A. Summary of Discussion Paper on Re-designing Ancillary Services Mechanism in India dated 6th September, 2018

This discussion paper aims to assess the performance of the existing framework of frequency support and balancing ancillary services mechanism in India suggests reforms in the context by way of introduction of auction based procurement of Ancillary Services.

The paper has addressed the following issues:

- Dependence on un-requisitioned surplus power which may or may not be available when needed by the grid
- Adequacy of reserves not defined in terms of duration and flexibility
- Procurement of ancillary services is on cost-plus principles
- IPPs, CPPs and MPPs are excluded
- Ambit of Ancillary Services (RRAS) is restricted and does not include performance metrics
- Presently, only those regional entity generators are included under the RRAS mechanism whose tariff for the full station is determined or adopted by the Central Commission. Thermal Merchant generators / IPPs are excluded from the ambit of ancillary services. These generators also comprise a sizeable chunk and can provide additional reserves for dispatch under the ancillary services
- Concept of Gate closure
- Lack of a calibrated approach to transform the extant administered Ancillary Services mechanism to a market based mechanism

The key design and operational challenges in existing AS mechanism have been touched upon:

- Need of adequate reserves quantum available for despatch
- Adequacy of "reserves" requires a clearer definition of reserves, for example, "reserves" for how long?
- Need to define Adequacy in terms of "flexibility"
- Performance Monitoring of Ancillary Services
- Gate Closure for Scheduling Process
- Minimum threshold quantum for Ancillary Services

By way of an analysis of international experience the paper has explained that the market design options for AS broadly differ based on different approaches for procurement of ancillary services (AS) and also for market clearing and settlement mechanism. As explained in the discussion paper on Real Time Market by the Commission issued for public consultation, integrated markets (where system operation as well as market operation is managed together by the system operator) are typically a characteristic of all US wholesale electricity markets, which operate day-ahead forward market and real-time imbalance market. Most European and the Australian markets follow largely exchange based market operation designs (where market operation is carried out at the exchange and system operation is handled by the system operator).

Proposed Market Design for India:

The wholesale energy market should be capable of providing the bulk of energy balancing through forward trading ahead of gate closure with the service operator only procuring ancillary services required within the settlement period. The SO should avoid procurement mechanisms that unnecessarily dampen or otherwise interfere with the efficient operation of the wholesale market.

The paper carefully considers the following key principles to form the basis for the current and future ancillary services market:

- Competitive and market based
- Transparent
- Level playing field - Technology Agnostic Paradigm
- Fit for the future

B. Increasing need for Ancillary Services:

There is an urgent need for Ancillary Services (AS) to support the power system when large quantities of RE is integrated into the grid. Forecasting RE generation and estimating balancing requirement would help manage the overall variability in the system. However the error in forecasting leading to deviation from schedule would requires AS for mitigation. The cost of provisioning AS would be a financial burden on the central and state governments. In the current market scenario the cost of AS cannot be loaded onto RE generators because: a) Additional costs would reduce the economic viability and competitiveness of RE generators and would deter investors. b) All disturbances in the power system do not originate from RE sources. There is also a requirement of Ancillary Services to manage the variability of the power system due to conventional generation as well as consumers deviating from schedule. There is however, a need to develop a market mechanism to meet the following requirements of introducing AS in the Indian power system.

- To maintain quality, reliability and security of electricity grid
- To maintain load-generation balance in case of sudden failures (e.g., outage of generating unit / transmission line)
- To provide support for load forecasting uncertainties (e.g., weather)
- To provide support for unforeseen variation in renewable generation
- For relieving congestion in transmission network
- For restoring grid from blackout

The existing reserve capacity requirement as per the CERC Report of the committee on spinning reserve, 2015:

Type	**Requirement**
Primary	4.0 GW
Secondary	3.6 GW
Tertiary	5.2 GW
Total	**12.8 GW (~3.7% of total installed generation capacity, i.e., 344 GW)**

C. Gaps to be addressed in the proposed AS mechanism and recommendations:

The following tables cover the market and policy recommendations for consideration of the committee.

