Smart Infrastructure in New England
An investment for growth and prosperity
Introduction

October 2012

Dear Council Members:

For the past few years, the New England Council (NEC) has worked with Deloitte Consulting to explore the most important issues affecting our region as we try to secure a firm foothold in the 21st century U.S. economy. What do we need to do — our government, our communities, our businesses, and our workforce — to grow and prosper?


This year’s report — Smart Infrastructure in New England: An investment in growth and prosperity — defines the what and how of building and maintaining the infrastructure New England needs to accelerate economic growth. One aspect is certain: infrastructure is more important — and more complex — than ever. A “smart” infrastructure links products, services, people, ideas, and skills by using new strategies and technologies that work better and cost less.

Perhaps the most significant message of this year’s research is this: for every $1 billion New England invests in smart infrastructure, a potential 27,000 new and sustainable jobs may be created over and above the immediate construction work.

With this report, we present an unequivocal call to transform our thinking about infrastructure.

The New England Council is looking forward to working together with industry, infrastructure specialists, financial partners, policy makers, educators, economic development agencies, and other stakeholders to build a “smart” infrastructure and to make New England an undisputed economic powerhouse.

Deloitte completed this study pro bono, and NEC is pleased to present the results.

Yours sincerely,

James T. Brett
President and CEO
The New England Council
### Table of contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive overview: Smart Infrastructure in New England</td>
<td>1</td>
</tr>
<tr>
<td>Exploit: Structural advantages</td>
<td>3</td>
</tr>
<tr>
<td>Connect: Regional networks and industry clusters</td>
<td>12</td>
</tr>
<tr>
<td>Develop: “Learnings with earnings”</td>
<td>19</td>
</tr>
<tr>
<td>Finance: Creative and innovative options</td>
<td>24</td>
</tr>
<tr>
<td>Expected benefits</td>
<td>30</td>
</tr>
<tr>
<td>Recommendations</td>
<td>35</td>
</tr>
<tr>
<td>Acknowledgements</td>
<td>36</td>
</tr>
<tr>
<td>Contributors</td>
<td>37</td>
</tr>
</tbody>
</table>
Executive overview:
Smart Infrastructure in New England

In an era when everything is always moving — when people, products, services, information, and capital have to get from one place to another within a region or around the world — infrastructure is the enabler. In the 21st century, infrastructure is about connectivity. Bringing together the leading assets and capabilities, in the most efficient way, is the driving strategy that makes an infrastructure “smart” — that makes an infrastructure the accelerator of economic growth and prosperity.

Infrastructure reinvented for the 21st century
Today, infrastructure is a lot more than canals, railroads, highways, and aviation; and it is more than telecommunications and energy. The reason it is more is that it is all of these together, driven by new thinking about the optimal ways to connect the assets a region needs to compete effectively.

In researching this report, we began with two fundamental premises:

1. That an investment in infrastructure could yield high returns in the form of economic growth, faster supply chains, and reduced congestion in the movement of core economic assets.
2. That while ideas for improving infrastructure were being discussed, the region lacked a coherent strategy for moving forward — a strategy based on quantifiable, expected benefits and available financing. In fact, while infrastructure is one of the most important prerequisites for economic prosperity, it may be one of New England’s larger impediments, preventing the region from exploiting many opportunities for growth.

In our work, our joint Deloitte-NEC team confirmed these premises and uncovered four principles that we believe define a 21st century infrastructure for New England:

- The infrastructure that efficiently connects a competitive workforce wins with higher productivity, faster innovation, a more responsive supply chain, at acceptable costs
- Infrastructure needs to link economic hubs and educational institutions, creating a productive network of urban areas, skilled and educated workforces, and associated supply chains
- It is no longer good enough to manage transportation supply 1950s-style. New technology and networked systems allows the economical management of demand and the relief of congestion
- Financing needs to get creative and include public-private partnerships and infrastructure banks

A path forward
In this report, we present the results of our research organized in a framework (Figure 1) for achieving the desirable end state: an infrastructure that enables the New England states to compete effectively and sustainably, not just in the next few years, but in the decades to come.

We call such an infrastructure “smart” because it includes the fundamental building blocks necessary for productive commerce: transportation systems (by water, rail, road, and air), diversified energy sources (natural gas, oil, coal, hydro, wind, and nuclear power) and, in today’s information-driven world, access to high-speed internet. But given a world of complex, competitive landscapes, a “smart” infrastructure also includes a skilled workforce and the reliable, reasonable financing necessary for economic development.
Study objectives
In 2012, The New England Council (NEC) commissioned a joint study with Deloitte to analyze the potential for maintaining and improving the region’s infrastructure. The objective of the study was to determine an appropriate infrastructure strategy, including concepts, technologies, and financing approaches. Key to the study’s purpose was the determination of estimated benefits, qualitative and quantitative, from infrastructure investments. As part of this effort, we defined infrastructure in 21st century terms, assessed the strengths and weaknesses of New England’s current infrastructure, and determined the leverage that infrastructure provides for economic development.

Study approach
We conducted a detailed analysis of primary and secondary data to build a comprehensive picture of the leading infrastructure concepts being deployed around the world. Particular emphasis was placed on innovations in Singapore and London because of their leading practice transportation systems.

We also interviewed various stakeholders, including NEC members, executives in energy, communications, and transportation industries; public finance experts, and innovative educators. In workshops, we tested hypotheses and refined key messages. To gain a clear understanding of the region’s competitive business environment (in what we call “home-shoring” areas), we used a number of Deloitte and government databases, especially those compiling structural costs and labor trends. Finally, we quantified (to the degree possible, given available resources) the expected benefits of infrastructure investment.

As a value-added part of this effort, we developed recommendations for the region to create an actionable infrastructure development strategy — a strategy for improving New England’s competitiveness and accelerating growth.

Figure 1: A “smart” infrastructure

To build a 21st century infrastructure in New England — one that would enable growth and prosperity — private and public investors need to work together to take these steps:

Exploit the region’s structural advantages to achieve a responsive supply chain, operating at lower cost with less congestion and fewer bottlenecks, by taking advantage of attractive, lower cost “home-shoring” subregions in support of dominant industries.

Connect its regional networks and industry clusters to leverage their inherent economies with the appropriate infrastructure technology and management.

Develop workforce skills in a “learnings with earnings” collaboration, following a new “apprenticeship model” that brings together the interests of business, education, and government.

Finance strategic opportunities creatively, using a full range of innovative options to match affordability with productivity and speed to market.

In summary: Smart Infrastructure of the 21st century is the interconnect of the region enabling transportation, energy, communications, education, and economic assets to interact and promote growth using innovative financing options.
Exploit:
Structural advantages

New England has three distinct economic advantages relative to its industrial infrastructure: 1) several lower cost, high-skill subregions that can be competitive globally through innovation and productivity, 2) clusters of companies and resources in multiple industries, including advanced manufacturing, health and life sciences, software development, information services, and financial services that can be networked for effective leverage, and, 3) a highly competitive broadband market, with multiple service providers operating throughout the region. But New England’s infrastructure lacks an energy resource that is both reliable and cost competitive. In fact, prices for energy in the region are double those of some southern U.S. states. This disadvantage needs to be mitigated over time.

Structural advantage #1: Lower cost, attractive “home-shoring” regions

Three subregions in New England — the I-91 Corridor, the Down East Corridor of Maine and New Hampshire, and the Blackstone Valley Corridor/quiet Corner — have acceptable cost structures for industries making complex products and/or offering sophisticated services. Combining these “make” and “distribution” regions with the industry and knowledge hubs concentrated in Eastern Massachusetts could form a very attractive supply chain. We call this concept home-shoring, a counter to off-shoring. Home-shoring allows for a highly collaborative and interactive supply chain bypassing the friction and difficulties of more long-distance chains. And the friction of long-distance supply chains is substantial: long lead times, higher inventory levels, more difficult supplier management, higher political and environmental risks, loss of intellectual capital, more difficult engineering collaboration, lower flexibility, and less responsiveness.

By investing in an infrastructure that could support industry clusters and enable their integration through regional networks, New England could attract new business to the region. Corporations could locate manufacturing and distribution facilities in the three home-shoring subregions (Figure 2).

Figure 2: Home-shoring regions

Source: Deloitte Analysis; Deloitte Global Footprint Database
The home-shoring subregions have appropriate cost structures for skilled-labor industries: operating costs in these regions compare favorably to those in southern states (Figure 3). In fact, the cost of a highly engineering product manufactured within the I-91 or Down East Corridors is only four to five percent higher than that for the same product made in the Southeast. Salaries are relatively comparable, and any cost differences come mainly from higher taxes and energy prices in the Northeast. That small cost differential can be easily offset with productivity, innovation, and speed to market.

