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August 2016
CONTRIBUTORS

This study was conducted by Navigant Consulting, Inc. (Navigant) with support from the Connecticut Green Bank (CGB) and Connecticut Department of Economic and Community Development (DECD), and assistance by Connecticut utilities Eversource Energy and United Illuminating (UI).

Note: If this document is referenced, it should be cited as: Navigant Consulting Inc., Connecticut Department of Economic and Community Development, and Connecticut Green Bank. June 2016. Clean Energy Jobs in Connecticut.
# TABLE OF CONTENTS

1. 2016 Study Overview

2. Jobs Impact Based on Dollars Invested

3. Current RE and EE Jobs

4. Appendix
Connecticut Green Bank requested Navigant refresh their Clean Energy Economy Baseline Study as the industry has evolved.

**2009-2010 STUDY**¹

- **Central focus:** To provide detailed inventory/accounting of renewable energy and energy efficiency jobs and wages, jobs impact based on dollars invested, clean energy value chain, and a summary of DECD work

- **Study pool:** 74 companies interviewed, 95 researched

- **Interview focus:** Job counts and industry insights

- **Technology:** Energy efficiency (EE) in general and renewable energy (RE), primarily solar PV and fuel cells

**2015-2016 REFRESH**

- **Central focus:** To provide an updated calculator tool to estimate the economic development benefits (i.e., job-years created) from clean energy investments in Connecticut

- **Study pool:** 31 companies interviewed, 40 researched

- **Interview focus:** Technology-specific data inputs for calculator

- **Additional technologies:** New distributed energy resources (DER) such as electric vehicle (EV) charging and energy storage

¹Connecticut Renewable Energy and Energy Efficiency Economy Baseline study, Navigant Consulting, Inc. [Completed in March 2009 and subsequently updated in 2010]
Navigant employed a top-down approach, seeking to interview and research the biggest employers and, using that data, extrapolate to the whole market.

- Focus was on product development and manufacturing as well as project development and deployment jobs across various leading and emerging RE and EE technologies.
- Cross-checking was conducted using CGB, utility, and DECD resources, Navigant’s internal databases, and Connecticut industry experts.
- The state-wide industry size was estimated by extrapolation. Assumptions and methodology were verified by CGB and DECD.
- For market segments not included in utility or Green Bank data, employee counts were updated from the last study based on Navigant’s existing data sources and professional judgement.
- Charts and figures in this presentation represent direct jobs specific to RE and/or EE only and refer to indirect and induced jobs only when specified.
- 40 companies were researched in detail, and 31 interviews were conducted including:
  - 22 RE/EE companies
  - Three utilities
  - Three organizations/institutions
  - Three subject matter experts (SMEs)
A focused interview approach was used to gather results from top employers or other sources and extrapolate for all current jobs.

1. **Build the initial company database.** Navigant developed a company and contact list using information from Connecticut Green Bank, Navigant’s 2010 study, trade organizations, utilities, other public sources, and companies known to the evaluation team.

2. **Research primary contact information.** Missing email addresses and telephone numbers were researched through online searches and phone calls.

3. **Create, test, and revise the interview questions.** The interview question set was refined several times with the goal of making it concise while capturing information that was of greatest interest (see next slide).

4. **Conduct interviews.** Navigant managed the interview process and conducted the interviews. The evaluation team conducted 31 formal interviews of some of the largest RE/EE companies and contacted other stakeholders in this sector to augment the information collected from the formal interviews.

5. **Data collection.** Navigant worked with Connecticut Green Bank and other Connecticut departments to cross-check and supplement the team’s assumptions and findings.

6. **Review and clean the data set.** Navigant worked with Connecticut Green Bank and other Connecticut departments to extensively review the analysis and results for accuracy and completeness, following up to verify and correct information as needed.
Based on a recommendation by the CGB, Navigant focused the calculator and jobs study on sections of the value chain most closely associated with project installation, which is the focus of the CGB.

**RE/EE Value Chain**

- **Products**
  - Mfg. Line Construction
  - Product Dev. & Mfg.
  - Project Dev. & Deployment
  - O&M
  - Generation & RE Credits (RECs)
  - Off-Taker*

- **Services**
  - Power electronics, fuel cell mfg.
  - Solar sales and installation, RE project developers
  - Vendors who install EE technology and upgrades

**RE examples:**
- Power electronics, fuel cell mfg.
- Solar sales and installation, RE project developers
- Vendors who install EE technology and upgrades

**EE examples:**
- N/A

*Note: An off-taker is an entity that purchases electricity or RECs from an independent power producer or marketer.*

Included: Jobs directly related to growth of installed capacity

Excluded: Less focused on installed jobs and/or jobs are limited
In line with the value chain segments examined, “jobs types” included in the calculator related to manufacturing, installation, engineering, and project management.

<table>
<thead>
<tr>
<th>General Job Type</th>
<th>Example Specific Occupation Types¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing</td>
<td>Production occupations (e.g., assemblers, fabricators, equipment operators, and process workers)</td>
</tr>
<tr>
<td>Installers/Field Technicians</td>
<td>Installation and construction occupations (e.g., solar PV installers, heating, AC and refrigeration mechanics and installers, insulation workers, floor, ceiling and wall)</td>
</tr>
<tr>
<td>Electricians</td>
<td>Electricians, electro-mechanical technicians, electrical and electronics installers and repairers</td>
</tr>
<tr>
<td>Engineers/Project Managers</td>
<td>Engineers (e.g., mechanical, civil, and electrical engineers); management occupations (e.g., project, construction, and engineering managers)</td>
</tr>
</tbody>
</table>

This analysis mainly considers direct jobs in private companies that employ people who are based in Connecticut. A multiplier for calculating indirect and induced jobs from the number of direct jobs was provided by the DECD for this study.

