ISO New England

2013 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 independent, not-for-profit corporation responsible for overseeing the day-to-day reliable operation of New England's power generation and transmission system; designing, administering, and monitoring the region's competitive wholesale electricity markets; and managing comprehensive regional power system planning. The company's workforce of power system engineers, economists, computer scientists, and other professionals fulfill these three critical responsibilities that together ensure New England has reliable, competitively priced electricity today and into the future.

ISO New England's board of directors and 550 employees have no financial interest in any company doing business in the region's wholesale electricity marketplace. ISO New England serves the six-state region of Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont and is regulated by the Federal Energy Regulatory Commission (FERC).


+3 MW/min

From the Chairman

In 1997, ISO New England was established to help bring new efficiencies to the way the region produces, buys, sells, and transports electricity. The task set out before us was equal in both scope and complexity. Now with 15 years of operation under our belt, we can clearly see the signs of progress: New England's power grid is more resilient than ever before. Competitive wholesale electricity markets have attracted over 500 buyers and sellers and encouraged the development of cutting-edge, lower-cost resources and technological advancements. Thanks to the hard work of many, we have enhanced grid operations and regional planning to solve a number of reliability issues.

Over 14,000 megawatts (MW) of new power plant projects have been interconnected to the grid since ISO New England began operations. That's an average of almost 1,000 MW per year—the equivalent of a power plant large enough to provide electricity to 800,000 homes. More than 2,000 MW of demand resources are available to reduce demand and bolster the grid's reliability. And $5 billion in private transmission investment has been made, reenergizing New England's high-voltage infrastructure and nearly eliminating congestion and its associated costs. The combined effect of these improvements, along with low natural gas prices, have created substantial savings for the region, helping reduce the value of the wholesale electric energy markets by over 40% in four years—from $12 billion in 2008 to approximately $5 billion in 2012.

New England's progress also can be measured in environmental gains. Over the past decade, the region's power system has successfully reduced air emissions by up to 60%. This achievement is made all the more impressive by the fact that the total system generation increased by 11% for the same period. As economics, government policy, and technology shape New England's stance on environmental issues, ISO New England's role is to oversee a competitive marketplace that enables these forces to bring about significant, positive change.

Looking back on the milestones New England has achieved in 15 years, it is truly impressive to see the effects of collaboration on a regional scale. The framework we've built together will enable New England to develop new strategies to meet our electricity needs in the most efficient way possible. Working with state and federal policymakers and industry stakeholders, the ISO continues to move forward on many initiatives to prepare and plan for the integration of new types of resources and engineering advancements and to continuously improve the wholesale electricity markets, operations, and planning processes.

As always, we strive to complete our projects in priority order and meet our extensive day-to-day responsibilities while ensuring that business operations are well-managed, fiscally responsible, and responsive to New England's electricity stakeholders. I thank you for your support, your insights, and your contributions to the evolution of New England's power system.

Sincerely,

David Vitale
Chairman of the Board

From the CEO

Risk is not a welcome factor in any organization, let alone one charged with ensuring a reliable supply of electricity to 6.5 million homes and businesses. The electricity that keeps hospitals operating and traffic signals lit isn't optional after all, it's a necessity. That fact, however, doesn't make us immune to risk.

In reality, as a power system operator, ISO New England tackles uncertainty every day—fluctuations in supply and demand because of weather or an unexpected outage of a power plant or transmission line can make it challenging for the ISO to balance the needs of the power system. Our control room relies on the performance and flexibility of a wide variety of resources on the grid to navigate any event. By following rigorous procedures and establishing a fair, effective operating environment for resources, the ISO has been able to consistently keep the lights on in some of the toughest situations. Today, however, a unique convergence of economic and environmental factors is having a serious impact on the diversity, flexibility, and performance of the region's resource mix—risks that threaten the reliable supply of electricity for New England's homes, businesses, and public services.

In late 2010, the ISO launched a Strategic Planning Initiative to analyze, understand, and address these risks. Over the course of 18 months, we collaborated with New England states and market participants to identify the greatest threats to grid reliability as well as the changes needed to mitigate them.

We have found that the region's dependency on natural gas to fuel a large percentage of its generators is the most pressing concern. While low-cost natural gas from the Marcellus shale has been a boon to New England—resulting in billions of dollars of lower cost electricity—the transportation of this fuel through pipelines from the west into the region is frequently constrained, and the low cost of this fuel has reduced the more expensive imports of Canadian gas and liquefied natural gas. As a result, the region is highly dependent on an aging and relatively inflexible fleet of oil- and coal-fired generators to maintain reliability during peak demand periods or when the gas pipeline system is limited.

New England's oil- and coal-fired power plants are already facing significant financial stress from this confluence of market economics and stringent environmental standards. These pressures are forcing many owners of these assets to consider retiring them in the short to medium term. Furthermore, New England policymakers are seeking to increase the amount of renewable energy in the region, resulting in a clear need for a flexible and responsive companion resource base on the grid to provide electricity when the wind doesn't blow or the sun doesn't shine. We also have observed that as a general matter, overall resource performance isn't what we expect during power system contingencies, such as large generator or transmission line outages.

Because the ISO does not own the power plants or transmission lines, we cannot directly address the infrastructure and resource performance problems facing the region. However, we do have a responsibility to develop the market incentives and operating rules to address these concerns—courses of action that would ensure that these resources exist, are available, and run as our operators need to effectively manage the system.

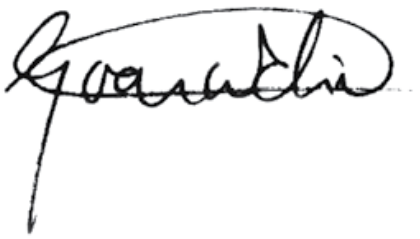
In the fall of 2012, the ISO and stakeholders shifted emphasis from collecting and analyzing information to designing solutions. Our comprehensive study and discussion of the issues at hand have led us to conclude that the region must continue to build on and enhance the wholesale electricity markets to create stronger financial incentives for generators and demand resources. These enhancements will work to ensure that the ISO has access to the resources it needs to operate the grid reliably and that the provision of these services is valued efficiently through a competitive marketplace.

This *Regional Electricity Outlook* provides an overview of the challenges and describes immediate-, short-, and long-term solutions underway or under consideration through our stakeholder process. The proposals being developed are driving ISO New England's business plan for each of its areas of responsibility: designing and administering the wholesale electricity markets, operating the grid, and planning the power system. Documents that provide a more technical, in-depth explanation of the issues and strategies are available at www.iso-ne.com/spi.

It is clear that resolving these challenges will not be simple, and it will take several years to realize the benefits of the solutions. While immediate action by the ISO is necessary to preserve grid reliability, support also will be required across states, regions, and even industries—by federal and state regulators, generators, and natural gas pipeline owners/operators. We look forward to working with our stakeholders as part of this ongoing process. It is important to remember that, often, the best ideas are born out of necessity. Today the power system faces significant and formidable obstacles. But tomorrow, it will be smarter, stronger, and more environmentally sound because of our collective efforts.

Sincerely,

Gordon van Welie
Chief Executive Officer

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Built to Succeed

What is reliability?

In almost every piece of literature you read about the power grid, you will see reliability listed as Priority Number One. What does reliability mean for most of us? It is the fact that when we start the coffeemaker or turn on the television in the morning, the coffee will flow and banter between lively news anchors will fill the room. You can expect your morning routine to unfold with comfortable predictability in large part because the wholesale side of the power system is making sure that the right amount of electricity is always available to all corners of the grid.

Diversity, flexibility, performance

To balance electricity supply and demand every moment of the day, ISO New England system operators need a portfolio of resources across the grid that can offer a range of capabilities under a variety of conditions. This includes power plants that can run constantly to meet the required minimum amount of generation, resources that can start up quickly or dial back in response to changes in consumer demand or unexpected events, and generators that use a range of fuels should the region face a shortage in supply of, or access to, any one fuel source.

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 your day start and finish just as you planned. When a resource does not perform in accordance with its specifications or obligations, grid operators are forced to depart from efficient and reliable 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.

Strengthening our core

Over the past few years, ISO grid operators experienced numerous events during stressed system conditions when the performance and flexibility of power plants and demand resources were insufficient to correct these situations in a timely manner. This has led to growing concerns that as the power system continues to evolve, the mix of supply resources may be unable to operate when and as needed to maintain the grid's present level of reliability. These concerns arise from several different circumstances taking place in New England:

Challenge 1: Increasing reliance on natural gas as a fuel source for power plants and the potential for reduced operational performance during stressed system conditions

Challenge 2: The large number of aging, economically-challenged oil- and coal-fired generators that provide fuel diversity to the resource mix

Challenge 3: Greater future needs for flexible supply resources to balance variable, renewable resources that have operating characteristics markedly different from those of traditional generating resources

New England has made great strides to implement a thriving wholesale electricity marketplace, advanced grid operations, and successful regional planning processes. Today, the region's wholesale electric power industry has reached its next stage of maturity in which existing rules, processes, and systems need to be refined to improve resource performance and dispatch, better meet current and future operational needs, and shore up the long-term reliability of the system.

The following sections of the REO explore each of the three challenges in order of urgency, with Challenge One being the most immediate. It is important to note that the solutions presented are likely to adjust over time. Because New England's power grid is a tightly interconnected network, each resource addition, retirement, or change, can affect the makeup of the grid as a whole. Analyzing challenges and developing solutions must therefore be an ongoing, iterative process.

