Georgia Jobs Project

A Guide to Creating Advanced Energy Jobs

MARCH 2016

AMERICAN JOBS PROJECT

A Letter from the American Jobs Project

It is no secret that America's middle class is in crisis; indeed, "the hollowing out of the middle class" has become a well-worn phrase, causing politicians to rail, bloggers to rage, and citizens to reel. Polls consistently reveal that jobs and the economy are at or near the top of citizen concerns.[1] Over the past few decades, the loss of middle-income jobs in America has been due largely to the global shift in manufacturing ("tradable jobs") to emerging economies.[2] Of the millions of jobs lost during the recession, most were good-paying, middle-class jobs.[3] Unfortunately, many of the jobs created during the recovery have been in low-skill, low-paying occupations.[4] These trends are not going to reverse themselves. Leadership is needed, but the gridlocked U.S. Congress has failed in recent years to adopt robust policies to stoke middle-class jobs in America.

In President George W. Bush's autobiography, *Decision Points*, the former president recounts a conversation he had with then-President of China, Hu Jintao. "What keeps you up at night?" President Bush asked President Hu as an icebreaker. As we can easily guess, what kept President Bush up at night was worrying about terrorism. Hu Jintao's response was telling: what kept him up at night was "creating 25 million new jobs a year" for his people.[5]

Is it possible to create good-paying American jobs in today's global economy? And what if the solutions did not involve Congress at all? What if there were creative middle-class job creation strategies being developed and tested in the laboratories of democracy—the states and cities? The American Jobs Project seeks to answer these questions and provide a research-based roadmap for action for state and local leaders who are kept up at night trying to figure out how to create jobs for the people they serve.

Our quest starts with identifying the biggest market opportunity of our era: the global demand for advanced energy solutions. That demand—whether borne out of a need for diverse, reliable, and clean power or to achieve energy independence from unstable regimes—creates "the mother of all markets" for local U.S. businesses to build and sell those solutions.[6] Strategically minded businesspeople looking at global growth projections in advanced energy demand are making major investments and reaping large revenues. In 2014, the private sector reported $1.3 trillion in global advanced energy revenues, the fastest growing

year on record.[7] Advanced energy investments are now bigger than the global apparel sector and almost four times the size of the global semiconductor industry.[8] And jobs? Up to 16.7 million jobs are projected to be in the global advanced energy sector by 2030, almost tripling the 5.7 million people employed in the sector in 2012.[9] The question for the United States is: Where will those new jobs be created?

The American Jobs Project is concerned with finding ways to make our states the answer to this question. If countries across the globe, including the United States, are seeking technical products and solutions for growing energy needs, how can U.S. businesses take advantage of this demand and build products locally that can be exported to the world? And how can we equip U.S. residents with the skills those businesses need to build their advanced energy products?

It is true that the United States will not likely be able to attract back the traditional manufacturing jobs of the past; those jobs are gone—either to low-wage countries or to automation—and we must accept the fact that they are not coming back.[10] But our research shows that with innovative policies and a smart focus on industrial sectors, states can become hubs of innovation and job creation in specific advanced industries that soar with a state's strengths.

The American Jobs Project gives policymakers the tools to create good-paying jobs in their states. We propose innovative solutions built on extensive research and tailored to each state. Many are best practices, some are new, and all are centered on a state's business ecosystem. These solutions are written with an eye towards streamlining bureaucracy and are seasoned with the principles of competition, local control, and fewer regulations.

If these recommendations are adopted, the beneficiaries will be those hard-working Americans looking for the dignity of a good-paying job.

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About Us

American Jobs Project

The American Jobs Project is a national, interdisciplinary, research-based initiative. Our team includes nearly 100 student researchers with a broad range of expertise, including law, business, engineering, and public policy. We have ongoing relationships with hundreds of on-the-ground stakeholders and are actively collaborating with university partners and industry allies.

Academic Partner

Georgia Tech provides an institutional framework for long-term collaboration in energy research. The university serves as a hub for promoting greater understanding and better solutions to our most complex energy and environmental challenges. As the nation's largest engineering program, Georgia Tech is playing an integral role in developing the technologies that are enabling companies worldwide to make better, cleaner decisions about how they generate, distribute, and use energy. Researchers at Georgia Tech are not just helping to create cleaner, more efficient fuel options or mitigate the environmental impact of conventional energy supplies, they are creating better performing, more economically viable energy options.

Acknowledgments

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We extend sincere gratitude to the hundreds of individuals from businesses, government, nonprofits, utilities, and universities for meeting with us, exploring ideas, participating in working groups, collaborating on the report, and sharing their vision for the future.

Dozens of hands were involved in the process of researching, writing, and designing the report. Mary Collins and Nicole Danna led research and writing. Jackie Kimble, Stephanie Smith, and Kate Ringness served as the lead editors and Henry Love was the lead analyst. Amariah Baker was the graphic designer. Other contributors included Francisca Escobar, Shaila Narang, Eric Scott, Laura Hobbs, Rachel Young, Jacob Gill, Tiffany Wong, Patrick Liao, and Andrew Herrmann.

Executive Summary

The American Jobs Project was borne of two tough problems: loss of middle-class jobs in America and congressional paralysis. It seeks to address these problems by taking advantage of one of the biggest market opportunities of our era—the advanced energy sector—and to do so at the state, not the federal level. Policymakers who leverage the unique strategic advantages of their state to grow localized sectors of interconnected companies and institutions are poised to create quality jobs.

Georgia can lead in advanced energy in the Southeast United States and nationally, and has the potential to be globally competitive. The state is already home to 801 advanced energy firms that contribute an estimated $3.3 billion in gross revenues to the state while providing nearly 24,000 full-time jobs.[11] Extensive research and more than forty interviews with local experts and stakeholders in Georgia identified two economic sectors with particular promise for jobs: smart buildings and solar.

Georgia has a well-established innovation ecosystem, strong education, research and development, and is home to many Fortune 500 companies. Georgia already has innovative economic clusters in smart buildings and solar. Georgia's policymakers can build on existing strengths with policies to help the state's businesses grow, innovate, and outcompete regional, national, and global competitors. With the right policies, Georgia can support over 24,000 jobs annually from 2016 to 2030 in the smart building and solar clusters.

This project serves as a research-based roadmap for state and local leaders in Georgia. It provides a set of policy options that build on existing programs and strengths in the state and focus on leveraging Georgia's resources to create skilled, good-paying jobs.

Summary of Recommendations

The analysis presented in this report culminates in four thematic sets of recommendations for Georgia's policymakers. Each set of recommendations identifies opportunities for barrier removal and future growth in the advanced energy sector. Taken together, these recommendations chart a course for Georgian leaders to create and enhance jobs in the advanced energy sector.

Solar

Streamline Solar Permitting: Reduce the soft costs of installing solar by simplifying permitting processes, lowering permit fees, and establishing consistent interconnection requirements throughout Georgia.

Encourage Foreign Direct Investment: Recruit foreign solar companies and manufacturers to Georgia in order to boost investment and fill gaps in the supply chain.

Create a Property Tax Exemption for Solar: Incentivize residential investment in solar by granting property tax exemptions for solar panel installations and other advanced energy technologies.

Offer a Green Source Rider Program: Establish a utilities-led program that allows energy-intensive customers, such as big-box retailers, college campuses, and data centers, to voluntarily purchase renewable energy.

Establish a Solar Factory Retooling Financing Program: Increase solar manufacturing in Georgia by providing capital for retooling factories, purchasing equipment, and building facilities.

Smart Building and Energy Efficiency

Make Property Assessed Clean Energy (PACE) Financing Simple: Encourage energy efficiency building upgrades by allowing property owners to finance investments with a loan that is repaid through their property tax bill.

Expand On-bill Financing for Georgia Power: Provide utility customers with an on-bill financing option in order to mitigate the high upfront costs of home energy improvements.

Use Revenue Decoupling to Encourage Energy Efficiency: Establish a mechanism that decouples a utility's fixed rates and variable rates (based on sales) in order to stabilize utility earnings and remove disincentives for supporting energy efficiency programs.

Adopt Municipal Benchmarking Ordinances: Establish city-level benchmarking ordinances throughout the state in order to

monitor commercial building energy performance, encourage smart building investments, and achieve environmental benefits.

Update Georgia Building Codes: Adopt the most recent residential and commercial building codes in order to expand the market for energy efficient structures.

Pilot a Dynamic Rate Structure: Help utilities reduce peak demand and avoid costly investments in generating facilitates by piloting a dynamic rates program. With dynamic rates, customers would pay the real-time cost of generation rather than the average cost. They would respond to the higher price of power at peak times by reducing energy use.

Innovation Ecosystem and Access to Capital

Establish a Capital Gains Tax Exemption for Investment in Startups: Increase the flow of venture capital by establishing a capital gains tax exemption for investments in targeted Georgia startups.

Facilitate Partnerships within the Energy Innovation Ecosystem: Attract public and private research money and venture capital funding to Georgia by aligning advanced energy sector efforts and establishing collaborative partnerships among various stakeholders.

Workforce Development

Develop Certificate and Degree Programs around High-Performance Buildings: Collaborate with Georgia's universities and technical colleges to create certificate and degree programs that prepare students for jobs in the smart building and energy efficiency sector.

Develop Degree Programs in Energy Engineering and Sustainability Science: Prepare students for jobs in the solar and smart building industries by establishing more formal degree programs related to advanced energy engineering and sustainability science.

Create More Apprenticeship Opportunities in Advanced Energy Technologies: Meet employer demand for trained workers and prepare Georgians for jobs in advanced energy sectors by incentivizing companies to expand apprenticeship opportunities.

Chapter 1: Introduction

The American Jobs Project aims to spur job creation in the advanced energy sector by identifying innovative and state-specific policy and technology roadmaps. This national initiative takes advantage of the emerging global demand for advanced energy products and services. The American Jobs Project team analyzed the advanced energy economy in Georgia and designed recommendations specifically tailored to the state's strengths. These recommendations were informed by extensive research and over forty interviews with local stakeholders and experts.

This report identifies opportunities to boost growth in two economic clusters in the advanced energy sector that leverage the state's legacy industries and current investment activities. State and local leaders who seek to leverage the state's resources to create skilled, good-paying jobs can use this report as a foundation for action.

Market Opportunity

Demand for advanced energy has soared in recent years and is poised for continued growth. Since 2004, new investment in the advanced energy sector has totaled $2.3 trillion worldwide.[12] In the United States alone, over $386 billion was invested in advanced energy between 2007 and 2014; $51.8 billion was invested in 2014.[13] In nationwide polls, Americans increasingly support renewables over other forms of energy[14] and demand for renewable energy is likely to continue to grow. By 2030, states will need to significantly reduce pollution from power plants.[15] The best way to meet those targets is from a combination of investing in advanced energy technology, utilizing renewable energy sources, and reducing demand through energy efficiency. Projections show that renewable energy will add the vast majority of new generation (69-74 percent) between now and 2030.[16] These trends point to a clear market signal: demand for advanced energy will continue to grow over the next 15 years.[17]

Economic Clusters

> *"Clusters are geographic concentrations of interconnected companies and institutions in a particular field."*
>
> – Michael Porter, *Clusters and the New Economics of Competition*[18]

Economic clusters encompass a variety of linked industries and institutions—including suppliers of specialized services, machinery, and infrastructure—which form a supply chain.[19] Clusters also extend to manufacturers of complementary products and to industries related in skills and technologies. By placing themselves in close proximity to industry allies, companies can benefit from each other's unique expertise and skilled workers.[20] Companies in a cluster enjoy closer access to specialized skills and information, which helps increase productivity and efficiency.[21]

Economic Cluster

Economic Clusters are created when industries and institutions become linked with suppliers of specialized services, machinery, and infrastructure that are within close proximity, forming a supply chain. Key elements to a successful cluster include Policy Certainty, Workforce Development, Innovation Ecosystem, and Access to Capital.

Policy Certainty

- Provides a clear market signal
- Reduces business risk
- Allows for long-term planning

Workforce Development

- Invests resources in people
- Bridges skills gap
- Develops training programs and industry partnerships

Innovation Ecosystem

- Promotes research and development
- Facilitates new technology to market
- Incubates early-stage businesses

Access to Capital

- Provides funding for new and growing businesses
- Connects investors with market opportunities
- Attracts entrepreneurs

Geographic proximity and repeated exchanges of information help foster an environment of coordination and cooperation among these companies and institutions. Business clusters are shown to increase the productivity of participating companies, drive innovation in the field, and facilitate the commercialization of this innovation by increasing communication, logistical support, and overall interaction between cluster entities.[22] Clusters also help build a strong foundation for creating and retaining employment opportunities.

Georgia's Energy Profile

Current Energy Portfolio

Georgia currently relies on imports of natural gas and coal to fuel almost 70 percent of its energy production.[23] In 2012, Georgia spent $1.7 billion on coal[24] and $165 million on natural gas from out-of-state markets.[25] The state does not have any appreciable local resources for these fossil fuels, though it does have in-state resources for renewables in biomass, solar, wind, and hydropower. Georgia's plentiful biomass resource has started adding to energy generation in the state. In 2013, biofuels contributed to 1.4 percent of energy production,[26] while biomass made up 3.2 percent of electricity generation.[27] The state also boasts four nuclear reactors, ranking it among the top ten states in the nation for nuclear generation potential.[28] East of the Rockies, Georgia leads in hydropower production with thousands of dams.[29] Georgia also has the fastest growing solar market in the nation,[30] but is still fifteenth in the nation for installed capacity,[31] which makes up less than 1 percent of installed generation.[32] There are no wind projects in Georgia, but new technologies could create opportunities to take advantage of the substantial land-based and offshore potential. There are also many wind manufacturing companies active in the state.[33]

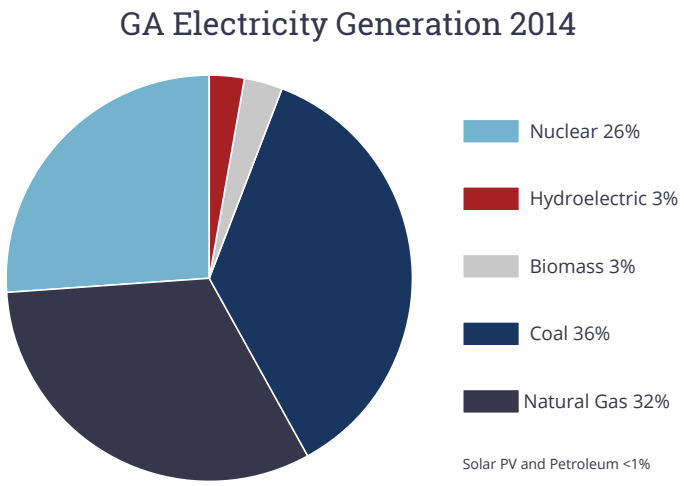


Figure 1. Georgia's Electricity Generation 2014

Georgia Power, an investor-owned utility, provides the vast majority of power to consumers in the state.[34] As of August 2015, the residents of Georgia paid 12.2 cents per kilowatt-hour, which is below the national average.[35] Transportation is responsible for the most energy consumption in the state.[36] Georgia ranked eleventh in the nation for total energy consumption, with 2,795 trillion BTUs used in 2013.[37]

Advanced Energy Development

Atlanta has taken a leadership role in the building efficiency space. Mayor Reed has enrolled Atlanta in the Department of Energy's Better Buildings Challenge with the 2020 goal of reducing energy and water consumption by 20 percent.[38] Additionally, through a national initiative known as the City Energy Project, Atlanta aims to decrease commercial energy use by 20 percent by 2030, reduce carbon emissions by 50 percent over the same time period, and create about 1,000 jobs annually in the first several years.[39]

In 2015, Georgia's solar industry employed an estimated 3,200 employees, about a 10 percent growth in the industry since 2014.[40] As displayed by the graph below, much of the growth in solar capacity is the result of Georgia Power's Advanced Solar Initiative. The 2013 initiative requires Georgia Power to procure 525 megawatts (MW) of solar capacity, bringing total capacity to 900 MW by the end of 2016.[41] More recently, Georgia has approved the use of third-party solar financing in the state,[42] which is likely to be a huge advantage for homeowners seeking more reliable financing options for their solar projects.

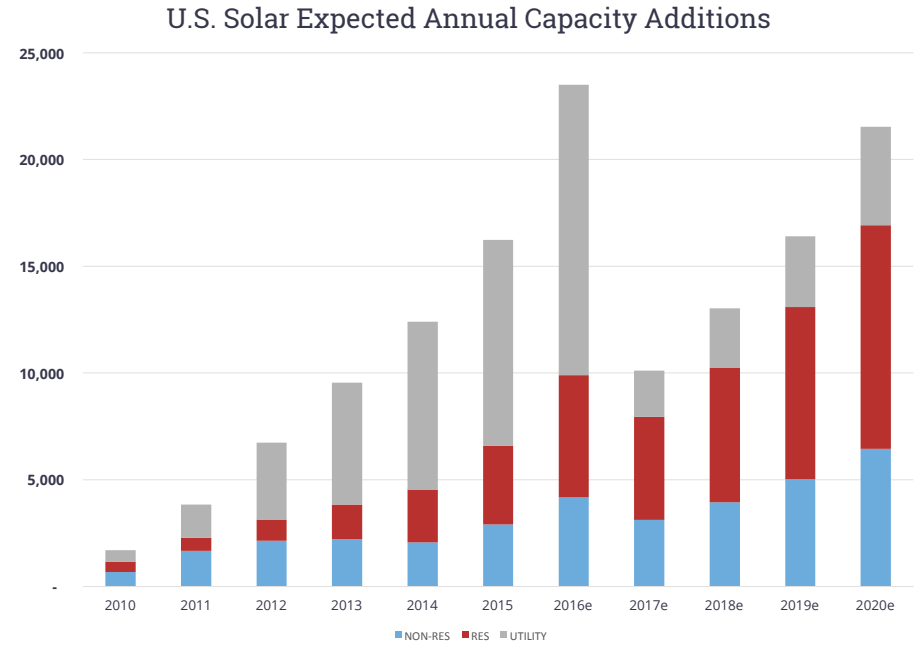


Figure 2. U.S. Solar Expected Annual Capacity Additions

Jobs Potential

Maximizing job creation within Georgia is highly dependent on local action. An original equipment manufacturer (OEM) and its local suppliers employ workers from their community. Those employees spend much of their earnings at businesses in the local economy, such as grocery stores and restaurants. Local businesses also hire employees from within the community, who spend their earnings at other local establishments. This results in a multiplier effect, where a single dollar of spending in a community circulates through local businesses and their employees numerous times. Thus, recruiting advanced energy OEMs and their suppliers to a community can result in increases in local spending that are many times greater than the actual expenses of those companies.

