

# 2020 ANNUAL REPORT



# About the Connecticut Hydrogen - Fuel Cell



### Mission

To enhance economic growth in Connecticut through the development, manufacture, and deployment of fuel cell and hydrogen technologies and associated fueling systems.

### **Objectives**

- To create public awareness with industry, academia, and government regarding the benefits and uses of fuel cell and hydrogen technologies.
- To facilitate identification, communication, and management of key information among users, manufacturers, infrastructure managers, and the supply chain.
- To strengthen Connecticut's fuel cell and hydrogen industry through academic and government involvement.
- To provide a forum for discussing common issues and for developing joint projects.
- To be the state recognized leader for economic development in the hydrogen and fuel cell sector.

### **Board of** Governors

#### Nel Hydrogen

Stephen Szymanski, Director - Business Development (Chairman)

#### **Doosan Fuel Cell America**

David Giordano, Govt Relations and Business Dev (Vice Chairman)

#### Connecticut Center for Advanced Technology, Inc.

Joel M. Rinebold, Director of Energy

#### **Connecticut Green Bank**

Bryan Garcia, President and CEO

#### FuelCell Energy, Inc.

Derek Phelps, Director, Business Development.

#### Infinity Fuel Cell and Hydrogen, Inc.

William F. Smith, President

#### **Precision Combustion, Inc.**

Anthony Anderson, Director, Marketing and Business Dev.

#### Skyre, Inc

Trent Molter, President and CEO

#### Air Liquide

Roy Bant, Hydrogen Energy Business Development Manager, Northeast

### Markets



The hydrogen fuel cell industry in Connecticut has been challenged by the 2020 pandemic of COVID; however, the market, consumer interest, and government support for clean, reliable, and dispatchable energy has kept the industry relevant and successful to meet market needs for commercially available energy technology. With expectations for new federal leadership and a new Clean Energy Policy in 2021 there is optimism that hydrogen and fuel cell technology will be highlighted as a solution for clean stationary power; zero emission transportation for cars, trucks, aircraft, materials management, and space exploration; and as a zero emission energy carrier to integrate and store energy from asynchronous wind and solar resources with hydrogen.

This year has seen progress for solicitation, construction, and operation of stationary fuel cells. Key highlights include the manufacture of over 100 units (50 to 60 MW of capacity) per year from Doosan Fuel Cell in South Windsor and an operational portfolio of 32.6 MW (as of October 1, 2020) with 41.2 MW in various stages of development and construction (as of October 31, 2020) from FuelCell Energy of Danbury and Torrington.

### **Key Connecticut Statistics**

**Connecticut Hydrogen and Fuel Cell Industry Data** 

OEMs **10** 

Supply Chain Members: 611+

Direct Jobs: 983

Indirect Jobs: 773

Induced Jobs: 1.078

Total Jobs: **2,834** 

Total Revenue + Investment: \$601

Million

Total Labor Income: \$286 Million

assesses the direct, indirect, and induced values of the Northeast region's hydrogen and fuel cell supply chain using 2016 and 2017 data.

The manufacture of hydrogen production equipment for hydrogen users, including fuel cell electric vehicles, continues to grow with over 2,700 PEM electrolyzers delivered from the Wallingford, CT manufacturing facility.

The **Connecticut Center for** Economic Analysis has analyzed potential impact the Connecticut's hydrogen and fuel cell industry on jobs and revenues and finds that between 2015 and 2042, the aggregated impacts on employment could vield between approximately 170,000 244,000 job-years; the aggregated impacts on real gross domestic products could yield between \$38 B and \$54 B; and that if Connecticut retains its relative market share of fuel cell sales, 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, delivering more tax revenue.

Specialty vehicles such as material handling equipment, airport tugs, and street sweepers, used by a variety of industries, including manufacturing, construction, mining,

Fuel cell and hydrogen technology sales to markets reinforces the value of this industry to Connecticut with nearly 1,000 direct jobs, over 2,800 total jobs, over \$600 million in total revenue and investment, and \$286 million in total labor income.



