Florida Jobs Project

A Guide to Creating Advanced Energy Jobs

MARCH 2016

AMERICAN JOBS PROJECT

A Letter from the American Jobs Project

It's 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 last 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 the then-President of China, Hu Jintao. "What keeps you up at night?" President Bush asked President Hu as an ice-breaker. As we can easily guess, what kept President Bush up at night was worry 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 about finding ways to make our states the answer to this question. If countries across the globe, including the U.S., are seeking technical products and solutions for our 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 U.S. 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 have to accept the fact that they are not coming back.[10] But our research shows that with innovative policies and a smart focus on industrial clusters, 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 upon extensive research and tailored to each state. Many are best practices, some are new, and all are centered upon 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 has included 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.

Florida Energy Systems Consortium

The Florida Energy Systems Consortium (FESC) was created in 2008 by Florida statute to promote collaboration among Florida's twelve public universities for the purposes of sharing energy-related expertise and assisting in the development and implementation of a comprehensive energy strategy for the state. The Consortium was charged with conducting research and development on innovative energy systems that lead to alternative energy strategies, improved energy efficiencies, and expanded economic development for the state. To kick off this program, the legislature provided approximately $38 million for energy research, education, outreach, and technology commercialization at five of the Florida universities.

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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.

Florida already has a strong foundation in the advanced energy sector, and is well positioned to benefit further as demand for alternative energy products increases. The state's $6.2 billion advanced energy economy currently contains 14,000 businesses employing more than 130,000 Floridians.[11,12] Florida's public universities, research facilities, and its skilled labor force present opportunities for the state to further serve growing regional, national, and global markets and create even more good-paying jobs for its residents. Extensive research and more than forty interviews with local stakeholders and experts in Florida have resulted in identifying two economic sectors that show particular promise: solar and biofuels.

The advanced energy industry can play a significant role in Florida's future economic development. By emphasizing technological innovation in the solar and biofuel sectors, Florida will enable its companies to take advantage of market opportunities across the globe. Florida's leaders can enact enabling policies to expand the solar and biofuel industries and help local businesses innovate, grow, and outcompete national and global competitors. Indeed, with the right policies, Florida can support as many as 98,500 jobs annually through 2030.

This project serves as a research-based guide for state and local leaders who seek to develop smart policies focused on leveraging Florida's resources to create skilled, good-paying jobs. Concerted effort at the state and local levels can create an environment that attracts advanced energy businesses to take root in Florida. Employees in the advanced energy sector will spend their earnings in the local economy at grocery stores and restaurants, and those local establishments will need to hire more employees to satisfy demand. This creates a multiplier effect throughout Florida's economy, where a single dollar spent in a community circulates through local businesses and their employees numerous times.

Summary of Policy Recommendations

The analysis presented in this report culminates in four thematic sets of recommendations for Florida's leaders. Each set of recommendations identifies opportunities for barrier removal and future growth opportunities in the solar and biofuels sectors. While the recommendations are intended to be complementary and would be powerful if adopted as a package, each can also be viewed as a stand-alone option.

Solar Technology

Support the Development of Community Solar Projects: Enabling community solar by allowing multiple subscribers to a shared, utility-provided solar array and also allowing local communities to organize shared projects with the assistance of third-party financing.

Improve Net Metering for Solar Projects: Authorizing aggregate, virtual, and community net metering in an effort to extend the benefits of net metering to Floridians who are currently excluded from net metering. Ensuring customers continue to receive equitable and transparent net metering charges through safe harbor provisions. Net metering allows customers to sell excess energy back to the grid.

Allow Third-Party Sales of Electricity: Removing restrictions on third-party financing models would enable consumer choice, expand the Florida solar market, and capitalize on the state's tremendous solar potential.

Offer a Green Source Rider Program: Connecting large, energy-intensive companies with renewable energy without shifting costs to other ratepayers. Private sector demand for renewable energy is clear: fifty-one Fortune 500 companies have signed a declaration demanding access to clean energy.

Create an Online Crowdfunding Platform to Support School Solar Projects: Supporting solar projects for schools and community centers by creating an online crowdfunding platform to pool public donations.

Biofuels

Create the Florida Biofuels Information Center: Overcoming unfamiliarity of biofuels by establishing a resource that aggregates information on how to enter the biofuels industry into one easy-to-use portal. The information center can use online resources, trainings, and conferences to educate stakeholders on the economic benefits of biofuels.

Enhance Florida's Biofuel Industry Through Foreign Direct Investment: Attracting foreign companies to boost advanced biofuel investments within Florida. Foreign investors can bring manufacturing expertise and resources that are currently lacking in the state's biofuels economy.

Establish a Biofuel Retailer Tax Credit: Encouraging more flex fuel retailers to open businesses in Florida by offering a tax credit to overcome high overhead costs of installation. Similar credits in other states have resulted in increased sales of flex fuels.

Encourage Public Alternative Fuel Vehicle Fleets Through Performance Contracts: Encouraging local and state governments to use performance contracting models, commonly known as Energy Service Companies (ESCOs), to upgrade public fleets to use alternative fuels. Municipalities around the country have decreased costs by upgrading public fleets through ESCOs.

Innovation Ecosystem and Access to Capital

Create a University Research and Development Tax Credit: Incentivizing businesses to invest in local university-level research and development through refundable and transferrable tax credits.

Establish the Breakthrough Research Institute for Biofuel Technology: Creating a next-generation biofuel research institute that strategically targets federal research dollars.

Workforce Development

Improve Industry-Wide Recognition and Participation With Apprenticeships: Providing financial incentives for companies that hire and train apprentices; working directly with employers to tailor apprenticeship requirements, wages, and associate curricula to specific technical needs; and integrating apprenticeship programs with stackable credentials.

Expand Early College Programs to Improve STEM Education: Increasing the number of early college programs available throughout the state to better prepare students for STEM careers.

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. The American Jobs Project team analyzed the advanced energy economy in Florida and designed recommendations specifically tailored to the state's strengths. These recommendations are informed by extensive research and over forty interviews with local stakeholders and experts.

This report identifies opportunities to stimulate growth in two economic clusters in the advanced energy sector that leverage the state's legacy industries, current investments, and entrepreneurial business development activities. State and local leaders who seek to capitalize 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.[13] In the United States alone, over $386 billion was invested in advanced energy between 2007 and 2014; $51.8 billion was invested in 2014.[14] In nationwide polls, Americans increasingly support renewables over other forms of energy[15] and demand for renewable energy is likely to continue to grow. States will need to significantly reduce pollution from power plants, which will make an even stronger case for advanced energy technology, renewable energy resources, and increased energy efficiency.[16] Projections show that renewable energy will be the vast majority of new generation (69-74 percent) between now and 2030.[17] These trends point to a clear market signal: demand for advanced energy will continue to grow over the next fifteen years.[18]

Florida's Energy Profile

Current Energy Portfolio

Florida ranks third in the U.S. for total energy consumption, due in part to its large population and active transportation sector.[19] However, the state's per capita energy consumption ranks near the bottom among the fifty states due to low energy demand in Florida's industrial sector.[20,21] Most of the state's domestic

energy production comes from two nuclear power plants and renewable energy systems, but imports of petroleum, natural gas, and coal supply most of the state's transportation and electricity demand.[22,23] Florida is the second-largest generator of electricity in the nation.[24] Natural gas accounts for almost 70 percent of Florida's electricity generation, followed by coal at about 16 percent.[25] Renewable energy sources account for 2 percent of Florida's electricity generation, which is considerably lower than the 15.8 percent national average.[26] Biomass energy from agricultural and municipal solid waste dominates renewable energy production in Florida, with growing contributions from solar photovoltaics.[27]

Renewable Energy Development

Florida does not currently have a renewable portfolio standard (RPS) in place,[28] largely due to the failure of a proposed RPS in 2009.[29,30,31] Instead, Florida offers a number of incentives for renewable energy development, including the Renewable Energy Tax Incentives program that offers $89 million in potential tax credits or sales tax refunds over its lifetime.[32,33] In 2014, the program's incentives created or supported over 900 jobs and resulted in a total economic contribution of $262 million, over ten times the initial allotment.[34] Florida also allows net metering for customer-owned renewable generation.[35] In the transportation sector, legislators repealed the 2011 Renewable Fuel Standard (RFS) after two years, removing the requirement to blend all gasoline with a percentage of fuel from biofuel.[36,37] Without an RFS, Florida risks stifling growth and innovation in the biofuels industry. Adding to this stifling of innovation, the Florida Public Utilities Commission voted to cut state energy efficiency goals by more than 90 percent in late 2014.[38]

Evolving Energy Needs

Florida faces critical choices on how to change its energy profile through state-level policy. The state should consider balancing its power generation portfolio to ensure energy security and reliability. Natural gas has become the predominant fuel source for electricity generation, displacing petroleum and coal,[39] however, all three fossil fuels still make up the bulk of energy consumption.[40] Because Florida is a net importer of fossil fuels,[41] its heavy reliance on out-of-state fuels for electricity generation raises concerns regarding the state's vulnerability to price fluctuations and supply disruptions. Additionally, coal and natural gas imports funneled over $1.66 billion out of state in 2013.[42] Florida's renewable energy sources, meanwhile, have seen steady growth in generation capacity, with most of the present and predicted capacity coming from solar and biomass.[43]

These sources have the potential to improve energy security and diversify supply in Florida while also boosting in-state economic development. By expanding the state's solar and biofuel industries through targeted policies, Florida's lawmakers can attract more energy projects, businesses, and jobs.

Economic Clusters

> *"Clusters are geographic concentrations of interconnected companies and institutions in a particular field."*
>
> – Michael Porter, *Clusters and the New Economics of Competition*[44]

Economic clusters encompass a variety of linked industries and institutions—including suppliers of specialized services, machinery, and infrastructure—which form a supply chain.[45] 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

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

benefit from each other's unique expertise and skilled workers.[46] Companies in a cluster enjoy closer access to specialized skills and information, which helps increase productivity and efficiency.[47]

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 companies in the cluster, drive innovation in the field, and facilitate the commercialization of this innovation by increasing communication, logistical support, and overall interaction between cluster entities.[48] Clusters also help build a strong foundation for creating and retaining employment opportunities.

Jobs Potential

Maximizing job creation in Florida 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.

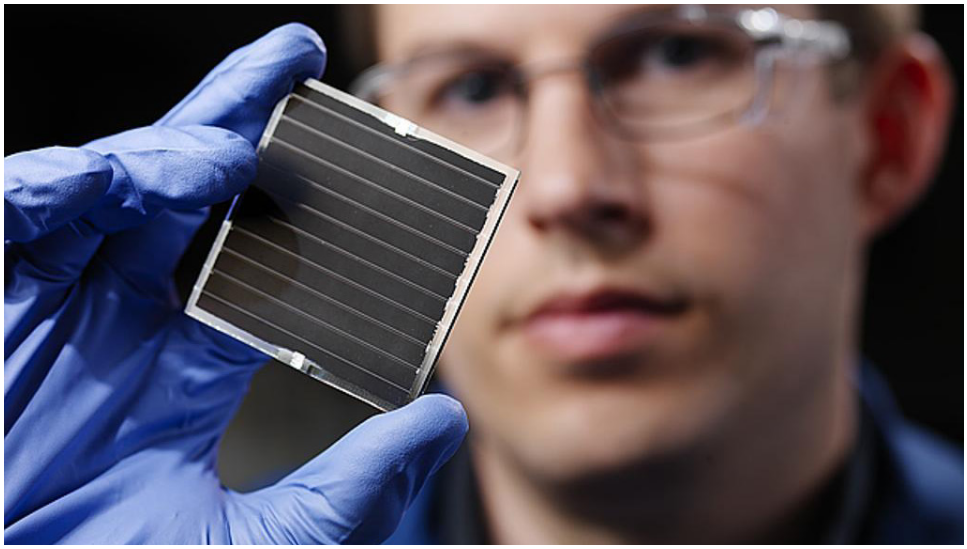
Report Structure

This report is divided into four complementary chapters, each covering key elements of building advanced energy economic clusters in solar and biofuel technologies. Chapters 2 and 3 present a supply chain analysis for Florida's solar and biofuel sectors, respectively. This analysis culminates in an assessment of Florida's potential for advanced energy jobs within each cluster, as well as specific policy recommendations tailored to Florida's needs. Chapter 4 analyzes Florida's innovation ecosystem and access to capital—both crucial elements of cluster development—and provides recommendations for further developing the state's innovation pipeline. Chapter 5 provides recommendations for workforce development programs and policies to prepare Floridians for advanced energy jobs. The conclusion of the report summarizes key themes.

Chapter 2: Solar Technology

Florida's policymakers will play a decisive role in the future of solar energy in the state. Over the last decade, solar energy deployment has grown rapidly in the United States due to falling solar photovoltaic (PV) prices, technological advancements, favorable government policies, available financing, and increased consumer demand for clean and renewable sources of energy. States have taken advantage of solar energy through large-scale, utility-owned projects, as well as residential and commercial rooftop installations and community solar projects. By targeting the state's emerging solar cluster with smart and strategic policy choices, Florida's leaders can attract jobs and make the state a leader in solar manufacturing. With policies that encourage growth and technological innovation, Florida can meet the demand for solar products from a strong in-state market and capitalize on export opportunities.

This chapter provides a guide to developing and strengthening Florida's solar economy. After analyzing Florida's 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 Florida's policymakers to generate and enhance job-creating clusters in the solar sector.



Solar cell are the basic unit of a solar panel.
Photo Credit. Pacific Northwest National Laboratory - PNNL / Foter / CC BY-NC-SA

Strengths, Weaknesses, Opportunities, and Threats for Solar Technology in Florida

STRENGTHS	WEAKNESSES
• Third highest rooftop solar potential in the United States[1] • Ranked eighth in number of solar jobs in the United States[2] • Tenth largest supplier of utility-scale solar generation in the United States[3] • World-class solar research institutions and universities • Net metering allowed[4] • Existing PACE financing programs[5] • Property tax exemption for residential solar installations[6]	• Third-party sales of electricity not permitted[7] • Reliance on traditional fuels, especially natural gas imports[8] • No statewide portfolio standards or goals for renewable energy[9]
OPPORTUNITIES	**THREATS**
• Cost reductions in the supply chain • Utilities willing to own and operate solar • Potential for strong solar clusters in major cities • Orlando's federally designated Solar America City status[10] • State commitment to the cleantech industry[11]	• Utility pushback on distributed generation • Increasing pressure by utilities to add high fixed costs to net metering[12] • Potential high power costs reducing business attraction • Solar growth partly dependent on grid technology

Florida's solar industry is poised for significant growth. Nationally, Florida ranks third in terms of solar resource potential, but only ranks fourteenth in total installed capacity.[13] Florida could expand current assets to capture more of this solar potential and take advantage of an expanding regional market. The state's robust supply chain and world-class universities represent significant strengths that could be leveraged to spur solar PV-based manufacturing and installation in Florida.

The state currently houses more than 400 companies in the solar value chain, employing over 6,500 workers (PV and thermal).[14,15] Additionally, state universities have continued to support the

solar industry through robust investments in research and development (R&D). For example, the Florida Energy Systems Consortium (FESC), which coordinates energy research through university-industry collaboration, has several solar-based projects and resources.[16] The state also benefits from accredited PV research conducted by the Florida Solar Energy Center.[17] With an established industry and R&D base, Florida is well positioned to expand its existing solar PV businesses to capitalize on growing economic opportunity throughout the state and beyond.