With the right policies, Georgia has the opportunity to create more than 24,000 jobs annually from 2016 to 2030 throughout the smart, energy-efficient building and solar industries.

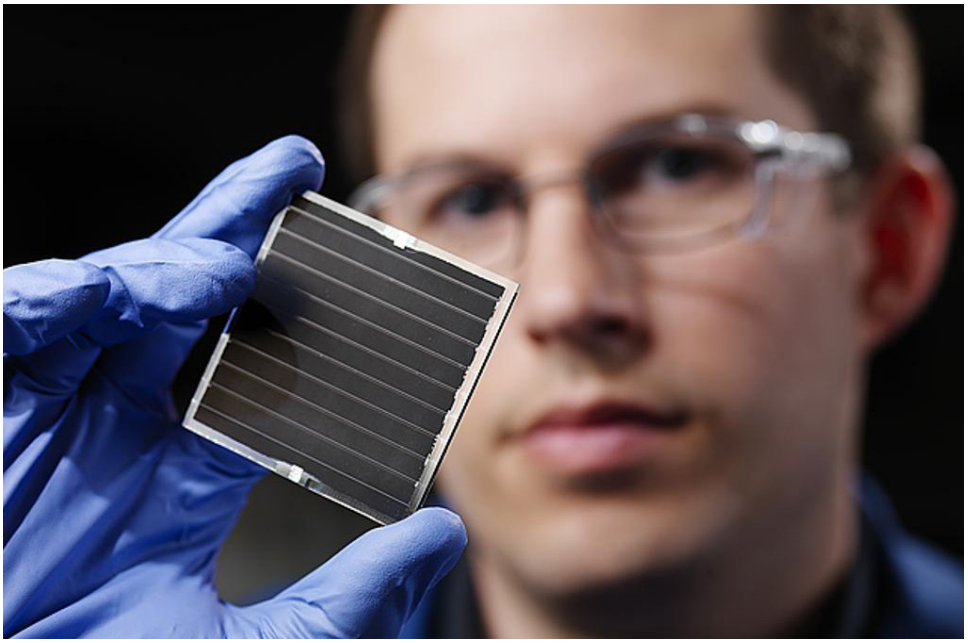
Report Structure

The analysis presented in this report is divided into four complementary chapters, each covering key elements of growing advanced energy economic clusters in smart buildings and solar. Chapters 2 and 3 conduct a supply chain analysis for Georgia's emerging solar and smart building clusters. This analysis culminates in an assessment of Georgia's potential for advanced energy jobs within each cluster and specific policy recommendations tailored to the state's needs. Chapter 4 analyzes Georgia's innovation ecosystem and access to capital, both crucial elements of sector development, and provides recommendations for further developing the state's innovation pipeline. Chapter 5 provides recommendations for workforce development programs and policies to prepare Georgians for advanced energy jobs. The conclusion of the report summarizes key themes and the Extended Learning Sections summarize our jobs modeling methodology and highlights of Georgia's innovation ecosystem.

Chapter 2: Solar Technology

Georgia's policymakers will play a decisive role in the future of solar energy in the state. Solar energy continues to grow in the United States due to falling solar photovoltaic (PV) prices, technological advancements, favorable government policies, available financing, and increased consumer demand for renewable sources of energy. Targeting the state's emerging solar sector with smart, strategic policy choices can create jobs, while helping the state meet a portion of its energy needs. By emphasizing growth and technological innovation, Georgia will be able to take advantage of opportunities to not only meet the demands for solar products from a strong in-state market, but also capitalize on export opportunities in regional, national, and international markets.

This chapter is a guide to strengthen and develop Georgia's emerging solar economy. After analyzing Georgia' existing solar supply chain and discussing the state's potential for creating good-paying solar jobs, the chapter culminates in policy recommendations for future growth. These recommendations chart a course for Georgia's policymakers to generate and enhance jobs in the solar sector.



Solar cell
Photo Credit. Pacific Northwest National Laboratory - PNNL / Foter / CC BY-NC-SA

Georgia's Strengths, Weaknesses, Opportunities, and Threats in the Solar Energy Sector

STRENGTHS	WEAKNESSES
• Georgia is the fastest growing solar state in the United States • Nearly 200 solar companies already provide a wide variety of solar goods and services in Georgia • The Solar Power Free-Market Financing Act of 2015 provides residents with access to outside financing for solar installations • Georgia is home to a leading technical university with a nationally-funded center of excellence in solar innovation • Georgia is second in the South Atlantic in utility-scale solar with 250 megawatts (MW) and is expected to add more than 600 MW in 2016[1]	• Inconsistent permitting and interconnection standards between counties increase the cost of solar installation • Georgia does not employ a renewable portfolio standard (RPS) • Tax treatment of residential solar installations discourages homeowners from installing solar on their properties
OPPORTUNITIES	**THREATS**
• Solar prices have dropped dramatically in the last decade, moving towards parity with the grid • The extension of federal tax credits will encourage new investments • The business-friendly climate could attract international solar businesses to the state, creating jobs and boosting statewide revenue • Utilities willing to take the lead in solar deployment and innovation through utility procurement and distributed generation	• Low electricity rates make payback periods on solar installations longer • Solar is a crowded industry, and Georgia's leaders will have to make a unique value proposition in this space • Other states are aggressively and successfully pursuing solar manufacturers

Georgia was recognized as the fastest-growing solar market in the country in 2014 based on the state's innovative research, plentiful solar resources, and declining costs of materials.[2] With more sunny daylight hours annually than any other state in the Southeast, including Florida, Georgia boasts a strong foundation for building a solar cluster.[3] Georgia is second in the Southeast for utility-scale solar deployment, driven by Georgia Power's investment in the space.[4] Significantly, Georgia recently passed the Solar Power Free-Market Financing Act of 2015, which allows third-party financing of solar installations. The Georgia Public Service Commission approved the Georgia Power Advanced Solar Initiative in 2012 to acquire 210 MW of solar capacity and authorized another 525 MW the following year as part of an integrated resource plan.[5]

Georgia was ranked among the top states for business in the country due to numerous business-friendly policies, a strong labor force, and a robust economic outlook.[6] Solar is the second largest advanced energy sector behind efficient building firms. In 2015, Georgia's solar industry employed approximately 3,200 people, a 10 percent increase from 2014.[7]

The Peach State is also home to cutting edge solar innovation. Georgia Tech, which was listed as the fifth strongest engineering school in the nation by Business Insider, has made significant developments in the solar field.[8] The University Center of Excellence for Photovoltaics Research and Education (UCEP) at Georgia Tech was established by the Department of Energy (DOE) "to improve the fundamental understanding of the science and technology of advanced PV devices, to fabricate record high efficiency solar cells, to provide training and enrich the educational experience of students in this field, and to give the United States a competitive edge by providing guidelines to industry and DOE for achieving cost-effective and high-efficiency PV devices." UCEP is one of just two such centers in the United States (the other is located at the University of Delaware).[9]

However, despite this promising foundation, Georgia lacks many fundamental solar policies that are common in other states. For example, Georgia has not adopted property tax exemptions for solar. Additionally, the state could benefit from streamlining and standardizing the permitting process associated with solar installations. Through policy leadership aimed at overcoming these barriers, Georgia stands to prosper by eliminating inefficiencies and boosting its solar economy.

Solar Market Trends

Rising Demand

Global solar photovoltaic (solar PV) installed capacity has increased by a factor of nearly 70 over the last decade, from 2.6 gigawatts (GW) in 2004 to 177 GW in 2014.[10]

In the United States, solar PV cells are a primary source of new electricity generating capacity. Total solar installed capacity in the first quarter of 2015 represented 51 percent of all new electricity generating capacity.[11] Strong demand for solar has made the United States the world's fifth largest solar market in terms of installed capacity.[12] Forecasts show significant growth continuing through 2040.[13]

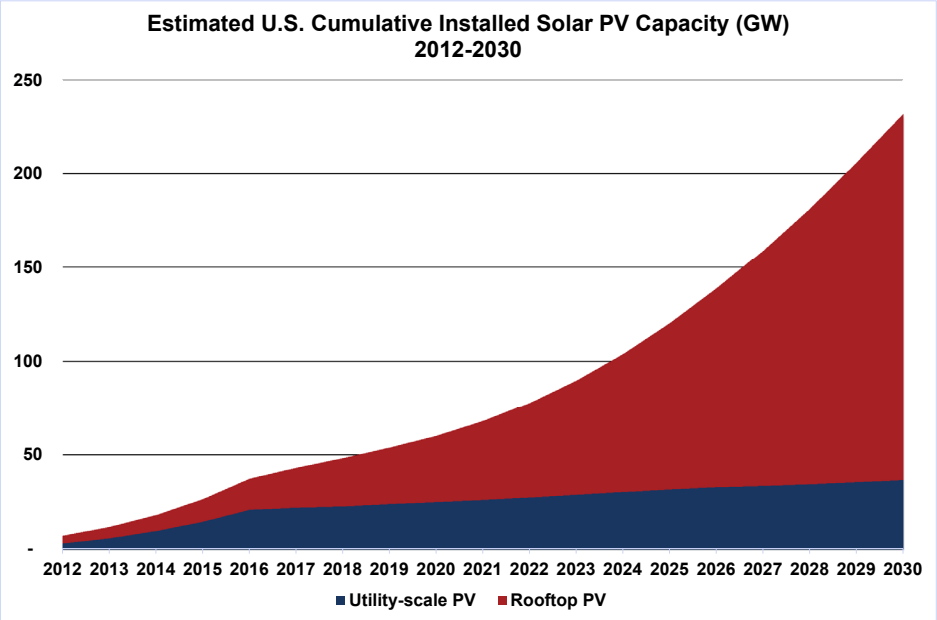


Figure 3. Estimated U.S. Cumulative Installed Solar PV Capacity, 2012-2030 (Source: Bloomberg New Energy Finance. 2015 New Energy Outlook - Americas. June 23, 2015)

Falling Costs and Increasing Efficiencies of Solar

In 1961, President Kennedy challenged the United States to land a man on the moon and return him safely to Earth by the end of the decade. In the same spirit, the Department of Energy's SunShot Initiative has challenged the nation to make solar energy cost-competitive with other forms of electricity.[14] The program has made considerable progress towards achieving its goal of driving down the cost of solar energy to $0.06 per kilowatt-hour, without incentives, by the year 2020: the average cost of solar PV panels has decreased by more than 60 percent and the cost of a solar electric system has decreased by more than 70 percent since 2010.[15] Today, solar is cost-competitive in fourteen states

where the solar levelized cost of electricity ranges from $0.10 to $0.15 per kilowatt-hour and the retail electricity price comes in at $0.12 to $0.38 per kilowatt-hour.[16]

What is Levelized Cost of Electricity?

The levelized cost of electricity (LCOE) is a summary measure of the cost of energy-generating technologies. The LCOE considers an assumed lifespan and utilization level in order to quantify the per-kilowatt-hour building and operating costs of a generating plant.[17] To calculate the LCOE, a variety of factors and inputs are assessed including capital costs, fuel costs, operation and maintenance costs, and financing costs.[18] The LCOE provides a way to compare the cost of installing a solar system to the rate for electricity charged by utilities. Due to nonexistent fuel costs for generation and very low variable operations and maintenance costs, LCOE for solar technology is mostly determined by capital and financing costs.[19]

While the cost of solar energy has declined, the efficiency of solar technology has increased. In 2014, the average capacity factor of solar projects built in 2013 was 29.4 percent, compared to 24.5 percent for 2011 projects.[20] This means that the same sized system can produce 20 percent more electricity.

What Does Rising Solar Demand and Falling Cost Mean for Georgia?

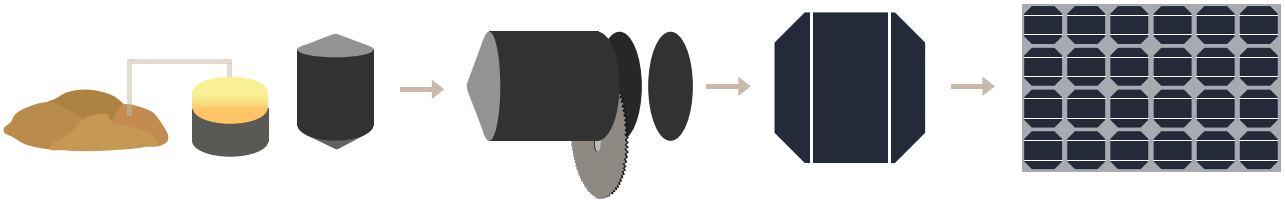
The offshoring of manufacturing jobs was not driven by intrinsic geographic, technological, or cultural factors; rather, aggressive policy and low wages in competitor nations shifted American jobs overseas.[21] The International Energy Agency conducted a detailed analysis of the manufacturing shift to China, which "suggests that the historical price advantage of a China-based factory over a U.S.-based factory is not driven by country-specific factors, but by scale, supply chain development, and access to finance."[22] State policy that helps build a market and develop the solar supply chain, promotes access to capital, and invests in solar workforce development will attract solar companies. With the right combination of policies, solar resources, available land, and access to capital, Georgia can compete for market-driven solar manufacturing, generation, installation, and exports.

Solar Technology Manufacturing

In order for Georgia policymakers and leaders to craft forward-thinking policy that reflects the future of solar technology, it is important to understand the solar manufacturing process and advances in the space.

The Solar Manufacturing Process

Crystalline silicon panel technology is the current standard for panels installed in the United States. There are four main steps to assemble a crystalline silicon panel.



Extracting and Purifying Silicon

The production of a PV panel begins by deriving silica from sand. After the silica is extracted, it is purified to make a high-purity silicon powder.

Manufacturing the Wafer

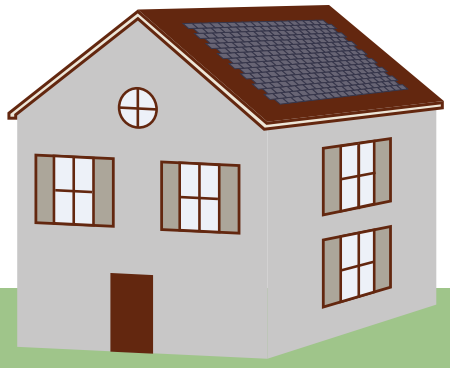
With the silicon powder, a wafer can be manufactured by doping the molten high-purity silicon with boron. Molten silicon is poured into a mold creating blocks of solid polysilicon. The block is then cut, polished, and cleaned.

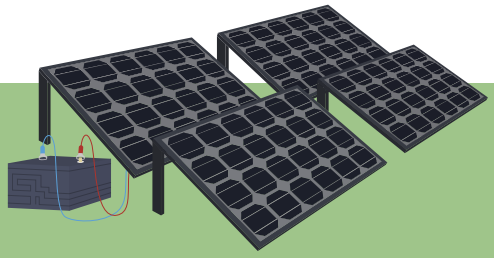
Assembling the Modules

During cell manufacturing, one side of the wafer is doped, usually with phosphorous. A conductive grid and anti-reflective coating are adhered to the top and a conductive back plate is assembled to the bottom of the cell. Cells are then combined electrically to form a module. A glass or film sheet is placed on the front and back. The module is covered by an outer frame, usually made of aluminum.

Assembling the Array

The finished solar panels are delivered to the customer. Downstream solar activities involve distribution, engineering design, contracting, installation, and servicing. There are also ancillary services involving financial, legal, and nonprofit groups that provide support for solar projects.





The Future of Solar

Research and innovation in the solar industry is leading to exciting breakthroughs

Building with Solar Cells
In the future, solar technology will be incorporated into the structure of a new building, rather than installed on a roof after construction is complete. For example, the near-medium-term future could see walls, skylights, windows, and shingles manufactured with solar materials.

Solar for the Home of the Future
"Smarter" solar panels will incorporate technology and sensors to provide real-time information about energy generation and demand. Unprecedented interconnectedness and energy management software will open the door for increased customization.

Organic Solar
Organic solar cells are a new type of carbon-based solar cell. This technology can be manufactured in innumerable applications, such as transparent paint. For example, windows could be coated in a transparent organic paint that provides electricity to the building.

Ultra-High Efficiency Solar Cells
The higher the efficiency of a solar panel, the more electricity it can create from the sun's rays. With ultra-high efficiency cells, less area is needed to obtain the same amount of electricity. Researchers project that solar cells could be four times more efficient in the near future.

Solar Soft Costs and Information Technology
Data-driven innovations will help reduce the soft costs of solar marketing and provision. Better data analytics will improve system design and uptake through performance modeling and investment projections. Lead generation firms and price comparison tools are already streamlining customer acquisition by connecting homeowners to solar installers.

Solar and Energy Storage
Solar panels only generate electricity when the sun is shining. New battery storage technology allows solar energy to be stored when excess electricity is generated during the day and then dispatched in the absence of sunlight.

Solar Supply Chain

The solar supply chain is comprised of companies working across a variety of technology categories. Several businesses in Georgia are already working in the solar industry, in areas such as advanced materials, manufacturing, and installation. Table 1 lists the number of in-state companies in Georgia in three major categories: Contractor/Installer, Manufacturing/Supplier, and Other (including financing, engineering, and legal support).

