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Power
Pathways to decarbonization

Decarbonizing the power sector: Keys to a cleaner future

The power sector accounts for approximately 40% of total global CO_2 emissions[1]—playing a key role in the value chain of many sectors, including buildings, transportation, steel, or chemicals. Given its substantial carbon footprint, decarbonizing the sector will be a critical step in achieving the world's Paris Climate Agreement targets.

That said, the path to net-zero will inevitably be a complex and challenging one, although already underway. Power is not only essential for modern day societies, but demand for it is on the rise. In fact, the International Energy Agency (IEA) expects global electricity demand to grow steadily at 2% CAGR until doubling current-day levels in 2050.[2]

Understanding this, any transition will have to prioritize resiliency and system stability—by focusing on things like affordability, global access, and security of supply, as well as sustainability. It must also take steps to proactively manage transitional challenges like supply chain stretching, workforce reskilling and upskilling, local planning and permitting bottlenecks, unincentivized system stability, capped in-sector financing, social inertia, and disengaged customers.

Here, we'll explore the sector's pathway to decarbonization by examining the current state of the power sector, potential transitional challenges, and new opportunities.

The evolution of the power sector landscape

The push for electrification

The electrification of transportation, buildings, industry, and other sectors will be a key pillar in economy's path to net-zero—with electricity expected to constitute the largest portion of total energy consumption for buildings (67%), industry (50%), and transportation (48%) in 2050.[3]

Major drivers include the rise of electric mobility and the electrification of heating and cooling appliances in residential buildings. The number of low-emission light-duty vehicles will grow from 11 million to 350 million vehicles by 2030.[4] In buildings, the use of electric heat pumps is expected to increase by 200% by 2030.

Demographic growth and economic development in developing countries will also create greater demand for electricity. 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,[5] spurred mainly by economic growth.

Evolving regulations

To accelerate future power 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 United States, meanwhile, 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.[6] This could lead to a significant location advantage and could create a pull-effect for suppliers, talent and capital to move 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 is currently set at 2060, while its emissions are expected to grow steadily, achieving its peak prior to 2030 (Figure 1).

Figure 1:
Regulatory landscape in some key geographies

	Asia Pacific	Europe	Americas
Emissions targets	• **China**: reduce CO_2 intensity of economy by 18% from 2021 to 2025 • **India**: reduce emissions intensity of its GDP by 45% from 2005 to 2030 • **Japan**: reduce emissions by 46% from 2013 to 2030	• EU targets for **climate neutrality** by 2050 and **55% emissions reduction** by 2030 compared to 1990 • UK targets to reduce emissions in 2030 by at least 68% compared to 1990 levels and a 78% reduction by 2035.	• **US and Canada**: National targets for net-zero GHG emissions by 2050 • **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 renewable energy sources (RES) and 70 GW nuclear generation by 2025 • **India**: 60% of total installed capacity from renewables by 2030 • **Japan**: 36-38% RES target by 2030	• 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** • UK's new commitments to accelerate transition and to reach **95% of electricity by 2030 being low carbon**	• **US**: 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 • **Canada**: reach nearly 90% renewables generation by 2030 in Canada
Electric vehicle	• **Japan**: aim for 100% zero emissions passenger vehicles (including hybrids) by 2035 and for light commercial by 2040 • **China**: reward scheme for fuel cell electric vehicles (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 • Light vehicle **emissions need to be reduced to zero by 2026** to comply with taxonomy	• **US**: Target of 50% of all new passenger cars and light-duty trucks to be zero-emissions vehicles by 2030

Source: Monitor Deloitte Analysis

Technological competitiveness

The power sector is increasingly ramping up capacity in both solar photovoltaic (PV) and wind energy to substitute fossil fuel generation (Figure 2). IEA anticipates renewables will account for more than 80% of new power infrastructure leading up to 2050.

Solar PV is expected to be one of the most competitive power generation technologies in North America and Asia Pacific by 2050, constituting almost half of global power capacity.[7] This, in turn, will be followed by wind, which will represent approximately a quarter of available power capacity.[8]

Reaching this point will require 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])

