

Renewable Power Generation Costs in 2021

Presenters:

Pablo Ralon and Sonia Al-Zoghoul, Renewable Energy Cost Status and Outlook

TUESDAY, 04 OCTOBER 2022 • 14:00 – 14:30 CEST

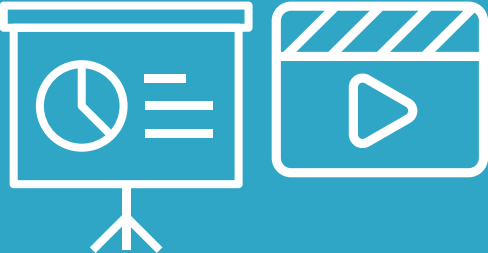
SPEAKERS



Pablo Ralon
IRENA



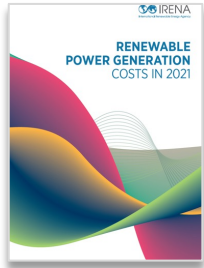
Sonia Al-Zoghoul
IRENA



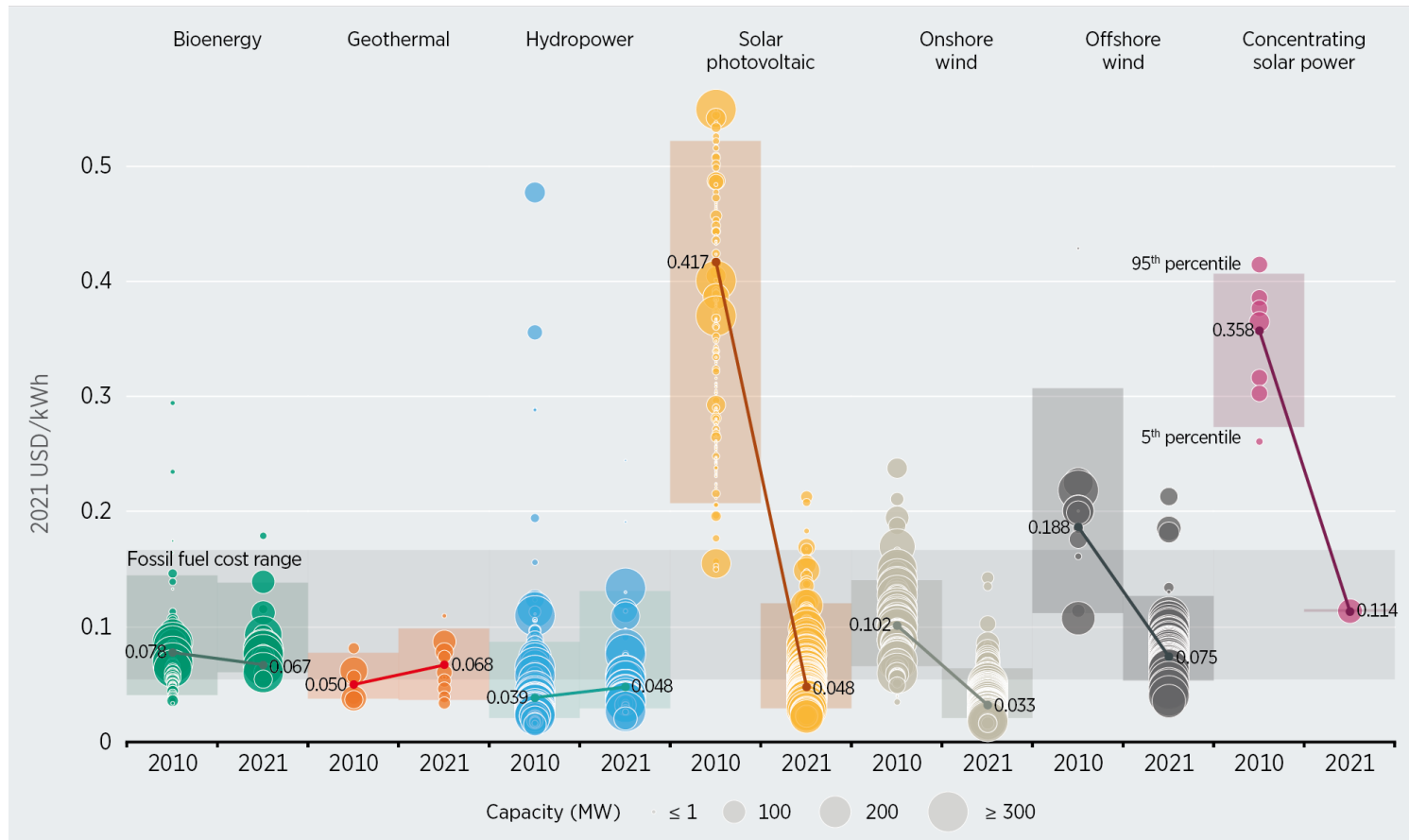
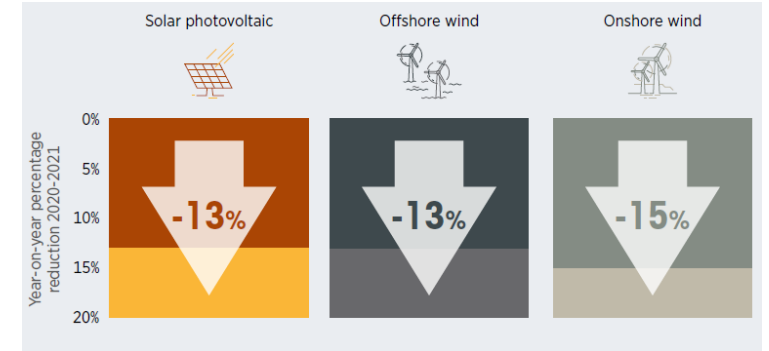
Renewable Power Generation Costs in 2021

Michael Taylor, Pablo Ralon and Sonia Al-Zoghoul

In most parts of world RE least-cost source of new electricity



- 73% (163 GW) of new utility-scale capacity in 2021 globally cost less than cheapest fossil option.
- Globally, new renewable capacity added in 2021 could reduce electricity generation costs in 2022 by at least USD 55 billion.

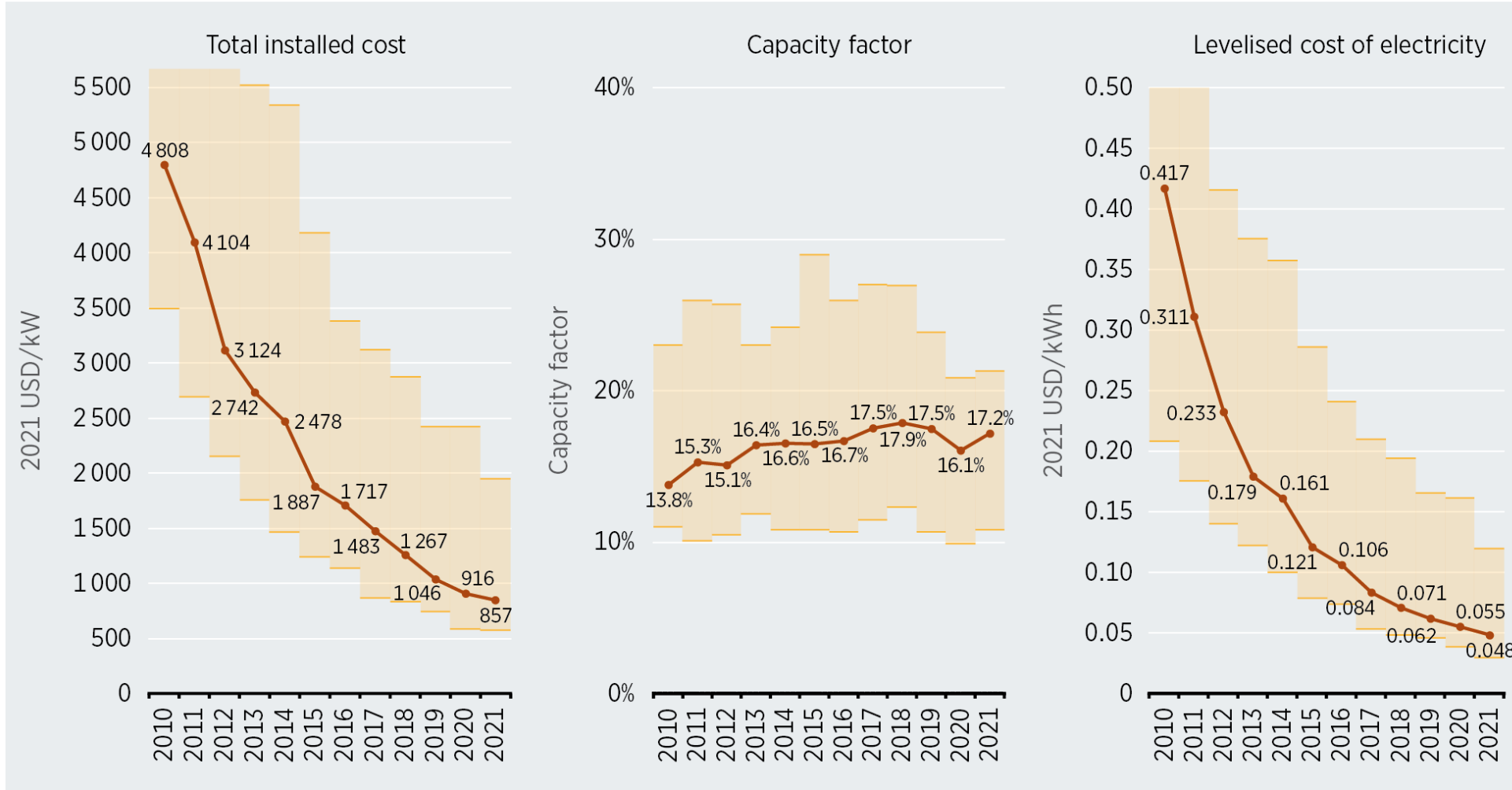


- Costs continued to decline in 2021 despite of supply chain disruptions.
- Renewable received largest ever increase in competitiveness in 2022 in Europe due to fossil fuel price crisis.



