Pathways to Paris: ASEAN

Technology and Policy Options to Reduce GHG Emissions

Massachusetts Institute of Technology

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https://globalchange.mit.edu/research/research-projects/pathways-paris

Main Takeaways – ASEAN Challenge

For the Paris Agreement process…

- **The Association of Southeast Asian Nations (ASEAN) countries** pledge to reduce their emissions through 2030 and introduce numerous policies to fulfill their pledges.
- The ASEAN countries face the challenge of **reducing GHG emissions** while at the same time **expanding energy supply** to meet the needs of their **rapidly developing** economies.
- This **report** offers a discussion of **policy** and **technology options** in the energy sector that can assist ASEAN countries' in achieving their emission mitigation targets.

Main Takeaways – Emissions Gap

The **"emissions gap"** is the needed reduction to meet the Paris pledges.

The ASEAN region emissions gap

- About **400 $MtCO_2e$** under **UNCONDITIONAL pledges.** The ASEAN region will have to reduce emissions by **11%** in 2030 relative to its current trajectory.
- About **900 $MtCO_2e$** under **CONDITIONAL pledges** (i.e., subject to more ambitious global efforts and technology and financial transfers). The ASEAN region will have to reduce emissions by **24%** in 2030 relative to its current trajectory.

In aggregate, the ASEAN region is making **good progress** towards its Paris goals but still requires **additional action** to sufficiently decrease emissions from its current trajectory.

Individually, while some countries are projected to be close to or to even over-achieve their goals for 2030, others need **substantial additional efforts**.

Main Takeaways – Policy and Technology Options

There are many **policy** and **technology options** to reduce the emissions gap. We **recommend**:

Policy Options

- **Carbon pricing** through taxes or cap-and-trade systems tends to be the most cost-effective option but can be politically challenging to implement.

- **Other policy instruments** are therefore needed to promote clean technology, such as:
  - Renewable energy auctions
  - Support to natural gas infrastructure development for countries with large coal use

Technology Options

- **Wind** and **solar** generation provide attractive options for lowering emissions.

- **Natural gas** promotes lower-carbon power generation and enables higher penetration of intermittent renewables by serving as backup capacity.

Main Takeaways – Economy-Wide Analysis

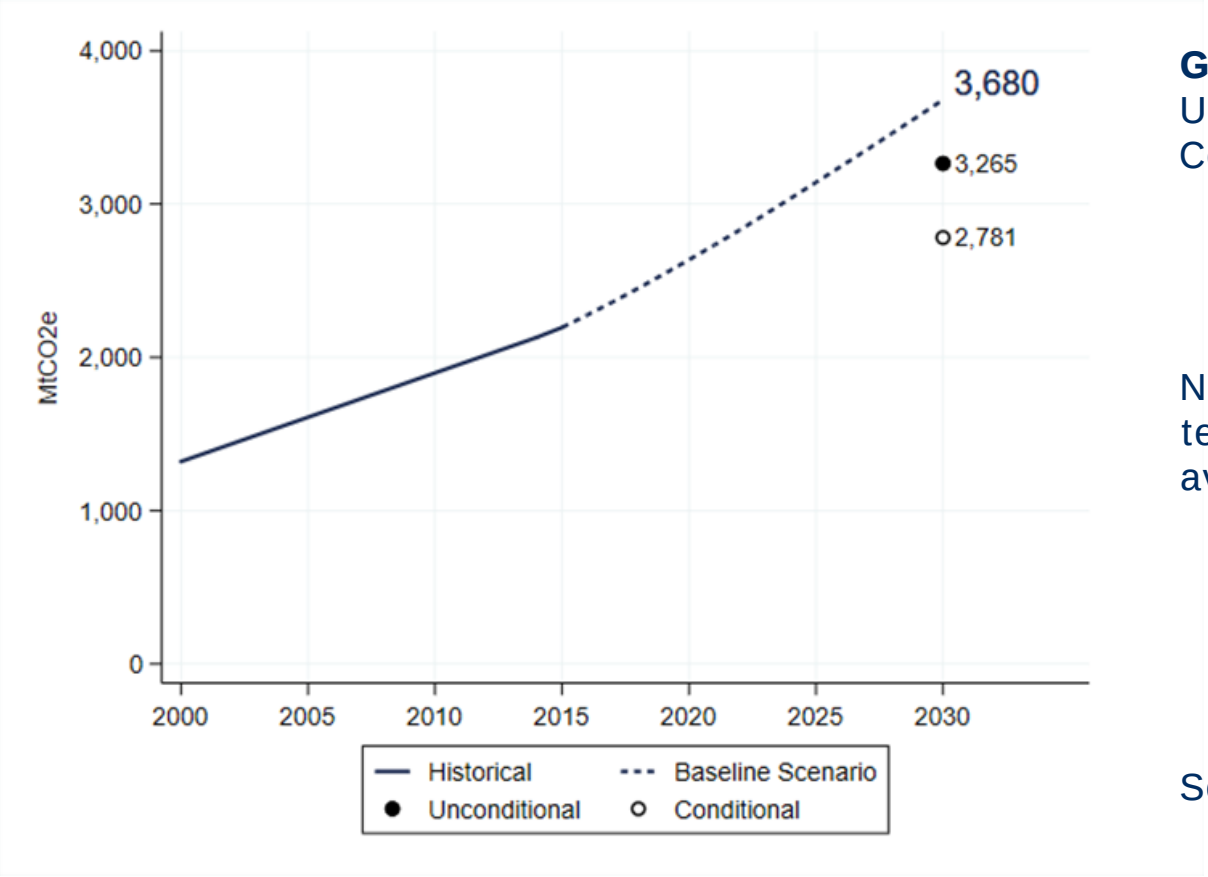
We perform a "deep-dive" (economy-wide) analysis for Indonesia and Vietnam to assess the economic impacts of meeting their NDC pledges.

