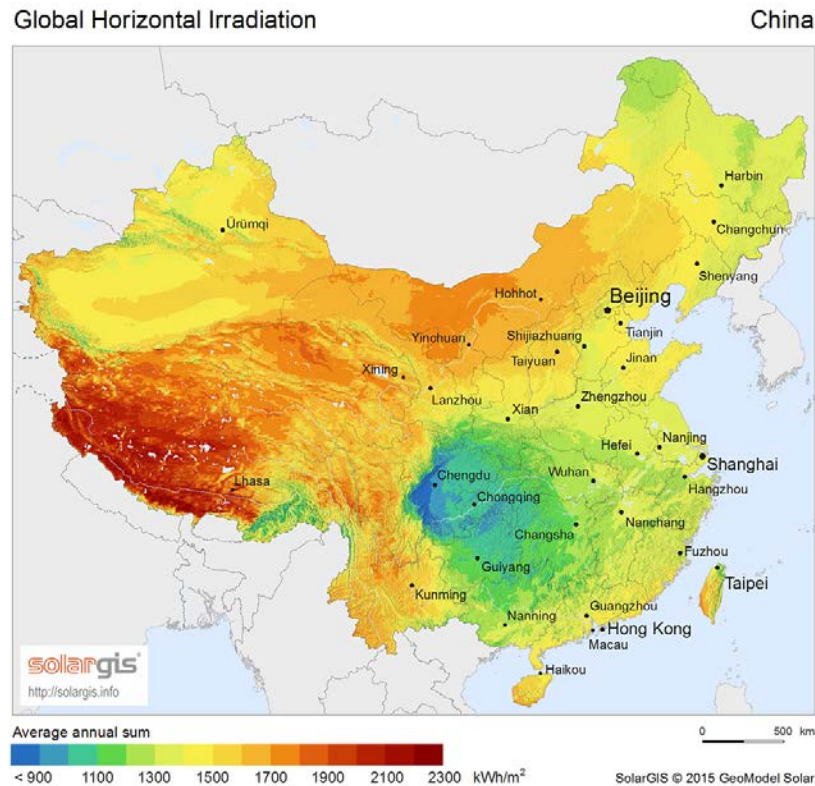


Challenges and Opportunities for achieving 100% Renewable Energy

Dr. David Renné
President, International Solar Energy Society



- The climate challenge
- The growth and opportunities in solar energy
- Renewables working together



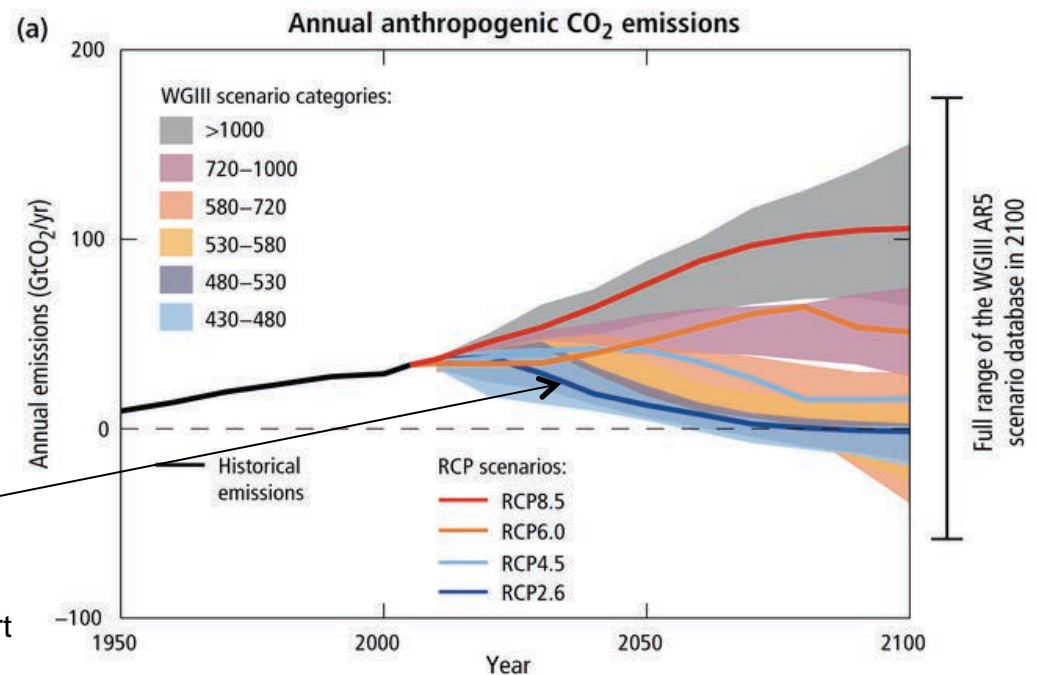
Source: SolarGIS

What the IPCC 5th AR Tells Us

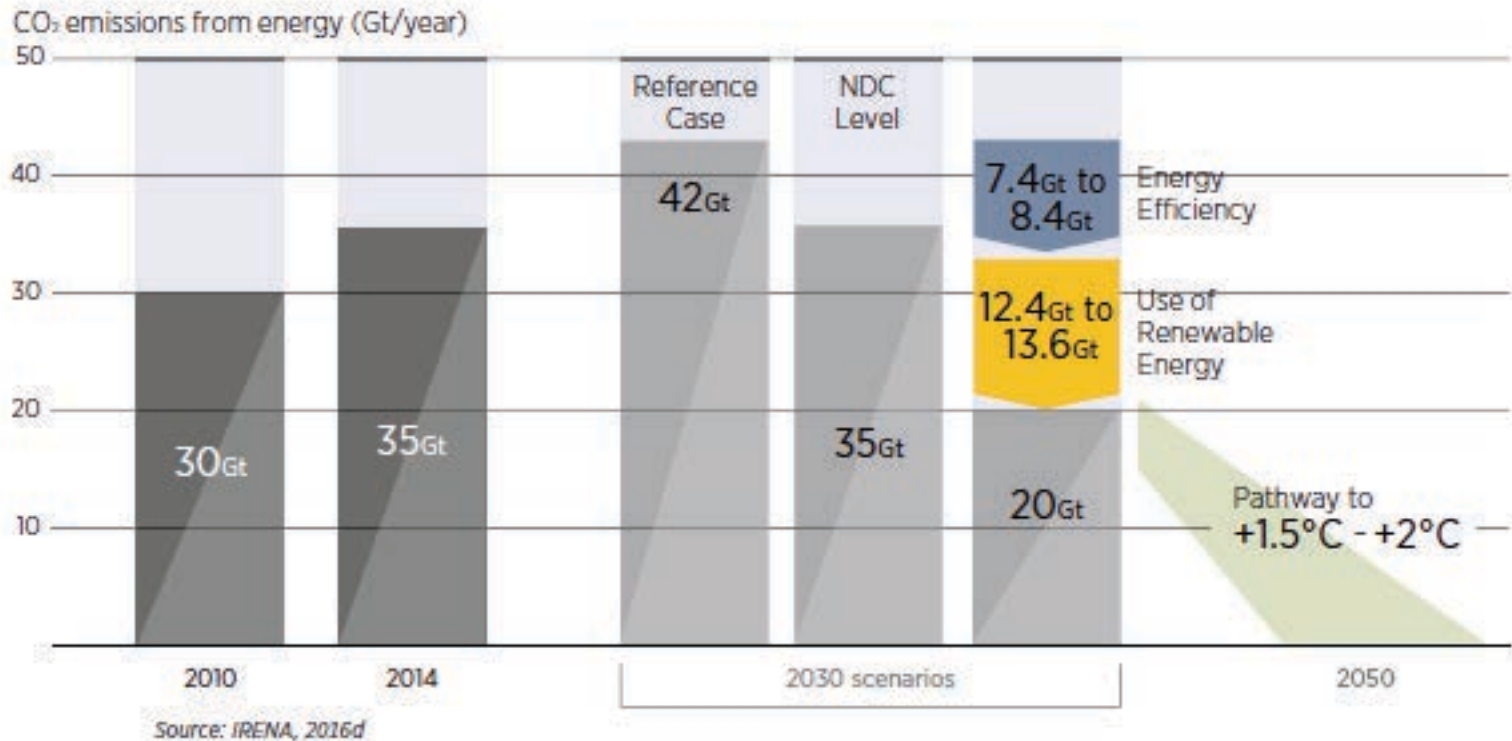
- IPCC has established 4 “Representative Concentration Pathway” (RCP) scenarios
- RCP 2.6 is most aggressive...and the only scenario that maintains global warming at $<2^{\circ}\text{C}$ by 2100.

