Perspectives on the Energy Transition

Global Energy Transition Prospects and the Role of Renewables

Dolf Gielen, Director Innovation and Technology Centre, IRENA

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IRENA: Introduction & Overview

- Established in 2011; HQ in Abu Dhabi, UAE
- IRENA Innovation and Technology Centre – Bonn, Germany
- Mandate: To promote the widespread adoption and sustainable use of all forms of renewable energy worldwide
- Objective: To serve as a network hub, an advisory resource and authoritative, unified, global voice for renewable energy
- Scope: All renewable energy sources produced in a sustainable manner

150 Members

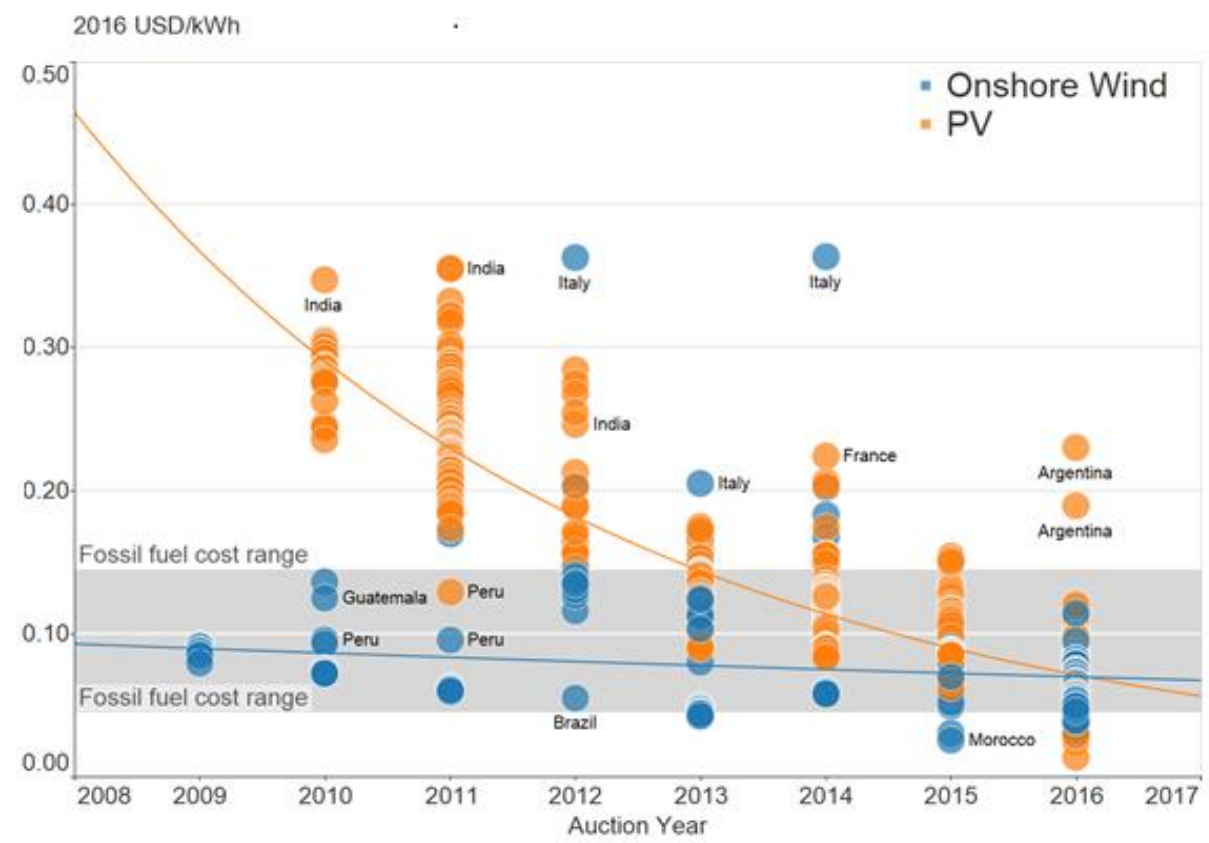
30 States in Accession

IRENA Renewable Energy Roadmap (REmap)

- IRENA's **Global Renewable Energy Roadmap** (bottom-up)
- Shows feasible, cost-effective ways to **significantly increase the share of renewables** in world's energy mix by 2030, and substantially decarbonise the energy sector by 2050
- Analyses **options** for countries, sectors and technologies
- Assesses policy and investment **implications**
- Outlines **costs & benefits** of transition to renewable energy (economic, social, environmental)

