

# Photovoltaic Technologies: Status and Trends

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ICAO Capacity Building Seminar on Low Emissions Aviation Measures

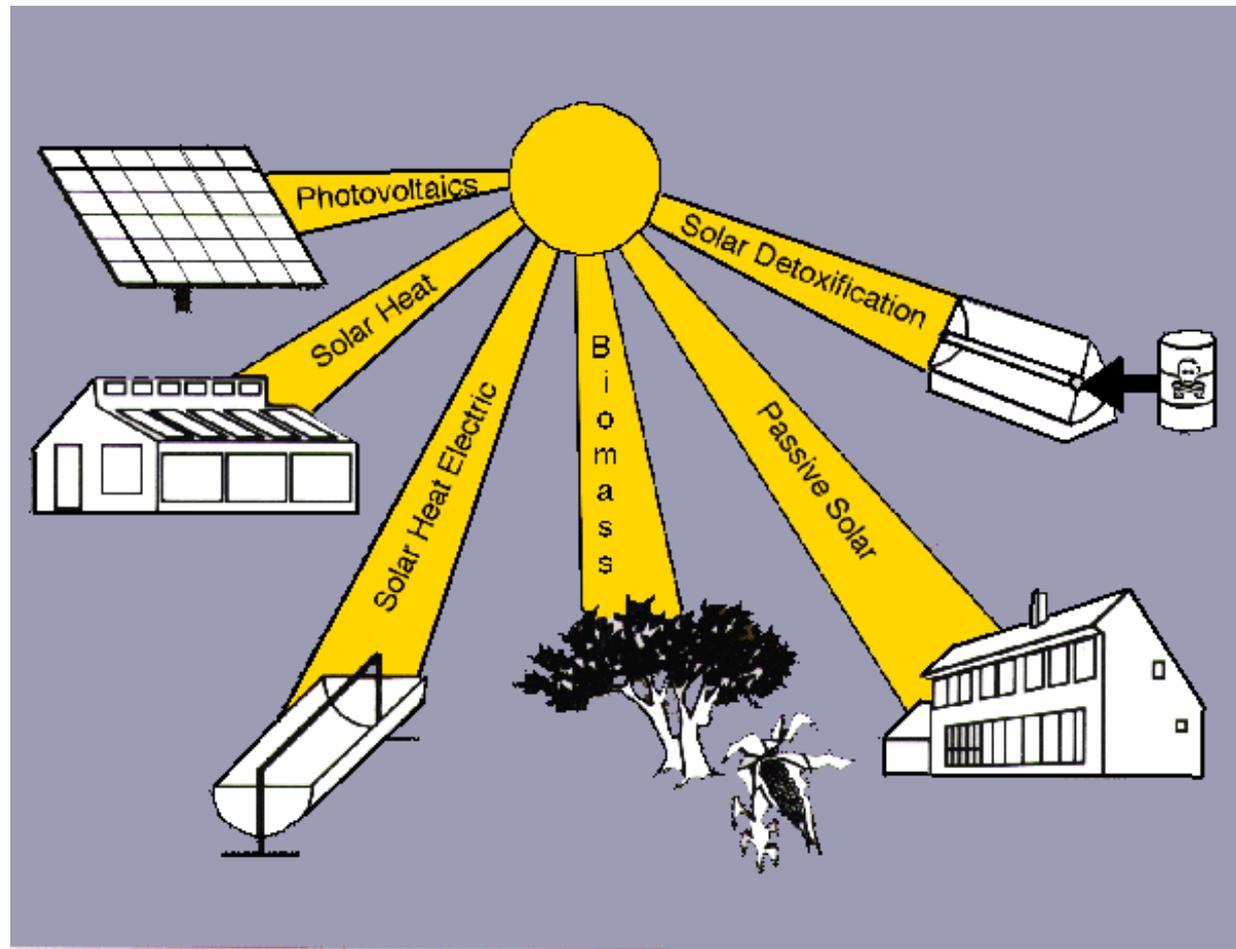
25-26 April 2018

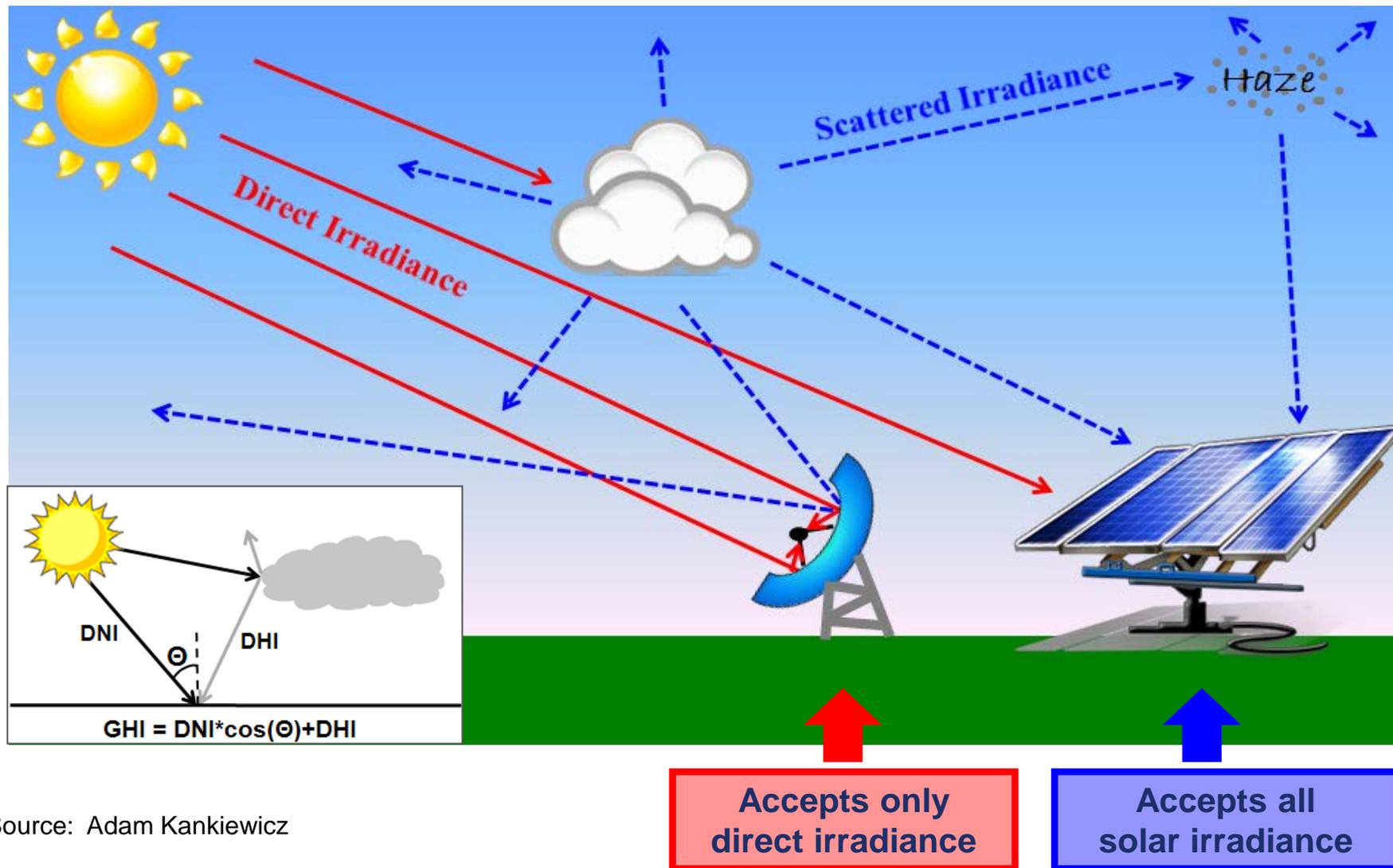
Kingston, Jamaica



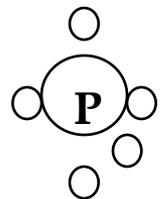
| ICAO

- 
- Solar Energy Fundamentals
  - Solar Energy Trends
  - Issues related to grid-tied solar
  - Summary comments

