Renewable Grid Integration Assessment

Overview of Thailand Case study

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Grid integration of variable renewable energy, ACEF
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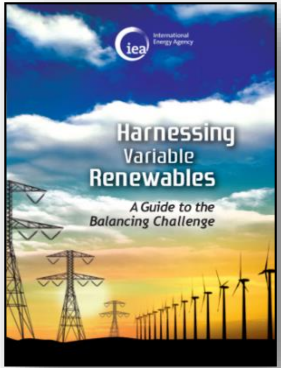
IEA

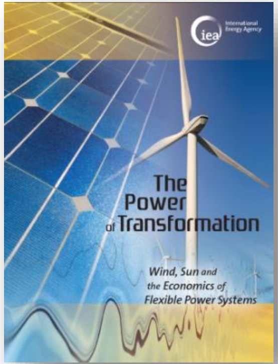
IEA System Integration of Renewables analysis at a glance

- Over 10 years of grid integration work at the IEA
  - Grid Integration of Variable Renewables (GIVAR) Programme
    - Use of proprietary and external modelling tools for techno-economic grid integration assessment
    - Global expert network via IEA Technology Collaboration Programmes and GIVAR Advisory Group
  - Part of delivering the IEA modernisation strategy

2011 | 2014 | 2016 | 2017 | 2017

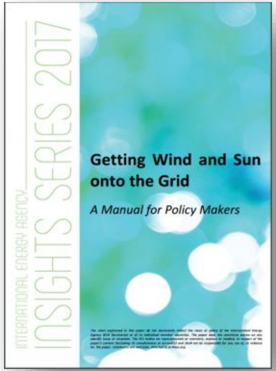


Technical

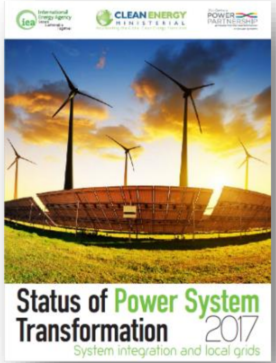


Framework, Technology, Economics

Policy



Implementation



Progress & Tracking

Thailand grid integration project overview

- Thailand's Ministry of Energy (MOEN) has officially requested the IEA to provide support on the study of the impact of *variable renewable energy (VRE)* and mitigation strategies under the project ***"Thailand grid renewable integration assessment"***.

- It aims to assist the main stakeholders through workshops, discussions/meetings, detailed study and analysis
  - Energy policy and planning
  - System operators – transmission and distribution levels
  - Energy regulatory commission

Objectives of the project

- Support the reliable and cost-effective uptake of RE generation in Thailand
  - Identifying barriers to renewable deployment and integration challenges as well as proposing possible options in addressing these challenges;
- Provide support by sharing international and regional best practices in integrating renewables
  - Drawing upon the IEA's network of international experts;
- Conduct quantitative and qualitative analysis on the impact and value of renewables in the power system;
- Facilitate national and international dialogue through capacity building workshops and trainings.

Analysis components of the project

1. Existing power system context

- VRE phase assessment for existing system
- Qualitative assessment of suitability of existing grid codes for VRE

2. Grid impact assessment

- Analysing options to accommodate RE integration
- Contractual and technical flexibility

3. Distributed solar PV

- Technical potential of rooftop PV in Thailand
- Economic impacts of PV
- Recommendations and action priorities

4. Power sector planning and VRE system costs

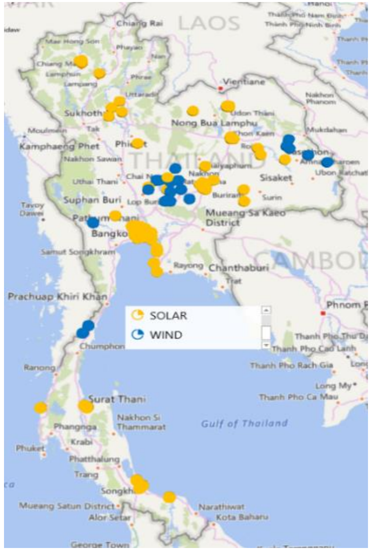
- Assessment of power sector planning in Thailand
- System cost and cost benefit analysis

Each work stream provides insights and recommended actions for Thailand Grid Renewable Integration

Future power system scenario assumptions for 2036

- Detailed 30-minute power system model
- **Validation scenario**
  - Based on the 2016 system
  - Provides a baseline for comparison
- **Core scenarios in 2036**
  - Base scenario (Power Development Plan)
  - Assumed higher shares of wind/solar to assess possible integration challenges
- **Operational and contractual flexibility option scenarios**
  - Gas and power purchase contract,
  - power plant operational characteristics,
  - DSM, EV, storage

Core Scenario	Description	Annual shares
Current (2016)	For validation, 3GW solar and 600 MW wind	~3%
Base case (2036)	PDP 2015 target of 6 GW solar and 3 GW wind	6%
RE1 (2036)	12 GW solar, 5 GW wind	12%
RE2 (2036)	17 GW solar, 6 GW wind	15%

