International Energy Agency

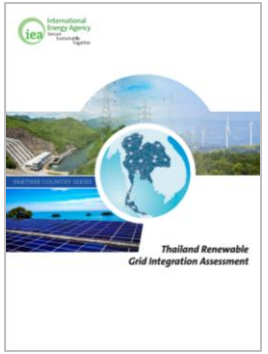
Thailand power system flexibility study

Renewable Integration and Secure Electricity Unit

Launch webinar, 4 June 2021

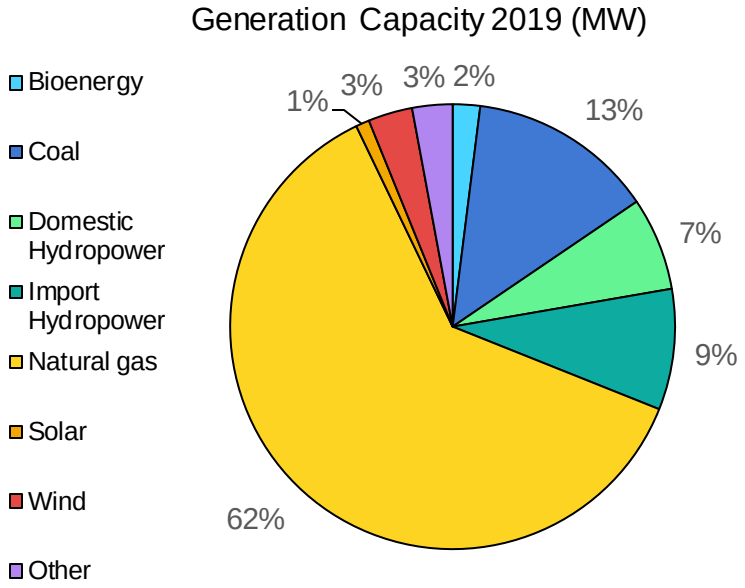
Background of Thailand Power System Flexibility study

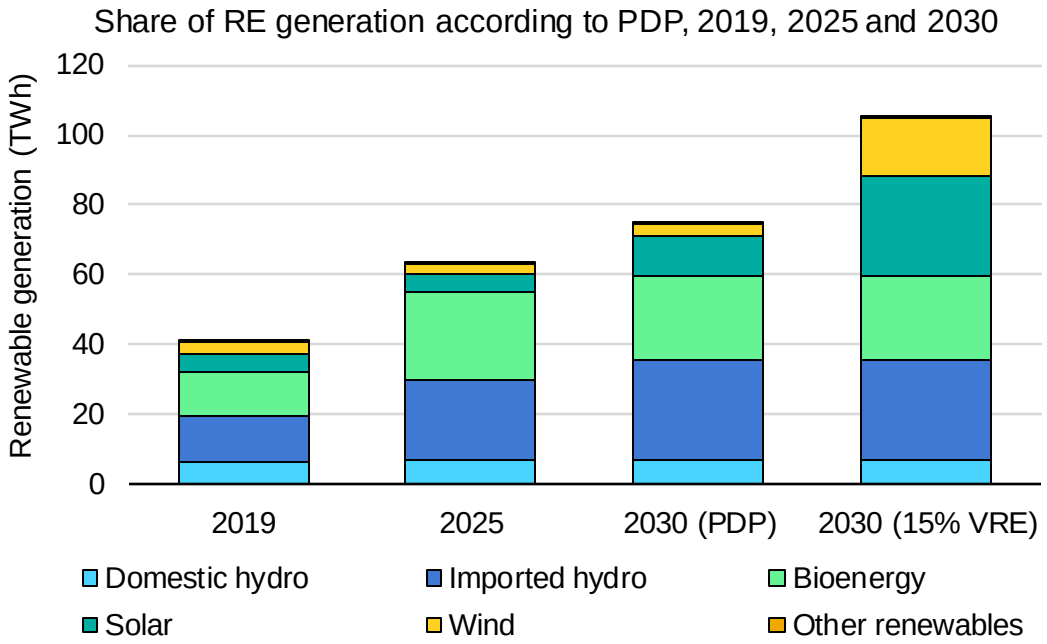
- In 2018, the IEA conducted a RE grid integration study to understand integration challenges (in collaboration with MoEN, EGAT, EPPO, DEDE). Key findings were:
  - Much more ambitious wind and solar targets are possible from the operational aspect
  - Flexibility is key to integrate more solar and wind (both technical and contract)
- **'Grid flexibility'** is one of the main elements in the 2018 PDP
- 2020-21 In-depth flexibility analysis to understand the value and impact of flexibility options
- Two main avenues to enhance its flexibility: **Technical and contractual.**



Technical flexibility		Contractual flexibility
• Analyse **the value of technical flexibility options** from technical and economic perspectives • Flexible resources include **flexible power plants, battery energy storage systems (BESS) and pumped storage hydro**	*Interaction between technical and contractual flexibility is important*	• Analyse **impacts of existing power purchase and fuel supply contract structures** on system flexibility. • Identify **appropriate options for the existing and future contract structures**, both for fuel supply and offtake of electricity.

Generation mix in Thailand

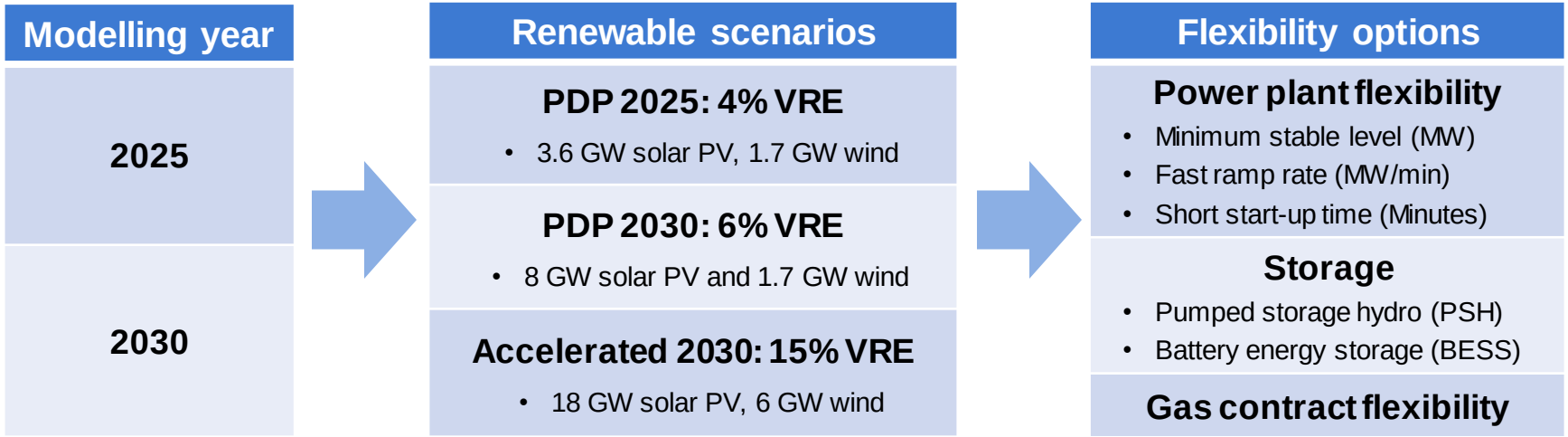




- 47 GW installed capacity and around 30 GW peak demand. Gas-fired is the largest generation source
- 4% annual share of VRE (variable renewables: Solar PV and Wind) in 2020
- The VRE target in PDP: 4% in 2025, 6% in 2030 and 8% in 2037.

