



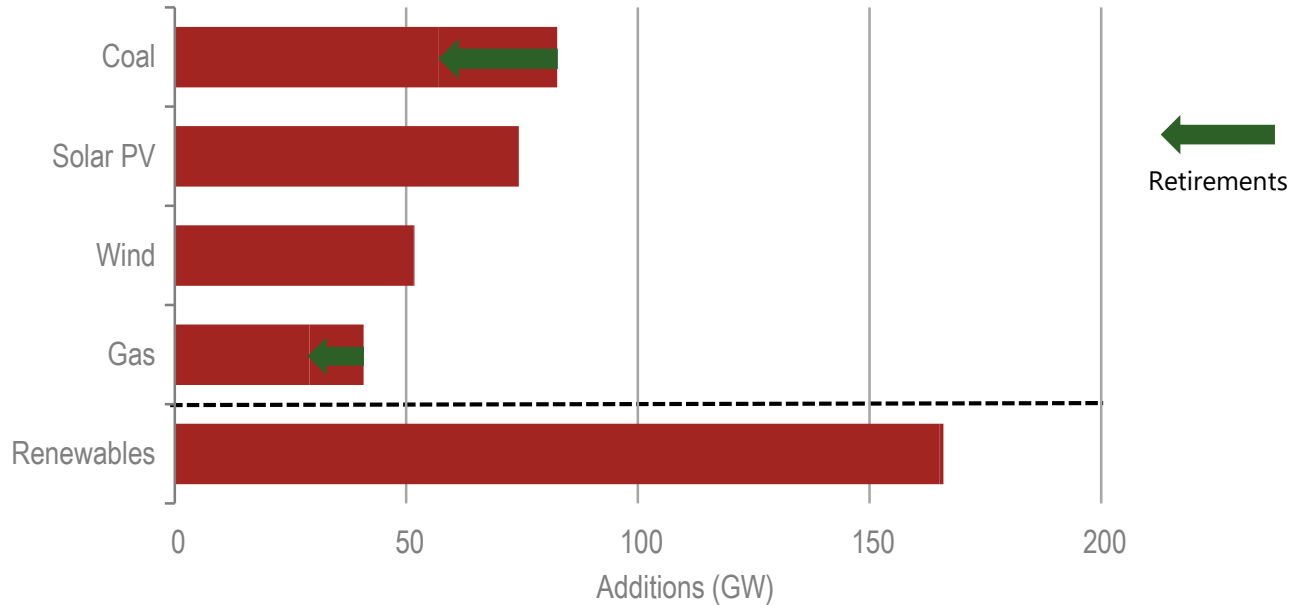
Renewable Markets and System Integration Status and Forecasts

Dr. Paolo Frankl, Head Renewable Energy Division

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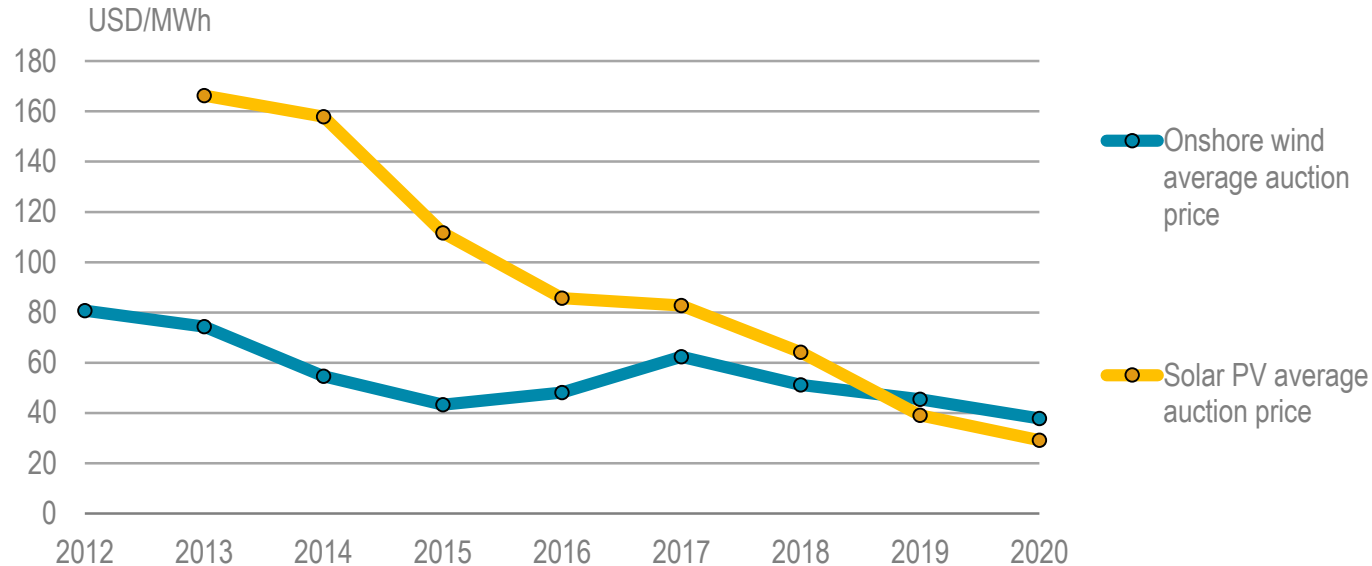
2016 – Renewables hitting new records driven by solar PV

