Alternative and innovative energy technologies for Net Zero Carbon Transition

International Conference on Net-Zero Carbon Transition

11 July 2024

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Energy Division, United Nations ESCAP

The Economic and Social Commission for Asia and the Pacific

- The Commission promotes cooperation among its 53 member States and 9 associate members
- The ESCAP secretariat supports inclusive, resilient and sustainable development by generating action-oriented knowledge, and by providing technical assistance and capacity-building services
- The ESCAP secretariat supports countries in achievement of national development objectives and the implementation of the 2030 Agenda for Sustainable Development

- 59% of the world's population
- 49% of global energy demand
- 57% of global fuel-related GHG emissions

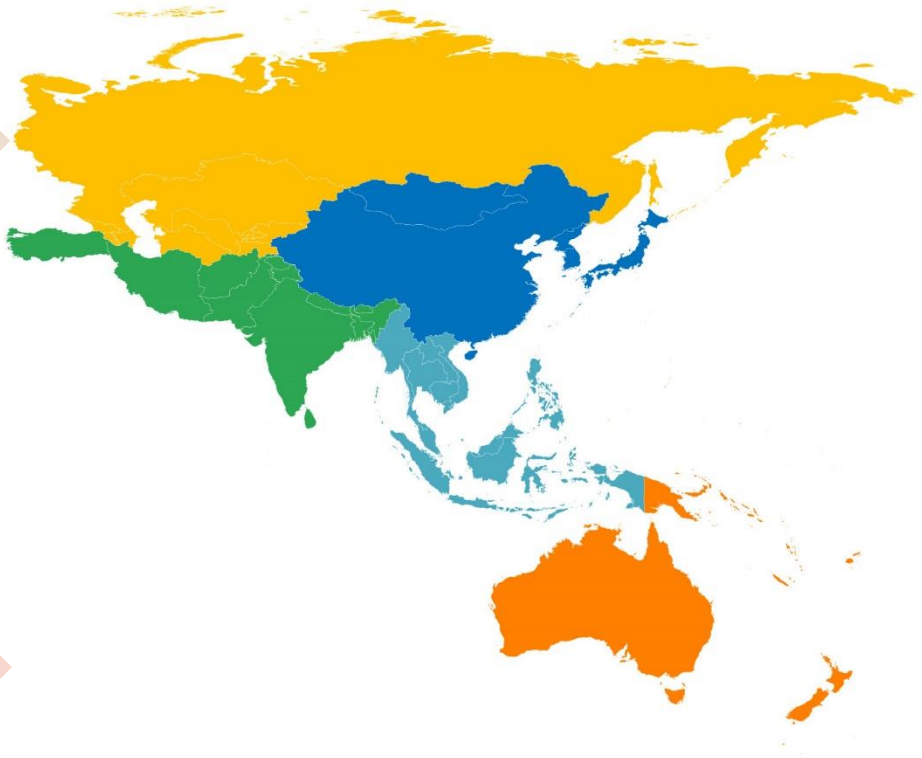
Energy Division – supporting member States in the energy transition

Sustainable Energy Development

- Achievement of SDG 7 targets
- Phase down of coal
- Sustainable cooling

Regional Energy Connectivity

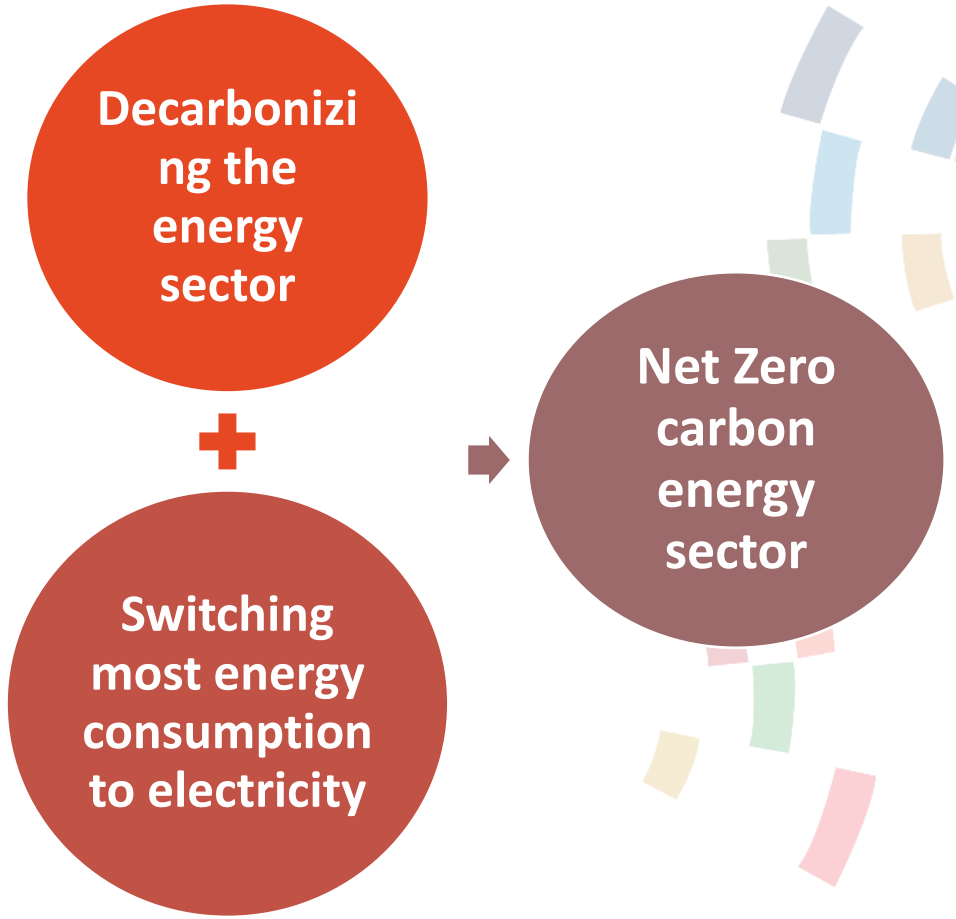
- Regional roadmap on power system interconnection
- Critical raw materials in the Asia-Pacific energy transition



What Does Net-Zero Emissions Mean?

- Two-part approach
  1. Produce emissions free electricity by decarbonizing the power sector
  2. Ensure most energy demand is met by electricity

Any remaining emissions will need to be balanced through carbon removal processes



Strategies and technologies needed to transition to net zero carbon in the energy sector

Decarbonization of the power sector

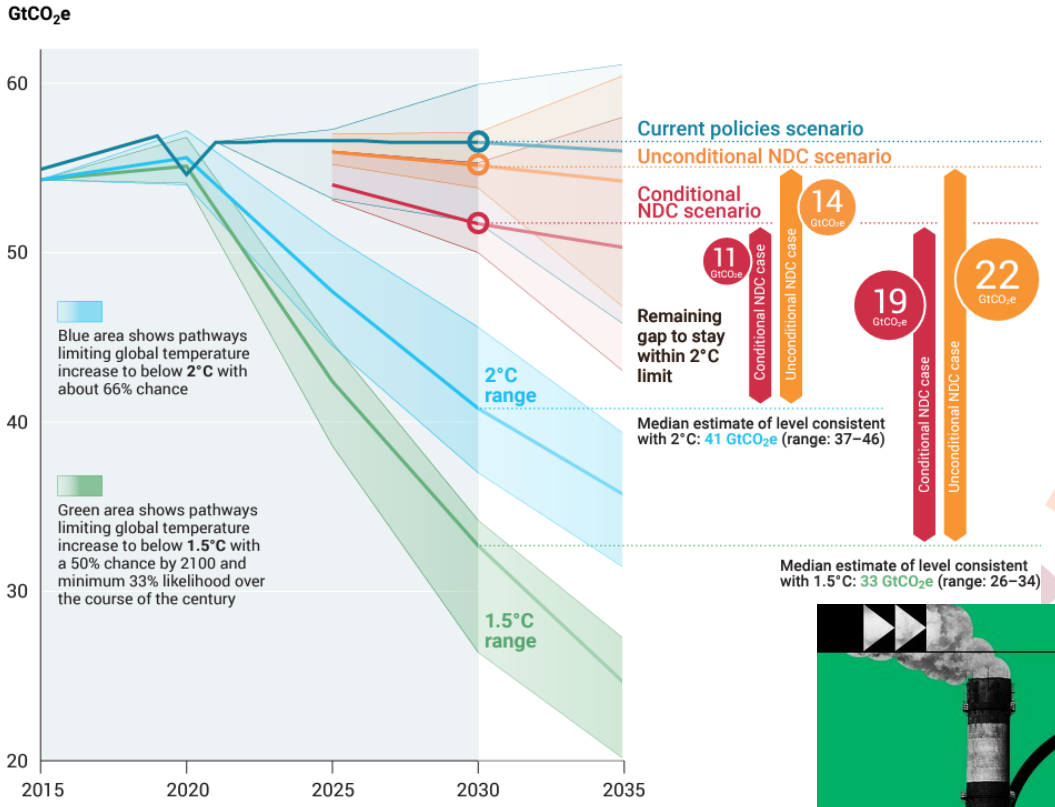
- Renewable energy
- Energy efficiency
- Carbon capture & storage
- Energy storage
- Smart grid
- Hydrogen

Switching most energy consumption to electricity

- Electrification of the transport system
- Improvement of building energy efficiency
- Electric boilers in industries
- Electric cookstoves
- Electric heating system

Relation between net zero emissions and 1.5^{0}C pathway

- Currently, the Earth is already about 1.1°C warmer than it was in the late 1800s, and emissions continue to rise.
- To keep global warming to no more than 1.5°C – as called for in the Paris Agreement – emissions need to be reduced by 45% by 2030 and reach net zero by 2050.



Reduction in global greenhouse gas emissions needed by 2030, from 2010 levels, to keep warming to no more than 1.5 degrees Celsius

UNEP (2023); UN (2023)

Net zero: the good, the bad and the ugly

The good

- Emissions free: 1.5- or 2-degree pathway
- Human health, livelihoods, water and food security
- Clean environment
- More jobs
- Enhanced energy security and resilience
- Improved marine and terrestrial ecosystem
- Reduced climate disasters

The bad

- Significant capital investment (in the early years)
- Some sectors and industries may be negatively exposed most to net zero
- Changes in economic competitiveness in some business sectors are likely to occur

The ugly

- Radical changes in the fossil fuel industry (extinction?)
- Economic impacts on fossil fuel exporting countries.

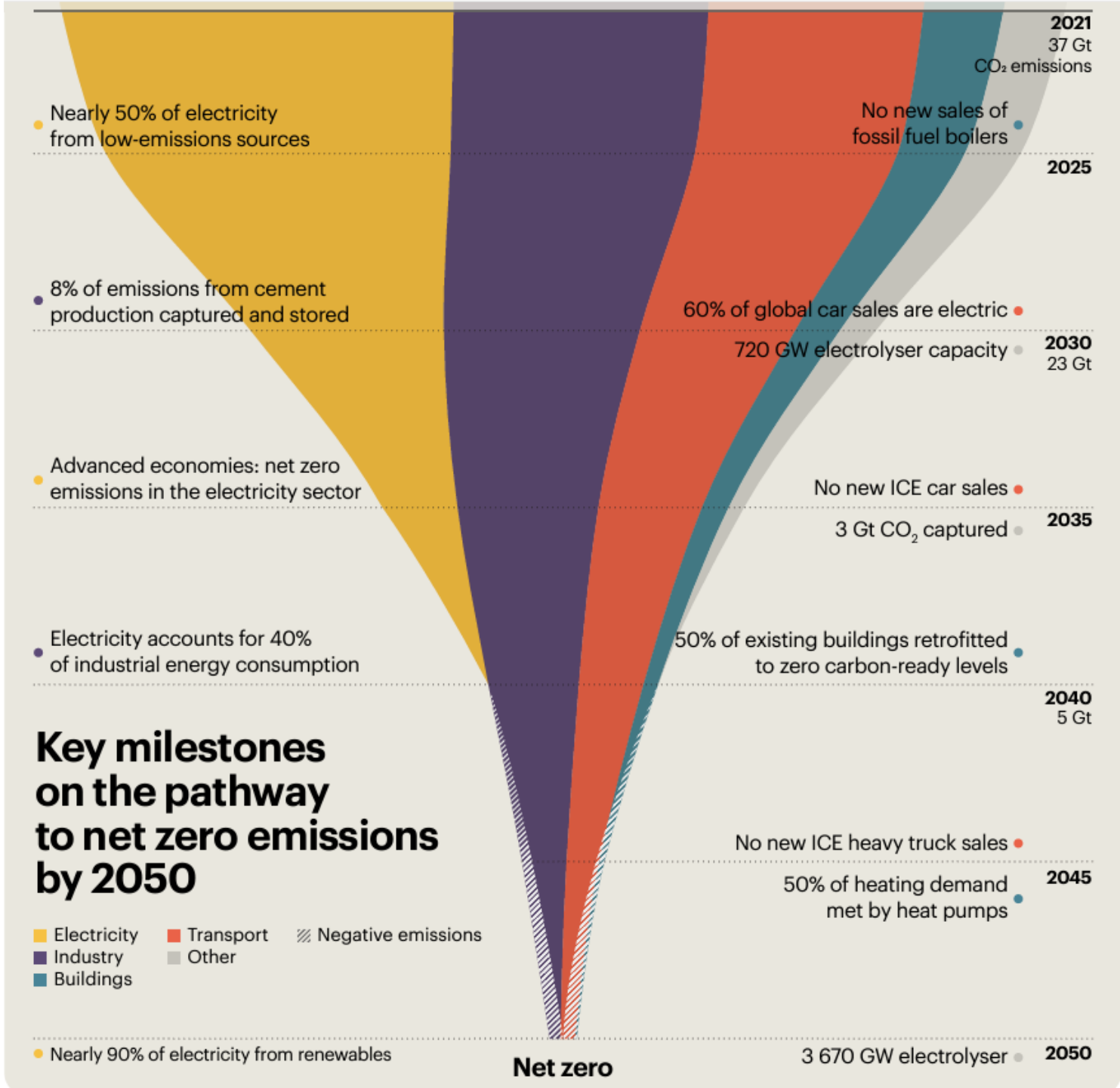
Matrix of measures for net zero emissions

- Energy and land-use systems will all need to be transformed to achieve net-zero emissions.
  - power, industry, mobility, buildings, agriculture, forestry and other land use, and waste
- Rapid transformation will be required across all global systems
  - how we power our economies
  - how we transport people
  - How we produce goods to feed a growing population.

