

Decarbonization of ASEAN energy systems: Necessary investments and economic impacts

Nov. 14, 2022

UNFCCC COP 27 Official Onside Event by IEEJ & KAPSARC

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| Model analysis

- Background
- Methodology
- Results for ASEAN
- Additional costs for CN

| Economic impacts under financial constraints

| Recent efforts to fill the financial gaps

AETI (Asia Energy Transition Initiative)

- | Announced by METI in May 2021; “Diverse and pragmatic energy transition”
- | Convened the Asia Green Growth Partnership Ministerial or AGGPM meeting in Oct. 2021 and Sept. 2022.

Asia Energy Transition Initiative (AETI)

1. **Support for formulating energy transition roadmaps**
2. Presentation and promotion of the concept of Asia Transition Finance
3. US\$10 billion financial support for renewable energy, energy efficiency, LNG, CCUS and other projects
4. Technology development and deployment, utilizing the achievement of Green Innovation fund
5. Human resource development, knowledge sharing and rule-making on decarbonization technologies

Model overview: IEEJ-NE (New Earth) ASEAN Model

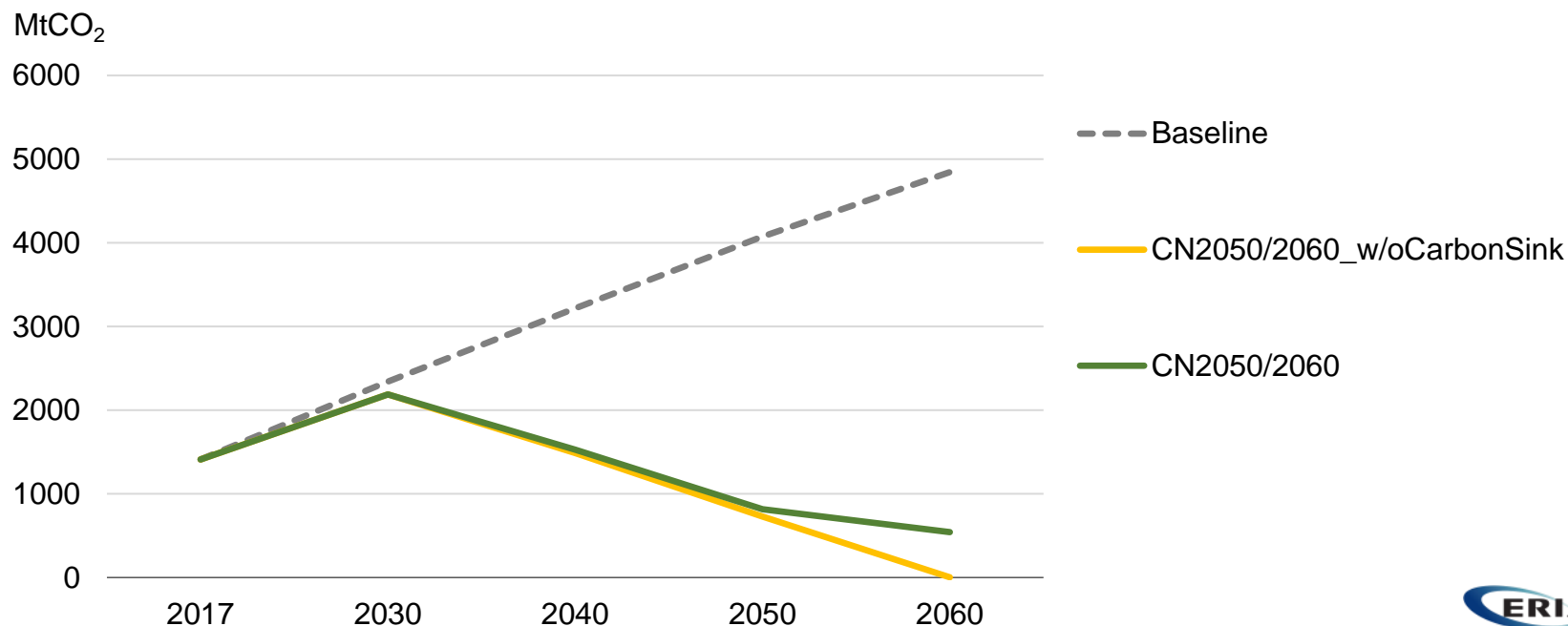
Regional division	10 ASEAN countries (10 nodes)
Time period	2017-2060 with representative years of 2017, 2030, 2040, 2050 and 2060
Objective function	Discounted total system cost for ASEAN
Discount rate	8%
Temporal resolution	2190 time slices (4-hourly resolution) per year for electricity supply and demand balance
Number of technologies	350+ technologies
End-use sector	<p>Industry: Iron & Steel, Cement, Chemicals, Paper & pulp, Other industries</p> <p>Transport: Light-duty vehicle, Bus & truck, Rail, Aviation, Navigation, Other transport</p> <p>Residential: Light and appliances, Space cooling, Water heating, Kitchen</p> <p>Commercial: Light and appliances, Space cooling, Water heating & Kitchen</p> <p>Other: Agricultural and other energy demand</p>

Case settings

- Baseline** does not assume any emission constraints by 2060.
- CN2050/2060** assumes energy-related CO₂ emission constraints by country and achieves net zero CO₂ emissions with natural carbon sink by 2060 in ASEAN.
- CN2050/2060_w/oCarbonSink** assumes net zero energy-related CO₂ emissions by 2050 in BRN and SGP and by 2060 in the rest of the countries. This is the case we initially assumed.

