

**KEY LARGO WASTEWATER TREATMENT DISTRICT
BOARD OF COMMISSIONERS
COMMISSION MEETING AGENDA**



June 17, 2014 4:00 PM
98880 Overseas Hwy
Key Largo, FL 33037

**Steve Gibbs
Andrew Tobin
Robert Majeska
Norm Higgins
David Asdourian**

**Chair
Vice Chair
Secretary-Treasurer
Commissioner
Commissioner**

.....
**Margaret Blank
Ray Giglio
Carol Walker**

**General Manager
General Counsel
District Clerk**

PLEASE TAKE NOTICE AND BE ADVISED, that if any interested person desires to appeal any decision of the KLWTD Board, with respect to any matter considered at this meeting, such interested person will need a record of the proceedings, and for such purpose, may need to ensure that a verbatim record of the proceedings is made, which record includes the testimony and evidence upon which the appeal is to be based. Persons with disabilities requiring accommodations in order to participate in the meeting should contact the District Clerk at 305 451-4019 at least 48 hours in advance to request accommodations.

- A. CALL TO ORDER - PLEASE MUTE CELL PHONES**
- B. PLEDGE OF ALLEGIANCE**
- C. ROLL CALL**
- D. APPROVAL OF AGENDA WITH ANY ADDITIONS, DELETIONS, OR CONTINUANCES**
- E. PUBLIC COMMENT**
- F. BULK ITEMS**

- G. COMMISSIONER'S ITEMS**
- H. CUSTOMER SERVICE**
- I. ENGINEERING REPORT** **TAB 1**
 - 1. Solar Power at WWTP Action
- J. OPERATIONS REPORT**
- K. FINANCIAL REPORT** **TAB 2**
 - 2. Fiscal Year 2013 Comprehensive Annual Financial Report (CAFR)
- L. LEGAL COUNSEL REPORT**
- M. GENERAL MANAGER'S REPORT**
- N. COMMISSIONER'S ROUNDTABLE**
- O. ADJOURNMENT**

MISSION STATEMENT:

"The Mission of the Key Largo Wastewater Treatment District is to preserve and protect the delicate ecosystem of the Florida Keys while providing exceptional customer service."

TAB 1

KEY LARGO WASTEWATER TREATMENT DISTRICT
Agenda Request Form

Meeting Date: June 17, 2014

Agenda Item No. 1

- | | |
|--|---|
| <input type="checkbox"/> PUBLIC HEARING | <input type="checkbox"/> RESOLUTION |
| <input type="checkbox"/> DISCUSSION | <input type="checkbox"/> BID/RFP AWARD |
| <input checked="" type="checkbox"/> GENERAL APPROVAL OF ITEM | <input type="checkbox"/> CONSENT AGENDA |
| <input type="checkbox"/> Other: | |

SUBJECT: Solar Power at WWTP

RECOMMENDED MOTION/ACTION: Authorize production of an RFP

Approved by General Manager *for Margaret Bluff*
Date: 6/12/2014 *[Signature]*

Originating Department: Engineering	Costs: Estimated \$575,000 Funding Source: Mayfield Grant	Attachments:
Department Review: <input type="checkbox"/> District Counsel <input checked="" type="checkbox"/> General Manager <i>[Signature]</i> <input type="checkbox"/> Finance	<input type="checkbox"/> Engineering _____ <input type="checkbox"/> Clerk _____	Advertised: Date: _____ Paper: _____ <input checked="" type="checkbox"/> Not Required
	All parties that have an interest in this agenda item must be notified of meeting date and time. The following box must be filled out to be on agenda.	Yes I have notified everyone _____ or Not applicable in this case _____: Please initial one.

Summary Explanation/Background: Additional information regarding the benefits of solar power are provided along with a memo from Weiler Engineering. This topic has been discussed previously and is being brought back with a recommendation that the District publish a Request for Proposals. Once completed, the RFP will be brought back to the Board for approval to publish. After responses are received, staff will review the proposals and bring them to the Board for discussion and possible action.

Resulting Board Action:

- Approved Tabled Disapproved Recommendation Revised



MEMORANDUM

To: KLWTD Board
From: Serge Mashtakov, PE
Date: 06 June, 2014
Re: KLWTD, Solar Power (Photo Voltaic) Array, Additional Information

As requested by the Board, the following additional information is provided for review. Based on the available information we are recommending to proceed with producing the Request for Proposals (RFP) in which the technical and organizational specifics will be outlined. The recommendation is to incorporate in RFP selections criteria various factors of interest including: Total Coast, Panel Efficiency, Manufacturer Warranty, Installation Warranty, Manufacturer Experience and references, Installation Contractor Experience and references, experience and references in South Florida, Service and Maintenance availability and other factors. Each evaluation factor will be assigned a weighted score so that the low bid is not necessarily the winning bid.

The RFP will be presented to the Board for review and approval. The result of RFP process will produce contractually binding proposals from multiple licensed contractors. Based on the review of the proposal by the staff and a staff recommendation of award, the Board will be able to choose the most suitable option.

As part of the RFP, the proposer will be required to design all support systems for 200 mph wind velocities and coastal exposure D. All frames and foundations will be specified utilizing low maintenance materials and techniques including heavy hot dip galvanized steel frames, stainless steel hardware, low corrosion reinforcement etc. Such approach will help to reduce O&M costs in the future and improve cost benefits of the system.

Additional Information:

1. Solar Systems Manufacturers.

List of Photovoltaic Manufacturing and developing companies active in the US market:

- Advanced Energy Systems
- Alpha Solarco
- ASE Americas
- AstroPower/GE Energy
- Boeing Aerospace

