17th Latin American Smart Grid Forum

04-05 August, Sao Paulo

Advanced Technologies Innovating Energy Business and Markets

Reji Kumar Pillai
President – India Smart Grid forum
Chairman – Global Smart Energy Federation

India Smart Grid Forum (ISGF)

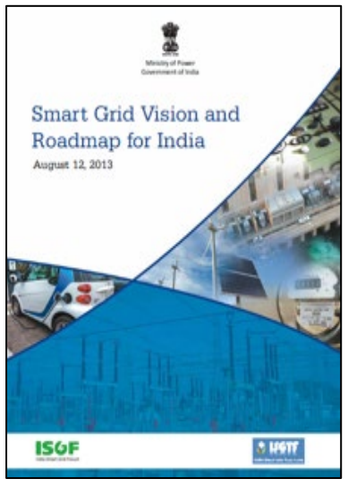
About India Smart Grid Forum (ISGF)

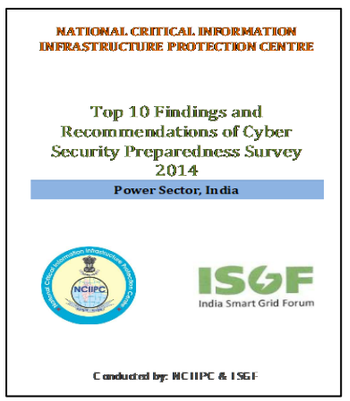
- ISGF, established as a Public Private Partnership (PPP) initiative of Government of India in 2011, is spearheading the mission to accelerate electric grid modernization, electric mobility and energy transition in India
- The India Smart Grid Forum (ISGF) has evolved as a Think-Tank of global repute on Smart Energy, Electric Mobility and Energy Transition
- 200+ members comprising of ministries, utilities, technology companies, academia and research
- **9 Working Groups:** Grid Modernization & Smart Cities; Smart Metering (AMISPs); IoT, AI & Analytics; Digital Architecture and Cyber Security; Policy, Regulations and Business Models; Renewables & Microgrids; Flexibility & Electric Mobility; Smart Gas; Smart Water
- ISGF has been driving the digitalization of utilities and is actively involved in standards development, technology demonstration pilots; training and capacity building and various advisory and research activities

More about ISGF: www.indiasmartgrid.org and more details in the Backup Slides

Key Contributions (1/2)

1. **Smart Grid Vision and Roadmap for India** - Issued by Ministry of Power in Aug 2013
2. **Framework for National Smart Grid Mission (NSGM)** and **Model Smart Grid Regulations** in **2015**
3. **M2M Communications Roadmap** and **Rollout of IPv6 for Power Sector**
4. **Approval for release of 7 MHz of license-free spectrum for M2M Communications** and **GoI approval for Private Wireless Networks under 5G for Captive Use**
5. **Cyber Security Preparedness Assessment of Electric Utilities** and **Manual on Cyber Security for Power Systems -** in collaboration with NCIIPC and VJTI
6. **Green Number Plates for Electric Vehicles -** ISGF White Paper 2014; and ISGF Study Report 2017
7. **Separate Electricity Tariff for Electric Vehicle Charging -** ISGF presentation to FOR in 2016
8. **Business Model for Smart Metering as a Service** proposed by ISGF in 2017 White Paper has been adopted by MoP and DISCOMs under RDSS program
9. **Right-Sizing of Electric Bus Battery** – ISGF Study Report on Electrification of Public Transportation in Kolkata argued for right sizing the batteries in buses according to route length in the city; and brought down the price of electric buses < Rs 1 crore in 2018
10. **Energy Storage Roadmap for India: 2019-2032 –** published by NITI Aayog, MOP and MNRE in 2029
11. **Electric 2-Wheelers and 3-Wheelers to be sold without batteries –** proposed by ISGF in the Study Report in 2017; GOI approved in 2021 which paved the way battery swapping stations





Key Contributions (2/2)

12. **New Buildings to be built with EV Charging Points in 20% of the Parking Space –** proposed by ISGF in White Paper in 2018; and approved by TCPO in 2019
13. **Electric Cooking** – ISGF White Paper in 2020; and BEE adopted Electric Cooking in the GO ELECTRIC program
14. **District Cooling Systems (DCS)** – ISGF White Paper in 2020; and BEE included DCS in the India Cooling Action Plan; prepared Technical Specs for DCS
15. **Replacement of Diesel Generators with Battery Energy Storage Systems (BESS)** – ISGF White Paper in 2020;adopted in MOP's ESS Framework in 2023
16. **Introduced several innovative technologies in the Indian Power Sector – including Blockchain Technology for Peer-to-Peer Trading of Rooftop Solar Energy**
17. **Solar Rooftop Registry prepared by ISGF is being adopted by CEA and integrate with PM Surya Ghar Portal 2.0**
18. **Successful Demonstration of Vehicle-to-Grid (V2G) Technology in India and Draft Regulations for V2G to CERC/FOR**
19. **Electrification of Agricultural Sector –** introduction of Electric Tractors in Maharashtra
20. **Smart Inverter Standards by BIS (IS 18968-2025)** and introduction of Smart Inverters for DER connection with grid
21. **Formation of All India DISCOMs Association (AIDA)** – www.aida-india.org
22. **BIS Standards for Smart Meters, EVSE, LVDC Grids; and adoption of many IEC and IEEE standards by BIS**
23. **IEC - IEEE World Smart Energy Coordination Workshop series**: 9 editions held
24. Bilateral Workshop Series with EU, USA, France, Germany, Brazil and Africa
25. Indian Delegations to several International Events - DistrubuTECH, Enlit Europe, CIGRE, CIRED, ACEF, Enlit Asia

Power Sector Scenario in India

Power Sector Scenario in India

- **Power System Overview: Third largest power system in the world** - installed capacity of **486 GW**, 300 million+ consumers – **1.36 GW in 1947 at the time of Independence – 374X growth in 78 years**
- **99.99% of the 1.4 billion population** is connected to the grid; generation capacity expected to double in next 7 years; and exceed **2100 GW by 2047**
- The country has met a record maximum power demand of **250 GW on 30th May 2024,** and thermal generation hit an all-time high of 176 GW
- GoI has also implemented the Pradhan Mantri Sahaj Bijli Har Ghar Yojana (SAUBHAGYA) which achieved universal household electrification – power connection to all households across the country. Under this scheme, with an investment of **US$ 2.5 billion, 27 million households were electrified in 17 months** – a World Record!. Now all **619,000 villages in India are electrified**
- India is pursuing an ambitious renewable energy (RE) program and at Glasgow in November 2021, India has committed an enhanced RE target of **500 GW by 2030 and Net Zero by 2070**
- **PM Surya Ghar Muft Bijlee Yojana: To install 10 million rooftop solar (RTS)** with an outlay of INR 75,021 crore – up to INR 78K subsidy for 3 kW RTS systems
- **250 Million Smart Meters:** The Revamped Distribution Sector Scheme (RDSS) was launched by Government of India in July, 2021 – innovative business model suggested by ISGF: Metering as a Service; orders placed for 180 million; 55 million installed
- **Time of Day Tariff for all customers from April 2025**: up to 20% rebate during high solar hours; and up to 20% surcharge during peak hours in towns where smart meters have been installed
- Per International Energy Agency (IEA) projections in 2023, Indian power system is set to grow **to 823 GW by 2030** and **1584 GW by 2040**. Out of 1584 GW, **869 GW is expected to be RE resources**
- According to a June 2025 report by **Omniscience Capital**, the total power demand in India is set to triple in next ten years – **1399 BU in 2023 to 4041 BU in 2035! The Per Capita power consumption is estimated to increase from 1400 kWh in 2023 to 2575 kWh by 2035**

