2012
Comprehensive Energy Strategy for Connecticut

Draft for Public Comment

PREPARED BY

The Connecticut Department of Energy
and Environmental Protection

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Executive Summary

Connecticut's Draft Comprehensive Energy Strategy gives the State a more systematic basis for addressing energy opportunities and challenges. It provides a foundation for better informed policy, regulatory, and legislative decisions – as well as better energy choices at the household and business level. This Draft Strategy covers all fuels in all sectors with a planning horizon out to 2050. It offers analysis of the State's current energy circumstances and a set of recommendations designed to advance the Governor's agenda of moving Connecticut toward a cheaper, cleaner, and more reliable energy future.

At the heart of the Draft Strategy is a series of policy proposals aimed at expanding energy choices, lowering utility bills for Connecticut residents and businesses, improving environmental conditions, creating clean energy jobs, and enhancing the quality of life in the State. The Draft Strategy offers recommendations in five major priority areas:

- Energy efficiency
- Electricity supply including renewable power
- Industrial energy needs
- Transportation
- Natural gas

In integrating energy, environmental, and economic goals, the Draft Strategy breaks new ground and advances a broad and robust structure for thinking through energy options. It moves away from subsidizing favored technologies or companies toward a flexible "finance" model that encourages entrepreneurship and private sector leadership in scaling up clean energy projects. Emphasis is placed not on picking "winners" but on using limited government resources to leverage private capital and increase the flow of funds into energy efficiency, renewable power, natural gas availability, and a 21st century transportation infrastructure that promotes mobility options, transportation-oriented development, and market-based opportunities for clean fuels and clean vehicles.

This Draft Strategy builds on the fundamental premise that the public's interest in and ongoing commitment to clean energy depends on the emergence of new technologies that out-compete fossil fuel alternatives. It therefore proposes an array of economic incentives designed to drive down the cost of new energy technologies. By harnessing market forces and competitive pressures, this policy framework promises to spur innovation while offering support for a portfolio of renewable power generation alternatives.

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The Draft Strategy further seeks to align Connecticut's energy future with the emerging opportunity provided by shale gas for a lower-cost, less-polluting, and domestically available (and thus more reliable) foundation for society's energy needs. In identifying natural gas as a bridge to a truly sustainable energy future, it puts forward a seven-year game plan for expanding natural gas use across Connecticut with a goal of providing nearly 300,000 Connecticut homes, businesses, and other facilities with access to gas.

DEEP analysis suggests that the initiatives advanced below will measurably reduce Connecticut's greenhouse gas emissions -- putting the state on a trajectory toward progress on climate change. But significant additional measures and breakthrough technologies will be required to achieve the goal of an 80% emissions reduction by 2050 as spelled out in the State's 2008 Global Warming Solutions Act.

ENERGY EFFICIENCY STRATEGY

Energy conservation offers a mechanism for reducing utility bills for every family and business in Connecticut while creating thousands of new jobs. The Draft Strategy calls for an expanded commitment to "all cost-effective" energy efficiency through programs that will:

- Reach all sectors and all buildings – government, municipalities, universities, colleges, schools, hospitals, places of worship, commercial and industrial facilities, and homes including houses, apartments, condos, and senior living centers – with special focus on groups that have not been fully reached by past efficiency programs such as small businesses and the low-income community
- Go beyond a traditional focus on upgraded lighting and weather stripping to deliver deeper efficiency gains in heating, air conditioning, ventilation, insulation, windows, furnaces, boilers, and other appliances such as refrigerators as well as process efficiencies in the manufacturing sector
- Leverage private capital through innovative financing mechanisms including Connecticut's first-in-the-nation Green Bank (the "Clean Energy Finance and Investment Authority"), standardized energy efficiency performance contracts, and the State's new Commercial Property-Assessed Clean Energy (C-PACE) program
- Reinvigorate and broaden the existing Home Energy Solutions program to ensure that additional ratepayer dollars achieve maximum reach and impact
- Incentivize Connecticut's utilities to deliver on efficiency goals through "decoupling" and other performance-based mechanisms
- Establish building efficiency standards for both new construction and retrofits as well as a mechanism for benchmarking building efficiency and disclosing efficiency scores at the time of rental or sale
- Advance information technology opportunities for greater efficiency including a smart grid, advanced meters, and smart appliances on a carefully structured basis.

Executive Summary

ELECTRICITY SECTOR STRATEGY

Providing Connecticut's citizens with cheaper, cleaner, and more reliable electricity is a core focus of the Draft Strategy. To advance this agenda, DEEP proposes to:

- Build on the analysis of the recently released Integrated Resources Plan to ensure that Connecticut has adequate power generation capacity over the next decade to match electricity supply with demand
- Keep both generation and transmission costs down through proper planning, infrastructure investments, and engagement in federal and regional energy decisionmaking processes including increased scrutiny of the rules and incentives established by the Federal Energy Regulatory Commission and the Independent Systems Operator (ISO New England) which runs the wholesale electricity marketplace in our region
- Use economic incentives (including reverse auctions, declining subsidies, Power Purchase Agreements, etc.) to bring down the cost of renewable electricity, spur innovation, and promote a portfolio of alternative energy technologies that can compete with existing fossil fuel generation over time
- Focus on the deployment of renewable energy at scale using limited government resources to induce private sector investment through the Connecticut Green Bank (CEFIA), Zero (and Low) Emissions Renewable Energy Credits, and other innovative financing mechanisms
- Study Connecticut's Renewable Portfolio Standard (which calls for 20% renewable power by 2020) with an eye toward considering: (1) raising the target, (2) broadening what counts as "renewable," and (3) expanding in-state clean power generation
- Promote more "distributed generation" with proposals to expand virtual net metering and examine submetering, and to launch a pilot program of microgrids that would keep critical facilities (hospitals, prisons, sewage treatment plants, etc.) and core services (police and fire departments, warming centers, grocery stores, gas stations, pharmacies, banks, and phone charging locations) in a number of cities and towns "up" when the grid is down
- Ensure greater grid resilience through tree trimming, hardening of wires and poles, and funding for improved information technologies that allow outages to be tracked and restored more quickly while providing better communications with affected communities and individuals
- Launch an Advanced Energy Innovation Hub at UConn in the University's new Technology Park that would support basic research on topics such as: fuel cells, batteries and storage, microgrid engineering, and small-scale hydropower.

INDUSTRY SECTOR STRATEGY

Connecticut's competitiveness and prospects for economic growth require special attention to energy needs in the manufacturing sector. Thus, the Draft Strategy proposes to:

- Ensure that expanded energy efficiency programs reach all of the State's manufacturing companies
- Provide the industrial sector with support for efficiency investments that go beyond buildings to include specialized process efficiency programs and combined heat and power projects
- Prioritize factories and other industrial "anchor loads" in the extension of natural gas mains
- Launch a Clean Energy Business Solutions Program to be managed by CEFIA under the direction of the Department of Economic and Community Development in support of job creation and retention where energy costs are a critical factor

TRANSPORTATION SECTOR STRATEGY

Cars, trucks, buses, trains, and planes account for 32% of the energy consumed in Connecticut and an even higher percentage of the fossil fuels burned. Providing the State's citizens with mobility options is therefore a high priority of the Draft Strategy, which calls for:

- Expanded commitment to transport-oriented development and a broader mobility focus that encourages bikeways, walking paths, and other quality of life investments
- Secure funding for transportation infrastructure in support of reduced road congestion, improved air quality, and a strengthened platform for economic growth and job creation
- Investment in a clean fuels/vehicles initiative that will ensure that the basic infrastructure needed for vehicle choice will be in place including:
- Sufficient electric vehicle charging stations (about 100 statewide) so that no one in the state need suffer from "range anxiety"
- Support for conversion of fleets (delivery vans, taxis, garbage trucks, public works vehicles, etc.) to natural gas in conjunction with private sector-funded construction of natural gas filling stations that will be publicly available
- Establishment of a core set of Liquefied Natural Gas stations at truck stops in support of the growing number of long haul trucking fleets considering conversion to natural gas as their primary fuel
- Expanded hydrogen filling stations as demand for fuel cell-powered vehicles grows
- Support for better fuel economy in Connecticut vehicles and development of second-generation biofuels such as biodiesel from food waste

NATURAL GAS SECTOR STRATEGY

America's energy situation has been dramatically transformed by the increased availability of domestic shale gas at prices that are now significantly lower than oil. One of the nation's largest reserves of this gas, the Marcellus Shale, is in Pennsylvania and New York (as well as Ohio and West Virginia) less than 100 miles off Connecticut's western border. Because natural gas combustion produces lower emissions than oil or coal, conversion to natural gas promises a cheaper, cleaner, and more reliable fuel for heating, power generation, and perhaps transportation. DEEP acknowledges that there are significant environmental and public health issues associated with the drilling and transport of natural gas, which the State will actively address wherever possible.

As things now stand, Connecticut is not well positioned to take advantage of the emerging natural gas opportunity. Only 31% of Connecticut homes heat with gas today, compared with 47% in Massachusetts and 48% in Rhode Island. The percentage of commercial and industrial entities with access to gas is only slightly higher. The Draft Strategy proposes to make gas available to as many as 300,000 additional Connecticut homes and businesses, beginning with the roughly 217,00 customers who are on gas mains now but not heating with gas. Specifically, it calls for:

- Financing options to be made available to homeowners and businesses to eliminate the upfront burden of converting furnaces, boilers, and other appliances to natural gas – with the average residential cost of about $7500 being paid back over a decade through an "on-bill repayment" system that would be collected by the gas companies (but funded by banks and the capital markets), providing the average household with immediate cost savings of about $800 per year
- Alternative financing for low-income homeowners through community banks and credit unions with the State providing incentives or financing through CEFIA
- Regulatory changes (i.e., extended payback periods) that would enable potential gas customers who are not on but are near gas mains to have their connections financed by the State's three gas companies and repaid through the added revenues of the new customers
- Roughly 900 miles of gas mains to be built with a particular focus on providing "anchor loads" (factories, hospitals, schools, or other facilities with significant energy consumption) with access to gas mains
- Funding as follows:
    - The $3 billion needed for heating system conversions to be funded by private capital
    - The roughly $815 million required to connect those on or near gas mains to be financed by the gas companies

    - The approximately $1.4 billion needed for the construction of new gas mains to be spread across some combination of new gas customers, all gas ratepayers, and bond funding
- Incentives for the State's gas companies to ramp-up the required construction quickly, which DEEP estimates will translate into as many as 7000 jobs
- Utility construction projects to be linked so that the construction cost of new gas mains can be shared with those installing water or sewer pipes, fiber optic cables, or underground electric lines.

This Draft Connecticut Comprehensive Energy Strategy is meant not just to offer a policy direction but also to launch a dialogue. The recommendations and analysis highlighted above and discussed in more detail in the full report will be the subject of a series of public hearings, technical meetings over the next several months. To view the full schedule of hearings and meetings, and to learn more about how to submit written or oral comments on the Draft Strategy, please visit the DEEP website at www.ct.gov/energystrategy. In light of the comments received and in consultation with the Connecticut Energy Advisory Board and relevant state agencies, DEEP will refine the draft analysis and issue a final Strategy early in 2013.

Energy Efficiency Strategy

INTRODUCTION

Investing in energy efficiency is one of the most cost-effective ways to reduce the high energy bills facing Connecticut residents and businesses. Because Connecticut's per capita energy expenditures for buildings ranks among the highest in the United States, we give special focus in this Draft Strategy to improving the efficiency of Connecticut's buildings.[1] Connecticut's residents and businesses spend $8.1 billion to heat, cool, light, and provide hot water for buildings—an amount higher than the State's budget for health care or education. These high energy costs weigh on everyone's budgets, and are a burden to businesses that reduces their potential to create jobs and contribute to the statewide economy.

Building-related energy consumption also harms Connecticut's environment as the heat and power consumed requires vast quantities of fossil fuels to be burned. Producing electricity and burning natural gas and heating oil emit tons of air pollutants. These energy sources emit pollutants such as sulfur dioxide (SO_2) and nitrogen oxides (NO_x), which reduce air quality and cause health problems, as well as greenhouse gases, which add to the risk of climate change. Reduced energy consumption—especially at peak times—reduces the need for (and expense of) new power generation capacity and transmission lines. Chapter 2 (Electricity) discusses "peak load shaving" in more detail.

Spending less on energy preserves capital that Connecticut companies can invest in their core business, enabling them to compete more effectively. And because Connecticut has very limited in-state fuel resources, it also means that fewer dollars flow out of the State to buy energy, boosting Connecticut's economy and supporting more jobs at home. But the benefits go far beyond the reductions in energy costs. Energy efficiency brings substantial savings in equipment and maintenance costs, since heating and cooling systems in efficient buildings can be smaller and potentially operated less frequently, extending the useful lives of this equipment. In addition, increasing the energy efficiency of homes improves comfort and quality of life.[2]

TAKING ENERGY EFFICIENCY TO THE NEXT LEVEL

This Draft Strategy assesses the strengths and weaknesses of the State's existing efficiency programs, and makes recommendations designed to expand the reach of these programs, with a particular focus on reaching

[1] U.S. EIA, State Energy Data System; and U.S. Census Bureau, United States Summary.

[2] Muldavin, Scott R. Green Building Finance Consortium, "Value Beyond Cost Savings: How to Underwrite Sustainable Properties." Available at http://www.greenbuildingfc.com.

a broader set of ratepayers, including small businesses and low-income citizens.[3] This Draft Strategy seeks to "deepen" the efficiency investments being made to go beyond changing out light bulbs and installing weather-stripping to cover heating systems, ventilation, insulation, appliances (such as refrigerators), and other intensive efficiency measures. It proposes to restructure the State's existing home energy audit programs (the Home Energy Solutions, or "HES" program) to encourage the previously referenced "deeper" efficiency measures, and to sharpen the incentives provided to utilities and energy service companies to encourage wider and deeper energy efficiency improvements.

At the heart of this Draft Strategy is the recognition that energy efficiency is an investment. Money has to be put up to buy insulation, a new furnace or boiler, or more efficient appliances. But for many residents and businesses, the upfront cost of efficiency investments is a serious obstacle. Thus, this Draft Strategy introduces several new financing mechanisms designed to help Connecticut companies and citizens make the energy efficiency investments they need to lower their bills.

Further gains in efficiency are also inhibited by a lack of *actionable* information on exactly what a ratepayer should do in the way of *cost-effective* efficiency improvements. Consumer inertia, and uncertainty about who to trust when it comes to both energy efficiency assessments and actually getting the work done represent important additional obstacles. Thus, this Draft Strategy proposes a new efficiency outreach effort ("Energize Connecticut") to help households and businesses understand their energy options, and new business models for delivering energy efficiency results.

CONNECTICUT BUILDS ON A STRONG LEGAL AND POLICY FOUNDATION TO SUPPORT ENERGY EFFICIENCY

Over the last few decades, Connecticut has shown great leadership in energy policy. The State has built a strong legal and regulatory framework to support energy efficiency, focused on investment in energy efficiency through ratepayer-funded programs implemented by the state's regulated electric and natural gas utilities.

But there is room for improvement. In 1998, the Connecticut General Assembly established an energy efficiency fund, supported by a $0.003/kWh assessment on all retail electric end use, and a conservation charge levied on customers of the local gas distribution companies (LDCs).[4] These change nearly tripled the annual investment in electric efficiency from about $30 million annually in the early 1990s, to about $90 million in 2000. Investments in natural gas conservation also increased over this time period, from about $1 million in 1994-2000, up to about $11.5 million in 2010. After 2005, ratepayer contributions to the

[3] References to the State's energy efficiency programs in this Draft Strategy refer to the Conservation and Load Management Programs administered by Connecticut's electric and gas distribution companies and funded by electric and gas ratepayers.

[4] Connecticut Public Act 98-28, "Act Concerning Electric Restructuring," (1998). Public Act 05-01 established a Conservation Adjustment Mechanism to collect revenues for natural gas efficiency programs in 2006. See Connecticut Public Act 05-01, "An Act Concerning Energy Independence," 2005.

Connecticut Energy Efficiency Fund were supplemented by new revenue sources, including revenues from the Independent System Operator Forward Capacity Market, sales of Class II Renewable Energy Credits, and proceeds from the sale of carbon dioxide (CO_2) allowances through the Regional Greenhouse Gas Initiative (RGGI).

In 2007, the State reinforced its commitment to energy efficiency when it enacted Public Act 07-242, which called for the implementation of "all cost-effective energy efficiency."[5] By 2011, annual investment in electric efficiency reached $124 million, while annual investment natural gas conservation increased to $17 million. Total program investment in 2011 was about $144 million.

These investments in efficiency earned Connecticut a first place ranking from the American Council for an Energy Efficient Economy (ACEEE) in 2006 as the state with the best energy efficiency policies and programs in the nation, and Connecticut has remained in the top ten since the inception of the scorecard.[6] More importantly, these investments delivered real energy savings for Connecticut consumers. From 2007 to 2011, Connecticut efficiency programs helped to reduce the state's electricity consumption by more than 5% and natural gas consumption by almost 1% (Figure 1).[7] More than 285,000 (or about 20%) Connecticut homes received home energy evaluations and associated measures such as efficient lighting, weatherization, and air sealing through the residential energy efficiency programs between 2000 and 2011. In addition, over 34,000 Connecticut businesses have participated in the energy efficiency programs during this same period.[8] Since 2000, investments in energy efficiency have saved over 650 megawatts (MW) in peak demand and reduced consumption by about 13%.[9]

[5] Connecticut Public Act No. 07-242, "An Act Concerning Electricity and Energy Efficiency."

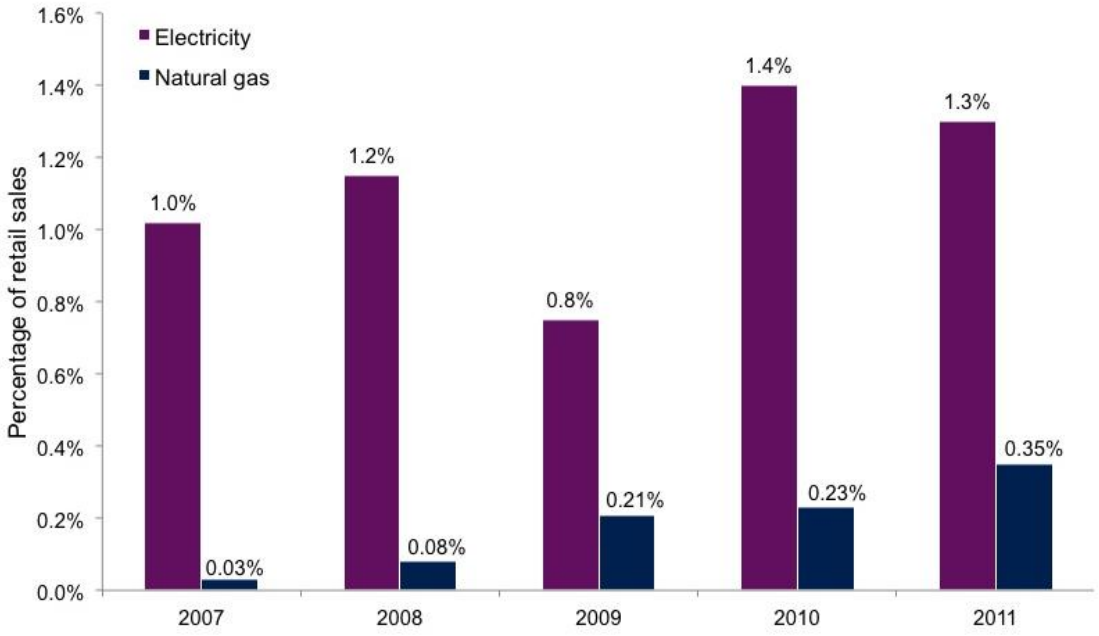
[6] Eldridge, Maggie, Bill Prindle, Dan York, and Steve Nadel. ACEEE, "State Energy Efficiency Scorecard for 2006." Available at http://www.aceee.org. Connecticut has fallen to 8th in the ACEEE rankings, in part because other states have dramatically ramped up their efficiency efforts at a faster pace than Connecticut.

[7] Northeast Energy Efficiency Partnerships, "A Regional Roundup of Energy Efficiency in the Northeast and Mid Atlantic States." Available at http://www.neep.org/uploads/policy/2011 Regional Roundup_FINAL.pdf.

[8] *See* "2012 Conservation and Load Management Plan," available at http://www.dpuc.state.ct.us/DEEPEnergy.nsf/c6c6d525f7cdd1168525797d0047c5bf/2fa1f8d01cfc0cc785257981007276d4/$FILE/2012%20CLM%20Electric%20and%20Gas%20Plan%20FINAL.pdf.

[9] *Ibid.*

Figure 1: Annual electric and natural gas efficiency savings as a percentage of retail sales, 2007-2011



Source: Northeast Energy Efficiency Partnerships, Regional Roundup.

Although the State's investment in energy efficiency has generally increased over time, it has not yet reached the level where all cost-effective savings are captured. Moreover, Connecticut's leadership position in energy efficiency has eroded relative to other states. In 2011 (based on 2009-2010 performance), Connecticut dropped to 8th place in the ACEEE rankings in terms of energy efficiency.

In June 2012, the Department of Energy and Environmental Protection (DEEP) issued an Integrated Resources Plan (IRP) for Connecticut's electricity sector which called for a ramp up in efficiency to mitigate the impact of a projected increase in electricity rates after 2017. The 2012 IRP showed that by increasing the budget for electric efficiency programs from $105 million (the current amount funded by the conservation assessment of $0.003/kWh and other revenues such as RGGI) to $206 million annually, Connecticut could achieve all cost-effective efficiency savings and offset expected increases in electricity consumption, realizing a net reduction in electric usage of about 0.4%. In addition, the 2012 IRP projected that this increased investment in electric efficiency could reduce SO_2 and NO_x emissions by between 5% and 10%, while supporting 5,500 in-state jobs by 2022 and growing the State's economy.[10]

The 2012 IRP—as a plan for the electricity sector—only addressed electric efficiency; it did not analyze the potential cost-effective efficiency savings for natural gas or fuel oil. A lack of data makes it difficult to identify

[10] Connecticut Department of Energy and Environmental Protection, "2012 Integrated Resource Plan for Connecticut." p. 35, Figure 28. Available at http://www.dpuc.state.ct.us/DEEPEnergy.nsf/c6c6d525f7cdd1168525797d0047c5bf/cb827b1ffa58b2fd85257a1d0060c374?OpenDocument

the precise amount of gas or oil savings for Connecticut. With respect to natural gas, a study was prepared in 2009 of natural gas energy efficiency potential for Connecticut's commercial and industrial sectors. No similar study has been completed recently for natural gas efficiency potential for the state's residential sector. Similarly, there are currently no existing oil efficiency potential studies for Connecticut. In light of these data limitations, the savings potential for natural gas and fuel oil in Connecticut was approximated by reference to gas and oil efficiency potential studies from Massachusetts and Vermont, states whose building stock is similar in type and vintage to Connecticut's. Based on these two sources, the level of spending needed to achieve all cost-effective potential energy savings is estimated to be about $120 million annually for both natural gas and oil. When combined with the electric savings level identified in the 2012 IRP, the all cost-effective level of spending for energy efficiency programs for all sectors could be approximately $327 million per year through 2022.[11] It is important to note that these figures are presented for illustrative purposes only, to highlight the possible range of spending levels that could be required to achieve all cost-effective savings for electric, natural gas, and fuel oil in Connecticut.

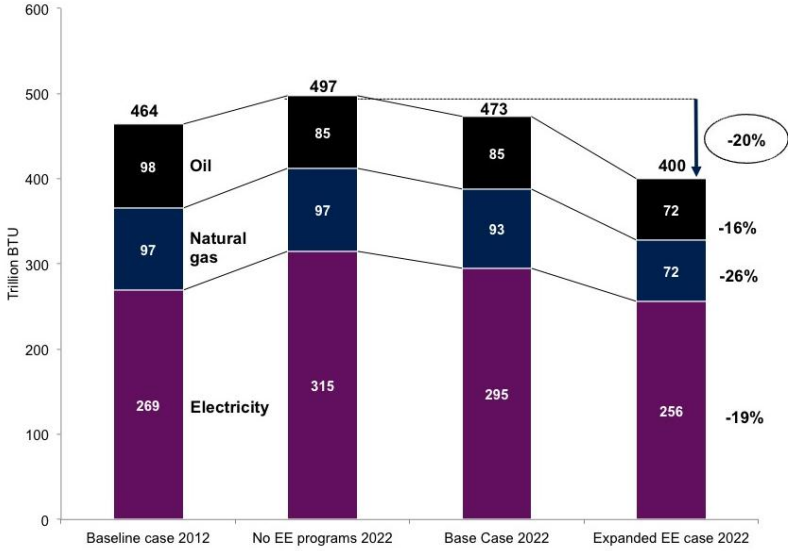
Under this scenario, as shown in Figures 2, 3, and 4, the resulting costs and savings associated with the residential and commercial buildings sector would be significant.[12] Connecticut homes and businesses could reduce energy use by up to approximately 20% and spend roughly $13 billion less on energy costs (for net savings of $8 billion). This could result in an overall reduction in energy use for Connecticut of 14% when compared to 2012 baseline levels.

[11] This figure includes $290 million for residential and commercial buildings, as well as $37 million for industrial efficiency measures. For more information on this analysis including the methodology and assumptions, see Appendix A (Efficiency & Industry).

[12] Costs and savings associated with industrial efficiency measures are not included in Figures 2, 3, and 4.

Figure 2: Forecasts of Primary Energy Consumption for Buildings in Connecticut in 2022

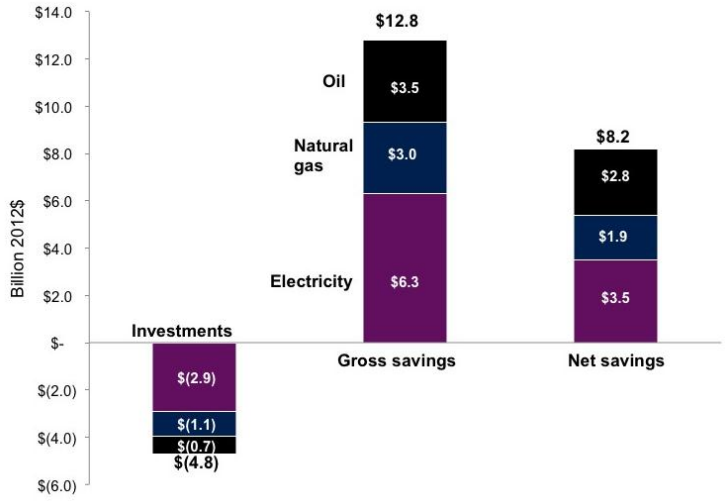
In the Expanded Energy Efficiency (EE) scenario, total primary energy consumption decreases by 20% compared to the No EE Programs scenario, with reductions in oil, natural gas and electricity. The Base Case EE scenario would result in a decrease in primary energy consumption by approximately 5% compared to the No EE Programs scenario



Source: RMI Vision Model Analysis, discussed in Appendix A (Efficiency & Industry).

Figure 3: Present value of energy efficiency investment and savings for Connecticut buildings, 2012–2022

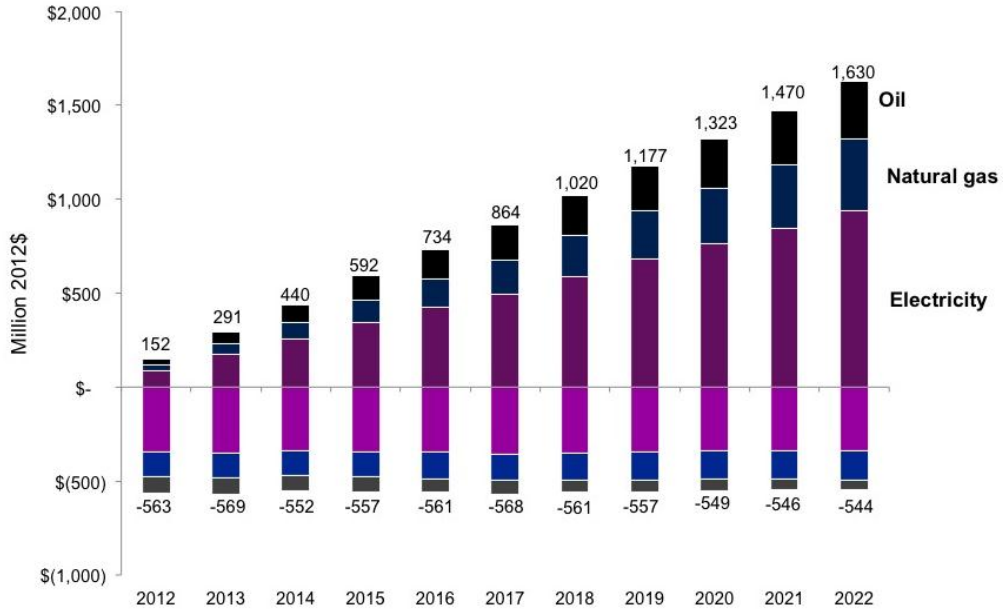
For the years 2012-2022, total investments—including participant costs—of $4.8 billion (in 2012 dollars) would yield gross savings of $12.8 billion realized from lower energy costs, for a net savings of $8.2 billion.



Source: RMI Vision Model Analysis, discussed in Appendix A (Efficiency & Industry).

Figure 4: Annual benefits and costs of energy efficiency investment, 2012-2022

Energy efficiency investments begin to show a net benefit in 2015. Columns above the x-axis indicate benefits of capturing the electricity, natural gas, and oil efficiency opportunity. Columns below the x-axis indicate the investment costs for electricity, natural gas, and oil.



Source: RMI Vision Model Analysis, discussed in Appendix A (Efficiency & Industry).

A critical element of this Draft Strategy's energy efficiency proposals centers on a shift from reliance on ratepayer funding to a much greater focus on private capital leveraged by limited government funding. From the funding available through Connecticut's first-in-the-nation "Green Bank," the Clean Energy Finance and Investment Authority (CEFIA), to a structure for standardized energy savings performance contracts for the State and municipalities to engage energy service companies, to a new statewide Commercial Property Assessed Clean Energy (C-PACE) finance program, this Draft Strategy calls for expanded options for financing energy efficiency investments and clean energy more generally. By providing structure and scale to the effort to bring private capital into the clean energy arena, this Draft Strategy seeks to expand access to financing and to lower the cost of borrowing. Over time, as these sources of private capital expand, the use of taxpayer and ratepayer resources will be able to be scaled back.

The State has taken some steps towards increasing funding to the all cost-effective level identified in the 2012 IRP, recognizing that a gradual ramp up is needed to ensure that the quality and cost-effectiveness of programs are maintained. In January 2012, the Public Utility Regulatory Authority (PURA) authorized a doubling of natural gas efficiency program budgets from $17 million to $34 million annually. In July 2012, DEEP approved an expanded budget for electric efficiency programs that recommended PURA establish a Conservation Adjustment Mechanism to collect additional ratepayer funds that would increase the overall

budget for electric efficiency programs by $34.2 million in 2012.[13] A PURA proceeding is now under way to consider whether to establish a Conservation Adjustment Mechanism for this purpose.[14]

The foundation for this Draft Strategy's goal of transitioning programs away from government-funded grants, rebates, and other subsidies, and towards deploying private capital to finance energy efficiency has begun to be built. The enactment of Public Act 11-80 in 2011 established new institutions and policies that are already helping to diversify funding for energy efficiency. CEFIA was established in 2011 to develop programs that will leverage private sector capital to create long-term, sustainable financing for energy efficiency and clean energy to support residential, commercial, and industrial sector implementation of energy efficiency and clean energy measures.

Connecticut Leading by Example: Reducing Energy Use in State and Municipal Buildings

Connecticut's "Lead by Example" program was created in 2011 to fund energy efficiency improvements in state and local government buildings so as to reduce energy use in state facilities at least Connecticut by 10% by January 1, 2013, and provide support for the state's municipalities to achieve energy reductions in their buildings. As of the end of September 2012, more than $10 million in bond funds had been committed to 41 different projects. These projects have an average pay back of 5.9 years and will achieve energy reductions that are the annual equivalent of more than 358,700 fewer gallons of gasoline used or 1,460 homes being taken off the grid. The Lead by Example program has also developed a standardized Energy Savings Performance Contracting (ESPC) process that can reduce energy use in state and municipal facilities by 25% or more. This program enables state agencies and municipalities to implement multi-million dollar retrofit projects that are paid for by future energy savings and can be structured to require no upfront capital investment.

These policy developments are helping improve the efficiency of Connecticut's buildings. Before turning to discuss additional challenges and opportunities for improving building energy efficiency, it is important to explore some of the features of Connecticut's buildings sector—including size, patterns of energy usage, ownership structure, age, and so on. These features must be taken into account when considering the types of programs and incentives that will achieve the greatest efficiency savings.

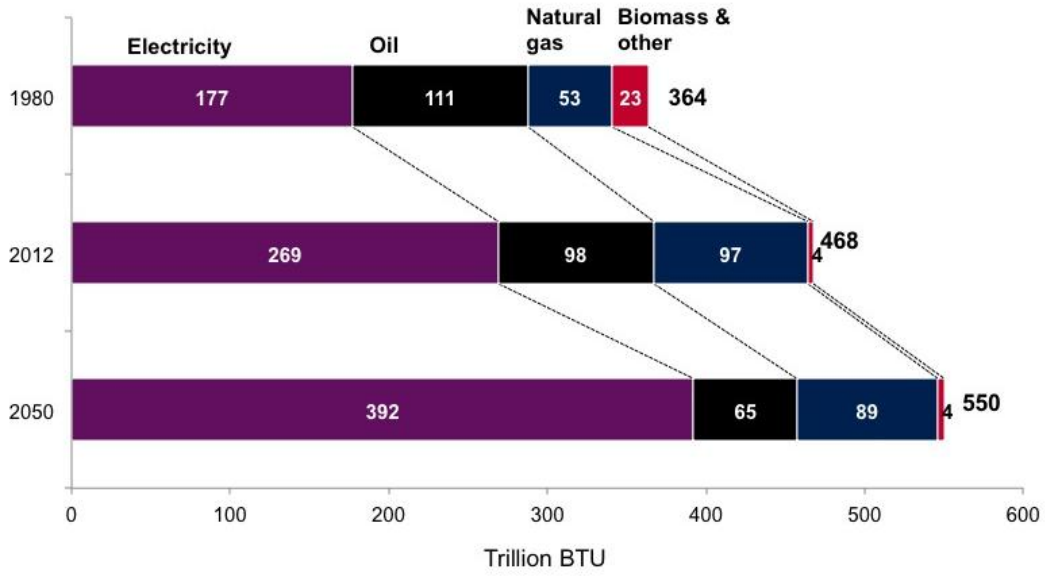
[13] Connecticut Department of Energy and Environmental Protection, "Approval of the 2012 Conservation and Load Management Plan." Available at http://www.ctenergyinfo.com/120217%202012%20CLM%20Base%20Plan%20Final%20Approval.pdf

[14] PURA, "Docket #12-08-11: Application of The United Illuminating Company for Approval of a Conservation Adjustment Mechanism," Available at http://www.dpuc.state.ct.us/dockcurr.nsf/8e6fc37a54110e3e852576 190052b64d/fc5e30e84 12693ab85257a5b00553d2f?OpenDocument

OVERVIEW OF THE BUILDINGS SECTOR

Today, residential and commercial buildings are the largest users of energy in Connecticut, collectively accounting for 58% of the state's energy usage and 87% of its electricity usage annually. These figures represent an almost 30% increase in building energy consumption since 1980 (Figure 5), due to a modest increase in population, as well as an increase in the average size of buildings (particularly single-family residences), and the increased prevalence of energy-intensive equipment, such as electronics, appliances, and air conditioning. Over the next several decades, building energy consumption in Connecticut could grow substantially. In a business-as-usual scenario (which assumes modest energy efficiency savings per year), consumption is projected to grow to 550 trillion BTUs per year in 2050, nearly 20% higher than today's energy use of approximately 468 trillion BTUs.[15] The growth in energy consumption is expected to come from increased demand for air conditioning and appliances, which include office equipment, computers, televisions, and video game equipment.

Figure 5: Historical and forecasted primary energy consumption for Connecticut buildings



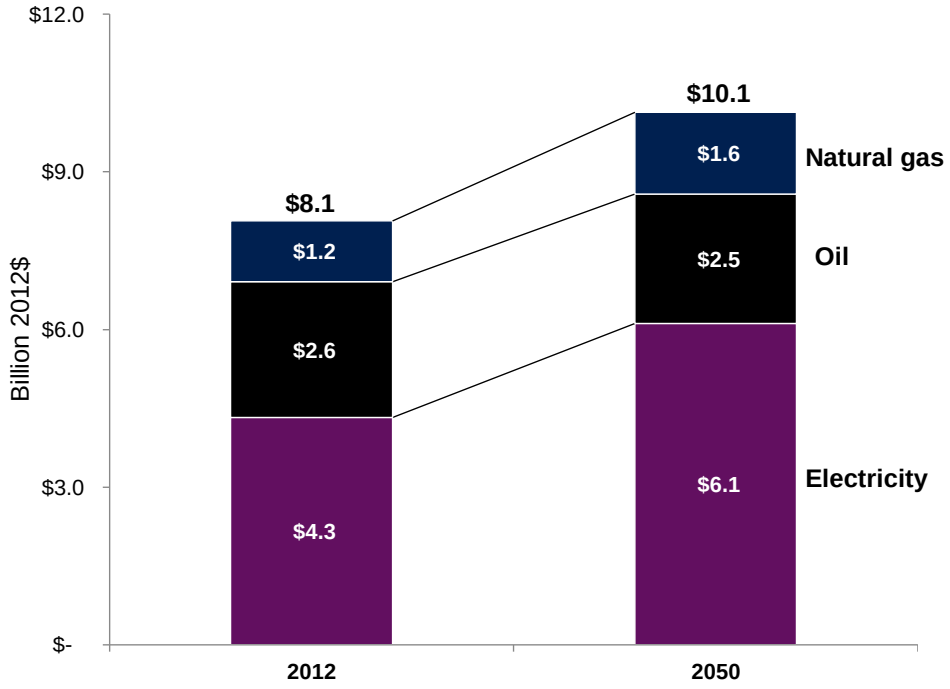
Source: U.S. EIA, State Energy Data System; and U.S. EIA, Annual Energy Outlook 2012.

This increased consumption will result in higher energy costs for Connecticut homes and businesses, unless much greater focus is placed on energy efficiency. Other New England states, including Massachusetts, Vermont, and Rhode Island, are expanding their investment in energy efficiency. As those states shrink their electric consumption, a greater proportion of costs associated with regional electric consumption will be shifted to Connecticut unless the state keeps pace. The U.S. Energy Information Administration (EIA) predicts that energy costs for the state's buildings will rise to $10.1 billion in 2050 (Figure 6). The burden of rising

[15] U.S. Energy Information Administration State Energy Data System, "2012 Annual Energy Outlook."

energy costs could prevent individuals and businesses from maximizing their potential to create jobs and contribute to the statewide economy. Substantial gains in energy efficiency, on the other hand, could mitigate those rising energy costs, limiting the need to build new power stations, transmission lines, and other costly grid investments.

Figure 6: Current and projected costs of energy consumption for Connecticut buildings

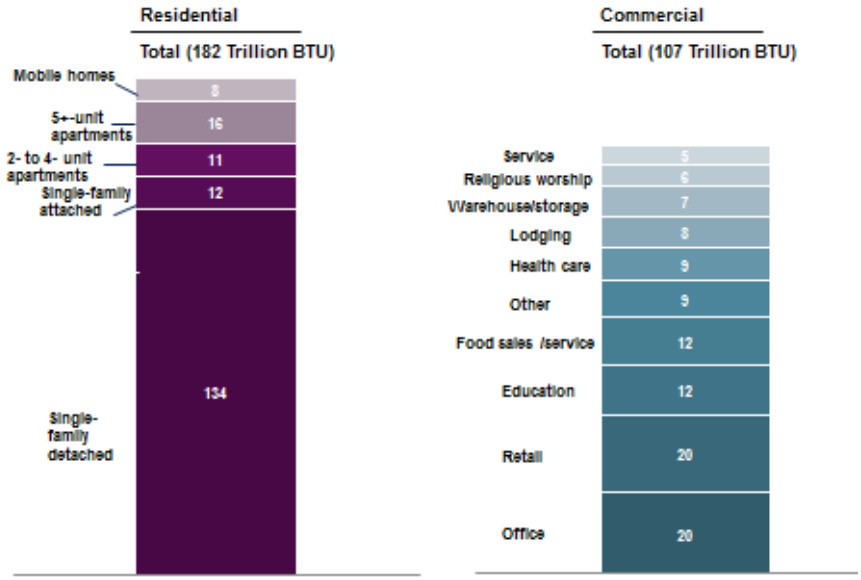


Source: U.S. EIA, State Energy Data System; and U.S. EIA, Annual Energy Outlook 2012.

To understand what kinds of programs and incentives are needed to support building energy efficiency, it is important to understand the character of, and the differences between, the residential building sector and the commercial building sector. Of the two sectors, the 1.5 million homes in the residential sector consume far more—nearly 70% more—energy than the commercial sector. While none of the state's single-family residences individually consume as much energy as a commercial skyscraper or an industrial facility, residential buildings in the aggregate use almost as much energy as the commercial and industrial sectors combined. As a percentage of the state's total energy usage, residential buildings consume 33%. Most residents live in detached single-family structures, which (as Figure 7 shows) collectively consume nearly 75% of energy used by the residential sector. Other families live in mobile homes, attached single-family structures, and multifamily apartment buildings. Thirty-one per cent of Connecticut residents rent.[16]

[16] United States Census Bureau, "American Community Survey: 2010 Data Release." Available at http://www.census.gov/acs/www/data_documentation/2010_release/

Figure 7: Connecticut buildings' energy use by property type, end-use energy, 2012

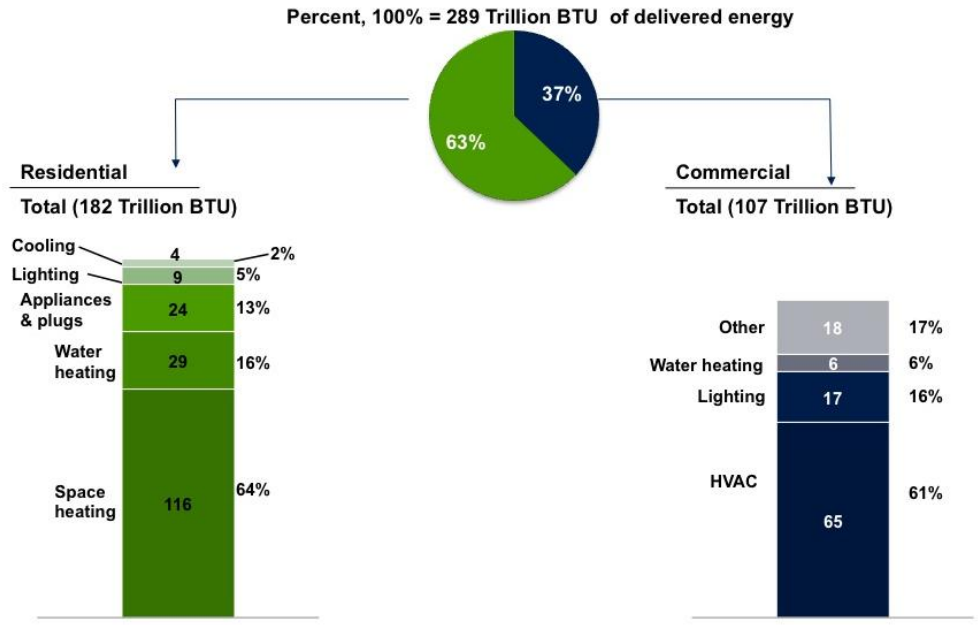


Source: U.S. EIA, State Energy Data System; and U.S. EIA, Annual Energy Outlook 2012.

Commercial buildings are even more varied in size and ownership structure. Commercial buildings, as that term is used in this Draft Strategy, includes both tiny storefronts with monthly demands of less than ten kilowatts and larger commercial and industrial facilities with monthly demands of between one and fifteen megawatts.[17] Some of the largest commercial buildings use more energy than some of Connecticut's largest manufacturing facilities. Schools and large commercial buildings often have dedicated facilities managers who are responsible for operating heating and cooling equipment, responding to concerns about building temperature, and replacing lights as they fail. These maintenance professionals are often stuck operating old or inefficient HVAC systems; lack training regarding energy efficiency; or lack the authority to improve the efficiency of these systems. By contrast the largest customers often have staff that is dedicated to energy management. Ownership of commercial buildings varies. Some commercial buildings are owner-occupied, while many more are leased. Tenants and building occupants may have little knowledge of or control over energy use or may not directly pay for utilities, underscoring the need to develop programs and incentives that will spur building owners to invest in efficiency improvements, even in circumstances where the tenant pays the utility bill (and would reap the benefits of energy savings).

[17] The discussion of commercial buildings in this Chapter applies to buildings used for industrial processes as well, to the extent that those buildings serve similar functions in terms of lighting and space heating. Strategies for addressing the special energy needs of industry—from data center operation to manufacturing processes—are discussed in Chapter 2 (Industry).

Figure 8: Breakdown of building energy consumption by end use, end-use energy, 2012[18]



Source: U.S. EIA, State Energy Data System; and U.S. EIA, Annual Energy Outlook 2012.

Despite the variety among them, buildings consume energy in very similar ways across types. As Figure 8 demonstrates, over 60% of the energy used in buildings is used for heating and cooling. The next highest uses are water heating in residential buildings and lighting in commercial buildings, representing about 1/6th of energy usage in each respective building type. Of the primary energy (that is, energy produced from raw fuels or otherwise found in nature) used by buildings today, 59% comes from electricity, 21% from oil, and 20% from natural gas. Electricity and natural gas use has increased while oil and biomass consumption has declined. Another common feature across building types is the prevalence of existing building stock (as opposed to new construction).[19] New construction in the state over the last few years has been very limited and is projected to remain so over the next decade due to economic conditions.[20] As a result, existing

[18] Figure 8 illustrates building energy consumption by end use. This information does not reflect the peak energy demand for these end uses.

[19] An important subset of existing buildings are those that are considered historically significant. The majority of buildings in the state are over fifty years old, and many are designated historic and listed on a register of historic places, either individually or as part of a historic district. This listing may require that significant changes, particularly changes to the exterior, be reviewed by a local board. Owners may also be restricted from changing their properties by private conservation or preservation restrictions adopted by prior owners. Accordingly, some owners of historic buildings may be concerned about the way that physical changes from energy efficiency retrofits or renewable energy installations will be reviewed, or whether they will be approved at all. Balancing their concerns with the broader public policy supporting historic preservation is an increasingly important policy dilemma, particularly in Connecticut, a state with one of the richest and most diverse stocks of historic buildings in the country.

[20] KEMA, "Connecticut Natural Gas Commercial and Industrial Energy-Efficiency Potential Study." Available at http://ctsavesenergy.org/files/CTNGPotential090508FINAL; and KEMA, Electric Efficiency Study.

buildings are expected to consume 98% of total building consumption in 2022.[21] These figures suggest that a focus on "retrofit" strategies is essential.

Having discussed the State's legal and policy framework for supporting energy efficiency, as well as the characteristics of Connecticut's building stock, we can now turn to address the various challenges and opportunities that influence the State's ability to capture cost-effective energy savings.

IMPROVING THE EFFECTIVENESS OF CONNECTICUT'S ENERGY EFFICIENCY PROGRAMS

Ensuring Consistent Funding To Achieve All Cost-Effective Efficiency Measures For All Fuels

Achieving a necessary level of funding and making that funding consistent are critical steps to realizing the state's energy efficiency goals. While Connecticut has increased funding for natural gas and electricity efficiency programs over the years, the levels fall short of what is needed to achieve all cost-effective efficiency. The funding also falls short of demand, meaning that in many years, the energy auditing programs shut down for the latter part of the year for lack of funds. The existing investments in energy efficiency are paid for by a charge on electric and gas bills, giving those who heat with electricity or natural gas priority when it comes to energy audits.

One of the biggest challenges to achieving greater energy savings is securing efficiency funding for all fuels. Connecticut has no dedicated funding mechanisms to support efforts to use heating fuel oil more efficiently. Oil efficiency is crucial, because 50% of homes and 10% of businesses use oil for heating. Issues that need to be resolved before a policy that ensures that oil heat customers are included in efficiency programs include: whether a dedicated charge needs to added to fuel oil purchases to support these programs; whether cross subsidization of oil customers is appropriate since they are also electric customers; and the degree to which any energy savings, regardless of fuel source, are included in determining cost-effectiveness.

Consistency of funding is also important. In the decade prior to 2010, funds for energy efficiency programs were reduced three separate times to help cover shortfalls in the State's general budget. The resulting fluctuation and unpredictability in program budgets has affected the quality and the development of Connecticut's nascent energy efficiency industry. Contractors won't expand to include weatherization services, building owners won't invest in more efficient equipment, companies won't develop new technologies, entrepreneurs won't find innovative ways to bring efficiency services to more customers and investors won't provide low cost capital unless all of them can be assured of a stable, sustainable market for these products and services.

[21] KEMA, "Connecticut Natural Gas Commercial and Industrial Energy-Efficiency Potential Study." Available at http://ctsavesenergy.org/files/CTNGPotential090508FINAL; and KEMA, Electric Efficiency Study.

Chapter 1: Energy Efficiency Strategy

The state's residential energy efficiency programs provide homeowners with measures that reduce their electricity usage (such as the installation of efficient light bulbs), and measures like air sealing that improve the efficiency of their heating system. Electric customers who heat with electricity or natural gas contribute to these energy efficiency programs through both their electric and natural gas bills. Electric customers who heat with fuel oil contribute to the programs through their electric bill but do not pay any equivalent charge on their fuel oil bills to support oil efficiency measures. To the extent that they receive heating measures through the state's energy efficiency programs, those measures are "cross-subsidized" by electric ratepayers. To reduce the subsidy, oil heating customers may face higher co-pays for the state's electric efficiency programs. Funding for oil efficiency has only been sporadically available through one-time sources like the federal American Recovery and Reinvestment Act (ARRA) and the Regional Greenhouse Gas Initiative (RGGI). ARRA funding has ceased, and RGGI revenues are not sufficient to fund programs to fully realize the large opportunity for reducing the amount of oil that homes and businesses use to heat their buildings. To ensure that oil heating customers are able to take advantage of energy savings through the state's energy efficiency programs on a more sustainable basis, such as by establishing a dedicated charge on fuel oil prices to support oil efficiency programs. Otherwise, the only way to provide oil customers access to the benefits of the state's efficiency programs is by allowing for cross-subsidization for oil measures by electric and gas ratepayers.

The State took an important step toward providing greater predictability in program planning in September 2012, when PURA and DEEP directed the utilities to begin submitting a three-year budget and plan for Conservation & Load Management Programs.[22] Lengthening the planning and budget horizon allows the managers of the State's award-winning programs to be more creative and flexible, and provide insulation installers, equipment suppliers and other vendors who participate in those programs the predictability they need to invest in efficiency and to build their own businesses.

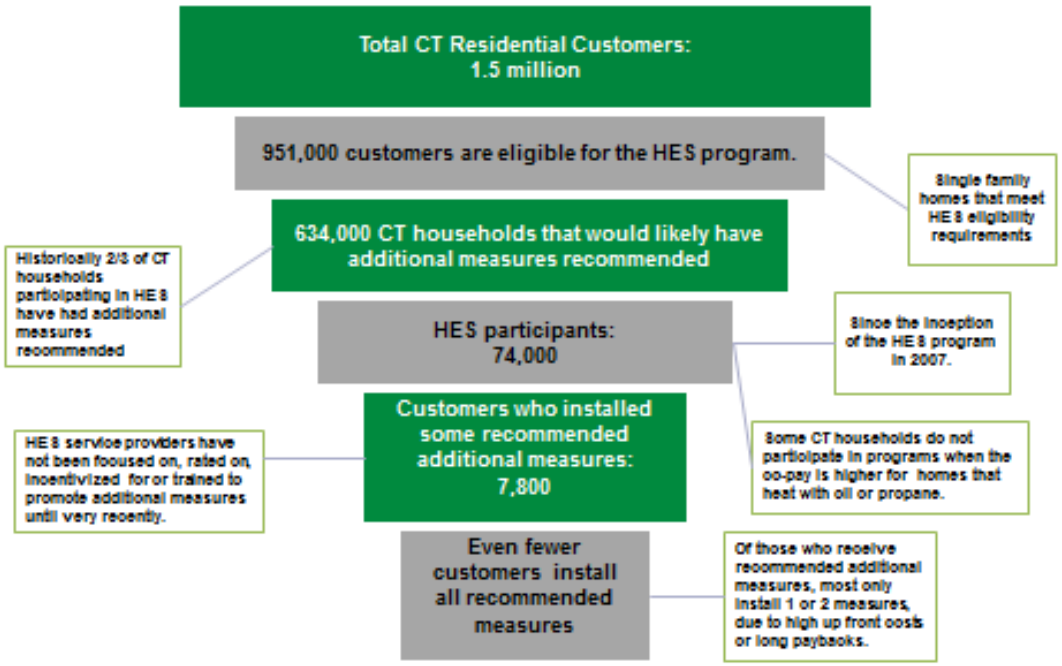
The best way to ensure consistent funding for energy efficiency is to diversify the revenue sources that support it. Ratepayers cannot indefinitely support the bulk of energy efficiency program budgets. Energy efficiency is a cost-effective investment, but more is needed—in terms of financing mechanisms, experienced vendors, consumer awareness, and funding from financial institutes, institutional investors and the capital markets, to reach a point where that investment is understood and valued in the marketplace. In the long term, the development of a market for energy efficiency is the best way to ensure that private capital can be leveraged to support programs that are currently funded by collections from electric and gas ratepayers.

[22] PURA, "Docket # 12-02-01: PURA Review of the Connecticut Energy Efficiency Fund's Electric Conservation and Load Management Plan for 2012," Available at http://www.dpuc.state.ct.us/dockhist.nsf/(Web+Main+View/All+Dockets)?OpenView&StartKey=12-02-01. This change brought Connecticut in line with planning and budget horizons used other New England states. Massachusetts's statewide plans for gas and electric utilities look three years into the future, and Vermont has recently established a 12-year plan. See National Grid, Joint Statewide Efficiency Plan; Northeast Energy Efficiency Partnerships, "Energy Efficiency in Vermont."

Reforming Efficiency Programs To Achieve Deeper Savings

Energy efficiency programs must become more effective in achieving "deeper" savings (ie., achieving more savings per program participant) by adding insulation, more efficient heating and cooling systems, and installing more efficient appliances and electronic equipment. In the residential context, about 75% of the energy savings realized through the State's residential energy efficiency programs result from savings from quick and easy steps like air sealing and replacing inefficient light bulbs.[23] Data from 2007 to 2011 shows that only about 10% of the State's residential customers who receive a home energy audit through the Home Energy Solutions program actually install some of those recommended "deeper" measures (Figure 9).

Figure 9: Funnel analysis for Home Energy Solutions program in Connecticut



Source: Based on 2012 Conservation and Load Management Plan.

Although those deeper measures are still cost-effective, they generally have a higher upfront cost and longer payback time. The Energy Efficiency Board is consulting with experts in the field to determine how to structure the existing HES program so that it creates a stronger incentive for contractors participating in the program to persuade homeowners who receive energy audits to install "deeper" energy efficiency measures, including through use of a field service tool that more clearly explains the value of these measures to the home owner. The current system has overly focused HES contractors on performing the initial audits en masse. Improvement is needed to offer much more effective incentives for additional follow-up measures that achieve

[23] Connecticut Energy Efficiency Fund, "2011 Report of the Energy Efficiency Board." Available at http://www.ctenergyinfo.com/Final 2012 ALR 20120301.pdf.

far greater energy savings. Similar challenges face programs aimed at industrial customers. As described in the Chapter 2 (Industry), efficiency programs have been effective at achieving savings from switching to more efficient lighting, but have not been able to effectively capture the significant potential savings from modifying or replacing inefficient equipment used in industrial processes.