RCP 2.6 is a “peak and decline” CO_2 emissions scenario

Source: IPCC 5th Assessment Report



The Challenge Facing Society...

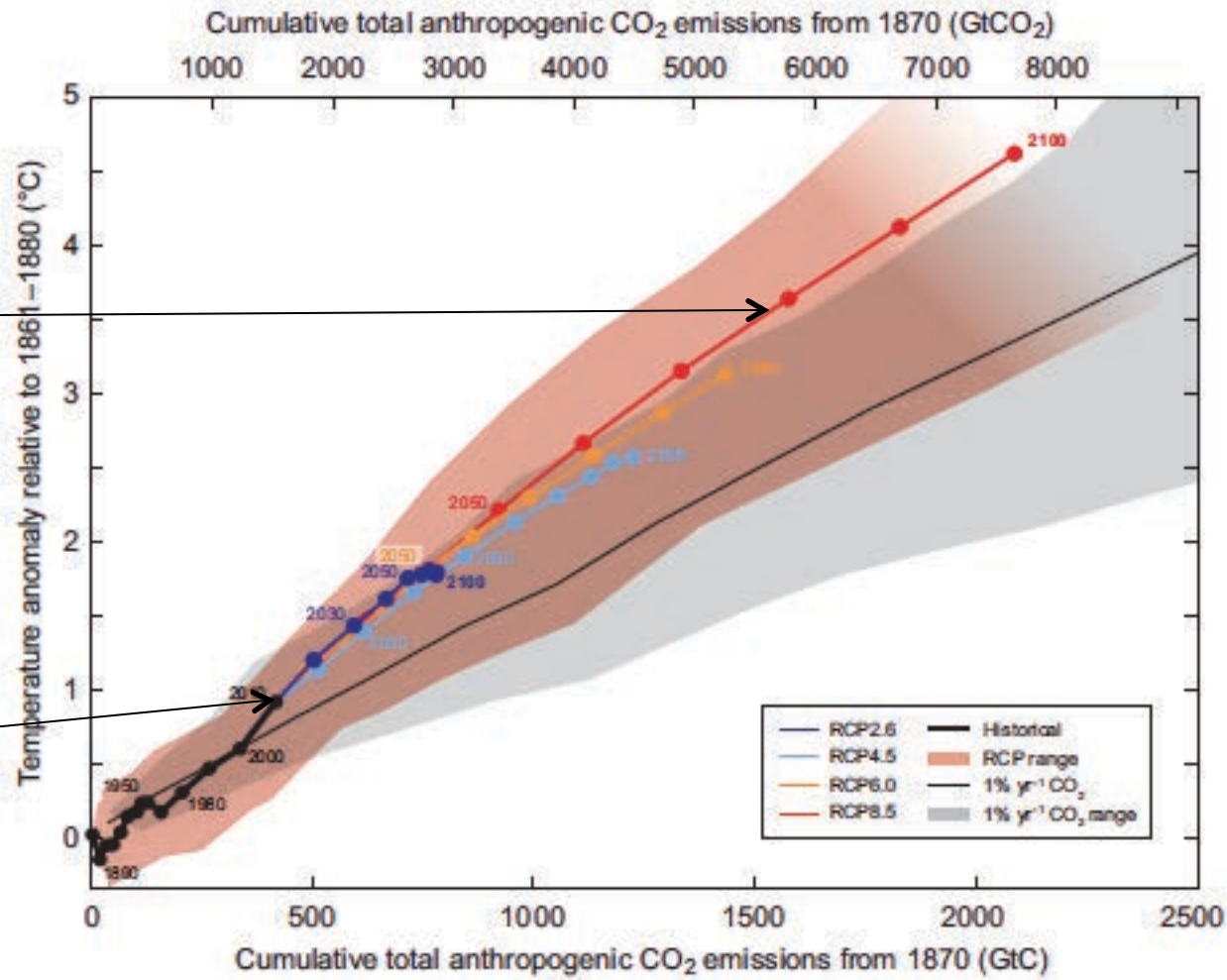


To limit climate change to +2 °C, cumulative CO₂ emissions must not exceed ~1000 GtCO₂ ***from now on...***

