# RENEWABLE ENERGY
## Medium-Term Market Report 2014

International Energy Agency

# *Renewables Medium-Term Forecasts and Long-Term Scenarios*

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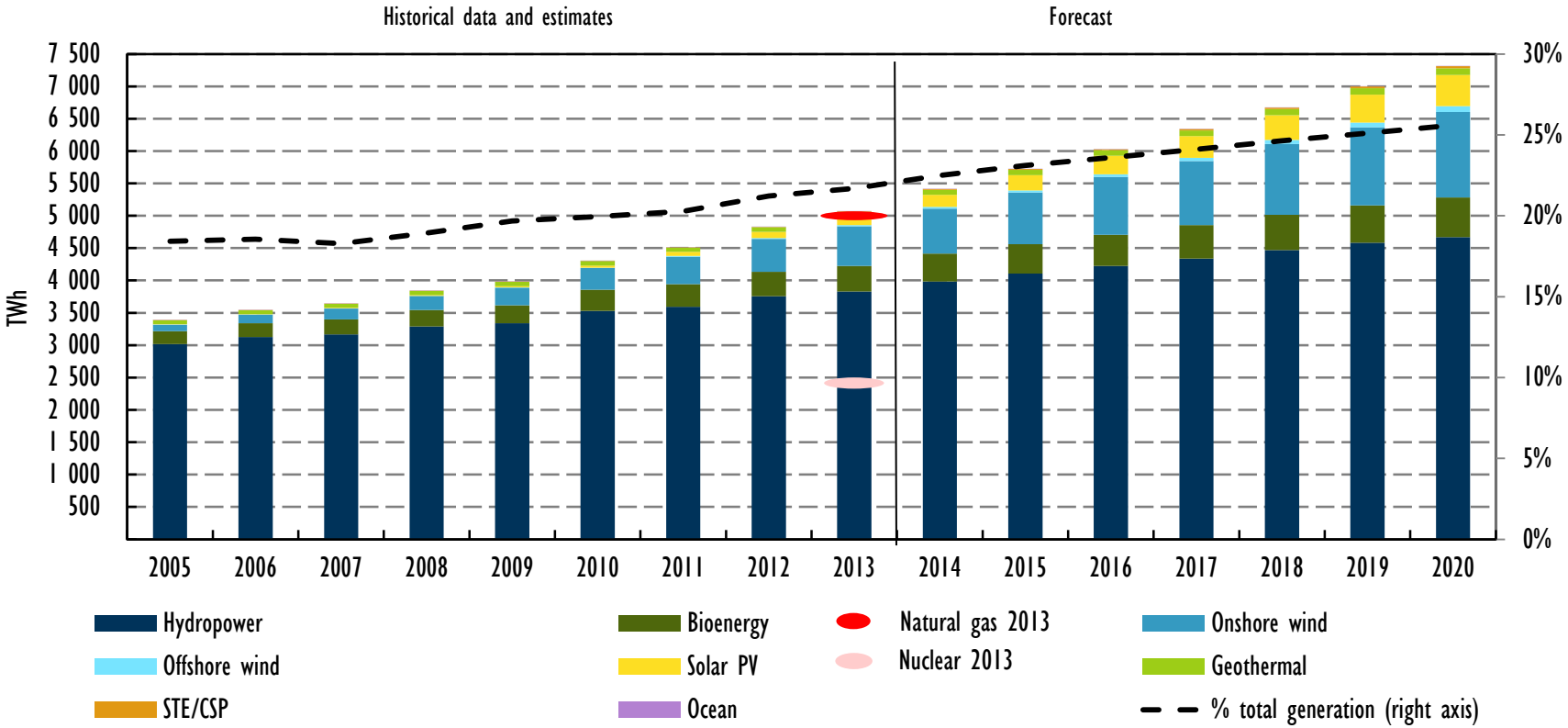
**International Energy Agency**

**Market Analysis and Forecasts to 2020**

# Strong momentum for renewable electricity

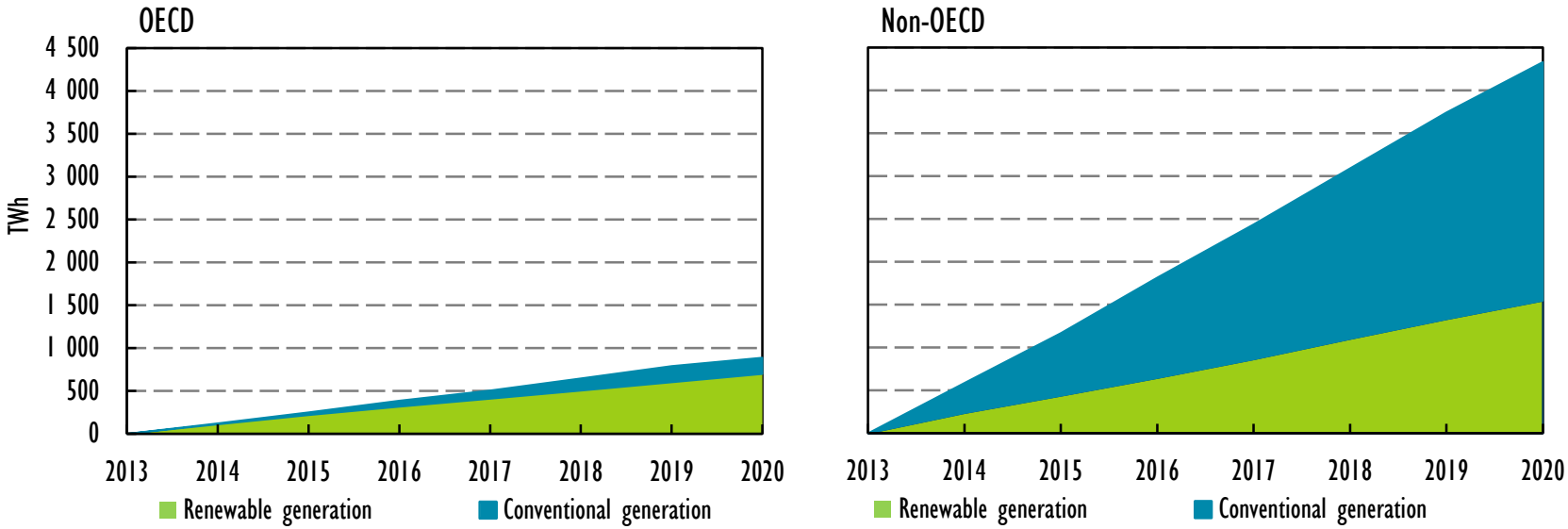
## Global renewable electricity production, historical and projected




- **Renewable electricity projected to scale up by 45% from 2013 to 2020**

# Renewables are major source of new generation

## Cumulative change in gross power generation by source and region, 2013-20



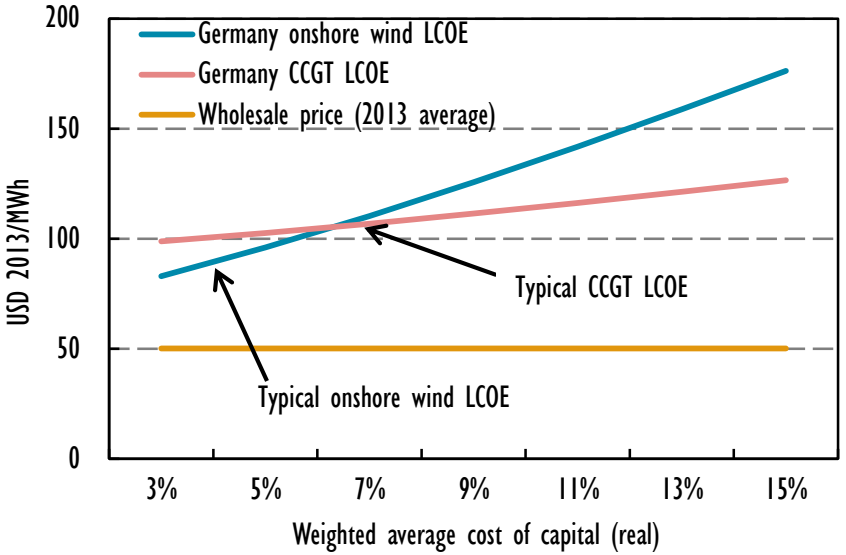

- **Renewables account for 80% of new generation in OECD**
  - **Limited upside in stable markets with slow demand and growing policy risks**
- **Renewables are largest new generation source in non-OECD, but meet only 35% of growth**
  - **Large upside for dynamic markets with fast-growing demand**

# Renewables becoming a cost-competitive generation option in more cases

- In some dynamic markets with country-specific conditions and market frameworks, new onshore wind is the economically preferred option versus new fossil fuel plants (e.g. Brazil, Chile and South Africa)
  - But fossil fuel subsidies can distort this picture

- In some stable markets, onshore wind with good financing cheaper than new CCGT plants
  - But market design based on wholesale pricing may not provide adequate remuneration

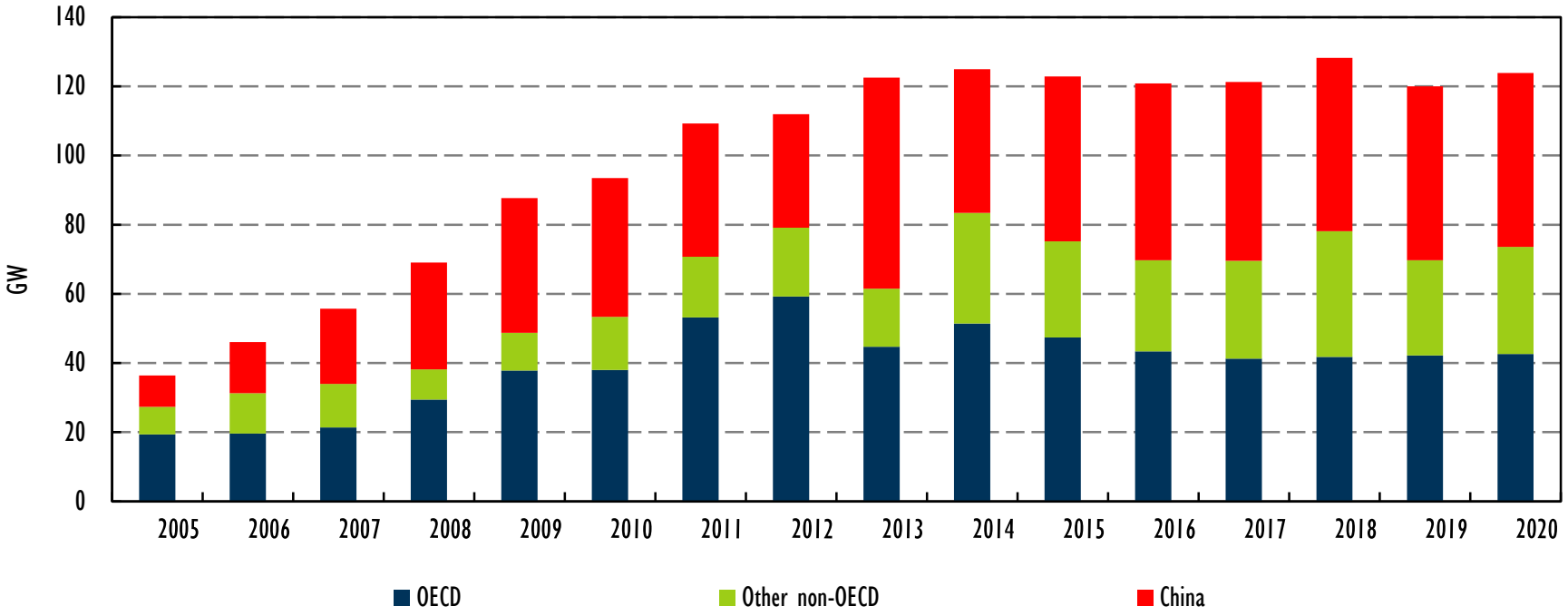
**Germany LCOEs versus wholesale prices**




Notes: Onshore wind full load hours are assumed at 2000 and that for CCGT is 3500.
Source: IEA analysis with day-ahead average base-load wholesale prices for 2013 from Bloomberg LP.

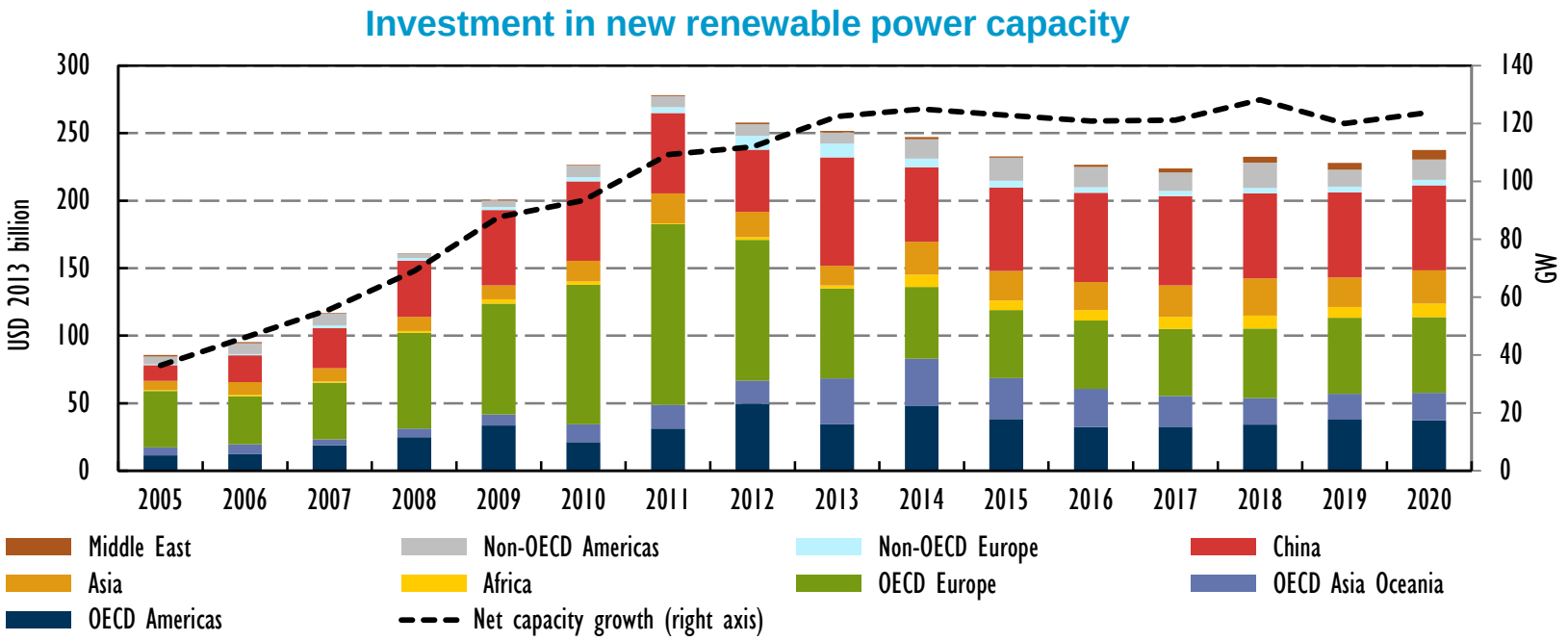
# Increasing risks are expected to slow renewable growth