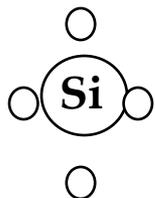




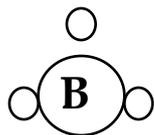
Source: Adam Kankiewicz



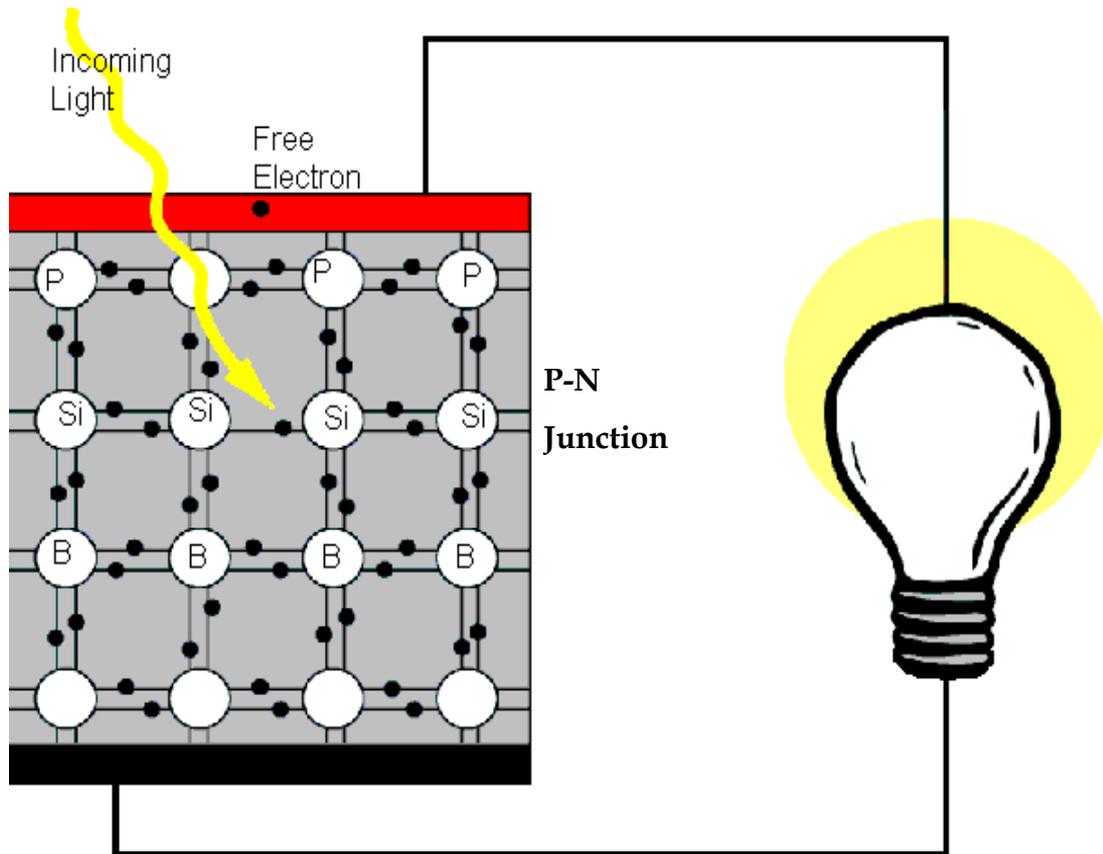
Phosphorous: 5 valence electrons



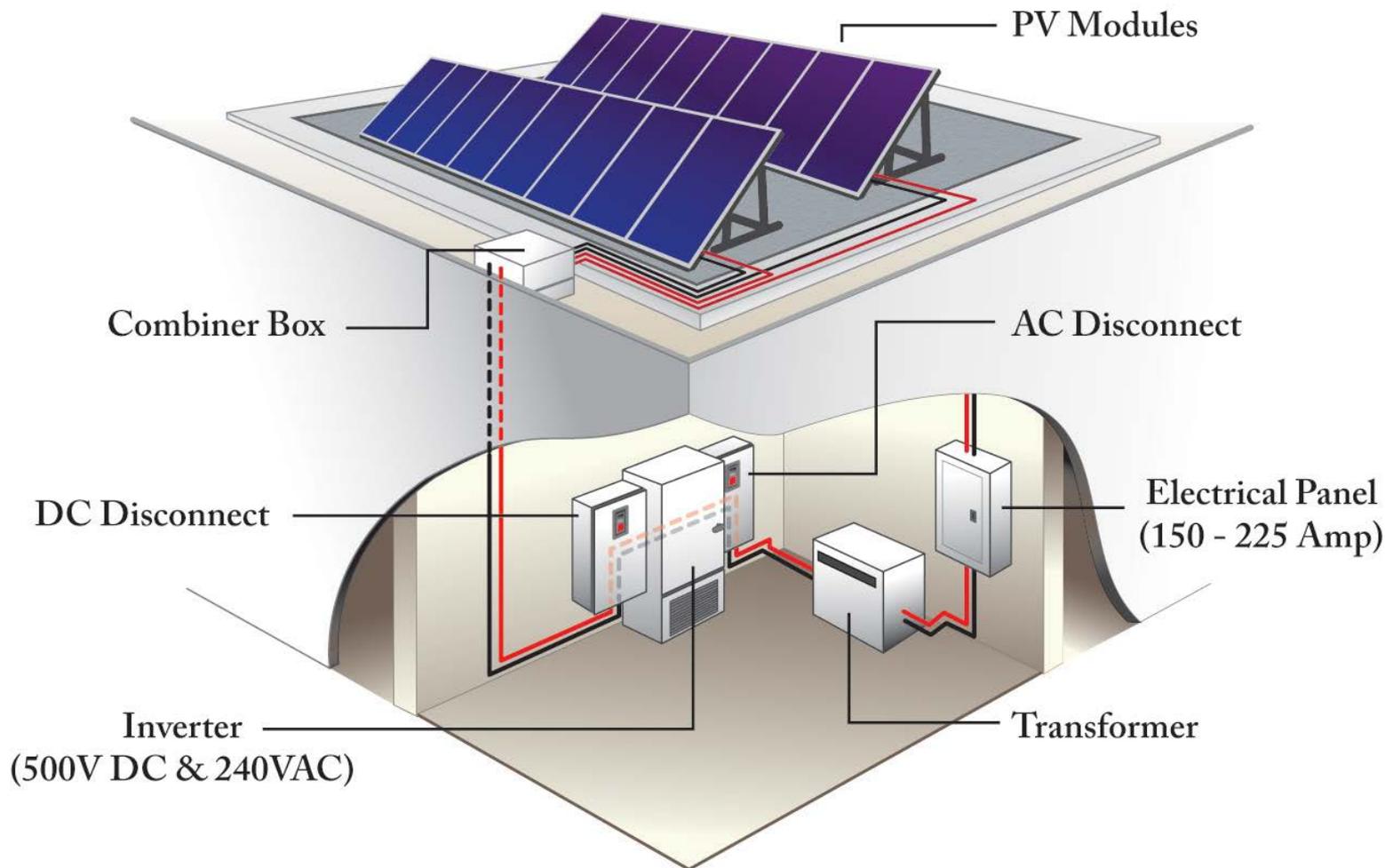
Silicon: 4 valence electrons



Boron: 3 valence electrons



**No material is consumed and the process could continue