Advanced Technologies Innovating Energy Business and Markets

New Technologies in the Power Sector

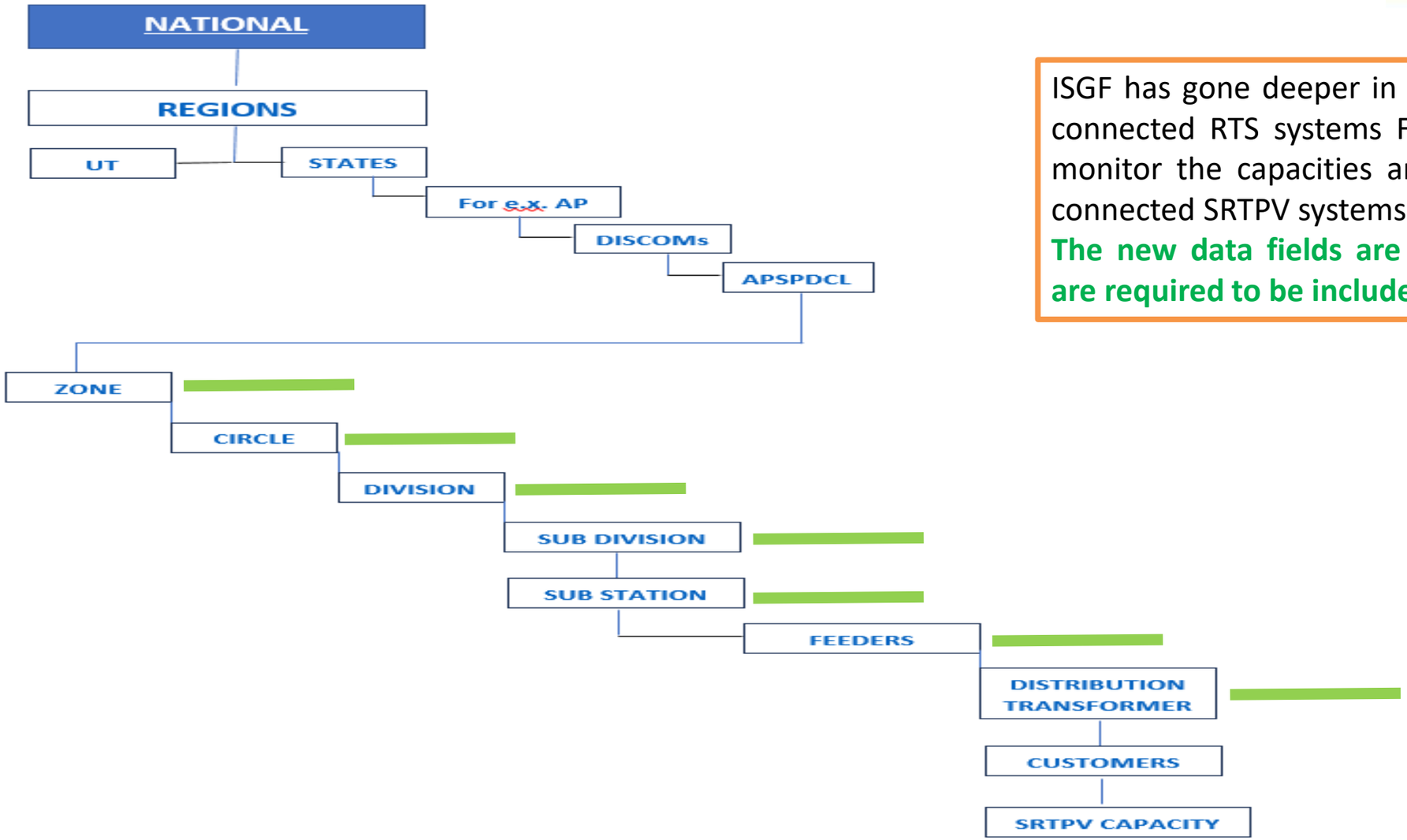
- **National Rooftop Solar Registry**
- **Vehicle to Grid Technology (V2G)**
- **Charging of EVs with Green Electricity**
- **Blockchain and Peer-to-Peer (P2P) Trading of Rooftop Solar Energy**
- **Unified Energy Interface (UEI) and Digital Energy Grids, the birth of energy internet – GO LIVE in August 2025 in Lucknow**
- **Distributed Digital Energy Grids with Digital Twin of Power Systems in Metaverse** – Digital IDs for all grid elements and interfacing stakeholders, detailed EMT models for the critical zones dominated by new age inverter based systems; and traditional phasor type models for the systems dominated by large generators; this will also incorporate the physical and atmospheric parameters – **Concepts ready; Demonstration project to commence in 2026**
- **Electrification of Farm Equipment** – ISGF Study Report 2025; Electric Tractor Deployment to start in Q4/2025
- **Grid Interactive Buildings and Campuses** – Demonstration project to commence in Q4/2025
- **School Bus Electrification** – Demonstration project to commence in Q1/2026
- Smart Inverters for DER – IEEE 1547: 2018 (IS 18968: 2025)
- Handbook of **Successful AI-ML-Robotics Applications and Roadmap for Adoption by Utilities – release September 2025**
- Handbook for Utilities for Efficient Management of Feeders with High Concentration of Rooftop Solar and Experiencing Reverse Power Flow – First Draft by June 2026
- Quantum Algorithms and Quantum Computing for Optimal Power Flow (OPF), Unit Commitment and Power Flow Rerouting in near real-time

National Rooftop Solar Registry

National Registry of Rooftop Solar (RTS)

The Hon'ble Minister of Power launched the National Registry of Rooftop Solar (RTS) systems developed by ISGF on 14th November 2024 at the Distribution Utility Meet (DUM2024) in Lucknow (www.dumindia.in)

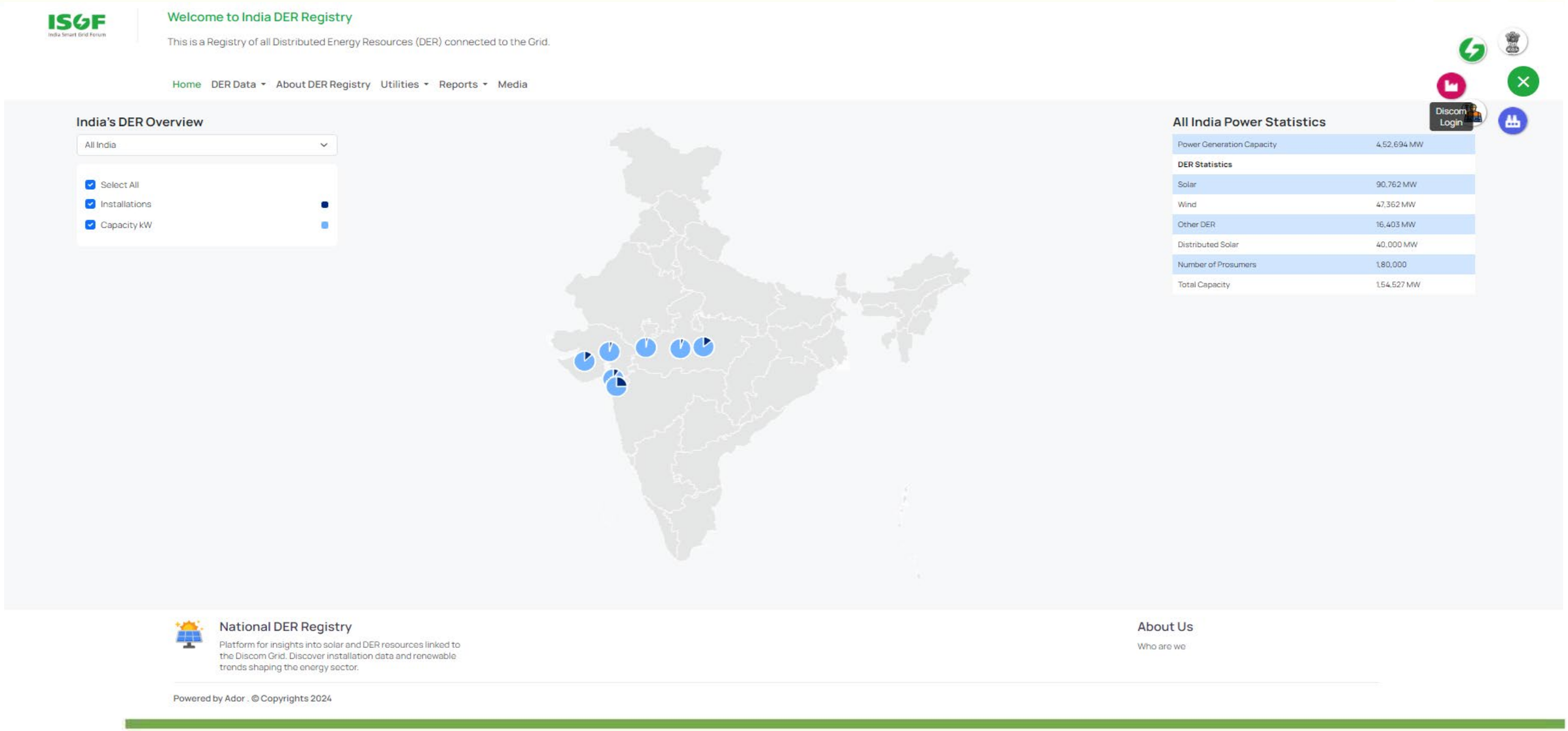
National RTS Registry – Architecture



ISGF has gone deeper in capturing the details of grid connected RTS systems Feeder-wise and DT–wise to monitor the capacities and performance of the grid connected SRTPV systems.

The new data fields are highlighted in green which are required to be included in the Registry.

National RTS Registry – Homepage: www.indiaderregistry.in



National RTS Registry - DISCOMs/Licensees List

ISGF India Smart Grid Forum

Welcome to India DER Registry

This is a Registry of all Distributed Energy Resources (DER) connected to the Grid.

Home | DER Data | About DER Registry | Utilities | Reports | Media

Discom Login

Contact Details of Discoms

Show 10 entries | Search:

Sr No	State	Discom Name	Contact	Discom Login
1	ANDAMAN and NICOBAR ISLANDS	Electricity Department, UT of Andaman & Nicobar	9436757589	Login
2	ANDHRA PRADESH	Andhra Pradesh Eastern Power Distribution Company Limited	9436757589	Login
3	ANDHRA PRADESH	Andhra Pradesh Southern Power Distribution Company Limited	9436757589	Login
4	ANDHRA PRADESH	Andhra Pradesh Central Power Distribution Company Limited	9436757589	Login
5	ARUNACHAL PRADESH	Department of Power Arunachal Pradesh	9436757589	Login
6	ASSAM	Assam Power Distribution Company Limited	9436757589	Login
7	BIHAR	North Bihar Power Distribution Company Limited	9436757589	Login
8	BIHAR	South Bihar Power Distribution Company Limited	9436757589	Login
9	CHANDIGARH	Chandigarh Electricity Department	9436757589	Login
10	CHHATTISGARH	Chhattisgarh State Power Distribution Company Limited	9436757589	Login

Showing 1 to 10 of 75 entries

Previous 1 2 3 4 5 ... 8 Next

National RTS Registry - DISCOM Login Page

ISGF India Smart Grid Forum

Welcome to India DER Registry

This is a Registry of all Distributed Energy Resources (DER) connected to the Grid.

