Minnesota Energy Efficiency Potential Study: 2020–2029

Appendix P: Analysis of Workforce Impacts of Modeled Energy Efficiency Programs

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Introduction

The full report that this appendix supports, *Minnesota Energy Efficiency Potential Study: 2020-2029*, is available for download on the project website.

Minnesota has a thirty-plus year history of leadership in energy efficiency policy and achievements. In order to continue to maximize the benefits of cost-effective energy efficiency resource acquisition by utilities, the project team, consisting of Center for Energy and Environment (CEE), Optimal Energy (Optimal) and Seventhwave, was commissioned to:

- Estimate statewide electric and natural gas energy efficiency and carbon-saving potential for 2020-2029;
- Produce data-driven and stakeholder-informed resources defining market segments, end uses, measures, and programs that could be targeted in the decade ahead to realize the state's cost-effective energy efficiency potential; and
- Engage stakeholders in order to help advance robust energy policies and energy efficiency programs in the state, and to inform future efficiency portfolio goals.

Utility energy efficiency programs provide a number of economic benefits to society, including energy bill savings to customers and labor benefits to those installing efficiency measures. A strong workforce pipeline is essential to ensuring enough qualified workers are available to implement the energy saving technologies of the present and future. This will be especially true in the next decade, given the anticipated volume of retirements in the aging building trades' workforce. To plan for this and to create a continued workforce pipeline requires a deep understanding of future hiring and training needs, allowing workforce strategists across the state's public workforce system to best serve employers and jobseekers alike.

This analysis explores the workforce impacts of modeled utility investments in energy efficiency programs, both in terms of total employment and projected occupational growth and retention to achieve Minnesota's energy efficiency potential. The findings in this appendix are based on the data, efficiency measures, and other findings included in the full Minnesota Energy Efficiency Study[1].

[1] Center for Energy and Environment, Optimal Energy, and Seventhwave. 2018. *Minnesota Energy Efficiency Potential Study (2020-2029),* (https://www.mncee.org/mnpotentialstudy/home/)

Overview of Energy Efficiency Employment

Energy efficiency jobs are an important component of Minnesota's clean energy economy, supported by strong state policies to reducing energy use and greenhouse gas emissions. There were an estimated 44,800 energy efficiency jobs in Minnesota in 2017, representing more than 75 percent of total clean energy employment in the state[2]. Clean energy jobs in general, and energy efficiency jobs in particular, have grown at twice the rate of all other jobs in the state[3].

The U.S. Department of Energy defines energy efficiency employment as both the production of energy-saving products and the provision of services that reduce end-use consumption[4]. The most recent U.S. Energy and Employment Report (USEER) noted sustained growth of energy efficiency jobs across the United States, including a 3 percent increase from 2016 to 2017[5]. The fastest growing efficiency jobs are related to efficient heating and air conditioning, followed by efficient lighting systems and ENERGY STAR® appliances.

According to USEER, 57% of the more than two million jobs in the energy efficiency sector in 2017 were in the construction industry [6]. Construction workers directly involved in the installation and maintenance of energy efficient technologies represent about 18% of the total construction workforce in the US, and the number of workers spending at least 50% of their time on energy efficiency related work has been increasing steadily.

In addition to construction, about 20% of energy efficiency jobs were in professional and business services, and 14% were in manufacturing. Additionally, retail trade jobs involved in selling energy

[2] Clean Energy Trust. 2018. *Clean Jobs Midwest: Minnesota Executive Summary*. (https://www.cleanjobsmidwest.com/state/minnesota)

[3] Clean Energy Trust. 2018. *Clean Jobs Midwest: Minnesota Executive Summary*. (https://www.cleanjobsmidwest.com/state/minnesota)

[4] Barret, J. and R. Pollin. *2018. U.S. Energy and Employment Report*. National Association of State Energy Officials and Energy Futures Initiative. (pg. 73-84) (https://static1.squarespace.com/static/5a98cf80ec4eb7c5cd928c61/t/5afb0ce4575d1f3cdf9ebe36/1526402279839/2018+U.S.+Energy+and+Employment+Report.pdf)

[5] Barret, J. and R. Pollin. *2018. U.S. Energy and Employment Report*. National Association of State Energy Officials and Energy Futures Initiative. (pg. 73-84) (https://static1.squarespace.com/static/5a98cf80ec4eb7c5cd928c61/t/5afb0ce4575d1f3cdf9ebe36/1526402279839/2018+U.S.+Energy+and+Employment+Report.pdf)