## Renewable power annual net capacity additions, historical and projected




- **Policy and market risks threaten to slow deployment momentum for renewables**

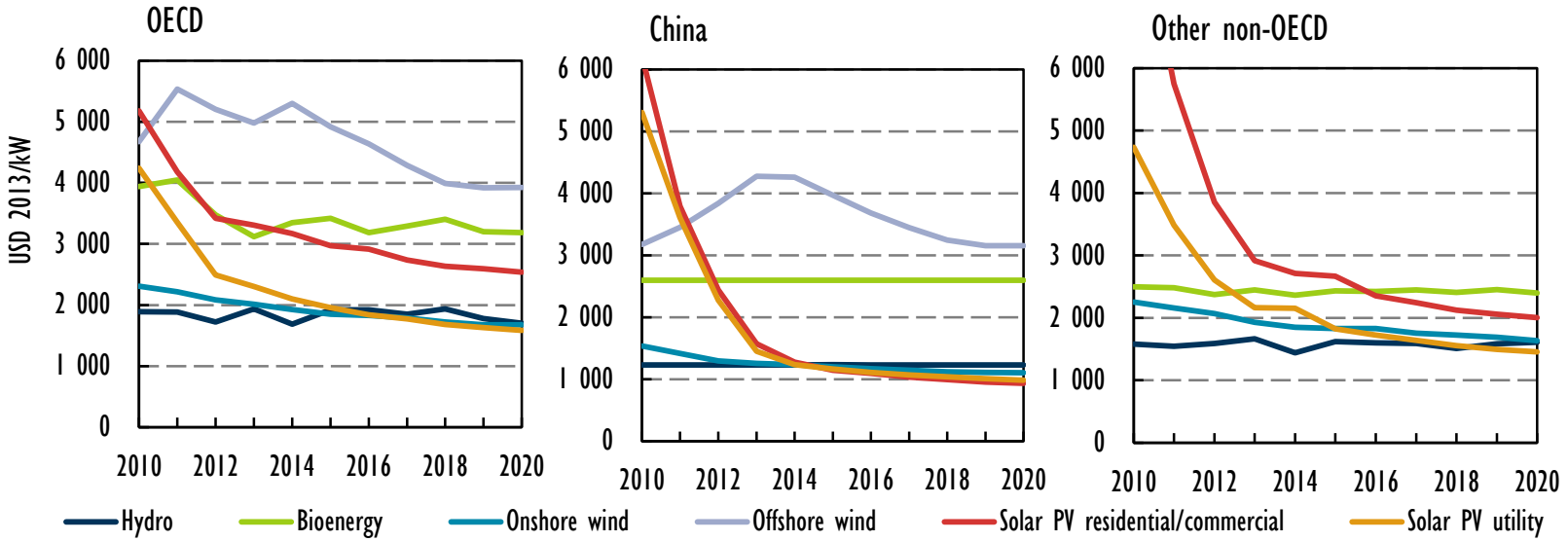
# Renewable investment has risen to high levels




- Investment in 2013 relatively steady at USD 250 billion, but lower than peak in 2011
- Slowing capacity growth and falling technology costs limit investment in new renewable power capacity over medium term

# Renewable investment costs falling

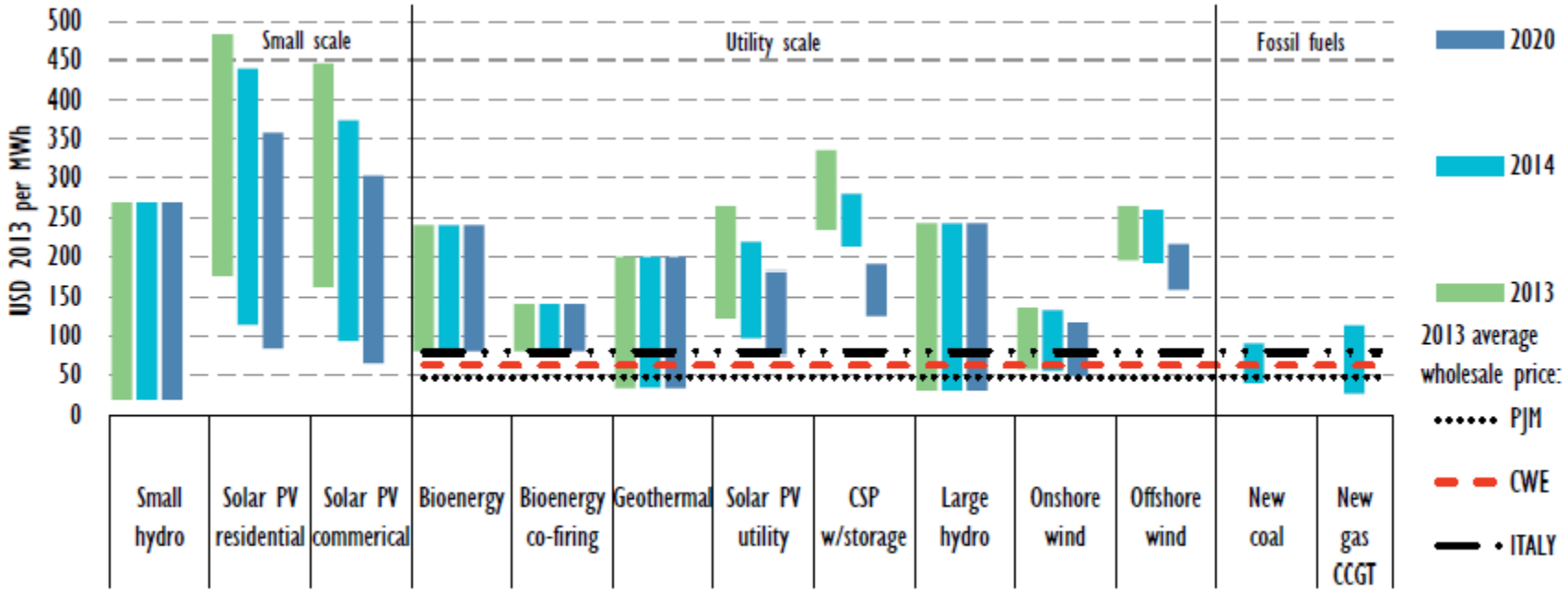
## Weighted average annual renewable investment costs, historical and projected




Notes: Average unit investment costs are based on gross additions, which include capacity refurbishments that are typically lower cost than new capacity. Costs vary over time due to technology changes as well as where deployment occurs in a given year..

- **With scale up of deployment and learning, investment costs of most dynamic technologies (solar PV and onshore wind) continue to fall**

# Renewable electricity increasingly competitive

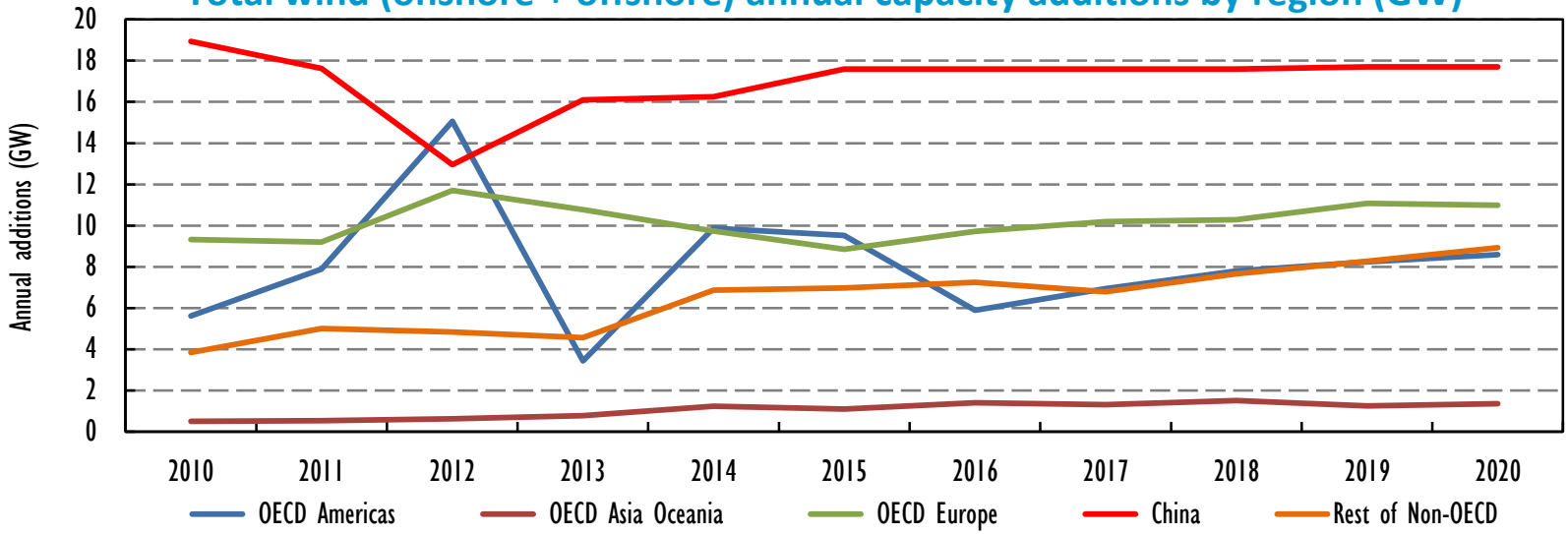



- **Levelised cost of electricity generation continue to decrease for most renewable technologies**

# Global RE capacity additions led by wind

- **Still, onshore outlook less optimistic than in *MRMR 2013***
  - **Policy uncertainties and grid integration challenges weigh upon outlook**
- **Offshore wind outlook also more pessimistic, with financing and integration challenges**

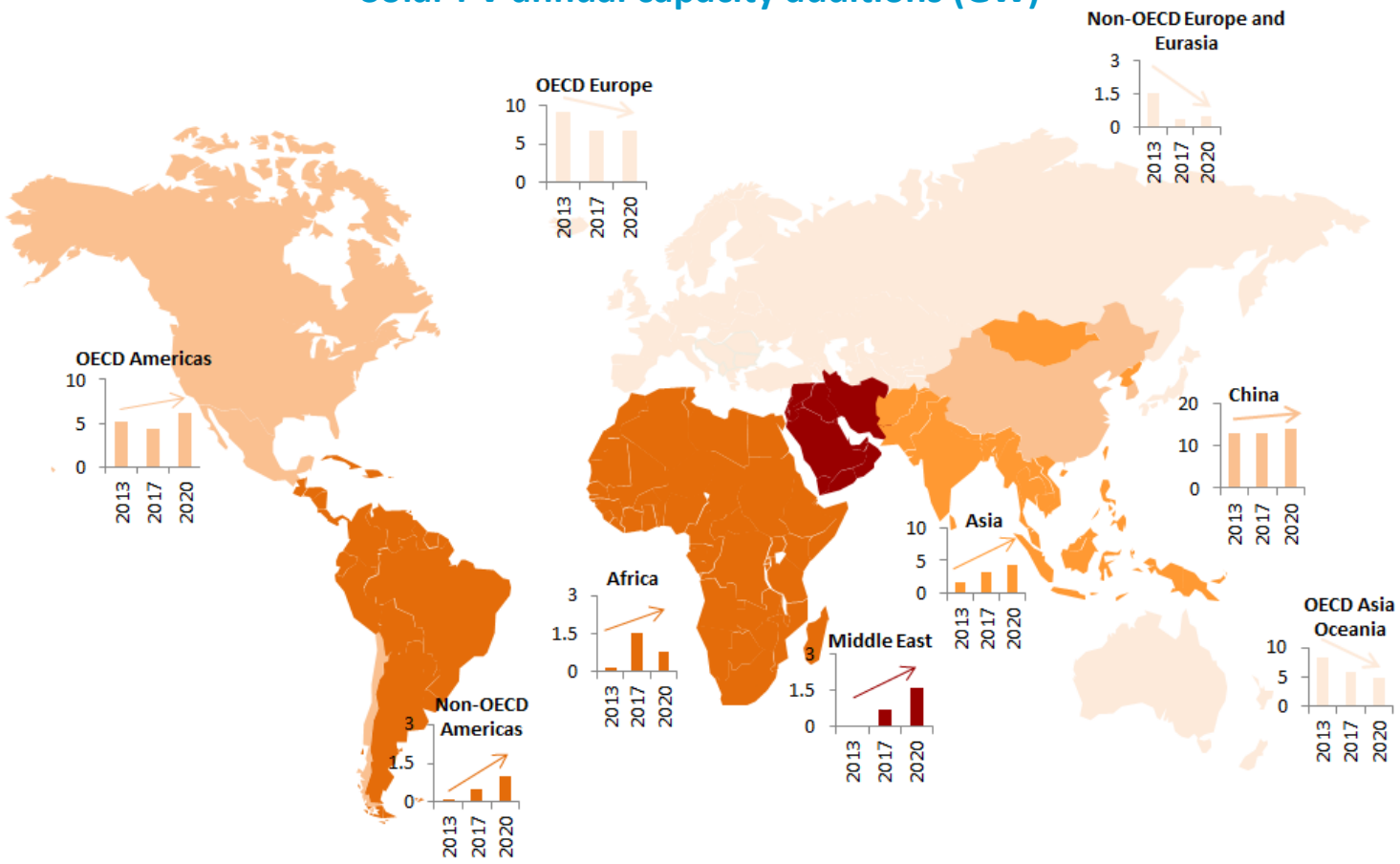
**Total wind (onshore + offshore) annual capacity additions by region (GW)**




| GW | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| World Onshore | 37.2 | 39.1 | 43.9 | 34.0 | 42.9 | 41.9 | 39.2 | 39.7 | 41.4 | 42.1 | 43.1 |
| World Offshore | 1.0 | 1.2 | 1.3 | 1.7 | 1.3 | 2.2 | 2.5 | 3.1 | 3.5 | 4.5 | 4.5 |

# Stronger outlook for solar PV

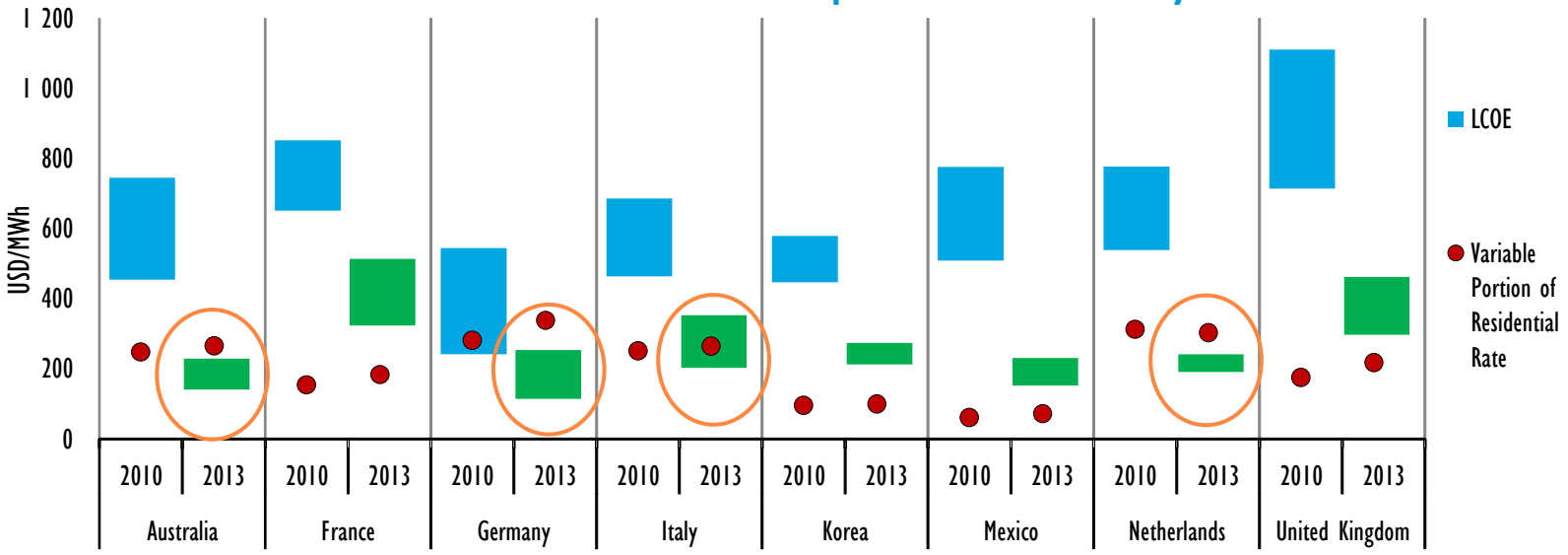
## Solar PV annual capacity additions (GW)




