
ISGF White Paper

Interstate P2P Trading of Green Energy

How India is Leading a Silent Revolution in Digital Energy Grids and Peer to Peer (P2P) Energy Transactions

Abstract

With support from the Uttar Pradesh Electricity Regulatory Commission (UPERC), ISGF introduced the Peer-to-Peer (P2P) transactions of Rooftop Solar (RTS) energy on blockchain platform in 2020 in UPPCL, Lucknow. In the following years, ISGF has conducted larger pilot projects with Tata Power Delhi Distribution Ltd (TPDDL) in 2021 and with CESC, Kolkata in 2022. These successful pilots led to groundbreaking P2P Regulations in UP in 2023, in Delhi and Karnataka in 2024 and in Kerala in 2025. In collaboration with FIDE (www.fide.org), ISGF implemented the world's first Digital Energy Grid (DEG) demonstration in UPPCL, Lucknow in 2025. With DEG, the P2P participants can meet each other, negotiate trades and settle payments on digital platforms built over and above the blockchain platform which is connected to the utility's IT systems. ISGF supported the India Energy Stack (IES) Team for designing and implementing (including obtaining regulatory approvals from DERC and UPERC) the world's first Interstate and multi-utility P2P transactions of green energy which was showcased at the Global AI Impact Summit in New Delhi in February 2026. P2P Transactions of green energy is envisaged in the new Draft National Electricity Policy 2026. This has been a phenomenal journey in the past 5 years from pilots to regulations to national policy. India is leading a silent revolution on digital energy grids and P2P energy transactions which the world can learn from India!

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About India Smart Grid Forum

The India Smart Grid Forum (ISGF) is a Think-Tank of global repute on Smart Energy, Electric Mobility, Grid Modernization and Energy Transition. ISGF, established as a Public Private Partnership (PPP) initiative of Government of India in 2011, is spearheading the mission to accelerate electric grid modernization and energy transition in India. ISGF is registered as a Not-for-Profit Society under Indian Societies Act and has its head office at CBIP Building, Malcha Marg, Chanakyapuri, New Delhi 110021.

1 INTRODUCTION

Ministry of Power (MOP), Government of India has launched the India Energy Stack (IES), a groundbreaking initiative in June 2025 to build digital public infrastructure (DPI) for the power sector in India and constituted a taskforce of experts to work towards this objective. IES is expected to be a unified, secure, and interoperable digital backbone for India's energy sector which will address challenges like fragmented systems, lack of unique identifiers, and limited data interoperability, drawing inspiration from Aadhaar and Unified Payments Interface (UPI). The key features of IES include unique digital IDs for consumers, assets, and transactions to ensure traceability; real-time consent-based data exchange for better decision making; open APIs enabling seamless integration and innovation across systems; tools for dynamic pricing, green tariffs, and peer-to-peer (P2P) energy trading. The primary objective of IES is to modernize the power sector, support Net-Zero goals, enhance grid efficiency, and renewable energy integration through real-time analytics. To develop IES, MOP has nominated REC Ltd as the nodal agency and constituted a Task Force comprising of experts from the industry, utilities and academia under the mentorship of Shri Nandan Nilakani. FSR Global has been appointed as the Knowledge Partner.

The Digital Energy Grid (DEG) on Unified Energy Interface (UEI) architecture will be one of the strategic pillars of the IES. Globally, this is the **first time a DPI is being designed for the power sector where P2P energy trading will address one of the important use cases envisioned under IES**. This makes P2P an important driver of India's digital energy transformation. P2P within the IES is not just about trading excess rooftop solar energy, it is about **building the foundation for a 21st century energy market**. It connects consumers, prosumers, EVs, batteries, and digital apps into a single ecosystem where energy is transacted as easily as money is transferred today through UPI. By making P2P the **core of India's digital energy future**, the country is sending a clear message: the future of power is **local, digital, and consumer driven**. And with this, India will achieve a **global first** demonstrating how Digital Public Infrastructure can unlock massive participation, innovation, and sustainability in the electricity sector.

IES has released the IES Strategy 0.2 and IES Architecture 0.2 Documents on 17th December 2025 which envisaged pilot demonstration of interstate P2P trading. Rural Electrification Corporation (REC)/MOP has accepted the proposal submitted by India Smart Grid Forum (ISGF) to undertake a pilot demonstration of Interstate P2P Trading in the National Capital Region (NCR) involving 3 DISCOMs in 2 states – Pashchimanchal Vidyut Vitran Nigam Limited (PVVNL) of UPPCL in UP and Tata Power Delhi Distribution Limited (TPDDL) and BSES Rajdhani Limited (BRPL) in Delhi. This was successfully demonstrated on fast track and showcased at the Global AI Impact Summit held in New Delhi in February 2026.