[6] Barret, J. and R. Pollin. *2018. U.S. Energy and Employment Report*. National Association of State Energy Officials and Energy Futures Initiative. (pg. 73-84) (https://static1.squarespace.com/static/5a98cf80ec4eb7c5cd928c61/t/5afb0ce4575d1f3cdf9ebe36/1526402279839/2018+U.S.+Energy+and+Employment+Report.pdf)

efficient appliances and building materials, which are not tracked in USEER, employ another 4.2 million Americans across several different sectors[7].

In Minnesota, energy efficiency jobs comprise 22% of all construction jobs[8]. With 32% of construction workers represented by unions in the state, many of these jobs offer living wages and benefits and have established training pipelines to prepare individuals in these skilled trades[9].

A 2014 study by the Minnesota Department of Employment and Economic Development conservatively estimated that close to 10,000 workers in Minnesota spend at least 50% of their time doing energy efficiency work, and that these workers were evenly split between manufacturing, sales, installation, and support services as seen in Table 1.

Table 1. Minnesota energy efficiency employment by value chain (2014)[10]

Industry	Percent
Sales & distribution	24%
Installation & maintenance	23%
Manufacturing	20%
Support services	21%
Component suppliers	5%
Project development & financing	4%
Research & development	2%
Other	1%

[7] Barret, J. and R. Pollin. *2018. U.S. Energy and Employment Report*. National Association of State Energy Officials and Energy Futures Initiative. (pg. 73-84) (https://static1.squarespace.com/static/5a98cf80ec4eb7c5cd928c61/t/5afb0ce4575d1f3cdf9ebe36/1526402279839/2018+U.S.+Energy+and+Employment+Report.pdf)

[8] E4TheFuture and E2. 2018. *Energy Efficiency Jobs in America.* (https://e4thefuture.org/wp-content/uploads/2018/09/EE-Jobs-in-America-2018.pdf)

[9] Hirsch, B. and D. Macpherson. 2018. *Union Membership 2017.* United States Census Bureau. (https://mn.gov/deed/data/data-tools/compare-mn/labor/union.jsp)

[10] Kaiser, J., J. Melville, and R. Steichen. 2014. *Minnesota Clean Energy Economy Profile – How Industry Sectors are Advancing Economic Growth.* Minnesota Department of Employment and Economic Development (DEED).(https://mn.gov/commerce-stat/pdfs/mn-clean-energy-econ-full-rpt.pdf)

In terms of which technologies are driving energy efficiency employment, investment in heating, ventilation, and air conditioning (HVAC) efficiency by far has the greatest impact. Just under half of energy efficiency jobs in Minnesota are related to HVAC installation, maintenance, and repair as seen in Table 2. About a third of remaining energy efficiency jobs are split between installation of efficient lighting, and advanced building materials and insulation.

Table 2. Energy efficiency employment in Minnesota by subsector (2016)[11]

Employment Subsectors	Jobs	Percent
Traditional and high efficiency HVAC	20,976	47%
ENERGY STAR appliances & efficient lighting	11,960	27%
Advanced building materials/insulation	3,797	8%
Other	8,126	18%
Total	44,859	

More than half of Minnesota energy efficiency employment is concentrated in the Twin Cities Metro Area (Table 3), where building density is greatest. However, the remaining jobs are located fairly evenly across the state. Understanding the geographic distribution of efficiency jobs is important to project where employment growth might occur should Minnesota reach its efficiency potential.

[11] Clean Energy Trust. 2018. *Clean Jobs Midwest: Minnesota Executive Summary*. (https://www.cleanjobsmidwest.com/state/minnesota)

Table 3. Energy efficiency employment in Minnesota by location[12]

Area	Jobs
Minneapolis-St. Paul-Bloomington	25,554
Rural Minnesota	12,722
St. Cloud	1,732
Duluth	1,670
Rochester	1,566
Mankato-North Mankato	837
Moorhead	366
East Grand Forks	245
Winona	166

Achieving Minnesota's efficiency potential would drive continued job growth across a number of different industries and occupations. Unlike other distributed energy resources that may be located out-of-state, the local and on-site nature of installing energy efficiency measures means labor demand and job growth will inherently benefit Minnesota workers. Keeping this sector of the economy healthy and strong requires more than an enduring policy framework. It requires a high-quality and consistently flowing workforce pipeline.

