



# Ventaja tecnológica de First Solar

Rodrigo García – Director Asuntos de Gobierno

# First Solar at a Glance



Over 10GW installed worldwide and a 3.3GW contracted pipeline



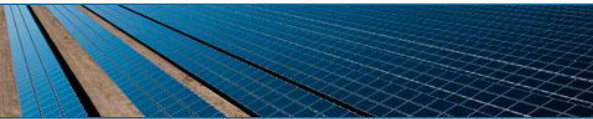
Cost competitive with conventional energy sources today



Partner of choice for leading utilities and global power buyers



Driving innovation across entire value chain and plant solution



Strongest financial stability & bankability in the industry



Founded in 1999 and publicly traded on Nasdaq (FSLR)

# TOPAZ SOLAR FARM

site: San Luis Obispo, USA

size: **550MW**

owner: MidAmerican Energy  
Holdings Company

**Largest investment grade renewable bond in history**



## AGUA CALIENTE

site: Yuma County, AZ, USA

size: **290MW**

owners: NRG Energy and  
MidAmerican Solar

**Reliable bulk power generation utilizing advanced plant controls and forecasting**



## LUZ DEL NORTE

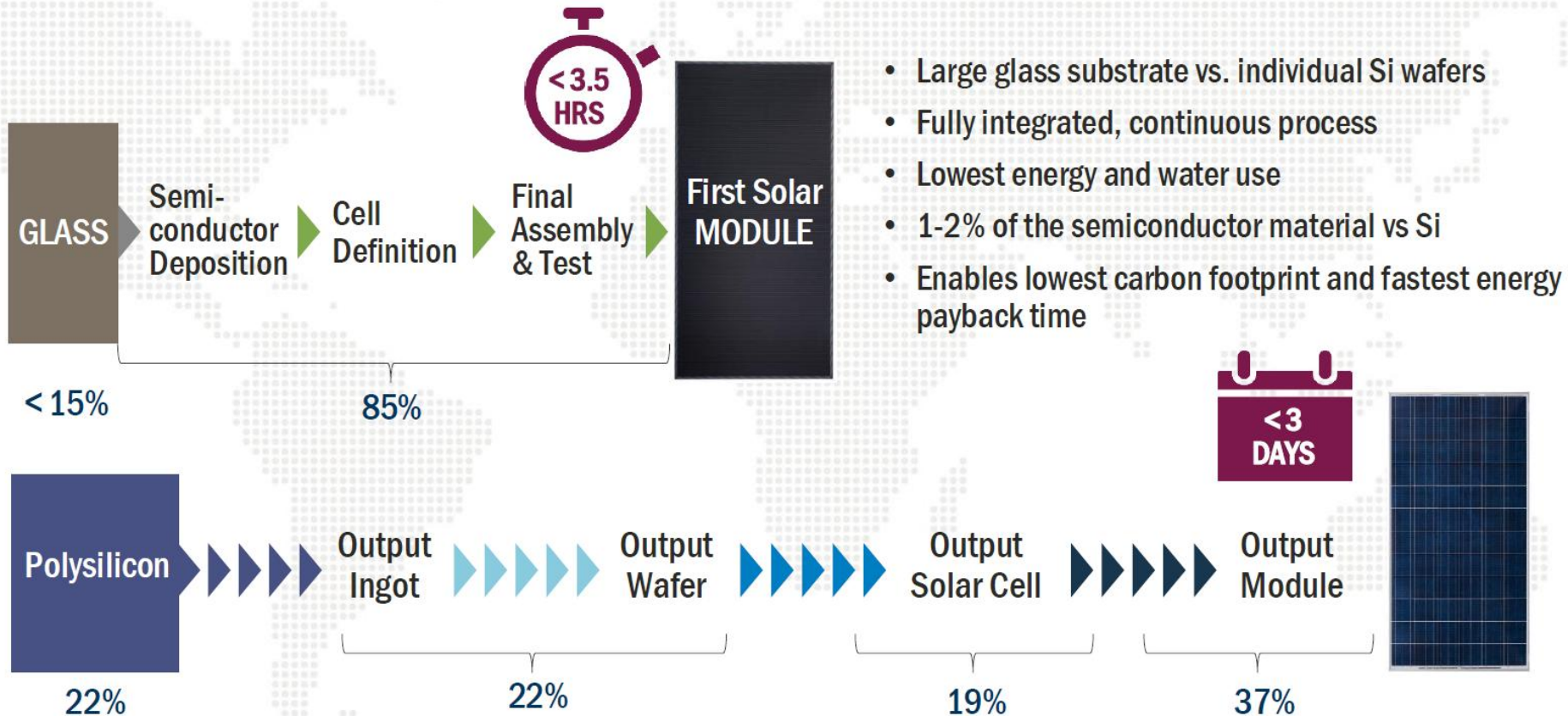
site: Copiapó, Chile

size: **141MW**

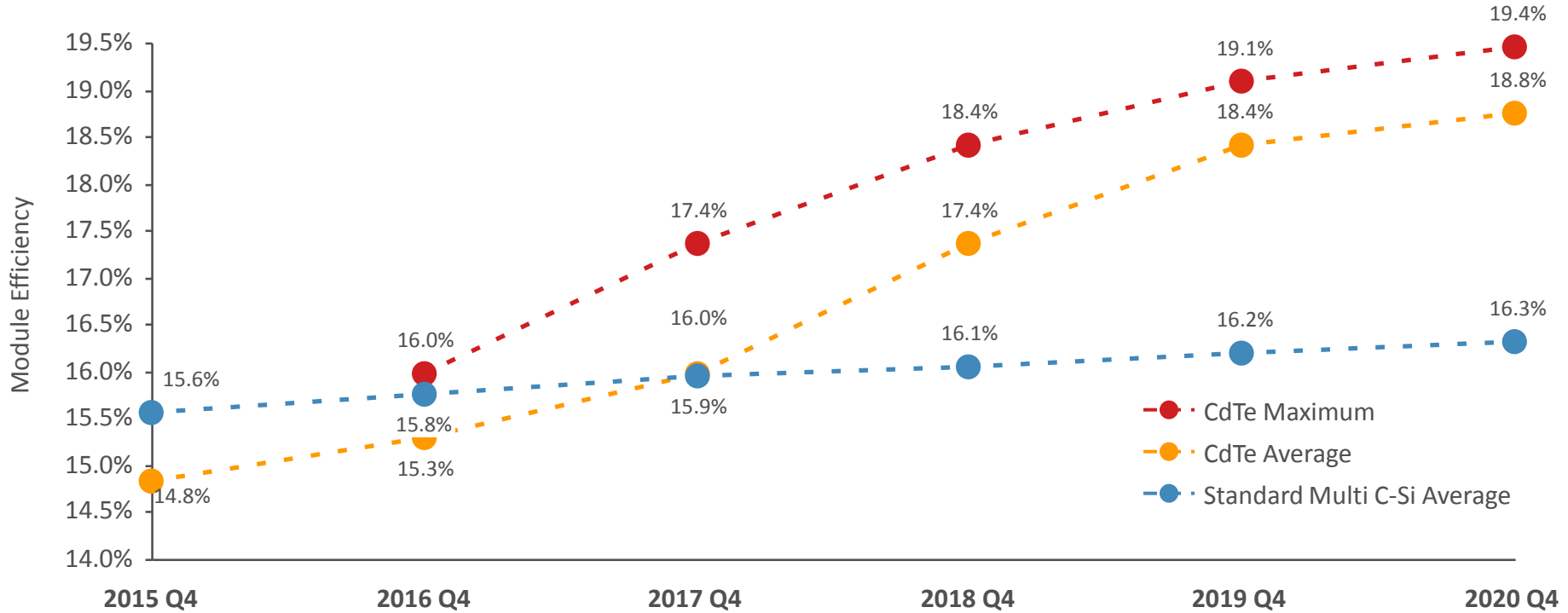
owner: First Solar, Inc.

