

CLEAN ENERGY JOBS IN CONNECTICUT

FINAL REPORT

AUGUST 10, 2016

NAVIGANT REFERENCE NO. 184823



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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).

The logo for Navigant Consulting, Inc. features the word "NAVIGANT" in a bold, sans-serif font. The letter "A" is stylized with a green triangle pointing upwards, and the letter "V" has a green triangle pointing downwards.

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.*

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2016 STUDY OVERVIEW

COMPARISON

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

2009-2010 STUDY¹

- **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]

APPROACH

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)

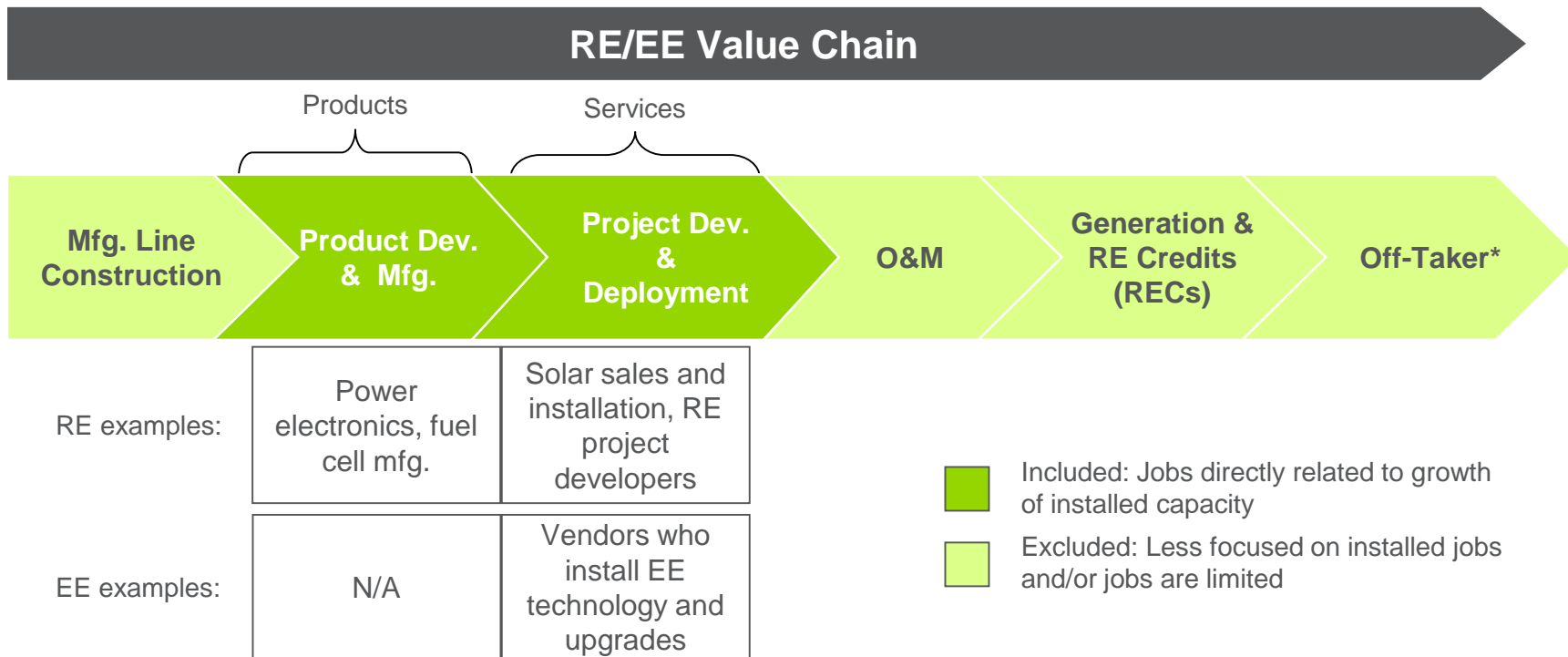
A focused interview approach was used to gather results from top employers or other sources and extrapolate for all current jobs.

- 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.

2016 STUDY OVERVIEW

VALUE CHAIN

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.



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

2016 STUDY OVERVIEW

JOB TYPES

In line with the value chain segments examined, “jobs types” included in the calculator related to manufacturing, installation, engineering, and project management.

General Job Type	Example Specific Occupation Types ¹
Manufacturing	Production occupations (e.g., assemblers, fabricators, equipment operators, and process workers)
Installers/Field Technicians	Installation and construction occupations (e.g., solar PV installers, heating, AC and refrigeration mechanics and installers, insulation workers, floor, ceiling and wall)
Electricians	Electricians, electro-mechanical technicians, electrical and electronics installers and repairers
Engineers/Project Managers	Engineers (e.g., mechanical, civil, and electrical engineers); management occupations (e.g., project, construction, and engineering managers)

¹Specific Occupation titles from Bureau of Labor Statistics – May 2015 State Occupational Employment and Wage Estimates Connecticut
http://www.bls.gov/oes/current/oes_ct.htm

DIRECT VS. INDIRECT JOBS

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.

DIRECT JOBS

- 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.

INDIRECT 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.

INDUCED 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.

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

Secondary scope through use of multipliers

Source: S. Grover, "Energy, Economic, and Environmental Benefits of the Solar America Initiative," August 2007, NREL/SR-640-41998.

DECD ANALYSIS OF INDIRECT AND INDUCED JOBS

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:

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

- 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 REMI¹ 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.

¹REMI 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.

2016 STUDY OVERVIEW

TECHNOLOGIES

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

Technology	Markets
Fuel cells	Residential
Solar PV	Commercial and industrial (C&I)
Solar thermal	Utility
Wind	
Geothermal	
Small hydro	
Energy storage	
EV charging	

Energy Efficiency

Technology*	Markets
High efficiency heating, ventilation and air conditioning (HVAC)	Residential (including low-income weatherization)
Efficient lighting	C&I
Efficient home appliances	Small business
Water heating	
Building envelope	
Demand response	

*Note: For the purpose of this analysis, Navigant merged all EE technologies and presented the results by market.