- Strong growth in emerging markets and some OECD areas
- Policy debates over distributed PV a source of forecast uncertainty

# Socket parity emerging as potential deployment driver for distributed PV

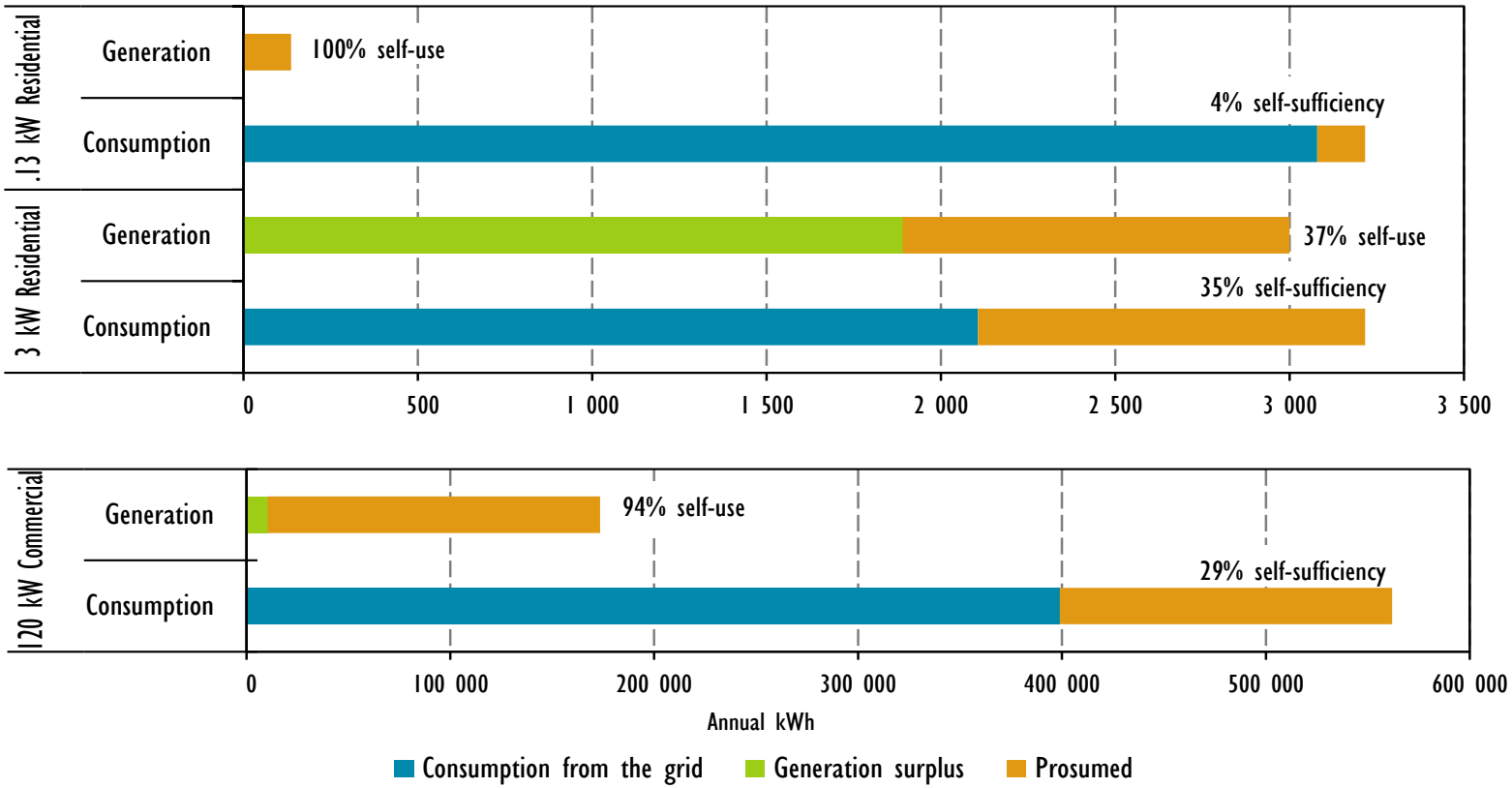
## LCOE of residential PV vs variable portion of electricity tariff




- **Economic attractiveness from offsetting electricity bill requires self-using most of the PV electricity**
  - **Currently limits potential, in particular for households**
- **Reaching socket parity is a driver for private actors**
  - **But PV may still have significant impact on total system costs, in particular depending on allocation of fixed network costs**

# Distributed solar PV: customer type and system size impacts economic attractiveness

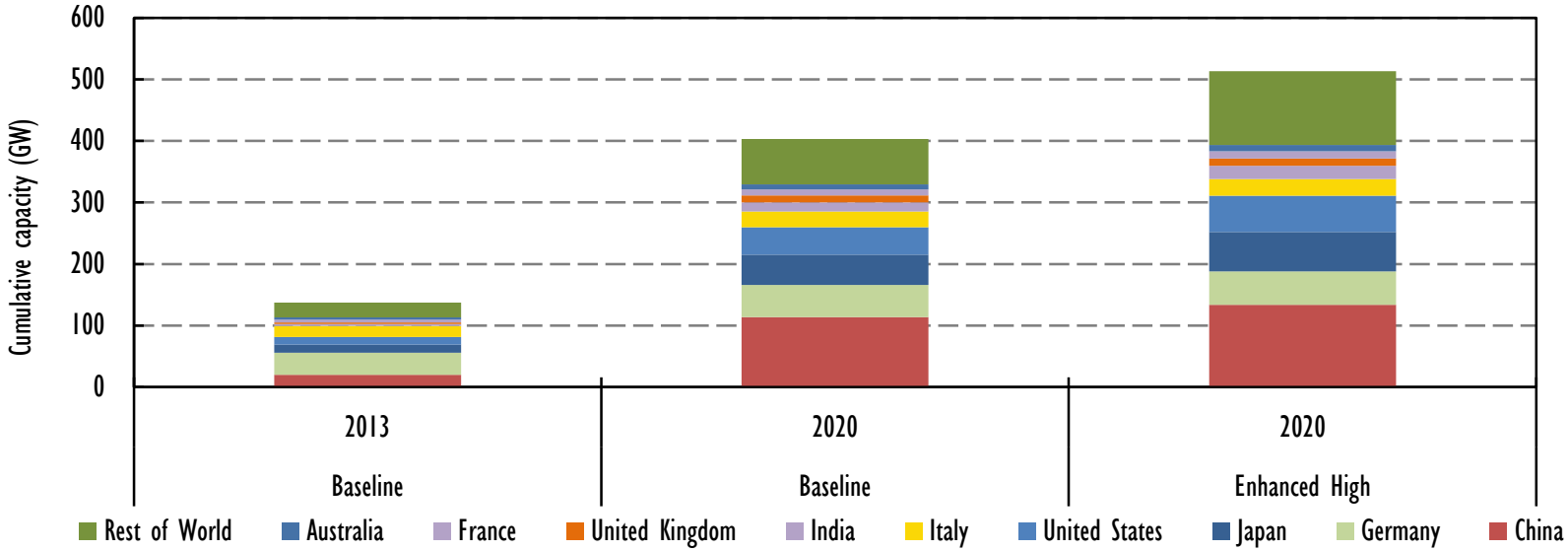
## Comparison of self-use and self-sufficiency shares by solar PV system size and customer




- Socket parity reached in several countries is a driver for private investment
- But: Economic attractiveness from offsetting electricity bill requires
  - Self-using most of the PV electricity
  - Fair allocation of fixed network costs

# Higher solar PV under enhanced case

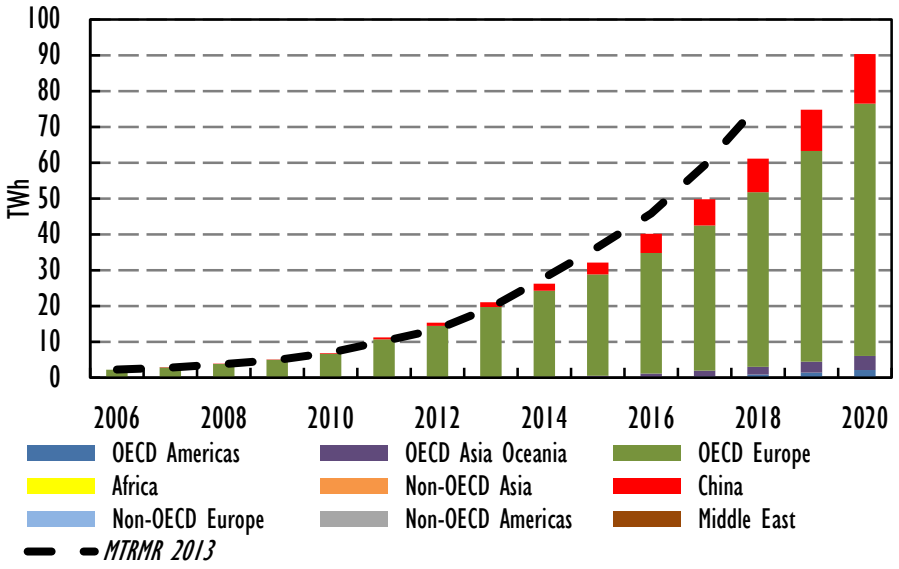
## Solar PV cumulative capacity, baseline versus enhanced case



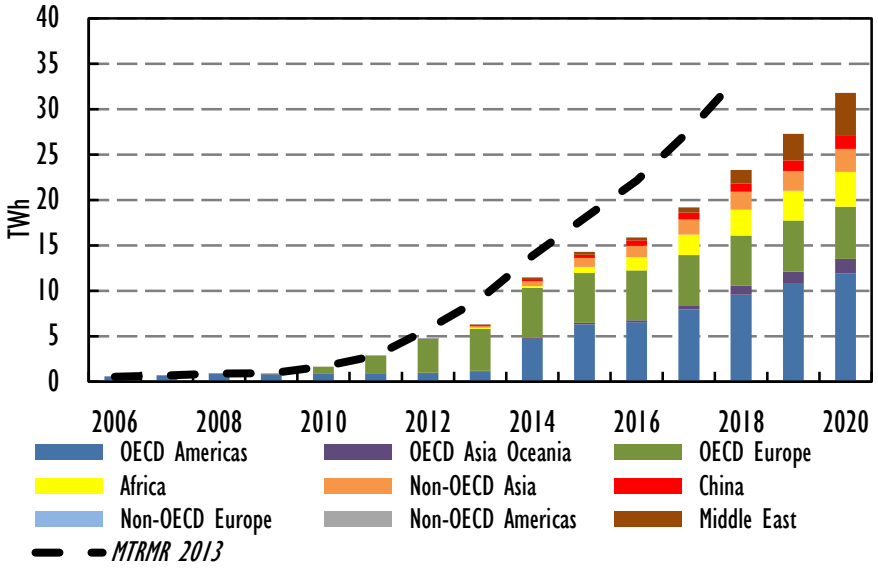

- **With certain market and policy enhancements -**
  - **Fair rules and appropriate electricity rate design for allocating the costs and benefits from fast-growing distributed solar PV**
  - **Greater implementation of ambitious policy aims (e.g. Middle East)**
  - **Faster-than-expected decreases in solar PV costs**
- **Solar PV capacity could top 500 GW globally in 2020**

# Other technologies growing slowly

## Offshore wind generation




## Solar thermal electricity generation




- Potential of offshore power remains high, but technical, financial and grid connection issues pose challenges
- Storage adds value to CSP, but deployment hampered by relatively high costs

# Progress tracked on different scales

| Incremental TWh increase (2013-20) | |
|---|---|
| 1. China | + 880 |
| 2. Brazil | + 207 |
| 3. United States | + 180 |
| 4. India | + 127 |
| 5. Japan | + 72 |
| 6. Germany | + 71 |
| 7. United Kingdom | + 52 |
| 8. Turkey | + 45 |
| 9. Canada | + 41 |
| 10. Mexico | + 38 |

| Memo: EU-28 | + 251 |
|---|---|

| Average annual growth (2013-20) | |
|---|---|
| 1. Saudi Arabia | + 117% |
| 2. Jordan | + 65% |
| 3. UAE | + 51% |
| 4. Qatar | + 37% |
| 5. Israel* | + 27% |
| 6. South Africa | + 25% |
| 7. Cambodia | + 22% |
| 8. Ethiopia | + 20% |
| 9. Nigeria | + 15% |
| 10. Morocco | + 15% |

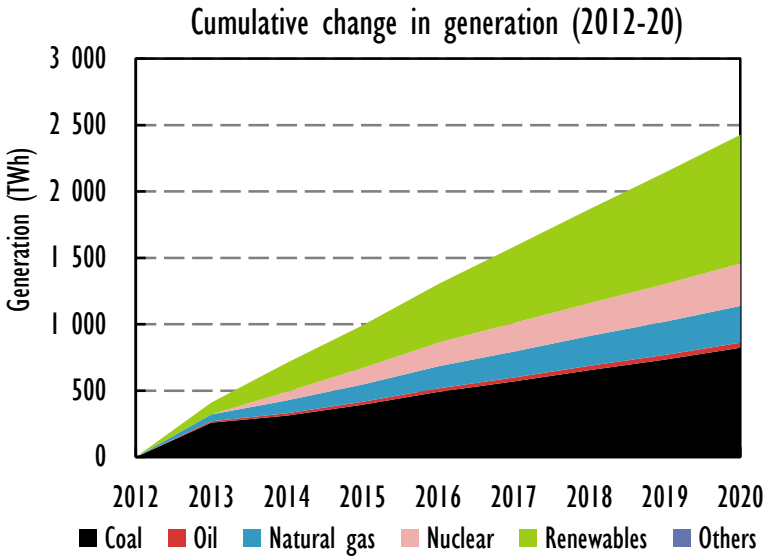
Note: countries with at least 1 GW of renewable capacity by 2020