The Home Energy Solutions Program

The Home Energy Solutions (HES) program has evolved from a pilot effort provided through a handful of vendors in 2007 to a program that delivers comprehensive energy efficiency services to thousands of homes annually. The program is currently delivered through a limited number of vendors (25 in 2012) that are selected through an RFP. However, there are many more qualified energy services companies that are capable of providing these services. For example, CL&P and UI anticipate that more than 130 companies will respond to the latest HES vendor RFP, all vying for a spot on the HES vendor roster.

The HES program has supported development of a robust Home Performance industry in Connecticut. The program has created jobs, developed a structure to train energy service professionals, saved energy, and helped provide a cleaner, healthier Connecticut for future generations. But delivering the current program is expensive and we cannot continue limiting the number of vendors that deliver these services.

The HES program has focused on participation, i.e., the number of homes served annually, and relied on high subsidies to deliver these measures. This Draft Strategy recommends moving away from the current model: high subsidies delivered by a handful of service providers. We simply can't constrain this industry much longer. The pieces are in place to move HES to a market based system. In addition to hundreds of trained energy service technicians, low interest financing is available to support the necessary consumer investment, convenient on the bill repayment options and the tools to easily gather data for tracking our weatherization effort and to present information to consumers empowering them to make smart energy choices for a cleaner, cheaper, and more reliable future. The missing piece is consumer demand for the product. Rather than driving program participation for its own sake, we must focus our efforts on increasing consumer awareness of the value of these services by touting the benefits of Home Performance: energy and cost savings, increased comfort and safety. This will stimulate demand for Home Performance services in the private market, and drive consumers to invest in deeper savings.

Ensuring That Underserved Communities Can Easily Access Efficiency Benefits

Ensuring that the basic energy needs of all utility customers are met has long been a public policy goal in Connecticut. Over the years the state, and federal government, have instituted numerous means-tested assistance programs including direct energy assistance benefits, federally funded state administered weatherization assistance, conservation improvements funded through the State's energy efficiency programs, and a matching payment program that helps customers pay energy bills. Despite these efforts, many limited income individuals and households struggle to meet their energy needs. Recognizing this, DEEP recently conducted an analysis of existing programs to determine how much they lowered the end cost of electric

energy was to these homes.[24] The evaluation showed that although the measures result in costs that are more than 10% below regular rates, they are not achieving the goal of ensuring basic needs to all customers. An analysis of the effectiveness of these various programs suggests that more benefits could be achieved by reforming, coordinating, and targeting the use of current resources.

Different sub-segments of consumers face different barriers that prevent them from benefiting from programs and incentives that could help lower their energy costs. For instance, despite the fact that a homeowner would directly benefit from the installation of efficiency measures, trust barriers often keep owners from signing up to have the work done, even when it is heavily subsidized or completely paid for. On the other hand, renters face an entirely different set of barriers to improving the weatherization of their homes and apartments. Landlords may refuse to provide access to their buildings because they fear discovery of code violations, and they may have little incentive to invest in energy-saving improvements if their tenants are paying the utility bills. However, a resident landlord may be more interested if upgrades and the costs can be shared with tenants who also benefit.

Discussions with limited income consumers, service providers, advocates and the utilities helped categorize the following sub-segments that need energy assistance and highlight the specific challenges to lowering costs and improving service to each. As a result this Draft Strategy proposes careful development of targeted strategies to address each following types of customers.

- **Small Businesses in Low-income Communities.** The typical business in this segment has fewer than 10 employees (more often fewer than 5); many lease substandard business spaces and face the landlord tenant conundrum of who pays and who benefits and others live in the same building. Needs for these businesses include both building and equipment (which they would own) upgrades to reduce energy costs. In accordance with Public Act 11-80 the Department has launched an Office of Energy Efficiency Businesses (see inset box).
- **Rental Housing.** As noted above, this category has several sub categories including typically small owner-occupied (1-4 units, and 5 and greater units), to very large buildings with an absentee landlord, and many varieties in between.
- **Single Family Owner Occupied.** This category has a subcategory of senior citizens, who have some unique issues that can largely be addressed through better education about programs availability and criteria.

[24] Connecticut Department of Energy and Environmental Protection, "Low Income Discount Rate Review." Available at http://www.dpuc.state.ct.us/DEEPEnergy.nsf/fb04ff2e3777b0b98525797c00471aef/46f8e631cff1cf2a852579bb006cffa6/$FILE/Notice & Report.pdf.; This draft report was initiated in compliance with Section 112(e) of Public Act 11-80; A final version of the report is forthcoming from DEEP.

- **Public Housing.** Securing capital is one of the primary barriers to performing efficiency upgrades in public housing.

The end goal in all of these categories is to reduce customers' energy costs, improve the health and comfort of their homes. Barriers that are common for most all of these customers include a lack of capital to make investments, often poor credit, transiency, and in many cases the reality that the landlord, rather than the tenant holds the decision cards. Health and safety issues are also a major challenge to actually being able to work in a building. Identifying a way to fund asbestos removal and replacement of knob and tube wiring could significantly decrease the percentage of homes that want to do upgrades but are not able to proceed because of these or other unsafe circumstances. This work could be coordinated with workforce development efforts to train residents in the community for skilled jobs in the trades industry.

Connecticut's New Office of Energy Efficient Businesses

In order to spur increased participation in energy improvements among Connecticut's businesses, DEEP (in coordination with the Connecticut Center for Advanced Technologies) is establishing the Office of Energy Efficient Businesses (OEEB). The purpose of OEEB will be to provide information to Connecticut small businesses (particularly in low-income communities) that are interested in reducing their energy consumption and, if necessary, to act as a coordinator between the business and the Connecticut Energy Efficiency Fund (CEEF). The OEEB will allow more businesses to take advantage of any financing options or programs offered by the CEEF. In addition to providing these support services, the OEEB will establish a pilot program which will identify three business communities to be actively targeted for energy improvements. Under this pilot program businesses within the targeted communities will be approached and encouraged to participate in eligible programs by trained OEEB staff. The pilot program will last one year and the success of the program will be measured through various metrics including, the number of businesses that pursue energy improvements and the amount of energy consumption reduced.

FOSTERING A MARKET THAT VALUES ENERGY EFFICIENCY

Despite its many benefits, energy efficiency isn't the easiest product to sell. There are three key market barriers to increasing customer adoption. Customers lack information and awareness about how much energy their buildings use and where the best opportunities to save energy are. Even if they have this information, they may not realize the value of efficiency as compared to other competing investments. Finally, they may lack access to financing to minimize the upfront costs of efficiency upgrades. The goal is to create a culture that demands energy efficiency establishes standards that enable consumers to easily ascertain the efficiency profile of their own homes or buildings, and makes financing for energy efficiency measures both easily accessible and affordable.

Marketing Energy Efficiency

Studies in other states have found that most people simply are not aware that subsidized efficiency programs—or the opportunities for energy savings—exist. That's why the State is launching a new effort, called "Energize Connecticut" to market clean energy programs and incentives, using everything from old media like TV and print to social media and community outreach. It is also crucial to give people information about their energy costs. Few energy customers examine their electricity, natural gas, or oil bills closely enough to figure out how much energy they are actually paying for each month. Fewer still compare their consumption to that of their neighbors, or to what might be possible if they invested in insulation or other efficiency measures. Without that knowledge, they can't identify opportunities for reducing costs. Even when people are aware of the efficiency opportunities in their buildings, they don't always invest in energy efficiency measures. Although these measures are cost-effective, they compete with the dozens of other priorities for the limited investment dollars a homeowner, renter, or building manager may have at their disposal. Connecticut's residents and businesses need to understand not just the energy cost reductions and dollar savings, but other benefits, like healthier more comfortable homes, staff productivity, higher tenant satisfaction, and sales increases.[25]

Creating the most effective programs for boosting energy efficiency in Connecticut's buildings is conceptually no different than devising business and marketing programs for selling cars or home improvement products. Both tasks require extensive data about the market (i.e. the state's buildings and building owners), a system for assessing and responding to the needs of the occupants, and the ability to rapidly measure the success of program efforts. That is why program administrators, vendors, and contractors would benefit from access to the same marketing, operations and technology tools used by the world's leading brand-name companies, such as advanced database, modeling and customer relationship management software.

Reducing Upfront Capital Costs

Many customers who are interested in efficiency currently can't economically procure the capital to make the investment. To address this challenge, Connecticut has already implemented innovative financing programs. For instance, small business owners can get loans for efficiency upgrades from the utilities at ratepayer-subsidized interest rates. The loans are then paid back on utility bills. Note that these "on-bill" repayment programs do not include enforcement mechanisms, such as the ability to shut off service to customers who default on the loans, nor do they run with the meter. Participation levels in Connecticut's small business financing programs are some of the highest in the country, and represent a little more than a thousand residents and businesses per year.[26] Financing programs must be expanded by accessing more capital and the

[25] Muldavin, Scott R. Green Building Finance Consortium, "Value Beyond Cost Savings: How to Underwrite Sustainable Properties." Available at http://www.greenbuildingfc.com.

[26] Bell, Casey, Steve Nadel , and Sara Hayes. ACEEE, "On-Bill Financing for Energy Efficiency Improvements: A Review of Current Program Challenges, Opportunities, and Best Practices." Available at http://aceee.org/node/3078?id=4491.

development of different financing models designed to cost-effectively meet the needs of different customer segments..

To that end, CEFIA was established in 2011 to develop programs that create long-term, sustainable financing by leveraging private sector capital in the State's residential, commercial, industrial, and municipal/not-for-profit sectors. Some recent initiatives include the Clean Energy Financial Innovation program and the Residential Clean Energy Financing program, which use credit enhancements such as loan loss reserves, interest rate buy-downs, and subordinated debt to incentivize private capital for energy efficiency investment.

The enactment of Public Act 12-2 established an important mechanism for financing energy efficiency in commercial buildings, by authorizing CEFIA to administer the C-PACE program discussed earlier in this Chapter.[27] The C-PACE program enables commercial and industrial property owners in participating municipalities to access low cost, long term upfront financing for energy-related improvements. The privately sourced capital is then repaid by the property owner through a special "benefit" assessment on their property tax bills. The same legislation also provided CEFIA bonding authority, secured by the State's Special Capital Reserve Fund (SCRF), to issue up to $50 million in bonds backed by an SCRF account.

BUILDING A REGULATORY ENVIRONMENT THAT INCENTIVIZES EFFICIENCY

Codes and standards are important tools that the State can use to reduce energy consumption in buildings and appliances. Connecticut can ensure significant energy savings by adopting building codes that require contractors to achieve the prescribed energy efficiency levels when they renovate or upgrade existing buildings. Connecticut law requires that the State adopt the newest International Energy Conservation Code (IECC) within 18 months of its publication or by July 1, 2103. Standards in the newest IECC edition will improve the energy efficiency of new construction by about 30% over the existing code.[28] It is equally important to develop measures that will better ensure that building inspectors understand and enforce the energy portion of the building code. Energy auditors and energy service providers also need to be appropriately trained and conform to best practices in their field.

Although appliance standards are primarily set at the federal level, states can adopt standards for products for which no federal standard has been set. Connecticut should continue to work closely with the Northeast Energy Efficiency Partnership to promote higher efficiency standards for appliances. Adopting any newly promulgated standards promptly can bring substantial savings to consumers, particularly as electronics more and more a part of people's lives.

[27] *See* Connecticut Public Act 12-2, "An Act Implementing Certain Provisions Concerning Government Administration," 2012

[28] New Buildings Institute, "2012 IECC Development & Resources." Available at http://www.newbuildings.org/comprehensive-iecc-proposal.

Employing Efficiency To Reduce Peak Demand

Even if Connecticut captures all cost-effective energy efficiency, electric rates could still increase. The reason? Despite decreasing the overall consumption of electricity, peak demand, the overall use of electricity that is higher than average supply conditions, could rise. The installation of equipment like air conditioning that drives peak demand is expected to increase in the coming years. As a result, Connecticut must find ways to expand its peak demand reduction efforts. In addition to maintaining support for existing demand response programs, the State needs to expand the installation of renewable energy (especially solar); incorporate measures that reduce peak demand in the state's energy efficiency programs; support behavioral change through advanced technologies like smart meters and appliances; and implement dynamic pricing mechanisms that reflect the change in cost to provide electricity throughout the day to encourage customers to reduce their consumption during periods of peak demand.[29] Advanced meters can display real-time energy use, allowing customers to see how much energy they are using at any given time and what they are paying for it. Such meters can also transmit information to online Internet portals, where consumers can log in and check their usage in real time. Combined with electricity rates that vary depending on demand or the time of day, this information will enable consumers to adjust their energy use to minimize overall costs. The information would also provide a powerful market incentive to increase the efficiency of energy use. Chapter 3 (Electricity) addresses these opportunities in more detail.

Regulatory changes are also needed if we are to make the utilities full partners in capturing all cost effective energy efficiency. This can be done by incentivizing the electric and gas distribution companies to achieve greater levels of energy efficiency. In the traditional utility business model, utilities make more money the more electricity or gas that they sell. As a result, they want customers to use more energy, not less. A better approach is to 'decouple' revenue from energy sales, adjusting rates to cover the utilities' allowed costs and a reasonable return even if their sales drop due to efficiency gains. Allowing utilities to share in the savings from lower energy use gives decoupled companies an even stronger incentive to help conserve.[30] Today, UI has a pilot decoupling rate structure, but PURA denied decoupling for CL&P, the larger utility.[31] No decoupling mechanism has been implemented for the state's three regulated natural gas utilities.

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[29] Connecticut Department of Energy and Environmental Protection, "2012 Integrated Resource Plan for Connecticut." Available at http://www.dpuc.state.ct.us/DEEPEnergy.nsf/c6c6d525f7cdd1168525797d0047c5bf/cb827b1ffa58b2fd85257a1d0060c374?OpenDocument

[30] Satchwell, Andrew, Peter Cappers, and Charles Goldman. Ernest Orlando Lawrence Berkeley National Laboratory, "Carrots and Sticks: A Comprehensive Business Model for the Successful Achievement of Energy Efficiency Resource Standards." Available at http://eetd.lbl.gov/ea/emp/reports/lbnl-4399e.pdf.

[31] Connecticut Light and Power, "Application of The Connecticut Light and Power Company to Amend Rate Schedules." Available at http://www.dpuc.state.ct.us/dockhist.nsf/8e6fc37a54110e3e852576190052b64d/08e9f28205bbb7068525755a005ad01d?OpenDocument.

ENERGY EFFICIENCY STRATEGY: RECOMMENDATIONS

Optimizing the economic, environmental and public health gains that can be achieved through energy efficiency efforts requires increased investments, better services that yield greater savings, broader customer engagement and a clear, consistent commitment through policy and regulations to an energy framework that prioritizes the use of energy efficiency to meet the state's energy needs. The following recommendations are important components to establishing that framework.

IMPROVE CONSERVATION AND LOAD MANAGEMENT PROGRAMS TO ENSURE MAXIMUM IMPACT FOR RATEPAYER DOLLAR SPENT

1. Provide Sufficient And Consistent Long-Term Funding For Efficiency Programs

Consistent with the recommendations of the 2012 IRP, in order to capture the energy efficiency gains in buildings, this Draft Strategy recommends increasing the funding for electric efficiency programs to the all cost-effective level of $206 million, and sustained funding for natural gas efficiency at at least the increased level approved by PURA in January 2012. This increase in funding should be implemented in a gradual way, to ensure that the quality and cost-effectiveness of the state's energy efficiency programs is maintained during the period of expansion. At the same time, efforts to increase private financing of energy efficiency—discussed below—should be expanded quickly, to shift from reliance on ratepayer funding to a much greater focus on private capital leveraged by limited government funding.

This Draft Strategy also recommends that the State ensures that efficiency programs address "all fuels" and provide the levels of investment needed to include oil efficiency measures. The most logical ways to ensure that oil efficiency measures are carried out in conjunction with the electric and gas programs would be for the General Assembly to levy a surcharge on fuel oil to support efficiency measures for fuel oil customers. This option should be evaluated and commented upon in light of the fact that the expansion Draft Strategy proposed in the Chapter 4 (Natural Gas), the conclusion that boosting efficiency is the best option for customers in areas of the state where it will not be economically feasible to covert from oil to natural gas.

2. Revamp Existing Efficiency Fund Programs To Ensure Maximum Impact For Ratepayer Dollar Spent

In order to support innovation, the Draft Strategy recommends that existing and new programs be evaluated by using consistent metrics that drive innovation to reduce costs and to spur participation. Those metrics should include total cost per unit of energy saved, customer acquisition costs, and material costs. In addition, incentives should be developed for lowering the cost per unit of saved energy and for increasing participation.

The Connecticut Energy Efficiency Board should undertake an examination of the HES residential efficiency program to determine if there is an alternative incentive structure for the program that would ensure the deployment of the maximum amount of residential efficiency by driving "deeper" follow-up efficiency measures, as opposed to only performing the initial energy audit, lighting and air sealing measures. The

program has over-rewarded companies that can perform the initial audits en masse. It does not offer effective incentives for implementation of additional follow-up measures that achieve far greater energy savings. As a consequence, the program currently results in a low level of carrying out "deeper" follow-up efficiency measures. Ratepayers—and customers who have had audits—would be well-served by increasing the volume of these follow-up measures.

Those metrics should include total cost per unit of energy saved, customer acquisition costs, and material costs. In addition, this Draft Strategy recommends developing incentives for lowering the cost per unit of saved energy and for increasing participation. One approach would be to evaluate contractors and vendors using a "scorecard" that assesses such performance measures as sales conversions and number of measures installed. Higher scores would earn contractors and vendors financial rewards. Such a scorecard should be developed, tested, and refined to make it as effective as possible.

A further improvement that should be considered would be the development of a licensure standard for HES home performance contractors. This standard could be similar to standards for Home Improvement Contractors, and could be tied to different levels of the Building Performance Institute's certification programs to promote growth in the sector and provide confidence to customers that enlist the service of these professionals.

LEVERAGE PRIVATE CAPITAL TO SUPPORT ENERGY EFFICIENCY INVESTMENTS

The capital that will be required for Connecticut to reach its energy efficiency and clean energy goals will be substantial. Financing programs currently available from the utilities and the Connecticut Energy Efficiency Fund are inadequate to meet this need as they rely on the use of limited ratepayer funds. As discussed above, CEFIA is developing new financing programs designed to attract private capital investment to support clean energy investments for both homeowners and businesses. Advancing these programs, as described below, is critical to develop consistent, sustainable funding for energy efficiency that—over time—would require lower levels of ratepayers support. New innovative financing tools like C-PACE, on-bill financing, and performance contracting will further help customers pay for energy efficiency. Taking these programs to scale will require increasing customer awareness and driving demand to ensure that a higher number of customers participate in these programs.

3. Develop Financing Programs To Make Residential Clean Energy Investments More Affordable

In order to make it easier for customers to invest in energy efficiency improvements, DEEP is working with the utilities, CEFIA, and other organizations to better coordinate existing financing and incentive programs and to significantly expand the availability of financing. Legislation enacted in 2011 and 2012 authorizes use of two important tools to provide financing options to Connecticut residents and businesses. Section 99 of Public Act 11-80, directs CEFIA to promote additional private capital investment for Connecticut's energy efficiency and clean energy goals, through financing and leveraging private capital, and Section 116 of Public

Act 11-80 directs DEEP to establish a residential heating equipment financing program through on-bill financing or other mechanisms. This Draft Strategy proposes that the State pilot two mechanisms to finance energy efficiency upgrades for the residential sector, to determine whether one or both are effective in attracting sufficient capital, at low interest rates, to make residential clean energy investments—including investments to upgrade or replace inefficient furnaces and boilers—affordable on the scale needed to achieve Connecticut's energy goals.

One of the mechanisms for financing residential energy efficiency measures is a "low or no" interest rate loan program modeled on the zero interest HEAT loan offered by Mass Save (Massachusetts' utility-administered efficiency program).[32] The HEAT loan program is administered directly by community banks and credit unions, with Mass Save subsidy in the form of an upfront buy-down of the interest rate to 0%. This Draft Strategy proposes that CEFIA pilot a similar program with Connecticut banks, utilize private capital providers to fund the income eligible program and will also establish a loan loss reserve, interest rate buy down or other credit enhancement mechanisms to support affordable interest rates and enable a payback period for the homeowner of up to twelve years. Such a financing program is likely to be attractive to community and local banks because of (1) CEFIA's credit enhancement, (2) potential access to new customers, (3) improvements to the local community building stock in an underserved market, and (4) the possibility of federal Community Reinvestment Act benefits for the participating banks.

The second mechanism is "on-bill" financing, which can enable homeowners to finance energy efficiency, heating equipment upgrades or conversions, and renewable energy improvements with little or no upfront costs by paying for those measures over an extended time on their monthly utility bills. Typically, the loan terms are structured so that savings from the efficiency or clean energy improvements are greater than the loan repayment cost. As a result, the homeowner has no increase in their monthly utility bill and ideally gets some gets some portion of the savings from day one.[33]

From the lender's perspective, a key advantage of an on-bill financing program is that homeowners generally have a good track record of paying their utility bills which reduces the risk of default and enables more attractive borrowing terms, thereby driving higher loan volumes and lower interest rates, and generating greater levels of private capital investment in clean energy and efficiency. Extensions of credit for energy efficiency measures are unsecured obligations of the borrower. To be attractive to lenders such an on-bill financing program must have enforcement mechanisms that lower lenders' risks enough to be able to get lower-cost capital so as to provide lower interest rates and longer term loan repayment periods.

32 Mass Save, "Offers: Mass Save HEAT Loan Zero Interest Financing for 2012." Available at http://www.masssave.com/residential/offers/heat-loan-program.

33 In some instances, non-electric energy efficiency measures covered through on-bill financing, could have an increase in the monthly electric utility bill.

Mechanisms that allow utility service to be shut off in the event of nonpayment, and that keep the debt obligation "with the meter" (so that the loan obligation—as well as the benefits from the energy efficiency measures—transfer to the new owner if a property is sold) are two requirements that would make this possible. Without these kinds of enforcement mechanisms, the cost of raising this capital will be high when compared to other financing options, such as mortgage debt and home equity lines of credit. Without "buying down" the interest rate, such loans may not be attractive or affordable for the majority of consumers. These types of enforcement mechanisms obviously can have severe consequences for households, and therefore eligibility for this type of on-bill financing should be limited to customers who have stable credit scores. For those homeowners who do not qualify for the on-bill residential heating equipment financing program, the "low or no" cost loan would provide an alternative source of efficiency financing.

An on-bill program would require PURA's approval to the extent that he program affects CL&P's and UI's customer bills. This Draft Strategy recommends that PURA consider authorizing an on-bill residential heating equipment financing program with the enforcement mechanisms and with appropriate eligibility criteria, as described above. This program could be managed by CEFIA and funded primarily through third party financing, such as local, regional or money-center banks rather than ratepayers. A sufficient period of homeowner repayment history should enable CEFIA to access the bond market and secure even lower cost financing for hundreds of millions of dollars of energy improvements. In launching this program, CEFIA could utilize credit enhancements for capital sourced from banks as well as other financing tools such as the Special Capital Reserve Fund to support funds raised in the bond market.

4. Establish Commercial Property Assessed Clean Energy Districts In Municipalities Across The State

As described earlier in this Chapter, in June 2012, the Connecticut General Assembly passed Public Act 12-2, which enabled the creation of a financing program that enables commercial, industrial, and multi-family property owners in Connecticut to access upfront financing for energy improvements. Commercial Property Assessed Clean Energy (C-PACE) is a tax-lien financing program that allows interested property owners to finance qualifying energy efficiency and clean energy improvements on their properties through an additional charge ("assessment") on their property tax. Similar to a sewer tax assessment, capital provided under the C-PACE program is secured by a lien on the owner's property tax bill. Property owners pay the improvements back over time, based on the voluntary assessment placed on the property tax bill. The PACE lien takes first priority over mortgage-holders, and the repayment obligation transfers automatically to the next property owner if the property is sold. Because the payment is tied to the property tax, a secure payment stream, low interest capital can be raised from the private sector with no government financing required. This arrangement spreads the cost of clean energy improvements – such as energy efficient boilers, upgraded insulation, new windows, or solar installations – over the expected life of the measure.

Across the country, this financing model has enabled property owners to access capital for energy improvements. Connecticut's C-PACE program is administered by CEFIA. While the program is statewide,

municipalities interested in extending this type of financing to their property owners must opt-in through an agreement with CEFIA. Dozens of municipalities have indicated interest in opting into this program. This Draft Strategy recommends that (1) municipalities should work with CEFIA to pass resolutions through their legislative bodies that will enable their business owners to access this attractive financing program to improve their buildings and (2) consideration should be given to enacting property tax exemptions for clean energy programs and projects administered through the State such as the C-PACE program.

LOW-INCOME STRATEGY TO ENSURE THAT LOW-INCOME COMMUNITIES BENEFIT FROM ENERGY-EFFICIENCY PROGRAMS

In addition to developing financing models for residential customers with low incomes or poor credit, as discussed above, this Draft Strategy proposes several recommendations to ensure that low-income communities participate in and benefit from the state's energy efficiency programs.

5. Develop Programs To Support Pre-Weatherization Measures

Landlords may be reluctant to participate in the State's energy efficiency programs if their properties have health- and safety-related code violations—such as asbestos, mold, or "knob-and-tube" electric wiring—that would have to be remedied before a home energy audit can be performed. This Draft Strategy recommends that programs should be developed, primarily for the oldest housing stock in distressed communities, to support or incentivize "pre-weatherization" measures (i.e., remediation of code violations) in order to remove this barrier to participation in the state's energy efficiency programs.

6. Incorporate Energy Efficiency Measures Into Upgrades Of State-Administered Housing

Governor Malloy has made a strong commitment to upgrading and expanding state-administered housing units across Connecticut. At the same time, DEEP and CEFIA will work to promote enforcement of energy efficiency standards (e.g. weatherization standard) in conjunction with Section 8 Housing Quality Standards (HQS) unit inspections. Doing so will ensure that building occupants are afforded higher quality living environment, and owners of the units can save on energy costs and pass these savings through. The best way to do this is to use financing mechanisms to support improvements. Accordingly, DEEP and CEFIA should work with the Connecticut Housing Finance Authority to ensure that the State's $300million commitment to upgrading public housing captures efficiency upgrades and leverages available funding to advance these efforts.

7. Improve Existing Means-Tested Energy Assistance Programs

DEEP's analysis of the effectiveness of various State energy assistance programs, discussed above, suggests that more benefits could be achieved by reforming, coordinating and better targeting the use of currently allocated resources. For example, the Matching Payment Program (MPP) for low income utility customers has worthy attributes and goals, but may be underperforming in terms of reducing utility uncollectible expenses, improving customer payment habits, and other desired outcomes. Consideration should be given to modifying

the program to build on MPPs best attributes, such as its arrearage/debt forgiveness component, timely payment incentives, and counseling elements. Consideration should be given to redesigning the MPP program into one based upon twelve month regular and required percentage of income payment.

8. Target Funding to Address Split Incentives

DEEP should work to develop program tools that promote efficiency and alternative energy improvements in multifamily properties while equitably managing the split of benefits between the owners and tenants. One option available to the state would be to provide a tax credit for 2-4 unit multifamily properties where the owner does not pay for utilities, which would incentivize implementation of a set level of efficiency, natural gas heating conversions, and/or alternative energy improvements. This approach would require some level of owner contribution tied to limits for raising rents.

9. Expand Outreach And Financing Options For Businesses In Low-Income Communities To Achieve Energy Efficiency

Pursuant to Section 119 of Public Act 11-80, DEEP has engaged the Office of Energy Efficient Business and the Connecticut Center for Advanced Technology to provide outreach to small businesses in low income urban communities (see text box earlier in this Chapter). Going forward, these efforts should be coordinated with those of Operation Fuel's BEST program and other similar programs and services aimed at the targeted communities, to better ensure that small, largely minority owned, businesses in our urban centers avail themselves of the energy efficiency opportunities that can economically benefit them.

ENACT REGULATORY CHANGES TO EXPAND EFFICIENCY OPPORTUNITIES

10. Implement Decoupling To Align Utility Incentives With Energy Efficiency

Utilities traditionally have made more money when they sell more electricity or gas, creating a powerful incentive to push for less efficient uses of energy or to avoid promoting energy efficiency measures. Flipping this incentive around requires separating utilities' revenue from their sales volume, a process known as "decoupling." While this basic decoupling removes the disincentive for utilities to promote efficiency, performance incentives (currently in place) or a performance-based return on equity give utilities an even stronger incentive to work with customers to boost efficiency and save them money. For a more detailed discussion of this Draft Strategy's recommendations with respect to decoupling and incentives, refer to Chapter 3 (Electricity).

11. Adopt And Enforce The Latest Codes And Standards To Ensure High-Performing Buildings

Though market-based approaches to promoting efficiency are important, many energy consumers may not respond to market signals. As a result, more stringent building codes and appliance standards are an important driver of higher efficiency. In the summer of 2013, Connecticut must adopt and enforce the latest International Energy Conservation Code for residential buildings and the American Society of Heating,

Refrigerating and Air Conditioning Engineers (ASHRAE) Standard 90.1 for commercial buildings, as required by statute.[34]

Just as importantly, the State must provide adequate resources to train local building inspectors about the new codes on a regular basis to ensure that enforcement is uniform across the state. The State also should continue to adopt improved appliance standards, and coordinate with other states in the region to harmonize standards and thus increase market power. It should also explore the state's potential ability to provide incentives to large commercial users to upgrade to high-efficiency appliances and encourage equipment suppliers to primarily stock the most energy efficient equipment.

FOSTER A MARKET FOR ENERGY EFFICIENCY

12. Empower Consumers With Information About Efficiency Benefits

Several strategies may help consumers better obtain the information they need to make informed decisions about the ways they consume energy. New education materials explaining the benefits of energy efficiency should be included in energy bills and some state and local government mailings such as those related to income and property taxes.

This Draft Strategy recommends that residential marketing efforts focus on increasing awareness about Home Performance, the benefits these services provide, the available contractor network and low cost options to help pay for these investments. This must be done in concert with the state's goal to weatherize 80% of Connecticut homes by 2030.[35] The residential Home Performance industry should track progress towards the goal of 80% of homes weatherized by 2030. This effort will require the gathering and compilation of a substantial amount of information about the efficiency attributes of each home that is visited. Data from the HES program and other weatherization efforts should be used to populate a database of Connecticut homes with energy related information. This information should be shared with homeowners, landlords, and tenants, to inform them about the relative efficiency of their home and cost-effective opportunities to improve the efficiency of these properties.

To the extent possible, refinancing, rehab or upgrade, and home buyer programs should be coordinated with CEFIA and the State's energy efficiency programs, and any health and safety programs, so that efficiency measures and health and safety improvements are also financed. The State could also encourage consumers to educate other consumers. For example, building owners whose energy efficiency or renewable energy upgrades are funded by State dollars could be given the option to display some type of on-site education (e.g., a sign or smart-phone scannable code) about the upgrades.

[34] Conn. Gen. Stat. § 29-256a

[35] Conn. Gen. Stat. § 16-245m

13. Empower Building Owners to Market Their Energy Efficiency Improvements

Investments in energy efficiency measures are clearly effective in bringing down a building's energy costs, but this information is not readily apparent to prospective tenants or buyers. As a result, rents and home prices do not necessarily reflect or reward the efficiency investments that have been made in a home or apartment building, even though those investments provide real economic value in terms of lower energy costs. Approximately 5% of the residential housing stock in Connecticut, changes hands each year. This turnover represents a golden opportunity for assessing a property's "efficiency profile" and for improving its efficiency. The State needs to engage commercial and residential real estate professionals who are on the "front lines" of these transactions and encourage their participation in understanding the benefits of efficient buildings. Buyers have often included the costs of cosmetic or redecorating upgrades in mortgages. Promoting inclusion of insulation, heating/cooling system upgrades, along with other measures, could be financed at the time of purchase and yield significant savings for the new owner making it even easier to meet whatever increased mortgage payment that might be incurred.

This Draft Strategy recommends the development of a residential building energy labeling program on a voluntary, pilot basis. Homeowners interested in participating could be provided a label or information sheet that summarizes a building's energy efficiency performance that could be included as part of the seller disclosure form when the building is on the market. Such a labeling program would help buyers make informed decisions, and would reward homeowners who invest in efficiency by increasing the value of their homes on the real estate market. By establishing a uniform metric for evaluating the efficiency of all occupied spaces, the labeling program could also help the State meet the requirements of part of the 80% weatherization goal in Public Act 11-80, as discussed above.

At the same time, this Draft Strategy suggests that the General Assembly consider legislation to require that landlords of commercial and residential buildings provide energy cost data to tenants, for rental units where the tenant directly pays the bills. This rental energy disclosure could be modeled on the building label described above, and could be included routinely as part of every lease agreement.

FURTHER ACTIONS

The location of buildings can also have a significant impact on levels of air and water pollution. Since the mid-twentieth century, Connecticut's new building activity has primarily occurred in suburban and rural areas. The dispersion of buildings, and consequent disinvestment in many of the state's central cities, has increased Connecticut's reliance on the automobile (and the gasoline it uses—imported from other states). The increased use of the automobile, in turn, has had significant effects on the environment, as discussed further in Chapter 5 (Transportation), and on the health of regional economies that depend on strong central cities. Strategies and accompanying policy decisions that promote building developments and redevelopments in ways that take advantage of existing or proposed transportation and utility infrastructures can do much to

address pressing environmental and economic challenges that are only peripherally addressed in this Draft Strategy.

CONCLUSION

Because the building sector consumes nearly 60% of the State's energy, it offers the largest single opportunity to use energy efficiency to reduce both energy use and greenhouse emissions. That is why the State has already set ambitious targets, developed innovative programs, financed a range of pilot and longer-term projects, begun efforts to align utilities' and consumers' incentives and needs, and focused on developing policies to ensure economic and environmental sustainability.

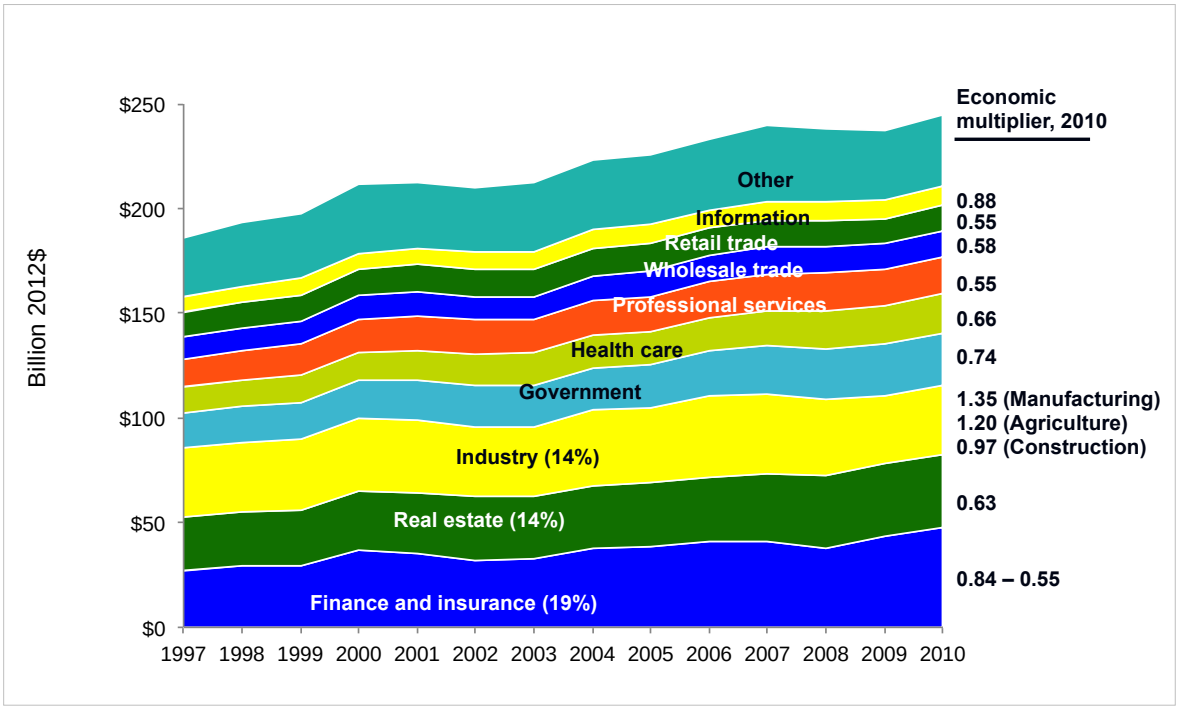
This Draft Strategy charts a path to advancing these initiatives even further, by proposing steps to create stronger incentives for utilities to invest in efficiency, making it easier for customers to choose to switch to natural gas, and launching new efforts to use oil more efficiently. Lower energy costs also make the state's businesses more competitive and keep Connecticut's dollars at home. An aggressive effort to improve building efficiency is the single most important tool that we have–and control—to ensure a cheaper, cleaner, and more reliable energy future for Connecticut.

Industry Sector Strategy

OVERVIEW OF THE INDUSTRIAL SECTOR

Connecticut's industrial sector serves as a powerful economic engine in the state. Providing low-cost energy options for the industrial sector is essential for Connecticut's economic competitiveness. The state's manufacturing businesses are diverse, ranging from high-tech to metal finishing—with a growing focus on precision manufacturing. The industrial sector contributes over $30 billion per year to Connecticut's Gross State Product (GSP), comprising 14% of the total GSP. That makes it the third largest sector in the state in terms of GSP, ranking behind only the finance and insurance sector, and the real estate sector (Figure 1).[36]

FIGURE 1: Gross State Product and economic multiplier by sector



Source: U.S. BEA, Gross Domestic Product by State.

Eighty percent of the state's industrial GSP is from manufacturing, with construction providing nearly the entire remaining portion (19%).[37] Overall, the manufacturing sector has the highest economic multiplier effect (1.35) in the state, meaning that every dollar in manufacturing output generates another $1.35 in economic

[36] U.S. Department of Commerce Bureau of Economic Analysis, . "Advance 2011 and Revised 1997–2010 GDP-by-State Statistics." Available at http://www.bea.gov/newsreleases/regional/gdp_state/2012/pdf/gsp0612.pdf.

[37] *Ibid.*

activity in other sectors to supply parts, materials and technical and business services.[38] Agriculture and construction also have high economic multiplier effects.

Today, more than 220,000 people are employed in skilled industrial jobs in Connecticut. The workers in this sector earn the state's second highest average wages (Table 1) after finance and insurance.[39] The majority of workers (75%) in the industrial sector are employed in manufacturing, with most of the remainder (23%) employed in construction.[40]

TABLE 1: Total employment, average wages for Connecticut's largest employment sectors, 2011

Sector	CT Total Sector Employment 2011	CT Average Annual Wage (2012$)	US Average Annual Wage (2012$)
Health Care	250,782	$48,242	$48,026
Government	237,498	$56,616	$51,853
Industry	223,333	$72,274	$47,631
Manufacturing	*166,279*	*$77,717*	*$47,086*
Construction	*51,493*	*$58,917*	*$48,874*
Agriculture	*5,019*	*$29,255*	*$25,937*
Mining	*542*	*$69,977*	*$58,418*
Retail	180,203	$31,446	$29,633
Finance & Insurance	114,561	$155,798	$60,752
Hospitality/Food Services	113,309	$18,826	$22,957
Total State/U.S.	1,612,373	$61,751	$45,682

Source: Connecticut Department of Labor, Quarterly Census*; and U.S. Bureau of Labor Statistics,* Employment and Wage Estimates.

Connecticut has experienced a steady loss of industrial sector jobs over the past several decades, as has the nation as a whole. Manufacturing accounted for 15% of non-farm employment in Connecticut in 1997 but only 10% of employment in 2010. While manufacturing employment has decreased, output has increased due to gains in productivity (Figure 2).[41] Indeed the productivity of Connecticut's workers ranks near the very top of the nation. But despite this strong position in terms of production output, Connecticut's relatively high energy and electricity costs have been a drag on this sector, particularly during the recent challenging period of economic recession.

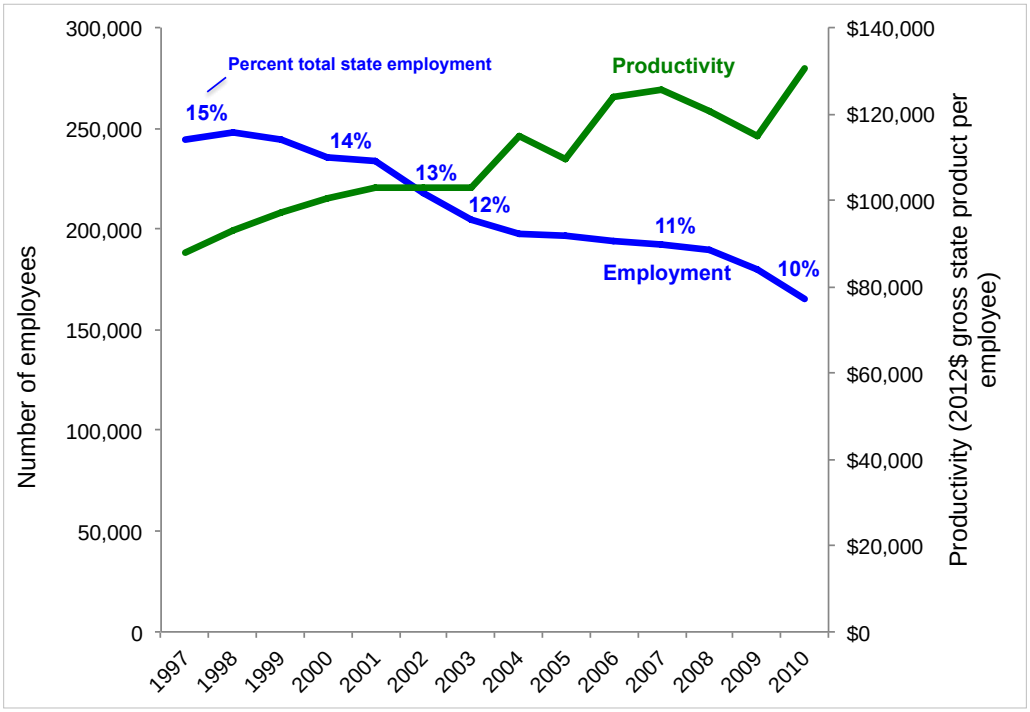
[38] U.S. Department of Commerce Bureau of Economic Analysis, *Industry-by-Industry Total Requirements.after Redefinitions (1998 to 2010). Washington DC: U.S. Bureau of Economic Analysis, 2010.*

[39] Connecticut Department of Labor, . "Employment & Wages by Industry - Quarterly Census of Employment and Wages - State of Connecticut." Available at http://www1.ctdol.state.ct.us/lmi/202_minorareas_lma.asp.

[40] *Ibid.*

[41] Connecticut Department of Economic and Community Development, . "Connecticut Economic Strategic Plan." p. 37. Available at http://www.ct.gov/ecd/lib/ecd/connecticut_esp-final.pdf.

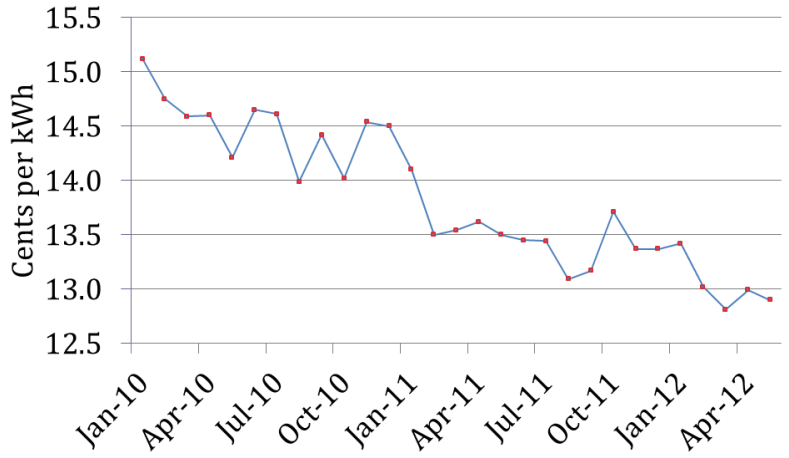
FIGURE 2: Connecticut manufacturing employment and productivity, 1997-2010



Source: U.S. BEA, Annual Survey of Manufacturers*; and Connecticut Department of Labor,* Quarterly Census.

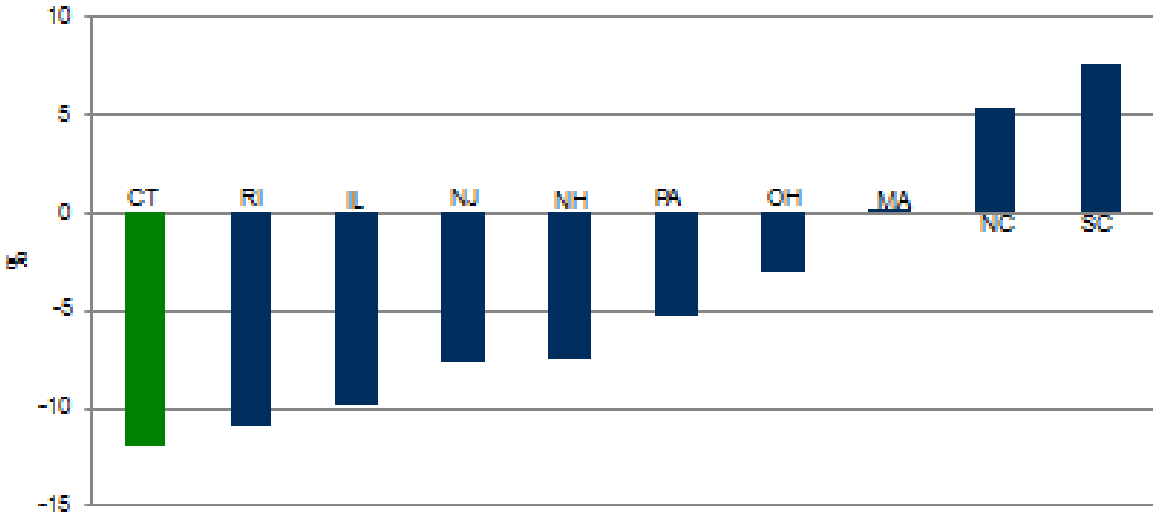
Fortunately, the price of electricity for industrial customers has come down significantly in the last several years (Figure 3). As Figure 4 shows, industrial electric rates in Connecticut have been dropping at a faster rate than neighboring states, or even states in more traditionally low-cost electricity regions. This trend reflects the fact that Connecticut has invested in cleaner power generation (such as replacing coal-fired generation with natural gas-fired generation) over the past decade while many other states, especially in the Midwest and South, face rising electricity rates as they are forced to retire old fossil fuel generating plants based on tightening environmental standards and discouraging fuel economics.

FIGURE 3: Connecticut Average Electricity Prices for the Industrial Sector, January 2010-May 2012



Source: EIA Monthly, January 2010-August 2012

Figure 4: Percent Change in Average Electricity Prices in the Industrial Sector Among Selected States, May 2010-May 2012



Source: EIA Monthly, May 2010-May 2012

Connecticut manufacturers have remained competitive regionally and globally because many of them make high-value products in an energy efficient manner supported by a highly skilled labor force. Connecticut ranks third in the nation in the percentage of masters, professional, or doctoral degrees, second in industrial research and development per $100,000 of sales, and fifth in the percentage of scientists and engineers in the

workforce.[42] Given this foundation for highly productive manufacturing, the state is well-positioned to expand its industrial base as electricity and other energy costs decline.

These advantages explain why companies that manufacture high-value products — such as helicopters, aircraft engines, office equipment, drugs, chemicals, and fuel cells — have increased their share of the state's GSP, while primary metals and electronics production have shifted to lower-wage states or countries. One example of how these high value products benefit the state is the hydrogen and fuel cell industry. In 2010 that industry contributed $267 million to the gross state product and more than $22 million in state and local tax revenue, while supporting about 1,000 jobs scattered through about 600 companies that play some supporting role to the hydrogen and fuel cell industry in the state.[43] As is the case with manufacturing, the agricultural sector has similarly turned to high-value products. Nearly half of the agricultural subsector's revenue comes from greenhouse produce and flowers, and from nursery plant operations.[44]

Industrial Sector Energy Use

Understanding how the industrial sector uses energy, and the types of energy upon which it relies, can help direct strategies to increase efficiency and lower costs. The industrial sector currently consumes 76 trillion BTUs of electricity, natural gas, oil, and biomass per year to power the state's thousands of factories, data centers, research facilities, farms, construction sites, water and wastewater utilities, and other industrial operations.[45] This represents 10% of Connecticut's overall energy consumption.

Overall, electricity accounts for nearly half of the primary energy expenditures attributed to the industrial sector, while representing only 17% of primary energy used (Figure 5).[46] In other words, companies expend more than half of their energy dollars for electricity, which only supplies 17% of their energy needs. Reducing industrial electricity consumption would be one of the most productive ways to lower costs for Connecticut companies. Natural gas accounts for a third of industrial energy consumption, while oil represents 16% and biomass the remaining 5%.[47]

[42] Northeast Utilities, *On Course*. Connecticut Economic Review. Hartford, CT: Northeast Utilities, 2012. www.cl-p.com/Business/EconomicDevelopment/Economic_Review/

[43] Connecticut Center for Advanced Technology, "Hydrogen and Fuel Cell Industry Development Plan" (2012) page 2.

[44] U.S. Department of Agriculture, Economic Research Service, "State Fact Sheets: Connecticut." Available at http://www.ers.usda.gov/data-products/state-fact-sheets/state-data.aspx?StateFIPS=09&StateName=Connecticut

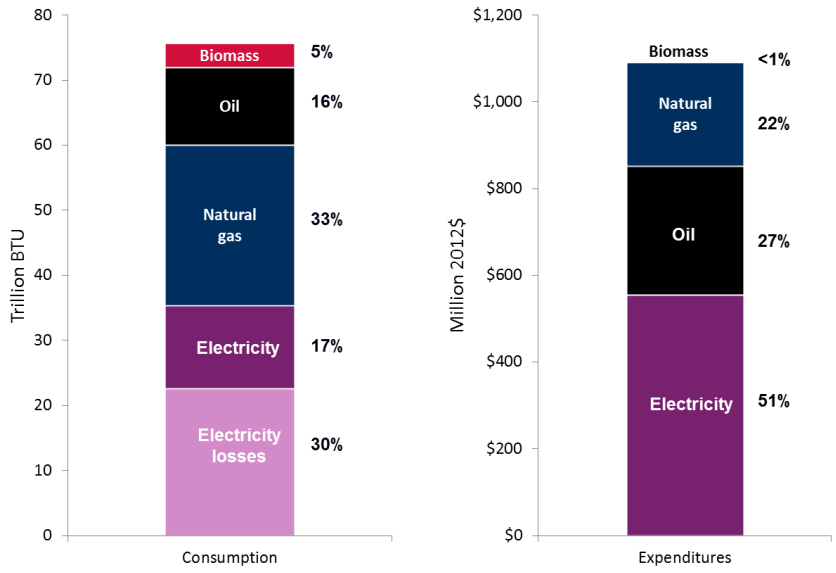
[45] U.S. Energy Information Administration State Energy Data System, "Industrial Sector Energy Consumption Estimates, 2009." Available at http://www.eia.gov/state/seds/hf.jsp?incfile=sep_sum/plain_html/sum_btu_ind.html

[46] *Ibid.*

[47] *Ibid.*

FIGURE 5: Connecticut industrial primary energy consumption and expenditure by fuel type, 2010

Electricity accounts for 17% of primary energy used but over half of industry's energy expenditures; the rest comes from natural gas and oil.



Source: U.S. EIA, Industrial Energy Price and Expenditures; and U.S. EIA, Industrial Sector Energy Consumption.

The majority of these fuels are consumed in the manufacturing subsector, which is responsible for 88% of industrial sector electricity use.[48] Within manufacturing, electricity and natural gas consumption varies across different subsectors, depending on the size of the subsector and the energy intensity of the manufacturing processes. Manufacturing aerospace parts and transportation equipment, along with the fabricated metals needed for those parts, are two of the state's biggest manufacturing businesses, and also some of the largest consumers of electricity (Table 2).

[48] Microsoft Excel file shared with Connecticut Department of Energy and Environmental Protection. April, 2012; Connecticut Department of Labor, "Employment & Wages by Industry - Quarterly Census of Employment and Wages - State of Connecticut." Available at http://www1.ctdol.state.ct.us/lmi/202_minorareas_lma.asp.; and U.S. Department of Commerce Bureau of Economic Analysis, "Advance 2011 and Revised 1997–2010 GDP-by-State Statistics." Available at http://www.bea.gov/newsreleases/regional/gdp_state/2012/pdf/gsp0612.pdf.

TABLE 2: Annual delivered industrial electricity consumption in Connecticut, by sub-sector, 2011

Industry Subsector*	Electricity Sales, 2011 (GWh)	Number of Facilities (2011)	% of GSP (2010)
Total Manufacturing	2,375	4,808	10.5
Misc. Manufacturing	478	334	1.0
Fabricated Metals	432	1,259	1.4
Transportation Equipment	236	253	2.4
Chemicals	167	183	1.8
Industrial Machinery	158	497	0.8
Computer and Electronics	153	329	0.8
Food and Beverage	138	351	0.5
Rubber/Plastics	133	181	0.3
Primary Metals	121	78	0.2
Electrical Equip.	98	174	0.7
Printing	91	373	0.2
Paper	55	82	0.2
Non-Metallic Minerals	43	155	0.1
Textiles & Apparel	42	142	0.1
Lumber/Furniture	23	396	0.1
Petroleum/Coal Products	8	n/a	0.1
Construction	288	9,385	2.6
Agriculture	29	368	0.1
Mining	16	61	0.0
Total Industry	2,707	14,622	13.8

Source: Connecticut Light and Power, "Electricity Sales"; Connecticut Department of Labor, Quarterly Census*; and U.S. BEA,* Gross Domestic Product by State*. *Sales data does not include municipal utilities, which account for 6% of electricity sales in the state.*

Connecticut's paper and primary metals industries are a relatively small percentage of GSP, but papermaking and metal forming are energy-intensive processes. As a consequence, paper and metal forming subsectors are the state's largest consumers of natural gas, accounting for over 60% of total manufacturing natural gas use.[49]

After manufacturing, construction (which includes residential and commercial new construction plus significant remodels) is the largest user of energy within the industry sector, accounting for about a fifth of the total energy used by industry. The State has already begun to address the end products of construction—for example, imposing requirements that large State-funded buildings meet rigorous "green building" standards, and establishing a tax credit for comparable privately-developed green buildings. But the process of construction itself, and specifically the energy use concerns that this Draft Strategy seeks to address, have not

[49] KEMA, "Connecticut Natural Gas Commercial and Industrial Energy-Efficiency Potential Study." Available at http://ctsavesenergy.org/files/CTNGPotential090508FINAL.

