

# 2-1. APEC Energy Demand and Supply Outlook: Introduction and Scenario Definition

## **APERC Workshop**

The 70<sup>th</sup> Meeting of the APEC Energy Working Group (EWG70)  
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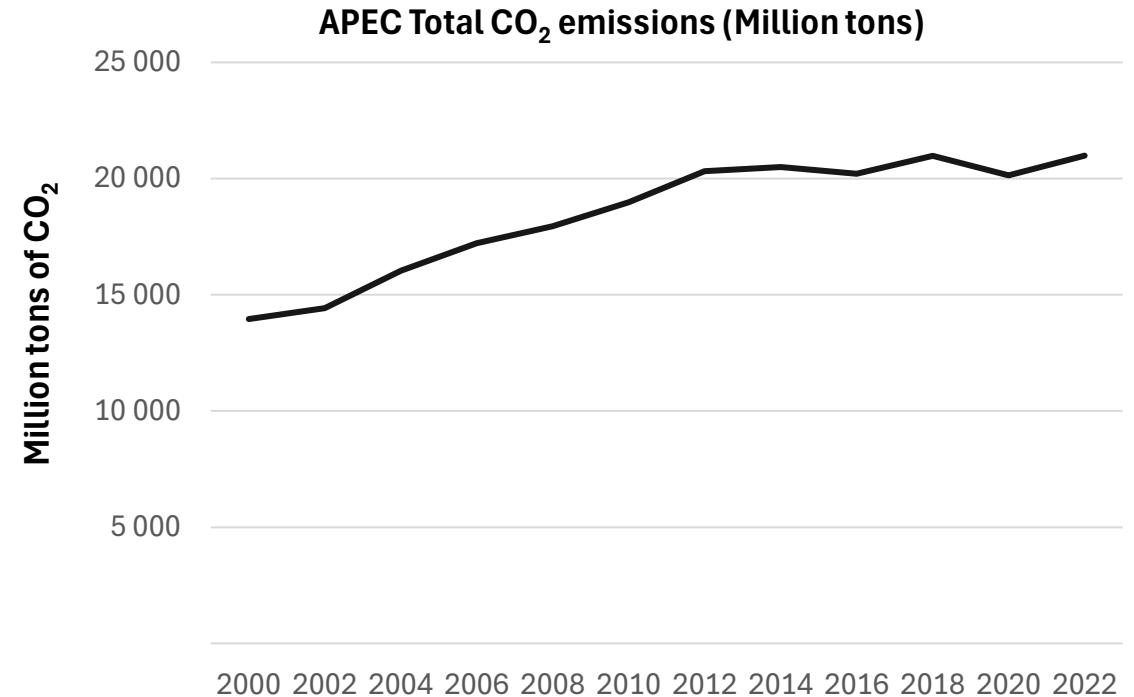
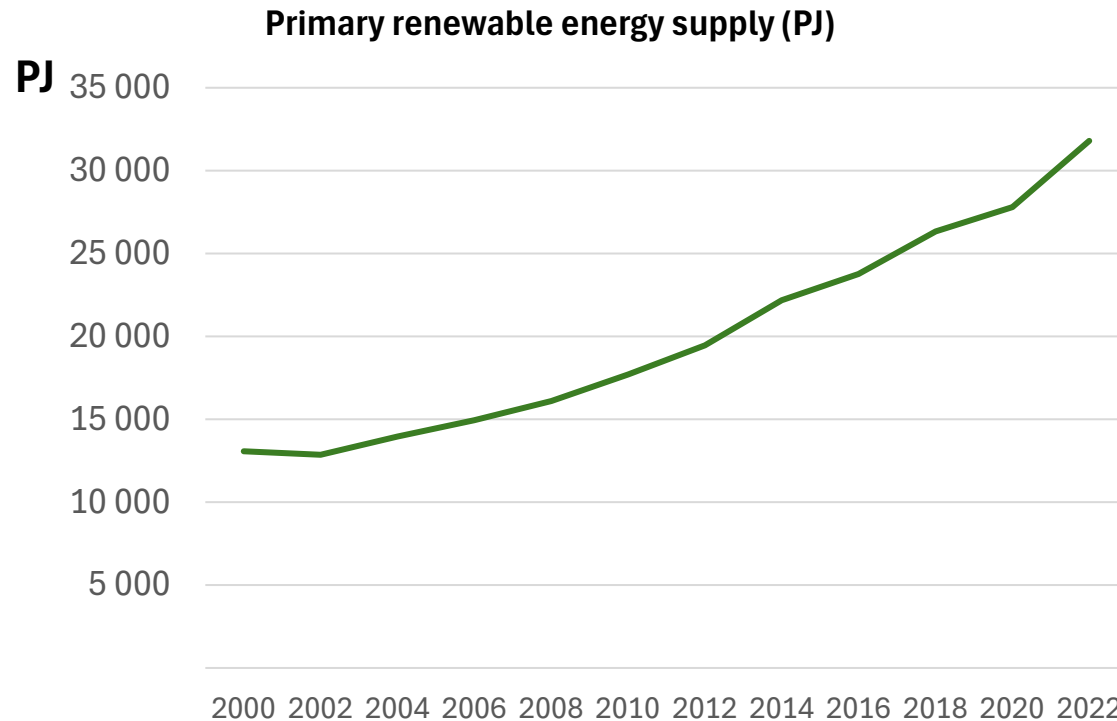
# Outline