2 P2P PILOT PROJECTS IN INDIA AND THE REGULATORY REGIME

ISGF has carried out 3 successful pilot projects of P2P Trading of RTS Energy on Blockchain Platforms. These pilot projects are:

- a. **UPPCL, Lucknow:** ISGF along with our technology partners have implemented South Aisa's first P2P pilot project in UPPCL, Lucknow in 2020. This project had 9 prosumers and 3 consumers; and the project went live in December 2020 (Low participation owing to Covid pandemic).
- b. **Tata Power Delhi Distribution Limited (TPDDL), Delhi:** ISGF along with our technology partners have executed a larger P2P pilot with 117 participants in 2021 in TPDDL, in Delhi.

- c. **CESC, Kolkata:** ISGF Team carried out an even larger P2P pilot in CESC Kolkata with 1001 Commercial and Industrial customers in 2022.

Details about these projects are given in the ISGF White Paper: **“Opportunities From Energy Market Regulatory Reforms in India”** which can be accessed at: https://indiasmartgrid.org/isgf/public/banner_img/1690604163wPzsGitK3ppF8FRSwn4dlFgpQHrE23jPojqL9hWG.pdf.

Based on the recommendations from the demonstration project in Lucknow, Uttar Pradesh Electricity Regulatory Commission (UPERC) had issued enabling guidelines in April 2023 for scaling up P2P trading of RTS energy in Uttar Pradesh. Similar regulations have been issued in Delhi and Karnataka in 2024 and in Kerala in 2025 by respective state electricity regulatory commissions (SERCs).

Table 1 below compares the provisions in the P2P guidelines/regulations in these 4 states.

Table 1: Comparison of P2P Regulations in 4 States

SI No	Parameter	Uttar Pradesh	Delhi	Karnataka	Kerala
1	Date of Issue	05 th April 2023	24 th June 2024	06 th August 2024	05 th November 2025
2	Title	Guidelines for Peer-to-Peer Solar Energy Transaction through Blockchain Platform	Delhi Electricity Regulatory Commission (Peer to Peer Energy Transaction) Guidelines, 2024	KERC (Implementation of Peer-to-Peer Solar Energy Transaction) Regulations, 2024	Kerala State Electricity Regulatory Commission (Renewable Energy and Related Matters) Regulations, 2025
3	Eligible Participants	Prosumers with rooftop solar (Gross/Net metering) and Consumers within same DISCOM	Prosumers and consumers ≤ 200 kW sanctioned load; RE capacity up to 500% of sanctioned load	Registered SRTPV Consumers having Net metering or Gross metering arrangement	Prosumers and consumers with RE / BESS (future rollout)
4	Registration Process	Registration with DISCOM and empaneled P2P platform	Registration through DISCOM and approved P2P platform	Registration with DISCOM and platform aggregator	Registration with DISCOM (KSEBL)

5	Registration Charge	As specified by DISCOM / Platform	Nil	As specified by DISCOM	Not specified
6	Metering Requirement	Post-paid Smart Meter mandatory for both prosumer and consumer	ToD compliant Energy Meter or Smart Meter mandatory	Post Paid Smart Meter /ToD Compliant Energy Meter	Smart Meter / ToD meter expected
7	Technology Platform	Mandatory Blockchain based P2P platform	Blockchain or any other secure digital technology	Digital trading platform	To be notified after pilot study
8	Transaction Price	Mutually agreed price between P2P participants on P2P Platform	Dynamic / mutually agreed price between Prosumers and Consumers	Market-discovered / mutually agreed	To be notified
9	Transaction Charges	₹0.42/kWh (incl. GST) shared equally by buyer and seller	To be approved by DERC based on DISCOMs petition	As approved under pilot	To be notified
10	Wheeling Charges	Applicable as per applicable UPERC tariff order	Nil for both Prosumers and Consumers	Applicable, except when connected at same DT/sub-station	Likely applicable (not waived)
11	Network / Open Access (OA) Charges	Wheeling charges applicable; Cross Subsidy Surcharge (CSS) – waived; Additional surcharge – Nil, 100% waiver	Complete waiver of wheeling, CSS and additional surcharge till 31 March 2026	Relaxed / waived during pilot	To be notified
12	Platform Service Fee	Payable to P2P service provider as approved by UPERC	Regulated platform service fee approved by DERC	Regulated by Commission / DISCOM	To be determined by KSERC
13	Settlement and Billing	Billing by DISCOM; P2P settlement integrated with	Billing by DISCOM / Service Provider; priority	Settlement handled under sandbox arrangement	Energy accounting from January