Source: https://www.wri.org/insights/net-zero-ghg-emissions-questions-answered

Global perspectives on achieving net zero emissions

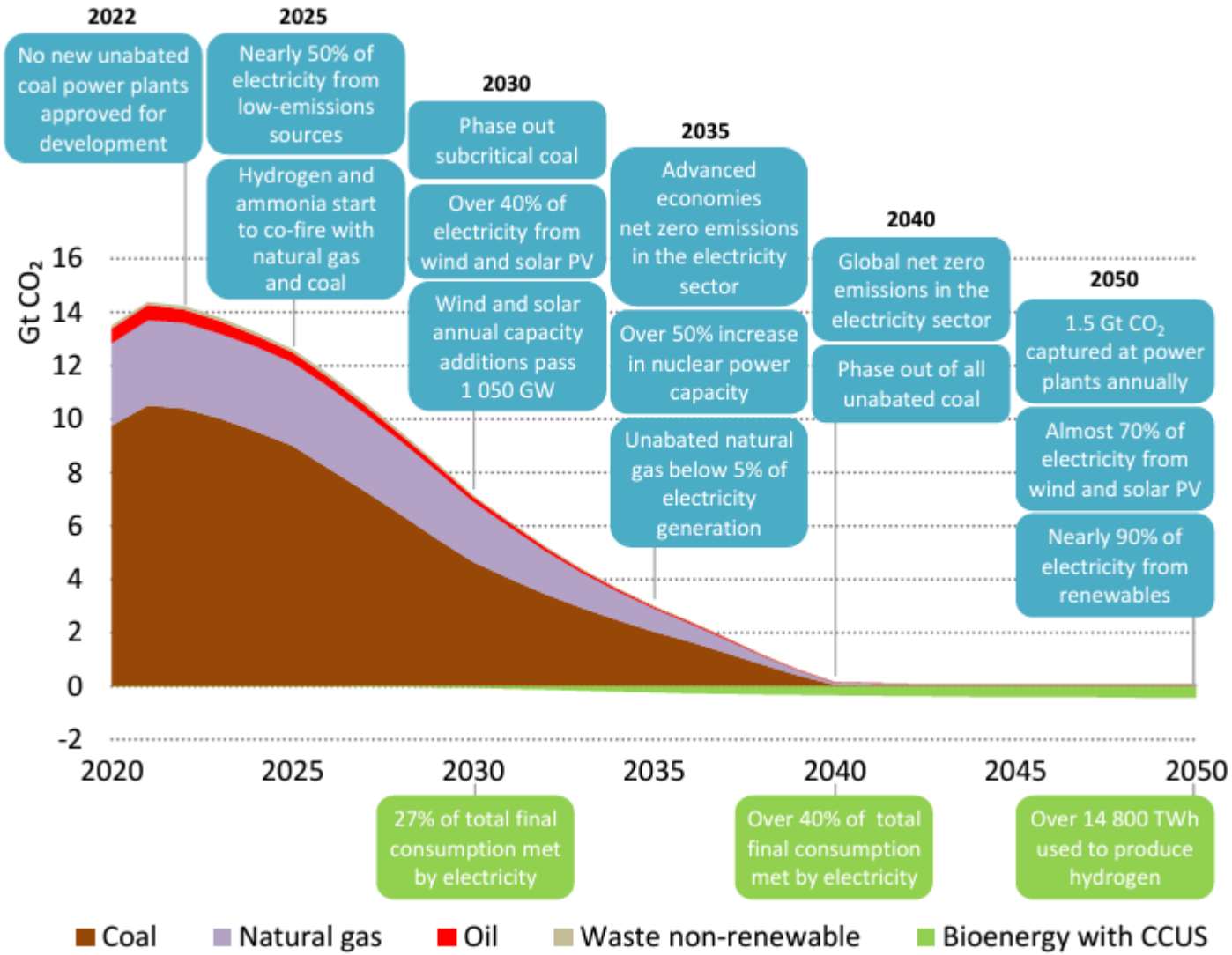
- Power sector decarbonization
  - 50% by 2025
  - 90% by 2050
- Electric vehicle
  - By 2030, 60% global car sales are electric
  - No new ICE care sales by 2035
  - No new ICE heavy truck sales by 2045
- Industry sector
  - 40% industrial energy from electricity



IEA, 2022

CO_2 emissions by source and key milestones in the electricity sector

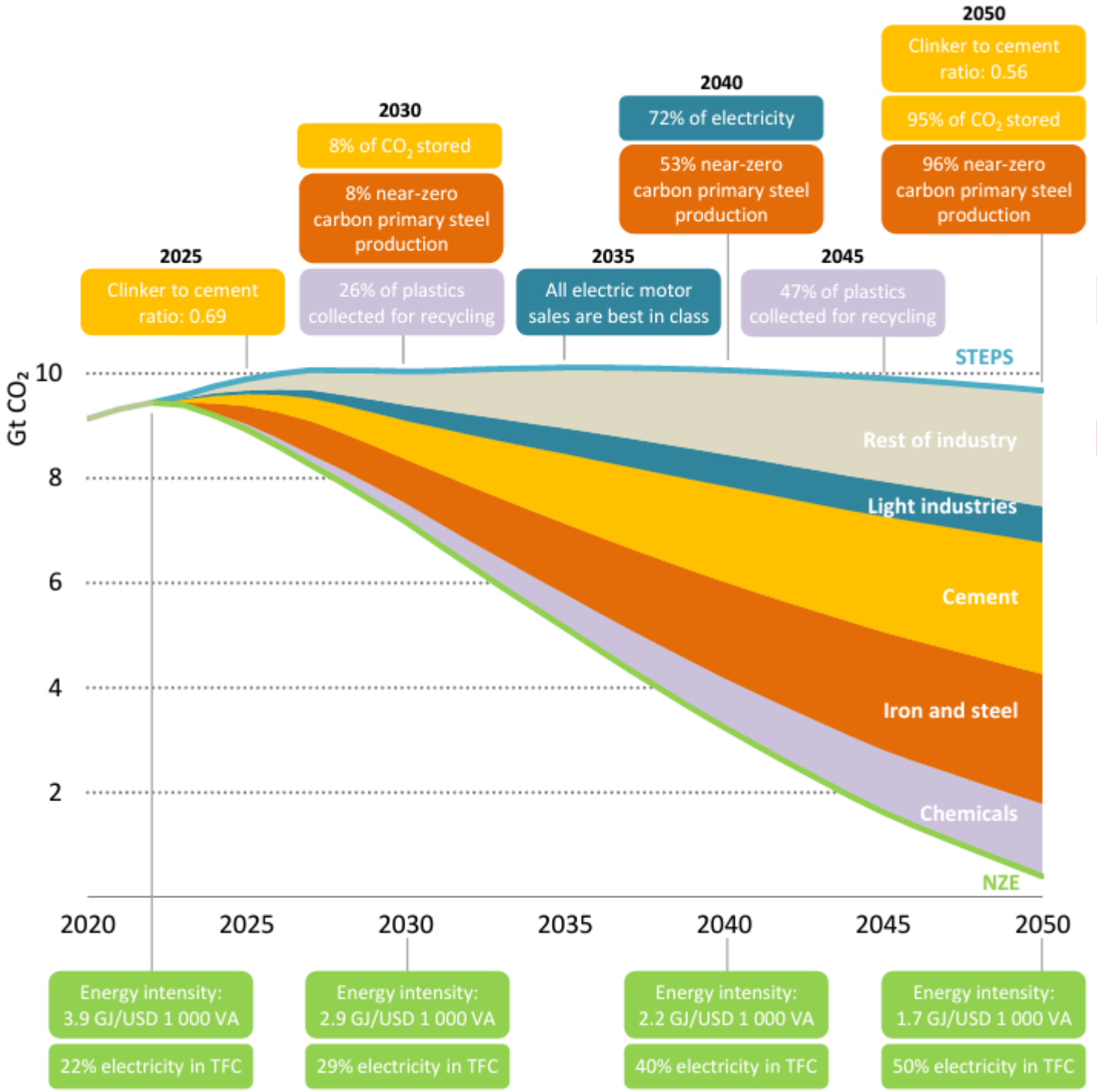
Electricity is the first sector to reach net zero emissions in 2040, tapping a wide set of low emissions sources and enabling other sectors to cut emissions through electrification



IEA, 2022

Emissions reduction and key milestones in the industry sector

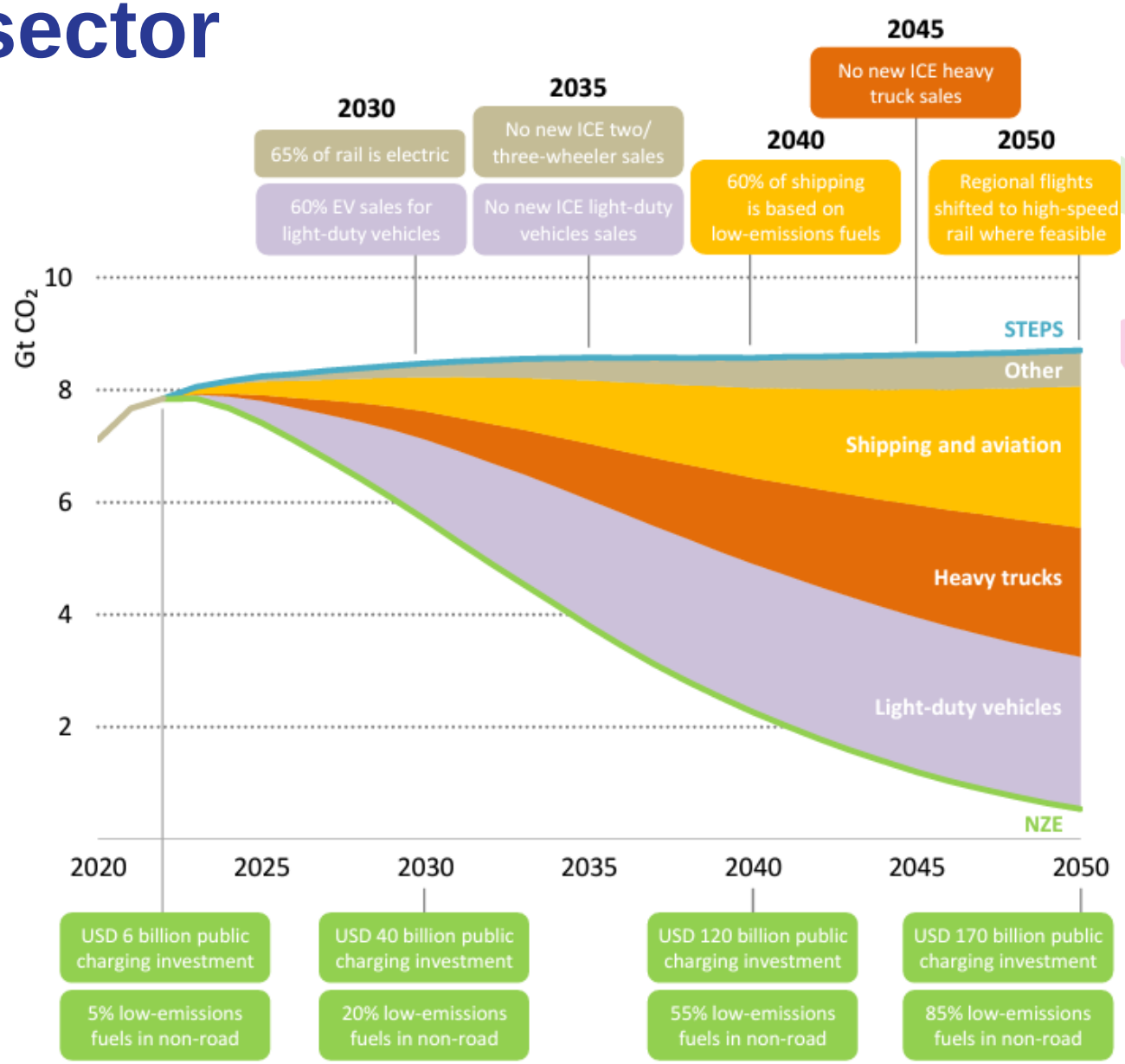
Industry requires a portfolio of technologies and measures to reach net zero emissions, such as energy and material efficiency, electrification, hydrogen and CCUS



IEA, 2022

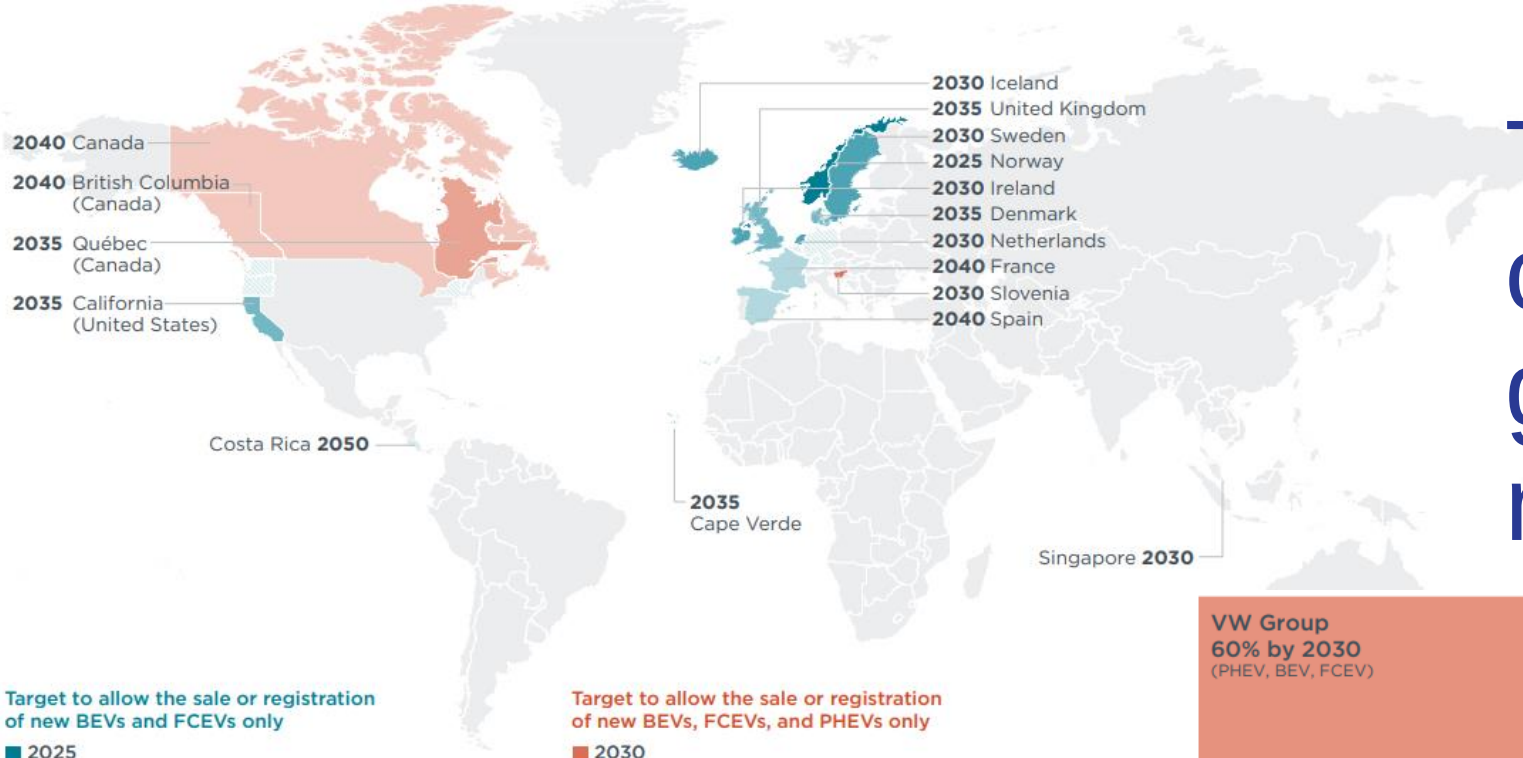
Emissions reduction and key milestones in transport sector