I. Market Mechanism:

Proposed in discussion paper	Recommended
Auction based procurement of tertiary ancillary services - Day Ahead Market where generators would bid simultaneously in Day Ahead Energy and Day Ahead Ancillary Services Market and the two shall be cleared together (Co-optimization model)	Addressing adequacy of resources (access to enough power to be able to meet the highest expected level of demand) and system quality (right mix of resource (consumers and generators) capabilities deployed to ensure that demand and supply are always balanced), is essential to maintaining reliability of power at least-cost while the power sector shifts from being dominated by conventional power to renewables.
	To provide ancillary and balancing services there should be an introduction of control reserves through capacity products besides energy only products on the power exchange. A simple method that may be adopted is apportioning the capacity mechanism into products based on the target mix of resource capabilities derived from the net demand forecast. All resources, including qualifying demand-response and end-use energy efficiency resources, would bid into the highest-value product for which could qualify. The most flexible product is cleared first, followed by the next, and so on. Additionally, a bid based reserve market model can be designed to provide primary and secondary frequency control at regional level as well as national level alongside the day ahead (DA) main market.

II. Policy proposition:

Proposed in discussion paper	Recommended
There is dependence on un-requisitioned surplus power which may or may not be available when needed by the grid	There is a need to bring in additional machines on bar and maintain spinning reserves to facilitate flexing of generation to meet ramp requirements.
It has been observed that Ancillary services for balancing in India have been used for multiple hours with the objective of meeting morning demand	A clear distinction needs to be drawn between balancing ancillary service and meeting demand and supply through energy markets. There is a need for decoupling the energy and ancillary market. The ancillary service market should be able to provide services beyond balancing the grid. The potential benefits of a capacity based market alongside provision of voltage control

	and black start services should be considered from technical and financial point of view.

III. Market participants

Proposed in discussion paper	Recommended
All Inter-State / Intra-State generation (Public or Private) resources may be qualified to provide Ancillary Services	Traders, Consumers and DISCOMs
RE resources, with appropriate retrofit, be qualified to provide energy and Ancillary Services at a later date	The paper proposes a level playing field and therefore all technologies and services should be able to compete for ancillary services with consistent rewards and obligations for all providers to ensure the least cost options are developed and allow all technologies to compete, regardless of size or type. The framework should deliver the service that is required at a competitive cost from both existing participants and new entrants.
	Additionally, The Staff Paper on Introduction of Electricity Storage System in India, 2017 mentions that storage could be an alternative method of providing spinning reserves or ancillary support services. Storage can act as a primary service with a response time of under 5 secs. There can be a minimum mandate for energy storage to DISCOMs and adequate incentives may be provided.

D. Advantages of AS (Primary and Secondary services)

The paper clearly states that the segments viz. secondary control (AGC) and fast tertiary, would be open to market mode on gaining experience from the pilot studies and the Commission may notify a date in future for introduction of markets for these two ancillary support services. Also, primary support is mandatory in nature and all generators are required to have the capability to provide the support if called for.

However, addressing adequacy of resources (access to enough power to be able to meet the highest expected level of demand) and system quality (right mix of resource (consumers and generators) capabilities deployed to ensure that demand and supply are always balanced), is essential to maintaining reliability of power at least-cost while the power sector shifts from being dominated by conventional power to renewables.

Some of the key benefits of utilising flexible resources are as under:

a.) Technical benefits – better speed of response and ramp up time
b.) Financial benefits – behind-the-meter or customer-focused solutions, including approaches to achieve and monetise benefits across the electricity supply chain from new business models to technologies such as storage, inverter controls or load control

Introduction of new will generate additional services along with incentivising participants.