**Latam's Largest PV Plant under operation.**

# PV Manufacturing Process - Comparison



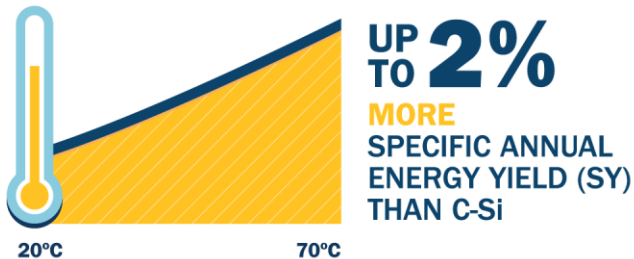
# FS Competitive Advantage: PV Module Efficiency Roadmap (%)



# ENERGY DENSITY ADVANTAGE

A

## SUPERIOR TEMPERATURE COEFFICIENT



B

## BETTER SPECTRAL RESPONSE



C

## BETTER SHADING RESPONSE



D



EFFICIENCY DIFFERENCE BETWEEN FIRST SOLAR AND mc-Si

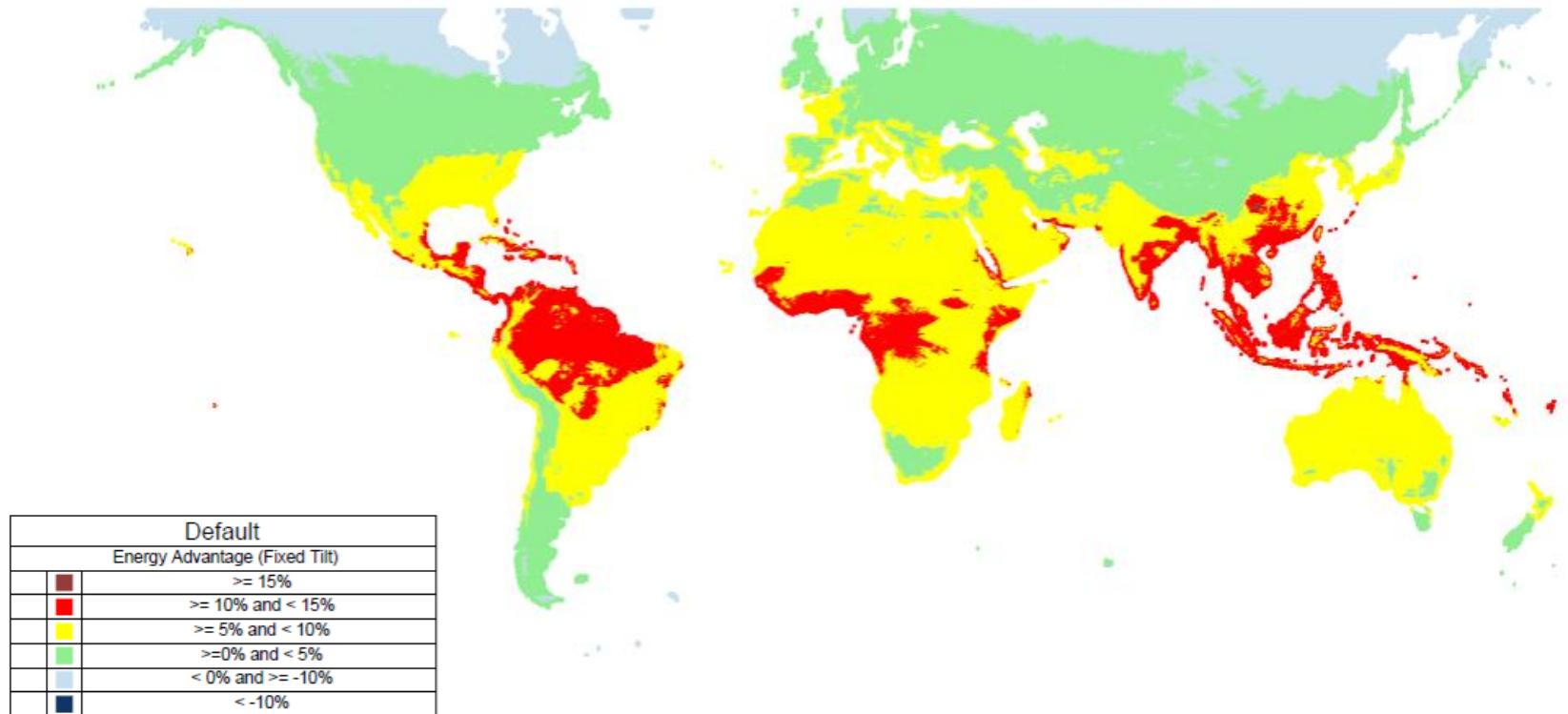
$$A+B+C+D = \text{UP TO } \mathbf{11\%}$$

BETTER ENERGY DENSITY

Represents lead line efficiency for both First Solar and multi-crystalline silicon. Multi-crystalline silicon based on 2016 forecast from ITRPV roadmap dated July 2015.



