Role of renewables in the energy transition

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International Renewable Energy Agency (IRENA)

Renewables essential for de-carbonising the global energy system

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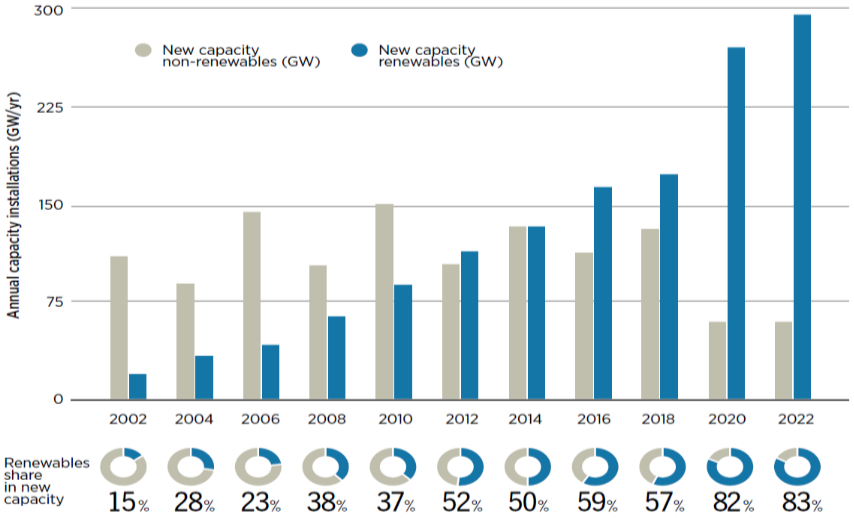
- Limiting global warming to 1.5°C will require reductions in annual energy-related CO2 emissions of about 37 Gt from 2022 levels to achieve a net zero scenario in the energy sector by 2050 (IRENA,2023)
- Due to their low carbon footprint, massive deployment of renewables coupled with energy conservation and efficiency will be vital to combat climate change and reducing emissions



- Expansion of renewable power confirms upward trend against declining fossil fuel capacity
- Still large-scale deployment remains centered on a limited number of economies
- All end-use sectors will have to use more renewables including in heating, cooling and transportation

Massive deployment of renewable energy crucial for reducing GHG emissions and combating climate change

Renewables costs reduction as a driver of energy transition

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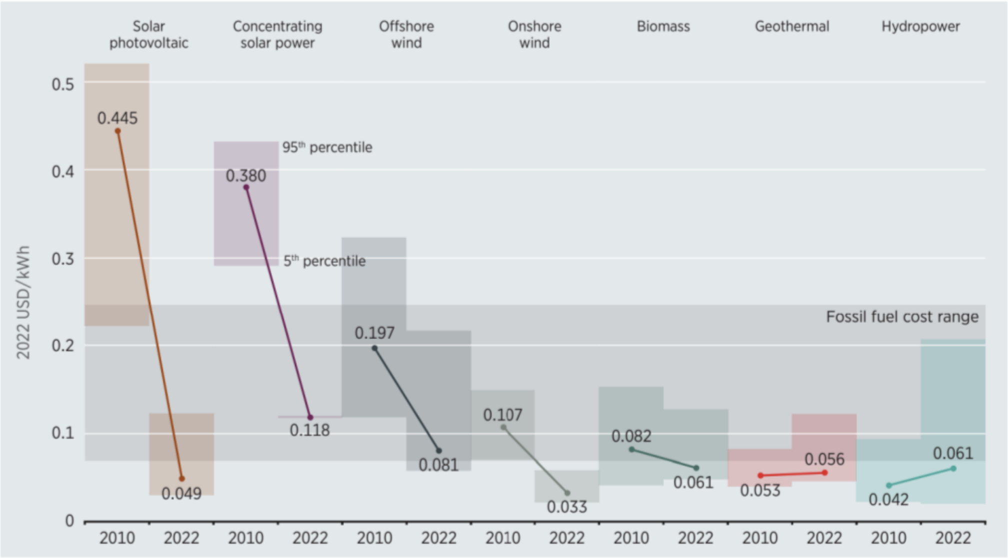
Global LCOE from newly commissioned utility-scale renewable power technologies, 2010 and 2022