		DISCOM billing cycle	settlement for P2P energy		2026; P2P after pilot
14	RPO Treatment for P2P Transaction	RPO benefit retained by DISCOM	Counts towards DISCOM RPO if consumer not obligated	RPO remains with DISCOM	RPO accounting with DISCOM
15	Notable / Distinguishing Features	First detailed state level P2P framework in India ; clear scheduling, deviation and settlement rules	Most progressive framework; strong financial incentives and charge exemptions	Pilot-oriented approach to test market design before full-scale regulations	Explicit recognition of P2P, VPP and V2G , but implementation deferred pending pilots
16	Time Block for transaction	Day-ahead scheduling by 17:00 hrs of (n-1) day; intraday scheduling allowed up to 4 time blocks before delivery	Schedule to be submitted at least 8 time blocks before commencement of supply; no rescheduling thereafter	Day-ahead scheduling by 17:00 hrs of (n-1) day; intraday allowed up to 4 time blocks	To be notified post pilot (P2P to commence only after pilot study)
17	Restriction on Energy unit trade w.r.t. the capacity of the solar plant.	Prosumer cannot transact more than actual rooftop solar generation per day	Prosumer cannot transact more than 20% CUF of installed RE capacity per day	Restricted to surplus solar energy under net/gross metering	To be specified after pilot
18	Under injection of energy by P2P Prosumer	Prosumer pays difference between DISCOM energy charges and mutually agreed P2P price for the shortfall energy	Prosumer pays Consumer the difference between DISCOM tariff and agreed P2P price for the shortfall energy	Under-injection settled based on difference between scheduled and actual energy, as per DISCOM mechanism	To be notified after pilot
19	Under-drawl of energy by P2P Consumer	Consumer pays full committed P2P energy to Prosumer; excess energy injected into grid settled with DISCOM	Consumer pays full pledged P2P quantum to Prosumer; excess energy injected settled at DISCOM landed cost	Consumer obligated to pay committed P2P quantum	To be notified after pilot

3 DIGITAL ENERGY GRID (DEG) DEMONSTRATION IN UPPCL

Although UPERC Guidelines were issued in April 2023, UPPCL could not scale up the P2P project owing to difficulties with major modifications needed in their billing system. Per UPERC Guidelines, the DISCOM is responsible for collecting and settling following financial transactions:

- Collect the energy charges from consumer and pay to the prosumer
- Collect the wheeling charges from the consumer (for the DISCOM)
- Collect the platform service fees from the prosumer and consumer and pay to the platform service provider

To incorporate these transactions in the existing billing systems of DISCOMs is very cumbersome. Hence, ISGF in collaboration with FIDE (www.fide.org) has proposed building digital platforms above the blockchain (trust layer) where prosumers and consumers can discover each other, bid, negotiate and enter in to buy-sell contracts as well as settle the payments. The blockchain layer will be connected to the DISCOMs metering and billing applications where necessary adjustments can be carried out for the trades executed on the P2P platforms. This is the genesis of the Digital Energy Grids on Unified Energy Interface (UEI) architecture as depicted in the diagram below.

