Modeling Energy Transition in ASEAN

LTES Asia Webinar

20 September 2023

Zulfikar Yurnaidi
Manager, Energy Modeling and Policy Planning (MPP) Department
ASEAN Centre for Energy (ACE) – Roles and Responsibilities

Intergovernmental organisation within ASEAN structure that represents the 10 ASEAN Member States’ interests in the energy sector.

As a Think tank..
Conduct studies and provide policy recommendations

..Catalyst
Collaborate with national, regional, and international entities

..and Knowledge hub
Data and knowledge repository and analysis

Implementing Agency of Regional Blueprint
ASEAN Plan of Action for Energy Cooperation (APAEC) 2016-2025 Phase II 2021-2025
ASEAN Plan of Action for Energy Cooperation (APAEC) 2016-2025 Phase 2: 2021-2025

Theme: “Enhancing Energy Connectivity and Market Integration in ASEAN to Achieve Energy Security, Accessibility, Affordability and Sustainability for All”

Sub-Theme: “Accelerating Energy Transition and Strengthening Energy Resilience through Greater Innovation and Cooperation”.

RENEWABLE ENERGY TARGET
Increase RE share to 23% in TPES and 35% in ASEAN installed power capacity by 2025

EI REDUCTION TARGET
Reduce EI by 32% in 2025 based on 2005 level.

ASEAN Energy Outlook (AEO) complements the APAEC and supports the creation of pathways for achieving the regional targets. Guided by Programme Area No. 6: Regional Energy Policy and Planning; Action Plan 1.2: Publish regular regional energy outlooks and strategic reports on the thematic issue.
AEO Throughout the Years

1. AEO 1 to AEO3 (2006 – 2012*)
Almost fully developed by IEEJ (Japan), with ACE as the facilitator.

- Presented at 33rd AMEM: Minister-CEO Dialogue in KL, Malaysia, September 2015.
- 80% work by External Consultant, ACE supported on data collection process.

- Launched at 35th AMEM in Manila, the Philippines, September 2017
- ACE worked 40% not only on data collection but also on modelling work.

4. AEO6 (2018 – 2020)
- ACE do about 70% of the modelling work, engaging the External Consultant mostly on the analytics part.

5. AEO7 (2021 – 2022)
- Launched at 40th AMEM, 2021.
- ACE do up to 100% of the modelling work, engaging the External Consultant mostly as advisory role.
ASEAN Energy Outlook (AEO) complements the ASEAN Plan of Action for Energy Cooperation (APAEC) and supports the creation of pathways for achieving the regional targets. Guided by Programme Area No. 6: Regional Energy Policy and Planning; Action Plan 1.2: Publish regular regional energy outlooks and strategic reports on the thematic issue.

**COLLABORATION**
Consultation with experts from all 10 AMS through individual country visits for data collection, scenario discussion, and regional targets

**HARMONISATION**
Each AMS model is done individually in one regional environment, making it possible to standardise the data for all AMS while still able to analyse individual country

**VALIDATION**
Close and constant coordination with the assigned Focal Points for data collection & target interpretation

AEO aims to be the voice of ASEAN for the energy sector, as it incorporates major involvement from all 10 AMS in every process.
The 7th ASEAN Energy Outlook (AEO7)

Launched in 40th ASEAN Ministers on Energy Meeting in Cambodia

**Introduction**

Establishes contextual setting of the ASEAN energy landscape, challenges, efforts, ambitions, and the role of regional cooperation and outlook in addressing energy dynamics within the region.

The population and economic growth activities linked to global energy dynamics and implications for the energy sector.

The elements of energy security, accessibility, affordability, inclusivity, and sustainability challenges for ASEAN.

The role of energy cooperation under the ASEAN Plan of Action for Energy Cooperation (APAEC) and AEO7 supports in creation of pathways to address the challenges.

**Methodology**

Provides the reasoning behind the AEO7 modelling arrangement.

- Key Assumptions
  - Demographics
  - Socio-Economic
- Demand Analysis
  - Residential
  - Transport
  - Industrial
- Exploration Analysis
  - Agriculture and Others
- Transformation Analysis
  - Electricity Generation
  - Fuel Production and Conversion
  - Energy Transmission and Distribution
- Resource

**Exploring Multiple Futures**

Explains the analysis of the modelling results based on the AEO7 scenarios and the implications for energy demand and supply, emissions, and socio-economic impacts in the ASEAN region, including social cost of energy, renewable job creation, and land use of biofuel.