In meeting unconditional targets…

- **The GDP cost in Indonesia is only 0.03%** relative to GDP in a business-as-usual scenario in 2030.
- **The GDP cost in Vietnam is only 0.008%** relative to GDP in a business-as-usual scenario in 2030.

This country-specific analysis shows that emission reduction goals are **achievable at a manageable cost.**

ASEAN countries have to manage the challenges of economic development by ensuring fast economic growth while pursuing ambitious emission reduction targets



Gap from Baseline in 2030:
Unconditional – 11%
Conditional – 24%

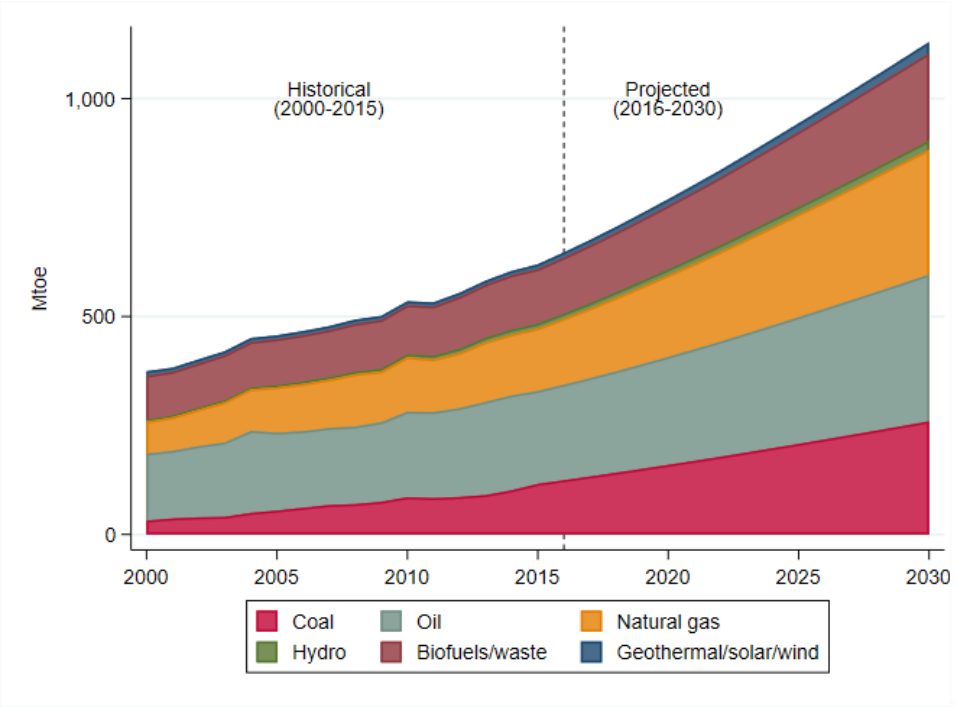
Numerous policy and technology options are available to close the gap.