# FS Energy Yield Advantage: Advantage Map 2017



Energy yield advantage for CdTe over c-Si varies from 5 – 15% by location

# First Solar's New Series 5 (365 W Module)



© Copyright 2014, FIRST SOLAR



**HIGHER  
POWER!**

- 365W module beats 330W multi-c-Si per installation



**10-12%  
HIGHER  
ENERGY  
DENSITY!**

- Efficiency plus Energy Yield advantages deliver up to 12% higher Energy Density



**BOS  
OPTIMIZED!**

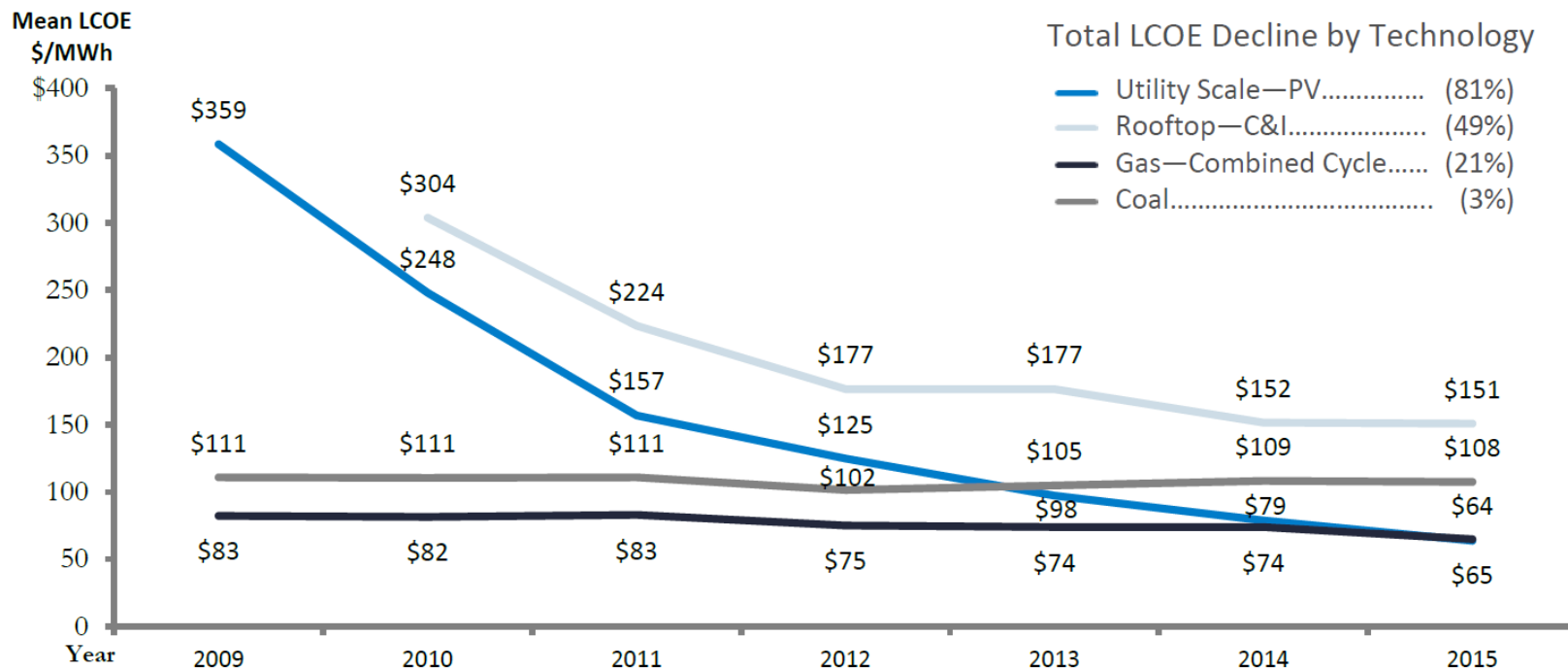
- Eliminate all clips
- Reduced electrical connections by 2/3
- >2x Increased installation velocity



**World  
Leading  
Reliability!**

- Maintains world leading extended durability profile and certifications

# Unsubsidized Levelized Cost of Energy - Historical



Note: Reflects average of unsubsidized high and low LCOE range for given version of LCOE study.

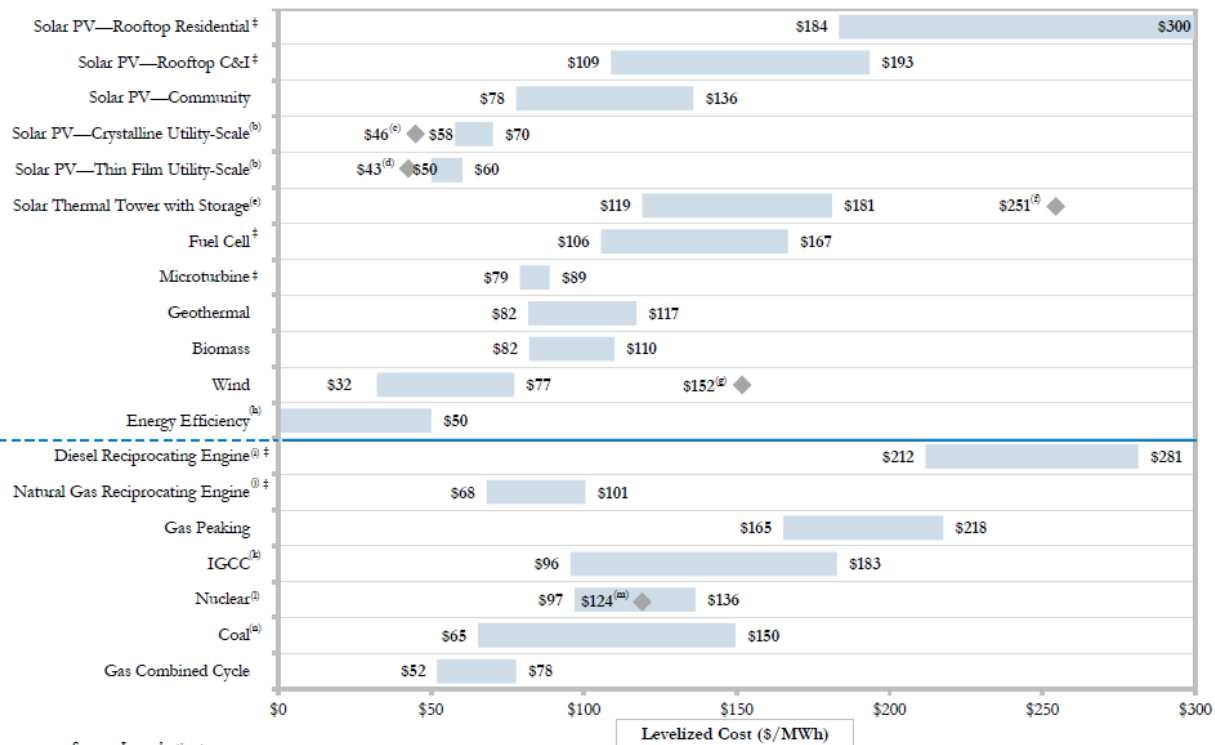
- a) Reflects total decrease in mean LCOE since the later of Lazard's LCOE—Version 3.0 or the first year Lazard has tracked the relevant technology.
- b) Reflects mean of fixed tilt (high end) and single axis tracking (low end) crystalline PV installations.
- c) Lazard's LCOE initiated reporting of Rooftop Solar—C&I in 2010.