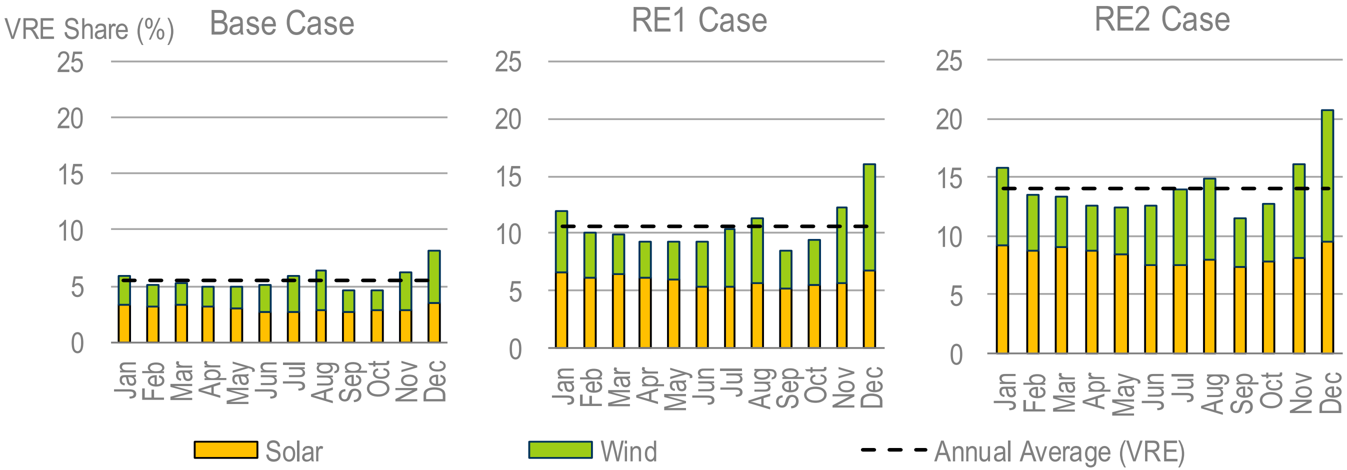


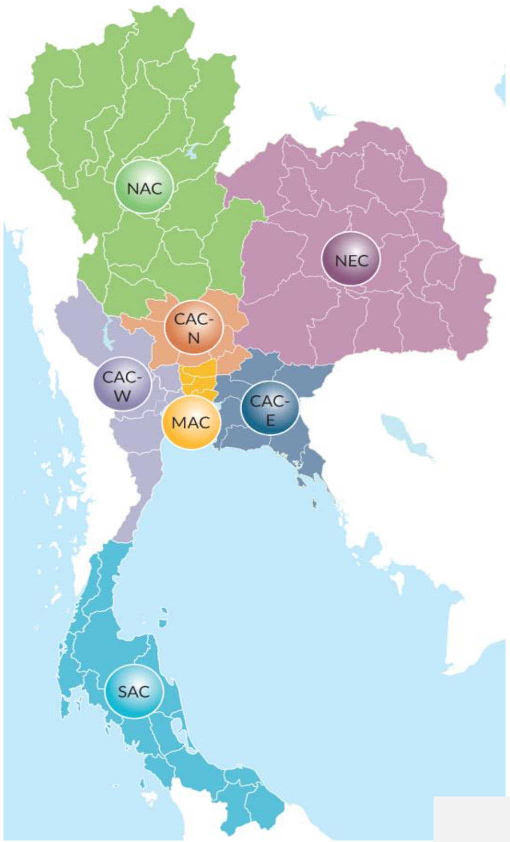
RE2 scenario (2036)

- Site selection based on
  - Resource potential
  - proximity to transmission
  - other considerations