Note: *CN2050/2060_w/oCarbonSink* is the case we initially assumed. We had discussions with ASEAN countries based on the initial results, and developed *CN2050/2060* reflecting each country's comments.

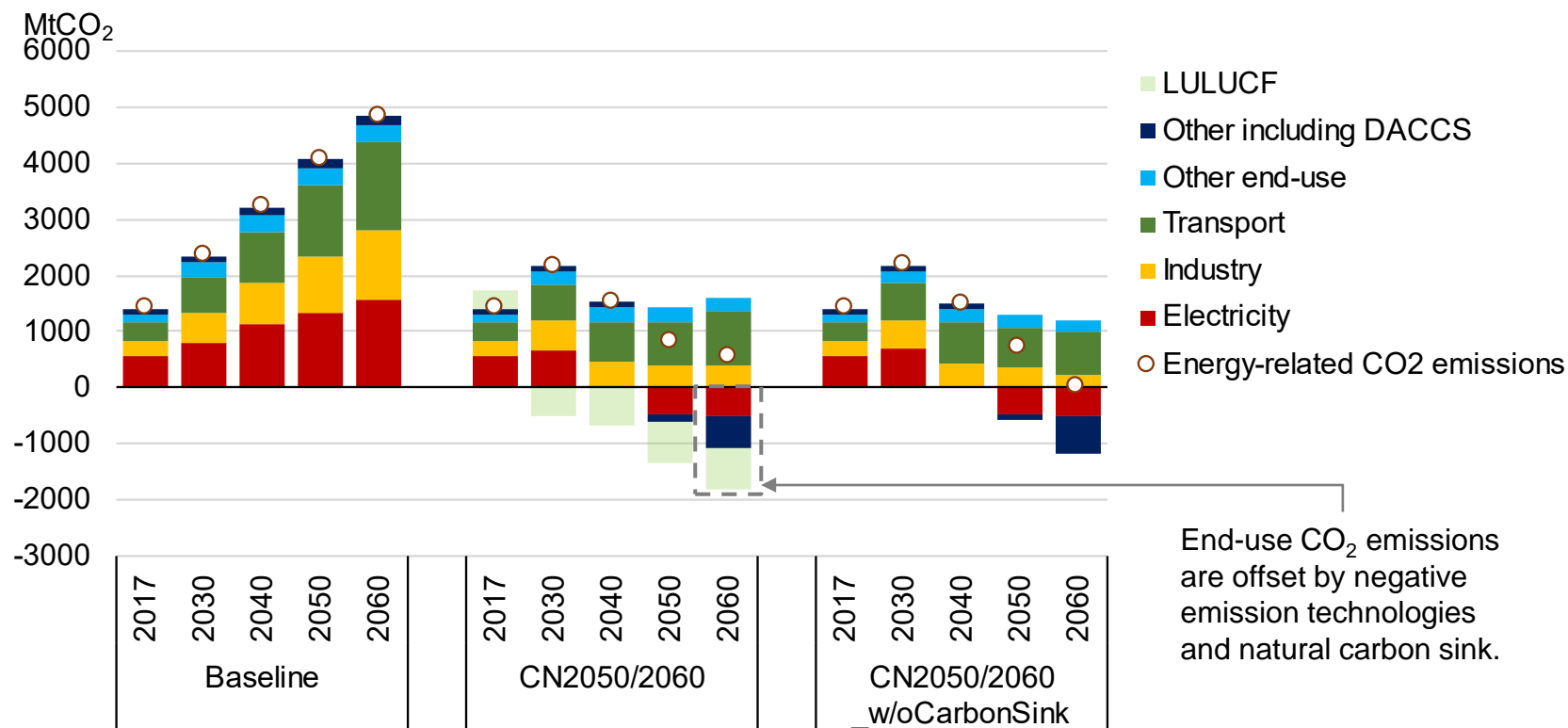
Energy-related CO₂ emission constraints in ASEAN



Sectoral CO₂ emissions

- End-use emissions reduction, combined with negative emission technologies¹, is estimated to be a cost-efficient strategy for ASEAN carbon neutrality.
- Power sector is almost decarbonized by 2040, while the CO₂ from the transport, especially bus and truck, remain in the *CN* cases because of high costs of alternative vehicles.