The majority of energy efficiency establishments in Minnesota are small businesses – 80% of energy efficiency businesses have fewer than 25 employees. More than three quarters of energy efficiency businesses nationally report having difficulty finding workers[13]. The reasons cited most often include insufficient experience, training, or technical skills, lack of qualifications, and insufficient non-technical skills like work ethic, dependability, or critical thinking. Challenges such as a general workforce shortage in Minnesota and the anticipated 'silver tsunami' of retirements in many trades and occupations threaten the ability of the clean energy economy to maintain and accelerate growth.

At the same time, these challenges represent opportunities to create accessible career pathways for disadvantaged populations that continue to be left out of economic growth and opportunity. Additionally, new skills are required to work in clean energy jobs as technologies change and as remaining efficiency opportunities become more complex. To feed the workforce pipeline, and to

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[12] E4TheFuture and E2. 2018. *Energy Efficiency Jobs in America.* (https://e4thefuture.org/wp-content/uploads/2018/09/EE-Jobs-in-America-2018.pdf)

[13] Lehmann, S. et al. 2016. *Energy Efficiency Jobs in America: A comprehensive analysis of energy efficiency employment across all 50 states.* Environmental Entrepreneurs (E2) and E4TheFuture. (https://www.e2.org/wp-content/uploads/2016/12/EnergyEfficiencyJobsInAmerica_FINAL.pdf)

better serve a more diverse workforce, training programs will need to adapt both curriculum and training models. Further work is needed to assess gaps in the current energy efficiency workforce pipeline, and propose solutions that will ensure the long-term ability of the efficiency industry to meet demand.

Methodology

To calculate the estimated employment effects of achieving the state's energy savings potential, a review was conducted of previous employment impact studies focused on energy efficiency[14]. The majority of studies used an input-output model to generate an estimate of job-years created per $1 million invested in efficiency. A job-year is the equivalent of one full time job for one year . Across all studies, this estimate included multipliers for direct, indirect, and induced employment impacts. Direct jobs are generated as a result of an investment, whereas indirect jobs are created throughout the supply chain and induced jobs result from the ripple effect of expenditures throughout the local economy and region[15]. In some cases, the energy efficiency jobs multiplier was compared to employment multipliers for energy generation for both renewable and non-renewable fuel sources. Employment multipliers vary among the studies reviewed, ranging from 4 to 7 direct job-years generated per $1 million dollars invested in energy efficiency. When indirect and induced jobs are included, employment impacts of $1 million invested in energy efficiency range anywhere from 11 to 26 job-years.

A 2015 analysis commissioned by the Minnesota Department of Commerce looked at the jobs impact of the Conservation Improvement Program (CIP). It found that CIP activities in Minnesota across 180 utilities from 2008-2013 will have a net effect of 8,404 direct job-years, 2,506 indirect job-years, and 43,866 induced job-years, for a total of 54,777 job-years and $2.2 billion in labor income through 2032[16].[17] This produces a multiplier of 4.05 direct jobs per $1 million in combined spending from both program costs and participant co-funding, which aligns with multipliers developed by other studies reviewed. The Department of Commerce study also looked at which employment sectors were most impacted by CIP spending. This part of the analysis only looked at the total employment impact (direct, indirect, and induced), so it is not useful in determining what sectors experience the greatest direct employment impact. Based on this analysis, the greatest impact by far was in the service sector (76% of total job-years). This analysis found that just 4% (2,228) of job-years were in construction, and 5% (2,865) were in manufacturing. If indirect and induced employment impacts were removed from the analysis, the impact on these two sectors would likely be higher.

In the analysis, the project team conducted for the potential study, direct and indirect employment impacts were estimated based on the state's potential for utility-funded efficiency efforts. This study took incremental costs per energy efficiency measure invested by utilities, and multiplied the value by a

[14] For a complete list of studies reviewed, see methodology Attachment 1: References.