Transmission advancements

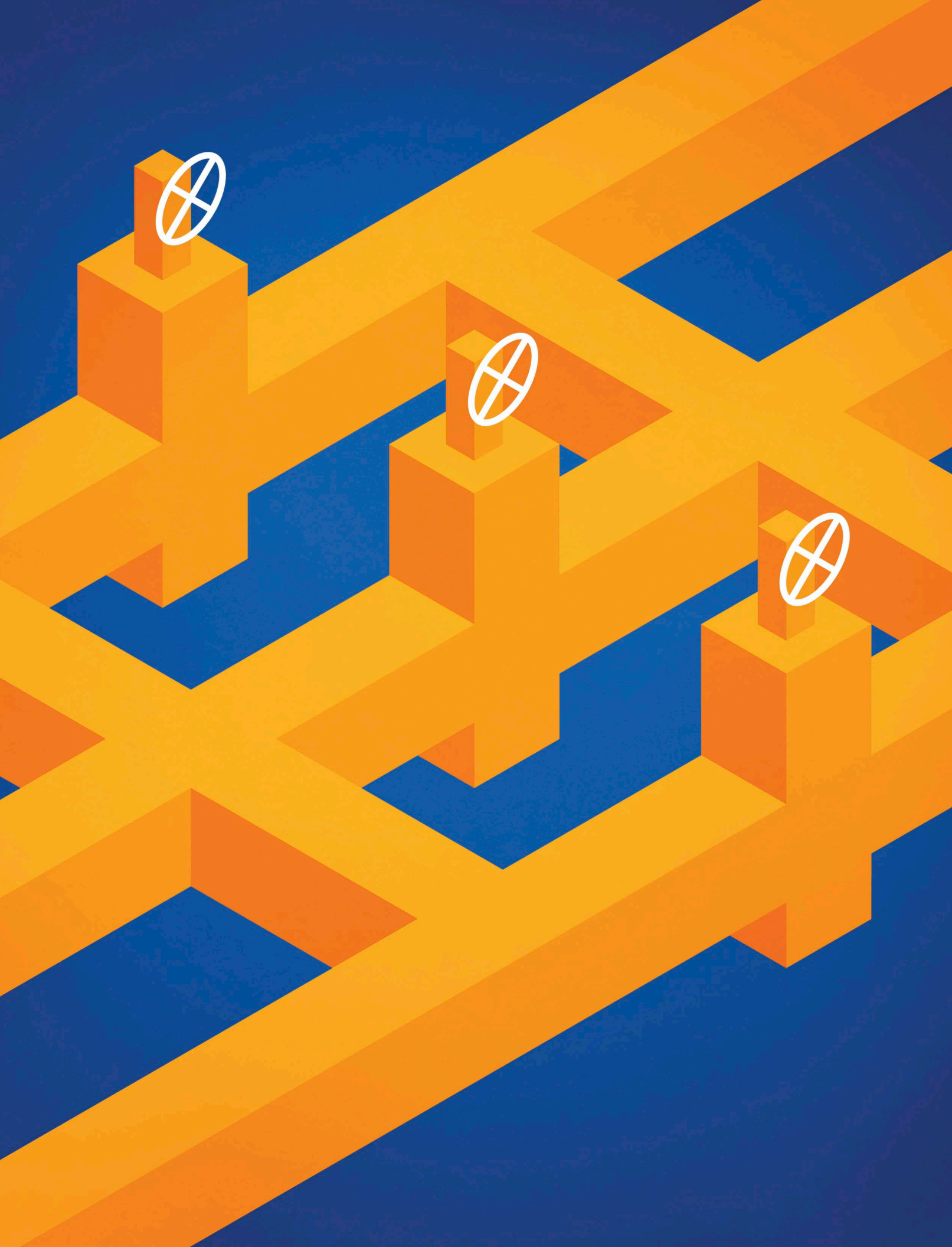
In addition to needing a diverse fleet of high-performing supply and demand resources, system operators also count on the ability to move wholesale electricity freely and efficiently within the region and with neighboring grids. A comprehensive, secure high-voltage infrastructure provides the foundation of reliability, accommodates the integration of new types of resources, and enables greater access to lower-cost power, therefore offsetting costs. Not long ago, insufficient transmission infrastructure was a high-priority concern for the region; however, nearly $5 billion in transmission investment has been made over the past decade as a result of the region's comprehensive system planning process—and another $5 billion is in development over the coming five years. This extensive expansion of the system gives the ISO the latitude and tools needed to better address the current strategic planning challenges.

Why efficiency matters

Efficiency is about minimizing the cost of producing and delivering electricity while maintaining the high level of reliability consumers require. Markets deliver efficiency by pricing wholesale electricity competitively, motivating suppliers to find the most cost-effective ways to produce it. Efficient, high-performing resources are more likely to be selected to generate electricity and to have the flexibility to meet changing power demand over the course of the day. In turn, markets hasten the retirement of resources that are inefficient, more costly, and less reliable.

Learn more about the grid, wholesale markets, and the challenges we face

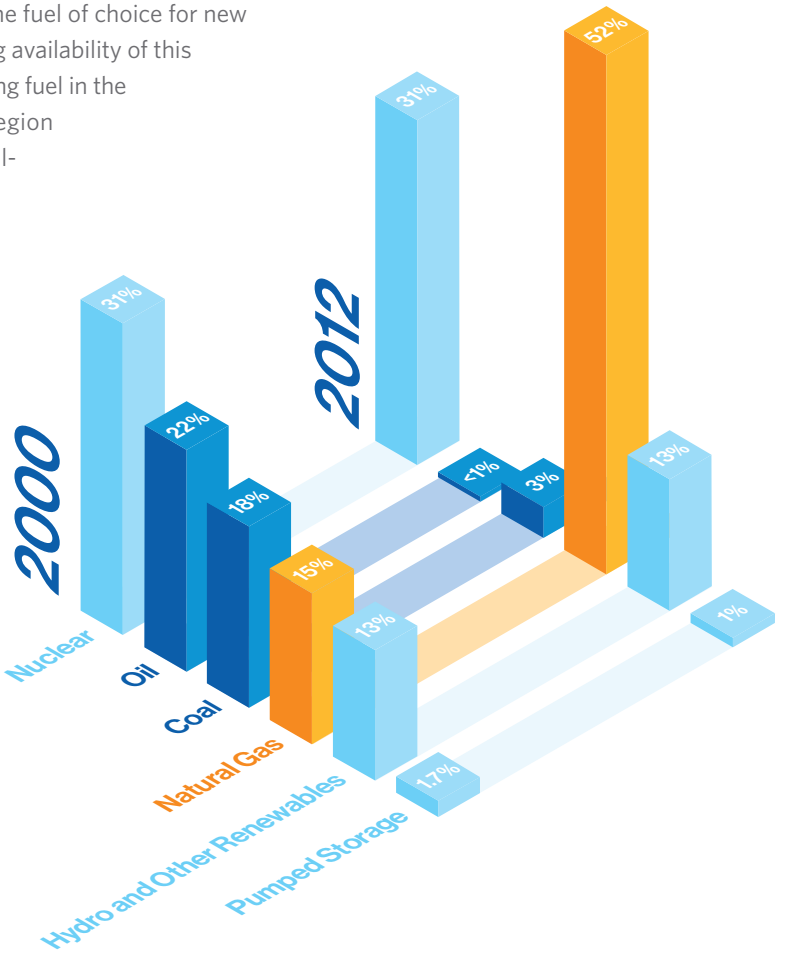
The *Regional Electricity Outlook*, together with the *Regional System Plan* and *Wholesale Markets Project Plan*, form a collection of documents designed to help provide stakeholders critical information about the current state of the grid, issues affecting the future of New England's power system, and the near- and long-term solutions designed to resolve them. All are available on ISO New England's website, www.iso-ne.com.



Challenge 1

Mitigating the risks of New England's dependence on natural gas

Natural gas has become the dominant fuel used to produce electricity in New England. Approximately 12,000 of the 14,000 MW of generating capacity built over the past 15 years are natural gas combined-cycle units, and gas continues to be the fuel of choice for new power plant construction. The growing availability of this relatively inexpensive and clean-burning fuel in the eastern part of the US benefits the region in many ways. The increase in natural-gas-fired generation has resulted in a significant decrease in both power plant emissions and the wholesale cost of electricity.



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.

Today, however, the lack of dependable fuel arrangements by generators, limited on-site fuel storage or alternate fuel arrangements, and increasing constraints on the pipeline system have hindered the performance of New England's natural gas generators, creating serious, immediate risks to grid reliability. In various instances, natural gas generators have not provided electric energy because they were unable to procure either the fuel or its transportation, or because they determined the price of gas was too expensive to purchase in real time. The ISO currently is managing these situations by using inefficient and more expensive oil- and coal-fired plants—yet these resources are also at risk (see Challenge Two).

The region's growing dependence on natural gas and its related issues have been a consistent concern during winter, when the priority for natural gas supplies goes to heating New England's homes and businesses. But as the use of natural gas has increased, this dependence has become a major challenge for managing the electric grid throughout the year. As older coal- and oil-fired plants retire and new gas-fired plants are built to replace them, it is likely the region will come to rely even more on this fuel. In addition, gas-fired plants can provide much of the flexibility needed to balance intermittent wind power resources, so it is expected that gas-fired resources will be needed on line as wind resources are built and interconnected (see Challenge Three).