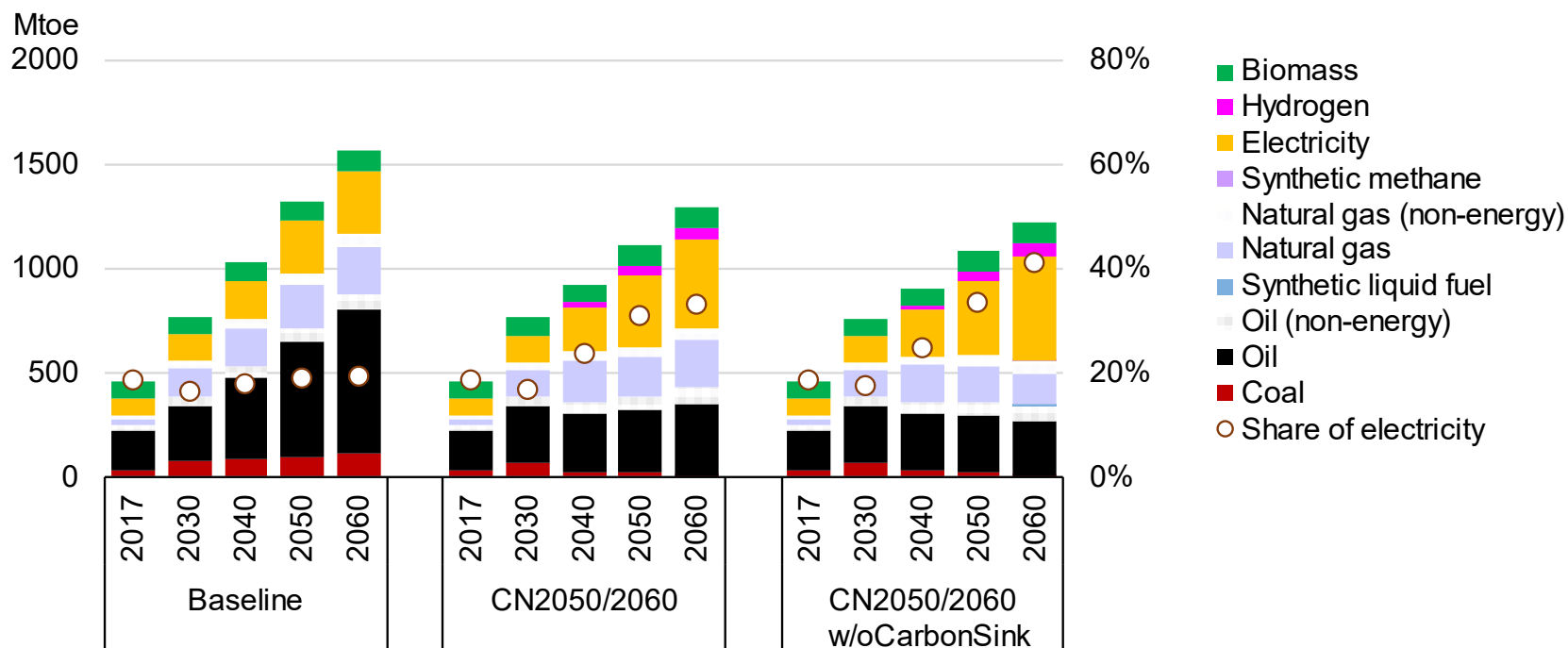
Sectoral energy-related CO₂ emissions in ASEAN



Final energy consumption

- Energy saving and electrification are core strategies for decarbonizing end-use sectors.
- Electricity becomes the largest end-use energy source by 2050.

