ISO New England

2014 Regional Electricity Outlook

Reliability is the core of ISO New England's mission, fulfilled by three interconnected and interdependent responsibilities.

Overseeing the day-to-day **operation** of New England's electric power generation and transmission system

Managing comprehensive regional power **system planning**

Developing and administering the region's competitive **wholesale electricity markets**

ISO new england

Contents

About ISO New England

ISO New England is the not-for-profit corporation responsible for keeping electricity flowing across the six-state New England region: Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont. The company's power system engineers, economists, computer scientists, and other professionals ensure the region has reliable, competitively priced wholesale electricity today and into the future. The ISO is independent—none of the ISO's Board members, officers, or employees has a financial interest in any company doing business in the region's wholesale electricity marketplace. The Federal Energy Regulatory Commission (FERC) regulates the ISO.

About this Report

The ISO's unique role gives it an objective, bird's-eye view of trends that could impact the region's power system. In 2010, the ISO launched the Strategic Planning Initiative (SPI) in collaboration with New England states and market participants to identify upcoming challenges and potential solutions. This report provides an update on SPI actions, as well as other ISO efforts to improve its services and performance. Together with the *Regional System Plan* and *Wholesale Markets Project Plan*, the *Regional Electricity Outlook* keeps stakeholders informed about the current state of the grid, issues affecting its future, and actions to address these issues. Contact ISO New England's Corporate Communications and External Affairs teams at (413) 535-4309 for copies.

Please note: The facts and figures in this report were current at publication in January 2014. However, the ISO is continually generating data and analyses. For the most current information, please visit www.iso-ne.com.

From the Board Chair

Our pursuit of excellence in operating the grid has introduced efficiency and bolstered reliability.

It is with great pride that I assumed leadership of ISO New England's Board of Directors in 2013.

Seventeen years ago, New England policymakers, regulators, and industry participants decided that the prevailing paradigm of monopoly and vertically integrated utilities was not resulting in efficient investment outcomes for the region's electricity consumers. The decision was made to utilize organized wholesale electricity markets to ensure the reliable and competitively priced supply of electricity to the region. The ISO was formed in 1997 to implement this policy direction and was given three critical responsibilities: designing and running competitive wholesale electricity markets, effective centralized system operations, and dynamic and transparent regional planning. The successful execution of these functions has yielded a power system that is reliable, efficient, and environmentally sound, to the benefit of all New Englanders.

On the ISO's watch, the region has attracted approximately $11 billion in private transmission investment through 2017, reenergizing New England's high-voltage infrastructure and nearly eliminating congestion on the system and its associated costs. Our pursuit of excellence in operating the grid—a complex job that we perform every minute of every day—has introduced efficiency and bolstered reliability. And through wholesale electricity markets, New England has seen the power of competition at work and enjoyed substantial returns. The marketplace's fairness, transparency, and robustness have delivered competitively set prices, ensuring that the lowest-cost resources are selected to produce electricity most of the time. Coupled with the boom of inexpensive natural gas, the total amount transacted in the energy markets dropped from $12 billion in 2008 to $5 billion in 2012.

The marketplace has also attracted the interconnection of close to 15,000 megawatts (MW) of new, efficient, lower-carbon-emitting power plants—with resource owners shouldering the development risk, not consumers. Over the next few years, more than 2,000 MW of renewable energy sources have been proposed to join the New England fleet, helping to fulfill many public policy goals. And by 2016, over 2,500 MW of demand resources are expected to be participating in the region's energy markets, providing an alternative to adding costly generation and transmission. Key efforts to facilitate the integration of these resources are described in this report, including market changes, innovative forecasting efforts, and collaborations with nationally renowned research laboratories.

Even with this outstanding progress, the grid today is at something of a crossroads. The ISO has been warning for some time of serious challenges facing the region as the power system evolves from one based on traditional, large infrastructure to one that incorporates a rapidly changing fuel mix, new technologies, and smaller, distributed resources. As you'll read in this report, we're already experiencing reliability risks and seeing upward pressure on wholesale electricity prices. The ISO has been urgently engaging with stakeholders over the past year to implement market-based solutions that will allow the region to weather this transition. The fixes aren't simple, but I am confident that the ISO, together with stakeholders, can continue to fulfill the mission originally given to us to ensure reliable, competitively priced wholesale electricity through markets.

In addition, the ISO has put into place numerous business enhancements and initiatives during the past year to facilitate informed participation, foster collaborative partnerships, and ensure transparency for stakeholders—all at marginal increases in our annual operating costs. We also continue to introduce technological innovations and efficiencies that will help us keep pace with a rapidly evolving power system and provide even more value for the region. As always, the ISO remains committed to fulfilling its obligations in a responsible, cost-effective manner.

I thank you for your ongoing support and contributions as we work together to create an even stronger and more reliable power system for New England.

Sincerely,

Kathryn J. Jackson
Board Chair

The ISO's New Board Chair

Kathryn J. Jackson, Ph.D., joined the ISO Board in 2008 and was named chair in late 2013. She is Chief Technology Officer at Westinghouse Electric Company. Read her full bio at www.iso-ne.com.

From the CEO

The challenges to grid reliability are not a question of if they will arise, but of when—and when is now.

In 2010, ISO New England launched the Strategic Planning Initiative (SPI), a major collaborative effort with the states and industry stakeholders to formulate responses to the biggest challenges on the power system's horizon. Now in 2014, we find these tightly interrelated challenges have become reality, and they are accelerating.

New England's generating fleet is rapidly transforming. Natural gas plants and renewable energy resources are hastening the retirement of older, economically-challenged coal and oil units. Today, natural gas fuels about half of the electricity produced in the region (compared to about 15% in 2000), and gas- and wind-powered resources make up 95% of proposed new generators. But while this transformation has set the region on the path desired by policymakers toward lower emissions, it is clear that we have a number of reliability and economic issues that need to be addressed.

Inadequate infrastructure is behind some of these challenges: insufficient natural gas pipeline capacity restricts the available natural gas supply to generators and causes high wholesale electricity prices, while wind resources are connecting to areas of the transmission system too weak to carry all of the potential power. Other challenges are related to the current design of New England's wholesale electricity markets, which aren't providing the proper incentives to drive reliable performance in today's, and especially tomorrow's, environment. The older coal and oil generators also face an additional, daunting economic challenge: infrequent operation makes it difficult for them to remain viable or raise the revenue needed for investments that could enable more frequent operation. This is causing the owners of these generators to make the rational business decision to retire these resources.

The capacity that will replace New England's retiring generators is likely to be a combination of renewable and gas-fired resources. However, the relationship between renewables and the conventional resources needed to ensure grid reliability presents a puzzle: more wind and solar power creates a need for fast-starting, flexible resources that can take up the slack when the wind stops or the clouds roll in. New natural gas generators will likely fill this role, with their relative ease of siting and typically lower fuel costs—but this will further strain natural gas pipeline capacity.

"Green energy" is also setting up a new challenge on New England's horizon as policymakers continue to seek investment in grid-connected renewable resources, as well as "behind-the-meter" (distributed) renewable resources and energy-efficiency (EE) resources. The lower fuel costs and the potential negative pricing of renewable resources plus any significant reductions in electricity demand from EE will likely decrease net energy market revenues for gas, nuclear, and other conventional resources—resources that make up the majority of regional generation and that are crucial for grid reliability. This economic conundrum will also apply to newer technologies, such as electricity storage options, and even some renewable resources that rely on net energy market revenues.

Properly designed markets hold the key to solving many of these problems. That's why the ISO has been working urgently to study, devise, and implement market-based solutions to help improve the day-to-day performance of New England's generating fleet; enable the ISO to better meet current operational needs; and attract and retain the flexible resources that tomorrow's grid will rely on. Of particular importance will be the enhancements described in this report to the Forward Capacity Market (FCM), which will act as a catalyst for driving long-term change.

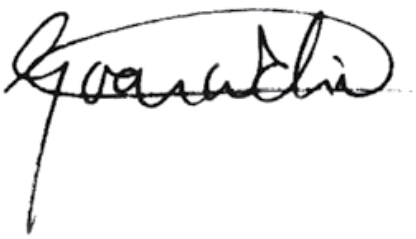
Just over a decade ago, the region agreed that implementing the FCM was the most appropriate way to ensure future resource adequacy and system reliability for New England; this was in contrast to energy-price-only designs, bilateral procurement, or other market designs used elsewhere. However, as the Forward Capacity Market has matured and the power system and economics have changed, it's become clear that the FCM is not sending the appropriate price signals to incentivize resources to be available during stressed system conditions or to make investments to improve performance. Furthermore, the current FCM design incorporates a vertical demand curve that results in very volatile pricing, which is an impediment to attracting and retaining sufficient resources to maintain reliability.

While the ISO's market changes will spur resources to firm up their ability to be available and produce electricity when needed (for example, by gas generators investing in dual-fuel capability), our planned market changes may not be sufficient to drive investment in additional natural gas pipeline capacity to increase gas supply to the electricity industry. The New England state regulators recognize the problem and are exploring mechanisms to bridge the two industries (as discussed on page 30).

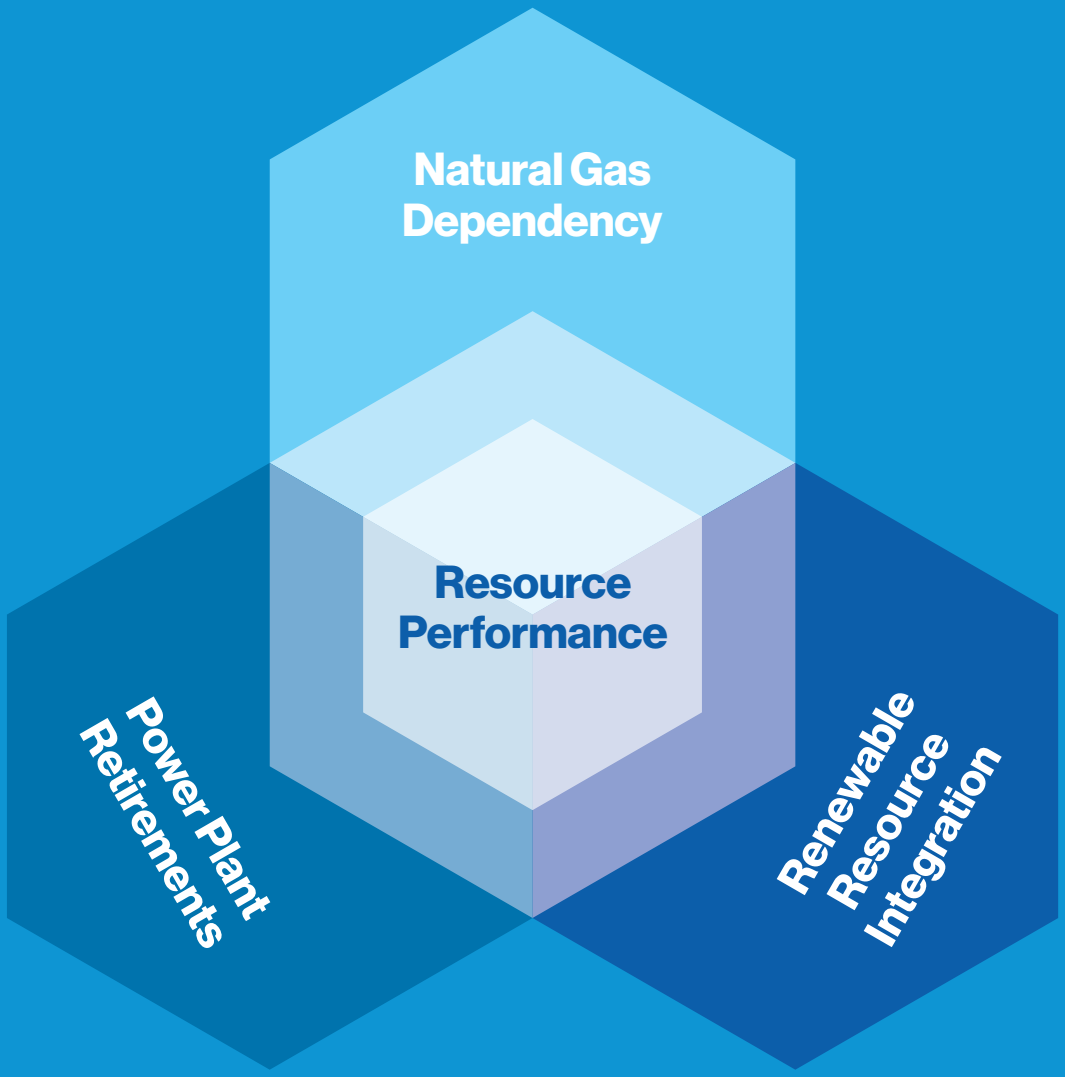
As a region, we face serious risks and have tough choices to make. It will take continued collaboration and a concerted effort from the ISO, the industry, and policymakers to keep our evolving power system on a reliable and efficient course. This edition of the *Regional Electricity Outlook* provides an update on SPI-related market changes completed in 2013 and underway for 2014 and beyond, as well as on other ways the ISO continues to deliver on our promise to New England: to make the objective decisions and do the hard work required to keep power flowing reliably and at competitive prices to the millions of homes, businesses, and service providers in the region.

