Sunny Future for the Solar Industry

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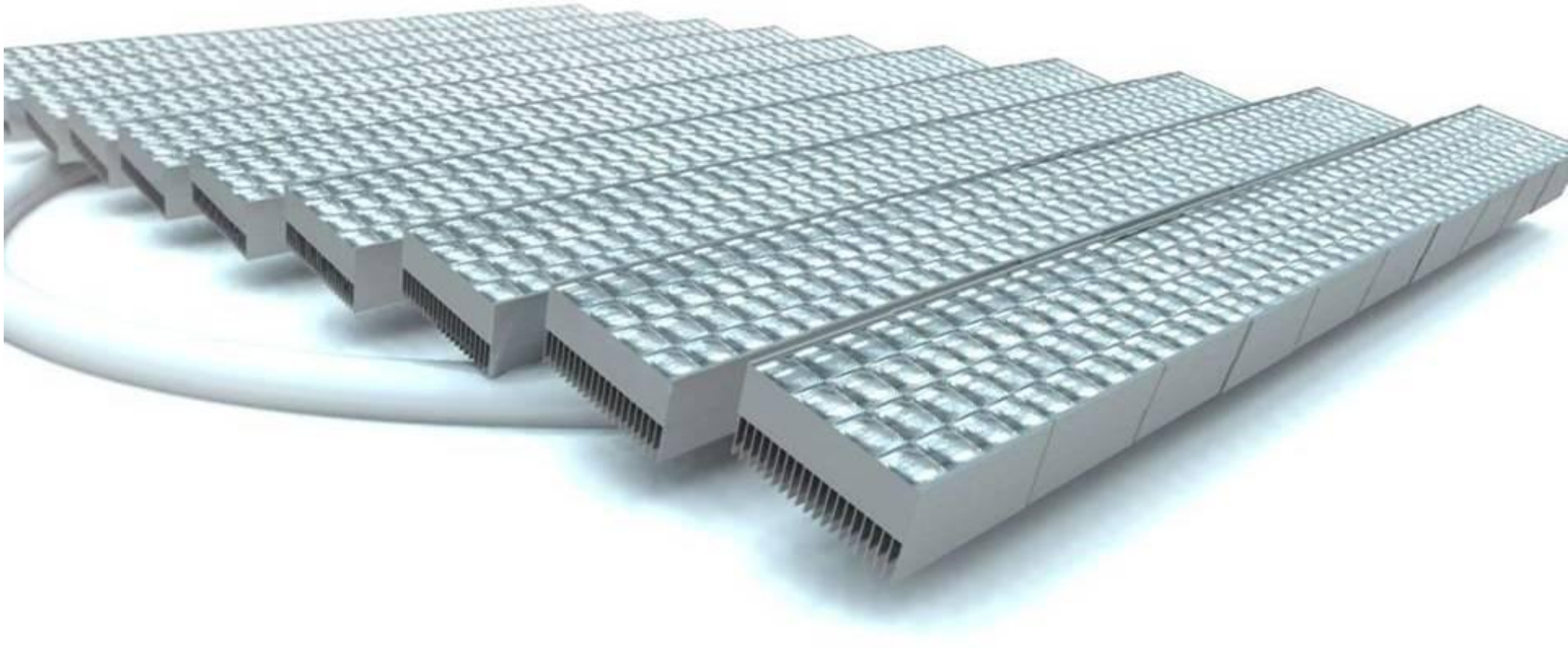
I3 ECPV Solar Panel

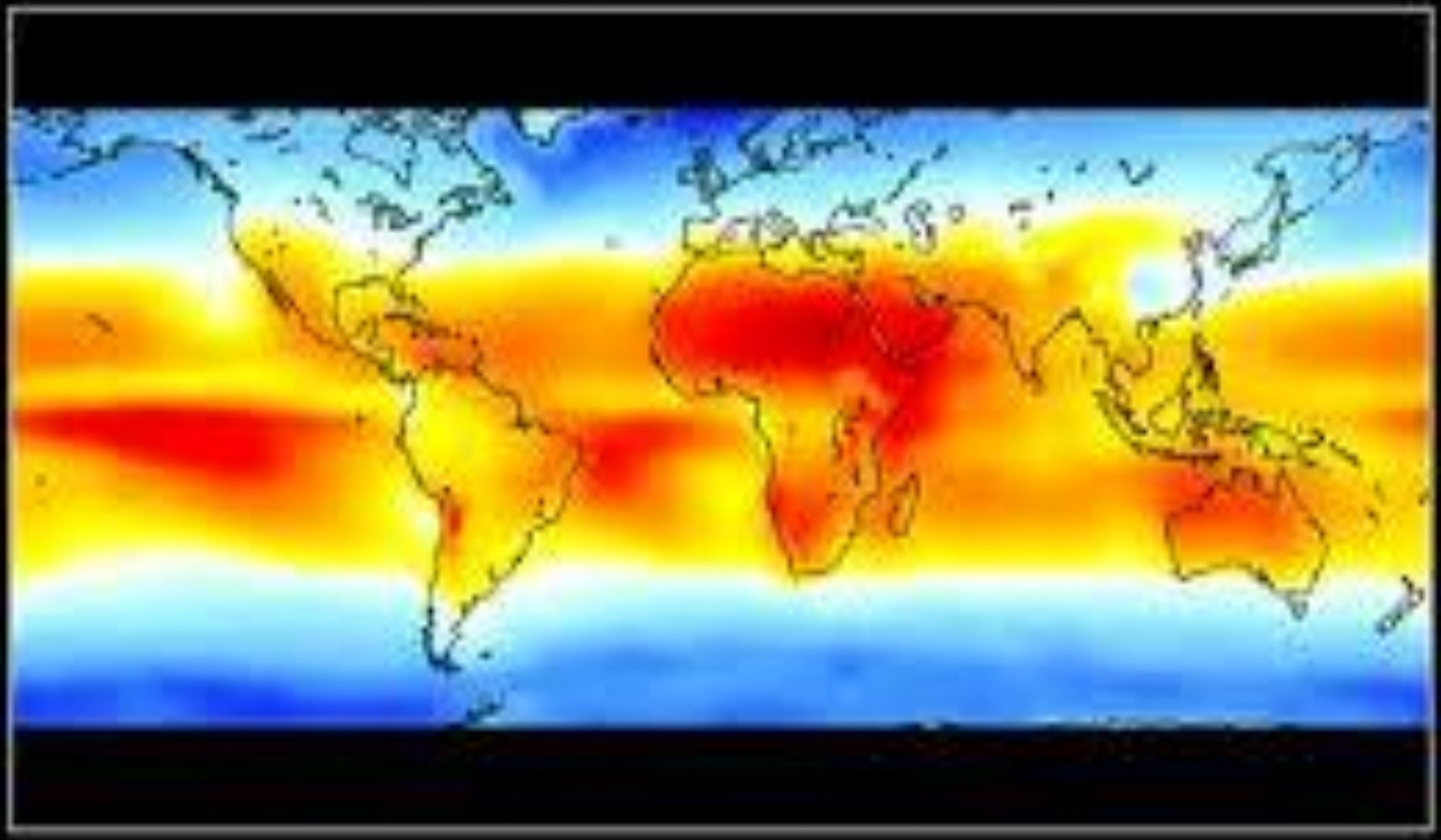
BEST Suite of Performance in all categories in the Solar Industry



