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India Smart Grid Forum

DISTRIBUTION UTILITY MEET DUM 2023

Session 7 : Rise of the “Prosumer” and Prosumer Engagement Strategies for Net Zero Power Systems

Topic: P2P Transactions of Green Energy & Local Energy Markets

Presented By

Anand Menon, Director of Digital Grids Projects, Powerledger





Decentralised Energy Markets - Four Pillars

Customers as Market Participant

- Provides a highly agile distributed market and is one of the biggest business drivers
- Helps address the economic inequities of net metering

Robust Business Model

- Subscribers can switch to P2P voluntarily and increase their revenue stream.
- DISCOMs can collect transaction fees on the traded energy volume and meet RPO to avoid penalties.

Enhancing Grid Stability

- Supply-demand balance at the local feeder level reduces grid congestion, improves power quality.
- Reduced cross-country energy transfer improves grid stability. BESS addresses supply and demand imbalances locally.

Trust and Transaparency

- High volume transactions need efficient record-keeping and transaction management.
- Blockchain technology with smart contracts provide tamper-proof, transparent, and auditable records

Learnings from successful Pilots

Following the successful demonstration of the T77 project in Bangkok, Thailand where 700kW of RTS was traded across six commercial, educational and residential sites, several pilots were conducted in Indian states, with key learnings as below:

a) Incentivise uptake of RTS through a P2P price that benefits both prosumers and consumers @ in UPPCL, Rs 5.6/kWh as against a retail rate between 7-8.5 / kWh and NM of Rs 2/kWh

b) Utilities can fulfil their RPO targets and customers can reduce quantum of power procured through open access through trading P2P

c) Potential investment deferral for network expansion through increased self-sufficiency

d) Opportunity for DISCOMs to increase revenue through transaction charges on every traded unit of energy instead of subsidised energy charges in NM

Key Takeaway: P2P trading offers a robust alternative to current tariff structures to promote RTS.

Why would a Power Utility want to promote Rooftop Solar and do a LEM?

Current scenario and observations:

1. Centralised VRE expansion leads to a high FCOE resulting in expensive electricity

2. Present Tariff structures and CFA subsidies are not able to accelerate growth of DERs

3. Global simulation studies show a substantial reduction in grid exports and imports of nearly 25%, with different combinations of residential and community battery

Response

Utilities could reduce the potential need for politically toxic solar curtailment and promote deployment of DER and expand DOE by setting up a Local Energy Market (LEM) to:

1. Defer CapEx for grid augmentation
2. Offer a comprehensive lower cost Market-Grid solution encompassing grid DOE calculations with LEM.
3. Pursue a tariff re-structuring model. Regulators are open to this.
4. Create positive involvement between PV enthusiasts and the Utilities.

Successful pilots have already led to the UPERC issuing Guidelines to include P2P trading and Delhi to amend the NM tariff structure.

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THANK YOU

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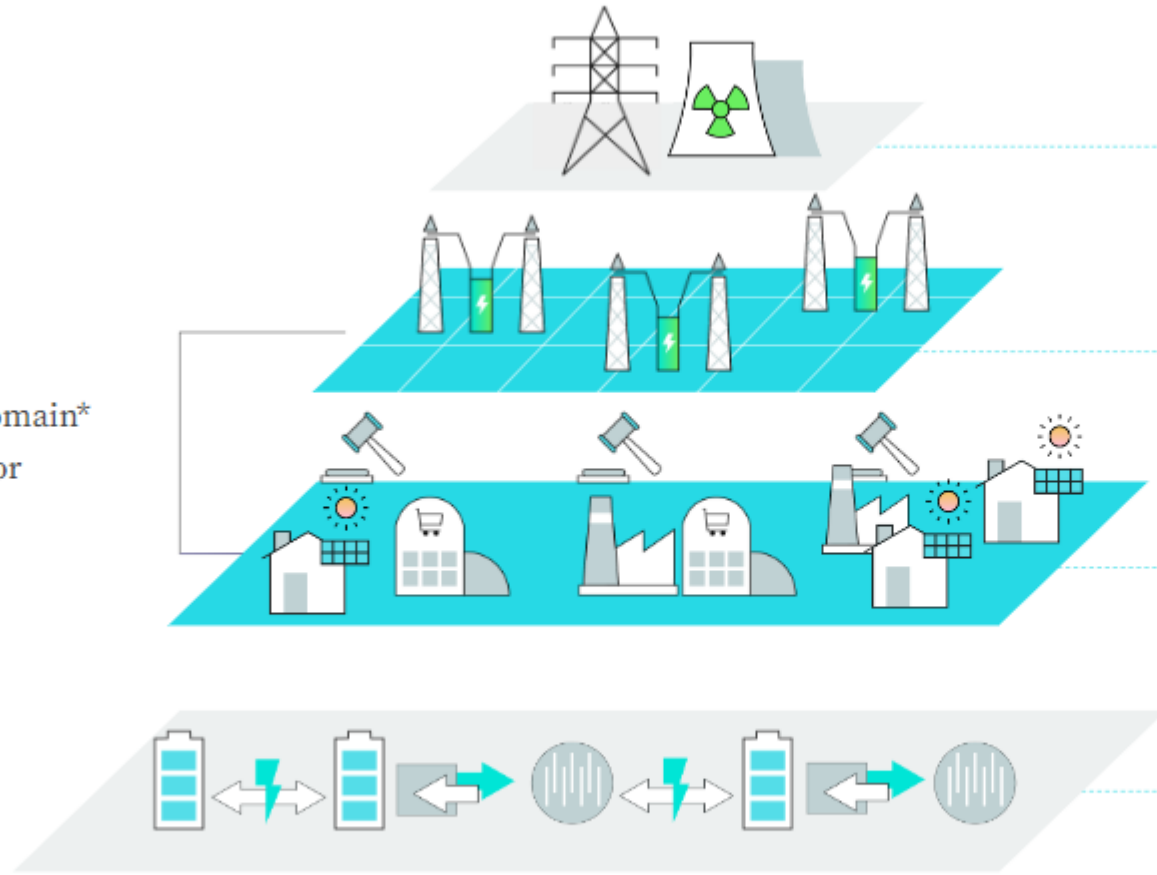
Links/References (If any)





