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# Power

## Pathways to decarbonization

# Decarbonizing the power sector: Keys to a cleaner future

The power sector decarbonization challenge is a massive endeavor, and efforts are already underway (e.g., India and China). The sector accounts for approximately 40% of total global CO2 emissions, demonstrating its significance in the decarbonization efforts. (IEA, 2022a).

The power sector also plays and will increasingly play a key role in the value chain of many other sectors, such as buildings, transportation and industries such as steel and chemicals. Without successful decarbonization of the power sector, transformation of these sectors would be impossible. This places greater responsibility on the sector to transform itself into a net-zero emissions system in advance of other sectors and reach expected sustainability. Affordability, global access and security of supply must, in addition to sustainability, be a focus of this transformation. Due to the critical nature of the power sector, resilience and system stability are essential in order to sustain the wider economy, especially in the face of rising electrification across industries. In this sense, **global electricity demand is expected to grow steadily at 2% CAGR until 2050, which will double demand** compared to the present. (IEA, 2022a).

Many more challenges may arise during the sector's transition, such as supply chain stretching and reskilling and upskilling workforce, overloaded planning and permitting processes, unincentivized system stability, capped in-sector financing, overcoming social inertia and engaging customers to play an active role. Managing these transitional challenges will be critical in order to navigate the pathway to carbon neutrality and seize the opportunities that arise.

# The evolution of the power sector landscape

In the next 30 years, global electricity demand is expected to increase by about 100% from current levels (IEA, 2022a). In 2020, total electricity consumption was approximately 24 PWh, a figure that could reach 49 PWh by 2050, according to the IEA.

## Sector trends

The electrification of transportation, buildings, industry and other sectors can drive such growth. Electricity will likely constitute the largest portion of total energy consumption for buildings (67%), industry (50%), and transportation (48%) in 2050 (IEA, 2022a). Major drivers include the rise of electric mobility and the electrification of heating and cooling appliances in residential buildings. In addition, the number of low-emission light-duty vehicles will grow from 11 million to 350 million vehicles by 2030 (IEA, 2022a). In buildings, the use of heat pumps is expected to increase by 200% by 2030.

Besides electrification, demographic growth and economic development in developing countries may also place great demands on power. Some of these regions are already going through this large-scale transformation. Electricity consumption in Asia Pacific, for example, has risen by approximately 50% over the last decade (IEA, 2022a), supplied mainly by economic growth.

To accelerate future sector abatement, regulatory and policy frameworks are already in place in key markets. The European Union has taken the lead in green policies and decarbonization efforts with the European Green Deal and Fit-for-55 regulatory package, through which it aims to become the first net-zero region in the world in 2050, with emissions reductions of 55% by 2030. The US has re-entered the Paris Agreement and has legislated the Inflation Reduction Act (IRA), which aims to achieve a 30% emissions reduction by 2030.

The IRA may have a considerable effect on the cost of green energy, lowering it by up to 32% for solar and by up to 53% for wind energy (Credit Suisse, 2022). This could lead to a significant location advantage and could create a pull-effect for global suppliers to relocate their production sites to the US. By comparison, funding in the EU is of similar size but much harder to access and does not follow the same supply-side approach as the IRA. Thus, policymakers globally may be required to streamline their funding processes.

Both the US and the EU are striving to reach net-zero in 2050, while China is going through a regulatory regime change with the 14th Five-Year Plan that has given an unprecedented focus on new technologies and renewable penetration, as well as grid connection to support it. However, China's net-zero target state is yet set at 2060, while its emissions are expected to grow steadily achieving its peak prior to 2030 (Figure 1).