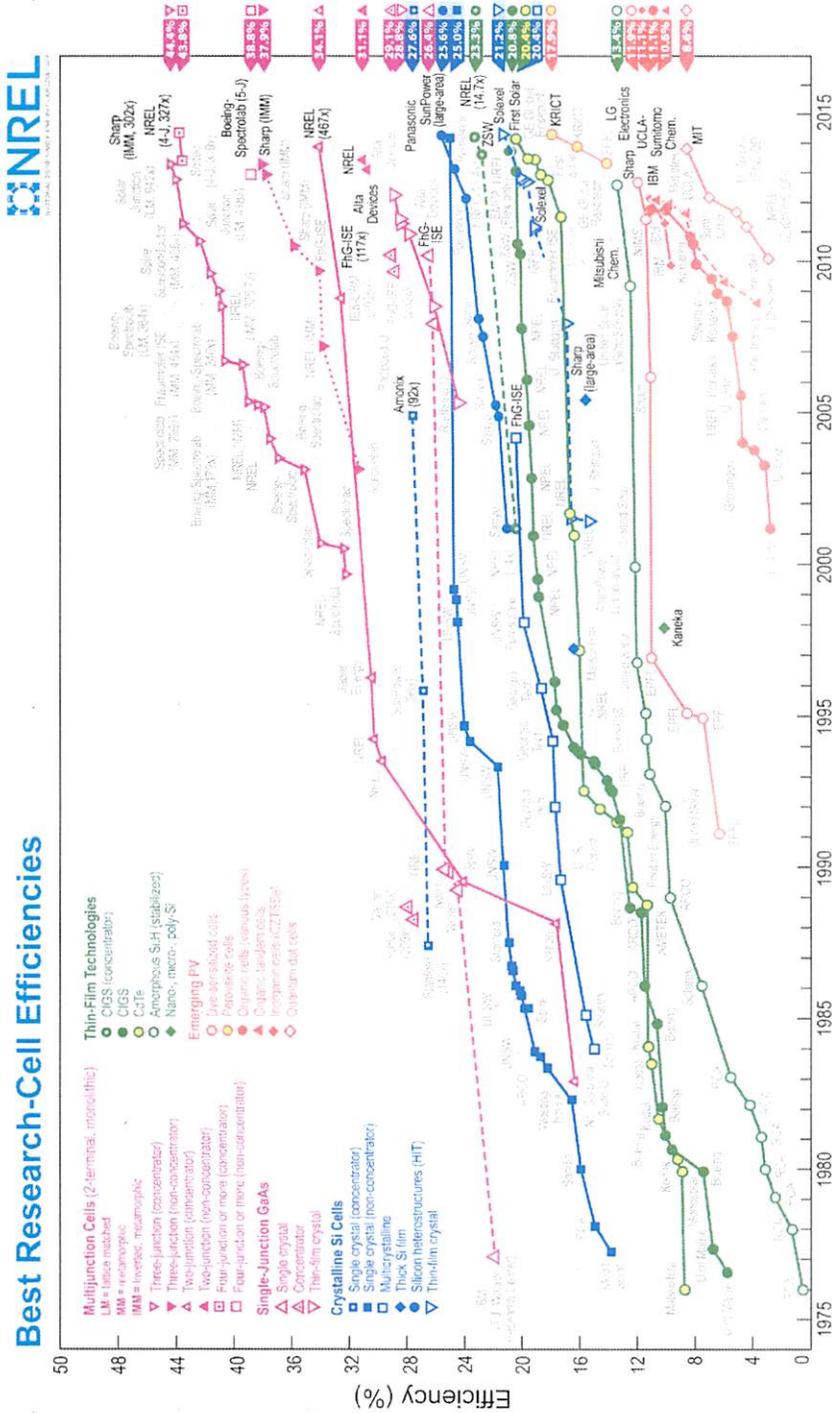
- BP Solar
- Cronar
- Crystal Systems
- Dow Corning
- Energy Conversion Devices
- Energy Photovoltaics
- ENTECH
- Evergreen Solar
- First Solar
- Glasstech Solar
- Global Photovoltaic Specialists
- Global Solar Energy
- Golden Photon
- Iowa Thin Film Technologies
- ITN Energy Systems
- Kopin
- MAGE
- Mobil Solar Energy
- Omnion Power Engineering
- Photon Energy
- Photovoltaics International
- PowerLight
- RWE Schott Solar/Schott Solar
- Shell Solar Industries
- Siemens Solar Industries
- Sinton Consulting
- Solar Cells
- Solar Design Associates
- Solar Electric Specialties
- Solar Engineering Application
- Solar Kinetics
- Solarex
- SolarWorld
- Spectrolab
- Specialized Technology Resources
- Spire
- Springborn Laboratories
- SunPower
- Texas Instruments
- Trace Engineering Company

- Utility Power Group
- Westinghouse Electric
- Xantrex Technology

The above listed manufacturers produce or develop crystalline silicon, thin-film, and concentrator solar technologies of a different scale and stage of development. More companies may be available on the market. (Source: National Renewable Energy Laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy.)

There are hundreds of Certified Solar Contractors in Florida. The practice is regulated by the Florida Department of Business and Professional Regulation just as any other construction trade.

2. Photovoltaic Cell Efficiencies



PUNTA GORDA OFFICE: 201 WEST MARION AVENUE - SUITE 1306 | PUNTA GORDA | FL 33950 | TEL 941-505-1700 | FAX 941-505-1702
 MARATHON OFFICE: 6805 OVERSEAS HIGHWAY | MARATHON | FL 33050 | TEL 305-289-4161 | FAX 305-289-4162
 KEY WEST OFFICE: 6630 FRONT STREET | KEY WEST | FL 33040 | TEL 305-289-4161 | FAX 305-289-4162
 WE INVITE YOU TO VISIT OUR WEB SITE AT WWW.WEILERENGINEERING.ORG OR EMAIL US AT INFO@WEILERENGINEERING.ORG

The chart available from NREL demonstrates updated efficiency characteristics for different photovoltaic technologies and sub-technologies. For our application of on-land non-concentrator solar power, the most suitable technology is a Crystalline Silicon Cells (color coded BLUE). Other technologies are either not practical or not available for industrial use at this time.

The SunPower cells, used in our preliminary assessment of the viability of solar power, are topping the efficiency list according to this graph. These more efficient cells not only produce more electricity at the same sun light conditions (approximately +23%) but also extend the time when the electricity can be produced during the low light conditions (morning, evening, overcast) which adds another up to +8% of efficiency. Overall, the Crystalline Silicon Cell efficiencies can be as much as 30% greater than the lower efficiency cells. Due to the limited amount of space available and practically no expansion potential for the District, it is recommended to specify Photovoltaic Cell arrays with higher efficiencies in the RFP document.

3. PV Cell Arrays O&M

Since PV Cells don't have any moving parts and operate in low voltage range, the routine operation and maintenance procedures are very limited. An occasional washing of panel surfaces is needed in certain locations (proximity to dusty process, roads, bird nesting etc.). Quarterly or biannual inspections of electrical connections and attachments of the panels to supporting frames is a good practice.

The Real-Time monitoring systems are available from different manufacturers. Such systems allow the owner to monitor if any deviations in array efficiency have occurred indicating that maintenance is required. The output information of the monitoring system can be made available to the public (on the District's web site) and can be monitored by the District. The following link provides an example of such a system installed in Stock Island Marina Village:

<https://www.sunpowermonitor.com/residential/kiosk.aspx?id=61063944-bdd8-48db-bd5f-cfbe236bb990>

That array represents an example of higher efficiency panels used in Monroe County. The same panels are used by FPL in their large scale solar plants in DeSoto County and Kennedy Space Center (see attached case study and articles).

Proposed Arrays for KLWTD will be relatively small and simple to maintain. Solar panels are normally sectioned in strings of 10-12 panels and in the case of poor performance or failure of single a single panel the string can be easily isolated and limited number of them can then be inspected for defects or damage. Thermal Imaging equipment is commonly used to inspect and

located defects on the panel surface. Faulty grounding any other current related characteristics can be live monitored from a single location at the control panel or even remotely.