[15] ACEEE (American Council for an Energy-Efficient Economy). 2011. *How Does Energy Efficiency Create Jobs?* Washington, D.C. (https://aceee.org/files/pdf/fact-sheet/ee-job-creation.pdf)

[16] Cadmus. 2015. *The Aggregate Economic Impact of the Conservation Improvement Program 2008-2013: Assessing the impacts on Employment, Employee Earnings, Household Income and Savings, Business Revenue, Industry Production, Capital Investment and Innovation, and State Domestic Product*. Minnesota Department of Commerce. (http://mn.gov/commerce-stat/pdfs/card-report-aggregate-eco-impact-cip-2008-2013.pdf)

[17] Labor income includes worker wages and benefits as well as proprietor income

jobs multiplier. Incremental cost does not include program administration – it only includes either the full replacement cost (retrofit – replacing specifically because it's the more energy efficient one), or the incremental cost of installing the efficient version over the standard version (replace on fail when the efficient version is more expensive), depending on the measure. Employment multipliers were calculated based on an average of several of the more robust analyses identified from the literature review, yielding a multiplier of 4.57 direct job-years and 2.84 indirect job-years supported per $1 million invested. The employment outputs focus only on direct and indirect jobs supported through energy efficiency investments, as these are the jobs most closely tied to increased demand for efficiency equipment and services. Thus, this study did not include an estimate of induced jobs.

To determine where these jobs would be concentrated, this analysis applied a primary occupation to each efficiency measure based on assumptions of which type of worker would install the measure. For some measures, such as furnaces and air conditioners, secondary occupations were applied to capture the employment impacts in other occupations needed to support the primary installer. Measures were also broken out between residential and commercial/industrial sectors to identify which sectors would experience the greatest employment impacts.

Each primary and secondary occupation is associated with an occupational code sourced from O*NET Online, a database of labor statistics gathered from the Department of Labor and survey responses from workers in each occupation. O*NET Online assigns a Standard Occupational Classification (SOC) code to occupations to track reported job titles, required skills, typical educational attainments, training requirements, median wages, and employment growth projections. O*NET Online also tracks occupational data within the "green" or environmental economy and further divides the sector into subcategories like energy efficiency. Occupations in this subcategory, as well as others, were used to create the list of occupations used for this analysis.[18] Once occupational codes were assigned to each task, a group of building science experts and engineers reviewed the assignments for accuracy.

Using the employment multipliers, estimated job-years supported by utility-invested efficiency measures were calculated using the product of the job multiplier and the incremental cost per measure (millions of dollars). This was done using both direct and indirect multipliers, broken down into primary and secondary occupational categories.

To calculate direct jobs supported by utility investments, the total incremental cost per measure was multiplied by the direct jobs multiplier (4.57). If the measure did not have a secondary occupation associated with it, then the above calculation was the total amount of jobs estimated for that measure. For example, an air-conditioner tune-up will likely only require a "Heating, Air Conditioning, Refrigeration Mechanics and Installers" to implement the measure. In this case, 100% of the total direct employment impacts calculated were assigned to this occupation. However, many measures had a secondary occupation associated with the installation, thus the product of the total incremental spending and the direct jobs multiplier needed to be weighted. The project team's analysis determined

[18] For a complete list of SOC codes used for this study, see methodology Attachment 2: List of Occupations Required to Achieve Minnesota's Efficiency Potential

a labor share split of 75%/25% was an appropriate assumption between the primary and secondary occupations. In other words, this study assumed that the primary occupation would be responsible for 75% of the labor required to implement a measure and the secondary occupation(s) would support the primary for the remaining 25% of the labor. Some measures also had more than one secondary occupation, adding complexity to determining what occupational titles will represent the direct jobs supported through utility investments. To identify and quantify how many direct, secondary jobs would be supported, this analysis assumed that each secondary occupation would play an equal role in implementing the measure when more than one secondary occupation was assigned. A good example of this is for the measure of installing an energy recovery ventilator on existing unitary equipment. In this case, the primary direct job associated with the installation is a “Heating, Air Conditioning, Refrigeration Mechanic and Installers” and the secondary occupations include a mechanical engineer, electrician, and sheet metal worker. The primary job was allocated 75% of the total direct employment from the total investment, whereas each secondary occupation received a third of the total secondary direct employment (which was 25% of the total direct employment). Combined, the direct primary and direct secondary job-years supported by the incremental costs sum to the total direct job-years for a given measure.