- **Energy Transition Challenges**
- Overview: APEC Energy Demand and Supply Outlook, 9<sup>th</sup> Edition
- Energy modeling improvements
- Summary

# Most APEC economies have adopted ambitious decarbonization targets

Economy	2030 Reduction target	Economy	2030 Reduction target
<b>Australia</b>	Reduce GHG emissions by 43% below 2005 levels by 2030.	<b>New Zealand</b>	Reduce GHG emissions by 50% by 2030 from 2005 levels.
<b>Brunei Darussalam</b>	Reduce GHG emissions by 20% relative to BAU levels by 2030.	<b>Papua New Guinea</b>	Carbon neutrality within its energy industries sub-sector by 2030.
<b>Canada</b>	Reduce GHG emissions by 40 – 45% below 2005 levels by 2030.	<b>Peru</b>	Reduce GHG emissions by 30% relative to BAU levels by 2030. Further reduce up to 40%, subject to international support.
<b>China</b>	Peak CO <sub>2</sub> emissions before 2030. Reduce CO <sub>2</sub> emissions per unit of GDP by over 65% from 2005 level by 2030.	<b>The Philippines</b>	Reduce GHG emissions by 75% relative to BAU levels by 2030 (2.71% unconditional, and 72.29% conditional).
<b>Chile</b>	Peak GHG emissions by 2025. GHG emissions level of 95 million tonnes CO <sub>2</sub> e by 2030.	<b>Singapore</b>	Reduce GHG emissions to around 60 million tonnes CO <sub>2</sub> e in 2030.
<b>Hong Kong, China</b>	Reduce emissions by 26 – 36% by 2030 below its 2005 levels.	<b>Russia</b>	Reduce GHG emissions by 70% relative to 1990 levels by 2030.
<b>Indonesia</b>	Reduce GHG emissions by 31.9% from BAU levels by 2030. With int'l support, increase reduction by 43.2% by 2030.	<b>Chinese Taipei</b>	Reduce GHG emissions by 50% relative to BAU levels by 2030.
<b>Japan</b>	Reduce GHG emissions by 46% by 2030 relative to 2013 levels. Increase efforts to further reduce by 50%.	<b>Thailand</b>	Reduce GHG emissions by 30% relative to BAU levels by 2030. Further reduce up to 40%, subject to enhanced support.
<b>Korea</b>	Reduce GHG emissions by 40% by 2030 from its 2018 levels.	<b>United States</b>	<del>Reduce its GHG emissions by 50 – 52% below 2005 levels by 2030.</del> Withdraw from Paris Agreement; phase out IRA subsidies for EVs, wind, and solar; open more acreage to oil and gas development.
<b>Malaysia</b>	Reduce GHG emissions intensity (against GDP) by 45% in 2030 from 2005 levels.	<b>Viet Nam</b>	Reduce GHG emissions by 15.8% relative to BAU levels by 2030. Further reduce up to 43.5%, subject to international support.
<b>Mexico</b>	Reduce GHG emissions by 30% and 35% relative to BAU levels by 2030 (unconditional and conditional, respectively).		