Comparison of Different PV Technologies

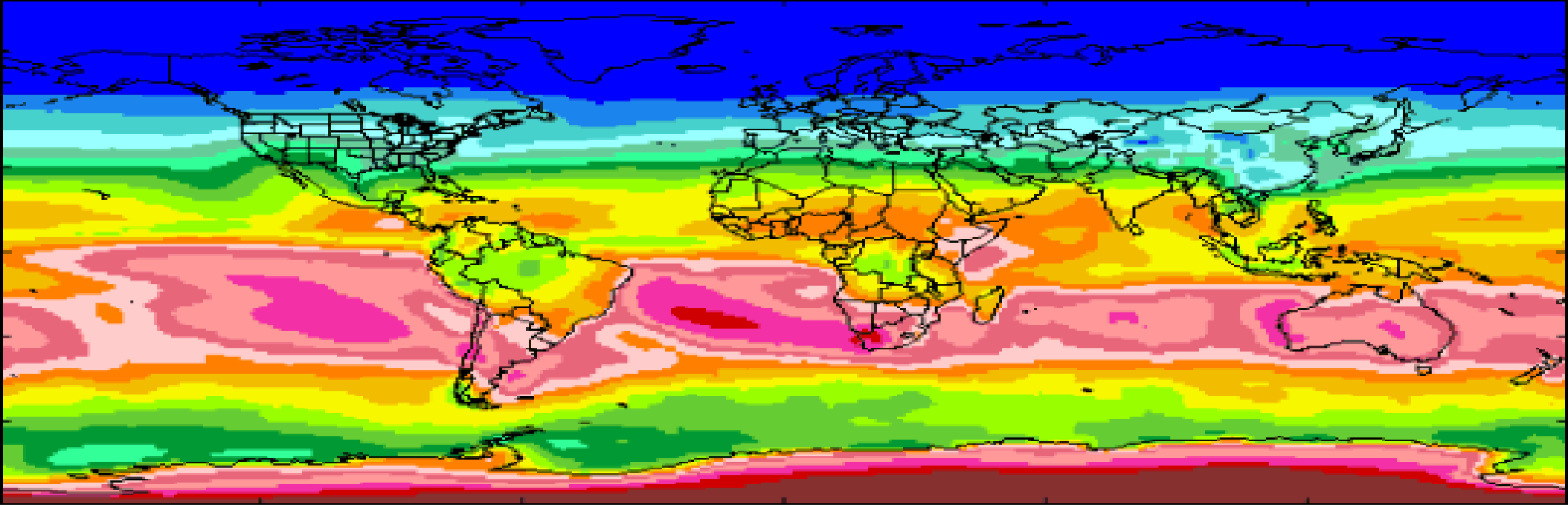
	I3 Solar	Versus	Competition			
I3 Solar	43%	Germanium	Excellent	Rigid	$4M / 10MW	Comparable
PV Technology	Efficiency Module Avg. (Cell)	Key Materials Supply Issues	Materials Utilization	Substrate Types	Estimated Capital Expenditure (per Watt)	Estimated Cost of Production (per Watt)
Crystalline Silicon	13% – 14% (22%)	Polysilicon Currently Abundant	Poor (Subtractive)	Rigid only	$1.50–$2.00	$1.10 – $1.35
Amorphous Silicon	6% – 7% (13%)	Silane Gas Availability Cost	Poor (Subtractive)	Rigid and Flexible	$1.65 – $3.00	$1.00 – $1.25
Cadmium Telluride	9% – 11% (16.5%)	Tellurium Availabilty	Medium (Subtractive)	Rigid only	$1.50 – $1.60	$0.75 – $1.00
CIGS by Vacuum Process	10% – 12% (20%)	Poor Usage of Indium	Poor (Subtractive)	Rigid and Flexible	$2–00 – $2.25	$1–25 – $1.75
ISET's Printed CIGS	10% – 12% (20%)	Low Requirement, Efficient Usage Of Indium	High (Additive)	Rigid and Flexible	$0.75 – $1.00	$0.50 – $0.65