Power capacity additions by fuel 2016



**Renewables breaking an all-time record accounting for two thirds of global net capacity additions;
For the first time solar PV becoming the global leader in net capacity growth**

Announced wind and solar PV average auction prices by commissioning date

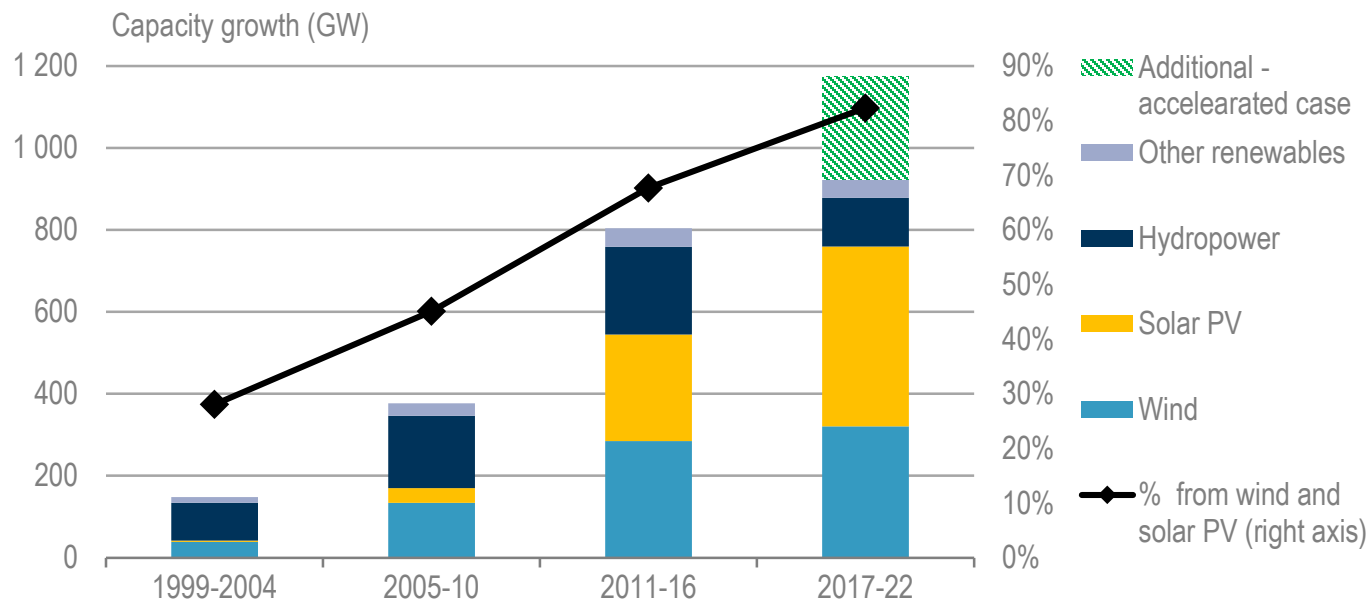


Price discovery through competitive auctions effectively reduces costs along the entire value chain; Auctions with long-term contracts will drive almost half of new capacity growth over 2017-22