- For the purpose of this baseline analysis, direct jobs are considered existing jobs in the specified Connecticut industries.
- In policy analysis, direct jobs are commonly defined as the initial change in final demand for the industry sector in question. Direct job impacts describe the changes in economic activity for sectors that first experience a change in demand because of a project, policy decision, or some other stimuli.

**DIRECT JOBS**

- Represents the response as supplying industries increase output in order to accommodate the initial change in final demand. These indirect beneficiaries will then spend money for supplies and services, which results in another round of indirect spending.

**INDIRECT JOBS**

- Jobs generated by the spending of households who benefit from the additional wages and business income they earn through direct and indirect activity. The increase in income, in effect, increases the purchasing power of households.

**INDUCED JOBS**

Primary scope (the numbers presented in this report are direct jobs unless otherwise indicated)

Secondary scope through use of multipliers

DECD provided a multiplier for calculating indirect and induced jobs from the number of direct jobs for this study.

- DECD performed the simulations by creating net new jobs in the following sectors that include the occupations listed below:

<table>
<thead>
<tr>
<th>Occupation</th>
<th>NAICS Code</th>
<th>Sector Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrician, Installer/Field Technician</td>
<td>23</td>
<td>Construction</td>
</tr>
<tr>
<td>Engineer</td>
<td>541</td>
<td>Professional, technical, and scientific services</td>
</tr>
<tr>
<td>Fuel Cell Manufacturing (Solid State)</td>
<td>334</td>
<td>Computer and electronic product manufacturing</td>
</tr>
<tr>
<td>Fuel Cell Manufacturing (Electrochemical Generators)</td>
<td>335</td>
<td>Electrical equipment and appliance manufacturing</td>
</tr>
</tbody>
</table>

- DECD then obtained the multiplier by dividing the total employment generated in the economy by the net new jobs in the above sectors entered as input into Connecticut’s REMI\(^1\) model.

- The simulations generated an employment multiplier of 2.3, which means that for each RE/EE job, an additional 1.3 jobs are created, on average, each year.

- This relatively high multiplier most likely reflects the relatively large local supply of labor and intermediate goods; the decrease in the same multiplier over the 2010 study is likely due to the narrower job base classifications used this time around, as well as higher worker productivity in these sectors as companies do more with fewer workers.

\(^1\)REMI V.1.6.7, Connecticut Single Region Model. REMI is a dynamic input-output model that assesses individual and firm behavioral responses to changes in relative prices over time. This simulation provides the potential regional employment impact of the relevant industry groups in Connecticut.
This study includes some additional RE and EE technology industries as compared to the last study, such as EV infrastructure and energy storage.

### Renewable Energy

<table>
<thead>
<tr>
<th>Technology</th>
<th>Markets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel cells</td>
<td>Residential</td>
</tr>
<tr>
<td>Solar PV</td>
<td>Commercial and industrial (C&amp;I)</td>
</tr>
<tr>
<td>Solar thermal</td>
<td>Utility</td>
</tr>
<tr>
<td>Wind</td>
<td></td>
</tr>
<tr>
<td>Geothermal</td>
<td></td>
</tr>
<tr>
<td>Small hydro</td>
<td></td>
</tr>
<tr>
<td>Energy storage</td>
<td></td>
</tr>
<tr>
<td>EV charging</td>
<td></td>
</tr>
</tbody>
</table>

### Energy Efficiency

<table>
<thead>
<tr>
<th>Technology*</th>
<th>Markets</th>
</tr>
</thead>
<tbody>
<tr>
<td>High efficiency heating, ventilation and air conditioning (HVAC)</td>
<td>Residential (including low-income weatherization)</td>
</tr>
<tr>
<td>Efficient lighting</td>
<td>C&amp;I</td>
</tr>
<tr>
<td>Efficient home appliances</td>
<td>Small business</td>
</tr>
<tr>
<td>Water heating</td>
<td></td>
</tr>
<tr>
<td>Building envelope</td>
<td></td>
</tr>
<tr>
<td>Demand response</td>
<td></td>
</tr>
</tbody>
</table>

*Note: For the purpose of this analysis, Navigant merged all EE technologies and presented the results by market.*
Because the focus of this study was the jobs calculator and installation-focused job creation—specifically product and project development jobs—the study could be expanded to address other segments.

Some areas for future investigation include:

<table>
<thead>
<tr>
<th>Area of Study</th>
<th>Analysis Focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial EE</td>
<td>Commercial EE jobs count by job title and customer type</td>
</tr>
<tr>
<td>Other RE Manufacturing and R&amp;D</td>
<td>Emerging RE manufacturing and R&amp;D in Connecticut, including EV charging and storage</td>
</tr>
<tr>
<td>RE Utility Employees</td>
<td>Number of employees or job-years focused on administering RE programs</td>
</tr>
<tr>
<td>Value Chain Segments</td>
<td>Other areas of the value chain not explored in this study, including supply chain, operations and maintenance (O&amp;M), academic, etc.</td>
</tr>
</tbody>
</table>
TABLE OF CONTENTS

1. 2016 Study Overview

2. Jobs Impact Based on Dollars Invested

3. Current RE and EE Jobs

4. Appendix
The jobs calculator estimates the job-years created from $1 million in investment based on industry inputs such as cost allocation of labor and current wages.

