

# Some thoughts on emerging issues in Resource Adequacy

Capacity Building Workshop on Resource Adequacy for Karnataka

Technical Session 2: Generation RA Planning for Karnataka

Prayas (Energy Group), 16<sup>th</sup> December 2024

# Outline

- Methodological aspects
- Process and Data aspects
- Forward Looking Thoughts

- **Methodological aspects**

- Demand Forecasting across different time-periods
- Planning for increasing Non-DISCOM demand
- Capacity Credit Analysis
- Coincident Peak Analysis
- Other aspects

# Demand Forecasting across different time-periods

- Continues to be based on annual growth rates and assumed load factors
  - Not suitable with increasing penetration of renewables and demand uncertainty
- Rigorous analysis of historical demand and better forecasting methods
  - Sector-wise, circle/district-wise demand estimation and load shapes
  - End-use efficiency and demand side measures, impact of ToD pricing
  - Rooftop generation and solarisation of agriculture
  - Electrification of transport, industrial heat and cooking
  - Sales migration, Further push under Green OA
  - Scenario based approach
  - Underlying data and assumptions need to be published and sufficiently explained
  - Granular demand estimation, preferably at 15-min granularity
- Aligning forecasts across regulations (MYT, RA, Grid Code, DSM, etc.)

# Planning for increasing Non-DISCOM demand

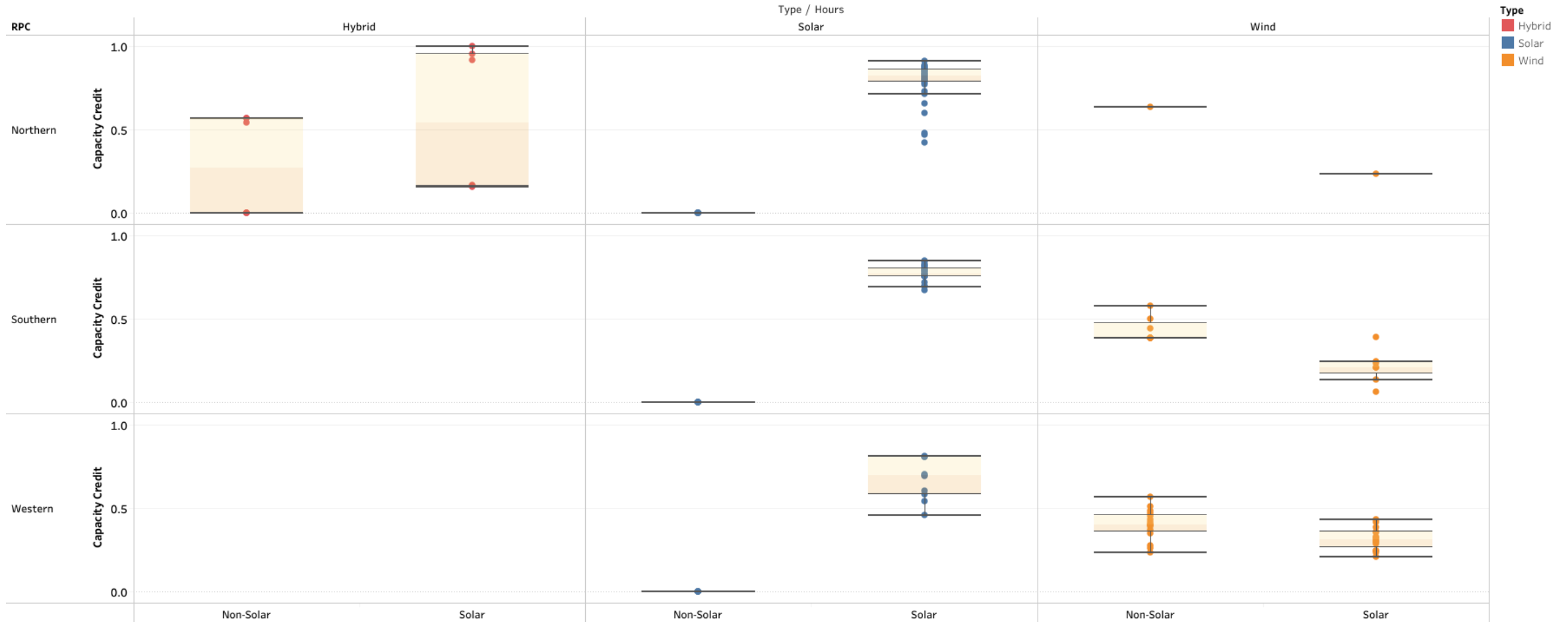
- **Sales migration** makes it extremely challenging to estimate DISCOM demand especially over a 5-10 years timeframe. Additional unknown of possible **retail competition** through multiple/parallel distribution licensees.
- Significant demand (and even generation capacity) could be embedded within DISCOM network (no visibility at SLDC level). For e.g.; the upcoming solar under KUSUM-C
  - Need to have data sharing to re-construct actual load curves for RA analysis.
- With partial OA, captive & liberal banking frameworks, the reliance of these consumers on DISCOMs for reliability will continue.
  - With RE, such capacity requirements are substantial (even if generating equivalent energy at other times)
  - DISCOMs would need to plan capacity to address banking and standby requirements. Could have separate contracts for such services. PoLR at rates much higher than standby.
  - Unfair to expect DISCOMs to procure capacity on OA/CPP consumers (esp. with no CD with DISCOM).