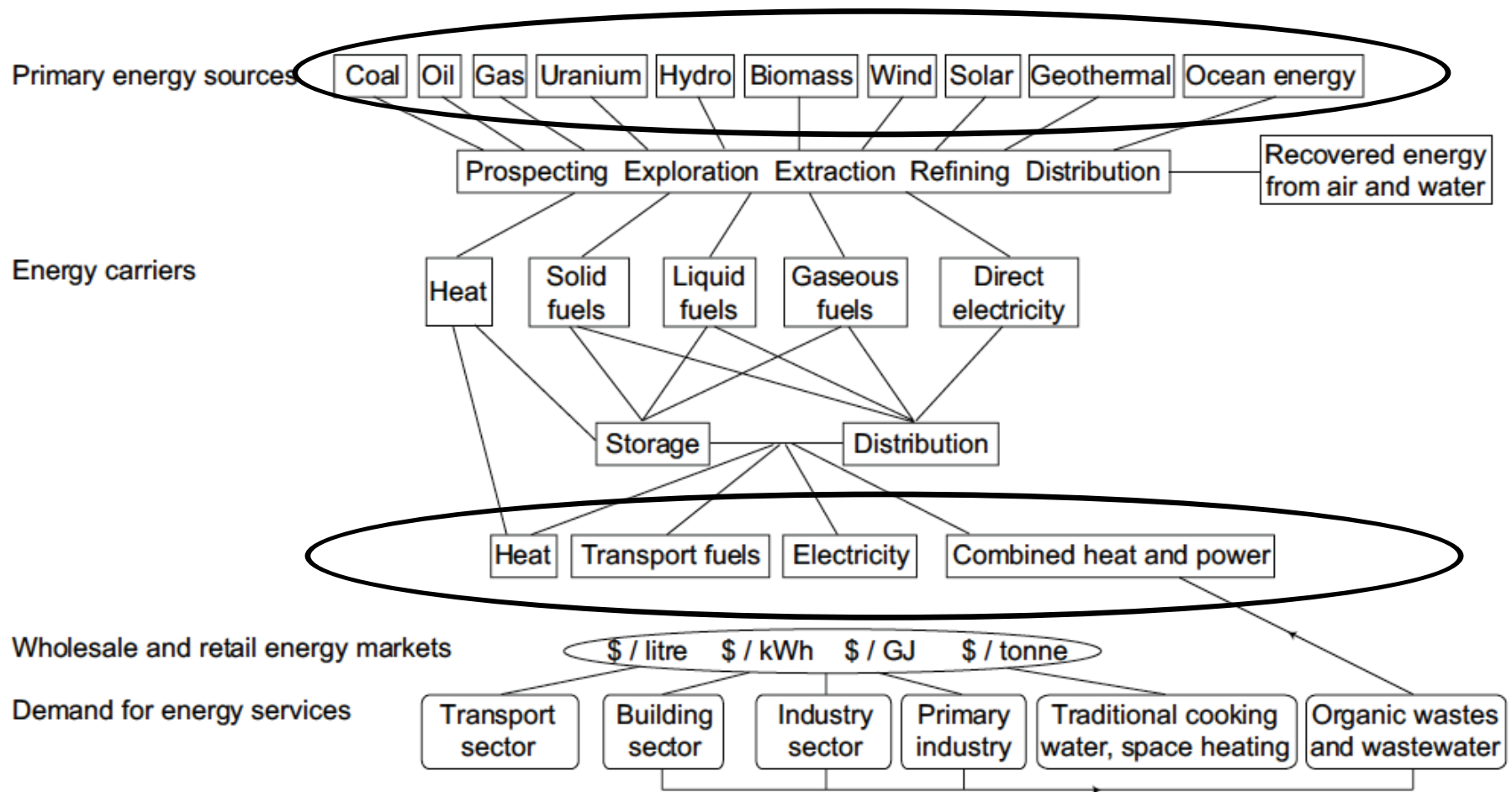
Where will we be by 2100?