Table 1. Companies in Georgia's Solar Supply Chain

CATEGORY	NUMBER IN THE STATE
Contractor/Installer	87
Manufacturing/Supplier	40
Other	47
Total Companies	**174**

One of Georgia's greatest strengths within the solar supply chain is Georgia Tech's University Center of Excellence for Photovoltaics (UCEP), the premier crystalline PV research center in the United States. The center is home to cutting edge solar innovation that aims to fabricate solar cells at record-high efficiency and establish guidelines for creating the most cost-effective and efficient PV devices.[23] Significantly, Suniva, a leading U.S. manufacturer of high-efficiency crystalline silicon solar cells and modules, is a successful product of the UCEP center.[24] Suniva is based in Metro Atlanta and provides Georgia with a competitive edge over other states as it is one of the only companies in the United States to manufacture solar cells.[25]

Additionally, several companies in Georgia make components for PV panels such as module framing, PV wire, and connection cables. These components are necessary for the construction of complete solar modules, further increasing the strength of Georgia's solar supply chain. Since 2008, SolarWorld, a top producer of solar panels and installation equipment, has purchased $20.1 million in solar parts, services, materials, and supplies from the state of Georgia.[26] With a strong manufacturing base and increasing solar demand, Georgia has the opportunity to expand exports of solar components to other states.

Georgia's Solar Cluster

Using the detailed location information provided by the SEIA Solar Jobs Company Database, Georgia's solar supply chain was mapped to show the development of natural clusters in the state. The map below shows that a dense solar cluster is beginning to form around Atlanta. This cluster is bolstered by proximity to one of Georgia's top universities, the Georgia Institute of Technology.

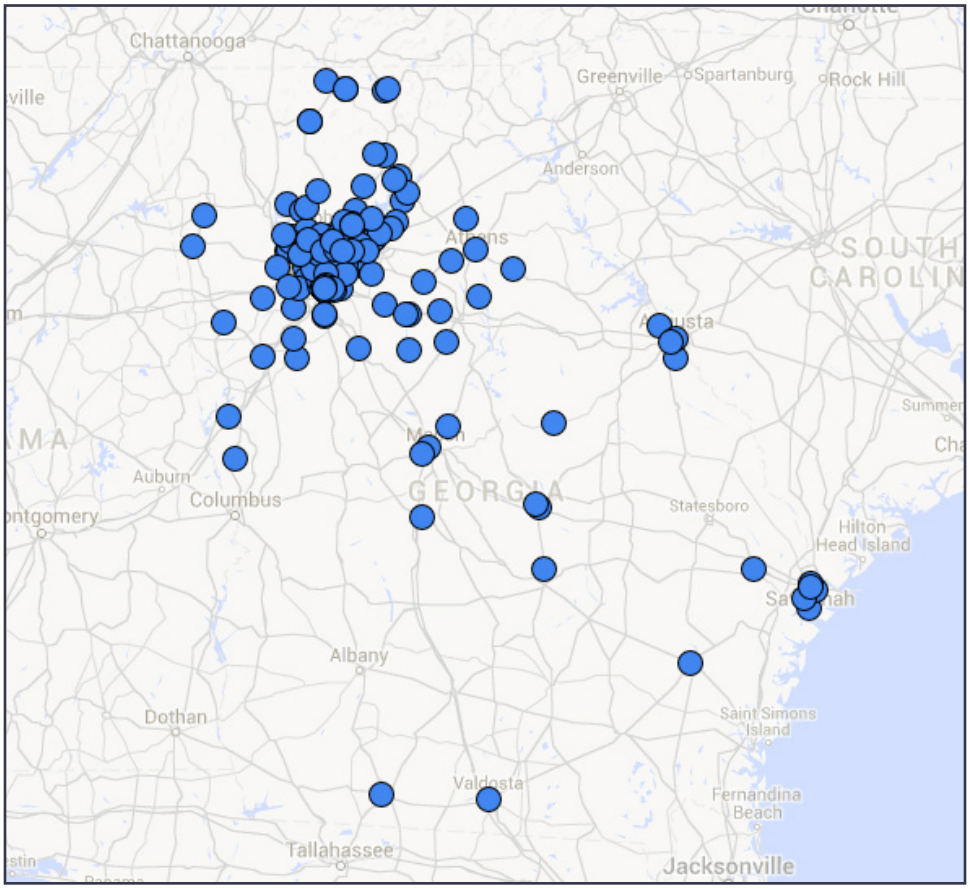


Figure 4. Georgia's Solar Companies Forming a Cluster Around Atlanta (Source: SEIA.org)

Roof-integrated photovoltaic shingles
Photo Credit. U.S. Department of Energy

Georgia Tech Solar Panels
Photo Credit. Georgia Tech Research Institute / Wikimedia Commons

Solar Employment Potential

As demand for solar skyrockets, Georgia has the opportunity to expand the solar economy, increase in-state spending, and employ an average of more than 18,600 Georgians annually over the next fifteen years. If optimistic projections prove to be correct and Georgia's solar companies are able to fill most of their supply chain needs with in-state purchases, over 279,000 direct, indirect, and induced job-years would be generated. While more than 92,000 of those would be direct job-years in the state's solar industry, over 186,000 indirect and induced job-years could be created if solar companies were able to procure supplies from in-state companies.

These projections for job-years potential in Georgia's solar industry are based on tools and analysis by the National Renewable Energy Laboratory (NREL), Energy Information Administration, and Bloomberg New Energy Finance. Additionally, the Jobs and Economic Development Impacts tool (JEDI) was utilized to estimate job-years at different levels of local supply chain concentration for rooftop solar (residential and commercial buildings) and utility-scale solar.

To highlight why clustering supply chain businesses in Georgia is so important, we have estimated the number of direct, indirect, and induced jobs based on future demand and the percentage of supply chain purchases made within the state. Figures 5 and 6 show how the number of rooftop and utility-scale solar job-years vary as the local share changes. The figures show the number of direct, indirect, and induced jobs based on local purchase percentages of 25 percent, 50 percent, and 75 percent. This range was chosen to represent reasonable goals for average local purchases, as 0 and 100 percent both represent extremes of purchasing behavior that we do not believe are realistic. Since projections often vary, we analyzed how those supply chain differences affect three reputable estimates of future demand: Bloomberg New Energy Finance as a high-demand scenario, the Energy Information Administration Annual Energy Outlook 2015 Clean Power Plan Base Policy as a moderate scenario, and DOE Office of Energy Efficiency and Renewable Energy's Wind Vision as a low-demand scenario. Figure 5 presents estimates for utility-scale construction, operations, and maintenance jobs. For rooftop solar, estimates of construction, operations, and maintenance jobs are in Figure 6.

In all three demand scenarios, increasing the percentage of local spending by Georgia's solar companies creates thousands of job-years. For example, in the high-demand scenario, increasing in-state local purchases from 25 percent to 75 percent would create almost 123,000 direct, indirect, and induced job-years. In

What is a Job-Year?

A job-year is one full-time equivalent job for one year (i.e., forty hours per week for fifty-two weeks, which is 2,080 hours per year). If two people each work a part-time job for twenty hours per week for fifty-two weeks, this is counted as one full-time equivalent job for one year, i.e., one job-year. If one person works forty hours per week for ten years, this is counted as ten job-years.

Why use job-years?

By using job-years, our analysis can take into account the length of a job. In energy projects, many construction and installation jobs are short-term, while manufacturing and maintenance jobs may be long-term. Using job-years allows us to accurately count both types of jobs. For example, if ten full-time solar construction workers are expected to each spend 208 hours on a utility-scale solar project, this is measured as one job-year. Alternatively, if one full-time engineer is expected to spend fifteen years operating that same solar array, this is measured as fifteen job-years. In our analysis of Georgia's solar supply chain, total job-years are aggregated over the 2016 to 2030 period.

Direct, Indirect, and Induced Job-Years

In order to estimate the potential economic impact of Georgia's solar supply chain, direct, indirect, and induced job-years are measured.

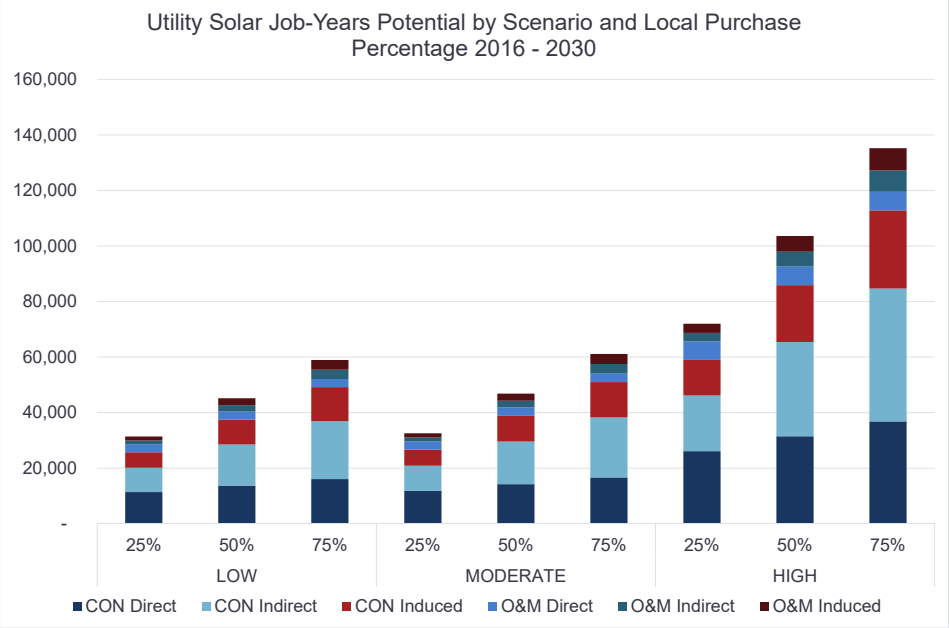
- Direct job-years: reflect jobs created in the solar industry to meet demand
- Indirect job-years: reflect jobs created at supply chain companies resulting from increased transactions as supplying industries respond to increased demand from Georgia's solar industry
- Induced job-years: reflect jobs created throughout the local economy as a result of increased spending by workers and firms in Georgia's solar and solar supply chain industries

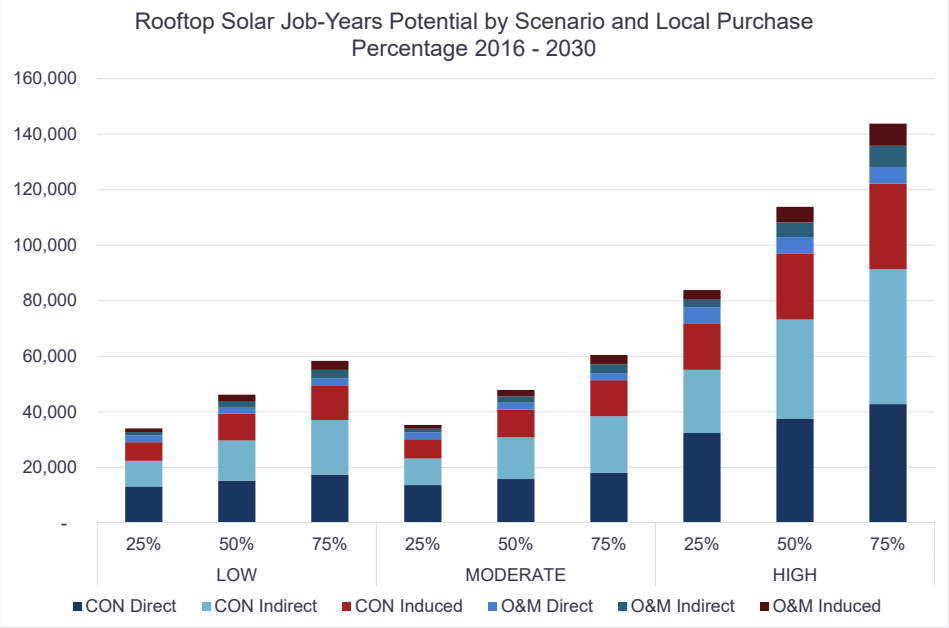
Local Share

Local share is the percentage of expenditures that are spent in Georgia. For example, if a solar installation company plans to spend $3 million on imported solar PV panels and $1 million on additional supplies from companies in Georgia, the local share is 25 percent. In the JEDI model, local share is an independent variable.

the moderate-demand scenario, that same increase in in-state local purchases would create over 53,700 job-years. Even in the low-demand scenario, increasing the percentage of in-state local purchases from 25 percent to 75 percent would create nearly 51,800 direct, indirect, and induced job-years.

If a concerted effort were made by the state to fill in the supply chain and strengthen the solar cluster, Georgia companies could meet the expected demand for rooftop and utility-scale solar, creating more than 186,000 job-years. Increasing the number of supply chain businesses can create thousands of good-paying, skilled jobs and make Georgia a leader in the solar industry.





Figures 5,6. Utility and Rooftop Solar Job-Years Potential

Policy Recommendations

Georgia has made recent strides in implementing policies that support solar power in the state. In order to build on this momentum and create thousands of good-paying, skilled jobs, Georgia can focus on innovative policies that remove obstacles and boost demand. Having a robust in-state market will attract private investment, strengthen the economy, and create new value chains, which will subsequently stimulate and accelerate new export markets.

Policy 1: Streamline Solar Permitting

Costly and inconsistent permitting and approval processes burden the solar industry in Georgia. Municipalities and counties across Georgia have varying permitting and interconnection procedures and fees, which significantly slows the solar installation process and increases costs to customers and installers. Furthermore, high costs due to cumbersome permitting and interconnection requirements have been shown to deter solar installers from entering markets all together.[27,28]

Modernizing solar permitting for residential and non-residential customers is a low-cost, straightforward way to strengthen Georgia's solar market. Current barriers to the permitting process include high permit fees, complex processes, and inconsistency across jurisdictions.[29] Addressing these challenges will reduce complexity, cut down soft costs, and signal to solar installers that Georgia's counties and municipalities are ready for their business. Projections show that streamlining permitting processes could reduce the cost of the average residential solar project by $700 and that standardizing local regulatory regimes could reduce the cost of a project by over $2,500.[30]

Georgia can look to recent successes in reducing permitting time and costs in Vermont and Colorado. In 2011, Vermont passed legislation that simplified and standardized the permitting requirements across the entire state, as well as reduced the processing time for solar projects.[31] In Vermont, local utilities have ten days to review the standard application and raise any related issues.[32] If no issues are raised within that time frame, the project is automatically approved for construction. In Colorado, the Fair Permit Act of 2011 reduced permitting fees for solar projects, ensuring that customers were not charged more than was necessary to review their project.[33] Colorado set the fee cap at $500 for residential systems and $1,000 for non-residential projects.[34]

San Jose, California integrated the solar permitting process into their city webpage and offers extensive permitting information in one easy-to-use location.[36]

Georgia could similarly lower soft costs and increase efficiency at a low cost to the state by streamlining permitting information, applications, forms, procedures, and technical requirements and making them readily available online. Streamlining the solar permitting process is a low-cost and low-risk solution for bolstering in-state solar markets. Offering this information online allows customers and installers to submit, review, print, and pay for permits in one convenient location. Integrating a permit checklist into a website that offers access to information and resources on solar installation can reduce mistakes while curbing time related to permitting processes.[35] By eliminating unnecessary fees and reducing the variability in permitting requirements across the state, Georgia can help lower the overall soft costs of installing solar.

Policy 2: Encourage Foreign Direct Investment

Georgia's governors have made efforts to recruit international companies to the state to create jobs for citizens. Georgia's Department of Economic Development (GDEcD) collaborates with international firms to help them relocate or expand business operations in Georgia. The GDEcD international investment team assists businesses from eleven strategic global markets around the world in tailoring site searches for available buildings, accessing programs to recruit and train workers, and gathering information on operating costs, taxes, potential suppliers, and financial incentives.[37]

The state already has a successful track record of foreign direct investment within the solar industry with Kimoto Tech, Inc., a Japanese company specializing in films and specialty substrates. Kimoto Tech opened a facility in Cedartown, where it manufactures solar cell films. To further enhance the robustness of the state's solar manufacturing supply chain, Georgia could look to additional foreign direct investment. The Governor and GDEcD can fill gaps in the solar supply chain by embarking on international investment missions to bring solar manufacturers to Georgia.

Direct foreign investment offers significant benefits for the state of Georgia in terms of job creation and economic stimulus. Existing business-friendly policies, simplified administrative procedures, and a skilled and competitive workforce all establish Georgia as solid ground for global business. With successful foreign direct investment strategies, Georgia can attract overseas solar component manufacturers to strengthen the solar manufacturing industry.

Policy 3: Create a Property Tax Exemption for Solar

Georgia has no statewide laws governing property tax assessment of solar PV systems,[38,39] which leads to local variation in how a system is valued both immediately after it is built and throughout the life of the equipment.[40] Real property and personal property over $7,500 are both taxable in Georgia, which has implications for solar installations.[41] Property taxes can have significant impacts on the financial viability of new and existing solar PV systems: an average solar system can raise the value of a home by up to $20,000.[42] Bundling solar PV installations into property tax assessments lowers the incentive to adopt solar because it raises costs for solar homeowners.

A solar property tax exemption is a simple measure to incentivize residential investments in solar. Thirty-eight states including Texas, Louisiana, and North Dakota currently grant property tax exemptions for solar panel installations and other advanced energy technologies.[43,44] Allowing exemptions identified in the state constitution or passing new legislation are two common methods to address property tax measures.[45] None of the eighteen U.S. jurisdictions that lack a property tax exemption for solar energy systems—Georgia included—rank among the top states in the country in terms of the amount of solar capacity installed, despite the fact that many of these states are located in regions of the country that receive relatively high amounts of solar energy.[46]

Given Georgia's promising solar capacity potential, the state could consider implementing a property tax exemption for solar to bolster the state's growing solar economy.

In 2008, Georgia passed the Clean Energy Property Tax Credit, which provided a one-time property tax credit for investments in clean energy and energy efficiency technology.[47] The program, which ended in December 2012, provided up to a $10,500 property tax credit per solar PV installation.[48] The law didn't address the property tax assessment implications of installing solar.