REmap
A Renewable Energy Roadmap

Auction and PPA price trends
Rapidly improving economics



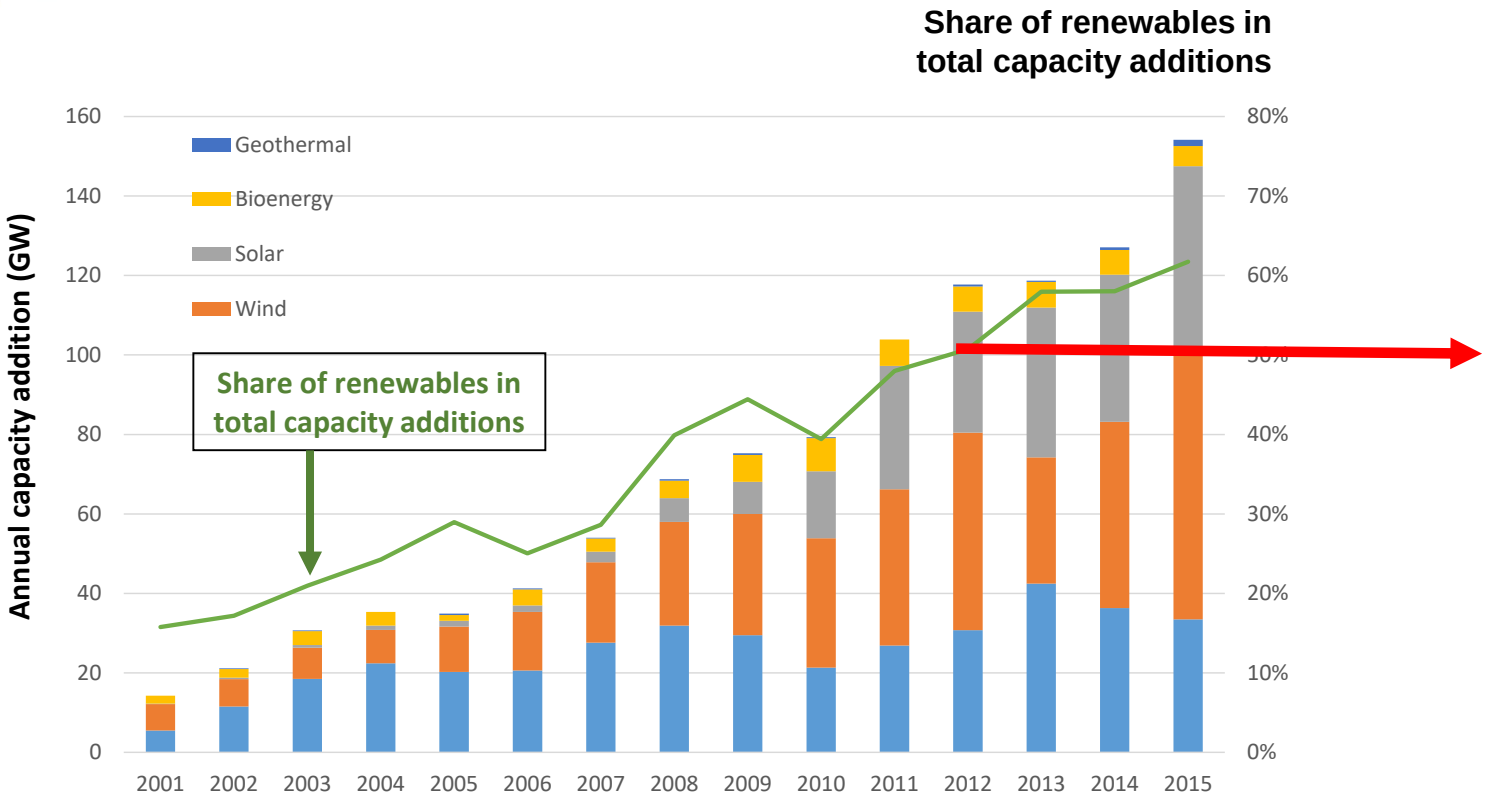
Key Messages

- Convergence of solar PV and onshore wind prices
- Project “boundaries” differ and affect the price
- Projects for a wide range of technologies and locations are being offered at very low long-term contract prices

Best practice

- Concentrating Solar Power CSP @ 9.5 UScents/kWh (Dubai)
- Solar PV @ 2.4 -3 UScents/kWh (Mexico, Abu Dhabi)
- Onshore wind @ 3 UScents/kWh (Morocco, Mexico)

On-going power sector transformation



Since 2012 >50% of total capacity additions

Key Messages:

- 2016 total renewables capacity: 2006 GW
- 2016 additional capacity: 161 GW
  - 71 GW solar
  - 51 GW wind
  - 30 GW hydropower
  - 9 GW biomass

End use sector trends that support energy transition

- Buildings, transport sector progressing, part of industry sector is lagging

Electrification and energy efficiency

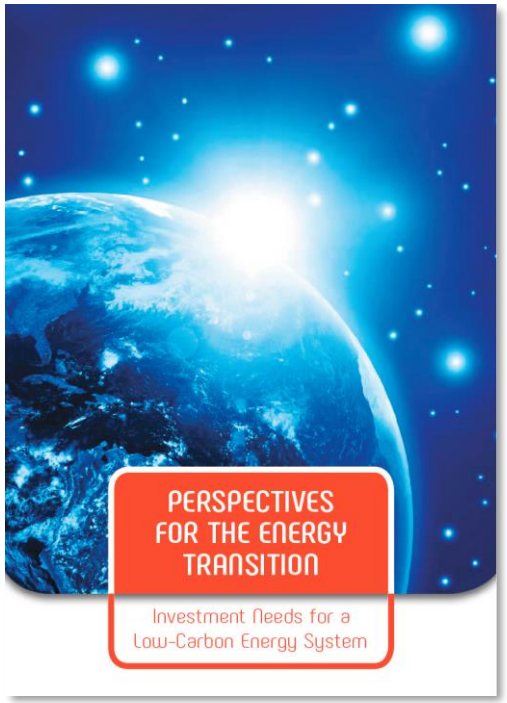
- Global energy intensity improvement has increased from 1.3%/yr to 1.8%/yr
- Global electric vehicle park doubled in 2016 to 2 million units
- Rapid growth heat pump deployment
- Home storage battery prices -60% in 2.5 years

Electricity grid trends

- Rapid growth off-grid and minigrid solutions
- Smart grids support high VRE shares
- A growing number of long distance UHVAC transmission lines