Note: These data are for the year of commissioning. The thick lines are the global weighted average LCOE value derived from the individual plants commissioned in each year. The LCOE is calculated with project-specific installed costs and capacity factors, while the other assumptions, including weighted average cost of capital (WACC), are detailed in Annex I. The grey band represents the fossil fuel-fired power generation cost in 2022, assuming that 2021 fossil gas prices were the correct lifetime benchmark rather than the crisis prices of 2022. While the bands for each technology and year represent the 5th and 95th percentile bands for renewable projects.

Source: IRENA (2022), Renewable power generation costs in 2022, International Renewable Energy Agency, Abu Dhabi.

- Renewables competitiveness accelerates, despite cost inflation
- Hydro and geothermal, have been cost-competitive for years where they operate.
- Solar and wind have also gained a competitive edge as a result of technological advances and increased investment.

→ As the costs of RE technologies have fallen, the business case for renewable energy has become a major driver of change

Renewables can enhance energy security for fossil fuel importers and create opportunities for exporters

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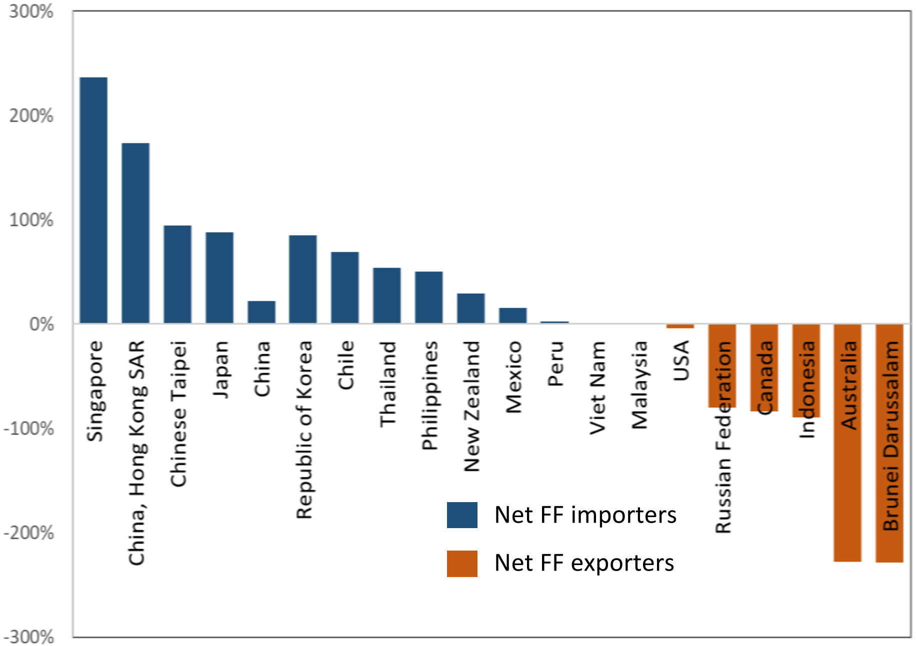
Fossil fuels dependency (fossil fuels imports-fossil fuel exports as a % of TES) for selected APEC economies, 2021

