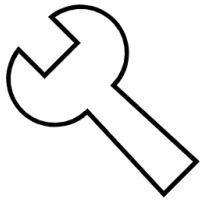
New Power Dynamics : Greening the Grid and RTM BCC&I - 2nd Edition of Annual Power Conference
8 October, 2020

Greening the Grid : Learning from Emerging Scenario

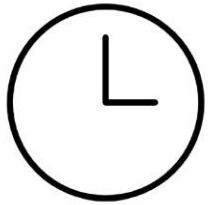
A.K. Saxena, Senior Director, The Energy and Resources Institute (TERI)

Studying Integration of Variable Renewables in the Indian Power System: The PyPSA-India Model



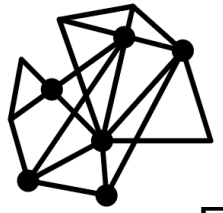
Technical Detail

- Full representation of generator technical constrains, like ramp rate, technical minimum, start up costs. More than 900 generating units represented



Temporal Detail

- Hourly simulation for all 8760 hours, capturing daily and seasonal variability of demand and supply.
- 15 minute resolution of some parts of the year to capture ramping constraints



Spatial Detail

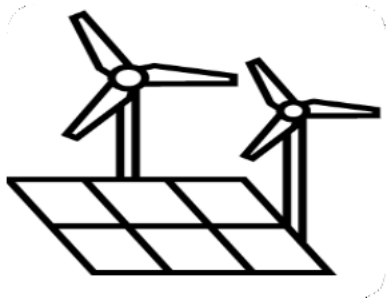
- Each state represented individually, with unique demand and supply profiles.
- Full representation of the interstate transmission system.
- Spatially explicit siting of renewables

✓ Optimise system operation to minimize cost

✓ Ensure respect of technical constraints

✓ Derive insights into system operation for high RE

Scenario Framework



Generation capacities

- Baseline capacity scenarios (26% VRE in total generation)
- High renewable energy scenarios (32% VRE in total generation)

Power system flexibility

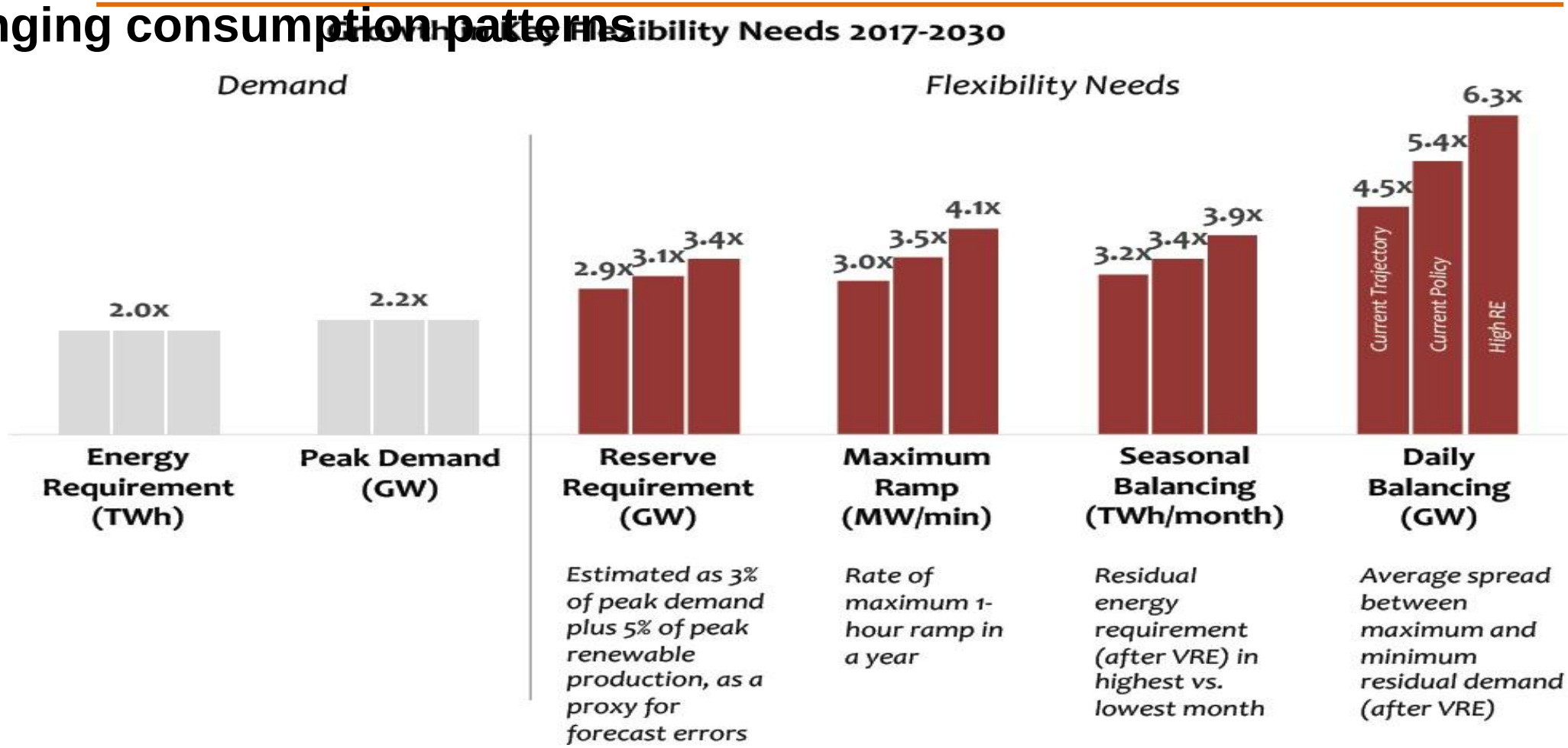
- Degree of thermal flexibility
- Introduction of battery energy storage

