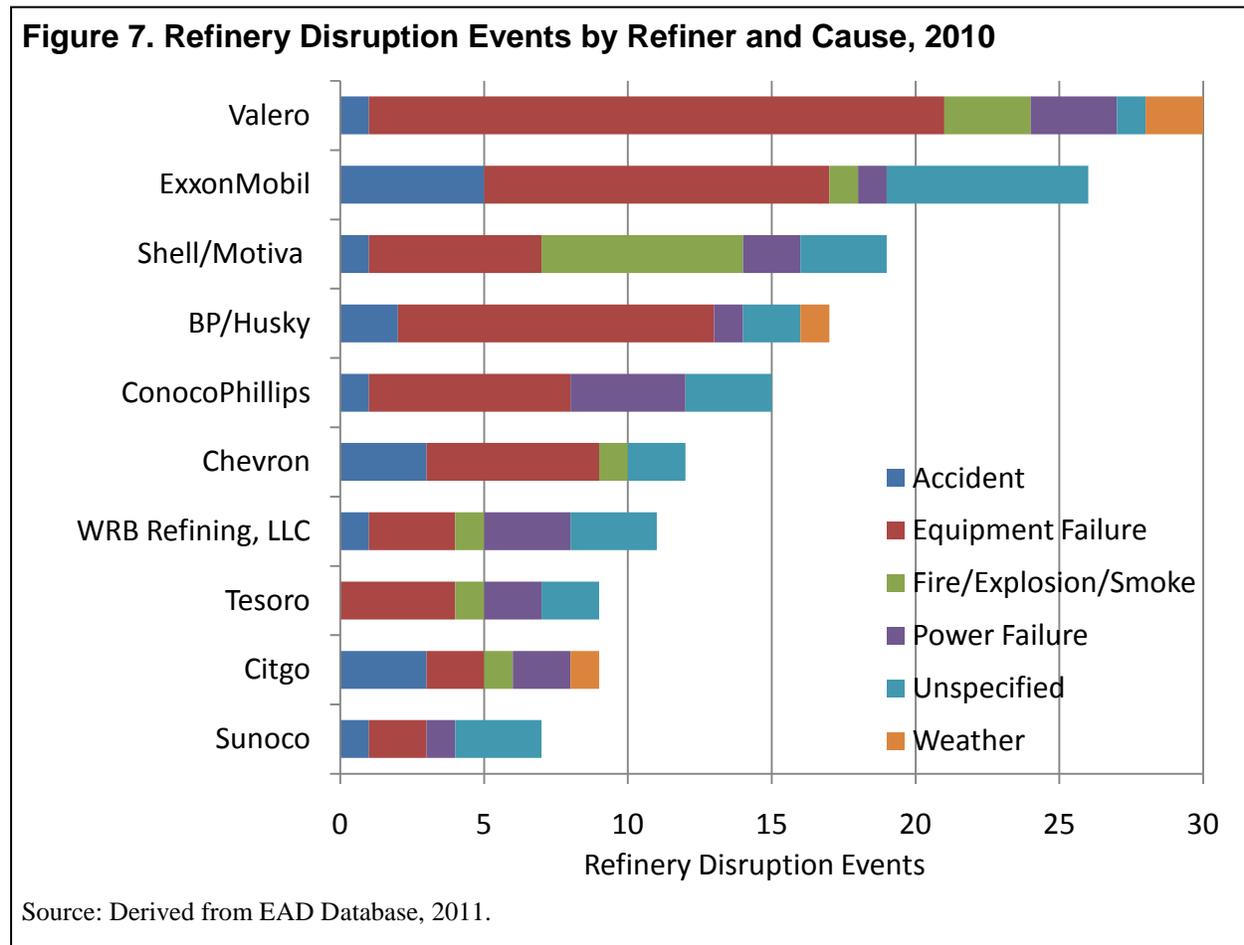
Notes: Refinery Sizes: Large >200,000, Medium 75,000-200,000, and Small <75,000 b/d. PADDs = Petroleum Administration for Defense Districts, <http://www.eia.gov/oog/info/twip/padddef.html>.

Source: Derived from EAD Database, 2011.

