



# **Electricity Grids and Secure Energy Transitions:**

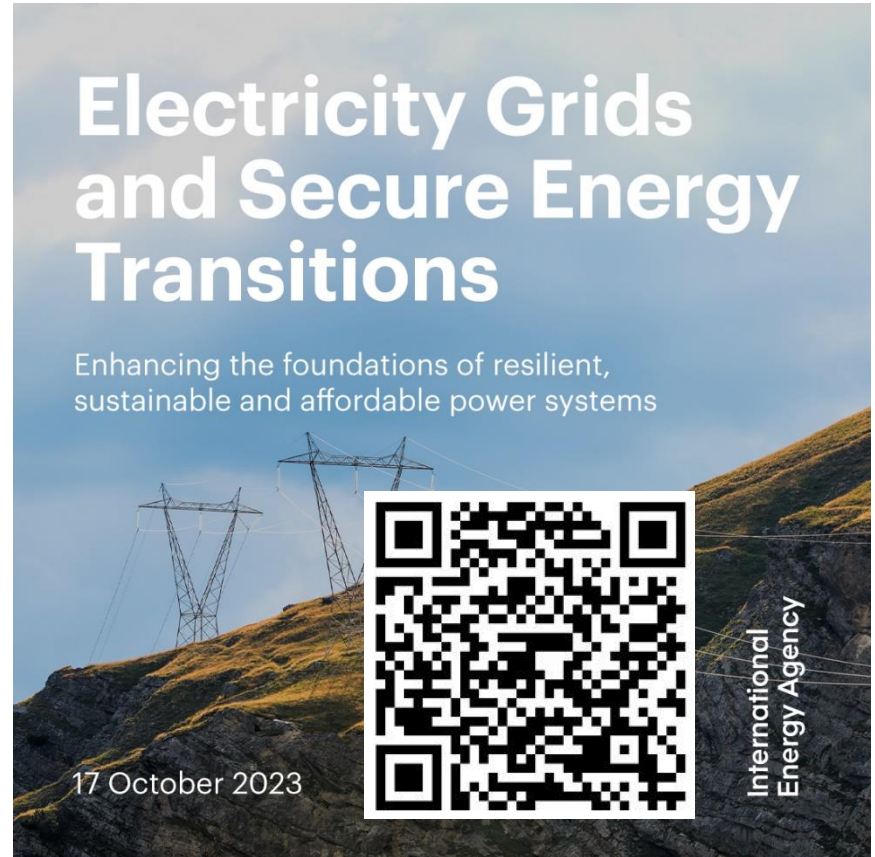
Enhancing the foundations of resilient, sustainable and affordable power systems

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REI Symposium on Renewables and Decarbonization of the Electricity Grid

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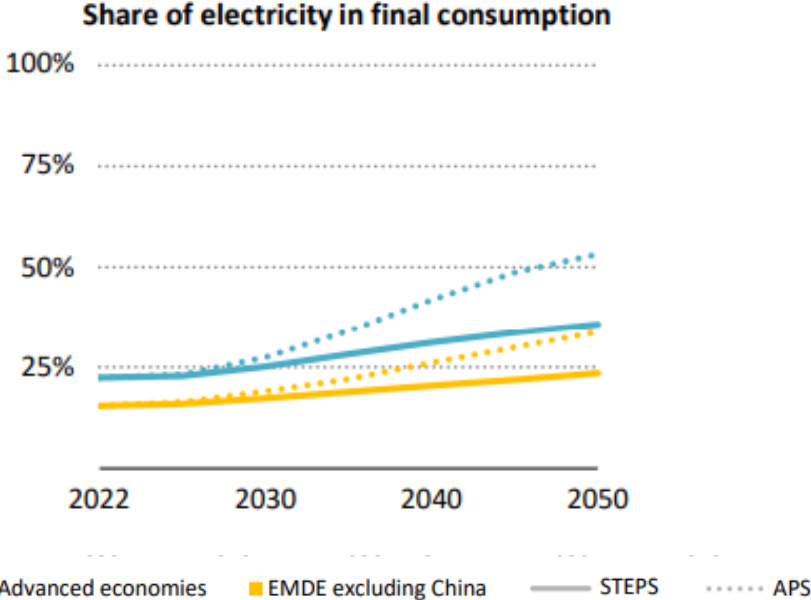
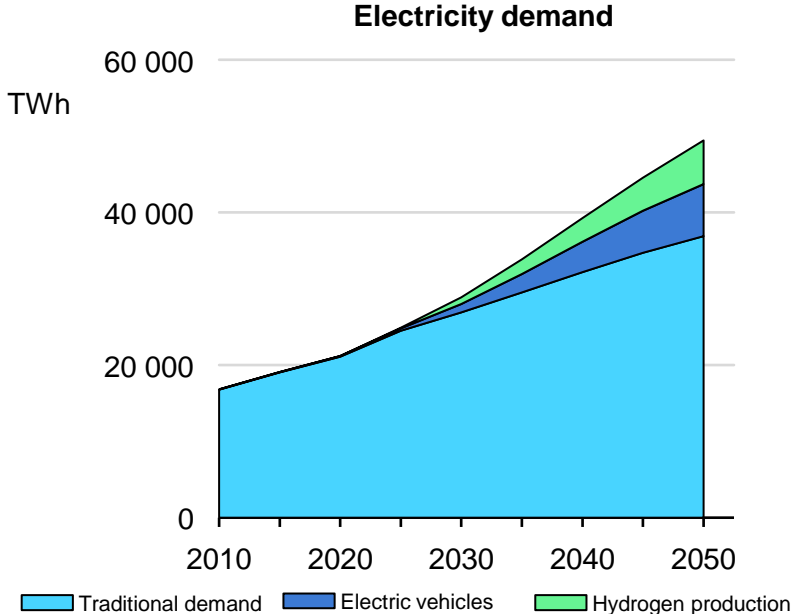
- Importance of electricity grids is growing as demand for clean electricity grows
- First-of-its-kind global stocktake of the world's grids as they stand now
- Assesses risk of them becoming a bottleneck to clean energy transitions and electricity security
- Examines the urgent upgrades required not only to physical infrastructure but also to the way grids are planned and managed – quantifying the costs of delayed action
- Provides key recommendations for policy makers, highlighting what is necessary in areas such as investment, regulation and planning