How the new paradigm looks: Two additional market layers
Increased Layer 2 reduces the flex requirement in Layer 3



Distribution utility Domain*

Dynamic market for every transaction

Layer 4

Wholesale market/TNSP

Layer 3

Utility flexibility services

On demand market

Layer 2

P2P Local Energy Market (MODE LEM, xGrid)

Transactions are reported to layer 4

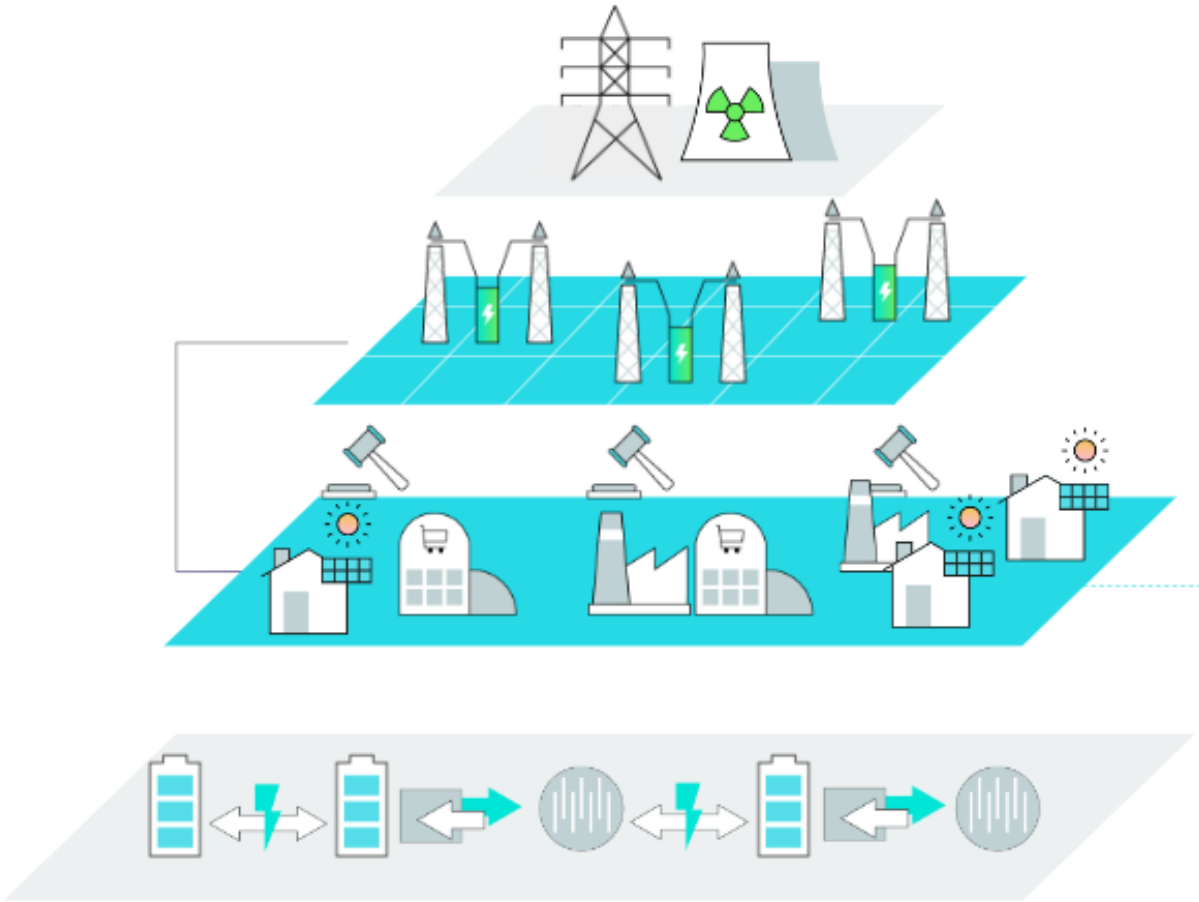
24x7 market

Layer 1

Building or site level

** These solutions address time and place needs for 24/7 renewable energy*

Local Energy Markets



Layer 2

LEM are typically defined for assets (prosumers/consumers) within a feeder. They can also be defined within a substation or at multi substation level.

