Contractual flexibility in power systems with solar and wind

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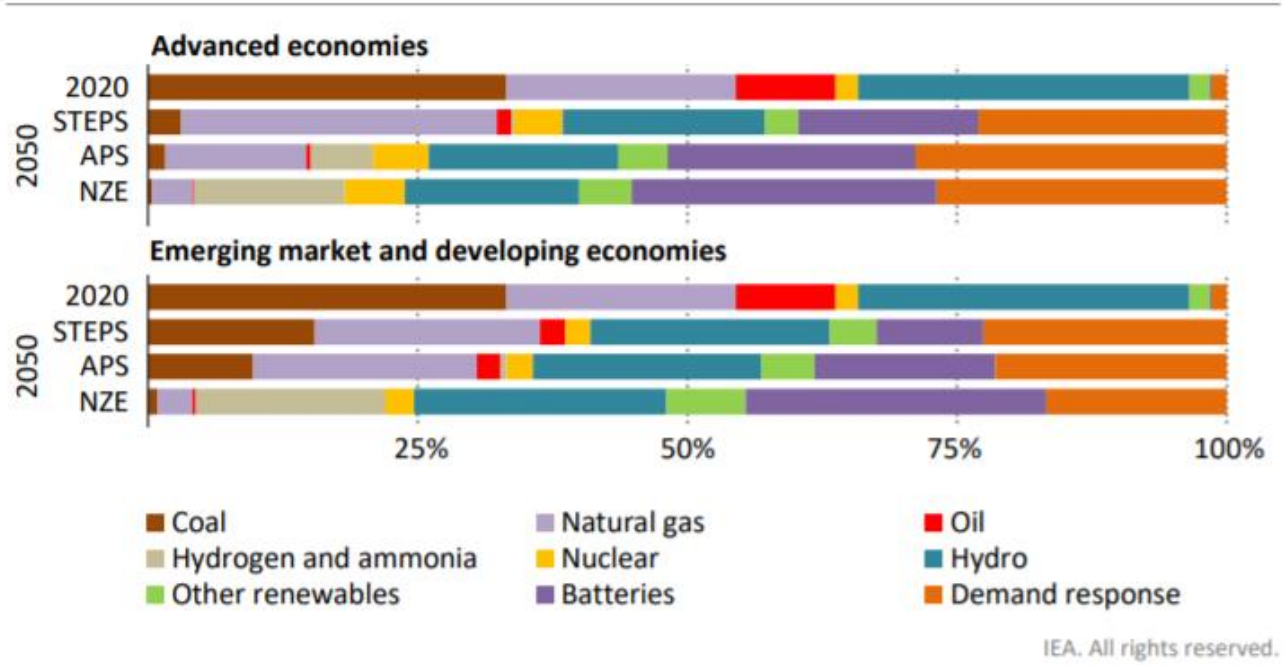
Flexibility is the cornerstone of VRE integration