| | Asia Pacific | Europe | Americas |
|---|---|---|---|
| **Emissions targets** | • **China:** reduce $CO_2$ intensity of economy by 18% from 2021 to 2025<br>• **India:** to reduce emissions intensity of its GDP by 45% from 2005 to 2030<br>• **Japan:** to reduce emissions by 46% from 2013 to 2030 | • EU targets for **climate neutrality by** 2050 and **55% emissions reduction** by 2030 compared to 1990<br>• UK targets to reduce emissions in 2030 by at least 68% compared to 1990 levels through, and a 78% reduction by 2035. | • **USA & Canada:** National targets for net zero GHG emissions by 2050<br>• **Central and South America:** Net zero emission targets by 2050 (Chile, Costa Rica, and Colombia) |
| **Power generation** | • **China:** by 2030, Indicative target of 40% electricity consumption from RES and 70 GW nuclear generation by 2025<br>• 60% of total installed capacity from renewables by 2030 in India and 36-38% RES target by 2030 in Japan | • Renewable Energy Directive set the target of 40% **renewable energy sources in the EU's overall energy mix by 2030.** REPowerEU plan increased the target in the directive to **45% by 2030**<br>• **UK's** new commitments to accelerate transition and to reach **95% of electricity by 2030 being low carbon** | • **USA:** 100% carbon pollution-free electricity by 2035. Extension of renewable tax credits for solar, and wind. Nuclear compensated with zero emissions credits in five states<br>• **Canada:** reach nearly 90% renewables generation by 2030 in Canada |
| **Electric vehicle** | • **Japan:** aim for 100% zero emissions passenger vehicles (including hybrids) for by 2035 and for light commercial by 2040<br>• **China:** reward scheme for FCEVs and exemption of vehicle purchase tax for zero emissions vehicles | • The national plans of member states support green mobility and EU **banned** sales of new petrol and diesel cars for 2035 onwards<br>• Light vehicle **emissions need to be reduced to zero by 2026** to comply with taxonomy | • **USA:** Target of 50% of all new passenger cars and light-duty trucks to be zero emissions vehicles by 2030 |

**Figure 1:** Regulatory landscape in some key geographies
**Source:** Monitor Deloitte Analysis

## Key technologies' competitiveness

Solar photovoltaic (PV) and wind technologies are already well positioned for scaling up (Figure 2). Indeed, the power sector is increasingly ramping up capacity in both solar PV and wind energy to substitute fossil fuel generation; renewables will account for most of the new power infrastructure up to 2050 (more than 80%) according to IEA scenarios.

Solar PV is expected to be one of the most competitive power generation technologies in North America and Asia Pacific by 2050. By 2050, solar will constitute almost half of the global power capacity, followed by wind, representing approximately a quarter of the available power capacity (IEA, 2022a).

Further electrification requires an increase in grid assets and a new set of products and services to support energy carrier switching and power-demand management. The acceleration needed to integrate new infrastructure during this decade will be significant (Figure 3).