Perspectives for the Energy Transition - Context

- At the request of G20 Presidency
- Launched March 2017
- Informs G20 decarbonization Action Plan discussion
- Explores the energy sector consequences of the climate agreement
- Translates Paris Agreement outcome into practicable action items
- Time horizon: 2050

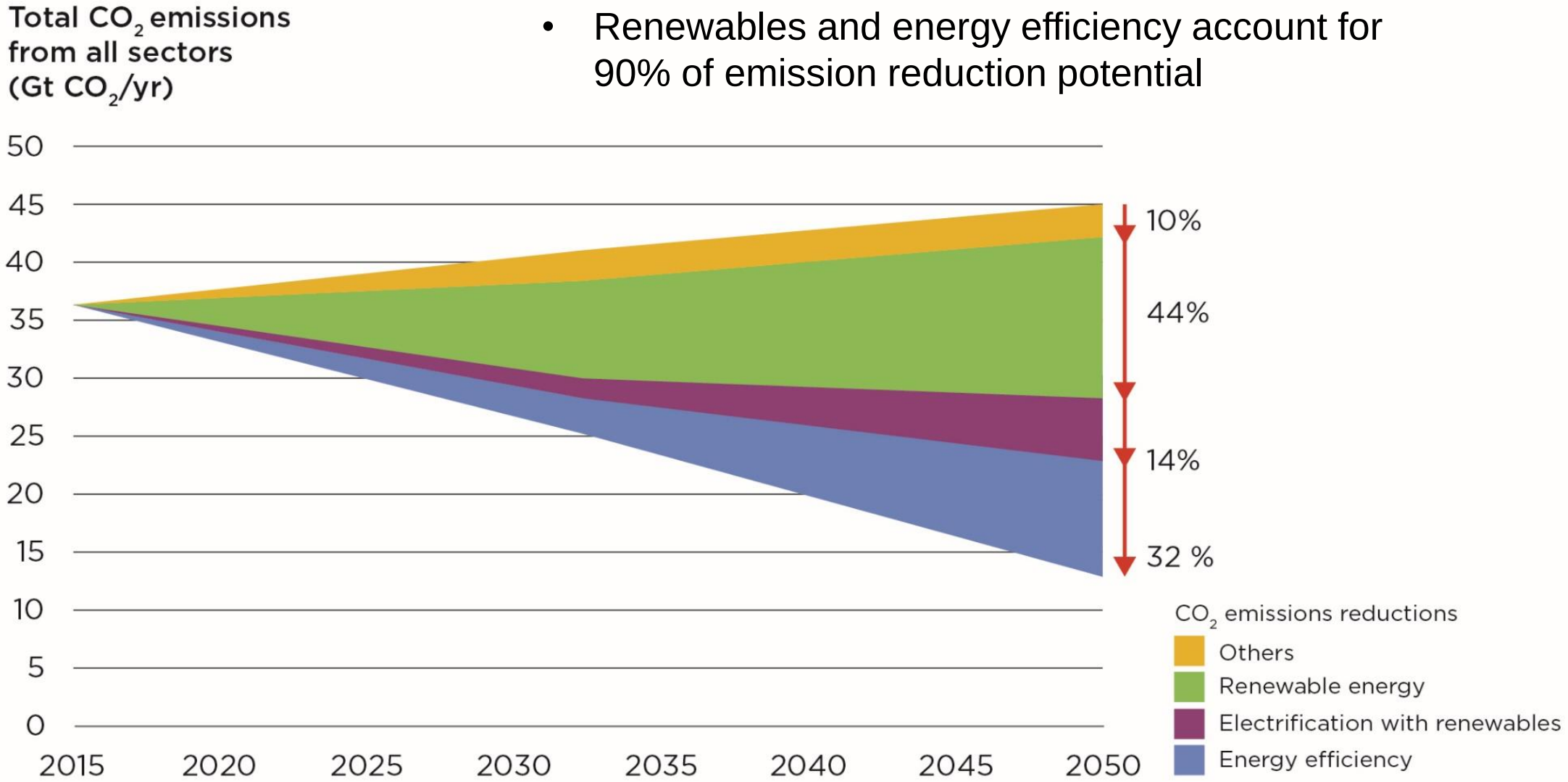


The Need for an Energy Transition - Highlights

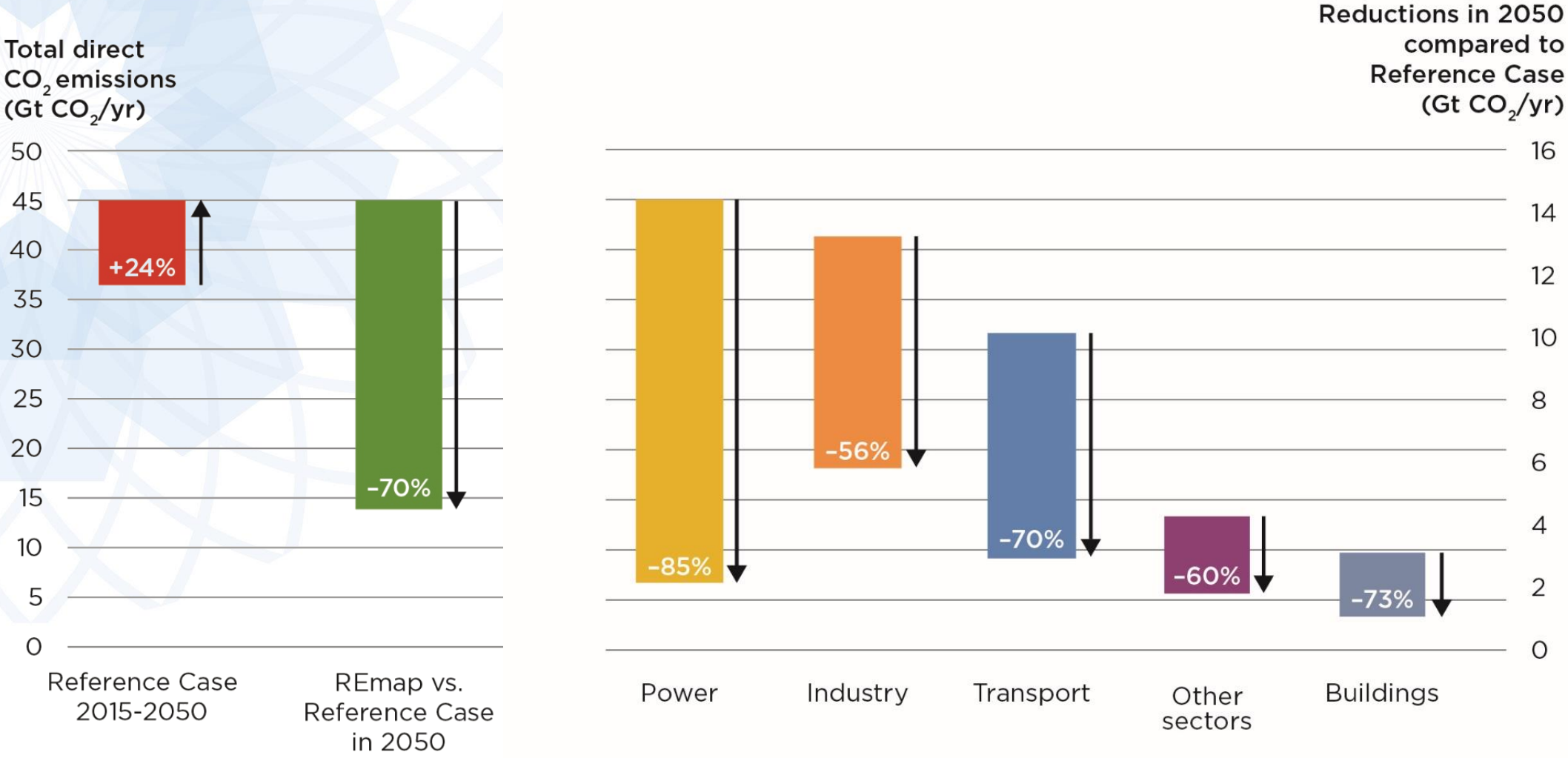
- The Paris Agreement requires global energy decarbonization by between 2050 and 2060
- Carbon emissions from energy use need to fall to zero by 2060 and stay at this level thereafter to achieve targets by the end of the century
- This requires an energy transition, largely based on renewable energy and energy efficiency
- This transition is technically feasible and economically beneficial
- The share of renewables needs to reach 2/3 of energy supply by 2050
- Global GDP will increase by 0.8% in 2050
- Renewables alone can support 26 million jobs in 2050, from roughly 9.8 million today
- Health and climate benefits exceed the cost by a factor of 2-6
- Investment needs to be scaled up, to reach USD 29 trillion over period till 2050 (USD 0.8 bln/yr)

Reducing global CO2 emissions in the energy sector

- Renewables and energy efficiency account for 90% of emission reduction potential

