List of Other Studies and Proceedings That Were Initiated or Concluded in 2018.

1. Connecticut completed a comprehensive energy strategy report that addressed EV adoption and infrastructure. They discussed programs such as grants for charging stations to improve range-confidence, rebates for EV purchases, and transit bus program "CTFastrak." The study also, accelerated adoption of an EV roadmap which included battery storage issues, impact to the electric grid, and developed partnerships with other EV parties.	See Exhibit A for document
2. Delaware did a cost benefit analysis of EV adoption. Key findings included: EV-related benefits are substantial; vehicle costs are decreasing; large improvements in emissions/air quality; potential for grid benefits will benefit all customers; managed charging is the best approach to maximize benefits; and it's very cost effective (RIM = 2.92). EV penetration in DE has been low but pace has picked up recently (p.8). DE forecasted sales through 2025 are still low, trend increases around 2027. (p10) Sales were 0.8% in 2019; 82% in 2035. Most charging is residential off-peak – primary driver of economic benefits (p16). The cost benefit analysis assumes federal incentives available through 2027. (p24) Delmarva Power & Light (DPL) is proposing 7 programs (p25): • Residential TOU rate • Residential level 2 charging • New Residential Smart Level 2 charging • New Multi Family Smart L2 • Neighborhood Smart L2 • DCFC • School Buses (largest spend) Average wholesale cost of electricity is reduced if charging happens off-peak. (p39)	See Exhibit B for document Delaware PUC Link - 1

3. Florida report updates a previous 2012 report on EV adoption. Sales are expected to remain small through 2028 (p.6 & 10). TOUs can help manage peak demands. (p7) EV charging is likely to require additional investment in distribution system. (p8) Report offers a good table of incentives available by state as of September 2017 (NC is included in list). Recent initiatives in Florida include EV rebates for the purchase of EVs; financing options for EVSE; HOV land privileges. (p15) Pilots approved include Gulf Power's residential charging station pilot that offers lower rates for EV charging and rebates for EVSEs; Duke Energy Florida was allowed to spend $8 million on deployment of 530 charging stations (L2 and DCFC), with 10% of those in low income areas. (p16)	See Exhibit C for document
4. Hawaii report discusses actions that could accelerate EV adoption. HI has an aggressive renewable energy goal (100% by 2045). The HI report identifies barriers to adoption (p43): lack of understanding/awareness; EV availability and costs; lack of charging infrastructure, rate structures for bus companies; lack of dealership incentives to sell EVs. The report focuses on light duty vehicles and buses early on (p64). Initiatives include partnering with others to improve education; lowering EV costs; expanding access to charging stations in residential multi-unit developments, workplaces, and public charging; smart charging of buses and light duty vehicles. (p65) The report also fosters opportunities for third parties to be involved with these initiatives and (p66) electrification of buses (transit and school). (p91)	See Exhibit D for document
5. Ohio's Power Forward Roadmap outlines among other things impacting grid modernization, the scope of EV's impacts on modernization. Commission found no immediate need to address EV home charging because it was a small impact to the grid. They did recognize the role of TOUs and a competitive marketplace for charging infrastructure. They also acknowledged a "chicken and egg conundrum" regarding DCFC stations, but did not take any action.	See Exhibit E for document
6. Colorado study includes vehicle-to-grid technology, trucks and buses, rate design and EV infrastructure needs. Report was filed January 15, 2019.	CO PUC Link - 1

7. Connecticut has a proceeding evaluating the role of EVs and how that will inform rate design.	CT PUC Link - 1
8. PEPCO has a transportation plan pending before the DC Public Service Commission. The programs included in that proposal includes: • Residential TOUs • Rebates for residential EVSEs • Incentives for residential single and multi-unit dwellings smart level 2 chargers • Incentives for L2 workplace and public neighborhood EVSEs • Incentives for DCFC • Incentives for fleet/light duty and taxi infrastructure and EVSE incentives for transit bus EVSE	DC PUC Link -1 DC PUC Link - 2
9. Duke Energy Florida has a 3-year pilot to study EV charging patterns. The pilot includes installing EVSE for multi-unit dwellings, workplaces, public level 2, and DCFC.	DEF Link - 1
10. Minnesota PUC has a proceeding now evaluating EV initiatives. They required utilities to file a report regarding future pilots and initiatives. Xcel Energy's report has similar characteristics and intentions that Duke has proposed.	MN PUC Link - 1
11. New York PUC issued an order February 7, 2019 that established framework for DCFC.	NY PUC Link - 1
12. Vermont PUC issued an order August 8, 2018 establishing an EVSE docket.	VT PUC Link -1
13. Arizona PUC issued order directing all utilities to propose pilots to gain information about EV charging and EV rates. Includes level 2, public, and bus-related EVSE.	AZ PUC Link - 1 AZ PUC Link - 2

14. Maryland PUC issued order January 2019 approving pilot programs similar to Duke. The order applies to several utilities including Delmarva and PEPCO which are listed elsewhere in this document.	MD PUC Link - 1
15. California PUC approved a pilot program for Southern California Edison to pilot EVSE. Another application is pending (Application No. A1806015) that includes EVSE deployment of DCFC and multi-unit dwellings.	CA PUC Link - 1 CA PUC Link - 2
16. National Grid filed a rate case that included a request for approval of level 2 residential and nonresidential level 2 EVSE, and DCFC. The request is still pending.	MA PUC Link - 1
17. On January 9, 2019, the Michigan PUC approved a pilot program for Consumers Energy that included residential and nonresidential rebates for EVSE.	MI PUC Link - 1
18. On May 2, 2019, the Michigan PUC approved a pilot program for DTE related to residential level 2 EVSE.	MI PUC Link- 2
19. Missouri PUC approved a request by Ameren on February 6, 2019 for EVSE pilots related to multi-unit dwellings, workplace, public, and corridor charging.	MO PUC Link -1
20. New Jersey PUC is still reviewing Atlantic City Electric's EV pilot proposals, which include rebates for residential level 2, multi-unit, workplace, and DCFC EVSE. (Docket No. EO18020190)	NJ PUC Link - 1
21. New Jersey PUC is reviewing Public Service Electric & Gas Company (PSE&G) EV pilot proposal, which includes rebates for residential level 2, multi-unit, workplace, and DCFC EVSE, and transit and school bus rebates. (Docket No. EO1810111)	NJ PUC Link - 2

22. Pennsylvania PUC approved a rate case order for Duquesne Light Company that included EV pilots for DCFC and public level 2 EVSE.	PA PUC Link - 1
23. South Carolina PUC is considering almost identical pilots for Duke Energy Carolinas and Duke Energy Progress that are being considered in North Carolina.	SC DEC PUC Link - 1 SC DEP PUC Link - 1
24. On December 13, 2018 Staff for the Washington PUC recommended approval of a pilot for Puget Sound Energy that applies to residential, multi-family dwellings, workplace, fleet, and public charging. Emphasis is given on giving access to low income customers. This recommendation effectively allows the pilots to be approved.	WA PUC Link - 1
25. Southern California Edison (SCE) has a pilot for public charging EVSE. The California PUC order was issued December 21, 2018 approving the request.	CA PUC Link - 3
26. The Kansas PUC issued an order dated December 13, 2018, that approved a program for public level 2 and 3 EVSE for Kansas City Power & Light.	KS PUC Link - 1

COMPREHENSIVE ENERGY STRATEGY

February 8, 2018

CT GENERAL STATUTES SECTION 16a-3d

Table of Contents

Executive Summary

The Connecticut Department of Energy and Environmental Protection (DEEP) has prepared this update to Connecticut's Comprehensive Energy Strategy (CES) to advance the State's goal of creating a cheaper, cleaner, more reliable energy future for Connecticut's residents and businesses. By statute, DEEP is required to periodically update the CES plan for all energy needs in the state, including, but not limited to, electricity, heating, cooling, and transportation. This CES analyzes energy use and key trends across these sectors, and it reports on progress made since 2013 (see Current State Trends and Background Information by Sector). Based on this analysis, DEEP recommends eight priority strategies to guide administrative and legislative action over the next several years (see Strategies).

Energy progress since 2013

Since the publication of the first CES in 2013, the State has advanced policies and programs that have put Connecticut on a path to reduce energy costs, improve system reliability, and minimize environmental impacts for its residents and businesses. Connecticut has achieved significant progress in key areas, including:

- **Rapidly expanded renewable energy programs at all project scales.** DEEP has directly procured cost-effective commitments of renewable energy generation and energy efficiency that equal the generation of a large power plant. Specifically, the State has procured over 400 megawatts (MW) of DEEP-solicited small-scale renewable energy and energy efficiency resources as well as over 400 MW of large-scale renewable energy projects, 90 MW of which will be located in Connecticut. In recent procurements the price of selected grid scale bids decreased by nearly half compared to procurements in 2012 and 2013, indicating that competitive procurements are an effective approach to securing renewable energy projects. The State also launched a Shared Clean Energy Facility pilot program, with DEEP selecting over 5 MW of solar that will have a dedicated subscription target of low- and moderate-income consumers. Through virtual net metering, state, municipal, and agricultural customers had opportunities to develop renewable energy generation projects that lowered their electricity bills.

- **Built critical infrastructure and enabled customer choice.** DEEP developed a first-in-the-nation statewide microgrid program to improve local resiliency for electrical load in critical community operations. Program implementation now includes five operational microgrids and five microgrids under development. The 2013 natural gas expansion program converted 39,104 residential customers to natural gas for heating, and it converted 12,021 commercial and industrial customers to natural gas for generation or other processes between 2014 and 2016.

- **Catalyzed residential and commercial investments in energy efficiency across the state.** Connecticut's award-winning Conservation and Load Management Plan (C&LM Plan), supported by a combination of ratepayer funds and proceeds from the Regional Greenhouse Gas Initiative and ISO Forward Capacity Market auctions, catalyzes activities that strengthen

Connecticut's economy. Together, these investments fuel an energy efficiency industry with 34,000 jobs in Connecticut, with approximately 12,000 of those jobs generated through implementation of the C&LM Plan. This results in a reduction of CO_2 emissions by 262,511 tons each year. Each year between 2014 and 2017 these investments have empowered Connecticut residents to collectively save more than $40 million annually, the state's businesses to save more than $38 million annually, and State agencies to save $6 million annually. For every public dollar invested, implementation of the C&LM Plan leverages multiple dollars of private investment from motivating actions by residents and businesses to invest their own capital in energy saving measures, which drives hundreds of millions of dollars each year in energy efficiency investment. In 2016, the C&LM Plan's implementation generated a nearly $1.4 billion increase in the gross state product.[1] Investments are spread across projects statewide, including in more than 20,000 low-income homes annually and in more than 6,500 businesses, large and small, each year. Catalysts also include utilities and others providing low- or no-interest financing for heating equipment with simplified applications and on-bill repayment, and market-based actions that transform energy use. In addition, Connecticut became the first state in the nation to implement the U.S. Department of Energy's Home Energy Score labeling system on a statewide voluntary basis, producing over 21,000 scores to date.

- **Forward-looking transportation investments.** The State launched the EVConnecticut program to provide grants for charging and alternative fueling stations to make Connecticut a range-confident state, and to deploy point-of-sale vehicle rebates through the Connecticut Hydrogen and Electric Automobile Purchase Rebate (CHEAPR) program—supporting the purchase of 1,300 EVs. In addition, CT*fastrak* bus rapid transit (BRT) service doubled the ridership in corridor to between 12,000-16,000 weekday trips and helping riders avoid rush-hour congestion. The publication of Let's Go CT!, Governor Dannel Malloy's transportation Call to Action, represents a 30-year vision for Connecticut's best-in-class transportation system.

- **Innovative investments by the Connecticut Green Bank.** The Connecticut Green Bank is making green energy more accessible and affordable for the State's families and businesses, while creating jobs and supporting local economic development. Since its formation in 2011, for every public dollar invested, the Green Bank has attracted six dollars of private investment[2]. Green Bank has created an estimated 13,000 jobs and driven a total of $1 billion of clean-energy investment[3]. This translates to more than 215 megawatts of clean power, over 20,000 projects, and reduction of CO_2 emissions by 2.6 million tons.

[1] Eversource Energy; The United Illuminating Company; Connecticut Natural Gas Corporation; The Southern Connecticut Gas Company. 2015. *Connecticut General Statutes Section 16-245m(d) 2016-2018 Electric and Natural Gas Conservation & Load Management Plan* . 1 October.

[2] http://www.ctgreenbank.com/wp-content/uploads/2016/11/CTGreenBank-CAFR-2016-Published-JJM-Revision.pdf

[3] http://coalitionforgreencapital.com/wp-content/uploads/2017/04/CT-Green-Bank-Org-Fact-Sheet.pdf

Process to develop the 2018 Strategy

DEEP held a series of scoping meetings, informational meetings, and workshops to obtain broad input during development of the CES.

- May 24, 2016: DEEP held a scoping meeting to receive stakeholder feedback on the major topics to be included in the strategy.
- October 27, 2016: DEEP held an informational meeting on demand resource management at the regional and local level.
- November 3, 2016: DEEP held an informational meeting on air- and ground-source heat pumps, solar water heating, and biodiesel as a thermal fuel.
- January 10, 2017: DEEP and the Department of Agriculture co-convened a workshop to discuss state renewable energy programs and their intersection with environmental, agricultural, and land-use policies.
- February 15, 2017: DEEP held an informational meeting on implementation of the agency's strategies to reduce and improve energy use in state buildings.

DEEP released the draft CES on July 26, 2017. In August and September of 2017, DEEP held public hearings in Willimantic, Bridgeport, Trumbull, Torrington, Hartford, and New Haven. In addition, DEEP held two technical meetings during August and September and held a 60 day public comment period.

DEEP received a total of more than 2,000 written and oral comments. Some of the most commonly referenced topics included:

- **CES strategies and policies to achieve carbon-emissions reduction targets.** Commenters questioned whether the proposed energy strategies would reduce GHG emissions enough to meet targets set by the Global Warming Solutions Act.
- **Development of clean energy and the Renewable Portfolio Standard (RPS)**. Several commenters recommended a more aggressive RPS, citing that 30 percent by 2030 was not sufficiently aggressive, and suggested increasing the RPS to 40+ percent. Commenters also advocated for Connecticut to transition from fossil fuels and increase development of "clean" or "green" renewable energy sources.
- **Conservation charge.** Many commenters expressed opposition to the proposed conservation charge on fuel oil and propane designed to sustain affordable investments in energy efficiency in buildings heated with oil or propane. The commenters cited concerns about financial impacts on residents and small businesses. Some commenters suggested a carbon fee instead of a propane/oil charge.

- **Biodiesel/bioheat.** Several comments were received in support of an expanded use of biodiesel as a heating fuel.

- **Heat pump conversions**. Several commenters opposed any subsidy for conversion of oil, propane, or natural gas customers to air- or ground-source heat pumps (considered a renewable thermal technology). Some commenters supported greater investment in geothermal heat pumps.

- **Economic development**. Commenters expressed a desire for inclusion of more money-saving/cost effective policies to benefit Connecticut citizens. They recommended the final draft align DEEP's energy policy with plans for local and statewide economic growth.

- **Shared solar.** Several commenters advocated for a statewide shared solar program.

- **Nuclear energy**. Several commenters discouraged state support for the Millstone nuclear generating facilities and/or nuclear power in general and called for replacement of nuclear with renewables.

- **Behind the meter (BTM) renewable generation**. Commenters expressed concern that the proposed move to a renewable tariff would "undervalue" BTM generation. Comments specifically identified a concern about the transition process to a new tariff and ensuring transparency throughout the process. Several commenters also encouraged DEEP to rethink eliminating net energy metering and also encouraged a process to evaluate benefits.

- **Renewables siting/farmland preservation**. Commenters identified land use and farm preservation as critical factors to balance in decisions about siting renewables in Connecticut.

- **Grid modernization**. The comments received were mostly supportive of grid modernization efforts, arguing that these efforts foster greater economic stability.

- **Energy affordability**. Several comments were received regarding the energy-affordability gap for low- and moderate-income residents.

- **Decarbonizing the transportation sector**. Some commenters argued there is a need to provide infrastructure for hydrogen fuel vehicles, consider biodiesel as transport fuel, and invest in more bike lanes. Commenters asked that environmental justice and equity be considered as incentives are designed.

- **Electric vehicles (EVs).** Some constituents asked that DEEP more thoroughly consider the impact that electric vehicles will have on the grid, on the state's economy, and on jobs. Overall, comments suggested that the state speed adoption of EVs and creation of the EV roadmap.
    - ***Consider impacts of battery production.*** Several commenters requested that DEEP consider the impact of EV battery production on the environment and on emissions.

- ***Increase renewable deployment and a "clean grid."*** Numerous commenters noted that EVs are only as clean as the electricity that charges them. They suggested that EVs should be charged with electricity produced by renewables.
- ***Charging infrastructure.*** Commenters suggested that DEEP work with the local fuel industry and use existing infrastructure to deploy EV charging stations. Recommended locations for charging infrastructure included existing gas stations and state/municipal property.

- ***CHEAPR.*** Several commenters recommended ensuring permanent funding for the Connecticut Hydrogen and Electric Automobile Purchase Rebate (CHEAPR) program in order to better incentivize clean-energy vehicles.

- **Mass transit**. Several commenters urged that DEEP prioritize mass transit over car infrastructure in order to reduce use of fossil fuels. They also suggested that mass transit should be encouraged, including the proposed Springfield-New Haven rail line.

- **Freight**. Some commenters suggested that the State increase the allowable weight of large commercial trucks in order to reduce the number of trips they must take and thereby reduce emissions. Others recommended DEEP work to move freight off of roads and onto railways.

- **Opposition to natural gas**. Commenters cited concerns about Connecticut's dependence on natural gas as a primary fuel. Commenters described the environmental implications of hydraulic fracturing and gas leaks. Some were concerned about natural gas expansion hindering the deployment of renewable energy. Others expressed concern about new pipeline infrastructure and supported leak-detection and remediation programs.

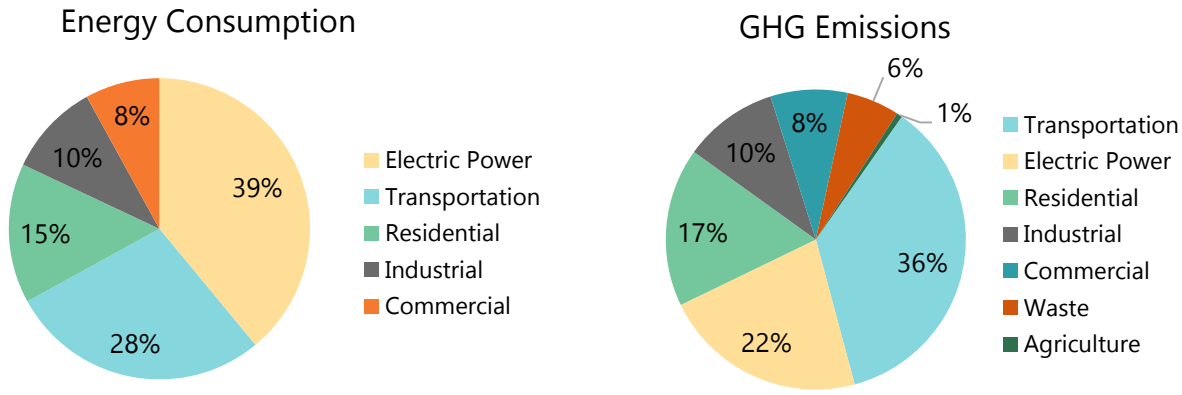
All of the comments received have been summarized and provided in the appendix.

Connecting Energy Policy and Climate Goals

Energy consumption accounts for 93 percent of GHG emissions in Connecticut. Across energy usage sectors, transportation is the largest contributor of emissions, accounting for 36 percent (see Figure ES1).[4] Residential, industrial, and commercial uses of energy – primarily for heating and cooling buildings – constitute 35 percent of GHG emissions.

