Demand Flexibility Readiness Index Methodology

To assess the flexibility opportunities in the country, it is important to understand the state-wise opportunity and readiness for flexing energy demand, especially to take advantage of renewable energy in its grids. While energy demand and resources vary across states, the availability of infrastructure and a supportive policy ecosystem are key enabling factors for discoms to implement Demand Flexibility (DF) and Demand Response (DR) programs. Table-1 presents a curated list of parameters that are identified for assessing the states/UTs for their capacity to plan and deploy demand flexibility initiatives.

The individual parameters can be categorised in four broad baskets that can influence the implementation of DF/DR in states. These parameters include load behaviour, regulatory environment, infrastructure, and prior experience of electricity distribution companies (discoms) in implementing DSM programs. These parameters are built on sub-categories, grouped to arrive at the thematic criteria, that are vital for assessing if states and their discoms are DF ready and thus enabling the ranking of states.

Table 1: Parameters considered for evaluation matrix

Parameters	**Sub-categories**
Load behaviour	RE mix (% of total generation)
	Rooftop solar installation (% of peak demand)
	Variation in load (1 – Load factor)
	Total EVs per 100000 people
	Peak demand CAGR (%) (Typically 3-5 year period to estimate growth trends)
	Share of C&I consumers in total sales
Regulatory environment	Draft DR/DF regulations
	Time of Day tariff (TOD) for domestic consumers
	Resource Adequacy state-level framework/regulation
Infrastructure	Technical and commercial efficiency (1 - A&T losses)
	Smart Meter Implementation penetration
	Presence of private discom (% of private discom in state)
Prior work/ interest for DSM	Number of EE appliance replacement programs
	Number of DR/DF programs
	States that have analysed smart meter data
	Discoms with the DSM cell

State evaluation

After establishing the parameters, to score the states, appropriate weightages were assigned to all parameters based on their significance within the evaluation matrix. The weightages were then

normalized according to the assigned weightage for each parameter, for ensuring a clear scoring of the states - a higher score indicates favourable ecosystem and infrastructure in the state for DF programs. The sub-category parameters chosen for the evaluation exercise and the rationale for their selection is discussed below. Data sources are also mentioned below.

1. Load Behaviour:

To understand the load variation and peak load demand which provides insight about, on what scale the load variation in the state shows the need for intervention for DF/DR activities.

i. **Variation in load:** For this parameter, data on electricity requirement of the states (in MU) and peak load demand (MW), was collected from the national energy dashboard. The load factor (Total demand in year (MWhs)/ (Maximum demand (MW) x 8760)) and the expression (1 - load factor) were used to indicate load variability. Load variability measures how much electricity demand changes over time compared to its highest level. Higher variability in load will indicate a higher need for DF/DR programs and hence higher the score. The highest weightage assigned to this parameter was 10.

ii. **RE capacity (% of total generation):** Total RE integration in the state shows the variability of the supply side and the opportunity for DF/DR intervention. It was calculated by (RE capacity/peak demand). The highest weightage assigned to this parameter was 10.

iii. **Rooftop solar installations:** This parameter considers total rooftop solar installed capacity in the state compared to the peak load demand. It was considered because integrating a high amount of Distributed RE will require DR/DF programs as the generation from these assets is not visible to discoms which can lead to demand forecasting and scheduling error. It was calculated by dividing the total installed rooftop photovoltaic capacity (MW) by the peak demand. The highest weightage assigned to this parameter was 5 points.

iv. **Growth in peak demand:** Considering the CAGR of peak demand, this shows the annual increase in peak demand which leads to need for expensive power purchases and network upgradation to address this demand, so to manage this load effectively DF/DR programs will be helpful. It was calculated by ([Peak demand in FY 2023-2024 / Peak demand in FY 2019-20)]^(1/4) – 1). The highest weightage assigned to this parameter was 5 points.

v. **EV registration:** This parameter was analysed based on the number of registered electric vehicles per 1,00,000 population for the year 2023-24 and normalized for each state. As EV charging load is a bulk power load, it can add to the peak demand while, on the other hand can provide grid services (vehicle-to-grid services). The highest weightage given was 10 points to this parameter.

vi. **Share of commercial and industrial consumers in total electricity sales:** States with a higher C&I share are assigned higher scores, as these consumers offer significant demand flexibility potential due to their large and controllable loads (such as HVAC systems, pumping, industrial processes, and refrigeration), which can be aggregated more easily than smaller residential loads. highest weightage given was 10 points to this parameter.

The above parameters are considered in assessing the load behaviour to understand the load pattern and the need for intervention for DF programs.