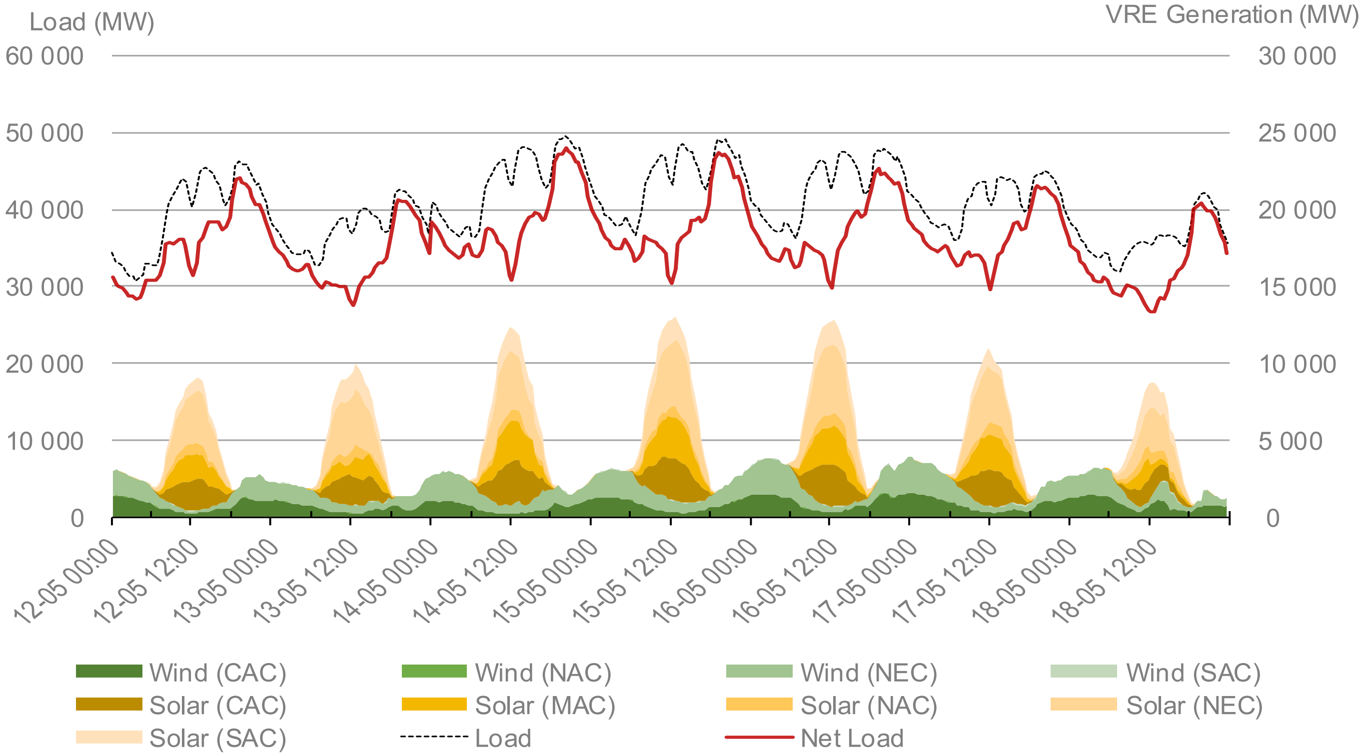
Modelling used for the analysis

- Thailand power system model built in the PLEXOS
  - 30-min demand data, for 7 regions
  - Dispatchable generator operating parameters:
    - *Ramp rates, min/max gen, heat rates, min up/down times*
  - Hydro energy constraints with seasonality
  - Transmission 230 and 500 kV
  - 30-min wind & solar generation