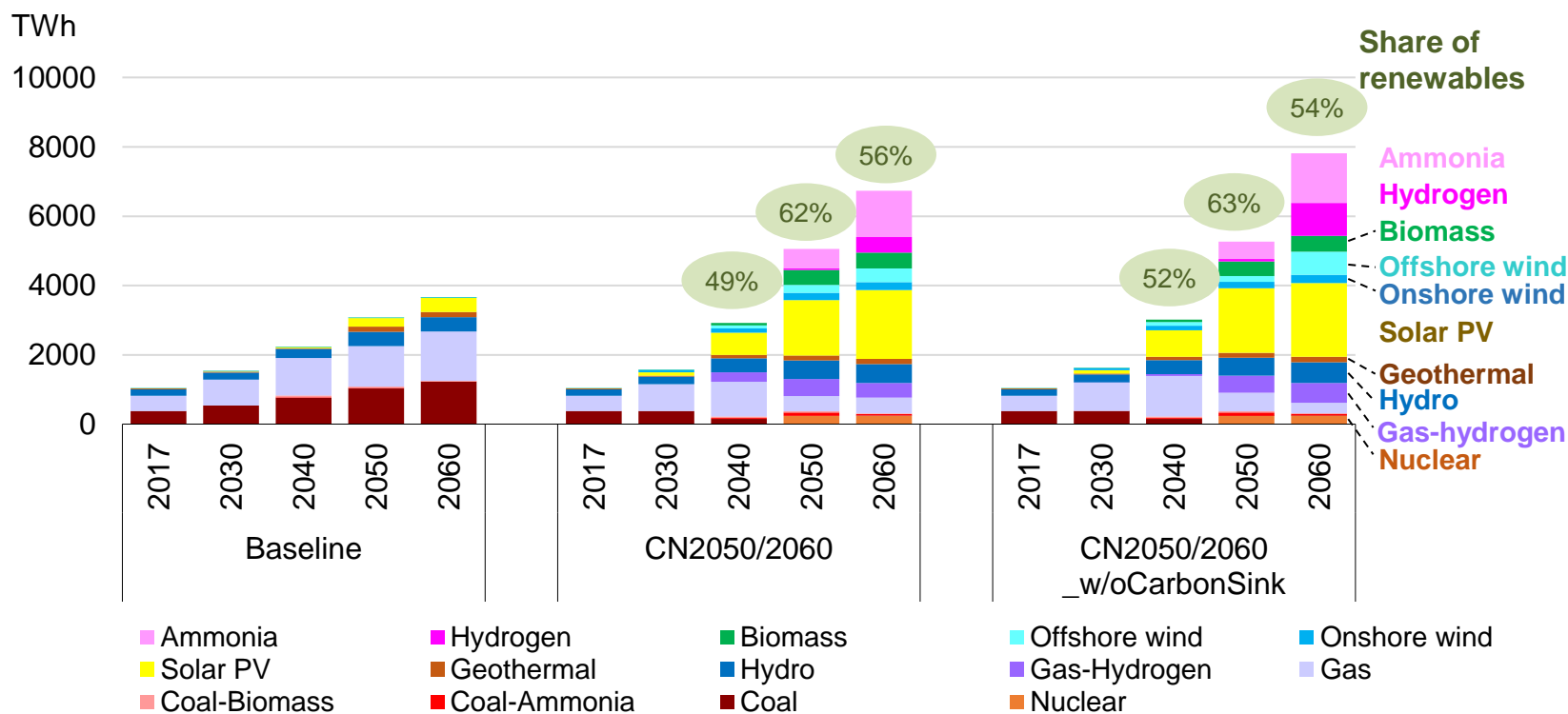
Final energy consumption in ASEAN



Power generation

- Renewables become the main power source in the *CN* cases.
- Hydrogen and ammonia, including co-firing, are also projected to be a part of the power generation mix for net zero emissions by 2060.

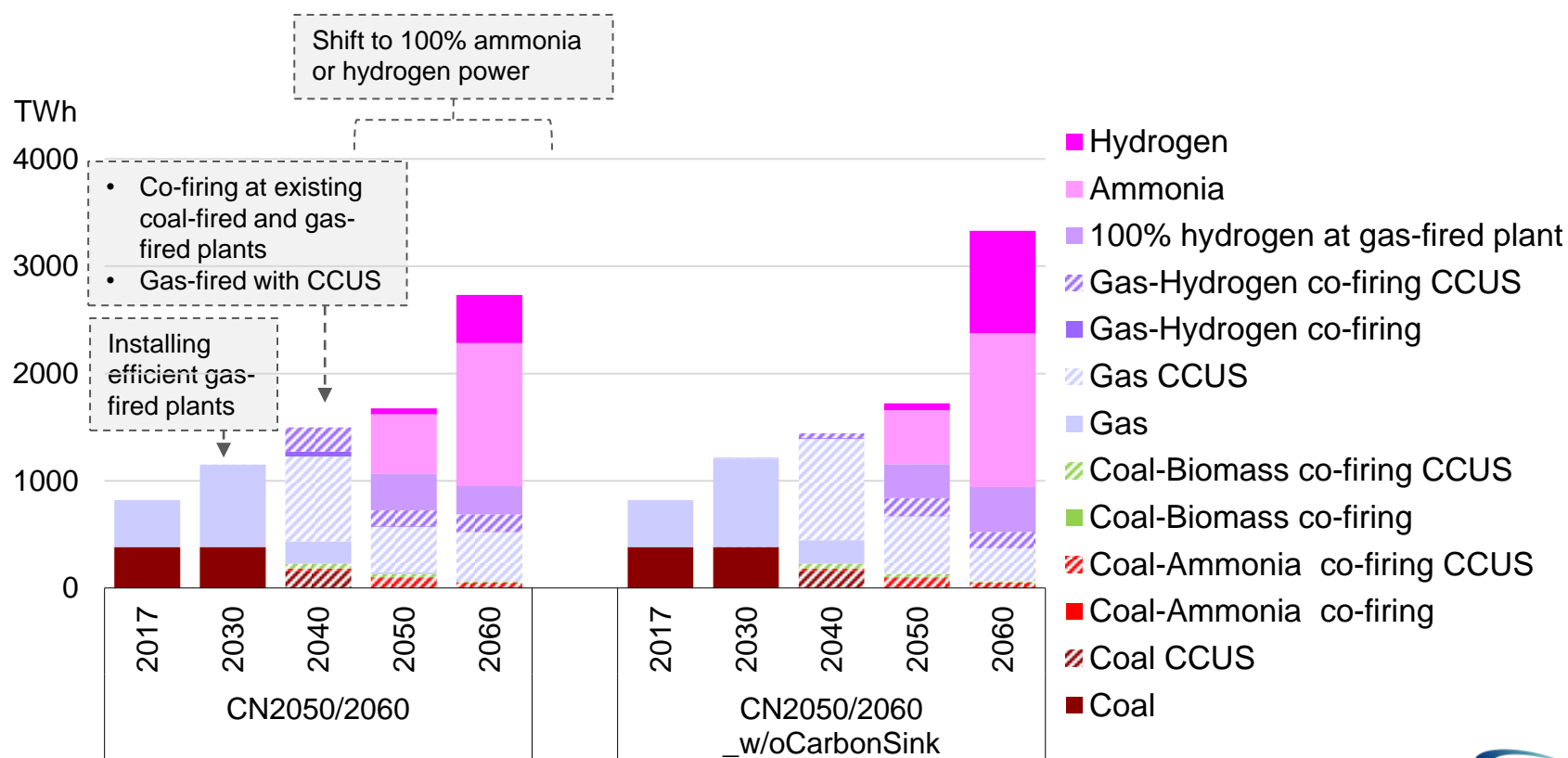
Power generation in ASEAN



Transition from fossil fuels to NH₃ & H₂ power generation

- In the short- to medium-term, such as 2030~40, efficient gas-fired plants is estimated to contribute to curbing CO₂ emissions from power generation.
- In the longer-term, gas-fired with CCUS, co-firing with ammonia or hydrogen, and 100% ammonia and hydrogen power would be candidates.