indefinitely**



## +75 GW



**Global Capacity at end of 2016 = 303 GW**

**2017 Estimate: +98 GW**

**+21 GW<sub>th</sub>**

**+0.1 GW**



**Global Capacity at end of 2016 = 456 GW<sub>th</sub>**

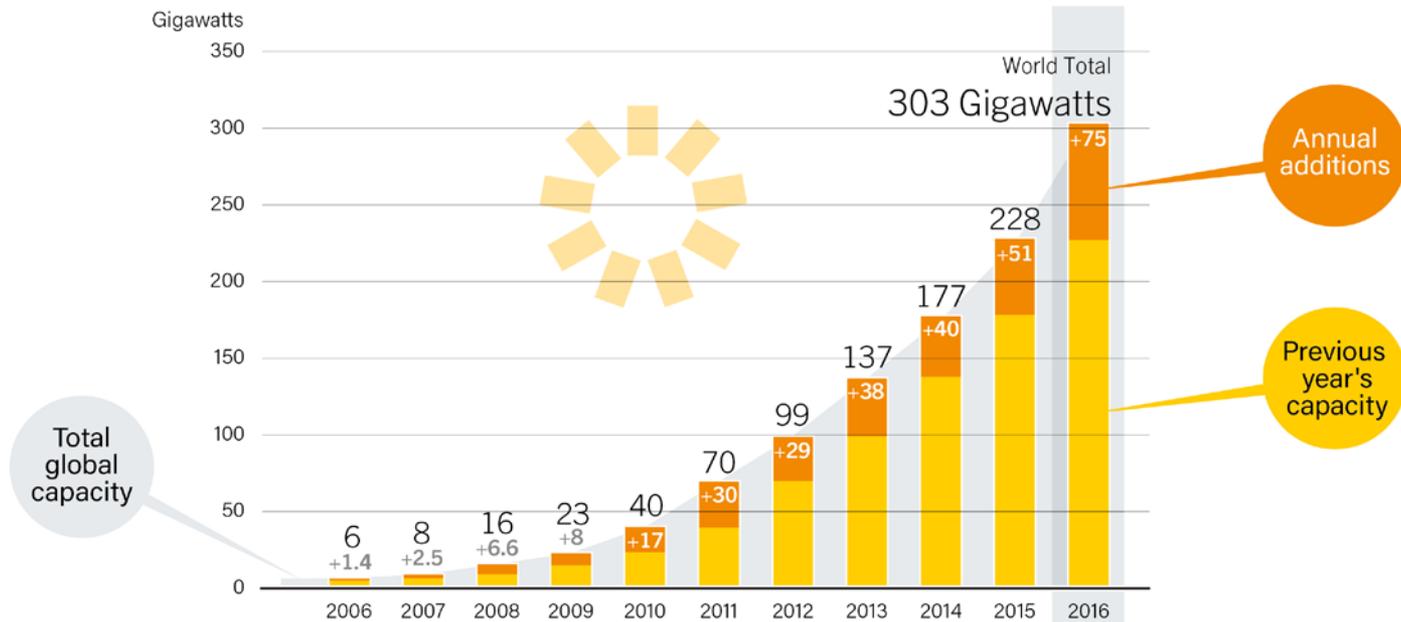
Source: "Global Heat Worldwide" as published in REN21  
GSR, 2017 ; Photo Credit: NREL Photo Library