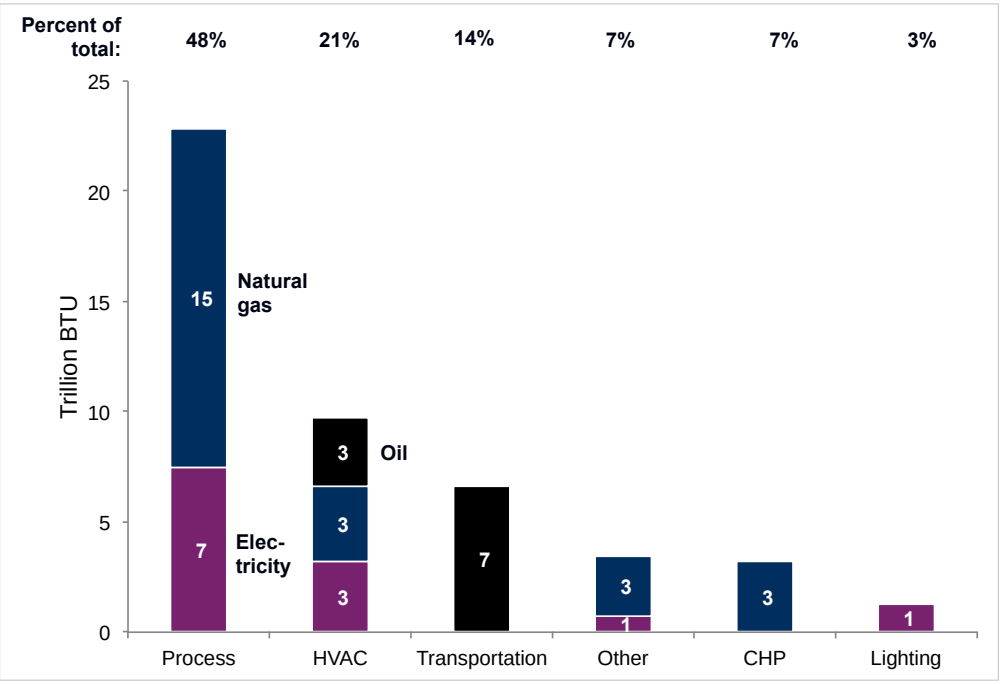
been fully considered by the State. Although construction has lagged somewhat in recent years due to the economic downturn, this Draft Strategy recommends addressing opportunities in this subsector.

Data centers are another large electricity user in the state. Though national and state statistics do not track their energy use as a separate sector, one researcher has estimated that data centers consume 2% of U.S. electricity; if replicated in Connecticut's growing data center industry, this industry would be the second largest industrial consumer of electricity in the state.[50] In many ways, data centers can be considered an industrial process (producing information technology from energy inputs), but since most data centers are housed within commercial buildings, they also have some commonalities with other buildings in the commercial sector. Because of the way they cut across sectors, data centers are not easily classified, but their large and growing energy use — as well as their need for high quality reliable power — merits developing policies aimed specifically at improving their efficiency.

Within the industrial sector, different subsectors utilize energy for different purposes (Figure 6). Nearly half of the energy used in industry powers the equipment used in industrial processes, from compressed air to motors, pumps, boilers and dryers. The low percentage of total energy use for industrial processes is an indicator that Connecticut's mix of manufacturing is not very energy-intensive compared to other states. Heating and cooling the buildings that house those processes accounts for nearly one quarter of the sector's energy use. The remaining portion powers lighting and fuels, CHP systems, and transport equipment.

[50] Koomey, Jonathan G. Analytics Press, "Growth in Data Center Electricity Use 2005-2010." Available at http://www.mediafire.com/file/zzqna34282frr2f/koomeydatacenterelectuse2011finalversion.pdf.

FIGURE 6: Connecticut industrial delivered energy consumption by end use, 2010



Source: U.S. EIA, Industrial Sector Energy Consumption; KEMA, Electric Efficiency Study; and KEMA, Natural Gas Efficiency Study.

Industrial Sector Energy Costs

In 2010, the latest year for which data are available, the industrial sector spent $1.1 billion on energy, 7% of the state's total energy expenditures.[51] Electricity is responsible for over half of this expenditure, even though it represents only 24% of delivered energy. One reason industrial electricity costs are a high percentage of total costs is that wholesale electricity prices in New England are relatively high.[52],[53] But note that despite high electricity rates, Connecticut's average electricity bills for industrial consumers rank twenty-fifth in the country both because of investments in efficiency and the sector's mix of less energy intensive industries relative to other states.[54] The good news for industrial customers, as shown in Figure 3, is that Connecticut's

[51] U.S. Energy Information Administration, "State Energy Price and Expenditure Estimates 1970-2010." Available at http://www.eia.gov/state/seds/sep_prices/notes/pr_print.pdf.

[52] U.S. Energy Information Administration, "Electric Power Monthly March 2012." Available at www.eia.gov/electricity/monthly/current_year/march2012.pdf.

[53] U.S. Energy Information Administration, "Industrial Average Monthly Bill by Census Division, and State." Available at http://www.eia.gov/electricity/sales_revenue_price/pdf/table5_c.pdf.

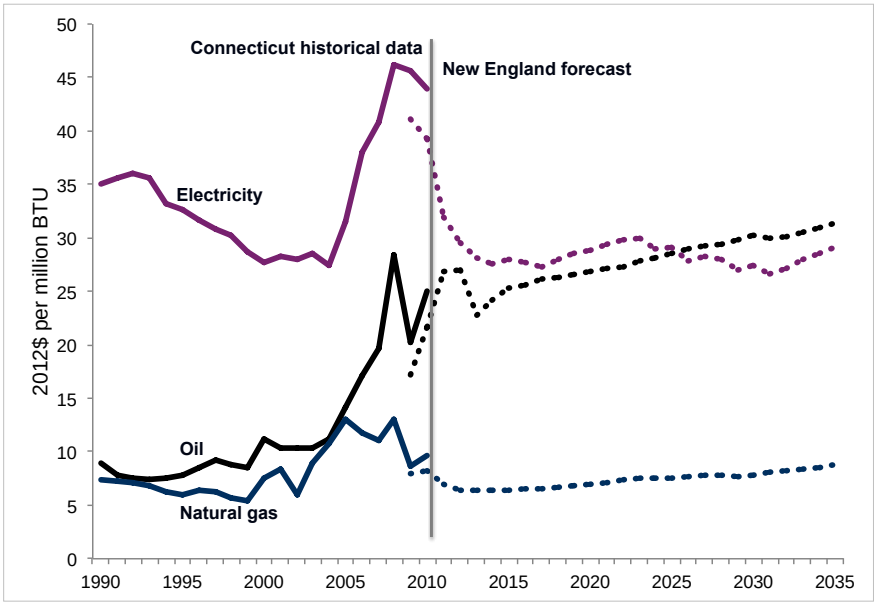
[54] U.S. Energy Information Administration, "Electricity Monthly Update April 2012." Available at http://www.eia.gov/electricity/monthly/update/archive/april2012/.

overall electricity rates are dropping rapidly (17% since January 2009), in part due to recent declines in natural gas prices, which forecasters suggest will continue to stay low for the next several years.[55]

Natural gas use accounts for 22% of total costs in the industrial sector. Although Connecticut's industrial natural gas prices are also high compared to other regions, they are lower than prices in other states within New England and the Northeast.[56] Natural gas prices, therefore, provide Connecticut with a regional competitive advantage.

Oil accounts for the remaining 27% of the industry sector's energy costs. Oil prices in real terms have nearly tripled since 2004 (Figure 7).[57] Like natural gas prices, oil prices show regional and state-by-state variation due to differing transportation costs and infrastructure constraints that can restrict supply. But recent oil price increases and volatility have had a much larger impact on costs than regional price differences. The U.S. Energy Information Administration (EIA)'s forecast of high oil prices means that even electric resistance heating, traditionally the highest cost form of heat, will compete on cost with oil heat within three years. But neither oil heat nor electric heat is likely to match the cost-effectiveness of natural gas over the next ten to twenty years.

FIGURE 7: Electricity, natural gas and oil industrial prices, Connecticut historical and New England forecast



Source: U.S. EIA, Industrial Energy Price and Expenditures; and U.S. EIA, Annual Energy Outlook 2012.

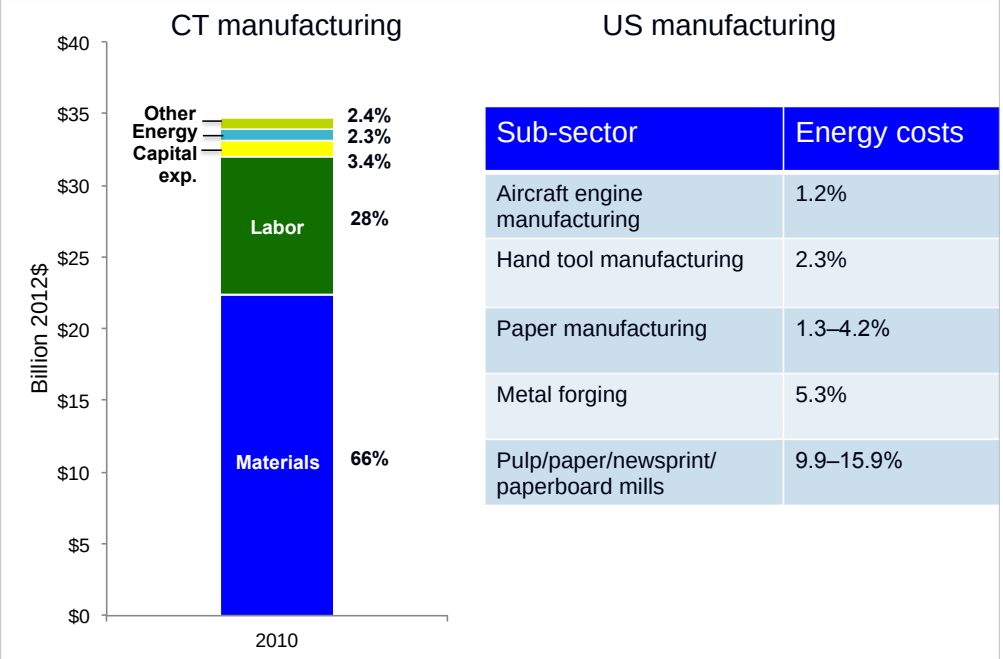
[55] U.S. Energy Information Administration, "Electric Power Monthly January 2011." Available at http://www.eia.gov/ftproot/electricity/epm/02261101.pdf.

[56] U.S. Energy Information Administration, "Natural Gas Prices: Connecticut." Available at http://www.eia.gov/dnav/ng/ng_pri_sum_dcu_SCT_m.htm.

[57] U.S. Energy Information Administration, "State Energy Price and Expenditure Estimates 1970-2010." Available at http://www.eia.gov/state/seds/sep_prices/notes/pr_print.pdf.

As a percentage of total operating costs, total energy costs vary across manufacturing sub-sectors but on average, they represent a small percentage of total operating costs. Designing and fabricating a jet turbine blade or a gene sequencer requires far less energy than making raw steel in giant blast furnaces, for instance. Within common manufacturing subsectors in Connecticut, energy costs range from 1% of total costs for aircraft engine manufacturing to 16% for paper mills. Across all of Connecticut's manufacturers, energy averages 2.3% of total costs (Figure 8). This number is in line with states like Massachusetts (2.4%), which has a similar mix of non-energy-intensive industries, but much lower than a state like Maine (6.6%), with its large, energy-intensive pulp and paper industry.[58]

FIGURE 8: Manufacturing expenditures by category, Connecticut average and U.S. by sub-sector, 2010



Sub-sector	Energy costs
Aircraft engine manufacturing	1.2%
Hand tool manufacturing	2.3%
Paper manufacturing	1.3–4.2%
Metal forging	5.3%
Pulp/paper/newsprint/ paperboard mills	9.9–15.9%

Source: U.S. BEA, Annual Survey of Manufacturers*; and NBER-CES Manufacturing Industry Database.*

While energy costs at manufacturing firms are a minor component of overall costs, profit margins for a typical manufacturing company are slim (often about 6–8% of revenues), and competition is fierce.[59] Selling an extra $100 of products will increase net profits by only $6 to $8. Cutting energy costs by $100, however, drops straight to the bottom line. That extra money can be used to hire more workers, or to invest in innovation and new products. An effective industrial energy strategy for Connecticut must improve economic competitiveness by bringing down the cost of energy supplied to the industrial sector, by increasing the efficiency of industrial energy consumption, and by using the least expensive energy resources.

[58] U.S. Department of Commerce Bureau of Energy Analysis, *Annual Survey of Manufacturer*; and NBER-CES Manufacturing Industry Database

[59] Yahoo Finance, "Net Profit Margin." Available at: http://biz.yahoo.com/p/6conameu.html.

CHEAPER AND CLEANER ENERGY OPPORTUNITIES FOR INDUSTRY

This Draft Strategy proposes six approaches to help Connecticut's industrial companies use less energy and develop cheaper energy sources. These include: (1) reducing electricity rates, (2) expanding energy efficiency programs, (3) encouraging fuel switching to cheaper and cleaner sources, (4) promoting CHP systems, (5) addressing the significant role that water plays in energy production and use, and (6) launching an advanced energy innovation hub at the University of Connecticut. These strategies will reduce energy costs today, keep them stable in the future, improve the industrial sector's competitiveness, and reduce the environmental impacts of the sector's energy use. Although Chapter 1 (Efficiency) and Chapter 3 (Electricity) provide a broader discussion of some of these recommendations, the discussion below focuses on how these strategies impact the industrial sector.

Reduce Electricity Rates

Creating policies that ensure that electricity rates continue to decrease for industrial customers will provide large positive economic benefits to the state. While the general strategies and rationale for reducing electricity rates are covered in Chapter 3 (Electricity), it is important that these strategies also be tailored to ensure that state's industrial customers enjoy the benefits of falling electricity prices. One industry-specific opportunity to reduce rates is fully within the control of industrial consumers. Any industrial customers procuring power through the standard service offer made through the utilities would currently see decreases in energy costs if they switched to using a competitive retail electric supplier. More than 90% of large industrial customers have switched off of the standard offer, and are now paying anywhere between 5 and 14 ¢/kWh for generation. This is a significant range, due in part to the fact that some companies locked into long-term contracts at a time when generation rates were higher than they are today. Many firms have an opportunity over the next year or two to identify more cost-effective electricity suppliers.[60]

Expand Energy Efficiency Programs for Industrial Customers

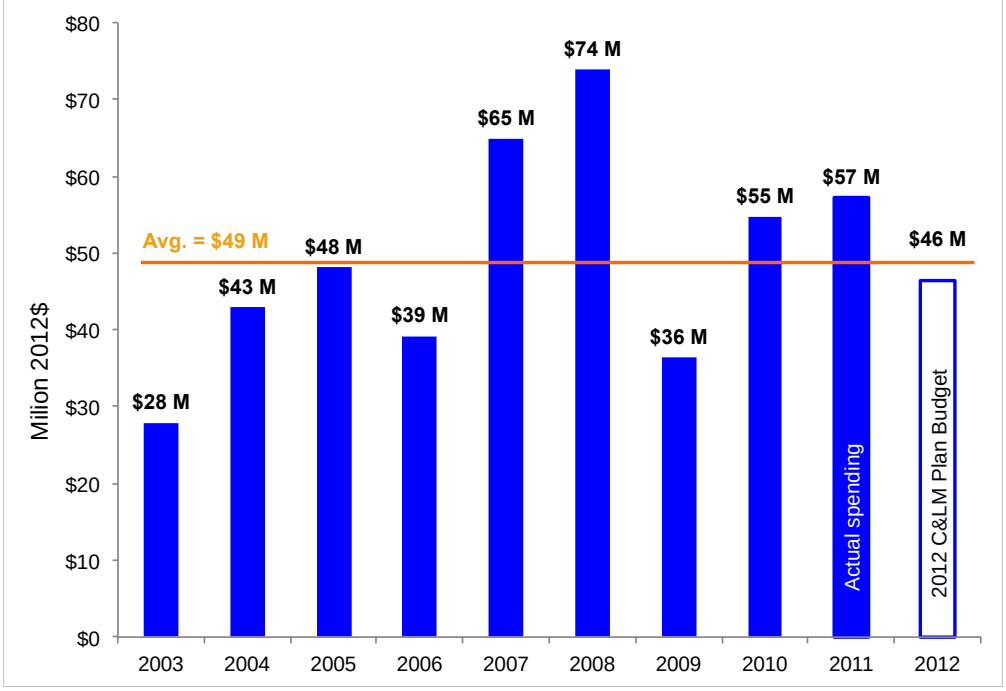
One of the cheapest, most cost-effective ways to reduce industrial energy costs is by improving efficiency. Upfront investment in efficient equipment or streamlined manufacturing practices typically pays back within a few years, and the investment then continues to bring savings over its remaining life.

Despite the often short payback periods offered by efficiency investments, there are still many barriers to investing in efficiency. For example, companies may not have the expertise in-house to spot efficiency opportunities. And efficiency improvements must compete with other investment opportunities for scarce capital. The primary rationale for establishing Connecticut's energy efficiency programs was to provide incentives and expertise that could help overcome these barriers. Annual funding for commercial and

[60] A complete listing of the generation rates currently offered by Connecticut licensed competitive suppliers is maintained on DEEP's website: ctenergyinfo.com.

industrial electric efficiency programs has averaged $49 million since 2003 (Figure 9).[61] This efficiency funding has yielded large reductions in energy use that have reduced costs and yielded significant environmental and public health benefits. In 2011 alone, industrial efficiency programs reduced electricity use by 300 megawatt-hours and natural gas use by 186,157 MCF.

FIGURE 9: Annual spending (pre 2011) and budget (2011-12) for commercial and industrial electric energy efficiency programs



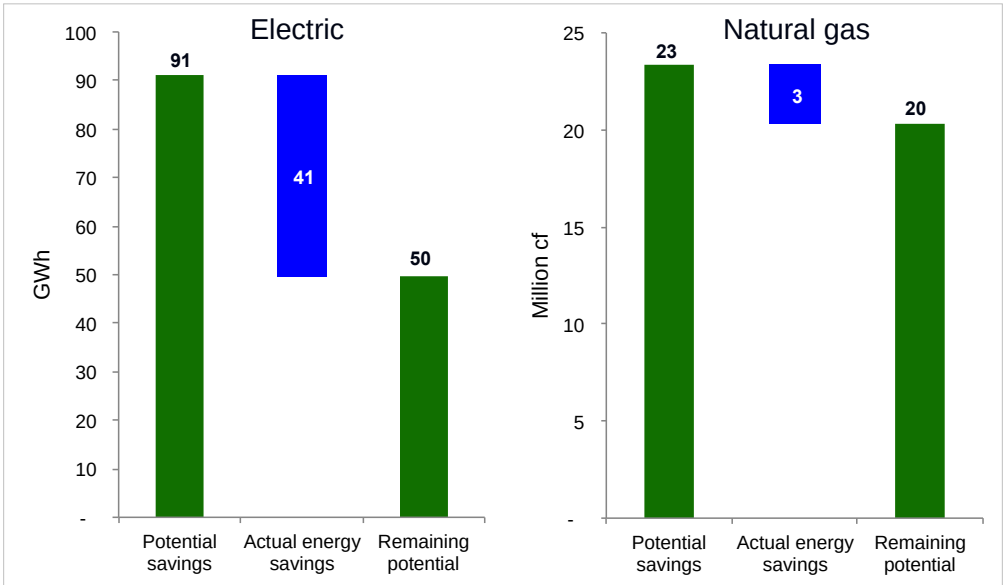
Source: *2012 Conservation and Load Management Plan.*

There is also a significant opportunity to further increase natural gas and electric savings. According to 2011 data, Connecticut's energy efficiency programs have helped customers save 41 gigawatt-hours in electricity and 3 million cubic feet of natural gas. However, these savings represent less than half of the potential cost-effective efficiency gains in electricity and only one-eighth of those in natural gas available in that year (Figure 10).[62]

[61] The Connecticut Light and Power Company, et al., "2012 Electric and Natural Gas Conservation and Load Management Plan." Available at http://www.ctenergyinfo.com/2012%20CLM%20Electric%20and%20Gas%20Plan%20FINAL.pdf.

[62] Northeast Utilities, "Energy Efficiency Programs 2011." Available at http://www.nu.com/responsible_energy/our-business/Energy-Efficiency-Programs-2011.html; KEMA, "Connecticut Natural Gas Commercial and Industrial Energy-Efficiency Potential Study." Available at http://ctsavesenergy.org/files/CTNGPotential090508FINAL; and KEMA, "Connecticut Electric Residential, Commercial, and Industrial Energy Efficiency Potential Study." Available at http://www.ctenergyinfo.com/CTElectricEEReport05032010FinalKEMAf2.doc.

FIGURE 10: Efficiency program achieved industrial energy savings for industry compared to potential cost-effective industrial energy savings, 2011



Source: Northeast Utilities, "2011 Efficiency Program"; KEMA, Natural Gas Efficiency Study*; and KEMA,* Electric Efficiency Study*.*

Achieving these additional savings requires a higher level of programmatic funding as well as additional sources of funding and financing. The 2012 Integrated Resources Plan (IRP) released by DEEP in June 2012 recommended an increase in funding for Connecticut's energy efficiency programs to help achieve all cost-effective efficiency savings. Fully scaling up the efficiency investment will require a much greater emphasis on using limited ratepayer funds to leverage private capital.[63]

While increased funding is essential, some improvements in efficiency program design are also needed to capture potential cost-effective industrial energy savings. Historically, commercial and industrial C&LM programs have been focused on measures that provide rapid, low-cost ways to achieve savings, such as installing more efficient lights and upgrading heating, ventilation, and air conditioning (HVAC) systems. Some companies have now been through two or three rounds of lighting upgrades, and these programs have provided significant savings. But these measures only achieve a fraction of the possible energy savings. According to 2011 data, lighting measures represent 39% of the savings achieved for electric customers, but only 13% of the potential savings (Figure 11).[64] HVAC programs have also had a significant impact, especially for natural gas customers. Although HVAC improvements account for 74% of achieved energy savings for

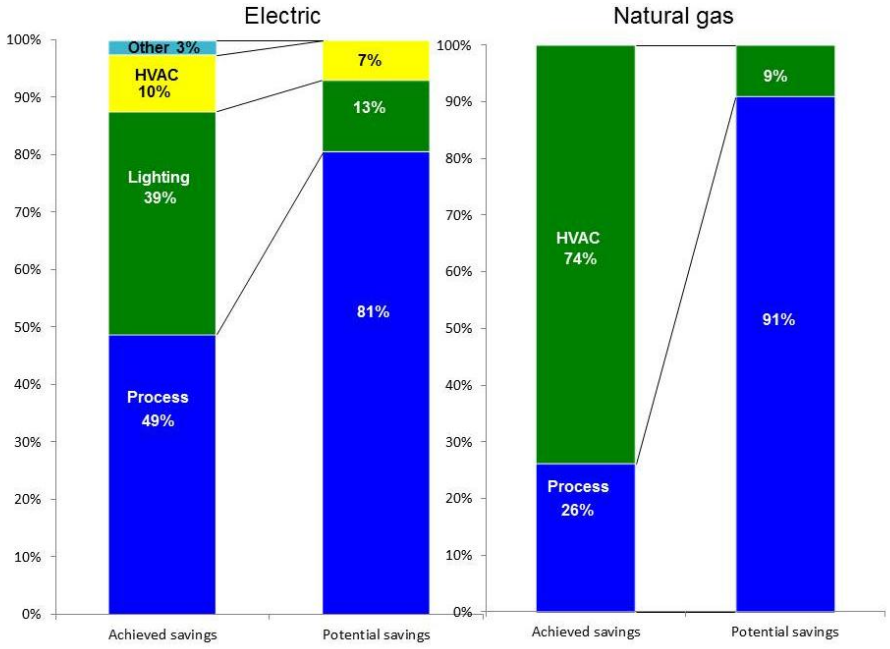
63 For more discussion on this topic, see Chapter 1 (Efficiency).

64 Northeast Utilities, "Energy Efficiency Programs 2011." Available at http://www.nu.com/responsible_energy/our-business/Energy-Efficiency-Programs-2011.html; KEMA, "Connecticut Electric Residential, Commercial, and Industrial Energy Efficiency Potential Study." Available at http://www.ctenergyinfo.com/CTElectricEEReport05032010FinalKEMAf2.doc.

natural gas users, those savings represent only 9%[65] of the remaining potential savings for natural gas customers (Figure 12).[66] Almost all of the remaining potential savings for industrial customers will come from improving the efficiency of industrial processes.

FIGURE 11: Electric and natural gas achieved efficiency savings captured compared to available savings by end-use, 2011

The biggest potential for energy savings now comes from improving the efficiency of industrial processes.

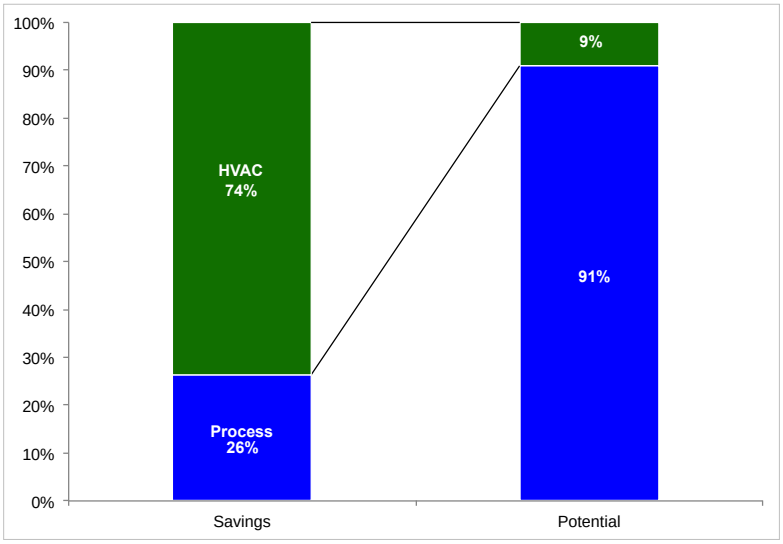


Source: Northeast Utilities, "2011 Efficiency Program"; and KEMA, Electric Efficiency Study.

[65] Northeast Utilities, "Energy Efficiency Programs 2011." Available at http://www.nu.com/responsible_energy/our-business/Energy-Efficiency-Programs-2011.html.

[66] KEMA, "Connecticut Natural Gas Commercial and Industrial Energy-Efficiency Potential Study." Available at http://ctsavesenergy.org/files/CTNGPotential090508FINAL.

FIGURE 12: Natural gas efficiency savings captured compared to available potential by end-use, 2011



Source: Northeast Utilities, "2011 Efficiency Program"; and KEMA, Natural Gas Efficiency Study.

These process savings have been largely untapped, for several reasons. First, much of the energy used for manufacturing processes in Connecticut is consumed by a diverse landscape of companies and types of products. Realizing process savings on a large scale therefore requires either expertise on many types of processes, or finding efficiency improvements that can be applied to a variety of common processes and companies.

Second, as shown in Table 3, nearly all of Connecticut's C&LM programs for industrial customers also serve the commercial sector. As a result, program managers focus on efficiency savings common to both commercial and industrial customers, which include very little process savings only found in industry. Only 1% of the proposed 2012 budget for commercial and industrial programs goes exclusively to the industrial sector for a program called PRIME (Process Re-engineering for Increased Manufacturing Efficiency), which concentrates on energy savings through "lean" manufacturing productivity improvements.[67] Expansion of funding for the PRIME program and other cost-effective measures directed toward industrial processes offer significant opportunities to improve energy efficiency for Connecticut businesses.

[67] The Connecticut Light and Power Company, et al., "2012 Electric and Natural Gas Conservation and Load Management Plan." Available at http://www.ctenergyinfo.com/2012%20CLM%20Electric%20and%20Gas%20Plan%20FINAL.pdf.

TABLE 3: Commercial and Industrial efficiency programs and budget, 2012 proposed

C&LM Program Name	Program Description	Proposed Program Budget '000s of 2012$)	Eligible Customers
Small Business Energy Advantage	Serves electric customers up to 200-kilowatt and firm gas customers with incentives, turn-key vendor driven solutions and 0% financing options.	$13,868	Commercial & Industrial
Business and Energy Sustainability (formerly O & M)	Focused on capturing energy savings through controls, operational improvements, behavior change and information.	$4,918	Commercial & Industrial
Energy Opportunities	A retrofit program providing prescriptive and custom incentives	$16,249	Commercial & Industrial
Energy Conscious Blueprint	Provides incentives for new construction, major renovations, and equipment replacement at end of life.	$10,889	Commercial & Industrial
PRIME	Provides lean manufacturing training to drive energy savings through productivity increases	$485	Industrial only

Source: 2012 Conservation and Load Management Plan.

Third, the current efficiency program planning and delivery timeframes are not well matched to the time horizons and risk profiles found in process energy efficiency upgrades. These upgrades generally take longer, must be timed to match processing line downtime, and carry the risk of slowing or shutting down assembly lines if equipment fails — challenges that lighting and HVAC projects do not face. These factors make process savings difficult to accommodate within the one-year C&LM program planning and budget approval cycles currently used in Connecticut. The time lags involved in the program approval process and the historical year-to-year uncertainty about funding levels also create administrative barriers to capturing process energy savings from projects that often take over a year to develop and implement. For this reason and others detailed in Chapter 1 (Efficiency), multi-year budget commitments for the distribution of the Connecticut Energy Efficiency Fund dollars would improve the performance of many of the Fund's programs.

Clean Energy Business Solutions

To support continued economic development and job creation and retention, the Clean Energy Finance and Investment Authority (CEFIA), working with the Department of Economic and Community Development (DECD), is launching a Clean Energy Business Solutions program, designed to strategically address energy cost challenges for existing Connecticut businesses or potential new arrivals. This program will provide financing to targeted companies of strategic importance for economic development in Connecticut with the goal of improving company competitiveness through delivering cleaner, cheaper, and more reliable sources of energy to their operations. This program will supplement long-standing commercial and industrial efficiency programs supported by the Connecticut Energy Efficiency Fund (show in Table 3). As noted above, only the PRIME program is focused on industrial process efficiency.

Models of Successful Industrial Efficiency Programs from Across the Country

A number of different states have successful efficiency programs targeting industrial subsectors and energy end-uses. Wisconsin succeeded in capturing savings from the pulp and paper industry only after funding an energy manager to identify efficiency opportunities. California achieved strong program participation from oil refineries by contracting for a program administrator knowledgeable in that sector. Connecticut's industrial sector mix will necessitate a different focus than those states. Significant opportunities exist in data centers and water/wastewater utilities.

The Pacific Gas & Electric Company (PG&E) has created a High Tech energy efficiency program to serve the many data centers located in northern California. This approach has allowed PG&E to address the challenges specific to that sector, including the overarching concern of equipment reliability, the barriers created by the divide between facilities' staff who manage data center operations and the IT staff who make equipment purchasing decisions, and the unique nature of data center efficiency measures. Connecticut's high concentration of finance and insurance firms, and the prevalence of dedicated data centers for those sectors, could make this approach a fruitful one for achieving process energy savings in data centers.

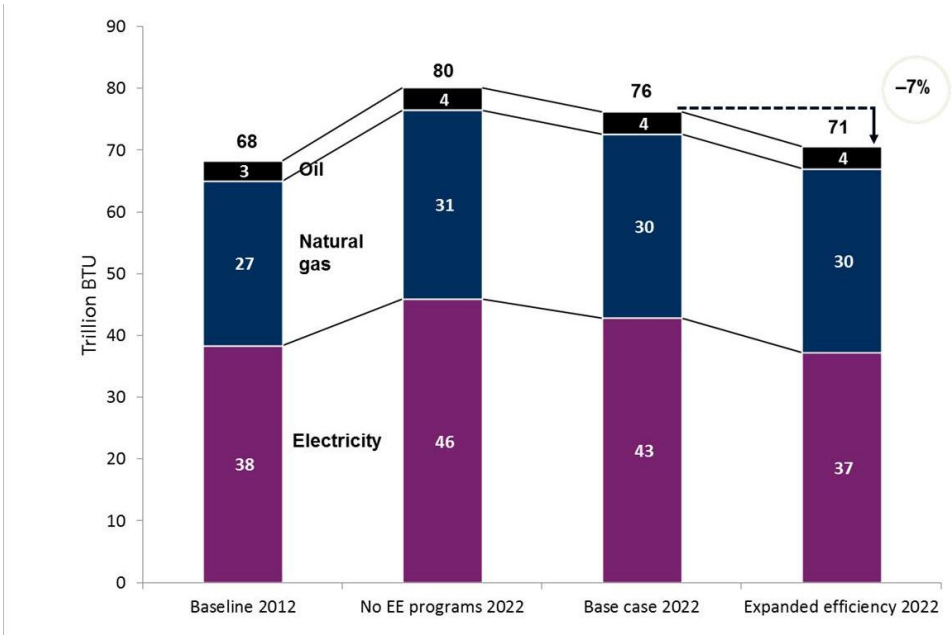
Similarly, the water and wastewater utility sector, which consumes 4% of U.S. electricity, represents a sizeable energy saving target for efficiency programs. Many of the approaches used to save energy in water systems can also simultaneously save water, improving the resiliency of water supplies and wastewater treatment systems. Connecticut can focus its programs on tailored approaches like improving pump efficiency and control, and reducing leaks to achieve savings from this subsector.

In summary, there is tremendous potential to achieve additional efficiency savings for electric and natural gas customers in the industrial sector, primarily through expanding the State's energy efficiency programs that serve more customers and are aimed at improving the efficiency of specific industrial processes. Investing in the expanded efficiency scenario outlined in the 2012 IRP and capturing all cost-effective natural gas and oil savings would reduce energy use in the industrial sector by 7% by 2022 in addition to current levels of efficiency capture (Figure 13).[68]

[68] *See* RMI Vision Model Analysis, discussed in Appendix A (Efficiency & Industry).

FIGURE 13: Industrial energy use in 2012 and 2022 (projected) – base efficiency programs and expanded efficiency programs

Investing in all cost-effective electric, natural gas, and oil efficiency (expanded efficiency) can keep energy use flat in 2022 from today and reduce use 7% compared to base efficiency savings.



Source: RMI Vision Model Analysis, discussed in Appendix A (Energy Efficiency & Industry)

Energy efficiency must be understood to be an investment— with funds expended paying off over time. Cumulative industrial energy efficiency investments of $600 million over the next decade would generate present value savings of $1 billion by 2022, for a $400 million net savings over this period.[69] Because efficiency savings accumulate over time, this efficiency investment will take six years to return annual savings in excess of the annual investment, but each successive year returns increasing net benefits.[70]

Fuel-Switching Opportunities For Industry

Industrial companies in Connecticut use 12 trillion BTUs of fuel oil. More than 70% of that oil is used for heating warehouses, factories, greenhouses, and other facilities.[71] The high price of oil in recent years means that Connecticut companies on average spend 27% of their energy budget on oil, even though oil provides only 16% of their energy.[72] Historically, oil and natural gas prices have moved in tandem, since natural gas production was typically a byproduct of oil production. As detailed in Chapter 4 (Natural Gas), large increases

[69] *See* RMI Vision Model Analysis, discussed in Appendix A (Energy Efficiency & Industry).

[70] Cumulative efficiency program and customer costs and cumulative customer energy cost savings, each discounted at 5% back to the present value.

[71] U.S. Energy Information Administration State Energy Data System, "Industrial Sector Energy Consumption Estimates, 2009." Available at http://www.eia.gov/state/seds/hf.jsp?incfile=sep_sum/plain_html/sum_btu_ind.html.

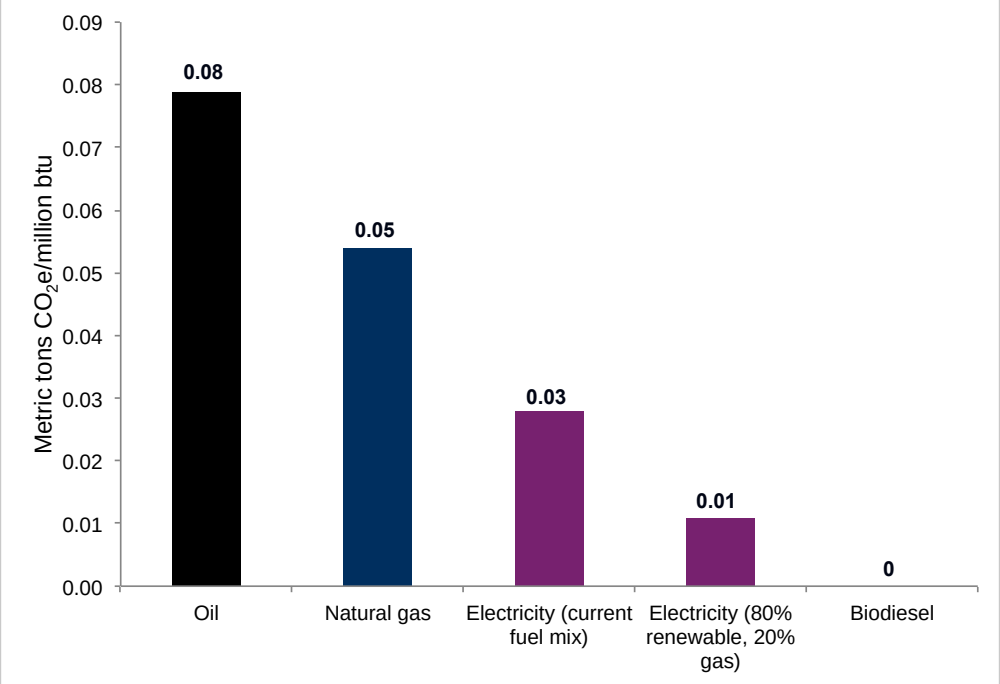
[72] U.S. Energy Information Administration, "State Energy Price and Expenditure Estimates 1970-2010." Available at http://www.eia.gov/state/seds/sep_prices/notes/pr_print.pdf.

in shale gas production have caused oil prices to decouple from natural gas prices, and current forecasts predict comparative prices for natural gas will stay low while oil prices will remain high. The oil that is used for heating could be cost-effectively replaced by natural gas where this fuel is available.

The average industrial customer spends nearly $40,000 annually to purchase over 1.1 billion BTUs of heating oil. Delivering the same amount of heat using natural gas would cost less than $9,000 annually at current price. Switching to gas will, of course, require a large up-front investment, but the payback in energy savings on that investment ranges from one to five years.

Replacing oil with natural gas would deliver significant cost and environmental benefits. Switching from oil to natural gas would reduce SO_x emissions by more than 99% and NO_x emissions by 29% in Connecticut (Figure 14).[73] On a per unit of energy delivered basis, natural gas provides a 32% reduction in greenhouse gases.

FIGURE 14: Greenhouse gas emissions factors for heating fuels



Source: U.S. EPA, "State Inventory and Projection Tool."

Currently, about 53% of industrial and 35% of commercial businesses have access to natural gas. As detailed in Chapter 4 (Natural Gas), another 22% of industrial firms and 40% of commercial businesses could cost-effectively switch to natural gas under current price projections. The volume of fuel used and the distance away from an existing main determine the targets for a favorable switch to natural gas. If the most cost-effective customers chose to convert, the cumulative savings to 2022 from those 1,000 customers

[73] *See* Appendix A (Energy Efficiency & Industry), discussing RMI Vision Analysis with emission factors from U.S. EPA, "State Inventory and Projection Tool."

switching to natural gas amounts to approximately $400 million in present value, or $300 million net. For more information on this topic, see the Chapter 4 (Natural Gas).[74]

Even if the gas system were expanded to connect these additional 1,000 industrial facilities, natural gas would still reach only 75% of facilities, leaving a quarter of industry with high-cost fuel oil or electric resistance as the most probable heating option.[75] The State should target increased efficiency efforts toward these customers and continue to explore energy alternatives, such as ground source heat pumps. Indeed, where natural gas cannot be made available cost-effectively, ground source electric heat pumps, also known as geothermal heat pumps, might provide a good way to reduce oil costs for some heating purposes.

Strategic use of ground source heat pumps would cost less over the lifetime of the equipment than continuing to use heating oil.[76] If the industrial oil customers not converting to natural gas were to install heat pumps at a cumulative cost of $40 million, they could reap $100 million in cumulative benefits, or $60 million net by 2022.[77] For an industrial company to change from oil to ground source heat pumps, it must overcome the first cost investment barrier. Innovative financing options will be needed to support installations. Similarly, additional efforts targeted at the portion of the market with the most promising economics will be needed to grow the heat pump installation market and drive down capital costs. While the total cost savings available to industry from conversion to heat pumps from oil are small relative to the other components of this strategy, heat pumps offer an economic long-term strategy for significant criteria pollutant and greenhouse gas emissions reductions.

Expanding Access to Combined Heat & Power

Connecticut's industrial sector uses a large amount of energy for heat to dry paper, make chemicals, and run myriad other processes. Traditionally, most of that heat is produced by burning fuel in a boiler. But that heat can also be produced by a CHP system, which burns fuel to produce electricity in addition to making useful heat, at a lower cost than purchasing both separately. Of the subsectors described earlier, data centers (whose large computing systems themselves are a source of heat) and water and wastewater facilities could utilize CHP most effectively.

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[74] *See* RMI Vision Model Analysis, discussed in Appendix A (Energy Efficiency & Industry). This natural gas NPV is based upon a 10-year phased implementation for direct comparison to the expanded efficiency, combined heat and power, and other fuel switching opportunities. The benefits from each annual investment are calculated for twenty years and discounted back to present value. The phased approach provides slightly different costs and benefits than the analysis in the Chapter 4 (Natural Gas), which shows all investment in year one in order to size the overall opportunity without consideration of the implementation period.

[75] Connecticut Department of Economic and Community Development. The Economic Impact of Expanding Natural Gas Use in Connecticut. By Stanley McMillen and Nandika Prakash. Hartford, CT, 2011.

[76] *See* RMI Vision Model Analysis, discussed in Appendix A (Energy Efficiency & Industry).

[77] *Ibid.*

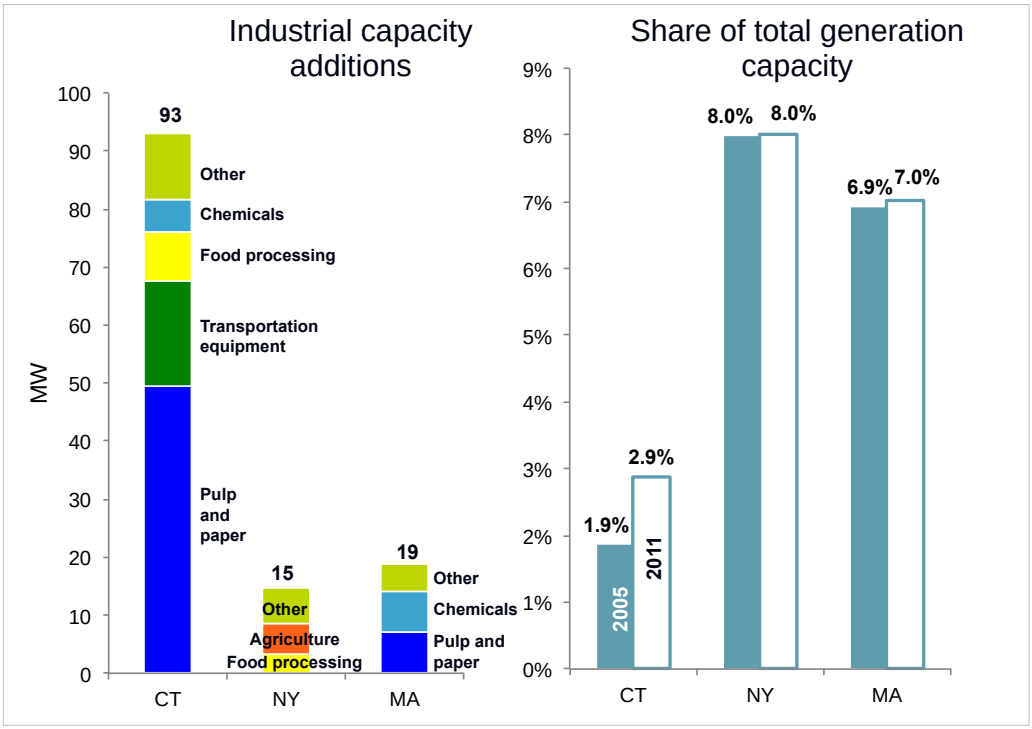
There are several barriers to realizing the benefits of CHP systems. Industrial firms face a large upfront investment cost, since an average seven megawatt CHP system costs about $14 million.[78] Electric utilities also charge CHP systems a monthly standby fee to hold electric capacity in reserve for planned or unplanned CHP system outages. The size and structure of this standby charge can have a large impact on project economics. Administrative barriers such as lengthy and convoluted interconnection processes and additional insurance requirements can add cost and uncertainty to a CHP project.

Connecticut has made significant progress reducing many of these barriers. In 2005, the Connecticut General Assembly directed the former Department of Public Utility Control (DPUC) to set up a grant program to spur the adoption of CHP, and to remove technical and regulatory barriers that stood in the way of installing these systems. The DPUC established standardized procedures for connecting CHP to gas lines and to the electricity grid, reduced the extra charges that utilities typically require for electric backup capacity, and eliminated natural gas delivery charges. The legislature also authorized grants and low interest loans that significantly reduced the capital costs of the systems and created a new Class III renewable energy credit for CHP and efficiency that brings in additional revenue to support these systems. These efforts created a boom in CHP, and Connecticut industry added 91 megawatts of CHP capacity—more capacity than any state in the region—between 2005 and 2011 (Figure 15).[79] That increase in installed CHP capacity increased industrial CHP as a percent of total statewide electric generating capacity from 1.9% to 2.9%.

[78] $2,000 per kilowatt for a 7-megawatt system, the average size of industrial CHP operating in Connecticut.

[79] Combined Heat and Power Installation Database. *Combined Heat and Power Units located in Connecticut*. ICF International and U.S. Department of Energy.

FIGURE 15: Industrial CHP capacity additions and share of total generation capacity, 2005-2011



Source: Combined Heat and Power Database; and U.S. EIA, Existing Capacity.

Connecticut's energy policies continue to encourage the adoption of additional CHP capacity. Public Act 11-80 recently reauthorized two CHP incentive programs that are similar to the 2005 grant program. These new programs are administered by DEEP and CEFIA. The CEFIA CHP program provides up to $350 per kilowatt for projects up to 5 megawatts, while the DEEP program offers up to $200 per kilowatt for projects up to 1 megawatt. The 2012 IRP recommends that Class III renewable energy credits be limited to CHP systems, rather than available to both efficiency savings and CHP generation. If adopted, this change will reduce the oversupply of these credits and help prices move above the current $10 per megawatt-hour floor.[80] DEEP is launching a comprehensive review of the Renewable Portfolio Standard that will include an evaluation of whether further changes to Class III renewable energy credits are warranted.[81]

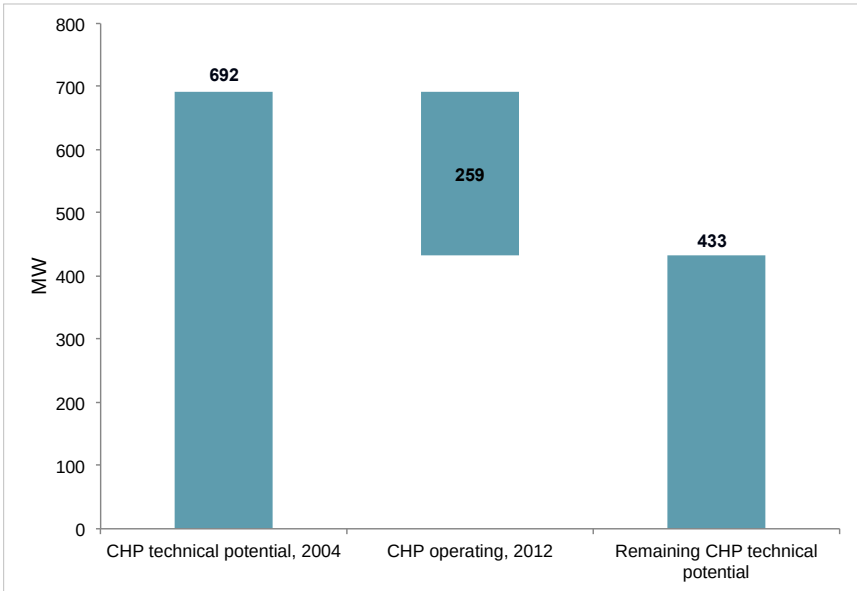
A 2004 study of statewide CHP potential concluded there are nearly 700 megawatts of technical potential — meaning that even after counting all CHP systems currently operating, there is over 400 megawatts of technical potential remaining in the industrial sector today (Figure 16).[82] Not all of that technical potential is cost-effective, however. Many individual companies would find that the savings from CHP are insufficient to

[81] For more discussion of the DEEP RPS Study, see Chapter 3 (Electricity).

[82] Institute for Sustainable Energy, *Distributed Generation Market Potential*. Technical potential refers to sites that have the characteristics necessary, such as simultaneous demand for electricity and heat, to allow a CHP system to operate.

justify the up-front investment. Across buildings and industry, only 40% of technical potential is estimated to be cost-effective.[83] If Connecticut industry installs 10 megawatts of CHP annually – less than the pace of installation since 2005 – it would result in annual energy cost savings of $87 million.[84] That pace of installations to 2022 would result in 100 megawatts of capacity added and require a cumulative investment of nearly $175 million to generate cumulative savings of nearly $475 million, or net savings of over $300 million (present value).[85] Beyond that identified potential, there may be further potential to develop multiple-facility CHP projects, where a single CHP system would provide heat and electricity to multiple adjacent facilities that could not economically support individual CHP systems. Industrial parks are particularly good candidates for this approach.

FIGURE 16: Industrial CHP technical potential



Source: Combined Heat and Power Database; and Institute for Sustainable Energy, Distributed Generation Market Potential.

However, there is some uncertainty about the size of the remaining economic potential and the incentives needed to capture it. The last CHP study the state conducted was in 2004, and the industrial sector has changed significantly since that time. As discussed earlier in this Chapter, the sector has contracted and also shifted in composition; both changes affect the size of the remaining CHP potential. Natural gas and electricity prices have also changed markedly since 2004, which will alter CHP system economics. An issue related to increasing the use of CHP is the degree to which CHP promotion can also benefit Connecticut's fuel cell manufacturers – and multiply the benefits to the state's economy. Thanks to the help of firms and

[83] *Ibid.*

[84] *See* RMI Vision Model Analysis, discussed in Appendix A (Efficiency & Industry).

[85] *Ibid.*

researchers all over the state, fuel cells provide users with an increasingly efficient way to capture waste heat. While Connecticut has more than six years of experience to help guide new CHP program development, it should also follow the example of many other states and regularly refresh a CHP potential study in order to better understand, and therefore target efforts to capture the remaining CHP opportunity. To more fully capture the economic CHP potential, the General Assembly should consider allowing larger projects to participate in the DEEP program and flexibility to offer larger grants if participation is low and such grants are cost-effective.

Addressing The Special Relationship Between Energy And Water

The interface between energy and water crosses so many sectors that it is difficult to fit discussion of the relationships, the challenges, and the opportunities in these areas entirely into this Chapter. The water industry itself includes public and private water companies that maintain water sources, treatment facilities, and delivery infrastructure and the wastewater treatment plants that collect, treat and discharge the water after its use. New drinking water regulations also require the use of more energy-intensive treatment technologies. Water is heavy (weighing 8.3 pounds per gallon), and pumping, extracting, treating, conveying and discharging it through its use cycle require enormous amounts of energy. A 2009 EPA report on water utilities found that globally, water utilities' biggest cost is energy, and that those costs can represent as much as 65% of a utility's annual budget.[86] As a result, the rewards for reducing those costs through efficiency process and motor upgrades are large in terms of water utilities' overall economics. Conserving water means pumping less of it, thereby saving energy. Similarly, using less hot water and heating it more efficiently also saves energy.[87] Water and wastewater utilities seeking to make water efficiency upgrades face many of the same barriers that other industries must overcome to implement energy efficiency measures: availability of capital for up-front investments; operational challenges and understanding; and regulatory practices that can provide a disincentive to conserve or that do not adequately support infrastructure improvements that would save water and energy. Numerous reports indicate that frequently 10-20% of water extracted from a source never reaches an end user and in some instances the losses are much higher. [88],[89]

EPA has set water industry goal of 10 per cent for what is termed unaccounted-for-water. Reductions in these losses will yield a commensurate reduction in the energy used to extract, treat, and convey that water to the point that it is lost. Water is also essential to producing most of the electricity generation in Connecticut that

[86] U.S. Environmental Protection Agency. 2009a. "Drinking Water Infrastructure Needs Survey and Assessment: Fourth Report to Congress." 2009b. "U.S. Water Utilities: Market Overview." March 2010. DWSRF Annual Allotments, available at http://water.epa.gov/grants_funding/dwsrf/allotments/allotments.cfm#2010.

[87] EPA, "Using Water Efficiently: Ideas for Utilities," available at http://epa.gov/watersense/pubs/utilities.html

88 National Drinking Water Clearing House: http://www.nesc.wvu.edu/ndwc/pdf/ot/tb/tb_leakdetection.pdf

89 Allan Lambert, International Water Data Comparisons Ltd, UK, Dale Huntington, Huntington & Associates, Fallbrook State, California Timothy G. Brown, Heath Consultants Incorporated, Houston, Texas Paper presented at the AWWA Distribution Systems Symposium, New Orleans, September 2000 http://www.findmoreleaks.com/downloads/AOL_Paper_061.pdf.

powers all that pumping, treating, and heating of water. Natural gas-fired boilers and combined cycle power plants systems require water for cooling, and water is heated to make steam to run the turbines to generate electricity. A 2005 U.S. Geological Survey report found that thermoelectric production accounts for about 40% of the freshwater withdrawals in the United States, and, while most of that water is returned, the transfers consume significant amounts of energy.

In addition to the significant energy and economic savings that could be realized through water utility efficiency upgrades and conservation, there are important environmental benefits. Recently adopted Stream Flow Regulations impose increasingly stringent requirements on the amount of water that utilities may withdraw in order to meet customer demand. These limitations aim to ensure the aquatic health of the state's surface water resources and since groundwater supplies are integrally related to surface water, reducing these withdrawals also help support adequate levels in surface waters. Changing weather patterns that have resulted in more serious droughts combined with the increased demand for water to serve growing populations, irrigate crops and provide cooling for power generation and industry, are making it increasingly difficult for much of the country and world to meet those needs. Connecticut is fortunate to have good water resources that, if well managed, can provide for future needs and would favorably position the state in comparison to other regions of the country as their resources become even more severely challenged. Hence, taking the steps recommended in this Draft Strategy to conserve and protect the state's water resources will have economic as well as public health and environmental benefits.

DEEP has jurisdiction over two of the three major categories of regulation relating to water resources and shares jurisdiction over a third with the Department of Public Health. Specifically, DEEP's Environmental Quality branch regulates the quality and quantity of the water resource itself in order to protect public health and aquatic habitat as well as coastal and inland wetlands. PURA establishes customer rates and assigns other responsibilities to the regulated investor-owned water utilities that serve about a third of the state's customers. While municipal and quasi-public water authorities are not regulated by PURA, additional efficiency investments by these entities will be important to achieving the benefits outlined in this Chapter statewide. It is also worth noting that municipal water and wastewater utilities are usually the municipalities' largest consumers of water. Therefore, conservation and efficiency improvements can reduce those utilities' energy costs, saving them money that can be used to meet other critical needs.

INDUSTRY SECTOR STRATEGY: RECOMMENDATIONS

By focusing on the five key areas described above, the State can help the industrial sector save energy and money, create jobs, improve competitiveness, boost the overall economy, and cut criteria pollutants and greenhouse gas emissions.