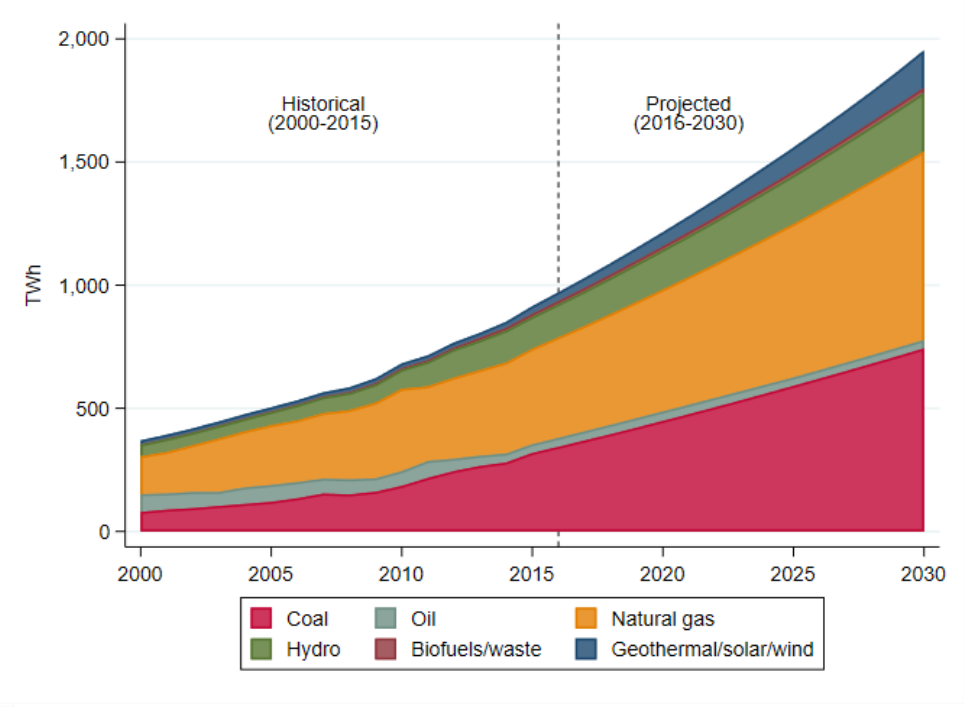
Source: MIT analysis

NDC Pledges and Resulting Emissions

Country	Baseline Scenario Emissions (MtCO2e)	Modeled Target			Gap from Baseline	
		Type	*Description*	*Emissions (MtCO2e)*	*Emissions (MtCO2e)*	*Percent of Baseline*
Brunei Darussalam	14	Unconditional	45% reduction in energy intensity of GDP (relative to 2005)	10	4	26%
		Conditional	None - same as unconditional	10	4	26%
Cambodia	15	Unconditional	None - same as Baseline scenario	15	--	--
		Conditional	27% reduction in emissions (relative to Baseline in 2030)	11	4	27%
Indonesia	1,450	Unconditional	16% reduction in emissions (relative to Baseline in 2030)	1,218	232	16%
		Conditional	20% reduction in emissions (relative to Baseline in 2030)	1,160	290	20%
Lao PDR	23	Unconditional	None - same as Baseline scenario	23	--	--
		Conditional	10% reduction in TPES (relative to Baseline in 2030)	21	1	5%
Malaysia	544	Unconditional	35% reduction in emission intensity of GDP (relative to 2005)	540	5	1%
		Conditional	45% reduction in emission intensity of GDP (relative to 2005)	457	88	16%
Myanmar	73	Unconditional	None - same as Baseline scenario	73	--	--
		Conditional	20% reduction in fossil-based generation (relative to Baseline in 2030)	70	3	4%
Philippines	293	Unconditional	None - same as Baseline scenario	293	--	--
		Conditional	70% reduction in emissions (relative to Baseline in 2030)	88	205	70%
Singapore	51	Unconditional	36% reduction in emission intensity of GDP (relative to 2005)	65	-14	-26%
		Conditional	None - same as unconditional	65	-14	-26%
Thailand	645	Unconditional	20% reduction in emissions (relative to Baseline in 2030)	516	129	20%
		Conditional	25% reduction in emissions (relative to Baseline in 2030)	484	161	25%
Vietnam	571	Unconditional	8% reduction in emissions (relative to Baseline in 2030)	525	46	8%
		Conditional	25% reduction in emissions (relative to Baseline in 2030)	428	143	25%
ASEAN	**3,680**	**Unconditional**	--	**3,265**	**415**	**11%**
		Conditional	--	**2,781**	**899**	**24%**