Sincerely,

Gordon van Welie
President and Chief Executive Officer




+3 MW/min


Natural Gas Dependency
Resource Performance
Power Plant Retirements
Renewable Resource Integration

Understanding Today's Grid Challenges

The Electricity You Need, When You Need It

Across the six states of New England, the dependable flow of electricity drives daily life, business, and critical services: Kitchen lights greet waking children in Vermont. A manufacturing plant hums to life in Rhode Island. A credit-card transaction is processed in a New Hampshire shop. Street lights guide commuters in Connecticut. A lighthouse flashes in Maine. Life-saving hospital equipment runs in Massachusetts.

This reliability on the retail side of the power system largely depends on reliability on the *wholesale* side. That's where ISO New England is, balancing the demand for electricity with its supply every minute of every day, so that when it's needed, it's there—instantly. That's why reliability is priority one in almost every ISO discussion of the power grid.

Reliability Requires a Flexible, High-Performing Resource Fleet

To make sure that the right amount of electricity is always available to all corners of the grid, ISO system operators need a portfolio of resources across the region that can offer a range of capabilities under a variety of conditions. This includes:

- Power plants that can run regularly to meet the required minimum amount of generation
- Resources that can start up or dial back quickly in response to sudden changes in consumer demand driven by weather or to unexpected events, including equipment failures or sudden changes in production by generators that run on renewable sources of energy

These resources have to react to the ISO control room's instructions precisely as directed. Their consistent performance—following through on commitments and delivering required services—is what helps New Englanders conduct their lives as planned.

But today, the ISO is increasingly seeing periods when some resources don't perform as needed during stressed system conditions. In fact, in a three-year study, the ISO found that New England's generating fleet averaged a delivery rate of 71% of the additional power requested of them during large system contingencies. When a resource does not perform in accordance with its specifications or obligations, grid operators are forced to depart from efficient dispatch of the system. This increases both the cost of operations and the chances of unintended power system outages—and puts the ISO in jeopardy of violating federal reliability standards. Those violations can carry steep fines and additional requirements that affect the entire region in the long term.

The Strategic Planning Initiative (SPI)

Through a collaborative, regional effort led by the ISO called the Strategic Planning Initiative (SPI), a convergence of factors has been identified that is affecting the performance of power system resources in the region, creating risk to the reliable supply of electricity for New England's homes, businesses, and public services. These factors and the actions required to address them are discussed on the following pages. Implementing solutions to these challenges is critical to ensuring that as the power system evolves, it continues to provide the same exceptional level of reliability that it has to date.

1. Natural Gas Dependency

Performance limitations are an immediate risk to reliability.

A Boon to the Region

Natural gas has become the dominant fuel used to produce electricity in New England. Relatively easy to site and less expensive to build than other types of generators, natural gas combined-cycle units made up the majority of the approximately 15,000 MW of generating capacity developed over the past 15 years. This has resulted in a significant decrease in both power plant emissions and the wholesale cost of electricity. With plentiful, inexpensive supply from the Marcellus Shale in Pennsylvania and New York right at New England's doorstep, natural gas continues to be the fuel of choice for new power plant construction in the region.

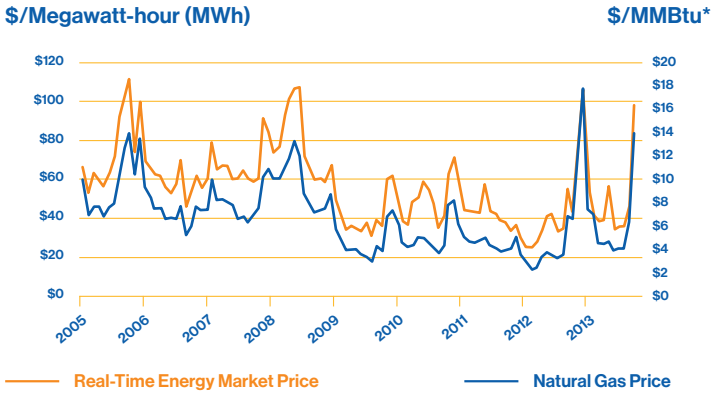
Fuel Availability Problems

However, a number of factors are affecting the ability of natural gas plants to get the fuel they need to perform, which has an immediate effect on power grid reliability and wholesale prices.

- **Inadequate infrastructure:** Demand for inexpensive Marcellus Shale gas by both power plants and home heating customers continues to rise. Because the existing pipeline system in New England was not sized to serve the increased demand, the pipeline system is increasingly constrained, especially in winter when heating and electric loads are high.
- **Unreliable fuel arrangements:** Most natural gas plants arrange for gas just a day ahead, instead of through priority, long-term contracts like companies that serve heating customers. So when the pipelines are at maximum capacity, natural gas to generators can be limited and render these generators unavailable.
- **Limited storage:** Unlike other types of generators that store fuel on site, many natural gas plants in the region have limited or no on-site storage, making them vulnerable to supply problems. Dual-fuel capability allows switching to oil when necessary, but only about a quarter of the region's gas fleet has this capability.
- **Out-of-sync markets:** The natural gas and wholesale electricity markets have different schedules, leaving the generators short on time to arrange fuel for the operating day or to make fuel-switching

Natural gas and wholesale electricity prices are linked

Because of New England's heavy reliance on this single fuel source, natural gas typically sets the price for wholesale electricity.



*MMBtu stands for Millions of British thermal units

decisions. Plus, gas-fired generators' ability to update electricity market offers to reflect fluctuating natural gas prices is limited under current market rules—a disincentive for them to perform if their real-time fuel costs are too high.

From a cost perspective, these fuel limitations can drive up the price for natural gas, increasing wholesale electricity prices, which can affect consumers in the long run. On the reliability side, when natural gas generators do not run when called on, the ISO is forced to dispatch more expensive oil- and coal-fired plants. But the availability and performance of these older plants can be uncertain. And because natural-gas-related performance issues can arise quickly, it is difficult for system operators to determine when to call on *non*-gas resources, some of which require a long time to start and ramp up and may also not have enough fuel to run as needed.

Case In Point

January 2013 brought the coldest five-day stretch in New England since 2009. In February, a blizzard dropped record snowfall. Both times, natural gas pipeline constraints pushed up gas prices and, consequently, wholesale electricity prices. The ISO had to call on oil- and coal-fired generating resources, resulting in significant "uplift" costs and reliability concerns. Some oil units were not expecting to run and had low fuel inventories, which they quickly depleted. For the first six weeks of 2013, the value of the energy market was about $1.3 billion higher than the total spent in the first six weeks of 2012. And yet overall, the winter of 2012–2013 was far from harsh.

Accelerating System Impacts

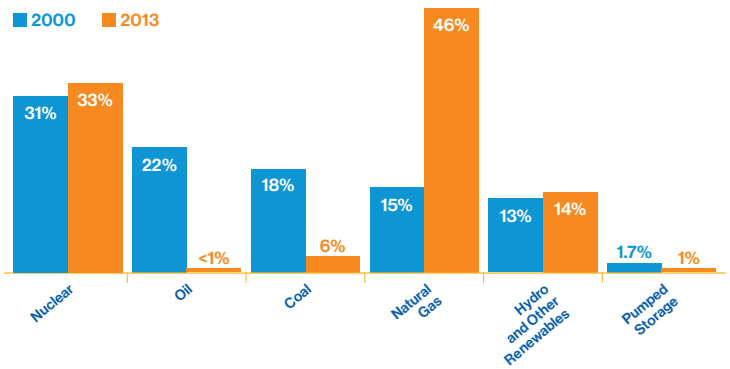
The region's reliance on natural gas generation—and our susceptibility to its risks—is likely to increase as more of these plants are built to replace retiring generators and to balance an increasing amount of variable generation on the system. (See pages 16–17.) Paradoxically, wind, solar, and other "green energy," with its low fuel costs, could make natural gas generators less profitable in the energy markets and lead to their eventual exit.

Required Actions

The ISO is working on market and operational changes to incentivize natural-gas-fired resources to make adequate fuel arrangements and to perform when needed. (See pages 18–25.) Refinement of the Forward Capacity Market (pages 23–25) is part of a long-term solution to maintain a high-performing fleet. However, market changes alone won't necessarily result in added pipeline capacity, as individual generators aren't likely to cover the cost of long-term pipeline infrastructure investment. The New England states are working on additional solutions, including ways to spur pipeline development. (See pages 30–31.)

Dramatic changes in the energy mix

The fuels used to produce New England's electric energy have shifted as a result of economic and environmental factors.



2. Power Plant Retirements

New England will need new ways to meet peak demand as aging plants close.

Age and Economics Push Out Older Resources

Rising costs associated with oil and coal and the advanced age of many of the power plants that use these fuels make it difficult for these resources to compete against newer, more efficient natural gas generators. The region's oil-fired generators represent more than 20% of capacity in the region, but produced less than 1% of its electricity in 2013—mainly for peaking service, or as a backup when natural gas plants were unavailable.

Because of age and infrequent operation, the performance of these resources can be uncertain when called on, posing risks to reliability:

- Equipment issues can affect their performance when dispatched.
- They have long start-up times. Up to 24 hours are needed to reach full output, which makes it difficult for ISO operators to rely on these resources.
- Oil units tend to have very limited fuel supplies on site to avoid the expense of purchasing oil that they may not use. So, even when called to run, they often can't run for very long.