Policy 4: Offer a Green Source Rider Program

Corporate demand for renewable energy is growing. As renewable energy has become increasingly cost effective, companies have started setting sustainability goals that include purchasing more renewable energy. Fortune 500 companies, including Intel Corporation and Starbucks, have declared their public commitment to renewable energy.[49] By the end of 2015, fifty-one companies had signed on to a collaborative declaration demanding access to clean electricity.[50] These firms purchased 3.4 GW of renewable energy in 2015—three times the amount purchased in 2014.[51] For many corporations, solar-powered electricity is increasingly desired. Corporate buyers have more than doubled their installed solar capacity since 2012.[52]

Over 80 percent of Fortune 500 companies have Georgia locations, and twenty Fortune 500 companies have global headquarters

in the state.[53] With rapidly increasing demand, many firms in Georgia and those considering locating in Georgia want streamlined access to renewable energy.[54] Georgia's largest utilities could meet this demand through a Green Rider Program, which would allow large corporate customers to voluntarily purchase renewable energy without shifting costs to other ratepayers. Green Rider programs have been adopted in ten states across the country.[55] Georgia Power and other utilities could draw from recent innovations by Duke Energy in implementing a similar program.

> Duke Energy offers the Green Source Rider program to provide large energy-intensive customers, such as manufacturers, big-box retailers, college campuses or data centers, with the option to offset their planned energy consumption with renewable energy.[56] Under the program, customers who have added at least 1 MW of new demand since June 30, 2012 can apply for a three to fifteen-year contract to buy power from renewable sources.[57] Rates are negotiated with each customer and customers are charged a monthly administrative fee, as well as an additional two-tenths of a cent per kilowatt-hour.[58] Participating companies have a different rate structure through the program to ensure that non-participating ratepayers do not pay any additional costs.[59] Google was the first customer to participate in the program, purchasing 61 MW of energy from a solar project in Rutherford County, North Carolina in December 2015 to serve its data center.[60]

A Green Rider program would support Georgia's business-friendly climate, while helping to bolster the state's solar sector.

Policy 5: Establish a Solar Factory Retooling Financing Program

Georgia is the fastest growing solar market in the United States based on growth in capacity,[61] but the state produces very few of the PV panels used to generate electricity. Although companies can find available manufacturing facilities using Georgia's online building-finder portal,[62] the cost of retooling a factory is a barrier to entry for solar PV manufacturers. Georgia can become a leader in solar manufacturing by initiating a Solar Factory Retooling program that will encourage in-state manufacturing of solar products through a revolving loan fund. Georgia can model its Solar Factory Retooling initiative after successful programs in Wisconsin.

In 2009, Wisconsin established the Clean Energy Manufacturing Revolving Loan Fund (CERLF) to provide low-interest financing (up to $1 million) to private companies for manufacturing facility upgrades.[63] For example, Gearbox, a Wisconsin-based manufacturer of wind turbine components, utilized CERLF funding to expand and grow its advanced energy operations.[64]

CERLF is jointly managed by the Wisconsin Economic Development Corporation and the Wisconsin Public Service Commission. The revolving loan fund received funding through the American Recovery Act and now boasts $38 million of working capital and equipment.[65]

Georgia's manufacturers could use loans to purchase machinery and equipment, upgrade or build facilities, or as initial operating capital. To receive a loan, firms could be required to meet metrics such as energy efficiency benchmarks or a minimum number of jobs produced in the state. Implementing a Solar Factory Re-tooling program will send a signal that Georgia is serious about cultivating its solar manufacturing industry and attracting middle-class jobs.

Chapter Summary

Smart, strategic policy choices can help Georgia leverage the state's unique dual strengths in advanced materials and advanced manufacturing in order to create a thriving solar economy. Fortunately, there are a number of low-cost and low-risk policy options that state leaders can implement to strengthen Georgia's solar sector. As clusters coalesce around a nucleus of activity and relationships, Georgia's policymakers should consider removing barriers and stoking in-state demand in order to create a diverse and robust economy.

Chapter 3: Smart Building and Energy Efficiency Technology

This chapter provides a guide to the emerging smart and efficient building sector in Georgia through analysis of the existing supply chain, an overview of Georgia's potential for smart building jobs, and policy recommendations for further strengthening and developing the sector.

Georgia's policymakers will play a decisive role in the future of energy efficiency and smart building technology in the state. Targeting the emerging smart building cluster with strategic policy choices creates good-paying jobs, while helping the state's residents and businesses save money on energy costs. By emphasizing growth and technological innovation in the smart building sector, Georgia will be able to take advantage of opportunities not only in meeting the demand for smart building products from a strong in-state market, but also in exporting to regional, national, and international markets.

What are Smart Buildings?

Smart buildings utilize information technology to automate operations with the goal of comfort and productivity, as well as energy efficiency and low environmental impact. Integrated sensors and controls connect thermal and electrical systems (e.g., lighting, appliances, plug-loads, energy generation and storage, heating and cooling), often organized under an energy management system. Through machine-to-machine communication, systems are able to respond and adjust to changing conditions in order to optimize building performance.

Energy Monitoring System
Photo Credit. U.S. Department of Energy

Georgia's Strengths, Weaknesses, Opportunities, and Threats in the Smart and Efficient Building Sector

STRENGTHS	WEAKNESSES
• Existing foundation of energy efficiency companies and talent, showcased in Atlanta's Better Buildings Challenge success • State policies that help drive energy efficiency (2009 IECC Building Energy Codes and ASHRAE 90.1-2007) and lead-by-example programs, such as the Governor's Energy Challenge 2020 • City of Atlanta's energy efficiency targets, benchmarking and retrofit policies, and efficient public lighting programs • Atlanta City Council's building energy benchmarking and disclosure ordinance • In-state advanced energy manufacturers produce various items for lighting, insulation, and refrigeration	• Lack of state-administered financial incentives for energy efficiency • No new state energy efficiency legislation or initiatives in recent years post-American Recovery and Reinvestment Act (ARRA) funding • Non-investor-owned utility (IOU) electricity providers are not subject to the Integrated Resource Planning process
OPPORTUNITIES	**THREATS**
• Efforts to remove financing barriers to energy efficiency can be further expanded or enhanced through PACE and on-bill financing • Advanced metering infrastructure allows Georgia Power customers to monitor their electricity use online • The Integrated Resource Planning process (which takes place every three years) requires IOUs to consider the impact of energy efficiency improvements	• Low electricity prices reduce incentives to pursue energy efficiency • Competition from other states, such as Illinois, North Carolina, and Colorado

Georgia's building efficiency sector is the largest of the state's advanced energy sectors. Georgia is home to 654 firms with 11,858 full-time building efficiency jobs, accounting for 52 percent of all clean energy firms, 62 percent of all clean energy full-time jobs, and $2.1 billion in revenue.[1] Georgia also has ample experience in smart grid technologies through research at Georgia Tech and other higher education institutions, the City of Atlanta, and the array of Atlanta-based companies driving advancements in this space. Additionally, Georgia received American Recovery and Reinvestment Act (ARRA) funding in 2009 for seven smart grid infrastructure improvement projects.[2] Capitalizing on the current momentum of smart grid infrastructure in the state represents a significant opportunity to expand Georgia's current smart building sector.

The City of Atlanta's leadership in energy efficiency policy and smart building technology development has further strengthened the sector in Georgia. Key energy efficiency policies and programs include the Atlanta Commercial Buildings Energy Efficiency Ordinance[3] and the 2010 Sustainability Plan, which outlines a 40 percent municipal energy reduction target by 2030.[4] Additionally, Atlanta is currently participating in the U.S. Department of Energy's Better Buildings Challenge.[5] The city has become the national leader in the Better Buildings Challenge[6] and third in the nation for the most Energy Star-certified buildings in 2015.[7]

Despite favorable achievements, Georgia still has room to reduce energy waste and reap the economic benefits of utilizing energy-efficient products manufactured in the state. Compared to other states, Georgia ranks thirty-seventh in the ACEEE's 2015 State Energy Efficiency Scorecard, dropping in rank from the previous year.[8] The state would benefit from implementing broad energy efficiency policies to enhance the existing smart building sector and reduce energy waste. In particular, Georgia lacks policies that remove regulatory barriers to energy efficiency investments for utilities. Pairing the state's existing Integrated Resource Planning (IRP) process with policies that incentivize utility companies to invest in energy efficiency programs will help the smart building sector grow.

The state has several energy efficiency policies and incentives that offer opportunities for expansion. For example, while Georgia Power provides five residential and three commercial energy efficiency programs, the budget allocated for these programs is still relatively small compared to other states.[9] Expanding these programs and increasing their budgets provides an opportunity for growth in the promising building efficiency space, particularly outside of Atlanta. Furthermore, Georgia has financing mechanisms in place that level the playing field for

energy efficiency investments. These policies can be expanded and updated to create a more robust market for energy efficiency in the state. Through policy leadership aimed at overcoming these barriers, Georgia stands to prosper by eliminating energy waste and boosting its smart building cluster.

Smart Building and Energy Efficiency Market Trends

Rising Demand

Buildings (commercial and residential) account for 41 percent of energy use in the United States.[10] Transforming how buildings are designed, built, and operated can help reduce energy use and save money.

Demand for smart building and energy efficient technology is growing nationally and globally. The global market for smart homes and buildings is expected to grow from $4.8 billion of revenue in 2012 to more than $35 billion by 2020.[11] This growth is attributed to government regulations, rising energy costs, and increasing environmental awareness.[12] Significantly, $12.4 billion of this market is expected to be in North America and the sector is expected to grow at more than 25 percent per year.[13] Furthermore, worldwide smart appliance sales will grow from $5 billion in 2015 to $34 billion by 2020.[14] This represents a considerable opportunity for Georgia companies to position themselves on the cutting edge of smart building and energy efficiency technology, provided a position of strength can be identified for industry growth and export leverage.

Increasing Market Share for Smart Buildings 2015-2020 (in Billions)

Compound Annual Growth Rate: 29.5%

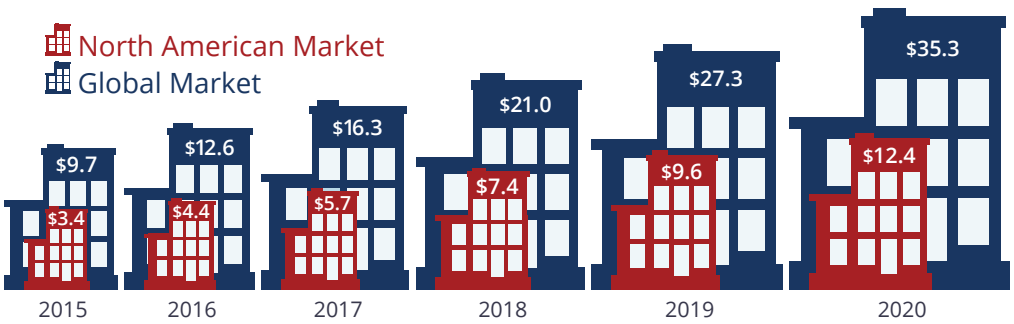


Figure 7. Source: Allied Market Research, "Global Smart Homes," January 2014

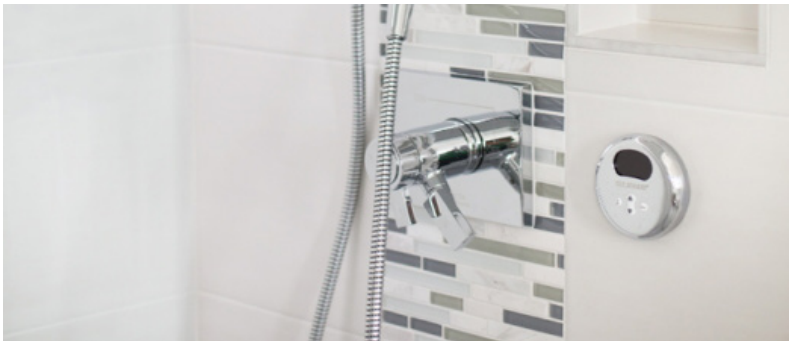
Smart buildings are "smart" because they utilize integrated sensors and controls to provide two-way communication and automated control between lighting, appliances, plug-loads, heating, and cooling systems; distributed energy generation; and energy storage systems. Oftentimes, these smart components are connected together through a home energy management system (HEM) for residential buildings or a building energy management system (BEM) for commercial and industrial buildings. These connections allow the building components to work together to maintain comfort while attaining maximum efficiency.

Typically, energy management systems include components that underpin the foundations of a smart building including sensors, controllers, actuators, and perhaps most importantly, management software. New BEM market entrants have attracted $1.4 billion in venture capital investment since 2000, which represents 26 percent of all investment in building energy technology arenas.[15]

Falling Costs

The costs of sensors have dropped dramatically in recent years, making average return-on-investment payback periods on smart building upgrades very short—two years, in many cases.[16] Significantly, the average cost per square foot of smart lighting systems has dropped by half or more in the past few years.[17] The Department of Energy's Building Technologies Office (BTO) has a goal of driving the cost of sensors and controls for buildings down to $1 per node installed.[18] BTO projects that by 2030, cost-effective technologies will exist to save buildings 35 percent of their energy usage.[19]

Additionally, smart buildings allow constant commissioning of equipment, meaning building managers or owners can make proactive repairs as opposed to costly reactive emergency repairs. Innovations in automation and smart sensors can also drive efficiencies in water use, security systems, and emergency detection of fires and other dangerous situations.[20]



Hot water button to reduce water waste
Photo Credit. Department of Energy

Smart Building Technology

In order for Georgia policymakers and leaders to craft forward-thinking policy that reflects the future of smart building technology, it is important to understand the different applications of smart building technology and advances in the space.

Smart Building and Energy Efficiency Supply Chain

The smart building supply chain consists of companies working across a variety of technology categories. For example, to achieve greater reliability and lower energy consumption, there must be a smart grid capable of communicating with the buildings. Additionally, smart meters are required to communicate between the grid and buildings. Energy management systems control the lighting, temperature, HVAC, air quality, security, and other energy consumption systems within the building. Smart appliances communicate with smart meters and mobile devices to optimize electricity consumption. Behind all these elements, sensors detect changes in the environment and are used to control the building.

Many businesses in Georgia currently design, research, and manufacture smart building products and services. This includes the design and construction of new buildings and the installation, maintenance, and sale of building system components. Table 2 describes each of these technology categories and lists the number of in-state companies.

Table 2. Companies in Georgia's Smart Building Supply Chain

CATEGORY	COMPANIES IN THE STATE	DESCRIPTION
Sensors	1	Devices used to measure surrounding or operating conditions.
Energy Management/ Building Automation Devices	3	Facilities that manufacture components used in home automation or energy management or facilities that retrofit existing buildings.
Smart Appliances	0	Washers, dryers, dishwashers that have connectivity capabilities.
Advanced Lighting	8	Lighting devices that have connectivity capabilities or react to surrounding light conditions.
Construction/Retrofit/ Automation Contractors	7	Design and install energy-efficient technology.
Advanced Materials	0	Materials that react to surrounding conditions.
Smart Meters/Smart Grid Capabilities	8	Devices that would help buildings work in conjunction with smart grid infrastructure.

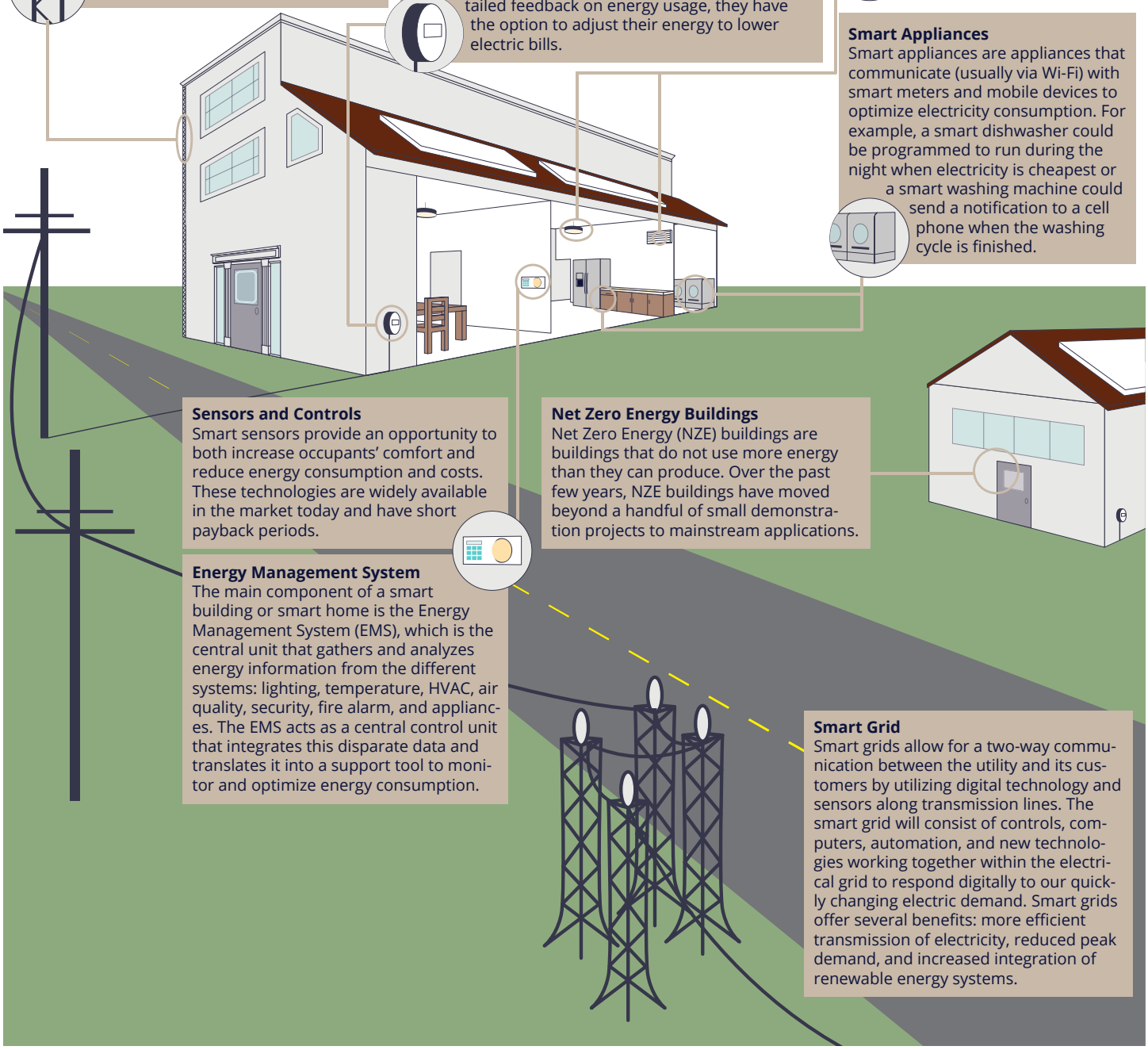
Smart Building Technology

Building Envelope
Envelopes include walls, windows, insulation, and roofing. A well-insulated structure without air leakages will prevent heat loss during cold weather and keep heat out during hot weather, greatly reducing heating and cooling demands. Similarly, insulated windows with low-emissivity coating and automated exterior shading contribute to energy savings. Reflective rooftops and walls can reflect UV, visible, and infrared radiation, reducing air conditioning needs.