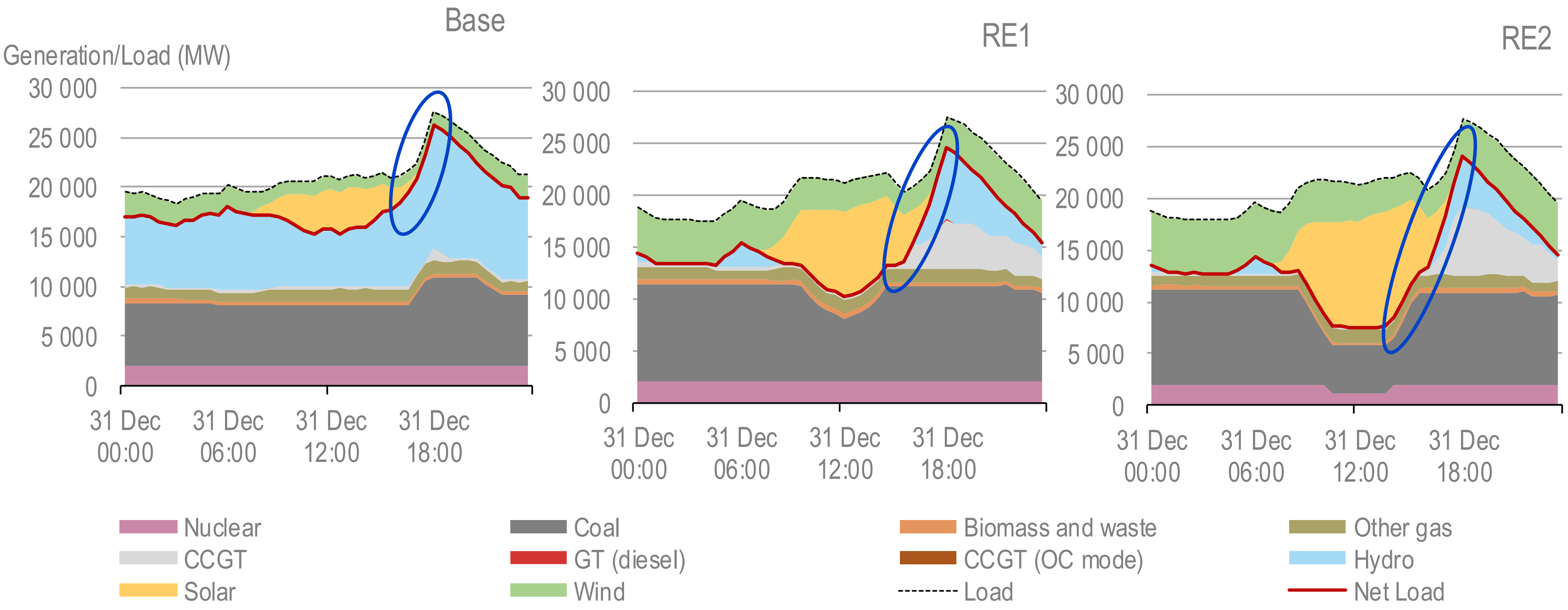


Detailed analysis of wind, solar output reveals complementarity



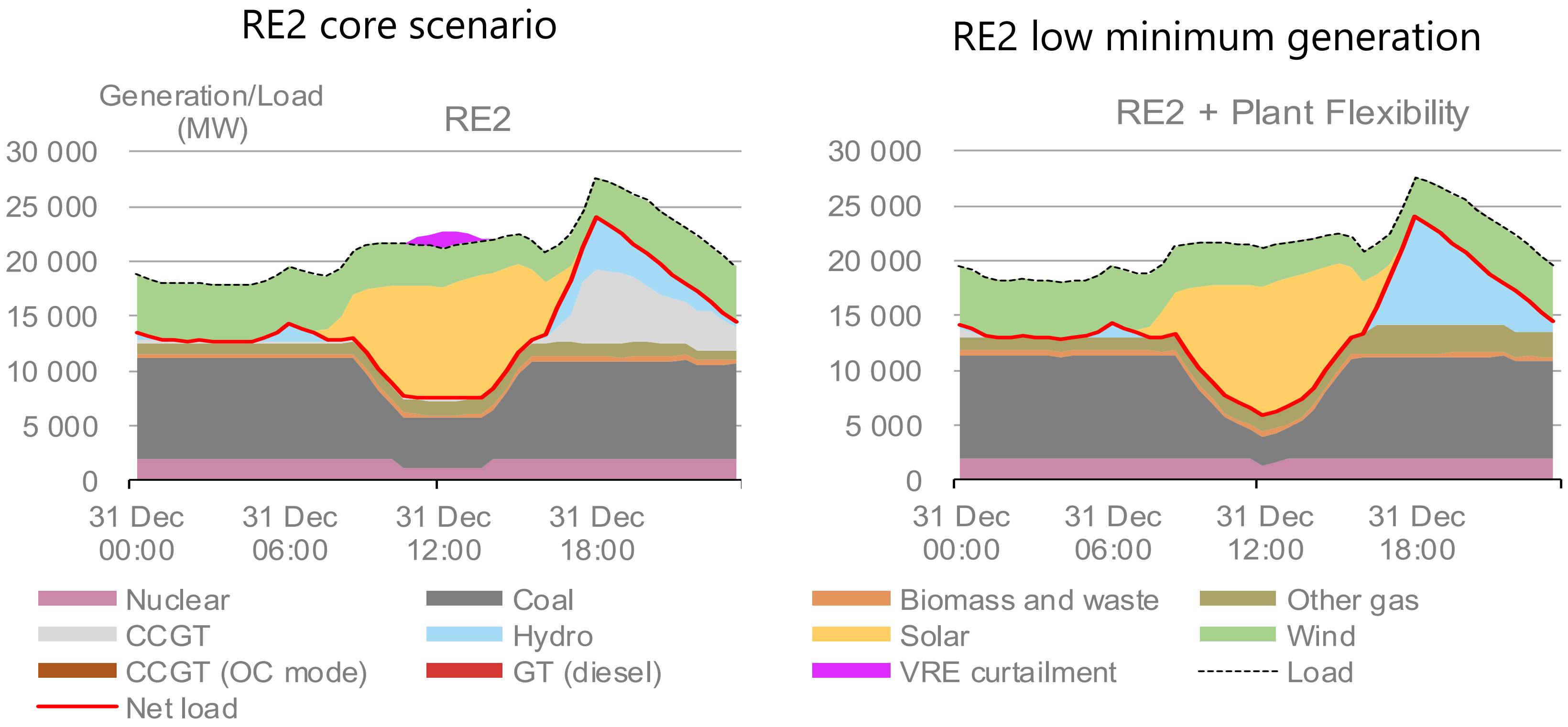
There is a high contribution of solar towards a midday peak demand while the wind profile generally ramps up during the late evening

Generation pattern during minimum load period



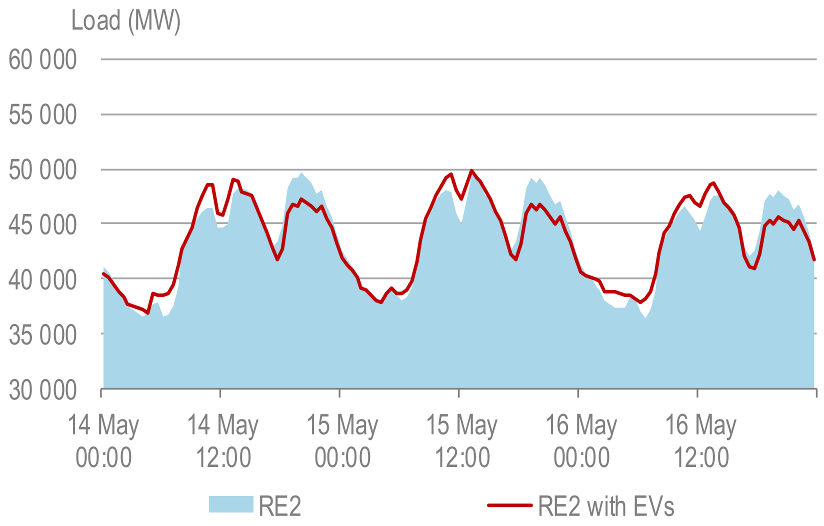
The system can meet demand reliably during the most challenging weeks, but this requires flexible operations of including steep ramping and cycling of coal plants.