2016 STUDY OVERVIEW

RECOMMENDATIONS

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:

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

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JOBS IMPACT BASED ON DOLLARS INVESTED

OVERVIEW

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

Occupation	Capital Invested	Company Overhead (SG&A) and Margin (%)	Project Cost		Labor (% of Project Cost)	Non-Labor (% of Project Cost)	Weighted Average Wage	Fully Burdened Employee Cost	Direct Job Years Created per Million Dollars Invested	Indirect & Induced Jobs Multiplier	Indirect & Induced Jobs Created per Million Dollars Invested	Total Job-Years Created from Capital Invested
			Overhead (SG&A) and Margin	After (SG&A) and Margin								
	A	B	C=A*(1-B)	D	E=100%-D	F	G=F*1.3	H=C*(D/G)	I	J=H*I	K=H+J	
Renewable Energy												
Fuel Cell												
Fuel Cell Manufacturing	\$ 1,000,000	20%	\$ 800,000	40%	60%	\$ 50,000	\$ 65,000	4.9	1.3	6.4	11.3	
Fuel Cell R&D/Engineering	\$ 1,000,000	20%	\$ 800,000	40%	60%	\$ 85,000	\$ 110,500	2.9	1.3	3.8	6.7	
Solar PV												
Solar PV Installation - Residential	\$ 1,000,000	20%	\$ 800,000	35%	65%	\$ 55,000	\$ 71,500	3.9	1.3	5.1	9.0	
Solar PV Installation - Non-Residential	\$ 1,000,000	20%	\$ 800,000	25%	75%	\$ 50,000	\$ 65,000	3.1	1.3	4.0	7.1	

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:

Occupation	Direct Job-Years Created per \$1 Million Invested	Indirect and Induced Jobs Created per \$1 Million Invested	Total Job-Years Created from \$1 Million Invested
Renewable Energy			
Fuel Cell			
Fuel Cell Manufacturing	4.9	6.4	11.3
Fuel Cell R&D/Engineering	2.9	3.8	6.7
Solar PV			
Solar PV Installation - Residential	3.9	5.1	9.0
Solar PV Installation - Non-Residential	3.1	4.0	7.1
Renewable Thermal Technologies			
Ductless Split Heat Pump	6.7	8.7	15.4
Geothermal	6.7	8.7	15.4
Solar Thermal	5.6	7.3	12.9
Other			
Wind Installation	6.2	8.0	14.2
Hydro Installation	6.2	8.0	14.2
EV Charging Stations - Installation	3.1	4.0	7.1
Storage Installation	2.2	2.9	5.1

JOBS IMPACT BASED ON DOLLARS INVESTED

RESULTS: ENERGY EFFICIENCY

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

Occupation	Direct Job-Years Created per \$1 Million Invested	Indirect and Induced Jobs Created per \$1 Million Invested	Total Job-Years Created from \$1 Million Invested
Energy Efficiency			
Residential (Single and Multifamily)			
Lighting	7.7	10.0	17.7
Home Energy Solutions (HES) - Audits	7.8	10.2	18.0
HES - Weatherization & HVAC	5.6	7.3	12.9
Gas Conversion	5.6	7.3	12.9
Commercial¹			
Small Business (e.g., Small Business Energy Advantage)	6.2	8.0	14.2
Large Commercial and Industrial (e.g., C-PACE)	5.6	7.3	12.9

¹The 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.

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

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

*May 2015 State Occupational Employment and Wage Estimates Connecticut http://www.bls.gov/oes/current/oes_ct.htm

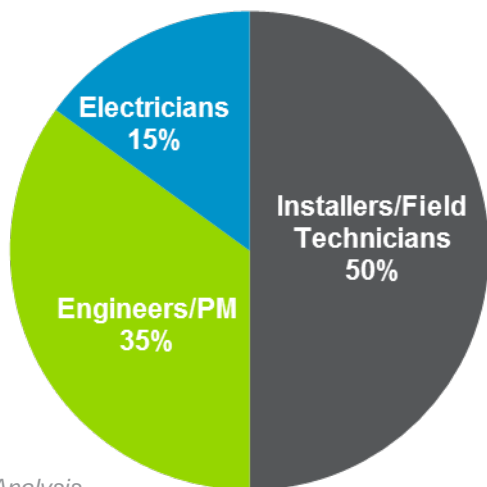
**May 2015 State Occupational Employment and Wage Estimates Massachusetts http://www.bls.gov/oes/current/oes_ma.htm

JOBS IMPACT BASED ON DOLLARS INVESTED

METHODOLOGY

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)



Source: Navigant Analysis

Employee Breakdown by Job Type*

Technology	Inst.	Elec.	Eng.
Commercial Solar	60%	15%	25%
Fuel Cell	60%	0%	40%
Wind	40%	20%	40%
EV Charging Stations	50%	30%	20%
Storage	25%	5%	70%
Lighting	80%	20%	0%
Small Business Energy Advantage (SBEA)	70%	15%	15%
Large C&I	50%	25%	25%

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

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

JOBS IMPACT BASED ON DOLLARS INVESTED

NOTES

Some assumptions were made and included as notes within the calculator to clarify key variables and inputs to job-year calculation.