4. Other resources:

FKEC:

Our local Power Utility Solar Arrays information. The link also includes an example of Real-time performance monitoring system. The article states the Array exceeds projected power generation:

<http://www.fkec.com/Green/solararrays.cfm>

FPL is using SunPower panels:

Florida Power and Light (FPL) is extensively using Solar Power as an alternative renewable source of power:

<http://www.fpl.com/environment/solar/projects.shtml>

http://us.sunpower.com/cs/Satellite?blobcol=urldata&blobheadername1=Content-Type&blobheadername2=Content-Disposition&blobheadervalue1=application%2Fpdf&blobheadervalue2=inline%3B+filename%3Dsp_fpl_%2Ben_ltr_cs.pdf&blobkey=id&blobtable=MungoBlobs&blobwhere=1300258513236&ssbinary=true

<http://www.fpl.com/news/2009/52709.shtml>

<http://www.bizjournals.com/southflorida/stories/2009/04/20/daily54.html>

5. List of Attachments:

- 01 - US Department of Energy. Renewable Energy Data Book. Solar
- 02 - Florida Power & Light - using SunPower PV panels - Case Study
- 03 - FPL, NASA celebrate new solar array at Kennedy Space Center
- 04 - Industry Article. "Most Efficient Solar Panels — Which Ones?"
- 05 - National Renewable Energy Laboratory. Learning About Renewable Energy. Solar Photovoltaic Technology Basics
- 06 - National Renewable Energy Laboratory. Photovoltaics Research Performance and Reliability R&D. Photovoltaic Reliability Publications
- 07 - FKEC Solar web page
- 08 - FPL Solar web page

09 - SunPower Monitoring System web page

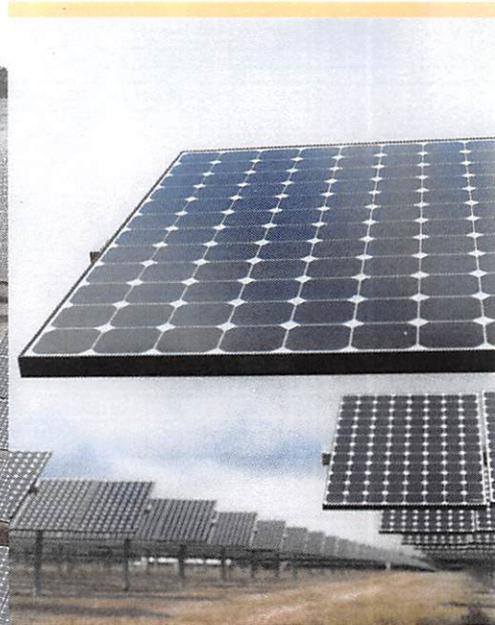
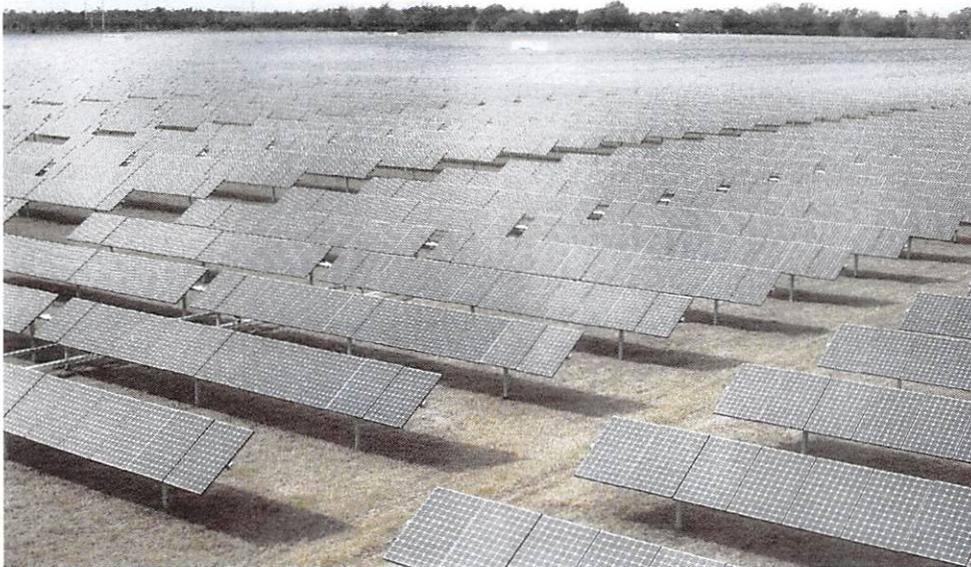
Sincerely,

Serge Mashtakov, P.E.

Attachment 1

Florida Power and Light Solar Array Information

SunPower Builds Country's Biggest Solar PV System for Florida Power & Light, Saving \$22 Million in the Process



In the "Sunshine State," the choice to go solar seems virtually pre-ordained – and SunPower is helping Florida Power & Light fulfill that destiny. The utility has completed construction on America's largest solar photovoltaic power plant in DeSoto County, and a second at NASA's Kennedy Center. SunPower designed and built both facilities, which will produce a total of 35 megawatts of solar energy. With an estimated 360 days of sunlight in Florida annually, FPL's future as a leading producer of clean, renewable energy will be sunny indeed.

BENEFITS

- DeSoto plant was built in less than a year, nearly \$22 million under budget
- Construction process created hundreds of jobs, sourced to local residents
- Utility customers enthusiastically approved, funded solar projects
- Plant will power more than 3,000 homes (20 percent of the county's population)
- Use of solar energy will decrease fossil fuel use by an equivalent of more than 275,000 barrels of oil
- Solar-powered electricity will avoid the release of more than 575,000 tons of greenhouse gas emissions

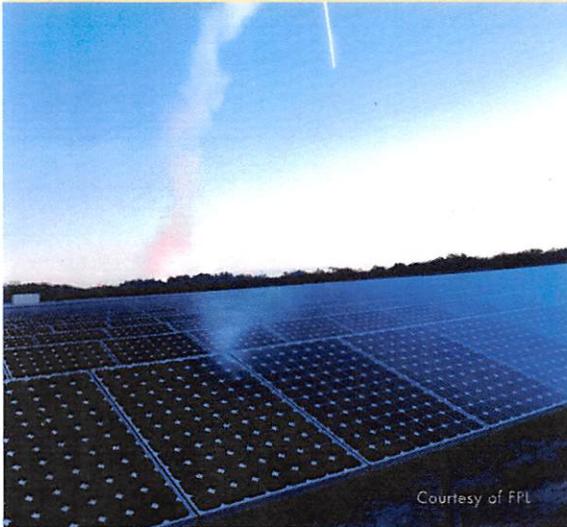
PROJECT OVERVIEW

Location: DeSoto County, Florida
Completed: October 2009
Installation Type: Ground-mount system
System Size: 25 MW
PV Surface Area: 180 acres
Number of Panels: 90,000
Products: SunPower® T0 Tracker

Location: Kennedy Space Center, Brevard County, Florida
Completed: April 2010
Installation Type: Ground-mount system
System Size: 10 MW
PV Surface Area: 60 acres
Number of Panels: 35,000
Products: SunPower® T0 Tracker

"No matter how you look at it, building the biggest solar plant in the country in less than a year – for \$22 million less than we budgeted – is a pretty huge deal."

Kathy Salvador
Manager of Project Development,
Florida Power & Light Company



Courtesy of FPL



20 BY 2020

Aiming to trim Florida's greenhouse gas emissions, in 2007 Florida Governor Charlie Crist announced a mandate for all of his state's utilities to generate at least 20 percent of their power from renewable energy sources by 2020. Fortunately, for nearly three decades the FPL Group – one of the nation's largest providers of electricity-related services – had been exploring innovative energy technologies such as wind and solar power. "We're a national leader in renewables," notes Kathy Salvador, manager of project development at Florida Power & Light (FPL), one of the FPL Group's main subsidiaries. "So going to solar powered-electricity for our 4.4 million customers complements that strategy."

