Universitat de Lleida

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TESI DOCTORAL

Business and regulatory issues of Solar Photovoltaic Generation in the State of Florida, U. S.

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Thank you, Lord.

Organization of the research

INTRODUCTION

Energy is of fundamental importance to society and has had the grates impact on humanity and the environment.

The vast power of the Sun's radiation is at once the most ancient and modern form of energy used by humanity. Solar power was the energy source upon which human societies had been based, both in the form of direct solar radiation and in indirect forms such as bioenergy, wind power or water. The last ones caused by solar heating of the oceans and atmosphere, to irrigate crops, to grind cereals and propel ships.

Later, our ancestors began to design buildings to take advantage of the sun's energy reducing the need for artificial sources of heat and illumination. By the early years of the industrial revolution, technologies continue to improve for taking advantage of the power of sun, firewood, water and wind. However, by then the advantages of fossil fuels, especially coal had become apparent, displacing wood, wind and water in homes, industries and transportation systems.

By the International Energy Agency (EIA 2017a, EIA 2016a), for the second year in a row, global carbon dioxide (CO_2) emissions have remained flat at 32.1 billion tons in 2015, and essentially similar since 2013. By the same source, China's emissions declined by 1.5% in 2015, as coal use dropped for the second year in a row by pushing coal use down. While in the United States, emissions declined by 2%, as a large switch from coal to natural gas and renewable energy use in electricity generation. From the global perspective, harmful impacts on our health, our environment, and our climate have created by the increase of the planet's temperature, primarily generated by human activity, which is overloading our atmosphere with carbon dioxide and other global warming emissions.

Recent gains in the United States' oil and natural gas production are changing the dialogue about energy strengths and vulnerabilities, and at the same time a deep discussion about the greenhouse effect. The global impact of shale oil is revolutionizing the world's energy markets, resulting in significantly lower oil prices, higher global GDP, changing geopolitics (IMF 2016) and shifting business models for countries, as well as oil and gas companies.

Federal, state and local policies are the foundation of clean-energy development in the United States. The regulatory structure for the electricity market has key differences across states. Many states have regulatory commissions, either elected or appointed by the governor or the state legislature, which have the responsibility to regulate energy responsibilities within their jurisdiction. States regulate and control all retail electricity rates and services, as well as decisions on location and construction of electricity generation and transmission. This is not different than several European countries.

The most important way in which the states have supported renewable energy has been by implementing policies and programs that directly incentivize the installation of clean energy generation, testing policy ideas and then spreading them across the country (CESA 2015: 21-23), getting data and analysis on clean energy technologies and on policy options as production tax credit (PTC), Investment Tax Credit (ITC), as well as at state level with the implementation of Feed-In Tariff (FIT), renewable portfolio standard, net-metering, interconnection and others.

Several States in the U.S. allow the commercialization of photovoltaic solar energy by developers, who are responsible for the design, permits, financing and installation of a solar energy system on the property of a customer prior to a financial agreement. The "developer" is authorized to sell the energy generated to other customers or consumers at a fixed rate that is usually lower than the charges made by an electricity company for a certain period of time. Likewise, several States have defined tax credits for the generation of renewable energy to reduce the initial costs of installation and purchase of solar energy systems. Other financial models of equipment leasing without involving the sale of electric power have been implemented in the U.S.

As a resident of the state of Florida, an electrical engineer and a clean-energy advocate, I tried in 2015 to install a Solar PV system in my home in Weston, which led me to evaluate alternatives with local companies and start the tortuous road of get approval by the local electric power company, in this case FP&L. At the same year, the "Floridians for Solar Choice" coalition, announced that was about 400,000 petitions short of qualifying for the 2016 ballot, which would allow businesses to generate and sell up to two megawatts of solar power to customers on the same or neighboring properties, a constitutional amendment that would have allowed third-party purchasing agreements

At the same time, I remembered the great wind and photovoltaic systems that I had visited in my travels to Spain, Germany, and the state of California. The frustration was born because I do not understand why in certain markets there were large implementations of renewable energy systems, while in the state of Florida there were obstacles and in some cases lack of knowledge of the advantages of implementing solar PV.

Through my initial analysis I found out that Florida is one of five states in the U.S. that specifically prohibit third-party energy ownership, which questioned my freedom of choice that is predominant in the American market, and my entrepreneur spirit about to develop new solar business models in Florida. So, I was not able to be a "developer" and to sell Solar PV energy generated in my property to other customers or consumers, whit exception to the energy utility and previous a blind agreement with the local energy utility.

In an interaction with several members of my community and the Solar United Neighbors of Florida, I realized that it was a common issue that several questions about the growth and implementation of Solar PV were not answered, many of them as follow:

- "Why isn't the Sunshine State the leader in the US in solar energy? Is it a matter of the structure of the energy sector, regulatory issues or of costs and availability of renewable energy?

- How the Florida's Legislature and regulators are managing the unregulated energy market?

- Does the Florida state lack the regulatory reforms needed to bring in residential and commercial third-party purchasing agreements?

- What are the incentives for residential and commercial customers to install renewable and especially solar PV?

- Are the Florida´s power utilities financially strong to move away from natural gas and fossil fuels in favor of renewable energy?

- How Florida utilities would expand their solar inventory as they meet goals for lowering emissions? Are they open to move from coal and fossil fuel´s energy generation to renewable energy?

- What would take for implementing utility-scale solar range size systems in the state of Florida?

This research work seeks to answer these questions and to explain the characteristics of the energy sector, the agencies and regulatory policies and agencies in the U.S. and the State of Florida as well as the financial structure of the energy utilities, main Amendments and Judicial actions for the promotion of renewable energy in Florida from 1974 to 2018, and its impact in solar capacity and generation, and the consequence job development in this sector. In addition, several simulations are presented to address the following issues:

- Competitive cost of solar PV
- Closure of coal and oil plants
- Energy Demand curve and storage
- Pressure of the population for net metering and interconnection rules for non-utility systems

- Implementation of Renewable Portfolio Standard
- Reduction in Soft Cost for Solar PV
- Financials on residential and commercial solar PV

In last chapter, it is presented the conclusions to these simulations and legal analysis. It is presented as well potential changes to the federal policies, avenues for working in the Florida energy regulated market where utilities own and manage the power plants that generate electricity, the electricity transmission lines, and the distribution equipment, ways for implementing utility-scale solar range size systems, and lease of residential Solar PV.

I am expecting that thorough this research, electricity generated by solar photovoltaic panels will be better understood as an inexhaustible and not pollute source of energy, and thus contributes to sustainable development as well as favoring local employment. As presented, I am convinced that over the next decade, solar energy will become the cheapest source of electricity in many parts of the world, as the cost of photovoltaic panels falls continuously, and Florida´s energy utilities, commercial and residential users would take advantage of the implementation of renewable energy by reducing current entry barriers. I am sure of it!

1. The Photovoltaic Generation and Ways of Promoting

The sun directly and indirectly contributed to the creation of coal, petroleum and gas, are called “fossil fuels”. Coal is a mineral or 'fossilized' remains of jungle vegetation that flourished on earth more than 150 million years ago. Petroleum is the fossilized remains of small marine creatures that thrived in the oceans at about the same time. The decaying vegetable formed natural gas and animal matter as it was turning into coal and petroleum. Today the fossil fuels provide over 80% of the world’s energy.

Following World War II, and with a strong growth in development nations, nuclear energy elevated hopes of plentiful, cheap and clean alternative to fossil. However, nuclear power has raised concern since its inclusion about safety, cost, waste disposal and weapons proliferation, which has stalled in some countries.

In response to support for Israel by U.S. in the Yom Kippur war against Egypt led the price of crude to a sharp price rise from $3 per barrel to $12 by 1973 - 1974, the so called ‘oil crisis’ and the major peaks occurred in December 1979 at $125.23 (BAKERI 2010: 8-10). The western government and the human society in general began to take more seriously the prospect of fossil fuels decline in production, and the possibility that their continued use could be destabilizing the planet’s natural ecosystems and the global climate. In the mid 1980s a huge decrease in the price of the crude reached the $14.44 so main industrial countries deiced to stop investing in renewable energy and others took a competitive advantage as the Europeans countries.

In the 1990s, the west outsourced its manufacturing to low-cost centers in Asia, and the energy demand in China, India and some Southeast Asia countries rocketed. The higher consumer spending, that also means higher demand for energy from the globalization of markets, the bulk of which came from fossil fuels.

However, there is a great deal of concern about the adverse environmental and consequences of fossil fuel and climate change is a key challenge for the energy sector worldwide and specially in developed countries.

Recent gains in U.S. oil and natural gas production are changing the dialogue about energy strengths and vulnerabilities. The global impact of shale oil is revolutionizing the world’s energy markets, resulting in significantly lower oil prices (PWC 2013: 10-11), higher global GDP, changing geopolitics and shifting business models for countries, as well as oil and gas companies.

The U.S is implementing a system that may fit for the 21st century. One that powers the economy with cutting edge technology and makes sure U.S. reaps the economic benefits of a global clean energy revolution. This mix had allowed a lower oil prices and an increase in more renewables.

With data from the Energy Information Administration the net electric generation in the U.S. had been flat for last six years, as presented in Table 1. By 2010 was 4,125,060 thousand Megawatt-hours (MWh) and in 2015 was 4,091,741 MWh, 33.1% of which was generated by coal, 32.6% by natural gas, 19.5% nuclear, 6.6% renewable sources excluding hydroelectric and solar, 6.1% hydroelectric conventional and 1% by solar. By 2017 the net electric generation in the U.S. was 4,038,944 MWh a 1.3% reduction from 2015 and 2.1% from 2010 levels; 29.9% was generated by coal, 31.5% by natural gas, 19.9% nuclear, 8.3% from renewable sources excluding hydroelectric and solar, 7.4% hydroelectric conventional and 1.9% from solar.

As presented in table 1, from 2005 to 2017 the contraction of the total net generation was drove by the substantial reduction of the use of coal in favor of other sources as natural gas and renewable sources excluding hydroelectric. The net-generation by renewables sources excluding hydroelectric and solar grew 3.85 times, the highest of all to 334,287 thousand MWh and solar from 550 MWh to 77,097 thousand MWh in same period, while the others had decrease with exception of natural gas and almost flat nuclear. This is a significant fact; renewable energy surged despite a slow national economy, uncertainty over federal and state tax credits and in some cases the absence of market context that assures a reasonable and predictable return for investors.

In this chapter a brief reference is made to the development of solar PV in the world from 1860 to 2016, about the main policies that have been implemented in leading countries to promote the implementation of renewable energy, it is also included an analysis about worldwide climate changes and what efforts are in place for the last 15 years to move from coal base energy generation to renewable energy. In fact, an analysis on regulatory policies, fiscal incentives and public financing to reduce the environmental impact of the energy sector and the policies that have been implemented to promote the use of renewable energy.

An analysis of the use of renewable energy and particularly of solar PV is also included for Australia, China, France, Germany, Italy, Japan, Spain, U.S., the impact of the regulatory and fiscal incentives to the 2002-2016 cumulative PV capacity, and the annual PV capacity variation related to the introduction and application of policies, and the impact of these in job creation worldwide and for some specific countries.

Table 1
U.S. Net Generation by Energy Source (All Sectors, Thousand MWh)

	Generation at Utility Scale Facilities & Small Scale Generation											
Period	Coal	Petroleum Liquids	Petroleum Coke	Natural Gas	Other Gas	Nuclear	Hydroelectric Conventional	Solar	Renewable Sources Exc. Hydroelectric and Solar	Hydroelectric Pumped Storage	Other	Total Generation
2005	2,012,873	99,840	22,385	760,960	13,464	781,986	270,321	550	86,779	-6,558	12,821	4,055,423
2006	1,990,511	44,460	19,706	816,441	14,177	787,219	289,246	508	96,018	-6,558	12,974	4,064,702
2007	2,016,456	49,505	16,234	896,590	13,453	806,425	247,510	612	104,626	-6,896	12,231	4,156,745
2008	1,985,801	31,917	14,325	882,981	11,707	806,208	254,831	864	125,237	-6,288	11,804	4,119,388
2009	1,755,904	25,972	12,964	920,979	10,632	798,855	273,445	891	143,388	-4,627	11,928	3,950,331
2010	1,847,290	23,337	13,724	987,697	11,313	806,968	260,203	1,212	165,961	-5,501	12,855	4,125,060
2011	1,733,430	16,086	14,096	1,013,689	11,566	790,204	319,355	1,818	192,163	-6,421	14,154	4,100,141
2012	1,514,043	13,403	9,787	1,225,894	11,898	769,331	276,240	4,327	214,006	-4,950	13,787	4,047,765
2013	1,581,115	13,820	13,344	1,124,836	12,853	789,016	268,565	9,036	244,472	-4,681	13,588	4,065,964
2014	1,581,710	18,276	11,955	1,126,609	12,022	797,166	259,367	28,924	261,522	-6,174	13,461	4,104,838
2015	1,352,398	17,372	10,877	1,333,482	13,117	797,178	249,080	39,032	270,268	-5,091	14,028	4,091,741
2016	1,239,149	13,008	11,197	1,378,307	12,807	805,694	267,812	54,866	305,579	-6,686	13,754	4,095,487
2017	1,207,901	12,583	8,508	1,272,864	14,159	804,950	300,045	77,097	334,287	-6,495	13,045	4,038,944

Source: *Own Elaboration from official data from Energy Information Administration (EIA 2015, EIA 2017a: Table 1.1)*

1.1. Brief reference to the nature and history of photovoltaic generation

Although the sun shined everywhere on the planet and has been for thousands of years, the use of its energy as electricity has not been exploited until recently. The solar energy that hits the earth's surface in one hour is the same as the amount consumed by all human activities in a year.

The history of photovoltaic (PV) generation is back to the 1860s when Willoughby Smith published in the 1873 Journal of the Society of Telegraph Engineers about results by testing underwater telegraph lines for faults using selenium. Accidentally, Smith discovered after conducting a series of experiments, that electricity travels through selenium in presence of light but it was drastically reduced if this material was in darkness. Smith concluded that selenium increased conductivity according to the intensity of light. This was followed by a series of accidental and deliberate attempts to build rudimentary solar cells.

According to Mir-Artigues P and del Río P (2016: 37-42), in the late 1870s, two American scientists, Professor William Grylls Adams and his student Richard Evans Day discovered that the sun's energy creates a flow of electricity in selenium, a critical step in the photovoltaic generation. They felt confident that they had discovered something completely new.

By the early 1880s, Charles Fritts invented the first photovoltaic cell by putting a layer of selenium on a metal plate and coating it with gold leaf. Placed in the sunlight, this cell made a small amount of electricity (Zweibel, Hersch 1984: 7-8). Although selenium solar cells failed to convert enough sunlight to power electrical equipment, they proved that a solid material could change light into electricity without heat or without moving parts.

This was not enough to ask for attention from the scientific community, that knew about black materials capturing the sun's heat energy, but they couldn't see how a cell that wasn't black could use the sun's light to make electricity. The scientist's question was: is the radiation the immediate cause or does it act by producing some change in the chemical state?

The PV technology was contesting with other more advanced technologies that were generating electricity. Steam-driven electricity generators had been in use since Michael Faraday invented the first electromagnetic generator in 1831. By 1882 using coal to create steam, Thomas Edison opened his first electric power station in lower Manhattan, which would become the prototype for the dawning power generation industry.

In 1905, Albert Einstein published a paper on the photoelectric effect, explaining how light was made of tiny packets of energy that wiggled like waves as they sped along. He called the energy packets photons. Einstein argued that these particles of energy are much more powerful in invisible light (such as ultraviolet light) than they are in light we can see (PVPower 2015). In fact, they have enough energy to knock loose electrons off some materials like selenium and silicon. It is these free electrons that move through wires as electricity. Einstein's concepts also became very relevant as scientists tried to make PV cells more effective in using sunlight to generate electricity. Einstein's work provided photo electricity with a scientific framework it had previously lacked and that could now explain the phenomenon in terms understandable to science, referring to this phenomenon as the photovoltaic effect.

By Einstein work, photovoltaic is described as the direct conversion of light into electricity at the atomic level. Some materials show the photoelectric effect that causes them to absorb photons of light and release electrons. An electric current result that can be used as electricity, when these free electrons are captured.

By the late 1920s and earliest 1930s, new type of photovoltaic cells were developed using copper and the semiconductor copper oxide. This device also had an efficiency of less than 1% hardly enough to justify its use as a power source. Both the selenium and copper oxide devices were used in applications such as light meters for photography.

In early 1940 the first silicon solar cell was created by accident by Russell Ohl, at Bell Labs. Ohl was investigating a piece of silicon when he passed the light of a flashlight onto the silicon and noticed that the voltmeter attached to the silicon registered an unexpectedly high reading.

In the earliest 1950s, Calvin Fuller and Gerald Pearson, working for Bell Laboratories, were trying to improve silicon transistors for electrical equipment by controlling the properties of semiconductors by introducing impurities. By accident they created a PV cell that also generated electricity when it was placed in light. It was made out of two different kinds of silicon that had different metals mixed in. By 1953, with the cooperation of Daryl Chapin they found that silicon PV cells made nearly five times more electricity than selenium cells. Bell Labs announced the invention on April 25, 1954 in Murray Hill, New Jersey (APS Physics 2015). They demonstrated their solar panel by using it to power a small toy Ferris wheel and a solar powered radio transmitter.

Before 1958, by mixing tiny amounts of different chemicals into slices of silicon crystals, they invented a photovoltaic-cell fifty times more efficient at generating electricity than the selenium cells had been 20 years earlier. Reporting the Bell discovery, The New York Times praised it as "the beginning of a new era, leading eventually to the realization of harnessing the almost limitless energy of the sun for the uses of civilization" (CSC 2016).

The work on PV cells at Bell Labs fortuitously came just prior to the space age. In 1958, Dr. Hans Ziegler argued that conventional batteries would run out of power in days, silencing millions of dollars worth of electronic equipment. In contrast, solar cells could power a satellite for years because the technology that would last much longer than the satellite's batteries. The US Navy finally let a few small PV cell–powered radio transmitters go into orbit on a satellite called Vanguard I. The energy is removed from photons through a single p-n junction[1]. A few weeks later, Russia's new satellite radio equipment was in orbit powered by photovoltaic cells.

Despite solar cells' success in powering both American and Soviet satellites during the 1950s and early 1960s, many at NASA doubted the technology's ability to power its more ambitious space ventures. But solar engineers proved the skeptics wrong. By 1972, over one thousand satellites were running on solar power with lighter, more durable, and better at generating electricity Dunar A., Waring S. 1999: 84-92)

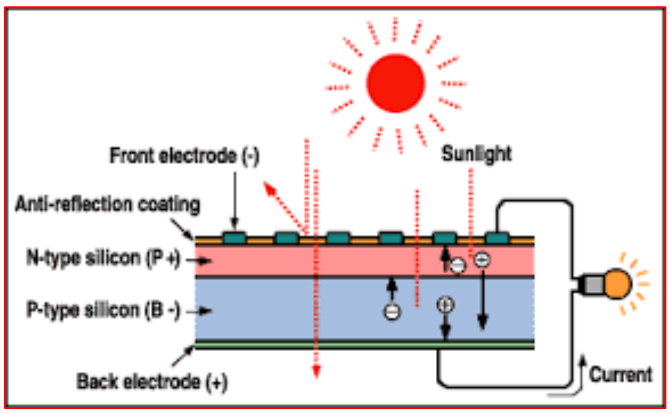

Fig 1.1. Silicon solar cell showing PV mechanism, p-n junction**.** *Source*: (BLS 2017)

Cost was never a factor for space cells, with limited applications on earth. By the late 1970s, the efficiency of PV systems was improved with materials such as thin ribbons of silicon and sheets of silicon, including materials called amorphous silicon. By material complexity this is the first-generation solar cells which were manufactured from silicon, usually flat-plate, and generally very efficient. The manufacturing process is complex and energy intensive. These solar cells are large in size and manufactured from mainly very pure silicon, also expansive. These PV cells had been installed in a variety of uses especially in remote places where it was too expensive to use electric power lines, to power radios, pump water and telephone systems. Photovoltaic systems were also valuable for offshore oil-rigs to provide lighting.

(2) A p-n junction is formed when p-type (positively charged) material and n-type (negatively charged) material are placed in contact with each other. A p-n junction is formed by joining p-type and n-type semiconductors in close contact. A current will flow readily in one direction (forward biased) but not in the other (reverse biased), this creates the basic diode.

From the 1970s the attention to the use of photovoltaic cells re-emerged, especially because the oil embargo of 1973. The U.S. Government realized the relevance of energy security and implemented policies to encourage the adoption of renewable energy (HBS 2012: 16-21), such as public procurement and tax credits.

In 1973 the US Solar Energy Research Institute was established and in 1974 the Solar Energy Research, Development and Demonstration Act was passed through Congress (1974). Worldwide production of photovoltaic cells increased from almost zero to 10MW in 1982, primarily as a result of the US government procurement programs.

Oil companies also invested in photovoltaic companies as good targets to use their excess money and lower their business risk. Other firms involved in PV development in the 1970s included Sharp in Japan, Philips, through their French subsidiary RTC, ARCO Solar and Solarex (CBR 2014: 8-18), these two US based firms.

Bill Yerks, in the late 1980s invented a new kind of PV cell made of screen printing a mix of silver glue with glass (SolarWorld 2015). Yerkes is recognized for his achievement in industrializing crystalline silicon solar manufacturing. In the early 1900s governments of developing countries began to fund solar energy programs, favoring large-scale, centralized solar-cell plants. These power stations usually covered large areas and they were often called solar farms.

An improved first-generation PV system (fully commercial) use the wafer-based crystalline silicon (c-Si) technology, either single crystalline (sc-Si) or multi-crystalline (mc-Si). Crystalline silicon is the material most commonly used in the PV industry, and wafer-based c-Si PV cells and modules dominate the current market (IRENA 2012: 4-9). High cost reductions had been possible through

An improvement was introduced from the University of New South Wales (UNSW) in Sydney, Australia, as an alternative of using the common screen-printing technique 'buried contact' approach (UNSW 2011). The development reduced the part of the cell surface which was covered by the grid contacts and hence not available for sunlight, thereby increasing the individual cell's efficiency (Watt 2003: 22). Because of their flexibility, thin film solar cells can double as rooftop shingles and tiles.

Researchers have been looking for ways to improve the efficiency and cost-effectiveness of solar cells. The third-generation solar cells, introduced in early 2000s, are being made from a variety of new materials besides silicon, including solar inks using conventional printing press technologies, solar dyes, and conductive plastics or polymers. These are also known by emerging thin-film solar cells. Based on photochemistry rather than solid-state semiconductor physics (MIT

2015: 21-27), the dye-sensitized solar cell (DSSC) mimics photosynthesis to generate electricity. This type of cell is made of organic material and can be manufactured using automated and fast techniques such as industrial roll-to-roll printing.

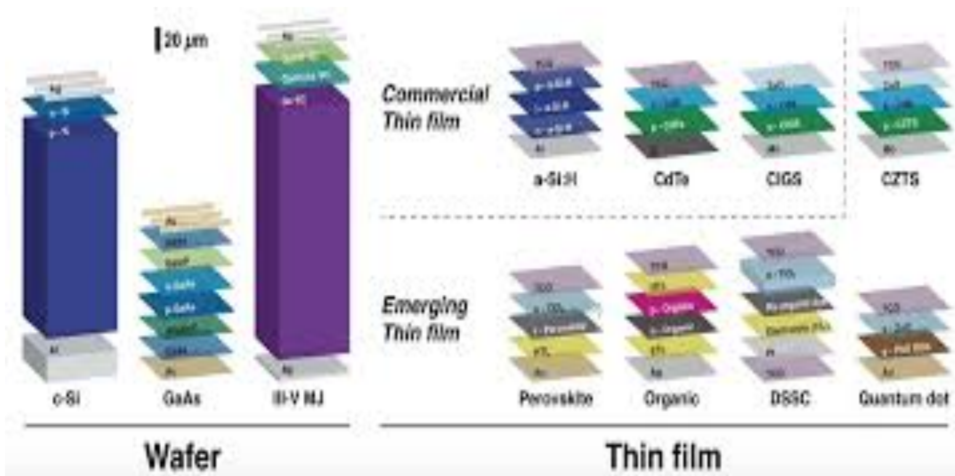

Fig. 1.2. Silicon solar cell showing PV mechanism, p-n junction**.** *Source*: MIT (2015: 23)

Additionally, the DSSC solar cells can also be engineered into transparent or flexible sheets that are lightweight, making them ideal for mobile applications and for fitting to a variety of uneven surfaces that could generate electricity, thus rendering it particularly useful for in- door power and building facades applications. An example is the Luminescent solar concentrators (LSCs), generally consist of transparent polymer sheets doped with luminescent species.

For decades, solar cells have gotten cheaper to make as manufacturing methods, designs and efficiencies have improved, as well as more efficient, making them an energy contributor to electric grids in several countries. Diverse material had been used by a great number of laboratories to achieve different efficiencies in the period 1975–2015, which is shown in Fig. 1.3., solar cell efficiency had reached the highest by about 46% at the end of 2015 by using GaAs material, follow by the monocrystalline solar cell with over 25% efficiency, and thin film technology had over 23%. The dye-sensitized and organic base cells, the new materials for solar cells, were still rated at low efficiency and around 11.9% in 2015. By MIT (MIT 2015: 26-27), these new efficiencies are opening opportunities for applications for solar PV.

As the efficiency of solar cells is improving, the economics of solar power are improving as well. It is a far more cost competitive power source today than it was in the mid-2000s, when installations and manufacturing were taking off, subsidies were generous, and investors were loading in.

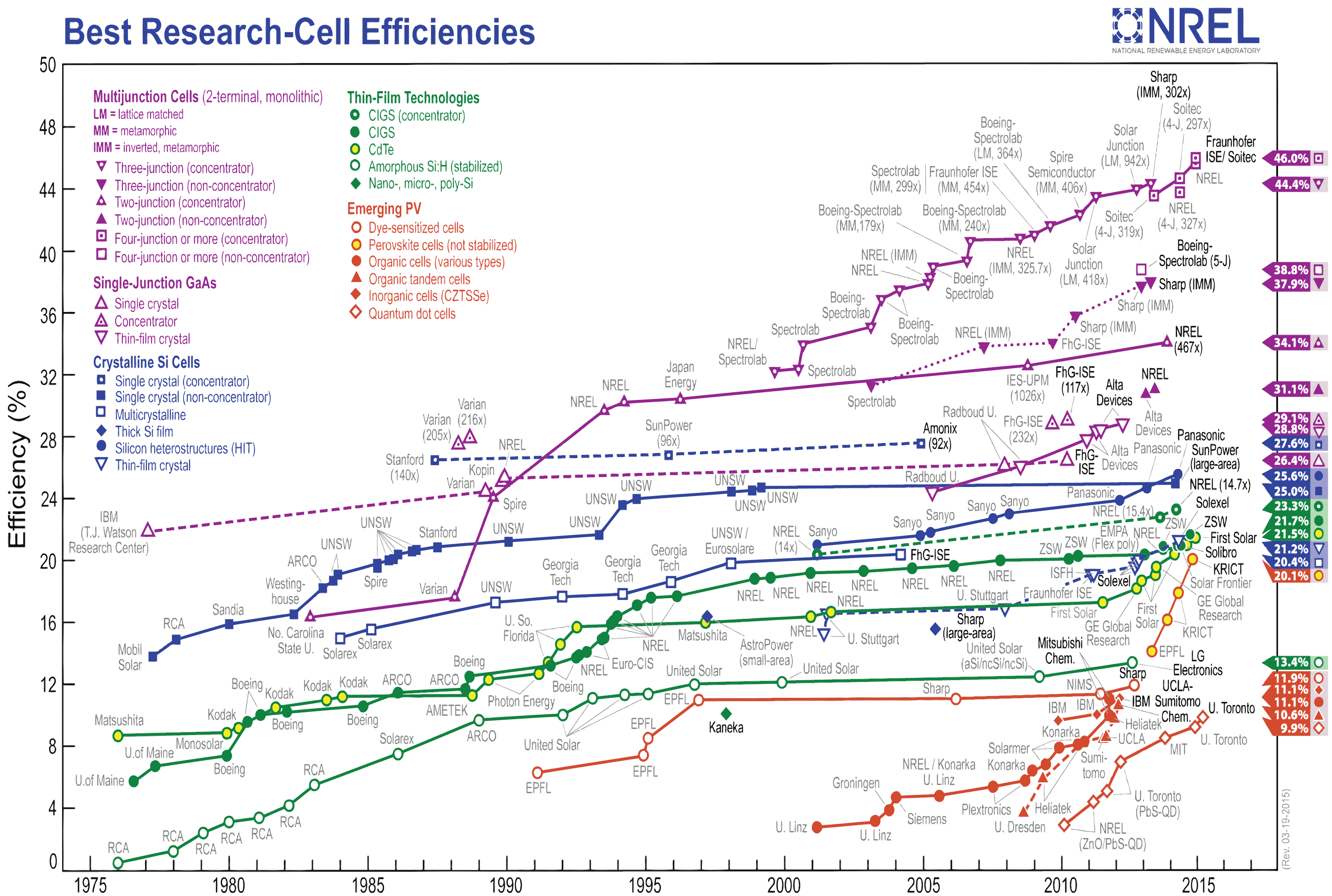

Fig. 1.3. Solar cells efficiencies found by different laboratories in the Global market by the end of 2015**.** *Source*: MIT (2015: 27)

By McKinsey Quarterly review “global installations have continued to rise by over 50 percent a year, on average, since 2006” (McKinsey 2014).

By the same source, there are also opportunities to reduce costs associated with installation and service. In fact, financing, customer acquisition, regulatory incentives, and approvals may represent close to 50% the expense of installing residential systems in the United States. At the same topic, strong investment policies by governments like China, or Japan that is seeking to replace its nuclear capacity with solar, make strong cases for an increase in the installation of solar systems worldwide.

Currently, once electricity is generated by a solar PV system, this goes onto the grid and must be used immediately or be lost. Since the sunlight does not shine all hours of a day or it is not present at peak hours of consumption, the electricity is lost, if it's not used. This means that most solar PV systems are only meeting electrical demands for a portion of the day (SAS 2010) or storage solutions may be considered.

Another issue is the storage of electric energy. Scientists have found new ways to store energy produced by solar PV systems. One option is battery solutions that can store this energy, with mixed levels of inefficiency, high cost and have a pretty short shelf life (Energies 2015: 21), making them low attractive options for utility companies and consumers. Companies and scientists are exploring other ways to store the PV electricity (Altenergy 2016) so that it can be used on demand.

1.2. Photovoltaic promotion policies: design, implementation and results

The fundamental source of the earth's climate system is the electromagnetic radiation coming from the sun. Climate changes may be generated by variations in the frequency composition, intensity of incident solar radiation hitting the earth and the heat reradiated back to space, in addition to those from man-made climate change.

Recent records of climate changes, however, cannot be explained by natural causes alone. Research reveals that natural causes do not justify most observed warming (EPA 2016, NASA 2016) especially warming since the mid-20th century. Rather, it is extremely probable that human activities have been the main cause of that warming, which may generate disastrous consequences and costly adverse effects.

Action to reduce the impact of climate change is critical, is the most important factors in the modern days. In December 2015, one hundred ninety-five world leaders sign up the "Paris Agreement" to a global warming target of between 1.5C to 2C and pledging action to cut carbon emissions at the 2015 United Nations Climate Change Conference, COP21 (BHRRC 2016). This announcement requires local governments actions to mitigate climate change, as well as setting the stage for future investment in renewables and energy efficiency.

By the same source, the projected demand of energy will reach 16.5 billion tons of oil equivalents in 2030, compared to 10.3 billion tons in 2002. Most of this energy demand would come from fossil fuels, and oil would continue to be the single largest fuel in the global primary energy mix, even though its portion will fall slightly, from 36% in 2002 to 35% in 2030 (IEA 2015: 1, Castro 2013: 824-835). The share of renewable energy sources would remain flat, at around 4%, while that of nuclear power would drop from 7% to 5%.

Renewable energy is one of the alternative sources, which has the capacity to mitigate all those factors. Most countries had introduced some energy policy in the last 20 years to promote electricity from renewable energy sources. Nevertheless, it requires more accelerated activities worldwide because current public opinions' high concerns on climate change due to the greenhouse gases released from the burning of fossil fuels, and crisis of energy availability. Ramping up renewables is essential to meet climate goals without decelerating economic growth. Renewable energy source, as solar energy [2], is sustainable, it is clean and all-natural.

2) Because of its non-CO2 emission during operation, scale flexibility, noiseless and relatively simple operation and maintenance, photovoltaic (PV) appears to be quite relevant for electricity generation between other solar energy technologies. The International Energy Agency (IEA) estimates that solar power could provide as much as 11% of global electricity production by 2050 (Dinçer 2010: 714).

The mitigation and adaptation of global climate change and energy availability demand policies that encourage the production and use of renewable energy. It is relevant that such policies would be achieved via processes that involve several actors, not just bureaucrats and decision-makers, but also citizens, stakeholders, scientists, and other energy experts. If policy-makers rely only on the advice of one type of actor – e.g., energy producers – the legitimacy of the policy is lessened and questionable, and its implementation is delayed.

Attracting investments, increasing deployment and driving cost reductions are fundamental roles of renewable energy policies, which have played, and will continue to play a fundamental role. Policy-makers facing crucial climate change and energy availability had introduced new policies that mainly drive the expansion of renewable energy developments and technologies by attracting investment and creating markets that are generating economies of scale and innovative technology advances, resulting in decreasing costs and fueling sustained growth in the sector. A mix of regulatory policies, fiscal incentives, and public financing mechanisms are some of these policies.

According to REN 21's Renewable 2015 Global Status Report "by early 2015, at least 164 countries had renewable energy targets and 145 countries had renewable energy support policies in place" (REN 2015: 9,18), up from the 138 and 127 countries, respectively, that were reported in GSR 2013. By the same source, few countries — particularly China, Germany, Denmark, the US and Spain, among others — have led the development of renewable policies that have driven much of the change witnessed over the past decade.

In order to reduce the environmental impact of the energy sector a variety of policies have been developed and implemented to promote the use of renewable energy. The taxes and incentives for renewable energy available worldwide can be divided into three categories (REN21 2015: 99-101):

1) Regulatory policies:
   - renewable energy targets
   - feed-in tariff (FIT)/premium payment:
   - electric utility quota obligation/ renewable portfolio standard (RPS)
   - net metering
   - biofuels obligation/mandate
   - heat obligation/mandate
     - tradable renewable energy credit (REC)

2) Fiscal incentives:
   - capital subsidy, grant and rebate
   - investment and production tax credits (ITC and PTC)
   - reductions in sales taxes, energy taxes, CO_2 taxes, VAT and other taxes

- energy production payment.

3) Public financing
    - public investment, loans and grants
    - public competitive bidding/ tendering

Additionally, the global climate action accord struck in Paris, the formation of the International Solar Alliance initiative, the finalization of the Clean Power Plan in the U.S, and the extension of the solar investment tax credit are some of the energy policies and initiatives introduced recently.

Converting these policies and incentives into tangible deployment targets has been an important next step for countries that have implemented them, to offer both long-term planning security and policy direction for the private and public sectors. Allowing policies and regulatory frameworks could guarantee predictable revenue streams for projects, develop a stable and predictable investment environment, and help to overcome non-economic barriers.

Despite electric grid-related restrictions, opposition in some countries from electric utilities worried about rising competition, and ongoing high global subsidies for fossil fuels, several regulations have been adopted at regional and country level. There are a lot of debates surround the effectiveness of each one, expecting a choice that has to be made between them, which could be decided by the countries because their own particular circumstances and objectives. By REN 21 (2015: 18, 2019: 247) the renewable energy targets, capital subsidy, grant and rebate, and the feed-in tariff (FIT) and lately the renewable energy certificates (REC) are the most common policies applied until now.

Among all the renewable energy sources, solar energy is one of the most abundant and the cleanest energy source. Taking eight countries that represent the 81% of the cumulative PV capacity at 2014, as presented in Table 1, shows the adopted taxes and incentives by selected countries to promote the use of renewable energy. The main objectives of these taxes and incentives have been aligned to reduce the environmental impacts of the energy sector, reducing reliance on fossil fuels and encouraging new industrial development. Thousands of states and cities in the world have adopted renewable energy policies or laws for targeting the renewable energy and mitigations to the climate changes.

Feed-in policies remained in place in 73 countries at the national level and in 35 states/provinces in Australia, Canada, China, India, and the United States. From our sample countries, Spain does not have in place Feed-in tariff (FIT) policies since 2012. Spain changed its position on renewable energy FIT contracts due to fiscal challenges (IER 2012) and lower credit ratings.

As part of the worldwide taxes and incentives, major regional and country targets or regulations that has been adopted as for example the Renewable Energy

Targets presented at Table 2 for the eight selected countries.

Another important worldwide player, India determined an overall goal of 170 GW of renewable energy by 2022 and increased its solar power target to 100 GW by 2022. As a block the European Union set a region-wide goal of a 27% renewable energy share by 2030, with flexibility for member states to set national targets. These targets aspire to achieve a more competitive, secure and sustainable energy system and to meet its long-term 2050 greenhouse gas reductions target in place. Moreover, in 2013 was adopted the Arab Renewable Energy Framework (AREF), by the 22-member states of the Arab League, creating a development regional renewable energy framework.

By REN21 (2016), 64 countries had considered single and neutral technology renewable energy tenders in 2016. In same year, auctions are accelerating the decade-long plunge in the cost of solar power. According to Bloomberg New Energy Finance “In March 2016, a unit of Italy’s top utility Enel SpA agreed to sell solar in Mexico for $35.50 a megawatt-hour; in May, Masdar Abu Dhabi Future Energy Co. and Abdul Latif Jameel of Saudi Arabia bid for a photovoltaic project in the United Arab Emirates that set a global record with offers to supply solar power for as little as $29.90 a megawatt-hour or $0.029 cents per kilowatt hour. Auctions force developers to compete for contracts to sell electricity and give authorities sole control over scale, pressuring developers to bid as low as they dare” (Bloomberg 2016).

Renewable Portfolio Standards (RPS) or quota policies were in force in 26 countries at the national level (REN21 2016: 119-121) and 33 by 2018 (REN21 2019: 19), including China and the United Kingdom, plus other states provinces in Belgium, Canada, India (27 states and 7 union territories), and 29 states in the United States, including the District of Columbia, and two territories, while another 8 states have non-binding renewable energy goals.

By the same sources, net metering policies were in place in 48 countries in 2016 and in 66 countries by 2018 (REN21 2019: 61), as well as, some European countries, such as the Czech Republic, Greece, and Spain, had implemented fees for grid connection and/or taxes on renewable energy output (EPIA 2016), including generation for self-consumption and for sales back to the grid.

These policies and incentives have proven their effectiveness over the past years. As showed in Fig. 1.4 and Table 3 the growth in the installation of solar PV has been impressive since 2010. In fact, the total PV cumulative capacity worldwide was over 505 GW in 2018 or over 100GW from 2016 or an impressive 5 times growth from 2016, 33% growth in 2016 and 29% in 2015 (REN21 2019: 4, 19), especially in China, India, the USA and Japan accounting for more than 70 % of the additional installed capacity. By the same report China is the country with more added annual capacity since 2014.

Table 2
Renewable Energy Support Policy at 2018 for Selected Countries

Country	Australia	China	France	Germany	Italy	Japan	Spain	USA
Regulatory Policies								
Renewable energy targets	x	x	x	x	x	x	x	x
Feed-in tariff (FIT)/ premium payment	x	x	x	x	x	x		x
Electric utility quota obligation/ renewable portfolio standard (RPS)	x	x				x		x
Net metering	x				x		x	x
Biofuels blend obligation/ mandate	x	x	x	x	x		x	x
Renewable Heat obligation/ mandate		x	x	x			x	x

Tradable renewable energy credit (REC)	x		x	x		x		x
Tendering	x	x	x	x	x	x	x	x
Country	**Australia**	**China**	**France**	**Germany**	**Italy**	**Japan**	**Spain**	**USA**
Fiscal Incentives and Public Financing								
Tax Incentives		x	x	x	x	x	x	x
Investment and production tax credits (ITC and PTC)		x	x	x	x		x	x
Reductions in sales taxes, energy taxes, CO2 taxes, VAT and other taxes		x	x	x	x	x		x
Energy production payment		x					x	

Public investment, loans, grants, capital subsidies or rebates	x	x	x	x	x	x	x	x

Source: Own Elaboration from official data from REN (2015: 99-101, 2016: 119-121, 2019: 66-67)

Table 3
Renewable Energy targets at 2018 for selected countries

	Australia	**China**	**France**	**Germany**	**Italy**	**Japan**	**Spain**	**USA**
Renewable Energy Targets	23.5% by 2020	15% by 2020	23% by 2020	18% by 2020	17% by 2020		20% by 2020	No National target, it varies by states. Government agencies 20% by 2020
		20% by 2030	32% by 2030	30% by 2030		14% by 2030		
				45% by 2040				
				60% by 2050				

Source: Own Elaboration from official data from REN (2016: 161-168, 2019: 188-190)

By the same source, during the period 2011–2012, the EU countries led in the addition of renewable energy, with a 68% of the global renewable energy capacity added by these countries. While Europe still represented 51% of the global cumulative capacity market in 2014, its growth was 9% in 2014 and 16% in 2013.

By IEA-PVPS reports (2015, 7; 2018a, 3), Asia Pacific is the second region in cumulative capacity, with over 63 GW of cumulative capacity in 2014, a 60% growth, and 113% growth in 2013. Adding an impressive 24GW in 2014, the highest ever by any region. During the 2013 to 2014, the Asia Pacific countries led in the addition of renewable energy, with a 58% of the global renewable energy capacity added by all countries. By 2017, Asia added around 223GW, the highest ever of any region, led by China that added 53GW, followed by India with 9.1GW and Japan adding 7GW. At the same year, Europe added around 119GW, a steady amount since 2013, and the Americas added close to 52GW thanks to the USA and some Latin American countries, according the IEA-PVPS report (2018a:10).

1.2.1. Germany

Climate protection policies have been a prominent part of German politics and policy decision makers for more than two decades, as well as the expansion of renewable energies is one of the central pillars in Germany's energy transition. In 2002 the Germany's National Sustainable Strategy adopted different types of energy sources with specific targets: the climate gas emissions targets 40% by 2020 and 80–95% by 2050 compared to 1990 levels (REN 21 2016: 161; CEW 2016), with the goal to increase the share of renewable energies in final energy consumption to 18% by 2020 and to 60% by 2050 and to growth the share of electricity from renewable sources in total electricity consumption to at least 35% by 2020 and at least 80% by 2050.

In order to facilitate the developments of sustainable energy for protecting the environmental effects, in 2012 the German Government introduced the "Renewable Energy Sources Act (EEG) 2012", which also advocate the further developments of power generations technologies (CEW 2016) from renewable energy sources.

Evaluating the country evolution of cumulative and annual capacity worldwide, at 2014 Germany was the market leader for solar PV systems installation with an estimated cumulative installed capacity of 38 GW as presented in Table 4, a 22% share of global installations, which shows a huge increase in demand for the generation of solar power. Nevertheless, by 2018 it has a 9% market share, reaching 45.4GW in same year, a modest increase versus previous years. In fact, from cumulative capacity of 18GW in 2010 and 103MW at the end of 2000. Germany installed 1,9 GW in 2014, and 3,3 GW in 2013, after three years at levels of PV installations of 7,5 GW per year between 2010 and 2012.

This is the result of Germany's national policy from 2010, where National Renewable Energy Action Plan (NREAP) predicted the renewable energy share in Germany by 2020 would be 38%, 50% by 2030, 65% by 2040 and 80% by 2050 and also (Mir-Artigues and del Río 2016: 310-316), the total cumulative capacity of solar PV would be 51.75 GW.

By the same sources, the government limited the feed-in-tariffs (FITs) to 90% of the system output for systems 10kW to 1MW in size (Mir-Artigues and del Río 2016: 314-315), and the remaining 10% can be consumed on site, sold in wholesale markets or compensated at the average daytime spot price market. This FIT is gradually decreased over a 20 - year period to reward rapid adoption of renewables, while also safeguarding that green-power generation would eventually become competitive. Since 2005 to 2014, Germany had one of the biggest PV cumulative capacity worldwide, as presented in Table 4. Based on a total electrical consumption of 519TWH, the PV penetration in Germany is 6.7%, as presented in Table 5, a 23% PV annual capacity per habitant (w/hab) the highest in the European Union in 2014.

By the same source, Germany lost its leading position in 2015 in PV Solar cumulative capacity and in 2018 ranks fourth (EIA-PVPS 2019: 7-12). At December 2017 Germany had a 10.4% share of global cumulative capacity with 42GW (IEA 2018: 15) and 45.4GW in 2018. In Europe, Germany confirmed its leading position among the continent and installed close to 1.8 GW in 2017 as presented in Table 5.

1.2.2. China

For most of the past 20 years, China has had double-digit rates of economic growth. This growth had enormous implications for energy consumption and environmental impact (LSE 2016: 1-4) as carbon emissions. In 2005, the National People's Congress has passed The Renewable Energy Law (REL), that was the foundation for the publication of the "Guidelines for Using the Public Fund for Renewable Energy Development in 2006" by the National Development and Reform Committee.

China's renewable energy policy is now managed by the "Medium and Long-Term Development Plan for Renewable Energy in China" that projected the consumption of energy from renewable sources would go up by 15% by 2020 (NDRC, 2016), of this around 100GW in solar. This target helps the country in developing of renewables and aligning the national and provincial's energy planning methods (Mir-Artigues and del Río 2016: 326-328), which contributed to implement the national energy target and guidance at provinces levels, to design more effective incentive mechanisms and, to increase the reliability of renewable energy schemes.

By the same sources, in August 2013 the Chinese government introduced new feed-in tariffs (FITs), at both state and provincial levels, to fuel the growth of distributed solar rooftop installations. Additionally, the central government currently provides 20-year subsidies for distributed PV rooftop projects. Based on these new policies, China had experienced the biggest 2-year growth of 21.6GW capacity between 2013 and 2014.

China, the world's most populous country with over 1.3 billion people, installed 10,6 GW in 2014 an 8% installation per inhabitant, according to the National Energy Administration, a record level, that positioned the country in the first place with regard to all time PV installations, slightly lower than the 11 GW in 2013, with concerns about the ability to develop distributed PV.

According to REN21 (2015: 62), the PV penetration in China in 2014 was just below the 1% from the 5,523 TWH total electricity consumption, the biggest worldwide market. In 2015, China added around 15.2GW of solar PV capacity, reaching close to 44 GW (REN21 2016: 62). For 2016, China added 34.5GW of Solar Capacity PV, to reach close to 79GW (REN21 2017: 67) followed by Japan with close to 44 GW in same year.

As presented in Table 4, at the end of 2017 China reached the 131 GW of Solar PV accumulative capacity, a 32% of worldwide 402GW, and in 2018 reached 176GW or 35% of worldwide 505GW. Just in 2017 China added 53GW solar PV capacity and in 2018 45GW. In other words, the global PV market outside of China grew from 41,5 GW to 45 GW while China drove the global numbers up to at least 98 GW. China accounted for almost the 54% of the total installed capacity in 2017, and 44% in 2018.

According to IEA-PVS (2018b, 54) the NDRC&NEA issued in may 2018 the "Notification of 2018 PV Relevant Issues" (NDRC/NEA [2018] 823), with the main changes as listed below:

- Cancellation of the 2018 quota for PV plants
- Building and residential PV will be controlled within 10 GW and if the projects can't get grid connection before May 31, there will be no subsidy to the projects;
- After May 31, Feed-in Tariff will be reduced to 0,5, 0,6 and 0,7 CNY/kWh and subsidy for the self-consumption will be reduced to 0,32 CNY/kWh.

These policies are aimed to slow down the speed of PV market expansion in China, a major change in policy for this relevant market, which created a decrease in annual capacity of 7.9GW between 2017 to 2018 as presented in Table 5.

1.2.3. Japan

In 2009, Japan restarted a new policy for giving the subsidy for the residential PV systems and also introduced a new program for the purchase of surplus PV power. Through this policy, Japan installed 991MW PV systems in 2010 (METI 2016), a 205% versus 2009, 1.7GW in 2012, 7GW in 2013, and 9.7GW in 2014.

The Fukushima Daiichi nuclear disaster had impacts on Japanese energy policies and politics. For facing the energy demands, the government has taken the projection for renewable energy to 20% of the total power generation by 2030 (JETRO 2016: 2), with about 7% coming from solar PV and other energy mix. The point of the energy policy for energy mix is to ensure stable supply, realize low-cost energy supply, and pursue environmental suitability on the premise of "Safety."

Japan has a 77% PV annual capacity per habitant, the highest worldwide, as presented in Table 6. The Japanese Government has taken the projections to reach the capacity of 28GW (13.5%) and 53GW (20%) for solar PV by the end of 2020 and 2030, respectively.

Japan had installed 9,7 GW in the country in 2014, placing it very close to the Chinese record, with a total cumulative capacity of 23GW in same year, a remarkable increase from 3.6GW in 2010. Following industrial, agricultural, and IT revolutions, the renewable energy is said to be “the fourth revolution” because the rapid increase in its implementation in Japan.

As presented in Table 4, Japan continued its declining path with around 7 GW installed and connected to the grid in 2017, below the 10.8GW in 2015 and 7.9GW in 2016. At the end of 2017 Japan reached 49 GW of solar PV accumulative capacity, a 12% of worldwide PV Solar. In 2018, Japan reached an accumulative capacity of 56GW or 11% share worldwide.

After the solar boom in Japan between 2012 to 2014 as a result of the government introducing generous feed-in-tariffs (Mir-Artigues and del Río 2016: 309-310; IEA-PVS 2018: 11-15), the country is moving to a tender system, in the hope that this will create a more sustainable PV market.

1.2.4. United States of America

With data from the Energy Information Administration (EIA 2015: Table 1.1A) the net electric generation in the U.S. by 2015 was 4,087,381 MWh, 33% of which was generated by coal, 33% by natural gas, 20% nuclear, 7% renewable sources excluding hydroelectric and solar, 6% hydroelectric conventional and almost 1% by solar. By 2017 the net electric generation in the U.S. was 4,014,804 MWh, almost flat than 2015, where 30.1% was generated by coal, 32% by natural gas,

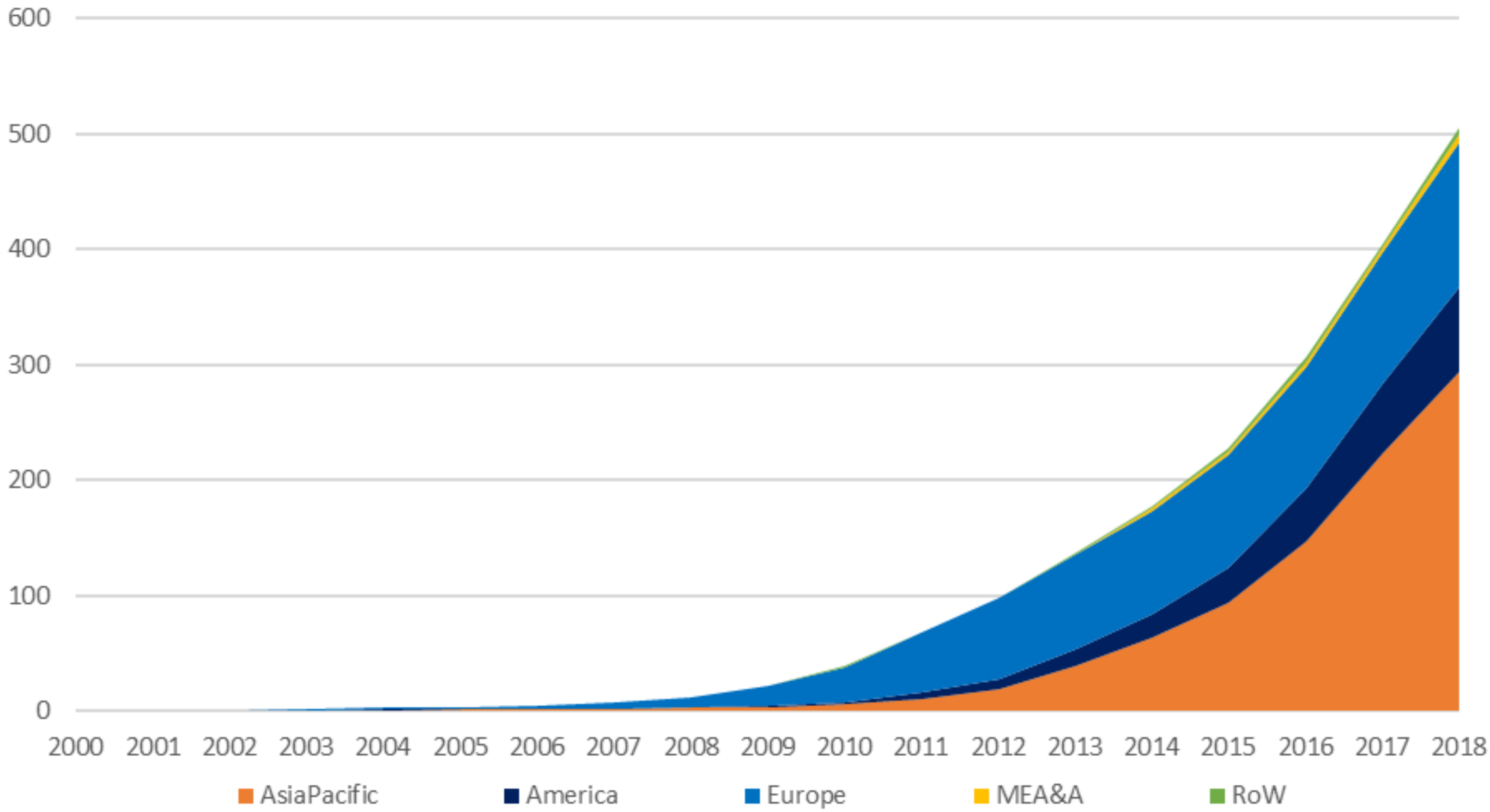

Fig. 1.4. Evolution of cumulative PV capacity by region 2000 – 2018 in GW**.** *Source*: IEA-PVPS (2019: 11)

Table 4
Evolution of cumulative PV capacity by country 1995-2018

	Cumulative Capacity (MW)								
Country	**1995**	**2000**	**2005**	**2010**	**2014**	**2015**	**2016**	**2017**	**2018**
Australia	13	29	61	571	4,088	5,109	5,985	7,500	11,300
China	-	19	70	800	28,380	43,530	78,080	131,000	176,100
France	3	11	26	1,207	5,702	6,605	7,164	8,000	9,000
Germany	7	103	2,101	17,956	38,250	39,710	41,186	42,000	45,400
Italy	16	19	38	3,502	18,606	18,915	19,297	19,700	20,100
Japan	43	330	1,422	3,618	23,339	34,150	42,041	49,500	56,000
Spain	1	2	55	4,330	5,376	5,425	5,483	5,600	5,861
USA	-	-	198	2,040	18,317	25,674	40,436	51,600	62,200
Rest of the World	22	59	223	5,458	34,908	48,551	63,723	87,600	119,439
Total IEA PVPS	**105**	**574**	**4,193**	**39,483**	**176,966**	**227,669**	**303,395**	**402,500**	**505,400**

Source: Own Elaboration from official data from EIA-PVPS Trends (2015: 7; 2017: 10-11; 2018: 10-13; 2019: 7-12)

Table 5
Evolution of annual PV capacity by country 1995-2017

	Annual Capacity (MW)								
Country	**1995**	**2000**	**2005**	**2010**	**2014**	**2015**	**2016**	**2017**	**2018**
Australia	13	4	8	383	862	1,022	876	1,250	3,800
China	-	19	8	500	10,640	15,150	34,550	53,000	45,100
France	3	2	2	837	954	903	559	875	1,000
Germany	7	73	935	7,418	1,900	1,461	1,476	1,800	3,400
Italy	16	1	7	2,321	409	308	382	409	400
Japan	43	122	290	991	9,740	10,811	7,890	7,000	6,500
Spain	1	-	28	481	23	49	58	147	261
USA	-	-	79	850	6,238	7,357	14,762	10,600	10,600
Rest of the World	22	10	37	3,009	9,005	13,642	15,174	22,919	31,839
Total IEA PVPS	**105**	**230**	**1,394**	**16,791**	**39,771**	**50,703**	**75,727**	**98,000**	**102,900**

Source: Own Elaboration from official data from IEA-PVPS Trends (2015: 7; 2017: 10-11; 2018a: 10-13, 2019: 7-12)

Table 6
PV Electricity statistics by selected countries 2014

Country	Electricity Consumption 2014 (TWH)	PV Electricity Production (TWH)	PV Penetration (%)	PV Installation in 2014 (MW)	Habitants 2014 (Million)	2014 Installation per Habitant (W/Hab)
Australia	228	5.8	2.5%	904	24	38%
China	5,523	36.8	0.7%	10,640	1,364	8%
France	465	6.2	1.3%	939	66	14%
Germany	519	35.0	6.7%	1,900	81	23%
Italy	308	24.7	8.0%	424	61	7%
Japan	965	24.6	2.5%	9,740	127	77%
Spain	223	8.6	3.9%	23	46	1%
USA	3,869	23.8	0.6%	6,211	319	19%
World	**20,000**	**212.4**	**1.1%**	**39,829**	**7,200**	**6%**

Source: Own Elaboration from official data from IEA PVPS Trends 2015 (IEA-PVPS 2015: 7)

20% nuclear, 8.3% renewable sources excluding hydroelectric and solar, 7.5% hydroelectric conventional and almost 1.3% by solar.

By the same source, from 2010 to 2017 the 3% contraction of the total net generation was drove by the reduction of the use of coal in favor of other sources as natural gas and renewable sources excluding hydroelectric. The net generation by renewables sources excluding hydroelectric and solar grew 101% to 334,287 thousand MWh, solar increased from 1,212 thousand MWh in 2010 to 52,958 thousand MWh the highest growth of all, while the others had decrease with exception of natural gas. This is a significant fact; renewable energy surged despite a slow national economy, uncertainty over federal and state tax credits and in some cases the absence of market context that assures a reasonable and predictable return for investors.

Several renewable energy support policies are the contributors of the adoption of PV energy in the USA as presented in Table 1. In response to the rising cost of fossil energies throughout the 1970s, United States created national policies to support energy alternatives and conservation as the Public Utility Regulatory Policies Act or PURPA in 1978 (Grossman and Cole 2003: 116-118, Hunt S. 2002: 429). In same year was established the Energy Tax Act, the first investment tax credits (ITC) for renewable energy technologies. The business ITC for solar was reduced from 15% to 10% between 1986 to 1988. The ITC is one of the most important policies in US solar energy market. This reduces the tax liability for individuals or businesses that purchase qualifying solar energy technologies (Mir-Artigues and del Río 2016: 308-309). The ITC was buried the US in 2005 and legally was up to the 3rd quarter of 2012.

By the National Conference of State Legislature, 29 States and Washington, D.C. have adopted at 2016, renewable portfolio standards (RPS) have been one driver for renewable electricity generation in the United States since its insertion. These standards require utilities to sell a specified percentage or amount of renewable electricity (DSIRE 2016), which can apply only to investor-owned utilities (IOUs) but many states also include municipalities and electric cooperatives (Munis and Co-ops), with equivalent or lower requirements. Table 7 shows the dates that theses RPS had been adopted by state. The majority of states with RPS policies allow utilities to exchange renewable energy certificates or renewable energy credits (RECs), to help utilities comply with RE obligations. The states that are not listed in Table 7 had not adopted RPS.

Many states in the US are also allowing net metering, for residential and commercial customers that generate their own electricity from solar power, to feed electricity they do not use back into the grid. As of August 2014, of the 44 jurisdictions with net metering, 25 have some type of restriction, 16 place no restriction on the aggregate capacity, and 3 have notification or “trigger” policies (DSIRE 2016). For utilities, the availability of net metering may be a concern from a revenue erosion or reliability perspective.

The third-party PV Power Purchase Agreements (PPAs) has recently emerged in the solar industry as one of the most popular methods of solar financing for consumers to realize the benefits of solar energy. PPAs were driving the solar markets in the western part of the country (DSIRE 2016) but it did not affect five states including Florida and Virginia. Although a majority of states have statutes mentioning or defining PPAs, 15 have enacted substantive legislation to authorize and regulate these agreements, according to the National Conference of State Legislature

As presented in Table 4, USA cumulative solar PV reached 51 GW in 2017 and 62.2GW in 2018 from 2GW in 2010. The PV market in USA continued to grow installing 10.6 GW in 2018, same capacity in 2017, 14.8 GW in 2016 (IEA-PVS 2018: 11-18) and 7.4 GW in 2015

1.2.5. Italy

Implemented since 2005, the Conto Energia or Energy Budget scheme has allowed an increasing market development (Mir-Artigues and del Río 2016: 320-322), resulting in a boom in installations in 2010 and 2011 and connections to the grid in 2011 and 2012. It was closed in July 2013, once the financial cap set by Italian authorities for the total yearly incentive cost at 6,7 BEUR was reached.

By the same source, in 2014, the European Union established new regulations ruling the energy sector beyond 2020, setting a region-wide goal of a 27% renewable energy share by 2030 (SEN 2017: 33).

While Italy has not yet articulated a clear objective for its energy mix in 2030 (REN21 2017: 188), already Italy has a goal of 26% by 2020 according to Italy's National Renewable Energy Action Plan (NREAP). The government organizations involved in promoting the renewable energy policies in the country are: Gestore dei Servizi Energetici (GSE), Gestore dei Mercati Energetici (GME) and Autorita per l'Energia Elettrica e il Gas (AEEG).

In order to achieve these targets Italy runs several incentive schemes as the Feed-in tariffs or Conto Energia, introduced in the year 2005, resulting in a boom in installations in 2010 and 2011 (Fig. 1.5) with a pick of 9.3GW in 2011. This FIT was modified in 2012 with a total annual expenditure ceiling for incentives of €700 million applicable for systems above 12 kW included (IEA-PVPS 2015: 5).

According to latest Strategia Energetica Nazionale (SEN 2017: 48-56) other incentives that were introduced are:

- Net Metering, the GSE has the role of managing net metering and paying the related contribution for plants with a capacity of up to 20kW and 200kW;

Table 7
State that have adopted Renewable Portfolio Standard by state at 2016

State	Title	Established
Arizona	Renewable Energy Standard	2006
California	Renewables Portfolio Standard	2002
Colorado	Renewable Energy Standard	2004
Connecticut	Renewables Portfolio Standard	1998
Delaware	Renewables Energy Portfolio Standard	2005
Hawaii	Renewable Portfolio Standard	2001
Illinois	Renewable Portfolio Standard	2001 (voluntary target); 2007 (standard)
Indiana	Clean Energy Portfolio Goal	2011
Iowa	Alternative Energy Law	1983
Kansas	*Renewable Energy Goal*	*2009 (standard); 2015 (goal)*
Maine	Renewables Portfolio Standard	1999
Maryland	Renewable Energy Portfolio Standard	2004

State	Title	Established
North Dakota	*Renewable and Recycled Energy Objective*	*2007*
Ohio	Alternative Energy Resource Standard	2008
Oklahoma	*Renewable Energy Goal*	*2010*
Oregon	Renewable Portfolio Standard	2007
Pennsylvania	Alternative Energy Portfolio Standard	2004
Rhode Island	Renewable Energy Standard	2004
South Carolina	Renewables Portfolio Standard	2014
South Dakota	*Renewable, Recycled and Conserved Energy Objective*	*2008*
Texas	Renewable Generation Requirement	1999
Utah	*Renewables Portfolio Goal*	*2008*
Vermont	Renewable Energy Standard	2005 (voluntary

Massachusetts	Renewable Portfolio Standard	1997
Michigan	Renewable Energy Standard	2008
Minnesota	Renewables Energy Standard	2007
Missouri	Renewable Electricity Standard	2007
Montana	Renewable Resource Standard	2005
Nevada	Energy Portfolio Standard	1997
New Hampshire	Electric Renewable Portfolio Standard	2007
New Jersey	Renewables Portfolio Standard	1999
New Mexico	Renewables Portfolio Standard	2002
New York	Renewable Portfolio Standard; Reforming the Energy Vision (REV)	2004
North Carolina	Renewable Energy and Energy Efficiency Portfolio Standard	2007
	Other States with no Renewable Portfolio Standard at 2016	
		target); 2015 (standard)
Virginia	*Voluntary Renewable Energy Portfolio Goal*	*2007*
Washington	Renewable Energy Standard	2006
West Virginia	*Alternative and Renewable Energy Portfolio Standard-REPEALED*	*2009; Repealed 2015*
Wisconsin	Renewable Portfolio Standard	1998
Washington, D.C.	Renewable Portfolio Standard	2005
Guam	*Renewable Energy Portfolio Goal*	*2008*
Northern Mariana Islands	Renewables Portfolio Standard	2007; goal reduced in 2014
Puerto Rico	Renewable Energy Portfolio Standard	2010
U.S. Virgin Islands	*Renewables Portfolio Targets*	*2009*

Source: Own Elaboration from official data from National Conference of State Legislatures. (NCSL 2016)

- Energy efficiency credits scheme;
- Distributed generation and market liberalization
- Others as: green certificates, market premiums, and reverse auctions for promoting renewable electricity generation

The implementation of these policies had help Italy to have the highest worldwide PV electricity production of 24.7 TWH in 2014, of 308TWH total electricity consumption, an 8% rate as presented in Table 5 and he highest worldwide in that year. Italy had a total cumulative capacity of 18.6GW in 2014, a remarkable increase from 3.5GW in 2010. Italy installed 9.3GW the highest of 2011, over Germany's annual capacity at the same year. As presented in Table 5, from 2014 to 2017 the annual solar PV capacity was reduced to an average 377GW per year, reaching an accumulative solar PV capacity of 19.7 GW at the end of 2017, and in 2018 reaching a 20.1GW.

1.2.6. Spain

According to Mir-Artigues and del Rıo (2012: 5557–66), in Spain until September 2008, the legal frameworks for Renewable Energy Sources support were the Real Decreto or Royal Decree 436/2004 and the 661/2007. The support system was based on the option of the producer to choose whether to sell the generated electricity with a fixed tariff or whether to sell it in the free market taking favor of the sales price. In other words, the decree 661/2007 was based on the guarantee to buy all the electricity produced at a price above that of the market, one of the first countries to introduce it. By the same source, other significant policy innovation by 1990 to 2008 was the variable premium system for wind energy, the first to introduce FITs for concentrating solar power (CSP), as well as the first to provide bonuses for systems able to supply reactive power to the grid, to assist with grid stability and reliability.

As presented in Fig. 1.5, in 2007 and 2008, Spain experienced an unprecedented boom in the deployment of solar PV modules, due in large part to a generous feed-in tariff (IEA-PVS 2015: 25-26), which was not changed to account the decrease in technology costs. In 2008 Spain installed over 3GW of PV modules driving Spain to the very first place in the world PV market in that year. Eventually, policy changes that were considered retroactive were made, angering investors and becoming the focus of much analysis and criticism (Mir-Artigues and del Río 2016: 316-320), among the international policy community.

After a low year in 2009, as presented in Fig. 1.5, the market went down to between 20 and 450 MW a year. In 2013, the Government announced the stop of the FIT by the 24/213 Power Sector Act (IEA-PVS 2015: 25-26). The new system is based on estimated standard costs, with a legal possibility to change the amounts paid every four years. The new schemes are based on the payment of capacities rather than production, causing many projects to be in a state of default.

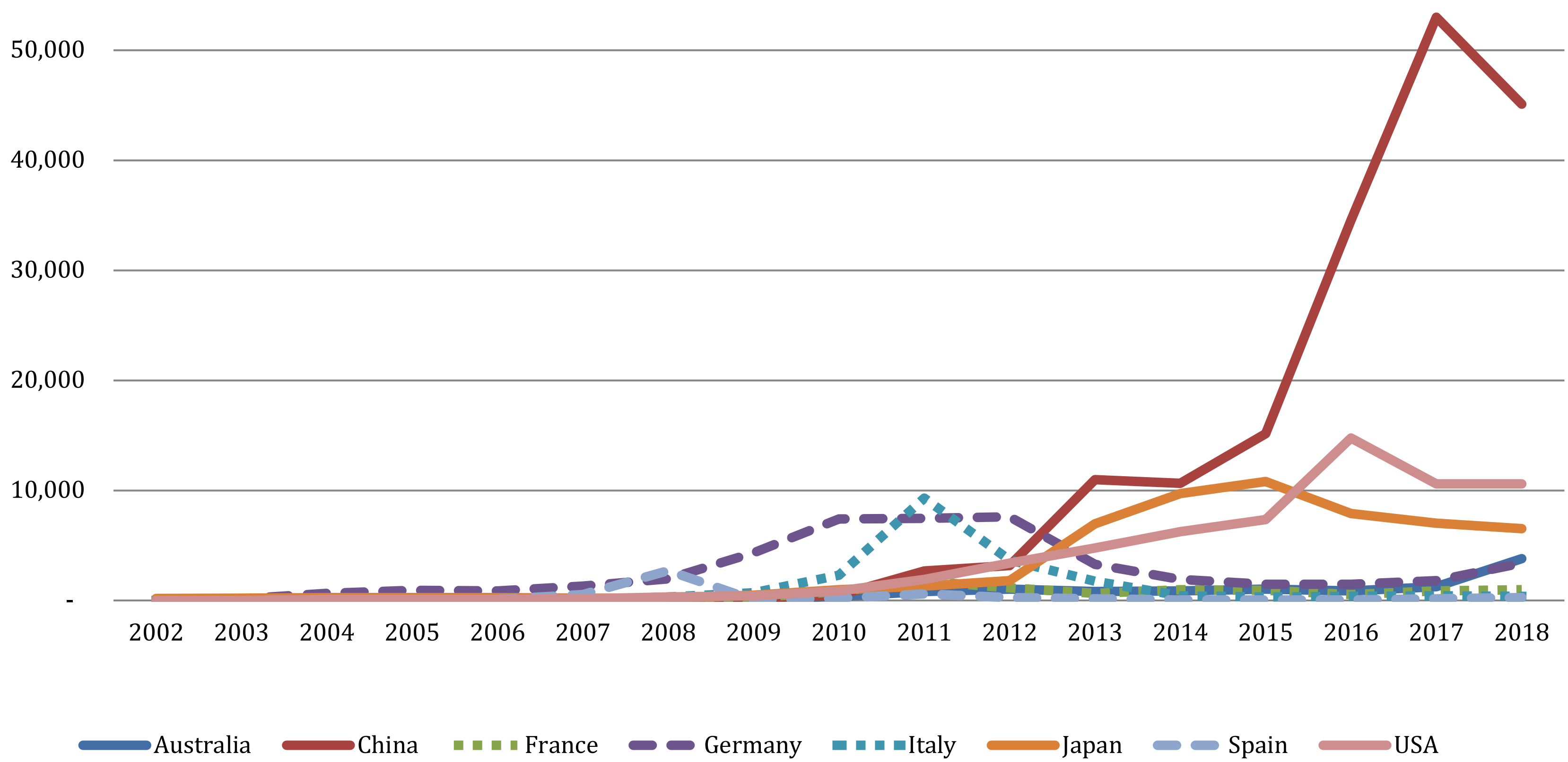

Fig. 1.5. PV Annual Capacity per year by the end of 2018 in MW**.** *Source*: Own Elaboration from official data from REN21 and IEA PVPS Trends (REN21 2015: 127; IEA-PVPS 2015: 7; IEA-PVPS 2016: 7-10, 2019: 7-12)

At 2016, Spain stands as one of the major European markets for the PV accumulative capacity; nevertheless, its electric energy production was of 8.6TWH in 2014 a 3.9% of the electricity consumption in same year (IEA-PVPS 2015: 7). The 5.4GW PV cumulative capacity represents a 3.1% of the total 175GW worldwide, with a very low 23MW installed in 2014. In July 2015, the government began the procedure to approve a new draft that could include a so-called “sun tax”.

As presented in Table 8, the constant retroactive policies from 2008 to 2018 created uncertainty in Spain, and the specter of further retroactive changes continued to hang over the electricity sector, while the reputational damaged for the RE industry of this unrelenting sequence of major revisions and retroactive changes contribute to small increase in solar capacity in 2014-2016 to 40MW per year, with a modest expectation in 2017 with a yearly capacity installation of 147 MW (IEA-PVS 2017: 10-13). By 2018, the growth was almost flat adding 261MW (IEA-PVS 2019: 7-12).

In order to simplify registration procedures, by 2018 Spain revised its net metering policy for solar PV (REN21 2109: 45, 61, 184), which also removed the charge on self-consumption adopted in 2015. By the same source, and following a major milestone, Barcelona met its goal of 100% renewable electricity in government operations, as Madrid met in previous years. In addition, in same year, tendering and construction on solar PV-CSP hybrid plants were announced in Spain, as part of major infrastructure projects.

1.2.7. France

The first regulation on energy established by France was the National Program for Tackling Climate Change back in 2000, which has been updated almost every two years according to the Energy Policy Framework Law of 2005. France initially supported the PV development through a pure FIT scheme, paid for by residential electricity consumers (Mir-Artigues and del Río 2016: 322-323). The last update of the National Program for Tackling Climate Change was published in 2012, which pushes for policy to reduce GHG emissions by 40% in 2030 and 60% in 2040 (REN21 2017: 188).

According to the French Ministry of Sustainable Development, a “National Debate on Energy Transition” was held between November 2012 and July 2013, to identify appropriate ways to address the energy system from the economic, environmental, and social angles. This debate originated some recommendations on energy policy that were the foundation for the “Energy Transition for Green Growth Act” approved in 2015 (GF 2017), which lays out a roadmap for transforming France's energy model and confirmed the renewable energy target to 23% by 2020 and expand to have renewable energies account for 32% of final energy consumption and 40%

Table 8
Overview of major Renewable Energy Changes in Spain (2008 – 2013)

RD 1578/2008	-	Move to an auction-based system regarding PV for contract allocation
	-	Differentiation between ground and roof-mounted PV
	-	PV tariffs drop from roughly EUR 0.46/kWh to EUR 0.32/kWh
RDL 6/2009	-	Move to an auction-based system for contract allocation for the rest of RES-E technologies
	-	High administrative and financial hurdles to be able to enter the PV auction process (e.g. proof of the administrative authorization and building license; proof of financial resources to be able to undertake at least 50% of the investment; purchase agreement between plant developer and manufacturer/supplier of equipment for at least 50% of equipment costs, etc.)
RD 1565/2010	-	cuts of PV tariffs of up to 45% (for ground mounted systems)
RD 1614/2010	-	retroactive introduction of caps of eligible hours for all existing CSP and wind projects
	-	reduction of wind premiums by 35% for the years 2011/2012
RDL 14/2010	-	retroactive introduction of caps of eligible hours for all existing PV projects & special (higher) reduction of eligible hours for PV installations for the years 2011-2013
	-	additional grid access fee for RES electricity producers of 0.5 €/MWh
RDL 1/2012	-	Spain approves a moratorium on RE projects starting end of Jan. 2012 by suspending feed-in tariff pre-allocation procedures and removal of any economic incentives for new power generation capacity involving cogeneration, all kind of renewable energy sources and waste resources
RDL 15/2012	-	introduction of a 7% tax on all electricity sales, conventional and renewable, applied to both new and existing projects
	-	partial financing of the RES-E remuneration through the state budget
RDL 2/2013	-	abolishment of remuneration option for RES-E power generation based on market price + feed-in premium, applicable to both existing and future projects
	-	change of the mechanism of indexation of the RES-E remuneration to the consumer price index (inflation), decoupling it from food and fuel price increases
	-	abolishment of the additional premium of up to 0.7 €ct/kWh for repowered wind farms

Source: Renewable Energy World (REW 2013) of electricity generation by 2030 (REN21 2017: 188). For accomplishing these targets, it would be required to bring biomass, geothermal power, district heating and other sustainable energy sources into more homes.

Immediate actions to address the Energy Transition for Green Growth Act's targets had been implemented as: the energy transition tax credit (Crédit d'impôt transition énergétique – CITE) with a refund of 30% of the total cost of energy renovation work, up to a limit of €8,000 for a single person and €16,000 per couple (GF 2017); interest-free eco-loan that allows property owners to benefit from an interest-free loan of up to €30,000 for the performance of energy renovation work; and the energy renovation platforms that support private individuals in their renovation works.