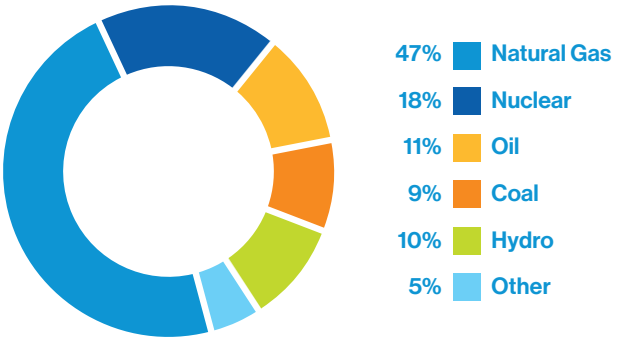
By operating infrequently, these resources cannot recover the cost of capital investments to maintain their plants and ensure performance—nor can they afford new control technologies to meet stringent state, regional, and federal environmental requirements. For many, the only option is to retire.

Accelerating System Impacts

In 2012, the ISO analyzed the potential impacts to the transmission system if 28 oil- and coal-fired generators older than 40 years were to retire by the end of the decade. The analysis found that if all these at-risk units retired, approximately 6,000 MW of resources would need to be replaced, repowered, or

What's powering New England through the summer peak?

Look at fuel usage during high electricity demand on the peak of a summer day in 2013. While coal and oil together produced 20% of peak electricity that day, these resources produced only about 7% of electricity over the entire year. (See page 13.)



retained to satisfy both generation and transmission reliability requirements. Given current trends, the majority of the replacement resources would be natural-gas-fired generation.

It's an expected market outcome for aging, uneconomic plants to retire at some point. However, the potential magnitude of retirements over a relatively short timeframe poses a serious reliability challenge to the region. It reinforces New England's dependence on natural gas and weakens the ability to weather operational issues caused by the lack of availability of gas generators. The potential closure of other types of generation over time, such as nuclear and hydro units that may not be relicensed, may further exacerbate the challenge.

Required Actions

The ISO has been employing short-term strategies to counter reliability risks, such as dispatching resources out of merit, implementing stop-gap energy procurement measures (see page 20), and retaining resources that want to retire. However, these fixes are costly and inefficient; a long-term, market-based solution is preferable. The ISO sees the refinement of the Forward Capacity Market (see pages 23–25) as part of this long-term solution, attracting investment in new, flexible resources to create a more reliable resource mix over time.

Case In Point

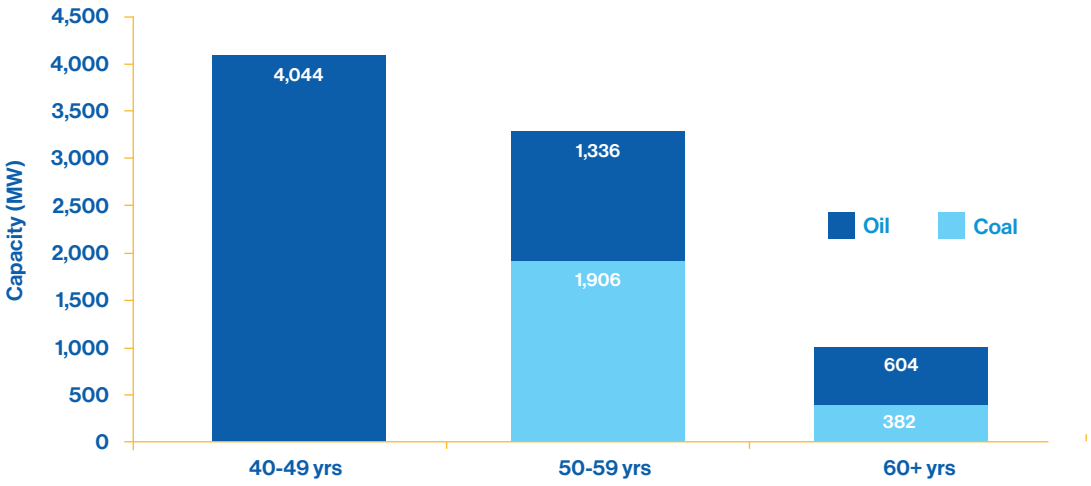
Retirements were announced for several of the region's large, older generators in 2013:

- 1,535 MW from Brayton Point Station—the region's largest coal-fired plant, which also includes four small diesel units
- 342 MW from Norwalk Harbor Station—a large oil-fired plant
- 604 MW from Vermont Yankee Nuclear Power Station

Salem Harbor Station announced its retirement in 2011, which removed 749 MW (coal and oil) from the 2014–2015 commitment period. These four plants represent the exit of **almost 3,300 MW** over the next five years.

An aging fleet

A 2012 ISO analysis found that about 8,300 MW of New England's oil and coal capacity would be over 40 years old in 2020. Since then, some of these older plants have already announced retirements. (See sidebar.)



3. Renewable Resource Integration

Balancing variable generation with reliability will require extensive changes.

En Route to a Greener Grid

Wind and solar energy have been expanding dramatically in New England, though it will be several years before they generate a significant portion of the region's electricity. With zero emissions and no fuel costs, these resources can help achieve federal and state environmental goals and mitigate the volatility of wholesale electricity prices related to the volatility of fossil fuel prices. The states' Renewable Portfolio Standards and other environmental targets call for renewable resources and energy efficiency to meet about one-third of New England's projected total electric energy needs by 2022. Today, 40% of the proposed projects in the ISO's Generator Interconnection Queue are wind-powered.

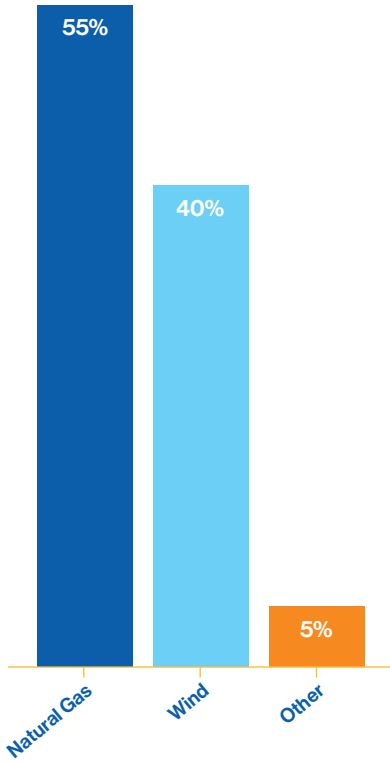
"Fuels" with Complex Characteristics

Renewable resources have different operating characteristics than traditional power plants. So, the reliable large-scale integration of these resources presents challenges for grid planning and operation that the ISO must address. For example:

- Changing weather conditions can lead to rapid and sizeable swings in electricity output (which is why these resources are called variable or intermittent).
- Wind speeds can be at their lowest levels in the summer and during extreme cold snaps—conditions when electricity demand is high. Power from solar arrays also tapers off in late afternoon as demand is peaking, particularly in the winter.
- Many solar arrays are installed "behind the meter," so their generation is not dispatchable by the ISO. It's also difficult to account for and forecast in system planning and operations.
- Rules for interconnecting wind resources to the grid are not the same as for traditional power plants. Wind farms are also often built in remote areas where the transmission system isn't designed to carry large amounts of power. To avoid overloading the transmission system,

What will tomorrow's energy mix look like?

Examining new generator proposals submitted to the ISO as of January 2014, it's easy to see how public policy and economics are driving the industry's choices for tomorrow's fuel sources.



the ISO sometimes has to call on wind resources to reduce their electricity output; thus, the system is unable to benefit from the full capability of these resources. To maintain system reliability, the ISO may also curtail wind resources at times when excess energy is produced (for example, at night when demand is low).

(See page 28 for more on wind and solar.)

Required Actions

Accommodating a high percentage of variable resources will require wide-ranging changes across the transmission system, grid operations, markets, and system planning. For example:

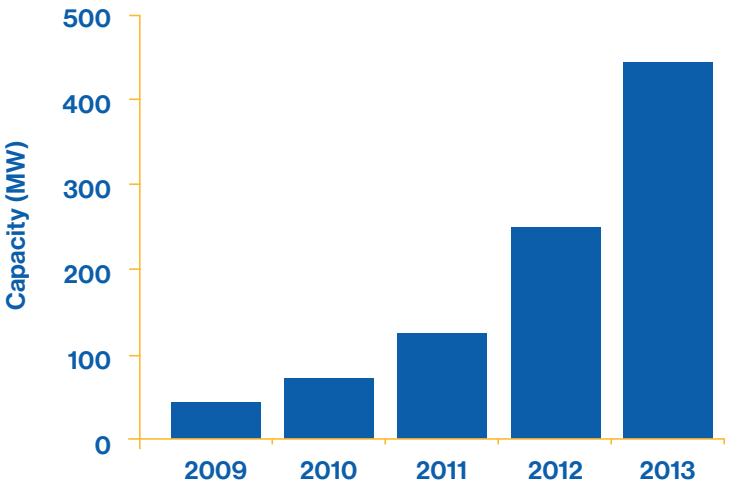
- System operators need more sophisticated forecasting and other tools to manage dispatch with resources that can have rapid and sizeable swings in output.
- To balance these swings, the system must hold more capacity in reserve that can come on line quickly. Natural gas generators and other fast-responding resources, such as storage, fit the bill. But enhancements to the energy, reserve, and capacity markets are needed to better incentivize performance and infrastructure investments that will attract and retain this fleet, as well as ensure the fleet is responsive to rapid changes in system conditions. (See pages 18–25.)
- Billions of dollars in transmission expansion and upgrades would be needed to connect large amounts of remote wind energy to demand centers.

Case In Point

During summer 2013, the ISO was required to "curtail" (reduce) output from wind farms during the July heat wave, even as it called for increased generation from other resources. Various factors played a role, including:

- A weakness in the remote transmission system where the wind farms were interconnected
- Certain necessary interconnection upgrades that were not yet complete

Page 28 has more.



Solar power is growing rapidly in New England.

As shown here, the amount of regional photovoltaic (PV) nameplate, or rated, capacity has been almost doubling annually. Most PV resources are connected to the distribution system and not visible to the ISO; therefore, these figures are approximate values. The ISO is in the process of collecting detailed information about current and future PV resources. About 2,000 MW of nameplate PV is anticipated by the end of 2021.

Working Toward Market-Based Solutions

The ISO is facilitating a comprehensive response to interrelated challenges.

ISO New England does not own power plants or transmission lines, and we cannot directly require resources to make infrastructure investments or take action to improve their performance. Instead, it is the ISO's responsibility to ensure a reliable supply of competitively priced wholesale electricity through markets. Therefore, the ISO must continuously enhance the competitive wholesale electricity marketplace so that it sets the correct incentives to ensure that enough resources are developed, are available, and run when needed. To this end, the ISO has been actively collaborating with stakeholders on comprehensive, near- and long-term rule changes across the region's suite of **energy, reserve,** and **capacity markets** to address the challenges identified through the Strategic Planning Initiative (SPI). The changes share overriding goals:

- Enhancing market mechanics to better enable resource performance
- Improving market incentives for performance
- Procuring sufficient resources to meet the region's electricity needs

What's in a Rule Change?

Market design is an ongoing, iterative process, often based on the changing needs of the power system. Revising market rules is intensive and can take many months. First, ISO experts study the situation and possible solutions, and then bring proposed changes through a stakeholder process. Changes are then submitted for Federal Energy Regulatory Commission review and approval. A lengthy implementation phase may follow, which often requires software development, testing, and training—all of which can require several more months, or years, of ISO work. The ISO must be meticulous when making any market rule and technology changes, as errors could lead to market disruptions.

Market rule changes are reflected in the *ISO New England Transmission, Markets, and Services Tariff* (the ISO tariff) and related documents. For the current status of market projects, see the *2014 Wholesale Markets Project Plan*.

To learn more about economic studies and other analyses of New England's transmission system, as well as other ISO work related to regional system planning, see the *2013 Regional System Plan*.