SUNPOWER IS THE OBVIOUS CHOICE

As a state-regulated utility, FPL was required to have appropriate legislation in place to produce solar power. Explains Salvador, "We needed a specific policy that would allow us to recover the costs from our customers." By 2008 Florida lawmakers approved such legislation, authorizing the production of 110 megawatts of solar power statewide. In anticipation of the bill's passage FPL began evaluating solar providers, sending out a Request for Information to approximately 50 vendors, and then asking for bids from a short list of finalists. "Given the efficiency and cost of SunPower solar panels, their experience with utility-scale projects, and the fact that they could commit to delivering within our timeframe, SunPower was the obvious choice," Salvador says.

BENEFITS NOW AND FOR THE FUTURE

SunPower constructed two ground-mounted solar installations for FPL. The first, a 180-acre, 25MW facility now called the DeSoto Next Generation Solar Energy Center, was completed in record time, with a price tag that earned FPL's acclaim. "It took less than a year, we finished ahead of schedule, and we came in \$22 million under budget," Salvador reports (the second, 10MW facility at NASA's Kennedy Space Center, also was online before its targeted completion date). DeSoto County's economy received a significant boost from the project, Salvador adds. "We created 400 construction jobs, and our county – which is a poor one – will receive millions of dollars in taxes, which will help strengthen our infrastructure." In early 2010, legislation was being proposed to expand Florida's solar power production to 700 megawatts over the next three years. "When that passes," Salvador predicts, "we'll be ready."

SunPower Corporation
1-800 SUNPOWER
sunpowercorp.com

Connect with Us:    

May 27, 2009

FPL, NASA celebrate new solar array at Kennedy Space Center

CAPE CANAVERAL, Fla. – At Kennedy Space Center today, Sen. Bill Nelson and Reps. Suzanne Kosmas and Bill Posey joined officials from Florida Power & Light Company and NASA to celebrate the groundbreaking of FPL's Space Coast Next Generation Solar Energy Center.

The new solar photovoltaic power facility is the result of a unique public-private partnership between FPL and NASA and demonstrates both organizations' commitment to bringing clean-energy solutions to the state.

"The Space Coast Next Generation Solar Energy Center is an important part of Florida's clean-energy future. I grew up in Florida, seeing NASA as the home of historic American achievements, so I love the idea of FPL helping to power the space program," said FPL President and CEO Armando J. Olivera. "Like NASA, FPL is looking beyond the horizon. We are building more emissions-free solar power with the quality of life of our children and grandchildren in mind."

"The partnership between NASA and FPL is an excellent one that comes at the right time," said Robert Cabana, director of Kennedy Space Center. "It will help provide clean, renewable power to Florida residents, it will help support America's space program by supplying electricity directly to Kennedy Space Center, and it helps to reduce our reliance on fossil fuels and improves the environment."

The Space Coast Next Generation Solar Energy Center will be located on NASA property at Kennedy Space Center and, when completed, will produce an estimated 10 megawatts of clean, emissions-free power for FPL customers, which is enough energy to serve roughly 1,100 homes.

FPL is also building a separate solar facility of approximately one megawatt that will provide clean power directly to Kennedy Space Center, helping NASA meet its renewable energy goals.

"There's no better time than right now to start using the sun and other clean sources to power America," said Nelson. "And, perhaps, there's no better agency to help lead the way than NASA. Let's hope power companies all over the country take a cue from this partnership."

"Florida is poised to be a leader in America's growing clean energy economy, which naturally includes solar power," said Kosmas. "Bringing new clean energy jobs to our communities is one of my top priorities. This joint effort between NASA and FPL is an example of how we can create jobs while investing in common-sense solutions to the economic, environmental and national security challenges we face today."

"As a member of the Congressional Renewable Energy Caucus, I have a strong commitment to renewable energy and am pleased to see this project going forward right here on the Space Coast," said Posey. "This is an important step in the development of future sources of renewable energy and is one way we can reverse our dependence on foreign oil."

The Space Coast Next Generation Solar Energy Center will reduce carbon dioxide emissions by more than 227,000 tons, which is the equivalent of removing 1,800 cars off the road each year according to the U.S. Environmental Protection Agency. It will also save approximately 122,000 barrels of oil and 2.8 billion cubic feet of natural gas over its lifetime.

Additionally, the solar array will provide about 100 jobs during construction, helping to boost the local economy in Brevard County. FPL expects to complete the project by the middle of next year at the latest.

The facility will feature approximately 35,000 highly efficient solar photovoltaic panels from SunPower, a global leader in commercial-scale solar power technology, across 60 acres at Kennedy Space Center. The panels are 50 percent more powerful than conventional solar panels. Last month, SunPower and FPL Group announced a supply agreement beginning in 2010 through 2012. SunPower has also committed to locating a research and development center in Florida if the state continues its robust solar program.

The Space Coast Next Generation Solar Energy Center is one of three solar facilities that FPL is currently building in the state of Florida, totaling 110 megawatts of clean, renewable energy generation. The Martin Next Generation Solar Energy Center in Indiantown will be the world's first hybrid solar thermal facility to connect to an existing fossil fuel plant. It is the largest of the three at 75 megawatts and is scheduled to be complete in 2010. FPL's contractor on the project, Lauren Construction & Engineers, is currently hiring about 1,000 workers to complete the work.

FPL's DeSoto Next Generation Solar Energy Center, a 25-megawatt solar photovoltaic facility in Arcadia, will be the nation's largest photovoltaic array when it is complete later this year. The project has brought more than 200 construction jobs to DeSoto County.

Find more information about FPL's Next Generation Solar Energy Centers online at www.FPL.com/solar.

Florida Power & Light Company

Florida Power & Light Company (FPL) is the largest electric utility in Florida and one of the largest rate-regulated utilities in the United States. FPL serves 4.5 million customer accounts in Florida and is a leading employer in the state with nearly 11,000 employees. The company consistently outperforms national averages for service reliability while customer bills are well below the national average. A clean energy leader, FPL has one of the lowest emissions profiles and the No. 1 energy efficiency program among utilities nationwide. FPL is a subsidiary of Juno Beach, Fla.-based FPL Group (NYSE: FPL). For more information, visit www.FPL.com.

Connect with Us: [f](#) [t](#) [B](#) [YouTube](#)

Solar Energy Centers



At our three solar energy centers throughout Florida, we're making the most of our state's sunshine, turning it into clean energy and using it to power your home or business. By using solar energy and other American-made energy sources, like natural gas, we've been able to **reduce our dependence on foreign oil** by more than 98 percent—the equivalent of 750,000 barrels of oil just from solar energy*. We're also helping to make the air we breathe cleaner because our emissions-free solar plants prevent millions of tons of greenhouse gases. Through the years, we've invested millions to bring you this clean energy as part of our ongoing efforts to explore technologies and find ways to change our energy future for the better.

*Barrels of oil figure represents the equivalent amount needed if electric generation produced by FPL's solar plants since 2009 had been produced using oil.



Watch Videos

[FPL Made in America](#)
[America's Natural Gas Alliance](#)

Martin Next Generation Clean Energy Center

At this first-of-its-kind "hybrid" solar facility in the world, we've teamed up Florida's sunshine with affordable, American-produced natural gas to deliver reliable electricity to you around the clock. When the sun is shining, we use more than 190,000 mirrors over roughly 500 acres to harness Florida's sunshine. The sun's rays heat fluid-filled tubes, producing steam, which generates electricity for your home or business. At night or when it's cloudy, U.S. natural gas steps in to continue producing clean electricity for you as featured in this [video](#) from America's Natural Gas Alliance. The facility opened in 2010 and can produce enough electricity to power about 11,000 homes. It also prevents greenhouse gases from entering the atmosphere every year – the equivalent of removing nearly 13,000 cars from the road.



