Global Renewable Market Outlook

Cédric Philibert

Renewable Energy Division

International Energy Agency

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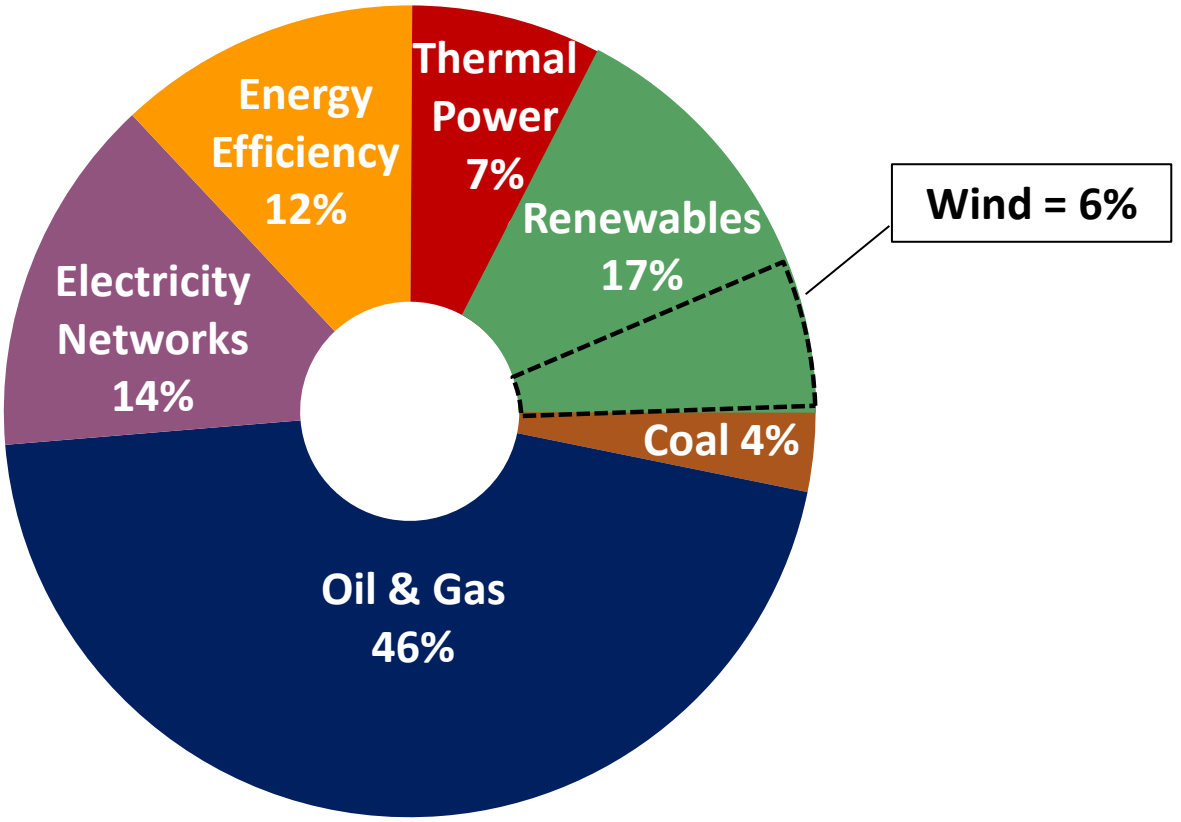
Investment flows signal a reorientation of the global energy system

Global Energy Investment, 2015

USD 1.8 trillion

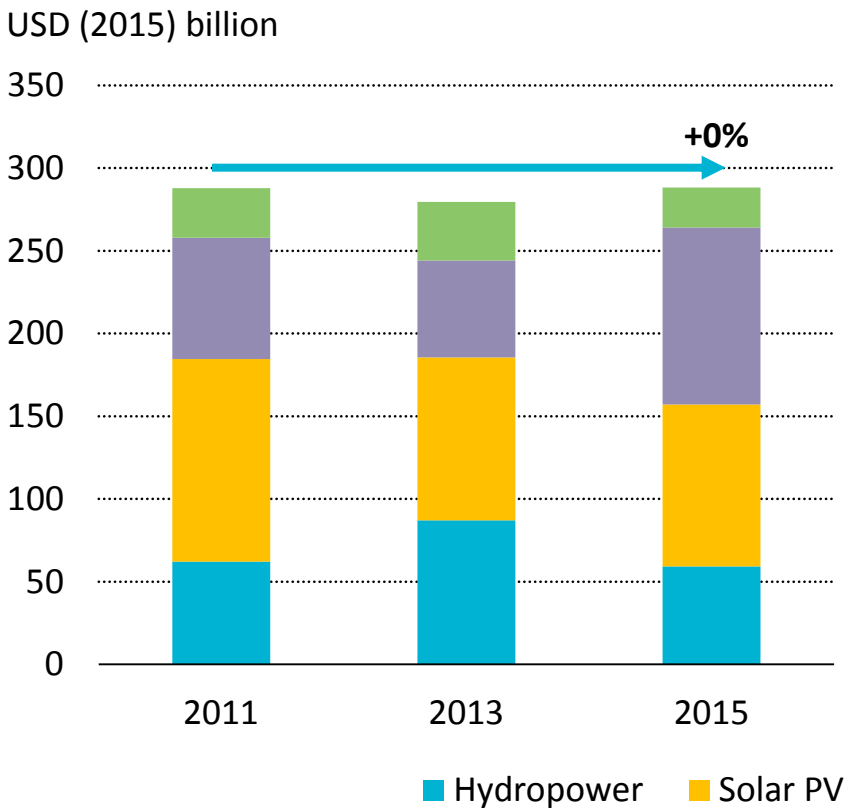


An 8% reduction in 2015 global energy investment results from a $200 billion decline in fossil fuels, while the share of renewables, networks and efficiency expands

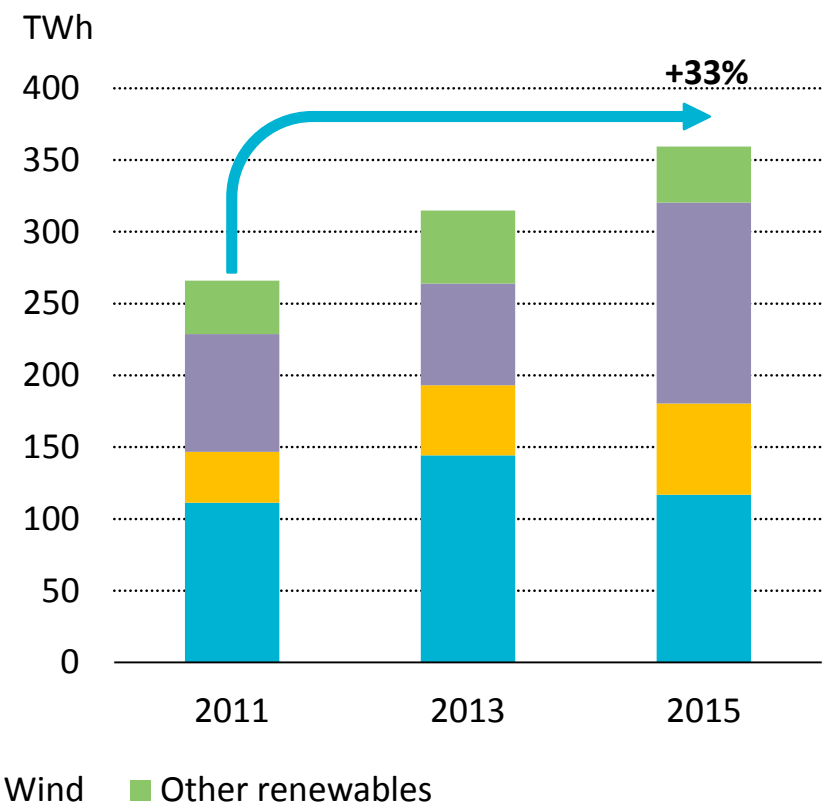
Renewables investment buys much more electricity