Florida's investor-owned utilities (IOUs) have dominated the development of solar through large-scale installations.[18] Current in-state conditions have hindered growth in the rooftop solar market, providing a significant growth opportunity for Florida's solar economy. Florida offers net metering to compensate customers for renewable electricity generation from residential and commercial projects, but additional fees and requirements impede widespread rooftop solar deployment. Third-party sales of electricity from solar installations are not permitted in Florida, preventing customers from taking advantage of this popular means of financing for PV projects.[19] The state lacks a Renewable Portfolio Standard (RPS), which provides a stable investment environment for the development of various energy resources, including solar PV. Furthermore, the IOUs' reliance on traditional fuels and lack of political support for solar power further threaten progressive policy development. Greater cooperation and collaboration could open the door for a strong in-state solar market with an extended regional reach.

Solar Market Trends

Rising Demand

Global solar photovoltaic (PV) installed capacity has increased by a factor of nearly 70 over the last decade, from 2.6 GW in 2004 to 177 GW in 2014.[20] As a result of this growth, investment dollars are flooding the market, prices are falling, and the industry is undergoing a period of rapid innovation.

In the United States, solar PV cells are a primary source of new electricity generating capacity. In the first half of 2015, solar represented 40 percent of all new electricity generating capacity.[21] Strong demand has made the United States the world's fifth largest solar market in terms of installed capacity.[22] Forecasts show significant growth continuing through 2030 (Figure 1).[23]

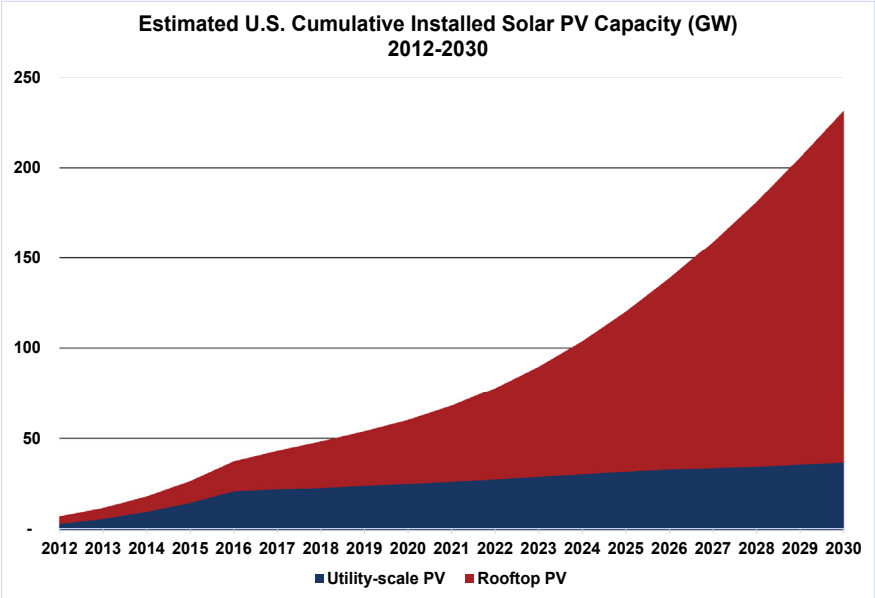


Figure 1. U.S. solar installed capacity could exceed 200 GW by 2030.
(Source: Bloomberg New Energy Finance, 2015 New Energy Outlook - Americas, June 2015)

The extension of the 30 percent federal solar tax credit is projected to inject $38 billion of investment into the market, amounting to an additional 20 GW of solar power.[24] The boost in demand is coupled with the declining cost of solar, which makes it increasingly competitive with coal and natural gas.[25]

Falling Costs and Increasing Efficiencies of Solar

In 1961, President Kennedy challenged the United States to land a man on the moon and bring him safely back home by the end of the decade. In the same spirit, the Department of Energy's SunShot program has challenged the nation once again. This time the challenge is not about space, but energy.[26] 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 since 2010.[27] Today, solar is cost-competitive in fourteen states where the solar levelized cost of electricity ranges between $0.10–$0.15 per kilowatt-hour and the retail electricity price comes in at $0.12–$0.38 per kilowatt-hour.[28] The cost of solar per kilowatt-hour is forecasted to be cheaper than coal and natural gas within the next five to ten years.[29]

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.[30] To calculate the LCOE, a variety of factors and inputs are assessed, including capital costs, fuel costs, operation and maintenance costs, and financing costs.[31] 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.[32]

While the cost of solar energy has declined, the efficiency of solar technology has increased. From 2011 to 2014, the average capacity factor of solar projects increased from 24.5 percent to 29.4 percent.[33] This indicates that systems of the same size can now produce at least 20 percent more electricity than in the past.

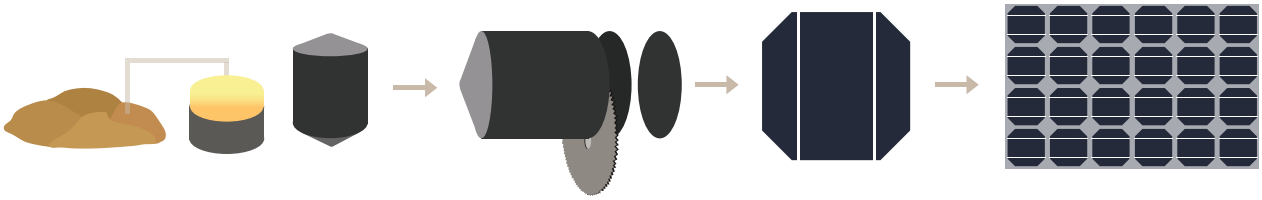
What Does Rising Solar Demand and Falling Cost Mean for Florida?

The offshoring of manufacturing jobs was not driven by intrinsic geographic, technological, or cultural factors; rather, aggressive policies and low wages in competitor nations shifted American jobs overseas. 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."[34] State policy that fosters a strong market, develops 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, Florida can compete for market-driven solar manufacturing, generation, installation, and exports.

Florida's active research community, skilled workforce, and manufacturing base provide a strong foundation for expanding the state's solar market. Identifying gaps in the value chain could help Florida determine the best industries to leverage the state's strengths and capitalize on future growth. For example, the North American flat roof racking industry is projected to grow by an annual rate of 17.5 percent and the solar inverter industry is estimated to grow by 10 percent through 2018.[35,36] Florida-based companies, such as PCM Solar (racking) and Yaskawa – Solectria

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

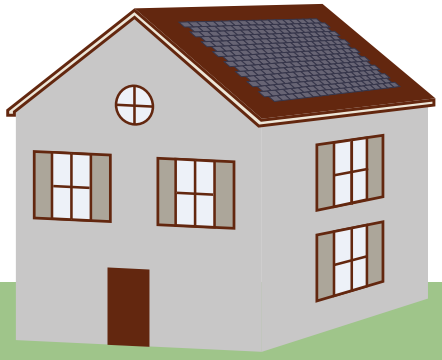
With the silicon powder, a wafer can be manufactured by doping the molten high-purity silicon with boron. Molten silicon is poured into a mold creating blocks of solid polysilicon. The block is then cut, polished, and cleaned.

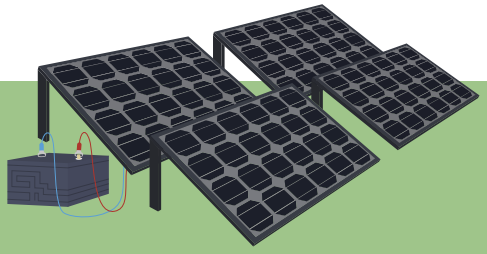
Assembling the Modules

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 (inverters), could capitalize on this expected growth. Furthermore, expanded manufacturing in Florida will create the possibility for solar exports to neighboring states, fueling economic and job growth locally.

Solar Technology Manufacturing

There are many types of solar cells with different manufacturing processes and assembly configurations. In order for Florida 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 graphic on the adjacent page shows the manufacturing process and future developments of solar technology.

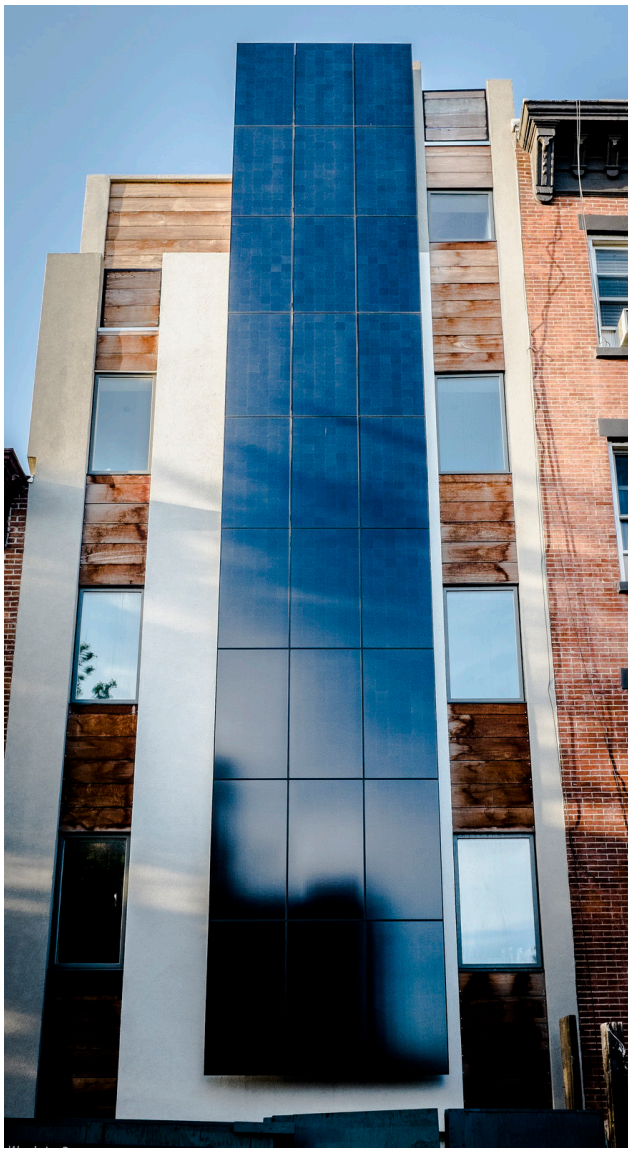


Photo Credit. wwward0 / Foter / CC BY

Florida's Solar Supply Chain

The solar photovoltaic (PV) supply chain is comprised of companies working across a variety of technology categories. Table 1 lists the number of companies in Florida working in each subsector of the solar supply chain. Manufacturing companies that produce multiple components are categorized based on their primary product.

Table 1. Florida's Solar Supply Chain (Source: Internal Analysis of SEIA Database)

CATEGORY	NUMBER IN-STATE	DESCRIPTION
Manufacturing	*48*	
Full System	3	Design and manufacture full solar system
Advanced Materials	4	Develop materials used for solar cells
Cells/Modules	2	Manufacture solar cells and modules
Frames	0	Manufacture structural frames for solar cells
Sealants and Protective Films	0	Create structural sealants used to hold cells and structural frames together or manufacture films used to protect the surface of solar cells
Manufacturing Tools and Equipment	7	Manufacture tools or provide testing equipment used in the process of manufacturing solar PV systems
Inverters	3	Manufacture inverters used in solar PV systems
Mounting/Racking	5	Manufacture structural components to mount solar PV systems
Wires	1	Supply wires and cables to connect electrical components for solar installation
Surge Protectors	3	Supply surge protector devices to protect electrical components on solar systems
Tracking Systems	0	Manufacture components such as tracking devices, gears, and motors used in solar tracking systems
Batteries/Controllers	5	Manufacture batteries to store electrical energy from solar PV and controllers to regulate battery charge
Other	15	Develop specialized system designs or related components
Services	*356*	
Contractors/ Installers	207	Design and install rooftop or utility-scale solar PV projects
Project Developers	31	Assist with development of full-scale utility solar system projects and have a stake in the project
Distributors	32	Distribute finished solar systems from manufacturers
Consultants	22	Assist in various stages of project development
Other	64	Provide services, such as financial and legal support, customer advocacy, marketing, and research
Total	**404**	

Strengths and Opportunities for Growth

More than 400 companies in Florida are engaged in PV manufacturing and installation, which suggests that there is a strong solar energy market within Florida.[37] The state's solar panel manufacturing and delivery operations could be expanded to provide exports to neighboring states and larger regional markets.

Florida boasts a unique supply chain dedicated to energy storage, safety components, and standalone solar systems, likely due to Florida's exposure to natural disasters. The state is home to three companies that lead the global market for surge protector devices, which protect solar equipment from lightning strikes.[38] Additionally, companies such as Solar Stik™ offer portable power generators, and Yake Solar Power Corporation supplies the rural electrification market with off-grid applications—both of which also supply storage options.[39,40] PWRstation Corp. offers retractable solar racking systems, which allow owners to protect panels in the event of hurricanes and other dangerous weather conditions.[41]

Currently, only a handful of Florida companies provide essential PV components (cells, modules, panels, and inverters) and advanced materials for production (solar-grade silicon, crystalline silicon, and chemicals for thin-film PV production). DM Solar and SolarTech are the only manufacturers of solar cells and modules for solar electricity in Florida.[42] Additionally, sealants and frames to support solar cell manufacturing do not come from an in-state supplier.

Currently, Florida's full solar system providers mainly assemble third-party components or parts manufactured internationally, which provides an opportunity for local companies to fill gaps in the state's supply chain.[43] Areas of growth could also include other balance-of-system components, such as wires, tracking devices, and charge controllers. Bolstering Florida's manufacturing capabilities could fill many of these gaps in the supply chain and significantly expand the state's solar industry.

As a major hub for foreign direct investment, Florida could target international companies to strengthen the solar sector.[44] For example, the state could attract Evonik Industries and Wacker Chemie, two leading German companies in the chemicals business with close ties to the solar industry, in order to address Florida's limited supply of advanced materials.[45] Wacker Chemie produces both sealants and silicon wafers for solar cell production.[46] Additionally, Florida could bolster its base of full-system developers by recruiting panel manufacturers. These firms could include SolarWorld (Germany), REC (Norway), Sharp

(Japan), or Yingli and Suntech (China). In addition, Florida could target electrical component manufacturers, such as SMA and KACO, which provide inverters for all scales of installed solar PV. These top companies would provide the technology and expertise needed to expand Florida's solar industry.

Florida's Solar Cluster

Companies in Florida's solar supply chain are located along the southeast coast, from Miami to Cape Canaveral. There are strong signs of solar clusters forming in some of Florida's biggest cities, especially around Jacksonville, Orlando, Tampa, and Miami. These areas have a diversity of businesses involved in manufacturing, installation, and ancillary services. Early-stage clusters are found near major population hubs and Florida's top universities.