**Global Capacity at end of 2016 = 4.8 GW**

Source: REN21 GSR, 2017; Photo Credit: NREL Photo Library

## Solar PV Global Capacity and Annual Additions, 2006-2016

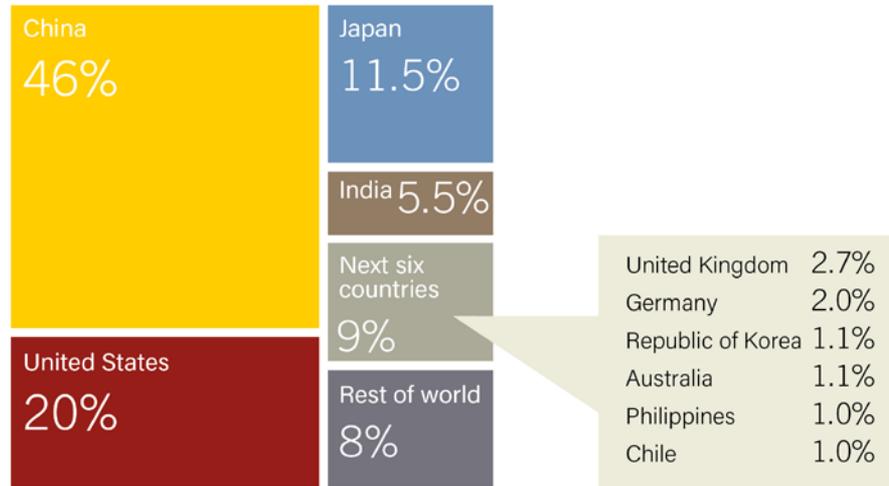


REN21 *Renewables 2017 Global Status Report*



**PV Capacity expected to grow to >1 TW in next 5 years**

Solar PV Global Capacity Additions, Shares of Top 10 Countries and Rest of World, 2016

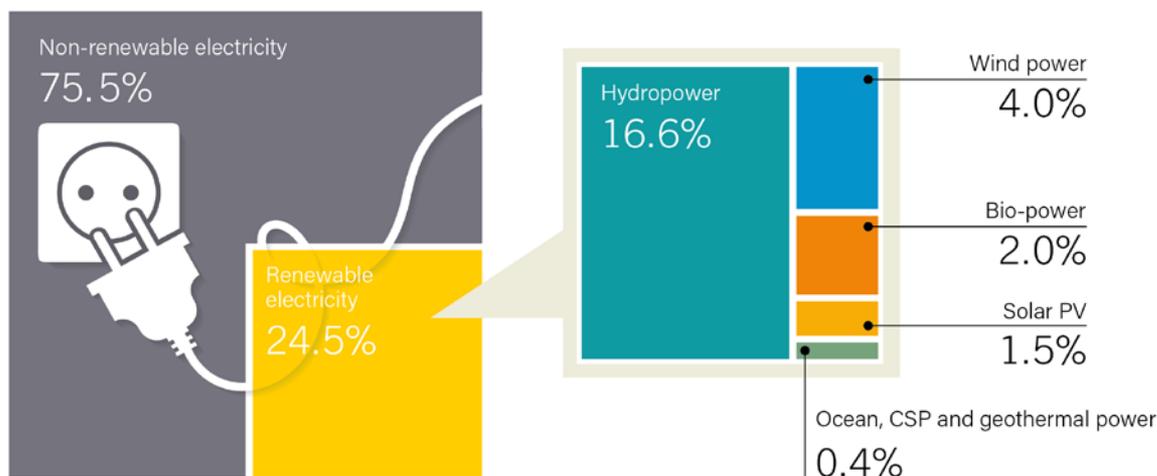


REN21 *Renewables 2017 Global Status Report*



**Top 4 Markets Account for >80% Additions in 2016**

## Estimated Renewable Energy Share of Global Electricity Production, End-2016

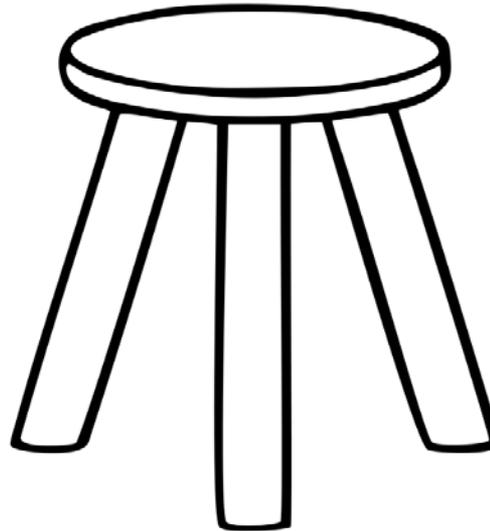


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## RE Share Continues to Increase in Power Sector