View the ISO tariff, ISO reports, and ISO filings at www.iso-ne.com.

Energy Markets

The electricity the ISO manages minute-to-minute to meet instantaneous demand is bought and sold through the Real-Time Energy Market. Generating resources can also lock in prices and production schedules one day in advance by participating in the Day-Ahead Energy Market. The ISO has been working on major rule changes to both of these markets to bolster the ISO's ability to dispatch resources effectively, to improve how resources perform and respond to these dispatch instructions and schedules, and to ensure prices accurately reflect current system conditions. All these changes will help contribute to the reliable operation of the grid.

Stop-Gap Measure for Winter 2013/2014 Reliability

Before these longer-term energy and capacity market changes could be made, the ISO implemented a reliability program for winter 2013/2014 that provided a necessary short-term solution to mitigate system operation challenges associated with the region's heavy reliance on natural gas to produce electricity, as well as concerns about fuel availability of other resources. As part of this program, oil-fired and dual-fuel generators selected to participate were paid to secure fuel inventory and fuel-switching capability—but were also subject to nonperformance charges. The ISO selected an amount of resources to participate that balanced concerns about reliable operations and costs to consumers. (See filings ER13-1851-000 of June 28, 2013, and ER13-1851-001 of August 9, 2013.)

Completed in 2013

Generation Capacity Auditing

The ISO changed how it audits generation resources in New England's energy markets. Changes include enhancements to off-line reserve capacity auditing, parameter auditing, and claimed capability (i.e., capacity) auditing that will help the ISO ensure that resources can perform up to their obligations, leading to better dispatch response during stressed system conditions. (See filing ER13-323-000 of November 6, 2012.) In related efforts, the ISO also began monitoring generator fuel inventories more closely and reinforcing the obligation of all resources to follow ISO dispatch instructions.

Day-Ahead Energy Market Schedule Changes

The ISO accelerated schedules for submitting Day-Ahead Energy Market offers and making daily resource adequacy assessments to better align with the national day-ahead natural gas scheduling system. Gas-fired generators now have more time to arrange fuel deliveries for the operating day and to make fuel-switching decisions (for those with dual-fuel capability). Also, ISO operators now have more advance notice to call on resources with long start-up times. (See filing ER13-895-000 of February 7, 2013.)

Underway for 2014

Energy Market Offer Flexibility

The ISO is implementing rule changes that allow generators to better reflect the real-time price of fuel in their supply offers. This will improve generators' financial incentives to follow ISO dispatch and will set more accurate prices in the energy market. A primary project on the ISO's 2014 work plan, these changes require a significant effort to modify business processes and tools across many ISO departments, including system operations; market administration, settlements, and monitoring; and IT infrastructure and software. Starting in December 2014, market participants will be able to submit:

- Power supply offers that vary by hour in the Day-Ahead Energy Market, in contrast with current rules requiring the same offer for the entire operating day
- Timely changes to offers (until 30 minutes before the hour in which the offer applies) in the Real-Time Energy Market versus current rules restricting changes to a brief "reoffer period" the previous day
- Negative offers as low as –$150 per megawatt-hour (MWh)

(See filing ER13-1877-000 of July 1, 2013.)

Wind Forecasting and Dispatch (Phase 1)

On January 15, 2014, the ISO began incorporating wind forecasting into ISO processes, scheduling, and dispatch services. (The ISO had previously offered a preliminary informational wind power forecast since May 2013.) In addition to the ISO's use, wind resources can download the forecast of expected output for their individual units, which can help them build a strategy for bidding in the Day-Ahead Energy Market. As part of phase 1 of this project, the ISO has also created displays that improve operators' situational awareness and is now maintaining historical wind data for future use by the forecast service, and in auditing and other analyses. With wind forecast integration complete, the ISO will be working toward full economic dispatch of wind resources in phase 2 of this project.

Electric Power and Natural Gas Sector Coordination

Early in 2014, the Federal Energy Regulatory Commission issued regulations that allow the ISO and operators of the gas transmission system to share a broad range of nonpublic information to promote the reliability and integrity of each system. The ISO filed tariff revisions to permit the newly authorized communications in New England starting in early 2014. The changes will improve communications between the control rooms of the gas and electricity networks, so operators will have better information on which to base their decisions. (See filing ER14-970-000 of January 10, 2014.) Related ISO efforts include mining data from various sources to estimate the availability of natural gas for energy purposes; analyzing capacity scenarios across different seasons based on information gathered from fuel surveys and pipelines; and establishing operating plans to deal with different system conditions.

Why Allow Negative Offers in Energy Markets?

Negative offers are already being used by neighboring power systems to create an economic incentive to not overproduce electricity when demand is low or when the grid can't handle it physically. Currently, ISO New England does this by manually ordering resources to curtail their output.

A generator would make a negative offer—essentially, pay to keep operating—because this is preferable to shutting down. For example, generators may face start-up and shut-down expenses that make it more economical to keep running. Negative pricing will also be used to help balance variable resources, such as wind power, which may want to run at times when demand is low (for example, at night).

Allowing curtailment to happen through the market rather than by manual ISO orders gives the resources the control to signal how much they value continuing to operate.

Longer Term

Integration of Intermittent Resources

The ISO is working to put in place by 2015 dispatch enhancements and associated market rule changes to more effectively use wind resources. Changes under consideration include enhanced automated dispatch to account for variability in weather conditions, as well as a requirement for telemetry equipment that allows wind resources to communicate real-time output and other data to the ISO and to receive automated dispatch instructions from the ISO, as other resources do.

Price-Responsive Demand: Energy Market (FERC Order 745)

Changes are underway to fully integrate demand-side resources into the energy markets by 2017 so they can be dispatched, just like supply resources, when it makes economic sense to do so. (Page 34 has more details.) (See filing ER12-1627-000 of April 26, 2012.)

Subhourly Real-Time Energy Market Settlement

The real-time markets (energy, reserve, and regulation) are settled hourly, even though the ISO calculates real-time locational marginal prices (LMPs) every five minutes. Moving to subhourly settlements of these markets may allow the more accurate compensation of resources able to respond quickly to changing system conditions. This change is under analysis.

SPI Key

- Performance
- Natural Gas Dependency
- Renewable Resource Integration
- Power Plant Retirements

Reserve Markets

Reserve markets support the energy markets by ensuring the grid has enough resources ready to come on line quickly in the event of a demand spike or an unexpected generator or transmission outage. Because SPI challenges have increased the need for flexible operations and reliable reserves, enhancements are needed to the Forward Reserve Market (FRM) and real-time reserve pricing. The changes will provide greater ability to manage intraday fuel supply contingencies and produce prices and compensation that are more reflective of true costs for these services.

Completed in 2013

Changes to the Forward Reserve Market Reserve Requirement

The ISO is now procuring 25% more 10-minute non-spinning reserve (TMNSR) in the forward reserve auction. This change supports the availability of reserves to meet *real-time* reserve requirements, which were increased in 2012 to compensate for the nonperformance of some resources during stressed system conditions. (See filing ER13-465-000 of November 27, 2012.)

Replacement-Reserve Requirement Changes

The replacement-reserve requirement is now set higher when Daylight Savings Time is not in effect to accommodate winter's additional peak-load ramping and fuel uncertainty and to help improve real-time market prices. This change will create a stronger performance incentive for fast-responding resources during reserve deficiencies.

Forward Reserve Market Incentives

The existing FRM failure-to-reserve penalty rate was modified to better reflect the real-time replacement cost when a participant is unable to meet FRM obligations. (See filing ER13-1733-000 of June 20, 2013.)

Reserve-Constraint Penalty Factor for the Replacement Reserve

The Reserve-Constraint Penalty Factor (a price cap) has been increased for the 30-minute operating reserves (TMOR) requirement. This reduces the need for out-of-merit commitment of additional resources to meet the system's reserve requirements and produces market prices that better reflect the cost of these requirements. (See filing ER13-1736-000 of June 20, 2013.)

Longer Term

Subhourly Real-Time Reserve Market Settlement

As with the energy markets, the ISO is evaluating moving to subhourly settlements in real-time reserve markets for the more accurate compensation of resources able to respond quickly to changing system conditions.

Forward Capacity Market

Complementing the daily energy and reserve markets is the region's Forward Capacity Market (FCM). Long-term capacity markets such as the FCM are used to provide economic incentives to attract investment in new and existing resources to maintain power system reliability requirements. In the FCM, the ISO holds an annual auction in which suppliers compete for the opportunity to meet the region's projected electricity demand three years out. Suppliers with the lowest price offers clear the auction and receive capacity payments—these payments are in addition to what resources receive in the energy and reserve markets. Because prices in the energy and reserve markets are more volatile and change as grid conditions change (for example, fuel prices change, the fuel mix changes, and new infrastructure is built that may alter prices in some locations), resources need a stable revenue stream to maintain their viability—particularly as the grid evolves. In exchange for capacity payments, the resources have an obligation to be ready to run when called on.

After several years of real-world experience with the FCM, the ISO has identified three issues that require enhancements to the market:

- The FCM does not provide sufficient incentives for generators to perform during stressed system conditions, resulting in resources that sometimes fail to produce energy when needed most—despite receiving capacity payments.
- The FCM's structure for determining capacity zones may not be refined enough to send price signals for new resources to locate in the areas of New England where new capacity is needed most.
- The FCM's fixed capacity requirement may result in unnecessarily volatile auction clearing prices as the market moves from periods of excess supply to periods when new resources are needed.

The first challenge—resource nonperformance—poses a risk to system reliability. Without reforms to improve incentives for investment that can enhance performance, New England could face a future in which its fleet of capacity resources does not have the capabilities needed to operate reliably under stressed conditions.

The second and third challenges concern price formation in the FCM. More accurate and stable price signals will help promote investment, reduce revenue volatility for suppliers, and ensure that new resources enter in the most valuable locations as many of New England's aging power plants retire.

The modifications to the FCM listed on the following pages will be a catalyst for the long-term changes New England needs to produce a sufficient, more reliable, and more flexible fleet of power supply resources.

Completed in 2013

FCM Shortage-Event Triggers

The definition of a shortage event—a period in which the total amount of available generation falls short of levels required for reliable operations—has been revised to be more meaningful. During shortage events, system operators can call on generators to come on line quickly

SPI Key

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to help balance supply and demand. Resources with capacity supply obligations that don't produce power when called on during these conditions have their capacity payments reduced. However, the previous definition of a shortage event (when the system was deficient in 10-minute reserves for more than 30 minutes) was not broad enough to accurately reflect actual "at-risk" periods. Since the beginning of the FCM, several instances of extremely tight conditions have occurred on the grid in which shortage events were not triggered. The result was that when the ISO called on capacity resources during these situations of heightened risk, those that failed to perform faced only limited penalties—or no penalties at all.

A shortage event is now declared when the grid is deficient in 30-minute reserves (not just 10-minute reserves) and after the dispatch of demand-response resources. This change is expected to trigger shortage events under a broader and more accurate range of stressed system conditions. As a result, resources will have a greater incentive to perform during times of power system stress and to minimize the chance of outages. (See filing ER13-2313-000 of September 4, 2013.)