# The energy transition quandary

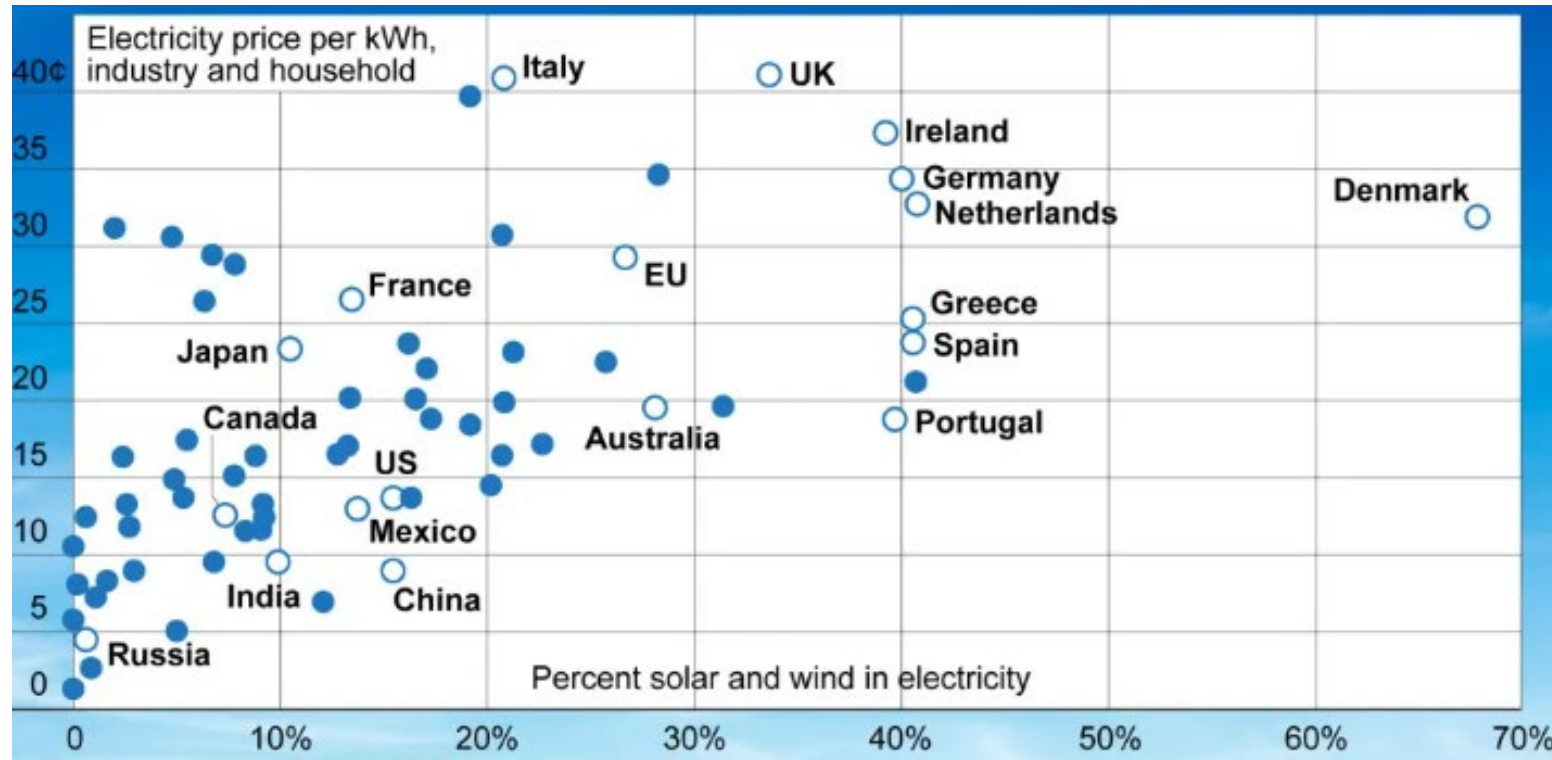


- *APEC energy intensity continues to decline and the growth in renewable energy supply is accelerating.*
- *Renewable energy increased 63% from 2012 to 2022, but CO<sub>2</sub> emissions have remained relatively constant over the same period.*

# Renewable energy affecting grid reliability

Event	Variable Renewable Energy Complications
<b>2016 South Australian Blackout</b>	Effects of major storm were exacerbated by grid's reliance on wind farms which shut down during high winds. Lack of "inertia" in the system also led to cascading failures. Black start required.
<b>2019 United Kingdom Blackout</b>	Lightning strikes caused an offshore wind farm to trip. Low wind speeds prior to the event combined to create a blackout for 1 million customers.
<b>2020 California Blackouts</b>	Operators struggled to manage the "duck curve" in the evenings after 9 gas-fired plants and one nuclear power plant were closed due to environmental considerations and increased confidence in wind and solar capacity.
<b>2021 Texas Winter Storm Blackout</b>	Icing and low wind speeds froze wind turbines which combined with reduced gas fired generation and peak load to create blackout.
<b>2022 California Heatwave Outages</b>	California's push for 60% renewables by 2030 amplified challenges, as insufficient storage and dispatchable power couldn't compensate for VRES variability.
<b>2024 Victorian Blackout</b>	Wind farms temporarily offline due to high wind speeds. 40% renewable share complicated grid stabilization, as variable output required careful load shedding to prevent a system-wide failure.
