Can Connecticut Meet Renewable Portfolio Standards and Improve Air Quality, Increase Energy Reliability, and Strengthen the Economy?

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Introduction

Connecticut can simultaneously improve energy reliability, increase environmental performance, and grow opportunities for economic development through implementation of clean energy incentives, including compliance with the state's Renewable Portfolio Standard (RPS). Regional cooperation will be of high value, but Connecticut and each other state will be in a position to decide on the best clean energy portfolio to enhance energy reliability while encouraging technologies that provide the most favorable opportunities for grid management and economic development.

Connecticut's RPS is intended to encourage the development of clean renewable energy that will also help provide long-term energy reliability. The RPS requires generators and the Electricity Distribution Companies (EDCs) to provide, purchase, or pay for Class I, Class II, or Class III Renewable Energy Credits (RECs). Generally, Class I renewables include solar, wind, fuel cells, run of river hydroelectric, tidal and ocean wave, and certain biomass and anaerobic digestion. Class II resources include resource recovery, certain biomass, and some hydroelectric. Class III resources include combined heat and power, conservation and load management, and waste heat recovery.[1] The RPS is proportionally based on the energy loads of the state, as shown in Table 1:

Table 1 – Connecticut Generation Requirements

	Class I	Class I or II	Class III
On and after 1/1/2016	14.0%	3%	4%
On and after 1/1/2017	15.5%	3%	4%
On and after 1/1/2018	17.0%	3%	4%
On and after 1/1/2019	19.5%	3%	4%
On and after 1/1/2020	20.0%	3%	4%

As shown above, in year 2017 there is a requirement for 15.5 percent of the energy used in the state to come from Class I renewables. This requirement grows to 20 percent by 2020. As shown in Figure 1, progress and compliance for 2014 has been tracked showing the majority (71 percent) of Connecticut's Class I resources coming from biomass facilities. Approximately .5 percent of the state's RPS was met by alternative compliance payments (ACP).[2, 3]

[1] CGS §16-1 (20) - *Connecticut Class 1* resources include: (1) electricity derived from solar power, wind power, fuel cells (using renewable or non-renewable fuels), geothermal, landfill methane gas, anaerobic digestion; (2) other biogas derived from biological sources, ocean thermal power, wave or tidal power, low-emission advanced renewable energy conversion technologies; (3) certain run-of-the-river hydropower facilities not exceeding 30 megawatts (MW) in capacity; (4) biomass facilities that use sustainable biomass fuel and meet certain emissions requirements; and (5) electricity produced by end-user distributed generation (DG) systems using Class I resources.
CGS §16-1 (21) - *Connecticut Class 2* resources include: (1) trash-to-energy facilities; (2) certain biomass facilities not included in Class I; and (3) certain older run-of-the-river hydropower facilities.
CGS §16-1 (38) - *Connecticut Class 3* resources include: (1) customer-sited CHP systems, with a minimum operating efficiency of 50%, installed at commercial or industrial facilities in Connecticut on or after January 1, 2006; (2) electricity savings from conservation and load management programs that started on or after January 1, 2006, provided that on or after January 1, 2014, no such programs supported by ratepayers shall be eligible; and (3) systems that recover waste heat or pressure from commercial and industrial processes installed on or after April 1, 2007.
[2] DOCKET NO. 15-09-18: Annual Review of Connecticut Electric Suppliers' and Electric Distribution Companies' Compliance with Connecticut's Renewable Energy Portfolio Standards in the Year 2014, September 28, 2016.
[3] While ACPs satisfy the law, they do not directly provide physical development of renewable resources.

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As shown in Figure 2, the majority (74 percent) of Connecticut's Class I renewable generation in 2014 came primarily from Maine, New Hampshire, and Vermont via biomass facilities and only 16 percent was sourced locally from Connecticut.[4] While the use of biomass from northern New England meets the requirements of the Connecticut RPS, it falls short in several areas. It has not provided 1) local improvements to the local air sheds and the lungs of residents in Connecticut, 2) generation at local electric distribution nodes for voltage support and energy reliability, and 3) the use of local research, engineering, manufacturing, and construction resources for projects in Connecticut to create jobs in clean energy development.

