Contractual flexibility
Context

- Commercial flexibility is provided by underlying contractual structures and institutions.

- It plays a big role in unlocking the flexibility potential of electricity demand and supply (i.e. power generation assets).

- This section examines the need for increased commercial flexibility in the Thai system, both in PPAs and fuel supply contracts.

- The data used from this analysis was provided by EGAT (i.e. PPAs, PDP 2019-2037 and demand details)
Some gas and co-generation contracts expire before 2030, while no hydro expires before 2035.

Note: does not include imported hydro capacity (3 500 MW) and geothermal projects included in the 2018 PDP.

Source: EGAT
Capacity overview per PDP (2019-2037)

Note: Capacity includes VRE and is not adjusted by capacity factor; this means that the capacity margin reflects a situation where all generation produces at full capacity.

Thailand’s capacity margin remains above 20% beyond 2037.
Assumptions for flexibility stress test scenarios

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Level of resource availability and minimum-take obligations for conventional generation and co-generation</th>
<th>Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Renewables</td>
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<td></td>
<td>Hydro</td>
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<td></td>
<td>Conventional generation and co-generation</td>
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<tr>
<td>1</td>
<td>Minimum: per lowest capacity factor for wind (12.4%), solar (0.8%) and biomass (2.4%)</td>
<td>Peak *</td>
</tr>
<tr>
<td>2</td>
<td>Maximum demand during 26 October 2019 (minimum demand 04h00 to 04h30 and maximum demand 07h00 to 07h30).</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Maximum: per highest capacity factor for wind (100%) and solar (83.5%)</td>
<td>Peak **</td>
</tr>
<tr>
<td>4</td>
<td>Maximum demand during 7 December 2019 13h00 (minimum demand 03h30 to 04h00 and maximum demand 06h30 to 07h00).</td>
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</tr>
<tr>
<td>5</td>
<td>Minimum: per lowest capacity factor for wind (12.4%), solar (0.8%) and biomass (2.4%)</td>
<td>Peak *</td>
</tr>
<tr>
<td>6</td>
<td>Maximum demand during 7 December 2019 13h00 (minimum demand 03h30 to 04h00 and maximum demand 06h30 to 07h00).</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Maximum: per highest capacity factor for wind (100%) and solar (93.5%)</td>
<td>Peak **</td>
</tr>
<tr>
<td>8</td>
<td>Maximum demand during 7 December 2019 13h00 (minimum demand 03h30 to 04h00 and maximum demand 06h30 to 07h00).</td>
<td></td>
</tr>
</tbody>
</table>

- Maximum and minimum demand during 26 October 2019 (minimum demand 04h00 to 04h30 and maximum demand 07h00 to 07h30).
- ** Maximum and minimum demand during 7 December (minimum demand 03h30 to 04h00 and maximum demand 06h30 to 07h00). Off-peak timing in Thailand varies according to the season, and are not fixed night-time hours.
Flexibility analysis results

Scenario 1: Low renewables with peak demand

Until 2026 there is a potential lack of downward flexibility during the peak.

Source: EGAT
Scenario 3: High renewables with peak demand

The peak demand absorbs most of the minimum-take generation during the peak

Source: EGAT
Until 2026 there is a potential lack of downward flexibility during the peak.
Enhancing commercial flexibility

- Restructuring active contracts opens an opportunity to utilise technical flexibility.
- With multilateral power trade, EGAT can establish more flexible market solutions.
- Relaxing minimum take obligations gives EGAT the option of optimally dispatching on the basis of a Marginal Cost of Production
- Restructuring of contracts needs to be done with extreme care to ensure a healthy investment environment. An auction principle could allow voluntary and competitive provision of flexibility.
Changing contractual structures – a balancing act

• Changing contractual structures should not be taken lightly

• If done incorrectly it can damage investor confidence and increase the cost of the clean energy transitions

• Creating an auction is a good option for increasing flexibility

• The auctions can define what characteristics should change and contract holders can bid for it

• Before launching an auction it is important to hold stakeholder consultations

• EGAT and IPPs should be able to bid in on equal terms
Fuel supply contracts impact on flexibility

• Like minimum take obligations in PPAs impact flexibility so does fuel supply contracts.

• In Thailand especially gas contracts impact power system flexibility.

• Take or pay obligations impact the marginal cost of generation for example daily take or pay obligations.

• Gas turbines are technically some of the most flexible thermal plants.

• They can ramp very fast and thus are able to contribute positively to the ramps created for example by Solar PV.

• However when take or pay obligations are present they may effectively have the same marginal cost as renewable energy because fuel is a sunk cost.
Take or pay volumes

Adjustments to current contracts can help ensure flexibility from gas turbines
Portfolio approach to gas supply

• Ensuring fuel needs to take three considerations into account
  - Security of supply
  - Flexibility
  - Affordability

• LNG is a very flexible with offtake obligations that are monthly or even yearly

• Other instruments like options can also be used to ensure security of supply

• While the flexible gas contracts are more expensive overall fuel costs should go down with the portfolio approach

• The minimum stable fuel can be bought via inflexible contracts but they should be supplemented by more flexible contracts to account for demand that can vary due to VRE
The IEA’s participation in this event was made possible through the Clean Energy Transitions in Emerging Economies programme has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 952363.
Additional slides
Minimum-take capacity only starts to significantly decline after 2034

Source: EGAT
Assumed minimum-take capacity by technology

<table>
<thead>
<tr>
<th>Technology</th>
<th>Minimum-take capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cogeneration (firm)</td>
<td>100% (peak) and 65% (off-peak) of declared capacity</td>
</tr>
<tr>
<td>Cogeneration (non-firm)</td>
<td>100% of declared capacity</td>
</tr>
<tr>
<td>Renewables (firm and non-firm)</td>
<td>100% of declared capacity</td>
</tr>
<tr>
<td>Gas, bunker oil, lignite, coal, hydro (imports)</td>
<td>Minimum generation of declared capacity per unit</td>
</tr>
<tr>
<td>Geothermal</td>
<td>100% of declared capacity</td>
</tr>
<tr>
<td>Diesel</td>
<td>None</td>
</tr>
<tr>
<td>Hydro (EGAT)</td>
<td>100% of declared capacity</td>
</tr>
</tbody>
</table>

The assumptions represent the restrictions in current PPAs and form the basis of our commercial flexibility analysis.