The disruption events in the EAD are represented as stemming from the following causes: accident, equipment failure, fire/explosion/smoke, power failure, weather, and unspecified. Equipment failures were responsible for nearly half of all disruption events in 2010. Weather caused the fewest refinery disruptions, with a small number reported exclusively in PADD 2 (the

Midwest) and PADD 3 (Gulf Coast), respectively. According to EAD coverage, small refineries were relatively more likely to report a disruption caused by fire/explosion/smoke. It may be worth further research to determine whether small refinery disruptions caused by equipment failures are underreported in the sources used to compile the EAD.

Certain refiners experienced more unscheduled disruptions than others (see Figure 7).



### Pipelines

The EAD tracks pipeline events across the United States. A pipeline event can be an unanticipated outage, disruption, or curtailment; a fuel leak; a fire or explosion; or an equipment failure. These events impacted crude-, product-, and to a lesser extent liquefied petroleum gas (LPG) pipelines. In 2010, pipeline events were reported in pipelines serving at least 25 States spanning PADDs 1 through 5. However, PADD 2 (Midwest) accounted for the largest total number of events, due in part to the significant problems that Enbridge had along its crude pipeline system in the Midwest.

In 2010, there were nine pipeline disruptions with EAD coverage that lasted longer than a week. These were the most disruptive events, and they occurred throughout the United States rather than in one particular area. Four of these events involved Chevron-operated pipelines. It

appears, however, that a pair of events on Enbridge pipelines caused the greatest disruption. On July 27, the Enbridge 190,000 b/d Indiana-to-Ontario Line 6B spilled 19,500 barrels of crude in Michigan. Cleanup continued through August 20, and the line was not fully restored until into early September. On September 9, however, another leak forced shut Enbridge's 670,000 b/d Wisconsin-to-Indiana Line 6A. During the second event, approximately 6,100 barrels spilled onto a roadway and into a retention pond in Romeoville, Illinois. By September 13, 6,050 barrels of spilled oil were recovered, and by September 17, Enbridge was preparing to restart the pipeline. Both of these events caused reduced rates at associated refineries.

Nearly two-thirds of the reported events impacted crude pipelines, and just under one-third impacted product pipelines. In addition to being more numerous, crude-pipeline disruptions also tended to last longer. Of the nine pipeline events lasting longer than one week (according to the EAD) eight impacted crude pipelines.

A much smaller number of reported events occurred on LPG pipelines. One particular disruption on the TEPPCO LPG pipeline, however, impacted propane deliveries for months. On August 27, 2010, the TEPPCO line sprang a leak in upstate New York, and did not resume full service until February 3, 2011. As a result, 165 miles of pipe were shut, increasing pressure on the regional market during winter. TEPPCO first estimated that the repairs on the pipeline would be complete by mid-autumn, but this was pushed back several times due to unusually bad winter weather. New York saw some of the steepest price gains, with the average price for a gallon of propane rising 57 cents.

### **Hours-of-Service Exemptions**

The EAD tracks emergency hours-of-service (HOS) exemptions granted by State governments to companies that transport heating fuel and propane to customers. The main source of this information is the National Propane Gas Association (NPGA). According to the NPGA website, "State authorities issue HOS exemptions to a company's drivers during time of emergencies. These HOS exemptions affect certain sections of the Federal Motor Carrier Safety Administration rules, which govern the operating hours for drivers of commercial motor vehicles."

According to the EAD, there were 40 unique HOS exemptions issued across 25 States in 2010 (some of which were legacy exemptions originally issued in 2009). Twenty of these States issued HOS waivers lasting more than one week (see Table 2). The majority of HOS exemptions were issued due to cold weather conditions and snow storms during the winter months of January, February, and December. Two HOS exemptions were issued due to product supply concerns (one in January, one in October), and one was issued due to Hurricane Earl in September.

Geographically, HOS exemptions were found exclusively in the eastern half of the United States. Southern States in particular tended to issue HOS exemptions; every State in the South issued an HOS waiver in 2010, with the exceptions of Florida, Louisiana, and the District of Columbia.