[4] Connecticut's transportation emissions, as a percentage of total GHG emissions, are well above the national average of 27 percent. See U.S. EPA's inventory of U.S. Greenhouse Gas emissions and Sinks: 1990 -2015, April 2017. https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2015

FIGURE ES1: Connecticut Energy Consumption and GHG Emissions by Sector



Source: United States Energy Information Administration

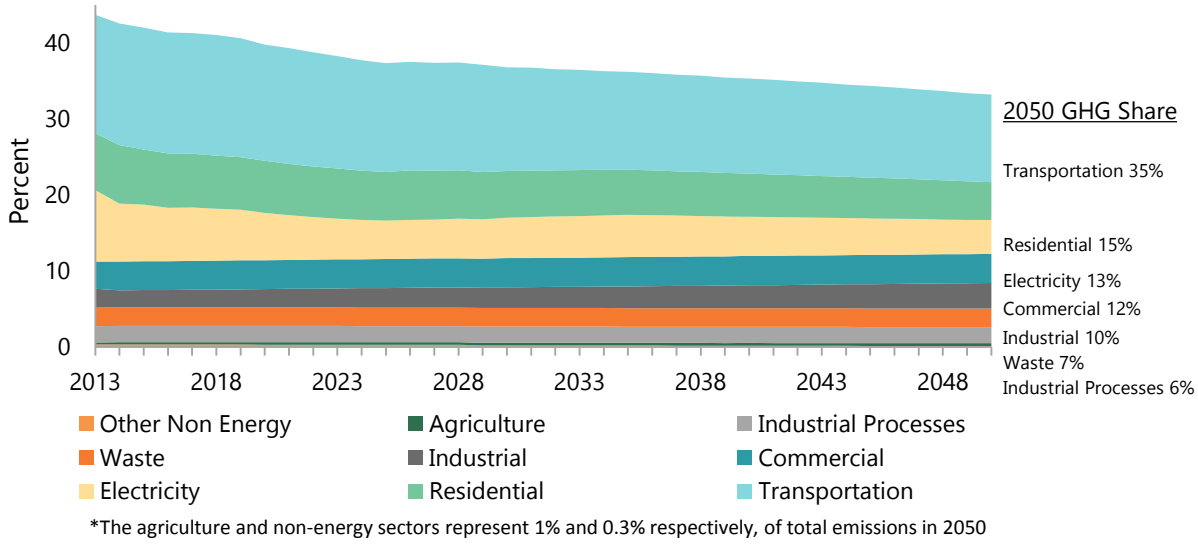
At 22 percent, the electric power sector is the second-largest source of Connecticut's GHG emissions. However, since 2001 electric sector emissions have been declining. According to ISO New England, between 2001 and 2014 carbon dioxide emissions from electric generation in New England dropped 26 percent, while nitrogen oxide emissions declined 66 percent and sulfur dioxide emissions declined 94 percent. This decline can be attributed to the transition from carbon-intensive fuel sources such as coal and oil to less carbon-intensive fuel sources such as natural gas and renewables.[5] It is important to note that in 2015, following retirement of the Vermont Yankee nuclear plant, New England saw a rise in carbon dioxide emissions of 2.5 percent over 2014 emissions.[6]

DEEP's 2016 inventory of GHG emissions in 2013 (the most recent report available) shows that the state had reduced emissions 4 percent below 1990 levels and 14 percent below 2001 levels.[7] Connecticut has made progress in reducing GHG emissions, but far deeper cuts are needed in the coming decades to meet the Global Warming Solutions Act's (GWSA) 2050 target. Connecticut must continue to move swiftly to decarbonize its energy supply across all sectors.

[5] New England Power Grid 2016-2017 Profile, ISO New England, https://www.iso-ne.com/static-assets/documents/2017/01/ne_power_grid_2016_2017_regional_profile.pdf
[6] 2015 ISO-NE Electric Generator Air Emissions Report
[7] 2013 Connecticut Greenhouse Gas Emissions Inventory, CT DEEP, 2016
http://www.ct.gov/deep/lib/deep/climatechange/2012_ghg_inventory_2015/ct_2013_ghg_inventory.pdf

In an analysis completed by the Northeast States for Coordinated Air Use Management (NESCAUM) for the Governor's Council on Climate Change, the business-as-usual reference case shows emissions from the electric power sector will continue to decline through 2050, while emissions from the transportation sector will remain almost constant at 35 percent.[89] The residential, electric power, commercial, and industrial sectors follow at 15, 13, 12, and 10 percent, respectively, in 2050 (Figure ES2).

FIGURE ES2: Economy-wide GHG Emissions Business as Usual Reference Case



*The agriculture and non-energy sectors represent 1% and 0.3% respectively, of total emissions in 2050

Today, over 80 percent of Connecticut households and commercial and industrial buildings are heated with fossil fuels.[10] Improving building efficiency, and reducing vehicle miles traveled can help decrease the use of carbon-intensive fuels. Yet, to achieve the long-term vision of a zero-carbon economy, widespread electrification of building thermal loads and the transportation sector is required. By 2050 electricity must become the dominant form of energy consumed in Connecticut, and the cornerstone of the state's carbon-free economy will be decarbonization of the electric power sector.

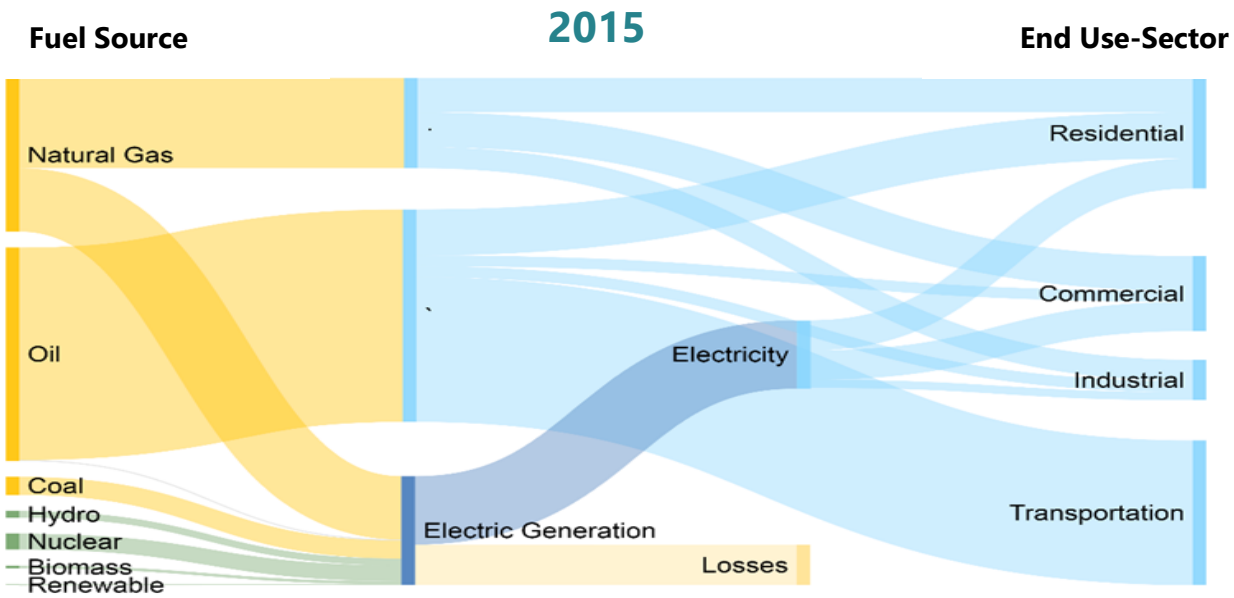
As electricity demand increases to meet more of the state's thermal loads and transportation needs, curbing peak energy demand through demand management and energy efficiency measures will become increasingly important. Energy efficiency can reduce both consumption and peak demand, avoid transmission and distribution costs, and mitigate price effects in the wholesale market. Energy savings from efficiency investments are currently being achieved at a cost of about 4.5 cents per kWh

[8] Governor Dannel P. Malloy's Executive Order 46 (4-22-15) established the Governor's Council on Climate Change to examine the efficacy of existing policies and regulations designed to reduce GHG emissions and identify new strategies to meet the established emission reduction targets.
[9] Governor's Council on Climate Change meeting. January 22, 2016.
[10] Gronli et. al. 2017. Feasibility of Renewable Thermal Technologies in Connecticut: Market Potential.

of lifetime electric savings.[11] Therefore, not only is it a low-cost energy resource that delivers savings to ratepayers but also a critical method for offsetting and neutralizing increased demand from expanded electrification of home heating and cooling.

Figure ES3 shows the estimated energy flow for 2015.[12] The left side of the figure identifies the primary type of energy supply (natural gas, oil, coal, hydro, nuclear, biomass, or renewables). The height of each bar corresponds to the amount of energy from that source. The figure also shows the portion of energy supply that is used to generate electricity, while others are used directly by each end use sector (residential, commercial, industrial and transportation).

FIGURE ES3: Connecticut Energy Flows in 2015



Data Source: United States Energy Information Administration

[11] Molina, Maggie, "The Best Value for America's Energy Dollar: A National Review of the Cost of Utility Energy Efficiency Programs," Publications, American Council for an Energy-Efficient Economy, 2014, http://aceee.org/research-report/u1402.
[12] EAI

Governor's Council on Climate Change

On Earth Day 2015, Governor Malloy issued Executive Order 46, creating the Governor's Council on Climate Change (GC3). The Council is composed of 15 members from state agencies, quasi-state agencies, companies, and nonprofits. Governor Malloy tasked the Council with:

- Establishing interim goals that will guide the state to the 2050 emission reduction target;
- Annually monitoring statewide GHG emissions to determine if the state is poised to meet its 2050 target and any established interim goal(s);
- Examining the efficacy of existing policies and regulations designed to reduce GHG emissions; and
- Recommending new policies, regulations, or legislative actions that will assist in achieving established emission-reduction targets.

Council members are currently in the process of analyzing greenhouse gas emission reduction scenarios to inform their recommendations on strategies that lead to long-term emissions reductions and to ensure that the state is on a path to meet its Global Warming Solutions Act goal of 80 percent below 2001 levels by 2050.

For more information on GC3 activities: www.ct.gov/deep/GC3

To meet Connecticut's 2050 greenhouse gas emissions reduction target[13], as well as the 2030 interim target of 45% below 2001 levels recommended by the Governor's Council on Climate Change, transformation of these energy flows is necessary. This will necessitate increases in: renewable energy generation and energy storage; deployment of electric vehicles; thermal energy electrification; and energy efficiency. As part of this transformation, fossil fuel use will decline over time and be displaced by increased renewable generation and electricity use.

Key Strategies for 2018-2021

Connecticut energy policy must support the state's broader environmental policies to meet clean air, clean water, land conservation and development, and waste reduction goals, including reducing GHG emissions 10 percent below 1990 levels by 2020 and 80 percent below 2001 levels by 2050. Connecticut's ambitious GHG reduction targets fundamentally impact how the state will produce, distribute, and consume energy. If successfully implemented, these shifts will produce benefits for Connecticut residents and businesses—cleaner air, a modernized grid, and new clean energy business opportunities. How the State designs and funds supporting policies is critically important.

The State should prioritize approaches that ensure sustainable, orderly development of our clean energy economy and ensure the benefits and costs of shifting to a zero-carbon economy are fairly shared across all Connecticut residents and businesses. The energy policy choices the State makes over the next several years will: continue to shrink the energy-

[13] Connecticut's Global Warming Solutions Act requires the state to reduce greenhouse gas emissions by 10% from 1990 levels by 2020 and 80% from 2001 levels by 2050. Conn. Gen. Stat. Sec. 22a-200a.

affordability gap; reduce peak energy demand and decrease fuel security risks and distribution system costs; reduce the cost of renewable energy deployment and integration based on competition and smart siting; expand and integrate electric vehicle charging infrastructure into the distribution system cost-effectively, optimizing to serve the needs of both consumers and the grid; seize the opportunity for in-state clean energy business development; and pursue new, more sustainable approaches to funding and procuring energy efficiency.

Connecticut's ambitious emissions-reduction goals cannot be achieved by government alone. Private actors including businesses, civic and advocacy groups, private citizens, religious organizations, associations, and colleges and universities play a critical role. Collaborative partnerships, private investment, and technology innovation are crucial means for achieving the necessary reductions. Climate change solutions that go beyond government action will help stimulate the economy and build strong, vibrant, and resilient communities across the state. A focus on broader benefit to communities is key. For instance, Connecticut's transportation systems should enhance quality of life for residents, sustain the character of local communities, and enrich the state's economy now and in the future. Linking transportation planning and decision-making to economic growth and sustainable development will not only enhance the well-being of Connecticut residents but also make the state a more desirable place to live and work.[14]

Guided by the long-term vision of transitioning to a zero-carbon economy, this CES highlights eight key strategies to guide administrative and legislative action over the next several years. These strategies are listed in Table ES1 and detailed in the 2018 Comprehensive Energy Strategies chapter. Further background on the current state and trends in each sector, including buildings, electric power, and transportation, are elaborated in subsequent chapters.

Strategy 1: Ensure sustainable and equitable funding for efficiency
A. Implement sustainable funding for energy efficiency
B. Find equitable solutions for oil and propane conservation
C. Reduce the energy burden of low-income households
D. Address health and safety barriers to further unlock efficiency and create healthier homes
E. Catalyze the competitiveness of Connecticut's businesses with increased energy productivity
Strategy 2: Advance market transformation of the energy efficiency industry
A. Integrate energy efficiency with real estate market forces

[14] Let's Go CT!, the Department of Economic and Community Development's 2015 Strategic Plan, and the current draft of Connecticut's Conservation and Development Policies Plan (2018-2023) mutually reinforce these long-term goals for Connecticut's transportation infrastructure.

B. Develop a sustainable workforce to meet industry demand
C. Standardize efficiency with energy performance codes, standards and certification
D. Transition to cleaner thermal fuels and technologies
Strategy 3: Grow and sustain renewable and zero-carbon generation in the state and region
A. Increase the Renewable Portfolio Standard to 40 percent by 2030
B. Utilize existing procurement authority for regional nuclear and hydropower resources
C. Continue procuring grid scale renewables based on needs determined in the Integrated Resources Plan (IRP) in a cost-effective and environmentally-sustainable manner
D. Phase down biomass and landfill gas RECs in Connecticut's Class I RPS
Strategy 4: Expand deployment of all cost-effective distributed generation ("behind the meter") programs in a sustainable manner
A. Grandfather existing distributed generation systems
B. Determine total authorized utility spending for all distributed generation tariffs
C. Designate consumer categories within the spending cap
D. Hold semi-annual competitive solicitations for Low and Zero Emission Tariff categories
E. Integrate a statewide shared clean energy program into the new LREC/ZREC auctions
F. Enhance voluntary renewable energy product disclosure
G. Establish renewable generation rates for residential customers
Strategy 5: Continue to improve grid reliability and resiliency through state and regional efforts
A. Support ISO New England in improving regional winter natural gas generation fuel security and reliability
B. Continue to deploy community microgrids to support statewide resiliency goals in strategic locations and support the Energy Assurance Plan
C. Ensure coastal resiliency of substations and other critical grid infrastructure to support DEEP's flood management goals
Strategy 6: Reduce transportation greenhouse gas emissions by accelerating adoption of low- and zero-emission vehicles and strengthening alternative-fueling infrastructure
A. Develop an EV Roadmap

B. Increase EV uptake through consumer education and new fleet purchasing models
Strategy 7: Increase mobility, connectivity, and accessibility by advancing smart-growth, mixed-use transit-oriented development, and innovative transportation partnerships
A. Facilitate state and regional transportation planning that improves system efficiency and reduces vehicle miles traveled
B. Develop and support innovative transportation partnerships
Strategy 8: Modernize the grid
A. Initiate grid modernization proceedings
B. Integrate efficiency, storage, and renewables to manage peak demand
C. Ensure interoperability of demand response communications between buildings and the grid
D. Apply best practices from the federal Grid Modernization Lab Initiative

2018 Comprehensive Energy Strategies

Strategy 1: Ensure sustainable and equitable funding for energy efficiency

The benefits of energy efficiency go far beyond cost savings and emissions reductions. Energy efficiency invests money back into the local economy in the form of skilled jobs being performed locally and in the form of increased value of our homes and businesses. It improves the health and safety of building occupants and empowers ratepayers to control their energy costs. Connecticut's ability to achieve a cheaper, cleaner, more reliable energy future depends on millions of building owners and occupants seizing the clean and efficient energy opportunities available to them. By fully valuing energy efficiency as a resource, we can holistically take actions to strengthen and improve Connecticut's economic competitiveness and quality of life.

A. Implement sustainable funding for energy efficiency

In accordance with Connecticut General Statutes 16-245m, the statewide Electric and Natural Gas Conservation and Load Management Plan (C&LM Plan) guides implementation of the majority of energy efficiency and demand reduction activities in the state and has been funded for many years through a charge on electric and natural gas consumption. This consistency has provided a level of certainty for planning efficiency investments, leveraging private capital, tracking progress toward climate goals, and catalyzing jobs in the energy efficiency industry.

However, the Connecticut General Assembly's passage on October 31, 2017, of the state budget for State Fiscal Years 2018 and 2019 (through passage of June Special Session Public Act 17-2) resulted in the loss of $63.5 million per year from the Energy Conservation and Load Management Fund (also known as the Connecticut Energy Efficiency Fund, or CEEF), through a diversion of revenues generated by the 3 mill charge on electric bills.[15] This charge was the primary revenue source for implementation of the C&LM Plan. June Special Session PA 17-2 also diverted $14 million of revenue from the 1 mill charge on electric bills that funds the Connecticut Green Bank, an institution that otherwise would leverage these funds to drive efficiency and renewable energy investments across the state. Additionally, in the same public act, the General

June SS PA 17-2 Sec.	Revenue Source Diverted	Annual Amount	State Fiscal Years
682	Regional Greenhouse Gas Initiative Auction proceeds [A portion used for C&LM Plan implementation, a portion used for CT Green Bank]	$10,000,000	2018 and 2019
683	Energy Conservation and Load Management Fund aka "CT Energy Efficiency Fund" for Conservation and Load Management Plan (C&LM Plan) implementation	$63,500,000	2018 and 2019
685	CT Clean Energy Fund for CT Green Bank	$14,000,000	2018 and 2019
	Total per year	**$87,500,000**	Each year
	Total for two years	**$175,000,000**	Two Years

[15] One mill charge is equal to $0.001 per kilowatt-hour for electric utility customers. It is used to fund electric energy efficiency measures in these customers' businesses and homes.

Assembly diverted $10 million from the Regional Greenhouse Gas Initiative (RGGI) auction proceeds each year in State Fiscal Years 2018 and 2019—the majority of which was intended to fund energy efficiency investments in homes heated by oil and propane. A portion of those diverted RGGI auction proceeds also were intended to fund operations of the Connecticut Green Bank.

As a result of these diversions, $175 million from the direct investment of ratepayer funds plus additional millions from investments of leveraged private capital—will not occur in Connecticut over the course of State Fiscal Years 2018 and 2019. This redirection to the state's General Fund has necessitated deep cuts to the C&LM Plan originally approved by the Department of Energy and Environmental Protection (DEEP) on December 31, 2015.

In response, on December 26, 2017, DEEP approved an update to the C&LM Plan that addresses the adjustments made by the utility companies with the advice of the Energy Conservation and Management Board (aka Energy Efficiency Board) necessary to implement the diversion prescribed by the General Assembly. However, despite efforts to minimize the effects of these adjustments, diversion of the C&LM Plan's investments to the General Fund has caused significant disruptions to economic investments underway across the state. In 2018 and 2019, these disruptions include:

- Significant job losses that could result from contract cancellations worth over $126 million plus the estimated $252 million in private capital from planned customer investments leveraged through those contracts.
- Each year, a $2.9 million cut per year in education and training investments will negatively impact workforce development and the energy efficiency job market, which is rapidly growing in the state and in 2017 stood at 34,000 jobs.
- Each year, over $31 million in energy efficiency upgrades that reduce operating costs for our businesses and industries and enable them to invest in growth will not occur, reducing business competitiveness.
- Each year, over 12,900 homes will not receive energy assessments that provide significant on-the-spot weatherizing upgrades and immediate energy bill savings and that qualify homes for reduced pricing on insulation. Approximately 5,600 of these are lower-income households that often require additional financial assistance to close the energy-affordability gap.
- Unless another revenue source is identified, most buildings heated with oil and propane will no longer receive services related to heating and cooling improvements once the source of efficiency funding—a portion of proceeds from RGGI auctions—is depleted.
- Reduced revenue and increased costs of repurchasing multiple years of capacity from planned energy savings already sold to the ISO New England regional electricity market will cost Connecticut ratepayers an estimated $30 million over ten years in the form of purchases of reconfigured capacity, forfeited financial assurance, and potential penalties for failing to deliver capacity, with actual costs potentially higher due to fluctuation of spot market prices.

Likewise, diversion of revenues from the mill charge and the RGGI auction proceeds used to fund the Connecticut Green Bank will result in effects such as:

- the loss of $185 million of private investment in renewable energy projects in Connecticut;
- triggering of minimum liquidity covenants for the Connecticut Green Bank;
- reductions in investment in renewable energy for Connecticut's commercial, industrial, non-profit, and multifamily buildings through the Green Bank's Commercial Property Assessed Clean Energy program.