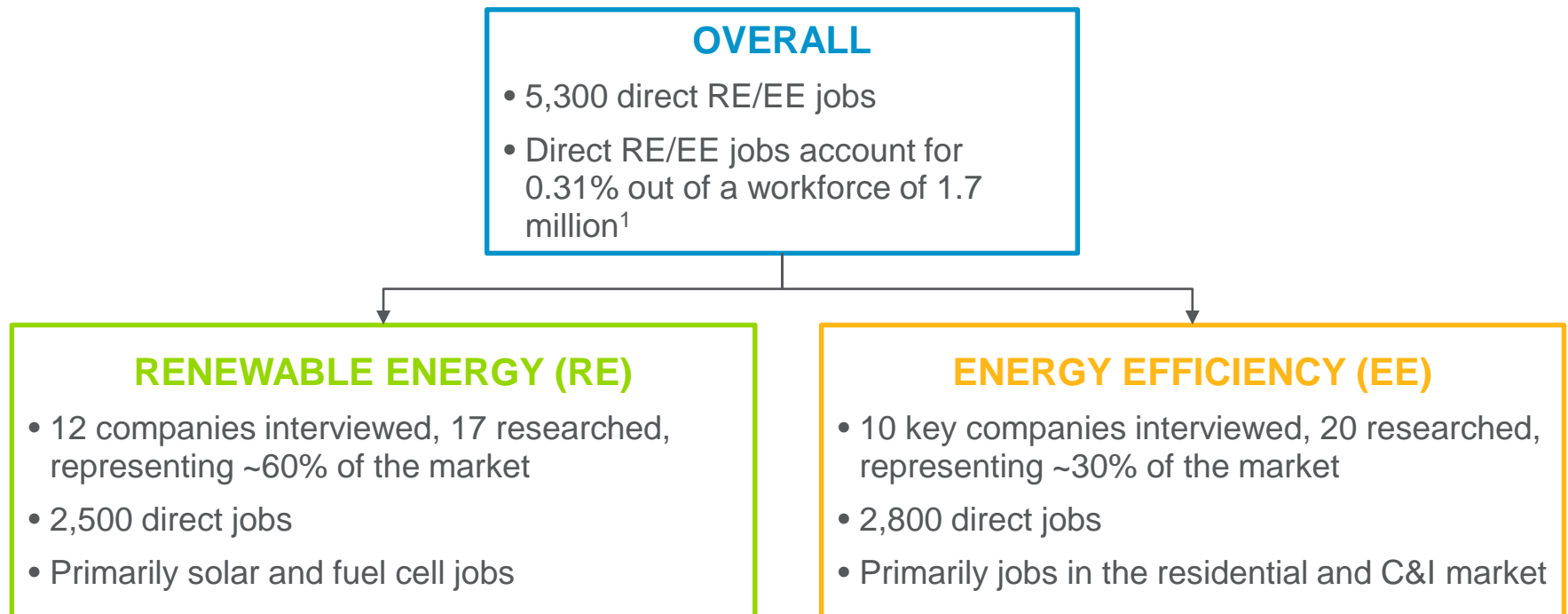
- Job-year final values are representative of the **2015-2016** market in Connecticut.
- Company Overhead and Margin (C) is **assumed to be 20%** and accounts for jobs related to sales, marketing, management, and other overhead jobs and expenses.
- **Labor (D)** is the percentage of the project cost 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.**

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CURRENT RE AND EE JOBS OVERVIEW

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.



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.

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

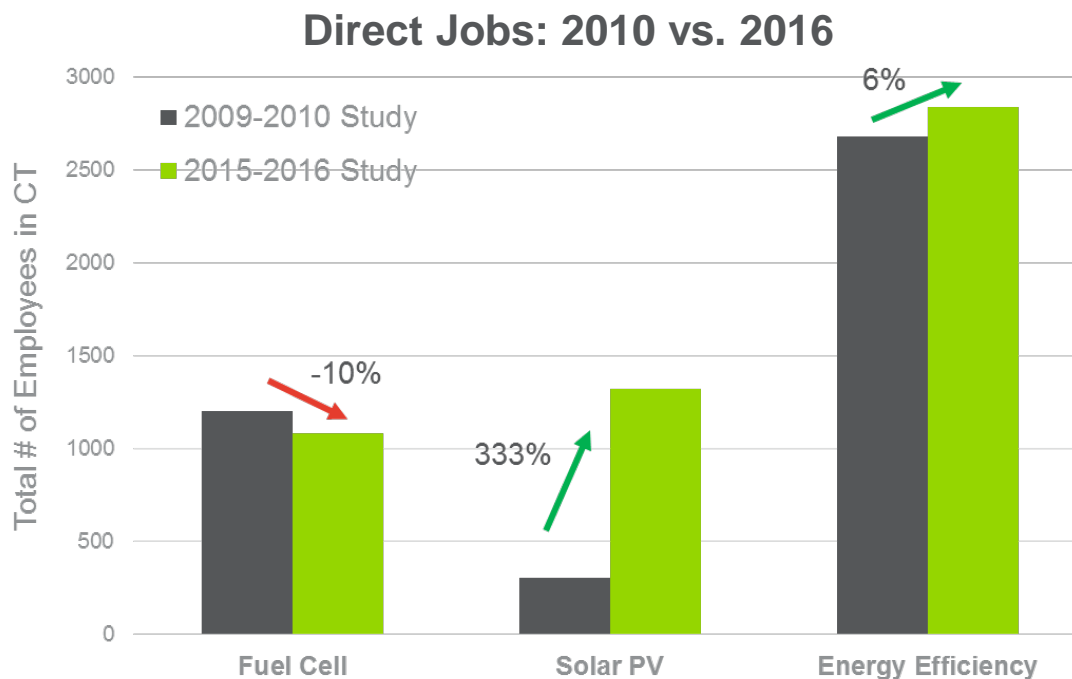
KEY FINDINGS

- 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.

CURRENT RE AND EE JOBS

KEY FINDINGS

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.



Source: Navigant Analysis

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.

CURRENT RE AND EE JOBS

INDUSTRY REVIEW

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.

2010 Top 10 RE/EE Employers*

United Technologies Corp. (UTC)

FuelCell Energy, Inc.

Sensor Switch

Schuco USA

US Insulation Corp.

Home Depot

Trane

Noble Environmental Power

Alliance Energy Solutions (AES)

Wal-Mart

2016 Top 10 RE/EE Employers*

FuelCell Energy, Inc.

SolarCity

Doosan Fuel Cell America, Inc.