<b>2024 UK Low Wind Events</b>	Low wind speeds. UK's 30% wind power share exposed reliability risks caused by insufficient storage and interconnection capacity.
<b>2025 Heathrow Airport Substation Fire</b>	Still under investigation, extreme day-night thermal cycling associated with solar can degrade transformers not designed for these conditions.
<b>2025 Spain and Portugal Blackout</b>	Report by the Transmission System Operator indicates that an inverter associated with a photovoltaic solar plant induced voltage oscillations that triggered a cascade of protective equipment disconnections.

# Increasing wind and solar share raises total system costs



Source: IEA Data, Bjorn Lomborg

- Bjorn Lomborg estimates that every 10 percentage point increase in solar and wind share raises systems costs by 4 cents per kWh
- Richard Schmalensee states that relying heavily on wind and solar complicates grid management requiring electricity storage and backup generation that increase total system costs.



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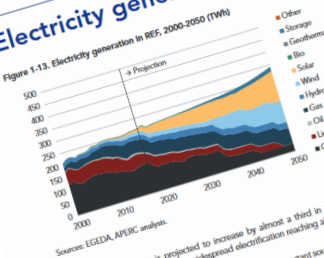
# APEC Energy Demand and Supply Outlook

- Priority task for APERC under the APEC Energy Action Programme adopted by leaders in 1995
- Provide analyses and policy insights about future energy demand and supply in APEC economies
- Separate energy and emissions projections for each APEC member economy
- 2022 EGEDA data are used as the base year for modeling.
- APERC researchers have developed and are now sharing with economies the projections for the **9th edition of the Outlook** to be published in **October 2025**, with a forecast horizon to **2060**



## Electricity generation

Figure 1-13. Electricity generation in REF, 2000-2050 (TWh)



Sources: EGEDA, APERC analysis.