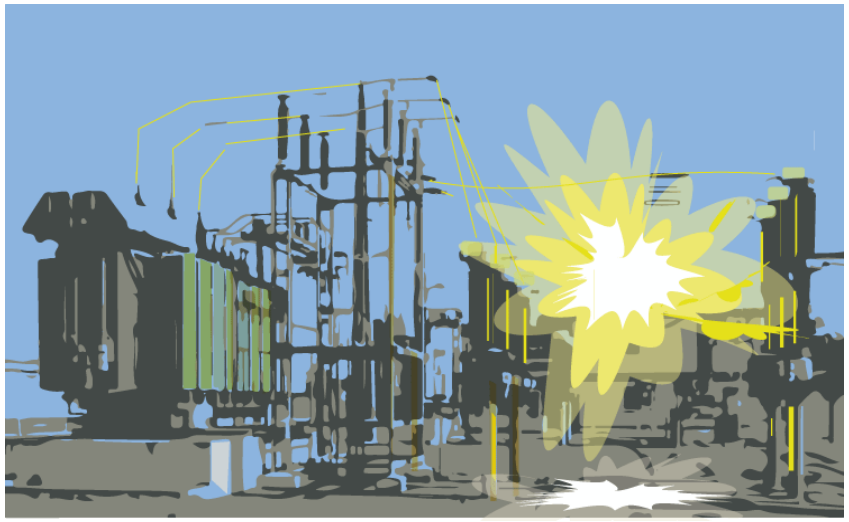
See also: https://energycentral.com/c/pip/lems-what-devil-use-are-they

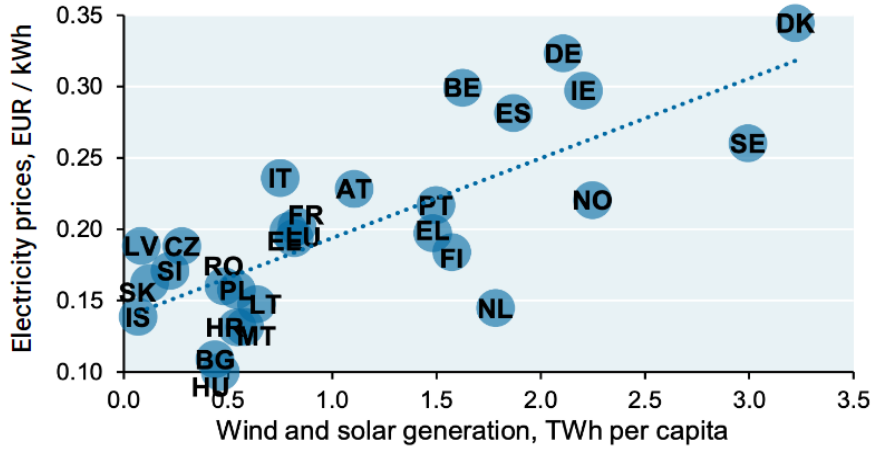
Problems in power grids - challenges & concerns

Impact of high variable renewable energy (VRE) penetrations

- **Time & Space problem:** which leads to expensive electricity.
- **Reliability & Security concerns** to ensure inertia and system strength.
- **Additional ancillary services** are required to cater to increased VRE sources.

Key Takeaway: Levelised Full Cost of Electricity (FCOE) for VRE assets is much higher than LCOE





Source: Eurostat, JPMAM. 2022.