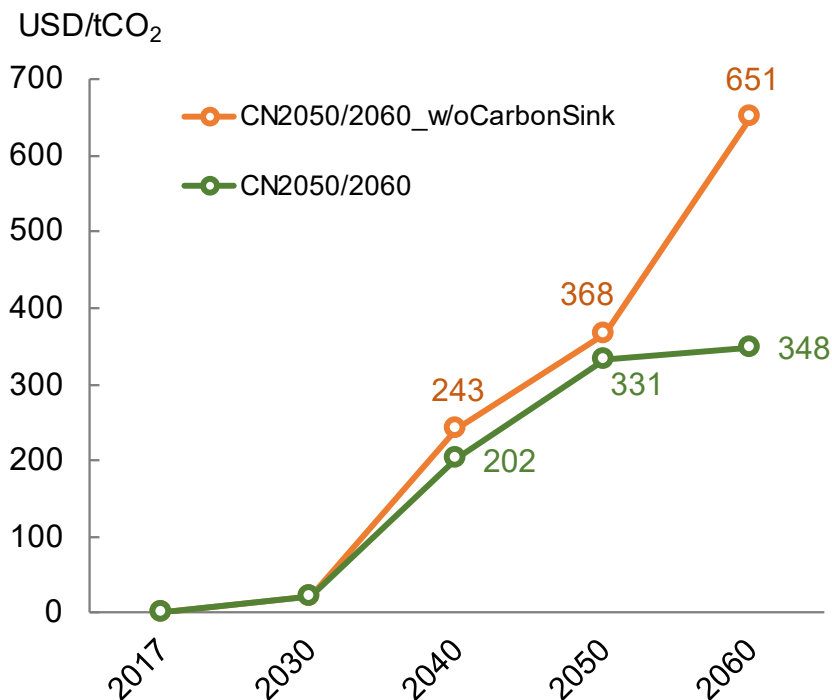
Power generation from coal, gas, ammonia and hydrogen in ASEAN



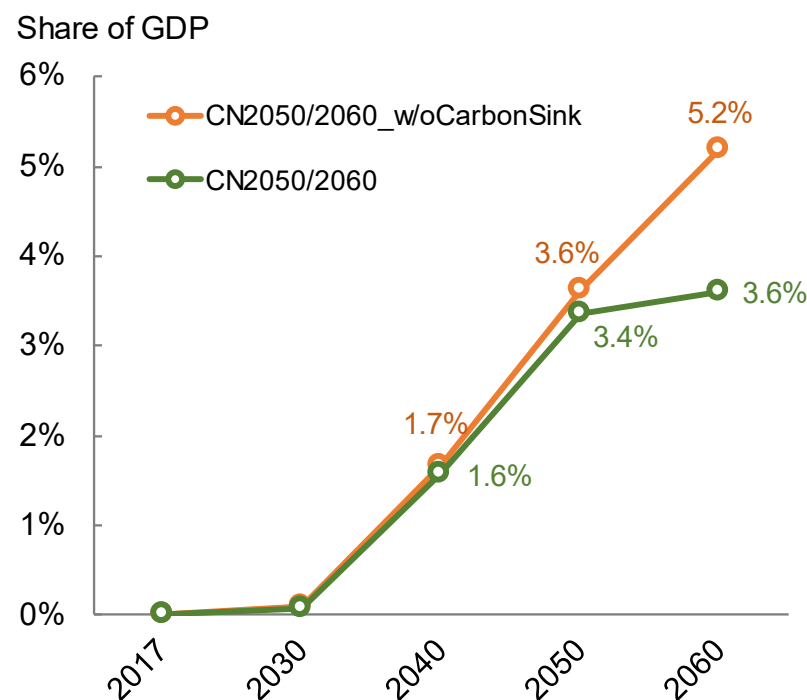
Costs for reducing CO₂

- Marginal abatement cost, which represent the intensity of decarbonization policies, would be 348 USD per tCO₂ in the *CN2050/2060*, and 651 USD in the *CN2050/2060_w/oCarbonSink*, implying economic challenges for net zero emissions.
- Additional annual cost from the *Baseline* to the *CN2050/2060* and the *CN2050/2060_w/oCarbonSink* is estimated to be about 3.6% and 5.2% of ASEAN GDP in 2060.