As for calculating indirect jobs, this analysis used the product of the indirect multiplier of 2.84 jobs per million dollars in incremental spending. While this is less complicated than the direct jobs, it does not analyze which occupations will represent these indirect jobs. This is in part because indirect jobs are harder to identify as they occur further upstream of the supply chain, also these occupations are sometimes unrelated to energy efficiency and therefore are out of the scope of this study.

Conclusion and Results

For Minnesota to fully achieve its potential for utility-funded energy efficiency, this will generate a total of $6,657,000,000 in energy efficiency investments. These investments will create or retain a projected total of 30,400 direct job-years and 18,900 indirect job-years and cumulatively represent a total of 49,300 job-years supported. As Table 4 shows, most of the projected efficiency jobs will be concentrated in the commercial/industrial sector.

Table 4. Job-years supported by potential utility-invested efficiency by sector

Sector	Direct Job-Years Supported	Indirect Job-Years Supported	Total
Residential	12,000	7,500	19,500
Commercial/Industrial	18,400	11,400	29,800

A detailed table of the results of this analysis is included below (Table 4). About 21% of both commercial and residential jobs are projected to be in heating, ventilation, air conditioning, and refrigeration – occupations that already have strong projected growth statewide. Electricians are another occupation that benefits considerably by utility investments, representing 10% of total jobs supported. These two occupational categories represent the majority of the labor required to achieve the state's efficiency potential. Looking ahead, it will be critical for training programs specializing in these fields to sufficiently integrate emerging technologies into their curriculum so that the future workforce is prepared to meet evolving skill demands.

Table 5. Job years supported by potential utility-invested efficiency, by occupation

Direct job type	Expected job-years	% of total job-years
HVAC technicians	10,500	21%
Electricians	5,100	10%
Insulation installers	2,200	5%
Mechanical engineers	2,100	4%
Architects	2,000	4%
Plumbers, pipefitters	1,800	4%
Retail salespersons	1,400	3%
Weatherization technicians	1,100	2%
Stationary engineers and boiler operators	700	2%
Other	3,500	7%
Total direct job-years	30,400	62%
Indirect job-years	18,900	38%
TOTAL JOB-YEARS	**49,300**	100%

As Table 5 illustrates, the largest portion of occupations supported by the state's efficiency potential are in the building and construction trades. This is promising because career pathways for these occupations often do not require a four-year college degree, but rather a technical degree at a community college or completion of a union apprenticeship. Here lies an opportunity for Minnesota's building trades unions and public workforce system to anticipate which occupations will be in greatest demand, and to work collaboratively to ensure that an adequate volume of qualified workers are available to achieve the state's efficiency goals.

Minnesota's workforce system may play a particularly important role for employers large and small who will be swept up in the anticipated 'silver tsunami' of retirements expected over the next decade. The National Center for Construction Education and Research estimates that 29% of skilled construction workers will retire by 2026 and 41% will have retired by 2031[19]. This volume of retirements paired with employers' current and persistent challenges in finding enough applicants poses a threat to Minnesota reaching its efficiency potential. At the same time, the number of open positions represents an opportunity to include more women and people of color, groups that are currently underrepresented in

[19] National Center for Construction Education and Research (NCCER). 2017. *The End of an Era: The Dawn of of Digital.* The Cornerstone.(https://www.nccer.org/docs/default-source/pdfs/nccer-cornerstone-fall-winter-2017-final.pdf)

the building and construction trades. Further work is needed to build career pathways that will ensure Minnesota has an adequate and diverse supply of workers qualified to implement emerging energy-saving solutions.

Energy efficiency also provides more jobs per utility-investment than other forms of clean energy. According to Heidi Garrett-Peltier, an established researcher on employment impacts of clean energy investments, energy efficiency provides the most total (direct and indirect) job-years per $1 million invested, as seen in Table 6, compared to wind, solar, and traditional fuel sources. As the state's population continues to rise—particularly in the metropolitan area—new construction and renovation of aging building infrastructure will continue to drive demand for construction labor. Market forces, corporate sustainability goals, and policy priorities will likely initiate further demand for energy efficient technology and expertise, reinforcing the need for adequate integration with training in the skilled trades. These jobs are inherently local, and have the best potential to create opportunities for Minnesota workers as compared to other clean, distributed energy resources like solar and wind energy, which may or may not be located in-state. As the State of Minnesota looks for ways to achieve its climate goal of reducing greenhouse gas emissions 80% emissions by 2050, energy efficiency should be considered as a primary strategy for reducing carbon emissions in combination with increased renewable energy and strategic electrification of end-use technologies.