Globally at 2016, France stands at the sixth place for the PV accumulative capacity; nevertheless, its electric energy production was of 6.2TWH in 2014 a 1.3% of the electricity consumption in same year (REN21 2015: 59). The 5.7GW PV cumulative capacity represents a 3.2% of the total 177GW worldwide, with 939MW installed in 2014 as presented in Table 4; at 2017 France reached 8GW of solar PV cumulative capacity, adding in average 800MW per year since 2014 to 2017 (IEA-PVS 2017: 10-13). By 2018 France reached 9GW of PV accumulative capacity.

1.2.8. Australia

According to Climate Council (2014), one of the windiest and sunniest countries in the world is Australia, which is a prime market for renewable energy generation greater than present capacity. However, Australia has a low share of renewable electricity generation. In the case of solar PV electricity production, Australia had a 5.8% share with a total of 228 TWH electricity consumption in 2014 (IEA-PVPS 2015: 7), as presented in Table 6.

The Australian states have headed the way on emissions and renewable energy policy, influencing national action. In 2004 and 2006, South Australia and Victoria introduced state based renewable energy targets in response to a low 2% federal target. South Australia moved from having slight renewable energy a decade ago to already met its 2020 renewable energy target of 33%. South Australia has now set a 50% 2025 target (Climate Council 2015: iii). The ACT or Australia Capital Territories had reduced emissions to 80 percent below 1990 levels by 2050, with an interim target of 40 percent by 2020.

The off-grid market, previously Australia's main PV market, no longer has any specific program support, with the ending of the Renew-able Remote Power Generation Program during 2009. Nevertheless, the Australian grid-connected PV market grew due to the rebates available through the Solar Homes and Communities Plan (TAI 2011: 3-6), and the Solar Credits Renewable Energy.

As presented in Table 5, a total of 383MW of PV was installed in Australia in 2010, a four time increase over 2009. From 2014 to 2017 an average of 100 MW was installed reaching a PV accumulative capacity of 7.2 GW in 2017 (IEA-PVS 2017: 10-13) and in 2018 an impressive 11.3GW.

By EIA-PVS (2018b: 42), because the high electricity prices and continued reduction in PV system prices, in 2018 a combined 3,9 GW was commissioned, having by far a record year for Australian PV installations, with record volumes in every market segment, and every state. In fact, by the same source, the residential PV (<10 kW) grew by 42 % to 1,115 MW, small commercial (10-100kW) grew by 57 % to 528 MW, large commercial (101 kW-5 MW) also grew by 313 % to 361 MW, and utility-scale grew 1,553 % to 1 886 MW.

In summary and as presented along this chapter, because of a growing interest in renewable energy, solar power has received a lot of attention over the past several years. In fact, as presented through the analysis of above countries, the shift in the electricity sector has effectively become unstoppable. Globally, more renewable energy capacity has been installed and China is one of the major adopters because the size of the country and its economy.

However, solar power generation itself is not new; it has been used for more than half a century, mostly on a small scale or for specialized purposes, such as generating electricity for spacecraft and satellites or for use in remote areas. Large scale solar generation is considered a clean energy is expected to growth because solar power has many environmental benefits and is decreasing in price, which will allow at some point in the future to become increasingly competitive with fossil fuels.

Despite the rapid growth that solar PV had experimented since 2010, it has generated 3.1 million jobs worldwide, up 12% from 2015 (IRENA 2017: 5) and almost 10 times from 2011, a significant job creation. As presented in Table 9, the growth came mainly from China, the United States and India, whereas jobs decreased for the first time in Japan, and continued to decline in the European Union. This is one of the contributions that solar PV is making to our economy and our society.

Table 9
Estimated Direct and Indirect Jobs in Solar PV, Selected Countries in Thousands (2011 - 2017)

	China	USA	Japan	Germany	France	World
2017	1,962	247	302	32	16	3,095
2016	1,641	174	210	56	26	2,495

2015	1,652	194	377	38	21	2,772
2014	1,580	143		56	11	2,273
2013	300	90		88		1,360
2012	300	82		111		820
2011	120	17	26	120		350

Source: Own Elaboration from official data from EIA-PVPS Trends (2015: 7; 2017: 10-11; 2018: 10-13)

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2. Policies to Promote Renewable Sources in the United States of America

The United States remains the largest economy in the world, with a 2017 gross domestic product (GDP, in chained 2009 dollars) of USD 17,096 trillion total (BEA 2018), or USD 52,195 per capita, a 2.2% increase versus 2016. It covers an area of 9.8 million square kilometers, with a population of 321.4 million (estimated) in 2017 (CIA 2018). The country is a union of 50 states and one federal district, the District of Columbia. The major population areas are New York City and northern New Jersey with 18.6 million inhabitants on the east coast; Los Angeles, Long Beach and Santa Ana with 12.3 million on the west coast; and the Chicago area with 8.7 million in the eastern center of the country, Miami 5.8 million, Dallas-Forth Worth 5.7 million inhabitants among others. According to the Central Intelligence Agency, the civilian labor force stood at 156.4 million in 2015, 5.2% of which were unemployed in 2015. The population density of the United States is relatively low, with 32.7 inhabitants per square kilometer and 81.6% is an urban population.

The United States has experienced the fastest growing of the developed economies in the period 2015-2017 (TVG 2018; 9-11), the 2.4% pace of growth helped to considerably reduce the slack in the country's labor market. By the same source, the unemployment rate levels below 4% in 2017, is helping the housing sector to recover, banks have returned to health, corporate profitability is high and equity prices have reached new peaks. Economic growth is expected to gain speed through 2018.

There is slight doubt that electric energy is a key driver of human progress. In fact, to maintain our way of life and the economic development of our society, we require continuous access to energy at an affordable price. In this way, it is required and imperative the creation and implementation of energy policies. In the United States this takes place at several levels: federal, state and local. This means that achieving substantial change by overcoming regulatory and economic inertia (ACEEE 2013) will require a combined focus on what can be done nationwide at all government levels. In any case, the United States is implementing a system that may fit for the 21st century. One that powers the economy with cutting edge technology and makes sure U.S. reaps the economic benefits (Executive Office of the President 2016: 241 – 247) of a global clean energy revolution. This mix had allowed a lower oil prices and an increase in more renewables.

With data from the U.S. Energy Information Administration (EIA 2017a, EIA 2016b) and presented in Fig 2.1, renewable generation (hydroelectric, solar, wind and others) in the US is an increasing part of total generation. Hydroelectric is the largest contributor, but that hydro generation has decreased for last decade. On the other hand, wind has been growing rapidly, as has solar, although from a much lower level, which makes the increase imperceptible by the same source.

By Fig. 2.1, the total net generation increased by 32.9% from 3,037,988 Megawatt-hours (MWh) in 1990 to 4,038,944 MWh in 2017, while the type of energy source had substantially changed. In this period of time, coal and petroleum has experienced the sharpest decline, in favor of other sources as natural gas and renewable sources excluding hydroelectric. Gas as fuel increased 241.5%, nuclear increased 39.5%, while coal generation has contracted by 34.2% over this period, petroleum decreased by 83.3% (EIA 2017a), and hydroelectric has been almost flat with just 2.5% increase in the same period of time. Conversely, renewable energy excluding hydroelectric has boomed over the same period to over 5 times and solar has been from 0 generation in 1990 to 77,097 MWh or 1.9% of total energy generated in the U.S.

The United States' net generation is almost flat over the past eight years, with a total of 4,038,943 MWh in 2017 from 4,125,060 MWh in 2010, which are attributing in part to energy efficiency, including federal and state product efficiency standards, state and local building codes, and efficiency programs operated by utilities (EIA 2017a) and others. Changes in the structure of the economy like more services and less heavy manufacturing, and weather probably play a role as well.

By the same source, the net electric generation in the U.S. by 2015 was 4,091,740 Megawatt-hours (MWh), 33.1% of which was generated by coal, 32.9% by natural gas, 19.5% nuclear, 6.6% renewable sources excluding hydroelectric and solar, 6.1% hydroelectric and almost 1% by solar. By 2017, the net electric generation was slightly lower than 2015, reaching 4,038,943 MWh of which was generated by: 29.9% coal, 31.9% by natural gas, 19.9% nuclear, 8.3% renewable sources excluding hydroelectric and solar (EIA 2017a), 7.4% hydroelectric and 1.9% by solar. Since 2000 has been a steady move out of coal and into natural gas.

In the renewable energy category, wind has been responsible for most of the increased generation. Gas and renewables sources are expected to increase in use in the future, both in absolute terms and as a share of total power generation and capacity.

In 2015, the net generation by solar sources grew 49.6% the highest of all type of sources, after growing triple digit marks between 2012 and 2013 and 96% in 2014 (EIA 2016b, EIA 2017a), while the others had decrease with exception of natural gas and renewable sources excluding hydroelectric and solar. Additionally, renewable energy sources, including hydroelectric and solar, account for 13.3% of net U.S. electrical generation in 2015. These are significant facts; renewable energy surged despite a slow national economy, uncertainty over federal and state tax credits and in some cases the absence of a comprehensive market context that assures a reasonable and predictable return for investors.

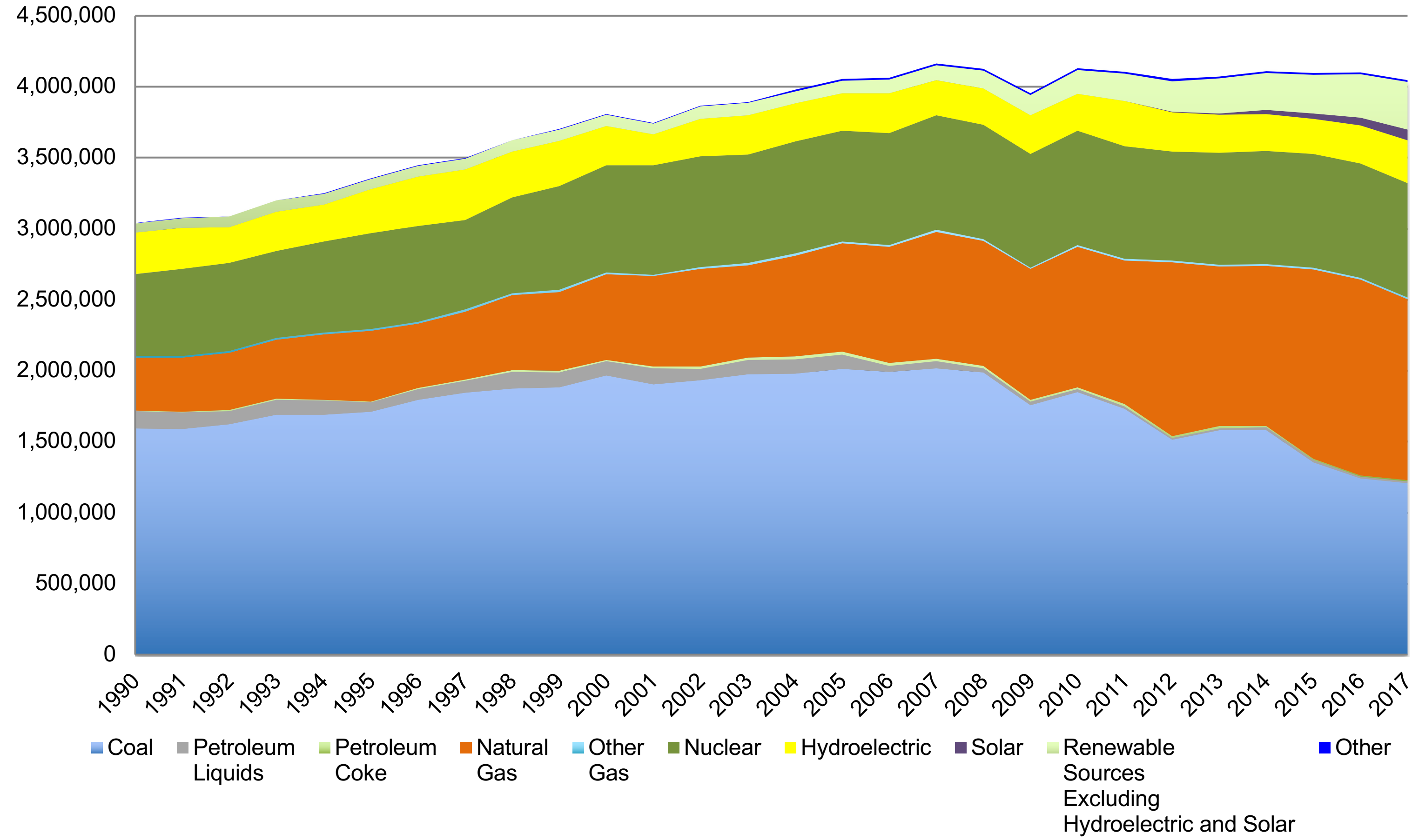

Fig. 2.1. U.S. Net Generation by Energy Source in all sectors, 1990-2017 (Thousand MWh)**.** *Source: Own Elaboration from official data from EIA (2005; 2006; 2007; 2008; 2009; 2010; 2011; 2012; 2013; 2014; 2015; 2016b; 2017a*

Still coal is cheap and reliable. The disadvantage is that it is dirty, generating more greenhouse-gas emissions than any other fossil fuel and contributing to air pollution. Natural gas is also available and has been taking part of coal's energy production. It is clear that the US has a huge investment in the current energy infrastructure, and it is just not going to write it off. The idea that there could be a "one shot" to go all renewable in ten or twenty years would not happen and would require a new set of standards, regulations, financial support, investments and consumers support.

Energy is fundamentally about improving the quality of daily life, and its policies should support it, in addition to a positive impact in job creation, pollution reduction, gas prices, and climate change.

In this chapter, an analysis of the increase of net generation by renewable energy sources is made from 1990 to 2017, an almost flat net generation until 2006, and from 2007 a quick increase in renewables, especially with the generation from wind and from 2013 by solar, because the implementation of the Public Utility Regulatory Policy Act (PURPA) in 1978 in favor of wind energy generation, until 2005 with the Energy Policy Act published by the Congress of the United States of America (EPA 2005),

It is also included in this chapter an analysis of the EPA 2005 offered tax benefits to individuals who increase energy efficiency in existing homes, required all public utilities to offer net metering on request, tax credits for wind and other alternative energy producers, and mainly encourages more domestic energy production. In addition, this law reiterated a commitment to competition in wholesale power markets as national policy, and also provided loan guarantees for entities that develop or use innovative technologies that avoid the by-production of greenhouse gases.

Subsequently in this chapter, an analysis to the policies and regulations at federal level as production tax credit (PTC), Investment Tax Credit (ITC), as well as at state level with the implementation of Feed-In Tariff (FIT), renewable portfolio standard, net-metering, interconnection and others. An analysis is also included to solar PV energy and the increase in cumulative capacity, benefited significantly from state programs and policies. Nevertheless, not all states with active solar markets have the same bundle of policies and programs, them the results in the implementation of solar PV is different, which is presented as a correlation analysis from the number of incentives and regulations versus net generation from renewable sources excluding hydroelectric with data available at 2015.

2.1. Main measures at the federal level

The United States has some of the best wind, solar, geothermal, hydro, and biomass resources in the world. It has the opportunity to be the forerunner in the global transition to renewable energy because its vibrant culture of innovation, abundant financing options, a highly skilled workforce, along with an entrepreneurial and agile business sector.

“Over three thousand public, private and cooperative utilities, including more than one thousand independent power producers (IPPs), three regional synchronized power grids, eight electricity reliability councils, some one hundred and fifty control area operators, and thousands of separate engineering, economic, environmental, and land-use regulatory authorities” (RAP 2011: 9) are part of the electricity industry in the United States.

By the same source, ownership is divided among a variety of structures:

- Investor-owned utilities,
- Publicly owned utilities (largely municipal),
- Federal, co-operative (largely rural) utilities,
- Other providers
    - State-owned public utility districts and irrigational districts or power marketers and energy service providers (ESP),
    - Independent non-utility power producers (IPP),
    - Combined heat and power (CHP) independent power producers,
    - Commercial and industrial combined heat and power generators.

In the country the energy policy agenda was confronted significant change over the past years, rising domestic production of oil mainly by hydraulic fracturing, shale gas and bioenergy. Economic assistance for a limited amount of time may be justified by the need to attach a price signal to the environmental and energy security benefits of renewable energy deployment, so technologies may come competitive.

These policies, in the case of the United States, are looking to deliver a reliable, affordable and environmentally sustainable energy system, away from its reliance on fossil fuels on the way to a sustainable energy system with greater energy independence. The federal government maintains a strong preference for market-based regulations in energy and environment policy. Nevertheless, the electricity industry is subject to a multipart series of regulatory rules at municipal, state and federal levels, with some exemptions.

Under Article II of the United States Constitution (Executive Office of the President 2016), the President is responsible for the execution and enforcement of the laws promulgated by Congress. Fifteen executive departments carry out the day-to-day administration of the federal government. They are joined in this by other executive agencies such as the Environmental Protection Agency (EPA) and the Department of Energy (DOE). The Department of Energy has the mission to advance the national, economic and energy security of the country (Executive Office of the President 2016), and to promote energy security by encouraging the development of reliable, clean and affordable energy.

The U.S. Constitution agrees to federal regulation of utilities only where interstate commerce is involved. Therefore, intrastate activities are subject to control by state regulatory commissions (Executive Office of the President 2016), which grant the construction of generating plants and transmission lines, while all states approve retail prices for their jurisdictional electric utilities.

Based on the increase of net generation by energy sources, it has been two distinct phases in the history of renewable energy policies and markets in the United States and how they evolved over time. As presented in Fig. 2.2, an almost flat net generation until 2006, and from 2007 a quick increase in renewables, especially with the generation from wind and from 2013 by solar.

First phase - PURPA Era:

Before 1978, Electric utilities had no obligation to purchase power from third parties, The Public Utility Regulatory Policy Act (PURPA) passed in 1978 in the middle of the energy crisis that snatched through industrial world economies, over the five energy bills approved in that year. One of the most important effects of the law was to create a market for power from non-utility power producers (Grossman and Cole 2003: 116-118, Hunt 2002: 429), requiring utilities to buy power from independent companies that could produce power for less than what it would have cost for the utility to generate the power. PURPA is the only existing federal law that requires competition in the utility industry, or deregulation process (Savacool 2008: 151-152, Munson 2005: 105), and the only law that encourages renewables at the utility-scale, if cost competitive with conventional.

An analysis by P. Grossman and H Cole regarding the effect of PURPA that summarize the impact of this law is presented as “PURPA had two effects in the regulatory theory. First, the entire electric industry was perceived as not being a natural monopoly because the generation sector was competitive and there were competitive elements for the distribution sector as well. Second, questions were raised about continue wisdom of treating the transmission segment as a natural monopoly” (Grossman and Cole 2003: 118). PURPA’s main effect was to increase industrial and commercial on-site generation. Between 1990 and 2006, slowly renewable projects, mainly wind, saw the greatest benefit and started to provide service, as presented in Fig. 2.2.

Nevertheless the great effort by President Carter on explaining the benefits of comparatively cleaner energy, few renewables were able to compete with new

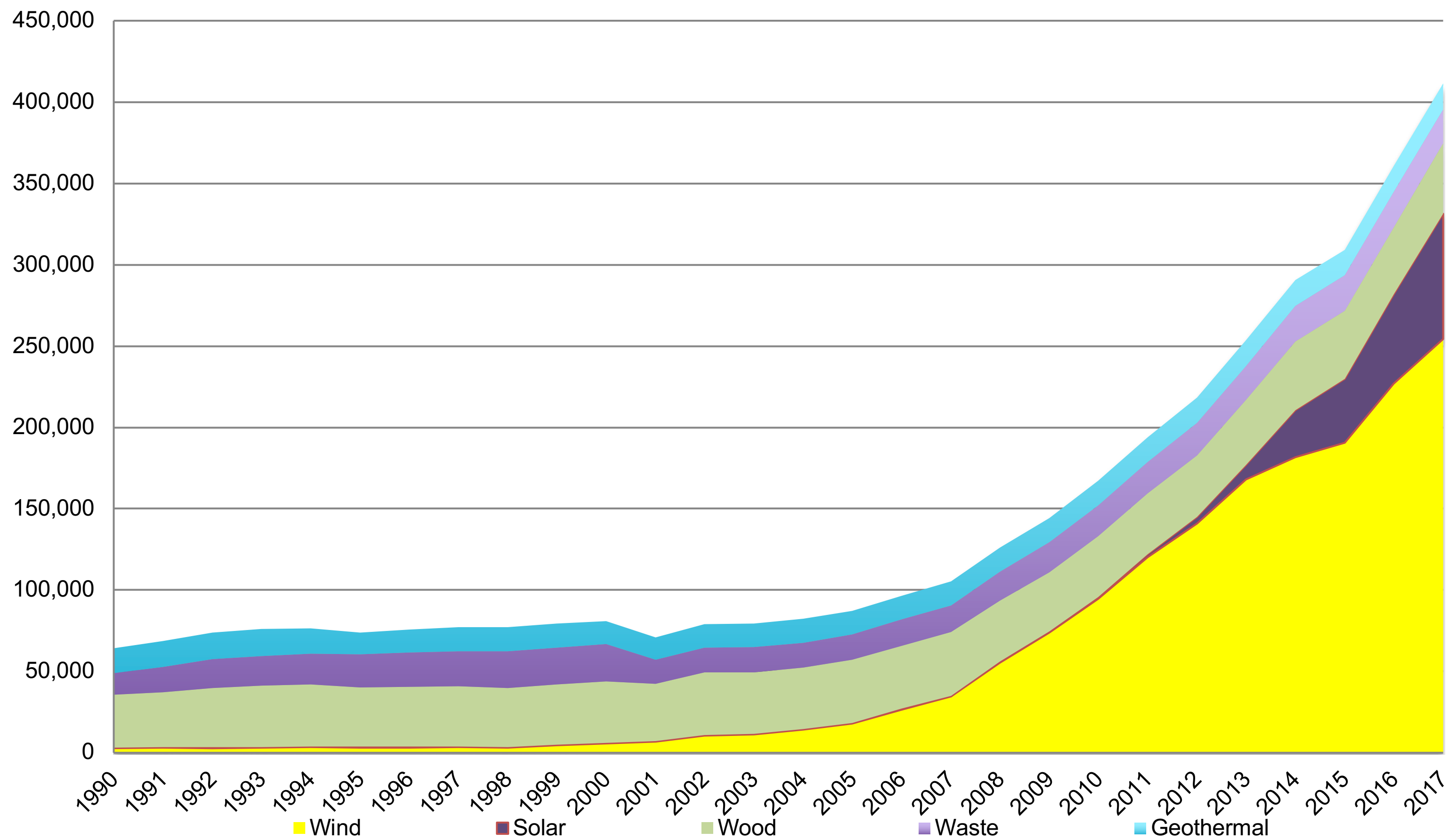

Fig. 2.2. U.S. Net Renewable Generation by Energy Sector: Total (All Sectors), 1990-2015 (Thousand MWh)**.** *Source: Own Elaboration from official data from EIA (2005; 2006; 2007; 2008; 2009; 2010; 2011; 2012; 2013; 2014; 2015; 2016b)*

natural gas turbines and most of PURPA contracts signed in the 1980s have expired at today, or "avoided cost"[3] rates became less favorable (Foldvary and Klein 2003: 175). This is the first recognized use of feed-in tariffs worldwide, nevertheless was mostly dismantled by the early 1990s because declining electricity prices.

Another legislation piece that was announced in this first period, it is the Energy Policy Act (EPA) of 1992, which is an amendment of the Federal Water Power Act of 1920 (AFDC 1992). The EPA was created as a framework for wholesale electricity generation, energy efficiency on building energy efficiency standards, equipment energy efficiency standards among others (ACEEE 1992), additionally provided financial incentives to users and developers of clean-fuel vehicles and intended to expand the use of natural gas.

Policymakers at federal level mystified over whether to adopt RPSs (i.e., mandatory targets for renewable electricity) or public benefits funds (i.e., grants, rebates, and other incentives) in this period. These policies were developed when the cost of renewable energy technologies was significantly higher than both conventional electricity prices (DeLong 2003: 2-18) and utilities' avoided generation costs.

By 1990 already 2.8 GWh were wind generated in the United States, and for 2006 it reached 26.6 GWh or 6.9% of total renewable generation including hydroelectric. Solar generation reached 508 MWH in 2006. Other sources as wood, waste and geothermal maintained their generation level between 1990-2006. PURPA and EPA 1992 have been the most effective measures in promoting the adoption of renewable energy.

PURPA and EPA enabled 18 states to offer consumers the right to choose their energy provider with some level of retail competition. In this period, various state renewable policies were enacted, which will be discussed later in this chapter.

Second phase - EPA Era: (2007 to Present)

Urged by increasing energy prices and rising dependence on foreign oil, a new energy law was formed by competing fears about energy security, environmental quality, and economic growth. Different parties play a role in the development of U.S. energy efficiency policies, such as energy security, grid reliability or air pollution. The U.S. experienced in this period, a significant progress in the development of energy efficiency policies.

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(3) Avoided Cost is fundamentally the marginal cost for a public utility to produce one more unit of power, acquired through another resale or supplier instead of building a new plant.

A new version of the Energy Policy Act was published in 2005 by the Congress of the United States of America (EPA 2005), which offered tax benefits to individuals who increase energy efficiency in existing homes, required all public utilities to offer net metering on request, tax credits for wind and other alternative energy producers, and mainly encourages more domestic energy production.

By same source, the EPA 2005 reiterated a commitment to competition in wholesale power markets as national policy, and also provides loan guarantees for entities that develop or use innovative technologies that avoid the by-production of greenhouse gases. The EPA 2005 also established the 20% energy efficiency gain target by 2020 for Federal Agencies, which was complemented by the Energy Independence and Security Act of 2007.

An element that marks this period is also the reduction of the prices of the PV modules in the USA, which started to go down gradually by the end of 2008, and an accelerated reduction since 2009 until 2012. "In fact, the reduction in 2008 was only 2 % in the US market, but in the next 13 quarters it reached 51%. The reduction was particularly pronounced in the beginning of 2009 and during 2011" (Mir-Artigues and del Rio 2016: 161-192). Additionally, by the Solar Energy Industry Association (SEIA, 2016a) "the cost to install solar has dropped by more than 70% over the last 10 years, leading the industry to expand into new markets and deploy thousands of systems nationwide".

By the end of 2012, already 141 GWh were wind generated in the United States, or 29% of total renewable generation including hydroelectric. Solar generation reached 4.3 GWh in 2006 (EIA 2005). Wood, waste and geothermal generation maintained their generation level between as in the PURPA era. By the same source, the total renewable generation including hydroelectric was 495GWh in 2012 from 386GWh in 2006 or 28% increase mainly from wind.

The enactment of the American Recovery and Reinvestment Act of 2009 (ARRA) or Recovery Act, financed more than USD 90 billion in investments and tax incentives), the "President's Blueprint for a Secure Energy Future" published in 2011 (AFDC 2012) doubling of electricity generation from wind, solar and geothermal sources by 2020 relative to 2012 levels), and the "All-of-the-Above Energy Strategy" announced in 2012 and published in 2014 (Executive Office of the President 2014) that support for economic growth and job creation; enhanced energy security; and deployment of low-carbon energy technologies.

All these listed Acts and U.S. President's Plans had significant impact on the sector by increasing investment in energy infrastructure, clean energy projects and energy efficiency as presented in Fig. 2.2 by the increase of renewable energy generation from 2007 to 2017 (EIA 2007, EIA 2010, EIA 2017a). This strategy incorporates advanced extraction of natural gas and oil reducing net oil imports, limited nuclear expansion, aggressive energy efficiency in buildings and appliances, improved automobiles fuel efficiency, as well as support for renewable energy.

In June 2013 it was announced a comprehensive Climate Action Plan for tackling climate change. The plan outlined steps to cut carbon pollution, including standards for both new and existing power plants, actions to prepare for the impacts of climate change, and plans to lead international efforts to address global climate change. In January 2014 (Executive Office of the President 2013), it was issued a Presidential Memorandum directing the Administration to conduct a Quadrennial Energy Review (QER) to provide an integrated view of, and recommendations for, federal energy policy in the context of economic, environmental, occupational, security, and health and safety priorities.

On August 2015, the Clean Power Plan was announced by President Obama and EPA, which will normalize the existing fleet of fossil-fired power plants, intends to cut emissions 32% (relative to 2005 levels) by 2030 through assigning each state a target emissions level (in tons of carbon) or emissions rate (in tons per megawatt hour). This plan was also backed by the New Source Performance Standards (NSPS), which set limits on emissions from newly constructed plants and will require new coal-fired power plants to install carbon capture and storage technology.

As described above, under the Energy Policy Act of 1992 and later versions, a number of federal policies and subsidies sustained the renewable power generation capacity deployment for instance: the production tax credit, investment tax credit, renewable portfolio standards (renewable energy targets for utilities for generation mix), feed-in tariffs, R&D subsidies, funding and guidelines for industrial cogeneration, and lately the North American Smart Grid Interoperability Panel to organize and speed up standards harmonization.

In April 2016, the Senate passed the Energy Policy Modernization Act, the first broad energy bill update to federal energy policy since the energy Independence and Security Act of 2007, to better align the nation’s oil, gas and electricity systems with the changing ways that power is produced in the United States. This Act introduced provisions to promote renewable energy, improve the energy efficiency of buildings, and to cut some planet-warming greenhouse gas pollution.

According to the Database of State Incentives for Renewables & Efficiency (DSIRE 2016) and presented in Table 1, since 2002 and at June 2016 there are 22 federal policies in place in the USA, 19 of them as Financial Incentives and 3 Regulatory Policies.

Table 1
U.S. Federal Incentives for Renewables

Name	Category	Policy/Incentive Type	Created
Modified Accelerated Cost-Recovery System (MACRS)	Financial Incentive	Corporate Depreciation	3/15/02
Renewable Electricity Production Tax Credit (PTC)	Financial Incentive	Corporate Tax Credit	3/11/02
Business Energy Investment Tax Credit (ITC)	Financial Incentive	Corporate Tax Credit	3/15/02
Residential Energy Conservation Subsidy Exclusion (Corporate)	Financial Incentive	Corporate Tax Exemption	3/5/02
USDA - Rural Energy for America Program (REAP) Grants	Financial Incentive	Grant Program	4/9/03
Tribal Energy Program Grant	Financial Incentive	Grant Program	5/1/03
USDA - High Energy Cost Grant Program	Financial Incentive	Grant Program	9/27/10
USDA - Repowering Assistance Biorefinery Program	Financial Incentive	Grant Program	10/8/12
USDA - Rural Energy for America Program (REAP) Energy Audit and Renewable Energy Development Assistance (EA/REDA) Program	Financial Incentive	Grant Program	2/18/15
Low Income Home Energy Assistance Program (LIHEAP)	Financial Incentive	Grant Program	3/16/15
USDA - Rural Energy for America Program (REAP) Loan Guarantees	Financial Incentive	Loan Program	4/9/03
Clean Renewable Energy Bonds (CREBs)	Financial Incentive	Loan Program	5/2/06
U.S. Department of Energy - Loan Guarantee Program	Financial Incentive	Loan Program	9/12/08
Qualified Energy Conservation Bonds (QECBs)	Financial Incentive	Loan Program	10/23/08
USDA - Biorefinery Assistance Program	Financial Incentive	Loan Program	10/4/12
FHA PowerSaver Loan Program	Financial Incentive	Loan Program	12/4/14
Fannie Mae Green Initiative- Loan Program	Financial Incentive	Loan Program	5/28/15
Residential Renewable Energy Tax Credit	Financial Incentive	Personal Tax Credit	8/10/05
Residential Energy Conservation Subsidy Exclusion (Personal)	Financial Incentive	Personal Tax Exemption	3/5/02
Energy Goals and Standards for Federal Government	Regulatory Policy	Energy Standards for Public Buildings	6/19/06

Green Power Purchasing Goal for Federal Government	Regulatory Policy	Green Power Purchasing	2/19/04
Interconnection Standards for Small Generators	Regulatory Policy	Interconnection	10/30/07

Source: Own Elaboration from official data from DSIRE, 2016 (Database of State Incentives for Renewables & Efficiency)

From these 22 federal policies, two relevant policies have supported the implementation of renewable systems since 2002:

The Production Tax Credit (PTC) is applicable for geothermal electric, wind biomass, hydroelectric, municipal solid waste, landfill gas, tidal, wave, ocean thermal, wind (Small), hydroelectric (Small). This federal tax credits for renewable energy have served as one of the primary financial incentives for its deployment over the last two decades in the United States.

The PTC provides a tax credit for the production of electricity from renewable sources and the sale of that electricity to an unrelated party. The Credit amount applies to first 10 years of operation (DSIRE 2016), is as follows:

- $0.023/kWh for wind, geothermal, closed-loop biomass
- $0.012/kWh for other eligible technologies Applies to first 10 years of operation

According to the National Renewable Energy Laboratory it estimated that "extending federal RE tax credits, as enacted in the *Consolidated Appropriations Act of 2016*, can boost RE deployment through the early 2020s. However, longer-term deployment effects are less certain because deployment drivers including future natural gas prices, RE cost reductions, and the CPP could play a more substantial role in the 2020s and beyond. More rapid RE growth—driven by the tax credits—can result in significant cumulative CO2 emissions reductions" (NREL 2016: 22).

The Business Energy Investment Tax Credit (ITC) is one of the most important federal policy mechanisms to support the deployment particularly of solar energy in the United States. It is applicable for solar, geothermal, qualified fuel cell or micro turbine property, combined heat and power systems, small wind and geothermal heat pumps. The ITC provides a credit for qualifying energy property. The ITC for any taxable year is the energy percentage of the basis of each energy property (DSIRE 2016) placed in service during the taxable year. According to SEIA, "the residential and commercial solar ITC has helped annual solar installation grow by over 1,600 percent since the ITC was implemented in 2006 - a compound annual growth rate of 76 percent" (SEIA 2016a).

The credit amount under this policy is:

- 30% for solar, fuel cells, small wind, on residential (under Section 25D) and commercial (under Section 48) properties
- 10% for geothermal, microturbines and CHP

In order to take advantage of these tax credits, a company must have income at least equal to the credit, or must find a partner that does, and incur the significant cost of tax equity financing to obtain some of the benefits. In some cases, this issue had created business models in order to maximize the use of the tax credits.

This ITC credit will be available at its current 30% level through 2019, after that will be reduce over the next several years and expire at the end of 2021. The credit will remain at 10% permanently for commercial systems after 2021 (DSIRE 2016) as presented in Fig. 2.3. The extension of the federal ITC will continue increasing residential solar PV installations between 2016 and 2020 by providing market certainty for companies to develop long-term investments that drive competition and technological innovation, which lowers costs for consumers.

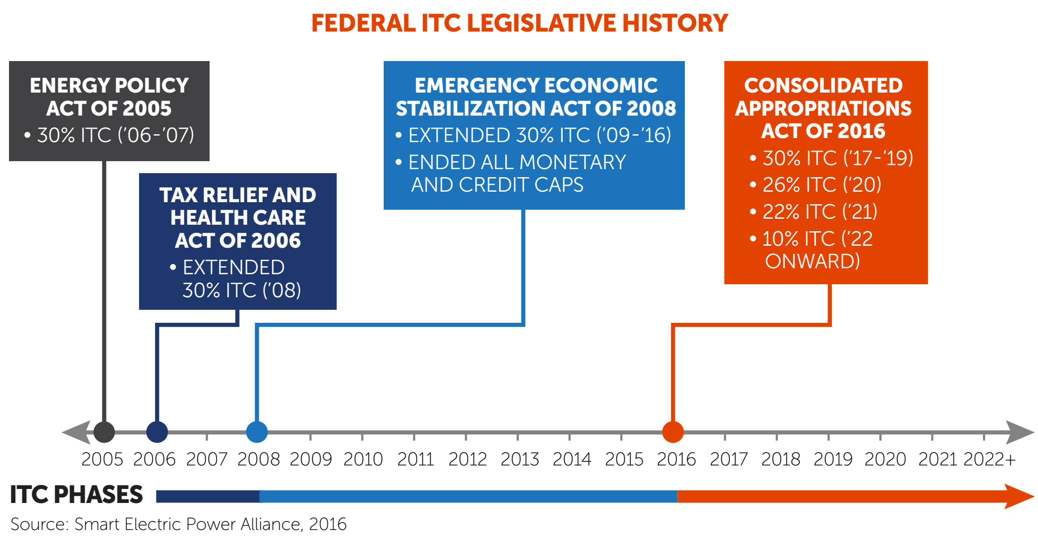

Fig. 2.3. Federal Investment Tax Credit (ITC) extended, 2005-2022+. *Source*: Smart Electric Power Alliance - SEPA (2016: 10)

Energy innovation proposes the best opportunity to resolve the correlated questions of climate change, worldwide insecurity over energy supplies, lack of consistent federal and state policies, and rapidly growing energy demand. But this has to be achieved (Executive Office of the President 2014) in a timely transition to reliable, low-cost, low-carbon energy. Efforts to ensure that new investments include energy efficiency and support the growth in renewable resources are not captured neatly by any single policy mechanism.

By data from EIA, today's energy generation mix in the United States is radically different from just 11 years ago. In 2005: 49,5% was generated by coal, 18.8% by natural gas, 19.3% nuclear, 2.1% renewable sources excluding hydroelectric and solar, 6.5% hydroelectric and 0% by solar (EIA 2005). In contrast in 2017: 33.1% was generated by coal, 32.6% by natural gas, 19.4% nuclear, 6.6% renewable sources excluding hydroelectric and solar (mainly wind), 6.1% hydroelectric and almost 1% by solar (Table 1). Nevertheless, the increase in energy generation between 2005 and 2015 is just 0.8%, reaching 4,087,381 thousand MWh. At this point, wind looks to be on a trajectory to overtake hydropower as the leading source of U.S. renewable electricity.

By Table 1, it is relevant to compare the energy mix of 2015 with 2017 because the total energy generation was flat in this period: 29.9% was generated by coal, 31.5% by natural gas, 19.9% nuclear, 8.3% renewable sources excluding hydroelectric and solar (mainly wind), 7.4% hydroelectric and 1.9% by solar (EIA 2017a), a substantial increase by solar generation in a two-year period.

By the same source, the dominant supplier of electricity in the U.S. has been the electric utilities. In fact, the net generation by sector in the year 2015 was 2,331,041 thousand MWh by electric utilities or 57%, 1,599,539 thousand MWh by independent power producers or 39.1%, 13.029 thousand MWh by the commercial, and 143,773 thousand MWh by industrial or 3.5% (EIA 2015: Table 1.1.A). This shows a high concentration in favor of electric utilities, a model that has over the past one hundred years.

As presented in Table 2, the renewable energy industry has enjoyed high growth in the United States, with strong numbers in 2015 of 544,241 Thousand MWh, 45.8% generated by conventional hydroelectric or nearly half of total renewable electricity generation, 35% by wind, 4% by solar photovoltaic and the rest by other sources. U.S. electricity capacities of biomass, geothermal, and hydropower have remained relatively stable from 2000 to 2015.

By the same table, in 2017 the total generated energy by renewable sources was 687,289 MWh, 43.7% generated by conventional hydroelectric, 37% by wind, and 7.2% by solar photovoltaic reaching 49,688MWh from just 16 MWh in 2007.

It’s been an at-times bumpy ride as the industry has faced unfavorable rulings and policies at federal level. The conventional hydroelectric generation has declined to 251,168 Thousand MWh or 7.1 perceptual points from 2005 in favor of wind and solar photovoltaic. In particular, over the end of 2015, the U.S. solar industry has soared to thrilling wins as the Paris agreement, ITC extension, and record installations, reaching 26,473 Thousand MWh generated in 2015 from 551 Thousand MWh in 2005.

Currently, many of these policies discussed in this section enjoy quite a lot of public support, but their future is highly uncertain, plus the absence of a national carbon price policy. To ensure that energy policy challenges facing the country were addressed in a consistent manner it should be a clear connection at the federal policy level between environmental, energy and security policies, and tighter co-ordination among Congress, the Administration, and state governments, as well as between executive and legislative branches of the federal government.

Table 2
U.S. Net Generation from Renewable Sources as a percentage of each year: Total (All Sectors, Thousand MWh)

Period	Wind	Solar Photovoltaic	Solar Thermal	Wood and Wood-Derived Fuels	Waste	Geothermal	Conventional Hydroelectric	Total Renewable Generation
2007	9.8%	0.0%	0.2%	11.1%	4.7%	4.1%	70.2%	352,747
2008	14.5%	0.0%	0.2%	9.8%	4.7%	3.9%	66.9%	380,932
2009	17.7%	0.0%	0.2%	8.6%	4.4%	3.6%	65.5%	417,724
2010	22.1%	0.1%	0.2%	8.7%	4.4%	3.6%	60.9%	427,376
2011	23.4%	0.2%	0.2%	7.3%	3.7%	3.0%	62.2%	513,336
2012	28.5%	0.7%	0.2%	7.6%	4.0%	3.1%	55.9%	494,573
2013	32.1%	1.6%	0.2%	7.7%	4.0%	3.0%	51.4%	522,073
2014	33.7%	2.8%	0.5%	7.9%	4.0%	2.9%	48.2%	538,579
2015	35.0%	4.0%	0.6%	7.7%	4.0%	2.9%	45.8%	544,241
2016	37.2%	5.4%	0.6%	6.7%	3.6%	2.6%	43.9%	609,445
2017	37.0%	7.2%	0.5%	6.3%	3.0%	2.3%	43.7%	687,289

Source: *Own Elaboration from official data from EIA (200; 2008; 2009; 2010; 2011; 2012; 2013; 2014; 2015; 2016b, 2017a)*

All these regulatory policies do not address the lack of a comprehensive policy for photovoltaic deployment. In fact, in the lack of clear national policy mechanism to make sure the country reaches renewable energy, the United States has set a goal to double renewable energy production (DSIRE 2016) from wind, geothermal and solar sources compared to 2012, to 20% by 2020.

2.2. States pioneer in photovoltaic promotion

With exception of the solar energy in satellite systems, solar energy has played a minor role in the U.S. since the advent of industrialization until the early 1980s. In 1982, the state of California had the first photovoltaic 1 MW capacity system in Hesperia, developed by ARCO. The U.S. Department of Energy, working with an industry consortium, begins operating Solar One, a 10 Megawatt central-receiver demonstration project the same year. The project showed the viability of concentrating solar power technology.

ARCO Solar installed a 6-megawatt photovoltaic substation in central California in 1983. The 120 acres facility supplied the Pacific Gas & Electric Company's utility grid with sufficient energy to power up to 2,500 homes. ARCO Solar had several product developments as the of released the world's first commercial thin-film power module called G-400, made of amorphous silicon (SolarWorld 2016). In 1983 also, Solar Design Associates completed a stand-alone, 4-kilowatt powered home in the Hudson River Valley, in NY (SSD 2016), the first of several projects that have been implemented by this company worldwide.

The Sacramento Municipal Utility District in California, commissions its first 1-megawatt photovoltaic electricity generating facility in 1984 (GSC 2016), which later was expanded to two megawatts.

Since September 1982, the Florida Solar Energy Center (FSEC) was operating the Southeast Regional Experiment Station (SRES) for the Department of Energy (DOE). In 1987 the SERES began evaluating amorphous silicon (a-Si) thin-film PV modules for application in utility-interactive systems in a 15 kWp a-Si (SRES 1994: 1-3) utility interactive system in Orlando, Florida, which provided the basis on which the FSEC achieved national recognition. This was the first and clear example of Florida State aligned with solar PV development in the U.S.

As another contribution of the State of Florida to the development of solar photovoltaic, the University of South Florida hits for the first time the 15.9% efficiency with cadmium telluride thin-film in 1992 (SUNELEC 2016), the solar makeup First Solar uses today around 22% efficient,

In 1993, Pacific Gas & Electric completed the installation of the first grid-supported photovoltaic system in Kerman, California. The 500-kilowatt system was the first "distributed power" effort (PVUSA 1992), allowing for greater system reliability and peak-shaving capability. The PVUSA Project Team was in charge of site development, infrastructure, grid interconnection, and the SCADA system.

In 1999, the National Renewable Energy Laboratory achieves a new efficiency record for thin-film photovoltaic solar cells with 18.8 percent efficiency for the prototype solar cell (SUNELEC 2016). In the same year, the construction of the 4

Times Square was completed, which incorporated building-integrated photovoltaic panels on the 37th through 43rd floors that produce a portion of the buildings power. A year later, the largest residential installation in the US to be registered with the Department of Energy in Colorado, it was a 12 kW solar electrical system for a 6,000-square feet family home.

Subsequent renewable energy projects had been implemented, especially for solar energy generation since the early 2000. NASA begins installing 32,800 solar panels on what will be the largest solar power array deployed in space at the International Space Station. A year later, the solar-powered aircraft—Helios sets a new world record for non-rocket-powered aircraft: at 96,863 feet, close to 30 kilometers high (NASA 2016b), with more than 62 thousand lithium battery solar cells.

The Nellis Solar Power Plant was the first military solar PV system, a 13.2 MW PPA installed in 2007 (SunPower 2016), which was added 15 MW in 2016 by SunPower Corp.

As noted in last pages, a combination of private sector ingenuity, investment and government policy certainty have driven significant technology improvements, and new implementations of solar photovoltaic systems over the past several years, reaching 7.2% of the total 687,289 Thousand MWh (EIA 2017a) generated in the U.S.

2.2.1. State regulatory review

There are several regional, state and local policies and initiatives that complement the federal efforts, but in many cases are not integrated. As renewable technology costs continue to fall, especially for solar PV, and conventional fuel prices continue to rise or are static (IRENA 2016: 12-15; MIT 2015: 79), these policies are being adapted to these new power economic sectors.

The State Public Utility Commissions (PUCs) have power over planning, rates, and terms of service, with processes that vary by state. PUCs have regulated investor-owned utility (IOUs) that generate, transmit, and distribute electricity (SCEP 2010: 1-2). However, since mid-1990s, thirteen states and the District of Columbia deregulated their electricity markets, also referred to as retail choice, which means that electricity generation may be owned and operated by independent power producers, and allowing companies and consumers to choose their electricity supplier. State air agencies and other environmental regulators have also authority over the electric power sector, because of its substantial environmental impacts.

Some state policies provide complementary cost recovery and performance incentives for energy efficiency, installation and promotion, as well as address potential financial disincentives for utilities because their capital-intensive equipment investments. PUCs have the task to align the utility financial interest with state and customer interest in affordable, reliable electricity service that minimizes environmental impacts (DSIRE 2016) and at the same time incentivize private and corporate investments in the sector.

In order to provide affordable and reliable clean electricity several states are adopting new or modifying existing renewable energy to enable larger investment in energy efficiency. DSIRE (2016) and Department of Energy (DOE 2017a) databases have a complete list of renewable policies and interconnection standards, to support investment by families and businesses in energy efficiency, distributed renewable energy, and at the same time aligning resource planning and encouraging utilities to incorporate these resource options into their infrastructure investment and operational decisions. By the same source, States are also providing policy direction to ensure that new electric grid investments are made and deployed in a manner that maximizes energy efficiency and renewable energy.

Since 1992, federal support of renewable generation has mainly compromise tax credits that provide per kW subsidies of generation or fractional subsidies of capital cost. Tax credits usually require renewable generation developers (DSIRE 2016, DOE 2017a) to partner with large tax-paying financial institutions who are disposed to serve as ‘‘tax equity’’ providers. This raises costs significantly because developers scarcely have enough taxable revenue to make use of tax credits.

According to the Database of State Incentives for Renewables & Efficiency (DSIRE 2016), at end of June 2016, all U.S. states had policies to promote the generation of electricity from renewable energy (defined here as excluding hydroelectric facilities). It is covered in this analysis the Feed-In Tariff (FIT) – financial incentive -, and three major “regulatory policies”: Renewable Portfolio Standard (RPS), Net Metering and Interconnection. These last regulatory policies govern the investment in renewable energy at the state level and also outline the terms for utility investment in renewable and solar and utility processes related to solar installation.

Only six U.S. states (California, Hawaii, Indiana, Michigan, Vermont and Washington) had passed price-based **Feed-In Tariff** (FIT) policies that generally require that electricity generated from renewable energy be purchased at a fixed premium price (DSIRE 2016, DOE 2017a). FIT’s were first implemented in the U.S. in 1978.

Unfortunately, the U.S. is lagging significantly behind other nations in the implementation of FIT’s. Despite the overwhelming evidence to the success of FIT policies, as mentioned before in Europe, very few feed-in tariffs have been implemented in the United States. FIT policies can help utilities meet their RPS target, if designed with features such as capacity caps, incentives that decline with installed capacity levels, or incentives that are linked to market conditions. FIT programs are price-based policies.

Globally, the FIT approach is more popular than the RPS approach (MIT Sloan 2012: 1-2, 9-12). Nevertheless, based on the lack of interest adopting regulation, U.S. states have mainly chosen RPS over FIT to subsidize renewable electricity generation. “It is possible that states had bad memories of their experience under the Public Utilities Regulatory Policies Act (PURPA) of 1978, which required them to purchase renewable generation at utilities’ “avoided cost,” thereby establishing a FIT-like regime. Or they may have been reluctant to attempt to set wholesale rates for renewable power, given the jurisdiction of the Federal Energy Regulatory Commission (FERC) over wholesale power rates” (MIT Sloan 2012: 11). By the same source, this may be also because goals are generally more attractive than price.

As presented in Table 3 and according to National Conference of State Legislature (NCSL 2016), twenty-nine states and Washington, D.C. have passed **Renewable Portfolio Standard** (RPS) programs, which apply to 55% of total U.S. retail electricity sales, to help achieve renewable energy generation, and it is considered a national standard. Along with electric utility restructuring, the first RPS programs in the US were approved in 1983, as the second wave of RPS programs began in 1999 until 2016 as presented in Fig. 2.4. Roughly half of all RPS states have raised their overall RPS targets or carve-outs since initial RPS adoption. Five states reached the terminal year of their RPS in 2015: Michigan, Montana, New York, Texas and Wisconsin, and Maine in 2017.

Eight states have set renewable energy goals. Iowa was the first state to establish an RPS and Hawaii has the most aggressive RPS requirement. Iowa and Texas require explicit amounts of renewable energy capacity rather than percentages and Kansas requires a percentage of peak demand. Michigan requires a mix of amounts and a percentage of peak demand.

These RPS programs require a minimum fraction of electricity demand be met by renewable energy and the entity that sell or produce have to obtain renewable energy credits (DSIRE, 2016), in proportion to their output, equal to at least a minimum fraction of their retail sales. These requirements can apply only to investor-owned utilities IOU[4,] but many states also include municipalities and electric cooperatives (Munis and Co-ops), though their requirements are equivalent or lower. Renewable energy generators could receive payment for the environmental attributes of their electricity by selling RECs[5] to any party that valued those attributes, even if that party did not have a contract to purchase the actual electricity.

(4) An investor-owned utility or IOU is defined as a business organization, providing a product or service regarded as a utility, and controlled as private enterprise rather than a function of government or a utility cooperative. Its focused is to optimize return on investment for shareholders

(5) Renewable energy credit (REC) is a tradable instrument that represent the elements of 1 Megawatt-hour of renewable energy generation on the electricity grid produced from renewable energy projects and are sold separate from commodity electricity

No two of these state RPS programs are identical, and the differences among programs are often substantial. Some RPS programs are clearly aimed at creating jobs installing and maintaining solar cells rather than manufacturing them, and at promoting in-state economic activity, giving credit only for renewable generation that serves in-state customers. According to Lawrence Berkeley National Laboratory (LBNL 2014: 12), 57% (57 GW) of all non-hydro renewable capacity additions from 2000–2015 are under-contract or owned by entities with RPS obligations and entered operation after RPS enactment, statistic that would be imperfect, because some of those renewable energy projects may have been developed even without RPS in place.

By the number of state regulations U.S. have overwhelmingly chosen RPS over FIT to subsidize renewable electricity generation (MIT Sloan 2012: 9-11).

Net Metering (NM) and Interconnection rules for Distributed Generation (DG[6]) systems still remain critical facilitators in supporting the continued growth of renewable energy, by leveling the playing field for clean DG relative to traditional central power generation. These are policies used by states to accelerate the development of clean energy supply.

DG system requirements for grid connections are important because they involve electrical system safety and reliability. State interconnections typically address larger DG projects connecting to the distribution grid, while the Federal Energy Regulatory Commission (FERC) has jurisdiction over project interconnection at the transmission level.

As presented in Table 4, as of July 2016, forty-four states, and Washington DC have approved net metering, with different terminology and approaches to policies with respect to capacity limits, eligible technology, net metering credit retention and renewable energy credit ownership. The basic principle behind net metering is that the amount of electricity produced by the DG system is measured against the amount of electricity used by the customer.

Net metering policies help states in meeting their renewable energy requirements or targets, and it has been critical to solar energy's rapid expansion (NCSL 2016) in the United States. To encourage DG, many states have adopted simplified processes under net metering rules.

(6) Distributed generation (DG) or distributed energy is referred to the use of small-scale power generation technologies located close to the load being served. These power generation includes: reciprocating engines, micro turbines, combustion turbines, small steam turbines, fuel cells, photovoltaic, and wind turbines

Table 3
States with Mandatory and Voluntary Renewable Portfolio Standards

State	Title	Established	Requirement
Arizona	Renewable Energy Standard	2006	15% by 2025
California	Renewables Portfolio Standard	2002	33% by 2020
			40% by 2024
			45% by 2027
			50% by 2030
Colorado	Renewable Energy Standard	2004	30% by 2020 (IOUs)
			10% or 20% for municipalities and electric cooperatives, depending on size
Connecticut	Renewables Portfolio Standard	1998	27% by 2020
Delaware	Renewables Energy Portfolio Standard	2005	25% by 2025-2026
Hawaii	Renewable Portfolio Standard	2001	30% by 2020
			40% by 2030
			70% by 2040
			100% by 2045
Illinois	Renewable Portfolio Standard	2001 (voluntary target);	25% by 2025-2026
		2007 (standard)	
Maine	Renewables Portfolio Standard	1999	40% by 2017
Maryland	Renewable Energy Portfolio Standard	2004	20% by 2022
Massachusetts	Renewable Portfolio Standard	1997	Class I: 15% by 2020 and an additional 1% each year after
			Class II: 5.5% by 2015

Michigan	Renewable Energy Standard	2008	10% by 2015
			DTE Electric: 600 MW by 2015
			Consumers Energy: 500 MW by 2015
Minnesota	Renewables Energy Standard	2007	26.5% by 2025 (IOUs)
			25% by 2025 (other utilities)
Missouri	Renewable Electricity Standard	2007	15% by 2021 (IOUs)
Montana	Renewable Resource Standard	2005	15% by 2015
Nevada	Energy Portfolio Standard	1997	25% by 2025
New Hampshire	Electric Renewable Portfolio Standard	2007	24.8% by 2025
New Jersey	Renewables Portfolio Standard	1999	24.5% by 2020
New Mexico	Renewables Portfolio Standard	2002	20% by 2020 (IOUs)
			10% by 2020 (co-ops)
New York	Renewable Portfolio Standard;	2004	29% by 2015;
	Reforming the Energy Vision (REV)		50% by 2030 (REV- *currently in process*)
North Carolina	Renewable Energy and Energy Efficiency Portfolio Standard	2007	12.5% by 2021 (IOUs)
			10% by 2018 (munis. and coops)
Ohio	Alternative Energy Resource Standard	2008	25% by 2026
Oregon	Renewable Portfolio Standard	2007	25% by 2025 (utilities with 3% or more of the state's load)
			10% by 2025 (utilities with 1.5% - 3% of the state's load)
			5% by 2025 (utilities with less than 1.5% of the state's load)
Pennsylvania	Alternative Energy Portfolio Standard	2004	18% by 2020-2021
Rhode Island	Renewable Energy Standard	2004	14.5% by 2019
South Carolina	Renewables Portfolio Standard	2014	2% by 2021

Texas	Renewable Generation Requirement	1999	5,880 MW by 2015
			10,000 MW by 2025 (goal; achieved)
Vermont	Renewable Energy Standard	2005 (voluntary target); 2015 (standard)	55% by 2017
			75% by 2032
Washington	Renewable Energy Standard	2006	9% by 2016
			15% by 2020
Wisconsin	Renewable Portfolio Standard	1998	10% by 2015
Washington, D.C.	Renewable Portfolio Standard	2005	20% by 2020
Voluntary Renewable Portfolio Standard			
Iowa	Alternative Energy Law	1983	105 MW of generating capacity for IOUs
Indiana	Clean Energy Portfolio Goal	2011	10% by 2025
Kansas	Renewable Energy Goal	2009 (standard); 2015 (goal)	15% by 2015-2019
			20% by 2020
North Dakota	Renewable and Recycled Energy Objective	2007	10% by 2015
Oklahoma	Renewable Energy Goal	2010	15% by 2015
South Dakota	Renewable, Recycled and Conserved Energy Objective	2008	10% by 2015
Utah	Renewables Portfolio Goal	2008	20% by 2025
Virginia	Voluntary Renewable Energy Portfolio Goal	2007	12% by 2022 (IOUs)
			15% by 2025 (IOUs)

Source: Own Elaboration from official data from NCSL (2016)

Year	ENACTED	MAJOR REVISIONS
1983	IA	
1991		IA
1994	MN	
1996	AZ	
1997	MA, ME, NV	
1998	CT, PA, WI	
1999	NJ, TX	MN, WI
2000	NM	AZ
2001		MN, NV
2002	CA	NM
2003		CT, MN, NV
2004	CO, HI, MD, NY, RJ	NJ, NM, PA
2005	DC, DE, MT	CT, CO, NV, TX
2006	WA	AZ, CA, CT, HI, NJ, WI
2007	IL, NH, NC, OR	CA, CO, CT, DE, MD, ME, MN, NJ, NM, PA, TX
2008	MI, MO, OH	DC, DE, HI, MA, MD, NJ
2009	KS	NI, IL, ME, MN, NV, OR, TI
2010		CO, DE, IL, MA, MD, NJ, NY
2011		CA, CT, DC, DE, IL, MA, MD, NC, WI
2012		MA, MD, NJ, NH, NM, NY, OH
2013		CO, CT, MD, MN, MT, NM, NV
2014		IL, MA, OH, OR, WI
2015	VT	CA, CT, HI, KS, VT
2016		OR

Current as March 2016

Fig. 2.4. RPS Policies by state, enacted and major revisions for period 1983 to 2016. *Source*: Own Elaboration from official data from LBNL, 2014 (Lawrence Berkeley National Laboratory

Currently, most states find that smaller DG systems are more likely to produce power primarily for their own use; exports to the grid tend to be incidental. The payment received for surplus power generated by the DG can be a critical component of project economics. The price at which the utility is willing to purchase this power can vary widely and is also affected by federal and state requirements. Additionally, under pressure from electric utilities, some state public utility commissions, or PUCs, have started to reassess how to set electricity rates (NCSL 2016) in order to ensure utilities can cover costs and realize a reasonable return on their investments.

Technology is creating a bidirectional networked grid and several state regulatory commissions now recognize that the Net Energy Metering (NEM) cost shift is sizeable and that all customers who use the grid, including NEM customers, need to pay for the cost of the grid. By DSIRE (2016) and DOE (2017a), during Q2 2016, thirty-six utilities in 24 states considered or enacted changes to net energy metering policies to compensate rooftop solar customers for excess generation sent to the grid. At the end of 2016, nearly every single U.S. state took some type of policy action related to Distributed Solar or DG.

The line historically drawn by the utility meter is blurring. States have become gradually aware that clear interconnection standards are a critical component of the development of in-state renewable energy markets. By DSIRE (2016), forty-five states (plus Washington D.C.) have approved standard interconnection requirements for distributed generators (Table 4). In some cases, net metering provisions can be considered a subgroup of interconnection standards for small-scale projects.

Some states have adopted standards that apply to all types of customer systems, and regardless of whether or not the system is net-metered. Other states have adopted interconnection standards that apply only to smaller systems that are net-metered. Most states with comprehensive standards have established multiple levels of review based on system capacity, complexity and level of certification. Net metering is recognized as a significant issue for the long-term financial viability of electric utilities, which is under pressure in several states.

An opportunity for new policies is in the transmission and distribution system, which losses increase as the distance between generation and customer load increases. When renewable energy is located in the distribution system close to customers, it can reduce losses by improving voltage and reactive power management. This also includes energy storage to support renewable energy integration. Increasing customer Interest in and adoption of solar, energy storage and distributed generation DG are causing a rising number of utilities to rethink their approach about the integration of DG into their business models.

Table 4
States with Interconnection standard, Net Metering and Fed In Tariff

State	Maximum System Size for a State Interconnection Standard	Net Metering System Size Limit (kW)	Fed-In Tariff
Alabama		25 (**)	
Arizona		125% of demand	
Arkansas		25/300	
California	None	1000	30 kW - 3 MW DC; $0.17/kWh, max $0.3825/kWh
Colorado	10 MW	120% of demand (co-ops and munis: 10/25)	
Connecticut	20 MW	2000/3000	
Delaware		25/100/2000 co-ops and munis: 25/100/500)	
Florida	2MW (*)	2000 (**)	
Georgia		10/100	
Hawaii	None	100	Systems up to 5 MW; rates vary by system size and technology
Idaho	10 MW	500 (**)	
Illinois	None	40 (**)	
Indiana	None	1000 (**)	3 kW- 1 MW; Solar 5 kW - 10 kW: $0.17 - $0.1564/kWh, Solar 10 - 200 kW: $0.15/kWh - $0.138/kWh
Kansas		15/100/150	
Kentucky	30 KW (*)	30 (**)	
Louisiana		25/300	

Maine	None	660 (co-ops and munis: 100)	
Maryland	10 MW	2000	
Massachusetts	None	60/1000/2000/10000(**)	
Michigan	None	150 (**)	Residential: 275 kW/monthly, Developer: 75 kW/Semi-annually, Non-Residential: 750/kW/Bi-monthly; Residential: $0.240/kWh Non-Residential: $0.199/kWh
Minnesota	10 MW	40	
Missouri		100	
Montana		50 (**)	
Nebraska		25	
Nevada	20 MW	1000 (**)	
New Hampshire	1 MW (*)	1000	
New Jersey	None	None (**)	
New Mexico	80 MW	80000 (**)	
New York	2 MW	10/25/500/1000/2000	
North Carolina	None	1000 (**)	
North Dakota		100 (**)	
Ohio	20 MW	None (**)	
Oklahoma		100 (**)	
Oregon	10 MW	25/2000 (**)	
Pennsylvania	5 MW (*)	50/3000/5000 (**)	
Rhode Island	None	5000 (**)	
South Carolina		20/1000 (**)	
South Dakota	10 MW		
Texas	10 MW		
Utah	20 MW	25/2000 (**)	

Vermont	None	20/250/2250	Maximum capacity is 2.2 MW; Solar: $0.13/kWh
Virginia	20 MW	20/500 (**)	
Washington	20 MW	100	Community solar projects: up to 75 kW; $0.12/kWh - $1.08/kWh; max $5,000/year
West Virginia	2 MW	25/50/500/2000	
Wisconsin	15 MW	20 (**)	
Wyoming		25 (**)	

Source: Own Elaboration from official data from DSIRE, 2016 (Database of State Incentives for Renewables & Efficiency)

The Energy Policy Act of 2005 created a 30 percent ITC for residential and commercial solar energy systems, which was later extended and passed by the Congress creating the Treasury Grant Program in 2009, and by 2015 the Omnibus Appropriations Act comprised a multi-year extension of the residential and commercial ITC for projects completed by the end of 2023. The ITC is one of the most important federal policy instruments to back the deployment of solar energy in the United States, providing favorable market conditions for companies to develop long-term investments that generate competition and technological innovation, which result in lowers costs for consumers.

Limited budgets and incomplete information about the effectiveness of the various policy options in their specific situation and in creating and executing policies that supports market development goals are few of the challenges that policymakers face constantly.

2.2.2. Renewable energy by state, analysis

By data published by EIA for the period ending 2017, reveals an incredible gap between Texas, California and the rest of states (EIA 2017a) in the generation of energy from renewable sources. A relevant snapshot of how states in the US make renewable power, from industrial-scale generation to rooftop solar panels, excluding hydroelectric.

By data from EIA, presented in Fig. 2.5, between 2005-2017, the states of California, Texas, Iowa, Oklahoma, Minnesota, Illinois, Kansas, Washington, Oregon and Colorado have led the renewable net generation from renewable sources market (excluding hydroelectric), a combined 62% share of 2015 net generation, and 65% share in 2017. The listed states have Renewable Energy Standards with exception of Iowa and Oklahoma that have Voluntary Renewable Portfolio Standards. As presented in the same figure, in the same period, California and Texas are the states with the highest net generation for last 12 consecutive years, reaching together a combined 93,657 Thousand MWh in 2015, and 135,365 Thousand MWh in 2017, from 22,102 Thousand MWh in 2005, or over six times.

California and Texas are leading the nation’s rollout of solar and wind power. Florida generated 4,992 Thousand MWh from renewable energy sources (excluding hydroelectric) in 2015, a 1.6% decrease versus 2014. In addition, Florida generated 5,811 Thousand MWh from renewable energy sources (excluding hydroelectric) in 2017 almost flat generation for last 13 years (EIA 2017a) with exception of 2014 with 5,073 Thousand Megawatt hours. In 2005 the Florida’s net generation from renewable energy sources (excluding hydroelectric) was 4,292 Thousand MWh, which was higher than the energy generated from renewables from Texas and lower than California.

About 9.6% of total U.S. electricity supplied in 2017 was generated from non-hydro renewable energy sources such as wind, solar, biomass, and geothermal, up from 7.3% in 2015, and 6.8% in 2014, which is an interesting trend that shows an increase in the generation of renewables sources. By same source (EIA 2016b, 1.1.A), data presented in Table 5, the 2015 total energy generation from renewable energy sources (excluding hydroelectric) in the US was 4,087,381 Thousand Megawatt hours led by Texas, Florida, Pennsylvania, California, Illinois, Alabama, New York and Carolina, which represent 42% of that generation in that year.

The total Net Generation from Renewable Sources Excluding Hydroelectric in 2015 was 298,358 Thousand Megawatt hours, a 7% increase over 2014, the lowest increase since 2009. In general terms the yearly rate rise has been double digit with a 23% between 2007 and 2008. Texas is the biggest state in energy size with 450,604 Thousand Megawatt hours followed by California with 237,338 Thousand Megawatt hours.

By the other hand, Texas, California, Iowa, and Oklahoma generated around 42% of total renewable energy excluding hydroelectric (298,358 Thousand Megawatt hours or 7.3% of total 2015 generation). Texas is the biggest state in renewable energy size with 47,159 Thousand Megawatt hours or 10% of total energy generated in the state in 2015. California generated 46,498 Thousand Megawatt hours from renewable sources excluding hydroelectric in 2015, or 23% of total energy generated in the state.

By taking the share of generated energy from renewables excluding hydro by state, Vermont led all states by generating 40% of its electricity from non-hydro renewables as presented in Table 5. Maine (37%), Iowa (32%), South Dakota (25%), Kansas (24%), California (23%), Idaho (21%) and Minnesota (20%) are the states generating its electricity from renewables excluding hydro. Florida has only the 2% of total 237,338 Thousand Megawatt hours, of generated energy from renewables excluding hydro.

In much of the country, state policy is as important as federal in advancing clean energy and the underlying infrastructure (BCSE 2016) necessary to support it. As an attempt to understand the major factors that affect the effectiveness of energy policy, Table 4 also presents the number of type of incentives and regulations of renewable energy policies that have been adopted in different states. The data was collected from the Database of State Incentives for Renewables and Efficiency (DSIRE 2016) website and integrated the following type of incentives and regulations:

- State Incentives: Bond Program, Corporate Tax Credit, Corporate Tax Deduction and Exemption, Feed-in Tariff, Grant Program, Green Building Incentive, Industry Recruitment/Support, Leasing Program, Loan Program, PACE Financing, Performance-Based Incentive, Personal Tax Credit and Deduction, Property Tax Incentive, Rebate Program, Sales Tax Incentive, Solar Renewable Energy Credit Program, Utility Rate Discount

- State Regulations: Building Energy Code, Energy Standards for Public Buildings, Generation Disclosure, Green Power Purchasing, Interconnection, Net Metering, Public Benefits Fund, Renewables

- Portfolio Standard, Solar/Wind Access Policy, Solar/Wind Contractor Licensing, and Solar/Wind Contractor Licensing

Person’s correlation method was applied to the contribution of renewable energy to the total energy by estate in 2015, as presented in Table 5, with the number of incentives and policies related to renewable energy by state. The result (-0.2146) indicates that state incentive policies for renewable energy do not correlate to the contribution of renewable energy to total energy.

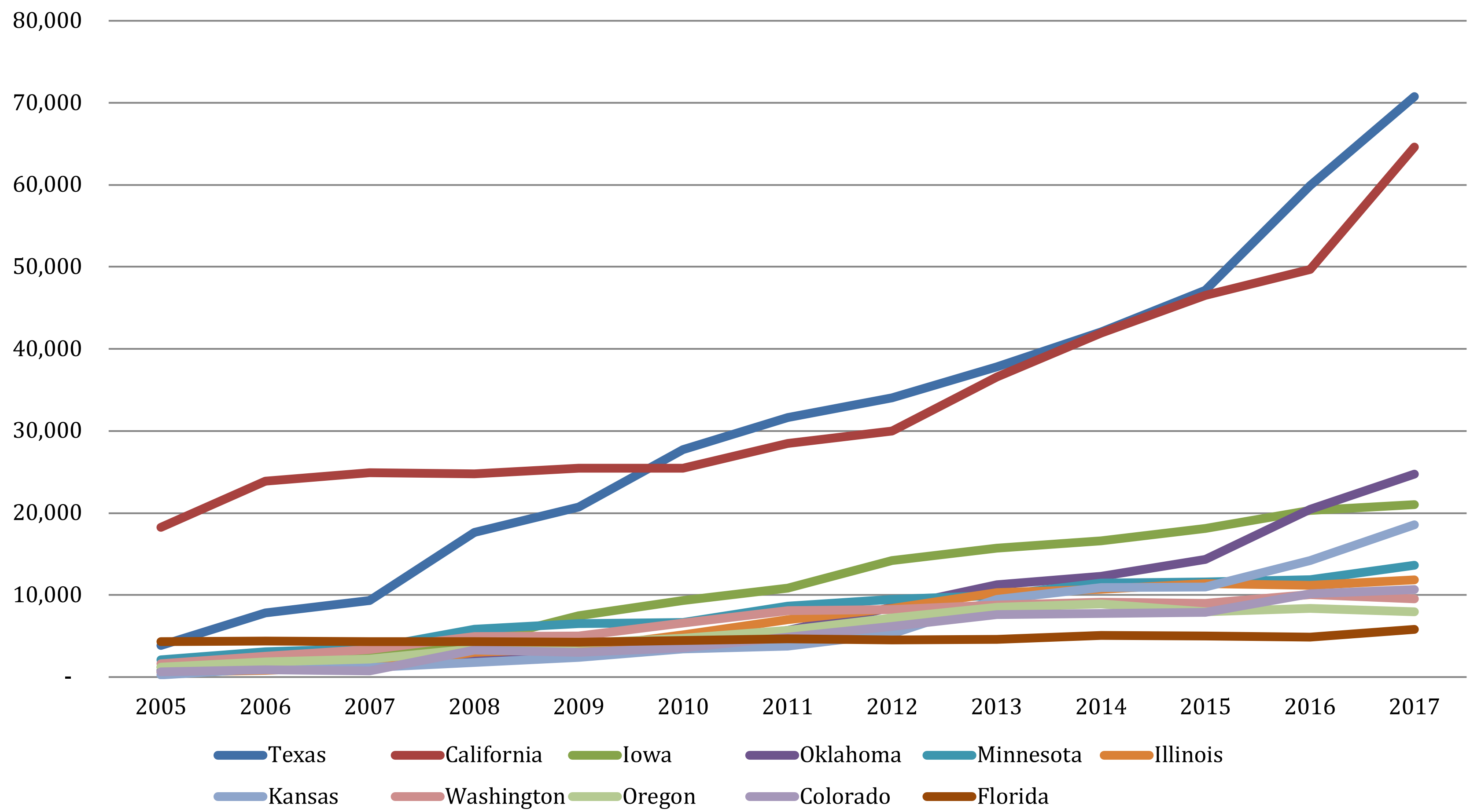

Fig. 2.5. Top Ten States plus Florida Net Renewable Generation, excluding Hydroelectric at Utility Scale Facility, 2005-2017 (Thousand MWh). *Source*: *Own Elaboration from official data from EIA (2006; 2007; 2008; 2009; 2010; 2011; 2012; 2013; 2014; 2015, 2016b, 2017a)*

Table 5
Correlation of Share Net Generation from Renewables excluding Hydroelectric vs. Incentives and Regulations

State	(Thousand MWh) Net Generation - Renewable Sources Excluding Hydroelectric 2015	Net Generation 2015	Share Net Generation - Renewable Sources Excluding Hydroelectric	Types of State Incentives	Types of States Regulations
Alabama	3,329	152,967	2%	4	2
Alaska	217	6,073	4%	5	4
Arizona	4,199	113,351	4%	3	9
Arkansas	1,496	55,682	3%	6	4
California	46,498	197,994	23%	10	10
Colorado	7,862	52,515	15%	7	10
Connecticut	829	37,649	2%	9	9
Delaware	144	7,729	2%	3	9
Florida	4,992	237,338	2%	10	9
Georgia	4,525	128,259	4%	6	5
Hawaii	1,248	9,930	13%	8	8
Idaho	3,152	15,170	21%	5	3
Illinois	11,359	194,103	6%	8	10
Indiana	5,131	103,840	5%	8	6
Iowa	18,139	57,172	32%	7	8
Kansas	10,997	45,781	24%	1	7
Kentucky	438	83,232	1%	8	4
Louisiana	2,729	107,643	3%	7	6
Maine	4,444	12,157	37%	2	9
Maryland	1,116	36,390	3%	9	9
Massachusetts	2,120	32,291	7%	11	10
Michigan	7,330	114,160	6%	7	8
Minnesota	11,600	57,499	20%	7	8
Mississippi	1,472	64,813	2%	4	4
Missouri	1,158	83,610	1%	4	6
Montana	1,975	29,546	7%	7	6
Nebraska	3,222	39,291	8%	7	4
Nevada	5,429	38,840	14%	6	9
New Hampshire	2,065	20,162	10%	4	9

New Jersey	1,827	75,193	2%	8	9
New Mexico	2,740	32,858	8%	9	7
New York	6,541	139,731	5%	11	9
North Carolina	4,239	128,944	3%	9	7
North Dakota	6,538	36,918	18%	4	4
Ohio	2,097	122,125	2%	7	9
Oklahoma	14,341	76,063	19%	5	7
Oregon	7,971	58,857	14%	9	11
Pennsylvania	5,951	215,871	3%	7	9
Rhode Island	240	7,001	3%	8	10
South Carolina	2,235	96,548	2%	8	6
South Dakota	2,481	9,734	25%	4	6
Tennessee	1,201	75,417	2%	8	3
Texas	47,159	450,604	10%	6	10
Utah	1,225	42,044	3%	7	7
Vermont	842	2,091	40%	8	7
Virginia	4,076	84,351	5%	11	8
Washington	8,981	109,933	8%	8	9
West Virginia	1,381	72,229	2%	3	5
Wisconsin	3,314	66,679	5%	7	9
Wyoming	3,768	48,932	8%	4	4
U.S. Total	298,358	4,087,381	7%	334	361
		Correlation with Share Net Generation		**-0.2146**	**0.1244**

Source: Own Elaboration from official data from (EIA 2016b: 1.17.B) and DSIRE 2016 (Database of State Incentives for Renewables & Efficiency)

In the case of state regulation policies, the correlation coefficient is positive (+0.1244), which means that the number of mandatory policies is correlated to the proportion of renewable energy used over the total amount of energy consumed by the state. This can be interpreted as that the greater the type of mandatory policies, the greater the proportion of renewable energy that will likely be generated in the state.

In others words, incentive policies seem to be less effective than regulatory policies. The compulsory regulation policies force industries and users to comply and are usually enforced. Incentive policies are voluntary.

2.2.3. Top solar energy states

Solar PV is by far the most important solar technology for distributed generation, as defined before in this chapter, that uses solar cells assembled into solar to convert sunlight into electricity.