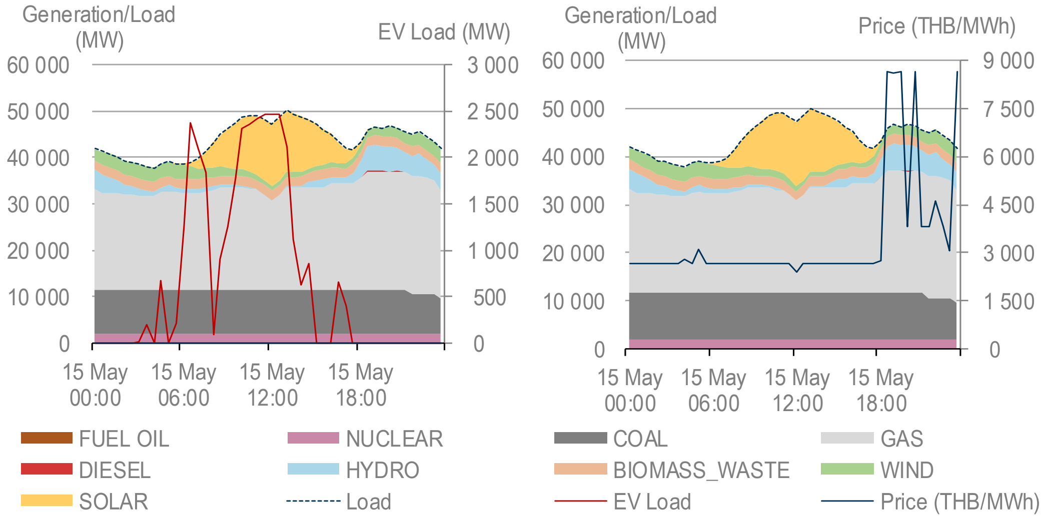
Impact on dispatch of reduced minimum generation



Reduced minimum generation of power plants allows increased deloading of thermal generation (mostly coal but also other gas) while it is still available to increase output as net demand increases

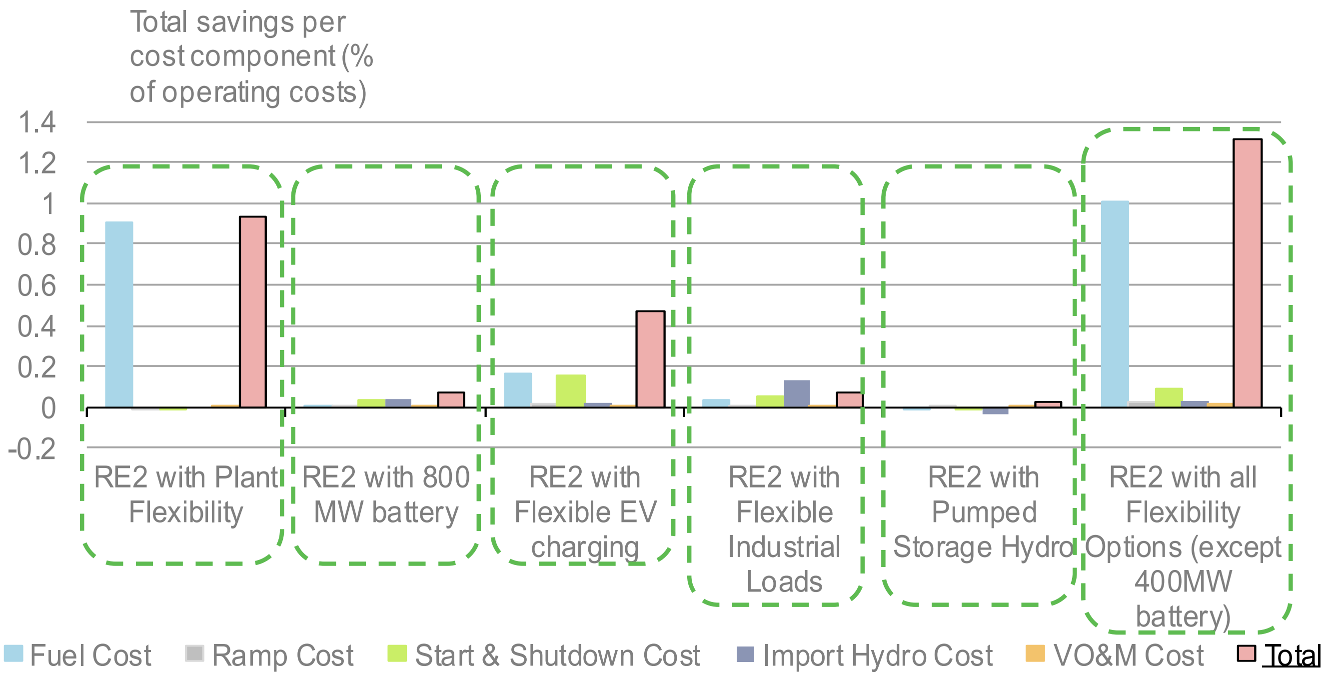
Demand Side Response from Electric Vehicles





Demand response can shift load to periods of abundant supply, while reducing demand during evening hours.