Renewables growth more and more dependent on wind and solar



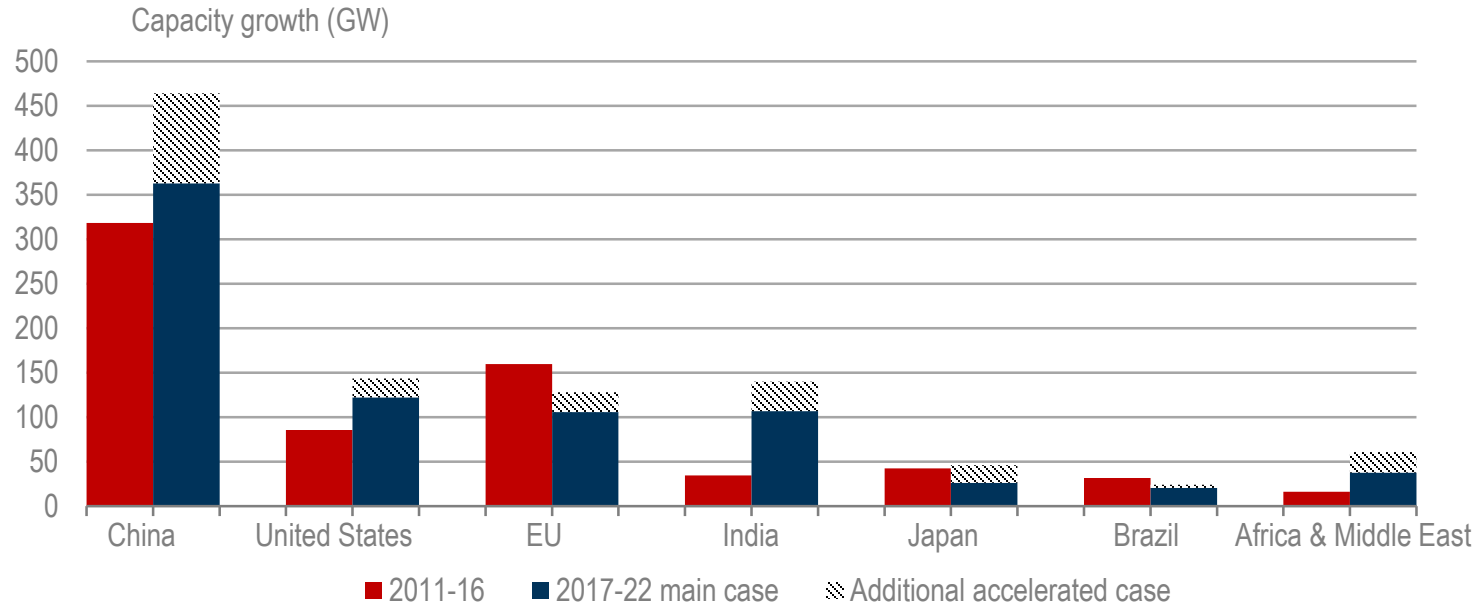
Renewable electricity capacity growth by technology



Solar PV enters a new era, becoming the undisputed leader in net power capacity growth worldwide; In the Accelerated Case solar PV forecast to triple capacity up to 880 GW by 2022

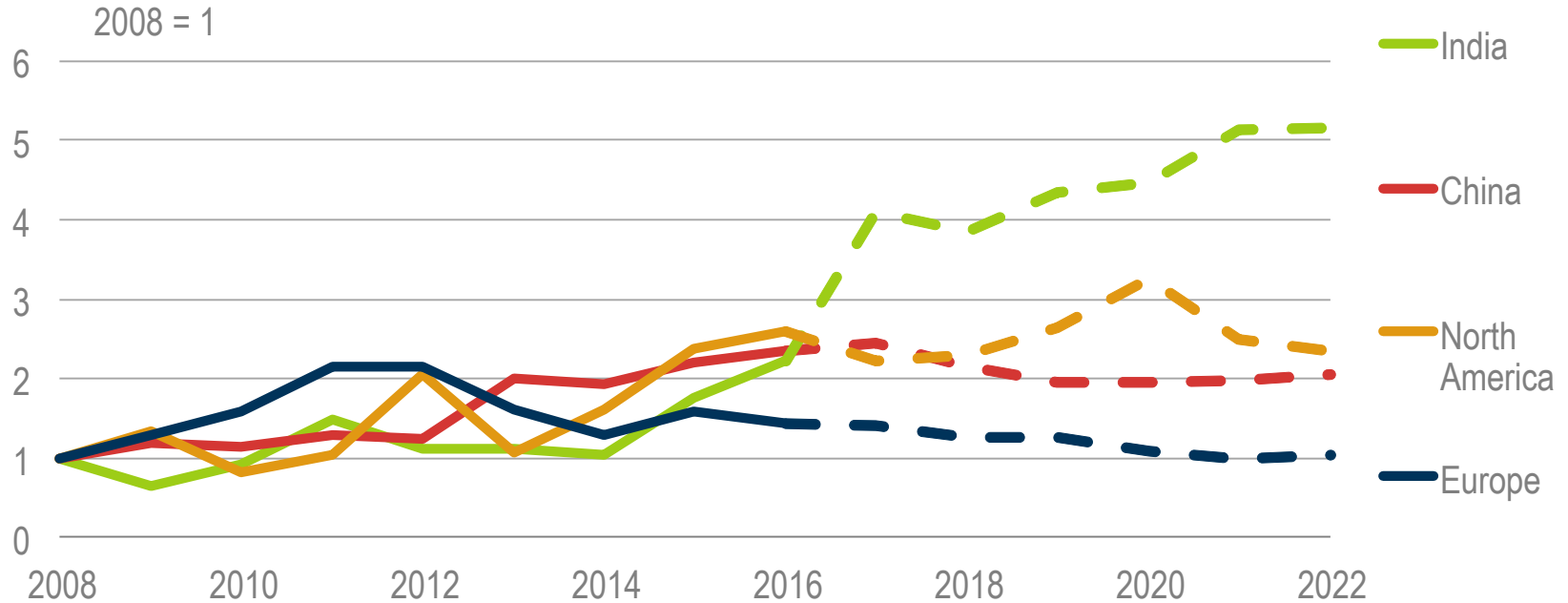
China continues to lead growth while India overtakes the EU