The ISO is exploring with stakeholders improvements designed to ensure and create the incentives for the availability, performance, and flexibility of resources such as natural-gas-fired power plants. These improvements can be categorized as near-term changes that can be implemented quickly; intermediate-term changes that could be implemented in the next year or two; and longer-term changes that could be implemented over the course of the next three to five years. Each of the proposed changes is taken through comprehensive stakeholder and federal approval processes before being implemented.

Natural gas next door

New ways to extract natural gas have resulted in the recent influx of affordable gas from the Marcellus Formation. Even though this source is located on New England's doorstep, the region is still faced with a number of factors that affect the reliability of fuel supplies.

The pipelines delivering New England's natural gas have to supply a wide variety of customers, some of whom contract for priority delivery. Natural gas supply to power plants can be interrupted to serve these customers. At times, constraints on pipelines can jeopardize a power plant's ability to run. This can be due to physical limitations on the pipeline or pipeline maintenance.

Moving additional natural gas into New England will require investment in pipeline infrastructure. However, additional pipeline capacity is built only if customers commit to long-term contracts, and it is unclear who in the region, other than local gas distribution companies, would find such contracts economically attractive.

Current operations and near-term market fixes

Dispatching with Better Visibility, Flexibility

ISO New England has taken several immediate actions during 2012 and 2013 to help system operators better understand the performance limitations of gas-fired plants and more effectively accommodate these resources during system dispatch. These include:

- Monitoring generator fuel inventories closely and reinforcing dispatch obligations of all resources
- Proposing rules that would enhance the ability to audit the operating characteristics of power plants so control room operators have greater visibility into a resource's reserve capability
- Increasing the amount of reserve requirements for real-time system operation so more resources can be ready when called on during stressed system conditions
- Proposing to increase the amount of reserves acquired through the Forward Reserve Market to support the availability of resources to meet those increased real-time requirements

Enhancing Information and Coordination

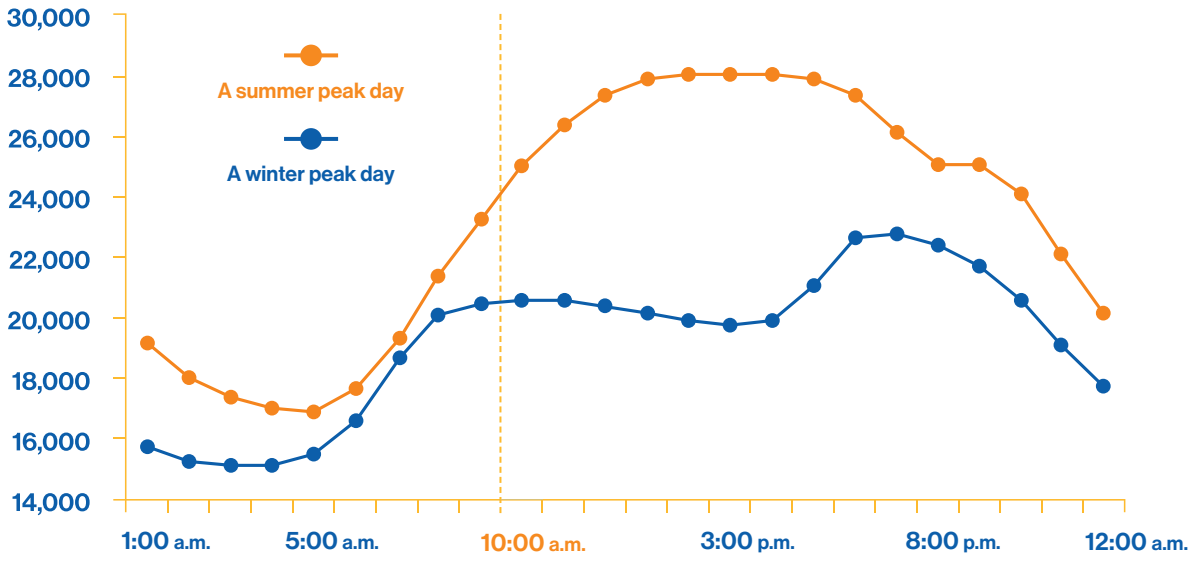
New England is at the forefront to improve operational coordination between the electric industry and pipeline operators. Since the 2004 cold snap, New England's Electric/Gas Operations Committee has facilitated essential communications that have helped maintain power system reliability. More recently, the ISO is pursuing changes to its Information Policy to share generator-specific information with the gas pipelines and for the pipeline operators to in turn share their gas availability information. Should gas supply be insufficient for all generators to meet their schedules, this information would help ISO operators better anticipate and address potential reliability problems. The electric- and gas-sectors also are working to improve coordination of maintenance on both systems.

Aligning Gas and Electric Market Timing

The natural gas and wholesale electricity markets have different schedules, making it difficult for some gas-fired generators to participate in both markets effectively and for system operators to determine when to call on non-gas resources for the operating day. A proposal underway currently seeks to move up the Day-Ahead Energy Market timeline to help address this issue. In doing so, gas-fired generators would have more time to arrange fuel for the operating day and make fuel-switching decisions should they have dual-fuel capability. This also would give ISO operators more flexibility when determining which non-gas resources to call on line, better accommodating resources that require a long time to start up.

New England hourly demand (MW)

The gas operating day starts at 10:00 a.m. when electricity demand is growing and additional generation is needed.



Global factors, local consequences

The global price of liquefied natural gas (LNG) plays an important role in New England's electricity production. Because domestic natural gas prices are currently low and LNG prices in Europe and Asia are currently high, LNG suppliers are selling their fuel outside the US market. As a result, LNG supplies in New England have been greatly reduced, leading to underutilization of the gas pipeline infrastructure in northern New England, which connects LNG facilities, and overutilization of gas pipeline infrastructure in central and southern New England, which connects domestic natural gas sources.

What's more, recent disruptions to global pipeline and tanker deliveries of LNG also have created significant challenges for some of New England's power plants. Operational contingency plans; swift communication; and coordination with state officials, affected generation facilities, and natural gas companies, alleviated concerns with LNG disruptions in the summer of 2012. Nevertheless, the future reliability of LNG supplies to the region is uncertain.

Medium-term market enhancements

Tightening the Shortage-Event Trigger

A shortage event is a period when the power system is stressed and using nearly all available resources to satisfy electricity demand. The term "shortage" means the total amount of available generation is less than (or short of) the normal target level to maintain reliable operations. This target level is always set higher than current power demand to ensure reliable power supply continues uninterrupted even if a large generation or transmission facility suddenly has an outage.

The current Forward Capacity Market (FCM) offers provisions that provide financial incentives for resources to perform and minimize the chance of generation outages during shortage-event periods. However, these financial provisions apply only during situations when available generation is far below the normal target level (i.e., a deficiency in the system's 10-minute generation reserves, for a period of a half hour or more). This provision has proven to be not sensitive enough to indicate when the system is entering a heightened "at risk" period. Because this financial incentive is rarely used, the ISO doesn't have assurance the resources will perform. To correct this, in 2013, market rules will be proposed to initiate a shortage-event trigger earlier—during periods when the grid has a deficiency in *total* operating reserves rather than a deficiency only in 10-minute reserves. By triggering shortage events sooner, resources will have the incentive to perform during at-risk periods over a wider range of at-risk situations that can occur in New England's power system.

Changing Electric Market Offers in Real-Time to Reflect Fuel Prices

Natural gas prices fluctuate throughout the day, but currently market participants can only update their offers to buy and sell in the Day-Ahead Energy Market during limited hours and not during the actual operating day. Any changes to a generator's fuel costs after that time cannot be reflected in the resource's offer. This restriction can cause operators to dispatch generators using "stale" power supply offers that are below a generator's actual production cost, or alternatively, can prevent a generator from lowering its power supply offer if its actual cost is less than anticipated the previous day. Both situations are becoming more common because of the increased volatility in fuel prices, particularly for natural gas.

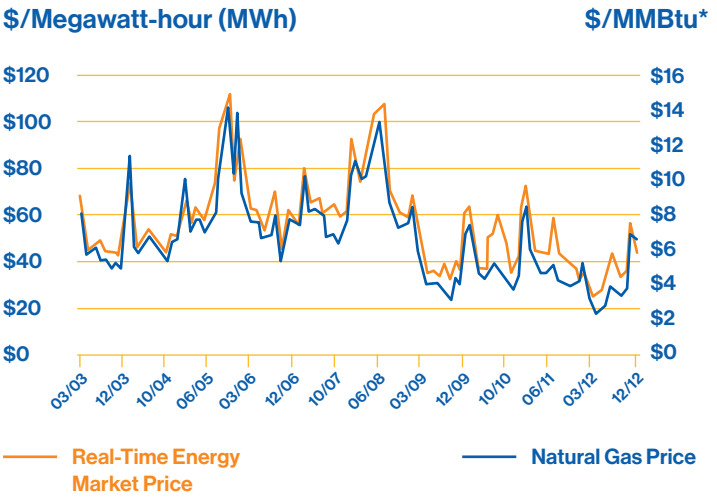
In summer 2013, the ISO will work with stakeholders to propose market rule changes that would allow participants to submit time-dependent (i.e., hour varying) power supply offers in the Day-Ahead Energy Market, as well as to submit updated power supply offers during the operating day. This will improve a resource's ability to reflect the actual costs of fuel and operations in their offer, which can vary during the operating day. This step also will improve how prices are set in the energy market. More accurate pricing provides the necessary signals or incentives for resources to perform, thus ensuring reliability.