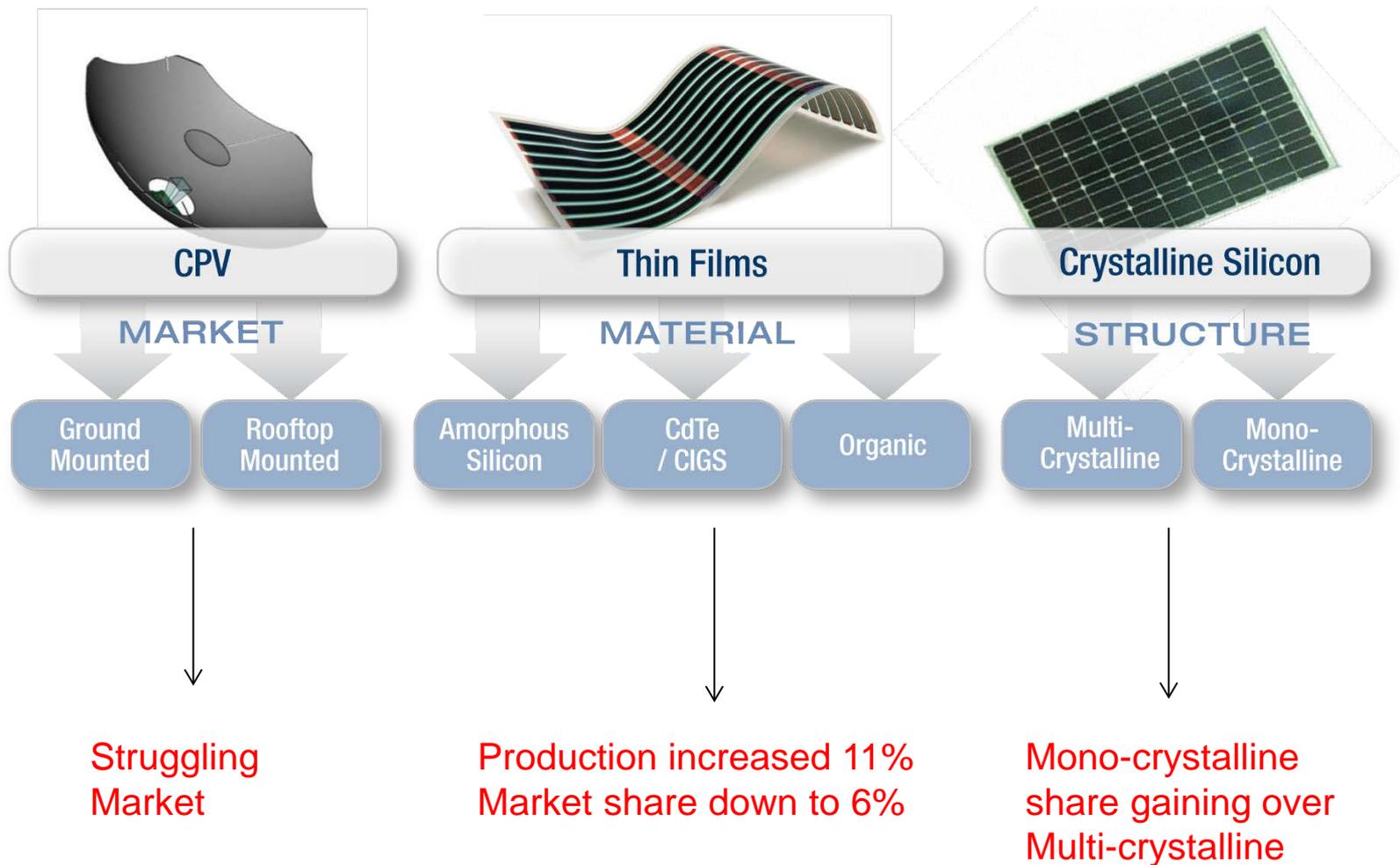
# The “Three-Legged Stool” that Supports Successful Solar Programs



**Bankable Technologies; R&D  
(Cells, modules, inverters, storage,  
Etc.)**

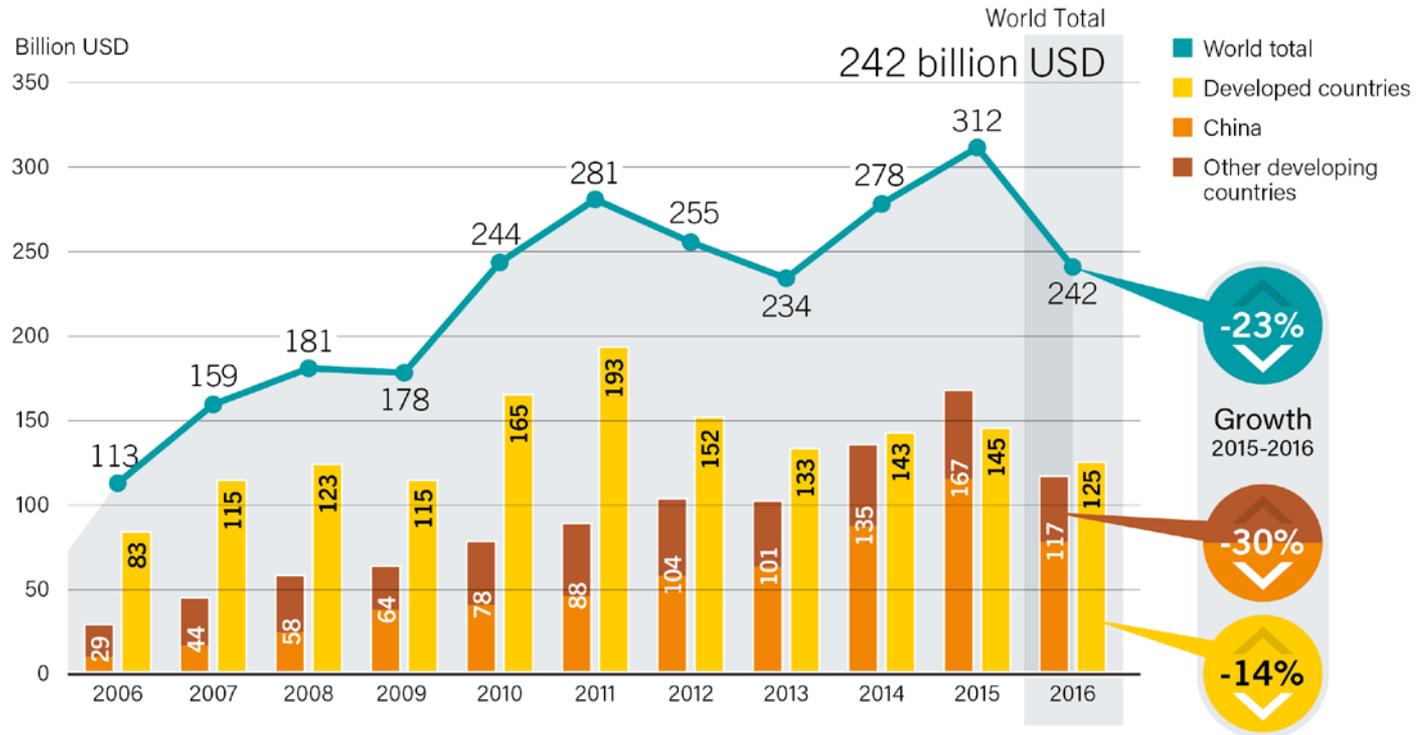
**Access to Capital  
(Especially private)**