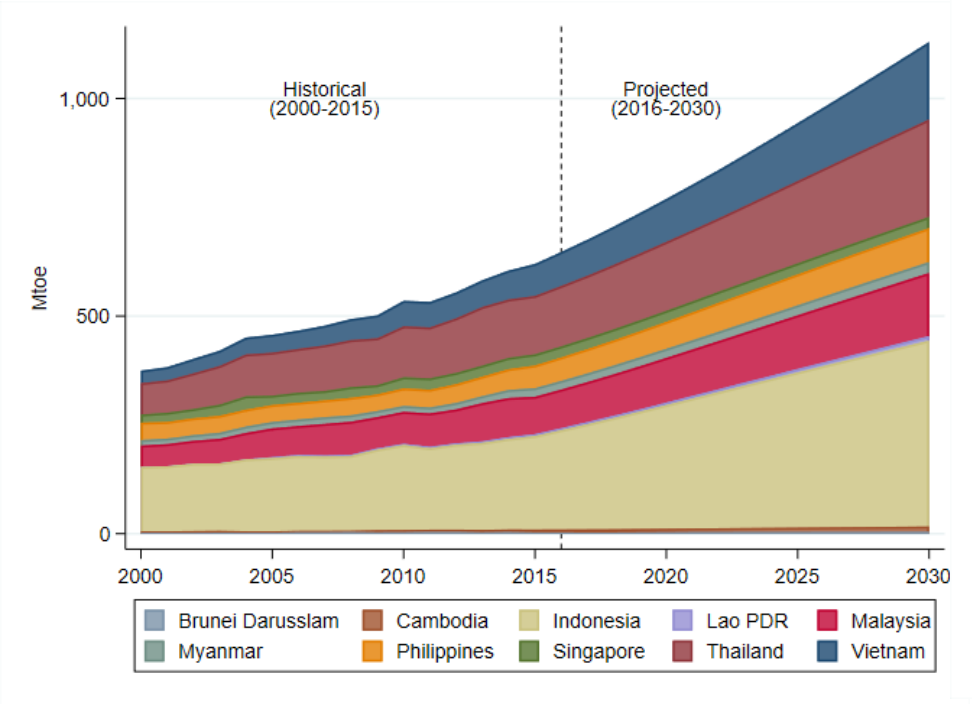
ASEAN Primary Energy and Electricity by Type

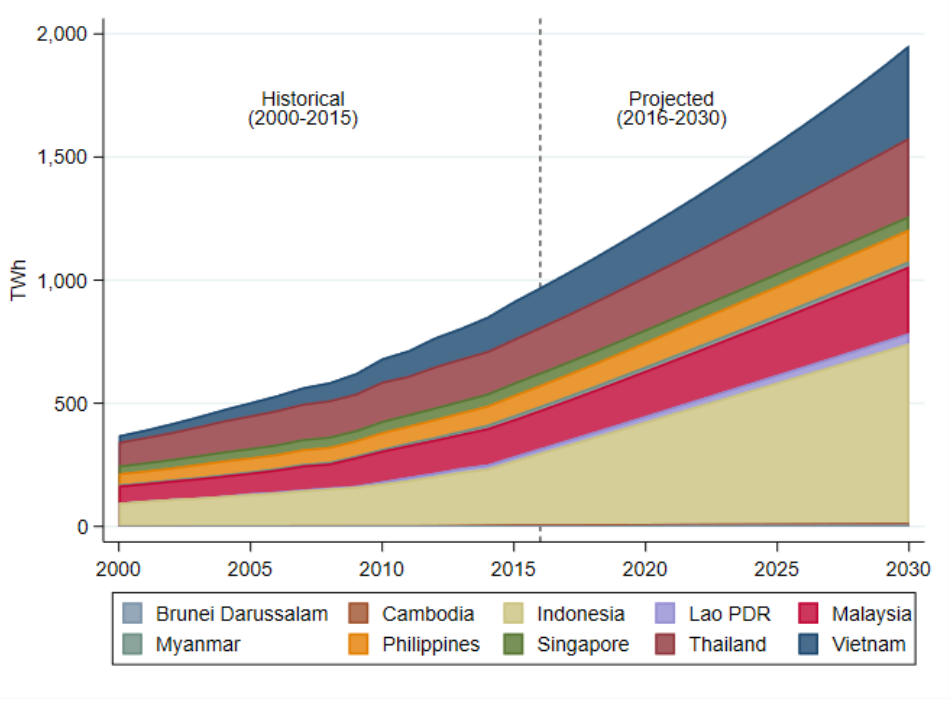




Fast growth in power generation from wind and solar (**five-fold** increase from 2015 to 2030) *but still r*eliance on fossil fuels