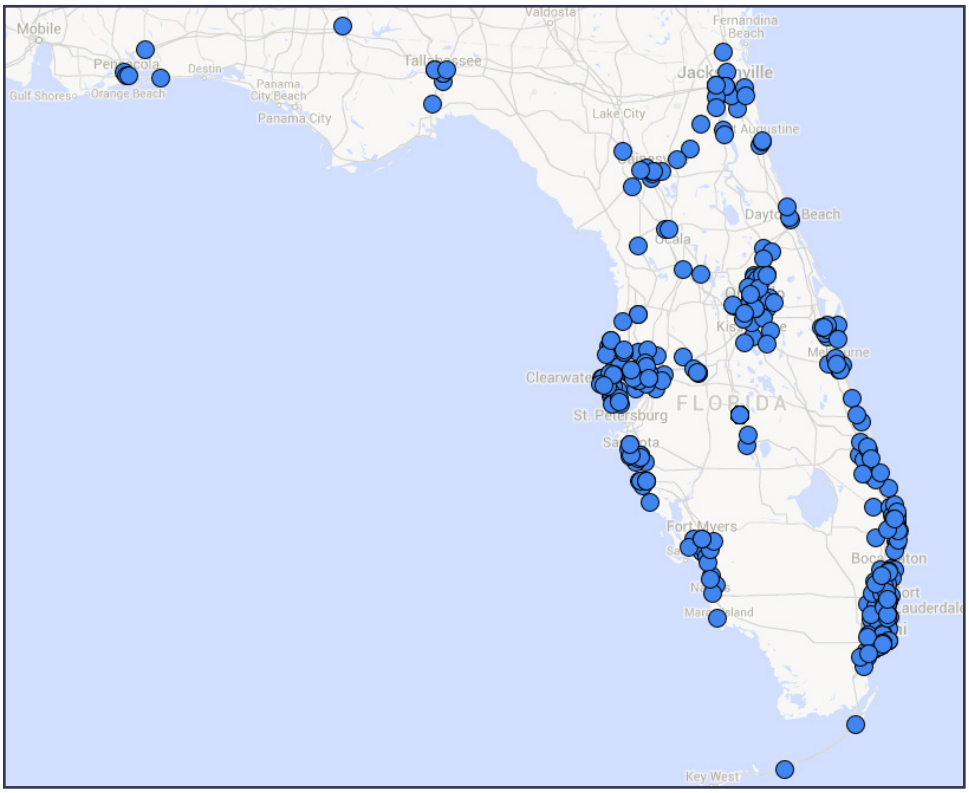


Figure 2. Solar Clusters are forming in four main areas in Florida: Jacksonville, Orlando, Tampa, and the East Coast. (Source: Solar Energy Industries Association)

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 large commercial 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 Florida's solar supply chain, total job-years are aggregated over the 2016 to 2030 period.

Florida's Potential for Solar Jobs

As demand for solar increases, Florida has the opportunity to expand the solar economy, increase in-state investment, and employ an average of about 44,500 Floridians annually over the next fifteen years. If optimistic projections prove to be correct and Florida's solar companies are able to fill most of their supply chain needs with in-state purchases, over 667,000 direct, indirect, and induced job-years would be supported. While over 208,000 of those would be direct job-years in the state's solar industry, nearly 460,000 indirect and induced job-years could be supported if solar companies were able to procure supplies from in-state companies.

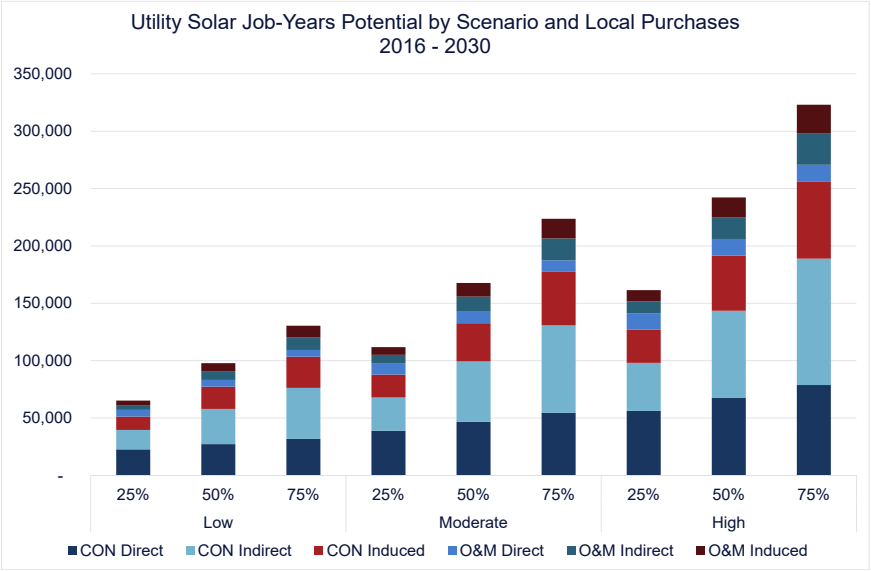
These projections for job-years potential in Florida's solar industry are based on tools and analysis by the Energy Information Administration, DOE's Office of Energy Efficiency and Renewable Energy, and Bloomberg New Energy Finance. Additionally, the Jobs and Economic Development Impacts tool (JEDI) 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.

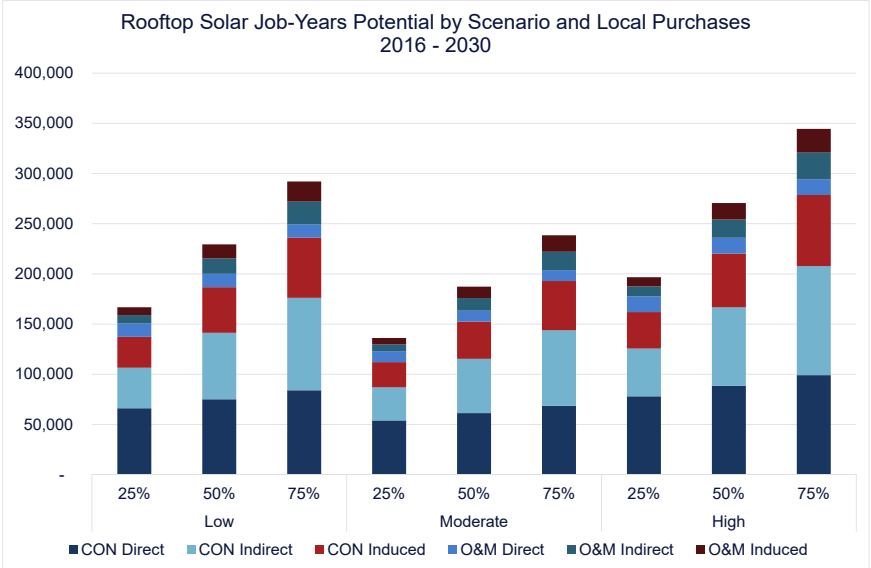
To highlight why clustering supply chain businesses in Florida is so important, we have estimated the number of direct, indirect, and induced jobs based on future demand and the percentage of supply chain purchases made within the state. Figures 3 and 4 show how the number of utility-scale and rooftop 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, Energy Information Administration Annual Energy Outlook 2015 Clean Power Plan Base Policy as a moderate scenario, and DOE Office of Energy Efficiency & Renewable Energy's Wind Vision as a low-demand scenario. Figure 3 presents estimates for utility-scale construction, operations and maintenance jobs. For rooftop solar, estimates of construction, operations and maintenance jobs are in Figure 4.

In all three demand scenarios, increasing the percentage of local spending by Florida'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

support over 309,000 direct, indirect and induced job-years. In the medium-demand scenario, that same increase in in-state local purchases would create over 214,000 job-years. Even in the low-demand scenario, increasing the percentage of in-state local purchases from 25 percent to 75 percent would create over 190,000 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, Florida companies could meet the expected demand for rooftop and utility-scale solar, supporting over 667,000 job-years. Increasing the number of supply chain businesses can create thousands of good-paying, skilled jobs and make Florida a leader in the solar industry.





Figures 3,4. Graphs of Florida's Potential for Solar Jobs

Direct, Indirect, and Induced Job-Years

In order to estimate the potential economic impact of Florida'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 Florida's solar industry
- **Induced job-years:** reflect jobs created throughout the local economy as a result of increased spending by workers and firms in Florida's solar and solar supply chain industries

Local Share

Local share is the percentage of expenditures that are spent in Florida. 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 Florida, the local share is 25 percent In the JEDI model, local share is an independent variable.

Policy Recommendations

With extensive supply chain resources, a skilled workforce, and established research institutions, Florida is well equipped to become a leader in solar energy. Policymakers can bolster the state's solar economy by focusing on innovative policies that spur demand and make Florida irresistible to solar manufacturers. Having a robust in-state market will attract private investment, strengthen the economy, and create new value chains.

Policy 1: Support the Development of Community Solar Projects

Approximately 85 percent of U.S. residential customers can neither own nor lease residential systems because they are renters or have unsuitable roofs.[48] Nearly half of all U.S. businesses are also locked out of the solar market for the same reasons.[49] Community solar is a popular solution to this issue, and fourteen states and the District of Columbia currently offer this option to customers.[50] Community solar projects enable consumers who live in an apartment, do not have a sunny roof, or cannot afford a full system to buy or lease a piece of an array and receive credit on their electricity bill for the power their panels produce.[51]

Florida could look to Colorado as an example of successful leadership in community solar. In 2010, Colorado passed the Community Solar Garden Act, which encouraged community solar projects and provided subscription guidelines.[52] The response was overwhelmingly positive with "shares in the facilities sold out in as little as 30 minutes after they were announced."[53] The state also amended restrictions to expand the potential subscriber base for projects.[54] With clear legislation, Florida could replicate Colorado's success throughout the state and encourage the development of community solar projects to benefit those communities experiencing technical and financial barriers.

Solar Made Simple: The Benefits of Community Solar[47]

- Customers purchase the amount of solar they can afford, rather than investing in a whole system.
- Permitting, site assessments, and interconnection challenges are all handled at the project level and not by individuals, saving time for customers.
- Utilities can also participate and help ensure benefits to the grid.
- Programs can be designed to allow customers to transfer their energy to new homes.
- Renters in multi-unit buildings and business owners are able to participate.

Community Solar in the Sunshine State[55]

In October 2013, the Orlando Utilities Commission (OUC) built the first community solar project in Central Florida. Serving as parking lot canopies, the 400 kW array supports thirty-nine subscribers, with one block of solar-generated power providing more than enough energy for the average residential customer. About 55 percent of OUC customers in multi-family housing now have the opportunity to invest in solar. Following the twenty-five-year contract, OUC has a waiting list in place for future subscribers and is already looking to begin a second project.

Without specific enabling legislation, the process for developing a community solar project can be cumbersome. In order to improve the ease of such projects, Florida leaders could pass legislation expressly allowing community solar. These projects are typically developed under two different models: (1) an electric utility or cooperative builds, owns, and operates a project that customers can subscribe to, or (2) community members organize to purchase and own a project (often supported by third-party financing).[56] Florida could allow for both models in order to maximize local access and control. For community-owned projects, the legislation could extend the same net metering laws as applied to individual residents. For subscription-based projects, customers could purchase a portion of the array and receive benefits through community net metering (see following recommendation). Additionally, Florida could give priority to public land leases designated for community solar. With smart policies that encourage community development, all Floridians who wish to purchase solar power could have access to it.

Policy 2: Improve Net Metering for Solar Projects

Net metering is the primary mechanism for compensating residential and small-scale solar projects in Florida. Under net metering, customers with renewable electric generators can reduce their electric bill by generating some or all of their power and receiving a credit (at the full retail rate) from their utility for any excess generation.[57] Net metering guarantees a return on investment, making it a major driver of solar deployment.[58] However, current Florida policy restricts net metering benefits to single-property owners and imposes additional costs on net-metered customers. Florida could improve its net metering policy to increase the number of customers who can benefit from net metering and to ensure solar customers are treated equitably.

Authorize Aggregate, Virtual, and Community Net Metering to Expand Customer Access

Solar net metering is currently only available to single-property owners. Florida could extend policy benefits to other types of customers by authorizing aggregate, virtual, and community net metering.

Types of Net Metering

- Aggregate net metering allows a property owner with multiple meters on the same property or adjacent properties to offset the aggregate load with a single generating system.[59]
- Virtual net metering expands on aggregate net metering by allowing a property owner with multiple meters to distribute credits to individual accounts, which can be from non-adjacent properties.[60]
- Community net metering detaches benefits from property ownership by allowing multiple users to benefit from a single generating system, mainly a community solar project.[61]

Expanding the net metering policy would enable renters, multi-property owners, and customers in multi-unit residences, commercial spaces, and government-owned facilities to take advantage of net metering incentives. Consequently, customers interested in solar would be able to consider alternative system designs with greater cost savings. In particular, community net metering is an essential component for the development of community solar projects.

Establish Clear Safe Harbor Provisions

Net metering in Florida is shrouded in uncertainty due to potential policy changes, including maintenance fees for customers with solar installations.[62] Florida lawmakers could consider establishing safe harbor provisions to level the playing field and ensure that net-metered customers are protected from additional or unanticipated costs.

Utilities may require a "standby charge" for net-metered customers to recover the cost of producing additional electricity for demand not met by intermittent distributed generating systems.[63] This standby charge may be in the form of a fee, required insurance, or equipment upgrades.[64] These charges can place a significant burden on small generators (most residential customers) and community solar subscribers—enough to diminish the benefits of net metering.[65] Additional charges can also decrease the cost-competitiveness of solar PV, limit the resiliency of customers to rate changes, and signal a higher risk level to investors, all of which negatively impact the soft costs of solar deployment.[66] Nevada recently experienced a similar shock to its market when major solar installers, SolarCity and Sunrun, shut down operations in the state following the decision to cut rates and add fixed charges for net metering.[67]

Florida's Energy Efficiency and Conservation Act prevents the utilities commission from approving rate systems that discriminate

against customers who employ the use of energy conservation systems.[68] While it appears that solar energy systems were intended to be included in this law, its application to the solar industry is unclear. Adding clear safe harbor provisions to net metering regulations would ensure that extra charges are not imposed on net-metered customers unless they are applied to all customers. Net metering in Florida has been a critical policy tool to make payback periods for solar PV economically feasible for residential and commercial customers. By safeguarding this incentive and expanding access, distributed solar generation can play a greater role in maximizing Florida's solar resources.

Policy 3: Allow Third-Party Sales of Electricity

Approximately 60 percent of new rooftop solar installations nationwide are completed through third-party ownership.[72] Third-party ownership allows residential customers who are unable to afford the upfront costs of solar PV systems or who have unsuitable credit to still enjoy the benefits of solar-generated electricity. Financiers offer no-money-down systems to customers while recovering costs through federal tax credits, renewable energy certificates, and savings from avoided electricity consumption. The customer usually pays a sub-retail rate for electricity, and is even able to purchase the system once the third-party contract expires.[73] While leasing solar systems is allowed,[74] Florida is one of eight states in the country that currently prohibit third-party ownership financing models by restricting third-party electricity sales.[75]

Florida can look to Georgia for an example of state enabling legislation for allowing third-party sales of electricity. In May 2015, Georgia legalized third-party sales of electricity through the Solar Power Free-Market Financing Act, which has resulted in significant growth potential for many in-state companies.[76,77]

Florida could allow third-party electricity sales in order to expand consumer choice and decrease overall solar system costs through increased competition. Distributed generation currently accounts for less than 50 MW of solar power in Florida, yet Florida's rooftop solar generation potential is estimated to be nearly 100 times that amount.[78,79] Third-party sales of electricity would enable more customers to transition to solar.[80] Florida could follow Georgia's example to attract more solar providers to the state and capitalize on its large solar potential. Allowing third-party electricity sales would make solar PV accessible to more consumers and expand Florida's solar industry.