**Assessing Measures for Energy Resilience**

Elaborates on six emphasised energy sectors considered essential to attaining secure and reliable energy amidst transition.

- Grid Integration
- Fossil Fuels
- Industrial Efficiency
- Renewable Energy
- Financing Energy Transition
- Nuclear Power

**Recommendations and Improvements**

Offers key energy policy proposals and strategic steps to address barriers in utilising resources to meet the demand of the ASEAN Member States from end-use and power sectors, and aligning them with the regional targets, in conjunction with institutional, data, and model improvement prospects for the subsequent editions of the ASEAN Energy Outlook.
The Modeling of AEO

AEO mainly uses Low Emissions Analysis Platform (LEAP) software, a scenario-based demand-driven modeling tool that can be used to track energy consumption, production and resource extraction in all sectors of an economy.

**Simplified version of energy balance and projection calculation**

**HISTORICAL**

- **Demand**
  - Data Source: Energy Balance Table

- **Transformation**
  - Data Source: Power Development Development Plan (PDP) document, AMS submission

- **Resources / Supply**
  - Calculated by LEAP

**PROJECTION**

- **Demand**
- **Transformation**
- **Resources / Supply**

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Modelling Approach – Residential Sector

- **Historical (2005 – 2020)**
  - Fuel Breakdown
    - Traditional Cooking
    - Modern Cooking
  - Cooking
  - Lighting

- **Projection (2021 – 2050)**
  - Home Appliances
    - Refrigeration
    - Washing Equipment
  - Others
  - Non-Electricity
  - Cooling (AC)
  - Electricity

Bottom-up approach enables detailed technological breakdown of energy use, which includes the detail on their efficiency and fuel types.
Modelling Approach – Transport Sector

Bottom-up approach enables detailed technological breakdown of energy use, which includes the detail on their efficiency and fuel types.
Modelling Approach – Commercial Sector

Detailed breakdown **detailed sub-sectoral breakdown** of energy use, which includes the detail on their energy intensity and activity level.

One Community for Sustainable Energy
Modelling Approach – Industry Sector

Detailed breakdown detailed sub-sectoral breakdown of energy use, which includes the detail on their energy intensity and activity level.
**AEO7 Scenario Overview**

Historical data from 2005 – 2020 are projected out to 2021 – 2050 in four scenarios.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Baseline Scenario</th>
<th>AMS Targets Scenario (ATS)</th>
<th>APAEC Targets Scenario (APS)</th>
<th>Least-Cost Optimisation (LCO)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Efficiency</td>
<td>The energy growth pattern kept at a constant level as of the last historical year.</td>
<td>Based on individual Member States’ targets</td>
<td>Raise individual Member States’ targets to meet the regional target</td>
<td>Same deployments of EE&amp;C strategies with APS to meet the regional target.</td>
</tr>
<tr>
<td>Renewable Energy</td>
<td>Kept constant at the level for last historical year</td>
<td>Based on individual Member States’ targets</td>
<td>Raise individual Member States’ targets to meet the regional target</td>
<td>The power system was optimised to determine the least-cost dispatch that allows attainment of national and regional RE targets.</td>
</tr>
<tr>
<td>Installed Power Capacity</td>
<td>No installed capacities from national Power Development Plan (PDP)</td>
<td>Consistent with PDP, prioritising renewable energy when adding new capacity</td>
<td>Included PDP at minimum but accelerated deployment of RE capacity based on each country’s potential</td>
<td>The PDP capacity additions are included but model is allowed to build additional plants, and select the dispatch that constitutes the least-cost.</td>
</tr>
</tbody>
</table>