World Energy Investment 2016

Global renewable power investment



Generation from investment in capacity



Hydropower Solar PV Wind Other renewables

Investment in renewables-based capacity more than covers 2015 global electricity growth. Wind leads, surging 35% in 2015 on economics and record offshore growth

New capacity in renewables, led by wind, exceeds fossil-fired plants

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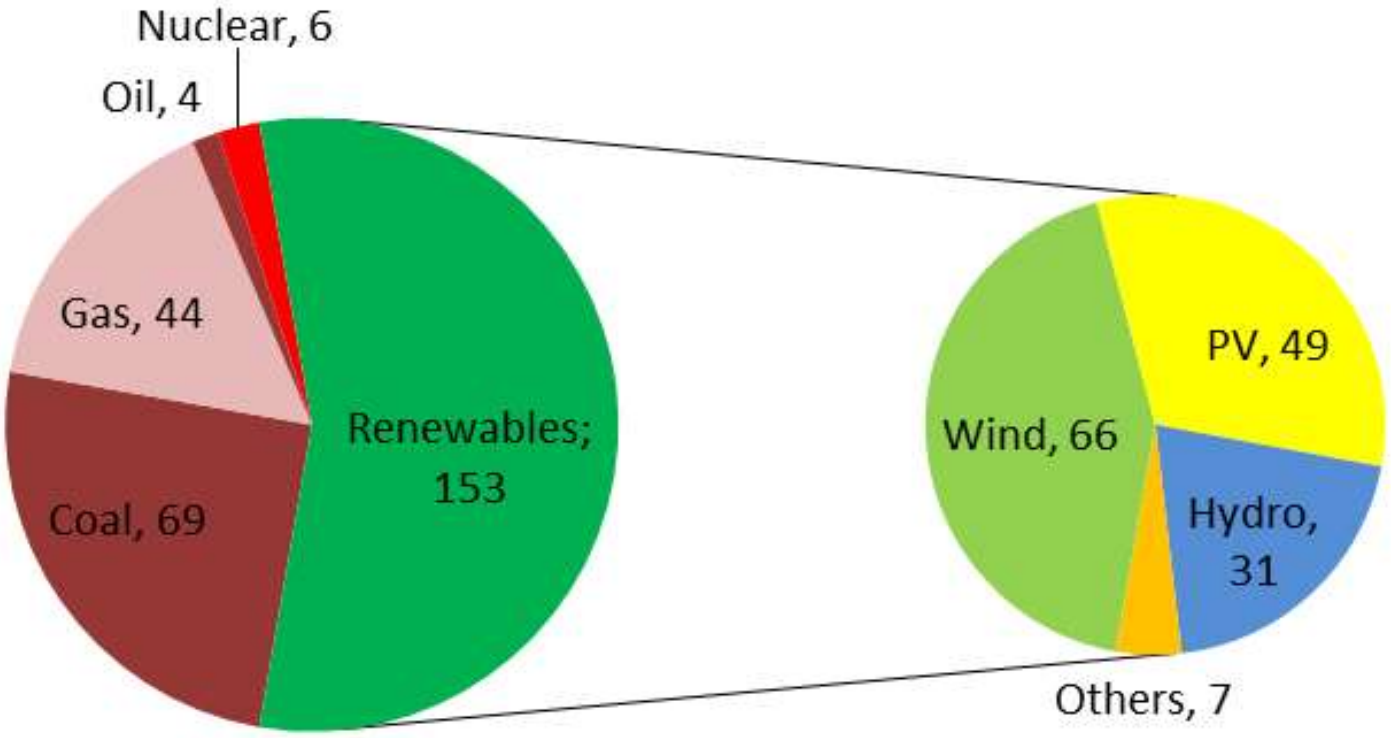
Net capacity increases, 2015 (in GW)



2015 saw record level annual additions in wind and solar, compensating a decrease in hydropower

2015: a record year for renewables

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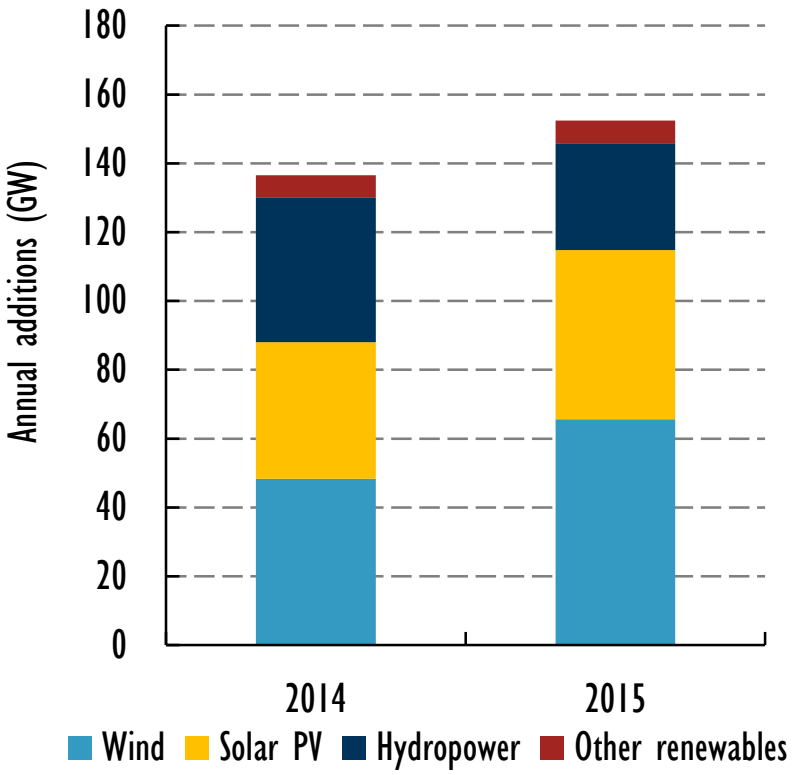
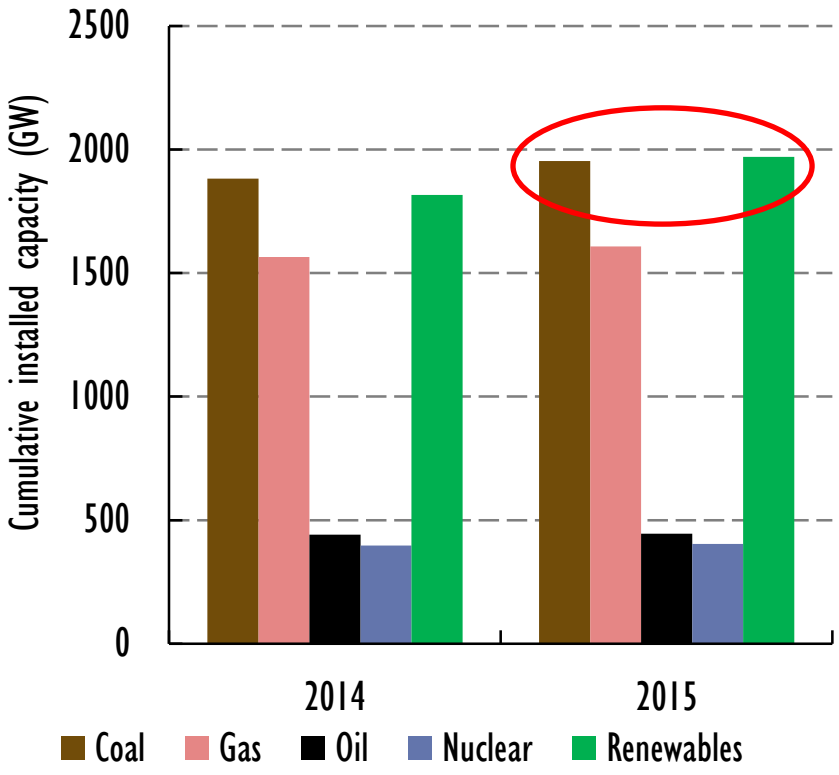
Renewable additions (2014-15) and cumulative installed power capacity





