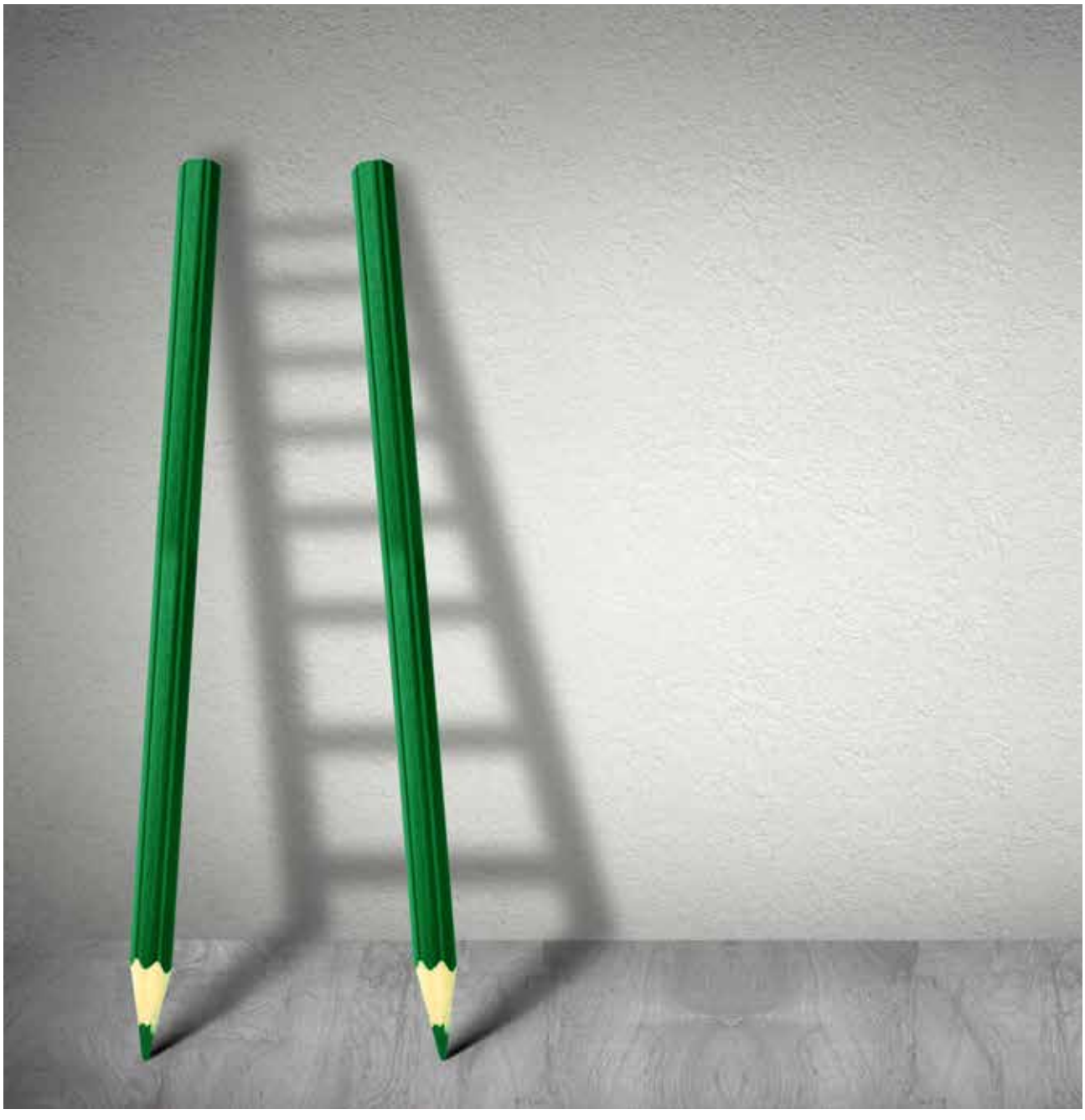
IEX INDIAN ENERGY EXCHANGE
INNOVATION TECHNOLOGY FUTURE

INNOVATIONS @ ENERGY



TECHNOLOGY DEVELOPMENTS@ IEX

IEX has been proactively working to strengthen and advance its Exchange and Enterprise technology. As technology is at the core of our business, we are continuously investing and re-aligning to offer our technology infrastructure to integrate the requirements of new products as well as upgrade the technology set-up to provide best-in-class and seamless experience to our customers. Our endeavour is to automate the operations and optimise Exchange processes and systems. Some of the recent technology developments are highlighted below:

National Open Access Registry

The National Open Access Registry (NOAR), to be launched shortly, is a centralised electronic platform developed by POSOCO for facilitating short-term open access. The NOAR will act as an interface for all the stakeholders, availing short-term open access in inter-state transmission system, including open access participants, state distribution utilities, State/Central/IPP generators, trading licensees, power exchanges, NLDC/RLDCs/SLDCs, Regional Power Committees, CERC and SERCs. The platform will allow automation of the approval processes related to the short-term open access, including bilateral and collective transactions.

IEX is working with POSOCO to automate the process of data exchange and validation of standing clearance and processing of Term-Ahead, Day-Ahead and Real-Time market transactions. The automation will help in smooth communication between the Power Exchange and POSOCO and will bring transparency and efficiency. It will help IEX customers in automation and greater efficiency through the elimination of manual interventions.

Financial Reconciliation

We will shortly launch the bank transactions reconciliation for our members through our existing web platform. The key benefits of providing financial reconciliation to our members are as follows:

- Transaction date-wise debit/credit details in one click
- Reconciliation of segment-wise transactions
- All transactions towards Pay-in/Pay-out/Margin-in/Margin-out, etc. can be reconciled line item-wise.
- Appropriate narration in line with bank statements will be made available for better understanding
- Quick information for their audit queries
- Identification of transaction value towards multiple segments is possible

Data Insights

The data insights at our web platform were launched in Feb '22 for all our members and clients. The platform is a one-stop window to access market data and analytics. Our customers can view data and analytics related to cleared volume, cleared price, buy, sell trend at member and at the portfolio level for all segments. In addition to this, the platform offers uncleared volume analysis with respect to price, demand trends at the state level, DSM-related details, and transmission outage details.

ROLE OF ANCILLARY MARKET IN INDIA'S POWER SYSTEM

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Introduction

World over and in India, the power sector is undergoing rapid transition driven by four broad levers 4Ds: De-carbonisation, Digitalisation, De-centralisation, and Democratisation. The pace of de-carbonisation of the power sector is set to get turbocharged with India's recent ambitious commitment in CoP26 to achieve Net Zero by 2070. Further, India has also committed to meet 50% of energy consumption from renewable sources and achieve a target of 500 GW of non-fossil-based generation capacity by 2030.

This rapid transition in power sector driven by 4Ds requires the power system to evolve and resonate with the dynamic requirements to support large-scale integration of renewable energy sources. The high variability and unpredictability in generation from renewable sources, growing commoditisation of electricity by distributed generation, and changing role of consumers to prosumers creates several challenges in safe, reliable, efficient and secure operation of the power system. Therefore, Ancillary Services that provide a robust, reliable, and efficient support is required to ensure large-scale de-carbonisation without compromising, adding to the safety and reliability of the grid operations.

Understanding Ancillary Services and India's Existing Framework

Ancillary Services are an indispensable part of power system operation, which are required for maintaining load generation balance on real-time basis and enhancing the reliability of the power system. Broadly, there are two types of Ancillary Services: Frequency Services and Non-frequency Services.

- **Frequency Ancillary Services:** Three levels of Frequency Control are generally used to maintain load-generation balance i.e., Primary Frequency Control, Secondary Frequency Control and Tertiary Frequency Control.
- **Non-frequency Ancillary Services:** This includes Network Control Ancillary Services and System Restart Ancillary Services. Network Control Ancillary Services include voltage support and reactive power support. The System Restart Ancillary Services are used to restore the system after partial or full blackout.