Renewables growth and the need for Regulation

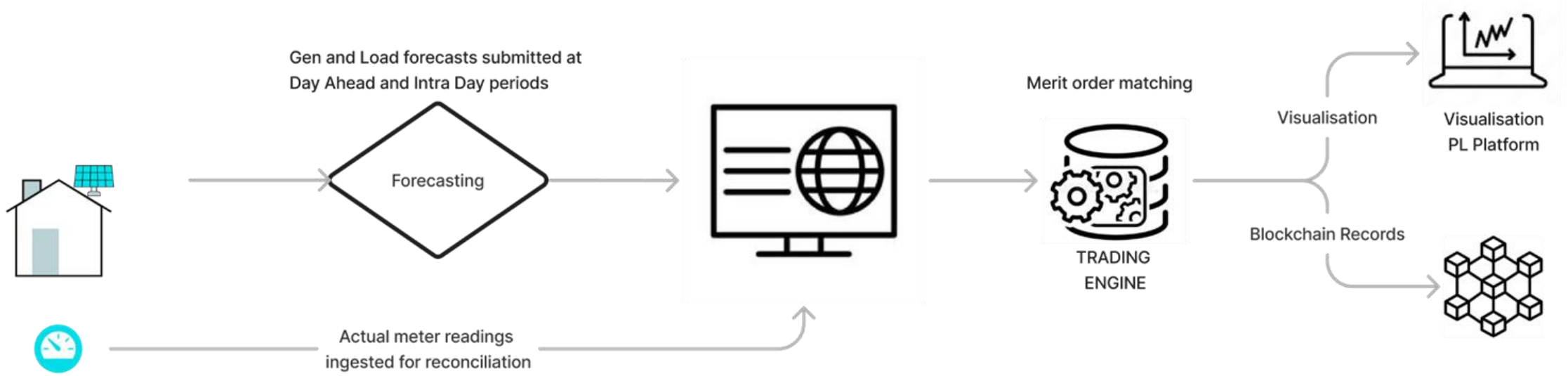
a) From 122 GW of renewable energy capacity today**,** India *has set a target of achieving* ***500 GW of installed capacity by 2030*** *from non-fossil fuels, including around* ***270 GW of solar capacity.***

b) Approximately ***11.5 GW of RTS is installed to date. In spite of CFA subsidies and tariff structures, its uptake has been delayed and the deadline to reach 40 GW has been extended to 2026.***

c) Currently, renewable energy is exempt from certain land, water or mineral use regulations putting pressure on resource availability.

Key Takeaway: Current market models fall short of expectations to promote growth of decentralised renewable sources while centralised installations would deplete natural resources

Platform Workflow - Overview



Step 1: Forecast of generation and consumption is made available to the user in two timelines : Day ahead & Intra-day

Step 2: Users are allowed to make a bid or an offer for the energy available until a predefined gate closure time at each interval of the day - day ahead & intra day timelines

Step 3: Powerledger trading engine conducts merit order matching only for the intervals that the user has created bids and offers. All other intervals are settled as per BAU metering tier (NM/GM).

Step 4: The outputs of the matches are recorded into the blockchain to create an immutable entry as proof of transaction.

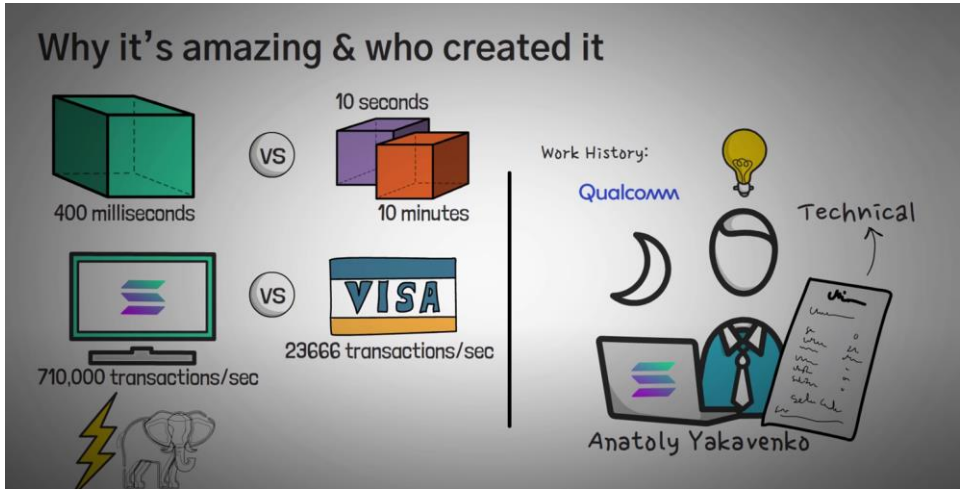
Step 5: Actual meter readings are ingested when available and interval comparison/reconciliation is done for the intervals where bids and offers were made. Reports are generated for each meter/user with adjustments for over or under injection and used for billing purposes