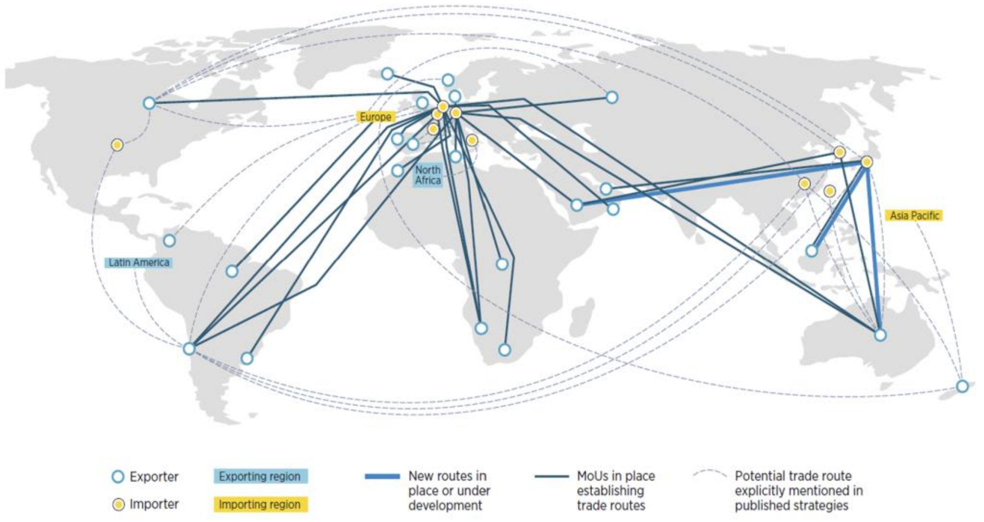


Source: UNSD and IEA data

- Renewables contribute to energy security by diversifying the energy mix and reducing dependence on imported fossil fuels.
- This enhances:
  - resilience to supply disruptions
  - geopolitical uncertainties
  - help decouple economies from volatile international fossil fuel price fluctuations e.g. 2022 fossil fuel shock
- Renewables will also create opportunities for fossil fuel exporters to diversify their economies e.g. Australia's National Hydrogen Strategy

Renewables are expected to influence the geography of energy trade

An expanding network of hydrogen trade routes, plans and agreements



Source: IRENA (2022), [Geopolitics of the Energy Transformation: The Hydrogen Factor](), International Renewable Energy Agency, Abu Dhabi.

- Renewables are also expected to create new trade patterns in:
  - renewables related goods, technologies e.g. smart meters, batteries
  - electricity interconnections e.g. to account for VRE
  - shifts in trade of renewable energy commodities e.g. Hydrogen
- Shift to renewables is expected to reconfigure new alliances and create new interdependencies among economies
- International cooperation will be necessary to devise transparent markets

Renewables will drive innovation in technology and energy infrastructure to accelerate the energy transition

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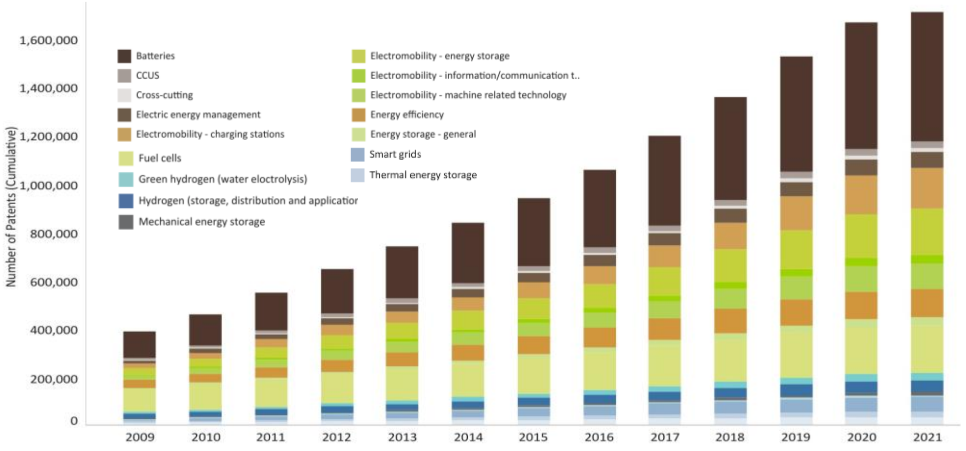
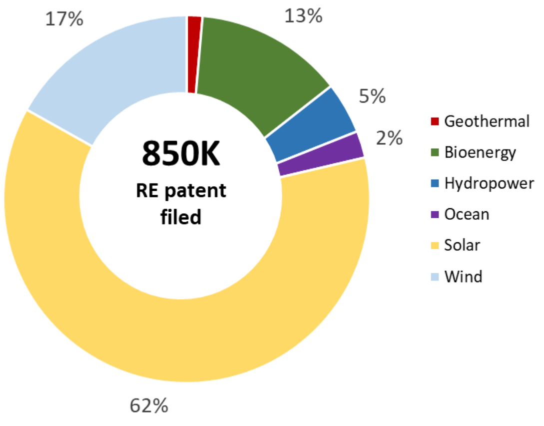
The need for flexible energy systems has led to more innovation in enabling technologies including energy storage solutions