# Electricity takes centre stage – grids need to ensure security



Share of renewables in power generation and electricity in final energy consumption by region and scenario, 2022-2050

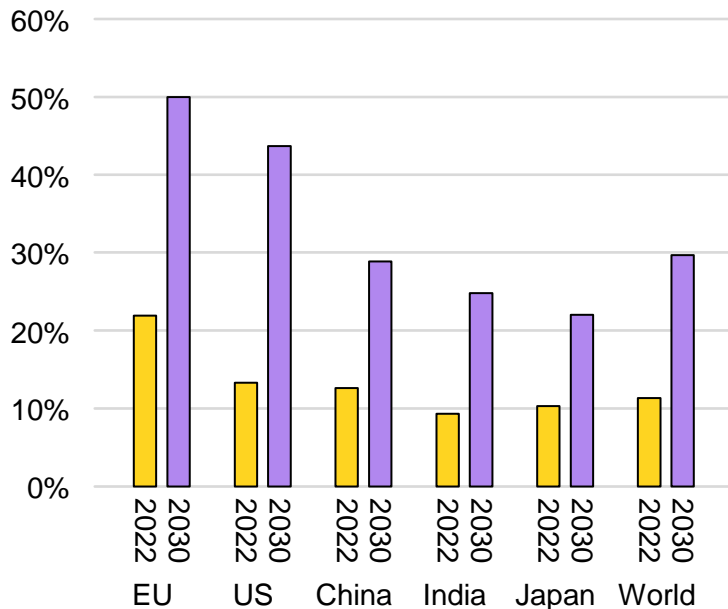


Source: [World Energy Outlook 2023](#) (IEA)

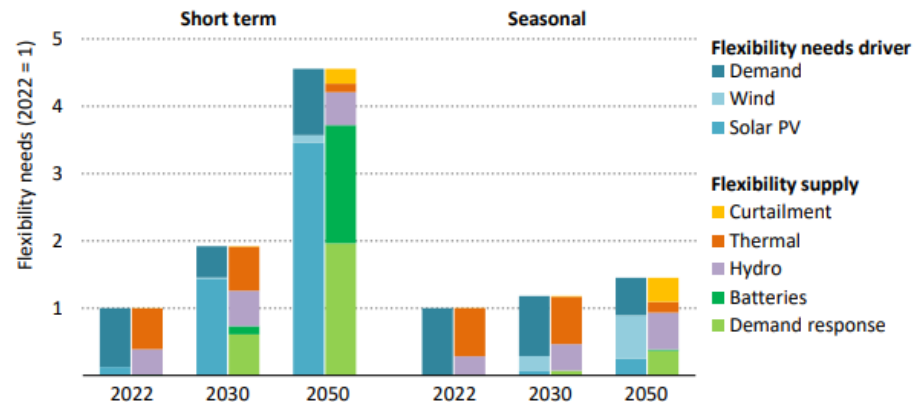
**Demand is set to grow fast, with new demand types growing.  
Share of electricity in total final energy consumption exceeds 50% in advanced economies by 2050.**

# Supply side is changing – needs grid capacity and flexibility

### Wind and solar PV share of electricity supply



### Global power system flexibility needs and supply in the APS



IEA. CC BY 4.0.

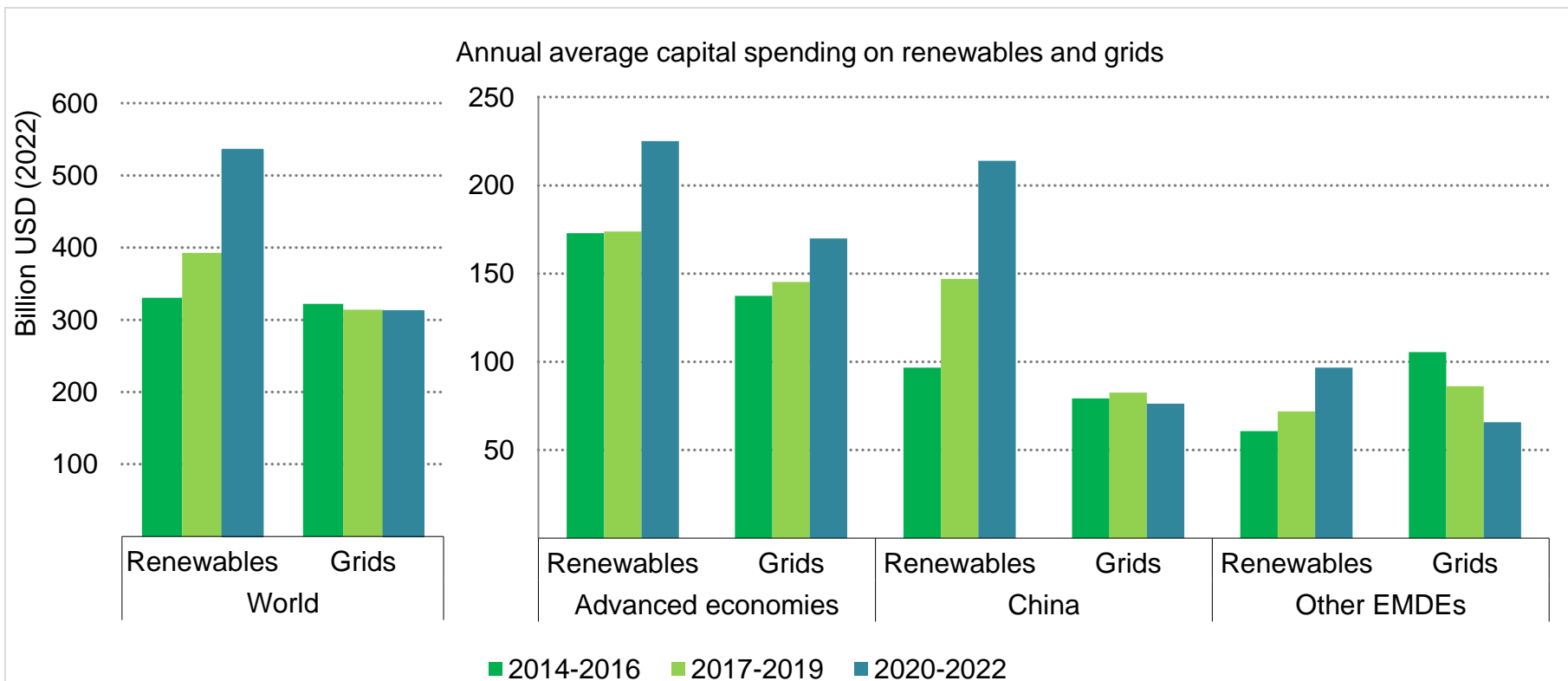
*Short-term needs increase significantly, mainly due to solar PV, with batteries and demand response emerging as crucial suppliers of flexibility; seasonal needs rise less sharply*

Notes: Flexibility needs are computed for 2030 and 2050 taking into account changes in electricity supply and demand and weather variability over 30 historical years. Demand response includes the flexible operation of electrolyzers.