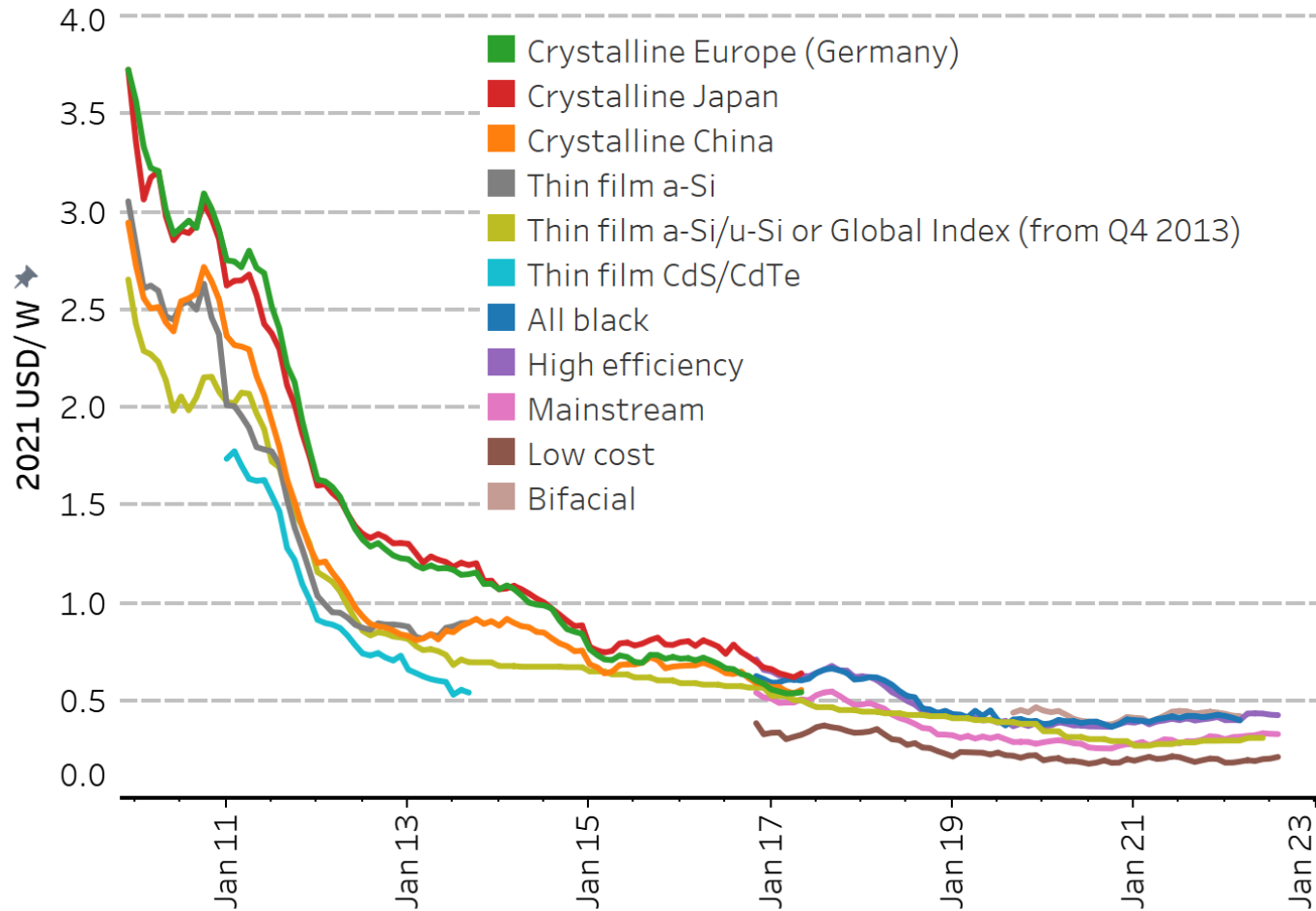
Solar PV

Solar PV: Evolution of key metrics



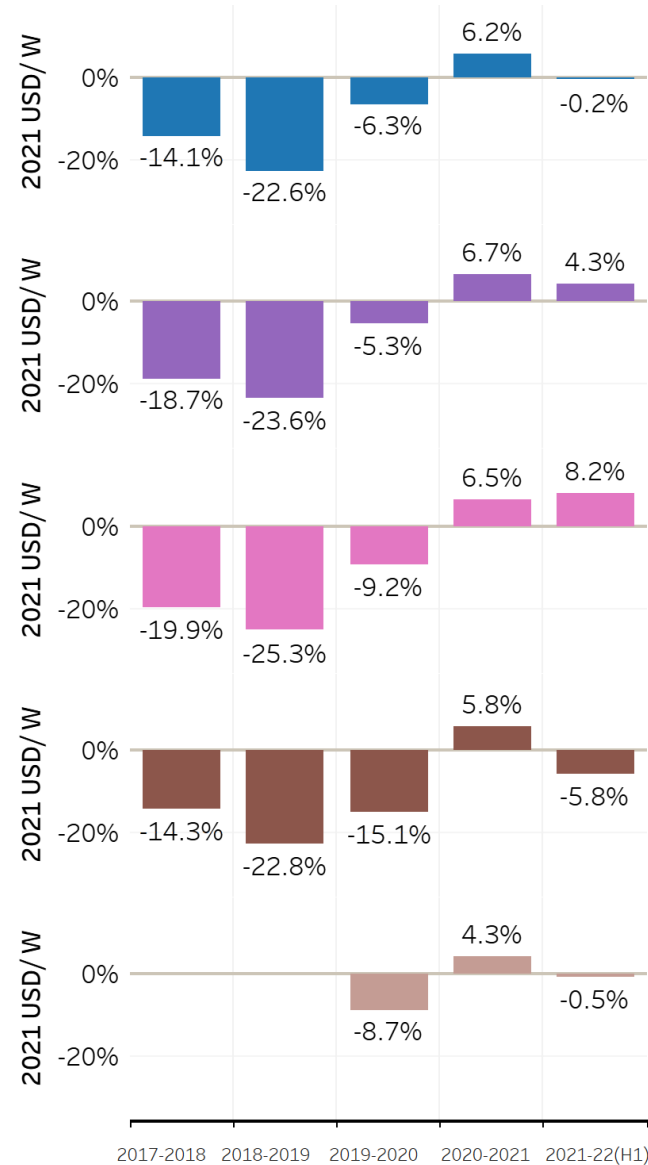
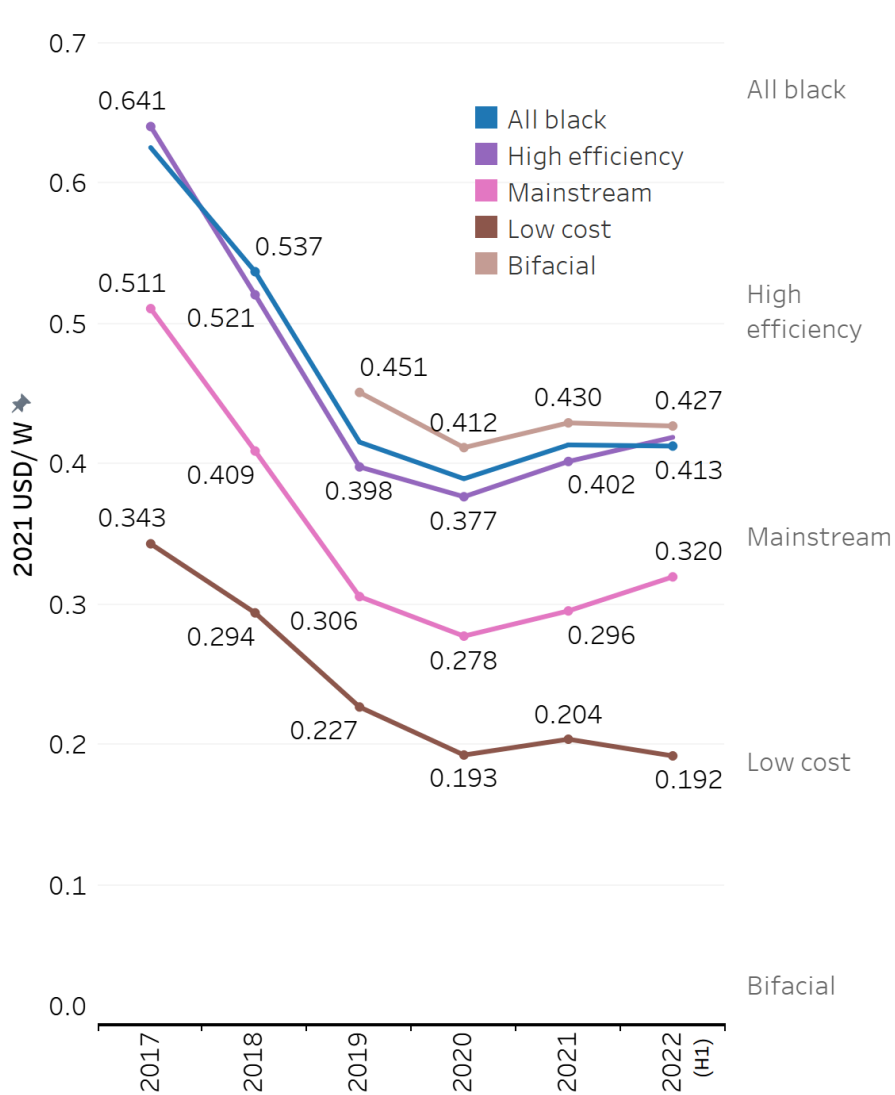
- Over 843 GW installed by the end of 2021 (**21-fold growth** between 2010-2021)
- Total installed costs w. avg. declined 6% from 2020 and **82% from 2010**.
- In 2021, the LCOE YoY reduction was **13% (88 lower than 2010)**

Module costs declined driven by manufacturing and efficiency gains



- Between December 2009 and December 2021, crystalline silicon module prices declined by between **88% and 95%**
- Mainstream modules sold for USD 0.26/W during December 2021 (12% lower than Dec 2020)
- Range of costs in Dec 2021 from USD 0.20/W for the lower cost modules to as high as between USD 0.42 and USD 0.44/W.

In 2021, PV module prices climbed due to supply chain disruptions

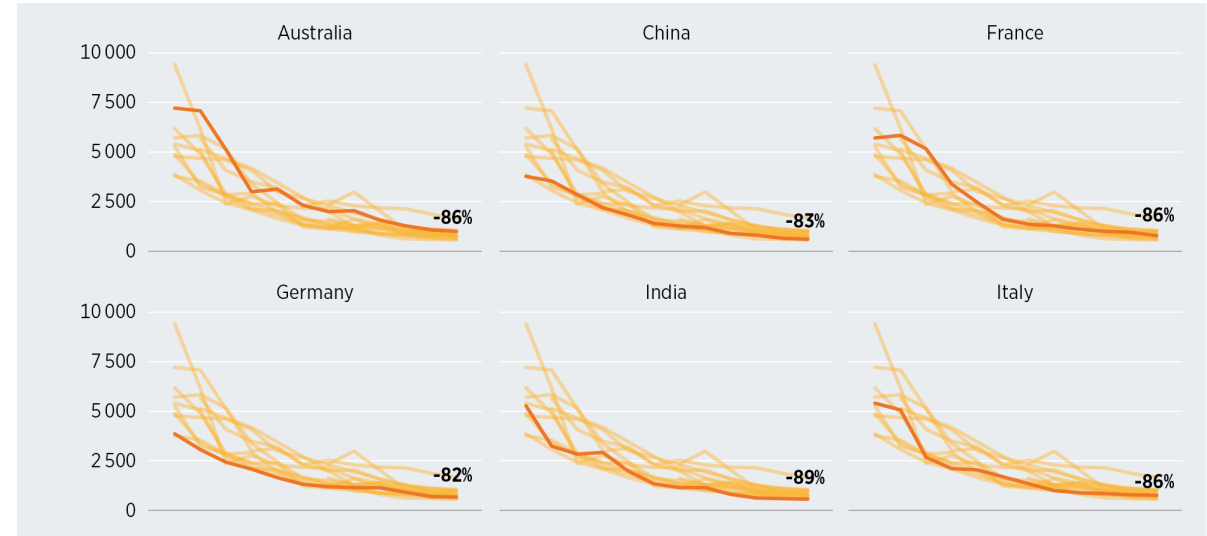


- This has mean higher material costs, or lower availability with **2021 costs 4%-7% higher than in 2020.**
- Data for H1 2022, shows mainstream modules increased 8% compared to 2021.
- High efficiency modules are 4% higher in H1 2022 compared to 2021
- Low cost offerings declined 6% between 2021 and H1 2022, returning to 2020 levels

Reductions occurred despite supply chain disruptions

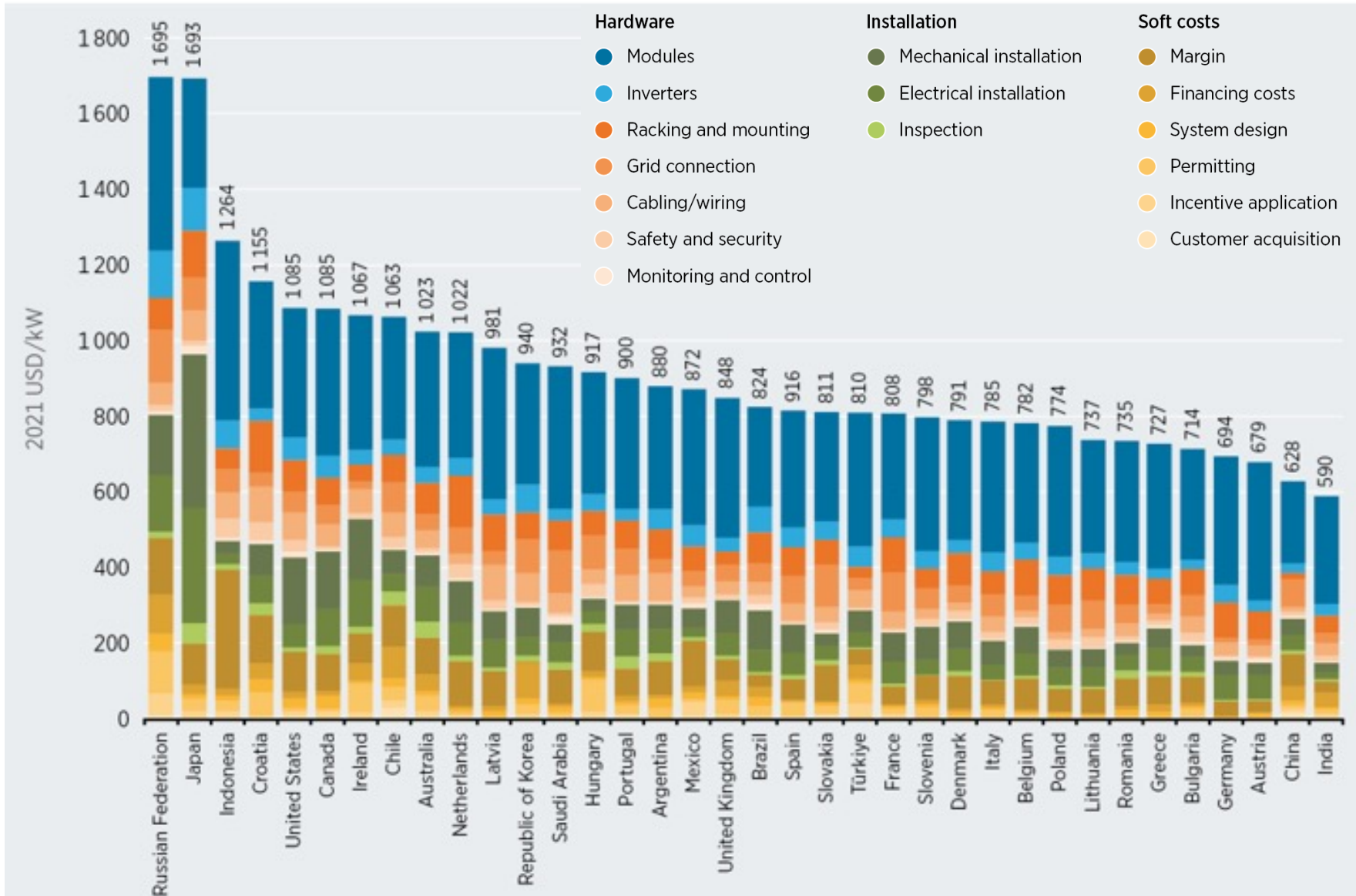
Total installed cost reduction of 4% - 11% in historical markets (China, India, Japan, Korea, US and Germany)

Very competitive costs in India led to w. avg. TIC of USD 590/kW in 2021, a value 6% lower than in China.