Cumulative renewable capacity surpassed coal at the end of 2015

International Energy Agency

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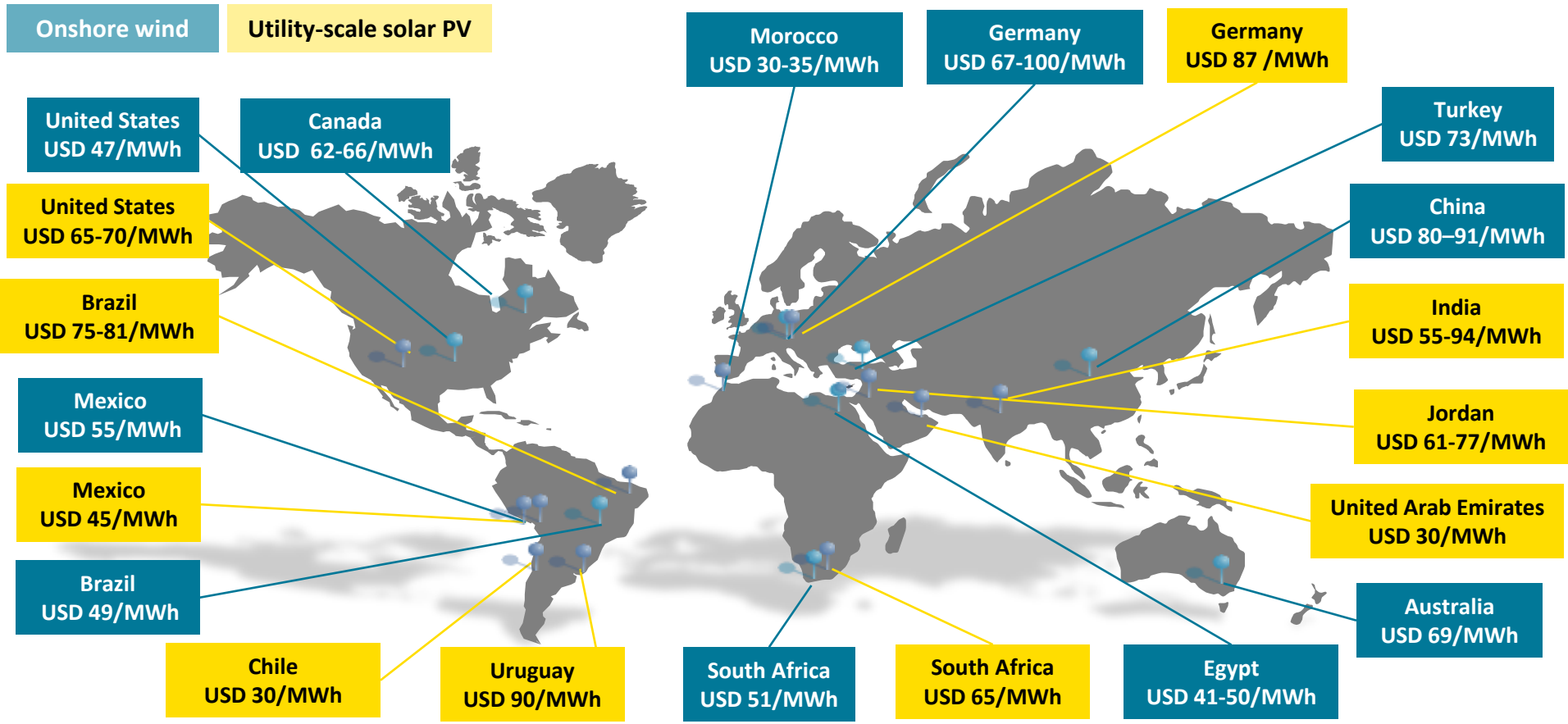
Record low price announcements

Recent announced long-term contract prices for new renewable power to be commissioned over 2016-2019