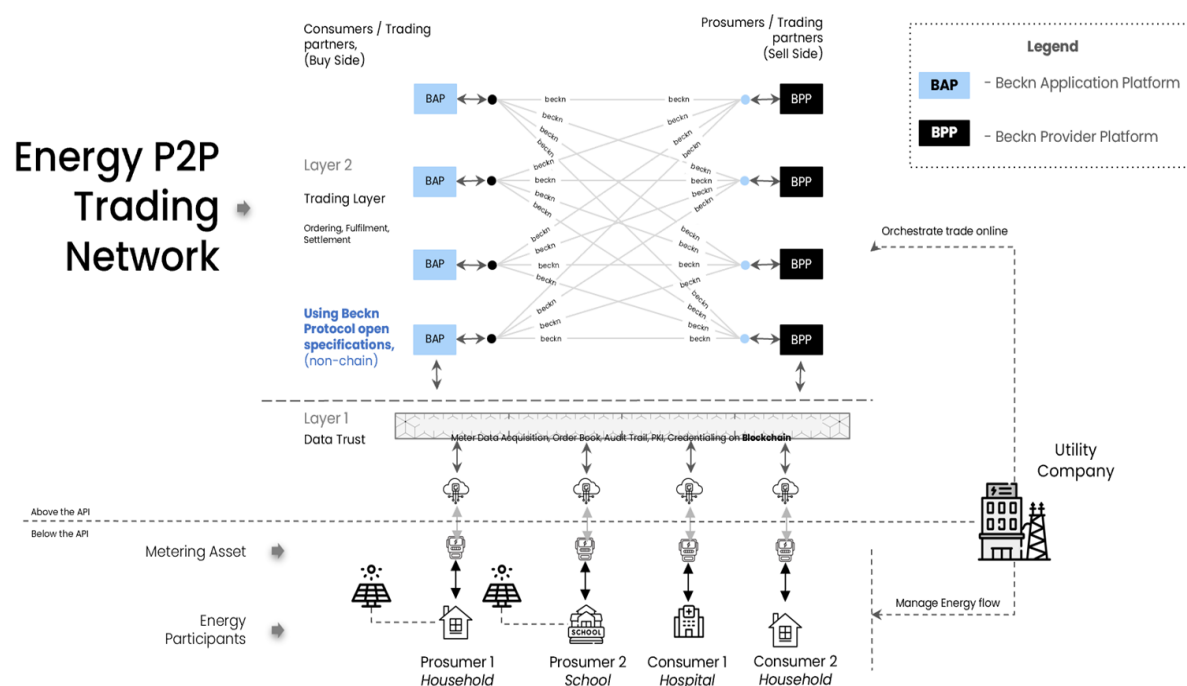


Figure 1: DEG Demonstration Project in UPPCL, Lucknow – Architecture Diagram

Above architecture illustrates how a P2P energy trading network functions using the Beckn protocol and a blockchain based data trust layer. At the bottom are energy participants such as households, schools, and hospitals, some act as prosumers (who generate and sell rooftop solar energy) and some as consumers (who buy energy). Their smart meters continuously record energy import/export data. This meter data moves upward into Layer-1 (Data Trust Layer) powered by blockchain, which acts as a secure single source of truth for metering, trade validation, and settlement records. Utilities remain fully involved; they manage physical energy flow on the grid, ensure safety and reliability, and receive validated meter data for billing adjustments.

Above this, Layer-2 is the trading layer, where multiple P2P applications operate. Prosumers use Beckn Provider Platform (BPP) platforms and consumers use Beckn Application Platform (BAP) platforms to place buy and sell bids. The Beckn protocol enables secure discovery, negotiation, contracting, fulfilment, and settlement between buyers and sellers in an open network, meaning multiple platforms can interoperate rather than being locked into a single marketplace. Once trades are matched, contracts are digitally signed, wallets are settled, wheeling charges and platform fees are applied, and final traded units are reconciled using smart meter data. This ensures trustworthy billing, regulatory compliance, faster settlements, and scalable open-network innovation in India's energy ecosystem.

3.1 Trading Logics, Information and Money Flows

On the DEG/P2P platform, the trading process is designed on a Day-Ahead contracting and assured financial settlement framework. Prosumers publish their expected next-day surplus solar availability along with the selling price on the BPP, while consumers place their buying requests on the BAP. These platforms run automated discovery and matching, allows a negotiation round if needed, and finalizes mutually agreed contracts by 5pm. Once a trade is confirmed, the platform performs a wallet and payment validation check through an integrated RBI compliant payment gateway. The payable amount from the buyer's wallet is securely blocked in an escrow account, ensuring that once energy is delivered, the payment is guaranteed and the buyer cannot default. The digitally signed trade contracts are then stored on the blockchain based Trust Layer, making the entire process transparent, auditable, and tamper proof.

On the delivery day, electricity physically flows through the DISCOM's distribution network; there is no peer-to-peer physical wire the DISCOM grid continues to deliver power reliably. Meanwhile, smart meters capture the exact exported energy by the prosumer and the imported energy by the consumer. This metered data is transferred through the meter data management system (MDMS) of the DISCOM to the blockchain trust layer, where the platform reconciles the contracted quantity v/s actual delivered energy. Based on this verified data, the financial settlement happens automatically through the payment gateway mechanism. The escrowed money is released to the respective stakeholders, payment to the prosumer for the supplied energy minus the platform service fee of ₹ 0.21/kWh, transfer of wheeling charges (₹1.01/kWh) to the DISCOM, deduction of platform service fees of ₹ 0.21/kWh from buyer, and application of deviation settlement rules if actual supply differs from the contracted supply.