### 2016 Analysis: RE/EE Job-Years Created from Public Investments Made by Connecticut Green Bank

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Capital Invested</th>
<th>Company Overhead (SG&amp;A) and Margin (%)</th>
<th>Project Cost After Overhead (SG&amp;A) and Margin</th>
<th>Labor (% of Project Cost)</th>
<th>Non-Labor (% of Project Cost)</th>
<th>Weighted Average Wage</th>
<th>Fully Burdened Employee Cost</th>
<th>Direct Job Years Created per Million Dollars Invested</th>
<th>Indirect &amp; Induced Jobs Created per Million Dollars Invested</th>
<th>Total Job-Years Created from Capital Invested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewable Energy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel Cell</td>
<td>$1,000,000</td>
<td>20%</td>
<td>$800,000</td>
<td>40%</td>
<td>60%</td>
<td>$50,000</td>
<td>$65,000</td>
<td>4.9</td>
<td>1.3</td>
<td>6.4</td>
</tr>
<tr>
<td>Fuel Cell R&amp;D/Engineering</td>
<td>$1,000,000</td>
<td>20%</td>
<td>$800,000</td>
<td>40%</td>
<td>60%</td>
<td>$85,000</td>
<td>$110,500</td>
<td>2.9</td>
<td>1.3</td>
<td>3.8</td>
</tr>
<tr>
<td>Solar PV</td>
<td>$1,000,000</td>
<td>20%</td>
<td>$800,000</td>
<td>35%</td>
<td>65%</td>
<td>$55,000</td>
<td>$71,500</td>
<td>3.9</td>
<td>1.3</td>
<td>5.1</td>
</tr>
<tr>
<td>Solar PV Installation - Residential</td>
<td>$1,000,000</td>
<td>20%</td>
<td>$800,000</td>
<td>25%</td>
<td>75%</td>
<td>$50,000</td>
<td>$65,000</td>
<td>3.1</td>
<td>1.3</td>
<td>4.0</td>
</tr>
<tr>
<td>Solar PV Installation - Non-Residential</td>
<td>$1,000,000</td>
<td>20%</td>
<td>$800,000</td>
<td>25%</td>
<td>75%</td>
<td>$50,000</td>
<td>$65,000</td>
<td>3.1</td>
<td>1.3</td>
<td>4.0</td>
</tr>
</tbody>
</table>

*Excerpt from the jobs calculator.*

**Updates to Previous Study**

- These values are representative of the **2015-2016** market in Connecticut.
- Final values are given in **job-years** created per $1 million in capital invested.
- Public vs. private funding is **not specified** in the 2016 calculator refresh.
- Job-years created are calculated **after Sales, General & Administrative (SG&A) and margin** is removed.
JOBS IMPACT BASED ON DOLLARS INVESTED
KEY FINDINGS

More job-years in EE are created per $1 million capital investment than for RE because material costs and wages are, on average, lower in the EE industry.

FAST FACTS

A $1 million capital investment creates:
• ~5 job-years for energy storage installers
• ~7 job-years for EV charging station installers
• ~9 job-years for residential solar installers
• ~11 job-years for fuel cell manufacturers
• ~14 job-years for wind project installers
• ~14 job-years for commercial EE installers
• ~15 job-years for renewable thermal technologies (RTT) installers
• ~18 job-years for residential EE installers

Job-years created are direct, indirect, and induced.

KEY FINDINGS

• More fuel cell manufacturing job-years are created per $1 million investment than solar installation jobs because a larger portion of funding goes toward labor.

• Renewable Thermal Technologies (RTT) and residential EE technologies create the most job-years per investment because labor and material costs are lower for these technologies.

• Investments in residential solar create more job-years from investment than commercial solar because material costs make up a larger portion of overall project cost for commercial customers.

• Other RE technologies such as energy storage and EV charging stations are still new to market and maintain high material costs, with less investment going toward installation labor.
JOBS IMPACT BASED ON DOLLARS INVESTED
RESULTS: RENEWABLE ENERGY

RE job-years created per $1 million capital invested per the calculator approach:

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Direct Job-Years Created per $1 Million Invested</th>
<th>Indirect and Induced Jobs Created per $1 Million Invested</th>
<th>Total Job-Years Created from $1 Million Invested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewable Energy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel Cell</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel Cell Manufacturing</td>
<td>4.9</td>
<td>6.4</td>
<td>11.3</td>
</tr>
<tr>
<td>Fuel Cell R&amp;D/Engineering</td>
<td>2.9</td>
<td>3.8</td>
<td>6.7</td>
</tr>
<tr>
<td>Solar PV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solar PV Installation - Residential</td>
<td>3.9</td>
<td>5.1</td>
<td>9.0</td>
</tr>
<tr>
<td>Solar PV Installation - Non-Residential</td>
<td>3.1</td>
<td>4.0</td>
<td>7.1</td>
</tr>
<tr>
<td>Renewable Thermal Technologies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ductless Split Heat Pump</td>
<td>6.7</td>
<td>8.7</td>
<td>15.4</td>
</tr>
<tr>
<td>Geothermal</td>
<td>6.7</td>
<td>8.7</td>
<td>15.4</td>
</tr>
<tr>
<td>Solar Thermal</td>
<td>5.6</td>
<td>7.3</td>
<td>12.9</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wind Installation</td>
<td>6.2</td>
<td>8.0</td>
<td>14.2</td>
</tr>
<tr>
<td>Hydro Installation</td>
<td>6.2</td>
<td>8.0</td>
<td>14.2</td>
</tr>
<tr>
<td>EV Charging Stations - Installation</td>
<td>3.1</td>
<td>4.0</td>
<td>7.1</td>
</tr>
<tr>
<td>Storage Installation</td>
<td>2.2</td>
<td>2.9</td>
<td>5.1</td>
</tr>
</tbody>
</table>
## EE job-years created per $1 million capital invested per the calculator approach:

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Direct Job-Years Created per $1 Million Invested</th>
<th>Indirect and Induced Jobs Created per $1 Million Invested</th>
<th>Total Job-Years Created from $1 Million Invested</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy Efficiency</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential (Single and Multifamily)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lighting</td>
<td>7.7</td>
<td>10.0</td>
<td>17.7</td>
</tr>
<tr>
<td>Home Energy Solutions (HES) - Audits</td>
<td>7.8</td>
<td>10.2</td>
<td>18.0</td>
</tr>
<tr>
<td>HES - Weatherization &amp; HVAC</td>
<td>5.6</td>
<td>7.3</td>
<td>12.9</td>
</tr>
<tr>
<td>Gas Conversion</td>
<td>5.6</td>
<td>7.3</td>
<td>12.9</td>
</tr>
<tr>
<td><strong>Commercial</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small Business (e.g., Small Business Energy Advantage)</td>
<td>6.2</td>
<td>8.0</td>
<td>14.2</td>
</tr>
<tr>
<td>Large Commercial and Industrial (e.g., C-PACE)</td>
<td>5.6</td>
<td>7.3</td>
<td>12.9</td>
</tr>
</tbody>
</table>

1. The municipalities, universities, schools, and hospitals (MUSH) market is included in Commercial.
JOBS IMPACT BASED ON DOLLARS INVESTED

METHODOLOGY

The two key inputs to calculate job-years created for each RE and EE job type are labor allocation of total project cost and average wage.