Smart Meters
Smart meters are a tool to obtain information from the two-way communication system existing in a smart grid. Smart meters help the energy providers manage the demand on the grid and increase service and reliability. This allows the electric companies to monitor the electric system more quickly and make a more informed decision about which power resources to use at a given time to maximize efficiencies. On the consumer side, smart meters help the user see how and when their home or business is consuming energy. By offering the customer more detailed feedback on energy usage, they have the option to adjust their energy to lower electric bills.

Lighting and Equipment
Lighting, air conditioning, ventilation, and heat pumps are the main uses of energy in a building. Upgrading to the most efficient HVAC systems, Energy Star appliances, and lighting have proven to reduce energy bills. In particular, solid-state lighting upgrades can reduce lighting energy use by nearly one-half.

Smart Appliances
Smart appliances are appliances that communicate (usually via Wi-Fi) with smart meters and mobile devices to optimize electricity consumption. For example, a smart dishwasher could be programmed to run during the night when electricity is cheapest or a smart washing machine could send a notification to a cell phone when the washing cycle is finished.



Sensors and Controls
Smart sensors provide an opportunity to both increase occupants' comfort and reduce energy consumption and costs. These technologies are widely available in the market today and have short payback periods.

Net Zero Energy Buildings
Net Zero Energy (NZE) buildings are buildings that do not use more energy than they can produce. Over the past few years, NZE buildings have moved beyond a handful of small demonstration projects to mainstream applications.

Energy Management System
The main component of a smart building or smart home is the Energy Management System (EMS), which is the central unit that gathers and analyzes energy information from the different systems: lighting, temperature, HVAC, air quality, security, fire alarm, and appliances. The EMS acts as a central control unit that integrates this disparate data and translates it into a support tool to monitor and optimize energy consumption.

Smart Grid
Smart grids allow for a two-way communication between the utility and its customers by utilizing digital technology and sensors along transmission lines. The smart grid will consist of controls, computers, automation, and new technologies working together within the electrical grid to respond digitally to our quickly changing electric demand. Smart grids offer several benefits: more efficient transmission of electricity, reduced peak demand, and increased integration of renewable energy systems.

Georgia's Smart Building Cluster

The City of Atlanta's participation in the Better Buildings Challenge and the presence of the City Energy Project have established Georgia's capital as a leader in advanced energy technology. As demonstrated by the map below, a smart building cluster has formed around the Metro Atlanta area. The cluster is particularly strong in home and building automation and smart grid technologies.

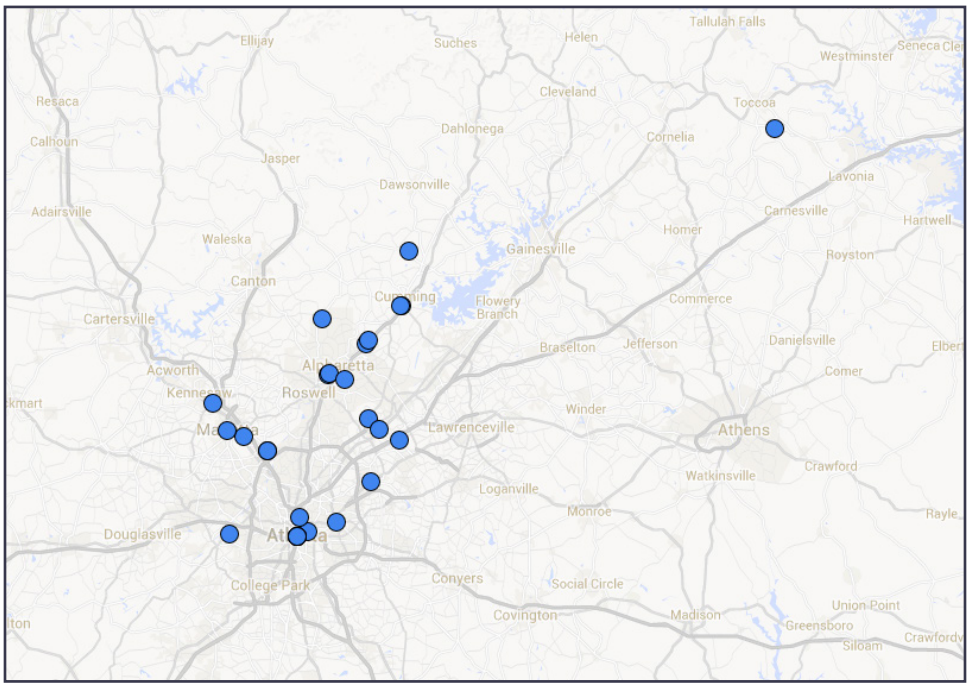
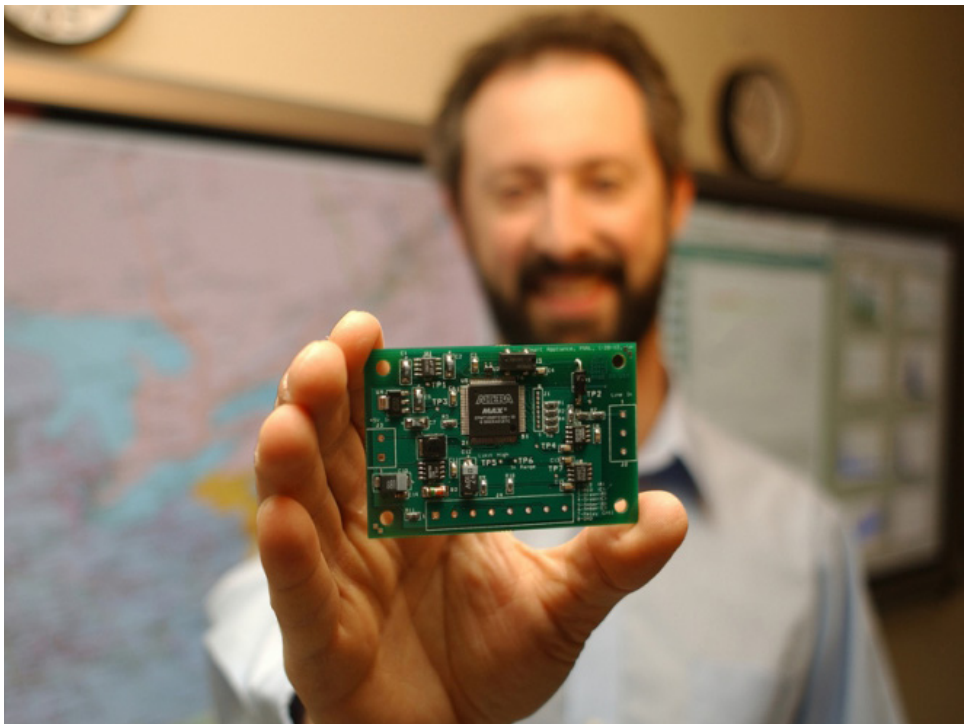


Figure 8. Map of Smart Building Supply Chain

Smarthome automation control
Photo Credit. Samsungtomorrow / Foter / CC BY-NC-SA



Integrated circuit to help make home appliances more responsive to the electric grid.
Photo Credit. U.S. Department of Energy

Installing energy efficient windows.
Photo Credit. Department of Energy

Smart Building And Energy Efficiency Employment Potential

As demand for smart buildings and energy efficiency improvements skyrockets, Georgia has the opportunity to expand the economy, increase in-state spending, and employ an average of over 5,300 Georgians annually over the next fifteen years. If optimistic projections prove to be correct and Georgia's smart building and energy efficiency companies are able to fill most of their supply chain needs with in-state purchases, over 80,000 direct, indirect, and induced job-years would be generated. While nearly 27,000 of those would be direct job-years in the state's smart building and energy efficiency industry, over 53,000 indirect and induced job-years could be created if those companies were able to procure supplies from in-state businesses.

These projections for job-years potential in Georgia's smart building and energy efficiency industry are based on tools and analysis by the University of California Berkeley's Donald Vial Center on Employment in the Green Economy and the Energy Information Administration (EIA). We utilized the Energy Efficiency Jobs (EEJ-1) model to estimate direct job-years based on projections of energy efficiency savings and generally accepted economic multipliers.

To highlight why clustering supply chain businesses in Georgia is so important, we have estimated the number of direct, indirect, and induced jobs based on future efficiency within the state. Figure 9 shows how the number of energy efficiency and smart building job-years vary as the percentage of supply chain purchases made within Georgia changes. The figure shows the number of indirect and induced jobs based on multiplier effects of 2.0, 2.5, and 3.0. Since projections often vary, we analyzed how those supply chain differences affect three reputable estimates of future demand: the EIA's Annual Energy Outlook 2015 for the Clean Power Plan's High Energy Efficiency Compliance forecast as a high-demand scenario, the EIA's Base Policy forecast as a moderate-demand scenario, and the EIA's No Energy Efficiency Compliance forecast as a low-demand scenario.

In all three demand scenarios, increasing the percentage of local spending by Georgia's smart building and energy efficiency companies creates thousands of job-years. For example, in the high-demand scenario, an increase of in-state supply chain purchases that raises the multiplier from 2.0 to 2.5 would generate over 13,000 indirect and induced job-years. Even in the low-demand scenario, that increase in in-state supply chain purchases would create over 9,000 indirect and induced job-years.

What is a Job-Year?

A job-year is one full-time equivalent job for one year (i.e., forty hours per week for fifty-two weeks, which is 2,080 hours per year). If two people each work a part-time job for twenty hours per week for fifty-two weeks, this is counted as one full-time equivalent job for one year (i.e., one job-year). If one person works forty hours per week for ten years, this is counted as ten job-years.

Why Use Job-Years?

By using job-years, our analysis can take into account the length of a job. In energy projects, many construction and installation jobs are short-term, while manufacturing and maintenance jobs may be long-term. Using job-years allows us to accurately count both types of jobs. For example, if ten full-time electricians are expected to each spend 208 hours installing LED lighting in a new smart building, this is measured as one job-year. Alternatively, if one full-time engineer is expected to spend fifteen years operating that smart building, this is measured as fifteen job-years. In our analysis of Georgia's smart building and energy efficiency supply chain, total job-years are aggregated over the 2016 to 2030 period.

Direct, Indirect, and Induced Job-Years

In order to estimate the potential economic impact of Georgia's smart building supply chain, direct, indirect, and induced job-years are measured:

- Direct job-years: reflect jobs resulting from initial changes in demand in Georgia's smart building industry.
- Indirect job-years: reflect jobs resulting from changes in transactions between industries as supplying industries respond to increased demand from Georgia's smart building industry.
- Induced job-years: reflect jobs resulting from changes in local spending as a result of increased demand in Georgia's smart building and indirect industries.

Multiplier

Multipliers are used to capture the secondary effects of increases in direct job-years. A multiplier of 1.0 signifies that no indirect or induced job-years will be created. A multiplier of 2.0 signifies that, for every one direct job-year, the number of indirect and induced job-years created in the local economy will add up to one full-time equivalent job-year. For example, if rising demand for energy efficient upgrades creates ten new HVAC installation job-years and the local multiplier is 2.5, then fifteen new indirect and induced job-years will be created in the local economy.

If a concerted effort were made by the state to fill in the supply chain and strengthen the smart building and energy efficiency cluster, Georgia companies could meet the expected demand from the residential, commercial, and industrial sectors, creating over 53,000 job-years. Increasing the number of supply chain businesses can create thousands of good-paying, skilled jobs and make Georgia a leader in the smart building and energy efficiency industries.

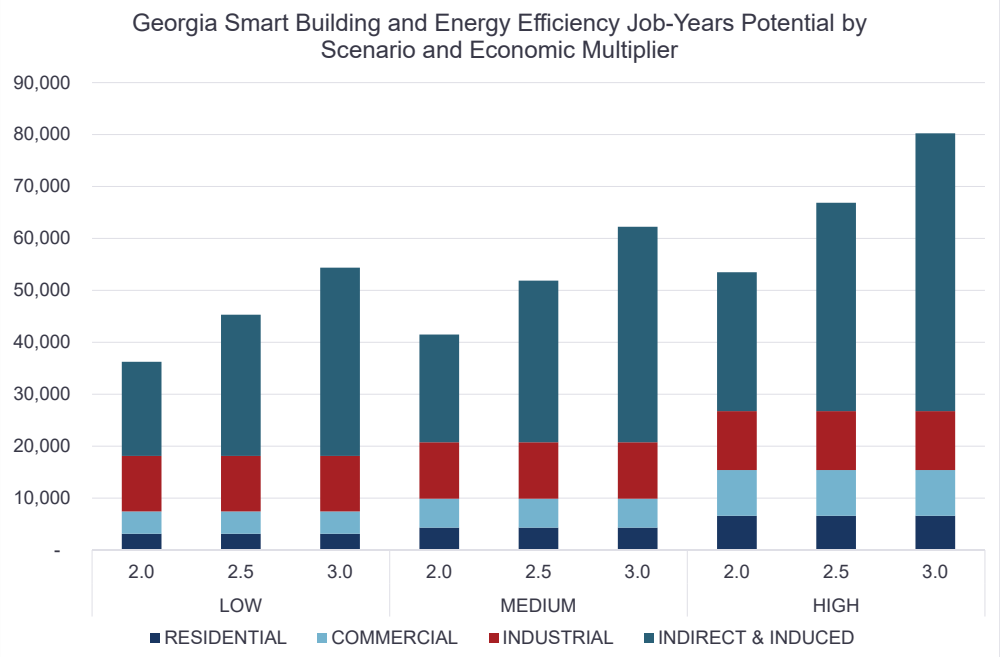


Figure 9. Smart Building and Energy Efficiency Job-Years

Installing a smart meter
Photo Credit. pgegreenenergy / Foter / CC BY

Policy Recommendations

Georgia policymakers can bolster the state's smart building and energy efficiency cluster by (1) removing financial and regulatory barriers to spur investment in energy efficiency and (2) exploring new and existing policies that stimulate demand within the state. Creating a robust in-state market will attract private investment, strengthen the state's economy, and create good-paying jobs for residents.

Policy 1: Make Property Assessed Clean Energy (PACE) Financing Simple

In 2010, Georgia leaders confirmed the importance of financing energy efficiency investments by passing PACE-enabling legislation. The PACE program addresses the access to capital barrier that many building owners face.[22] This significant financing tool helps put energy efficiency on a level playing field with other investments that a small business may be considering.

Georgia's PACE legislation should have made it easier for property owners to obtain private loans; however, only Atlanta has established a PACE program to date.[23] Other cities and municipalities in Georgia could follow Atlanta's lead and establish local PACE programs. To empower other local governments to quickly and efficiently launch PACE programs, Georgia could create a standardized design and implementation plan. Texas has led the way on this front with the creation of Keeping PACE in Texas, a nonprofit that united more than 100 PACE stakeholders to develop a best practice toolkit called "PACE in a Box."

Best Practice: "PACE in a Box"

The Texas Legislature passed the PACE Act in June 2013.[24] Keeping PACE in Texas, a nonprofit organization, spurred local municipality support for the legislation and encouraged city participation throughout the state. The organization also developed "PACE in a Box," a toolkit that contains all of the necessary information for any city in Texas to implement PACE. The toolkit standardizes the implementation of PACE across the state, while drawing on best practices from other examples across the country.[25] "PACE in a Box" also allows larger cities with more resources like Austin and Houston to customize the program by picking and choosing from best practices.[26] "PACE in a Box" was seeded with $200,000 from the Texas State Energy Conservation Office and $800,000 from foundations and PACE stakeholders.[27] As a result of that investment, Texas now has a uniform, scalable, turnkey program that facilitates the creation of consistent PACE programs throughout the state.[28]

Property Assessed Clean Energy Financing (PACE)

PACE programs allow property owners to pay for renewable energy and energy efficiency investments with a loan that is repaid through their property tax bill. The loans are attractive for borrowers because energy investments often require more upfront capital than would otherwise be available to many residents. Lenders are willing to offer attractive interest rates because their loan is secured by a tax lien on the property. PACE financing is now available in over 800 U.S. municipalities and more than 80 percent of the country's population lives in states that provide PACE financing.[21]

By developing similar guidelines, Georgia could equip cities and counties to quickly and efficiently create their own PACE programs. The Texas toolkit is online, providing Georgia with accessible resources to write its own high-quality toolkit for a small fraction of the cost. Ensuring that PACE financing is broadly available for installing efficient building equipment can stimulate demand for the state's smart building sector.

Policy 2: Expand On-Bill Financing for Georgia Power

What is On-Bill Financing?

On-bill financing allows utilities (or financial institutions) to provide the upfront capital to finance energy efficiency improvements through a loan that is repaid over time on the customer's monthly utility bill.[29] Savings from energy efficiency upgrades are paired directly with monthly loan payments on the bill and regular payments are collected by the utility company until the loan is fully repaid.