**Favorable and Reliable Policies  
and Targets**



Source: REN21 GSR, 2017

## Global New Investment in Renewable Power and Fuels, Developed, Emerging and Developing Countries, 2006-2016



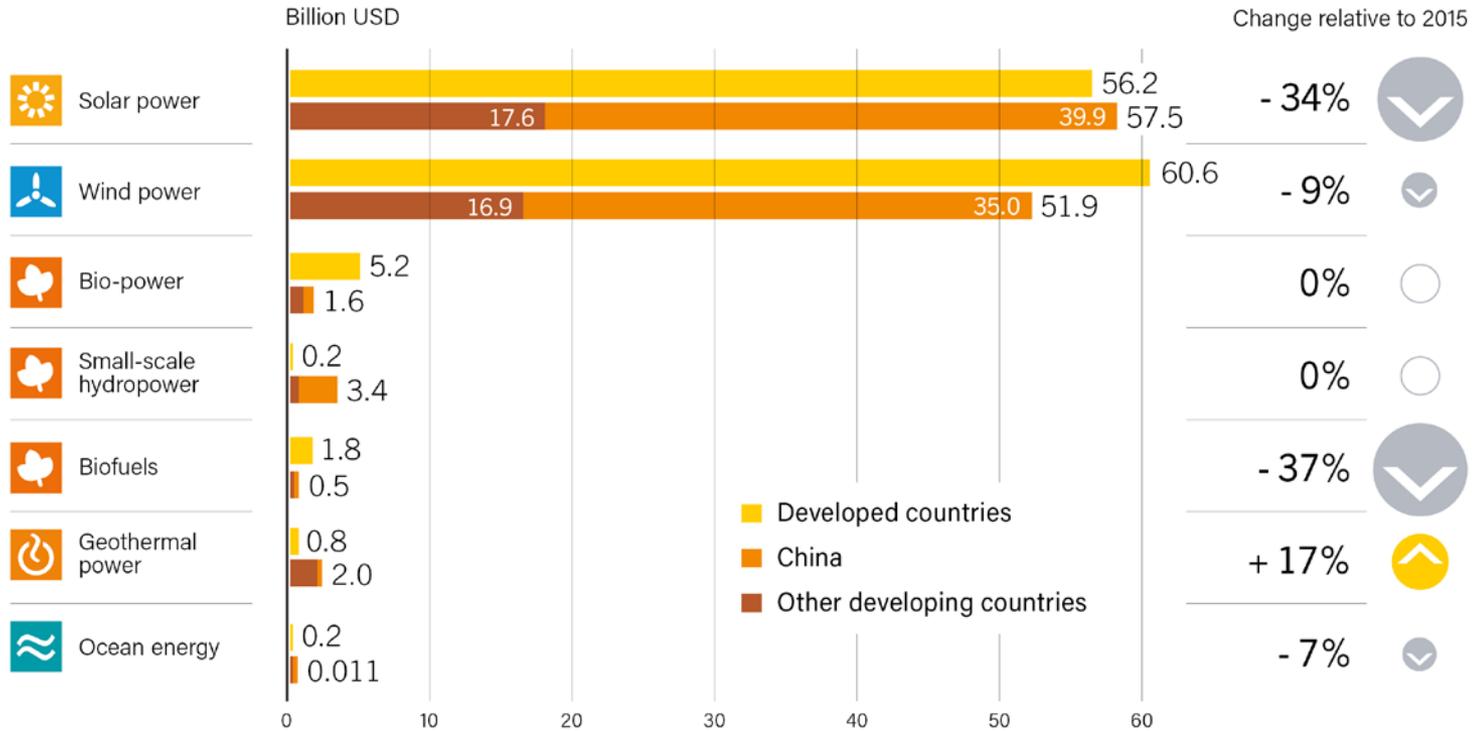
Note: Figure does not include investment in hydropower projects larger than 50 MW. Investment totals have been rounded to nearest billion.

REN21 *Renewables 2017 Global Status Report*



Source: BNEF.

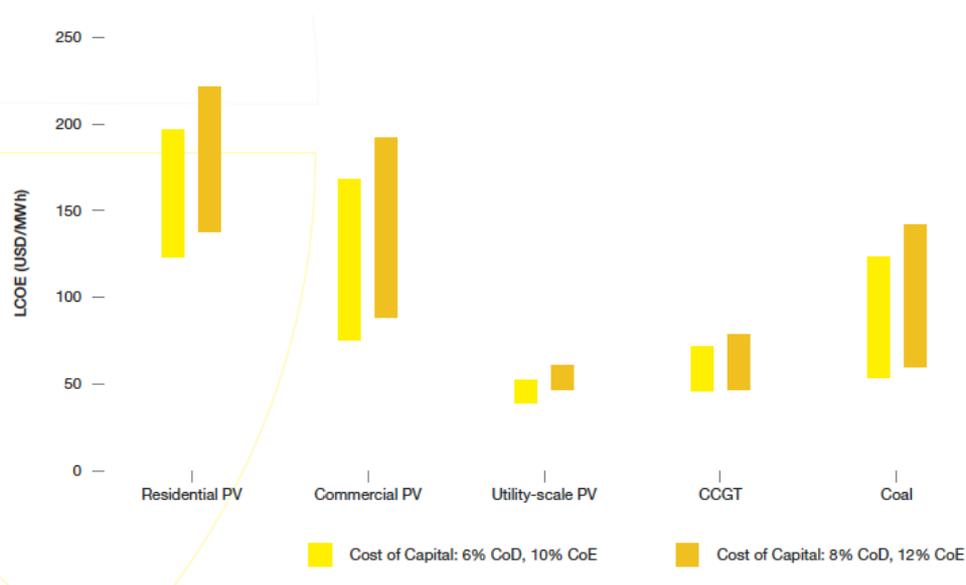
## Global New Investment in Renewable Energy by Technology, Developed and Developing Countries, 2016