ASEAN Primary Energy and Electricity by Country

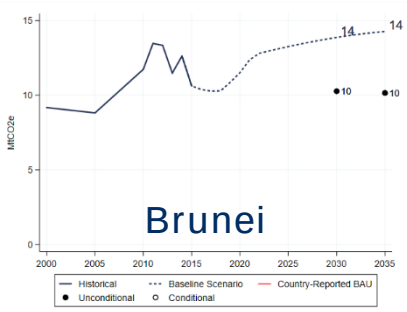


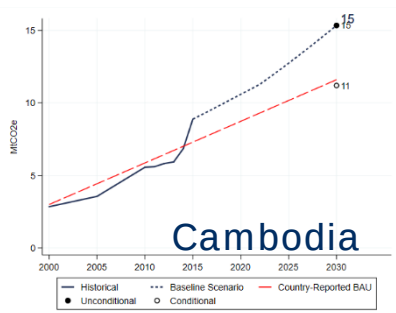


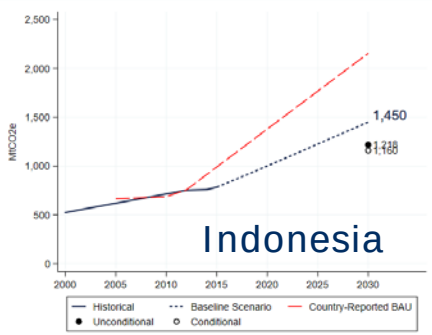
Increase in primary energy and electricity in all ASEAN countries

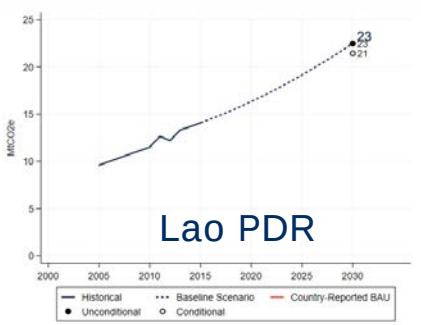
Country-specific analysis (Illustrative – see Report for details)

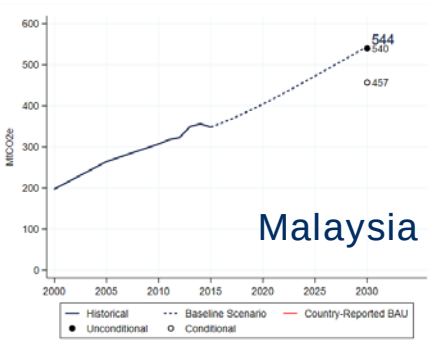
Projections of Energy, Electricity, Emissions - The resulting unconditional and conditional gap

