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To: Ellen Scalettar, Director of Policy, Research and Legislation, Office of the Senate President Pro Tempore, State of Connecticut  
From: Elena Papoulias and Robert Tannenwald  
Date: April 4, 2008  
Re: Fuel Cell Production and Development Incentives in New England

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This memo describes fuel cell production and development incentives in New England, with a special focus on Connecticut's subsidy programs. Nationwide, only New York, Ohio and California have incentive programs comparable to that of Connecticut, although Rhode Island is in the process of expanding its program. High entry barriers coupled with an absent hydrogen infrastructure contribute to the high costs of fuel cell production. This provides the rationale driving federal and state subsidies which promote fuel cell research.

The data presented here has been collected through state government websites as well as fuel cell development websites.

## **I. Fuel Cells: Production, Development, and Cost**

Fuel cells produce energy by combining fuel and oxidants (usually hydrogen and oxygen) through an electrochemical process. Because the process is completed without combustion, fuel cells noiselessly produce large amounts of clean energy. Moreover, as long as the necessary flows are maintained, fuel cells can continuously produce energy. The byproducts of the energy process, water and heat, can also be captured thorough the process of cogeneration so that both electricity and useful heat can be used. In this way fuel cells have been most useful in remote locations such as spacecrafts, rural areas, or large parks and have an increasingly useful purpose in military applications or as backup energy for commercial buildings. In Connecticut, for example, fuel cell generators serve New Haven's East Shore Wastewater Treatment plant, the Mohegan Sun casino, Hartford's St. Francis Hospital, and South Windsor High School. Fuel cell production can also be reversed so that the byproduct of the process yields the hydrogen input; this technology has been recently used by NASA.

The hydrogen input actually makes fuel cell production a costly endeavor as it requires an expensive hydrogen infrastructure that is currently non-existent. In the absence of such an infrastructure, the cost of fuel cell production is much higher than traditional energy generating methods, resulting in high entry barrier costs. For example, fuel cells cost \$4,500 per kilowatt to operate compared to diesel generators which cost between \$800 and \$1,500 per kilowatt or natural gas turbines which cost \$400 per kilowatt. Yet when produced efficiently, energy from fuel cells can cost \$0.15 per kilowatt to produce; this is less than half the cost of producing

conventional energy. Fuel cells are also approximately 22 percent more efficient than burning gas in a conventional power plant. Yet the cost of fuel cell production keeps consumers and producers of the technology at an impasse: the price of fuel cell production will not decrease unless more fuel cell energy is sold (and economies of scale can be reached), but fuel cells are not selling because they are so expensive. This catch-22, largely due to the lack of an established hydrogen infrastructure, makes for high entry costs forcing producers to seek funding from the federal or state governments.

## **II. Federal Incentives**

All New England fuel cell industries first benefit from two federal tax credits.<sup>1</sup> The Residential Solar and Fuel Cell Tax Credit is a personal tax credit applicable to various renewable energy technologies, including fuel cells. Under this credit, \$500 per 0.5 kilowatt of energy produced by fuel cells can be deducted. The Business Energy Tax Credit similarly allows for a credit of equal value to businesses obtaining energy from fuel cell equipment. Additionally, the federal government provides grants to fuel cell manufacturers through the Department of Energy, Department of Defense, Department of Transportation, and the Environmental Protection Agency.<sup>2</sup>

## **III. State Incentives**

### **A. Connecticut**

#### **1. Connecticut's Rationale**

Connecticut is the only state in New England to have harnessed fuel cell production and innovation in an attempt to develop the nascent industry by hosting numerous fuel cell production facilities. Both publicly traded and private companies can access federal and state incentives. Such facilities include publicly traded FuelCell in Danbury, UTC Fuel Cells in South Windsor and Distributed Energy Systems. Privately-owned Hydrogen Source in South Windsor, and GenCell Corp. in Southbury have also received state subsidies for fuel cell production.

Connecticut's rationale in providing fuel cell incentives is to host and develop the industry within the state in order to capture a large market share of production and then benefit from the positive spillovers of such industry domination. The Connecticut Center for Advanced Technology (CCAT) estimates that when the global fuel cell market matures, estimated annual revenues will be between \$43 and \$139 billion while Connecticut, at projected growth rates, could potentially capture \$14 to \$54 billion of that revenue. Indeed, world electricity consumption is expected to double between 2003 and 2030. Moreover, US-federally funded research is projected to reach more than \$1 billion in FY2010, \$650 million of which will come from the Department of Energy. Connecticut hopes to capture 15%, or \$97 million, of those Department of Energy funds. Still, there is a long way to go. Preliminary studies cited in a 2007 press release from Connecticut's Department of Economic and Community Development estimated that global revenues in the next decade will reach \$18.6 billion annually. In 2004 global government spending on the hydrogen and fuel sectors reached only \$1.5 billion. The industry is clearly in its early stages, but Connecticut plans to target the industry in the hopes of reaping the benefits from capturing a greater market share.

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<sup>1</sup> Under the Energy Policy Act of 2005. These credits expire on December 31, 2008.

<sup>2</sup> For example, a 2006 \$49million grant was promoted by the FTA to encourage fuel cell production destined for use on public transit.

Connecticut also hopes that such heightened demand and production will lead to other spillovers, including higher employment rates. The CCAT finds that fuel cell production added 927 jobs in Connecticut in 2006 and 229 jobs in 2007; by 2010, they estimate employment in the fuel cell industry will reach 1,635. Moreover, the group estimates several economic multipliers indicating positive industry spillovers for the state: for every job the hydrogen and fuel cell industry supports, 1.31 jobs are indirectly supported in other sectors; for every \$1.00 paid to an employee within these industries, an additional \$0.72 is paid to other employees in the fuel cell supply chain; and for every \$1.00 of revenue generated by the two industries, an additional \$0.84 of revenue is received by Connecticut's businesses. Other spillovers include the creation of a larger tax base—\$29 million in state tax revenues are currently generated annually. Such promising benefits further motivate Connecticut's fuel cell production incentives.