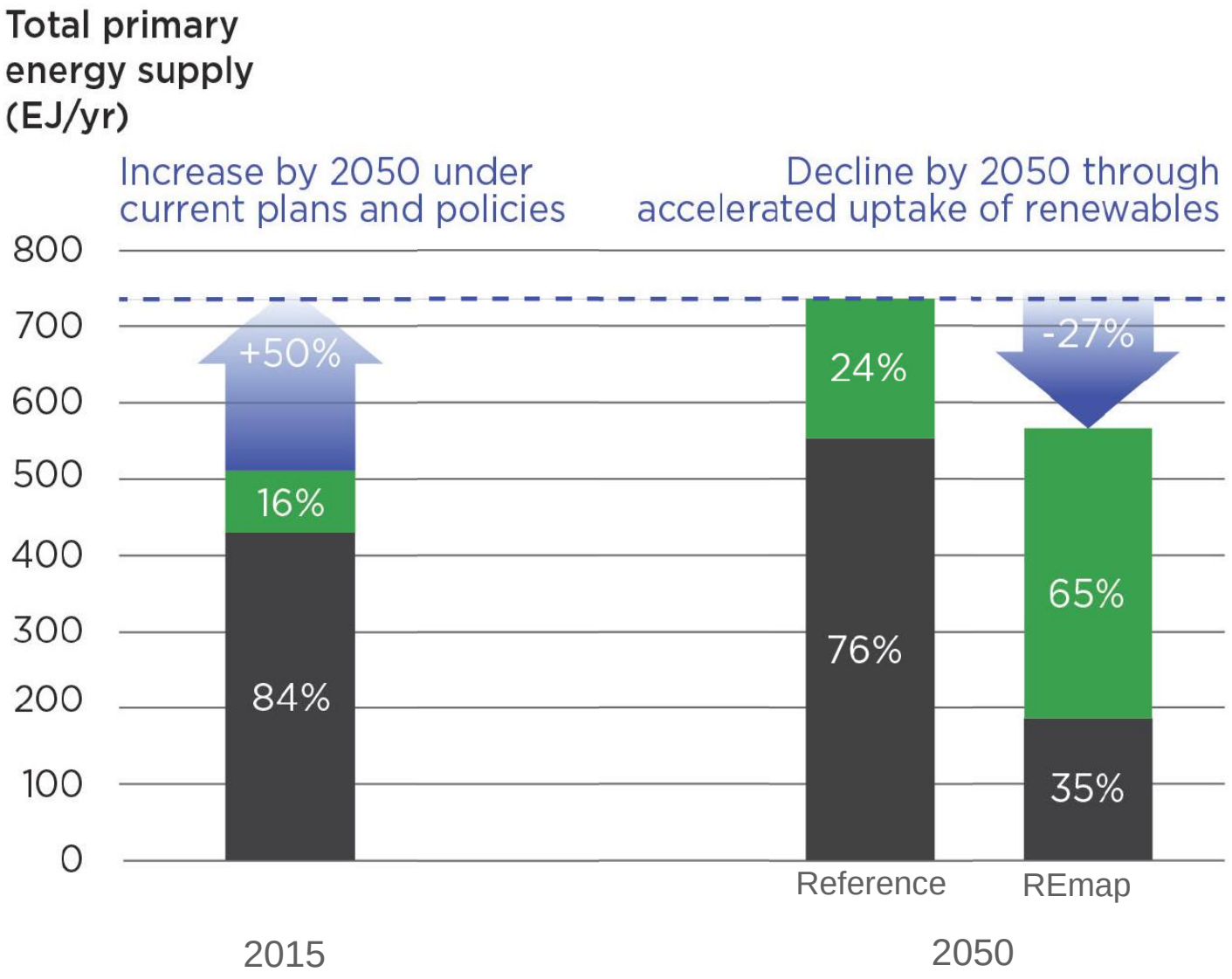


Key global emissions reduction by sector



- By 2050 energy-related CO_2 emissions will need to decrease to below 10 Gt
- CO_2 emissions from the power and buildings sectors will be almost eliminated
- Industry and transport would be the main sources of emissions in 2050

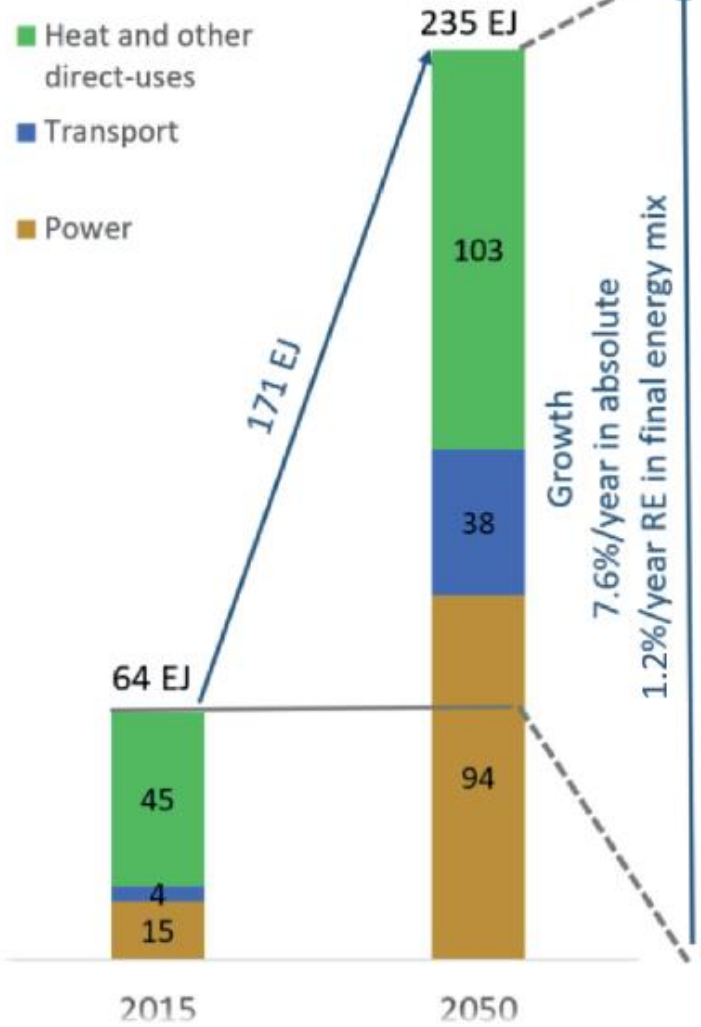
Breakdown of total global primary energy supply



Key Messages:

- With REmap, renewable energy covers 2/3 of the 2050 energy supply
- This requires a seven-fold increase in the annual growth of renewable energy share in energy compared to recent years