Solar System Financing: Lease Versus Third-Party Ownership

Options for financing solar projects include leases and third party ownership with power purchase agreements (PPAs). Under a lease, a customer pays for the system over a specific period of time with low upfront costs.[69] However, leases are not an available option to all customers, due to financial constraints. With a PPA, a third party owns the solar system and the customer contracts to buy the electricity from the third party, usually at a rate lower than retail electricity rates. Florida currently allows solar leases, but does not authorize solar PPAs because of regulatory restrictions on third-party sales of electricity.[70,71]

Policy 4: Offer a Green Source Rider Program

Corporate interest in renewable energy is growing, and Florida is in a prime position to capitalize on this demand. As renewable energy has become increasingly cost-effective, companies have started setting sustainability goals that include purchasing electricity from renewable sources. Fortune 500 companies, including Intel Corporation and Starbucks, have declared their public commitment to renewable energy.[81] By the end of 2015, fifty-one companies had signed on to a collaborative declaration demanding access to clean electricity.[82] These firms purchased 3.4 GW of renewable energy in 2015—three times the amount purchased in 2014.[83]

For many corporations, solar-powered electricity is a desirable option. Corporate buyers have more than doubled their installed solar capacity since 2012.[85] Florida utilities could meet this demand through a Green Source Rider Program, which would allow large corporate customers to voluntarily purchase renewable energy without shifting costs to other ratepayers.[86] Similar programs have been adopted in ten states across the country, including North Carolina, Virginia, and Nevada.[87]

Benefits of Green Source Riders

If designed well, Green Source Riders can provide benefits to society, utilities, and key account customers. Green Source Riders can:[84]

- Reduce overall soft costs by providing economies of scale and optimizing avoided cost benefits, reducing transaction costs, and lowering customer acquisition costs
- Increase tax base and jobs by companies locating in the areas where the riders are offered
- Expand access to renewable energy
- Improve customer retention
- Minimize impact on other customers

Duke Energy's Green Source Rider In North Carolina

Duke Energy Carolinas offers the Green Source Rider program in North Carolina which provides large energy-intensive customers—such as manufacturers, big-box retailers, college campuses, or data centers—with an option to offset their planned energy consumption with renewable energy.[88] 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.[89] Rates are negotiated on a case-by-case basis and customers are charged a monthly administrative fee, as well as an additional two-tenths of a cent per kilowatt hour.[90] Participating companies have a different rate structure through the program to ensure that non-participating ratepayers do not pay any additional costs.[91] Google was the first customer to participate in the program, purchasing 61 MW of energy from a solar project in Rutherford County, in December 2015 to serve its data center.[92]

The Florida Public Service Commission (PSC) could investigate the impact of allowing utilities to offer non-residential customers voluntary renewable energy tariffs, as Oregon has done.[93] If the renewable energy tariff is deemed to be feasible, the PSC could expressly permit utilities to develop Green Source Rider Programs for companies in their territory and streamline the application process for program approval. Florida is home to fifteen Fortune

500 companies and other nationally-ranked businesses.[94,95] A Green Source Rider program would foster a solar and business-friendly climate while boosting the state's economy and creating jobs for Floridians.

Policy 5: Create an Online Crowdfunding Platform to Support School Solar Projects

Florida could target solar projects on schools to expand production of solar energy. Schools must rely on multiple sources of funding when installing a solar system due to lack of available financing.[96] Administrative burden is also a barrier to developing school solar projects. The state could streamline the process of initiating a project and raising capital by creating an online crowdfunding platform. This platform could be used to campaign for donations to finance solar projects.

School administrators across the country report that solar energy is providing schools with significant cost savings—allowing districts to reallocate funds for educational use.[97] For example, after installing solar systems, Pennsylvania school districts have had one-year savings up to $280,000.[98]

Public solar project crowdfunding has been successful overseas. In the United Kingdom, the nonprofit 10:10 provides outreach and fundraising support for schools' solar campaigns.[99] Anyone can contribute to the schools' crowdfunding efforts through 10:10's online platform. The program has raised more than £400,000 in three years to build on-site solar systems for schools.[100,101] Thirty-one projects are fully funded and fifty-six currently have active campaigns.[102] Florida has the opportunity to replicate this success in its communities.

Through a Florida solar crowdfunding tool, public entities would be able to establish a campaign to which community members could donate. Costs associated with creating the platform could be covered by contributions from industry or general fund allocations. The state could also allocate a limited amount of funds to enable public entities to jumpstart campaigns and coordinate fundraising efforts. Through this innovative funding model, Florida could not only extend energy savings and educational opportunities to local communities but also stimulate the state's solar economy.

What is Crowdfunding?

Crowdfunding is the process of raising money for a project or venture through contributions from a large span of people, typically through an online platform. Equity crowdfunding is the same process but contributors gain an ownership stake in that project.

Chapter Summary

Smart, strategic policies can help Florida leverage the state's strengths to create a thriving solar economy. As clusters coalesce around a nucleus of activity and relationships, Florida policymakers should consider removing barriers and stoking in-state demand to create a more diverse and robust solar sector. Florida can achieve this by providing equitable access to solar energy through community solar projects, improving net metering regulations, and enabling third-party financing; attracting corporate solar procurement through a Green Source Rider Program; and providing citizens with a means to crowdsource solar projects in their communities. Through smart, proactive policies, leaders can strengthen and expand the advanced energy economy, maximize the state's solar potential, and create good-paying jobs for Floridians

Roof-Integrated Photovoltaic Shingles
Photo Credit. U.S. Department of Energy

Chapter 3: Biofuels

American demand for biofuels has increased due to concerns about vehicle emissions and conventional fuel import dependence. Florida is well positioned to be a leader in this market. By enacting smart and strategic policies, Florida's policymakers can stimulate the state's nascent biofuel industry and spark job growth. Biofuel production can effectively harness the state's abundant biomass resources with the help of enabling policies and technological innovation. Investing in biofuel technologies can diversify Florida's energy resource mix and decrease expenditures on imported fuels. By reducing its dependence on any single energy source, Florida can achieve a secure and affordable energy future. Moreover, biofuels have the potential to expand beyond Florida's energy needs and meet demand in regional, national, and international markets.

This chapter provides a roadmap for Florida's policymakers to support the in-state biofuels sector. To chart this growth, the chapter analyzes the existing supply chain and its potential to create good-paying jobs. Based on this foundation, the chapter highlights biofuel policy opportunities that state policymakers can use to stoke economic development.

What Are Biofuels?

Biofuels are liquid transportation fuels derived from biomass (biological material).[1] They provide a clean and renewable fuel alternative that can be used as a blending agent or a replacement for gasoline to reduce vehicle emissions. The most common types of biofuels are ethanol and biodiesel.[2] Ethanol is made with starches and sugars from plants such as corn or sugarcane, and biodiesel can be produced from vegetable oils, animal fats, or cooking grease.[3] Because of competing land uses and feedstock needs, next-generation biofuels, commonly referred to as "advanced biofuels", depend less on food crops and more on sustainable biomass inputs. For example, second-generation biofuels, such as cellulosic ethanol, utilize inedible food parts and agricultural residues, such as corn husks.[4] Third-generation biofuels from algae and fourth-generation biofuels from engineered biomass are other opportunities in renewable fuel production.[5]

Strengths, Weaknesses, Opportunities, and Threats for Biofuels in Florida

STRENGTHS	WEAKNESSES
• Abundance of inedible biomass feedstocks • State-funded Research and Development Bioenergy Grant Program • The Florida Energy Systems Consortium, an internationally recognized bioenergy research leader • Algal biofuel research and production in the state • Well-trained workforce • Favorable business environment • Biofuel investment tax credits	• Few conventional biofuel plants in the state[6] • Lack of coordination in Florida's biofuels industry • Heavy reliance on ethanol imports • Nascent biomass processing research • Expensive cellulosic ethanol production • Renewable Fuel Standard repealed in 2013
OPPORTUNITIES	**THREATS**
• Potential growth in existing supply chain • Existing public-private partnerships to build on • Biomass processing and feedstock clusters • Rural economic development from demand for biomass • Diverse downstream markets • Growing demand for ethanol in the U.S. military • Large European demand for woody biomass and biofuels	• Competitive biofuel industry growth in nearby states • Offshoring of machinery productions • Little policy support • High capital requirements for bioenergy technologies • Risk of hurricane destruction to feedstock and processing facilities • Competing land uses

Florida is well positioned to foster a robust biofuel technology sector, spur business development, and stimulate job growth within its borders. The state has one of the highest biomass resources in the nation, largely from non-food crops that are ideal for advanced biofuel production.[7] These inedible feedstocks include municipal waste, sugarcane waste, citrus pulp, and

Feedstocks for Biofuel Production

Feedstocks are natural products containing starches, sugars, or fats that are processed to produce biofuels. Major feedstocks include:

- Corn
- Sugarcane
- Citrus pulp
- Agricultural residues, such as corn husks and stalks
- Municipal waste
- Wood chips and forest residues
- Sugar beets

Ethanol vs. Cellulosic Ethanol

In the United States, ethanol is traditionally made from corn. Starch in the corn breaks down to produce ethanol. Cellulosic ethanol, however, is made from dense plant material such as corn stalks. The cellulose from plant material is broken down into ethanol for use as a fuel.

agricultural residues.[8] Florida's current biomass resource could produce over 8 billion gallons of cellulosic ethanol per year, enough to replace two-thirds of Florida's annual gasoline consumption.[9] To capitalize on these assets, Florida offers many attractive financial incentives, including an investment tax credit, a production credit, and research funds through the state's Bioenergy Grant Program.[10] Florida's biofuel pilot projects have distinguished the state as a leader in biofuel technologies.[11] Florida's industry base and public-private partnerships provide a foundation to build this industry.

Florida must act quickly to assert its position in the biofuels market. The repeal of the Florida Renewable Fuel Standard in 2013 dampened commercial development of conventional and advanced biofuels.[12] The biofuels industry also lacks public-private coordination. For example, few resources on the benefits and opportunities of biofuels are currently available to the public. These hurdles, among others, have contributed to Florida's dependence on ethanol imports despite abundant existing resources.[13] Targeted policies are needed to encourage biofuel production and related-equipment manufacturing, which could strengthen the in-state biofuel industry and make Florida a major national competitor.

Biofuels Market Trends

Rising Demand for Biofuels

Demand for biofuels is growing on a global scale. Moderate projections reveal a 17 percent increase in production between 2013 and 2019, while more bullish studies predict 31 percent growth.[14] While ethanol and biodiesel will continue to meet most demand, second-generation biofuels such as cellulosic ethanol will also play a greater role in meeting demand. Annual growth for these biofuels is projected at 49 percent through 2020, when the market could equal $24 billion.[15] Biofuels could account for 27 percent of all transportation fuels by 2050.[16]

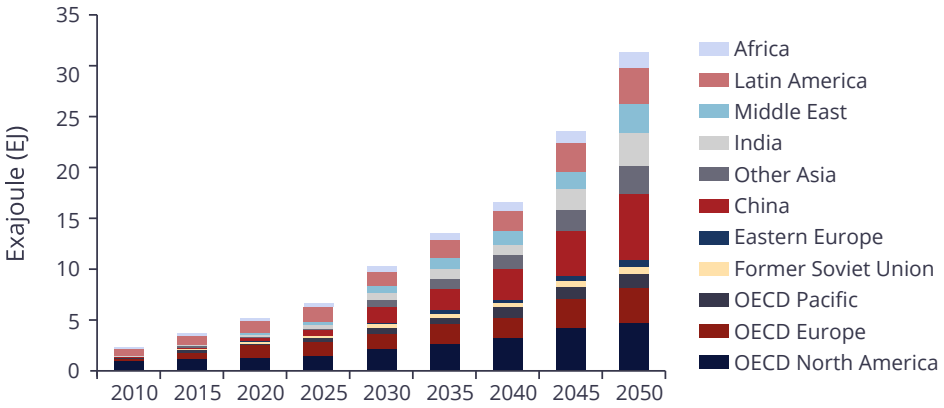


Figure 5. Global demand for biofuels projected to increase dramatically up to 2050. (Source: IEA Technology Roadmap)

Due to federal and state policy support, the United States is a global leader in biofuel production.[17] The United States is a net exporter and the leading producer of corn-based ethanol in the world.[18] National demand for biofuels is expected to rise due to the Renewable Fuel Standard, which targets consumption at 36 billion gallons by 2022.[19] There will also be a larger focus on advanced biofuels due to concerns of feedstock availability and cost. In the 2013 marketing year, biofuel production accounted for 38 percent of the U.S. corn crop and 24 percent of U.S. soybean oil production.[20] National biomass energy consumption grew by 60 percent from 2002 to 2013 due to rising ethanol demand.[21]

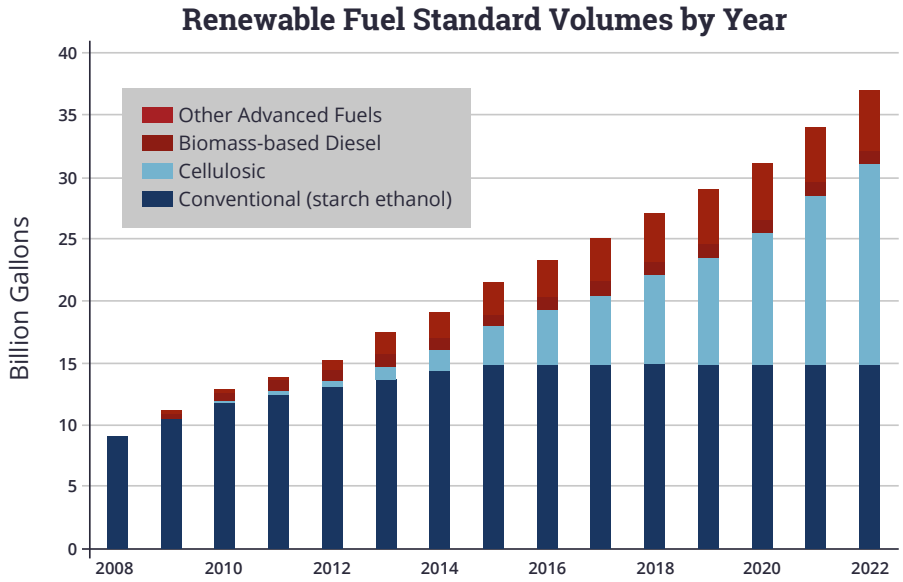


Figure 6. The U.S. Renewable Fuel Standard requires increasing amounts of advanced biofuels up to 2022.
(Source: U.S. Department of Energy, Alternative Fuels Data Center)

Falling Costs of Biofuels

The cost of biofuel production depends on the feedstock, conversion, and capital costs.[22] Total biofuel production costs vary widely, ranging from $0.52 to $4.02 per gallon in North America.[23] For conventional ethanol and biodiesel production, feedstock accounts for 45 to 70 percent of total production costs.[24] Feedstock costs (25 to 40 percent) and capital costs (35 to 50 percent) are major barriers to scaling up next-generation biofuels.[25]

For all types of biofuels, capital costs are expected to drop with greater economies of scale, the co-location of biofuel plants, and technological advancements.[26] Feedstock costs are more variable but diversifying biomass sources could open up low-cost options and reduce price volatility.[27] Transportation infrastructure could also be targeted to reduce distribution costs.[28]

Most biofuels could be cost-competitive by 2030 with increased scale and efficiency.[29] In 2014, cellulosic biofuels ranged between 24 to 50 percent more expensive than corn-based ethanol.[30] However, industry leaders predict cellulosic ethanol could become price-competitive with corn-based ethanol in 2016.[31] Production costs are predicted to decrease for more advanced fuels as well. The cost of fourth-generation biofuels is projected to decline by 49 percent between 2012 and 2017, only a five-year period.[32]