Average Daily Solar Radiation at the Surface

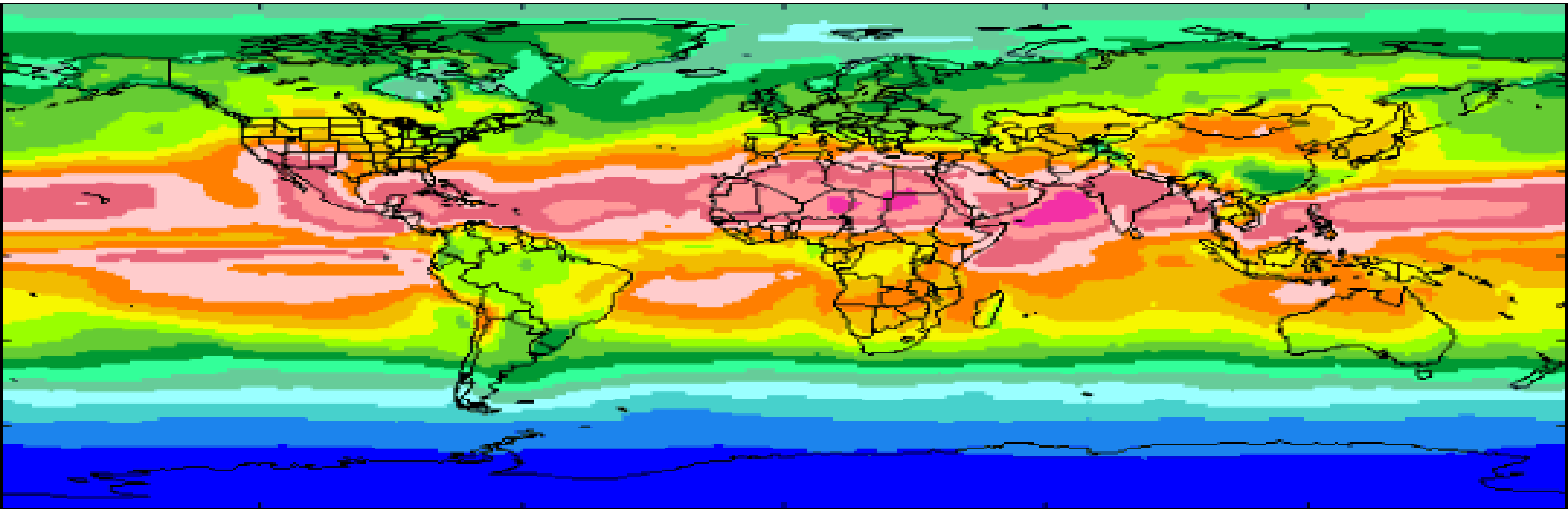


watts per square meter per day

75 100 125 150 175 200 225 250



January 1984–1993

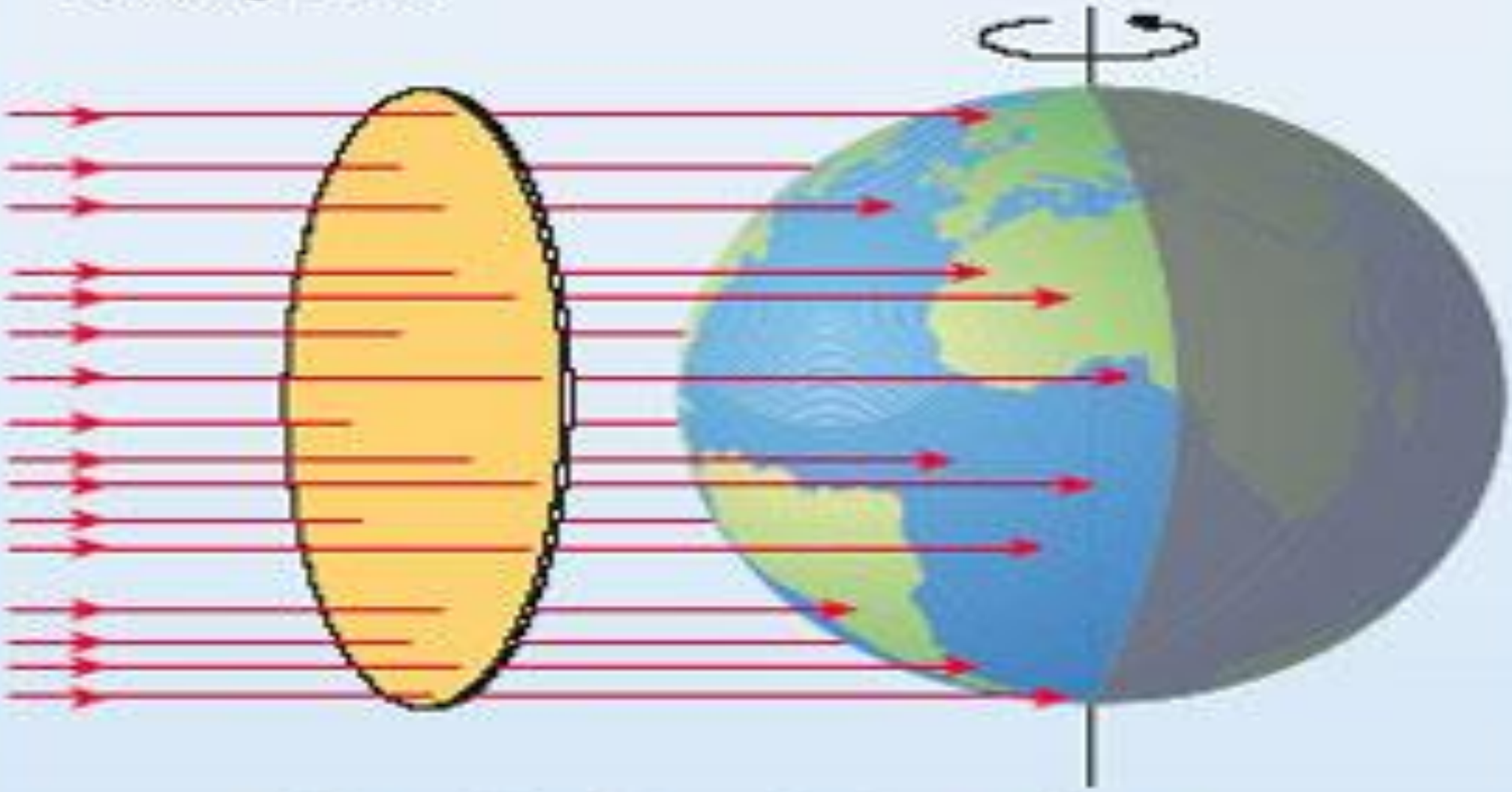


April 1984–1993

Solar Insolation (kWh/m^2/day)