Transmission system and power transfer flexibility

- Development of the transmission system
- Optimization of scheduling and dispatch across states

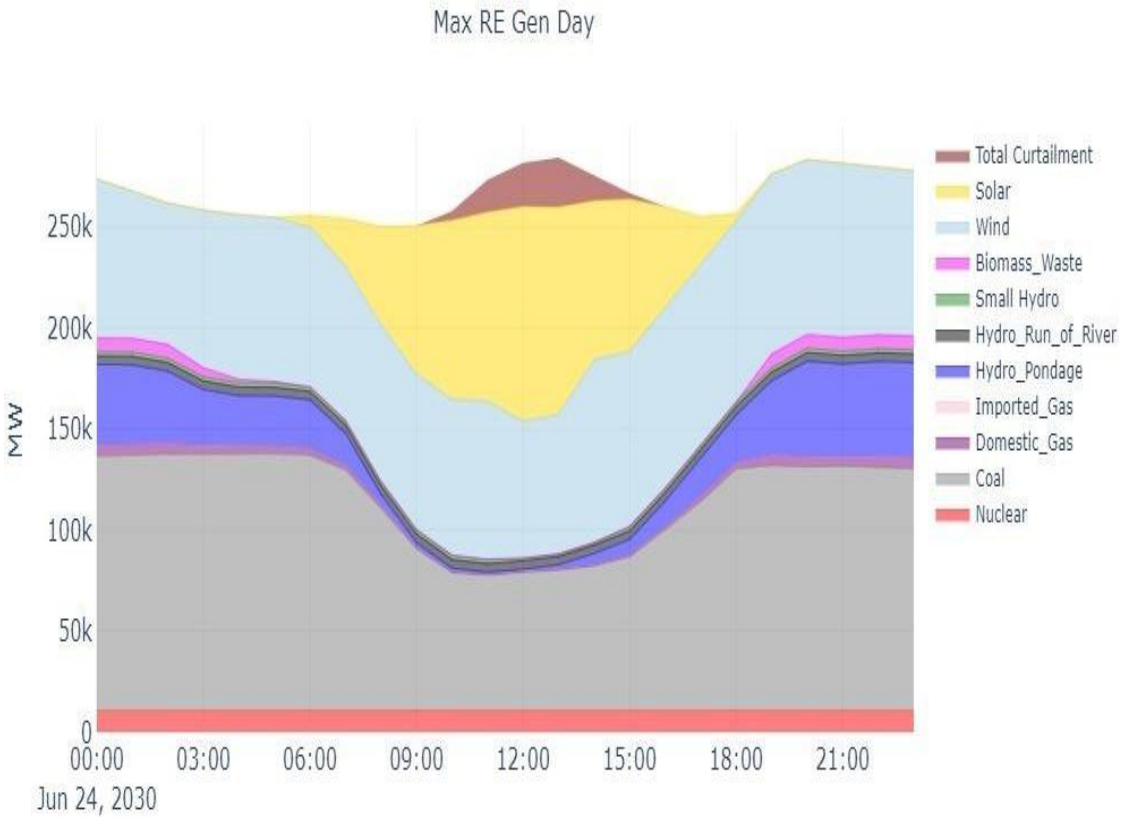
- ✓ Seven unique scenario combinations
- ✓ Four sensitivities around key aspects of RE integration
- ✓ More than 100 hours of model simulation
- ✓ Entire results dataset available for public download
- ✓ Dedicated website for results visualization and