Competitive cost structures continue to prevail in newer markets:
Netherlands (9% decline) and Türkiye (5% decline)

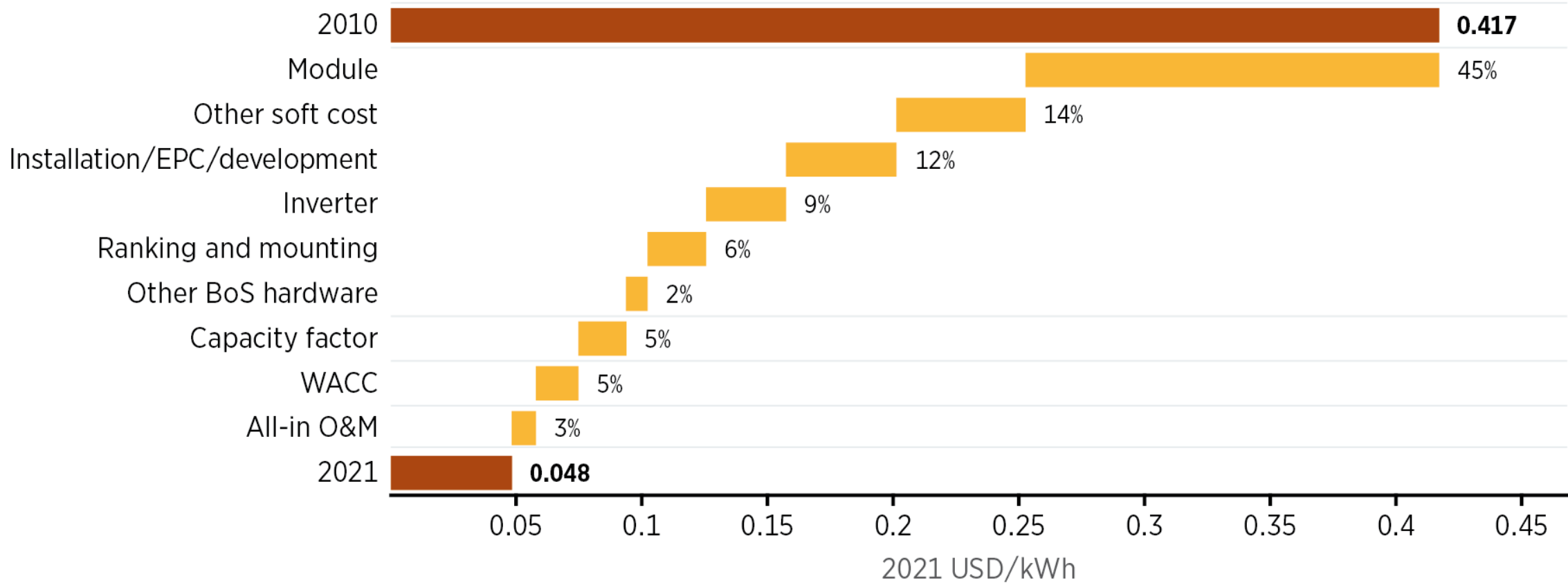
Detailed breakdown of utility-scale solar PV total installed costs 2021



- While solar PV has become a mature technology, regional cost variations do persist, though **cost convergence continues** year by year.
- Modules and inverters accounted for 61% of the global weighted average TIC decline between 2010 and 2021.

How has the LCOE of utility solar PV become so low?

Solar PV **module costs declined so rapidly** that new solar PV markets have emerged, globally



EPC, installation, and development costs, with other soft costs, accounted for 26% of the LCOE decline. Together, cost reductions in inverters, racking and mounting, and other BoS hardware made up 17%.



Concentrating Solar Power

Concentrating solar power: a decade of improvement

CSP from 2010 to 2020



- 70%** Solar field costs
- 50%** Total installed costs
- 68%** Levelised cost of electricity

COSTS

PERFORMANCE

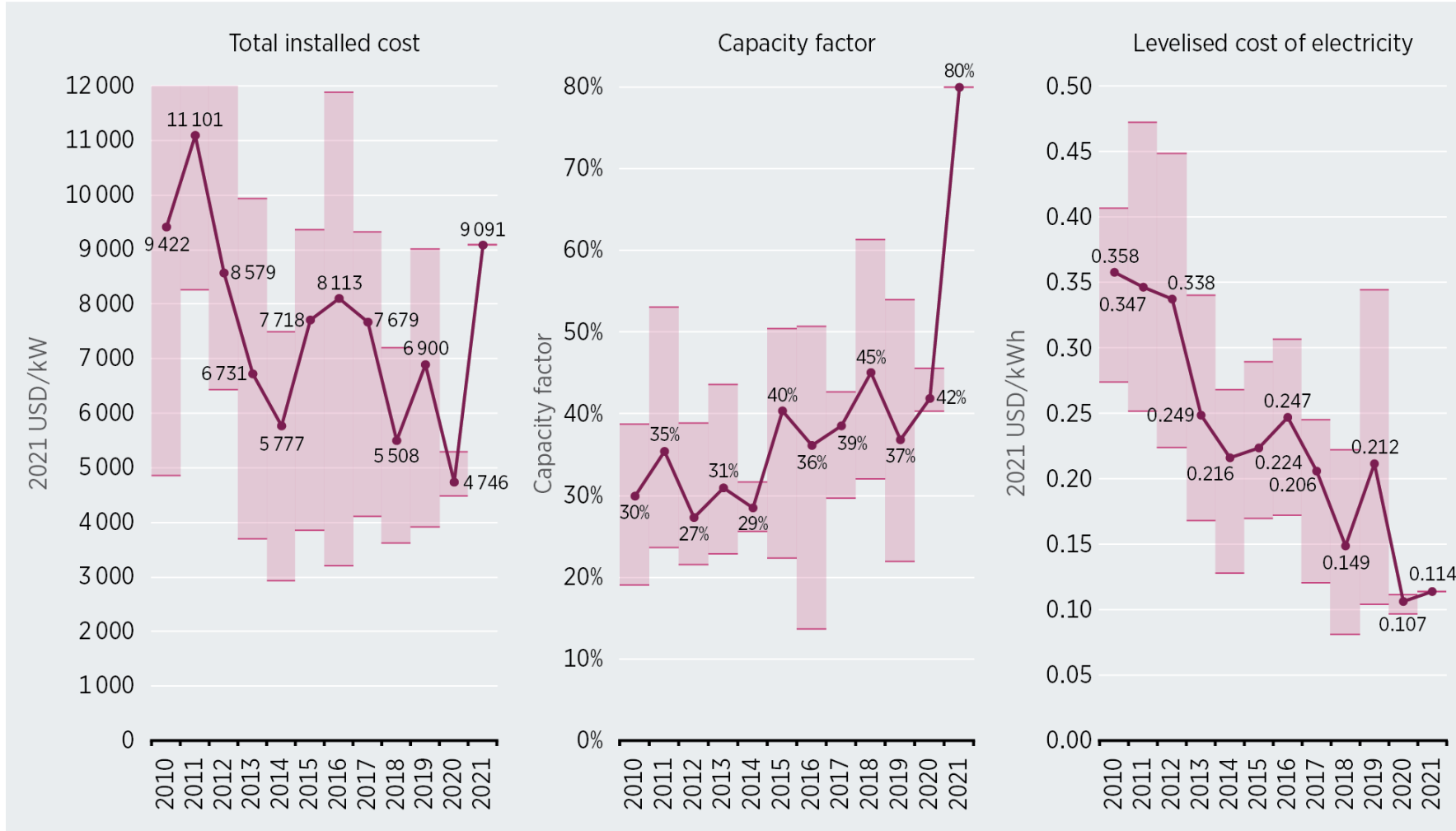
- PTC aperture width **+24%**
- Storage duration **+218%**
- Capacity factor **+40%**



IRENA
International Renewable Energy Agency

**Renewable Technology
Innovation Indicators:**
Mapping progress in costs,
patents and standards

Total installed costs for CSP fell by 50% between 2010 and 2020



- The w avg CF of newly-commissioned CSP plants increased from **30% in 2010 to 42% in 2020** globally
- TIC:
 - 2010-2020: -50%
 - 2019-2020: - 6%
- Between 2010 and 2021 the LCOE declined **68% to USD 0.114/kWh**
- CSP, now in the **mid-cost range** of new capacity from fossil fuels

Total installed costs for CSP fell by 50% between 2010 and 2020

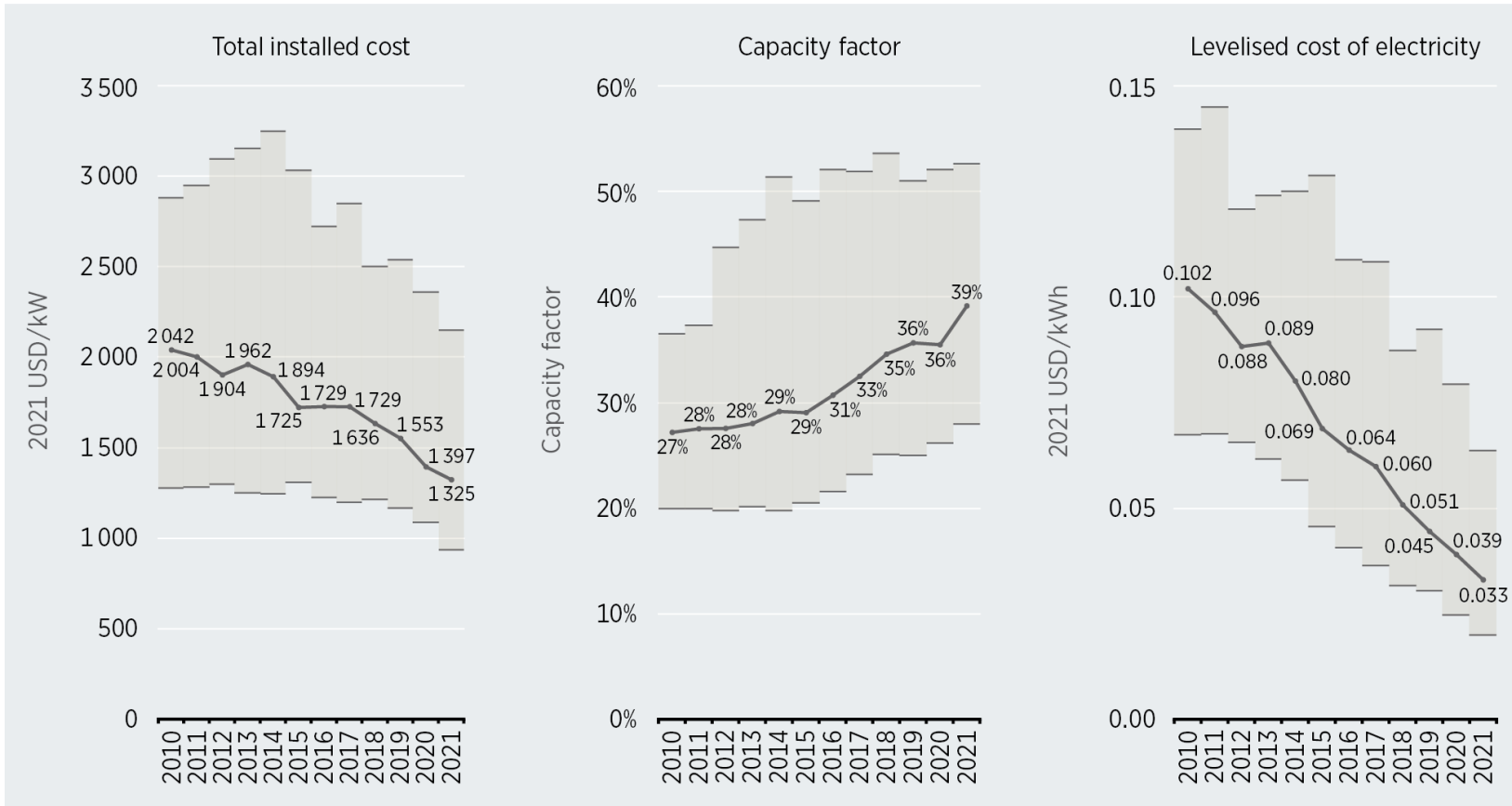


- CSP plants **almost exclusively include low-cost and long-duration thermal storage** systems
- CSP plants are now routinely being **designed** to meet **evening peaks and overnight demand**.
- Larger storage capacity, gives CSP **greater flexibility** in dispatch and the ability to target output in high-cost periods.