Figure 3: Cost structure of a highly engineering product

![Cost structure of a highly engineered product](image)

Above and beyond cost parity, other advantages are apparent in the three home-shoring subregions, and these can be summarized as “location, location, location.” All three regions include mid-sized communities, airports and/or seaports, and many community colleges — all factors that make them well-suited for economic and commercial growth (Figure 4). Companies and clusters in these regions could be — and should be — networked through advanced communications and with knowledge hubs (e.g., engineering centers, corporate headquarters, etc.) in major metropolitan areas.

Figure 4: Advantages that support growth in the home-shoring regions

<table>
<thead>
<tr>
<th>Home-shore destination potential</th>
<th>Down East</th>
<th>I-91 Corridor</th>
<th>Blackstone/RI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Airports</strong></td>
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<tr>
<td>Portland</td>
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<tr>
<td>Pease</td>
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<tr>
<td>Manchester</td>
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<td>Bradley</td>
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<tr>
<td>TF Green</td>
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<tr>
<td><strong>Seaports</strong></td>
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<tr>
<td>Portsmouth</td>
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<td></td>
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<tr>
<td>Portland</td>
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<tr>
<td>NA</td>
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<td></td>
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</tr>
<tr>
<td>Providence</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Community Colleges</strong></td>
<td>7</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td><strong>Industry Clusters</strong></td>
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<tr>
<td>Signal Processing/Electronics</td>
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<tr>
<td>Aerospace</td>
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<tr>
<td>Medical Devices</td>
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<tr>
<td>Semiconductor</td>
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<tr>
<td>Precision Machining</td>
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<tr>
<td>Signal Processing/Electronics</td>
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<td>Aerospace</td>
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<td>Medical Devices</td>
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<td>Precision Machining</td>
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<tr>
<td>Semiconductor</td>
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<tr>
<td><strong>Destination mid-size Communities</strong></td>
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<td>Portland</td>
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<td>Keene</td>
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<td>Hanover</td>
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<td>Northampton</td>
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<tr>
<td>Providence</td>
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<td>Warwick</td>
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<td></td>
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<tr>
<td>Northhampton</td>
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Source: Deloitte Analysis; Deloitte Global Footprint Database

Source: Public Literature Search; Deloitte Analysis
Home-shoring means investing in the reliable and affordable infrastructure that could connect cost competitive regions of New England with its knowledge and industry hubs, thus attracting new business.

Structural advantage #2: Robust industry clusters
New England has a number of highly networked industry clusters. The concentration of skills and capabilities gives New England a competitive advantage over less clustered, less dense set of assets in other regions of the U.S. These industries — including signal processing, optics, measuring devices and instruments, biotech, medical devices, aerospace and defense, high-end electronics and software, and material sciences — are known for innovation and research. Skill-intensive and productivity-based (in other words, not driven to compete with low-cost labor and big-scale output), they have high-skill concentrations, often over 50% higher than the U.S. average. A sample picture of the significance of clusters is the aerospace example (see Figure 5) led from the network hubs in central Connecticut. 284 companies are networked in a very tight ecosystem.

Figure 5: Sample industry cluster: Aerospace companies in New England

Representing 254 companies in the New England area*

<table>
<thead>
<tr>
<th>State</th>
<th>Tier 1</th>
<th>Tier 2</th>
<th>Tier 3</th>
<th>OSP</th>
<th>Logistics</th>
<th>Shared Support</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>MA</td>
<td>8</td>
<td>27</td>
<td>5</td>
<td>16</td>
<td>0</td>
<td>1</td>
<td>22%</td>
</tr>
<tr>
<td>RI</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>2%</td>
</tr>
<tr>
<td>VT</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2%</td>
</tr>
<tr>
<td>NH</td>
<td>3</td>
<td>11</td>
<td>2</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>8%</td>
</tr>
<tr>
<td>CT</td>
<td>27</td>
<td>71</td>
<td>17</td>
<td>49</td>
<td>1</td>
<td>1</td>
<td>65%</td>
</tr>
</tbody>
</table>

*These companies represent a sampling of the company’s supply chains in the region
Source: Deloitte-NEC Analysis

Dense industry clusters are essentially competitive networks where people, resources, capabilities, and capacity can be leveraged better. As competitive entities, regional networks and industry clusters can drive real economic growth:

- A network improves (and the learning curve accelerates) with cumulative volumes; hence, overall network productivity can improve upon any single company’s economies of scale.
- A network can leverage the capabilities and capacities of the whole cluster, making for a more efficient and effective product/service supply chain.
- Sustainable innovation comes not from an isolated R&D pipeline but from a network of shared ideas and joint problem solving.
- Networks can help solve the “first unit” problem (i.e., begin at a lower cost associated with producing and taking to market the first unit of a new product or service while being early to market) by encouraging collaboration and shared risks/rewards.
- Once a network is operating, it is much easier to add and share services among the participants, thereby allowing participants to “do less and profit more.”

The next section of this report, “Connect regional networks and industry clusters,” covers the transportation systems needed to take advantage of the potential economics and scale inherent in the region’s industry clusters and home-shoring opportunities. Above and beyond meeting transportation requirements, the three subregions could create industry networks through the use of New England’s advanced communications networks.

**Structural advantage #3: Competitive broadband market**

In today’s information-driven world, access to high-speed internet is critical to economic success, and New England’s broadband infrastructure is a competitive advantage for the region.

A strong broadband network is the communications backbone for companies, allowing them to transmit significant amounts of data (such as engineering drawings) from one site to another and around the world, to perform real-time transactions, and to communicate in real time using the latest teleconferencing technologies. The networking of industry clusters (and, in extension, the effective implementation of home-shoring), requires a strong communications system that links companies to each other and to knowledge hubs. For these reasons, access to high-speed broadband could be a deciding factor when a company chooses a location.

In the three home-shoring subregions, broadband deployment is widespread, the speeds are among the highest and access is virtually universal (see Figure 6 for the broadband coverage map for New England). The major broadband providers have demonstrated speeds of 10Gbps or higher for commercial users and speeds of up to 300 MBPS for residential users. Broadband service providers continue to expand their reach whenever and wherever demand is sufficient (Figure 7 shows the growth in broadband cable lines in New England from 2006 to 2010). In addition, public initiatives, such as the Massachusetts Broadband Institute (MBI), are running fiber-optic cable throughout New England to bring broadband to subregions that now have limited connectivity.

**Figure 6: Broadband coverage in New England**

![Broadband coverage in New England](source: Federal Communications Commission, Broadband Availability | MapBox, May 23, 2012)
New England’s broadband market is competitive, with multiple service providers, including Comcast and Verizon, operating throughout the region. The industrial and commercial environment pushes providers to be innovative, continuously increasing the quality of services and the value to customers. Furthermore, New England is often used as the testing ground for the latest technology, as evidenced by the capital expenditures of cable companies, which invested more than $3.5 billion in the region from 2006-2010\(^1\). The major service providers can build out custom networks for commercial customers as the need arises.

Given the advanced state of New England’s broadband infrastructure, companies can be confident that they can have a fast and reliable connection. As New England states seek to attract new businesses to the region, broadband capabilities could be marketed as a key differentiator.

**Companies can be sure of a fast and reliable broadband connection anywhere in the region.**

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\(^1\) New England Cable & Telecommunications Association, Inc. “Connecting New England: Cable’s Impact on the Region’s Economy”
**Structural disadvantage: Unreliable, expensive energy**

To better take advantage of home-shoring and regional network economics, New England should provide reliable energy at a reasonable price to customers (commercial and retail).

Unfortunately, power prices in the region are among the highest in the country, double those of some southern states. As Figure 8 shows, five of the top ten states with the highest commercial prices for electricity are in New England. Since the region has limited local natural resources, energy must be transported long distances; investing in an energy infrastructure to reduce transportation costs could help decrease prices to customers, allowing New England to somewhat offset its disadvantage and remain competitive in attracting new business to the region. Note that energy costs and associated policies are a significant criteria for site selection of new business.

To ensure reliability, New England has to enhance and maintain diversity of energy sources. As shown in Figure 9, New England depends heavily on natural gas, with oil and nuclear power being important (but significantly slighter) resources, while most of the United States depends much more (relatively) on coal. Figure 10 shows the breakdown of fuel sources for New England’s electric power. As the region develops a future energy plan, fuel diversity is important to reduce system risk and improve reliability.

High energy prices are not New England’s only energy challenge. The region’s electricity transmission system was once considered outdated and not designed to handle current, let alone future, demand. However, over the last decade 400 transmission projects required for power system reliability were put into service with another $5billion in upgrades planned over the next five years. On the downside, transmission cost, once incidental, is headed over 2¢/kwh.