**Table 2. Hours-of-Service Waivers Issued, 2010**

State	Winter 2009-2010			Winter 2010-2011		
	Start Date	End Date	Duration	Start Date	End Date	Duration
Alabama	1/7/10	2/3/10	28			
Delaware	1/6/10	2/21/10	22*	12/27/10	12/30/10	3
Georgia	1/5/10	2/3/10	29	12/13/10	1/11/11	30
Illinois	1/1/10	1/22/10	16*	12/27/10	1/2/11	6
Indiana	1/8/10	1/21/10	13			
Iowa	10/1/09	1/15/10	107			
Kentucky	1/8/10	1/21/10	13			
Maryland	1/6/10	2/18/10	21*	12/13/10	1/1/11	18
Mississippi	1/6/10	2/3/10	29			
New Jersey	1/8/10	1/29/10	21	12/17/10	12/31/10	14
New York	1/10/10	2/3/10	25	12/8/10	12/20/10	12
North Carolina	1/7/10	2/5/10	30	12/17/10	12/31/10	14
Ohio	1/8/10	2/18/10	24*			
Oklahoma	1/7/10	2/5/10	30			
Pennsylvania	1/7/10	1/21/10	15	12/29/10	1/8/11	10
South Carolina	1/6/10	2/3/10	29	12/13/10	1/11/11	30
South Dakota				10/12/10	10/31/10	19
Tennessee	1/8/10	1/22/10	14			
Virginia	12/20/09	2/28/10	70	12/16/10	1/13/11	28
West Virginia	12/19/09	1/17/10	29	12/17/10	12/27/10	10

Notes: \*Delaware, Illinois, Maryland and Ohio each experienced multiple waiver events within the listed time period.

Arkansas, Connecticut, Kansas, Missouri, and Texas also issued HOS waivers lasting a week or less.

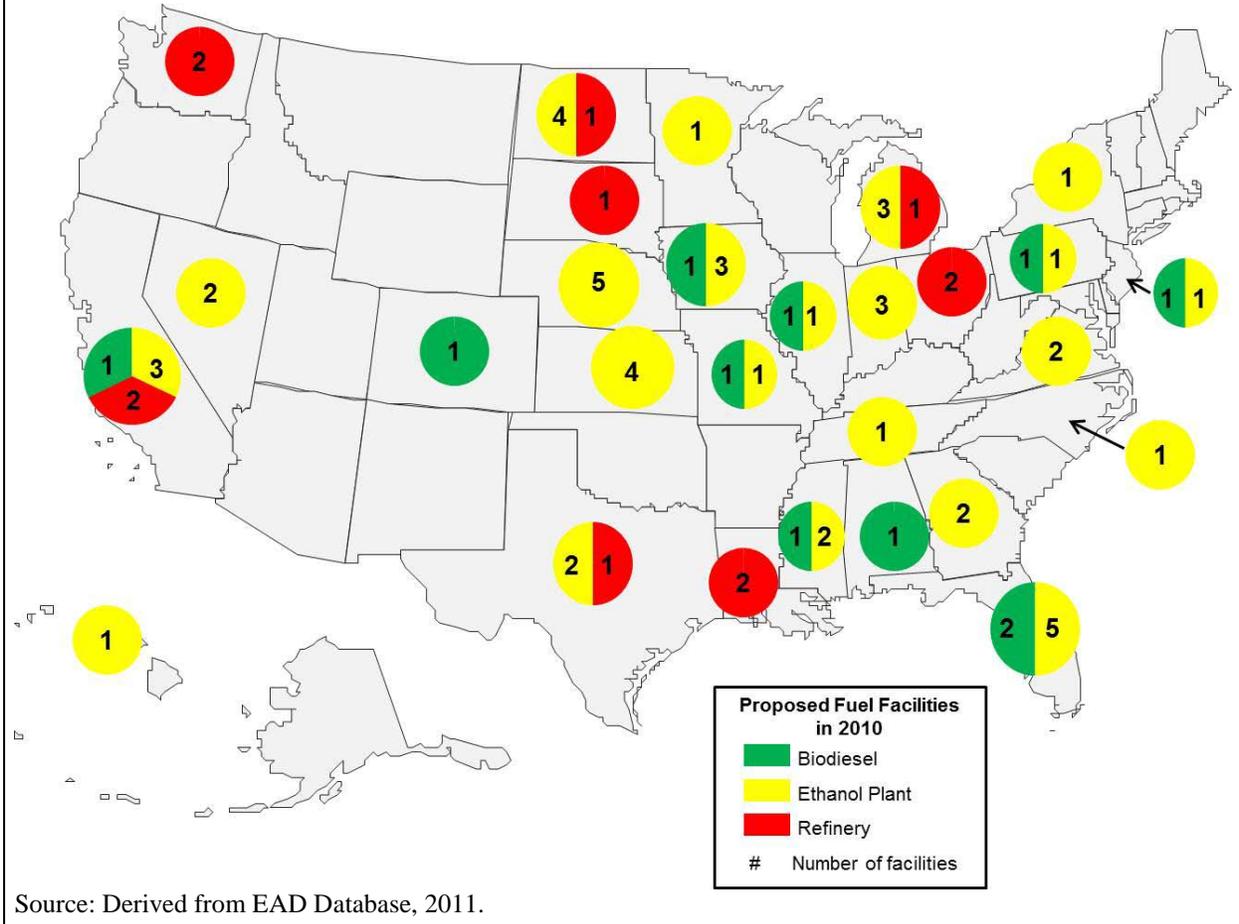
Source: Derived from EAD Database, 2011.