Financing home energy improvements can be challenging because these types of investments often involve high upfront capital investments. This financial barrier can be prohibitive, especially for working families and seniors living on fixed incomes.[30] To overcome these barriers, Georgia should consider providing utility customers with on-bill financing, a simple and convenient tool for covering the upfront costs of efficiency improvements.

Georgia has already taken steps to increase access to this significant financing tool. The Georgia Environmental Finance Authority (GEFA) provides a mechanism for utilities to deploy on-bill financing for Georgia's 24 Energy Management Cooperatives (EMCs) and three municipalities.[31] GEFA's on-bill financing opportunities were funded by the Energy Efficiency and Conservation Block Grant Program, which was part of the American Recovery and Reinvestment Act (ARRA). At the time GEFA offered this program, Georgia Power, the largest energy provider in the state, did not participate.[32]

While ARRA funding is no longer available, Georgia Power could administer an on-bill program or partner with state Energy Service Companies (ESCOs), city or state governments, or investment firms. At the state government level, GEFA has developed a state agency manual for performance contracting and a list of pre-qualified vendors.[33] Utilizing GEFA's list of energy service companies,[34] Georgia Power could begin an on-bill financing program for their customers. Alternatively, Georgia Power could recruit private lenders to fund on-bill loans while they provide payment processing, servicing, and other functions. Implementing on-bill financing through the largest energy provider in the state would help residential and commercial customers overcome the initial financial barrier to energy efficiency investments.

Policy 3: Use Revenue Decoupling to Encourage Energy Efficiency

Because of the way utilities are structured, utility companies lack incentives to encourage investment in energy efficiency and to explore innovations that would serve their customers.[35] Traditionally, utilities are authorized to recover their costs and provide a reasonable rate of return for their investors. Based on estimated sales, regulators set a price on electricity for the next several years that allows the utility to recover their revenue requirement.[36] This structure can create problems if energy efficiency or distributed energy generation reduces a utility's sales. If electricity sales are below estimates, the utility may be unable to recover their expected return on investment. This dynamic can create a disincentive for utilities to establish energy efficiency programs.

Close to half the states have addressed this problem by adopting some form of decoupling regulation for their utilities.[38] Georgia's natural gas utilities are regulated under a form of decoupling called a "straight fixed variable rate" design.[39] This model differentiates between a utility's fixed costs and the variable costs (the cost of the gas) on a customer's monthly bill. The utility imposes a set ratepayer fee on its fixed costs, and recoups a steady stream of revenue each month without regard to the amount of natural gas sold.[40] The variable part of the bill (the gas sold) is thus decoupled from the fixed portion. Similar regulatory reform could be implemented on the electric utility side as well.

Recent research highlights the success of revenue decoupling mechanisms across the country. Efforts in Idaho and Wisconsin offer examples of how decoupling can be implemented. By removing the disincentive for energy efficiency, decoupling can open the door for increased energy savings. For example, energy efficiency savings increased in Idaho from 0.5 percent in 2006 before decoupling was implemented to 1.3 percent in 2010.[41] Additionally, by adding more stability to utility earnings, decoupling may lower the future cost of capital that utilities receive from investors. This could provide long-term savings if utilities can access low-cost financing for investing in grid infrastructure.

Decoupling is an important part of aligning financial incentives for energy efficiency and can play a part in driving greater innovation in Georgia. The governor could issue an executive order requiring the Georgia Public Service Commission (PSC) to implement a decoupling rule. The process for implementing some decoupling mechanisms would require formal rulemaking from the PSC. There are a number of regulatory mechanisms that could achieve this result.

What is Decoupling?

Under decoupling, regulators set a target revenue level for utilities. If electricity sales are reduced due to energy efficiency or distributed energy generation, electricity rates automatically adjust without a lengthy or expensive rate case process.[37] This can keep utilities on track to meet their revenue requirement and reduce the volatility in their earnings. It also reduces the disincentive for utilities to implement energy efficiency programs.

What is Benchmarking?

Benchmarking building energy performance is an important tool for realizing energy savings. Benchmarking informs businesses and other organizations about how they use energy, where they use it, and what drives their energy use. It provides information about opportunities to increase profitability by lowering energy costs and offers a reference point for gauging the effectiveness of energy management practices and insights for continuous improvement. Additionally, benchmarking gives governments information that can be used to set building codes and standards for the future. Consistent benchmarking translates into tangible energy savings: buildings that benchmark their energy use over three years save an average of 2.4 percent per year.[42]

Policy 4: Adopt Municipal Benchmarking Ordinances

Atlanta has recently committed to several initiatives that will make it a top-tier sustainable city in the United States. The city has participated in two large scale projects: the Department of Energy's Better Buildings Challenge aimed at reducing resource use by 20 percent by 2020, and the City Energy Project, which is a ten-city initiative aimed at establishing an ordinance for each city's building efficiency.

Significantly, Atlanta passed the Commercial Buildings Energy Efficiency Ordinance in April 2015, becoming the first city in the Southeast to implement energy reduction targets for commercial buildings.[43] The ordinance requires energy performance monitoring and reporting for all commercial buildings over 25,000 square feet,[44] covering 2,350 buildings in the city (80 percent of the commercial sector). The city estimates that the policy will help create 1,000 jobs each year initially and reduce commercial energy use by 20 percent by 2030. The policy is also expected to cut 2013 carbon emissions levels in half by 2030.[45]

Other cities in Georgia should consider following Atlanta's leadership in benchmarking and use the Atlanta ordinance as a blueprint for their own performance monitoring and reporting. Benchmarking could support Georgia's energy efficiency and smart building sector, as well as help cities achieve significant environmental and economic benefits.

Tracking electricity usage
Photo Credit. U.S. Department of Energy

Policy 5: Update Georgia Building Codes

Georgia currently uses building codes that predate the rapid expansion of energy efficiency. The state has typically adopted past versions of the IECC and ASHRAE 90.1 standards with amendments to the code after its adoption. Georgia currently uses the 2009 IECC version and 2007 ASHRAE standards.[48] To create a greater market for efficiency products, the state could adopt the more current 2015 IECC building code. The Georgia Department of Community Affairs is currently promoting the 2009 IECC with amendments passed in 2011 and 2012. Alternatively, Georgia may choose to wait for the 2018 version to be released since the codes are updated every three years.

Changes in the 2015 IECC (over the 2012 version) that have a beneficial impact on residential energy include:[49]

- Increased insulation requirements for return ducts in attics.
- New requirements for heated water circulation systems and heat trace systems that are expected to reduce heat loss from pipes and energy use by circulation pumps.
- New insulation requirements for three-quarter-inch pipes, a common size in typical residential buildings.
- New demand control requirements for specific recirculating systems that are expected to reduce energy consumption.
- New requirement for historic buildings to comply with code unless there is "compromise to the historic nature and function of the building." Previously, historic buildings were generally exempted from the code.
- New requirement for outdoor reset control for hot water boilers that are expected to result in more efficient heating.

To support a competitive market for building energy efficiency, Georgia could implement the most recent building codes and couple their code adoption with a strong compliance plan. The costs of implementing the additional requirements in the 2015 codes vary across building type, but research shows that each subsequent IECC has led to considerable savings over the prior codes and decreases the cost of energy.[50]

What are Building Energy Conservation Codes?

The International Energy Conservation Code (IECC) is a residential building code created by the International Code Council to establish minimum design and construction requirements for energy efficiency in buildings. Codes established by the International Code Council are the most widely adopted codes for residential structures in the United States and many other global markets.[46] Commercial building codes are largely based on the ASHRAE 90.1 standards developed by the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).[47]

Policy 6: Pilot a Dynamic Rate Structure

Given the current lack of available energy storage, utilities must build or purchase adequate generation to meet system peak demand, despite the fact that the system only experiences peak demand intermittently. If utilities can reduce peak demand needs, they can avoid costly investments in generating facilities that are only utilized a small portion of the time. One way to reduce peak demand is by altering the rate structure provided to customers. With dynamic rates, they pay the real cost of generation at

any given time as opposed to the average cost of generating. Under this structure, customers respond to the higher price of power at peak times by reducing their energy use. The peak demand reduction saves the utility money, which is passed on to customers in the form of lower costs during off-peak times.[51] This structure may be especially attractive to energy-intensive industries, such as manufacturing, that are able to take advantage of energy during off-peak times.

Recognizing the benefits of this structure, Georgia Power currently allows its industrial and commercial customers to participate in a Real-Time Pricing (RTP) rate structure.[52] This program is one of the largest and most successful in the world: Georgia Power can shed 17 percent of demand, which equals approximately 800 MW of generation capacity under emergency conditions. This saves the company from building additional generation for those few times that demand is very high. The rate structure is built on a two-part tariff. Georgia Power works with customers to calculate their baseline usage. Once this is set, customers pay for their baseline use at the standard rate and are either charged extra or credited at the hourly rate depending on whether they consumed more or less in a given billing cycle. The hourly rate is the "real-time" component and tracks the marginal cost the utility experiences for providing power in that particular hour. Customers are notified of the hourly rates on a day-ahead or hour-ahead basis so they can plan consumption accordingly.[53]

Georgia Power currently offers RTP to very large customers (over 250 kW), dynamic pricing for residential customers with electric vehicles, and "peak nights/weekends pricing" for all customers on an opt-in basis.[54] If Georgia allowed residential and small business customers to participate in the RTP rate structure, they could positively impact demand for smart building products such as in-home displays, programmable thermostats, and smart appliances. This would also open the door for more energy- and cost-saving models, such as automated demand response programs. For example, Commonwealth Edison has partnered with local smart home device manufacturers to successfully implement a residential RTP program in Illinois.[55]

Georgia Power has already deployed advanced metering infrastructure (AMI) to its entire service territory.[56] This automation capability significantly reduces the transaction costs of extending RTP to residential and business customers and is also a requirement for gathering the necessary data to institute RTP. Georgia could encourage RTP by co-funding a pilot program that includes smart building technologies from vetted in-state producers. Georgia Power could then assess the results and take the program to scale if appropriate.

Chapter Summary

Smart, strategic policy choices can help Georgia leverage the state's unique strengths and base of legacy companies to create a thriving smart building technology and energy efficiency sector. Georgia has a strong manufacturing base with many companies already building energy-efficient products. As clusters coalesce around a nucleus of activity and relationships, Georgia's policy-makers can remove barriers and stoke in-state demand. Georgia can spur growth in the sector by adopting stronger building energy codes, introducing innovative financing options to remove barriers to energy efficiency investments, and tracking energy use at the city and state levels. Strategic policies and strong leadership could reduce waste, increase consumer choice, and make Georgia a more efficient and economically competitive state.

Chapter 4: Innovation Ecosystem and Access to Capital

In today's competitive, globalized economy, businesses are more likely to thrive in cities and states that offer a rich, innovative ecosystem and break down barriers to capital. A successful innovation ecosystem bridges the gap between the knowledge economy and the commercial economy, while access to capital programs provide the necessary funds to facilitate commercialization and expansion of businesses. State and local government institutions, as well as private entities, can take action and collaborate to maximize the impact of innovation, support new and expanding businesses, and create good-paying jobs in Georgia.

Innovation ecosystems foster quality research and development (R&D), help commercialize new technologies, and support early-stage businesses. Allowing ideas to be easily transferred from the lab to the marketplace accelerates further entrepreneurship and job creation. Robust innovation ecosystems include efficient intellectual property protection mechanisms, mentorships for entrepreneurs, and engagement of business and venture capital.

Seamless connections between researchers, entrepreneurs, investors, and non-dilutive capital are vital for advanced energy technology businesses to thrive. The new energy economy is a race, and only those capable of bringing innovative ideas to the marketplace quickly and efficiently will win.

Innovation Ecosystem

- Promotes research and development
- Facilitates movement of new technology to market
- Incubates early-stage businesses

Access to Capital

- Provides funding for new and growing businesses
- Connects investors with market opportunities
- Attracts entrepreneurs

Non-Dilutive Capital

Non-dilutive capital funding, such as grants and loans, does not affect ownership of a company. These funding sources may carry interest rates or have restrictions on how they are used, but will not affect the shares of the company.

Georgia's Innovation Ecosystem

Since the 1980s, Georgia has made innovation a top priority. Three nationally-renowned public research institutions—along with the private research powerhouse, Emory University—call Georgia home. Despite this innovation infrastructure, Georgia's venture capital still lags behind other states. When Georgia's venture funding peaked at $500 million in 2014, it only accounted for 1 percent of the national total.[1] Combining policies that give new companies greater access to capital with a continued focus on R&D and technology transfer would bolster Georgia's emerging advanced energy economy.

Research Institutions and Initiatives

Georgia houses a number of advanced energy research centers and institutes, several of which are relevant to solar and smart buildings. The Emory Bioinspired Renewable Energy Center aims to develop solar energy storage through photocatalytic processes,[2] while the Georgia Tech Strategic Energy Institute focuses on education, research, and technology transfer.[3] Suniva, a major manufacturer of solar panels in Georgia and Michigan, began at the University Center of Excellence for Photovoltaic Research and Education (UCEP) at Georgia Tech.[4] Georgia State University's Sensorweb Research Laboratory conducts research on smart grid applications, including high renewable energy penetration, micro-grids, and electric vehicle charging infrastructure.[5]

Georgia also benefits from a robust R&D pipeline. The pipeline includes the Georgia Research Alliance (GRA), which works with the state's university system and the Georgia Department of Economic Development to leverage $600 million of public funding.[6] Since its inception in 1990, the GRA has acquired $2.6 billion in additional investments, launched more than 150 new companies, recruited scientists to Georgia universities, invested in research technology for new labs, and fostered relationships with industry.[7] Additionally, Georgia Institute of Technology's R&D expenditures ranked twenty-fourth in 2014, outpacing universities such as University of Southern California and University of Texas at Austin.[8]

Resources for Startups

Georgia Tech's Integrated Program for Startups is a streamlined process that gives faculty, staff, and students access to a uniform licensing agreement, Advanced Technology Development Center (ATDC) resources, and one-on-one consulting with academic and industry experts.[13] Georgia Tech's Technological Innovation: Generating Economic Results program brings together Emory Law and Georgia Tech MBA students to help commercialize PhD students' research.[14]

Additionally, Georgia Tech has two successful university incubators: the VentureLab, which focuses on launching student-led startups, and the ATDC, which provides space, coaching, and networking services to startup companies. Companies that graduate from the ATDC boast a 90 percent success rate after five years.[15] In total, ATDC companies have raised over $2 billion in capital.[16] VentureLab offers three unique tracks: kickstarting startups, finding product and market fit, and establishing a repeatable model.[17] The 2015 VentureLab Startup Competition awarded $15,000 to Bioletics, a biotech startup founded by

Existing Technology Transfer Efforts in Georgia

University of Georgia, Clark Atlanta University, Georgia State University, Mercer University, Georgia Regents University, Emory University, Kennesaw State University, and Georgia Tech all feature an office dedicated to technology transfer and industry relations.[9] The University of Georgia's technology transfer office often ranks in the top five schools in the country for total number of licenses generated annually.[10] Kennesaw State University has revamped its technology transfer efforts and increased funding for the Research and Services Foundation from $50,000 to $10 million since 2009.[11]

Partnerships between large corporations and promising early-stage companies are a critical technology transfer pathway. The Georgia Mentor-Protégé Connection (administered by the Department of Economic Development, the Georgia Education Foundation, and Georgia Tech) helps foster this link by pairing mentor companies—such as AT&T, Coca-Cola, and Georgia Power—with nominated protégés.[12] Launched in 2012, the program creates jobs by helping small firms increase their capacity. Only small businesses nominated by a mentor firm may apply, and the business must be Georgia-based.

Georgia Tech and Emory students.[18] Additional in-state resources include Georgia State University's CollabTech in downtown Atlanta[19] and the University of Georgia's Innovation Gateway program.[20]

Private incubators have taken a foothold in Atlanta, Duluth, and Norcross.[21] Startup Atlanta focuses on scaling startups and connecting them with regional leaders. The organization has obtained thirty-five CEO pledges to evaluate at least one new product or service from an Atlanta startup and commit a senior executive to a startup's board of supervisors.[22]

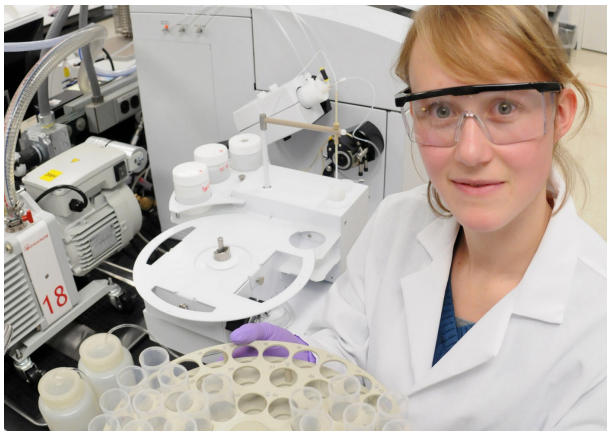
Government Programs

In addition to university and private-sector efforts, the Department of Economic Development maintains a Center of Innovation for Energy, which manages a $3 billion budget and connects advanced energy companies with key players, including state agencies, universities, industry, cities, and public service commissions.[23]

Summary

Georgia's ambitious approach to research is considered an increasingly crucial aspect of successful economic policy. A report from the Organization for Economic Cooperation and Development states that investment in knowledge-based capital (KBC) now accounts for a larger portion of national GDP than tangible capital.[24] Furthermore, KBC has a greater impact when resources can flow easily between KBC-intensive firms.[25]

By focusing on innovation and commercialization, Georgia will continue to attract entrepreneurs and investors to the state. Other states are beginning to take a larger role in coordinating their own innovation ecosystems, which will increase the competition for talent and investment capital across the country.



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Access to Capital

Access to capital is critical to the success of advanced energy technologies. New and growing businesses face severe financial hurdles during technology development, commercialization, and expansion. Having access to investors and non-dilutive capital can be the difference between success and failure. In order to maximize the success of advanced energy businesses that create good-paying jobs, states should consider actively facilitating access to capital.