The consequences of these legislative diversions affect the ability of the energy efficiency industry to plan investments and retain employees in Connecticut. The effects of withdrawing demand reductions generated through implementation of the C&LM Plan that already had been sold to the ISO New England Forward Capacity market are costly and difficult to address, because their impact spans Connecticut's residential population, its businesses, infrastructure, and the environment.

In order to continue Connecticut's leadership in smart energy use and catalyzing a clean energy workforce—particularly in the context of strategically expanding electrification of building heating and transportation—the need to establish sustainable funding models for energy efficiency and clean energy investments is greater than ever. DEEP is prepared to collaborate with industry representatives, other stakeholders, and the General Assembly to explore potential paths to remedy the devastating impact these diversions have had on the clean-energy economy in Connecticut, including identifying sustainable methods for catalyzing investments in efficiency across the state.

In the context of funding challenges, re-committing to a statewide goal can help reinforce the need to continue the momentum and find creative solutions. To date, Connecticut has established an energy efficiency resource standard (EERS) based on the equivalent treatment of energy efficiency with energy supply sources and in the efficiency goal set and currently enforced through implementation of the C&LM Plan. Connecticut General Statutes Section 16-245m requires that the state's C&LM Plan "shall include a detailed budget sufficient to fund all energy efficiency that is cost-effective or lower cost than acquisition of equivalent supply, and shall be reviewed and approved by the [DEEP] commissioner." Currently, the goal is to achieve all cost-effective efficiency (within the constraints of available investment capital).[16,17, 18] Going forward, DEEP recommends the state adopt a minimum annual efficiency goal across all fuels, based on the average performance of the efficiency investments of the last several years. DEEP estimates that this performance equates to approximately 1.6 million MMBTU per year across all fuels, and recommends this annual goal be implemented through 2025 to emphasize the greater emissions-savings impact of efficiency in the near term as the grid decarbonizes.

New funding tools will also be needed to ensure the State stays on track. One such sustainable method to catalyze efficiency investments—procuring electric energy efficiency as a resource— is already underway in Connecticut. In May 2016, DEEP issued a request for proposals for long-term contracts of renewable projects less than 20 MW or energy efficiency projects of any size. Of 100

[16] Eversource Energy; The United Illuminating Company; Connecticut Natural Gas Corporation; The Southern Connecticut Gas Company. 2015. *Connecticut General Statutes Section 16-245m(d) 2016-2018 Electric and Natural Gas Conservation & Load Management Plan* . 1 October.
[17] Connecticut Public Act 07-242
[18] Connecticut Public Act 13-298

submitted bids, 25 were selected, providing a total of 401.99 MW of clean energy capacity, with 34 MW from energy efficiency projects.

The 2016 procurement demonstrates DEEP's ability to use a procurement process to obtain energy efficiency. To continuously improve this method of procuring energy efficiency and ensuring investments in energy efficiency in the context of the General Assembly's diversion of the 3 mill charge, DEEP will pursue specific statutory authority to procure an estimated 25 MW (not to exceed the cost equivalent of 3 mills) of electric energy efficiency (passive demand response) each year through competitive procurement processes. DEEP will work to ensure that these procurements are structured in a manner to encourage competition between the electric distribution companies (EDCs), third-party efficiency providers (e.g., Efficiency Vermont or Efficiency Maine), the Connecticut Green Bank, and others.

B. Find equitable solutions for oil and propane conservation

To achieve its environmental goals and address energy affordability, Connecticut must continue to improve the efficiency of its oil and propane consumption for commercial and residential heating.[19] In Connecticut, residential heating produces approximately 17 percent of carbon emissions; and in 2017, 44 percent of Connecticut's households used oil to heat their homes.[20]

Oil and propane conservation shows great potential to reduce emissions and lower energy bills for customers, but existing funding mechanisms to support such conservation are unsustainable and inequitable. Currently, electric and natural gas customers contribute to implementation of the C&LM Plan through a consumption-based charge on their electricity and natural gas bills. The C&LM Plan provides all electricity customers incentives for measures they may take to reduce their household or business energy consumption. However, there is no charge on the bills of oil or propane customers to support the conservation programs, even though oil customers are the largest segment of participants in the C&LM Plan programs, constituting over 50 percent of Home Energy Solutions projects and rebate uptake.[21] Due to this unbalanced contribution mechanism, heating oil and propane customers who participate in state energy fefficiency programs essentially have been subsidized by natural gas and electric customers who are charged a conservation assessment on both their heating and their non-heating consumption. Unless the General Assembly reverses the diversions or a new source of funding is identified for providing services to residents heating with oil and propane, DEEP anticipates rationing and ultimately eliminating efficiency services at most oil heated homes once RGGI funding is depleted.

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[19] U.S Global Change Research Program. "*Climate Science Special Report: Fourth National Climate Assessment Volume I.*" 2017. https://science2017.globalchange.gov/

[20] United States Energy Information Administration, "Connecticut State Profile and Energy Estimates", 2017, http://www.eia.gov/state/data.php?sid=CT#ConsumptionExpenditures

[21] HES is a basic home weatherization and energy efficiency program funded by the Connecticut Energy Efficiency Fund and administered by Eversource, United Illuminating, Yankee Gas Services Company, Connecticut Natural Gas Corporation, and Southern Connecticut Gas Company. More information can be found at www.energizect.com.

In light of the General Assembly's diversions of RGGI auction proceeds that funded conservation and efficiency investments in homes not heated with electricity or natural gas, it is now more important than ever to establish an equitable and sustainable funding source for promotion of energy efficiency measures in Connecticut's 600,000 oil- and propane-heated homes. In the Draft CES issued in July 2017, DEEP recommended that, unless a sustainable alternative conservation incentive mechanism was identified, an oil-conservation charge should be applied on a per-gallon basis to fund weatherization services and incentivize installation of high-efficiency equipment in place of outdated heating systems. DEEP received numerous comments in opposition to the conservation charge on fuel oil and propane—and very few comments in favor of it. However, some commenters suggested that carbon pricing on all heating fuels (including natural gas) would be a fairer approach, instead of a targeted oil and propane charge. Carbon pricing for all heating fuels could provide an incentive to invest in energy efficiency measures as well as support a transition to a lower-carbon thermal alternative. Therefore, DEEP recommends that the state continue exploring equitable funding sources such as a fuel conservation fee, as well as carbon pricing programs that address heating fuels or that integrate with economy-wide programs, preferably in concert with other states.

C. Reduce the energy burden of low-income households

While on a per capita basis Connecticut consumes energy at a lower rate than most of the nation, Connecticut residents pay some of the highest annual energy bills in the nation.[22] Operation Fuel's 2016 report on home energy affordability in Connecticut estimated an "affordable" energy cost burden to be 6 percent of household income, yet many Connecticut residents spend 8 percent to 36 percent of household income on energy.[23] This is particularly apparent in Connecticut's 322,000 low-income households, whose average affordability gap is around $1,404.[24] In aggregate, Connecticut's low-income households currently experience a $450 million energy-affordability gap.[25] This gap exists because more than one-third of total residential units and more than one million Connecticut residents live in a household with an income of less than 200 percent of the federally defined poverty level or 60 percent of the state median income.[26]

To minimize the energy-affordability burden, the U.S. Department of Health and Human Services provides funding via the Connecticut Department of Social Services to help qualified households pay energy bills through the Low-Income Home Energy Assistance Program (LIHEAP). Implementation of the C&LM Plan currently assesses and provides on-the-spot air sealing and efficiency upgrades to

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[22] See https://www.eia.gov/state/rankings/?sid=CT#series/12

[23] Colton, Roger D. 2016. "Home Energy Affordability in Connecticut: The Affordability Gap, Prepared for Operation Fuel."

[24] This number does not represent the total energy costs per household but rather the portion beyond the affordable amount. The 2015 ACS identified this number of households as at or below 200 percent of the Federal poverty level.

[25] Colton, Roger D. 2017. "Home Energy Affordability in Connecticut: The Affordability Gap, Prepared for Operation Fuel." http://www.operationfuel.org/wp-content/uploads/2017/12/2017-ConnecticutHEAG-11-27-17-RDC-edits.pdf

[26] Connecticut Department of Social Services. 2016. "Selected Annual Federal Poverty and State Median Income Guidelines." *www.ct.gov/dss.* 1 July. http://www.ct.gov/dss/lib/dss/pdfs/povsmi.pdf.

approximately 20,000 low-income homes each year[27], and a U.S. Department of Energy Weatherization Assistance Program grant currently funds provision of similar services to approximately 400 qualified homes in Connecticut each year.

Given the legislative diversion of funding for implementation of the C&LM Plan, reallocating C&LM Plan funds is critical to continue weatherizing qualified homes, which reduces energy waste and in turn leverages the LIHEAP funding for financial assistance. DEEP additionally recommends continuing to allocate a portion of available LIHEAP funding to support emergency furnace replacements, energy efficiency, and related health and safety support to help these households ensure their homes can be weatherized.

Operation Fuel, Inc.[28], and Connecticut's Low Income Energy Advisory Board have recommended coordination and data sharing between the utility energy-assistance and efficiency programs to work more proactively with low-income households that have high energy burdens to resolve affordability problems before they become bill-payment problems. Recent work on such data sharing by the utility companies and the Department of Social Services is expected to enhance understanding of the energy burden of the state's low-income residents, but this data-sharing effort is at risk, due to the reduced funding resulting from the legislature's seizure of funding intended for implementation of the C&LM Plan.

As detailed in the Buildings Chapter, DEEP and the Connecticut Green Bank will also continue to advance opportunities, where appropriate, to facilitate affordable deployment of on-site residential solar energy generation.[29]

D. Address health and safety barriers to further unlock efficiency and create healthier homes

In addition to conserving energy, weatherization helps ensure healthy and safe housing for Connecticut's citizens and improves property values.[30] However, many homes have been found to have one or more health or safety barriers— such as mold, asbestos, or pests—that prevent completion of a weatherization service.[31] This intersection of energy, health, and safety provides an opportunity for Connecticut to simultaneously achieve greater energy affordability and important socioeconomic benefits. These benefits exist outside the traditional energy sphere and help mitigate both property insurance claims and health insurance claims by reducing structural, health, and safety hazards in and around the home, thus reducing economy-wide cost burdens. To fairly allocate the costs associated with these benefits and maintain economic efficiency, DEEP recommends Connecticut end this cost externalization and collaborate with the property and health insurance

[27] 20,000 low-income homes were reached prior to the diversion of funding for the C&LM Plan.
[28] Applied Public Policy Research Institute for Study and Evaluation. 2016. *Meeting the Energy Needs of Low-Income Households in Connecticut.* Operation Fuel, Inc.
[29] Connecticut Green Bank. 2014. Memo to Connecticut Green Bank Board of Directors: Role of a Green Bank – Low Income Solar Deployment. The Connecticut Green Bank.
[30] Oak Ridge National Laboratory. "*Health and Household-Related Benefits Attributable to the Weatherization Assistance Program.*" 2014. http://weatherization.ornl.gov/Retrospectivepdfs/ORNL_TM-2014_345.pdf
[31] Presentation by Eversource and United Illuminating to the Connecticut Energy Efficiency Board on January 5, 2018. https://app.box.com/s/t8d2qu1i079d80wn05cdxdf2sjp378xo/file/264110273737

industries, the health care industry, housing stakeholders, social service providers, and others to provide programs that help homes with health and safety issues ready the home for weatherization. By collaborating with these sectors not traditionally linked to energy, Connecticut has the potential to create long-term, sustainable funding mechanisms that will be able to provide the energy and health benefits associated with weatherization well into the future. DEEP and others are working to implement funding and financing options for addressing these barriers. Specifically, DEEP, the Department of Social Services, and the Low Income Energy Advisory Board have recommended and are implementing allocations of LIHEAP funds for eligible households for use in addressing health and safety concerns prior to weatherization.

DEEP and the Connecticut Green Bank are also advancing financing for a broader income demographic by capitalizing revolving loans that can be used to close this financing gap associated with making homes ready for energy efficiency improvements.

E. Catalyze the competitiveness of Connecticut's businesses with increased energy productivity

In 2016, the C&LM Plan's implementation generated a nearly $1.4 billion increase in the gross state product.[32] The annual Gross Domestic Product for Connecticut's businesses and industries has collectively increased 14 percent since 1997 while their energy consumption has fallen about 36 percent, resulting in an overall increase in energy productivity of business operations.[33] This means Connecticut's businesses are using less energy to produce the same quantity of goods and services (or more). While this positive overall trend is in part attributable to the growth of non-energy-intensive, service-based industries, an assessment of the manufacturing and industrial production sectors reveals the same positive trends.[34]

Continuing to reduce energy demand while maintaining economic output is a critical strategy businesses can use to control costs and increase productivity. Connecticut must remain committed to improving efficiency and energy productivity across all industry sectors. This will require broad actions, from relatively simple upgrading of HVAC or lighting systems to the more complex installation of combined heat and power systems. By reducing businesses' energy costs, businesses can improve their bottom lines, creating a better economy and job market.

Until now, the utility-administered business partnership programs and the Connecticut Green Bank's Commercial Property Assessed Clean Energy Program have been major resources for Connecticut businesses seeking to implement and finance energy efficiency projects. Given the General Assembly's diversion of these funds for State Fiscal Years 2018 and 2019, DEEP recommends that discrete portions of energy efficiency procurements be designated for

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[32] Eversource Energy; The United Illuminating Company; Connecticut Natural Gas Corporation; The Southern Connecticut Gas Company. 2015. *Connecticut General Statutes Section 16-245m(d) 2016-2018 Electric and Natural Gas Conservation & Load Management Plan* . 1 October.

[33] United States Energy Information Administration, *Connecticut State Profile and Energy Estimates.* https://www.eia.gov/state/?sid=CT

[34] Id.

commercial and industrial projects in order to promote Connecticut businesses' continued integration of efficiency investments into their business plans.

Strategy 2: Advance market transformation of the energy efficiency industry

As energy efficiency becomes more mainstream and investments are driven by market supply and demand rather than ratepayer-funded programs, DEEP has identified important market components that must proceed to maintain progress toward mainstreaming efficiency as the standard practice for buildings, industrial processes, and commercial products. Implementation of the C&LM Plan has built momentum in market transformation and must continue to evolve. Other activities outside of the C&LM Plan must also continue to ensure energy efficiency becomes the norm throughout our economy.

A. Integrate energy efficiency with real estate market forces

The real estate industry has great potential to drive market demand for residential energy efficiency. Research shows that more and more homebuyers recognize the long-term value of operating an efficient home and are therefore willing to pay a premium for energy efficiency features.[35] The challenge is to consistently value these improvements and translate that value to realtors, appraisers, building inspectors, and home buyers. The goal is to prompt buyers to expect the home they purchase to be energy efficient and have affordable energy bills in the same way they expect the foundation to be structurally sound and the plumbing to be in good repair. Accordingly, Connecticut must increase educational outreach and related resources to real estate professionals to train them on how to encourage and empower homeowners to seek information on the home's energy efficiency, thereby improving efficient homes' competitiveness in the real estate market.

The most effective way to make the value of energy efficiency clear to homeowners is to use standardized documentation methods. In 2015 Connecticut became the first state in the nation to fully adopt the U.S. Department of Energy's Home Energy Score in its energy efficiency assessment programs. This program is designed to generate a nationally standardized "miles-per-gallon" score of a home's energy efficiency, transparently highlighting the value of efficiency improvements.[36] Connecticut has completed over 21,000 Home Energy Scores to date; but to continue increasing the prevalence of these scores in homes across the state, DEEP recommends that home energy performance professionals, HVAC technicians, and building inspectors become certified to perform the Home Energy Score. This will facilitate employment of a standardized metric that consumers can use to better understand—and effectively demand—energy efficiency, particularly during transactions.

[35] Salzman, Maddy. 2016. *Green Labels in Real Estate Literature Review.* United States Department of Energy.
[36] U.S. Department of Energy. n.d. *Home Energy Score.* https://betterbuildingssolutioncenter.energy.gov/home-energy-score.

B. Develop a sustainable workforce to meet industry demand

Connecticut's commitment to clean and efficient energy must be backed by a strong and capable workforce. Beyond decreasing energy use and energy waste, preparing entry-level individuals for successful careers in the energy efficiency and renewable energy fields promotes and sustains economic growth in the state. This field also provides diversified career options to mid-career job seekers as well as students and young people considering their futures in the face of growing higher education costs. Recent development of an Associate of Applied Science Degree in Energy Management through Connecticut's community college system is a positive avenue to prepare Connecticut residents for employment in the clean-energy field.[37] Despite Connecticut's significant, existing energy efficiency workforce (around 34,000 employed in the field), there is still a shortage of skilled labor.[38] Not only does this constrain the industry's ability to meet market demand for such technologies and the energy savings associated with them, it also inhibits economic growth. Responses to a 2017 Connecticut Business and Industry Association-DEEP survey of energy efficiency workforce needs revealed that 57 percent of surveyed businesses are struggling to find entry-level workers to fill the workforce pipeline, and 73 percent reported that a lack of required technical skills was the largest barrier to hiring.[39] As clean-energy industries gain footholds in Connecticut, it is imperative that the State promote training and retaining of technicians and other professionals specializing in clean and efficient energy to ensure that these evolving industries succeed.

C. Standardize efficiency with energy performance codes, standards, and certifications

While cars, appliances, and other products can quickly become obsolete, buildings are intended to endure into the future. This means that their designs will affect Connecticut's energy consumption for decades to come. To achieve all cost-effective energy efficiency, Connecticut must continue adopting current building codes that incorporate the latest International Energy Conservation Code and support product-efficiency standards, while working with other states and regional organizations to advance federal product-efficiency standards.

Building codes and product standards not only keep our buildings safer and healthier but allow them to operate more cost-effectively in the future. This can also give them a competitive edge in the real estate market and provide a more consistent expectation of their impact on the grid and environment.[40] Additionally, building codes begin setting up infrastructure for a modernized grid. For example, as the electric vehicle market is expanding, Connecticut's building code now ensures

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[37] https://www.tunxis.edu/program/energy-management/

[38] United States Department of Energy. "*2017 US Energy and Jobs Report State Charts".* 2017. https://energy.gov/sites/prod/files/2017/01/f34/2017%20US%20Energy%20and%20Jobs%20Report%20State%20Charts%202_0.pdf

[39] Connecticut Business and Industry Association & CT DEEP. *2017 Survey of Connecticut Energy and Energy Efficiency Workforce Needs.* 2017. https://www.cbia.com/resources/workforce-development/workforce-reports-surveys/2017-survey-energy-energy-efficiency-workforce/

[40] The U.S. EPA ENERGY STAR program calculates that a 10 percent decrease in energy use could lead to a 1.5 percent increase in net operating income (NOI) — with greater potential as savings grow. In commercial real estate valuation, the use of the capitalization rate (NOI divided by sales price/property value) demonstrates that the greater the NOI, the more valuable the property.

that in new buildings electric vehicle charging can occur with minimal adaptations. Connecticut should also continue to enforce state statutes that require state-funded major renovations and new construction to comply with the state's statutory High Performance Building requirements, which compel achievement of a minimum specified U.S. Environmental Protection Agency Portfolio Manager ENERGY STAR Score.

Connecticut also must ensure that higher-efficiency HVAC equipment, appliances, and other products are available in the market and that installers are trained in proper installation. At the same time, customers should be equipped to analyze options based on a simple lifecycle analysis that accounts for both operating and installation costs, enabling them to identify efficient equipment that, when locked in for decades, will achieve the greatest energy savings. Connecticut supports and encourages residents and businesses to select appliances and products that meet U.S. EPA ENERGY STAR and U.S. EPA WaterSense product-efficiency certifications.[41] Encouraging replacement of outdated, inefficient equipment not only captures a measurable level of energy savings but also can prompt consumers to take further energy efficiency measures. This is particularly so in the case of equipment failure or retirement. Using these situations as opportunities to improve furnaces, boilers, air conditioning systems, etc., is imperative, given the long useful life terms of heating and cooling equipment. All heating, ventilation, and air conditioning equipment should be upgraded to the most efficient technology available.