Renewable capacity growth by country/region



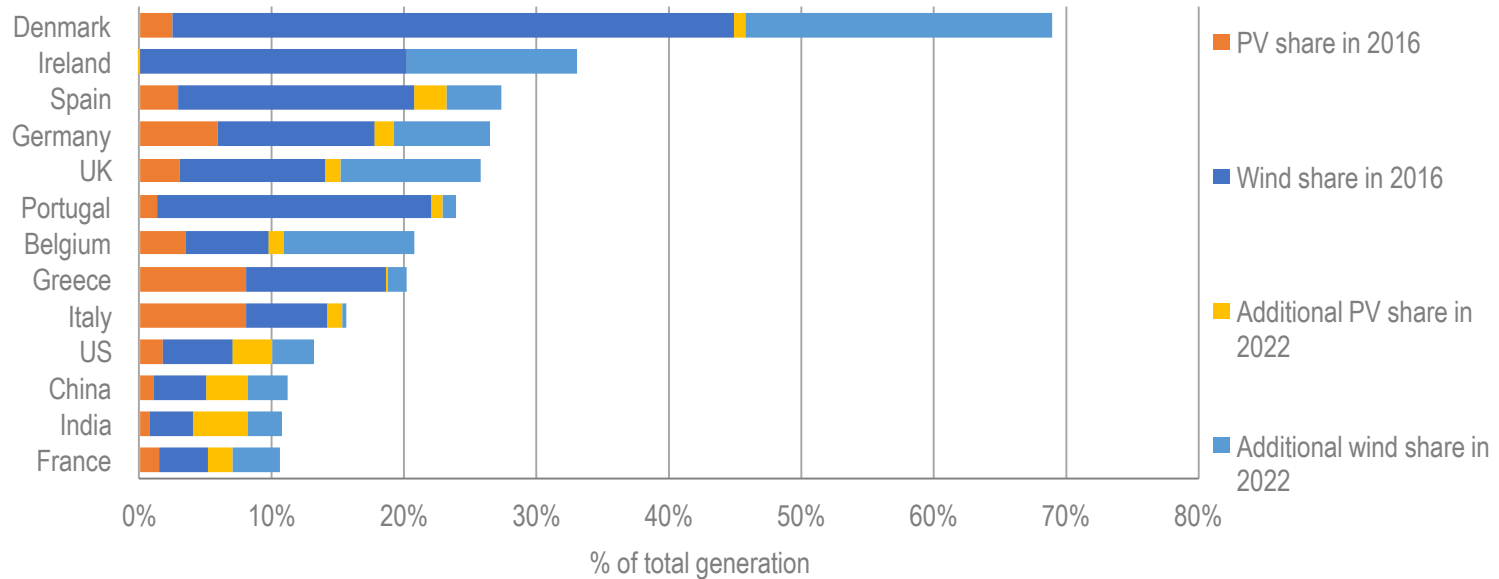
The forecast is 12% more optimistic vs. last year mainly due to solar PV revisions in China and India; Growth could be 27% higher with enhanced policies addressing regulatory uncertainties and grid integration

Indexed net RES capacity additions for selected regions/countries



Without further policy effort, Europe RES deployment level is expected to return to 2008 values

Wind and solar transforming the power sector



More flexible power systems, adapted market design and policies will have to play a key role in integrating larger shares of wind and solar in a secure and cost-effective way

Level of VRE penetration ↑

System-friendly VRE deployment

- Location
- Generation time profile
- System services
- Distributed resources integration
- Technology mix
- Integrated planning

