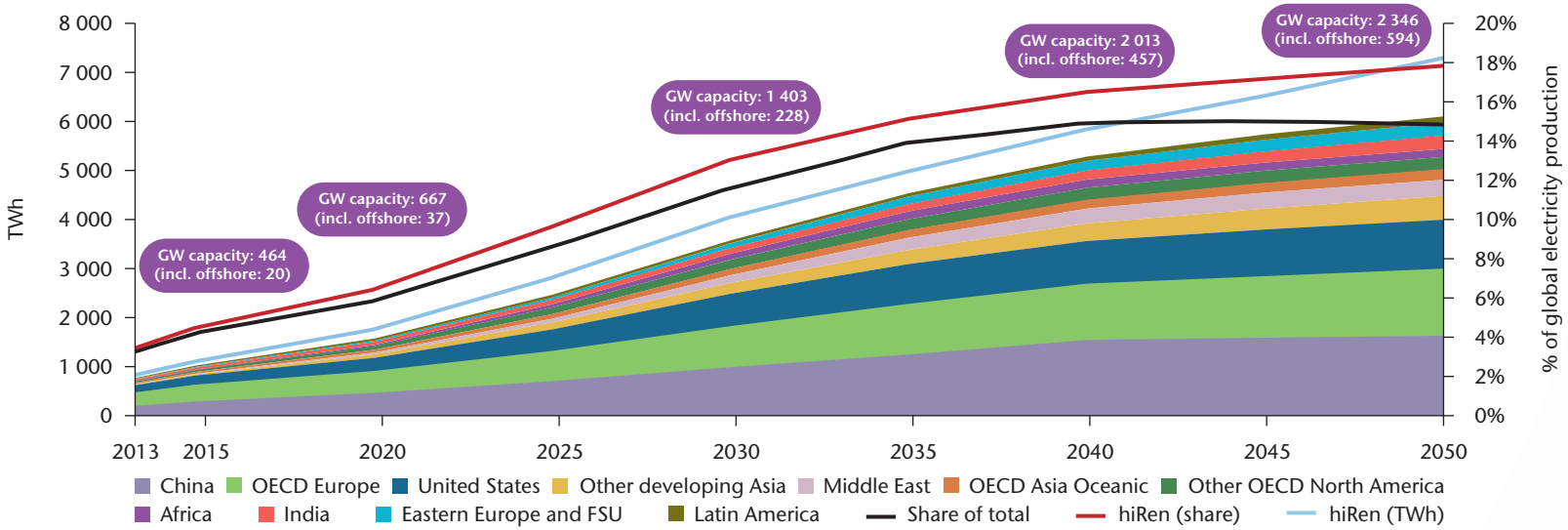
WIND ENERGY ROADMAP 2013 edition

International Energy Agency

Regional electricity production from wind power in TWh and share of global electricity