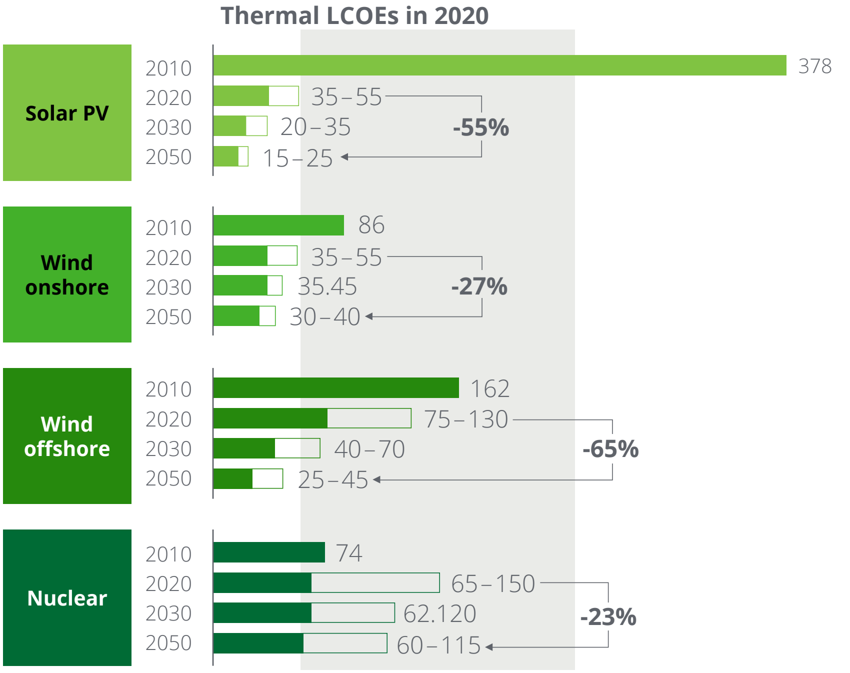
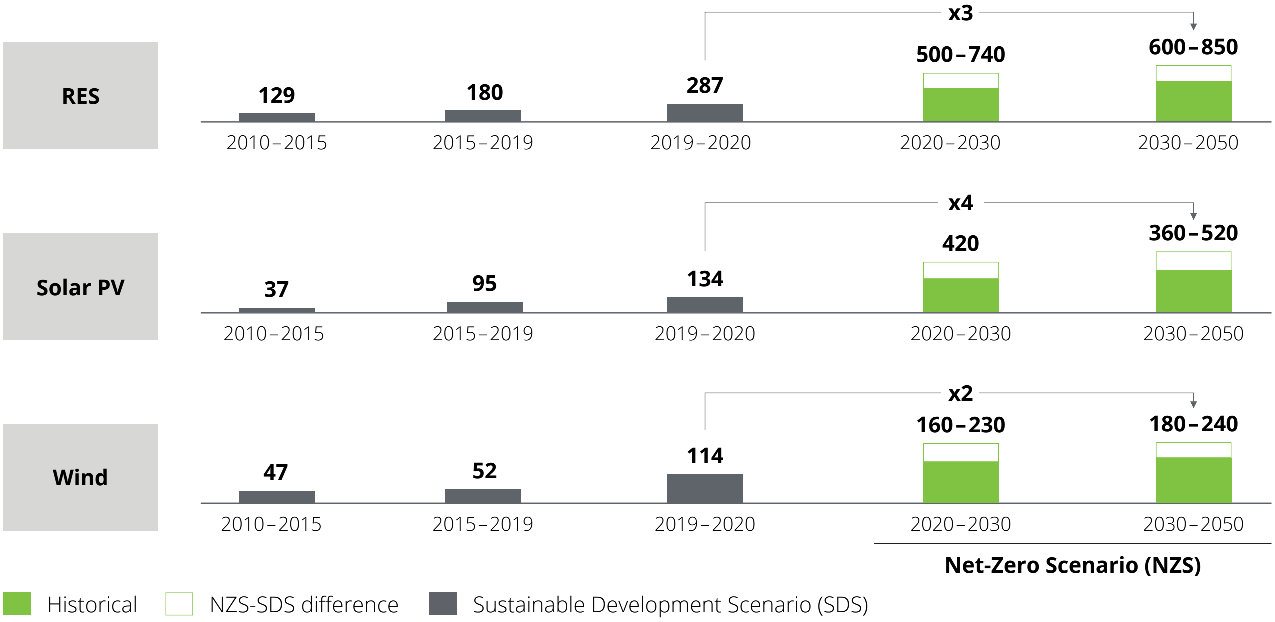


Figure 3:
Average annual capacity to be installed by technology (GW)



Source: IEA, 2022a

Challenges

The power sector is in transition along operational, market, and business dimensions, and this creates multiple challenges.

To hit Paris targets, and avoid a worst-case climate scenario, the transition must be rapid—which compresses decision-making timeframes and amplifies risk. Additionally, a successful effort must involve the collaboration of stakeholders along the entire power value chain—including power utilities and their customers, public entities, material and component suppliers, and financing parties.

To hit Paris targets, and avoid a worst-case climate scenario, the transition must be rapid

Given the pace and breadth of this type of change, the sector will inevitably encounter a range of hurdles, including:

Stretched supply chains and workforces

In the short-term, high inflation and rising interest rates may place renewable developments at risk, as they put pressure on financial models. To achieve long-term success, manufacturing capacity and access to raw materials will be key—as there's a chance today's global paradigm of fossil fuel dependency may transform into a mineral and equipment dependency.