Home About Contact

About the Solar Register

Solar Register FAQs

Discom Login

Username

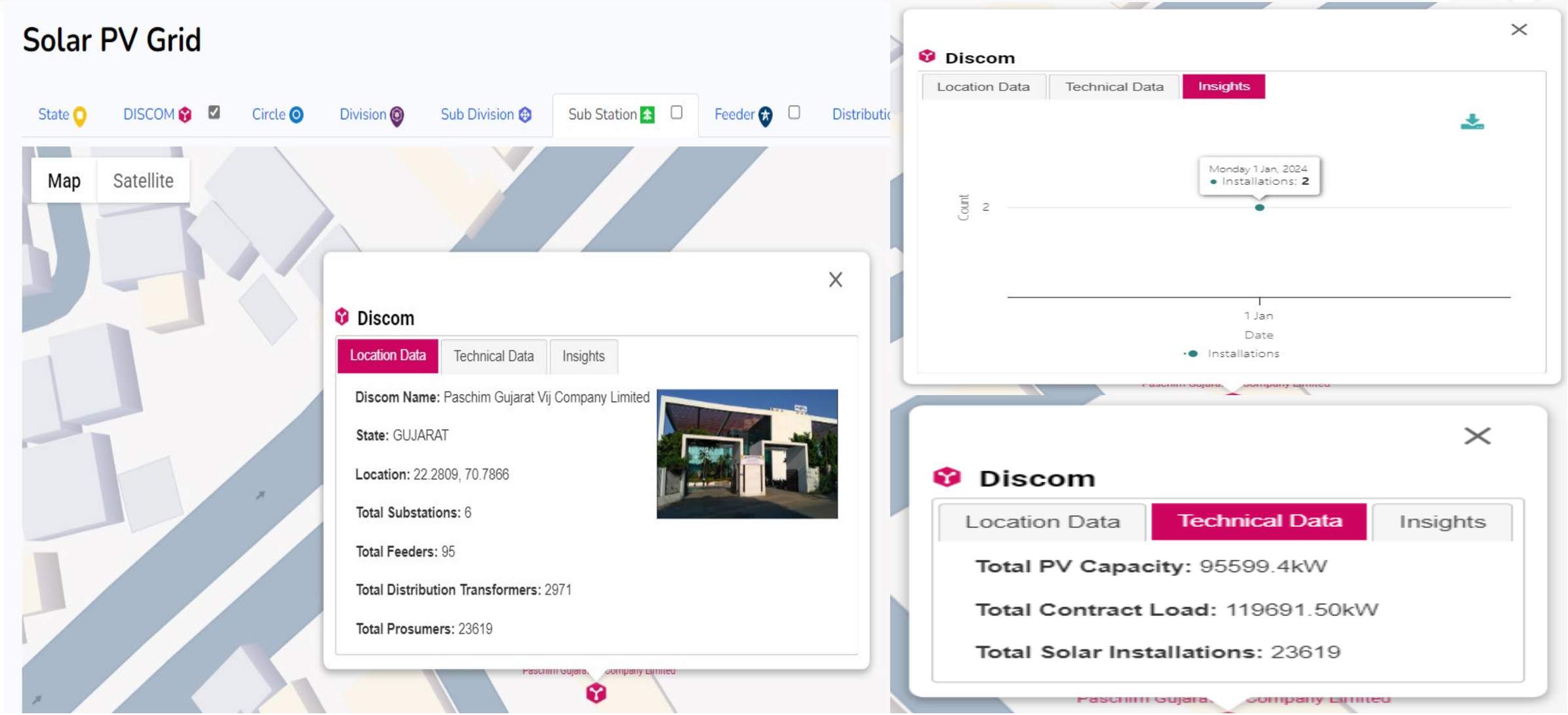
PGVCL

Password

Login

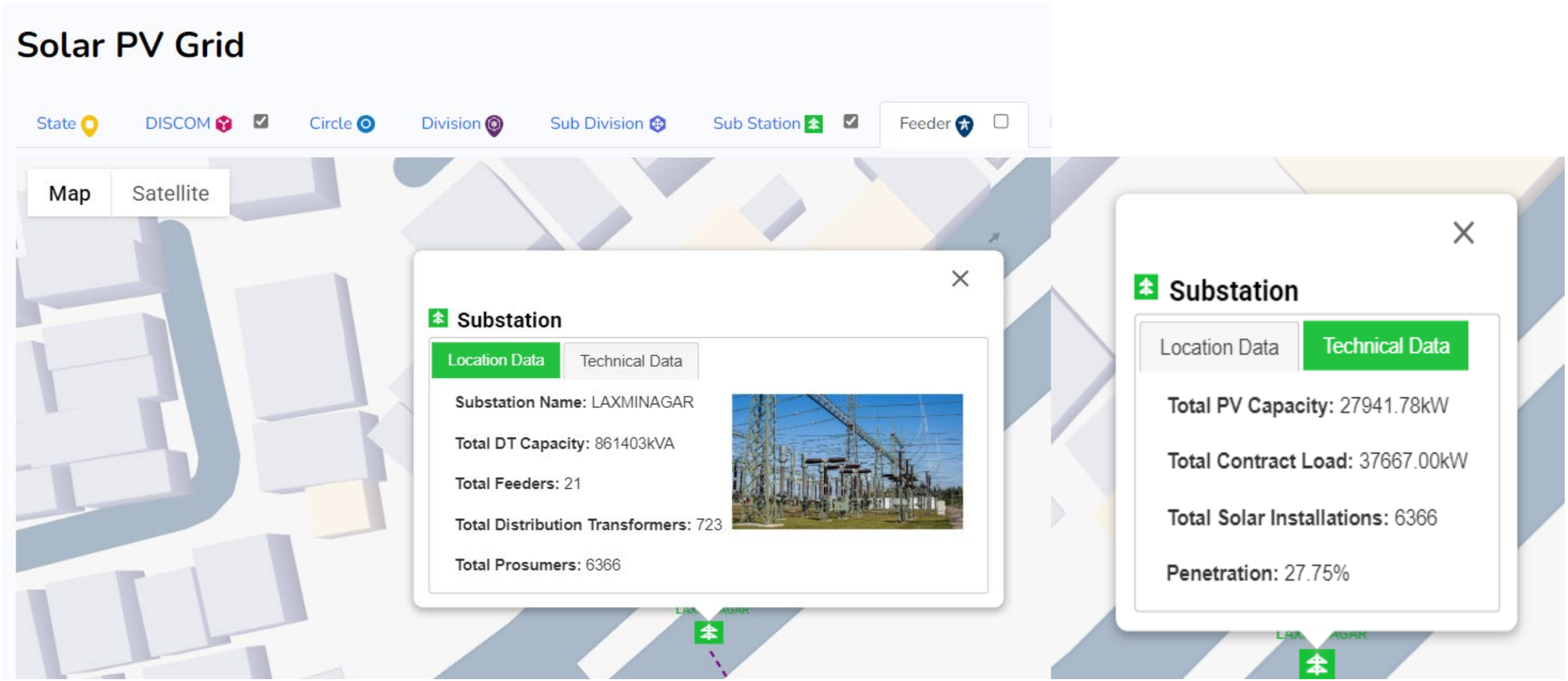
Don't have an account? Sign up

National RTS Registry – DISCOM-wise Data