Technical flexibility

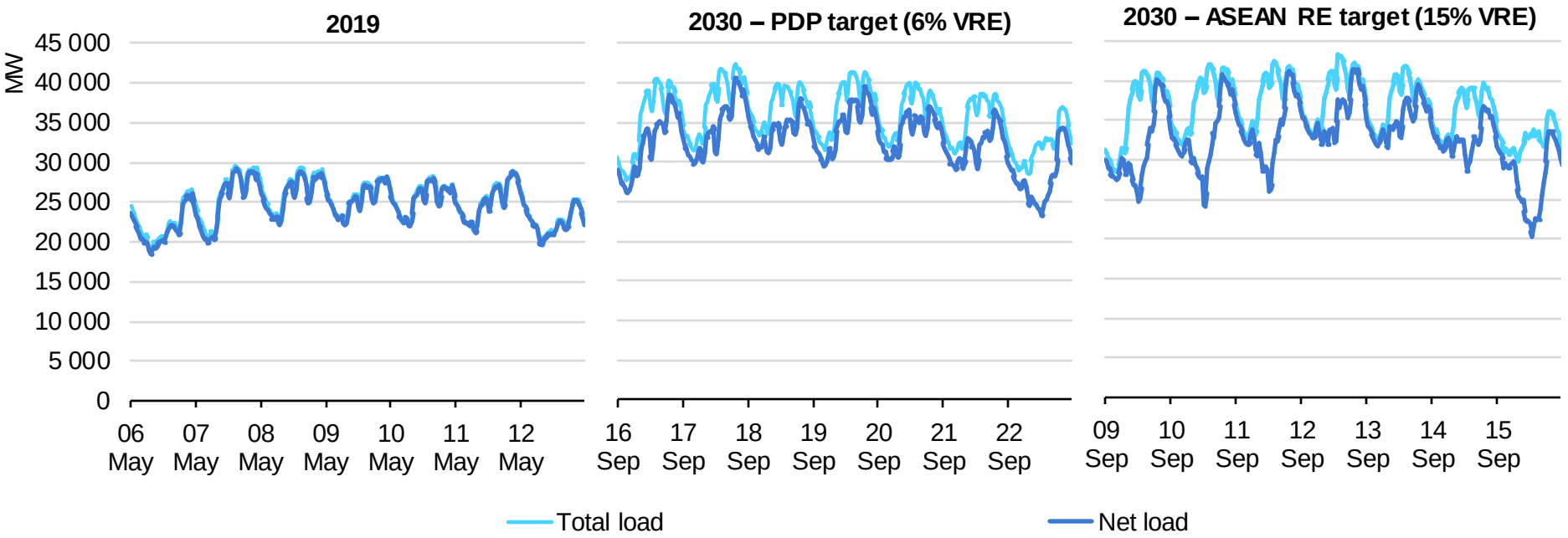
Scenario overview



- Assessment in both short- (2025) and medium-term (2030)
- Considers different flexibility options and accelerated deployment of renewables
- Includes technical (generation, transmission) and contractual (fuel supply) constraints

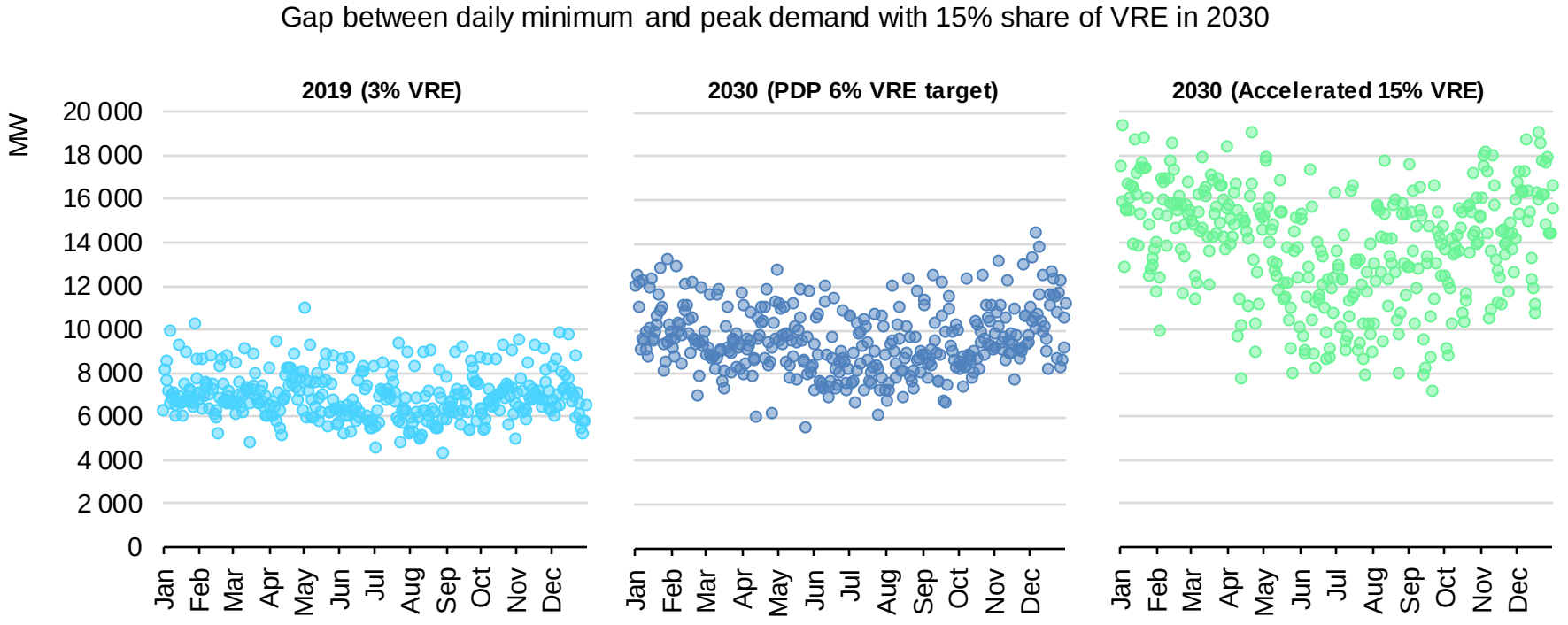
Net demand profiles for Thailand during peak period

Load and net load profiles during the peak period with different share of VRE, 2019 and 2030