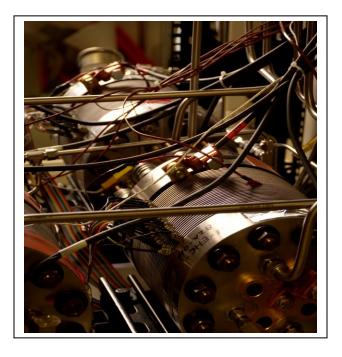
agriculture, retailers, and wholesalers, can be powered with hydrogen fuel cells. Batteries that currently power some equipment for indoor use are heavy, take up significant storage space, and provide limited hours of run time. Fuel cell powered equipment has zero emissions, a lower annual cost of ownership, and almost twice the estimated product life than battery powered equipment. In addition, hydrogen powered fuel cells are becoming commercialized for drones and other UAV as a lightweight, quiet, long range, and cost-effective transportation alternative. Recently, Connecticut-made hydrogen powered fuel cells and hydrogen generators have been commissioned by NASA for space exploration.

Economic benefits, environmental quality, and energy reliability are driving the development of hydrogen and fuel cell technologies for regional, national, and global markets. Policy for clean reliable stationary energy, energy storage, and clean transportation have been important drivers for deployment of FCEVs, hydrogen infrastructure, and fuel cell stationary power generation.

Connecticut companies have developed hydrogen and fuel cell technology and created significant opportunities for more efficient use of cleaner energy, job creation, and economic development in Connecticut and the region. This technology has also provided Connecticut an opportunity to help utilize its renewable energy industry transportation, energy storage, and electric generation at consumer sites.

The age distribution of hydrogen and fuel cell companies suggests a substantial expansion in the sector, with several small businesses exhibiting recent growth. Growth of hydrogen and fuel cell patents in the Northeast far exceeds the growth of all types of clean energy patents in the region. The proximity of the original equipment manufacturers (OEM) and supply chain companies in this cluster has provided a competitive advantage for research, design, development, manufacturing, and export of commercial products to national and international markets. emerging hydrogen and fuel cell technology advances, the number of companies and employment for the industry would grow substantially.

These market opportunities represent a short-term investment for long-term productivity. Provisions for support and deployment should recognize the short-term cost to facilitate long-term market productivity with an expectation of a payback on investments.



The market continues to grow for advanced technology that delivers zero or low emission power, zero emission transportation, power for unmanned aerial vehicles/aircraft, carbon separation, air filtration, and energy storage. These technologies have been supported by the needs of clean energy markets to deliver products for power, reliability, and energy security.

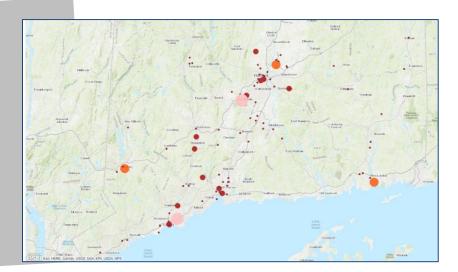
Research, development, and deployment confirms Connecticut's role as a showcase for regionally manufactured energy storage and renewable energy. Recently, PCI was awarded a DOE award to develop a novel solid oxide fuel cell (SOFC) power generation system offering improved efficiency, a lower carbon footprint, and reduced costs. PCI was also selected by DOE to develop a hybrid SOFC power generator and energy storage system for allelectric commercial aircraft. PCI, working in collaboration with the University of Connecticut will also develop a new fuel cell system design for NASA spacecraft on missions to the Moon and Mars.

The Connecticut Center for Advanced Technology, Inc. administers the Connecticut Hydrogen Fuel Cell Coalition with support from industry stakeholders

# Connecticut's Hydrogen & Fuel Cell Industry Status

#### Stationary Fuel Cell Installations in Connecticut

There are near term market opportunities for: 1) 170 MW of fuel cells, 2) 6-7 hydrogen fueling stations, and 3) 591 FCEVs in CT.



Stationary fuel cells provide an opportunity to convert hydrogen or hydrogen rich gas into renewable energy without combustion and emissions associated conventional power generation technology.