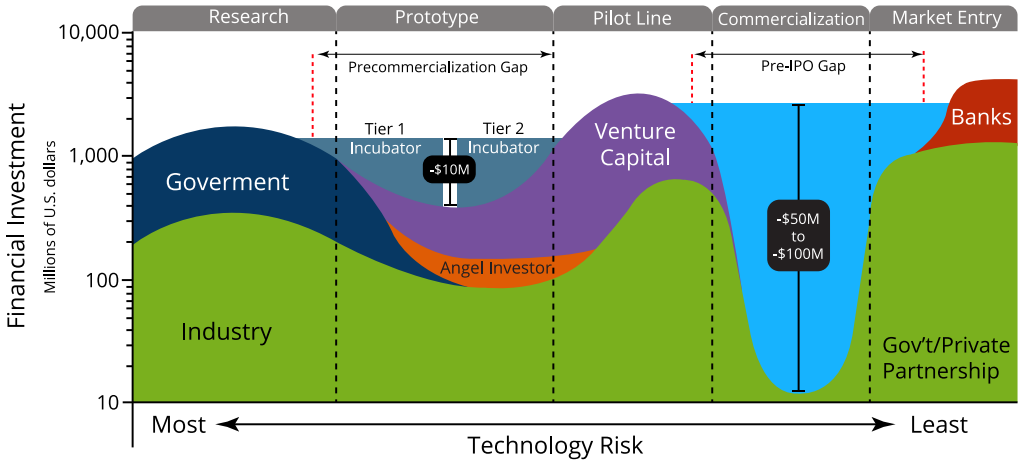

Figure 10. New technologies need help crossing the second "valley of death" during the commercialization process. (Source: Department of Energy)

Venture Capital and Funds

Georgia is home to at least twelve established venture capital funds.[26] Additionally, the Georgia Department of Economic Development has identified twelve networks as a source of financing for innovative entrepreneurs.[27] These networks include the Technology Association of Georgia, Ariel Savannah Angel Partners, Atlanta Technology Angels, Value Plus Ventures, CEO Ventures, and more. Angel investor networks can help facilitate deal flow and encourage further angel investment activity.[28] Additionally, the nonprofit Georgia Micro Enterprise Network disseminates training and lending opportunities across the state, featuring more than seventy members including Invest Atlanta, the OneGeorgia Authority, Crowdfunder, and other key players.[29]

Invest Georgia is a state venture capital "fund of funds" which uses public dollars to invest in venture capital funds and leverage additional private investment within the state.[30] The program's goal is to inject $100 million of public money into Georgia's startups and businesses over the course of five years, matched by at least an additional $100 million in leveraged private investment.[31] However, the program is far from its goal with only $10 million secured and future funding commitments are up in the air.[32]

Invest Georgia[37]

- Distribute funds to venture capital firms to invest in Georgia companies
- Eighty percent of profits go back to the fund to be reinvested, with 20 percent retained by the private venture capital firms
- Overseen by a public board of five members who appoint and supervise an independent administrator

Improving Access to Capital for Small and Early-Stage Companies[40]

- **Georgia Loan Participation Program:** State purchases up to 25 percent of an approved loan, ranging from $100,000 to $5 million.
- **Georgia Funding for Community Development Financial Institutions:** Credit to small businesses in underserved communities from a pool of $20 million.
- **Small Business Credit Guarantee:** Loan guarantees of 50 percent and a conversion option with a risk reserve pool that offers 80 percent reimbursement for losses.
- **Georgia Capital Access Program:** Currently a $2 million risk reserve pool for small business loans funded with borrower and lender fees matched with federal State Small Business Credit Initiative funds.

Georgia's research institutions generate hundreds of commercially viable inventions annually, but in recent years Georgia's innovation ecosystem has run into a venture capital setback. Over the last decade, more than twenty companies that incubated in Georgia's higher education institutions moved out of state.[33] A reason frequently cited for this flight of innovative firms has been the decline of available venture capital. From 2011 to 2012, venture capital funding in Georgia fell from $383.4 million to $265 million.[34] In 2014, the United States saw a 61 percent increase in venture dollars while Georgia lagged with a much smaller 29 percent increase.[35] Additionally, Georgia only captured 1 percent of total national venture funding in 2012 and 2013.[36]

Non-Dilutive Capital

The Small Business Jobs Act of 2010 provided Georgia with more than $45 million for leveraging additional private funds within the state.[38] The initiative has generated several mechanisms to improve access to capital for small and early-stage companies: the Georgia Loan Participation Program, funding for Community Development Financial Institutions to serve small businesses in low- to moderate-income and minority communities, the Small Business Credit Guarantee, and the Georgia Capital Access Program.[39]

Georgia benefits from local and regional loan programs as well. Invest Atlanta, the city's economic development authority, operates several loan programs for small businesses, including the Phoenix Fund, which lends $10,000 to $100,000 to assist with building, machinery, and working capital needs.[41] Georgia also boasts regional commissions that assist local governments with planning and development. The commissions offer small business loan programs through partnerships with the U.S. Small Business Administration. In the Northwest Georgia Regional Commission, for example, financial support for 149 businesses resulted in 2,369 jobs and a total investment of $78 million in the region.[42]

Tax Incentives

Georgia's R&D tax credits incentivize technological innovation. Similar to the federal structure, companies earn a tax credit as a portion of the yearly increase in their R&D expenditures. R&D expenditures in a given year that are in excess of the previous year's amount are multiplied by 10 percent and applied to 50 percent of the corporate income tax liability.[43]

Additionally, the state directly incentivizes angel investments with an Angel Investor Tax Credit worth 35 percent of the total investment, up to $50,000 per year.[44] The credit is designed to encourage investment in startups. The state also exempts

sales and use tax for an array of activities related to capital sale, purchase, and repair for manufacturing and high-tech companies.[45]

The Georgia Department of Economic Development (GDEcD) is the primary state agency that works to connect advanced energy startups with industry, universities, and investors, while also providing these companies with access to capital through tax incentives and small business loan programs. The GDEcD offers the job and investment tax incentives to businesses "engaged in manufacturing, warehousing and distribution, processing, telecommunications, tourism, or research and development industries."[46] Currently, "manufacturing" includes enterprises that manufacture solar components, wind components, batteries, biofuels, and electric vehicles. The agency could send a more direct policy signal by explicitly including "advanced energy" manufacturers as qualifying businesses.

The GDEcD runs six Centers of Innovation, including the Energy Technology Center,[47] which provide:

- Technical industry expertise to help develop ideas and products
- Exposure to new markets and opportunities
- Collaborative research with leading state universities
- Assistance with product commercialization
- Access to business, academic, and government resources to find solutions[48]

Summary

Although Georgia has a strong research pipeline and extensive commercialization efforts, access to capital remains a problem that must be addressed in order to foster robust economic clusters in the state. Currently, Georgia's declining venture capital numbers and relatively low influx of funding are impacting the state's competitiveness in the national and global advanced energy markets.

Types of Investors

- Accredited Investors are individuals with earned incomes that exceed $200,000 (or $300,000 if married) for three consecutive years or a net worth (not including their home) of $1 million or more.[53]
- Equity Crowdfunders are non-accredited investors allowed to invest in companies with restrictions on how much they can commit. The Invest Georgia Equity Crowdfunding Exemption allows non-accredited Georgia investors to invest up to $10,000 in any company based in the state.[54]

Policy Recommendations

Policy 1: Establish a Capital Gains Tax Exemption for Investments in Startups

Georgia is fighting for a larger share of venture capital and other early-stage investment funding to keep its university innovations and startups in the state. Instituting a tax exemption for investments in targeted early-stage Georgia companies would incentivize venture capital from accredited investors and equity crowdfunders. Georgia could offer a capital gains tax exemption for investments in qualified startup companies. The exemption could require a three-year minimum investment to be eligible, and could extend for up to ten years. Having patient capital gives companies more certainty and helps avoid the "valleys of death" during technology development and commercialization. Knowing that investors have an incentive to make long-term investments will attract startups to Georgia.

A similar program has been successful in the United Kingdom. From 2013 to 2014, the Seed Enterprise Investment Scheme (SEIS) raised $240 million through investment in almost 2,000 companies.[49] This shows significant growth compared to the 2012-2013 cycle, during which 1,155 companies raised $125 million.[50] Almost 1,700 of the 2013-2014 companies were raising funds under SEIS for the first time, representing $215 million of the total investment.[51]

Other countries have taken note of the program's success and are attempting to replicate the results. For example, the Australian Government is rolling out their National Science and Innovation Agenda in July 2016, which includes a tax exemption for investments in early-stage companies. The plan is based on the success of the United Kingdom's SEIS program.[52]

Policy 2: Facilitate Partnerships within the Energy Innovation Ecosystem

Given the complex nature of the advanced energy space, having effective partnerships across sectors is critical in making progress and fostering innovation. Strategic alignment between Georgia's leading research universities, private companies, nonprofits, and government entities can accelerate advanced energy sector growth and create good-paying jobs for Georgia's residents. Better cross-sector organization for energy innovation can take several forms, including the advancement of shared policy objectives, the enhancement of visibility around energy innovation issues, and the coordination of resources.

Collaboration is especially important given the increasing amount of capital directed toward early-stage R&D. The U.S. government plans to double its current level of investment in advanced energy activities over the next five years.[55] Aligning various stakeholders in the energy innovation ecosystem can help attract capital, bring breakthrough research to market, and make Georgia a key player in the advanced energy space.

Georgia could capitalize on corporate demand for innovation. For example, Southern Company recently established the Energy Innovation Center to develop new energy technologies and improve customer value.[56] Based near Georgia Tech, research is driven by employee ingenuity, university collaboration, and industry partners.[57] The state could play a larger role in connecting businesses to other groups in the advanced energy R&D space.

In order to strengthen the advanced energy sector, the GDEcD could invest in coordination efforts that align the in-state innovation ecosystem to attract more public and private research money and venture capital funding. Proactively aligning efforts will help Georgia compete and continue to thrive as an engine for innovation.

Chapter Summary

Georgia has a well-established innovation ecosystem that includes a robust research and development apparatus, as well as strong technology transfer efforts. The state's universities, incubators, applied innovation centers, and tax incentives provide Georgia with a broad foundation for spurring growth in advanced energy businesses. Policymakers have signaled interest in addressing the state's access to capital shortage for early-stage firms by creating Invest Georgia, but following through on funding commitments to unlock private capital and stimulate further investment is critical for success. Additionally, Georgia could improve the environment for startups by continuing to lead the way on equity crowdfunding and implementing a capital gains tax exemption for startup investments. Pro-market, forward-thinking policies like these would allow Georgia's advanced energy entrepreneurs to continue to innovate, bring ideas to market, and create good-paying jobs for residents.

Ohio Federal Research Network

Recognizing the importance of coordination within and across sectors, the state of Ohio funded the Ohio Federal Research Network in July 2015.[58] Wright State Applied Research Corporation will receive $20 million over the course of two years and The Ohio State University will receive $5 million to establish a collaborative network between Wright-Patterson Air Force Base, NASA Glenn Research Center, state academic research programs, and the private sector.[59] About $10 million of the total funding will be used to create a model of how the research network will run.[60]

The Ohio Federal Research Network's goal is to acquire $300 million in new federal research contracts for Ohio-based companies in the next five years.[61] Estimates show that this funding will result in 2,500 new jobs, $250 million in private sector investment, and one hundred companies established or expanded.[62]

Chapter 5: Workforce Development for Solar and Smart Buildings

A skilled workforce is fundamental to the success of an industrial cluster. If firms in the same sector are able to coordinate with the government, schools, and related nonprofits on policies and programs to train workers for their sector, they will be better equipped to identify their employment needs and find workers with needed skills to fill available jobs.

Many jobs in the solar and smart building clusters require skilled workers, which provide an opportunity to increase the number of good-paying positions for Georgia's residents. This is especially important given the Great Recession's disproportionate impact on mid-wage jobs in Georgia. Mid-wage employment accounted for 52 percent of private-sector job losses and only 15 percent of gains from the post-recession recovery.[1] Investments in training and education programs that provide workers with solar and smart building skills will help the state maximize its advanced energy economy.

In terms of jobs and revenue, building efficiency is the leading advanced energy industry in Georgia. The sector provided 11,858 full-time jobs in 2015 and accounted for $2.1 billion in revenues.[2] Companies in this space face gaps in high-performance building experience and energy auditing expertise,[3] suggesting there is an opportunity to invest in programs that train workers with these skills.

Georgia's solar sector has experienced strong job growth in recent years. The state's solar industry employed more than 3,200 solar workers in 2015, representing a 10 percent growth from 2014.[4] The approval of third-party financing is likely to further bolster solar growth in Georgia, increasing demand for good-paying jobs in the industry. However, half of Georgia solar firms currently find it "very difficult" to find the workers they need.[5] Georgia solar firms are also less likely to provide on-the-job training programs for their employees compared to out of state firms (76 percent in Georgia compared to 89 percent nationwide).[6] The state has an opportunity to address solar skill shortages and increase the pool of qualified workers by investing in training programs.

A thoughtful, sector-based workforce development approach should include: industry best practices for recruiting, hiring, training, promotion, and compensation; education and training infrastructure (including community colleges, project-based learning experiences, and apprenticeship programs); and public policy, specifically rules, regulations, and funding streams related to workforce and education.[7] Leaders in the state can focus these efforts on those regions and populations that are still experiencing high unemployment.

Workforce Development Strengths

Georgia's robust public education system and existing workforce development efforts provide a strong base for professional and technical skill expansion. The state's extensive higher education system educates thousands of students through a network of public universities and technical colleges. Georgia also currently promotes various workforce expansion and professional training opportunities within the advanced energy sector.

Universities and Technical Colleges. The University System of Georgia (USG) consists of thirty public institutions of higher education, including world-renowned universities such as Georgia Institute of Technology and the University of Georgia. The system includes four research universities, four comprehensive universities, nine state universities, and thirteen state colleges. The USG graduates a sizeable number of students each year, granting a total of 58,809 degrees in 2014, including 36,302 bachelor's degrees, 10,454 master's degrees, and 1,521 doctorates.[8]

The Technical College System of Georgia (TCSG) provides another layer of education for Georgians through a network of twenty-two technical colleges. In 2014, TCSG enrolled more than 140,000 students and nearly 30,000 students graduated.[9] The TCSG provides students with vocational-focused training and education opportunities with technologies that are prevalent in the Georgia economy. Each technical college is assigned a service delivery area, which allows them to establish strategic partnerships with local businesses in order to create education and training programs that directly benefit local companies.[10] The TCSG has been successful at placing its students in the workforce, with job placement levels topping 80 percent.[11]

Quick Start. Georgia is home to Quick Start, an award-winning workforce training and development program. Quick Start develops workforce training systems for companies that are relocating to Georgia or looking to expand their current operations in the state. Based on a company's industry and unique goals,

the program utilizes state funding to create custom work training programs at no charge to the company.

Since its inception in 1967, Quick Start has completed 6,527 projects and trained almost 1.1 million workers.[12] In 2013, the program helped create 9,431 jobs and save an additional 2,997 jobs.[13] Quick Start has consistently been ranked number one in the United States in surveys of site professionals and has provided training for companies such as Baxter International, Caterpillar, and Mitsubishi Power Systems Americas.[14] Significantly, 70 percent of Quick Start's projects are outside of the Metro Atlanta area, giving residents outside the state's capital an opportunity to fill high-skilled positions.[15]

Quick Start provides a tremendous opportunity for the advanced energy economy in Georgia. The program has proven to be effective in attracting new companies to enter the state, as well as helping existing companies grow their operations. Georgia can expand on the success of this homegrown, competitive advantage by leveraging the experience Quick Start has already garnered in nearly fifty years of training workers.

Energy Efficiency Training. The Southface Energy Institute is an Atlanta-based organization with the goal of promoting sustainable cities through education, research, advocacy, and assistance to Georgia communities. Southface provides an array of training courses for professionals across different areas of energy efficiency. In 2013, Southface supported 144 trainings attended by over 3,500 individuals across the Southeast.[16] Notably, the program's Southeast Weatherization and Energy Efficiency Training (SWEET) Center is one of the few in the nation to become an Interstate Renewable Energy Council (IREC) Accredited Training Provider.[17]

Photo Credit. PSNS & IMF / Foter / CC BY-NC-SA

Policy Recommendations

To ensure the success of the advanced energy sector in the state, Georgia's policymakers must commit to workforce development efforts that target solar and smart building skill gaps. Georgia can build upon existing job growth and education, training, and certification programs to capitalize on expansion opportunities in the state.

Policy 1: Develop Certificate and Degree Programs Around High-Performance Buildings

The lack of knowledge surrounding high-performance buildings is a major workforce development barrier in the smart building space.[18] To address this knowledge gap, Georgia could look to its universities and technical colleges to provide certificate programs in energy efficiency and high-performance building assessment.

> In other states, community colleges have filled this knowledge gap by offering degrees and certificates tailored to the skills needed to operate a high-performance building. For example, Laney College, a community college in Oakland, California, is home to the Environmental Control Technology program, which offers an associate degree and three certificate programs for high-performance building education. The college is also in the process of establishing a Building Performance and Energy Efficiency degree to expand student learning beyond individual systems within a building, such as HVAC and lighting. The new program will take a holistic, integrative approach to managing smart buildings of the future. These programs help students acquire skills in system programming, building operations, performance measurement, and sustainable design. Typical courses include Control Systems Networking, Psychrometrics and Load Calculations, and Energy Management and Efficiency in Building Systems.[19]

Georgia's leaders could work with universities and technical colleges to create programs focused on high-demand skills, such as data analysis, controls, and programming. Developing these programs in the TCSG system would be especially valuable because, as other states have shown, many of these skills can be gained in two years. Allowing students to graduate in the shortest time possible should reduce program costs, making these programs affordable and accessible to more Georgians. With these certificates and programs, graduates would be prepared to

enter the efficient building workforce in a variety of good-paying, skilled roles, including installers, operators, code officials, LEED experts, home energy raters, and smart building managers.