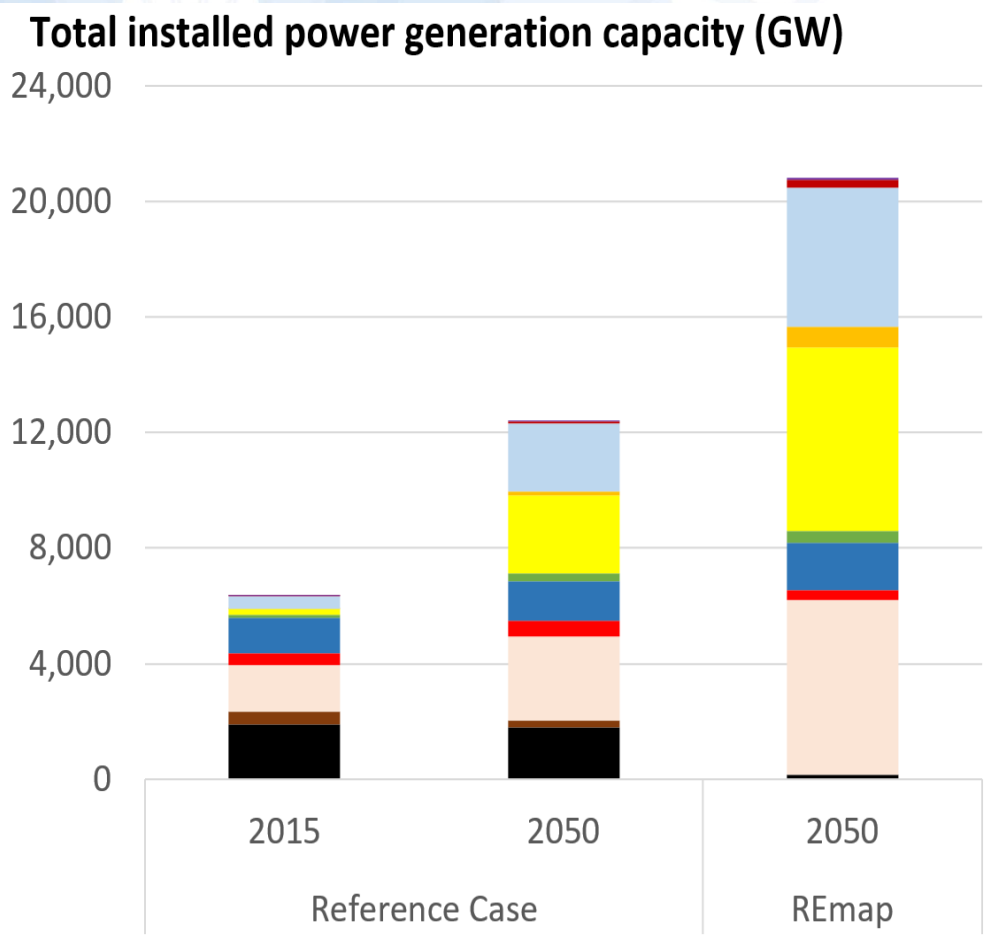
Renewable energy technology growth 2015-2050