Source: [World Energy Outlook 2023](#) (IEA)

**Wind and solar PV are re-shaping electricity supply. It is set to be 80% of new capacity additions, and drive the future need of power system flexibility. Flexibility providers shift from thermal to demand response and batteries.**

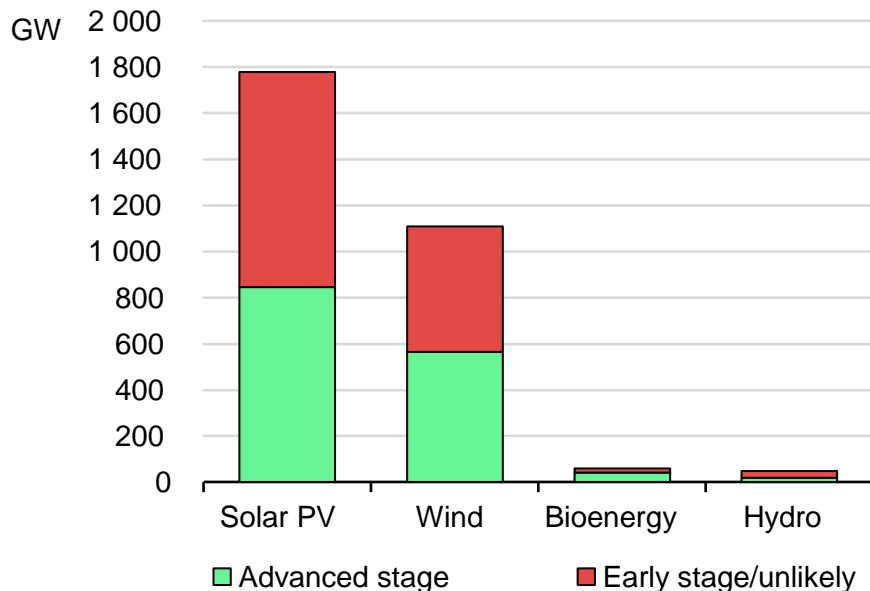
# While investment in renewables has grown, grids have not kept pace



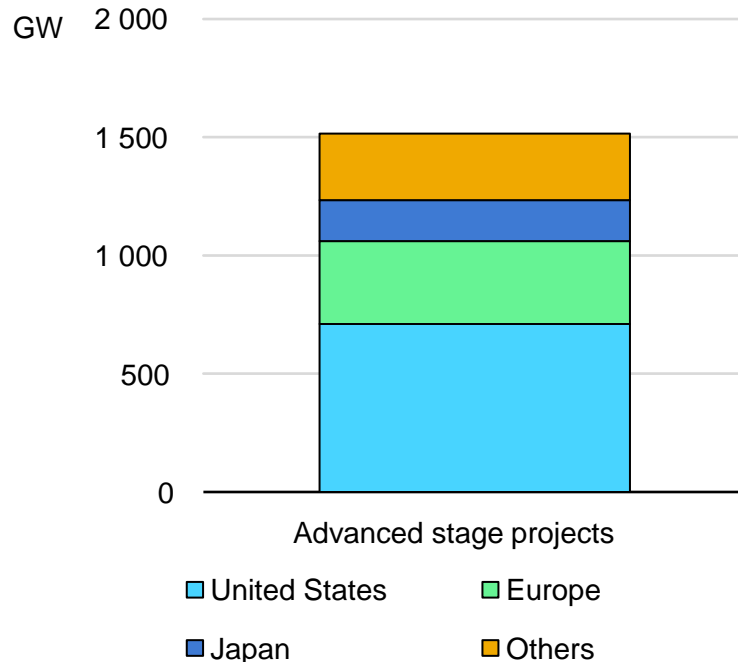
**Public announcements by government and industry in terms of expected investment in the coming decades do not clearly indicate strong commitments in comparison with renewables and end use electrification.**