- Electricity generation is projected to increase by almost a third in REF three-quarters in CN, owing to widespread electrification reaching almost all of the 21 APEC economies.
- Coal (including lignite) has historically been the most important source of electricity in CN, though its use has declined steadily since the 2000s. A small amount of coal generation remains in the 2000s.
- Both coal and lignite still provide important baseload generation for Australia. Its relative prominence diminishes steadily through the 2000s.
- Australian residential rooftop solar has posted world-leading growth, reaching 1.9 GW in 2018, and is projected to reach 10 GW by 2050.
- Utility scale solar surpasses rooftop generation in 2018 and will continue to grow strongly in both scenarios.
- The Sun Cable project, which will export electricity from the Sun Belt to the East Coast, is likely to be completed by 2025.
- Domestic natural gas supply is likely to be met by 2050.

## Components of CO<sub>2</sub> emissions

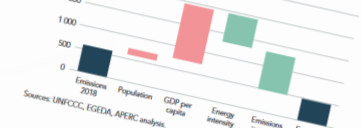
Figure 7-51. CO<sub>2</sub> emissions components in REF, 2018 and 2050 (million tonnes)



Sources: UNFCCC, EGEDA, APERC analysis.

- Indonesia emitted just under 600 million tonnes of CO<sub>2</sub> in 2018, which amounted to less than 2% of APEC CO<sub>2</sub> emissions. Indonesia has low emissions per capita, placing it at the bottom of the 21 APEC economies.
- In a world with no energy intensity or emissions intensity improvements, Indonesia's projected population and GDP growth would lead to CO<sub>2</sub> emissions more than tripling out to 2050, to 1.9 billion tonnes. Population increases place upward pressure on emissions, but it is the projected growth in GDP per capita that contributes to the most significant upward pressure on Indonesia's CO<sub>2</sub> emissions.
- In REF, improvements in energy intensity and emissions intensity mean that CO<sub>2</sub> emissions are projected to be less than double to 1.1 billion tonnes in 2050. CO<sub>2</sub> emissions reductions are attributable to energy intensity and emissions intensity in a roughly even split.

Figure 7-52. CO<sub>2</sub> emissions components in CN, 2018 and 2050 (million tonnes)



Sources: UNFCCC, EGEDA, APERC analysis.

- In CN, emissions fall to 484 million tonnes in 2050. This is a fall of almost 20% from 2018 levels, and is 50% lower than emissions in REF.
- Emissions intensity improvements in CN are double that which occur in REF. These improvements are associated with fuel switching and CCS technologies which are present in Indonesia in CN. Energy intensity improvements are 50% larger in CN than in REF. The improvements are fostered by improved market incentives and assumed greater policy support by the Indonesian government in CN.
- To compensate for the positive CO<sub>2</sub> emissions by the energy sector in CN, CO<sub>2</sub> emissions sinks from the non-energy sectors, such as land use and forestry sector, are needed to achieve carbon neutrality ambitions.

Note: The above charts are a representation of the Kaya identity which is  $CO_2 \text{ emissions} = \text{Population} \times \frac{\text{GDP}}{\text{Population}} \times \frac{\text{Energy supply}}{\text{GDP}} \times \frac{CO_2 \text{ emissions}}{\text{Energy supply}}$

APEC Energy Demand and Supply Outlook 8th Edition, Vol. 2 | 235



# Scenarios for the 9th edition of the Outlook

## The Reference scenario (REF)

- Economy-specific pathways based on historical trends, recent developments, and APERC's assumptions about the evolution of the energy system within each APEC economy, while acknowledging technical restraints. REF offers a baseline to compare with TGT projections.

## The Target scenario (TGT)

- A hypothetical pathway where each economy achieves its energy-related policy targets regardless of cost-effectiveness. When implementation details are lacking, assumptions are inferred from the targets themselves or emissions-related goals..