1. Continue Efforts To Reduce Electricity Rates And Costs

As discussed above and in Chapter 3 (Electricity), DEEP will, in coordination with the utilities and others, continue to work to reduce electricity rates and bills for industrial consumers. Specifically, DEEP plans to (a) propose expanded efficiency funding as required to achieve all cost-effective efficiency and a 0.7% reduction in natural gas consumption based on today's customer use; and (b) ensure that industrial customers who are not currently being served by competitive suppliers are informed of the potential savings they could achieve.

2. Reconfigure energy efficiency programs to the needs of industry

The State should expand funding for efficiency programs and adopt multi-year program plans that meet the time horizons needed for most industries, so as to effectively capture all cost-effective savings, an issue explored in depth in Chapter 3 (Electricity). Additional efficiency program funding should in part be dedicated to developing programs to capture process energy savings that are tailored to the needs of specific industries including, but not limited to, data processing centers, water utilities, construction, and manufacturing processes. Energy efficiency program delivery has typically addressed commercial and industrial customers as a single customer class. Expanding the PRIME program, which is aimed squarely at improving industrial processes, will be a first priority. Administering other commercial and industrial programs will require a tailored approach in program design, customer engagement, and program incentives to address specific needs of industrial customers.

3. Enable Fuel Switching To Cheaper And Cleaner Fuels

As Chapter 4 (Natural Gas) proposes, the State should advance opportunities for commercial and industrial customers on existing gas mains to switch to natural gas. DEEP further proposes that the utilities be authorized to extend the system for those "off main" where the cost benefit of conversion creates a positive return. With respect to industrial customers, Chapter 4 recommends a focus on converting on-main or near-main customers and extending the gas main infrastructure to potential new commercial and industry customers where it is economically feasible. In addition to the recommendations in Chapter 4, Connecticut's gas companies should look for opportunities to combine off-main extension projects with CHP projects. Installation of CHP may make main extension projects more economically feasible from the customer's perspective.

This Draft Strategy also recommends consideration of the triple benefit of fuel cell applications as they provide clean energy to customers, can operate in island mode during power outages, and support economic growth for in-state fuel cell manufacturers and their supporting industries.

4. Remove Known Barriers And Refine Combined Heat & Power Strategy To Capture Remaining Potential

DEEP recommends that in order to more fully capture the economic CHP potential, legislative changes should be considered that would allow larger projects to participate in the DEEP program and flexibility to offer larger grants if participation is low and such grants are cost-effective. Furthermore, as described in Chapter 3

(Electricity), a review of current submetering and net metering laws is needed, and should consider any changes necessary to encourage CHP development. DEEP will also update its assessment of current CHP potential to understand how much is economic and to ensure that programs address other barriers to realizing potential.

5. Encourage Water Conservation

This Draft Strategy makes three recommendations related to water and wastewater utilities, focused on promoting efficiency and conservation, which in turn leads to a reduction in energy use.

First, the Draft Strategy recommends that PURA should establish water rates that encourage, rather than penalize, water utilities for promoting and achieving conservation. Current rates are largely established on a per-gallon basis, which means that working to help customers conserve and thereby reduce a water companies' withdrawals (in accordance with the stream flow regulations goals), lowers the utility's sales and hence the revenues needed to sustain the infrastructure and business. Beyond helping ensure adequate supply levels in the state's water bodies, water conservation reduces costs, conserves energy and helps ensure the state's valuable water assets for future generations.

Second, the State should expand the Water Infrastructure Conservation Adjustment (WICA) surcharge mechanism, authorized by the legislature in 2007 from 5% to 10% to better provide support for water utilities to repair and replace an aging water infrastructure. Many of the State's water pipes are over 100 years old, and in 2007 it was estimated that, at the time the WICA charge was being considered for Connecticut, the Connecticut Water Planning Council estimated that it would take 240 years to completely replace the aging system.[90]

Third, C&LM plans submitted by the electric and natural gas distribution companies should be revised to include water conservation measures in general, rather than just those that reduce energy use related to heating water. As noted above, the plans should also include specific efficiency programs for water and wastewater utilities.

6. Launch An Advanced Energy Innovation Hub

DEEP and the University of Connecticut (under the leadership of the Engineering Department) will launch an Advanced Energy Innovation Hub in the new Tech Park at UConn to develop breakthrough energy technologies. Initial research efforts will focus on: (1) fuel cells, (2) microgrid engineering, (3) batteries and storage (building off of the University's leading role in advanced materials), and (4) small-scale (and environmentally benign) hydropower. DEEP will provide a portion of the funding for an initial period of four

[90] Water Planning Council Advisory Group, "Final Report of the Water Infrastructure Workgroup." Available at http://www.dpuc.state.ct.us/DPUCINFO.nsf/4d7534dff7a2413c85256b7500697b32/ab12750098cf99ca85257352003e27bf?OpenDocument

years. The University will match this support—and seek additional sources of funding. DECD will provide further funding aimed at commercialization of the breakthroughs developed.

FURTHER ACTIONS

Implementation of these six recommendations will reduce the cost of energy for industry, helping to realize the vision of a more efficient and competitive industrial sector that will, in turn, strengthen the state's economy. These recommendations simultaneously provide significant greenhouse gas and criteria pollutant emission reductions, lessening the public health and climate impacts associated with those emissions.

An additional recommended action is to ensure more consistent collaboration between the research arm of the University of Connecticut and other government partners so as to develop strategies and provide assistance that will address the large-scale needs of industry and support clean technology development and manufacturing in the state. Some of the world's leading experts conduct research at the University's Center for Clean Energy Engineering, focusing on fuels and fuel processing, advanced energy conversion, energy storage, smart grids, and renewable energy, among other areas. DEEP and DECD will engage with these experts, as well as others in different university units, to further engage them in the discussion about the State's clean energy future.

Going forward, it is in the state's interest to explore how distributed generation (DG) and microgrids could benefit industrial customers. As discussed in detail Chapter 3 (Electricity), the State is already at work on developing a pilot distributed generation and microgrid program to ensure that critical facilities, such as hospitals, wastewater treatment plants, emergency centers, and jails have power if and when the grid shuts down. Such microgrids could also be used for private need, to ensure reliability for industry and ensure that data centers remain operational, aerospace parts can be manufactured, and crops can be processed, even if the grid loses power.

The recommendations in this Chapter are ambitious and when implemented will dramatically improve the economics and environmental impact of energy use within this sector, but this Draft Strategy also recognizes that additional measures will be needed to meet the State's long term environmental goals.

CONCLUSION

Connecticut can strengthen its industrial sector through energy efficiency and the use of cleaner supplies of energy. The largest and lowest risk opportunity is through investing in efficiency. Efficiency is the lowest cost alternative to new energy supply, and there are very few plausible scenarios that would turn this investment negative. Similarly, investing in additional CHP capacity brings strong economic benefits to industry, but the costs of incentives and other public support needed to capture it must be evaluated relative to the benefits it provides. And encouraging fuel switching provides significant additional economic and environmental benefits.

Chapter 2: Industry Sector Strategy

Seizing the opportunities outlined in this industrial sector strategy will boost the profits and competitiveness of thousands of companies and construction and agricultural operations. It will preserve and grow Connecticut's vital industrial base by making the state more attractive as an industrial location. It will create jobs, keep more dollars in state, and improve the state's economy. It will also improve air quality and reduce greenhouse gas emissions. These efforts are essential elements of the governor's vision of a cheaper, cleaner, and more reliable energy future for an economically strong state.

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Electricity Sector Strategy

INTRODUCTION

No technological system is more complex or affects our society more profoundly than the electricity sector. The electricity Connecticut residents consume is generated by a variety of sources—from the Millstone nuclear generation facility, to natural gas-fired power plants, to solar cells located on rooftops around the state. The electricity from these sources is delivered to all corners of Connecticut through more than 1,800 miles of high-voltage transmission lines, which feed into a much larger, lower-voltage network of more than 17,000 miles of power lines that distribute power to every home, business, and other facility on the New England grid. This electricity keeps the lights on, runs our smart phones and TVs, cools our offices and houses, and powers production lines and countless other industrial processes in hundreds of locations across the state.

For too long, Connecticut's residents and businesses have paid some of the highest electric rates in the country. This Draft Strategy addresses this problem in a variety of ways. But it also recognizes that how electricity is generated profoundly affects our air quality, water resources, and the climate. Our choices in regard to power generation and distribution also affect Connecticut's business climate and our potential for job growth.

A successful strategy for Connecticut's electricity sector must make the electricity that society depends on cleaner, cheaper, and more reliable. Although average electricity rates across the state have decreased by 17% since 2009, the State have more work to do. To ease the strain of energy bills on Connecticut households and to ensure that Connecticut businesses can stay competitive, this Draft Strategy proposes several policy actions to further reduce electric bills.

At the same time, Connecticut has suffered from some of the country's worst air pollution, in part due to its geographic location downwind of out-of-state coal- and oil-burning power plants. A cleaner energy future requires support for electricity generation from low- or no-emission sources, as well as regional coordination and federal regulation to phase out dirty power plants within and beyond the state's borders. As this Draft Strategy demonstrates, Connecticut under Governor Malloy intends to be a leader in the push for cleaner power generation across our entire airshed.

Ensuring the reliability of the electric sector must also be a priority. Connecticut's economy, public health systems, and even basic social interactions depend on an uninterrupted flow of electricity from power plants across vast networks of poles and wires. Any disruption of that flow, however, brief can have catastrophic implications. This Draft Strategy therefore proposes further investments in grid reliability: tree trimming, hardening of wires and poles, and investments in a "smart" electric grid, as well as development of more distributed generation and microgrids across the state.

But note that there is the possibility of tension among these goals. Any one of these priorities, if pursued independently, has the potential to undermine the others. Electric generating units can emit air pollutants that harm public health. Connecticut has great potential sources of renewable energy, but not all of them can be harnessed cost-effectively. Investments in system hardening to prevent power outages can drive up utility bills. For these reasons, an effective strategy for the electricity sector must reduce electric demand, enhance reliability, and meet environmental goals in a complementary way. This Chapter briefly summarizes the structure of Connecticut's electricity sector, including current challenges and opportunities arising in this sector. It concludes with a set of recommendations that are crafted to take advantage of those opportunities, so as to advance the Governor's commitment to cheaper, cleaner, and more reliable electricity, while balancing the need for environmental progress, economic prosperity, and job growth.

OVERVIEW OF THE ELECTRICITY SECTOR

Over the last few decades, Connecticut's electricity sector has undergone profound changes in terms of the types of fuel used to generate electricity, the structure and regulation of the companies that have historically owned and maintained power plants and distribution lines in the state, the amount of air pollution and other environmental impacts of the electricity sector, and even the ways that Connecticut homes and businesses consume electricity itself. Consider that in the mid-1990s, Connecticut residents and businesses purchased electricity primarily from two state-regulated investor-owned utilities, The Connecticut Light & Power Company (CL&P) and The United Illuminating Company (UI), which owned and operated fleets of power plants, transmission, and electric distribution lines across the state.[91] Nuclear power plants built in Connecticut in the late 1960s and 1970s generated half of the state's electricity by the mid-1980s,[92] and fuel oil-fired generating stations accounted for most of the other half. This reliance on in-state generation from fuel oil, coupled with Connecticut's geographic location downwind of other coal- and oil-burning power plants, meant that Connecticut ranked high among other states in terms of concentrations of harmful air pollutants such as ozone, sulfur dioxide (SO_2), nitrogen oxides (NO_x), and carbon dioxide (CO_2).

Legislation enacted in 1998 mandated sweeping changes to the structure of the electricity sector.[93] CL&P and UI were ordered to sell off their generation assets and begin operating solely as electric distribution companies. Under this restructured arrangement, the electric distribution companies own and maintain the poles and wires that distribute electricity to Connecticut customers. At the same time, Connecticut retail

[91] Approximately 66,000 Connecticut customers are serviced by municipal electric utilities. http://www.cmeec.com/whoiscmeec.htm.

[92] U.S. Energy Information Administration State Energy Data System. "Transportation Sector Energy Consumption Estimates, Selected Years, 1960-2010, Connecticut." http://www.eia.gov/state/seds/sep_use/total/pdf/use_CT.pdf Nuclear-powered electricity generation declined steeply in the mid-1990s, with the shutdown of the Connecticut Yankee Atomic Power Company's Haddam Neck plant in 1994, and the temporary shutdown of the Northeast Nuclear Energy Company's Millstone plant in 1995.

[93] *See* Connecticut Public Act 98-28, "An Act Concerning Electric Restructuring," 1998.

electricity customers were given the choice of buying electricity at competitive rates offered by independent suppliers, or to continue purchasing electricity at a rate called the "standard offer" from the electric distribution companies (who in turn purchase the power from independent suppliers and the regional wholesale electricity market).[94]

This same legislation mandated specific charges on customer bills to support the state's energy efficiency[95] and renewable energy programs.[96] It also established for the first time a Renewable Portfolio Standard (RPS) for the state, which requires that over time, an increasing percentage of the electric generation provided to Connecticut customers must be produced from renewable energy sources such as solar, wind, small run-of-river hydropower, landfill gas, fuel cells, certain biomass, ocean, tidal, wave, and other advanced energy conversion technologies.[97]

Today, Connecticut's electricity sector uses more than 300 trillion BTUs per year to generate about 30 terawatt-hours of electricity.[98] Approximately 47% of that electricity is generated by the Millstone Nuclear Power Station, which has two nuclear reactors operating in Waterford, Connecticut. Approximately 45% is produced by natural gas-fired power plants, which over the last several years have largely replaced older coal- and oil-fired facilities as gas prices have declined and coal and oil prices have increased.[99]

Retail Electricity Prices Have Declined Since 2009

While proponents of restructuring anticipated that the switch to competitive supply would lead to lower electricity rates, electricity rates climbed precipitously after deregulation, reaching an all-time high in 2009 due to a combination of factors. The regional wholesale power market, operated by the Independent System Operator for New England (ISO New England), procures needed generation using an auction market that induced investment in new generation capacity and which provides high reliability, but at the cost of high generation prices. The auction structure now in place makes Connecticut ratepayers particularly vulnerable to fluctuations in natural gas prices. Connecticut's under-investment in transmission lines led to federally-mandated congestion charges that increased the transmission and distribution portion of customer bills. Additionally, ratepayers were burdened with Competitive Transition Assessment (CTA) charges to reimburse the electric distribution companies for stranded costs, such as expenses incurred building generation facilities

[94] *See* Connecticut Public Act 98-28, "An Act Concerning Electric Restructuring," 1998.

[95] The conservation surcharge, set by statute at 3 mills per kWh, is imposed on all customer classes of the electric distribution companies. *See* Conn. Gen. Stat. § 16-245m.

[96] *See* Connecticut Public Act 98-28, "An Act Concerning Electric Restructuring," 1998.

[97] *Ibid.*

[98] U.S. Energy Information Administration State Energy Data System. "Transportation Sector Energy Consumption Estimates, Selected Years, 1960-2010, Connecticut." Available at http://www.eia.gov/state/seds/sep_use/total/pdf/use_CT.pdf

[99] Connecticut Department of Energy and Environmental Protection, *2012 Integrated Resources Plan*. Available at http://www.ct.gov/deep/cwp/view.asp?a=4120&q=486946.

that had not been fully recovered before restructuring.[100] Contract "laddering" was implemented in 2004, whereby power purchases were made in three year blocks to reduce generation price volatility. Although laddering stabilized generation rates, this procurement strategy prevented Connecticut standard offer customers from benefiting from declining gas-fired power prices for several years.

Since 2010, however, Connecticut's average retail electricity costs have dropped by 17% (Figure 1).[101] Declining natural gas prices are responsible for some of this reduction, but other costs that show up on customer bills are also declining. After a decade of paying CTA charges of about 1 ¢/kWh to cover stranded costs from restructuring, CL&P customers saw the CTA charge decline to 0.128 ¢/kWh in 2011. The CTA charge for UI customers is currently set at 1.51 ¢/kWh, and will be phased out over the next two years. Smart transmission investments are helping to reduce congestion charges and maintain transmission security. Transmission and distribution costs have increased as a result of these investments, but these increases have been more than offset by declining generation costs.

Ratepayers in CL&P service territory will also see a freeze on distribution rates for the next few years as part of terms agreed to by CL&P during the Northeast Utilities-NSTAR merger negotiations with the State.[102] UI will likely request a distribution rate increase in the near future, as their current rate of return is lower than the average rate of return for all utilities in the country in any year since 1990.[103] While a low rate of return keeps electric rates down in the short term, it also inhibits new investment and produces other negative consequences that will need to be addressed.

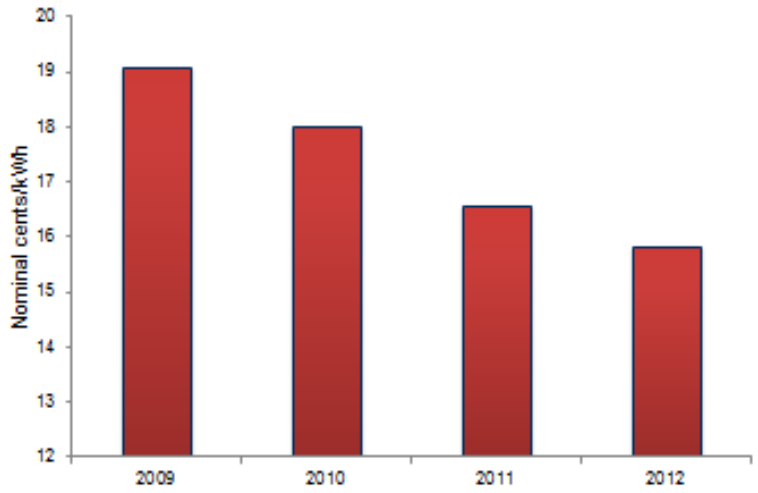
[100] Stranded costs are generally defined as costs incurred by a utility company (e.g., for building and owning generation plants and increasing capacity) that the company is no longer able to recoup because of changes in regulations. In Connecticut, as a result of deregulation, CL&P and UI were mandated to sell off their generation assets, thereby "stranding" those generation costs that the companies would otherwise have been able to recoup through regulation.

101 Connecticut DEEP, UI and CL&P Electric Rates.See PURA Docket Number 12-06-01; CL&P Exhibit MJM-2' UI Revised Exhibit 8.

[102] *See* PURA Docket Number 12-01-07.

[103] Regulatory Research Associates, "Regulatory Focus," April 2012.

Figure 1: Average electricity prices in Connecticut across all sectors, 2010–2012



Source: PURA Docket No. 12-06-01; CL&P Exhibit MJM-2; UI Exhibit 8

These general trends may be more or less pronounced for customers who have switched to competitive suppliers, depending on the generation rates they are paying those suppliers. More than 80% of commercial and industrial customers have switched to competitive suppliers, while only about 45% of residential customers have done so.[104] Although slow to develop, the competitive market now includes over 35 suppliers offering competitive pricing as well as a variety of retail products, such as fixed and variable price plans and renewable products. For those who remain on the standard generation rate offered by the electric distribution companies, the State has launched a new procurement process to improve access to lower cost power.

A Cleaner Generation Fleet Is Yielding Environmental Benefits

As noted above, natural gas-fired power plants have largely displaced older coal- and oil-fired facilities in terms of electricity production over the last several years (Figure 2). This shift to a relatively clean fuel mix means that emissions of pollutants like NO_x and SO_2 have dropped to all-time lows in the state.[105] Connecticut's electricity sector today emits only 18% of the state's greenhouse gas emissions, even though it consumes 38% of the primary energy used in the state.[106]

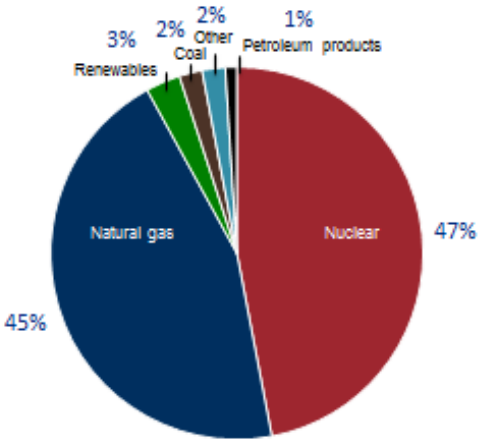
104 See Compliance Filings Docket Number 06-10-22.

105 Connecticut Department of Energy and Environmental Protection, 2012 Integrated Resources Plan. Available at http://www.ct.gov/deep/cwp/view.asp?a=4120&q=486946.

106 U.S. Energy Information Administration State Energy Data System. "2009 State Emissions by Sector." Available at http://www.eia.gov/environment/emissions/state/excel/Table3_2009.xlsx.

Figure 2: Electricity supply by resource and CO_2 emissions by sector in Connecticut.

Connecticut's electricity system today is primarily supplied by nuclear and natural gas (92% of generation). Note: The electricity supply chart does not include imports from other states.



Source: U.S. EIA Monthly-February 2012

The State has set clear goals to further reduce the electricity sector's impact on public health and the environment. Public Act 02-64, enacted in May 2002, imposed strict standards to reduce public health impacts from electricity generation by limiting the emissions of sulfur dioxide from the six dirtiest in-state power plants. This Act did not address oxides of nitrogen, a precursor to ground level ozone (i.e., smog). Such pollutants are subject to the intractable problem of interstate air pollution transport in the eastern United States. The development of more protective federal air quality standards for ozone required Connecticut to instead rely on its existing regulatory framework and technical expertise to assess air quality needs, analyze available control technologies and amend emissions standards to achieve updated air quality standards. Public Act 03-72, enacted in May 2003, imposed mercury emission standards on coal-fired power plants beginning on July 1, 2008 that are among the most stringent in the nation—and more stringent than the standards adopted by U.S. Environmental Protection Agency in 2012 known as the Mercury and Air Toxics Standards rule.[107]

In addition to requiring stricter pollution controls to reduce public health impacts, Connecticut has been a leader in taking steps to reduce the greenhouse gas emissions related to generating electricity. In 2008, Connecticut became one of nine states to implement the Regional Greenhouse Gas Initiative (RGGI), the first mandatory carbon dioxide cap and trade program in the United States.[108] While seeking to reduce the negative environmental impacts of traditional generation, the State has also set very aggressive targets for deploying cleaner generation sources. The Global Warming Solutions Act (Public Act 08-98) sets a goal of

[107] See 77 CFR § 9304 (February 16, 2012).

[108] New Jersey had been a part of RGGI initially but withdrew in 2011.

reducing greenhouse gas emissions by 80% by 2050.[109] And Connecticut's Renewable Portfolio Standard (RPS) requires that 20% of generation serving state customers be from renewables by 2020. Meeting the 2020 RPS goal will require the development of 6,196 gigawatt-hours, or nearly 3 gigawatts of low-carbon supply — more than 25 times the amount of power generated by Class I resources (i.e., solar power, wind power, and fuel cells) within Connecticut in 2011.[110]

New approaches will be essential to cost-effectively meet Connecticut's renewable power goals. This Draft Strategy proposes to ramp up renewable energy using a new "finance" model designed to draw private capital into promising alternative power projects. It also seeks to harness market forces to lower the costs of renewable energy. Connecticut's first-in-the-nation "green bank," the Connecticut Clean Energy Finance and Investment Authority (CEFIA) lies at the heart of this "finance" approach. This Draft Strategy proposes that CEFIA expand its portfolio of flexible financing mechanisms to promote further investments in renewable power from a wide range of private sector companies deploying a diverse set of technologies.

DEEP is also preparing a study of the state's RPS targets and timetable with an eye toward evaluating the impacts of allowing additional clean resources, such as low-cost, clean hydropower from Canada. These additional clean resources may qualify for some portion of the new RPS in a way that reduces overall costs while promoting more extensive in-state development of traditional renewable resources.

[109] *See* Connecticut Public Act 08-98, "An Act Concerning Connecticut Global Warming Solutions." 2008.

[110] Connecticut Department of Energy and Environmental Protection, 2012 Integrated Resources Plan, D-13. Available at http://www.ct.gov/deep/cwp/view.asp?a=4120&q=486946.

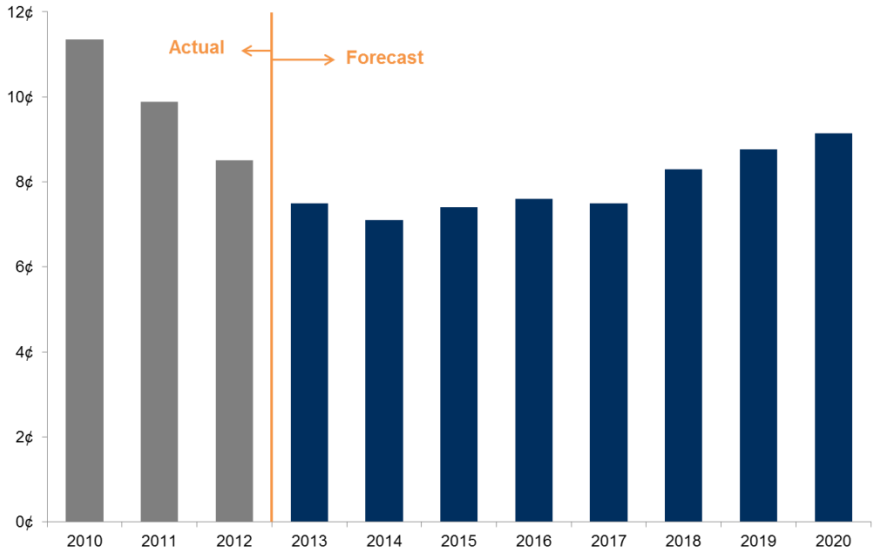
What Is The Regional Greenhouse Gas Initiative?

The Regional Greenhouse Gas Initiative (RGGI) is the first mandatory carbon dioxide cap and trade program in the United States. States participating in RGGI set a cap on total carbon emissions in the region. Each participating state is allotted a limited number of emission allowances. Any electric generator in a RGGI-participating state that is larger than 25 megawatts to obtain "allowances" sufficient to cover its emissions. RGGI is the first cap and trade program to rely on an open and transparent auction process to distribute a large percentage of allowances to regulated entities. The seventeen auctions held to date have generated over $1.08 billion dollars for the participating states. Most of the states in RGGI have reinvested the majority of the money they receive from the purchase of these allowances in energy efficiency and clean energy resources, thereby even further reducing emissions and mitigating program costs. In Connecticut, about 70% of the proceeds from the sale of RGGI CO2 allowances augment energy efficiency programs overseen by the Energy Efficiency Board, while 23% of the proceeds support renewable energy programs administered by the Clean Energy Finance Investment Authority. To date, these programs have received $43.9 million and $14.5 million respectively. These funds have supported wide-ranging and dynamic programs to reduce energy use, including residential energy audits and large commercial and industrial lighting and HVAC efficiency projects. RGGI funds have also supported renewable energy programs such as the installation of 16 solar photovoltaic installations in commercial, municipal, nonprofit, and educational settings throughout Connecticut. During its first two and a half years, those RGGI-funded investments have also boosted economic growth in Connecticut by an estimated $189 million and have created approximately 1,300 jobs.

Connecticut has already taken steps to make its generation assets cleaner and positioned itself for future electricity price competitiveness. States that have failed to invest in cleaner generation sources are now beginning to pay the price for their inaction, as new EPA regulations come into place that require generators to emit fewer pollutants. Thanks to these earlier investments in a cleaner generation fleet, Connecticut ratepayers will avoid large rate increases associated with environmental compliance costs that other areas of the country will now have to incur. At a time when many states will be facing an increasing cost of generation due to these factors, Connecticut's generation costs are projected to continue to fall in the short term (Figure 3).

Figure 3: Projected Average Annual Generation Service Charge (GSC) for Connecticut Customers (Nominal Cents/kWh), 2010-2017

Projections based on current commodity price projections; 2013-2017 projections for CL&P service territory (80% of the state).



Source: CT DEEP; CL&P; Brattle Group Projections

Renewed Investment In Reliability

Controlling the environmental impacts of the electricity sector is crucial. So too is ensuring the reliability of the electric grid. Managing this system is a complex task that requires the instantaneous balancing of supply and demand, since demand occurs when power is needed, and supplies of electricity cannot be cost-effectively stored using current technologies. Demand for electricity changes constantly during the day, as temperatures rise and people crank up their air conditioners, or as factory assembly lines start up or shut down. At peak use times (often on the hottest summer afternoons), demand can be twice the annual daily average.[111] The regional electric grid operator, ISO New England, must constantly ramp production from power plants up or down so that at any given moment, the power used in Connecticut and across the New England region always perfectly matches the power being produced.

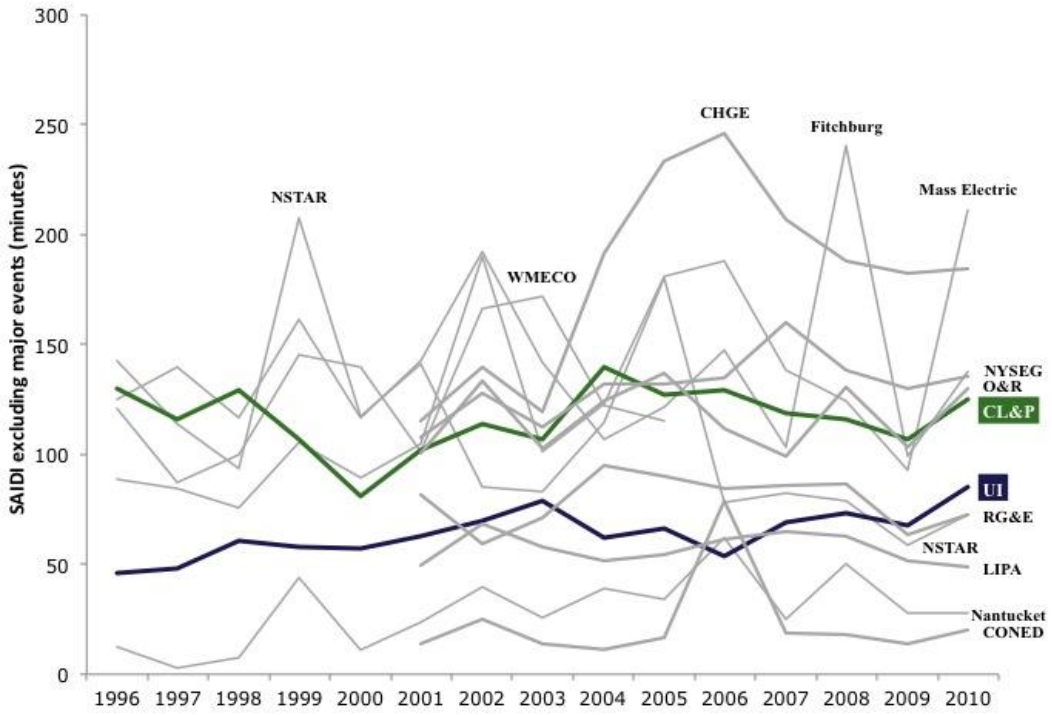
Generally speaking, Connecticut's average system reliability has been as good as or better than that of most states in recent years (Figure 4). In an average year, a customer in Connecticut experiences only two hours without power and most go years without experiencing an outage.[112]

[111] ISO New England, "2012 Forecast Data File."

[112] Connecticut DPUC, 2011 Annual Report on Reliability.

Figure 4: System Average Interruption Duration Index (SAIDI) for New England Utilities.

Connecticut's average system reliability is as good as or better than that of other states; however, major storms produced two prolonged outages in 2011. The SAIDI values shown here exclude "major storms."



Sources: Connecticut DPUC, 2011 Annual Report on Reliability; Massachusetts DPU, Fitchburg Gas and Electric Light Company; Massachusetts DPU, Massachusetts Electric Company; Massachusetts DPU, Nantucket Electric Company; Massachusetts DPU, NSTAR Electric Company; Massachusetts DPU, Western Massachusetts Electric Company; New York Department of Public Service, Electric Reliability Performance Report; and New York Office of Electricity and Environment, 2005 Interruption Report.

But in 2011, the state had two catastrophic power outages. In August 2011, Tropical Storm Irene left 800,000 customers without power for up to nine days. This record outage was surpassed only six weeks later when an unusual October snowstorm took out power for 880,000 customers. Full restoration of service from the October storm took twelve days.[113] The October storm was by almost any measure an unusual occurrence; the last event with a similar impact was a Category III hurricane that hit Connecticut in 1938. However, the prospect of a warming climate and rising sea levels may increase the state's vulnerability to these types of storms. The human and economic costs that resulted from these prolonged power outages have fundamentally changed the discussion about what constitutes adequate reliability in the electric sector. They have underscored the need to reduce the likelihood of disastrous outages, combined with measures taken to alleviate the human toll and economic impact from those that do occur.

[113] McGee, Two Storm Panel Report. Available at http://www.ct.gov/dep/lib/dep/forestry/vmtf/two_storm_panel_final_report.pdf.

Challenges Ahead

Declining rates, lower levels of air emissions, and renewed investments in reliability spell progress for Connecticut, but several key challenges must be met over the next few years to ensure that recent progress continues. Many of these challenges were analyzed in the 2012 Integrated Resources Plan (IRP) for Connecticut, released by DEEP in June 2012. The 2012 IRP analyzed projected supply and demand for electricity in Connecticut through 2022, and concluded that Connecticut's electricity sector can adequately and reliably meet the state's demand for electricity for several more years without building any new power plants.[114] Analysis performed for the 2012 IRP showed that rates should continue to decline through 2016 with a business-as-usual approach.[115] The price customers have paid for electricity generation, which topped 12 ¢/kWh for several years, should remain at or below 8 ¢/kWh through 2017, thanks to an expanding supply of cheap natural gas. Recent advances in drilling techniques have made vast domestic shale gas resources (all located outside of Connecticut) available. Domestic natural gas production has increased by 20% in the last five years, and the delivered price of natural gas for electricity generation in Connecticut fell by 50% from April 2011 to April 2012.[116] Natural gas fired generation is currently 15-50% lower in cost than coal-fired power.[117] And for the first time, natural gas is being used to fuel as much electricity generation in the United States as coal.[118]

While the state's residents and businesses are likely to enjoy steady or decreasing electricity prices over the next few years, electricity rates may well go up again after 2017, as the costs associated with electricity generation are projected to increase by as much as 3 ¢/kWh.[119] Why is this expected to happen? There are several reasons. First, regional demand for electricity—which declined during the economic recession—is likely to increase. In Connecticut, electricity consumption is expected to grow by approximately 1% per year, causing power demand to begin to outstrip supply. Second, natural gas prices are expected to increase over time, driving up the cost of generation.

Finally, demand for renewable generation across New England is expected to outpace available supply. Many New England states have renewable generation targets in place. Connecticut's Renewable Portfolio Standard (RPS) sets a high target for renewable generation (20% from Class 1 resources by 2020). Connecticut

[114] Connecticut Department of Energy and Environmental Protection, 2012 Integrated Resources Plan. Available at http://www.ct.gov/deep/cwp/view.asp?a=4120&q=486946.

[115] Analysis for the 2012 IRP was performed in early 2012, and conclusions about the timing of this trend were current as of the time of the analysis.

[116] U.S. Energy Information Administration, "Natural Gas Gross Withdrawals"; and U.S. Energy Information Administration, "Average Cost of Natural Gas."

[117] Calculations using NREL's online LCOE calculator (http://www.nrel.gov/analysis/tech_lcoe.html) with input data from Black & Veatch, *Cost and Performance Data*; U.S. EIA, "Average Cost of Coal"; and U.S. EIA, "Average Cost of Natural Gas."

[118] U.S. Energy Information Administration, "Net Generation by Energy Source."

[119] Rates in 2022 could turn out to be higher or lower depending on market conditions, but are still expected to increase from projected 2017 levels. 2012 IRP

generates only a small amount of renewable power in-state from hydroelectric dams, solar installations, and fuel cells. The state's generators and utilities satisfy most of their renewable requirements by purchasing renewable energy credits generated elsewhere in New England.

Unless regional development of renewable resources and enabling transmission accelerates, Connecticut customers could face Alternative Compliance Payment obligations of more than $250 million (in 2012 dollars) annually by 2022 under the structure of the existing RPS. Thus, this Draft Strategy recommends a rapid expansion of in-state renewable power while also supporting a regional collaboration to procure the most cost-effective out-of-state renewable resources.

Connecticut faces a further challenge in that its generation fleet primarily relies upon two sources: nuclear (47%) and natural gas (45%).[120] While these sources meet current needs, this lack of diversification in generation exposes the state to both price and reliability risks, including potential electricity rate increases if natural gas-fueled generation costs spike or the loss of a major power source should one of its nuclear plants need to go off-line for an extended period. This latter threat was brought into focus in the summer of 2012, when higher than normal water temperatures in Long Island Sound forced the shutdown of one of the state's two active nuclear units. [121] Understanding the implications of these challenges and risks and exploring the options for addressing them is crucial to maintaining and enhancing Connecticut's electric system.

More than 90% of the nuclear, natural gas, and coal power plants in Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont will exceed average industry lifetimes by the mid-21st century.[122] Replacing these plants will require investments in new resources, and can provide an opportunity to create a cheaper and cleaner electricity sector. Because new plants can have a life of more than thirty years, it will be important for Connecticut to set policies that ensure new resource developments are consistent with the State's long-term environmental, economic, and reliability goals.

To adapt to these challenges and trends, Connecticut needs an electricity sector that has greater flexibility, more diverse sources of supply, a higher use of renewable energy, and a commitment to capacity increases in step with demand growth. A more diverse "portfolio" of power generation facilities would enhance both reliability and rate stability. At the same time, electricity costs must be managed and reduced to support a healthy, competitive economy. Efficiency is one of the most effective ways to reduce costs, and this Draft Strategy makes enhanced efficiency a top priority, as discussed in Chapter 1 (Efficiency).

[120] U.S. Energy Information Administration State Energy Data System. "Electric Power Monthly: February 2012." Available at http://www.eia.gov/electricity/monthly/

[121] "Warm Seawater Forces Millstone Plant Shutdown," *The Hartford Courant* 13 August 2012.

[122] *Analysis based on:* U.S. Energy Information Administration. *Existing Generating Units*; Hodgkins, "Wave U.S. plant retirements."

MANAGING AND REDUCING PEAK ELECTRIC DEMAND

Demand for electricity can be managed and reduced through greater participation in demand response programs, an increase in renewable energy (especially solar), targeting demand as part of the State's energy efficiency programs, and behavioral change supported by advances in technology and dynamic rates. These efforts can reduce the need to build new generating capacity, avoid new transmission costs, provide a buffer against rate increases driven by rising natural gas prices, lower capacity payments, and improve the environment. Moreover, lowering demand will also buy time to explore and develop other supply options for the more distant future so that the state can take advantage of new (or newly cost-effective) technologies to meet long-term energy and environmental policy goals. In this section, we discuss several strategies that can meet these goals, and improve the Connecticut's overall load factor.

Demand Response

Demand response programs are administered by the Independent System Operator of New England (ISO New England) as part of an overall strategy to maintain the reliability of the electric grid. These programs allow ISO New England to manage loads in response to extremely high prices or supply conditions that threaten the system to avoid brown outs, outages or equipment damage or failure. This Draft Strategy recommends increased participation in these programs to control costs for Connecticut ratepayers and to allow ISO New England greater flexibility in managing the system.

Connecticut has been a leader in implementing demand response. The 2012 IRP highlighted that 520 megawatts of peak demand response capacity is available in Connecticut today.[123] Most of this capacity comes from larger customers who have agreed to reduce demand or provide grid support in the event that demand is projected to exceed the supply of electricity. Such events occur at most only a few times a year, typically on the hottest days when the grid is at a critical reliability stage.

Many types of entities such as large universities, hospitals, and commercial and industrial companies take advantage of these demand response programs to lower their overall electricity costs. For example, when overall demand is high, Western Connecticut State University reduces the electricity it uses by shutting down fourteen of its buildings and moving students to other classrooms. The university is rarely asked to do this — only three times in five years — but this simple act of moving students to other classrooms can help alleviate the reliability risks and increased costs that occur when electricity demand reaches peak levels. The university also reaps a financial benefit: it is paid $100,000 a year to provide this service.[124]

Although the State has developed successful demand response programs, there is potential to further reduce peak energy demand. If current programs continue through 2020, and Connecticut pursues even greater

[123] Connecticut Department of Energy and Environmental Protection, 2012 Integrated Resources Plan. Available at http://www.ct.gov/deep/cwp/view.asp?a=4120&q=486946.

[124] EnerNOC, Western Connecticut State University.

adoption of demand response, studies show that 15% of peak demand could be targeted (compared to 7% today).[125] The greatest opportunities for new demand response will come from enrolling new customers in the existing programs and providing an opportunity for smaller customers to participate. These opportunities are much easier to implement today because of the availability of new technologies, particularly advanced metering and information systems. But Connecticut must make an investment in these technologies to capture this potential. DEEP will continue to work with ISO New England to strengthen and broaden its response programs. In addition, DEEP will work with ISO New England to more fully incorporate demand response into the capacity and energy markets.

Therefore this Draft Strategy recommends that the State increase awareness about the opportunities for larger customers to enroll in these programs and invest in technologies that will allow smaller customers, including residential customers, to participate in these programs. Recommendations surrounding advanced meters are discussed below.

Energy Efficiency Fund – Renew Efforts to Target Peak Demand

The focus of Connecticut's energy efficiency programs has changed over past 12 years. In 2000, the programs were targeted towards energy savings, i.e., reducing kilowatt-hour consumption. In 2003, the focus shifted to reducing peak demand, as transmission constraints were identified in southwest Connecticut and congestion charges began to be assessed to Connecticut ratepayers under changing ISO New England market rules. Significant investment in transmission facilities between 2004-2008 relieved these constraints and helped reduce congestion costs. As a result, the focus of the energy efficiency programs has shifted back to energy efficiency, once again targeting measures that reduced the amount of electricity being consumed. This Draft Strategy recommends that in addition to targeting energy savings that the programs also more aggressively pursue peak demand reductions.

Technology - Smart Appliances, Smart Grid, and Advanced Meters

As mentioned above, Connecticut has been a leader in demand response. But demand response is only used to address specific situations such as when reliability is threatened or when prices are extremely high. As such, these programs do not provide sustainable, day-to-day peak demand reduction. This is an area in which Connecticut can do much more to lower its peak demand. This Draft Strategy recommends that Connecticut invest in the technologies necessary to allow all customers the opportunity to lower their costs by managing peak demand.

An array of new technologies make it possible to manage power demand from end uses such as residential air conditioners and water heaters by automatically reducing these electric "draws" for brief periods of time.

[125] FERC, *Demand Response Potential*. The 15% and 30% reductions are based on analysis done in 2009. If the 2020 potential for demand response were calculated today it might be slightly different.

Historically, the electric grid was operated to serve demand and maintain reliability but was unable to provide the tools necessary to understand and respond to the economic consequences of that demand. Advances in technology are changing the way the electric system operates. Appliances like refrigerators, hot water heaters, and air conditioners will be equipped with communication devices, allowing grid operators to adjust multiple small loads for short periods of time. These "smart appliances" will be common in the marketplace over the next few years providing residential and small business customers the opportunity to participate in demand response programs. These appliances will be just one component of a "smart grid:" an electric system that uses information and communications technology in an automated fashion to improve the efficiency and reliability of providing electric service while at the same time controlling costs.

Recent advances in information technology for meters, controls, appliances, and equipment are beginning to knit the grid, its sources of supply, and its sources of demand, into an intelligent, better-integrated system that can be controlled in a far more dynamic fashion than is possible today. Throughout the country, different utilities are experimenting with advanced demand response programs by testing technology, pricing structures, and smart appliances. Central to all of those programs are advanced meters (also called "smart" meters) that can be used for two-way communication between grid operators and loads, and that can modulate demand as needed or desired. Without advanced meters Connecticut will be unable to take advantage of the benefits that dynamic pricing and the enhanced demand management opportunities that emerging technologies will provide.

The vast majority of Connecticut electric customers still have traditional meters, which only measure gross monthly usage and provide no information to consumers on their time of use, demand, or other usage characteristics. Advanced metering technologies and capabilities are evolving, so a thoughtful strategy must avoid adopting systems that may become obsolete within a few years. Advanced meter use also needs to be tied to dynamic pricing to ensure that customers have appropriate and fair incentives to use power at optimal times.

In some places, advanced metering efforts have run into opposition from customers who fear that the technology could raise costs, create health risks, or invade privacy. These concerns must be addressed so that consumers are fully informed about this technology. As policymakers strive to meet renewable portfolio standards that will result in having more variable renewable resources integrated onto the system, advanced metering technologies offer important features that could be utilized to improve service and reduce costs.

Dynamic Pricing

The cost to produce and deliver electricity varies throughout the day. It is generally higher on weekdays, between noon and eight p.m. (Connecticut's peak demand period), and lower during the remaining hours (the off-peak period). However, most customers pay the same price for electricity 24 hours a day and 7 days a week. As a result, there is no incentive for people to change the way they consume electricity. This Draft Strategy recommends expanding time-of-use pricing and other dynamic rate mechanisms to offer customers a

financial incentive to reduce usage during peak hours in order to lower their energy bills and help control overall costs.

Consistent with this strategy's emphasis on a framework to promote improved energy outcomes, Connecticut needs a structure of dynamic rates to allow all customers the opportunity to align their electric use with the incentive created by time-of-use pricing. Currently, the state's two regulated electric utilities offer time-of-use meters and rates to all customer classes. However, each utility faces different challenges with regard to their individual metering infrastructure and the costs associated with deploying advanced meters.

CL&P serves about 1 million residential customers and 120,000 small business customers, all of whom have monthly demands of less than 350 kilowatts. CL&P completed the installation of an Automated Meter Reading (AMR) system in 2005 that allows CL&P to read each customer's meter using a drive by, one-way radio signal technology. This system allowed CL&P to reduce meter reading costs by eliminating the use of pedestrian meter readers. Unfortunately, the meters that were installed do not record time-of-use consumption and it would be costly to install new meters that can collect this information. For instance, if a residential customer requests a time-of-use meter, CL&P would need to replace the existing AMR meter with a new time-of-use AMR meter, which CL&P does not generally inventory. These new meters will become obsolete in a very short time depending on when an advanced meter solution is ultimately selected. Although CL&P's AMR *system* can support time-of-use rates, the meters cannot support more sophisticated dynamic pricing strategies, such as hourly pricing; nor can the existing system be cost-effectively converted to do so.

As a result of the former Department of Public Utility Control (DPUC) Docket No. 05-10-03 (2006), a mandatory time-of-use policy was established for all CL&P customer classes. Under that policy, CL&P began a phase-in of time-of-use rates for its business customers with a monthly demand of 100-350 kilowatts. Customers with demands of 200-350 kilowatts were placed on time-of-use rates. The phase-in was suspended for customers with monthly demands of 100-200 kilowatts. The mandatory time-of-use policy for residential customers was also suspended while meter-related technology and cost issues were being reviewed.

This Draft Strategy recommends that CL&P submit a detailed plan to the Public Utilities Regulatory Authority (PURA) for a multi-stage roll out of advanced meters in a manner that minimizes stranded costs, prioritizes adoption by customers most likely to benefit from their use, and provides for hybrid rate structures and/or affordable basic service for customers opting out of any installation program. Additionally, the mandatory time-of-use policy should be reactivated as advanced meters are installed. Central to any rollout strategy will be pricing that reflects the cost of procuring electricity (higher during periods of peak demand and lower when demand is low) so as to provide commensurately positive and negative signals to customers. Until such a plan is approved, this Draft Strategy recommends that CL&P not promote time-of-use rates to its residential customers until advanced meters are available. CL&P should instead develop a program, and rollout schedule, to deploy advanced meters. The plan should target meters as they fail or otherwise need to be replaced and target different customer classes, based primarily upon which classes (such as high use residential customers)

are most likely to benefit from advanced meters. Approval of such a plan will also require that PURA examine current time-of-use rates and other dynamic pricing structures to ensure that rates will encourage behavioral change among customers. In adopting time-of-use rates, consideration should also be given to providing hybrid structures that protect vulnerable classes of ratepayers (e.g., senior citizens and the disabled). In particular this Draft Strategy recommends that PURA consider a flat rate for a base level of usage such that real time pricing applies only at higher levels of use. Such a hybrid structure should still provide low use customer an incentive to shift non-essential uses to off-peak time periods.

UI, the other electric distribution company serving Connecticut customers, retrofitted its current meters with one-way cellular communications capability during the 1990s. This allows UI to read its meters remotely and frequently (ie., on an hourly basis). As a result, UI's current meters can support time-of-use rates for all customer classes without UI needing to replace the meter, or visit the meter to reprogram it. As a result, UI can place any customer on a time-of-use rate without incurring additional costs to do so. However, UI's metering infrastructure is approaching the end of its useful life. As a result, UI has been replacing its current meters with advanced meters. In addition to supporting time-of-use pricing these meters can support other dynamic rate structures, like hourly rates (i.e., 24 hourly price points), can communicate with smart appliances and provide real-time consumption data to UI and its customers. Because the existing meters are older and fully depreciated, encouraging the adoption of time-of-use rates to facilitate demand response can be done without creating stranded costs. These differences mean that UI is better positioned to provide its customers with the opportunity to control their use and cost in the near term.

Therefore, this Draft Strategy recommends that UI promote time-of-use rates to all of its residential and small business customers. Both UI and CL&P should also provide information to customers about ways to conserve energy and the opportunity to participate in the State's energy efficiency programs. It is worth noting that over 70,000 customers are currently taking service under UI's residential time-of-use rate. Although UI has been a leader in time-of-use and seasonal rates, more can be done to promote demand response during peak periods. UI should develop and promote more dynamic price options for its customers.

Developing Low-Cost Renewable Generation

In addition to managing demand through efficiency and demand response, Connecticut must develop low-cost renewable generation, to make the electricity sector more diverse, affordable, and reliable, while also meeting the State's commitment to reduced environmental impacts. As discussed above, the 2012 IRP predicts that by 2018, the supply of economically-viable, grid-ready renewable generation available in the region will be insufficient to meet the targets set by Connecticut's RPS and other New England states' renewable generation targets. Since 2010, Connecticut has taken several important steps that will help prevent this supply shortfall from happening.

In 2011, Connecticut created CEFIA, the nation's first "green bank," which is focused on finding finance-oriented solutions to the new generation deployment required to meet the 2020 goals.[126] CEFIA represents a breakthrough in financing clean energy with a portfolio of incentive programs aimed at supporting both energy efficiency and renewable power. Notably, in March 2012, CEFIA launched a Residential Solar Investment Program (RSIP) that makes solar PV technology more accessible and affordable to households through innovative incentives and programs.[127] The program will result in no less than 30 MW of renewable energy deployment in the residential sector.[128] As part of its commitment to the residential sector through the RSIP, CEFIA has deployed a website that allows homeowners interested in installing solar PV systems to compare installation prices among installation contractors who have participated in the program.[129] In addition, CEFIA has other funding instruments aimed at attracting private capital investment in clean energy deployment, such as the Connecticut Solar Lease program (a public-private partnership that engages tax equity investors and lenders to finance rooftop solar PV and solar hot water system projects for residential ratepayers), and Commercial Property Assessed Clean Energy (C-PACE), a groundbreaking program that facilitates loan financing for clean energy improvements to commercial and industrial properties by using a municipal tax assessment mechanism to provide security for repayment of the loan. Further CEFIA programs that will utilize energy savings agreements and creative financing approaches to improve energy efficiency for Connecticut's independent colleges and universities, as well as a collaboration with the Department of Housing and Urban Development via its Energy Innovation Fund-Multifamily Pilot Program, which will utilize a CEFIA-provided loan loss reserve to provide at least $4 million for Connecticut Housing Finance Authority properties.

In December of 2011, DEEP received and evaluated proposals from private developers to build, own, or operate up to 10 megawatts (MW) of zero emission Class I renewable energy source generation facilities, in accordance with Section 127 of Public Act 11-80. Out of 21 proposed projects, DEEP selected two projects to be eligible to enter into long-term power purchase agreements pursuant to the Act, representing the addition of approximately 10 MW of renewable generation to the state's renewable energy portfolio. Currently, these projects and the associated contracts are undergoing review at PURA.

In the summer of 2012, a Zero Emissions and Low Emissions Renewable Energy Credit (ZREC/LREC) program was launched. This program gives an incentive to companies that develop clean energy projects

[126] See *State Clean Energy Finance Banks: New Investment Facilities for Clean Energy Deployment* a Brooking-Rockefeller Project on State and Metropolitan Innovation (September 2012).

[127] The Residential Solar Investment Program (RSIP) was established by CEFIA pursuant to Section 106 of Public Act 11-80.

[128] *See* Connecticut Public Act 11-80, Section 106, "An Act Concerning The Establishment Of The Department Of Energy and Environmental Protection and Planning For Connecticut's Energy Future," 2012.

129 CEFIA, "Residential Solar Incentives." Available at http://www.ctcleanenergy.com/YourHome/ResidentialSolarInvestmentProgram/ResidentialSolarIncentives/tabid/617/Default.aspx.

which require the lowest level of ratepayer funding. The ZREC/LREC program utilizes a reverse auction structure to capture maximum generation capacity per ratepayer dollar spent. At the heart of the "Connecticut model" for cheaper and cleaner energy lies a commitment to having the state break with the common practice of "picking winners," instead allowing market competition to identify the most cost-effective projects while creating a platform that will encourage a wide range of entrepreneurial efforts. The ZREC/LREC program is emblematic of this approach.

DEEP is now preparing a study—separate from this Draft Strategy—to evaluate options to cost-effectively meet the state's renewable power goals with an eye toward evaluating the state's current 20%-by-2020 RPS target and reconsidering whether the RPS target should be raised, and what the state defines as renewable power. Options could include qualifying other resources such as geothermal, or large-scale hydropower from Canada and elsewhere, increasing efficiency and Combined Heat and Power (CHP), and the potential for cost-effectively developing in-state resources. Consideration will also be given to whether the current percentages for various classes of renewables and the timeframes for compliance are still supportive of the RPS's overall objectives. The RPS study will consider the regional renewables potential, including where resources are located, their transmission and siting requirements, and the total costs for each resource. The overarching goal of this study is to meet Governor Malloy's commitment to cheaper and cleaner power.

DEEP is also working with other New England states through a coordinated procurement process organized by the New England State Committee on Electricity (NESCOE) to identify opportunities to cost-effectively expand renewable energy development in the region. As part of that work, it will be essential to understand the challenges and expenses associated with transmission and siting concerns for the generation itself and the complexities of coordination with other states in the region regarding planning, permitting, and cost allocation. For example, as the 2012 IRP points out, the processes to approve transmission and fairly allocate costs across state borders are not yet resolved.[130] Since regional, non-Connecticut resources such as onshore wind may be the most cost-effective large scale renewables, greater clarity about the costs and benefits of regional development and their associated transmission will help ensure that Connecticut is in a strong position to inform its involvement in any regional renewable solicitation.

It is important to point out that New England is not facing a renewable power shortfall because the region lacks the technical potential to develop such resources. Rather there has not been a carefully designed strategy spelling out how to access, finance, and integrate potential sources of renewable electricity in a cost-effective way. Studies show that the New England region has a large and diverse supply of potential low-carbon energy sources, equal to nearly 3.7 million gigawatt hours per year, or 37 times the amount of energy needed to meet

[130] Connecticut Department of Energy and Environmental Protection, 2012 Integrated Resources Plan, Appendix G. Available at http://www.ct.gov/deep/cwp/view.asp?a=4120&q=486946.

the region's demand for electricity in 2010.[131] It is clear that each of the potential sources of renewable power faces its own unique challenges, including siting and costs.