Key Message # 1 : Flexibility needs will increase faster than electricity demand, driven by increased variable generation and changing consumption patterns



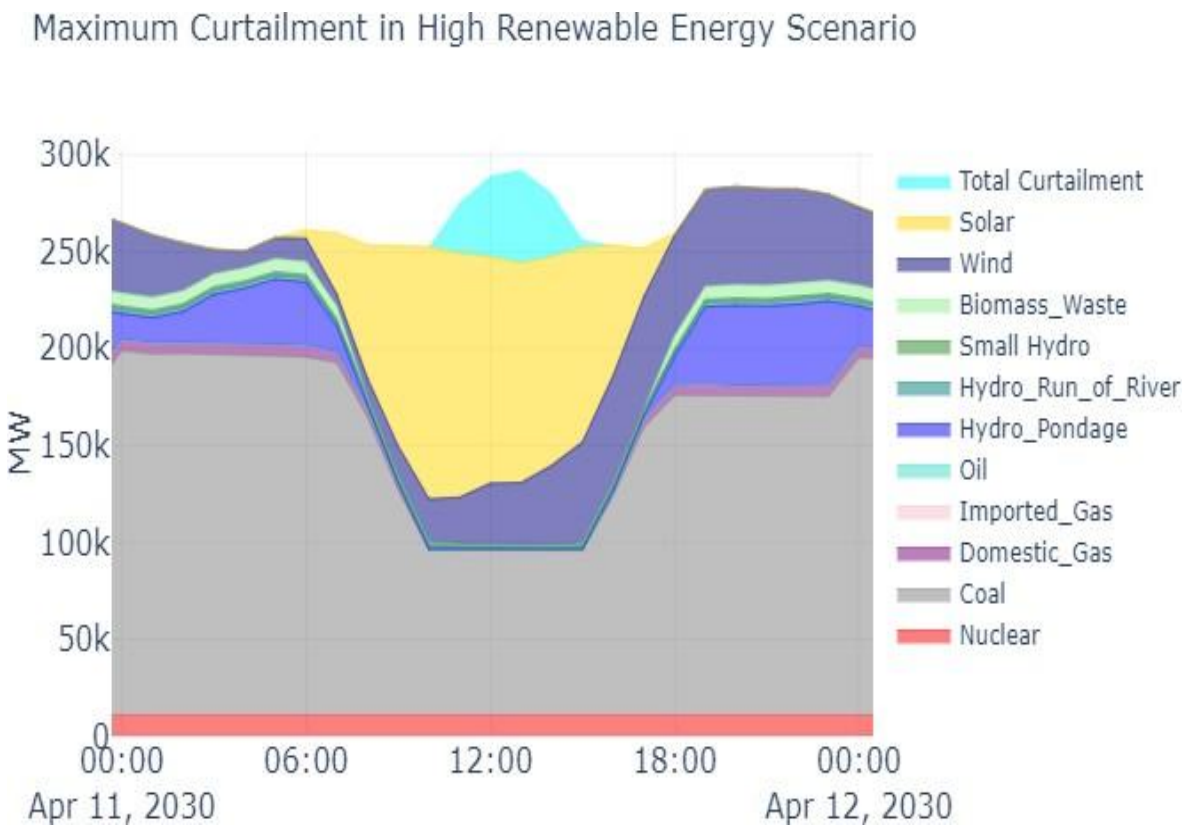
A portfolio of flexibility options across demand, supply and storage can lower implementation costs and risks.