Space Coast Next Generation Solar Center

This innovative public-private partnership with NASA brings more clean, solar energy to our customers. The solar center leverages the expertise of NASA, the first pioneers of solar power use in space, and FPL's leadership in renewable energy here at home. Located at Kennedy Space Center, it uses PV solar panels to convert light into electricity for you. Since it began serving our customers in 2010, this center feeds about 18,500 MWh of electricity into our state's electric grid each year, or enough for more than 1,100 homes. Like all of our solar energy centers, it helps us reduce foreign oil use and prevent the emission of about 13,000 metric tons of greenhouse gases each year, which is like removing 2,700 cars from the road.



DeSoto Next Generation Solar Energy Center

At Florida's first-ever solar energy center, 90,500 solar panels move into position to catch the sun's rays. The largest of its kind in the nation when it opened in 2009, this facility continues to serve customers using photovoltaic, or "PV," technology – a process for converting sunshine directly into electricity for our customers. It works for you during the day, when the sun is not hiding behind clouds, producing about 52,000

MWh of electricity annually. That's enough to power about 3,000 homes. The emissions-free center is estimated to help us eliminate nearly 37,000 metric tons of greenhouse gases each year and thousands of barrels of oil, making it a clean and energy independent way to bring you electricity.

[A NextEra Energy Company](#) | [Investors](#) | [Terms](#) | [Privacy Policy](#) | [Safety Policy](#) | [FPL Blog](#) | [Newsletter](#) | [RSS](#) | [FPL Advertising](#) | [Email Updates](#) | [Social Media Mashup](#)

Copyright ©1996 - 2014, Florida Power & Light Company. All rights reserved.

FPL.com is optimized for the following browsers: IE 8.0 and higher, Firefox 5.0 and higher and Chrome 12.0 and higher.



Attachment 2

General Solar Power Information and Efficiencies

National Renewable Energy Laboratory Learning About Renewable Energy

Solar Photovoltaic Technology Basics

Solar cells, also called photovoltaic (PV) cells by scientists, convert sunlight directly into electricity. PV gets its name from the process of converting light (photons) to electricity (voltage), which is called the *PV effect*. The PV effect was discovered in 1954, when scientists at Bell Telephone discovered that silicon (an element found in sand) created an electric charge when exposed to sunlight. Soon solar cells were being used to power space satellites and smaller items like calculators and watches. Today, thousands of people power their homes and businesses with individual solar PV systems. Utility companies are also using PV technology for large power stations.

Solar panels used to power homes and businesses are typically made from solar cells combined into modules that hold about 40 cells. A typical home will use about 10 to 20 solar panels to power the home. The panels are mounted at a fixed angle facing south, or they can be mounted on a tracking device that follows the sun, allowing them to capture the most sunlight. Many solar panels combined together to create one system is called a solar array. For large electric utility or industrial applications, hundreds of solar arrays are interconnected to form a large utility-scale PV system.

Traditional solar cells are made from silicon, are usually flat-plate, and generally are the most efficient. Second-generation solar cells are called thin-film solar cells because they are made from amorphous silicon or nonsilicon materials such as cadmium telluride. Thin film solar cells use layers of semiconductor materials only a few micrometers thick. Because of their flexibility, thin film solar cells can double as rooftop shingles and tiles, building facades, or the glazing for skylights.

Third-generation solar cells are being made from variety of new materials besides silicon, including solar inks using conventional printing press technologies, solar dyes, and conductive plastics. Some new solar cells use plastic lenses or mirrors to concentrate sunlight onto a very small piece of high efficiency PV material. The PV material is more expensive, but because so little is needed, these systems are becoming cost effective for use by utilities and industry. However, because the lenses must be pointed at the sun, the use of concentrating collectors is limited to the sunniest parts of the country.

More Information

- [PV for Electricity Providers](#)
- [PV for Farmers and Ranchers](#)
- [PV for Homeowners](#)
- [PV for Small Business Owners](#)
- [PV for Students](#)

PV Research at NREL

- [PV Research](#)
- [PV Testing and Analysis](#)
- [National Center for Photovoltaics](#)

This video provides an overview of NREL's research in solar photovoltaic technology.

[Text Version](#)



A large silicon solar array installed on the roof of a commercial building.



Thin-film solar tiles installed on the roof of a home in Ohio.



A large solar array in Germany.

Did you find what you needed?

Most Efficient Solar Panels — Which Ones?

One of the most common things people ask when they start to consider going solar or start to plan their life-changing solar expedition is which are the most efficient solar panels. However, first of all, that's not even the right question for most people, and second of all, the literal answer to that question really isn't relevant for the average consumer. Let me explain....

First of all, the important matter is not which solar panels are most efficient, but which solar panels are the best value for the money. If you've got space for 10 solar panels on your roof and you have an option between solar panels "ABEfficient" that are a bit more efficient but twice the price of solar panels "CDCheap," chances are, you are going to make a much bigger savings by going with CDCheap. Of course, the important thing would be to see what's available in your situation and simply run the numbers (or, if you are allergic to math, have a friend who can do math run the numbers for you).

But, anyway, if you really want to know which are the most efficient solar panels (or solar cells) out there, I actually happened to be putting together a list of solar records recently and can give you the rundown. But, as I do so, I'll drop in a few key notes making the point above a bit clearer. Before looking at solar panels as a whole, let's have a quick look at the producers of some of the most efficient solar cells (the key component of solar panels) and their efficiency records:

- **44.4% efficient solar cells by Sharp (<http://solarlove.org/sharp-solar-cell-efficiency-record-another-one-44-4/>).** Notably, these world-leading solar cells by Sharp are in the concentrator triple-junction solar cell category. Such solar cells are complicated and are not used in residential or commercial applications... because they are bloody expensive. They are used in space applications by the likes of NASA, where a bit of extra space (or, as it may be, less space via extra efficiency) can make a huge difference.
- **37.9% efficient solar cells by Sharp (<http://solarlove.org/sharp-regains-solar-cell-efficiency-record/>).** Just a step down, these are in the triple-junction, non-concentrator solar cell category. If this is all new to you, it might take you awhile to see the difference in the categories. The difference is that these solar cells don't use anything to concentrate the light hitting the solar cells, while the 44.4% efficiency cells above do use something to concentrate the light (of course, adding to their costs).
- **32.6% solar cells by a Spanish solar research institute (IES) and university (UPM) (<https://upload.wikimedia.org/wikipedia/commons/a/aa/PVeff%28rev130621%29.jpg>).** These are another step down, as they are in the two-junction, concentrator solar cell category. (For an intro on "junctions," by the way, check out [this multi-junction photovoltaic cell article](http://en.wikipedia.org/wiki/Multijunction_photovoltaic_cell) (http://en.wikipedia.org/wiki/Multijunction_photovoltaic_cell) on Wikipedia.) Again, these are still far different solar cells from what are used in commercial or residential installations.
- There are about a dozen or so extra categories that I could run down. Some categories have very high efficiencies but the solar cells are quite expensive, while others are actually on the other end of the spectrum (no pun intended) and are very cheap but have very low efficiency. Of course, some are both inefficient and expensive, but apparently worth researching nonetheless. The key, as I noted earlier, is finding the best balance between cost and efficiency.