Onshore Wind

Onshore wind cost and performance trends



2010-2021:

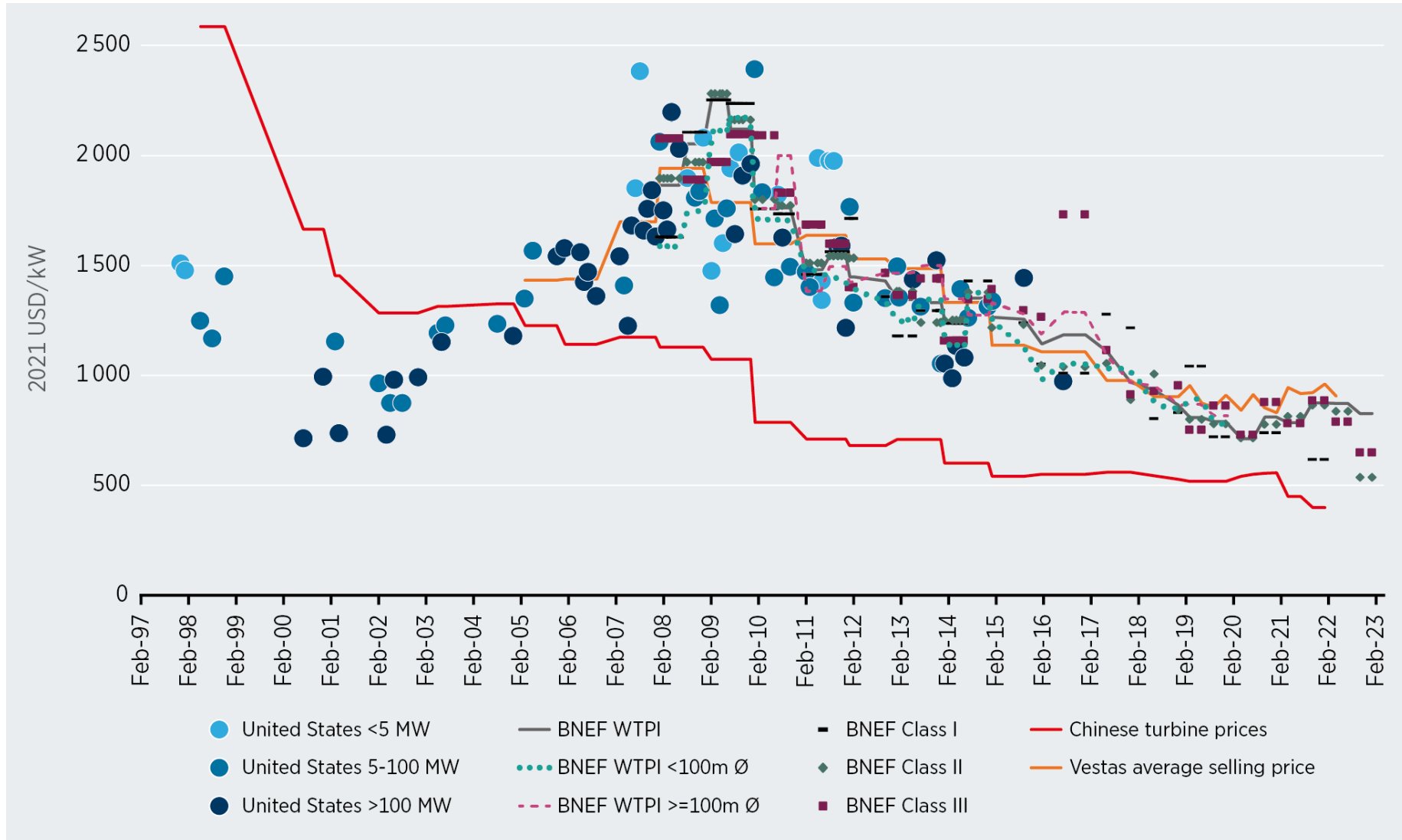
- Deployment grew **4-fold** to reach 769 GW (**72 GW in 2021**)

The global weighted average:

- Total installed cost reduced by **35%** to **USD 1 325/kW**
- Capacity factor increased **from 27% to 39%**
- LCOE reduced **by 68%** to reach **USD 0.033/kWh**

Source: IRENA Renewable Cost Database.

Wind turbine characteristics and costs

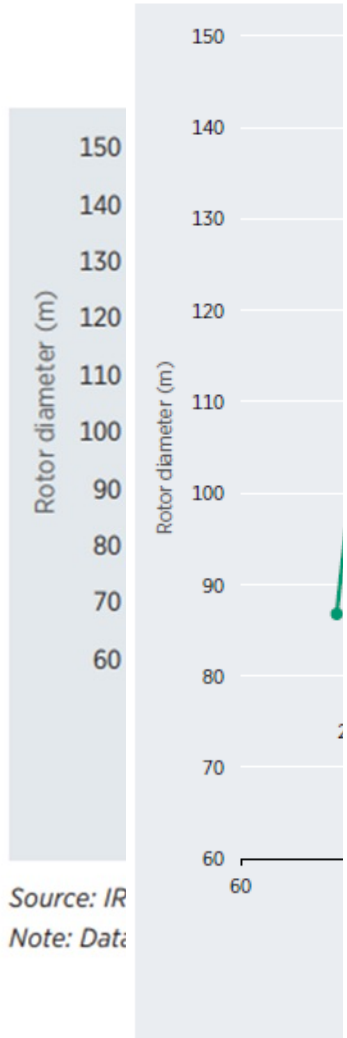


Average 2021 turbine price:

- In China: USD 425/kW (84% lower than 1998)
- Outside China: USD 780/kW to USD 960/kW (48% to 62% lower than 2009)
- Recent uptick outside China (supply chain disruptions in 2020 and 2021)

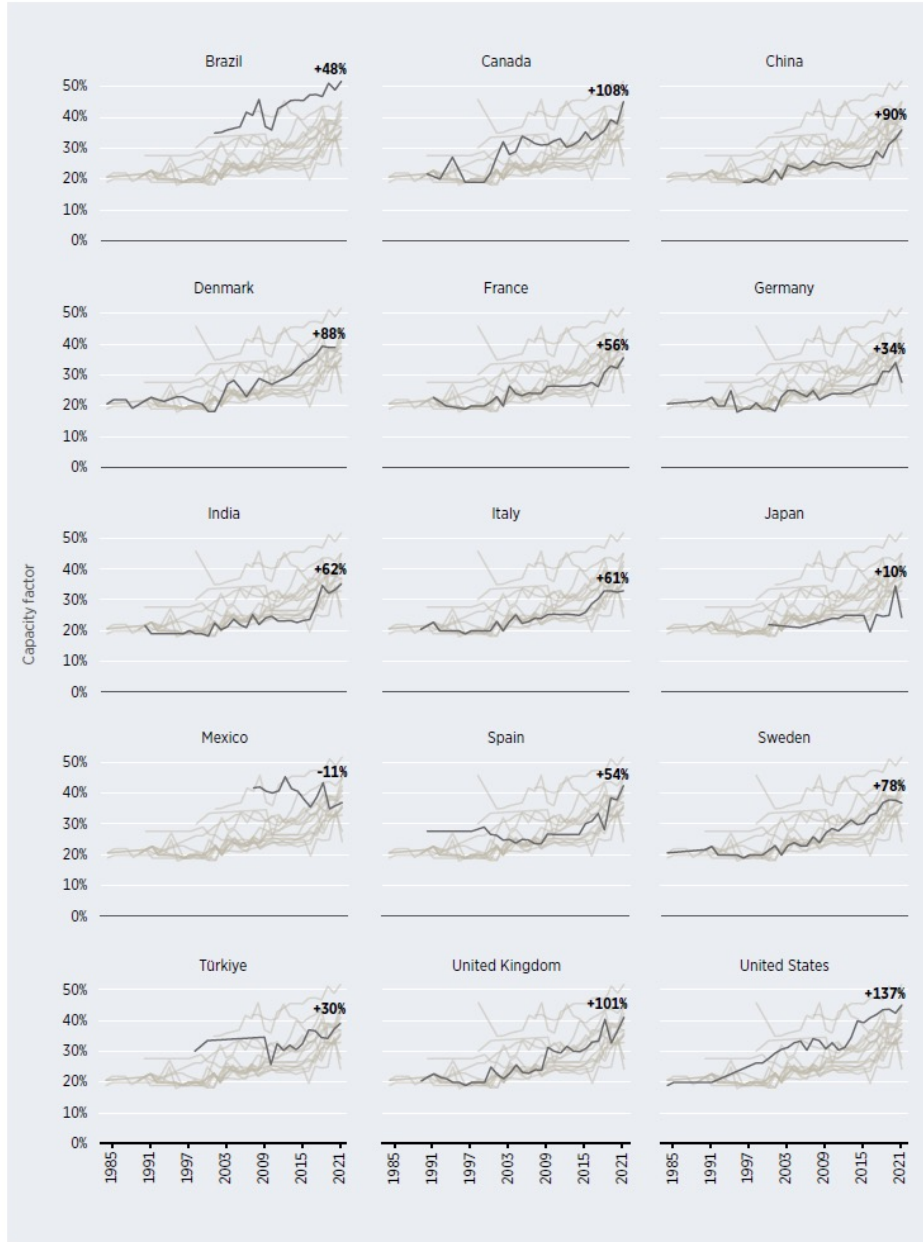
Higher capacity factors driven by technology improvements

Technology improvements have resulted in an almost **one-third** improvement in the global weighted average capacity factor