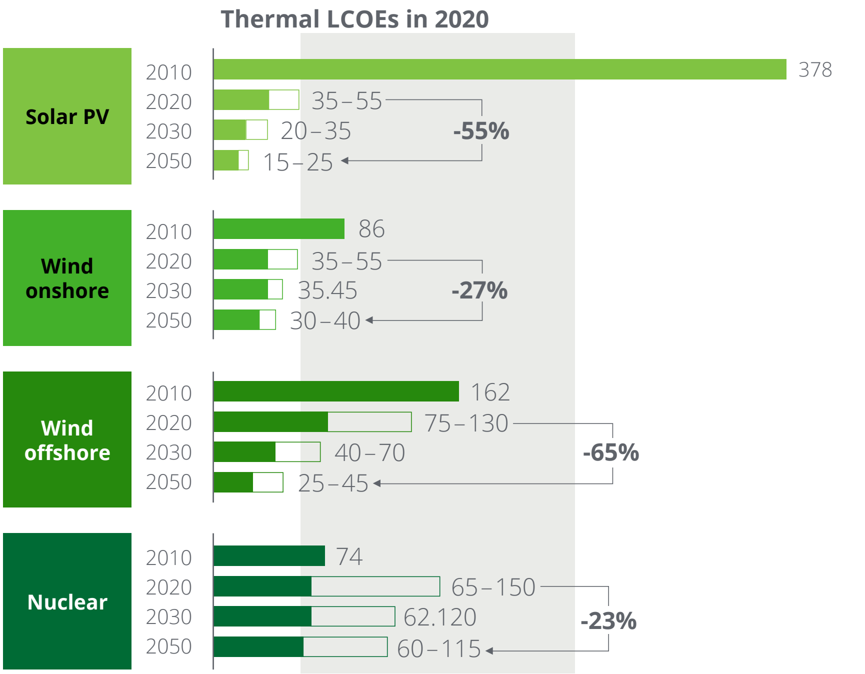


**Figure 2:** Key power generation technologies LCOEs (levelized cost of electricity [€/MWh])

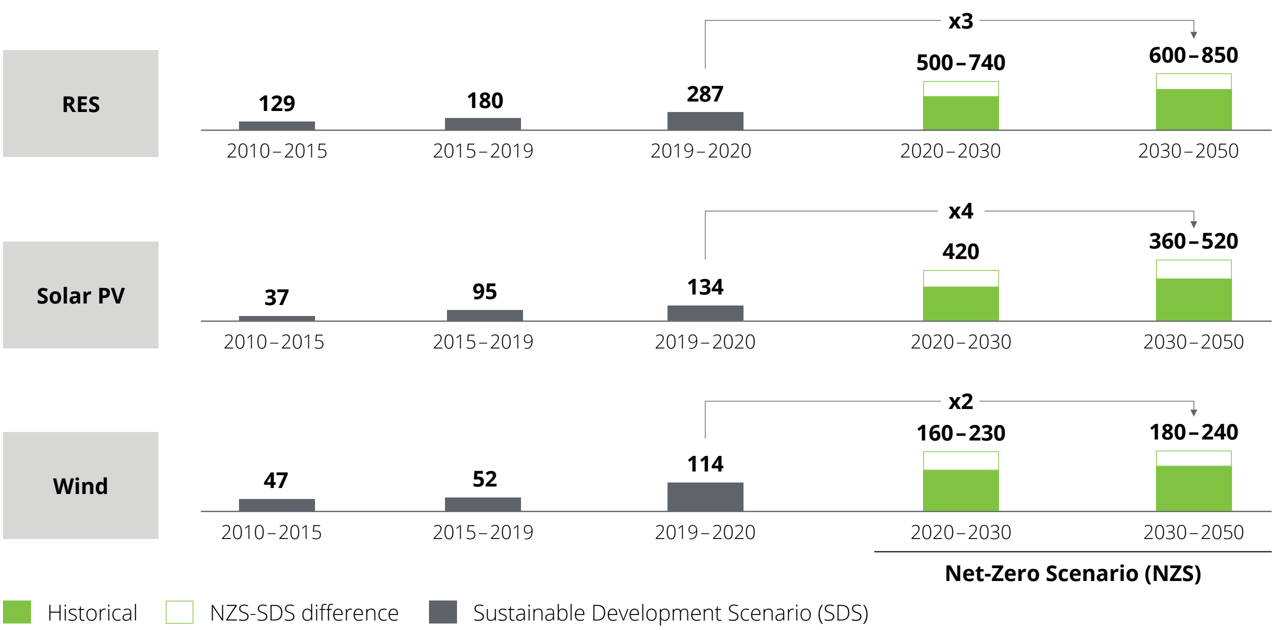


**Figure 3:** Average annual capacity to be installed by technology (GW)
**Source:** IEA, 2022a

# Challenges

The power sector is in transition along operational, market and business dimensions, and this creates multiple challenges. Indeed, the pace of the transition underway is required to avoid climate change acceleration. However, a massive challenge is implied due to this quickness, which amplifies risk and compresses decision-making timeframes. Efforts from all stakeholders along the power value chain will be needed to tackle sector challenges; power utilities and their customers, as well as public entities, material and component suppliers, and financing parties, will all have to take part in this global endeavor.