Trane

EMCOR

Home Depot

Greenskies Renewable Energy

CED Greentech

Trinity Solar

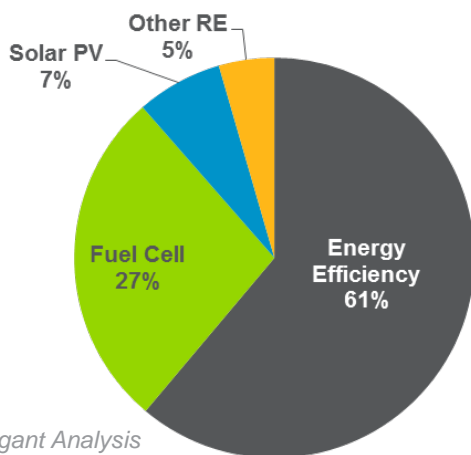
Competitive Resources

**Utility jobs excluded.*

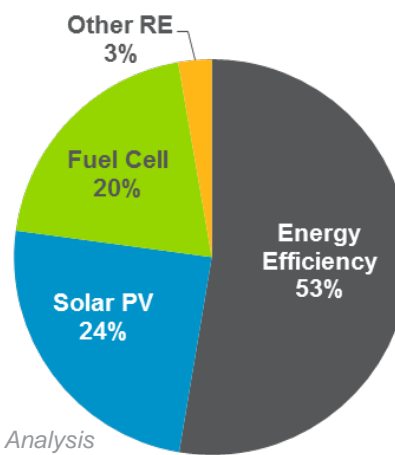
CURRENT RE AND EE JOBS INDUSTRY REVIEW

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

RE + EE Jobs by Technology: 2010
4,500 Jobs



RE + EE Jobs by Technology: 2016
5,300 Jobs



Source: Navigant Analysis

Source: Navigant Analysis

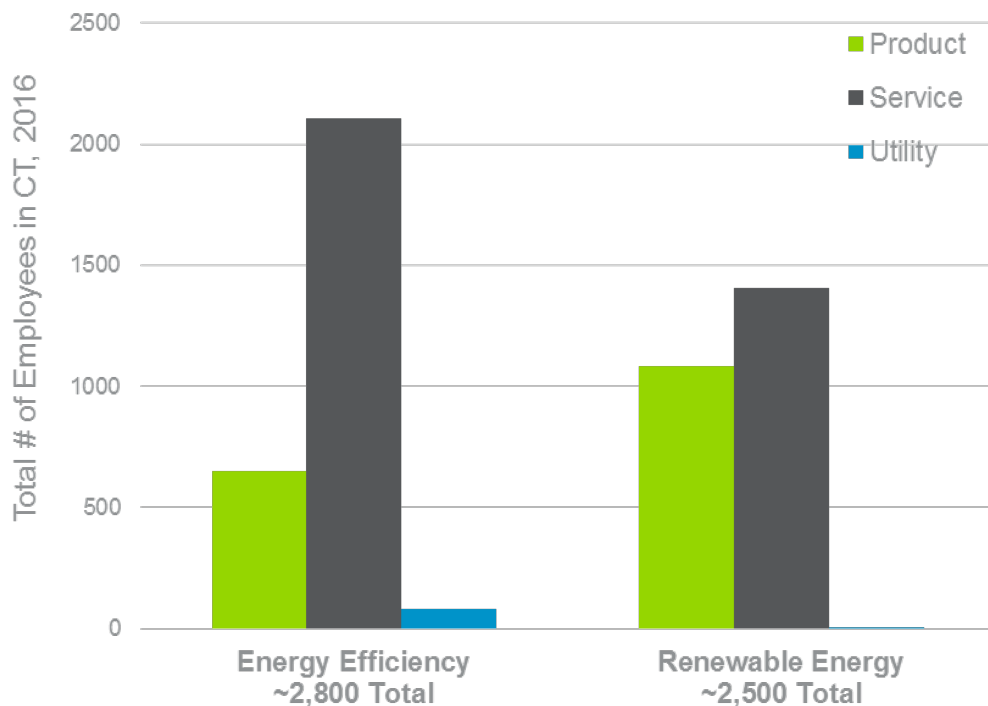
- The methodologies differ between this and the previous study; therefore, the results may not be 1-to-1 comparable.
- The decrease in employment in the fuel cell industry was related to the bankruptcy of UTC Power in 2013 following acquisition by ClearEdge. (Doosan acquired the ClearEdge assets in 2014.). 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.

CURRENT RE AND EE JOBS

BREAKDOWN OF JOBS BY PRODUCT, SERVICE, AND UTILITY

The majority of RE companies and EE companies in Connecticut offer services, with the majority of product jobs belonging to the fuel cell industry.

Breakdown by Product and Service Jobs



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).

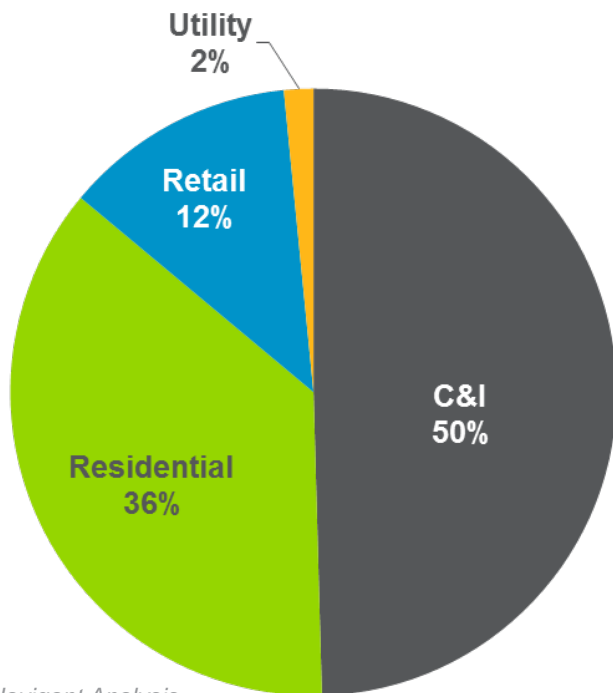
- For this study, focus is on those parts of the value chain that, for the most part, have jobs in product and service offerings.
 - Jobs were classified as offering either primarily products or primarily services, though companies may offer both.
- Product companies either manufacture and sell to customers 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).