Cost benefits of additional flexibility options



Additional flexibility options allow for further cost savings when integrating higher shares of renewables, with fuel cost savings due to additional plant flexibility having the biggest impact

Key findings – operational, economic and institutional aspects

- **Grid impact assessment**
  - Much more ambitious solar and wind energy targets are possible from the operational aspect.
  - Net ramping requirements increase with higher shares of VRE generation
  - Power purchase and gas supply contracts limit currently available flexibility
  - DSM, EV and storage and reduced min generation are cost-effective flexibility options
- **Distributed PV**
  - Roof-top availability is no relevant constraint to uptake of distributed solar PV
  - Electricity tariff reform is required to ensure a long-term, sustainable uptake of distributed PV
- **Power system planning and system cost assessment**
  - Move towards more integrated planning will be beneficial
  - Flexibility options can improve system integration and reduce system costs

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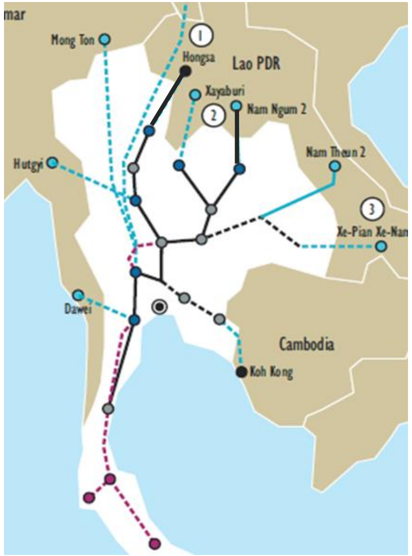
1) Existing power system context

Items

- Grid integration context
- Grid connection codes
- Renewable energy control centre

Approaches

- VRE phase assessment for Thailand
- Qualitative assessment of suitability of existing codes for VRE
- Role, best practices and Thailand context for implementation of RE control centre



The Thai electricity system is flexible technically, but institutional and contractual constraints limit mobilising this flexibility

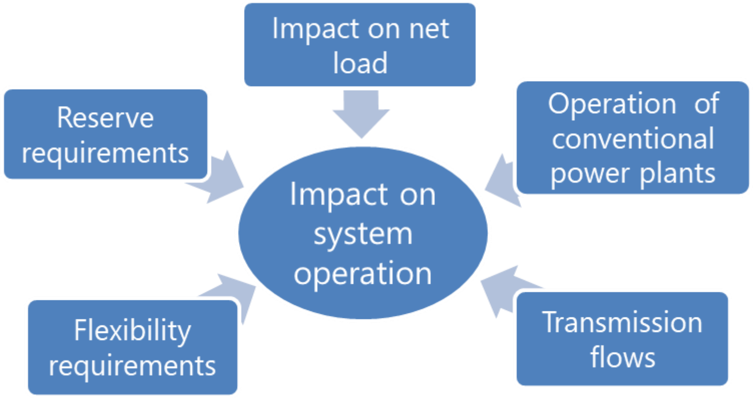
Grid Impact Assessment

Items

- VRE Impacts on system operation
- Flexibility options to accommodate VRE integration
- VRE integration phase assessment for 2036

Approaches

- Detailed 30-minute power system model
- Scenario analysis of flexibility options (*power plant, DSM, EV, storage*)
- Assessment of modelling results in the context of integration phases



Thailand's future electricity system has sufficient flexibility options to accommodate a reasonable share of VRE generation, but some required advanced planning to provide benefits.

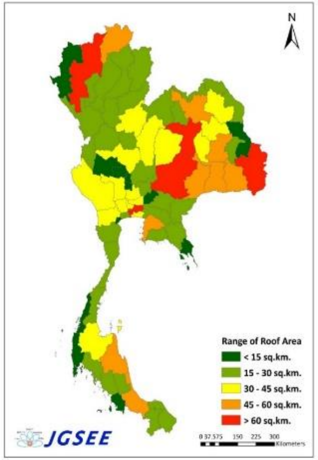
3) Distributed solar PV

Items

- Technical potential of rooftop PV in Thailand
- Economic impacts of PV
- Recommendations and action priorities

Approaches

- Measurement of rooftop area and generation estimates
- Evaluation of the impact on the utilities
- Cost benefit analysis for setting purchasing tariff



Available roof-top area is no relevant constraint for distributed PV, but changes to tariff structures are needed to ensure that costs and benefits are shared fairly

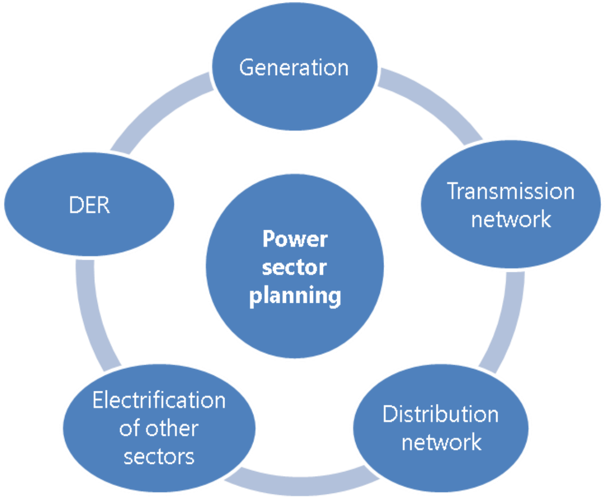
4) Power sector planning and VRE system costs

Items

- Assessment of power sector planning in Thailand
- System cost and cost benefit analysis