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1 New England Energy Alliance, Electricity Transmission Infrastructure Development in New England

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Improvement Opportunities

The development of renewable energy sources is a growing trend in the U.S. New federal regulations, expected to be completed by the end of 2012, will limit the use of coal-fired plants and encourage new technologies. State governments are also taking matters into their own hands, setting ambitious goals for the percentage of energy coming from renewable sources by 2020. Leaders in the energy industry will be forced to find balanced ways to comply with new regulations, while keeping prices acceptable.

That being said, New England should develop a reliable energy infrastructure. We propose the following opportunities to maintain a diversified portfolio of energy sources, while also reducing commercial prices in the long run.

Opportunity #1: Maintain nuclear sites

Today, New England relies heavily on nuclear power to provide reliable capacity; the region’s four nuclear power facilities generate 30 percent of its electric energy. Nuclear energy is the only local fuel source and plays a big role in maintaining fuel diversity. Just as important, low operating costs make nuclear power an economical choice. Nonetheless, it is unlikely that new plants will be built in New England in the future, while prices would likely rise if a current plant were decommissioned. This is the economic rationale for keeping nuclear facilities operating.

In addition to providing cost and reliability advantages, nuclear energy also plays an important role in attaining greenhouse gas reduction goals. Nuclear energy is an emission-free energy source, producing no carbon dioxide, nitrogen oxide, or sulfur dioxide. Nuclear power complies with the Regional Greenhouse Gas Initiative (RGGI), which sets a cap on CO2 emissions. RGGI covers all New England states. As national and state governments pass additional legislation limiting greenhouse gases, energy leaders will look for energy sources that play an important role in compliance. If nuclear power plants were closed, new sources of energy would need to be emission-free to continue to meet emissions standards.

Opportunity #2: Invest in infrastructure for natural gas

The discovery of new reserves and the debate about development methods have made natural gas a hot topic of discussion. Recent research suggests that North America has abundant natural gas supplies and that the U.S. will increase natural gas production over the next 20 years. Figure 11 shows projections from the U.S. Energy Administration through 2035. Many natural gas and large oil companies, like Chevron and Exxon, are investing in natural gas drilling in the U.S., particularly in the Marcellus shale, which is estimated to contain 141 trillion cubic feet of usable natural gas, enough gas to power the entire U.S. for six years. Given its proximity to New England, the Marcellus shale may be a lower cost energy option for the region.

Figure 11: U.S. natural gas production by source, 1990–2035


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Right now, New England’s natural gas infrastructure is limited. The region has no production or underground storage capabilities, so natural gas is transported long distances; the region relies heavily on imports from the Gulf of Mexico, Canada, and overseas. One onshore Liquefied Natural Gas (LNG) terminal and two offshore terminals supplement the interstate and Canadian pipelines. Not surprisingly, natural gas trades at premium prices in the Northeast, compared to the rest of the U.S., primarily due to congestion during times when demand is high.

It would be advantageous for New England to build out a natural gas transmission system to capture the benefits of lower-cost energy and meet the needs of the region. A transmission system would alleviate congestion challenges during peak demand and increase or maintain reliability for the region.

**Opportunity #3: Decrease dependency on heating oil**

The fate of natural gas adoption in New England will hinge on how successfully the region decreases its dependence on oil. Right now, New England states have the highest dependency on oil in the country; 80 percent of homes in Maine are heated with oil, compared to an average of nine percent for all U.S. homes (Figure 12). This strong demand for oil creates a paradox for natural gas projects: homeowners are reluctant to make the switch since natural gas is expensive and unreliable, while natural gas companies are hesitant to build out natural gas infrastructure in New England without sufficient demand.

New England should decrease its reliance on oil to encourage investments in natural gas transmission projects by offering incentives to both homeowners and natural gas companies.

**Opportunity #4: Promote competition in regional transmission planning consistent with FERC Order 1000 and avoid long-term contract and commitment costs**

To help control costs, New England needs to open transmission construction to competition. Additionally, projects with long-term commitments — such as $435 million Merrimack Coal Scrubber and Cape Wind — are way beyond market prices and will require extraordinary efforts to offset their cost in other ways.

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**Figure 12: Home heating fuel by state (2000 census)**

<table>
<thead>
<tr>
<th>Home Heating Fuel by State (2000 Census)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME</td>
</tr>
<tr>
<td>Homes heated with oil</td>
</tr>
</tbody>
</table>

Source: U.S. Census Bureau, Historical Census of Housing Tables, May 23, 2012
Opportunity #5: Gain regional clarity on renewables, green energy and subsidies
Most New England states have lofty goals for renewable energy by 2020. Renewable portfolio standards require that utilities obtain a specific percentage of electricity from renewable sources (Figure 13 shows percentages for New England states).

Figure 13: State renewable energy standards, 2020

<table>
<thead>
<tr>
<th>State</th>
<th>% Renewable Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME</td>
<td>10%</td>
</tr>
<tr>
<td>NH</td>
<td>11%</td>
</tr>
<tr>
<td>MA</td>
<td>15%</td>
</tr>
<tr>
<td>RI</td>
<td>16%</td>
</tr>
<tr>
<td>CT</td>
<td>20%</td>
</tr>
</tbody>
</table>

Source: ISO-NE, New England 2011-12 Regional Profile, December 2011

Is wind power a big part of the future picture for New England? Although wind is being targeted as a potential renewable energy solution for New England, implementation costs would be significant and the technology is not yet an economical solution. Although wind turbines have become more efficient and can produce power at much lower wind speeds, the unpredictability of wind requires another source of energy to back up the wind power when turbines are idle. Right now, the region has an estimated 10,000MW of off-shore wind power, making it a still-emerging source, even when compared to the more mature technology associated with land-based wind power. The unique challenges of harnessing off-shore wind include saltwater corrosion, rough weather, and the need for large capital investments.

It is our view that a significant energy public policy discussion needs to be vetted regionally. Key questions to be addressed include:

• Should hydroelectric power be considered a renewable?
• Should tax payers and rate payers subsidize efforts in renewables, green energy including wind power, and the switching from oil heat to natural gas?
• Should the New England states collaborate and make bundled purchases of renewable power?
• Should consumers bear more cost for natural gas pipeline development?
• Are market forces and existing mechanisms alone sufficient to achieve diversity and lower cost for the region’s energy portfolio?

A diversified portfolio of energy sources would support economic development, while reducing commercial prices for industry in the long run.

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1 ISO-NE 2011-12 Regional Profile
Connect:
Regional networks and industry clusters

An efficient transportation system is needed to move people, link supply chains, and distribute products throughout the region and beyond. Without this, the companies in New England’s industry clusters — those distinctive advantages of the region’s economy — will have difficulty competing effectively. These companies’ complex supply chains rely on the seamless integration of every transport mode: truck, air, water, and rail. Without a connective transportation infrastructure, continued growth and prosperity will be limited.

Current issues and challenges
For a company, an inefficient transportation infrastructure is a daily frustration; but for a whole region, it is much more than that: it is a potential reason for investors to look elsewhere. If a manufacturer is evaluating two areas of the country for a new facility, the one with a supply chain that is regularly three to five days slower will not come out on top. New England’s railroads, highways, seaports, and airports must be enhanced and maintained to meet the current and future needs of both the local and global economies.

Here are a few substantive deficiencies in New England’s current transportation infrastructure:

• A limited number of direct international flights, particularly to emerging markets such as Brazil, India, and China, restricts the region’s ability to compete fully on the global stage. Although New England has multiple international airports — most passengers must travel through New York City to reach emerging markets. Mid- to long-term, this may hurt the region’s competitiveness in key industries.

• An outdated highway transportation infrastructure (the Central Artery/Tunnel project notwithstanding) creates traffic congestion impacting on major commercial roadways, such as I-90, I-91, I-93, and I-95.

• In its 2011 annual report on urban mobility (based on INRIX traffic data), the Texas Transportation Institute (Texas A&M University) ranks Boston as the ninth worst metropolitan area (out of 100) in hours lost per commuter due to traffic congestion. Bridgeport-Stamford ranked 21st, New Haven ranked 28th, Hartford ranked 41st, and Providence ranked 67th. Congestion causes lost productivity and increased costs for commuters and businesses alike, while affecting where people decide to live and where companies decide to locate. (Businesses locate close to population clusters, but also need to move products throughout the region.) Congestion also introduces variability into shipping times.

• Researchers have documented the relationship between highway congestion and economic growth. Economist Kent Hymel found that a reduction in congestion could boost employment. A study by David Hartgen (University of North Carolina, Charlotte) and M. Gregory Fields concludes that congestion impacts production output: a 10 percent reduction in travel times could increase a region’s production by one percent. These studies support the notion that investments in infrastructure to reduce congestion and increase access could provide significant economic benefits.