Policy 2: Develop Degree Programs In Energy Engineering and Sustainability Science to Meet the Growing Demand for Workers

In order for the state's advanced energy economy to thrive, Georgia requires workers with advanced energy and energy engineering skills. Georgia does not yet have a degree program focused on sustainability science or management. Only related courses are offered in the state.

Across the nation, several universities have successfully established programs in advanced energy or energy engineering, including Pennsylvania State University. Through the B.S. in Energy Engineering, the university offers a multi-disciplinary education, with courses in renewable energy, electrochemical engineering, business, finance, and management.[20] During the first two years of the program, students take classes similar to most other engineering degrees, but during the last two years, they take classes that apply engineering skills to energy problems. For example, students apply thermodynamics and chemical processing to the natural gas and biomass industries.[21] The program also offers internship opportunities with the Department of Energy and opens the doors to a wide range of career opportunities for graduating students.[22]

Additionally, energy engineering programs could consider providing hands-on training with energy systems so students obtain a knowledge base of renewable and alternative energy systems, which will prepare them for new systems that are sure to develop in the future.

To establish a similar energy engineering program in Georgia, Albany State and Georgia Tech University could collaborate to establish a new major. The partnership could tie into Albany State's existing Regents Engineering Transfer Program, which enables students to begin their engineering studies at Albany State and receive a B.S. degree in engineering from Georgia Tech. Another option is to expand Albany State's Dual Degree (3+2) Program, which allows students to graduate with both a B.A. from Albany State and a B.S. in Engineering from Georgia Tech in five years.[23] The new program could follow Penn State's model of offering a multi-disciplinary education with hands-on training. Because Albany State is a historically Black college, creating an

energy engineering program could have a meaningful impact on unemployment rates for African-Americans in Georgia, which are currently at 12.4 percent—nearly twice the overall state average.[24]

Solar training
Photo Credit. pennstatenews / Foter / CC BY-NC-ND

Policy 3: Create More Apprenticeship Opportunities in Advanced Energy Technologies

A large hurdle in matching Georgia residents with jobs in solar is a lack of prior experience and skills. This problem could be solved by creating more apprenticeships and certification programs that are tailored to the needs of solar companies within each region. Georgia's leaders could achieve this by leveraging the state's technical college system and Quick Start's private-sector partnerships.

Southwest Georgia Leading in Advanced Energy

Southwest Georgia is already a leader in advanced energy. At Procter & Gamble's Albany Manufacturing Center, a new biomass plant is under development to provide renewable energy for the company's production of paper products.[25] In Albany, the Marine Corps Logistics Base (MCLB) is working to become the first "net-zero" Marine Corps installation in the country.[26] Co-housing an energy engineering program at Albany State and Georgia Tech could support these recent advanced energy investments in Southwest Georgia.

Southwire's "12 for Life" Program

Southwire Company, a leading manufacturer of wire and cable used in the distribution of electricity in Georgia, combines hands-on training with traditional classroom learning for at-risk students. Since 2007, the company's "12 for Life" initiative has offered students paid, four-hour shifts at the company's manufacturing plant in Carrollton. While they work, students learn a variety of manufacturing skills, including machine operation and quality assurance. For the remainder of the day, students earn credits toward their high school diploma in a traditional classroom setting. The program boasts over 1,100 graduates, and nearly half of those students continued on to a post-secondary education. Another 20 percent obtained jobs with Southwire or a related employer.[30]

South Carolina's Apprenticeship Carolina™ system offers a simple model for improving apprenticeship opportunities statewide. The state's successful Apprenticeship Carolina™ system offers employers a modest $1,000 state tax credit per apprentice per year.[27] Additionally, the state engages businesses through training consultants, who work with employers to guide them through the process to establish a qualifying apprenticeship program. The program has served over 13,000 apprentices and averages more than 120 new apprentices per month.[28] Registered apprenticeship programs have a significant return on investment: over the span of an apprentice's career, the tax revenues are more than $27 per $1 invested and career earnings are on average $240,037 higher among those who completed the program compared to similar nonparticipants.[29]

Georgia could also tie economic development incentives to the provision of apprenticeships. Companies that train more workers could receive more incentives. This would give hard-working Georgians the opportunity to gain skills in the solar and smart building industries, while still bringing home a paycheck. To bypass congressional inaction, the Georgia General Assembly could enact an apprenticeship program similar to South Carolina's. State leaders could also consider visiting South Carolina to learn more about their successful apprenticeship programs. Encouraging the establishment of apprenticeships in the advanced energy industry would meet employer demand for trained workers and prepare Georgians for good-paying, skilled jobs.

Chapter Summary

Georgia has the potential to expand the state's smart building and solar energy sectors through targeted workforce development initiatives. By capitalizing on the well-established University System of Georgia, the Technical College System of Georgia, and top-notch workforce development programs, the state can ensure the successful expansion of advanced energy sectors. By developing certificate and degree programs around high performance buildings, education programs in energy engineering and sustainability science, and more apprenticeship opportunities, Georgia can prepare its workforce for the advanced energy economy.

Conclusion

In order to build on Georgia's success in the advanced energy space and position the state for continued growth, policymakers will need to make advanced energy a priority. The purpose of *The Georgia Jobs Project: A Guide to Creating Advanced Energy Jobs* is to analyze the state's advanced energy economy in order to create recommendations specifically tailored to the state's needs. The policies recommended in this report are complementary and intended to help the state grow demand for advanced energy technologies, manufacture products within the state, enable entrepreneurship for technological advances, fund innovation with accessible capital, and equip workers with the skills required for the state's future economy.

Policy leadership in the advanced energy space can play an important role in promoting Georgia's advanced energy clusters and creating quality jobs for Georgians. Advanced energy clusters focused on solar, smart building technology, and energy efficiency offer a great opportunity for the state to grow its economy, create jobs for the state's residents, and become a leader in the production and deployment of advanced energy technology.

If Georgia's policymakers take swift and purposeful action to grow the solar and smart building and energy efficiency technology industries, the state can support over 24,000 jobs annually through 2030.

Georgia has the right mix of strengths to leverage this opportunity. With smart, forward-thinking policies, the state can diversify its economy and create thousands of middle class jobs for hard-working Georgians.

For more information about advanced energy technologies and best practice policies, visit http://americanjobsproject.us/.

Extended Learning Section

Appendix A: Research Institutions, Technology Transfer, and Resources for Startups

Research Universities in Georgia[1]

Very High Research Activity

- Emory University, Atlanta
- Georgia Institute of Technology, Atlanta
- Georgia State University, Atlanta
- University of Georgia, Athens

High Research Activity

- Clark Atlanta University, Atlanta

Limited Research Activity

- Argosy University, Atlanta
- Georgia Southern University, Statesboro

Other[2]

- Georgia Regents University, Augusta
- Mercer University, Macon
- Morehouse School of Medicine, Atlanta

Energy-Related Research Institutes and Laboratories

- Emory Bioinspired Renewable Energy Center[3]
- Georgia Tech Strategic Energy Institute[4]
- Georgia Southern University Renewable Energy and Engines Laboratory[5]
- Georgia State University Sensorweb Research Laboratory[6]
- University of Georgia Bioenergy Systems Research institute[7]
- Clark Atlanta University Center for Functional Nanoscale Materials[8]
- Kennesaw State University Alternative Energy Innovation Center[9]

The Georgia Research Alliance

The Georgia Research Alliance (GRA) fosters innovation by strengthening the university system and expanding commercialization efforts. The GRA recruits eminent scholars from various research areas including agricultural technology, computing, biomedical engineering, and energy and environmental engineering, among others.[10] GRA Ventures is the investment arm of the institute, and the program is overseen by the GRA Commercialization Council, a group of over one hundred industry experts who advise GRA and university faculty.[11] Since its inception in 2002, it has evaluated 400 unique university inventions and helped advance 300 distinct technologies to market with $22 million in commercialization grants and $10 million in low-interest loans.[12] Taken as a whole, GRA's annual $30 million in investments and capacity-building efforts result in an estimated economic impact of $825 million, creating more than 6,000 technology and science jobs in the state.[13]

Other Existing Networking Partnerships

Georgians have already taken the initiative to mobilize and build the networks essential to any economic cluster. The Technology Association of Georgia's Smart Energy Society works to drive smart energy job growth by promoting collaboration, education, and networking among members.[14] The Metro Atlanta Chamber's Clean Tech Leadership Council connects clean tech companies with universities, corporate leadership, and other resources.[15] Other existing network relationships further bolster the foundation of Georgia's innovation ecosystem.

Partnerships between large corporations and promising early-stage companies are a critical technology transfer pathway. The Georgia Mentor-Protégé Connection (administered by the Department of Economic Development, the Georgia Education Foundation, and Georgia Tech) helps foster this link by pairing mentor companies—such as AT&T, Coca-Cola, and Georgia Power—with nominated protégés, which often include environmental engineering and software firms.[16] Launched in 2012, the program creates jobs by helping small firms increase their capacity. Only small businesses nominated by a mentor firm may apply, and the business must be Georgia-based. The Department of Economic Development facilitated twenty-six mentor-protégé pairings in 2015, giving these small business unparalleled access to business development and network connections.[17]

Tax Incentives

Georgia has established a job tax credit available for companies in strategic industries worth $750 to $4,000 per new job created

each year, depending on the county in which the company is located. Companies located in counties with high unemployment or in designated Opportunity Zones, Less-Developed Census Tracts, and Military Zones receive larger credits.[18] Additionally, the Quality Jobs Tax Credit is available to companies that create at least fifty net new jobs. The credit starts at $2,500 for jobs that pay 110 percent of the average county wage, and can reach as high as $5,000 for jobs that pay 200 percent or more.[19]

If a qualifying job tax credit firm increases total imports and exports by 10 percent from the prior year, it qualifies for a "port bonus" which results in a value of $1,250 per new job per year.[20] A similar bonus applies to manufacturing companies who meet the import or export requirement and claim Georgia's Investment Tax Credit, which may be claimed in place of the job tax credit for capital investments of $50,000 or more.[21]

The MEGA Project Tax Credit provides large-scale facilities with a $5,250 job credit per net new job per year for the first five years.[22] This is a significant incentive for companies considering utility-scale advanced energy production facilities. Additionally, Georgia is home to three Federal Foreign Trade Zones, located in Atlanta, Savannah, and Brunswick, which allow companies to defer, decrease, and eliminate duties on imported materials, enhancing the supply chain.[23]

Appendix B: Jobs Modeling Methodology

The American Jobs Project combines existing tools, analysis, and projections from several reputable sources to estimate job creation. Rather than providing a specific estimate, we show jobs potential across a range of possible outcomes. All jobs are shown in job-years that exist during the analysis timeline (2016-2030).

The key to job creation lies in local action. Our estimates are intended to start a conversation about how local stakeholders can work together to set their goals and utilize the same tools and data that we have used to estimate potential impacts.

The solar jobs analysis used the Job and Economic Development Impacts (JEDI) model and evaluated growth estimates across different levels of local-share spending for scenarios from the EIA's Annual Energy Outlook 2015 Clean Power Plan analysis, EERE's Wind Vision, and Bloomberg New Energy Finance. Smart building and energy efficiency jobs utilized the JEE-1 Model from the Donald Vial Labor Center and evaluated energy efficiency compliance scenarios from the EIA's Annual Energy Outlook 2015 Clean Power Plan analysis.

Tools for Economic Impact Analysis

A number of modeling tools are available for estimating economic impacts from advanced energy industry growth. This report employs two of the most common tools available: Jobs and Economic Development Impact (JEDI) and Impact Analysis for Planning (IMPLAN). Results from the JEDI model only show job gains and do not evaluate losses in other industries. They are based on approximations of industrial input-output relationships, and do not include intangible effects.[1] The JEDI model is widely used because it estimates construction and other project economic impacts at the local (usually state) levels.[2] IMPLAN estimates the economic impact of each dollar invested in a sector and the resulting ripple, or multiplier, effects across the economy.[3] Multipliers are used to generate the economic impacts of the project across three different categories of jobs: direct, indirect, and induced.[4] Not all advanced energy technologies can be modeled with JEDI. For smart building and energy efficiency jobs, we utilized the EEJ-1 Model, created by University of California Berkeley's Donald Vial Center on Employment in the Green Economy.

It is important to note the limitations of these modeling methods. As mentioned, the estimates shown are only gross job-year creation. Job losses in industries that compete with those in our analysis are not evaluated. Models do not dictate behavior, so indirect and induced jobs estimates could vary greatly based on the reality of what is actually purchased locally. Also, foreign and domestic competition can play a significant role in limiting the potential for job creation. The estimates presented in this report are highly dependent on sustained local action towards developing and maintaining these industries.

Estimates Used in the Georgia Report

Solar

JEDI was used to estimate jobs potential for the solar industry in Georgia. We show the jobs potential from several scenarios based on different percentages of local share (i.e., how much of the total industry supply chain and service expenditures could happen in the state to serve local and national demand). In the report, we show a range of 25-75 percent of local share at 25 percent increments—0 percent would represent an unlikely situation where no products or services are purchased in the state and 100 percent would represent an equally unlikely scenario in which all products and services are provided by a perfect in-state supply chain. The true potential likely lies somewhere in between, but is dependent on the options and incentives for purchasing local

goods and hiring local firms to provide services. In cases where there were only regional estimates, we assume that Georgia would maintain its current weighted average of solar capacity in the region over time. Where detailed information was not available for rooftop solar, estimates are based on "Tracking the Sun" weighted average distribution for residential, small commercial and large commercial buildings.[5] This was also used for average capital costs per megawatt (MW) for analyses in JEDI. Job-years included in this analysis represent all job-years that exist during the 2016-2030 timeframe. Data used in the JEDI analysis was collected from the three sources listed below.

DOE Office of Energy Efficiency and Renewable Energy: Wind Vision

The Wind Vision Study Scenario is a scenario that extends wind deployment trends, leverages the domestic wind industry manufacturing base, and complements the broader literature.[6] The Study Scenario is represented by wind power penetration levels of 10 percent by 2020, 20 percent by 2030, and 35 percent by 2050 and includes projections for other renewable energy sources.[7] Study Scenario impacts are compared to a Baseline Scenario in which wind capacity is fixed at 2013 levels.[8] This allowed the team to identify and quantify impacts for future wind deployment.[9] The assessment was the work of more than 100 individuals from major stakeholder sectors (government, industry, electric utilities, and nongovernmental organizations), conducted over a two-year period from 2006–2008. The study analyzed wind energy's potential contributions to economic prosperity, environmental sustainability, and energy security.

Bloomberg New Energy Finance[3]

Data from the "Medium-term outlook for US power: 2015 = deepest de-carbonization ever" report were provided by Bloomberg New Energy Finance (BNEF).[10] BNEF projections build off an empirical process of research, based on market projections, EIA information and interviews with industry stakeholders. These projections are updated and published annually, though the back-end data is private and cannot be shared except by permission. BNEF graciously provided the data to us on the condition we would not publish it and only use it for our economic impact analyses. This in no way implies an endorsement of our project or our projections by BNEF.

Energy Information Administration: Annual Energy Outlook (AEO) 2015 Clean Power Plan

A further explanation of the methodology of the AEO 2015 Clean Power Plan analysis is in the following section. The scenario used for the solar projection was the Base Policy scenario.

Smart Building and Energy Efficiency

University of California Berkeley's Donald Vial Center on Employment in the Green Economy developed the Jobs from Energy Efficiency (JEE-1) model to quickly estimate direct job outcomes of different policy scenarios related to smart building and energy efficiency (EE) efforts. While NREL's JEDI model and other tools are commonly used to estimate the job benefits of renewable energy projects and policies, the absence of a similar tool for employment related to energy efficiency makes it difficult for policy makers and advocates to quantify the economic development benefits of energy efficiency policies and investments without sophisticated and time-intensive analysis. The JEE-1 model is a simple, quick, and relatively easy-to-use tool that can estimate gross direct job creation of alternative scenarios.

The model is based on job-years per gigawatt hour (GWh) multipliers calculated for different energy efficiency program types across four primary sectors: residential, commercial, MUSH, and industrial/agricultural.

The JEE-1 model is based on the best available literature on 1) total cost of saved energy, 2) effective useful life estimates of energy efficient products, and 3) jobs per million dollar investment in energy efficiency.

Indirect and induced jobs are estimated using a simple range of multipliers common to energy efficiency jobs estimates: 2.0, 2.5 and 3.0.

Energy Information Administration: Annual Energy Outlook 2015 Clean Power Plan

This report considers the proposed Clean Power Plan as modeled using EIA's National Energy Modeling System (NEMS). NEMS is a modular economic modeling system used by EIA to develop long-term projections of the U.S. energy sector, currently through the year 2040.[11]

The level of regional disaggregation in NEMS varies across sectors. For example, Lower 48 states electricity markets are represented using twenty-two regions, coal production is represented by fourteen regions, and oil and natural gas production is represented in nine regions. In many, but not all cases, regional

boundaries follow state borders. To the extent possible, this analysis represents the Clean Power Plan using regional targets derived from the state-level targets in the EPA's proposal.

The Reference case projections developed in NEMS and published in the *Annual Energy Outlook 2015* generally reflect federal laws and regulations and state renewable portfolio standards (RPS) in effect at the time of the projection. The Reference case does not assume the extension of laws with sunset provisions. In keeping with the requirement that EIA remain policy-neutral, the Reference case does not include proposed regulations such as the Clean Power Plan.

By explicitly modeling the intensity targets, NEMS does not require or assume specific levels for individual compliance strategies. The discussion of EIA's analysis presents results in terms of the compliance options used to meet the regionalized Clean Power Plan targets.[12]

The scenarios used for the smart building and energy efficiency analysis were: Base Policy, No Energy Efficiency Compliance, and High Energy Efficiency Compliance. These projections represent the range of expected reductions in energy consumption due to smart building and energy efficiency. This was measured as the net annual difference between the Base Case (business as usual) scenario's total energy consumption and the three Clean Power Plan scenarios for residential, commercial, and industrial sectors.

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Front Material & Chapter 1: Introduction

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