Source: Lazard estimates.

# Unsubsidized Levelized Cost of Energy Comparison

ALTERNATIVE ENERGY<sup>(a)</sup>

CONVENTIONAL



Source: Lazard estimates.

Note: Here and throughout this presentation, unless otherwise indicated, analysis assumes 60% debt at 8% interest rate and 40% equity at 12% cost for both conventional and Alternative Energy generation technologies. Assumes diesel price of ~\$2.50 per gallon, Northern Appalachian bituminous coal price of ~\$2.00 per MMBtu and a natural gas price of ~\$3.50 per MMBtu for all applicable technologies other than Natural Gas Reciprocating Engine, which assumes ~\$5.50 per MMBtu. Analysis does not reflect potential impact of evolving regulations/rules promulgated pursuant to the EPA's Clean Power Plan. See following page for footnotes.

‡ Denotes distributed generation technology.

# Acelerado desarrollo de la industria de energías renovables

## Panel beaters

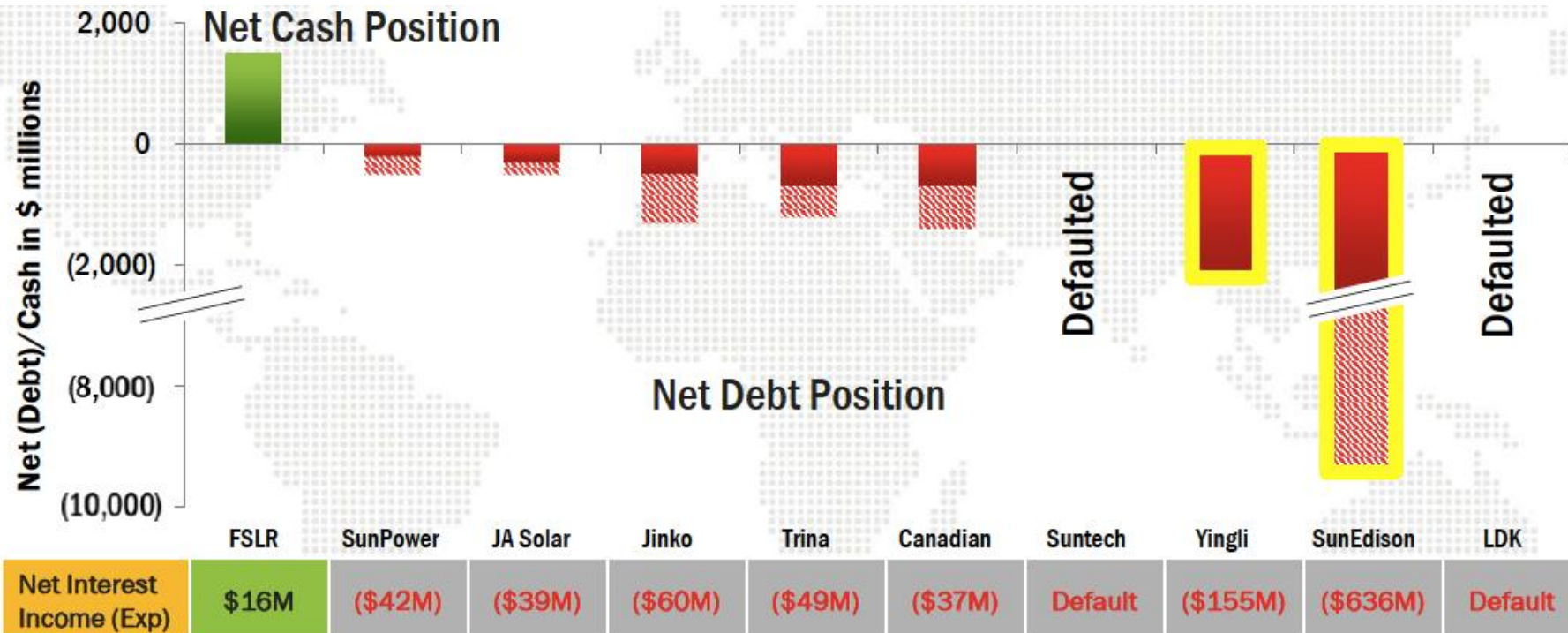
Tenders for solar-energy installations



Source: IEA

País	Fecha	PPA mínimo (US\$/MWh)
Chile	Q4-2015	64,9
Perú	Q1-2016	48
México	Q1-2016	38,8
EAU	Q2-2016	29,9

# First Solar Balance Sheet Management Today



**2016 Competitor Capacity Announcements: Wafer (1.6GW) ; Cell (5.2GW) ; Module (6.3GW)**

<sup>5</sup>Source: Net cash/debt based on Photon Consulting estimates as of Dec 2015. Net interest expense for 2015 or last 12 months based on company filings. Competitor capacity based on public announcements. Estimated investment in capacity assumes \$0.34/w for wafer, \$0.23/w for cell and \$0.09/w for module. © Copyright 2016, FIRST SOLAR

First Solar es el partner solar de preferencia.

- ✓ Experiencia y track record global
- ✓ Ventaja y Roadmap Tecnológico
- ✓ Bancabilidad y solidez financiera
- ✓ Módulos más eficientes a un menor costo



**First Solar®**



# History of Leadership Across Entire Solar Value Chain



1<sup>st</sup> global module recycling program



1<sup>st</sup> to break \$1/watt cost barrier  
1<sup>st</sup> to produce 1GW in single year