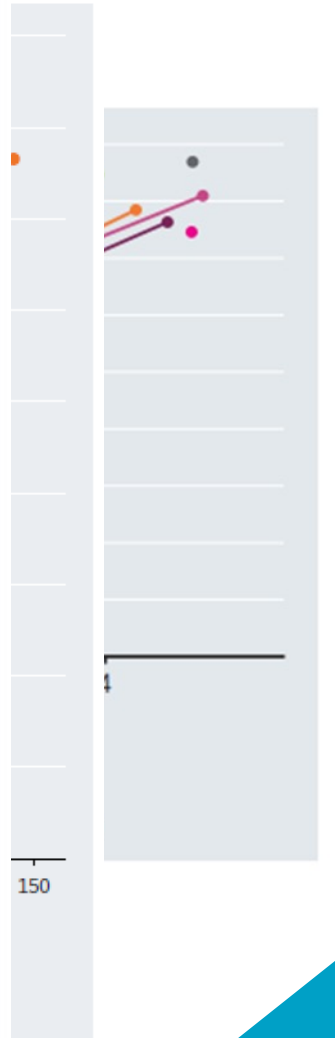


Source: IRENA Renewable Cost Database
Note: Data from 1985 to 2021

Source: IRENA Renewable Cost Database

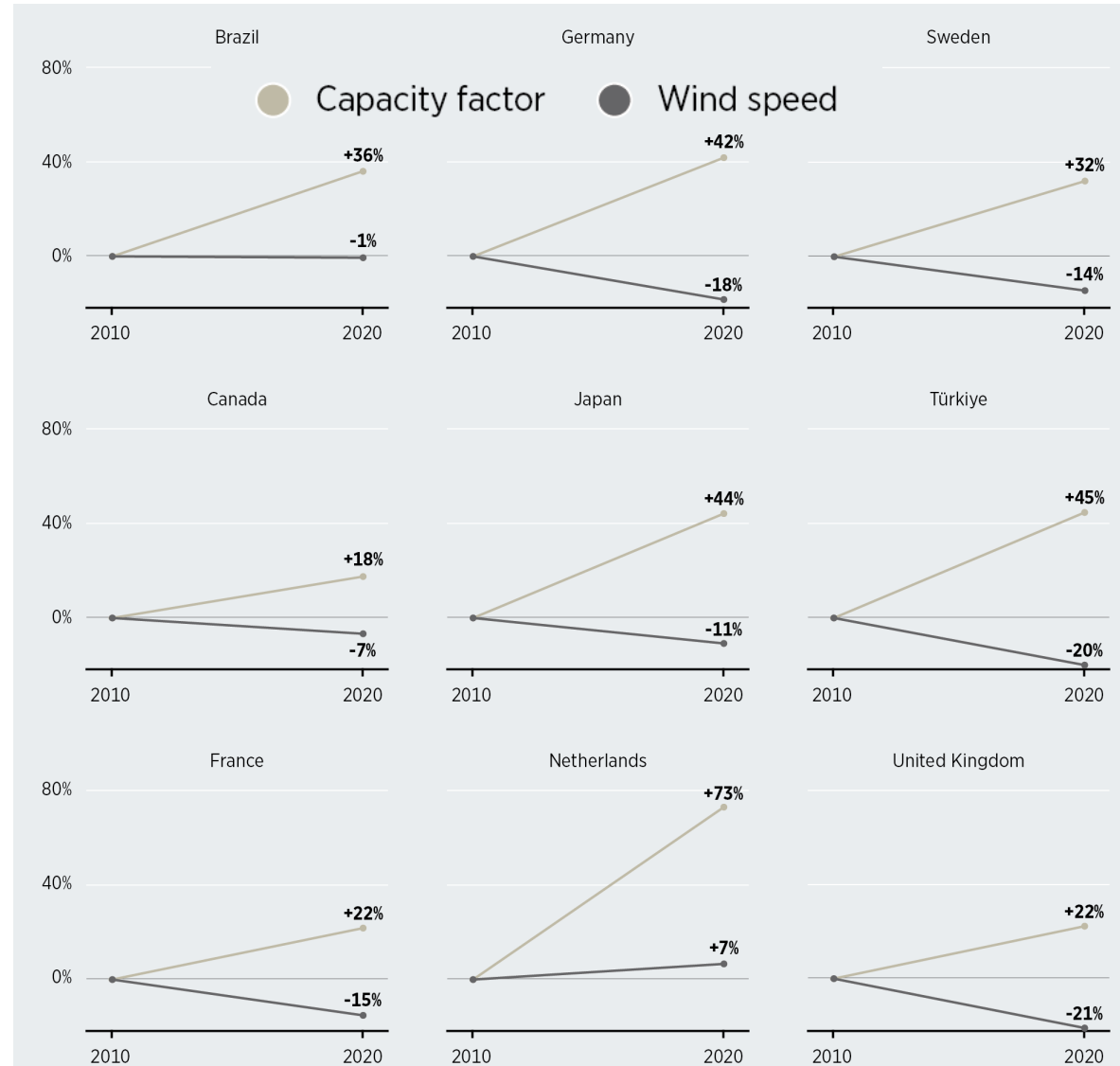


Source: IRENA Renewable Cost Database



Wind speed and capacity factor trends in major markets

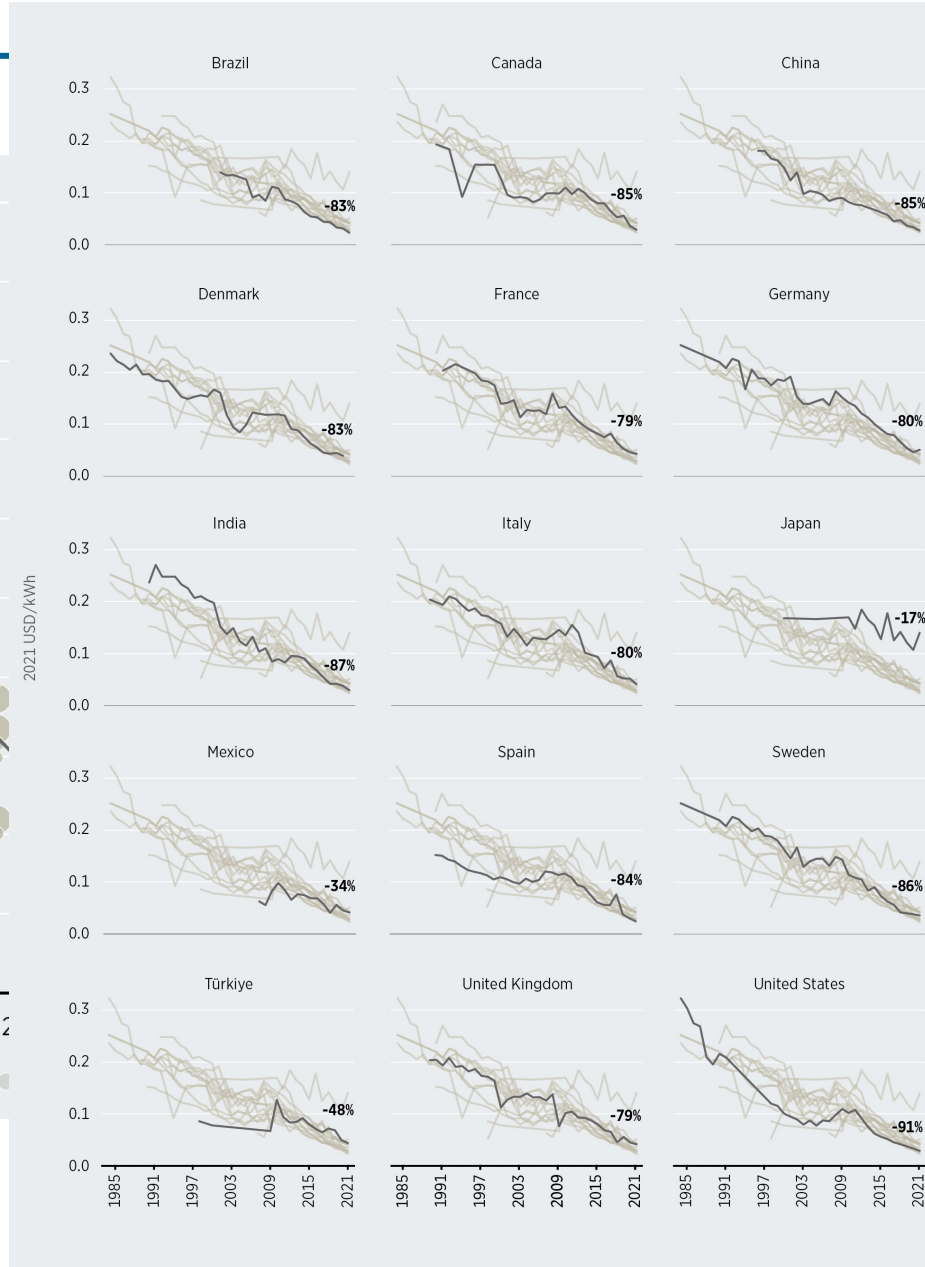
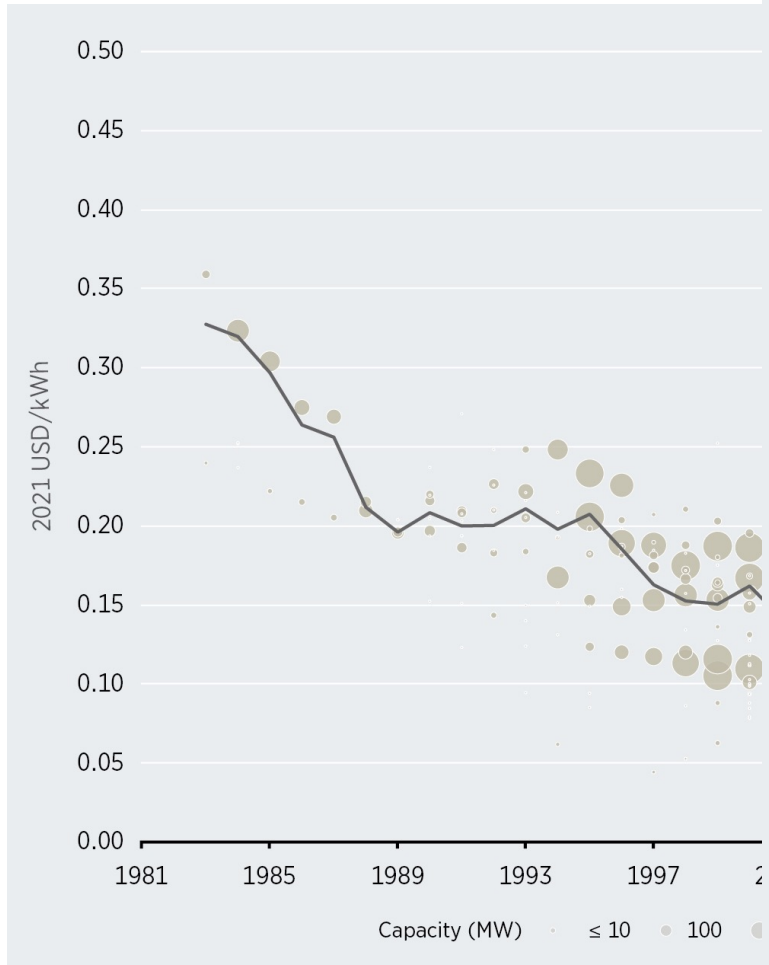
- Major onshore markets show **increased w avg. CFs despite decline of w avg. wind speeds** in 2010-2020
- This confirms that **technology improvements** contributed greatly to an **increase** in the global **w avg. CF**



Source: IRENA Renewable Cost Database.

- The decline in wind speed could be due to less access to better wind resources
- Might be the result of projects in areas with lower wind speeds (now economic).

Levelised cost of electricity



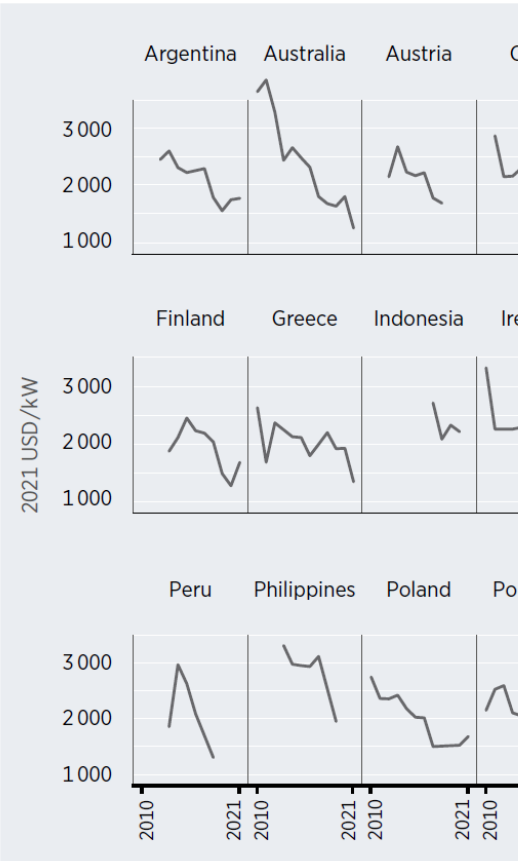
Global LCOE of onshore wind has declined by **90%** between 1984-2021:

- **USD 0.320/kWh - USD 0.033/kWh**

Source: IRENA Renewable Cost Database.

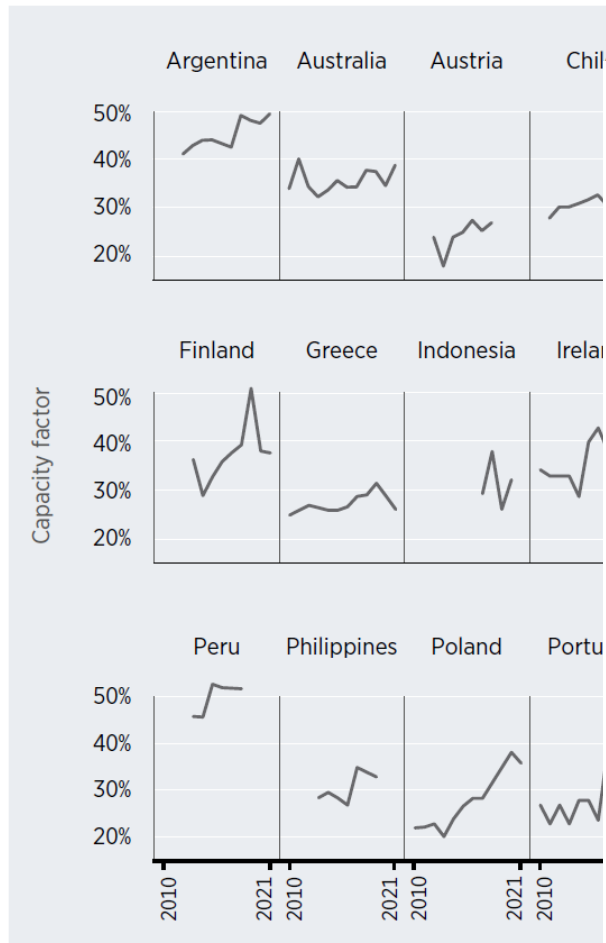
Cost trends for smaller onshore wind markets