D. Transition to cleaner thermal fuels and technologies

To continue the state's progress toward meeting Global Warming Solutions Act goals and improve air quality, decarbonization of thermal systems is necessary. A recent analysis conducted by the Governor's Council on Climate Change found that, by 2050, 87 percent of the residential thermal load in Connecticut must be served by low-carbon or zero-carbon technologies, including renewable thermal technologies (RTTs) – such as water and air-source heat pumps, ground-source heat pumps, and solar water heating – powered by carbon-free electricity in order to meet the emissions reductions mandated by the Global Warming Solutions Act.[42] RTTs use thermal resources from the sun, air, and ground, allowing them to provide extremely efficient heating and cooling. Therefore,

[41] Connecticut builds its appliance and product energy efficiency standards off those defined by the California Code of Regulations' State Appliance Energy Efficiency Standards, Title 20, and federal regulations included in the Energy Policy Act of 2005 and the Energy Independence and Security Act of 2007. Products that do not meet these California standards cannot be sold or installed in Connecticut on or after the effective date of the standard, unless federal efficiency standard regulations are in place, which preempt state standards. Connecticut last updated its appliance standards statutorily in 2011 and is developing recommendations for regulatory updates in the near future.

[42] Governor's Council on Climate Change, retrieved from http://ct.gov/deep/lib/deep/climatechange/gc3/gc3_10_19_17/gc3_meeting_10_19_2017.pdf

these technologies offer important means to sharply reduce residential, commercial, and industrial GHG emissions.[43] [44]

However, given today's energy market conditions (and excluding available rebates), heat pumps and solar water heating generally are cost-effective—have positive "net present value" for the customer—as whole-building substitutes for only a narrow segment of Connecticut's building stock.[45] [46] With fossil fuel prices currently lower than other thermal options, RTTs presently are cost-effective as whole-building substitutes only when they replace electric-resistance heating. RTTs provide a direct return on investment in less than 15 years in most of these contexts and less than 5 years in some.[47] [48]

With cost serving as the main driver of New Englanders' HVAC choices, Connecticut needs to focus its near-term RTT whole-building conversion strategy on the approximately 15 percent of single-family Connecticut homes that rely primarily on electric-resistance technologies for space and water heating, while preparing to expand this focus as changes in fuel costs, equipment costs, equipment efficiency, thermal demand, and interest rates make RTTs cost-effective in a wider range of buildings.[49] By approaching thermal electrification in a systematic process, Connecticut will have greater ability to control for cost-effectiveness and demand growth. Further details on this strategy can be found in the Buildings Chapter.

Connecticut should simultaneously promote a particular RTT that is becoming a suitable *partial* substitute for conventional HVAC units in single-family homes. The Yale assessment of RTT market conditions cited above examined only systems sized to satisfy 100 percent of buildings' heating loads.[50] This assumption does not reflect the market for a key technology: ductless air-source heat pumps, the RTT that is making the strongest inroads in New England's HVAC market. Ductless air-

[43] Meister Constultants Group . 2015. "Waking the Sleeping Giant: Next Generation Policy Instruments for Renewable Heating & Cooling In Commercial Builidngs (RES-H Next)." *iea-retd.org.* http://iea-retd.org/wp-content/uploads/2015/02/RES-H-NEXT.pdf.

[44] International Energy Agency. 2014. "Heating Without Global Warming: Market Developments and Policy Considerations for Renewable Heat." *www.iea.org.* https://www.iea.org/publications/freepublications/publication/FeaturedInsight_HeatingWithoutGlobalWarming_FINAL.pdf.

[45] Gronli, Helle, Fairuz Loutfi, Iliana Lazarova, Paul Molta, Prabudh Goel, Philip Picotte, and Tanveer Chawla. 2017. "Feasibility of Renewable Thermal Technologies in Connecticut: Market Potential." Yale University, Center for Business and the Environment, http://cbey.yale.edu/sites/default/files/FORTT_Market%20Potential.pdf.

[46] This calculation accounted for cost of installing, financing, operating, and maintaining HVAC equipment. It excluded non-energy benefits such as reduced social cost of carbon, improved air quality, and enhanced comfort.

[47] Gronli, Helle, et. al. 2017. "Feasibility of Renewable Thermal Technologies in Connecticut: Market Potential." Yale University, Center for Business and the Environment.

[48] This study's sensitivity analysis indicated that rebates capable of reducing the initial cost of heat pumps and solar hot water by 25 percent — considerably more than current rebates accomplish — would make these RTTs cost effective as replacements for electric-resistance heating in additional kinds of commercial buildings. However, under the study's assumptions, even these hefty rebates would not make the RTTs cost-effective replacements for fuel oil or natural gas systems in residential or commercial buildings (table 18, p. 76).

[49] On cost as the primary driver of HVAC decision making, see Meister Consultants Group, 2017, *Bringing Renewable Thermal Solutions to Scale in New England: Activity 2 — Analysis of Local Markets*, p. 16.

[50] Gronli, et al. 2017. "Feasibility of Renewable Thermal Technologies in Connecticut: Market Potential."

source heat pumps typically are installed to heat or cool a single room or zone rather than an entire building. A recent study by Cadmus Group—focusing on the cost of operating RTTs—found that these units, and especially versions optimized for cold climates, routinely are cost-effective in single-family homes in Massachusetts and Rhode Island, which have climates and energy prices comparable to Connecticut's. Air-source heat pumps were always more cost-effective than both propane and electric-resistance heating, Cadmus found, and air-source heat pumps optimized for cold climates were more cost-effective than oil heating except during periods of extreme cold.[51] [52]

An important consideration here is that in New England about 30 percent of ductless air-source heat pumps are being installed primarily to provide summer cooling and about 65 percent for both heating and cooling.[53] DEEP encourages the promotion of ductless air-source heat pumps as an alternative to other air conditioning technologies because this can often cost-effectively displace conventional air conditioning in the warm months as well as displace propane heating during the entire heating season and oil heating during significant portions of the heating season.[54] [55] [56]DEEP recommends that implementation of the C&LM Plan and financing from Connecticut Green Bank should advance growing customer demand for space cooling to strategically encourage installation and use of ductless air source heat pumps (especially models optimized for cold climates) that in the summer can provide efficient cooling and in the winter can cost-effectively displace heating supplied by oil, propane, or electric resistance units.[57] [58]

Cleaner fuel types also provide solutions that improve air quality and reduce greenhouse gas emissions. DEEP will consult with representatives of the state's fuel oil industry to assess whether the New England biodiesel market—the largest biodiesel manufacturer is in Connecticut—has matured sufficiently in recent years that revision of the statute would be warranted. The ability to

[51] The Cadmus Group, Inc. 2016. "Ductless Mini-Split Heat Pump Impact Evaluation." December. http://ma-eeac.org/wordpress/wp-content/uploads/Ductless-Mini-Split-Heat-Pump-Impact-Evaluation.pdf.

[52] In 2016, cold-climate ASHPs were more cost-effective than oil heat down to temperatures as low as 26 degrees F.; and especially efficient cold-climate units (HSPF 13) were more cost-effective than oil down to 15 degrees F. The latter units were more cost effective than even natural gas heating down to 28 degrees F. Crucially, this cost-effectiveness is routinely achieved even in the absence of sophisticated control technologies (which are only now emerging) that can maximize customer savings through integrated management of both RTT and conventional fossil-fuel-based HVAC equipment.

[53] The Cadmus Group, Inc. 2016. "Ductless Mini-Split Heat Pump Impact Evaluation." December. http://ma-eeac.org/wordpress/wp-content/uploads/Ductless-Mini-Split-Heat-Pump-Impact-Evaluation.pdf.

[54] National Climate Assessment. U.S. Global Change Research Program. n.d. http://nca2014.globalchange.gov/report/regions/northeast.

[55] DEEP analysis of National Oceanic and Atmospheric Administration data indicates that the number of cooling-degree days in Connecticut has increased about 30 percent since 1905, while the annual number of days with high temperatures over 90°F has trended upward from about 8 to more than 20. The National Climate Assessment predicts that with continued rapid increases in global atmospheric concentrations of greenhouse gases, parts of Connecticut routinely will see 30-40 days per year over 90°F in the middle of the century—on par with the most extreme summers of the 20th century.

[56] The Cadmus Group, Inc. 2016. "Ductless Mini-Split Heat Pump Impact Evaluation." December. http://ma-eeac.org/wordpress/wp-content/uploads/Ductless-Mini-Split-Heat-Pump-Impact-Evaluation.pdf.

[57] The R1617 study commissioned by the Energy Efficiency Board and now being conducted by the Board's Evaluation Administrator will provide further insights into the economics of ductless ASHPs in Connecticut.

[58] Meister Consultants Group, 2017, Bringing Renewable Thermal Solutions to Scale in New England: Activity 2 — Analysis of Local Markets, pp. 15, 17.

significantly increase displacement of fossil fuel with biodiesel hinges on the industry's ability and willingness to transparently track the sourcing of feedstocks, locations of biodiesel manufacturing, and biodiesel content of fuel oil sold and consumed in the state.

Expansion of Connecticut's natural gas system for thermal use was a critical strategy of the 2013 CES that was designed to give customers greater choice in their energy options and to reduce emissions from oil combustion. However, given a narrowing in the differential prices between natural gas and fuel oil, the demand for gas has decreased significantly in the intervening years, especially in the residential sector. In turn, despite the fact that main installation and gas conversions are still occurring at rates higher than in the past, the actual miles of main installed and gas conversions have not materialized at the rate the LDCs projected. From 2014 through 2016, at least 39,104 residential customers converted to natural gas heating, in addition to at least 12,021 commercial and industrial customers converting for generation or other processes. The lower rate of main installation and gas conversions confirms the intent of the plan, because LDCs are only installing gas mains to meet current and near future customer demand (i.e., they are not overbuilding the gas distribution system) and customers are only converting if they find it cost-effective. With expanded use of fuel cells and distributed generation in the state, much of the anticipated residential natural gas demand is also being shifted to the commercial and industrial sectors, where there is greater demand. For example, in coming years most Low Emissions Renewable Energy Credit contracts will make use of the LDCs' distribution system and help offset some of the costs of gas expansion. At this time, natural gas provides a cost-effective, relatively cleaner energy supply that Connecticut will need to continue to count on as we increase the capacity and reliability of renewable options.

Strategy 3: Grow and sustain renewable and zero-carbon generation in the state and region

Over the next thirty years, Connecticut will need to procure more carbon-free power to meet the Global Warming Solutions Act (GWSA) goals of reducing emissions by 80 percent from 2001 levels by 2050. To do so, Connecticut must reduce its use of fossil and other emitting fuels to generate electricity and consider all reasonable resource options as replacements, including Class I resources, large-scale hydropower, and nuclear, to maximize the potential benefits while minimizing the rate impact to electricity customers. The Governor's Council on Climate Change has been analyzing different scenarios and trajectories for changes to the generation mix supplying Connecticut's electricity demand that will be necessary to meet the GWSA goals.

Determining the ideal pace of growth of renewable energy through the RPS in a cost-effective manner for electric ratepayers can be challenging, given the increasing promise of cost-effective electricity storage, the unknown rate of electrification of the transportation and buildings sectors, unknown future technologies, and market rule changes federally and regionally.[59] Connecticut must

[59] For instance, through the regional IMAPP process, stakeholders are discussing new methods to integrate and retain renewable power that allows the states to achieve their policies and continues to receive the benefits of the competitive wholesale markets. Changes to the market rules could make renewable energy deployment and emissions reductions achievable through mechanisms outside of the RPS.

carefully balance planning in the short to medium time horizon with the less certain future. It is clear, however, that over the next 10 years, expansion of clean energy will be necessary to place Connecticut on a path toward meeting the GWSA goals. All of the scenarios and trajectories analyzed by the GC3, however, require significant decarbonization of the grid, coupled with electrification of transportation and building heating.

Therefore, DEEP recommends the following resource plan to support and grow renewable energy sources and zero-carbon resources to meet the state's RPS and GWSA goals.

A. Increase the Renewable Portfolio Standard to 40 percent by 2030

Under current law, the Class I RPS requirement increases each year until it reaches 20 percent in 2020 and stays at that level thereafter. The State should continue growth in renewable energy requirements and increase the pace of growth to 2 percent per year, establishing a 40 percent Class I RPS by 2030. DEEP believes that 40 percent by 2030 is an ambitious trajectory for Class I resources at this time, particularly when combined with the phase down of biomass described in Section D of this strategy. Together, these policies will significantly increase demand for new, zero-emitting renewables in the state and region, which may increase the costs of RECs. It is difficult to quantify costs of this increase at this time because transmission lines would likely need to be built in order to bring this significant amount of renewables online by 2030. In order to limit ratepayer exposure for this expanded pace of growth in the Class I requirements, DEEP recommends lowering the alternative compliance payment ("ACP") for Class I renewables.

One of the objectives of the RPS is to support development of resources that will reduce regional GHG and other air emissions. The phasedown of biomass and landfill gas (see section D) will go far in providing more opportunity for zero-carbon resources and their RECs to contribute to this goal, but more will be needed. After biomass and landfill gas, fuel cell RECs contribute the next highest percentage of the RPS compliance for Class I RECs. Fuel cells powered by natural gas provide important grid reliability and resiliency benefits but do not directly advance the state's decarbonization goals. A carve-out or separate Class tier limiting fuel cells and other GHG-emitting alternative technologies currently in Class I could help address this issue. The IRP planning process can evaluate REC and RPS trends over time and propose eligibility adjustments as needed.

B. Utilize existing procurement authority for regional nuclear and hydropower resources

Connecticut currently receives approximately 24 percent of its load from carbon-free nuclear power, specifically the Millstone 2 and 3 units in Connecticut and the Seabrook plant in New Hampshire.[60] Ensuring a diversity of sufficient zero-carbon resources, including nuclear generation, is an important strategy that could meet all of our key objectives to provide cleaner, cheaper and more reliable power to Connecticut residents and businesses. On August 2, 2017, DEEP and PURA initiated a joint

[60] With the expected closure of the Pilgrim Nuclear Power Station in 2019, the region will have three operating nuclear reactors remaining: two reactors at Millstone, and one at Seabrook. Yankee Rowe, Vermont Yankee, Connecticut Yankee, Maine Yankee, and Millstone 1 have all closed down for a variety of reasons related to the economics of operating smaller (less than 1000 MW) reactors and, in some cases, local opposition.

proceeding to provide an open and transparent forum for the agencies to conduct a study and produce a report in accordance with Governor Malloy's Executive Order No. 59 issued on July 25, 2017. As part of this proceeding, DEEP and PURA assessed the risk of the retirement of nuclear units, the financial needs of these units, and potential policy options to ensure progress toward meeting GWSA goals. After initiating and accepting public comment on this proceeding, the Connecticut General Assembly passed June Special Session Public Act 17-3, *An Act Concerning Zero Carbon Solicitation and Procurement*, which requires DEEP and PURA to conduct an assessment similar to the Executive Order 59 study and gives DEEP discretionary procurement authority for a variety of zero-carbon resources, should such study find that there is a need for such procurement.

In its final report released on February 1, 2018, DEEP and PURA concluded that, based on best available public information used in the initial Levitan & Associates analysis, that the Millstone units are profitable through 2035 under multiple scenarios. Considering stakeholder comments and submissions from Dominion, DEEP and PURA further concluded that certain changed cost inputs, if verified by review of audited financial documents, could result in the Millstone units being at risk. Moreover, the Millstone units are critical to both Connecticut and the New England region, in terms of fuel security and meeting greenhouse gas reduction goals. New zero-emission generating resources, or incremental additions to existing zero-emission resources like large scale hydropower, displace carbon emissions in Connecticut and New England, and are necessary to meet the GHG reduction targets of Connecticut's GWSA.

Therefore, in the absence of actionable regional mechanisms, DEEP and PURA concluded that a procurement under June Special Session Public Act 17-3 (P.A. 17-3) should go forward, with certain conditions to ensure that the state's ratepayers are protected from paying above-market costs for resources that are not verified to be at risk of retirement. DEEP and PURA concluded that it is fair and prudent to allow existing resources to demonstrate through the submission of credible financial data that they are at risk to retire. The resource would then not be assumed to be part of the existing or reference set of resources. In the event of such demonstration, the existing resource would bid and be scored on the same set of non-price benefits as new resources.

In addition, through its existing procurement authority, DEEP has the ability to contract for up to 15 percent of load with verifiable large-scale hydropower, of which approximately 11.6 percent of authority is remaining.[61] This large-scale hydropower can help meet interim GWSA goals and plan for the ultimate replacement of Millstone with zero-carbon energy resources, either after Millstone's relicensing date or sooner. To bring substantial quantities of incremental large-scale hydropower into New England will require new transmission lines and therefore likely a significant financial commitment by ratepayers. New transmission lines are typically 1,000 MW and cost $2 billion or

[61] Conn. Gen. Stat. §§ 16a-3g, 16a-3j. Under this authority, verifiable large-scale hydropower must compete with Class I renewable energy sources.

more. Due to the size of these projects, it would be best to coordinate the procurement to share the cost with other New England states.[62]

DEEP and PURA will continue to seek other more regionally-integrated mechanisms such as a Dynamic Clean Energy Forward Market or Zero-Emission Energy Credits (ZECs) that are harmonized with the existing competitive market and will ensure that any investments, if needed, to retain key nuclear generating facilities would be shared appropriately with the region that benefits from them.

A. Continue procuring grid scale renewables based on needs determined in the Integrated Resources Plan (IRP) in a cost-effective and environmentally sustainable manner

Through its authority under Public Acts 13-303, 15-107, and June Special Session Public Act 17-3, DEEP has authority to procure a combined 67 percent of load from a variety of renewable energy and zero-carbon resources. In future IRPs, DEEP will determine if there is a need for additional renewable energy sources or zero-carbon resources to meet the RPS, GWSA, or other energy goals.[63] With the expansion of the RPS to 2 percent of Class I resource per year and the phase down of biomass and landfill gas in Class I renewables, significant new resources need to come online to meet this requirement, including through DEEP-run grid scale procurements. DEEP intends to analyze the need to conduct grid scale solicitations in future IRPs.

DEEP also recommends that the EDCs retain RECs purchased in all state-sponsored clean energy programs and settle them on behalf of all ratepayers. This would include the REC purchases made pursuant to Sections 6-8 of Public Act 13-303, Public Act 15-107, and the low-emission renewable energy certificate/zero-emission renewable energy certificate (LREC/ZREC) programs, in addition to the successor distributed generation programs outlined in Strategy 4. Not only would this proposal avoid the administrative burden of purchasing and reselling these products in the market, but it would ensure that Connecticut can claim credit for bringing these renewables online and avoid double counting of resources that are currently counted as a load reduction. The RECs would be settled on behalf of all ratepayers and would reduce the purchase obligation for all other load-serving entities, including the EDCs and retail and wholesale suppliers. DEEP recommends that PURA establish a docket to explore implementation of this change.

Finally, DEEP recommends establishing a working group to establish best practices to optimize the siting of grid scale renewables in Connecticut. With the passage of Public Act 17-218, the State is

[62] In its recent solicitation seeking 9,450,000 MWh of large-scale hydropower and other clean energy resources, Massachusetts selected the Northern Pass hydropower bid to enter into contract negotiations with its electric utilities at an estimated cost of $1.6 billion and delivering 9.45 TWh per year of hydropower. DEEP did not participate with Massachusetts in this procurement because of timing and other restrictions.

[63] In addition, DEEP will identify in the IRP if there is a need for additional capacity to meet electric load for the forecasted period that would warrant a procurement under the Public Utility Regulatory Policies Act ("PURPA"). Given the active docket at PURA to amend its regulations implementing PURPA to reflect the state's restructured electric industry, DEEP will submit specific recommendations to amend these regulations. Similar to the process run by the former Department of Public Utility Control, the IRP will assess whether the forecast identifies a specific need for capacity that cannot be met through the regional competitive market and recommend whether PURA should initiate a procurement for those resources.

entering new territory with regard to the siting of renewables. This legislation has updated the Siting Council process to reflect the emerging reality of grid scale renewable installations in Connecticut. DEEP will monitor how the Siting Council process develops and whether the General Assembly struck the right balance between meeting the state's policy goals for renewables and meeting its goals for open space, core forest, and farmland preservation. DEEP recommends that the Department of Agriculture provide the Siting Council with standards to determine whether a proposed project materially affects prime agricultural soil, based on its expertise and policy planning documents. DEEP will provide the Siting Council with standards to determine whether a proposed project materially affects core forests.

In addition, DEEP will identify priority areas in the state, such as brownfields, state properties, or previously developed sites that would benefit from hosting Class I renewable energy sources or minimize siting issues. DEEP will work with the Department of Agriculture, the Office of Policy and Management, the Department of Economic and Community Development, and the EDCs to identify priority areas that take into account land-use considerations, consistency with the Plan of Conservation and Development and the needs of the electric distribution system. In addition, DEEP will outline specific siting criteria and apply them as threshold requirements or as evaluation criteria in any future DEEP RFPs.