Figure 1 – Class I Fuel Source (2014)

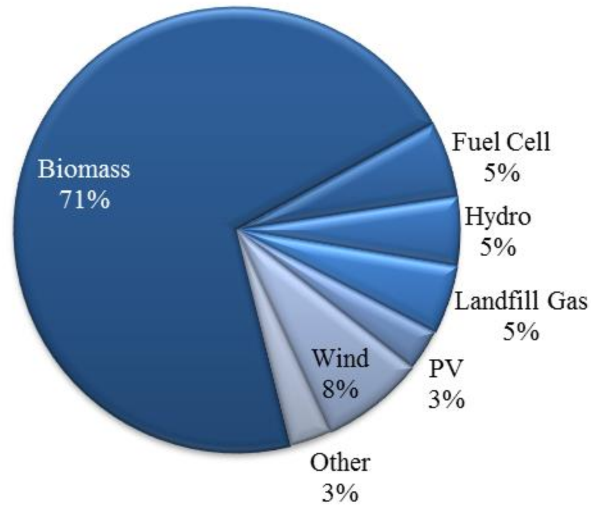
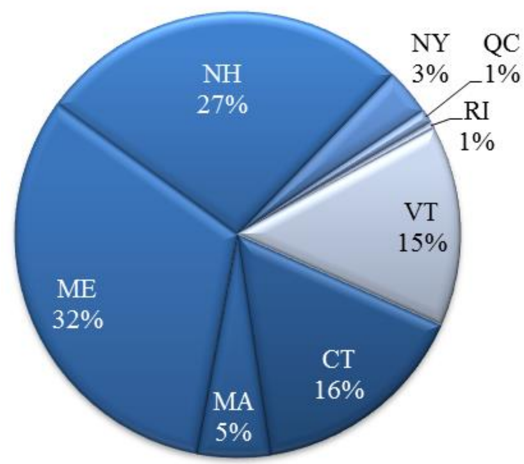


Figure 2 – Generator Location of RECs Used for CT Class I Compliance (2014)



The Opportunity and Challenge

From 2016 to 2020, the Connecticut RPS will require an additional 2,189,232 MWh of Class I renewable power, an increase from a 14 percent Class I RPS target in 2016 to 20 percent by 2020.[5] Even with recent procurements, a significant addition of Class I renewable energy must be obtained to achieve compliance. The *opportunity* exists now for Connecticut to look at a complete set of energy, environmental and economic goals to achieve final compliance. The *challenge* for Connecticut is to effectively remove the "silos" between environmental protection, energy reliability, and economic development in RPS decision-making and other regulatory energy procurements. The suggested work will involve recognition of State goals within each of the silos and introduction of a balanced weighting of criteria. Only when this is accomplished and implemented will a balanced RPS portfolio emerge with the highest value to Connecticut residents, businesses, and industry.

While market forces must apply, here is where government can accelerate progress to implement public policy with incentives to provide clean, dispatchable, and renewable power at end user sites where presumably there is a greater relative need for energy supply. With the combining of these energy and environmental silos, comes an opportunity to develop talent in Connecticut using local research, engineering, and construction resources to create jobs in Connecticut and bolster economic development. Further, the local manufacture of advanced clean energy technologies should absolutely be encouraged wherever possible to integrate the economic silo into the RPS process. The integration of energy, environmental protection, and economic development will support local manufacturing and help increase local market demand. This will in turn drive down production costs and increase opportunities for export, fortifying locally-made clean energy industries as global market leaders.

[4] DOCKET NO. 15-09-18: Annual Review of Connecticut Electric Suppliers' and Electric Distribution Companies' Compliance with Connecticut's Renewable Energy Portfolio Standards in the Year 2014, September 28, 2016;

[5] Connecticut Siting Council; "DOCKET NO. F-2014/2015;" http://www.ct.gov/csc/lib/csc/pendingproceeds/forecast_2014_2015/f-2015_finalreport.pdf, December 30, 2015; Approximately 92 percent of ISO New England forecast load is used to calculated the RPS compliance load.

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The Economic Merits of the Hydrogen Fuel Cell Industry

It would make perfect economic sense for states to provide support for local industries that produce clean energy technologies so long as such support does not violate federal provisions protecting interstate commerce. While states cannot interfere with interstate commerce, an area legally occupied by the federal government, Connecticut and other states could select and support general technologies of highest value to the residents of their states. For example, New Hampshire may seek to support the wood burning biomass industry, New York may seek to support hydroelectric and the production of renewable hydrogen, and Connecticut may seek to support the fuel cell industry. The market will ultimately decide, but state leaders have the authority to support the appropriate technologies at the right places to merge all three silos – energy reliability, environmental performance, and economic development.