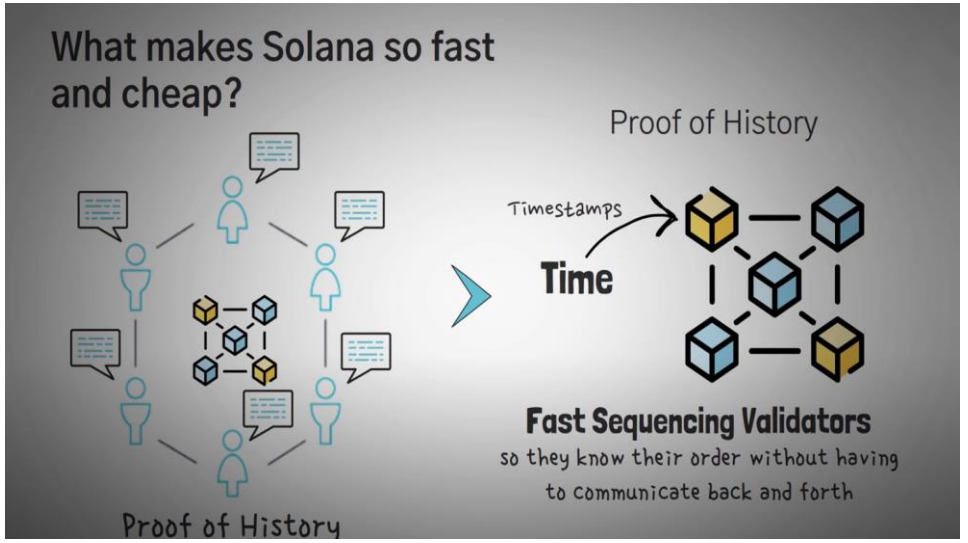
Gen3 blockchain technologies: Setting the stage to advanced accounting systems

Heralding a new path to handle distributed architecture

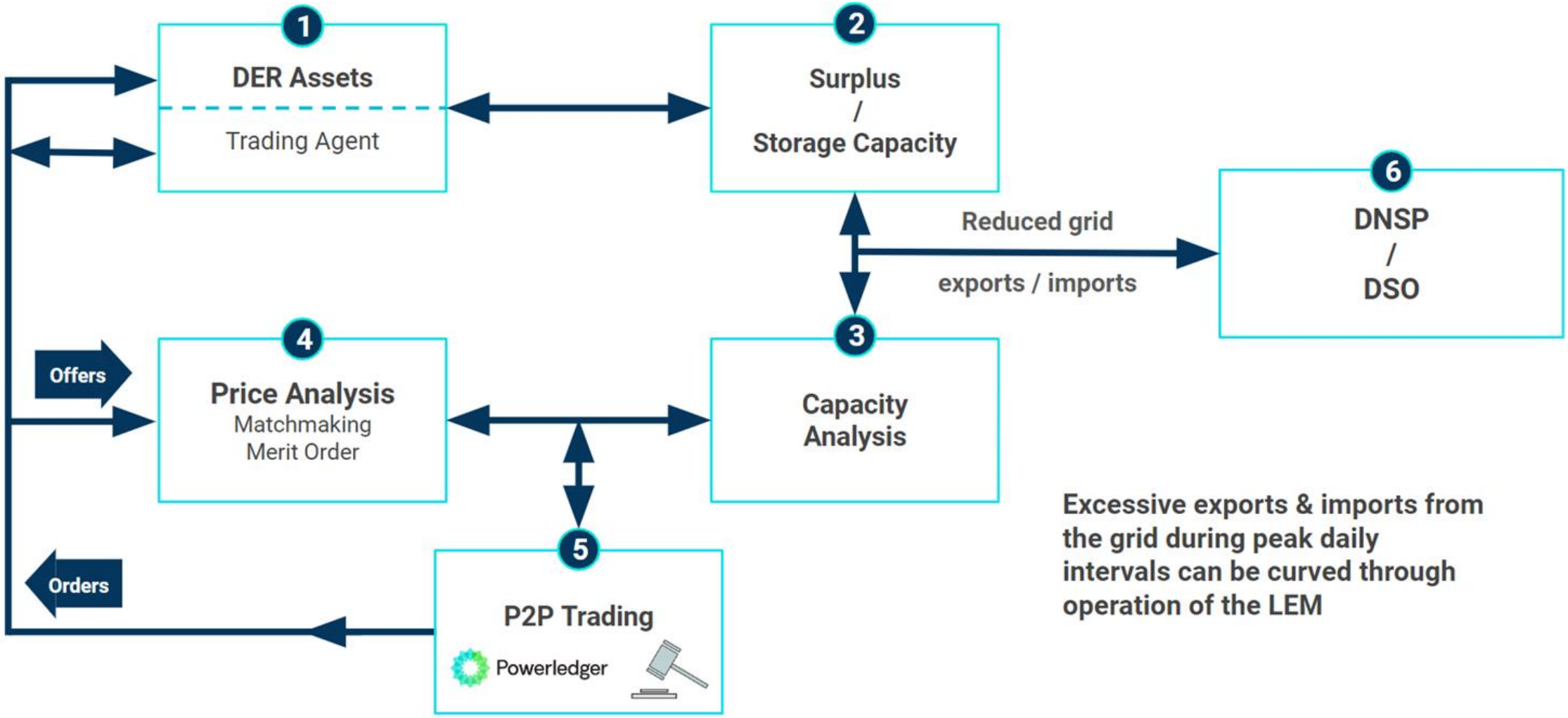
- **A highly agile distributed market with prosumers & consumers behind the meter** as market participants addresses emerging challenges
- **Gen 3 : High throughput, low transaction fees, low energy consumption, fast processing [PoS + PoH]**
- **Use cases -** P2P trading, Demand Response, Grid management, metered billing & security, electric vehicles, attribute certificates
- **Centralised systems are exposed to error and fraud**, cannot manage high volumes of near real-time transactions safeguarding trust