To illustrate this point, the IEA anticipates that in 2040 the power sector will require between four and six times more minerals to create the renewable capacity necessary to achieve carbon neutrality.[9] This is a challenge that will require growth in 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.[10] To satisfy this soaring demand, it will be essential to identify opportunities to leverage both current and future workforces. Upskilling and reskilling can help mitigate the scarcity of skills related to green jobs, especially in new energy technology areas (e.g., renewables, storage, and electric vehicles (EVs) and digital transformation (e.g., robotization, artificial intelligence (AI), internet of things (IoT), and 5G). This includes data science, analytics, modelling, and data-driven management.

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[11] and, in China, there are three times more projects waiting for permits than are under construction.[12]

In the US, the number of projects in the permitting process outnumbers those under construction four to one. Around 80 GW of utility-scale wind projects and 150 GW of solar PV projects are awaiting permits in the EU.[13] Reducing permit wait times will help the sector meet its 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 stability over the coming decades, therefore, this type of renewable power infrastructure must allow for greater flexibility on an hourly, daily, and seasonal basis. This requires increasing firmness and balancing/ancillary services capabilities through measures like demand management, flexibility services, and storage. The latter enables larger two-way flows between supply and demand.

In terms of security of supply, the power sector should also preserve a small component of synchronous generation (dispatchable) to reduce the cost of providing grid stability and balancing. Battery storage, bioenergy, Concentrated Solar Power (CSP), geothermal or new thermal generation coupled with Carbon Capture and Storage (CCS), nuclear, and hydrogen/ammonia could ensure security of supply over 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.[14] 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.[15]

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, risk of 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 beneficiaries of new energy infrastructure will be critical. Developing new infrastructures requires engaging and involving—as early as possible—local communities, landowners, public administration, and businesses to socialize new projects, explain the benefits, and to address their needs and concerns. This will help overcome potential 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 (e.g., grids) and in power markets. But also, new opportunities may arise for new service providers, as well as for customers to reduce energy costs.

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

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 businesses 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, and insurance) that could 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).

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

	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** and **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 distributed energy sources (DERs), EVs, 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	✓	✓		✓	✓		

Moving forward

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.

Authors and contacts

This paper is part of a collection of insights on possible pathways to decarbonization for high-impact sectors. Each sector perspective offers a foundational starting point for leaders who would like to better understand the landscape across these critical sectors. For additional sector papers and links to in-depth reports, please visit Pathways to decarbonization on Deloitte.com.

At Deloitte, we support power and utilities players on their path to net-zero by helping them develop, finance, and implement the sustainable solutions required to achieve a multi-faceted transformation. With in-depth knowledge of the evolving regulatory environment, extensive power and sustainability expertise, and a vast client ecosystem, we provide an invaluable hub for the development of enhanced business capabilities, transformation know-how, and behavioral change management.

To learn more about how we can support your organization, contact us.

Thomas Schlaak
Global Power, Utilities & Renewables Leader
Partner, Deloitte Germany
tschlaak@deloitte.de

Laureano Alvarez
Energy & Natural Resources
Partner, Monitor Deloitte Spain
jlalvarez@deloitte.es

Ignacio Povo
Energy & Natural Resources
Senior Manager, Deloitte Spain
ipovo@deloitte.es

Endnotes

1 International Energy Agency (IEA), World Energy Outlook 2022, October 2022
2 International Energy Agency (IEA), World Energy Outlook 2022, October 2022
3 International Energy Agency (IEA), World Energy Outlook 2022, October 2022
4 International Energy Agency (IEA), World Energy Outlook 2022, October 2022
5 International Energy Agency (IEA), World Energy Outlook 2022, October 2022
6 Credit Suisse, US Inflation Reduction Act: A Tipping Point in Climate Action, pp 23, November 2022
7 International Energy Agency (IEA), World Energy Outlook 2022, October 2022
8 International Energy Agency (IEA), World Energy Outlook 2022, October 2022
9 International Energy Agency (IEA), World Energy Outlook 2022, October 2022
10 Deloitte, Work toward net-zero, November 2022
11 Nathaniel Bullard, "The Renewable Energy Asset Rotation Cycle Is Stuck", Bloomberg, April 29, 2021
12 Nick Ferris, "Data Insight: The Permitting Problem for EU Wind Farms," Energy Monitor, April 5, 2022
13 International Energy Agency (IEA), How to Avoid Gas Shortages in the European Union in 2023, pp 20, December 12, 2022
14 International Energy Agency (IEA), World Energy Outlook 2022, October 2022
15 Refinitiv, "2022 Financials of companies from the power sector" data query, January 2023