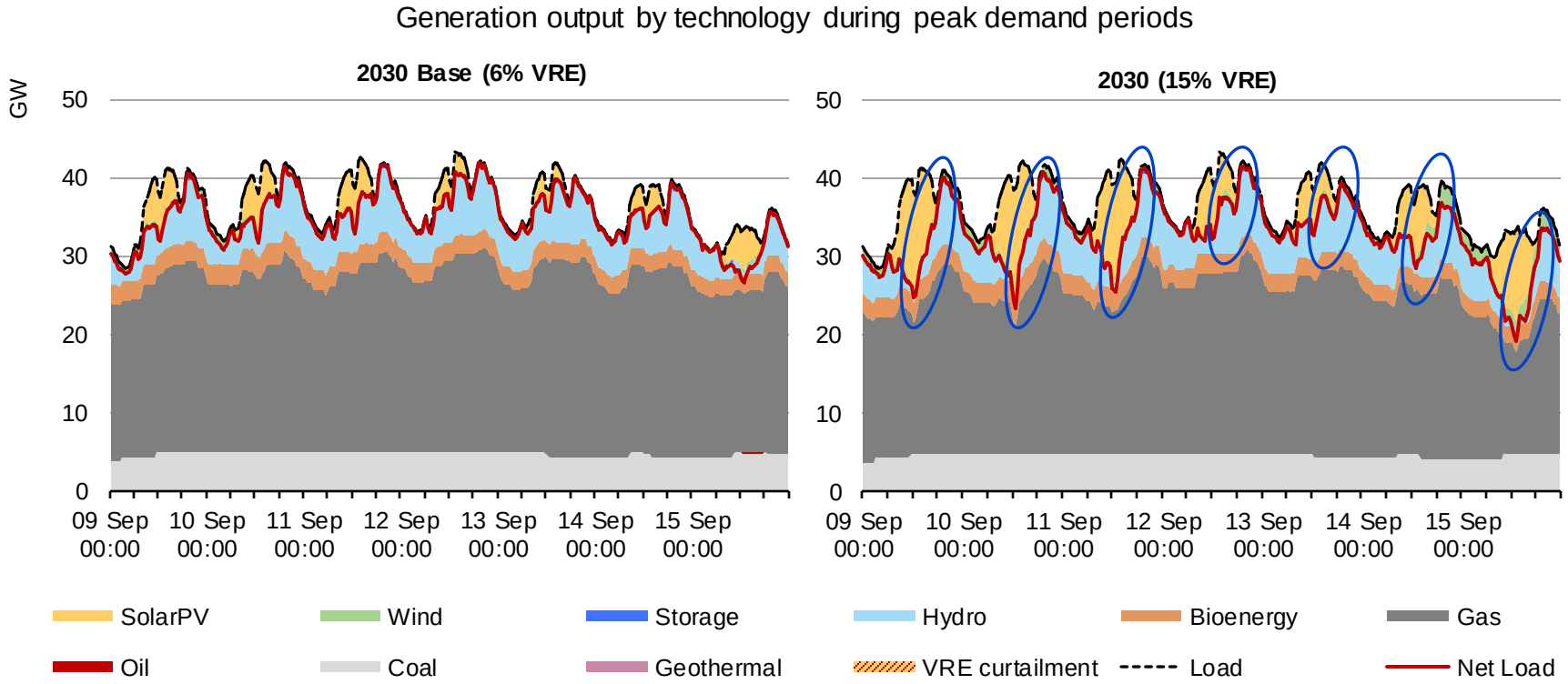
- Greater variability of demand with more VRE. Larger gap between daily minimum and peak demand
- Higher ramping requirement in the evening peak on Sundays and public holidays

Flexibility requirements with more solar and wind power



The larger gap between minimum and peak demand leads to greater flexibility requirements and operational challenges that result in more frequent cycling of conventional power plants.

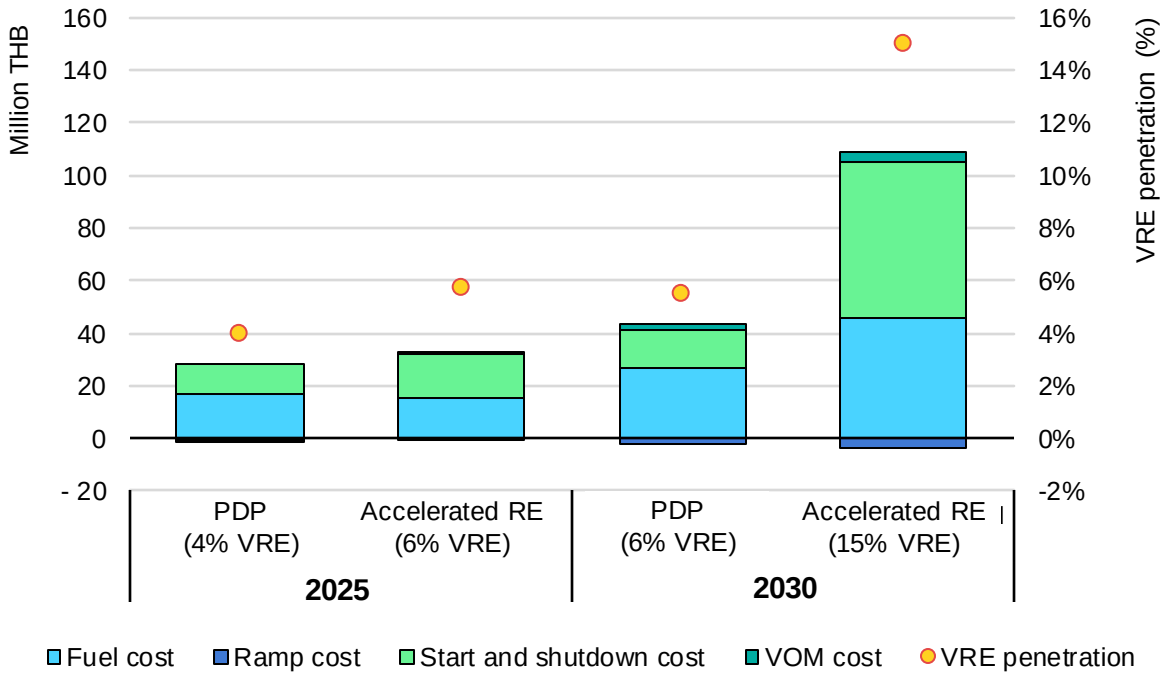
Greater flexibility requirements with more solar and wind generation



Greater variability in net load profiles with more solar PV and wind but it is still manageable. Hydropower and CCGT provide a large amount of ramping requirements to meet evening peak when solar generation reduces.