Primary control generally refers to local automatic control available in all conventional generators, which delivers reserve power negatively in proportion to change in system frequency. The Primary Reserves have been ensured through suitable amendments in the IEGC, which require the generating stations to keep such reserves for system security by not scheduling beyond the installed capacity. The Primary Reserves are delivered automatically through turbine governors, in which the generating units respond quickly to the frequency deviation as per droop characteristic of the units. Primary Reserve responds to frequency signals typically within 5-10 seconds and sustain up to 5 mins. Thus, Primary Control works by deploying Primary Reserves instantaneously to restore the system frequency to tightened nominal frequency band of 49.95-50.05 Hz.

To relieve the Primary Reserves, Secondary Control responds in 30 seconds and can ramp up to their full output within 15 mins and can sustain up to 30 mins. The Secondary Control is deployed by the System Operator through control signals like Automatic Generation Control which delivers the reserve to restore the system frequency. For Secondary Reserves, CERC has made it mandatory for all ISGS to be AGC enabled, which ensures availability of Secondary Reserves.

Tertiary Reserves are deployed to relieve Secondary Reserves and it is generally activated within 15 minutes from the despatch instructions and can sustain up to 60 mins. Tertiary Reserves are activated in case the Secondary Reserves have been continuously deployed in one direction for 15 min. The Tertiary Control is implemented through manual change in despatch or drawl and unit commitment in order to restore the secondary reserves.

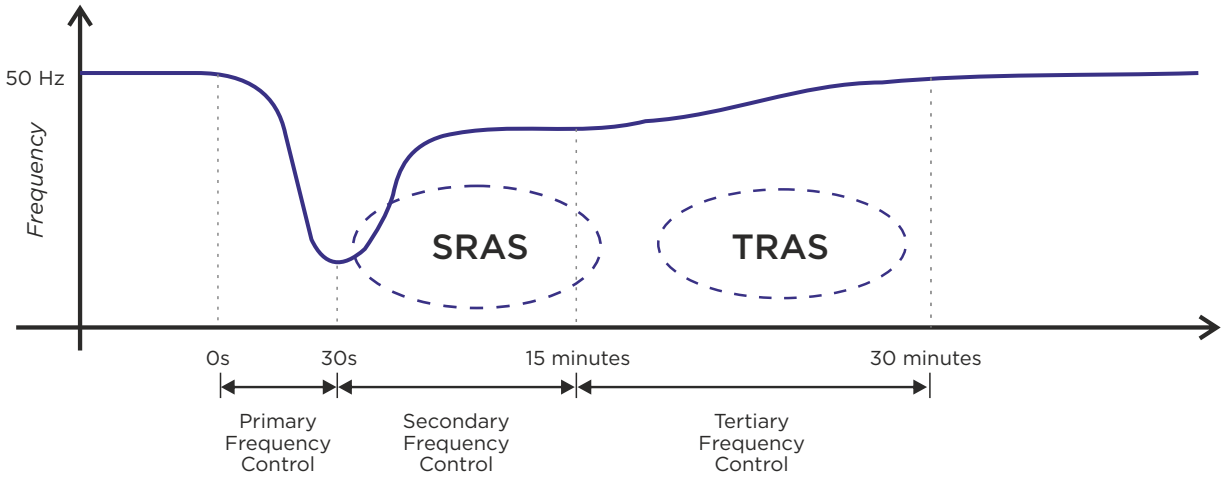


Fig: Activation and Deployment of Ancillary Services
(Ref: CERC, Draft Ancillary Services Regulations 2021, Explanatory Memorandum)

In India, the System Operators i.e., NLDC supported by RLDC and SLDC, are responsible for maintaining the grid operation in safe and reliable manner. Till date, the regulatory framework for Ancillary Services in India has been provided by CERC Reserve Regulatory Ancillary Services Regulations 2015, through regulated mechanism. Under this regulation, the Tertiary Reserves are deployed by system operator using the URS in the generating stations that are regional entities and whose tariff is determined by CERC for their full capacity. A mark up is provided over and above the variable charge to incentivise participation by the generators.

However, the need was felt for carrying reforms in the Ancillary Services procurement due to various reasons such as inadequate Up Reserves (for 30-40% of time) in high demand period, increasing cases of use of Ancillary Services for meeting morning peak demand, etc. Further, under RRAS 2015, thermal stations are mainly utilised for Ancillary Services. The Thermal stations have ramping limitations and over next decade the energy transition dominated by variable renewable energy, increasing numbers of prosumers, etc. would require fast response Ancillary Services to effectively balance the load.