Finally, reconciled transaction and settlement data is shared with the DISCOM billing system. This ensures that P2P purchased units are deducted from the consumer's billed consumption and P2P sold units are deducted from the prosumer's solar energy export units in their electricity bills. The overall design delivers trustworthy trade execution, assured payments through escrow and payment gateway integration, regulatory compliance, tamper proof blockchain records, and seamless integration with DISCOM billing and operations, making the DEG/P2P marketplace financially secure and technically robust.

4 THE INTERSTATE P2P DEMONSTRATION

The IES Strategy 0.2 and IES Architecture 0.2 envisaged to demonstrate the feasibility of interstate P2P trading, and ISGF along with our technology partners undertook the pilot project in NCR involving following DISCOMs:

- i. **PVVNL under UPPCL** which supplies electricity in Noida and Ghaziabad area in the NCR where smart meters are deployed under RDSS. PVVNL implemented Oracle MDMS and Billing System
- ii. **TPDDL, Delhi:** In TPDDL service area in Delhi where Tata Power's Unified Data Stream (UDS) is the MDMS and SAP ISU Billing System.
- iii. **BSES Rajdhani Power Ltd (BRPL):** The pilot demonstration covered BRPL's prosumers and consumers with smart meters in Janakpuri area in Delhi.

5 REGULATORY SUPPORT THE INTERSTATE P2P PILOT IN NCR

Separate Petitions were filed by TPDDL and BRPL to Delhi Electricity Regulatory Commission (DERC) for approval of the Interstate P2P Demonstration Pilot Project in January 2026. Similar Petition was filed by PVVNL to UPERC in February 2026. As explained in Section 2, both UP and Delhi have issued P2P Guidelines. UPERC Guidelines specifies the following trading rules, wheeling charges and platform service fees:

- a. **Energy Trading:** The charges for the energy traded on the P2P platform will be mutually agreed between the seller (prosumer) and the buyer (consumer).
- b. **Wheeling Charges for the DISCOM:** ₹ 1.01/kWh to be paid to the DISCOM towards wheeling charges and billing and settlement fees. This money is to be paid by the buyer (Consumer). No GST applicable on this wheeling charges.
- c. **Platform Service Fees:** Service fee of ₹ 0.21/kWh to be paid by both buyer and seller to the P2P platform service provider. This includes 18% GST.
- d. **Penalties for under Injection by the Prosumer:** Per existing regulations, the prosumer who promised to sell X units at ₹ Y/kWh but exported only X-Z units next day, is liable to compensate the consumer (buyer) for the short fall of Z units at the difference in the rate between the buyer's grid tariff and the P2P agreed purchase price of ₹ Y/kWh.
- e. **Penalties for under Withdrawal:** A consumer who agreed to buy X units at ₹ Y/kWh but failed to draw that quantity by Z kWh should compensate the Prosumer at the difference between his gross metering rate and the agreed purchase price on P2P platform (₹ Y/kWh)
- f. For over withdrawal the grid tariffs will apply; and for over injection it will get credited to the solar export credit of the prosumer

Owing to slab systems for all consumers in UP, there is difficulty in determination of the difference between the P2P agreed purchase price and the grid tariff of the consumer in a particular month (which vary according to which slab he falls in that month). Hence in the ongoing DEG demo, ISGF team is not able to apply the penalties for under injection.

DERC Guidelines has not specified any platform service fee for which the DISCOMs need to file petition. DERC has given complete waiver of wheeling, Cross Subsidy Surcharge (CSS) and additional surcharge till 31st March 2026.