Gen3 blockchain technologies automatically executing smart contracts are mature enough to manage distributed systems





Local Energy Markets



LEM Fundamentals

- Typical three types of participants (residential or C&I) of LEM:
  - Consumers, also with increasing EV charging
  - Prosumers with solar PV
  - Prosumers with solar PV and BESS
- All LEM participants stand to gain, however prosumer with BESS gains the most (the payback for a 3.3kW/12kWh battery can be reduced from 9-10 years to 6.5 years).
- Buyers bid in the LEM at buy rates lower than their tariff rate, while sellers bid at rates above prevailing FiT.
- LEM offers a new revenue stream for owners of rooftop solar and BESS.
- With a LEM, there is less energy supplied from superior grid (wholesale market generators).
- A LEM is run by a distribution utility (many times with a retailer partner).
- **LEM is operational 365 days, 24/7. VPP services can however override the LEM commands, and hence can work in parallel**
- LEM expands the hosting capacity.

Trading details - typical 15 min time interval

15 min interval - Day Ahead Market closes 5 pm

SELLERS									
Meter ID	Tariff default	Forecast [kWh]			Sell Offer		Actual meter read	Actual meter read	Deviation
		Gen	Load	Surplus / Deficit	Energy [kWh]	Unit Price [INR]	Energy [kWh]	Energy [kWh]	Injection [Over/Under] kWh
xxx	NM	100	20	80	80	1.5	75	NA	5
xxx	NM	500	475	25	400	1.5	477	NA	-77
xxx	GM	880	342	538	538	2	800	340	-262
xxxxx	GM	340	380	-40	0	2	300	380	-300
xxxxx	GM	309	213	96	96	2	198	213	-102

BUYERS								
Deviation	Actual meter read	Buy Offer		Forecast [kWh]			Tariff default	Meter ID
Drawal [Over/Under] kWh	Energy [kWh]	Energy [kWh]	Unit Price [INR]	Gen	Load	Deficit		
0	80	80	1.5	0	80	80	none	xxx
0	400	400	1.5	0	400	400	none	xxx
0	538	538	2	0	538	538	none	xxx
0	0	0	2	0	0	0	NM	xxx
0	96	96	2	0	96	96	NM	xxxxx

The submitted schedules of sellers and buyers are matched with each other in a **merit-order matchmaking process** in the trading engine of the service provider's platform. Priority-wise, lowest sell offers are matched with the highest buy offers and the mutually agreed price can be the sell rate, buy rate or the average of the two rates.

Each matched trade is a transaction for record purposes. Actual meter reads from the smart meters are used to calculate the deviations for the sellers and buyers from their schedules in order to derive the incurred penalties for settlement at the end of the billing cycle.

Data in the cells marked in blue colour would be transferred into the blockchain ledger as transactions after validation by validators in the PoS - Proof of Stake consensus mechanism.