### **New Fuel Production Capacity and Facilities**

There were many proposals to increase the production of conventional petroleum products, biofuels, and ethanol across the United States in 2010 (see **Error! Reference source not found.**).

The last conventional refinery to be built in the United States was the Garyville, Louisiana refinery in 1976. Thirty-four years later, Marathon proposed a 109,000 b/d expansion to Garyville, and Hyperion proposed a brand new 400,000 b/d refinery in South Dakota. BP-Husky, ConocoPhillips, Marathon, Shell and Valero proposed expansions to another 10 refineries. The proposed refinery projects were spread fairly evenly across the contiguous United States, with the exception of the Northeast, where no refinery projects were proposed. The only expansions reported as actually under construction in 2010 were found in California, North Dakota, and Michigan.

**Figure 8. Proposed Fuel Facilities, 2010**



Refinery capacity expansions of over 100,000 b/d were proposed in the Midwest and South regions. Most of the proposed projects, however, were considerably smaller. The projects actually under construction in 2010 were relatively small compared to all proposed projects. According to reports, the reasons given for expanding refining operations included: meeting increased demand, expanding production of low-sulfur fuel, replacing old units, and adding capacity to process heavy oil. Even so, one proposed 200,000 b/d expansion in Wisconsin was canceled due to concerns over a lack of demand.

Numerous companies also proposed new facilities to produce unconventional fuels, such as biodiesel and ethanol. There were at least 11 notable proposals for new or expanded biofuel refineries in 2010, with a total proposed capacity of 96 million gallons per year. These planned facilities would be spread across 10 States. However, there were also reports of two other large biorefinery projects being postponed in 2010, both due to concerns over tax credits. The two postponed projects were to have a combined total capacity of 95 million gallons per year, nearly the same as the capacity of all 11 of the other proposed facilities put together. Proposed feedstocks at these biofuel facilities vary widely, and include algae, plant scraps, wood chips, and oilseed.

At least 50 new ethanol plants were proposed in 2010, with a total annual production capacity of 2.5 billion gallons. More ethanol plants were proposed in the Midwest (26) than any other region, and the average capacity for proposed plants in the Midwest was over twice that of any other region. The average plant size in the Midwest was at least 84 million gallons per year. In the South, 15 smaller ethanol plants were proposed, averaging just less than 35 million gallons per year. Companies proposed using a wide variety of feedstocks to produce ethanol. Both cellulosic and waste-to-ethanol plants were proposed in the Midwest, South, and Northeast regions, with cellulosic ethanol plants appearing to be particularly popular. However, many reports did not indicate which feedstock would fuel the plant, so it is not possible to determine which proposed feedstock was dominant in 2010. A few relatively large proposed ethanol plants were delayed or canceled in 2010, primarily due to economic reasons.

## Natural Gas

2010 was an important year for natural gas production as a whole, particularly due to expanded research and development of unconventional natural gas production methods. New technologies such as hydraulic fracturing and horizontal drilling increased projected U.S. natural gas reserves to nearly double. Overall, the leaps in technology that occurred in 2010, particularly in shale gas, will likely cause natural gas extraction, production, and use in general to increase dramatically in the coming years.<sup>10</sup>

Over the course of the year, a number of disruptions occurred at natural gas processing plants, pipelines, platforms, fields, and wells in the United States. The majority of these events were caused by equipment failure, power failure, or storms. Due to differences in sector reporting protocols, however, natural gas disruptions do not appear as frequently as petroleum disruptions in the EAD.