Flexible power plants provide small operational cost savings

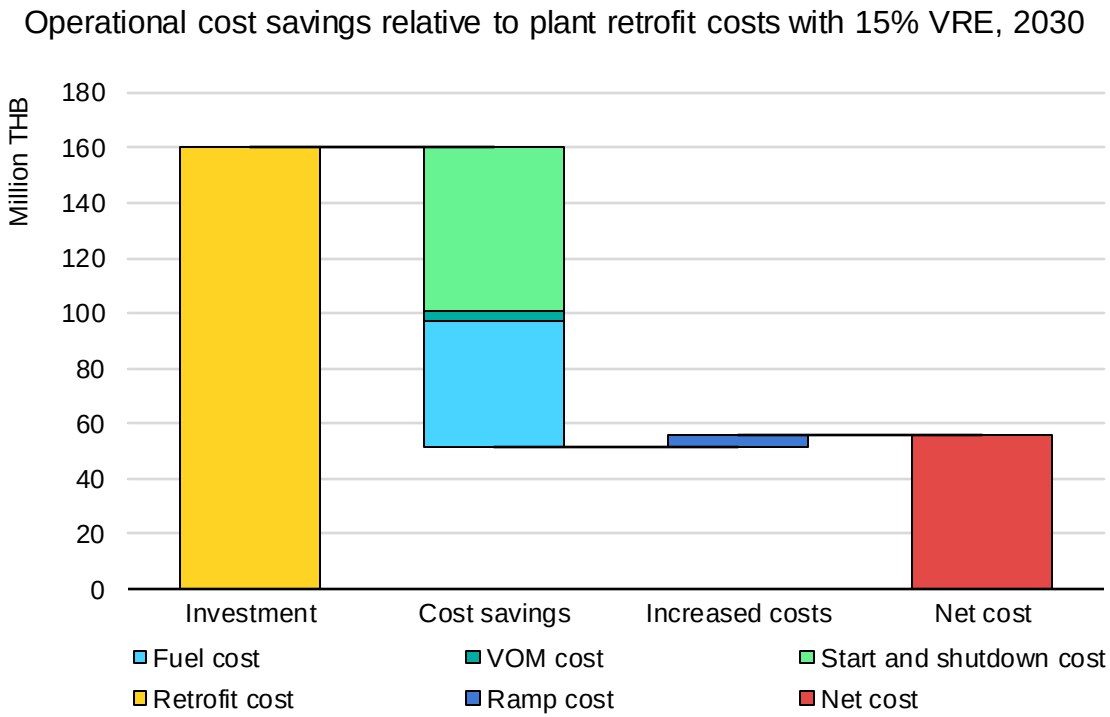
Annual operational cost savings from power plant flexibility in 2025 and 2030



Lowering minimum stable level leads to greater cost savings compared to higher ramp rates and faster start-up time.

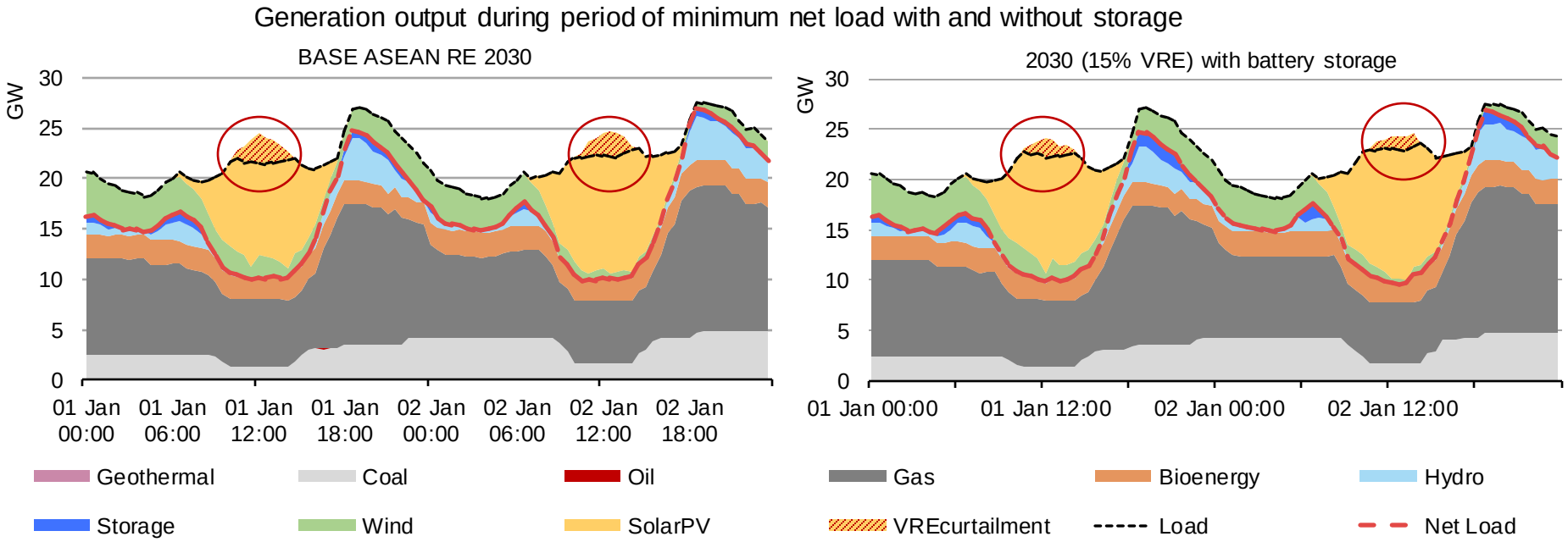
- Key characteristics of flexible power plants: **low minimum stable level**; **high ramp rates**; **fast start-up time**.
- Flexible power plants can result in operational cost savings to the system, but very small (<0.1%)
- The main cost saving components are fuel and start-up costs
- Greater operational cost savings with higher VRE but these savings are still small

Economic impact of flexible power plants



The annualised cost of retrofits power plants to make them more flexible (i.e. lower the minimum stable level) outweighs the operational cost savings. This is due to constraints in fuel and power purchase contracts.

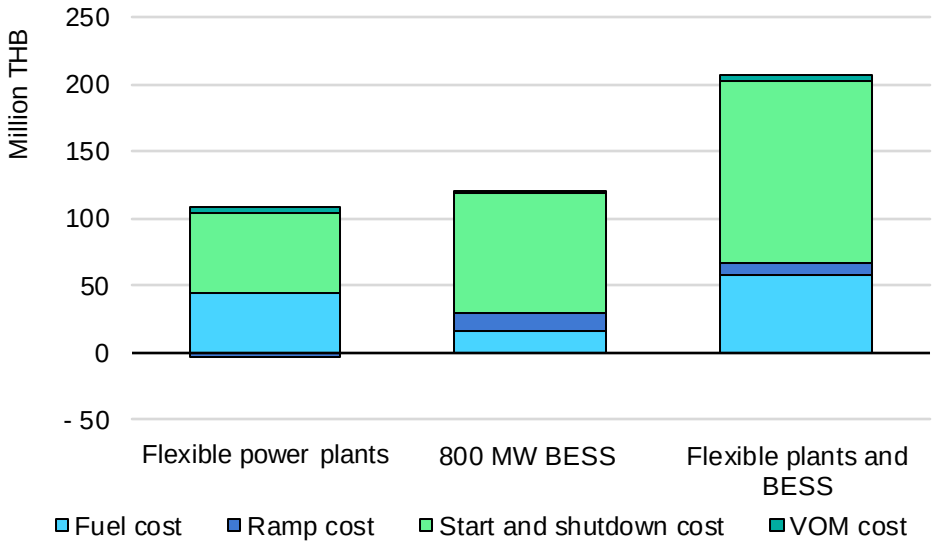
Potential role of storage in providing flexibility