Electrification of road transport and rail brings rapid and massive emissions reductions; behavioural changes and low-emissions fuels are key in aviation and shipping

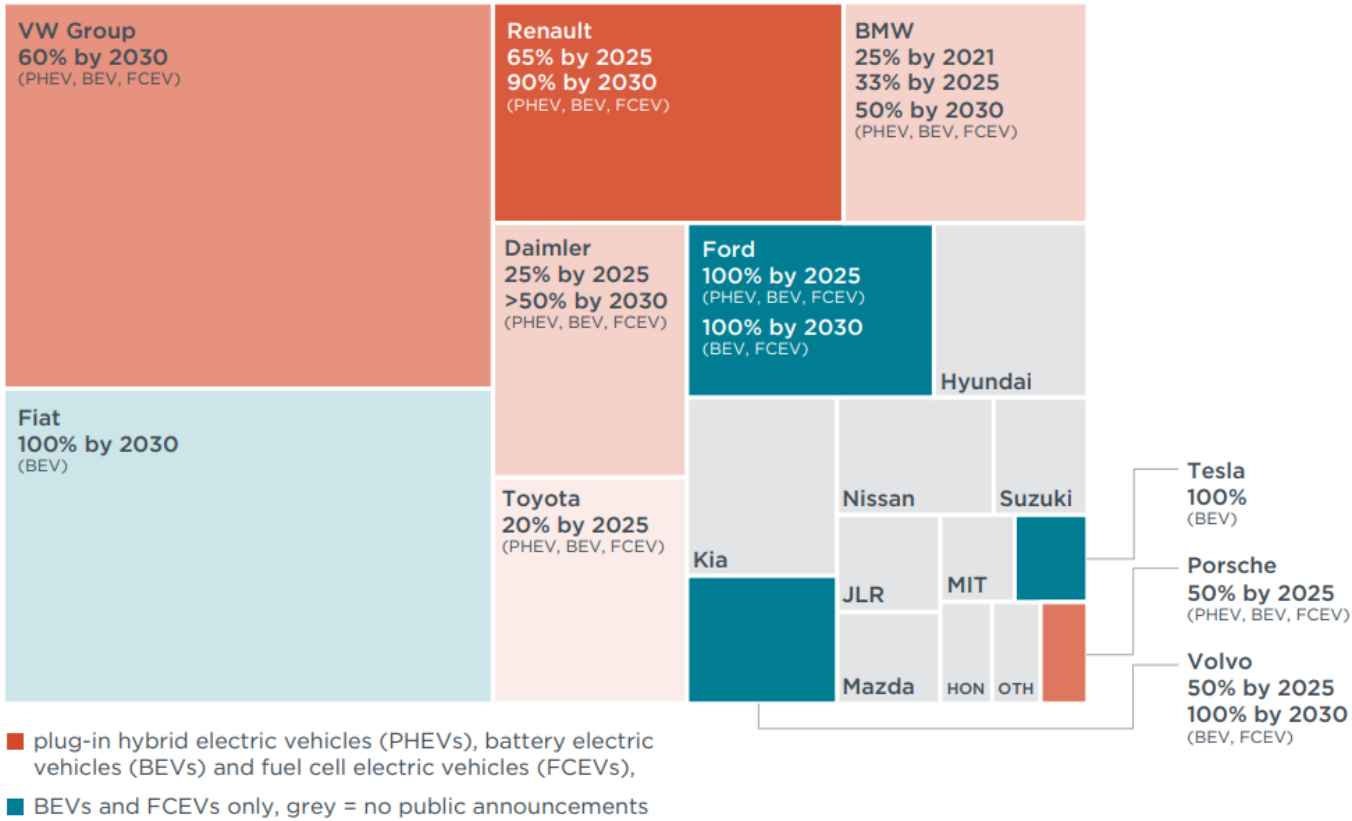


IEA, 2022

Transport sector commitments by governments and manufacturers

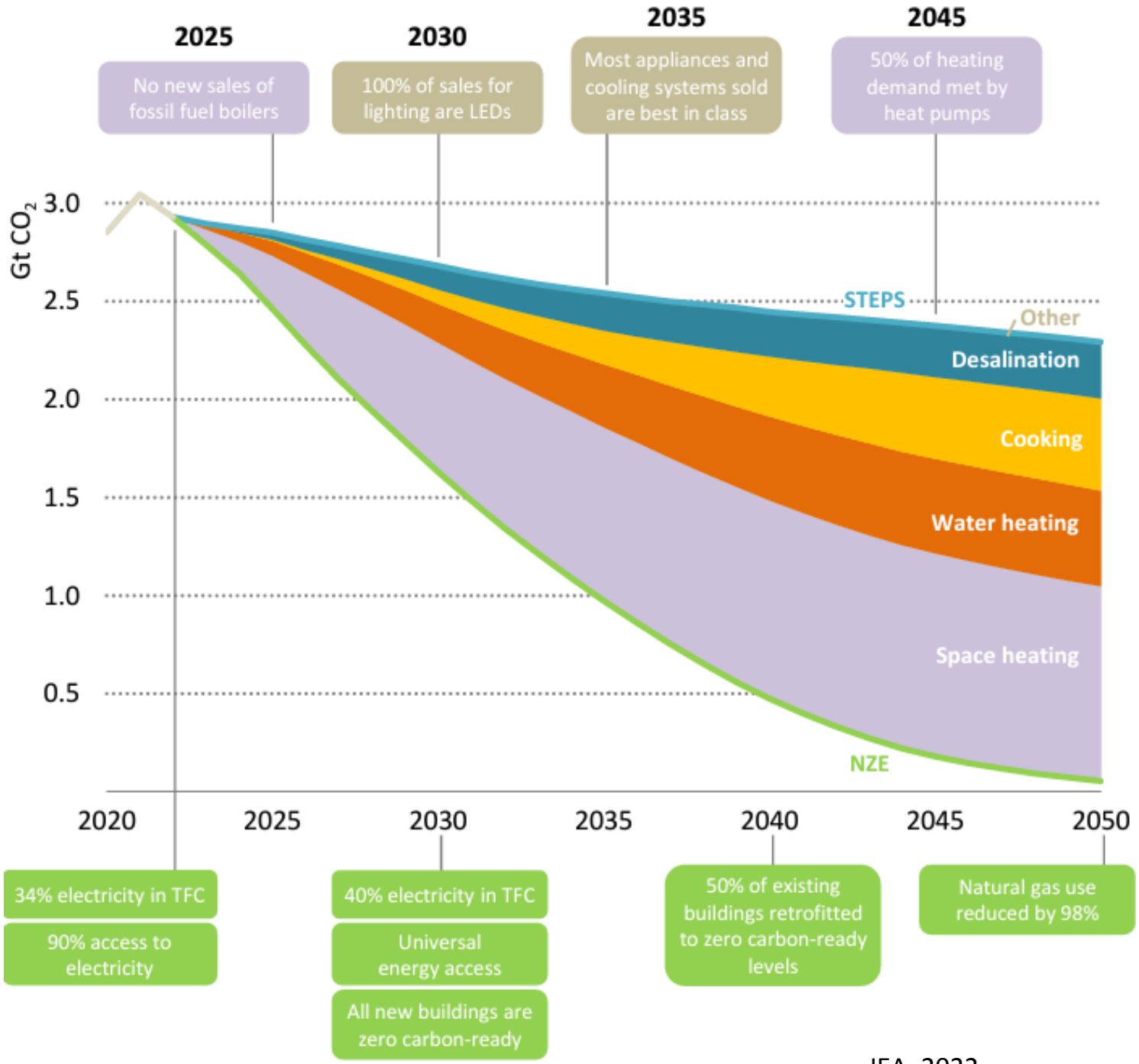


Governments with official targets to 100% phase out sales or registrations of new ICEs, as of 2021



Emissions reduction and key milestones in the buildings sector

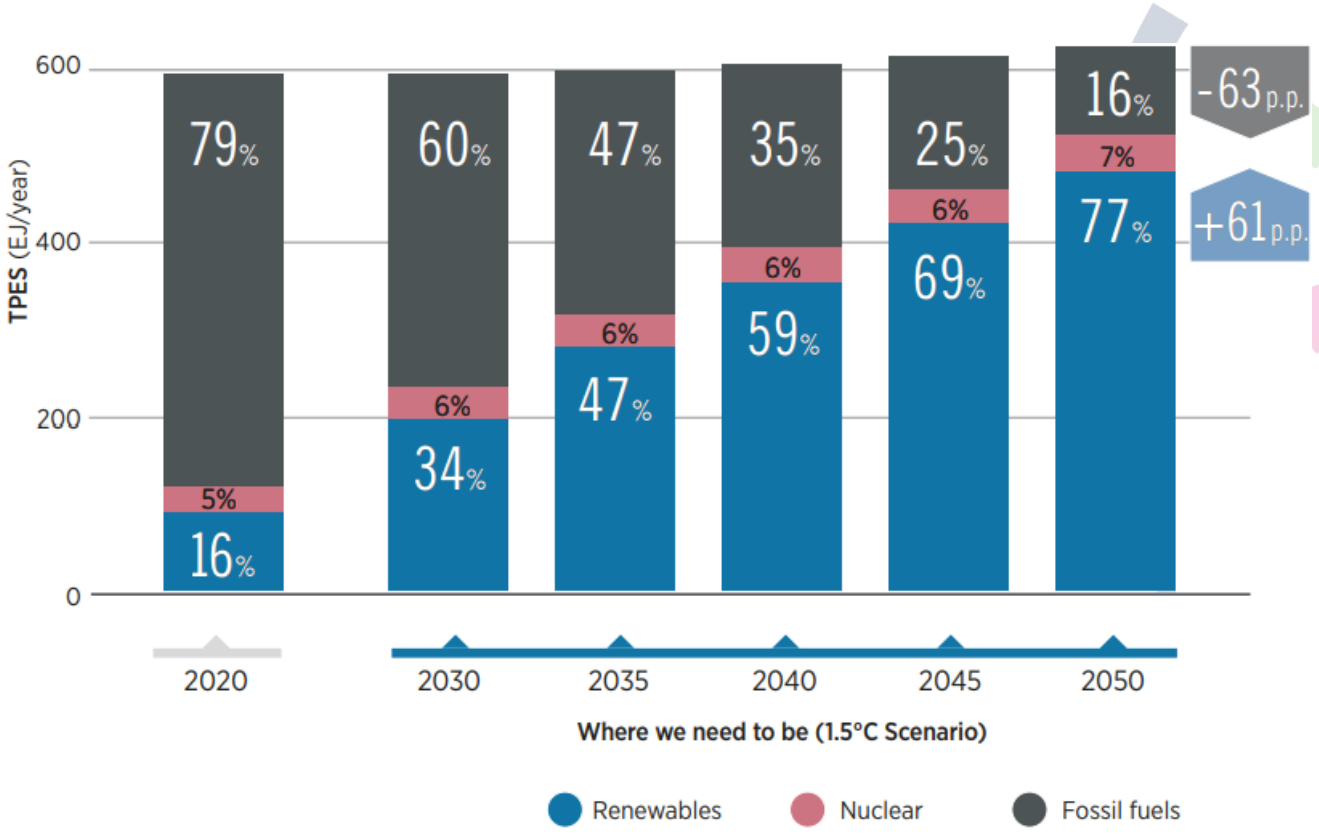
- Space heating delivers 50% of emissions reductions in buildings, driven by electrification and demand reductions from efficiency and behavioural changes



IEA, 2022

What it means for global energy supply for 1.5^{0}C scenario?

- Renewables would account for 77% of primary energy supply by 2050 in the 1.5°C Scenario
- Much improved energy efficiency, structural and behavioural changes are all needed



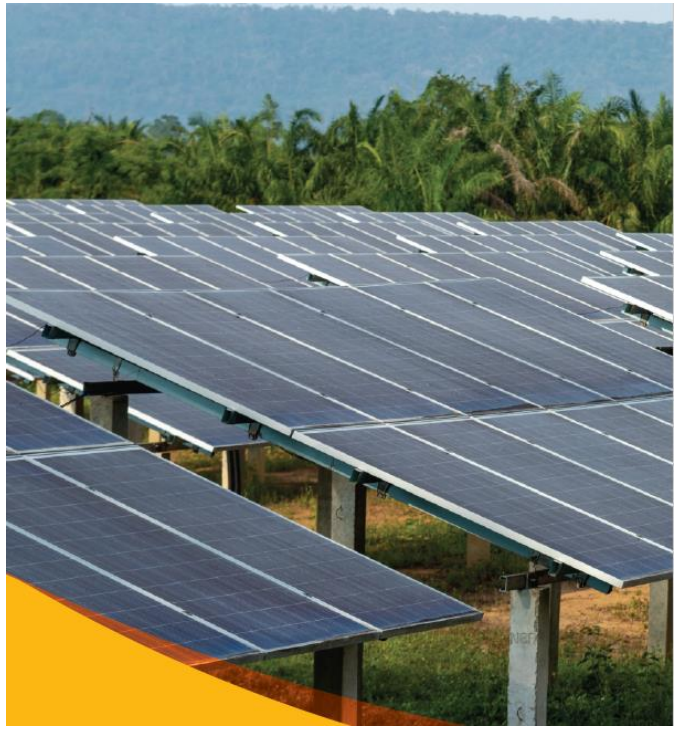
Global energy mix for 1.5^{0}C scenario
Source: IRENA (2023)

Where are we with the technologies?