• In central and western Massachusetts, bridge heights limit the use of double-stacked container cars, effectively halving potential capacity in some instances. While efforts are underway to improve access, more can be done to increase the flexibility of the existing system and realize benefits in the near- and mid-term that can drive future growth. The recently approved engineering and environmental impact analysis for the Patriot Corridor Double-Stack Clearance Initiative is a step towards improving that flexibility.

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6 David Shrank, et al., TTI’s 2011 Urban Mobility Report (September 2011)
8 David Hartgen, Gridlock and Growth: The Effect of Traffic Congestion on Regional Economic Performance (August 2009)
Future opportunities and investments
To position the region competitively for the future, New England should prioritize and invest in smart infrastructure that can manage demand and congestion. The five opportunities presented here — not an exhaustive list, but a starting point — represent techniques that NEC believes could have a positive impact on the performance of transportation infrastructure in New England.

Opportunity #1: Integrate consumption-based pricing for critical roadways
Consumption-based pricing systems have been successfully implemented in major metropolitan areas to regulate all traffic movement (see sidebars for case studies of Singapore and London); we suggest there are principles that could be applied in New England. While it may be a political nonstarter to charge a daily usage fee to every vehicle entering a New England city — say, Boston — it is certainly possible that consumption-based pricing could be deployed on critical roadways to both reduce congestion and provide additional revenue. One potential application in New England could be the use of High Occupancy Toll (HOT) lanes on critical, chronically congested roads (e.g., I-93 through Boston and I-95 through Providence).

HOT lanes will soon improve traffic flow on the heavily congested roadways surrounding Washington, D.C., while the “Florida 95 Express” project converted High Occupancy Vehicle (HOV) lanes to HOT lanes, an idea that could be replicated on HOV lanes on New England roadways. Additional examples of HOT systems can be found in California, Minnesota, Texas, Colorado, and Utah — projects which present successful applications of a system that could benefit New England in more ways than one.

Case Study: London
From Deloitte Research, Combatting Gridlock — How Pricing Road Use Can Ease Congestion

Every weekday morning in London, the equivalent of 25 busy motorway lanes of traffic would try to enter the center of the city. Drivers would spend half their time in queues, costing the local economy GB£2–4 million every week. For decades, there had been discussions about instituting a congestion charge to alleviate this gridlock, but all such proposals were shelved due to intense opposition.

In 2000, circumstances converged to create a climate favorable to change. First, the public clamor for politicians to “do something” about traffic reached a crescendo. In the Road Charging Options for London report (1999), more than 90 percent of greater London residents said, “There is too much traffic in London.” At the same time, in a survey conducted by Market Opinion and Research International, 70 percent of London businesses said “improving public transport” should be a priority for the next mayor; 55 percent said “reducing traffic levels” was a high priority. Second, leading mayoral candidate Ken Livingstone announced he would consider a congestion charge for London if he was elected. After being elected, he indeed quickly committed to implementing such a charge. Three years later (February 2003), London’s congestion charge went live.

The London scheme, the largest of its kind in the world, charges vehicles driving into central London (an area of 21 square km) a flat fee of GB£5 per day between 7:00 am and 6:30 pm, Monday through Friday. Each day more than 200,000 vehicles are charged. Enforcement comes from automatic number plate recognition (ANPR) technology using cameras situated on the boundary and throughout the charging zone. The charge can be paid online, by telephone, by SMS text messaging, by post, and at retail outlets. Vehicles are registered in a database, which the system accesses to check captured images of license plates of those entering the zone; unregistered vehicles are issued a penalty charge notice of GB£80, a figure that is reduced to GB£40 if paid within 44 days.

Enforcement has been a big challenge, with problems ranging from stolen or replicated license plates to errors in registration. Measures to address these problems have ranged from asking drivers to confirm certain details when they set up their accounts to using vans to track persistent evaders. While some problems might have been avoided with a transponder-based system, that would have delayed the project by several years; as a result, the more the sophisticated pricing approaches used in California and Singapore (i.e., prices vary according to the costs imposed on other traffic) were not possible. The city plans to migrate eventually to a system with more advanced technology and pricing.

10 Ungemah, David H. and Swisher, Myron. “So you want to make a HOT lane?”. Texas Transportation Institute. 2006
11 Capital Beltway Hotlanes, accessed via www.virginiahotlanes.com

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Opportunity #2: Charge contractors for excess disruptions to roadway capacity

Although most road construction projects are planned to minimize disruptions to capacity, project delays and extensions can cause problems. One solution could be a payment scheme that motivates contractors to complete the work in a timely manner. For example, they could be charged — on a graduated scale, per lane/per day — for capacity losses.\(^\text{12}\)

Also, contractors should be encouraged to use leading construction methods and technologies. For example, rapid-cure roadway materials set faster than traditional materials, thereby decreasing lane downtime. One way to develop and promote efficiency and innovation is through centers of excellence (COEs) where companies could access the knowledge and leading practices of academia, industry, and government to complete construction projects faster and cheaper. COEs could distribute information to contractors and even potentially mandate their use. Simple approaches and tools like these have been successfully implemented elsewhere in the world (notably in London, UK).\(^\text{13}\)

Opportunity #3: Move New England to the forefront of aviation technology and services

Air transport has increased rapidly over the last 30 years, and the annual market outlook from The Boeing Company predicts that commercial air traffic will triple in the next 20 years because of the rise of a middle class in developing economies.\(^\text{14}\) New England should be proactive in providing access to these markets if it intends to sustain and increase its global competitiveness.

The New England Airport Coalition projects average annual increases in international travel of 4.7 percent through 2020 (see Figure 14). Airlines currently offer international flights out of New England airports, but there are very few, if any, direct flights to developing economies. To grow the economy and be competitive in the future, New England airports should look to increase access to emerging markets with nonstop flights to select cities; incentives, such as low priced leasing agreements, could motivate the airlines. Progress is being made on this front: for example, Boston’s Logan International Airport now offers nonstop flights to Tokyo (but, of course, Japan is a long-established economic power and does not possess the market potential of a Brazil, India, or China).

Figure 14: New England passenger forecast

![New England Air Traffic Passenger Forecast](image)

Source: The New England Airport Coalition

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\(^\text{12}\) TRL, Reducing Congestion from Highway Works (May 2012)

\(^\text{13}\) TRL, Reducing Congestion from Highway Works (May 2012)

\(^\text{14}\) The Boeing Company, Current Market Outlook 2011-2030 (23 May 2012)
In addition to increasing access to emerging markets, New England should continue to become an early adopter of the Next Generation Air Transportation System ("NextGen"), a combination of technology and process enhancements that include shorter routes and more efficient processes. The system is designed to reduce the cost of flights, ease congestion at airports and in the sky, reduce delays, and increase capacity — without the need for additional physical infrastructure, such as terminal gates and runways. The New England metroplex is eligible for implementation, but is not part of the initial rollout. The real reason New England’s airspace bottlenecks is the NY-PHL-DC airspace corridor. Current FAA’s efforts there will have a direct positive impact on Boston’s delay/bad weather reliability picture, since most traffic coming to and leaving the Boston area needs to fly through or around the NY-PHL-DC airspace corridor.

Given Massport’s investment in NextGen ground radar/communications as well as advanced GPS procedures, it should promote its brand as a reliable airport system (Figure 15).

Opportunity #4: Use innovative intermodal solutions to improve rail capacity and access

Rail transport is cost effective for freight transport and — just as important — it reduces overall roadway congestion. To realize these benefits, while increasing the flexibility and capacity of the region’s existing rail footprint, New England should use innovative intermodal solutions, which are a lower cost way of making the transportation system more dynamic, responsive to demand, and cost effective.

An example already working successfully in New England is RailRunner® — an intermodal freight operator based in Lexington, MA whose innovative rail offering (Terminal Anywhere®) increases shipping flexibility, while lowering costs and emissions, by allowing for intermodal hubs at strategic locations. These quick-transfer hubs — much smaller than a typical depot — decrease congestion and reduce wear and tear on highways. Figure 16 shows a schematic of the Terminal Anywhere® Solution.

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15 Targeted NextGen Capabilities for 2025, Joint Planning and Development Office, November 2011
16 http://www.railrunner.com

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Opportunity #5: Finds ways to use rapid bus transit

While rail-based rapid transit is core to an effective urban transportation systems — as an alternative to the automobile — it is not always practical. For one thing, rail transit systems cost a lot to build and expand, especially given the cost of land in today’s already crowded cities. Furthermore, successful operating models rely on population density to drive demand; a subway or light rail system would not be viable in many of New England’s smaller towns. Nonetheless these less dense cities have thousands of commuters that clog their transportation networks. What’s an alternative?