- Storage (either PSH or batteries) can make the system flexible by allowing storage of cheap energy during off-peak periods and generating during peak periods
- Storage reduces VRE curtailment, although curtailment levels are very low (only occurring during New Year holidays where demand is very low)

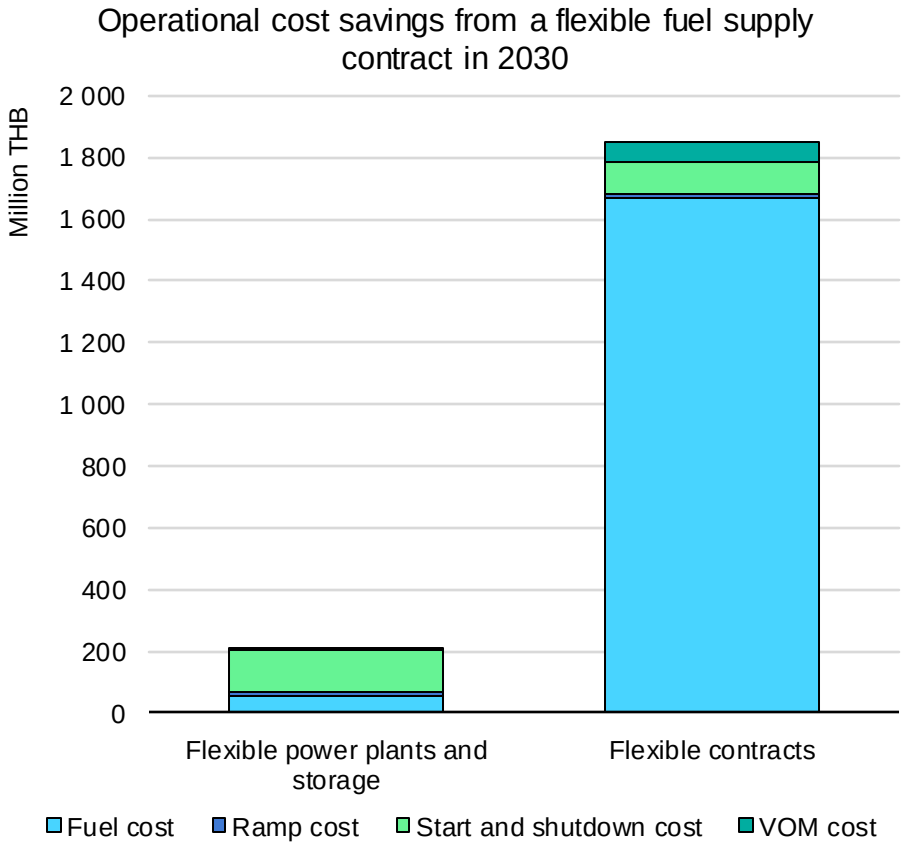
Flexible power plants and storage can become complementary options

Operational cost savings from combined flexibility options at 15% VRE share in 2030



- With 15% share of VRE in 2030, a combination of flexible power plants and storage can provide further cost savings, but still modest compared to the overall cost.
  - The investment cost plant retrofits and storage still outweigh the operational cost savings.
  - The small cost savings due largely to inflexible fuel supply and power purchase contracts

The value of technical options depends on fuel supply contracts



- The operational cost savings from a flexible fuel supply contract are significantly greater than the savings from flexible power plants and storage options
  - Minimum take-or-pay obligations
- A significant reduction in operational costs as system operators can access a large amount of latent flexibility in the system and dispatch the system in a more cost-effective manner.

Summary - Technical Flexibility

- As the share of VRE increases, so **the power system's need for flexibility will grow**
  - Higher ramping requirements and larger gap between daily minimum and peak demand
  - Operational practices and planning should take into consideration these flexibility requirements.

- **Thailand's system has inherent technical flexibility** through gas & hydro generation and transmission network. The system can technically integrate up to **15% share of VRE by 2030** (19GW solar, 6GW wind)

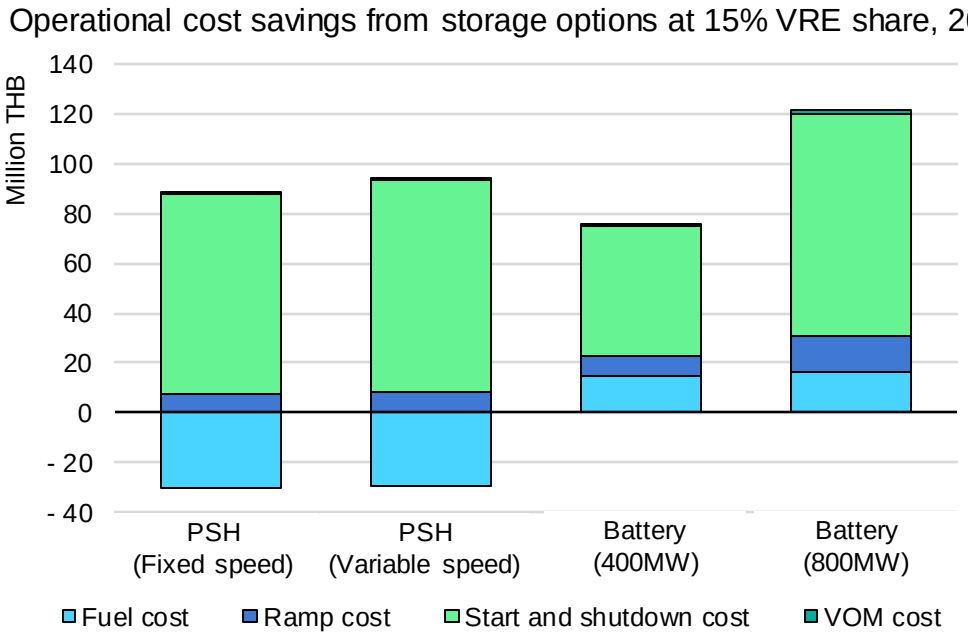
- Power plant retrofits, pumped storage hydro and battery storage can provide flexibility services but they are **not a priority in the short- to medium-term** under the current context of Thailand's power sector
  - Contractual constraints (fuel contract and PPA) limit mobilising this technical flexibility by preventing the use of otherwise available and cost-optimal resources in the system.