# We start to see symptoms of slow adaptation

### Capacity of renewable energy projects in connection queues



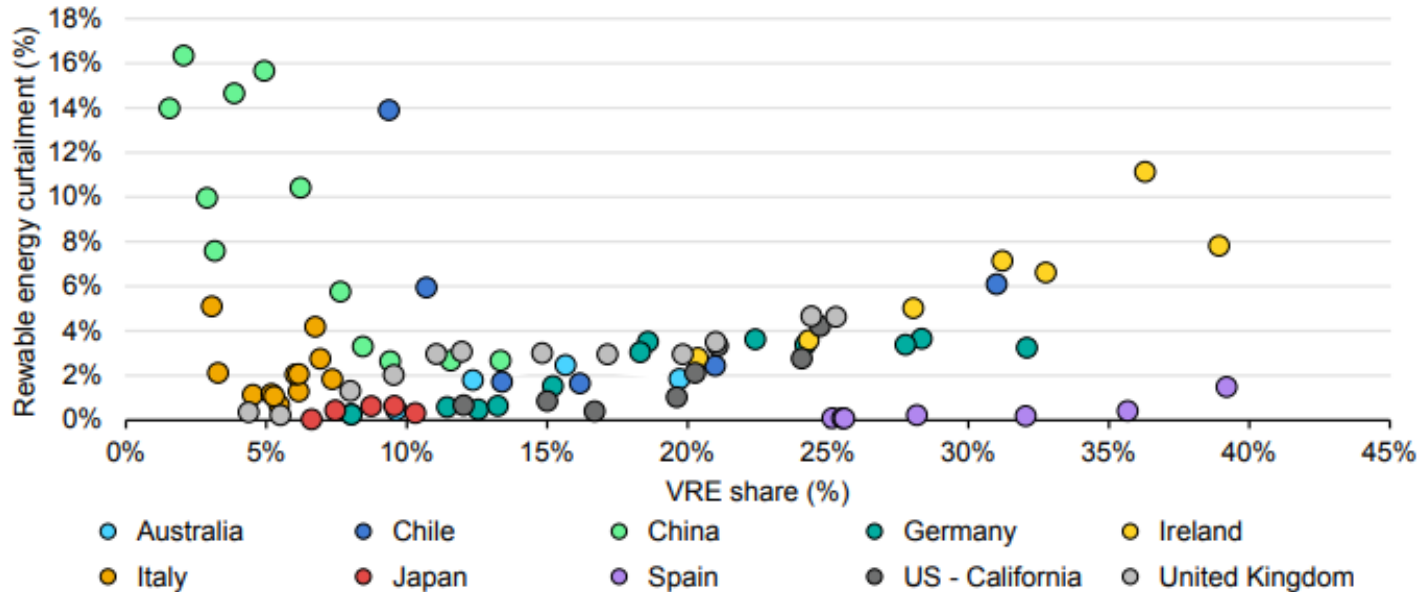
### Capacity of advanced stage projects in queues



**We estimate at least 1500 GW are wind and solar projects around the world are in an advanced stage of development. While investment in renewables has almost doubled in the last decade, investment in grids has remained stagnant.**

# Adequate grids are key for limiting operational costs and curtailment

Variable renewable energy(VRE) shares in generation and technical curtailment for selected countries

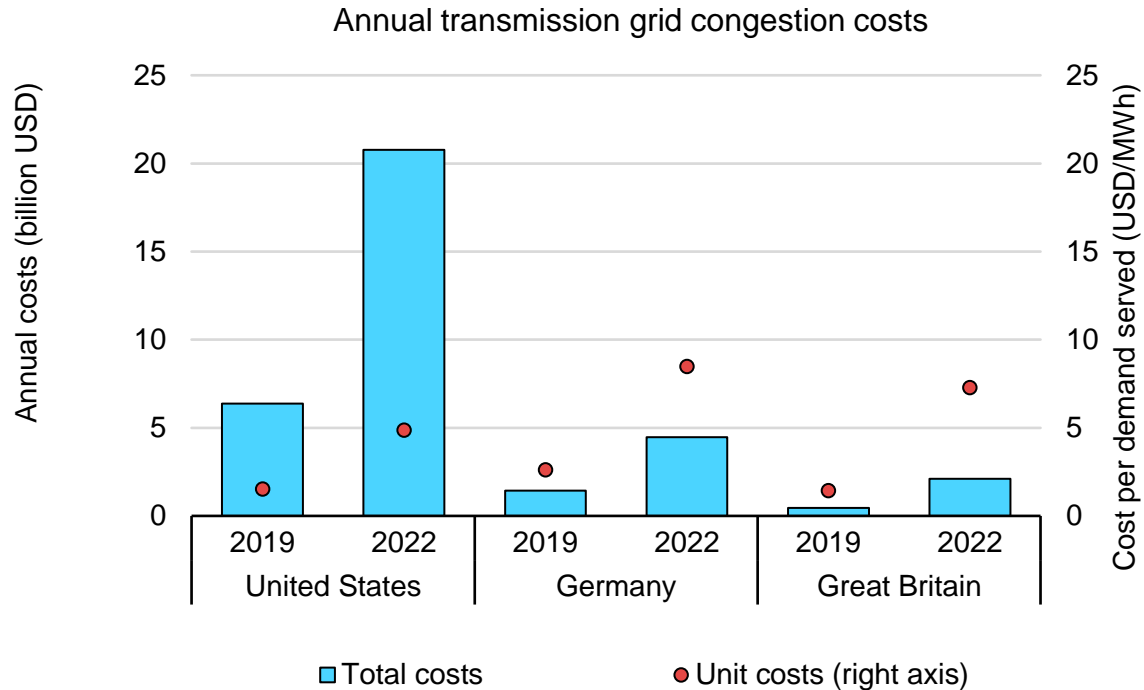


Source: [Renewable Energy Market Update - June 2023](#) (IEA)

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**This trend is particularly evident in areas where major grid infrastructure investments and/or advanced market design and regulation are not keeping pace with VRE deployment.**