# Capacity Credit Analysis

- Demand, generation and outage (planned/un-planned) data needed for multiple weather years
- Capacity value depends on other capacity additions.
  - Certain resources have diminishing capacity credit with increased penetration: In a solar heavy system, marginal solar will have lower capacity value
  - Impact of other resources on capacity credit: With storage in the system, solar could have higher capacity value
- Needs to be calculated with different combinations of resources in an iterative process. Need for advanced methods in near future.
- Need to consider additional state specific relevant factors (fuel/water availability, vintage) while determining CC of conventional generation sources.
- Determination of energy storage CC should be linked to state-wise peak hour duration.
- Determine CC of demand response technologies in future.

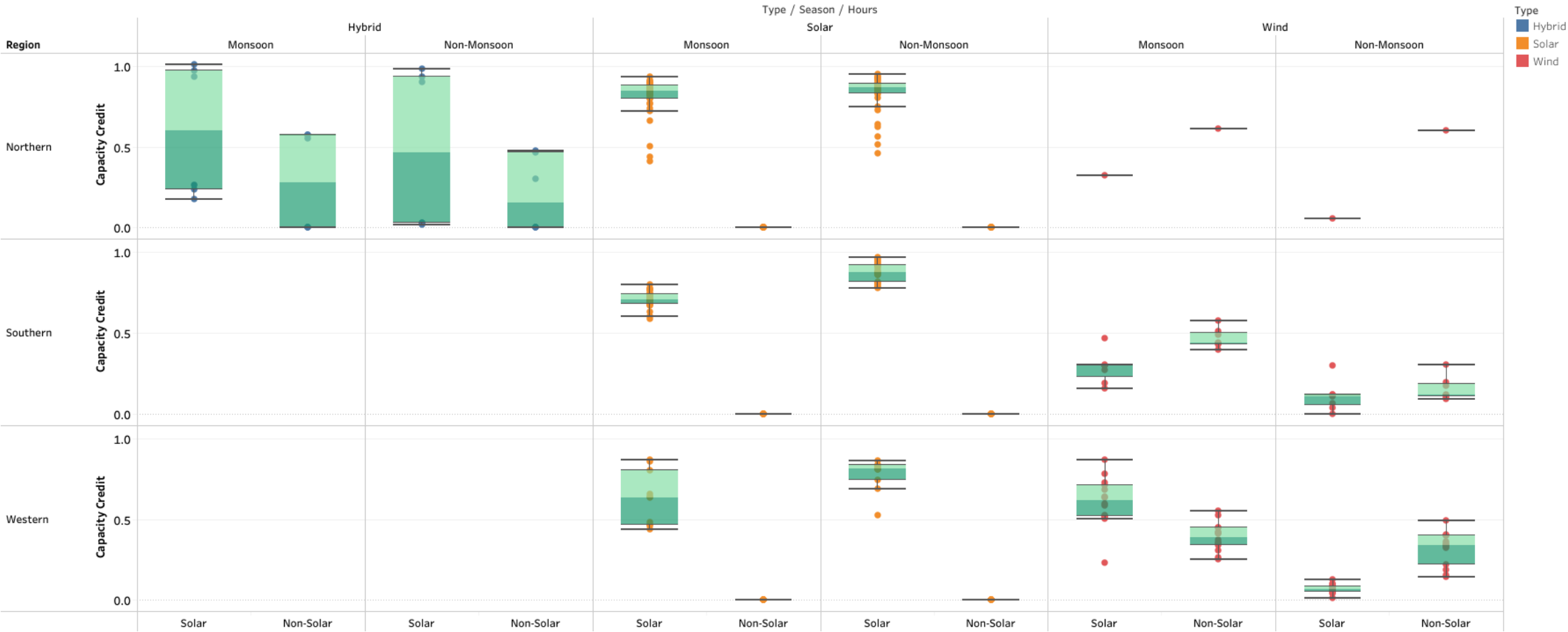
# CC analysis based on ISTS projects...1