- Renewable energy technologies
  - Solar PV, Wind, biomass, hydro, etc.
- Energy efficient technologies
- Hydrogen
- Energy storage technologies
- Smart meter
- Nuclear

Solar photovoltaic

- Highly matured and widely commercialized technology
- Various uses – both for electricity and heating
  - Utility-scale, floating PV, rooftop PV, solar home system, solar water heater, streetlight, etc.
- Substantial cost reduction in the past 10-15 years



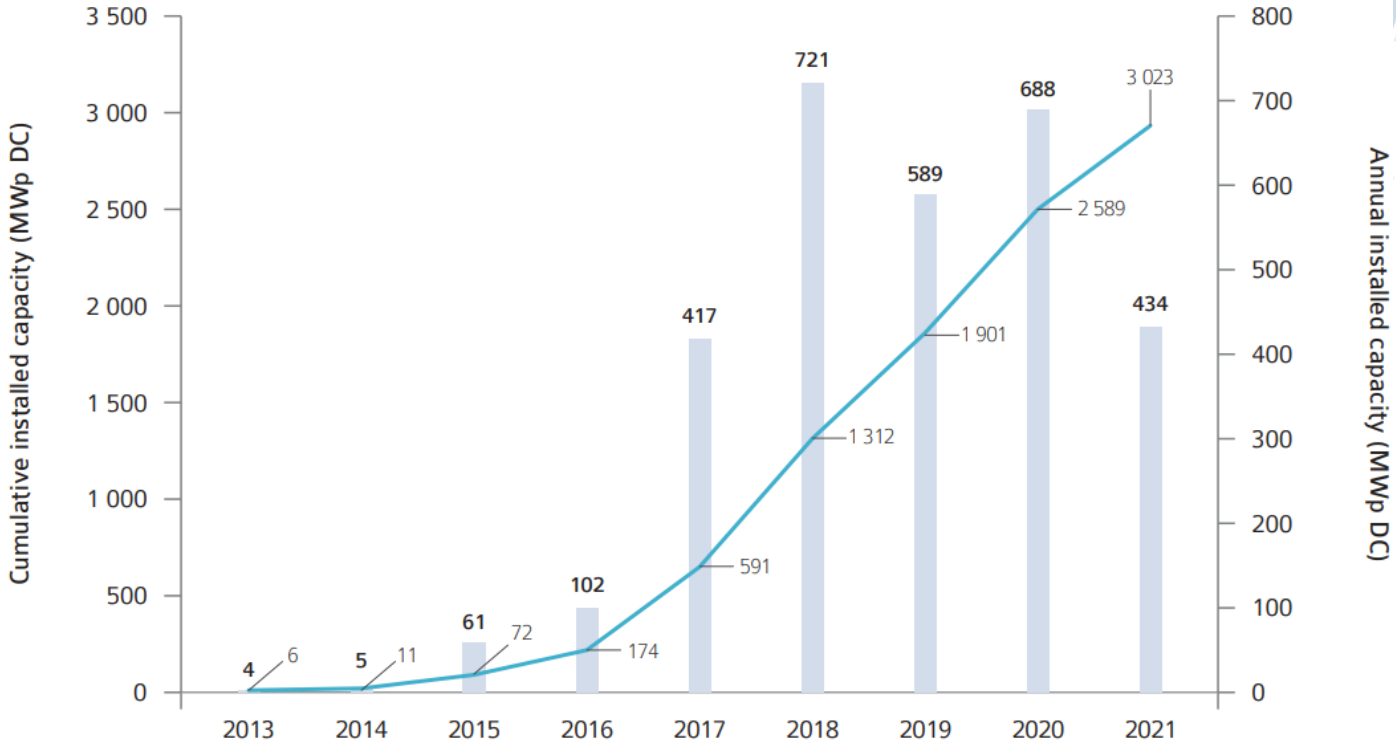
Solar photovoltaic – floating PV

- Floating PV systems are mounted on a structure that floats on a water surface
- The development of floating PV on man-made water areas is a solution to land scarcity in high population density areas
- Can be combined with hydropower.

Image source: https://images.app.goo.gl/9Nvrq9ZR73iUa4FF7

Floating PV market

- Market status
  - Global installed capacity 2020: 2.6 GW
  - 339 projects in 35 countries
  - Accelerated growth in last 3 years: 1.5GW additional capacity
- Outlook for net zero scenario
  - Future demand driven by Asian countries
    - India plans 1 GW
    - Korea plans 2.7 GW
- Competitiveness
  - 2020 estimated: USD 0.354/kWh



Source: https:/iea-pvps.org/wp-content/uploads/2022/01/IEA-PVPS-Trends-report-2021-4.pdf

The strengths of the Hydro-Floating Solar Hybrid

- Low cost due to its large generating capacity of more than 30 MW
- Enhancing power system security with Integrated Renewable Firm Power System coupled with Energy Storage System
- No impact on society, community, and environment
- No impact on the agriculture area, the community's boat route, and the daily life activities of the locals.
- Devices used to install floating solar panels are made from the same materials of plumbing pipes, which are environment friendly.

Floating PV – challenges

- Uncertainty about FPV ecological impacts
- Lack of buy-in - visual impacts
- Uncertainty about water rights
- Lengthy, expensive and unclear environmental approval process
- Shortage of trained workforce
- Absence of clear policies around FPV

Image source: https://images.app.goo.gl/Pc4nvnBxeMDNXHT66

FPV policies in Asia

- Japan
  - Incentivized the deployment of FPV systems in land-constrained areas that had competing land-use needs for agriculture.
  - This allowed populations to ease land-use pressures and align with policies that provided clean and affordable electricity.
- Republic of Korea
  - Invested in growing a local, job-creating FPV industry and helped avoid land-energy conflicts caused by land-based PV systems competing with other land-use needs.
- Taiwan
  - Created an “AquaPV” policy to incentivize aquaculture farmers to install PV at their farms.

Floating PV in Thailand

- A few floating solar PV systems are already in operation
- EGAT has plans for 16 projects with total installed capacity of 2.7 GW
- EGAT has built the world largest floating solar on the Sirindhron dam in Ubon Ratchthani
  - 45MW installed capacity
  - 72 acres of water surface
  - Emission reduction capacity of 72ktCO2-e/yr
  - Estimated cost: 34 million Baht

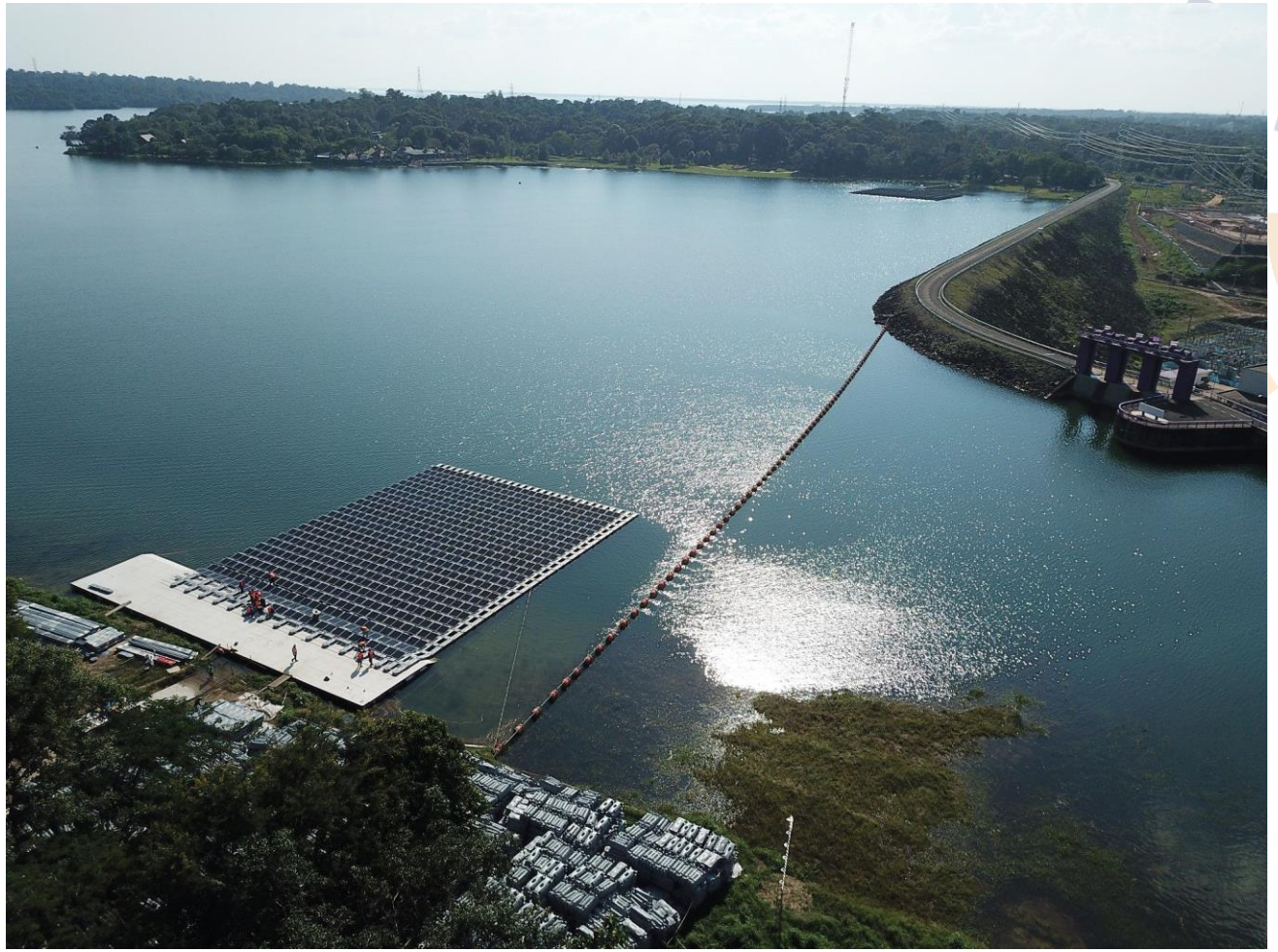


Image source: https://www.egat.co.th/home/en/the-worlds-largest-hydro-floating-solar-hybrid/

Energy storage technologies

- Energy storage systems will be a must as we accelerate the uptake of renewable energy
- Currently expensive but expected to get cheaper
- Some RE systems are already cost-competitive with ESS

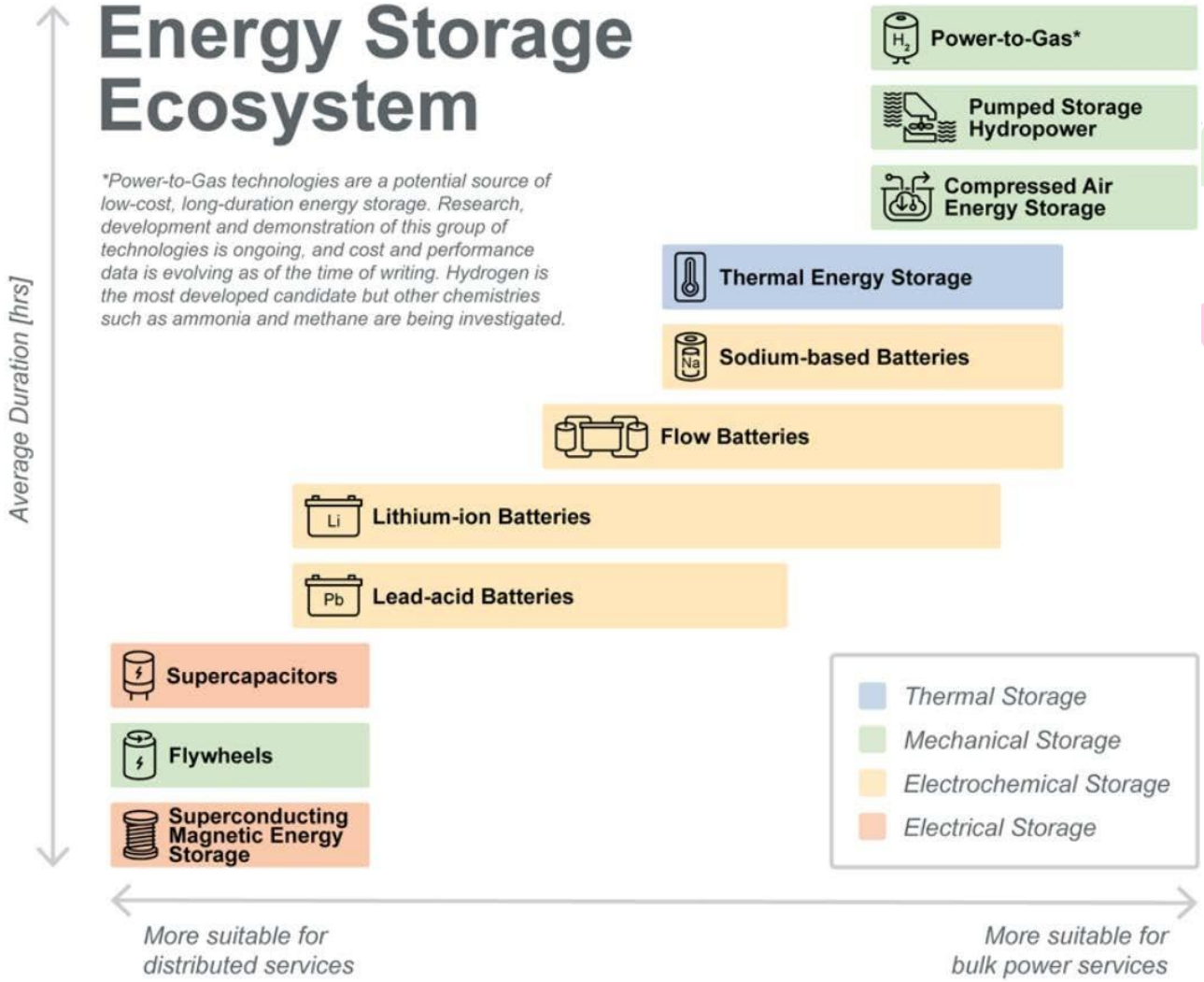
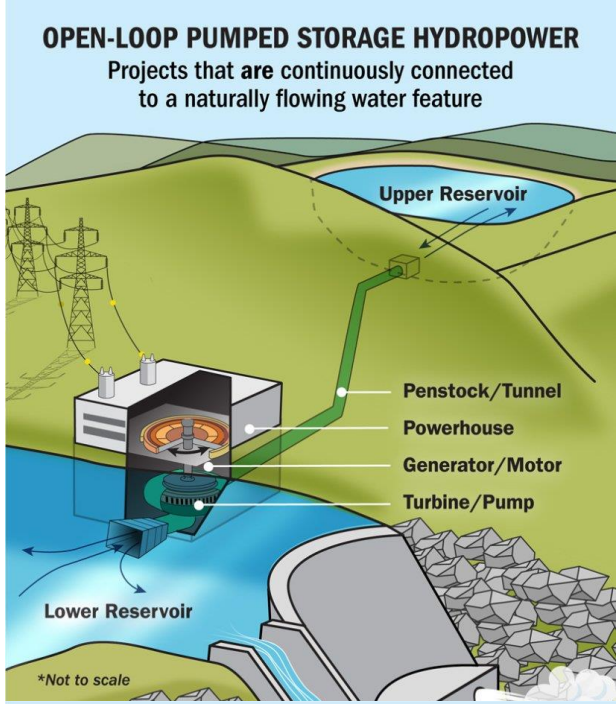


Image source: NREL (2022)

Pumped hydro storage

- Installed PHS capacity reached 161 gigawatts (GW) by 2018
- PHS capacity is set to double by 2050
- Levelized cost of PHS
  - 15-year lifetime: 150–200 USD/MWh
  - 40-year lifetime: 186 USD/MWh (compared to 285 USD/MWh for Li-ion battery facility)
  - 100-year lifetime: 58 USD/MWh
- Capital cost (site specific): 617 – 2,465 USD/kW