Table 6. Average number of full-time employees created per million dollars invested[20]

Industry	Total FTE (direct and indirect jobs) per $1 million
Average Energy Efficiency across industries	7.72
Average Wind	7.52
Average Solar	7.24
Average Fossil Fuels	2.65

[20] Garrett-Peltier, H. 2017. *Green versus Brown: Comparing the Employment Impacts of Energy Efficiency, Renewable Energy, and Fossil Fuels Using an Input-Output Model*. Economic Modelling 61 (February 2017): 439–47. (https://doi.org/10.1016/j.econmod.2016.11.012).

Attachment 1: References

ACEEE (American Council for an Energy-Efficient Economy). 2011. *How Does Energy Efficiency Create Jobs?* Washington, D.C. (https://aceee.org/files/pdf/fact-sheet/ee-job-creation.pdf)

ACEEE (American Council for an Energy-Efficient Economy). 2012. *Energy Efficiency and Economic Opportunity*. (https://aceee.org/files/pdf/fact-sheet/ee-economic-opportunity.pdf)

Anderson, D., D. Belzer, O. Lingston, and M. Scott. 2014. *Assessing National Employment Impacts of Investment in Residential and Commercial Sector Energy Efficiency: Review and Example Analysis*. Richland, Washington: Pacific Northwest National Laboratory. (https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-23402.pdf)

Barret, J. and R. Pollin. *2018. U.S. Energy and Employment Report*. National Association of State Energy Officials and Energy Futures Initiative. (pg. 73-84) (https://static1.squarespace.com/static/5a98cf80ec4eb7c5cd928c61/t/5afb0ce4575d1f3cdf9ebe36/1526402279839/2018+U.S.+Energy+and+Employment+Report.pdf)

Cadmus. 2015. *The Aggregate Economic Impact of the Conservation Improvement Program 2008-2013: Assessing the impacts on Employment, Employee Earnings, Household Income and Savings, Business Revenue, Industry Production, Capital Investment and Innovation, and State Domestic Product*. Minnesota Department of Commerce. (http://mn.gov/commerce-stat/pdfs/card-report-aggregate-eco-impact-cip-2008-2013.pdf)

Clean Energy Trust. 2017. *Clean Jobs Midwest: Minnesota Executive Summary*. (https://www.cleanjobsmidwest.com/wp-content/uploads/2017/09/CJM-2017-ExeSum-MN.pdf)

Clean Energy Trust. 2018. *Clean Jobs Midwest: Minnesota Executive Summary*. (https://www.cleanjobsmidwest.com/state/minnesota)

Comings, T., S. Fields, G. Keith, and K. Takahashi. 2014. Synapse Energy Economics, Inc. *Employment Effects of Clean Energy Investments in Montana*.(http://www.synapse-energy.com/sites/default/files/SynapseReport.2014-06.MEIC_.Montana-Clean-Jobs.14-041.pdf)

E4TheFuture and E2. 2018. *Energy Efficiency Jobs in America.* (https://e4thefuture.org/wp-content/uploads/2018/09/EE-Jobs-in-America-2018.pdf)

Garrett-Peltier, H., J. Heintz, and R. Pollin. 2009. *The Economic Benefits of Clean Energy: How the economic stimulus program and new legislation can boost U.S. economic growth and employment*.. Amherst, Massachusetts: Center for American Progress and Political Economy Research Institute. (https://www.peri.umass.edu/fileadmin/pdf/other_publication_types/green_economics/economic_benefits/economic_benefits.PDF)

Garrett-Peltier, H. 2011. Political Economy Research Institute. *Employment Estimates for Energy Efficiency Retrofits of Commercial Buildings.* Amherst, Massachusetts: Political Economy Research Institute. (https://www.peri.umass.edu/publication/item/426-employment-estimates-for-energy-efficiency-retrofits-of-commercial-buildings)

Garrett-Peltier, H. 2017. *Green versus Brown: Comparing the Employment Impacts of Energy Efficiency, Renewable Energy, and Fossil Fuels Using an Input-Output Model*. Economic Modelling 61 (February 2017): 439–47. (https://doi.org/10.1016/j.econmod.2016.11.012).