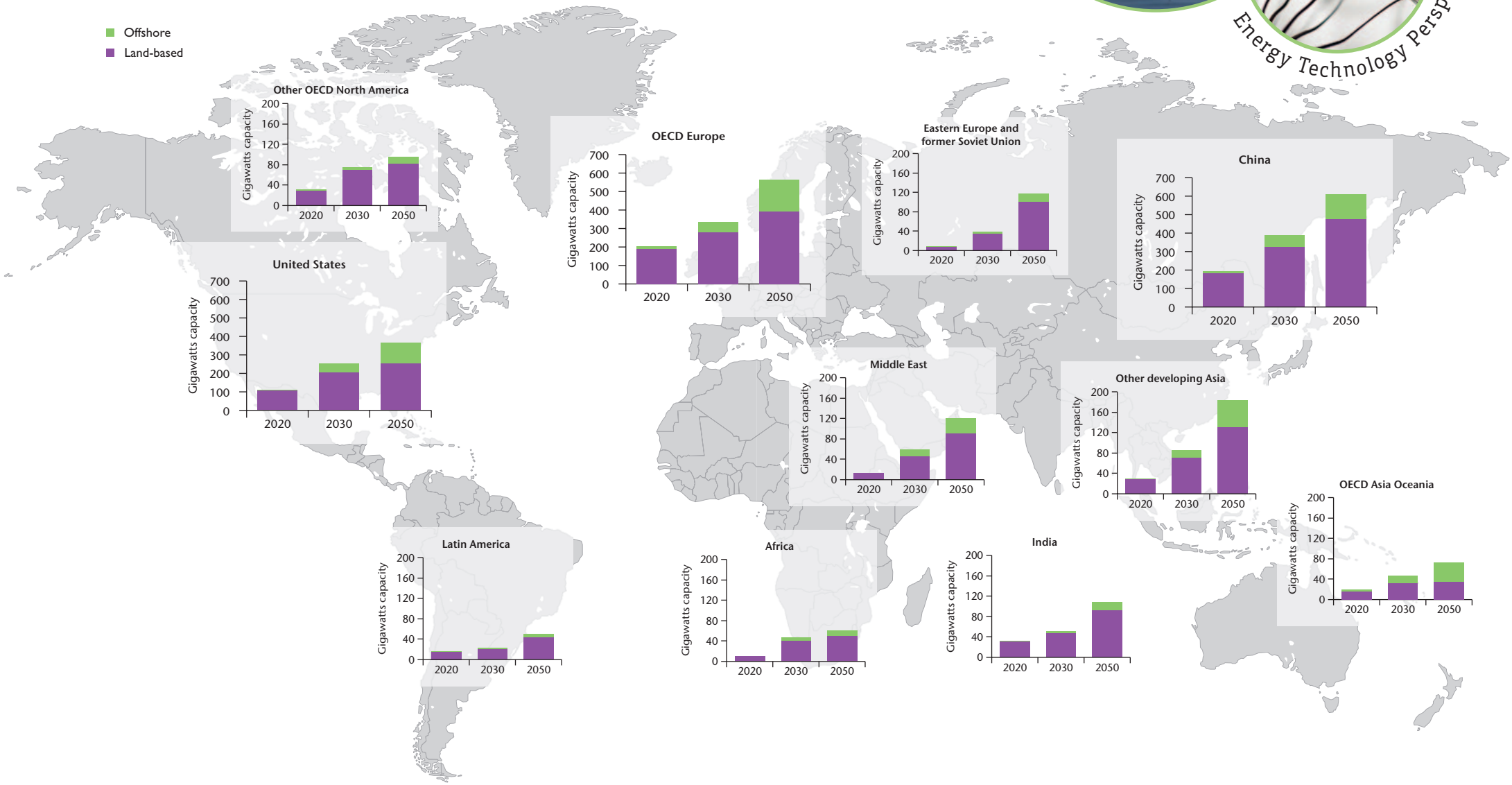


Key findings

- Since 2008, wind power deployment has more than doubled, approaching 300 GW cumulative installed capacities led by China (75 GW), the United States (60 GW) and Germany (31 GW). Wind power now provides 2.5% of global electricity demand – and up to 30% in Denmark, 20% in Portugal, 18% in Spain. Policy support has been instrumental in stimulated this tremendous growth.
- Progress in the past five years boosted energy yields (especially in low-wind-resource sites) and reduced operation and maintenance (O&M) costs. Land-based wind power generation costs range from USD 60/MWh to USD 130/MWh at most sites. It can already be competitive where wind resources are strong and financing conditions are favourable, but still requires support in most countries. Offshore wind technology costs levelled off after a decade-long increase, but are still higher than land-based.
- This roadmap targets 15% to 18% share of global electricity from wind power by 2050, a notable increase from the 12% aimed for in 2009. The new target of 2 300 gigawatts (GW) to 2 800 GW of installed wind capacity will avoid the emission of up to 4.8 gigatonnes (Gt) of carbon dioxide (CO_2) annually.
- Achieving these targets requires rapid scaling up of the current annual installed wind power capacity (including repowering), from 45 GW in 2012 to 65 GW by 2020, to 90 GW by 2030 and to 104 GW by 2050. The annual investment needed would be USD 146 billion to USD 170 billion.
- The geographical pattern of deployment is rapidly changing. While countries belonging to the Organisation for Economic Co-operation and Development (OECD) led early wind development, from 2010 non-OECD countries installed more wind turbines. After 2030, non-OECD countries will have more than 50% of global installed capacity.
- While there are no fundamental barriers to achieving – or exceeding – these goals, several obstacles could delay progress including costs, grid integration issues and permitting difficulties.
- This roadmap assumes the cost of energy from wind will decrease by as much as 25% for land-based and 45% for offshore by 2050 on the back of strong research and development (R&D) to improve design, materials, manufacturing technology and reliability, to optimise performance and to reduce uncertainties for plant output. To date, wind power has received only 2% of public energy R&D funding: greater investment is needed to achieve wind's full potential.
- As long as markets do not reflect climate change and other environmental externalities, accompanying the cost of wind energy to competitive levels will need transitional policy support mechanisms.
- To achieve high penetrations of variable wind power without diminishing system reliability, improvements are needed in grid infrastructure and in the flexibility of power systems as well as in the design of electricity markets.
- To engage public support for wind, improved techniques are required to assess, minimise and mitigate social and environmental impacts and risks. Also, more vigorous communication is needed on the value of wind energy and the role of transmission in meeting climate targets and in protecting water, air and soil quality.