Enabling technologies patents energy filed patents for APEC economies, 2000-21*

Increased uptake of RE, advanced innovations and research in renewable energy technologies



Cumulative RE filed patents for APEC economies, 2000-21*

RE power will require existing infrastructure to be modernized, with grid reinforcement and expansion on both land and sea to optimize VRE

*__Source__ IRENA INSPIRE (www.irena.org/Inspire) based on EPO PATSTAT 2021 Autumn edition, and on the Climate Change Mitigation Technologies (Y02) classification by EPO. It provides comprehensive, but by no means exhaustive information on patents filed for renewable energy worldwide.

A note on critical materials*

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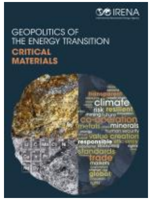
- The energy transition will be a main driver of demand for several critical minerals.
- Assessment of the criticality of materials is dynamic and continuously changing
- Dependency risks and supply dynamics of critical materials fundamentally differ from those of fossil fuels
- There is no scarcity of reserves for energy transition minerals, but capabilities for mining and refining them are limited.
- The mining and processing landscape of critical materials is geographically concentrated, including in several APEC economies :
  - *Australia (lithium), Chile (copper and lithium), China (graphite, rare earths), Indonesia (nickel)*



*Source: IRENA (2023), Geopolitics of the energy transition: Critical materials, International Renewable Energy Agency, Abu Dhabi.

Key mining economies for select minerals

Nickel (28 Ni)	
Indonesia	48.8%
Philippines	10.1%
Russian Federation	6.7%
France (New Caledonia)	5.8%
Australia	4.9%
Canada	4.0%
China	3.3%
Brazil	2.5%

Lithium (3 Li)	
Australia	46.9%
Chile	30.0%
China	14.6%
Argentina	4.7%
Brazil	1.6%
Others	2.2%

Cobalt (27 Co)	
Democratic Republic of the Congo	70.0%
Indonesia	5.4%
Russian Federation	4.8%
Australia	3.2%
Canada	2.1%
Cuba	2.0%
Philippines	2.0%

Copper (29 Cu)	
Chile	23.6%
Peru	10.0%
Democratic Republic of the Congo	10.0%
China	8.6%
United States	5.9%
Russian Federation	4.5%
Indonesia	4.1%
Australia	3.7%

* latest data available as of 2023

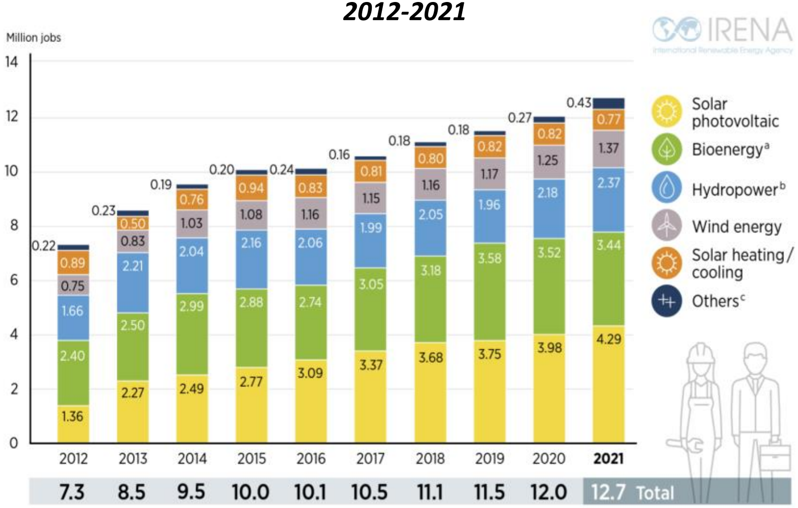
Source: (US Geological Survey and US Department of the Interior, 2023; JRC, 2020; USGS, 2023b).