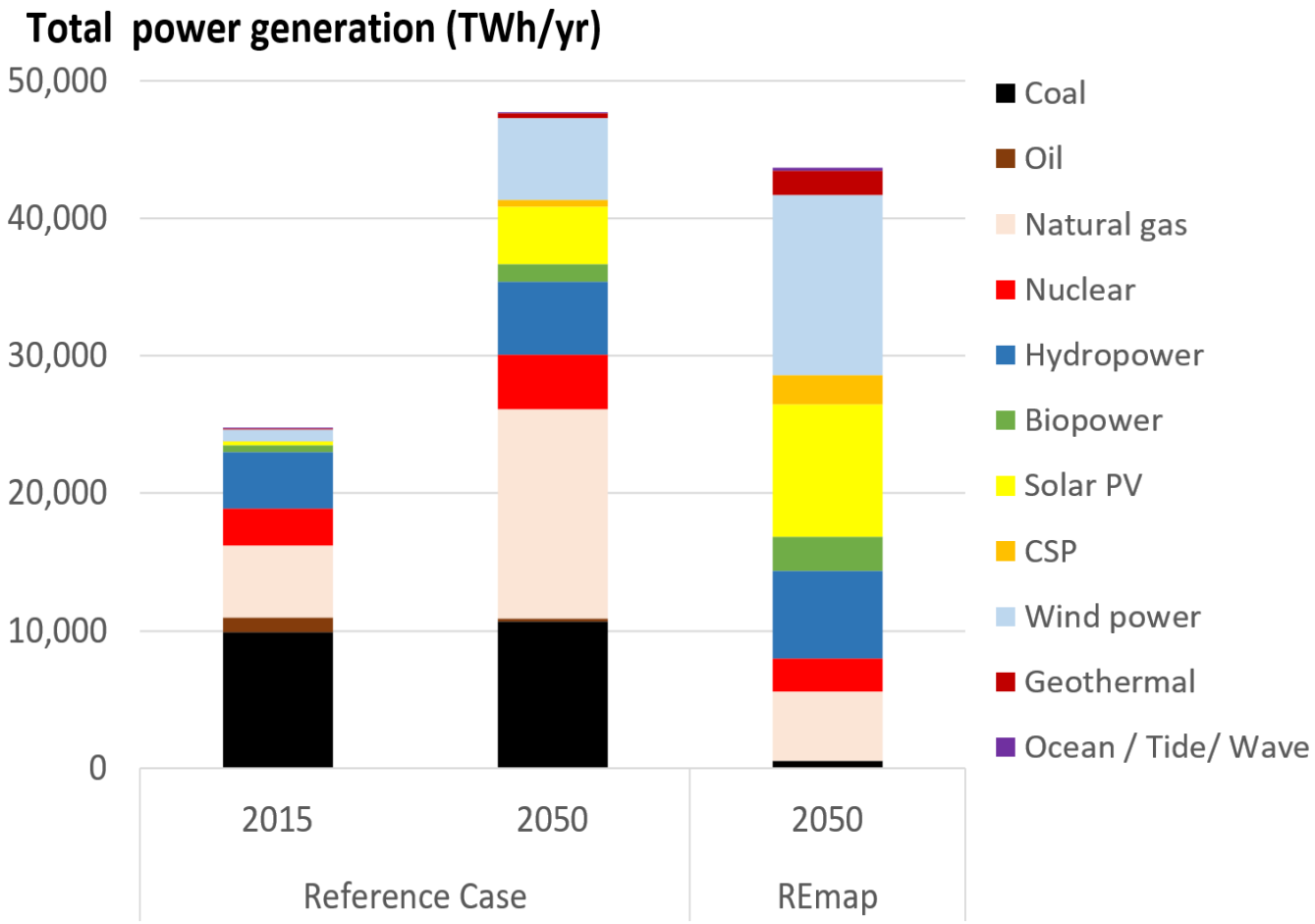


Required compound annual growth rate per technology

Power	**5.3%**
Solar PV	11.1%
Wind	8.1%
Hydropower	1.2%
Geothermal	9.1%
Biomass power	4.7%
Other Power	17.3%
Transport	**6.2%**
Liquid biofuels	5.5%
Hydrogen for transport	20.6%
Heat and other direct-users	**2.3%**
Biofuel buildings	-1.2%