World record 22.1% cell  
World record 18.2% module

1999 ... 2005 ... 2007 2008 2009 2010 2011 2012 2013 2014 2015



Acquired EPC & project DEV



World's largest PV plants



Proprietary plant controller



Financed ~11B solar plants



Industry leading tracker technology



State-of-the-art Operations Center

**TetraSun**  
Acquired disruptive x-Si technology

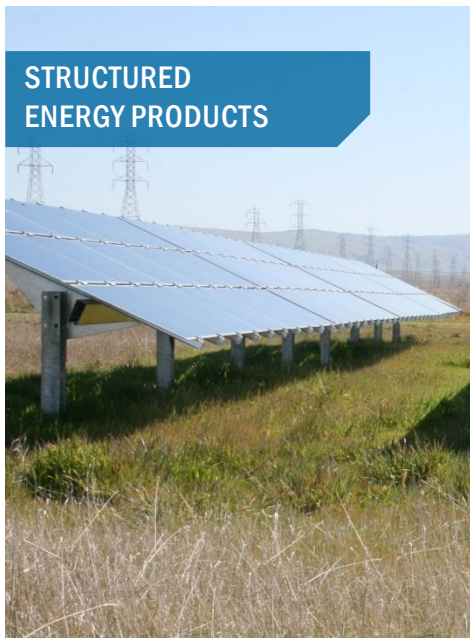


Integrating into the global energy mix

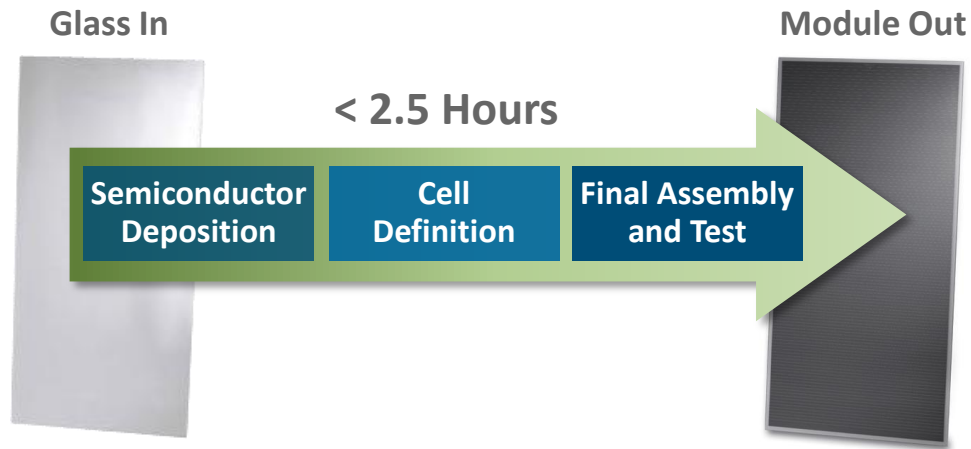
# Product Offerings

“Together, **with our global partners**, we are enabling a world powered by clean, affordable solar electricity.”

—Jim Hughes, First Solar CEO



# PV Module and Manufacturing Technology



- 98-99% reduction in semiconductor material
- Fully integrated, continuous process vs. batch processing
- Large 60x120cm (2'x 4') substrate vs. 6" wafers

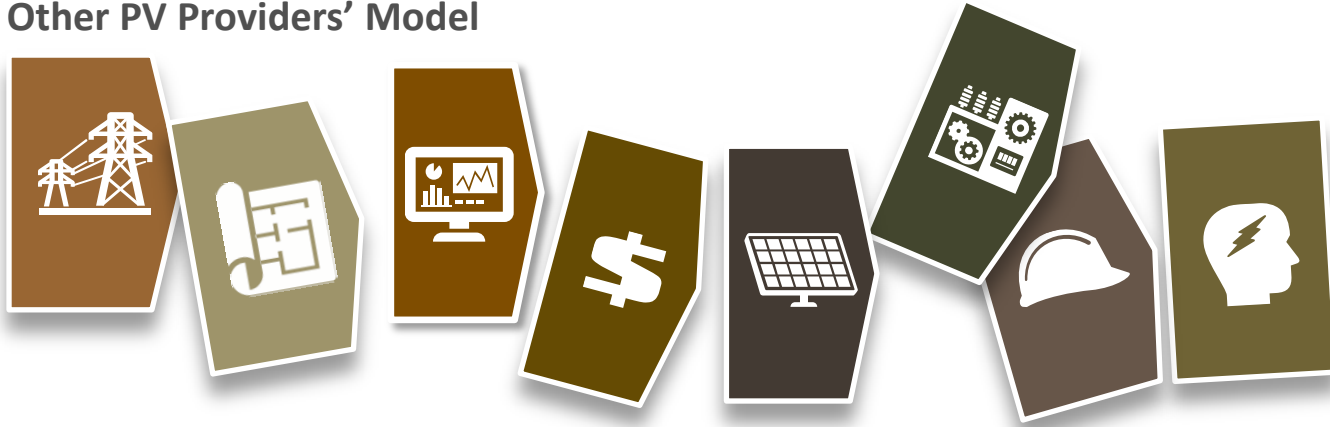
## Conventional Crystalline Silicon Batch Technology



First Solar Fully Integrated, Automated and Continuous Thin Film Process

# The First Solar Advantage

## Other PV Providers' Model



**= More Cost  
& More Risk**

## First Solar's Model



**= More Value  
& Less Risk**

**PV energy solutions with superior value and less risk**

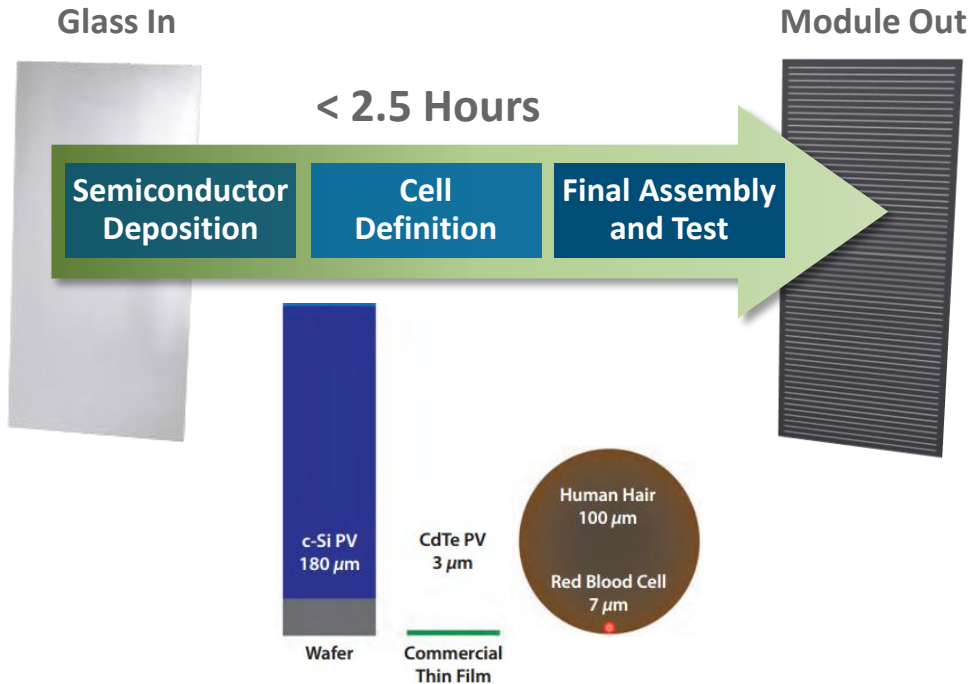
# First Solar Modules



- Frameless glass-glass laminate (60 x 120 cm, 12.0 kg) is durable and recyclable
- Power increments of 2.5W (5% rating tolerance) up to 115W per module
- High energy yield in real operating conditions (PR>80%)
  - Largest advantages in hot, humid climates
  - Low temperature coefficient (-0.29%/°C to -0.34%/C)
  - High spectral gain in high humidity
- Robust against shading in landscape orientation (perpendicular to cells)
- Certified reliability and safety according to IEC 61646 and IEC 61730 @1500VDC;
  - UL Listed; Extended Harsh Climate Reliability: Thresher, Long Term Sequential, Atlas 25+
- 25-year Linear Power Output Warranty for 80% of nominal power subject to warranty terms and conditions
- Manufacturing certified to ISO 9001:2008 (quality), ISO 14001:2004 (environmental) and OHSAS 18001:2007 (occupational, health & safety) standards
- Collection and Recycling EOL Program

# A Reminder of What we do...

First Solar Fully Integrated, Automated and Continuous Thin Film Process








# FS Competitive Advantage: Record Thin Film Module Efficiency at 18.6%



In June 2015, FS CdTe modules set another world record with 18.6% efficiency.