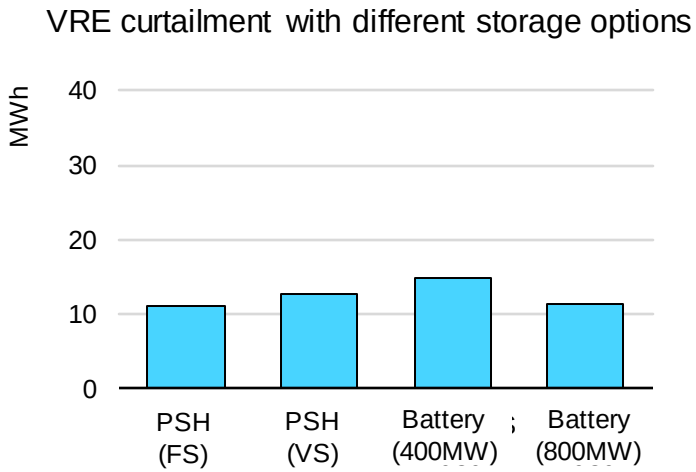
- As Thailand **accelerates its clean energy transition with more renewables, flexible power plants, pumped storage and battery storage** can become a complementary and economically viable option
  - This is subject to institutional changes to fuel supply and power purchase contracts
  - Mobilising available technical flexibility may call for regulatory incentives to facilitate and promote the use of flexibility options

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

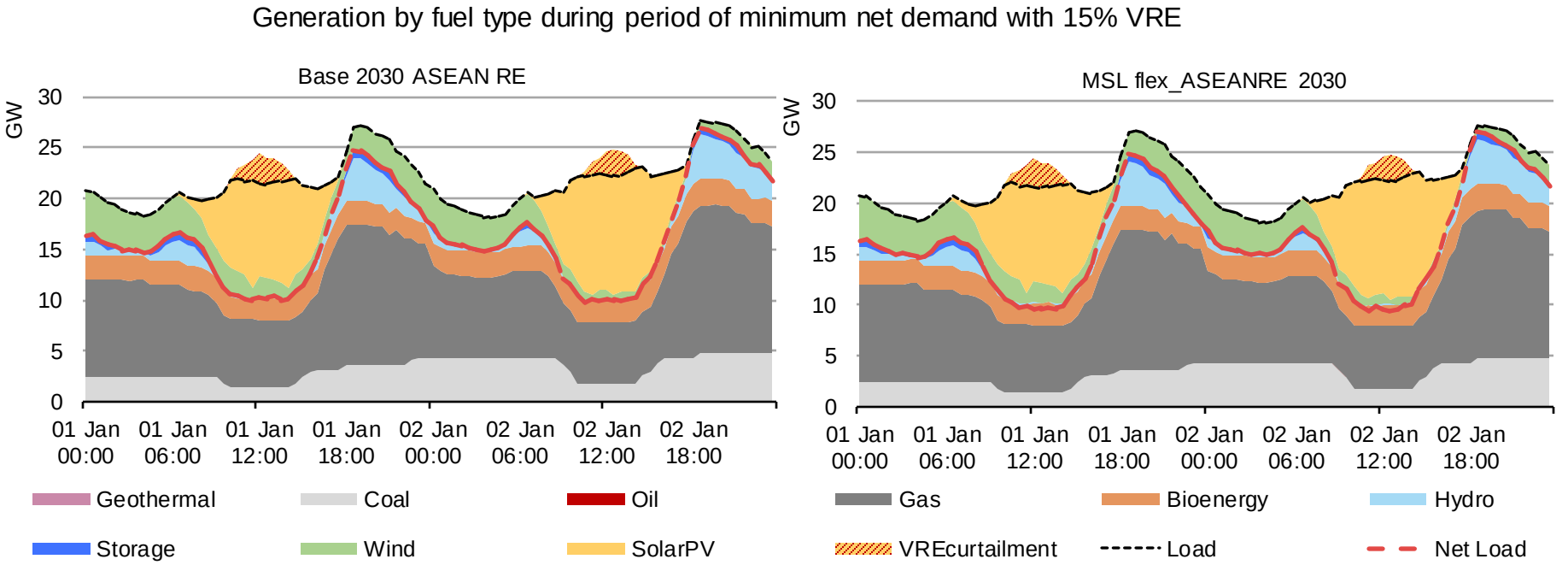
The role of pumped storage hydro and battery storage





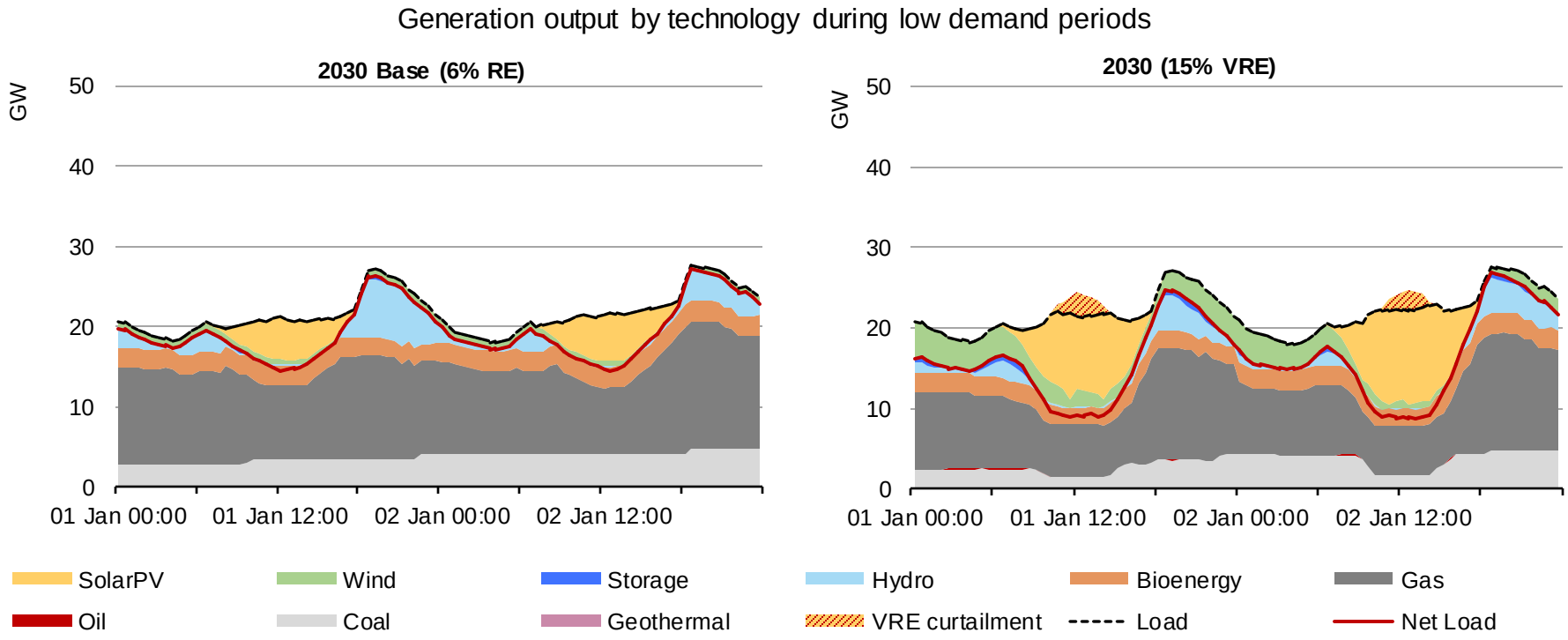
- New PSH can reduce the operational costs (lower start-up costs from thermal plants). The difference in the cost savings between fixed-speed and variable-speed PSH is almost negligible
- Investing in PSH and BESS is not a priority in the short to medium term given small cost savings