On the other hand, it is unclear how much of this technical renewable potential is economically viable now or in the future. Across the United States, renewable power prices are declining rapidly. The cost of wind power has dropped by 2-15% since 1998, depending on the type of wind resource.[132] The best wind resources can now compete with natural gas generation. The per-kilowatt-hour installed cost of solar photovoltaic (PV) systems has declined by 35% in the past decade. Some experts expect solar PV systems to cost less than retail rates for electricity purchased from utilities within the next five years, even without subsidies (but cost will still be more than the wholesale cost of gas-fired generation).[133]

The Importance Of A Portfolio Approach To Renewable Development

Diversity is a key element of a successful integration of variable renewables, both with respect to the type and location of resources. Diverse types of resources can complement each other. For example, solar PV provide power in the daytime, while wind power often provides its largest output at night. Similarly, with respect to the location of resources, solar panels in one part of the state may be shaded by clouds, but those located elsewhere may be under sunny skies. Beyond onshore wind and solar, other types of low-carbon sources—such as wave or tidal power or new small-scale hydropower0—are not currently viable but over time may become available at appealing costs. Their integration into the state's electricity system could contribute to the system's diversity, and in turn its reliability.

These price trends are having an impact in Connecticut and the New England region. In Connecticut (where we have limited in-state wind potential) and the New England region as a whole, high transmission costs are barriers to capturing the full potential of wind resources.[134] The largest potential cost-competitive clean energy resource in Connecticut is solar PV generation. Both solar PV systems and fuel cells can work within the current distribution system and so require no new investment in transmission. The combined potential for utility scale solar installations—which exceed one megawatt in capacity and are mounted on the ground—and smaller rooftop solar systems dwarf other low-carbon resources that might be developed in the state at this time.[135] Currently, both utility scale and rooftop solar systems are typically more expensive than out-of-state renewable options, but costs for both resources are falling rapidly (rooftop costs shown in Figure 5). Estimates

[131] Lopez, Renewable Energy Technical Potentials.

[132] Barbose, Tracking the Sun IV; and Wiser, "Cost of Energy from U.S. Wind Projects."

[133] Black & Veatch, Cost and Performance Data.

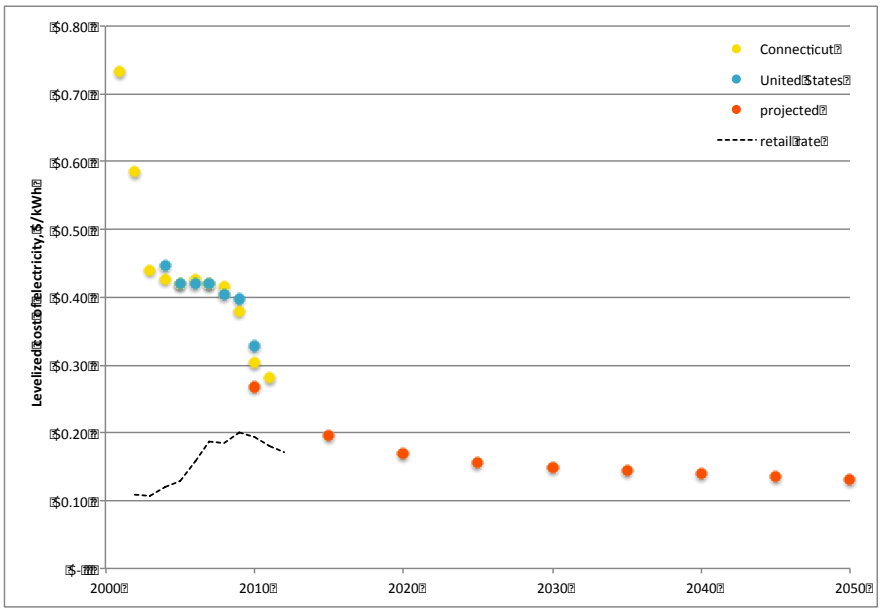
[134] Lazard, Levelized Cost of Energy.

[135] Rooftop and utility-scale solar PV have a technical potential of 33,601 gigawatt-hours per year. Excluding on/off-shore wind and enhanced geothermal, which are currently not developable in Connecticut, the other renewables account for a potential of 1,893 gigawatt-hours per year. Lopez, Renewable Energy Technical Potentials.

from consultants Black & Veatch show the costs of utility-scale and rooftop solar PV systems declining by 13% and 37%, respectively, between 2010 and 2020.[136]

Figure 5: Historic and projected costs of rooftop solar PV in Connecticut and the United States.

This figure shows the average levelized cost of residential rooftop solar PV in Connecticut, which allows the cost to be compared directly to retail rates. At typical financing and performance assumptions for a residential system in Connecticut, the 2001 installed cost of $13.81/W (direct current) equates to a levelized cost of energy of $0.73 per kilowatt-hour, while today's average cost of $5.29/W (direct current) equates to $0.28 per kilowatt hour. For comparison, see the levelized cost of hypothetical systems installed in Connecticut with average U.S. installed costs and future projected costs from Black & Veatch.



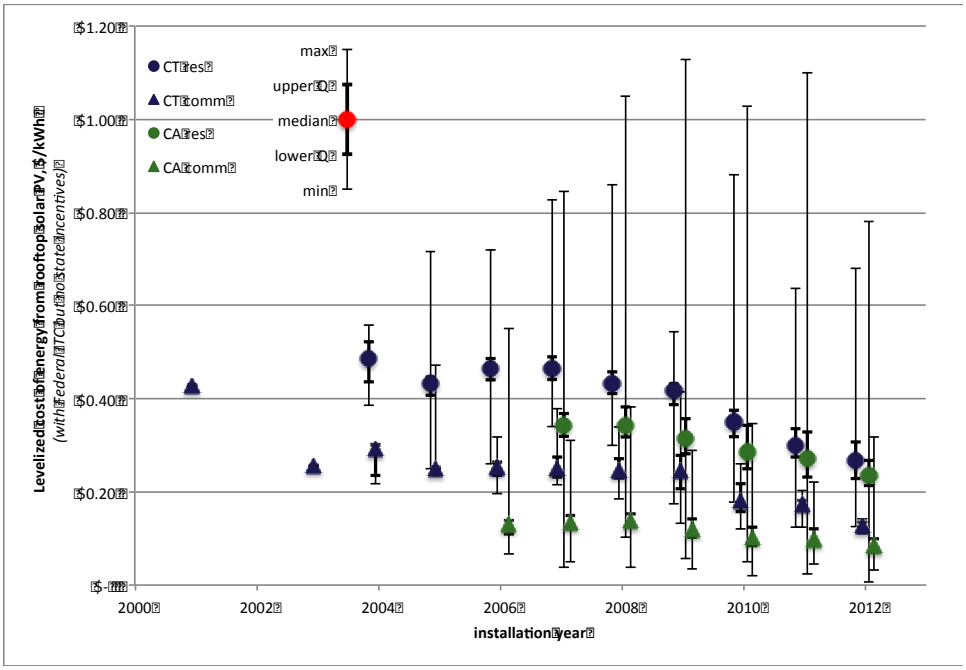
Source: CEFIA, "PowerClerk Data Export"; CEFIA, "PV On Site Project Dashboard"; Barbose, Tracking the Sun IV*; Black & Veatch,* Cost and Performance Data; *U.S. EIA, "Average Retail Price of Electricity"; and NREL, "System Advisor Model."*

Connecticut has an opportunity to further accelerate price reductions in solar PV. A survey of the rooftop solar PV market in Connecticut reveals a very wide range in installed costs. The most expensive installation in Connecticut today costs about five times more per kilowatt than the least expensive option. This spread in project costs is not unique to Connecticut, as illustrated by the data for rooftop installations in Connecticut and California over the past several years (Figure 6). It suggests that a carefully constructed set of incentives designed to drive down costs combined with an unswerving commitment to find and adopt "best practices" could yield significant benefits.

[136] Black & Veatch, *Cost and Performance Data*.

Figure 6: Minimum, median, and maximum costs for solar PV projects in Connecticut and California, 2001–2012

While the median costs of energy from residential and commercial solar PV systems have been declining in both Connecticut and California, both states have a huge spread in costs from project to project. Cost ranges are tighter for commercial installations, which typically have more "buying power" than homeowners and often shop around for the most competitive bids.



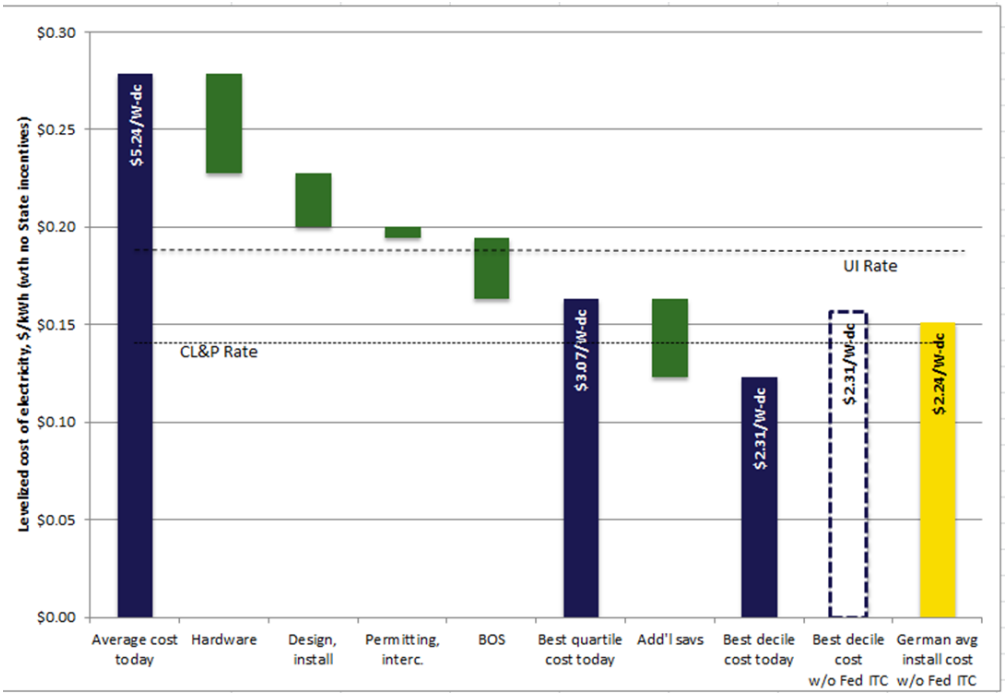
Source: CEFIA, "PowerClerk Data Export"; CEFIA, "PV On Site Project Dashboard"; Go Solar California, "California Solar Statistics"; and NREL, "System Advisor Model."

A portion of this spread is due to uncontrollable factors that make some projects more challenging than others (e.g., roof type and accessibility), but much of it is driven by differences in the experience, capability, and project scale of solar installers. If *every* installation in Connecticut came in at the costs of the least expensive quartile of solar projects, average installed costs would be 40% lower—and the cost of the electricity these projects produce would approach or beat residential retail rates (Figure 7).[137]

[137] See Appendix B (Electricity) for more details.

Figure 7: The opportunity for cost reductions in rooftop solar PV in Connecticut

All residential solar PV projects would be cheaper than retail electricity rates (dashed line) if installers could achieve top quartile performance for material and installation costs. Connecticut must work to create scale and drive down installation costs now, while the Federal 30% investment tax credit is still in place, to prepare for its expiration in 2016. All costs exclude existing state incentives. "Balance of system" costs make up the remainder of an installation's cost, after counting hardware, design, installation, permitting, and interconnection. These costs typically include installer marketing, customer acquisition, and overhead.



Source: Analysis based on CEFIA, "PowerClerk Data Export"; CEFIA, "PV On Site Project Dashboard"; and Wesoff, "Germany Solar Installations."

To explore this important point in more detail, today's average installation cost, including the federal 30% investment tax credit but no state subsidies, is 25¢/kWh in Connecticut. In contrast, the average cost for the least expensive quartile of installations is only 16.3¢/kWh. That is only slightly higher than the average residential energy-only rate of 14¢/kWh for CL&P residential customers, and lower than UI's average residential energy-only rate of 18.6¢/kWh.[138] With net metering, the electricity generated by rooftop solar systems that offsets the customer's consumption is credited to the owner of the system at the full retail rate. That means solar PV costs that are below the full retail rate reduce a customer's electricity bill, making an enticing financial case for anyone who has contemplated installing solar systems.[139]

Many countries and states, including Connecticut, have already seized on the opportunity to implement policies aimed at reducing solar costs. Experience with the ZREC program indicates that a more competitive solar market can reduce the average cost of installation. Recent results from the program demonstrate that

138 PURA Docket No. 12-01-01.

139 Using the retail rate as a benchmark does not, however, fully represent costs from a system standpoint, since avoided fixed transmission and distribution costs have to be shifted to other customers or reassigned on a non-volumetric, non-avoidable basis.

utilizing the "reverse auction" structure of the ZREC program effectively drives down installed costs in the industry. The program has demonstrated the ability to deliver Renewable Energy Credit (REC) payments that are around half the price of solar deployment programs in other states.[140]

CEFIA's Residential Solar Investment Program (RSIP) is also contributing to the decline in average residential system cost, by attracting solar installers using incentives that decline over time. Since the start of the program, average residential systems installed through the RSIP have declined by 5%.[141] Connecticut, along with Massachusetts, California, and Oregon, is using a "Solarize" program to drive down installation costs by working with municipalities to aggregate residential customers.[142] This pooling allows installers to bid for larger installation quantities and to reduce customer acquisition costs. While the state has a number of incentives to help promote solar PV adoption, driving to top quartile cost reduction performance would help increase adoption rates and ensure that they continue at a high level even after the expiration of state and federal incentives. Under prices bid by installers as part of CEFIA's ongoing Solarize pilot, it is now possible to forecast installed costs for residential solar PV in Connecticut that approach grid parity. Table 1, below, reflects the levelized cost of electricity for residential solar PV under a variety of financing scenarios.

Table 1. Declining Average Installed Costs of Residential Solar PV Lead to a Lower Levelized Cost of Energy:

$ / W	¢ / kWh		
	No Financing	*Partially Financed, Using Federal ITC*	*100% Financed, No ITC*
$5.00	18.64	25.09	27.85
$4.75	17.71	23.83	26.46
$4.50	16.78	22.58	25.07
$4.25	15.84	21.33	23.68
$4.00	14.91	20.07	22.28
$3.75	13.98	18.82	20.89
$3.50	13.05	17.56	19.50

Source: CEFIA Analysis of Residential Solar Investment Program Data through September 2012

The second scenario outlined in Table 1 is most reflective of current reality: the federal Investment Tax Credit (ITC), in effect through 2016, eliminates 30% of the upfront costs, leaving the remaining 70% to be financed at market rates. This scenario demonstrates that as efforts such as Solarize Connecticut help drive down the installed cost per watt of solar PV (from current averages of $5.00/watt to $3.50/watt, and potentially even lower), residential solar systems can produce electricity at an effective price close to retail grid parity, even without significant state incentives. Moreover, in combination with Solarize, driving the state's residential

[140] Available at http://www.ct.gov/deep/cwp/view.asp?a=4120&Q=503720

[141] This figure is current through August 2012.

[142] Irvine, *The Solarize Guidebook*; and CEFIA, "Solarize CT Pilot."

solar installer base to top quartile cost reduction performance will help increase adoption rates and ensure that they continue at a high level even after the expiration of state and federal incentives.[143]

Fuel cells, which are defined as Class I renewable resources in Connecticut, are another important element of the renewable resources strategy, as their usage can help the State meet its RPS goals. Better integration and support of fuel cell usage into the state's homes, industrial facilities, and cars could provide both a clean source of power and Connecticut jobs.

ENSURING SYSTEM RELIABILITY

Electric power must be delivered 24 hours a day, 365 days per year, without interruptions. Providing such reliability involves three important components: resource adequacy, transmission security, and distribution resiliency. "Resource adequacy" refers to the fact that grid operators must, in practical terms, have enough electricity supply to meet demand in every hour of each year even if some resources are temporarily disabled. "Transmission security" is the system's ability to deliver electricity to the distribution system (i.e., the "last mile") while protecting individual facilities and maintaining the overall stability of the grid as system conditions change. Lastly, "distribution resiliency" refers to the capability of the distribution system to provide power from the transmission system to end-use customers under all conditions as well as to restore service quickly in the event of storms or other disruptions. The vast majority of service interruptions occur at the distribution level, both in Connecticut and nationally. Unfortunately, the cost of improving distribution reliability may be high relative to the cost of improving resource adequacy and transmission security.

The State plays an important but small role in ensuring resource adequacy. ISO New England determines the installed capacity requirement for New England and conducts a forward capacity market to ensure that there are adequate resources available to meet resource needs. Connecticut's role is to ensure that its policies promote acceptable levels of generation capacity especially within the state's sub-areas, and that the market will respond efficiently and at competitive prices. The State has stepped in when necessary and taken actions to assure resource adequacy when the market has failed to respond to price signals. As an example, the State conducted a procurement of peaking capacity to fill the need for local reserves when the market failed to respond to price signals for several years. If it finds that the current capacity markets are not delivering incentives for the development of adequate resources at just and reasonable rates, the State can advocate for process changes before ISO New England and the Federal Energy Regulatory Commission (FERC), or it can consider sponsoring long-term contracts to address specific needs.

[143] Two existing incentives are most notable: an Investment Tax Credit (ITC) for 30% of project installation costs of solar, fuel cells, and small wind and 10% of project installation costs of geothermal, microturbines, and CHP; also a Production Tax Credit (PTC) of a set amount of incentive per kWh of generation from wind, geothermal, closed-loop biomass, or other specified technologies. www.dsireusa.org

Connecticut's renewable energy goals will indirectly affect the state's power resources in the future. Connecticut and other New England states have committed to achieving a much higher penetration of renewable resources such as wind and solar. But note that some renewable power technologies may pose operational challenges if developed on a large scale, because their output cannot be perfectly forecast and fluctuates throughout the day. These challenges demand new sources of system flexibility, which may come from larger operating reserves.[144] Operating reserves are electric generating resources that are held back from use until they are needed to replace generating sources or transmission lines that unexpectedly stop working. In the future, operating reserves could also be used to balance the system when the output from solar PV or wind power drops.

In the short-term, the level of variable resources in the overall supply mix is sufficiently small relative to the total system that additional investment to integrate variable resources will not be needed for some time. Many systems around the world have successfully integrated up to 20–25% variable renewables without much change to system operations or costs. ISO New England and its stakeholders are already discussing ways to make sure the system has enough other flexible resources to balance the hourly and minute-by-minute ups and downs of intermittent renewables.

The State plays an even more limited role in ensuring transmission adequacy and security. The ISO New England and FERC share responsibility for oversight of transmission lines. But the State does have a role in working with ISO New England and FERC, to ensure that federal planning fairly considers non-transmission alternatives that might meet identified needs at lower cost. DEEP is committed to playing a more active role in FERC and ISO New England proceedings to ensure that the transmission strategies developed and the incentives provided for transmission projects are well-conceived and consistent with the goals of this Draft Strategy. In addition, Connecticut's siting policies can dramatically impact the cost and options for building transmission. Those policies should promote—and not deter—the construction of appropriate infrastructure.

In contrast to resource adequacy and transmission security, distribution resiliency is directly overseen by PURA and implemented by the electric distribution companies. Distribution outages are by far the biggest challenge for ensuring reliability. They are also the most complicated (and potentially costly) to address. While Connecticut's distribution system is fairly reliable day-to-day (as seen in Figure 4 above), it is vulnerable to major disruption in extreme events, such as the two storms of 2011.

In the wake of those storms, the State has taken several steps to reduce the chances of such prolonged outages, described below. A "Two Storm Panel," convened by Governor Malloy, identified several approaches to improve resilience, including better vegetation management, infrastructure hardening, undergrounding of utility lines, improved communications and emergency response timing and practices, better backup generation for critical loads, and microgrid designs that could support critical services at times of major

[144] The Brattle Group, Resource Adequacy Renewable Energy.

outages.[145] Each measure has significant costs and tradeoffs. For example, putting wires underground can avoid large outages, but can be prohibitively expensive.

In response to a recommendation from the Two Storm Report, DEEP established a Vegetation Management Task Force to produce specific standards and guidelines regarding management of tree trimming along Connecticut's roads. The Task Force recently recommended steps the State, municipalities, utilities, and property owners can take to improve the resiliency of roadside trees and forests against future catastrophic weather events while ensuring the reliability of the state's power grid.[146] This Draft Strategy proposes that the guidelines advanced—most notably the principle of "right tree, right place"—guide the state and its utilities.

In response to proceedings conducted by PURA, the state's utility companies are required to engage in strategies intended to improve system reliability.[147] For example, CL&P, the utility whose service area was most affected by the 2011 storms, is already conducting more aggressive tree trimming and infrastructure hardening program that will enhance the resiliency of the traditional grid, but additional deployment of distributed generation and backup generation could pay further dividends. PURA has also ordered the following measures:

- CL&P shall implement a maintenance tree trimming program based on a four-year trim cycle.
- CL&P shall redesign the interface between the call center technologies and the outsource Interactive Voice Record vendor to improve communications as well as other initiatives directed at its town liaison program and communication of restoration times to customers and public officials to improve storm related communications.
- CL&P shall implement the rollout of additional technology that provides real time electronic communication capability to enable real time status updates from the field regarding the status of restoration efforts.

Additionally, CL&P has already undertaken a number of actions in response to the various reports and hearings to improve the company's planning process and to invest in needed programs. CL&P indicates that it has allocated an additional $7.3 million in 2012 to support additional maintenance tree trimming and an additional $20 million to support additional enhanced tree trimming. CL&P also recently submitted a system resiliency program with the PURA that includes proposals for pole administration and certain distribution equipment upgrades in accordance with an updated emergency preparedness response plan.

[145] McGee, *Two Storm Panel Report*. Available at http://www.ct.gov/dep/lib/dep/forestry/vmtf/two_storm_panel_final_report.pdf.

146 State Vegetation Management Task Force, "Final Report Issued to the Department of Energy and Environmental Protection, August 28, 2012." Available at http://www.ct.gov/dep/lib/dep/forestry/vmtf/final_report/svmtf_final_report.pdf.

147 See PURA Docket Nos. 11-09-09, 12-06-09 and 12-07-06.

Should We Underground Our Power Lines?

In the wake of the severe power outages of 2011, some observers suggested that Connecticut adopt a system-wide commitment to putting its electric lines below ground. DEEP has explored this issue, and concluded that while undergrounding would make sense in some circumstances, it cannot be adopted as a state-wide policy because such a commitment would entail an expense that would not be justified by the benefits that would accrue. The cost of putting power lines underground averages about $11 million/mile. Depending on how many miles of power lines have been undergrounded already, this could easily increase retail electricity rates in excess of 200%. Further, undergrounding is not always the best option for ensuring reliability. Whereas outages may occur less frequently with an underground line, outages can last much longer when an underground line must be repaired. Additionally, some studies show that overhead lines are more reliable than underground lines at later stages in their life cycle.

MICROGRIDS

The State recently enacted Public Act 12-148 to bolster resiliency by requiring investments in many of the approaches described above. Specifically, the law requires utilities to develop better emergency response plans, creates financial incentives to induce better emergency response, and more backup generation at key sites. DEEP has launched a pilot program in accordance with Public Act 12-148[148] that will support the demonstration of microgrids to protect critical facilities like hospitals, public shelters, police and fire stations, water treatment plants, and telecommunications towers—as well as municipal centers, where a system of distributed generation that can be "islanded" would allow some number of grocery stores, gas stations, and other facilities to stay "up" when the grid fails.[149] A microgrid entails a system of 24/7 local generation (not simply back-up generation) and a system of "trips" and "transfers" that modifies the existing distribution infrastructure so as to isolate the "microgrid" so that they have power even when there is a large-scale grid outage. The program is currently scheduled to deliver a first round of pilot microgrid projects beginning in the summer of 2013 and continuing through 2014.

Most critical sites, such as hospitals and police stations, already have access to backup power. But in some instances, backup generators do not have the firm fuel supplies needed to operate through a long outage or are not in proper condition to run continuously for long periods. New backup standards, such as designing for longer operational independence or requiring regular testing or minimum fuel supplies for existing backup systems, could bolster resilience. Over the long term, distribution level resiliency can also be enhanced by smarter, more distributed, or otherwise novel grid architectures, including microgrids.

[148] Connecticut Public Act 12-48, "An Act Enhancing Emergency Preparedness" (2012).

149 http://www.dpuc.state.ct.us/DEEPEnergy.nsf/$EnergyView?OpenForm&Start=1&Count=30&Expand=1&Seq=3

Further, as Connecticut becomes increasingly reliant on aging nuclear units and gas fired generation, the interdependencies between the gas and electric markets will be a critical factor in maintaining system reliability. Recent analysis indicates that there is sufficient flexibility in the electric system to meet reliability needs in New England, but meeting the daily operating needs is increasingly a challenge to system operators. The immediate challenge facing the region is to better align the gas and electric markets while making sure the markets send the proper price signals to participants. Connecticut has an opportunity to help assure regional system reliability by taking a leading role in the discussions that are taking place at ISO New England, the New England Power Pool, and FERC related to gas-electric reliability. In the longer term, Connecticut must work with other states in the region, or independently if necessary, to ensure that enough pipeline capacity is available to allow Connecticut ratepayers to access shale gas that can provide economic and environmental benefits in the electricity generation and home heating sectors. Connecticut is now working with NESCOE to conduct a study aimed at answering many of these questions, so that it will be in a position to play an integral part in the regional discussions.

ELECTRICITY SECTOR STRATEGY: RECOMMENDATIONS

For the reasons discussed above, this Draft Strategy proposes the following recommendations to enable Connecticut residents and businesses to take advantage of the opportunities outlined in this Chapter and to transform the existing electric system into one that meets the state's energy needs at the least cost while using the cleanest resources and ensuring greater reliability.

1. Expand Conservation & Load Management Funding To Invest In All Cost-Effective Electric Efficiency

Energy efficiency represents the best way to lower the electric bills for all of Connecticut's residential and business ratepayers. Thus, a central conclusion of this Draft Strategy is that the State must aggressively pursue expanded levels of efficiency across all sectors (government, commercial, industrial, and residential). To ensure that Connecticut ratepayers achieve greater benefits more commensurate with those in neighboring states, increasing investment in energy efficiency is one of the primary recommendations of both the 2012 IRP and this Draft Strategy.[150] This recommendation is discussed in greater detail in Chapter 1 (Efficiency).

2. Reduce Peak Demand and Improve Load Factor Through Technology and Pricing

This Draft Strategy recommends that the State increase awareness about the opportunities for larger customers to enroll in demand response programs and invest in technologies that will allow smaller customers, including residential customers, to participate in these programs as well. In addition to targeting energy savings, the State's energy efficiency programs should more aggressively pursue peak demand reductions.

[150] Connecticut DEEP, 2012 Integrated Resource Plan.

This Draft Strategy further recommends that CL&P submit a detailed plan to PURA for a multi-stage roll out of advanced meters in a manner that minimizes stranded costs, prioritizes adoption by customers most likely to benefit from their use, and provides for hybrid rate structures and/or affordable basic service for customers opting out of any installation program. The Draft Strategy also recommends that CL&P not promote time-of-use rates to its residential customers until advanced meters are available. The Draft Strategy also recommends that CL&P's mandatory time-of-use policy be reactivated as advanced meters are installed.

This Draft Strategy recommends that UI promote time-of-use rates to all of its customers. Both UI and CL&P should provide information to customers about ways to conserve energy and the opportunity to participate in the State's energy efficiency programs. UI should also develop and promote additional dynamic price options for its customers.

3. Align Utilities' Incentives With Achieved Efficiency Savings And Other Performance Metrics

Utilities have traditionally had a disincentive to promote energy efficiency, because their revenues were determined by the amount of electricity they delivered, so that any efforts to lower customer use of electricity would reduce their revenues. This disincentive can be eliminated through a regulatory mechanism called "decoupling," which enables the utility to recover its allowed costs even as sales decline due to efficiency gains. Decoupling can lower customers' energy bills while providing utilities assurance that they will collect the money they need to operate their systems.[151]

The General Assembly has long recognized the need for decoupling. Legislation enacted two decades ago, required the former DPUC (the regulatory agency that is now known as PURA) to investigate the relationship between utilities' sales and earnings, and to set rates in a way that encourages the use of conservation and load management programs.[152] The DPUC was required to balance a variety of factors, including a utility company's success in complying with state energy conservation goals with the impact on rates. More recently, Section 107 of Public Act 07-242 directed the DPUC to: "order the State's gas and electric distribution companies to decouple distribution revenues from the volume of natural gas or electricity sales through any of the following strategies, singly or in combination: (1) A mechanism that adjusts actual distribution revenues to allowed distribution revenues, (2) rate design changes that increase the amount of revenue recovered through fixed distribution charges, or (3) a sales adjustment clause, rate design changes that increase the amount of revenue recovered through fixed distribution charges, or both. In making its determination on this matter, the department shall consider the impact of decoupling on the gas or electric distribution company's return on equity and make necessary adjustments thereto."

[151] Satchwell, "Carrots and Sticks."

[152] Conn. Gen. Stat. § 16-19kk(b) and *See* Section 16-19tt of the Connecticut General Statutes ("Conn. Gen. Stat.") codifying Section 107 of Public Act 07-242

To date, however, UI is the only regulated utility in Connecticut that currently has full decoupling, but only on a pilot basis. UI's decoupling mechanism, established in 2009, provides the utility the difference between the actual revenue it collects as compared to the allowed revenue that is set by regulators.[153] Under this structure, UI submits an annual filing to PURA and is either allowed to collect any revenue shortfall, or required to issue a refund if it collects more than the allowed revenues. In 2009, UI collected $1.9 million less than its allowed revenue, and was allowed to recover this amount from customers.[154] In 2010, UI collected $1.3 million more than its allowed revenue and therefore issued a refund to its customers. UI's decoupling was initially approved as a pilot program. PURA extended the pilot period in 2011, and will decide whether to continue decoupling during UI's next general rate case.[155] Meanwhile, the DPUC implemented decoupling through rate design for CL&P in 2007,[156] but denied full decoupling for CL&P in 2010.[157] Two of Connecticut's three natural gas utilities have requested that the DPUC implement decoupling; both of these requests were denied.[158]

Decoupling mechanisms must be designed carefully and consider impacts to rates. To truly effect cultural change within the utility, decoupling must be a long-term regulatory commitment; it can't be implemented on an "on-again, off-again" or pilot basis. Therefore, this Draft Strategy recommends that PURA implement full, permanent decoupling in the next general rate case for UI and CL&P. In addition, the Draft Strategy recommends that Section 16-19tt of the Connecticut General Statutes be amended to require that "a mechanism that adjusts actual distribution revenues to allowed distribution revenues" be the sole mechanism used to decouple revenues from sales for each of the state's gas and electric utilities.

Decoupling is an important step towards ensuring that the utilities effectively implement the State's energy efficiency programs. At best, however, decoupling only removes a disincentive to delivering energy efficiency, and leaves the utility unharmed if it reduces customer demand for electricity. Currently, Connecticut's electric utilities are allowed to earn performance incentives for achieving savings goals and other metrics as part of their administration of the State's energy efficiency programs. These performance-based benefits tied to

[153] See Decision dated February 4, 2009, in Docket No. 08-07-04, Application of The United Illuminating Company To Increase Its Rates and Charges.

[154] See Decision dated September 1, 2010, in Docket No. 08-07-04RE02, Application of The United Illuminating Company To Increase Its Rates and Charges – Review of Decoupling Pilot, Pension Tracker, ROE Sharing Mechanism and GET Adjustment.

[155] See Decision dated August 31, 2011, in Docket No. 08-07-04RE03, Application of The United Illuminating Company To Increase Its Rates and Charges – Review of Decoupling Pilot, Pension Tracker, ROE Sharing Mechanism and GET Adjustment.

[156] See Decision dated January 28, 2008, in Docket No. 07-07-01, Application of The Connecticut Light and Power Company to Amend Rate Schedules.

[157] See Decision dated June 30, 2010, in Docket No. 09-12-05, Application of The Connecticut Light and Power Company to Amend Its Rate Schedules.

[158] See Decision dated June 30, 2009, in Docket No. 08-12-06, Application of Connecticut Natural Gas Corporation for a Rate Increase; and Decision dated July 17, 2009, in Docket No. 08-12-07, Application of The Southern Connecticut Gas Company for a Rate Increase.

achievement of efficiency goals should continue in addition to decoupling, to fully incentivize the utilities to implement efficiency programs in a cost-effective way.

This Draft Strategy therefore also recommends that PURA consider authorizing a variable return on equity tied to quantitatively-tracked results in achieving public policy goals related to storm response, global efficiency goals, grid reliability, electricity costs, and perhaps other factors. This system would allow each company to earn a performance-based rate of return based on defined performance targets. Performance-based returns will create substantial incentives to perform. In fairness to ratepayers, poor performance should result in a reduction in basis points. A similar construct could be developed for the gas companies tied to goals outlined in Chapter 4 (Natural Gas). If PURA allows a performance-based return on equity that includes goals tied to efficiency, then the performance incentives currently in place for the efficiency programs may need to be adjusted. DEEP welcomes input on ways this ratemaking approach could be developed, as part of the public comment period in the Draft Strategy.

4. Engage More Vigorously In Regional And Federal Regulatory Processes

The challenges facing Connecticut policymakers can also provide the newly created DEEP Bureau of Energy and Technology Policy (Bureau) an excellent opportunity to increase its engagement with other states and regional organizations to help shape the direction of and the mandates within which FERC and ISO New England operate. The Bureau can further the policy objectives of Governor Malloy, as outlined in the Draft Strategy, by working with the Connecticut legislative delegation and other representatives from New England. Moreover, the Bureau can work on a national level to ensure that FERC's mandates clearly align with state and regional energy and environmental policy goals rather than working against those goals. Additionally, the creation of the Bureau and the development of the Comprehensive Energy Strategy coincide with many important discussions already underway as the region deals with challenges facing the electric industry as identified in ISO New England's recently released strategic planning initiative. Connecticut can play a leading role in important regional discussion with ISO New England and the New England Power Pool on issues such as the alignment of markets and planning, the region's increased reliance on natural gas for electricity production, and designing the reserve and capacity markets so as to provide market participants only the level of incentives needed to ensure an adequate level of supply.

5. Work With Municipalities To Expand Programs And Policies That Drive Down The Cost Of In-State Renewable Resources

As discussed above, solar PV currently offer a substantial near-term renewable energy opportunity for Connecticut. The costs of installed solar PV are still high relative to out-of-state renewable power options, but solar PV costs are falling fast and there is an opportunity for Connecticut to help solar installers drive installed costs even lower. As described above, some of Connecticut's best solar installers already provide solar PV systems that operate at a cost below residential rates. This Draft Strategy recommends that the State take steps to ensure that the vast majority of installers meet this benchmark, to drive the average installed cost of solar PV below residential rates.

To complement these existing programs, this Draft Strategy proposes that the State and municipalities work together to streamline permitting, siting, and other requirements to help reduce soft costs involved in solar PV installations. As the hardware costs involved in solar PV installations continue to decline, so-called "soft" costs, such as permitting, interconnection, and customer acquisition, will account for a greater percentage of installation costs. Many states and countries have launched policies and initiatives aimed at reducing these "soft" costs. For example, Germany uses widespread training and certification programs, and streamlined permitting processes to improve the efficiency and lower the costs of solar installations. In the United States, non-hardware or soft costs are more significant than in Germany, representing 30-50% of solar PV installation costs in recent years.

Connecticut is one of 22 nationwide recipients of U.S. Department of Energy (DOE) SunShot Initiative funding to reduce soft costs through the Rooftop Solar Challenge.[159] The focus of the Connecticut Rooftop Solar Challenge is to streamline and standardize processes, remove barriers, reduce soft costs and fees associated with permitting, inspection, interconnection, net metering, and planning and zoning for rooftop solar PV in Connecticut. Permitting fees in the 169 Connecticut jurisdictions are generally uncapped and vary widely, while wasted time and delays due to inefficient and inconsistent permitting, inspection and interconnection processes and requirements add cost to installer labor or overhead. Solutions include implementation of best practices such as consistent, streamlined processes and application requirements and forms, fees based on recovering processing costs, making information on processes readily available online, online permitting to save installer travel and jurisdiction processing time, and legislation that would standardize and streamline the process. The Rooftop Solar Challenge project will also put together state-level recommendations for guidance and legislation enabling streamlining of processes and removal of barriers for installation of rooftop solar PV in Connecticut.

At the same time, CEFIA should expand its work with municipalities to drive down the costs of solar PV installations through its Solarize program. By pooling solar installations, this program allows installers to bid for larger installation quantities and to reduce the cost of acquiring customers. Solarize Connecticut is still in its early stages, but its cost reduction strategy appears promising. In the summer of 2012, the installer bids selected for the first four Solarize pilot communities reflected pricing 10-30% below the current average installed cost for residential solar PV in the state. Some installers bid as low as a 40% discount off current averages. These numbers suggest that Solarize aggregation strategies could help dramatically lower the cost of residential solar PV to Connecticut homeowners, and potentially drive significantly accelerated deployment. Over the long-term, CEFIA should seek to expand the lessons learned from the Solarize Connecticut model and apply them to other renewable energy (i.e. solar hot water systems, ground source heat pumps, etc.) and energy efficiency (i.e. furnace and boiler replacements, weatherization, etc.) technologies not only within the residential sector, but also the commercial and industrial sectors with the

[159] See http://www.eere.energy.gov/solarchallenge/. This program is administered in Connecticut by CEFIA.

goals of reducing installed costs, rapidly increasing customer demand, and transitioning from subsidizing these technologies towards financing them. In conjunction with these efforts, consideration should be given to enacting property tax exemptions for clean energy programs and projects administered through the State.

6. Evaluate Options For Waste-To-Energy in Connecticut

Under Connecticut's RPS, waste-to-energy facilities largely comprise Class II generation in Connecticut. These facilities also handle 50% of the state's solid waste. Historically, long-term contracts with the electric distribution companies have been necessary to ensure the economic viability of these facilities with the expectation that proceeds from the Class II market would provide a sustainable future revenue source. However, many long-term contracts have ended, the Class II market is currently oversupplied, energy prices have declined, and operating costs have increased. Reduced revenues, unsold renewable energy credits (RECs), and increased costs have created financial hardship, and raised concerns about significant environmental consequences for the future of the State's management and disposal of solid waste. This issue was highlighted in the 2012 IRP and will need to be further explored as part of DEEP's RPS study. As part of its review DEEP will consider the appropriate balance between renewable energy and environmental policy goals and consider the statewide transformation efforts currently underway through the work of Governor Malloy's Recycling Task Force.

7. Expand Virtual Net Metering Opportunities To Promote Deployment Of Large-Scale Renewable Systems

Virtual net metering allows customers who operate behind-the-meter generation (ie., the host) to assign the surplus production from the generator to other metered accounts, such as beneficial accounts that are not physically connected to the generator. The surplus production is then used to reduce the electric bill of the beneficial account(s) through an accounting mechanism. Virtual net metering is designed to encourage the installation of additional distributed generation by providing a financial model that makes the investment economically feasible.

Section 121 of Public Act 11-80 authorized virtual net metering for Connecticut's municipalities and allowed the electric distribution companies to credit surplus production to offset the generation service charge of a municipality's beneficial accounts. Because most behind-the-meter generation is not modeled in the ISO New England system, surplus production from these units simply reduces system load within the electric distribution company's service territory and provides no direct payment to the electric distribution company. Because no payment is made to the distribution company, the offset to the beneficial account's retail generation charge creates a subsidy that is paid for by other ratepayers. The Act capped the subsidy at $1 million, which in turn limited the amount of distributed generation that can be installed under this policy.[160]

[160] *See* Connecticut Public Act 11-80, Section 106, "An Act Concerning The Establishment Of The Department Of Energy and Environmental Protection and Planning For Connecticut's Energy Future," 2012.

An alternative way of incentivizing these projects would have PURA establish a variable power purchase schedule that establishes fixed credit amounts for renewable power generated behind the meter. These schedules may vary depending on the type of generation and whether the host was a municipality, agricultural customer or private entity. This schedule would not only promote the State's energy and economic goals but also balance the financial incentives needed to make renewable generation economical with the need for all customers to contribute to the costs of maintaining the electric grid.

Another alternative would be for Connecticut to adopt the varied rate schedule model used in Massachusetts. This mechanism establishes a schedule that would apply fixed credit amounts for the renewable power generated behind the meter. These schedules might vary depending on the type of generation and whether the host was a municipality, agricultural customer, or other private entity. This would promote the State's energy and economic goals and balances the financial incentives needed to make renewable generation economic with the need for all customers to contribute to the costs of maintaining the grid. Adopting the Massachusetts model would have the added benefit of establishing standardized net metering policies in the two states that now are served by the same NU/NSTAR utility.

Still another way to reduce the subsidy would be to have these generators were modeled in the ISO New England market system as Settlement Only Generators. This would require that the generators be equipped with advanced metering capable of recording the hourly net output to the distribution system. The hourly data would need to be collected and used in the electric distribution companies' settlement calculation so the surplus production could be paid at the real time locational marginal price. The income from this payment could then be used to reduce the subsidy, allowing additional virtual net metering capacity within the current cap. This Draft Strategy solicits comments and suggestions regarding these and other options that would support the deployment of more renewable distributed generation, without unduly burdening ratepayers and the utilities charged with administering these programs.

8. Strengthen The Regional Carbon Dioxide Cap Through RGGI Program Review

Connecticut's participation in RGGI is essential to achieving the State's RPS goals. Due to several factors, but most notably the dramatic shift from oil and coal generation in the region to lower-emitting natural gas generation, there has been a dramatic reduction in carbon dioxide emissions from electric generating units over the past few years. Between 2009 and 2011, regional emissions were 34% below the current regional carbon dioxide cap.[161] As a result, the RGGI "cap" has not been reached, and allowances have recently been sold only at the "reserve price." These lower carbon dioxide emissions are great news for the environment and public health. Indeed, lower emissions have led to lower demand for carbon dioxide allowances, which as created a significant surplus of unsold emissions allowances, and caused the price paid for allowances at

[161] Available at http://www.rggi.org/

auctions to fall from a high of $3.51 per ton reached in the first several auctions to the minimum reserve price of $1.93 per ton in the latest auction. [162]

As a result, this Draft Strategy recommends that Connecticut work with other RGGI states to adjust the regional carbon dioxide cap through the public RGGI Program Review process, to ensure that the program continues to incentivize better environmental outcomes. Specific issues that are being considered as part of the RGGI program review include:

- Lowering the emissions cap to ensure reductions from current emissions levels going forward while providing a means to ensure an adequate supply of allowances at a reasonable price;
- Adjusting the manner in which compliance is determined by requiring periodic compliance checks during the three year compliance period;
- Addressing carbon emissions associated with imports of electricity from non-RGGI states into the RGGI region;
- Evaluating options to revise the lowest ("reserve") price for which allowances can be sold;
- Considering the benefits of retiring unsold allowances; and
- Ensuring that RGGI auction proceeds are put to their highest and best use in Connecticut through benefit cost analysis of current funding allocations.

In addition, this Draft Strategy recommends that Connecticut continue discussions and efforts to include other jurisdictions in a greenhouse gas reduction program. As always, any adjustments to the RGGI program must be pursued in a manner that protects electric customers from unanticipated price impacts. Early concerns that RGGI would drive up electricity prices have not materialized. Moreover, revenues generated from the auction of allowances have been primarily reinvested in energy efficiency, which has helped to reduce emissions and overall program costs. In addition, Connecticut's RGGI-implementing regulations include a price trigger that will automatically rebate any auction revenue in excess of $5 per ton directly to electric customers.

RGGI states are working cooperatively through an open and transparent process to examine opportunities to improve the program. Preliminary staff analysis indicates that meeting RGGI related environmental, energy, and economic goals can be achieved at minimal cost. In addition, preliminary energy modeling indicates that a significantly lower RGGI cap could be implemented with only a modest price impact of ¼ to ½ percent on the average residential energy bill in Connecticut or between 20 and 80¢ each month depending on usage. This modest cost estimate has yet to be finalized or analyzed in relation to the anticipated benefits using macroeconomic modeling. This analysis will be completed by the end of 2012. Based on a previous

[162] *Ibid.*

macroeconomic analysis, a total benefit-cost analysis is likely to demonstrate that a revised RGGI program will continue to have an overall positive impact on Connecticut's economy, resulting in more energy dollars remaining in-state.

9. Develop Submetering Protocols To Promote The Use Of Renewable Energy And Combined Heat And Power In Multi-Tenant Buildings

Multi-tenant commercial and residential buildings present an opportunity for the installation of renewable energy (solar PV, wind turbines, fuel cells, and geothermal wells) and/or CHP at little cost to the State.[163] Both technologies help reduce a building's reliance on the grid, with renewable energy having the added bonus of diversifying the energy supply.

Among the many ways the State can promote these technologies, two deserve mention here. The first is by allowing submetering of electricity produced on site by the landlord in a multi-tenant building. In a submetering scenario, each tenant has their own meter and is charged by the owner of the generating equipment (usually the landlord) based on usage. In other states, such as New York, landlords of large buildings can install newer equipment, usually renewable energy or a system with a CHP component to generate power on site and fully recover their costs over time by submetering tenants. In Connecticut, by contrast, submetering of electricity is specifically allowed at campgrounds and marinas. DEEP believes that the existing statute authorizes PURA to allow submetering in other applications, however legislative clarification may make the process more certain.[164]

The current submetering regulations, other than consideration for campgrounds and marinas, have not changed since their implementation over 25 years ago. Accordingly, this Draft Strategy recommends Connecticut review its approach to amend Section 16-19ff to support new technologies and the current energy and regulatory landscape and to explicitly allow submetering in multi-tenant buildings. Connecticut should further establish guidelines for PURA to use in amending its regulations to simplify the application process and to ensure compliance with consumer protection requirements.

10. Develop And Deploy Microgrids To Support Critical Services And Ensure Public Safety During Electricity Outage Crises

Microgrid designs have the potential to provide highly reliable power for critical facilities and also support the health of the overall electricity grid. Although the technology is relatively new to the United States, numerous microgrids exist around the world, and Connecticut should proceed to test different ways of deploying distributed generation and microgrids to mitigate the impact of widespread power outages. The State has already begun the process of launching a pilot program that will result in the deployment of ten to fifteen microgrids over the next eighteen months. Continued evolution in local generation, energy storage, and other

[163] CHP refers to any energy-generating mechanism that also generates useful heat.

[164] Conn. Gen. Stat. § 16-19ff.

information technology-enabled grid devices make it a compelling time to experiment with microgrids. An expanded commitment to microgrids should be explored based on the results of the pilot projects. The pilot program is scheduled to deliver projects in 2013 and 2014[165]. After this pilot program is concluded, DEEP should work to identify the successes and difficulties encountered in this pilot program, and craft recommendations for a larger microgrids program based on these results.

DEEP should also engage CEFIA in facilitating the creation of a tax equity financing fund for fuel cell technology in partnership with private sector investors, DEEP, and the electric distribution companies. Like the Connecticut Solar Lease program for residential homeowners, a fuel cell tax equity fund can attract private capital investment into Connecticut and support its cleaner, cheaper, and more reliable energy goals.

11. Implement the Reliability Recommendations Of The Two Storm Panel

State and local government planning and preparedness is necessary to address major power disruption more comprehensively and inclusively, including coordination with utility providers and procedures for responding to utility outage events. The Two Storm Panel Commission Report contains several recommendations for actions that DEEP, PURA, Department of Transportation (ConnDOT), the Connecticut Siting Council and other state agencies can take on a wide variety of topics, with subjects ranging from utility issues (e.g., electric, gas, water, sewer, telephone, cable, television, data and piping infrastructure) to municipal assistance and changes that can be implemented at the State level to improve the State's readiness for the next emergency.

Many of the recommendations from the Two Storm Report have already been implemented or are underway as previously mentioned in this Chapter. There are several additional initiatives DEEP can undertake to address storm preparedness. For example, DEEP can investigate the physical and fiscal issues associated with the development of distributed power generation systems in critical areas and delineated "town centers." This would include a review of energy improvement districts, use of microgrids, and potential legislative fixes to address any issues associated with crossing rights-of-way. DEEP is prepared to cover this examination in the course of its microgrid program.

In furtherance of the January 25, 2012 findings of the Connecticut Geospatial Information Systems (GIS) Council Storm Response and Recovery Assessment Group[166], with regards to a state level GIS Emergency Response team, DEEP shall pursue discussions with the State agencies involved with the report on how best to accomplish the goals of such a group and require that electric utilities develop GIS applications-incorporating information from advanced meters/grids and mobile data terminals to facilitate the real-time sharing of data on service outages.

[165] http://www.dpuc.state.ct.us/DEEPEnergy.nsf/$EnergyView?OpenForm&Start=1&Count=30&Expand=1&Seq=3

[166] Connecticut Geospatial Information Systems (GIS) Council Storm Response and Recovery Assessment Group, "Draft Findings Report, January 25, 2012." Available at http://www.ct.gov/gis/lib/gis/Final_Draft_GIS_Storm_Assessment_Findings_Report_01_25_12.pdf

CONCLUSION

Since 2010, Connecticut's electricity sector has made important strides towards a cheaper, cleaner, and more reliable energy future. Electricity rates are decreasing, power plants are burning cleaner fuels, and there is renewed attention to the need to invest in reliability. With the creation of the new Department of Energy and Environmental Protection, the State has new planning and policy capabilities to help anticipate and adapt to trends in technology development, fuel prices, electricity markets, and state and federal environmental and energy policies that impact the cost, reliability, and environmental impact of our electricity sector. The establishment of CEFIA is enabling the State to engage the market in new ways to advance Connecticut's long-term policy objectives.

This Draft Strategy for the electricity sector recommends actions that will enable Connecticut to create an energy future that looks very different from today's. It underscores the importance of expanding funding for all cost-effective energy efficiency and an increased emphasis on reducing peak demand. It proposes mechanisms to ensure that traditional energy supplies continue to decrease their negative health and environmental impacts, recommends approaches to better identify cost-competitive renewable resources that will be critical to the state's future, and, specifically proposes approaches to drive down the cost of solar PV — the largest cost-effective in-state renewable resource — to significantly boost customer adoption and economic benefits to Connecticut. Following the path outlined in this Chapter and other Chapters in this Draft Strategy, will establish Connecticut as a leader in creating a cheaper, cleaner energy future while growing the state's economy and ensuring that Connecticut is an increasingly desirable place to live and work.

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Natural Gas Sector Strategy

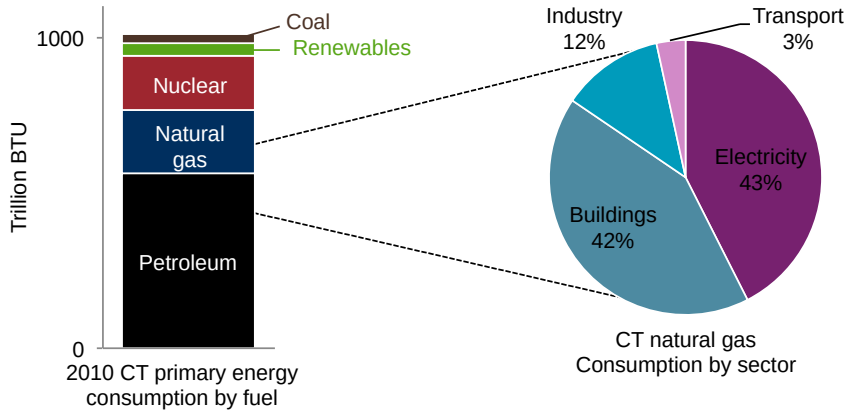
INTRODUCTION

For decades, the prices of natural gas and oil have been linked, with gas historically being the more expensive of the two. Over the last several years, the price of the two commodities have diverged, or "decoupled," from one another. The emergence of new extraction techniques (most notably hydraulic fracturing, or "fracking") have brought enormous amounts of natural gas supply to the marketplace from shale basins in Arkansas, Texas, and the mid-Atlantic states. As a result, the average wholesale price of natural gas (before factoring in the cost of transportation and delivery to the customer) has dropped from over $7 per million BTU in 2007 to well below $3 per million BTU in 2012, with prices projected to remain low for the foreseeable future. In that same time, the average wholesale price of oil has risen from $12 to over $16 per million BTU (averaging $96/barrel in 2012), and is projected to remain high due to growing global demand for oil, especially in emerging markets such as China and India. This recent development presents Connecticut residents and business owners with a once-in-a-generation opportunity to switch to a cheaper, cleaner fuel source, and as a result, lower their energy bills while decreasing the level of harmful air pollution and breaking free of the price spikes that dependence on oil results in since so much of it is imported from unstable regions of the world. This Draft Strategy seeks to offer Connecticut residents and businesses "gas choice", the opportunity to take advantage of this lower cost and cleaner burning fuel.

Some sectors of Connecticut's economy have already begun to shift to gas. Since 2009, natural gas consumption in Connecticut has increased by 24%, mostly attributable to increased use for electric generation. Electricity generation rates are coming down as a result of this switch to a cheaper fuel source.[167] Many industrial firms that require a lot of energy to power manufacturing processes have also made the switch to natural gas (Figure 2). These two sectors now account for more than half of Connecticut's natural gas consumption (Figure 1).

[167] Nearly 35% of Connecticut's electricity is now generated from natural gas. For a more detailed discussion of natural gas use for electricity generation, see the *2012 Connecticut Integrated Resource Plan*.

FIGURE 1: Connecticut natural gas consumption[168]



Source: U.S. EIA, "State Energy Data System."

At the same time, the significant upfront costs of converting heating equipment and, in some instances, expanding natural gas distribution infrastructure have prevented other energy users from taking advantage of low natural gas prices. In the transportation sector, natural gas is now a cheaper fuel than gasoline and diesel, but natural gas-powered vehicles are currently more expensive than conventional vehicles, and few natural gas refueling stations are available in the state at this time. Over the next decade, the use of natural gas for transportation will likely increase by a small percent, as commercial vehicle fleets and—to a much lesser extent--some light duty passenger vehicles convert to natural gas use. These trends are addressed in more detail in Chapter 5 (Transportation).

In contrast to power plants and manufacturers, homeowners and businesses have been slower to adopt natural gas as a fuel to heat their homes, stores, office buildings, factories, and other facilities. Only 31% of the state's 1.4 million residences currently use natural gas for space heating. That penetration percentage is lower than the rest of New England and the U.S. average, which are about 50%.[169] Only 35% of Connecticut businesses use natural gas (for space heating or otherwise) (Figure 2).[170] Why aren't more residents and businesses converting to natural gas use for space heating and other uses? The primary reason lies in the significant upfront cost of installing natural gas heating equipment, which presents a significant barrier to adoption. For homes and businesses located more than 150 feet from a gas main, the cost of equipment may be dwarfed by the cost of expanding the main itself.

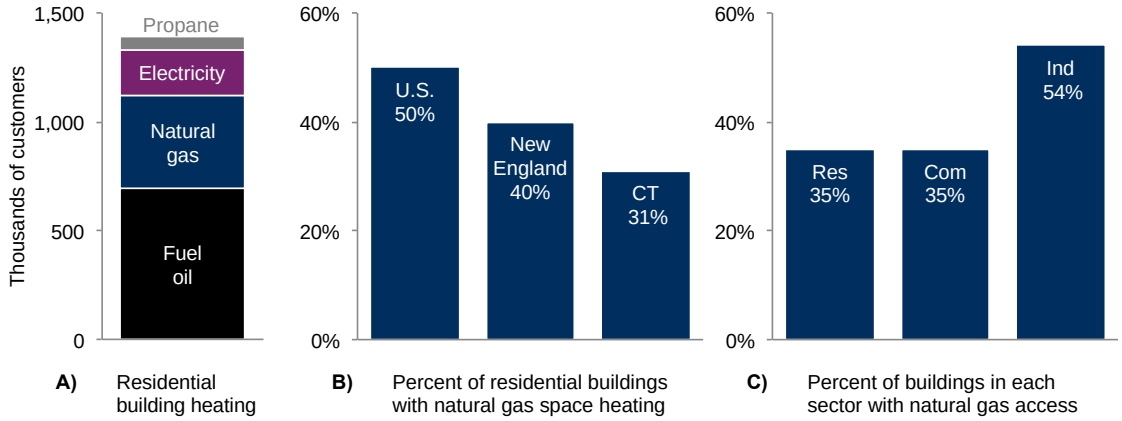
[168] Connecticut natural gas consumption will be ~15% higher in 2011 than the 2010 data shown here, driven primarily by a 28% increase in electricity sector consumption. U.S. EIA, "Natural gas consumption by end-use."