Capacity\_credit (Region Wise)



# CC analysis based on ISTS projects..2

Capacity Credit during Monsoon & Non-Monsoon Season





# Coincident Peak Analysis

- Consideration of multiple demand scenarios in the coincident peak determination methodology for future years.
- Explore additional distinction across Monsoon and Non-Monsoon seasons just like the innovative approach for solar and non-solar hours while determining coincident peak and capacity credits.

# Other aspects

- **There isn't one optimal solution**
  - Possible that multiple combinations of different types of resources that can meet reliability requirements at relatively similar costs. Critical that scenario-based analysis and presentation of results with multiple options is part of the framework to enable informed decision making
- **Harmonisation of regulations within a state**
  - States have several regulations (MYT, RA, Capex, Demand Flexibility & DSM, State Grid Code etc.) Develop checklist to see if existing regs comply with the requirement?
  - FoR constituted a Working Group on "Harmonisation of Rules and Regulations (FoR MoM, Aug, 2023)
    - Specific issues of RA implementation in states can be addressed here.

- **Process and Data aspects**

- Need for a bottom-up, deliberative and inclusive process, transparency and consultation in RA studies
- Building complementary Processes
- Trial period, Capacity building, deferring penalties

# Need for a bottom-up, deliberative and inclusive process, Transparency and consultation in RA studies

- Draft reports should be made public, stakeholders encouraged to participate, strengthens IRP and increases stakeholder buy-in of the process.
  - Significant uncertainty with such long-term studies, needs shared ownership.
- Equally applies to the input/output data as well as the modelling tools used.
  - Inputs, assumptions and all data files should be shared in public domain and regularly updated. Vetting of input data and assumptions is as important to interpret results.
  - Get inputs from public and other experts based on alternate modelling studies if any.
  - Ideally use different modelling platforms / methods for Indian context as well. Open-source helps

# Building complementary Processes, trial period

- Technical validation sessions for data gaps and directives as needed
- Reasoned orders with specific responses to all comments and suggestions
- Quarterly review of procurement-based capacity in pipeline at state level
  - Format can be similar to CEA Broad Status Report
- Prudent to trial the RA studies in a sandbox environment over ~2 years or so. Used for learning, building institutional capacity, without significant downside risks.
- **Need for capacity building during trial period (~2 years) without penalties/non-compliance charges for non-compliance of RA.**
  - Instead, penalties for not adhering to processes/timelines (submission of RA/IRP reports, data etc.) during trial period.

- **Forward looking thoughts**
  - Basics First
  - Few insights, innovation possibilities

# Basics first

- Could begin with RA analysis of past years, FY 24/FY 25. Was there adequate capacity to meet PRM, if not, what would have been the penalty.
- Checking level of maintaining reserves of all types for FY 24/FY 25.
- Start with simpler methods for capacity crediting before moving to more advanced ones like ELCC, which are extremely important esp. for long-term studies.
- Over time bring in uncertainty in weather and demand/generation patterns into analysis. Both need high quality granular data. Finally, could bring in probabilities of extreme weather events.