1. **Labor allocation:** The average of the values provided in company interviews and discussions with SMEs (particularly for wind and storage) was used.

2. **Average wage:** The wage for each of the four job types analyzed by the calculator was taken from the Bureau of Labor Statistics, or BLS, (CT, 2015) for the most similar occupation titles.

<table>
<thead>
<tr>
<th>Job Type for Calculator</th>
<th>BLS Occupation Code*</th>
<th>BLS Occupation Title*</th>
<th>BLS Wage CT*</th>
<th>BLS Wage MA**</th>
<th>CT Wage vs. MA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing</td>
<td>51-0000</td>
<td>Production occupations</td>
<td>$41,730</td>
<td>$39,500</td>
<td>6%</td>
</tr>
<tr>
<td>Installers/Field Technicians</td>
<td>47-2231</td>
<td>Solar photovoltaic installers</td>
<td>$37,270</td>
<td>$43,860</td>
<td>-15%</td>
</tr>
<tr>
<td>Electricians</td>
<td>47-2111</td>
<td>Electricians</td>
<td>$55,750</td>
<td>$64,790</td>
<td>-14%</td>
</tr>
<tr>
<td>Engineers/PM/R&amp;D</td>
<td>17-2141</td>
<td>Mechanical engineers</td>
<td>$84,520</td>
<td>$91,270</td>
<td>-11%</td>
</tr>
</tbody>
</table>


3. A **weighted-average wage** was then calculated for each RE and EE offering by multiplying the BLS wages by the job classification breakdown, which was collected through interviews and internal research/experts.

- The job classification breakdown used for residential solar is provided in the pie chart.
- The job classification breakdowns used for all other technologies are provided in the table.

### Residential Solar Employee Breakdown by Job Type
(Average 36 Total Employees)

<table>
<thead>
<tr>
<th>Job Type</th>
<th>Electricians</th>
<th>Installers/Field Technicians</th>
<th>Engineers/PM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricians</td>
<td>15%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installers/Field Technicians</td>
<td>50%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engineers/PM</td>
<td>35%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Employee Breakdown by Job Type*

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial Solar</td>
<td>60%</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>Fuel Cell</td>
<td>60%</td>
<td>0%</td>
<td>40%</td>
</tr>
<tr>
<td>Wind</td>
<td>40%</td>
<td>20%</td>
<td>40%</td>
</tr>
<tr>
<td>EV Charging Stations</td>
<td>50%</td>
<td>30%</td>
<td>20%</td>
</tr>
<tr>
<td>Storage</td>
<td>25%</td>
<td>5%</td>
<td>70%</td>
</tr>
<tr>
<td>Lighting</td>
<td>80%</td>
<td>20%</td>
<td>0%</td>
</tr>
<tr>
<td>Small Business Energy Advantage (SBEA)</td>
<td>70%</td>
<td>15%</td>
<td>15%</td>
</tr>
<tr>
<td>Large C&amp;I</td>
<td>50%</td>
<td>25%</td>
<td>25%</td>
</tr>
</tbody>
</table>

*Employee breakdowns were determined based on information collected in interviews, as well as with available internal research for the technologies included in this study.

Source: Navigant Analysis
JOBS IMPACT BASED ON DOLLARS INVESTED

ASSUMPTIONS

The calculator primarily determines job-years per investment for installation- and manufacturing-type labor.

• Distribution/supply work is considered indirect.

• Subcontracted work is considered indirect.

• **Assumed** 20% for company overhead (SG&A) costs (including jobs) and margin (%).

• The wages **included** are calculated as a weighted average of four different job classifications:
  - Installers/Field Technicians
  - Electricians
  - Engineers/Project Managers/R&D
  - Manufacturing

• **Excluded** from the weighted average wage are the following job types:
  - Administrative and executive
  - O&M
  - Finance and accounting
  - Sales and marketing
Some assumptions were made and included as notes within the calculator to clarify key variables and inputs to job-year calculation.

- Job-year final values are representative of the 2015-2016 market in Connecticut.
- Company Overhead and Margin (C) is assumed to be 20% and accounts for jobs related to sales, marketing, management, and other overhead jobs and expenses.
- Labor (D) is the percentage of the project cost that is used to pay installers, electricians, project managers and engineers.
- Non-Labor (E) is the percentage of the project cost that is used to cover all other project expenses, including materials and non-labor soft costs.
- Weighted Average Wage (F) is distributed among installers, electricians, and PM/engineers based on wages in Connecticut as reported by the U.S. Department of Labor as of May 2015.
- The weight for each job type is based on research and/or interview feedback for employee breakdowns for that field/technology.
- Total Direct Job-Years Created from Capital Invested (H) is the total number of installer, electrician, and PM/engineering jobs created for 1 year.
- Total Indirect and Induced Job-Years (J) is calculated from DECD inputs.
# TABLE OF CONTENTS

1. 2016 Study Overview

2. Jobs Impact Based on Dollars

3. **Current RE and EE Jobs**

4. Appendix
Overall, this analysis estimates Connecticut has 5,300 direct jobs in the product development and manufacturing and project development and deployment segments of the RE/EE value chain.