[169] U.S. Energy Information Administration (EIA), *Residential Energy Consumption Survey.*

[170] Connecticut Department of Economic and Community Development. *Expanding Natural Gas.*

FIGURE 2: Connecticut natural gas usage

(A) Relatively few Connecticut homes are heated using natural gas. (B) The percentage of Connecticut homes heated by natural gas is lower than that of the New England region and the U.S. average. (C) A large portion of Connecticut buildings in all three sectors do not have natural gas access—i.e. do not use gas for space heating or otherwise.



Source: U.S. EIA, "State Energy Data System"; U.S. EIA, Residential Energy Consumption through 2010*; and Connecticut Department of Economic and Community Development,* Expanding Natural Gas.

This Chapter of the Draft Strategy focuses on the opportunity to expand access to natural gas, providing "gas choice" for as many as 300,000 families and companies. Given the lower price, reduced environmental impact, and domestic availability of natural gas, ensuring that Connecticut citizens have an opportunity to switch to natural gas, if they choose, is a major economic and environmental opportunity, and one that advances Governor Malloy's vision for the state of a cheaper, cleaner, and more reliable energy future. When savings over time are greater than upfront costs, residents get the benefit of lower heating bills. Fuel switching would bring environmental gains, lowering emissions of federally regulated pollutants such as SOx, NOx, and particulate matter. Connecticut residents would be put to work building out the needed infrastructure for an expansion, and the economy would get a boost from the extra money in people's wallets being spent on other goods and services, instead of energy. In addition, there would be wider benefits to the country as a whole from energy dollars being spent on a domestic energy source instead of on foreign oil.

This Chapter proposes a set of options to help residents and businesses switch to natural gas quickly and affordably for their space heating needs, as well as some options to deliver greater efficiency savings and cost-effective alternatives for building heating for those who cannot cost-effectively convert their buildings to natural gas.

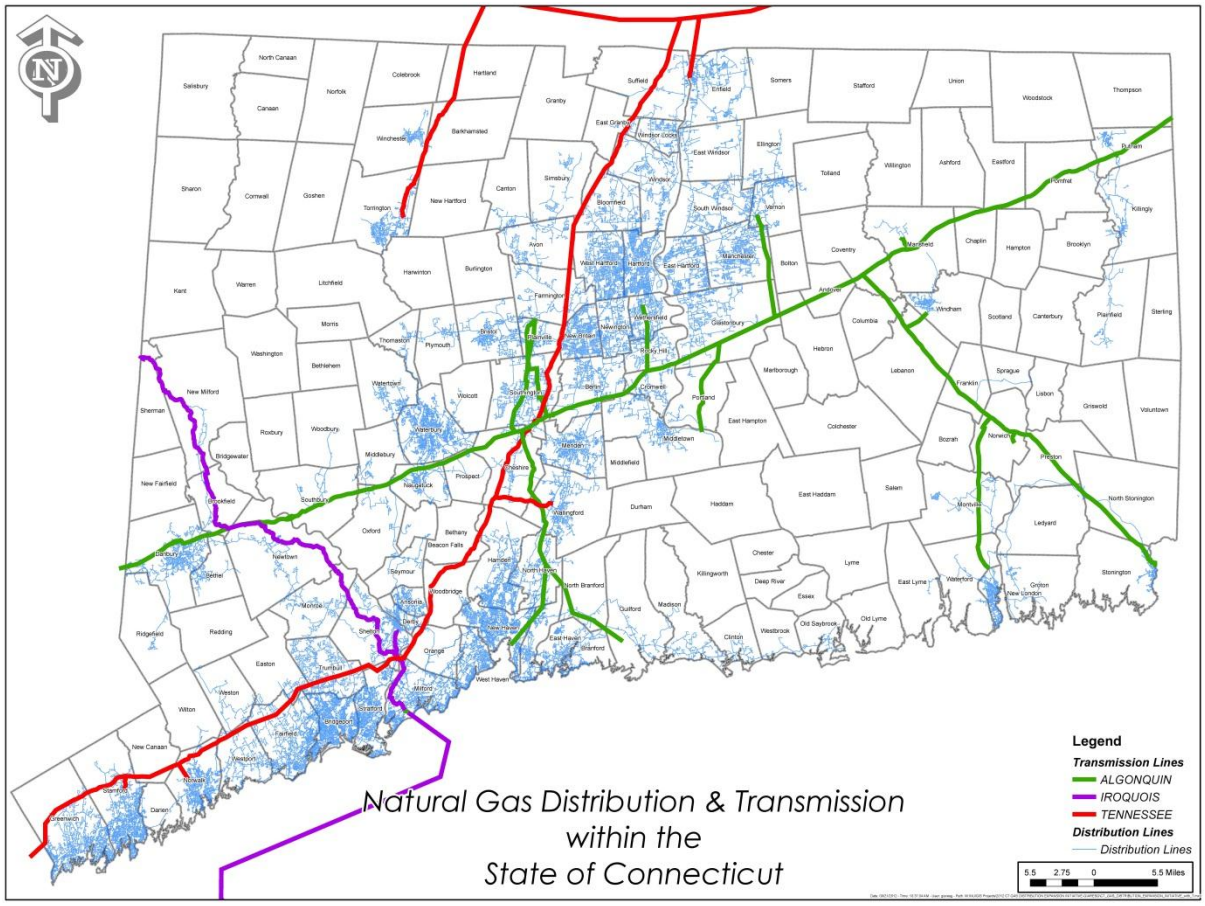
CONNECTICUT'S NATURAL GAS OPPORTUNITY

Natural gas is a relative newcomer to the energy landscape of Connecticut. For centuries, Connecticut's residents heated their homes and businesses with wood, then coal, and then oil. Wood could usually be obtained from abundant nearby forests, coal became available as wood sources were depleted, and then oil became abundant and could be easily delivered across the state. In contrast, natural gas delivery typically requires pipelines with large initial infrastructure costs. The United States did not begin to build an extensive

network of natural gas pipelines until the 1920s. And natural gas did not become widely available in Connecticut until the 1960s. Three major transmission pipelines—Algonquin Gas Transmission, Tennessee Gas Pipeline and, later, the Iroquois Gas Transmission System—were constructed to bring gas to New England from both the Gulf of Mexico and Canada. Today, three local gas distribution companies (referred to in this Chapter as gas companies) provide natural gas service to Connecticut customers. The gas companies have constructed a distribution system of pipelines or "mains" to distribute natural gas to end-use customers spread in higher concentrations along the state's coast and through its central industrial section (Figure 3).

FIGURE 3: Connecticut's Natural Gas Infrastructure

Connecticut natural gas infrastructure is concentrated in areas with high population density, such as the central part of the state and along the coast.

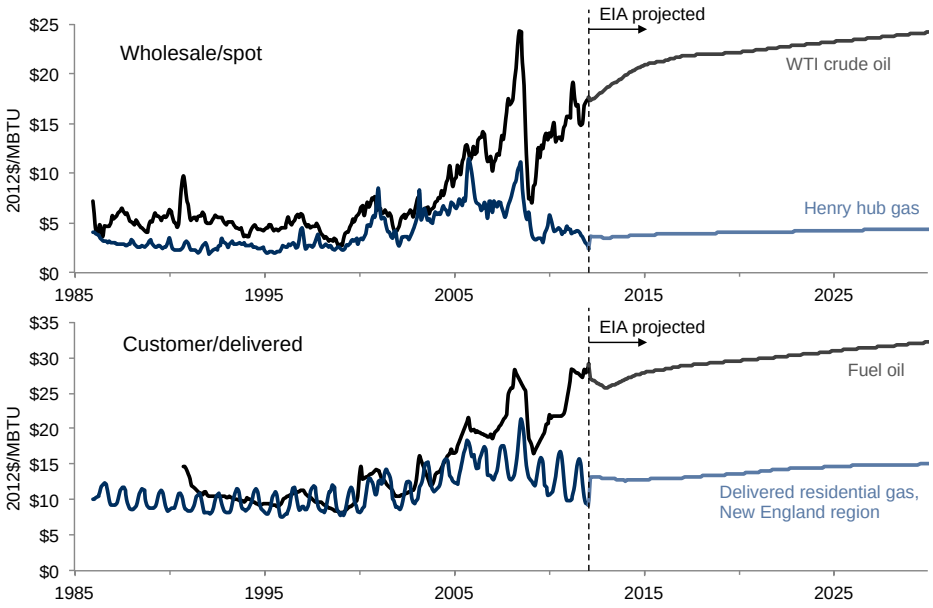


Source: Connecticut Natural Gas, Southern Connecticut Gas, and Yankee Gas

Low-cost and abundant shale gas has transformed America's energy outlook. Advances in drilling techniques—most notably hydraulic fracturing, also known as "fracking," and improved horizontal drilling—have led to an enormous expansion in the amount of economically recoverable natural gas in the United

States, including in the eastern United States.[171] Domestic natural gas production has increased by 19% since 2007, largely from unconventional sources such as shale gas, while prices have dropped by over 50% and have diverged from rising oil prices.[172] As shown in Figure 4, the U.S. Energy Information Administration's (EIA) latest forecast projects that gas prices will remain low for at least the next 20 years, thanks to abundant known domestic reserves and new technologies that allow gas to be extracted from those reserves. Natural gas is currently 60-75% lower in cost than the equivalent amount of energy produced by petroleum-based fuels.[173] Natural gas is largely produced and consumed domestically, since limited export capacity currently exists in the United States.[174] As a result, natural gas prices in the United States are currently less susceptible to the geopolitical gyrations that surround oil.

Figure 4: Oil and natural gas prices with U.S. EIA projections[175]



Source: U.S. EIA.[172]

[171] See the following for a brief explanation of hydraulic fracturing and horizontal drilling techniques: http://www.propublica.org/special/hydraulic-fracturing-national.

[172] Natural gas and oil price histories are from U.S. Energy Information Administration (EIA). Price projections are from the reference case in U.S. EIA, *2012 Annual Energy Outlook (AEO)*. Delivered gas and fuel oil prices are from AEO supplementary tables for the New England region. Prior to the 2008 price spike, Natural Gas prices were relatively steady around the $6-7/MBTU range. Since then, prices have dropped more than 50% with recent prices below $3/MBTU.

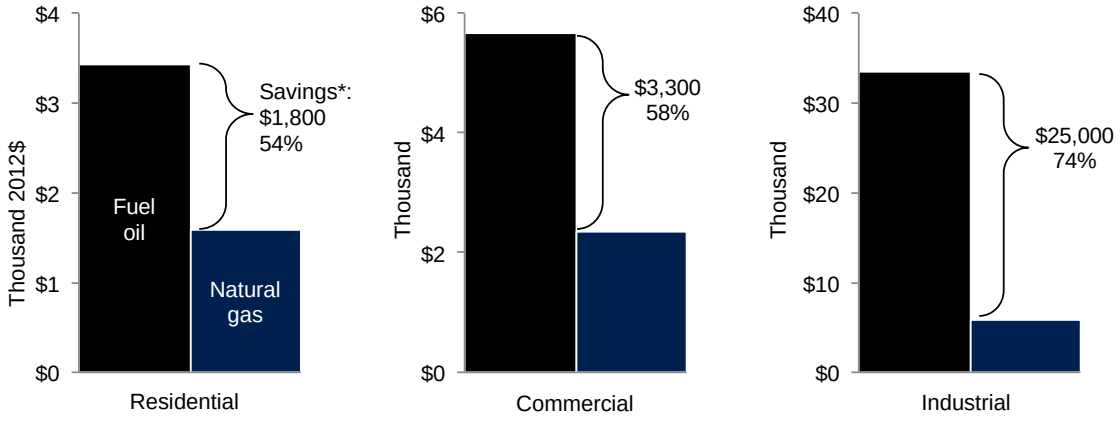
[173] Delivered prices from U.S. EIA, *State Energy Data System*, updated using price rise/decline since 2010 using U.S. EIA, "Natural Gas Prices"; and U.S. EIA, "Weekly Heating Oil Prices."

[174] In 2010, the United States exported 11 percent of its total natural gas supply. Annual Energy Outlook 2012, U.S. EIA, p. 94.

[175] The "spot" price is the wholesale market price for purchasing a commodity, in this case oil or gas, for (near) immediate delivery. Spot prices for oil and gas are typically given for a benchmark location, such as "Henry Hub" located in Erath, Louisiana (a major trading "hub" where nine major interstate pipelines come together) and/or for a known grade, such as West Texas Intermediate (WTI)(a relatively easily refined grade of crude oil produced in Texas).

Some sectors are better able than others to switch to lower cost, cleaner-burning natural gas. Unlike the transportation sector (where the high cost of natural gas-powered vehicles limits its use as a fuel in the immediate future), and industrial processes and electricity generation sector (where the use of natural gas is largely optimized already), the building sector has the greatest potential to increase its natural gas use. Only about a third of Connecticut residences and commercial buildings heat with natural gas despite the fact that it is currently 60-75% cheaper than fuel oil, 70-80% cheaper than propane, and 75-85% cheaper than electric resistance heating.[176] This means that the average homeowner heating with natural gas pays 54% ($1,800) less each year to heat his or her home than the average homeowner heating with fuel oil. For commercial businesses, natural gas is 58% ($3,300) cheaper to heat with than fuel oil. Annual energy bills for industrial customers heating with natural gas are 74% ($25,000) lower than for their oil-heating competitors (Figure 5).

Figure 5: Average annual savings from heating with natural gas instead of fuel oil, by sector



*Source: U.S. EIA. 2012. AEO 2012 Early Release - Supplemental tables for regional detail, Table 11, New England. * Savings based on the differential in average fuel prices for the period 2012-2032.*

The cost of converting a building's space heating system from fuel oil to natural gas varies depending on several factors, including the proximity of the building to a gas main, and the amount of energy needed to heat the building. These costs include:

- **Equipment Replacement Costs** - The new gas customer must replace their existing oil-burning furnace or boiler and hot water heater with gas furnaces or boilers and, often, gas water heaters. For a residential customer, the cost of a new, high efficiency gas furnace or boiler, which can be used with existing radiators/ductwork, plus a natural gas water heater, will range from approximately $3,000-4,000. The customer may also have to pay to have their oil tank removed, depending on where it is located—whether underground, or inside the home. With installation

[176] Prices from U.S. EIA, *State Energy Data System*. Updated using price rise/decline since 2010 using U.S. EIA.

and disposal costs factored in, the total bill for residential equipment replacement adds up to an average of $7,500.[177]

- **Hookup Costs** – Some buildings may already be "hooked up" to a gas main—for example, if a home has a gas stove for cooking, but relies on an oil-burning furnace or boiler for heat. If not, a meter and a ½" to 2" diameter underground service line must be installed by the gas company to connect the building to a gas main in a street adjacent to the building. Sometimes the service line can be pushed through the soil instead of requiring a trench to be dug. Service and meter installations will cost on average, roughly $4,283 for a residential customer, $7,669 for a commercial customer and $11,504 for an industrial customer.[178]
- **Main Extension Costs** – In many cases, there is no gas main located in a street adjacent to the building. In that circumstance, the gas main itself must be extended in order for the customer to access natural gas. As a general rule of thumb, if a new customer is located more than 150 feet from a gas main, some extension of the main will be needed in order to connect the customer to natural gas service. Main extensions are estimated to cost about $1 million per mile, or about $190 per foot, but these costs can vary significantly. Depending on where the new gas main will be located, permits or approvals may be required by DEEP and the Connecticut Siting Council to address soil remediation, wetlands, and water quality impacts. Municipal governments may also require permits for paving or excavation. Paving costs alone may comprise 20% of main extension costs. These paving costs that can be reduced if a gas main extension is coordinated with water, sewer, or other infrastructure repairs that involve tearing up and repaving streets.

For commercial and industrial customers, with larger installations, overall conversion costs are proportionally higher and vary more widely, due their wider range of heating needs. These customers typically need larger heating equipment and potentially larger service lines and more advanced meters than homeowners do, and they also have greater disposal costs (Table 1).

[177] Connecticut Department of Economic and Community Development, *Expanding Natural Gas*; Navigant, "Technology Forecast Updates"; and Communication with local installers; Customer conversion cost includes equipment and labor for replacement with new furnace/boiler and water heater, disposal of fuel oil tank, new controls, balancing, etc. See, Appendix C (Natural Gas)Table TA-3 for a summary of response from communication with local installers.

[178] Connecticut Department of Economic and Community Development, *Expanding Natural Gas, p. 9. The* Department adjusted the industrial number by a factor of 1.5X for the purposes of this analysis.

Table 1: Approximate cost for conversion to natural gas, by customer type

Primary cost drivers are heating equipment, and service line/meter. Gas main extensions can add significant costs to off-main customers' expenses—these costs will vary widely.[179]

Customer Type	Equipment Replacement	Hookup	Main Extension
Residential	$7,500	$4,283	~$190 per ft.
Commercial	$20,300	$7,669	
Industrial	$40,600	$11,504	

Source: Connecticut Department of Economic and Community Development, Expanding Natural Gas; *Communication with local installers; and Navigant, "Technology Forecast Updates."*

Who pays for the costs of conversion? All new natural gas customers must pay for the cost of equipment replacement. Some pay for these costs out-of-pocket. Others may utilize a home equity loan or other financing mechanism to spread the equipment costs out over time. But the upfront cost has been an obstacle for many who might like to convert to natural gas. Developing new financing options to make natural gas conversion easier is therefore an important part of the Draft Strategy.

In practice, the majority of the "hookup" costs (service line and meter) are paid for by the gas company in most instances (Table 2). Under the current regulatory structure, the gas company may invest (and then recover from existing ratepayers) the costs of expanding the distribution system to add a new customer, so long as the expected increase in revenues from supplying natural gas to the new customer is sufficient to recover both the costs and the associated utility rate of return over a 15 or 20 year period ("payback period").[180] This regulatory mechanism, also called the "hurdle rate test," is intended to protect ratepayers against the risk that the gas companies will invest in new customer additions that are not cost-effective. For the average new "on-main" residential customer (ie., a customer located within 150' of a gas main), the hurdle rate test allows the gas companies to invest an amount sufficient to cover the "hookup" costs, provided there are no complex construction requirements involved.

[179] Main extension costs were estimated for reaching approximately 90,000 off-main customers. For these customers, based on the current distribution system average (number of customers per length of main), an estimated 900 miles of main extension would be required. Main extension cost was then accrued by demand—e.g. if a customer or sector will use x% of total segment B demand, the cost for main extension to that customer is assumed to be x% of the total main extension cost. By using this method the intention is to provide a societal cost/benefit perspective. An alternate method would likely require a detailed bottom-up analysis. In reality, costs are likely to weigh more heavily on "anchor tenants" and those customers who are willing to commit to gas service at the time of the main extension.

[180] Currently, the hurdle rate for Yankee Gas is based on a 15-year payback period. In April 2011, the hurdle rate for Connecticut Natural Gas and Southern Connecticut Gas was extended to a 20-year payback period, under a two-year pilot program.

Table 2: Approximate allowed gas company contribution to new customer addition, by customer type (Hurdle Rate)

Customer Type	Estimated Increase in Sales (MMBTU/Year)	15 Year Hurdle Rate (Yankee)	20 Year Hurdle Rate (SCG, CNG)
Residential	100	$5,264	$5,190
Commercial	126	$7,209	$12,615
Industrial	971	$20,604	$34,640

Source: Response to DEEP data request (August 27, 2012).

In the event that revenues associated with the new customer are insufficient to recover the hookup costs over the allowed payback period, the new customer must pay these costs up-front, through a charge called a "Contribution in Aid of Construction" (CIAC). For the majority of new customers located on-main, little to no CIAC will be required.[181] Conversely, "off-main" customers located 150 feet or more from a gas main will likely have to pay a significant CIAC in order to convert to natural gas. As will be discussed in more detail below, if a potential new off-main industrial customer uses a large amount of energy (e.g., a factory, a hospital, or a school), the savings from using natural gas instead of heating oil may balance out the CIAC charge for a major gas main extension. Alternatively, a potential new off-main residential customer who does not consume a lot of energy may be able to lower the CIAC charge if the customer lives in a dense neighborhood and can convince his or her neighbors to convert, thereby spreading the main extension cost over several new customers.

THE FUEL SWITCHING OPPORTUNITY, BY CUSTOMER SEGMENT

Whether it makes economic sense for a fuel oil customer to switch to natural gas depends on a variety of factors, including the amount of energy the customer uses for building heating, the proximity of the nearest gas main, and the cost of the furnace, boiler, or other equipment that must be replaced. To evaluate the opportunity for Connecticut homes and businesses to cost-effectively switch to natural gas, potential new customers have been divided into the following segments, based on the factors that affect the cost-effectiveness of their conversion potential.[182]

[181] Gas companies response to DEEP data request (July 16, 2012), p. 3.

[182] Average costs are used here for economic evaluation, but are not applicable to an individual potential gas customer's economic decision whether or not to convert to natural gas. Within each of these segments, there are sub-segments that are broadly defined by residential, commercial, and industrial customers whose economics also differ depending on conversion costs and energy use.

Segment A: On-Main And Low-Use Customer Prospects

Currently, there about 216,000 homes and businesses in Connecticut that are located on-main.[183] The gas companies estimated that, out of those 216,000 total potential customers, approximately 15% are currently heating their homes with electricity, which is difficult and expensive to convert to gas, and another 4% would be unwilling to convert for other reasons. Therefore, close to 20% of the total potential customers would not be likely prospects for gas conversion.[184] The gas companies estimate the number of potential on-main customers is closer to 177,000. No main extension would be needed to convert these customers to natural gas. As explained above, the "hookup" costs to install a service line and meter would be paid for by the gas company in most instances, and therefore the home or business owner would only have to pay for equipment replacement costs in order to switch to natural gas.

In addition to this potential "on-main" customer segment, there are another 63,000 residences in Connecticut that have natural gas service and use it for cooking, but not for space heating. The gas companies have indicated that more than one-third (24,000) of these so-called "low-use" customers live in apartments or other multi-family dwellings that are heated by a central furnace or boiler. Those customers are unlikely prospects for equipment conversion due to what's called the "split incentive": while the apartment-dweller pays the heating costs for their unit and may be eager to save money by switching to natural gas, the building owner would shoulder the costs of installing natural gas equipment and has no incentive to switch. The remaining 39,000 potential customers will have the same overall conversion costs as the "on main" customers (i.e., for equipment replacement), however the gas companies incur little to no distribution infrastructure costs when the customer converts.[185] For the purposes of this analysis, DEEP believes 39,000 is the appropriate number of potential customers in this segment.

As Table 3 indicates, converting all the likely on-main and low-use customer prospects would increase the share of Connecticut residences heating with natural gas from 31% to 52%, and would increase the share of commercial and industrial firms heating with gas up 75%, each. Extrapolating from the costs of expansion discussed above, DEEP estimates that the capital costs the gas companies would incur in adding distribution infrastructure (i.e., service line and meter) for Segment A customers would be approximately$815 million. In most instances, these costs would be covered by the hurdle rate calculation, and would therefore be recovered by the gas companies from existing ratepayers. In addition, new customers would invest approximately $1.84 billion to pay for the cost of equipment replacement. Adding these two components together, the total cost of converting all of the targeted Segment A customers, including the equipment replacement costs paid for by

[183] Gas companies' response to DEEP data request (August 17, 2012), p.1.

[184] *Ibid.*; DECD, "The Economic Impact of Expanding Natural Gas Use in Connecticut" (2011).

[185] Gas companies response to DEEP data request (August 17, 2012).

the new customer, is estimated to be about $2.6 billion.[186] Recommended financing incentive options to help pay for this investment are discussed later in this Chapter.

Table 3: Number of Customers, by Segment

Customer Type	Total Premises	Current Gas Customers	A		B	C
			Low Use	On Main	Off Main	Unlikely to Convert
Residential	1,400,000 (100%)	482,000 (34%)	39,000 (3%)	161,000 (12%)	51,500 (4%)	666,500 (48%)
Commercial	133,600 (100%)	47,000 (35%)		16,000 (12%)	37,300 (28%)	33,300 (25%)
Industrial	4,500 (100%)	2,350 (52%)		650 (14%)	400 (9%)	1,100 (25%)

Segment B: Off Main Customer Prospects

As discussed above, for premises located more than 150 feet from a gas main, conversions will require not only equipment replacement and hookup costs, but also some gas main extension. As described above, the cost of a gas main extension can add up quickly at about $1 million per mile on average. Under the existing regulatory structure, any costs not recoverable through future revenues over a 15- or 20-year period must be paid up front by the new customer.

Larger off main customer prospects, often referred to as "anchor customers," have more of an economic incentive to switch than smaller customers due to their higher usage. A factory, school, or hospital that consumes a large amount of energy for heating can achieve significant savings by switching from oil to natural gas, and in some cases the savings outweigh the CIAC cost for the main extension. Smaller off main customer prospects, such as a home or small business, may not consume enough energy themselves to have the savings benefit outweigh the CIAC cost if they were to switch to natural gas on their own. The conversion of a nearby anchor customer, however, might bring the gas main close enough to these smaller customers, and reduce or even eliminate their CIAC cost. Anchor loads would be more likely to convert to natural gas if they could share the cost of the main extension with their neighbors. Alternatively, a group of off main homes or businesses clustered together in a dense neighborhood may find that by converting to natural gas at the same time, their collective revenues are sufficient to recover the costs of the main extension over a 15- to 20-year period, and thus avoid or reduce the CIAC required.

As these examples show, there are a variety of factors that affect the economics of a gas main extension; consequently, it's hard to say with precision how many "off main" homes and businesses are likely candidates

[186] See, Appendix C (Natural Gas), Table TA-2.

for gas conversion. In 2011, Connecticut's three natural gas distribution companies commissioned the Connecticut Department of Economic and Community Development (DECD) to produce a study of "The Economic Impact of Expanding Natural Gas Use in Connecticut."[187] The DECD study analyzed the potential of increasing the share of Connecticut homes and businesses heating with natural gas up to 50% for residential customers, and 75% for commercial and industrial firms. To reach the 50% and 75% penetration level targets for residential and C&I customers, respectively, the DECD study estimated that in addition to converting all on-main and low-use customer prospects (Segment A), an additional 89,000 new off-main customers and almost 900 miles of gas main could be added in two five-year periods.[188] These 89,000 off-main potential customers identified in the DECD study were identified by the gas companies as having the best combination of factors—high energy consumption, proximity to an existing gas main and other potential customers—to support cost-effective conversion.

For the purposes of the Draft Strategy, these 89,000 potential off-main customers will be referred to as Segment B. DEEP estimates the gas companies would incur capital costs for adding distribution infrastructure for Segment B customers on the order of approximately$1.44 billion ($512 million for service and meters, and $926 million for gas main extensions). In addition, customers would incur approximately $1.16 billion for equipment replacement. The total cost of converting all of the Segment B customers, including the equipment replacement costs paid for by the new customer, is estimated to be about $2.6 billion.[189] . The actual number of customers that are viable off-main prospects will ultimately depend on a number of factors including gas prices, costs of main extensions, and the actual number of customers converting in a given locale. To add a customer in Segment B, the cost compared to Segment A customers, is estimated to increase, on average, by an additional ~$7,200 for residential buildings or by more than $13,000 for commercial buildings, and by more than $87,000 for industrial facilities.[190]

Segment C: Unlikely Prospects For Conversion

As Table 3 indicates, almost half of Connecticut's residences and a quarter of commercial and industrial premises are not good candidates for conversion to natural gas at this time given their distance from gas mains. This is a large group: about 666,500 residences, 33,300 commercial buildings, and 1,200 industrial facilities—amounting to about 54% of buildings in the state that are now heated by fuel oil, propane, or electricity.[191] Many of these prospects are located far enough from existing natural gas infrastructure that the costs of converting them to gas heat (i.e., equipment replacement, hookup, and substantial main extension)

[187] DEEP has utilized some of the data contained in the study, where applicable, to develop a comprehensive cost/benefit analysis of the natural gas opportunity that exists.

[188] Connecticut Department of Economic and Community Development, *Expanding Natural Gas*, p.14.

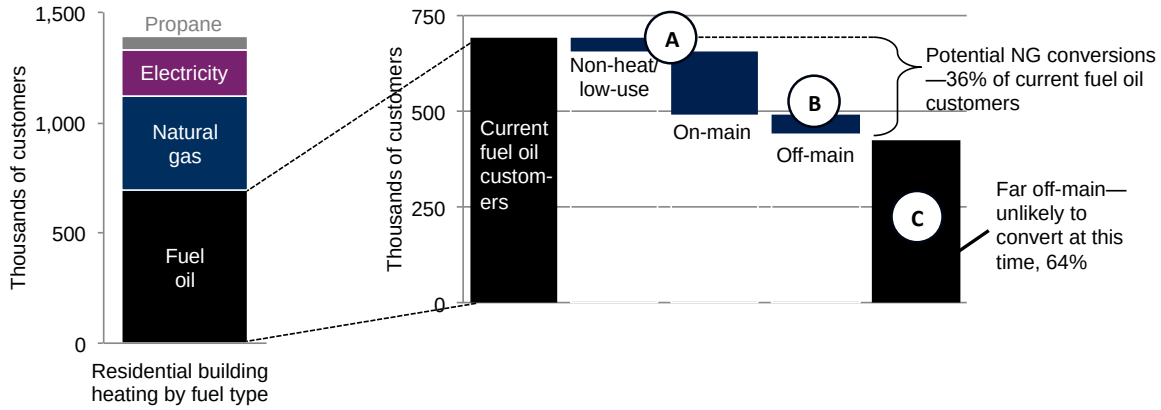
[189] See Appendix C (Natural Gas), Table TA- 2

[190] Main extension costs were estimated for reaching 90,000 off-main customers.

[191] Connecticut Department of Economic and Community Development, *Expanding Natural Gas.*

are prohibitive relative to their energy demands if they must bear the cost of infrastructure investment alone. These customers are grouped in Segment C, and are considered unlikely prospects for conversion at this time. It is important to recognize however, that some of these buildings may become conversion prospects in the future, as gas mains are extended to connect Segment B customers. Gas main extensions to reach Segment B may thereby reduce the distance needed to connect nearby premises in Segment C. An example of the three segments (A, B, C), and their potentials for fuel switching, is shown in Figure 6 for the residential sector.

Figure 6: Conversion potential by customer segment, for the residential sector



Source: Connecticut Department of Economic and Community Development, Expanding Natural Gas.

THE COSTS AND BENEFITS OF CONVERSION, BY CUSTOMER SEGMENT

After grouping potential customers according to the segments described above, DEEP estimated the costs and benefits, in terms of net present value (NPV), of converting each segment to natural gas. NPV is a value used to assess and compare investment opportunities—it is the (present value) monetary gain or loss due to an investment decision. NPV is calculated by summing the net costs, including the new customer and gas company investment, and the expected benefits for a given opportunity.192 To calculate the NPV of natural gas conversion for the Draft Strategy, DEEP estimated the conversion costs for each segment and the savings over 20 years, with a discount rate of 5% applied to the savings estimate, to bring them to present value.193 DEEP calculated the savings based on projected fuel prices in the reference case for the New England region presented the 2012 Annual Energy Outlook (AEO) produced by the U.S. Energy Information Administration (EIA). The 2012 AEO reference case projects that natural gas prices will rise by 2.1% per year from 2010 through 2035, to an annual average of $7.37 per million BTU (2010 dollars) by 2035, and that oil prices will

[192] To calculate NPV, all cash flows, whether cost or benefit, are discounted to their present value in order to account for the time value of money—i.e. a sum of money received today is worth more than the same sum received in the future, because of inflation and because of forgone investment returns or interest that could have been received in the interim period.

[193] See Appendix A (Efficiency & Industry) for an explanation of why the 5% discount rate was used.

remain at least three times higher than natural gas prices through that period.194 While there is certainly a risk of gas price fluctuations and a narrowing of oil-gas price gap, the expectation of $4-6 per million BTU is widely accepted out to about 2020. A detailed description of the data and assumptions used in DEEP's NPV calculation is provided in the Appendix C (Natural Gas).

The Department's calculations show that, applying the 2012 AEO reference case for fuel price, and assuming that each building continues to consume the same amount of energy over time —converting all Segment A and B homes, businesses, and factories not currently served by natural gas to gas heating would yield a huge net economic benefit: $2.8 billion in net present value over 20 years (Table 4). Converting Segment A customers would create the great majority of the value (90% or $2.6 billion), while Segment B conversion accounts for 10% or $0.2 billion in NPV.195 This calculation understates the NPV of conversion, however, to the extent that it does not fully incorporate the economic development gains that could arise if more homes and businesses are able to access to inexpensive natural gas.196

[194] U.S. EIA, *Annual Energy Outlook 2012* at 91, available at http://www.eia.gov/forecasts/aeo/pdf/0383(2012).pdf. Note that the natural gas price does not include the cost of delivery (transmission) into the state. Other energy analysts such as CERA and Platts support broad-based validity of these price projections,

[195] This natural gas NPV is based upon all conversion investments made in year one. The benefits are calculated for twenty years and discounted back to present value. This approach is used to size the overall natural gas opportunity for each sector and segment. In reality, the investment will be phased over a discrete time period, an approach modeled in Chapters 1 and 2, Efficiency and Industry.

[196] While these analyses illustrate the total potential for average natural gas conversions across Connecticut, whether or not converting to natural gas makes good financial sense for a particular building depends on its actual conversion costs and energy use. For example, a Segment B building (more than 150 feet from the main) could use a large enough amount of energy so that its payback period is short and NPV large. In contrast, a Segment A building nearer the main might have a longer payback period and lower NPV due to low gas use. There is variability to every individual situation; the larger-picture projections in this Chapter, however, provide a solid foundation for individual analysis.

Table 4: Economic benefits from conversion, by customer segment and sector

Segment	Customer Type	Prospective Customers (Estimated)	20-year present value of fuel savings for a single conversion	Average NPV for a single conversion	20-year net present value for entire segment ($million)	Total Savings($million)
A	Residential, Low Use	39,000	$22,324	$14,824	$592	$2,600
	Residential, On Main	161,000	$22,324	$10,541	$1,696	
	Commercial	16,000	$40,020	$12,051	$188	
	Industrial	600	$304,727	$252,624	$144	
B	Residential	52,000	$22,324	$3,333	$172	$2,800
	Commercial	37,000	$40,020	$(919)	$(34)	
	Industrial	400	$304,727	$165,248	$71	

While this NPV analysis shows the clear economic benefits of converting to natural gas for building heating, it is important to understand the risks involved in a large-scale conversion strategy. As noted above, future prices can never be forecast with absolutely certainty. Natural gas prices could rise unexpectedly. Demand for natural gas could rise as more electric generation switches from coal or oil to natural gas. An expansion in natural gas exports could redirect United States gas supplies to markets in Asia and Europe where gas prices are much higher, driving up the price of natural gas here in the United States. Additionally, reserves could prove more difficult to access than currently thought. Fuel consumption could drop because of the investment of energy efficiency measures called for elsewhere in the Draft Strategy, reducing the potential savings from natural gas conversion. Potential negative environmental impacts from "fracking"—such as groundwater contamination, methane leakage, or other damage to the environment or public health—could require regulatory changes in the areas where natural gas is produced. This could slow the pace of drilling or drive up the costs in order to address these issues.

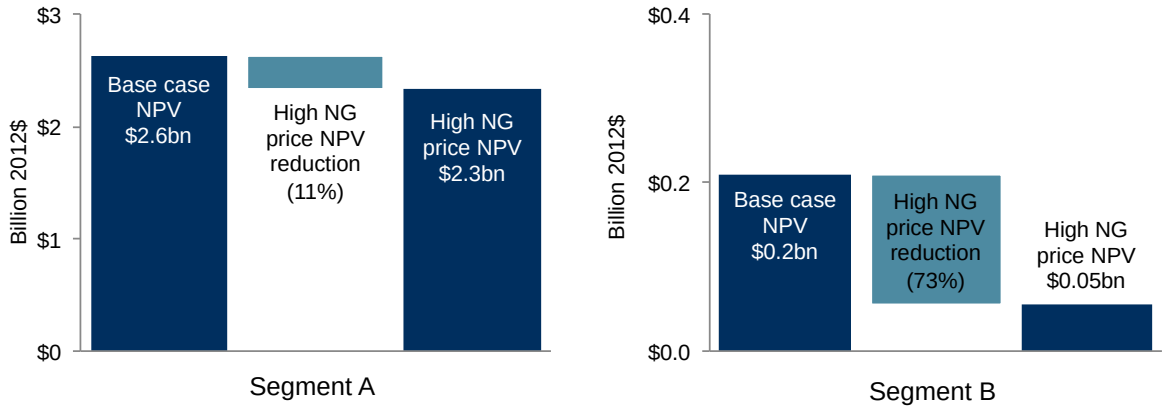
DEEP takes the environmental concerns related to fracking very seriously. Recent surveys indicate that Connecticut's own potential undiscovered natural gas resources are so minimal that they are highly unlikely to be developed.[197] Proper fracking regulations are needed in the states that do have recoverable natural gas reserves. Safety and environmental regulation of fracking has been better in some states than others. DEEP will work with other states and the federal government to ensure that natural gas imported into Connecticut has been developed according to the highest environmental standards, and establish a "no leakage" target for

[197] A recent USGS survey estimated undiscovered reserves of 3.5 billion cubic feet of natural gas in five assessment units in Connecticut's Hartford Basin. These reserves are tiny in comparison to the Marcellus shale, which is estimated to contain 84 trillion cubic feet of gas.

the pipelines bringing gas to Connecticut. For its part, Connecticut is aggressively working to upgrade cast-iron local distribution infrastructure.

To assess the impact of these uncertainties on the analysis, DEEP compared the NPV of natural gas conversion under several different scenarios, applying (alone, and in combination) 2011 AEO fuel price projections that assume lower or higher recovery of natural gas reserves, and lower or higher oil prices. DEEP's calculations, which are explained in detail in Appendix C (Natural Gas), showed that if (retail) home heating oil prices turn out to be lower (approximately $17.50 per MMBtu, or $2.40/gallon)[198] than projected in the 2012 AEO reference case (approximately $28.50 per MMBtu, or $3.90/gallon), neither Segment A nor Segment B conversions would be cost-effective. In all of the other scenarios we tested, DEEP found that converting all "on main" homes and businesses (Segment A) from fuel oil to gas will still create positive NPV within EIA's forecast range for natural gas prices (Figure 7). In fact, natural gas prices would have to rise ten times higher than EIA's current "high" natural gas price projections to negate the benefits of conversion for average Segment A customers. For Segment B, the Department's calculations showed that residential and industrial conversions would still create value and reduce bills even under the EIA high natural gas price scenario. But if prices were to rise two-fold above the "high" EIA gas price, that would negate the benefits of conversion.

Figure 7: Sensitivity of net present value to natural gas prices (based on EIA high natural gas price scenario)



Source: Analysis using data from U.S. EIA, Annual Energy Outlook *2011; and U.S. EIA,* Annual Energy Outlook 2012.

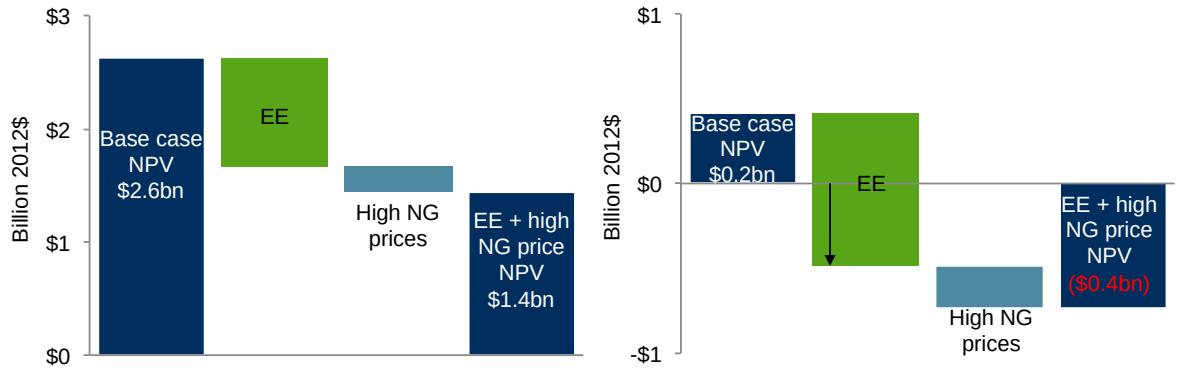
The deployment of energy efficiency measures will also influence the cost-effectiveness of natural gas conversion. As detailed elsewhere in the Draft Strategy, Connecticut has a significant opportunity to reduce energy costs by improving the efficiency of its buildings. See, Chapter 1 (Efficiency). Efficiency measures reduce the amount of energy needed to heat a home or business which will also reduce the savings that would be recouped from switching from fuel oil to cheaper natural gas. To model the impact of a sustained

[198] Based on the low oil price scenario as forecasted in the U.S. EIA, *Annual Energy Outlook 2011, averaged for the period 2013-2033.*

investment in all cost-effective efficiency measures across the state, DEEP assumed a 20% reduction in energy consumption in the residential sector, and a 15% reduction in the commercial and industrial sectors. Even if these efficiency goals are achieved, switching potential "on main" customers to natural gas (Segment A) still yields enormous value: about $1.7 billion in aggregate NPV.

For Segment B buildings, achieving planned energy efficiency savings could potentially create a net negative NPV for commercial and residential buildings, though the industrial segment would remain slightly positive. If planned efficiency gains were to coincide with a rise in the price of natural gas, Segment A would still remain a solid positive investment, but Segment B would not. (Figure 8) Additional sensitivity scenarios can be found in Table 6 in Appendix C (Natural Gas). These are average results that can be used for strategic guidance and for managing risks, but the outcomes of actual conversions will vary in each segment.

Figure 8: Sensitivity of net present value to combined energy efficiency and high NG prices



Source: RMI analysis, discussed in Appendix C (Natural Gas)

After weighing all of these risks and uncertainties, the Department's analysis concludes that a large benefit will accrue to the State if it can effectively convert buildings whose economics are positive (i.e., the net benefits exceed the costs of investment). That said, there are several factors that must be addressed to minimize the barriers that exist today in order to effectively capture of the opportunity: conversion costs, conversion rates, and what to do about the approximately 50% of homes whose locations and energy use make conversion cost prohibitive.

ADDITIONAL COSTS AND BENEFITS TO SOCIETY

While the discussion so far has focused on the direct costs and benefits of switching to natural gas from the perspective of potential new customers, it is important to also consider the other costs and benefits of fuel switching to society as a whole. Customer fuel savings can generate societal benefit, for example. Neither natural gas nor fuel oil are produced in Connecticut. Most of the money Connecticut consumers spend on either fuel flows into the pockets of out-of-state energy producers. Every dollar that Connecticut customers save by switching to natural gas, therefore, is a dollar that can be redirected into the state's economy.

The Department of Economic and Community Development study identified significant economic benefits that could result from a natural gas distribution buildout in terms of jobs created, increased tax revenue, and increased net GDP. Assuming that a distribution buildout occurs over ten years, the DECD study estimated the addition of 54,000 job-years of net total employment, with 8,000 jobs added per year in the first five years and 3,100 added per year in years 6-10. The DECD further estimated that a ten-year buildout would increase net GDP by $4.1 billion over the expansion period ($2.8 billion in the first five years and $1.3 billion in the later years) and would generate $0.4 billion in increased state tax revenue (86% realized in the first five years). Assuming the expansion is completed in 2021, the DECD projected a set level of savings that would accrue to customers and business owners, equivalent to $250 million/year injected into Connecticut's economy (once program is completed) by saving residential customers up to $1,200 per year on their heating bills; and a $215 million annual reduction in energy costs for commercial and industrial customers over the same time period.[199]

Natural gas fuel switching can also improve regional competitiveness by attracting or retaining businesses by offering lower fuel costs. The extension of a gas main to connect a manufacturing plant to natural gas can help a company lower its energy costs, which can benefit society by creating or retaining jobs in-state, and boosting the Connecticut's economic competitiveness within the region.

The conversion of on-main and off-main customers to natural gas would also generate environmental benefits for all Connecticut residents. The combustion of fossil fuels emits several types of pollutants, including carbon dioxide(CO_2), nitrogen oxides(NOx), sulfur oxides (SOx), and particulate matter (solid or liquid particles in soot or smoke that are discharged into the air).[200] NOx, SOx, and particulate matter are regulated by the federal government because they cause respiratory illnesses, harm the environment, and damage property. CO_2 and NOx are greenhouse gases, meaning that they trap heat in the atmosphere and thereby contribute to climate change.

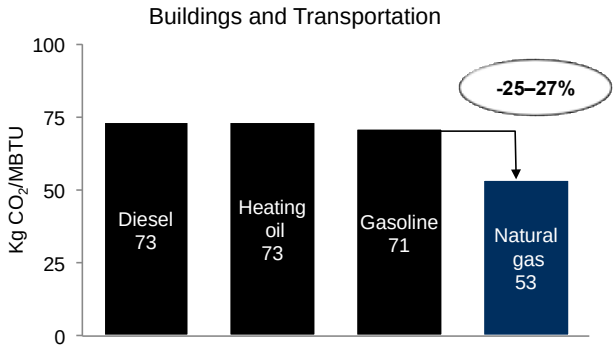
Natural gas produces less air pollution when burned than other fossil fuels. Connecticut is already seeing the air pollution benefits of fuel switching in the electricity sector. Burning natural gas instead of fuel oil for heating, or in place of gasoline or diesel fuel for transportation, can reduce emissions of NOx by 20-50% and SOx by up to 99%,[201] and can reduce CO_2emissions by up to 25-27% (Figure 9).[202] Emissions of particulate matter are typically reduced as well, but the amount of reduction depends on the specific application.

[199] The Department notes that these figures are based on an assumed annual savings of $1,264, $2,825 and $44,497 for residential, commercial and industrial customers, respectively, reflecting market conditions at the time the DECD study was conducted, as well as a 10 year timeframe for completion of a natural gas expansion. Under current market conditions, actual savings are now larger.

[200] http://www.epa.gov/oms/invntory/overview/pollutants/pm.htm

[201] NESCAUM analysis based on: U.S. Environmental Protection Agency (EPA), "MOVES"; Connecticut DEEP, "Emissions Inventory"; U.S. EPA , "Clean Air Markets"; and U.S. EPA, "Emissions Factors." SOx emissions are reduced by 40-60% compared to gasoline and low sulfur diesel or fuel oil, whereas they can be reduced up to 99% compared to commonly available (2000ppm sulfur) fuel oil.

Figure 9: Carbon dioxide emissions from fossil fuel combustion, by fuel type



Source: U.S. EPA

These reductions in air pollution, however, only take into account the burning natural gas instead of other fossil fuels at the point of use; they do not consider the potential environmental impacts occurring "upstream," where the natural gas is produced, or the potential for methane leakage from natural gas pipelines as the gas is transmitted to Connecticut. Although these upstream issues need to be considered for any fuel source, they have garnered special attention with regards to natural gas. Some studies point to minor and/or manageable impacts, while others suggest these upstream impacts could potentially offset any end-use greenhouse gas emissions reduction. As the impacts of drilling/transport emissions of natural gas relative to fuel oil are unclear at this time, DEEP did not adjust the figures used in the Draft Strategy for air pollution reductions.

Assuming that these upstream impacts from natural gas production/transportation are not dramatically different than oil, the conversion of all potential Segment A and Segment B customers could reduce the state's greenhouse gas emissions by about 8% relative to today's building heating related emissions. An eight percent reduction would contribute measurably towards the 80 percent greenhouse gas reduction requirement from 2001 levels by 2050, as required in the State's Global Warming Solutions Act (GWSA) of 2008. More dramatic steps will be needed in the future in order to meet the state's greenhouse gas emissions reduction targets. DEEP expects that natural gas will continue to have a major role in energy planning as the country continues to move toward a clean, renewable energy future, as natural gas generation is effective in balancing the intermittency of solar and wind generation.

Large scale expansion of natural gas as a heating fuel would cause some economic dislocation. Because fuel oil use will drop, some of the state's fuel oil companies will lose delivery revenues, particularly in certain service areas. The same will be true for those distributing and servicing fuel oil based equipment. At the same time, natural gas conversion will create jobs—primarily for the installation of natural gas infrastructure and heating equipment. As noted above, the 2011 DECD study estimates that converting Segment A and Segment B

[202] For more information, see International Energy Agency, *Golden Rules*; Kirchgessner, "Estimate of Methane Emissions"; and Barcella, *Mismeasuring Methane.*

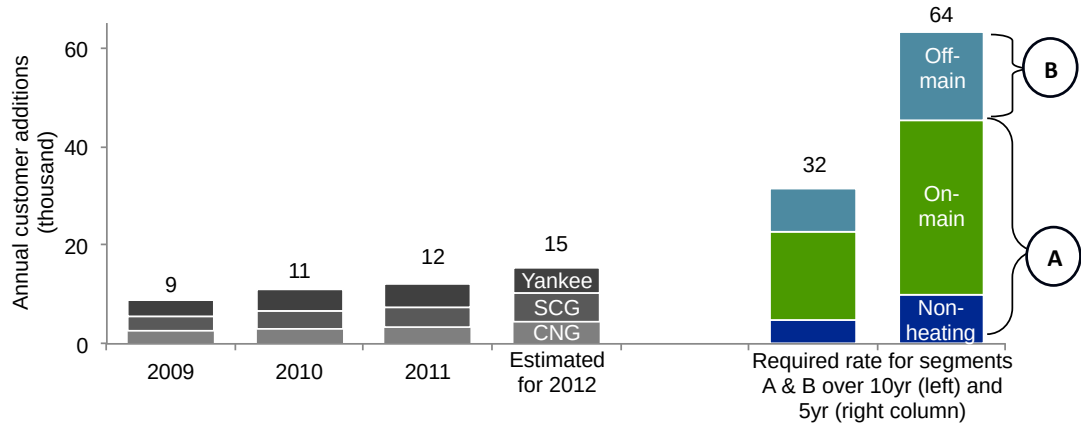
customers would create 54,000 man-years of work, meaning that 5,400 people could be employed for 10 years (assuming a 10 year expansion time frame).[203] As will be discussed in the recommendations section, below, participation in a natural gas expansion program can present new opportunities for fuel oil dealers that would lessen the impact of associated oil business revenue loss.

PLANNING FOR EXPANSION

In light of the potential fuel cost savings described above, it is no surprise that increasing numbers of Connecticut homes and businesses are already taking steps to switch from fuel oil heating to natural gas (Figure 10). Over the past three years, the number of new natural gas customers has increased steadily, from 9,000 customers added in 2009 to an estimated 15,000 expected to convert in 2012. At this rate, it would take 14 years for all Segment A customers to convert to natural gas, and 20 years to convert both Segment A and Segment B customers.

Figure 10: Comparison to recent natural gas customer addition rate

Conversion to natural gas has increased in recent years driven by lower prices and gas companies' marketing efforts.



Source: Data provided by Connecticut Natural Gas and Southern Connecticut Gas. A 2012 estimate from Yankee Gas was not available; therefore the number was estimated by applying the growth rate from the other gas companies to Yankee's (larger) market share.

Table 5 shows the payback from the customer's perspective under the current regulatory structure and assuming no incentives to convert to gas. Switching to gas today can generate annual fuel savings that cover the cost of conversion in less than two years for industrial customers in Segment A, and little more than four years for residential customers in Segment A and industrial customers in Segment B. But even in highly economic circumstances, some customers may be deterred from converting because of upfront cost they must pay.

[203] Estimated job creation is for both segment A and B and was taken from Connecticut Department of Economic and Community Development, *Expanding Natural Gas*

Table 5: Summary of paybacks

Segment	Customer Type	Prospective Customers (Estimated)	Estimated Customer Conversion Cost	Estimated CIAC Cost	Estimated Annual Fuel Savings	Simple Payback (years)
A	Residential, Low Use	39,000	$7,500		$1,800	4.2
	Residential, On Main	160,800	$7,500		$1,800	4.2
	Commercial	15,500	$20,300		$3,100	6.5
	Industrial	570	$40,600		$24,000	1.7
B	Residential	51,500	$7,500	$6,300	$1,800	7.7
	Commercial	37,000	$20,300	$12,100	$3,100	10.5
	Industrial	430	$40,600	$67,900	$24,000	4.5

The situation is compounded by the fact that customers' existing equipment is usually working and they therefore would be retiring it before the end of its serviceable life. Most furnaces fail during the winter months at which point the customer's sole priority is rapid replacement to restore heat to their home or business. Fuel switching will not be a viable option, since service lines and gas mains cannot be installed overnight. HVAC contractors can also be extremely busy during the winter months, exacerbating delays.

The current process for developing new gas mains is both time- and cost-intensive. For example, where an "off-main" customer expresses interest in conversion but cannot afford to pay the entire CIAC charge needed to build out the main, gas company sales representatives may recruit nearby homeowners or businesses to convert and spread the CIAC charge. As potential customers opt in or opt out of the conversion process, the economics of the main extension, and in some cases, the associated CIAC, will change. This may cause more customers to opt in or out due to the required CIAC. Acquiring new customers requires assembling and obtaining commitments from this "portfolio" of potential customers, which is an iterative and time-consuming and in many instances, unsuccessful process. Siting the new main can also be time- and resource-intensive. Depending on where the new gas main will be located, permits or approvals may be required by DEEP and the Connecticut Siting Council to address soil remediation, wetlands, and water quality impacts. Municipal governments may also require permits for paving or excavation.

Given the challenges discussed above, it is important to consider the benefits of a more coordinated fuel switching program, organized through a planning process overseen by the state. Such a coordinated planning process has the potential to not just speed up the rate of customer conversions, but to ensure that customers have a real choice. A more structured process will also reduce the costs of conversion, and ensure the reliability of gas supply. A planning process would raise customer awareness about the economic opportunity from fuel switching, accelerating the pace at which the State and its citizens will get the benefits of conversion.

For example, a planning process could reduce the conversion costs for Segment B by coordinating main expansion with other infrastructure improvement projects such as sewers, storm water control, and road resurfacing. Anecdotal evidence suggests that such coordination could reduce main expansion costs from ~10-40% under some conditions, such as by eliminating the cost of excavating and repaving streets for individual distribution projects.

ENSURING A RELIABLE NATURAL GAS SUPPLY

Reliability of natural gas supply is also an important consideration in an expansion planning process, as increased demand will naturally increase the need for regional natural gas supply capacity. The interstate pipeline system that supplies Connecticut's natural gas is already constrained, and there is limited liquid natural gas (LNG) capacity in Connecticut. At current use rates, there will not be enough interstate pipeline, storage, or peaking capacity to serve a large-scale addition of new customers. Natural gas pipeline supply projects typically take 3-4 years to develop, meaning that capacity must be purchased based on projections of customer demand several years later. In implementing a large-scale natural gas expansion program, the Connecticut's gas companies will need to acquire new capacity at larger increments than in the past. Underestimating and purchasing too little capacity can lead to reliability issues (i.e., a shortfall in supply during peak winter season), or might require the gas companies to turn away new customers who want to convert.