0 ~8.5

incoming solar radiation spread over surface of rotating Earth



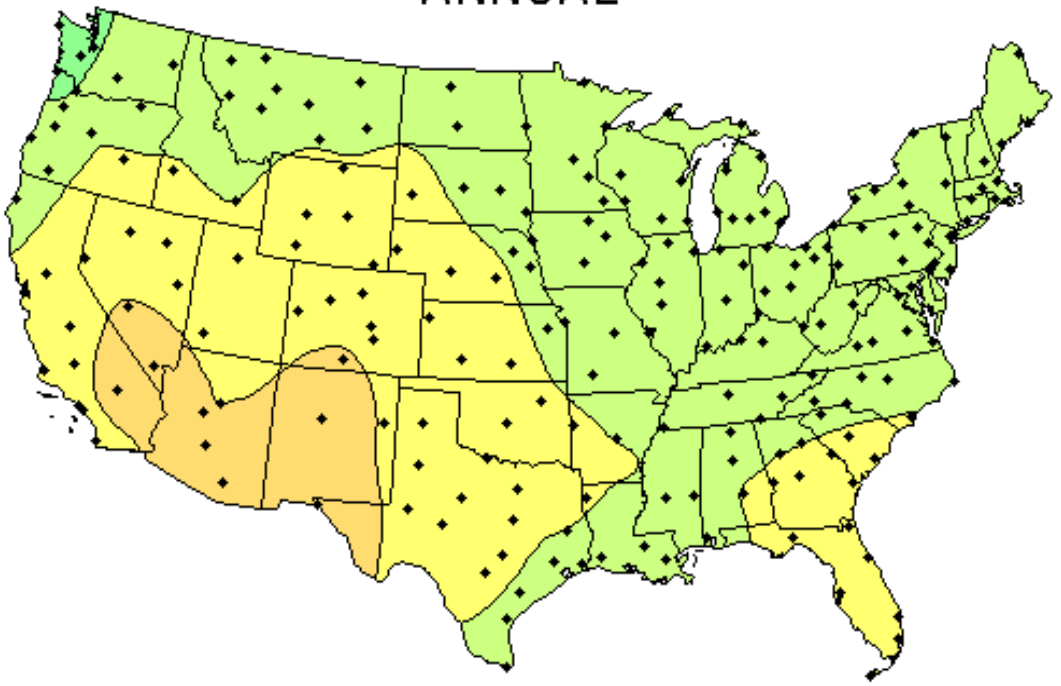
disc radius R
area πR^2
receives
1368 W m^{-2}

but

sphere
area $4\pi R^2$
receives
342 W m^{-2}

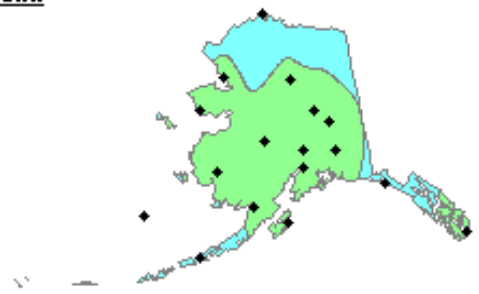
Average Daily Solar Radiation Per Month

ANNUAL

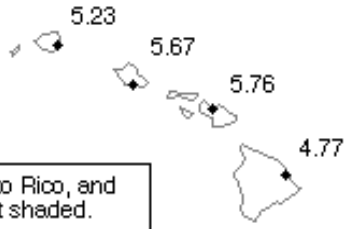


Flat Plate Tilted South at Latitude

Alaska

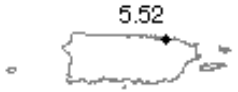


Hawaii



Hawaii, Puerto Rico, and Guam are not shaded.

San Juan, PR



Guam, PI

Collector Orientation

Flat-plate collector facing south at fixed tilt equal to the latitude of the site: Capturing the maximum amount of solar radiation throughout the year can be achieved using a tilt angle approximately equal to the site's latitude.

This map shows the general trends in the amount of solar radiation received in the United States and its territories. It is a spatial interpolation of solar radiation values derived from the 1961-1990 National Solar Radiation Data Base (NSRDB). The dots on the map represent the 239 sites of the NSRDB.

Maps of average values are produced by averaging all 30 years of data for each site. Maps of maximum and minimum values are composites of specific months and years for which each site achieved its maximum or minimum amounts of solar radiation.

Though useful for identifying general trends, this map should be used with caution for site-specific resource evaluations because variations in solar radiation not reflected in the maps can exist, introducing uncertainty into resource estimates.

Maps are not drawn to scale.

National Renewable Energy Laboratory
Resource Assessment Program

kWh/m^2/day

- 10 to 14
- 8 to 10
- 7 to 8
- 6 to 7
- 5 to 6
- 4 to 5
- 3 to 4
- 2 to 3
- 0 to 2
- none

FLATA13-208

Supply Chain Effect in PV Industry

Supply Chain

Poly Silicon Materials
Mono Crystalline Industry
Wafer Producers
Poly & Mono PV
Panel Manufacturers
Balance of Plant (BOP)
Frame, Mounting, Tracking, Inverters, Cabling
Power Conditioning & Controls
Sensors, Monitoring Systems, Software
Distributors & Marketers
(+ Cost of Customer Acquisition)
Installation & Maintenance
Solar Farm Operators, PPA Contractors
Roof Top & Residential

Supply Chain Effect & Plant Utilization

- Each company or players in the supply chain strata need to adjust their plant utilization rate
- Higher the utilization (in % of capacity), faster the capex amortization and pay off debt
- If the plant utilization is in the upper quartile, especially when it is in 90% level, additional plants may be started by different industry players
- The companies with high utilization rates get better Debt to Equity Ratio
- Thus can get follow on investments at attractive terms.
- Continuous supply chain adjustments happen

Recent Supply Chain & Plant Utilization

- Historic plant utilization rates at above 90%
- Typically provided by the leading polysilicon suppliers to the solar PV industry
- Even when polysilicon spot prices declined 70% between Q1’11 and Q2’12, Tier 1 polysilicon suppliers maintained these high utilization rates.
- Polysilicon makers strive to run plants at optimal capacity levels
- Maximizing production offers the lowest cost structures
- By spreading depreciation costs over a larger volume
- This often results in the highest yields
- Avoids shutdown/start-up costs
- Enables volume purchases of raw materials