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These petitions sought approvals from respective commissions on following provisions:

1. PVVNL, TPDDL and BRPL have been chosen by MOP/REC to be part of the Pilot Demonstration of Interstate P2P Project which need to be completed by 15th February 2026, so that MOP could showcase it as IES use case at the Global AI Impact Summit scheduled in Delhi in February 2026.
2. In view of the urgency with the Interstate P2P Pilot to be completed on fast track, the petitions sought the SERCs to grant permission for following:
 - a. **Wheeling Charges:** UPERC Guidelines provisions ₹ 1.01/kWh for the DISCOMs to be paid by the consumer (buyer) for Intra-DISCOM P2P transactions. For this pilot project of interstate P2P transactions, this amount may be allowed to split equally between the DISCOM of the Prosumer (Seller) and the DISCOM of the Consumer (Buyer); however, the full wheeling charges will be paid by the buyer as per the existing UPERC Guidelines.
 - b. **Platform Service Fee:** Per UPERC Guidelines, both Prosumer and Consumer need to pay ₹ 0.21/kWh each towards platform service fees (this include the GST). Approved for same platform service fees for the prosumers and consumers in both TPDDL and BRPL was sought from DERC.
 - c. **Energy Charges:** The energy charges will be mutually agreed between the prosumer and the consumer which will be settled on the P2P platform directly without involvement of the DISCOMs. The P2P Service Provider will indemnify the DISCOMs from any disputes/claims related to the energy charges and platform service fees.
 - d. **Penalties for Under Injection and Under Withdrawal:** It was requested to waive off these penalties for the proposed interstate pilot project.
 - e. **Cross Subsidy Surcharge (CCS):** In the existing regulations in 4 states there is no CCS for P2P transactions. It was requested to waive-off the CCS and other additional surcharges for the Inter-State pilot project.
 - f. **Waiver of other Charges for Interstate Power Trading for this Pilot Project:** Per existing rules for power market operations, interstate power trade involve following charges:
 - *ISTS Transmission Charges*
 - *ISTS Transmission Losses*
 - *NLDC / RLDC System Operation Charges*
 - *SLDC Charges (UP + Delhi)*
 - *Open Access Charges (of UP and Delhi)*
 - *Scheduling Charges*

It was requested to waive-off these charges for the proposed Interstate P2P Demonstration Project under the IES initiative.

Both DERC and UPERC have accorded approvals for the interstate P2P demonstration project in February 2026 well before the target demonstration date of 16th February 2026. These approvals are provisional and for a period of 6 months. Both Commissions have advised the utilities to refer the matter relating to interstate power trading charges to Central Electricity Regulatory Commission (CERC) as the state commissions do not have the jurisdiction in interstate trades.

6 PROJECT STATUS

A comprehensive live demonstration of the Digital Energy Grid (DEG) enabled P2P Green Energy Trading platform was undertaken across the National Capital Region (NCR), covering 3 DISCOMs. This project established and demonstrated a fully functional, operationally secure, financially robust, and regulatorily compliant P2P energy marketplace operating across multiple utilities in one of the most complex and commercially significant electricity market in India. This showcased how consumers and prosumers across these utilities could seamlessly participate in day-ahead renewable energy contracting, delivery, metering validation, billing reconciliation, and wallet-based financial settlement using a common technology stack. The platform is integrated with smart meters and MDM systems, integrated with DISCOM billing platforms, utilize a blockchain based trust and validation layer, and incorporated an RBI compliant payment gateway with escrow for assured settlements. This project established a first-of-its-kind framework where energy trading can take place within and across utility/state boundaries, while ensuring complete control, visibility, and revenue assurance for participating DISCOMs.

7 STRATEGIC OUTCOMES

1. The Interstate P2P Trade Demo project was showcased by MOP at the Global AI Impact Summit scheduled in New Delhi in February 2026. This is the first such Interstate P2P experiment globally on the Digital Energy Grid and established India as a leader in this domain.
2. This pilot demonstration in NCR will lay the foundation for a **replicable and scalable blueprint** for nationwide deployment of decentralized digital energy marketplaces. It will validate how India's power sector can transition toward **consumer-centric, digitally governed, flexible and renewable-driven energy ecosystems**, while maintaining DISCOM stability, system security, and regulatory trust.

8 WAY FORWARD

ISGF will seek guidance from Central Electricity Regulatory Commission (CERC) on fast track on how to deal with the interstate charges for P2P transactions. ISGF has prepared Model P2P Regulations for Intra-DISCOM transactions which will be modified for interstate transactions based on CERC inputs and published soon.

India is leading a silent revolution on digital energy grids and P2P energy transactions which the world can learn from India!

ISGF thank all our valued Technology Partners **FIDE, KrypC, PowerXchange, Kazam, PulseEnergy, VoltBrew, IntelliSmart, Accenture** and the Utilities **UPPCL, PVVNL, TPDDL, BRPL; and MOP, REC and FSR Global**.



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