Now, there's less research on solar panels than on solar cells because the core of the technology is the solar cell, so that's what researchers at many institutes and universities spend their time on. No one is even going to try to manufacture a solar panel that won't sell because it isn't made of marketable solar cells. Still, there are many different types of solar panels (more accurately known as solar modules) on the market and many, many manufacturers of some of the most common types. So let's look at the leaders in this category.

Why didn't I start with the solar modules? Because then it would be easier to miss the point, which is that **solar panel efficiency is not the metric you use to choose solar panels for you home**. Getting on to the solar modules, here are the most efficient solar modules in a few key categories:

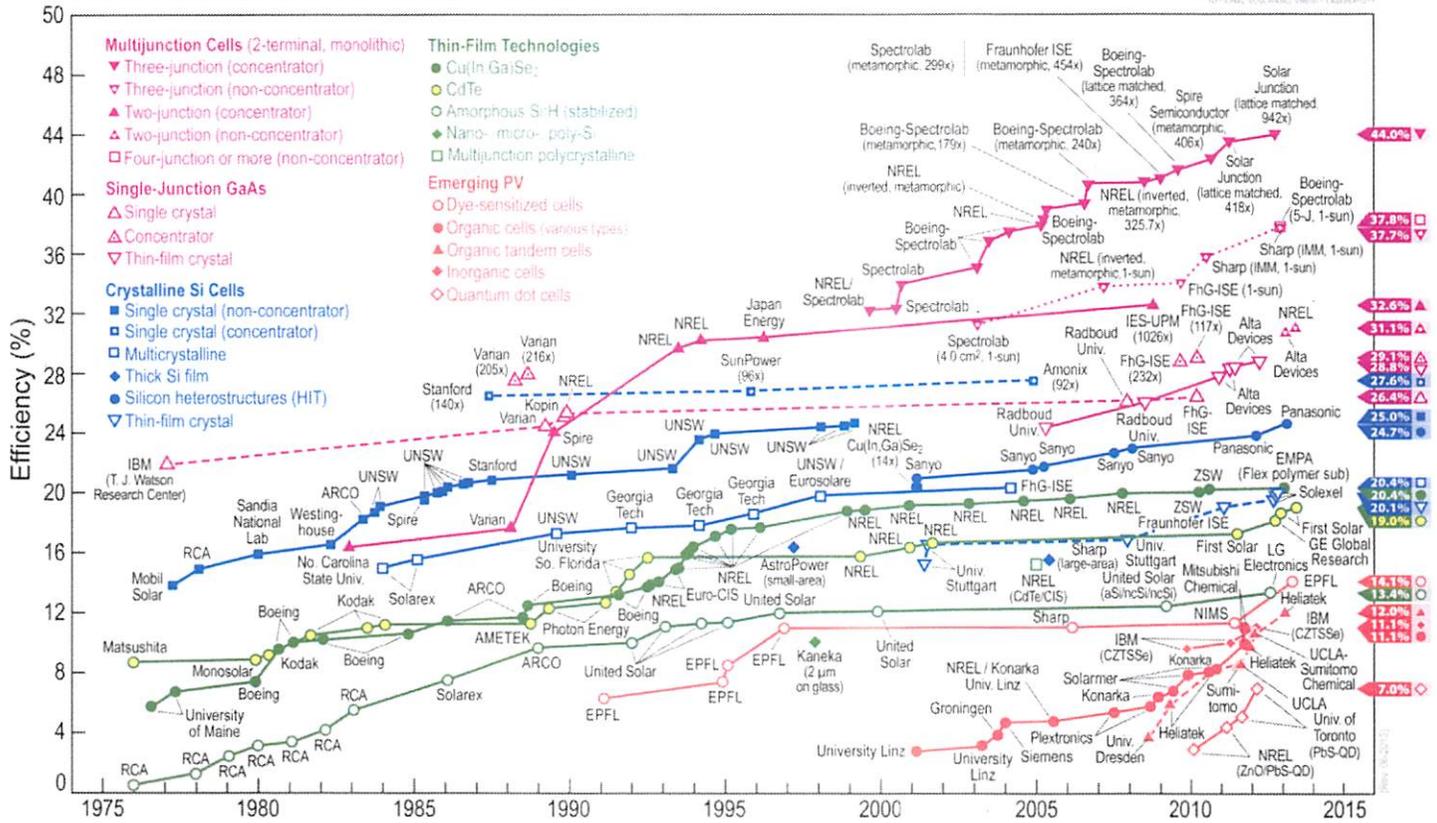
- **36% efficient Amonix solar modules (<http://solarlove.org/amonix-achieves-world-record-for-pv-module-efficiency-in-test-at-nrel/>)** hold the overall solar PV module efficiency record. However, these are made with concentrator solar cells and are not used in residential applications.
- **21.5% SunPower solar modules (<http://solarlove.org/sunpower-launches-commercial-solar-panels-with-world-record-efficiency-x-series/>)** hold the commercial solar module efficiency record. SunPower's SPR-327NE-WHT-D modules (<http://cleantechnica.com/2013/04/08/world-record-x-series-solar-panels-no-for-sale/>) are also the leading solar modules in solar module yield field tests, and other SunPower solar modules come in #2 and #3 in those tests. (For those of you to who this matters or is interesting, SunPower is a US-based solar panel company.)
- **17.4% Q-Cells thin-film solar modules (<http://cleantechnica.com/2011/12/05/new-thin-film-solar-module-efficiency-record-set/>)** hold the record in this specific solar panel category. Thin-film solar panels are widely used, but not in residential applications. (Q-Cells was a German company, but it filed for insolvency in 2012 and was then acquired by the Korean company Hanwha.)
- **16.1% First Solar thin-film solar modules (<http://cleantechnica.com/2013/04/10/first-solar-stock-surges-on-3-big-announcements/>)** claim the cadmium-telluride (CdTe) photovoltaic (PV) module conversion efficiency record. Again, these are generally not used for residential applications, but I think including them helps to reinforce my key point yet again. (First Solar, a US-based company, was actually the #1 solar developer and the #2 solar module manufacturer in the world last year. Despite a relatively low 16.1% record efficiency in this category of solar panels, First Solar does very well with these relatively cheap solar modules in certain applications.)
- Just as one final example in order to show that the variation doesn't stop there, **15.5% solar modules from MiaSolé (<http://cleantechnica.com/2012/05/25/miasol-sets-new-world-record-flexible-pv-module-efficiency/>)** hold the flexible PV solar module efficiency record. Naturally, in some applications, one doesn't just need solar panels, one needs flexible solar panels. But, that probably isn't you....
(<http://cleantechnica.com/2012/05/25/miasol-sets-new-world-record-flexible-pv-module-efficiency/>)

The takeaway point is:

Skip the focus on hypotheticals and irrelevant superlatives. Forget about what the "most efficient solar panels" are. Check on the solar installers in your area (you can get connected to them via [our home page \(http://costofsolar.com/\)](http://costofsolar.com/)). See what they quote you. Ask them what solar panels they would use if you want to know. And compare your options to your heart's content. Don't go trying to find solar panels that were designed for NASA satellites.

By the way, the following chart from NREL (<http://www.nrel.gov/>) isn't fully up to date (solar efficiency records are broken quite frequently), but it gives you a good sense of the large variety of solar technologies:

Best Research-Cell Efficiencies



(http://costofsolar.com/management/uploads/2013/07/Best_Research-Cell_Efficiencies.png)

Join the US solar power rooftop revolution! (<http://costofsolar.com/>)

Share this now!