# Adequate grids are key for limiting operational costs and curtailment

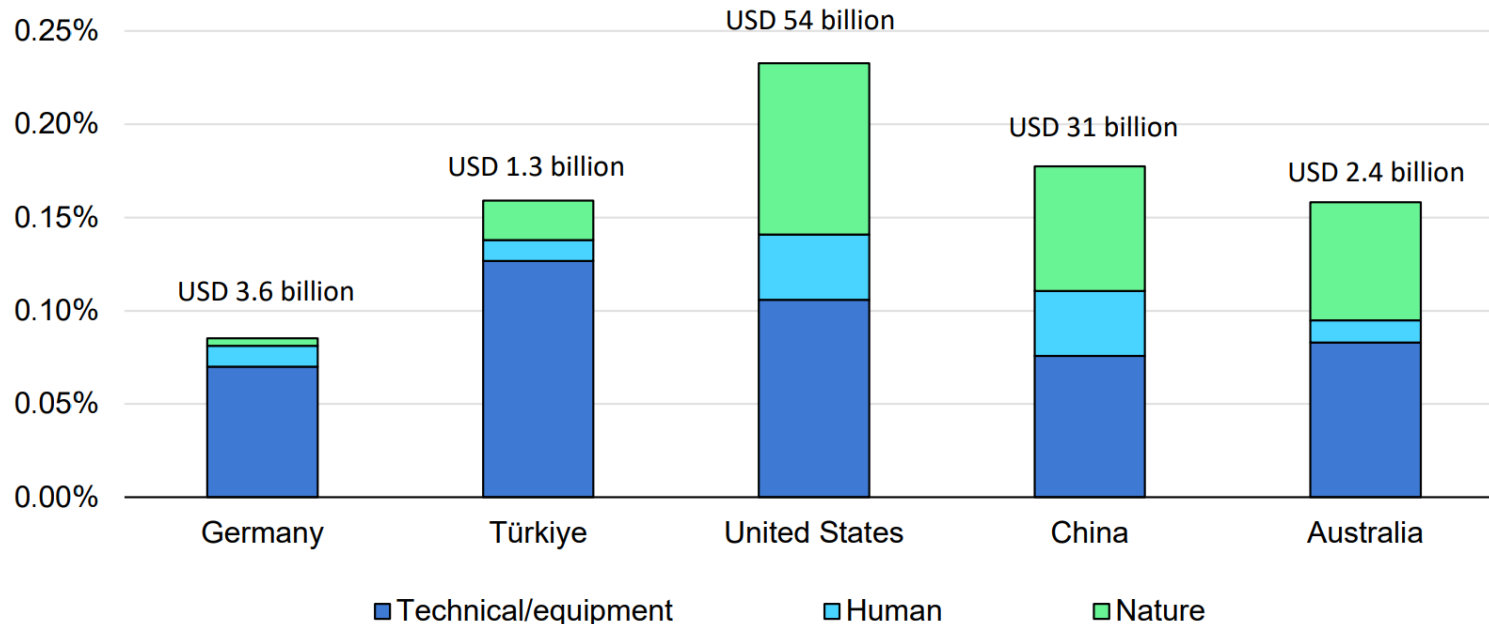


**Grid congestion is costing billions via redispatch and curtailment in various countries today. Higher renewable penetration does not directly cause much more curtailment...if there is adequate grid development.**



# Grids are essential for electricity security

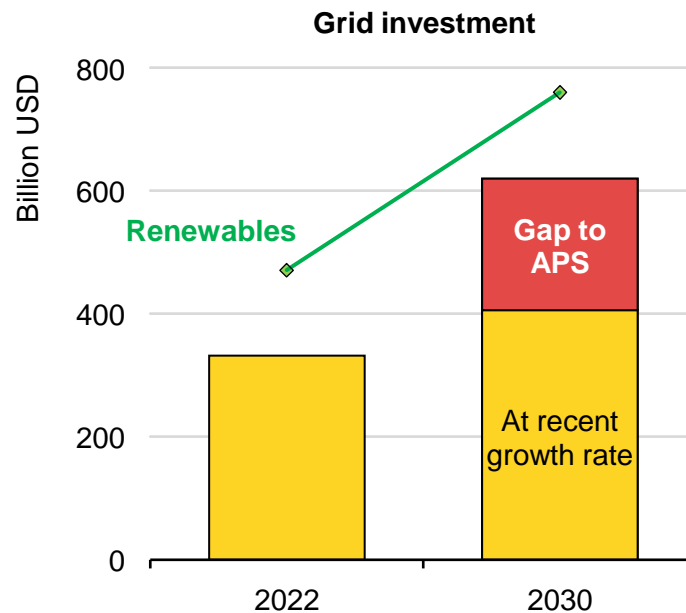
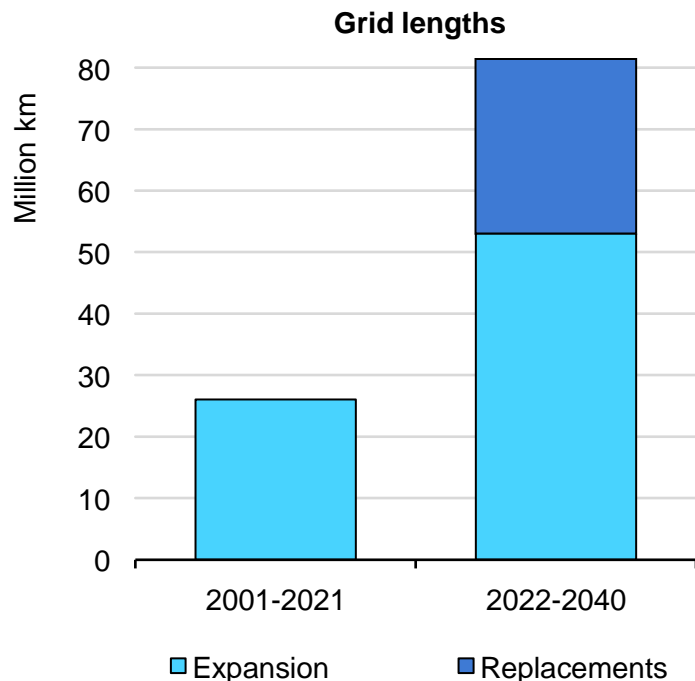
Estimated economic impact of grid-related outages by cause as a share of GDP in selected countries, 2021



**Grid-related technical/equipment failures alone caused outages that amounted to a global economic loss of at least USD 100 billion in 2021, or 0.1% of global GDP.**

# Grid development needs to accelerate to keep up with transitions

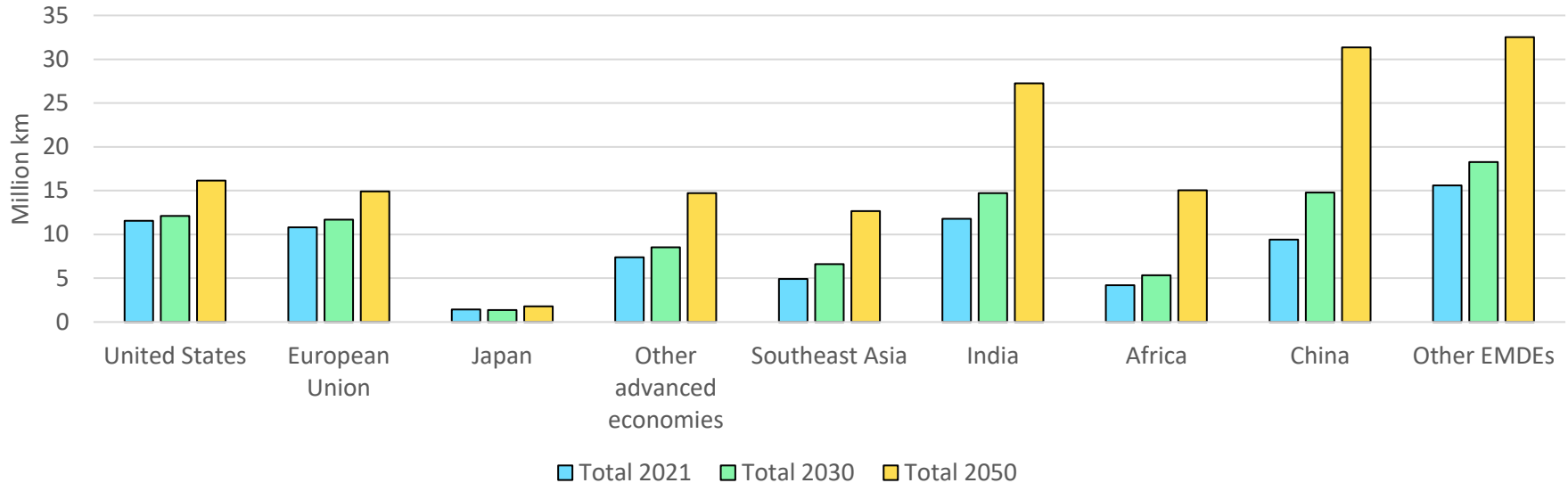
Grid development in the Announced Pledges Scenario