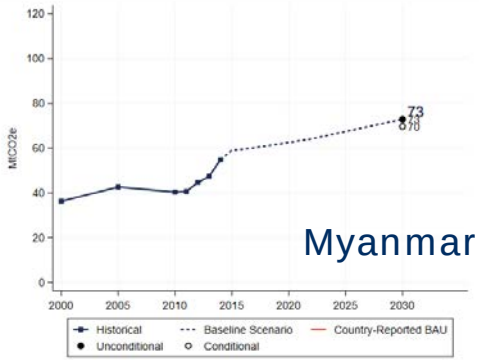


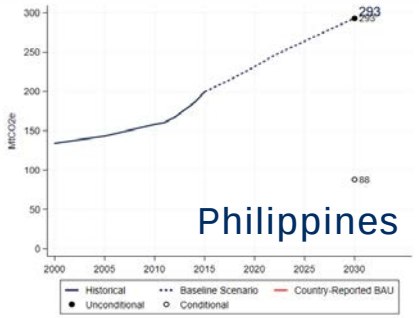


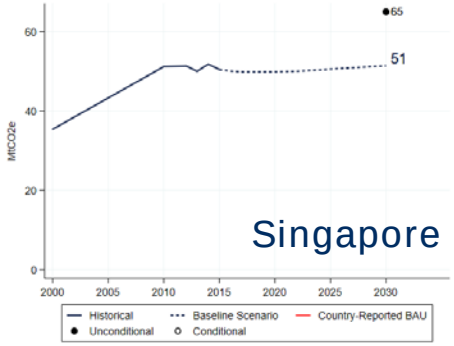


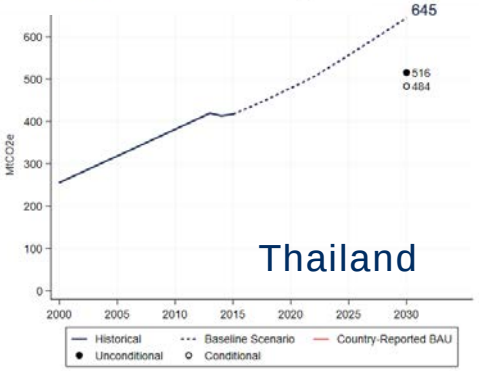


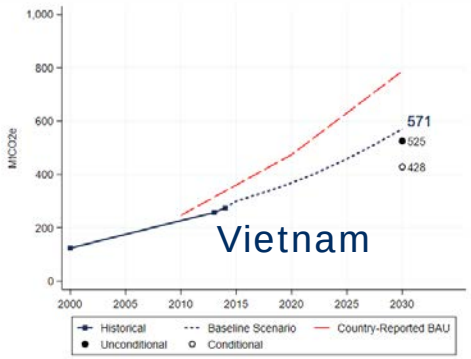












Technology Options

CATEGORY		EXAMPLES
TIER I: Building and Retrofitting Power Plants	**Less Capital-Intensive**	Natural gas
		Wind and solar
		Renewables more limited by geography (e.g. small-scale hydro, pumped hydro, waste, geothermal, and tidal/wave)
	More Capital-Intensive	Nuclear and large hydro
TIER II: Improving Efficiency and Optimization		Higher efficiency power plants (e.g. ultra-super critical coal plants)
		Higher utilization of the currently installed lower-carbon generation technologies
		Digitalization applied to both the production and consumption sides
TIER III: Enhancing Market and Network Organization		Options to enable distributed generation
		Time-of-day pricing
		Improved integration of renewables (e.g. new transmission lines, virtual power plants, microgrids, tools for better citing and forecasting of wind and solar farms)
		Battery energy storage
TIER IV: Options with Potential Sustainability Issues		*Large scale biomass-based options*
TIER V: Options for Future Consideration		*Carbon capture and storage (CCS), advanced nuclear, advanced energy storage (e.g. generating hydrogen with renewable power)*

Policy Options and Instruments

CATEGORY		EXAMPLES
Price Controls		Carbon tax
		Non-fiscal price support measures (e.g. feed-in tariffs, feed-in premiums, generation-based direct payments)
Quantity Controls	**With Trading**	Emissions trading (cap-and-trade and baseline-and-credit schemes)
		Green/white certificate schemes (e.g. renewable portfolio standards with trading, energy efficiency certificate trading)
	Without Trading	Renewable energy auctions
		Performance standards
Technology Controls		Technology standards
		Permitting and licensing requirements
(Fiscal) Subsidies		Grants
		Credits and rebates (e.g. production and investment tax credits, reduction in energy and other taxes)
		Depreciation rules
		Loan guarantees
Suasive Instruments		Labeling and information
		Mandatory audits
		Energy management/Corporate Social Responsibility (CSR) systems
Planning Instruments		National action plans, programs, and strategies
		Resources and infrastructure planning (e.g. resource mapping, siting and zoning, and grid integration planning)

Structure of the Report

Executive Summary

Section I	Introduction
Section II	Pledges of the ASEAN countries for the Paris Agreement process
Section III	Projected ASEAN Energy and Electricity Profiles out to 2030
Section IV	Policy and Technology Options for ASEAN to Reduce Emissions
Section V	Country-level studies (Energy, Electricity Generation, Emissions, Policies and Measures)
Section VI	Economy-wide analyses for Indonesia and Vietnam
Section VII	Experience in other regions with policy measures to reduce emissions

References

Appendices

Key Insights - Overview

Main takeaways on…

…the role of the energy sector.

"While eventually emission reductions will need to come from all sectors of the economy, the energy sector offers a significant opportunity to obtain reductions using available technology and policy solutions at a relatively low cost."

…low-carbon generation.

"Investments in generation from natural gas, - which has a lower carbon intensity than coal, - or investments in wind and solar with zero carbon emissions in power generation, would pave the way for more aggressive emission reductions in the future."

…the importance of well-designed policies.

"Policy frameworks are the key to determine a nation's ability to incentivize the deployment of new technologies, attract private capital, internalize externalities (such as the health effects of air pollution), modernize electricity transmission and distribution, and expand access to energy."

Key Insights – Energy Profile

A view of the 2030 ASEAN energy profile through…

…total primary energy supply (TPES).

"We project that ASEAN TPES in 2030 will be 30% from oil; 25% from natural gas; 23% from coal; 18% from biofuels and waste; 2% from geothermal, solar, and wind; and 2% from hydro."

…electricity generation.

"While generation from both natural gas and coal drive overall generation growth, coal-fired generation is increasing in share of total generation from 35% in 2015 to 38% in 2030, while the share of natural gas falls from 42% in 2015 to 39% in 2030."

…the role of coal.

"According to IEA (2017b), ASEAN is the only region of the world where the share of electricity generation from coal is projected to substantially increase."

Key Insights – Policy Options

Key policy takeaways on…

… electricity market reform.

"Challenges have prompted discussion of ratemaking practices that better reflect the spatial and temporal value of electricity and grid services (e.g. time-of-use and scarcity pricing), and increased use of capacity markets to reward firm, dispatchable generation capacity."

…the policy environment.

"In a practical business environment, focusing on only one core policy instrument without ensuring an adequate, enabling framework of complementary planning, regulatory, market design and other related measures may limit the effectiveness of that policy and fail to create the required certainty for investment, in particular for the introduction of new and clean energy technologies."

… supporting wind and solar.