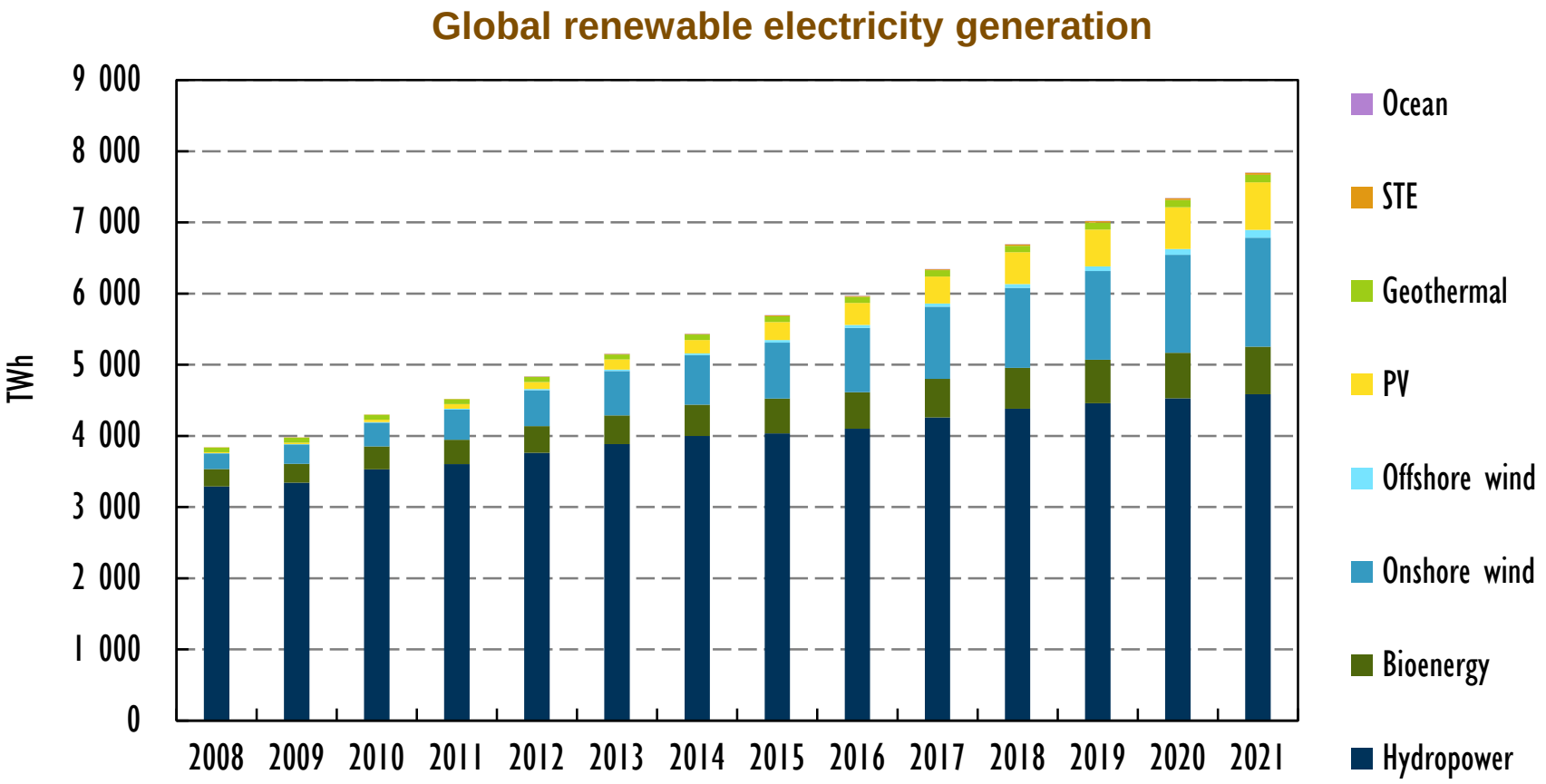


This map is without prejudice to the status or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area

Note: Values reported in nominal USD includes preferred bidders, PPAs or FITs. US values are calculated excluding tax credits. Delivery date and costs may be different than those reported at the time of the auction.

Best results occur where price competition, long-term contracts and good resource availability are combined

Renewables to meet new generation needs and replace old power capacity



Between 2015-21 wind generation doubles and solar PV almost triples, with renewables reaching around 27% of total electricity by 2021

More ambitious policies could further enhance the outlook in line 2°C target

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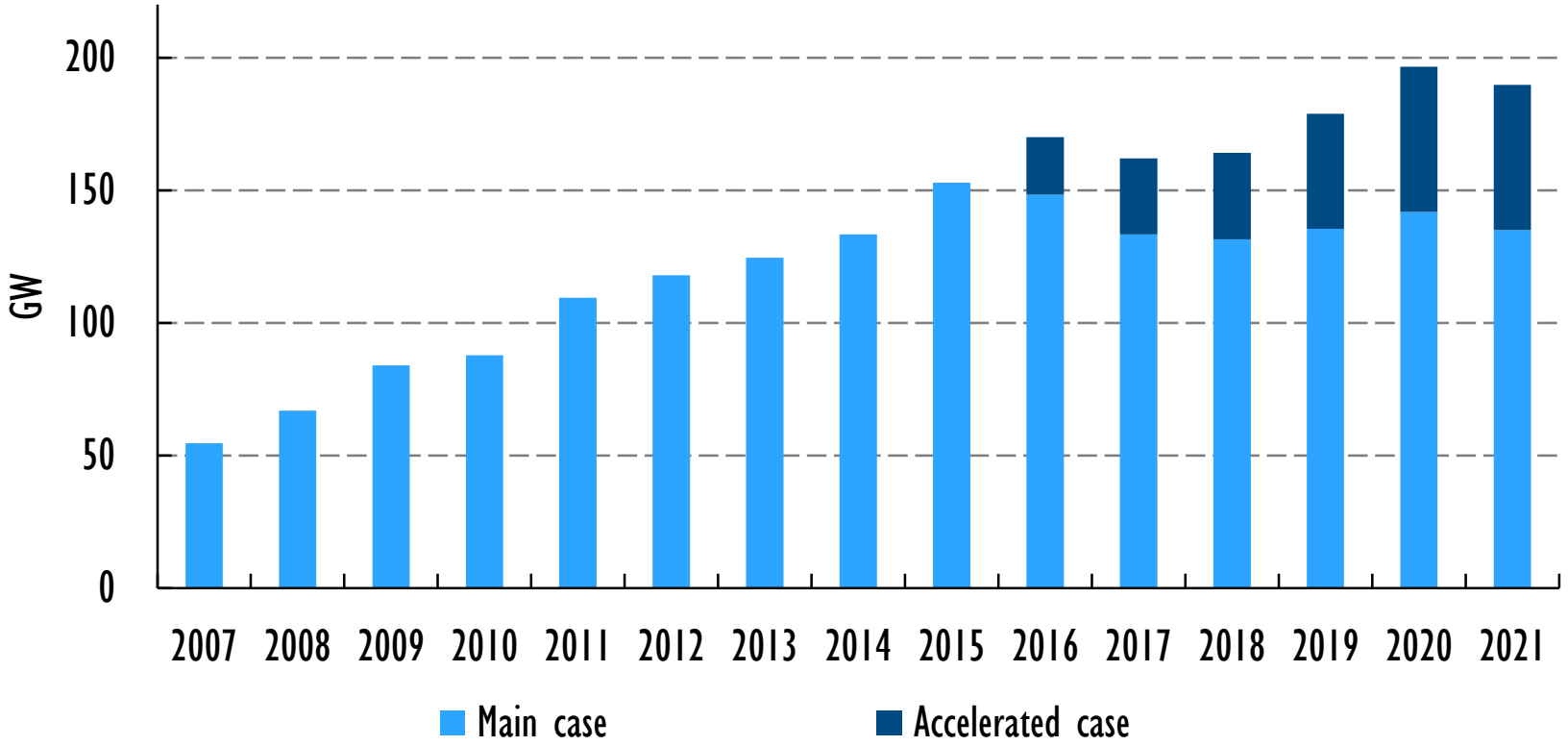
Renewable electricity capacity additions in Accelerated Case vs. Main Case



Renewables are in line with NDC pledges by 2030 but reducing policy uncertainty and overcoming financing & grid integration challenges remain key to achieve 2°C target