CURRENT RE AND EE JOBS

JOBS BY CUSTOMER MARKET

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



Source: Navigant Analysis

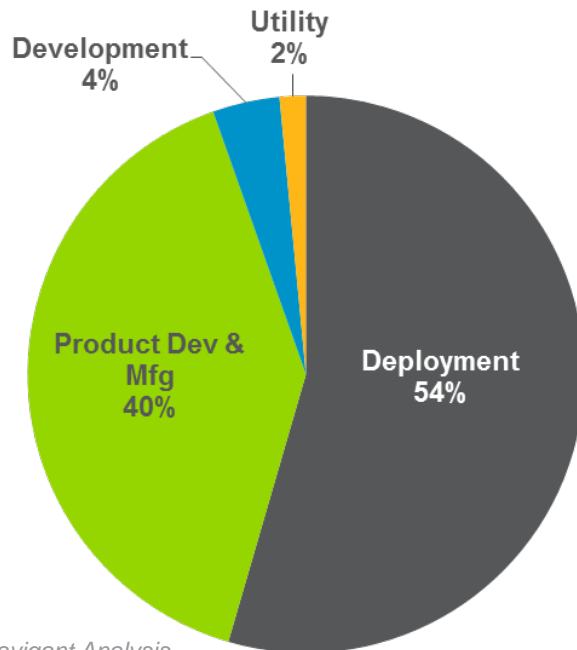
- All fuel cell employees are categorized as working in the C&I customer market, which accounts for approximately 1,100 jobs.
- About 40% of the 2,800-plus EE employees serve the C&I customer market as well.

CURRENT RE AND EE JOBS

JOBS BY VALUE CHAIN

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



Source: Navigant Analysis

Note: Direct jobs in deployment and development mostly include installer and engineer job types.

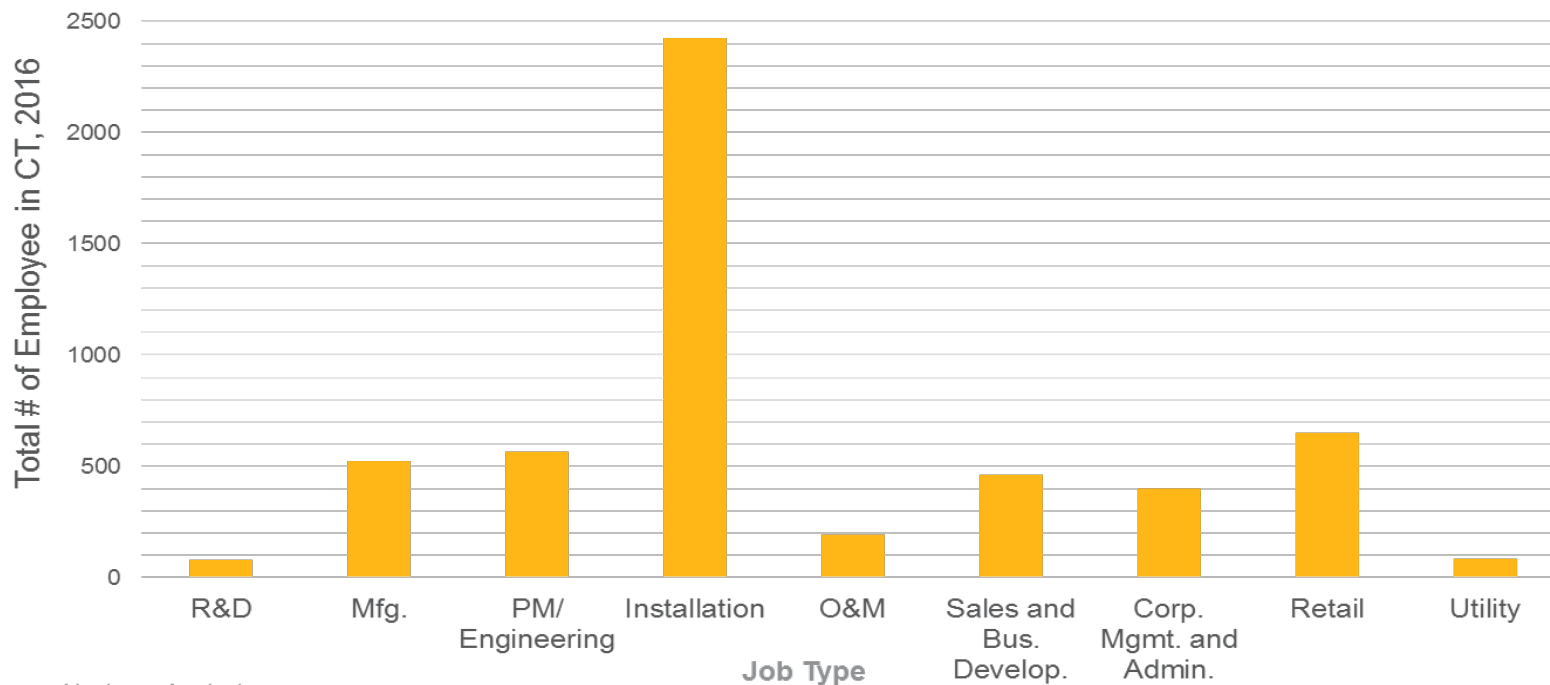
- Navigant specifies the difference between deployment and development as companies in deployment employ their own installers, while project developers subcontract the installation.
- Solar and other RE technologies (apart from fuel cells) account for the majority of the deployment and development jobs.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

CURRENT RE AND EE JOBS

JOBS BY JOB TYPE

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.

RE + EE Jobs by Job Type in CT: 2016
5,300 Direct Jobs



Source: Navigant Analysis

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:
 - Renewable energy and energy efficiency
 - State leaders for each product of interest
 - 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
 - Feedback from 2010 study was that biggest players were representative of the statewide industry
 - 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).

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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 most 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)**


INTERVIEW GUIDE

The following list of dropdowns were used with the interview questions and allowed respondents to identify all that applied.

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

APPENDIX

RE CALCULATOR RESULTS (DETAILED)