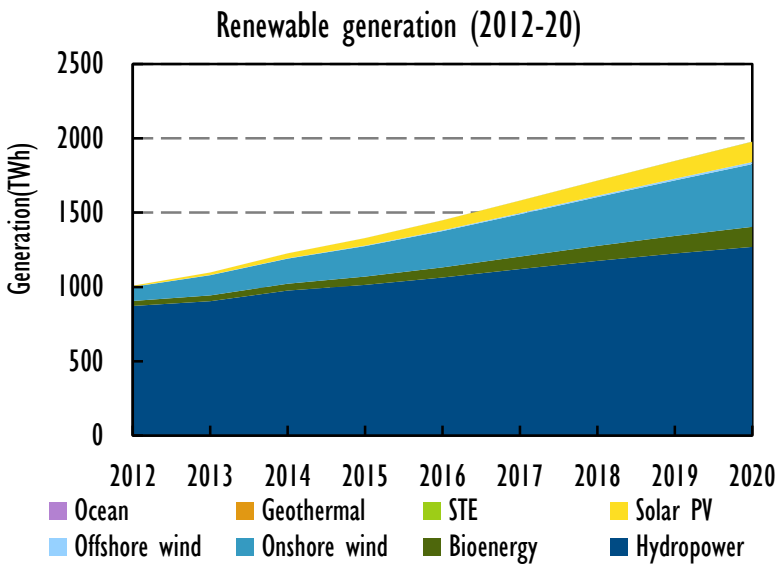
* The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

# China accounts for 40% of global growth

- Strong generation needs, pollution reduction goals and policy environment with ambitious targets support China's deployment
- Renewables comprise 45% of new generation to 2020, ahead of coal
- Some emerging challenges –
  - Slower demand outlook than in *MTRMR 2013*
  - Integration of large amounts of variable renewables
  - Uncertainties over favourable economics for distributed PV scale up

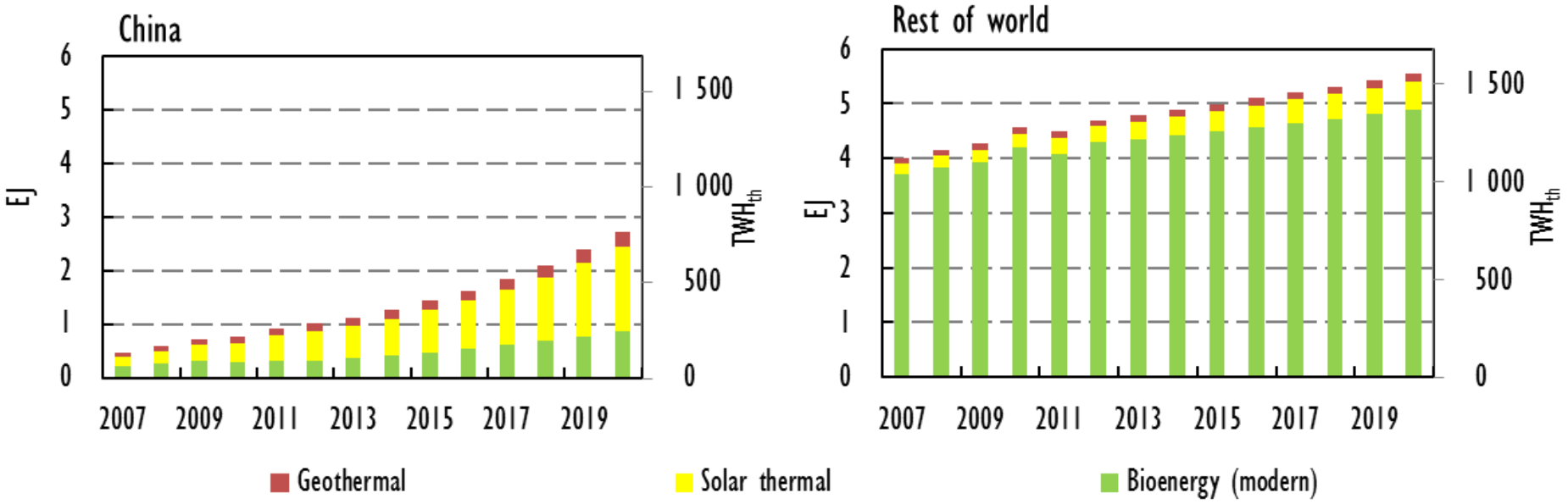
## Evolution of China's power generation mix, 2012-20



# China accounts for 70% of growth in world modern renewable heat use in buildings 2013-20

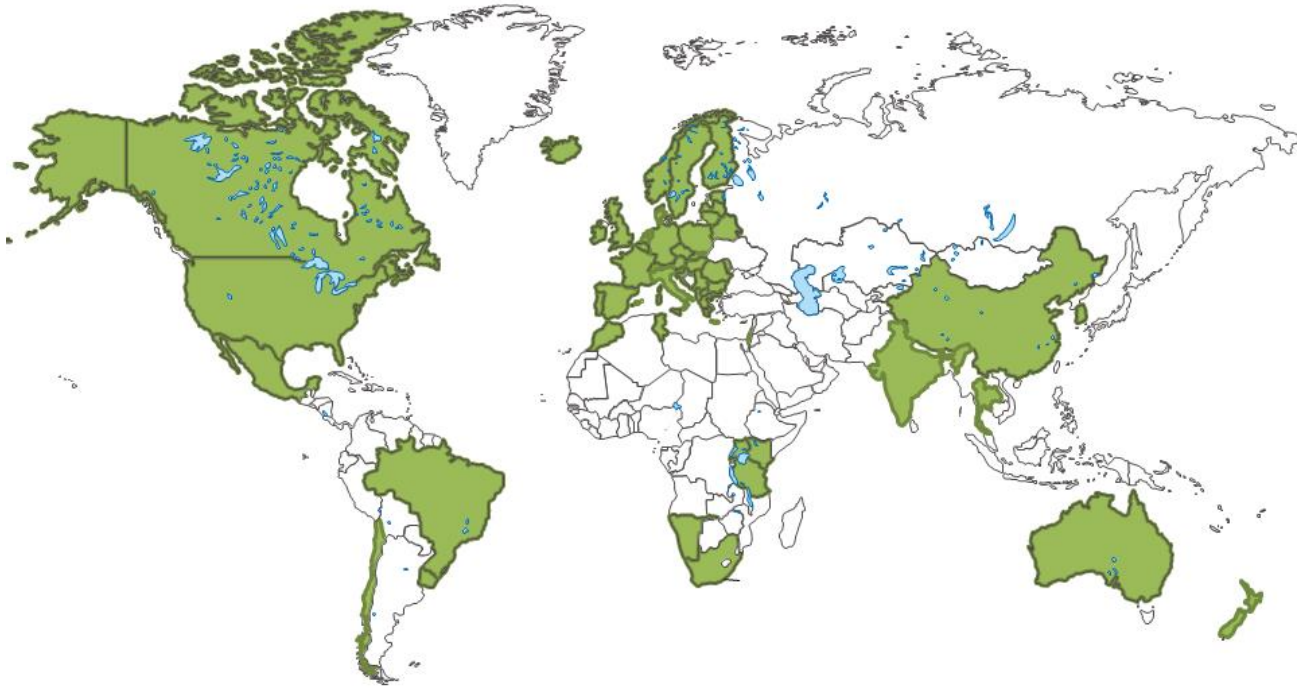
## Modern renewable energy use for heat in buildings




- **Favorable combination of support policies and cost-competitiveness of renewable heat technologies supports growth of renewable heat in China**
  - **Solar thermal (+15%/year) is fastest growing technology**

# Role of renewable use in heat also increasing, but policy support still limited

## Countries with targets and support policies for renewable heat

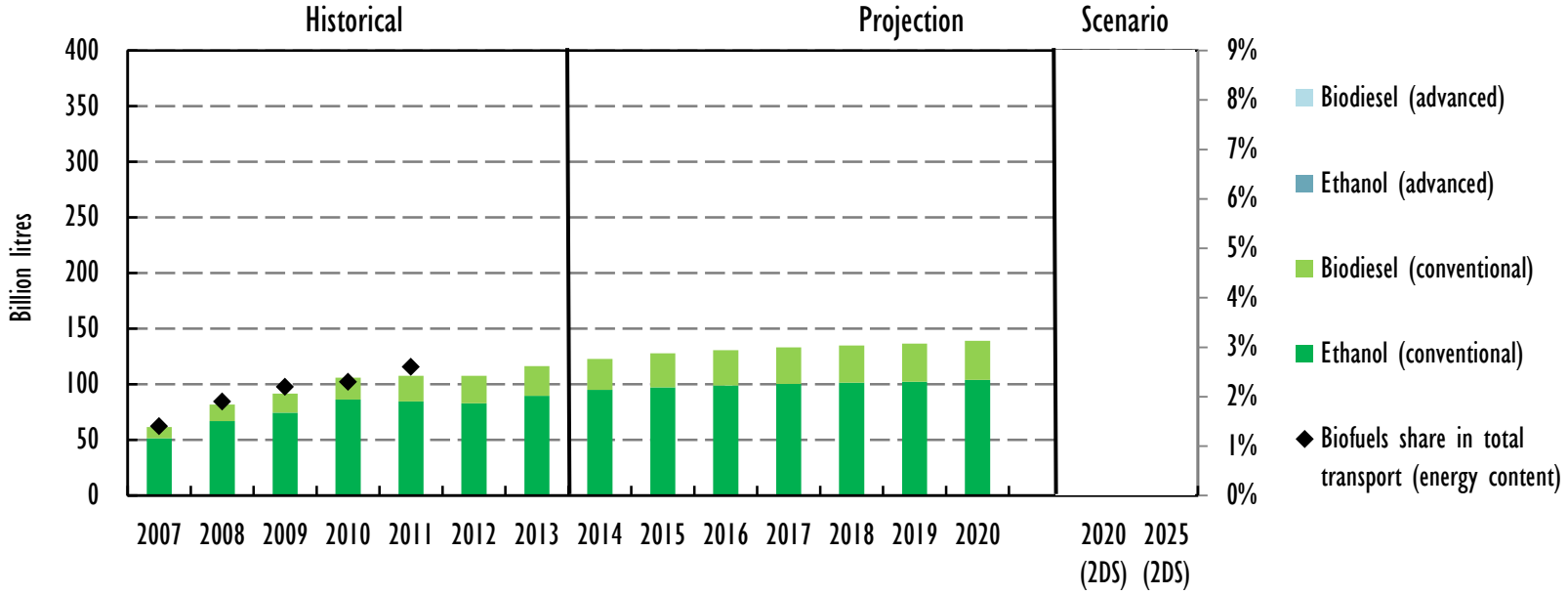


This map is without prejudice to the status of or sovereignty over any territory to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

- **Modern renewable heat continues to grow, providing 9% of world final energy use for heat in 2020**
  - **Broader adoption of support policies for renewable heat could reduce energy consumption and enhance energy security**

# Transition to advanced biofuels for transport threatened by policy uncertainty

## Projected biofuel production versus targets in IEA 2°C Scenario (2DS)




- Conventional biofuel production continues to grow, and will provide 4% of road transport fuel demand in 2020
- First commercial-scale advanced biofuel plants coming on line
  - Without adoption of long-term policy framework, advanced biofuels sector faces grim future

# Main messages to policy makers

- Solutions to future development rest in policy makers' hands
  - Policy risk main barrier to investment
- Policies to focus on cost-efficiency
  - But policy changes must be predictable, and retroactive changes must be avoided
- Given capital-intensive nature, renewables require market context that assures reasonable and predictable returns
- Resolving governance question will be key for investor certainty in post-2020 EU framework
- Muddled signals may send the wrong messages about renewables at a time when newer markets have opportunity to leapfrog to more flexible and cleaner energy systems

# For further insights and analysis…


International Energy Agency

- **The Medium-Term Renewable Energy Market Report 2014 can be purchased online at:**