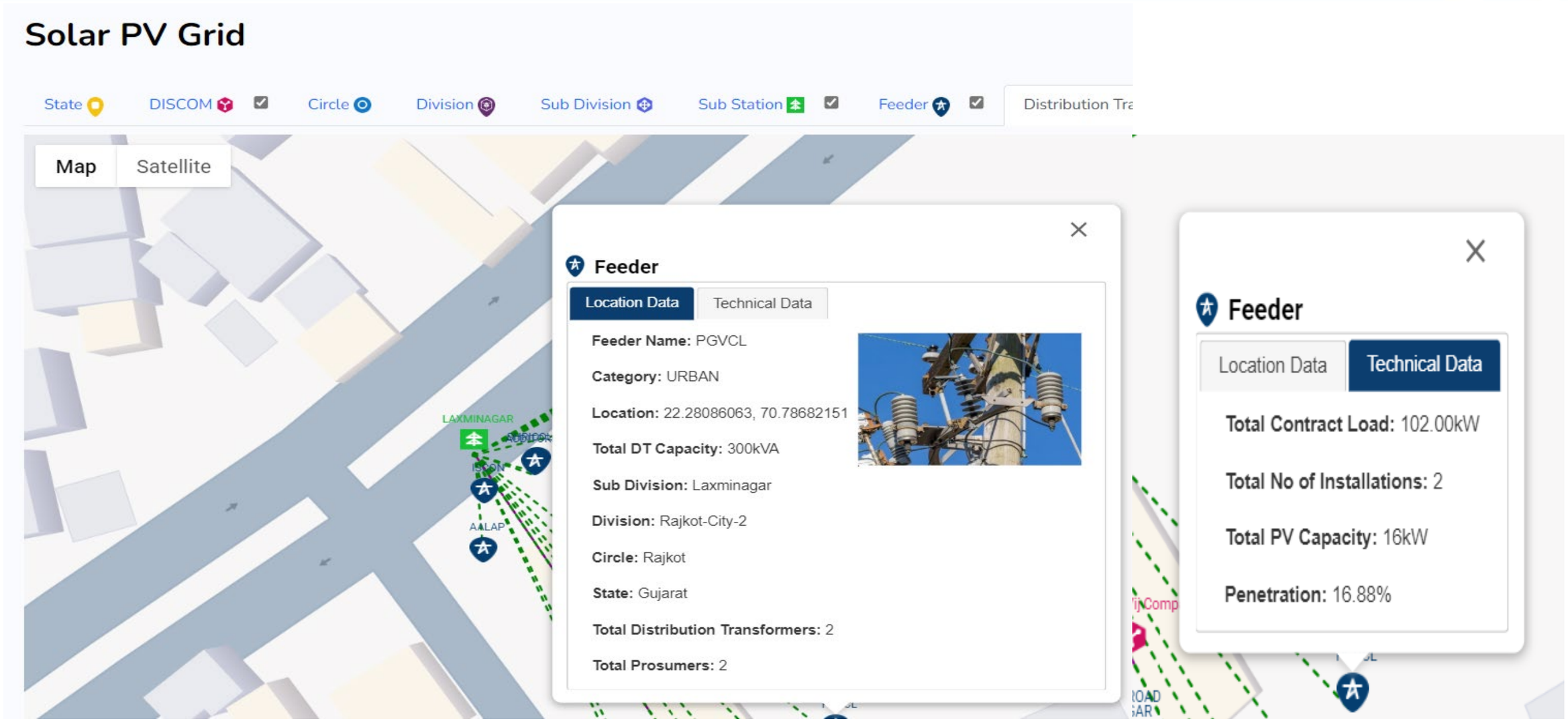


National RTS Registry – DISCOM-wise Map

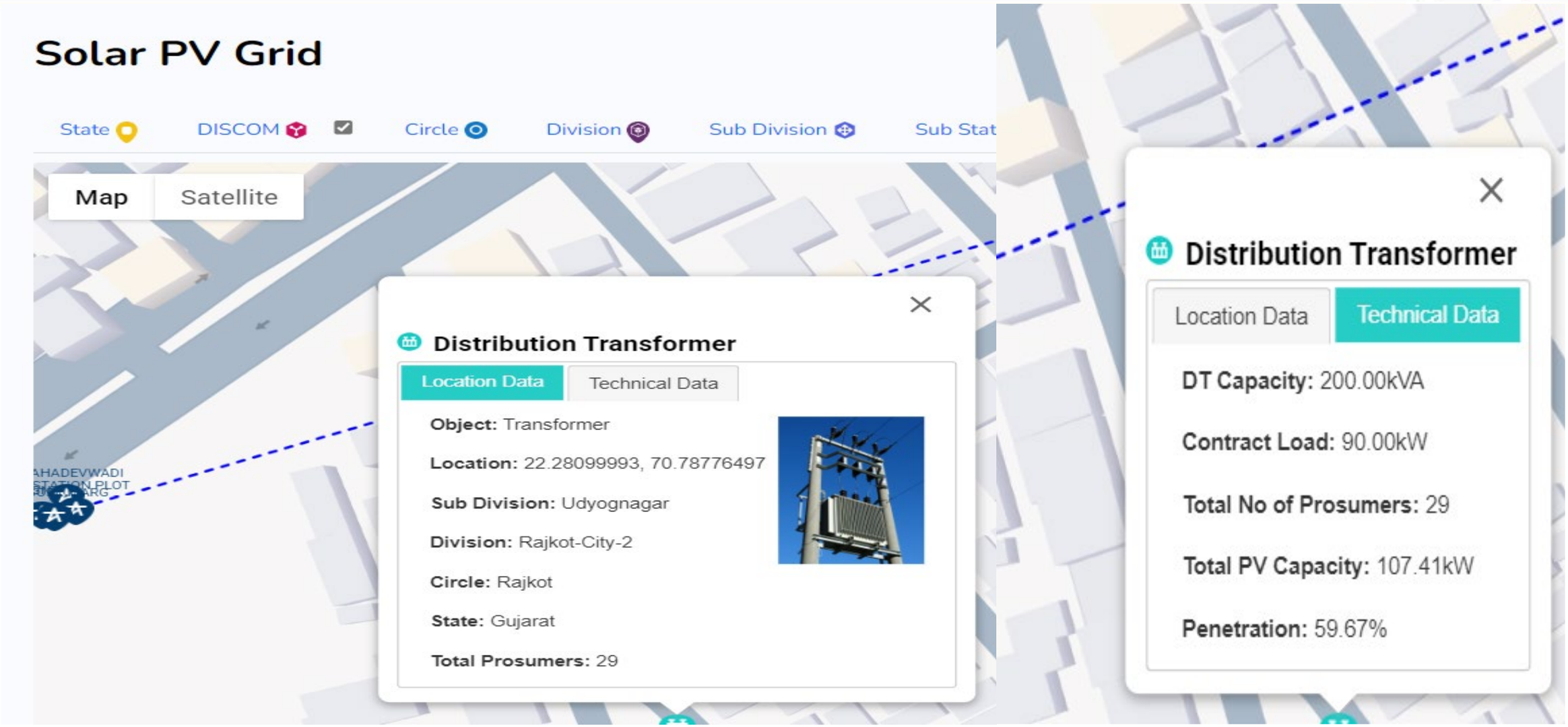
National RTS Registry – Substation-wise Details



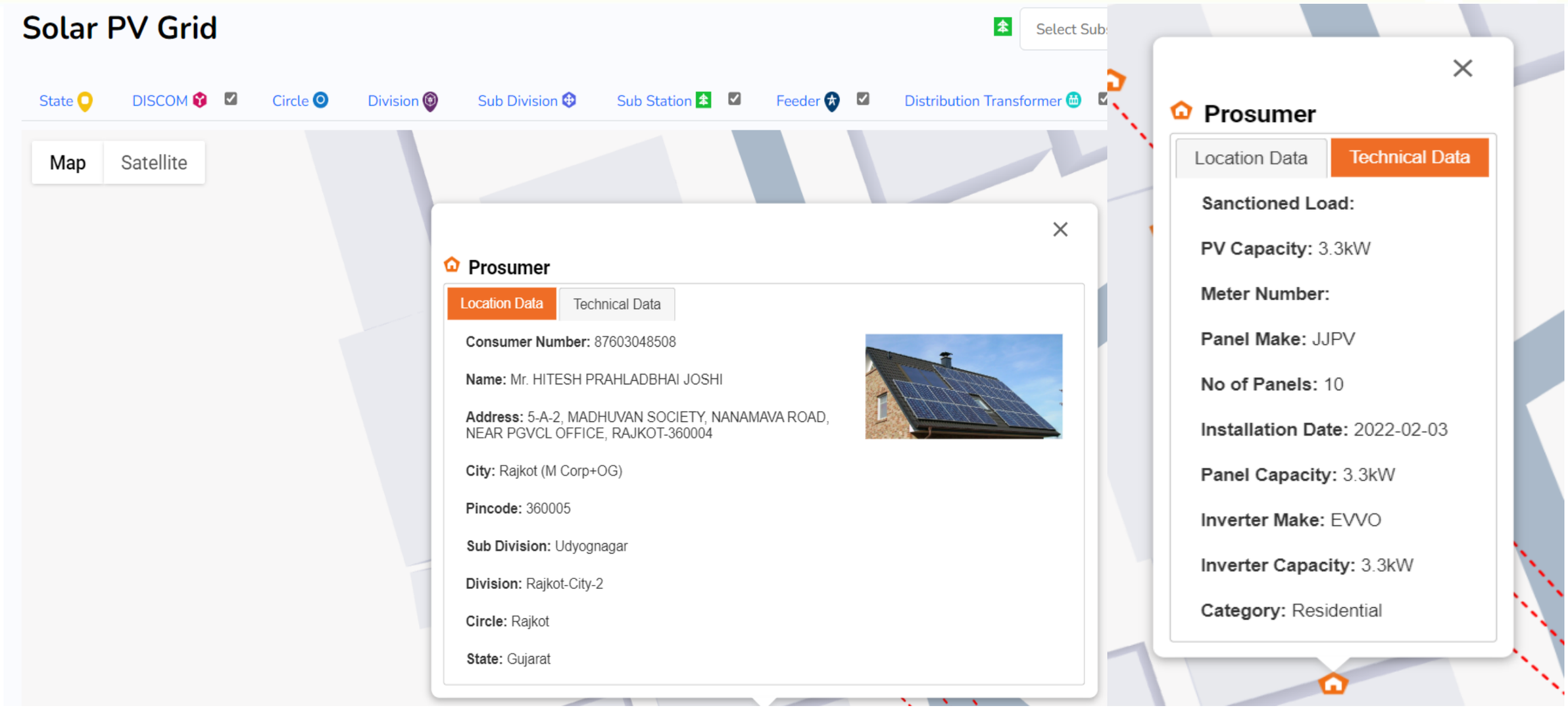
National RTS Registry – Feeder-wise Details