B. Phase down biomass and landfill gas RECs in Class I RPS

In 2014, 76 percent of Connecticut's Class I RPS requirements were met with RECs from biomass and landfill gas. While these facilities provide certain societal benefits, most qualifying units are existing resources that began operation before the RPS program was launched in 2003. DEEP believes the first priority should be to restructure eligible Class I technologies to focus on development of new zero-carbon resources in New England. As recommended in the 2014 IRP and consistent with Section 5 of P.A. 13-303, DEEP will begin phasing down the REC value of biomass in 2019.

Since the 2013 CES, the supply of renewables has increased due to state programs and energy procurements, particularly by Connecticut and Massachusetts. It appears there will be a surplus of regional renewable generation though 2020. In addition, the overall capacity situation in New England is also projected to be in a surplus position. DEEP therefore believes it is a good time to begin phasing down the value of biomass and landfill gas RECs. Doing so will reduce emissions of the resources that Connecticut purchases for Class I RPS compliance to help fulfill the goals of the GWSA and provide opportunities for new renewable-energy sources.

To implement this phasedown, eligible generation for Class I biomass and landfill gas RECs will be reduced after 20 years for new facilities and 15 years for existing facilities from the time they were approved as a Class I renewable energy source in Connecticut. DEEP believes it is appropriate to apply the New/Existing facility designations that PURA established for hydropower to biomass and

landfill gas.[64] This phasedown schedule will provide both new and existing facilities reasonable time to amortize their investments.

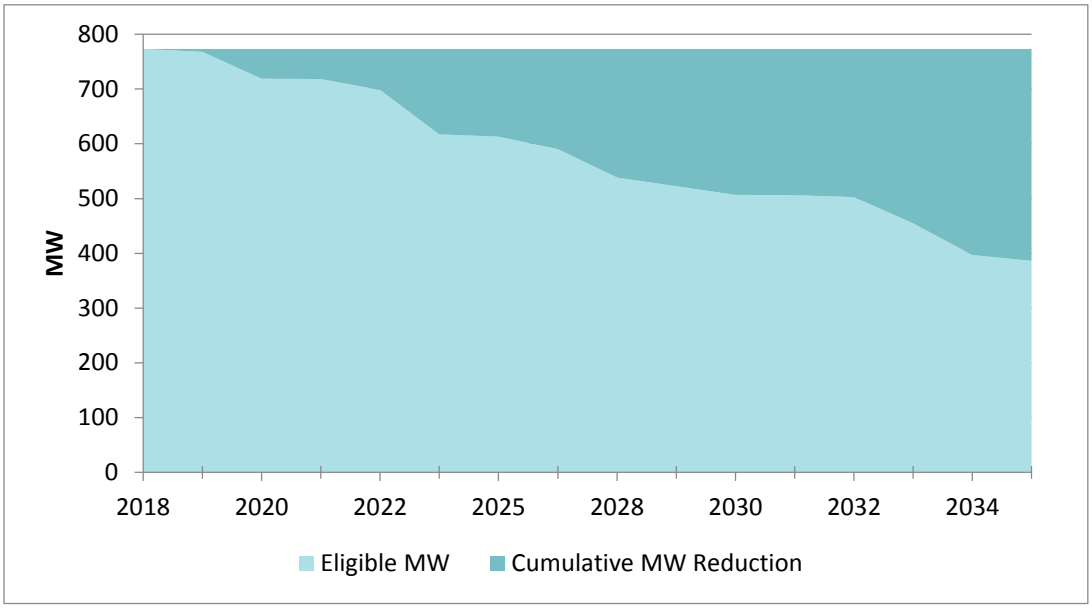
After the initial license period ends, the amount of generation eligible as a Class I resource will be reduced for each biomass and landfill gas project, which will gradually reduce the value of Class I RECs to all biomass and landfill gas facilities. Class I RECs will still be generated as they have been, but the amount of generation eligible as a Class I resource in Connecticut will decline to 50 percent of the actual generation output from the facility each year. One MWh would still be required to be produced to receive a REC. A REC for a Class I biomass facility would be priced the same as other Class I resources. The other 50 percent of the annual generation output, which is not eligible in Connecticut, will still be eligible to be sold to meet RPS requirements in other states. For example, New Hampshire recently enacted legislation that would increase the ACP price for its Class III resources, which includes biomass, from $45 to $55 per REC.[65]

DEEP expects that the MWs of biomass and landfill methane gas (LMG) that are eligible as a Class I resource in Connecticut will decline according to the chart below. Eligible MWs could decline even further if a biomass or landfill methane gas facility goes offline. Under this methodology, some biomass/LMG facilities will see a reduction in their Class I REC eligibility in 2020, while others will not do so until after 2030. In future proceedings, DEEP will determine if the phase down should continue beyond 50 percent.

[64] New facilities are those that began operation after 2003 and existing facilities are those that began operation prior to 2003. An existing facility may be considered a new facility if it was abandoned for at least two consecutive years and there had been a capital investment in the structure greater than 50% of the total value of the equipment at the facility. Many existing facilities made significant investments for emission control equipment to qualify as a Class I renewable energy source. (PURA Final Decision, DPUC Declaratory Ruling Concerning "Run-of-the-River Hydropower" as that Term is Used in the Definitions of Class I and Class II Renewable Energy Source in C.G.S. § 16-1(a)(26) & (27), Docket No. 04-02-07, 13-14 (Sep. 10, 2004).

[65] New Hampshire Senate Bill 129 (2017).

FIGURE S1. Cumulative Reduction of Biomass and Landfill Methane Gas MWs Eligible for Connecticut's Class I RECs, 2018-2035



Strategy 4: Expand deployment of all cost-effective distributed generation ("behind the meter") in a sustainable manner

Connecticut's ambitious GWSA goals rely on electrification of transportation and building heating and a decarbonized electric grid. As the state seeks a sustainable, cost-effective pathway to reduce electric sector GHG emissions, the relative costs of different programs, policies and technologies must be assessed. As of today, distributed generation—including resources like rooftop solar and customer-sited fuel cells—costs state ratepayers more on a per-kWh basis than grid scale renewables. The compensation structure for current behind the meter output is based on net energy billing (also known as "net metering") and is linked to retail electricity rates. For residential customers, these rates have steadily increased over time, while for commercial and industrial customers, these rates have been subject to more dramatic changes (including reductions in volumetric rates) based on increased demand charges. In addition to differing by customer class, electricity rates also differ by utility. When utilities pay for the output of distributed generation, they must recoup those costs through charges on all ratepayers.

Distributed generation can provide additional benefits beyond those provided by out-of-state grid-connected projects, such as reducing system line losses, potentially delaying the need for transmission and distribution infrastructure, reducing electric bills for participating customers, increasing resiliency and energy security, and contributing to economic development in Connecticut. Residential or commercial rooftop solar also does not present the same land-use tensions and siting concerns that grid scale projects frequently face. However, the addition of behind the meter renewable capacity also places integration and administrative costs on the electric grid, including cost shifting to non-participants that results from the current net energy billing structure.

Many of the REC-purchasing incentive programs for distributed generation created over the last seven years—including LREC/ZREC and the Residential Solar Investment Program ("RSIP")—are scheduled to sunset in the next three years or sooner.[66] Moreover, the virtual net metering program quickly reached the statutory cap for municipalities, meaning there is no additional money available for new municipal installations. In addition, tying compensation for resource output at the level of retail electricity rates (the underlying premise of net metering and virtual net metering) guarantees that compensation paid for these resources will likely increase over time. In contrast, by all measures the cost of installing these systems, and therefore compensation for the output, should decline. When utilities pay for the output of distributed generation, they must recover those costs through charges on all ratepayers. A more cost-contained, sustainable model that still promotes growth in distributed generation is urgently needed.

The underlying structure of the net metering and virtual net metering programs—collectively termed net energy billing—is not easily understood and can vary considerably for the same energy. Residential customers with solar projects are compensated through net energy billing based on retail electric rates, which vary from year to year, but recently have ranged from 17.5 cents/kWh in 2015 to 20.5 cents/kWh in 2017. An individual customer's rate changes at least annually, due to varying cost of supply and delivery resources. In addition, because electric rates vary between customer classes and utilities, the amount that customers receive for their generation can vary significantly. Therefore, compensation can change drastically based on the outcomes of a rate case, which is unrelated to the costs or benefits that these resources provide. For example, the Eversource rate case in 2014 increased demand charges for certain commercial customers, reducing the volumetric charges that could be netted out with net energy billing. This likely reduces the savings that customers receive relative to the savings they expected, based on forecasted rates when their systems were initially installed.[67]

Thus net metering and virtual net metering tariffs are not based on either the value that such resources provide to the grid or on the compensation required by the owner of the distributed-generation facility. The blunt structure of these programs was effective when these resources were first coming online; but now that the market for distributed generation is more mature, it is time to ensure these programs are financially sustainable over the long term. While DEEP recognizes the importance of expanding clean-energy resources and the value that distributed generation plays in the diversity of the electric system, the agency also has seen the benefit of utilizing competitive procurements to drive down the cost of clean-energy resources for ratepayers. Therefore, restructuring net energy billing would be the best way to meet Connecticut's carbon-reduction goals, control costs, and make distributed generation pricing more equitable and transparent.

DEEP recommends that the existing net metering and virtual net metering laws be modified to establish a regulatory and competitive framework to allow crediting on a cents/kWh basis for a fixed term of 20 years for purchasing both the energy and RECs from total production of distributed

[66] For behind the meter resources, the LREC/ZREC program will conduct its final auctions in 2018 and the SHREC program will expire at the earlier of 300MW of installations or December 21, 2022.
[67] PURA Docket No. 14-05-06, Application of the Connecticut Light and Power Company to Amend Rate Schedules.

generation. DEEP recommends combining the energy and REC purchase programs for distributed generation into a single tariff-based program and PURA initiate proceedings to implement this recommendation, including structuring the purchases and any metering infrastructure necessary for customers going forward. As detailed below, DEEP proposes that the amount the utilities are authorized to spend annually on all distributed generation would be $35 million, with an additional $35 million available each year for new resources, similar to how the current LREC/ZREC budget operates. Instead of offsetting each kWh used by the customer with a kWh produced by their renewable project, customers would be credited a fixed amount on a cents/kWh basis for each kWh produced to receive savings on their electric bill.

A. Grandfather existing distributed generation systems

In fairness to existing projects using net metering and virtual net metering, DEEP recommends that they be grandfathered and allowed to use their current net energy billing tariff for up to 20 years from their in-service date. After the 20 years for both the grandfathered projects and project utilizing the new restructured net energy billing tariffs, the customers would get a set rate on a cents/kWh basis, as determined by PURA in the development of the tariff(s).

B. Determine total authorized utility spending for all distributed generation tariffs

DEEP evaluated six scenarios to determine what approach would provide the most cost-effective results to support the growth of distributed generation from 2020 to 2030 while also mitigating cost-exposure to electric ratepayers. Additional details on the calculations in this section are included in Appendix B.[68] These scenarios included:

1. A Business as Usual approach, in which the RSIP and LREC/ZREC programs are expanded through 2030 and net energy billing continues indefinitely.
2. A MW cap resulting in 2.5 percent of the load served by distributed generation by 2030 (i.e., 0.25 percent per year, as suggested in the draft CES in July 2017).
3. A MW cap resulting in 5 percent of the load served by distributed generation by 2030 (i.e., 0.5 percent per year).
4. A spending cap of $25 million per year.
5. A spending cap of $30 million per year.
6. A spending cap of $35 million per year.

DEEP found that under a Business as Usual approach the net present value (NPV) of Net Direct Ratepayer Cost[69] would be about $1.7 billion (2017$). Under the 2.5 percent and 5 percent cap scenarios, DEEP estimates that the NPV of the Net Direct Ratepayer Cost would be substantially less ($600 million and $1.2 billion, respectively) than continuing to support resources at the current pace. However, this approach would result in much less renewable development. For example, under the

[68] This analysis envisioned deployment of renewables for all sectors and technologies to take place from 2021 to 2030. Cost were determined on a Net Present Value basis using a 5% discount rate.

[69] Net Direct Ratepayer Cost is defined as the difference between (1) subsides and net metering credits and (2) avoided generation. Avoided generation was calculated using the forecasted retail rate for standard service generation.

Business as Usual Approach, the State would be on track to procure an additional 1,100 MW of new solar projects by 2030. Under a 2.5 percent cap, the amount would be approximately 315 MW; under a 5 percent cap, 630 MW.

DEEP also evaluated three "Budget Based" approaches analogous to budgeting for the LREC/ZREC program. Under these approaches, the State would set a spending cap to purchase generation from Class I resources and that spending cap would be refreshed each year for the new procurement. The three levels of spending evaluated were $22.5 million, $30 million, and $35 million. Over the life of the program, the NPV of the Net Direct Ratepayer Cost for these resources would be $275 million, $367 million, and $428 million, respectively. Under all of the Budget Based approaches, the NPV of Net Direct Ratepayer Costs is significantly less when compared to the Business as Usual cost of net metering. For example, the NPV of the Net Direct Ratepayer Costs is about $1.3 billion less under the $35 million Budget Based approach compared to the Business as Usual cost under net metering, while simultaneously providing about 900 MW of solar and 95 MW of fuel cells.

After evaluating the six scenarios, DEEP recommends an annual investment amount of $35 million for distributed generation. This amount would best help Connecticut meet its energy and environmental goals, while also mitigating major cost-exposure to ratepayers. Setting an annual dollar cap, rather than an annual MW or percent of load cap, would encourage competition within the program and allow for more resources to come online in any given year as the cost of the purchases decline. This level of spending ensures the growth of the distributed generation clean-energy industry continues at a pace of growth similar to deployment levels in recent years.

TABLE S1: Program and Ratepayer Costs (NPV) under Six Scenarios[70]

Scenario	Business as Usual [71]	BTM Cap at 2.5%[72]	BTM Cap at 5%[73]	$22.5 Million/ Year[74]	$30 Million/ Year[75]	$35 Million/ Year[76]
Duration	Ongoing	Ongoing	Ongoing	20 Year Contracts	20 Year Contracts	20 Year Contracts
Program Cost (Millions)	$5,047	$1,549	$3,097	$1,964	$2,619	$3,055
Generation Value (Millions)	$3,322	$949	$1,897	$1,689	$2,252	$2,627
Net Direct Ratepayer Cost (Millions)	$1,725	$600	$1,200	$275	$367	$428

[70] See Appendix B for a detailed explanation of these calculations.
[71] Business as Usual: Under this approach the Green Bank Subsidy would be expanded thru 2030 with an installation target of about 32 MW per year. In addition, the LREC/ZREC program would be expanded from 2021 to 2030, with the same $8 million annual spending target and 15 year REC contracts. Net Metering would also continue indefinitely for all residential, commercial, industrial projects.
[72] BTM Cap at 2.5%: Under this approach the state would allow new BTM projects to represent .25%/year for a cumulative 2.5% cap in 2030. Each sector (Residential, Commercial, and Industrial) would be allocated 1/3 of the annual cap. Residential projects would continue to receive state subsidies and C/I projects would continue to receive a REC subsidy similar to the LREC/ZREC program, however annual spending would never exceed the amount needed to reach the annual percentage cap for each sector. Net Metering would also continue indefinitely for all residential, commercial, industrial projects.
[73] BTM Cap at 5%: This approach is similar to the 2.5% cap, however the annual cap would be .5% for a cumulative 5% cap in 2030.
[74] $22.5 Million/year: Under this approach, Tariffs would be established for Residential, Commercial, and Industrial projects and annual spending would be limited to $22.5 million per year for a cumulative budget of $4.5 billion to install new projects from 2021 to 2030. The annual budget would be split evenly between Residential Solar projects, C/I solar projects, and C/I fuel cell projects.
[75] $30 Million/year: This approach is similar to the one above, however annual spending would be limited to $30 million per year for a cumulative budget of $6 billion to install new projects from 2021 to 2030.
[76] $35 Million/year: This approach is similar to the one above, however annual spending would be limited to $35 million per year for a cumulative budget of $7 billion to install new projects from 2021 to 2030.

TABLE S2: Estimated Cumulative Installed Capacity and Percent of Load under Six Scenarios (2021-2030)

Scenario	Business as Usual [77]	BTM Cap at 2.5%[78]	BTM Cap at 5%[79]	$22.5 Million/ Year[80]	$30 Million/ Year[81]	$35 Million/ Year[82]
Residential Solar (in MW)	315	157	315	261	348	406
C/I Solar (in MW)	794	157	315	311	415	485
C/I Fuel Cell (in MW)	85	25	50	61	81	95
Percent of Load in 2030	8.94%	2.53%	5.06%	5.22%	6.95%	8.11%

TABLE S3: Monthly Residential Bill Impact under Six Scenarios

	Business as Usual	BTM Cap at 2.5%	BTM Cap at 5%	$22.5 Million/ Year	$30 Million/ Year	$35 Million/ Year
2021 (Nominal Dollars)	$0.53	$0.19	$0.38	$0.28	$0.37	$0.43
2025 (Nominal Dollars)	$2.38	$0.85	$1.70	$1.15	$1.53	$1.78
2030 (Nominal Dollars)	$5.01	$1.64	$3.29	$1.13	$1.51	$1.76

[77] *See* Footnote 67.
[78] *See* Footnote 68.
[79] *See* Footnote 69.
[80] *See* Footnote 70.
[81] *See* Footnote 71.
[82] *See* Footnote 72.

C. Designate consumer categories within the spending cap

The recommended $35 million annual purchase amount would be split three ways between three different categories—Low Emission Renewable Energy Tariffs, Zero Emission Renewable Energy Tariffs, and Residential Renewable Energy Tariffs—with approximately $11.6 million annually per category. The requirements for projects in these categories would mirror existing requirements in programs similar to LREC/ZREC, RSIP, and virtual net metering.

The Low Emission Renewable Energy Tariffs category would be limited to commercial and industrial customers that utilize low-emission Class I renewables, including anaerobic digestion, similar to the current LREC program.[83] The maximum system size would be 2 MW. The size of the facility would be based on the load at one meter, with the exception of state, municipal, and agricultural customers, who are allowed to aggregate the load of multiple beneficial account meters when sizing the facility. This limitation mirrors the program parameters of the existing virtual net metering program.

Similarly, the Zero Emission Renewable Energy Tariffs would be limited to commercial and industrial customers that utilize zero-emission Class I renewables, similar to the ZREC program.[84] The maximum system size would be 2 MW. The size of the facility would be based on the load at one meter, with the exception of state, municipal, and agricultural customers, who are allowed to aggregate the load of multiple beneficial account meters when sizing the facility.

Finally, the Residential Renewable Energy Tariff would be limited to residential customers, and these small rooftop solar systems would be capped at 25 kW and sized according to the load at the home's meter.

For all three of the tariff categories, if at any point during the year the actual cumulative generation exceeds the expected annual load, the customer should be paid at the Wholesale Locational Marginal Price (LMP) for any excess production for the remainder of the year. For example, if a customer consumes 8,400 kWh per year, but by October 15 actual cumulative production equals the expected annual load, then any amount of production for the remainder of October, November and December will be paid at the annual Wholesale LMP.

D. Hold semi-annual competitive solicitations for Low and Zero Emission Tariff categories

DEEP recommends that prices for larger distributed generation utilizing the Low and Zero Emission Tariffs be established by competitive bids. The agency expects that a competitive procurement structure would drive down the price of these resources and result in even more deployment of

[83] LREC resources are "generation projects that are less than two megawatts in size, located on the customer side of the revenue meter, serve the distribution system of the electric distribution company, and use Class I technologies that have no emissions of no more than 0.07 pounds per megawatt-hour of nitrogen oxides, 0.10 pounds per megawatt-hour of carbon monoxide, 0.02 pounds per megawatt-hour of volatile organic compounds, and one grain per one hundred standard cubic feet." Conn. Gen. Stat. § 16-244t.

[84] ZREC resources are "generation projects that emit no pollutants and that are less than one thousand kilowatts in size, located on the customer side of the revenue meter and serve the distribution system of the electric distribution company." Conn. Gen. Stat. § 16-244r.

distributed generation. In later years, more resources can come online as the average procurement price drops.