"In countries where the regulatory model does not encourage sophisticated integration of distributed generation, intermittent renewables will face substantial challenges to expand."

Key Insights – Technology Options 1

Key technology takeaways concerning…

…wind and solar.

"Renewable energy technology options continue to mature. Their costs continue to fall, making renewable energy increasingly competitive."

…natural gas development.

"To realize the potential of natural gas, policy options include a support to natural gas infrastructure development and loosening or removing price rigidities. An important component of a national gas strategy is allowing more private participation in supply, transportation, and marketing of natural gas, including third-party access to natural gas infrastructure."

Key Insights – Technology Options 2

Key technology takeaways concerning…

…coal-based power.

"A clear message regarding technology options, however, is that coal-based power becomes even riskier because a CCS option is still uneconomic, and future emission targets are likely to increase in stringency."

…preparations for more ambitious emission targets.

"While coal power is the cheapest and most reliable energy option in many ASEAN countries, natural gas provides a viable alternative in order to reduce GHG emissions and local air pollutants. However, because future emission reduction targets (for the period beyond the current Paris pledges) are likely to be more aggressive, we recommend, in addition, exploring options for nuclear and CCS technologies, keeping in mind that these capital-intensive projects require longer planning timelines and extensive government support."

…digitalization and energy management.

"We also recommend a wider use of technologies that enable energy efficiency improvements, both in the construction of more efficient power plants and through the use of digital technology to improve existing supply- and demand-side processes and incorporate new methods of energy transformation, delivery and usage processes such as Microgrid, Virtual Power Plant, storage and distributed energy management."

Key Insights – Paris Targets and Generation

Attainability of Paris Agreement targets by…

…replacing coal with NATURAL GAS in generation.

"Even if all coal-based generation in ASEAN is replaced with natural gas or renewables-based generation, the conditional Paris Agreement goals would not be met."

"We estimate a reduction of about 426-537 $MtCO_2$, depending on natural gas generation efficiency, when all coal power generation is replaced with natural gas generation. Emission reductions from the replacement of coal with natural gas are close to what is needed for the aggregate ASEAN emission reduction with the unconditional targets (415 $MtCO_2$) but not enough for meeting conditional reductions (899 $MtCO_2$)."

…replacing coal with WIND in generation.

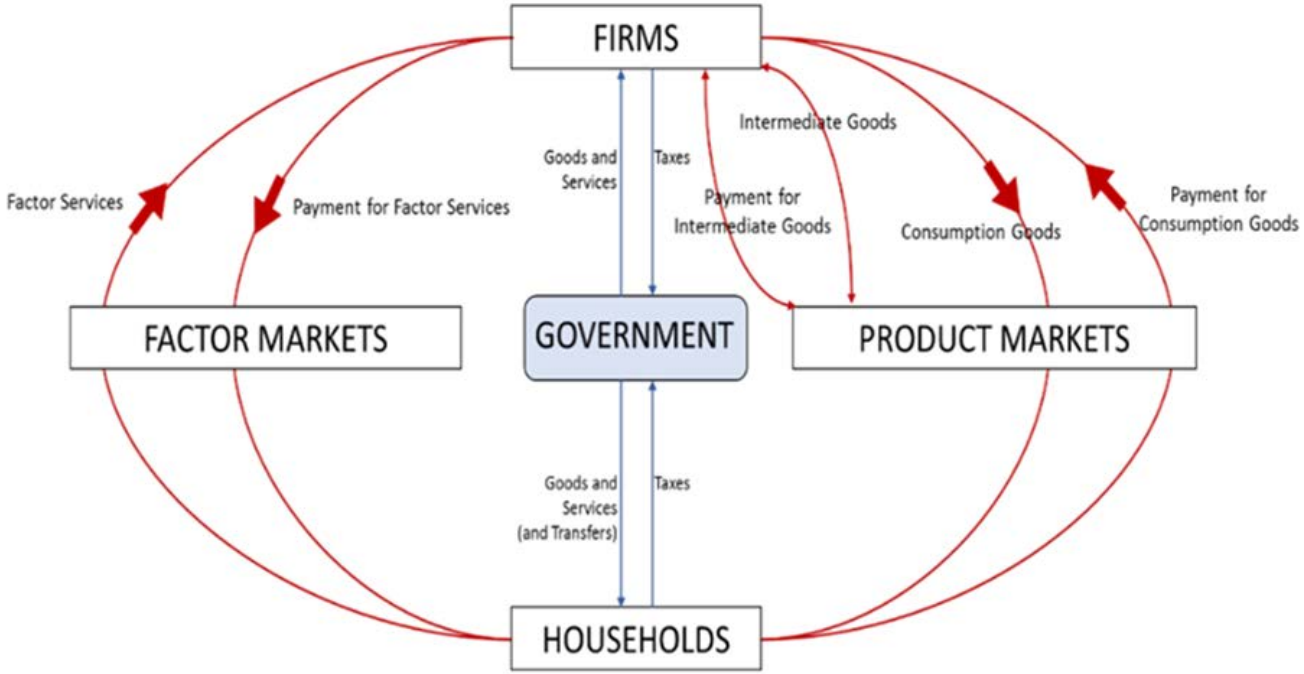
"*For the ASEAN region, we estimate that meeting unconditional targets corresponds to about 154 GW of additional wind capacity (or about 38,394 4-MW turbines) and meeting conditional targets requires the addition of 333 GW (or about 83,176 4-MW turbines) when turbines operate with a 30% capacity factor. These numbers can be compared to the ASEAN regional capacity for wind generation in 2015 of 600 MW (ACE, 2017), or effectively 150 4-MW turbines."*