											
Occupation	Capital Invested	Company Overhead (SG&A) and Margin (%)	Project Cost After Overhead (SG&A) and Margin	Labor (% of Project Cost)	Non-Labor (% of Project Cost)	Weighted Average Wage	Fully Burdened Employee Cost	Direct Job Years Created per Million Dollars Invested	Indirect & Induced Jobs Multiplier	Indirect & Induced Jobs Created per Million Dollars Invested	Total Job-Years Created from Capital Invested
	A	B	C=A*(1-B)	D	E=100%-D	F	G=F*1.3	H=C*(D/G)	I	J=H*I	K=H+J
Renewable Energy											
Fuel Cell											
Fuel Cell Manufacturing	\$ 1,000,000	20%	\$ 800,000	40%	60%	\$ 50,000	\$ 65,000	4.9	1.3	6.4	11.3
Fuel Cell R&D/Engineering	\$ 1,000,000	20%	\$ 800,000	40%	60%	\$ 85,000	\$ 110,500	2.9	1.3	3.8	6.7
Solar PV											
Solar PV Installation - Residential	\$ 1,000,000	20%	\$ 800,000	35%	65%	\$ 55,000	\$ 71,500	3.9	1.3	5.1	9.0
Solar PV Installation - Non-Residential	\$ 1,000,000	20%	\$ 800,000	25%	75%	\$ 50,000	\$ 65,000	3.1	1.3	4.0	7.1
Renewable Thermal Technologies											
Ductless Split Heat Pump	\$ 1,000,000	20%	\$ 800,000	60%	40%	\$ 55,000	\$ 71,500	6.7	1.3	8.7	15.4
Geothermal Installation	\$ 1,000,000	20%	\$ 800,000	60%	40%	\$ 55,000	\$ 71,500	6.7	1.3	8.7	15.4
Solar Thermal Installation	\$ 1,000,000	20%	\$ 800,000	50%	50%	\$ 55,000	\$ 71,500	5.6	1.3	7.3	12.9
Other											
Wind Installation	\$ 1,000,000	20%	\$ 800,000	60%	40%	\$ 60,000	\$ 78,000	6.2	1.3	8.0	14.2
Hydro Installation	\$ 1,000,000	20%	\$ 800,000	60%	40%	\$ 60,000	\$ 78,000	6.2	1.3	8.0	14.2
EV Charging Stations - Installation	\$ 1,000,000	20%	\$ 800,000	25%	75%	\$ 50,000	\$ 65,000	3.1	1.3	4.0	7.1
Storage Installation	\$ 1,000,000	20%	\$ 800,000	20%	80%	\$ 55,000	\$ 71,500	2.2	1.3	2.9	5.1

APPENDIX

EE CALCULATOR RESULTS (DETAILED)

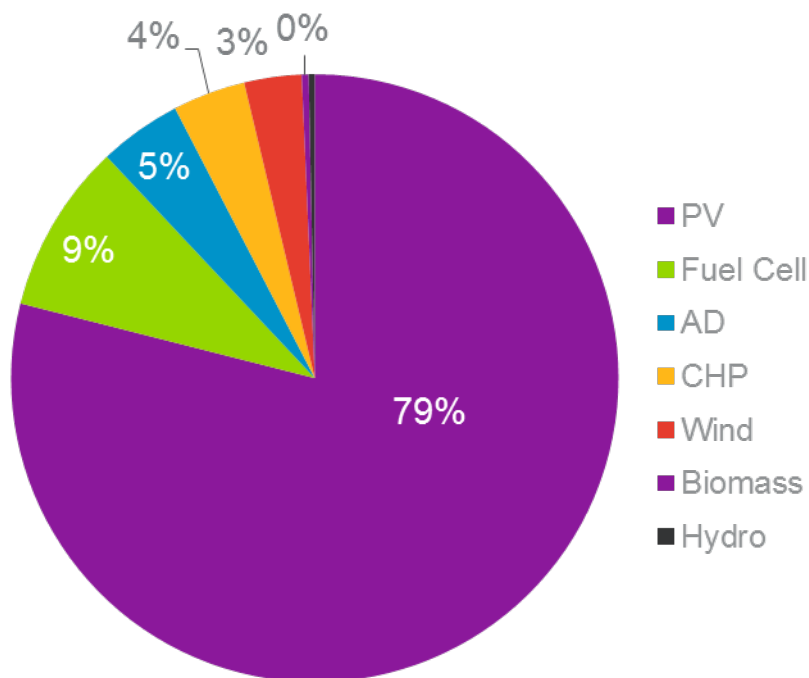


Occupation	Capital Invested	Company Overhead (SG&A) and Margin (%)	Project Cost After Overhead (SG&A) and Margin	Labor (% of Project Cost)	Non-Labor (% of Project Cost)	Weighted Average Wage	Fully Burdened Employee Cost	Direct Job Years Created per Million Dollars Invested	Indirect & Induced Jobs Multiplier	Indirect & Induced Jobs Created per Million Dollars Invested	Total Job-Years Created from Capital Invested
	A	B	C=A*(1-B)	D	E=100%-D	F	G=F*1.3	H=C*(D/G)	I	J=H*I	K=H+J
Energy Efficiency Residential (Single and Multi-Family)											
Lighting	\$ 1,000,000	20%	\$ 800,000	50%	50%	\$ 40,000	\$ 52,000	7.7	1.3	10.0	17.7
Home Energy Solutions (HES) - Audits	\$ 1,000,000	20%	\$ 800,000	70%	30%	\$ 55,000	\$ 71,500	7.8	1.3	10.2	18.0
HES - Weatherization & HVAC	\$ 1,000,000	20%	\$ 800,000	50%	50%	\$ 55,000	\$ 71,500	5.6	1.3	7.3	12.9
Gas Conversion	\$ 1,000,000	20%	\$ 800,000	50%	50%	\$ 55,000	\$ 71,500	5.6	1.3	7.3	12.9
Commercial											
Small Business Energy Advantage	\$ 1,000,000	20%	\$ 800,000	50%	50%	\$ 50,000	\$ 65,000	6.2	1.3	8.0	14.2
Large Commercial and Industrial	\$ 1,000,000	20%	\$ 800,000	50%	50%	\$ 55,000	\$ 71,500	5.6	1.3	7.3	12.9

INTERVIEW TARGETS

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.