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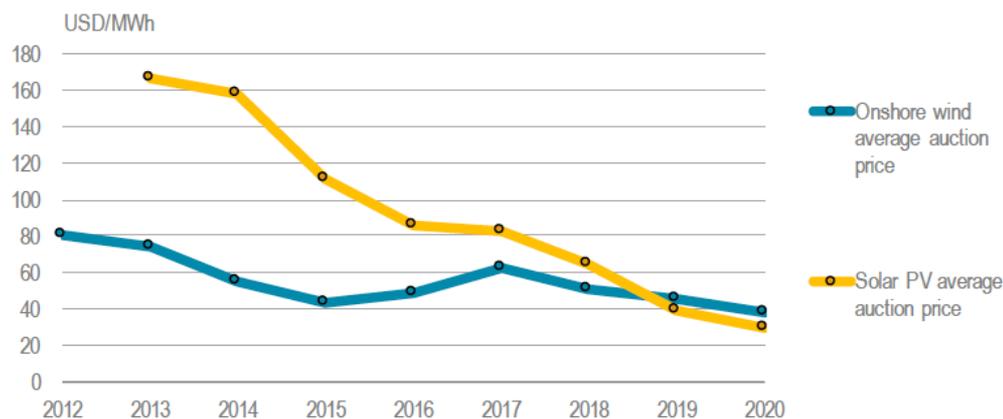


Source: BNEF.



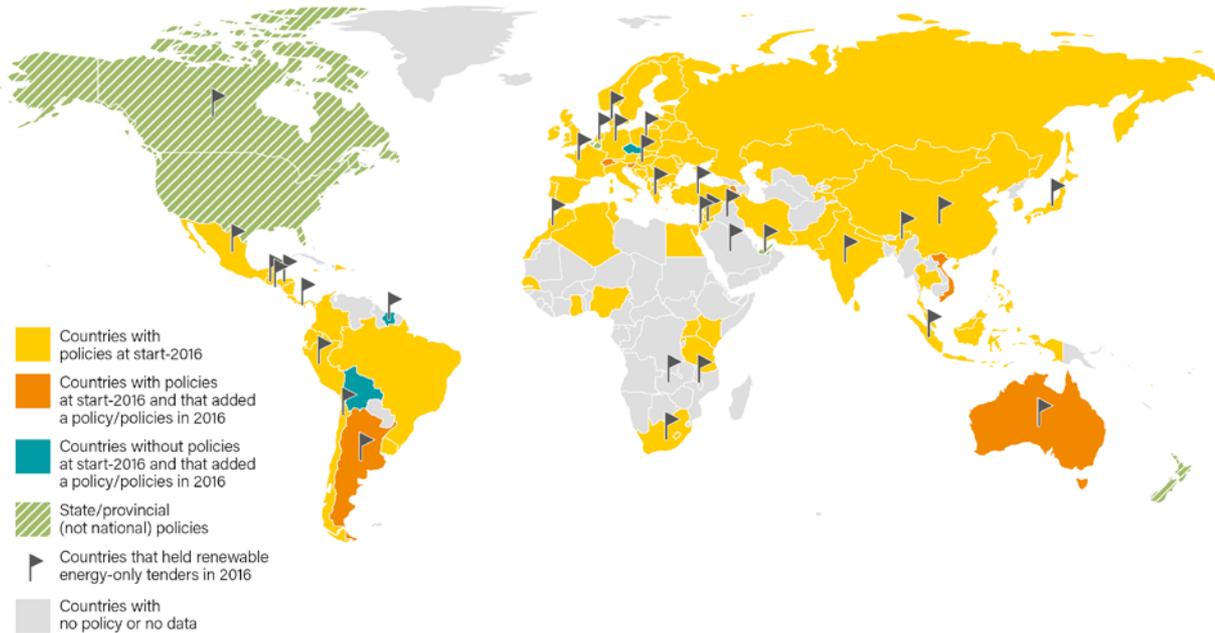
Source: SolarPower Europe Global Market Outlook 2017

Announced wind and solar PV average auction prices by commissioning date



Source: IEA Renewables 2017

## Countries with Renewable Energy Power Policies, by Type, 2016



Note: Figure shows countries with Renewable Portfolio Standards, feed-in tariffs/premium payments and net metering policies. Countries are considered to have policies when at least one national-level policy is in place; these countries may have state/provincial-level policies in place as well. Diagonal lines indicate that countries have no policies in place at the national level but have at least one policy at the state/provincial level.