Changing Reserve Needs throughout the Day

The ISO and stakeholders are considering whether to enable additional reserve resources to be committed and dispatched within the operating day. Doing so would give control room operators greater flexibility to more effectively respond to intraday fuel contingencies, reduce the costs of out-of-merit dispatch, and more efficiently value the reliability sought through real-time energy prices.

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

Longer-term market development

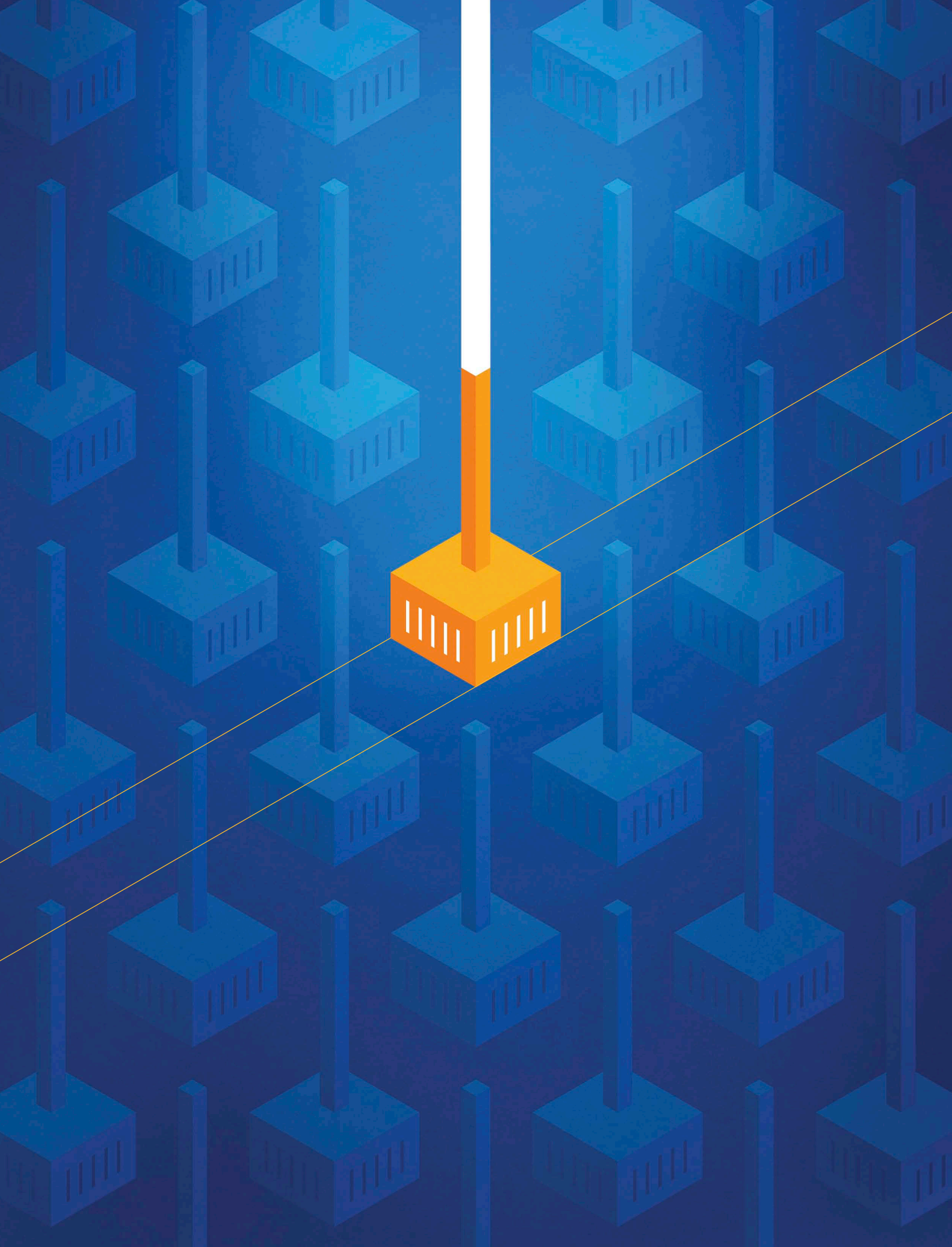
Performance Incentives

In New England, wholesale electric power is bought and sold day to day through the energy markets. Reserve markets support the energy markets by ensuring the grid has enough resources ready to come on line should demand spike or a power plant or transmission line experience a sudden outage. Capacity markets complement both the energy and reserve markets by ensuring that sufficient resources are designed and built to provide energy and reserves each day. Capacity markets send price signals that attract new investment and encourage the availability of existing resources.

Enhancements to the Forward Capacity Market are being considered so that it further complements the energy and reserve markets by providing stronger financial incentives for all resources to perform during stressed system conditions. For the natural-gas-related challenges, one goal of these enhancements is to stimulate generation resources to make investments that ensure a reliable fuel supply. Presently, gas-fired resources rely on a "just in time" fuel delivery system using interstate pipelines that, in general, must be scheduled in advance of the operating day to ensure adequate fuel. When unforeseen problems in the natural gas supply chain occur during the operating day, flexible resources that have the fuel to maintain the power system's reliability are needed. As the region's reliance on natural gas grows, greater private investment in hardware, fuel arrangements, or other supplier-selected solutions to ensure resource performance and availability is essential. Changes to the Forward Capacity Market will improve suppliers' incentives to undertake these investments.

Other long-term enhancements to the Forward Capacity Market include a "pay-for-performance" incentive structure that increases the financial reward to suppliers whose resources deliver energy or reserves during stressed system conditions. This performance incentive design will result in financial transfers from resources that perform poorly to resources that perform well, providing strong incentive for each resource to perform as needed. Resources that can meet the system's needs by exceeding their capacity market obligations will benefit by doing so. Mirroring the current capacity market's features that reduce consumer price risk, the transfers will be structured so that New England's consumers will continue to pay a forward price, determined by a competitive auction three years in advance, and will not bear the short-run risk of covering performance-incentive payments.

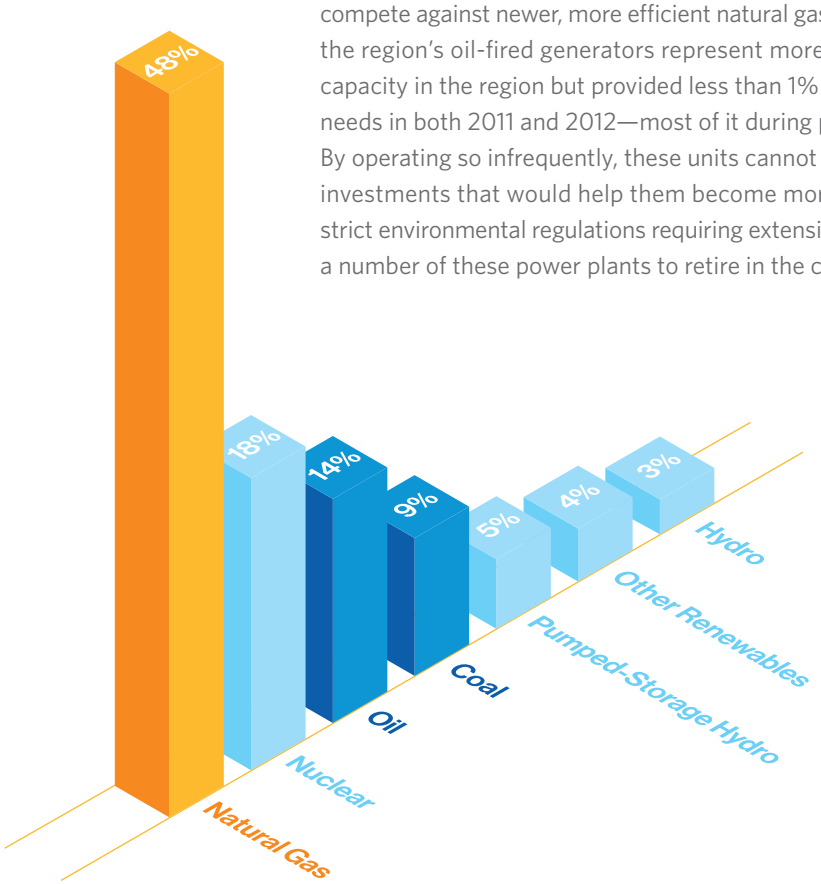
Ultimately, these enhancements are expected to change market participants' long-term investment incentives and produce a more reliable and more flexible fleet of power supply resources at the lowest possible cost. In the interim, the enhanced performance incentives will lead to increased operational-related investments by existing facilities, including more reliable fuel supply arrangements that can improve resource performance and availability during stressed system conditions. The ISO anticipates filing market rule changes for the ninth annual Forward Capacity Market's auction in 2014, which determines suppliers' obligations for the 2018–2019 delivery years.