INDC's

We are here



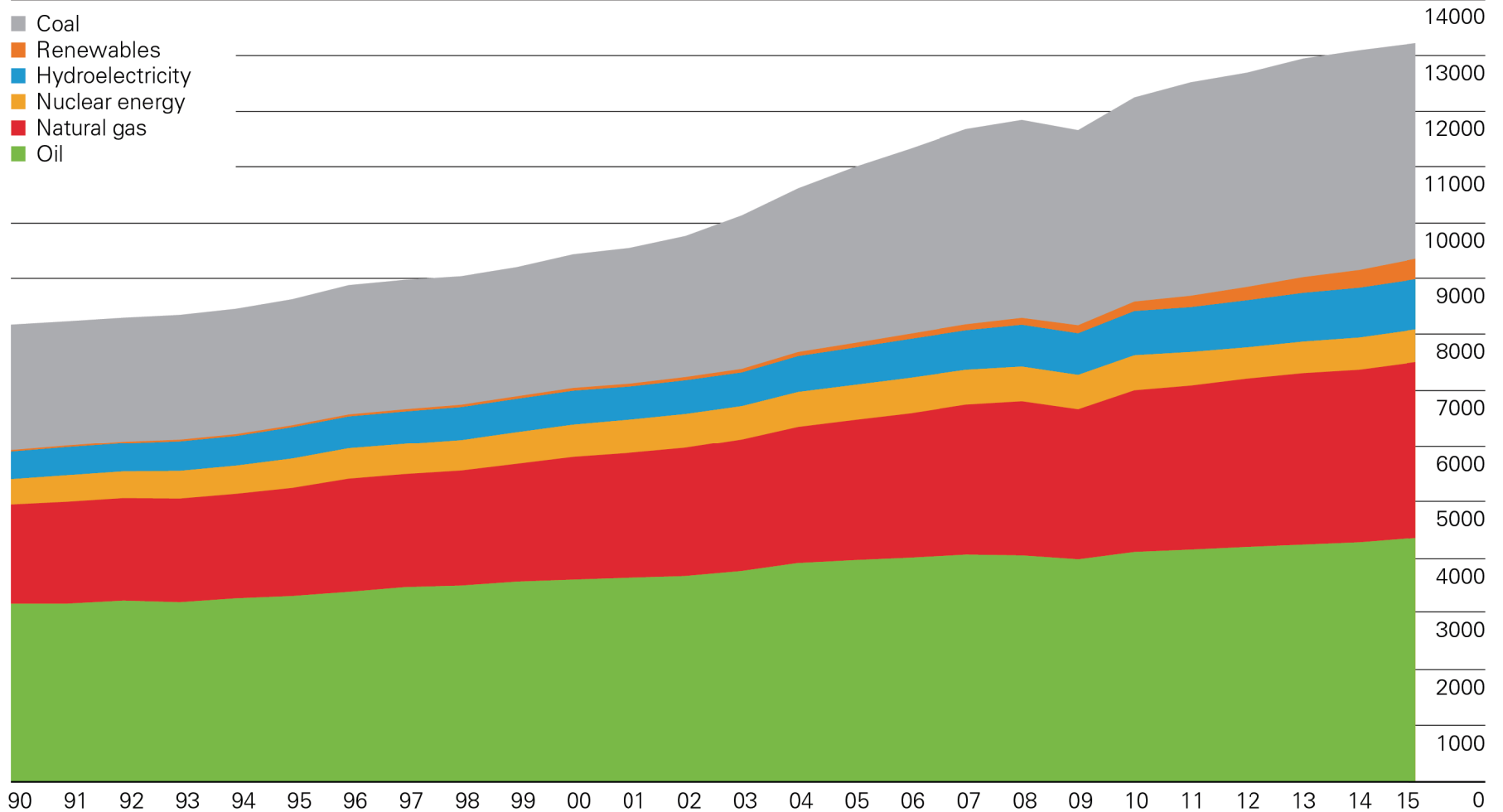
Energy Supply vs. Energy Consumption



Source: IPCC AR5

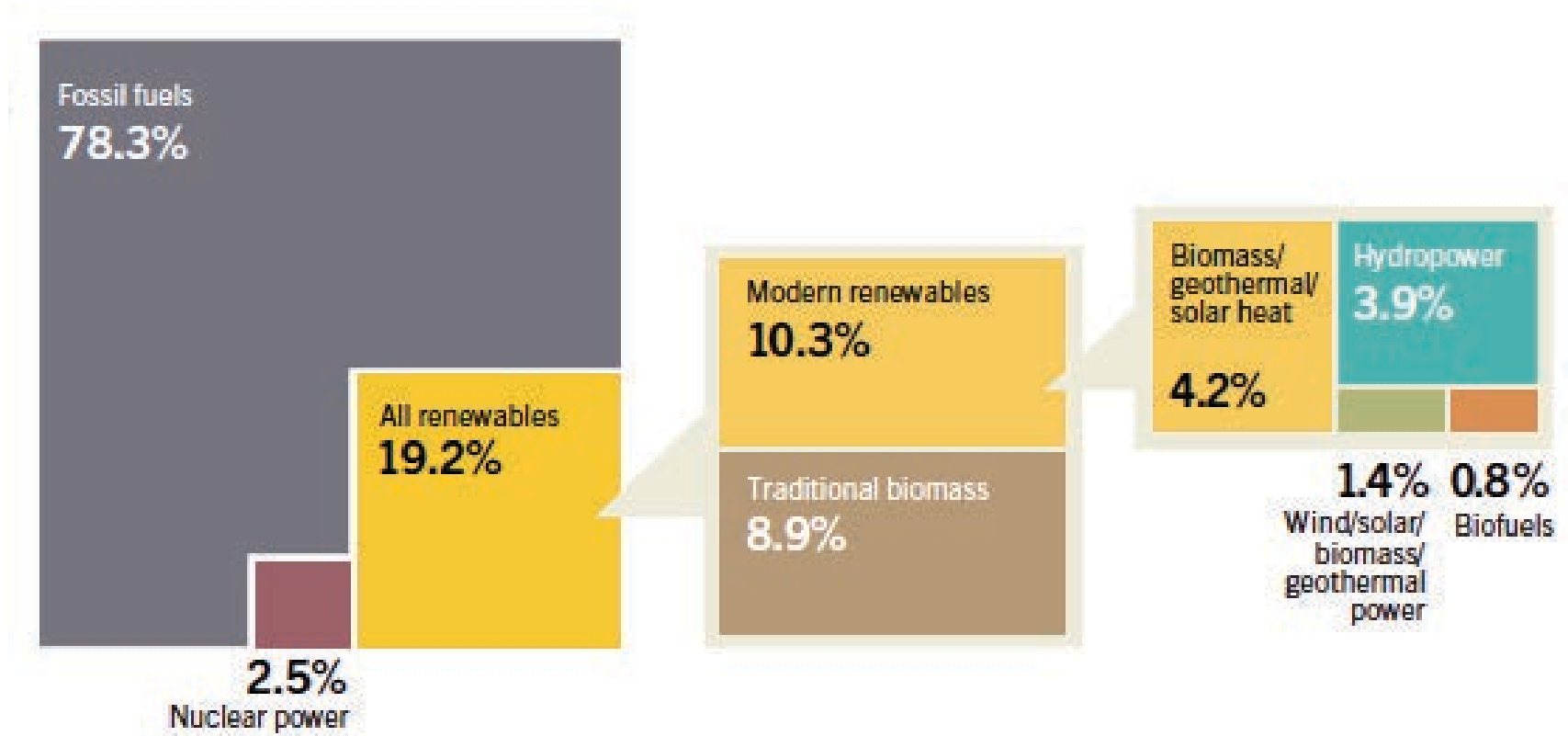
Primary energy world supply

Million tonnes oil equivalent



BP Statistical Review of World Energy
2016 © BP p.l.c. 2016

RE Share of Global Energy Consumption, 2014

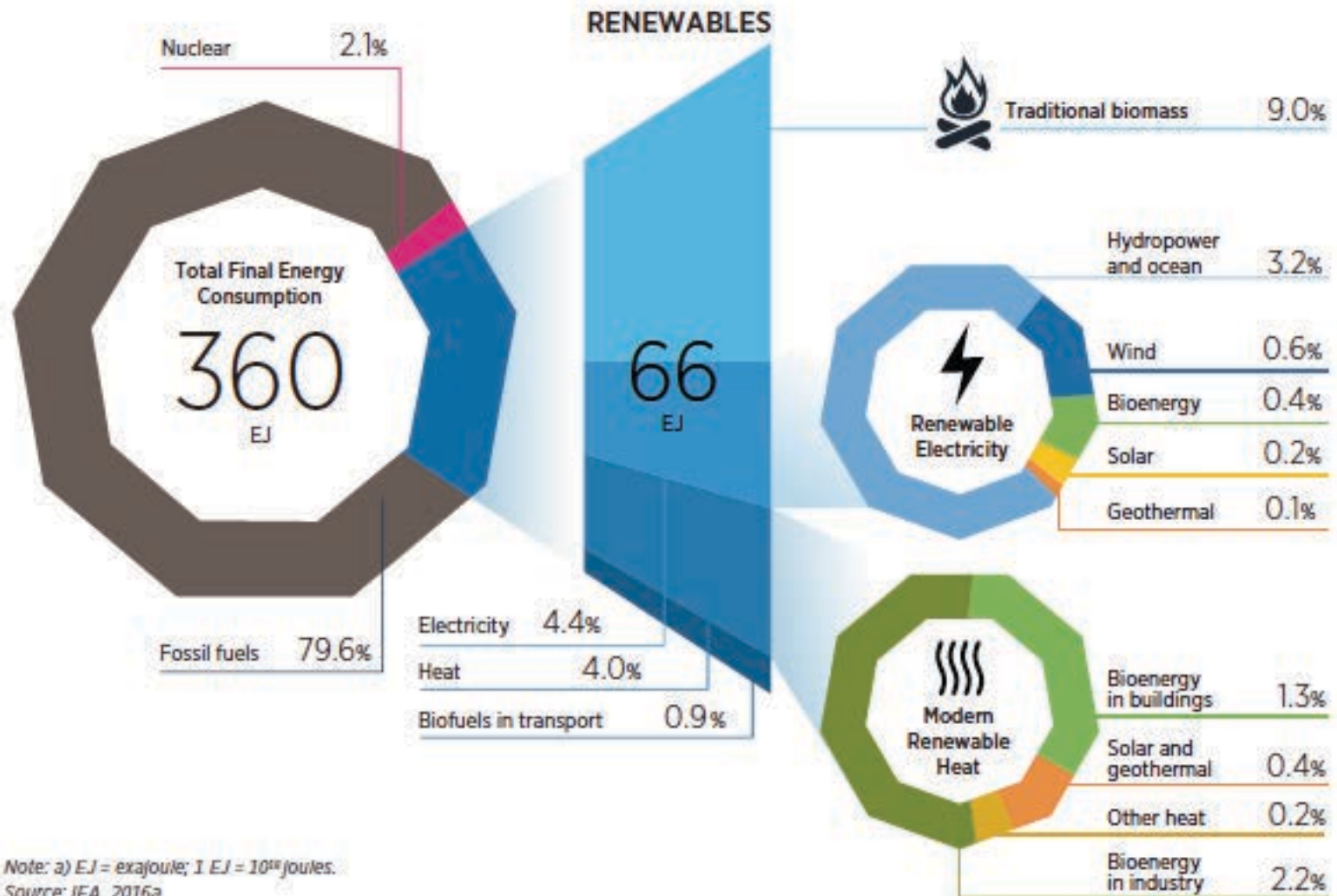


Source: REN-21 2016 Global Status Report

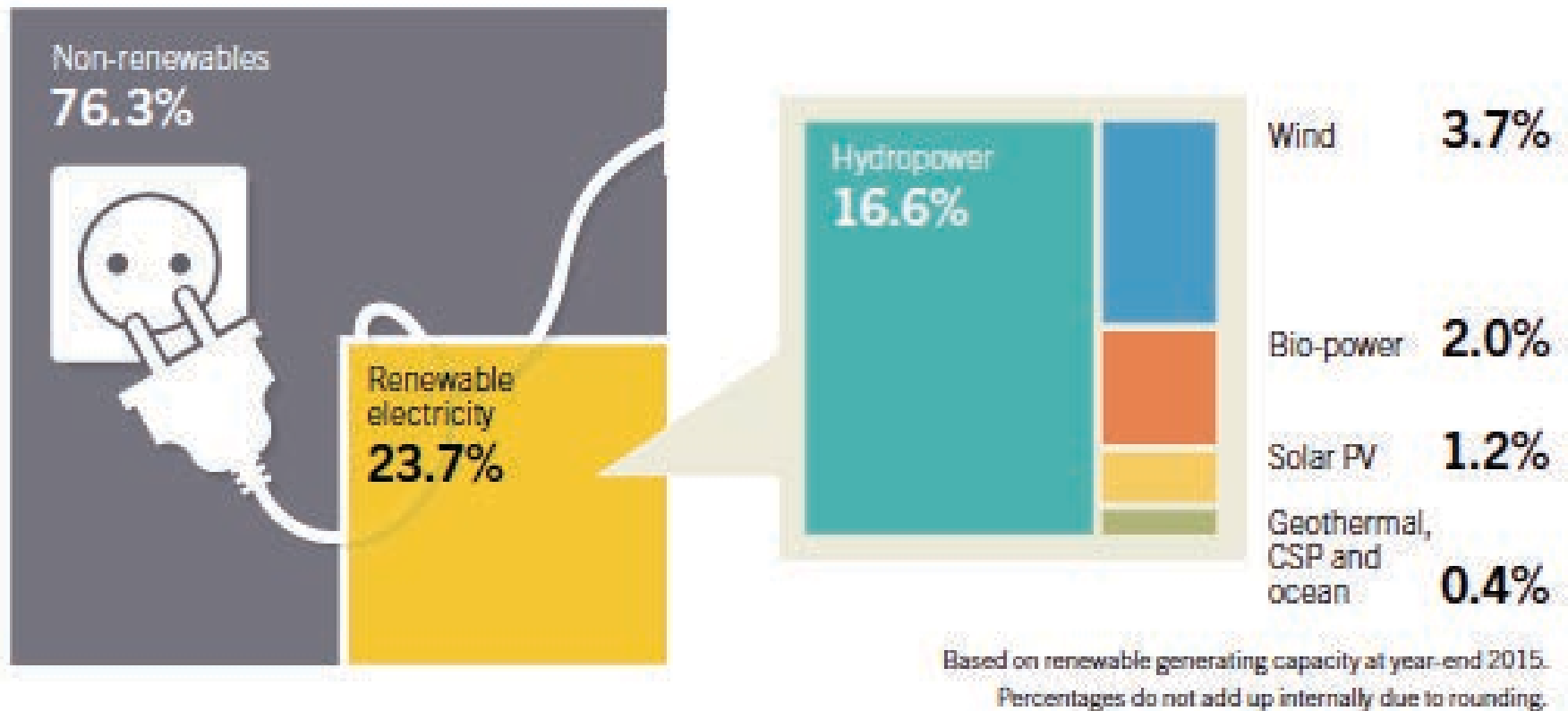
Note: SE4ALL goals = 36% by 2030, with universal energy access

Total Final Energy Consumption, 2014

$$1 \text{ EJ} = 10^{18} \text{ J} = 23.8 \text{ Mtoe}$$