The benefits of fuel cells apply at both broad and local project levels. On a broad basis, the fuel cell industry is alive and growing in the Northeast region with Connecticut at the center of the industry hub. While this industry continues to grow with increased sales, it is still emerging and would grow at a faster pace with appropriate support. Such support would help Connecticut maintain its position as the geographic center of a hydrogen fuel cell "cluster" and as a global leader for research, manufacturing, and distribution to world markets. This cluster provides benefits to its customers, supply chain companies, suppliers, and workers in Connecticut and the entire region. The proximity of the OEMs and supply chain companies in this cluster has provided a competitive advantage for continued research, manufacturing, and export of commercial products to national and international markets.

Based on an IMPLAN economic analysis conducted in 2015[6]:

- The Northeast hydrogen and fuel cell industry has a total economic impact of $1.421 billion in revenue and investment, 6,558 full- and part-time jobs, and $619.6 million in labor income.
- The Northeast hydrogen and fuel cell industry generates an estimated $83.8 million to $95.3 million in state and local taxes.
- Several states in the region (e.g., Connecticut, Massachusetts, New Jersey, and New York) are among the top locations for the hydrogen and fuel cell industry, based on their current activities or potential for future growth.
- Within the region, the industry's largest impacts are felt in Connecticut (e.g., total employment impact of 3,406 workers), New York (e.g., total employment impact of 1,618 workers), and Massachusetts (e.g., total employment impact of 1,138 workers).
- In Connecticut, the hydrogen and fuel cell industry supports approximately 3,400 total jobs, and 600 supply chain companies; produces $726 million in total revenue and investment; and yields $40 million in state and local tax revenue.

Based on an economic analysis conducted by the Connecticut Center for Economic Analysis (CCEA) in 2016[7]:

- The fuel cell industry, in which Connecticut is a leading player, is expected to grow rapidly: by 2024 Global Market Insights projects sales of $25.5 billion, with double-digit annual growth in virtually all markets.[8]
- Shipments globally exceeded 60,000 units in 2015, while the megawatts grew 65 percent to 300 MW.
- The fuel cell industry would be a major contributor in restoring Connecticut's economic vitality, particularly in retaining high tech research and advanced manufacturing jobs, generating increased investments, and delivering more tax revenue.

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[6] Economic Impact derived from 2015 Economic Impact of the Northeastern Hydrogen Energy and Fuel Cell Industry, January 2016. This analysis assessed the direct, indirect, and induced values of the Northeast region's hydrogen and fuel cell industry.

[7] Connecticut Center for Economic Analysis (CCEA); "Projecting the Economic Impact of an Expanding Connecticut Fuel Cell Energy Sector 2017 -2042;" November 10, 2016.

[8] Global Market Insights; http://www.globalinsights.com/index.php/design-and-features; November 2016.

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Local and Project Level Value

On a project level, fuel cell power plants provide sales tax, property tax and local capital investment, and job creation unmatched by any other Class I resource. Further, the fuel cell industry is the only Class I resource that has a strong OEM presence and manufacturing supply chain in the region, with the cluster hub in Connecticut.

By example, the manufacture and installation of 50 MW of fuel cell power plants, in Connecticut provides:

- In-state capital investment of approximately $280 million;[9]
- Approximately $63 million in local property tax revenue over 10 years plus a one-time tax revenue of between $28 and $35 million;[10, 11]
- Approximately $5 million of investment in local electrical and gas infrastructure; and[12]
- Approximately 400 direct manufacturing jobs and an additional 800 indirect and induced jobs in Connecticut.[13]

Identification of Critical Energy Users and Key locations and Potential Fuel Cell Applications

Hydrogen and fuel cell technologies offer significant opportunities for improved energy reliability, energy efficiency, and emission reductions. Large fuel cell units may be appropriate for applications that serve the grid and large electric and thermal loads at consumer sites. Smaller fuel cell units may provide backup power for telecommunication sites, restaurants/fast food outlets, and smaller sized public facilities. Further, the market potential for clean, reliable, cost effective, and on-site generation is substantial and is projected to grow.