Challenge 2

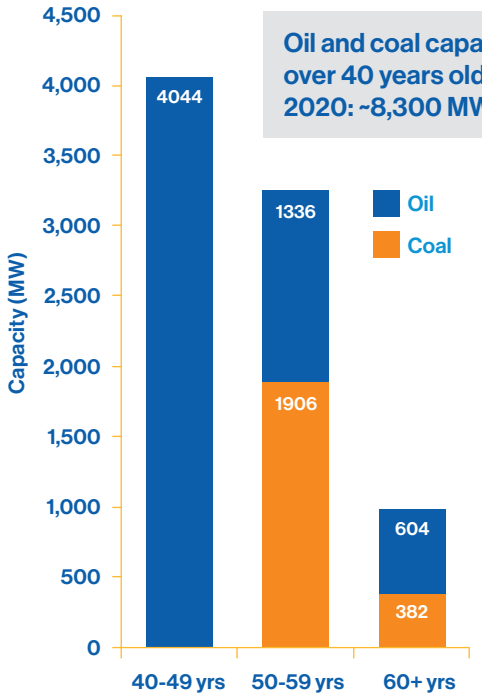
Planning for retirement: How New England can prepare for an aging generator fleet

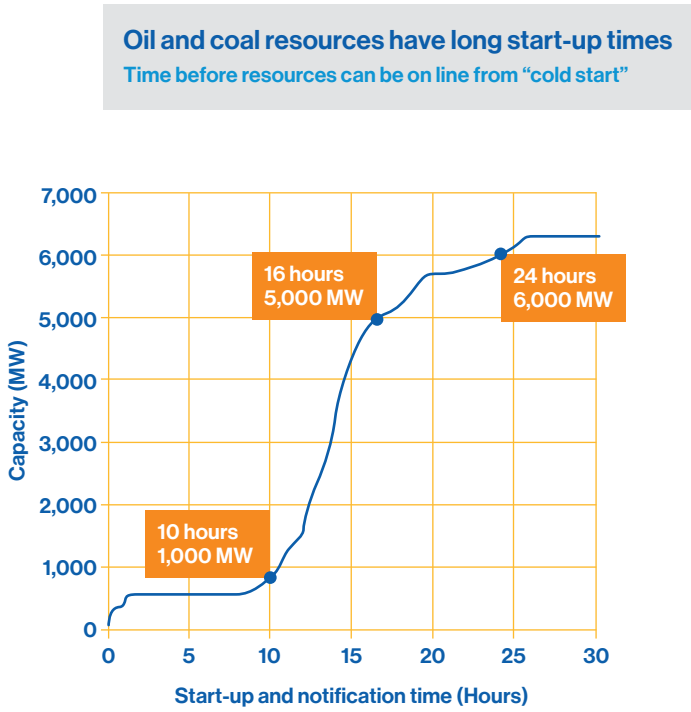
The rising costs associated with oil and coal, and the declining costs of natural gas, have made it difficult for older oil and coal power plants to compete against newer, more efficient natural gas generators. For example, the region's oil-fired generators represent more than 20% of existing capacity in the region but provided less than 1% of the region's electricity needs in both 2011 and 2012—most of it during periods of peak demand. By operating so infrequently, these units cannot recover costs for capital investments that would help them become more efficient. In addition, strict environmental regulations requiring extensive investment may force a number of these power plants to retire in the coming years.



What's powering New England through the peak?

Look at fuel usage during high electricity demand on the peak of a summer day in 2011. Oil-fired resources produced 14% of electric energy during the peak but produced only 1% of electricity over the entire year.





Long start-up times—up to 24 hours to reach full power production—make it challenging to rely on older plants for backup generation. Many of these units were originally designed to provide baseload electricity but are being relied on now for peaking service, ramping, or reserves when the natural-gas plants are constrained.

While it is an expected market outcome for uneconomic plants to retire, the potential magnitude of retirements in a relatively short timeframe poses a serious reliability risk to the region. The loss of each coal- or oil-fired power plant 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.

In early 2013, the ISO published the *Strategic Transmission Analysis—Generation Retirement Study*, an assessment of system reliability risks stemming from potential resource retirements. The study analyzed the transmission system impacts if 28 oil- and coal-fired generators, representing nearly 8,300 MW of capacity, were to retire by the end of the decade. In 2020, if all the at-risk units in the region seek to retire, over 6,000 MW of resources would need to be replaced, repowered, or retained to satisfy both generation and transmission reliability requirements. Because of the favorable economics of natural gas, a significant portion of the replacement resources will likely be natural-gas-fired generation.

Near-term solutions

The region faces a systemic risk if too many units cannot perform simultaneously. To manage this, the ISO has at times had to rely on some near-term strategies, such as retaining resources that want to leave the capacity market, dispatching resources out of merit, procuring emergency capacity, and proposing backstop transmission investments. While necessary for the short-run reliability, these fixes are costly and inefficient.

As described in Challenge One, several constructive immediate actions are helping system operators better manage the system. These include closely monitoring generator fuel inventory, reinforcing current dispatch obligations, enhancing the ISO's ability to audit the operating characteristics of power plants so the control room has a clearer window into a resource's reserve capabilities, and increasing the amount of required reserves so that it has more resources ready to call on during system events.

Longer-term incentives for a more reliable resource mix

Potential changes to the Forward Capacity Market, as described in Challenge One, are being considered to encourage investments by existing resources to improve performance and availability, such as reducing start-up times and improving operational flexibility. The FCM would reward resources delivering least-cost solutions and performing well during stressed system conditions. These FCM enhancements also would draw investment in new, flexible resources, trending toward a more reliable resource mix over time.

In addition, FCM improvements will help better align market responses with system planning processes so that market resources (i.e., generation, demand resources, merchant transmission) can be considered on equal footing with cost-of-service transmission solutions. In late 2013, the ISO anticipates filing market rule changes that will substantially increase performance incentives, taking effect in 2018–2019. Thereafter, the ISO will focus on the issue of improving the alignment between the FCM and the system planning processes.

The risks ahead

In 2020, nearly 8,300 MW of generation are expected to be older than 40 years. Representing more than 25% of total generating capacity, a significant portion of New England's generator fleet faces retirement. That creates serious risks for the region, including:

- Markets and reliability rules may not be well-suited to efficiently manage the sheer magnitude of retirements.
- As the oldest generators in New England, many of the at-risk units are located at critical locations on the transmission grid. If they retire without repowering, transmission security challenges could be created on both the local and regional scale.
- The loss of fuel diversity will amplify the region's dependence on natural gas outlined in Challenge One.

The big picture: Fitting the pieces of the grid puzzle

Many of the region's older oil- and coal-fired generators were built at or near major electricity demand centers, such as the Boston area, to best meet peak consumer demand. The replacement of a large number of these resources could alter the makeup of the grid and create transmission reliability and security issues, depending on where the new resources are located.

The *Strategic Transmission Analysis—Generation Retirement Study* found that the replacements for the 28 at-risk oil-and coal-based resources do not necessarily need to be located in those same demand centers. In fact, repowering all existing sites at their existing locations would likely result in congestion and actually increase the amount of capacity that would need to be replaced.

Transmission development expected between now and 2020 will significantly expand and fortify the area of the grid known as the region's energy hub and the connections to it from other areas of the grid. Based on the study findings, adding 5,000 MW of the 6,000 MW of the replacement capacity to that area of the grid may best serve most of the region's demand and maintain transmission reliability and security.

The remainder of the replacements for the oil- and coal-fired capacity must be developed in specific locations, such as the southeast section of Massachusetts and areas in Connecticut, because of transmission constraints. These areas require local capacity or transmission reinforcements to address transmission reliability concerns.

Depending on the pattern of unit retirements and the timing of new, major transmission projects, the needs of the New England system may change dramatically. Consequently, the ISO and stakeholders will need to consider the solutions developed carefully.

Forecasting efficiency

Energy efficiency (EE) has seen remarkable growth in recent years. ISO New England has developed the nation's first multistate energy-efficiency forecast to track this growth and measure the impact of state-sponsored EE programs on the region's electricity needs. The forecast shows EE initiatives will see investment totaling nearly $5.7 billion from 2015 through 2021. The projected energy and demand savings shown in the forecast, as well as some transmission upgrades and a changing load forecast, reveal the region was able to defer $260 million of proposed transmission upgrades. This level of savings is expected to continue or increase in the future. And as energy efficiency continues to be added, the region can expect to defer or eliminate the construction of expensive power system infrastructure.