National RTS Registry – DT-wise Details

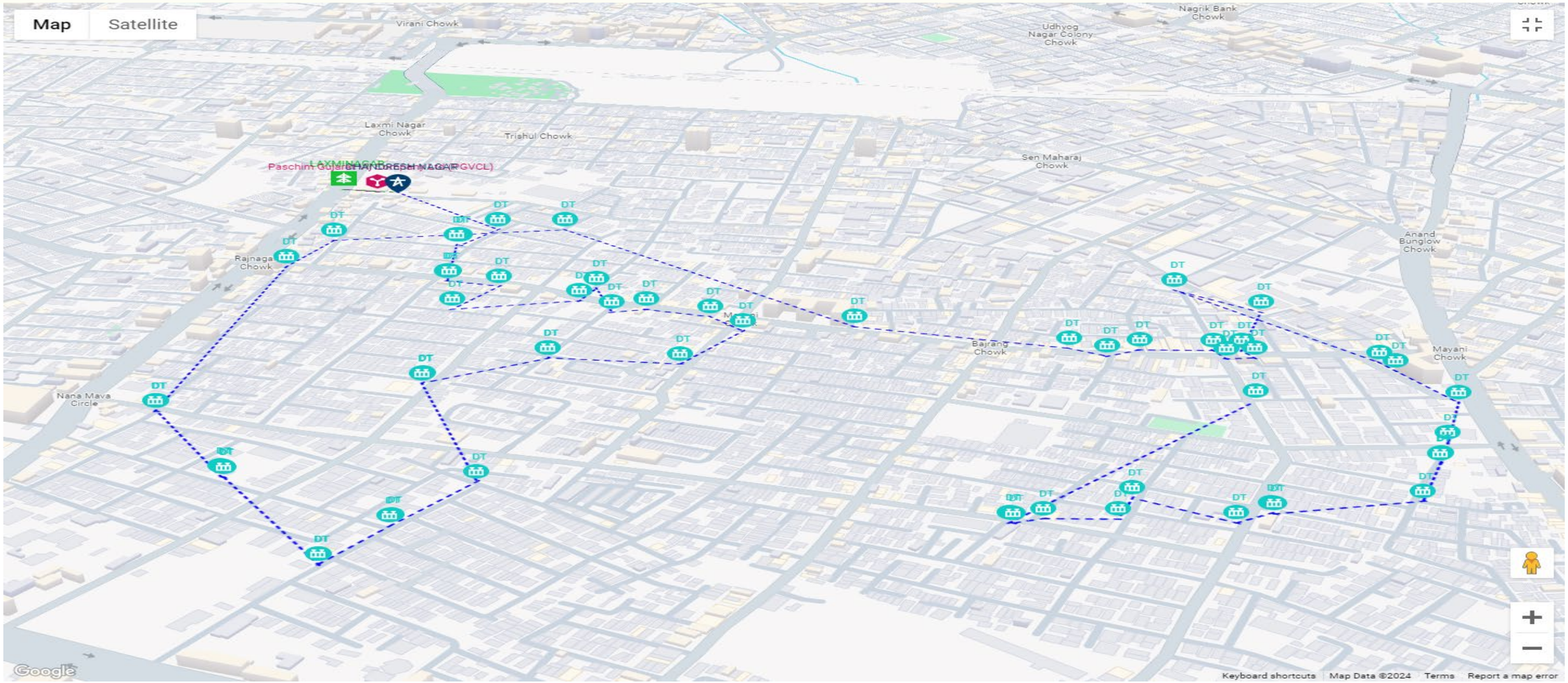


National RTS Registry – Prosumer-wise Details



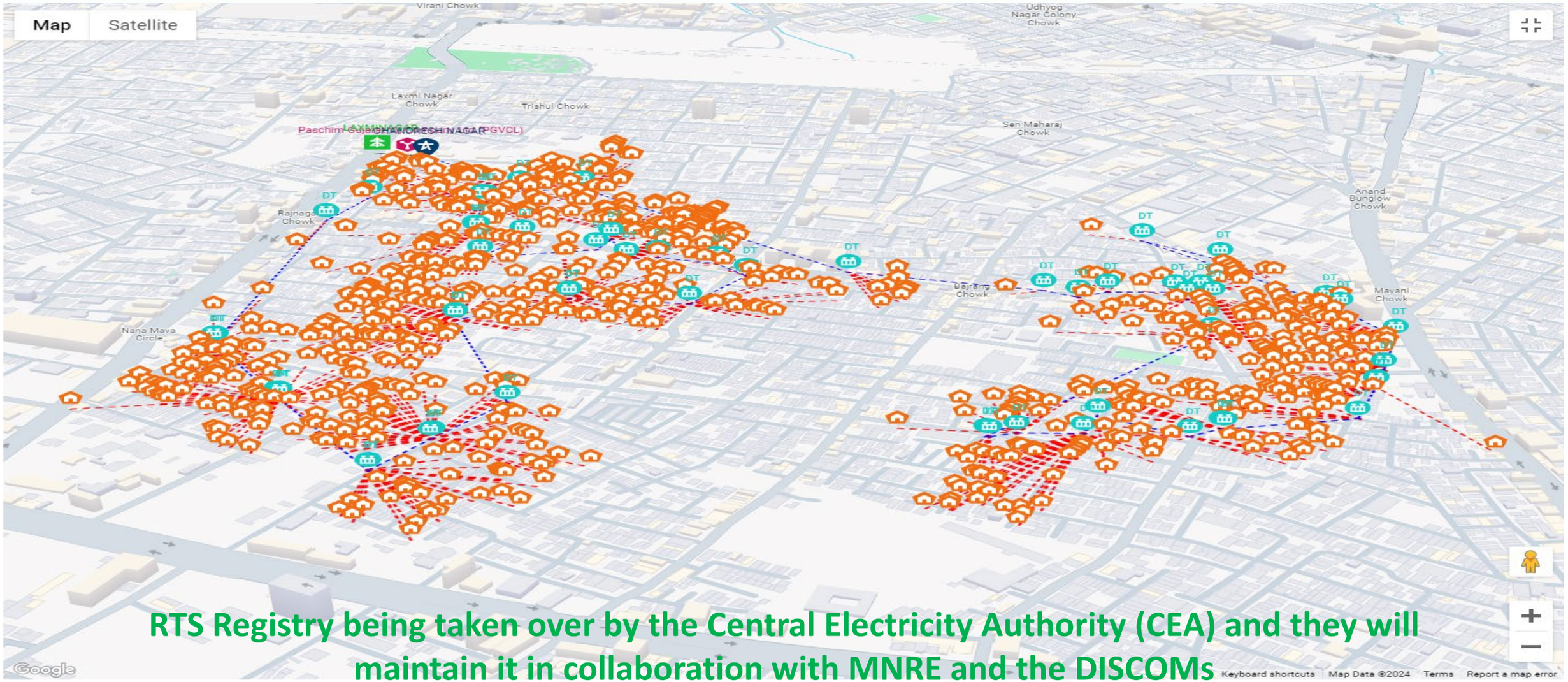
National RTS Registry - Dashboard Overview

Mapping Substation to Feeder to Distribution Transformer



National RTS Registry - Dashboard Overview

Mapping Substation to Feeder to Distribution Transformer to Prosumer



RTS Registry being taken over by the Central Electricity Authority (CEA) and they will maintain it in collaboration with MNRE and the DISCOMs

Vehicle-to-Grid (V2G) Demonstration

V2G Pilot Demonstration (AC V2G)

- India Smart Grid Forum (ISGF) has undertaken a groundbreaking pilot project to demonstrate Vehicle to Grid (V2G) technology and charging of EVs with green electricity in India

The key objectives of V2G Technology:

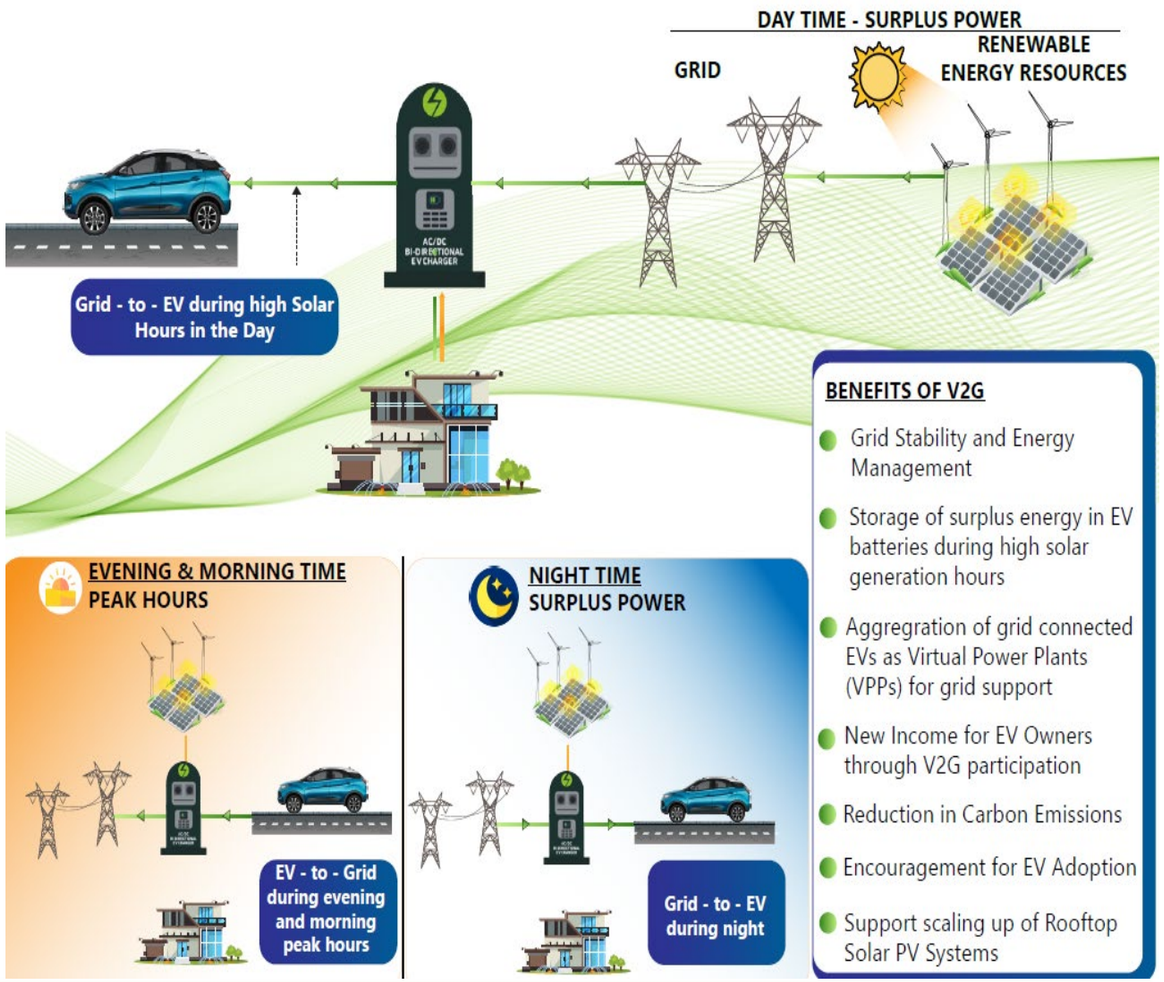
- Promotion of Renewable Energy (RE)
- Grid Balancing
- Reduction in Peak Power Purchase Cost
- Additional Income for the EV Owners
- RE Integration and Virtual Power Plants (VPP)

Scope of Project:

The demonstration project had **2 distinct components:**

Component 1: Demonstration of V2G Technology and Test the Functionalities

Component 2: Charging of EVs with Green Electricity



Component 1: Demonstration of V2G Technology

Technology Partners:

- University of Delaware (UDEL) – Technology Support
- Nuvve Holding Corp – Bi directional Charger
- Watt & Well - BMPU

Project Partners and V2G Demonstration Sites:

- BSES Rajdhani Power Limited (BRPL), Delhi
- BSES Yamuna Power Limited (BYPL), Delhi
- Tata Power Delhi Distribution Limited (TPDDL), Delhi
- Agency for New and Renewable Energy Research and Technology (ANERT), Trivandrum, Kearala

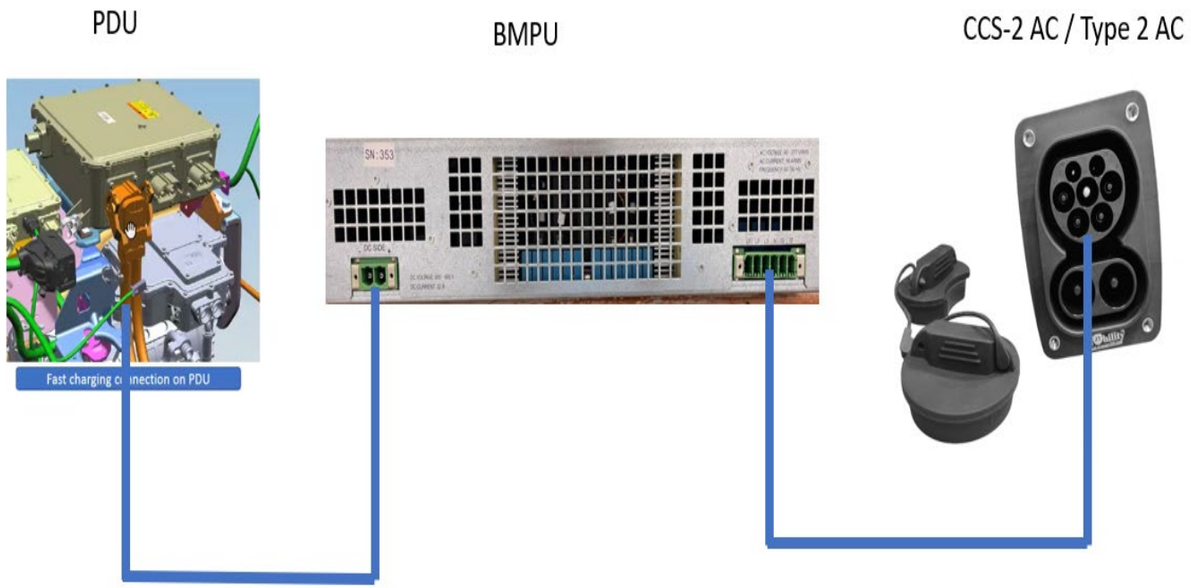
Project Observers:

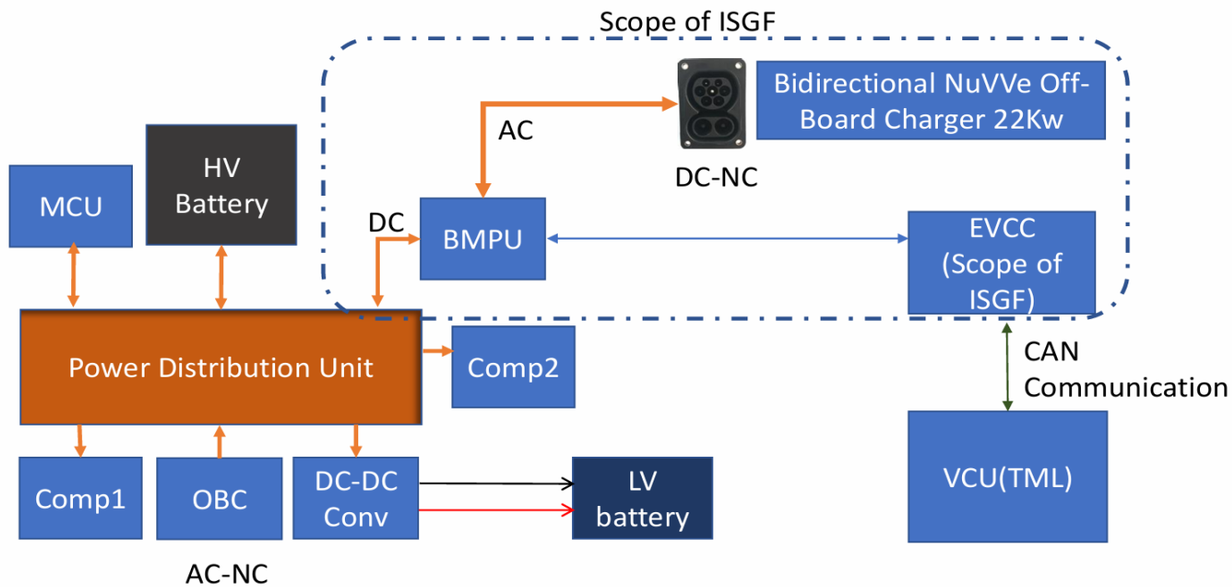
- Central Electricity Authority
- Tata Motors Limited and Tata EV

Project Description:

- ISGF with technical support from the University of Delaware (UDEL), USA has executed the first of its kind pilot demonstration of V2G technology in South Asia
- ISGF has retrofitted **4 Tata Nexon EVs with on-board bi-directional power modules**. Most V2G demonstrations in the world have used DC V2G.
- This project tested AC V2G, which should dramatically reduce equipment cost. The **11kW Bidirectional Modular Power Unit (BMPU)** installed in the Tata Nexon were procured from Watt&Well, USA and the **AC bidirectional chargers (19 ~ 52 kW)** were procured from Nuvve Holding Corp, USA.

Retrofitting Architecture





Pilot Projects Demonstration Sites

The V2G demonstration pilot project was conducted at following sites:

1. BRPL Corporate Office, New Delhi
2. BYPL, BSES Bhawan, Nehru Place, New Delhi
3. Smart Grid Lab, Tata Power Delhi Distribution Limited, Delhi
4. Agency for New and Renewable Energy Research and Technology (ANERT), Trivandrum, Kerala

BRPL

TPDDL

BYPL

ANERT

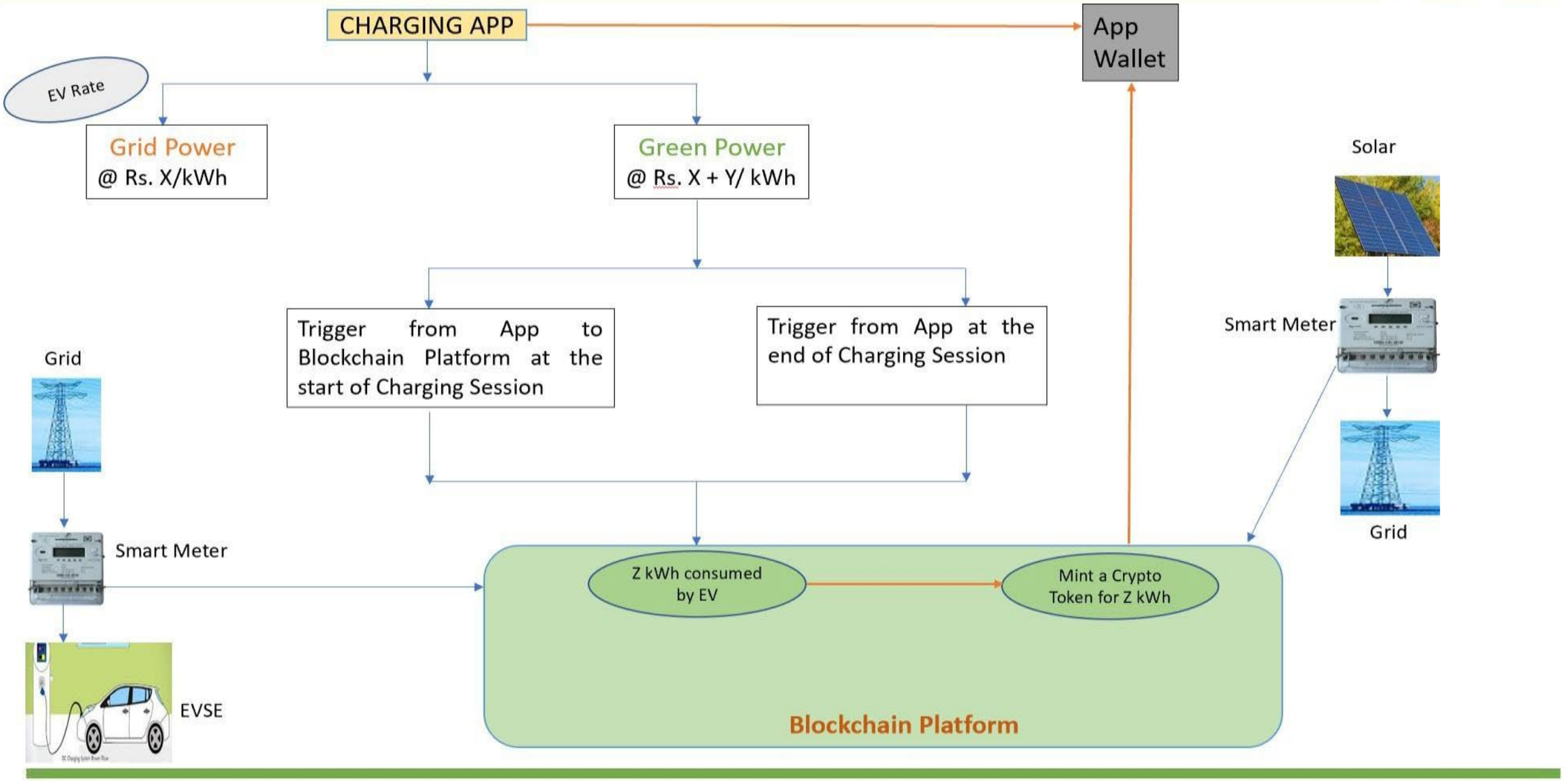
Component 2: Charging of EVs with Green Electricity

- ISGF with technical support from **KrypC Technologies Pvt Ltd, EarthtronEV, Kimbal Smart Metering and ElectreeFi** successfully tested charging of EVs with green electricity in Delhi and issued a Green Energy Certificates on blockchain platform. This demonstration aims to scale up RE adoption and promote clean transportation through EVs powered by RE.