The shift to renewables and energy efficiency can deliver large socio-economic benefits for a ‘just’ energy transition

Beyond pure economics, the energy transition, through its shift to renewables and energy efficiency can improve on several human well-being indicators including:

- Employment and skills creation
  e.g. vocational opportunities for green employment
- Health impacts *e.g. reduction of air pollution*
- Improved energy access
  e.g. through mini grids, biogas for cooking, off-grid solar lights
- Diversity and inclusion - *an inclusive and just energy transition must embrace diversity and inclusion across all demographics*

Evolution of global renewable energy employment by technology, 2012-2021



a Includes liquid biofuels, solid biomass and biogas.
b Direct jobs only.
c “Others” includes geothermal energy, concentrated solar power, heat pumps (ground based), municipal and industrial waste, and ocean energy.

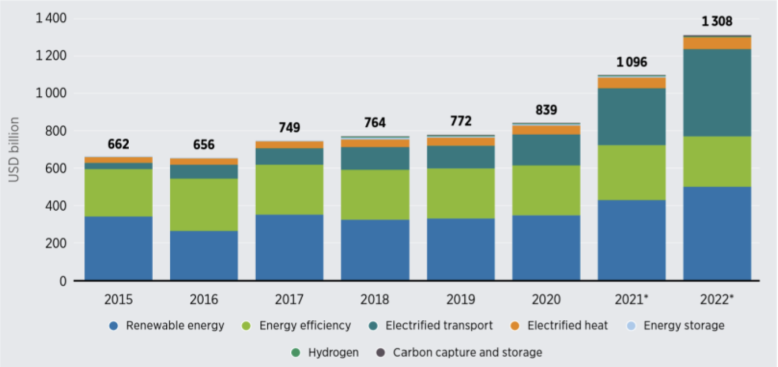
Source: IRENA jobs database.

Policy/regulatory frameworks and investments must systematically prioritise acceleration of the energy transition

- Policy and regulatory enablers must systematically prioritise the acceleration of the energy transition
- A considerable scale-up of renewables needs to go hand-in-hand with investments in enabling infrastructure.
- Net-zero commitments must be embedded in legislation and translated into implementation plans
- Comprehensive policies are needed not only to facilitate deployment but also to ensure the transition has broad socio-economic benefits
- Planning needs to extend beyond borders and the narrow confines of fuels to focus on the requirements of the new energy system and the economies it will sustain

e.g. investment and planning decision concerning energy infrastructure today should consider the structure and geography of the low-carbon economy of the future

Annual global investment in renewable energy, energy efficiency and other transition-related technologies, 2015-2022



Notes: Renewable energy investments for 2021 and 2022 represent preliminary estimates based on data from Bloomberg New Energy Finance (BNEF). As BNEF has limited coverage of large hydropower investments, these were estimated at USD 7 billion per year, the annual average investment in 2019 and 2020. Energy efficiency data are from IEA (2022a). These values are in constant 2019 dollars, while all other values are at current prices and exchange rates. Due to the lack of more granular data, the units could not be harmonised across the databases. For this reason, these numbers are presented together for indicative purposes only and should not be used to make comparisons between data sources. Data for other energy transition technologies come from BNEF (2023a).

Based on: IEA (2022a) and BNEF (2023a).

Source: IRENA and CPI (2023), Global landscape of renewable energy finance, 2023, International Renewable Energy Agency, Abu Dhabi.

Monitoring, Reporting, Verification and Evaluation mechanisms need to be in place to monitor progress of the energy transition

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- MRV systems play a crucial role in the energy transition by providing the data and transparency to track progress, ensuring accountability, and supporting evidence-based decision-making

- The specific type of MRV systems needed for the energy transition will vary depending on the context, goals, and scale of the transition E.g. grid monitoring systems to policy compliance reporting

- MRV systems are not only to be restricted to mitigation e.g. monitoring integration of renewables or tracking of emissions and international financial support provided

- They will need expand to monitoring the social and economic impacts of the energy transition and adaptation and resilience monitoring

What does it mean for the types of data that needs to be collected?