Total installed costs



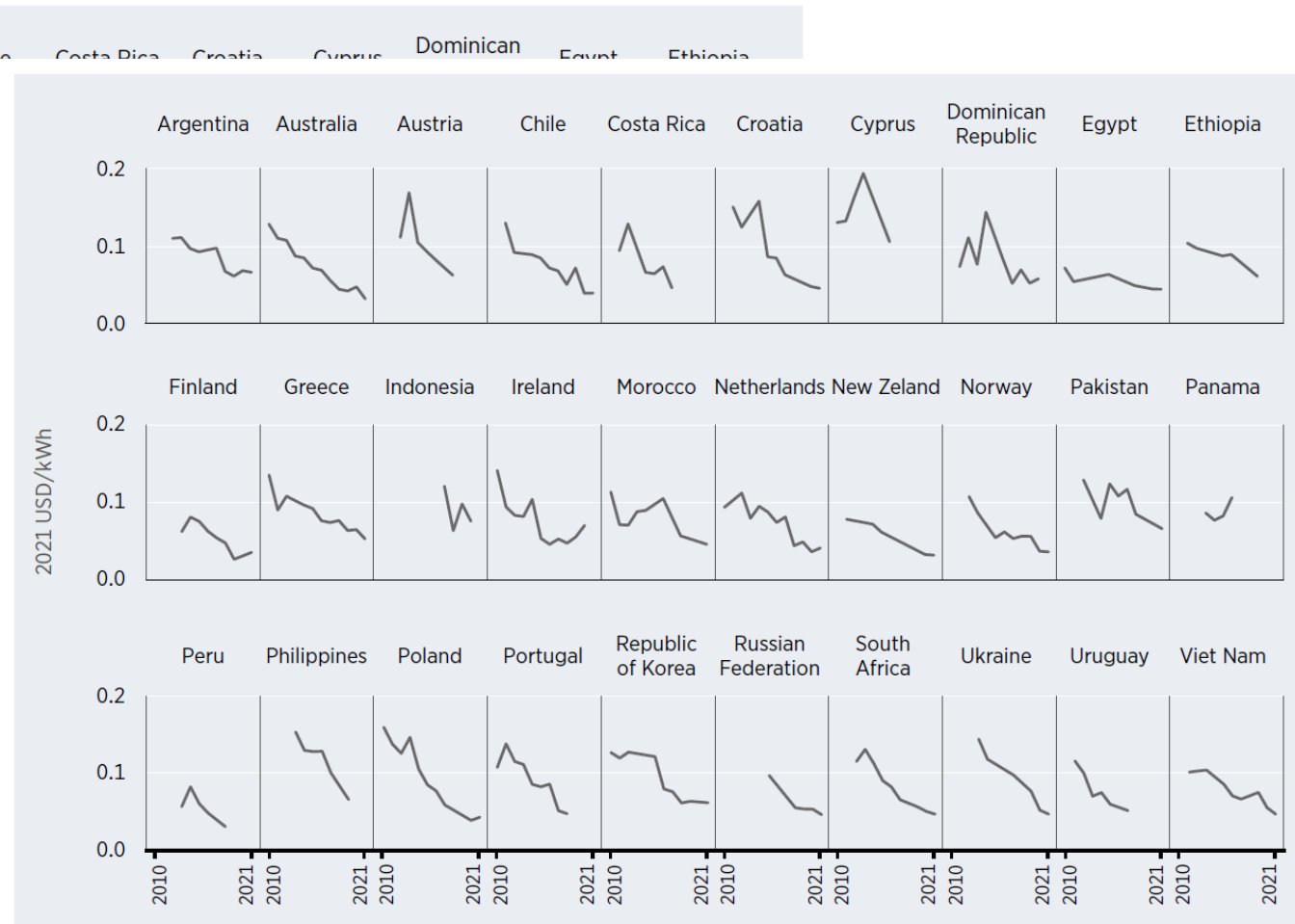
Source: IRENA Renewable Cost Database.

Capacity factors



Source: IRENA Renewable Cost Database.

LCOE

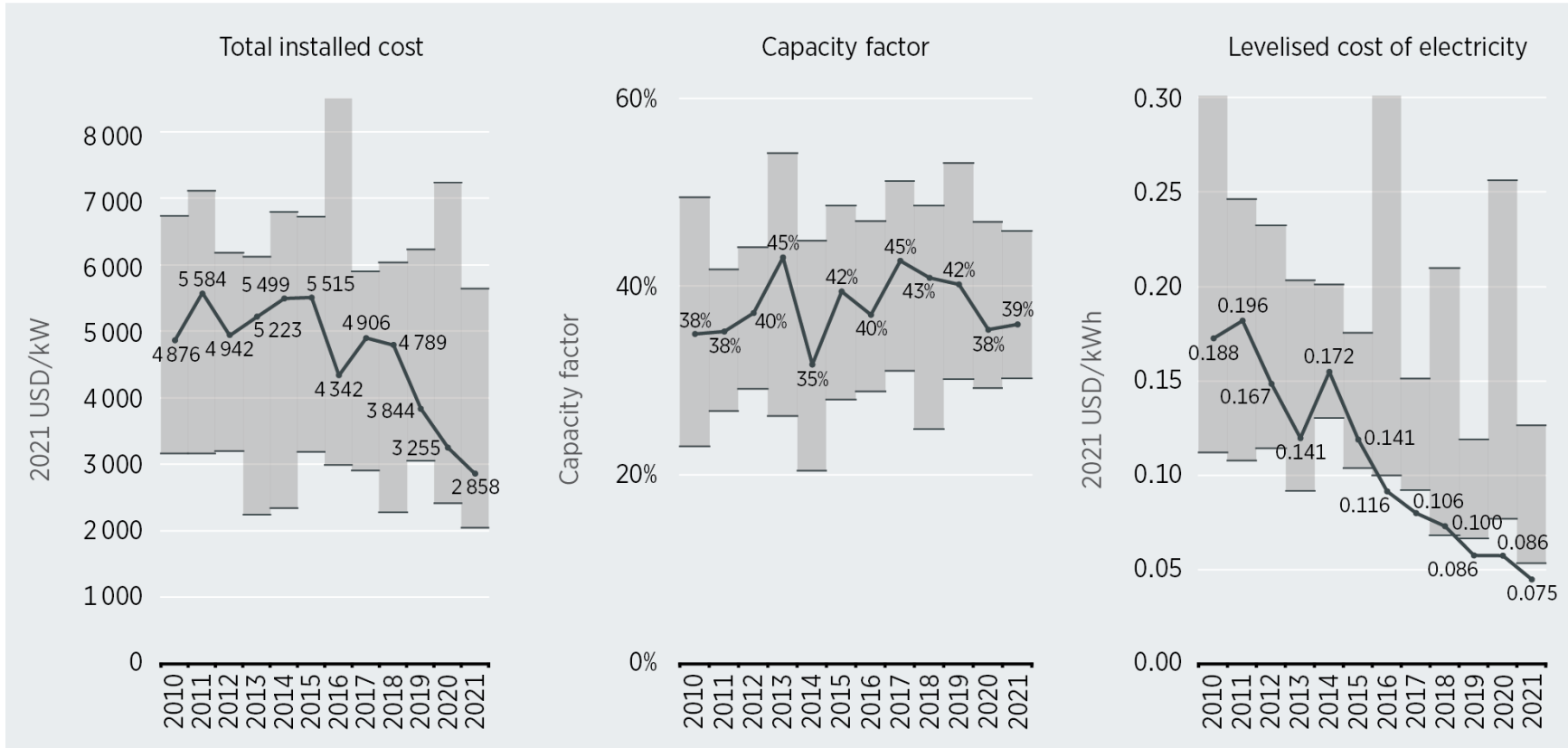


Source: IRENA Renewable Cost Database.

Offshore Wind



Offshore wind cost and performance trends



Between 2010-2021, the global weighted average:

- Total installed cost reduced by **41% to USD 2 858/kW (3.1 GW to 55.7 GW)**
- CF at **39%** (drop after 2017 is due to increased share of **Chinese deployment** lower resource)
- LCOE reduced **by 60% to USD 0.075/kWh**
- **China accounted for 82% (17.4 GW) of new capacity in 2021)**

Source: IRENA Renewable Cost Database.

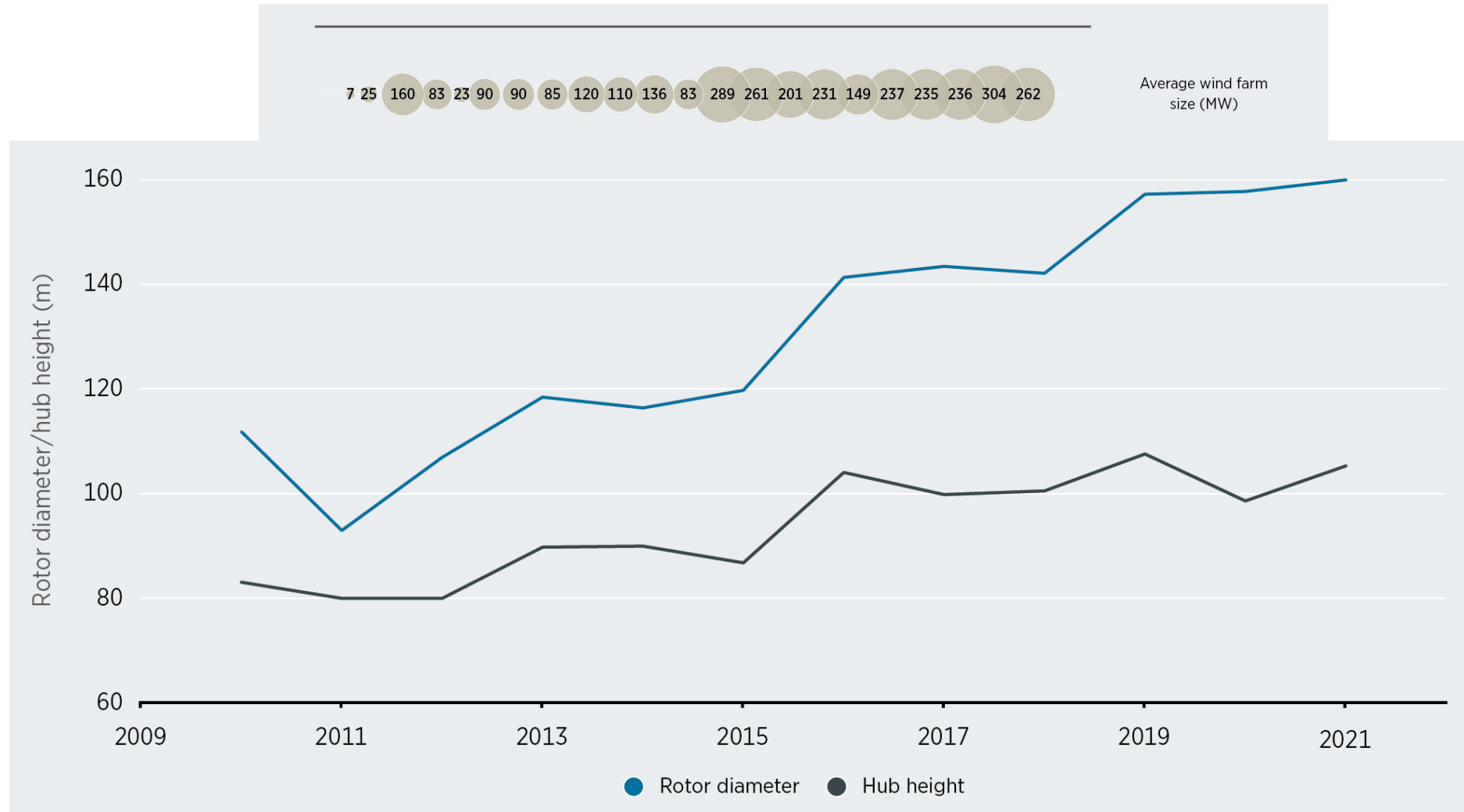
Offshore wind project characteristics - Deeper waters and farther from shore



Trend towards deployments **farther offshore in deeper waters, with larger turbines** and installations growing in new and established market.

Source: IRENA Renewable Cost Database.

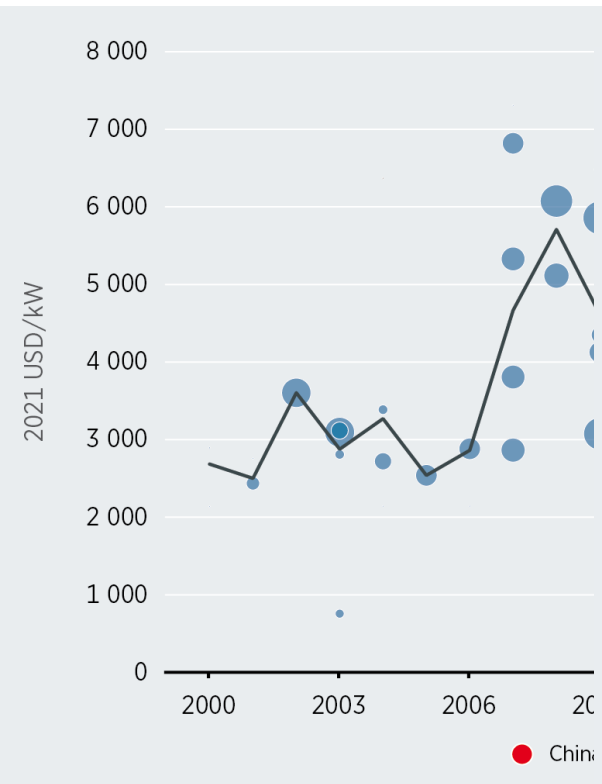
Turbine size and wind farm capacity



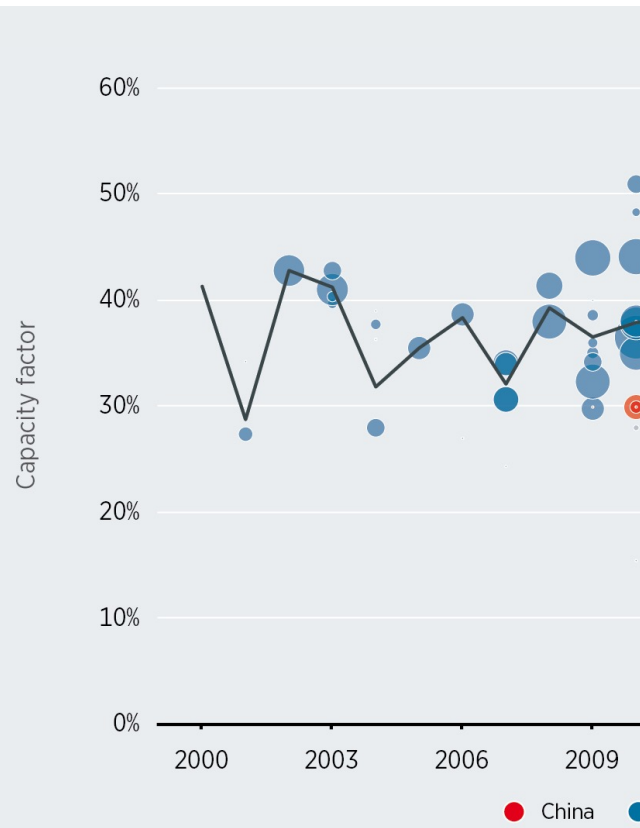
Source: IRENA Renewable Cost Database.