**Over the next two decades, 80 million km need to be added or replaced, as much as the global grid length today, calling for grid investment to double by 2030, in step with renewables, raising material needs.**

# Global competition to enhance grids in pace with announced targets

Installed line length, transmission and distribution, by region in the Announced Pledge Scenario (million km)



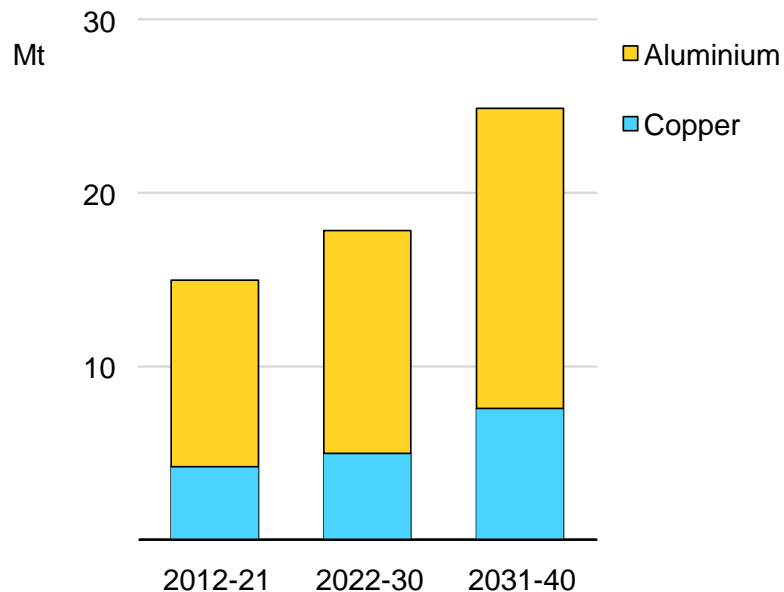
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Sources: IEA analysis based on [Global Transmission](#).

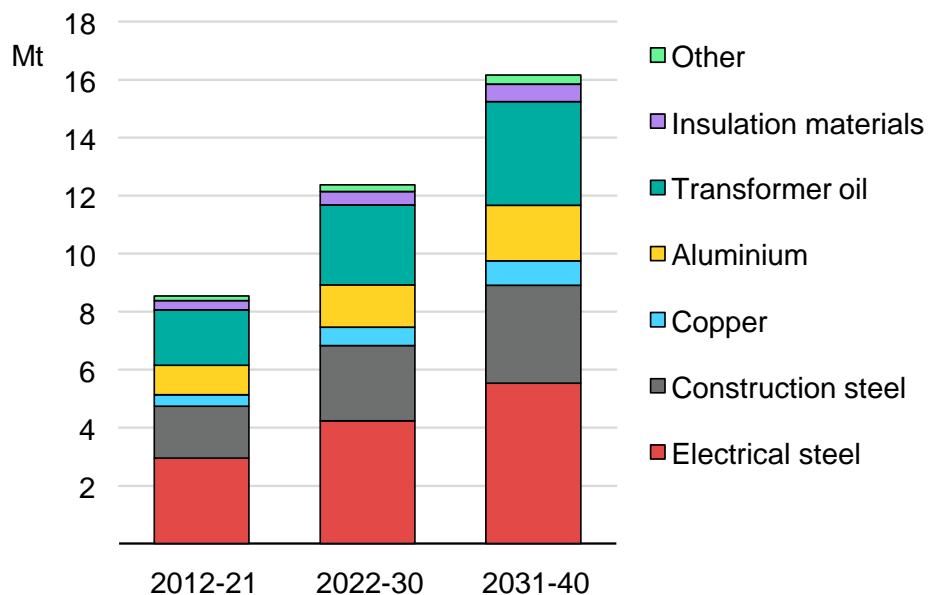
**By 2050, Japan grows almost 30% from today's level of grid lengths. This happens in parallel with stronger growth rates in India and China.**