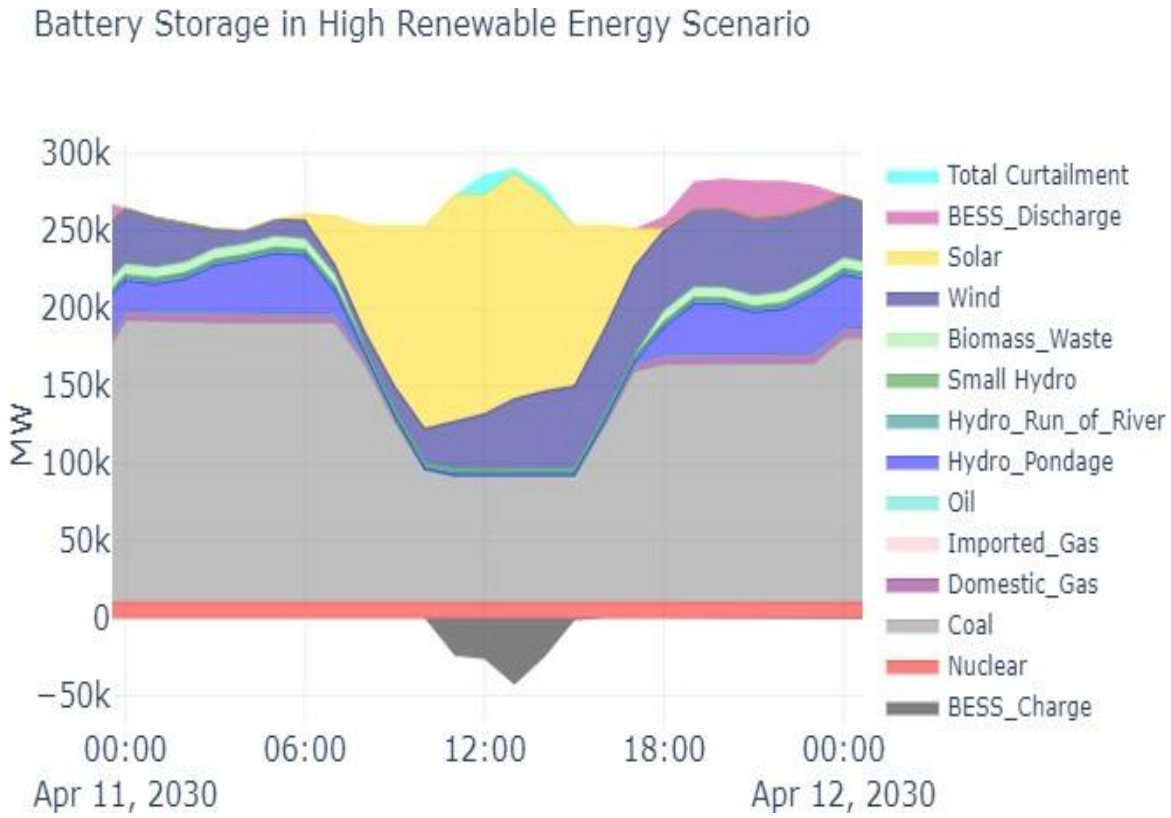
Key Message # 2 : The Conventional Coal and Hydro Fleet Have a Crucial Role to Play