Peer-to-Peer (P2P) trading of roof top solar PV Energy

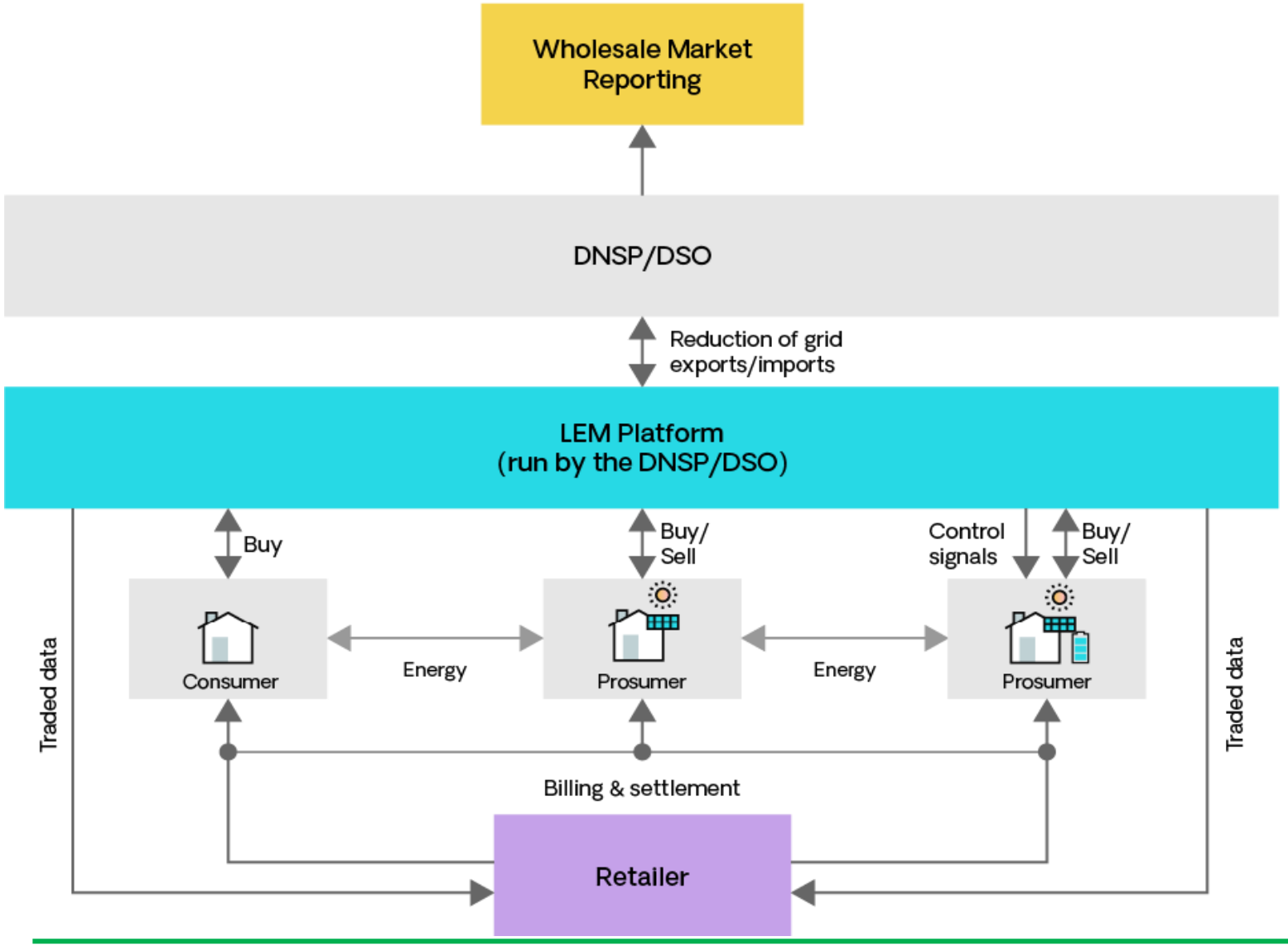
Peer-to-Peer energy (P2P) trading is the buying and selling of rooftop solar PV energy between two or more gird connected parties in a secured and a reliable way with proper accounting and billing mechanisms implemented with the help of blockchain technology. Any excess energy from rooftop solar PV can be transferred and sold to other consumers via a secure platform.

The Government of Karnataka will promote peer-to-peer trading of rooftop solar PV energy and pilot project(s) shall be promoted. The implementation of P2P model shall be as per the guidelines and regulatory framework as notified by the KERC from time to time.

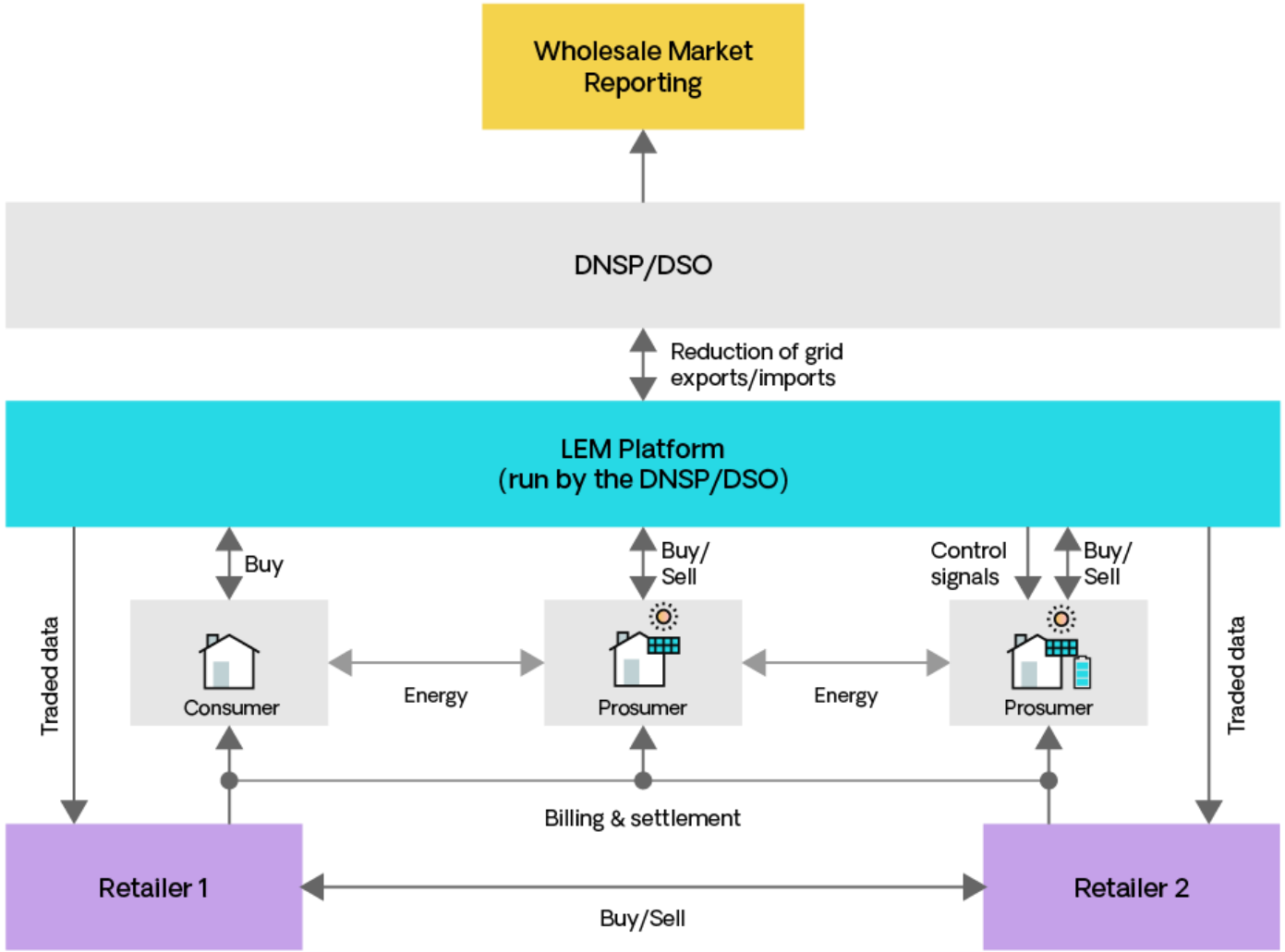
Current P2P Regulations as per Karnataka Renewable Energy Policy 2022-27