However, certain natural gas explosions stood out among the major developments of 2010. For example, a June 7 explosion on the Enterprise natural gas pipeline in North Texas forced offline 250 MMcf/d of capacity. That incident was caused when a contractor for the local electric utility struck the pipeline. On September 9, an explosion on the gas pipeline operated by Pacific Gas & Electric in San Bruno, California killed seven people and destroyed 37 houses. In addition to these incidents, other natural gas explosions occurred with a troubling regularity:

- At a natural gas well in Wise County, Texas an explosion injured two workers on March 19.
- An equipment malfunction caused an explosion and fire at Bay State Gas's LNG Plant in Massachusetts on April 24.
- An explosion on an Enogex natural gas pipeline near Pocasset, Oklahoma injured three on June 29.
- A gas well explosion in western Pennsylvania killed two on July 23.
- A Consumers Energy distribution pipeline exploded in Wayne, Michigan, on December 29,<sup>11</sup> killing two and injuring two others.

### Processing Plant and Pipeline Disruptions

In 2010, the majority of the natural gas stories in the EAD concerned natural gas production or transportation. Most of these reported events occurred in Texas, and by far, most were about outage, shutdown, or disruption, with some restoration and flaring stories as well. These numbers do not indicate that Texas is particularly disruption prone; rather, they reflect the fact that the TCEQ is very stringent in its reporting on natural gas plant disruptions, just as it is with electrical power plant outages. After Texas, the State with the second-largest number of reports was Pennsylvania.

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<sup>10</sup> <http://www.eia.gov/oiaf/aeo/tablebrowser/#release=AEO2011&subject=0-AEO2011&table=14-AEO2011&region=0-0&cases=ref2011-d020911a>.

<sup>11</sup> <http://www.consumersenergy.com/News.aspx?id=3816&year=2010>.

In 2010 there were five gas processing plants in Texas with a significant number of disruptions:

- Exxon's Fullerton
- DCP Midstream's Goldsmith
- Southern Union Gas' Keystone
- Regency Field Services' Tilden
- Regency Field Services' Waha

All named gas processing plants and pipelines that recorded events in 2010 were located in Texas. The largest number of disruptions occurred in the summer, specifically in June, July and August of 2010. Although 2010 saw a number of natural gas explosions, the overwhelming majority of events in named gas processing plants and pipelines were outages, shutdowns, or disruptions. It is also noteworthy that named gas processing plants had significantly more events than named gas pipelines.