**OVERALL**
- 5,300 direct RE/EE jobs
- Direct RE/EE jobs account for 0.31% out of a workforce of 1.7 million

**RENEWABLE ENERGY (RE)**
- 12 companies interviewed, 17 researched, representing ~60% of the market
- 2,500 direct jobs
- Primarily solar and fuel cell jobs

**ENERGY EFFICIENCY (EE)**
- 10 key companies interviewed, 20 researched, representing ~30% of the market
- 2,800 direct jobs
- Primarily jobs in the residential and C&I market

Note: Indirect and induced jobs can be calculated using a multiplier of 1.3 for all jobs (DECD).

1Connecticut Department of Labor, Nonfarm Employment/Residents Employed as of April 2016
http://www1.ctdol.state.ct.us/lmi/ctnonfarmemployment.asp.
Employment in the solar industry has grown by approximately 30% since 2010 to become the largest RE industry for jobs in Connecticut.

**FAST FACTS**

- The total number of direct jobs for the RE industry in 2016 is ~2,500.
  - In 2010, the total number of RE jobs was ~1,700.
- 78% of the total fuel cell industry identified.
  - Leading employers include Doosan Group and FuelCell Energy.
- 68% of the total solar industry identified.
  - Biggest contributors include SolarCity and Trinity Solar.
- 26 RE companies identified: 9 companies interviewed, 17 companies researched in detail.
- Of ~2,500 direct jobs:
  - 44% products
  - 56% services

**KEY FINDINGS**

- The majority of RE jobs are split between the solar and fuel cell industries, with other RE technologies making up the remaining 6% of RE industry jobs.
- Installation and engineering jobs account for the largest job type at solar companies.
- Manufacturing and engineering jobs account for the largest job type at fuel cells companies.
- The majority of solar employees in Connecticut focus on the residential market.
CURRENT RE AND EE JOBS
RESULTS: ENERGY EFFICIENCY

Overall employment in the EE industry has remained relatively constant, experiencing most job growth in the residential customer market.

**FAST FACTS**

- The total number of direct jobs for the EE industry in 2016 is ~2,800.
  - In 2010, the total number of EE jobs was ~2,700.
- 28% of the residential EE industry identified.
  - Biggest contributors include Competitive Resources and Energy Efficiencies Solutions.
- 27 EE companies identified: 7 companies interviewed, 20 companies researched in detail
- Of ~2,800 direct jobs:
  - 23% products
  - 74% services
  - 3% utility

**KEY FINDINGS**

- EE technologies mainly included lighting, HVAC, and building envelope, with the majority of companies participating in multiple technologies.
- Installation jobs account for the majority of roles in EE.
- Most EE jobs are focused on the residential and C&I customer markets, with the remaining focused on retail and utility.
  - The average number of employees at C&I companies is 90-120 vs. 10-40 at residential companies.
- Percentage of total EE employees participating in the C&I and retail markets was based off the percentage from the 2010 study.
The number of direct solar industry jobs in Connecticut is more than 4 times greater than it was 5 years ago, while fuel cell and EE employment numbers have stayed relatively the same.

**Direct Jobs: 2010 vs. 2016**

- **Fuel Cell**: 10% decrease
- **Solar PV**: 333% increase
- **Energy Efficiency**: 6% increase

*Note: The methodologies differ between this and the previous study; therefore, the results may not be 1-to-1 comparable. For example, not as many commercial EE companies were directly identified and interviewed in this study, so other sources were used to estimate the number of commercial EE companies and jobs.*
The top 10 RE/EE employers represent approximately 50% of total direct jobs in 2010 and 2016, but there has been significant turnover, which is evident in the variances between the lists below.

<table>
<thead>
<tr>
<th>2010 Top 10 RE/EE Employers*</th>
<th>2016 Top 10 RE/EE Employers*</th>
</tr>
</thead>
<tbody>
<tr>
<td>United Technologies Corp. (UTC)</td>
<td>FuelCell Energy, Inc.</td>
</tr>
<tr>
<td>FuelCell Energy, Inc.</td>
<td>SolarCity</td>
</tr>
<tr>
<td>Sensor Switch</td>
<td>Doosan Fuel Cell America, Inc.</td>
</tr>
<tr>
<td>Schuco USA</td>
<td>Trane</td>
</tr>
<tr>
<td>US Insulation Corp.</td>
<td>EMCOR</td>
</tr>
<tr>
<td>Home Depot</td>
<td>Home Depot</td>
</tr>
<tr>
<td>Trane</td>
<td>Greenskies Renewable Energy</td>
</tr>
<tr>
<td>Noble Environmental Power</td>
<td>CED Greentech</td>
</tr>
<tr>
<td>Alliance Energy Solutions (AES)</td>
<td>Trinity Solar</td>
</tr>
<tr>
<td>Wal-Mart</td>
<td>Competitive Resources</td>
</tr>
</tbody>
</table>

*Utility jobs excluded.
Parallel to the growth of the solar industry, employment in this market has experienced the greatest increase among technologies.

- The methodologies differ between this and the previous study; therefore, the results may not be 1-to-1 comparable.
- The decrease in employment in the fuel cell industry was related to the bankruptcy of UTC Power in 2013 following acquisition by ClearEdge. (Doosan acquired the ClearEdge assets in 2014.). Subsequently, in June 2016, Doosan made some additional layoffs.
- The small increase in EE employment was likely due to the industry increase in available residential program funding and technologies.
- The increase in solar employment was driven by technology cost reduction (i.e., hard and soft costs), public policy, incentives, and access to financing.
The majority of RE companies and EE companies in Connecticut offer services, with the majority of product jobs belonging to the fuel cell industry.

- For this study, focus is on those parts of the value chain that, for the most part, have jobs in product and service offerings.
  - Jobs were classified as offering either primarily products or primarily services, though companies may offer both.
- Product companies either manufacture and sell to customers or buy from manufacturers and sell to RE/EE installers and developers.
- Service companies provide services such as installation and auditing.
- RE industry service jobs are primarily in solar (~1,300 jobs out of ~1,400 service jobs).
- RE industry jobs at product companies are solely in the fuel cell industry (~1,100 jobs).
- EE industry is mostly service jobs (~2,100 of total EE jobs), with some retail and supply jobs (~600) and minimal utility jobs (~80).