RE Share of Global Electricity Production, end-2015



Source: REN-21 2016 Global Status Report

RE Share Continues to Increase in Power Sector

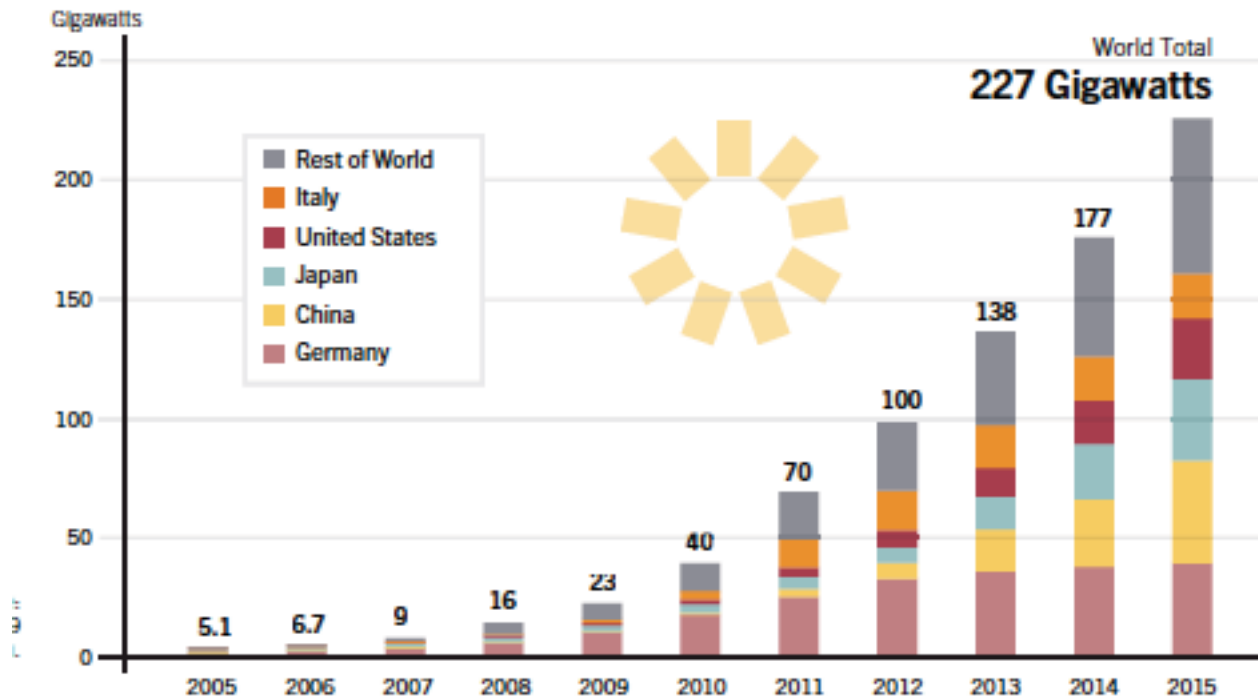
The Solution: Global Target of 100% RE

- All end-use energy consumption sectors (production, transport, and heat) must be included
 - Power Sector ~20% and growing rapidly
 - Transport Sector ~ 37%
 - Heat Sector ~43%
- All renewables must work together
- A transformation of our energy system is required
- The transformation is already occurring...

Decarbonising only the Power Sector is insufficient...