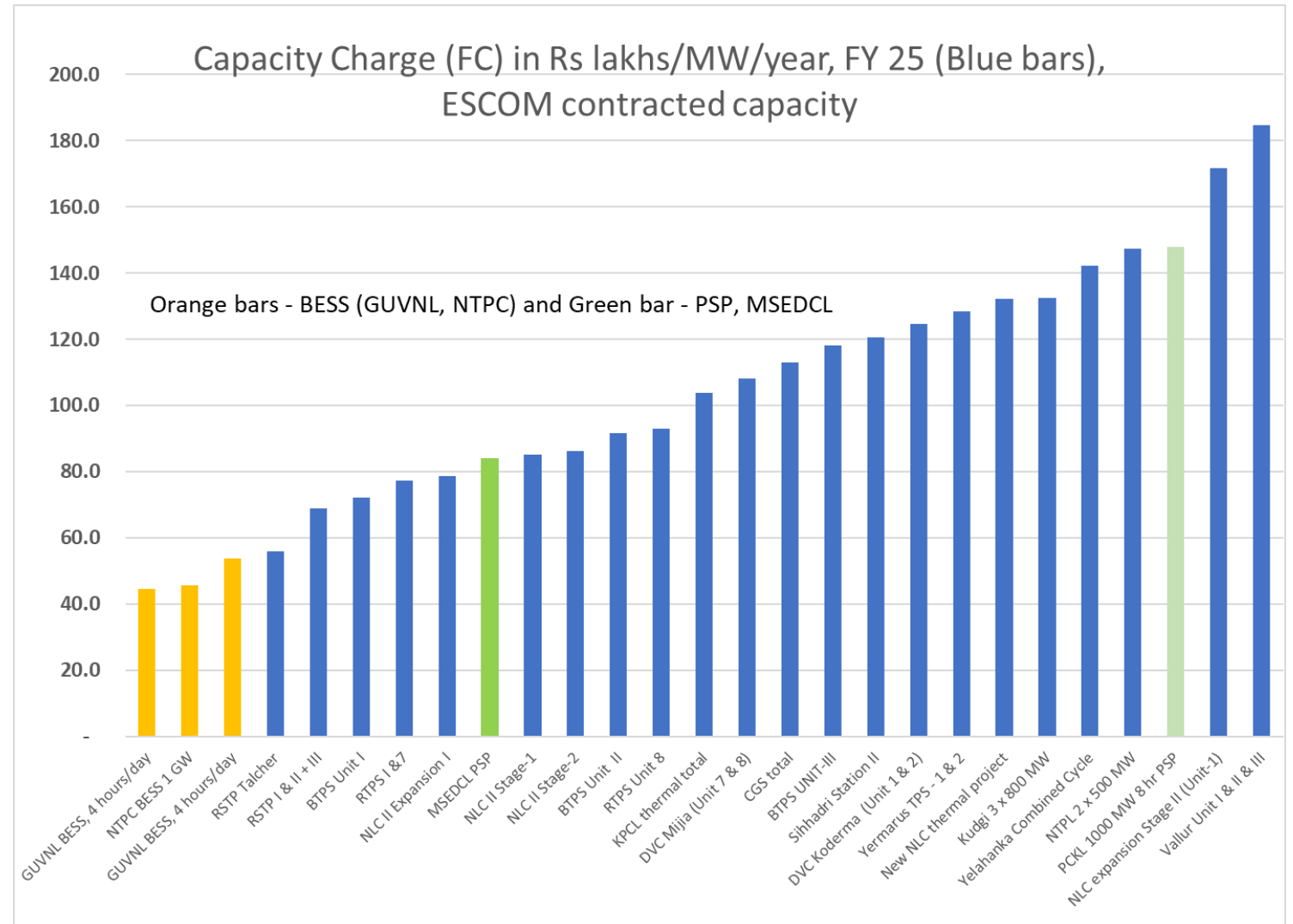
# Few insights, innovation possibilities

- Instead of only focussing on lowest cost (L1), value of generation/demand resource can be objectively calculated in the form of CC for NCP.
  - Which wind/solar resource is more complementary to MH load profile?
  - What is the value of DR for 100 / 200 hours?
- Storage sizing, value of the storage can be better understood analysing its contribution in reducing DISCOM's contribution to NCP.
- Need to mandate DISCOMs to update studies based on recent capacity approvals from MERC.