Source: Navigant Analysis

Note: The “Utility” category includes ~80 EE program administration jobs and <10 RE program administration jobs within Eversource, UI, and Norwich Public Utilities (NPU).
More than half of RE and EE employees studied in the state serve the C&I customer market.

RE + EE Jobs by Customer Market in CT: 2016

5,300 Direct Jobs

- All fuel cell employees are categorized as working in the C&I customer market, which accounts for approximately 1,100 jobs.
- About 40% of the 2,800-plus EE employees serve the C&I customer market as well.

Source: Navigant Analysis
More than half of RE and EE employees studied in the state work in the deployment part of the value chain.

RE + EE Jobs by Value Chain in CT: 2016

5,300 Direct Jobs

- Navigant specifies the difference between deployment and development as companies in deployment employ their own installers, while project developers subcontract the installation.
- Solar and other RE technologies (apart from fuel cells) account for the majority of the deployment and development jobs.
- All fuel cell employees and the retail and supply portion of the EE industry make up the product development and manufacturing percentage.

Source: Navigant Analysis

Note: Direct jobs in deployment and development mostly include installer and engineer job types.
Most RE and EE employees studied in the state working within the manufacturing and deployment segments have installation jobs, primarily in the solar and EE industries.
CURRENT RE AND EE JOBS

APPROACH

The following summarizes the methodology used to collect data through interviews and then extrapolate for statewide current jobs.

1. Calculation of total number of jobs for top companies:

   • Interview top companies:
     o Renewable energy and energy efficiency
     o State leaders for each product of interest
     o Variety of roles along value chain
   • Ask each company for current total number of RE/EE jobs

2. Extrapolation to represent the total market in Connecticut:

   • Determine market share of interviewed and research companies in Connecticut RE/EE industry
     o Feedback from 2010 study was that biggest players were representative of the statewide industry
     o For market segments without interview data, estimate market share based on 2010 study
   • Extrapolate to calculate for non-interviewed companies:
     If interviewed companies had X jobs representing Y% of market share, then all jobs = X / Y%
Various sources of public and private data were used to extrapolate the jobs reported in interviews and literature to statewide industry employment.

1. Green Bank and utility-provided data, as well as industry reports and articles, were used to estimate total market size.
   - Publicly available industry reports and internal research were used to estimate the fuel cell market size.
   - Green Bank data was used for the residential solar market size (assuming Green Bank data captures 100% of the residential solar market).
   - Utility Zero Emission Renewable Energy Credit (ZREC) data was used for the commercial solar market size (assuming the top ten installers for small, medium and large commercial projects in the ZREC program represent the commercial solar market).
   - Utility EE data was used for the residential EE market size (assuming utility EE data captures 100% of the residential EE market).
   - Commercial EE and “Other” RE technology market size were based off market share from the 2010 study (limited interviews and data on these players).

2. Jobs reported by companies interviewed or researched were then divided by the market sizes from the first step to calculate statewide industry size in terms of employment.
   - Only full-time employee (FTE) jobs were reported in interviews and research.
   - LinkedIn current employee counts in Connecticut were used for some companies with missing information, and a multiplier of three was applied (derived from companies where employee count was reported in interviews divided by the number on LinkedIn).
# TABLE OF CONTENTS

1. 2016 Study Overview  
2. Jobs Impact Based on Dollars  
3. Current RE and EE Jobs  
4. Appendix
The interview guide for this study was based off the last study, with questions more directed toward the current economy in Connecticut.

YOUR COMPANY
1. Please tell us a little about yourself and your role in the company.
2. Describe your overall business.
3. Describe your RE/EE business.
   a. Do you offer primarily RE, EE, or a combination?
   b. Do you offer primarily products or services?
   c. To which renewable or energy efficiency technology do you must closely associate? See dropdown list RE (and Other) Products and EE Products
   d. In which area of the value chain does your RE/EE business primarily operate? See dropdown list Value Chain (High-level) and Value Chain (Detailed)

CUSTOMERS
4. Which market do you primarily serve? See dropdown list Market Segment
5. What percentage of RE/EE customers are in CT?

PROJECT ECONOMICS
6. What is the average/median wage for different specialties/job classifications that your company uses for your RE/EE work (provide examples)?
7. What is average project cost?
8. What is the typical split between labor and material as a percent of total project cost?
9. Which RE/EE state-funded programs do you participate in?
10. What percentage of your project costs are funded by upfront state incentives (e.g., Connecticut Energy Efficiency Fund, Green Bank)?
11. Of these project economics inputs you provided, what are the market conditions that could trigger them to change?

CURRENT JOBS
11. How many FTE (full-time equivalent) employees did you have working on RE/EE jobs in Connecticut at the end of 2015?
12. What portion of your Connecticut RE/EE employees are in each value chain segment? See dropdown list Value Chain (High-level) and Value Chain (Detailed)
The following list of dropdowns were used with the interview questions and allowed respondents to identify all that applied.