Towards high shares of variable renewables

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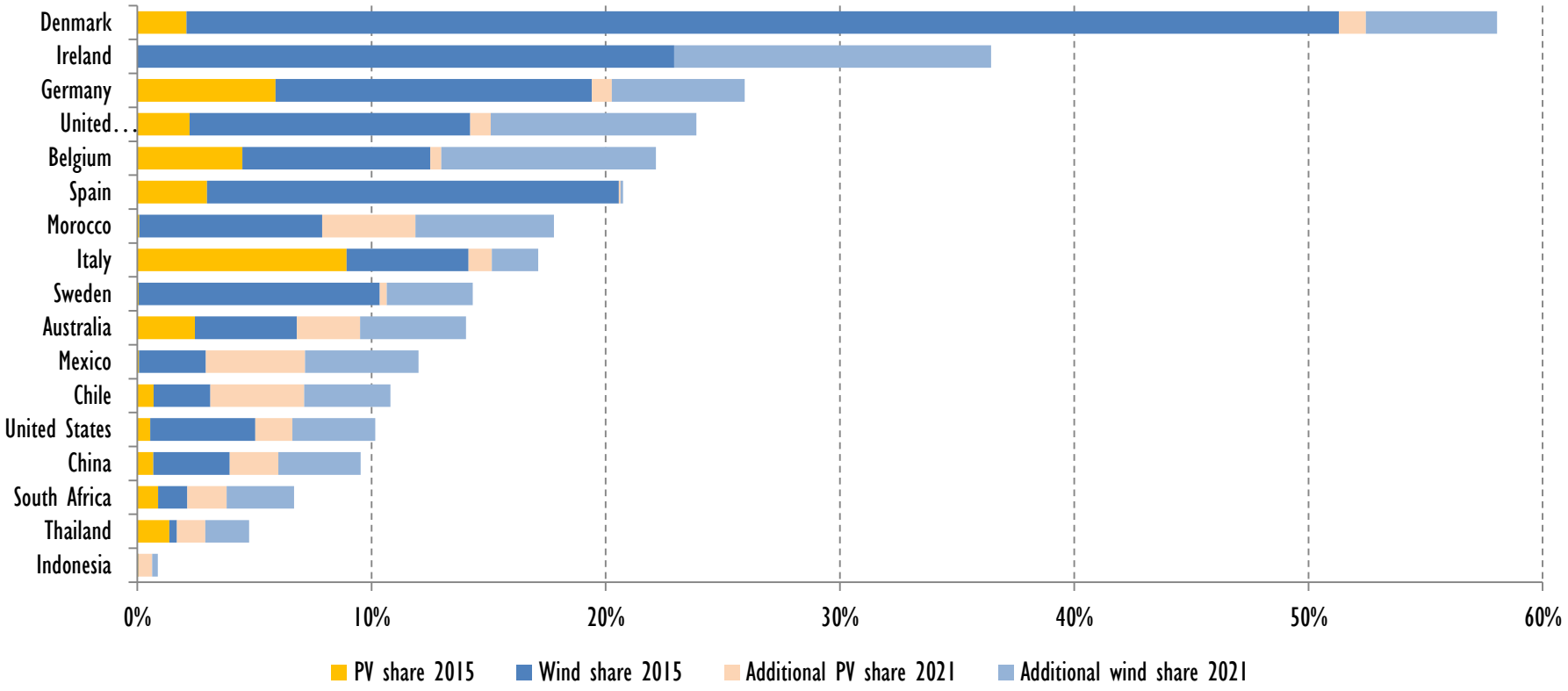
Share of variable electricity generation in 2015 and 2021

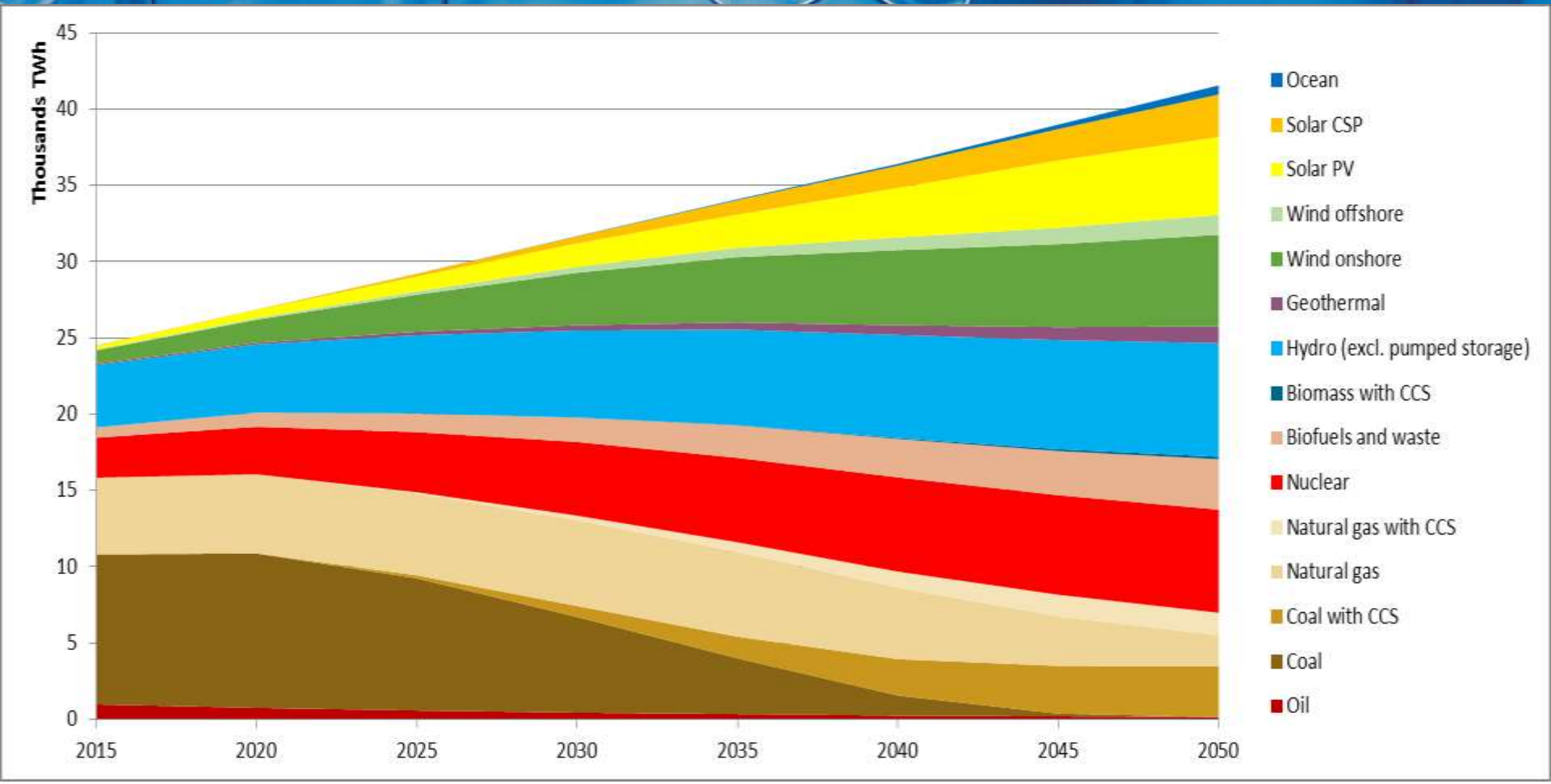


Experience in a number of countries shows how to integrate significant shares of VRE

Source: IEA estimates from IEA Medium-Term Renewable Energy Market Report 2016.