Marginal CO₂ abatement cost (MAC)
ASEAN weighted average



Additional annual cost
ASEAN total

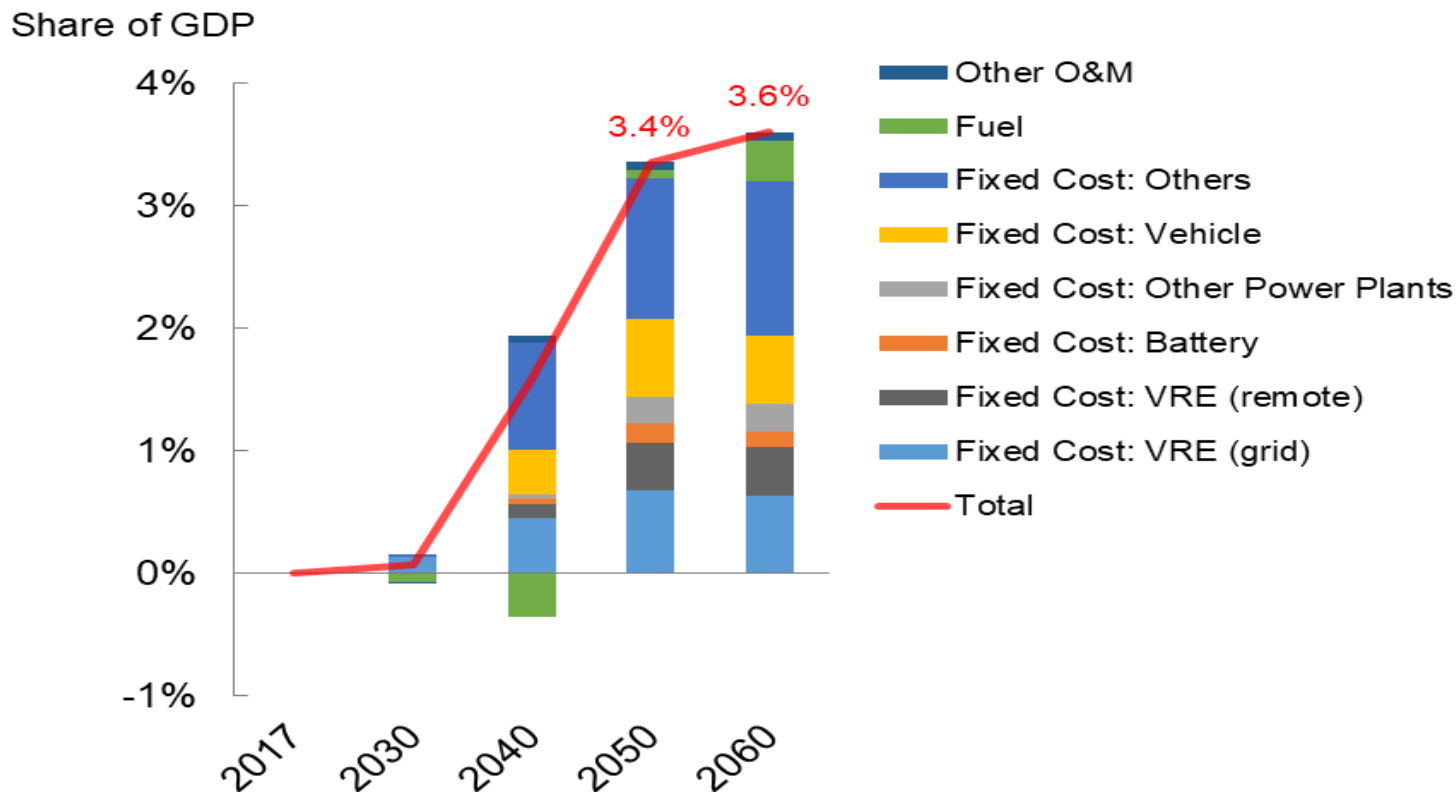


Note: The costs presented here do not include costs to enhance emissions reductions in the LULUCF sector.

Sectoral break-down of additional costs

Within additional annual cost in 2060, fixed costs for electricity, end-use and vehicles will account for 38%, 35%, and 15% respectively.

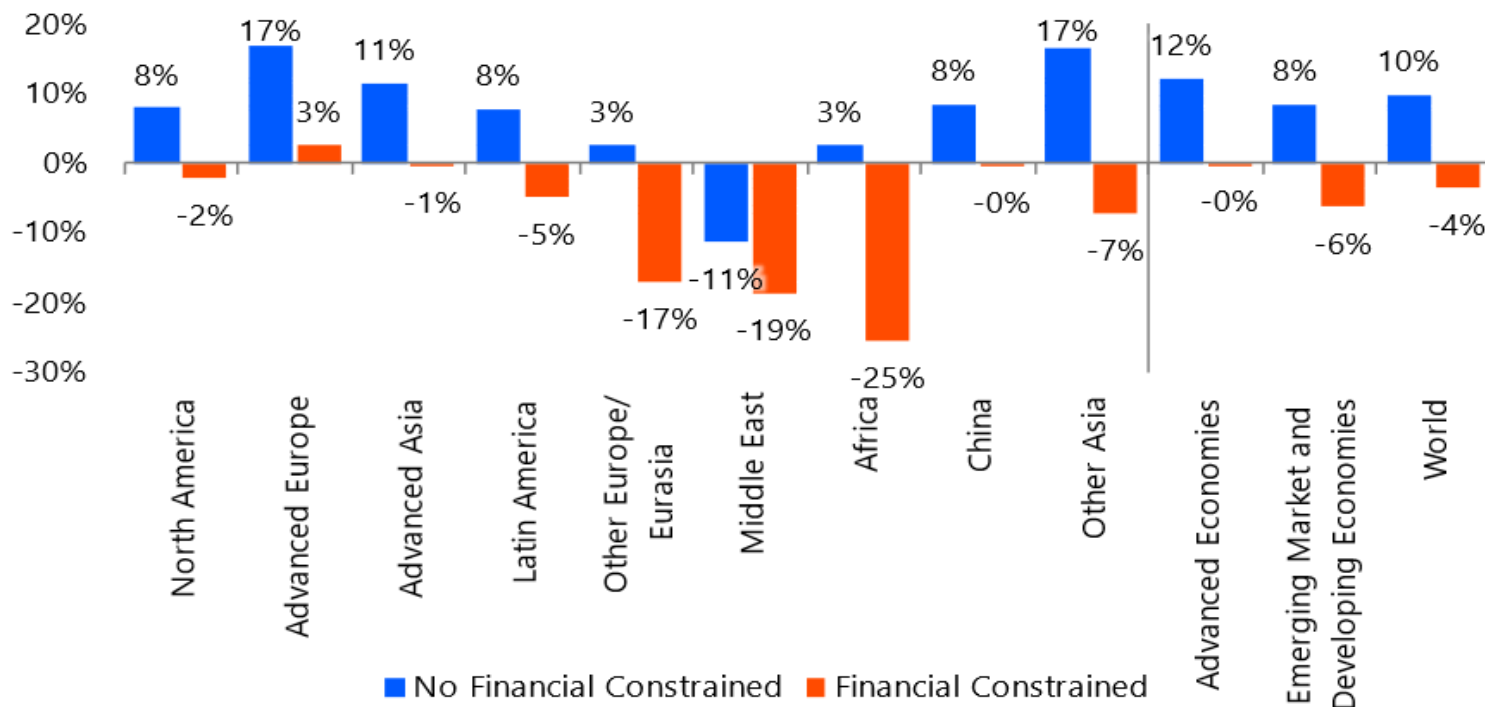
Break-down of additional annual cost
ASEAN total