Solar energy has benefited significantly from state programs and policies. Nevertheless, not all states with active solar markets have the same bundle of policies and programs. Policies driving adoption of solar PV in the U.S. include net metering (BI 2016), renewable portfolio standards with distributed generation requirements, authorization to allow third-party ownership models (DSIRE 2016), and incentives. Regulators are also urging utilities to explore advanced technologies and new business models some of them oriented to own or operate distributed generation assets. The growth in the U.S. PV market has been aided by a variety of policy interventions as policies and subsidies and by falling prices of modules (MIT 2016: 79) and other specialty hardware.

By the MIT Energy Initiatives because an increased competition among suppliers especially from China, innovative financing options, combination of improvements in technology and manufacturing processes, and a decline in the cost of the PV system, are contributing to a rapid growth in the deployment of PV in the U.S. As presented in Fig. 2.6, in 2008, "the average price for a module stood at around \$4.00 per peak watt (Wp). By the end of the second quarter of 2014, the average price had fallen a remarkable 84% to around \$0.65/Wp" (MIT 2015: 79).

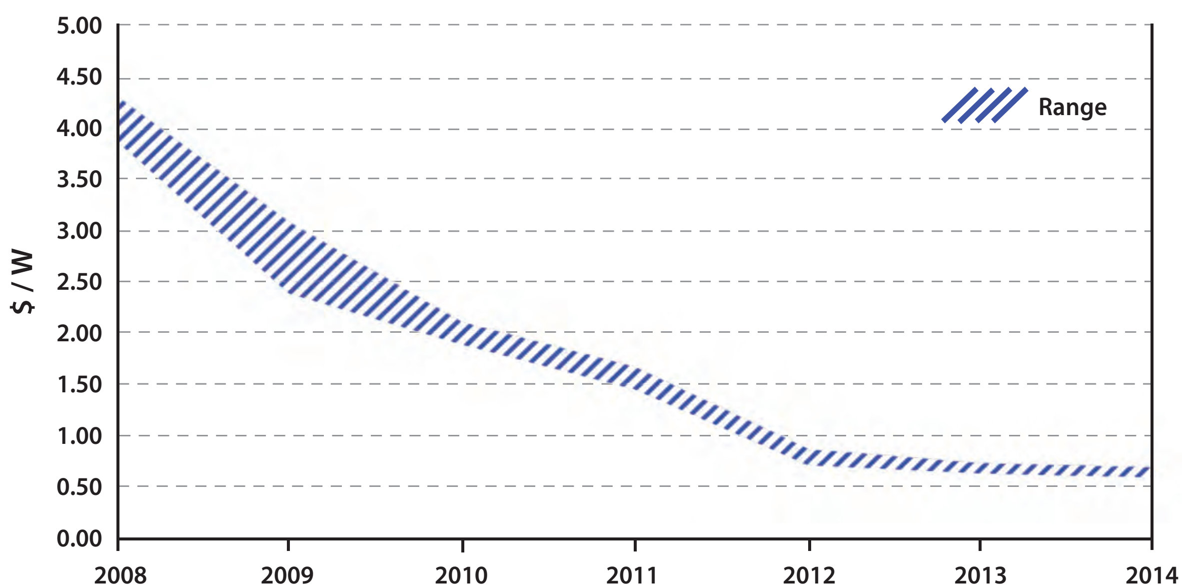

Fig 2.6. Evolution of PV Module Prices in the United States from 2008 to 2014. *Source*: (MIT 2015: 79)

By the same source, the barriers to entry for solar are quickly crumbling, because the low price of new installations. However, nearly 60% of the cost of a residential system is still attributable to non-hardware costs, including on-site labor, engineering, permitting, zoning, hooking a solar system up to the power grid, and other soft costs.

According to SEIA in second quarter of 2016, the average pricing for residential rooftop systems landed at $3.14/W in USA (SEIA 2016a), and utility fixed-tilt in same period saw an average pricing of $1.17/W. At the end of 2016, the Dubai Electricity and Water Authority received bids as low as US$3/kWh for the 800-MW Sheikh Maktoum solar park phase three, marking the lowest cost until 2016 for solar power worldwide. At the end of 2017 the German Federal Network Agency announced that for a 750 KW solar system had received Bids below €0.04/kWh (PV Magazine 2018) for the first time. Rapid module price declines have drastically lowered systems prices, a trend that is reducing the barriers for implementing solar.

According to Table 6 and Fig 2.7, the U.S. installed 852 megawatts (MW) of photovoltaic (PV) solar systems in 2010, representing 29% growth over 2008. California installed 259 MW followed by New Jersey with 132 MW (SEIA 2010: 5), a 30.4% and 15.5% respectably for each state.

Table 6
Annual Solar PV Installations 2010 – 2016, Top Twelve States (MWdc)

	2010	2011	2012	2013	2014	2015	2016	Accumulative @ 2016
California	259	577	1,046	2,621	3,549	3,268	5,096	17,084
Utah				2	14	231	1,241	1,489
Georgia			11	91	45	248	1,023	1,432
North Carolina	31	55	124	335	397	1,140	1,014	3,016
Nevada	61	44	198	47	339	299	984	2,017
Texas	23	47	51	75	129	213	672	1,215
Arizona	63	273	719	421	247	258	657	2,700
Massachusetts		31	134	240	308	330	406	1,487
New Jersey	132	313	419	236	240	181	353	1,986
New York	23	60	63	72	147	242	320	775
Hawaii		39	92	130	88	98	99	586
New Mexico	43	116	24	45	88	56	45	694
Other states	217	370	491	446	656	696	2,852	6,123
Total	*852*	*1,925*	*3,372*	*4,761*	*6,247*	*7,260*	*14,762*	*40,604*

Source: Own Elaboration from official data from SEIA *(2011; 2012; 2013; 2014; 2015, 2016a)*

By same sources, in 2011 PV installations reached 1,855 MW or 109% versus 2010 driven primarily by the non-residential sector (SEIA 2011: 2); the cumulative PV capacity operating at end of that year was 3,954 MW. California was the primary driver of the growth with 577 MW, New Jersey added 313 MW and Arizona 273 MW, the U.S. PV market remained relatively concentrated in these few key states. As presented in Fig. 2.7, residential installations grew 23% in 2011 over 2010 to reach 344 MW; non-residential installations grew 136% to reach 833 MW, and the utility installations grew 242% in 2011 to reach 748 MW, by far the largest growth of any segment.

Residential solar leases and power purchase agreements (PPAs) continued to increase throughout 2012 according to SEIA (2012: 3), and the annual U.S. PV installations grew 76% in this year to reach 3,372 MW, drove by the utility sector with more than doubling capacity over 2011 to reach 1,808 MW installed. As presented in Table 6, in the same year, California continues dominating the Solar PV market adding 1,046 MW, Arizona came in second adding 719 MW, thanks largely to the completion of a number of utility-scale projects in the state. New Jersey had an impressive 419 MW installed during the year, which would be reduced in following years as the market is overbuilt relative to (RPS) schedule.

Because increases of solar installations and as energy storage become economically an option, the traditional utility business model had been getting called into question (BI 2016) year after year. Net energy metering (NEM) disagreements emerged between utilities and solar promoters across several markets, ranging from California, Colorado and Arizona, to emerging solar states as Utah, Idaho, Louisiana and Georgia.

In an effort to meet RPS obligations and because to utility PV's growing economic competitiveness in the electricity market, the U.S. installed 6,201 MW of solar PV in 2014, up 30% over 2013, according to SEIA (2014: 3). As presented in Fig. 2.7, in 2014 the utility sector installed 3,915 MW, or over 60% of all sectors' total capacity mainly by First Solar's Topaz Solar and Desert Sunlight projects, each 550 MW capacity. "There are just over 14 GWdc of utility-scale solar projects in the U.S. with power-purchase agreements in place and expected completion dates of 2015 or 2016" (SEIA 2014). The residential solar has steadily gained steam as homeowner financing options (leases, loans, and PPAs) become more widely available, system costs continually decline, and market participants innovate, reaching 1,268 MW a 60% increase from 2013. As modules make up a greater portion of utility system price than residential or commercial, changes in the module market disproportionally impact overall utility systems pricing and the total net generation by sector.

By Table 6, in 2014 California installed 57% of total PV capacity reaching 3,549 MW, North Carolina installed 397 MW or 18% from previous year, Nevada grew over 6 times in similar period to install 339 MW, and Massachusetts grew 28% to install 308 MW in 2014. In Southern California around 70 small cities added at least 1 MW of residential solar in 2014, making this state the largest residential market in the U.S. specially because the availability of third-party financing solutions, along with the increasing penetration of PACE and other loan products.

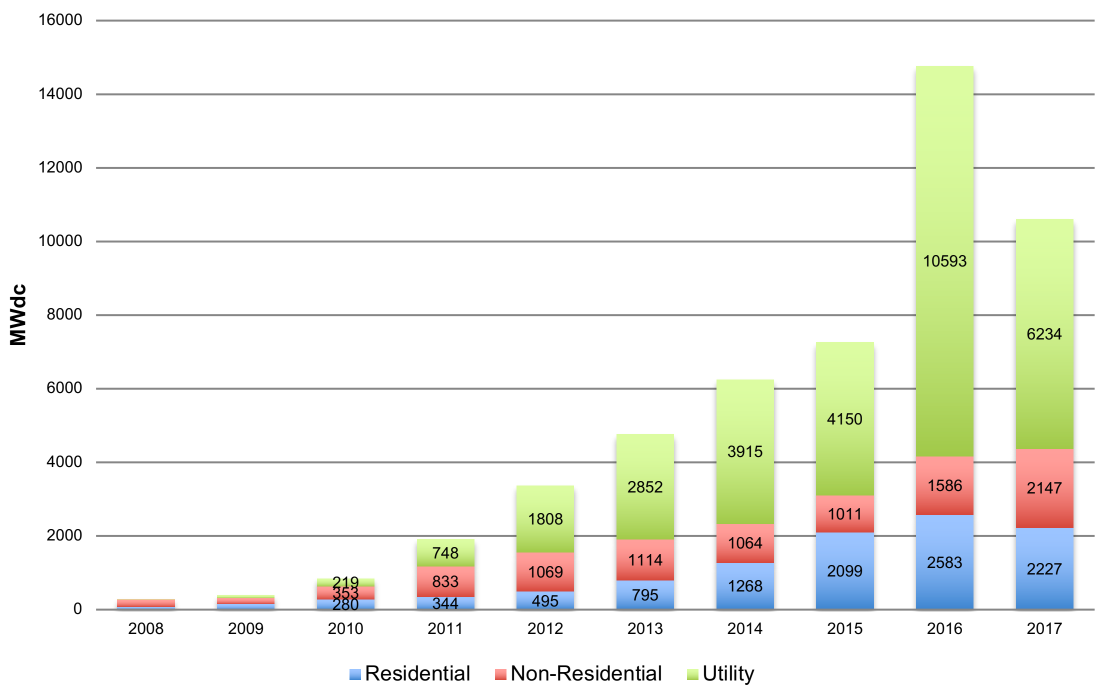

Fig. 2.7. Solar PV Capacity Added per Sector, 2012-2017 by sector. *Source*: Own Elaboration from official data from SEIA *(2011; 2012; 2013; 2014; 2015, 2016a, 2017)*

According to SEIA (2015: 4), solar PV deployments or capacity reached 7,260 MW direct current in 2015, up 16% over 2014 and 24 times the amount installed in 2008. Total operating solar PV capacity reached 25.6 GW by the end of this year in the U.S. By the same source "For the first time ever, solar beat out natural gas capacity additions, with solar supplying 29.4% of all new electric generating capacity brought on-line in the U.S. in 2015" (SEIA 2015: 5). At the state level, 81% of total capacity remained relatively concentrated in California, North Carolina, Nevada, Massachusetts, Arizona, Georgia and New York, as presented in Table 6. California continued leading all states in PV solar capacity installations with 3,266 MW, the leader state since 2008.

The residential PV market experienced an interesting annual growth rate in 2015, reaching 2,099 MW and marking the third consecutive year of greater than 50% annual growth, while California's residential market added nearly 50% of this capacity. Nevertheless, several states had considered reforms to net metering rules that threaten the market's ability to maintain the growth trajectory of previous years. The Non-residential solar was flat for the third year in a row, with 1,011 MW additional solar.

The utility solar sector remained the largest segment by capacity, with 4,150 MW in 2015 supported by developers in North Carolina that needed to complete projects ahead of an expiring in-state tax credit. In addition to California, North Carolina became the first state to add more than 1 GW of utility PV on an annual basis. Texas and the Southeast, utilities had been retiring their aging coal fleets and replacing them with utility PV, in conjunction with combined-cycle natural gas plants (SEIA 2015: 6). Most solar-active utilities are in California, Hawaii,

New Jersey and North Carolina, additionally community solar[7] programs continue to capture the interest of utilities nationwide. One factor of this trend of PV generation by market segment is that non-residential and utility-scale PV systems had comparatively more consistency in state-by-state pricing than residential markets.

Critical elements for the success solar PV solar capacity in 2015 and 2016 is the extension of the federal Investment Tax Credit through 2021, adding the "commence construction" rule that provides the market with policy visibility through 2023. Additionally, regulators, lawmakers, or utilities in at least 46 states studied, proposed, or enacted policy changes pertaining to net metering, valuation of distributed solar, fixed or solar charges, third-party or utility-led rooftop solar ownership, or community solar in 2016.

By SEIA, in 2016 the U.S. Solar PV capacity was double versus 2015 reaching 14,762 MW (SEIA 2016a: 3), over seventeen times the amount installed in 2008. California installed 5,096 MW, more than 34% of all solar in the U.S. in 2016, the highest amount to any state in U.S. and more than the total solar PV installed by all states in 2013. Utah installed 1,241 MW, Georgia 1,023 MW and North Carolina 1,014 MW in 2016. The high growth of solar PV in 2016 was done by the utility sector in the U.S. as presented in Fig. 2.7, primary driven by projects ahead of schedule at utilities, and concerns of extension of the 30% federal ITC (SEIA 2016a: 10-11), a major tax credit that was approval extension in early 2017.

According to Table 6, the accumulative solar PV capacity in the U.S. at December 2016 was 40,604 MW. California has been leading since 2010 the implementation of solar PV, reaching 17,084 MW or 42% of total U.S. capacity. As presented in Fig. 2.7, the utility installations reached 10,593 MW or 72% of total capacity in 2016, followed by the residential sector with 2,583 MW.

For the particular case of the Florida State, at December 2017 had a solar PV capacity of 1,355 MW, similar to Georgia, another east southern state. In 2015

(7) Community Solar is a type of business model in which: 1) a group of participants voluntarily pay for a portion of a community solar garden or farm that is located off-site; 2) the electricity produced flows directly into the grid; and 3) participants receive a compensation for the electric production of their portion of the community solar garden.

Florida added 43MW solar capacity, in 2016 added 404 MW and 749MW (SEIA 2017: 9) in 2017.

Now, by data published by EIA and presented in Fig. 2.8, regarding net solar PV generation from utilities and distributed generation for the period ending 2017, reveals an incredible gap in net generation of energy from solar sources between the state of California, and the rest of states. Just in 2017 California generated 31,370 Thousand MWh a 42% share of all states combined, followed by the state of Arizona with 5,774 Thousand MWh a 8% share, very similar than North Carolina. The state of Florida just generated 1,142 Thousand MWh in same year, 1.5% of total solar PV generated by all states.

Between 20012-2017, the state of California, is leading the PV Solar net generation as presented in Fig 2.8, which is a consequence of the growth of solar capacity presented in Table 5. The state is essentially where the solar revolution took off in the United States, as presented in Table 3 as well. California has a high goal for Renewable Portfolio Standard at 33% renewable energy output by 2020 and 50% by 2030 (DESIRE 2016), busted by the 30 percent federal investment tax (ITC) credit, and support through incentives that include rebates, tax credits and feed-in tariff incentives as presented in this chapter.

For the solar industry, it is time to start thinking about the next order of magnitude. In the last decade solar energy has experienced a rapid growth and not only did the number of installed solar capacity, solar energy has become a player in the energy generation as well. At December 2017, solar PV systems generated approximately 2% of all electricity in the U.S., but there is a realistic path toward 10% over the next 10-15 years or maybe an inflexion point in the near future. Solar represented in 2017, 18% of total net generation of renewables excluding hydro, from 2% in 2012, as presented in Fig. 2.9.

As mentioned by MIT Energy Initiatives (2015: ix) “Solar electricity generation is one of very few low-carbon energy technologies with the potential to grow to very large scale”, and this research address it to the Florida State in detail in chapter 4 and 5.

The widespread adoption of solar power has spurred a growing demand for technologies to store and manage variable energy supplies. Distributed generation, battery storage and new efficiency mandates stir talk of disruption and question how utilities will react (ACCENTURE 2016), which are another piece of the puzzle that requires attention especially at state level. In fact, in addition to utilities and the energy industry, state legislatures also started paying more attention to energy storage and DG.

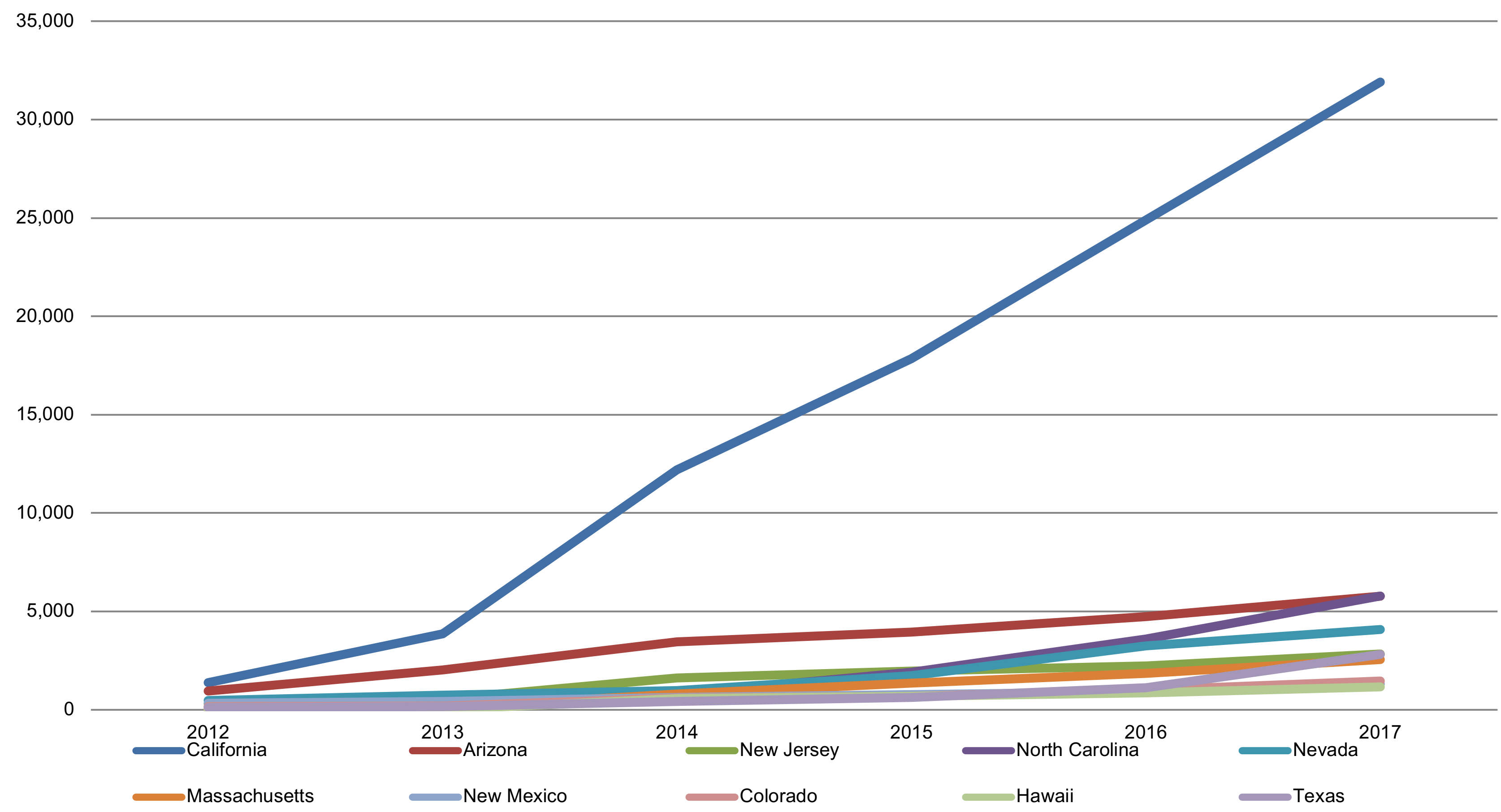

Fig. 2.8. Top Ten States Net Solar Photovoltaic Generation 2012-2017 (Thousand MWh). *Source*: Own Elaboration from official data from SEIA *(2011; 2012; 2013; 2014; 2015)*

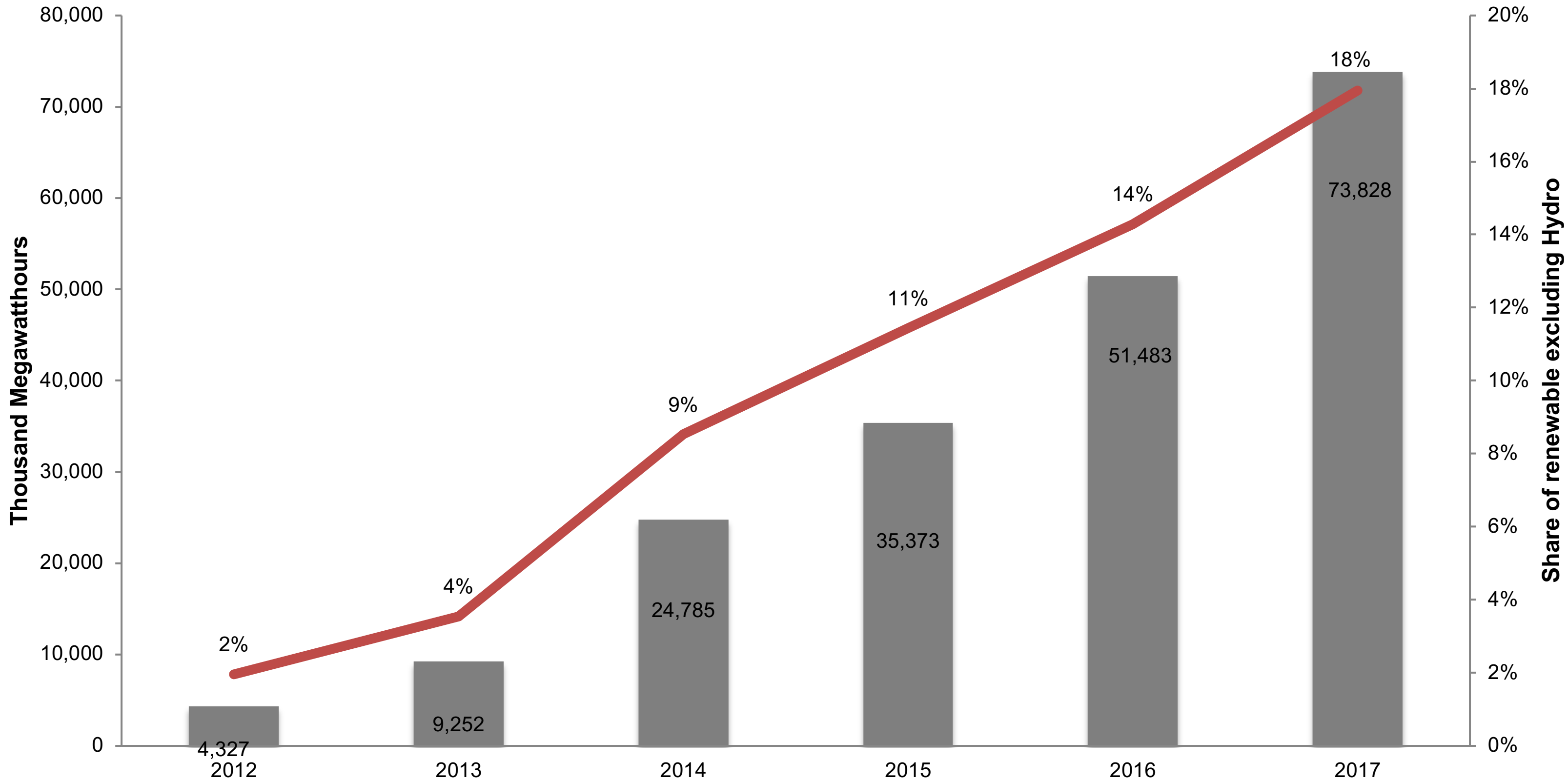

Fig. 2.9. Total Net Generation from Solar Photovoltaic and share from Renewables excluding Hydro in U.S., 2012 – 2017**.** *Source*: *Own Elaboration from official data from EIA (2012; 2013; 2014; 2015, 2016b, 2017a)*

Over the last century, the energy storage industry has continued to evolve and adapt to changing energy requirements and advances in technology. “Energy storage can be seen as an alternative to investing in conventional network equipment to accommodate high PV-penetration scenarios” (MIT 2015: 167). Energy storage can help increase the market compensation of solar PV owners, by increasing electricity prices in net load valleys because storage allows PV owners to take advantage of low prices during valley hours to store energy.

Some of these technologies implemented successfully and listed by the Energy Storage Association (ESA 2016) are:

- Solid State Batteries – from advanced chemistry batteries and capacitors to some electrochemical storage solutions
- Flow Batteries or rechargeable battery - where the energy is stored directly in the two chemical components dissolved in liquids for longer life cycle, and quick response times
- Flywheels - a rotating mechanical device that is used to store rotational energy mechanical that can deliver instantaneous electricity
- Compressed Air Energy Storage - utilizing compressed air to create an energy reserve. A classic example is the 290MW system from CAES
- Thermal - capturing heat and cold to create energy on demand. An example is in St Lucie, Florida public schools that uses thermal energy storage to generate ice at night and help cool the buildings during the day
- Pumped Hydro-Power - creating large-scale higher elevation reservoirs of energy with water, as in hydroelectric. This is the most mature energy storage technology with hundreds of electric storage stations currently in operation worldwide and in the U.S. This technology has constraints from its dependence on suitable geographical settings as well as from constraints to licensing and environmental regulations.

By the MIT Energy Initiatives (2016) “the United States has approximately 240 gigawatt hours (GWh) of energy storage capacity, which represents about 2.3% of overall U.S. electricity generation capacity”, around 96% of this storage capacity is provided by pumped hydroelectric (pumped hydro-power) systems.

In the U.S. the energy policies and decisions related to local electric power distribution systems are primarily made by state legislators and regulators. It is expected that bulk storage, ancillary services, and distributed storage sited at the utility substation will be regulated within next few years as well.

The trend experienced in the penetration of renewable energy, as presented in this research, is also a trend in the need of energy storage (EIA 2014a: 26 – 30) for residential, non-residential and utility systems. The energy storage solutions should be competitive with currently available, non-storage-based options (e.g., natural gas peak plants. This means that the total cost of storage systems including subsystem components, installation, and integration costs, must be reduced.

***

3. The Electricity Sector and its Regulations in the State of Florida

The state of Florida, one of the top travel destinations in the world, is the southeastern most American state, bordering with the Atlantic on one side, the Gulf of Mexico on the other and by Georgia and Alabama to the north. Florida is 500 miles long and 160 miles wide at its most distant points, with a total land area of 54,252 square miles.

According to the Bureau of Economic Analysis, Florida is the third most populated state in the U.S. with 20,61 million people at July 2016 or 6.4% of the U.S. population (BEA 2016), behind California and Texas and bigger than the state of New York. There are 67 counties in Florida. The state of Florida's population ranges from 2,700,794 people in the Miami-Dade County, all the way down to 8,621 people in the Lafayette County. Florida's capital is the city of Tallahassee, located to the northwest portion of the state. With a population size of this magnitude, addressing Florida's energy needs is a top priority

Wells Fargo Securities (Wells Fargo 2016) commented that Florida's economy had a rising 3.6 percent GDP in 2016, following gains of 3.1 percent in 2015 and 2.6 percent in 2014. Florida's $818 billion GDP in 2016 was the 3rd bigger GDP in the nation, behind California, Texas and New York. From same report, Florida's growth GDP in 2016 was behind Arkansas, Washington, Oregon, Colorado, New Hampshire, Arizona, Utah and Massachusetts (Wells Fargo 2016), which was attributed to real estate and construction industry output that made up half of its gains in the second quarter of 2016.

Visit Florida estimated that over 116 million tourists visited the state in 2017 and over 4 million from 2016, up 3.6% from 2016 (Visit Florida 2017) or 4.3% from 2015. Florida is much more than a vacation and retirement destination, which accounts for 8.3 percent of the 65 and older population in the United States. Construction, professional and business services, education and healthcare and the leisure and hospitality sector are also contributing to the GDP growth.

By the Department of Commerce, Florida exports totaled $53.9 billion in 2015 and $55 billion in 2017 (Department of Commerce 2017), especially $32.7 billion from Miami-Fort Lauderdale-West Palm Beach metro area. By the same source, the Miami - Fort Lauderdale - West Palm Beach is the 7th largest metro area reporting exports nationwide. The South American countries account for the larger share of Florida's exports, mainly computer & electronic products, transportation equipment, chemicals, and machinery.

According to the U.S. Energy Information Administration report “Energy-Related Carbon Dioxide Emissions at the State Level, 2000-2014” (EIA 2017b, 1-4), over this time period, CO2 emissions decreased in 35 states and rose in 15 states. Florida fell 4.8% in same time period, to 228.2 million metric tons of carbon dioxide. The Florida’s energy-related carbon dioxide emissions by sector in 2014 was related to electric power (47.8%) and transportation (44.4%). In contrast, in 2014 the energy-related carbon dioxide emissions were 358 million metric tons in California, 12.9% from the electric power sector and 56.1% from transportation. Texas’ energy-related carbon dioxide emissions in same year were 641.7 million metric tons, 35% from the electric power sector, 26.4% from the industrial sector and 34.5% from transportation.

By combining the state's gross domestic product (GDP) and the amount of energy consumed per unit of economic output or, precisely, British thermal units (Btu), the EIA calculate the energy intensity of a state. By the same source, California, Connecticut, Maryland, Massachusetts, and New York had the lowest energy intensity – all around 3,000 Btu per dollar, while Florida was over the 5,000 Btu per dollar, a 16% decline of 2000 values, close to the nation’s average of 6,000 Btu per dollar in 2014.

Because the 228.2 million metric tons of carbon dioxide emissions in the state of Florida, which 47.8% comes from the electric power, some initiatives had been implemented specially at utility level to curve them. Florida’s net generation has increased 8.8% over the past 12 years, with a total of 237,338 MWh in 2015 from 218,118 MWh in 2004, which are attributing in part to energy efficiency, federal and state product efficiency standards, state and local building codes, and efficiency programs operated by utilities and others. Changes in the structure of the economy and an increase in the population are also factors to consider.

With data from the U.S. Energy Information Administration as presented in Fig 3.1, the generation based on coal and petroleum has experienced the sharpest decline over 2004 to 2017 period, in favor of other sources as natural gas (EIA 2017a). In fact, nearly two-thirds of Florida's net electricity generation or 66% of Utility Scale Facility Net Generation was coming from natural gas in 2015, compared with 35% in 2004. Florida has the highest proportion of natural gas electricity generation of any state. Coal and Petroleum generation was reduced from 47% to 19% in similar time period. Nevertheless, net generation from renewable sources (excluding hydroelectric) has been 1% flat in the same period.

As presented in Fig. 3.1, according to the U.S. Energy Information Administration (EIA 2016b, EIA 2017a) the net electric generation in the state of Florida by 2015 was 237,338 MWh or 5.8% of net generation nationwide, second only to Texas. In 2017 the net energy generation in the State of Florida was 237,338 MWh or 5.9% of the net generation nationwide, which shows a flat net generation since 2015 for this state. Nevertheless, as presented in Chapter 2 of this study, the energy retail

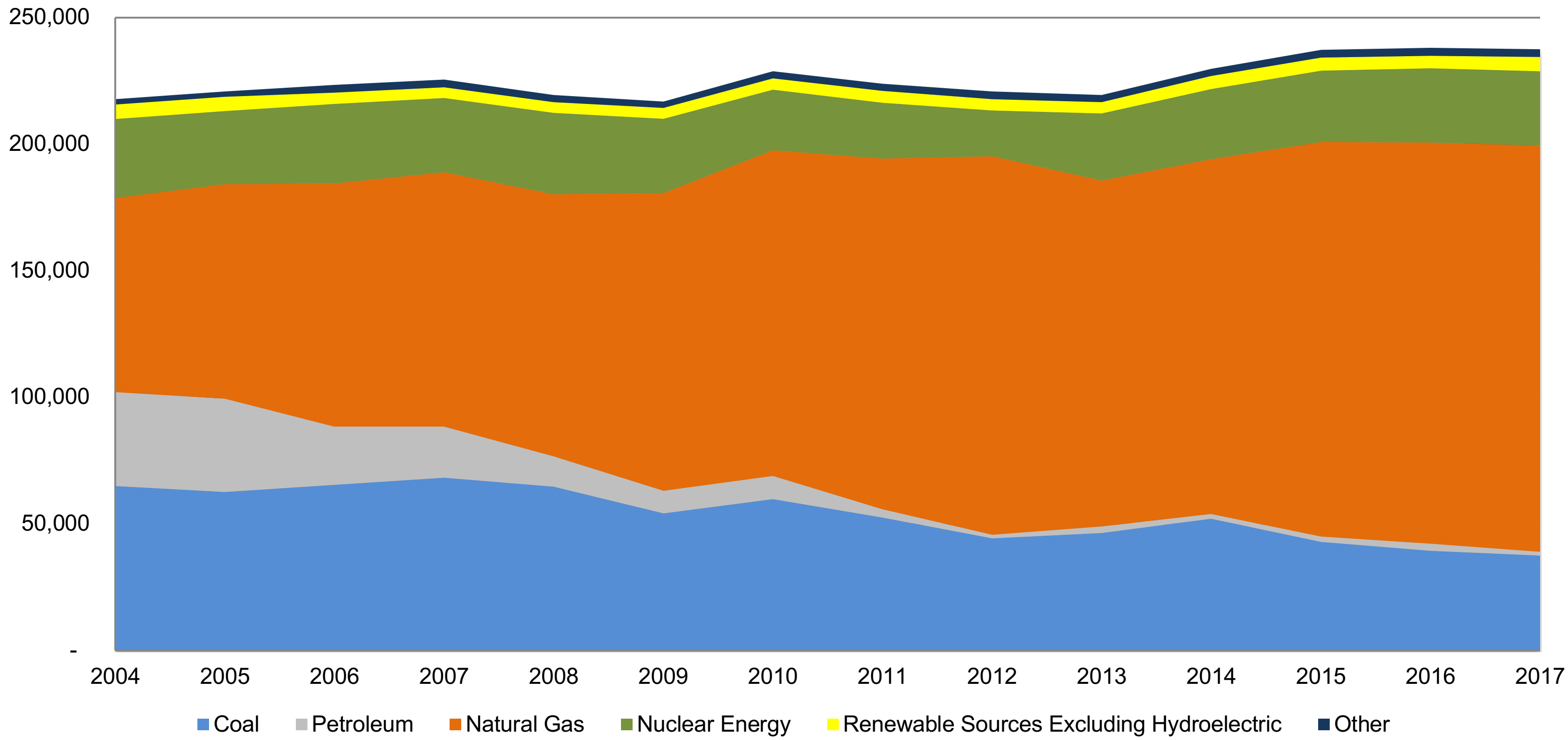

Fig. 3.1. Net Generation, in the state of Florida, by Energy Source in all sectors, 2004-2017 (Thousand MWh)**.** *Source*: Own Elaboration from official data from EIA (2005; 2006; 2007; 2008; 2009; 2010; 2011; 2012; 2013; 2014; 2015; 2016b; 2017a)

electricity sales in Florida did not drop as in the U.S. by 2% in 2017. The net electricity generation was distributed by 15.8% by coal, 0.6% by petroleum, 67.7% by natural gas, 12.3% nuclear, 2.4% renewable sources excluding hydroelectric, and 1.3% by other sources.

By the same Figure, since 2004, it has been a steady move out of coal and into natural gas as referred before but with no advance to renewable energy (EIA 2016b, EIA 2017a). In fact, the renewables category has growth 29.5% from 4,487 Thousand MWh in 2010 to 5,811 Thousand MWh in 2017. Solar generation at utility level has growth from 80 Thousand MWh in 2010 to 5,811 Thousand MWh in 2017. The only concentrating solar thermal plant in Florida is the Martin generation Station that produced one-fourth of the state's net solar generation in 2015 or 75 MW of electricity capacity. Jacksonville Solar Project is among the largest solar installations in Florida with a capacity of 12 MW.

Florida's total electric consumption ranks among the highest in the country mostly because of its sizeable population and extensive use of air conditioning, especially high summer with high electricity use, and heating during winter months, converting to one of the states with unique energy market in the USA. According to Florida Public Service Commission (FPSC 2016: 37, 44), as presented in Table 1, residential customers make up nearly 88 percent of Florida's electricity customers and purchase 52 percent of its electrical energy, while commercial electrical usage rates comprise about 36 percent, while industrial customers purchase the remaining around 11 percent.

Table 1
Electric Customers by Class and Consumption in 2016

Customer Class	Energy Sales (GWh)	Percent of Sales	Number of Customers	Percent of Customers
Residential	123,449	52.28%	9,197,125	87.64%
Commercial	85,147	36.06%	1,134,458	10.81%
Industrial	20,848	8.83%	28,513	0.27%
Other*	6,708	2.84%	134,696	1.28%
Total	236,152		10,494,792	

Source: Own Elaboration from Statistics of the Florida Electric Utility Industry, (FPSC 2016: 37, 44)

In addition to the high concentration of energy demand by residential customers, the effects of Florida's high temperatures and humidity include fluctuation in residential customers' electrical usage throughout the day.

According to the Florida Energy Efficiency and Conservation Act annual report (FEECA 2017: 7) and the Florida Solar Energy Center (FSEC 2017), the daily load shape curves typical to Florida summer and winter days are as showed in Fig. 3.2 for summer and winter. These daily usage patterns cause greater trough to peak variation in the demand for energy consumed in Florida than in other states with more industrial customers.

In the summer, air-conditioning demand starts to increase in the morning and peaks in the early evening, a pattern that aligns with the sun's heating of buildings. In contrast, in the winter it peaks mid-morning and late evening the winter load curve has two peaks, the largest in mid-morning, followed by a smaller peak in the late evening, both of which correspond to heating loads.

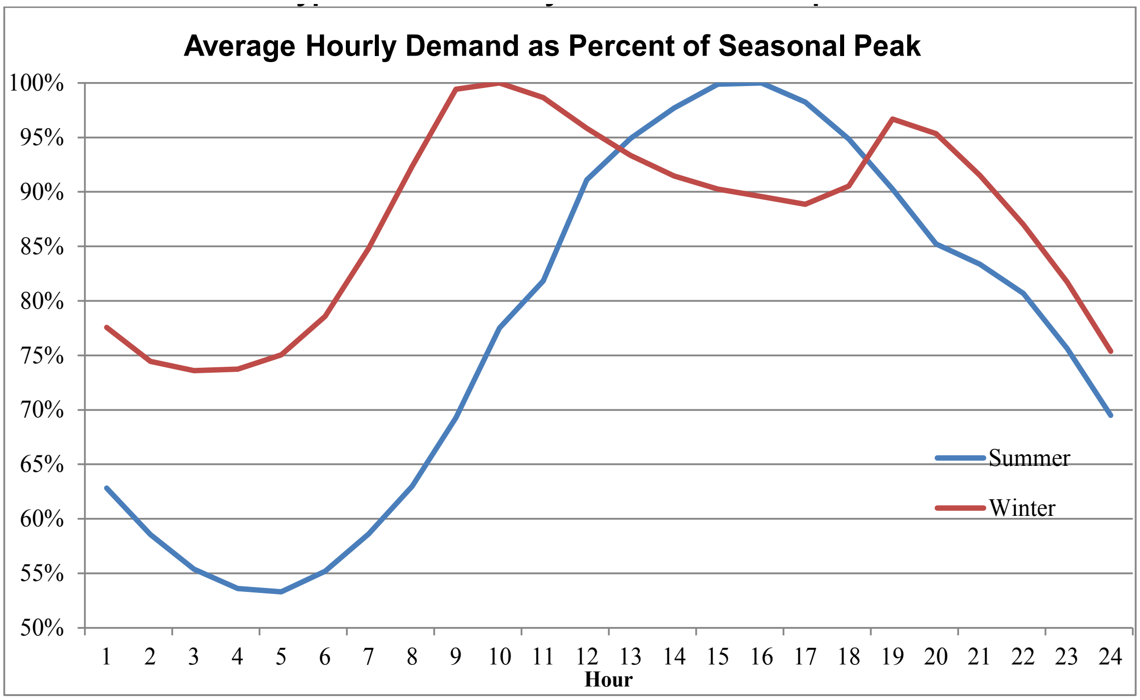

Fig 3.2. Typical Florida Daily Electric Load Shapes. *Source*: Florida Public Service Commission (FPSC 2017: 7)

By the same source, the heating and air-conditioning loads vary dependent on weather and external temperature. The winter peak occurs around 6:30H to 9:00H with a small peak around the 19:00H to 21:00H from May to October, while the summer peak occurs around 15:15H to 18:00H from November to April, as presented in Fig 3.2.

From all these facts, Florida is known as the Sunshine State, but it isn't known as the most cooperative place for generating solar energy. In fact, Florida doesn't have a renewable portfolio standard, nor does it allow for power-purchase agreements. The solar energy market in Florida has been slowly growing even in the absence of these policy measures.

From the electric utility viewpoint, they don not just generate electricity. They build the infrastructure like power lines, transmission stations, transformers, that brings electricity to our houses, offices, factories, etc. and for that requires some financial protection to their investments.

In this chapter, an analysis is presented of the agencies and regulatory policies in the State of Florida, since the invention of the incandescent light bulb in 1879 by Thomas Alva Edison at 2016. The roles and responsibilities of the entities in charge of regulating an applying regulation as the Florida State Senate, Committee on Communications, Energy, and Public Utilities responsibilities, the Florida Department of Agriculture and Consumer Services, Office of Energy, the Florida Public Service Commission (FPSC), the Federal Energy Regulatory Commission (FERC), and the Florida Solar Energy Center.

It is also in this chapter and analysis of the Florida state electricity market, resources, companies, financial figures, with emphasis on the utilities retail sales and financial performance of 2010-2015. A deep analysis is made to main Municipal utilities, Cooperatives, and Investor-owned utilities serving aver 10.5 million customers, with a total generation of 236,152 GWh in 2015, and revenues of over USD 23 billion.

In this research, it is cover in more detail the financial, customer mix and approach of renewable energy with emphasis to Solar PV of 10 power utilities in Florida, that represent the 90% of the energy sold in the state of Florida. These are:

Investor-owned Electric Utilities

- Florida Power & Light Company
- Duke Energy Florida
- Tampa Electric Company
- Gulf Power Company
- Florida Public Utilities Company

Municipal Electric Utilities

- Jacksonville Electric Authority (JEA)
- Orlando Utilities Commission

Rural Electric Cooperatives

- Withlacoochee River Electric Co-op
- Lee County Electric Co-op
- Clay County Electric Co-op
- Sumter Electric Co-op

3.1. State agencies and regulatory policies

Since a utility delivers essential services for individuals and businesses and the technological and economic characteristics of the industry are also such that a single provider is frequently able to serve the overall demand, originating natural monopolies. By these conditions economic regulation is the intervention into a market that is necessary to achieve public benefits that the market fails to achieve on its own. In the U.S., Electric and natural gas utilities that deliver retail services to consumers are regulated by state, federal and local agencies, dictating the terms of service and prices as well as impose environmental responsibilities on utilities.

According to the Institute for Energy Research (IER 2014), the modern electric utility industry in the United States can be traced to the invention of the successful incandescent light bulb in 1879 by Thomas Alva Edison, and by 1882, he installed the world's first central generating plant on Pearl Street in New York City's financial district. At a national level, in the early 1900s, electric and gas utilities competed with traditional fuels (e.g., peat, coal, and biomass) and were allowed to operate without regulation, installing their wires and pipes over and under city streets. Nevertheless, by the same time, the first state regulation of electric utilities emerged in New York.

By the same source, 1907 it was created the Commonwealth Edison company, the first consolidation of energy generation companies, that turned some generating stations into substations allowing the use of turbine generators, power transformers and power distribution lines, this first virtual monopoly in Chicago. Similar strategy was emulated by utility businesspersons in other cities throughout the United States, to exploit the benefits of large-scale turbine-generators and alternating current transmission.

By the same time, Wisconsin pushed through creation of a railroad commission that had full jurisdiction over railroad rates, schedules, service, and operations of the state's transportation companies, which in 1907 was extended to the state's electric companies and buildings, followed by New York and later by other states. By 1914, 43 more states followed the example of New York and Wisconsin by creating government oversight of electric utilities that peaked to more than 2,500 in 1922 (RAP 2011). Early utilities would often compete for the same customers including building duplicate distribution systems.

The Sherman Antitrust Act of 1880 was the first measure enacted by the U.S. United States Congress to limit cartels and monopolies of any type, authorizing the Federal Government to dissolve the trusts. In 1914 the Congress passed the Clayton Antitrust Act that provides further clarification and substance to the Sherman Antitrust Act of 1890 on topics such as price discrimination, price fixing and unfair business practices.

“In 1921, privately owned utilities were providing 94 percent of the total generation of electric power, and publicly owned utilities contributed only 6 percent. These large privately owned or investor owned utilities, controlled utilities in different parts of the country, making it impossible for state regulators to provide appropriate oversight over such far-flung enterprises” (Rojas and Eggelletion 2000: 4).

According to the U.S. Department of Energy since state regulation was not sufficient to control the action of interstate holding Companies headquartered out-of-state, Congress passed the Public Utility Holding Company Act of 1935 (PUHCA), which grants power to the US Securities and Exchange Commission (SEC) the power to approve or deny mergers and acquisitions (DOE 1993, 3 – 6) and, if necessary, force utility companies to dispose of assets or change business practices if the company's structure or activities are not deemed to be in the public interest.

Because of the New York blackout of 1965, where thirty million people were without electricity for as long as 13 hours, the power industry responded by creating the North American Electric Reliability Council (NERC 2013), a voluntary utility-managed reliability organization, to assure system planning & operating criteria that are intended to ensure the reliability and security of the bulk power system, or for each utility with generation or transmission assets.

In 1977, the Federal Energy Regulatory Commission (FERC 2017a) was created to oversight, in interstate commerce, of the natural gas industry, electric utilities, hydroelectric projects, and oil pipeline transportation systems. The FERC has its origin from the 1920s Federal Power Commission, which in 1935 the Congress provide the mandate, through the Federal Power Act of 1935, to set "just and reasonable" wholesale electricity prices.

As described in previous chapter, in 1978 the deregulation of the energy sector began with the passage of the Public Utilities Regulatory Policies Act, known as PURPA (USBR 2017), Section 210. PURPA advocated for energy conservation and reduction of oil imports, the use of renewable and alternative energy sources. As a result, it was created a structure for Independent Power Producers or IPP, a new category of power producers, allowing the generation of energy for resale at the utility's full-avoided costs.

By the early 1980s, high inflation and increasing fuel costs resulted in a sluggish economy throughout the U.S. Most utilities requested repetitive, often significant, rate increases and several utilities were on the verge of bankruptcy. Regulators required utilities to evaluate conservation and other alternatives rather than automatically building new plants (RAP 2017), by implementing the Integrated Resource Planning (IRP) that require electric utilities to acquire all cost-effective energy efficiency prior to investments in more expensive resources.

According to American Public Power Association (APPA 2003, 4) In 1992, the Energy Policy Act (EPA) was passed that amended PURPA allowing the creation of exempt wholesale generators (EWGs), which exempt them from the provisions of the Public Utility Holding Company Act (PUHCA) of 1935: a corporation could own generation facilities that sell power in wholesale markets while remaining exempt from the definition of an electric utility under PUHCA or qualifying facility under PURPA. This act also granted FERC with the authority to order and condition access by eligible parties to the interconnected transmission grid. In fact, the FERC's Order 888 of 1996 required that transmission owners provide open, nondiscriminatory access to transmission facilities at the same price they would charge themselves. These two approaches resulted in power marketers, independent power producers, and utilities having the capacity to buy and sell in both regional and national markets.

This action by Congress eliminated restrictions on the price that would be charged for wholesale electricity, but it allowed states to decide whether to allow retail competition. The market was then truly opened and deregulated states start to appear (IER 2014). Several states have become deregulated markets over the last 30 years, largely in the Northeast, Mid-Atlantic, and Texas. Other states, such as California, are partially deregulated or have had deregulation suspended.

It is relevant to note that regulation of utilities in USA is based on the inherent risk that a single monopoly supplier will overcharge consumers due to the lack of competition and high demand, meaning that the price of electricity would be cost of service, not market-based. The regulation replaces competition (DOE 2002) as the determinant of prices, including a reasonable return of, and on, investment. Prices are set to recover those costs, based on the sales volumes for each class (residential, commercial, and industrial). This approach has been adopted by FERC to stimulate the economy exchanges and to protect buyers (specially, small utilities) from the intrinsic advantage the sellers (specially, large near utilities) had in the transaction.

In the case of the state of Florida, the federal changes described before had been introduced in different time periods. In 1887, the Florida Legislature created the Railroad Commission of the State of Florida (FPSC 2017a), added jurisdiction over telephone services in 1911 and over motor carrier transportation in 1929. The Florida Railroad Commission was changed to the Florida Railroad and Public Utilities Commission in 1947, adding jurisdiction over investor-owned electric utilities in 1951, a year later over investor-owned natural gas utilities and safety only for municipally owned gas utilities, and in 1959 over privately-owned water and wastewater companies. By the same source, the Florida Railroad and Public Utilities Commission name changed to the Florida Public Utilities Commission in 1963, and renamed to Florida Public Service Commission (FPSC) in 1965 added jurisdiction over airlines.

The state of Florida does not have a Renewable Portfolio Standard, but the state does have a Renewable Fuel Standard (FPSC 2017a), focusing instead on increasing energy efficiency as a means to decrease energy consumption. The laws that are providing a path to increase energy efficiency are:

- Florida Energy Efficiency and Conservation Act, and
- Florida Energy and Climate Protection Act, both

These two laws as well the Florida Energy Law published in Chapter 2012-7117 are integrated in Annex A, B, C and D respectively at this research.

3.1.1. The Florida State Senate, Committee on Communications, Energy, and Public Utilities

According to the Florida State Senate (FLSS 2012-2014, 14-15), within the Florida State Legislature, there are two committees that handle energy issues: The Senate Communications, Energy and Public Utilities Committee and the House Regulatory Affairs Committee. The Communications, Energy, and Public Utilities Committee examines legislation in the areas of energy, water and waste water, natural gas, communications and utility infrastructure during emergencies, and this Committee is the primary organization for state energy and climate change programs and policies. In the energy area, the Committee has the following responsibilities:

- Economic regulation of the investor-owned utilities
- Reliability oversight of both regulated utilities and municipal and cooperative utilities
- Siting of power plants and transmission lines
- Renewable and alternative sources of electric energy
- Renewable and alternative sources of transportation energy

The Committee oversights its responsibilities through state legislation that is implemented by the following main entities:

- Department of Environmental Protection, by reviewing applications for power plants and transmission lines
- Office of Public Counsel, which advocates on behalf of utility consumers before both state and federal regulatory authorities and before the Florida and federal courts
- Florida Public Service Commission (FPSC), is an independent regulatory agency, that exercise regulatory authority over utilities in the areas of: rate base/economic regulation, competitive market oversight, and monitoring of safety, reliability, and service.

According to the Florida State Senate (FLSS 2017), the House Bill 7117 is a broad energy bill enacted during the 2012 Regular Session of the Florida Legislature, which in part addresses renewable energy, energy efficiency and conservation, and electric vehicles. The Bill adds factors for FPSC to consider in reviewing 10-year site plans submitted to commission by electric utilities; provides guidelines for financial assistance to residential & commercial property owners who make energy efficiency improvements or install renewable energy devices; deletes obsolete directive to FPSC to adopt rules for renewable portfolio standard.

By the same source, the senate committee has nine members, appointed by the senate president. The house committee contains three subcommittees, including the Energy and Utilities Subcommittee, which has 14 members. The members and leaders of this Committee are:

Chair:
Senator Aaron Bean (Republican Party)

Vice Chair:
Senator Bill Montford (Democratic Party)

Members:
Senator Doug Broxson (Republican Party)
Senator Daphne Campbell (Democratic Party)
Senator Jeff Clemens (Democratic Party)
Senator Denise Grimsley (Republican Party)
Senator Kelli Stargel (Republican Party)
Senator Dana D. Young (Republican Party)

By the same source, this Committee produced in 2017 several pieces of legislation, as the most relevant that will be covered in Chapter 4 of this research:

- CS/SB 90 – Renewable Energy Source Devices, that implements the renewable energy tax exemption constitutional amendment approved in 2016.
- CS/CS/HB 687 – Utilities, that creates the Advanced Wireless Infrastructure Deployment Act (Act), providing for the collocation of small wireless facilities on an authority utility pole
- CS/CS/HB 1021 – Construction, that authorizes the manufacture or sale of solar energy systems in Florida by the Florida Solar Energy Center standards

3.1.2. Florida Department of Agriculture and Consumer Services, Office of Energy

The Florida Department of Agriculture and Consumer Services was established in 1868 when the Office of Commissioner of Immigration was created, and in 1969 the Florida Legislature reorganized the department and established the Division of Consumer Services and the Division of Forestry (FDACS OOE 2016, 1-2). The Legislature also renamed the department to include its new responsibilities: Florida Department of Agriculture and Consumer Services.

By the same source, the Florida Department of Agriculture and Consumer Services promotes Florida agriculture, protects the environment, safeguards consumers, and ensures the safety and wholesomeness of food. It is comprised of 18 divisions and offices, it supports. The Commissioner is Adam Putnam, who was elected to serve a second term on November 4, 2014.

According to Florida Department of Agriculture and Consumer Services (FDACS OOE 2016, 1-2) and the Florida Energy Law (Annex C), this is the primary office for Florida's energy programs and policies including administering financial incentive programs, enforcing the Florida Energy and Climate Protection Act, performing or coordinating federal energy programs delegated to the state and providing recommendations to the governor and the legislature.

The Florida Department of Agriculture and Consumer Services had several initiatives to promote energy-saving technologies and educate about renewable energy and research conducted in Florida. As part of this Department, the Florida Energy Clearinghouse, a consumer-friendly portal to compare energy-saving technologies and learn more about energy usage, energy production, renewable energy technologies and research being conducted in Florida.

3.1.3. Florida Public Service Commission (FPSC)

Due to deregulation, the FPSC received safety jurisdiction over all electric utilities in 1986. Nevertheless, the FPSC lost jurisdiction over airlines in 1978, in 1985 railroads were deregulated, and in 1995 the telephone service allowed competition (FPSC 2015: 1-2), and the Commission's jurisdiction over telecommunications was reduced.

The Florida Legislature enacted legislation in 2008 emphasizing customer-owned renewable energy resources. The Commission then amended Rule 25-6.065, F.A.C., on interconnection and net-metering to facilitate customer-owned renewable generation up to 2 MW in capacity.

According to the FPSC Statement of Agency Organization & Operations (FPSC 2015: 1 - 2), this organization pursue several goals considering the needs of consumers with the needs of a utility and its shareholders: for economic regulation specially approving rates, earnings and use of resources and technology in the provision and consumption of utility services; regulatory oversight to protect consumers by ensuring that entities provide utility services to all who request it; service regulation and consumer assistance that facilitate the delivery of safe utility services at quality and reliability levels according to the Commission's standards. The Commission has established exclusive utility service territories, regulating the rates and profits of a utility, and requiring the utility to provide service to all who requested it.

By the same source, the FPSC's authority for its activity is contained in the following Florida Statutes:

- Chapter 120, Rulemaking
- Chapter 186, Planning and Development (10-Year Site Plans)
- Chapter 350, Organization, Powers and Duties
- Chapter 364, Telecommunications
- Chapter 366, Electric Utilities
- Chapter 367, Water and Wastewater Systems
- Chapter 368, Gas Transmission and Distribution Facilities
- Chapter 403, Power Plant, and Transmission Line Siting, and Intrastate Natural Gas Pipeline Siting
- Chapter 427, Special Transportation and Communications Services

The rates for electric retail customers are set after specific requirement form the power utility, to allow its investors an opportunity to earn a reasonable return on their investment, for what the FPSC require to justify all of its expenses for the operations of the utility. Additionally, the utility presents investments done in plant and other facilities and allows a reasonable return on the investment necessary to provide good service. The FPSC frequently holds a customer hearing within the utilities service area so that the Commissioners can hear from the public. The FPSC's decision can be appealed to the state's court system (FPSC 2015), as the case of CITIZENS OF the STATE of Florida, etc., Appellant, v. FLORIDA PUBLIC SERVICE COMMISSION, et al., Appellees. No. SC13–144, decided on August 28, 2014.

The FPSC main responsibilities are the execute the legislative mandates by channels that can be summarize as:

- Conducting hearings,
- Analyzing rate filings through testimony (usually pre-filed),
- Enforcing rules and tariffs, and
- Providing technical assistance to the commissioners

By the same publication (FPSC 2015: 4-10) and by FPSC Facts and Figures of the Florida Electric Utility Industry (FPSC 2016: 1) at December 2015 the Commission had jurisdiction over several utilities services in Florida:

- According to Chapter 366 of Florida Statute, all electric utilities, and maintaining a liaison with federal agencies whose policy decisions and authority affect electric and gas utilities (Florida Statute 2015) are under the Commission's jurisdiction:

- 5 investor-owned electric companies,
- 34 municipally owned electric utilities and
- 18 rural electric cooperatives

- According to same Chapter, it has jurisdiction to all natural gas utilities:
    - 8 investor-owned,
    - 27 municipally-owned and
    - 4 special gas districts

- According to Chapter 364 of Florida Statute, the FPSC has regulatory authority over telecommunication companies (FPSC 2015, Florida Statute 2012), and handles issues that involve the wholesale over- sight of the wire-line telecommunications industry:
    - 10 incumbent local exchange companies (ILECs),
    - 241 competitive local exchange companies (CLECs),
    - 57 pay telephone companies,
    - 21 alternative access vendors (AAVs) and
    - 14 shared tenant service providers (STS)

- According to Chapter 367 of Florida Statute, the FPSC has jurisdiction over 146 investor-owned water and/or wastewater utilities in 37 of Florida's 67 counties (Florida Statutes 2012b), and its earnings.

By the end of 2017, the Florida Public Service Commission fully regulated the rates and services 5 investor-owned electric companies, which provide close to 79 percent of all electricity sold to retail customers (FPSC 2017b) in Florida. In addition, the FPSC had jurisdiction regarding rate structure, territorial boundaries, bulk power supply operations, and power supply planning over 35 municipally owned electric systems and 18 rural electric cooperatives (FPSC 2016b: 10-13). The commission exercises regulatory authority over utilities in one or more of three key areas: rate base and economic regulation; competitive market oversight; and monitoring of safety, reliability, service and an uninterrupted supply to the general public.

The Florida Public Service Commission consists of five members, appointed by Governor Rick Scott and confirmed by the Senate, for a four-year term as provided in Chapter 350, Florida Statutes. The Commissioners are:

- Julie I. Brown, Chairman — Appointed through 01/01/19
- Art Graham — Appointed through 01/01/18
- Ronald A. Brisé — Appointed through 01/01/18
- Jimmy Patronis — Appointed through 01/01/19
- Donald J. Polmann — Appointed through 01/01/21

From a writing interview with FPSC Chairman Julie Brown and FPSC Commissioner Ronald Brisé, they noted that: “In 2006, the Legislature enacted the Section 366.92, F.S., which authorized the Florida Public Service Commission (FPSC) to adopt goals for renewable resources. In 2008, the Legislature amended Section 366.92, F.S., to require the FPSC to develop and provide a draft renewable portfolio standard (RPS) rule to the Legislature by February 1, 2009 for ratification. An RPS would establish a market for renewable generation by requiring utilities to serve their customers’ load with a specified proportion of renewable electric generation. In response to the Legislative directive, the FPSC developed a draft RPS rule and sent the rule to the Legislature for consideration on January 30, 2009. The rule contained a standard of 20 percent renewables by 2020, while protecting Florida’s ratepayers with an initial rate cap of 2 percent. A summary of FPSC main responsibilities is presented in Table 2.

Table 2

Florida Public Service Commission (FPSC)

What the FPSC Regulates	
1	Investor-owned electric companies such as: Florida Power & Light Company, Florida Public Utilities Company, Gulf Power Company, Duke Energy Florida, and Tampa Electric Company. Rates and charges Meter and billing accuracy Electric lines up to the meter Reliability of the electric service
2	New construction safety code compliance for transmission and distribution
3	Territorial agreements and disputes
4	Need for certain power plants and transmission lines
5	It does not regulate rates and adequacy of services provided by municipally owned and rural cooperative electric utilities, except for safety oversight. The PSC reviews the rate structure these utilities use to collect their costs, but has no jurisdiction over what costs are included in rates

Rate Revision Process	
1	Public utilities must file the wholesale rates, terms and conditions, to allow utility investors an opportunity to earn a reasonable return on their investment.
2	FPSC often holds a customer hearing within the utility’s service area so that the Commissioners can hear from the public
3	Technical hearings are held in which evidence is presented by expert witnesses in support of each viewpoint represented
4	The utility is required to justify all of its expenses for the operations of the utility

Source: Own Elaboration from Florida Public Service Commission, Inside the Florida PSC 2017 (FPSC 2017c, 6-9)

The Legislature did not ratify the draft rule or enact an RPS for Florida in the 2009 or 2010 sessions. In 2012, the Legislature adopted House Bill 7117, which repealed the language in Section 366.92, F.S., authorizing the FPSC to adopt goals for renewable resources." (Brown, Brisé, personal interview, April 16, 2017).

3.1.4. Federal Energy Regulatory Commission (FERC)

According to the Federal Energy Regulatory Commission (FERC 2017a), traces its history back to the 1920s with the creation of the Federal Power Commission, and in 1935 the Congress passed the Federal Power Act, requiring the Federal Power Commission to set "fair and reasonable" wholesale electricity prices. Within this foundation, the FERC was established in 1977 as a replacement for the Federal Power Commission, to regulate pricing.

In 1992, the Congress passed the Energy Policy Act, giving to FERC the independent authority to order wholesale competition with regulatory oversight responsibility, in a new open market. As a result, utility companies had to open their transmission lines to electricity wholesalers on request, with strict free-market principles or nondiscriminatory transmission access, an impressive task because of the various state deregulation schemes. The FERC enforces its regulatory requirements through imposition civil penalties.

The Energy Policy Act of 2005 gave FERC additional responsibilities (FERC 2017a) in the electric area:

- Regulates the transmission and wholesale sales of electricity in interstate commerce, by promoting electric power reliability and lower costs for consumers, and reducing transmission congestion

- Reviews certain mergers and acquisitions and corporate transactions by electricity companies, by examining the proposed transaction's effect on competition, rates, and regulation, and the potential for cross-subsidization

- Reviews the siting application for electric transmission projects under limited circumstances, and ensures the reliability of the high voltage interstate transmission system through mandatory reliability standards

- Monitors and investigates energy markets

Congress assigned these responsibilities to FERC in various laws enacted over nearly 100 years, such as the:

- Federal Power Act
- Public Utility Regulatory Policies Act
- Natural Gas Act, and Interstate Commerce Act
- Energy Policy Act of 2005

The Federal Energy Regulatory Commission is an independent agency that regulates the transmission and wholesale sale of electricity and natural gas in interstate commerce (FERC 2017b), and regulates the transportation of oil by pipeline in interstate commerce. FERC is composed of up to five commissioners who are appointed by the President of the United States with the advice and consent of the Senate. Commissioners serve a five-year term. The Commissioners, at November 2017, are:

- Neil Chatterjee, Chairman
- Cheryl A. LaFleur,
- Robert F. Powelson
- Neil Chatterjee
- Robert Powelson

At today, the FERC is in charge of regulating pricing for about 73 percent of the electricity used in the U.S. In the case of Florida State the FERC approves prices to power utilities to wholesale customers. A summary of FERC main responsibilities is presented in Table 3.

Table 3

Federal Energy Regulatory Commission (FERC)

	What the FERC Regulates
1	Transmission of electric energy in interstate commerce by public utilities, i.e. the rates, terms & conditions of interstate electric transmission by public utilities
2	Sales of electric energy at wholesale in interstate commerce by public utilities, i.e. the rates, terms & conditions of wholesale electric sales by public utilities
3	FERC has exclusive jurisdiction over the "transmission of electric energy in interstate commerce," and over the "sale of electric energy at wholesale in interstate commerce," and over "all facilities for such transmission or sale of electric energy
4	Corporate activities and transactions by public utilities – mergers, securities issuances, interlocking directorates, etc.
5	Accounting by public utilities
6	Reliability

	Rate Revision Process (Federal Power Act Section 205)
1	Public utilities must file the rates, terms and conditions for interstate electricity transmission and wholesale electricity sales
2	Public notice of a filing is issued, providing a time for responses
3	All public utilities that own, control or operate jurisdictional transmission facilities are required to have open access transmission tariffs, to eliminate undue discrimination/preference

4 Non-public utilities may have "reciprocity" open access transmission tariffs

Source: Own Elaboration from Federal Energy Regulatory Commission, 2014), Strategic Plan FY 2014 – 2018 (FERC 2014, 7-24)

Power utilities in Florida have limited competition in the state market for retail electricity customers. Changes introduced in regulation which introduce competition in the Florida retail electricity market, such as government incentives that facilitate the installation of solar generation facilities on residential or other rooftops at below cost or that are otherwise subsidized by non-participants, or would permit third-party sales of electricity (FERC 2017b), would have a material adverse effect on utilities' business, financial condition, results of operations and prospects. This is a critical factor that position several utilities for opposing the Legislative for such type of subsidies.

3.1.5. Florida Solar Energy Center

Created by the Florida Legislature in 1975, and under the Solar Energy Standards Act of 1976, the Florida Solar Energy Center (FSEC) was created to serve as the state's energy research institute, in cooperation with the University of Central Florida.

The center develops and promulgate standards for solar energy systems manufactured or sold in this state based on the best currently available information to properly identify the most reliable designs and types of solar energy systems. The center establishes criteria for testing performance of solar energy systems and maintains the necessary capability for testing or evaluating performance of solar energy systems. The FSEC is responsible for certifying all solar equipment sold in Florida, unless the equipment has been certified by a licensed engineer to meet the standards (FERC 2017b) in Florida's most recent building codes.

All solar energy systems manufactured or sold in the state must meet the standards established by the FSEC. A copy of the law covering this Center is presented in Annex A.

3.2. Description of the state electricity market: resources, companies, financial figures

According to FPSC the electric utility market in Florida is comprised of three types of entities (FPSC 2016b: 1 - 13):

- Municipal utilities,
- Cooperatives, and
- Investor-owned utilities

By the same source, the municipal utilities are not-for-profit, and governed by an elected city commission, or an appointed or elected utility board, with capital rose through operating revenues or sale of tax-exempt bonds. The cooperatives are not-for-profit electric utilities that are owned by the members they serve, and provide at-cost electric service to their members. The investor-owned utility sector is the biggest in Florida that serves development areas that provides a profit for their service. As in many states in U.S.A., not all electric utilities generate all the electricity they sell to their retail customers (FPSC 2017a). In fact, several municipal electric utilities, all rural electric cooperatives, and one small investor-owned utility purchase all or part of their generation requirements from other utilities in the state and outside the state of Florida. Electric utilities also purchase the transmission services require to move electric power from the power plants (FPSC 2017) where the electricity is generated to the load centers. The cost and sales price of these transactions is negotiated between utilities or determined by a formula tariff approved by the Federal Energy Regulatory Commission.

According to same FPSC source, since the inception of the Florida Energy Broker in 1978 based on Congress' enactment of the Public Utilities Regulatory Policy Act of 1978 (PURPA) and the Energy Policy Act of 1992 (EPACT) pursued open access for wholesale transmission, the wholesale market in Florida had influence in the wholesale sales, which currently is run by more flexible separately negotiated contracts, conducted between Florida's utilities. The FPSC has broad authority under Sections 366.04(2)(c), and 366.05(8), Florida Statutes, over transmission grid-related matters (the Grid Bill). The FPSC is vested with jurisdiction over the planning, development, and maintenance of a coordinated electric grid throughout Florida, which is reflected in the “10 Year Plan” (FPSC 2017a) published by main utilities every year.

One example of these transactions and agreements between electric utilities is the 240 MW natural gas unit called Hardee Power Station, approved by FPSC in 1989, a joint project between Tampa Electric Company Power Services and Seminole Electric Cooperative. Another example is the 514 MW power plant in Volusia County, approved in1999, and requested by the Utilities Commission, City of New Smyrna Beach, and Duke Energy New Smyrna Beach Power Company Ltd., L.L.P. An extreme example is the operation of 950 MW natural gas-fired peaking power plant in Brevard County by Constellation Power, an unregulated subsidiary of

Baltimore Gas and Electric Company, in Brevard County, with the of selling capacity and energy through the wholesale electric market to Florida's utilities.

According to FPSC's Facts & Figures of the Florida Utility Industry report (FPSC 2017a: 35 - 42; FPSC 2014: 36 - 43) and Table 4, the electric sector served to 10,494,792 customers in 2016, 74.8% of them or close to 7.85 million customers by five investor-owned utilities, 14.5% or over 1.5 million customers by thirty-five municipal utilities, and 10.8% or over 1.1 million customers by eighteen cooperatives. This share of the market had been similar since 2010 were 9,942,910 customers were served: 73.3% by investor-owned utilities, 18.2% by municipal utilities and 8.4% by cooperatives.

By the same source and as presented in Table 4, over 236,152 Gigawatt-Hours were generated in the State of Florida in 2016, a 6.7% increase from 2010 levels, the Investor-Owned Electric System has a 77% share of this generation, followed by the Municipal Electric System with 15% share and the Rural Electric Cooperatives with an 8% share. The Rural Electric Cooperatives had the highest growth with 24.2% in 2015 over 2010 levels, the Municipal Electric System a 17.1%, while the Investor-Owned Electric System had a 2.1% increase.

As presented in Table 5, the Florida Power & Light Company, based in Juno Beach, is the biggest power utility operating in the state of Florida with a 46.4% of the total generation in 2016, followed by Duke Energy Florida LLC, formerly Florida Power, with a 16.4% or 38,773,961 MWh, Tampa Electric Company, based in Tampa, with a 8.1% of the total generation, and Gulf Power Company, headquartered in Pensacola, with a 4.7%, all of them are part of the Investor-Owned Electric System.

By the same source, JEA located in Jacksonville - Florida, is the largest community-owned electric municipal utility company in Florida that served 456,894 customers with 12,215,148 MWh generated in 2016, very close to Gulf Power Company that served to 455,415 customers, an Investor-owned utility. The Orlando Utility Commission is the second in energy generated and number of customers served with 300,179 customers served and 6,598,932 MWh generated in 2016.

Table 5 also shows that Withlacoochee River Electric Co-Op Inc., based in Pasco County, is the largest Rural Electric Cooperative in Florida that served to 211,243 customers with 3,914,371 MWh; followed by Lee County Electric Co-Op that served to 211,685 customers and 3,800,338 MWh generation in 2016.

Concurring to the latest FPSC Facts & Figures of the Florida Utility Industry report (FPSC 2017a: 10, 40, 41; FPSC 2014: 9-13), and presented at Table 4, the Total Installed Capacity in 2016 was 54,139 MW, almost flat from previous years

Table 4
Main statistics of the Florida Electric Utility Industry, 2010 - 2016

	2010	2011	2012	2013	2014	2015	2016
Installed Nameplate Capacity by Type of Generation (MW)	***53,227***	***55,000***	***52,402***	***52,402***	***54,533***	***54,195***	***54,139***
Conventional Steam	20,563	19,909	17,837	17,837	17,684	17,616	16,774
Internal Combustion and Gas Turbine	7,454	8,184	8,697	8,697	7,870	8,048	7,453
Combined cycle	21,245	22,908	22,345	22,345	25,312	24,866	26,130
Hydroelectric	52	52	52	52	52	51	51
Steam - Nuclear	3,913	3,947	3,471	3,471	3,600	3,599	3,599
Other	-	-	-	-	15	15	132
Total Energy Generated (Giga watt-hours)	***225,930***	***213,107***	***203,731***	***204,605***	***226,678***	***234,119***	***236,152***
Residential	118,870	110,692	104,028	104,999	116,529	122,535	123,449
Commercial	80,128	75,402	74,211	74,146	76,238	88,530	85,147
Industrial	20,708	19,731	18,454	18,487	25,913	16,617	20,848
Other	6,224	7,282	7,038	6,973	7,998	6,437	6,708
Total Number of Customers (Thousands)	***9,345***	***9,223***	***9,095***	***9,221***	***10,200***	***10,416***	***10,495***
Residential	8,233	8,123	7,967	8,076	8,881	9,130	9,197
Commercial	1,011	1,002	977	985	1,079	1,133	1,134
Industrial	28	24	24	29	41	20	29
Other	73	74	127	131	199	132	135
Revenues by type of Customers ($ Thousands)	***22,940,120***	***22,822,684***	***21,179,921***	***22,060,049***	***24,281,166***	***24,681,941***	***23,349,025***
Residential	13,130,852	12,705,770	11,852,134	12,409,792	13,808,364	14,235,700	13,550,470
Commercial	7,165,633	7,303,597	6,990,684	6,905,538	7,325,378	8,419,986	7,495,717

Industrial	1,869,629	2,017,392	1,597,629	2,015,606	2,321,203	1,347,946	1,622,082
Other	774,006	795,924	739,474	729,113	826,222	678,308	680,756
Average Residential Bill (1000 KWhs)		***$124.79***	***$122.15***	***$123.75***	***$125.50***	***$116.62***	***$113.58***

Source: Own Elaboration from Statistics of the Florida Electric Utility Industry, FPSC (2017a: 10, 20, 41; 2015b: 10, 20, 40, 43; 2014: 9, 21; 2013: 8, 19; 2012: 8, 19; 2011: 8, 19; 2010: 8, 19, 42)

Table 5
Utilities Retail Sales 2010-2015 (MWh)

	2010	2011	2012	2013	2014	2015	2016
Investor-Owned Electric Systems							
Duke Energy Florida, LLC	38,925,066	37,596,932	36,380,683	36,615,987	37,240,099	38,553,183	38,773,961
Florida Power & Light Company	104,790,401	103,585,591	102,486,274	103,050,990	104,389,052	109,820,398	109,662,646
Florida Public Utilities Company	745,949	697,208	653,519	630,676	648,235	638,345	645,696
Gulf Power Company	11,750,660	11,407,228	10,987,832	10,929,745	11,390,697	11,085,872	11,081,505
Tampa Electric Company	19,213,462	18,563,569	18,408,580	18,417,662	18,525,739	19,006,474	19,234,525
Municipal Electric Systems							
Alachua	124,258	121,942	* NR	NR	116,659	121,530	130,432
Bartow	282,377	264,361	257,599	257,304	261,505	273,041	277,393
Beaches Energy Services	758,554	732,175	699,527	687,865	702,194	713,708	722,486
Blountstown		NR	NR	NR	36,307	35,439	35,345
Bushnell	25,211	23,692	NR	NR	23,801	23,252	23,892
Chattahoochee	44,023	41,037	36,104	35,796	36,574	37,890	37,277
Clewiston	103,275	98,396	96,278	93,753	95,925	100,978	101,094
Fort Meade	42,088	39,888	38,857	38,967	39,295	40,512	40,878
Fort Pierce Utilities Authority	535,567	529,703	515,941	516,235	518,446	550,871	551,618
Gainesville Regional Utilities	1,824,502	1,769,222	1,699,935	1,694,401	1,708,818	1,765,193	1,796,293
Green Cove Springs	118,068	110,894	NR	NR	96,513	111,677	106,946
Havana	NR	24,546	NR	NR	24,107	24,079	23,483
Homestead	397,418	451,500	NR	NR	493,636	535,095	526,881
JEA	13,103,903	12,740,038	11,906,884	11,829,364	12,224,128	11,090,657	12,215,148
Key Energy Services	691,923	707,164	702,495	707,235	715,008	751,178	742,272
Kissimmee Utility Authority	1,360,922	1,346,630	1,333,923	1,350,728	1,383,233	1,472,391	1,521,688
Lake Worth Utilities Authority	398,157	NR	NR	NR	373,598	430,307	434,758

Lakeland	2,955,211	2,955,211	2,770,042	2,832,342	2,904,061	3,034,075	3,029,959
Leesburg	501,379	470,194	453,107	455,380	441,239	470,555	473,329
Moore Haven	16,737	NR	NR	NR	12,933	16,178	15,135
Mount Dora	93,114	88,836	84,632	85,683	87,009	89,184	89,184
New Smyrna Beach	395,853	376,774	365,076	372,081	386,381	396,602	414,356
Newberry	NR	NR	NR	NR	32,774	33,986	34,480
Ocala Electric Utility	1,273,758	NR	NR	NR	1,221,227	1,256,904	1,296,691
Orlando Utilities Commission	3,011,443	3,223,235	NR	NR	6,210,381	6,535,984	6,598,932
Quincy	NR	NR	NR	NR	125,747	123,847	120,177
Reedy Creek Utilities Company	1,163,116	1,138,348	NR	NR	1,127,952	1,149,020	1,154,677
Starke	72,252	70,068	65,387	64,825	66,269	67,841	68,775
Tallahassee	NR	NR	NR	NR	2,637,695	2,654,983	2,639,582
Vero Beach	737,006	720,450	701,617	688,020	704,939	738,209	736,094
Wauchula	NR	59,745	NR	NR	59,712	63,349	59,293
Williston	NR	NR	NR	NR	30,316	31,935	33,229
Winter Park	NR	NR	NR	NR	420,523	433,409	437,232
Rural Electric Cooperatives							
Central Florida Electric Co-op	507,071	457,935	445,997	447,305	464,089	471,129	491,417
Choctawhatchee Electric Co-op	780,435	777,145	731,688	748,286	805,232	818,143	835,460
Clay County Electric Co-op	3,327,933	3,163,768	2,971,589	3,012,976	3,127,781	3,152,976	3,279,354
Escambia River Electric Co-op	177,917	167,951	NR	NR	177,604	175,021	174,820
Florida Keys Electric Co-op	639,829	651,920	640,872	659,748	679,462	720,650	709,568
Glades Electric Co-op	337,068	NR	311,001	305,418	307,948	315,608	315,891
Gulf Coast Electric Co-op	357,598	329,775	NR	NR	336,426	339,769	341,231
Lee County Electric Co-op	NR	NR	NR	NR	3,570,274	3,790,662	3,800,338
Okefenoke Rural Electric Membership Co-op	142,692	163,585	153,875	151,761	157,544	157,160	161,794
Peace River Electric Co-op	621,149	595,154	599,868	602,492	624,492	679,718	708,465
Sumter Electric Co-op	2,954,744	2,764,711	2,771,266	2,836,670	2,982,645	3,149,363	3,238,522

Suwannee Valley Electric Co-op	461,067	452,801	425,422	442,172	479,238	505,520	533,673
Talquin Electric Co-op	1,079,716	NR	NR	NR	965,142	955,069	953,400
Tri-County Electric Co-op	NR	NR	NR	NR	298,986	300,179	310,193
West Florida Electric Co-op	504,165	NR	465,858	477,632	504,163	498,390	495,708
Withlacoochee River Electric Co-op	4,078,478	3,627,733	3,570,119	3,565,155	3,685,143	3,811,169	3,914,371
Utilities Total Retail Sales (MWh)	**221,425,515**	**213,107,055**	**203,731,847**	**204,604,654**	**226,678,896**	**234,118,657**	**236,151,547**

Source: Own Elaboration from Statistics of the Florida Electric Utility Industry, FPSC (2017: 36; 2016: 36; 2015b: 36; 2014: 32; 2013: 32; 2012: 31; 2011: 32) with a total generation of 234,119 Gigawatt-hours, and over 10 million customers or 11.5% increase over 2010's level.