Electricity system flexibility by source and scenario, 2020 and 2050



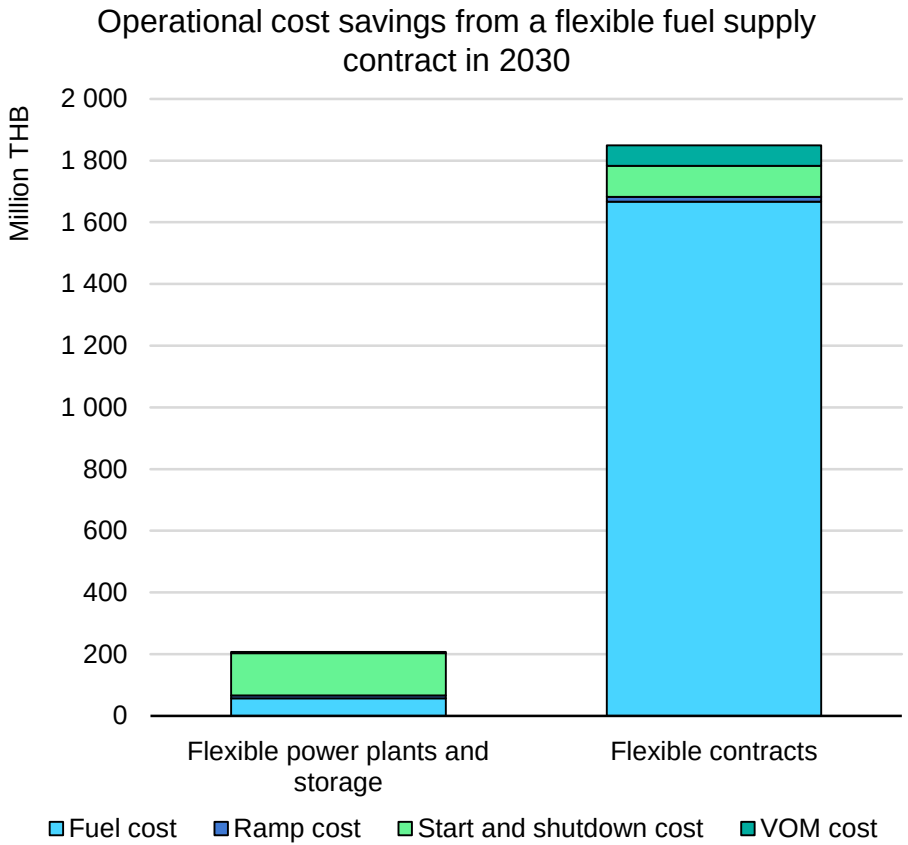
Coal and natural gas remain cornerstones of electricity flexibility in the STEPS, but the mix of flexibility sources shifts dramatically on the path to net zero emissions by 2050

Contractual structures are important to facilitate flexibility

- The technical capability of the thermal fleet to ramp and operate flexibly can be very different from the overall ability since commercial and institutional structures also impact flexibility

- Examples of commercial and institutional structures that impact flexibility can be
  - Physical PPA's
  - Long term transfer agreements on transmission
  - Fuel supply contracts
  - Ownership requirements for assets in vertically integrated markets
  - Asset development process
  - Market structure

Thailand is an important example of contractual inflexibility



- 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.

Examples in other places of the world

- In India spot markets have been introduced, but the utilisation of the short term markets is limited, which has been liked to long-term physical PPAs
- Cross-border transmission is often developed with long-term transmission contracts which can also be limiting for VRE integration
- In ASEAN hydro resources from e.g. Laos and Cambodia can contribute to integrating for example PV in for example Viet Nam or Thailand
- This however requires the needed institutional and commercial structures to facilitate flexible cross-border power trade
- In China inter-provincial trading can be key to lowering curtailment of VRE
- In short grids and commercial structures allowing utilisation of assets needs development to achieve clean energy transitions

Achieving affordable clean energy transitions

- In order to make the clean energy transitions most affordable it's important to understand how to utilise current assets
- Can current coal plants change operational patterns and allow for integration of VRE?
- Can both national and cross-border grids be optimised to help increase flexibility?
- What type of flexibility should be invested in?
  - Would gas plants risk being stranded assets?
  - What contractual structures are appropriate?
  - Do any current structures need to be changed?

What do flexible contracts look like?

- Flexible contracts for thermal assets can include the following aspects
  - Separating physical production guarantees from budget stability
  - Lowering minimum take obligations
  - Relating minimum run rates to technical capabilities
  - Implementing differentiated price incentivising flexibility
  - Implementing budget security instruments like floors on settlement irrespective of generation
  - Providing financial incentives for retrofits for older plants to increase flexibility
- Flexible contracts for VRE can include the following aspects
  - Clear procedures for curtailment
  - Clear settlement for curtailment
  - Compensation mechanisms that incentivise system friendly deployment
  - Forecasting requirements

Conclusion

- A holistic approach to flexibility needed for VRE integration is needed
- To ensure affordability the flexibility of the current assets should be investigated and utilised
- For future flexibility a lot can be achieved with grids, hydro and other storage solutions
- If thermal power like gas is needed, ensure that contracts reflect utilisation of inherent flexibility to limit lock in effect

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