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1. Hydrogen data
2. Energy infrastructure data (including electric vehicles, charging infrastructure, batteries and other storage technologies), which may become more important to monitor in future.
3. Socio-economic data, particularly jobs (to see what changes may be needed to the workforce to make the transition a success)
4. Distributed and decentralised generation related data, as the transition is likely to involve a lot of small producers (not just off-grid, but others also providing their own power some of the time- autoproducers)
   e.g. plants using their own PV in island mode some of the time, people charging vehicles with their own PV panels, or own consumption "behind the meter" in net-metering schemes

- These are gradually becoming more challenging for data collection in many places with heavy reliance on administrative data collection (rather than surveys)

Some thought may be needed to adapt or expand those systems to avoid growing data gaps in the future.

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Thank you

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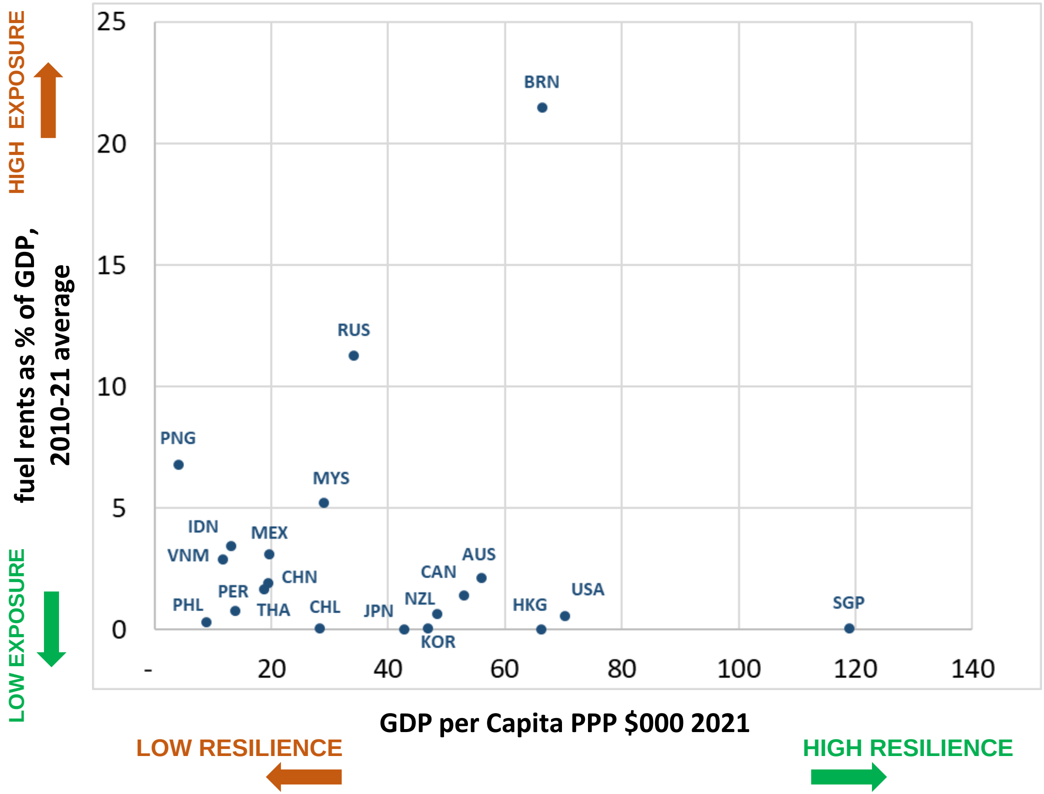
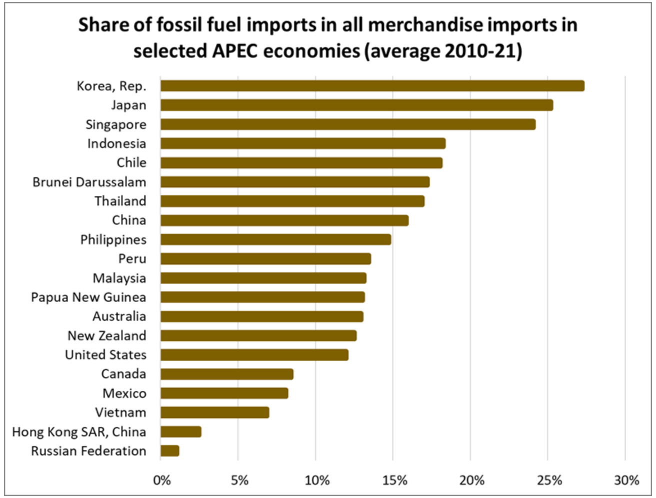
Annex