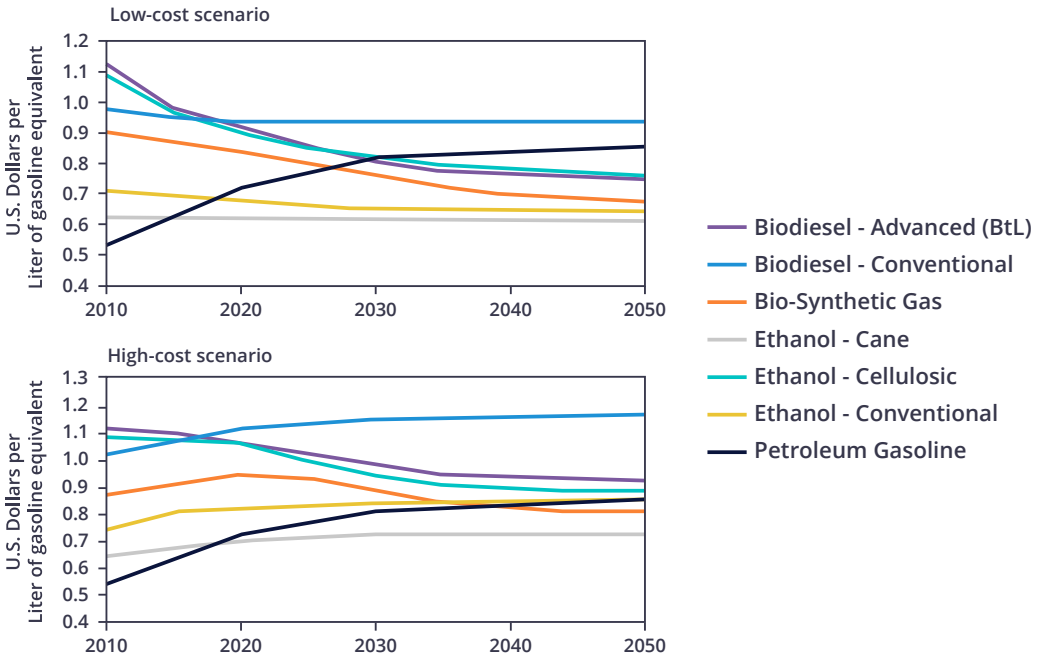


Figure 7. Cost Comparison of Biofuels and Gasoline
(Source: IEA Technology Roadmap)

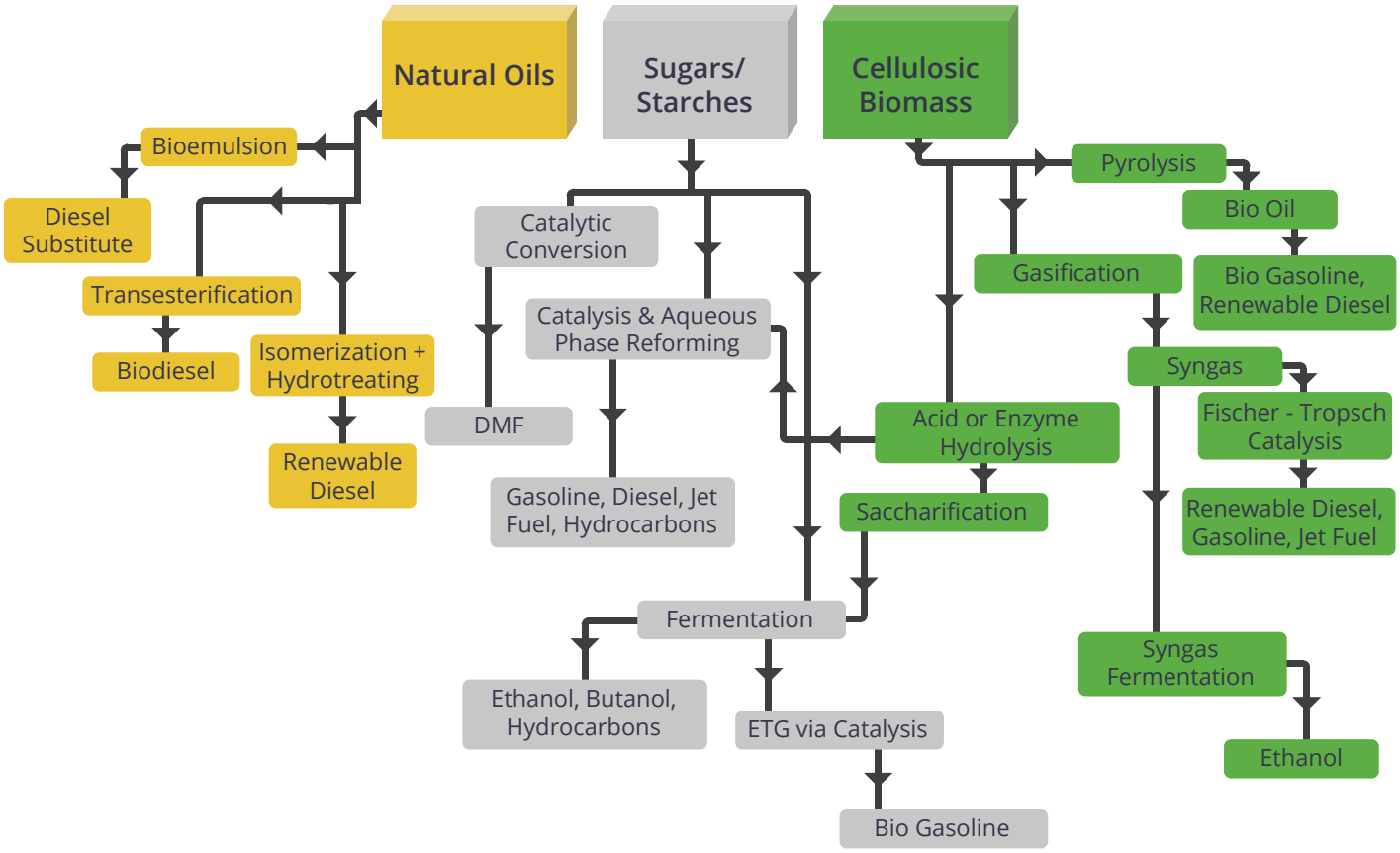
What Does Rising Demand and Falling Costs Mean for Florida?

Florida could take advantage of rising demand and falling costs by leveraging its abundant biomass resources. Florida could build in-state market capacity by increasing production and attracting businesses across the supply chain. Potential ethanol supply is enough to replace most of the state's gasoline consumption, yet the state has few ethanol production plants.[33] Florida's current biodiesel production capacity is 30 million gallons per year, which could expand significantly with more investment in production facilities.[34] Iowa, for example, has invested heavily in biodiesel production and now has an annual production capacity of 289 million gallons.[35] Charting the growth of different biofuels can help Florida determine the best areas to leverage the state's strengths and capitalize on future growth. By stoking the in-state biofuel sector, Florida could ultimately export biofuels and production technologies to neighboring regions, fueling local economic development and job growth.

Biofuel Manufacturing

Biofuels can be produced from many different sources through various manufacturing processes. For Florida policymakers and leaders to craft forward-thinking policies that support the future of biofuel technology, it is important to understand the biofuel production process.

Biofuels Pathways



(Source: Advanced Biofuels Association)

Biofuel Supply Chain

Companies in the biofuel supply chain offer diverse products and services, including feedstock distribution, machinery manufacturing, biochemical development, and fuel production. Table 2 below lists the number of companies in Florida working in each subsector of the supply chain.

Table 2. Florida's Biofuel Supply Chain (Source: Internal Analysis)

CATEGORY	NUMBER OF COMPANIES	DESCRIPTION
Feedstock Production	5	Supply feedstocks for biofuel production (includes algae, eucalyptus, and sugarcane)
Biofuels Production	17	Produce biofuels from a variety of feedstocks
Biodiesel	7	
Ethanol	9	
Drop-in Fuel	1	
Biochemical Conversion	5	Offer process technologies for biochemical conversion or supply enzymes and chemicals for biofuel production
Machinery Manufacturing	1	Manufacture industrial machinery for biofuel production
Storage, Transportation, and Distribution	4	Provide storage tanks, transport supply, or distribute biofuels on the wholesale market
Total Companies	**32**	

Strengths and Areas for Growth

The state of Florida has long been a hub for sugar production and processing. Once considered the world's leading commodity, sugar helped build Miami and eventually the state at large.[36] Now, with the advent of bioethanol, sugar is making a comeback in Florida. The commodity has been hailed as the new oil, and has received sizable investments from chemical giants such as BASF.[37,38]

Florida has already utilized its longstanding connection to sugar through fermentation, cellulosic conversion, and algal production to become one of the nation's leading biofuel producers. While sugar fermentation is a straightforward and mature process,

the ability to profit from algal fuels and cellulosic conversion is particularly impressive.[39] Advanced biofuel producers in Florida have succeeded with these challenging technologies through creative solutions demonstrating keen business sense.

Two companies currently lead innovation in Florida's cellulosic ethanol cluster: REG Life Sciences and Alliance Bioenergy. Despite recent drops in oil prices, both companies have managed to remain viable while working with cellulosic conversion technologies.[40,41] This is largely due to their production of goods typically made from petroleum byproducts in addition to next-generation biofuels. In addition, the companies have developed their technologies to use virtually any feedstock, including waste from the lumber industry and agriculture. This flexibility reduces the costs of production.[42] Both companies have also diversified their revenue streams, with REG producing biodiesel and Alliance licensing out key patents for a dependable cash flow.[43,44]

While Florida houses more than a dozen biofuel producers with diverse specialties and focuses, the state lags behind in enzyme and advanced chemical production. Policies to target these untouched technologies in the biofuels industry could spur rapid growth for businesses and jobs.

Photo Credit. oakridgelabnews / Foter / CC BY-NC-ND

Florida could also increase production of industrial machinery for biofuel production. Companies would be able to tap into the state's highly trained workforce and strong manufacturing base of more than 18,600 companies.[45] Companies could also expand operations or retool facilities to transition into the biofuels industry through existing incentives for capital investments and job creation.

Clustering Florida's Biofuel Industry

Southeastern Florida has ideal capital and labor factors for a robust biofuel industry. The region has large feedstocks in sugarcane, bagasse, and wood products.[46] In addition, the southeastern region of Florida boasts prominent research centers, including the University of Florida Tropical Research and Education Center, which conducts leading biofuel research.[47] Many of Florida's biofuel power plants are also heavily concentrated in the southeastern part of the state.[48] All of these resources, combined with the state's access to waterways for national and international trade, make southeastern Florida a clear candidate for a strong biofuel industry.

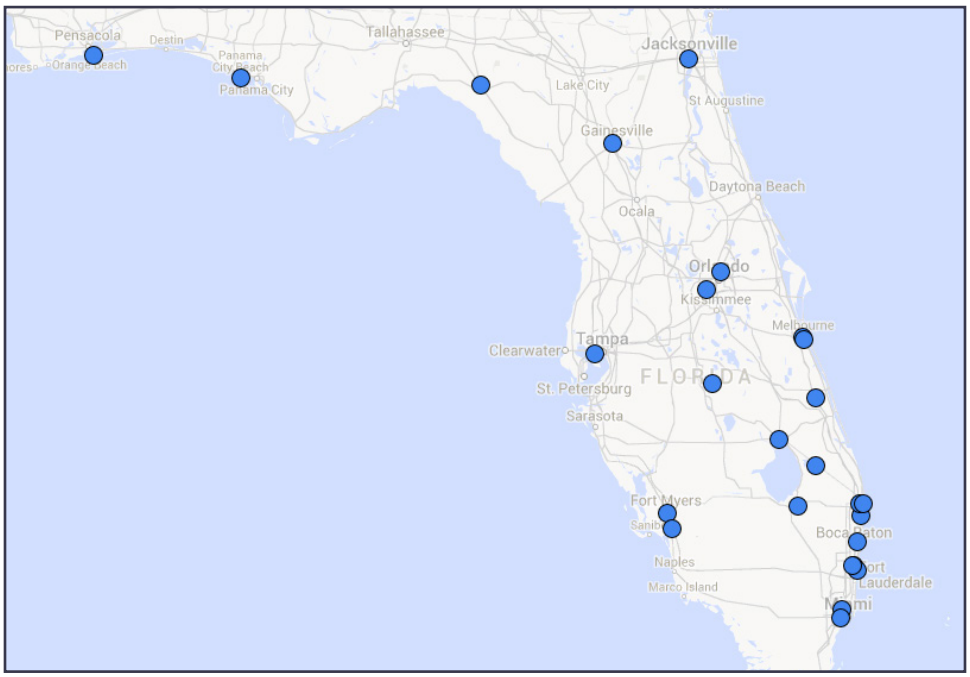


Figure 8: Biofuel Supply Chain in Florida

Florida's Potential for Biofuel Jobs

As demand for advanced biofuels increases, Florida has the opportunity to expand the advanced biofuels economy, increase in-state spending, and support up to 54,000 jobs per year over the next fifteen years. If Florida's advanced biofuels companies are able to increase their national market share to 5 percent, over 820,000 direct, indirect, and induced job-years could be supported. While nearly 177,000 of those would be direct job-years in the state's advanced biofuels industry, over 643,000 indirect and induced job-years would also be supported.

These projections for job-years potential in Florida's advanced biofuels industry utilized existing analysis of the national economic impacts from advanced biofuels, an NREL survey of current advanced biofuels facilities, and updates to the EPA's Renewable Fuels Standard.[49,50,51] Based on the national projections, we estimated the direct, indirect, and induced jobs created at different levels of national market share and multiplier effects. There are many types of advanced biofuels and even more ways of processing the biomass they originate from. For this reason, many assumptions were required for the direct jobs and multipliers.

To highlight why growing the advanced biofuels industry in Florida is so important, we have estimated the number of direct, indirect, and induced jobs based on Florida's current share of production in the national advanced biofuels industry. Figure 9 shows how the number of advanced biofuels jobs vary as Florida's market share increases from 1 percent to 5 percent. Florida's current market share of the advanced biofuels production is less than 1 percent.[52]

Increasing Florida's share of the national advanced biofuels market would create thousands of jobs for Floridians. If Florida's national market share of advanced biofuels jobs rose to 2.5 percent, the industry would support over 53,000 direct job-years and nearly 193,000 indirect and induced job-years between 2016 to 2030.

If a concerted effort were made by the state to expand the advanced biofuels cluster, Florida companies could increase their national market share to 5 percent, supporting over 820,000 job-years. Increasing the number of advanced biofuels companies and supply chain businesses can create thousands of good-paying, skilled jobs and make Florida a leader in the advanced biofuels industry.

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 construction workers are expected to each spend 208 hours on a large commercial biofuel project, this is measured as one job-year. Alternatively, if one full-time engineer is expected to spend fifteen years operating that same biofuel project, this is measured as fifteen job-years. In our analysis of Florida's biofuel 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 Florida's advanced biofuel supply chain, direct, indirect, and induced job-years are measured.

- **Direct job-years:** reflect jobs created in the biofuel 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 Florida's biofuel industry
- **Induced job-years:** reflect jobs created throughout the local economy as a result of increased spending by workers and firms in Florida's biofuel and biofuel supply chain industries

Multipliers

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 biofuel creates ten new biofuel job-years and the local multiplier is 2.5, then fifteen new indirect and induced job-years will be created in the local economy.

