Regional Power Master Plan
Harmonizing the Greater Mekong Sub region (GMS)
Power Systems to Facilitate Regional Power Trade

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Outline

- Project Background
- Study Objectives and Methodology
- GMS Study Model and Scenarios
- Selected Results
  - Summary of Cost Benefit
  - Benefits of Cross-border Power Trade/ VRE Development
  - Summary of Regional Generation & Transmission Plans
- Key Study Outcomes
Project Background
Greater Mekong Sub (GMS) region has an increasing power demand.

- Main contributors to the regional load demand are Thailand and Viet Nam

Note: China (Yunnan and Guangxi provinces) is modeled as a node with excess power for export.
The load and the generation resources in the region are unevenly distributed.

- Laos, Myanmar and Cambodia have high hydro power potential
- Viet Nam and Thailand have high wind and solar potential.
Study Objectives and Methodology
Study Objectives

• The main objective of this project is to perform studies to develop a regional generation and transmission master plan for the Greater Mekong Sub-Region (GMS).
  – Determine **optimal regional generation planning scenarios** (for the period from year 2022 to year 2035).
  – Determine the **optimal cross-border power transmission scenarios** to facilitate generation plan for year 2022 to 2030.
  – Perform PSS®E based load flow studies to verify the technical feasibility of the proposed plans and identify additional system upgrades (if required).
  – Determine the **most ‘economically’ and technically feasible** cross-border transmission expansion plans and corresponding regional generation development scenarios.
Study Methodology

• Load forecast, existing generation plans and cross-border power trade plans are used to develop the regional generation and transmission plan

Key inputs and expected outcomes of regional plan development

Development and Optimization of Regional Generation and Transmission Plan

Transmission-constrained probabilistic costing (SDDP™) & Detailed Technical Analysis (PSS®E)

Beneficial Transmission Upgrades
Generation planning Recommendations
Expected Cost Savings
Study Methodology

• A number of regional generation development scenarios are developed to include the uncertainty associated with the data inputs to generation/transmission plan.

• Uncertainty in load growth, economic, technological and policy related factors are considered in the analysis.

![Diagram of Generation/Transmission scenarios]

- **Load growth**
  - Medium load growth
  - High load growth
  - Low load growth

- **Economic factors**
  - High fossil fuel cost
  - Low VRE cost
  - Low gas price

- **Technological/policy factors**
  - Battery technology,
  - Aggressive cross-border power trade
  - **Nuclear energy (?)**
OPTGEN™/SDDP™ Study model - Scenarios

• 33 (11 x 3) main study scenarios were used to account for the uncertainty in

<table>
<thead>
<tr>
<th>Economic factor</th>
<th>Technological/Policy factor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base</td>
</tr>
<tr>
<td></td>
<td>Solar-battery storage</td>
</tr>
<tr>
<td></td>
<td>Nuclear</td>
</tr>
<tr>
<td></td>
<td>High cross-border power trade</td>
</tr>
<tr>
<td>Base</td>
<td>M</td>
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<tr>
<td>VRE cost reduced</td>
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<td>High fossil fuel price</td>
<td>M</td>
</tr>
<tr>
<td>Low gas price</td>
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</table>

• **Base study scenarios** are developed assuming the most likely generation and transmission development options (Based on current generation plans – optimized transmission considering cross border power trade)

• In addition, **3 reference study scenarios** are developed for comparison of costs
  – Generation and transmission development inputs are same as ‘Base’ study scenarios
  – No transmission optimization (only the existing/planned transmission links)
OPTGEN™/SDDP™ Study model – Representation of load

- The discretized daily load curve was modeled using 7 load “blocks”
OPTGEN™/SDDP™ Study model – Availability of Renewable based generation

Solar availability

Wind availability

Mean Discharge and Hydro Availability

Wet Season

Discharge | Hydro Generation
OPTGEN™/SDDP™ Study model – Lines

- Existing Cross-border transmission lines
- Planned Cross-border transmission lines
- Only 220 kV and above
PSS®E Study model

- Complete 500 kV and the relevant 230/220 kV and 110/115 kV networks.
- Detailed analysis including AC load flow based reliability studies
- Base scenario and selected scenarios are studied
- Study year - 2030
Selected Results
### Cost Benefit Summary

#### Medium Demand Growth Scenarios Cost Savings (B$)

<table>
<thead>
<tr>
<th>Economic factor</th>
<th>Base</th>
<th>Solar-battery storage</th>
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<td>27</td>
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<tr>
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<td>20</td>
<td>-10</td>
<td>29</td>
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#### High Demand Growth Scenarios Cost Savings (B$)