2. Regulatory Environment:

These regulatory related parameters are considered to get information about past regulatory and policy efforts by the state/UT that will show the preparedness and available ecosystem for the implementation.

i. **Draft DF/DR regulation:** Regulatory initiatives of State Electricity Regulatory Commissions (SERCs) mandating DF/DR programs provide a better push within discoms. Highest weightage considered is 10 points.

ii. **ToD for domestic consumers:** Data collected from different reports on ToD structures in the country shows that ToD pricing in India is primarily applied to high-tension (HT) or high-end domestic consumers. For the purpose of this evaluation, both mandatory and voluntary ToD applications are considered, with higher scores assigned to states where ToD pricing is mandatory. The scoring also accounts for the connected load threshold. states that extend ToD pricing to a larger portion of domestic consumers with lower connected loads demonstrate stronger regulatory commitment to managing demand at all levels. Such inclusivity indicates a more favourable environment for DF/DR implementation. Highest weightage considered is 5 points.

iii. **State-level resource adequacy regulation:** For this parameter, information was collected from existing draft or notified RA regulations for states and UTs. The rationale for including this parameter was that the RA framework considers DF/DR as a resource, providing a favourable environment for implementation. The information was collected from the websites of SERCs and JERCs. If a state-level resource adequacy regulation existed, it received the maximum score of 5.

3. Infrastructure and operational efficiency:

One of the most important parameters of the matrix, 'Infrastructure' shows the technical availability and need for the DF/DR programs in the state. The five indicators analysed were technical and commercial efficiency, ACS to ARR gap, smart meter installation status, presence of private discom.

i. **Technical and commercial efficiency (AT&C losses):** This parameter indicates the efficiency of the state/UTs. So lower losses mean higher efficiency and higher supply efficiency indicates better infrastructure and operations. States/UTs that have achieved low loss levels demonstrate the foundational strength necessary to implement advanced grid management programs like Demand Flexibility (DF) and Demand Response (DR)., which can further improve financial performance. It was calculated by (1-AT&C losses) that will give the efficiency. The highest weightage was 10 for this parameter and the information was collected from the report on the performance of utilities.

ii. **Smart meter implementation status:** Analysed the statewide data on sanctioned smart meters and the sum of cumulative achievement to understand this parameter. Smart metering is crucial for the implementation of DR/DF programs, detailed data from smart meters ensures the DF program's implementation is successful. The highest weightage assigned to this was 10 points. It was calculated by dividing the no. of smart meters Installed by no. of smart meters sanctioned achieved so far.

iii. **Presence of private discoms:** This criterion was considered because usually, private discoms in India have been improving their infrastructure to enable flexible demand. They often operate in smaller, urban areas with more affluent consumers, enabling them to implement better infrastructure and pilot innovative DR/DF programs more easily. While this indicates pockets of advanced operational readiness, it may not reflect the readiness of the entire state or the public DISCOM network. Therefore, the presence of private DISCOMs is considered a qualitative

indicator of potential DF/DR adoption rather than a direct scored metric. States with private DISCOMs may leverage these experiences to support broader program rollout, but care should be taken to avoid over-weighting this factor in the overall readiness assessment.

4. Prior activities or interest for DSM utilities:

Experience in implementing DSM activities in the states/UTs shows discoms' willingness in planning and leveraging demand-side opportunities. Furthermore, a few utilities in the country have already piloted demand response initiatives and it was anticipated that these states would be more willing to engage in flexibility initiatives more actively.

i. **No. of energy-efficient appliance replacement programs:** The total number of energy-efficient appliance replacement programs was used to assess the experience of states in DSM activities and Discom's ability to engage with consumers to drive EE/DSM initiatives and they are more likely to have successful DF initiative. Data was collected from various reports, and the highest weightage given was 5.

ii. **Number of DR/DF programs:** This parameter suggests that the states have implemented the DR/DF programs, importantly developed technical capabilities for the implementation of these initiatives, which were identified from BEE's reports. Similarly, to energy efficiency programs, the frequency of these DR/DF programs fetched more points, while the highest weightage assigned was 10 points.

iii. **States that have analysed smart meter data:** Smart meter installation is important, but understanding the state's capabilities to collect, store, and analyse data from smart meters is also necessary. This will be important in designing flexibility programs. The highest weightage assigned to this indicator was 10.

iv. **States that have DSM cells in Discoms:** The presence of a dedicated DSM cell within a state DISCOMs is considered as an evaluation parameter in assessing the suitability of states for implementing Demand Flexibility. A DSM cell reflects the utility's commitment and institutional readiness to design, coordinate, and monitor DF initiatives effectively. The highest weightage assigned to this indicator was 5.