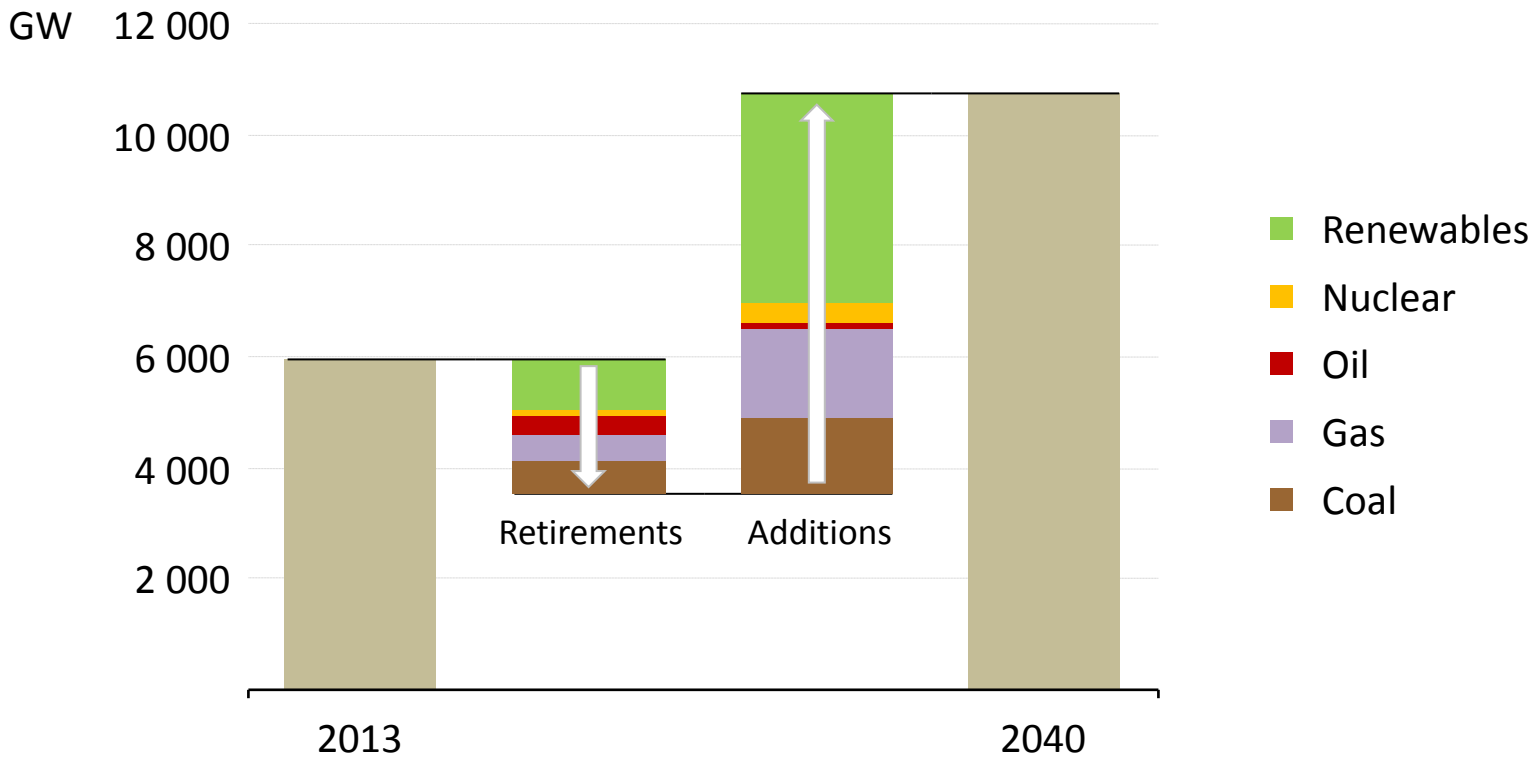
  **www.iea.org**

- **Thank you for your attention!**

# Retirements add to the investment challenge in the power sector



## Power capacity by source, 2013-2040

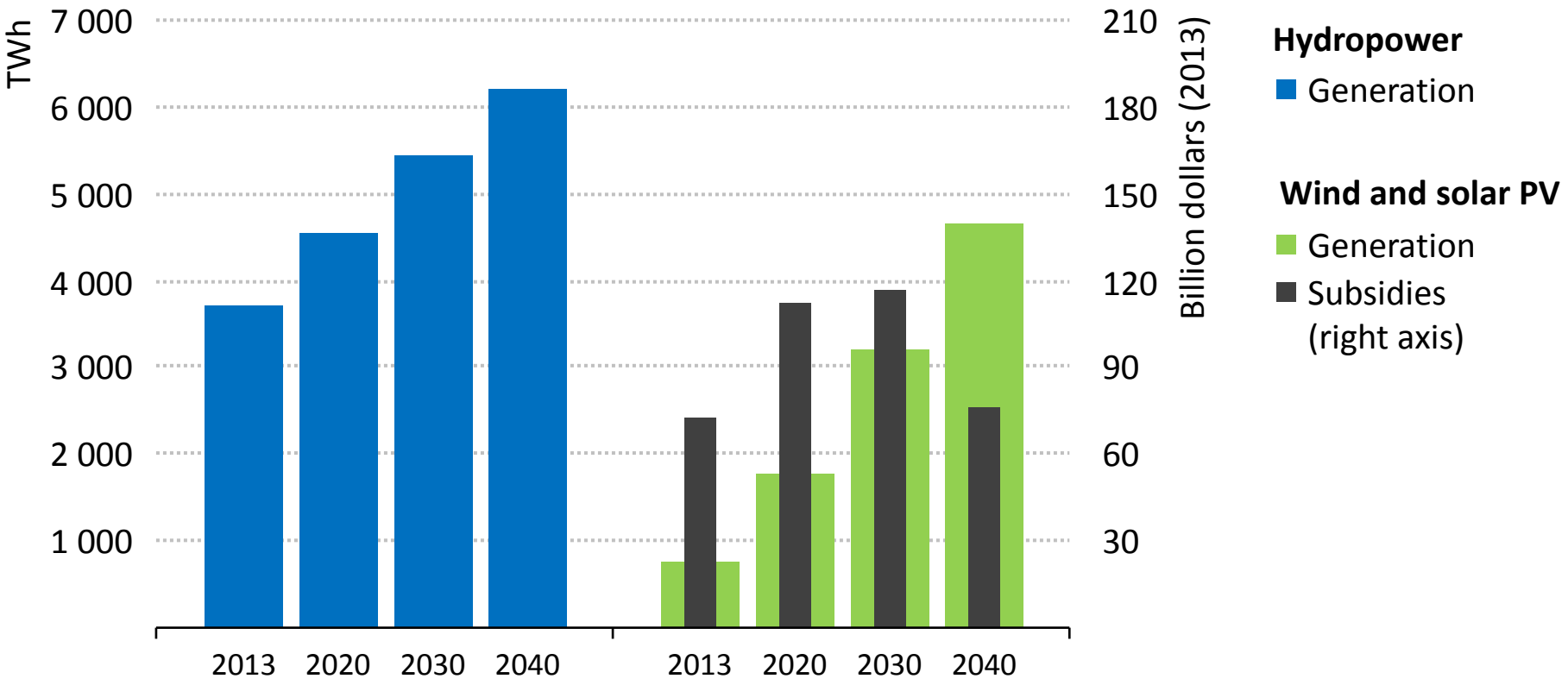



***Despite limited demand growth, OECD countries account for one-third of capacity additions – to compensate for retirements & to decarbonise***

# Renewables overtake coal to become the leading source of power

World Energy Outlook 2014

## Renewables-based power generation and subsidies

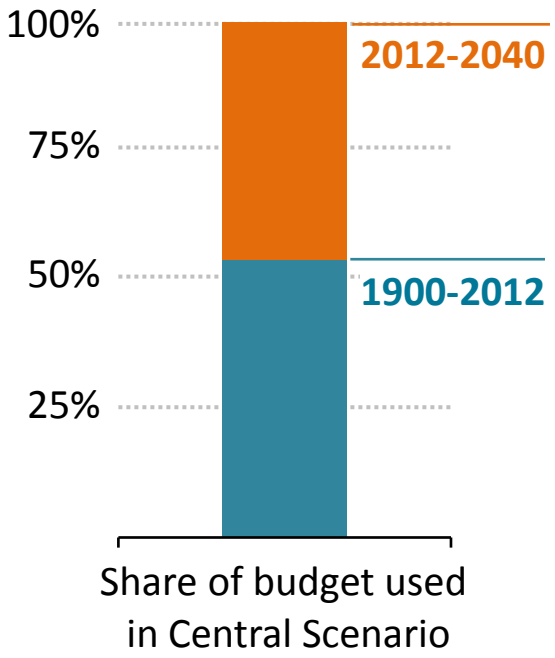



***Renewables supply half of the growth in global power demand; wind & solar PV subsidies decline from 2030 as costs fall & recent higher-cost commitments expire***

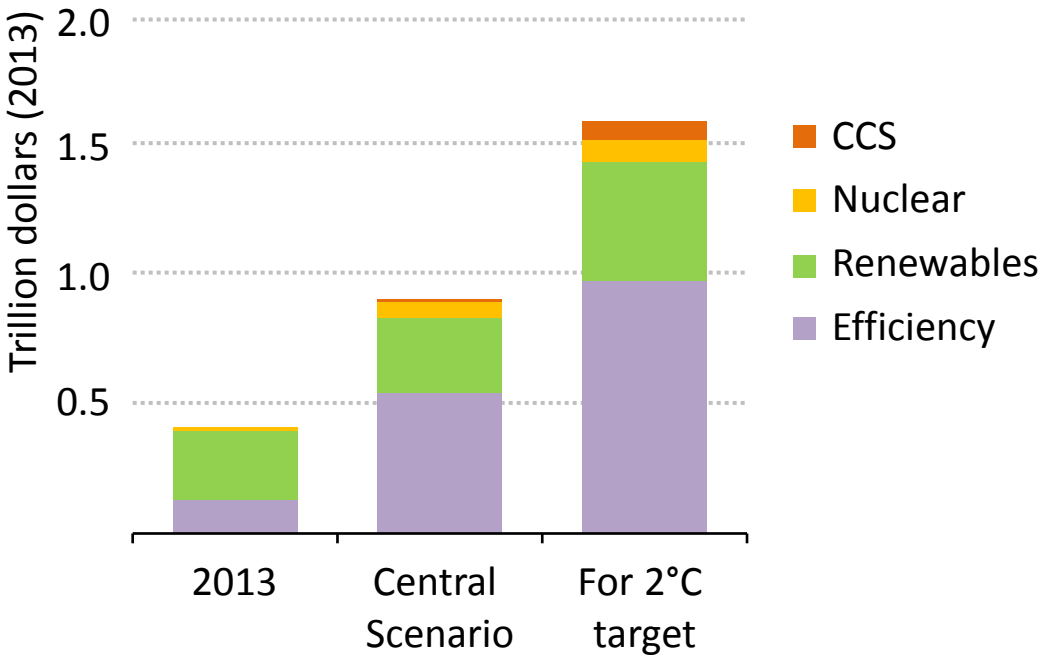
# The 2 °C goal – last chance in Paris?



## World $CO_2$ budget for 2 °C ~2300 Gt




## Average annual low-carbon investment, 2014-2040

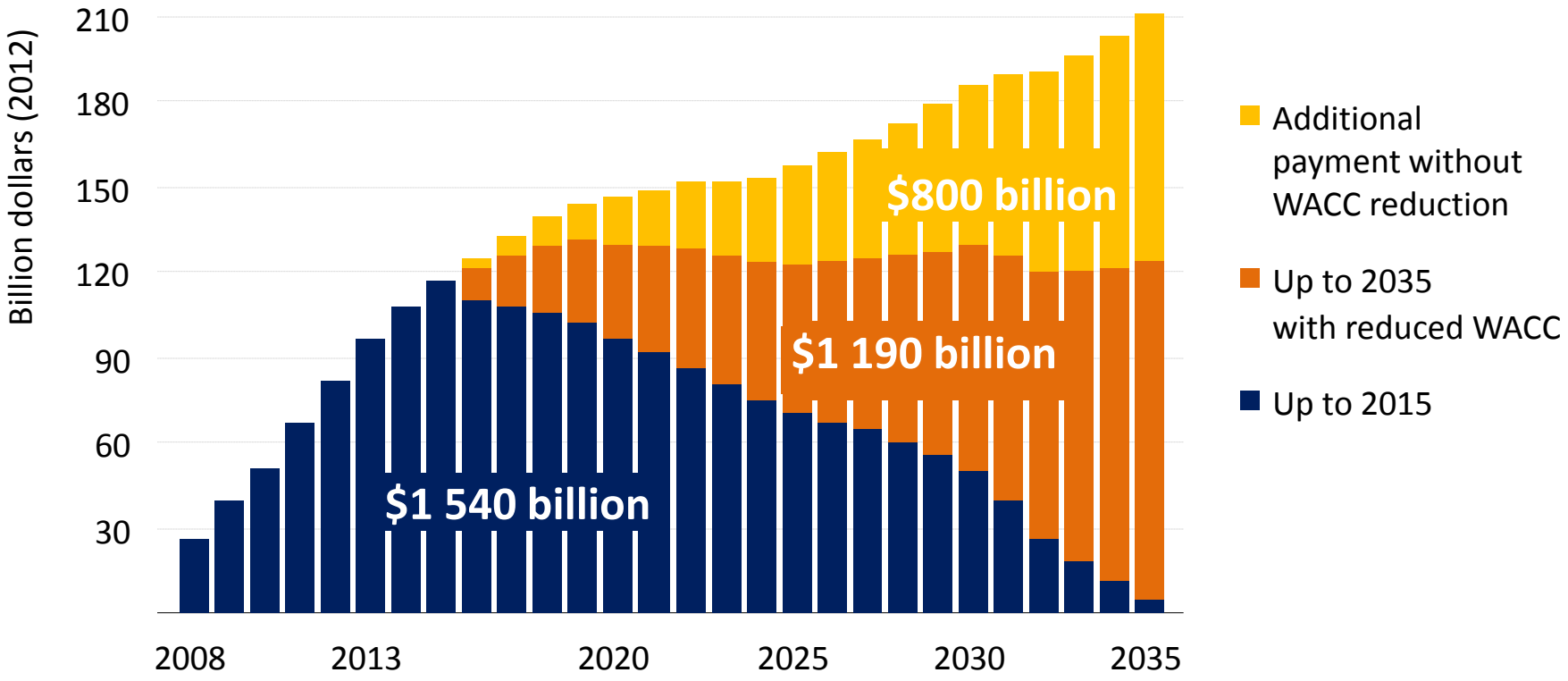



***The entire global $CO_2$ budget to 2100 is used up by 2040 – Paris must send a strong signal for increasing low-carbon investment four times beyond current levels***

# Attracting financing in the 450 Scenario



## Subsidies to renewables in the 450 Scenario

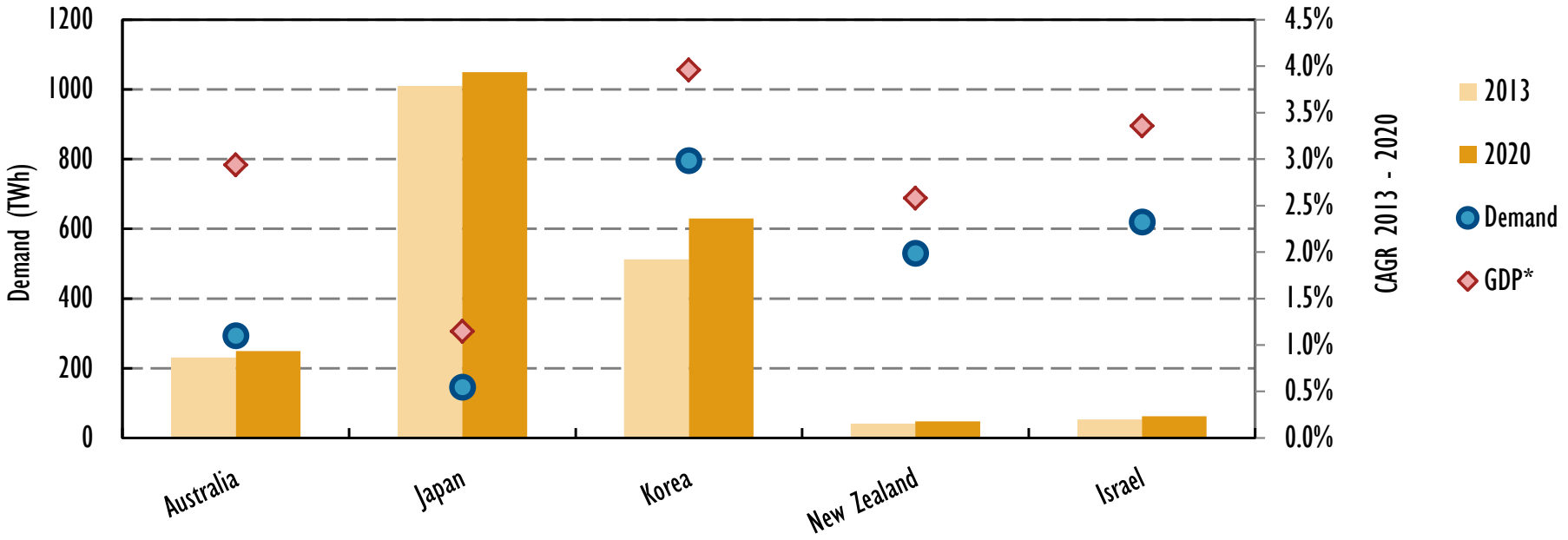



***New financing vehicles could help lower the cost of capital – a reduction of three pct points would make renewables more competitive, reducing subsidies by 40%***