Hendricks, B. and J. Madrid. 2011. *A Star Turn for Energy Efficiency Jobs: Energy Efficiency Must Have a Starring Role in Putting America Back to Work*. Washington, D.C. (https://www.scribd.com/document/64161335/A-Star-Turn-for-Energy-Efficiency-Jobs)

Hirsch, B. and D. Macpherson. 2018. *Union Membership 2017.* United States Census Bureau. (https://mn.gov/deed/data/data-tools/compare-mn/labor/union.jsp)

Jacobson, M., et al. 2013. *Examining the feasibility of converting NYS all-purpose energy infrastructure into one using wind, water, and sunlight.* Energy Policy 57 (2013) 585-601. (https://web.stanford.edu/group/efmh/jacobson/Articles/I/NewYorkWWSEnPolicy.pdf)

Kaiser, J., J. Melville, and R. Steichen. 2014. *Minnesota Clean Energy Economy Profile – How Industry Sectors are Advancing Economic Growth.* Minnesota Department of Employment and Economic Development (DEED).(https://mn.gov/commerce-stat/pdfs/mn-clean-energy-econ-full-rpt.pdf)

Lehmann, S. et al. 2016. *Energy Efficiency Jobs in America: A comprehensive analysis of energy efficiency employment across all 50 states.* Environmental Entrepreneurs (E2) and E4TheFuture. (https://www.e2.org/wp-content/uploads/2016/12/EnergyEfficiencyJobsInAmerica_FINAL.pdf)

National Center for Construction Education and Research (NCCER). 2017. *The End of an Era: The Dawn of of Digital.* The Cornerstone.(https://www.nccer.org/docs/default-source/pdfs/nccer-cornerstone-fall-winter-2017-final.pdf)

National Center for O*NET Development. 2018. *Overview*. O*NET Resource Center. (https://www.onetcenter.org/overview.html)

National Grid. 2014. *Macroeconomic Impacts of Rhode Island Energy Efficiency Investments*. National Grid Customer Department. (http://www.ripuc.org/eventsactions/docket/4527-NGrid-Macroeconomic_Impacts.pdf)

Stapleton, K. 2013. *Assessing Green Employment: A Review of Relevant Literature.* Vermont

Department of Labor, Economic & Labor Market Information Division. (http://www.vermontgreencareers.org/wp-content/uploads/2014/01/Assessing-Green-Employment.pdf)

Sternberg, R. and T. Wong. 2017. *The Minnesota Jobs Project: A guide to Creating Jobs in Energy Efficiency*.(http://americanjobsproject.us/wp-content/uploads/2017/06/Minnesota-Jobs-Project-Full-Report-6.19.17.pdf)

United States Department of Energy. 2017. U.S. Energy and Employment Report. United States Department of Energy. (https://energy.gov/sites/prod/files/2017/01/f34/2017%20US%20Energy%20and%20Jobs%20Report_0.pdf)

Attachment 2: List of Occupations Required to Achieve Minnesota's Efficiency Potential[21]

Occupation Title	SOC Code
Architects, Except Landscape and Naval	17-1011.00
Boilermakers	47-2011.00
Coin, Vending, and Amusement Machine Servicers and Repairers	49-9091.00
Computer User Support Specialist	15-1151.00
Computer and Information Systems Manager	11-3021.00
Construction Laborers	47-2061.00
Electricians	47-2111.00
Energy Engineers	17-2199.03
Farm and Ranch Managers	11-9013.02
Heating, Air Conditioning, Refrigeration Mechanics and Installers	49-9021.00
Industrial Engineering Technicians	17-3026.00
Installation, Maintenance, and Repair Worker, All Other	49-9099.00
Insulation Workers, Floor, Ceiling, and Wall	47-2131.00
Light Truck or Delivery Services Driver	53-3033.00
Mechanical Door Repairers	49-9011.00
Mechanical Engineers	17-2141.00
Plumbers, Pipefitters, and Steamfitters	47-2152.00
Refuse and Recyclable Material Collectors	53-7081.00
Retail Salespersons	41-2031.00
Sheet Metal Workers	47-2211.00
Software Developers, Systems Software	15-1133.00
Stationary Engineers and Boiler Operators	51-8021.00
Weatherization Installers and Technicians	47-4099.03

[21] National Center for O*NET Development. Overview. *O*NET Resource Center*. Retrieved August 21, 2018, from (https://www.onetcenter.org/overview.html)