Recent Poly Silicon Example

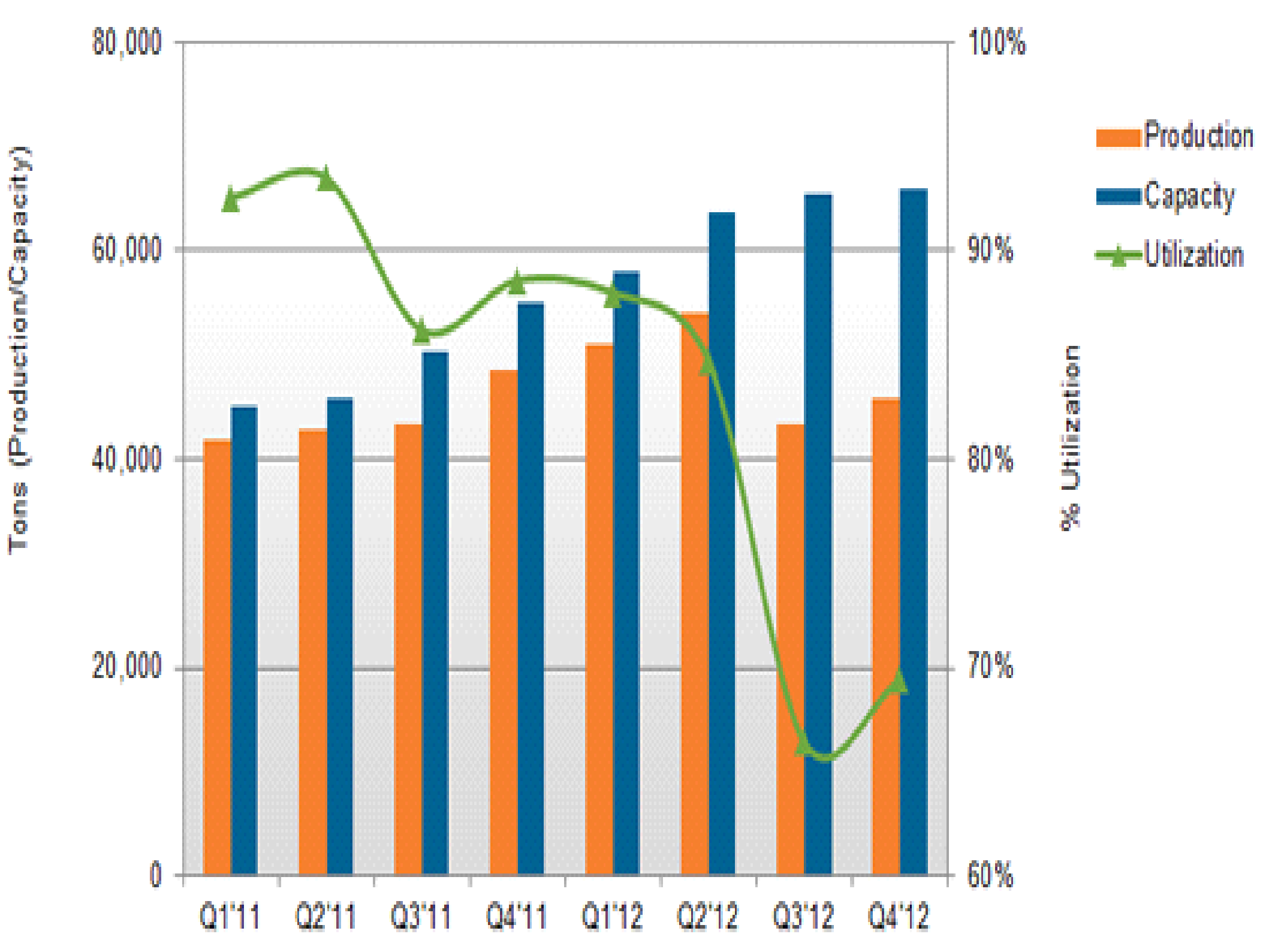
- Polysilicon suppliers maintained high utilization rates while prices remained above cash costs.
- Average spot prices fell below $20/Kg in Q3’12
- Continued down to $16/Kg in Q4’12
- Tier 1 makers with best-of-class cost structures were forced to adjust production levels.

China – Poly Silicon

- China is the world's **largest end-market for Poly Silicon**
- **Consumed ~188,000 tons** of poly silicon for PV between Q1'11 and Q3'12
- Same period **262,000 tons of materials were provided to the Chinese market from a combination of domestic production and foreign imports**
- Foreign imports grew to record highs during most of 2012
- As a result, the **74,000 tons of excess supply contributed to a strong inventory buildup**
- Combined with weaker than hoped end-market PV demand during 2H'12, ultimately led to the recent utilization corrections

Poly Utilization

- The **reduced utilization rates** have also had a profound impact on the previously aggressive capacity expansion plans of PV poly silicon suppliers
- In fact, several Tier 1 **poly silicon** manufacturers, including Wacker, Hemlock, OCI, and Tokuyama, have **now decided to delay ramping up and building new poly silicon plants**
- **The started stabilizing polysilicon prices towards the end of Q4'12rationalization of supply finally**
- This trend continues into early Q1'13
- Price pressure is expected to remain strong with poly silicon makers hoping to increase utilization rates as early as possible
- Several poly silicon plants are still currently scheduled for completion, but this new capacity is likely to remain idle until end-market PV demand increases


80,000
60,000
40,000
20,000
0
Tons (Production/Capacity)
100%
90%
80%
70%
60%
% Utilization
Production
Capacity
Utilization
Q1'11
Q2'11
Q3'11
Q4'11
Q1'12
Q2'12
Q3'12
Q4'12

Global Solar PV Industry Trend

Solar Trend Summary

New photovoltaic installations:
Worth over 31 GW in 2012

Lost ground in Q4 2012

Despite continuing overcapacity
Price declines

Forecasts are that the global industry will return to growth in Q2 2013

World passes

100 GW

in cumulative installed PV capacity

30GW added globally in 2012

Roughly the same figure as was added in the 2011 boom year

Europe saw just 13 GW of newly installed photovoltaic added

down from 23 GW

Installed capacity failed to grow

Indicative of the troubles associated with a

global oversupply of poly silicon

Trade disputes between China, US & Europe

Germany still a world leader with 7.6 GW of solar capacity added

Italy was still the world's 3rd largest market, with 3.3 GW.