Average annual material needs for selected grid technologies in the APS

### Transmission and distribution lines



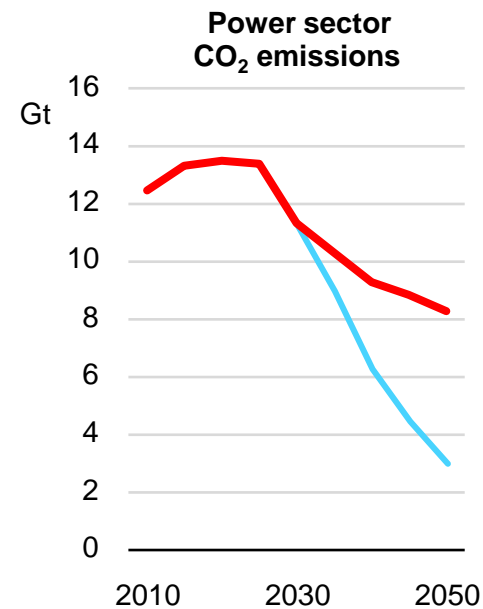
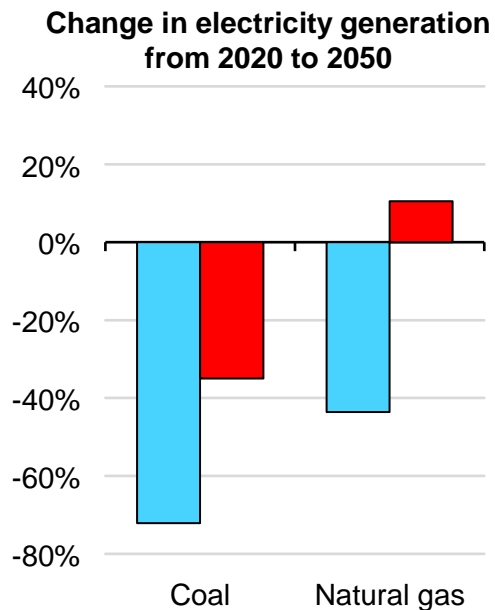
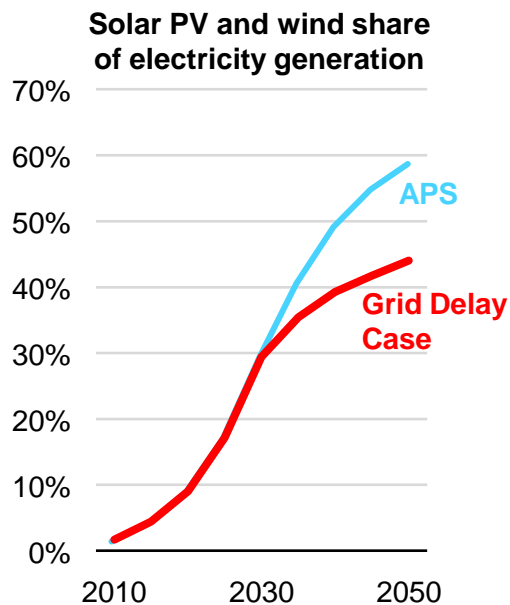
### Transformers



**The demand for materials to make equipment for electricity grids, especially copper and aluminium, soars over the next two decades, calling for resilient supply chains.**

# Clean energy transitions depend on robust electricity grids

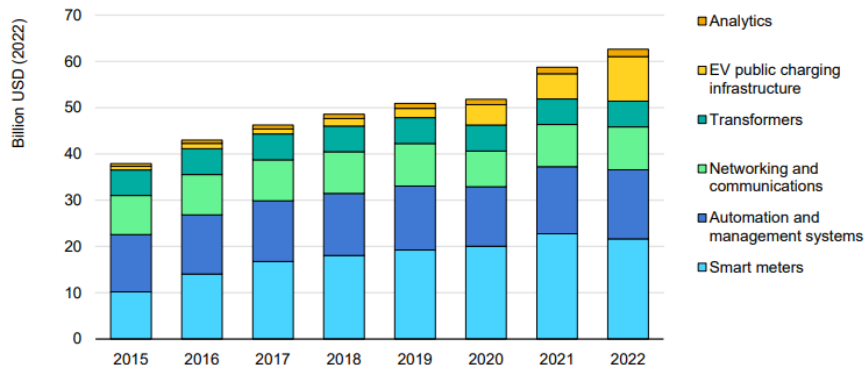
Impacts of failing to accelerate grid investment and modernisation



**Failing to step up the pace of grid investment and modernisation would stifle the growth of renewables, and lead to greater use of coal and natural gas, raising fossil fuel import bills by USD 500 billion and CO<sub>2</sub> emissions**

# It's not just about more lines but using assets in a smart way

Investment in digital technologies, 2015-2022

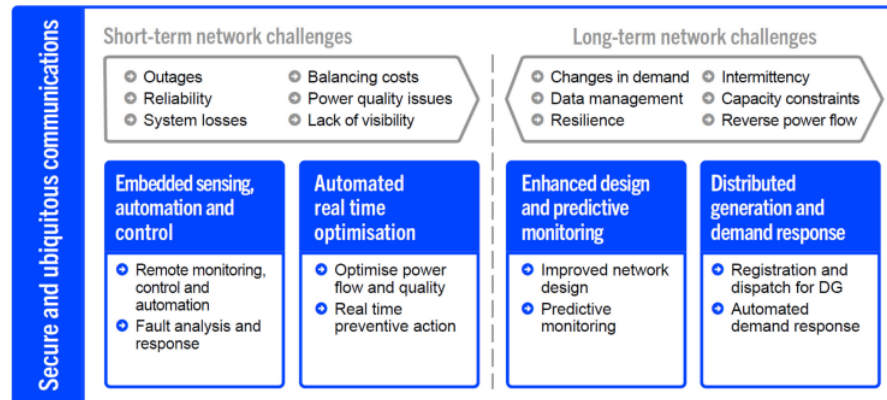


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Note: Digital includes transmission and distribution automation, networking and communications, analytics (asset performance management, power quality and grid operations), smart meters, advanced distribution management systems, energy management systems, transmission line sensors, vegetation management, dynamic line rating and digitalisation of power transformers and substations.

Sources: IEA analysis based on data from [Guidehouse](#).

Digital solutions to tackle short- and long-term grid challenges



IEA. CC BY 4.0.