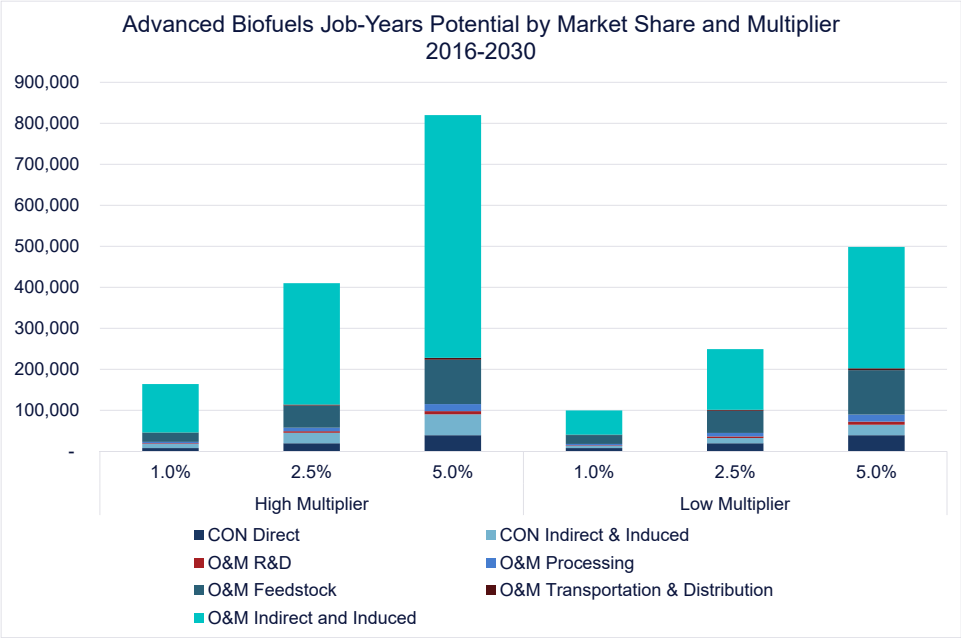
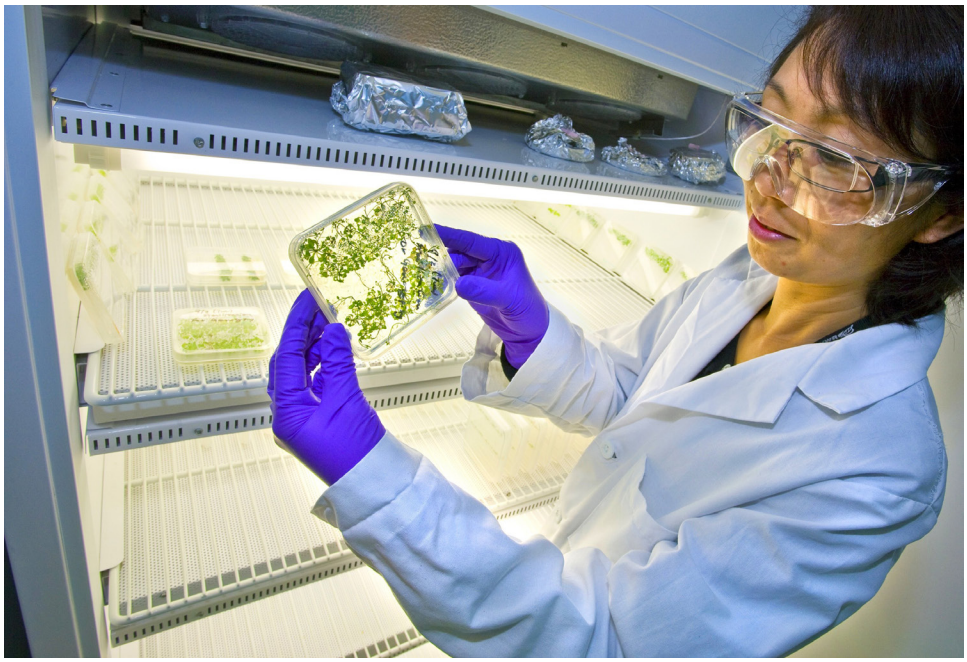


Figure 9. Increasing local spending will increase job-years for Floridians.



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Policy Recommendations

Florida boasts many assets to support biofuel industry growth, including an ideal climate for feedstock growth, strong investment incentives, and a high-tech workforce. To take full advantage of the market opportunity for biofuels and secure good-paying jobs for Floridians, state leaders could establish strategic, proactive policies to stimulate supply and demand.

Policy 1: Create the Florida Biofuels Information Center

Biofuel business development is inhibited by a lack of public resources to help entrepreneurs overcome significant upfront costs. The primary source of biofuel business information in Florida is the Florida Biofuel and Bioenergy Association (FBBA). The FBBA is a membership-based association, meaning companies pay an annual fee for access to its resources.[53] The fee could deter many seed and early-stage companies from seeking the assistance they need. Additionally, the FBBA does not host conferences, which significantly reduces networking and education opportunities for non-members. Florida could supplement FBBA's efforts by establishing the Florida Biofuels Information Center (FBIC) to provide improved resources to businesses and the public.

Model Resources in Iowa and Nebraska

The Iowa Renewable Fuels Association (IRFA) has successfully overcome the information barrier in Iowa. IRFA's mission is to "foster the development and growth of the state's renewable fuels industry through education, promotion, and infrastructure development."[54] Although the organization is funded by membership fees, its extensive online resources are available to the public. Relevant resources are provided for producers, retailers, and current or potential consumers. By sharing information with all stakeholders, IRFA contributes to a well-integrated economy with a high level of demand and supply. With more than 3 billion gallons produced in 2015, Iowa leads the nation in ethanol production.[55] Nebraska—ranked second in the country in ethanol production—has created a similar one-stop shop for information on biofuels.[56] The Nebraska Renewable Energy Association (NeREA) provides startup process overviews, state regulatory and tax information, and a biodiesel feasibility study calculator.[57]

The FBIC could stimulate the state's biofuel sector by helping

businesses gain a more comprehensive understanding of the industry. The FBIC could manage online resources, trainings, and conferences, which would inform interested parties about the potential of biofuels within the state and connect companies with other industry leaders. Additionally, the FBIC could collaborate with the FBBA to increase membership and disperse information. For example, the FBIC could interface with the public and introduce firms to the market, while the FBBA facilitates relationship building within the industry. To become a global leader in biofuels, Florida must establish strong relationships throughout the industry.

Policy 2: Enhance Florida's Biofuel Industry Through Foreign Direct Investment

Many state leaders recruit international companies to create jobs for their workforce, and Florida is no exception. Foreign companies, spanning dozens of industries, provide thousands of jobs in Florida.[58] In fact, Florida ranked sixth in the nation for employment in foreign-owned firms.[59] As a major hub for foreign direct investment, Florida could take advantage of the expanding biofuels market and recruit international companies to fill supply chain gaps.[60] These opportunities for growth include enzyme and advanced chemical production and processing equipment.

Florida could target international companies that supply enzymes and advanced chemicals for biofuel production. Currently, Dyadic International is the only in-state business providing these advanced materials to the biofuel industry. Florida could reach out to specific companies based on the advanced materials required for production. In particular, demand for amylase biofuel enzymes is set to rise and Florida could become a leading supplier.[61] Major producers of the enzyme amylase include Jiangsu Boli Bioproducts Co. (China), Royal DSM (Netherlands), Enzyme Supplies Ltd. (Wales), and Schaumann Bioenergy (Germany).

Florida could target manufacturers of processing equipment for chemical analysis and testing to support the advanced chemicals sector. Metrohm AG, a global leader in precision instruments for chemical analysis, currently manages a distribution facility in Riverview.[62] Florida could capitalize on this existing relationship to attract the company's manufacturing operations to the state.

Attracting foreign capital to the state could fill gaps in the biofuel

supply chain and create good-paying jobs for Floridians. The state's business-friendly climate and highly skilled workforce makes Florida an attractive option for many global businesses.

Policy 3: Establish a Biofuel Retailer Tax Credit

More than 17.4 million U.S. vehicles are flex fuel-ready and in 2011, there were over 600,000 flex fuel vehicles in Florida.[63,64] Flex fuels are gasoline-ethanol blends with up to 85 percent ethanol (E85).[65] While demand for E85 is expected to grow from 196 million gallons in 2013 to in excess of 400 million gallons in 2023, demand is heavily dependent on the availability of fueling stations.[66] Florida can meet the demand of the growing flex fuel fleet by installing flex fuel pumps at gas stations. Gas stations must be specially retooled to provide this option for customers and Florida is not keeping up with other states installing flex fuels pumps. For example, Florida currently has sixty-six stations, while Illinois has 242.[67] The high overhead costs associated with installing flex fuel infrastructure create a significant barrier to growth. To help overcome this barrier, Florida's policymakers could establish a tax credit for retailers with flex fuel pumps.

Biofuel retailer tax credits have proven successful in Iowa, a leading ethanol-producing state. Iowa currently offers four tax credits to promote the distribution of ethanol, E85 and E15 gasoline, and biodiesel-blended fuel.[68] Currently, Iowa boasts more than 200 E85 fueling stations throughout the state.[69] Florida leaders could encourage a similar spike in flex fuel stations through a tax credit that mitigates high upfront installation costs and provides sustained benefits for retailers and consumers. Incentivizing retailers to make flex fuels readily available to customers could boost statewide demand for biofuels and encourage production.

Policy 4: Encourage Public Alternative Fuel Vehicle Fleets Through Performance Contracts

Florida's abundant biofuel resource provides an opportunity for the state to increase energy independence, decrease fuel expenditures, and create good-paying jobs by retooling public fleet vehicles. Local and state governments could use alternative fuel vehicles (AFVs) powered by biofuels or other renewable fuels to enhance energy security, decrease fuel costs, and stimulate demand for locally sourced fuels.[76] Despite these benefits, barriers such as limited experience with AFVs, inaccurate cost and benefit predictions, limited budget authority, and limited access to financing and incentives prevent governments from retooling their fleets to use alternative fuels.[77] To overcome these barriers,

Building Flex Fuel Infrastructure in Iowa

Supported by a USDA grant, Iowa's Fueling Our Future 100 program provides matching funds to retailers installing flex fuel upgrades. In 2015, the program awarded $2.49 million to support the installation of 107 blender pumps and eight underground storage tanks.[70] Iowa's governor has stated that this initiative supports good jobs, provides consumers with choices, and benefits the Iowa economy.[71]

Protec Fuel's Success with Flex Fuel Stations in Florida

Protec Fuel opened the first E15 fueling station in South Florida in January of 2015.[72] The investment proved to be so successful that the company made E15 available at additional stations in Central Florida, expanding on its existing supply of E85 stations.[73] All flex fuels made available by Protec Fuel are manufactured in the United States, supporting American jobs and the national economy.[74] In September 2015, the company established a partnership with Algenol to distribute 18 million gallons annually of algae-based ethanol.[75]

What is an Energy Service Company?

Energy service companies (ESCOs) operate on an energy performance contract (EPC) to finance and facilitate installation of energy efficiency projects in buildings.[78] ESCOs traditionally serve governments, hospitals, universities, and schools, saving these end-users a total of $50 billion in avoided energy costs as of 2014.[79]

Public AFV Fleet for Philadelphia School District

The Rose Tree Media School District near Philadelphia, Pennsylvania worked with Johnson Controls Inc., an ESCO, to establish energy efficiency building performance contracts. Johnson identified an additional opportunity for savings–converting the bus fleets to use compressed natural gas. Johnson managed the conversion of diesel buses to natural gas, converted maintenance infrastructure and operations, built fueling stations, and provided staff training and transition assistance. The Rose Tree School District, which operates seventy-four school buses, is projected to save $6.5 million in fuel costs and $1 million overall on the project over a twenty-year period.[80]

Florida's policymakers could engage in performance contracts similar to those employed by energy service companies (ESCOs). Pennsylvania has successfully implemented this mechanism for compressed natural gas vehicles.

The state of Florida currently allows public contracts that achieve efficiency gains through "a measured reduction in the cost of fuel."[81] Local policymakers could expand this mandate to allow ESCO-style performance contracts to upgrade fleet vehicles to run on biofuels. By upgrading fleets to AFVs, hospitals, municipalities, schools, and universities could save money, expand the state's energy independence, capitalize on local biofuel resources, and create good-paying jobs for Floridians.

Chapter Summary

Florida has the necessary ingredients to develop a thriving biofuel industry. Strategic policy choices that leverage the state's abundant biomass resources, strong workforce, and business-friendly environment would strengthen Florida's commitment to the advanced energy economy. By establishing informational resources for new businesses, attracting foreign investment to the state, supporting the expansion of flex fuel stations, and retrofitting public vehicle fleets for biofuels, Florida can spur in-state demand and encourage production. Prioritizing biofuel industry growth could boost the state's economic development and create good-paying jobs for Floridians.

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 Florida.

"One of the reasons the innovation sector still creates plentiful jobs is that it continues to be a labor-intensive sector, since the main production input in scientific research is human capital—in other words, people and their ideas."

– Enrico Moretti, *"The New Geography of Jobs"*

Innovation Ecosystem

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

Access to Capital

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

Access to capital is critical for the success of advanced energy technologies. Businesses will face significant 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 stimulate job growth, states should consider actively facilitating access to capital.

Non-Dilutive Capital

Non-dilutive capital, such as a grant or loan, 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.

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 businesses capable of bringing innovative ideas to the marketplace quickly and efficiently will be considered winners.

Florida's Innovation Ecosystem

Through policy, private sector partnerships, and a strong focus on its academic institutions, Florida already supports a robust innovation ecosystem capable of commercializing products and generating cutting-edge research. There are a number of

networks between companies, universities, and private research institutions that help coordinate and expand research activities across the state. Florida's cleantech industry is currently on pace to achieve comparable success to the state's biotechnology and medical industries, which serve as models for innovation and job creation.[1]

Although Florida ranked fifth in the nation for state expenditures directed at research and development (R&D) in 2013, the state attracted little federal and private funding.[2,3,4] While Florida ranks among the top twelve states in securing federal funding, its position may be misleading given a select few states attract the bulk of awards.[5] The state also attracted little angel and venture capital funds for research at the seed and early stages.[6] Although Florida has the infrastructure and academic institutions needed for growth in its solar and biofuel industries, it lacks the financial resources to fully commercialize new energy technologies and products.

Research Institutions and Initiatives

Florida supports uniquely collaborative energy R&D at the university level. The state's academic research efforts are largely coordinated by the Florida Energy Systems Consortium (FESC) through its twelve member universities.[7] FESC shares thirty research centers, along with faculty expertise, to spur development in advanced energy fields, with projects in areas such as biofuel conversion and solar power applications.[8,9] Florida's innovation ecosystem is also uniquely linked through the Florida Research Consortium (FRC), a strategic partnership of education, business, and government across all fields to support the commercialization of university research.[10] Founded in 2001, FRC's efforts have helped establish and fund ten campus-based Centers of Excellence, including two dedicated to alternative energy.[11] Florida's technology transfer assets are concentrated in a one-stop shop for investors and entrepreneurs. The Institute for Commercialization of Public Research (ICPR) acts as a central repository for all commercialization-ready technologies from the technology transfer offices of the twelve universities.[12]

Florida boasts nine university research parks, more than any other state in the nation.[13] The Florida Gulf Coast University Innovation Hub (I-HUB) is on course to become a new energy innovation powerhouse in Florida. I-HUB is a 1.2-million-square-foot complex in Southwest Florida dedicated to research and technology transfer in advanced energy industries, with plans to be entirely powered by solar.[14] The newly-opened Emergent Technologies Institute (ETI), I-HUB's anchoring facility, will serve as a major research laboratory and outreach center, encouraging partnerships between universities and industry.[15] For example,

ETI plans to develop a graduate program in renewable energy engineering with Florida Gulf Coast University and to serve as a training center for solar installers.[16]

The Florida High Tech Corridor Council (FHTCC) is a regional economic development initiative created in collaboration with three top-tier universities to grow a high-tech industry through research and workforce development.[17] The FHTCC matches $1 in funds for every $3 of corporate contributions to foster university-industry collaborative research.[18] Businesses in the sustainable energy industry are eligible to receive FHTCC awards ranging from $10,000 to $150,000.[19] Since program inception in 1996, the Council has invested nearly $62 million in funds for 1,350 research projects, accompanied by $175 million in investments and in-kind contributions from the private sector.[20] The cumulative economic impact of this program has been measured at $938 million.[21]

In 2014, Florida universities spent $2.3 billion on R&D expenditures, ranking Florida ninth in the United States.[22] Five Florida universities were among the top 200 for research funding, led by the University of Florida.[23] However, industry-sponsored research at Florida's universities has considerable room for growth. In 2014, less than 5 percent of all Florida academic R&D expenditures were funded by the business sector, compared to 6.7 percent in South Carolina and 12 percent in North Carolina.[24] If the share of privately-funded research were to increase, Florida could see significant market-based improvements in its innovation ecosystem.

Resources for Startups

Incubators and Accelerators

Incubators are designed to provide support services to early-stage startups. Incubator assistance can include office space, professional networks, access to financing, and business skill training. Accelerators assist companies in the later stages of business development, usually addressing short-term needs such as product launches.