Both the Low Emission Renewable Energy Tariffs category and the Zero Emission Renewable Energy Tariffs category would compete in a semi-annual competitive solicitation conducted by the EDCs using an auction process similar to the current LREC/ZREC structure. Shared Clean Energy facilities would be allowed to compete in both of these auctions, as discussed in more detail below. This process would set a price for the energy and RECs for Class I distributed generation for that auction. Through competition, the market can deliver clean energy resources at a cheaper price for ratepayers, provided that markets are effectively monitored to ensure that they are competitive and that regulators have sufficient authority to adjust market structures to sharpen competition and manage ratepayer risk, particularly in light of rapid declines in technology costs. For example, PURA should not require the EDCs to spend the entire annual budget if bids that come in during the auction are not cost-competitive. One way to achieve this could be by establishing reasonable price caps based on prior auctions.

Auctions for these larger installations would begin in 2019, because the last auctions under the existing LREC/ZREC programs are in 2018. The new arrangement would not only continue the purchase of RECs to serve as a successor to the LREC/ZREC program but would serve as a successor to the virtual net metering program and make money available for municipalities every year. DEEP recommends that the EDCs continue to use a structure similar to LREC/ZREC and create separate procurements for different size resources under the MW limit (i.e., small, medium, and large projects) to ensure a variety of projects and customers can participate in the program. It should also be noted that the procurements can be structured to prioritize meeting certain energy policy goals, as detailed more in Strategy 8 below.

E. Integrate a statewide shared clean energy program into the new LREC/ZREC auctions

The Shared Clean Energy Facility (SCEF) pilot demonstrated the viability of a renewable energy cents/kWh crediting structure. The pilot also drew proposals that will reach low- to moderate-income customers and projects that will be sited on brownfields and other underutilized lands—rather than prime farmland or core forest—avoiding siting issues encountered with some grid scale projects. Customer enthusiasm and demand for shared solar is high, and it should be provided a meaningful channel as the state looks to increase deployment of renewable energy.

However, fundamental program design challenges remain, centering on the fact that contracts between projects and the EDCs are paid for by all ratepayers but a credit is allocated only to participating customers.[85] To date, all contracts or tariffs with renewable generation, both grid-

[85] As an alternative measure to reduce rate impacts on non-participants, PURA could consider allowing utilities to recover certain project costs—particularly values like the RECs and avoided energy costs—from all ratepayers, but allocate the remaining cost of the contract to only the subscribers. This more closely models how shared solar programs in traditionally-regulated states have operated.

connected and behind the meter, have been paid for by all ratepayers. For grid-connected projects, the financial benefits from those long-term contracts go to all ratepayers. For behind the meter projects, some financial benefits go to all ratepayers, but many of the financial benefits accrue only to participating ratepayers who own or lease rooftop solar systems. In the case of behind the meter generation, host customers receive bill credits for their net generation, but put "skin in the game" either by purchasing the solar system or by leasing through fixed monthly payments. In other words, revenue from the sale of energy to the utility (as well as avoiding the need to purchase grid-delivered energy) provides a return on their investment in solar panels. In addition to this financial commitment, the project is sited on the customer's home or property. Similarly, with virtual net metering, the host has a financial interest through a purchase or lease, and the project is sited on their property or a property in which they have an interest.

In contrast, proposals under the SCEF pilot program required no meaningful commitment on the part of participating subscribers. None of the proposals received required the purchase or lease of a portion of the system; rather, participating customers simply receive a credit from the EDC that is paid for by all ratepayers and pass a portion of that along to the solar developer.

Allowing SCEF subscribers to receive a bill credit without putting "skin in the game" means that credit is simply added to the price bid by the project, locking all ratepayers into a higher-priced contract than the market otherwise would accommodate. In the absence of meaningful subscriber participation, DEEP could procure a unit of the same size through its grid scale procurements at a lower price for all ratepayers. When community solar is offered to subscribers without requiring any meaningful commitment or lease agreement from the subscriber, the system is functioning the same as a grid scale installation but with an added cost to non-participant ratepayers to pay for administering and delivering credits to subscribers who have not provided any material support to the system. Credits to participating customers raise the cost of the project, and this cost ultimately is borne by other ratepayers. Based on DEEP's experience with competitive solicitations, small grid-scale projects, similar in size to community solar projects, can be developed in Connecticut more cost-effectively than through the shared solar pilot structure and, in the process, provide the same benefits for *all* ratepayers, not just subscribers.

Designing a successful and cost-effective statewide shared solar program requires a clear means to keep project costs down, minimize impact on non-participants, and ensure the program meets other policy goals. Therefore, DEEP recommends:

- **Competition.** After the pilot stage, shared solar projects should be allowed to participate in the Low and Zero Emissions Renewable Energy Tariff auctions. This will allow these projects to compete alongside similarly sized projects that serve commercial and industrial customers, municipalities, state agencies, and agricultural customers. Sections B, C and D above describe how total spending for those auctions would be set.

- **Eligibility.** To ensure meaningful customer participation, the new statewide SCEF program should require that all participating customers (with possible exemptions for low and middle income customers and small businesses as detailed below) purchase solar panels or a

percentage of the facility output and pay the full cost upfront, or enter into a long-term lease arrangement that requires a fixed payment each month not tied to the actual monthly output of the facility. This fixed payment would contribute to development of the clean energy system and limit the rate impact on non-participant ratepayers. A lease arrangement could be structured to provide a flat rate over the lease term. This would enable participants to receive the value of owning a PV system (obtaining electric bill credits in return for their support of the grid) without the burden of installation and maintenance. The EDC would pay credits to the customer on a fixed cents/kWh basis for energy the facility produces. These improvements would limit the rate impact on non-participating ratepayers for the credits obtained by subscribers. The SCEF pilot's successful use of a competitive process to solicit bids with an energy-and-RECs bid design closely resembles the renewable energy tariff structure in this Strategy, providing clearer alignment and consistency across renewables programs.

- **Exemptions for low and moderate-income customers and small businesses:** DEEP recognizes that leasing/ownership requirements would likely result in higher costs and other burdens for participants. Many states intend their shared solar programs to specifically benefit low- and moderate-income (LMI) customers who do not have rooftop solar access and cannot take advantage of conventional net metering. Imposing high program participation requirements may work against this accessibility goal. Ensuring high participation rates by LMI customers can be a worthwhile goal in the context of reducing energy burden and meeting other policy objectives. A program or projects specifically targeting LMI customers and/or small business customers could be exempted from the leasing/ownership requirements through the tariff structure.

F. Enhance transparency of voluntary renewable energy products

Greater consumer choice and increasing cost-effective renewable deployment opportunities and market development could also be achieved through a stronger framework for voluntary renewable energy products offered by competitive electric suppliers. Although several competitive electric suppliers offer voluntary renewable energy choices, the product offerings of many suppliers fall far short of the standards of the Connecticut Clean Energy Options (CCEO) program in terms of the sourcing of renewable energy to benefit Connecticut customers (types and geographic location of generation), product disclosure, a consistent REC-based product, and REC verification standards. DEEP recommends that PURA's new regulations for voluntary renewable energy products, to be drafted in Docket No. 16-08-23, require these products to meet the supplier standards of the CCEO program. This will increase transparency and make sure customers are meeting the goals they are intending to meet when purchasing these voluntary products (e.g., supporting new in-state or local projects).

Specifically, PURA should require suppliers to disclose the sources and geographic location of the clean energy that they offer. DEEP recommends that marketing for voluntary renewable products be separately identified on the Rate Board of the EnergizeCT website for clarity. In addition, PURA should

implement a tracking and verification process for the attributes of voluntary clean energy to ensure that customers are getting the benefit of the renewables they are purchasing.

G. Establish renewable-generation rates for residential customers

Smaller residential installations under 25 kW may not be suitable to participate in a competitive process like the structure for the Low and Zero Emissions Renewable Energy Tariffs. Although these installations may be more expensive, they create opportunities for residents and small businesses to site clean energy on their properties. Therefore, DEEP recommends that these systems have access to a renewable energy tariff for energy and RECs at a set price on a cents/kWh basis. The price would be set by PURA in an open and transparent proceeding.[86] This tariff would be effective upon the expiration of the RSIP/SHREC program, which sunsets at 300 MW or 2022 (whichever comes first), serving as a successor to that program.

Bonus payments (often called "adders" in this context) should be established to meet other policy objectives, such as deferring distribution system upgrades or addressing peak loads. This structure provides greater certainty to those developing distributed generation and eliminates potential changes to the net metering compensation that can occur from changes in the rate structure of retail electric rates. It would also better protect renewable energy programs from funding sweeps by the General Assembly.

In establishing a price for the residential tariff, DEEP recommends that PURA consider the following options:

1.) The price can be set based on the results of the competitive auction for larger distributed generation with an adder, similar to the Small ZREC tariff. This may be an effective way to set the tariff rate on an interim basis while PURA conducts a more extensive analysis, if it chooses.

2.) The price also could be based on the direct cost to bring the system online and operate over the term, including a reasonable rate of return for the customer/developer.

Developing the tariff for small residential distributed generation based on the cost of the projects is the best way to ensure funding adequate to encourage development while also minimizing the rate impact on customers who do not participate in the program. The price for new resources could be adjusted as needed, which would allow the market to adjust based on changes to federal tax incentives, for example, without slowing the pace of deployment. A cost-based approach is much easier to estimate and far less subjective than determining the value of distributed generation.

[86] Recently, PURA indicated that it would study the value, including the costs and benefits, provided by distributed energy resources in a docketed proceeding that should result in a better alignment of programs costs and program benefits. PURA Correspondence, Temporary Suspension of Docket, PURA Docket No. 16-02-30, PURA Review of the Electric Distribution Companies Cost of Service Study Methodologies and Rate Design (Apr. 3, 2017).

Estimating the benefits of distributed generation is important to understand the cost effectiveness of particular policy options, but the value may not be the best way to set a compensation level for these resources. The value could be less than needed to encourage development of distributed generation if the value is estimated to be below the cost. On the other hand, if the value is estimated to be very high, this approach could overcompensate participants and developers by paying them more than needed to develop their projects and provide a reasonable rate of return. A particular resource may have a high value, but the market can deliver the same product at a lower price, which saves all ratepayers money and allows more extensive investment in clean energy resources. The State should distinguish between the value of generation from a distributed resource and the compensation required by the facility producing such generation. In order to maximize net benefits to Connecticut's ratepayers, the State needs to procure clean energy at a low cost. Determining the compensation rate will be a contentious undertaking, and the rate will need to be re-assessed on a regular basis to adjust for changes in system costs. Over time, the value of the resource will likely increase or stay the same, but the cost of distributed generation such as solar and fuel cells should decline. In setting the tariff rate for small distributed generation, PURA should balance the need to spur a reasonable and sustainable pace of expansion of clean energy resources at the least cost for all ratepayers to allow for further investments in the future.

Strategy 5: Continue to improve grid reliability and resiliency through state and regional efforts

The ISO New England grid mix has trended toward natural-gas-fired generation due to historically low natural gas prices. Pipeline infrastructure for natural gas has not kept up, creating a winter peak challenge. Thermal loads receive priority on gas lines, constraining gas availability for electricity generation. This increases the likelihood that the region's remaining oil and coal generation will be required to run, causing generation prices to rise dramatically.

The cold snap between December 25, 2017, and January 8, 2018, during which New England had average temperatures below normal for 13 consecutive days, exposed the operational difficulties of a regional grid reliant on constrained natural gas. During the cold snap, Northeast natural gas prices rose significantly (at times they were at $140 per MMBtu, the highest in the world), causing electricity prices to also rise and causing oil and coal units to run. Energy prices went from around $20 million/day up to nearly $70 million/day. Natural gas generation fell from 38 percent of the regional grid's fuel mix on December 24, 2017, to 19 percent on January 6, 2018. At the same time, oil went from 1 percent to 36 percent, while coal went from 2 percent to 6 percent. ISO New England became so concerned that oil-fired generation would run out of oil supply that it began to preemptively commit more expensive resources.

In addition to fuel security, extreme weather, sea level rise and coastal flooding due to climate change are all threats to the grid system.

A. Support ISO New England in improving regional winter natural gas generation fuel security and reliability

On January 17, 2018, ISO New England published an Operational Fuel-Security Analysis (Fuel Security Study) which "evaluated the level of operational risk posed to the power system by a wide range of potential fuel-mix scenarios. The study quantified the risk by calculating whether enough fuel would be available for the system to maintain power system reliability throughout the entire winter." [87] ISO New England studied 23 possible resource combinations and outage scenarios during the winter of 2024/2025. The study drew six major conclusions:

1. *Outages:* The region is vulnerable to season-long outage of any of several major energy facilities.

2. *Key dependencies:* Reliability is heavily dependent on liquid natural gas (LNG) and electricity imports; more dual-fuel capability is also a key reliability factor.

3. *Logistics:* Timely availability of fuel is critical, highlighting the importance of fuel-delivery logistics.

4. *Risk:* All but four of the 23 scenarios studied result in load shedding, indicating a trend toward increased fuel-security risk.

5. *Renewables:* Increased use of renewables can help lessen fuel-security risk, but this is likely to drive oil-and coal-fired generator retirements which, in turn, will necessitate the use of more LNG.

6. *Positive outcomes:* Higher levels of LNG, imports, and renewables can minimize system stress and maintain reliability; delivery assurances and transmission expansion would be needed.[88]

Significantly, one of the vulnerabilities ISO New England identified is a season-long loss of the Millstone Station. The study concluded that the loss of Millstone would require 47-70 hours of load shedding over 10-12 days. Even the highest assumed potential levels of LNG, oil, imports, and renewables would not avoid load shedding in New England if Millstone Station were off-line for a prolonged period of time.[89]

The fuel security risk is not new. For various reasons, some New England states have not been in a position to share the costs of the necessary infrastructure investments to relieve winter constraints caused by inadequate natural gas infrastructure. Connecticut is not able to resolve the gas generator

[87] See, Fuel Security Study, pp. 1-5. https://www.iso-ne.com/static-assets/documents/2018/01/20180117_operational_fuel-security_analysis.pdf.
[88] Operational Fuel Security Analysis, Discussion with Stakeholders, slide 13 available at https://www.iso-ne.com/static-assets/documents/2018/01/a02_operation_fuel_security_analysis_presentation.pdf
[89] See, Fuel Security Study, pp. 42, 43-45

winter reliability problems on its own. A solution requires the participation of all six New England states. ISO New England has taken the position that it does not have the authority to directly address the region's fuel infrastructure needs. The system operator has indicated it is looking for "market based incentives" to help ensure fuel security. DEEP will be an active participant in ISO New England stakeholder discussions on solutions to fuel-security risks.

In addition, DEEP remains committed to utilizing its authority by conducting additional procurements, if necessary, under all sections of Public Act 15-107, in coordination with other states, to secure more reliable and affordable electric service for the benefit of Connecticut's electricity ratepayers and to meet the State's energy and environmental goals and policies.

B. Continue to deploy community microgrids to support statewide resiliency goals in strategic locations and support the Energy Assurance Plan

DEEP will continue outreach on the value and importance of community microgrids to municipal employees and officials either individually or in partnership with the Connecticut Conference of Municipalities, Council of Small Towns, and the Connecticut Center for the Advancement of Technology. DEEP supported legislation to expand the range of expenses that may be reimbursed to municipalities under the program. In 2016, the program's bond funding was expanded to provide matching funds or low-interest loans for an energy-storage system or clean distributed-generation projects for a microgrid. DEEP also will explore the possibility of funding the interconnection infrastructure with matching funds and having the applicant contribute funds to those costs.

The original enabling legislation requires DEEP to distribute the funds to small, medium, and large municipalities, to the extent possible. To scale the microgrid program across the state, DEEP encourages the EDCs and the municipal electric utilities (MEUs) to identify locations where critical facilities are located within geographic proximity of each other and share this information with municipal officials and employees. This will be an important element of the implementation of Public Act 17-144, which requires the EDCs to present a plan to PURA for deployment of up to 30 MW of grid-enhancing fuel cells, which could include fuel cells within microgrids that would enhance reliability of the larger grid. DEEP will participate in meetings between the EDC or MEU and the affected municipality to provide assistance to the municipality in understanding the benefits and costs of the microgrid. Additionally, DEEP will work with the Division of Emergency Management and Homeland Security to develop a comprehensive microgrid deployment strategy for the state and increase outreach in areas without a microgrid nearby, such as northwest Connecticut.

C. Ensure coastal resiliency of substations and other critical grid infrastructure to support DEEP's flood management goals.

Current ISO New England rules do not clearly indicate when it is appropriate for transmission operators to take action to address region-wide challenges arising from climate change. Rather, transmission operators bring issues to NEPOOL and ISO New England on an ad hoc basis with the hope that they can convince stakeholders and the ISO that identified resilience issues affecting the bulk transmission system represent an "asset condition" that needs to be addressed. If the

transmission operator is successful, the costs of the project are regionalized; if not successful, the transmission operator can either bring it to the local regulator for local allocation of costs or abandon the project. However, there are no clear standards on what constitutes an "asset condition" in the context of resiliency and climate adaptation. Connecticut is working through the NEPOOL process to encourage development of standardized guidelines for addressing these threats. DEEP will continue to work for a timely resolution to this issue.

Strategy 6: Reduce transportation greenhouse gas emissions by accelerating adoption of low- and zero-emission vehicles and strengthening alternative-fueling infrastructure.

The transportation sector is the state's largest contributor to GHG emissions, and steep reductions will be required to ensure Connecticut meets its Global Warming Solutions Act target of reducing emissions 80 percent below 2001 levels by 2050 as well as the 45 percent target for 2030 recommended by the Governor's Council on Climate Change (GC3).[90] Therefore, recognizing that many of the state's residents and businesses will likely depend largely on automobiles for years to come, Connecticut must accelerate deployment of zero- and low-carbon vehicles to achieve meaningful emissions reductions and to increase energy reliability and security.

With light-duty vehicles accounting for 95 percent of Connecticut's vehicle fleet and 70 percent of its on-road energy consumption, electric-drive vehicles powered by rechargeable batteries or hydrogen fuel cells currently present the strongest potential to significantly reduce greenhouse gas emissions in the transportation sector—especially when the electricity and hydrogen are produced with low-carbon resources.[91] Even with the current mix of generation sources, the potential for emissions reductions from electric vehicle deployment is not inconsequential. The average emissions rate for the New England region is half of the national average emission rate due to the large percentage of low- and zero-carbon generation resources that produce the region's electricity.[92] As a result, the average annual emissions of an all-electric vehicle in our region is one fourth the emissions of a vehicle with a gasoline-combustion engine.[93]

Emissions modeling performed for the GC3 found that approximately 92 percent of Connecticut's passenger and light-duty fleet needs to consist of zero-emission vehicles (ZEVs) by 2050 in order to

90 The Governor's Council on Climate Change is tasked with recommending an interim statewide GHG reduction target for the years 2020-2050 and identifying short- and long-term strategies to achieve the necessary reductions. The Office of Governor Dannel P. Malloy, "Executive Order No. 46," April 22, 2015, http://portal.ct.gov/en/Office-of-the-Governor/Pages/Press-Room/Executive-Orders?SearchKeyword=&Month=by+Month&Year=2015.

91 Atlas Public Policy and The Cadmus Group Inc., *Moving Forward with Green Energy: Market Potential Assessment for Alternative Fuel Vehicles in Connecticut*, September 2016, 48, http://atlaspolicy.com/wp-content/uploads/2016/11/2016-09-01_Moving_Forward_with_Green_Energy.pdf.

92 Emissions and Generation Resource Database (eGRID), accessed November 15, 2017. https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid

93 U.S. Department of Energy, Alternative Fuels Data Center, accessed November 15, 2017. https://www.afdc.energy.gov/vehicles/electric_emissions.php

meet the GWSA.[94] This transformational change requires Connecticut to continue to develop and implement programs and policies that mainstream the adoption of ZEVs and develop the infrastructure needed to support them.

In response to energy and environmental regulatory interventions designed to increase deployment of low- and zero-emission vehicles, auto manufacturers have significantly increased investments in the design and production of plug-in vehicle technologies, including battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs), collectively referred to as electric vehicles (EVs). With more than 35 models available in a variety of styles from small and medium sedans to SUVs, second-generation EVs are providing diverse options that meet a variety of lifestyle needs. For instance, PHEVs now on the market have an electric range of 13-53 miles, while BEVs have an electric range of 62-335 miles.[95] Advances in technology have led to more powerful batteries at lower costs, thereby reducing the overall price tag for EVs and improving consumer "range confidence."[96] With declining battery costs, the cost per mile to operate an electric passenger vehicle is about one-quarter the cost of the average conventional vehicle due to the EV's highly efficient drivetrain. This, along with significantly lower maintenance costs, dramatically decreases the overall cost of car ownership. With a wider array of vehicle models available, reduced purchase and ownership costs, and extended drive ranges, demand for EVs will certainly continue to accelerate.