Potential role of flexible power plants to the system



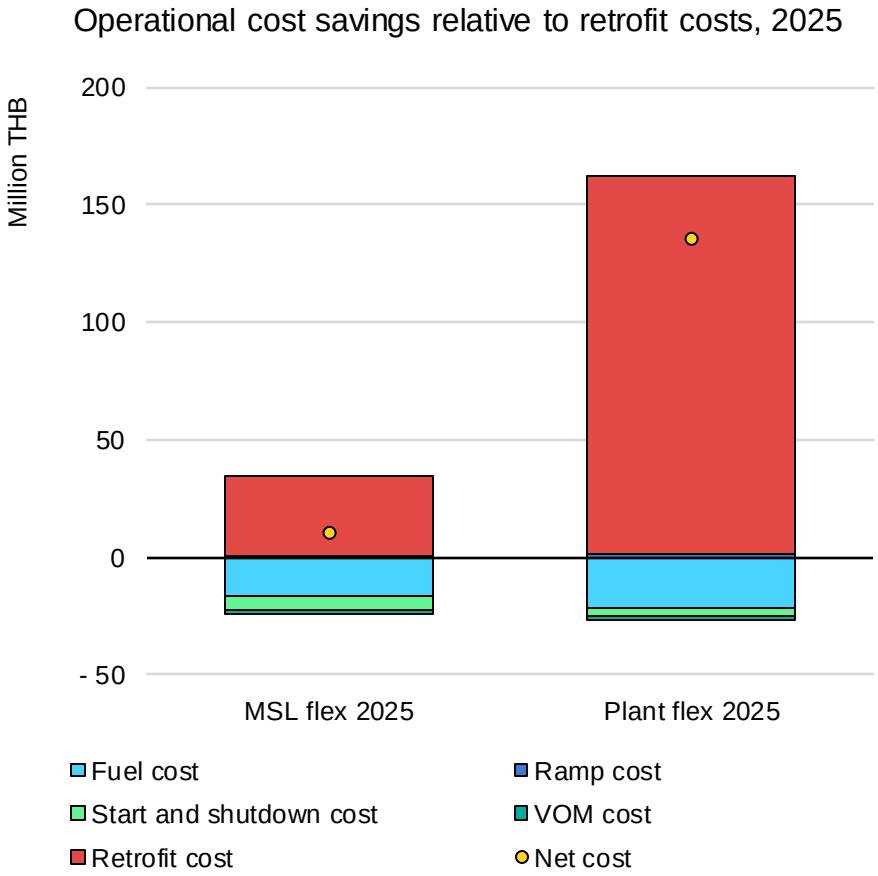
- Lower minimum generation levels of thermal fleet can allow the system to better accommodate the daily swing in net demand

Thailand's power system is capable of handling variable renewables



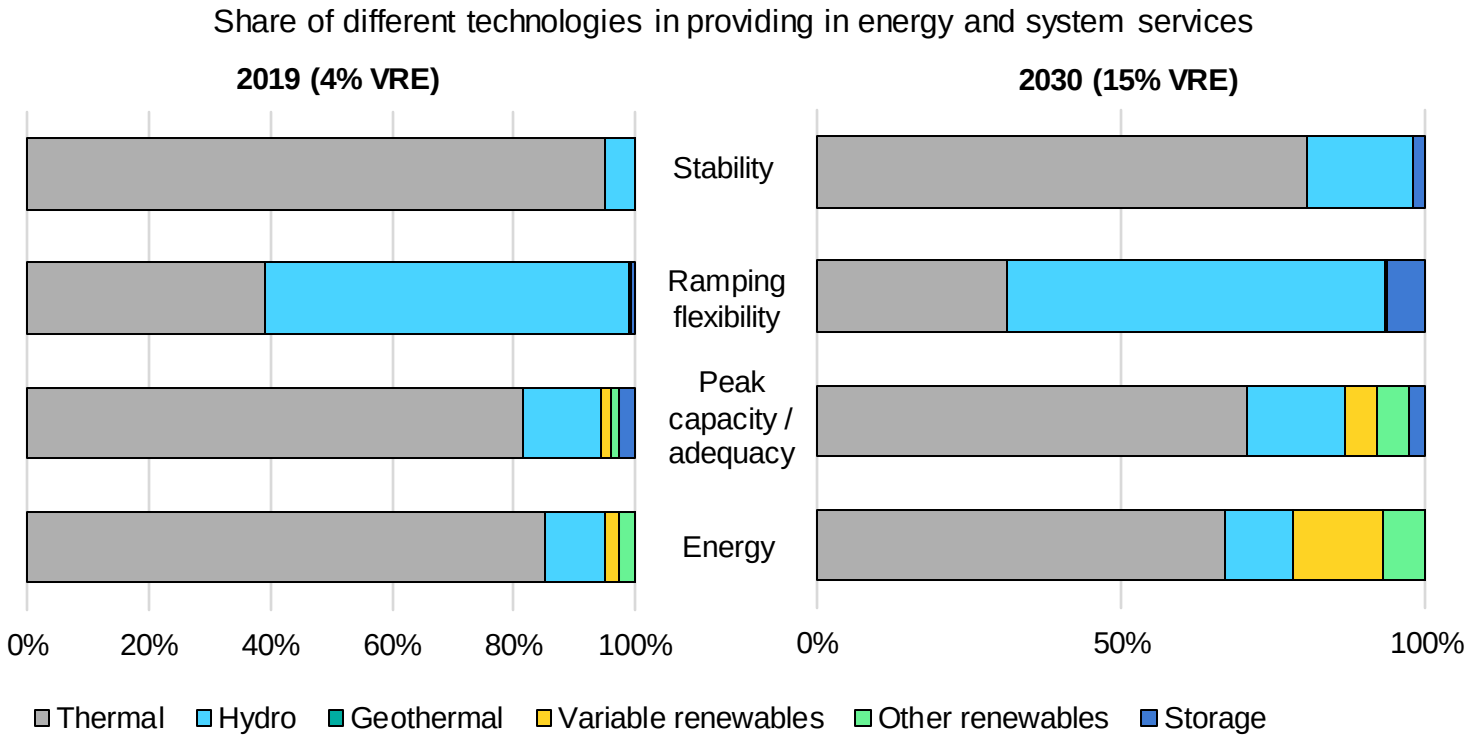
Thailand's power system can potentially handle 15% share of VRE in 2030. Very low levels of annual VRE curtailment, with less than 0.1%. VRE curtailment only occurs during the New Year holidays with extremely low net demand