Underway for 2014

FCM Pay-for-Performance (PFP)

The ISO is developing a new "pay-for-performance" mechanism in the FCM that will create stronger financial incentives for capacity suppliers to:

- **Perform when called on during periods of system stress:** With PFP, a resource that underperforms will forfeit some or all capacity payments awarded in a Forward Capacity Auction; resources that perform in its place will get the payment instead. This means that the financial risk of nonperformance is placed on resource owners who have accepted capacity obligations; the capacity market price is not affected during times of system stress, thus protecting consumers.
- **Make investments to ensure performance:** Facing the risk of forfeiting capacity payments for underperformance—as well as the chance to receive more compensation for overperformance—resource owners will have the incentive to make investments that ensure their resource can perform. They have a variety of options, such as upgrading to dual-fuel capability; entering in short-notice or noninterruptible gas supply agreements; investing in new fast-responding assets; or simply ensuring robust maintenance practices and adequate staffing. FCM rules will not dictate the technology or other means by which suppliers elect to do this, but will merely create the incentive for resource owners to make cost-effective investments that meet the needs of operating a reliable system.

In other words, just as with any contract for future delivery of a commodity, the buyer should only pay for the amount of product the seller actually delivers. If the seller underdelivers, it loses revenue. Knowing this, the seller can take steps—change business practices, invest in better equipment, and the like—to guarantee full delivery.

FCM PFP may also stimulate efficient resource evolution, hastening the retirement of inefficient resources with poor historical performance. It may also put upward pressure on capacity prices as resources evaluate their nonperformance risks and formulate offers that more accurately reflect their investments. Ultimately, however, FCM PFP offers the most efficient and effective way to promote investments necessary to improve performance, to provide high-performing resources a stable revenue stream to maintain their viability, and to ensure continued predictable capacity

prices and long-term reliability for consumers. (See filings ER14-1050-000 and ER14-1050-001 of January 17, 2014.)

Note: Before settling on FCM pay-for-performance as the most suitable approach for ensuring resource adequacy and improved performance in the region, the ISO met with stakeholders, consulted outside experts, and considered different market design options, such as "high-shortage pricing." (This option uses high administratively-set reserve-constraint penalty factors to significantly increase real-time energy prices above current values during periods with shortages of operating reserves.) However, ISO analysis revealed that while some options might also improve resource performance and alter long-term investment decisions, they came with undesirable risks. In the case of high-shortage pricing, for example, key concerns were that it would lead to less stable net revenues for capacity suppliers; would increase volatility in the Real-Time Energy Market; and would cause buyers in that market to directly assume the costs of the performance incentive (i.e., the high shortage price).

Capacity Zone Modeling

The FCM has always used a zonal structure that ensures the right amount of capacity is procured in parts of New England with high demand or transmission limitations. However, the ISO, stakeholders, and FERC have observed that the existing zonal structure may not be flexible enough to accommodate changes over time in the transmission system's capabilities and locations of highest need. To address these concerns, the ISO and stakeholders are evaluating how best to determine the appropriate number of and boundaries for capacity zones modeled in future Forward Capacity Auctions as the system evolves.

Principles of Effective Capacity Markets

The ISO's proposed FCM pay-for-performance approach uses basic market principles that work well in many markets for many types of products. This approach will create a strong incentive for suppliers to perform when New England needs them most.

- **Performance pays:** A supplier that exceeds its obligation should be rewarded for that performance. A supplier that doesn't deliver when needed misses out and receives lower capacity payments.
- **Match compensation with value:** A market's compensation to suppliers that perform well should align with the value consumers place on reliable service when supplies are tight. This provides economically sound incentives for investments that ensure reliability.
- **Use resource-neutral market rules:** All suppliers, regardless of technology, should be compensated similarly for similar performance.

FCM Sloped Demand Curve

The Forward Capacity Auctions have always procured a fixed quantity of capacity regardless of the auction clearing price. In contrast, capacity auctions in other regions use a downward-sloping demand curve for new capacity, in which the total quantity procured depends on the clearing price.

Introducing a downward-sloping demand curve into New England's FCA has the potential to reduce price volatility over time, yielding smaller swings in capacity prices when the market moves from conditions of excess supply to periods when new capacity resources are needed, which may occur as aging plants retire. (See pages 14–15.) Adding a demand curve will also allow the removal of other administrative pricing triggers that have proven difficult to implement.

Possible demand curves that can produce these less volatile clearing prices while continuing to meet long-term reliability goals are under evaluation. The ISO will be moving quickly in 2014 to discuss a proposed demand curve with stakeholders.

Other FCM Enhancements

Several other refinements are under consideration for the Forward Capacity Market and its Forward Capacity Auction that do not relate directly to the Strategic Planning Initiative. Learn more about them in the *2014 Wholesale Markets Project Plan* available at www.iso-ne.com.

SPI Key

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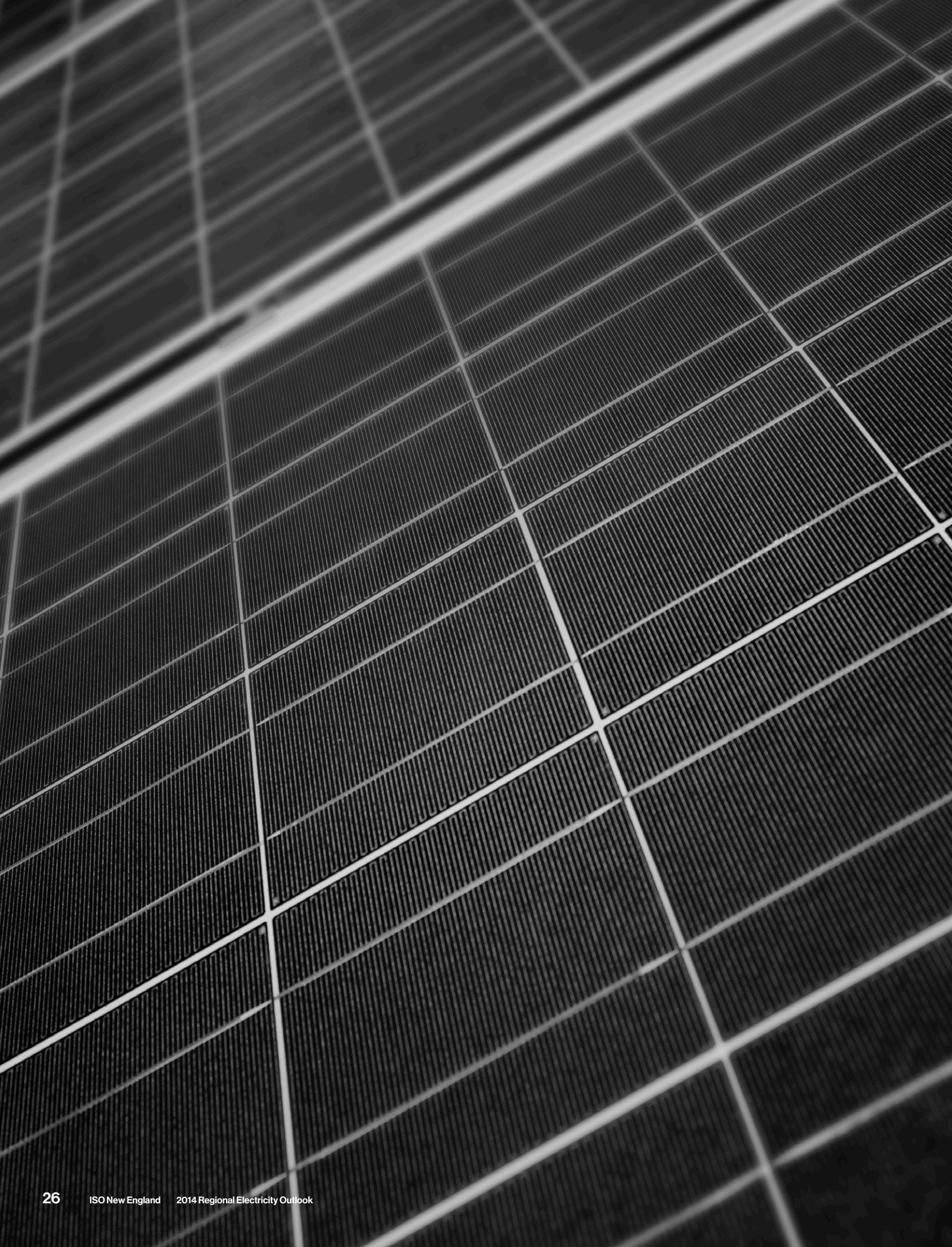


Energy Policies Drive Change

Numerous ISO efforts are underway to accommodate the wide-ranging effects of state energy initiatives.

A Balancing Act

Long-term analysis and planning of the power system is one of ISO New England's primary responsibilities to ensure reliability. The ISO coordinates its planning activities with all stakeholders, including the six New England states, and provides state leaders with data and analyses that facilitate informed decision making. While each state has a unique set of objectives and goals, actions across the region are advancing energy efficiency, developing renewable resources, and reducing pollutants from power plants.

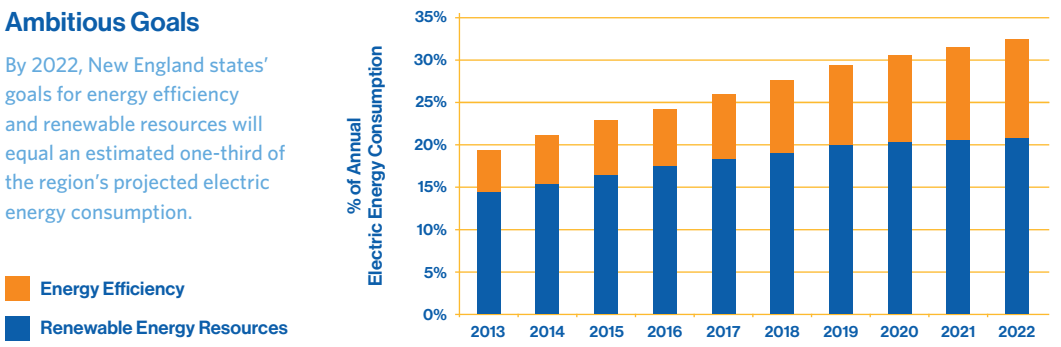
These energy policies have had a major impact on the region, easily seen in the increasing number of solar arrays and wind turbines dotting the landscape. Not as visible are the effects on the power system's reserve, regulation, ramping, and capacity needs—effects that will be magnified as these resources assume a larger percentage of the region's generation. Because the ISO stays fuel and technology neutral, it can balance state policy objectives with federal standards and requirements as it works to adjust market rules, operations, and system planning to accommodate the complex operating characteristics and needs of these variable resources. "Fuel neutrality" means that the ISO lets the lowest-priced offers of wholesale electricity (regardless of the fuel type) determine which power resources are called on to run. This helps keep New England's wholesale electricity markets open, fair, and competitive.

The Governors' Regional Initiative

Recognizing the collective desire for "affordable, clean, and reliable energy," the six New England governors jointly launched the Regional Energy Infrastructure Initiative in late 2013. It calls for developing a regional plan for strategic and cooperative investments in energy efficiency, new and existing renewable generation, natural gas pipelines, and electricity transmission. The ISO will serve as a resource in the plan's development through its collaboration with the New England States Committee on Electricity (NESCOE).

Ambitious Goals

By 2022, New England states' goals for energy efficiency and renewable resources will equal an estimated one-third of the region's projected electric energy consumption.



"Behind-the-Meter" Challenges

The ISO is working with stakeholders to address reliability issues like these that affect photovoltaic integration:

Data gaps—Most PV resources aren't interconnected to the regional power grid, so their output isn't visible to ISO system operations. Yet knowing a generator's real-time output and availability is crucial for dispatch and planning.