- Email
(<http://costofsolar.com/most-efficient-solar-panels-which-ones/?share=email>)
- Google +1
(<http://costofsolar.com/most-efficient-solar-panels-which-ones/?share=google-plus-1>)
- Facebook
(<http://costofsolar.com/most-efficient-solar-panels-which-ones/?share=facebook>)
- Twitter
(<http://costofsolar.com/most-efficient-solar-panels-which-ones/?share=twitter>)
- Reddit
(<http://costofsolar.com/most-efficient-solar-panels-which-ones/?share=reddit>)
- StumbleUpon
(<http://costofsolar.com/most-efficient-solar-panels-which-ones/?share=stumbleupon>)
- Pinterest
(<http://costofsolar.com/most-efficient-solar-panels-which-ones/?share=pinterest>)
- LinkedIn
(<http://costofsolar.com/most-efficient-solar-panels-which-ones/?share=linkedin>)
- Tumblr
(<http://costofsolar.com/most-efficient-solar-panels-which-ones/?share=tumblr>)

☛ Solar Panels (<http://costofsolar.com/category/solar-panels/>) © July 1, 2013 ■ no comments

Profile

Attachment 3

Summary of Use of Solar Power

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy

2012 Renewable Energy Data Book





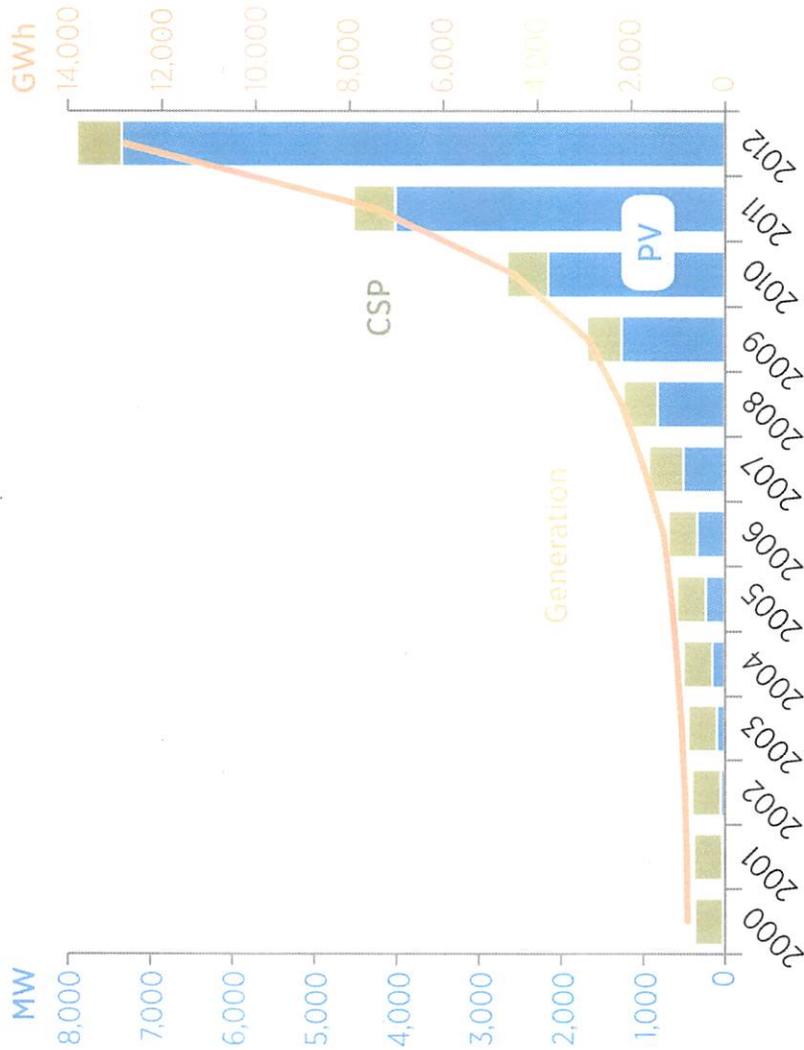
V. Solar

Solar: Summary

- Solar electricity generating capacity **grew by a factor of over 21 between 2000 and 2012** and currently accounts for 0.3% of annual U.S. electricity generation.
- Countries with extensive solar policies—such as Germany, Spain, and Italy—lead the world in solar photovoltaic (PV) deployment. Similarly, **U.S. states with extensive solar incentives lead the United States in both cumulative and annual installations in 2012** (California, Arizona, New Jersey, Nevada, and Colorado).
- U.S. manufacturers currently have a small share of the worldwide PV market. **Asian—particularly Chinese—manufacturers lead the market with nearly 85% of the global photovoltaic module production.**
- 30 MW of new concentrating solar power (CSP) capacity came online in the United States in 2012. **Approximately 1.6 GW of CSP projects are currently under construction** in the United States and are projected to come online in 2013 and 2014; 900 MW are estimated to come online in 2013 alone.

U.S. Total Installed Solar Electricity Capacity and Generation

	U.S. Solar Energy Generation (GWh)		U.S. Solar Energy Capacity (MW) and % Increase from Previous Year		
	U.S. Solar Energy Generation (GWh)	PV*	CSP	Total	Increase
2000	804	18	354	372	4.3%
2001	822	29	354	383	3.0%
2002	857	52	354	406	5.9%
2003	929	97	354	451	11.2%
2004	1,020	155	354	509	12.8%
2005	1,145	234	354	588	15.5%
2006	1,312	339	355	694	18.0%
2007	1,718	508	419	927	33.5%
2008	2,208	819	419	1,237	33.5%
2009	2,922	1,257	430	1,686	36.3%
2010	4,505	2,153	507	2,660	57.7%
2011	7,454	4,011	516	4,527	70.2%
2012	12,775	7,344	546	7,890	74.3%

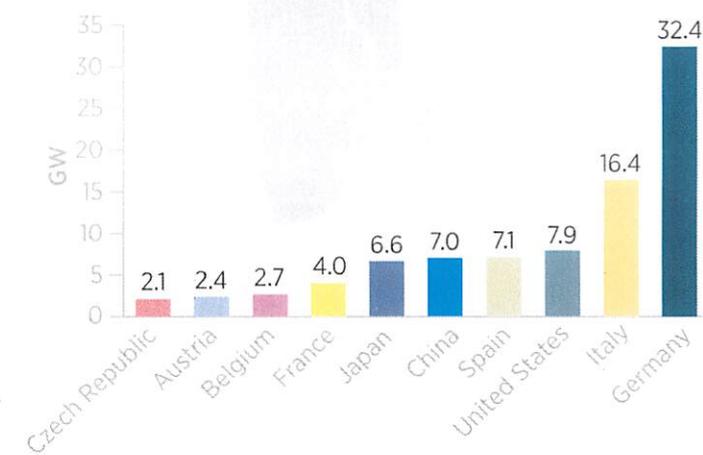
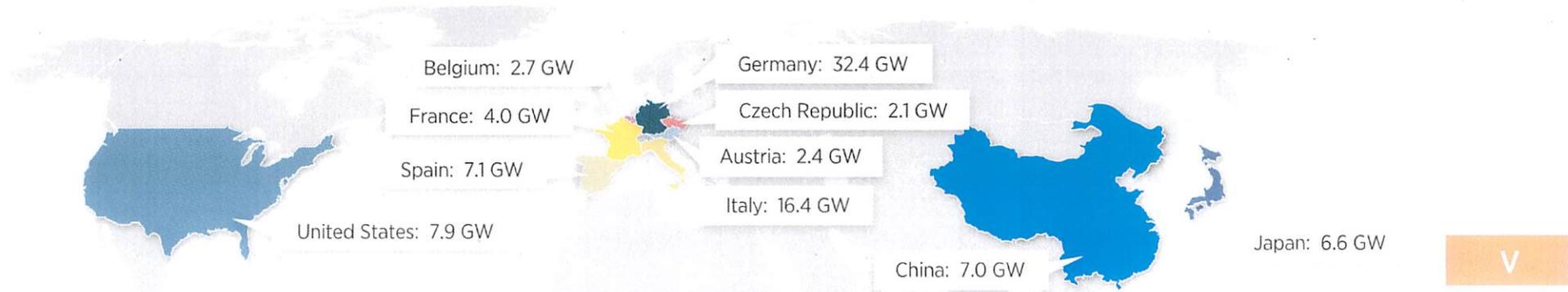