The potential end users identified in Figure 3 include where mission critical energy is needed for uninterrupted power. These users consist of a wide array of private, state, and federal buildings for offices, manufacturing, educational institutions, food sales and services, lodging, in-patient healthcare, and public order and safety. Similarly, on-site power installations are potentially viable at wastewater treatment plants, landfills, telecommunications towers, ports, high traffic airports, and for electric grid service (See Table 2). NEESC has identified approximately 1,804 of these sites in Connecticut that could support the development of between 420 MW to 460 MW of power capacity. The data provide evidence that significant potential exists for on-site Class I power production, potentially sourced from fuel cell technology. Grid side applications, using fuel cell technology, located in proximity to these end users (potentially connected and integrated with microgrids) or at other key circuits and load centers can also yield a high level of installed capacity and can enhance the overall reliability of the utility grid. The high efficiency, high capacity factor, compact nature of fuel cell technology is well suited for distributed power at or near the point of use, and would typically not conflict with land conservation that could potentially occur with the use of other renewable generation technologies.[14]

If integrated with the RPS as a key driver for cleaner air quality, fuel cell technology can help Connecticut meet National Ambient Air Quality Standards (NAAQS) for ground level ozone by reducing nitrogen oxide (NOx) emissions, especially in urban areas. Fuel cell technology for on-site power at the identified 1,804 sites in the state could result in approximately 420 MW to 460 MW of high efficiency, dispatchable power that would provide the following benefits annually:

- ***Production of approximately 3.6 million to 3.9 million MWh of renewable electricity***
- ***Reduction of NOx emissions by approximately 500 to 550 tons (electric generation only)*** [15]

[9] Based on an installed cost of $5,600 per kW.
[10] Based on a $280 million investment*.30 mill rate* 75 percent assessed value = $6.3 million/year*10 years.
[11] Represents a proportion of the calculated state and local tax revenue identified in the 2015 Economic Impact of the Northeastern Hydrogen Energy and Fuel Cell Industry, January 2016.
[12] Based on ten installations at $500,000 per project for gas and electric infrastructure.
[13] Indirect and induced impacts based on an industry multiplier of 3.0; 2015 Economic Impact of the Northeastern Hydrogen Energy and Fuel Cell Industry, January 2016.
[14] Approximately 1,830 MW of PV Solar capacity at 13.6% capacity factor (per NREL PVWATTS for Connecticut Climate) would be required to meet the projected RPS requirements for Class I energy compared to approximately 255 MW of fuel cell capacity at 97% capacity factor.
[15] Catalog of CHP Technologies, U.S. EPA Combined Heat and Power Partnership, March 2015 and 2014 ISO New England Electric Generator Air Emissions Report, January 2016.