<table>
<thead>
<tr>
<th>RE Products</th>
<th>EE Products</th>
<th>Market Segment</th>
<th>Value Chain (High-Level)</th>
<th>Value Chain (Detailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel Cell</td>
<td>HVAC</td>
<td>Residential</td>
<td>Mfg. Line Construction</td>
<td>R&amp;D</td>
</tr>
<tr>
<td>Solar PV</td>
<td>Lighting</td>
<td>Small Business</td>
<td>Product Dev. &amp; Mfg.</td>
<td>Raw Material Supplier</td>
</tr>
<tr>
<td>Solar Thermal</td>
<td>Appliances</td>
<td>Large C&amp;I</td>
<td>Deployment</td>
<td>Component Mfg.</td>
</tr>
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<td>Wind</td>
<td>Water Heating</td>
<td>MUSH</td>
<td>O&amp;M</td>
<td>Assembly &amp; Test</td>
</tr>
<tr>
<td>Geothermal</td>
<td>Commercial Refrigeration</td>
<td>Utility/IPP</td>
<td>Generation and REC</td>
<td>RE Deploy: Distributor</td>
</tr>
<tr>
<td>Hydro</td>
<td>Pumps, Motors, Drives</td>
<td>Retail</td>
<td>Off-Taker</td>
<td>RE Deploy: Developer</td>
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<td>Hydrogen</td>
<td>Building Envelope</td>
<td>Other</td>
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<td>RE Deploy: System Integrator</td>
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<tr>
<td>Biomass</td>
<td>Demand Response</td>
<td>Multiple</td>
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<td>RE Deploy: Installer</td>
</tr>
<tr>
<td>Anaerobic Digestion</td>
<td>Other</td>
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<td>RE Deploy: Project Investor</td>
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<td>CHP</td>
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<td>RE Deploy: Business Support</td>
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<td>Microgrids</td>
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<td>EE Deploy: Supply &amp; Wholesale</td>
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<td>Storage</td>
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<td>EE Deploy: Retail &amp; Distribution</td>
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<td>Grid Infrastructure</td>
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<td>EE Deploy: Delivery &amp; Installation</td>
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<td>AFV Infrastructure</td>
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<td>EE Deploy: Marketing &amp; Outreach</td>
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<td>EE Deploy: Evaluation &amp; Consulting</td>
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<td>Multiple</td>
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<td>EE Deploy: Business Support</td>
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<td>In-House O&amp;M</td>
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<td>Contract O&amp;M</td>
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<td>Finance &amp; Ownership</td>
</tr>
</tbody>
</table>
# Appendix

## RE Calculator Results (Detailed)

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Capital Invested</th>
<th>Company Overhead (SG&amp;A) and Margin (%)</th>
<th>Project Cost After Overhead (SG&amp;A) and Margin</th>
<th>Labor (% of Project Cost)</th>
<th>Non-Labor (% of Project Cost)</th>
<th>Weighted Average Wage</th>
<th>Fully Burdened Employee Cost</th>
<th>Direct Jobs Created per Million Dollars Invested</th>
<th>Induced Jobs Multiplier</th>
<th>Induced Jobs Created per Million Dollars Invested</th>
<th>Total Jobs Created from Capital Invested</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Renewable Energy</strong></td>
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<td>$800,000</td>
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<td>60%</td>
<td>$50,000</td>
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<td>4.9</td>
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<td>8.4</td>
<td>11.3</td>
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<td>$1,000,000</td>
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<td>$800,000</td>
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<td>65%</td>
<td>$55,000</td>
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<td>1.3</td>
<td>4.0</td>
<td>7.1</td>
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<td><strong>Renewable Thermal Technologies</strong></td>
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<td>Ductless Split Heat Pump</td>
<td>$1,000,000</td>
<td>20%</td>
<td>$800,000</td>
<td>60%</td>
<td>40%</td>
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<td>$71,500</td>
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<td>1.3</td>
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<td>Geothermal Installation</td>
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<td>40%</td>
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<td>Solar Thermal Installation</td>
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<td>50%</td>
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<td><strong>Other</strong></td>
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<td>Wind Installation</td>
<td>$1,000,000</td>
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<td>$800,000</td>
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<td>$60,000</td>
<td>$78,000</td>
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<td>Hydro Installation</td>
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<td>$800,000</td>
<td>60%</td>
<td>40%</td>
<td>$60,000</td>
<td>$78,000</td>
<td>6.2</td>
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<td>EV Charging Stations - Installation</td>
<td>$1,000,000</td>
<td>20%</td>
<td>$800,000</td>
<td>25%</td>
<td>75%</td>
<td>$50,000</td>
<td>$65,000</td>
<td>3.1</td>
<td>1.3</td>
<td>4.0</td>
<td>7.1</td>
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<td>Storage Installation</td>
<td>$1,000,000</td>
<td>20%</td>
<td>$800,000</td>
<td>20%</td>
<td>80%</td>
<td>$55,000</td>
<td>$71,500</td>
<td>2.2</td>
<td>1.3</td>
<td>2.9</td>
<td>5.1</td>
</tr>
</tbody>
</table>
### APPENDIX

#### EE CALCULATOR RESULTS (DETAILED)

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Capital Invested</th>
<th>Company Overhead (SG&amp;A and Margin (%))</th>
<th>Project Cost After Overhead (SG&amp;A and Margin)</th>
<th>Labor (% of Project Cost)</th>
<th>Non-Labor (% of Project Cost)</th>
<th>Weighted Average Wage</th>
<th>Fully Burdened Employee Cost</th>
<th>Direct Job Years Created per Million Dollars Invested</th>
<th>Indirect &amp; Induced Jobs Created per Million Dollars Invested</th>
<th>Total Job-Years Created from Capital Invested</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Residential (Single and Multi-Family)</strong></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Lighting</td>
<td>$ 1,000,000</td>
<td>20%</td>
<td>$ 800,000</td>
<td>50%</td>
<td>50%</td>
<td>$ 40,000</td>
<td>$ 52,000</td>
<td>7.7</td>
<td>1.3</td>
<td>10.0</td>
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<tr>
<td>Home Energy Solutions (HES) - Audits</td>
<td>$ 1,000,000</td>
<td>20%</td>
<td>$ 800,000</td>
<td>70%</td>
<td>30%</td>
<td>$ 55,000</td>
<td>$ 71,500</td>
<td>7.8</td>
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<td>HES - Weatherization &amp; HVAC</td>
<td>$ 1,000,000</td>
<td>20%</td>
<td>$ 800,000</td>
<td>50%</td>
<td>50%</td>
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<td>$ 71,500</td>
<td>5.6</td>
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<td>Gas Conversion</td>
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<td>20%</td>
<td>$ 800,000</td>
<td>50%</td>
<td>50%</td>
<td>$ 55,000</td>
<td>$ 71,500</td>
<td>5.6</td>
<td>1.3</td>
<td>7.3</td>
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<td><strong>Commercial</strong></td>
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</tr>
<tr>
<td>Small Business Energy Advantage</td>
<td>$ 1,000,000</td>
<td>20%</td>
<td>$ 800,000</td>
<td>50%</td>
<td>50%</td>
<td>$ 50,000</td>
<td>$ 65,000</td>
<td>6.2</td>
<td>1.3</td>
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<tr>
<td>Large Commercial and Industrial</td>
<td>$ 1,000,000</td>
<td>20%</td>
<td>$ 800,000</td>
<td>50%</td>
<td>50%</td>
<td>$ 55,000</td>
<td>$ 71,500</td>
<td>5.6</td>
<td>1.3</td>
<td>7.3</td>
</tr>
</tbody>
</table>
Because solar makes up 79% of the RE industry in Connecticut based on power capacity (kW), it was important to reach out to solar companies.