Market Share of RE Companies: 2011-2015
165 MW



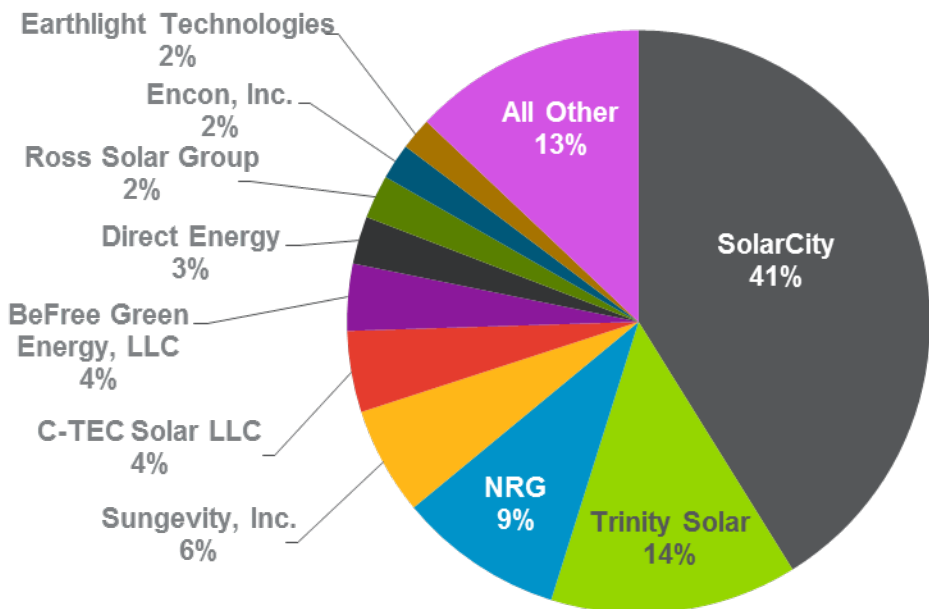
- Solar makes up 79% of the RE market in Connecticut based on total number of kilowatts.
- Solar makes up 99.9% of the RE market in Connecticut based on the 15,042 projects reported by the CGB from 2011-2015.
- There are more anaerobic digestion (AD) and combined heat and power (CHP) projects, by count, 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

RE INTERVIEW TARGETS: SOLAR

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



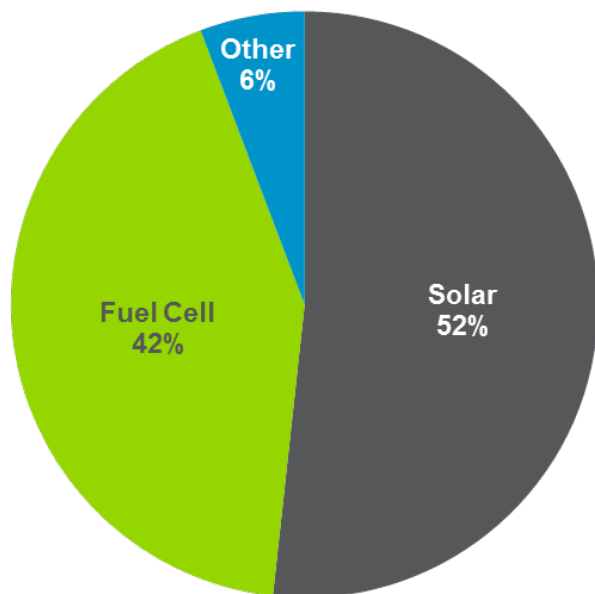
Source: Connecticut Green Bank data, Navigant analysis

- 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

RE JOBS ANALYSIS

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.

RE Jobs by Technology in Connecticut
2,500 Direct Jobs



Source: Navigant Analysis

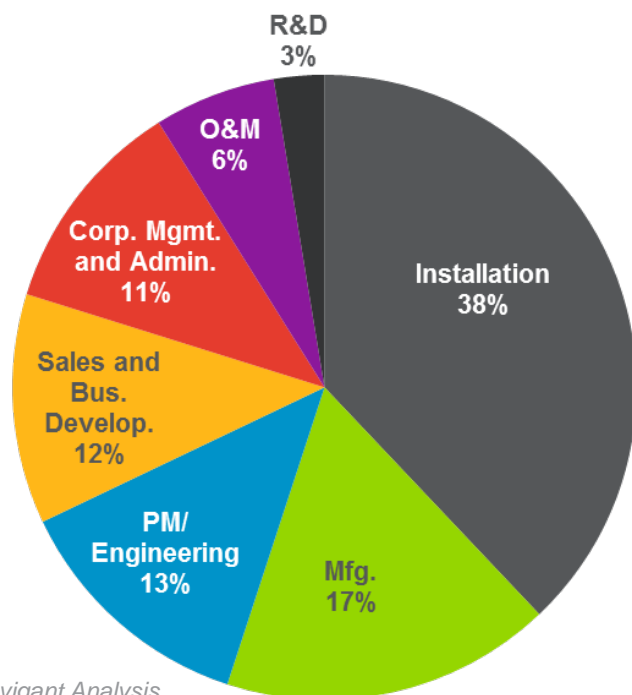
- Solar jobs account for 52% of the overall RE industry (~1,300 jobs).
 - In 2010, only 18% of RE jobs were solar.
- Fuel cell jobs account for 42% of the RE industry (~1,100 jobs).
 - In 2010, fuel cells account for 71% of the total RE jobs.
- The “Other” category includes solar thermal, geothermal,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

RE JOBS ANALYSIS

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

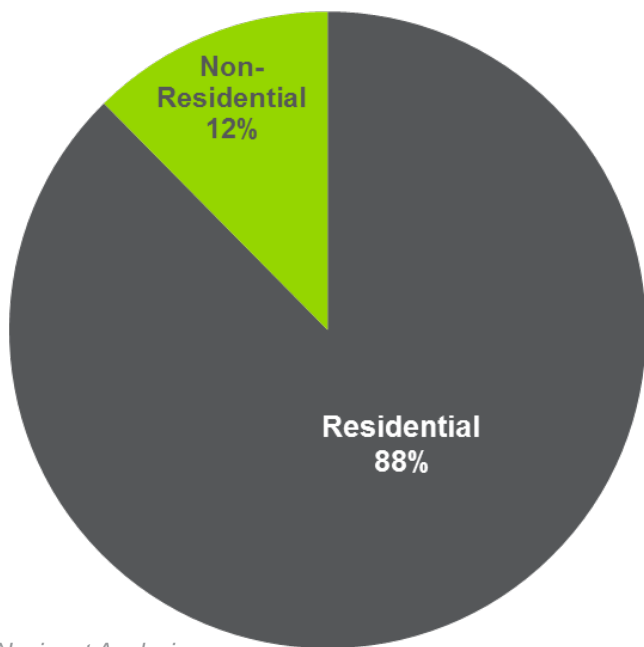


Source: Navigant Analysis

- 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.