Global electricity mix changes in the 2DS

ETP 2016

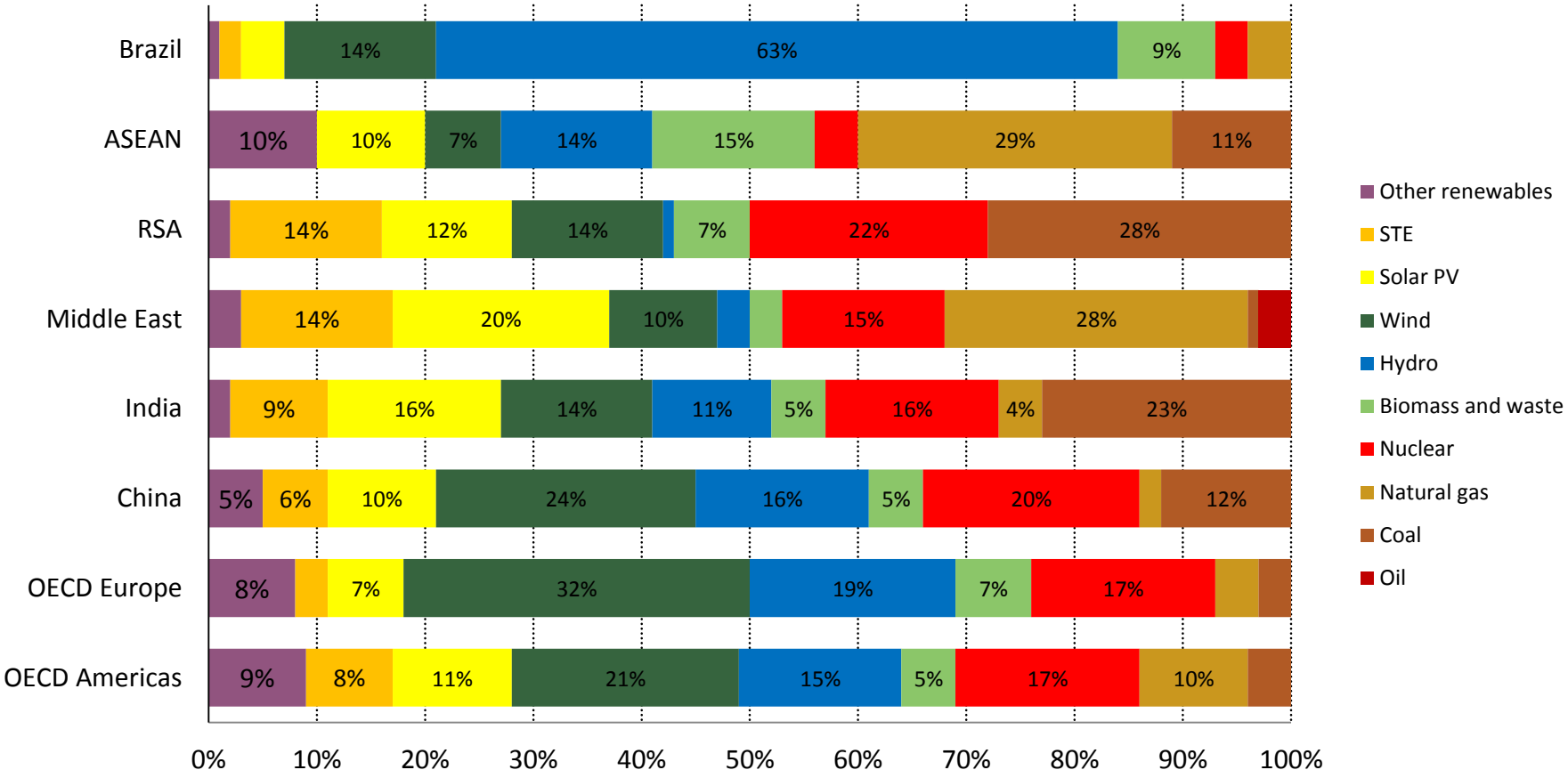


A shift reversal is needed with renewables providing over 60% of global electricity by 2050 or before

Electricity mixes by 2050 in the 2DS vary widely

ETP 2016

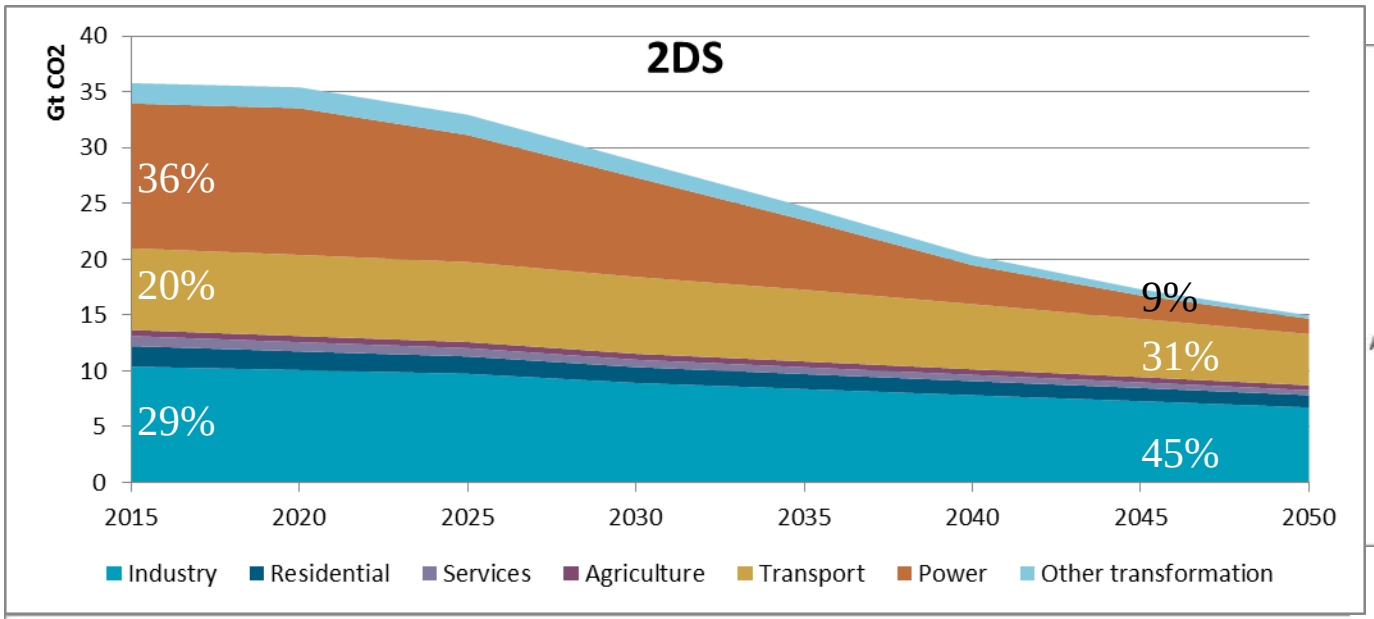
Electricity mixes by 2050 in the 2DS in selected regions