## Stretched supply chain and workforce

In the short-term, inflation and interest rates rising may place renewable developments at risk, as it puts pressure on the business models (e.g., market context and hypotheses have changed over the last two years). In the long-term, manufacturing capacity and raw materials supply will be key. Today's global paradigm of fossil fuel dependency may transform into a mineral and equipment dependency. To illustrate, in 2040, between four and six times more minerals will be needed than 2020 to install the renewable capacity required for the path to carbon neutrality (IEA, 2022a). This is a challenge that will require local supply chains; geographical diversification; innovation to reduce critical material usage; long-term supply agreements; and the circularity scale-up of key elements (e.g., lithium for batteries).

Those regions with high component manufacturing levels, along with research or grid modernization may require a significant increase in the talent pool and new skills. To satisfy this soaring demand, it will be essential a combination of leveraging current and future workforce. Upskilling and reskilling can help mitigate the scarcity of skills related to green jobs, especially in digital and green-technology areas.

## Overloaded planning and permit process

The permit process is already a bottleneck for renewable energy source (RES) deployment. In Germany, for example, it takes six years to start operating a wind farm (Bloomberg, 2021) and, in China, there are three times more projects waiting for permits than are under construction (EnergyMonitor, 2022). Whereas in the US, the number of projects under permitting processes outnumbers four to one those under construction. Around 80 GW and 150 GW of utility-scale wind and sola PV projects respectively are awaiting permits in the EU (IEA, 2022b). Reducing permit wait times will help enable meeting renewable deployment targets.

## Unincentivized system stability

As mentioned previously, solar PV and wind will be the key technologies in decarbonizing power generation. However, they both carry a non-dispatchable profile that weakens the stability of the system. To ensure this stability, greater flexibility on an hourly, daily and seasonal basis over the coming decades is key. This requires increasingfirmness and balancing/ancillary services capabilities, based on demand management, flexibility services and storage. The latter enables larger two-way flows between supply and demand. Moreover, nuclear and traditional thermal generation would still provide security of supply in many regions for a number of years. This means the powe sector needs a small component of synchronous generation (dispatchable) to remain within the system to reduce the cost of providing grid stability and balancing. Battery storage, bioenergy, Concentrates Solar Power (CSP), geothermal or new thermal generation coupled with Carbon Capture and Storage (CCS), nuclear and hydrogen/ammonia will be the cornerstone of security of supply in the long-term.

## Capped in-sector financing

Annual global investment in clean power and grid infrastructure will need to be about three times larger than historical investment levels over the next decade (IEA, 2022a). Afterwards, the financing needs will be even larger, at least until 2050, according to the IEA. However, today's in-sector cash flow is not enough to finance the transition (Refinitiv, 2022).

Involvement from both public institutions and private entities will be essential to meet the investment levels required to cover technology costs and improve efficiency.

## Overcoming social inertia

Decarbonization already faces several social challenges, including uneven adoption across regions, communities left behind in energy transition, and local objections to new energy infrastructure. In addition, ensuring that affected communities and socio-economically disadvantaged communities are primary beneficiaries of new energy infrastructure will be critical. Involving everyone globally can be key to help overcome opposition to abating emissions.

## Engaging customers to play an active role

Economic development and demographic growth will result in increased power demand. Enabling customers to play an active role in demand management and efficiency improvement may create a more flexible system. Moreover, the rise of distributed generation and the changing nature of supply and demand will create enormous disruption in infrastructure (i.e., grids) and in power markets. But also, new opportunities may arise for new service providers, as well as for customers to reduce energy costs.

# Opportunities

As a response to these challenges, power sector decarbonization and electrification present various business opportunities across four pillars: size, setup, system and security.