The 87.7% of customers, or 9.19 million, are residential that consumed 52.3% of the total energy generated in 2016, while 10.8% are commercial customers that consumed 36.1% of the total energy generated and 0.3% are industrial customers that consumed 8.8% of the total energy in the same year. The distribution in number of customers is almost the same for all years from 2010 to 2016, with small variations in the consumed energy in favor of Industrial customers versus commercial customers. Nevertheless, an increase of 4.5% in energy generation between 2016 and 2010, there is an increase of 1.8% in revenues in same period originated mainly for incremental revenues by Giga watt-hour with residential and commercial customers, while decreased with industrial customer.

According to 2016 Ten-Year Site Plans of Florida's Electric (FPSC 2016c, 23 - 26), renewable energy facilities represents around 3.1% of overall generation capacity, or 1,860 MW renewable of 58,421 MW total in 2015. The renewable energy comes from non-utility generators in an 89%. Solar represented 263MW or 0.45% of total capacity.

By the same source, Florida's utilities plan to provide to the network an additional 2,005 MW of renewable generation until 2026. Of this plan, around 1,586 MW to be installed from solar: 1,102 MW of utility-owned solar, 184 MW of contracted solar and 300 MW of as-available energy contract solar facilities.

According to FPSC Interconnection and Net Metering of Customer-Owned Renewable Generation Reports (FPSC 2017b), it had 15,965 renewable generation interconnections in 2016, from 3,930 in 2011 as reflected in Table 6. In the 2016, 72% of these interconnections were from customers to Investor-owned Electric Utilities, 15% to Municipal Electric Utilities and 13% to Rural Electric Cooperatives, very similar than previous 5 years.

Table 6

Renewable Interconnections and Gross Power Rating by Type of Utility, 2011-2016

	# of Customer-Owned Renewable Interconnections					
	2011	2012	2013	2014	2015	2016
IOU	2,767	3,794	4,820	6,291	8,561	11,543
Municipal	614	791	1,007	1,202	1,616	2,375
Rural Electric Co-op	549	684	853	1,053	1,423	2,047
TOTAL	3,930	5,269	6,680	8,546	11,600	15,965

	KW Gross Power Rating

	2011	2012	2013	2014	2015	2016
IOU	19,442	30,401	43,938	57,489	79,872	101,283
Municipal	5,002	7,021	8,689	10,151	13,083	18,756
Rural Electric Co-op	3,262	4,099	4,865	6,403	8,880	12,720
TOTAL	27,706	41,521	57,492	74,043	101,835	132,759

Source: Own Elaboration from FPSC Interconnection and Net Metering of Customer-Owned Renewable Generation Reports, FPSC (2017a)

By same Table, Solar Gross Power rating by Type of Utility had a drastic increase with solar capacity interconnected to Investor-owned Electric Utilities, reaching 101,283 KW in 2016, that come from 11,543 renewable interconnections.

3.2.1. Investor-owned Electric Utilities

Around 75% of the USA population is served by Investor owned utilities (IOU), which are private entities that issue stocks, sell bonds and are regulated at the state level by regulatory commissions, in the case of Florida by the Florida Public Service Commission (FPSC) as defined before. The FPSC set the retail rates charged by IOUs for their services, which also ensure that IOUs respond to customer service requests and are properly maintaining utility infrastructure.

There are five Investor-owned Electric Utilities in the state of Florida, covering specific service areas, as presented in Fig. 3.2. These utilities are:

- Florida Power & Light Company (FPL)
- Florida Public Utilities Company (FPU)
- Gulf Power Company (GPC)
- Duke Energy Florida LLC (DEF)
- Tampa Electric Company (TECO)

According to Fig. 3.2 and Table 7, the number of customers served by Investor-Owned Electric utilities in 2016 was 7,846,761 or 0.54% higher than 2015, a 7.6% increase from 2010. Nevertheless, the energy generated from 2010 to 2016 is almost flat with an increase of 2.3% in this period or 0.16% from 2015 reaching 179,398,333 MWh. Florida Power & Light Company had the biggest territory served, and the most habituated area in Florida. In 2015 served to 4,806,234 customers, generating over 109,820 Gigawatt-hours in 2015, with a total of $11,468 Millions in total operating revenues. This means a $2,386 in operating revenues per customer, the lower in the IOUs, followed by Duke Energy Florida LLC with a $2,744 per customer, Tampa Electric Company at $2,857 per customer, and Gulf Power Company at $3,299 per customer.

By the same source, in 2016 Florida Power & Light Company served 4,869,040 customers, generating over 109,662,646 Gigawatt-hour a 0.14% decrease from 2015 levels. This is a major change than 2010, Florida Power & Light Company had $2,319 in operating revenues per customer, followed by Duke Energy Florida LLC with $3,202 per customer, Tampa Electric Company at $3,294 per customer, and Gulf Power Company at $3,698 per customer, as presented in Table 7.

According to FPSC Interconnection and Net Metering of Customer-Owned Renewable Generation Reports (FPSC 2017b), it was 11,543 renewable generation interconnections in 2016, from 2,767 in 2011. In the 2016, 46.9% of these interconnections were from customers to Florida Power & Light, 38.5% to Duke Energy Florida and 9.5% to Tampa Electric Company, very similar than previous 5 years. In the same year, the Solar Gross Power Rating (AC) was 48,992 KW to Florida Power & Light, 37,125 KW to Duke Energy Florida and 12,065 KW to Tampa Electric Company, from a total of 101,283 KW to this type of utilities.

3.2.1.1. Florida Power & Light Company (FPL)

FPL is a rate-regulated electric utility participated primarily in the generation, transmission, distribution and sale of electric energy, incorporated in 1925 in the state of Florida. FPL is owned by NextEra Energy (NEE), a company incorporated under the laws of Florida in 1984, with electric generation facilities in 30 states in the U.S., 4 provinces in Canada and in Spain. NEE had a total solar net generating capacity of 2,108 MW at December 31, 2016, located in 11 states in the U.S., 1 province in Canada and 1 province in Spain.

According to the NEE 2016 Annual Report (NEE 2016, 70 - 72) and Table 7, FPL is the largest electric utility in the state of Florida, servicing most of the east and lower west coasts of Florida with approximately 10 million people through over 4.8 million customer accounts in approximately 27,650 square miles of served territory. This is a natural monopoly for one power utility in one region. At the end of December of 2015, FPL had 109,820,398 MWh of net generation, over 25,000 MW, 74,800 miles of net generating capacity, which was increased to 26,000 MW by the end of 2016.

By the same Annual Report source, FPL's service is provided primarily under franchise agreements to its retail customers negotiated with municipalities or counties and its price regulated by the FPSC. FPL serves in most of the territory along the east coast of Florida (except the Jacksonville area and five other municipalities that have municipal electric service), the agricultural area around southern and eastern Lake Okeechobee, the lower west coast area, and portions of central and north central Florida, as presented in Fig. 3.2.

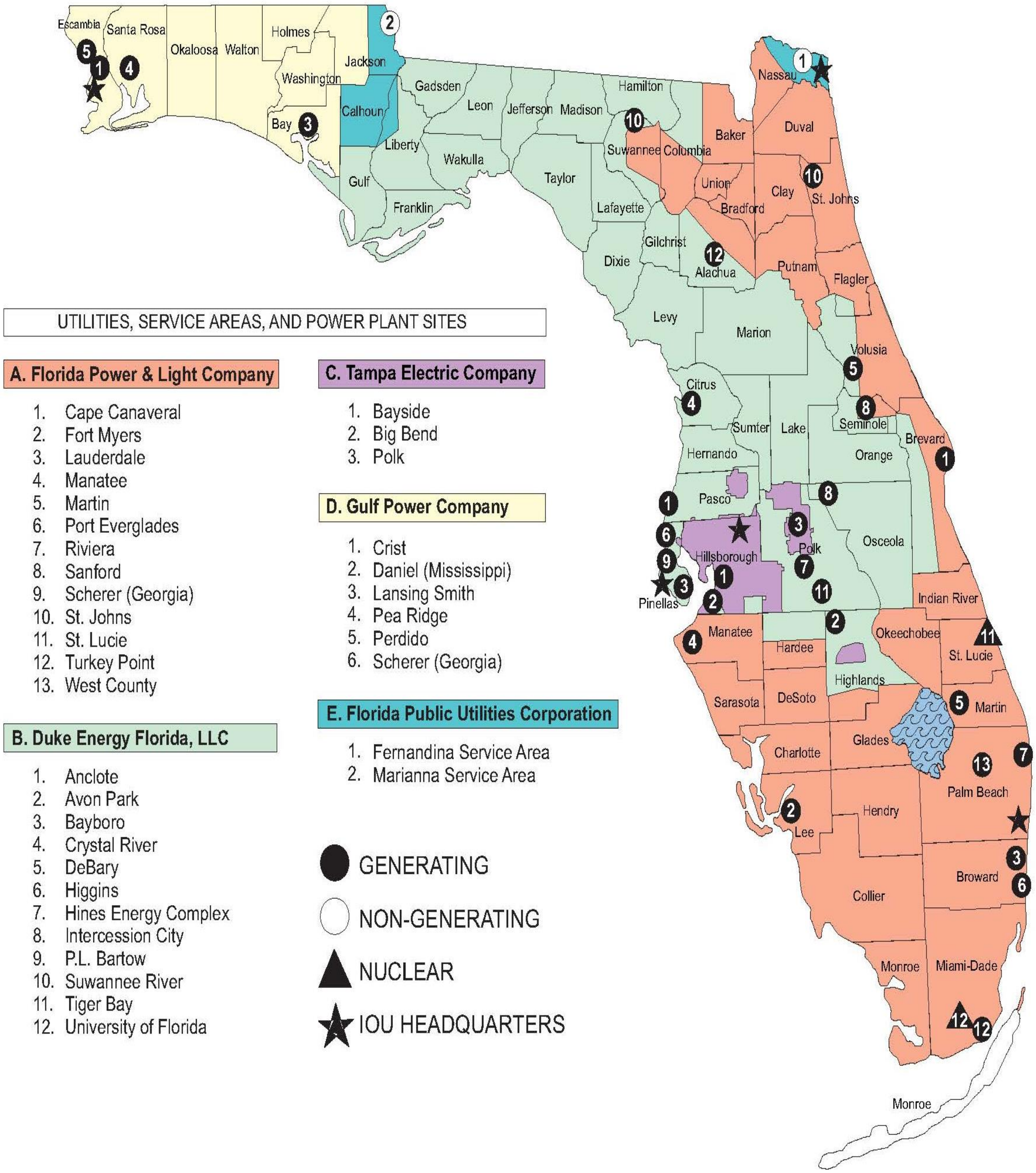

Fig. 3.2. Investor-Owned Electric Utilities**.** *Source*: PFCS Statistics of the Florida Electric Utility Industry., PFCS (2017e: 4)

Table 7
Main statistics of Investor-Owned Electric Utilities 2010 – 2016

	2010	2011	2012	2013	2014	2015	2016
Summer Net Capacity by Generation (MW)	***40,161***	***41,367***	***38,890***	***38,890***	***41,266***	***41,180***	***41,050***
Duke Energy Florida, LLC	9,811	9,959	9,095	9,095	9,154	9,101	8,323
Florida Power & Light Company	23,372	24,430	22,836	22,836	25,072	25,233	26,139
Florida Public Utilities Company	NR	NR	NR	NR	NR	161	NR
Gulf Power Company	2,686	2,686	2,683	2,683	2,704	2,348	2,251
Tampa Electric Company	4,292	4,292	4,276	4,276	4,336	4,337	4,337
Total Energy Generated (MWh)	***175,425,538***	***171,850,528***	***168,916,888***	***169,645,060***	***172,193,822***	***179,104,272***	***179,398,333***
Duke Energy Florida, LLC	38,925,066	37,596,932	36,380,683	36,615,987	37,240,099	38,553,183	38,773,961
Florida Power & Light Company	104,790,401	103,585,591	102,486,274	103,050,990	104,389,052	109,820,398	109,662,646
Florida Public Utilities Company	745,949	697,208	653,519	630,676	648,235	638,345	645,696
Gulf Power Company	11,750,660	11,407,228	10,987,832	10,929,745	11,390,697	11,085,872	11,081,505
Tampa Electric Company	19,213,462	18,563,569	18,408,580	18,417,662	18,525,739	19,006,474	19,234,525
Total Number of Customers	***7,290,400***	***7,328,312***	***7,371,313***	***7,472,714***	***7,587,698***	***7,804,913***	***7,846,761***
Duke Energy Florida, LLC	1,640,813	1,642,145	1,645,133	1,682,181	1,699,077	1,798,990	1,760,016
Florida Power & Light Company	4,520,280	4,546,979	4,576,415	4,626,946	4,708,819	4,806,234	4,869,040

Florida Public Utilities Company	28,286	30,986	31,089	31,155	31,272	31,506	31,787
Gulf Power Company	430,030	432,403	434,441	437,698	442,370	449,471	455,415
Tampa Electric Company	670,991	675,799	684,235	694,734	706,160	718,712	730,503
Total Operating Revenues ($ Millions)	***19,536***	***18,518***	***18,144***	***18,090***	***19,750***	***19,940***	***18,671***
Duke Energy Florida, LLC	5,254	4,369	4,664	4,498	4,940	4,936	4,470
Florida Power & Light Company	10,482	10,609	10,033	10,214	11,189	11,468	10,692
Gulf Power Company	1,590	1,520	1,440	1,440	1,591	1,483	1,485
Tampa Electric Company	2,210	2,020	2,007	1,937	2,030	2,053	2,024

Source: Own Elaboration from Statistics of the Florida Electric Utility Industry, FPSC (2017b: 23, 36, 43, 13; 2015b: 13, 23, 35, 42; 2013: 22; 2012: 22; 2011: 22; 2010: 12, 22, 35, 41)

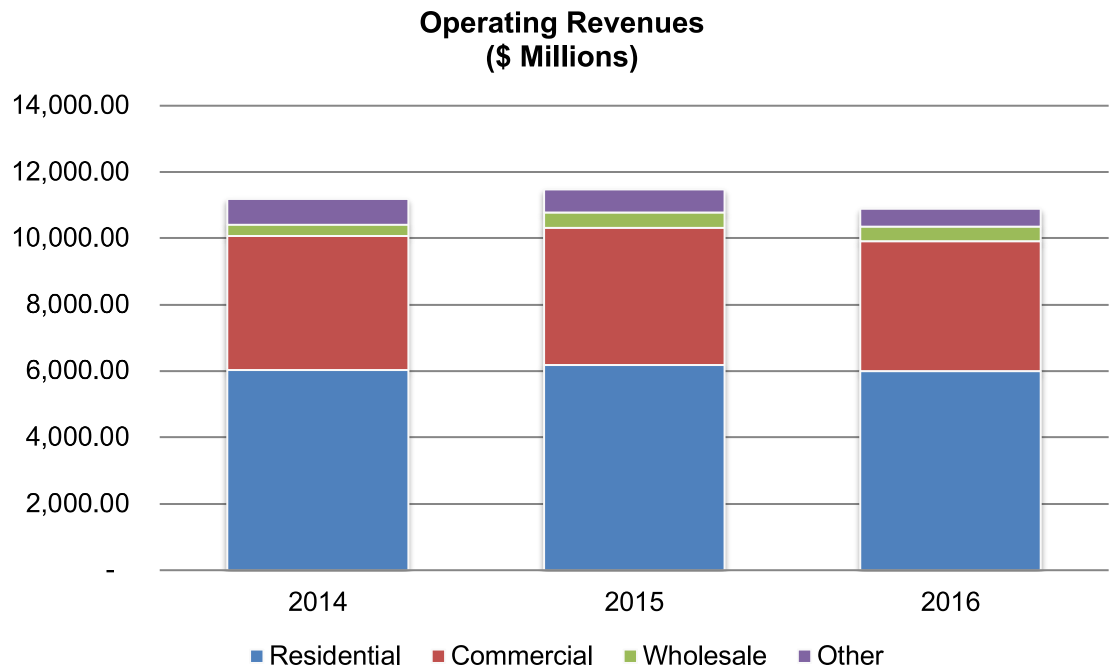

Fig. 3.3. FPL Operating Revenues by Type of Customer, for period 2014 -2016**.** *Source*: Own Elaboration from NEE 2016 Annual Report (2016: 6, 69)

At the end of 2016 it counted for 180 franchise agreements, covering approximately 88% of FPL's retail customer base in Florida. The term of a franchise agreement is usually 30 years, in which the municipality or county agrees not to form its own utility, and in return the FPL has the right to offer electric service to residents.

As presented in Table 7, the number of FPL customer accounts increased 2.1% and its Operating Revenues increase 2.5% between 2014-15. Nevertheless, this trend is down in 2016 by 5% or $573 millions as presented in Fig. 3.3, especially in the commercial with negative $206 millions, negative $200 Millions in the residential sector, negative $23 millions in the wholesale and the rest in other type of customers. In 2016, operating revenues from wholesale and industrial customers combined represented approximately five percent of FPL's total operating revenues or $ 981 millions, or 9% of total operating revenues.

The FPSC sets rates that are intended to allow FPL the opportunity to collect from retail customers total revenues (revenue requirements) equal to FPL's cost of providing service, including a reasonable rate of return on invested capital. The prices (or rates) that FPL may charge are approved by the FPSC in the case of retail customers, and by the FERC in the case of wholesale customers, respectively. FPL's allowed regulatory Return on Common Equity (ROE) is

10.55%, with a range of 9.60% to 11.60%. If FPL's earned regulatory ROE falls below 9.60%, FPL may seek retail base rate relief

According to table 8, FPL's Operating Revenues in 2016 decreased 6.5% versus 2015 and just 2.7% over 2011. Nevertheless, the Net Income in 2016 was 4.8% higher than 2015, or $1,727 millions, mainly because a decrease of $937 million in the Operating Expenses. The Operating Expenses had reduced from 80.4% of the revenues in 2011, to 76.7%, 75.7%, 75.2%, 74.4% and 71% in 2012, 2013, 2014, 2014 and 2016 respectively. This had result in better Net Incomes from 10.1% or $1,068 millions in 2011 to 15.9% in 2016, a compound annual growth rate (CAGR) of 10.1%. By the same source, FPL’s Total Assets were $45,501 millions, a CAGR of 7.42% since 2011 to 2016.

At December 31, 2016, FPL owned and operated an aggregate generating capacity of 22,305 MW in 2016, through 33 units that used fossil fuels, primarily natural gas, and had joint ownership interests in 3 coal units, plus owning or operating 4 nuclear units with generating capacity of 3,453 MW total, and 5 solar generation facilities with generating capacity totaling 259 MW or 1.2% of total capacity.

By the same source, as of December of 2016 FPL relies upon a mix of fuel sources for its generation facilities, 70% of the fuel was from natural gas, 23% nuclear, 4% coal, 3% purchase power. Oil and solar collectively was less than 1%.

According to Florida Power & Light Company (FPL 2017a, FPL 2017b: 79 - 84) the company had implemented by 2016 around 340 MW in solar panels. Just in 2016, FPL added four 74.5 MW solar in each energy centers, with a total cost of about $400 million. At that time, FPL’s solar portfolio included:

- FPL DeSoto Next Generation Solar Energy Center, DeSoto County, 25 MW
- FPL Space Coast Next Generation Solar Energy Center, Brevard County, 10 MW
- FPL Martin Clean Energy Center, Martin County, 74.5 MW,
- FPL Manatee Solar Energy Center, Manatee County, 74.5 MW
- FPL Citrus Solar Energy Center, DeSoto County, 74.5 MW
- FPL Babcock Ranch Solar Energy Center, Charlotte County, 74.5 MW
- Small deployments below 3 MW in total at: FPL Solar Circuit at Daytona International Speedway at Volusia County, FPL SolarNow program at the Broward Young at Art Museum & Library in Broward County, the Palm Beach Zoo & Conservation Society at Palm Beach County, and at the Palmetto Estuary Nature Preserve at Manatee County; in addition to the Solar research installation at Florida International University at Miami-Dade County

Table 8
Financial Results of Operation, Florida Power & Light Company (FPL)

Results of operation (in millions $)	2011	2012	2013	2014	2015	2016
Operating Revenues	10,613	10,114	10,445	11,421	11,651	10,895
Operating Expenses	8,537	7,757	7,906	8,593	8,674	7,737
Operating Income	2,076	2,357	2,539	2,828	2,977	3,158
Other Income and Expenses	33	52	60	38	73	76
Interest Expense	387	417	415	439	445	456
Income Before Income Taxes	1,722	1,992	2,184	2,427	2,605	2,778
Income Tax Expense	654	752	835	910	957	1,051
Net Income	1,068	1,240	1,349	1,517	1,648	1,727
Total Assets	31,816	34,853	36,488	39,222	42,523	45,501

Source: Own Elaboration from 10-K NEE Financial Reports, (2016b: 69-72, 2014: 77-80, 2012: 78-81)

In 2017, FPL is implementing solar plants at eight locations adding nearly 600 MW of solar capacity, some of them to be in commercial operation by March 2018:

- FPL Coral Farms Solar Energy Center, Putnam County, 74.5 MW
- FPL Horizon Solar Energy Center, Alachua and Putnam Counties, 74.5 MW
- FPL Wildflower Solar Energy Center, DeSoto County, 74.5 MW
- FPL Indian River Solar Energy Center, Indian River County, 74.5 MW
- FPL Blue Cypress Solar Energy Center, Indian River County, 74.5 MW
- FPL Hammock Solar Energy Center, Hendry County, 74.5 MW
- FPL Barefoot Bay Solar Energy Center, Brevard County, 74.5 MW
- FPL Loggerhead Solar Energy Center, St. Lucie County, 74.5 MW

By FPL'S 2017 Ten Year Power Plant Site Plan (FPL 2017b, 21), it was announced plans to build nearly 2,100 MW of new solar PV in Florida through 2023, an increase of 298 MW of PV each year starting in 2017 through 2023. This plan is including the approximately 600 MW in development at sites listed above, meaning an increasing to approximately 2,420 MW of solar energy by the end of 2023, that consisting of approximately 2,345 MW of PV and 75 MW of solar thermal.

NextEra Energy the owner of FPL, announced on March 2018 that JinkoSolar will supply them with up to 2,750 MW of solar modules, about 7 million solar panels (Jingo, 2018), over a period of four years. Jingo will open a manufacturing facility in Jacksonville - Florida.

By the same source, JinkoSolar has operations in several countries worldwide, with headquarters in China, with an integrated annual capacity of 8 GW for silicon ingots and wafers, 5 GW for solar cells and 8 GW for solar modules. This company has over 12,000 employees across its eight production facilities and 16 overseas subsidiaries.

3.2.1.2. Duke Energy Florida LLC

According to the Duke Energy 2016 Annual Report (Duke 2016a, 6), this is an energy company headquartered in Charlotte, North Carolina that operates in the United States primarily through its direct and indirect subsidiaries. Electric Utilities and Infrastructure conducts operations primarily through the regulated public utilities of Duke Energy Carolinas, Duke Energy Progress, Duke Energy Florida, Duke Energy Indiana and Duke Energy Ohio. As of December 31, 2016, the Electric Utilities and Infrastructure segment provided retail electric service through the generation, transmission, distribution and sale of electricity to approximately 7.5 million customers within the Southeast and Midwest regions of the United States, and over 24 million people and 95,000 square miles across six states.

By the same source "Duke Energy Florida is a regulated public utility primarily engaged in the generation, transmission, distribution and sale of electricity in portions of Florida. Duke Energy Florida's service area covers approximately 13,000 square miles and supplies electric service to approximately 1.8 million residential, commercial and industrial customers", (Duke 2016b, 15).

Duke Energy Florida (DEF) is interconnected with 21 municipal and nine rural electric cooperative systems that serve additional customers in Florida. As presented in Fig. 3.2, its service area is in west central Florida and includes the populated areas around Orlando, as well as the cities of Saint Petersburg and Clearwater. DEF operates as the sole supplier of electricity within their service territory and is subject to the regulatory provisions of the FPSC and FERC.

As presented in Table 7, the number of DEF customer accounts increased 1% and its Operating Revenues was flat between 2014-15. Nevertheless, this trend is down in 2016 by 8.2% or $409 millions as presented in Fig. 3.4, especially in the residential sector with negative $395 millions because decrease in fuel and capacity revenues due to lower fuel prices to retail customers, and negative $12 millions in the wholesale and the rest in other type of customers. In 2016, operating revenues from wholesale and industrial customers combined represented approximately five percent of DEF's total operating revenues or $ 548 millions or 12% of total operating revenues. The continued adoption of more efficient housing and appliances is having a negative impact on average usage per residential customer over time.

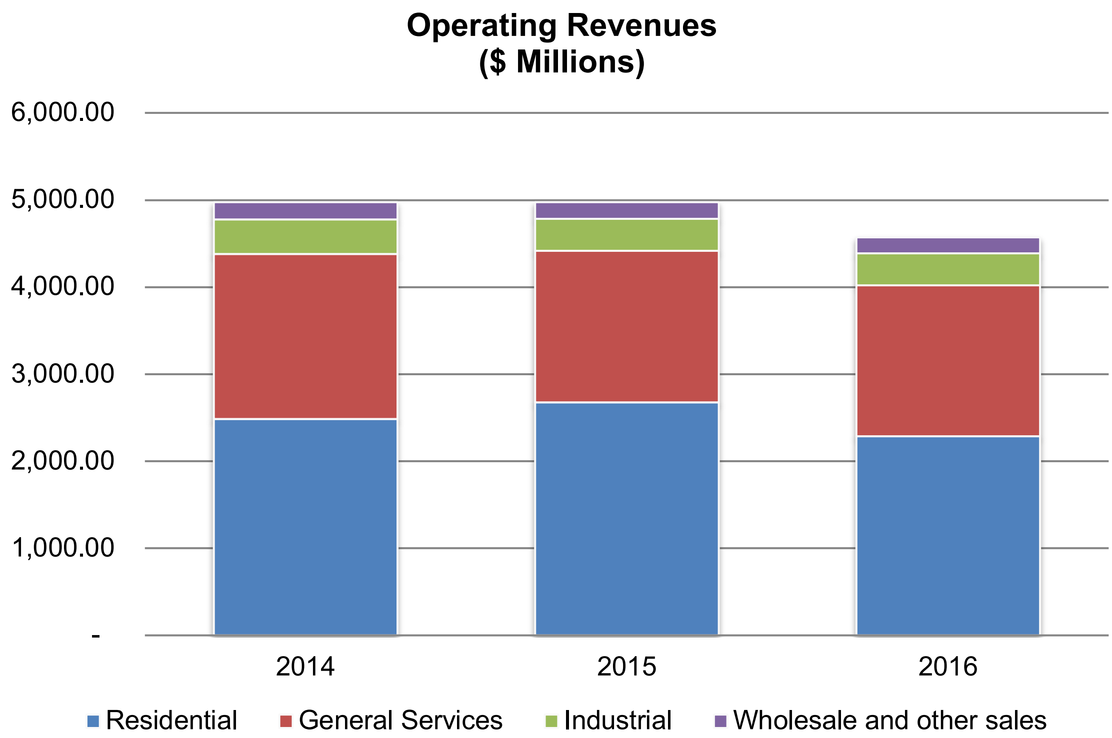

Fig. 3.4. Duke Energy Florida Operating Revenues by Type of Customer, for period 2014 -2016**.** *Source*: Own Elaboration from 10-k DEF Financial Reports, Duke Energy (2016b: 10, 56; 2015: 10, 54; 2014: 9, 51)

Similar to FPL, the prices (or rates) that DEF may charge are approved by the FPSC in the case of retail customers, and by the FERC in the case of wholesale customers. According to table 9, DEF 's Operating Revenues in 2016 decreased 8.2% versus 2015 and increased 4% over 2011. The Net Income in 2016 was 8% lower than 2015, or $551 millions, mainly because a decrease of $409 million in the Operating Revenues. The Operating Expenses had reduced from 84.0% of the revenues in 2011, to 86.6%, 84.8%, 78.3%, 77.6% and 77.2% in 2012, 2013, 2014, 2014 and 2016 respectively. This had result in better Net Incomes from 7.1% or $314 millions in 2011 to 12.1% in 2016, a compound annual growth rate (CAGR) of 11.9%.

At December 31, 2016, DEF owned and operated an aggregate generating capacity of 8,839 MW in 2016, through 12 units that used fossil fuels, one of them with coal with a capacity of 2,291 MW, 8 units with Gas/Oil or 5,128MW, 1,242 MW with Gas, 174 MW with Oil and 4 MW with distributed solar generation.

As of December 31, 2016, Duke Energy owns and operate 2,311 MW from wind in 14 sites across the U.S. Duke Energy also owns and operate 2,894 MW from 20 solar farms, being the largest the Canetoe II in North Carolina with 80 MW capacity.

Table 9
Financial Results of Operation Duke Energy Florida (DEF)

Results of operation (in millions $)	2011	2012	2013	2014	2015	2016
Operating Revenues	4,392	4,689	4,527	4,975	4,977	4,568
Operating Expenses	3,689	4,060	3,839	3,897	3,862	3,527
Operating Income	703	629	688	1,078	1,115	1,041
Other Income and Expenses	30	39	30	20	24	44
Interest Expense	239	255	180	201	198	212
Income Before Income Taxes	494	413	538	897	941	873
Income Tax Expense	180	147	213	349	342	322
Net Income	314	266	325	548	599	551

Source: Own Elaboration from 10-K DEF Financial Reports, Duke Energy (2016b: 56; 2015: 54; 2014: 51; 2012: 51)

Duke Energy Renewable Services, member of Duke Energy, owns, operates and maintains 17 wind powered electrical generation facilities in Texas, Wyoming, Oklahoma, Pennsylvania, Colorado, Wisconsin, Kansas with 2,311 MW total capacity, being the largest the “Los Vientos Windpower” in the state of Texas with 912 MW capacity. Also owns, operates and maintains 19 solar powered electrical generation facilities in North Carolina, California, New Mexico, Florida, Arizona, Texas and Colorado with 2,894 MW capacity, being the largest the Canetoe II in North Carolina with 80 MW capacity. The power produced from renewable generation is primarily sold through long-term contracts to utilities, electric cooperatives, municipalities and commercial and industrial customers.

According to DEF (Duke 2016c, 1-2) the company had implemented around 20 MW capacity in four solar facilities in the state of Florida:

- Perry Solar Energy Center, Taylor County, 5 MW
- Walt Disney World Solar Energy Center, Orange County, 5 MW. This was designed in the shape of a “not-so-hidden-Mickey”.
- Osceola Energy Center, Osceola County, 3.8 MW
- Stanton Solar Energy Center, Orange County, 6MW. This supplies electricity to Orlando Utilities Commission under the terms of a 20-year power purchase agreement.

According to Duke Energy’s 2016 Sustainability Report (Duke 2016d, 26) the objectives for 2017 and beyond, are based on the generation of cleaner energy through an increased amount of natural gas, renewables generation and the continued safe and reliable operation of nuclear plants, with an estimated investment within the next 10 years, of $11 billion. By Duke Energy Florida, LLC Ten-Year Site Plan, as of December 31, 2016 (Duke 2017, 62) “DEF is planning to install over 750 MW of solar PV over the next 10-year period as an energy resource”.

3.2.1.3. Tampa Electric Company (TECO)

According to latest EMERA Annual Report (EMERA 2016, 1-5) and TECO Energy 2015 Annual Report (TECO 2016, 11), Tampa Electric Company (TEC) is a public utility operating within the State of Florida. It was incorporated in Florida in 1899 and was reincorporated in 1949. TEC has two business segments with different geographical coverage:

- Tampa Electric operation provides retail electric service to almost 725,000 customers, at the end of December of 2016, with a system generating capacity of 4,730 MW. The retail territory served comprises an area of about 2,000 square miles in West Central Florida, as presented in Fig. 3.2. TEC is also subject to the regulatory provisions of the FPSC and FERC.

- Peoples Gas System or PGS operation, is engaged in the purchase, distribution and sale of natural gas for residential, commercial, industrial and electric power generation customers in Florida. With over 365,000 customers, PGS has operations in Florida’s major metropolitan areas and New Mexico.

Tampa Electric Company is owned by TECO Energy (NYSE: TE), Inc. which was incorporated in Florida in 198. TECO is a holding company for regulated utilities and other businesses. TECO Energy currently owns no operating assets but holds all of the common stock of TEC and, through its subsidiary, New Mexico Gas Intermediate, Inc., owns New Mexico Gas Company, Inc.

On September 4, 2015 was announced the Merger Agreement between TECO Energy and EMERA, which was completed in July 1, 2016, becoming TECO a wholly owned indirect subsidiary of EMERA. Emera Inc. is headquartered in Halifax, Nova Scotia with approximately $29 billion in assets and 2016 revenues of more than $4 billion. The company invests in electricity generation, transmission and distribution, gas transmission and distribution, and utility energy services (TECO 2016b, 1).

The prices (or rates) that TEC may charge are approved by the FPSC in the case of retail customers, and by the FERC in the case of wholesale customers, respectively. FPL's allowed regulatory Return on Common Equity (ROE) is in the range of 9.25% to 11.25% in 2016 (EMERA 2016, 103).

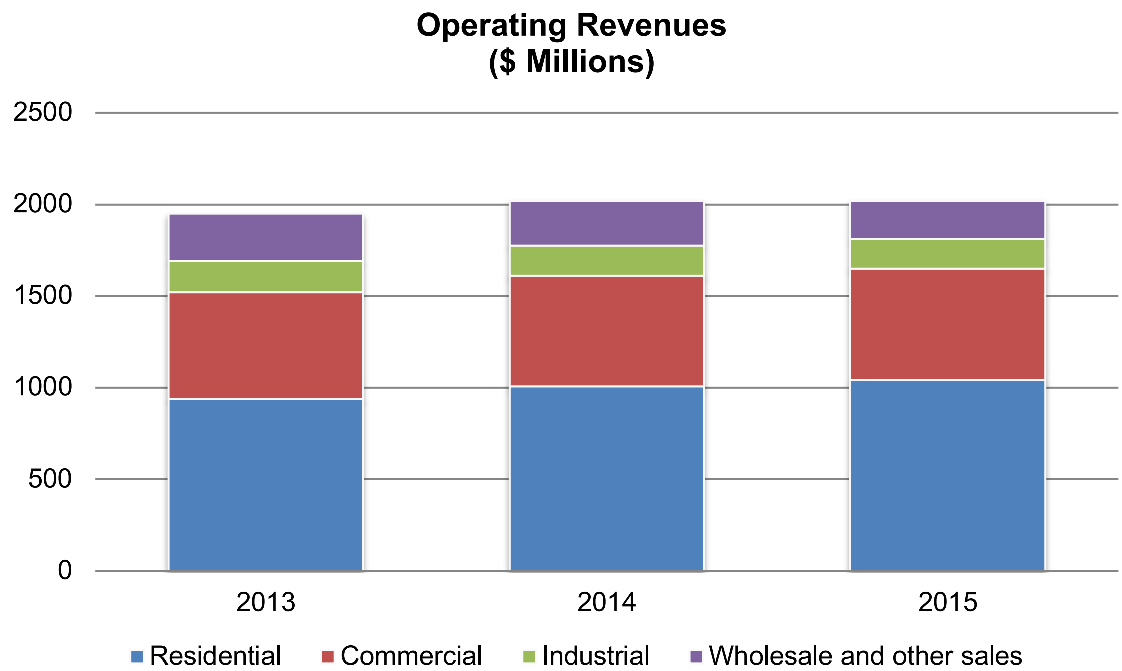

Fig. 3.5. Tampa Electric Operating Revenues by Type of Customer, for period 2013 2015**.** *Source*: Own Elaboration from 10-K TECO Financial Report (2015: 6)

According to table 10, TEC 's Net income in 2015 was $241.0 million, compared with $225 million in 2014, driven by 1.8% higher average number of residential customers. The Operating Expenses had been flat around 77.9% of the revenues in 2011, to 79.0%, 80.1%, 78.5%, 77.1% and 77.7% in 2012, 2013, 2014, 2015 and 2016 respectively. This had result in better Net Incomes from 10% or $203 millions in 2011 to 12.1% in 2016. The compound annual growth rate (CAGR) of Net Income between 2011 to 2015 was 4.42%. By the same source, TEC's Total Assets were $7,709 millions in December 2015, a CAGR or 6.80% since 2011.

According to TEC's 2016 annual report (TECO 2015: 26; TECO 2014, 66) the company had implemented by 2016 around 27 MW in solar projects across the area of operation:

- Tampa Electric installed a 1.6 MW solar array at Tampa International Airport in December 2015.
- Tampa Electric had installed 2.1 MW of solar panels at eight community sites including two schools, Tampa Electric Manatee Viewing Center, the Museum of Science and Industry, Tampa's Lowry Park Zoo, the Florida Aquarium, and LEGOLAND Florida.
- In march 2017, Tampa Electric launched the 23 MW utility-scale solar photo voltaic project at Tampa Electric's Big Bend Station.

Table 10
Financial Results of Operation Tampa Electric Company (TEC)

Results of operation (in millions $)	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Operating Revenues	2,021	1,981	1,951	2,021	2,018	1,150
Operating Expenses	1,573	1,565	1,562	1,586	1,557	893
Operating Income	447	417	389	435	461	257
Other Income and Expenses	1	6	11	15	18	14
Interest Expense	122	110	92	93	95	54
Income Before Income Taxes	325	313	308	358	385	217
Income Tax Expense	122	120	117	133	144	78
Net Income	203	193	191	225	241	139
Total Assets	5,926	6,042	6,127	6,565	7,709	7,817

Source: Own Elaboration from 10-K TECO Financial Reports (2016: 34; 2015: 37, 111; 2013: 47, 111)

By the same source, Tampa Electric is considering to implement large scale solar power and to reduce the carbon intensity of generation through increased use of natural gas. According to Tampa Electric Company's 2017 Ten-Year Site Plan (TECO 2017, 73 - 74), by 2026 it is expected to have a net energy for load by fuel source of 22,253 GWh, with a mix of: 32.8% coal, 60.3% gas, 0.2% solar or 44 GWh, 6.7% from other sources, including Purchased Energy from Non-Utility Generators. In 2016 total energy was 20,163 GWh with a mix of: 38.0% coal, 50.2 gas and 11.8% from other sources.

3.2.1.4. Gulf Power Company

Gulf Power Company is member of Southern Company, which was incorporated under the laws of Delaware on November 9, 1945 (Southern Company 2016, I-1), owns all of the outstanding common stock of the following public utility company: Alabama Power, Georgia Power, Gulf Power, and Mississippi Power, that supply electric service in the states of Alabama, Georgia, Florida, and Mississippi, respectively.

According to the same source (Southern Company 2016: I-10, I-35 to I-44), Gulf Power is engaged in the generation and purchase of electricity and transmission, distribution, including renewable energy and sale at retail in the northwest portion of Florida. The 71 communities of operation include Pensacola, Panama City, and Fort Walton Beach as well as rural areas. Gul Power is a Florida corporation founded under the laws of the State of Maine in November 2, 1925, and became a Florida corporation under the laws of the State of Florida on November 2, 2005. At December 2016, four electric cooperative associations, financed by the Rural

Utilities Service, operate within Gulf Power's service territory. At the same year, Gulf Power owned and/or operated 7 fossil fuel generating stations.

As presented in Table 7, the number of Gulf Power's customer accounts increased 1.6% to 449,471 accounts in 2015, its Operating Revenues of $1,590 million in 2014 were lower in 2015, and flat in 2016 to $1,485 millions as presented in Fig. 3.6. In 2016, it was a reduction of $29 millions in the wholesale sector due to expiration of a contract, which revenue was recovered by all other sectors. In same 2016, the operating revenues from residential and commercial customers combined represented approximately 75.7% of Gulf Power's total operating revenues or $ 1,124 millions.

Gulf Power is also subject to retail regulation by the FPSCs and wholesale regulation by the FERC. These regulatory agencies set the rates the operating companies are permitted to charge customers based on allowable costs, including a reasonable ROE. In 2016, it continued its current authorized retail ROE midpoint (10.25%) and range (9.25% to 11.25%).

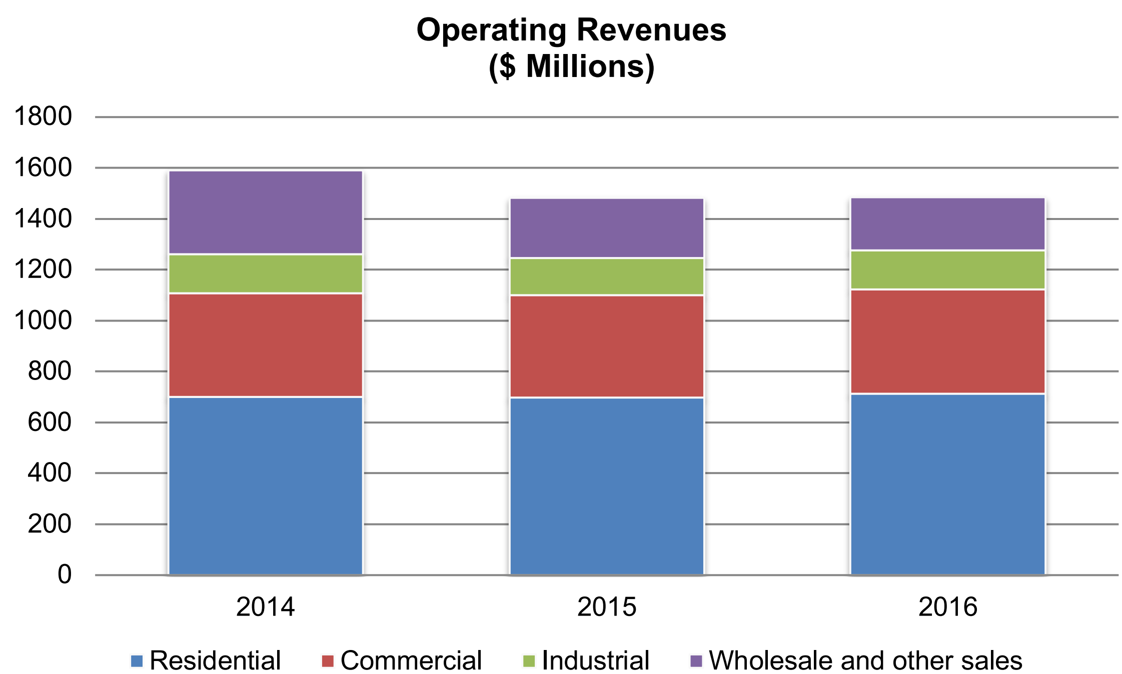

Fig. 3.6. Gulf Power Company Operating Revenues by Type of Customer, for period 2013 -2015**.** *Source*: Own Elaboration from 10-K Southern Company Financial Reports (2016: II-382)

According to Table 11, Gulf Power's Operating Revenues in 2016 were flat compared with 2015, and decreased 2.3% over 2011. The Net Income in 2016 was 10.8% lower than 2015, or $171 millions, mainly because an increase of Operating Expenses. The Operating Expenses had reduced from 85.2% of the revenues in 2011, to 81.4%, 81.6%, 82.3%, 80.4% and 80.9% in 2012, 2013, 2014, 2014 and 2016 respectively. This had result in better Net Incomes from 7.3% or $111 millions in 2011 to 9.4% in 2016, a compound annual growth rate (CAGR) of 4.75%. By the same source, Gulf Power's Total Assets were $4,822 millions at December 2016, a CAGR or 4.49% since 2011.

Table 11

Financial Results of Operation Gulf Power Company

Results of operation (in millions $)	2011	2012	2013	2014	2015	2016
Operating Revenues	1,520	1,440	1,440	1,590	1,483	1,485
Operating Expenses	1,295	1,172	1,175	1,309	1,193	1,202
Operating Income	225	268	265	281	290	283
Other Income and Expenses	58	60	56	53	49	47
Interest Expense	4	3	3	9	8	5
Income Before Income Taxes	172	211	212	237	249	231
Income Tax Expense	61	79	80	88	92	91
Net Income	111	132	132	149	157	140
Total Assets	3,872	4,177	4,338	4,708	4,920	4,822

Source: Own Elaboration from 10-K Southern Company Financial Reports for period 2011 – 2016 (2016: II-342 - II-346; 2014: II-307 - II-311; 2012: II-311 – II-315)

By the same source, as of December 31, 2016, Southern Company owns and operate 2,282 MW from solar in 33 sites across in Georgia, Texas, North Carolina, Nevada, and New Mexico (Southern Company 2016: I-39 – I-42). The largest solar facility is Desert Stateline, located in San Bernardino County, California, with 300 MW capacity. Additionally, Southern Company has 1,197,730 MW in wind capacity in seven locations in Oklahoma, Missouri, and Texas.

In April 2015, Southern Company announced that the FPSC approved Gulf Power's three energy purchase agreements totaling 120 MW of utility-scale solar generation, located at three military installations in northwest Florida: 50 MW at NAS Pensacola's NOLF Saufley, 40 MW at NAS Whiting Field's NOLF Holley, and 30 MW at Eglin Air Force Base. Purchases under these solar agreements are expected to begin by late 2017.

Utilities are increasingly asking their commissions for community solar regulation and project approval. The FPSC approved Gulf Power's Community Solar Pilot Program on April 2016, which complement the 120 MW military solar generation operations. The program offers Gulf Power's customers an opportunity to voluntarily contribute to the construction and operation of a solar photovoltaic facility with electric generating capacity of up to 1 MW through annual subscriptions.

According to Gulf Power's 2017 Ten-Year Site Plan (Southern Company 2017, 49 - 50), by 2026 it is expected to meet a net energy for load by fuel source of 12,326 GWh, with a mix of: 57.48% coal, 31.99% natural gas, 10.43% from renewable sources or 1,286 GWh with 1.87% solar, and a negative 1.44% from interchange. In 2016 total energy was 12,030 GWh with a mix of: 4,697 GWh from coal, 8,724 GWh from gas, 756 GWh from renewables.

3.2.1.5. Florida Public Utilities

According to latest 10-K Chesapeake Utilities Corporation (CUC), (Chesapeake Utilities Corporation 2017, 3 to 5), this is a Delaware corporation formed in 1947 that provides: natural gas distribution operations in Delaware, Maryland and Florida; electric distribution operations in Florida; and natural gas transmission operations on the Delmarva Peninsula and in Florida. CUC has ownership over the following subsidiaries: Aspire Energy of Ohio operates in 40 counties throughout Ohio; Chesapeake Utilities and Sandpiper Energy distribute natural gas in Delaware and Maryland; Eastern Shore Natural Gas serving customers in Delaware, Maryland and Pennsylvania; Florida Public Utilities (FPU) distributes natural gas, electricity and propane to various regions in Florida; Peninsula Energy Services Company (PESCO) provides natural gas to customers in Florida and on the Delmarva Peninsula; Peninsula Pipeline Company provides natural gas transportation services in Florida; and Sharp Energy, distributes propane to nearly 40,000 customers in Delaware, eastern Pennsylvania, Maryland and Virginia.

In 2009, Chesapeake Utilities (NYSE: CPK) acquired Florida Public Utilities, a company that has been in the energy throughout Florida since 1924 (Florida Public Utility 2017). FPU owns close to 2,841 miles of natural gas distribution across 21 Floridian counties and distributes natural gas and propane to approximately 76,000 customers 16,000 customers throughout Florida, respectively. FPU electric serves to 32,000 electricity customers, in the Calhoun, Liberty, and Jackson counties, and Amelia Island, with over 100 thousand inhabitants.

According to 10-K Chesapeake Utilities Corporation (Chesapeake Utilities Corporation 2017, 14), FPU purchases its wholesale electricity primarily from two suppliers, JEA and Gulf Power. The contracts provide generation and transmission service to northeast Florida through contracts that will expire in December 2017 and 2019, correspondingly.

As presented in Table 7, the number of FPU's customer accounts for the electric distribution increased 0.8% to 31,695 accounts in 2016, 77% of them were Residential customers and almost 23% Commercial, with only 2 industrial customers. The number of customers had been almost flat with 31,371 in 2014, 31,430 in 2015 as presented in Fig. 3.7.

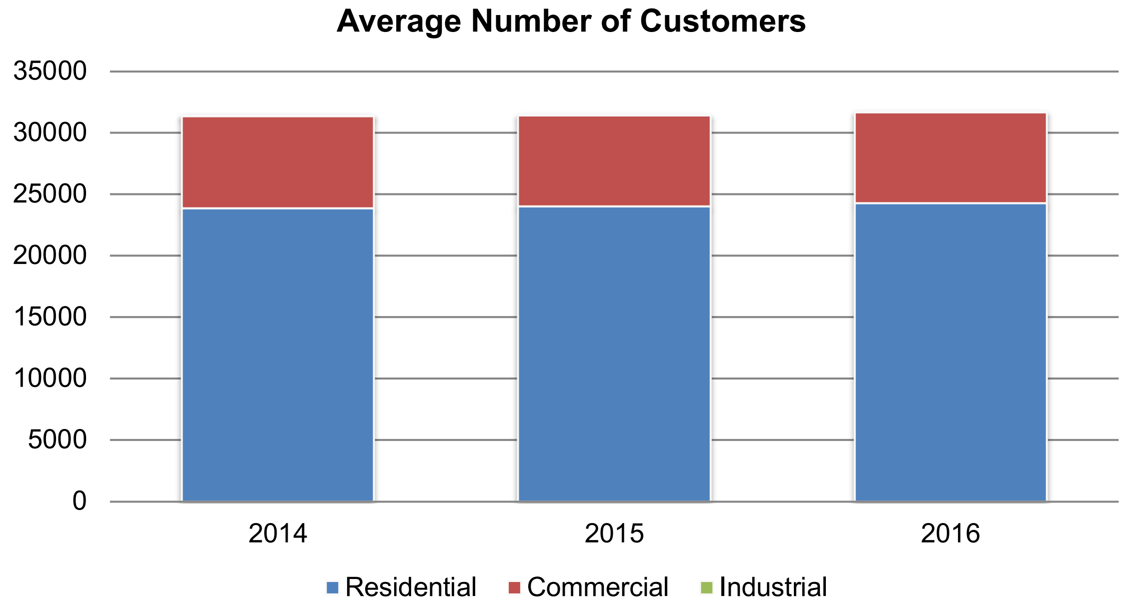

Fig. 3.7. Florida Power Utilities, Average Number of Customer of the Electric Distribution, for period 2014 -2016**.** *Source*: Own Elaboration from 10-K Chesapeake Utilities Corporation Reports (2016: 4; 2015: 5; 2014: 5)

According to 10-K Reports (Southern Company 2016: 11; Southern Company 2015: 12; Southern Company 2014: 11) FPU's Operating Revenues for the electric distribution were $84 million in 2016, $81 million in 2015, $76 million in 2014 millions and $74 millions in 2013 as presented in Fig. 3.8, and a CAGR of 4.32% in this period of time. In 2016 the Operating Revenues were originated: $47 million from the residential sector, $42 millions from the Commercial sector and $3 millions from the industrial sector, as presented in Fig. 3.8. According to same source the Operating Revenues from "Other" sources are negative because include unbilled revenue, other miscellaneous charges, fees for billing services provided to third parties, and adjustments for pass-through taxes.

Chesapeake Utilities and FPU do not have a renewable program in place. FPU has a renewable energy purchase agreement with Rayonier Performance Fibers, to purchase between 1.7 MWH and 3.0 MWH of electricity annually through 2036. Rayonier is a materials company that supplies electricity to FPU in Amelia Island.

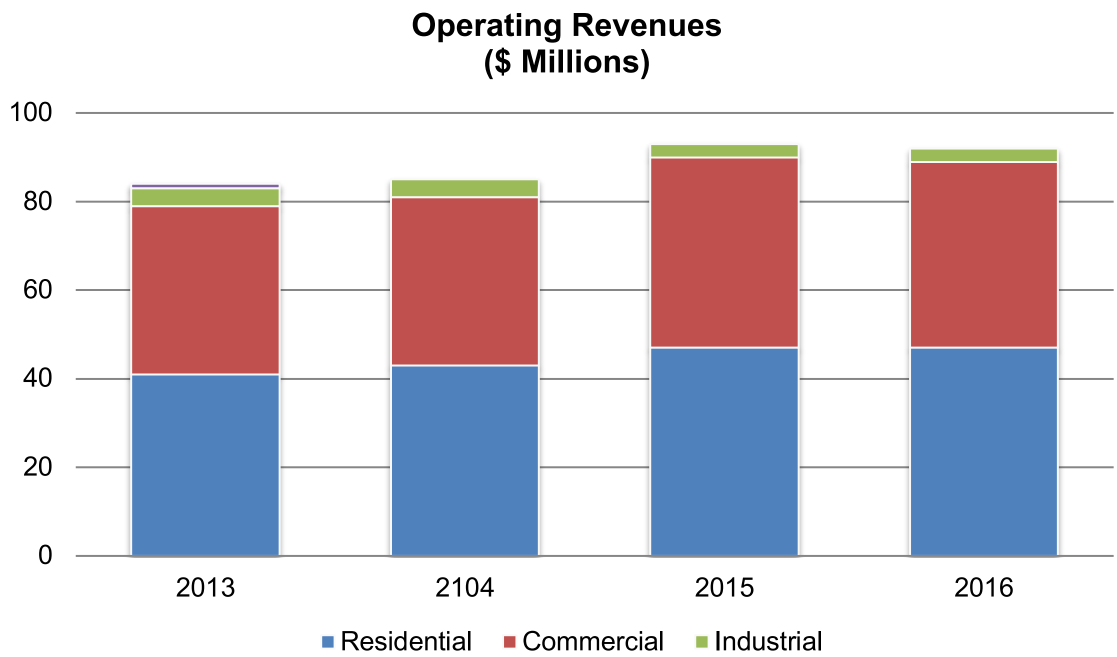

Fig. 3.8. Florida Power Utilities Operating Revenues by Type of Customer, for period 2013 -2015**.** *Source*: Own Elaboration from 10-K Chesapeake Utilities Corporation Reports (2016: 4; 2015: 5; 2014: 5; 2013: 5)

3.2.2. Municipally-owned Electric Utilities

The electric utility industry in the U.S. consist of municipal utilities, cooperatives and investor-owned utilities. The municipally-owned electric utilities are Publicly Owned Utilities (POU), with member-owned cooperatives or government or municipally owned utilities, which are generally exempt from regulation by state regulatory commissions because they are assumed to have the customers best interests in mind when setting rates and service standards. In the case of Florida, the FPSC oversight the municipally-owned electric utilities.

The municipally-owned electric utilities structure is similar to a traditional vertically integrated model where the generation and transmission is provided by other companies, and their core business is in the distribution and retail. Nevertheless, in the state of Florida, some municipal utilities have their own generation. The major limitation to this model is the lack of scale that may increase operational costs.

According to Florida Municipal Electric Association (FMEA 2017), Municipal utilities are governed either by an elected local city commission or by an appointed or elected utility board. Municipal utilities are subject to all the state's laws regarding public bodies, including open meetings law, open records laws, public bidding laws. Municipal utilities are not-for-profit, and its capital is raised through operating revenues or sale of tax-exempt bonds. Municipal electric utilities in Florida also return money to the city general fund.

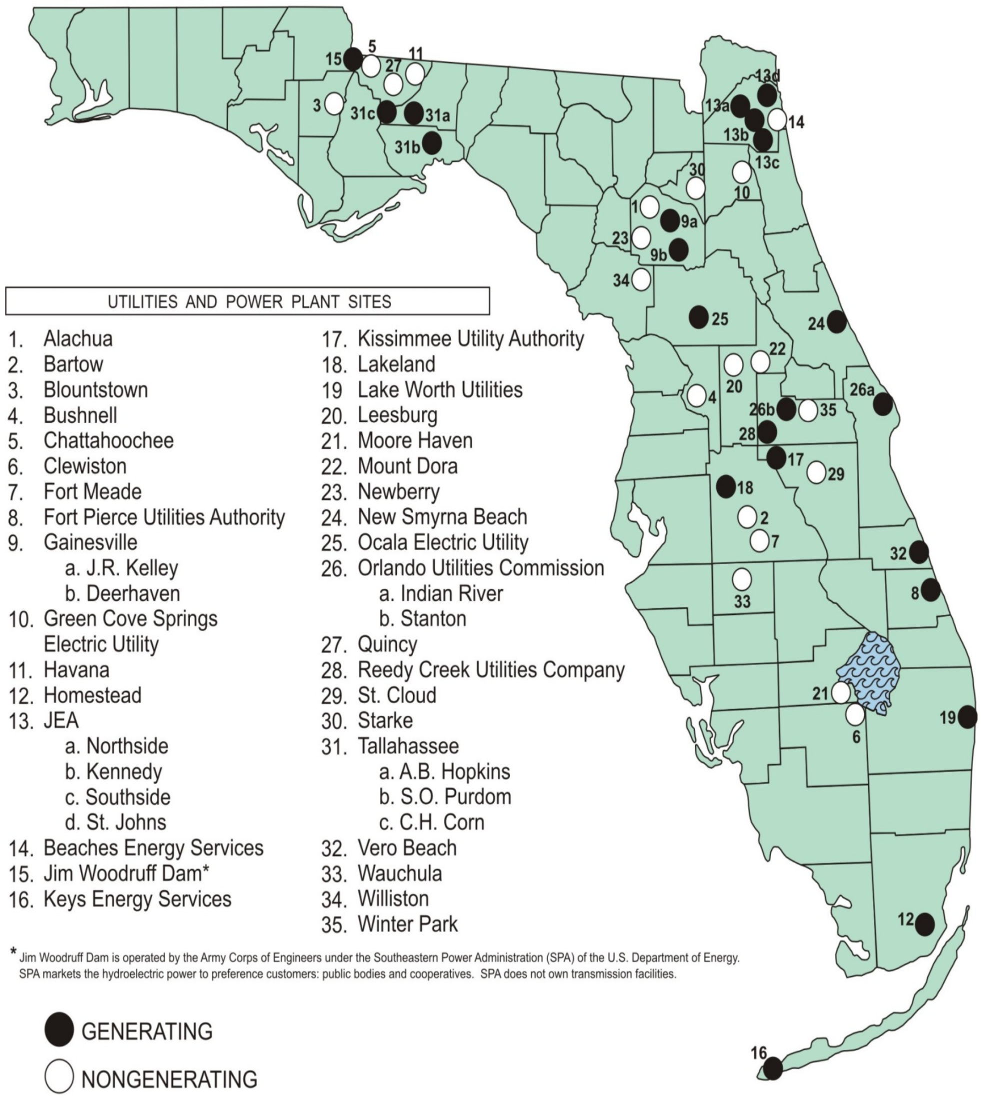

Fig. 3.9. Municipal Electric Utilities**.** *Source*: *Source*: PFCS Statistics of the Florida Electric Utility Industry, PFCS (2017e, 11)

By to FPSC's Statistics of the Florida Electric Utility Industry report (FPSC 2017e: 13 - 43; FPSC 2015b: 35 - 42; FPSC 2014: 36 - 43), there were 33 Municipal utilities in the state of Florida, as presented in Fig. 3.9, some of them with generating facilities and other with non-generating facilities. The municipal utilities represent one fifth of the served customers and energy generated by the Investor-owned Electric Utilities in Florida, as presented in Table 12, with a total energy generated of 35,174 Gigawatt-hours in 2015 or 20.2% higher than 2010, serving almost 1.5 million customers, a decrease of 17.5% from over 1.8 million customers in 2010. Eight municipal utilities serve to over 1.2 million customers or 80% of total municipal utilities. From the number of customer size, the major utilities in this sector that represent the 81.3% of total customers, and 80% of total energy generated by all municipal utilities. These are:

- JEA
- Orlando Utilities Commission
- Lakeland
- Tallahassee
- Gainesville Regional Utilities
- Kissimmee Utility Authority
- Beach Energy Services, and
- Vero Beach

In the state of Florida, the following utilities are governed as a utility authority by an appointed board:

- JEA
- Orlando Utilities Commission
- Kissimmee Utility Authority
- New Smyrna Beach Utilities Commission

According to Table 12, JEA served the highest number of customers, followed by Orlando Utilities Commission, Lakeland and Tallahassee, with 449,263 customers, 290,915, 125,666 and 117,827 customers respectively. In 2015, the four municipality utilities served to 983,671 customers, generating over 23,315 Gigawatt-hours or 66.3% of total energy generated by all municipal utilities.

According to FPSC Interconnection and Net Metering of Customer-Owned Renewable Generation Reports (FPSC 2017b), it was 2,375 renewable generation interconnections in 2016, from 614 in 2011 to the Municipally-owned Electric Utilities. In the 2016, 34.6% of these interconnections were from customers to JEA, 11.0% to Orlando Utilities Commission and 10.9% to Gainesville Regional Utilities, very similar than previous years. In the same year, the Solar Gross Power Rating (AC) was 5,070 KW to JEA, 4,060 KW to Orlando Utilities Commission and 3,047 KW to Tampa Electric Company Gainesville Regional Utilities, from a total of 18,756 KW to this type of utilities.

3.2.2.1. Jacksonville Electric Authority (JEA)

JEA, founded in 1895, is the eighth-largest community-owned electric utility in the United States and one of the largest water and sewer utilities in the nation providing electric, water and sewer service to residents and businesses in northeast Florida: Duval and Nassau counties and parts of St. Johns and Clay counties.

According to JEA 2016 Annual Report (JEA 2017, 18), and Table 12, JEA operates in an area of 900 square miles and served over 455 thousand electric retail customers in 2016, and 2015, and generated over 11,090 GW H in 2015, a decrease of 3.3% from 2010. The number of JEA's customer accounts for the electric distribution increased 5.4% from 2015, to 449,263 accounts in 2016. JEA's electric generation mix in the same year was 42% from coal, 32% natural gas, 15% petroleum coke, and 11% for other sources including solar. In addition, JEA served to 337,217 water customers and 260,937 sewer customers in 2016.

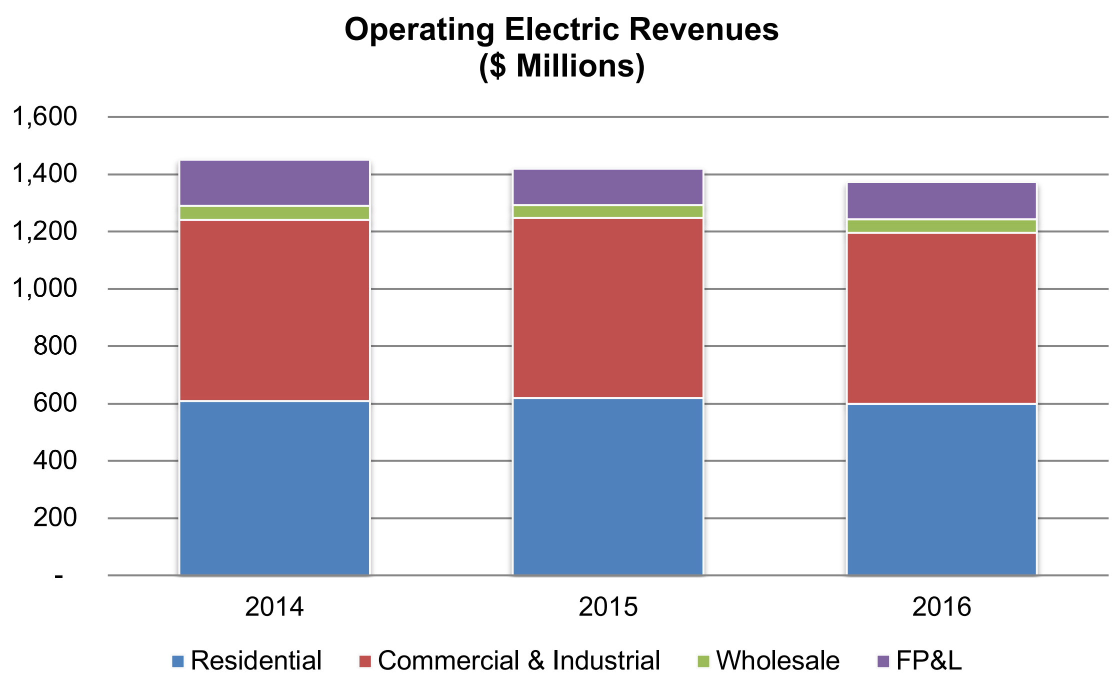

Fig. 3.10. JEA Operating Revenues from Electric Sector by Type of Customer, for period 2014 -2016**.** *Source*: Own Elaboration from JEA 2016, Annual Report (2016: 20, 24)

According to Table 13, JEA's Operating Revenues in 2016 from 2010 had a negative CAGR of 4.13%, almost similar to its operating expenses of negative CAGR of 4.44%. Nevertheless, the Net Income before taxes in 2016 was 19.8% higher than 2015, or $235 millions, mainly because a reduction on the Operating Expenses in that year. The Operating Expenses had fluctuated from 76.9% of the revenues in 2011, to 76.4%, 81.6%, 80.8%, 77.5% and 75.7% in 2012, 2013, 2014,

Table 12
Energy Generated and Number of Customers by Municipal Electric Utilities 2010 – 2017

	2010	2011	2012	2013	2014	2015	2016
Total Energy Generated (MWh)	***29,271,561***	***28,104,049***	***21,727,404***	***21,709,979***	***35,318,905***	***35,173,859***	***36,489,009***
Alachua	124,258	121,942	NR	NR	116,659	121,530	130,432
Bartow	282,377	264,361	257,599	257,304	261,505	273,041	277,393
Beaches Energy Services	NR	732,175	699,527	687,865	702,194	713,708	722,486
Blountstown	NR	NR	NR	NR	36,307	35,439	35,345
Bushnell	25,211	23,692	NR	NR	23,801	23,252	23,892
Chattahoochee	44,023	41,037	36,104	35,796	36,574	37,890	37,277
Clewiston	103,275	98,396	96,278	93,753	95,925	100,978	101,094
Fort Meade	42,088	39,888	38,857	38,967	39,295	40,512	40,878
Fort Pierce Utilities Authority	535,567	529,703	515,941	516,235	518,446	550,871	551,618
Gainesville Regional Utilities	1,824,502	1,769,222	1,699,935	1,694,401	1,708,818	1,765,193	1,796,293
Green Cove Springs	118,068	110,894	NR	NR	96,513	111,677	106,946
Havana	NR	24,546	NR	NR	24,107	24,079	23,483
Homestead	397,418	451,500	NR	NR	493,636	535,095	526,881
JEA	13,103,903	12,740,038	11,906,884	11,829,364	12,224,128	11,090,657	12,215,148
Key Energy Services	691,923	707,164	702,495	707,235	715,008	751,178	742,272
Kissimmee Utility Authority	1,360,922	1,346,630	1,333,923	1,350,728	1,383,233	1,472,391	1,521,688
Lake Worth Utilities Authority	398,157	NR	NR	NR	373,598	430,307	434,758
Lakeland	2,955,211	2,955,211	2,770,042	2,832,342	2,904,061	3,034,075	3,029,959
Leesburg	501,379	470,194	453,107	455,380	441,239	470,555	473,329

Moore Haven	16,737	NR	NR	NR	12,933	16,178	15,135
Mount Dora	93,114	88,836	84,632	85,683	87,009	89,184	89,184
New Smyrna Beach	395,853	376,774	365,076	372,081	386,381	396,602	414,356
Newberry	NR	NR	NR	NR	32,774	33,986	34,480
Ocala Electric Utility	1,273,758	NR	NR	NR	1,221,227	1,256,904	1,296,691
Orlando Utilities Commission**	3,011,443	3,223,235	NR	NR	6,210,381	6,535,984	6,598,932
Quincy	NR	NR	NR	NR	125,747	123,847	120,177
Reedy Creek Utilities Company	1,163,116	1,138,348	NR	NR	1,127,952	1,149,020	1,154,677
Starke	72,252	70,068	65,387	64,825	66,269	67,841	68,775
Tallahassee	NR	NR	NR	NR	2,637,695	2,654,983	2,639,582
Vero Beach	737,006	720,450	701,617	688,020	704,939	738,209	736,094
Wauchula	NR	59,745	NR	NR	59,712	63,349	59,293
Williston	NR	NR	NR	NR	30,316	31,935	33,229
Winter Park	NR	NR	NR	NR	420,523	433,409	437,232
Total Number of Customers	***1,812,527***	***1,348,039***	***1,094,205***	***1,105,726***	***1,653,962***	***1,496,226***	***1,519,066***
Alachua	4,265	4,168	NR	NR	4,423	4,482	4,522
Bartow	11,634	11,618	11,603	11,736	11,876	12,036	12,195
Beach Energy Services	NR	33,319	33,260	33,929	34,282	34,903	34,601
Blountstown	NR	NR	NR	NR	1,349	1,312	1,324
Bushnell	1,072	1,026	NR	NR	1,021	1,031	1,040
Chattahoochee	1,228	1,205	1,175	1,162	1,156	1,157	1,161
Clewiston	4,160	4,195	4,167	4,206	4,237	4,289	4,315
Fort Meade	2,748	2,711	2,711	2,722	2,652	2,803	2,660
Fort Pierce Utilities Authority	27,757	27,750	27,717	27,738	28,166	28,251	28,306
Gainesville Regional Utilities	92,340	92,265	92,556	93,134	93,855	94,628	95,161

Green Cove Springs	3,927	3,801	NR	NR	3,865	3,921	4,058
Havana	NR	1,355	NR	NR	1,391	1,427	1,448
Homestead	21,713	22,369	NR	NR	23,032	23,211	24,031
JEA	412,796	409,193	413,017	419,299	426,373	449,263	456,894
Keys Energy Services	29,908	30,171	30,282	30,406	30,752	31,167	30,002
Kissimmee Utility Authority	62,199	63,167	64,297	65,370	66,608	68,396	70,400
Lake Worth Utilities	24,693	NR	NR	NR	25,783	26,558	26,236
Lakeland	121,697	121,747	122,057	122,803	124,018	125,666	127,152
Leesburg	22,547	22,509	22,478	22,709	23,483	23,793	24,597
Moore Haven	1,008	NR	NR	NR	1,017	863	1059
Mount Dora	5,689	5,663	5,705	5,680	5,712	5,798	5,828
New Smyrna Beach	25,078	25,401	25,581	25,869	26,375	26,740	27,561
Newberry	NR	NR	NR	NR	1,687	1,723	1,774
Ocala Electric Utility	477,975	NR	NR	NR	49,168	51,896	50,187
Orlando Utilities Commission**	220,306	223,618	NR	NR	278,790	290,915	300,179
Quincy	NR	NR	NR	NR	4,796	4,767	4,783
Reedy Creek Utilities Company	1,283	1,301	NR	NR	1,374	1,387	1,463
Starke	2,715	2,699	2,691	2,686	2,731	2,759	2,779
Tallahassee	NR	NR	NR	NR	116,709	117,827	119,005
Vero Beach	33,806	33,598	33,722	33,924	34,616	34,538	34,893
Wauchula	NR	2,641	NR	NR	2,680	2,775	2,798
Williston	NR	NR	NR	NR	1,473	1,552	1,707
Winter Park	NR	NR	NR	NR	14,150	14,392	14,947

Source: Own Elaboration from Statistics of the Florida Electric Utility Industry, for period 2010 -2015; FPSC (2017a: 36, 43; 2015b: 36,42; 2014: 35; 2013: 33; 2012: 32; 2011: 32; 2010: 32, 42)

2015 and 2016 respectively. This had result in better Incomes before Income Taxes from 12.8% or $215 millions in 2011 to 17.2% in 2016, a compound annual growth rate (CAGR) of 1.79%. By the same source, JEA's Total Assets were $5,314 millions at September 2016, an almost flat CAGR or -0.65% since 2011.

JEA is the only utility in the state of Florida with a formalized commitment to generate at least 7.5% of its electric energy from renewable energy sources by 2015. According to JEA Ten Year Plan (JEA 2017, 12-13) in 2009, JEA entered into a 30-year purchase power agreement with Jacksonville Solar, LLC for the produced energy from a solar farm, which has been constructed in a 100- acre site in JEA service territory. The facility, which consists of 200,000 photovoltaic panels generates 21 GW H of electricity per year.