Challenge 3

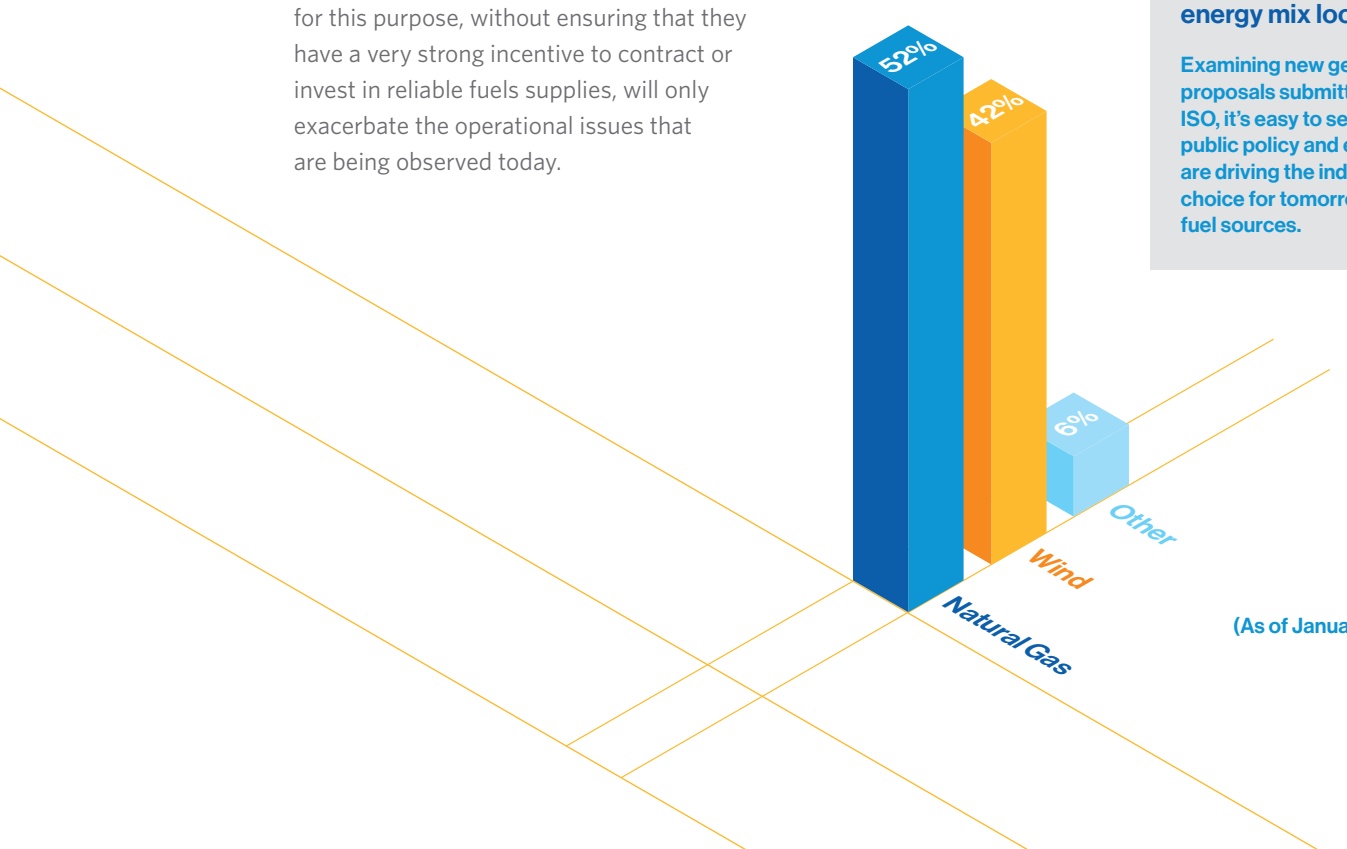
Integrating variable resources while maintaining reliability

New England has multiple wind-rich areas ripe for development, making renewable energy an exciting possibility for the region's future. With zero emissions and no fuel costs, the addition of significant amounts of wind energy will help achieve federal and state environmental goals, mitigate wholesale electricity price volatility caused by wide-ranging prices of traditional fuels, and help alleviate fuel diversity concerns under normal system operating conditions.

However, renewable resources such as wind are not always capable of producing electricity at times when the need for diverse resources is most important. Wind speeds can be at their lowest levels in the summer, when New England's demand is peaking, and in the winter during extreme cold conditions when demand is high. Adding large amounts of this variable resource also would increase the complexity and decrease the flexibility of control room operations. If this wind potential is realized, system operators must be prepared to manage dispatch with resources that can have rapid and sizeable swings in output. To balance these potential swings by variable resources, the system must hold more capacity in reserve that can come on line quickly. While the short startup times of natural gas power plants provide a suitable complement, relying on natural gas generators for this purpose, without ensuring that they have a very strong incentive to contract or invest in reliable fuels supplies, will only exacerbate the operational issues that are being observed today.

What will tomorrow's energy mix look like?

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



(As of January 2013)

Accommodating a potential influx of wind resources

Regionwide, Renewable Portfolio Standards and other environmental targets call for 30% of New England's projected total electric energy needs in 2020 to be met by renewable resources and energy efficiency. Today, approximately 40% of the proposed projects in the ISO's generator Interconnection Queue are wind-powered.

These variable resources will have a greater impact on system reserve, regulation, and ramping needs as they assume a larger percentage of the grid's total capacity. In the near term, ISO New England is working to integrate wind forecasting into resource commitment and dispatch. The ISO is enhancing the accuracy and range of its forecast with greater insight into variable resources and taking steps to ensure these entities have incentives to follow dispatch orders quickly. Considerable investment in smart grid technologies will be needed to provide system operators with the tools to manage the unpredictability of wind because its output can vary over relatively short time periods.

The 2010 New England Wind Integration Study (NEWIS) analyzed various factors associated with the planning, operating, and market aspects of wind integration. The ISO will continue to implement the strategies outlined in NEWIS as wind projects proposed in the interconnection queue enter service.

How supercomputers are helping build tomorrow's grid

Unlike power plants that rely on stockpiles or pipelines that ensure a constant supply of fuel, wind farms cannot schedule their electricity generation with complete certainty. That uncertainty creates significant challenges for the grid operator. Planning for real-time and day-ahead energy needs is difficult when a large percentage of generating resources might be off line because the wind isn't blowing.

ISO New England is teaming up with scientists from the Lawrence Livermore National Laboratory (LLNL) to find more efficient ways of integrating variable resources into the grid. LLNL selected the ISO in March 2012 to participate in a one-year program using high-performance computing (HPC) to model and simulate a new robust unit commitment (UC) solution used to dispatch generators.

Relying on LLNL's expertise in high-performance computing, ISO New England is running simulations on the new UC solution and examining its economic and operational benefits to real-time dispatch and pricing.

Market changes to reflect variability, flexibility

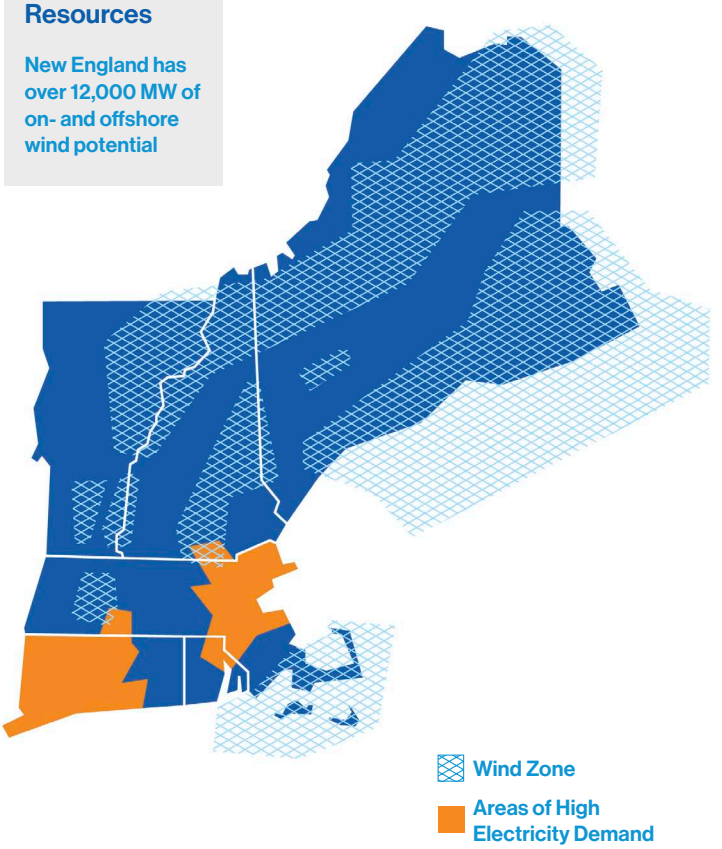
Because renewable resources such as wind power run when the wind blows and cannot easily shut down, system conditions could result during which too much electricity is flowing on the grid, causing the market price to drop to zero. When the price drops to zero, the ISO cannot dispatch in economic merit order. Currently, resources such as wind or even nuclear plants cannot reflect in their supply offers a preference to avoid shutting down. If they are not selected to run, they face inefficient start-up and shut-down expenses. The ISO is examining whether to allow resources to submit negative offers in the energy markets as a solution to this problem. In this situation, generators would pay to operate, which would be less expensive than for them to shut down and restart. This would also send a strong market signal that additional reductions in generation or an increase in demand is needed to ensure reliability.

Changes to the Forward Capacity Market as described in Challenge One that improve incentives for resource flexibility and availability are being developed to better secure investment in resources that can balance intermittent power supply. While the risks associated with this challenge are a longer-term concern, addressing FCM changes now to improve incentives for resource flexibility will facilitate investment planning decisions by the private sector. Other considerations include allowing variable resources to be paid five-minute locational marginal prices in the energy market, which could provide more appropriate compensation and promote efficient performance.

Market design changes are long-term solutions that require time, stakeholder input, and thoughtful planning to achieve successful implementation.