One New England city — Hartford, CT — is constructing a rapid transit busway, along the footprint of both former and current freight rail right-of-ways, which is designed to mimic the benefits of rail-based transit at a fraction of the cost. Figure 17 contains a map of the bus line. Serving as a dedicated surface road for bus travel, the system will provide a viable commuting option that will reduce automobile-based congestion and pollution. Other cities in New England should consider an opportunity such as this or other solutions for cost-effective traffic management.

Figure 17: Hartford bus way map

Source: http://ctfastrak.com/ctbusway/src/index.html

New England’s railroads, highways, seaports, and airports should be enhanced and maintained to meet the current and future needs of the local and global economies.

Case Study: Singapore

As the world population grows and globalization advances, the demand for transportation services only rises. Nowhere is this more evident than in cities. With population density comes stress on transportation systems, most designed to accommodate the traffic volume of an earlier era. Stress breeds congestion and, in turn, long transit times, high fuel costs, and damaging environmental impact. Faced with these challenges, many of the world’s cities are searching for solutions, and many are looking to Singapore for answers.

Singapore is a densely packed island, more than 3.5 times the size of Washington, D.C., with a population of more than five million. Yet, the traffic on the city’s roads flows smoothly, at nearly double the average speed of other, larger cities, such as Tokyo, Jakarta, and London. For this reason, Singapore is often heralded as the leading designer of successful transportation systems. Urban planners and transportation officials from around the world study Singapore’s approach (in fact, the country’s Land Transportation Authority has a division dedicated to hosting an “Academy” that “serves as a one-stop focal point for governments, organizations, and professionals around the world to tap Singapore’s know-how and exchange leading practices in land transport management”).

So what is Singapore’s secret to success? Perhaps more important is its consistent focus on innovation and its anticipation of future needs, first evidenced in 1975 when the government recognized that road expansion alone could not meet the future demands. At that time, Singapore became the world’s first urban center to institute congestion pricing for automobile use. Under the Area Licensing Scheme, motorists are charged a daily fee for entering the city. Today, Singapore continues to manage its transportation network aggressively, as evidenced by these programs:

- The Intelligent Transport System (ITS) integrates information from all other traffic management systems, controls 162 km of expressway, three tunnels, and 2,000 sets of traffic lights. The ITS center is operational 24/7.
- The Electronic Road Pricing (ERP) system — descendant of 1975’s daily congestion charge — is a network of dozens of overhead gantries located throughout major thoroughfares. Based on the specific location and time of day (traveling during peak hours and to certain locations costs more), the system charges each vehicle as it moves throughout the network.
- The Green Link Determining (GLIDE) system controls traffic lights by monitoring traffic conditions in real time; by synchronizing a “green wave” of lights, the system improves traffic flow.
- The Expressway Monitoring & Advisory System (EMAS) is an intelligent incident management system that notifies motorists of travel times. EMAS actively monitors traffic data (e.g., speed and vehicle occupancy) and detects incidents in real time based on video imaging software.
- Junction-Eyes (J-Eyes) are video-based monitoring devices that detect traffic conditions at major roadway junctions; the devices are deployed as part of the EMAS System to cover all expressways as well as on secondary arterial roads.
- TrafficScan Technology is a GPS-based monitoring system that analyzes average roadway speeds on major roadways based on actual vehicle speeds.

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18 Christopher Tan, “Singapore’s Transportation Secrets,” The Straits Times
19 Land Transport Authority (23 May 2012)
20 Road Pricing Strategy in Singapore (23 May 2012)
21 Change Mook Chong, Intelligent Transport Systems in Singapore, Land Transport Authority Singapore
Despite this impressive technology, traffic management is only half of the formula for success in Singapore. While the ITS network is virtually unmatched in its ability to monitor and adapt to roadway conditions, at a certain volume every system will become congested. To resolve this inevitability, Singapore also provides positive alternatives to car travel with a massive and continual investment in public transportation, namely rail and bus networks. In recent years, Singapore has announced plans to double its already quite considerable rail infrastructure by 2020. And the system, while not perfect, performs admirably: in a 2008 Gallup World Poll of 20 cities, residents of Singapore were the most satisfied with their public transport system. On the flip side, Singapore also discourages car ownership with a strict quota system and a significant charge for putting a car on the road (a charge that can equal 150 percent of the vehicle’s market value).

In The Straits Times, Christopher Tan summarizes Singapore’s strengths in transportation infrastructure: “Early planning. Timely action. Massive investment across many modes of transport.”

This last point cannot be ignored: the significant revenues from consumption-based pricing and car licensing provide funding for continued innovation and expansion. But perhaps the more important lesson to learn from the example set by Singapore is its bold vision and action more than 35 years ago.

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22 Singapore Land Transport Authority Master Plan
23 Tan, The Straits Times
Develop:
“Learnings with earnings”

A skilled workforce is fundamental for economic growth in New England. A 21st century infrastructure supports collaboration among communities, businesses, and educational institutions (especially community colleges and vocational schools) — a collaboration that links “learnings with earnings” by preparing people for gainful employment. In a new apprenticeship model, businesses invest in equipment and talent in the schools, while the schools develop the skilled labor needed for highly technical production jobs.

A new apprenticeship model
In a recent survey, Deloitte found that talent — that is, a highly skilled and educated workforce — ranked No. 1 among manufacturing in criteria for site selection. Not far behind — at No. 5 — is the quality of the physical infrastructure (Figure 18). By linking the two — by including talent development as part of its infrastructure strategy — New England could become a highly attractive choice for new businesses and overall economic growth.

Figure 18: Drivers of global manufacturing competitiveness

<table>
<thead>
<tr>
<th>Rank</th>
<th>Drivers</th>
<th>Driver score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Talent-driven innovation</td>
<td>9.22</td>
</tr>
<tr>
<td>2</td>
<td>Cost of labor and materials</td>
<td>7.67</td>
</tr>
<tr>
<td>3</td>
<td>Energy cost and policies</td>
<td>7.31</td>
</tr>
<tr>
<td>4</td>
<td>Economic, trade, financial, and tax systems</td>
<td>7.26</td>
</tr>
<tr>
<td>5</td>
<td>Quality of physical infrastructure</td>
<td>7.15</td>
</tr>
<tr>
<td>6</td>
<td>Government investments in manufacturing and innovation</td>
<td>6.62</td>
</tr>
<tr>
<td>7</td>
<td>Legal and regulatory system</td>
<td>6.48</td>
</tr>
<tr>
<td>8</td>
<td>Supplier network</td>
<td>5.91</td>
</tr>
<tr>
<td>9</td>
<td>Local business dynamics</td>
<td>4.01</td>
</tr>
<tr>
<td>10</td>
<td>Quality and availability of health care</td>
<td>1.81</td>
</tr>
</tbody>
</table>

Source: Deloitte and U.S. Council on Competitiveness — 2010 Global Manufacturing Competitiveness Index; ©Deloitte Touche Tohmatsu 2010

In fact, New England is at the convergence of two complementary forces to do just that: 1) advanced manufacturing capabilities (Figure 19) situated in industry clusters (as discussed in the “Exploit: Structural Advantages section” of this report) and a large number of public and private colleges and universities. One needs a skilled work force; the other can provide it.

Developing highly skilled workers is a relative strength in the region. For example, Massachusetts Institute of Technology (MIT) has been extraordinarily successful in capturing R&D funding and converting it into businesses; specifically, for every $1 billion in R&D funding, MIT creates 28 start-ups. But developing middle-level skills is a bit more problematic. Even during the recent recession, vacant jobs in sales management, advanced manufacturing, IT management, medical technology, and administration remained unfilled.
In the past, a middle-skilled worker would learn a craft as an apprentice. While that model is no longer in vogue, a new type of apprenticeship model is emerging, as community colleges and vocational schools collaborate with local businesses and communities to offer learners an opportunity to become earners. For example, in Rochester, New Hampshire, two businesses, the city and state governments, and a community college, worked together successfully to do that. Albany Engineered Composites developed novel technologies for weaving and molding carbon fibers into very light and strong fan blades for jet engines. Its major customer, Snecma/Safran, partnered with the company to make a $100 million investment in a 275,000 square-foot production facility. Rochester city officials secured and prepared the land for construction, while Great Bay Community College stepped up to develop a manufacturing training center and program. Now, 400 students are enrolled.\textsuperscript{25} The cost of the training programs were being somewhat offset by statewide grants.\textsuperscript{26}

Of course, creating these collaborative partnerships across New England would require significant change management. The linkages — between communities and businesses, between businesses and community colleges — would likely have to be systematic and purposeful. Communities would need to be facilitators (not obstructionists); businesses would need to define their skill needs clearly and then actively educate stakeholders in their commitment to economic development; and schools would need to develop a curriculum relevant to workforce and career development. Figure 20 illustrates a well-functioning partnership consistent with the Rochester example.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure20.png}
\caption{Aligning educational assets with economic and workforce development}
\end{figure}