Thus, to address the issues in RRAS 2015 and to expand the scope of Ancillary Services to support large-scale renewable integration, CERC has released Ancillary Services Regulations 2022. The key highlights of the regulation are as below:

- The new regulation expands the scope of providing Ancillary Services (Primary, Secondary and Tertiary) to intra-state generating stations, energy storage technologies and demand response
- It creates an incentive mechanism for fast response Ancillary Services, wherein SRAS (Secondary Response Ancillary Services) providers shall be despatched and compensated based on their ramp rates and variable/compensation charges. Place to begin with the procurement of SRAS would be on administrative mechanism and based on experience, market-based bidding process may be adopted
- It creates a competitive mechanism an to attract more participation in Tertiary Ancillary Services, wherein Market-based procurement shall be done for purchase of Tertiary Services through the Day Ahead Ancillary Services market and Real Time Ancillary Services market at Power Exchanges

Thus, the Ancillary Services Regulations 2022 shall facilitate creation of large pool of service providers and range of technologies with faster response through market-based mechanism, which is a step in the right direction to manage the grid operation (variable RE dominated power system) in safe, reliable and competitive manner.

Ancillary Services – Global Perspective

Market-based Ancillary Services are an also integral part of the power market in developed economies. The Ancillary Market in some of the global power markets are discussed as below:

US Power Market

The US wholesale electricity market operates as an integrated market i.e., both the system operation as well as market operation are carried out by each ISO themselves. While there is less similarity in market design for Ancillary Services in different ISOs, each ISO operates auction market for spinning, non-spinning reserves. Most of the markets in US procure Ancillary Services through Day-Ahead and/or Real-Time Market. The auction methodology for price discovery of ancillary market is uniform market clearing price, which ensures that generators bid at their marginal cost, thereby resulting in efficient price discovery. Another characteristic of US market is co-optimisation of Energy Market and Ancillary Market. The co-optimisation of energy and ancillary markets provides flexibility to utilise the generation capacity either for Energy or Ancillary Service, thereby, reducing the total system cost by optimal utilisation of generation capacity for system reliability and energy needs.

European Power Market

Unlike US market, in European power markets, market operation and system operation are separately handled by power exchanges and system operators, respectively. In EU markets, the Ancillary Services are procured by the system operator well in advance (monthly or annually) through an auction method. The bidding method principle followed for procurement of Primary, Secondary and Tertiary Reserve is based on pay-as-bid model. The advance procurement of the Ancillary Services (i.e month ahead or year ahead) by system operators is well in advance i.e., month ahead or on year ahead basis is aimed to ensure that there is enough reserve 'on the day'.

Another important aspect of EU Power Market is co-optimised allocation process for cross-zonal capacity for exchange of energy and bids for the exchange of balancing capacity or sharing of reserves across the integrated EU power market. This framework enables increased availability and optimisation of resources for Ancillary Services.

Innovation in Ancillary Services to Facilitate Energy Transition

In the conventional design of the electricity system, the power from the large generators is supplied to the transmission systems, while the distribution grid is responsible for serving the loads connected to the Medium Voltage (MV) and Low Voltage (LV). The frequency and voltage variation, which occurs (mainly due to load variation) are mainly controlled by system operators through the conventional generators. However, this centralised approach is becoming outdated due to addition of large-scale renewable plants (variable generation pattern) and growth of distributed de-centralised generation sources within the transmission and distribution system.

Thus, innovative models for Ancillary Services are required to support evolution of conventional power system to integrate variable RE generation. The new ancillary services & products and new market participation models would be required to support renewable integration.

New Ancillary Service Products

Ramping Products

In line with the projected growth of renewable capacity, especially solar generation, the net load curve is expected to become famous 'Duck Curve', as being observed in US and Australia, etc. The problem arises when the solar generation drops to zero during sunset, which is mostly a peak-demand time, making the fast ramping-up of the conventional units necessary to serve the power demand and balance the system. However, limitations of thermal stations to match the steep rise in power demand during sunset can significantly increase price of energy.