# Research Implementation: Roadmap

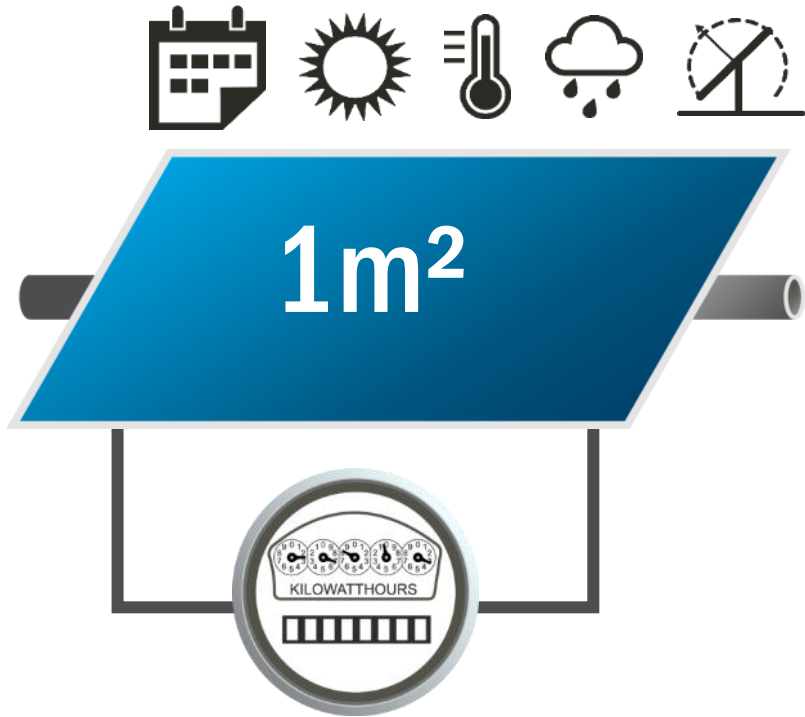
	2013	2014	2015	2016	Mid Term	
 <b>Research Cell</b>	18.7%	20%	21.0%	22%	24%	} 1-2 years
		✓ 21.0%	✓ 21.5%	✓ 22.1%		
 <b>Cell to Module Translation</b>						
 <b>Research Module*</b>	16.1%	17.2%	18.5%	19.4%	21.7%	} 1-3 years
		✓ 17%	✓ 18.2%	>19%		
 <b>Practical Manufacturing</b>						
 <b>Manufacturing Average**</b>	13.4%	14.4-14.9%	15.1-16.2%	16.9%	>19% <sup>†</sup>	
		✓ 14.4%	✓ 16.1%	16.7%		

\* Total Module Area Efficiency. 2015 record module would be 18.6% if reported on aperture area efficiency as is common practice amongst crystalline silicon manufacturer

\*\* Represents Q4 full fleet average. †Sei



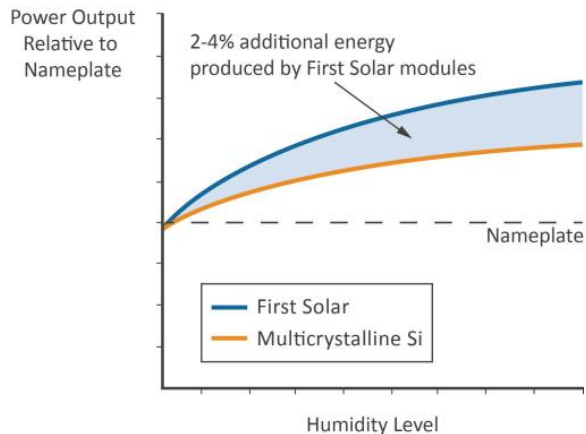
# ENERGY DENSITY ADVANTAGE



$$\frac{1 \text{ yr Energy}}{\text{m}^2} = \$$$

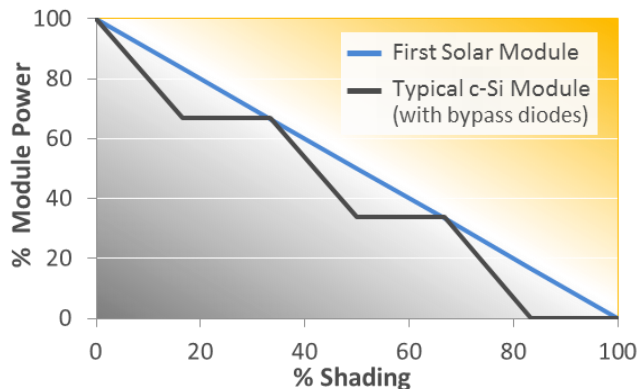
# FS Energy Yield Advantage: Three Major Reasons

## 1) Humidity/Spectral Response



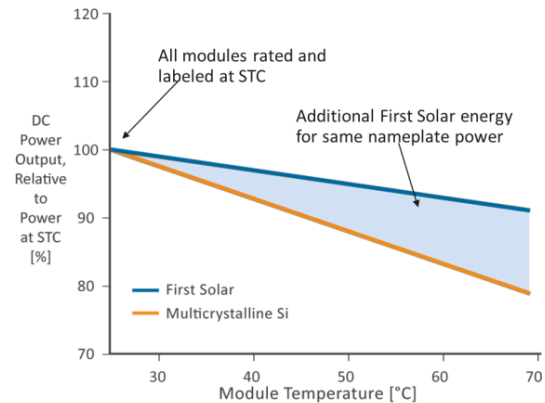
FS modules perform **2-4% better** in **hot and humid conditions** due to better spectral response