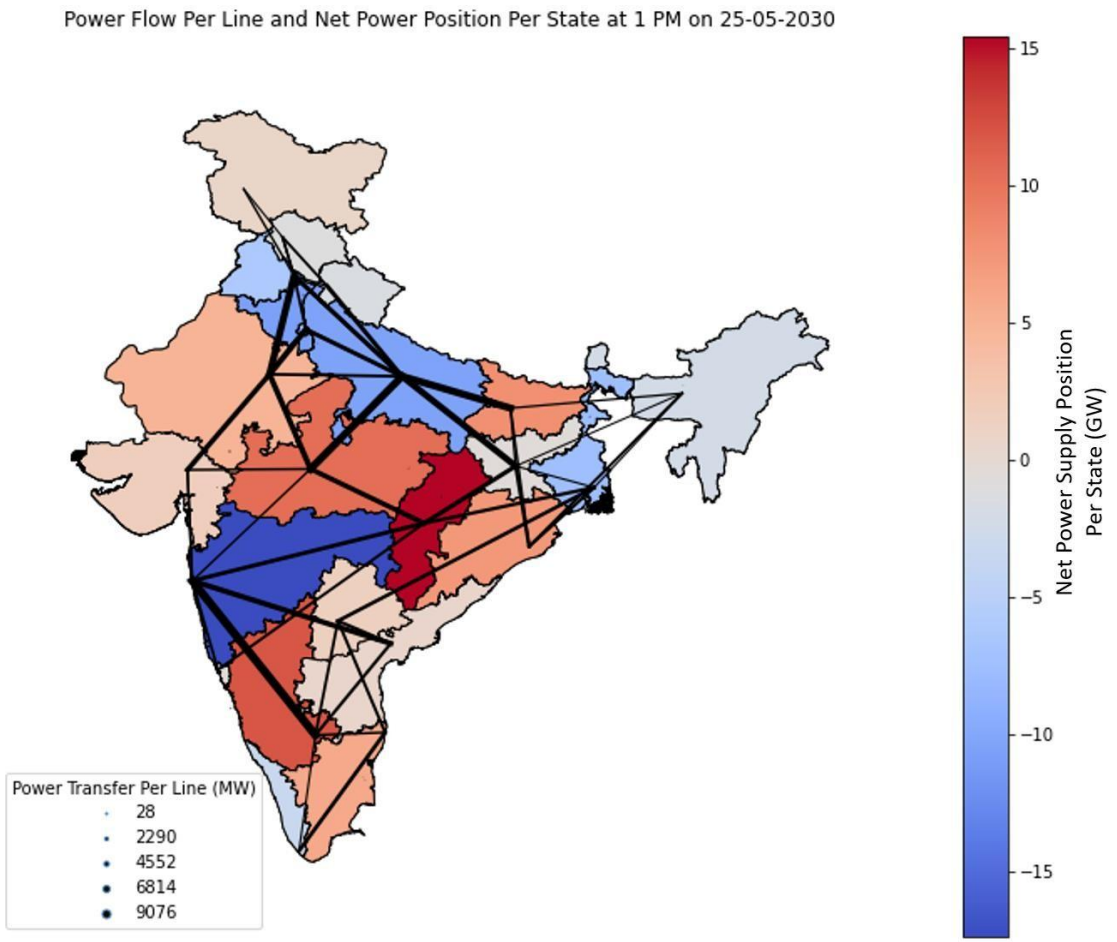
- The aggregate annual PLF of the coal fleet is 58-65%.
- But coal shifts from providing baseload to providing substantial flexibility by varying its output across the day and across the seasons.
- Achievement of the 55% technical minimum is crucial for the entire fleet by 2030, and some plants may be required to achieve a lower technical minimum.
- Technically challenging ‘two-shifting’ may be required from some coal units, unless other sources of flexibility are developed.
- Hydro provides an essential fast-ramping resource for
peaking, and must be reserved for this purpose.