The system operators would need reserves that can provide fast ramping capabilities to address such net load volatility. Conventionally, net load ramping requirements have been served by conventional generators. In most markets, such ramping by conventional generators is not identified as a separate ancillary service and is only compensated based on the marginal cost of electricity production. When such ramping is procured through energy markets, steep ramping requirements (evening peak) can lead to increased prices in the energy market, thereby distorting the market for other participants.

To address this issue, a separate ramping or flexibility product could be offered as part of the Ancillary Market to serve the net load ramping requirements. One such example is from CAISO. In Nov 2016, it implemented Flexible Ramp Up and Flexible Ramp Down Contracts, which are ancillary service market products to procure ramp-up and ramp-down capability for 15-minute and 5-minute time intervals. In CAISO, the ramping product is offered in real-time market and in fifteen-minute market. In MISO, the ramping product is offered in day-ahead market and real-time market.

As per POSOCO's report on "Analysis of ramping capability of coal-fired generation in India 2019", at all India level, only 35% of the thermal generating stations have been able to demonstrate ramp rate of at least 1%/min. Therefore, there is a need for market-based fast ramping products to deal with anticipated steeper Duck Curve in India in a before cost-effective manner. Further, such product will reduce the price spikes in the energy market and this will also generate market signals to attract more investments in technologies providing ramping support.

Fast Frequency Response Provided by Energy Storage

In cases of sudden variation in demand and supply in the system, conventionally, quick restoration of frequency within a few seconds to minutes is provided by conventional generators through autonomous governor control. However, with increased VRE penetration, autonomous response offered by the conventional generators may not be sufficient to address frequency drops. The batteries with sub-second response capability are well suited to providing balancing services and fast frequency response.

A separate ancillary service market product can be created to procure such services from battery storage systems. Several markets have created products, which allows BESS and other fast response energy storage sources to provide fast frequency reserves. For instance, National Grid in the United Kingdom has added a new product to contract with battery storage providers for fast frequency reserve services. Similarly, Australia's energy market operator contracted Tesla's 100 MW/129 MWh lithium-ion battery in South Australia, which provides accurate response to the frequency control and ancillary services market at a lower rate than conventional sources of energy. CAISO in 2020 also allowed BESS and hybrid energy storage resources to provide Ancillary Services.

New Market Participants Providing Ancillary Services

Some of the newer participants and manner in which they can provide Ancillary Services have been discussed below:

Wind Turbines for Inertial Response

Inertial response refers to the ability of synchronous generators to speed up or speed down to overcome immediate frequency disturbances. Inertial response has been traditionally provided by large thermal generators and large hydropower plants. The wind turbines connected to the power system through a power electronic converter can provide inertial response (also known as synthetic inertia) during frequency disturbances. During a frequency surge, the power electronic controller can apply a retarding torque on the turbine to reduce generation, whereas during frequency drops, the controller can utilise the kinetic energy of the turbine to increase power output.

Thus, suitable market-based products supported by policy and regulatory framework could be adopted to utilise wind turbines in providing fast frequency response.