...and overall, end use energy consumption only accounts for 65-75% of total GHG emissions

Global PV Capacity by 2015



Source: REN-21 2016 Global Status Report

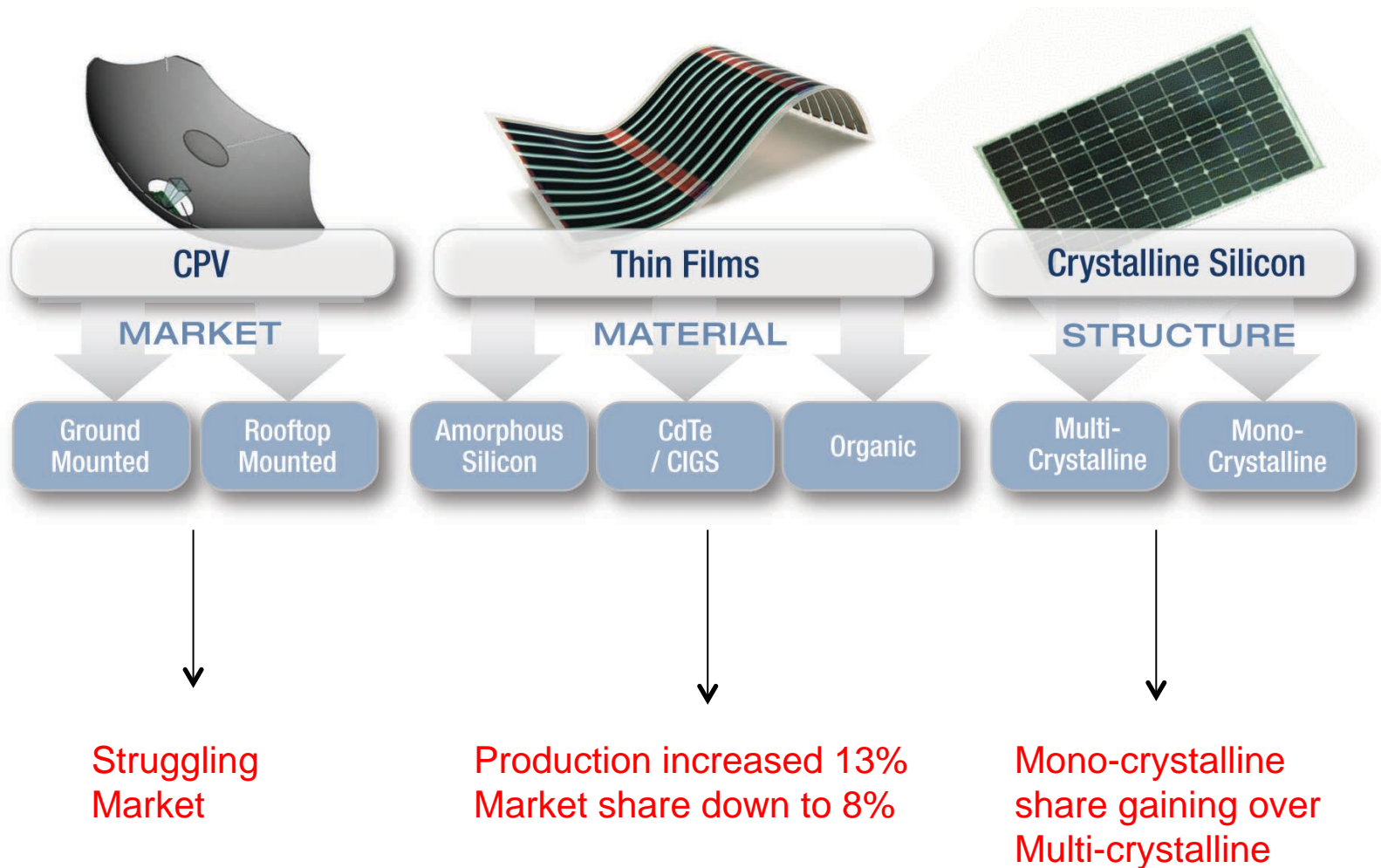
Largest capacity increases in 2015: China, Japan, U.S.

Global Capacity at end of 2016: ~300 GW



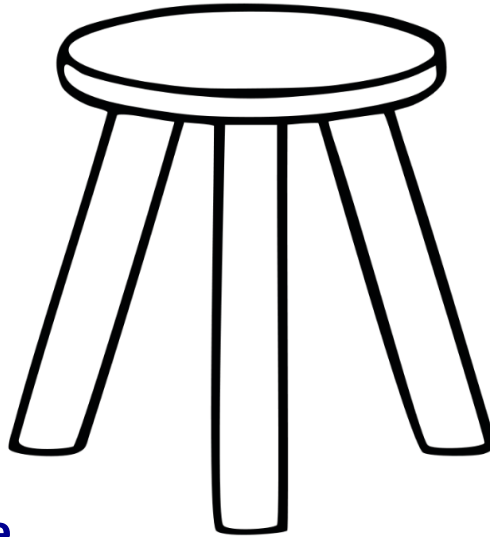
Estimates derived from REN21 GSR, 2016; Photo Credit: NREL Photo Library