IRENA (2020)



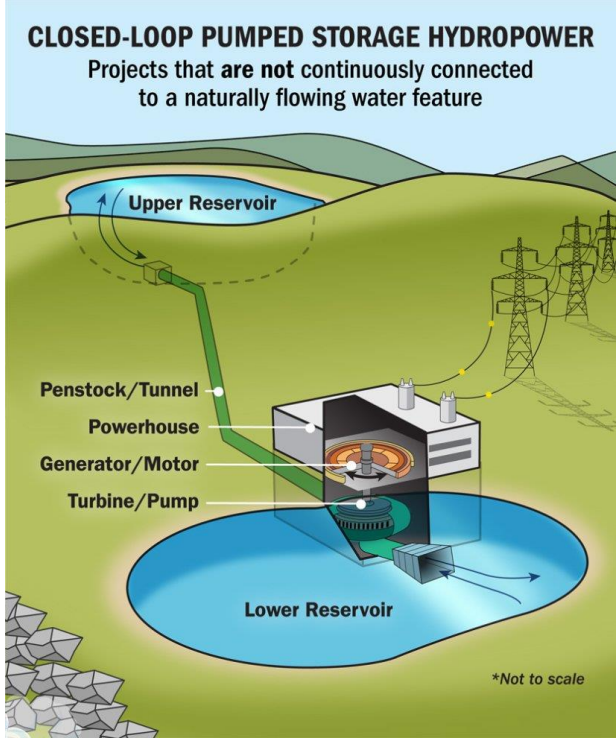


Image source: https://www.energy.gov/

PHS – the case of Kyushu

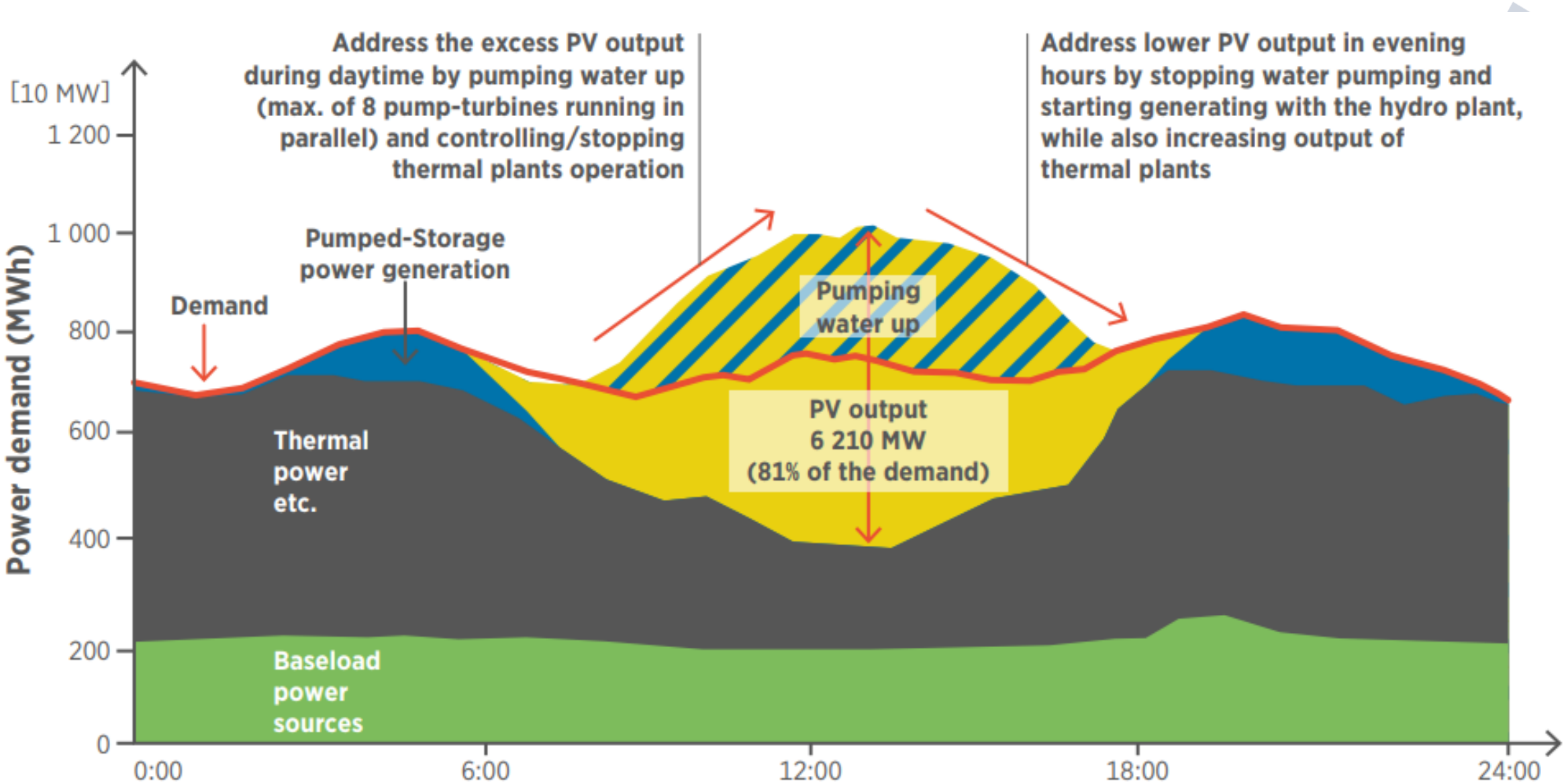
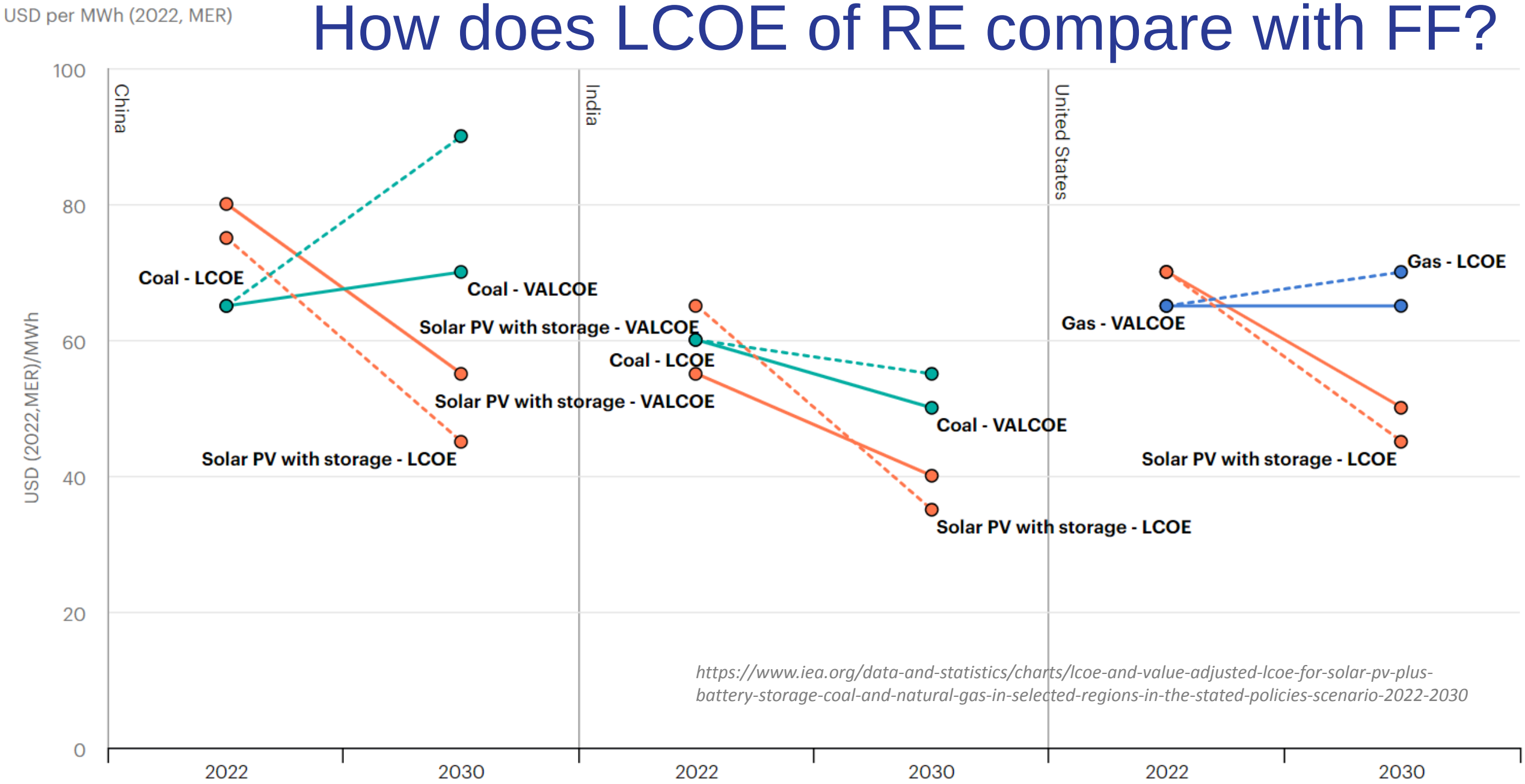


Image source: IRENA (2020)

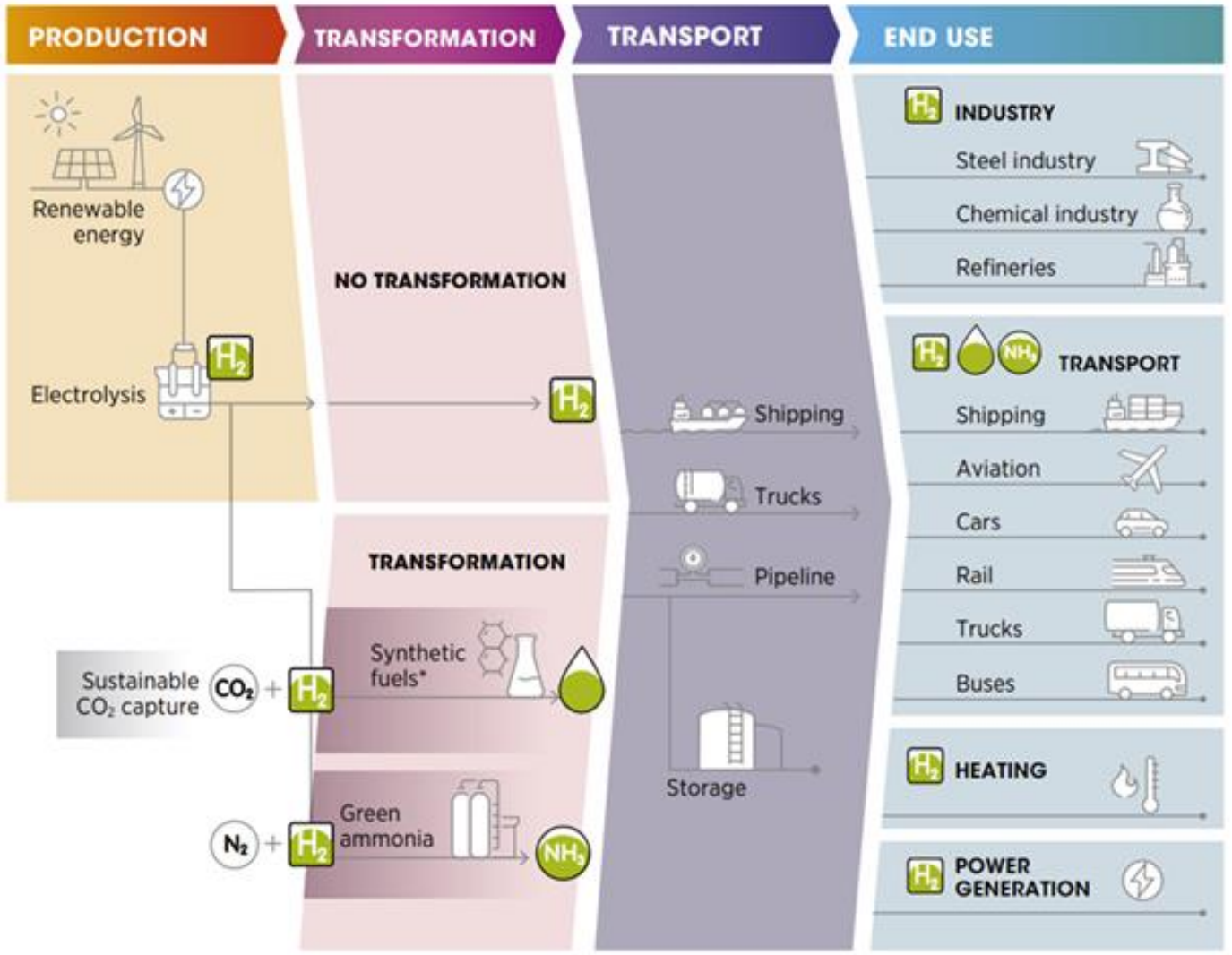
How does LCOE of RE compare with FF?



https://www.iea.org/data-and-statistics/charts/lcoe-and-value-adjusted-lcoe-for-solar-pv-plus-battery-storage-coal-and-natural-gas-in-selected-regions-in-the-stated-policies-scenario-2022-2030

Hydrogen

- Hydrogen is an emerging technology.
- It can be produced from multiple feedstocks and can be used across virtually any application
- Hydrogen is produced on a commercial basis today. It is used as a feedstock in the
  - chemical industry and in refineries,
  - as part of a mix of gases in steel production, and
  - in heat and power generation



IRENA, 2022

The colours of hydrogen

Green hydrogen

Green hydrogen is extracted using a method that does not produce GHG emissions. Essentially, by powering the electrolyser from renewable energy sources

Blue hydrogen

Produced using a process called 'steam reforming', which uses steam to separate hydrogen from natural gas. This process does produce GHGs, but carbon capture and storage technologies capture and store those emissions.

Grey hydrogen

Grey hydrogen is also extracted from natural gas using steam reforming but in this case, relevant technologies don't capture resulting emissions. Instead, they are released into the atmosphere.