China vs Europe

Total installed costs



Capacity factors



LCOE



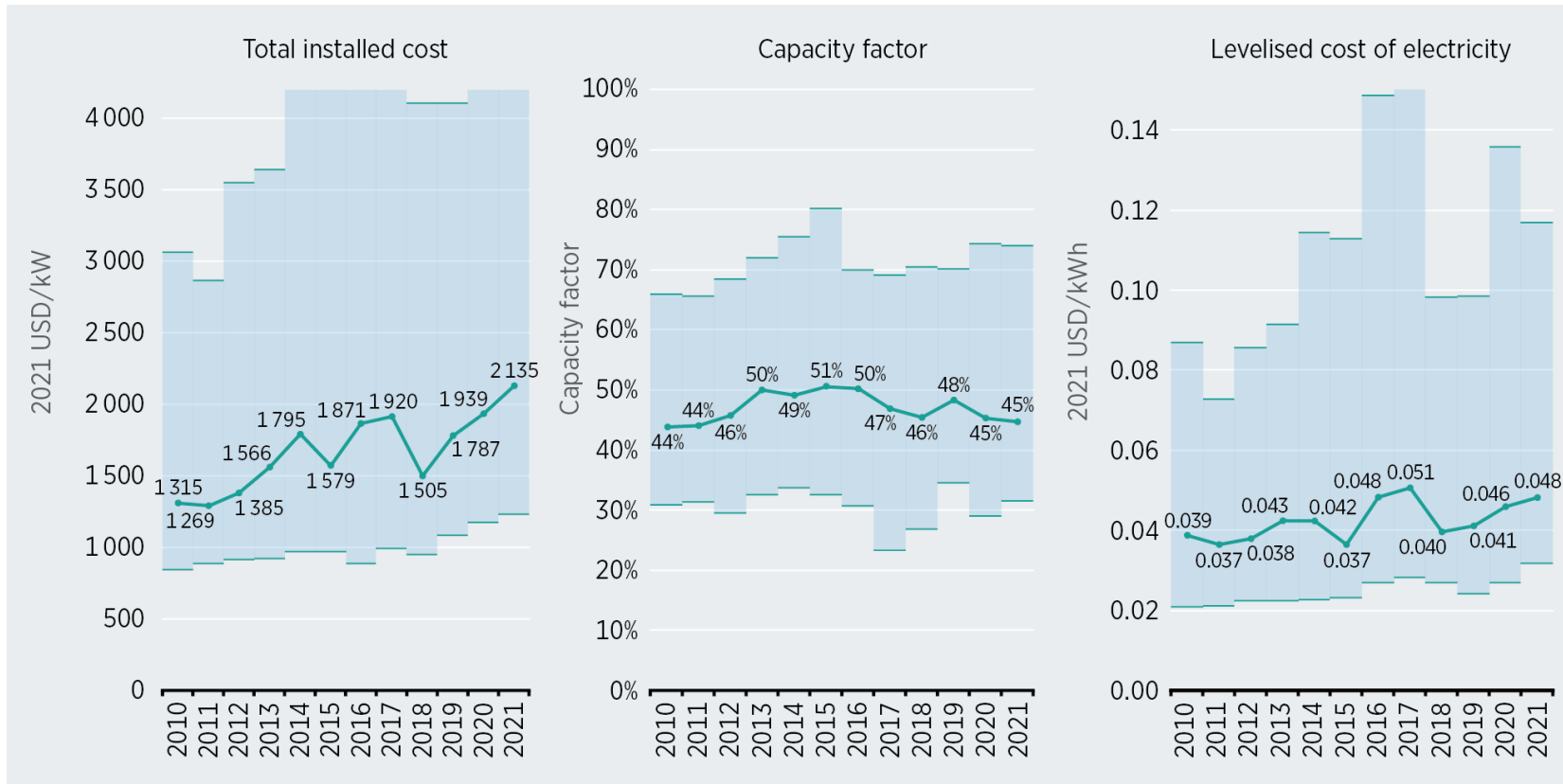
Source: IRENA Renewable Cost Database.

HYDROPOWER

BIOENERGY

GEOHERMAL

Hydropower cost trends and performance

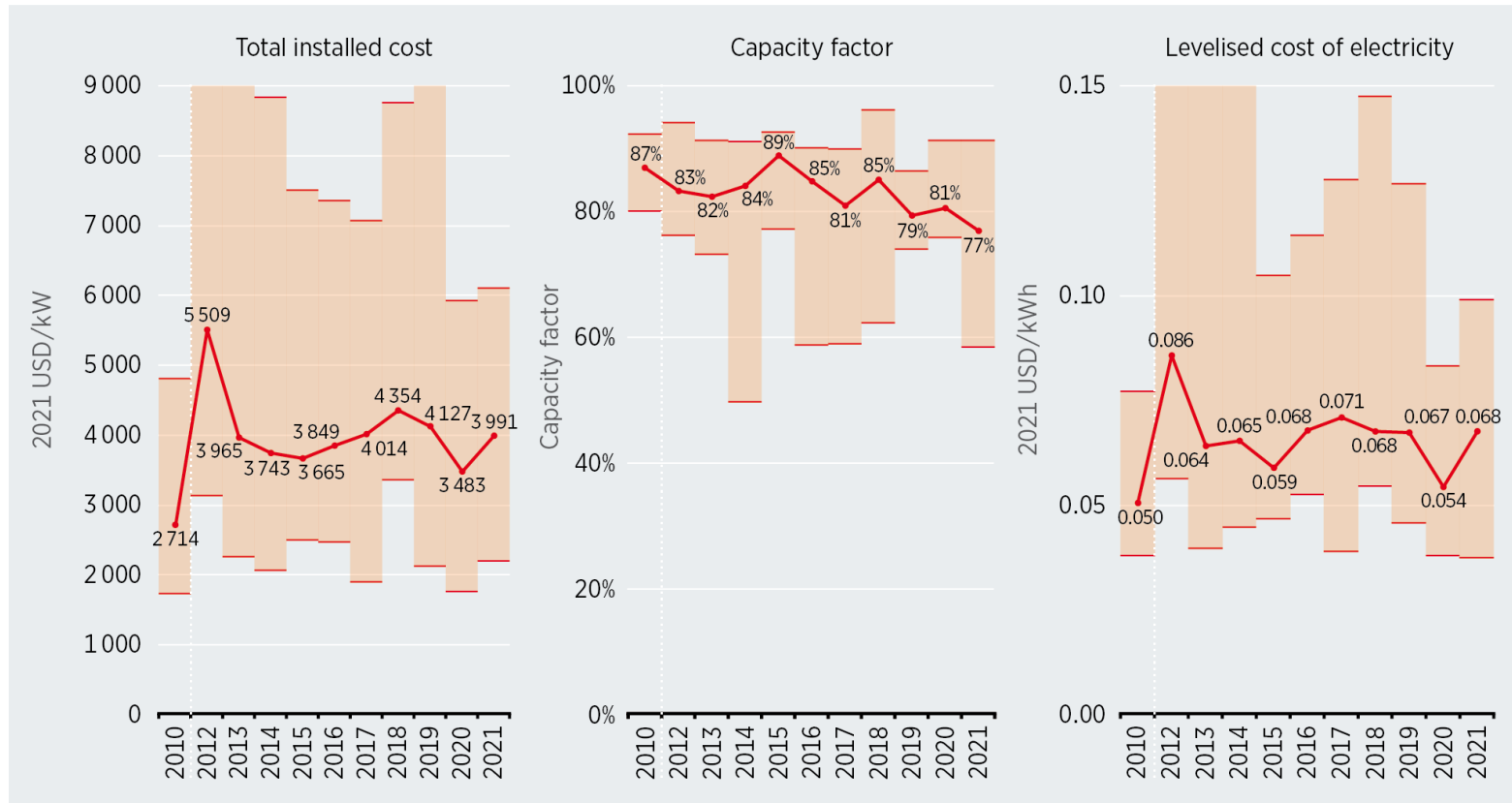


Between 2010-2021, the global weighted average:

- Total installed cost increased in 2021 to **USD 2 135/kW**, higher than the **USD 1 939/kW** in 2020.
- Capacity factor increased **from 44% to 45%**
- LCOE increased **by 23% from USD 0.039/kWh to USD 0.048/kWh**

Source: IRENA Renewable Cost Database.

Geothermal cost trends and performance



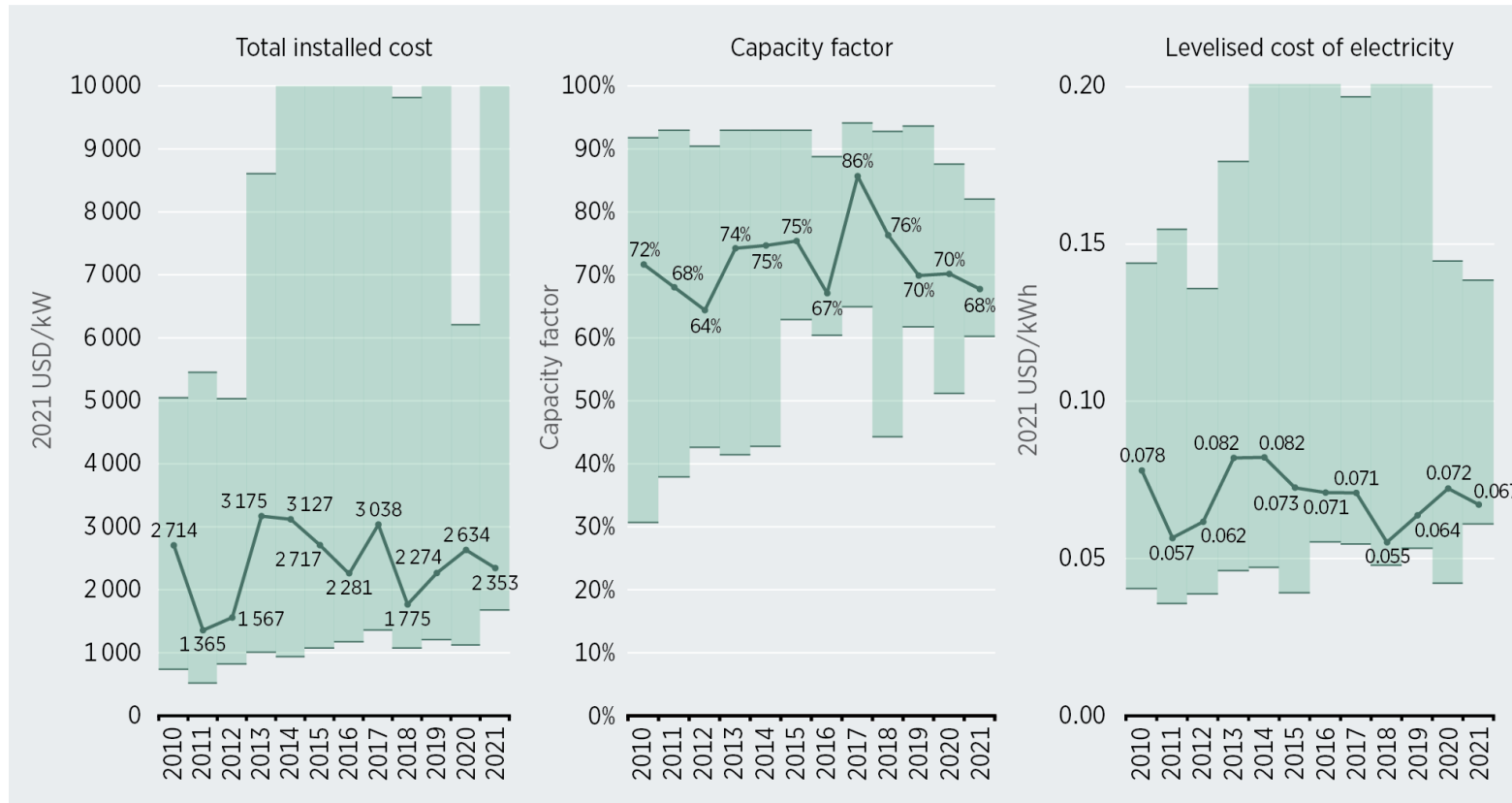
In 2021, the global weighted average total installed cost of the **eight geothermal power plants** in IRENA's database was **USD 3 991/kW**

Capacity factor between 2010-2021 decreased from **87% to 77%**

LCOE **increased to USD 0.068 /kWh** in 2021

Source: IRENA Renewable Cost Database.