DEEP will work with gas pipeline developers and the LDCs to ensure that the transmission capacity for gas coming into Connecticut rises with the growth in demand. Discussions among the gas companies, DEEP, existing and potential future pipeline developers are already underway. Historically, new capacity additions have been priced on an incremental basis and have come to the market more expensive than existing capacity. However, DEEP believes the gas marketplace is evolving rapidly and that cost of new pipelines and gas capacity can be reduced by proper planning and achieving greater economies of scale which spreads the fixed cost of an expansion project over a larger number of units. DEEP will continue to work closely with the gas companies, potential pipeline developers, and other parties with an interest in creating/obtaining greater access for New England demand centers to Marcellus shale to obtain the best possible price for capacity into Connecticut.

NATURAL GAS SECTOR STRATEGY: RECOMMENDATIONS

Based on the foregoing assessment of current and future supplies, customer demand, and costs of fuel oil and natural gas, the Draft Strategy proposes the establishment of a planned natural gas expansion process, to more effectively help cost-effective, NPV positive potential customers switch to natural gas over a seven year time period. The goal of this program would be to provide customers in Segments A and B (who can cost-effectively switch to natural gas) the choice of making the switch more quickly and efficiently, to cut their heating bills by half or even 75%. As explained above, the conversion of those customer segments can produce

broader benefits for all Connecticut citizens, by reducing air pollution and boosting the state's business competitiveness.

Capturing these benefits will require significant investment from Connecticut gas companies, new and existing gas customers, and private capital. Where this conversion opportunity promises to produce broader societal benefits, an investment of tax revenues may also be appropriate. To facilitate this conversion program, the Draft Strategy proposes a set of regulatory changes and economic incentives that, if implemented as part of a planned expansion process, can reduce the costs of fuel switching, ensure a more reliable gas supply, and help more Connecticut homeowners and businesses take advantage of fuel savings. For customers beyond the economically feasible reach of expansion, the Draft Strategy supports a robust, fully-integrated energy efficiency program while exploring a range of heating options, including improved furnaces and new technologies such as solar thermal water heating, ground source heat pumps and other technologies.

The components of the Draft Strategy's long-range energy planning objectives can be summarized follows:

- Establish a planning process for natural gas expansion
- Raise customer awareness of the fuel-switching opportunity
- Make efficiency investments and fuel switching affordable through financing and incentives—ensure the public has real energy choices.
- Enact regulatory changes to broaden the reach of financing that the utilities can provide
- Establish an Economic Development Fund to support fuel-switching for off-main commercial and industrial customers in support of the state's economic growth agenda
- Reduce the costs of off-main expansion, by streamlining permitting and siting processes as well as coordinating main extensions with the build out of other underground infrastructure (e.g., water lines, fiber optic cable, and electric lines.
- Offer training and assistance to employees and businesses adversely impacted by gas expansion.
- Create a range of fuel-saving options for customers unlikely to convert to gas or choosing not to do so

Each of these recommendations is described in more detail below. It is important to emphasize that these recommendations are part of a proposed process for coordinated natural gas expansion, which DEEP is putting forward for public review and comment as part of the Draft Strategy. Some of these recommendations would require legislative approval; other recommendations would require action by PURA. DEEP looks forward to receiving feedback during the public comment period on the Draft Strategy, including pointing out any technical errors, and suggestions of alternative recommendations DEEP should consider.

1. Establish a Planning Process for Natural Gas Expansion

As described above, there are many benefits to establishing a coordinated planning process for natural gas expansion. These benefits include increasing the rate of customer conversions, lowering the costs of conversion, and ensuring the reliability of gas supply. The Draft Strategy proposes that the gas companies jointly file a plan to expand its natural gas conversion activities to target cost-effective potential on- and off-main customers over the next seven years. The Plan should be developed in consultation with DEEP, and submitted to PURA for approval. A detailed Plan should include, but not be limited to, the following components:

- **Establish a customer conversion plan and schedule.** The plan should identify the number of new on- and off-main customers in each sector (residential, commercial, industrial, etc.) that the gas companies will target for conversion in during the planning period, including a map showing geographical locations and densities. The plan should show how the gas companies have maximized alignment of expansion territory with DOT and municipal road construction projects other planned infrastructure build-out. The plan should also identify:
    - Potential "anchor load" customers that the gas companies intend to target (providing their distance from the nearest main and potential load), and the economic development potential from converting those anchor loads.
    - Potential high-uptake areas based on housing vintage, new development, past customer interest, etc.
- **Feasibility analysis.** The Plan should demonstrate the feasibility of reaching the conversion goals for on- and off-main customers, including:
    - Expected capital budget for both on- and off-main conversion projects
    - Proposed incentives, including an analysis of all available options and discussion of why selected options were chosen
    - Identification of expected costs of distribution service installations and customer equipment for each sector and segment of customers (on and off-main, etc.) based on selected options/incentives
    - Plan to secure the infrastructure and overhead (e.g., personnel, construction materials, partnership with HVAC contractors) and capacity needed to reach the conversion goals, and associated costs
    - A cost/benefit analysis projecting impacts on rates and revenues over a twenty year time frame
    - A discussion on changing market conditions (e.g. gas-to-oil spread), if applicable, and the corresponding effect, if any, on the goals of this Chapter of the Draft Strategy.
- **Outreach and marketing analysis.** The Plan should include a well-structured marketing analysis for each sector. What segments have the largest awareness gaps? What greater awareness can be achieved and what are the most significant barriers to conversion for each customer segment and

sector? How can conversions be achieved most effectively? How will the gas companies market the conversion opportunity to each segment and sector, and what will be the associated costs?

- **Cost reduction strategy.** The Plan should identify the steps the gas companies will take or have taken to reduce the costs of conversion, such as neighborhood outreach efforts, organizing dedicated crews for main extension, streamlining permitting and siting compliance, etc.
- **Capacity Procurement.** To ensure reliability, the Plan should identify the capacity needed to serve the new customers included in the conversion goal; demonstrate how the gas companies will acquire the capacity to serve the new customer load; and identify projected costs of new capacity additions. Since the timing of the issuance of this plan is coincident with announced participation there is currently a project in an "open season" and other potential projects in the pipeline, the gas companies will need to work quickly in identifying their capacity needs relative to the Draft Strategy recommendations.
- **Financing mechanisms.** The Plan should include a detailed strategy for leveraging third-party investment to finance equipment conversion and main extensions for the new customers added, including the sources of capital, expected cost of capital, administrative costs, etc., and indicating any regulatory changes necessary to implement the proposed financing mechanism(s).
- **Regulatory proposals.** The Plan may include suggested regulatory changes (e.g. hurdle rate model, new customer rate riders, PGA credit sharing), describing how any proposed change is necessary to reach the conversion goals, and including a rate-impact analysis of each proposed change.

2. Raise Customer Awareness Through Marketing

It is important to make customers who can cost-effectively switch to natural gas aware of both the opportunity and the options for financing and reducing the costs of converting to natural gas. Greater customer awareness will help customers plan for conversion, rather than waiting until a furnace failure when conversion is unlikely to be feasible. It will also help to aggregate demand among "off-main" customers, to maximize opportunities to spread or eliminate CIAC charges. And it will help drive conversions among those who don't have sufficient capital by helping them understand financing opportunities.

Outreach should be targeted towards those customers with the greatest economic benefit and who are most likely to convert. There are several ways to raise customer awareness. The gas companies should enhance their websites to provide more information to help customers switch to gas. The companies currently spend shareholder funds to promote gas use and should continue to do so in the future. A robust marketing effort could cost $1.5 to $2.0 million annually for the combined effort of the three gas distribution companies.

3. Financing mechanisms to make fuel switching affordable and reduce upfront costs

Converting from fuel oil to natural gas requires a large upfront investment. (The cost averages $7,500 for Segment A and is higher for Segment B and for commercial and industrial potential customers). As discussed above, switching to gas can generate annual fuel savings that cover the cost of conversion in less than two years for industrial customers in Segment A, and little more than four years for residential customers in Segment A and industrial customers in Segment B. But many potential customers either can't afford to pay these costs upfront, or are reluctant to spend money to replace equipment that still works.

New customers in Segment A must pay for the costs of replacing their heating equipment. Financing equipment replacement at commercial interest rates in the range of 6-8% would allow these customers to cover these costs with no money paid up-front, while bringing them immediate and attractive reductions in their fuel bills. As an example, financing the conversion at 8% would mean that the average new residential customer in Segment A will see an approximate annual net savings of $682 compared to their current fuel oil bill (Table 6).

Table 6: Equipment replacement financing options

Sector	Customer Cost to Convert	Annual Fuel Savings	Annual Benefit to Customer (Fuel Savings minus Payment)					
			0%	2%	4%	6%	8%	10%
Residential**	$7,500	$1,800	$1,050	$965	$875	$781	$682	$579
Commercial	$20,300	$3,100	$1,070	$840	$597	$342	$75	($204)
Industrial	$40,600	$24,000	$19,940	$19,480	$18,994	$18,484	$17,949	$17,393

*Source: RMI analysis; Annual fuel savings based on projected fuel price for first 10 years after conversion. **Residential sector includes both "low use" and "on main" customers in Segment A.*

Many customers currently finance their conversion through home equity loans or high efficiency energy programs. But there are ways to expand and streamline access to financing. This Draft Strategy recommends setting up new financing options, increasing the identification of sources of capital, making required regulatory changes and managing any risks associated with new financing options. Specifically, this Draft Strategy proposes two financing mechanisms, discussed in detail in Chapter 1 (Efficiency), which should be utilized for natural gas conversions. Those mechanisms include a "low or no" interest rate loan program for high efficiency heating and domestic hot water systems modeled by the Mass Save program. The second mechanism is "on-bill" financing directly through the customers utility bill[204]. The gas companies do not have currently have an on-bill financing mechanism in place and regulatory approval may be required in order for implementation.

On-bill financing looks like a promising option. With this mechanism, the gas companies (or another financial entity) can arrange for financing while collecting loan payments with the customer's regular monthly bill. The customers see the net savings on their bills. And because the payment is tied to gas service, this mechanism lowers the risk of non-payment and increases the ease of collection for those providing capital. The financing program can be capitalized using utility capital, financial institutions, state bonds or self-funding and can be administered through collaboration between the gas companies and an entity such as Connecticut Housing Investment Fund or the Clean Energy Finance and Investment Authority (CEFIA). It is important to minimize

[204] The structure of these financing mechanisms is discussed in more detail in the Chapter 1 (Efficiency).

the total cost of financing. By doing so lower rates can be offered to participants improving the economics of projects while reducing or eliminating any subsidies by other ratepayers.

For Segment B customers, the additional cost for main extension makes conversion more expensive, on average. As with Segment A, developing financing options to overcome initial investment costs and ensuring sufficient awareness of the opportunity will be critical to achieving high conversion rates. But the higher conversion costs in Segment B compared to Segment A means that, on average, financing at commercial rates will be uneconomic for residential and commercial customers. For example, an average residential customer financing a conversion at 8% would actually see an increase in annual costs related to heating of $257 (Table 7).

Table 7: Segment B financing options

Sector	Customer Cost to Convert	Annual Fuel Savings	Annual Benefit to Customer (Fuel Savings minus Payment)					
			0%	2%	4%	6%	8%	10%
Residential	$13,800	$1,800	$420	$264	$99	($75)	($257)	($446)
Commercial	$32,400	$3,100	($140)	($507)	($895)	($1,302)	($1,729)	($2,173)
Industrial	$108,500	$24,000	$13,150	$11,921	$10,623	$9,258	$7,830	$6,342

*Source: RMI analysis. * Annual fuel savings based on projected fuel price for first 10 years after conversion.*

Reducing the interest rate would improve the economics for potential customers in both Segment A and Segment B. Incentives may be needed to make the fuel-switching opportunity both affordable and attractive and drive the conversion of Segment A and Segment B customers over the next seven years. For example, a program to reduce the interest rate by 3% on 10-year loans for equipment replacement for 100,000 residential customers would cost approximately $112 million, assuming an average loan size of $7,500. A 3% interest rate reduction on 10-year loans for equipment replacement for 25,000 commercial customers could cost approximately $75 million, based on an average loan size of $20,000. Additional incentives will be necessary to address the higher costs for Segment B customers.

Some conversions will be much more financially attractive than others. Each main expansion can open up new opportunities and improve the economics for those who happen to be along its expansion route. Because there is a wide difference in building conversion economics, it is essential to understand them in detail both by sub-segment and geographic location and how those economics might change as the conversion proceeds.

DIRECT INCENTIVES

The single greatest impediment to customer conversions (where there is already local distribution infrastructure) is the ability to pay the upfront cost of replacing the existing heating systems, especially when

the system is still in working order. While a typical residential customer could save up to $1,800/year, the initial estimated cost of $7,500 is a barrier for many homeowners. Similar barriers exist for businesses. In order to lower initial customer conversions costs, the Draft Strategy proposes the following ways to target direct incentives to reduce the cost of off main customers and encourage highly efficient furnaces. These direct incentives could be funded from a variety of sources, including tax credits, or reprogramming existing incentives.

4. Incentives To Drive Aggregation Of New Off-Main Customers

As discussed above, aggregating potential off-main customers is an effective way to drive down costs of main expansion. DEEP proposes that the State offer anincentive to potential "off main" customers who sign a contract with their gas company to convert to natural gas before a certain date (for example, December 31, 2013). If a majority (say, 80%) of a neighborhood signs up, a slightly higher incentive could beoffered each home, to further reward coordinated action. This incentive would be offered only to Segment B customers—those who are "off main" but near gas mains—so as to spread the CIAC costs as broadly as possible. The time limitation would be essential to drive new customer signups, giving the gas companies greater certainty about potential customer additions. Additionally, DEEP is exploring several options in order to help further reduce the costs of main extensions for Segment B customers.

5. Establish Economic Development Fund To Capture Societal Benefits From Extending Gas Mains

In some cases, the addition of a new commercial or industrial "anchor load" customer may yield societal benefits beyond the cost savings that accrue to the customers. For example, connecting a factory to natural gas can drive down operating costs and help the factory stay competitive, thereby keeping jobs in the state. As many off-main "anchor load" customers are hospitals, schools, and municipal buildings, connecting those buildings to natural gas will yield fuel savings that translate into lower operating costs — and thus lower taxes.

The Draft Strategy recommends establishing an economic development fund to partially subsidize the costs of main extensions for off-main "anchor load" customers who generate these types of special societal benefits. This fund could be administered by DECD. It could be funded by a combination of sources, including new and existing ratepayers, taxpayers, and gas company shareholders.

Given the importance of moving blocks of off-main customers onto mains together, the state will explore incentives to promote coordinated action

6. Provide Incentives To Encourage Installation of High-Efficiency Furnaces

In order to maximize the benefits of the fuel switching opportunity, it is important to ensure that potential customers are "right-sizing" their equipment and installing the most efficient furnaces on the market. The State's energy efficiency programs currently offer subsidized home energy audits and a $500 rebate for homeowners who install new high efficiency heating systems. If the level of conversions in the Draft Strategy over the next seven years is realized, demand for these incentives will exceed current funding levels.

Therefore, funding for the efficiency programs may need to be supplemented or reallocated to accommodate this increased demand.

Alternatively, completing home energy audits and installing high-efficiency furnaces could be made a condition of participation in the low-interest financing program discussed above. If that's the case, the interest rate on financing offers may need to be lower in order to offset the customer's additional costs of complying with the requirements. The programs currently offer some incentives to encourage the installation of high efficiency gas furnaces and boilers.

ENACT REGULATORY CHANGES

7. Change Hurdle Rate Calculation to Reduce Upfront Customer Charge for Main Extensions

Under a regulatory mechanism called the "hurdle rate test," gas companies are authorized to invest a certain amount of the costs of expanding the distribution system to add a new customer. This amount is largely dependent on the expected increase in revenues over a specified time period (payback period) from supplying natural gas to the new customer. Currently, the hurdle rate test that Yankee Gas employs utilizes a 15-year revenue payback period. In April 2011, Connecticut Natural Gas and Southern Connecticut Gas were authorized by the former DPUC to extend the payback period they use in their hurdle rate test, from 15- to 20-years, under a two-year pilot program. In contrast, the payback period for NStar, a gas company in Massachusetts, is 33 years for residential customers.

The Draft Strategy recommends that PURA amend the hurdle rate test for all three gas companies to allow for payback period of 25-years. Amending the hurdle rate in this manner would enable the gas companies to cover more of the cost of main extensions for off-main customers, significantly improving their economics of conversion, and as a result, conversion rates. Specifically, the amendment would reduce the required CIAC by up to $1,700 for an average residential customer, $4,158 for a commercial customer, and $43,000 for a large industrial customer. This modification would also eliminate small CIAC of $400 to $500 that can sometimes be quoted to an on-main customer. DEEP estimates that expanding the hurdle rate payback period to 25 years would increase the rate base of the gas companies by approximately $339 million and decrease the total CIAC charges needed to convert all Segment B customers by approximately 40%. DEEP welcomes comments on this recommendation as part of the public comment process on the Draft Strategy.

8. Alternative Rate Rider To Pay Customer Main Extension Costs

DEEP also recommends that PURA allow new customers to pay their CIAC charges over time, through payments on their gas bill, instead of an upfront payment. As such, DEEP recommends that PURA consider setting rates generically for customers that require a CIAC payment based on similar characteristics such as usage and distance from the main. This latter change would reduce the administrative and transaction costs involved in calculating the CIAC charge for each new customer, provided that it collects enough revenue to cover the overall costs of main extension. This would reduce the upfront cost of conversion and thereby enable

a greater number of Segment B customers to take advantage of the fuel-switching opportunity. Implementing this recommendation would require PURA to revise and/or rescind previous orders. DEEP welcomes comments on this recommendation as part of the public comment process on the Draft Strategy.

9. Allow Greater Flexibility When Calculating Customers' Main Extension Costs

The current process for expanding gas mains is cumbersome. An engineering and cost analysis is performed to determine if a CIAC is required from each customer. If (when) additional customers show interest, or interested customers drop out due to high conversion costs, the hurdle rate test must be rerun in order to recalculate the CIAC.

DEEP recommends that the gas companies be allowed more flexibility in the calculation of revenues in the hurdle rate test when projects are analyzed. Currently revenues are only included in the hurdle rate calculation if there is a firm commitment by a customer to switch to gas. Each project must also be cost beneficial on its own. If the project is completed, new customers that later sign up for service along that main do not incur any CIAC related to the original main extension, as the CIAC has already been paid. Flexibility should be given to allow the gas companies to group projects together (portfolio view) for the purpose of comparing forecast new revenues to the revenue requirement necessary to support the incremental infrastructure. The portfolio view would increase gas companies' flexibility to serve more customers while not exposing existing customers to significant cross subsidization.

DEEP also recommends that some additional revenues be allowed to be forecasted in the hurdle rate analysis if there is a reasonable chance that additional customers will be added in the future. This would allow projects to proceed based on a timeline of expected conversions over a reasonable time frame of three- to five-years. The expectation is that an additional percentage of customers will chose to take gas service over that time frame, satisfying the need for future revenues covering the upfront cost of the project. These changes would entail some risk but would allow for a more systematic and flexible planning and construction of main extensions, which should help to reduce costs to all ratepayers. The impact of these guidelines would be monitored over time and adjustments can be made to ensure that the interests of new and existing customers are maintained.

10. Establish A Mechanism For Timely Recovery Of Capital Expenditures Made By The Gas Companies.

Due to the capital-intensive nature of a large-scale natural gas expansion program, the Draft Strategy proposes that PURA consider establishing a mechanism for the gas companies to recover prudent investments in a timely manner, outside of a rate proceeding. This mechanism could also serve to incorporate into rates, the additional revenues the gas companies expect to generate as more customers are added to the system.

11. Sharing Of Purchased Gas Adjustment Credits

Existing gas customers have enjoyed meaningful rate reductions over the last several years due to the declining price of natural gas. The gas companies regularly transact on-system interruptible and "off system

sales" which generate marginal revenues. Currently 99% of the benefit from these sales flows back to all customers as a bill credit through the Purchased Gas Adjustment Credit. This credit is commonly referred to as the Non-Firm Margin credit.

Using a portion of the Non-Firm Margin credit to offset rate base or other costs incurred for expansion would reduce the possible impact on existing customers. Although existing customers would not see an immediate bill credit their rates would be reduced and they would receive similar or even greater benefits over time because fewer costs would be accumulated into rate base, reducing the interest expense on capital costs. Another approach would be to use a portion of the Non-Firm Margin credit to reduce the CIAC costs for off-main customer's converting to gas. This Draft Strategy proposes that PURA allow 50% of the Purchased Gas Adjustment Credit to be used to support system expansion. DEEP welcomes comments on this recommendation as part of the public comment process on the Draft Strategy

12. Reduce The Costs of Equipment Conversion And Main Extension

While many of the costs involved in natural gas conversion are difficult to control—particularly the costs of the fuel and the costs of moving the gas from the wellhead to Connecticut— there are other costs that can be reduced through coordinated expansion and bulk purchasing. These include the paving cost component of gas main extensions, the labor costs involved in deploying crews to install meters, service lines and gas mains, as well as the "soft costs" involved in complying with state and local permitting and siting requirements applicable to gas main extensions and the unit costs of natural gas heating equipment itself.

With respect to paving costs, DEEP has already discussed above the significant cost savings that could be achieved where gas main extensions are coordinated with other infrastructure projects. If a municipality is already planning to install or repair water lines, sewage pipes, or other infrastructure, installing a gas main at the same time can save 20% of the costs of main extension by sharing the costs of excavation and re-paving the street. Pursuant to Section 10 of Public Act 12-148, An Act Enhancing Emergency Preparedness and Response, enacted on June 15, 2012, the Connecticut Department of Transportation and any municipality are required to notify PURA of pending construction projects on state highways and other public highways, so that PURA can notify public service companies of the opportunity to "install . . . any water, sewer, or gas line." Accordingly, PURA should develop procedures to implement this notification requirement, and should ensure that the gas companies focus their natural gas expansion plans in areas where DOT and municipalities are planning road construction.

The permitting and inspection process could become a bottleneck as the levels of conversions increase rapidly over the next several years. Several options should be explored including: a) creating a generic approval process for Siting Council approvals and standardizing the application and approval process for gas mains and interconnections. These options would improve the process for the gas companies, their contractors and customers seeking to switch to gas and reduce the associated "soft costs." Towns and municipalities can play an important role in reducing permitting and siting costs. There are important lessons that could be applied

here from the experience of solar PV installation, and specifically the SunShot and Solarize programs currently being administered by CEFIA in partnership with several municipalities. The Sunshot program focuses on driving down the so-called "soft costs" involved in solar PV installations, by working with towns and municipalities to develop common applications, or making it possible for companies to apply for permits online. Similar innovations could be applied to local permitting processes relevant to natural gas. And to the extent that permits for gas main extensions fall under DEEP's jurisdiction, DEEP will work to streamline those permit processes. Some other aspects of the Solarize program offers could also be applied to drive down conversion costs. *See,* Chapter 3 (Electricity). Municipalities interested in helping their residents and businesses take advantage of the natural gas opportunity could take a similar approach, by raising customer awareness and aggregating customer demand to obtain lower costs for natural gas equipment (or gas main extensions) through bulk procurement.

13. Offer Training And Assistance Programs To Reduce Economic Dislocation

The build-out of Connecticut's natural gas infrastructure to service Segment A and Segment B customers will create a large number of jobs, employing an estimated 5,400 people for a ten-year period.[205] At the same time, this conversion strategy will result in a substantial decrease in fuel oil consumption in the state. A key recommendation of this Draft Strategy, therefore, is to develop training and assistance for businesses adversely affected by this transition, to help them re-develop their businesses to take advantage of the economic opportunity created by the natural gas conversion and expansion of conservation efforts, including the opportunity to market natural gas furnaces and other equipment, or to become vendors in the Home Energy Solutions program. DEEP could work with the Board of Regents and community colleges to develop training programs. Many fuel oil companies are small, family-owned operations, and are trusted by their customers. For these reasons, fuel oil companies can be especially effective in becoming home energy service companies—advising customers on their options with regard to energy efficiency investments including the natural gas conversion opportunities. A marketing strategy could also include a mechanism whereby gas companies pay a finder's fee to third parties who sign up new natural gas customers. The gas companies should invest several million dollars of shareholder funds to support these measures over the next few years. Further, the potential costs and benefits of extending supplier choice to residential natural gas customers should be analyzed.

14. Create Options For Customers Who Are Unlikely To Convert

Approximately 50% of residential customers and approximately 25% of commercial and industrial customers will not have access to natural gas in the foreseeable future. This Draft Strategy proposes several energy cost reduction options for homes and businesses that are not located near a natural gas main, and helps them understand the costs and benefits of each option. Improving the energy efficiency of the home offers the

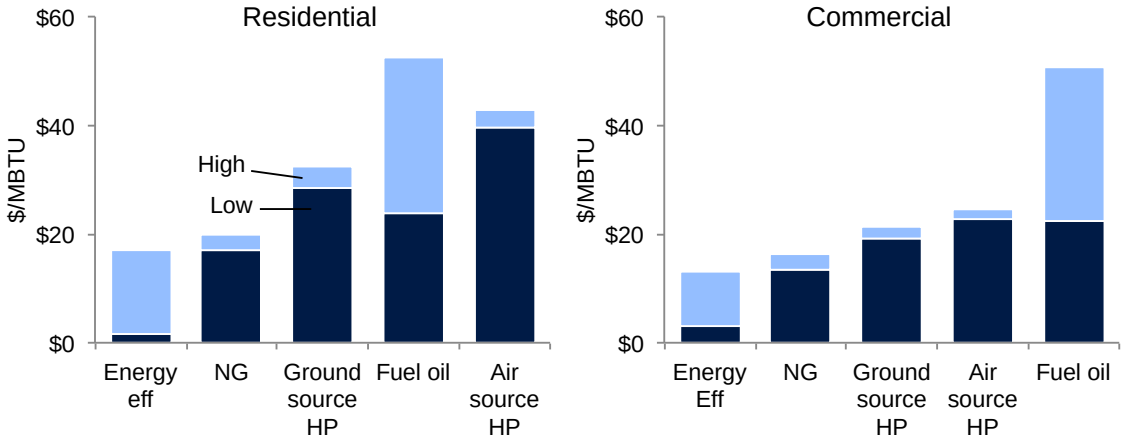
[205] Connecticut Department of Economic and Community Development, *Expanding Natural Gas*

biggest lever for helping these customers (Figure 12). An incented option to upgrade to a more energy efficient furnace should also be a part if the package each "non-gas" customer is offered. Because these customers have not had access to (consistent) efficiency funding and because the high fuel oil prices make efficiency gains even more cost-effective for large investments, this is an especially large opportunity, discussed further in Chapter 1 (Efficiency). At the same time, this Draft Strategy recommends that the General Assembly adopt standards for the sulfur content of home heating oil that some neighboring states have already adopted, so as to lower costs and reap environmental benefits.

After addressing energy efficiency, there are several options that can further reduce the need for reliance on heating oil. These include solar hot water systems and geothermal heat pumps. As with natural gas conversion, supply options can have large investment costs whose economics will vary widely by location, energy use, and equipment needs (Figure 11). This Draft Strategy recommends pilot projects for ground-source heat pumps (which extract heat from the ground instead of the air as in conventional heat pumps) and solar hot water. The pilot projects will help inform the work on current alternative technology economics, potential for cost reductions, other barriers and possible levers to overcome them.

Figure 11: Levelized cost of space heating options[206]

Ranges depend on both high and low projected fuel price scenarios as well as uncertainty around capital cost.



Source: RMI analysis based on Navigant, "Technology Forecast Updates."

[206] The levelized cost of energy—in this case for space heating—can be used to compare the cost of providing energy or energy efficiency for various technologies with a wide distribution of opex and capex. It is the required annual payment (accounting for both capex and opex) for providing or saving (in the case of energy efficiency) a given unit of energy. For more see the following: http://www.nrel.gov/analysis/tech_lcoe_documentation.html.

CONCLUSION

Natural gas presents Connecticut with a significant opportunity to move towards the governor's vision of a cheaper, cleaner, more reliable energy future for the state. Residents and businesses across the state are already making choices every day about whether to invest in the natural gas opportunity in the face of a highly dynamic energy marketplace. The goal of this draft strategy for the natural gas sector is to give Connecticut citizens better options when it comes to fuel switching and reducing their energy bills, by reducing the costs of conversion, implementing financing and regulatory mechanisms that reduce upfront costs, and developing options for customers who cannot cost-effectively switch fuels to capture energy savings through energy efficiency and testing of alternative space heating technologies. If several hundred thousand customers near gas mains choose to switch to natural gas, they can save on their heating bills, while cutting air pollution in Connecticut significantly and lowering greenhouse gas emissions.

It is important to recognize that seizing this opportunity has risks and will demand continued monitoring and flexibility to ensure that investments are prudent in a dynamic and evolving marketplace. Caution is necessary when pursuing any large-scale fuel switching opportunity, and a comprehensive planning process is therefore recommended to ensure that this strategy is cost-effective, does not overly burden existing ratepayers, and that new gas customer demand is matched with adequate gas supply so as to ensure reliability.

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Transportation Sector Strategy

INTRODUCTION

Connecticut's three and half million residents and varied economic activities are dependent upon a transportation system that provides the foundation for the state's economy, quality of life, and the character of our communities. The state's transportation system also consumes large amounts of energy and impacts the health of our population and the environment. Transportation-related energy use is dependent on the types of fuels used, the types of vehicles or other modes of transport used, and the number of vehicle miles traveled (VMT). A sustainable transportation energy future will require significant refinements to this system in order to provide increased mobility options to citizens and businesses. The transportation sector accounts for 32% of the state's total energy consumption[207] but in the process produces roughly 40% of the state's greenhouse gas emissions[208]. In addition, one type of fuel, oil, comprises 95% of the energy used by the transportation sector[209] which in turn drives the high percentage of emissions generated in the transportation sector and leaves the public exposed to "pain at the pump," as well as price spikes caused by global markets out of the state's influence. Transportation modes and patterns also directly affect economic activity in the state as goods and people are moved.

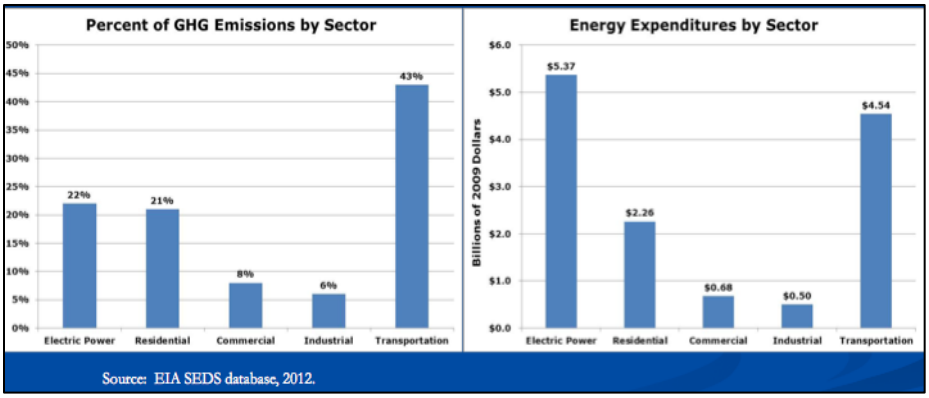
[207] U.S. Energy Information Administration State Energy Data System, "Energy Consumption Overview: Estimates by Energy Source and End-Use Sector," (2010), available at: http://www.eia.gov/state/seds/sep_sum/html/pdf/sum_btu_1.pdf.

208 U.S. Energy Information Administration State Energy Data System, "2009 State Emissions by Sector," available at: http://www.eia.gov/environment/emissions/state/excel/Table3_2009.xlsx.

209 U.S. Energy Information Administration State Energy Data System, "Transportation Sector Energy Consumption Estimates, Selected Years, 1960-2010, Connecticut," available at: http://www.eia.gov/state/seds/sep_use/total/pdf/use_CT.pdf.

FIGURE 1: GHG emissions and energy expenditures by sector

2009 data forecasted for 2012, adjusted for inflation



Source: U.S. EIA, "State Energy Data System"

This Draft Comprehensive Energy Strategy is the first formal integration of transportation issues into the State's overall energy planning, with a strong focus on offering Connecticut transportation choices. The State, however, has limited authority in some of the areas that have the most impact on transportation energy use. For example, vehicle efficiency standards, funding for transit, and the composition of fuels have historically been determined at the federal level[210]. Municipalities have jurisdiction over land use and development patterns at the local level. However, this Draft Strategy proposes a stronger role for State policymakers, as outlined in this Chapter.

Over the last decade in particular, Connecticut has demonstrated leadership in several of these areas, adopting ambitious policy innovations to improve transportation systems and options in the state. The State has made significant investments in public transit, with new rail and bus lines and expanded service, as part of federal and state stimulus packages. In addition, the State has promoted transit-oriented development as a part of a concerted effort to integrate economic development and transportation strategies in order to provide increased opportunities for people to live, work, and play using a combination of trains, buses, cars, bicycles and walking to travel from one place to another.

Recognizing that many Connecticut residents and businesses will continue to rely on automobiles for years to come, the State has implemented policies to make that reliance more economically and environmentally sustainable. For example, Connecticut is one of thirteen states to adopt California's tough automobile pollution standards for passenger cars. These tighter standards are projected to reduce greenhouse gas emissions by about 18% by 2020 and by roughly 27% by 2030 relative to business-as-usual levels.[211,212]

[210] Corporate Average Fuel Economy – U.S. Environmental Protection Agency: 40 CFR § 85, 86, and 600; Corporate Average Fuel Economy – National Highway Traffic Safety Administration: 49 CFR § 523, 531, 533, 536, and 537; Renewable Fuel Standard – U.S. Environmental Protection Agency: 40 CFR § 80.

211 Environmental Defense Fund, "California's Clean Cars Law," (2004), available at: http://www.edf.org/transportation/policy/california-clean-cars-law.

Widespread adoption of the California "clean car" rules has encouraged automakers to agree to more stringent federal pollution, greenhouse gas, and fuel economy standards. The State has also been replacing a growing number of its truck and bus fleets with alternatives, such as biofuels, natural gas, electricity and hydrogen. State fleets are helping to demonstrate the viability of these alternatives, which builds the market for "clean vehicles" and cleaner fuels. However, of the current 2.5 million vehicles registered in Connecticut, fewer than 1,680 are currently powered by alternative fuels (see Appendix D).[213] Indeed, there exists a significant set of obstacles to a clean fuels/clean vehicles future. This Draft Strategy avoids trying to guess what the state fuel of choice will be in 2020 or 2030. But, at the same time, this Draft Strategy proposes building out a basic platform for many options, with a sufficient diverse refueling infrastructure so that choices are not made for Connecticut driver, but rather, by them.

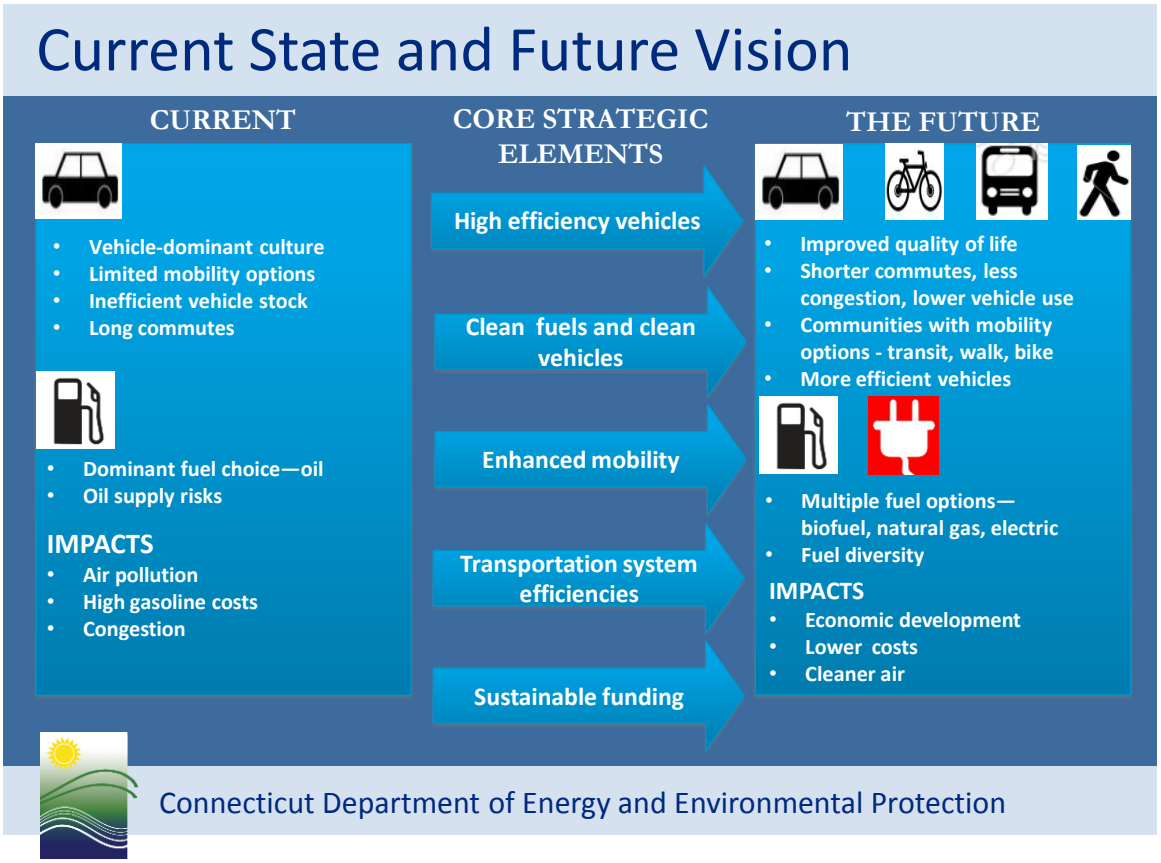
Connecticut has implemented innovative approaches to reduce diesel emissions and eliminate unnecessary idling by buses and trucks to save fuel and lower emissions. In addition, construction of parking spaces and electrification of truck stops has enabled some long-haul trucks to rest without keeping their engines running. Expanding upon these and other policy innovations, this Draft Strategy proposes several initiatives that will put Connecticut on a path to lower overall energy use, dramatically reduce the state's reliance on oil, lower traditional air pollution and greenhouse gases, and save consumers and businesses time and money.

This Draft Strategy offers a foundation for tackling the tough mobility and related economic challenges involved in creating a cleaner and more efficient transportation system in a cost-effective manner that is not overly reliant on scarce government resources and is focused on providing residents with enhanced transportation choices. While expanding mobility options in an era of limited government resources will be challenging, doing so can also provide tremendous new opportunities that could strengthen Connecticut's communities and economy.

[212] The California Air Resources Board continues to assess emissions reductions – updates are available at http://www.arb.ca.gov/regact/2012/leviiighg2012/levappb.pdf.

[213] Connecticut Department of Motor Vehicles response to DEEP data request (September 28, 2012).

FIGURE 2: Draft Transportation Strategy Gives Residents the Power to Choose Their Transportation Solution



Source: Connecticut Department of Energy and Environmental Protection (2012).

Figure 2 provides an overview of the current and future vision for Connecticut's transportation sector. The core strategies focus on: 1) promoting the use of vehicles that are more efficient, less polluting and less reliant on oil fuels; 2) providing a platform to facilitate adoption of clean fuels and clean vehicles in step with public demand; 3) increasing mobility by promoting more travel options and transit oriented development; 4) following best practices to improve efficiencies in the transportation system; and 5) developing sustainable funding sources to maintain existing transportation infrastructure and to develop additional mobility options within the state. Implementation of these core strategies can help enhance quality of life, build more livable communities, promote economic development, reduce costs, and lower emissions to improve public health and the environment.

This Chapter focuses largely on the energy that helps people and goods get from one place to the other. It does not analyze the energy used during the manufacturing process by the many Connecticut companies that make transportation equipment. That topic is addressed in Chapter 2 (Industry). It is important to note that the choices made in the manufacturing transportation equipment area are economically significant. The manufacture of transportation equipment comprises 2.4% of the state's gross state product, and includes the

production of submarines, helicopters, jet engines, and the technology used in vehicular fuel cells.[214] Consideration of the potential economic impact – positive or negative - of specific transportation strategies on these manufacturers must be part of all policy evaluations.

OVERVIEW OF THE CURRENT STATE

Roughly 95% of Connecticut transportation energy comes from vehicular transport (with passenger cars representing 80% of the total and trucks and buses accounting for 15%). The remaining 5% of transportation energy is used by aircraft, locomotives, and ships.[215] These sources provide little opportunity for policy impact because the efficiency and use of airplanes, trains, and ships are primarily governed by federal (not State) laws and regulations. Therefore, the focus of this Chapter will be vehicular transportation sources and solutions.

Connecticut is a small, densely developed state with large numbers of people who commute relatively short distances in single occupancy vehicles. Thus, despite the high reliance on both automobiles and traditional transportation fuels (specifically, gasoline and diesel), the state is well positioned to be a test bed for the clean fuels and clean vehicles of the future. According to the Connecticut Department of Transportation (ConnDOT), vehicles are driven 31 billion miles annually in Connecticut. Of these 31 billion miles, nearly are from people traveling in passenger cars and light trucks[216]. This is roughly 3,500 miles less than the national average[217].

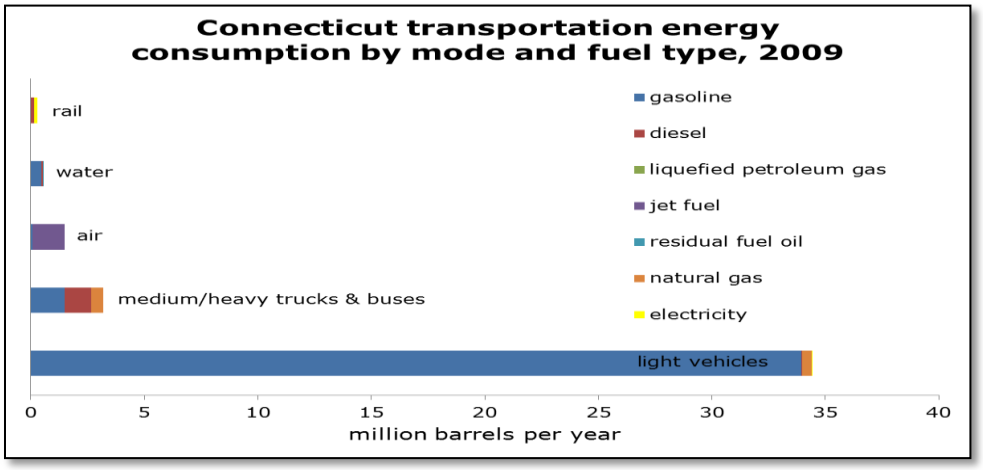
[214] Connecticut Light and Power and United Illuminating, "2011 Electricity Sales by NAICS Code," Microsoft Excel file shared with Connecticut Department of Energy and Environmental Protection, (April, 2012).

215 U.S. Energy Information Administration, "State Energy Data System 2011 Estimates," (2011), available at: http://www.eia.gov/states/seds/seds-data-fuel.cfm.

216 U.S. Department of Transportation Federal Highway Administration, "Highway Statistics 2010," available at: http://www.fwha.dot.gov/policyinformation/statistics/2010/.

[217] Connecticut Department of Transportation response to DEEP data request (September 14, 2012).

FIGURE 3: Connecticut transportation energy consumption by mode and fuel type in 2009



Source: NESCAUM analysis using the U.S. Energy Information Administration's State Energy Database System 2010 Estimates.

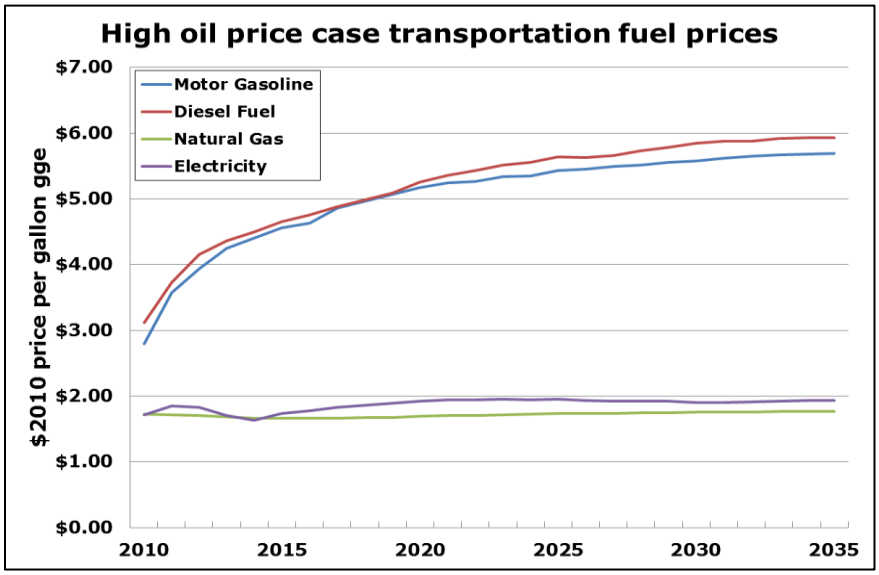
With 95% of Connecticut's transportation energy supplied by gasoline and diesel, transportation emerges as the least fuel-diverse of any of the state's energy use sectors. As shown in Figure 3, electric vehicles represent an insignificant amount of total vehicle miles traveled, and as such a very small portion of transportation energy consumed. But given the very clean sources of power in Connecticut (about 92% of generation is either nuclear or natural gas), the expanded use of electric vehicles in the state would yield substantial environmental benefits.

All told, energy spent on transportation costs about twice as much as energy used in homes in the United States. Nationwide, the average household spends 19% of their income on transportation. However, in communities where people can walk or take public transit, households can significantly reduce their transportation costs. For example, households in transit-friendly communities spend an average of only 9% of household income on transportation. Households that must rely predominantly on their own cars devote up to 26% of their income to transportation.[218] Therefore, enhancing mobility options also reduces costs for families, allowing them to free up dollars for other necessary expenses (such as healthcare, food, clothing, et cetera).

Oil is increasingly expensive compared to other fuels. While gasoline and diesel prices have fluctuated in recent years, they have generally been quite high and they are expected to increase somewhat in coming decades. Widely available alternatives, including electricity and natural gas, now cost considerably less than gasoline on a per mile basis. As shown in Figure 4, these prices are projected to stay at or near current levels for the foreseeable future, increasing their relative viability as transportation fuels over time.

[218] Reconnecting America's Center for Transit-Oriented Development, "Realizing the potential: Expanding housing opportunities near transit," (April, 2007), available at: http://www.reconnectingamerica.org/resource-center/books-and-reports/2007/realizing-the-potential-expanding-housing-opportunities-near-transit-2/.

FIGURE 4: Projected transportation fuel prices assuming high oil prices



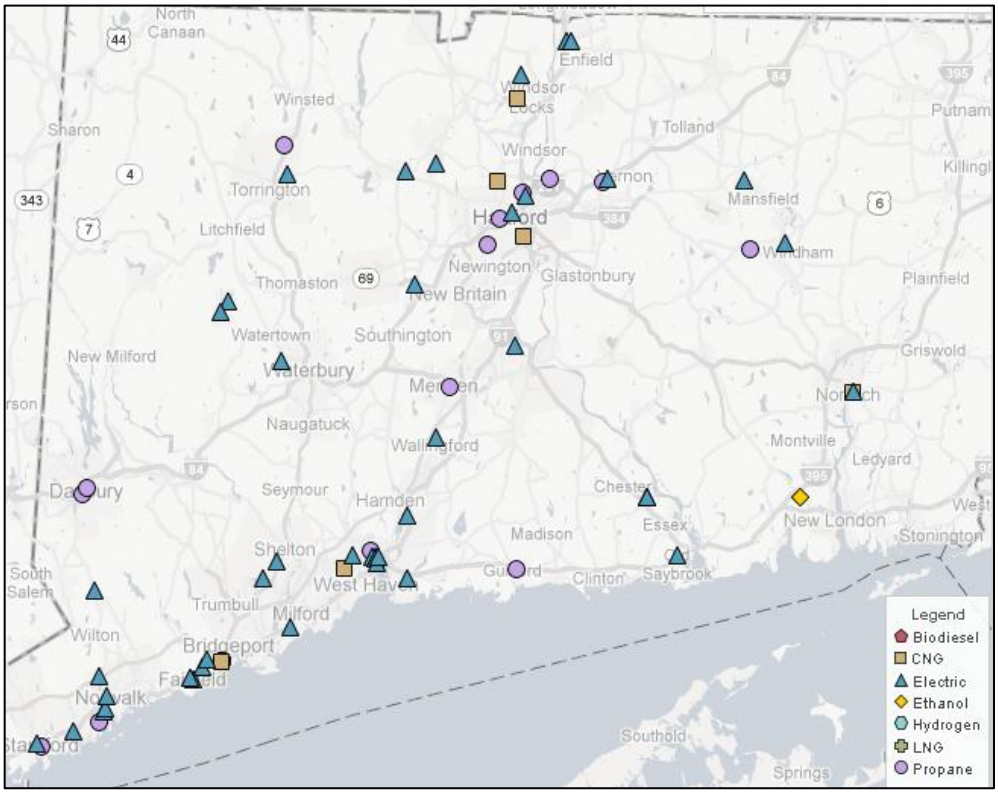
Source: U.S. Energy Information Administration, "Annual Energy Outlook 2011".

Less polluting alternatives such as electricity and natural gas are domestically produced and thus predicted to be more economically stable going forward. State residents and businesses dependent upon oil are more vulnerable to price spikes, and potentially to supply disruptions due to the volatile nature of the international oil market.

To facilitate the use of these cleaner alternatives, this Draft Strategy proposes to increase the number of stations that can refuel these vehicles. This approach will provide a basic infrastructure across the span of technologies and provide access to alternative fuels as consistent with driver choice. Connecticut intends to be prepared for a changing 21st century vehicle marketplace as new technologies bring down the cost of alternative fuel vehicles and as the penetration of these vehicles increases.

Alternative fuel stations include: compressed natural gas (CNG), electric, E-85 (made up of 85% ethanol alcohol and 15% gasoline), liquefied natural gas (LNG), propane, and hydrogen stations. Although access to these fueling stations is still limited, their growth in recent years reflects an increasing demand within the state for non-petroleum based transportation fuels options. Figure 5 depicts currently available alternative fuel stations within the state.

FIGURE 5: Location map of existing alternative fueling stations within the State



Source: CT Clean Cities Coalition (September, 2012).

Given the high percentage of oil that is imported, reducing the amount of gasoline consumed in Connecticut cars and trucks would bring significant economic benefits - notably, potential lower costs and fewer dollars shipped overseas. In addition, reducing oil consumption would have environmental and public health benefits, including improved air quality and lower greenhouse gas emissions. Vehicles use accounts for over 40% of the state's overall greenhouse gas emissions. Clean fuels and clean vehicles decrease these greenhouse gas emissions and would help the state work towards the goals of the 2008 Global Warming Solutions Act which calls for an 80% reduction of these emissions by 2050.

Many towns and cities across the state are deciding to use low-carbon fuel alternatives to meet their local government transportation needs. For example, the *2011 Annual Report* from Clean Cities (of the U.S. Department of Energy) reports that Groton Public Utilities acquired 23 light-duty hybrid vehicles increasing the average fuel economy of the fleet from just 20 miles per gallon to 32 miles per gallon. Furthermore, this switch saved the utility 3,536 gge (gallon of gas equivalents) and reduced the fleet's greenhouse gas emissions

by 43.6 tons.[219] The report outlines work in many municipalities and documents the positive impacts of alternative fuel use.

REGIONAL COLLABORATION

Regional collaboration between Connecticut, New England, and Mid-Atlantic states is critical in transforming the state's transportation sector. The travel of people, goods, and services between and through Connecticut and neighboring states is significant and not stand-alone. While this regional transportation network does not have one overarching regulating entity, regional initiatives are arising to address transportation issues at a larger-scale. The Transportation & Climate Initiative (TCI) is one such initiative that began in 2011. Connecticut participates in the TCI with 10 other states and the District of Columbia. There are four core work areas of this Initiative: "1) developing clean vehicles and alternative fuels; 2) creating sustainable communities; 3) adopting innovative communication and technologies; and 4) advancing more efficient freight movement."[220]

ROADWAY INFRASTRUCTURE

Energy use by vehicles is intimately linked with Connecticut's road infrastructure. Maintenance and design issues and the sheer volume of vehicles in the state cause significant congestion and translate into more time on the road. Thus, road capacity and condition affect energy consumption.

Because of its relatively high population density and dependence on the automobile, Connecticut has an extensive road network. For example, the state has nearly three times more miles of interstate per square mile than Virginia. Overall, Connecticut has 346 miles of interstate highways and an additional 1,086 miles of main arterial routes[221]. There is also a high volume of use on these roadways. Connecticut interstates are among the most heavily used in the nation: the state's three major highways (I-95, I-91, I-84) serve 100,000 to 170,000 vehicles per day, and heavy truck volumes comprise 10-15% of that traffic.[222] The population's high mobility needs are also reflected in the fact that the New Haven Metro-North Line is the nation's busiest commuter rail line,[223] and ridership is only projected to *increase* in the future (at a rate of 6% a year). ConnDOT estimates that ridership will reach an incredible 85 million rail rides in 2012.[224]

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[219] U.S. Department of Energy Clean Cities: Norwich Clean Cities, "2011 Annual Report", (2011).

[220] Transportation & Climate Initiative, "Transportation & Climate Initiative of the Northeast and Mid-Atlantic States," available at: http://www.georgetownclimate.org/sites/default/files/TCI%20brochure.pdf.

[221] Connecticut Department of Transportation response to DEEP data request (September 14, 2012).

[222] Connecticut Department of Transportation, "Transportation Fast Facts," (2012), available at: http://www.ct.gov/dot/lib/dot/documents/dcommunications/misc/2012_ConnDOTFast_Facts_online.pdf

[223] Connecticut Department of Transportation response to DEEP data request (September 18, 2012).

[224] Connecticut Department of Transportation, "Connecticut and Metro-North Make Service Investments in New Weekend and Off-Peak Trains," (July 19, 2012), available at: http://www.ct.gov/dot/cwp/view.asp?A=1373&Q=508220.

Chapter 5: Transportation Sector Strategy

Connecticut's transportation infrastructure is extensive, old, and costly to maintain. State-owned transportation assets consist of approximately 3,700 miles of highways, 3,900 highway bridges, 230 miles of rail track, 200 railroad bridges, 270 rail cars, 650 buses, 6 airports, a state pier, 2 ferries, and buildings such as transit stations, highway garages, highway service plazas, and rest stops. In addition, 17,265 miles of local roads and 1,241 local bridges are owned by Connecticut municipalities.[225] The state's interstate highway system was predominantly built in the 1950s and 1960s, and many stretches are now due for replacement or upgrades.[226]

ConnDOT's estimate of highway repair costs coincides with a realization that its ability to address these needs will be severely impacted by a steep decline in the federal and state revenue streams used to fund transportation-related improvements. Revenue sources for replacement of aging infrastructure are far lower than the levels that were in place when these projects were first constructed. The bonding capacity of the State Transportation Fund will diminish over the next few years as the 10-year special funding programs authorized by the Legislature in 2005 and 2006 – $1.3 billion in 2005 and $1.0 billion in 2006 – wind down.

Moreover, support from the National Highway Transportation Administration and revenues from the State gasoline tax, which has funded the construction and maintenance of roads, has declined sharply in recent years and is expected to continue to decrease. The cumulative effect of the revenue shortfall amounting to $2 billion in 2011 is projected to grow more than $4.5 billion in 2017. Options for funding these necessary projects will need to be carefully considered.