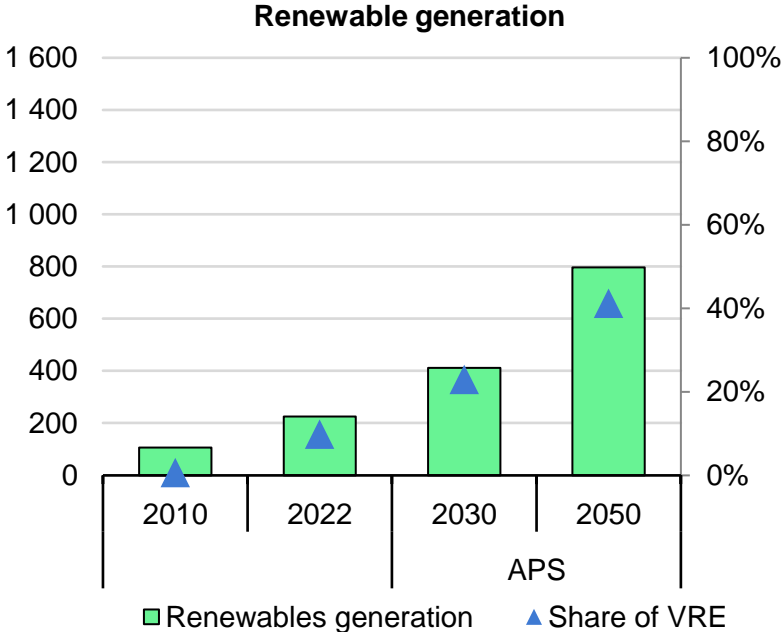
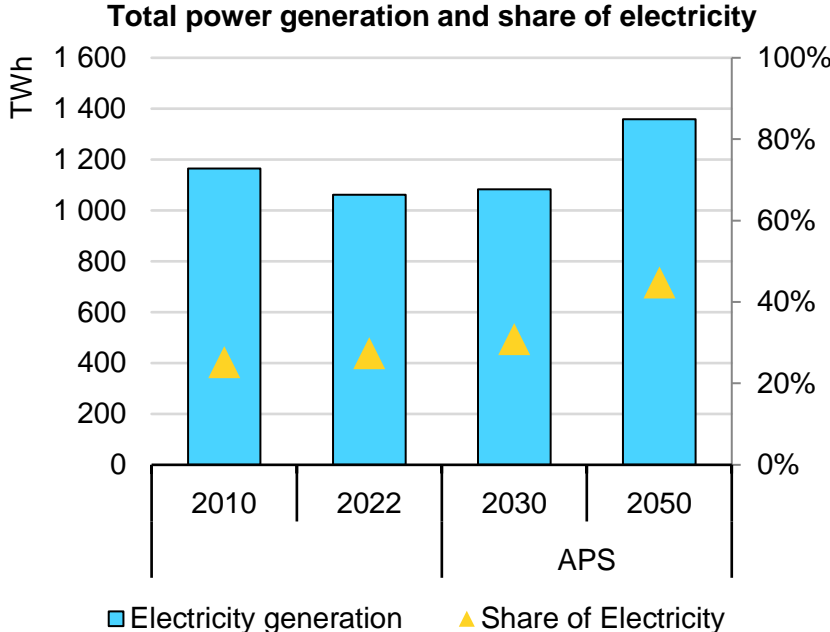
Note: DG = distributed generation.

Sources: IEA analysis based on 3DEN, [Unlocking Smart Grid Opportunities in Emerging Markets and Developing Economies](#) (2023), World Economic Forum, [Accelerating Smart grid Investments](#) (2010).

**Globally, investment in digital grid technologies has been increasing. Digital technologies are essential for optimising the use of energy resources and grid assets.**

# What does this mean for Japan?

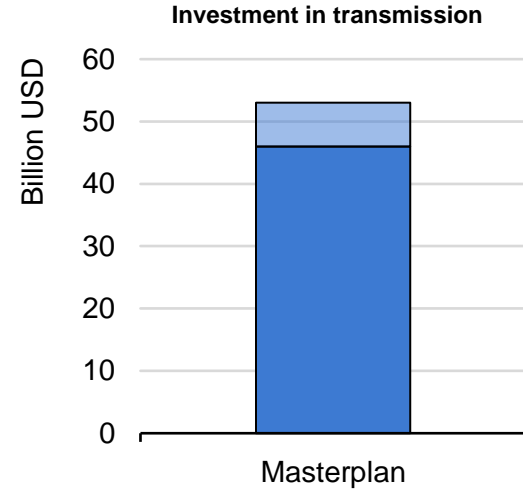
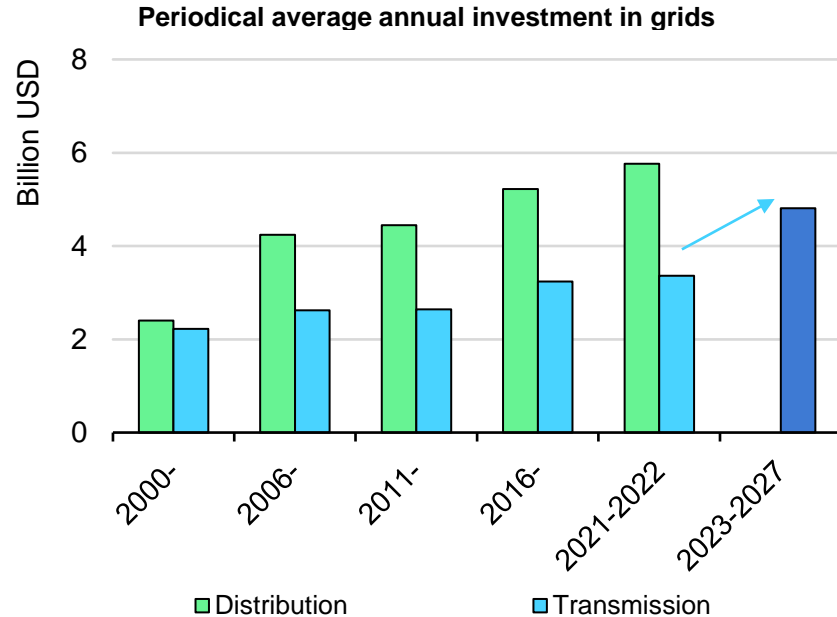
# Energy transitions rely on electrification and renewable energy



Source: [World Energy Outlook 2023](#) (IEA)

**Share of the electricity demand in final consumption is set to increase. Additionally, there is a need to significantly expand renewable energy in order to decarbonise power sources.**





Note: the amount of estimated investment is 6-7 trillion JPY.

**The revised wheeling charges for 2023-2027 and the Master plan prepared by OCCTO are expected to accelerate the Japanese energy transition.**

- **Bring planning up to date** – Strategic and integrated planning across sectors
- **Unlock investment** – Improve how grid companies are remunerated
- **Address barriers** – Regulatory overhaul towards proactive grid development
- **Secure supply chains** – Firm & transparent project pipelines to enable resilient supply chains
- **Leverage digitalisation** – Digitalise infrastructure and advance distributed resources
- **Build a skilled workforce** – Create a pool of talent with digital and electricity skills

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