Increase ambitions of RE and EE/EI standards

Least-cost option in power sector
## AMS National RE targets

<table>
<thead>
<tr>
<th>Country</th>
<th>Official Target on Renewable Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brunei Darussalam</td>
<td>Achieve a 30% share of RE in the power generation mix by 2035</td>
</tr>
<tr>
<td>Cambodia</td>
<td>25% increase in renewable energy in the power mix (generation capacity) by 2030 (solar, wind, hydro, biomass)</td>
</tr>
</tbody>
</table>
| Indonesia        | ① Increase RE share to 23% in primary energy supply by 2025 and 31% by 2050  
② Biodiesel blending ratio target 30% by 2025; Bioethanol blending ratio 20% by 2025 and 50% by 2050  
③ Achieve a 19.6% share of RE in electricity production in 2030 |
| Lao PDR          | ① 30% share of RE in total energy consumption by 2025, including 20% renewable electricity share (excluding large-scale hydro) and 10% biofuel share (blending ratio 5%-10%)  
② 13 GW total hydropower capacity (domestic and export use) in the country by 2030 |
| Malaysia         | Increase the RE share to 31% in the power capacity mix by 2025 and 40% by 2035 |
| Myanmar          | Increase the share of RE to 39% in electricity generation by 2030 (28% hydro or 5156 MW, and 11% other RE or 2000 MW) |
| Philippines      | ① Increase the RE share to 35% in the power generation mix by 2030 and 50% share by 2040  
② Implement 5% blending for biodiesel starting in 2022 |
| Singapore        | Increase solar energy deployment to at least 1.5 GWp by 2025 and 2 GWp in 2030 |
| Thailand         | Increase the RE share to 30% in TFEC by 2037, including 15%–20% renewable electricity in a total generation; 30%–35% of consumed heat from renewables; and a 20%–25% biofuel share in TFEC |
| Vietnam          | ① Increase the RE share in TFEC to 32.3% by 2030 and 44% by 2050  
② Increase the RE share in power generation to 32% by 2030 and 43% by 2050 |

Source: Multiple official documents
AMS National EE&C Targets

- **Myanmar**
  - Reduce the national electricity demand by 20% by 2030

- **Thailand**
  - Reduce energy intensity by 30% by 2037
  - From the 30% target, 36% of the target is aimed for transport sector by 2037

- **Lao PDR**
  - Reduce 17% of energy intensity by 2025

- **Vietnam**
  - Reduce Total final energy consumption by 8-10% by 2030 compared to BAU

- **Cambodia**
  - Reduce the final energy consumption by 20% by 2035
  - Reduce energy use in the transport sector by 15% by 2035

- **Malaysia**
  - Reduce electricity consumption by 8% by 2025

- **Singapore**
  - 35% Energy Intensity Reduction by 2030 based on 2005 levels

- **Indonesia**
  - 1% of energy intensity reduction per annum up to 2025

- **Brunei Darussalam**
  - 45% energy intensity reduction by 2035
  - From the 45%, 5.9% of the target is aimed for transport sector by 2035

- **The Philippines**
  - at least 10% of energy saving on electricity from all sectors by 2040, based on 2016 BAU

- **ASEAN**
  - Reduce energy intensity by 32% by 2025
Key Analyses: Pathways of ASEAN energy system

- Baseline Scenario projected a 4x of energy required to fuel the economic growth from 2020 to 2050. Energy efficiency measures reduce the need of energy to 3x and 2.7x in ATS and APS.
- LCO Scenario reduces the demand further to 2.5x of 2020.
- In all scenarios, fossil fuels remain the largest component.

Industry and transport sectors continue to be the highest energy consuming sectors in the region.
Key Analyses: Monitoring and Projection of Targets

Renewable Share in Total Primary Energy Supply

- APAEC Target by 2025: 23%
- Renewable Share in Installed Power Capacity
- APAEC Target by 2025: 35%
- National policies fall short of regional RE target by 5.5%-pt gap
- National exceeded the RE installed capacity target

Energy Intensity Reduction from 2005 Level

- APAEC Target: -22% in 2025
- Baseline
- AMS Targets Scenario (ATS): Achievement of ASEAN official national energy targets
- APAEC Targets Scenario (APS): Achievement of APAEC’s aspirational regional targets on RE and EI
- Least-Cost Optimisation (LCO): Least-cost power sector dispatch to attain APAEC’s regional targets

Increase ambitions of RE and EE/El standards

Source: The 7th ASEAN Energy Outlook, 2022
http://go.aseanenergy.org/AEO7
Oil products remain the largest fuel in the transport sector, about 91% of the energy consumption of the vehicle fleet in 2050 under the Baseline Scenario.

In the APS, deploying more efficient electric and hybrid vehicles reduces gasoline and diesel usage by about 72% and 59%, respectively.

Batteries can be used to provide stored power during peak hours. Crucial in enabling higher penetration of RE and maintaining the power grid's stability.

In the LCO Scenario, the region is expected to require 26.6 GW of capacity to store about 1,100 GWh of electricity by 2050.
In 2050, the annual GHG emissions from energy system would reach 6.7 Gt CO$_2$-eq in Baseline Scenario.