Additional Analysis

Relative preparedness of selected APEC economies for the energy transition



Source: World Bank



Renewables are going at a faster rate than non-renewables

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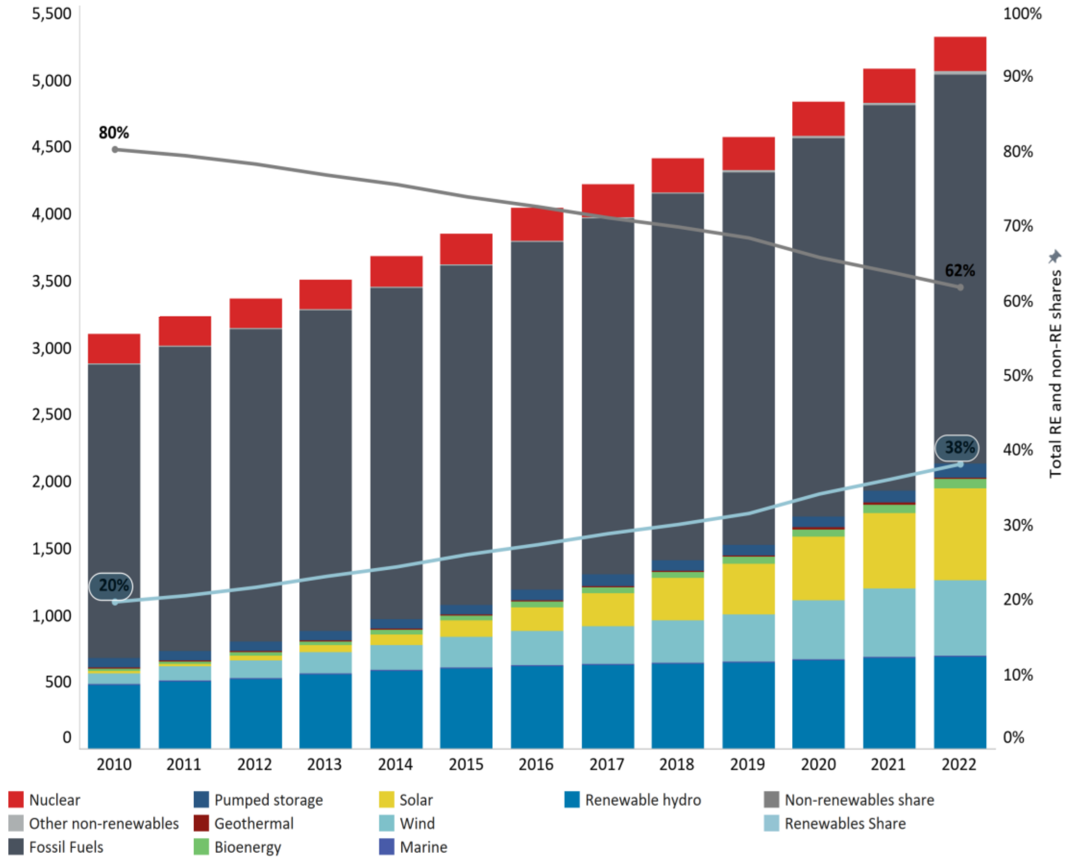
APEC Total Installed Power Capacity by Technology