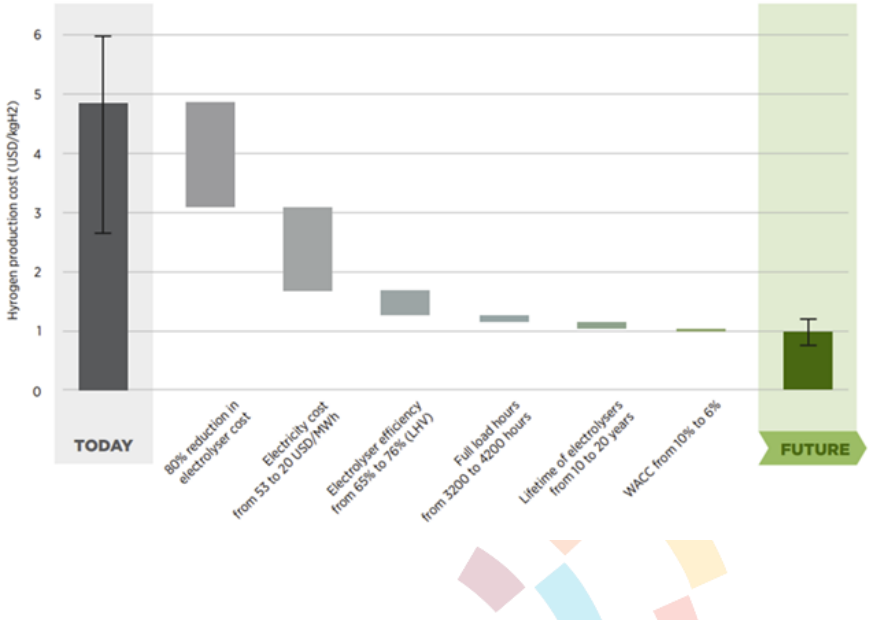
Brown and black hydrogen

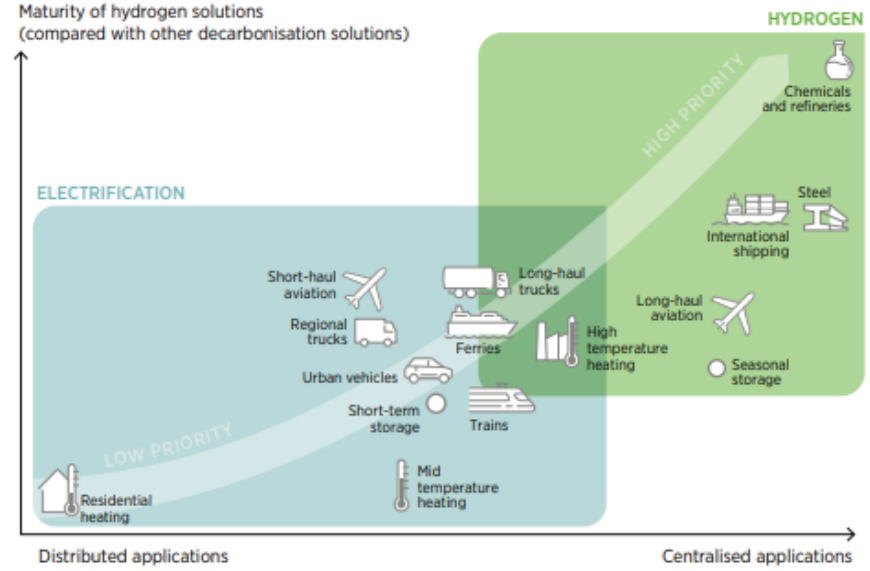
Brown hydrogen (made from brown coal) and black hydrogen (made from black coal) are produced via gasification.

Cost of hydrogen production

- Locations in the world that achieve a renewable electricity cost of USD 20/MWh or below could produce green hydrogen at
  - less than USD 2.5/kgH2 in the coming five to ten years; and
  - less than USD 1/kgH2 before 2040 in a scenario with an ambitious electrolyser deployment.

Hydrogen is an energy carrier – not a source
You need energy to produce hydrogen

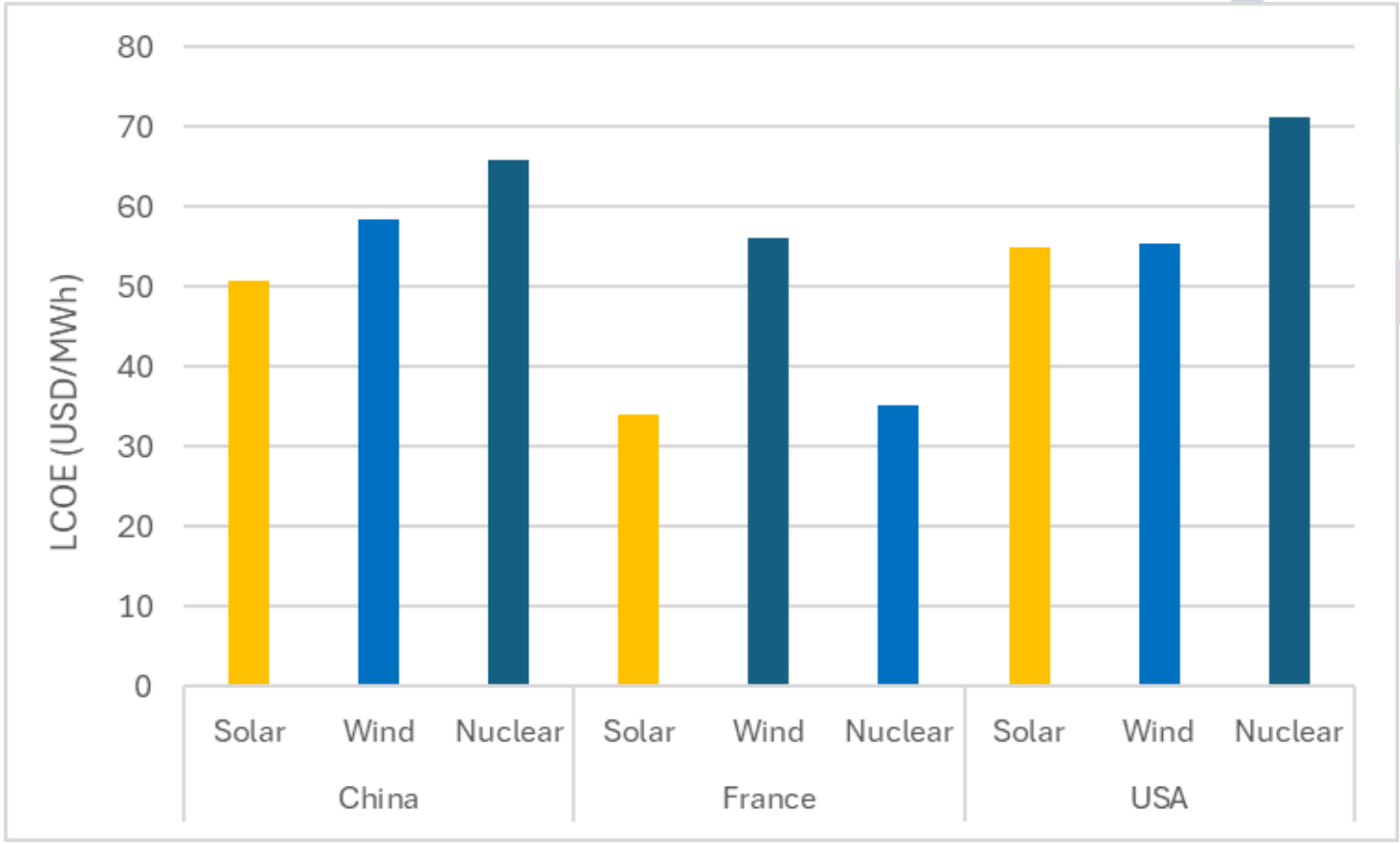




IRENA, 2022

Role of Nuclear in Net Zero Transition

- Nuclear power is emissions free and so may can contribute to net zero transition
- Safety and risk has been the key reason for ban in many countries
- A new breed called SMRs, is expected to be safer and less exposed to dangers



Based on data from the Nuclear Energy Agency (NEA, 2020)

Thailand's 2030, 2050 and 2065 goals

- Thailand has been leading by examples in this region with ambitious renewable energy and energy efficiency targets
- Thailand is on track to achieve 2030 targets for SDG 7 and NDC (unconditional)
- Thailand has announced the goal of carbon neutrality by 2050 and net zero emissions by 2065

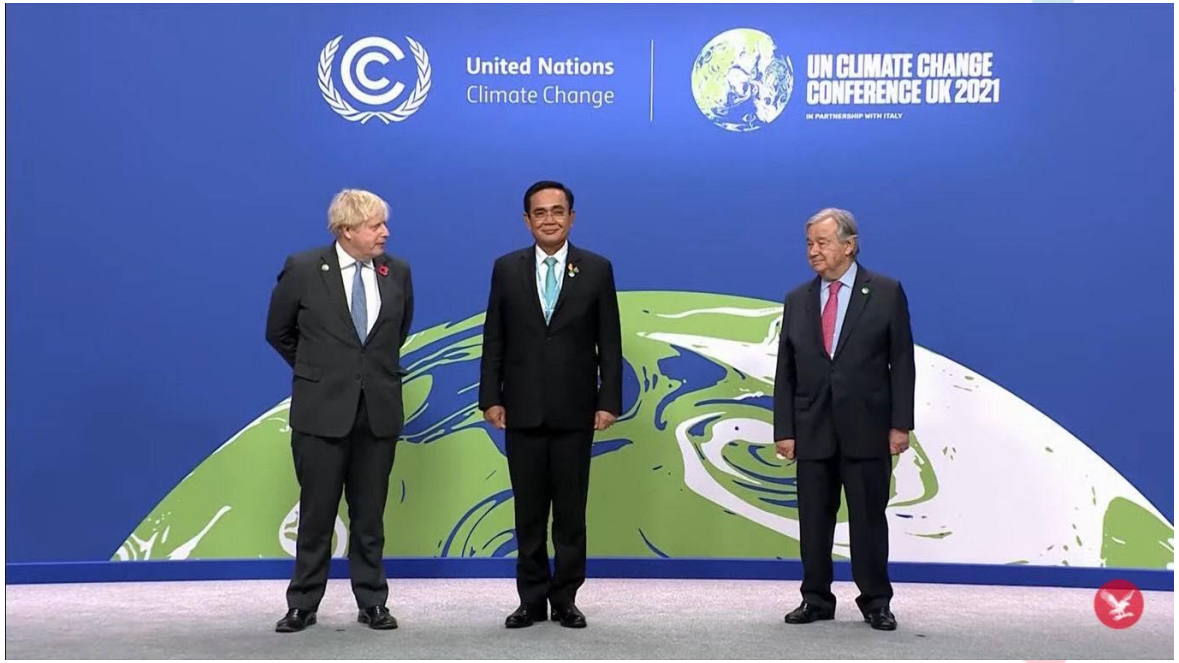
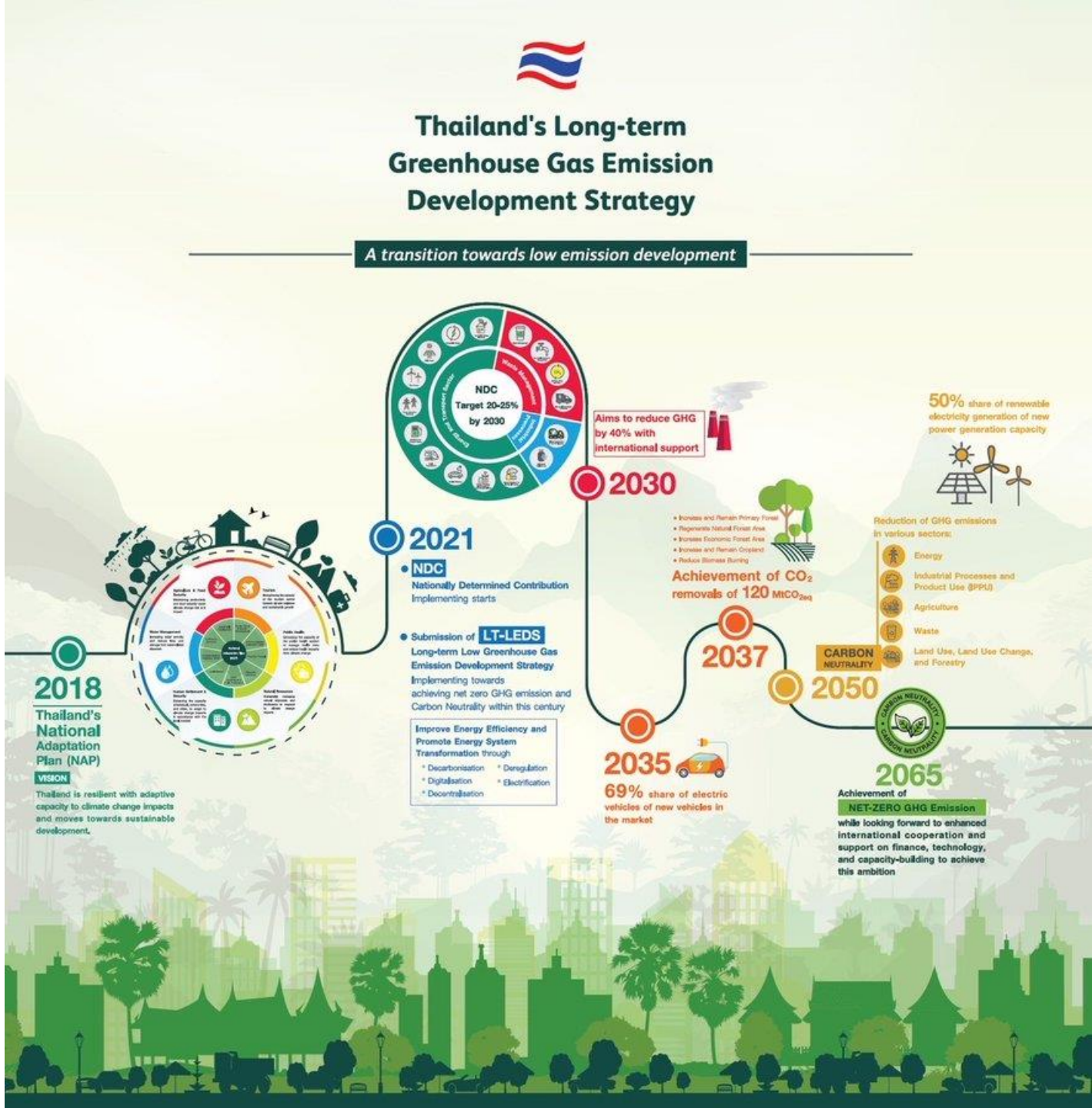


Image source: https://bkktribune.com/thailand-to-reach-net-zero-emissions-by-2050-if-supported-pm-prayut/

Plans for 2050 and 2065

- 40% emissions reduction by 2030
  - Conditional NDC target
- Carbon neutrality by 2050
  - 50% share of RE in electricity generation
  - 69% EVs by 2035
- Net zero emissions by 2065