Florida houses numerous incubators and accelerators to support growing companies. Assistance offered by these companies includes general business and financial services, as well as shared facility and office space. Arguably the most prominent incubator in the state is the Technology Business Incubator (TBI). Located in the Research Park at Florida Atlantic University, TBI has excellent access to pre-commercial technologies from university labs as well as South Florida's largest structured angel investment group.[25] Its prime location is ultimately what makes TBI one of the most successful drivers of business innovation in the state.

The University of Florida Innovation Hub is an incubator located on the University campus that provides labs and office space at a low cost for startups.[26] The Innovation Hub provides all resident startups with mentors-in-residence to guide and support companies. Pro bono hours from attorneys, accountants and marketers are available for expert consultation. Lastly, the Innovation Hub has community events including speakers and social meet ups. Since the Innovation Hub has opened, its startup

companies have created 760 jobs and raised $50 million.[27]

The University of Central Florida Business Incubation Program was created to spur economic growth and protect jobs in the region by supporting early-stage companies.[28] Since 1999, the program has helped generate $2.48 billion in economic output and has sustained nearly 3,700 local jobs.[29]

Government Programs

In addition to funding academic R&D, a number of public programs and incentives are available to support overall innovation and commercialization activities in Florida. The 21st Century Technology, Research, and Scholarship Enhancement Act of 2007 was a critical piece of legislation that established the Research Commercialization Assistance Grant Program to provide grant funding for early-stage companies.[30]

A large number of economic development organizations and university-industry collaborations support energy innovation in Florida. Most notably, Enterprise Florida, Inc. (EFI) is a public-private partnership that serves to connect all regional economic development agencies in the state.[31] EFI currently manages the SBIR/STTR Phase "0" Pilot Program, which supports and encourages the use of incubators, technology transfer offices, economic development organizations, and small business resource centers.[32] The goal of the pilot program is to increase the likelihood for startups to receive federal SBIR/STTR funding.[33]

Access to Capital

Access to capital is essential for entrepreneurs to grow their businesses, bring products to market, and create new jobs. Capital pricing can make the bottom-line difference in product affordability and market viability, yet many businesses are unable to secure the necessary capital to survive the commercialization phase. As shown in Figure 10, companies nationwide face funding shortages during the prototyping and commercialization phases, commonly known as the "valleys of death." In 2014, 75 percent of venture capital funding went to companies in California, New York, and Massachusetts; businesses in the other forty-seven states had to compete over the remaining 25 percent, stifling innovation across the country and highlighting the importance of state policies for new venture capital investments.[38] Florida has a strong history of prioritizing early investment to help new companies survive the double "valleys of death" and bring innovative technologies to market.

Energy Research Driven by Florida's Aerospace Industry

Energy Florida is an industry-led, nonprofit consortium with an explicit focus on growing energy clusters by leveraging the Space Coast region's aerospace assets and capabilities.[34] The consortium works closely with Space Florida, the state's aerospace economic development arm, to facilitate research programs. Specifically, the Space and Energy Innovation Center aims to develop, demonstrate, and commercialize innovative energy technologies and products for terrestrial and space applications.[35] With both state and federal funding, the Innovation Center will establish a national energy demonstration facility and develop specialized hubs for biofuels, alternative fuel vehicles, and smart grid technologies.[36] Space Center's Clean Energy Jobs Accelerator bolsters research efforts by supporting local business and workforce development.[37]

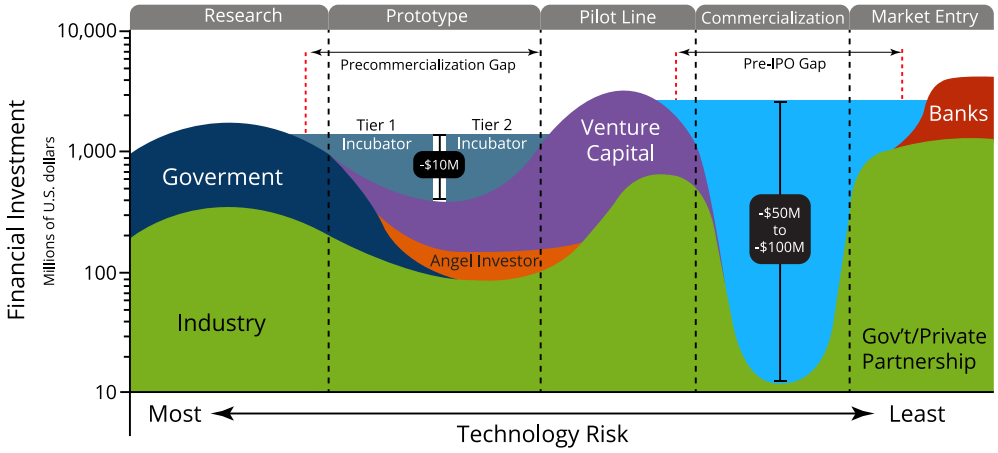

Figure 10. New technologies need help crossing the "Valley of Death" in the commercialization process (Source: U.S. Department of Energy)

Venture Capital Funds

Venture capital (VC) funds provide critical early-stage financing for high-potential startup companies in exchange for an equity stake in the company. Generally, venture capital funds are used to demonstrate and scale a working prototype. California, Massachusetts, and New York have historically dominated the VC landscape, a trend that continues today.[39] Consequently, VC investors have clustered in these states, bringing aspiring entrepreneurs and plentiful job opportunities with them. From 2013 to 2015, entrepreneurs in Florida secured 152 VC deals worth $1.78 billion.[40] Compared to other southeastern states in 2015, Florida ranked behind Georgia, Virginia, and North Carolina in total investment.[41] Currently there are sixty-seven cleantech startups in Florida that have received VC funding, with only five in the biofuels industry and only one in the solar industry.[42]

However, there are three notable public venture funds that have supported Floridian startups, suggesting the possibility for further public efforts to make up for the limited private VC investments in the state. The Florida Opportunity Fund (FOF), for example, is a state program that invests in venture capital funds and makes direct investments in business and infrastructure projects.[43] FOF has made several notable deals, including a $4.5 million deal in 2012 for REG Life Sciences and a $12 million deal in 2013 for JDC Phosphate.[44] In addition, Space Florida financed Cella Energy in 2012 with $3 million.[45] Even though Cella is a company based in the United Kingdom, it worked very closely with NASA to spark innovation in Florida. The Florida Institute for the Commercialization of Public Research, a nonprofit organization

that supports new company creation based on publicly-funded research, funded Garmor and Bing Energy with $300,000 each in 2013.[46]

Tax Incentives and Non-Dilutive Capital

Florida has no personal income tax and numerous tax advantages for businesses, including no state capital gains tax, limited property taxes, corporate income tax exemptions, and many others.[47] The Tax Foundation ranked the state as the fourth best business tax climate in the United States in 2016.[48] In addition to tax advantages, Florida encourages business growth through the Capital Investment Tax Credit (CITC), a twenty-year annual credit against the income tax.[49] Renewable energy projects can qualify for the CITC if their capital costs exceed $25 million and they create at least one hundred jobs.[50]

The Institute for the Commercialization of Public Research (ICPR) provides loans of up to $50,000 to qualified companies in Florida through its Seed Capital Accelerator Program.[51] To receive an ICPR loan, a company's core product must be based on technology developed from a publicly-supported research entity and backed by a recommendation from the technology transfer office of that entity. Furthermore, the company must secure funds matched one-to-one by the private sector.[52]

The state also offers the High Impact Performance Incentive Grant, a negotiated incentive for businesses in silicon technology and transportation equipment manufacturing.[53] Grant funding comes from the Florida Department of Economic Opportunity. To qualify, a manufacturing company must create one hundred new jobs and invest at least $100 million in the state within three years, whereas a research facility must create seventy-five new jobs and invest a minimum of $75 million in Florida in the same period.[54] Accepted awardees receive 50 percent of the grant upfront and the remainder once full employment and investments are made.[55]

Enterprise Florida has two programs that help small businesses obtain loans: the State Small Business Credit Initiative and the Microfinance Guarantee. These programs assist businesses in obtaining loan approvals and leveraging private capital.[56] They also provide security for lenders with a partial guarantee.[57] Additionally, Enterprise Florida manages the Florida Development Finance Corporation, a conduit issuer of industrial revenue bonds for small business ventures.[58]

What are Industrial Revenue Bonds?

Industrial revenue bonds (IRBs) are state or local government-issued tax-exempt loans for private business ventures. Specifically, companies can finance the "expansion, construction or acquisition of manufacturing facilities and equipment."[59]

Policy Recommendations

In order to take advantage of Florida's coordinated innovation research, the state must increase access to capital across all stages of research and development—from initial research to late-stage commercialization. The following policy recommendations target strategic funding streams to strengthen and accelerate advanced energy innovation and technology deployment, creating an attractive climate for entrepreneurs and existing businesses to grow.

Policy 1: Create a University Research and Development Tax Credit

Photo Credit. Rowan University Publications / Foter / CC BY-NC-ND

Encouraging investments in university-level research is essential for states to promote innovation ecosystems, remain economically competitive, and spur job creation. Florida's innovation ecosystem is struggling to remain competitive: the Pew Charitable Trusts and the Information Technology and Innovation Foundation rank Florida low for major innovation assets while other studies show that Florida's innovation ecosystem falls behind most states.[60,61] Florida's poor innovation ecosystem ranking could be, in part, due to Florida's low level of movement towards a clean energy economy, low level of patents per worker, few degree holders in science and engineering, and low R&D intensity (normalized by state GDP and as a percentage of worker earnings).[62] Though the University of Florida and other universities in the state are producing many patents compared to other universities in the United States,[63] the state as a whole is not meeting its potential per worker.[64] In addition, the state is not increasing consumption of clean energy and development of advanced energy technology as much as other states.[65] To improve those metrics, Florida must spur university R&D investment. One way the state can stimulate more investment in university research is by creating a University R&D tax credit similar to Arizona's University Research and Development Tax Credit.

Arizona Department of Revenue University Research & Development Tax Credit

Arizona's Research and Development (R&D) tax credit incentivizes businesses to invest in local R&D activities through a nonrefundable income tax credit. From 2011 to 2017, the R&D tax credit is equivalent to 24 percent of the first $2.5 million of investments plus 15 percent of additional investments over $2.5 million.[66] After 2018, the tax credit rates will drop to 20 percent and 11 percent, respectively. Since the inception of the credit, both the number of claimants and the total amount of credits used have been steadily climbing.[67] Though it is difficult to determine the number of research jobs created and the amount of R&D spending attributable to the tax credit program, the program has been growing and has been expanded.[68]

By creating a significant incentive for businesses to invest in local university research, Florida could make its innovative ecosystem competitive with other states. Florida should consider making its R&D tax credit refundable and transferrable, so businesses with low tax liability are also incentivized to invest in Florida R&D. A targeted university R&D tax credit will help stimulate Florida's innovation ecosystem, spurring investment in early-stage companies and creating good-paying jobs.

Policy 2: Establish the Breakthrough Research Institute for Biofuel Technology

Although Florida has dozens of research universities, the university system in Florida fails to deliver a competitive innovation ecosystem. Compared to other states, Florida has fewer patents, fewer degree-holders in science and engineering, and a low R&D intensity.[69] However, Florida holds a unique advantage in biofuels: the state has begun to corner the unique sector of next-generation algal biofuels research.[70] This momentum in biofuels innovation could be further leveraged by expanding Florida's biofuels research into four areas of opportunity including synfuel, hydrogenation-derived renewable diesel,[71] lignocellulosic biomass to biofuel, and creating other products from biofuel waste.

In order to build upon Florida's biofuels momentum and expand into other key areas of biofuels research, Florida could nominate a coordinating body, such as the Florida Energy Systems Consortium, to create a research institute that would assist universities in securing federal research funding. Florida can look to Ohio's Federal Research Network as an example.

Department of Commerce Grants

Recently, the Department of Commerce announced the first round of recipients of the Regional Innovation Strategies program grants—funds that are managed by the Economic Development Administration (EDA) to "advance innovation and capacity-building activities" through i6 Challenge grants, cluster grants for seed capital funds, and research park development grants.[77] Approximately $8 million in grants is available in total.[78] These federal funds could support efforts to improve innovation and capital access.

Ohio's 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. Wright State Applied Research Corp.[72] will receive $20 million over the course of two years and Ohio State University will receive an additional $5 million to establish collaboration between the state's research universities, Wright-Patterson Air Force Base, NASA Glenn Research Center, and the private sector.[73] Approximately half of this funding will be used to create a model of how the research network will run.[74] The goal of the Ohio Federal Research Network is to bring in $300 million in new federal research contracts to Ohio-based companies in the next five years.[75] It is estimated that this funding will result in 2,500 new jobs, $250 million in private sector investment, and the creation or expansion of 100 companies.[76]

By creating a Florida Federal Research Network, the state could ignite a robust innovation ecosystem by capitalizing on new areas for development in biofuels and stoking a culture of advanced energy research. This is especially important given increased federal funds directed toward early-stage R&D—the U.S. government will double its current level of investment in advanced energy over the next five years.[79] Aligning the energy innovation ecosystem to attract federal funding will bring breakthrough research to market and make Florida a competitive player in the advanced energy space.

Chapter Summary

Florida has demonstrated a strong commitment to the state's innovation pipeline. The state provides significant support to emerging companies through its research institutions and networks. However, Florida can do more to bring new ideas to market, ensure increased investment in technology innovation, and capitalize on the strong research environment within the state's public university system. Florida's innovation ecosystem has the capacity to develop and retain firms that will establish the state as a pioneering hub for advanced energy technology solutions.

Chapter 5: Workforce Development

Trained and skilled workers are fundamental to the success of an industrial cluster. Sector-based workforce development goes hand-in-hand with cluster development. If firms in the same cluster are able to coordinate with the government, schools, and related nonprofits on policies and programs to train workers, they will be better equipped to identify employment needs and find qualified workers with the necessary skills to fill available jobs.

Florida has largely recovered from the job losses experienced during the Great Recession; statewide unemployment dropped from a high of 11.2 percent in 2010 to 5.1 percent as of November 2015.[1] However, this drop in unemployment rates has masked the downturn of economic opportunities for Florida workers. Between 2004 and 2013, nearly 75 percent of Florida counties experienced a decline in average income (adjusted for inflation).[2] This decrease occurred in part due to the many low-paying jobs created after the recession. A recent study suggests that 61 percent of the job openings in Florida pay less than the livable wage for a single adult.[3] Indeed, Florida ranks twenty-fourth in the country in terms of the percentage of workers receiving a living wage.[4]

Florida's emerging solar and biofuel clusters require a diverse mix of skilled workers and generally offer above-average wages.[5,6] These sectors are growing rapidly in Florida. Estimates show that advanced energy jobs in the state grew by more than 6 percent in 2013, the last year for which data are available.[7] Additionally, these jobs are distributed evenly across the state, which provides economic and job growth opportunities for all regions.[8]

To qualify for advanced energy sector jobs, Floridians must possess a range of skills, from knowledge of advanced chemical science in biofuels to the electrician qualifications necessary for safe installation of solar panels. The 2014 State Technology and Science Index ranks Florida thirty-seventh in the United States, with particularly low scores in the "Human Capital Investment" and "Technology and Science Workforce" categories.[9] These rankings suggest a need for investment in workforce development programs that upskill Florida workers and help prepare them for higher-paying and skilled jobs in the advanced energy industry.

A survey of firms in Florida's advanced energy industry found that 75 percent of employers experienced some difficulty in finding qualified workers for open positions.[10] In order to overcome current skill gaps in the solar and biofuel sectors, Florida policymakers could establish a proactive workforce development strategy. Expanding the state's current workforce efforts will help position Florida as a leader in advanced energy markets and create good-paying jobs for residents.