Untapped Resources

New England has over 12,000 MW of on- and offshore wind potential



Bringing renewable energy to market

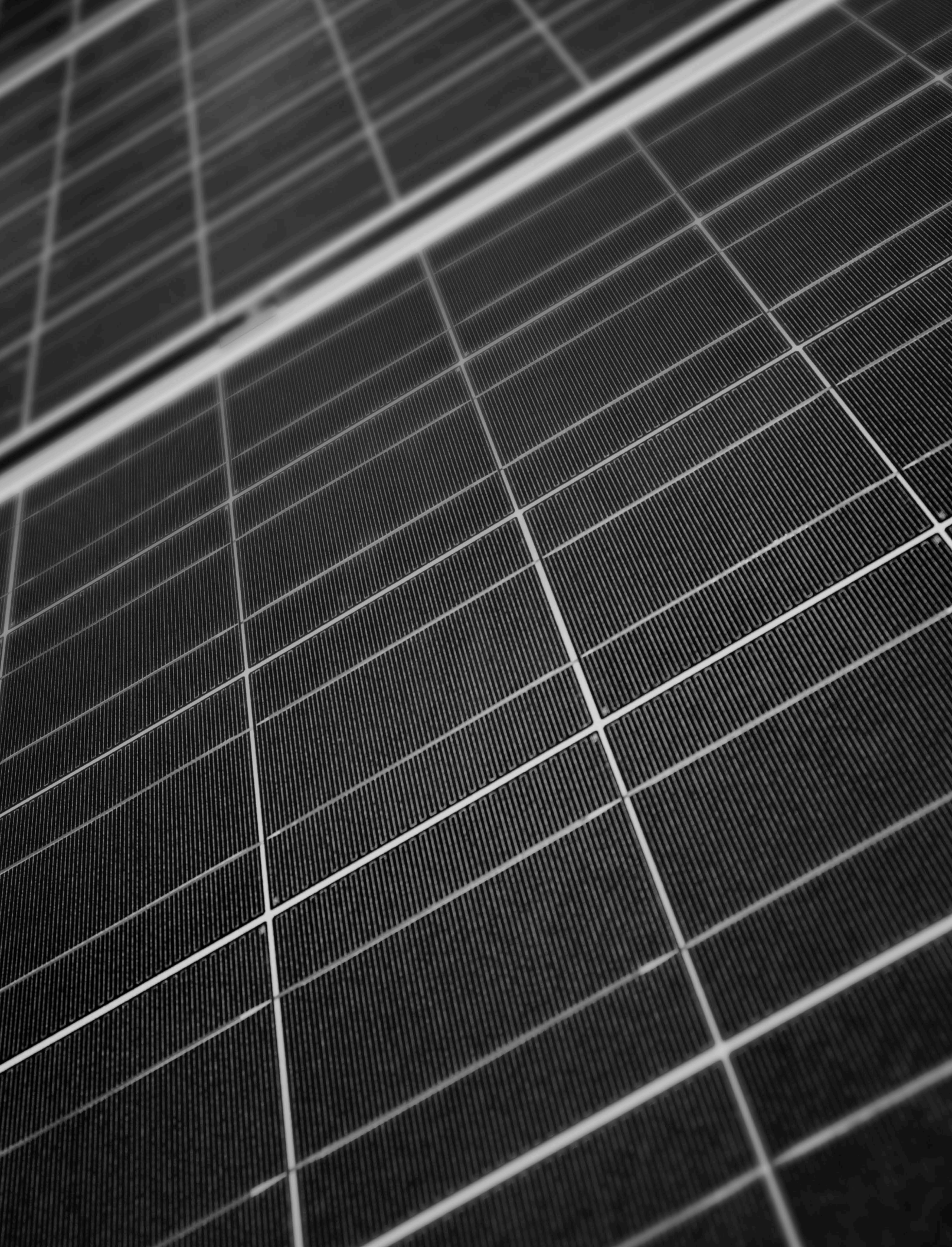
The extent to which wind energy will be developed will depend on the region's readiness to fund large-scale transmission investment to connect remote wind farms to demand centers. An analysis conducted at the request of the six New England governors found that the cost to interconnect from 2,000 MW to 12,000 MW of wind power would be between $1.6 billion to $25 billion in transmission upgrades.

While new wind resources are being added to the system, substantial increases are not expected for several years. The pace of growth may be mitigated by sustained, low natural gas prices; a delay at the federal level in developing clean energy and carbon legislation; or a reconsideration in some parts of the region of Renewable Portfolio Standards. Accommodating a high percentage of variable resources will require careful assessment of the timing of resource development and transmission development. Preparing for the challenge now will ensure that the region has the infrastructure, markets, and strategies in place to properly integrate these resources into the grid.

Shaving peak demand

New England's active demand resources reduce electric consumption during system peaks or periods of high prices when called on by the ISO. In so doing, demand resources 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, lower emissions, 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 demand days.

The ISO is working on the next step in the evolution of demand resources: the full integration of these resources into the energy market so they can be dispatched, just like supply resources, when it makes economic sense to do so.



ISO-Metrics

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 its decision-making process. They 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, consumer advocates, and environmental regulators; and the six governors, including the New England States Committee on Electricity. They are heavily involved in its budget and business planning processes, regional system planning, and market development. Each year, ISO New England management and its board of directors develop the company's business plan and budget through an open process. The process incorporates input from the states and market participants so that the ISO can accurately align its workplan with regional priorities and so that all industry stakeholders have a clear understanding of the company's goals and objectives.

As a not-for-profit corporation, ISO New England's performance can be measured not only by the reliability of New England's power grid but by the effectiveness of the services it offers.

Our stakeholders have regular access to ISO staff and directors, participating in dozens of committees and working groups, and even taking part in the nomination of its board of directors. In 2012, for example, the ISO held approximately 60 Markets, Reliability, Transmission, and NEPOOL Participants committee meetings and nearly 20 Planning Advisory Committee meetings.

The Consumer Liaison Group, formed in 2009, meets quarterly to share information about the economic impacts of New England's power system and wholesale electricity markets on consumers. In early 2011, ISO New England formed the Information Requests Group, a quarterly, ad-hoc forum for stakeholders 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.

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

Results on a budget

ISO New England's budget is determined in an open and inclusive process that involves stakeholders, including input from NECPUC and the states' consumer advocates, a review and advisory vote from NEPOOL, review and approval by its independent board of directors, and final approval by the Federal Energy Regulatory Commission (FERC).

The 2013 budget addresses three key categories that reflect ISO New England's ongoing efforts and growing responsibilities: the cost of continued operations and projects in the queue, activities related to the Strategic Planning Initiative, and changes in accounting estimates associated with pension costs, vacancy rate, and depreciation. The company's total operating budget for 2013 is $165 million. Excluding changes in accounting estimates, the 2013 budget is a 4.8% increase over 2012. The range of services and benefits the ISO provides will cost the average New England electricity consumer $0.83 a month in 2013. For more information, the ISO's financial statements are available on its website.

Customer satisfaction

Stakeholder feedback is an excellent 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 2012 survey, released in early 2013, revealed high overall satisfaction levels. If the percentage of respondents with no opinion is eliminated from the calculation of overall satisfaction, net positive satisfaction with ISO New England is 96%.

Achieving compliance

Standards

ISO New England takes pride in fulfilling its responsibilities to the highest standards and strives to maintain compliance with Federal Energy Regulatory Commission, 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. Its teams dedicate themselves to the safe, reliable operation of the grid through extensive training and continuous process improvement to ensure ISO New England achieves compliance.

In March 2012, the ISO underwent a compliance audit conducted by NPCC. 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

The ISO developed several major initiatives in 2012 to comply with FERC orders, such as Orders 1000 and 755. FERC Order 1000, *Transmission Planning and Cost Allocation*, addresses several complex issues related to regional planning and cost allocation for transmission projects. Order 1000 is designed to promote open, transparent, and efficient transmission planning. ISO New England is on track to meet the last of the Order 1000 deadlines in April 2013. Order 755, *Frequency Regulation Compensation in Organized Wholesale Power Markets*, requires several changes to the design of ISO New England's Regulation Market expected to be implemented in 2014. Regulation is a critical component of New England's power grid; it balances load, generation, imports and exports, maintains frequency, and keeps the system operating normally through a continuous process of minor corrections.

Backup Control Center

A key project for the ISO over the next two years will be the construction of a new Backup Control Center (BCC) designed to meet pending requirements from NERC. The existing BCC facility complies with current NERC standards but has no room for expansion and cannot satisfy the demands of the ISO's new Business Continuity Plan. The new BCC, to be located in Connecticut, will ensure continuous reliable operation of all critical functions, including operations, markets, and settlements. This will enable the ISO to meet 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. Through analysis and discussion with the ISO board, the NEPOOL Budget and Finance Committee, and other stakeholders, the ISO developed plans for a facility that will provide capabilities comparable to the BCC of other ISOs and RTOs. The preliminary capital budget (excluding capitalized internal labor) is $32.7 million. Construction is scheduled to begin in early 2013, with expected completion in 2014.

Providing information anytime, anywhere

ISO Express and *ISO to Go*

ISO New England launched a redesigned data portal, *ISO Express*, in late December 2011. This portal provides stakeholders with convenient access to grid conditions and wholesale electricity market information. Throughout 2012, the ISO made improvements to the new site, providing enhanced 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 will continue to make enhancements in 2013 to provide users with greater functionality. Over the coming year, the ISO also plans to redesign its primary website, making it easier for stakeholders to quickly and easily find the tools and information they seek.

In September 2012, the ISO released *ISO to Go*, a mobile application for smartphones aimed at educating New England's electricity users about the power grid and wholesale electricity markets. The app provides an overview of the grid and markets, conservation tips, up-to-date system conditions, and real-time information on the region's wholesale electricity prices.