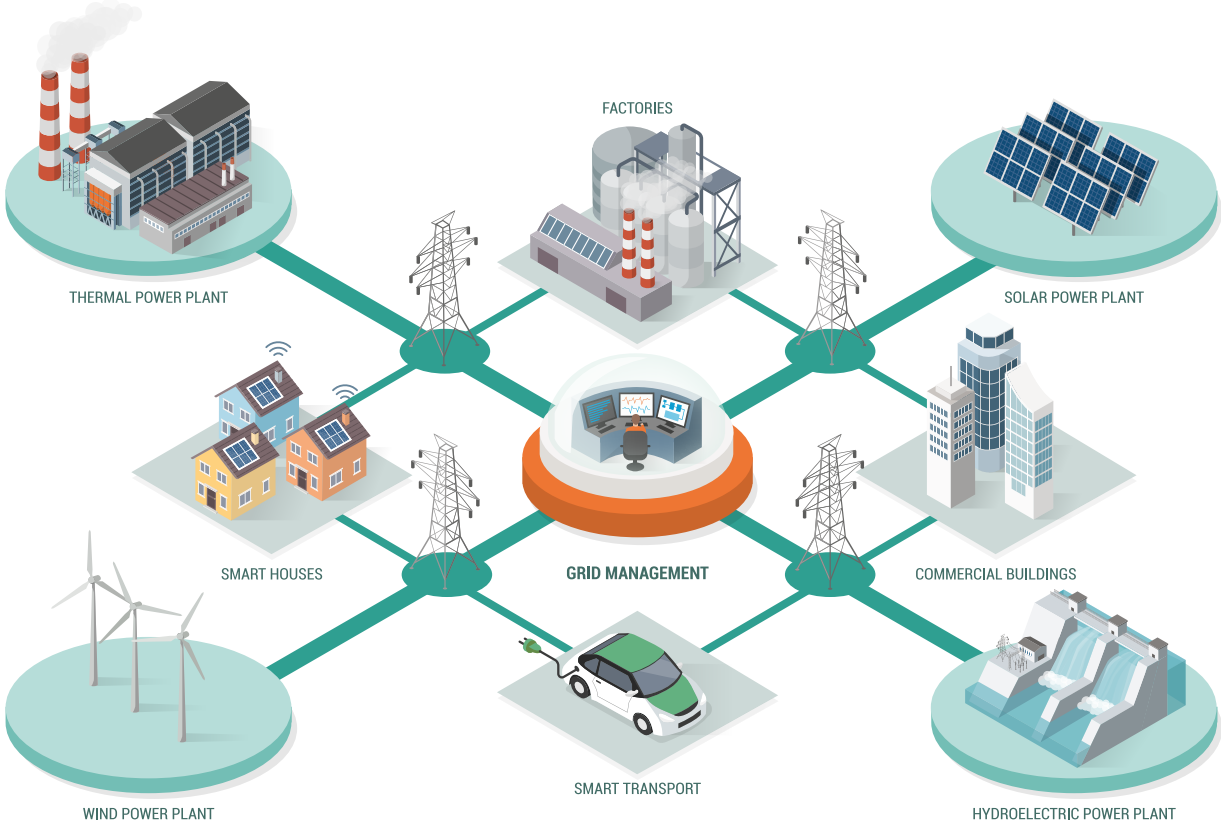
Solar PV Plants and Utility-scale BESS for Reactive Power

Reactive power helps maintain voltages in the network within prescribed limits. However, reactive power flowing for long distances in the transmission and distribution grid causes a number of problems, which include inadmissible voltage excursions and increased losses. Therefore, reactive power must be supplied, when needed, from a nearby source. This has conventionally limited market mechanisms for procuring reactive power, as there may be limited alternative sources of reactive power at a given location. Solar PV or BESS connected to the Smart inverters can provide reactive power support.

Thus, market-based separate product, which incentivises supply of reactive power from Solar PV shall help to maintain voltage fluctuations in the grid.

Distributed Energy Resources

Distributed Energy Resources (DERs), such as rooftop solar systems, behind the- meter battery storage systems, plug-in electric vehicles, and commercial and industrial loads, can provide ancillary services to system operators through price-based incentives, often referred to as 'explicit demand response'. DERs may be allowed to participate independently or through aggregators or retailers, depending on the market design in place. For instance, NYISO released a concept proposal of market design to enable DERs (<100 KW) to participate (directly or via aggregator) in wholesale as well as ancillary service markets.



Conclusion

The CERC Ancillary Services Regulations 2022 is indeed a step in right direction as it expands the scope for players to provide ancillary services to all generators, storage systems and demand response. This is expected to support innovative products and will attract newer players to set up resources to provide Ancillary Services through market-based mechanisms.

Further, the regulatory enablers to facilitate aggregation of Ancillary Services from distributed energy resources (e.g.- battery storage technologies) shall drive new investments, which will help to further deepen the Ancillary Market at power exchanges, thereby reducing the overall renewable integration cost.