\textsuperscript{25} "The Case for Community Colleges: Aligning Higher Education and Workforce Needs in Massachusetts," The Boston Foundation, November 2011

\textsuperscript{26} Great Bay Community College News Releases

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Across New England, alignment issues remain, beginning with the lack of a proven and easy-to-replicate framework for making "learnings with earnings" happen. Even though these three groups — communities, businesses, and schools — might share common interests; they have limited history of working together. Even within their own organizations, each of the stakeholders might have distractions; for example, community colleges often have multiple missions that leave them somewhat unfocused (the most highly focused and best funded state community college system is in North Carolina; on the other hand, the system in Massachusetts is less focused and somewhat underfunded in comparison).27

Overall, multiple disconnects would have to be addressed:

- Community colleges generally do not engage employers — at least, not proactively — in developing training that satisfy markets for middle-skilled labor; even today, with employment rates making headlines every day, many good jobs remain vacant in New England.
- Schools need to do a better job of transferring credits, in updating curriculum, and in acquiring the relevant assets/equipment. Vocational high school training programs should find ways to offer credit toward a degree at the community college when the course work is equivalent.
- Employers need to increase their visibility in the community, while pushing their job skill agendas. They should also expand on-site and on-the-job training, provide more internships, and increase donations of machinery and equipment to local schools.
- Communities (and state governments) should try to increase subsidies for training employees as well as for new employee wages, reduce restrictions on vocational high schools, and support funding for enrollment in both community colleges and technical high schools.

When "learnings" and "earnings" are linked, the economic benefits can be powerful, as evidenced with Worcester Technical High School. This breakthrough school, committed to excellence in academic and technical education, works with more than 15 local businesses; community support is enthusiastic (Figure 21). Worcester Technical High School sees its mission as the development of highly qualified, technically proficient employees who can compete in a global economy. Supporting the school is the Skyline Technical Fund, a private, nonprofit organization that helps fund the state-of-the-art equipment, technology, and materials to enhance programs, sharing this burden with community taxpayers. Graduates of the school typically get several job offers; somewhat unexpectedly, 70 percent go on to a four-year college.28

Figure 21: New Apprenticeship Program: Vocational training, community, and business partners

Source: Worcester Technical High School news releases

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27 Great Bay Community College News Releases
28 Worcester Technical High School News Releases
While there is a preconceived notion that a four-year degree is required to be successful in America, this is not always the case. In fact, 27% of people with a postsecondary license or certificate earn more than the average bachelor’s degree recipient. And these jobs are growing – Figure 22 shows the projected job growth for jobs requiring associate and vocational degrees versus those requiring more or less education. The key is not the level of education, but rather matching education with the demands of the market.

Figure 22: Occupation Training and Employment Growth

In an example of a company taking charge, Hypertherm, an innovative advanced manufacturer in New Hampshire, worked with the Vermont High Tech Council to create a world-class onsite training institute and online curriculum, as well as a distinctive program of student mentoring and coaching. In addition, Hypertherm has a partnership with the River Valley Community College’s Skills Through Apprenticeship and Retraining (STAR) program. Launched in December 2008, the STAR program offers Hypertherm employees an accelerated, two-year advanced manufacturing apprenticeship. At the same time, these workers earn 27 college credits and a Certificate in Advanced Machine Tool Technology, which can be applied towards an associate’s degree at the college.

In the three examples cited here, a collaboration among businesses and communities resulted in effective workforce development programs. The participants did not wait for labor markets to materialize; they created new opportunities that matched demand and supply. This proactive commitment to growth can be replicated across New England, especially in the home-shoring subregions where structural costs are lower and community colleges are prevalent. (Another advantage: students in two-year colleges tend to stay in the area after graduation compared to students in four-year colleges). Recent initiatives in Rhode Island, New Hampshire, and Massachusetts are already proving the value of the new apprenticeship concept.

Partnerships — among communities, businesses, and community colleges — benefit everyone by preparing people for productive employment and by attracting companies to a region that’s committed to their prosperity.

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29 Harvard Graduate School of Education, Pathways to Prosperity – Meeting the Challenge of Preparing Young Americans for the 21st Century, February 2011
30 “Hypertherm adds more jobs” NhEconomy.com, June 14, 2011

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Case Study: A German model comes to the U.S. 21

In Germany, more than 600,000 workers are trained through apprenticeship programs that involve industry, technical schools, and trade guilds. In the U.S., 600,000 skilled manufacturing positions remain vacant, even as unemployment levels remain frustratingly high. U.S. companies generally avoid apprenticeship programs, fearing either that the newly trained worker would flee to a new opportunity or that the program would be too costly for small enterprises. But as the German model shows, it is better to build a workforce than to assume that the labor market will react in a timely fashion.

Now, German companies opening facilities in the U.S. are bringing their version of the apprenticeship model with them. Community colleges in the South are tailoring academic programs for specific company needs, while the companies themselves are offering hands-on skill training in paid internships. Graduates typically get job offers after graduation. Here are three examples:

1. **Tennessee.** A partnership between Chattanooga Community College and Volkswagen AG created an apprenticeship program of vocational schooling in robotics and complex assembly operations (Figure 23).

2. **South Carolina.** In Charleston, Robert Bosch GmbH has been running an apprenticeship program with partner Trident Technical College since the 1970s. Following Bosch’s success, a dozen other industrial and A&D companies have now partnered with Trident.

3. **North Carolina.** In Charlotte, Central Piedmont Community College has partnered with 18 local companies, including the German enterprise, Siemens, as well a few U.S. companies, such as CAT and Timken.

It appears that these vocational community college-business partnerships in the South are gaining traction and supplying a reliable pool of skilled workers — that is an important message for New England.

Figure 23: Volkswagen Academy

Pristine and state-of-the-art, the Volkswagen Academy is a 162,000 square foot facility that blends traditional classroom and laboratory instruction with hands-on training opportunities. This educational strategy exposes individuals to critical and essential automotive manufacturing concepts and equipment with a goal of developing an exceedingly well-qualified, technologically-literate, and highly-skilled workforce.

Source: Chattanooga Community College News Release

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21 “Germany’s New Export: Job Training”, Wall Street Journal, 14 June 2012
Finance: 
Creative and innovative options

New England cannot rely on federal spending and gas taxes to pay for a “smart” infrastructure. What is needed instead — and what is, in fact, an emerging leading practice — are new ways of financing and funding infrastructure investments, as well as an increase in the use of public-private partnerships.

New funding and financing gaps
How to pay for needed infrastructure improvements? That is always the question at the end of the day, and when it comes to project funding and financing, there is never an easy, one-size-fits-all answer.

Despite the economic recovery, tax revenues in most states remain below prerecession levels, and the political pressure to balance budgets and decrease discretionary spending just keeps mounting. Today’s infrastructure is aging or already old, so projects for improving competitiveness through capacity utilization or expansion compete against those for necessary maintenance and repair. Traditional funding and financing sources just cannot meet the demand.

For example, the federal gas tax, the primary source of federal funding for transportation infrastructure, has remained at $0.184 per gallon since 1993 — a 33 percent reduction in real purchasing power — and there is insufficient political will to increase that rate in the near future. In fact, the problem is exacerbated as fuel-efficient vehicles reduce gas consumption. Not surprisingly, the National Highway Trust Fund has operated at a deficit since 2008.

The American Society of Civil Engineers estimates the gap between demand for investments and available funding to be $2.2 trillion over the next five years. See Figure 24 for estimated spending needs and shortfalls by infrastructure category. The challenges are significant, to say the least.

Figure 24: Five-year U.S. infrastructure needs and funding (in billions)

Source: American Society of Civil Engineers

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32 National Surface Transportation Infrastructure Financing Commission, Paying Our Way: A New Framework for Transportation Finance (February 2009)
33 American Society of Civil Engineers, 2009 Report Card for America’s Infrastructure (January 2009)
Options in infrastructure financing

In the past, infrastructure financing has come from pay-as-you-go cash transactions and tax-exempt municipal bonds. Now shortfalls are necessitating the infusion of private capital to augment these traditional sources, to accelerate project implementation, and to align financing with the useful life of the infrastructure. Private funds have committed an estimated $170 billion in equity capital to infrastructure investment — a 27 percent CAGR since 2006. For example, this year the Texas Department of Transportation finished a $2.5 billion expressway project in Fort Worth for just $573 million cost to taxpayers. In Chicago, Mayor Rahm Emanuel has lined up $1.7 billion in Public Private Partnership funds from the likes of Citi Bank, JPMorgan, and others. Such initiatives should grow even more in the future, as institutional investors, such as pensions, look for opportunities with stable, and low-risk returns.