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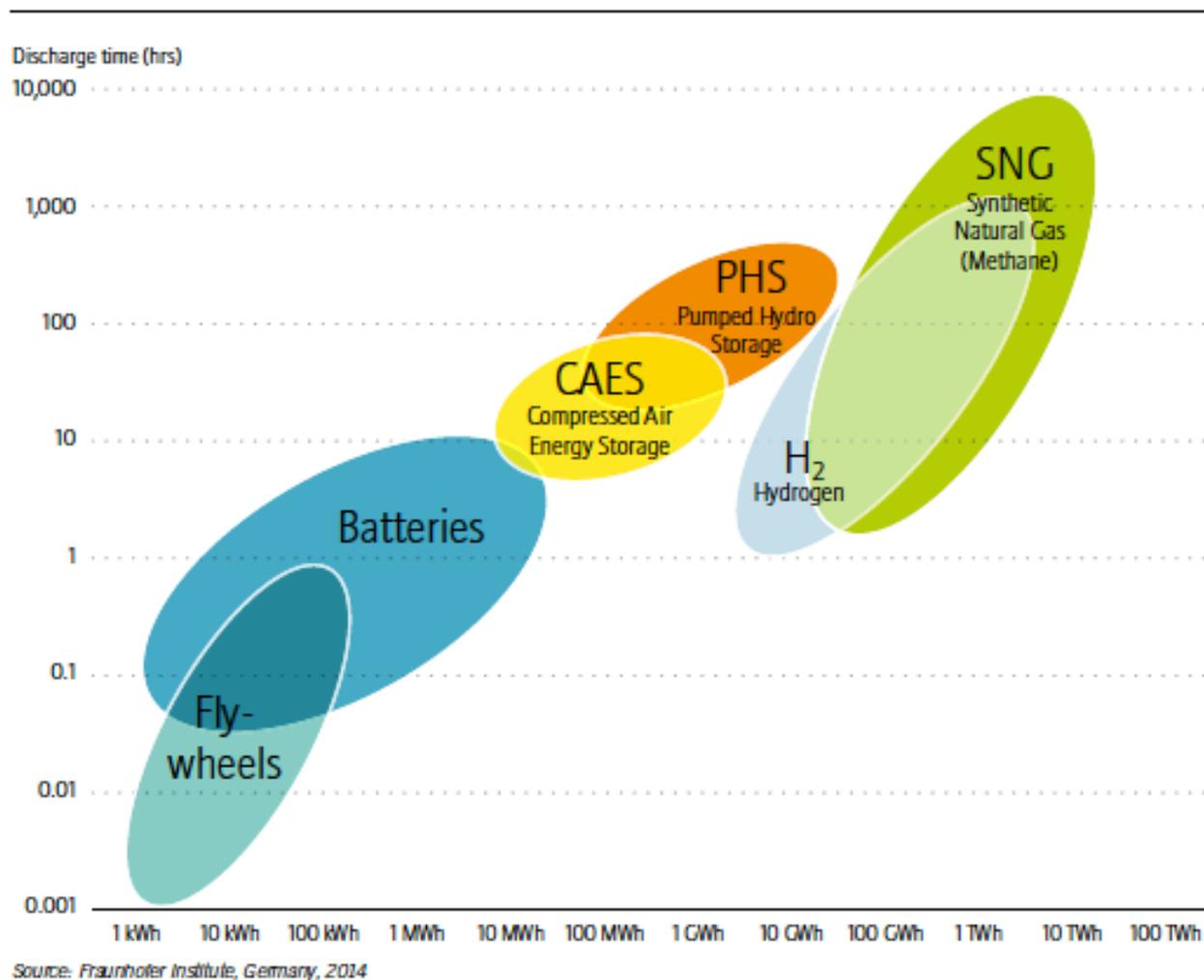


Source: REN21 Policy Database.

**Auctions** are the most rapidly expanding form of renewable energy policy support.

- Integration of VRE
- Forecasting resource variability
- Efficiency measures
- Storage Technologies
- Smart grids and load management
- Energy pricing strategies
- Effective balancing strategies
- International technology and integration standards

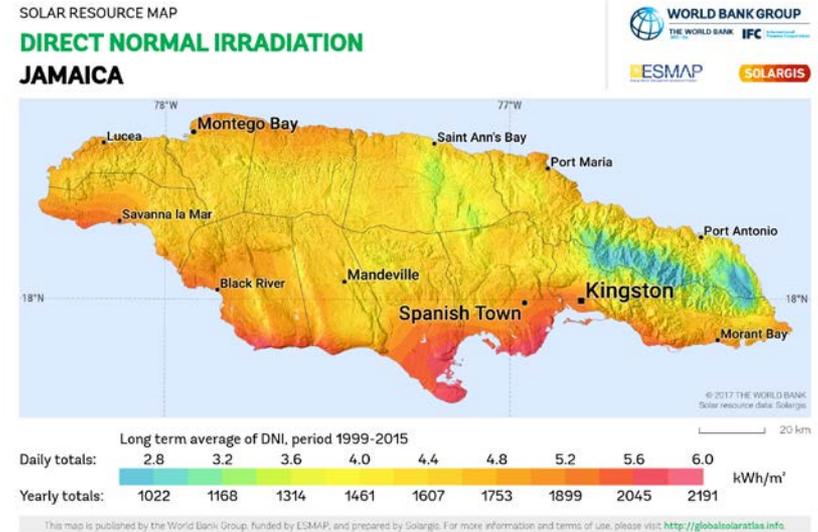
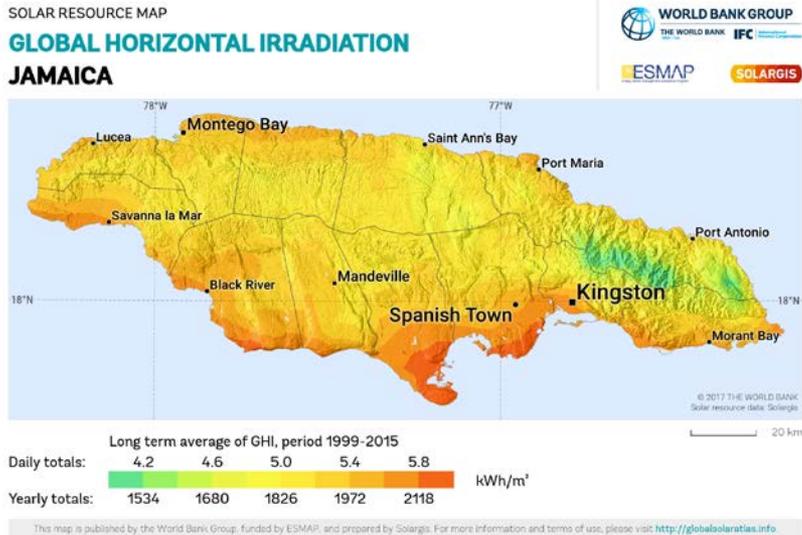




Source: REN21 Global Futures Report 2017

- Even with short-term oil price drops, renewables are now cost-competitive choice for power sector in many cases
- PV Applications, both distributed as well as central station, offer significant benefits
  - Increase grid and energy security
  - Improve our environment
  - Enhance local economy
- Issues for ICAO to address:
  - Creation of an enabling policy environment
  - Workforce development
  - Access to capital investment

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Jamaica Solar Resource Maps from SolarGIS