## 2) Shading Response



10% shading results in **10%** Power drop for FS vs. **30%** c-Si

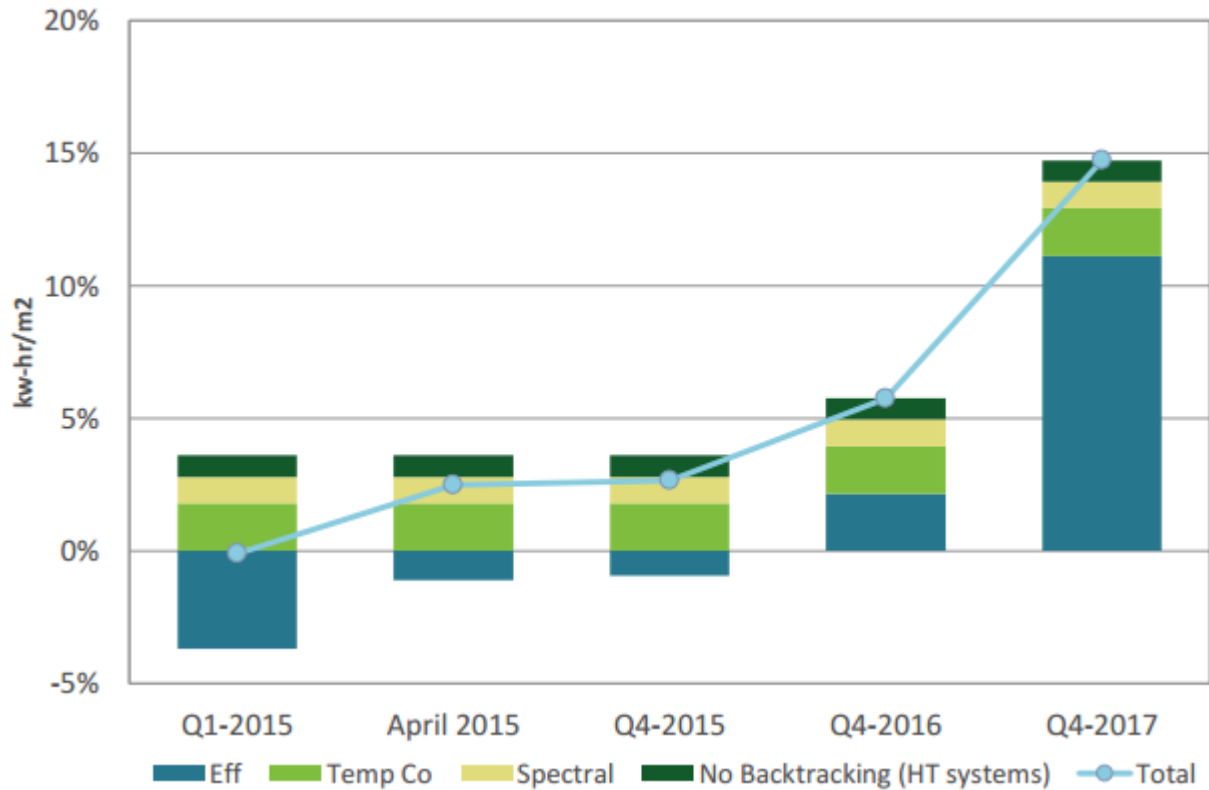
## 3) Temperature Coefficient



FS Modules produce up to **5%** more energy per watt in High temperature conditions due to low temperature coefficient

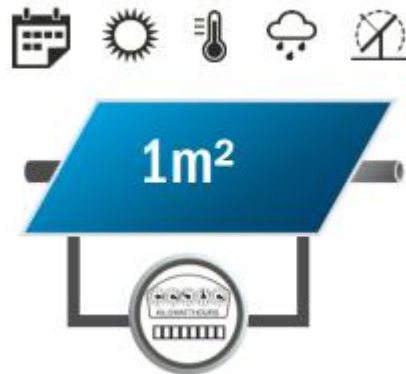
FS modules have higher energy yield than C-Si due to better spectral response, linear shading impact & lower temp coefficient.