Green growth is unlikely when there are constraints in funds

- Without financial constraints, global production would increase by 9.8%, while with constraints it would decrease by 3.7%.
- Regardless of financial constraints, the production value will decline in economies such as the Middle East, which is highly dependent on mining (fossil fuels).
- Advanced economies are more likely to enjoy green growth, while developing countries are not.

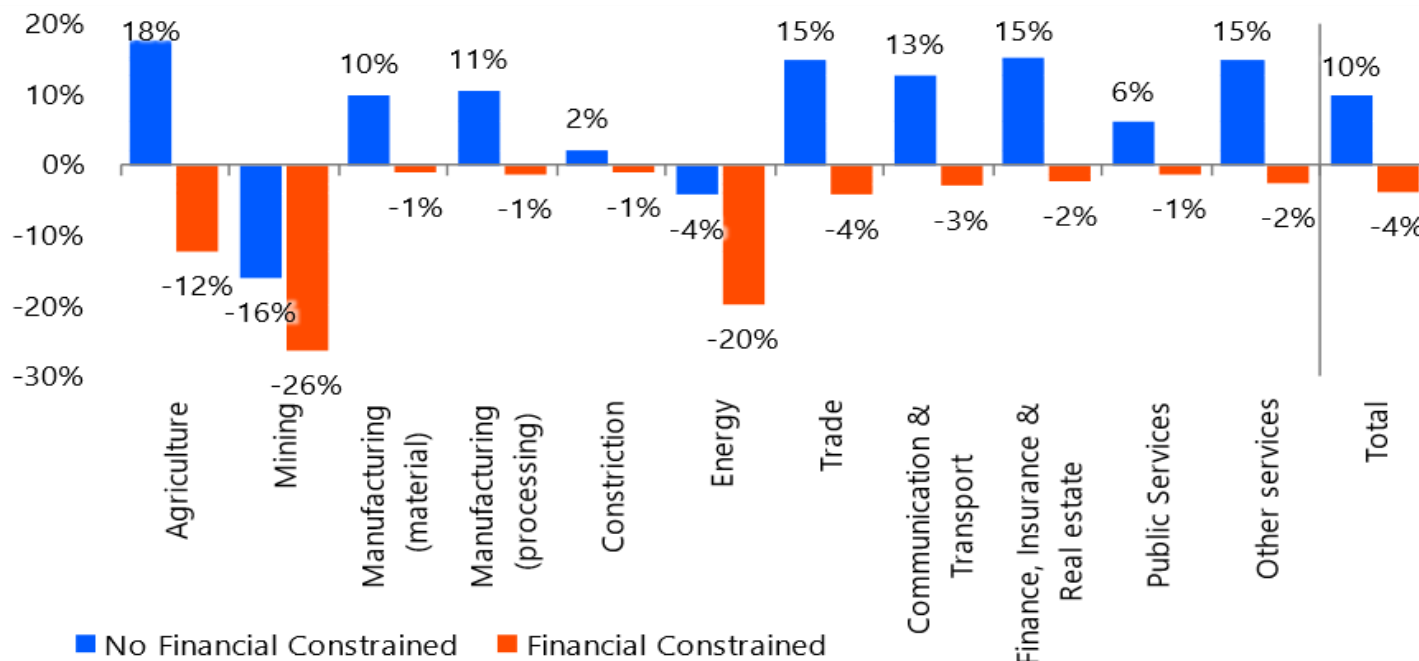
Changes in production in 2050
(By region. Compared to Reference Scenario)



Green growth is unlikely when there are constraints in funds

- Regardless of financial constraints, the production value of mining and energy supply related to fossil fuel will decrease.
- GDP accelerates by an average of 0.4% a year without financial constraints and decelerates by 0.1% with constraints
(IEA analysed acceleration of 0.4% in the 2020s in their Net Zero Emissions by 2050 Scenario *).