In 2050 Baseline Scenario, 8.8 million Ha of land is required to produce biodiesel (oil palm) and 2.3 million Ha for bioethanol (sugarcane), or about 2.5% of the AMS land mass.
Thank You

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One Community for Sustainable Energy

go.aseanenergy.org/AEO7
Energy security & sustainability are key for ASEAN. Why?

- Baseline Scenario projected a 4x of energy required to fuel the economic growth from 2020 to 2050. Energy efficiency measures reduce the need of energy to 3x and 2.7x in ATS and APS.
- In all scenarios, fossil fuels remain the largest component.
- To reach APAEC targets in 2025, energy efficiency measures need to be coupled with increasing share of RE.

In Baseline Scenario, without significant discoveries and/or additions to existing production infrastructures, and with continuous utilisation of fossil fuels, ASEAN would become a net importer of natural gas and coal starting from 2025 and 2039, respectively.
## Climate Targets: 10/10 Emission Reduction 9/10 Carbon Neutrality

<table>
<thead>
<tr>
<th>ASEAN Country</th>
<th>Emissions Reduction Target</th>
<th>Carbon Neutrality / Net Zero Target</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Emissions Reduction Target</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unconditional</td>
<td>Conditional</td>
</tr>
<tr>
<td>Brunei Darussalam</td>
<td>• 20% GHG emissions reduction by 2030 compared to Business as Usual (BAU)</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>• At least 10% GHG emissions reduction by 2035 through better supply and demand management of electricity consumption</td>
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</tr>
<tr>
<td></td>
<td>42% GHG emissions reduction or 64.5 MtCO₂eq by 2030 compared to BAU</td>
<td>Net zero emissions by 2050</td>
</tr>
<tr>
<td>Cambodia</td>
<td>N/A</td>
<td>Carbon neutrality by 2050</td>
</tr>
<tr>
<td>Indonesia</td>
<td>31.89% GHG emissions reduction by 2030 compared to BAU</td>
<td>43.2% GHG emissions reduction by 2030 compared to BAU</td>
</tr>
<tr>
<td></td>
<td>60% GHG emission reduction compared to the Baseline Scenario, or around 62 MtCO₂eq in absolute terms</td>
<td>Net zero emissions by 2060 or sooner</td>
</tr>
<tr>
<td>Lao PDR</td>
<td>Economy-wide carbon intensity (against GDP) reduction of 45% in 2030 compared to the 2005 level</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>N/A</td>
<td>Net zero emissions by 2050</td>
</tr>
<tr>
<td>Malaysia</td>
<td>424.52 MtCO₂eq emissions reduction by 2030</td>
<td>414.75 MtCO₂eq emissions reduction by 2030</td>
</tr>
<tr>
<td></td>
<td>72.29% GHG emissions reduction by 2030 compared to BAU</td>
<td>Carbon neutrality by 2050</td>
</tr>
<tr>
<td>Myanmar</td>
<td>2.71% GHG emissions reduction by 2030 compared to BAU</td>
<td>72.29% GHG emissions reduction by 2030 compared to BAU</td>
</tr>
<tr>
<td></td>
<td>Achieve peak emissions at 60 MtCO₂eq around 2030</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>N/A</td>
<td>Net zero emissions by 2050</td>
</tr>
<tr>
<td>Thailand</td>
<td>30% GHG emissions reduction by 2030 compared to BAU</td>
<td>40% GHG emissions reduction by 2030 compared to BAU</td>
</tr>
<tr>
<td></td>
<td>43.5% GHG emissions reduction by 2030 compared to BAU</td>
<td>Carbon neutrality by 2050 and net zero emissions by 2065</td>
</tr>
<tr>
<td>Vietnam</td>
<td>15.8% GHG emissions reduction by 2030 compared to BAU</td>
<td>43.5% GHG emissions reduction by 2030 compared to BAU</td>
</tr>
<tr>
<td></td>
<td>43.5% GHG emissions reduction by 2030 compared to BAU</td>
<td>Net zero emissions by 2050</td>
</tr>
</tbody>
</table>
Energy Transition is Inevitable: Regional Push on RE

2021 Status of RE target: RE Share in TPES

- RE share in TPES reached **14.4%** in 2021. It is an increase of 0.2%-point from 2020.
- RE supply was 96 mtoe out of 666 mtoe.