# Focus on Japan and Grid Integration

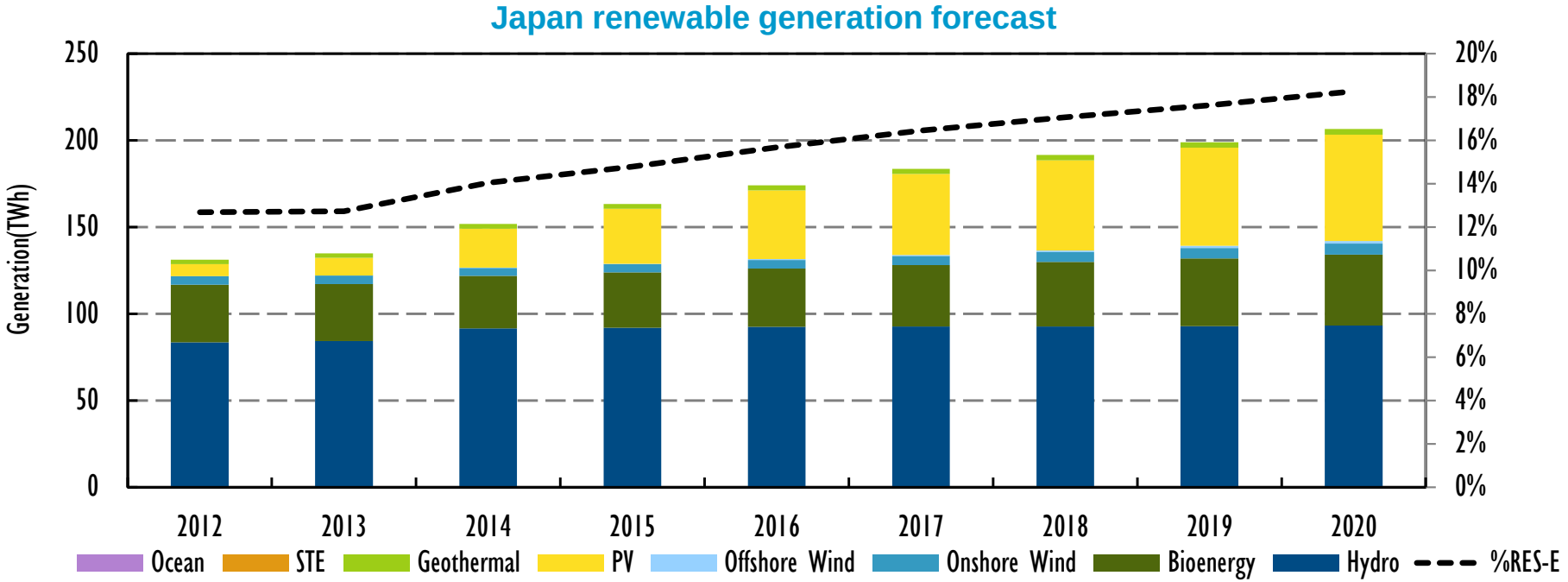
# Two speeds of demand growth for OECD Asia Oceania countries

## OECD Asia Oceania countries power demand versus GDP growth



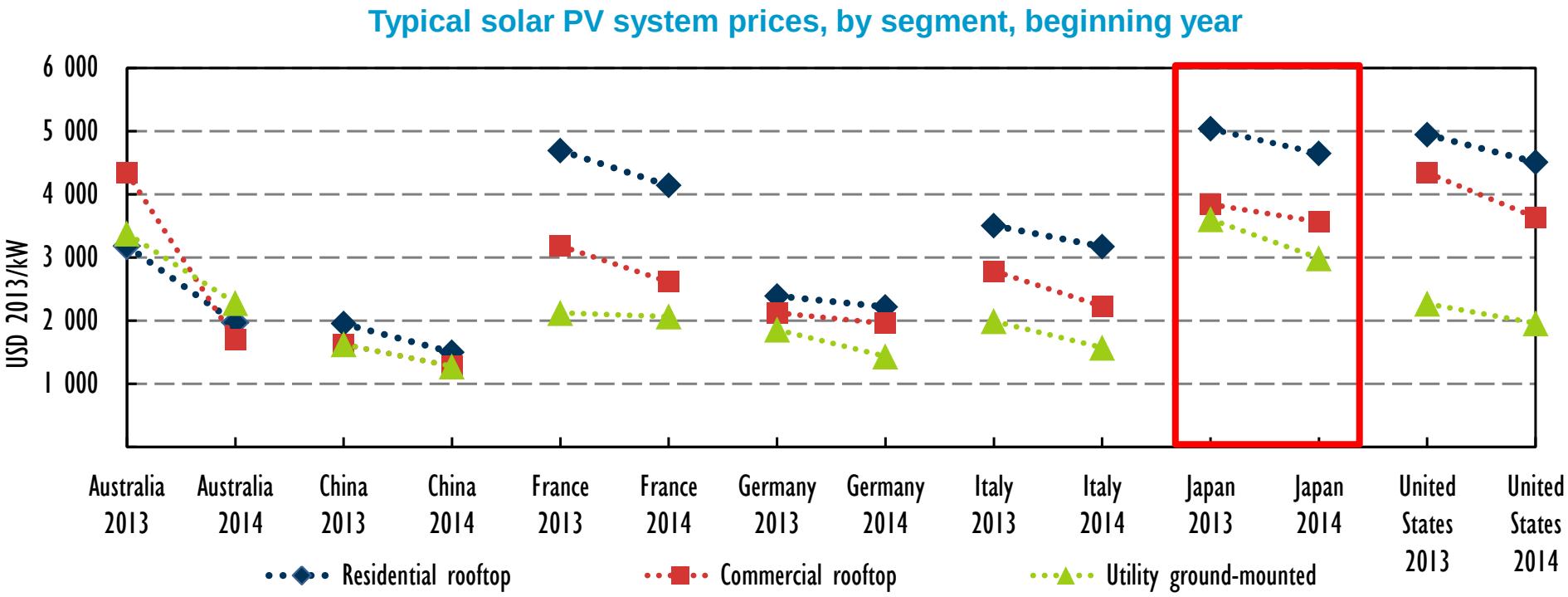

- Japan's power demand growth expected to be modest through 2020, due to power supply constraints, success of efficiency measures and slow GDP growth
- By contrast, Korea's demand expansion expected to be robust, with increasing industrial activity

# Japan's renewable expansion dominated by solar PV




- Solar PV capacity expected to rise to 49 GW in 2020 from over 13 GW in 2013
- Onshore wind constrained by non-economic barriers (land, permitting) and grid integration; offshore wind development nascent, but could scale up in long term
- Geothermal could be higher in long term, with reduced investment risks and streamlined environmental assessment
- Realising this forecast requires progress in implementation of planned electricity market reforms and greater clarity over renewable provisions in 4th Strategic Energy Plan

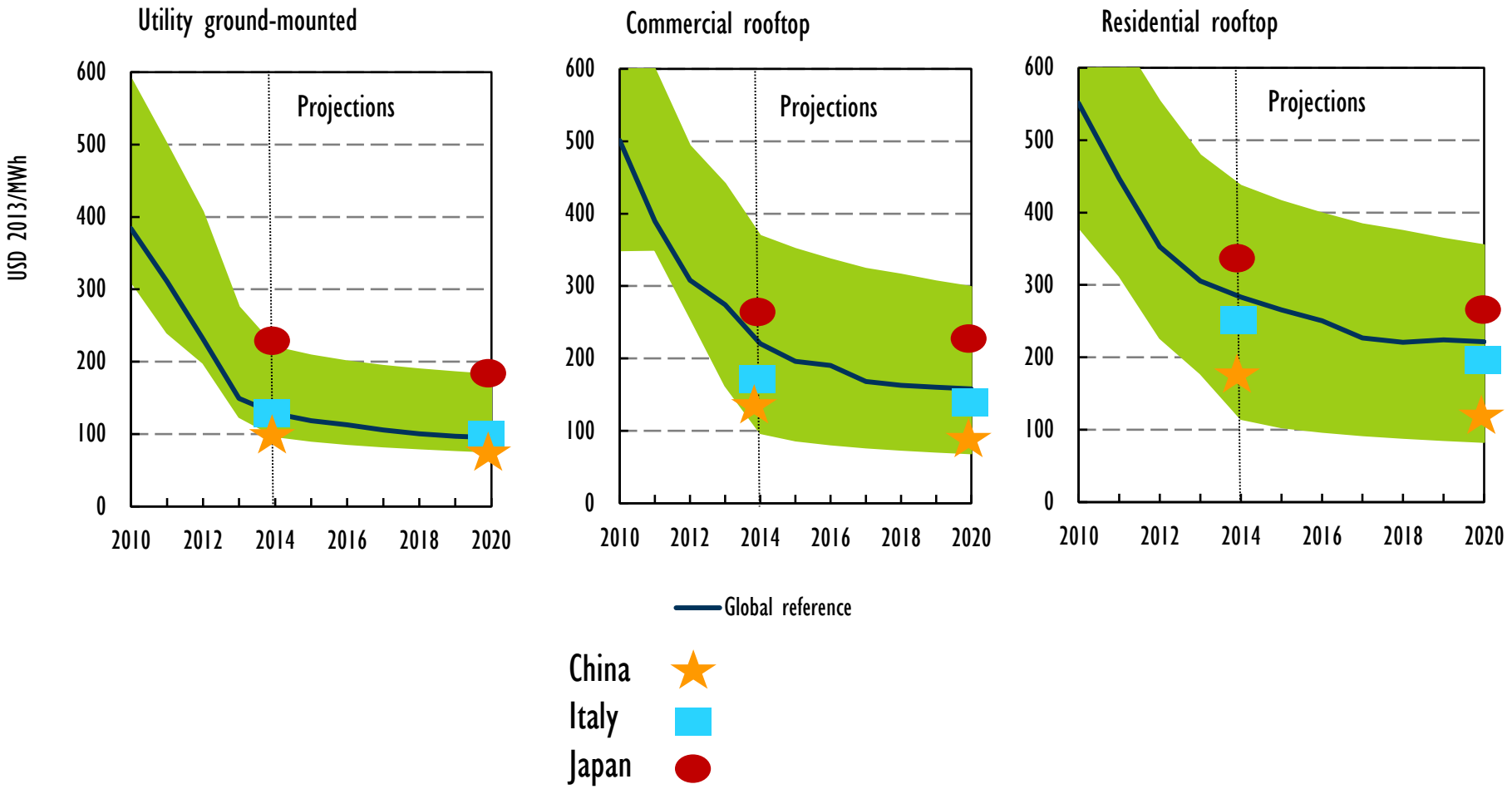
# Solar PV investment costs remain relatively high in Japan




- **Utility-scale PV among the world's most expensive due to relatively high module prices, permitting, grid connection bottlenecks and land use constraints**

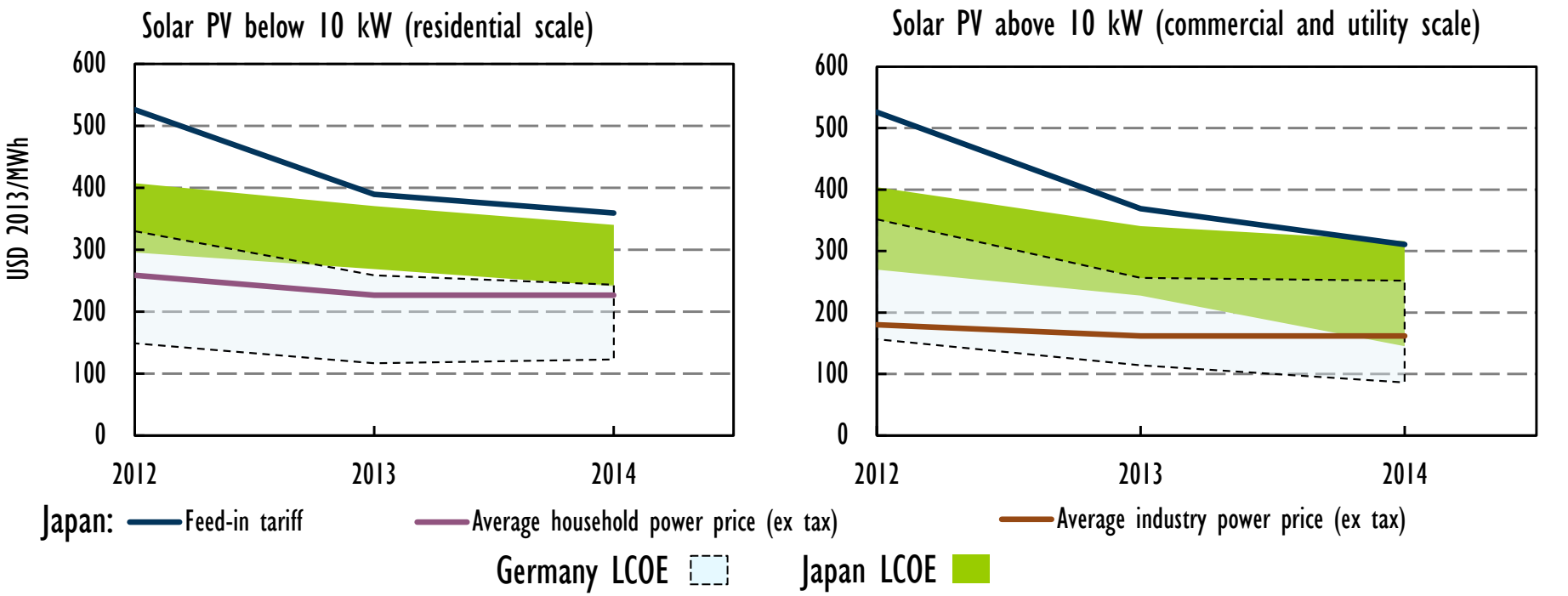
# Generation costs seen falling, but still high by global standards

## Historical and projected LCOEs for typical solar PV systems, beginning year



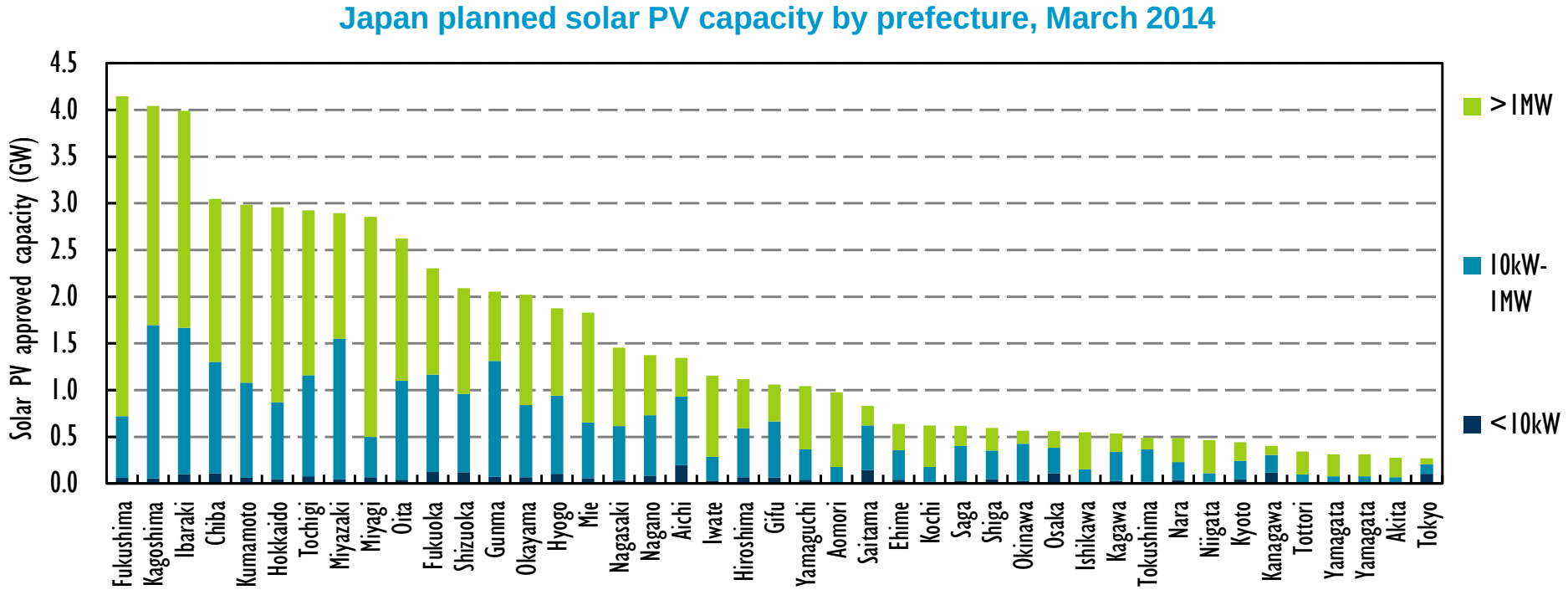
# What costs can be reduced? How?