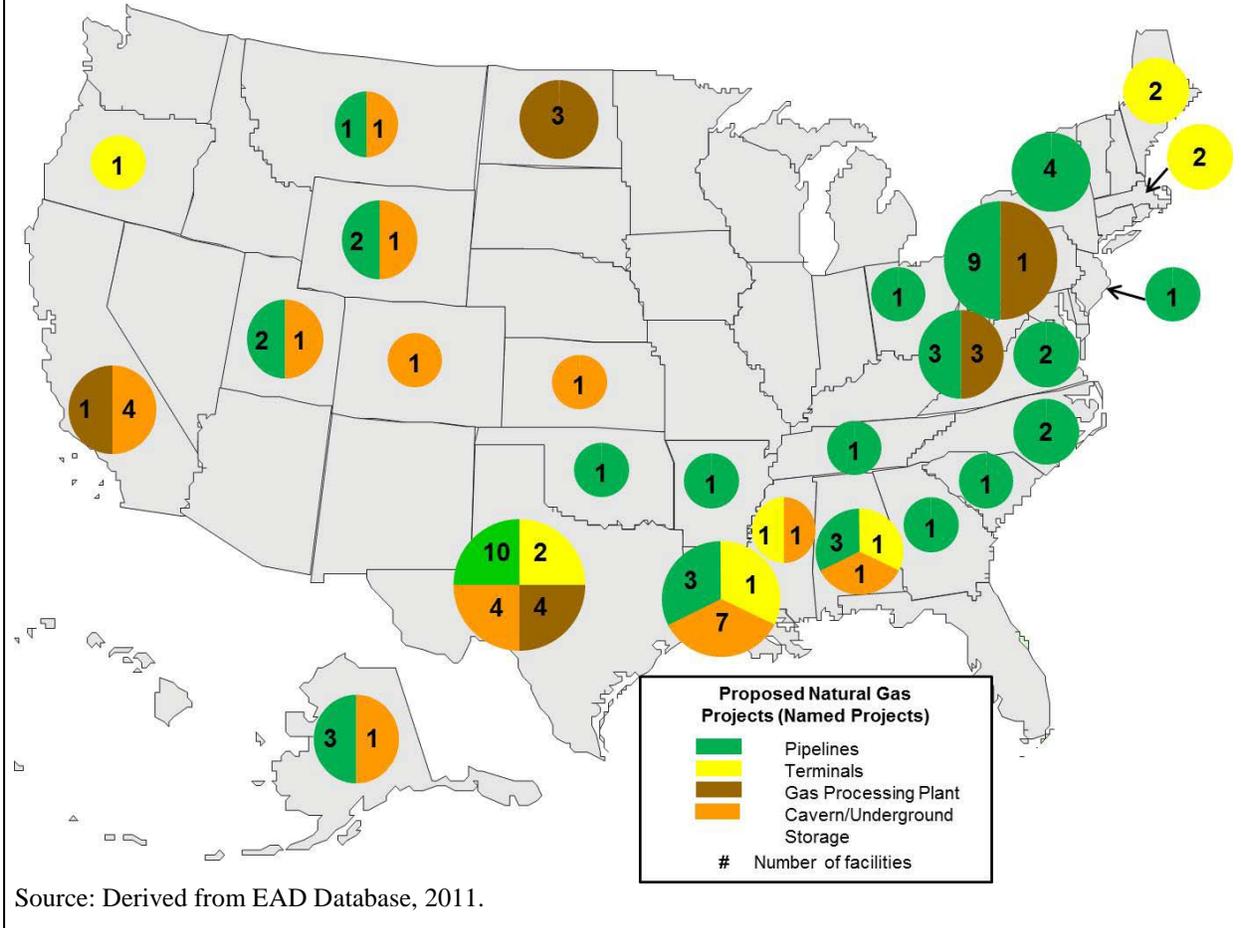
There were three gas compressor and booster stations in Texas that had a significant number of stories in 2010:

- Andrews Compressor Station
- Cedar Lake Booster Station
- West Credo Booster Station

### **Proposed Natural Gas Projects**

Due to the increasing profitability of natural gas extraction and production, 2010 saw a greater focus on developing the movement of natural gas across the country. Regionally, the largest number of proposed natural gas projects in 2010 came from the East Coast and the Gulf Coast (see Figure 9). This is not surprising given that most facilities from which natural gas is transported are on the East Coast and Gulf Coast. Proposed projects involved facilities such as cavern/underground storage, gas processing plants, pipelines, and receiving/loading terminals. Underground storage has been proposed along the Gulf Coast, parts of the Midwest and Rocky Mountain regions, and also in California. Terminals that have been proposed and built are mainly in the Northeast, Northwest, and Gulf Coast.

**Figure 9. Proposed Natural Gas Projects, 2010**



**Future Prospects for Natural Gas**

In addition to new conventional projects, recent developments in shale gas extraction via methods such as hydraulic fracturing and horizontal drilling have pushed natural gas production to an all-time high. As a result of this continually improving technology, natural gas inventories and domestic production have skyrocketed. Furthermore, due to gas production from unconventional sources, the United States imported dramatically less natural gas in 2010, thus resulting in greater energy security and self-sufficiency. Given the current environmental and energy security concerns in the United States, particularly related to petroleum use for transportation fuels, a number of policy proposals have begun to surface in order to further stimulate increased use of natural gas as a vehicle fuel.

## International Events

Although the EAD has a predominantly domestic focus, it also features stories on international energy events that directly impact the United States. In 2010, 15 percent of all EAD stories addressed international topics. Most of those stories fell into four basic categories:

- Disruptions along oil and gas transport infrastructure
- Energy production disruptions
- New/proposed/discovered supplies, primarily crude oil and natural gas
- New/proposed transport infrastructure, primarily oil and gas pipelines

Table 3 provides examples of stories in each of these categories.