New England could increase the use of tools and approaches designed to attract greater private investment in infrastructure. Here are several examples:

An infrastructure bank (IB) provides relatively low-interest loans and loan guarantees for infrastructure projects and uses the proceeds from loan repayments to make additional investments. In addition to stimulating local and private investment (e.g., an IB may stipulate that a certain percentage of financing come from other sources), IBs can provide flexible project financing through interest rates and repayment terms that align with the expected funding stream that will be used to repay the loan.

While there are several National Infrastructure Bank (NIB) proposals pending, it is uncertain when and if any of these will be approved. As an alternative to a NIB, New England can look to expand the use of State Infrastructure Banks (SIBs) or potentially create a regional infrastructure bank to address cross-state investments. As of 2010, there were 32 states with active SIBs that had entered into 712 loan agreements worth $6.5 billion. In New England, only Vermont, Maine, and Rhode Island have SIBs with loan agreements totalling $5 million. Figure 25 shows the loan agreements of New England states relative to the largest SIBs, including “lessons learned” that could apply in New England.

Figure 25: SIB loan agreements: “Lessons Learned”

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**Lessons Learned**

- Reduce federal regulations and restrictions through fully state funded SIB segment
- Enable decision making that can operate outside of political influences
- Develop comprehensive processes to select projects based on financial and social ROI
- Leverage multiple funding sources, both traditional and innovative
- Enable and encourage cross-jurisdiction investments

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35 U.S. Department of Transportation Federal Highway Administration, State Infrastructure Banks Fact Sheet (2012)
Private Activity Bonds (PAB) enable bonds issued to projects with significant private sector participation to retain tax-exempt status; SAFETEA-LU allows for $15 billion in bonds, of which $7.5 billion in allocations had been approved as of May 4, 2012, for 13 projects, none of which are in New England.36

Real Estate Investment Trusts (REITs) can also attract private investors for infrastructure maintenance and development projects. Among the advantages of infrastructure REITs are their liquidity, access to diverse institutional and individual investors, scalability, and tax advantages.37

Social Impact Bonds, also known as "Pay for Success Bonds," first launched in the UK in 2010. They are sold to private investors who are paid only if the project meets certain success criteria. The bond issuer pays a fixed return for verifiable results and can retain any additional benefits.38 Massachusetts has expressed interest in piloting these bonds and two leading companies in the space, Social Finance Inc. and Third Sector Capital Partners, are located in Boston.

Tax Credit Bonds reduce borrowing costs by providing the investor with tax credits, rather than interest payments, which can be used to offset tax liability. Programs are currently in place for renewable energy projects, energy conservation, and new school construction.39

Transportation Infrastructure Finance and Innovation Act (TIFIA) provides federal credit through direct loans, loan guarantees, and standby lines of credit for surface transportation projects with dedicated revenue streams. With low interest rates and flexible payment terms, TIFIA is similar to an NIB, but its funds are limited. The program has provided more than $3.6 billion in credit assistance to fund more than $16 billion in investments.40 Interlink in Rhode Island is the only New England project to use TIFIA.

Options in infrastructure funding

Attracting private financing is part of the solution, but addressing funding gaps is an even greater challenge. Here are two ways to “monetize” the value of infrastructure improvements.

• **Aligning charges with usage** — For some forms of infrastructure, such as energy and broadband, providers charge users for consumption or access to services. For others, such as transportation, user fees are typically not directly connected to consumption (e.g., vehicle registration fees) or have limited implementation (e.g., tolls). While consumption-based user fees are controversial, they do provide the dual benefit of raising funds for infrastructure development and maintenance and providing a way to manage demand for constrained resources. For example, congestion pricing can incentivize commuters to car pool or use major highways during nonpeak hours.

• **A Vehicle Miles Traveled (VMT) fee** — or a payment based on distance travelled — could augment or replace the gas tax, as well as provide a means for controlling traffic congestion. In its simplest form, VMT could consist of a periodic odometer check; however, GPS technology could also enable congestion pricing for toll and non-toll roads alike. Today, VMT is used for trucks in Germany and is being piloted in Oregon. Additional examples of potential user fee approaches are shown in Figure 26.

![Figure 26: Sample user fee funding approaches](http://www.transportation-finance.org/funding_financing/funding/proposed_funding_sources)
• **Taxing those who benefit** — “Value capture funding” means requiring beneficiaries to pay more for infrastructure. And why not? A good infrastructure can have positive impacts on property values, supply chain efficiencies, and overall economic prosperity. The value is typically captured by the property developers or owners; value captured funding collects a portion of this value and uses it to repay loans or to invest in infrastructure improvement.

Figure 27 shows several available options for value capture funding. Most of these methods have been used at the local level, but could be applied to larger, more regional projects. Of course, the larger the project scope, the greater the required coordination between local and state governments, since land use is typically controlled at the local level while transportation planning is managed by state or municipal governments. Also important is the effective communication of the value of the infrastructure investment: in some cases, multiple projects can be bundled into an infrastructure improvement program that can be pitched to constituents to gain approval for temporary or permanent tax increases.

**Figure 27: Sample value capture approaches**

<table>
<thead>
<tr>
<th>Funding source</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Value Tax</td>
<td>• Separate taxation of the land portion of property to better capture the benefit of infrastructure investments, usually through a split rate property tax</td>
</tr>
<tr>
<td>Tax Increment Financing (TIF)</td>
<td>• Using the prospect of increased property taxes resulting from the project to secure bonds; tax increment above baseline level is used to repay loans</td>
</tr>
<tr>
<td>Special Assessments</td>
<td>• Similar to TIF, except members of the benefiting district pay directly for the cost of improvement</td>
</tr>
<tr>
<td>Local Option Sales Tax</td>
<td>• Small premium (between 0.5% to 1.0%) on top of the state sales tax, applied only within a particular local jurisdiction</td>
</tr>
<tr>
<td>Development Impact Fees (DIF)</td>
<td>• One-time charges levied on development projects designed to finance new infrastructure and services associated with new development</td>
</tr>
<tr>
<td>Negotiated Extractions</td>
<td>• Similar to DIF, with the exceptions that they are not typically applied to off-site infrastructure provisions, but to contributions to local roads, parts, etc.</td>
</tr>
<tr>
<td>Joint Development</td>
<td>• Private partner provides facility or financial contribution for spatially coincidental infrastructure and adjacent private real estate development</td>
</tr>
<tr>
<td>Air Rights</td>
<td>• Establishment of development rights above (or in some cases below) infrastructure asset that generates an increment in land value</td>
</tr>
<tr>
<td>Shared Resources</td>
<td>• Private donations of telecommunications technology (principally fiber optic), and sometimes cash, granted in exchange for access to public rights-of-way</td>
</tr>
<tr>
<td>Unlock Value of Underutilized Assets</td>
<td>• Utilizing existing government assets that are undervalued or underutilized through sale, swap, or joint development of those assets</td>
</tr>
</tbody>
</table>


University of Minnesota Center for Transportation Studies, *Value Capture for Transportation Finance* (2009)
Public Private Partnerships (PPPs)
To make the most of limited infrastructure funding, governments are looking to the private sector not only for financing, but also for assistance in infrastructure design, build, operation, and ongoing maintenance. Innovative Public Private Partnerships (PPPs) can provide a greater return on each dollar spent in the form of economic and social benefits with lower overall risk.

Also, for the right projects, PPPs can drive improvements to infrastructure project costs, schedules, and service levels. PPPs enable effective risk-sharing and performance-based contracts that align incentives and accountability with the overall project objectives. This can reduce “design and build” costs and schedule overrun, while improving maintenance over the life of the infrastructure asset. PPPs also allow governments to leverage private sector innovation and leading practices.

Adoption of PPPs has been slower in the United States than in other parts of the world, but there are several lessons learned that can be applied to future PPPs in New England.

Lesson learned #1: Create a supportive legislative framework
PPPs require a legislative framework that promotes flexibility (in the types of partnerships and contract terms that can be used), that enables clear authority for government PPP decision makers, and that allows unsolicited proposals from private entities. In 2009, Massachusetts became the first state in New England to enact PPP supportive legislation.

Lesson learned #2: Use “value for money” or a similar analysis for project selection
Project selection is a critical part of infrastructure investment; for PPP projects to succeed, the costs and benefits of the entire project lifecycle should be considered. Public Sector Comparator/Value for the Money (PSC/VFM) analysis is one tool for improving project selection; it determines the difference in risk-adjusted cost to the public sector between conventional procurement and PPP procurement to find the lower cost or the greater value. PPP should not be considered if higher VFM cannot be proven.\(^2\)

Lesson learned #3: Select the appropriate partnership model to optimize, not increase, risk transfer
Governments have a tendency to want to transfer either too much or too little risk to the private sector. But the real question should be: which party is best equipped to manage a given risk factor? Improper risk allocation can result in the government overpaying for private sector risk management or in unrealistic service level expectations, which price potential partners out of the market.

