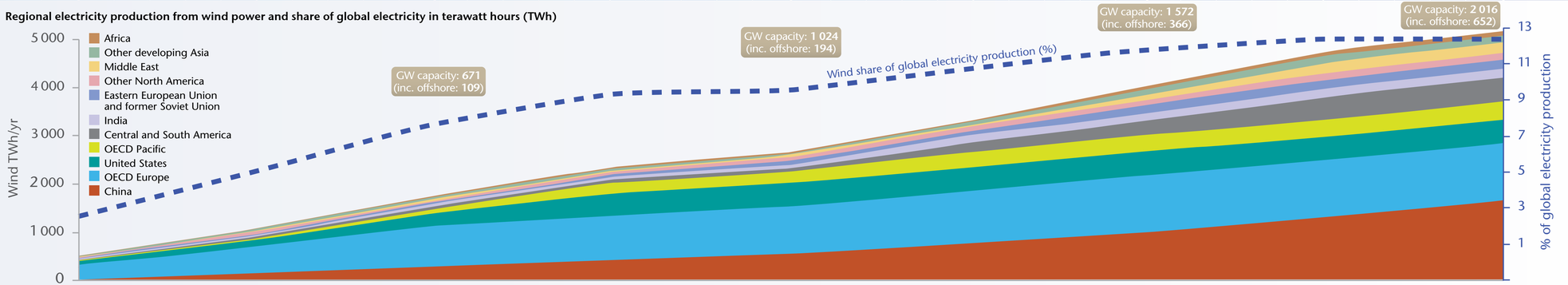
IEA
Wind energy roadmap targets

2010 2020 2030 2040 2050

Key findings

- This roadmap targets 12% of global electricity from wind energy by 2050. 2 000 GW of capacity will annually avoid the emission of 2.8 gigatonnes of CO_2 equivalent.
- Achieving these targets requires investment of some USD 3.2 trillion. 47 GW would need to be installed on average every year for the next 40 years – a 75% increase – amounting to USD 81 billion / yr.
- In 2030, non-OECD economies will produce some 17% of global wind energy, rising to 57% in 2050.
- Wind power can be competitive today where the resource is strong and when the cost of carbon is reflected in markets. Costs per MWh range from USD 70 – 130.
- Costs are expected to decrease further as a result of technology development, deployment and economies of scale – by 23% by 2050. Transitional support is needed to encourage deployment until full competition is achieved.
- Offshore costs are at present twice those on land, although the quality of the resource can be 50% higher. This roadmap projects cost reductions of 38% by 2050.
- To reliably achieve high penetrations of wind power, the flexibility of power systems and markets must be enhanced and, eventually, increased. Flexibility is a function of access to flexible generation, storage, and demand response, and is enhanced by interconnection, larger and faster power markets, smart grids, and forecasting.

Regional electricity production from wind power and share of global electricity in terawatt hours (TWh)



Wind Roadmap milestones

Timelines are indicative; some policy and power system actions have already commenced in leading countries.

Policy framework

- Transitional market support mechanisms; long-term deployment targets
- Monitoring of progress against targets; market rules reflect value of wind power
- Internalised external energy costs
- Integrated deployment plans; accelerated permitting processes
- Best-practice exchange with developing countries; targeted development financing and CO_2-based mechanisms

Public engagement & environment

- Raised public awareness of value of wind energy and of the need for stronger transmission systems
- Improved assessment and mitigation methods for socio-environmental impacts

Technology & industry

- Improved resource assessment
- Industry databases of resource, conditions and operating experiences
- Advanced rotors, lighter and stronger materials
- Offshore: cheaper foundations (<40m); improved supply chains and installation strategies
- Next generation of dedicated offshore turbines; foundations <200m
- Education and training programmes in OECD and developing countries
- Intensified R&D funding and international collaboration
- Stronger focus on deep offshore

Power system

- Improved forecasting models taken up in system operation
- Integrated transmission planning, incentives to build, equitable grid access
- Continental scale and offshore grid deployment
- Assessment of additional system flexibility needs
- Timely development of flexibility resources / reserves
- Optimised markets; responsive demand; smarter grids

Key actions and respective leading roles for:

- Government
- Wind industry
- Power system and regulators

Next 10 years: a critical period for wind power

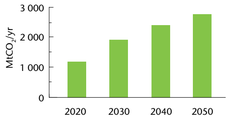
Cumulative wind power investment 2010 - 2020: USD 1 trillion

Actions 2010 - 2020

(In some countries, some actions are already underway.)

- Set long-term targets, supported by predictable market-based mechanisms to drive investment while pursuing cost reductions.
- Advance planning of new plants to attract investment, taking into account other power system needs and competing land/sea-usage.
- Appoint lead agencies to coordinate advance planning of transmission to harvest resource-rich areas and interconnect power systems; set incentives to build transmission; assess power system flexibility.
- Raise public awareness of the benefits of wind power and of the accompanying need for additional transmission infrastructure.
- Exchange best practice with developing countries; target development finance bottlenecks; further develop carbon finance options in developing regions.