2021 Status of RE target: RE Share in Power Capacity

- RE share in Installed Power Capacity reached **33.6%** in 2021. It is an increase of 0.3%-point from 2020.
- RE installed capacity was 99 GW out of total 295 GW.
Realisation of ASEAN’s cross-border interconnection system with higher penetration of variable renewable energy (solar and wind), under the ASEAN Power Grid.

Various forms of energy storage can be used to provide stored power during peak hours. Crucial in enabling higher penetration of RE and maintaining the power grid's stability.

In the LCO Scenario, the region is expected to require 26.6 GW of capacity to store about 1,100 GWh of electricity by 2050.
ASEAN energy demand: Industry-Transport and Oil

Industry and transport sectors continue to be the highest energy consuming sectors in the region.

Oil products remain the largest to be consumed, with 47% share in 2050 Baseline Scenario, and reduced to 38% in APS for the same year.
Financing can become either the bottleneck and catalyst

- The power sector investment cost is strongly impacted by the energy efficiency measures by end-users. The APS and LCO Scenario show the lowest power investment requirements in the later years, highlighting lower electricity demand.

- Cumulative investment in 2021-2050 (in Billion) – Baseline: USD 1,070; ATS: USD 879, APS: USD 726, LCO: USD 582.

- Higher share of RE coupled with higher electrification would require higher level of investment as well.

- A report by ACE and IRENA showed that 52% of end-use electrification and 90% renewable electricity generation require 2.8-3.7 trillion USD in power generation and 6.3-7.4 trillion USD for the whole energy system (4-5x of APS).

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### Annual Power Investment Cost

<table>
<thead>
<tr>
<th>Year</th>
<th>Baseline</th>
<th>ATS</th>
<th>APS</th>
<th>LCO</th>
</tr>
</thead>
<tbody>
<tr>
<td>2021-2030</td>
<td>30</td>
<td>25</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>2031-2040</td>
<td>25</td>
<td>20</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>2041-2050</td>
<td>20</td>
<td>15</td>
<td>10</td>
<td>5</td>
</tr>
</tbody>
</table>

### Investment Needs based on Various Scenarios

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Power Investment (Billion)</th>
<th>All Energy Investment (Billion)</th>
<th>RE in Electricity Generation</th>
<th>Electricity Share in TEFC</th>
</tr>
</thead>
<tbody>
<tr>
<td>AEO7 – ATS</td>
<td>879 billion</td>
<td>2,609 billion</td>
<td>50.4%</td>
<td>25.5%</td>
</tr>
<tr>
<td>AEO7 – APS</td>
<td>726 billion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2nd REO – PES</td>
<td>1,267 billion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2nd REO – 1.5S</td>
<td>2,834 - 3,723 billion</td>
<td>6,318 - 7,391 billion</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) Higher RE share but also lower overall energy demand due to stronger EE measures
2) 2nd REO investment need covers 2018-2050

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One Community for Sustainable Energy
Identifies 8 regional strategies and 16 specific initiatives will deliver 4 key outcomes

Outcomes

Boost green industries
Capturing full value of regional green industries

Enable ASEAN interoperability
Accelerating exchanges of green products & feedstocks

Establish global credibility
Attracting international capital & increasing liquidity

Build green capabilities
Developing talent & expertise to drive the transition

Initiatives

Identify & boost opportunities for greennification of the manufacturing value chains regionally
Enable ASEAN feedstock pathways for biofuels to capture global markets
Coordinate development of regional policies and regulations to support CCS/CCUS infrastructure

Upgrade ATIGA to comprehensively include circular products
Enable regional power trading, physical interconnection, and policy cooperation
Enable interoperability of regional transport & logistics infrastructure
Promote regional energy efficiency (EE) & conservation

Harmonize measurement, reporting & verification standards and policies to access global liquidity and regional carbon sink potential
Establish globally credible regional GHG inventory to flow from national reports
Standardize globally credible frameworks for corporate climate reporting
Encourage adherence to ASEAN Taxonomy on Sustainable Finance

Incentivize green fund managers to locate in ASEAN, and local funds to develop
Establish green skills taxonomy & facilitate movement of natural persons
Facilitate best practice sharing to support effective just transition at national level
Conduct capability building for sustainable infrastructure & smart cities

Strategies

Advance green value chain integration
Regional circular economy supply chains
Connect green infrastructure & market
Interoperable carbon markets
Credible & common standards
Attracting & deploying green capital
Green talent development & mobility
Green best practice sharing

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