As a transition strategy, fuel cells can use natural gas and "Green" hydrogen produced from asynchronous wind and solar resources that require energy storage to meet the consumer demand for dispatch of reliable energy.

Hydrogen powered fuel cells are providing a solution for zero emission transportation using compressed hydrogen as a long range and fast fill alternative to battery electric vehicles. The manufacture of FCEVs at US Hybrid in South Windsor and hydrogen production and refueling equipment at Nel in Wallingford provides technology as solution for compliance with government clean transportation goals for reduction of carbon emissions.



Automakers are now making plans to comply with a zero emission vehicle program modeled after the California ZEV Action Plan. and at least eight (8) states have committed signed and Memorandum of Understanding requiring large-volume automakers to sell approximately 3.3 M ZEVs between 2018 and 2025.

This initiative will reduce carbon emissions, primary air pollutants, and increase fuel diversity.

refueling Hydrogen stations currently exist in Hartford and Wallingford Connecticut.

The hydrogen from stations is sourced from solar and hydroelectric resources to minimize carbon and primary air pollutants.



With the availably of commercial technology, government and industry are now investigating the deployment of FCEVs with hydrogen refueling as a replacement of hydrocarbon fuels in the transportation sector, which accounts for approximately 30 percent of Connecticut's total energy consumption.

FCEVs have several advantages over conventional vehicles that can reduce price volatility, decrease dependence on oil, improve environmental performance, and provide greater efficiencies. Targets for FCEV deployment and hydrogen infrastructure development include public/private fleets, bus transit, and specialty vehicles. Zero emission FCEVs could replace existing conventional fleet vehicles in Connecticut, starting with 548 passenger vehicles providing annual CO<sub>2</sub> emission reductions of approximately 2,600 metric tons and 43 zero emission fuel cell electric buses (FCEBs) reducing annual CO<sub>2</sub> emissions by approximately 3,800 metric tons.

### Events, Activities, Technologies, and Markets:

THE CONNECTICUT HYDROGEN FUEL CELL INDUSTRY IS WELL POSITIONED FOR WORLD CLASS RESEARCH, DEVELOPMENT. AND DEPLOYMENT. THIS INDUSTRY PROVIDES:

- GLOBAL LEADERSHIP FOR DEVELOPMENT AND DEPLOYMENT OF CLEAN ENERGY TECHNOLOGY
- A REGIONAL SUPPLY CHAIN HUB FOR A CLEAN ENERGY **ECONOMY**
- ENERGY STORAGE TECHNOLOGY TO INTEGRATE RENEWABLE WIND AND SOLAR ENERGY WITH CONSUMER **MARKETS**
- TRANSITION TO A DECARBONIZED ENVIRONMENT

#### **Coalition Events and News:**

- Release of the 2020 Hydrogen Fuel Cell Development Plan for the Connecticut Hydrogen Economy - Economic Development, Environmental Performance, Energy Reliability. This "Roadmap" identifies strategic targets for deployment of fuel cells for stationary power, hydrogen refueling, and fuel cell zero-emission vehicles.
- Collaboration with the regional offshore wind industry to examine opportunities for energy storage. This collaboration provides potential opportunities to coordinate hydrogen storage with over 1,100 MW of offshore wind that has been procured by the State of Connecticut to meet renewable energy and carbon reduction goals.
- Collaboration with the public service industry to examine opportunities for hydrogen blending within existing infrastructure. This collaboration provides potential opportunities to reduce curtailment of asynchronous renewable generation with energy storage and incremental decarbonization of energy infrastructure.