Table 13
Financial Results of Electric Operation, JEA

Results of operation (in millions $)	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Operating Revenues	1,684	1,525	1,432	1,480	1,370	1,364
Operating Expenses	1,295	1,165	1,169	1,196	1,062	1,032
Operating Income	389	360	263	284	308	332
Other Income and Expenses	292	25	3	23	19	23
Interest Expense	203	168	158	146	130	120
Income Before Income Taxes	215	217	102	161	197	235
Income Tax Expense						
Net Income						
Total Assets	5,491	5,407	5,272	5,145	5,284	5,314

Source: Own Elaboration from JEA Annual Reports, for period 2011 - 2016 (2016: 22-23, 100-101; 2015: 89; 2014: 109-110; 2013: 108-109; 2012: 115-116; 2011: 104-105)

In 2014, the Board established a solar policy to add up to 38 MW of solar capacity to the system, with the operation of six PPAs, representing a total of 26 MW, distributed around service territory. In 2016, JEA announced the commercial operation of the 7 MW solar farm in Jacksonville, Florida, in partnership with groSolar, AEP OnSite Partners and American Electric Power. JEA has achieved 95 MW of renewable power capacity in 2016.

In 2016, JEA announced the SolarSmart rate program, giving customers the opportunity to invest and participate in solar energy in Jacksonville, even if customer doesn't have a rooftop. The program allows customers to subscribe for up to 100% of their energy to come from solar facilities that have been deployed in the Jacksonville-area.

3.2.2.3. Orlando Utilities Commission (OUC)

According to OUC (2017a) in 1922, the city of Orlando bought Orlando Water & Light Co, a private company in operation since 1901, and in 1923, the state Legislature granted the city a charter to establish the Orlando Utilities Commission to operate electric and water municipal utilities. OUC is a municipal utility owned by the citizens of Orlando, that provides electricity and water services to over 246,000 customers in Orlando, St. Cloud, and parts of Orange and Osceola counties, serving to more than 342,000 people. According to Table 12, OUC is the second largest municipal utility in Florida.

According to OUC 2016 Annual Report (OUC 2018: 18), OUC has own and operated agreements for its generation, with a net capacity of 1,484 MW from 300MW own generation and the rest under undivided ownership interests, plus a 15% of reserve margin. In the electric sector, OUC had 233,411 customers in average in 2016, with electric sales of 7,915 GWH, a CAGR of 3.27% since 2012, and an average annual revenue per customer of $370.59, as presented in Table 14, that had decreased from the $397.31 of 2012.

Table 14
Statistical Highlights, Orlando Utilities Commission (OUC)

Statistical Highlights	2012	2013	2014	2015	2016
Average Number of Customers	214,945	214,424	220,628	226,300	233,411
Electric sales (MWH)	6,958,465	7,011,759	7,551,150	7,731,958	7,914,684
Average annual residential usage (KWH)	11,192	11,134	11,488	11,760	11,999
Average annual revenue per customer	$397.31	$384.75	$398.86	$379.58	$370.59

Source: Own Elaboration from OUC Annual Reports, for period 2012 - 2016 (2016: 1; 2015: 1; 2013: 8)

According to Table 15, OUC's Operating Revenues in 2016 from 2011 had a negative CAGR of 0.25%, from $876 millions to $865 millions. The Operating Expenses also had a negative CAGR of 0.30% providing a Net Income before taxes in 2016 of just 2.1%% higher than 2015, or $98 millions, almost similar than 2015. The Operating Expenses had fluctuated from 84.5% of the revenues in 2011, to 86.1%, 85.8%, 85.0%, 84.2% and 84.3% in 2012, 2013, 2014, 2014 and 2016 respectively. This had result in better Incomes before Income Taxes from 8.9% or $78 millions in 2011 to 11.3% in 2016, a compound annual growth rate (CAGR) of 4.67%. By the same source, JEA's Total Assets were $3,606 millions at December 2016, an almost flat CAGR or 1.23% since 2011.

By Orlando Utilities Commission 2017 Ten-Year Plan (OUC 2017b, 20), the mix of generation capacity in 216 was based on 56.0% from natural gas, approximately 40.8 percent from coal, and 3.2% from nuclear.

Table 15
Financial Results of Operation, Orlando Utilities Commission (OUC)

Results of operation (in millions $)	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Operating Revenues	876	854	825	880	859	865
Operating Expenses	740	735	708	748	723	729
Operating Income	136	119	117	132	136	136
Other Income and Expenses	21	24	19	17	19	19
Interest Expense	79	70	62	60	59	57
Income Before Income Taxes	78	73	74	89	96	98
Income Tax Expense						
Net Income						
Total Assets	3,393	3,310	3,262	3,319	3,557	3,606

Source: Own Elaboration from OUC Annual Reports, for period 2012 - 2016 (2016: 1, 7; 2015: 1, 7; 2013: 8, 18)

According OUC 2016 Annual Report (OUC 2016, 3), OUC has a strategic goal of generating 20 percent of retail sales from clean energy by 2020, which requires investment in both landfill gas and solar generation. To achieve this goal OUC had invested in generation based on natural gas, as stated before, and implemented by 2016 the following solar portfolio:

- Installed Orlando's first solar-powered electric vehicle charging stations (2010)
- Built first solar farm in Orange County (2012)
- Built Central Florida's first community solar farm (2013)
- Curtis Stanton Energy Center, a nearly 6 MW solar farm, which was expanded to 12 MW, with panels blanketing more than 31 acres, to be in operation by 2018.

3.2.3. Rural Electric Cooperatives

Because the cost of providing service in the non-urban areas was unaffordable, and the investor-owned utilities refused to extend their service into non-urban areas until there was enough development to make a profit, President Roosevelt signed an executive order in 1935 creating the Rural Electrification Administration, and in 1936 the Rural Electrification Act was signed into law. The Act allowed local farmers, residents and businesses to join together to create their own non-for-profit electric utilities, and brought electricity to their communities at cost of electric service to their members. The first Florida co-ops were incorporated in 1937.

Rural Electric Cooperatives are private nonprofit entities governed by a board elected by the customers of the utility, where members of the cooperative work together for a common goal, and share in the profits of the Cooperative based on their annual energy charges. At the end of 2016, there were 864 Distribution and 66 Generation & Transmission cooperatives that deliver approximately 10 percent of the total kilowatt hours sold in the U.S. each year.

According to FPSC's Statistics of the Florida Electric Utility Industry report (FPSC 2017e: 32 – 40; FPSC 2015: 35 - 42; FPSC 2014: 36 - 43), there were 16 distribution cooperatives in the state of Florida in 2016, as presented in Fig. 3.11, and 2 generating cooperatives, in 86% of Florida's 67 counties, that collectively serve over 1.12 million inhabitants from close to 840 thousand customers in 2010, as presented in Table 16. The Rural Electric Cooperatives represent 14.3% of the served customers and 11.3% of the energy generated by the Investor-owned Electric Utilities in Florida, with a total of 20,264 Gigawatt-hours in 2015 or 26.9% higher than 2010.

Four Rural Electric Cooperatives served to over 780 thousand customers or 70% of total rural electric cooperatives' customers that represent the 70% of total energy generated by all these utilities. These are:

- Withlacoochee River Co-op
- Lee County Electric Co-op
- Sumter Electric Co-op, and
- Clay County Electric Co-op

According to Table 16, Withlacoochee River served the highest number of customers, followed by Lee County Electric, Sumter Electric and Clay County Electric, with 211,243 customers, 211,685, 194,964 and 172,861 customers respectively in 2016. In same year, the four rural electric cooperatives generated over 13,900 Gigawatt-hours or 70.1% of total energy generated by all cooperatives.

According to FPSC Interconnection and Net Metering of Customer-Owned Renewable Generation Reports (FPSC 2017b), it was 2,047 renewable generation interconnections in 2016, from 549 in 2011 to Rural Electric Cooperatives. In the 2016, 23.6% of these interconnections were from customers to Sumter Electric Cooperative, 21% to Clay Electric Cooperative, 16% to Lee County Electric and 15.6% to Withlacoochee River Electric Cooperative, very similar than previous years. In the same year, the Solar Gross Power Rating (AC) was 3,074 KW to Sumter Electric Cooperative, 2,662 KW to Clay Electric Cooperative, 1,913 to Lee

County Electric and 1,908 KW to Withlacoochee River Electric Cooperative, from a total of 12,720 KW to this type of utilities.

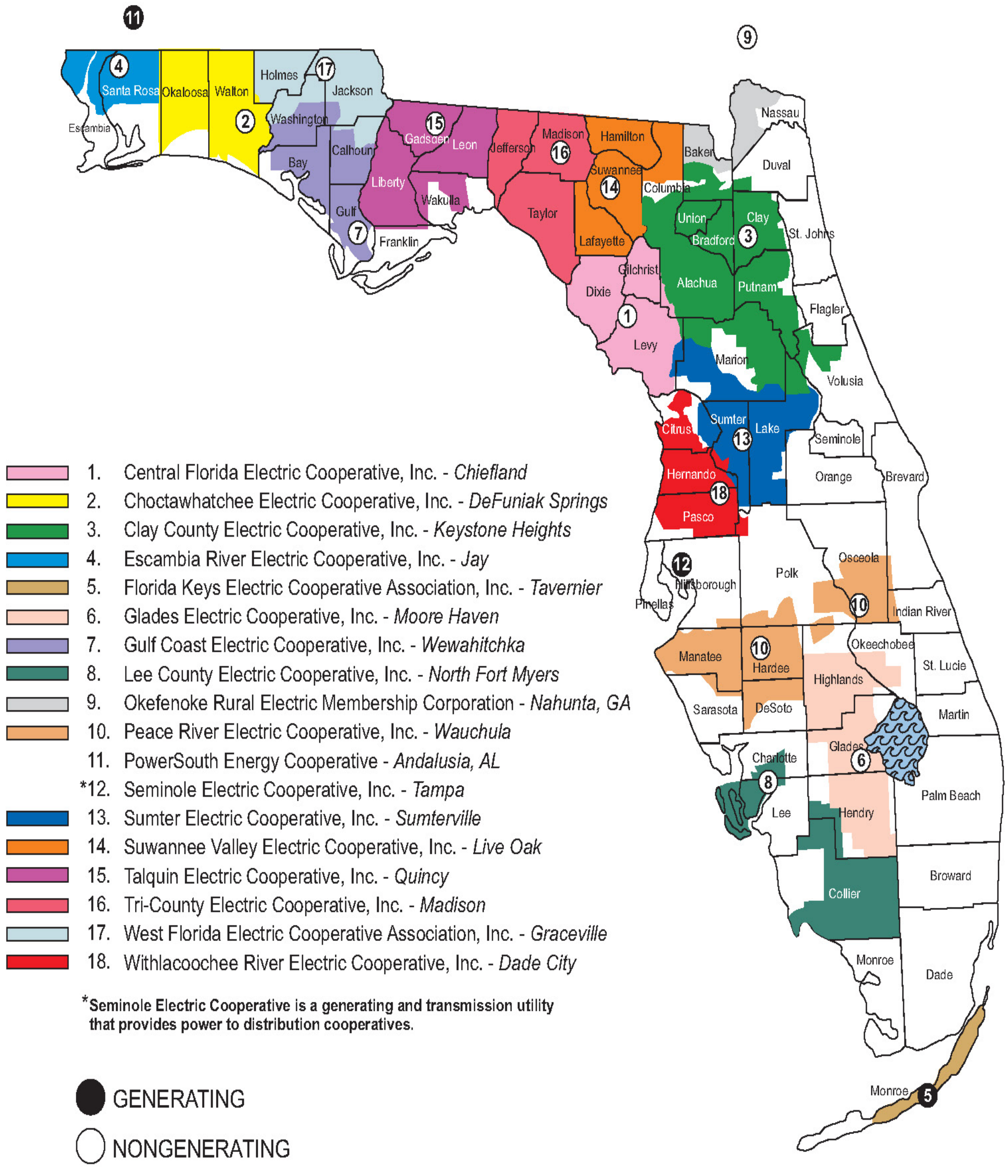

Fig. 11. Rural Electric Utilities**.** *Source*: *Source*: PFCS Statistics of the Florida Electric Utility Industry., PFCS (2017e, 6)

Table 16
Energy Generated and Number of Customers by Rural Electric Cooperatives

	2010	2011	2012	2013	2014	2015	2016
Total Energy Generated (MWh)	***15,969,862***	***13,152,478***	***13,087,555***	***13,249,615***	***19,166,169***	***19,840,526***	***20,264,205***
Central Florida Electric Co-op	507,071	457,935	445,997	447,305	464,089	471,129	491,417
Choctawhatchee Electric Co-op	780,435	777,145	731,688	748,286	805,232	818,143	835,460
Clay County Electric Co-op	3,327,933	3,163,768	2,971,589	3,012,976	3,127,781	3,152,976	3,279,354
Escambia River Electric Co-op	177,917	167,951	NR	NR	177,604	175,021	174,820
Florida Keys Electric Co-op	639,829	651,920	640,872	659,748	679,462	720,650	709,568
Glades Electric Co-op	337,068	NR	311,001	305,418	307,948	315,608	315,891
Gulf Coast Electric Co-op	357,598	329,775	NR	NR	336,426	339,769	341,231
Lee County Electric Co-op	NR	NR	NR	NR	3,570,274	3,790,662	3,800,338
Okefenoke Rural Electric Membership Co-op	142,692	163,585	153,875	151,761	157,544	157,160	161,794
Peace River Electric Co-op	621,149	595,154	599,868	602,492	624,492	679,718	708,465
Sumter Electric Co-op	2,954,744	2,764,711	2,771,266	2,836,670	2,982,645	3,149,363	3,238,522
Suwannee Valley Electric Co-op	461,067	452,801	425,422	442,172	479,238	505,520	533,673
Talquin Electric Co-op	1,079,716	NR	NR	NR	965,142	955,069	953,400
Tri-County Electric Co-op	NR	NR	NR	NR	298,986	300,179	310,193
West Florida Electric Co-op	504,165	NR	465,858	477,632	504,163	498,390	495,708
Withlacoochee River Electric Co-op	4,078,478	3,627,733	3,570,119	3,565,155	3,685,143	3,811,169	3,914,371
Total Number of Customers	***839,983***	***747,151***	***831,188***	***845,757***	***1,163,851***	***1,115,022***	***1,128,965***
Central Florida Electric Co-op	32,816	32,638	32,608	32,641	32,734	32,943	33,176

Choctawhatchee Electric Co-op	42,714	43,311	44,302	45,290	46,656	47,291	48,675
Clay County Electric Co-op	166,708	166,171	231,624	237,625	239,735	170,429	172,861
Escambia River Electric Co-op	9,971	9,957	NR	NR	10,254	10,467	10,700
Florida Keys Electric Co-op	31,124	31,204	31,535	31,832	32,292	32,415	32,723
Glades Electric Co-op	16,290	NR	16,034	16,054	16,180	16,373	16,368
Gulf Coast Electric Co-op	20,233	20,173	NR	NR	20,013	20,274	20,565
Lee County Electric Co-op	NR	NR	NR	NR	204,023	208,626	211,685
Okefenoke Rural Electric Membership Co-op	9,975	9,947	9,939	10,028	10,037	10,999	10,189
Peace River Electric Co-op	33,060	33,368	34,059	34,848	36,387	38,674	40,296
Sumter Electric Co-op	172,171	174,949	177,078	181,674	187,106	193,110	194,964
Suwannee Valley Electric Co-op	24,756	24,884	24,964	25,244	25,426	25,415	25,648
Talquin Electric Co-op	52,221	NR	NR	NR	52,894	53,213	53,593
Tri-County Electric Co-op	NR	NR	NR	NR	17,716	17,830	17,932
West Florida Electric Co-op	27,961	NR	27,859	28,168	28,036	28,202	28,347
Withlacoochee River	199,983	200,549	201,186	202,353	204,362	208,761	211,243

Source: Own Elaboration from Statistics of the Florida Electric Utility Industry, for period 2010 -2015; FPSC (2015b: 36,42; 2014: 35; 2013: 33; 2012: 32; 2011: 32; 2010: 32, 42)

3.2.3.1. Withlacoochee River Electric Co-op (WREC)

The first member Withlacoochee River Electric was connected on April 4, 1947, WREC is the third largest electric cooperative in the nation and the largest in the state of Florida with approximately 210,000 accounts in 2016, according to its 2016 annual report (WREC 2016, 3). WREC service area covers the rural areas of Pasco, Hernando, Polk, Sumter and Citrus Counties as presented in Fig 3.11. As a non-profit entity, any funds remaining at the end of the year are returned to the membership through the Capital Credits process and Revenue Rate Reductions. According the same source (WREC 2016, 17), and has returned over $25 millions in Capital Credits.

WREC had 210,436 customers in average in 2016, with electric sales of 3,914 GWH, a CAGR of 2.33% since 2012, and an average annual revenue per customer of $210.04, as presented in Table 17, almost flat from the $209.26 of 2012. WREC is the largest Rural Electric Cooperative in Florida, followed very closely by Lee County Electric Co-op.

Table 17
Statistical Highlights Withlacoochee River Electric (WREC)

	2012	2013	2014	2015	2016
Average Number of Customers	201,186	202,353	204,365	207,320	210,436
Electric sales (MWH)	3,570,119	3,565,154	3,685,142	3,811,169	3,914,371
Average annual residential usage (KWH)	13,584	13,572	13,980	14,232	14,388
Average annual revenue per customer	$209.26	$208.05	$216.77	$220.91	$210.04

Source: Own Elaboration from WREC Annual Reports, for period 2012 - 2016 (2016: 15; 2015: 13; 2013: 12)

According to Table 18, WREC's Operating Revenues in 2016 from 2011 had a CAGR of 1.22%, from $421 millions to $442 millions. The Operating Expenses were flat to $397 millions in 2016, providing a Net Income before taxes in 2016 of 7.3% higher than 2015, or $44 millions, and $41 millions in 2015. The Operating Expenses had fluctuated from 91.7% of the revenues in 2011, to 91.0%, 89.6%, 90.8%, and 89.8% in 2012, 2013, 2014 and 2015 respectively. This had result in better Incomes before Income Taxes from 6.2% or $26 millions in 2011 to 10.0% in 2015, a compound annual growth rate (CAGR) of 14.06%. By the same source, WREC's Total Assets were $1,012 millions at December 2015, an increase in CAGR or 4.0% since 2011.

WREC does not install or supply PV Systems, but provides an interconnection to the electric utility grid to its customers, allowing net metering. Nevertheless, Seminole Electric Cooperative, provided renewable energy portfolio in last 2015 and 2016 by building a 2.2 MW solar farm in Hardee County, Florida (WREC 2016, 4).

Table 18
Financial Results of Operation Withlacoochee River Electric (WREC)

Results of operation (in millions $)	**2012**	**2013**	**2014**	**2015**	**2016**
Operating Revenues	421	421	443	458	442
Operating Expenses	386	383	397	416	397
Operating Income	35	38	46	42	45
Other Income and Expenses	10	13	16	16	16
Interest Expense	19	19	19	17	17
Income Before Income Taxes	26	32	43	41	44
Income Tax Expense					
Net Income	26	31	43	41	44
Total Assets	865	894	914	965	1,012

Source: Own Elaboration from WREC Annual Reports, for period 2012 - 2016 (2016: 16; 2015: 16; 2013: 11-12)

3.2.3.2. Lee County Electric Cooperative (LCEC)

George Judd, an orange grower, sold the North Fort Myers Mariana Grove power plant in 1940 to the members who lived in North Fort Myers area. Since them, Lee County Electric Cooperative has been serving Southwest Florida, expanding to the areas Chokoloskee Island, Collier County, Marco Island, Golden Gate Estates, and sections of Alligator Alley, as showed in Fig. 3.11.

According to Lee County Electric Cooperative 2016 Annual Report (LCEC 2016, 2-3) and Table 16, LCEC is the second largest cooperatives in the state of Florida. As presented in Table 19, LCEC had 211,685 customers in average in 2016, with electric sales of 3,800 GWH, a CAGR of 2.49% since 2012, and an average annual revenue per customer of $185.18, as presented in Table 19, almost flat from the $199.12 of 2012. LCEC.

According to Table 20, LCEC's Operating Revenues in 2016 from 2011 had an almost flat CAGR of -0.38%, from $398 millions to $392 millions. The Operating Expenses were flat to $370 millions in 2016, providing a Net Income before taxes in 2016 of 30% higher than 2015, or $13 millions, and $10 millions in 2015. The Operating Expenses had been flat from 94.2% of the revenues in 2011, to 93.5%, 94.9%, 95.4%, and 94.4% in 2012, 2013, 2014 and 2015 respectively. This had result in low Incomes before Income Taxes from 3.8% or $15 millions in 2011 to

3.3% in 2015, a compound annual growth rate (CAGR) of 4.0%. By the same source, LCEC's Total Assets were $679 millions at December 2015, an increase in CAGR or 4.0% since 2011.

Table 19
Statistical Highlights, Lee County Electric Cooperative (LCEC)

	2012	2013	2014	2015	2016
Average Number of Customers	199,882	202,629	205,422	208,626	211,685
Electric sales (MWH)	3,443,983	3,458,475	3,570,274	3,790,662	3,800,338
Average annual residential usage (KWH)	12,672	12,636	13,032	13,800	13,704
Average annual revenue per customer	$199.12	$197.41	$198.62	$197.00	$185.18

Source: Own Elaboration from LCEC Annual Reports, for period 2012 - 2016 (2016: 2; 2015: 36; 2013: 1)

LCEC doesn't have any renewable project implemented at July 2017, and no plans for implementing by themselves any solar PV system. LCEC has developed a program to interconnect customers' renewable generation systems (RGS) including photovoltaic systems (PV) to LCEC's power grid, based on existing state and federal renewable energy programs.

Table 20
Financial Results of Operation Lee County Electric Cooperative (LCEC)

Results of operation (in millions $)	2012	2013	2014	2015	2016
Operating Revenues	398	400	408	411	392
Operating Expenses	375	374	387	392	370
Operating Income	23	26	21	19	22
Other Income and Expenses	6	6	3	2	3
Interest Expense	14	13	13	11	12
Income Before Income Taxes	15	19	11	10	13
Income Tax Expense					
Net Income	15	19	11	10	13
Total Assets	662	685	641	658	679

Source: Own Elaboration from LCEC Annual Reports, for period 2012 - 2016 (2016: 3; 2015: 36; 2013: 1)

3.2.3.3. Clay County Electric Cooperative (CEC)

Clay Electric Cooperative was organized in 193, as presented in Fig. 3.11 the CEC area of service expanses into 14 North Florida counties: Alachua, Baker, Bradford, Clay, Columbia, Flagler, Gilchrist, Lake, Levy, Marion, Putnam, Suwannee, Union and Volusia. CEC acquires its energy from Seminole Electric Cooperative as well as to eight other distribution cooperatives in the state of Florida.

According Table 21, CEC had 172,983 customers in average in 2016, with electric sales of 3,279 GWH, a CAGR of 2.79% since 2013, an average annual revenue per customer of $208.11, almost flat from the $202.81 of 2013. These statistics are very similar than other Electric Cooperatives in the state of Florida.

Table 21

Statistical Highlights Clay County Electric Cooperative (CCE)

	2013	**2014**	**2015**	**2016**
Average Number of Customers	167,647	168,641	170,711	172,983
Electric sales (MWH)	3,019,124	3,115,488	3,152,976	3,279,353
Average annual residential usage (KWH)	13,536	14,052	14,052	14,268
Average annual revenue per customer	$202.81	$218.81	$212.05	$208.11

Source: Own Elaboration from CEC Kilowatt, for period 2013 - 2016 (2016: 9; 2015: 5; 2014: 6)

According to Table 22, CCE's Operating Revenues in 2016 from 2011 had an almost flat CAGR of 1.92%, from $340 millions to $360 millions and almost flat for the last three years. The Operating Expenses were almost flat to $338 millions in 2016, providing a Net Income before taxes in 2016 of 21.7% lower than 2015, or $18 millions, and $23 millions in 2015. The Operating Expenses had been flat from 95.0% of the revenues in 2013, to 92.4%, 92.8%, and 93.9% in 2014, 2015 and 2016 respectively. This had result in low Net Incomes before Income Taxes from 3.5% or $12 millions in 2011 to 5.0% in 2015, a compound annual growth rate (CAGR) of 14.47% because higher net incomes in 2014 and 2015. By the same source, LCEC's Total Assets were $637 millions at December 2016, an increase in CAGR or 3.71% since 2013. These statistics are also very similar than the other two Electric Cooperatives previously analyzed in the state of Florida.

Table 22

Financial Results of Operation Clay County Electric Cooperative (CCE)

Results of operation (in millions $)	**2013**	**2014**	**2015**	**2016**
Operating Revenues	340	369	362	360

Operating Expenses	323	341	336	338
Operating Income	17	28	26	22
Other Income and Expenses	6	9	10	8
Interest Expense	11	12	13	12
Income Before Income Taxes	12	25	23	18
Income Tax Expense				
Net Income	12	25	23	18
Total Assets	571	611	615	637

Source: Own Elaboration from CEC Kilowatt, for period 2013 - 2016 (2016: 9; 2015: 5; 2014: 6)

By same sources, CCE doesn't have renewable projects implemented at July 2017, and no plans for implementing by themselves any solar PV system.

3.2.3.4. Sumter Electric Cooperative (SECO)

According to Sumter Electric Cooperative's web page (SECO Energy 2017), it was established in 1938 serving 400 rural farms near Webster county. At the end of 2016, SECO Energy is a not-for-profit electric cooperative serving nearly 200,000 families and businesses across seven counties in Central Florida, as presented in Fig. 3.11. By the same source, Seminole Electric Cooperatives, Inc. is its power provider. Seminole is owned by nine electric distribution cooperatives, and SECO is one of those nine members owners.

According to Table 23, SECO's Operating Revenues in 2016 from 2011 had a CAGR of 2.33%, from $331 millions to $363 millions. The Operating Expenses was $345 millions in 2016, providing a Net Income before taxes of $11 millions, a 45% lower than 2015. The Operating Expenses had increase from 93.1% of the revenues in 2012, to 93.2%, 93.7%, 93.6% and 95.0% in 2013, 2014, 2015 and 2016 respectively. This had result in low Net Incomes before Income Taxes from 3.5% or $12 millions in 2012 to 3.0% in 2016, a negative compound annual growth rate (CAGR) of 2.15%, helped by higher net incomes in 2014 and 2015. By the same source, SECO's Total Assets were $743 millions at December 2016, an increase in CAGR or 4.88% since 2012.

Table 23
Financial Results of Operation Sumter Electric Cooperative (SECO)

Results of operation (in millions $)	**2012**	**2013**	**2014**	**2015**	**2016**
Operating Revenues	331	340	364	374	363
Operating Expenses	308	317	341	350	345

Operating Income	23	23	23	24	18
Other Income and Expenses	-2	5	9	9	7
Interest Expense	13	13	13	13	14
Income Before Income Taxes	12	15	19	20	11
Income Tax Expense					
Net Income	12	15	19	20	11
Total Assets	614	654	693	725	743

Source: Own Elaboration from SECO Annual Reports presentations (SECO Energy 2017)

SECO doesn't have renewable projects implemented at July 2017, and no plans for implementing by themselves any solar PV system.

3.3. Keynotes of current electric energy sector in Florida

As presented in Table 5 of this Chapter, the residential sector buys the most electricity from the grid, accounting for 87.7% of customers, or 9.19 million, that consumed 52.3% of the total retail market in 2016, while 10.8% are commercial customers that consumed 36.1% of the total energy generated and 0.3% are industrial customers that consumed 8.8% of the total energy in the same year. In other words, the residential customers are the bigger buyers of energy from electric utilities, followed by the commercial sector.

This is significant, because residential customers in Florida provided an average revenue per customer of $1,473 per year in 2016, below the average of $2,225 for all sectors, and low below the $55,934 of industrial customer (FPSC 2017a: 10, 20, 41) in 2016, as presented in Table 24. It is important to note that the average retail price per customer has been decreasing at 1.63% CAGR from 2010 to 2016, with more reduction at industrial sector.

Another perspective of this analysis is presented in Fig.3.12 and the historic average price of electricity from 2010 to 2017 for all sectors charged by the electric utilities in the state of Florida. The average CAGR at Price of Electricity to Ultimate Customers is a decrease of 0.78% in the industrial sector reaching 8.62 Cents per Kilowatt-hour from 10.48 in 2010, while the residential customer paid in average 11.85 Cents per Kilowatt-hour in 2017 from 12.31 in 2010.These prices are not adjusted by inflation.

The IOS in total had $74.7 billions in assets at the end of 2016, according to the latest available data. The major player in the Florida electric energy market Florida Power & Light Company (FPL) served 4,869,040 customers or over 46% of total customers in Florida, generating over 109,662,646 Gigawatt-hour, with $45.5

billion in assets, as presented in Table 8. This electric utility had implemented by 2016 around 340 MW in solar panels, just in 2016 four 74.5 MW solar. NextEra Energy the owner of FPL, announced on March 2018 that JinkoSolar will supply them with up to 2,750 MW of solar modules, over a period of four years.Duke Energy Florida LLC had $16.6 billions in assets at the end of 2016, Tampa Electric Company (TECO) $7.8 billions in assets, and Gulf Power Company (GPC) $4.8 billions in assets would look for expanding their energy footprint with PV solar, following FPL energy and market strategy.

As presented in this Chapter, Florida utilities have announced significant plans for growth in solar over the next 5 years, and this is also happening in other states. As presented in Fig. 3.13, and by the Forecast of Solar PV capacity between 2016 to 2021 for electric utility and distributed solar in the Southeast State (MW) by the Southern Alliance for Clean Energy (SACE), large utilities had exhibited solar leadership in previous years and will continue in the future.

North Carolina is projected to remain the southeast leader in solar capacity and among the highest in the country reaching close to 6,000 MW installed solar PV capacity, while Florida would be close to 4,500 MW. Even adding all states and reaching 15,000 MW in 2021, the corresponding solar generation is less than 3% of retail sales.

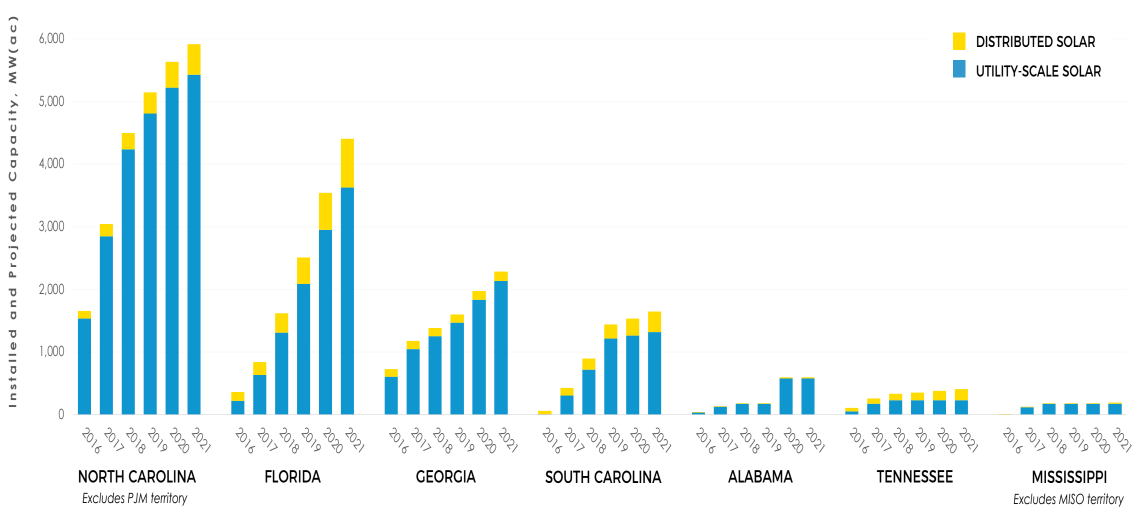

Fig. 3.13. Forecast of Solar PV 2016-2021 by Utility-Scale and Distributed Solar for Southeast State (MW) . *Source*: Southern Alliance for Clean Energy (SACE 2017: 11)

Utility-scale solar is favored by an economic advantage, policies, and discretionary utility practices that discourage customer-sited solar ("behind the meter"), specially because they are protected by the current legislation that essentially prohibits third-party providers from placing rooftop panels on homes and businesses and selling electricity from the panels to the homeowner or business owner.

Table 24
Revenue per Customer by Sector in Florida ($)

	2010	2011	2012	2013	2014	2015	2016
All Sectors	2,455	2,475	2,329	2,392	2,381	2,370	2,225
Residential	1,595	1,564	1,488	1,537	1,555	1,559	1,473
Commercial	7,088	7,289	7,155	7,011	6,789	7,432	6,610
Industrial	66,772	84,058	66,568	69,504	56,615	67,397	55,934
Other	10,603	10,756	5,823	5,566	4,152	5,139	5,043

Source: Own Elaboration from official data from FPSC (2017a: 10, 20, 41; 2015b: 10, 20, 40, 43; 2014: 9, 21; 2013: 8, 19; 2012: 8, 19; 2011: 8, 19; 2010: 8, 19, 42)

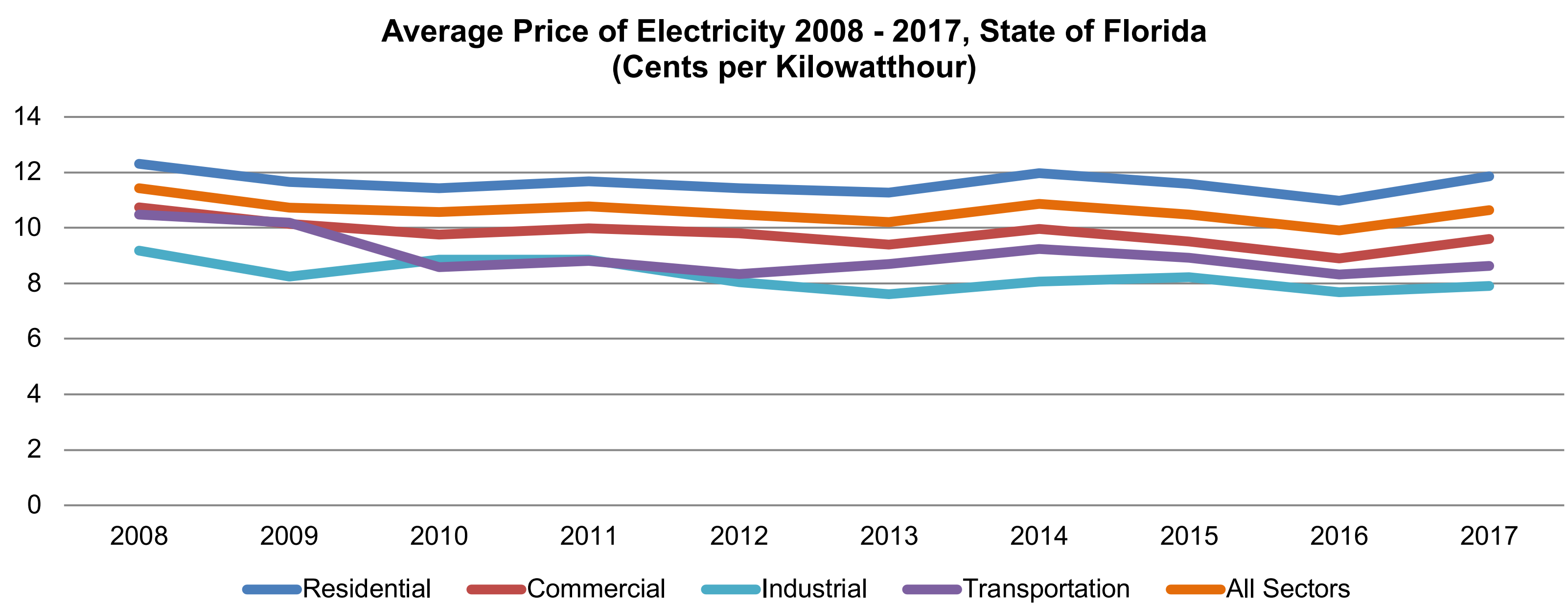

Fig. 3.12. Average Price of Electricity to Ultimate Customers in Florida. *Source*: Own Elaboration from official data from EIA (2008; 2009; 2010; 2011; 2012; 2013; 2014; 2015; 2016b; 2017a)

According to the same source, Florida utilities are on a path to close to 4,500 MW of solar by 2021. As presented in this Chapter, FPL will be adding 1,500 MW of solar by 2023 in addition to 600 MW previously announced. TECO and DEF are adding 600 MW and 700 MW, respectively by 2021. JEA announced a plan for 250 MW by 2020.

According to SACE and as presented in Fig. 3.14, the forecast for 2021 is that FPL will continue its leadership in Florida, with a capacity of 1,887 MW of utility scale solar and distributed solar, while DEF would reach 1,249 MW, these are two of the main IOS in the state.

	UTILITY-SCALE SOLAR, MW		DISTRIBUTED SOLAR, MW	
UTILITY	2017	**2021**	2017	**2021**
FLORIDA POWER & LIGHT	448	**1,640**	68	**247**
DUKE ENERGY FLORIDA	30	**935**	84	**309**
TAMPA ELECTRIC	14	**574**	13	**48**
JACKSONVILLE (JEA)	19	**272**	7	**24**
GULF POWER	60	**120**	5	**18**
TALLAHASSEE	10	**60**	2	**8**
ORLANDO (OUC)	18	**18**	8	**29**
LAKELAND	15	**15**	3	**9**
GAINESVILLE (GRU)	3	**3**	2	**8**
SEMINOLE	2	**2**	9	**35**

Fig. 3.14. Forecast of Solar PV 2016-2021 by Utility-Scale and Distributed Solar for main Florida utilities (MW)**.** *Source*: Southern Alliance for Clean Energy (SACE 2017: 15)

This is good path for having the IOS implementing solar PV systems, nevertheless is not enough to reach the levels that California and North Carolina would have by 2021.

In summary, state laws allow to electric utilities to be the only sellers of power energy, favoring electric utilities. Nevertheless, distributed solar is getting momentum with new business models, as the approved leasing model by SUNRUN.

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4. Experiences of PV Promotion in the State of Florida

The U.S. power sector has constantly traveled through major transitions a number of times in the past years. In 1935, as a respond to the Great Depression, the Congress passed the Public Utilities Holding Company Act (PUHCA), which created the foundation for the electric energy industry to evolve into a highly fragmented industry featuring many vertically integrated electric energy utilities, reducing them to “holding companies generally to an electric or gas utility system confined to a single area or region, with interconnected utility assets capable of coordinated and efficient operation.” (Markian, Melnyk and Lamb 2006, 11). By this regulation, individual electric energy utilities were allowed by the states in which they operated to be the single suppliers of electric energy service within prearranged service areas, introducing as a consequence of monopolies because “their producers have economies of scale so large those marginal costs of production fall throughout the relevant range of demand” (Allison and Williams 2010: 12).

As covered in Chapter 2, because of the Energy Crisis of the 1970s and mid 1980s, the legislation transitioned from the abundance of oil and energy of the 1960s to the oil embargo of the 1970s, causing a significant hike in the price of energy and turned the industry on its head once again, and at the same time marking the birth of modern political environmentalism (Shenk 2016). In this period of time, many electric utilities built relatively large power plants based on coal and large-scale nuclear plants, which turned out to have construction costs much higher than historic averages, at a time of higher inflation and interest rates, thereby causing significant increases in their rate bases.

As a respond to high prices of electricity generated by vertical integrated utilities, in 1978 the Congress enacted the Public Utility Regulatory Act (PURPA) in summary with price and profit controls and to encourage the development of mall hydropower sites, industrial co- generation, burning of municipal waste, and renewable resources and to diversify the domestic electric power base, Congress passed the Public Utility Regulatory Policies Act of 1978. Under Section 210 these vertical integrated utilities were required to purchase electric energy from qualifying small generators and co-generators (QF[8]) at a price no higher than what their incremental cost of purchasing or generating electric energy would have been had they not purchased electric energy from the QFs and also requiring competition in the utility industry and encourages renewables (Allison and Williams 2010: 12; Grossman and Cole 2003). This Act resulted in disallowing significant amounts of

(8) Under Federal, State and local laws, QFs may enjoy certain benefits. By Federal law the benefits are in “three categories: (1) the right to sell energy or capacity to a utility, (2) the right to purchase certain services from utilities, and (3) relief from certain regulatory burdens” (E&C 2017, 2)

utility expenditures and investments, in this manner creating disincentives for utilities to invest in the construction of new power plants, as elaborated in Chapter 2.

By the same source, the QFs "soon occupied a significant portion of the wholesale electric energy market, expanding from 576 facilities with an aggregate capacity of 27,429 MW in 1989 to more than 1,200 facilities with an aggregate capacity of 47,774 MW by 1993" (Allison and Williams 2010: 12; Grossman and Cole 2003). In 1992, Congress modified the PUHCA by creating an exempt wholesale generator category of generation owners who were exempted from PUHCA's ownership restrictions. Despite transmission access barriers of PUHCA and incentivized by the changes introduced by Congress, nontraditional generators other than QFs expanded significantly, attracted by the high energy prices, which as a result of stimulated energy conservation efforts and stifled economic growth.

As presented in Fig 4.1, in the late 1990s California and other 22 states restructured the electric energy industries to free end users to seek the most efficient electric generation service from an array of competitive electric energy suppliers by requiring to integrated electric energy utilities to financially or functionally unbundle their generation, transmission, and distribution services. This process is known as the deregulation of the energy sector, which did not happen in all states like Florida.

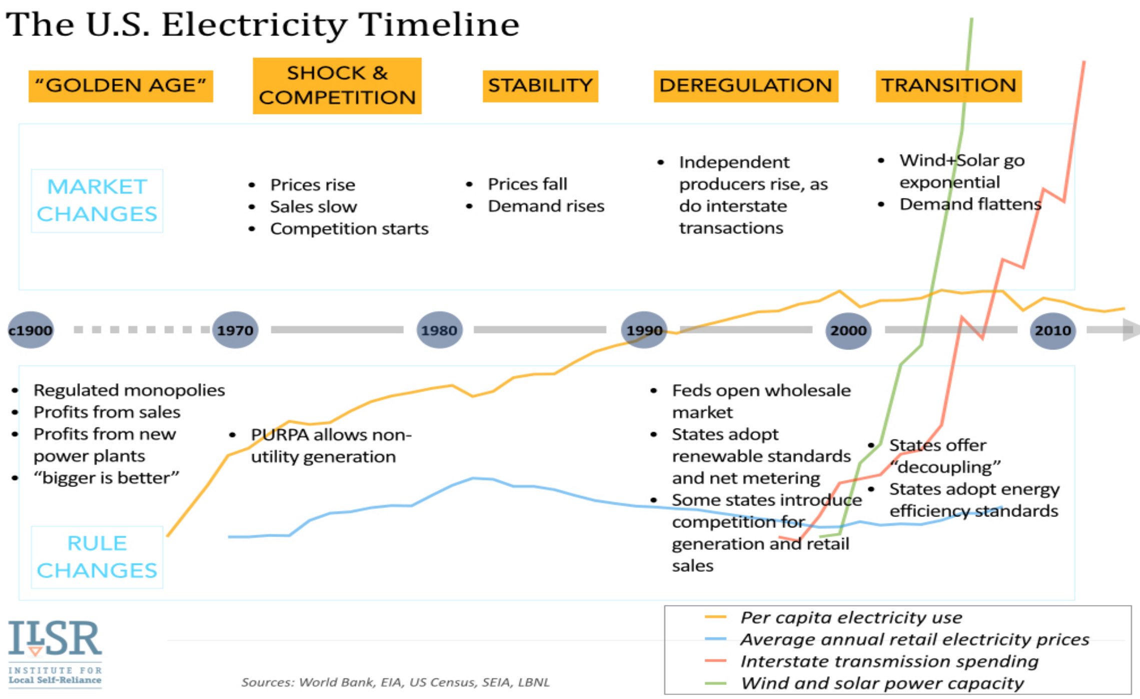

Fig. 4.1. The U.S. Electricity main periods. *Source:* Farrell (2014: 9)

Nevertheless, it has to be remembered from Chapter 2 that grids can interconnect electric energy generators and electric energy end users within big territorial regions, having natural monopoly features. In April 24, 1996, the FERC ordered that vertically integrated utilities functionally separate their transmission services from distribution and generation and offer open access to their transmission lines on a first-come first-served basis. The Order No 888 called Open-access transmission tariff (OATT) reduced market power and discrimination, which was complemented on October 25, 2001, by Advance Notice of Proposed Rulemaking. Additionally, Order 2003 FERC mandated that the costs of upgrading jurisdictional distribution facilities to accommodate the interconnection of new generation facilities should be directly assigned to interconnection customers (FERC 2003: 141). FERC's *Order 2006* establishes fast-track procedures for very small generators (< 2 MW) and small inverter-based generators (< 10 MW), such as those with solar panels (FERC 2006: 3), which produce direct current that must be converted to alternating current.

The process of generating electric energy also produces certain air pollution emissions, the levels of which vary depending on the primary energy source used in the generating process. This caused that States as California, Texas, North Carolina, and others as presented in Charter 2, adopted goals or requirements to utilize renewable energy sources for a specified portion of the state's electricity demand as renewable standards and net metering in early 1990s.

As presented in Chapter 2, in the 2000s the demand of energy flattens in the U.S. and the mix favored the use of natural gas and renewable sources. Based on data from the U.S. Energy Information Administration (EIA 2017a) the generation based on coal and petroleum experienced the sharpest decline over 2005 to 2017 period, in favor of other sources as natural gas. Coal and Petroleum generation was reduced from 53% to 30% in similar years. Net generation from renewable sources (excluding hydroelectric) was 2% in 2005 increasing to 8% in 2017.

In this chapter, an analysis is presented of the main regulatory policies in the State of Florida as: Interconnection Standards, Net Metering, Fuel Mix Disclosure, Energy Efficiency Incentives, Energy Standards for Public Buildings, Building Energy Code, Renewable Energy Easements & Rights Laws, Solar Contractor Licensing and others. From the incentive policies, it is covered in this chapter: Renewable Energy Production Tax Credit and Solar and CHP Sales Tax Exemption, Property Tax Abatement for Renewable Energy Property, Commercial Energy Efficiency Rebate Programs, Residential Energy Efficiency Rebate Programs, Loan Programs, and PACE Financing for renewable energy projects.

As a second section of this chapter, it is covered the main Amendments and Judicial actions for the promotion of renewable energy in the State of Florida from 1974 to 2018, and it impact in solar capacity and generation, and the consequence job development in this sector.

4.1. Regulatory and Incentive Policies

As presented in Chapter 2 of this research, U.S. federal, state and local governments have established various incentives to support the development of renewable energy projects. These incentives include accelerated tax depreciation, PTCs, ITCs, cash grants, tax abatements and RPS programs.

As defined in Chapter 3 of this research, the utility rates are approved and regulated by local and state agencies as it is the case of the Florida Public Service Commission (FPSC). The FPSC did not fully regulate publicly owned municipal utilities or consumer-owned electric cooperatives, and the commission oversaw the rate structure, territorial boundaries, and bulk power supply operations of the municipally owned electric utilities and the electric cooperatives.

U.S. federal, state and local governments have created various incentives to support the development of renewable energy projects. In the scope of state regulations, according to the Database of State Incentives for Renewables & Efficiency (DSIRE 2018), at end of January 2018, the State of Florida had one hundred and four regulatory policies and financial incentives to promote the generation of electricity from renewable energy (defined here as excluding hydroelectric facilities), divided in 28 Federal and 76 State programs. The state programs are divided in 21 Regulatory Policies and 55 Financial Incentives, as presented in Table1 and Table 2.

4.1.1. Regulatory Policies by the State of Florida

According to same source, at the end of January 2018 and presented in Table 1, of the 21 Regulatory Policies, 6 are in the energy efficiency area, one for solar equipment certification, one in interconnection, one regulation in net metering, one expired renewable portfolio standard from the municipal utility JEA (DSIRE 2018), eight for solar/wind access or licenses, among others.

Table 1
Regulatory Policies by the State of Florida

Name	Policy/Incentive Type	Created	Last Updated
Building Energy Code	Building Energy Code	6/30/06	9/24/15
Energy Efficiency Goals	Energy Efficiency Resource Standard	12/16/10	11/11/15
Miami-Dade County - Sustainable Buildings Program	Energy Standards for Public Buildings	7/22/11	9/1/16
City of Jacksonville - Sustainable Building Program Ordinance	Energy Standards for Public Buildings	8/30/16	9/1/16
Energy Conservation in Public Buildings	Energy Standards for Public Buildings	3/12/01	9/24/15

Broward County - Green Building Policy	Energy Standards for Public Buildings	8/30/11	8/7/15
Solar Equipment Certification	Equipment Certification	1/1/00	8/9/17
Fuel Mix Disclosure	Generation Disclosure	3/12/01	12/10/15
Miami-Dade County - Green Power Policy	Green Power Purchasing	10/25/16	10/25/16
Broward County - Green Power Purchasing Policy	Green Power Purchasing	10/18/16	10/18/16
Interconnection Standards	Interconnection	3/11/08	8/5/14
Net Metering	Net Metering	3/7/08	11/9/15
JEA - Clean Power Program	Renewables Portfolio Standard	5/22/03	2/16/17
City of Jacksonville - Downtown Rooftop Regulations	Solar/Wind Access Policy	9/6/16	9/6/16
Renewable Energy Easements & Rights Laws	Solar/Wind Access Policy	1/1/00	12/10/15
City of Gainesville - Public Facilities Siting	Solar/Wind Access Policy	1/1/00	7/9/15
Solar Contractor Licensing	Solar/Wind Contractor Licensing	1/1/00	12/10/15
Miami-Dade County - Solar System Permitting	Solar/Wind Permitting Standards	10/20/16	10/20/16
Hillsborough County - Solar and Wind Standards	Solar/Wind Permitting Standards	10/18/16	10/18/16
Broward County - Rooftop Solar System Permit Standard	Solar/Wind Permitting Standards	10/13/16	10/13/16
Broward County Online Solar Permitting	Solar/Wind Permitting Standards	11/20/12	7/16/15

Source: Own Elaboration from Database of State Incentives for Renewables & Efficiency, DSIRE (2018)

By Table 1, the state of Florida does not have Renewable Portfolio Standard (RPS), one of the critical policies to require utility companies to source a certain amount of the energy they generate or sell from renewable sources, leaving to the market the implementation of renewable sources as a result of competition, efficiency and innovation.

In an interview with FPSC's Chairman Julie Brown and Commissioner Ronald Brisé from, they noted that: "The Legislature did not ratify the draft rule or enact an RPS for Florida in the 2009 or 2010 sessions. In 2012, the Legislature adopted House Bill 7117, which repealed the language in Section 366.92, F.S., authorizing the FPSC to adopt goals for renewable resources" (Brown and Brisé, personal interview, April 16, 2017), which has not been implemented.

4.1.1.1. Interconnection Standards

The Florida Public Service Commission (PSC) approved interconnection rules for renewable energy systems up to two megawatts (MW) capacity in March 2008 (DSIRE 2018). The rules only apply to state's investor-owned utilities.

In the case of electric cooperatives or municipal utilities, the regulation required the development of a standardized interconnection agreement and net metering program for customer-owned renewable generation by July 1, 2009 (DSIRE 2018). Nevertheless, the FPSC do not have direct authority over these utilities, and this request was not mandatory.

Florida's interconnection rules for investor-owned utilities include provisions for three tiers of renewable-energy systems, for customer-owned renewable generation that must have a gross power rating that does not exceed 90% of the customer's utility distribution service rating (FPL 2017c), and also require mutual indemnification or compensation:

- Tier 1: 10 kilowatts (kW) or less. Applicants are not subject to application fees, interconnection studies or liability insurance (DSIRE 2018, DOE 2017). An external disconnect switch is not required for inverter-based systems, but a utility may choose to install a disconnect switch
- Tier 2: Larger than 10 kW, but not larger than 100 kW. Utilities may require that applicants have proof of general liability insurance of $1 million (DSIRE 2018, DOE 2017b). Utilities are authorized to require these customers to install a disconnect switch at the customer's expense
- Tier 3: Larger than 100 kW, but not larger than 2 MW. Utilities may require that applicants have proof of general liability insurance of $2 million (DSIRE 2018, DOE 2017b). Utilities are authorized to require these customers to install a disconnect switch at the customer's expense

Table 2
Renewable and Solar Interconnections

Type of Utility	# Renewable Generation Interconnections						
	2010	2011	2012	2013	2014	2015	2016
IOU	1,858	2,767	3,794	4,820	6,291	8,561	11,543
Municipal	493	614	791	1,007	1,202	1,616	2,375
Rural Electric Cooperative	461	549	684	853	1,053	1,423	2,047
Grand Total	**2,812**	**3,930**	**5,269**	**6,680**	**8,546**	**11,600**	**15,965**

Type of Utility	Solar Gross Power Rating (AC) - kW						
	2010	2011	2012	2013	2014	2015	2016
IOU	12,442	19,442	30,401	43,938	57,489	79,872	101,283

Municipal	4,099	5,002	7,021	8,689	10,151	13,083	18,756
Rural Electric Cooperative	2,667	3,262	4,099	4,865	6,403	8,880	12,720
Grand Total	**19,208**	**27,706**	**41,521**	**57,492**	**74,043**	**101,835**	**132,759**

Source: Own Elaboration from Florida Public Service Commission, FPSC (2017d)

By the same sources, the utilities must offer customers a standard interconnection agreement for the expedited interconnection of renewable generation systems. As a procedure, the systems must be inspected and approved by local code officials prior to interconnection to ensure compliance with applicable local codes.

According to the Florida Public Service Commission presented in Table 2, there were almost 16 thousand renewable generations interconnections in 2016, with an average of Gross Power Rating (AC) of 8.32 kW per renewable interconnection or a 22% increase from 2010 levels (FPSC 2017d). The number of interconnections had increase 468% from 2010 to 15,965 renewable generation interconnections, almost seven times the solar gross rating (AC) from 2010 to reach 132,759 kW in 2016.

By the same source, the IOUs had 76% of total solar gross power rating (AC) in 2016 for a total of 101,283 kW in 2016, while the two mayor power utilities with solar interconnections energy capacity are the Florida Power & Light (FPL) that reached 48,992 kW a 48% of total IOUs in same year, and Duke Energy Florida, Inc. (DEF) that reached 37,125 kW or 37% in same year.

4.1.1.2. Net Metering

According to DSIRE (DSIRE 2018), the Section 366.91 of Florida Legislature Statutes requires each utility to develop a standardized interconnection agreement and net metering program for customer-owned renewable generation. By same source, Section 366.91 item 2 c), defines that “Net metering means a metering and billing methodology whereby customer-owned renewable generation is allowed to offset the customer’s electricity consumption on site” (DSIRE 2018).

In March 2008, Florida enacted legislation H.B. 7135 allowing the Florida Public Service Commission (FPSC 2017b) to adopt interconnection rules for renewable-energy systems up to two megawatts (MW) in capacity. The PSC rules apply only to the state's investor-owned utilities; the rules do not apply to electric cooperatives or municipal utilities. Customers who generate electricity using solar energy, geothermal energy, wind energy, biomass energy, ocean energy, hydrogen, waste heat or hydroelectric power are covered under this net metering regulatory policy.

In 2013, the Federal Energy Regulatory Commission adopted new small generator interconnection standards for distributed energy resources up to 20 megawatts

(MW) in capacity called Order 792 (FERC 2017c), and incorporating provisions that afford an Interconnection Customer with the option of requesting from the Transmission Provider a pre-application report providing existing information about system conditions at a possible Point of Interconnection. The Order 792 is also applicable in the state of Florida.

These regulatory policies govern the investment in renewable energy at state level and also outline the terms for utility investment in renewable and solar and utility processes related to solar installation.

Table 3
Net Metering in Florida

Type of Utility	Total kWh delivered to the utility						
	2010	2011	2012	2013	2014	2015	2016
IOU	6,182,160	8,204,330	12,937,816	18,586,112	28,633,473	40,418,240	56,737,972
Municipal	1,671,028	2,646,897	2,457,771	3,899,721	4,253,251	5,492,701	8,435,598
Rural Electric Cooperative	1,662,401	3,035,505	3,279,279	3,844,571	3,913,185	3,677,518	5,142,000
Grand Total	**9,515,589**	**13,886,732**	**18,674,866**	**26,330,404**	**36,799,909**	**49,588,459**	**70,315,570**

Type of Utility	Total payment made to customer by utility						
	2010	2011	2012	2013	2014	2015	2016
IOU	$59,743	$76,440	$146,024	$63,680	$145,051	$145,533	$157,310
Municipal	$168,105	$191,711	$117,647	$148,939	$189,795	$70,754	$76,518
Rural Electric Cooperative	$108,709	$108,692	$121,296	$150,671	$203,839	$203,265	$265,726
Grand Total	**$336,558**	**$376,843**	**$384,966**	**$363,290**	**$538,686**	**$419,552**	**$499,554**

Source: Own Elaboration from Florida Public Service Commission, FPSC (2017d)

By DSIRE and the Department of Energy, in the state of Florida the "customer net excess generation (NEG) is carried forward at the utility's retail rate (i.e., as a kilowatt-hour credit) to a customer's next bill for up to 12 months. At the end of a 12-month billing period, the utility pays the customer for any remaining NEG at the utility's avoided-cost rate" (DSIRE 2018, DOE 2017b).

The quantity of energy delivered to utilities from renewable interconnected systems is more than seven times in 2016 versus 2010, reaching 70 GWh that represents 3.6% of the total energy from the total energy generated by power utilities in the state of Florida in 2016 (FPSC 2017d). From Table 3, the payment per kWh from utilities to customers for renewable energy was $0.0088 versus $0.0544 in 2010, a drastic decline.

4.1.1.3. Fuel Mix Disclosure

In March 1999, the FPSC issued an order requiring the Investor-Owned Utility or IOUs to provide information on their fuel mix (FPSC 2017b) to customers on a quarterly basis. Florida was the first state to institute this disclosure requirement without restructuring its electricity market.

Table 4 had been assembled with data from utilities, and shows the fuel requirements for the period 2007 to 2016, with a drastic reduction in the use of oil by 95% and coal by 35% in favor of natural gas, which increased 65% in same period, while nuclear fuel is flat.

Table 4
Fuel Requirements 2007-2016, projected 2017-2026

Year	Coal (Thousands of Short Tons)	Oil * (Thousands of Barrels)	Natural Gas (Billions of Cubic Feet)	Nuclear (U-235) (Trillion BTUs)
2007	30,957	31,190	691	317
2008	36,224	14,496	736	342
2009	26,238	10,285	845	315
2010	27,497	9,971	923	262
2011	25,420	2,395	1,006	253
2012	22,187	868	1,109	198
2013	23,547	911	999	301
2014	25,122	880	837	307
2015	23,217	1,111	1,149	309
2016	20,260	1,442	1,141	321
2017	*21,424*	*799*	*1,094*	*310*
2018	*16,658*	*247*	*1,144*	*308*
2019	*15,917*	*358*	*1,166*	*317*
2020	*16,533*	*159*	*1,152*	*316*
2021	*17,390*	*131*	*1,147*	*315*
2022	*17,350*	*146*	*1,153*	*321*
2023	*18,027*	*155*	*1,141*	*316*
2024	*18,420*	*160*	*1,149*	*316*
2025	*17,085*	*195*	*1,189*	*321*
2026	*17,230*	*183*	*1,204*	*316*

* Residual and distillate

Source: Own Elaboration from Florida Public Service Commission, FPSC (2017b)

The same Table 4 shows the fuel requirement projections for the state of Florida for the period 2017 to 2026 (FPSC 2017d), where oil requirements would decrease 77%, nuclear would maintain its current level, natural gas increasing 10% and the use of coal would decrease 20%.

4.1.1.4. Energy Efficiency Incentive

The Florida Energy Efficiency and Conservation Act (FEECA) was created in 1980 to implement goals and requiring electric and gas utilities to develop and implement programs to increase energy efficiency and conservation (FEECA 2018: 5-6).

FEECA rules that under the Florida Statutes Section 366.80-366.85 and Section 403.519 the largest electric utilities are required to meet energy savings or reduction goals set very 5 years by the Florida Public Service Commission (FPSC). Under the authority of this law are utilities whose annual sales amount to more than 2,000 GWh as of July 1, 1993, which means that Florida Power & Light Company (FPL), Duke Energy Florida (DEF), Tampa Electric Company (TECO), Gulf Power Company (GULF), Florida Public Utilities Company (FPUC), Orlando Utilities Commission (OUC), and Jacksonville Electric Authority (JEA) are subject to this regulation.

Table 5
FPSC's Demand-side Management goals or energy reduction goals for 2015-2024

Electric Utility	Summer Demand Goals (MW)	Winter Demand Goals (MW)	Annual Energy Goals (GWh)
FPL	526.1	324.2	526.3
DEF	259.1	419.3	195
TECO	56.3	78.3	144.3
Gulf	68.1	36.7	84.2
FPUC	1.3	0.4	2
OUC	5	8.4	13
JEA	10.8	9.7	25.8
Total	**926.7**	**877**	**990.6**

Source: Florida Energy Efficiency and Conservation Act, Annual Report 2016 (FEECA 2018: 14)

According to Florida Energy Efficiency and Conservation Act, "since its inception, FEECA utility-sponsored Demand-side Management (DSM) programs have cumulatively saved 7,813 MW of summer peak demand and 7,224 MW of winter peak demand, and in 2016, FEECA DSM programs saved over 6747 GWh" (FEECA 2018, 8).

By same source (FEECA 2018, 2-3) the FPSC is the entity that approved winter and summer peak demand and annual energy savings goals for the listed utilities, as defined for 2015 through 2024 period, as presented in Table 5.

4.1.1.5. Energy Standards for Public Buildings

According to DSIRE, in 2008 the Florida legislator enacted the regulation HB 7135, which is "mandating that buildings constructed and financed by the state must comply with the U.S. Green Building Council's (USGBC) Leadership in Energy and Environmental Design[9] rating system, the Green Building Initiative's Green Globes rating system, the Florida Green Building Coalition standards, or a nationally recognized high-performance green building rating system" (DSIRE 2018).

The Florida Department of Management Services developed the Florida Life-Cycle Cost Analysis Program (Chapter 60D-4, Florida Administrative Code), by mandate of the Florida Legislature, creating the Florida Energy Conservation and Sustainable Buildings Act in 2008 (FDMS 2018). The Act directed state agencies to incorporate sustainable building practices into the design, construction, and renovation of state buildings. The Act is also a great step forward to 1974 building code law requiring all local governments to adopt and enforce a building code.

Table 6
Florida state energy performance metrics for each year of SEMP submissions

Fiscal Year	Gross Square Footage (GSF)	Annual Energy Consumption (AEC) (kBTU)	Energy Performance Index (EPI) (kBTU/sf/yr)
FY2011-12	43,892,215	4,158,354,005	94.7
FY2012-13	46,869,556	4,180,908,545	89.2
FY2013-14	48,658,296	3,570,724,059	73.4
FY2014-15	47,947,983	3,853,514,020	80.4
FY2015-16	45,820,611	3,407,807,671	74.4

Source: State Energy Management Plan Annual Report 2016 (SEMP 2016: 2)

(9) LEED certification is a recognized framework for obtaining a certification of sustainability achievement, that provides an outline to create highly efficient, and cost-saving green buildings (LEED 2017)

By the same source, in 2010 the FDMS published the State Energy Management Plan (SEMP), to help and measure state agencies to reduce non-renewable energy consumption (FDMS 2018) and costs in state-owned and metered state-leased facilities. By the SEMP Annual Report 2016 plan, with approximately 45.8 million gross square feet of space.

The combined Annual Energy Consumption of the twenty-one state agencies under this regulation required approximately 3.4 billion kBTU (thousand British thermal units), which is a 18% reduction in 2015 from reported 2011 as presented in Table 6. The Energy Performance Index (EPI) in 2015 was 74.4 (kBTU/sf per year) kBTUs per square feet per year, or 21% from 94.7 (kBTU/sf per year) in 2011. By the same source (SEMP 2016: 8) the top three entities with the highest EPI are:

- Florida Department of Veterans Affairs with 215,5 (kBTU/sf per year),
- Florida Department of Financial Services with 153.5 (kBTU/sf per year) and
- Florida Department of Health with 141,0 (kBTU/sf per year).

According to FDMS (FDMS 2018), there are two solar power state facilities with a total of 51 kW: North Broward Regional Service Center a 26 KW solar system, and the Capital Circle Office Center in Tallahassee with a 25kW solar system.

As the SEMP, other counties and cities have adopted similar regulations. This is the case of the Board of County Commissioners of Broward County that in 2008 passed a resolution creating the County Green Building Policy (DSIRE 2018) or Miami-Dade County - Green Power Policy, mandating that new County-owned and operated buildings must achieve a minimum LEED rating. Another case is the Miami-Dade Board of County Commissioners, which in 2007 passed a resolution to incorporate sustainable building measures into county facilities, and all new construction over 50,000 square feet is required to attain LEED Silver designation, and all renovations must attain LEED Certified designation, this resolution is also called Miami-Dade County - Green Power Policy (DSIRE 2018). The only city in the state of Florida with a Sustainable Building Program is Jacksonville for public buildings, which requires to be certified by one of the following three standards: LEED, Green Building Initiative's Green Globes[10], or the Florida Green Building Coalition[11].

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(10) Green Building Initiative's Green Globes is a nationally recognized certification program, to address sustainability goals for new construction projects, or existing buildings and interiors. (GBI 2017)

(11) Florida Green Building Coalition is a state certification program, that apply to construction projects and local government operations, based on the environmental and climatic characteristics of Florida, to reach energy and resource efficient buildings (FGBI 2017)

According to the US Green Building Council (through January 10, 2017, Florida had 1,422 LEED Certified projects representing more than 125 million square feet, or over 26% of total 470 million square feet across the U.S. (USGBC 2017) from 3,366 LEED projects.

4.1.1.6. Building Energy Code

In 1980 the state become one of the first states to adopt a mandated statewide building energy code. According to the Florida Legislature, in 1998 the building construction standards were amended based on the Florida Statutes Chapter 553, creating The Florida Building Code. In June 2008, the Florida Legislature enacted the House Bill 697, to improve the energy performance of the state infrastructure and request the Florida Building Commission (FBC) to use the most current version of the International Energy Conservation Code (IECC) as a foundation code (Florida Legislature 2017c). On July 2016 the Energy Rating Index (ERI) score for the state became effective, which cannot exceed 58 for winter or summer climate zone. There is not data available to track the impact of the Building Energy Code in the energy savings at electric utility.

4.1.1.7. Renewable Energy Easements & Rights Laws

The legislation related to Renewable Energy Easements and Right Laws in the State took effect in July 2008 and has been updated since them. The latest version is the Florida Statutes, Chapter 163.4 that mandates that "a deed restriction, covenant, declaration, or similar binding agreement may not prohibit or have the effect of prohibiting solar collectors, clotheslines, or other energy devices based on renewable resources from being installed on buildings erected on the lots or parcels covered by the deed restriction, covenant, declaration, or binding agreement" (Florida Statutes 2017d). Nevertheless, certain restrictions related to visibility may be imposed on property owners as long as the effective operation of the system does not suffer as a result.

By the same source, the Florida Statutes, Chapter 704.07 mandates easements for the purpose of maintaining exposure of a solar energy system to sunlight, which must be created in writing. These ordinances are applicable to Commercial, Industrial, Local Government, Nonprofit, Residential, Schools, State Government, Federal Government, Agricultural, Multifamily Residential or Institutional (Florida Statutes 2017e).

According to DSIRE (DSIRE 2018), the cities of Jacksonville and Gainesville have implemented ordinances to this regulation, with the following variants:

- City of Jacksonville - Downtown Rooftop Regulations, which mandates that the design treatment of all roof components, including terraces, and shall consider the architecture of adjacent buildings and their rooftops
- City of Gainesville - Public Facilities Siting, requires the design development for public facilities within city limits to take into consideration existing and future solar access.

4.1.1.8. Solar Contractor Licensing

According to the Florida Solar Energy Industries Association, The Florida Legislature and the Construction Industry Licensing Board (CILB) have established the scope of work for solar contractors (FLASEIA 2018). The scope is regulated under Florida Statutes, Chapters 489.105 and 489.113 to install, maintain and repair solar hot water systems, solar pool heating systems and photovoltaic systems in residential, commercial and industrial facilities. According to same FLASEIA source and DSIRE (DSIRE 2018), it has been defined two categories of contractors:

- Certified Solar Contractor (CV) and Residential Solar Water, allowing working in residential and commercial solar water heating, solar pool heating and photovoltaic (solar electric) systems.
- Heating Specialty Contractor (CW), to work limited to solar water heating and solar pool heating systems on residences only

According to DSIRE (DSIRE 2018), the counties of Miami-Dade, Broward and Hillsborough have implemented ordinances to this regulation, with the following changes:

- Miami-Dade - Solar System Permitting, highlighting that the county is in a high velocity hurricane zone (HVHZ) and may require specific procedures to be followed in order to gain a solar system permit for residential or commercial sectors.
- Hillsborough County - Solar and Wind Standards, which outlines the appropriate uses and guidelines for the operation of a solar energy production facility (lots size shall be a minimum of five acres), and wind energy conversion system (maximum structure height is 45 feet in a residential area, and 120 feet in all other zoning districts)
- Broward County - Rooftop Solar System Permit Standard, and Broward County Online Solar Permitting, by allowing and promoting the installation of rooftop solar systems as accessory equipment on residential or commercial buildings, and the access to an one-stop online solar permitting process

4.1.1.9. Other Regulatory Policies

- JEA - Clean Power Program: According to DSIRE (DSIRE 2018), in November 1999, JEA, a municipal utility, formalized a commitment to generate at least 7.5% of its electric energy from renewable energy sources by 2015. This is the only case in the state of Florida were a Renewable Portfolio Standard (RPS) had been formalized. All other utilities in the state of Florida have not pledge for RPS. As mentioned in Chapter 3, at December 2016, JEA had achieved the 7.5% landmark with 95 MW of clean power capacity. This includes solar photovoltaic and thermal, wind, landfill gas, digester biogas, biomass and a fogging system installed on existing combustion turbines to increase their efficiency.

- Solar Equipment Certification: As mentioned in Chapter 3, under the Chapter 377.705 of the Florida Statutes the Florida Solar Energy Center (FSEC) is responsible for certifying all solar equipment sold in the state under the Solar Energy Standards Act of 1976, unless a licensed engineer certified that the equipment meet the standards of Florida's most recent building code. At January 2018, FSEC had certified equipment from 262 companies. A manufacturer has to fill an application and requests that FSEC test samples of the product at random.

4.1.2. Financial Incentives by the State of Florida

Currently, Florida has 55 financial incentive programs supporting the adoption of renewable energy, 37 of them as Rebate programs offered by electric utilities and few cities, 7 as loan programs, 2 as Green Building incentives, 2 PACE incentives and 7 in other areas (DSIRE 2018), including the Renewable Energy Production Tax Credit. According to DSIRE and as presented in Table 2, the Solar and CHP Sales Tax Exemption program, is the oldest financial incentive created in 2000, while the Grant Programs by the City of Tallahassee Utilities is the latest published in the state of Florida.

Table 7
Financial Incentives by the State of Florida

Name	Policy/Incentive Type	Created	Last Updated
Renewable Energy Production Tax Credit	Corporate Tax Credit	6/16/06	6/19/15
City of Tallahassee Utilities - Grant Programs	Grant Program	7/12/06	9/23/15
City of Miami - Green Building Density Bonus	Green Building Incentive	9/6/16	9/6/16
Miami-Dade County - Expedited Green Buildings Process	Green Building Incentive	11/11/08	8/6/15

Miami-Dade County - Targeted Jobs Incentive Fund	Industry Recruitment/ Support	11/7/08	7/15/15
City of Tallahassee Utilities - Solar Loans	Loan Program	7/13/06	7/7/16
City of Tallahassee Utilities - Efficiency Loans	Loan Program	6/25/10	5/19/16
Orlando Utilities Commission - Residential Solar Loan Program	Loan Program	2/13/08	12/4/15
Clay Electric Cooperative, Inc. - Solar Thermal Loans	Loan Program	9/7/08	9/22/15
Clay Electric Cooperative, Inc. - Energy Conservation Loans	Loan Program	9/1/06	9/22/15
St. Lucie County - Solar and Energy Loan Fund (SELF)	Loan Program	8/24/11	8/18/15
City of Lauderhill - Revolving Loan Program	Loan Program	7/13/12	11/25/14
Lakeland Electric - Solar Water Heating Program	Other Incentive	6/5/05	7/7/16
Miami-Dade County - Green Corridor Property Assessed Clean Energy District	PACE Financing	7/26/11	7/21/16
Local Option - Special Districts	PACE Financing	1/4/10	1/26/16
Orlando Utilities Commission - Solar Programs	Performance-Based Incentive	2/8/08	6/8/15
Property Tax Abatement for Renewable Energy Property	Property Tax Incentive	7/10/13	8/8/17
Lakeland Electric - Commercial Conservation Rebate Program	Rebate Program	8/18/09	4/17/17
Lakeland Electric - Residential Conservation Rebate Program	Rebate Program	8/18/09	3/16/17
JEA - Residential Energy Efficiency Rebate Program	Rebate Program	4/4/11	2/16/17
JEA - Solar Incentive Program	Rebate Program	5/1/02	11/9/16
JEA - Commercial Energy Efficiency Rebate Program	Rebate Program	8/18/09	11/9/16
Gainesville Regional Utilities - Energy Efficiency Rebate Program	Rebate Program	5/2/06	8/17/16
Ocala Utility Services - Energy Efficiency Rebate Program	Rebate Program	6/30/10	6/22/16
Fort Pierce Utilities Authority - Residential Energy Efficiency Rebate Program	Rebate Program	8/18/09	6/22/16
Duke Energy Florida - Commercial Energy Efficiency Rebate Program	Rebate Program	4/25/06	6/17/16
Duke Energy Florida - Home Energy Check Audit and Rebate Program	Rebate Program	4/26/06	6/17/16
Orlando Utilities Commission - Commercial Energy Efficiency Rebate Program	Rebate Program	5/13/13	5/19/16
Orlando Utilities Commission - Residential Energy Efficiency Rebate Program	Rebate Program	7/13/06	5/19/16
New Smyrna Beach - Residential Energy Efficiency Rebate Program	Rebate Program	11/18/09	1/4/16
City of Winter Park Energy Conservation Rebate Program	Rebate Program	3/19/13	9/24/15

Beaches Energy Services - Residential Energy Efficiency Rebate Program	Rebate Program	8/18/09	9/24/15
City of Tallahassee Utilities - Energy Star Certified New Homes Rebate Program	Rebate Program	12/1/08	9/23/15
City of Tallahassee Utilities - Residential Energy Efficiency Rebate Program	Rebate Program	7/28/08	9/23/15
Florida Public Utilities - Commercial Energy Efficiency Rebate Programs	Rebate Program	9/23/09	9/23/15
Florida Public Utilities (Gas) - Commercial Energy Efficiency Rebates	Rebate Program	9/22/15	9/23/15
Florida Public Utilities - Residential HVAC Rebate Program	Rebate Program	9/23/09	9/23/15
Florida Public Utilities (Gas) - Residential Energy Efficiency Rebate Programs	Rebate Program	9/23/09	9/22/15
City of Longwood - Raising Energy Efficiency Rebate Program	Rebate Program	1/24/12	9/22/15
Kissimmee Utility Authority - Residential & Commercial Energy Efficiency Rebate Program	Rebate Program	12/10/08	9/22/15
Clay Electric Cooperative, Inc. - Energy Smart Energy Efficiency Rebate Program	Rebate Program	10/4/07	9/21/15
Florida Keys Electric Cooperative - Residential Rebate Program	Rebate Program	8/1/12	9/21/15
Florida Power and Light - Residential Energy Efficiency Program	Rebate Program	4/1/08	8/6/15
Florida Power and Light - Business Energy Efficiency Rebates	Rebate Program	5/1/06	8/6/15
Tampa Electric - Commercial Energy Efficiency Rebate Programs	Rebate Program	4/23/09	8/5/15
Tampa Electric - Residential Energy Efficiency Rebate Program	Rebate Program	4/18/06	8/4/15
Gulf Power - Residential Energy Efficiency Programs	Rebate Program	12/3/07	7/23/15
Clay Electric Cooperative, Inc. - Energy Smart Solar Water Heater Rebate Program	Rebate Program	10/4/07	6/19/15
City of Tallahassee Utilities - Solar Water Heating Rebate	Rebate Program	1/22/08	6/19/15
Beaches Energy Services - Solar Water Heating Rebate Program	Rebate Program	8/18/09	6/19/15
Fort Pierce Utilities Authority - Solar Water Heating Rebate	Rebate Program	4/27/12	6/18/15
Ocala Utility Services - Solar Hot Water Heating Rebate Program	Rebate Program	8/13/10	6/18/15
Orlando Utilities Commission - Residential Solar Water Heater Rebate Program	Rebate Program	7/11/12	6/8/15
New Smyrna Beach - Commercial Energy Efficiency Rebate Program	Rebate Program	4/8/09	5/5/15
Solar and CHP Sales Tax Exemption	Sales Tax Incentive	1/1/00	5/5/15

Source: Own Elaboration from Database of State Incentives for Renewables & Efficiency, (DSIRE 2018)

An analysis to some of the existing regulations in the state of Florida is presented at the following pages.