Technology	**Service**
Battery Storage	Demand response
	Storage as a service model – revenue stacking
	Energy storage
	Balancing
Tri-Generation	Cooling and hot water
	Balancing

E. International Experience

Innovative technological solutions (in particular via renewable energy sources, inverters, grid technology, and demand-side management and electricity storage units) can make significant contribution to the provision of ancillary services in future. A summary of the changes expected on the Indian grid in the next few years and identified operating challenges are listed as under:

- Continued integration of variable generation
- Transmission enhancements
- Changes to load behaviour
- Increase in reserve requirement in the future
- Uncertainty on responsiveness of supply resources
- Requirement of increase in spinning reserves

With growth of RE in energy mix to increase by 2022, for large scale integration of renewables there is a need for:

- Intra-day trades at 24x7 exchange
- Regional balancing
- Ancillary services in the State
- Data, process, tech upgrades, decision-making
- State Pool: allocate state DSM charges
- Frequent schedule revisions, closer to dispatch
- Scheduling & deviation accounting of ALL generators

The following table provides a summary of some of the various ancillary services provided across some developed countries:

Country	Renewable Energy Integration (%)	Types of Ancillary Services
Toronto, Canada	24%	Certified black start facilities, Regulation service, Reactive support and Voltage control service, and reliability must-run. **Ontario IESO:** Ancillary services project of 52.8MWh of battery storage - part of a procurement by Ontario's Independent Electricity System Operator (IESO). The project will cover six ancillary services agreements with the IESO, to provide fast-acting response to voltage control and reactive power. **Ontario capacity Auction:** A capacity auction that will help meet the future resource needs of Ontario's electricity system and provide flexibility for new and existing technologies to compete in the marketplace.
UK	30% by 2020	Reserve Services, Frequency Services, Short term operating Reserve, capacity reserve **UK capacity market auction:** Energy storage technologies awarded just 5.3% (2.7 GW) of the total available capacity
Australia	33% by 2020	Frequency Control Ancillary Services (FCAS); Network Control Ancillary Services (NCAS); or System Restart Ancillary Services (SRAS)

Future procurements should target specific services instead of specific technologies. Service-oriented procurements will return better value than those that target specific technologies because of increased competition.

F. Cost Economics of adding new technologies – Case for Energy Storage

At present, India is required to mandatorily maintain primary support and all generators are required to have the capability to provide the support if called for. The generators in India, therefore, are prevented from scheduling beyond their installed capacity. The quantum of primary reserves mandated is 4000 MW. As we are moving to a market based mechanism for procurement of tertiary services based on the model of co-optimization, energy storage facilities that have the appropriate capability can also offer primary spinning reserve alongside other providers.

Example:

Energy Generated in FY 17-18 (BU)	1212 BU
Cost of generation (INR/unit)	3
Total Cost (INR Crores)	3,63,600

Additional cost of Primary AS	
Capacity Auction (MW)	4000
Cost of capacity in terms of storage for a 10 year PPA (INR cr/MW)	INR 1.5 Cr/MW
Additional Cost to the System (INR Crores)	6000

Total additional cost to the system (INR)	**0.016**

Considerations from storage point of view:

1.) May look at the revenue streams and economics of energy storage participating in regulation services within different markets (day-ahead, real time or ancillary).
2.) Frequency regulation application of ESS from a utility's perspective may be looked at as the schedule of base-load generators would be changed when a utility operates an ESS along with the change in constraint costs (differences between the market schedule of generation and the actual dispatch by the grid operator.)
3.) The investment economics of ES which has a high influence on the Net present Value over the ES lifetime may also be looked at. The main objectives of optimization for a potential ESS owner are participating in an ancillary service market and making profits from providing the service

G. Other considerations for overall ancillary services

Frequency control - Instantaneous reserve	**Frequency control - Provision of balancing energy**	**Voltage control - Provision of reactive power**	**System restoration and control**
Review of the use of potential from decentralised energy plants and storage facilities	Adaptation of product characteristics, prequalification requirements and implementation of adaptive demand calculation for balancing energy (tendering the balance energy demand)	Develop coordinated balancing energy provision from decentralised energy plants in the distribution grid and check alternative use of reactive power from high voltage for extra high voltage in individual cases	It must be possible to control RE systems during system restoration especially distribution system operators must be able to choose between grid expansion and optimised system control