Annual CO_2 equivalent emissions avoided through wind power 2020 - 2050

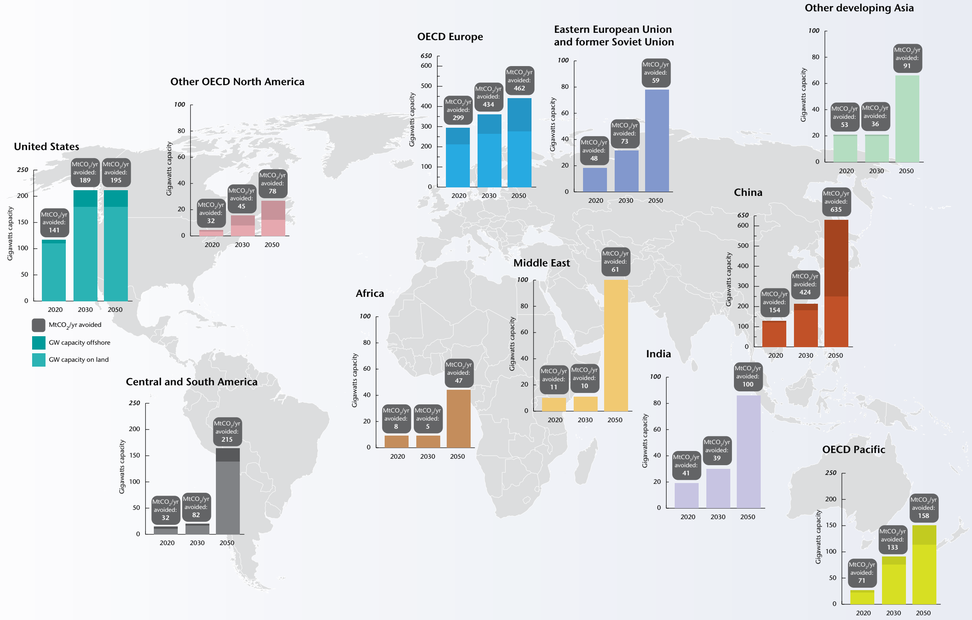


Global map of regional wind power capacity development and avoided CO_2 emissions

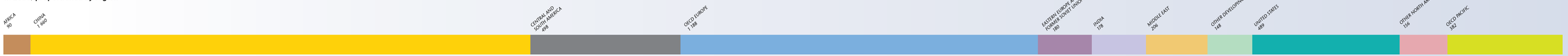
(over emissions avoided in the reference scenario)

Key points

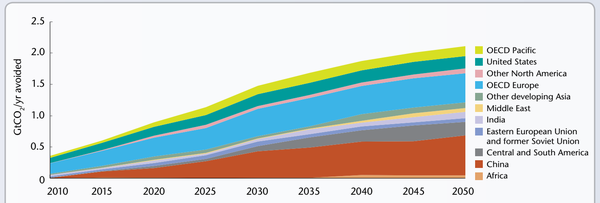
- In 2020, all global regions have multiple gigawatts of installed wind power capacity, ranging from just under 10 GW in Africa to more than 600 GW in China.
- By 2050, according to the ETP BLUE Map scenario, more than half of cumulative global investment in new capacity will have taken place in non-OECD countries.
- The need for swift economic growth, limited energy supply, and in some cases abundant conventional resources, combined with inadequate transfer of best practice, may encourage developing countries to look to conventional energy supply alone. Greater efforts are needed bilaterally and multilaterally to address this concern.



Terawatt-hours (TWh) generated by wind power in 2050, proportioned by region

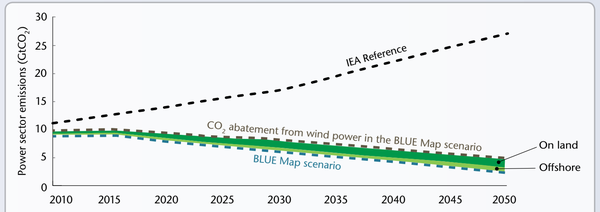


Regional CO_2 abatement through wind power in the BLUE Map scenario, 2010 – 2050, over the reference scenario



Key point: In 2050, China (30%) and OECD Europe (22%) deliver the greatest shares of CO_2 emissions abatement through wind power, followed by Latin America (10%) the US (9%) and OECD Pacific countries (6%).

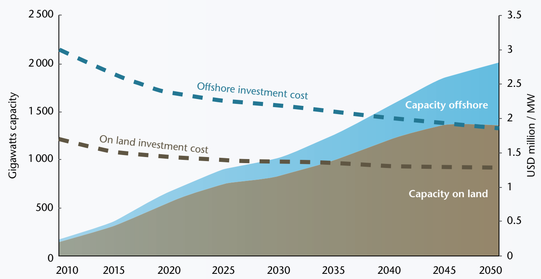
The wind power contribution to avoided CO_2 emissions in the BLUE Map scenario, 2010 – 2050, over the reference scenario



Key point: In 2050, power sector CO_2 emissions rise to 27 $GtCO_2$ / yr in the reference scenario and fall to 3 $GtCO_2$ /yr in the BLUE Map scenario. Wind power provides 2.1 $GtCO_2$ /yr (9%) of the difference, 0.76 $GtCO_2$ /yr of which is from offshore.

Global onshore and offshore deployment

Wind power capacity development and investment cost reduction offshore and on land in the BLUE Map scenario, to 2050



Key point: by 2050, 32% of wind capacity will be located at sea, up from 19% in 2030. Offshore technology is currently further from market than land based technology.

Offshore tasks:

- Intensified research and development to improve reliability, facilitated through shared industry databases of offshore operating conditions and experiences.
- Strengthened supply chains; sufficient purpose-designed installation vessels and harbour space; improved installation strategies.
- New generations of turbines and sub-surface structures fundamentally designed for the marine environment with minimum operations and maintenance requirement.