Inconsistent interconnection requirements—State regulations for PVs typically don't require the ability to withstand system disturbances (such as the loss of a transmission line) without tripping, unlike federal requirements for other generators. If a disturbance led to many PVs tripping off line at once, it could create a sudden surge of demand that the system may not be able to handle.

The Rise of Solar Energy

State-sponsored programs, federal subsidies and tax credits, and the ease of siting have all propelled solar photovoltaic resources (PVs) to one of the fastest growing types of generation in the region. These solar facilities can offset the electricity customers pull from the grid—but they can also create challenges for reliable grid operation. Like wind turbines, PVs are a variable resource: output varies with time of day, cloud cover, haze, temperature, and wind speeds. An added challenge is that PVs aren't typically connected to the high-voltage transmission system that the ISO manages—many are located "behind-the-meter" or connected directly to a home or business.

Current PV capacity in New England is small, but given the mounting volume and pace of development (see page 17), the ISO has accelerated its efforts to prepare for the impacts. For example, to improve how PVs are counted in long-term system planning, the ISO and stakeholders launched the Distributed Generation Forecast Working Group (DGFWG) in fall 2013 to develop a 10-year forecast of the growth of PVs and other DG resources in New England.

See pages 34–35 for more about the technological innovations the ISO is pursuing to create a more efficient, responsive, reliable system that can handle expanded renewable generation.

Wind Generation Continues to Expand

The ISO has already facilitated the integration of over 700 MW of wind power, and many more wind projects are expected, spurred by state and federal programs. Major efforts to prepare the grid and markets have been underway for some time. Some of these efforts may help with concerns about curtailment (being asked to reduce output), for example.

With their low fuel costs, wind resources typically offer low prices in the energy markets and therefore are almost always chosen to run. But they can be at higher risk of curtailment when sections of the transmission system are at risk of overload or at times when excess energy is being supplied to the power system (for example, at night when demand is low). Here's why:

- When these conditions occur, the ISO first curtails resources without a day-ahead commitment to operate. Most wind resources do not participate in the Day-Ahead Energy Market because of the uncertainty of how much wind will be available the following day.
- Additionally, most commercial wind farms in New England are built in remote areas where the transmission system wasn't designed to carry large amounts of power. Because transmission overloads could occur if all generators were to operate simultaneously in these areas, the ISO sometimes has to curtail generation there to maintain system stability.

The ISO has been working with resource owners to help them understand these issues and is offering its new wind power forecast to give wind resources the information needed to more effectively participate in the Day-Ahead Energy Market. Upcoming market rule changes to allow negative pricing will also help resources of all types signal how much they value running versus being curtailed. Along with these and other market and operational changes (see pages 18–25), the ISO and the Planning Advisory Committee are also discussing initial concepts for transmission build-out plans to better accommodate remote wind resources.

Hydro Power Ebbs and Flows

Unlike wind, solar, and other renewable energy sources, hydro power has long played a significant role in New England, and the region may soon be seeing more hydro-backed electricity as the result of state and federal actions:

- In June 2013, five New England states announced a regional initiative to explore expanded imports of large amounts of Canadian hydro power into the region to help limit carbon emissions and reduce electricity costs.
- The federal *Hydropower Regulatory Efficiency Act of 2013* could facilitate more hydro development in the region, as could state actions like Connecticut's restructured Renewable Portfolio Standards (RPS), which expand support for small hydropower facilities.

Conversely, the ISO is also closely monitoring another issue that could *reduce* the role of New England's existing hydroelectric generators: almost 2,000 MW will be undergoing FERC relicensing over the next 4–8 years. While many hydro units have been well suited to providing system regulation and reserves due to their flexible operational nature (unlike wind and solar resources), they could lose some of this flexibility as part of state and federal environmental considerations.

Collaboration on Grid Modernization

State incentives for the development of microgrids, as well as other efforts to modernize the grid and pricing, are expected to further increase operational complexity. These include:

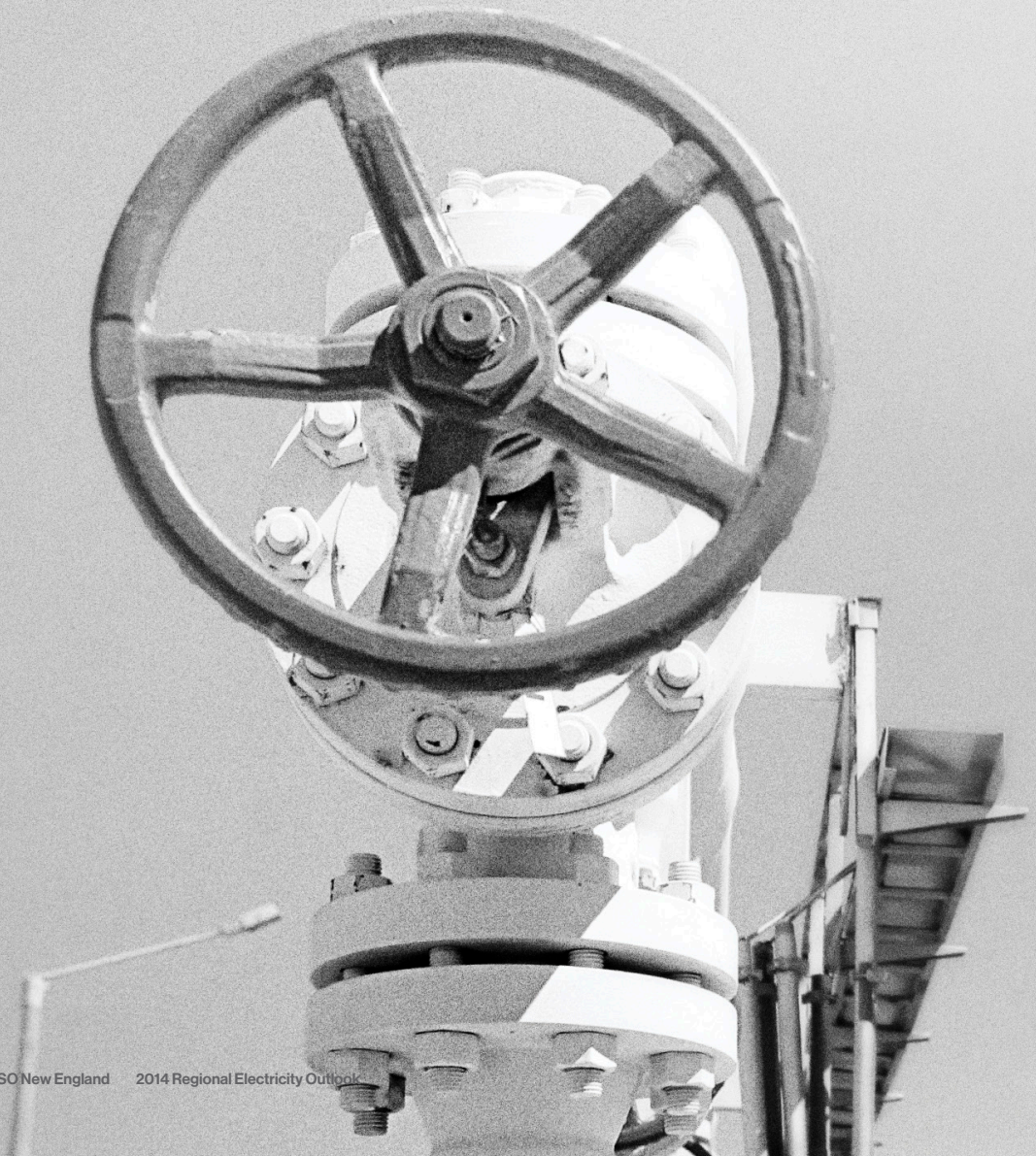
- *State-funded microgrid pilot programs* to help communities maintain critical services during major storms
- *Dynamic retail pricing initiatives* that would allow customers to see and respond to wholesale electricity prices. Most New England customers pay fixed retail prices that are insulated from the actual price of electricity in the wholesale electricity market.

The ISO serves as a resource to ensure that state proposals help to improve the functionality between wholesale and retail markets and don't create barriers to, or otherwise impede, competitive markets. Read more about the ISO's work on smart grid and other technologies on pages 34–35.

State Pipeline Solutions

In 2013, New England had the highest natural gas prices in the country, primarily because of insufficient pipeline capacity. The amount of relatively inexpensive Marcellus Shale gas currently being transported into New England isn't meeting the cumulative demand from residential and commercial gas customers *and* gas-fired electricity generators. Because of the relatively low price of natural gas compared with oil, the local distribution companies (LDCs) that distribute gas have been connecting and serving more and more residential and commercial customers. This leaves the LDCs with less spare transportation capacity to release to the market for purchase by gas-fired generators, which typically don't contract for long-term, firm gas transportation capacity. These generators are left competing for a small share of gas transportation. The result: higher prices when the gas pipelines are constrained. This situation is exacerbated by the current high price of stored liquefied natural gas (LNG) used to meet spikes in demand. (LNG tends to be four to five times more expensive than the typical price of gas sourced from the Marcellus Shale.)

New England only benefits from the low price of shale gas if it can be moved into the region—and that will take more pipeline capacity. While the ISO's improved electric/gas coordination (see page 21) and



other market design changes (see pages 18–25) will help improve electric system reliability, they won't necessarily encourage the long-term contracts that traditionally spur pipeline construction. New England's state regulatory bodies are keenly aware of the situation and are discussing infrastructure solutions, such as Maine's innovative public program to contract for pipeline capacity. In late 2013, New England's six governors also made pipeline issues a collective priority for the region when they launched the Regional Energy Infrastructure Initiative, which includes among its goals strategic and cooperative investments in natural gas pipeline. (See page 27.) The ISO offers its data and analysis in support of state-led efforts.

LNG: Global Factors, Local Effects

When the Marcellus Shale came into production a few years ago, domestic natural gas prices declined. With high demand and higher prices for natural gas overseas, much of the world's liquefied natural gas supply is being shipped to and sold in non-US gas markets. This has reduced available supplies in New England and made LNG more expensive here. The result is that less supply is available to meet growing demand and prices are more volatile when the pipelines are constrained. LNG prices in New England can even exceed global prices on days when LNG facilities cannot keep up with regional demand.

ISO-Metrics

Measuring ISO New England's performance and contribution to the region

Accountability and Transparency

Open, fair, and independent actions are the defining characteristics of ISO New England's operation. To ensure the highest levels of transparency, industry stakeholders are an integral part of the ISO's budget and business planning processes, regional system planning, and market development. They also have regular access to ISO staff and directors, take part in the nomination of the ISO Board, and participate in dozens of committees and working groups. For example:

- In 2013, the ISO held over 80 meetings of the Markets, Reliability, Transmission, and NEPOOL Participants Committees.
- The ISO held 15 Planning Advisory Committee meetings in 2013, which stakeholder representatives from over 100 entities attended.
- The ISO held a public meeting in September 2013 to discuss planning issues facing the New England region.
- The Consumer Liaison Group meets quarterly to share information about the economic impacts of New England's power system and wholesale electricity markets on consumers.
- The Information Requests Group, an ad-hoc forum for stakeholders, also meets periodically to provide input to the ISO on prioritizing requests it receives for providing new or enhanced market and power-system information to the wholesale electricity marketplace.
- In 2013, the ISO launched the Distributed Generation Forecast Working Group, a regional forum for interested parties to provide input to the ISO on a new long-term distributed generation forecast.
- ISO Customer Support fields over 10,000 inquiries from stakeholders annually over the phone and online.
- Annually, about 1,000 stakeholders attend ISO classroom or web-conference trainings.