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#### Low Demand Growth Scenarios Cost Savings (B$)

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<tr>
<td>Base</td>
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<td>18</td>
<td>18</td>
<td>28</td>
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<tr>
<td>VRE cost reduced</td>
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<tr>
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</table>
Annual Progression of Energy Usage

Base study scenario – Medium load growth

Energy Generation

- Hydro Generation (GWh)
- Thermal Generation (GWh)
- VRE Generation (GWh)
### Summary of regional transmission plans

<table>
<thead>
<tr>
<th>Year</th>
<th>From</th>
<th>To</th>
<th>Connection Points</th>
<th>Type</th>
<th>Capacity</th>
<th>CAPEX (2022 NPV M$)</th>
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<tr>
<td>2022</td>
<td>Myanmar</td>
<td>Thailand</td>
<td>Yangon area - Mae Moh</td>
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<td>Thailand</td>
<td>Mawlamyine - Tha Tako</td>
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<td>2023</td>
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<td>Thailand</td>
<td>Gan Lan Ba - Tha Wung via Lao PDR-N</td>
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<td>Mae Khot TPP - Mae Chan</td>
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<td>Cambodia</td>
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<td>Vietnam</td>
<td>Ban Soc/Ban Hatxan - Tay Ninh via Stung Treng</td>
<td>500 kV</td>
<td>1500</td>
<td>58.3</td>
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<tr>
<td>2027</td>
<td>Lao PDR</td>
<td>Vietnam</td>
<td>Savannakhet - Ha Tihn</td>
<td>500 kV</td>
<td>1500</td>
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<td>2028</td>
<td>Lao PDR</td>
<td>Vietnam</td>
<td>Xekaman 4 HPP - Ban Soc/Ban Hatxan - Pleiku</td>
<td>500 kV</td>
<td>3000</td>
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<tr>
<td>2028</td>
<td>China</td>
<td>Vietnam</td>
<td>Yunnan - Hiep Hoa</td>
<td>500 kV DC</td>
<td>3000</td>
<td>480.7</td>
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<tr>
<td>2029</td>
<td>Lao PDR</td>
<td>Vietnam</td>
<td>Nam Mo HPP - Ban Ve</td>
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<td>2029</td>
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<td>Vietnam</td>
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<td>Vietnam</td>
<td>Kampong Cham - Tay Ninh</td>
<td>500 kV</td>
<td>3000</td>
<td>31.4</td>
</tr>
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Summary of regional transmission plans

Base Scenario
Summary of regional transmission plans

Base Scenario (Medium Load Growth)

• **Four interconnections** are built between Laos and Viet Nam

• **HVDC lines** are built from China to Thailand and from China to Viet Nam

• Three interconnections are built between Thailand and Myanmar
Conclusions and Key Study Outcomes
• Regional generation planning scenarios were identified for the period from year **2022 to year 2035**.

• Cross-border power transmission plans to facilitate generation plans were obtained for year **2022 to 2030**.

• Main future directions identified in the study for further analysis
  – Base scenario – Transmission optimized
  – Aggressive cross border power trade – Generation and added transmission
  – Reduced VRE cost – Overall impact studied

• Base scenario
  – **18 $ Billion** total cost benefit
  – High cross-border transmission development in **Myanmar – Thailand** and **Laos- Viet Nam** interfaces
Key Study Outcomes

- Aggressive cross-border power trade scenario
  - 27 $ Billion total cost benefit

- Reduced VRE cost scenario
  - 20 $ Billion total cost benefit

- Regional transmission plan
  - Most of the candidate interconnections are optimized before 2030
  - These interconnections are largely beneficial to lower the total cost (CAPEX+OPEX) the GMS region
Key Study Outcomes

Optimized generation developments

- Large hydro in Myanmar and Lao PDR
- Large thermal and VRE in Thailand, Viet Nam
Key Study Outcomes

Optimized cross-border developments

• Highly impacting interconnections
  – Myanmar – Thailand interconnections (developed early in the study period)
  – Lao PDR – Viet Nam interconnections
  – Thailand – Cambodia – Viet Nam interconnections

• Other optimized interconnections
  – Lao PDR – Cambodia
  – China to Myanmar, Thailand, Laos & Viet Nam (Generally near the end of the period)
Finalizing the study

- Update the study results *based on feedback*
- Finalize detailed analysis
- *Final report*
Thank you