Changes in production in 2050
(By industry. Compared to Reference Scenario)



Asia Transition Finance (ATF) Guidelines

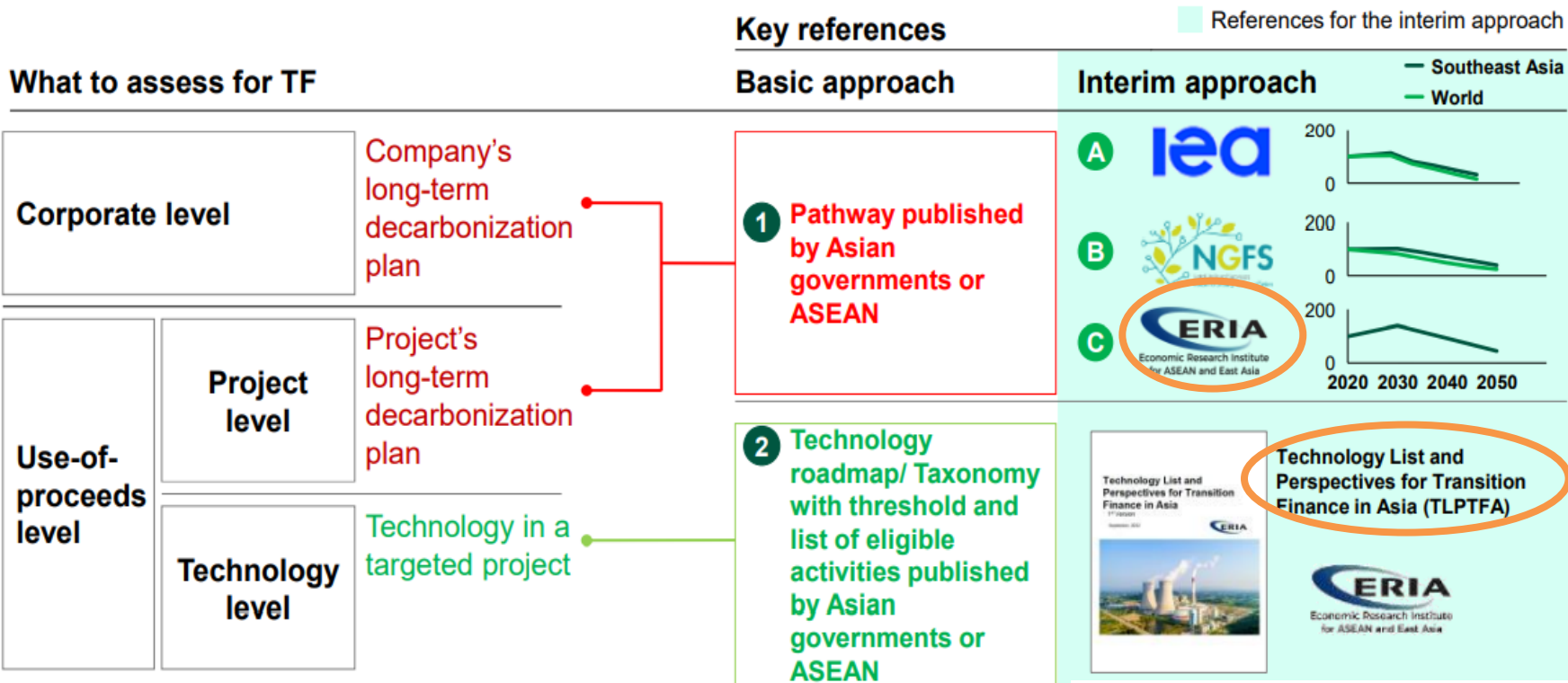
- | Published in Sept. 2022 by the Asia Transition Finance (ATF) Study Group, a private initiative led by Asian and global banks, focusing on ASEAN.
- | To complement the Climate Transition Finance Handbook published by the International Capital Market Association (ICMA).
- | The ICMA Handbook discusses four key elements:
 1. **A credible climate transition strategy and governance**
 2. Materiality with respect to a fundraiser's core activities
 3. **Science-based targets and pathways**
 4. Implementation transparency.
- | For the financial institutions (FIs), the Element 1 & 3 are challenging.

Source: ATF Guidelines

Transition Finance Suitability Assessment

- In the absence of government's roadmap, references such as ERIA/IEEJ and a technology list by ERIA are important for FIs.
- Furthermore ERIA/IEEJ are supporting ASEAN individual countries for formulating their energy transition roadmaps.

Interim approach for transition finance suitability assessment



ERIA's List of Technologies in the First Version

- ◆ **The first list covers 10 transition technologies in upstream (fuel production) and power sector accounting for +50% of total CO2 emissions.**
 - **Direct and sizable impact on emissions reduction**
 - **Neither zero emissions/green nor brown**
 - **Involving sizable deployment scale or investment**
- ◆ **To be expanded to other sectors (mid stream, down stream and end-use)**

Technology tier	Sector	
	Power (Electricity generation)	Upstream (Fuel production)
Early decarbonization	<div>1 CCGT (coal avoidance, higher efficiency conversion)</div> <div>2 Waste to energy power plant</div>	<div>6 Leak detection and repair (LDAR) for fugitive emissions reduction</div>
	<div>3 Biomass co-firing</div> <div>4 Low-carbon ammonia co-firing</div> <div>5 Low-carbon hydrogen co-firing</div>	<div>7 Process electrification in gas production and processing</div>
Deep decarbonization	<div>8 CCUS in coal/gas power plant</div>	<div>9 Blue hydrogen & blue ammonia production</div> <div>10 CCUS in gas processing</div>

■ Covered in "Power" section in this document

■ Covered in "Upstream" section ■ Covered in "CCUS" section

Thank you for your attention

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