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



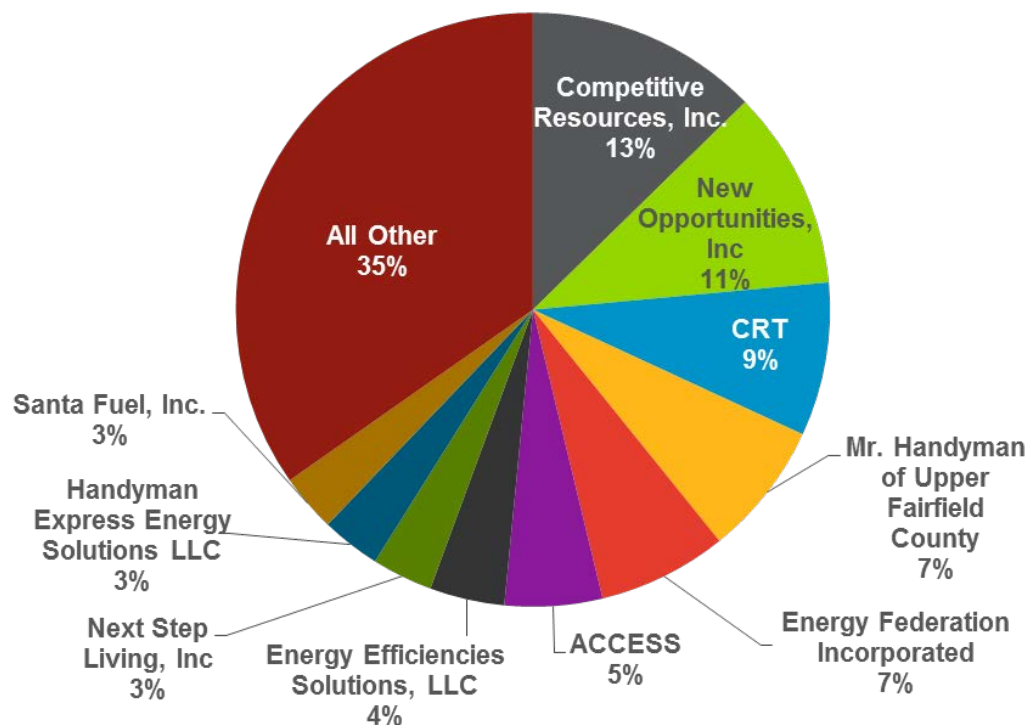
Source: Navigant Analysis

- 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

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



Source: Eversource data, Navigant analysis

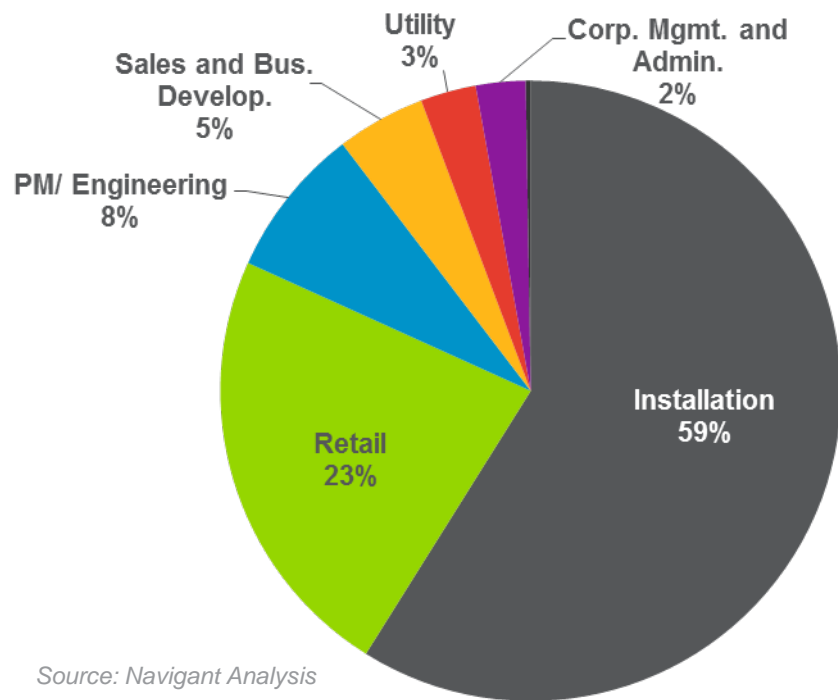
- Market leaders vary greatly based on annual power capacity (in MMBtu¹) and number of projects in the EE market due to different technology offerings.
- Unlike RE, the top EE leaders are closer in market share to each other and to all others.
- For this reason, although just as many EE companies were interviewed and researched as RE companies, a smaller portion of the market was captured—approximately 30%.

¹million British Thermal Units

EE JOBS ANALYSIS

Installation-type jobs make up 59% of EE-related labor, followed by 23% retail, across all EE technologies.

EE Jobs by Type in Connecticut
2,800 Direct Jobs

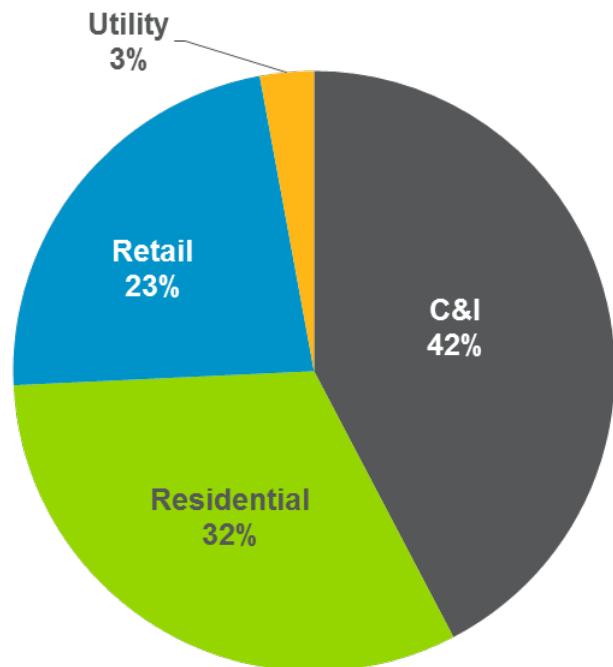


Source: Navigant Analysis

- 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



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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