# First Solar Module Energy Density Roadmap **Relative to c-Si**

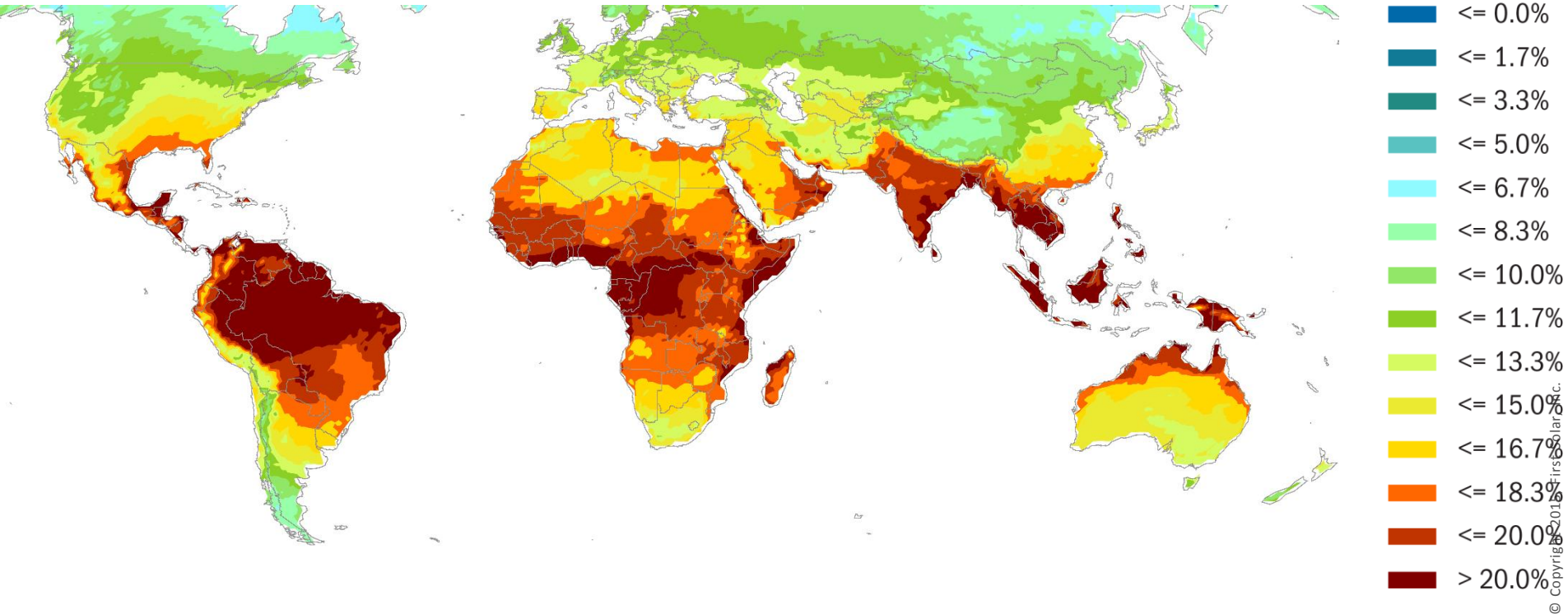


## Energy Density Improvements

- Now advantaged to multi c-Si based on April lead line efficiency



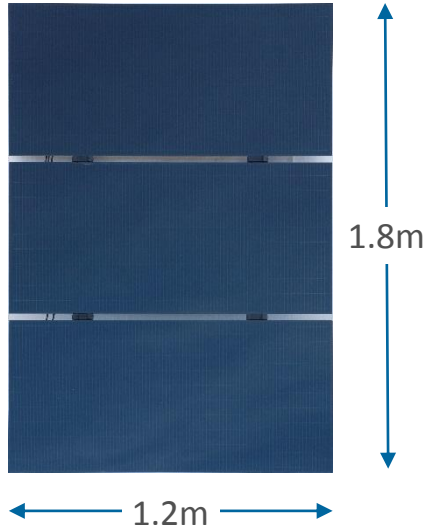
# ENERGY DENSITY ADVANTAGE | 2019



Represents lead line efficiency for both First Solar and multi-crystalline silicon. Multi-crystalline silicon based on ITRPV roadmap dated July 2015.

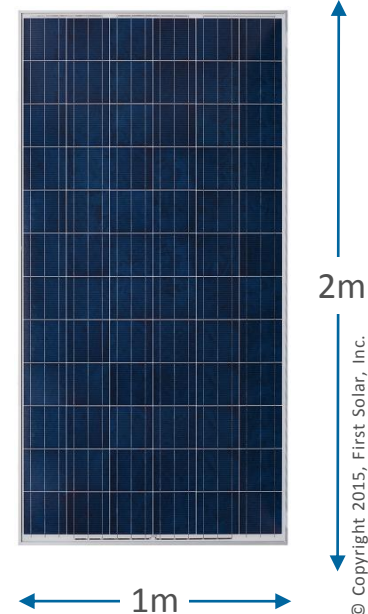
# COMPARISON of FS Series 5 to Multi c-Si Modules

FIRST SOLAR S5



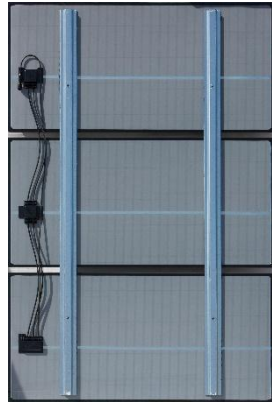
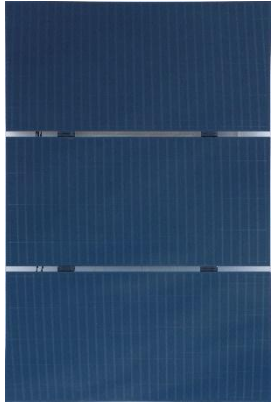
	Series 5	Multi c-Si	Multi c-Si w/ PERC
Maximum Power (Pmax)	365Wp	315Wp	330Wp
Temperature Coefficient of Pmax	-0.28%/°C	-0.40%/°C	-0.40%/°C
Spectral Gain	Up to 6%	0%	0%
Tracker Shading Gain	Up to 1%	0%	0%

Multi c-Si



Data from First Solar and competitor data sheets.

# FIRST SOLAR'S NEW S5 → 365W Module with All the Perks!



**HIGHER  
POWER!**

- 365W module beats 330W multi c-Si per installation



**10-12%  
HIGHER  
ENERGY  
DENSITY!**

- Efficiency plus Energy Yield advantages deliver up to 12% higher Energy Density



**BOS  
OPTIMIZED!**

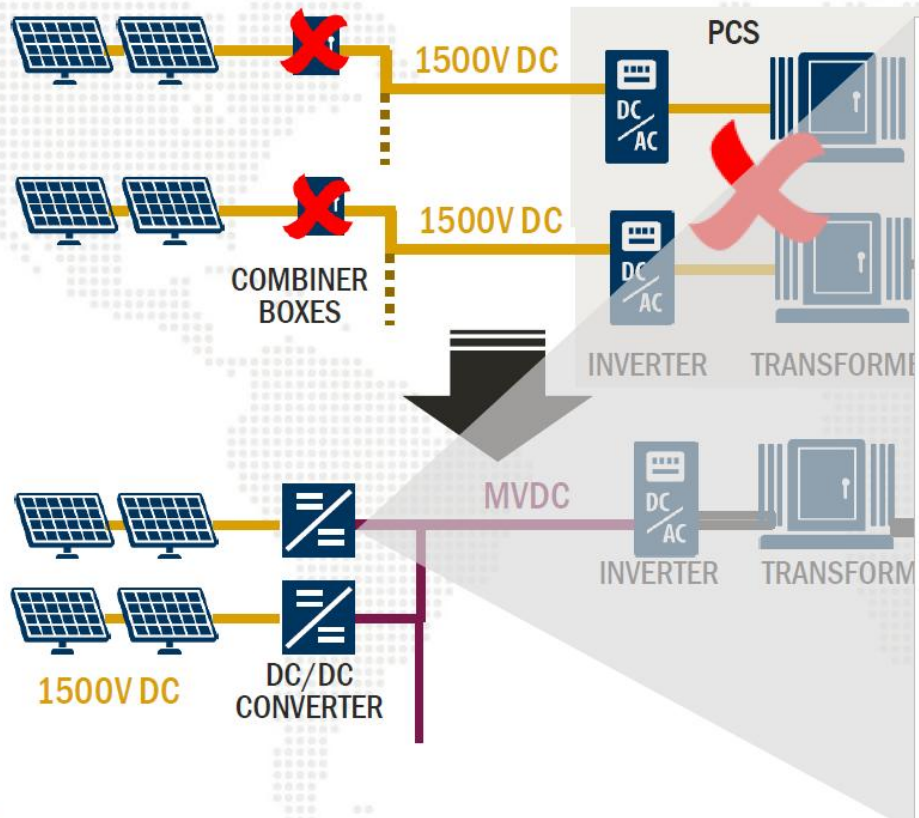
- Eliminate all clips
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**World  
Leading  
Reliability!**

- Maintains world leading extended durability profile and certifications

# Introducing: Medium Voltage DC Plant Architecture (MVDC)



# Partnering with Leading Global Power Buyers

“ We are very proud to be working with First Solar, who has a reputation for the delivery of **world class renewable energy projects internationally.**”

*Michael Librizzi, General Manager Midwest for WBHO Civil*



Track record of delivering to leading utilities and energy investors



# First Solar Project Finance

- Strongest balance sheet and cash position amongst all solar competitors
- Unparalleled use of First Solar modules in debt financed projects around the world
- Financial institutions worldwide support First Solar technology



First Solar is **BANKABLE**