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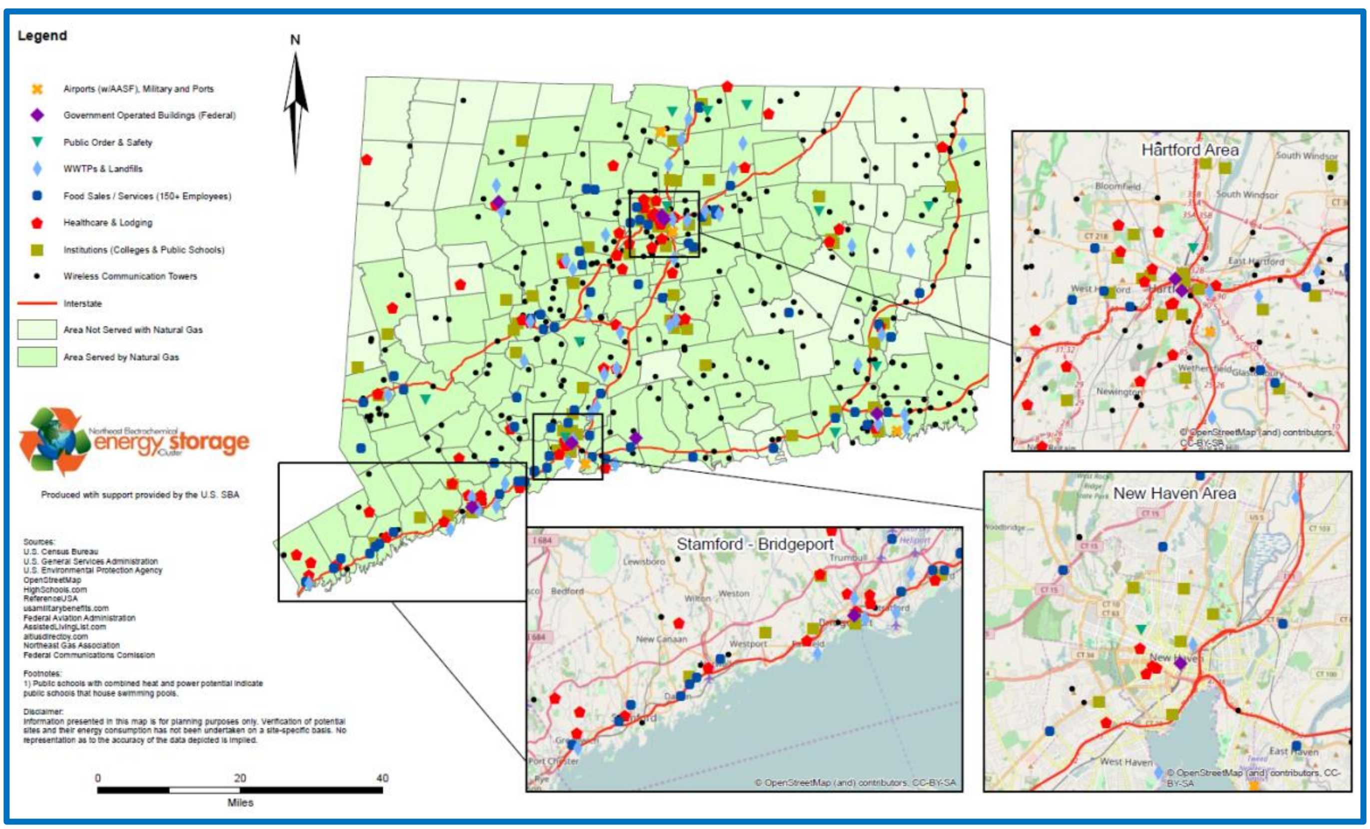
Correspondingly large levels of energy reliability, environmental, and economic benefit can also be derived from incremental installations of fuel cells on the grid. Further, distributed generation whether on site or grid sided that is dispatchable, able to follow loads, and available with a high capacity factor will avoid hidden costs to develop additional transmission and distribution facilities and not require backup power supplies that will be needed with remote renewable intermittent generation.

Separately, work should continue to identify energy needs at critical industries and end user sites. Information is needed and work should be undertaken to identify locations where economic development is advantaged by RPS technologies and where RPS technologies can best support and reinforce the State's utility infrastructure.

Table 2 – Summary of Potential Connecticut Hydrogen and Fuel Cell Targets for Stationary Applications[16]

Category	Total Sites	Potential Sites Developed
Institutions	1,701	265
Food Sales/Services	9,000+	994
Healthcare & Lodging	915	213
Public Order & Safety	209	51
Energy Intensive Industries	541	208
Government Operated Buildings	88	15
Wireless Telecommunication Towers	301	30
WWTPs & Landfills	100	15
Airports (w/ AASF), Military, and Ports	67	13 (3)
Total Stationary Sites	**12,922**	**1,804**
Total Estimated Loads		**420 – 460 MW**

Figure 3 – Connecticut: Potential Hydrogen and Fuel Cell Applications for Public and Private Facilities



[16] Generation is based on configurations of existing fuel cell technologies. Sizes used in estimations include: 2.5 kW, 200 kW, 300 kW, 400 kW, and 1.4 MW.

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Conclusion

Policy catalysts to improve air quality include clean energy RPS requirements. State leadership can guide decisions for clean energy to meet RPS requirements and also comply with policy for increased energy reliability through local in-state development of fuel cell technology at mission critical end users and energy nodes. Fuel cell power generation with increased availability and high capacity factors will reduce the need for costly transmission and distribution facilities, conserve land resources, improve energy reliability, and avoid the need to develop redundant power systems to backup intermittent renewable generation.

Connecticut would be well positioned to meet clean air requirements, energy reliability needs, and boost job creation and economic development with use of fuel cell technology that is manufactured and developed in the state.

Recognition of this relationship by policymakers could make Connecticut a showcase for renewable energy targeted to locations in need of increased energy reliability. This configuration will increase local end user reliability, which is of high value for businesses and industry, and will be cleaner with less air pollutant emissions. Encouragement of local manufacturing will complete a circle to combine environmental performance with energy reliability and economic development to meet local needs and will serve global markets.