China installed between 3.5 GW and 4.5 GW

2nd behind Germany

U.S. fourth with 3.2 GW
Japan fifth with 2.5 GW
France sixth with 1.2 GW.

330 GW of global PV capacity by 2020

97 GW in 2012

To

329.8 GW in 2020

16.5% CAGR

Continued to grow

even during a severe economic crisis.

PV is the third-largest
deployed renewable technology in terms of global installed capacity,

after small hydro and wind

On a Macro Level

Global goals of
energy security

Stability

Independence

are driving both developed and emerging governments

Solar Micro-grids
Grid-tied Distributed PV

Utility Scale Installations

On a more granular level

Funding & Incentives
by National & Regional Governments

Financing Schemes for Consumers

Reductions in Costs due to Technological Advances

Shift from Thin Film

To

Crystalline Silicon PV
(Mono and Poly)

Due to Silicon Prices Plummeting
+
China Factor

Competitive Scenarios

- High barriers to entry
- Cost Competition
- Branding
- Quality
- Reliability
- Efficiency
- Balance of Systems (BOS)
- Installation
- Cost of Customer Acquisition

- Requires Major Capital Investment
- Advanced Technological Expertise
- Extensive distribution & Installation

Reduced PV module prices
Feed-in tariff (FIT) subsidies in Europe
Widespread growth of small-scale distributed capacity

EU = Italy, Germany, Spain & France
Accounted for
70% of the world's new capacity
additions in 2011

Lucrative tariffs have already reduced and will lessen

Germany is estimated
to have accounted for
Around **32%**

of global PV installed capacity in 2012

Germany

2.7 GW in 2006 to 30.1 GW
just six years later in 2012

48 GW by 2020

Spanish Wind & Solar Boom

Generous subsidies during a

decade-long economic boom

Cost of the subsidies were not passed on fully to consumers

Acciona & Abengoa have been hit hard by the new rules

Decree by the government
Spain-based companies have virtually no form of appeal

Foreign Companies with Investments

Germany's E.ON

Japan's Mitsubishi & Mitsui

11 investors:

Ampere, AES Solar, KKR, RREEF Infrastructure, MEAG, KGAL, Infrared Capital Partners, HG Capital, Eiser Infrastructure Partners, Cube Infrastructure & Antin Infrastructure Partners.

USA & Canada

Investment Tax Credits (ITCs)
Production Tax Credits (PTCs)

Ontario's Green Power Tariff System

USA

Stimulus Package $3.1 billion to the states

Mexico

Sonora Desert in Northern 25 Sq KM
enough solar energy to supply
Mexico´s 114 million inhabitants with electricity

Average in Mexico 5 kWh/m2/day

0.06% of Mexico´s national territory would be sufficient to generate the entire electricity consumption of the country

Mexico is an Open Economy

Growth 3.8% last year
Similar figures expected for 2013
United States´ Neighbor
Plethora of free trade agreements attract investors from across the globe.

Mexico´s potential is still largely untapped

In 2011 solar power amounted to **only 1%** of the country´s energy matrix.

Asia

5 Chinese companies among the top 10 module Manufacturers Worldwide

Japan, India & Taiwan

Long-term Policies & Financial Incentives

R&D Initiatives

China

China **exports over 90%**
of its production capacity.

Facing **Serious Antidumping Allegations**

Planning to Significantly Increase
Domestic solar Module Installations

7.6 GW in 2012 to 70 GW in 2020

INDIA

Good 2012 Year for Indian Solar

Policy Support
Investments
India's Cumulative Solar capacity is > 1 GW
830 MW or nearly 80% was installed in 2012

2012 Most Successful India's Solar History.

Severe Energy Shortage in India

Very Poor Electrical Grid Coverage

Residential. Industrial, Commercial
Non Existent Power in Villages
No or lack Power for Irrigation