Biofuel industry	3.9%
Renewables district heat	4.9%
Geothermal heat	6.9%
Solar thermal	8.8%
Hydrogen	13.7%

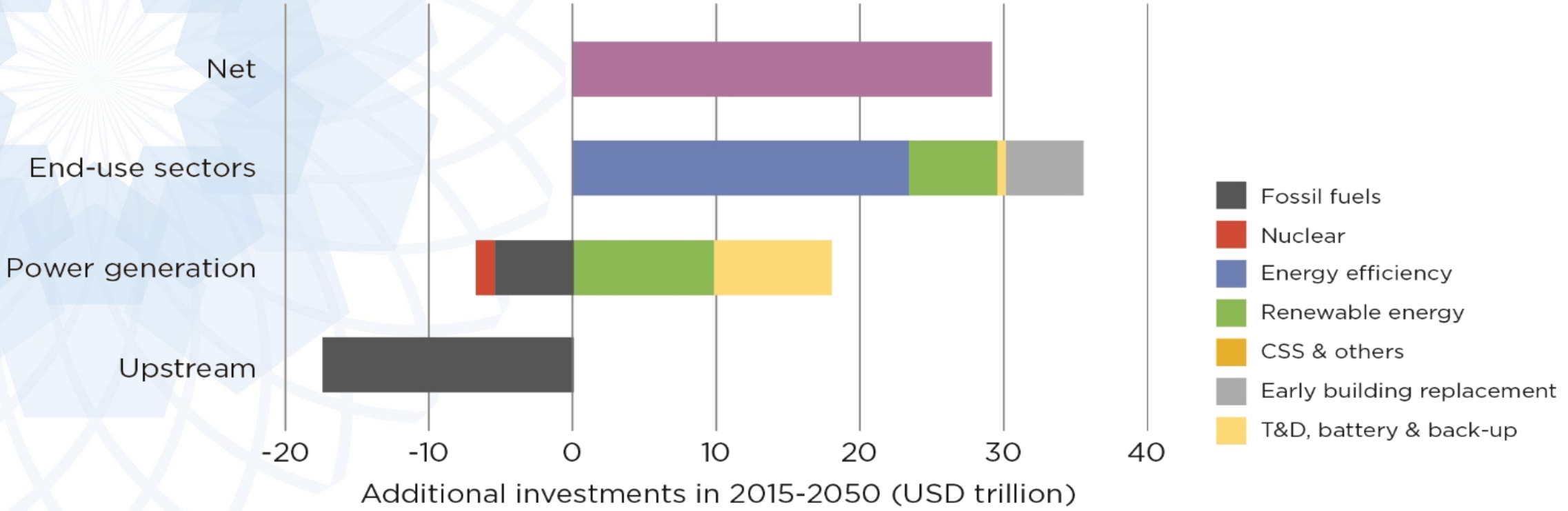
Main implications for the power sector





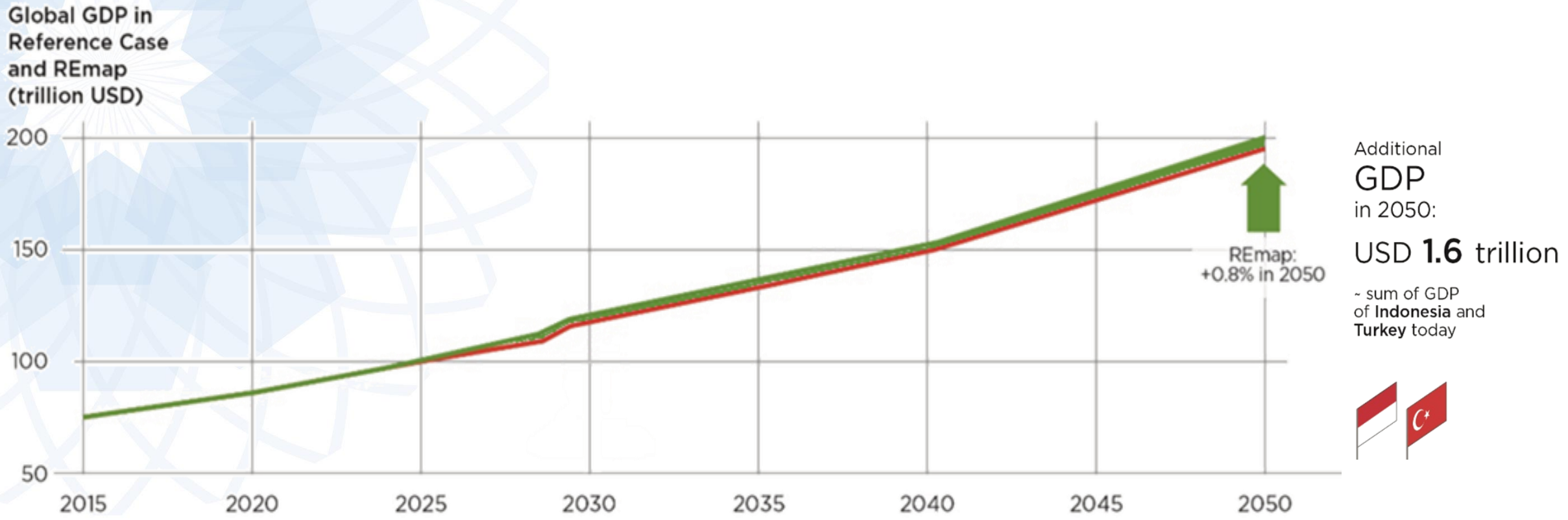
- With REmap, a diverse mix of renewables will provide more than 80% of electricity in 2050.