PV Technology trends



Source: REN21 GSR, 2016

100% RE Requires Renewables Working Together in all End-Use Energy Sectors

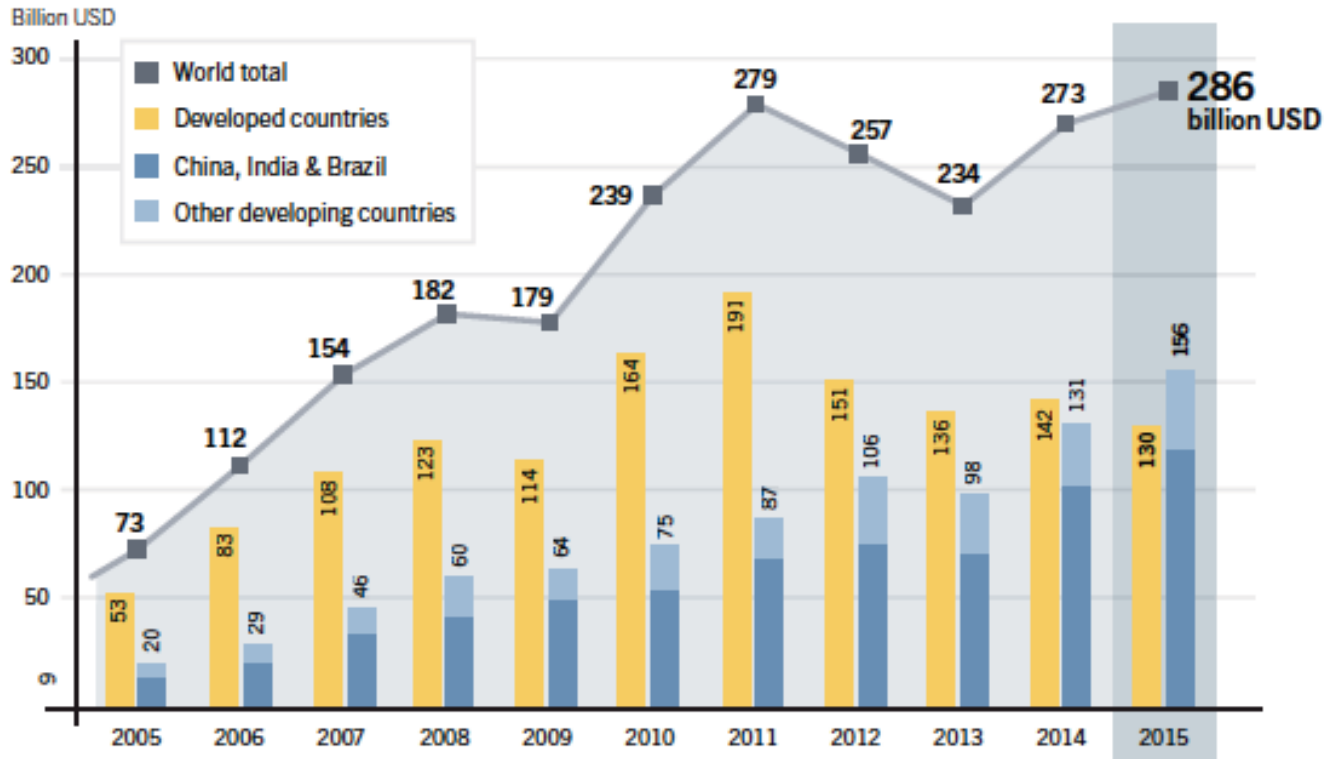


**Bankable Technologies; R&D
(Cells, modules, inverters, storage,
Etc.)**

**Favorable and Reliable
Policies and Targets**

**Access to Capital
(Especially private)**

Global Investment Flows



2016 est. = \$246B

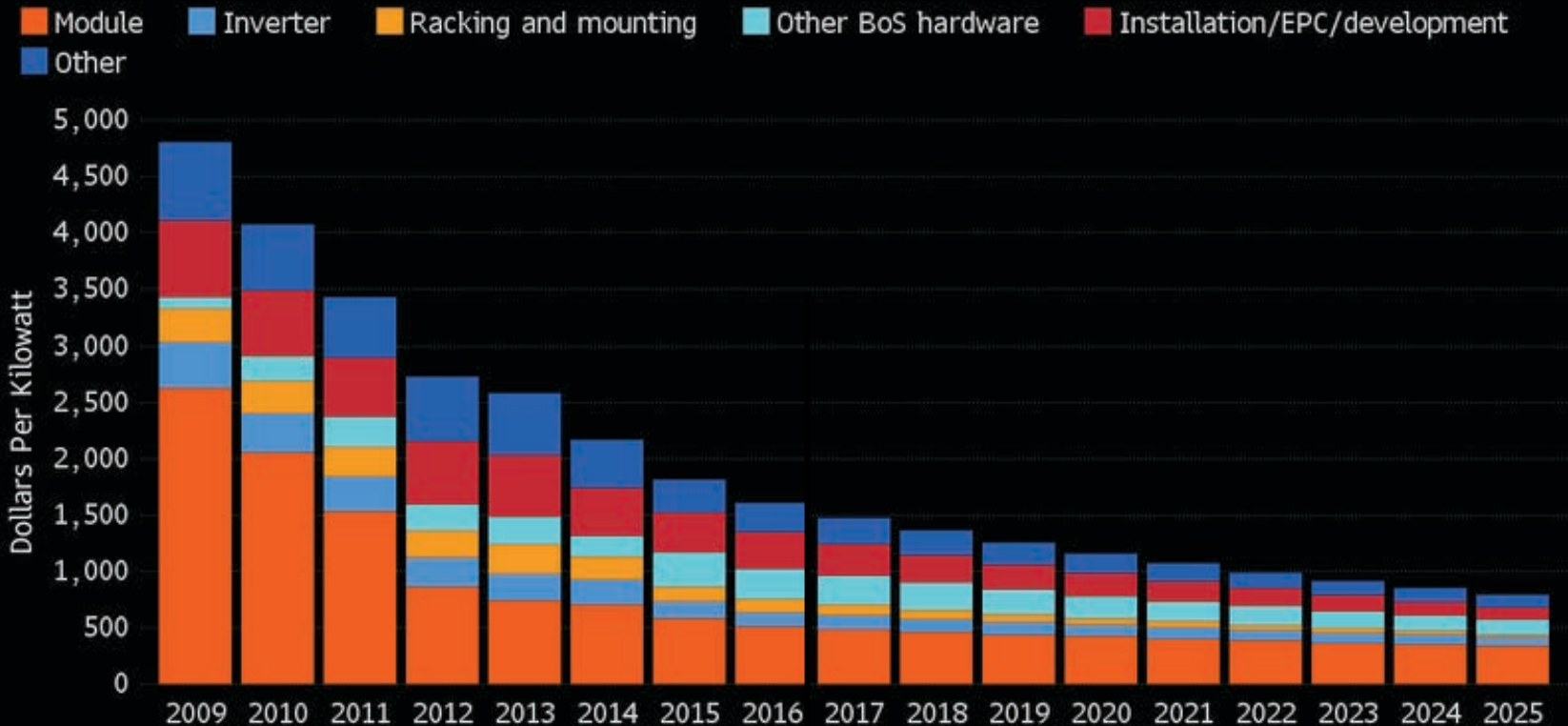
Source: REN21 GSR, 2016

It is estimated that \$900B/yr will be required to achieve 30% RE by 2030


Solar Costs are Dropping

Solar Farm Costs Are Shrinking

The global weighted average of a utility-scale solar project is set to fall by 84 percent