A Wide-Ranging Group

The ISO's stakeholders include:

- The New England Power Pool (NEPOOL), the voluntary association of the participants in New England's wholesale electricity marketplace
- State regulators, including those who form the New England Conference of Public Utilities Commissioners (NECPUC)
- State and federal legislators, attorneys general, and environmental regulators
- The six governors, including the New England States Committee on Electricity (NESCOE)
- The Consumer Liaison Group, a forum of electricity consumers and consumer advocates

This type of collaboration and teamwork has been the critical factor driving the region's success in developing power system infrastructure and a competitive suite of wholesale electricity markets.

Results on a Budget

The ISO is a nonprofit entity without equity; as such, it relies on collections under its tariff to fund its operational expenses. Each year, ISO management and the ISO Board develop the company's business plan and budget through an open process inclusive of all stakeholders so that the ISO can accurately align its work plan with regional priorities, and so that all industry stakeholders have a clear understanding of the company's goals and objectives. For example, in 2013, the ISO met with stakeholders on a number of occasions to review the budget and get stakeholders' feedback. The ISO's proposed budget was then formalized with input from NECPUC and other state agencies, such as the states' consumer advocates. NEPOOL also reviewed the budget and held an advisory vote. After the ISO Board voted on the final proposed budget, it was filed for approval with the Federal Energy Regulatory Commission.

$0.86 a month

The services and benefits the ISO provides will cost the average New England electricity consumer $0.86 per month in 2014, compared with $0.83 per month in 2013.

The company's total operating budget for 2014 is $169.3 million—a 3.2% increase over 2013. (These figures do not include the "true-up" for actual versus budgeted collections in 2012.) The ISO offset $6.2 million in increased costs for 2014 with savings, automation, and efficiencies, and $1.8 million with reduced pension plan costs. The 3.2% rise recognizes increased costs involved in maintaining current operations, as well as the measured growth needed to fulfill the ISO's obligations to implement the Energy Market Offer Flexibility changes (see page 20) and FERC Order 1000 (see page 34); to respond to stakeholder requests for more impact analyses; and to address increased cybersecurity risks. For more information, see the ISO's financial statements available at www.iso-ne.com.

Customer Satisfaction

Stakeholder feedback is a helpful indicator of the quality of the products and services the ISO offers, as well as areas that need improvement. Each year, the ISO asks market participants to rate their overall satisfaction. The latest survey (2013) revealed high overall satisfaction levels. If the percentage of respondents with no opinion is eliminated from the calculation, the net positive satisfaction with ISO New England is 93%.

Achieving Compliance

Standards

ISO New England takes pride in fulfilling its responsibilities to the highest standards. The ISO's teams dedicate themselves to the safe, reliable operation of the grid through extensive training and continuous process improvement to ensure the ISO achieves compliance with FERC, North American Electric Reliability Corporation (NERC), and Northeast Power Coordinating Council (NPCC) directives. These standards are not only mandatory, they carry civil penalties for failure to perform.

At the ISO's last NPCC compliance audit in March 2012, the audit team evaluated ISO New England for compliance with 32 standards from the 2012 NERC Compliance Monitoring and Enforcement Program, plus other NERC and regional reliability standards. NPCC reported the ISO complied with all applicable standards and identified zero violations or areas of concern.

Orders

Major efforts continue at the ISO to comply with these FERC orders:

- FERC Order 1000, *Transmission Planning and Cost Allocation*, requires fundamental changes to the transmission planning process as it has been conducted in New England since 2001. These changes have an impact on the transmission owners' right to build and the process for developing transmission projects. The order also requires planning to meet public policy objectives. The ISO worked with stakeholders through the NEPOOL process to comply with Order 1000 regional requirements in 2013. The ISO will be working on preparations for implementation throughout 2014 and likely into 2015.
- Order 755, *Frequency Regulation Compensation in Organized Wholesale Power Markets*, required several changes to the design of the ISO's Regulation Market, as well as extensive and sophisticated software modifications. These modifications include the creation of a new type of resource (i.e., regulation-only assets), the introduction of a new auction design, and the need to work with a third-party vendor. These changes are expected to be implemented in mid-2014.

  Regulation refers to the continuous process of minor corrections to system supply or output every four to five seconds to balance small demand and supply variations on the power system and ensure that the system frequency is maintained within specified limits.
- Order 745, *Demand-Response Compensation in Organized Wholesale Energy Markets*, set into motion a major business and information-technology project to develop and implement the market rules needed to enable the full integration of demand resources into the energy markets, and to allow for the extensive software changes required to both the market and system operations infrastructure. The full integration of demand resources is planned for the capacity commitment period that begins June 1, 2017.

  Demand-side resources reduce their own electricity use (demand) and contribute to the diversity and flexibility of resources on the grid. They help defer the need to build expensive power system infrastructure to support infrequent system peaks, decrease reliance on expensive fuels, balance variable resources, and reduce New England's "out-of-market" costs by eliminating the need to start up additional power plants on peak days.

Backup Control Center

In late 2013, the ISO completed a key project: construction of a new Backup Control Center (BCC), which will be operational in early 2014. The new BCC's size and closer location to ISO headquarters will allow for full activation and staffing by critical ISO staff very quickly following a required evacuation of the Master Control Center. This will ensure continuous reliable operation of all critical functions, including operations, markets, and settlements—capabilities comparable to the BCCs of other ISOs and RTOs. The new BCC will satisfy NERC and FERC requirements that specify a BCC should resume operations within two hours and be capable of prolonged operation in compliance with all reliability standards. Plans for the facility were developed through analysis and discussion with the ISO Board, the NEPOOL Budget and Finance Subcommittee, and other stakeholders. The current estimated full project cost is approximately $38.9 million, including costs for the land and construction, data center transition costs, incremental costs, and moving costs.

Technology and Innovation

ISO New England is actively pursuing innovations to help create a more efficient, responsive, reliable system that can handle expanded renewable generation and smart grid technology.

Some examples:

- The ISO is participating in a National Renewable Energy Laboratory study examining possible reliability and operational concerns associated with integration of photovoltaic resources.
- In partnership with the IBM Thomas J. Watson Research Center, the ISO is contributing to Watt-Sun, a project to improve solar forecasting.
- Teaming up with scientists from the Lawrence Livermore National Laboratory (LLNL), the ISO is helping to study how high-performance computing can be used to model and simulate a new robust unit commitment (UC) solution for dispatching generators, especially as more variable generation from renewable energy units comes on line. For every new UC configuration, 1,000 dispatch problems must be answered, requiring 20,800 hours on a desktop computer. Using high-speed computing and customized code, the team reduced needed calculation times to only 9.5 hours. The team also produced a sophisticated statistical wind generation model for use with future studies on the random behavior of wind.
- The ISO is participating in the development of the national smart grid interoperability standards, led by the National Institute of Standards and Technology (NIST), to establish protocols that provide common interfaces for smart grid equipment. ISO staff are also active in the Institute of Electrical and Electronics Engineers (IEEE), a professional society that helps develop standards for the interconnection and operation of smart grid technologies.
- Related to smart grid development, the installation of 40 phasor measurement units (PMUs or synchrophasors) and associated computer systems for collecting and analyzing data was completed in 2013. The PMUs sample power conditions about 30 times per second. This project has already yielded immediate benefits for New England by enabling new monitoring of system dynamics, as well as fast and accurate post-event analysis, and validation of improved power system models.
- The region is a leader in the smart grid application of high-voltage direct-current (HVDC) facilities and flexible alternating-current transmission systems (FACTS), which improve the use of system infrastructure.
- In partnership with other ISOs/RTOs, ISO New England is providing technical and other support for the development of demand-response-related standards by NIST and the North American Energy Standards Board (NAESB).
- To satisfy an increasing number of required transmission plan studies, the ISO is exploring an innovative use of cloud computing to enhance its ability to use more detailed and sophisticated system models and scenarios, and to do so faster and at a cost savings.

Smart Grid Technology Can Benefit the Region

Grid modernization will help:

- Provide New Englanders with the information, price structures, technologies, incentives, and tools that can empower them to use electricity more efficiently and reduce their individual energy costs
- Improve the operational efficiency of the grid, particularly during peak times when the grid is most stressed and electricity is most expensive
- Reduce transmission and distribution system operation, maintenance, and construction costs by reducing electricity demands at times of system peaks
- Reduce regional wholesale and retail electricity costs by reducing electricity demand at times of system peaks

Keeping Stakeholders Informed 24/7

The ISO is continually looking for new and better ways to share information with stakeholders.

ISO Express

ISO Express, the ISO's data portal, provides stakeholders with convenient, customizable access to grid conditions and wholesale electricity market information, including real-time data, detailed historical report generation, and web-based notifications of changing system conditions. Customer feedback drives development of the site, and the ISO has continued to make enhancements to provide users with greater functionality.

ISO to Go

The ISO offers a free mobile application for smartphones. The app helps educate New England's electricity users about the power grid and wholesale electricity markets and provides stakeholders with up-to-date system conditions and real-time information on the region's wholesale electricity prices.

ISO Newswire and ISO Tweets

Through a regularly updated news blog and Twitter account, the ISO helps stakeholders stay on top of developments at the ISO and in the wholesale electricity industry.

Increasing Competition for Electric Industry Professionals

Running the power grid requires highly skilled professionals—as do the ISO's other responsibilities for market operations and system planning. The ISO must compete against grid operators across the US—and world—to attract and retain a highly skilled, innovative workforce that can handle New England's ever-evolving and increasingly complex power system. The US is currently not producing enough power system engineers to meet demand, for example.