- **Power sector growth (size):** Electrification is a key driver for achieving decarbonization targets and will require significant investments across each step of the value chain (renewable generation, grids, and end customer). The significant financing needs and new business will foster new entrants, such as telcos, funds, and oil and gas companies. Risk profiles will change, and massive investments will require stable and predictable returns (while the role of merchant risk may diminish). Utilities may therefore consider asset rotation and partial divestments to finance growth in renewables and grids.
- **Market design (setup):** Future power markets will need to provide energy supply efficiently, balancing services and stability with a combination of technologies. This dynamic shift implies not only sharp increases of Capital Expenditures (CapEx) in Transmission System Operators (TSO) to manage power markets, but also a likely surge in Operating Expenses (OpEx) in areas such as grid planning, research, personnel costs, stakeholder management, IT and cybersecurity, maintenance, congestion management and grid losses.
- **Value chain economics (system):** The power sector is going through a deep system value redistribution, bringing up new winners and relevant players. Renewables' role as the main power source will carry long-term fixed revenues for generators through long-term contracts. Grid operators may see an expansion of their business because their infrastructure should absorb cumulative RES generation, economy electrification and increasing digitalization. Thanks to electrification, retail could experience a significant spread of products and services (e.g., heating, electric mobility, maintenance, insurance) that will generate abundant opportunities. New players will provide new services such as energy aggregators and flexibility.
- **Risks and uncertainty (security):** Transitional risks could arise in several areas: market, regulatory, physical, cybersecurity and geopolitical. Opportunities lie in developing key capabilities to effectively manage and mitigate those risks.

These opportunities and changing business dynamics will trigger business model shifts. New players may appear, and current business models may be reshaped (Figure 4).

It's clear that the decarbonization of the power sector is already attracting the attention of new industrial and financial players. Those players that act quickly while using capital effectively have one of the highest chances of success in this dynamic market environment. Being open to collaboration and demonstrating excellence in networked asset management may also determine success. Future winners will recognize the need to focus and the ability to adapt, investing in change by:

- Creating flexible structures and trimming portfolios;
- Industrializing growth-project execution;
- Adopting all-digital electricity assets;
- Organizing for internal capability rotation (from commodity to differentiated); and
- Transforming ways of working for speed and digital skills.

To continue to thrive, energy players must embark on a journey of multi-faceted transformation.

| | Integrated player | Circular player | Operator | Asset rotator | Product play | Aggregator | Distress |
|---|---|---|---|---|---|---|---|
| | **Captures value** through **synergies** between each step of the **value chain** | Focus on **waste management** and **recycling** & **re-purposing** of decommissioned assets | **Efficient players** focus on **operation and management** of **physical assets:** generation, grid and charging infrastructure | **Low-risk and low-return** business focus on asset rotation and steady **revenues** | **Customer oriented** that provides value to final customers through DERs, EV, charging points, distributed generation, etc. | **Power marketing:** manages and sells the energy and attributes through different markets (physical and financial) | **Focus on assets that are not ready for net-zero but they have a role to provide security of supply:** maximize value/ cash today |
| **Generation** | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ |
| **Grids** | ✓ | ✓ | ✓ | ✓ | | | |
| **Client** | ✓ | ✓ | | ✓ | ✓ | | |

**Figure 4:** Main business models on the road to net-zero emissions

# References

Bloomberg (2021), “The Renewable Energy Asset Rotation Cycle Is Stuck”

Credit Suisse (2022), “US Inflation Reduction Act – A Tipping Point in Climate Action”, p. 23

International Energy Agency – IEA (2022a), “World Energy Outlook 2022”

International Energy Agency – IEA (2022b), “How to Avoid Gas Shortages in the European Union in 2023”, p. 20

Energy Monitor (2022), “Data insight: The permitting problem for EU wind farms”

Refinitiv (2022), https://www.refinitiv.com/en, Financials of companies from the power sector

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