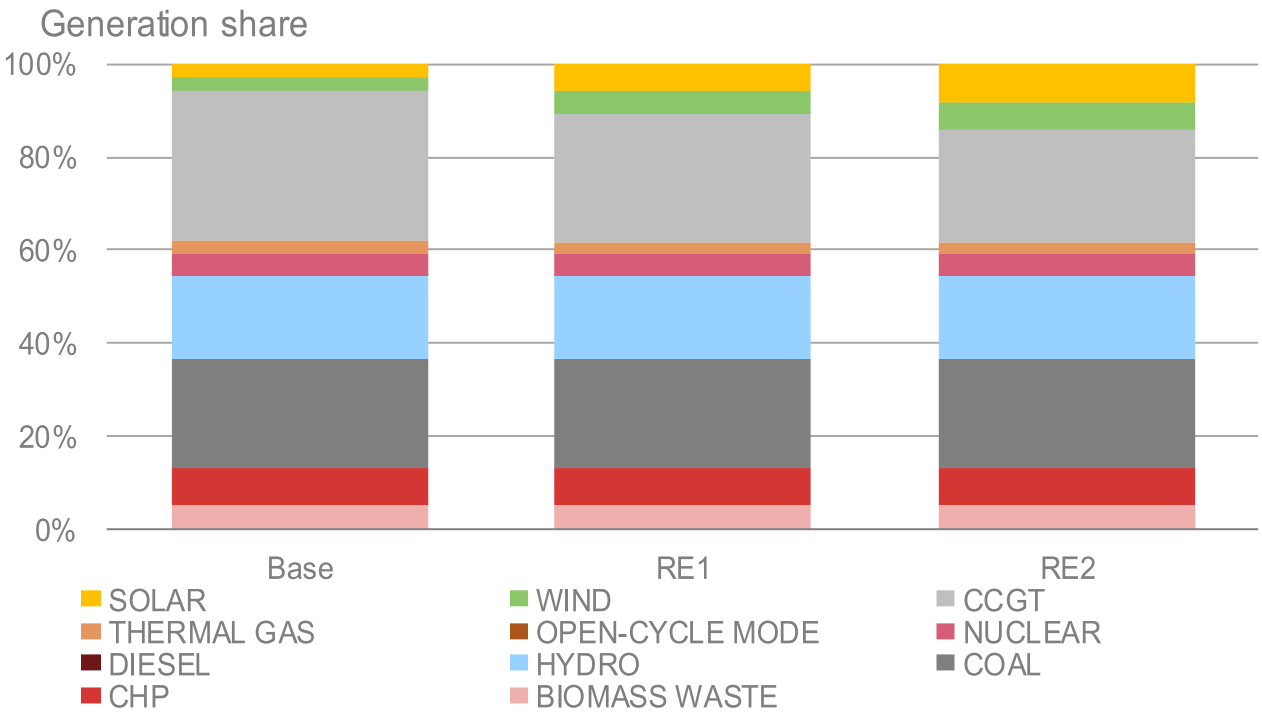
Approaches

- Detailed qualitative assessment of the PDP process
- Quantitative analysis of the system costs of VRE in the context of the future Thailand system



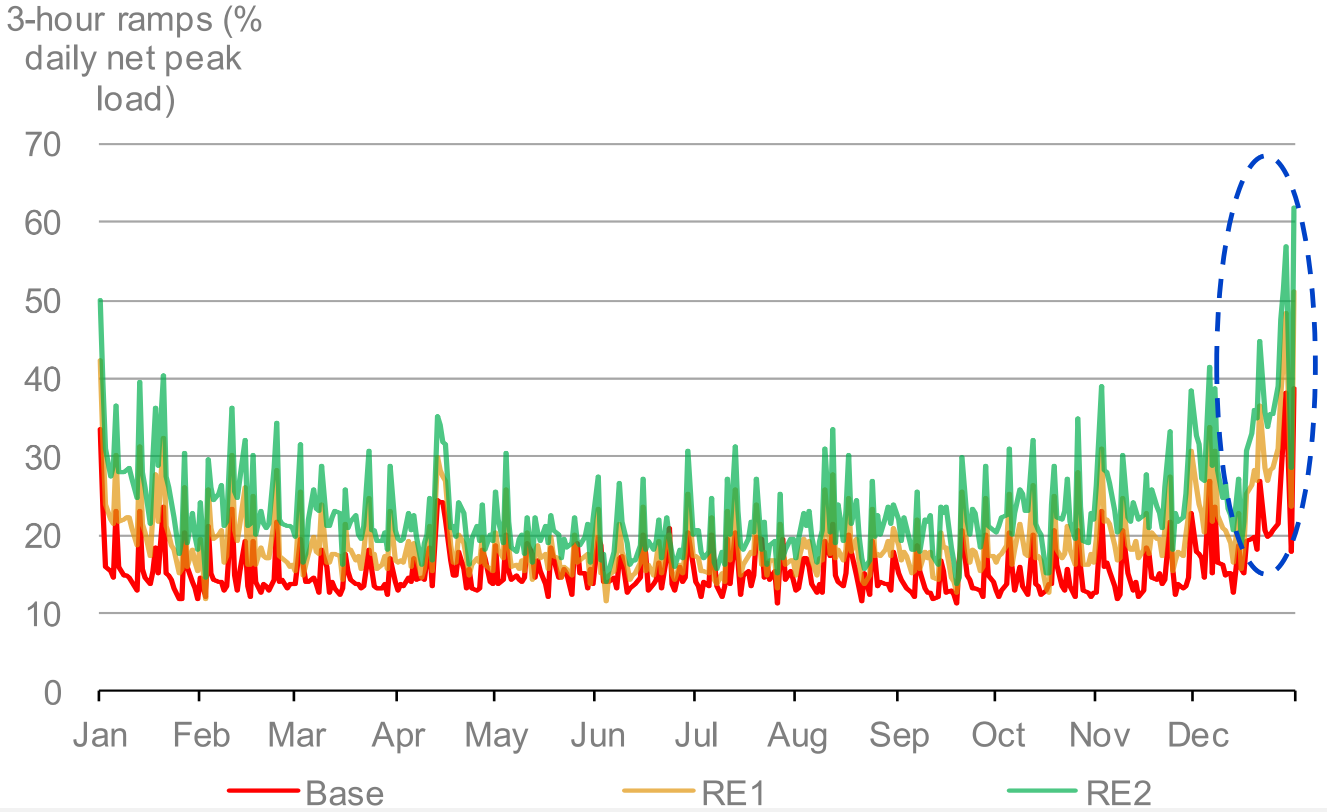
Planning processes show room for improvement. Solar PV and wind can reduce customer bills, but only if their cost in Thailand is reduced to international benchmark levels.