Key Steps:

- Collaborated with a Charge Point Operator (CPO) and identified a suitable Public Charging Station (PCS)
- Identified a 100 kW rooftop solar plant in a school in West Delhi and connected to BRPL electricity network
- Installed smart meter at this solar plant and integrated with blockchain
- Modified ElectreeFi's EV charging application software to incorporate option to charge EV with green energy
- Integrated the PCS through ElectreeFi EV charging application with the blockchain platform
- Enabled green energy certificate minted on KrypC's blockchain platform, when an EV driver opts for green electricity to charge the EV
- Green Certificates issued to the EVs can be aggregated, used against emission reduction targets or traded on carbon markets

Framework and Solutions for EV Charging with Green Electricity



Green Energy Certificate

Economic Benefits of V2G for Electricity Grid and Consumers

- Flexibility in Power System Operations
- Peak Shaving and Grid Balancing
- Frequency Control (Primary, Secondary and Tertiary Reserve)
- Support RE integration, particularly Rooftop Solar (RTS) – Variations in RTS generation can be smoothened by the EV battery connected to the grid.
- Other Ancillary Services (e.g., Voltage management, Emergency Power during Outages)
- Local Congestion and Capacity Management
- Increasing the Rate of Renewable Energy Self-consumption
- Optimization and Back-up Power and Reducing Grid Infrastructure Investment
- V2G may provide power back to the grid or to specific buildings, such as emergency shelters, hospitals, other critical facilities, or an entire neighborhood during power outages in areas prone due to extreme weather events, such as cyclones, floods etc.
- Potential Revenue Generation from providing grid services like frequency regulation or backup power
- Energy Security - In the event of power outages, V2G-enabled EVs can provide backup power to homes and businesses, enhancing energy security and resilience
- Bring down total cost of ownership of EVs

Unified Energy Interface (UEI)

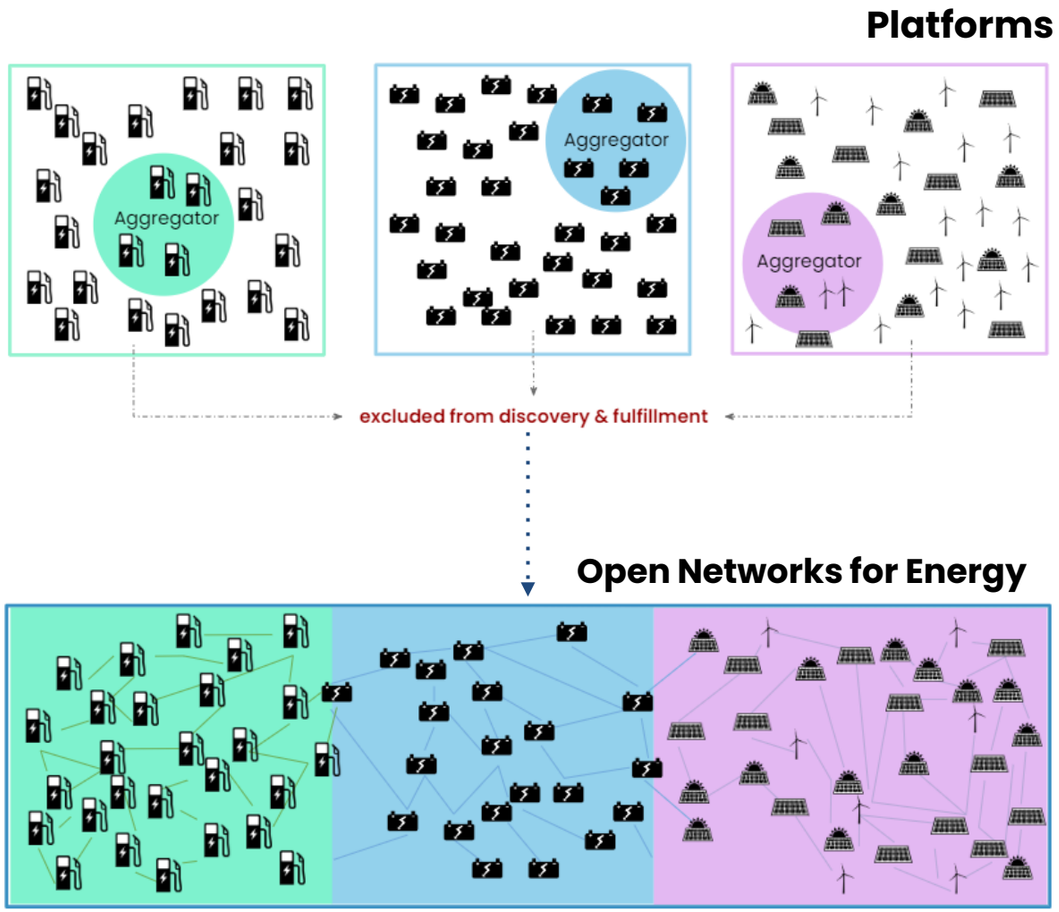
UEI – a shift from Platforms (Aggregators) to Protocols

UNIFIED ENERGY INTERFACE

Unified Energy Interface (UEI) is an **open network for energy** to enable transactions between digital energy systems

Solves for

Discovery
Ordering
Fulfilment
Post-Fulfilment



Market Expansion | Autonomy at Nodes | Asynchronous & Combinatorial innovation

Beckn Protocol

An economic resource discovery and transaction protocol

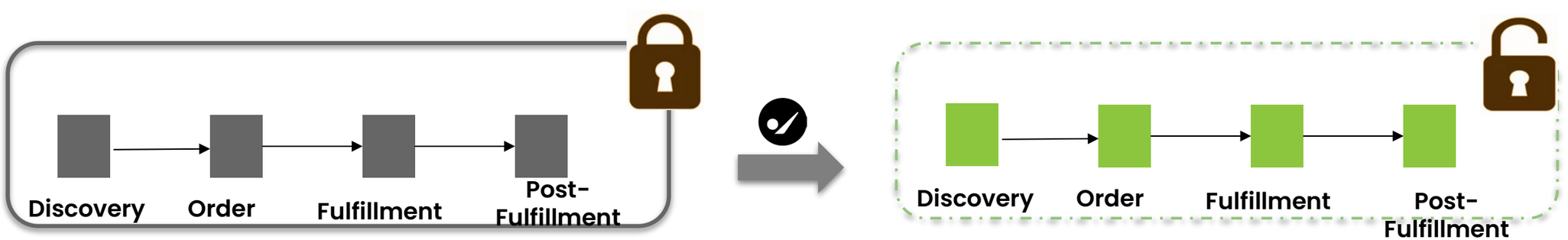
www.fide.org

- ./ Mobility service
- ./ Energy
- ./ Agri producers
- ./ Circular goods & service
- ./ Financial instruments
- ./ Skill ..

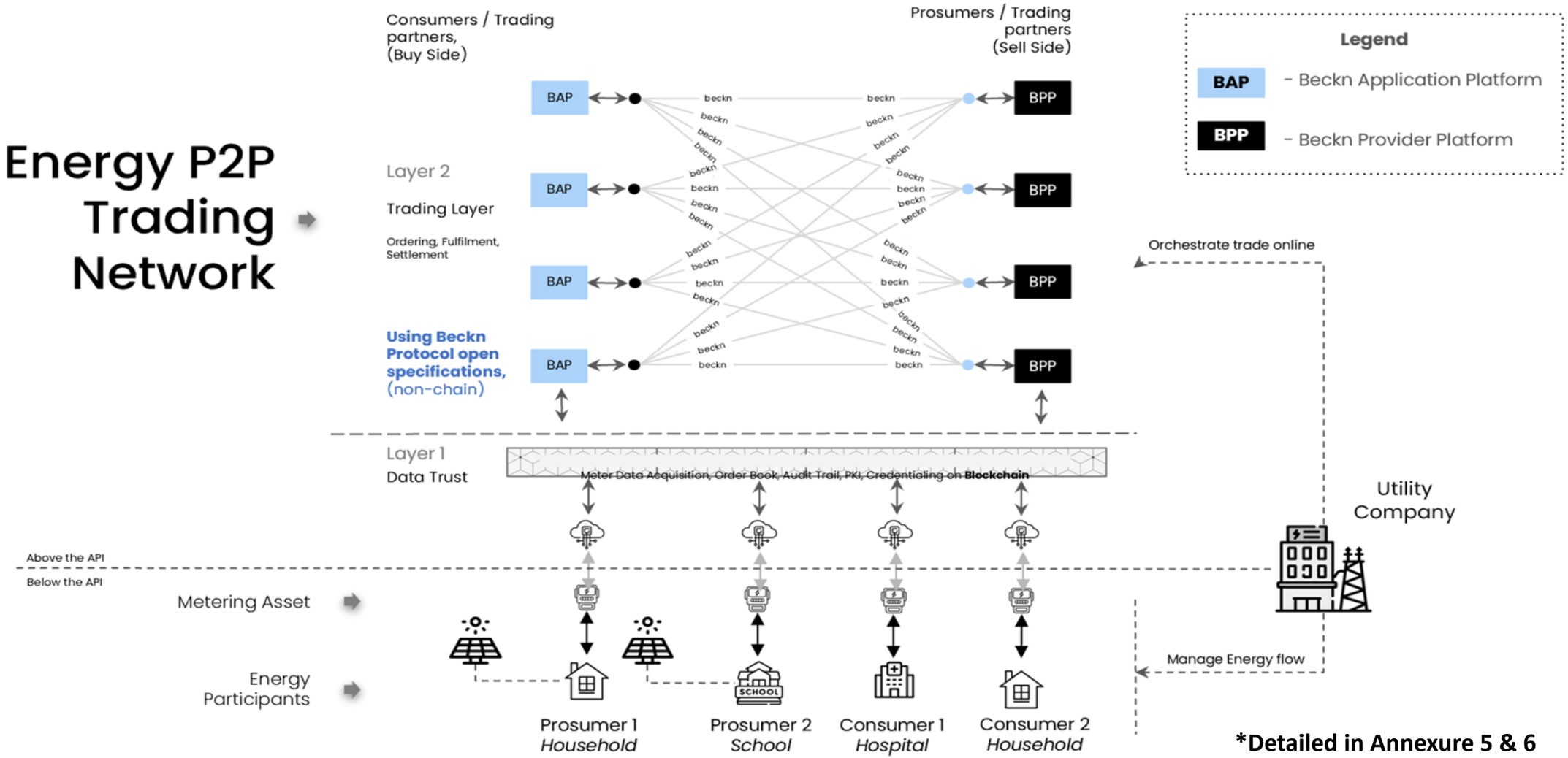
- ./ Ordering
- ./ Booking
- ./ Blocking
- ./ Sourcing...