Glossary

IEGC: Indian Electricity Grid Code

CAISO: California Independent System Operator

VRE: Variable Renewable Energy

AEMO: Australian Electricity Market Operator

CERC: Central Electricity Regulatory Commission

MISO: Mid Continent Independent System Operator

BSS: Battery Energy Storage System

SPV: Solar Photo Voltaic

AS: Ancillary Service

RRAS: Reserve Regulatory Ancillary Service

AGC: Automatic Generation Control

DER: Distributed Energy Resources

DAM: Day-Ahead Market

RTM: Real-Time Market

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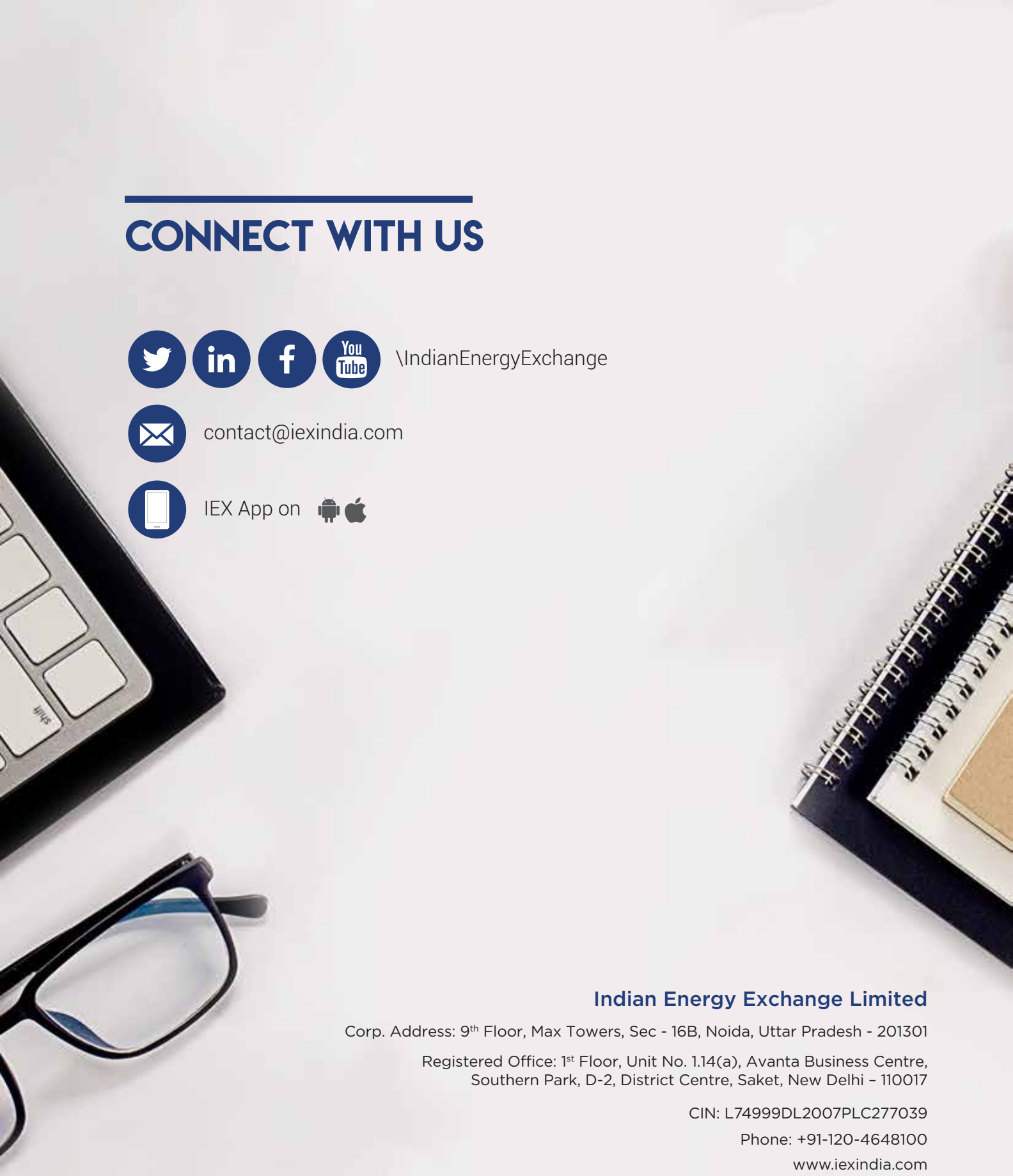

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