Bioenergy cost trends and performance



Between 2010-2021, the global weighted average:

Total installed cost **reduced** by **13%** from **USD 2 714** to **USD 2 353/kW**

Capacity factor **declined** to **68%**

LCOE **reduced** by **14%** from **USD 0.078/kWh** to **USD 0.067/kWh**

Source: IRENA Renewable Cost Database.

Improved competitiveness in 2021, already resulting in savings



**frees economies
from volatile
fossil fuel prices**



curbs energy costs



**reduces fossil
fuel imports**



**creates tangible
savings for
communities**



**At least USD 55
billion potential
global net
savings by 2022**



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IRENA



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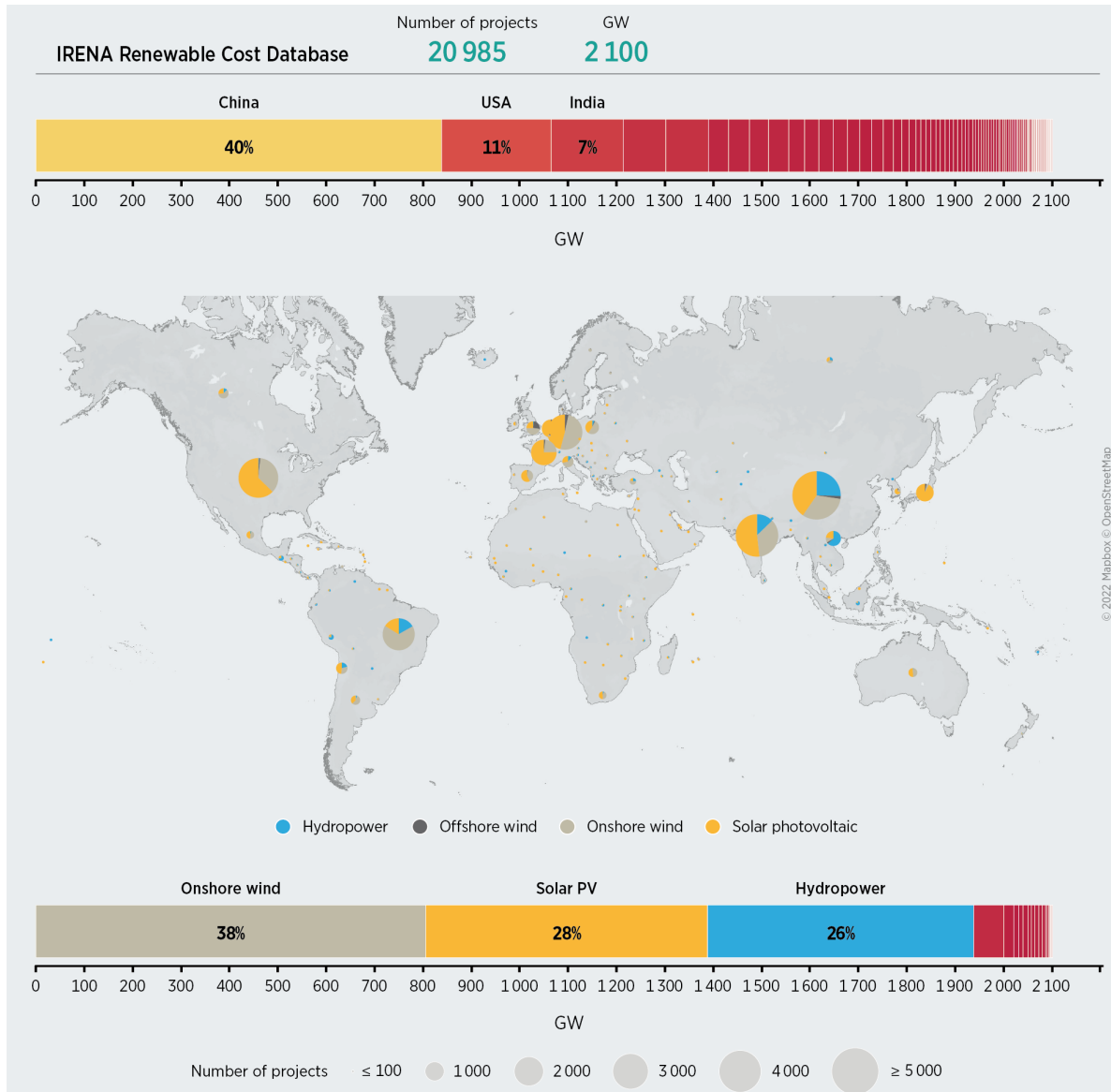
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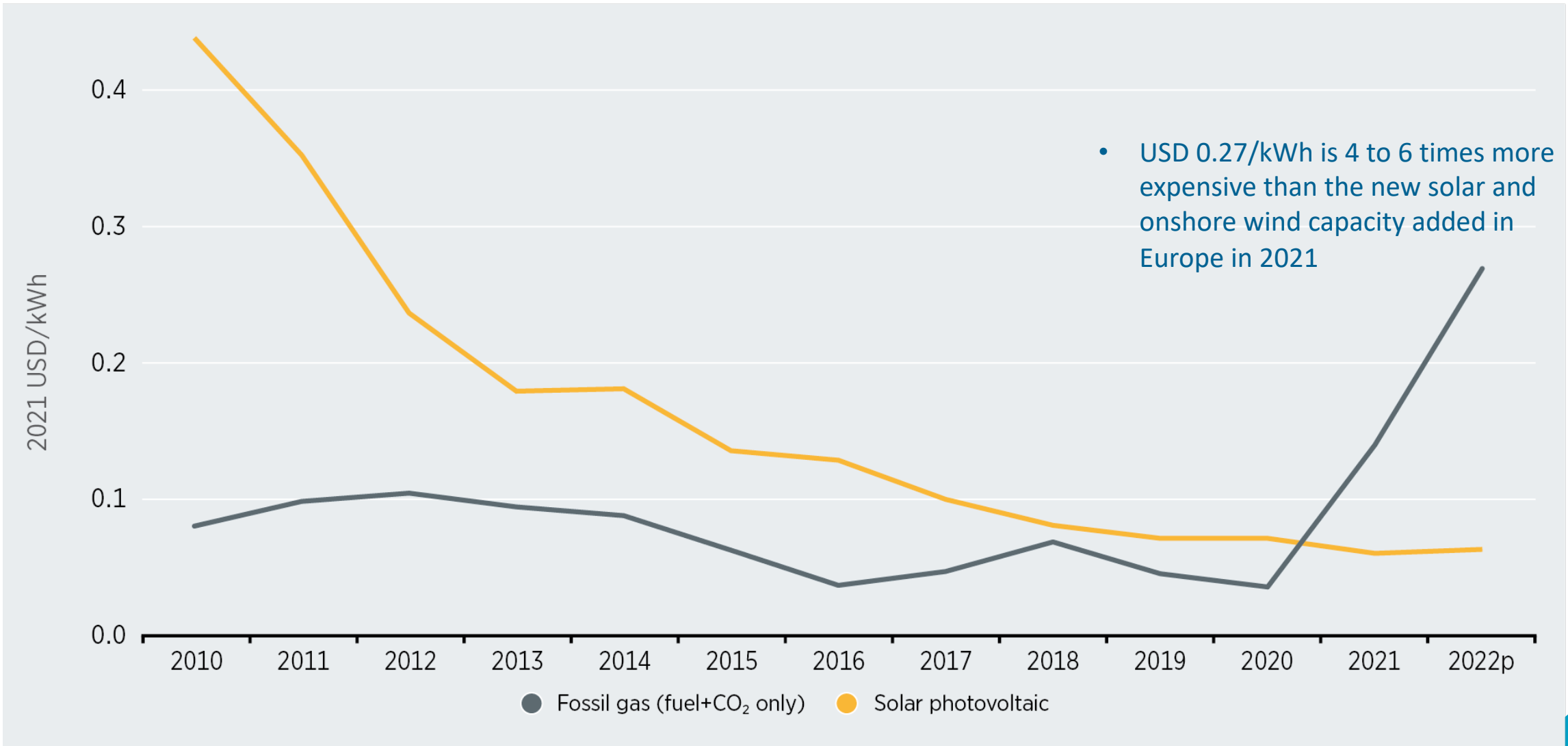
www.irena.org/events/2020/Jun/IRENA-Insights

The Renewable Cost Database

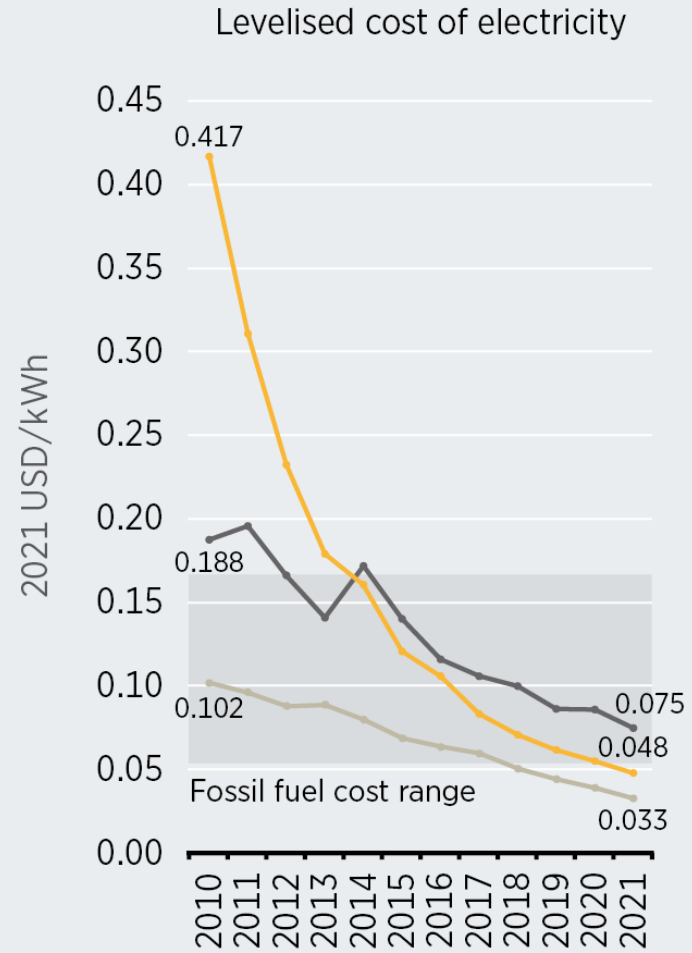
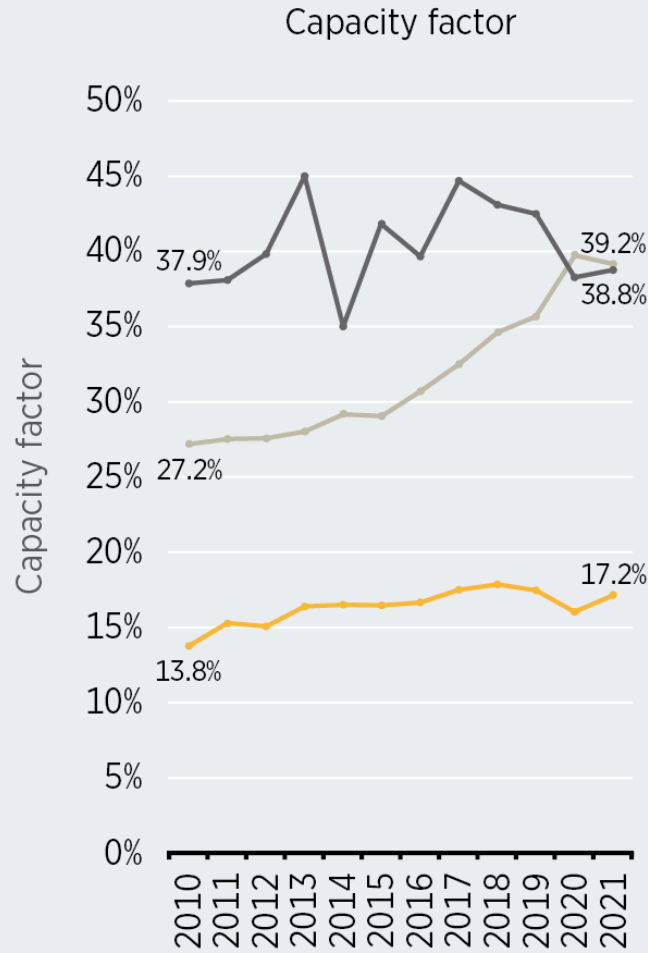


- Largely reflects the deployment of renewable energy technologies over the last ten to fifteen years
- **Project-level cost and performance data for around 2 100 GW of capacity from ~21 000 projects, commissioned up to and including 2021**
- 806 GW of project data available from 1983 onwards for onshore wind
- 582 GW of projects for solar PV

Weighted average LCOE of utility scale solar PV compared to fuel and CO2 cost only for fossil gas in Europe



Newly commissioned utility-scale solar PV, onshore and offshore wind, 2010-2021



● Solar photovoltaic ● Offshore wind ● Onshore wind