- ./ Decentralised, P2P
- ./ Generic but exhaustive
- ./ Layered
- ./ Transactions as micro-contracts...

Open Source Specifications | **Tech & AI Neutral** | **Open Community**

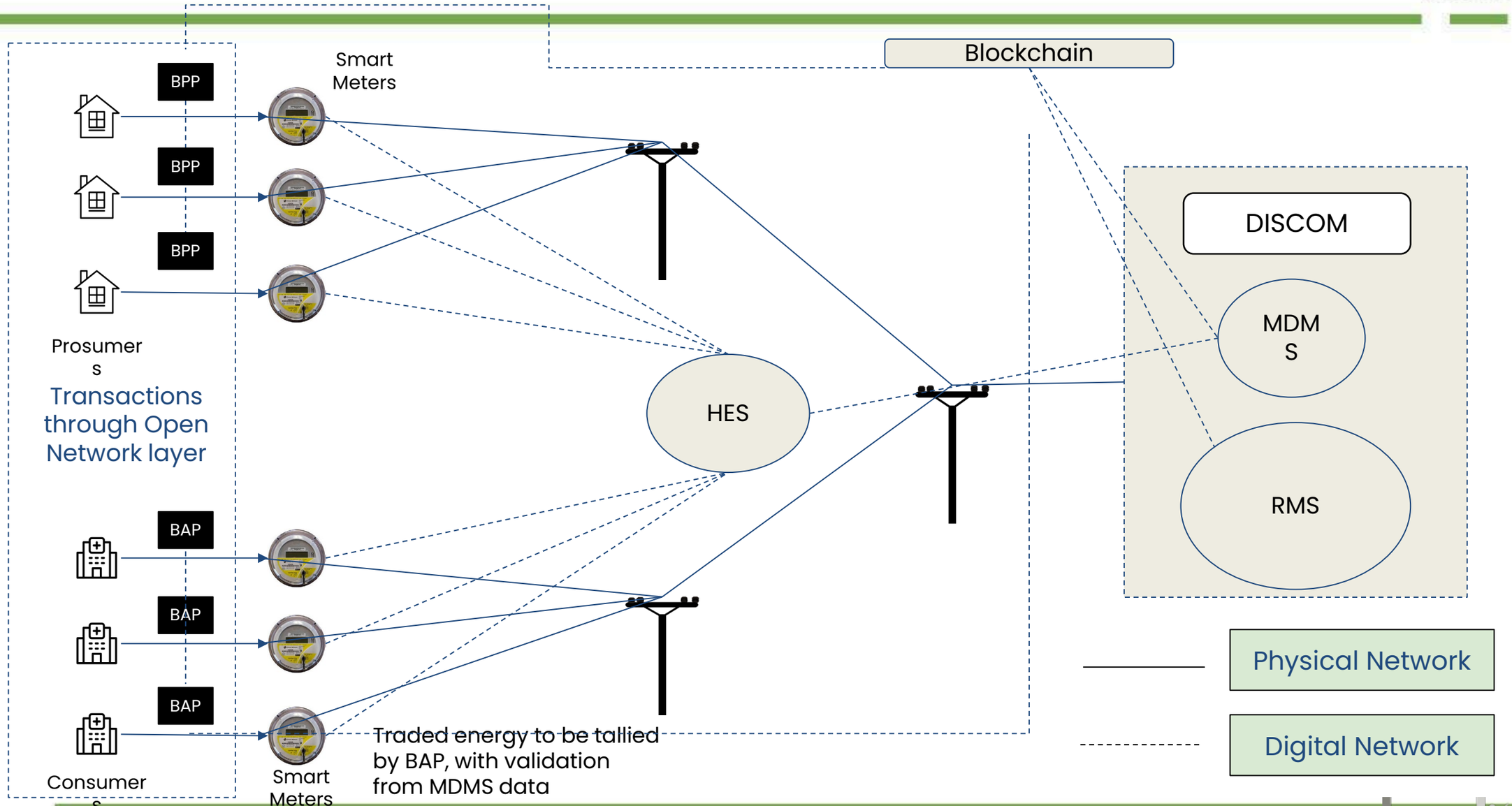


P2P Network on UEI Architecture (1/2)

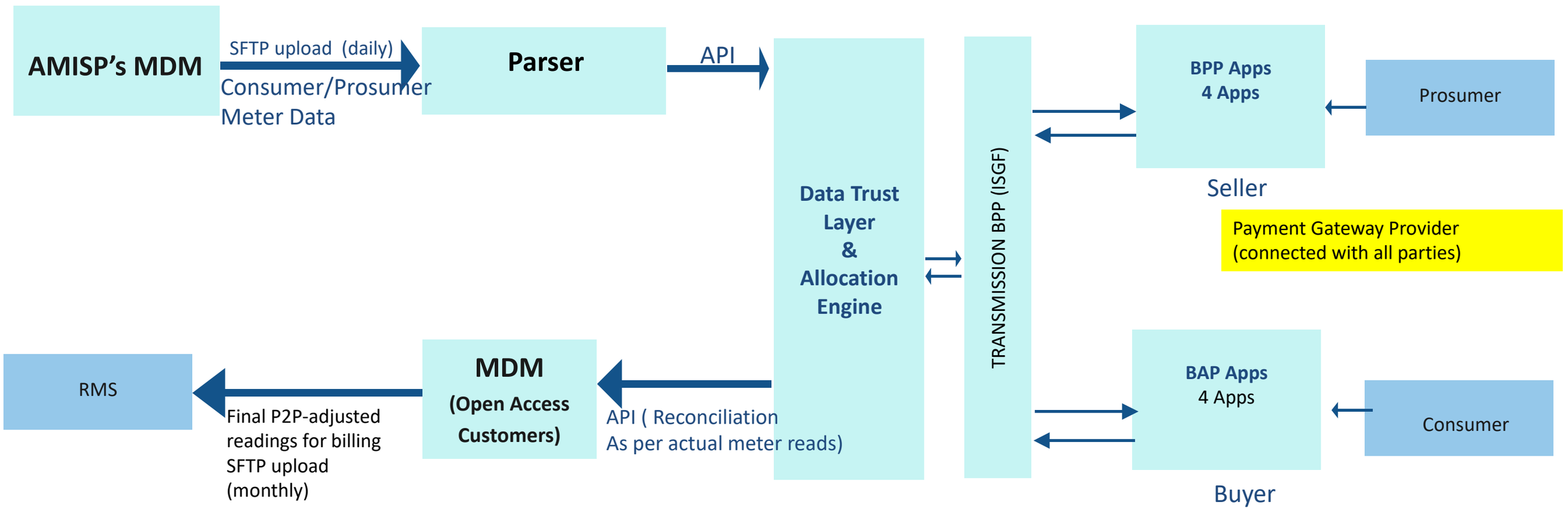


*Detailed in Annexure 5 & 6

P2P Network on UEI Architecture (2/2)



UEI System Architecture of UPPCL Demonstration Project



14 different systems interconnected and exchanging data successfully

P2P PROCESS

P2P User Onboarding

Postpaid consumers and prosumers fill out a registration form provided by ISGF or its partners. ISGF compiles and submits the participant list to UPPCL/DISCOM for verification. Verified participants are added to a Master List, flagged in the MDM and RMS systems, and linked to digital wallets for future transactions.

Step 01

Day-Ahead Contracting

Each day, prosumers submit their sell offers (units and price) and consumers place their bids through the BPP/BAP apps. The platform facilitates one round of negotiations, matches offers, verifies wallet balances, and generates digitally signed contracts. These contracts are recorded securely on the blockchain.

Step 02

Metering & Data Transfer

On the trading day, energy is delivered through the local grid. Smart meters record the actual energy exchanged. Meter readings are transferred from AMISP's MDM to blockchain layer, then to Inventive Software's MDM, which sends P2P-adjusted readings to RMS for billing purposes.

Step 03

Billing and Settlement

Digital wallets are debited and credited based on energy traded, wheeling charges (₹0.92/kWh), platform fees (₹0.21/kWh each), and deviation settlement charges. RMS uses the adjusted readings to prepare monthly bills for consumers and prosumers after accounting for P2P trades.

Step 04

Final Integration & Monthly Closure

By the end of each month, ISGF shares the final export and import data with Inventive via SFTP. Inventive integrates this into billing systems, ensuring P2P transactions are reflected accurately. From June 2025, the entire billing process for P2P participants will be automated.

Step 05

Contact Us

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