View and learn more at:

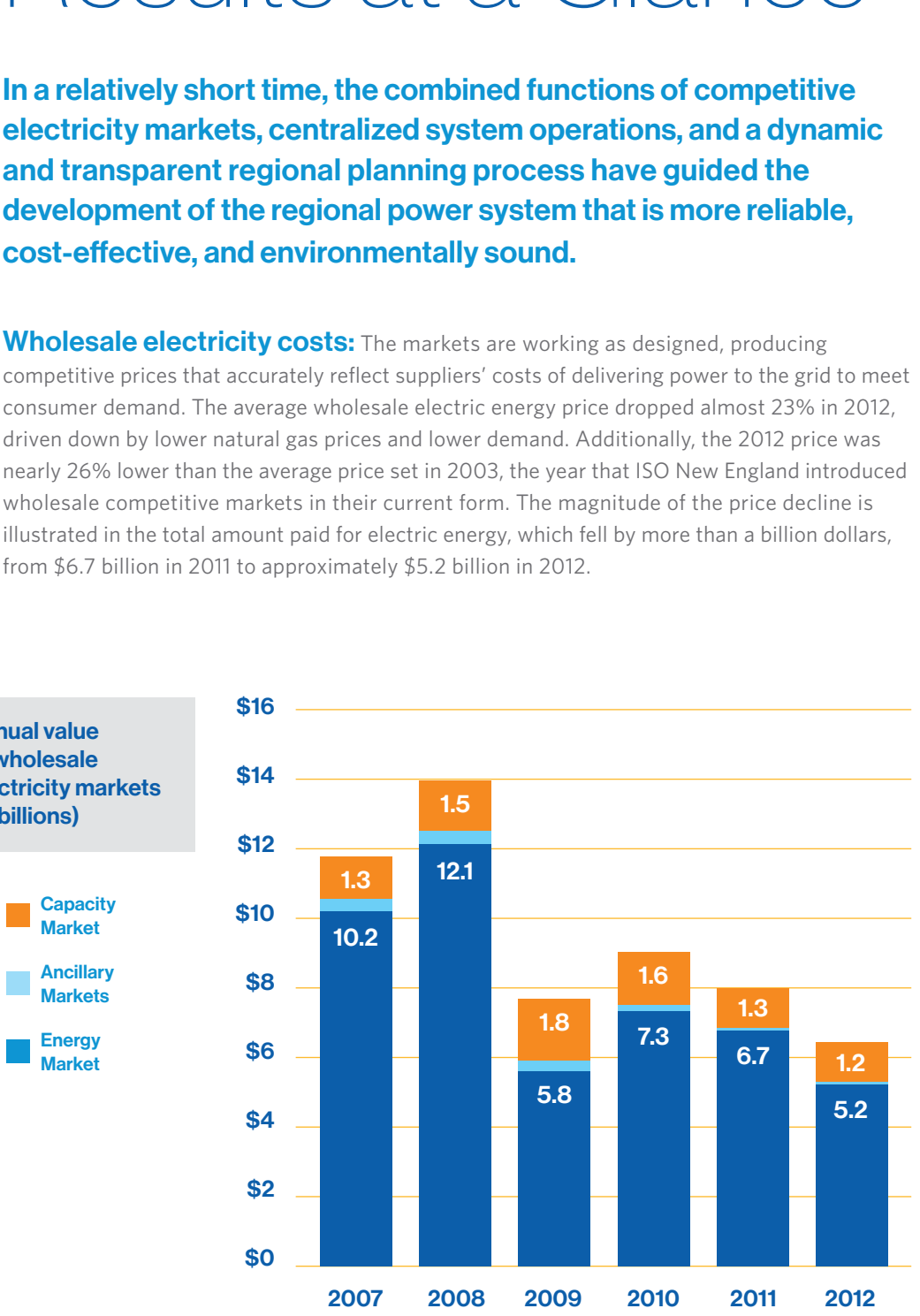
isoexpress.iso-ne.com
iso-ne.com/isotogo

Results at a Glance

In a relatively short time, the combined functions of competitive electricity markets, centralized system operations, and a dynamic and transparent regional planning process have guided the development of the regional power system that is more reliable, cost-effective, and environmentally sound.

Wholesale electricity costs: The markets are working as designed, producing competitive prices that accurately reflect suppliers' costs of delivering power to the grid to meet consumer demand. The average wholesale electric energy price dropped almost 23% in 2012, driven down by lower natural gas prices and lower demand. Additionally, the 2012 price was nearly 26% lower than the average price set in 2003, the year that ISO New England introduced wholesale competitive markets in their current form. The magnitude of the price decline is illustrated in the total amount paid for electric energy, which fell by more than a billion dollars, from $6.7 billion in 2011 to approximately $5.2 billion in 2012.

Annual value of wholesale electricity markets (in billions)



Supply: More than 14,400 MW of new, efficient, low-carbon-emitting supply have been added to the power system since 1997; with another 5,000 MW proposed. Because this investment is made by private firms and not public utilities, consumers are shielded from the investment risks they had been exposed to under the previous, regulated system. Moreover, in competitive electric energy markets, power plants are paid for performance and therefore have incentives to operate more efficiently, contributing to the grid's overall reliability and controlling power costs.

Demand-side resources: Demand resources, such as load management, distributed generation, and energy-efficiency projects, have increased from 100 MW in 2003 to more than 2,000 MW in 2012. This translates into thousands of individual demand assets integrated into the power system. More than 3,600 MW of demand resources are expected to be available by 2015.

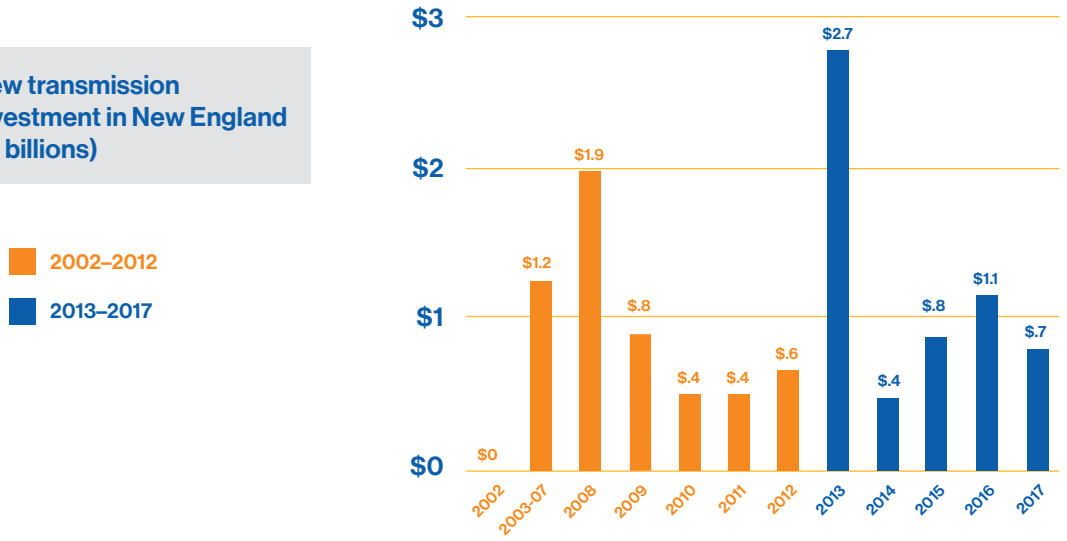
Environment: From 2001 to 2010, average emission rates for nitrogen oxides (NO_x), sulfur dioxide (SO_2), and carbon dioxide (CO_2) have declined by 54%, 64%, and 11%. This can be attributed to the increased use of new, more efficient natural-gas-fired power plants, the decline in the cost of that fuel, and the implementation of emission controls on some of the region's oil- and coal-fired power plants.

Technology: Markets are stimulating technological innovations that are modernizing the regional power system. Smart grid projects will result in a more efficient, responsive, and reliable system that can incorporate greater amounts of demand resources and alternative energy resources. For example, the final installation of 40 phasor measurement units (PMUs or synchrophasers) and associated computer systems for collecting and analyzing data is on schedule for June 2013. PMUs enhance system operators' ability to monitor and measure performance of the grid, broadening their ability to detect and promptly address problems. This will improve reliability and enable operators to reduce congestion and create other efficiencies that have the potential to lower wholesale electricity costs. The technology also will help accommodate the variable nature of wind resources. The project is funded in part by a grant from the US Department of Energy. The ISO also actively participates in smart grid research, education, and standards development.

Transmission: Since 2002, over 400 transmission upgrades totaling $5 billion have been put in service in all six New England states, virtually eliminating congestion on the system. Based on the results and needs described in the ISO's *Regional System Plan*, New England's transmission owners have constructed transmission projects throughout the region that reinforce transmission facilities serving areas that have experienced load growth, such as Vermont, southern Maine, and the New Hampshire seacoast area. Projects also have reinforced the system's 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 billion in transmission investment is planned over the next five years to meet reliability requirements, improve the economic performance of the system, and position the region to integrate renewable resources and alternative technologies.

ISO New England is seeking to align the transmission planning process and wholesale markets. One of the steps includes the evaluation of market resource alternatives to transmission upgrades needed for reliability. In 2011, the ISO completed a pilot project to analyze the megawatts of resources that would be needed at specific locations in Vermont and New Hampshire to reduce the need for transmission investment in these areas. The ISO has applied the lessons learned from this study to the next pilot study underway of the Greater Hartford and Central Connecticut area.

New transmission investment in New England (in billions)



Key Facts

- 6.5 million households and businesses; population 14 million
- Approximately 350 generators
- More than 8,000 miles of transmission lines
- 13 interconnections to power systems in New York and Canada
- More than 32,000 MW of generating capacity

- More than 2,000 MW of demand resources
- All-time peak demand of 28,130 MW set on August 2, 2006
- $5 billion in transmission investment since 2002; another $5 billion planned over next five years
- $5 billion total energy market value in 2012
- More than 500 buyers and sellers in the markets

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*As of January 2013

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