# Non-compliance penalty for RA

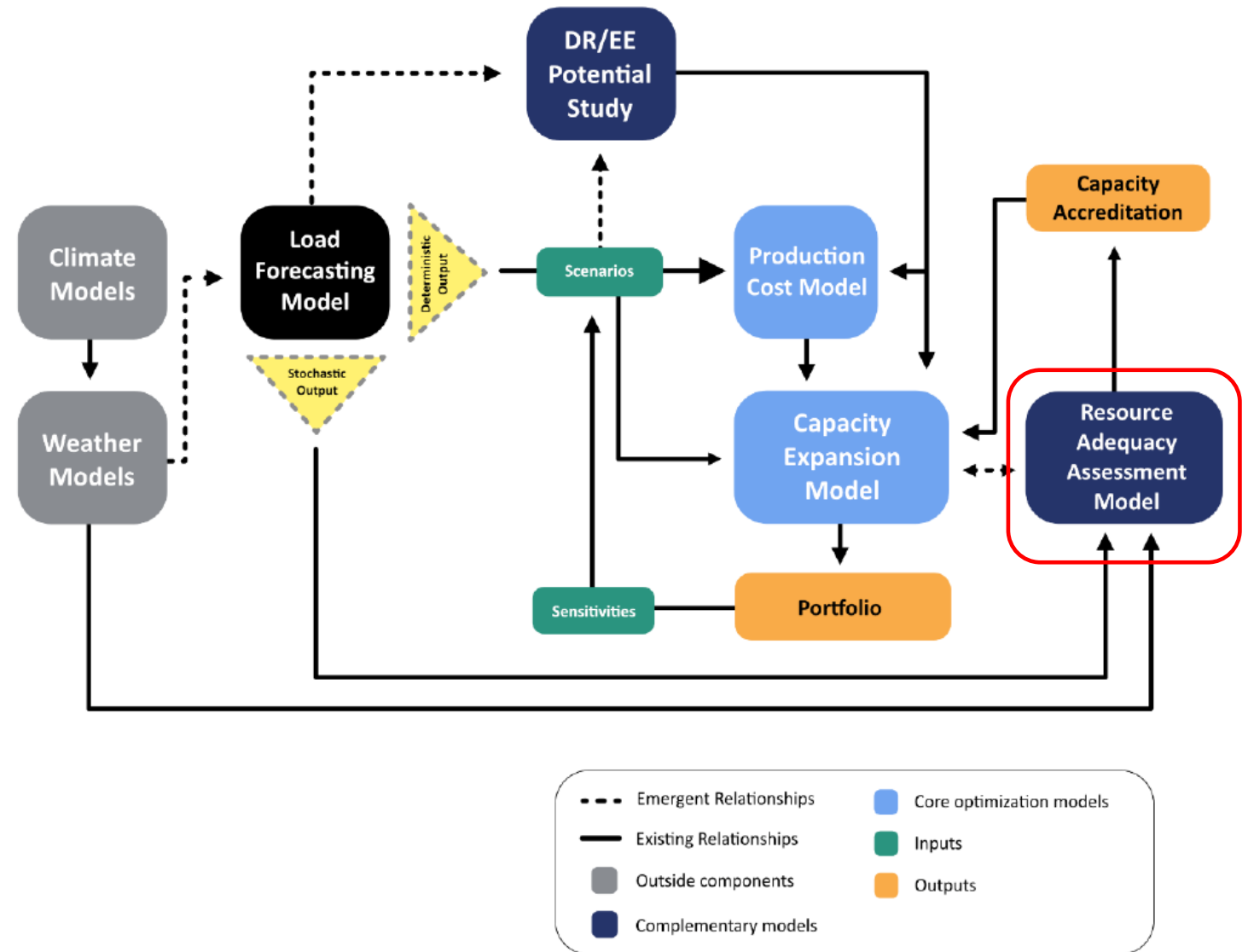
- Non-compliance charges in Kar
  - Marginal Capacity Charge (Rs/kW/month) or 1.25 times the Average Capacity Charge (Rs/kW/month) whichever is higher
- Non-compliance charges would be Rs 1,539/kW/month
  - Marginal Capacity Charge is Rs 15.39 lakh/MW/month
  - Average Capacity Charge is Rs 9.22 lakh/MW/month
- Over 3X the winning BESS bid in GUVNL auction
  - Rs 371/kW/month



Source: Prayas analysis based on MESCOM's data

# Example of a typical model structure used in IRP

Figure 3. Example of a typical model structure used in IRP processes and current (solid line) and potential (dashed line) interdependence



- RA, no doubt important is but a small part of the overall planning process.