Additional investment needs



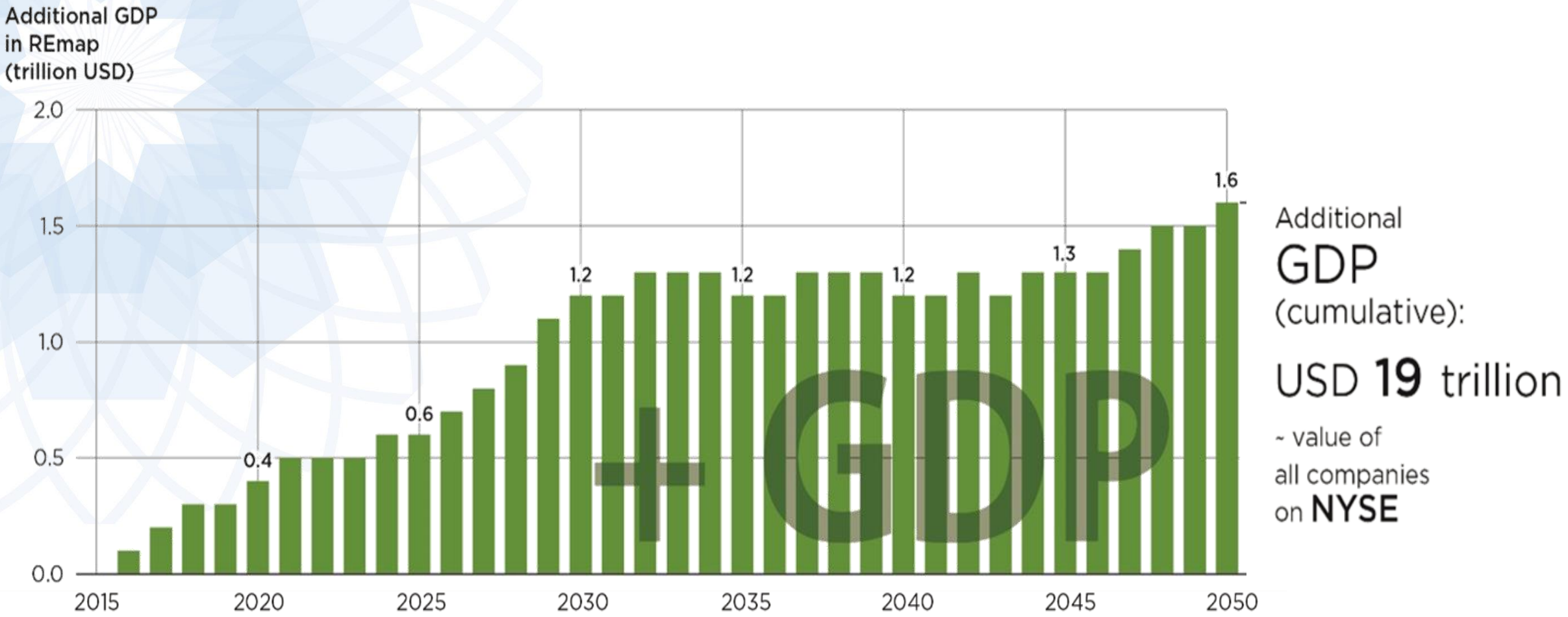
- Until 2050 the transition requires investing an additional USD 29 trillion (compared to Reference Case)
  - Less than 1% of global GDP per year.
- The largest additional investment needs are in energy efficiency, followed by renewables.
- The total investment requirements, however, are reduced by the avoided investments in fossil fuels upstream and conventional power generation.

Global GDP impacts of the REmap energy transition: absolute



- Decarbonising energy sector in line with REmap increases global GDP by around 0.8% in 2050 (compared to Reference Case)
- Equivalent to 1.6 trillion USD.

Global GDP impacts of the REmap energy transition: additional



In cumulative terms this constitutes almost USD 19 trillion in increased economic activity between today and 2050.

Policy Implications

- **Early action is critical** to limit climate change to 2ºC, to maximise the benefits of the transition, and to reduce the risk of stranded assets.
- **Deep emission cuts in the power sector** are needed and require sound policy frameworks and market designs to achieve a flexible and resilient system.
- Enact **policies targeted at end-use sectors** (e.g. renewables for heating and cooling and transport, sector coupling, holistic approach, synergies with energy efficiency).
- Need for adequate **energy pricing**, including pricing of externalities (e.g. carbon emissions).
- **Needs to accelerate innovation** to allow time for developing the fundamental new solutions for different sectors and processes, ahead of long investment cycles.
- **A comprehensive approach to policymaking** is needed, including energy, climate and broader economic policies.

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