Economy-Wide (AGE) Modeling

Deep-dive analysis

One "business-as-usual" (BAU) and six policy scenarios

- No climate policy (BAU)
- Meeting **unconditional** targets with coverage of **(1) all sectors** or **(2) selected sectors**
- Meeting **conditional** targets with coverage of **(3) all sectors** or **(4) selected sectors**
- Meeting **conditional** targets with **increased adoption of digitalization** and coverage of **(5) all sectors** or **(6) selected sectors**



Key Insights – Deep-Dive

Insights from the deep-dive analysis on…

…sectoral coverage of climate policies.

"The key insight from these simulations is that the sectoral coverage of climate policy should be a broad as possible. This can be achieved by either including as many sectors as possible in the ETS, or linking non-ETS sectors to included sectors by allowing domestic offset credits to be surrendered in lieu of ETS permits."

…economic impacts of a carbon price.

In Indonesia: "[…] a carbon price of $17.5/tCO2e (applied to all gases in all sectors) is required to reduce 2030 economy emissions by 16% relative to BAU. […] Additional costs due to the carbon price reduce GDP by 0.03% relative to the BAU level.

In Vietnam: "[…] a carbon price of $2.2/tCO2e, applied to all gases in all sectors, is required to reduce 2030 economy emissions by 8% relative to BAU. […] Meeting the emissions constraint reduces GDP by 0.008%."

Key Insights – Deep-Dive for Indonesia

Insights from the deep-dive analysis on…

…policy and technology options in Indonesia.

"To be effective at curbing emissions, Indonesia's instrument portfolio has to both address the substantial emissions from land use, land use change and forestry, while shifting the further expansion of energy production towards Indonesia's abundant domestic renewable resources."

"As Indonesia considers options to further strengthen its existing policy portfolio, it has a unique opportunity to accelerate the shift from continued growth of fossil fuels in electricity generation, heating, and transport to renewable energy sources."

"It is also vitally important that Indonesia continue initial efforts under the current administration to reform fossil fuel subsidies, which continue to bind a significant share of the public budget."

Key Insights – Deep-Dive for Vietnam

Insights from the deep-dive analysis on…

…policy and technology options in Vietnam.

"Policy recommendations therefore focus on ensuring that new electricity generation capacity is based on renewable energy and natural gas rather than coal and, especially in the short term, curbing energy demand growth as a way to buy time for fuel switching in the electricity sector. "

"Strengthening and better enforcement of existing policies on energy efficiency and renewable energy, continued energy price reform and restructuring of the power sector, and, prospectively, introduction of a carbon price are all suited to advance decarbonization of the power sector."

"Ultimately, a carbon price will also help channel private sector finance to low-carbon investments, helping overcome another major barrier for mitigation efforts faced in Vietnam."

Key Insights – Digitalization

Insights from the deep-dive analysis on…

…the impact of digitalization.

"Digitalization measures can support the dual-pursuit of development and climate policy goals, with up to a $1.8 billion (0.1%) increase in GDP and 14.6 TWh (2.6%) increase in electricity generation in Indonesia, and up to a $1.7 billion (0.3%) increase in GDP and 8.7 TWh (2.4%) increase in generation in Vietnam, in 2030 relative to scenarios without digitalization."

"More digitalization in power generation, by reducing the price of electricity, also increases total electricity generation. These results indicate that, if it is cost effective, increased digitalization could help Vietnam to decrease GHG emissions while also increasing electricity access."

Report Approach

"Our assessment is unique in providing a gap analysis that ***consistently covers all ASEAN countries.***

We provide all input data and tools used in our analysis in ***an open source format.***

We hope the open source format will enhance the capacity of ASEAN economies ***to analyze their pathways*** *to meeting their emission mitigation goals."*

Questions or comments about the report?

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