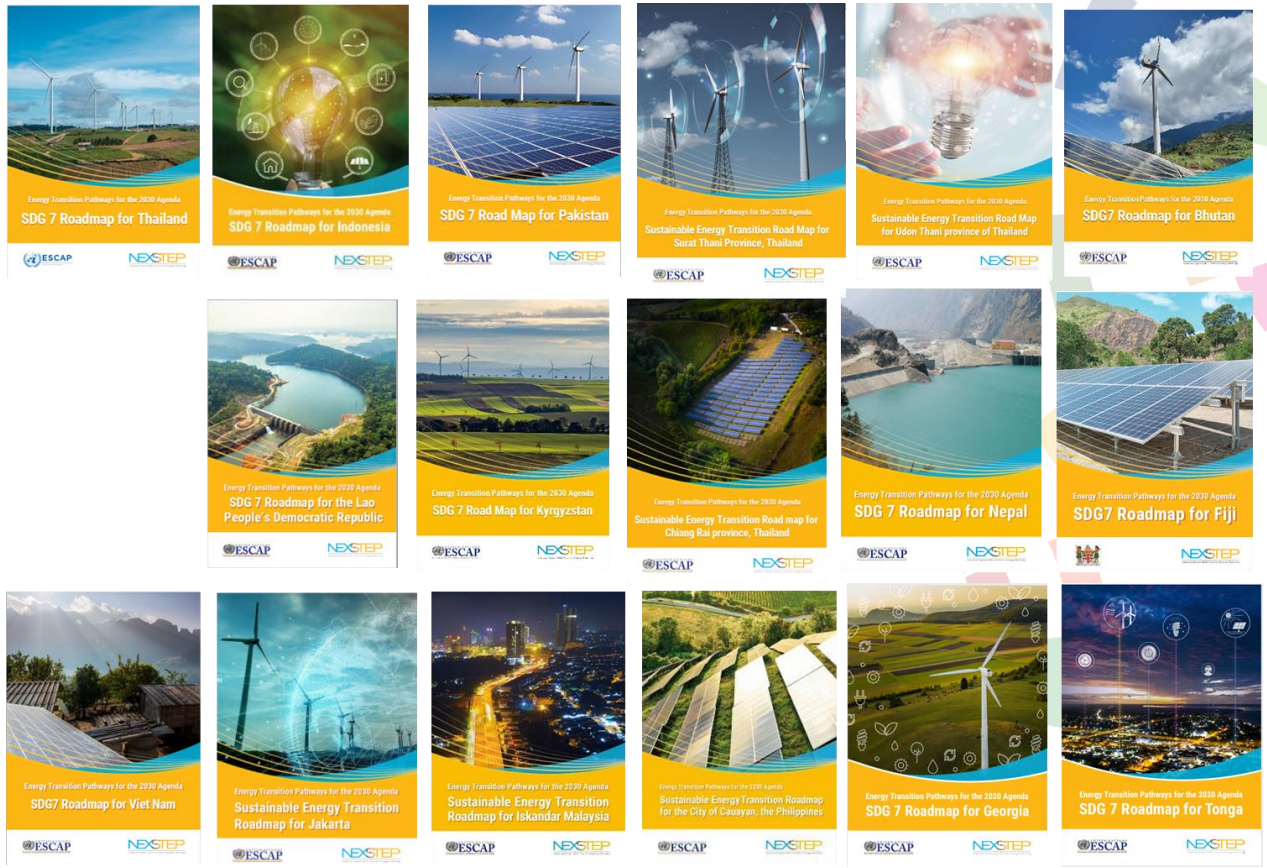


UNESCAP, 2024

NEXSTEP
National Expert SDG Tool for Energy Planning

ESCAP's support with Net Zero Transition

- ESCAP has been supporting countries with SDG 7 Road Map, containing modelling and analysis for SDG 7, NDC and Net Zero Carbon emissions
- Using the NEXSTEP framework
  - An integrated tool to assist policymakers make informed policy decisions on long-term energy sustainable energy transition
- NEXSTEP is now being widely used by ESCAP member States to develop national and sub-national roadmaps



- 16 national and 8 sub-national roadmaps developed
- Several others are ongoing

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NEXSTEP
National Expert SDG Tool for Energy Planning

NEXSTEP for Net Zero Carbon Planning

- In addition to SDG7 roadmap development, NEXSTEP has the ability to analyse and develop Net Zero Carbon scenario
- Scenario for decarbonisation of the power sector is included in most roadmaps
- A Net Zero Carbon scenario for 2050 has also been developed for most roadmaps

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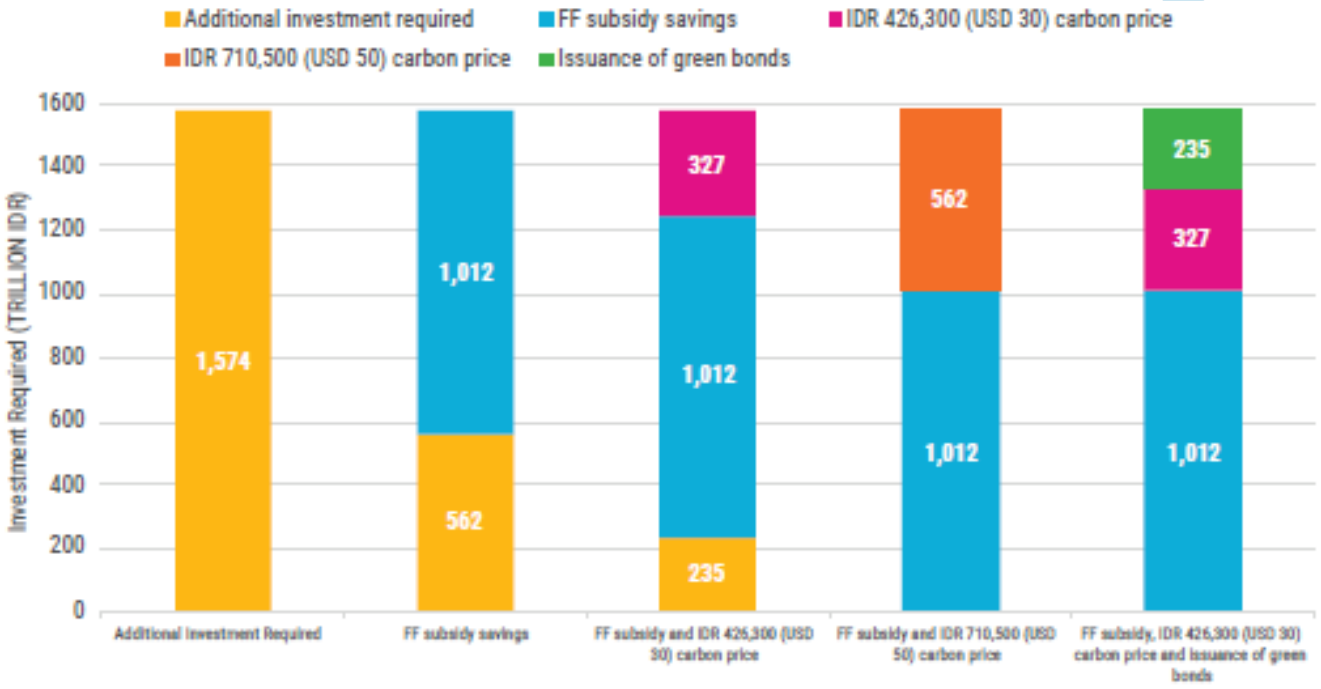
Examples – Decarbonisation scenario for Indonesia

- Key findings
  - Lifecycle costs of renewables, such as hydropower, geothermal, solar and biomass, are cheaper than coal-fired technologies.
  - Investments in new coal-fired power generation are no longer cost-effective compared with renewables and risks of stranded asset
- Recommendations
  - New investment in coal-fired power plant should be stopped to avoid emissions lock-in and economic risks.
  - Phasing out fossil fuel subsidy and/or a price on carbon can eliminate the additional cost of increased RE



Examples - Towards Net Zero scenario for the City of Jakarta

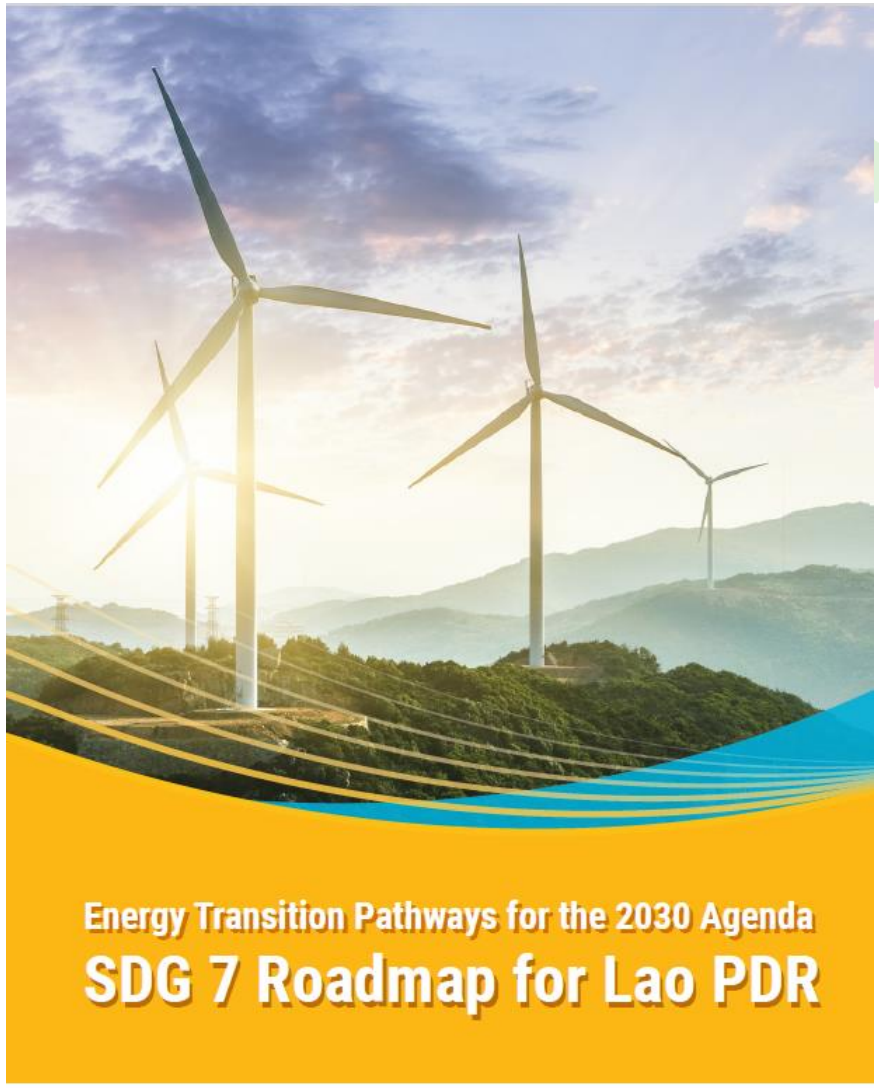
- Increased EE measures substantially in the demand sector, including
  - Gradual replacement of LPG cookstove with induction type electric cookstove
  - Introduction of electric motorbikes
  - Increase in bicycling

- Assessed the potential for 100% RE-based electricity purchase, e.g. through RE auction
- 100% RE-based electricity supply will cost less than even 50% RE-based supply.

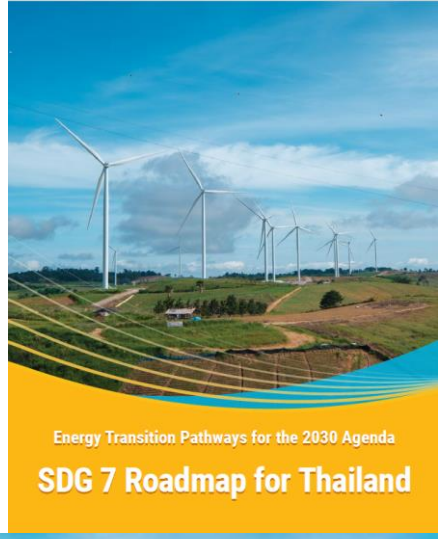
	Segments of electricity import	**Total 2020-2030 (million US$)**
Option 1: 50% renewable energy mix	Cost of 50% RE-based supply	5,220
	Cost of current mix-based supply	10,771
	Total cost of import	15,991
Option 2: 100% renewable energy mix	Cost of 100% RE-based supply	10,440
	Cost of current mix-based supply	-
	Total cost of import	10,440

Example Decarbonisation scenarios for Lao PDR

- Coal-fired power is responsible for 77% of energy sector emissions
- Emissions will reduce by 84% compared to the current policy settings
- Possibility of a big market for 100% RE-based electricity as Lao PDR will exports about 90 TWh electricity per year by 2030
- A RE premium on the export tariff (50% more than the current tariff of US$ 0.05/kWh) can result in net benefits of US$ 27 billion, an increase of 55% compared to the current policy scenario



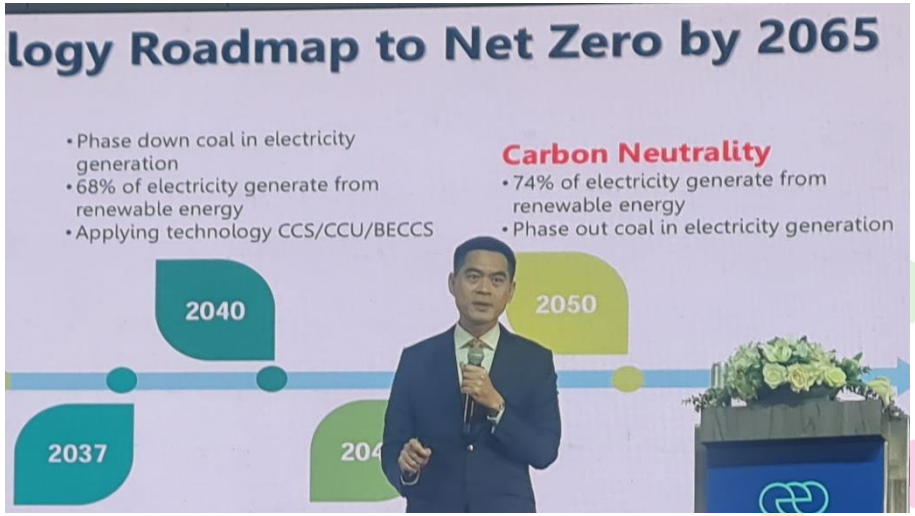
Net Zero Carbon analysis for Thailand



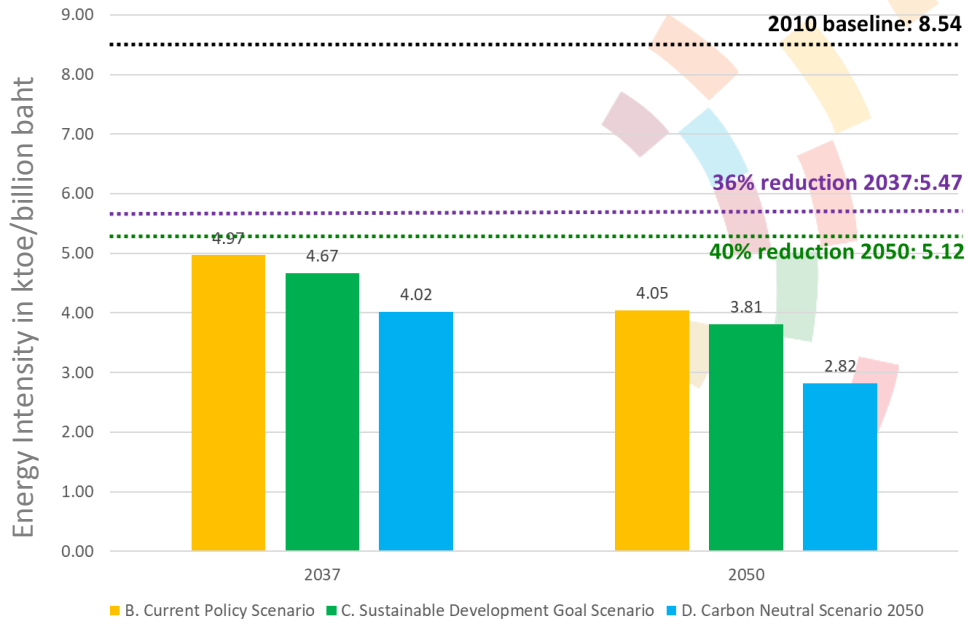
- **Sustainable energy transition roadmaps** for three provincial authorities
  - Surat Thani, Udon Thani and Chiang Rai
- The **national SDG 7 Road Map** has also been developed and launched this week on 8 July, in collaboration with the Ministry of Energy.