Storage is a BIG Gap

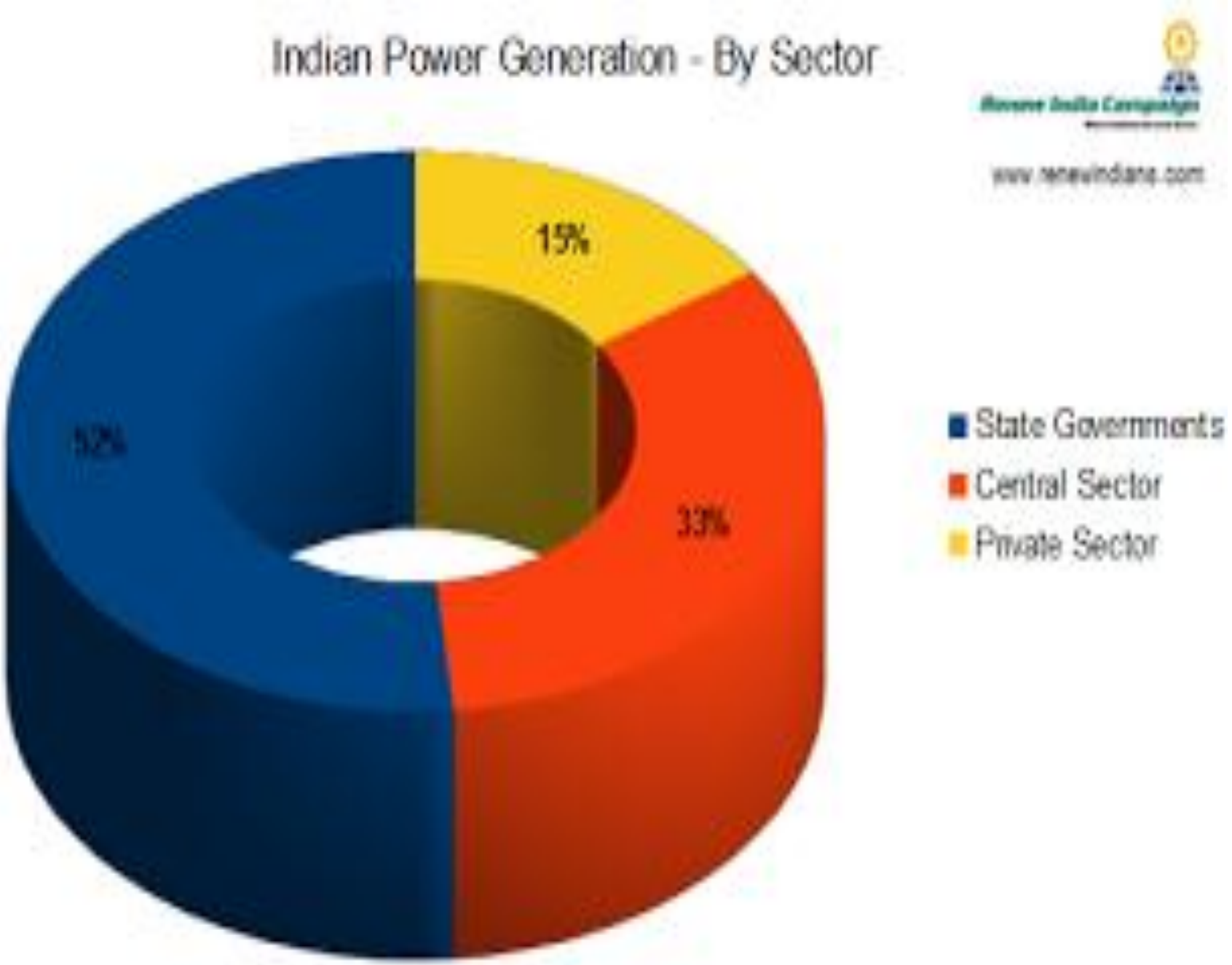
Mostly **Diesel Generators** are Used
Scheduled and Random Power Cuts

Seriously affecting industrial production & quality of life

India Power Summary

Total Power Generation Capacity of **210 GW**
Mainly running on commercial sources like:
Coal, Lignite, Natural Gas, Oil, Hydro, Nuclear

Renewable sources like:
Wind, Solar and Agriculture & Domestic Waste


Indian Power Generation - By Sector
www.renewindians.com
15%
52%
33%
State Governments
Central Sector
Private Sector