# Goal: Provide key insights for policy-makers

The 9<sup>th</sup> edition of the *Outlook* provides projections for two scenarios in four key areas:

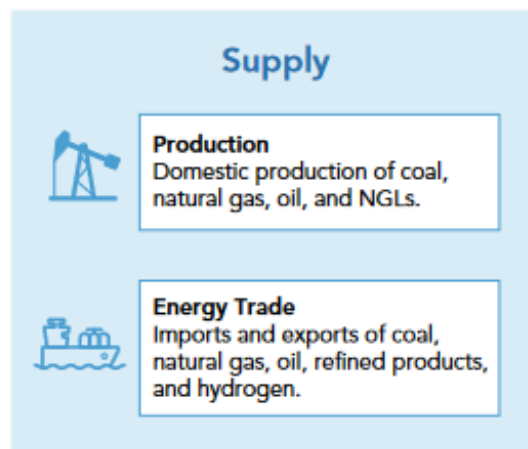
1. CO2 emissions
  - Both REF and TGT scenarios
2. Dependence on energy imports
  - Share of total primary energy supply
3. Electric grid reliability
  - Dispatchable versus non-dispatchable power sources
4. Cost associated with the energy transition
  - Focus on the power and hydrogen sectors

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# New and renewable energy technologies have implications throughout the energy system

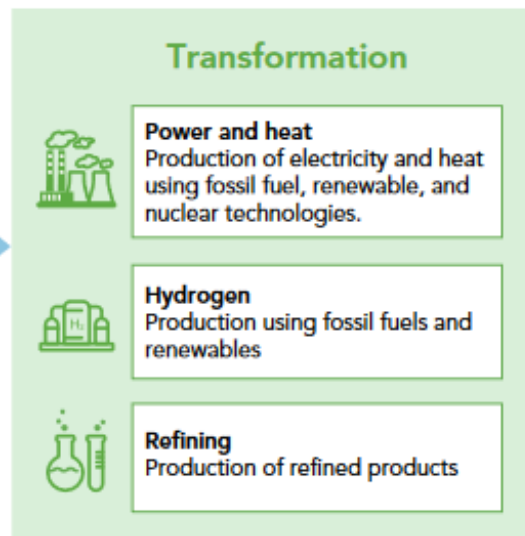
Production of  
hydrogen, ammonia  
and e-fuels



Trade in hydrogen,  
ammonia and e-fuels

Higher  
share of VRE

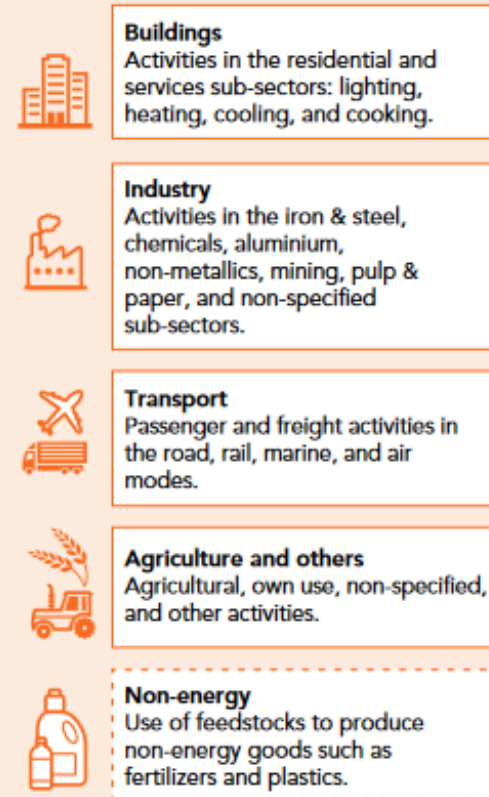
Carbon Capture  
and Storage



Grid storage  
technologies

Blending hydrogen with  
gas; ammonia with coal

**Demand**



Separate electricity  
projections for data  
centres

Hydrogen based  
steel production

EVs, hydrogen  
powered trucks

Synthetic fuels

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# Summary

- The energy transition is more difficult than many had assumed.
- Balancing energy sustainability, security, and affordability is key.
- APERC made improvements to our model to address energy transition issues.
- We have projected four key parameters for two scenarios:
  - CO<sub>2</sub> emissions
  - Energy import dependence
  - Dispatchable power generation needs
  - Required capital, fixed, and operating costs in the power and hydrogen sectors
- We hope these projections will be helpful for policymakers



**Thank you.**

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