Both maintenance and new road construction are expensive. In 2011, ConnDOT spent $861 million on repairing the current infrastructure and $0 on new roads. ConnDOT estimates, however, that far more money is required for maintenance and repair because budget allocations have not kept up with the needs. For instance, 8.3% of the state's more than 3,980 bridges need structural upgrades. The total price tag for repairs and maintenance throughout the state is estimated to be more than $16 billion.[227]

[225] Connecticut Department of Transportation, "Transportation Fast Facts," (2012), available at: http://www.ct.gov/dot/lib/dot/documents/dcommunications/misc/2012_ConnDOTFast_Facts_online.pdf.

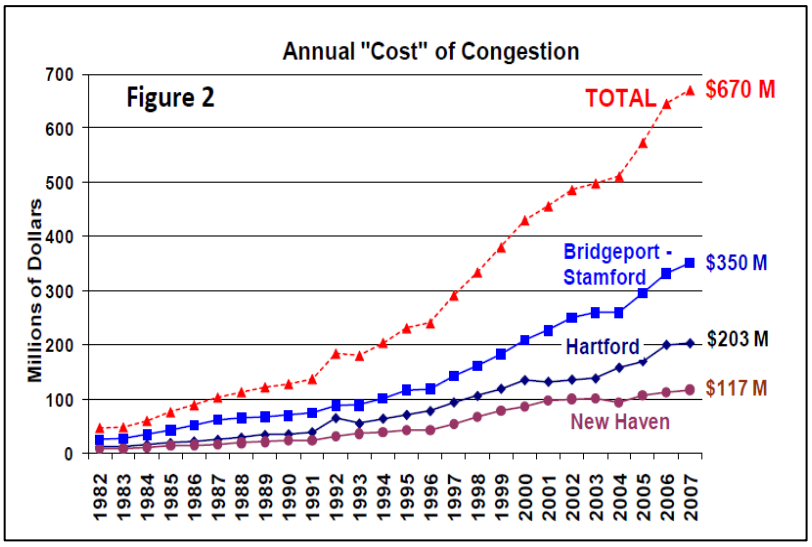
[226] Connecticut Department of Transportation response to DEEP data request (September 6, 2012).

[227] Connecticut Department of Transportation response to DEEP data request (September 18, 2012).

THE COST OF CONGESTION

Another challenging aspect of our existing transportation system is vehicle congestion. The Urban Mobility Report (the Report) estimates that congestion causes over 32 million hours of delay annually in Connecticut's three largest urban areas (Bridgeport-Stamford, Hartford, and New Haven)[228]. The average commuter on I-95, the Merritt Parkway and other roads in the Stamford-Bridgeport region spends the equivalent of more than four days a year delayed in traffic. Traffic congestion is also a serious problem in Hartford, New Haven, and other urban areas. The Report estimates that the total cost of congestion in those urban corridors is a conservative $670million per year in lost time and energy costs (Figure 6).[229,230] This total does not include the lost opportunities of businesses choosing not to expand or relocate in the region due the transportation gridlock. When local wage rates are used, congestion costs in southwestern Connecticut far exceed the costs suggested by the Report.[231] Congestion and travel delays also cause stress, reduce worker productivity, and lower the quality of life.

FIGURE 6: Annual costs of congestion for the three largest urban areas within Connecticut: Bridgeport-Stamford, Hartford, and New Haven. The combined costs of the three regions are represented in the red 'Total' line



Source: Connecticut Office of Policy & Management, "A Strategic Framework for Investing in CT's Transportation: Economic Growth – Infrastructure Preservation – Sustainable Communities".

[228] Lomax, T., Schrank, D., & Eisele, B., "2011 Annual Urban Mobility Report," University Transportation Center for Mobility, Texas A&M Transportation Institute (September, 2011), available at: http://mobility.tamu.edu/ums/.

[229] Connecticut Office of Policy & Management, "A Strategic Framework for Investing in CT's Transportation: Economic Growth – Infrastructure Preservation – Sustainable Communities," (January, 2011), available at: http://www.ct.gov/opm/lib/opm/tsb/meeting_materials/strategic_needs_statement_v9_2010-08-17.pdf.

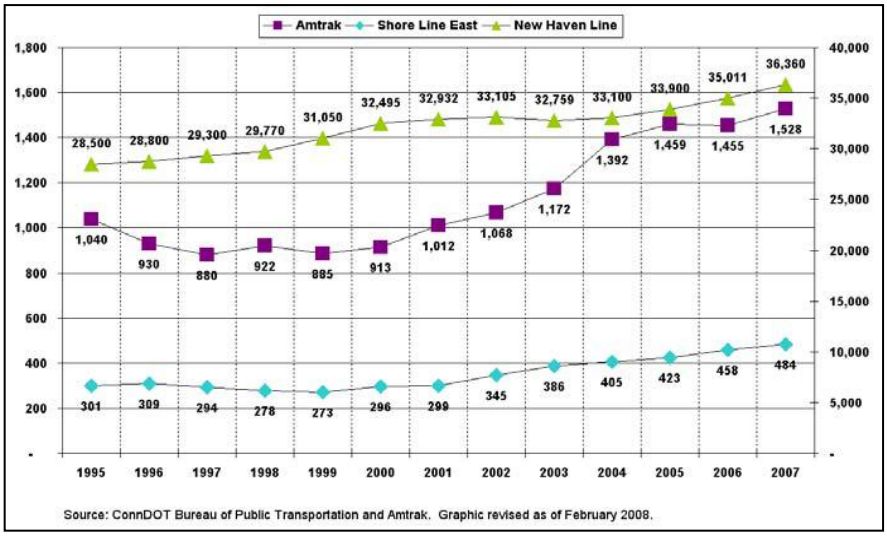
[230] The Report estimates that the national costs of congestion are $101 billion per year (based on 2010 data).

[231] Lomax et al., (September, 2011).

PUBLIC TRANSPORTATION SYSTEMS

Connecticut has relieved some of the strain on the highway network by investing in existing and new public transit systems. Ridership on Connecticut's three major train lines is also rising (Figure 7).

FIGURE 7: Annual ridership on Connecticut's three main transit lines: Amtrak, Shore Line East, and the New Haven line



Source: ConnDOT Bureau of Public Transportation and Amtrak.

To help alleviate some of the congestion on the state's highways, Connecticut is in the process of making significant investments in several major public transport projects. Federal and state governments are spending about $647 million on a high-speed rail link from New Haven through Hartford to Springfield, Massachusetts (the so-called "Knowledge Corridor"), which will more than triple the daily number of trains" (Figure 8).[232] This line is predicted to bring 12,000 construction and construction- related jobs, reduce vehicle miles traveled by 92.56 million miles in 2030[233], and save more than 3.5 million gallons of fuel annually. Another $569 million is being spent to create the CTfastrak dedicated busway transit system from Hartford to New Britain (Figure 9).[234] The busway will provide a swift transit alternative to driving and cut travel times on the I-84 corridor by reducing existing congestion. Additionally, Metro-North is enhancing its service from New York City to New Haven (Figure 10) by adding parking garages, making station improvements, investigating communication and signal needs, advancing efforts to rehabilitate moveable bridges, and evaluating the need for additional tracking. These improvements are estimated to add 5.5 million new person trips, divert 5 million car trips, reduce the vehicle miles traveled by 138.4 million miles, and save 4.8 million

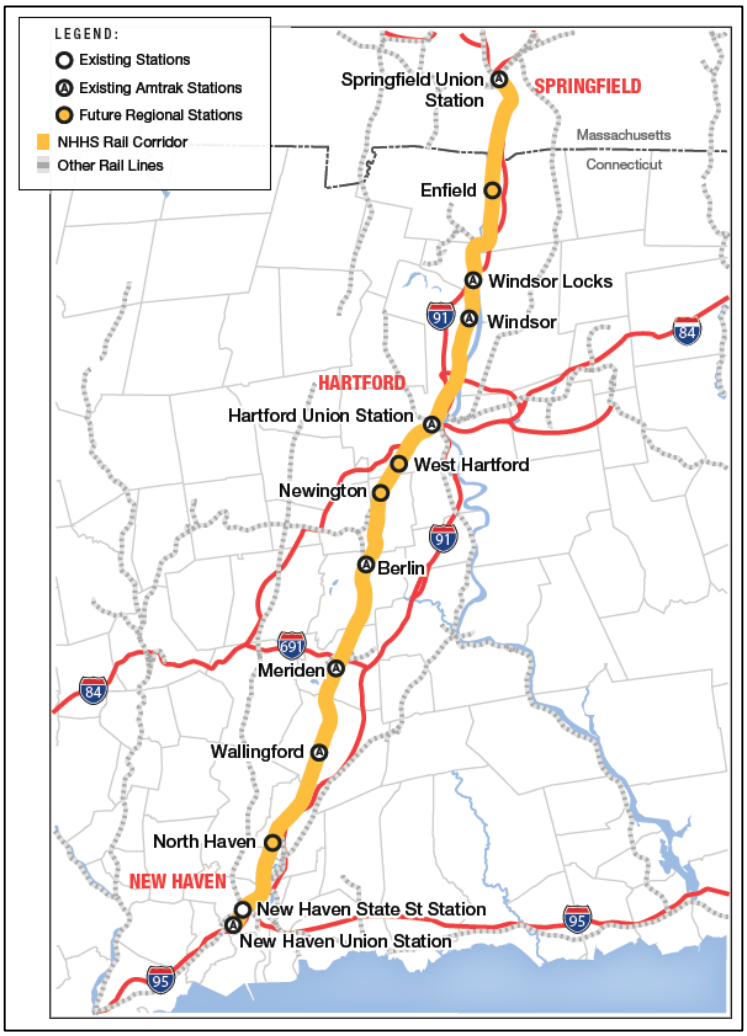
[232] Connecticut Department of Transportation, "New Haven – Hartford – Springfield Rail Program Objectives and Scope," (2012), available at: http://www.nhhsrail.com/objectives/cost.aspx.

[233] Connecticut Department of Transportation response to DEEP data request (September 14, 2012).

[234] Connecticut Department of Transportation, "CTfastrak," (2012), available at: http://www.ctfastrak.com/index.php/en.

gallons of fuel annually.[235] Completion of improvements such as these will increase the likelihood that people will opt to use public transport.

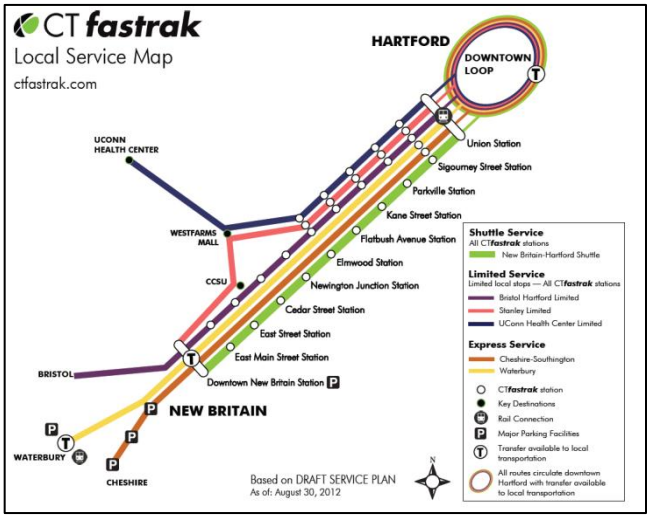
FIGURE 8: Map of the New Haven – Hartford – Springfield rail corridor



Source: New Haven – Hartford - Springfield Rail Program, "Project Map," (2012), available at: http://www.nhhsrail.com/pdfs/project_map_2011.pdf.

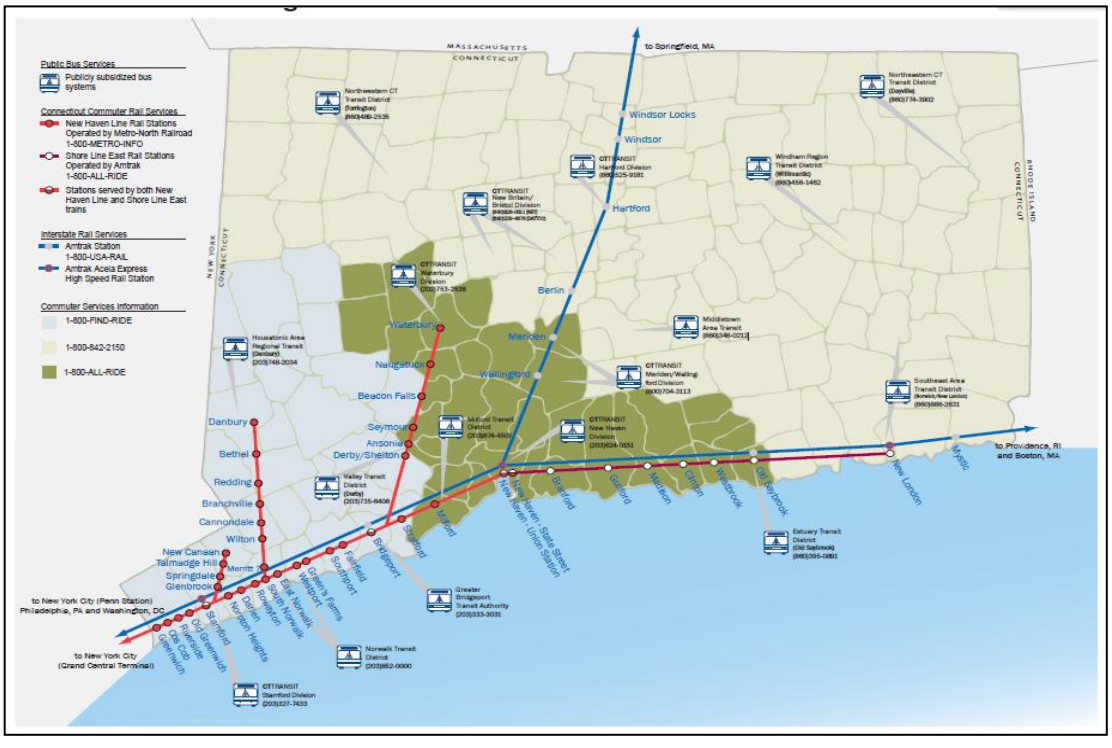
[235] Connecticut Department of Transportation response to DEEP data request (September 18, 2012).

FIGURE 9: Proposed route for the CTfastrak busway



Source: CTfastrak, "Local Service Map," (2012), available at: http://www.ctfastrak.com/images/ctfastrak_regional_and_local_maps_08-2012.pdf.

FIGURE 10: Map showing Metro-North system



Source: ConnDOT.

Chapter 5: Transportation Sector Strategy

DRIVERS OF CHANGE

Connecticut's transportation sector has been shaped by changing needs and technologies since the time of dirt turnpikes and horse-drawn carriages. Today the state faces new drivers of change. As noted above, the costs of transportation, from time wasted in traffic jams, to high levels of pollutants, to the cost risk associated with volatile fuel markets, are rising. Additional drivers of change include an emerging statewide effort to promote transit-oriented development, the growing transportation revenue gap, and the development of new vehicle technologies that offer a chance to significantly reduce energy use, energy costs, and pollution. The State can leverage these drivers of change discussed in more detail below, to help create a cleaner, cheaper transportation system that enhances the quality of life for all residents.

LAND USE PATTERNS AND MOBILITY

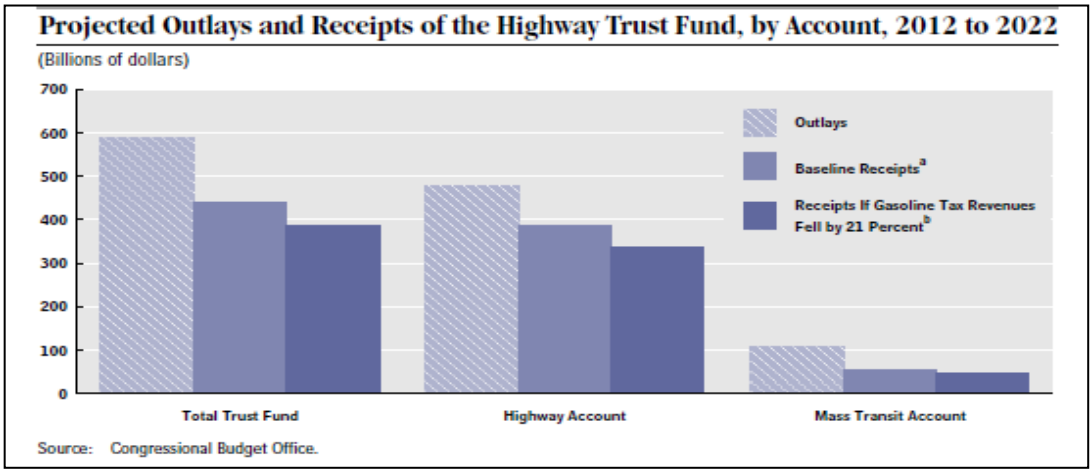
Over the last decade, State policy makers have increased support for transit-oriented development programs. For example, the Department of Community and Economic Development has developed streamlined procedures for approving and reviewing large-scale transit-oriented projects throughout the state. In October 2011, ConnDOT and the Office of Policy and Management (OPM) awarded grants from a transit-oriented development pilot program totaling $5 million to 11 cities, towns, and regional planning organizations around the state for site planning and market analyses to support development of residential, commercial, and employment centers within one-half mile of rail and bus stations. Furthermore, the General Assembly, nonprofit environmental, historic preservation, housing, land trust, and land use organizations have also taken steps to promote smart growth as a guiding principle of further development in the state.

Connecticut's Draft Strategy for expanding transit options aims to increase the opportunities for walking and biking to transit stops, jobs and shopping. Such design would enable residents to live, work and play with decreased reliance on cars, saving money and time, while benefiting the larger community through lower congestion, pollution, public health costs, and energy use.

TRANSPORTATION FUNDING GAP

Another driver of change in the Connecticut transportation sector is the looming revenue gap for funding the state's transportation improvements (Figure 11). Currently, revenues generated by the State and Federal gasoline taxes pay for most of these improvements. As more vehicles attain a greater level of energy efficiency, these revenues will decrease.

FIGURE 11: The looming U.S. revenue gap as projected by the Congressional Budget Office for the period of 2012 to 2020 (in billions of dollars)



Source: Congressional Budget Office.

Tougher fuel economy standards and high oil and gasoline prices have raised customer demand for fuel-efficient vehicles so that automakers are now offering a wide range of attractive, safe and efficient models. As these new vehicles displace older vehicles, the efficiency of the whole fleet rises – and overall fuel use drops which means lower gasoline tax revenue is collected.

For the United States as a whole, the Congressional Budget Office forecasts that gasoline tax revenues will drop about 21% by 2020 due to improved fuel economy.[236] Within the state, the 2011 revenue shortfall of$2 billion is projected to grow more than $4.5 billion by 2017.[237] Energy policy progress creates a transportation policy challenge. Notably, the more Connecticut vehicle owners increase their fuel efficiency and reduce their vehicle miles traveled, the larger the transportation revenue gap will become.

CHANGING TECHNOLOGY

Fast-moving shifts in vehicular technology are also forcing change. Interestingly, Connecticut has a rich history of innovation in this arena, from the earliest mass production of electric vehicles at the Pope Manufacturing Company in Hartford to the development of fuel cell technologies by many Connecticut-based companies (some of which are used to power vehicles). Within the industry, automakers have developed hybrid-electric versions of many popular vehicles that yield combined highway and city ratings of 40 miles per gallon or greater.

[236] Congressional Budget Office, "How Would Proposed Fuel Economy Standards Affect the Highway Trust Fund?," (May 2012), available at: http://www.cbo.gov/publication/43198.

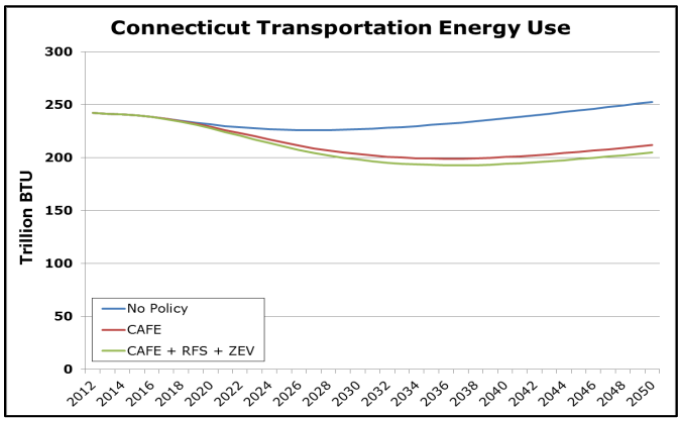
[237] Connecticut Department of Transportation response to DEEP data request (September 18, 2012).

Electric cars offer one option for the vehicle choice for the 21st century. The major automakers and dozens of smaller companies have either launched or announced plans to market in the near-term both fully electric cars and plug-in hybrid vehicles. These vehicles usually can travel the distance of a typical daily commute on electricity alone – recharging at the office or at home overnight. As previously noted within this Chapter as well as Chapter 3 (Electricity), Connecticut has taken steps to develop the necessary recharging infrastructure to support these transportation options for consumers.

Another option will be natural gas vehicles. At about one-third the price of diesel, some trucks, taxis, and delivery fleets are already converting to either liquefied natural gas (LNG) or compressed natural gas (CNG). A growing number of long-distance trucking companies have begun to move to CNG, so Connecticut will establish CNG filling stations at a number of truck stops along the interstate highways.

Meanwhile, the gasoline-powered versions of these and other vehicles are much more fuel efficient than their predecessors. The fuel economy gains for conventional internal combustion engine vehicles are expected to continue to increase sharply as new federal emission standards phase in. As these new vehicles displace older vehicles, the efficiency of the whole fleet rises. As a result of current federal average fuel economy standards and vehicle turnover, Connecticut transportation energy use will drop from 240 trillion BTUs in 2012 to about 200 trillion BTUs in 2030, an estimated 17% reduction (Figure 12). Figure 12 includes three scenarios: 1) a baseline with no national fuel economy policy; 2) a Corporate Average Fuel Economy (CAFE) standard; and 3) a CAFE standard plus a national renewable fuel standard (RFS) and a national zero emission vehicle program (ZEV). The percentage of decline could be much greater in Connecticut, if the State successfully encourages the purchase of the most efficient vehicles on the market.

FIGURE 12: Projected transportation energy use from 2013-2050 in Connecticut



Source: NESCAUM analysis using the EPA Motor Vehicle Emission Simulator (MOVES) model and post-processing tools, based on 2008 data.

OPPORTUNITIES AND CHALLENGES

Although Connecticut has begun to reduce energy use and costs in transportation and to change development patterns, more action is required. Switching to cleaner fuels for fleets of cars and trucks and encouraging the adoption of fuel-efficient vehicles would provide economic, public health and environmental benefits. Shifting freight from long-haul trucks to trains or ships can improve efficiency and reduce costs. A guiding principle of improved transportation is to make each trip as energy efficient as possible and to encourage people to use the most energy efficient transportation option available for that trip. Beyond helping provide clean fuel filling/charging options, the State will also promote ride- and car-sharing. Even more gains would come from increasing opportunities to walk or bike or to work from home, and from successful efforts to shape towns and communities around the ideas of smart growth and transit-oriented development. Connecticut residents should have a choice among all of these options to the greatest extent possible. All of these measures offer significant opportunities - as well as challenges - for promoting clean fuels/clean vehicles, enhancing mobility, and offering options that advance a cheaper and cleaner transportation sector.

Promoting Clean Fuels – Clean Vehicles

Over the next decade, Connecticut will closely follow emerging and dynamic trends clean fuels and clean vehicle technology market. During this period of rapid change and market advances, Connecticut will continue to monitor and take steps to position the State to take advantage of technology breakthroughs that are economically viable and environmentally preferable. During that time, the State will also promote higher efficiency internal combustion engine vehicles (ICE). The largest part of this opportunity is in cars and light trucks, which make up 90% the vehicles on the road. Gains are also possible in everything from delivery vans to refuse trucks. This Draft Strategy consciously avoids trying to pick winners or to define a preferred path toward a more sustainable transportation future. Rather this approach provides an open platform that enables new and varied technologies– electric, natural gas and propane, hydrogen fuel cell, biodiesel, and other vehicles – a chance to prove themselves. To that end, Connecticut will work to develop appropriate models that could help secure financing to develop an alternative fueling infrastructure sufficient to support a variety of clean vehicles, assuage general range anxiety, and further promote replacements of municipal and state fleets with cleaner alternatives through strategic pilot programs.

In response to the adoption of stricter federal fuel economy standards and growing consumer demand for efficient vehicles, automakers are already offering a wide variety of attractive, high mileage cars and trucks at prices comparable to similar less efficient vehicles. Consumers now have choices. There is an extensive array of options - from mid-sized, to minivans and SUVs, to luxury vehicles, and so on - that have higher levels of fuel efficiency. There is also the potential for breakthroughs in the bio-fuels industry, which has some activity in the State.

Chapter 5: Transportation Sector Strategy

The federal government's new fuel economy standards will raise the average for automobiles and light trucks to 54 mpg by 2025. Choosing cars with high fuel economy ratings compared to others of the same type and class brings big savings at the pump. When considering the projected costs of fuel, choosing a vehicle that gets 30 mpg rather than 25 mpg saves a consumer $4,000 over the life of the vehicle (Table 1).[238] This simple choice saves money and reduces emissions that are harmful to public health and the environment.[239]

TABLE 1: Expected payback period under a high oil price scenario for several different types of vehicle technologies. When lifetime fuel savings exceed incremental cost, the vehicle pays itself off

Vehicle Technology	Fuel Economy (mpg)	Incremental Cost (2012$)	Lifetime Fuel Savings (2012$)	Payback Period under High Oil Prices
Base vehicle compliant with CAFE	25	~~~	~~~	~~~
High fuel economy ICE passenger vehicle	30	($7,900)	$4,000	Instant Payback
Plug-in hybrid electric (PHEV) **without** $7500 Federal Tax Credit	electricity: 60 gasoline: 40	$10,700	$10,000	Greater than the Vehicle Lifetime
Plug-in hybrid electric (PHEV) **with** $7500 Federal Tax Credit	electricity: 60 gasoline: 40	$3,200	$10,000	3 years
Battery electric (BEV) **without** $7500 Federal Tax Credit	116	$14,300	$17,100	9 years
Battery electric (BEV) **with** $7500 Federal Tax Credit	116	$6,800	$17,100	4 years
Hydrogen fuel cell	39	$53,900	$15,300	Greater than the Vehicle Lifetime
Light-duty natural gas	23	$8,000	$13,000	7 years

Source: NESCAUM, VISION NE Transportation Fleet Model; U.S. EIA, "Annual Energy Outlook 2011"; NREL, "Business Case for Compressed Natural Gas in Municipal Fleets, 2010". See Appendix D (Transportation) for assumptions.

Even though the average fuel economy of cars and light trucks is increasing as newer, more fuel-efficient vehicles replace older ones, there may be barriers (awareness, social, economic, et cetera) that will keep Connecticut consumers from taking full advantage of the opportunity presented by the new technologies. In 2011, the average fuel economy of new cars and light truck bought in the state was 23 miles per gallon, though consumers have the option of buying significantly more fuel efficient vehicles. An analysis found that 'high

[238] NESCAUM response to DEEP data request (September 14, 2012).

[239] This analysis assumed a high oil price scenario with a 5% discount rate.

fuel economy vehicles,' averaging 4 miles per gallon more efficient than the average passenger car purchased in CT, could reduce a driver's fuel use by up to 10%.

Substantial benefits can be realized by taking steps to help consumers chose more efficient vehicles. This Draft Strategy proposes consideration of a feebate program with incentives for the purchase of high-efficient vehicles and disincentives for purchases of inefficient vehicles. The former Connecticut Department of Environmental Protection (DEP) and the Connecticut Department of Revenue Services evaluated a feebate program in 2005 and identified implementation challenges that need to be overcome to advance a feebate program in the state, though these agencies noted that such a program would be an effective tool to promote the purchase of more fuel efficient vehicles.

At the time of the study[240] Connecticut constituted around 1% of the new car sales market. As this limited market presence would not have the required effect of influencing manufacturing choices, it represented a key obstacle to implementing the feebate program. A second challenge was the need for significant education and outreach programs to adequately inform consumers, who are shopping for new cars, of the impacts of the feebate. The DEP examined various program designs and concluded that separate sliding tax schedules for cars and trucks based on average fuel economy proved to be the largest challenge for the proposed feebate program. In the 2006 report, DEP expressed its conclusion that while implementing a feebate program was technically feasible, it would be stymied by administrative complexities and significant up-front costs associated with retooling the sales tax infrastructure as it applied to the sales and lease of new motor vehicles.

For Connecticut to implement a successful feebate program it would need to include new approaches or solutions to the previously identified administrative challenges. In addition, this Draft Strategy proposes a more robust educational and outreach effort aimed at informing consumers' future car buying decisions.

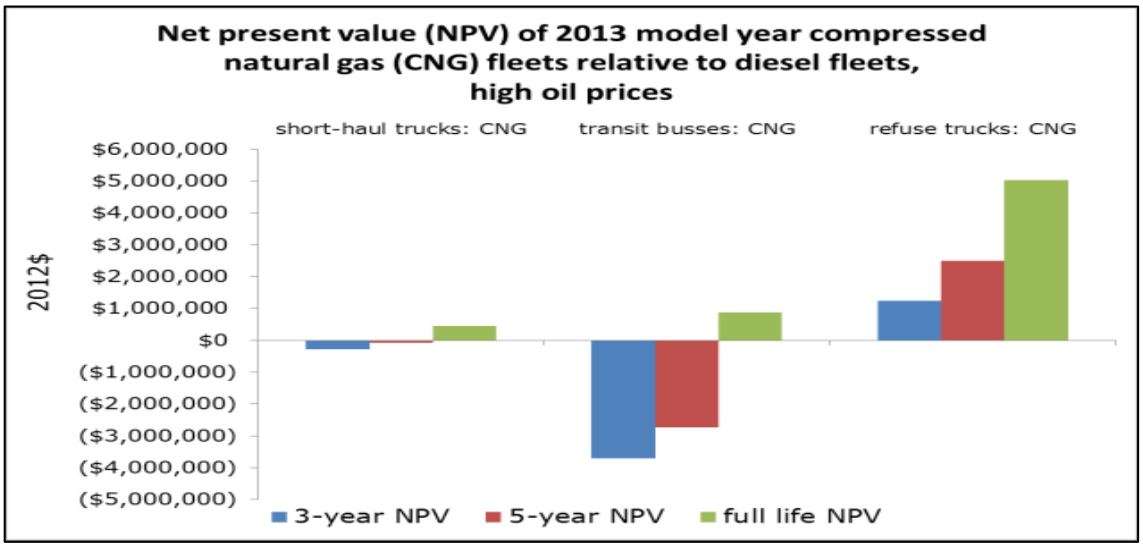
DEEP will continue to closely monitor advancements in plug-in hybrid and electric cars for opportunities to increase vehicle penetration. The challenge, however, is that at present these vehicles cost at least $3,000 more than comparable conventional vehicles (after including a $7,500 federal credit) (Table 1). If the federal tax credit expires as anticipated in 2015, the incremental cost of plug-in hybrid electric vehicles increases to greater than $10,000 (Table 1). The payback on this upfront investment appears to be longer than the 1-4 year payback period a typical consumer expects when purchasing a new vehicle.

Connecticut can also reduce fuel expenditures by helping transition appropriate vehicle fleets to CNG. Natural gas is an economically viable option for fleets such as buses, garbage trucks and taxis that regularly return to a central location for fueling. Two major Connecticut taxi companies have converted a portion of their fleet to natural gas vehicles, and additional fuel savings could come from the conversion of garbage trucks, short-haul trucks and transit buses to natural gas. Refuse trucks have the shortest payback period, with longer paybacks

[240] Connecticut Department of Environmental Protection, "Special Act No. 05-6: Connecticut Clean Car Incentive Program," (2005), available at: http://www.ct.gov/dep/lib/dep/air/climatechange/ctcleancarincentive.pdf.

for short-haul trucks and transit buses (Figure 13). A vehicle's payback period is determined by its fuel economy and the distance it travels per year; high mileage, low fuel economy vehicle like refuse trucks are ideal candidates for natural gas vehicles. There are numerous towns and cities in the state that have made the switch to natural gas powered vehicles. For example, the towns of Fairfield, Stratford, and Trumbull each have purchased CNG-powered vehicles. These vehicles save the towns from purchasing thousands of gallons of gas each year, and result in tens of tons of fewer greenhouse gas emissions.[241]

FIGURE 13: Predicted net present value (NPV) of compressed natural gas (CNG) vehicle purchases. Compressed natural gas vehicles purchased in 2014 have positive net present values, meaning that the value of fuel saved over time exceeds the initial purchase premiums

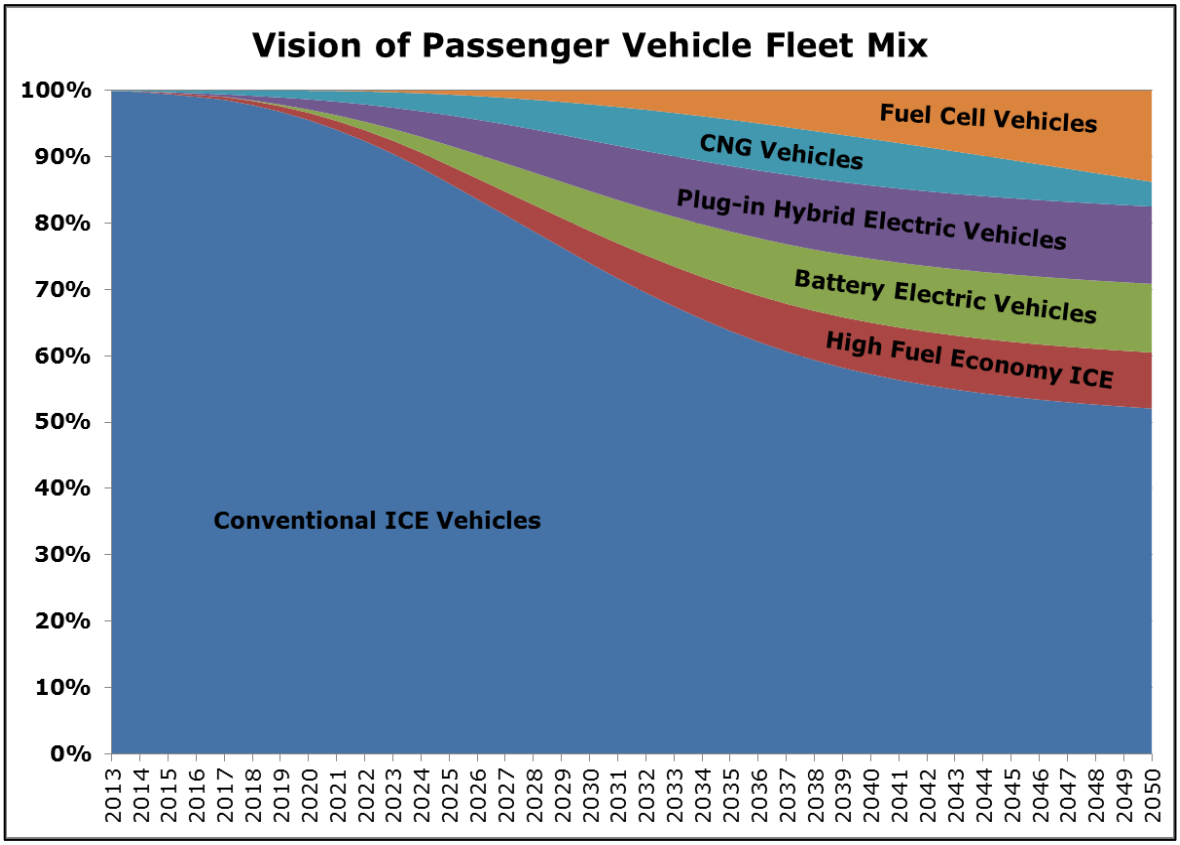


Source: NESCAUM analysis.

Finally, Connecticut should support research and development and deployment of hydrogen fuel cell vehicles. These vehicles offer the promise of very high efficiency, and very low environmental impact, while also benefiting over 600 companies that work within Connecticut's fuel cell industry. Taking full advantage of the advances in vehicle technologies and energy cost savings would significantly change the fuel mix of vehicles in the state and reduce oil consumption over time (Figure 14). There are a number of actions the State can take to help facilitate the adoption of alternative fuel vehicles. This Draft Strategy proposes that PURA adopt the use of firm rates for the basis of pricing natural gas vehicle fuel rather than linking the price to gasoline so that consumers can benefit from natural gas vehicle fuel savings. In addition, this Draft Strategy proposes strong coordination across State agencies to reduce barriers to the increased use of alternative fuel vehicles. Such coordination should address vehicle inspections, consumer protection issues, and building codes related to vehicle charging and fueling infrastructure.

[241] U.S. Department of Energy Clean Cities: Connecticut Southwestern Area Clean Cities, "2011 Annual Report", (2011).

FIGURE 14: Changes in the types of passenger vehicles would significantly reduce the amount of oil consumed by the transportation sector over time. Each band represents a percentage of the overall Connecticut fleet in a long-term vision scenario



Source: NESCAUM, Vision NE Transportation Fleet Model.

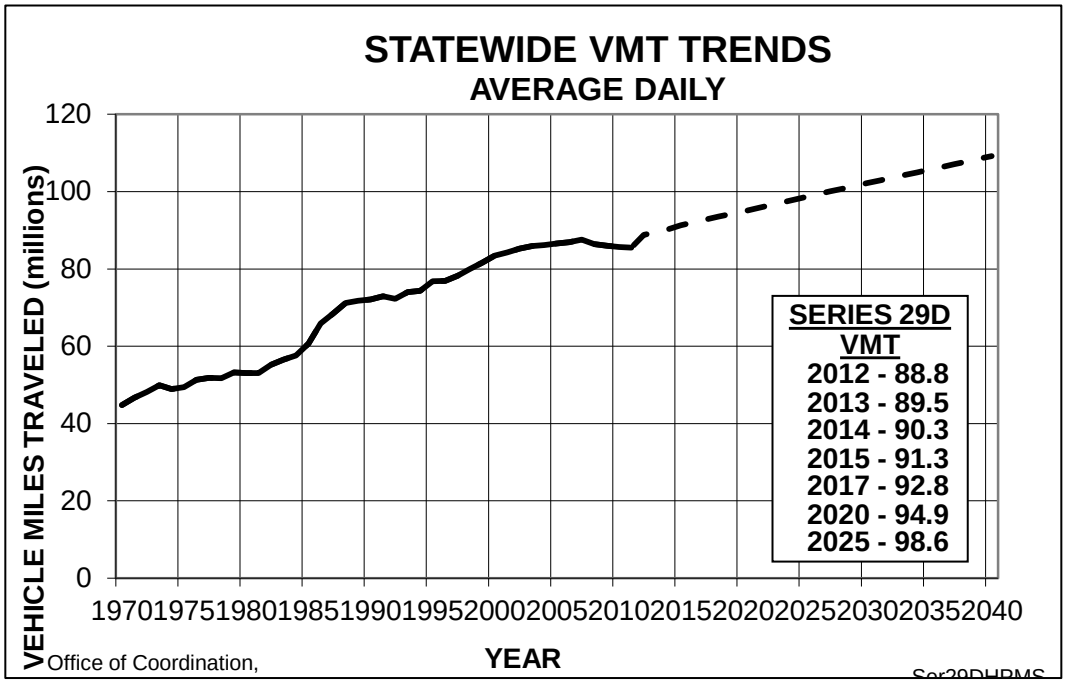
The transportation system itself can be made more efficient. Some options include more sophisticated timing of traffic lights to improve traffic flow and reduce congestion. Connecticut could also help companies improve logistics to make driving routes more efficient. Increasing the amount of cargo transported on trains or ships rather than trucks would save energy, reduce pollution and relieve congestion on major highways.

ENHANCING MOBILITY

Cleaner vehicles and fuels are not the only factors that contribute to transportation energy use, costs, and environmental impacts. VMT is an important piece of the equation. Land use patterns and mobility options largely influence how much people drive. Connecticut's VMT has grown steadily in recent decades and is projected to continue to grow, as shown in Figure 15. Research indicates that the energy and pollution gains

from cleaner vehicles and fuels can easily be offset by increases in VMT.[242] Thus, this Draft Strategy focuses on enhancing mobility options in addition to transitioning to cleaner vehicles and cleaner fuels

FIGURE 15: Average daily vehicle miles traveled in Connecticut



Source: Forecast - ConnDOT Statewide Travel Demand Model Series 29D and Highway Performance Monitoring System.

The City of Stamford has implemented a well-designed model of enhanced mobility in a transit-oriented community. Stamford has concentrated high-density residential and commercial development within one mile of its train station, and connected that development to other parts of the city with frequent bus service. This has resulted in an 18% increase in transit ridership and 14% increase in carpooling.[243]

Transit-oriented communities offer a host of other benefits in addition to saving energy and reducing automobile use. They tend to attract young professionals who can help revitalize downtowns and city economies. They lower governments' costs of delivering services (such as snow removal or road repair) because of their compact footprints. They can also direct reinvestment to historic buildings, which tend to have been built in dense areas that can support transit stations – offering an additional community benefit. A transit-oriented community that is more walkable may also increase real estate values compared to typical suburbs. Additionally, transit-oriented developments can strengthen central cities, such Stamford, Hartford,

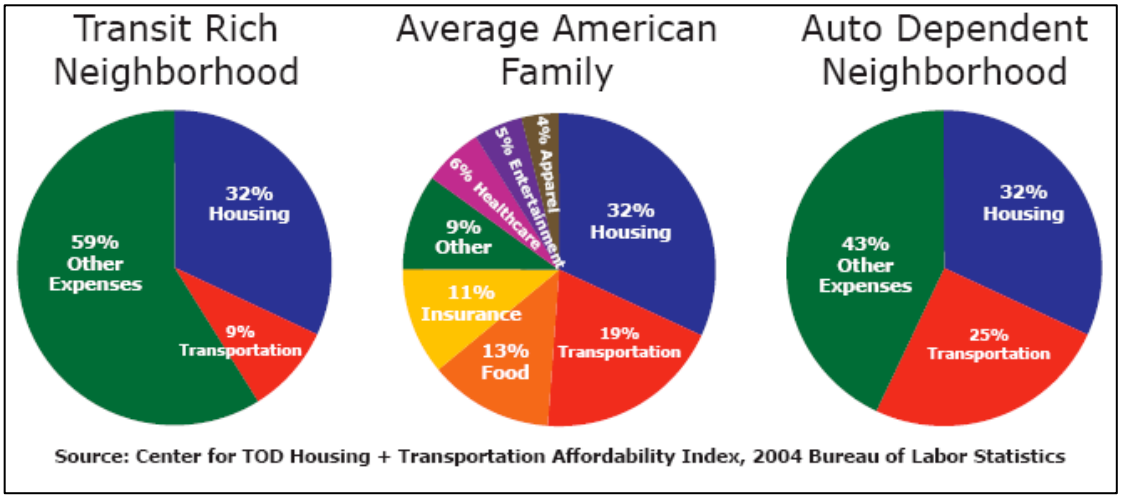
[242] Ewing, R. et al., "Growing Cooler the Evidence on Urban Development and Climate Change," Urban Land Institute (2008), available at: http://www.uli.org/wp-content/uploads/ULI-Documents/GrowingCooler.pdf.

[243] City of Stamford, CT, "Sustainability Amendment to the 2002 Master Plan," (2010), available at: http://www.cityofstamford.org/filestorage/25/52/138/164/202/SUSTAINABILITY_AMENDMENT_FINAL_12_23_2010.pdf

Bridgeport, Waterbury, and New Haven, which could all benefit from the additional infill projects that tend to follow the arrival of transit.

In Connecticut, where cost of living is higher than the national average, transportation savings accrue from transit-oriented development translate into additional savings that can be used for other family needs. The pie charts in Figure 16 below, compiled from the Housing and Transportation Affordability Index, illustrate how transportation costs can vary based on access to quality transit service and land use characteristics.[18]

FIGURE 16: Types of expenses in different U.S. neighborhoods



Source: Center for TOD Housing & Transportation Affordability Index, 2004 Bureau of Labor Statistics.

It is an opportune time for the State and its municipalities to seek opportunities to engage smart growth principles to guide future development around the lines by consciously shaping the development that is expected to occur around State's current major transit projects: the New Haven-Springfield rail line, the CTfastrak busway from New Britain to Hartford (which will have permanent stations), and the Metro-North rail enhancement. Together, these new transit projects will make it possible for thousands more Connecticut residents to travel by rail or bus. This would cut vehicle miles traveled by up to 240 million miles and save nearly 9 million gallons of fuel annually. The State and localities can maximize the benefits from these new transit stops.

OFFERING TRANSPORTATION CHOICE

While smart growth and transit-oriented development can change and improve the way people live and work, substantial the near-term energy savings and other benefits can also be realized by reducing the number of miles that typical cars and trucks travel. One possible incentive to reduce VMT would be an auto insurance structure that links premiums to the number of miles driven. A 2008 Massachusetts Institute of Technology study for Massachusetts projected that pegging insurance costs to miles driven can reduce vehicle miles

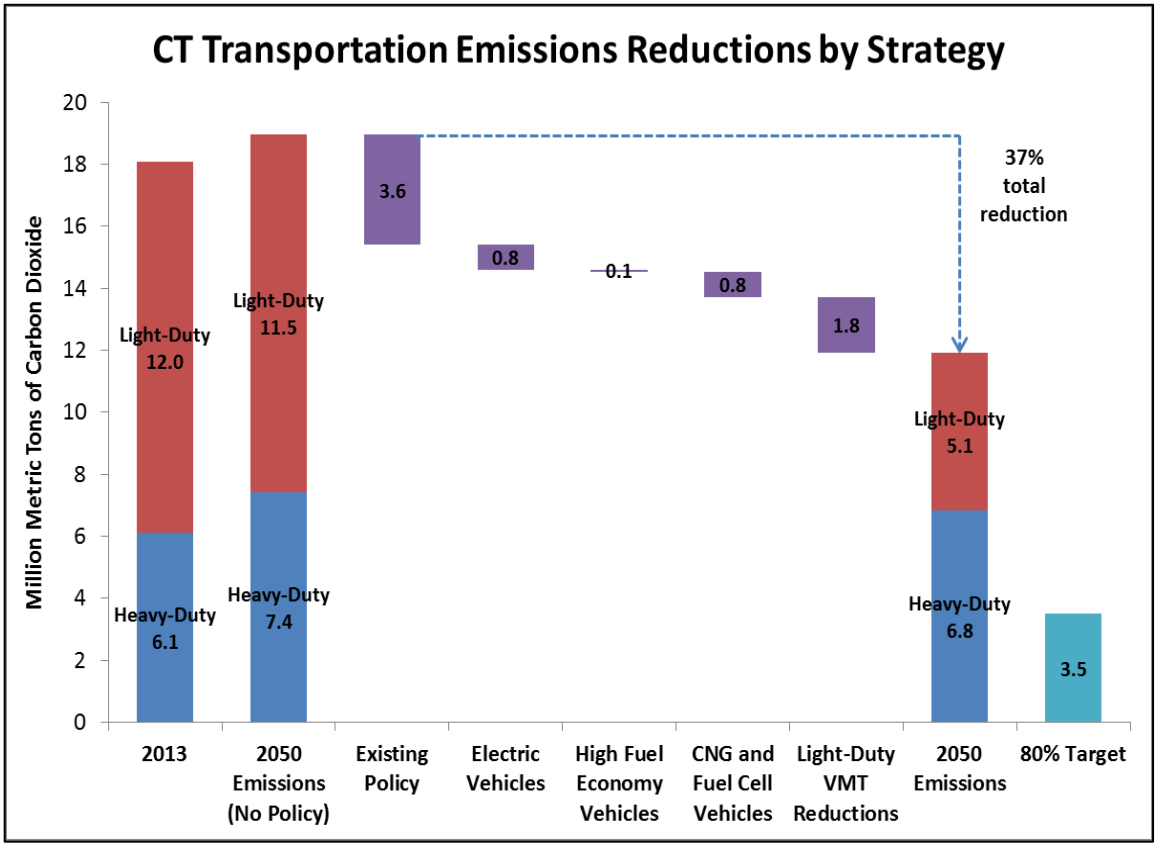
traveled by 3% to 7%.[244] Pilot pay-as-you-drive projects have cut driving by 8% and 10% in Minnesota and Texas, respectively.

Another incentive employers can provide is to subsidize employee public transit fares and eliminate free parking. Similarly, encouraging employers to allow workers to telecommute, or to work the same number of hours in fewer days, would reduce the number of cars on the road. Increasing carpooling or ridesharing puts the people who do travel into fewer cars. Promoting car sharing and making it easier to walk, bike or ride to existing buses, trains and subways – or directly to destinations – also positively impacts vehicle miles traveled. As noted above, the best, and by far most impactful, long-term approach for reducing transportation's negative impacts is to develop a framework for compact, transit-oriented development in Connecticut's larger cities. These cities, some parts of which suffer from disinvestment or underinvestment, offer many opportunities for dense development that could both support, and be supported by, transit nodes. A transit-oriented development strategy must involve an understanding of housing, urban economy, transit systems, vehicular parking and driving needs, job opportunities, essential services and infrastructure, and retail options.

Combined with the use of alternative fuel economy vehicles in the light-duty sector, significant reductions in light-duty vehicle miles travelled per capita and additional use of compressed natural gas for municipal fleets and short haul trucks could cut energy use by 19% and greenhouse gas emissions by roughly 37% by 2050. Even this aggressive suite of policies falls short of the state's 80% greenhouse gas reduction goal, illustrating the challenge in reducing transportation sector emissions. Figure 17 shows the relative contribution of different technologies and policies towards achieving these reductions.

[244] Ferreira, J. Jr. & Minikel, E., "Pay-As-You-Drive Auto Insurance in Massachusetts A Risk Assessment and Report on Consumer, Industry, and Environmental Benefit," Massachusetts Institute of Technology (November, 2010), available at: http://www.clf.org/wp-content/uploads/2010/12/CLF-PAYD-Study_November-2010.pdf.

FIGURE 17: Connecticut's Transportation Energy Strategy can cut greenhouse gas emissions by roughly 37% by 2050. This figure falls short of the 80% statewide reduction goal, however, it represents the potential greenhouse gas reductions possible by just one sector



Source: NESCAUM analysis using the EPA Motor Vehicle Emission Simulator (MOVES) model and post-processing tools.

TRANSPORTATION SECTOR STRATEGY: RECOMMENDATIONS

This Draft Strategy seeks to address the concerns and harness the opportunities described above and concludes, as it has in other Chapters, that the most economic and easily achievable benefits will come from increasing efficiency in all components of the transportation sector. Recognizing that government resources are limited, this Strategy recommends the following actions to achieve energy savings in the transportation sector:

1. Promote The Use Of Highly Efficient Vehicles For Passengers And Freight

Highly efficient, affordable cars and light trucks in every vehicle class are already on the market, but many customers are not aware of their availability and benefits. In coordination with the Department of Motor Vehicles (DMV) and ConnDOT, DEEP should disseminate information on state websites and in DMV communications to educate the public about the relative efficiency of vehicles within each vehicle class and encourage purchase of cars and light trucks that have high fuel economy ratings.

2. Develop A Clean Vehicle/Clean Fuels Technology Platform In Connecticut

In an effort to foster Connecticut's clean vehicle/clean fuel platform, DEEP will advance the following:

- A targeted build-out of an additional 50 publicly available Level 2 electric vehicle charging stations at shopping malls, parking lots, and other sites across the state – sufficient to eliminate range anxiety. In addition DEEP and ConnDOT will work to establish a network of 10 Level 3 electric vehicle charging stations by 2014, located primarily at highway service plazas on the interstate highways.
- Development of a pilot program to support the conversion of fleet vehicles to natural gas vehicles and the build-out of a network of publicly available LNG and CNG filling stations.
- Continued pursuit of federal funding opportunities to advance research and development of hydrogen fuel cell technology in the transport sector.
- Creation of an inter-agency working group comprised of ConnDOT, DEEP, the DMV, and the Departments of Consumer Protection, Administrative Services, and Revenue Services to identify and implement changes needed to support alternative fueled vehicles including, but not limited to DMV inspection processes, consumer protection issues for alternative fuels, and building code components related to alternative fuel charging and refilling.

This Draft Strategy also recommends that PURA adopt the use of firm rates rather than non-firm rates to base the price of natural gas vehicle fuel rather than linking it to the price of gasoline thereby providing a clearer price signal that will incent greater utilization of natural gas vehicles.

3. Facilitate Transit-Oriented-Development To Increase Mobility And Create More Livable Communities

The money currently being invested in the State's three major transit projects (CTfastrak, New Haven – Springfield rail, and Metro-North passenger rail enhancements) should be leveraged to maximize transit use and reduce vehicle travel demand. This can be done by coordination among agencies to align State infrastructure spending to support strategic growth within these corridors. For example, state funding for sewers and other infrastructure could be focused to allow for high-density development in these transit corridors.

The State should also continue to promote alternate commute options through its existing statewide transportation demand management measures such as ConnDOT's RideShare and Telecommute Connecticut. These successful programs should be expanded and marketed more aggressively.

In addition, OPM, DECD, ConnDOT, and DEEP will collaborate to support municipal efforts to build walkable, bikable, transit-oriented communities and to implement the following strategies that are consistent with State statutes and the State's draft Plan of Conservation and Development:

- Develop "priority funding areas" for growth and development (as required by PA 05-205 and in the draft Plan of Conservation and Development)
- Require state agencies to consider whether certain grant application proposals comply with smart growth principles (in accordance with Public Act 10-138)
- Pursue the Growth Management Principles in the draft Plan of Conservation and Development, including:
    - Redevelop and revitalize regional centers and areas with existing or currently planned physical infrastructure
    - Concentrate development around transportation nodes and along major transportation corridors to support the viability of transportation options
    - Promote integrated planning across all levels of government to address issues on a statewide, regional and local basis

4. Follow Best Practices To Improve The Efficiencies Of The Transportation System

Within the construct of current responsibilities ConnDOT will work with Regional Planning Organizations and the municipalities to improve traffic light timing to speed traffic flow and reduce congestion. In addition, existing traffic synchronization systems must be maintained to ensure they operate efficiently. The State will also encourage and support efforts by trucking companies to plan travel and delivery routes more efficiently, and continue to support efforts consistent with the Governor's Port Study to move freight from trucks to more energy efficient trains and ships.

5. Develop Sustainable Funding Sources For An Efficient Transportation System

▪ As the State seeks to establish a sustainable transportation funding mechanisms it needs to ensure that there is funding to support a clean, efficient and safe transportation infrastructure. The options outlined by the Transportation Strategy Board, included in Appendix D, need to be evaluated on the basis of their ability to provide funding sufficient to sustain current transportation sector needs as well as those that will be needed to enhance mobility options and reduce the negative economic and environmental impacts of transportation.

CONCLUSION

A cleaner, more efficient transportation sector would bring tremendous benefits to Connecticut. Improving the efficiency of the cars and trucks on our roads improves the quality of life for the state's residents, puts money back in people's pockets, reduces pollution, and boosts the state's economy. Giving people incentives and opportunities to explore transportation options that reduce energy use and costs will also reduce traffic congestion and improve everything from worker productivity to quality of life. Creating a hospitable environment for the vehicle/fuel technologies of the future will help ensure that Connecticut can play a leadership role as the in the market transforms to include these vehicles. By ensuring that communities are more walkable and bikable, and have enhanced options for safe, efficient transportation, Connecticut will offer its residents a broad array of choices to meet their transportation needs, and the State will become an even more attractive place to live and work.

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