## Japan solar PV LCOE ranges versus FIT levels, end-user price levels and Germany LCOEs




- Japan has somewhat better solar resources than Germany, but much higher costs
- High feed-in tariff levels a reflection of, or contributor to, inflated costs?
- Important for government to maintain dynamic approach to FIT adjustments to reflect international cost reductions and national market maturity
- International experience shows total costs must be kept under control

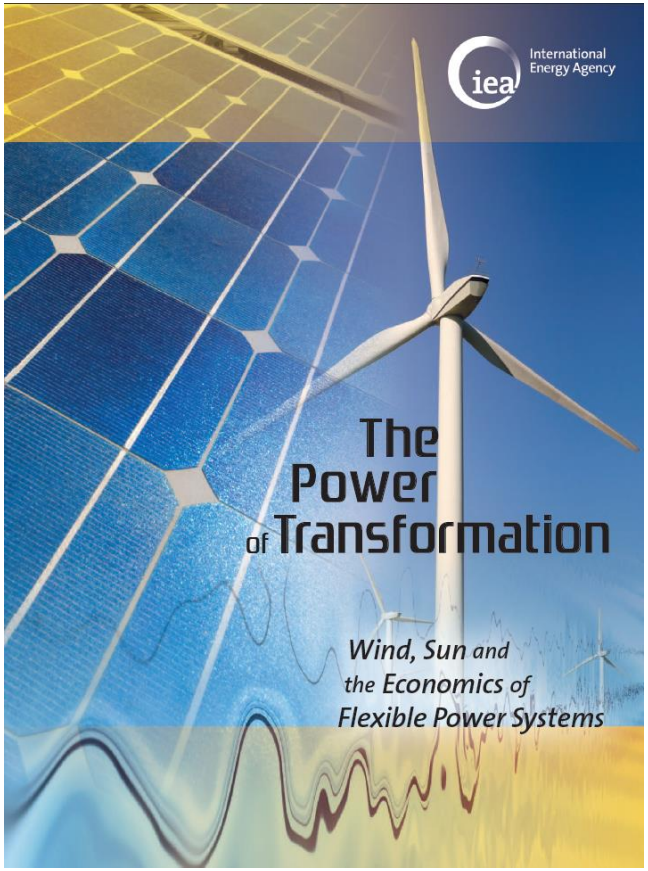
# Large PV project pipeline has emerged

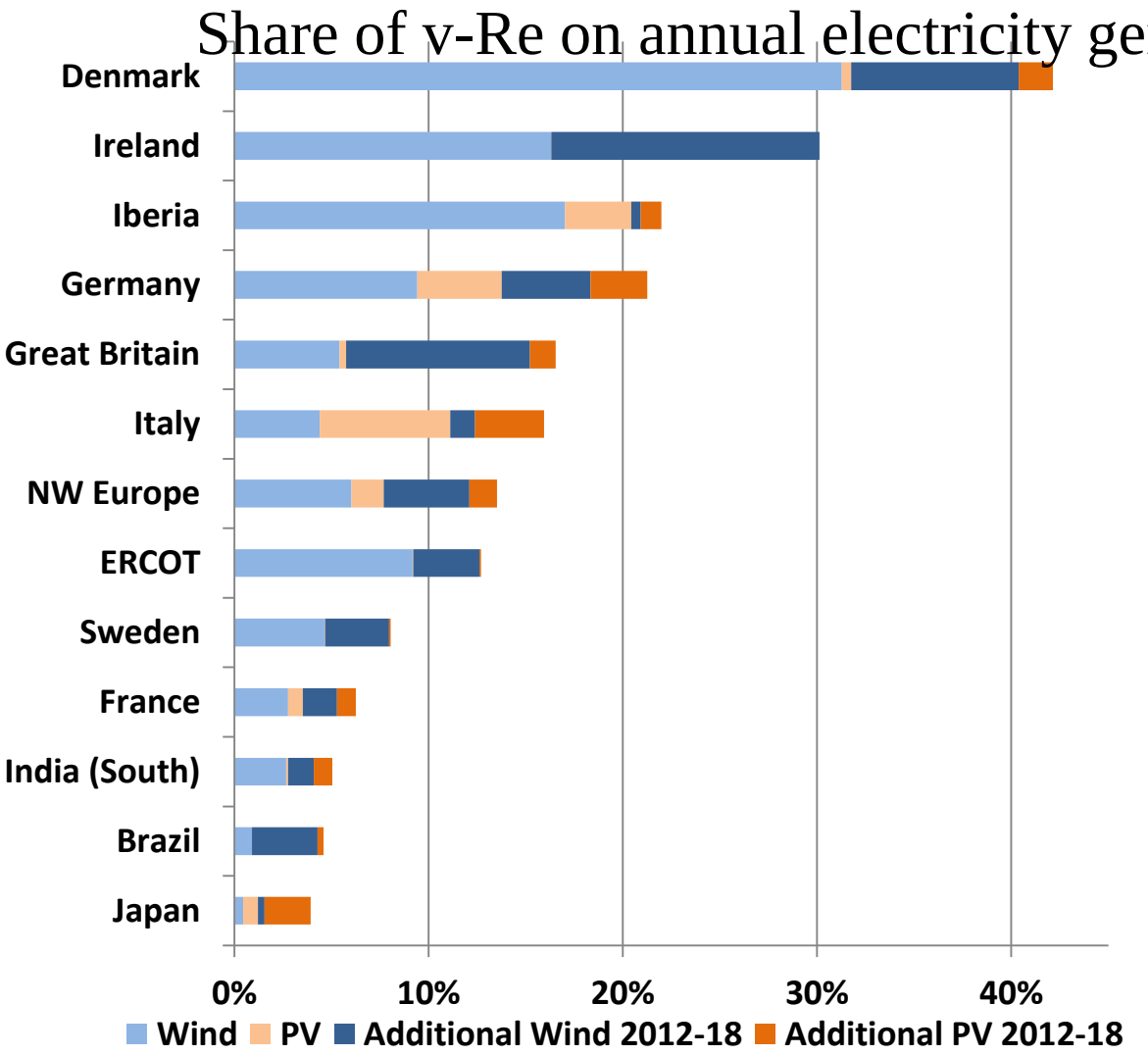



- **Utility-scale plants dominate registered PV projects, but only a fraction will likely get built due to project delivery and cost challenges**
- **Insufficient transmission, grid congestion and grid connection availability remain constraints – risk of local deployment hotspots!**

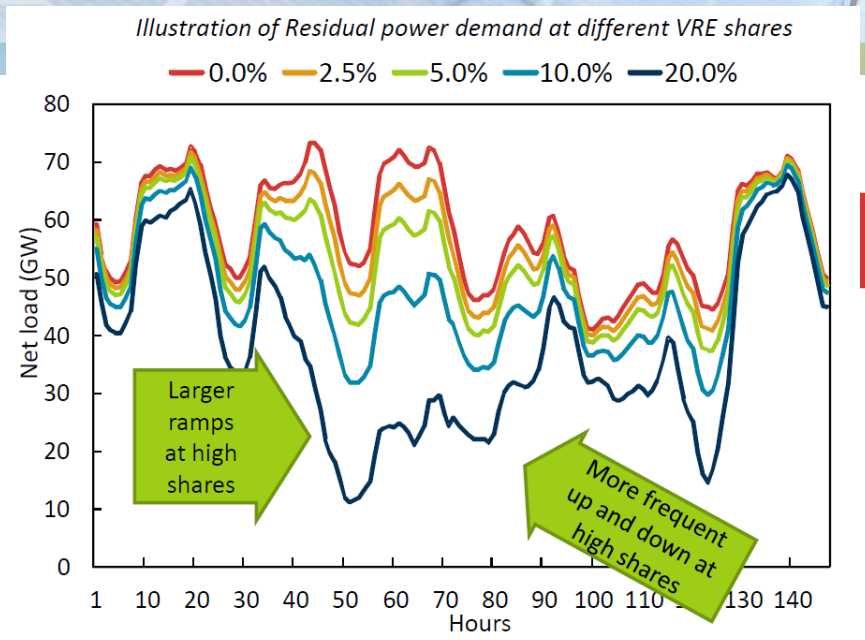
# Focus on Grid Integration: System Operation

# IEA Work on Grid Integration



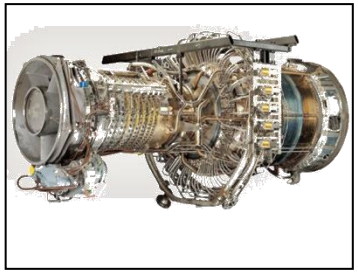
# Flexible power systems are key




**Flexibility of other power system components**

Grids

Generation



Storage

Demand Side

- More v-RE require flexible power systems
- More flexibility implies more diversification and resilience
  --> increased energy security
- IEA Electricity Security Action Plan

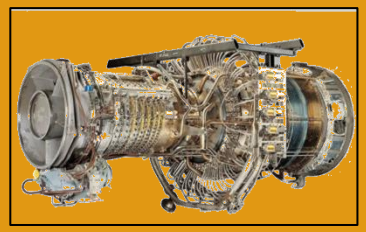
# Three pillars of system transformation

Technology spread

Geographic spread

Design of power plants

*System friendly VRE*

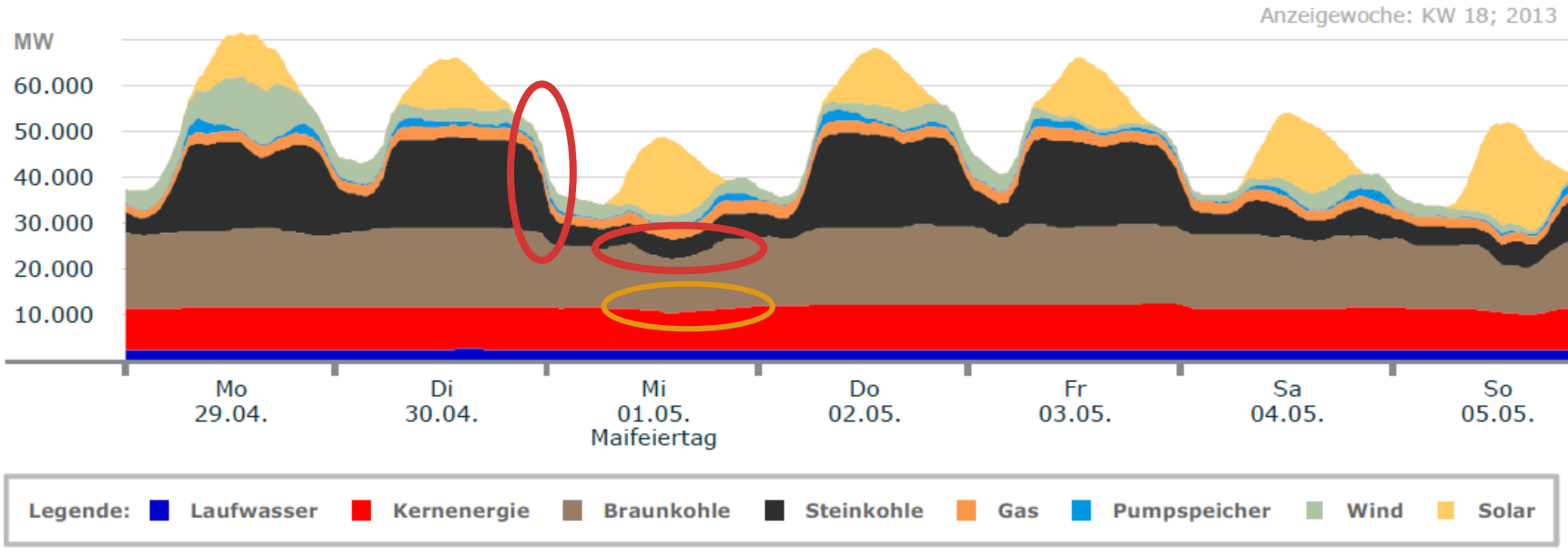



*Investments*

*Operations*

# Flexibility: ask for it…. and it appears

*A sunny 1st May 2013 in Germany – actual production*




Source: Fraunhofer ISE

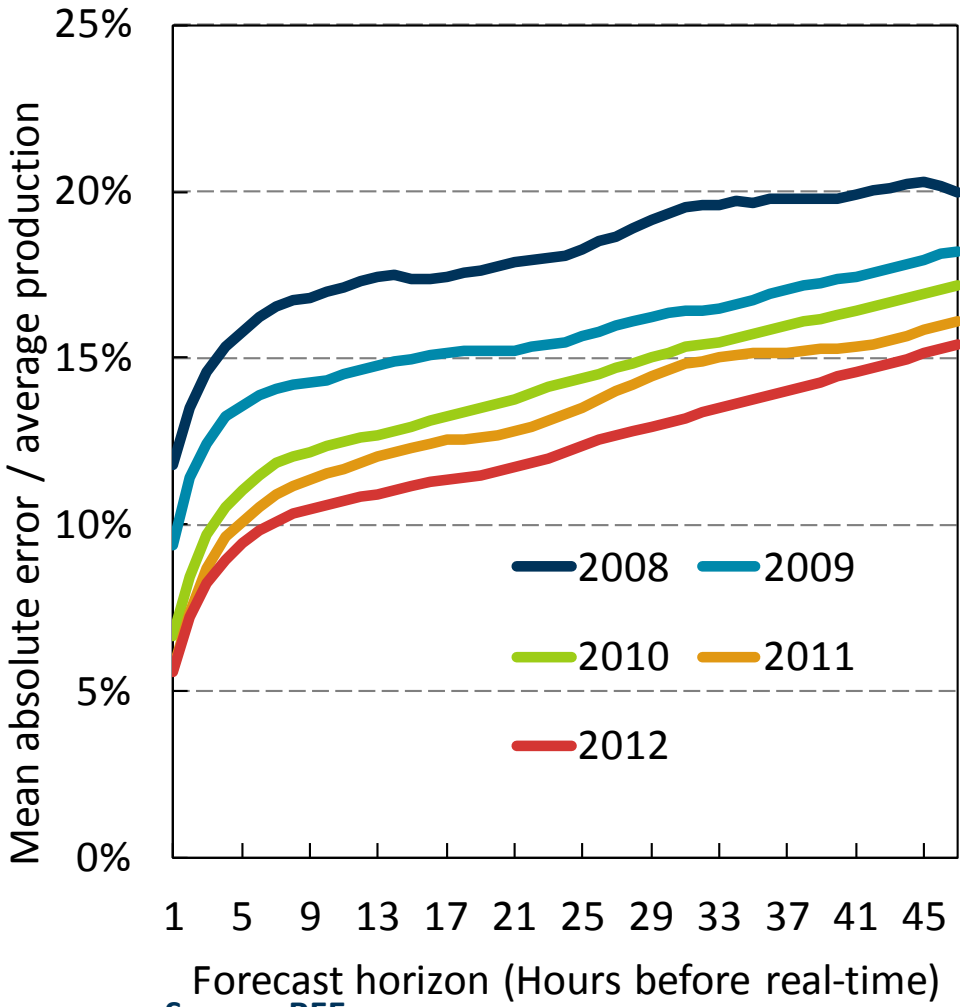
- German hard coal plants carry most of ramping duty in Germany
  - Lignite and nuclear ramp as well, even nuclear at some times
- Ramping costs can be minimised at low cost; retrofits are possible e.g. Flexible Coal: Evolution from Baseload to Peaking Plant (NREL, 2013)