Potential economic benefits of flexible power plants



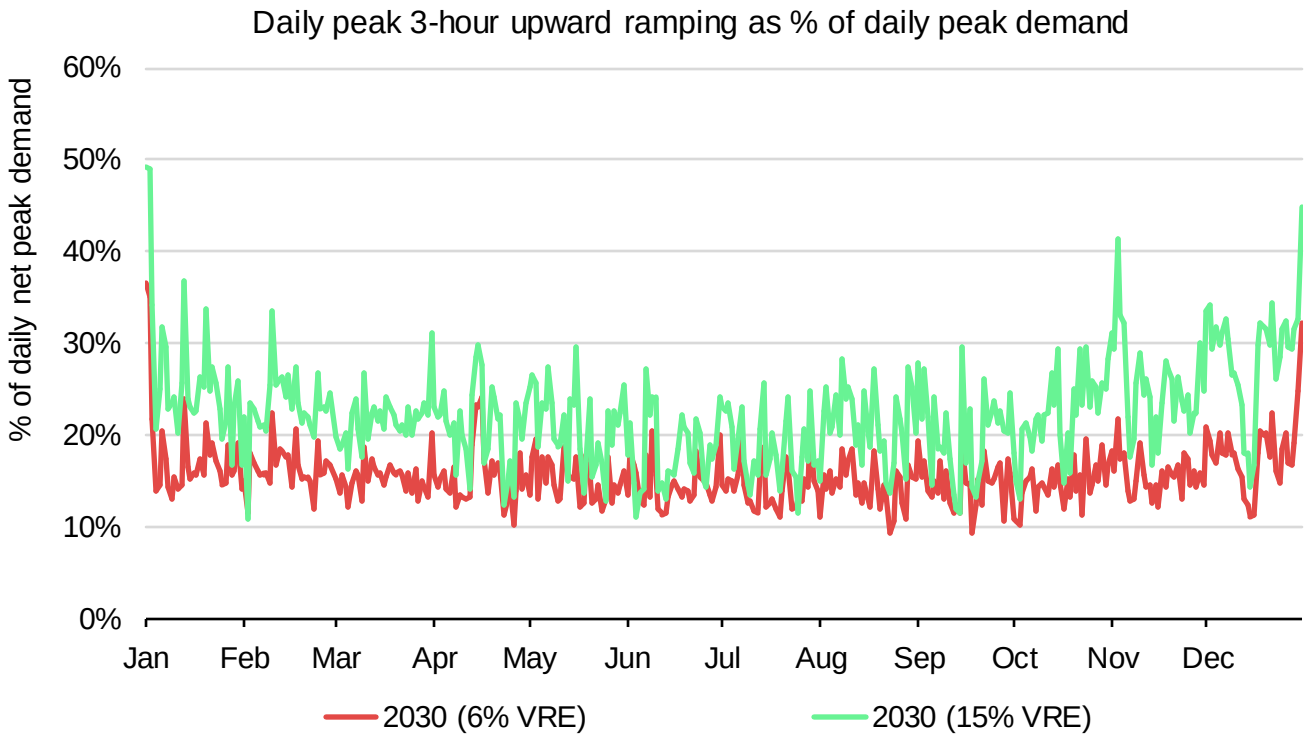
- The benefit of lower minimum stable level on operational costs outweighs those of faster ramp rates and shorter start-up times in the model
- The retrofit costs associated with improving the MSL are also considerably lower than the costs to improve the start-up time and ramp rates

Storage and renewables can contribute in providing system services



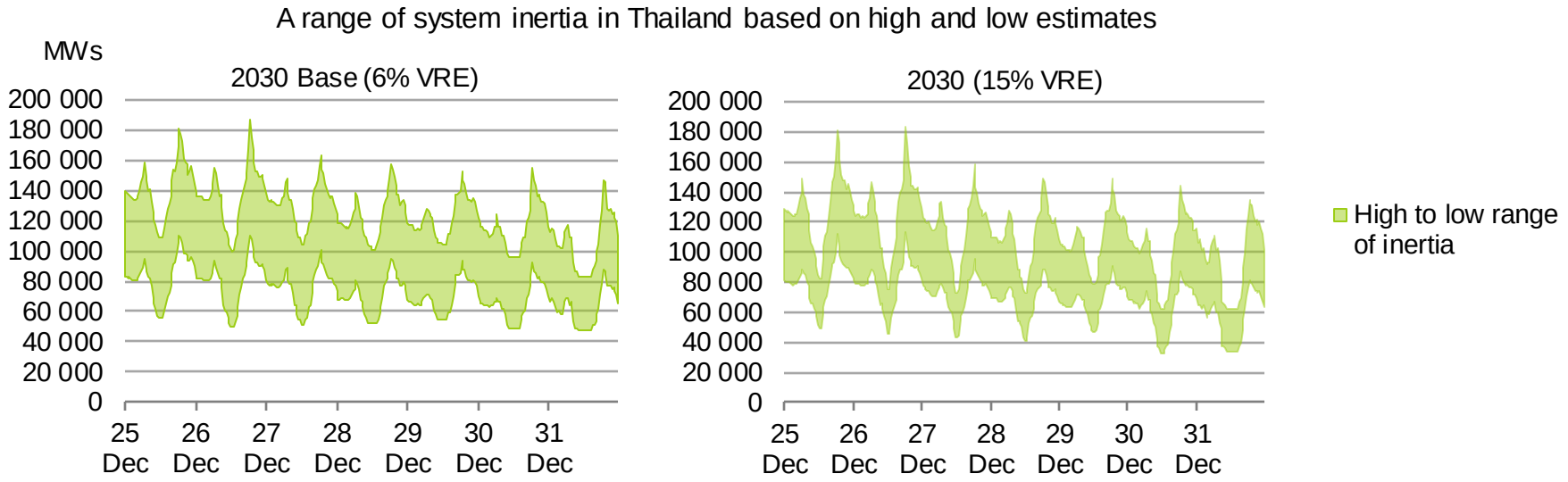
Power systems need to reward and incentivise flexibility and capacity contributions of different technologies in providing flexibility and stability services, which they are technically capable of

Greater flexibility requirements with more solar and wind power



The highest upward ramps occur in the holiday seasons. With 15% share of VRE, the highest 3-hour upward ramps could reach 13.2 GW (~75 MW/minute) or 50% of daily peak demand in 2030

The impact on power system stability depends on the level of VRE



- System inertia decreases with higher share of VRE due to the displacement of synchronous generator
- Inertial can be a key challenge for the system with **a high instantaneous VRE infeed (>50%)**
- Initial approximation shows reasonable levels of inertia in Thailand's system (>40GW.s)
- Dynamic studies are required to determine inertial requirement to limit RoCoF to a certain level (e.g. Texas, Ireland and GB)