Global map of regional wind power capacity development

Energy Technology Perspectives

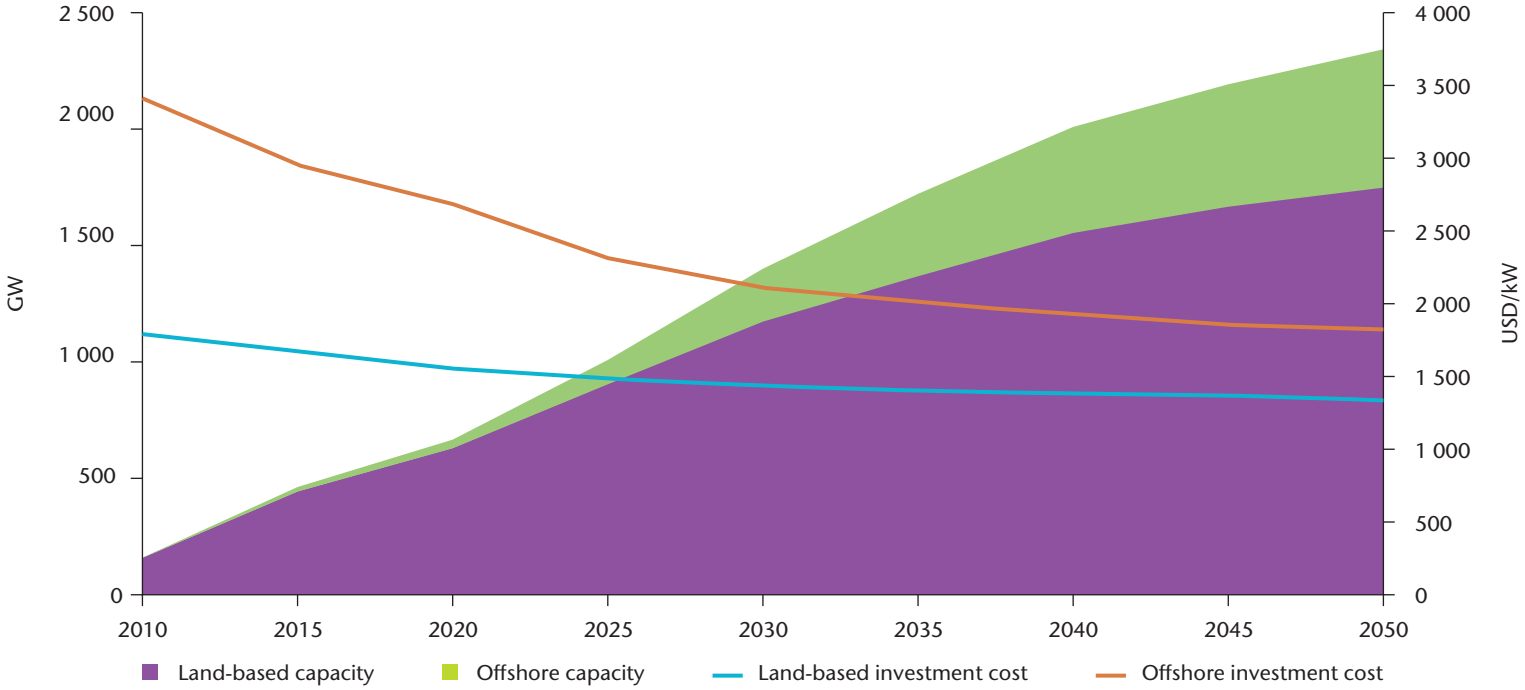


Key actions over the next 10 years

- Set long-term targets, supported by predictable mechanisms to drive investment and to apply appropriate carbon pricing.
- Address non-economic barriers. Advance planning of new plants by including wind power in long-term land and maritime spatial planning; develop streamlined procedures for permitting; address issues of land-use and sea-use constraints posed by various authorities (environment, building, traffic, defence and navigation).
- Strengthen research, development and demonstration (RD&D) efforts and financing by increasing current public funding two- to five-fold to drive reductions in costs of turbines and support structures, to increase performance and reliability (especially in offshore and other new market areas) and to scale up turbine technology for offshore.
- Adapt wind power plant design to specific local conditions (e.g. cold climates and low-wind sites), penetration rates, grid connection costs and the effects of variability on the entire system.
- Improve processes for planning and permitting transmission across large regions; modernise grid operating procedures (e.g. balancing area co-ordination and fast-interval dispatch and scheduling); increase power system flexibility using ancillary services from all (also wind) generation and demand response; and expand and improve electricity markets, and adapt their operation for variable generation.
- Increase public acceptance by raising awareness of the benefits of wind power (including emission reductions, security of supply and economic growth), and of the accompanying need for additional transmission.
- Enhance international collaboration in R&D and standardisation, large-scale testing harmonisation, and improving wind integration. Exchange best practices to help overcome deployment barriers.

Global land-based and offshore deployment

Wind power capacity development and investment cost reduction offshore and on land in the 2DS, to 2050



KEY POINT: by 2050, 25% of wind capacity will be located at sea, up from 6% in 2020. Offshore technology is still further from market than land-based technology.

Cumulative investment in the 2DS

	2010-20	2020-30	2030-50
OECD Europe	256	337	831
OECD Americas	209	455	628
OECD Asia Oceania	32	69	120
Africa and Middle East	42	173	194
China	305	385	839
India	36	38	158
Latin America	25	12	74
Other developing Asia	53	105	279
Other non-OECD	22	61	185
TOTAL	**980**	**1 635**	**3 308**

Wind energy roadmap milestones