Trends in Power Capacity

- APEC 21 total power capacity reached 5,300 TW in 2022 (3300 TW of non-renewables and 2000 TW of renewables)
- By end of 2022, non-renewables accounted for 62% of cumulative capacity compared to 80% in 2010.
- Share of renewables in total capacity increased from 20% in 2010 to 38% in 2022.
- By end of 2022, renewable hydropower still accounted for the largest share of renewable energy technologies (reaching 699GW), solar closely behind with 691 GW followed by wind (562 GW), bioenergy (70 GW) and geothermal (10GW).
- Renewables are going at a faster rate than non-renewables especially in recent years:

  2010-2022 CAGR non-RE +2%

  2010-2022 CAGR RE +10%

Renewable power generation doubled over the last decade

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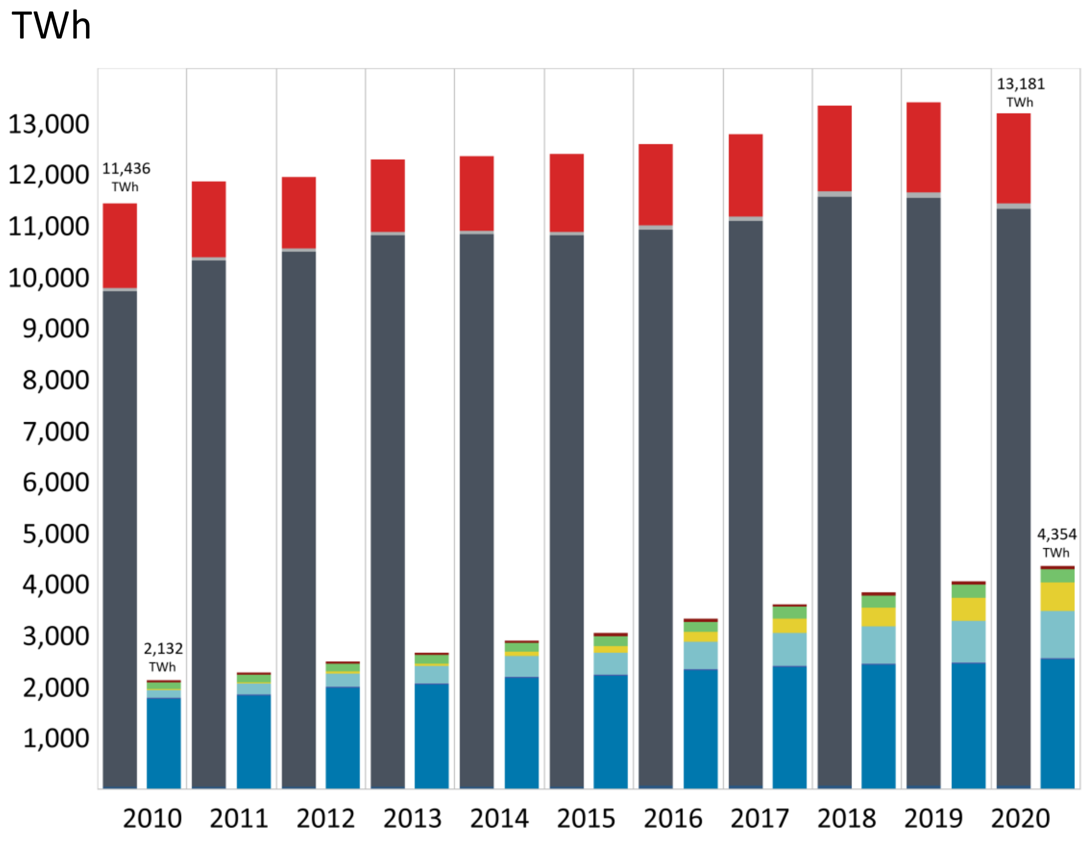

- Total renewable electricity production doubled over 2010-2020 reaching almost 4354 TWh in 2022
- Electricity from renewables grew at a CAGR of 7% from 2010 to 2020 compared to CAGR of 1% for non-renewables
- Among renewables, electricity from solar had the fastest CAGR of 44% from 2010-2022
- Share of renewables in electricity generation grew from 16% in 2010 to 25% in 2020