- Collaboration with state government and the US DOE to assist in the development of state hydrogen transportation "Roadmaps". This collaboration provides opportunities for Connecticut hydrogen and fuel cell manufacturers to meet market demands in areas outside of Connecticut.
- Management of the Northeast Regional Technical Exchange Center and expansion of the Hydrogen Fuel Cell Supply Chain Database to support energy storage.
- > Coordination with DECD to assist domestic and international companies establish and expand operations in Connecticut.
- Coordination with state, regional, and federal entities, as listed below, to expand opportunities for Connecticut companies:
  - Department of Energy;
  - National Laboratories (NREL);
  - Association of Clean Tech Incubators (ACTION);
  - Clean Cities Coalitions;
  - Connecticut Green Bank;
  - CT DEEP, DECD, and DOT;
  - Ohio Hydrogen Fuel Cell Coalition; and
  - New Jersey Fuel Cell Coalition.
- Identification and assessment of potential end user sites for hydrogen and fuel cell deployment and technical and economic cash flow analysis for selected public and private clients.
- Assessment of opportunities for Connecticut companies to access regional activities and markets.
- Analysis of fleet clusters, population, and registrations of existing alternative fuel and hybrid vehicles to identify opportunities for fleet FCEV deployment and hydrogen infrastructure development.

## **Industry Milestones**

NASA awards Infinity Fuel Cell and Hydrogen to help make power and energy products for lunar rovers, surface equipment, and habitats.

FuelCell Energy selected by DOE in collaboration with the Office of Nuclear Energy to support the design and manufacture of an electrolysis platform.

**Nel Receives Purchase Orders for US Navy PEM Electrolyzer Stacks** 

**Precision Combustion wins** competition for all-electric aircraft power generation

**US Hybrid producing the** fuel cell para-transit van with 250 mile-range for SARTA

NASA awards Skyre to develop a system to make propellent from frozen water at the moon's poles.

**PCI Wins DOE SBIR Award for Excess Electric Power-Driven Conversion of** Carbon Dioxide to Fuels

"PCI and UConn Team Win NASA Award to Develop a **Fuel Cell System Capable of Using Propellant Grade** Reactants"

### Coalition Members 2020

The Connecticut Hydrogen Fuel Cell Coalition is comprised of representatives from the fuel cell and hydrogen industry, government, and other stakeholders. General membership to the Coalition is open to any and all individuals, corporations and organizations whose fuel cell and hydrogen activities are aligned with the Coalition's goals.

Advent Technologies Manufacturer - www.advent-energy.com

Manufacturer/Developer – https://energies.airliquide.com/

Aris Energy Solutions Manufacturer/Developer – airswind.com/fuel-cell-mchp/

Center for Clean Energy Engineering Professional Services - www.energy.uconn.edu

Connecticut Center for Advanced Technology, Inc. Non-Profit - www.ccat.us

Connecticut Clean Cities Government Related - www.eere.energy.gov/cleancities

Connecticut Dept. of Economic & Community **Development** 

Government - www.decd.org

Connecticut Department of Transportation Government - www.ct.gov/dot

Connecticut Green Bank Government - www.ctcleanenergy.com

Connecticut Siting Council Government - www.ct.gov/csc

CTTRANSIT Public Transit - www.cttransit.com

Darien High School Fuel Cell Project Education - wwwdhsfuelcell.org

Design By Analysis, Inc. Technical Services - www.dbaworks.com

Dexmet Corporation Manufacturer - www.dexmet.com

Doosan Fuel Cell America, Inc. Manufacturer - www.doosanfuelcellamerica.com **Engineered Fibers Technology, LLC** Manufacturer - www.eftfibers.com

O FuelCell Energy, Inc. Manufacturer - www.fuelcellenergy.com

0 **Fuel Cell Perspectives Professional Services** 

Infinity Fuel Cell and Hydrogen, Inc. 0 Manufacturer - www.infinityfuel.com

**People's United Insurance Agency** O Professional Services - www.peoples.com/peoples

**Precision Combustion, Inc.** Manufacturer - www.precision-combustion.com

O **Nel Hydrogen** Manufacturer - www.nelhydrogen.com

Public Utilities Regulatory Authority (PURA) / **Department of Energy and Environmental Protection** Government - www.ct.gov/pura

**Pullman & Comley, LLC** Professional Services - www.pullcom.com

**Robinson & Cole, LLP** Professional Services - www.rc.com

**R&D Dynamics Corporation** 

Skyre, Inc. Manufacturer - www.skyre-inc.com

**US Hybrid Corporation** Manufacturer – www.ushybrid.com