Actions targeting VRE

Flexible resources *planning & investments*

- Grids
- Generation
- Storage
- Demand shaping

System and market operation

Actions targeting overall system

Efficient operation of the power system

- Ensuring least-cost dispatch
- Trading close to real time
- Market integrations over large regional areas

Unlocking flexibility from all resources

- Upgrade planning and system service markets
- Generation, grid, demand-side integration and storage

Security of electricity supply

- Allow scarcity pricing
- Possibly capacity mechanisms as safety-net

Sufficient investment in clean generation capacity

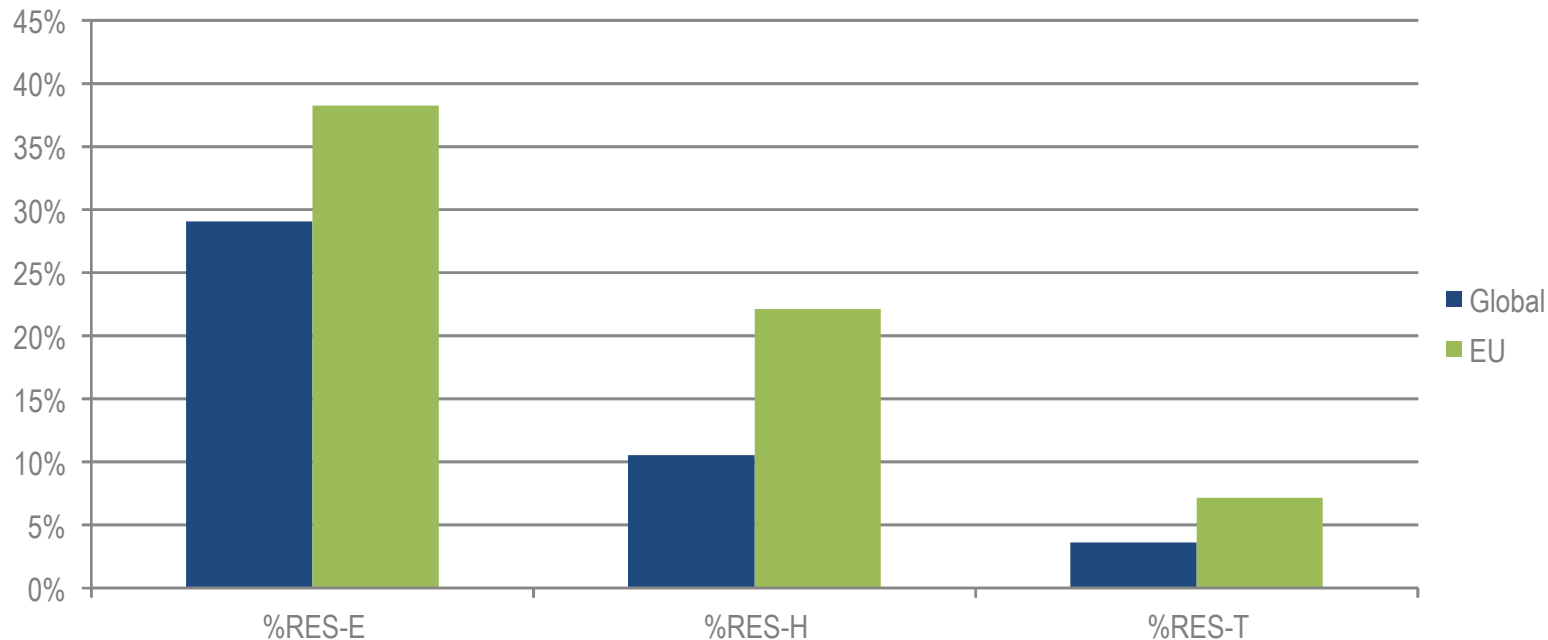
- Sufficient investment certainty
- Competitive procurement (with long-term contracts)

Pricing of externalities

- Reflecting the full cost (i.e. environmental impacts)

Europe: Higher renewable penetration than global average

Share of renewable penetration by sector (2022) in EU vs Global average



Electricity only accounts for around one fifth of total final energy demand today. The next rise in renewables will require multiplying their uses in buildings, industry and transport

- Renewables rise by 1 000 GW to 2022, equal to half of current total coal capacity
- Renewables generation exceeds 8 000 TWh by 2022, equal to total electricity consumption of China, India & Germany combined
- After leading initial growth, Europe needs to reap the benefits of cheaper renewables
- Integrated approach in Winter Package is important step in the right direction but ambition must keep pace with rapid technology progress
- Some priority areas
 - Distributed energy and fair allocation of fixed asset costs
 - Sector coupling and necessary infrastructure
 - Continue fostering large portfolio of technologies under development