## **2. Connecticut's Incentives**

Connecticut's fuel cell incentives are funded by the Connecticut Clean Energy Fund (CCEF). The CCEF is funded by an electricity surcharge of approximately \$0.10 per dollar spent on electricity by state residents. The CCEF has established several programs promoting each stage of fuel cell production and innovation and currently has \$30 million of funds. The Pre-development Program provides between \$250,000 and \$500,000 to fuel cell developers planning or researching production. The Renewable Distributed Generation Program subsidizes up to \$2 million of the installation of renewable energy sources, including fuel cells, in commercial or industrial settings. The Operational Demonstration Initiative provides up to \$750,000 for advanced technologies nearing the commercialization stage. The CCEF's most dramatic impact is perhaps its Project 100 initiative which mandates state utility distributors to source a portion of their energy supply from fuel cells<sup>3</sup>. Furthermore, Public Act 06-187, when signed into law, established the Connecticut Hydrogen Fuel Cell Coalition which performs fuel cell research and development. Project 100 was written in the spirit of a 2004 executive order requiring all state agencies and universities to purchase Class I renewable energy (wind, solar, fuel cell, biomass, landfill gas) in increasing quantities over the next 45 years (20% of all electricity supplied in 2010 must come from Class I sources; 50% by 2020; 100% by 2050). On the consumer side, Connecticut also provides capital grants, low interest loans, and tradable renewable energy credits to consumers who install or use Class I renewable energy.

## **B. Massachusetts**

Similar to Connecticut, Massachusetts also has an RPS requiring 1% of electricity be generated from renewable sources in 2003 and thereafter increasing the specified amount by 0.5% per year until 2009 when the increase jumps to 1% per year. The other incentive Massachusetts offers is the Alternative Energy and Energy Conservation Patent Exemption which allows a personal or corporate income tax deduction for royalty income received from the selling of, among others, fuel cell technology patents. Other funding opportunities are available through the Large Onsite Renewable Initiative and the Sustainable Energy Economic Development Initiative which award grants on a competitive basis. The Massachusetts Green Power Partnership also provides some grants to spur private investment in the building of renewable-energy producing facilities. Finally, Massachusetts also offers service support through partnerships with the Massachusetts Hydrogen Coalition and the Massachusetts Technology Collaborative.

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<sup>3</sup> This is known as a Renewable Portfolio Standard (RPS).

### C. Rhode Island

Rhode Island's fuel cell program is still growing. The Rhode Island Renewable Energy Standard requires utility providers to source 16% of their retail electricity from renewable sources by 2019. Rhode Island's Renewable Energy Fund is in the process of expanding its subsidy programs. Currently, the fund provides approximately \$3 million annually to subsidize the installation and usage of renewable energies, including fuel cells. More specifically, the fund provides a \$370,000 subsidy to commercial or industrial energy consumers attempting to purchase renewable energy, although they do not intend to fully pay for the entire system.<sup>4</sup>

### D. Maine

Maine's RPS requires each electricity provider to source at least 30% of its electricity from renewable sources, including fuel cells. In terms of funding, Maine offers one state funding source and cultivates two state partnerships. The Renewable Resources Matching Fund provides up to \$50,000 toward each renewable-energy related projects, including fuel cells. One of Maine's partnerships, the Chewonki Hydrogen Energy Project, has benefited from this funding. The Chewonki Center is a joint venture between three groups<sup>5</sup> intending to support all aspects of fuel cell production. Similarly, the Maine Hydrogen Energy Fuel Cell Partnership provides technical support to state businesses interested in utilizing fuel cell technology.

### E. Vermont

Vermont's incentives are smaller relative to Connecticut, Massachusetts, Rhode Island and Maine. Vermont offers a five percent sales tax exclusion to consumers purchasing or installing renewable-energy equipment. They are, however, the only New England state to offer a tax credit for renewable energy production under the High Technology Growth Credit. This credit offers qualifying businesses to enjoy up to three of the following income tax credit options:

- a. A percentage of payroll costs;
- b. 10% of R&D costs;
- c. Credit against export taxes;
- d. 5-10% credit of total investment in capital equipment;
- e. 6% of investment for renovation of old facilities;
- f. 20% of workforce training or development.

To date, New Hampshire's only renewable energy resource is its RPS which requires utility providers to source 16% of their retail energy from Class I sources by 2025. The RPS is a feature of all New England states, as is the net metering system which credits consumers for the amount of renewable energy they use.

It is important to note that many of these state incentives apply to other forms of renewable energy in addition to fuel cells. Therefore, many of these programs do not target fuel cell development, but rather, promote it. Relative to other New England states, Connecticut's fuel cell program is the most robust and ambitious. Only Connecticut offers subsidies to fuel cell developers while also implementing ambitious renewable energy standards. Across the country, only New York (NYSERDA), Ohio (Ohio Development Department) and

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<sup>4</sup> Currently this legislation is being expanded while the Fund is accepting "unsolicited proposals."

<sup>5</sup> The Chewonki Renewable Hydrogen Project is a joint venture between the Hydrogen Energy Center, The Chewonki Foundation and the Maine Energy Investment Corporation.

California (California Energy Commission) offer incentives comparable to those of Connecticut. Within New England, only Rhode Island is following Connecticut's strong lead.