Effect of renewable generation on conventional generation



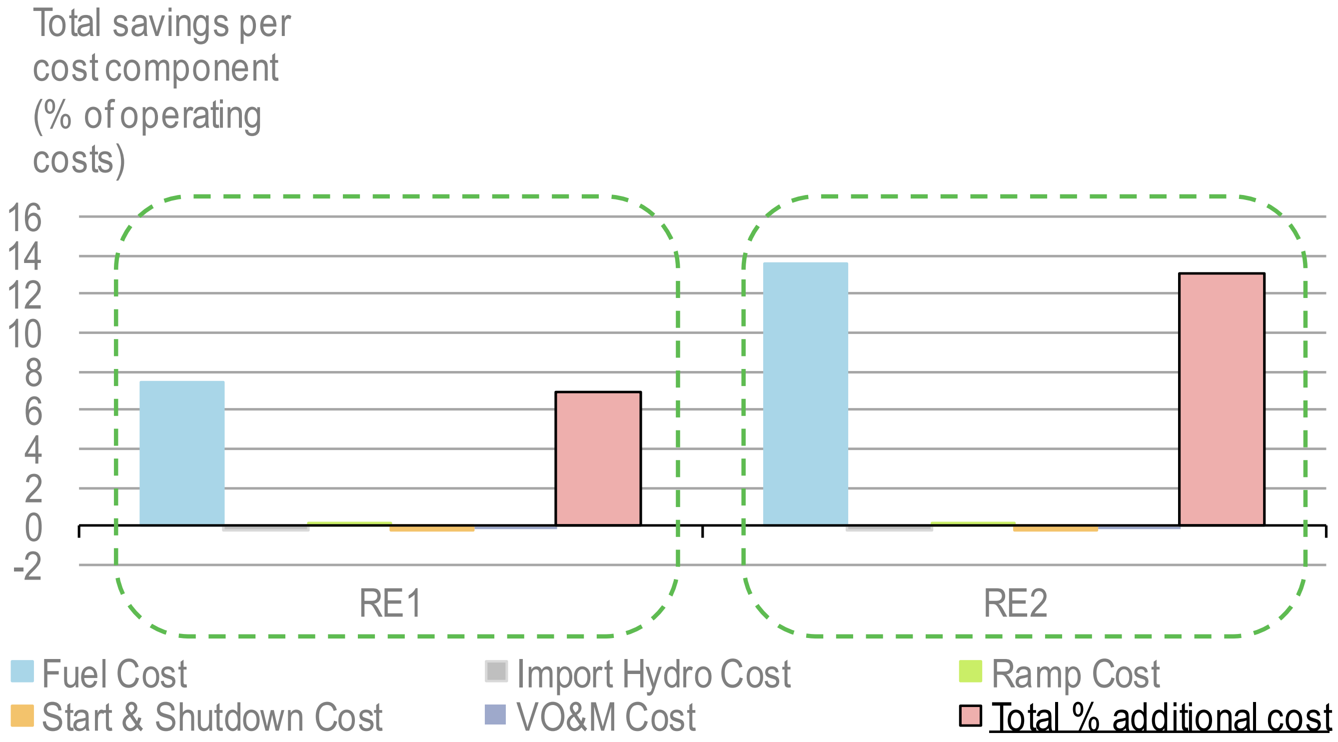
As shares of VRE increase, it predominantly displaces CCGT generation.

Maximum 3-hour ramping



The highest 3-hour ramps vary from a maximum of 39% of daily peak load in the Base to 62% in RE2

Cost benefits of flexible gas supply contracts



Inflexible long term gas contracts can potentially prevent significant fuel cost savings (up to ~14% in the RE2 scenario), though it is slightly offset by higher cycling costs