Key Message # 3: Battery Storage and Pumped Hydro Storage Can Provide Multiple Benefits and Need to be Developed At Scale by 2030





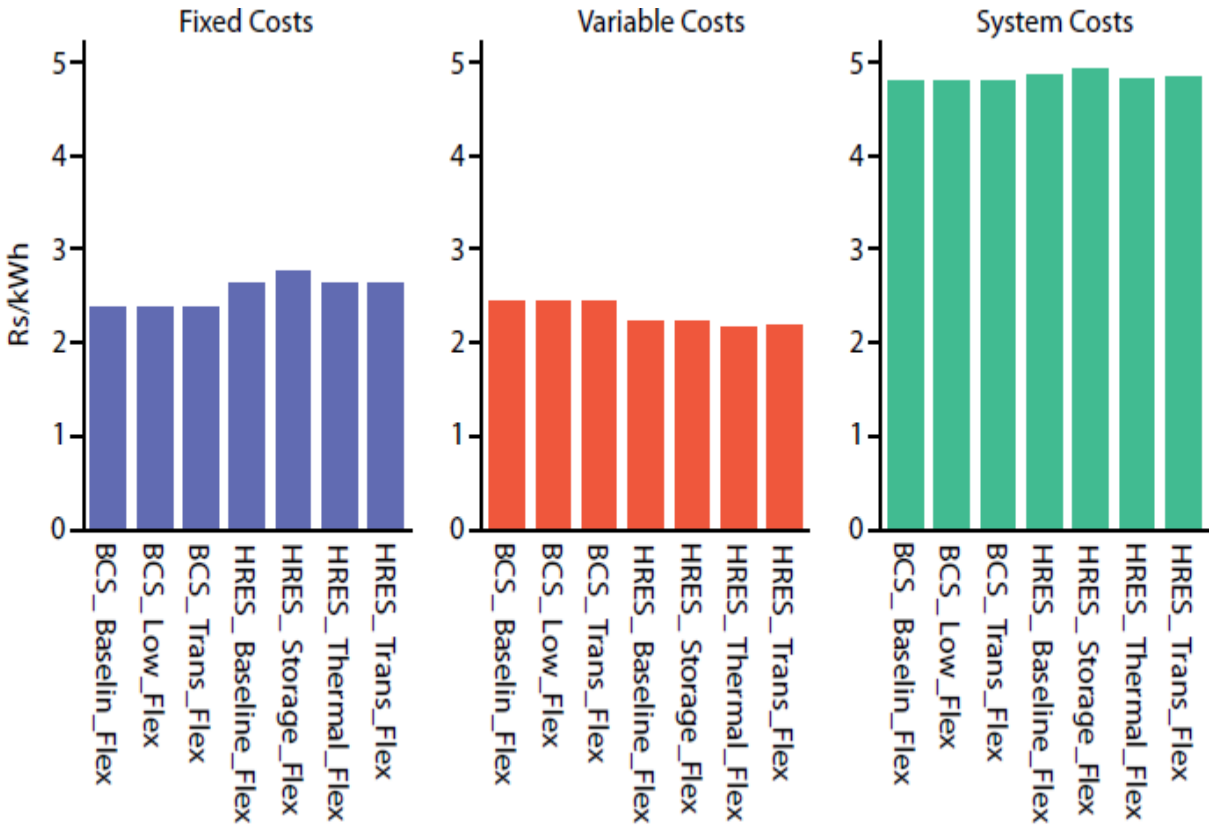
Key Message # 4 : The Power Grid Provides a Crucial Tool for Facilitating Higher Shares of RE Than States Could Achieve On Their Own



- India’s large and integrated grid provides a crucial tool
  for integrating large shares of RE.
- Interstate power flows are substantial and vary in direction and magnitude depending on the time of day and the season of the year.
- Managing these power flows requires not just more infrastructure, but also regulatory and market reforms to promote cross-border scheduling and dispatch of power.
- Power system planning at state level needs to incorporate a regional perspective, so that resource planning takes into account the regional perspective.

Key Message

5: India Can Integrate Large Shares of Variable Renewables by 2030 At No Extra System Cost



- The model provides a detailed assessment of total system costs:
  - Fuel costs and start up costs.
  - Investment and fixed O&M costs in generating assets.
- Total fixed costs are highest in the HRES scenarios, because these have the highest capacities and additional costs in the form of battery storage.
- However, total variable costs are lower in the HRES scenarios, because there is lower dispatch of high marginal cost power.
- Total system costs are essentially the same between the BCS and HRES scenarios, because of this substitution between fixed and variable costs.

Thank You

ak.saxena@teri.res.in

https://www.teriin.org