Lesson learned #4: Establish a dedicated PPP unit to manage design and implementation
The range of partnership models and their potential complexity make it difficult to manage PPPs through traditional public sector procurement organizations and processes. PPPs are a new way of doing business for most public entities, and they require more advanced financial and negotiating skills. Developing a dedicated PPP unit could help New England state governments to develop these skills and expedite the PPP procurement process.

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\(^2\) Deloitte, Partnering for Value: Structuring effective public-private partnerships for infrastructure (2009)

State governments are looking to the private sector not just for money, but also for help in infrastructure design, construction, operation, and maintenance.
Case Study: I-595 high occupancy toll lanes PPP

In early 2009, the Florida Department of Transportation (FDOT) entered into a $1.8 billion 35-year concession with a private consortium headed by ACS Infrastructure Development to build and operate high-occupancy toll lanes near Fort Lauderdale.

FDOT will set toll rates, retain all revenues, and make annual “availability payments” to the private concessionaire out of all of its revenues (including state appropriations, tax revenues, and tolls).

Financing was a combination of partner-provided private debt and equity and a $600 million TIFIA loan, a structure that allows as much public sector control over rate-setting as possible, while also ensuring that the private concessionaire is motivated to operate and maintain the road efficiently at the desired standard (Figure 28). The project represents the first U.S. toll road PPP structured with performance-based availability payments.

Source: Deloitte, Partnering for value, Structuring effective public-private partnerships for infrastructure (2009)
Expected benefits

Analysis suggests that a $1 billion investment in infrastructure could create approximately 22,000 to 27,000 jobs and increase New England’s GDP by approximately $9 billion.

What kind of positive economic benefits could New England expect from the ideas suggested in this report?

Benefit #1: GDP and job growth

According to the U.S. Chamber of Commerce, for each percentage point gained in its Transportation Performance Index (TPI) — a measure of availability, quality, and utilization across all means of passenger and commercial transportation — there is a corresponding 0.3 percent increase in GDP.43 Figure 29 shows the annual U.S. TPI score and Federal Transportation Expenditures from 1990 through 2009.

Figure 29: Transportation index and federal transportation expenditure

43 (www.uschamber.com/sites/default/files/ira/files/LRA_Transp_Index_Key_Findings.pdf)
Other studies suggest similar economic benefits. For example, Cesar Calderon and Luis Serven (both with the World Bank) studied more than 100 countries to find a positive correlation between infrastructure quality and economic growth from 1960 through 2000 (Figure 30).\(^44\) Research completed by economist David Aschauer also suggests that a one percent increase in infrastructure investment corresponds to a 0.24 percent increase in GDP.\(^45\) Lars-Hendrik Roller (Social Science Research Center Berlin) and Leonard Waverman (University of Calgary) studied the relationship between investments in telecommunications infrastructure and economic growth, analyzing data from 21 countries over a 20-year period; they found positive correlations between the number of communications lines and GDP. In addition, their model indicated that an increase in penetration rate would result in a significant increase in economic growth.\(^46\)

Figure 30: Infrastructure quality versus economic growth

![Infrastrucure Quality vs Economic Growth](image)


Using all this research, we can estimate how much an investment in infrastructure could boost GDP and create jobs in New England. Three investment scenarios and the results are outlined in Figure 31. A $1 billion investment in infrastructure could result in 22,000 to 27,000 new jobs in New England. Note: these figures do not include additional temporary jobs from construction activities, project management, and other implementation work. Jobs growth could be realized two to three years after infrastructure investments.

Figure 31: Estimated GDP growth and jobs created

<table>
<thead>
<tr>
<th>Incremental Investment</th>
<th>GDP Growth</th>
<th>Jobs Created</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low ($500 Million)</td>
<td>$4.3B to $4.9B</td>
<td>10,875 — 13,500</td>
</tr>
<tr>
<td>Medium ($1 Billion)</td>
<td>$8.5B to $9.7B</td>
<td>21,750 — 27,000</td>
</tr>
<tr>
<td>High ($2 Billion)</td>
<td>$17B to $19.4B</td>
<td>27,000 — 54,000</td>
</tr>
</tbody>
</table>


Assuming that New England invests $1 billion over the next five years (beginning in 2013), approximately 135,000 new jobs could be created from 2013 through 2020. See Figure 32 for projected job growth and Figure 33 for projected GDP growth.

Figure 32: Cumulative projected jobs created from $1 billion infrastructure investments

Figure 33: Projected return on infrastructure investments (growth in GDP)
Benefit #2: Foreign Direct Investment

Foreign Direct Investment (FDI) generally occurs in regions with high-performing transportation infrastructures since companies need to be efficient in moving goods and people within a region and around the world. The last decade has seen an increase in total global FDI in manufacturing, rising on average 12.4 percent annually from 1990 through 2006. In the United States, FDI created more than 300,000 new jobs in 2008.

The percentage of jobs resulting from FDI for New England states is higher than the national average. For example, in New Hampshire, FDI funds 22 percent of all manufacturing jobs. Competition between countries and regions to attract FDI is increasing and infrastructure may be the deciding factor in some cases (see Figure 34 for the relationship between FDI and the U.S. Chamber of Commerce TPI). Given the attractiveness of New England’s advanced manufacturing sector, infrastructure improvements could likely attract additional businesses to the region.

![Figure 34: FDI versus Transportation Performance Index (TPI)](image)


Benefit #3: Wealth creation

Research suggests that investments in transportation infrastructure can raise property values in a region. When efficient highways make traveling easier, people can live farther from where they work and companies can consider locations outside of major cities. The demand for housing rises.

For example, researchers at the University of Iowa found that an infrastructure-related increase in demand for housing generally correlates with an increase in housing prices. Using the I-494 highway project in the Minneapolis-Saint Paul area as a case study, they concluded that over a three-decade period the land values associated with the construction of I-494 increased because of improved regional access, greater local growth, and positive land usage policies.

Similarly, Calderon and Serven found that infrastructure quality has a negative correlation with income inequality (Figure 35). Their work and other studies suggest that infrastructure investments help reduce poverty.

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47 (www.ita.doc.gov/td/industry/oea/state_reports-2006)
48 David Forkenbrock, et al, Transportation Investment and Urban Land Use Patterns (2001)
If New England invested $1 billion each year for five years (beginning in 2013), approximately 135,000 new jobs may likely be created from 2013 through 2020.

Manufacturing Institute, Report on the Structural Cost of U.S. Manufacturing (October 2011)
Recommendations

New England should work to improve its infrastructure, but just throwing money at the problem is not the answer. Infrastructure investments should be strategic, carefully planned, and innovatively funded to achieve a return on invested capital.

Based on our joint Deloitte-NEC research, we make the following recommendations:

1. **Create new laws that authorize and support public-private partnerships** for infrastructure projects within New England. The region will not be able to finance projects with traditional tax methods. Innovative approaches and leading practices will need to be employed.

2. **Create a regional infrastructure bank** to address financing needs for interstate investments by allowing states to work together to increase the return on investment for the region.

3. **Assess traffic patterns** in New England and implement a consumption-based pricing solution to relieve congestion on critical roadways. Evaluate the use of HOT lanes on I-93 through Boston and I-95 through Providence.

4. **Offer incentives to airlines to add international flights from Boston to emerging markets** (such as India and China). Mechanisms could include marketing support, waived fees, low-priced terminal leases, and revenue guarantee programs.

5. **Work with the FAA to continue to adopt NextGen technologies**, which will help reduce costs and delays for flight in and out of the Boston metroplex; in addition, promote Massport’s brand of a reliable airport system.

6. **Develop a plan to repair/upgrade the energy/natural gas transmission infrastructure, with goals of reducing costs** to the consumer and increasing or maintaining reliability.

7. **Maintain existing nuclear power plants**. Although nuclear power plants in New England have come under criticism, the region should maintain existing nuclear power plants, since they are a source of lower-cost power and help to maintain fuel diversity.

8. **Develop a framework for collaboration** that connects companies with community colleges and vocational schools to *develop training programs that meet the needs of the labor market* and serve as a feeder for internships and full-time positions.
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About The New England Council
Founded in 1925, The New England Council is the nation’s oldest regional business organization. The Council is a non-partisan alliance of businesses, academic and health institutions, and public and private organizations throughout New England formed to promote economic growth and a high quality of life in the New England region.

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