Improving Our Customers' Experience

An Easier Way to Submit NX-9 and NX-12D Data

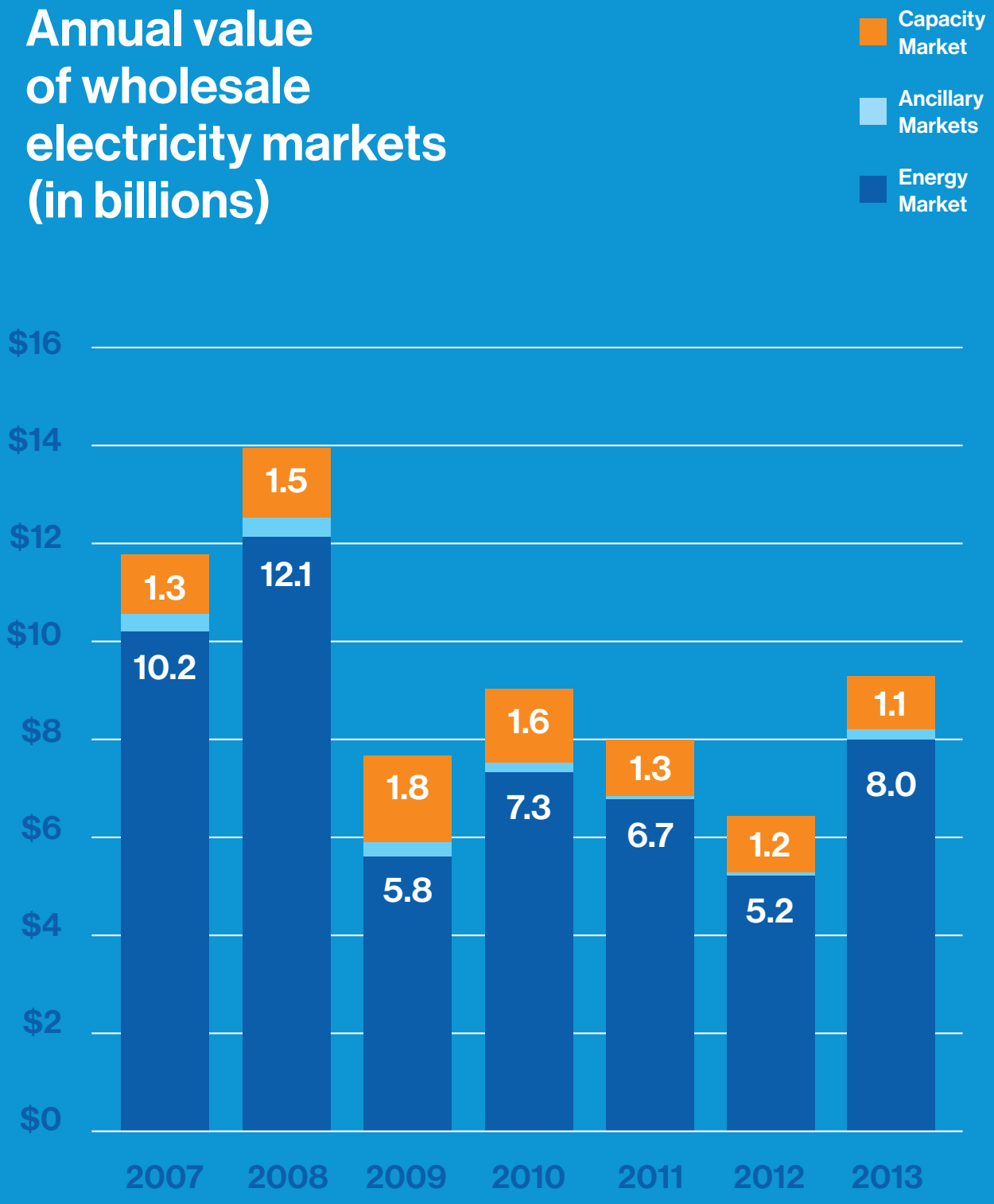
In late 2013, the ISO launched a new web-based application for quicker and more accurate entering and managing of NX-9 and NX-12D data (the physical characteristics, ratings, reactive output capability, and operational data of transmission system equipment collected by the ISO for use in operating the power system). Market participants now have a single location for data entry, real-time access to data, enhanced searching ability, and new tools for reviewing and analyzing data.

A Redesigned Website and Data Portal

The ISO will launch a redesigned website in 2014. With a reorganized site structure, more efficient navigation, and a new content management system, the redesigned website will help stakeholders more easily and quickly access the wide variety of data, information, and other tools the ISO makes available to market participants and other stakeholders.

The ISO's financial statements and other metric reports are available online at www.iso-ne.com.

Annual value of wholesale electricity markets (in billions)



Results at a Glance

The combined functions of competitive electricity markets, centralized system operations, and a dynamic and transparent regional planning process yield a regional power system that is more reliable, cost-effective, and environmentally sound.

Wholesale Electricity Costs

New England's wholesale electricity markets continue to produce competitive prices that accurately reflect suppliers' costs of delivering power to the grid to meet consumer demand.

- In 2012, natural gas prices reached a 10-year low, and wholesale energy market prices were the lowest they had been since the introduction of the current markets in 2003.
- In 2013, the region spent 54% more in the energy markets (see the chart on page 38), mirroring higher natural gas prices. Natural gas prices in New England in 2013 were the highest in the country. Higher demand for natural gas in the region, combined with pipeline constraints and the increased global price for liquefied natural gas, drove up the price of fuel; at times, more expensive generators had to be called on to meet demand when gas-fired power plants were unable to perform.

Supply

Close to 15,000 MW of new, efficient, low-carbon-emitting supply have been added to the power system since 1997 when the ISO began operations, with approximately 5,000 MW proposed. Because private firms make this investment and not public utilities, consumers are shielded from the investment risks they had been exposed to before the introduction of competitive markets.

Demand-Side Resources

Demand resources, such as load management, distributed generation, and energy-efficiency projects, have increased from 100 MW in 2003 to 1,850 MW in 2013. This translates into thousands of individual demand assets integrated into the power system. Over 2,500 MW of demand resources are expected to be available by 2016. EE programs are playing a notable role in this expansion, and the ISO's efforts to analyze the long-term impacts are ongoing.

- Annual New England state investments in EE programs are projected to grow from $500–600 million to approximately $800 million.
- The amount of EE performing as demand resources in the Forward Capacity Market is increasing at roughly 200 MW per year.

- The ISO's EE forecast, the nation's first multistate long-term EE forecast, projects a regional annual average energy savings of 1,358 gigawatt-hours (GWh) in the period of 2016 to 2022.
- While the region's energy consumption is projected to grow an average of 1.1% annually through 2022, when the energy-saving effects of EE are included, the forecast shows essentially no growth.

Environment

From 2001 to 2012, average emission rates for nitrogen oxides (NO_X), sulfur dioxide (SO_2), and carbon dioxide (CO_2) declined by 67%, 92%, and 23%, respectively. This mainly can be attributed to the decline in the region's oil- and coal-fired electricity production, and the implementation of emission controls on some of those plants.

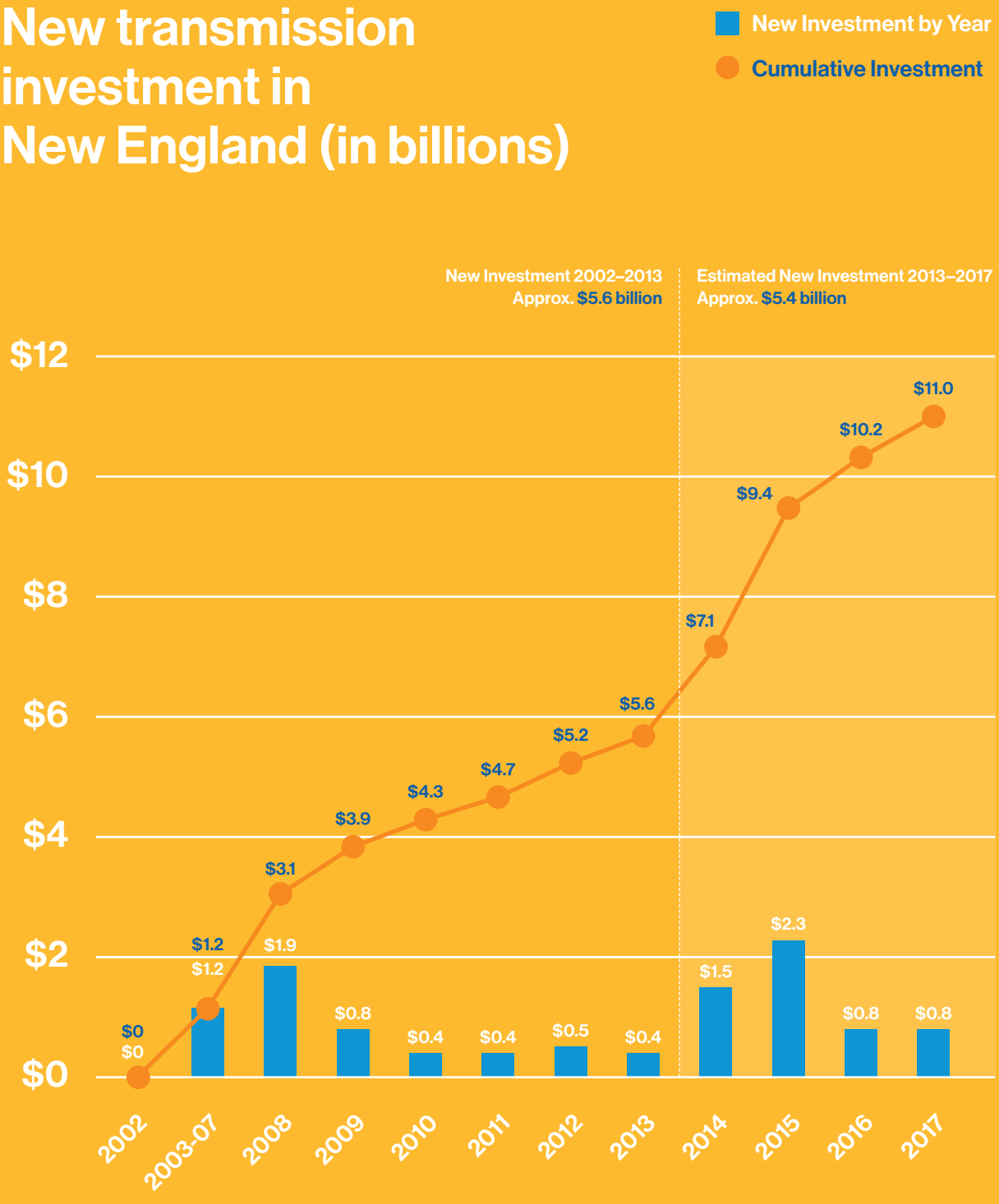
Preliminary data indicates that total emissions continued to decline in New England between 2012 and 2013. However, emissions (particularly carbon dioxide) from coal- and residual oil-fired generators rose significantly in 2013. This was attributable to greater production from these types of generators due in part to transmission constraints; generator outages; and natural gas supply problems over the winter. For the latest information, see the ISO's annual analysis of emission rates from New England's generating fleet, *ISO New England Electric Generator Air Emissions Report*, available at www.iso-ne.com.

Transmission

Since 2002, close to 500 transmission upgrades totaling about $5.6 billion have been put in service across New England, virtually eliminating congestion on the system. Based on the needs described in the ISO's *Regional System Plan*, New England's transmission owners initiated projects reinforcing transmission-serving areas that have experienced significant load growth, such as northwestern Vermont. Projects have also been initiated in critical load pockets, such as Southwest Connecticut and Boston, allowing the import of power from other parts of the system. New interconnections with neighboring power systems also have been placed in service. Approximately $5.4 billion in transmission investment is planned over the next four years to meet reliability requirements, improve the economic performance of the system, and position the region to integrate renewable resources and alternative technologies.

In its efforts to better align the transmission planning process and wholesale markets, the ISO has begun evaluating market resource alternatives (MRAs) to transmission upgrades. In 2011, the ISO completed a pilot project analyzing the Vermont and New Hampshire area. In 2012, the ISO performed an MRA study of the Greater Hartford and Central Connecticut area. The ISO is now working on streamlining MRA analysis and developing more meaningful ways to share study results with stakeholders, and aims to launch improved MRA analysis in 2014.

New transmission investment in New England (in billions)



Note: Numbers rounded; includes in-service, under-construction, planned, and proposed projects

Source: ISO New England Transmission Project List, October 2013

Key Facts

- **6.5 million** households and businesses; population **14 million**
- About **350 generators**
- Approximately **32,000 MW** of generating capacity
- About **2,000 MW** of demand resources
- Over **8,000 miles** of high-voltage transmission lines
- **13 interconnections** to power systems in New York and Canada

- Approximately **$5.6 billion** in transmission investment 2002–2013; approximately **$5.4 billion** planned 2013–2017

- All-time peak demand of **28,130 MW** set on August 2, 2006

- **$9.2 billion** traded in wholesale electricity markets in 2013 (**$8 billion** in energy markets; **$1.2 billion** in capacity and ancillary services markets)

- More than **500** buyers and sellers in the markets

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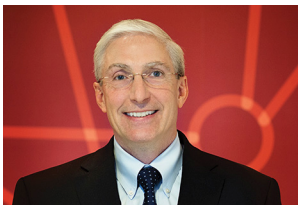

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