4.1.2.1. Renewable Energy Production Tax Credit and Solar and CHP Sales Tax Exemption

According to DSIRE (DSIRE 2018), in order to boost the expansion of renewable energy facilities in Florida and to create new jobs for Floridians, the state Legislature established a renewable energy production tax credit in June 2006 that expired in 2010. In April 2012, the Florida Legislature re-established and updated the renewable energy production tax credit which consists of three possible tax incentives according to the Florida Department of Agriculture (FDACS 2017). Eligible costs must be incurred between July 1, 2012, and June 30, 2016. Sales tax incentives typically provide an exemption from the state sales tax for the purchase of a renewable energy system.

By the same source, the Florida Legislature had exempted from Florida's sales and use tax since July 1, 1997 to solar energy systems, which are the equipment and requisite hardware that provide and are used for collecting, transferring, converting, storing or using incidental solar energy (FDACS 2017) for water heating, space heating and cooling, or other applications. Solar equipment must be certified by Florida Solar Energy Center for having access to this tax exemption. The tax incentives under these two fiscal incentives are divided in three refunds:

- The Florida Renewable Energy Technologies Sales Tax Refund, it is a refund on materials used in the distribution, including fueling infrastructure, transportation and storage, of biodiesel, ethanol and other renewable fuel. This is an underutilized refund based on the data presented in Table 8 from the FDG’s 2015 Analysis of the Economic Contribution of the Renewable Energy Tax Credit (FDACS 2015, 1), in the period 2014-15 there were over $972 thousand unused refunds, and in the previous period over $700 thousand unused refunds, of $1 million appropriated for this program.

Table 8
Utilization of the Florida Renewable Energy Technologies Sales Tax Refund

Fiscal Year	Appropriation	Total Refunds Approved	Unused Refunds
FY2012-13	$1 million	$0	$1 million
FY2013-14	$1 million	$261,686.16	$738,313.84
FY2014-15	$1 million	$27,740.66	$972,259.34

Source: 2015 Analysis of the Economic Contribution of the Renewable Energy Tax Incentive, Florida Department of Agriculture and Consumer Services (FDACS 2015, 1)

At a sales tax rate of 6%, the $27,740.66 in tax refunds supported total equipment purchases for renewable fuel distribution of $462,344.33 in the period 2014-15, and $4,361,436 in the period 2013-14.

- The Florida Renewable Energy Technologies Investment Tax Credit is an annual corporate tax credit, for the production, storage and distribution of biodiesel, ethanol and other renewable fuel, that equal to 75 percent of all eligible costs. This program allows $1 million per state fiscal year for each taxpayer with a limit of $10 million per state fiscal year.

Table 9
Utilization of the Renewable Energy Technologies Investment Tax Credit

Fiscal Year	Appropriation	Capital Costs	Operation and Maintenance Costs	Research and Development Costs	Approved Credit
FY2012-13	$10 million	$6,418,643	$2,007,596	$799,414	$6,878,263
FY2013-14	$10 million	$7,004,389	$2,944,440	$3,724,689	$10,000,000
FY2014-15	$10 million	$10,047,522	$2,414,870	$1,884,300	$10,000,000

Source: 2015 Analysis of the Economic Contribution of the Renewable Energy Tax Incentive, Florida Department of Agriculture and Consumer Services (FDACS 2015, 5)

According to same source, FDACS received 12 applications in the period 2014-2015, three applications were granted a full credit and one application was granted a partial credit. Nine of the 12 applications, including the applicant that received a partial credit, did not receive a full credit due to an exhaustion of funding and they are scheduled to receive a credit under the fiscal year 2015-2016 for a total of over $8.6 million.

- By DSIRE web page (DSIRE 2018), the Florida Renewable Energy Production Credit, for an annual corporate tax credit equal to $0.01/kWh of renewable electricity produced and sold by the taxpayer to an unrelated party during a given tax year. The combined total amount of tax credits assigned under this refund is limited to $10 million per state fiscal 2013-2014 through 2016-2017, and $5 million in state fiscal year 2012-2013.

Table 10
Florida Renewable Energy Production Credit Program

Fiscal Year	Appropriation	Total Credits Approved	Unused Credits
FY2012-13	$5 million	$5 million	$0

FY2013-14	$10 million	$10 million	$0
FY2014-15	$10 million	$10 million	$0

Source: 2015 Analysis of the Economic Contribution of the Renewable Energy Tax Incentive, Florida Department of Agriculture and Consumer Services (FDACS 2015, 8)

According to FDACS, it received 14 applications from qualified applicants applying for over $15.8 million in tax credits in 2015, with a maximum amount of $10 millions for appropriation. This is a popular refund that will continue to take advantage of the tax credits available through this program until 2017, including applicants as Florida Power and Light Company, and Florida Power Development a former coal-fired power plant that has been repurposed to a 70 MW renewable energy facility utilizing biomass.

4.1.2.2. Property Tax Abatement for Renewable Energy Property

By DSIRE the Property Tax Abatement for Renewable Energy Property awards partial sales and use tax and partial property tax reductions to eligible renewable energy facilities (DSIRE 2018). Under this tax reduction, Florida provides a 100% property tax exemption for residential renewable energy property and, since January 1, 2018, an 80% property tax reduction for non-residential renewable energy property, installed on commercial and industrial property. Property tax exemptions allow businesses and homeowners to exclude the added value of a solar system from the valuation of their property for taxation purposes

This is part of Amendment 4 approved in 2016 called Florida Property Tax Exemptions for Renewable Energy Equipment Amendment, which took effect on January 1, 2018 as discussed previously in this chapter. By the same source and until December 31, 2037, for non-residential renewable energy properties 80% of the value of a solar installation will be excluded from real property tax if the landowner owns the solar equipment, or lease the equipment. This means that 80% will be exempted from tangible personal property tax if, as an alternative, the solar developer, as a lessee on the property, owns the solar equipment.

The exemption applies to certain equipment used as part of a solar, wind or geothermal system. As defined at the Committee Substitute for Committee Substitute for House Bill No. 277, some of these parts under this tax reduction are:

- Solar energy collectors, photovoltaic modules, and inverters.
- Storage tanks and other storage systems, excluding swimming pools used as storage tanks.
- Rockbeds.

- Thermostats and other control devices.
- Heat exchange devices.
- Pumps and fans.
- Roof ponds.
- Freestanding thermal containers.
- Pipes, ducts, refrigerant handling systems, and other equipment used to interconnect such systems; however, such equipment does not include conventional backup systems of any type.
- Windmills and wind turbines.
- Wind-driven generators.
- Power conditioning and storage devices that use wind energy to generate electricity or mechanical forms of energy.
- Pipes and other equipment used to transmit hot geothermal water to a dwelling or structure from a geothermal deposit." (LAWS 2018)

This is a great opportunity for both businesses and consumers in the state of Florida to expand energy choices and control costs by getting access to tax reductions for residential renewable energy property and for non-residential renewable energy property, installed on commercial and industrial property.

4.1.2.3. Commercial Energy Efficiency Rebate Programs

As mentioned before in this chapter, through the Florida Energy Efficiency and Conservation Act, the largest electric and gas utilities in Florida are required to meet energy savings goals set by the FPSC (FEECA 2018). Rebates are an important part of the demand-side management programs that several electric utilities offer to achieve energy savings targets and reduce peak demands.

By DSIRE several electric utilities offer incentives for its business customers to save energy in eligible facilities. Rebates are available for energy saving improvements to upgrade the HVAC system and motors (DSIRE, 2018), building envelope, water heating, refrigeration, variable frequency drives, cool roofing, windows and lighting systems. All equipment must meet or exceed the stated program efficiency requirements. Nevertheless, all rebates are subject to approval and contingent upon fund availability.

By same source, the electric utilities that offer this rebate are: Florida Public Utilities, Duke Energy Florida, Tampa Electric, Florida Power and Light, Lakeland Electric, JEA, Orlando Utilities Commission and New Smyrna Beach. Table 11 summarized the incentives by electric utility for both Investor-Owned Utilities and Municipal Electric Utilities. No Electric Cooperatives offer rebates to commercial or industrial customers.

There is not public data available to quantify the extent of energy efficiency rebates program adaption, as well as to compare the relative strength and size of various programs, conservation energy amounts or quantities to compare reduction on energy bills. In addition, each power utility in Florida offers different amounts and types of rebates. According to Duke Energy their "customers have saved more than $1 billion by participating in the residential and business energy-efficiency programs" (Duke 2018).

Table 11
Commercial Energy Efficiency Rebate Programs by Electric Utilities

	Investor-Owned Utilities				Municipal Electric Utilities			
Incentive	**Florida Power and Light**	**Duke Energy Florida**	**Tampa Electric**	**Florida Public Utilities**	**Lakeland Electric**	**JEA**	**Orlando Utilities Comm.**	**New Smyrna Beach**
High-Efficiency Chillers	$2-$41 /ton	$50/ton	$0.56 - $1.17 /kW reduction	Up to $175 /kW				
Large Unitary AC/Heat Pumps	Up to $1,000	$75/ton				$60/ton		
Packaged Terminal Heat Pumps and Air Conditioners		$100/ ton	$37 /ton					
Air Conditioning Heat Pumps		$200 - $375 /system		$100		$60/ton	$20-$1,275 per unit	
Air Conditioning ECM Equipment			$180 /hp					
HVAC System-Related Improvements		Varies	$25 /ton			Varies		
Energy Recovery Ventilators:	Up to $1.49 /CFM		$1.32 - $2.26 /CFM					
High-Efficiency Electric Storage Water Heater			$0.01166 /Btu			$30/unit	100% of cost up to $650	
Thermal Energy Storage	Up to $580/ton							
Thermal Energy Storage Initial Commissioning	$20/ton shifted							
Thermal Energy Storage Feasibility Study	Up to $2,500/ facility							
Ceiling Insulation Upgrade	$0.15 /sq. ft.	$0.175 /sq.ft.	$0.255 /sq. ft.				$0.14 /sq.ft.	$0.125 /sq. ft. up to $375
Cool Roofs	Not specified	$0.15 /sq.ft	$0.60 /sq. ft.	$0.325 /sq.ft.		$0.10/sq. ft. up to $5,000	$0.14 /sq. ft.	
Roof Insulation Upgrade	$0.05 /sq. ft.	$0.07 /sq.ft.		$0.075 /sq.ft.			$0.07 per sq. ft.	
Reflective Window Film	$0.50-$1 /sq. ft.		$1.25 /sq. ft.			$0.40/sq. ft. up to $1,000	$1 / sq. ft.	$2 /sq. ft., up to $375
Lighting	Varies				$0.15/Watt reduced	Varies	$150 per kW	

Lighting Occupancy Sensors		$25/unit		$10 or $20 per sensor	
Variable Frequency Drives		$6/HP upgrade		$50/HP	
Refrigeration Equipment	Up to $2,205	$0.175/ W reduction		varies by type	
Refrigeration ECM Equipment		$125 /hp			
Refrigeration Anti-Condensate Heat Strip		$0.65 /ln. ft.			
Energy Star Washing Machine					$50 per unit
Custom Incentive	Varies		$150/kW demand reduction	$0.05 /kWh	$250 per kW

Source: Own Elaboration from Database of State Incentives for Renewables & Efficiency, (DSIRE 2018)

Florida Power & Light Company, Duke Energy Florida, Tampa Electric Company, Gulf Power Company, Florida Public Utilities Company, Orlando Utilities Commission, and Jacksonville Electric Authority (JEA) are required to meet energy savings goals set by the FPSC under the Florida Energy Efficiency and Conservation Act (FEECA 2018), because rebates are an important part of the demand-side management programs that several utilities offer to achieve energy savings targets and reduce peak demands. Gulf Power Co. doesn’t offer Commercial Energy Efficiency Rebates.

4.1.2.4. Residential Energy Efficiency Rebate Programs

For residential owners, energy efficiency upgrades often require substantial financial investments. In many cases energy efficiency upgrades would make sound financial sense in the long term, they may not be financially feasible in the short term. To help homeowners bridge the gap between energy efficiency and project affordability while addressing other concerns some electric utilities offer rebate programs.

According to DSIRE web page (DSIRE, 2018), Investor-Owned Utilities, Municipal Electric Utilities and Rural Cooperatives offer rebates to residential customers to promote energy efficiency in the residential sector. Customers who implement certain energy efficiency improvements in heat pumps, duct maintenance, window upgrades, upgrading ceiling or roof insulation, installing a reflective roof, an others. Homeowners and contractors building new homes can receive incentives to incorporate energy efficient design.

Table 12
Residential Energy Efficiency Rebate Programs by Electric Utilities

	Investor-Owned Utilities				Rural Cooperative	
Incentive	**Florida Power and Light**	**Duke Energy Florida**	**Tampa Electric**	**Florida Public Utilities**	**Florida Keys Electric Cooperative**	**Clay Electric Cooperative**
Central Air Conditioner			$275 per unit		30% up to $500, SEER 16	
Central Heat Pump		$200 - $800	$275 - $400	$400		$50 to $500
Duct Repair	up to $154	Up to $150	discounted to $50		30% up to $350	
ENERGY STAR Clothes Washer				$25		
ENERGY STAR Refrigerator				$25		
ENERGY STAR Window			$400	$25		
ENERGY STAR Heat Pump Water Heater				$25		
Attic insulation upgrade		$0.19/sq.ft. up to $200			30% up to $250.00	
Energy-efficient windows		$2/sq.ft. up to $400	$2 per sq. ft.			$0.44 / sq ft
Ceiling Insulation Upgrade			$200 - $350			$0.11 / sq ft
Cool Roof:	$325			$0.25/ sq. ft. up to 400		
Solar Hot Water Heater			$150		30% up to $500.00	$0.01 per BTU output

Source: Own Elaboration from Database of State Incentives for Renewables & Efficiency, (DSIRE 2018), Tampa Electric (TECO 2018), Duke Energy (2018a), Florida Power & Light Company (FPL 2017d, FPL 2018a), Florida Power Utilities (FPUC 2018), Clay Electric Cooperative (CEC 2018)

By same source, the Investor-Owned Utilities that offer Residential Energy Efficiency Rebate are: Florida Public Utilities, Duke Energy Florida, Tampa Electric, Florida Power & Light Company. Table 12 summarized the incentives by these utilities, Florida Keys Electric Cooperative and Clay Electric Cooperative, the only two Rural Cooperative offering this rebate, aligned to meet energy savings goals set by the FPSC under FEECA as explained before in this chapter.

According to same sources, all Investor-Owned Utilities listed in Table 12, provide energy audit service to identify areas where may be waste of energy in residential properties and to help determine further cost-savings measures that customers can take to lower their energy bills.

The higher rebate offered by this group of utilities is for the replace of existing system with a high-efficiency central heat pump and duct repair or seal, followed by attic insulation upgrade, energy-efficient windows and cool roof. Both, Duke Energy Florida and Tampa Electric are offering this type of rebate since 2006.

Table 13
Residential Energy Efficiency Rebate Programs by Municipal Electric Utilities

	Municipal Electric Utilities								
Incentive	**Lakeland Electric**	**JEA**	**Orlando Utilities Comm.**	**New Smyrna Beach**	**Fort Pierce Utilities**	**Beaches Energy Services**	**Kissimmee Utility Authority**	**City of Tallah. Utilities**	**Ocala Utility Services**
Insulation		$0.20 /sq. ft. up to $150			$0.40 /sq. ft. New				
Central Air Conditioner		$200, SEER 16			Varies by size and efficiency	$100 - $300		$100 or $350	
Central Heat Pump	$300	$200, SEER 16	$20- $1,275 per unit	$400 - $500		$100 - $300	$200	$100 - $350	$250
Duct Repair		$25	100% of cost, up to $160	50% of cost, up to $200			$200		
ENERGY STAR Clothes Washer	$100		$50 per unit		$50 per unit			$100	$100
ENERGY STAR Refrigerator	$75				$50 per unit			$75	$75
ENERGY STAR Window			$2 per sq.ft.						
ENERGY STAR Heat Pump Water Heater			100% of cost, up to $650			$500		$600	$350
Tank Water Heater					$300 - $550 per unit				
Tankless Water Heater					$500 - $675 per unit				
Clothes Dryer					$100 - $200 per unit				
Range					$100 - $200 per unit				
Dishwashers	$40							$40	$75 (ES)
Freezers	$40							$40	
Attic insulation upgrade	$200		$40 - $85	$0.125 per sq. ft.		$0.125 / sq ft, up to $300	$300		$0.10 / sq ft
Energy-efficient windows			$1 per sq.ft.	$1.50 per sq. ft.		cost of project, up to $100			
Solar Hot Water Heater		$400	$1,000		$450 per unit	$500		$450	$450 per system

Source: Own Elaboration from Database of State Incentives for Renewables & Efficiency (DSIRE 2018), Lakeland Electric (LE 2018), JEA (JEA 2018) Orlando Utilities Commission (OUC 2018), Fort Pierce Utilities (FPPU 2018), Beaches Energy Services (BE 2018)

Table 12 summarized the incentives offered by 8 Municipal Electric Utilities of 35 existing in the state of Florida. These are: Lakeland Electric, JEA, Orlando Utilities Commission, New Smyrna Beach, Fort Pierce Utilities, Beaches Energy Services, Kissimmee Utility Authority, and City of Tallahassee Utilities. The incentives offered are, in number, larger than rebates by Investor-Owned Utilities.

As mentioned before, in most Florida homes, the first largest energy use is for air conditioning and the second is for heating water. According to same sources, the rebate offered by all listed utilities is for the purchase and installation of qualifying central heat pump, from $20 to $1,275 per unit. Six Municipal Electric Utilities offer residential customers rebates for the purchase of ENERGY STAR appliances. By all utilities, for getting access to rebates, customers have to verify availability of rebate and submit documents with an application, which does not guarantee payment. Orlando Utilities Commission has been offering this type of rebate since 2006, the oldest of these utilities.

Similar to Commercial Energy Efficiency Rebate, there is not public data available to quantify the extent of the energy efficiency rebates program adaption. In addition, Tables 12 and 13 show a high disparity in the type of rebates, amounts that each power utility in Florida offers to their customers, that makes difficult to make a comparison on the effectiveness of each program. According to Duke Energy their “customers have saved more than $1 billion by participating in the residential and business energy-efficiency programs” (Duke Energy 2018b), the only public announcement of the size of this rebate.

According to Tables 12 and 13, Tampa Electric, JEA, Orlando Utilities Commission, Fort Pierce Utilities, Beaches Energy Services, City of Tallahassee Utilities, Ocala Utility Services, Florida Keys Electric Cooperative and Clay Electric Cooperative offer a rebate to residential customers whom install new and retrofit solar hot water heaters on their homes, for systems certified by the Florida Solar Energy Center (FSEC) certified. The rebate applies to first-time installation or to the replacement of an older solar water-heating system, and varies from $150 to $1,000 per customer. Pool heating systems and photovoltaic (PV) systems are not eligible for this rebate.

By the same source, there are other electric utilities that offer similar rebates to both residential and commercial customers. The City of Winter Park offers up to $300 for improvements in wall insulation and $75 for attic insulation. The City of Longwood offers $500 for or solar panels or photovoltaic systems, including pools. The Orlando Utilities Commission offers to purchase renewable energy credits (RECs) from residential and commercial customers who install a photovoltaic (PV) and/or solar thermal energy system on their property equal to $0.05 per killowatt-hour (kWh) for PV systems, $1,000 rebate for a solar hot water system for residential customers, and for commercial solar hot water heating systems receive a $0.03 per kWh.

4.1.2.5. Loan Programs

According to DSIRE (DSIRE 2018), electric utilities and two cities offer interest financing for energy efficient improvements for residential areas in air conditioners, natural gas furnaces, electric heat pumps, solar, natural gas and heat pump water heaters, floor, wall and ceiling insulation, natural gas dryers, ranges, grills, appliances, standby generators and outdoor lighting, solar photovoltaic systems, and the acquisition of energy efficient appliances. Loan payments are made on monthly utility bills. Financing terms are up to 10 years.

Table 14 shows that three municipal and one rural cooperative utility, and two cities offer loan programs in the state of Florida. Under these programs, customers may borrow up to $20,000 for PV systems and $50,000 for solar water-heating systems and Solar PV, with low interest rates that varies from 2% to 9.5% depending of customer's credit history rate.

Table 14
Loan Programs in some Municipal Electric Utilities, Rural Cooperatives and Cities in the State of Florida

	Municipal Electric			Rural Cooperative	Cities	
Maximum Loan	**City of Tallahassee Utilities**	**Orlando Utilities Comm.**	**Lakeland Electric**	**Clay Electric Cooperative**	**St. Lucie County**	**City of Lauderhill**
Solar PV	$20,000 max	$20,000 max			$50,000 max	$2,500 max
Solar Thermal		$7,500 max	Lease equipment $34.95 /month	$5,000 max	$50,000 max	$2,500 max
Other Measures	$10,000 max					
Solar Pool Heating				$5,000 max		
Energy Efficient Appliances	$10,000 max			$5,000 max		$2,500 max
Annual Interest Rate	5%	Solar PV: 2%-5.5%; Solar Thermal 0%-4%		5% - 8%	7-9.5%	0%

Source: Own Elaboration from Database of State Incentives for Renewables & Efficiency (DSIRE 2018), City of Tallahassee Utilities (CTU 2018), Orlando Utilities Commission (OUC 2018), Lakeland Electric (LE 2018), Clay Electric Cooperative (CEC 2018), City of Lauderhill (CLF 2018)

Saint Lucie County and City of Lauderhill are particular cases apart of electric utilities in offering loans for the installations of energy efficient appliances and solar PV systems. The loans are available since 2011 and 212 respectively. By DSIRE web page (DSIRE 2018) and City of Lauderhill's web page (CLF 2018), St. Lucie County received a $2.9 million grant award through the U.S. Department of Energy's Energy Efficiency Block Grant Program, while the City of Lauderhill implemented a municipal revolving loan program. Loan payments are made on monthly bank statements.

4.1.2.6. PACE Financing

According to the U.S Department of Energy, the Property Assessed Clean Energy (PACE) model is an instrument for financing renewable energy and energy efficiency improvements on residential and commercial properties. By funding the up-front cost of energy improvements, PACE programs (DOE 2018a) allow authorized local or state governments to offer loans, which are paid back over time by the property owners. Important to mention that the debt is tied to the property as opposed to the property owner(s).

In 2010, the Federal Housing Finance Agency released instructions contrary to purchasing mortgages of homes with a PACE lien due to loans acquire (FHFA 2018) a priority lien over existing mortgages.

By DSIRE (DSIRE 2018), in the state of Florida, the PACE Financing is authorized by the Local Option - Special Districts Program under Florida statutes to municipalities and counties, which establish dependent special districts with the authority to collect revenue. A local program at the city or county level must be available in the customer(s) area. The available PACE programs in the state of Florida are:

- Florida PACE Funding Agency (FPFA 2018) in the Flagler County and the City of Kissimmee
- Leon Energy Assistance Program (LEAP 2018 (LC 2018) in Leon County
- Miami-Dade County and the Green Corridor Property Assessed Clean Energy District formed by Cutler Bay, Miami, South Miami, Pinecrest, Palmetto Bay, and Miami Shores, offer a maximum loan of 10% of just value of the property, and a maximum term length of 20 years. This is applied over incorporated and unincorporated areas of the county. This is managed and controlled by the Article CXXXVIII – Voluntary Energy Efficiency and Renewable Energy Committee (MDADE 2018)
- Florida Green Energy Works program, managed by the Florida Green Finance Authority created by the Town of Lantana and Town of Magnolia Park (FLGFA 2018). The towns of West Palm Beach, Delray Beach, Boynton Beach, Tequesta and Lake Worth have also joined the Florida Green Finance Authority.

- The Solar and Energy Loan Fund Program (SELF 2018) based in St. Lucie County.

4.2. Amendments and main Judicial actions

The energy policy in the U.S. relates to the production, distribution, and consumption of diverse sources of energy, as fossil fuels and renewable energy sources, involves federal, state, and local governmental actions, with several interconnected levels of government and private entities. As commented in Chapter 2, the U.S. energy system is tremendously complex, with many different types of laws, institutions (Matthew and Jennie 2017: 35-37), and actors operating at multiple levels of government. Energy policies are legislated and enforced at local, state, and federal levels through legislation and regulations. This is done mainly through laws and regulation passed at all governmental levels and influenced by many stakeholders with different agendas.

In the state of Florida, there is not exemption to the interconnected levels of government that have presence in the energy sector. The Florida energy market is a regulated market where utilities own and manage the power plants that generate the electricity, the electricity transmission lines, and the distribution equipment (FPSC 2017c).

The main document that established basic law is the Constitution of the State of Florida (The Florida Senate 2017), which was ratified on November 5, 1968, and according to the Florida Department of State the Constitution may have amendments including in the energy area. There are four ways to amend the Florida state Constitution in issues related to energy and others (Florida Division of Elections 2017), which must be approved by at least 60% of voters in order to pass and if approved, it takes effect in January following the election, unless the amendment specifies otherwise. These ways are: Florida Legislature, Citizens' Initiative, Constitutional Revision Commission, or the Taxation and Budget Reform Commission. For the last 45 years, the most common amendments in Florida had been proposed by the Legislature or Citizens' initiatives. The State Legislature can put a proposed amendment on the ballot if 60% or more of the legislators in each chamber agree to do so in a joint resolution. For the citizens' initiatives the proponents must form a political committee, register with the Division of Elections and then create a petition, the proponents must collect signatures from registered voters equal to at least 8% of the total number of statewide votes cast in the previous Presidential election.

According to the League of Women Voters of Okaloosa County (LWV 2017), since 1974 the state of Florida had 4 ballot measures relating to state and local energy policy, which are the foundation of its legislation for the last 43 years. In addition, there is one pending ballot to be voted in 2018. These are:

1. Florida Electric Utilities, Amendment 6 (1974)
2. Florida Renewable Energy Tax Exemption, Amendment 1 (October 1980)

3. Florida Property Tax Exemptions for Renewable Energy Equipment, Amendment 4 (August 2016)
4. Florida Solar Energy Subsidies and Personal Solar Use, Amendment 1 (2016)
5. Florida Right to Produce and Sell Solar Energy Initiative (2018, pending)

From those ballots around last 24 years, each of them had introduced small variations as explained in the analysis below. Nevertheless, the most relevant ballot is the rejection to Florida Solar Energy Subsidies and Personal Solar Use, Amendment 1 (November 2016), which was promoted by local electric utilities.

4.2.1. Florida Electric Utilities, Amendment 6 (November 1974)

Presented by the Florida Legislature, this is one piece of Legislation that allowed the government and private agencies to build generating plants and power lines in the state, granting an exception for power facilities to the band on joint government - private ownership of property. According to the Florida Department of State, Division of Elections Database (Florida Division of Elections 2017b), and as presented in Figure 4.2, the ballot was approved by 55.99% of votes (FDS 2017), and the language that appeared on the ballot was:

“Authorizes a municipality, county, special district, or agency of any of them to become a joint owner of, giving, or lending or using the taxing powers or credit for the joint ownership, construction and operation of electrical energy generating or transmission facilities with any corporation, association, partnership, or person” (Official Ballot 1974).

The amendment opened the implementation of energy grid laws, allowing shift power from generating plants to consumption areas in all the state of Florida. This was a first step for allowing energy generation and transmission with non-utility entities.

4.2.2. Florida Renewable Energy Tax Exemption, Amendment 1 (October 1980)

Presented by the Florida Legislature, and approved by 74.99% of votes on October 7, 1980 according to the Florida State University’s Constitution Revision Commission Amendments (FSU 2017) and the Florida Department of State (FDS 2017), this amendment modified Articles VII – Finance and Taxation- and XII – Schedule - of the Florida Constitution (Annex 2) to provide a tax exemption relating, for up to ten years for those residents and businesses, using solar and other renewable energy equipment (FDE 2017a). Additionally, this amendment allowed the increase of renewable energy use to reduce the need for building new oil electric plants.

According to the Florida Department of State, Division of Elections (Florida Division of Elections 2017b) and as presented in Figure 4.3, the language that appeared on the ballot was:

"Proposing an amendment to Section 3 of Article VII and the creation of Section 18 of Article XII of the State Constitution to authorize, for purposes of ad valorem taxation, an exemption for a renewable energy source device and real property on which a renewable energy source device is installed" (Official Ballot 1980).

This is a relevant amendment to the Constitution because allowed cities and counties to grant tax exemptions for new and expanding businesses and community redevelopment (Ballotpedia 2017). A list of existing tax exemptions and incentive programs is listed and analyzed further this chapter, with an economic evaluation of some of these incentives.

4.2.3. Florida Property Tax Exemptions for Renewable Energy Equipment, Amendment 4 (August 2016)

Sixteen years after a similar Tax Exemption, it was put on the ballot a new one through the Florida Legislature, allowing business and commercial properties to have reductions from ad valorem taxation, as existing on residential properties. This ballot was allowed in August 2016, in part to avoid confusion with a separate solar measure, Amendment 1, which was on the November general election ballot. The Amendment 4 was approved by 72.62% of votes on August 30, 2016 according to the Florida Department of State (FDS 2017). Amendment 4 would modified Section 3 and Section 4 of Article VII of the Florida Constitution (Annex 2), and creates Section 34 of Article XII (FSU 2017).

According to the Florida Department of Elections (FDE 2017b), and as presented in Figure 4.4, the language that appeared on the ballot was:

"Proposing an amendment to the State Constitution to authorize the Legislature, by general law, to exempt from ad valorem taxation the assessed value of solar or renewable energy source devices subject to tangible personal property tax, and to authorize the Legislature, by general law, to prohibit consideration of such devices in assessing the value of real property for ad valorem taxation purposes. This amendment is in effect since January 1, 2018, and expires on December 31, 2037" (Official Ballot 2016).

In June 16, 2017, Florida Governor Rick Scott signed the solar energy legislation Senate Bill 90 (SB 90) in effect since January 1, 2018, that was unanimously approved by the Florida Senate and House (FDE 2017b). This bill implemented Amendment 4 that reduces the cost of solar power by exempting solar installations from taxes. This legislation encourages businesses and commercial properties in Florida to generate power from renewable sources.

According to Advanced Energy Economy (AEE 2017), the bill exempts for both residential and commercial properties, 80% of the value of a solar installation from the tangible personal property tax or TPP[12]. SB 90 also exempts 80% of the value of a solar installation from the assessment of real property taxes for commercial properties. A 100% exemption already exists for residential properties.

4.2.4. Florida Solar Energy Subsidies and Personal Solar Use, Amendment 1 (November 2016)

According to the Florida Department of Elections (FDE 2017a), the November 2016 ballot was supported through a citizen-initiated signature collection and backed by the electric utilities operating in the State of Florida. Amendment 1 was designed to (1) constitutionalize the right to personal solar equipment, and (2) constitutionally protect any law against requiring residents to subsidize solar power.

The ballot was not approved on November 8, 2016 according to the Florida Department of Elections (FDE 2017a), because it did not pass the 60 percent of those voting on the question, according to Section 5 of Article XI of the Florida Constitution (Annex A).

According to the Florida Department of Elections and as presented in Figure 4.5, the language that appeared on the ballot was:

"This amendment establishes a right under Florida's constitution for consumers to own or lease solar equipment installed on their property to generate electricity for their own use. State and local governments shall retain their abilities to protect consumer rights and public health, safety and welfare, and to ensure that consumers who do not choose to install solar are not required to subsidize the costs of backup power and electric grid access to those who do" (Official Ballot 2016b).

In an interview, Professor Amy L. Stein mentioned in summary that the ballot was designed to put the right to produce solar energy, which is provided by state statute, into the state constitution. In addition, the ballot was intended to allow state and local governments to prevent people who do not choose to produce solar energy from being required to subsidize the production of solar energy and as a constitutionally protection against any law requiring residents to subsidize solar energy. This last component generated an important debate in the State (AEE 2017), because it would limit non-utility solar options by preserving the status quo

(12) The Tangible Personal Property or TPP tax is everything other than real estate that is used in a business or rental property to earn income. Inventory and household goods are excluded (FDR 2017)

and providing the electric utilities with leverage to continue to control their customers. If approved, this amendment would have opened the way for penalties or fees on solar energy owners.

In an interview to former U.S. Vice President Al Gore to Tampa Bay Times in October 2016, he referred to Amendment 1 as: “The things they claim protect solar are protections you already have. But they are trying to fool you into amending your state Constitution in a way that gives them the authority to shut down net metering and do in Florida what they did in Nevada and just kill the solar industry” (TBT 2016).

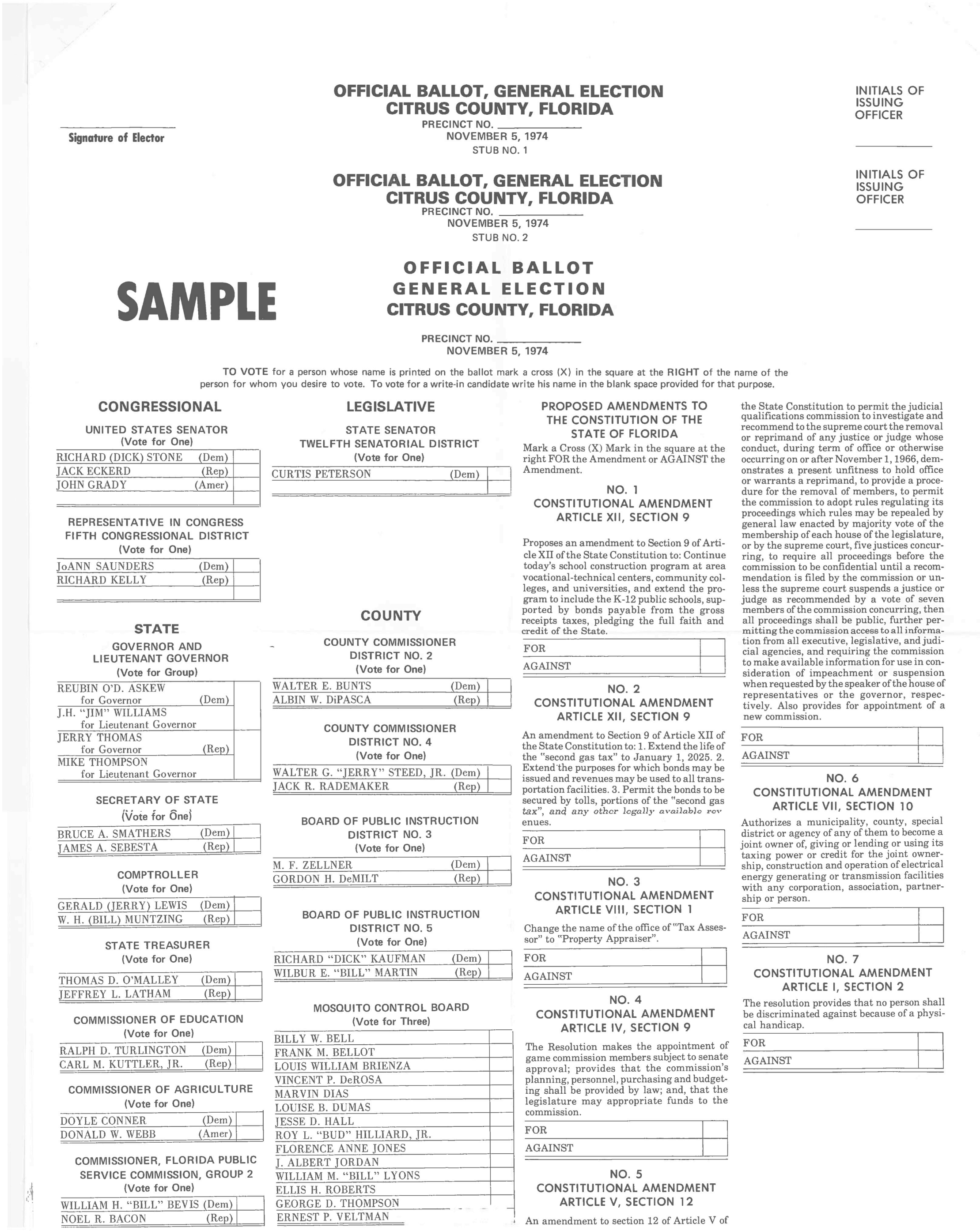
4.2.5. Florida Right to Produce and Sell Solar Energy Initiative (2018, pending)

As a consequence of Amendment 1 of November 2016, an amendment on November 6, 2018 was planned to appear supported by the Florida Right to produce and Sell Solar Energy Initiative. This measure did not make the ballot in the state on November 8, 2016 (Ballotpedia 2017b) and do not have plans for 2019. The measure is designed to add a Section 29 to Article X of the Florida Constitution (Annex A).

According to the Florida Department of Elections, the text for the proposed ballot, as presented in Fug. 6, would be as:

“Limits or prevents government and electric utility had imposed barriers to supplying local solar electricity. Local solar electricity supply is the non-utility supply of solar generated electricity from a facility rated up to 2 megawatts to customers at the same or contiguous property as the facility. Barriers include government regulation of local solar electricity suppliers’ rates, service and territory, and unfavorable electric utility rates, charges, or terms of service imposed on local solar electricity customers” (FDE 2017b)

Supporters like the Tea Party, Conservative Christians, Libertarians, Democrats, and Environmentalist, have come together to promote for solar friendly policies that would break up the utility centric energy approach that currently resides in Florida. Nevertheless, the amendment is not in the ballot for November 2018 elections (Ballotpedia 2017b) because was unable to reach the minimum signatures to qualify. At March 2019, it has not been presented the minimum signatures as well.



OFFICIAL BALLOT, GENERAL ELECTION
CITRUS COUNTY, FLORIDA
PRECINCT NO. ____________
NOVEMBER 5, 1974
STUB NO. 1

INITIALS OF ISSUING OFFICER

Signature of Elector

OFFICIAL BALLOT, GENERAL ELECTION
CITRUS COUNTY, FLORIDA
PRECINCT NO. ____________
NOVEMBER 5, 1974
STUB NO. 2

INITIALS OF ISSUING OFFICER

SAMPLE

OFFICIAL BALLOT
GENERAL ELECTION
CITRUS COUNTY, FLORIDA

PRECINCT NO. ____________
NOVEMBER 5, 1974

TO VOTE for a person whose name is printed on the ballot mark a cross (X) in the square at the RIGHT of the name of the person for whom you desire to vote. To vote for a write-in candidate write his name in the blank space provided for that purpose.

CONGRESSIONAL

UNITED STATES SENATOR
(Vote for One)

RICHARD (DICK) STONE (Dem)
JACK ECKERD (Rep)
JOHN GRADY (Amer)

REPRESENTATIVE IN CONGRESS
FIFTH CONGRESSIONAL DISTRICT
(Vote for One)

JoANN SAUNDERS (Dem)
RICHARD KELLY (Rep)

STATE

GOVERNOR AND
LIEUTENANT GOVERNOR
(Vote for Group)

REUBIN O'D. ASKEW for Governor (Dem)
J.H. "JIM" WILLIAMS for Lieutenant Governor
JERRY THOMAS for Governor (Rep)
MIKE THOMPSON for Lieutenant Governor

SECRETARY OF STATE
(Vote for One)

BRUCE A. SMATHERS (Dem)
JAMES A. SEBESTA (Rep)

COMPTROLLER
(Vote for One)

GERALD (JERRY) LEWIS (Dem)
W. H. (BILL) MUNTZING (Rep)

STATE TREASURER
(Vote for One)

THOMAS D. O'MALLEY (Dem)
JEFFREY L. LATHAM (Rep)

COMMISSIONER OF EDUCATION
(Vote for One)

RALPH D. TURLINGTON (Dem)
CARL M. KUTTLER, JR. (Rep)

COMMISSIONER OF AGRICULTURE
(Vote for One)

DOYLE CONNER (Dem)
DONALD W. WEBB (Amer)

COMMISSIONER, FLORIDA PUBLIC SERVICE COMMISSION, GROUP 2
(Vote for One)

WILLIAM H. "BILL" BEVIS (Dem)
NOEL R. BACON (Rep)

LEGISLATIVE

STATE SENATOR
TWELFTH SENATORIAL DISTRICT
(Vote for One)

CURTIS PETERSON (Dem)

COUNTY

COUNTY COMMISSIONER
DISTRICT NO. 2
(Vote for One)

WALTER E. BUNTS (Dem)
ALBIN W. DiPASCA (Rep)

COUNTY COMMISSIONER
DISTRICT NO. 4
(Vote for One)

WALTER G. "JERRY" STEED, JR. (Dem)
JACK R. RADEMAKER (Rep)

BOARD OF PUBLIC INSTRUCTION
DISTRICT NO. 3
(Vote for One)

M. F. ZELLNER (Dem)
GORDON H. DeMILT (Rep)

BOARD OF PUBLIC INSTRUCTION
DISTRICT NO. 5
(Vote for One)

RICHARD "DICK" KAUFMAN (Dem)
WILBUR E. "BILL" MARTIN (Rep)

MOSQUITO CONTROL BOARD
(Vote for Three)

BILLY W. BELL
FRANK M. BELLOT
LOUIS WILLIAM BRIENZA
VINCENT P. DeROSA
MARVIN DIAS
LOUISE B. DUMAS
JESSE D. HALL
ROY L. "BUD" HILLIARD, JR.
FLORENCE ANNE JONES
J. ALBERT JORDAN
WILLIAM M. "BILL" LYONS
ELLIS H. ROBERTS
GEORGE D. THOMPSON
ERNEST P. VELTMAN

PROPOSED AMENDMENTS TO THE CONSTITUTION OF THE STATE OF FLORIDA

Mark a Cross (X) Mark in the square at the right FOR the Amendment or AGAINST the Amendment.

NO. 1
CONSTITUTIONAL AMENDMENT
ARTICLE XII, SECTION 9

Proposes an amendment to Section 9 of Article XII of the State Constitution to: Continue today's school construction program at area vocational-technical centers, community colleges, and universities, and extend the program to include the K-12 public schools, supported by bonds payable from the gross receipts taxes, pledging the full faith and credit of the State.

FOR
AGAINST

NO. 2
CONSTITUTIONAL AMENDMENT
ARTICLE XII, SECTION 9

An amendment to Section 9 of Article XII of the State Constitution to: 1. Extend the life of the "second gas tax" to January 1, 2025. 2. Extend the purposes for which bonds may be issued and revenues may be used to all transportation facilities. 3. Permit the bonds to be secured by tolls, portions of the "second gas tax", and any other legally available revenues.

FOR
AGAINST

NO. 3
CONSTITUTIONAL AMENDMENT
ARTICLE VIII, SECTION 1

Change the name of the office of "Tax Assessor" to "Property Appraiser".

FOR
AGAINST

NO. 4
CONSTITUTIONAL AMENDMENT
ARTICLE IV, SECTION 9

The Resolution makes the appointment of game commission members subject to senate approval; provides that the commission's planning, personnel, purchasing and budgeting shall be provided by law; and, that the legislature may appropriate funds to the commission.

FOR
AGAINST

NO. 5
CONSTITUTIONAL AMENDMENT
ARTICLE V, SECTION 12

An amendment to section 12 of Article V of the State Constitution to permit the judicial qualifications commission to investigate and recommend to the supreme court the removal or reprimand of any justice or judge whose conduct, during term of office or otherwise occurring on or after November 1, 1966, demonstrates a present unfitness to hold office or warrants a reprimand, to provide a procedure for the removal of members, to permit the commission to adopt rules regulating its proceedings which rules may be repealed by general law enacted by majority vote of the membership of each house of the legislature, or by the supreme court, five justices concurring, to require all proceedings before the commission to be confidential until a recommendation is filed by the commission or unless the supreme court suspends a justice or judge as recommended by a vote of seven members of the commission concurring, then all proceedings shall be public, further permitting the commission access to all information from all executive, legislative, and judicial agencies, and requiring the commission to make available information for use in consideration of impeachment or suspension when requested by the speaker of the house of representatives or the governor, respectively. Also provides for appointment of a new commission.

FOR
AGAINST

NO. 6
CONSTITUTIONAL AMENDMENT
ARTICLE VII, SECTION 10

Authorizes a municipality, county, special district or agency of any of them to become a joint owner of, giving or lending or using its taxing power or credit for the joint ownership, construction and operation of electrical energy generating or transmission facilities with any corporation, association, partnership or person.

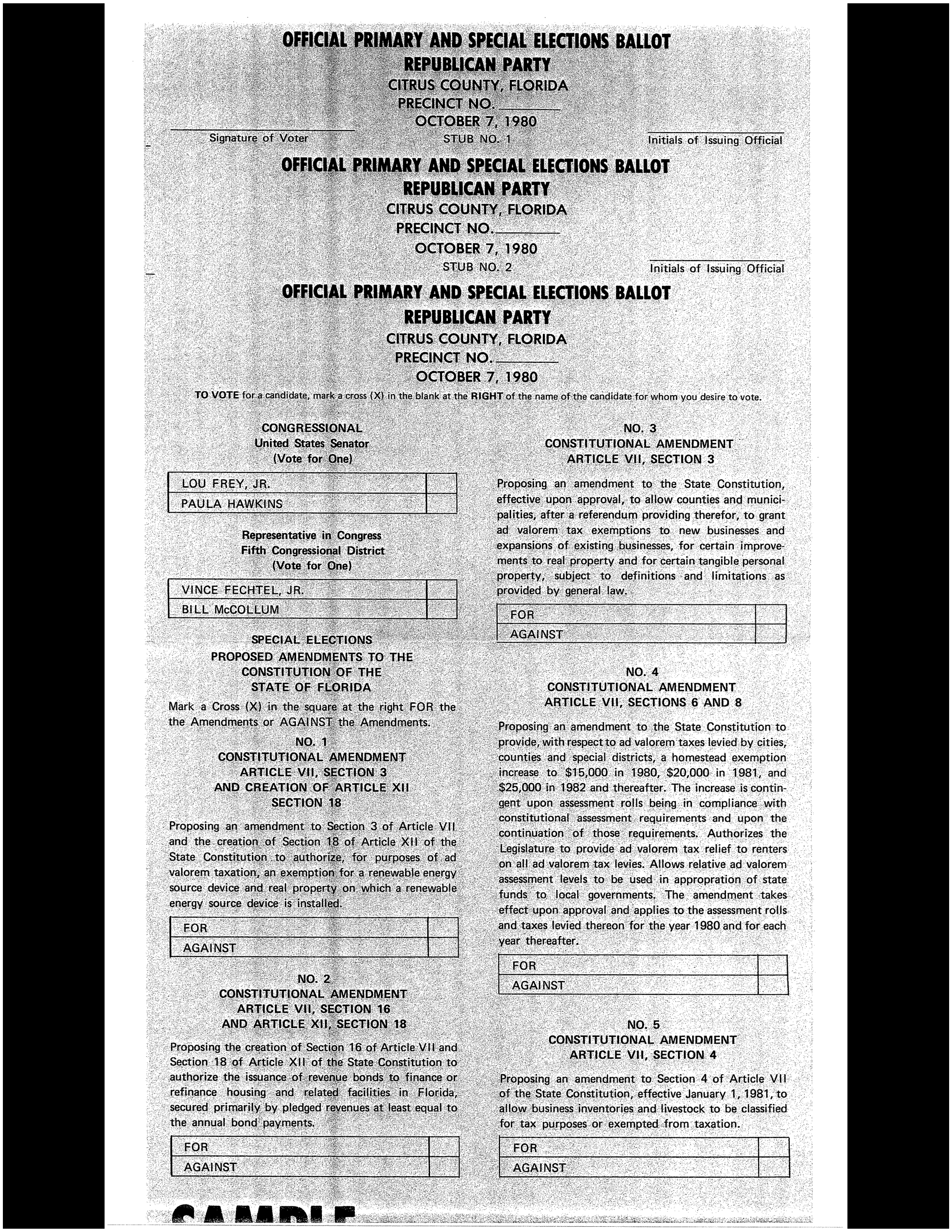
FOR
AGAINST

NO. 7
CONSTITUTIONAL AMENDMENT
ARTICLE I, SECTION 2

The resolution provides that no person shall be discriminated against because of a physical handicap.

FOR
AGAINST

Fig. 4.2. Sample ballot, Florida Electric Utilities, Amendment 6 (1974). *Source*: Official Ballot, General Election, Citrus County – Florida (General Election 1974)



OFFICIAL PRIMARY AND SPECIAL ELECTIONS BALLOT
REPUBLICAN PARTY
CITRUS COUNTY, FLORIDA
PRECINCT NO. ________
OCTOBER 7, 1980

Signature of Voter — STUB NO. 1 — Initials of Issuing Official

OFFICIAL PRIMARY AND SPECIAL ELECTIONS BALLOT
REPUBLICAN PARTY
CITRUS COUNTY, FLORIDA
PRECINCT NO. ________
OCTOBER 7, 1980

STUB NO. 2 — Initials of Issuing Official

OFFICIAL PRIMARY AND SPECIAL ELECTIONS BALLOT
REPUBLICAN PARTY
CITRUS COUNTY, FLORIDA
PRECINCT NO. ________
OCTOBER 7, 1980

TO VOTE for a candidate, mark a cross (X) in the blank at the **RIGHT** of the name of the candidate for whom you desire to vote.

CONGRESSIONAL
United States Senator
(Vote for One)

LOU FREY, JR.	
PAULA HAWKINS	

Representative in Congress
Fifth Congressional District
(Vote for One)

VINCE FECHTEL, JR.	
BILL McCOLLUM	

SPECIAL ELECTIONS
PROPOSED AMENDMENTS TO THE CONSTITUTION OF THE STATE OF FLORIDA

Mark a Cross (X) in the square at the right FOR the the Amendments or AGAINST the Amendments.

NO. 1
CONSTITUTIONAL AMENDMENT
ARTICLE VII, SECTION 3
AND CREATION OF ARTICLE XII
SECTION 18

Proposing an amendment to Section 3 of Article VII and the creation of Section 18 of Article XII of the State Constitution to authorize, for purposes of ad valorem taxation, an exemption for a renewable energy source device and real property on which a renewable energy source device is installed.

FOR	
AGAINST	

NO. 2
CONSTITUTIONAL AMENDMENT
ARTICLE VII, SECTION 16
AND ARTICLE XII, SECTION 18

Proposing the creation of Section 16 of Article VII and Section 18 of Article XII of the State Constitution to authorize the issuance of revenue bonds to finance or refinance housing and related facilities in Florida, secured primarily by pledged revenues at least equal to the annual bond payments.

FOR	
AGAINST	

NO. 3
CONSTITUTIONAL AMENDMENT
ARTICLE VII, SECTION 3

Proposing an amendment to the State Constitution, effective upon approval, to allow counties and municipalities, after a referendum providing therefor, to grant ad valorem tax exemptions to new businesses and expansions of existing businesses, for certain improvements to real property and for certain tangible personal property, subject to definitions and limitations as provided by general law.

FOR	
AGAINST	

NO. 4
CONSTITUTIONAL AMENDMENT
ARTICLE VII, SECTIONS 6 AND 8

Proposing an amendment to the State Constitution to provide, with respect to ad valorem taxes levied by cities, counties and special districts, a homestead exemption increase to $15,000 in 1980, $20,000 in 1981, and $25,000 in 1982 and thereafter. The increase is contingent upon assessment rolls being in compliance with constitutional assessment requirements and upon the continuation of those requirements. Authorizes the Legislature to provide ad valorem tax relief to renters on all ad valorem tax levies. Allows relative ad valorem assessment levels to be used in appropration of state funds to local governments. The amendment takes effect upon approval and applies to the assessment rolls and taxes levied thereon for the year 1980 and for each year thereafter.

FOR	
AGAINST	

NO. 5
CONSTITUTIONAL AMENDMENT
ARTICLE VII, SECTION 4

Proposing an amendment to Section 4 of Article VII of the State Constitution, effective January 1, 1981, to allow business inventories and livestock to be classified for tax purposes or exempted from taxation.

FOR	
AGAINST	

Fig. 4.3. Sample ballot, Florida Renewable Energy Tax Exemption, Amendment 1 (October 1980). *Source:* Official Primary and Special Elections Ballot, Republican Party, Citrus County – Florida (Official Ballot 1980)

Official Primary Election Ballot, August 30, 2016
Democratic Party, Citrus County, Florida

- **Instructions: To vote, fill in the oval completely ⬬ next to your choice. Use a black or blue pen.**
- **If you make a mistake, ask for a new ballot. Do not cross out or your vote may not count.**

United States Senator
(Vote for One)

- ⬭ Roque "Rocky" De La Fuente
- ⬭ Alan Grayson
- ⬭ Pam Keith
- ⬭ Reginald Luster
- ⬭ Patrick Murphy

School Board Member District 4
(Vote for One)

- ⬭ Sandy B. Counts
- ⬭ Kevin Maloney
- ⬭ Bill Murray

No. 4 Constitutional Amendment,
Article VII, Sections 3 and 4
Article XII, Section 34

Solar Devices or Renewable Energy Source Devices; Exemption From Certain Taxation and Assessment.

Proposing an amendment to the State Constitution to authorize the Legislature, by general law, to exempt from ad valorem taxation the assessed value of solar or renewable energy source devices subject to tangible personal property tax, and to authorize the Legislature, by general law, to prohibit consideration of such devices in assessing the value of real property for ad valorem taxation purposes. This amendment takes effect January 1, 2018, and expires on December 31, 2037.

- ⬭ Yes
- ⬭ No

School Board Referendum

School Board Sales Surtax to Finance Fixed Capital Improvements and Provide for Technology.

Shall a one-half cent (1/2 cent) per dollar sales surtax be levied for a period not to exceed ten (10) years to fund and/or finance fixed capital improvements to school facilities and to provide for technology implementation within the school district?

- ⬭ FOR the one-half cent sales tax
- ⬭ AGAINST the one-half cent sales tax

SAMPLE BALLOT

Fig. 4.4. Sample Ballot, Florida Property Tax Exemptions for Renewable Energy Equipment, Amendment 4 (August 2016). *Source:* Official Primary Election Ballot, Citrus County - Florida (Official Ballot 2016)

Official General Election Ballot, November 8, 2016
Citrus County, Florida

- Instructions: To vote, fill in the oval completely next to your choice. Use a black or blue pen.
- If you make a mistake, ask for a new ballot. Do not cross out or your vote may not count.
- To vote for a write-in candidate, fill in the oval and print the name clearly on the blank line provided for the write-in candidate.

School Board Member District 4
(Vote for One)

- ⬭ Sandy B. Counts
- ⬭ Bill Murray

Citrus County Community Charitable Foundation Seat 1
(Vote for One)

- ⬭ Sophia Diaz-Fonseca
- ⬭ Stephen L. Teaster II

Citrus County Community Charitable Foundation Seat 2
(Vote for One)

- ⬭ Sondra L. Moylan
- ⬭ Paul Perregaux

Mosquito Control Board Seat 2
(Vote for One)

- ⬭ Janet A. Barek
- ⬭ Mark Hammer
- ⬭ Steve Henninger
- ⬭ Leon Dale McClellan
- ⬭ Robert B. Waters

No. 1 Constitutional Amendment,
Article X, Section 29

Rights of Electricity Consumers Regarding Solar Energy Choice.

This amendment establishes a right under Florida's constitution for consumers to own or lease solar equipment installed on their property to generate electricity for their own use. State and local governments shall retain their abilities to protect consumer rights and public health, safety and welfare, and to ensure that consumers who do not choose to install solar are not required to subsidize the costs of backup power and electric grid access to those who do.

The amendment is not expected to result in an increase or decrease in any revenues or costs to state and local government.

- ⬭ Yes
- ⬭ No

No. 2 Constitutional Amendment,
Article X, Section 29

Use of Marijuana for Debilitating Medical Conditions.

Allows medical use of marijuana for individuals with debilitating medical conditions as determined by a licensed Florida physician. Allows caregivers to assist patients' medical use of marijuana. The Department of Health shall register and regulate centers that produce and distribute marijuana for medical purposes and shall issue identification cards to patients and caregivers. Applies only to Florida law. Does not immunize violations of federal law or any non-medical use, possession or production of marijuana.

Increased costs from this amendment to state and local governments cannot be determined. There will be additional regulatory costs and enforcement activities associated with the production, sale, use and possession of medical marijuana. Fees may offset some of the regulatory costs. Sales tax will likely apply to most purchases, resulting in a substantial increase in state and local government revenues that cannot be determined precisely. The impact on property tax revenues cannot be determined.

- ⬭ Yes
- ⬭ No

No. 3 Constitutional Amendment,
Article VII, Section 6
Article XII

Tax Exemption for Totally and Permanently Disabled First Responders.

Proposing an amendment to the State Constitution to authorize a first responder, who is totally and permanently disabled as a result of injuries sustained in the line of duty, to receive relief from ad valorem taxes assessed on homestead property, if authorized by general law. If approved by voters, the amendment takes effect January 1, 2017.

- ⬭ Yes
- ⬭ No

No. 5 Constitutional Amendment,
Article VII, Section 6
Article XII

Homestead Tax Exemption for Certain Senior, Low-income, Long-term Residents; Determination of Just Value.

Proposing an amendment to the State Constitution to revise the homestead tax exemption that may be granted by counties or municipalities for property with just value less than $250,000 owned by certain senior, low-income, long-term residents to specify that just value is determined in the first tax year the owner applies and is eligible for the exemption. The amendment takes effect January 1, 2017, and applies retroactively to exemptions granted before January 1, 2017.

- ⬭ Yes
- ⬭ No

City of Inverness
Charter Amendment 1

Should Article V, Section 5.07, sale, leasing or subleasing of city property, be amended to provide that leasing of real property for commercial, professional and public use may be leased for an initial term of up to 25 years, with renewals up to 10 year increments, for up to a 99 year term.

- ⬭ Yes
- ⬭ No

City of Inverness
Charter Amendment 2

Should a new Article V, Section 5.22, purchase of real property, be adopted providing procedures for the acquisition of real property and for the purchase of real property which exceeds $200,000.00 in value, that the city council shall obtain at least one governor and cabinet approved appraisal organization or state certified general appraiser.

- ⬭ Yes
- ⬭ No

Vote Both Sides of Page

Fig. 4.5. Sample ballot, Florida Solar Energy Subsidies and Personal Solar Use, Amendment 1 (November, 2016). *Source:* Official General Election Ballot, Citrus County - Florida (Official Ballot 2016)

CONSTITUTIONAL AMENDMENT PETITION FORM

Note:
- *All information on this form, including your signature, becomes a public record upon receipt by the Supervisor of Elections.*
- *Under Florida law, it is a first degree misdemeanor, punishable as provided in s. 775.082 or s. 775.08, Florida Statutes, to knowingly sign more than one petition for an issue. [Section 104.185, Florida Statutes]*
- *If all requested information on this form is not completed, the form will not be valid.*

Your name: ____

Please Print Name ***as it appears on your Voter Information Card***

Your address:____

City ____________________ **Zip**__________ **County**____________________

☐ Please change my legal residence address on my voter registration record to the above residence address (check box, if applicable).

Voter Registration Number ____________________ **or Date of Birth** ____________________

I am a registered voter of Florida and hereby petition the Secretary of State to place the following proposed amendment to the Florida Constitution on the ballot in the general election:

BALLOT TITLE: Rights of Electricity Consumers Regarding Solar Energy Choice

BALLOT SUMMARY: This amendment establishes a right under Florida's constitution for consumers to own or lease solar equipment installed on their property to generate electricity for their own use. State and local governments shall retain their abilities to protect consumer rights and public health, safety and welfare, and to ensure that consumers who do not choose to install solar are not required to subsidize the costs of backup power and electric grid access to those who do.

ARTICLE AND SECTION BEING CREATED OR AMENDED: Add new Section 29 to Article X
FULL TEXT OF THE PROPOSED CONSTITUTIONAL AMENDMENT:
Section 29 – Rights of electricity consumers regarding solar energy choice. –
(a) ESTABLISHMENT OF CONSTITUTIONAL RIGHT. Electricity consumers have the right to own or lease solar equipment installed on their property to generate electricity for their own use.
(b) RETENTION OF STATE AND LOCAL GOVERNMENTAL ABILITIES. State and local governments shall retain their abilities to protect consumer rights and public health, safety and welfare, and to ensure that consumers who do not choose to install solar are not required to subsidize the costs of backup power and electric grid access to those who do.
(c) DEFINITIONS. For purposes of this section, the following words and terms shall have the following meanings:
(1) "consumer" means any end user of electricity regardless of the source of that electricity.
(2) "solar equipment," "solar electrical generating equipment" and "solar" are used interchangeably and mean photovoltaic panels and any other device or system that converts sunlight into electricity.
(3) "backup power" means electricity from an electric utility, made available to solar electricity consumers for their use when their solar electricity generation is insufficient or unavailable, such as at night, during periods of low solar electricity generation or when their solar equipment otherwise is not functioning.
(4) "lease," when used in the context of a consumer paying the owner of solar electrical generating equipment for the right to use such equipment, means an agreement under which the consumer pays the equipment owner/lessor a stream of periodic payments for the use of such equipment, which payments do not vary in amount based on the amount of electricity produced by the equipment and used by the consumer/lessee.
(5) "electric grid" means the interconnected electrical network, consisting of power plants and other generating facilities, transformers, transmission lines, distribution lines and related facilities, that makes electricity available to consumers throughout Florida.
(6) "electric utility" means any municipal electric utility, investor-owned electric utility, or rural electric cooperative which owns, maintains, or operates an electric generation, transmission, or distribution system within the state.
(d) EFFECTIVE DATE. This section shall be effective immediately upon voter approval of this amendment.

____________________ X______________________________

DATE OF SIGNATURE **SIGNATURE OF REGISTERED VOTER**

Initiative petition sponsored by Consumers for Smart Solar, 2640-A Mitcham Drive, Tallahassee, FL 32308

If paid petition circulator is used:

Circulator's name______________________________

Circulator's address______________________________

____

For Official Use Only:

Serial Number: ____________________

Date Approved: ____________________

Fig. 4.6. Sample of Constitutional Amendment Petition Form *Source:* Florida Department of Elections (DFE 2017b)

4.2.6. Judicial ruling. The case of PW VENTURES, INC.

It is relevant to understand the PW Ventures, Inc Case, which has implications on the rights of third-party providers of energy in the State of Florida, allowing utilities as the only entities to sell power energy, based on the current law.

The Florida Supreme Court has jurisdiction over cases that may require clarification over the Chapters of the Florida Statutes (Florida Statutes 2017a) after a request by a party on its intervention. In an interview with Professor Hannah Wiseman, Attorneys' Title Professor, Florida State University College of Law (Wiseman Hannah, personal interview, January 8, 2018), it was discussed the case of *PW Ventures, Inc. v. Nichols*, 533 So. 2d 281, 284 (October 27, 1988), which is known as the *PW VENTURES, INC., Appellant, v. Katie NICHOLS, Chairman of Florida Public Service Commission, and Florida Public Service Commission, Appellees (Leagle 2018).*

In the 1980s PW Ventures pursued to build, own and operate a cogeneration on land leased, and sell the solar energy directly to another entity, in this case Pratt industrial complex in Palm Beach County, according to Professor Hannah Wiseman. The Florida Public Service Commission ruled that PW Ventures' proposed transaction with Pratt fell within its regulatory jurisdiction as a public utility subject. According to Leagle and Justia legal consulting (Leagle 2018, Justia 2018) PW Ventures appealed the ruling to the Florida Supreme Court. The Florida Supreme Court ruled in 1988 to prohibit third-party providers from placing rooftop panels on homes and businesses and selling electricity from the panels to the homeowner or business owners.

The Court based its ruling, in part on Chapter 366 on Public Utilities of the Florida Statutes, and in specific the Chapter 366.04 (Florida Statutes 2017b), it mandates to the Florida Public Service Commission (FPSC) to regulate and supervise each public utility with respect to its rates and service, to prescribe fair and reasonable rates and charges, classifications, standards of quality and measurements, as well as to exercise its powers to avoid uneconomic duplication of generation, transmission, and distribution facilities, among other tasks and responsibilities. In addition, Section 366.02 of same Florida Status directs that Public Utility means every person, corporation, partnership, association, or other legal entity by supplying electricity to (Florida Statutes 2017b) or for the public within the state of Florida, excluding municipal or rural cooperatives.

By the same Florida Statutes, the Supreme Court ruled that when a customer by consuming less electricity for using other source as solar energy, the result would be reduced revenues to the power utility, which revenue would have to be recovered by the remaining customers of the regulated utilities since the fixed

costs of the regulated systems (Florida Statutes 2017b would not have been reduced. This action would divert revenues to unregulated energy generators.
By the same source, it noted that the statutory protection of the FPSC was of the public interest requires only limiting competition in the sale of electric service, not a prohibition against self-generation. This is a critical element of the current laws in Florida because current law allows non-utilities to generate electricity for their own use and sell any excess to a power utility, but prohibits all non-utility sales of electricity to anyone other than a regulated power utility, regardless of the technology used to generate electricity (Leagle 2018, Justia 2018). In summary, consumers in Florida cannot buy electricity from non-utility power companies, and non-utility power companies, including rooftop solar companies, cannot sell power to retail customers in Florida.

The PW Ventures case is the case that essentially prohibits third-party providers from placing rooftop panels on homes and businesses and selling electricity from the panels to the homeowner or business owner (Holt and Galligan 2017, Wiseman Hannah, personal interview, January 8, 2018). By state law only allows utilities to sell power energy. Nevertheless, the prohibition does not extend to leasing generating equipment because leases do not involve the sale of electricity.

On April 20, 2018 The Florida Public Service Commission issued a statement confirming Sunrun Inc., a company based in California, can offer residential solar equipment leases in Florida (FPSC 2018a), in a 20-year solar equipment lease that is not a retail sale of electricity. By the FPSC ruling the Sunrun's lease agreement for the equipment, conforms to its petition by offering customers fixed payments independent of electric production. As a result, Sunrun will be allowed to lease rooftop solar equipment to homeowners without being considered a public utility under FPSC jurisdiction.

As a summary, each ballot had introduced small changes in favor of the implementation of renewables and solar PV in the state of Florida. The ballots had been on tax exemptions as the ballots of October 1980 and August 2016, to stop the subsidies to solar PV and renewables by electric utilities Even though that has always been legal (IEEFA 2018a), it was highly expensive until Amendment 4, Florida Property Tax Exemptions for Renewable Energy Equipment, to roll back taxes on solar equipment.

Nevertheless, the most relevant ruling of the last 24 years was the FPSC ruling of 2018, allowing homeowners in Florida to lease equipment to generate electricity for personal use and also benefit from interconnection and net metering with their local utility.

4.3. Evaluation: Quantitative analysis and assessment of the stakeholders

Energy security is one of the most important agendas in energy policies in the USA, because the stability for the economic development and its future which is impacted by the economic growth through industrialization and urbanization, growth in population and constant innovation. As presented in Chapter 3, it has been a shift towards an eco-friendly production and consumption patterns, especially in states with a highest Share of Net Generation in Renewable Sources Excluding Hydroelectric of Table 4 in Chapter 2 as California, Iowa, Maine, Vermont among others.

As part of the stability for the economic development, it is relevant to analyze the financial effect of the implementation of solar photovoltaic incentives and regulations, the evolution of Net Generation from Solar Photovoltaic, Number of Jobs in solar electric generation, and cost of energy to ultimate customers, to the state of Florida and to other top solar photovoltaic generation states, which is presented in this section of the research. Previous to this correlation analysis it has to be introduced the economic elements as presented below, with focus in 15 States with the higher net generation from solar photovoltaic in 2017.

An important fact to be introduce as a starting point on this evaluation is that, the U.S. solar industry generated US$210 billion in economic activity in 2017, including direct sales, wages, salaries, benefits, taxes and fees According to The Solar Foundation (SEM 2018). This is almost five times from $42 million revenues by the solar industry in 2007.

The first point on this evaluation is the number of Federal and State policies and incentives, which has been presented in Chapter 2 of this research. As summarized in Table 15, it is clear that California, Texas and Colorado have the highest number of incentives and regulations in the U.S. The State of Florida has 41% of the number of policies and incentives of the state of California, while North Carolina has close to same number of policies and regulations. This information will help to elaborate a correlation analysis presented at the end of this chapter in Table 19.

As noted in Chapter 2, deregulation of the energy market started in 1996 with Pennsylvania, Rhode Island, Ohio, followed by Illinois, New York and Oregon. Table 15 shows six states in our sample with deregulated energy markets. States may be partially regulated/deregulated, regulated only in some utility markets, or deregulated for industrial consumers. California's electric choice works on a very limited lottery system called Direct Access, having deregulated energy for some commercial & industrial consumers. Electricity deregulation is available to 85% of Texans according to Electric choices (EC 2018) publication.

Table 15
Number of Federal and State Policies and Incentives, and Deregulated Energy Status by selected States

	Number of Federal and State Policies and Incentives	Deregulated Energy Market
California	256	Yes
North Carolina	102	No
Arizona	76	No
Nevada	40	No
New Jersey	56	Yes
Texas	156	Yes
Massachusetts	99	Yes
Georgia	61	No
Utah	42	No
Colorado	134	No
New York	113	Yes
New Mexico	63	No
Hawaii	29	No
Florida	104	No
Maryland	88	Yes

Source: Own Elaboration from DSIRE (DESIRE 2018) and Electric Choices (EC 2018)

4.3.1. Solar generation and capacity in the state of Florida

A summary of the Energy Information Administration's Electric Power Monthly report of December 2017 is presented in Table 15 (EIA 2018) for top 15 states shows a rapid growth and expansion in 2017 of renewable energy and solar photovoltaic generation to 73,828 Megawatt hours (mWh) a 43.4% growth in electricity from solar from 2016 or over 1600% from 2012 levels. The energy generated by solar photovoltaic represented over 1.8% of all electricity generated in the United States in 2017, while in 2012 was around 0.1% or 4,327 mWh. In parallel with the solar generation growth, the total renewable generation grew 15.2% versus 2016 or 53.9% increase versus 2012. The total electricity generation fall 1.4% versus 2016 to 4,038,943 mWh, a decrease of 0.2% from 2012 levels showing that the US economy continues to become more energy productive.

The 15 States with the higher net generation from solar photovoltaic in 2017 are also presented in Table 16, where the 81% of the total solar P.V. are: California (42.5%), North Carolina (7.8%), Arizona (7.8%), Nevada (5.5%), New Jersey (3.8%), Texas (3.8%), Massachusetts (3.5%), Georgia (3.2%) and Utah (3.1%).

From same source, the state of Florida generated 1.5% of total solar photovoltaic in 2017. The State of Georgia, one of the southeastern states, just north of Florida, had growth the Net generation from Solar Photovoltaic to 2,364 mWh a double of the generation by Florida in same year, with a drastic increase in generation from last 2 years.

Table 16

Net generation from Solar Photovoltaic – Top 15 States and Total US (Thousand Megawatt hours - mWh)

	2017	2016	2015	2014	2013	2012
California	31,370	24,616	18,536	12,198	3,814	1,382
North Carolina	5,783	3,589	1,460	801	345	139
Arizona	5,774	4,726	4,108	3,454	2,111	955
Nevada	4,081	3,252	1,734	983	745	473
New Jersey	2,836	2,220	2,062	1,620	437	304
Texas	2,814	1,122	624	424	163	118
Massachusetts	2,554	1,863	1,314	806	106	30
Georgia	2,364	1,076	229	203	14	3
Utah	2,262	1,203	99	40	2	2
Colorado	1,463	999	643	606	248	165
New York	1,395	1,013	689	362	67	53
New Mexico	1,313	909	757	631	388	334
Hawaii	1,165	848	687	571	19	5
Florida	1,142	354	274	218	210	194
Maryland	1,067	728	457	307	63	22
U.S. Total Solar PV	73,828	51,483	35,805	24,785	9,036	4,327
U.S. Total Renewables	761,117	660,928	580,046	565,061	522,073	494,573
Total U.S.	4,038,943	4,095,487	4,091,740	4,104,839	4,065,964	4,047,765

Source: Own Elaboration from Energy Information Administration (EIA 2018)

As presented in Table 16, in 2012 the states ranking of solar photovoltaic net generation were California (31.9%), Arizona (22.1%), Nevada (10.9%), New Jersey (7.0%), North Carolina (3.2%), Texas (2.7%), Massachusetts (0.7%), Georgia (0.1%) and Utah (0%), while Florida generated 4.5% of 4,327 Megawatt hours. The difference shows the changes in solar photovoltaic net generation across states, with California as the major adopted of solar photovoltaic.

4.3.2. Cost of energy by end-user sector

At December 2017, the average price people in the U.S. pay for electricity was 10.26 cents per kilowatt-hour by EIA Table 5.6.A (EIA 2018), but there's huge variation from state to state as presented in Table 17 for the 15 selected states.

Table 17
Average price of electricity to Ultimate Customers by End-user Sector for 15 Selected States at December 2017

	Residential	Commercial	Industrial	All Sectors
California	18.48	14.39	11.35	11.25
North Carolina	10.42	8.37	5.93	8.90
Arizona	12.24	9.91	5.76	9.99
Nevada	12.34	8.04	5.19	8.43
New Jersey	15.59	11.62	9.84	12.96
Texas	11.11	8.16	5.39	8.35
Massachusetts	19.61	15.45	14.08	16.90
Georgia	10.66	9.90	5.55	9.21
Utah	10.32	7.90	5.45	7.96
Colorado	11.73	9.50	6.90	9.57
New York	17.00	13.44	5.94	13.75
New Mexico	12.38	9.44	5.52	9.01
Hawaii	30.75	28.91	25.01	27.99
Florida	11.94	9.70	7.80	10.67
Maryland	13.25	10.89	8.39	11.86
U.S. Total	12.5	10.32	6.63	10.26

Source: Own Elaboration from EIA (EIA 2018)

By the same source, in average, people in Hawaii pay the most for electricity about 27.99 cents per kWh, Utah had the lowest price, at about 7.96 cents per kWh. The state of Florida in average charge 10.67 cents per kWh, just over the average price in the U.S. Nevertheless, by sector there are differences within the same state. In the case of California, the state leader in the net generation of solar photovoltaic and deregulated market, the average price for residential customers is 7.13 cents per kWh of industrial charges, and 4.09 cents per kWh from commercial customers' charges. North Carolina, the second largest net generator of solar energy and a regulated energy market, has lower average price than Florida to 8.90 cents per kWh, it charged 10.42 cents per kWh to residential customers, 8.37 cents per kWh to commercial and 5.93 kWh to industrial customers.

Similar average price levels are in Arizona and Nevada, the third and fourth states by net generation in 2017 and regulated energy markets (EIA 2018). The six states with deregulated energy do not have similar average price of electricity, the variations are from 8.35 cents per kWh in Texas to 16.90 cents per kWh in Massachusetts, and 11.25 cents per kWh in California.

4.3.3. Solar job development

Because the rapid technological change that affects how society produces and uses energy, it is especially helpful to understand the relationship between energy and employment. As commented before on this chapter, governments, utilities and other organizations offer solar tax breaks and financial incentives to encourage the continued expansion of renewable energy and solar. Solar energy delivers positive environmental impacts (SINT 2012), including energy security and affordability, the potential for job creation among others.

The 2017 U.S. Energy and Employment Report - USSER mentions that the energy industry employed approximately 6.4 million Americans in Electric Power Generation and Fuels, Transmission, Distribution and Storage and Energy Efficiency sector (DOE 2018b, 8). Analyzing these sectors of the U.S. economy and their impact on job generation, the USEER report considers that:

- Electric Power Generation and Fuels employed more than 1.9 million workers in 2016, of those 1.1 million in traditional coal, oil, and gas. More than 860 thousand jobs are in the Electric Power Generation, and almost 250 thousands of those employees spending the majority of their time on solar, and close to 374 thousand employees spend some portion of their time working to manufacture, install, distribute, or provide professional services to solar technologies across the nation
- Transmission, Distribution and Storage employed about 2.3 million jobs, with approximately 830,000 working across utilities and construction
- Energy Efficiency, employed around 2.2 million, of them almost 1.8 million jobs are in the construction industry and almost 290,000 jobs producing Energy Star® certified products and energy efficient building material

By the analysis from USEER report (DOE 2018b), indirect jobs that support the energy industry are not included, this mean two areas: metal production or extrusion, and those created at the economy by the employees from this industry from wages.