Hydrogen-powered fuel cell electric vehicles (FCEVs) also are a promising technology poised to reduce emissions associated with light-duty vehicles. FCEVs offer an effective driving range of over 300 miles, emit only water, and, like gasoline vehicles, can be refueled in only 3-5 minutes. While the initial adoption of FCEVs outside of California will be challenged by high vehicle cost and limited fueling infrastructure, car manufacturers are partnering with hydrogen suppliers and providing leasing options that include fuel.[97] These leasing options should be available in Connecticut when adequate fueling infrastructure is available. Given the compelling environmental benefits of FCEVs, Connecticut should maintain support for FCEVs as the industry works to both increase vehicle availability and reduce hydrogen fuel cost with the long-term goal of producing an array of FCEVs that are cost-competitive with gasoline-powered vehicles.

Decarbonization of medium- and heavy-duty vehicles and rail freight poses the greatest challenge and relies primarily on increased efficiency, mode shifting, and low-carbon fuel stocks such as biofuels and hydrogen. For instance, introducing alternative fuels to medium- and heavy-duty vehicles can be more complex and costly than doing so for passenger vehicles. Unlike passenger vehicles, these larger vehicles' engines, chassis, and supplementary equipment are rarely designed

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94 Connecticut Department of Energy and Environmental Protection, "Governor's Council on Climate Change (GC3) Meeting Minutes - March 7, 2017 Meeting," http://www.ct.gov/deep/lib/deep/climatechange/gc3/3_7_17_gc3_meeting/gc3_meeting_3_7_2017.pdf.

95 "Find Plug-In Vehicles," Plug In America, accessed December 12, 2017, http://www.pluginamerica.org/vehicles.

96 Bloomberg New Energy Finance, "Electric vehicles to be 35% of global new car sales by 2040," February 25, 2016, https://about.bnef.com/blog/electric-vehicles-to-be-35-of-global-new-car-sales-by-2040/.

97 The Toyota Mirai FCEV has a manufacturer's suggested retail price (MSRP) of $57,500 and the Honda Clarity, due out in 2017, is expected to be similarly priced. "The 2017 Toyota Mirai Fuel Cell Vehicle," Toyota, accessed April 5, 2017, https://ssl.toyota.com/mirai/fcv.html.

and manufactured by a single firm, making systems integration a key challenge. Additionally, these vehicles have a much greater diversity in body types, weight classes, drive cycles, and uses than passenger vehicles, so identifying a single strategy to achieve emissions and petroleum reductions is challenging.[98] For these reasons, a targeted approach within a specific vehicle category (e.g., waste collection trucks or transit buses) is the most appropriate tactic.

To that end, the Federal Transit Administration recently granted the Connecticut Department of Transportation (CTDOT) $1.45 million in funding under the Low or No Emission Program.[99] The program's purpose is to support the transition of transit fleets nationwide to the lowest polluting and most energy efficient transit vehicles. The grant funding must be applied toward purchase or lease of zero-emission and low-emission transit buses, including acquisition, design, construction, and implementation of vehicles and charging infrastructure.[100] Accordingly, in 2018 CTDOT will use the funds to deploy a small fleet of electric buses through a joint effort with Greater Bridgeport Transit. CTDOT views this project as the next step in its zero-emission bus deployment program, which aims to minimize the carbon emissions of Connecticut's bus fleet.

In addition to accelerating deployment of low- and zero-emission vehicles, Connecticut will build on its current strategies to support and advance deployment of alternative fueling infrastructure. This includes harmonizing infrastructure deployment with the U.S. Department of Transportation's recently established alternative fuel corridors in strategic locations along major highways.[101] This will help to improve mobility of alternative fuel vehicles and promote development of a nationwide network. Another near-term strategy includes working directly with the motor-fuel industry to advance the state's goal to appropriately accelerate EV and hydrogen infrastructure deployment.

DEEP also supports continuing efforts by H_2USA and implementation of the H_2USA plan for FCEV re-fueling infrastructure[102] and FCEV deployment.[103] NESCAUM is coordinating a planning process with car manufacturers to develop a Northeast hydrogen network of on a scale similar to California's. Air Liquide and Toyota have partnered to build 12 hydrogen stations in the Northeast, the first of which is under development in Hartford and is expected to open in 2018.

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98 Atlas Public Policy and The Cadmus Group Inc., *Moving Forward with Green Energy: Market Potential Assessment for Alternative Fuel Vehicles in Connecticut*, September 2016, 16, http://atlaspolicy.com/wp-content/uploads/2016/11/2016-09-01_Moving_Forward_with_Green_Energy.pdf.

[99] James Ayre, "US Department Of Transportation Reveals $55 Million "Low Or No Emissions" Bus Grant Program," September 18, 2017, https://cleantechnica.com/2017/09/18/us-department-transportation-reveals-55-million-low-no-emissions-bus-grant-program/, accessed 11/30/2017.

[100] United States Department of Transportation, Federal Transit Administration, "Low or No Emission (Low-No) Program FY 2017 Notice of Funding," https://www.grants.gov/web/grants/view-opportunity.html?oppId=293467, accessed 11/30/2017.

101 "Alternative Fuels Corridors," U.S. Department of Transportation, Federal Highway Administration, accessed June 30, 2017, https://www.fhwa.dot.gov/environment/alternative_fuel_corridors/.

102 http://h2usa.org/sites/default/files/H2USA_LRWG_NEFactsheet.pdf

103 http://h2usa.org/sites/default/files/2017_Regional_H2_Fleet.pdf (in particular, see Transportation chapter, Figure 3).

Several key challenges and questions stem from the process of integrating vehicles into the electric grid at scale and ensuring consumer uptake. Many states that have signed the ZEV Memorandum of Understanding, have taken a more targeted process to address these.

A. Develop an EV Roadmap

Even with increasing demand, a growing roster of vehicle models, and an increasingly adequate infrastructure in place, the EV market is still in an early stage of maturation. To further support development of a self-sustaining EV market and ensure that increased electricity demand from EV deployment is a benefit rather than an impairment to the electric grid, DEEP will initiate an EV Roadmap process in 2018 that identifies Connecticut-specific policies, programs, and strategies the State should pursue to optimize deployment of EVs and associated infrastructure. This process will include a multi-faceted dialogue that considers how proposed efforts will impact Connecticut's citizens, businesses, and environment. The Roadmap will include:

Ensuring consumer and fleet vehicle uptake

- Pursuing sustainable funding for the CHEAPR program with an intention to ensure emissions reductions and a strategy to ramp down incentives as the market matures.
- Building on the State's "Lead by Example" program by developing an EV LBE program that outlines a multi-agency strategy to accelerate adoption of EVs in the State fleet.
- Evaluating appropriate time-of-use rate structures and demand charges that support adoption of EVs.
- Investigating strategic approaches to address equity and access to EV technologies for low- to moderate-income residents as the market matures.
- Expanding and enhancing consumer awareness and education.

Vehicle charging infrastructure

- Evaluating the appropriate role of utility companies in deployment of electric charging stations, including ownership and other models.
- Evaluating opportunities for statewide deployment of slow and fast-charging EV infrastructure, ensuring appropriate access for suburban and urban areas, single- and multi-unit dwellings, retail, workplaces, and recreational facilities.
- Evaluating the role of advanced-metering infrastructure as an effective tool to optimize EV charging load profiles.
- Evaluating and identifying potential opportunities to submit proposals to Electrify America's investment Cycle 2 (Q3 2019-Q4 2021, $300 million).

- Evaluating and identifying strategic opportunities to invest 15 percent of the state's Volkswagen Appendix D funds in EV infrastructure.

Going beyond passenger vehicles

- Reviewing targeted approaches to medium- and heavy-duty vehicle electrification, including an analysis of the benefits of converting transit bus and waste-collection truck fleets.

In coordination with PURA, DEEP's Energy Bureau will implement components of this Roadmap in a way that maximizes efficiency and timeliness and avoids duplication of effort.

B. Increase EV uptake through consumer education and new models for financing and fleet purchasing.

It is important for Connecticut to leverage opportunities to enhance public awareness about clean transportation options and the social and economic benefits of more-efficient modes of travel. Highly efficient cars and light trucks in every vehicle class are already on the market, but many customers are not adequately aware of their availability and benefits. In coordination with the Department of Motor Vehicles (DMV) and CTDOT, DEEP will continue to disseminate updated information on state websites and in DMV communications. This includes maintaining current outreach and awareness approaches such as developing print and online information and tools, organizing public events and workshops, increasing exposure to new types and modes of transportation, and highly visible demonstration projects. The information should educate the public about the relative efficiency of vehicles within each vehicle class and encourage purchase of low- and zero-emission vehicles. Social media platforms, such as Facebook and Twitter, should be emphasized.

DEEP and the Connecticut Green Bank will disseminate and promote the recently released Transportation Electrification Toolkit. A joint development from Atlas Public Policy, Connecticut Green Bank, and DEEP, this publicly available online resource serves as a dynamic tool for policy makers, municipalities, and businesses to develop strategies to encourage transportation electrification by pairing EVs with residential solar photovoltaic systems and by exploring electric shared-use mobility solutions. The toolkit consists of summaries of each transportation electrification concept, a case study from outside Connecticut, and potential approaches for policy makers to deploy the concept. The toolkit also provides a resource library and interactive data dashboards that provide quick access to relevant information on transportation electrification in Connecticut.[104]

DEEP will also continue to conduct outreach via Energize Connecticut[SM].[105] The Energize Connecticut[SM] web portal has grown into an important online resource that provides Connecticut

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104 "Transportation Electrification Toolkit for Connecticut," Atlas Public Policy, accessed June 30, 2017, http://atlaspolicy.com/rand/transportation-electrification-toolkit-for-connecticut/.

105 Energize Connecticut[SM] is an initiative of the Connecticut Energy Efficiency Fund, the Connecticut Green Bank, the State, and local electric and gas utilities. The initiative has funding support from a charge on customer energy bills.

consumers, businesses, and communities the tools and information they need to more easily and affordably realize energy savings. The portal provides access to transportation-focused energy information via the search feature; however, the portal should provide direct access to that material from the main page.

Several studies have found that consumers exposed to EVs are more likely to value the benefits of EV ownership and as a result are more inclined to consider purchasing an EV in the future.[106,107] Within available resources, the State will continue to partner with companies, non-profits, municipalities, and state agencies to host ride-and-drive events to provide consumers with first-hand experience driving an EV and opportunity to ask questions that may alleviate some of the perceived barriers to EV ownership.

Many Connecticut municipalities have created "Clean Energy Task Forces" to improve energy efficiency and deploy renewable energy technologies in their communities. This network of volunteers has proven to be a valuable asset for promoting clean energy options. DEEP should work with these task forces to identify opportunities to educate and engage citizens on the benefits of EVs and alternative modes of transportation in their communities.

Another opportunity to increase adoption of EVs in Connecticut is offering financing options for the secondary EV market. Working with the CT Automotive Retailers Association (CARA) and local credit unions, the Connecticut Green Bank recently announced financing for new and used electric vehicles in the form of the Smart-E EV Loan.[108] CARA estimates that approximately twice as many new EVs are leased than purchased, largely because the technology is rapidly evolving. As a result, many previously leased EVs are sold at auction to secondary market purchasers before being resold as used vehicles, predominantly to out of state buyers. Through the Smart-E EV Loan program, Connecticut has the opportunity to capture vehicles coming off lease at the lot and ensure those EVs remain in the state. The combination of lower priced used EVs with this new readily available low-interest loan product makes an EV purchases more affordable, particularly for first-time car buyers and low- to-moderate income consumers.

Group-purchase models such as "Solarize" have proven to be successful in deploying solar on homes and businesses in Connecticut and across the country. The models' success can be attributed to their ability to tackle three major market barriers: cost, complexity, and customer inertia.[109] Using locally organized outreach efforts, a Solarize campaign uses a limited-time offer to facilitate development of a critical mass of customers to purchase or lease photovoltaic systems. The model leverages

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106 Zeinab Rezvani, Johan Jannson, and Jan Bodin, "Advances in consumer electric vehicle adoption research: A review and research agenda," *Transportation Research Part D: Transport and Environment*, Volume 34, January 2015, 122-136, http://www.sciencedirect.com/science/article/pii/S1361920914001515.

107 Kenneth S. Kurani, Nicolette Caperello, & Jennifer TyreeHageman, *New Car Buyers' Valuation of Zero-emission Vehicles: California*, Institute of Transportation Studies, University of California Davis, March 2016, https://www.arb.ca.gov/research/apr/past/12-332.pdf.

[108] http://www.ctgreenbank.com/SmartEV

109 U.S. Department of Energy, *The Solarize Guidebook: A Community Guide to Collective Purchasing of Residential PV Systems*, http://www.nrel.gov/docs/fy12osti/54738.pdf.

group-purchasing power so that customers realize cost savings through a bulk purchase. The limited-time offer motivates people to follow through with the transaction so they don't miss out on a good deal.

This model has been successfully adapted to promote deployment and purchase of EVs in other jurisdictions. For instance, several communities in Colorado and Utah worked directly with an EV manufacturer and local car dealers to secure significant discounts on the suggested retail price of the EV (e.g., discounts of $2,000-$8,500). The discount substantially reduced the total purchase cost for the participating customer, leading to dramatic increases in EV sales—up to 300 percent community-wide. A survey of 330 participants revealed that 72 percent had not intended to purchase an EV prior to the promotion.[110] Following best practices identified by these programs, Connecticut should pursue a group-purchasing pilot-program in Connecticut to evaluate the effectiveness, cost, and benefits of an EV purchase program. A pilot program could specifically evaluate: the cost to run the program; how auto manufacturers and dealers would participate in the program; whether the program increases sales of EVs; and the extent of customer and community participation.

Strategy 7: Increase mobility, connectivity, and accessibility by advancing smart-growth, mixed-use transit-oriented development, and innovative transportation partnerships

People's ability to safely, reliably, and conveniently reach everyday destinations such as grocery stores, health care facilities, jobs, schools, and recreational opportunities is critical for prosperous and healthy communities. Measures that help achieve this include integrating transportation and land-use planning, improving pedestrian and bicycle infrastructure, and managing the transportation system for efficiency and accessibility.

Sustainable land-use planning and transit-oriented development (TOD) reduce congestion, promote active transportation and healthy lifestyles, and decrease the cost of transportation by reducing fuel use and vehicle wear, while increasing foot traffic to local businesses and facilitating revitalization of neighborhoods and brownfields. Likewise, businesses benefit by gaining greater access to suppliers, markets, and labor. By lessening or eliminating the need for automobiles, location-efficient communities also help decrease GHG emissions and other harmful pollutants associated with the combustion of fossil fuels.

Advances in technology and the sharing economy may provide policy makers and planners with innovative models that reduce the energy intensity of the transportation sector.[111] Smartphone apps and access to real-time information enable users to more easily track the location of transportation services and assess the speed of travel from location to location—critical information for people using alternative modes of transportation. This same information also helps to optimize traffic system

[111] In its paper *The Current and Future State of the Sharing Economy,* the Brookings Institution defines the sharing economy as "the peer-to-peer based activity of obtaining, giving, or sharing access to good and services." Niam Yaraghi and Shamika Ravi, *The Current and Future State of the Sharing Economy*, December 29, 2016, https://www.brookings.edu/research/the-current-and-future-state-of-the-sharing-economy/.

capacity and improve passenger experience. Smartphone apps also simplify transport payment, making travel faster and more seamless.

Even more than other sectors, transportation is being impacted by the sharing economy. Shared mobility services have provided people with an alternative to individual car ownership. Car-sharing, ride-sharing, and bike-sharing services have the potential to advance energy- and emissions-reduction goals by reducing VMT and utilizing clean and efficient vehicles. This type of nontraditional solution may prove to be an effective way to improve user connectivity and accessibility.

In addition to optimizing technological advances and shared-mobility services, testing programs that pair clean energy technologies may provide Connecticut with useful insights into innovative solutions that improve mobility and access to clean modes of transportation.

Expanding and enhancing the efficiency of public transportation, promoting non-motorized travel, and supporting compact, mixed-use transit-oriented development must remain a priority for Connecticut in order for the state to continue to improve quality of life for its residents and meet its GHG reduction goals.

A. Facilitate state and regional transportation planning that improves system efficiency and reduces vehicle miles traveled.

Connecticut has been at the forefront in developing a statewide TOD program that promotes economic development, mitigates traffic congestion, improves access, and enhances mobility options. To further align reinvestment potential with transit investment, the Interagency TOD work group will continue to evaluate and identify opportunities to support the state's TOD needs.[112]

In addition to this, the Office of Policy and Management's Plan of Conservation & Development for 2013-2018 promotes concentrated development around transportation nodes and along major transportation corridors to support the viability of multimodal transportation options. The Plan of Conservation & Development calls for State policies to:

- Promote compact, pedestrian-oriented, mixed-use development patterns around existing and planned public-transportation stations and other viable locations within transportation corridors and village centers;
- Encourage a network of pedestrian and bicycle paths and greenways that provide convenient inter- and intra-town access, including access to the regional public transportation network;
- Ensure that planning, design, construction, and operation of state and local highways accommodate municipal plans and the needs of all users, to the extent possible;

[112] Governor Malloy created the Interagency TOD work group in 2012 to address the transit oriented development needs of the state. Led by DECD, work group membership includes CTDOT, OPM, and DEEP.

- Improve transit service and linkages to attract more customers through better integration of all transportation options and advances in technology, while providing convenience, reliability, safety, and competitive modal choices;

- Coordinate with host municipalities on supportive land-use regulations, such as TOD zones and freight villages, where practical, to make most effective use of transportation facilities for movement of people and/or goods; and

- Identify brownfields and other strategic sites that are (1) within one-half mile or walking distance of public transportation facilities and/or (2) near other inter-modal transportation nodes and facilities, and consider them for designation as pre-approved development areas.[113]

CTDOT, OPM, DECD, DOH and DEEP will collaborate to support statewide efforts to implement strategies consistent with the Plan of Conservation & Development and implementation of Connecticut's long-term transportation plan, Let's Go CT! In its 30-year vision, Let's Go CT! outlines strategies for integrating the state's urban, suburban, and rural communities into a single system to maximize mobility and efficiency in the movement of goods and people. The vision builds on the regular transportation capital program and calls for funding a multi-modal transportation system that goes beyond maintaining the state's infrastructure in a state of good repair to make critical improvements in all areas of the state and on all modes of transportation. The strategies and initiatives laid out in the plan will result in increased efficiency, lower GHG emissions, and increased mobility options and will have a positive economic impact on the state.

The plan calls for preserving and enhancing the state's roads, highways, and bridges. A key goal of the plan is to have a highway network free of bottlenecks or unnecessary delay. Delay on the state's roadways increases fuel consumption, contributes to GHG emissions, and is expensive for its residents and businesses. In order for Connecticut to meet its emission reduction targets and make its transportation system as efficient as possible, improvement and preservation of the state's roadways are essential. Preservation of pavement reduces emissions in two ways: it allows vehicles to operate efficiently, and it maximizes the life of emissions-intensive pavement materials.[114]

Public transportation will also be enhanced and expanded as part of the long-term transportation plan. For example, CT*fastrak* will be extended east of the Connecticut River, and the Shore Line East line will be extended into Rhode Island. The plan also calls for completing the high-speed rail corridor connecting New Haven, Harford, and Springfield. Expansion and enhancement of the state's public

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113 Connecticut Office of Policy and Management, *Conservation & Development Policies: The Plan for Connecticut 2013-2018*, June 5, 2013, 15-16, http://www.ct.gov/opm/lib/opm/igp/org/cdupdate/2013-2018_final_cd_plan_(rev._june_2017).pdf.

114 Jim Chehovits and Larry Galehouse, "Energy Usage and Greenhouse Gas Emissions of Pavement Preservation Processes for Asphalt Concrete Pavements," Compendium of Papers from the First International Conference on Pavement Preservation, 41, http://centralcoast.apwa.net/Content/Chapters/centralcoast.apwa.net/Documents/Energy%20Usage%20and%20Greenhouse%20Gas%20Emissions%20of%20Pavement%20Preservation%20Processes%20for%20Asphalt%20Concrete%20Pavements.pdf

transportation system will support TOD, which in turn will provide residents with more mobility options, particularly walking and biking, and revitalize our urban centers. Furthermore, the plan aims to complete gaps in the regional and statewide trails networks and enhance walkability in urban centers, facilitating first- and last-mile connection to transit services. All of these transit enhancements will improve residents' access to alternative modes of transportation and reduce vehicle miles traveled. DEEP, along with other state agencies, will support these initiatives by promoting and encouraging the use of public transportation and non-motorized travel.