**THANK YOU**

Table ES-3 Roadmap to incorporate best practices for RA assessment into planning processes

Components of RA Framework	Planning Element	Benchmarks		
		Minimum Practice	Current Best Practice	Frontier Practice
Definition of RA	Temporal resolution for RA	Meet load in a fraction of the top peak net load hours of the year	Meet load on an 8,760 hour basis	Sub-hourly analysis to meet load and ramping requirements
RA metrics and targets	RA metrics and targets	Single metric (e.g. planning reserve margin) driven by a maximum LOLP (not by the 1-in-10 rule of thumb)	Develop and explore multiple metrics produced by stochastic models that track shortfall magnitudes, frequencies, and durations	Use multiple metrics that track magnitudes, frequencies, and durations; consider full probability distributions of metrics and economic metrics
Data	Weather data	A few years of historical weather data with daily maximums/minimums	Several decades of historical weather data with variables at an hourly temporal resolution	Combine historical data with climate model data for forward-looking hourly weather forecasts
Data	Load forecasting for resource adequacy	Rely on several years of historical load data	Develop econometric or engineering-based load models that explicitly capture the dependence of load on weather	Pair weather-sensitive load models with forward-looking climate change-based weather patterns
Data	VRE characterization	Historical wind/solar performance for several years	Forward-looking wind/solar data for new sites, informed by historical empirical profiles	Climate change-induced wind/solar profiles based on downscaled climate model output
Models	Transmission and market transactions	Basic modeling of firm capacity and available exchanges	Regional simulation to accurately account for the availability of imported resources and market depth uncertainty; locational reliability analysis.	Enhanced modeling of transmission line derates; strengthen integration between generation and transmission expansion
Models	RA modeling and integration with planning process	Basic chronological Monte Carlo LOLP analysis; simplified storage representation	Iterative LOLP-CEM approach; model chronological storage operations	Stochastic CEM that internally assesses and ensures RA; include unit commitment and operational details
Procurement	Capacity credit	ELCC for renewables	ELCC for all resources, analyzed from individual and portfolio perspectives	Energy adequacy analysis; portfolio-based ELCC accounting for interactive effects

Source: LBNL, Juan Pablo Carvallo, Nan Zhang, Benjamin D. Leibowicz, Thomas Carr, Sunhee Baik, and Peter H. Larsen, *A Guide for Improved Resource Adequacy Assessments in Evolving Power Systems: Institutional and technical dimensions*, June 2023.

# Best Practices for RA

- Link resource adequacy assessments with resource planning
  - Conduct resource adequacy assessments and resource planning analysis in a coordinated and iterative manner.
- Apply consistent accreditation frameworks to all resource types
  - Credit all resource types in a fair and consistent manner, and clearly align reliability modeling with realistic expectations of resource availability.
    - It is critical for utilities to avoid over-simplified assumptions that systematically disadvantage certain resource types.
    - Traditional capacity accreditation methodologies have been found to systematically undercount and understate the risks of unplanned outages at **thermal resources by as much as 20 percent**.
- Use a regional perspective to plan for resource adequacy
  - Align resource adequacy and resource planning with the larger region and market, when applicable, to more accurately capture regional interactions and impacts.
- *Source: Best Practices in Integrated Resource Planning: A guide for planner developing the electricity resource mix of the future, Nov 2024; Synapse Energy Economics and Berkeley Lab.*

# Resources

- IEEE- *Fundamentals of resource adequacy for modern power systems* – Core Principles, Last updated July 21, 2024.
- Singh, D., Chitnis, A. (2024). *Strengthening the Resource Adequacy Framework for a RE-Rich Future* (CSEP Technical Paper 6). New Delhi: CSEP.
- *Resource Adequacy in India's Electricity System*, Guillermo Terr'en-Serrano & Ranjit Deshmukh, presented at the event on RA organised by Central Electricity Authority and Prayas, August 9, 2023.
- LBNL, Juan Pablo Carvallo, Nan Zhang, Benjamin D. Leibowicz, Thomas Carr, Sunhee Baik, and Peter H. Larsen, *A Guide for Improved Resource Adequacy Assessments in Evolving Power Systems: Institutional and technical dimensions*, June 2023.
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