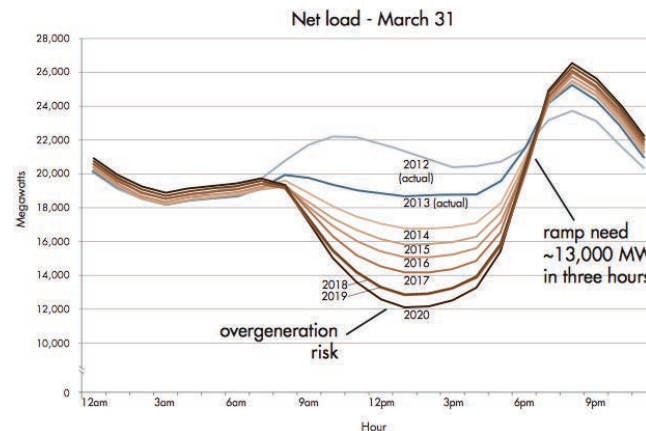


Source: IRENA analysis and Photon Consulting, 2016

Bloomberg 

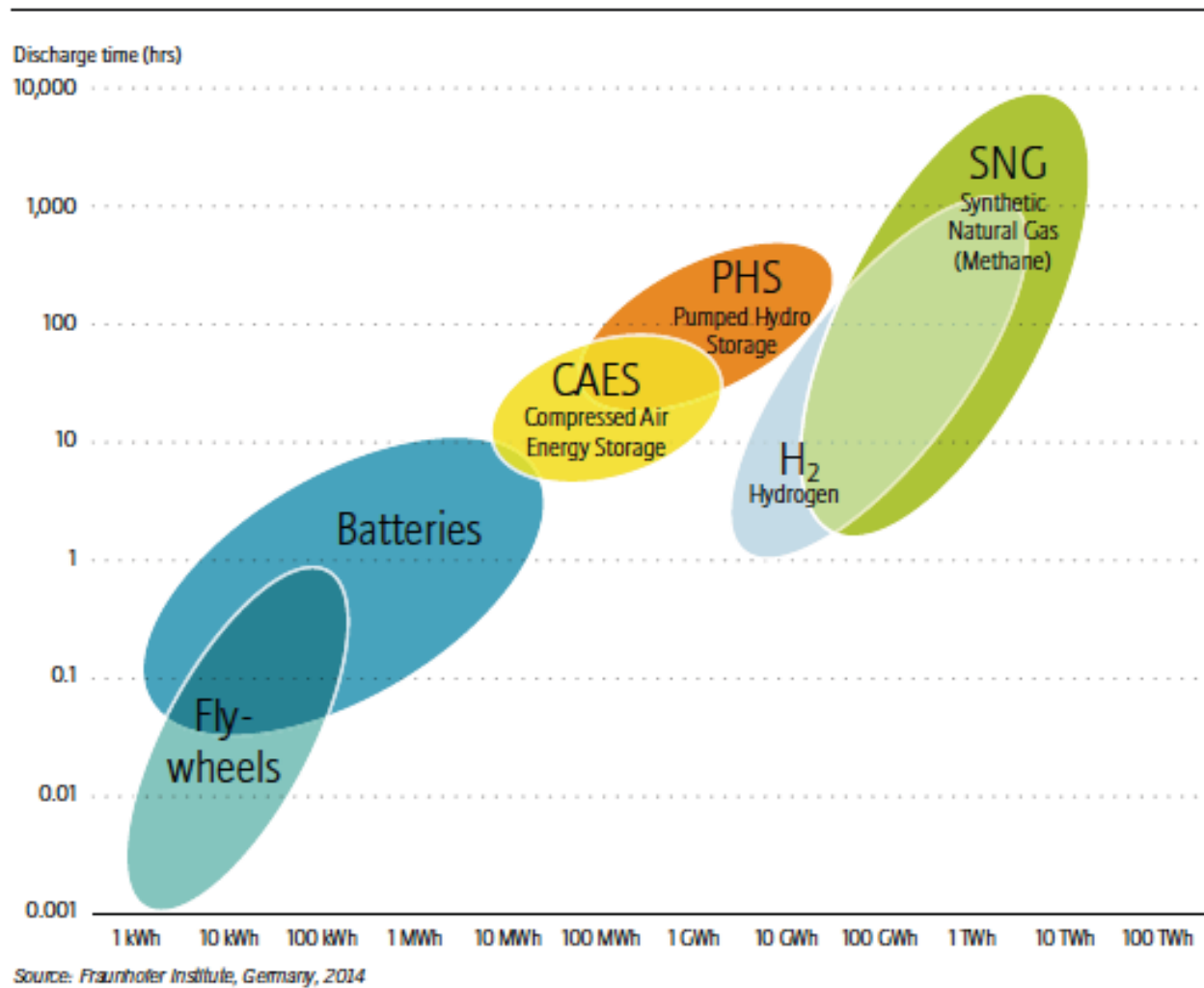
Source: BNEF

- Power Sector: Integration of VRE Requires Utility Flexibility
 - Resource forecasting
 - Storage Capabilities
 - Efficiency in generation and distribution
 - Expanded Distributed Energy Resource programs
 - Smart grids and load management
 - Energy pricing strategies (time-of-day, etc.)
 - Effective and geographically broader balancing strategies
 - International technology and integration standards



Source: California Independent System Operators

Storage will be Key



Source: REN21 Global Futures Report 2017

- **Transport Sector**
 - Integration of electric vehicles into the grid
 - Battery technology
 - Second generation biofuels
 - Driverless vehicles

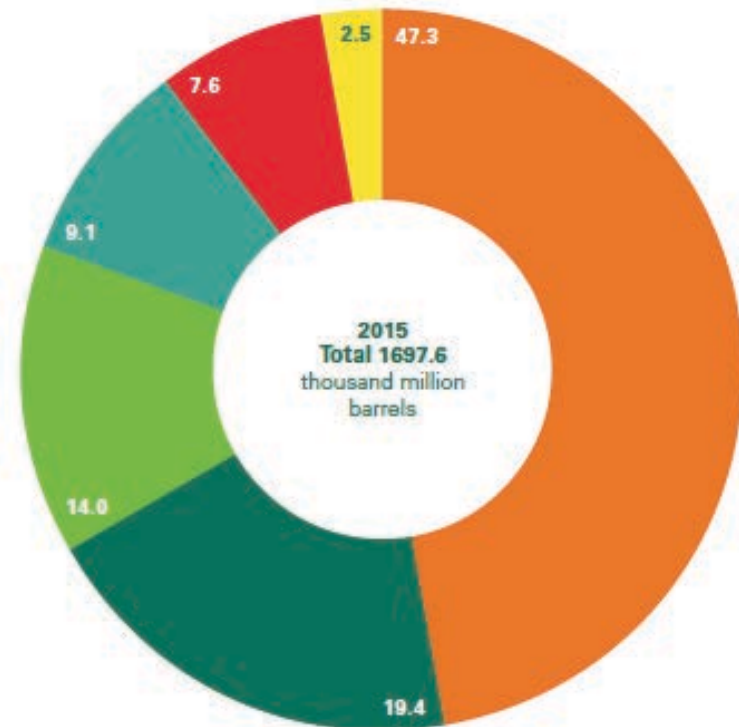
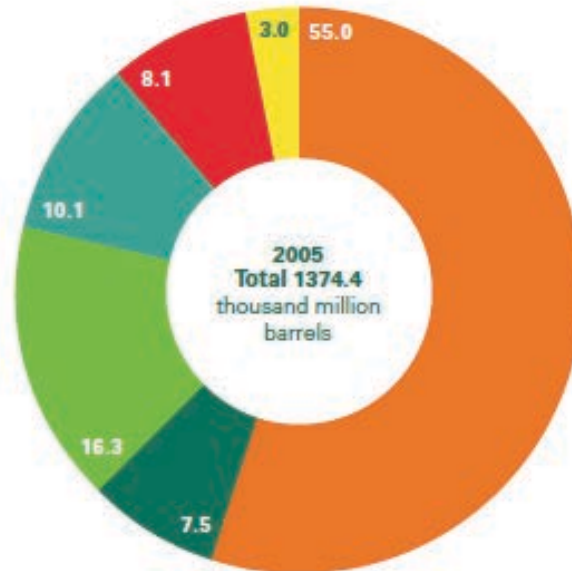
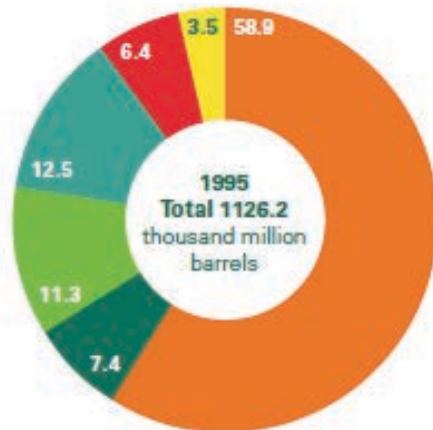
- **Renewable Heat**
 - Integration with Power Sector smart load management
 - Technology improvements and cost reduction
 - Scale-up to district heating and low temperature industrial process heat

Is “Peak Oil” a Myth?

Distribution of proved reserves in 1995, 2005 and 2015

Percentage

- Middle East
- S. & Cent. America
- North America
- Europe & Eurasia
- Africa
- Asia Pacific



Source: BP Statistical Review of World Energy, June 2016

The Prospects for 100% Renewables

- Notwithstanding climate challenges, RE makes good business sense
- To achieve climate mitigation goals, all renewables must work together to eliminate energy sector carbon emissions by mid-century
- 100% Renewables is technically feasible, but political will and access to capital is required
- Even with short-term oil price drops, renewables are now a cost-competitive choice for power in many cases
- But...the extraction industry is heavily financed and continues to identify new reserves...

We must leave remaining fossil resources in the ground for high-value use by future generations

Thank You!

Dave Renné
president@ises.org

**Join us at ISES Solar World Congress 2017
Jointly with SHC 2017 Conference
Abu Dhabi, UAE
29 October – 2 November 2017**