Thailand: Important measures beyond 2030

- To achieve its carbon neutrality in 2050, Thailand needs to focus on reducing carbon emissions from the energy sector.
- Building on the SDG scenario and extending the timeframe to 2050, this scenario suggests some additional measures.

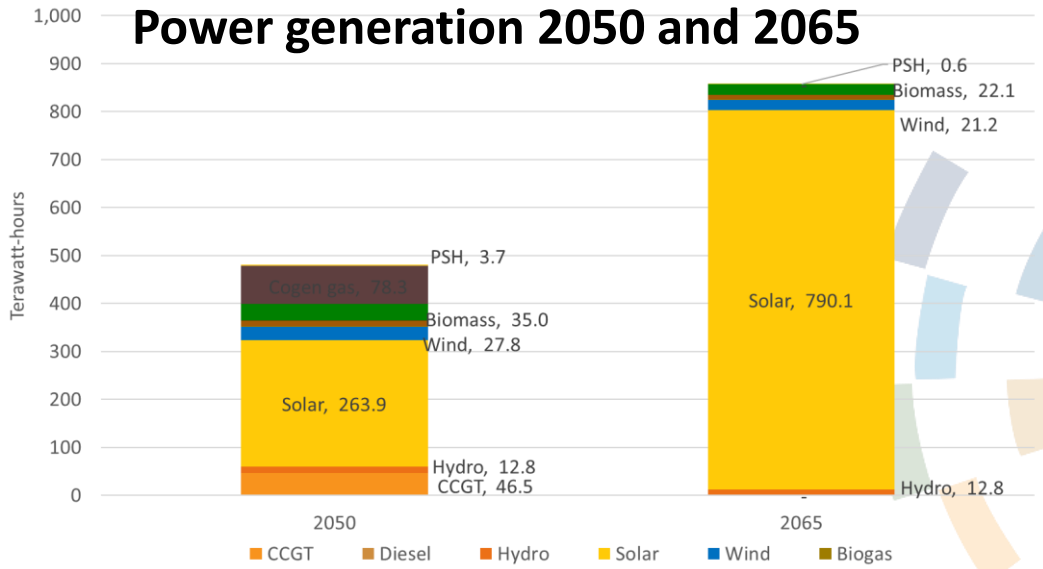


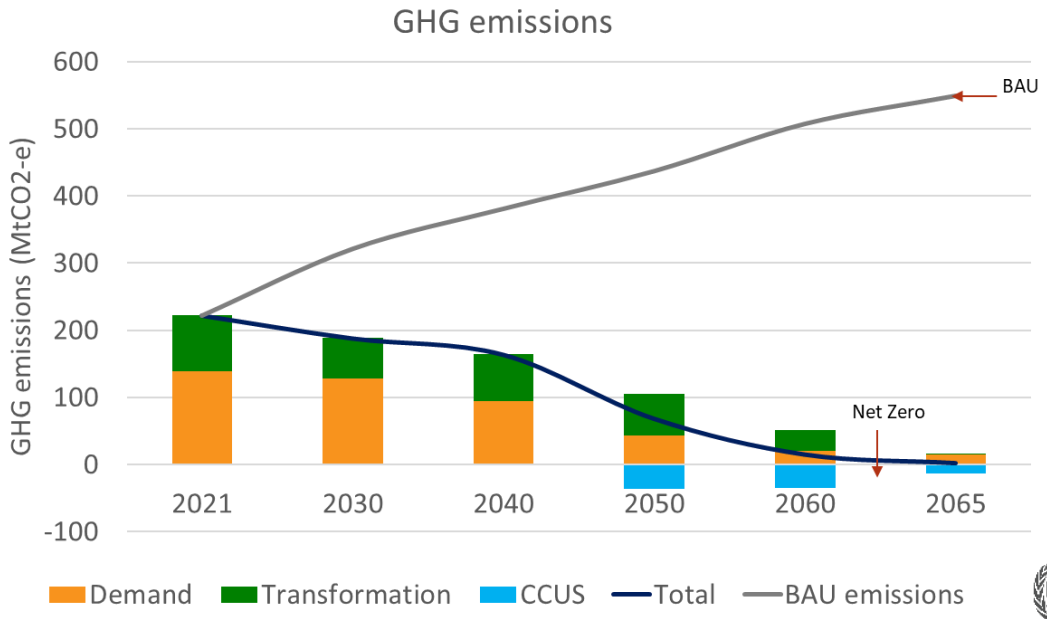
Residential and commercial sectors	Transport sector	Industry and agriculture sectors	Power sector
• 100% electric cooking • Efficient electric appliances • Improvement of thermal efficiency in all building types	• Phasing down ICE engines • Higher share of electric vehicle	• Efficient electrical equipment • Fuel substitution to, biomass, and/or biofuel • Solar pumping for irrigation	• Coal phase down by 2040 • Coal phase out by 2050 • Increasing share of RE capacity to 74% by 2050 • Carbon removal technologies



GHG emissions and power generation scenarios for the carbon neutrality and net zero

- Emissions will drop rapidly after 2040 due to
  - Phasing out coal-based power generation
  - Phasing down ICEs
  - Increasing share of EVs
  - Increasing RE in power generation
  - CCS application

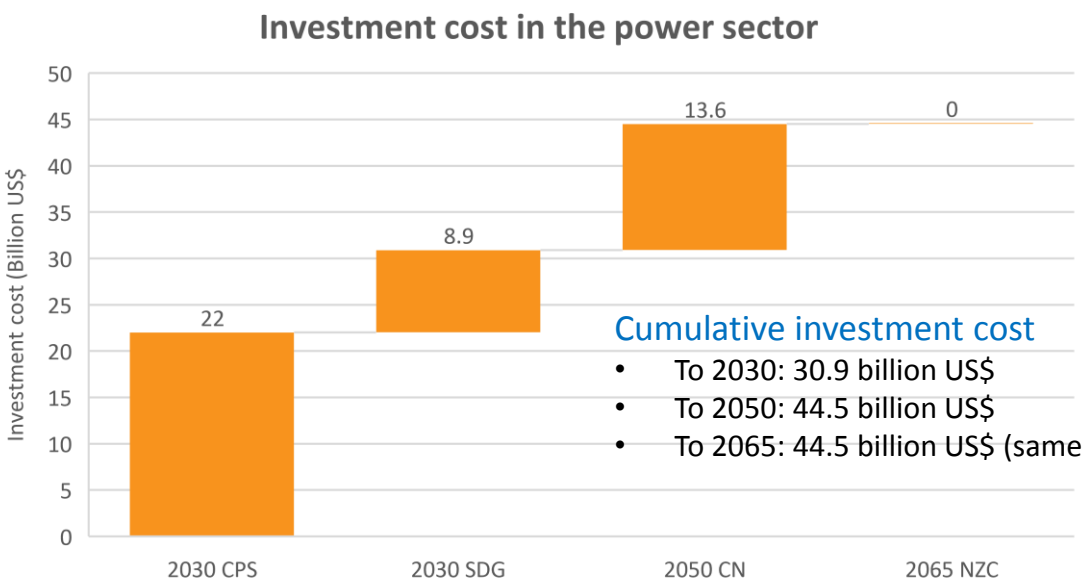




Thailand: Financial parameters

Carbon Neutrality and Net Zero

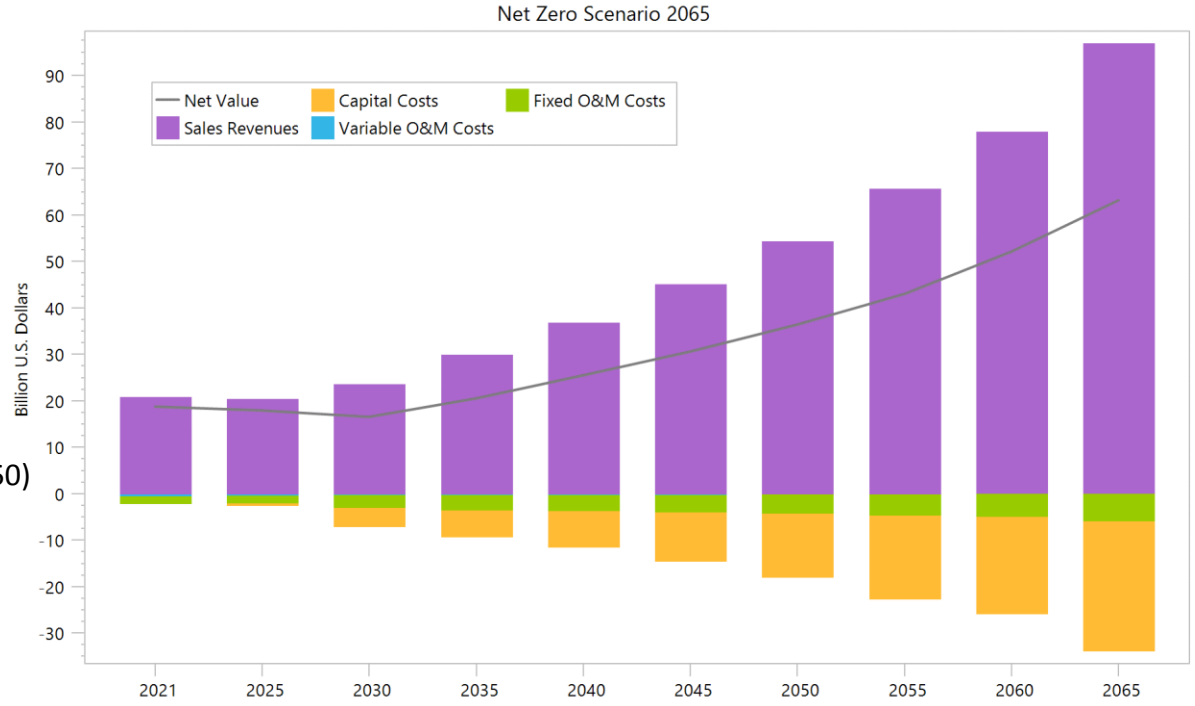
Investment cost



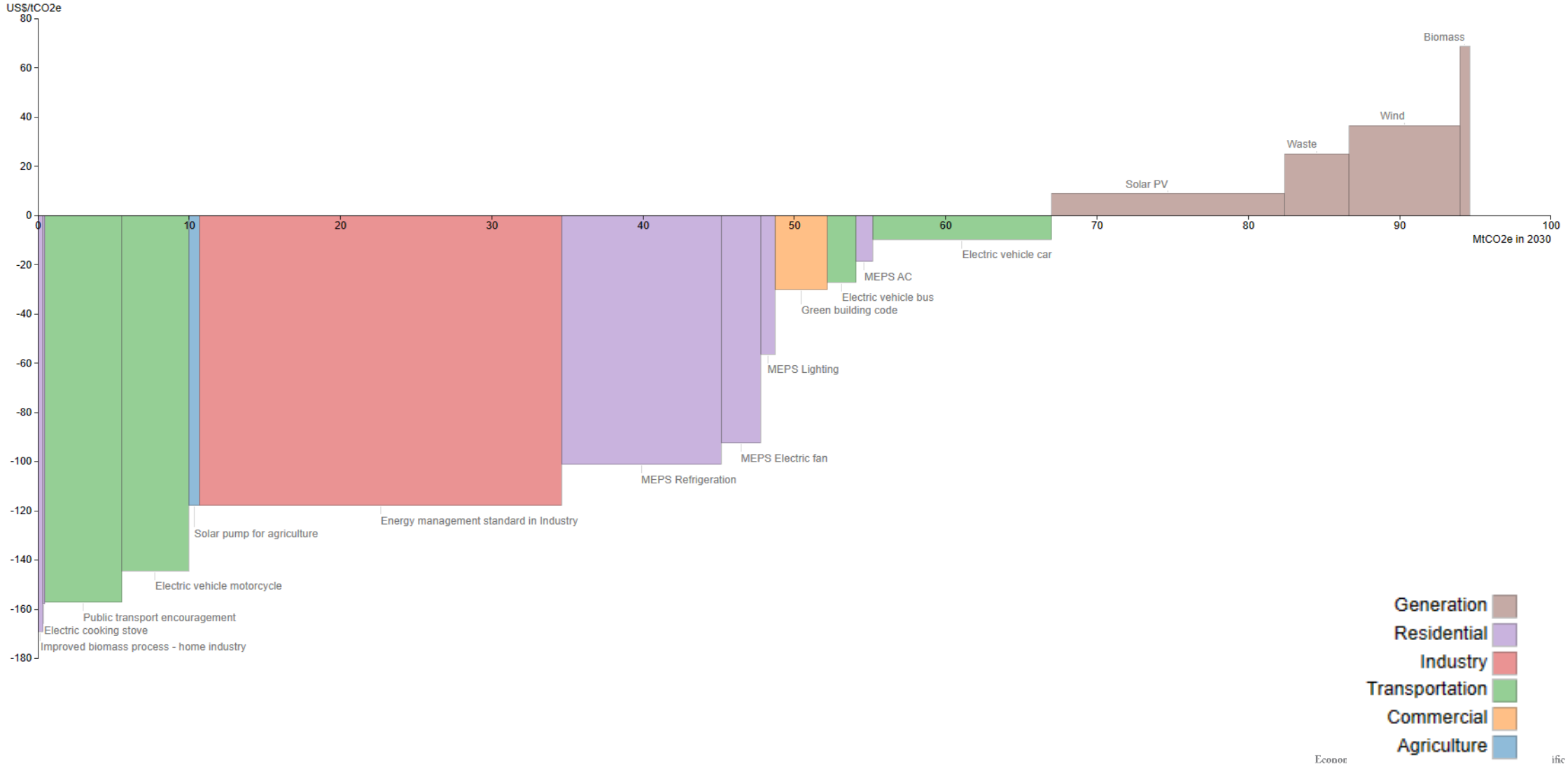
Cumulative investment cost

- To 2030: 30.9 billion US$
- To 2050: 44.5 billion US$
- To 2065: 44.5 billion US$ (same as 2050)

Net financial return



Marginal abatement cost curve (MACC) for Thailand



THANK YOU

QUESTIONS?

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