Sources: SEIA/GTM, Larry Sherwood/IREC

Generation numbers calculated from installed capacity using an 18% capacity factor for PV and a 25% capacity factor for CSP.

* Includes on- and off-grid capacity

Solar Electricity Installed Capacity (2012) – Select Countries

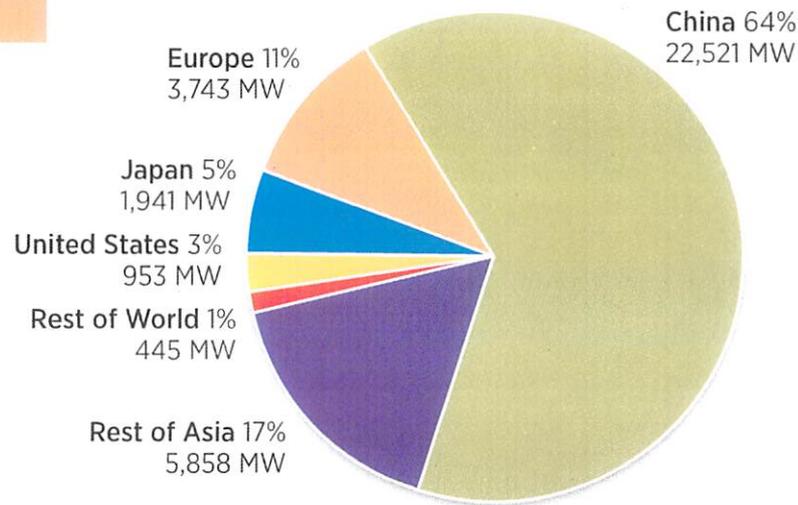


Sources: SEIA/GTM, REN21, Larry Sherwood/IREC
 * Includes PV and CSP

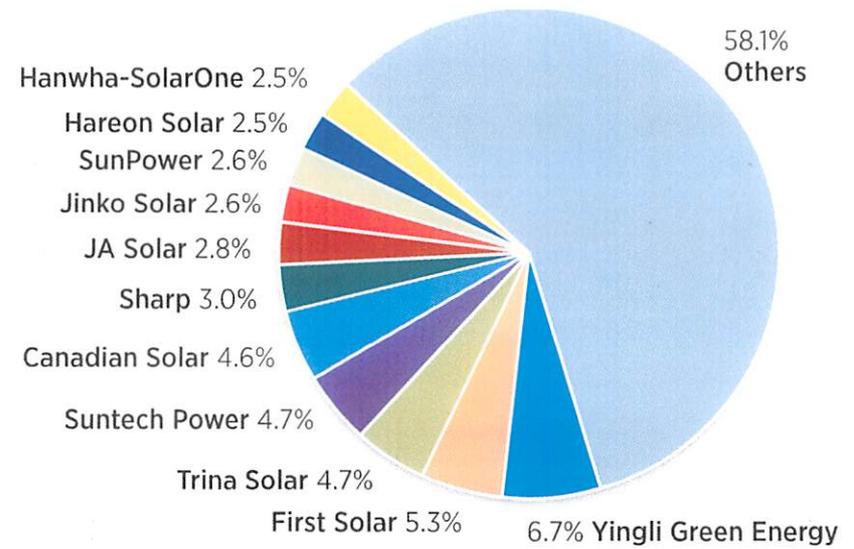
Worldwide Photovoltaic Manufacturing (2012)

Global Solar Module Production, 2012: 35,461 MW

By Country



By Manufacturer



States Leading Solar Electricity Development (2012)



PV Cumulative Capacity (MW)		
1	California	2,559.3
2	Arizona	1,106.4
3	New Jersey	955.7
4	Nevada	349.7
5	Colorado	299.6
6	North Carolina	207.9
7	Massachusetts	207.3
8	New Mexico	203.4
9	Hawaii	199.5
10	New York	179.4

PV Annual Capacity Additions (MW)		
1	California	983.2
2	Arizona	708.8
3	New Jersey	390.7
4	Nevada	225.6
5	Massachusetts	123.2
6	North Carolina	122.4
7	Hawaii	114.3
8	Colorado	102.9
9	Maryland	79.7
10	New York	55.6

CSP Cumulative Capacity (MW)		
1	California	364.5
2	Florida	75.0
3	Nevada	64.0
4	Colorado	31.8
5	New Mexico	6.0
6	Arizona	3.7
7	Hawaii	0.8



Sources: SEIA/GTM, Larry Sherwood/IREC
 Note: Grid-tied capacity only

TAB 2

KEY LARGO WASTEWATER TREATMENT DISTRICT
Agenda Request Form

Meeting Date: June 17, 2014

Agenda Item No. 2

- | | |
|--|--|
| <input type="checkbox"/> PUBLIC HEARING
<input checked="" type="checkbox"/> DISCUSSION
<input type="checkbox"/> ACTION ITEM
<input type="checkbox"/> Other: | <input type="checkbox"/> RESOLUTION
<input type="checkbox"/> BID/RFP AWARD
<input type="checkbox"/> CONSENT AGENDA |
|--|--|

SUBJECT: Fiscal Year 2013 Comprehensive Annual Financial Report (CAFR) and Audit Results presented by Grau and Associates.

RECOMMENDED MOTION/ACTION: Review and discussion of CAFR.

Approved by General Manager *[Signature]* Date: 6/12/2014

Originating Department:	Costs: \$ Funding Source:	Attachments: Draft
Department Review: <input type="checkbox"/> District Counsel _____ <input checked="" type="checkbox"/> General Manager <u><i>[Signature]</i></u> <input checked="" type="checkbox"/> Finance <u>CAFR</u>	<input type="checkbox"/> Engineering _____ <input type="checkbox"/> Clerk _____ <input type="checkbox"/> [Operations] _____	Advertised: Date: _____ Paper: _____ <input checked="" type="checkbox"/> Not Required

Summary Explanation/Background: The CAFR will be available by email Monday and a hardcopy at the meeting on Tuesday. Grau and Associates will present the FY2013 CAFR and Audit Results.

Resulting Board Action:

- Approved
 Tabled
 Disapproved
 Recommendation Revised