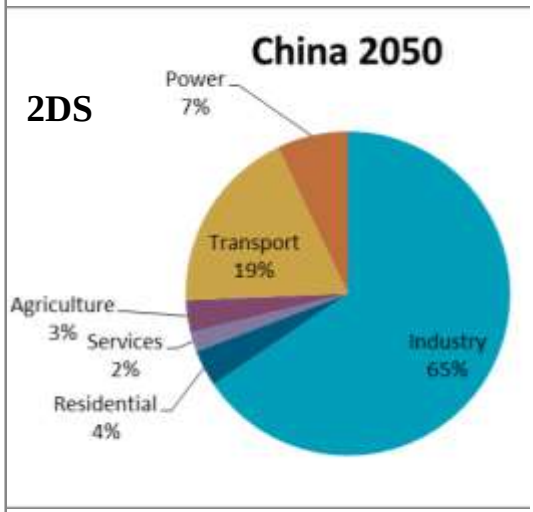


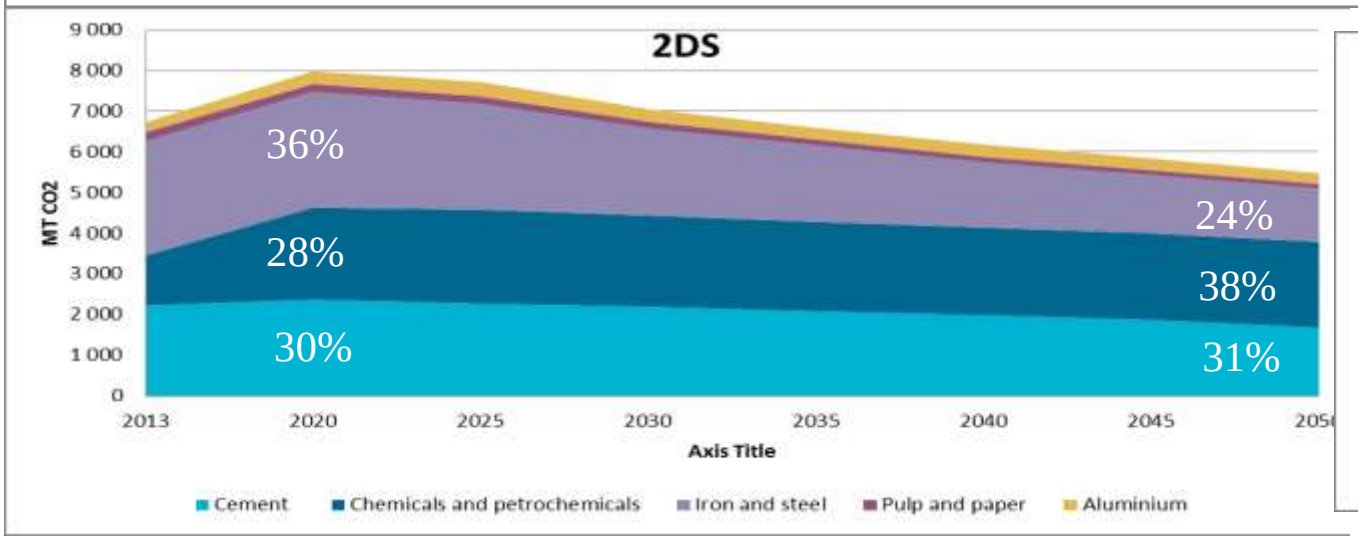
Resources and shape of the demand explains the variations

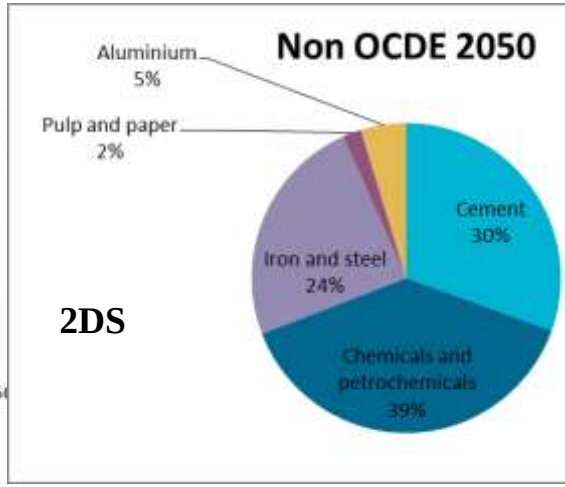
Industry, led by iron & steel, cement and chemicals, becomes 1st CO_2 source

ETP 2016









Next-generation policies needed

- Next-generation wind and solar PV need 'next-generation policies' focusing on system value and not just costs
- Focus on five main areas:
  - System services
  - Location of deployment
  - Technology mix
  - Generation time profile
  - Integrating planning, monitoring and revision

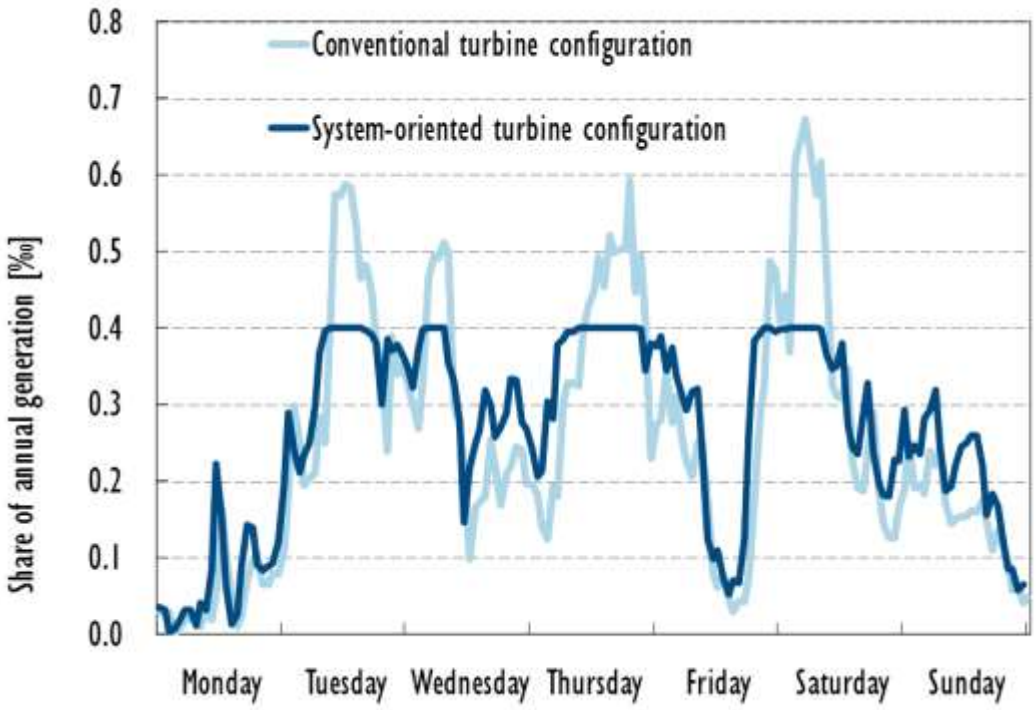
- Examples of best practice in Denmark, Germany, Spain, US, Mexico, Brazil, China, South Africa