India

5th largest Electricity Producer in the World

State Governments 51.5%

Central sector 33.1%

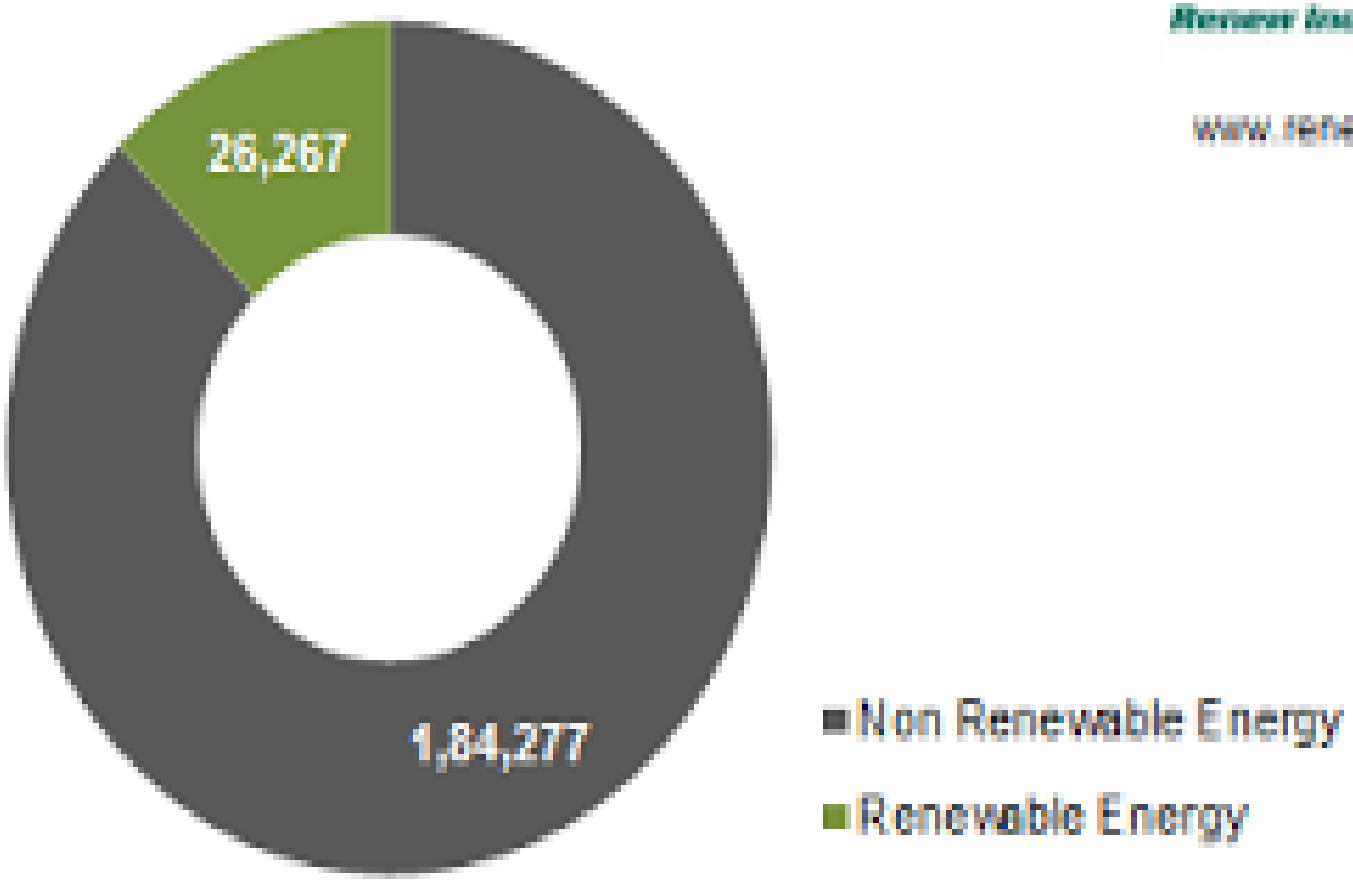
Private Sector 15.4%

Source: Planning Commission of India

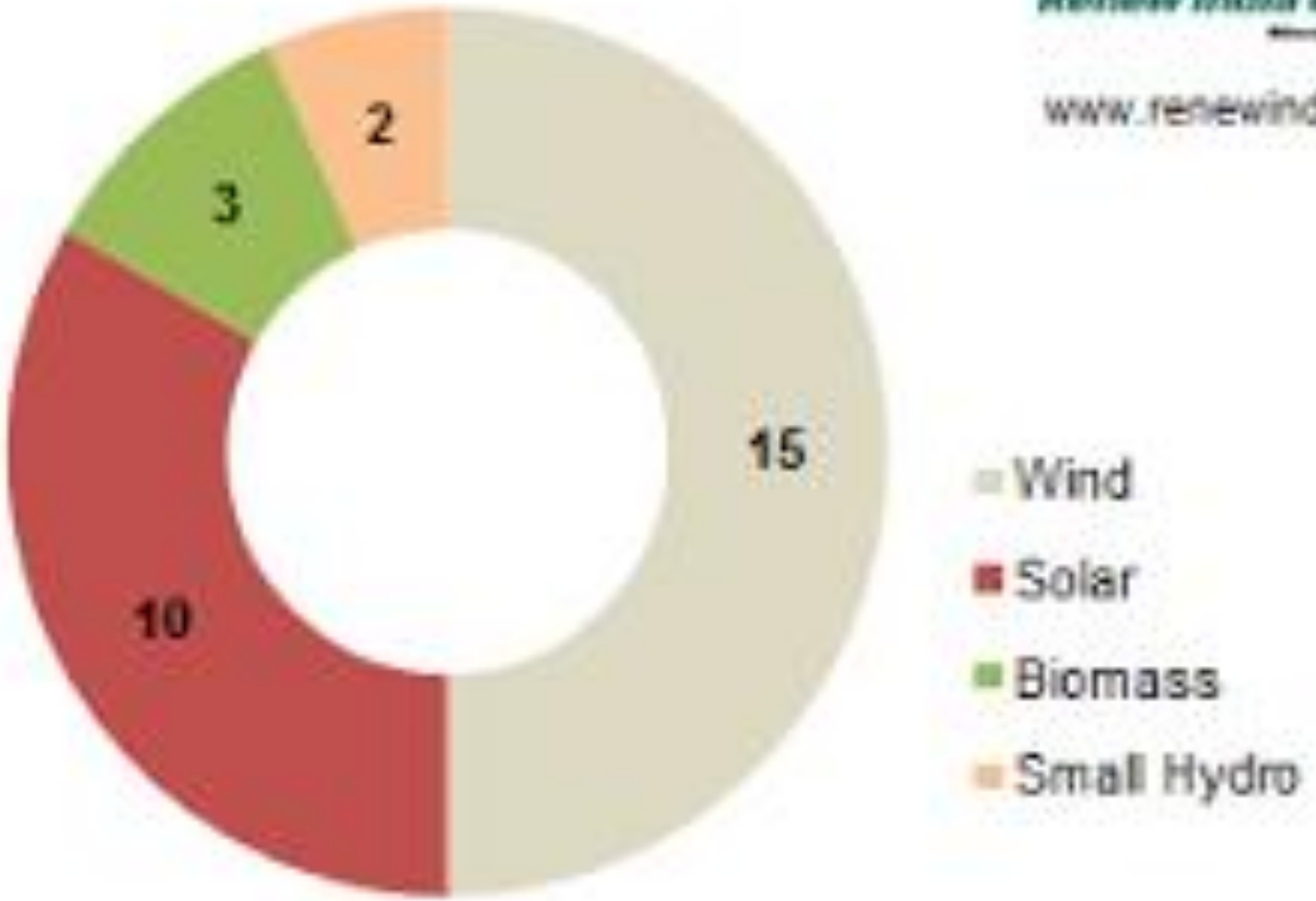
Contribution of Renewable Energy in India's Power Mix - MW;

Renew India Campaign

www.renewindians.com



Twelfth Five Year plan period Renewable Energy Installation Target in GW



Renew India Campaign

www.renewindians.com

Indian Ministry of Commerce is formally going ahead with the **anti-dumping** investigations

onto the PV modules manufactured in

China, US, Chinese Taipei and Malaysia

Ministry of National Renewable Energy (MNRE)

Planning **Solar Cities** across the Country
States are planning PV installations

in houses and install **Solar Street Lights**

States have announced **1GW to 3GW per state**

Total Indian Demand > 50 GW in 5 years

Opportunity for Foreign & Domestic Companies

Lot of jobs for installation labor & supervisors

"Softer Costs" will still Remain High

Rapid dip in prices of Solar Panels

BOS Costs are a significant portion of the Total Installed Cost

Permitting and other Installation Costs High

State of Kerala
10,000 Solar Home Project

Kerala is planning to improve it's Solar Footprint by introducing **10,000 Solar Home Project**

Solar PV systems of **1 KW size** on 10,000 Roof tops across the state

Good News for Employment: Solar Jobs

BIG Problems in the Indian Solar

Rupee Depreciation

Inflation

Very High Bank &
other Financing Interest Rates

Dependence on China & other countries
For panels and BOS

Undeveloped / Underdeveloped
Solar Manufacturing Infrastructure

Key Markets of the Future

South & Central America
Mexico, Brazil, Chile

Middle East
Qatar, Saudi Arabia, Abu Dabi, Dubai

Africa
South Africa, Ghana, Kenya, Nigeria

THANK YOU

Sunny Future for Solar

For any technology or business follow up

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