# VRE production forecasts

## *Where do Japanese EPCOs stand?*

- Forecasting of VRE production key strategy for cost-effective operation
- Forecasts improve dramatically with shorter horizon
- Real-time generation data key for short-term accuracy
- More mature for wind than for PV

***Accuracy of wind forecasts in Spain***

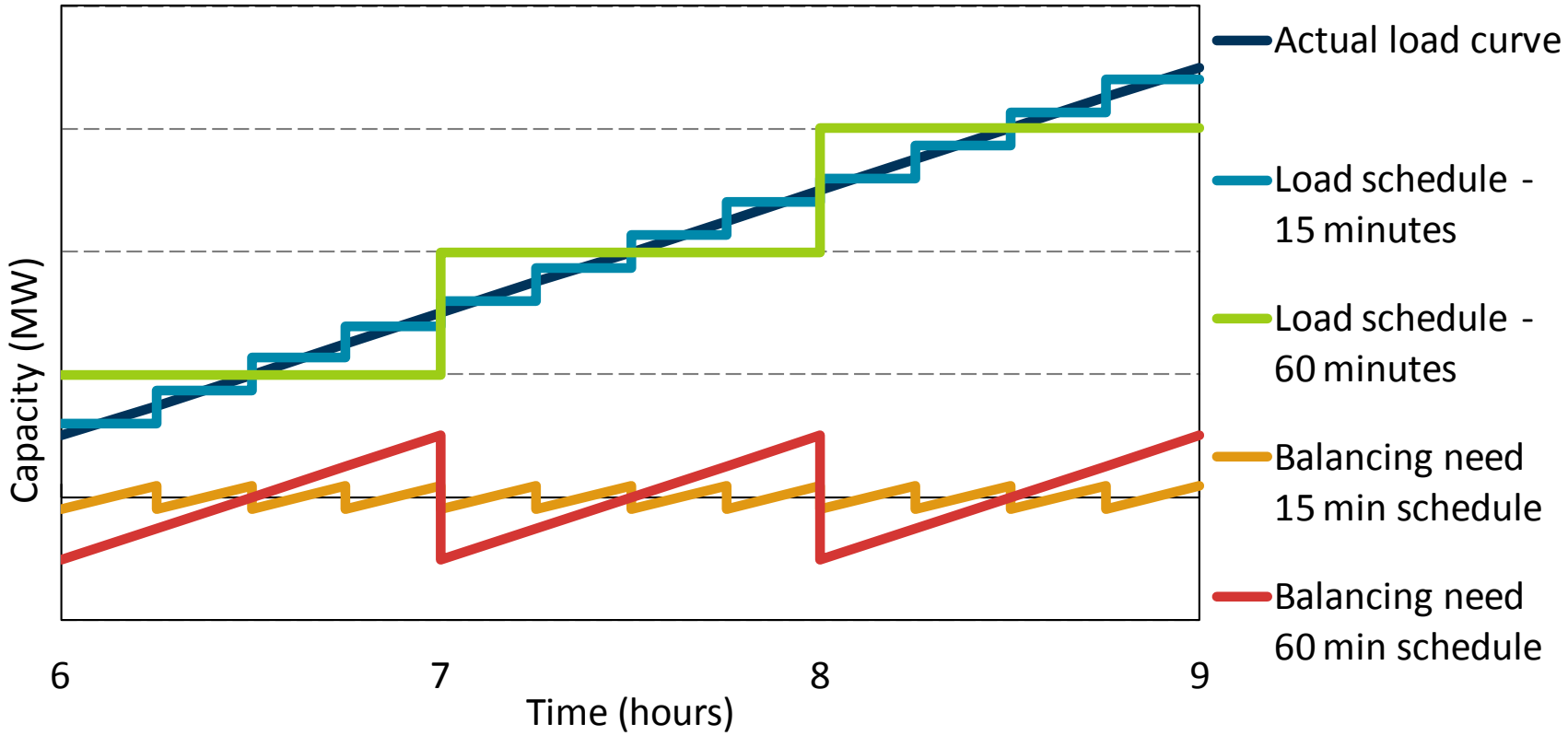



**Source: REE**

# Generation and transmission schedules

## *Are EPCOs going with the flow?*

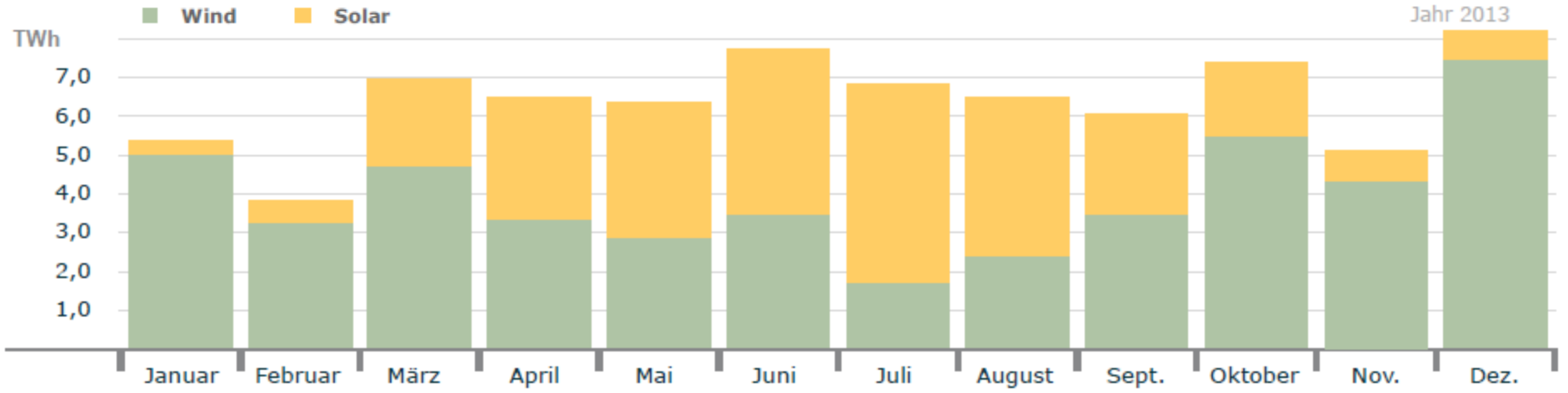
***Impact of scheduling interval on reserve requirements, illustration***




- **Short scheduling intervals (5min best practice)**
- **Adjust schedules up to real time (5min best practice)**

# Reaping technology synergies

*Monthly production, wind and PV, Germany, 2013*



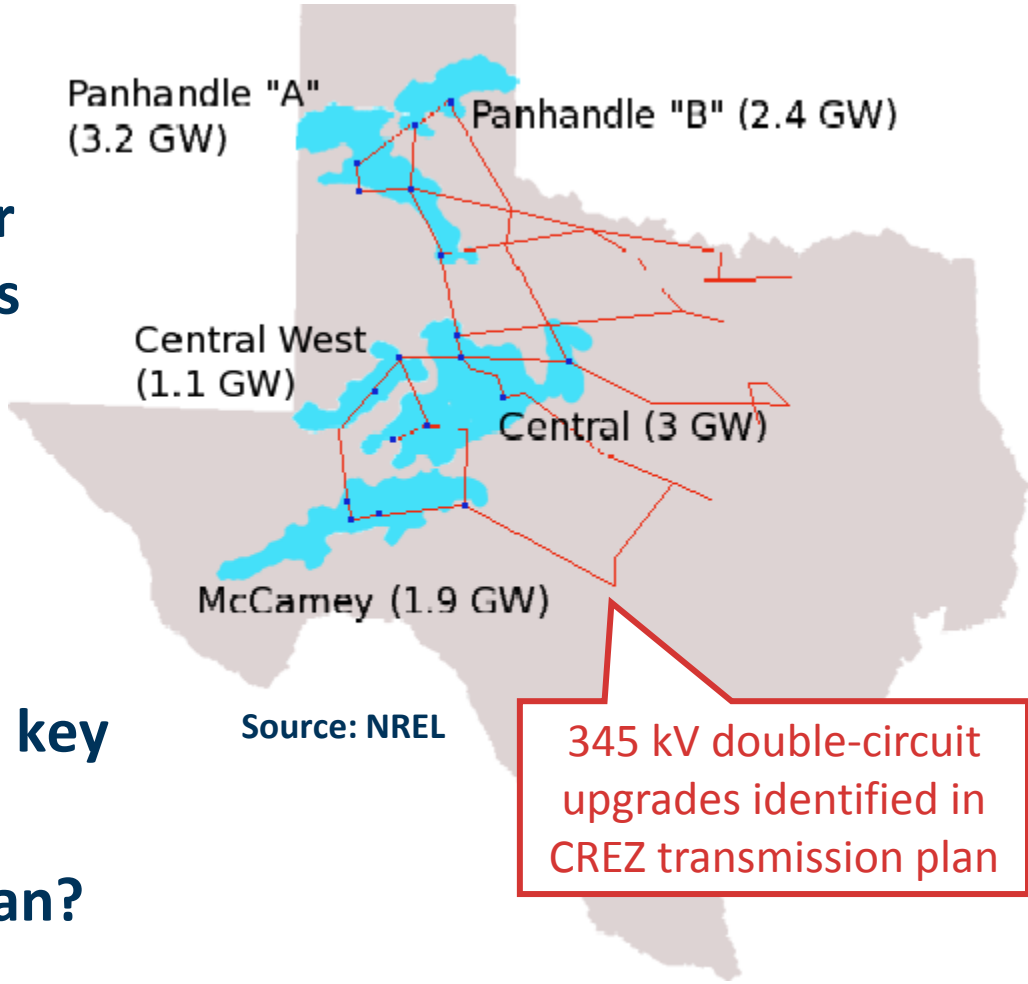

Source: Fraunhofer ISE

- Very strong focus on PV currently in Japan
- Deployment of *a portfolio* of renewables key strategy
  - Complementarities: wind, solar PV
  - Flexibility: hydro power, biogas
  - Firm capacity: biomass and geothermal

# Getting the grid - transmission

- Importance of coordinated development of grid and generation well understood
- Chicken and egg problem for first-off, distant VRE projects
  - Competitive Renewable Energy Zones (CREZ), Texas
  - Irish gate system
- Appropriate cost recovery is key
- What is the approach in Japan?

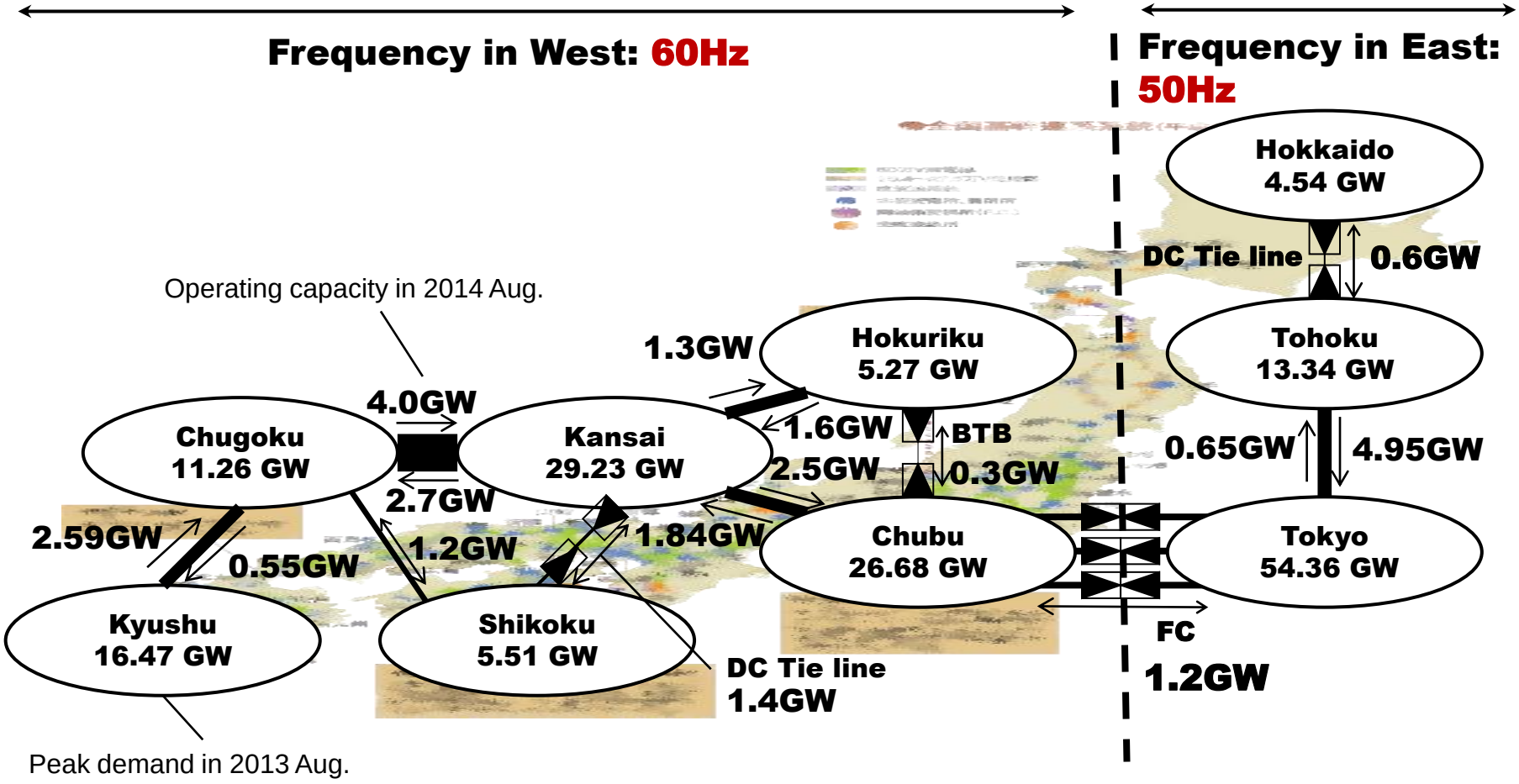
*CREZ, Texas*




Source: NREL

345 kV double-circuit upgrades identified in CREZ transmission plan

# Current situation in Japan




* DC – direct current, FC – frequency conversion

# Priorities for RE Japan

- **Objective should remain to foster a well-balanced portfolio of RE technologies**

- **Policies on PV should be adapted in order to**
  - **Reduce unit costs as much as possible and rapidly align to international best-practice benchmarks**
  - **Foster self-consumption where and when it is most needed**
  - **Reap out the great value opportunity of PV substituting expensive oil and/or LNG for peak and mid-merit electricity production**

- **Proceed in the power system reforms**
  - **Strengthen interconnections and enlarge balancing areas**
  - **Allow for fair and equal grid access conditions**



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