Increasing variable RE will need more system flexibility

1) Foster System-friendly RE

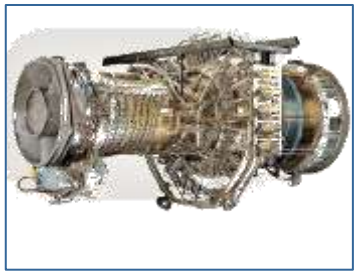
2) Better market design & operation

3) Increase flexibility of other power system components



Grids

Generation

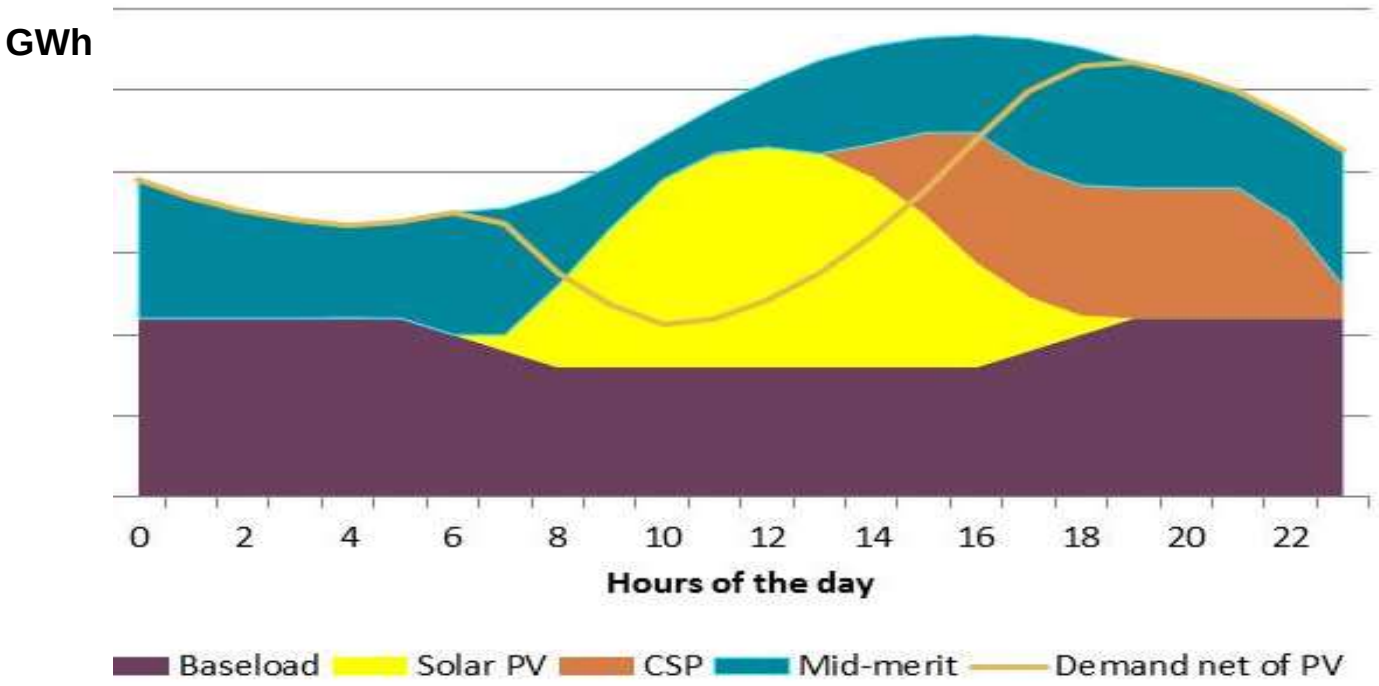


Storage

Demand Side

Complementary roles of PV and STE

Possible power mix in a sunny country, 2030



Source: *IEA Technology Roadmap (2014)*

Thanks to thermal storage, STE is generated on demand when the sun sets while demand often peaks and value of electricity increases

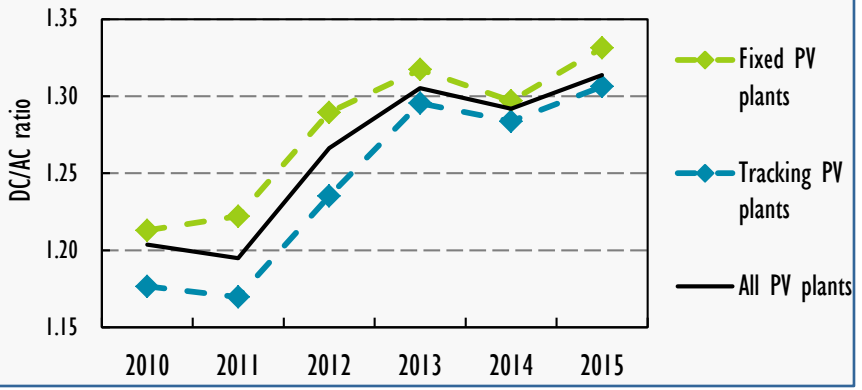
Optimising generation time profile

- **The design of wind and solar plants can be optimised to increase value**
  - Spreading the energy on more hours
  - Making generation match the demand more closely
- **Policy mechanisms need to signal difference in value depending on time**
  - Partial exposure to market prices via premium systems
  - Power purchase agreements adjusting remuneration to time of delivery (TOD)
  - Premiums for system friendly deployment choices

Policy example: California, USA

- West-facing PV systems produce closer to peak demand and receive payments up to 15% higher than south-facing systems
- TOD factors integrated into PPAs for large scale solar systems

DC to AC ratio by mounting type and installation year, United States



Policies remain crucial to attract financing

- **Sharp cost reductions of wind and solar costs change policy needs**
  - From providing financial support to creating a framework for investment
  - Innovation must extend from renewable technology to system integration
- **Financing system-friendly RE deployment**
  - **Securing long term remuneration is key** to investment and low-cost finance
  - But short term price signals must reflect the value of power
  - Time-structured power purchase agreements, and feed-in premiums combined with spot market prices, are the main options
- **Energy policies must be consistent and extend beyond power**
  - Electrification of end-use sectors will ease integration of variable renewable and promote decarbonisation of buildings, transport and industry
  - Removing fossil fuel subsidies and pricing carbon is both easier and more necessary when fossil fuel prices are low