The plan also calls for enhancements to the state's deep-water port system. It is important that the State continue to support movement of freight via air and water in order to reduce the number of freight trucks on the state's roads. Coupled with the improved rail system, the state's ports will play a key role in reducing emissions and energy consumption associated with movement of freight within and through the state.

Sustainable transportation funding is critical to developing a transportation network that is clean, efficient, and safe. Currently, state and federal transportation funding is derived primarily from fuel taxes associated with consumption of fossil fuels. Increased fuel efficiency of light-duty vehicles, combined with flat, or low growth in fuel taxes, means that existing funding sources for making these necessary transportation improvements are unstainable and inadequate. In order to implement these long-term transportation strategies, and achieve a more efficient, and cleaner transportation sector, a more sustainable funding source for transportation must be developed. Mechanisms to ensure funding availability—such as a transportation "lock-box" and travel-demand technologies, including but not limited to, electronic congestion pricing and user-based fees—should be considered viable ways to provide funding to sustain current transportation infrastructure needs and enhance mobility options that reduce the negative economic and environmental impacts of transportation.

For public transportation to be a viable and attractive option for commuters, the issue of the "first and last mile" (FM/LM) must be addressed. One of the longest-running challenges facing transit users, the FM/LM problem is how to effectively get riders from their front door to the nearest transit stop—and then from their last transit stop to their destination. Adoption of a Complete Streets policy can provide a comprehensive solution to the FM/LM challenge. Complete Streets helps to ensure that streets are safe for all users, especially cyclists, pedestrians, and public transit users. Safe walking paths and bikeways connect system users to public transit hubs, making a commuter more likely to consider public transit as an option. CTDOT and ten municipalities have adopted Complete Streets policies. The State will continue the efforts of CTDOT and others to implement Public Act 09-154, Connecticut Complete Streets Law, and other policies and practices that ensure safe bicycle and pedestrian access.

Connecticut's transportation systems is part of a larger regional network that requires coordination on transportation planning and infrastructure beyond the state's borders. While the regional transportation networks serving Connecticut do not have one overarching regulating entity, the State actively participates in several regional initiatives to address transportation issues on a larger scale. In the absence of this type of regional collaboration, the efficient movement of goods, people, and

services throughout Northeast could lead to increased costs for businesses and households in the region. Connecticut should continue to work with the following collaborative organizations:

- **Transportation for the Coalition of Northeastern Governors.** Connecticut continues to participate in the Transportation and Air Quality Committee of the Coalition of Northeastern Governors. Through this initiative, the northeastern states work together to: plan for safe and dependable commuter rail for the region; ensure federal funding for an integrated transportation system; and coordinate transportation assets such as passenger and freight rail systems.

- **Transportation & Climate Initiative.** Connecticut is a founding member of the Georgetown Transportation & Climate Initiative (TCI). A regional collaboration of 12 Northeast and Mid-Atlantic jurisdictions, TCI seeks to develop the clean-energy economy and reduce GHG emissions in the transportation sector.[115] Connecticut will continue to work with participating states to take action on initiatives in four core areas: clean vehicles and fuels, sustainable communities, freight efficiency, and information and communication technologies.

- **ZEV Task Force.** As a signatory of the ZEV Memorandum of Understanding, Connecticut will continue to actively participate in the ZEV Task Force. Facilitated by NESCAUM, the task force works to implement the Multi-state ZEV Action Plan. This includes coordinating and collaborating on a full range of program development efforts and implementation issues to promote effective and efficient implementation of ZEV regulatory initiatives.

- **I-95 Corridor Coalition.** Connecticut will also continue to participate in the I-95 Corridor Coalition. The coalition is an alliance of transportation agencies, toll authorities, and related organizations (including those focusing on public safety) from Maine to Florida, with affiliate members in Canada. The coalition provides a forum for key decision and policy makers to address transportation management and operations issues of common interest.

Through these partnerships, Connecticut, and the other member states are able to plan, research, and coordinate implementation of multi-state initiatives. Connecticut will continue to actively participate in regional initiatives such as these to help advance a clean and efficient transportation network throughout the region.

B. Develop and support innovative transportation partnerships

The personal automobile has been the primary mode of transport for Connecticut residents for many decades. However, with growing interest in urban living and participation in the sharing economy, there is increasing demand for transportation options that offer an alternative to vehicle ownership. A host of opportunities enabled by technology and entrepreneurial innovation are resulting in new

[115] Participating jurisdictions in the Transportation & Climate Initiative are: Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont.

mobility models that can reduce costs for consumers and address climate change and other environmental challenges.

Car-sharing, bike-sharing, and ride-hailing services provide an alternative to individual car ownership. The State should further explore and support innovative shared-mobility services that reduce consumer travel costs and environmental impacts. Shared-use mobility services also can help alleviate the FM/LM barrier. A user can hail a ride for a short distance using a service like Uber or Lyft, or can rent a car or bike from a car-sharing service like Zipcar or Motivate...

An example of such innovation is New Haven's partnership with Smart Mobility in launching a bike-share program. Thirty bike stations with 10 bikes each will be located around the city. Utilizing a fee structure that includes both membership and pay-as-you-go models, New Haven residents will be able to utilize the bikes to get to and from work, run errands, or get around town.[116]

Another innovative shared-mobility service is BlueIndy. In 2015, through a partnership between the City of Indianapolis, Indianapolis Power and Light, and the Bolloré Group, the largest electric car-sharing service in the United States was launched. BlueIndy aims to provide users with convenient access to an environmentally friendly car that is less expensive than owning a vehicle. With several membership options, from one-day to yearly, members can access an electric vehicle at one station location and drop it off at another. With approximately 240 vehicles and 80 charging stations, members are able to easily plan zero-emission vehicle trips to move around the city. Los Angeles recently announced that it also has signed a contract with Bolloré Group to operate an electric car-sharing service called BlueLA.[117]

These are examples of successful shared-mobility service models that municipalities can pursue to provide residents with increased access to affordable and clean transportation options. The State should facilitate formation of such partnerships by sharing best practices and publicly recognizing the leadership of municipalities that test innovative, clean-mobility models.

It is also essential for Connecticut to continue to support and promote programs and services that facilitate adoption of transportation demand management (TDM) strategies. Typically implemented by public agencies, by employers, or via public-private partnerships, TDM includes strategies that increase system efficiency by encouraging a shift from single-occupant vehicle to modes such as ridesharing, telecommuting, public transportation, and non-motorized travel like biking or walking. Reducing single-occupant vehicle trips decreases VMT and associated GHG emissions.

Connecticut must take advantage of opportunities to partner with private-sector businesses and organizations to engage their employees on the benefits and opportunities of utilizing alternative travel modes. CTDOT facilitates the CTrides program, which promotes TDM to employers by offering worksite assessments, TDM plans, parking management, carpool and vanpool events, and lunch-

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116 Markeshia Ricks, "Bike Share Rolling Into Town," New Haven Independent, January 18, 2017, http://www.newhavenindependent.org/index.php/archives/entry/bikeshare/.

117 Stephen Edelstein, "BlueLA expands French electric-car sharing service to California," Green Car Reports, December 21, 2016, http://www.greencarreports.com/news/1107918_bluela-expands-french-electric-car-sharing-service-to-california.

and-learn functions. More than 200 Connecticut companies have partnered with CTrides, increasing the potential for reductions in travel cost, VMT, emissions, and congestion. The State should continue to support and promote the CTrides program by helping to recognize Connecticut employers who are actively working to implement transportation-demand strategies. In partnership with CTrides, DEEP will also help to develop new innovative partnerships that encourage employers to promote and incentivize alternative transportation options for their employees.

Strategy 8: Modernize the grid

The traditional energy grid has existed as a linear path: from generation, to transmission and distribution, to consumption by buildings and their occupants. However, the future represents a much more complex, interconnected grid that allows buildings to adjust their consumption and demand, as well as be suppliers of distributed energy generation and to store and deploy energy through batteries and electric vehicles. Distributed generation and other non-wires alternatives can be a way to avoid the need for distribution system upgrades, like substation upgrades, and potentially lower costs for ratepayers (see Electric Power Sector Chapter).

Specifically, demand for electricity can be managed and reduced through greater participation in demand-response programs, targeting demand reduction as part of Connecticut's energy efficiency programs, behavioral change supported by advances in technology and dynamic time-of-use and demand-response rates. These efforts can reduce the need to build new generating capacity, avoid new transmission costs, provide a buffer against rate increases driven by high natural gas prices during peak winter months, lower capacity payments, and improve the environment. Demand-management techniques also pose a significant opportunity to reduce energy costs and environmental impacts, while increasing resiliency and reliability of our energy resources. This opportunity is brought into even sharper relief by the fact that in 2013 and again in 2015, more than one-third of the generating capacity procured by ISO New England was used to provide only 10 percent of hours of electricity.[118]

Demand response curtails demand for electricity based on market signals. Passive demand response, more commonly referred to as energy efficiency, enables electricity consumption to be continuously reduced, for example by installing more-efficient light bulbs or an energy-efficient refrigerator. These strategies reduce demand overall throughout the day. As previously discussed, energy efficiency is the cheapest and cleanest energy source.

Alternatively, active demand response is used only when peak demand is anticipated to be reached, typically in the middle of the day in the hot summer months when customers receive a signal shortly before the electric grid is about to experience a period of heightened demand and, in response, actively limit their electricity consumption during that specific period. Active demand response can

[118] ISO New England, Inc. 2013. *2013-2022 Forecast Report of Capacity, Energy, Loads, and Transmission.* ISO New England.
ISO New England, Inc. 2014. "Hourly Zonal Information, 2013 SMD Hourly Data." *www.iso-ne.com.* May. http://www.iso-ne.com/markets/hstdata/znl_info/hourly/2013_smd_hourly.xls.

reduce peak demand, and subsequently, overall system costs by preventing a less efficient power plant from needing to fire up, benefiting all customers. A number of strategies can be used to catalyze active demand response under current market conditions, both within the forward capacity market and outside of it.

A modern grid is necessary for implementing many CES Strategies. Therefore, grid modernization priorities for the next three years should cover the following key actions:

A. Initiate grid modernization proceedings

DEEP recommends that PURA initiate generic proceedings on grid modernization and adaptation of the utility business models. This may be best implemented in separate dockets to tackle issues that are interrelated but can be implemented in concurrent or different stages.

One docket could explore the EDCs' distribution-system planning methods and improvements that can be made to identify areas within the system that would benefit from distributed energy resources.[119] PURA should explore the feasibility of requiring the EDCs to conduct an alternatives analysis in distribution-system planning, such as distributed-generation alternatives. It may be impractical to require this type of analysis for any upgrade to the distribution system, but it may be more feasible to require a non-wires analysis when there is capital spending above a certain dollar threshold.

Any such analysis should be open and transparent and should explore the role that third parties could play in distribution system planning while simultaneously maximizing ratepayer savings. For example, there may be an opportunity to optimally site resources selected through the distributed generation procurements conducted by the EDCs consistent with Strategy 4, or resources selected through grid scale procurements conducted by DEEP, using information obtained through the EDCs' alternatives analysis or other distribution-system planning improvements. PURA should explore whether additional distribution system information (beyond what the EDCs include in the hosting capacity maps) can and should be available to customers to help in siting distributed energy resources.

Another docket should evaluate the costs and benefits to the electric system associated with deployment of distributed-energy resources. At a minimum, this proceeding should establish a tariff rate for residential distributed renewable energy resources consistent with Strategy 4. DEEP recommends establishing a base rate for small distributed energy resources based on resource type, such as solar and fuel cells. Additionally, DEEP recommends establishing adders on top of this base rate that compensate distributed-energy resources with additional electric utility benefits, including

[119] Currently, PURA has an ongoing docket that will explore the EDCs' distribution system planning practices, including the following goals: "(1) to assess the existing state of each EDC's distribution systems and plans; (2) to identify the near- and long-term needs of the distribution systems and what is driving them; and (3) to consider whether any new or modified planning objectives, metrics, solutions, performance incentives, oversight and/or procurement mechanisms should be implemented, in light of the evolving nature of the distribution grid and the electric system itself." PURA Docket No. 17-12-03, PURA Investigation into Distribution System Planning of the Electric Distribution Companies.

distributed generation paired with a time-of-use rate and storage (storage can include an electric vehicle) and location in an area of distribution system need.

Finally, PURA should initiate another generic grid modernization proceeding to investigate dynamic pricing and robust time-of-use rates for both Eversource and UI, including the feasibility of deploying advanced meters in Eversource territory. In order for demand response to effectively expand and integrate into the grid, communication systems between generation and consumption need to evolve in a standardized and systematic process. The "smart grid" is defined as a system of technologies that allow for two-way communication and computerized automation of the electrical grid. This allows for faster active demand response, with the grid directly communicating with advanced meters (often referred to as "smart meters") that control building energy use. These technologies allow ratepayers to centrally manage their building processes and appliances' energy usage and see how much electricity they are using and how much it costs in real-time. Over time, these enhancements can improve the efficiency of transmission, reduce operations and management costs to drive down rates, and allow for the integration of greater behind the meter renewable energy.

UI is in the process of replacing its conventional meters with more advanced technology as its metering infrastructure approaches the end of its useful life. This means that UI is better positioned to provide its customers with the opportunity to control their use and costs in the near term by promoting existing time-of-use rate options and developing new dynamic demand-response price options.

In contrast, a 2009 pilot deployment of advanced meters by CL&P (now Eversource) and a proposal to implement advanced metering infrastructure for all customers by 2016 was suspended in 2011 due to concerns that abandoning the current metering system would result in replacement costs of about $300 million and over $100 million of stranded costs.

However, since advanced meters were last examined, new technologies have been developed and other issues may have been resolved. DEEP recommends that PURA reopen the docket and that the EDCs prepare an updated analysis of the costs and benefits of advanced meters and consider available technologies that can be phased in.[120] A phased-in approach would minimize rate impacts and prioritize adoption by customers most likely to benefit from their use. The plan should target meters as they fail or otherwise need to be replaced.

Advanced metering technologies and capabilities are evolving, so a thoughtful strategy must avoid adopting systems that could become obsolete within a few years. It should be tied to time-of-use rate and dynamic pricing options to ensure that customers have appropriate and fair incentives to use power at optimal times. New rate options provide energy and capacity benefits by reducing demand and shifting energy consumption to off-peak periods. It also can enhance revenue

[120] Connecticut Public Utilities Regulatory Authority. "Application of the Connecticut Light and Power Company to Implement Time-of-use, Interruptible Load Response, and Seasonal Rates- Review of Meter study, Deployment Plan and Rate Pilot [05-10-03RE04]". 2011.
http://www.dpuc.state.ct.us/dockcurr.nsf/(Web+Main+View/All+Dockets)?OpenView&StartKey=05-10-03re04

collection, improve communications during outages, and streamline utility operations and system reliability. It is important to examine all of these costs and benefits of advanced meters. As policymakers strive to increase electric vehicles and distributed generation, advanced metering technologies offer important features that could be utilized to send proper price signals to customers, improve service, and reduce costs.

In addition, DEEP encourages the EDCs to submit energy storage proposals pursuant to Section 16-244w of the General Statutes, taking into consideration DEEP's feedback on its previous energy storage proposals, to take advantage of this opportunity to pilot the operation of such resources and their integration into the distribution system.

B. Integrate efficiency, storage, and renewables to manage peak demand

One of DEEP's major energy priorities is on reducing peak demand. The 2014 IRP stated that Connecticut's energy policies should help to reduce peak demand growth to 0.5 percent per year. Due to energy efficiency investments, energy demand has also begun to flatten, helping to relieve the grid and minimize periods of peak demand that triggers the need to use high-emitting fossil-fuel power generation. As of 2017, Connecticut has surpassed this goal and is expected to decrease peak demand by 0.4 percent annually between 2017 and 2026.[121] However, maintaining this focus on reducing peak demand will become more critical, not less, because this projection assumes that Connecticut's energy efficiency and renewable investments will continue at the current rates. The state's energy efficiency programs must continue this rigorous pace, especially as electrification of heating systems and electrification of vehicles will likely increase load and will need to be controlled, particularly during peak-demand periods. Benefits of demand response do not apply only to summer peak demand. Winter peaks are also a concern, given the procurement practices of natural-gas-fired generators. Reduction of winter peaks must be an ongoing priority in both the electric- and gas-conservation programs. DEEP therefore recommends that electric- conservation programs more aggressively pursue peak summer- and winter-demand reductions. Strategies that use buildings as a resource to manage peak demand will therefore play an increasing role in Connecticut's approach to managing peak energy demand.

Policymakers must also carefully consider how storage can enhance and smooth the integration of intermittent renewable generation.[122] If backup generation or stored energy is used in coincidence with time-of-use or dynamic pricing, building owners can reduce costs from high energy rates associated with periods of peak demand.

In 2015, the Massachusetts Department of Energy Resources conducted a study on energy storage, concluding that "the need to size all grid infrastructure to the highest peak results in system inefficiencies, underutilization of assets, and high costs to ratepayers," and that "energy storage is

[121] ISO New England, 2017, *2017 Capacity, Energy, Loads, and Transmission (CELT) Report.*

[122] Institute for Energy Research. 2013. *Germany's Green Energy Destabilizing Electric Loads.* 23 January. http://instituteforenergyresearch.org/analysis/germanys-green-energy-destabilizing-electric-grids/#.

the only technology that can use energy generated during low cost off peak periods to serve load during expensive peak periods."[123]

Likewise, as Connecticut seeks to electrify its transportation systems, EV fleets will increase. While EVs can increase electricity demand, they also potentially can serve as storage devices. Homes or buildings that utilize onsite generation, whether emergency or general, can store and use excess generation in the batteries of EVs. Preparing our buildings to accommodate such a solution is recommended not only to advance Connecticut's transportation goals but to expand affordable storage opportunities as battery technology becomes more affordable. DEEP encourages continued investigation of the achievable potential of water heaters and electric vehicles as energy storage units in residential buildings, especially those that have been weatherized, and are using renewables to power their homes. This could help reduce grid loads, costs to consumers, and emissions reductions.

C. Ensure interoperability of demand response communications between buildings and the grid

If we treat buildings and appliances as resources for the grid, then we will need to consult and incorporate national standards into advanced grid planning to ensure a secure, common, and stable basis for communicating information and moving power in both directions. Examples of such standards include the National Institute of Standards and Technology Smart Grid Standards, the American National Standards Institute/ National Electrical Manufacturers Association SG-ICE 1 *Smart Grid Interoperable and Conformant Testing and Certification Scheme Operator Guidelines,* and the American Society of Heating, Refrigeration and Air-Conditioning Engineers *Facility Smart Grid Information Model*.

Advanced meters and other data acquisition equipment allow utilities to learn private information about their ratepayers, like sleeping patterns or when they are home. Some consumer advocates have expressed concerns that if these data are not protected they could be used in burglary, fraud, or corporate espionage. Connecticut should consider legislation that protects ratepayers from these risks and minimizes utility liability. In 2011, the California legislature adopted SB 674, which prevents utilities from sharing or disclosing a customer's electrical meter data to any third-party without consent, allowing ratepayers to access their data for their own use but also control how anyone else uses it. When considering statewide deployment of advanced meters and other data-acquisition equipment to increase two-way communication, DEEP recommends adoption of similar legislation, the use of third-party standards, and, at a minimum, continuation of similar current standard practices designed to ensure data security.

D. Apply best practices from the federal Grid Modernization Lab Initiative

On the federal level, DOE and the national labs through the Grid Modernization Lab Initiative continue to play a pivotal role in advancing grid modernization efforts in several jurisdictions. DEEP

[123] Massachusetts Department of Energy Resources. 2015. *Massachusetts Energy Storage Initiative.* Massachusetts Executive Office of energy and Environmental Affairs.

will continue to engage directly with DOE and the national labs to share the outcomes of the relevant 88 grid modernization projects with Connecticut's utilities and other stakeholders. DEEP will evaluate opportunities to host specific proceedings or the utilization of other tools to disseminate information and lessons learned within DOE's six identified priority areas for advancing grid modernization. These six areas include: testing individual devices and integrated systems; developing tools and strategies to improve grid sensing and measurement; developing new control technologies to support new generation, load, and storage technologies; creating simulation and modeling planning tools; planning for physical and cybersecurity challenges and increasing grid resiliency; and providing technical assistance and institutional support. DEEP will continue to collaborate with DOE and the Connecticut utilities and other stakeholders with the goal of exploring opportunities to leverage federal efforts, including federal funding, as well as utilizing the results of the efforts of the Grid Modernization National Lab Consortium's testing and evaluation of tools, technologies, and systems included in the 88 federal projects.