**Table 3. International Story Types in the 2010 EAD**

Story Type	Example
Disruptions along Oil and Gas Transport Infrastructure	Pipeline leaks, fires, and/or explosions in Canada, Chile, China, India, Indonesia, Iran, Iraq, Kazakhstan, Mexico, Turkey, and Venezuela
	Argentinean strikes at crude oil export terminals in December
	Tanker accident in Strait of Hormuz
	Nigerian kidnapping of foreign workers and crude oil pipeline attacks
	Somali piracy/hijackings of oil tankers
Energy Production Disruptions	Venezuelan droughts interrupt power generation in January-February
	French strikes at refineries in February, March and September
	Refinery fires/explosions in Canada, Mexico, Spain, United Kingdom, and Venezuela
	Chilean earthquake shut-in of refineries and LNG terminals in March
New Crude Oil and Natural Gas Discoveries	Significant oil/gas find in Ghana in February
	Pemex offshore discovery in Campeche, Mexico in March
	Morocco oil shale and Namibia oil/crude find in September
	Offshore Norway discovery in November
	Brazil offshore oil/gas discoveries and increased production
New/Proposed Oil and Gas Pipelines	Turkey-Austria Nabucco natural gas pipeline approved to proceed in March
	Russia-Germany Nord Stream natural gas pipeline groundbreaking in April
	Russia-to-China East Siberia Pacific Ocean crude oil pipeline completed in September
	Extension of Ukraine's Odessa-Brody oil pipeline into Poland in 2014
	Capacity increases along Baku-Tbilisi-Ceyhan oil pipeline in June and November

International EAD stories are geographically distributed across all regions. Canada was the source of 41 percent of all international EAD stories. Canadian stories addressed disruptions at refineries, production fields, and pipelines. Major electricity outage stories throughout the Canadian provinces were reported in the EAD because of their significance to cross-border States. Likewise, Mexican energy assets impacted by weather events and civil unrest were not an unusual topic for international EAD stories. Of those stories, port, refinery, and production platform closings were most frequently addressed.

After Canada and Mexico, the countries with the most stories, in order of greatest frequency, are Nigeria, Iraq, Venezuela, Russia, Brazil, France, Turkey, Iran, and China.

## **Latin America**

On January 12, an earthquake with a 7.0 magnitude struck 10 miles southwest of Port-au-Prince, Haiti. The earthquake, along with subsequent aftershocks, directly impacted three million people, (one third of Haiti's population) and devastated an energy infrastructure already under stress from the country's economic and political challenges. DOE staff participated in international response efforts, assisting with assessing the extent of electric infrastructure damage.

Venezuela was the location of other important energy events in 2010, many relating to a drought that started in January and impacted hydropower and refineries. This drought caused Venezuela to reduce available electricity supplies to refineries, and the refineries in turn had to cut petroleum product exports. Furthermore, Venezuela decreased overall crude oil output from month to month in 2010, particularly during the period of August through December.

## **Europe**

EAD coverage of Europe and Russia focused on disruptions to oil and gas supplies with regard to production and transport via pipeline. Among the more disruptive events in Europe that year were the three refinery-related strikes in France that took place in February, March, and September. In February 2010, Total SA refinery workers went on strike for a week at six refineries. In April, Total SA workers struck at four refineries. Then in early September, 11 out of 12 French refineries and the Fos-Lavera oil port were shut by striking workers for a total of 33 days. Cascading effects were felt at refineries in Switzerland and the Netherlands, and fuel supplies were affected.

Russia continued to wield its oil and gas pipelines as political weapons in 2010. All year long, Russia's pipeline diplomacy was unstable with certain countries. Belarus, for example, had both its crude oil and natural gas pipeline exports cut by Russia multiple times in 2010. In August, Belarus announced plans to improve its energy infrastructure and tap alternate markets to reduce its dependence on Russian energy.

## **Middle East**

About half of the Middle East stories in the 2010 EAD were concerned with new capacity and expansion of crude oil, LNG, and natural gas facilities. Three Middle Eastern countries that appeared frequently in the EAD were Iraq, Iran, and Saudi Arabia. The Iraq and Iran stories tended to focus on disruptions in addition to new capacity.

In Iraq, the Kirkuk-Ceyhan crude pipeline between Iraq and Turkey experienced a number of shutdowns and other problems in 2010, most originating in Turkey. In late April, a bomb attack forced the pipeline shut, but it was able to reopen after three days. Additionally, numerous technical issues forced the pipeline shut, typically for only 24 hours each time. In early June,

sabotage was blamed for the rupture and shutdown of the pipeline. There was another explosion in August that killed two workers and forced the pipeline shut for several days.