Analyzing the Electric Power Generation and Fuels employment data, there is an interesting rising employment in solar, wind, bioenergy/CHP that coincides with the shift in energy generation by source, as presented in Fig. 4.7 for the Q2 2015 and Q1 2016. The Solar Generation grew 24.5% from 2015, and in 2016 represented 19% of the Electric Power Generation workforce in 2016 or 373,807 jobs the higher rate in this sector, and an increase of 25% over Q1 2015. Both Solar and Wind employment is higher in percentage than Fossil (DOE 2018b), a clear trend that renewable energies are generating more and faster job to the American economy. Another interesting fact from same Figure is that jobs from fossil generation are just over 151 thousand, a 40% of the over 373 thousand jobs originated by solar; in particular jobs from coal generation is over 86 thousand or 23% of jobs by solar.

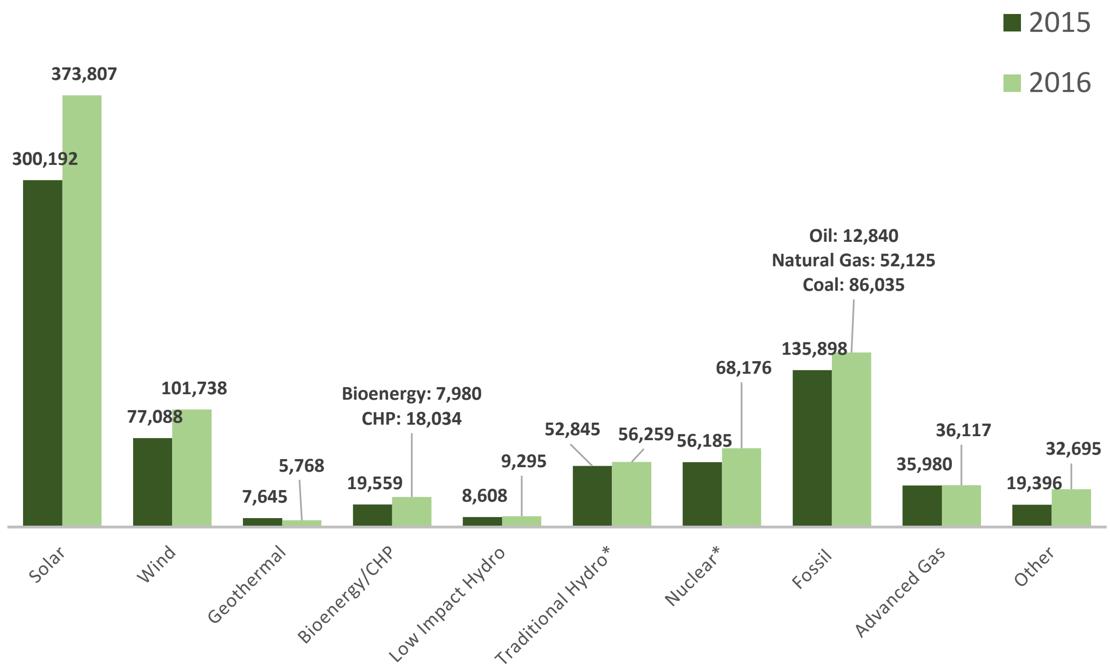


Fig. 4.7. *Electric Power Generation Employment by Technology*, Q2 2015 - Q1 2016 *Source: 2017 U.S. Energy and Employment Report (DOE 2018b: 30)*

By the same source (DOE 2018b, 38), 54.7% of solar workers by project were involved in residential projects, while 24.7% are in commercial and 20.6% in utility-scale projects nationwide.

According to 2017 US Energy and Jobs Report State Charts 2_0 (DOE 2018c: 56 - 60), in the state of Florida the Electric Power Generation and Fuels sector employed more than 69 thousand workers in 2016 about 50 thousand jobs in Transmission, Distribution and Storage and over 108 thousand jobs in the Energy Efficiency sector. As presented in Fig 4.8, over 49 thousand direct jobs were in the Electric Power Generation, with over 11 Thousand of those employees spending the majority of their time on solar, 12,261 jobs in Natural Gas Generation and 3,143 in Coal Generation. This shows that 22.5% of jobs in the Electric Power Generation were coming from solar electric generation, and important share over coal, wind electric and oil fossil fuel generation and just 2.4 points below natural gas generation, as presented in Fig. 4.7.

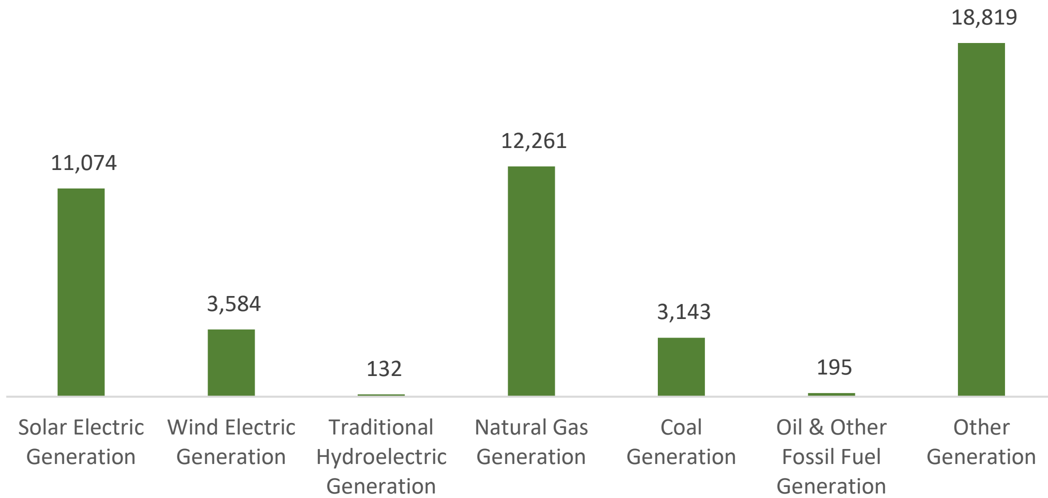


Fig. 4.8. *Electric Power Generation Employment by Technology, Florida State*, 2016 *Source: 2017 US Energy and Jobs Report State Charts 2_0 (DOE 2018c: 57)*

Complementing the U.S. Energy and Employment Report, and based on the Solar Foundation's National Solar Jobs Census for the 2017 and 2016 years (TSF 2018), the solar industry generates direct, indirect, and induced jobs and related economic impacts. The National Solar Jobs Census primarily address direct employment impacts, which had experienced rapid job growth from 2012 to 2016 and a decrease in 2017 to 250,271 jobs. As presented in Table 18, the solar employment grew 20% annually or 119,017 jobs from 2012 to 208,859 jobs in 2015, 25% in 2016 and decreased 3.8% in 2017. Solar employment since 2012 has grown by 110%, from just over 119 thousand to more than 250 thousand jobs in all 50 states. In the case of Florida, the solar employment grew by 224%, from 2,500 employees in 2012 to more than 8,500 jobs in 2017. In summary, by the same source, the solar industry added $84 billion to the nation's gross domestic product (GDP) in 2016.

According to the National Solar Job Census 2017 by the Solar Foundation, Florida produced $1.69 billion in direct sales in 2016, and paid more than $1.03 billion in salaries, wages, and benefits and added $1.7 billion to GDP for Florida in 2016 (TSF 2018). By the same source, California produced $24.7 billion in direct sales in same year and paid more than $16 billion in salaries, wages, and benefits and added $26.6 billion to GDP for this state in 2016. Texas produced $2.5 billion in direct sales and paid nearly $1.6 billion in salaries, wages, and benefits and added $2.5 billion to GDP for Texas in 2016.

By Table 18 and based on available data for previous years, the estimated solar photovoltaic capacity almost triple in the US between 2014 and 2017 to reach 41,131 Mw in 2017 (EIA 2018). By the same table, the capacity grew 34.5% from 2014 to 2015, 64.7% in 2015 and 24.8% in 2017 in the US. Solar photovoltaic capacity since 2014 has grown by 176%, from 14,878 Mw to more than 41 GW. In the case of Florida, the photovoltaic solar capacity grew over five times, from just 137 GW in 2014 to more than 700 GW in 2017, less than 1% the national estimated solar photovoltaic capacity.

Table 18
Solar Employment and Capacity Growth

	Solar Employment (# people)				Estimated Solar Photovoltaic Capacity (MW)			
	U.S.A.	**Florida**	**Texas**	**California**	**U.S.A.**	**Florida**	**Texas**	**California**
2017	250,271	8,589	8,873	86,414	41,131	704	1,682	15,994
2016	260,077	8,260	9,396	100,050	32,958	459	859	13,463
2015	208,859	6,560	7,030	75,598	20,009	182	445	9,005
2014	173,807	4,800	7,000	54,690	14,878	137	282	6,802
2013	142,697	4,000	4,100	47,223				
2012	119,017	2,500	3,200	43,700				

Source: Own Elaboration from The Solar Foundation, National Solar Job Census 2017 report, (TSF 2013, TSF 2014, TSF 2015, TSF 2016, TSF 2017, TSF 2018), and U.S. Energy Information Administration (EIA: 2015, 2016b, 2017a, 2018)

The Table 18 also shows that in 2017 more than 34% of all solar jobs in the country are located in California (TSF 2018), with close to 39% of estimated solar photovoltaic capacity or 15,994 GW. In the case of Texas, the estimated solar photovoltaic capacity is more than double than in Florida but the solar employment is almost similar. In other words, calculating the installed capacity per job for the three states and the US, we will have in 2017 0.16 MW/job nationally, 0.19 MW/job in California, 0.19 MW/job in Texas and 0.08 MW/job in Florida the lowest of this group. Nevertheless, in the state of Florida the solar job market growth 4% in 2017 versus 2017, while in California, Texas and the USA were some decrease between 4% to 14%, from data of Table 15.

By the same sources 82% of solar workers by project were involved in residential projects, while 12% were in commercial and 7% in utility-scale (TSF 2017, TSF 2018) projects in the state of Florida.

In summary, by running a correlation coefficient between solar photovoltaic net generation, the number of federal and state policies and incentives, the number of solar electric generation jobs and the average price of electricity to ultimate customers, is presented in Table 19.

There is a positive correlation between the net generation from solar photovoltaic and the number of federal and state policies and incentives or 0.7587, and even more correlation with the number of solar electric generation jobs or 0.9784. The finding is interesting because the number of policies and incentives can be by

Table 19
Solar Net Generation, Number of Jobs and Average Price of Electricity Correlation with Number of Policies and Incentives in 15 selected states

	Net Generation from Solar Photovoltaic (Thousand Megawatt hours)	Number of Policies and Incentives - Federal and State	Number of Jobs - Solar Electric Generation	Average Price of Electricity to Ultimate Customers (cents/kWh)
California	31,370	256	152,947	11.25
North Carolina	5,783	102	9,535	8.90
Arizona	5,774	76	9,774	9.99
Nevada	4,081	40	11,192	8.43
New Jersey	2,836	56	9,239	12.96
Texas	2,814	156	11,729	8.35
Massachusetts	2,554	99	19,635	16.9
Georgia	2,364	61	5,261	9.21
Utah	2,262	42	5,894	7.96
Colorado	1,463	134	8,027	9.57
New York	1,395	113	12,411	13.75
New Mexico	1,313	63	3,916	9.01
Hawaii	1,165	29	4,883	27.99
Florida	1,142	104	11,074	10.67
Maryland	1,067	88	7,279	11.86
Correlation		**0.7587**	**0.9784**	**-0.0961**

Source: Own Elaboration from DSIRE (DSIRE 2018), Electric Power Monthly December 2017 (EIA 2018), The Solar Foundation, National Solar Job Census 2017 (TSF 2018) the state provided, cities and electric utilities as evaluated in section b of this chapter.

There is no correlation between the net generation from Solar PV and the average price of electricity to ultimate customers, one of the main objectives in the promotion of renewable energies. PV solar only generates during daylight hours when electricity prices are high. Solar has high capital costs but close to zero operating costs, this means that solar will always produce when it is able. This drives down power prices when solar operates, displacing other, more expensive forms of generation as defined in Chapter 3 and 4. In fact, by reducing prices for hours when solar operates, solar could eventually reduce its own economic competitiveness, a phenomenon known as solar Duck Curve, which will be discussed in Chapter 5.

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5. Measures to Encourage Photovoltaic Generation in the State of Florida

As presented in Chapter 2 of this research, the Public Utility Regulatory Policies Act of 1978 (PURPA) required vertically integrated utilities to purchase energy from, or sell energy to, PURPA qualified co-generators and small power producers. As a result, independent power producers (IPPs), sometimes called non-utility generators (NUGs), increased in number. Nevertheless, IPPs have to file a notice with the Federal Energy Regulatory Commission (FERC) stating that their facility meets certain standards for certification as a qualifying facility (QF), or they have to apply to FERC for an order granting QF certification.

Reviewing the main regulatory actions in the U.S. market presented in Chapter 2, the FERC's issuance of Order 888 required all public utilities to provide open access to their transmission lines to transmit electricity at wholesale, which established rules governing a more open wholesale market. The open access initiatives of Order 888 resulted in power marketers, independent power producers, and utilities having the ability to buy and sell in both regional and national markets.

At the same chapter it was reviewed the relevant Energy Policy Act published by the Congress of the United States of America (EPA 2005), which offered tax benefits to individuals who increase energy efficiency in existing homes, required all public utilities to offer net metering on request, tax credits for wind and other alternative energy producers, and mainly encourages more domestic energy production. On August 2015, the Clean Power Plan was announced by President Obama and EPA, which will normalize the existing fleet of fossil-fired power plants, intends to cut emissions 32% (relative to 2005 levels) by 2030 through assigning each state a target emissions level (in tons of carbon) or emissions rate (in tons per megawatt hour).

These Federal regulations, plus others at state level discussed in same chapter, shaped changes a flat net electric generation in the U.S. slight annual reductions for last six years (EIA 2017a). The most important way in which the states have supported renewable energy has been by implementing policies and programs that directly incentivize the installation of clean energy generation, testing policy ideas and then spreading them across the country (CESA 2015: 21-23), getting data and analysis on clean energy technologies and on policy options, as presented in Chapter 2.
These regulations eliminated restrictions on the price that would be charged for wholesale electricity, but it allowed states to decide whether to allow retail competition, as presented in Chapter 3. The market was then truly opened and deregulated states start to appear (IER 2014). Several states have become deregulated markets over the last 30 years, largely in the Northeast, Mid-Atlantic,

and Texas. Other states, such as California, are partially deregulated or have had deregulation suspended.

In fact, by 2010 the energy generated was 4,125,060 thousand Megawatt-hours (MWh) and in 2015 was 4,091,741 MWh, 33.1% was generated by coal, 32.6% by natural gas, 19.5% nuclear, 6.6% renewable sources excluding hydroelectric and solar, 6.1% hydroelectric conventional and 1% by solar. By 2017 the net electric generation in the U.S. was 4,038,944 MWh a 1.3% reduction from 2015 and 2.1% reduction from 2010 levels; 29.9% was generated by coal, 31.5% by natural gas, 19.9% nuclear, 8.3% from renewable sources excluding hydroelectric and solar, 7.4% hydroelectric conventional and 1.9% from solar.

At the same chapter, it was presented that from 2005 to 2017, it was a substantial reduction of the use of coal in favor of other sources as natural gas and renewable sources excluding hydroelectric. The net generation by renewables sources excluding hydroelectric and solar grew 3.85 times, the highest of all sources of energy to 334,287 thousand MWh, and solar generation from 550 MWh to 77,097 thousand MWh in the same period, while the others had decrease with exception of natural gas. This is a significant fact, renewable energy surged despite a reduction in total energy in U.S. and despite a slow growth in the national economy, uncertainty over federal and state tax credits and in some cases the absence of market context that assures a reasonable and predictable return for investors.

The impact on the adoption of renewable energy in the U.S. is presented in Table 1 below and Chapter 2. Between 2005-2017 the states of California, Texas, Iowa, Oklahoma, Minnesota, Illinois, Kansas, Washington, Oregon and Colorado led the net generation from renewable sources - excluding hydroelectric - market (EIA 2006; 2007; 2008; 2009; 2010; 2011; 2012; 2013; 2014; 2015, 2016b, 2017a), reaching 387,245 MWh in 2017 from 70,728 MWh in 2015. The listed states have Renewable Energy Standards with exception of Iowa and Oklahoma that have Voluntary Renewable Portfolio Standards. Florida didn’t have Voluntary or Renewable Portfolio Standards.

As presented in Fig. 5.1, solar PV Capacity Added per Sector in the U.S. had a rapid growth since 2010, with a peak in 2016, as explained before for the adoption of renewable energy in several states. In any case, for the last 10 years the utility sector had had the mayor capacity installed year after year. This is an important fact because the nature of the investments and potentially the major force of adoption of solar PV, including in the Florida state, would be in the utility sector.

The same figure also shows that in 2017 the residential and utility segments experienced role reversal, as residential and utility PV long the growth segments of the solar market, both saw installations fall on an annual basis for the first time since 2010.

Table 1
Top Ten States plus Florida Net Renewable Generation, excluding Hydroelectric at Utility Scale Facility, at Utility Facility, 2005-2017 (Thousand MWh)

	Texas	California	Iowa	Oklahoma	Minnesota	Illinois	Kansas	Washington	Oregon	Colorado	Florida	Total
2005	3,853	18,249	1,202	804	2,101	570	256	1,625	1,210	633	4,292	70,728
2006	7,834	23,891	2,455	2,013	3,057	849	992	2,503	1,870	896	4,372	96,423
2007	9,339	24,928	2,862	2,144	3,495	1,237	1,153	3,360	2,206	740	4,349	102,988
2008	17,639	24,784	4,251	2,551	5,851	3,035	1,759	4,938	3,423	3,284	4,303	126,212
2009	20,750	25,462	7,507	2,464	6,501	3,514	2,385	4,976	4,123	3,009	4,248	141,115
2010	27,705	25,450	9,360	4,160	6,640	5,138	3,459	6,617	4,757	3,555	4,487	167,173
2011	31,613	28,484	10,872	5,700	8,643	7,019	3,759	8,071	5,683	4,873	4,695	194,993
2012	34,017	29,967	14,183	8,521	9,454	8,373	5,253	8,214	7,207	6,192	4,524	218,333
2013	37,784	36,564	15,731	11,220	9,929	10,299	9,486	8,751	8,527	7,643	4,618	253,328
2014	42,096	41,917	16,573	12,275	11,457	10,699	10,904	9,108	8,914	7,747	5,073	279,213
2015	47,159	46,498	18,139	14,341	11,600	11,359	10,997	8,981	7,971	7,862	4,992	298,358
2016	59,944	49,712	20,324	20,437	11,836	11,179	14,172	10,050	8,382	10,122	4,867	341,633
2017	70,759	64,606	21,018	24,737	13,628	11,847	18,561	9,517	7,980	10,668	5,811	387,245

Source: *Own Elaboration from official data from EIA (2006; 2007; 2008; 2009; 2010; 2011; 2012; 2013; 2014; 2015, 2016b, 2017a)*

In the state of Florida, the FPSC regulate the opening of new electric utilities offering service in the state. By state law only electric utilities can sell power energy with a strict prohibition on other energy generators. The citizens of Florida had approved small changes in favor of the implementation of renewables and solar PV in four state ballots as discussed in Chapter 4. The ballots had been on tax exemptions as the one of October 1980 and August 2016, to allow subsidies to solar PV and renewables by electric utilities and roll back taxes on solar equipment.

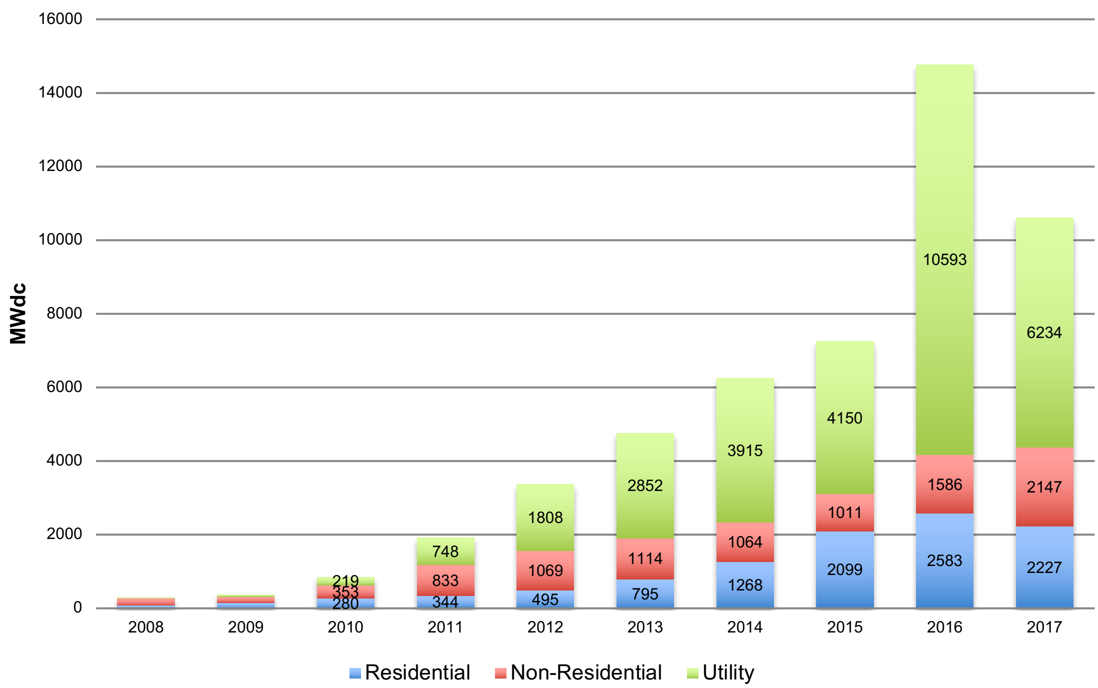

Fig. 5.1. Annual Solar PV Capacity Added per Sector, 2012-2017 by sector. *Source*: Own Elaboration from official data from SEIA *(2011; 2012; 2013; 2014; 2015, 2016a, 2017)*

As presented in Chapter 4, a ruling from the FPSC on early 2018 stated that the prohibition does not extend to leasing generating equipment because leases do not involve the sale of electricity and prohibits third-party providers from placing rooftop panels on homes and businesses and selling electricity from the panels to the homeowner or business owner (Holt and Galligan 2017; Wiseman Hannah, personal interview, January 8, 2018). This is the major change in energy generation from solar PV that eventually would increase the total capacity from these sources.

5.1. Proposal for the development of utility-scale photovoltaic plants

A utility-scale solar facility by definition, it is one which generates solar power and feeds it into the grid, supplying a utility with energy. The Solar Energy Industries Association, the leading trade group for solar developers, defines utility-scale solar as greater than 1 megawatt (SEIA 2018a), while the he National Renewable Energy Laboratory rather arbitrarily chose a 5-megawatt threshold (GTM 2018). By the same sources, solar PV plants operate across the U.S. totaling 2,892 MW at the end of 2017, as 26 GW of utility-scale solar power projects are under development.

After defining a utility-scale solar range size, any solar project needs to sell its power to remain afloat, specially an electric utility, as it is the case in the state of Florida. The only other way to sell solar power to a utility is through net metering, where the excess power is fed into the grid, purchased by the utility from the producer on a per-kilowatt-hour basis. As noted before in Chapter 2.2.1 net metering is enacted by state legislation, and each state has its own regulations as to the maximum size of a solar facility that is eligible. As presented in the mentioned chapter, net metering has been foundational for solar growth.

The development of utility-scale plants in the U.S. and in the state of Florida should consider, among others, relevant regulatory and financial factors that are covered below, summarized in the following areas:

- Competitive cost of solar PV
- Closure of coal and oil plants
- Demand curve and storage
- Pressure of the population for net metering and interconnection rules for non-utility systems
- Implementation of Renewable Portfolio Standard
- Reduction in Soft Cost for Solar PV

5.1.1. Competitive cost of solar PV

An analysis done by EIA and presented in Fig 5.1, the solar photovoltaic (PV) deployment has grown rapidly in the United States over the past eight years, totaling 41,131 MW in 2017 (EIA 2018).

At the same time and based on an analysis by NREL (2017, iv), PV system costs have continued to decline as presented in Fig. 5.2 in all sectors including residential, commercial and utility. The highest cost reductions happened at utility-scale PV fixed tilt from $4.57 in 2010 to $1.03 in 2017 or 77.4% reduction. The analysis by NREL shows a decline in all components of the PV system, including:

- Soft cost in installation labor, which dropped 74%
- Reduction in soft cost like: permitting, inspection, and interconnection, land acquisition, sale taxes, overhead and net profit
- Drop in hardware electrical balance of system, structural and electrical components,
- Inverter
- Module, the highest cost reduction in all components. The module prices dropped 86% over that time period

Fig. 5.2 also shows cost benchmark analysis for other sectors. A typical 5.7 kW residential PV had a cost reduction of 61% from 2010 to 2017 but has the highest installation costs and other soft costs in 2017; a 200 kW commercial PV system with a 65% reduction; a 100 MW utility-scale PV fixed tilt with a 77.4% reduction because considerable cost reduction in all solar PV system's components; and a 100 MW utility-scale PV one-axis tracker with a 79.6% reduction in same time period. This is a trend and "historical dynamics of the module prices and the growth of electricity generation capacity" (Mir-Artigues and del Río 2016: 53) reflected worldwide and in this case in the American market.

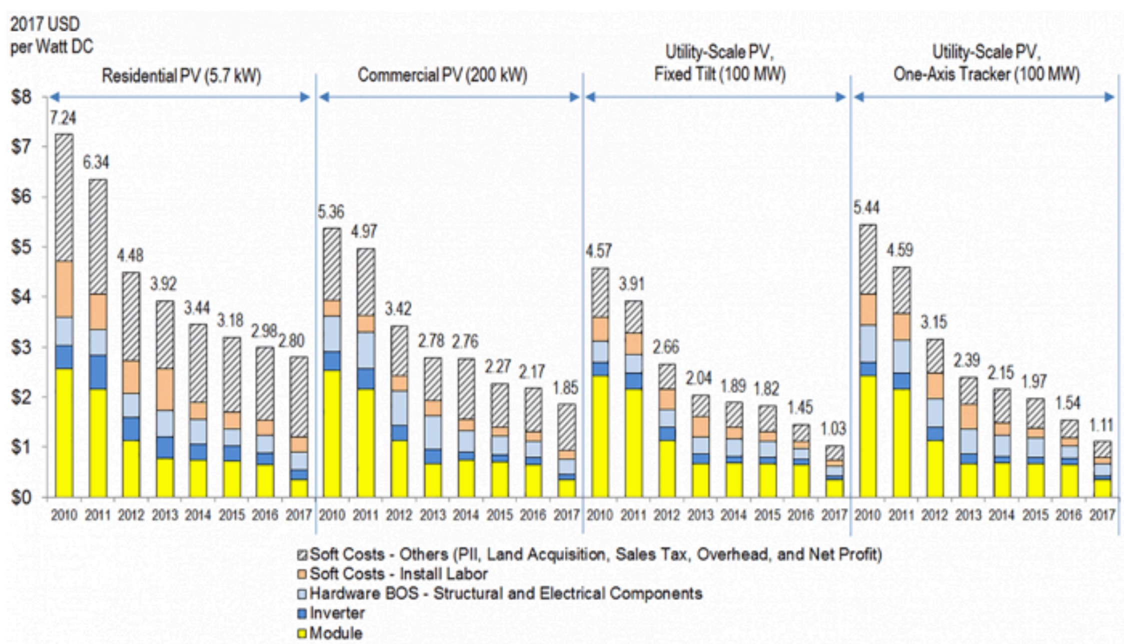

Fig. 5.2. PV system cost benchmark summary by sector (inflation adjusted), 2010–2017 in the U.S. *Source*: NREL (2017: iv)

A decline in the cost per watt of solar PV, create a decline in the cost of the watt-hour generated in addition to the lack of external fuel. By a report published by LAZARD, a financial consulting firm, maintained that there is "a continued decline in the cost of generating electricity from alternative energy technologies, especially utility-scale solar and wind" (LAZARD 2017), to below the operating costs alone of conventional generation technologies such as coal or nuclear, accelerating the transition from coal to wind and solar PV at utility-scale, as presented in Fig. 5.3 and based on the concept of levelized cost of electricity (LCOE), which refers to the estimation of the generation cost of a plant (US/kWh), if renewable or not, taking in considerations the fact that their output (kWh) is a physically homogenous good (Branker 2011: 4471).

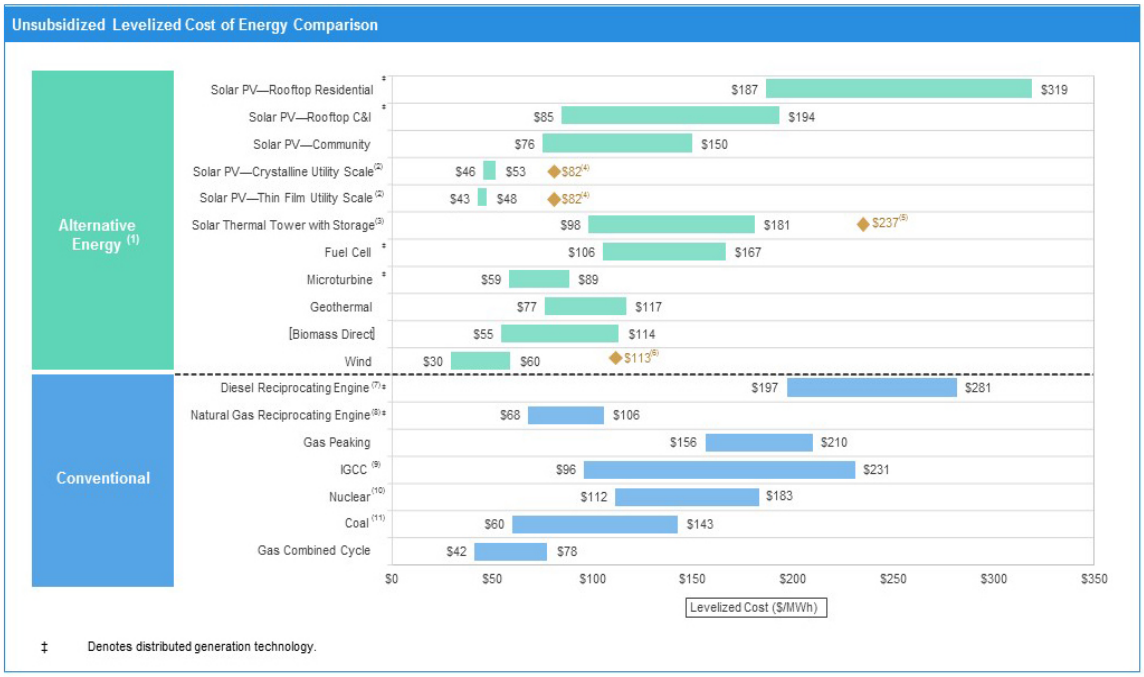

Fig. 5.3. Unsubsidized levelized costs of energy (LCOE) in USD/MWh by fuel in 2017. *Source*: LAZARD (2017)

The analysis made by LAZAR shows that solar PV utility scale unsubsidized LCOE is between $43 to $53, while coal generation is between $60 to $143 per MWh. The financial opportunity for generating a kWh at lower cost with solar PV than other technologies is forcing electric utilities to evaluate other alternatives in order to invest in future expansions or replacing current generators that can provide better EBITDAs with lower CAPEX, and at the same time to position them as contributors in the CO2 reduction.

In the case of Florida, by an analysis done by NREL based on LCOE, a commonly used to compare the cost competitiveness of alternative electricity generating platforms, and presented in Table 2, shows the real levelized cost of energy in the city of Orlando as 6.63 cents per kWh with a solar PV system, with a total installation cost of $1.02 per watt. From this analysis, there is an opportunity for reducing the LCOE costs, especially along soft costs.

Another opportunity is to increase drastically the capacity installed by electric utilities which would reduce the soft costs as overhead and installation costs. These cost reductions had been reached in other states like California, Texas, Arizona among others, were the installed solar PV capacity is higher than in Florida as presented in Chapter 4 of this research.

Table 2
Modeled real LCOE (¢/kWh), ITC = 0%, for a 100-MWdc utility-scale PV system with fixed-tilt in 2017 in several locations

State	Location	Total Installed Cost ($/W)	Nominal LCOE (cent per kWh)	Real LCOE (cent per kWh)
CA	Bakersfield	1.09	7.26	5.68
CA	Imperial	1.09	6.64	5.19
AZ	Prescott	0.98	6.20	4.85
AZ	Tucson	0.98	6.01	4.70
NV	Las Vegas	1.05	6.33	4.95
NM	Albuquerque	0.99	6.05	4.73
CO	Alamosa	0.99	6.05	4.73
NC	Jacksonville	0.96	7.25	5.67
TX	San Antonio	0.97	7.11	5.56
NJ	Newark	1.13	9.15	7.16
FL	Orlando	1.02	8.47	6.63
HI	Kona	1.14	8.08	6.32

Source: Own elaboration from NREL (2017: 47)

Another element to discuss in this scenario is the net electric generation in the state of Florida. As presented in Chapter 3 and Fig. 5.4, according to the U.S. Energy Information Administration (EIA 2016b, EIA 2017a), the net electric generation in the state of Florida by 2017 was 5.9% of the net generation nationwide to 237,821 MWh, a flat generation since 2015. For the state of Florida, the net electricity generation by sector by 2017 was distributed as: 15.8% by coal, 0.6% by petroleum, 67.7% by natural gas, 12.3% nuclear, 2.4% renewable sources excluding hydroelectric, and 1.3% by other sources. This means that there is an opportunity to continue reducing the generation coming from coal, or by replacing equipment that would at end of life or with high operational cost, replacing them with renewables as solar PV because the lower levelized cost. The main issue for addressing these replacements is the financial desire of the electric utilities to install renewable energy sources as solar PV. As presented in Fig 5.4 since 2009 had been increase generation by gas than other fuels.

5.1.2. Closure of coal and oil plants

The global economy had generated multiple changes since the insertion of electricity, in fact modern life is unimaginable without electricity, and improving access to electricity worldwide is critical to alleviating poverty, especially in underdeveloped countries. According to the World Energy Outlook 2017 (IEA 2018) four large-scale shifts in the global energy system had happened since 2016:

- The growing electrification of energy worldwide. By the same source, global energy would expand by 30% between today and 2040, with energy decreases in the U.S. and Europe
- The rapid deployment and falling costs of clean energy technologies, which has been presented in chapters 1 and 2, originated lately by a rapid deployment of solar PV led by China and India.
- The shift to a more services-oriented economy and a cleaner energy mix in China. By the World Energy Outlook 2017, the demand growth slowed in China from an average 8% per year from 2000 to 2012 to less than 2% per year since 2012, and by the New Policies Scenario policies it would slow further to an average of 1% per year to 2040.
- The resilience of shale gas and tight oil in the U.S. In fact, the U.S. is already a net exporter of gas, the US would become a net exporter of oil in the late 2020s, by the same source.

According to World Coal organization, (WCA 2018: 2) coal plays a relevant role in electricity generation worldwide, with a 37% of global electricity plants fuel by coal by 2017. The International Energy Agency (IEA 2018) and the WCA (2018: 11, 12) forecasted that coal will continue to play an important role in power generation over the long-term. The IEA projected that the share of coal in power generation will rise from 32% to 50% in Southeast Asia until at least 2025. Emerging economies require coal for more than just safe, reliable and affordable energy.

In the U.S., the coal generation has been decreasing since 2008 in both relative shares and absolute quantities, as presented in chapter 2. According to IEA (2017, 1_01_A to 1_20_B), the continued aging of the coal fleet, in which the median generating station was built in January 1966, have poorer economics, which complemented with new EPA regulations had contributed for this decrease. By 2017, the net electric generation in the U.S. was 4,038,943 MWh of which 29.9% or 1,207,901 MWh was generated by coal; by 2008 the net electric generation was 4,119,388 MWh of which 48% or 1,985,801 MWh was generated by coal. In ten years has been a reduction of 777,900 MWh generated by coal in favor of other sources, especially gas and renewables including solar.

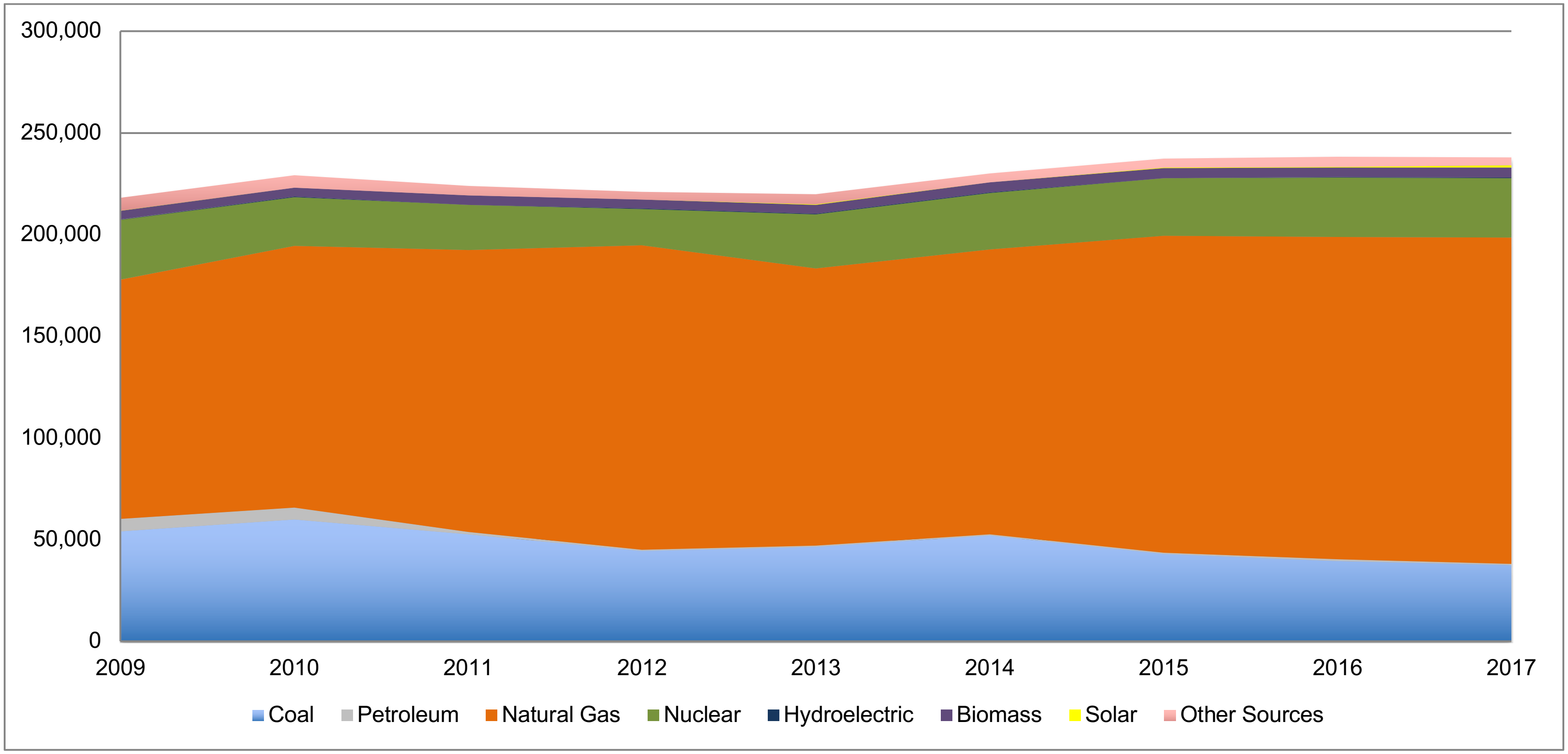

Fig. 5.4. Net Generation by Fuel at Florida State, 2009-2017 by sector. *Source*: Own Elaboration from official data from SEIA *(2011; 2012; 2013; 2014; 2015, 2016a, 2017, 2018)*

In fact, from 2007 to 2016, 531 coal units representing 55.6 GW of capacity were retired across the U.S. as presented in Fig. 5.5, the largest amount of coal capacity loss occurred through retirement of regulated units operating in Midcontinent Independent System Operator (MISO) and PJM operating in 23 states, the District of Columbia and the Canadian province of Manitoba.

The illustrative trend confirms that several electric utilities had reduced their coal generation in the U.S. by almost 777,900 MWh from 2008 to 2017, an average 78 MWh per year, and the reasons behind that decision are based on several factors that are cover below.

At 2017, the states with the highest share of net generation by coal are: Texas with 11.1%, Indiana with 6%, Ohio and West Virginia with 5.7% each, and Missouri with 5.6% (EIA 2017a, 1.4.B). Florida's net generation by coal was 37,512 MWh in 2017 versus 64,823 MWh in 2008, a 58% reduction in 10 years, as presented in Fig. 5.4.

As presented in chapters 2 and 3, electric utilities are authorized by regulators to invest in capital as power plants, transmission and distribution investments, then the electric utility can earn up to their authorized rate of return on the equity portion of invested capital. Electric utilities invest equity as in power plants, so their accounting shows these investments in "plant in service" accounts, as presented for main electric utilities in the state of Florida in Chapter 3.

Depreciation schedules are set up for these accounts to recognize the need to replace investments. Depreciation tends to reduce these account balances over time and utilities earn on the remaining non-depreciated balances in these accounts but new repairs and equipment allows utilities to continually revised and extend depreciation schedules, then electric utilities continue profiting from old plants for as long as they can hold onto them.

Some examples of this trend are the following transitions at electric utility level nationwide:

- The Public Service Company of New Mexico (PNM) that served its 510,000 customers with 56% coal in its total generation portfolio in 2015 announced in their Integrated Resource Planning report (PNM 2018) that the best option for low-cost and reliable power was to start retiring coal in 2022 and ending by 2031, and replace them by 2035 with 36% renewable and 33% natural gas, up from 11% and 6% respectively in 2017

- Wisconsin's largest utility We Energies, that served more than 2.2 million customers and coal supplied 50.6% of its total generation capacity in 2015, announced in November 2017 (Utility Dive 2018) the utility decided to close its 1.2 GW Pleasant Prairie coal plant in early 2018, and replacing part of the plant's generation capacity with Wisconsin's largest solar array, a 350 MW plant expected to go online by 2020.

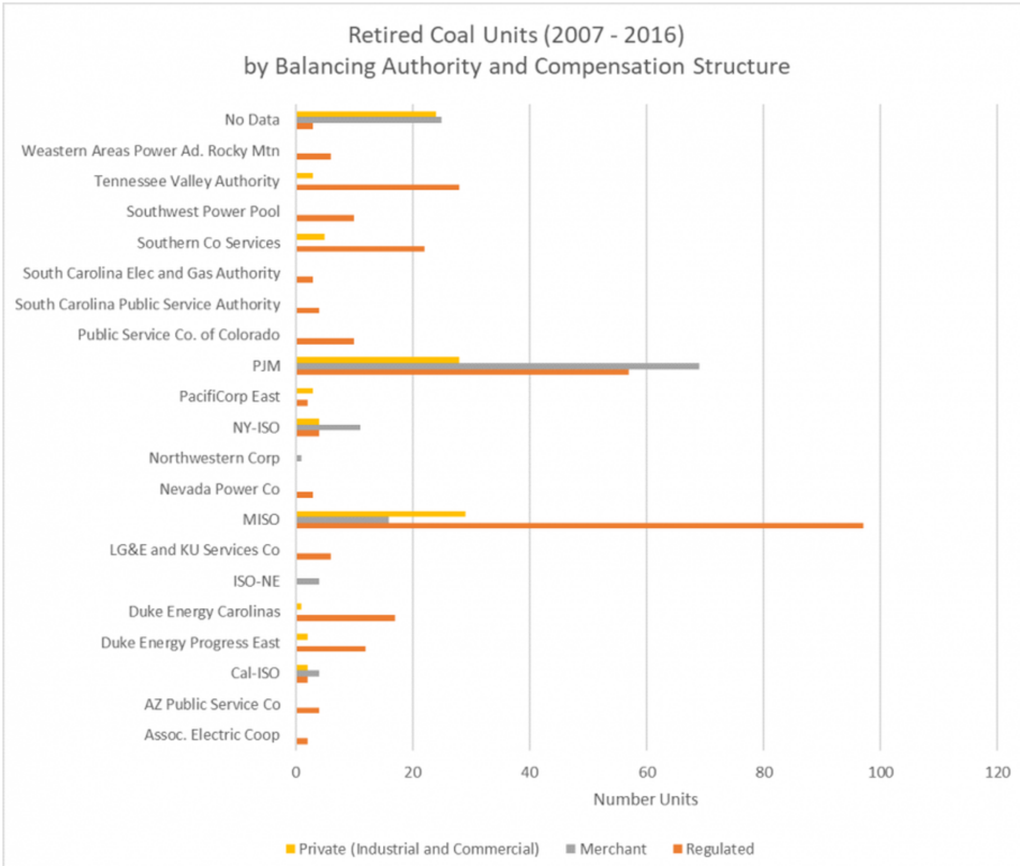

Fig. 5.5. Retired Coal Units by Balancing Authority and Compensation Structure, 2007-2016. *Source:* KCEP (2018)

- Luminant, which operates nearly 18 GW of Texas generation announced in October 2017 that it would close the 4.1 GW Monticello Power Plant and two coal units at Sandow Power Plant by January 2018. "Sustained low wholesale power prices, an oversupplied renewable generation market, and low natural gas prices, along with other factors, have contributed to this decision" (LUMINAT 2017)
- Ameren Missouri, the largest utility in Missouri with 10.2 GW generation capacity, announced at the end of 2017 that would close 50% of its coal plants in Meramec Energy Center in St. Louis County by the end of 2022 (AMEREN 2017), and would invest $1 billion in 700 MW of new wind capacity and 100 MW new solar by 2020.
- Xcel Energy that operates in Colorado has been closing coal plants since 2011 with a total of 1.1 GW, in addition of two units of the Comanche Generation Station totaling 660 MW of capacity by 2025 (XcelEnergy

2017: 2), which would be replace with 1 GW of wind and 700 MW of solar PV generation

- The Institute for Energy Economics and Financial Analysis (IEEFA) announced in October 2018 that it was expected a total of 15.4 gigawatts (GW) of capacity to close in 2018 through the retirement of 44 units at 22 plants in several states. In addition, at least 36.7GW of coal-fired capacity stand to be retired from 2018 through 2024 — 117 units in total (IEEFA 2018b: 2-3)

Using a free and open-source computer model created by Energy Innovation LLC called Energy Policy Simulator (EIP&T 2018: 1.1.4). It was possible to develop few simulations that will be presented in this chapter, this simulator helped to evaluate the impacts of policy or program announcements, as well as to identify policies that would achieve policymakers' goals and objectives and the data base is the same published from the U.S. Energy Information Administration (EIA), U.S. EPA, Argonne National Laboratory, U.S. Forest Service, and U.S. Bureau of Transportation Statistics, among others.

By the same source, Table 3 shows the Electric Capacity Projection by Fuel in U.S., for the years 2017-2050 without any reduction or modification to the current trends or "business as usual" scenario. For 2017 the total capacity is 1,060 GW with 23% from coal, 3% Petroleum, 38% Natural Gas, 10% Nuclear, 10% Hydro, 2% Distributed Solar PV, 3% Utility Solar PV, 9% Wind and 2% Other Sources. Under this scenario and based on current Federal and State policies, the projections to reach 1,610 GW in 2050 with a distribution of 13% from coal, 2% Petroleum, 33% Natural Gas, 5% Nuclear, 8% Hydro, 8% Distributed Solar PV, 14% Utility Solar PV, 16% Wind and 2% Other Sources. This means a 52% increase in capacity from 2017 levels, mainly Utility Solar PV with an incremental 188 GW, Natural Gas with 120 GW, Distributed Solar PV with 104GW, Wind with 157 GW, Hydro with 20 GW, and reductions in Coal capacity by 11%, Petroleum 4% and Nuclear in a 25% versus the capacity levels in 2017.

Based on this software simulator, it was possible to create a scenario based on existing trends and introducing a reduction, by legislative on Federal and State policies or regulatory bodies, in coal capacity of 7,000 MW each year from 2020 to 2050 from existing 2017 data, this means that from 240 GW in 2017 to 1 GW in 2050, which is almost cero. The results of the simulation and the base scenario are presented in Fig. 5.6. and Tables 4.

The simulation's data at Table 4 shows that by reducing coal capacity by 7,000 MW per year, there is an increase in the total capacity reaching 1,686 GW or 5% higher than "business as usual" scenario, that increase would be done by Utility Solar PV, Wind, Nuclear and Other Resources, while coal, Distributed Solar PV and hydro would have the lowest capacity increase. Nevertheless, in percentage, Utility Solar PV and Wind would have the highest increase, in fact Utility Solar PV would growth faster than the other fuels reaching in 2032 a 45% increase versus “business as usual” scenario in same year. Another data at this simulation is that the Utility Solar PV would growth from 3% of total capacity in 2017 to 20% on total capacity in 2050 as well as Wind, while Natural Gas would decrease to 34% of total capacity in same year.

In the state of Florida, similar trend than in the U.S. has been happening by the reduction of coal generation. Under similar previous analysis, in 2009 the net generation from coal was 54,052 MWh and by 2017 it was 31% lower or 37,512 MWh; in the case of petroleum in 2009 the net generation was 6,056 MWh and by 2017 only 532 MWh, as presented in Fig. 5.4. The coal and petroleum generation were replaced mainly by natural gas.

- Duke Energy Florida announced in April 2018 that will retire half of the company's coal-fired power plants in Florida, its Crystal River coal-fired units 1 and 2, which were built in 1966 and 1969 (Duke Energy 2018b). By the same source, Duke is finishing the installation of a 1,640 MW natural gas plant in Citrus County.
- Florida Power & Light closed in January 2018 the 1,300-megawatt coal-fired St. Johns River Power Park in Jacksonville, (FPL 2018b). In 2016, FPL shut down the Cedar Bay Generating Plant, another coal plant located in Jacksonville.
- Tampa Electric Co. is spending $853 million to convert its coal-fired Unit 1 at its Big Bend Power Station to natural gas and retire coal-fired Unit 2 in 2021 (TBT 2018).

It is to assume that if a reduction to 0 GW of coal capacity from 2020 to 2050 in the state of Florida, similar increase would happen in other fuels as Utility Solar PV and Wind with the highest increase, versus current scenario. In other words, a reduction in coal capacity would increase the installed capacity in solar PV by the electric utilities.

5.1.3. Energy Demand Curve

As presented in Chapter 3 of this research, and according to the Statistics of the Florida Electric Utility Industry report (FPSC 2017a: 7) and the Florida Solar Energy Center (FSEC 2016: 10-2 – 10-12, FSEC 2018), the daily load shape curves typical to Florida summer and winter days are as presented in Fig. 3.2 of chapter 3, for summer and winter seasons. These daily usage patterns cause greater trough to peak variation in the demand for energy consumed in Florida than in other states with higher number of industrial customers.

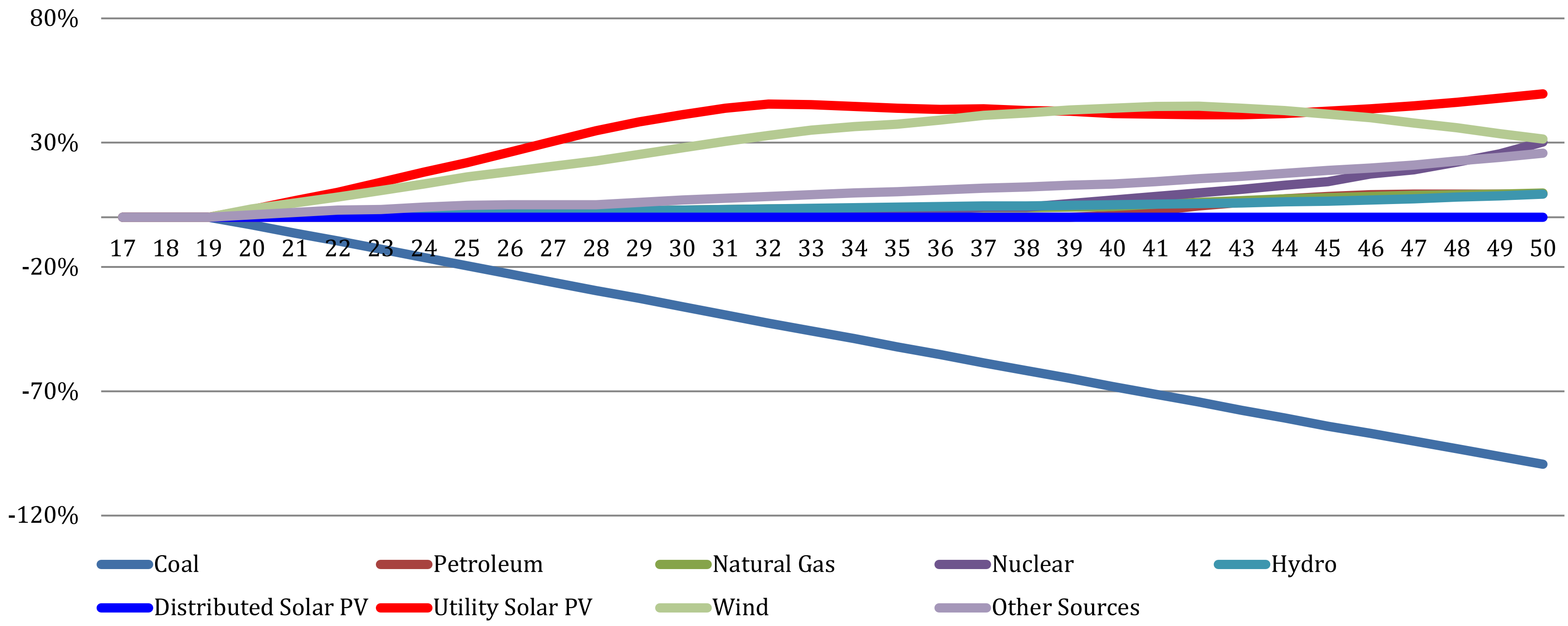

Fig. 5.6. Variation on Fuel Capacity by Simulation of 7,000 GW per year Reduction in Coal Electric Capacity by Fuel in U.S., 2017-2050 by sector. *Source*: Own Elaboration from Energy Policy Simulator (EIP&T 2018: 1.1.4)

Table 3
Electric Capacity Projection by Fuel in U.S., 2017-2050 – Business As Usual

Year	Coal	Petroleum	Natural Gas	Nuclear	Hydro	Distributed Solar PV	Utility Solar PV	Wind	Other Sources	TOTAL
2017	239.83	30.85	405.61	100.78	103.34	17.28	31.66	98.423	19.56	1,060
2018	229.59	30.74	404.66	99.10	103.92	20.79	41.74	102.938	19.85	1,066
2019	224.11	30.56	401.13	96.50	104.85	24.60	54.61	112.063	20.53	1,082
2020	219.02	30.45	395.81	96.50	105.68	28.65	65.41	119.463	21.03	1,095
2021	217.52	30.40	392.61	96.50	106.27	32.76	72.17	123.393	21.34	1,106
2022	216.52	30.34	393.22	96.50	106.69	35.53	74.97	125.063	21.47	1,113
2023	216.52	30.33	396.47	96.50	106.99	36.96	76.74	125.883	21.61	1,121
2024	214.72	30.32	401.40	95.38	107.36	38.74	79.03	127.093	21.77	1,129
2025	213.37	30.27	405.57	94.26	107.71	40.95	81.11	128.133	21.94	1,136
2026	213.37	30.25	409.53	94.26	107.87	43.38	81.59	128.248	22.13	1,143
2027	213.37	30.15	411.50	94.26	108.03	46.05	82.12	128.383	22.33	1,149
2028	213.12	30.14	415.34	94.26	108.17	48.88	82.48	128.463	22.55	1,156
2029	213.12	30.14	419.16	93.86	108.52	51.90	84.55	129.468	22.79	1,166
2030	213.12	30.14	423.41	93.46	108.90	55.13	87.06	130.808	23.05	1,178
2031	213.12	30.14	428.74	92.86	109.30	58.39	89.73	132.288	23.32	1,191
2032	213.12	30.13	433.89	92.46	109.82	61.65	93.86	135.128	23.62	1,206
2033	213.12	30.12	438.81	90.46	110.53	64.93	100.28	140.748	24.12	1,226
2034	213.12	30.12	444.80	87.26	111.33	68.21	107.83	148.013	24.64	1,248
2035	213.12	30.07	448.47	86.66	112.09	71.53	114.89	154.523	25.16	1,269
2036	212.81	30.05	454.68	85.16	112.85	74.85	122.06	161.168	25.69	1,292
2037	212.81	30.05	461.12	84.36	113.60	78.20	129.00	167.438	26.22	1,316
2038	212.81	30.01	466.28	83.66	114.39	81.56	136.52	174.608	26.78	1,340
2039	212.81	29.98	471.13	83.66	115.17	84.92	143.86	181.523	27.36	1,363

2040	213.07	29.92	474.55	82.86	116.05	88.30	152.38	190.378	28.12	1,389
2041	213.01	29.89	479.89	82.10	116.85	91.53	160.05	197.903	28.60	1,413
2042	212.95	29.86	485.23	81.34	117.66	94.86	167.61	205.403	29.14	1,437
2043	212.89	29.82	490.42	80.58	118.45	98.18	174.95	212.633	29.68	1,461
2044	212.83	29.79	495.60	79.82	119.23	101.51	182.09	219.648	30.22	1,484
2045	212.76	29.76	500.79	79.06	119.99	104.83	188.93	226.233	30.75	1,506
2046	212.70	29.73	505.97	78.30	120.75	108.15	195.68	232.763	31.28	1,529
2047	212.64	29.70	511.00	77.54	121.48	111.48	202.02	238.773	31.80	1,550
2048	212.58	29.67	516.03	76.78	122.19	114.80	208.12	244.533	32.33	1,570
2049	212.52	29.64	521.06	76.02	122.89	118.13	213.99	250.038	32.85	1,590
2050	212.46	29.61	526.09	75.26	123.58	121.45	219.72	255.438	33.36	1,610

*Source: Own Elaboration from data projection by Energy Solution – Business As Usual (*EIP&T 2018: 1.1.4*)*

Table 4

Electric Capacity Projection by Fuel in U.S., 2017-2050 – 7,000 GW per year Reduction in Coal Electric Capacity

Year	Coal	Petroleum	Natural Gas	Nuclear	Hydro	Distributed Solar PV	Utility Solar PV	Wind	Other Sources	TOTAL
2017	239.83	30.85	405.61	100.78	103.34	17.28	31.66	98.423	19.56	1,060
2018	229.59	30.74	404.66	99.10	103.92	20.79	41.74	102.938	19.85	1,066
2019	224.11	30.56	401.13	96.50	104.85	24.60	54.61	112.063	20.53	1,082
2020	212.28	30.45	396.58	97.64	105.89	28.65	67.52	123.438	21.25	1,096
2021	203.78	30.40	394.15	97.64	106.67	32.76	76.96	130.393	21.76	1,107
2022	195.77	30.34	395.68	97.64	107.32	35.53	82.47	135.133	22.09	1,115
2023	188.77	30.33	400.17	97.64	107.93	36.96	87.60	139.313	22.27	1,124
2024	179.97	30.32	406.02	96.52	108.59	38.74	93.28	144.168	22.63	1,133
2025	171.62	30.27	411.27	95.40	109.24	40.95	98.85	148.843	23.01	1,142
2026	164.62	30.25	416.77	95.40	109.76	43.38	102.93	151.688	23.23	1,151

2027	157.62	30.15	420.28	95.40	110.29	46.05	107.16	154.678	23.46	1,158
2028	150.37	30.14	425.82	95.40	110.82	48.88	111.29	157.543	23.71	1,167
2029	143.37	30.14	430.71	95.00	111.46	51.90	116.96	162.228	24.16	1,179
2030	136.37	30.14	435.88	94.60	112.13	55.13	122.96	167.323	24.62	1,192
2031	129.37	30.14	442.14	94.00	112.82	58.39	129.13	172.653	25.10	1,207
2032	122.37	30.13	448.06	93.60	113.60	61.65	136.52	179.708	25.60	1,224
2033	115.63	30.12	453.59	91.60	114.55	64.93	145.75	189.943	26.31	1,245
2034	108.89	30.12	460.36	89.54	115.61	68.21	155.99	202.173	27.05	1,271
2035	102.15	30.07	464.49	88.94	116.57	71.53	165.19	212.413	27.76	1,292
2036	95.10	30.05	471.31	87.44	117.60	74.85	175.11	224.053	28.51	1,317
2037	88.36	30.05	478.67	87.78	118.65	78.20	185.17	236.008	29.28	1,345
2038	81.62	30.01	484.61	87.08	119.70	81.56	195.11	247.743	30.06	1,371
2039	74.88	29.98	490.22	88.22	120.77	84.92	205.20	259.853	30.86	1,398
2040	68.13	30.11	495.52	88.56	121.94	88.30	216.10	273.703	31.86	1,427
2041	61.33	30.68	505.18	88.94	123.04	91.53	226.32	286.183	32.71	1,459
2042	54.53	31.19	514.49	89.31	124.18	94.86	236.71	297.173	33.65	1,489
2043	47.72	31.64	523.60	89.69	125.36	98.18	247.30	306.028	34.59	1,517
2044	40.92	32.01	532.37	90.07	126.58	101.51	258.23	313.753	35.55	1,544
2045	34.12	32.28	540.74	90.45	127.86	104.83	269.49	320.233	36.51	1,570
2046	27.57	32.44	548.56	91.97	129.21	108.15	281.15	325.708	37.49	1,596
2047	21.03	32.49	555.74	92.35	130.55	111.48	292.52	329.458	38.47	1,618
2048	14.48	32.46	562.77	93.87	132.01	114.80	304.53	332.518	39.62	1,641
2049	7.94	32.43	569.96	95.38	133.51	118.13	316.56	334.373	40.79	1,663
2050	1.39	32.39	577.35	98.04	135.08	121.45	328.77	335.813	41.96	1,686

Source: Own Elaboration from data projection by Energy Solution – 7,000 GW per year Reduction in Coal Electric Capacity (EIP&T 2018: 1.1.4

In the summer, the energy demand grows since the start of the working day until noon in summer time, when the peak is reached, although the values are maintained at a high level through the afternoon and the electricity demand starts to go down with the sunset. In fact, air-conditioning demand starts to increase in the morning and peaks in the early evening, and one hump pattern that aligns with the sun's heating of buildings. In winter, the energy demand peaks around mid-morning and late evening, this means that the winter load curve has two peaks or two humps, the largest in mid-morning, followed by a smaller peak in the late evening, both of which correspond to heating loads.

By the same source, the heating and air-conditioning loads vary dependent on weather and external temperature. The winter peak occurs around 6:30H to 9:00H with a small peak around the 19:00H to 21:00H from May to October, the demand never gets too high or too low, meaning it stays within a reasonably manageable range, and the ramp-ups and ramp-downs of demand are fairly gradual. By contrast, in the summer the peak occurs around 15:30H to 18:00H from May to September, which is higher than the winter peak.

In the winter time, there is a baseline amount of energy that's always needed — "base load" — covered by running big power plants, typically nuclear and coal, around the clock. These plants are typically slow to start or stop, but cheap once they are running. In addition, there's "intermediate load", usually covered with the next-cheapest tier of power plants, and at the top of that second hump, "peak load," satisfied by (usually natural gas) "peaker plants" that are expensive to run but easy to ramp up and down quickly. In the summer time, a robust baseline amount of energy is needed to generate, complemented by a robust "intermediate plants" and "peaker plants", in the case of Florida run by natural gas.

In the state of Florida, the daily energy load shapes are influenced by the energy load at the residential sector. The residential sector consumes more than half of Florida's electricity. More than 9 in 10 Florida households (EIA 2017a: 1_01_A to 1_20_B) use electricity as their primary energy source for home heating, and even more households use electricity for air conditioning. As presented in Fig. 5.8, with high mid-day air peak loads that coincide when there are solar generation potential peaks. As it can be observed, this descending pace is more intense when closer to midnight. Fortunately, the peak at noon and the high electricity demand in the following hours fit the solar PV electricity generation curve, which shows very high values since 9/10 in the morning until 15/16 in the afternoon

Florida is typically a summer-peaking state, which means summer peak demand generally controls the amount of energy capacity required. According to the Florida Reliability Coordinating Council, Inc. Florida's 2017 summer peak demand—47,508 MW—surpassed winter peak demand, which was 44,836 MW (FRCC 2018: 23). Only when solar would reach several percentage points of generation in the state would storage and demand response become necessary. The state of

Florida can benefit from solar PV without incurring the need for storage and demand response solutions, especially in summer season.

In Figure 5.8, the electrical demand on a peak summer day in a typical Florida home is presented. In order to reduce the electrical demand various measures were evaluated by the Florida Solar Energy Center between 2015 to 2016 and presented at the report From Energy Guzzler to Near-Zero Energy Home: Lessons from the Phased Deep Retrofit Project and an article published by Clean Technica in 2018 (FSEC 2016: 10-2 - 10-11, FSEC 2018, CT 2018) “Evaluated over a full year, the average household electricity use was reduced through a combination of efficiency measures and photovoltaic power generation by 82% (FSEC 2016:10-1, FSEC 2018)”, converting the residential loads more flat and stable when a greater penetration of efficiency in a household as presented in Fig 5.9.

The report considered the following efficiency and retrofit options:

- Very high-efficiency air conditioners and heat pumps
- Smart or connected thermostats such as Nest or Ecobee
- Heat pump water heaters (HPWH)
- Heat pump clothes dryers (HPCD)
- Fully variable speed pool pumps
- High efficiency refrigerators for those found to be using more than 3 kWh/day
- Supplemental ductless mini-split heat pumps to drop central AC load
- Adding more ceiling insulation or floor insulation
- Duct sealing after test
- High efficiency dishwashers
- Efficient lighting
- Solar PV system: 32.3 kWh

Thus, it is possible to see how the various efficiency measures cut demand on the peak summer day. By extrapolating this research by FSEC, it would possible to argue that similar residential load results would be found implementing in the residential sector making flat and stable when a greater penetration of efficiency measures is achieved in a household.

Nevertheless the low penetration of Solar PV in the state of Florida, a research done by Hale, Stoll and Novacheck (Hale, Stoll and Novacheck, 2018: 741-751), simulated a year of grid operations at hourly time resolution, and investigating the impact of system flexibility on the economic carrying capacity of PV by overlaying a baseline scenario with a number of flexibility options, with PV penetration levels of 20% and 32%, under a variety of technology cost, fuel price, and policy assumptions. The diurnal pattern of PV generation in summer and winter season, creates daily net-load time series with distinct morning and evening peaks that become more dramatic as PV penetration increases, as presented in Fig. 5.10. At high PV penetration these net-load lines vaguely resemble a duck named “duck curves”.

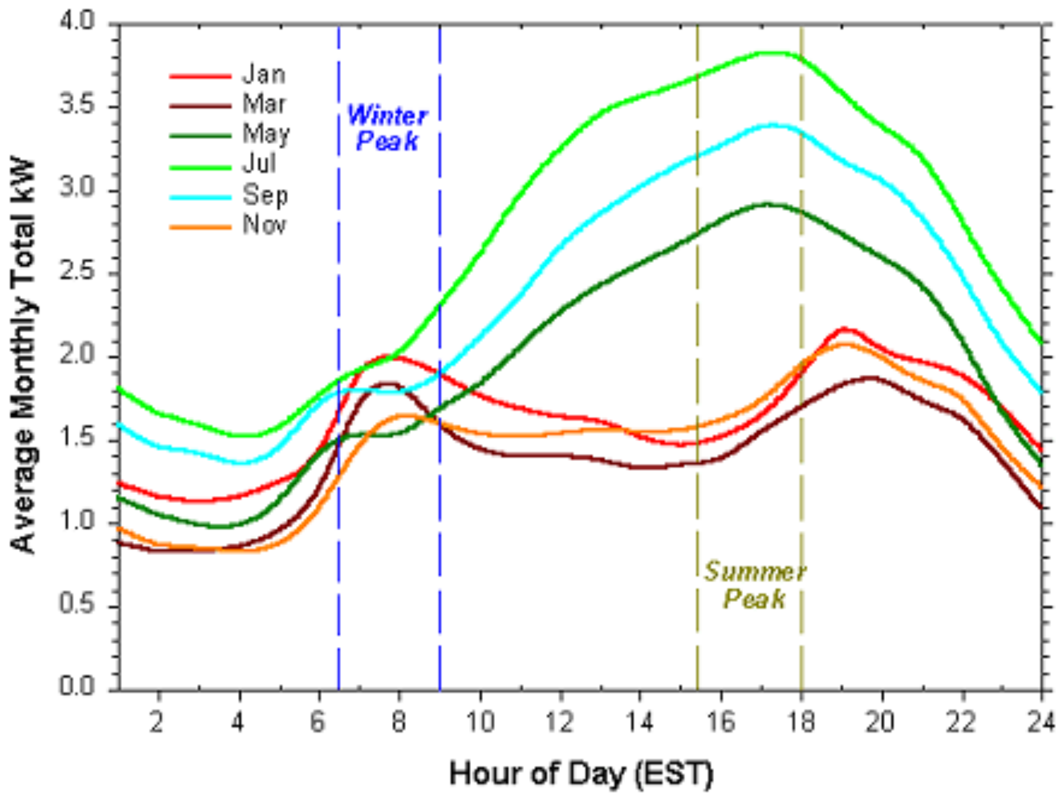

Fig 5.8. Typical Florida Daily Electric Load Shapes. *Source*: Florida Solar Energy Center (FSEC 2018)

Solar PV generation “eventually reach a point where net-load drops below zero for a substantial portion of the day, especially in winter season. Once high enough penetrations are achieved, such net-load patterns reduce the value of PV to the system and make further PV deployment less economically attractive”, causing that conventional generation to be forced to start up and shut down more frequently to accommodate PV generation, increasing cycling costs.

The duck curve also shows steep ramping needs and over generation risks. The potential for over generation as more renewable energy is added to the grid but demand for electricity does not increase is possible, which requires intervention of the market to maintain reliability. The duck curve in Figure 5.10 shows that oversupply is expected to occur around the middle of the day.

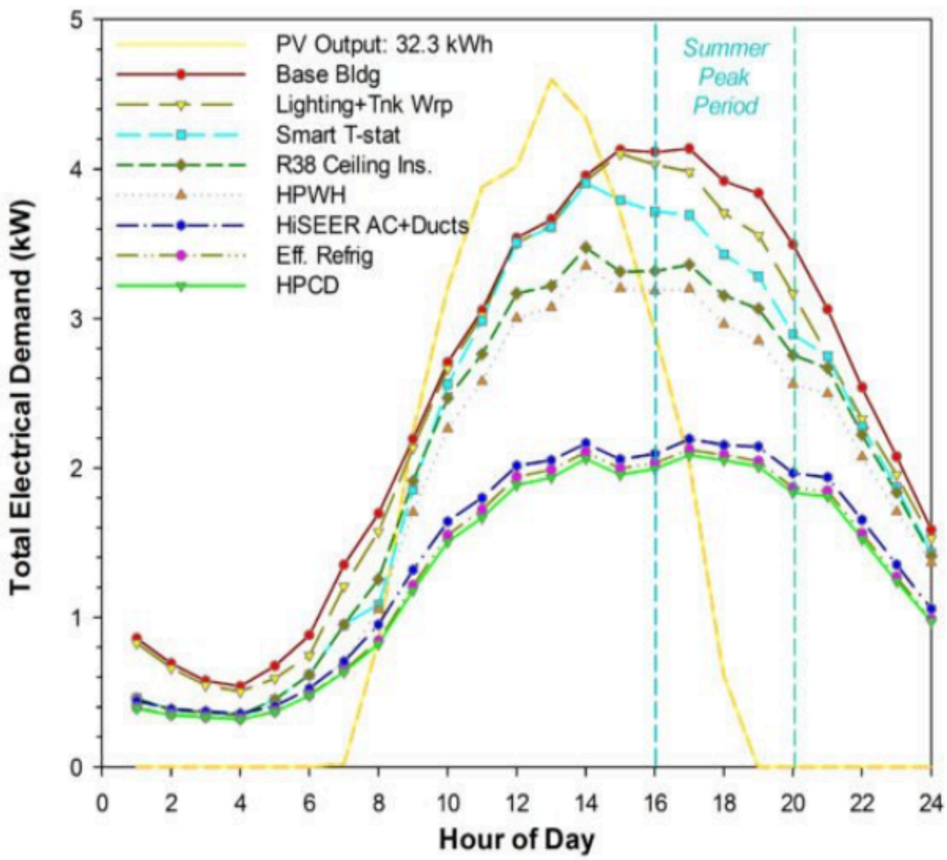

Fig 5.9. Simulated Summer Peak Day Performance for Average Florida Home, Pre & Post within Retrofit with PV (Melbourne, FL). *Source*: Clan Technica (CT 2018)

The electricity market worldwide is a “set of markets in which distributors and generators reveal their expectations of the sales or purchases of quantities of electricity, defined for a time period, which will then be effective from the next day” (Mir-Artigues and del Río 2016: 147), this is especially true because several IOUs, Cooperatives and Municipal utilities by and sale energy to other utilities in the state of Florida, making the planning of conventional generation an issue to consider in the future, that would impact the financial results of these utilities. Utilities and renewable generation have to guarantee the balance between the supply and demand of active power, resolving the unpredictable loss of variation of large generation.

5.1.4. Implementation of Renewable Portfolio Standard

As presented in Chapter 2 of this research, as of mid-2016, 176 countries around the world have adopted at least one type of renewable energy target (REN21 2017: 21). According to National Conference of State Legislature (NCSL 2016), twenty-nine states and Washington, D.C. had passed renewable portfolio standard (RPS) programs until 2016, which apply to 55% of total U.S. retail electricity sales, to help achieve renewable energy generation. In addition, eight states have set renewable energy goals. Iowa was the first state to establish an RPS and Hawaii has the most aggressive RPS requirement. Iowa and Texas require explicit amounts of renewable energy capacity rather than percentages and Kansas requires a percentage of peak demand. Michigan requires a mix of amounts and a percentage of peak demand.

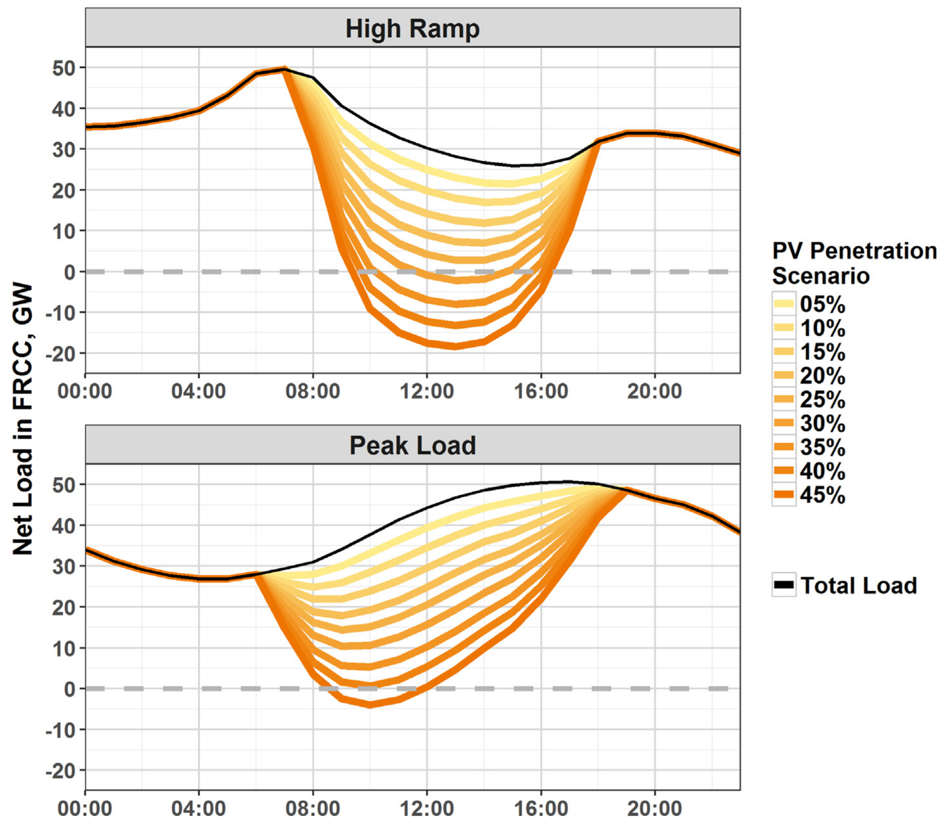

Fig. 5.10 Duck curve in Florida during a day in the high ramp (top) and peak load (bottom) periods**.** *Source*: Hale, Elaine T. Stoll, Brady L. and Novacheck, Joshua E (2018: 746)

No two of the state RPS programs are identical, and the differences among programs are often substantial. Some RPS programs are clearly aimed at creating jobs installing and maintaining solar cells rather than manufacturing them, and at promoting in-state economic activity, giving credit only for renewable generation that serves in-state customers.