Workforce development can include everything from career counseling to training and educational services. A thoughtful sector-based workforce development approach should include industry best practices for recruiting, hiring, training, advancement, 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.[11,12]

Workforce Development Strengths

Florida can enhance statewide workforce development efforts by tapping into several key strengths, including a robust education system, existing workforce development programs, and strong partnerships with employers in the advanced energy sector.

Florida Energy Systems Consortium

Headquartered at the University of Florida, the Florida Energy Systems Consortium (FESC) has coordinated energy research for Florida's twelve state universities since 2008. FESC embraces a "systems-wide" approach to clean energy research in order to ensure that efforts are organized, results are shared widely among Florida universities, and researchers work to promote the emergence of advanced energy industries in the state.[13] FESC works with the Florida Community College system and the Florida Advanced Technological Association to develop energy jobs training programs.[14]

University of Florida Institute of Food and Agricultural Sciences

The University of Florida's Institute of Food and Agricultural Sciences (IFAS) is an internationally recognized "federal-state-county partnership dedicated to developing knowledge in agriculture, human and natural resources, and the life sciences."[15] IFAS conducts cutting-edge research on a variety of agricultural science topics, including biofuel production from biogas and

cellulosic biomass.[16] The institute manages a paid internship program that enables students to participate in biofuel-related research projects.[17]

Quick Response Training

CareerSource Florida's Quick Response Training program provides grants to employers who offer customized training opportunities to their workers. The requirements for this grant program are flexible, which allows the state to assist a variety of businesses, including those involved in biofuels and clean tech.[18] In the fiscal year 2013-2014, fifty-one Quick Response Training grants funded training for 13,200 employees. The state estimates that employers matched these grants at a rate of $31 for every dollar awarded. The funds must be used to train workers for jobs that pay higher than the regional median salary. As a result, the program has helped increase the wages of participating workers by an average of approximately 36 percent within a year of completion.[19]

Bioenergy Education Program

South Florida State College has created the Bioenergy Education Program in partnership with nearby industry partners.[20] This program offers training in biofuel production and cultivation, offering employers a pool of labor that is capable of supporting multiple stages of the bioenergy value chain.

Florida Solar Energy Center

The Florida Solar Energy Center offers industry-specific professional development and certification opportunities for advanced energy jobs.[21] Many positions in the advanced energy economy can be met by workers with existing skills (e.g., electricians and welders). Such skills are easily transferred to the advanced energy industry when supplemented with specific training. Continuing education offerings allow an already-skilled electrician or contractor to expand their skillset and increase employment opportunities.

Photo Credit. Dennis Schroeder, NREL

Solar: Jobs, Skills, and Training Needs

Utility-scale and rooftop solar deployment and manufacturing requires a variety of professions, including solar technology research and development; solar panel manufacturing, installation, and maintenance; power plant workers; industrial project managers; real estate brokers; and lawyers. As a result, comprehensive workforce development and education programs are required to ensure that Floridians can fill positions throughout the entire solar supply chain. Table 3 provides a sampling of jobs available in the solar supply chain.

Table 3. Career Opportunites in the Solar Power Supply Chain

Job Title	Primary Responsibilities[22]
Semiconductor Processor	Manufacture electronic semiconductors to be used in solar panel wafers; employ skills and knowledge in chemistry and physics to design circuitry and improve conductive properties
Computer-Controlled Machine Tool Operator	Operate computer-controlled robots in the production of plastic and metal solar components
Welder/Brazier	Use electronics-production equipment to manufacture and alter metal solar components
Glazier	Produce and install solar panel glass covers
Coating Machine Operator	Operate machinery to coat photovoltaic (PV) surfaces with sealing glazes
Electronics Repairer	Repair and maintain electronic circuitry in solar panels
Electrical Equipment assembler	Assemble electronic circuitry in solar panels
Industrial Production Manager	Conduct day-to-day solar production management
Solar Panel Installer	Assemble and install commercial and residential PV systems on-site

Biofuels: Jobs, Skills, and Training Needs

Jobs in the biofuel industry encompass a wide range of professions, including maintenance workers, manufacturing technicians, project managers, engineers, operators, and consultants. The expansion of Florida's biofuel industry could lead to significant job growth across multiple professions. Knowledge in areas such as electrical wiring and technology, mechanics, chemistry, and manufacturing processes are key for industry professionals. Table 4 provides a sampling of jobs available in the biofuels supply chain.

Table 4. Career Opportunities in the Biofuel Supply Chain

Job Title	**Primary Responsibilities**[23]
Bio-Agriculture Farmer	Site, grow, and distribute crops to be used in the production of biofuels
Agricultural Researcher	Study and communicate methods with farmers to increase biofuel crop yield
Aquaculture Specialist	Evaluate and assess effects of agricultural processes on surrounding aquatic ecosystems
Material Handler	Unload incoming materials for plant use and load products for outgoing distribution
Chemical Plant Operator	Collect samples and conduct quality tests during operation; record data and monitor plant operations
Maintenance Technician	Install and maintain plant equipment
Laboratory Manager	Define methods of safety and quality standard compliance; ensure efficient plant and laboratory operations
Power Plant Manager	Conduct day-to-day bioenergy plant management
Quality, Safety, and Environmental Manager	Ensure compliance with environmental and safety regulations, as well as conformance to quality standards

Policy Recommendations

Florida's policymakers can bolster existing job growth and capitalize on opportunities in the advanced energy space through workforce development efforts that target skill gaps and structural challenges.

Policy 1: Improve Industry-Wide Recognition and Participation with Apprenticeships

Apprenticeship programs provide valuable on-the-job skills, making them an important component of career development and workforce training in emerging industries. Florida currently ranks forty-eighth in the country in the number of registered apprenticeships per capita.[24] The state's lack of apprenticeship opportunities negatively impacts students' job prospects and Florida's economy as a whole.

Apprenticeship Carolina™

South Carolina's Apprenticeship Carolina™ program offers a simple model for improving apprenticeship opportunities statewide. After instituting the program, South Carolina's total apprenticeships increased from 777 in 2007 to more than 11,000 positions in 2014.[25] These apprenticeships help in-state workers strengthen valuable technical skills in high-wage industries.[26] The program offers a tax credit for companies—$4,000 for each new apprentice over four years.[27] This tax credit does more than encourage apprenticeship hiring; it also signals to students and employers that apprenticeships can be a viable alternative to college instruction and provide economic value in STEM industries.[28]

Florida could follow South Carolina's lead by providing fiscal incentives for companies that hire and train apprentices. Additionally, the state could work directly with employers to tailor apprenticeship requirements, wages, and associated curricula to specific technical needs.[31] By integrating apprenticeship programs with stackable credentials, the state could help students progress more quickly to good-paying, skilled jobs. Florida could also establish links between apprenticeship opportunities, existing community college certifications, and relevant early college programs. Additionally, the state could collaborate with unions, trade associations, and corporations to engage in outreach programs that target high schools and encourage students to take advantage of apprenticeship opportunities in advanced energy sectors.

Stackable Credentials

A system of stackable credentials is an organized sequence of certificates that can be earned over time to strengthen skills and facilitate progress along a career pathway to higher-paying jobs.[29] This sequence has shorter-term skill development blocks that allow students to exit and enter while still having gained marketable skills, which reduces educational and employment barriers for non-traditional and disadvantaged students.[30]

Early College Success

Evaluations of early college programs in North Carolina found that participating students reported higher levels of academic engagement, were more likely to be on track to graduate high school, and were less likely to be suspended than students in comparison schools.[37]

Policy 2: Expand Early College Programs to Improve STEM Education

By 2020, two out of three American jobs will require a college credential, many of them in STEM fields.[32] To meet the demand for skilled labor, the United States will need the majority of high school students to graduate on time, enter college, and earn an associate's degree within three years or a bachelor's degree within six years of graduation. Unfortunately, only one in five students nationwide meets that goal today.[33] In 2012, the college degree attainment rate in Florida was only 36.5 percent.[34] Florida also ranks thirty-seventh in the country in the Milken Institute's State Technology and Science Index. There is an opportunity for the state to invest in science education and increase the number of graduates with STEM-related degrees.[35,36]

Early colleges are an innovative way to engage students in the classroom and better prepare them for the jobs of the 21st century. Through partnerships between high schools and local colleges, students can earn their high school diploma and an associate degree concurrently in a four- to five-year period.[38] This design enables more students to earn a diploma, particularly low-income and minority students. Students in early college are more likely to graduate from high school (90 percent versus 78 percent nationally).[39] This is especially impressive because the majority of early college students are from low-income families and are the first person in their families to attend college.[40] Florida policymakers can look to both Missouri and Ohio for examples of successful early college models.

Missouri Innovation Campus

The Missouri Innovation Campus, an early college program, is a collaboration between the University of Central Missouri, Lee's Summit School District, and Metropolitan Community College.[41] The program allows students in the greater Kansas City area to take college classes during high school and graduate with a bachelor's degree shortly after completing high school—all with minimal student debt. The program offers Bachelor of Science degrees in systems engineering technology, drafting and design technology, and computer science.[42] Through the use of grants, Missouri established eight additional Innovation Campuses, significantly expanding educational opportunities for students throughout the state.[43] Foundations and local businesses have provided additional support in the form of paid internships for participating students.[44,45] More than thirty businesses are active partners. These partnerships have been critical to the success of the program.[46]

Ohio's Innovation Generation

Ohio has improved upon the early college model by embedding work-based learning in the curriculum of early college classes. As one of twelve states linked to the Pathways to Prosperity Network, Ohio has provided a $14.4 million grant to fifteen school districts in Central Ohio to develop six career pathways, including advanced manufacturing.[47,48] The participating districts that are working with Columbus State Community College span five diverse counties and engage 22,249 students in eighteen high schools.[49] The program is intended to be a pilot that can be expanded throughout the state.[50] In the 2014–2015 school year, the first year of the program, nearly 25 percent of all eligible students elected to enroll in the program—over 5,400 students.[51]

To better prepare students for STEM careers, Florida could increase the number of early college programs available throughout the state, expanding to other campuses and regions and creating specialized programs. Florida leaders could establish industry-specific early college programs that address existing skills gaps in the solar and biofuel sectors. For example, Florida State College at Jacksonville recently partnered with Vistakon to develop an engineering technology and advanced manufacturing degree program for early college students.[52] With twenty-two students currently enrolled, the program also provides summer internships and post-graduation employment eligibility with Vistakon.[53] Establishing a career pathway in high school can reinvigorate Florida's high school education and increase the number of STEM-trained graduates available to support the advanced energy industry in the state.

Chapter Summary

Florida has the potential to expand the solar and biofuel sectors by leveraging the state's higher education system and investing in targeted workforce development initiatives. Coordinated efforts at the state and local levels could spur significant growth in the state's advanced energy economy, attract good-paying jobs, and furnish the workforce with highly trained individuals.

Creating a Multiversity on the Creative Coast

Florida has actively embraced innovation in academic learning. Composed of six colleges in the Sarasota-Manatee region, the Consortium of Colleges on the Creative Coast (also known as "C4") aspires to create a multiversity for its 20,000 students.[54] C4's goals include opening courses to students across campuses and working closely with economic development leaders to foster business partnerships.[55] Created two years ago, the consortium has been recently reenergized with the support of several foundations.[56] Through regional leadership, Florida has the opportunity to implement alternative learning strategies and foster quality education.

Conclusion

In order to build on Florida'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 Florida 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 Florida's advanced energy clusters and creating quality jobs for Floridians. Advanced energy clusters focused on biofuel and solar technology manufacturing offer great opportunities 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 Florida's policymakers take swift and purposeful action to grow the biofuel and solar industries, the state can support up to 98,500 jobs annually through 2030.

Florida 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 Floridians.

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

Extended Learning Section

Appendix A: Economic Impact 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. Advanced biofuels jobs used an existing analysis of the national economic impacts from advanced biofuels and supplementary data from the Environmental Protection Agency and the National Renewable Energy Laboratory.

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 into 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 tech-

nologies can be modeled with JEDI. For advanced biofuels, we utilized an existing IMPLAN analysis and developed scenarios of our own based on updated information.

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 Florida Report

Solar

JEDI was used to estimate jobs potential for the solar industry in Florida. 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 percent to 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 Florida 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 MW for analyses in JEDI. Job-years included in this analysis represent all job-years that exist during the timeframe of 2016-2030. Data used in the JEDI analysis were collected from the three sources listed below.

DOE Office of Energy Efficiency and Renewable Energy: Wind Vision

The Wind Vision Study Scenario includes projections for utility-scale solar PV and rooftop solar PV deployment.[6] The input parameters are similar to those found in the DOE's 2012 SunShot Vision Study, a comprehensive review of U.S. solar electricity generation potential that was managed by NREL.[7,8] The Wind Vision projections are based on updated assumptions about the phasing out of the solar investment tax credit.[9] Wind Vision's cost assumptions are based on SunShot Vision Study's 62.5 percent solar cost reduction scenario, where the 62.5 percent reduction is reached in 2020 and a 75 percent reduction is reached in 2040.[10] Wind Vision's authors compared those cost estimates to a sample of leading costs projections and found them to be consistent with the average estimates in the literature.[11]

Bloomberg New Energy Finance

Data from the "Medium-term outlook for US power: 2015 = deepest de-carbonization ever" report were provided by Bloomberg New Energy Finance (BNEF).[12] 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 2015 Clean Power Plan

The Energy Information Administration's Annual Energy Outlook 2015 comments on its jobs modeling methodology:

> 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.[13]
>
> The level of regional disaggregation in NEMS varies across sectors. For example, Lower 48 states electricity markets are represented using 22 regions, coal production is represented by 14 regions, and oil and natural gas production is represented in 9 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.[14]

Advanced Biofuels

Projections for job-years potential in Florida's advanced biofuels industry utilized existing analysis of the national economic impacts from advanced biofuels, an NREL survey of current advanced biofuels facilities, and updates to the EPA's Renewable Fuels Standard.[15,16,17] Based on the national projections, we estimated the direct, indirect, and induced jobs created at different levels of national market share and multiplier effects. There are many types of advanced biofuels and even more ways of processing the biomass from which they originate. For this reason, many assumptions were made for the direct jobs and multipliers.

We have estimated the number of direct and induced jobs based on Florida's current share of production in the national advanced biofuels industry, from 1 percent to 5 percent. Florida's current market share of the advanced biofuels production is less than 1 percent.[18]

The multipliers used for indirect and induced jobs were based on national multipliers, indicating a near-perfect supply chain. For this reason, we created an alternate "low" scenario that reduced the indirect and induced jobs by half.

Appendix B: FESC Member Universities and Key Energy-Related Programs/Laboratories

Member University	Key Research Program & Labs	Expertise
Florida A&M University	---	---
Florida Atlantic Univeristy	Center of Excellence in Ocean Energy Technology	Tidal/wave
	Southeast National Marine Rewnewable Energy Center	Tidal/wave
Florida Gulf Coast Univeristy	---	---
Florida International Univeristy	Energy Systems Research Laboratory	Smart Grids & Electric Energy
	Southeast Environmental Research Center	Environment
Florida State Univeristy	Center for Advanced Power Systems	Power Systems
	Energy & Sustainability Center	Alt. Energy
New College of Florida	---	---
Univeristy of Central Florida	Florida Solar Energy Center	Solar
	Florida Power Electronics Center	Power Tech
Univeristy of Florida	Florida Center for Renewable Chemicals & Fuels	Bioenergy
	Florida Institute for Sustainable Energy	Alt. Energy
	Powell Center for Construction & Environment	Green Building
Univeristy of North Florida	---	---
Univeristy of South Florida	Alternative Energy Research Center	Biofuels
	Clean Energy Research Center	Solar/biomass
Univeristy of West Florida	---	---

(Source: Florida Energy Systems Consortium)

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Front Material & Chapter 1: Introduction

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