In Iran, U.S.-led sanctions brought about gasoline supply issues throughout 2010. Companies imposing sanctions included Shell, Malaysia's Petronas, LUKoil, BP, Statoil, and Eni. Turkey continued to provide Iran with gasoline until July, when it cut exports by 74 percent. Iranian goals to boost oil production were hampered by these sanctions. In addition to the sanctions, an explosion forced the Iran-Turkey natural gas pipeline shut in late August.

## **Africa**

The majority of EAD stories involving Africa in 2010 addressed events in Nigeria such as attacks, explosions, leaks, curtailment, and theft. Much of the sabotage to oil infrastructure in Nigeria was carried out by the Movement for the Emancipation of the Niger Delta and other unknown assailants. These disruptions occurred all year long. Despite expectations that Shell would leave Nigeria in 2010, the company actually completed construction of a new pipeline and other oil and gas infrastructure late in the year.

## **Asia**

The central theme in EAD stories covering Asia in 2010 is the rapidly growing Chinese demand for oil. In January 2010, China surpassed the United States as the largest consumer of Saudi Arabian oil. Oil demand in April 2010 was notably higher than it was in 2009, and there was a corresponding boost in storage capacity, oil transport infrastructure, and oil and gas production in China. Furthermore, China began to depend on Russia for a larger supply of oil. Russia began East Siberia Pacific Ocean pipeline crude deliveries on November 1, and the planned Purpe-Samotler Russia-China oil pipeline is projected to be finished in 2012. In addition to its increasing imports of Russian oil, China is developing other oil sources, and in September 2010 China broke ground on the proposed Myanmar-China oil pipeline.

Along with an increasingly developed transportation infrastructure system, China has also begun to boost refined fuel storage capacity and refining. The Chinese National Petroleum Corporation plans to more than double oil and gas production in the Chinese province of Xinjiang over the next ten years, and significantly boost oil refining capacity in the next five years.

## Appendix A. Guidelines and Criteria for EAD Story Selection

Asset	Event	METRICS <sup>1</sup> for:		
		Major Development	Energy Story	Energy Note
<b>ELECTRICITY</b>				
Electricity End-Use	Power Outage/Restoration	250,000+ customers	25,000 -249,999 customers	10,000 – 24,999 customers
Power Plant	Shut Down/Restart/ New Capacity	Depends on Impact (2,000+ MW)	100+ MW	10 – 100 MW
Transmission Line		Depends on Impact (500+ kV)	115+ kV	< 115 kV
Substation	Break-in Damage/ Shutdown		Copper Theft or Severe	Minor or short-term
<b>PETROLEUM</b>				
Refinery	Shut Down/Restart/ New Capacity/ Flares	<ul style="list-style-type: none"> <li>• Gulf Coast: 200,000+ b/d</li> <li>• Other U.S.: 100,000+ b/d</li> </ul>	Any glitch that may have impact on production	Flares, if no impact to production and no other information is given
Production or Transportation <sup>2</sup>	Shutdown/Restart/ New Capacity	<ul style="list-style-type: none"> <li>•US/Canada: 200,000+ b/d</li> <li>•Foreign<sup>2</sup>: depends on impact (400,000+ b/d)</li> </ul>	<ul style="list-style-type: none"> <li>• US/Canada: 10,000+ b/d</li> <li>• Foreign<sup>2</sup>: 25,000+ b/d</li> </ul>	<ul style="list-style-type: none"> <li>• US/Canada: &lt; 10,000 b/d</li> <li>• Foreign: &lt; 25,000 b/d</li> </ul>
<b>NATURAL GAS</b>				
Production, Processing, or Transportation <sup>2</sup>	Shutdown/Restart/ New Capacity	Depends on Impact (500+ MMcf/d)	100+ MMcf/d	< 100 MMcf/d

1) Metrics Refer to Affected Volumes/Capacity

2) Transportation Includes Pipelines, Marine Tankers, Tanker Trucks, LNG Tankers, Import/Export Terminals, and Railroads

3) Foreign Producers Refer Only to Countries That Supply the U.S.