Based on the software simulator by Energy Innovation LLC called Energy Policy Simulator (EIP&T 2018), it was possible to create a scenario based on the introduction of Implementation of a nationwide Renewable Portfolio Standard of

30% RPS from 2020 to 2030 and 50% from 2030 to 2050. The results of this simulation are presented in Fig. 5.10. and Table 5 for electric capacity.

The Fig. 5.11 shows that by Implementation of the Renewable Portfolio Standard as defined in previous paragraph, it would be an increase over 140% between 2031 to 2035 in Utility Solar PV capacity, as well as in lower levels in Wind, and Other Resources, while coal, and natural gas capacity would decrease from 2020 to 2050.

The simulation shows that a 30% RPS from 2020 to 2030 will have a faster increase in percentage of Utility Solar PV than increasing a 50% RPS from 2030 to 2050, reaching a maximum increase in 2032 with a 145% versus similar year's capacity in "Business As Usual" scenario. Nevertheless, the increase in Utility Solar PV capacity will continue until 2050 at slower speed reaching 318.238 GW by 2050 or 18% of total capacity in same year. Win capacity would have similar curve than Utility Solar PV reaching a maximum increase in capacity by 2028, followed by a flat increase until 2032, with slower increase in capacity until 2050. Nevertheless, by 2050 Win capacity would reach 408.94 GW or 24% of total capacity in same year.

If we compare the 2018 capacity by fuel, we would find that coal represent 21% of total capacity, 37% by Natural Gas, 11% by Wind, 10% by Hydro, 9% Nuclear, 4% Utility Solar PV, 3% Petroleum, 2% Distributed Solar, and 3% other sources reaching 1,073 GW by that year. By the introduction of 30% RPS from 2020 to 2030 and 50% from 2030 to 2050 in country would reach a 1,736 GW capacity or 8% increase versus "Business As Usual" scenario with a different share by fuel as: 24% capacity from Win, 22% Natural Gas, 18% Utility Solar PV, 12% Coal, 7% Distributed Solar PV, 5% Other Sources. It is possible to conclude that an increase in RPS at national level would increase substantially the adoption of renewable energy especially for Wind and Utility Solar PV. The adoption of nationwide RPS mechanisms would result in competition, efficiency, and innovation that will deliver renewable energy at the lowest possible cost, allowing renewable energy to compete with cheaper fossil fuel energy sources.

In the case of Florida, on January, 2009 the Florida Public Service Commission unanimously agreed to require the state's utilities to generate 20 percent of their power from renewable resources by 2020, which is still not law until the legislature approves. This would drastically change the landscape for renewable energy applications (EIP&T 2018, Mir-Artigues and del Río 2016: 177-183) for a state that gets less than 3 percent of its power from renewable energy as presented in the previous simulation at national level. A policy that still is pending to be enacted by the Florida´s Congress, nevertheless the support by the Floridians to the Amendment 1 of November 2016, allowing to consumers to own or lease solar equipment installed on their property to generate electricity for their own use, and protecting its citizens against requiring residents to subsidize solar power.

5.1.5. Reduction in Soft Cost for Solar PV

As presented in Fig. 5.2, the cost of solar systems showed a steady decline over 2910 to 2017 for Residential PV, Commercial PV and Utility-Scale PV, including installation labor, land acquisition, sales tax, transaction costs, customer acquisition costs, overhead and net profit. From same figure, the soft costs are a substantial portion of a solar system and soft costs and hardware costs interact with each other as well. For example, module efficiency improvements have reduced the number of modules required to construct a system of a given size (NRLE 2017: viii), consequently reducing hardware costs that has also reduced soft costs from direct labor and related installation overhead.

Based on the software simulator by Energy Innovation LLC called Energy Policy Simulator (EIP&T 2018), it was possible to create a scenario based on the introduction of policies that would reduce by 50% the soft costs, as costs of permitting and financing that could be reduced by streamlining permitting processes, as well as automation, increased access to data and information, and software and information management tools can help reduce the time and effort needed to complete a solar installation. Other soft cost as labor would be difficult to reduce via policy but has been considered as part of this scenario. The results of this simulation are presented in Fig. 5.12.

The simulation shows that a 50% soft cost reduction from 2020 to 2050 will have a modest increase in percentage of Utility Solar PV, reaching a maximum 6% by 2050, and less than 1% decrease for wind generation. This may mean that a substantial reduction in soft costs do not have a relevant impact as previous samples or simulations.

As an example of the implementation of this scenario, in Broward County - Florida, residents can now get a solar energy system permit and a preapproved set of design plans in just thirty minutes thanks to a new online permitting system, which is impacting around 4 million inhabitants. Go Solar – Florida is expanding an online permitting solution to other local municipalities and six Florida counties, and will continue to engage Florida stakeholders to expand financing options.

The US Department of Energy's Sun Shot (SunShot 2014: 95-110) initiative had implemented a diverse portfolio of soft cost activities to empower state and local decision-makers through timely and actionable resources to reduce the costs and barriers on permits and financing resources, as well as on the creation of consistent, high-quality workforce training and skills-credentialing in the solar industry.

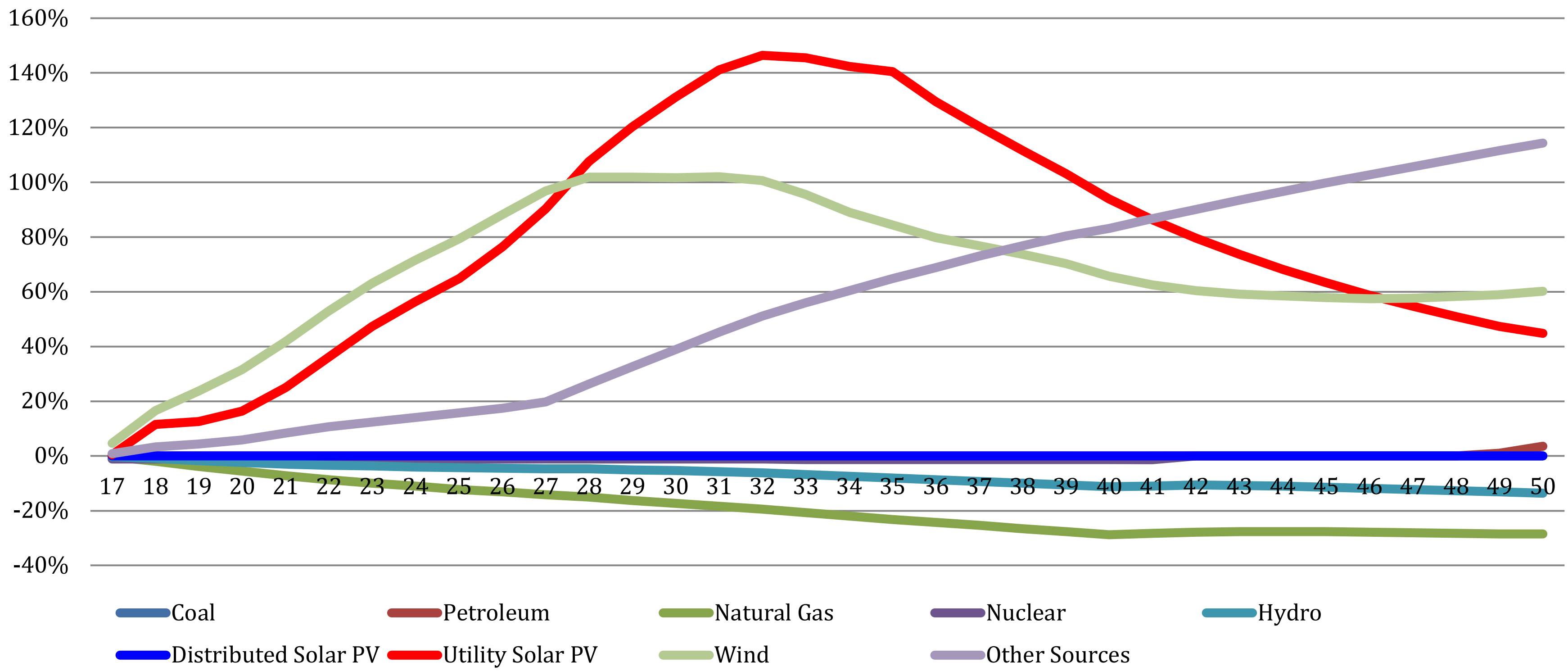

Fig. 5.11. Variation on Renewable Portfolio Standard by Simulation of 30% RPS from 2020 to 2030 and 50% from 2030 to 2050 in U.S., 2018-2050 by fuel. *Source*: Own Elaboration from Energy Policy Simulator (EIP&T 2018: 1.1.4)

Table 5
Electric Capacity Projection by Simulation of 30% RPS from 2020 to 2030 and 50% from 2030 to 2050 in U.S., 2018-2050 by fuel

Year	Coal	Petroleum	Natural Gas	Nuclear	Hydro	Distributed Solar PV	Utility Solar PV	Wind	Other Sources	TOTAL
2017	239.825	30.8537	404.38	99.639	103.036	17.276	31.792	102.97	26.11	1,056
2018	229.593	30.7384	396.96	97.957	103.036	20.79	46.56	120.08	27.07	1,073
2019	223.854	30.5593	385.88	95.365	103.035	24.599	61.43	138.59	28.06	1,091
2020	218.763	30.4499	373.48	95.365	103.035	28.652	76.104	157.22	29.05	1,112
2021	217.259	30.4024	363.96	95.365	103.015	32.764	90.254	174.94	30.04	1,138
2022	216.258	30.3379	359.03	95.365	103.009	35.529	102.148	191.38	30.85	1,164
2023	216.258	30.3261	357.20	95.365	102.993	36.956	113.082	205.35	31.49	1,189
2024	214.458	30.3165	356.74	94.243	102.99	38.739	123.514	217.98	32.13	1,211
2025	213.108	30.2698	355.67	93.125	102.988	40.953	133.746	229.92	32.79	1,233
2026	213.108	30.2515	355.32	93.125	102.988	43.384	143.942	241.46	33.46	1,257
2027	213.108	30.1544	352.98	93.125	102.988	46.051	156.296	252.66	34.36	1,282
2028	212.858	30.1437	352.67	93.125	102.988	48.884	171.294	259.28	36.53	1,308
2029	212.858	30.1423	351.24	92.725	102.988	51.903	186.294	261.28	38.72	1,328
2030	212.858	30.1423	350.10	92.325	102.988	55.126	201.294	263.94	40.92	1,350
2031	212.858	30.1393	350.05	91.725	102.988	58.389	216.294	267.29	43.13	1,373
2032	212.858	30.1322	349.35	91.325	102.988	61.65	231.294	271.22	45.35	1,396
2033	212.858	30.124	347.80	89.325	102.987	64.926	246.294	275.31	47.57	1,417
2034	212.858	30.118	347.17	86.124	102.987	68.213	261.294	279.83	49.80	1,438
2035	212.858	30.0746	344.22	85.524	102.987	71.527	276.292	284.93	52.04	1,460
2036	212.553	30.0525	343.80	84.023	102.987	74.85	280.246	289.67	54.29	1,472
2037	212.553	30.0511	343.77	83.222	102.987	78.198	284.414	296.04	56.55	1,488
2038	212.553	30.0073	342.31	82.522	102.987	81.556	288.934	303.18	58.82	1,503
2039	212.553	29.9789	340.54	82.522	102.987	84.917	292.146	309.17	61.11	1,516

2040	212.553	29.9173	337.80	81.722	102.987	88.296	295.47	315.43	63.42	1,528
2041	212.75	29.8863	343.60	80.962	104.004	91.534	298.094	321.81	65.60	1,548
2042	212.947	29.8553	349.71	81.341	105.121	94.857	301.002	329.57	67.85	1,572
2043	212.886	29.8243	354.28	80.581	105.677	98.182	303.708	338.57	70.10	1,594
2044	212.825	29.7933	357.92	79.821	105.985	101.506	306.334	348.27	72.35	1,615
2045	212.764	29.7623	361.72	79.061	106.311	104.829	308.55	357.34	74.60	1,635
2046	212.703	29.7313	364.91	78.301	106.532	108.154	310.666	366.66	76.86	1,655
2047	212.642	29.7003	367.63	77.541	106.66	111.477	312.372	376.43	79.11	1,674
2048	212.581	29.6693	369.42	76.781	106.702	114.801	314.03	386.97	81.36	1,692
2049	212.52	29.8973	372.41	76.021	106.731	118.125	315.34	397.16	83.61	1,712
2050	212.459	30.6523	376.45	75.261	106.731	121.449	318.238	408.94	85.86	1,736

*Source: Own Elaboration from data projection by Energy Solution (*EIP&T 2018: 1.1.4*)*

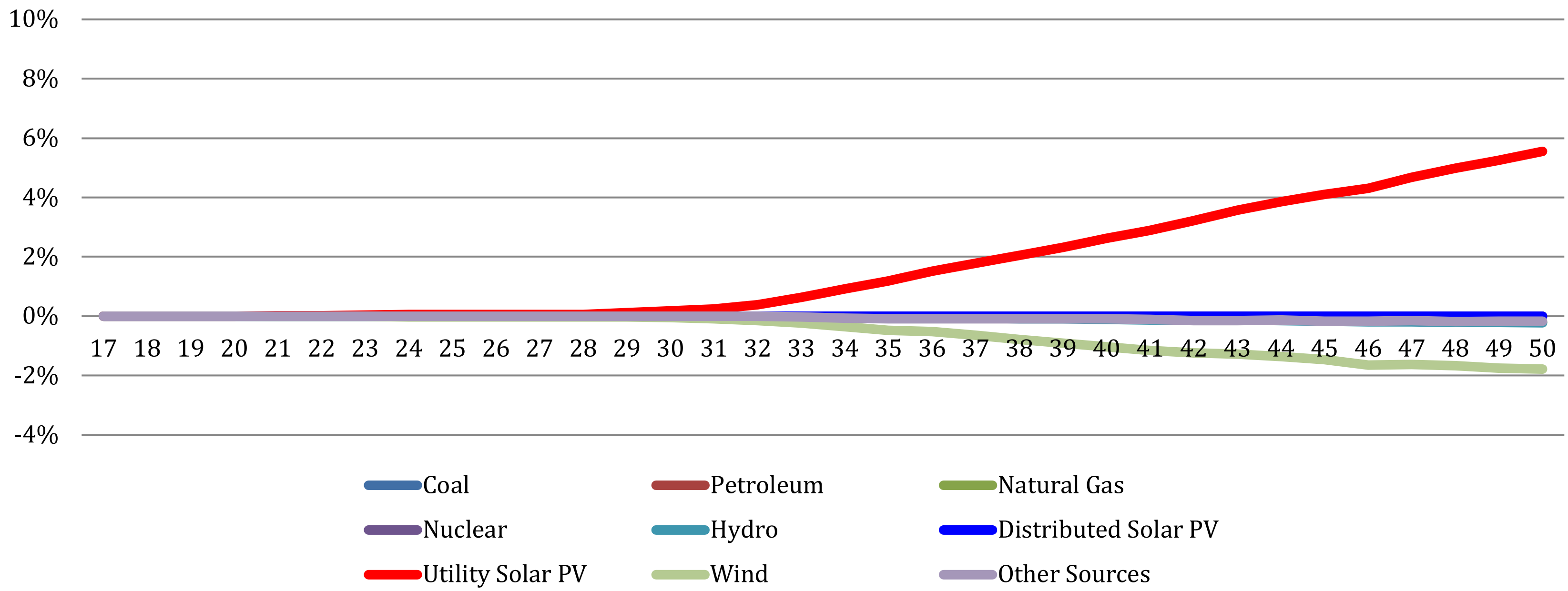

Fig. 5.12. Variation on Soft Cost in Solar PV by Simulation of 50% cost reduction from 2020 to 2050 in U.S., 2018-2050 by fuel.by sector. *Source*: Own Elaboration from Energy Policy Simulator (EIP&T 2018: 1.1.4)

5.2. Proposal to promote distributed and community solar PV

The power and utility industry are witnessing an unprecedented wave of transformational changes. The rise of solar power is one of the biggest sources of disruption. Another disruptive model are distributed solar and community solar.

Distributed solar PV can be defined as the production of electricity by means of panels or arrays, which are installed on the customer's side of the meter (NREL 2018a: 1-7, Mir-Artigues and del Río 2016: 243). The first significant distributed solar PV system installation in the USA was a 5 kW in a block of apartments in Quincy – Massachusetts in 1978 (Johnstone 2011: 91), which generated for self-consumption with surplus electricity being fed into the grid under given economic conditions, whereas electricity was bought from the grid if needed, with strong opposition by traditional electricity companies (Mir-Artigues and del Río 2016: 44). From here, several other distributed solar PV installations had been implemented, as presented in Fig. 5.1.

Grid-tied solar photovoltaic (PV) output may be consumed on-site (self-use) or exported to the grid (export). According to Solar Energy Industries Association (SEIA 2018b) Distributed Solar systems offer economic benefits to utilities, commercial and residential users specially to offset peak electricity purchases by the utility, resulting in lower electricity bills for customers, reducing the need to expand transmission grid capacity because all net metered PV systems deliver electricity at or near the point of consumption, and allowing users to fix a portion of their utility expenses for years at a cost lower than they would have paid otherwise.

By the power utility sector, Solar PV generation is a modality of distributed generation that affects the configuration of the electricity grid (Mir-Artigues and del Río 2016: 150-151), influencing grid-related costs, as the following:

- New investments in transmission lines to deliver the electricity produced by new utility-scale PV plants.
- The need to upgrade the distribution grid by the expansion of distributed solar PV from commercial and residential systems.
- The requirements to increase the flexibility of the electric system due the integration of different source of energy, with the effect on ancillary services and faster scheduling.
- By having variable sources of energy, it is required a different approach to the planning of long-term investments in grids architecture

Historically, if individual residential and commercial customers wanted to use solar energy, they needed to install solar systems on their roofs. With community solar, individual consumers can purchase a piece of a large solar installation built offsite or subscribe to its electricity output. According to a 2018 SEPA report (SEPA 2018, 5), the community solar market segment has doubled in 2017, growing from 347 MW-dc in 2016 to 734 MW-dc, and 495 MW-dc of this capacity was administered by a third-party community solar provider. Utilities administer the remaining 239 MW of installed capacity. This means that only 229 out of over 3,000 utilities in the U.S. have community solar programs in their service in 36 states. This translates to 90% of U.S. electricity customers, both residential and commercial customers, lacking access.

By the same source, community solar capacity is significantly less than rooftop and utility-scale solar. Nevertheless, the existence or not of shared solar policies several community solar programs are developed. In any case, many of the most active states have some form of state policy. The specific language in each of these policies varies dramatically, particularly concerning scale, bill credit rate, and ability of third-party ownership.

There are ranges of different community solar ownership models. These systems can either be owned by the utility, a third party, a non-profit, or by a community-based organization. In the state of Florida, few community solar systems had been implemented because it is regulated that electric utilities are the only companies allow to provide and sell energy to customers, as discussed in section 4.2.6 of Chapter 4 and Section 3.2 of Chapter 3. Participants can subscribe to a portion of a local community solar project and get a share of the electricity that system produces in the form of a credit on their electricity bill.

PV system costs have continued to decline as presented in Fig. 5.2 in all sectors including residential, commercial and utility. In the case of residential PV systems and according to Solar Estimate (Solar-Estimate 2018) the average cost per watt at November 2018 was $2.16 after 30% solar tax credit as presented in Table 6, which is a 23% lower from 2017. The lowest cost was in the state of Georgia at $1.95 per watt and the highest in Connecticut at $2.37 per watt. The same table shows the cost per PV system configurations from 6kW to 10kW, which are the most implemented in the residential sector in the U.S.

In addition to the decline of PV system costs, another factor to consider in the adoption of PV Solar systems or renewable energy is the cost per kWh that a normal residence pays. According the U.S. Energy Information Administration or EIA, the average price people in the U.S. pay for electricity is about 12 cents per kilowatt-hour, and a typical U.S. household uses about 908 kWh a month of electricity. But there's huge variation from state to state, for example people in Hawaii pay the most for electricity, about 33 cents per kWh in 2017, while Idaho

Table 6
Solar panel cost by state for each size of residential solar power system at November, 2018

State	Solar panel cost by state (after 30% solar tax credit)					
	6 kW System	7 kW System	8 kW System	9 kW System	10 kW System	Average cost ($/watt)
Alabama	12,180	14,210	16,240	18,270	20,300	2.03
Alaska	13,020	15,190	17,360	19,530	21,700	2.17
Arizona	13,230	15,435	17,640	19,845	22,050	2.21
Arkansas	11,928	13,916	15,904	17,892	19,880	1.99
California	13,356	15,582	17,808	20,034	22,260	2.23
Colorado	13,104	15,288	17,472	19,656	21,840	2.18
Connecticut	14,196	16,562	18,928	21,294	23,660	2.37
District of Columbia	13,818	16,121	18,424	20,727	23,030	2.30
Delaware	12,600	14,700	16,800	18,900	21,000	2.10
Florida	12,096	14,112	16,128	18,144	20,160	2.02
Georgia	11,676	13,622	15,568	17,514	19,460	1.95
Hawaii	14,364	16,758	19,152	21,546	23,940	2.39
Idaho	12,390	14,455	16,520	18,585	20,650	2.07
Illinois	13,104	15,288	17,472	19,656	21,840	2.18
Indiana	13,356	15,582	17,808	20,034	22,260	2.23
Iowa	12,348	14,406	16,464	18,522	20,580	2.06
Kansas	12,474	14,553	16,632	18,711	20,790	2.08
Kentucky	12,978	15,141	17,304	19,467	21,630	2.16
Louisiana	12,600	14,700	16,800	18,900	21,000	2.10
Maine	13,776	16,072	18,368	20,664	22,960	2.30
Maryland	12,600	14,700	16,800	18,900	21,000	2.10
Massachusetts	13,734	16,023	18,312	20,601	22,890	2.29
Michigan	12,642	14,749	16,856	18,963	21,070	2.11

Minnesota	13,398	15,631	17,864	20,097	22,330	2.23
Mississippi	12,390	14,455	16,520	18,585	20,650	2.07
Missouri	12,600	14,700	16,800	18,900	21,000	2.10
Montana	12,600	14,700	16,800	18,900	21,000	2.10
Nebraska	12,096	14,112	16,128	18,144	20,160	2.02
Nevada	12,432	14,504	16,576	18,648	20,720	2.07
New Hampshire	13,692	15,974	18,256	20,538	22,820	2.28
New Jersey	13,524	15,778	18,032	20,286	22,540	2.25
New Mexico	12,936	15,092	17,248	19,404	21,560	2.16
New York	13,776	16,072	18,368	20,664	22,960	2.30
North Carolina	12,348	14,406	16,464	18,522	20,580	2.06
North Dakota	12,600	14,700	16,800	18,900	21,000	2.10
Ohio	12,516	14,602	16,688	18,774	20,860	2.09
Oklahoma	12,600	14,700	16,800	18,900	21,000	2.10
Oregon	13,104	15,288	17,472	19,656	21,840	2.18
Pennsylvania	13,356	15,582	17,808	20,034	22,260	2.23
Puerto Rico	14,196	16,562	18,928	21,294	23,660	2.37
Rhode Island	13,608	15,876	18,144	20,412	22,680	2.27
South Carolina	12,936	15,092	17,248	19,404	21,560	2.16
South Dakota	12,600	14,700	16,800	18,900	21,000	2.10
Tennessee	13,104	15,288	17,472	19,656	21,840	2.18
Texas	13,104	15,288	17,472	19,656	21,840	2.18
Utah	12,600	14,700	16,800	18,900	21,000	2.10
Vermont	13,776	16,072	18,368	20,664	22,960	2.30
Virginia	13,272	15,484	17,696	19,908	22,120	2.21
Washington	12,390	14,455	16,520	18,585	20,650	2.07
West Virginia	12,600	14,700	16,800	18,900	21,000	2.10
Wisconsin	13,188	15,386	17,584	19,782	21,980	2.20

Wyoming	12,600	14,700	16,800	18,900	21,000	2.10

Source: Own Elaboration from Solar-Estimate (2018) had the lowest price, at about 8 cents per kWh. (EIA 2018). Residential customers in Texas, the country's largest deregulated market for electricity, pay a relatively low price for electricity as well of 11.3 cents per kWh, while in California is 15.2 cents per kWh.

In the case of Florida, the normal residence pays about 11.4 cents per kWh in 2017 according to FPSC (FPSC 2017b, A2-A3), which ranks 33th in the U.S. This is 5.2% less than the national average residential rate in same year. Table 8 presents the Residential Monthly Bills for all Florida Electric Utilities for 1,000 kWh, which excludes local taxes, franchise fees, and gross receipts taxes that are billed as a separate line item, and includes cost recovery clause factors effective December 2017. The average price in Florida State had been reduced from 12.1 cents per kWh in 2013 in nominal value. In the case of the IOUs the normal residence pays around 12.0 cents per kWh in 2017 versus 12.9 cents in 2013 in nominal value. FP&L had the lowest cost at 10 cents per kWh in 2017. In the case of Municipal utilities, the normal residence pays around 11.3 cents per kWh in 2017 from 12 cents per kWh in 2013, while a normal residence pays 12.1 cents per kWh in 2017 from 12.3 cents per kWh in 2013. Nevertheless, more residences are impacted by IOUs because their market share is about 88% as presented in Chapter 3 of this research.

But there are regulatory limitations for the rapid adoption of Solar PV. As presented in Chapter 4.2.6, in the state of Florida current law allows non-utilities to generate electricity for their own use and sell any excess to a power utility, but prohibits all non-utility sales of electricity to anyone other than a regulated power utility, regardless of the technology used to generate electricity (Leagle 2018, Justia 2018). In summary, consumers in Florida cannot buy electricity from non-utility power companies, and non-utility power companies, including rooftop solar companies, cannot sell power to retail customers in the state.

In addition, third party solar power purchase agreements are not allowed in Florida, as well as the FPSC adopted rules for the state's Investor Owned Utilities (IOUs) and requires municipal utilities and electric cooperatives to develop their own net metering programs. Regarding community solar policy or program, Florida currently does not have any statewide rule, but utilities and third-party developers offer community solar programs. As a summary of State Incentive Programs in the state of Florida as detailed in chapter 4.1 (NREL 2018b), is presented below:

Table 7
Solar PV, State Incentive Programs in the state of Florida

Program	Administrator	Incentive
Renewable Energy	Office of Energy, Department of	System owners are eligible for a production-based tax credit of $0.01/kWh for electricity sold to a third party. The rule stipulates that only output sold by

Production Tax Credit	Agriculture and Consumer Services	the taxpayer to an unrelated party is an eligible basis for the credit.
Property Assessed Clean Energy (PACE) financing	Local authorities	PACE allows property owners to repay loans for solar PV projects through a special assessment on the property over a specified loan term. Florida has authorized local governments to establish PACE programs for financing solar PV projects.
Solar Sales Tax Exemption	Florida Department of Revenue	Solar equipment is exempt from state sales taxes.
Non-residential Property Tax incentive	Florida Department of Revenue	Only 80% of the solar equipment's cost is taxable under the solar personal property tax and non-residential property tax.

Source: Own Elaboration from NREL (2018b)

Despite the regulatory environment challenges and energy policies and regulations, some positive and innovative strategies had been implemented from different entities to use solar PV as a source of electric energy in the state of Florida, as follows:

- Property Assessed Clean Energy (PACE) with presence in 30 counties: as presented in chapter 4.1.2.5, a form of financing for energy efficiency and solar installed as capital improvements to buildings. The maximum amount that may be financed is 20% of the just market property value (FPACE 2018)
- At early 2018 the FPSC issued a statement confirming Sunrun Inc. can offer residential solar equipment leases in Florida (FPSC 2018a), in a 20-year solar equipment lease that is not a retail sale of electricity. This ruling allows homeowners in Florida to lease equipment to generate electricity for personal use and also benefit from interconnection and net metering with their local electric utility
- City of Lakeland / Lakeland Electric: “Pay-for- Energy” solar hot water heater program, with a residential incentive that eliminates up-front & maintenance costs as presented in 4.1.2 – Financial incentives by the State of Florida

Table 8
1,000 kWh Residential Monthly Bills for All Florida Electric Utilities
Excludes local taxes, franchise fees, and gross receipts taxes that are billed as a separate line item. Includes cost recovery clause factors effective December 2017.

Rank 2017	Utility	Type	2017	2016	2015	2014	2013
29	Duke Energy Florida, LLC	IOU	$115.45	$108.48	$111.84	$117.84	$120.84
4	Florida Power & Light Company	IOU	$99.99	$89.27	$138.40	$140.50	$141.15
53	Florida Public Utilities Company - Northeast Division	IOU	$135.50	$136.83	$146.00	$142.00	$146.99
54	Florida Public Utilities Company - Northwest Division	IOU	$135.50	$136.83	$100.00	$129.50	$130.50
51	Gulf Power Company	IOU	$134.19	$132.19	$120.10	$117.10	$118.10
7	Tampa Electric Company	IOU	$102.06	$103.56	$135.81	$128.70	$115.91
23	Alachua	Municipal	$113.40	$113.54	$92.99	$122.66	$117.92
45	Bartow	Municipal	$128.32	$125.36	$117.23	$119.02	$119.02
40	Blountstown	Municipal	$122.35	$122.35	$122.91	$123.91	$124.91
48	Bushnell	Municipal	$130.05	$118.05	$111.16	$115.96	$115.96
1	Chattahoochee	Municipal	$94.14	$112.19	$117.00	$129.92	$132.80
8	Clewiston	Municipal	$102.14	$104.94	$97.63	$98.83	$109.32
46	Fort Meade	Municipal	$129.56	$124.56	$114.73	$114.73	$105.00
36	Fort Pierce	Municipal	$118.84	$107.84	$106.87	$106.14	$100.49
50	Gainesville	Municipal	$131.55	$130.40	$108.45	$112.85	$114.16
30	Green Cove Springs	Municipal	$116.00	$115.00	$119.67	$138.98	$131.87

2	Havana	Municipal	$96.03	$100.20	$119.30	$121.90	$119.70
25	Homestead	Municipal	$114.23	$114.23	$114.44	$120.38	$120.75
33	Jacksonville Beach	Municipal	$116.91	$117.91	$107.06	$107.06	$107.06
15	JEA	Municipal	$108.50	$108.50	$112.50	$137.50	$130.00
56	Key West	Municipal	$140.00	$120.33	$112.64	$118.64	$118.64
3	Kissimmee	Municipal	$97.12	$98.57	$121.30	$137.60	$119.90
21	Lake Worth	Municipal	$111.29	$114.73	$109.43	$109.43	$109.43
6	Lakeland	Municipal	$101.35	$97.27	$134.82	$139.39	$139.32
39	Leesburg	Municipal	$121.72	$105.09	$98.05	$104.36	$105.66
14	Moore Haven	Municipal	$107.90	$101.40	$102.36	$118.33	$122.35
31	Mount Dora	Municipal	$116.22	$108.52	$113.81	$113.81	$113.81
12	New Smyrna Beach	Municipal	$104.78	$104.78	$96.85	$120.95	$120.95
27	Newberry	Municipal	$115.00	$122.50	$116.20	$120.70	$125.55
35	Ocala	Municipal	$117.64	$110.64	$123.00	$129.30	$130.30
13	Orlando	Municipal	$106.00	$106.00	$114.55	$117.20	$115.94
9	Quincy	Municipal	$102.21	$111.51	$123.60	$129.10	$129.60
11	Reedy Creek	Municipal	$104.52	$103.93	$106.20	$107.39	$105.55
20	St.Cloud	Municipal	$110.24	$110.24	$137.50	$137.00	$141.50
24	Starke	Municipal	$113.44	$109.88	$119.58	$123.93	$130.93
22	Tallahassee	Municipal	$112.81	$105.72	$105.50	$113.50	$108.62
41	Vero Beach	Municipal	$122.95	$116.08	$132.14	$137.14	$133.64
5	W auchula	Municipal	$100.90	$105.50	$113.64	$123.64	$115.14
17	Williston	Municipal	$109.44	$101.64	$106.66	$109.23	$109.99
16	Winter Park	Municipal	$108.94	$102.54	$123.68	$123.68	$119.98
34	Central Florida	Cooperative	$117.50	$124.00	$127.79	$125.75	$124.50
38	Choctawhatchee	Cooperative	$120.75	$116.87	$124.70	$131.38	$128.72
18	Clay	Cooperative	$109.90	$109.90	$122.35	$122.35	$122.35
55	Escambia River	Cooperative	$137.00	$136.00	$120.05	$139.05	$134.05

19	Florida Keys	Cooperative	$109.95	$97.24	$127.00	$135.00	$130.00
52	Glades	Cooperative	$134.50	$128.50	$115.43	$128.48	$117.82
44	Gulf Coast	Cooperative	$127.10	$117.10	$115.31	$127.08	$129.00
10	Lee County	Cooperative	$102.50	$102.50	$113.30	$122.90	$113.50
32	Okefenoke	Cooperative	$116.70	$116.70	$98.92	$101.96	$106.95
43	Peace River	Cooperative	$126.56	$126.56	$118.55	$122.16	$113.16
26	Sumter	Cooperative	$114.90	$112.60	$145.00	$147.00	$141.00
37	Suwannee Valley	Cooperative	$120.00	$121.00	$103.84	$129.58	$123.99
42	Talquin	Cooperative	$126.50	$123.50	$94.30	$98.97	$92.73
49	Tri-County	Cooperative	$131.00	$127.00	$137.57	$124.35	$130.99
47	West Florida	Cooperative	$130.04	$125.44	$137.57	$132.00	$131.96
28	Withlacoochee River	Cooperative	$115.13	$119.97	$124.56	$134.56	$126.56
	Average		$114.23	$111.98	$115.64	$122.00	$120.98

Source: Own Elaboration from FPSC (2017b: A2 – A3)

- City of Gainesville: Feed In Tariff Program for 20-year contract to system owners for installations up to 1MW in capacity for amount of energy supplied to the grid, which was available from2009 to 2011
- Progress Energy SunSense Schools Program: Progress Energy Florida (PEF) offered to provide up to 11 public schools (K-12) in the State, annually with fully installed solar photovoltaic systems of up to 100kW in capacity
- In march 2018, the FPSC approved an experimental demand-side management program for Gulf Power Utility that essentially pays a capacity price to commercial and industrial loads as a way to reduce peak demand. Customers who sign up will receive capacity payments for load that can be shortened during certain conditions (FPSC 2018b: 1 - 4). Customers in the program will initially receive a monthly bill credit of $3.35 for every kilowatt subject to curtailment.

These and other initiatives of electric utilities are on a path to over 4,000 MW of solar by 2021 as reported by the Southern Alliance for Clean Energy (SACE 2017: 15). As presented in Chapter 3.2 and Fig. 5.13 by the Forecast of Solar PV capacity between 2016 to 2021 for electric utility and distributed solar in the Southeast State (MW) by the Southern Alliance for Clean Energy (SACE), large utilities had exhibited solar leadership in previous years and would continue until 2021. FPL would continue its leadership in Florida, with a capacity of 1,887 MW of utility scale solar and distributed solar, while DEF would reach 1,249 MW, TECO would reach 622 MW. These are three of the main IOS in the state.

	UTILITY-SCALE SOLAR, MW		DISTRIBUTED SOLAR, MW	
UTILITY	2017	**2021**	2017	**2021**
FLORIDA POWER & LIGHT	448	**1,640**	68	**247**
DUKE ENERGY FLORIDA	30	**935**	84	**309**
TAMPA ELECTRIC	14	**574**	13	**48**
JACKSONVILLE (JEA)	19	**272**	7	**24**
GULF POWER	60	**120**	5	**18**
TALLAHASSEE	10	**60**	2	**8**
ORLANDO (OUC)	18	**18**	8	**29**
LAKELAND	15	**15**	3	**9**
GAINESVILLE (GRU)	3	**3**	2	**8**
SEMINOLE	2	**2**	9	**35**

Fig. 5.13. Forecast of Solar PV 2016-2021 by Utility-Scale and Distributed Solar for main Florida utilities (MW). *Source*: Southern Alliance for Clean Energy (SACE 2017: 15)

Nevertheless, the existing laws protecting the electric utilities in the state of Florida, as presented in Table 9 and based on regulations from the Florida Legislature and applied by the FPSC, in 2017 it was an important growth of renewable share in the state. At that year, the number of Customer Owned Renewable interconnection increased three times increase, and just 29 of them from wind and others from Solar PV *(FPSC 2017d: 1 – 2; 2017f: 4-8)*. *The report* shows that 24,157 new distributed generation systems were connected to the power grid in 2017, 6 times the number of Customer Owned Renewable Interconnections from 2010, with a Gross Power Rating of 204,755 kW or 7 times of 2010 levels, an increase of almost 50 thousand kW from 2016.

From Table 9, most of the interconnections in 2017 were coming from Investor-Owned Utilities (IOUs), with a share of 74%, or 17,843 interconnections, with a 157,304 kW or 77% of the total 204,755 kW. The highest number of interconnections since 2011 was from the Florida Power and Light (FPL) and Gulf Power Company (GPC) representing over 15 thousand interconnections in same year. Interesting to note that Tampa Electric Company (TEC) had 10.38 kW/Interconnection in 2017 the highest of the year between all other IOUs and had been always the highest over the last 7 years. In 2011 most of the interconnections were coming also from IOUs with a 70.5% share, while 15.5% from Municipals and 14% from Rural Electric Cooperatives, meaning that IOUs had always maintained the highest interconnections' share. In 2011 the average PV system was 7.18kW/interconnection and in 2014 was 9.31kW/interconnection the highest in all years under this analysis.

The Florida's Distributed Generation compared with the State of California's installations is extremely small. According to the California Distributed Generations Statistics (CDGS 2018) at the end of 2017 California's Investor-Owned Utilities had close to 6,000 MW in interconnected solar PV net energy metering (NEM) applications, of them 65% were customer owned, 26% PPA, 8% lease and others 1%. This is true because the different approached to NEM policies as well as the dominance situation of IOUs in each state, as covered in Chapters 3 and 4 of this research. In addition, Third-party ownership of solar has driven residential solar market growth across the country as presented in Chapter 2.2.3, but Florida did not allow it.

From data collected form FPSC and presented at Table 9, in the State of Florida the average size of a distributed generation systems in 2017 was 8.48 kW/interconnection, while FPL had an average 9.81 kW/interconnection the highest in the State, and GPC has an average 5.88 kW/interconnection.

As presented in this research and the simulations in this chapter, because the low cost of installation and solar panels, the low cost of solar energy versus coal, the innovation in solar energy, the regulatory environment in favor of electric utilities, the new business models including lease of equipment, and the desire of the Floridians expressed on Amendment 1 of November 2016, called Florida Solar

Table 9
Number of Interconnections and Gross Power Rating in the State of Florida

	2011	2012	2013	2014	2015	2016	2017
	Number of Customer-Owned Renewable Interconnections*						
INVESTOR-OWNED UTILITY	2,785	3,815	4,832	6,308	8,578	11,560	17,843
Florida Power and Light (FPL)	1,580	2,117	2,565	3,241	4,257	5,418	7,525
Florida Public Utilities (FPU)	26	36	52	59	69	87	109
Gulf Power Company (GPC)	205	274	306	372	471	509	889
Duke Energy Florida, Inc. (DEF)	772	1,070	1,483	2,068	2,970	4,448	7,476
Tampa Electric Company (TEC)	202	318	426	568	811	1,098	1,844
MUNICIPAL	614	792	1,008	1,205	1,619	2,379	3,413
RURAL ELECTRIC COOPERATIVE	553	688	857	1,058	1,429	2,055	2,901
TOTAL	3,952	5,295	6,697	8,571	11,626	15,994	24,157
	kW Gross Power Rating						
INVESTOR-OWNED UTILITY	19,500	30,476	44,790	61,571	83,914	107,360	157,304
Florida Power and Light (FPL)	11,959	16,227	23476	33,594	43,924	55,001	73,826
Florida Public Utilities (FPU)	104	142	238	271	343	499	646
Gulf Power Company (GPC)	691	1,026	1192	1,543	2,210	2,617	5,223
Duke Energy Florida, Inc. (DEF)	5,006	8,987	13152	18,267	27,505	37,128	58,471
Tampa Electric Company (TEC)	1,740	4,094	6732	7,896	9,932	12,115	19,138
MUNICIPAL	5,005	7,029	8,694	10,203	13,135	18,816	27,634
RURAL ELECTRIC COOPERATIVE	3,871	4,708	6,472	8,014	10,495	14,345	19,817
TOTAL	28,376	42,213	59,956	79,788	107,544	140,521	204,755

Source: Own Elaboration from data projection Florida Public Service Commission (FPSC 2017d: 1 - 2)

Energy Subsidies and Personal Solar Use, which analysis was presented in Section 4.2.4 of this research., to support the implementation of renewable energy, it makes total sense for electric utilities to continue investing in solar PV farms. In fact, FPL announced last January 16, 2016 the '30-by-30' plan (FPL 2019) to install more than 30 million solar panels by 2030. By taking the rough estimate of 350 W per panel this means 10,500 MW from solar PV. This is a clear example that electric utilities in Florida are moving to solar generation.

5.3. Financials on residential and commercial solar PV

As presented by Southern Alliance for Clean Energy in Figure 5.13 of this Chapter, the Forecast of Solar PV 2016-2021 by Utility-Scale and Distributed Solar for main Florida utilities (SACE 2017: 15), it would be a relevant growth of 3.66 times of Distributed Solar by 2021 reaching 735 MW of solar energy versus 3,639 MW Utility-Scale Solar that would have a 5.88 times growth from 2017 levels. This means that Distributed Solar would be 16.8% of total solar energy by 2021.

Another important element is the birth of new groups promoting the implementation of solar energy called 'prosumer' groups (or producer and self-consumer) like Solar United Neighbors of Florida (https://www.solarunitedneighbors.org/florida/), Florida Solar Energy Industries association (https://www.flaseia.org), Clean Energy Florida (http://www.cleanenergyfl.org) and others that help provide the basic informative tools so people can make an informed decision. In addition, the concept of energy democracy is increasingly being used by several activists in the USA, as well as in the State of Florida, to call for and justify integrations of policies linking social and economic equity with renewable energy transitions.

There are some limitations in the state of Florida for installing PV Solar systems of any size. In the case of FPL, the net metering guidelines established that interconnected systems "should not be sized so large that energy produced by the renewable generator would be expected to exceed 115 percent of the customer's annual kWh consumption" (FLP 2018b). This is a limitation that customers are experiencing in the approval process.

Among the tools available for evaluating the cost for implementing solar PV in residential and commercial systems, the National Renewable Energy Laboratory or NREL have developed a comparison tool, called System Advisory Model (SAM), which is a "performance and financial model designed to facilitate decision making for people involved in the renewable energy industry, ranging from project managers and engineers to incentive program designers, technology developers, and researchers" (LEDS 2018), using computer models developed at NREL, Sandia National Laboratories, the University of Wisconsin, and other organizations.

The SAM model is used in this chapter, which calculates among other variables, the cost of a solar PV system and pay back periods of four residences in the state of Florida. The residences that had been selected to show the impact by the policies of the three types of utilities: FPL, an Investor-owned Electric Utility, the Orlando Utilities Commission, a Municipal Electric Utility, and Withlacoochee River Electric Co-op, a Rural Electric Cooperative.

Before using the SAM Model (NREL 2019) to the four sample residences, it was necessary to determine PV System specifications as presented in Table 10 as the size of the DC System Size to 6 kW to accommodate for the four residential systems without energy storage, and on the limitations of Net Metering by electric utilities, the DC to AC Size Ratio of the system to 1.2, the Rated Inverter size to 5 kW, the cell material of Crystalline Silicon with an efficiency of 15% with glass module cover, and assuming the same Annual Peak Demand of 6.8 kW and an Annual Total Demand of 14,488 kW.

Table 10
PV residential system and Financial Specifications for SAM modeling, without energy storage

PV System Specification	
DC System Size (kW):	6.0
Array Type:	Fixed open rack
Array Tilt (deg):	20
Array Azimuth (deg):	180
System Losses (%)	14.08
Invert Efficiency (%)	96
DC to AC Size Ratio:	1.2
Rated Inverter size (kW)	5
Capacity Factor (%)	17.7
Financial Model	
Total Installed Cost ($)	16,174
Project life (years)	25
Inflation rate (%)	2.5
Real discount rate (%)	6.4
Mortgage (%)	100
Mortgage rate (%)	5
Mortgage term (years)	25
Electricity demand (kW)	6.8
Annual total demand (kWh)	14,488

Source: Own Elaboration from the National Renewable Energy Laboratory's SAM Model (NREL 2019)

Table 11
Solar panel payback period based on four residential examples

Residence Location	6450 Colomera Dr, Boca Raton, FL 33433	2983 Oakbrook Dr, Weston, FL 33332	3112 Alamo Dr, Orlando, FL 34786	17528 Sandgate Court, Land Lakes, FL 34638
Location:	Lat, Lon: 26.37N, -80.14E	Lat, Lon: 26.091N, -80.38E	Lat, Lon: 28.491N, -81.54E	Lat, Lon: 28.21N, -82.46E
Electric Utility	FPL	FPL	Orlando Utilities Comm	Withlacoochee River Elec Coop
Fixed Charge ($/month)	7.57	7.87	8.00	18.00
Incentives - Federal ITC (%)	30	30	30	30
Incentives - State ITC (%)	-	-	-	-
Nominal LCOE (cents/kWh)	11.7	11.8	11.9	12.6
NPV ($)	(100)	(800)	1,000	(5,300)
Payback period (years)	19.8	22.1	17.0	>25
Incentives - Federal ITC (%)	30	30	30	30
Incentives - State ITC (%)	30	30	30	30
Nominal LCOE (cents/kWh)	7.3	7.4	7.5	7.9
NPV ($)	3,100	2,900	4,700	(1,521)
Payback period (years)	15.0	15.5	11.6	>25
Incentives - Federal ITC (%)	30	30	30	30
Incentives - State ITC (%)	50	50	50	50
Nominal LCOE (cents/kWh)	4.4	4.4	4.5	4.8
NPV ($)	5,600	5,400	7,300	1,000
Payback period (years)	10	10.4	7.6	>25

Source: Own Elaboration from the National Renewable Energy Laboratory's SAM Model (NREL 2019)

Table 12
Saving in US Dollars per year, originated by the installation of 6kW PV System in different locations and utilities

Residence Location	6450 Colomera Dr, Boca Raton, FL 33433	2983 Oakbrook Dr, Weston, FL 33332	3112 Alamo Dr, Orlando FL 34786	17528 Sandgate Court, Land Lakes, FL 34638
Saving PV system ($/yr)				
Y1	820.47	803.07	1,156.98	418.57
Y2	837.05	819.28	1,180.28	426.89
Y3	853.96	835.83	1,204.05	435.38
Y4	871.21	852.71	1,228.30	444.03
Y5	888.82	869.94	1,253.04	452.86
Y6	906.78	887.51	1,278.28	461.86
Y7	925.10	905.44	1,304.03	471.04
Y8	943.80	923.73	1,330.30	480.39
Y9	962.88	942.40	1,357.10	489.94
Y10	982.33	961.44	1,384.44	499.68
Y11	1,002.19	980.87	1,412.34	509.61
Y12	1,022.46	1,000.69	1,440.79	519.74
Y13	1,043.12	1,020.92	1,469.83	530.07
Y14	1,064.22	1,041.55	1,499.45	540.60
Y15	1,085.74	1,062.61	1,529.67	551.35
Y16	1,107.70	1,084.09	1,560.51	562.31
Y17	1,130.10	1,106.01	1,591.96	573.48
Y18	1,152.96	1,128.37	1,624.04	584.88
Y19	1,176.28	1,151.20	1,656.79	596.51
Y20	1,200.08	1,174.48	1,690.19	608.36
Y21	1,224.36	1,198.23	1,724.26	620.46
Y22	1,249.12	1,222.47	1,759.03	632.79
Y23	1,274.41	1,247.19	1,794.50	645.36
Y24	1,300.19	1,272.43	1,830.70	658.19

Y25	1,326.51	1,298.17	1,867.61	671.27

Source: Own Elaboration from the National Renewable Energy Laboratory's SAM Model (NREL 2019)

By running the SAM Model, and because the same size of the Solar PV System, the total installed cost of the calculated system is the same for all four residential samples, or $16,174, it was selected the same project life of 25 years, an inflation rate of 2.5% annual, a mortgage for the 100% of the cost of the system allowing to compare pay back in four different locations, as presented in Table 10, which is the foundation for the results of Tables 11 and 12.

With data from Table 10, applied to four mentioned residential systems, with a 30% Federal Investment Tax Credit and 0% for the State ITC, the SAM calculated the Nominal LCOE, Net Present Value (VPV) and the Payback Period in years for each system as presented in Table 11. Under these parameters the calculated Payback Period is around 17 year to more than 25 years and the Net Present value is from negative $5,300 to $1,000. Table 12 shows for this particular case the saving in US dollars per year, originated by the installation of 6kW PV System in different four locations and three utilities.

By considering a 30% Federal Investment Tax Credit and 30% for the State ITC, the SAM calculated the Payback Period, which is around 11.6 year to more than 25 years, and the Net Present value is from negative $1,521 to $4,700, a mayor reduction for the FPL and the Orlando Utilities Commission utilities.

By considering a 30% Federal Investment Tax Credit and 50% for the State ITC, the SAM calculated the Payback Period, which is around 10 and 7.6 year, and the Net Present value is from negative $7,300 to $1,000 a mayor reduction for the FPL and the Orlando Utilities Commission utilities, and to more than 25 years for the Withlacoochee River Electric Co-op with a positive $1,000 NPV, for this Rural Electric Cooperative.

By using the SAM model for four commercial systems selected to show the impact by the policies of the same three types of utilities of the residential example: FPL, Orlando Utilities Commission, and Withlacoochee River Electric Co-op. The zip codes are the same but the locations are different.

Before using the SAM Model (NREL 2019) to the four sample commercial, it was necessary to determine PV System specifications as presented in Table 13 as the size of the DC System Size to 80 kW to accommodate for the four commercial systems without energy storage, with a DC to AC Size Ratio of the system to 1.2, the Rated Inverter size to 67 kW, the cell material of Crystalline Silicon with an efficiency of 15% with glass module cover, and assuming the same Annual Peak Demand of 274.2 kW and an Annual Total Demand of 809,089 kW for all four systems

Because the same size of the Solar PV System, and by running the SAM Model, the total installed cost of the calculated system is the same for all four commercial samples, or $145,519, it was selected the same project life of 25 years, an inflation rate of 2.5% annual, a mortgage for the 100% of the cost of the system allowing to compare pay back in four different locations, as presented in Table 13, which is the basis for the results of Tables 14 and 15.

Table 13
PV commercial system and Financial Specifications for SAM modeling, without energy storage

PV System Specification	
DC System Size (kW):	80.0
Array Type:	Fixed open rack
Array Tilt (deg):	20
Array Azimuth (deg):	180
System Losses (%)	14.08
Invert Efficiency (%)	96
DC to AC Size Ratio:	1.2
Rated Inverter size (kW)	67
Tota System Losses (%)	14.1
Financial Model	
Total Installed Cost ($)	145,519
Project life (years)	25
Inflation rate (%)	2.5
Real discount rate (%)	6.4
Mortgage (%)	100
Mortgage rate (%)	5
Mortgage term (years)	25
Annual Peak Demand (kW)	274.2
Annual total demand (kWh)	809,089

Source: Own Elaboration from the National Renewable Energy Laboratory's SAM Model (NREL 2019)

With data from Table 14, applied to four mentioned commercial systems, with a 30% Federal Investment Tax Credit and 0% for State ITC, the SAM Model calculated the Nominal LCOE, Net Present Value (VPV) and the Payback Period in years for each system as presented in Table 15. Under these parameters the calculated Payback Period is between 13.7 year to more than 25 years and the Net Present Value (NPV) is from negative $27,000 to $10,600. Table 16 shows for this particular case the saving in US dollars per year, originated by the installation of a 80kW PV System in different four locations and three utilities in the state of Florida.

By considering a 30% Federal Investment Tax Credit and 30% for the State ITC, the SAM calculated the Payback Period, which is between 7.5 year to more than

Table 14
Solar panel payback period based on four commercial examples

Commercial Location	5982 SW 18th St, Boca Raton, FL 33433	4205 Bonaventure Blvd, Weston, FL 33332	6300 Jack Nicklaus Pkwy, Windermere, FL 34786	15602 Pioneer Museum Rd, Dade City, FL 33523
Location:	Lat, Lon: 26.37N, -80.14E	Lat, Lon: 26.091N, -80.38E	Lat, Lon: 28.491N, -81.54E	Lat, Lon: 28.45N, -82.22E
Electric Utility	FPL	FPL	Orlando Utilities Comm	Withlacoochee River Elec Coop
Fixed Charge ($/month)	14.00	25.00	18.00	27.63
Incentives - Federal ITC (%)	30	30	30	30
Incentives - State ITC (%)	-	-	-	-
Nominal LCOE (cents/kWh)	4.9	5.0	5.0	5.0
NPV ($)	14,200	10,600	31,100	(27,000)
Payback period (years)	18.9	20.5	13.7	>25
Incentives - Federal ITC (%)	30	30	30	30
Incentives - State ITC (%)	30	30	30	30
Nominal LCOE (cents/kWh)	2.2	2.2	2.2	2.2
NPV ($)	45,900	42,200	62,800	4,500
Payback period (years)	10.7	11.8	7.5	>25
Incentives - Federal ITC (%)	30	30	30	30
Incentives - State ITC (%)	50	50	50	50
Nominal LCOE (cents/kWh)	0.4	0.4	0.4	0.4
NPV ($)	66,900	63,300	83,900	25,600
Payback period (years)	4.8	5.1	4	>25

Source: Own Elaboration from the National Renewable Energy Laboratory's SAM Model (NREL 2019)

Table 15
Saving in US Dollars per year, originated by the installation of 6kW PV System in different locations and utilities

Commercial Location	5982 SW 18th St, Boca Raton, FL 33433	4205 Bonaventure Blvd, Weston, FL 33332	6300 Jack Nicklaus Pkwy, Windermere, FL 34786	15602 Pioneer Museum Rd, Dade City, FL 33523
Saving PV system | ($/yr)				
Y1	8,427.60	7,968.00	10,393.80	3,504.50
Y2	8,595.10	8,129.90	10,604.80	3,576.90
Y3	8,765.90	8,294.90	10,820.00	3,650.90
Y4	8,940.20	8,463.50	11,039.80	3,726.40
Y5	9,117.80	8,635.40	11,263.90	3,803.40
Y6	9,299.00	8,810.80	11,492.60	3,882.10
Y7	9,483.90	8,989.90	11,726.00	3,962.30
Y8	9,672.30	9,172.50	11,964.10	4,044.30
Y9	9,864.50	9,359.00	12,207.20	4,128.00
Y10	10,060.70	9,549.20	12,455.20	4,213.40
Y11	10,260.50	9,743.30	12,707.20	4,300.60
Y12	10,464.50	9,941.30	12,964.70	4,389.70
Y13	10,672.50	10,143.50	13,226.50	4,480.60
Y14	10,884.60	10,349.70	13,494.10	4,573.30
Y15	11,100.90	10,560.10	13,767.20	4,668.10
Y16	11,321.50	10,775.00	14,046.00	4,764.70
Y17	11,546.60	10,994.10	14,329.00	4,863.50
Y18	11,776.10	11,218.10	14,619.00	4,964.30
Y19	12,010.20	11,445.40	14,914.00	5,067.10
Y20	12,248.80	11,678.00	15,215.00	5,172.20
Y21	12,492.30	11,917.00	15,521.00	5,279.50
Y22	12,740.50	12,159.00	15,835.00	5,388.90
Y23	12,993.80	12,407.00	16,154.00	5,500.70

Y24	13,252.00	12,659.00	16,481.00	5,614.70
Y25	13,515.80	12,916.00	16,813.00	5,731.30

Source: Own Elaboration from the National Renewable Energy Laboratory's SAM Model (NREL 2019

25 years, and the Net Present value is from $4,500 at Withlacoochee River Electric Co-op, a Rural Electric Cooperative, to $62,800 at Orlando Utilities Commission, a Municipal Electric Utility.

By considering a 30% Federal Investment Tax Credit and 50% for the State ITC, the SAM Model calculated the Payback Period between 4 to more than 25 years, and the Net Present value between $25,600 to $83,900 for similar utilities of previous evaluation.

Community solar is expected to grow rapidly in the years to come in the U.S. To take advantage of the opportunities it presents, as well as to confront the challenges associated with it, utilities must define a clear strategy, establish differentiating capabilities and new operating models, and develop a tight network of partners that can help them harness this new source of power. Ultimately, until Florida officially changes its laws to allow for third-party ownership, there will continue to be some level of uncertainty in the market and a small growth of residential and commercial PV Solar systems.

The previous examples are showing that Net Metering and State Investment Tax Credit are critical for incentivizing the adoption of Solar PV, while electric utilities' buying capabilities can create reductions in panel cost as well as installation and permit cost. Nevertheless, electric utilities have to recover their investment cost in generation equipment, which requires some protection from local regulators to ensure energy supply according the customers' demands. This is the balance that the Florida Legislators have a agree for the future of solar PV and other renewables in the state of Florida.

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6. Conclusions

Energy is fundamentally about improving the quality of daily life, and its policies should support it, in addition to a positive impact in job creation, pollution reduction, gas prices, and climate change. This is a goal that many countries have in considerations on the development of new policies and regulations.

By the International Energy Agency (EIA 2017a, EIA 2016a), for the second year in a row, global carbon dioxide (CO_2) emissions have remained high at 32.1 billion tons in 2015, and essentially similar since 2013. Whit this factor in mind, the development of renewable energy has become necessary, and with green gas emission being a major concern to combating global warming, solar and particularly solar PV had been getting special attention.

By IEA-PVPS Trends (2015: 7; 2017: 10-11; 2018: 10-13), the worldwide Solar PV capacity in reached 402 GW in 2017, a 37.2% of total Renewable power capacity, not including hydro, a major growth from almost 105 MW worldwide in 1995.

Germany, Italy, Spain and France in Europe; China, Japan and Australia in Asia; and United States in the Americas lead the adoption of PV generated electricity with a set of regulations as the renewable portfolio standards (RPS), feed-in tariffs, give out incentives, subsidies, and tax exemptions. These nations already count for over 314 GW of Solar PV cumulative capacity, almost 78% of worldwide PV capacity at 2016. It can be concluded that overall regulations in these countries had been useful in allowing a relevant growth in Solar PV with higher results in countries like Germany, Italy and Japan by considering the Solar PV capacity per person. There is a positive impact of these deployment that had generated 3.4 million jobs worldwide (IRENA 2018: 46) in 2017, up 12% from 2015 levels.

From the analysis on this research, energy targets remain one of the major means for policy makers to express their commitment to renewable energy deployment. By 2017, 57 countries had 100% renewable electricity targets and 179 countries with national/state/provincial renewable energy targets (IRENA 2018: 19). In addition, feed-in policies remain relevant in supporting schemes for renewables, and integrating renewable electricity into power systems with 113 states/provinces/countries with feed-in policies.

Now, the United States (U.S.) remains the largest economy in the world, with a 2017´s gross domestic product (GDP, in chained 2009 dollars) of USD 17,096 trillion total (BEA 2018), or USD 52,195 per capita. There are “over three thousand public, private and cooperative utilities, including more than one thousand independent power producers (IPPs), three regional synchronized power grids, eight electricity reliability councils, some one hundred and fifty control area operators, and thousands of separate engineering, economic, environmental, and land-use regulatory authorities" (RAP 2011: 9), which are part of the electricity industry. The electric generation had been almost flat over the past eight years, with a total of 4,038 GWh in 2017 from 4,125 GWh in 2010, which are attributing in part to energy efficiency, including federal and state product efficiency standards, efficiency programs operated by utilities (EIA 2017a) and others. Additionally, a 75% of the USA population is served by Investor Owned Utilities (IOU), which explains the policies protecting investments in major energy generators.

In order to regulate this massive quantity of players, several federal policies had been integrated to the electric energy sector, some of them previously implemented in European countries, the main policies are:

- The Public Utility Regulatory Policy Act (PURPA) passed in 1978 created a market for non-utility energy producers (Grossman and Cole 2003: 116-118, Hunt S. 2002: 429), requiring utilities to buy energy from independent companies that could produce power for less than what it would have cost for the utility to generate the power. PURPA is the only existing federal law that requires competition in the utility industry, or deregulation (Savacool 2008: 151-152, Munson 2005: 105), and the only law that encourages renewables at utility-scale.
- The Energy Policy Act (EPA) of 1992 created as a framework for wholesale electricity generation, energy efficiency on building energy efficiency standards, equipment energy efficiency standards among others (ACEEE 1992). By 2005, both PURPA and EPA enabled 18 states to offer consumers the right to choose their energy provider with some level of retail competition.
- A new version of the EPA was published in 2005, which offered tax benefits to individuals who increase energy efficiency in existing homes, requiring all public utilities to offer net metering on request, tax credits for wind and other alternative energy producers, and mainly encourages more domestic energy production.
- In June 2013 it was announced the Climate Action Plan including standards for both new and existing power plants. On August 2015, the Clean Power Plan was announced by EPA, which normalized the existing fleet of fossil-fired power plants, intends to cut emissions to 32% (relative to 2005 levels) by 2030 through assigning each state a target emissions level (in tons of carbon) or emissions rate (in tons per MWh).
- In April 2016, the Senate passed the Energy Policy Modernization Act, which introduced provisions to promote renewable energy, improve the energy efficiency of buildings, and cut planet-warming greenhouse gas pollution, which had been in hold by current President of the U.S.

The impact of the previous policies and regulations since 2002 and at June 2016 in the U.S. market (DSIRE 2016) has been the implementation of 22 federal policies, 19 of them Financial Incentives as the Production Tax Credit (PTC) and the Investment Tax Credit (ITC), three Regulatory Policies as the Green Power Purchasing Goal for Federal Government and the Interconnection Standards for Small Generators. In addition, 29 states and Washington D.C had passed Renewable Portfolio Standard (RPS) programs, 6 states and Washington D.C had passed Feed-In Tariff (FIT), 44 states had passed Net Metering (NM) among the most relevant, which had impacted the adoption the renewable energy sources.

As a result of the implementation of federal and state policies and incentives, today's energy generation mix in the United States is radically different from 2005. In fact, from a total 4,087,381 GWh in 2005 the distribution was: 49,5% generated by coal, 18.8% by natural gas, 19.3% nuclear, 2.1% renewable sources excluding hydroelectric and solar, 6.5% hydroelectric and 0% by solar (EIA 2005). In contrast in 2017: 29.9% was generated by coal, 31.5% by natural gas, 19.9% nuclear, 8.3% renewable sources excluding hydroelectric and solar (mainly wind), 7.4% hydroelectric and 1.9% by solar (EIA 2017a) of a total of 4,014,804 GWh in that year.

Analyzing the renewable energy growth by states (EIA 2005, 2017), between 2005-2017, the states of California, Texas, Iowa, Oklahoma, Minnesota, Illinois, Kansas, Washington, Oregon and Colorado have led the renewable net generation from renewable sources (excluding hydroelectric) market, a combined 62% share of 2015 nationwide net generation, to 65% share in 2017. California and Texas are the states with the highest net generation for last 12 consecutive years, reaching together a combined 93,657 GWh in 2015, and 135,365 GWh in 2017, from 22,102 GWh in 2005.

Now, by data published by EIA regarding net solar PV generation from utilities and distributed generation for the period ending 2017, reveals an incredible gap in net generation of energy from solar sources between the state of California, and the rest of states. In 2017 California generated 31,370 GWh a 42% share of all states combined, followed by the state of Arizona with 5,774 GWh an 8% share, very similar than North Carolina. The state of Florida generated 1,142 GWh in same year, a major difference for the "Sunny State" that rank number 3 by the Rooftop PV Technical Potential but lack the implementation.

Florida is the third most populated state in the U.S. with 20,61 million people at July 2016 or 6.4% of the U.S. population (BEA 2016), and $818 billion GDP the 4rd bigger in the nation, behind California, Texas and New York. Florida's net electric generation had increased 8.8% from 2004 to 2015, reaching 237,338 MWh in 2015 from 218,118 MWh in 2004 (EIA 2017a), meaning that the state of Florida´s energy generation in 2015 was close to Australia´s levels. The distribution by source of 2015´s generation was: 15.8% by coal, 0.6% by petroleum, 67.7% by natural gas, 12.3% nuclear, 2.4% renewable sources excluding hydroelectric, and 1.3% by other sources.

The Florida´s electric energy market is divided in 33 Municipal Electric Utilities, 16 Rural Electric Cooperatives, and 5 Investor-owned utilities serving over 10.5 million customers at 2016, and the entities in charge of regulating and applying regulation are: the Florida State Senate by the Committee on Communications, Energy, and Public Utilities, the Florida Department of Agriculture and Consumer Services by the Office of Energy, the Florida Public Service Commission (FPSC), the Federal Energy Regulatory Commission (FERC), and the Florida Solar Energy Center.

At end of January 2018, the State of Florida had 104 regulatory policies and financial incentives to promote renewable energy generation excluding hydroelectric, divided in 28 Federal and 76 State programs. These 76 state programs are divided in 21 Regulatory Policies and 55 Financial Incentives. The state of Florida does not have Renewable Portfolio Standard (RPS) nor Third Party Ownership (TPO), two of the critical policies to require utility companies to source a certain amount of the energy they generate or sell from renewable sources and interconnecting generating systems to the grid.

The Section 366.91 of Florida Legislature Statutes requires each utility to develop their own standardized interconnection agreement and net metering program for customer-owned renewable generation (DSIRE 2018), which only apply to state's investor-owned utilities. The Florida Public Service Commission (PSC) approved interconnection rules for renewable energy systems up to two megawatts (MW) capacity in March 2008, the rules do not apply to electric cooperatives or municipal utilities. The Property Assessed Clean Energy (PACE) is a financial incentive implemented in the USA and the State of Florida for financing renewable energy and energy efficiency improvements on residential and commercial properties, which had limited adoption because offers same interest rates compared than commercial loans.

The Florida energy is a regulated market where utilities own and manage the power plants that generate electricity, the electricity transmission lines, and the distribution equipment (FPSC 2017c). Concurring to the latest FPSC Statistics (FPSC 2017d: 10, 40, 41; FPSC 2014: 9-13), the Total Installed Capacity in 2016 was 54,139 MW, almost flat from previous years with a total generation of 234,119 Gigawatt-hours, and 10.5 million customers. The 87.7% of customers, are residential that consumed 52.3% of the total energy generated, while 10.8% are commercial customers that consumed 36.1% of the total energy generated and 0.3% are industrial customers with 8.8% of the total energy in the same year.

The main document that established basic law is the Constitution of the State of Florida, which can be modified by public amendments. The last amendment in the renewable energy sector is the Florida Solar Energy Subsidies and Personal Solar Use, Amendment 1 of 2016, which in summary was designed, with the support of IOUs, to put the right to produce solar energy into the state constitution with some caveats. This amendment was intended to allow state and local governments to prevent people who do not choose to produce solar energy from being required to subsidize the production of solar energy and as a constitutionally protection against any law requiring residents to subsidize solar energy. This last component generated an important debate in the State (AEE 2017), because it would limit non-utility solar options by preserving the status quo and providing the electric utilities with leverage to continue to control their customers. This amendment would have opened the way for penalties or fees on solar energy owners. This amendment was not approved by Floridian citizens and generated a change in the state on the role of electric utilities on renewable generation.

It is relevant to understand that the Constitution of the State of Florida essentially prohibits third-party providers from placing rooftop PV panels on homes and businesses and selling electricity from solar panels to homeowners or business owner (Holt and Galligan 2017, Wiseman Hannah, personal interview, January 8, 2018). This was litigated in Court by the PW Ventures Inc. Case, that recognized by the State´s Constitution that electric utilities are the only entities to sell electrical energy.

Nevertheless, the prohibition does not extend to leasing generating equipment because leases do not involve the sale of electricity, the FPSC on march 2018 confirmed that Sunrun Inc., can offer residential solar equipment leases in Florida (FPSC 2018a), in a 20 to 25 years solar equipment lease with customers´ fixed payments independent of electric production for personal use and also benefiting from interconnection and net metering to their local utility.

The largest IOU in the state is the Florida Power & Light Company (FPL) that served 4.8 million customers, generating over 109,662 GWh by 2016. From the renewable energy generation, Florida´s utilities are on a path to 4.5 GW of solar by 2021. FPL would add 2.1 GW of solar by 2023, Tampa Electric Company (TECO) and Duke Energy Florida LLC (DEF) would add 600 MW and 700 MW, respectively by 2021, and Jacksonville Electric Authority (JEA) announced a plan for installing 250 MW by 2020. This is the result of the failure to approve Amendment 1 of 2016 by Floridians, increasing the implementation of solar PV systems in this state, nevertheless it is not enough to reach the levels that California and North Carolina would have by 2021.

As presented in Chapter 5, there are some circumstances that are forcing the adoption of utility-scale plants in the state of Florida that are subject to the protection that actual laws provide to electrical utilities investments, as well as the regulatory policies and financial incentives to promote renewable energy generation and the growth of solar PV:

- Competitive cost of solar PV. The financial opportunity for generating a kWh at lower cost (LCOE) with solar PV than other technologies is forcing electric utilities to evaluate other alternatives and all IOUs have announced invest in future expansions or replacing current generators that can provide better EBITDAs with lower CAPEX.

- Closure of coal and oil plants, the coal generation has been decreasing since 2008 in both relative shares and absolute quantities, especially because the continued aging of the coal fleet. In fact, several electric utilities had reduced their coal generation in the U.S. by almost 777,900 MWh from 2008 to 2017, an average 78 MWh per year. The simulation presented in Section 5.1.3 – Energy demand Curve, and Figure 5.6, by the variation on Fuel Capacity by Simulation of 7,000 GW per year Reduction in Coal Electric Capacity by Fuel in U.S., between 2017-2050 by sector shows that Utility Solar PV would have the faster adoption of all other source of energy, which would be positive for the higher penetration of Solar PV.
- Demand curve and storage, the daily energy load shapes are influenced by the energy load at the residential sector, in fact Florida is typically a summer-peaking state. This means that making the planning of conventional generation an issue to consider, that would impact the financial results of electrical utilities.
- Pressure of the population for policies that allows net metering and interconnection rules for non-utility systems, which was explained in Chapter 4 as a result of Amendment 1 of November 2016.

The development of both at residential and commercial distributed solar. As mentioned before, Florida ranks number 3 by the Rooftop PV Technical Potential by NREL but rank 14 by the Estimated Distributed PV Installed Capacity. While there are some federal policies that can influence distributed solar, the real power lies with the states. The Florida state has significant barriers in place to distributed solar development based on the presence, or absence, and strength of key distributed solar policies as Mandatory RPS, Third Party Ownership and strong Mandatory Net Metering

Under current regulatory and financial factors, and based on the analysis of this research, it has been identified some regulatory changes that would positively impact the promotion of renewable energy for both utility-scale solar and distributed solar in Florida, allowing the "Sunny State" to expand substantially the implementation of Solar PV, these are:

- Create mandatory targets by enacting strong RPS with a distributed solar carve-out and renewable energy credits. As presented in Chapter 4 and 5, these policies can play an integral role in state efforts to diversify their energy mix, promote economic development and reduce emissions. The simulation presented in Section 5.1.4 – Implementation of Renewable Portfolio Standard, and Figure 5.6, by the variation on Federal Renewable Portfolio Standard by Simulation of 30% RPS from 2020 to 2030 and 50%

from 2030 to 2050 in U.S., 2018-2050 by fuel, shows that by this implementation it would be an increase over 140% between 2031 to 2035 in adopting Utility Solar PV capacity, with a peak between 2030 to 2035.

- Remove the system size limit for net metering, in the state of Florida there is cap up to 115 percent of residential customer´s current energy need, and of up to 2 megawatts (MW) of capacity, which disincentive the use of available areas for installing solar PV systems.
- Allow for co-op and municipal utilities to participate in net metering, because current legislation leave 25.2% of customers that are not serve by IOUs without renewable energy´s net metering.
- Allow for third-party PPAs and leasing to improve accessibility of distributed solar resources. Florida regulators have ruled that Sunrun's 20-year solar equipment lease in Florida is not a retail sale of electricity, and this regulation would be extended to other companies that can promote the use of solar PV or other renewable energy systems. This is an extraordinary option for new players to
- Strengthen interconnection standards to ensuring the safety and reliability of the electric grid, with affordable and efficient consumer access to renewable energy between electrical utilities, community solar and residential or commercial customers
- Allow community solar between residential, commercial and utility customers. As presented in Chapters 4 and 5, Florida utilities are advancing shared/community solar programs that should expand access for customers interested in solar, which should be supported with appropriate laws.
- Create solar access laws to protect individual home and business owners' rights to install solar panels on their property
- Expansion of PACE financing and other financial tools to low income families to allow the installation of solar PV.
- Allow to increase value of houses based on the installation of a solar PV system, or the installation of plug-and-play solar systems. The average American moves more than 11 times over their lifetime, and more than a third of Americans rent a housing, which makes a 25-year investment in a rooftop solar system challenging. This is the case of the author of this research.
- Higher I Federal Investment Tax Credit and State ITC, the simulation presented in Section 5.3, Table 11 shows that by applying a 30% Federal Investment Tax Credit and 30% for the State ITC, the SAM model calculated for four residence in the state of Florida, the Payback Period around 11.6 and for a 30% Federal Investment Tax Credit and 30% for the State ITC a

payback 10 and 7.6 year, both lower than no State ITC. Similar simulation is presented in Table 13 for four commercial systems also present lower payback periods with similar ITCs ranges, in line with the residential simulation.

From this research´s data, Florida has long lagged when it comes to tapping into the abundant solar rays. It is time that regulators and electrical utilities recognize solar power as a vital component of a diverse energy future. As Solar PV has become a mainstream energy resource, there must be a recognition that this source as just any other generating asset. At 2018 the percentage of State's Electricity from Solar was 1.2% (FLSEIA 2019) as presented in Chapter 3, this research is looking to motivate the different parties to increase that percentage to the 10%s or 20%s by 2030. In any case, The California passed the Senate Bill 100 (CL 2019) to meet 50 percent of its energy needs with clean power by 2025 and 60 percent by 2030 before ramping up to 100 percent by 2045, a goal that I hope the Florida Legislature would take in consideration.

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8. Annex of Documentary and Statistical Information

A. Florida Energy Efficiency and Conservation Act
B. Florida Energy and Climate Protection Act
C. Florida Energy Law published in Chapter 2012-7117
D. Constitution of the State of Florida
E. Simulation on Fuel Capacity by Simulation of 7,000 GW per year Reduction in Coal Electric Capacity by Fuel in U.S., 2017-2050 by sector
F. Simulation on Renewable Portfolio Standard by Simulation of 30% RPS from 2020 to 2030 and 50% from 2030 to 2050 in U.S., 2018-2050 by source
G. Simulation on Soft Cost in Solar PV by Simulation of 50% cost reduction from 2020 to 2050 in U.S., 2018-2050 by source
H. Simulation on Solar PV installation by Simulation multiple scenarios: 7,000 GW per year Reduction in Coal Electric Capacity, 50% soft cost reductions, and 50% RPS from 2020 to 2050 in U.S., 2018-2050 by source

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