165 MW

- Solar makes up 79% of the RE market in Connecticut based on total number of kilowatts.
- Solar makes up 99.9% of the RE market in Connecticut based on the 15,042 projects reported by the CGB from 2011-2015.
- There are more anaerobic digestion (AD) and combined heat and power (CHP) projects, by count, but more kilowatts from fuel cells.
- The employee-to-kilowatt or employee-to-project count ratio for fuel cell, AD, and wind projects follows a drastically different structure than solar due to average project capacity and technology specifics.

Source: Connecticut Green Bank data, Navigant analysis
The list of first priority solar companies to contact/research was created based on market share data provided by the Green Bank.

Market Share of Solar Companies: 2015

6,122 Projects

- SolarCity holds the greatest share of the solar market in Connecticut based on kilowatts and number of projects.
- The top 10 solar contributors were part of the first priority RE companies to interview.
- For those companies Navigant was able to get an employee count for, this market share was used for extrapolating statewide.
- It was assumed that the Connecticut Green Bank database covered 100% of the residential solar market.

- Utility data for the top ten installers for small, medium and large commercial projects in the ZREC program was used to represent the commercial market.
The majority of RE jobs are split between the solar and fuel cell industries, with other RE technologies making up the remaining 6% of RE industry jobs.

- Solar jobs account for 52% of the overall RE industry (~1,300 jobs).
  - In 2010, only 18% of RE jobs were solar.
- Fuel cell jobs account for 42% of the RE industry (~1,100 jobs).
  - In 2010, fuel cells account for 71% of the total RE jobs.
- The “Other” category includes solar thermal, geothermal, wind, small hydro, EV, energy storage, biomass, and hydrogen.¹

¹Few companies from the “Other” category were interviewed for this study given the focus on current leading technologies; therefore, the total percentage of these technologies was generally assumed to be the same as the 2010 study.
Installation-type jobs make up the majority of RE labor, mainly due to the large size of the solar industry in Connecticut.

RE Jobs by Type in Connecticut
2,500 Direct Jobs

- Installation jobs account for the largest job type at solar companies.
- Manufacturing and engineering jobs account for the largest job type at fuel cell companies.
  - R&D also makes up a portion of the fuel cell jobs but does not appear in any other technology industry in this study.
- Sales and business development-type jobs made up a larger portion at solar companies as compared to fuel cells.
- Corporate, management, and administrative-type jobs were noted as a portion of employees across all technologies.
APPENDIX
RE JOBS ANALYSIS

Similar to the trend across the country, residential is the primary customer market for solar in Connecticut.

Solar Jobs by Customer Market in Connecticut

1,300 Direct Jobs

- The majority of solar employees in Connecticut focus on the residential customer market.
- Some companies reported to work in both residential and non-residential; however, in those cases, the majority of employees focused on residential.
- The non-residential market includes:
  - Small business
  - Large C&I
  - MUSH
  - There were few, if any, jobs associated with utility-scale solar

Source: Navigant Analysis
APPENDIX

EE INTERVIEW TARGETS

The EE market is highly fragmented, with many companies operating; utility data was used to identify the largest players.

Market Share of EE Companies: 2015
49,210 Projects

- Market leaders vary greatly based on annual power capacity (in MMBtu\(^1\)) and number of projects in the EE market due to different technology offerings.
- Unlike RE, the top EE leaders are closer in market share to each other and to all others.
- For this reason, although just as many EE companies were interviewed and researched as RE companies, a smaller portion of the market was captured—approximately 30%.

Source: Eversource data, Navigant analysis

\(^{1}\text{million British Thermal Units}\)
Installation-type jobs make up 59% of EE-related labor, followed by 23% retail, across all EE technologies.

- Installation jobs account for the majority of roles in EE.
- Job titles included under installation varied in skill level and trade:
  - Electricians (master and apprentice)
  - Plumbers and other HVAC-specific technicians
  - Installers of appliances, windows, and insulation
- The retail channel is more important to EE relative to RE.
- Corporate, management, and administrative-type jobs and sales and business development-type jobs account for only a small portion of EE-related labor.
Most EE jobs are focused on the residential and C&I customer markets, with the remaining focused on retail and only a few on utility.

EE Jobs by Customer Market in Connecticut

- **2,800 Direct Jobs**

- **Residential** 32%
- **C&I** 42%
- **Retail** 23%
- **Utility** 3%

**Source: Navigant Analysis**

- The majority of EE employees in Connecticut focus on the residential and C&I customer markets.
  - Though there are less EE companies focused on C&I in Connecticut, they hire a larger amount of employees per company.
- The non-residential market includes small business, C&I, and MUSH customers.
- A significant portion of the residential market serves multifamily customers.
- The retail segment includes retail and wholesale suppliers.
- Jobs in the utility sector only include employees who work primarily on EE-related work, such as supporting EE programs and incentives across markets.
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