Endeavour Energy simulation of LEM energy trading

LEM - Architecture and Stakeholders - for Marsden Park Trial



LEM - Architecture and Stakeholders



What's in it for Participants, Retailers & Distribution Utilities

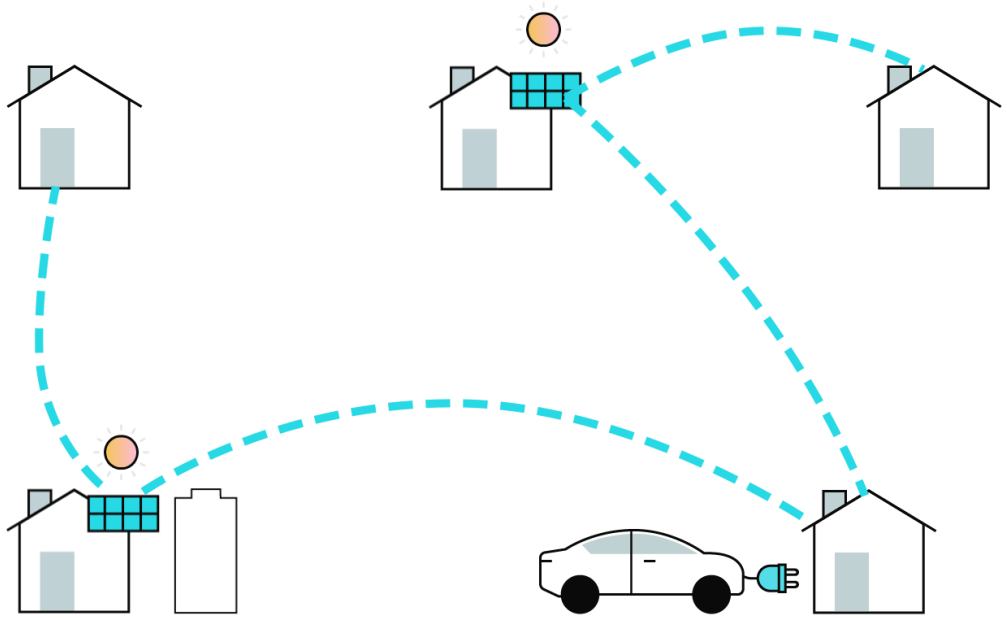
Blockchain enabled transactive energy trading

Decentralised VRE - Addressing the problems of time & space

Transactive Energy trading & decentralised record-keeping

- **Local Supply-demand balance** reduces grid congestions and improves power quality.
- **Trading of Distributed Energy Resources (DER)** reduces network spend.
- **Decentralised record-keeping systems with ‘smart contracts’** handle vast amounts of transactions ensuring a trustless environment

Key Takeaway: Energy-efficient blockchain and smart contracts ideal to ensure trust for large magnitude transactions



P2P trading - The prosumer actively gets involved in supporting the ancillary services and balancing markets