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RENEWABLE ENERGY INTEGRATION IN INDIA

Challenges, Solutions and Transactive Energy Market Proposition

AGENDA

1. Renewable-The Promising Business Case
2. India Renewable Story
3. RE Grid Integration Challenges & Solutions- Regulatory, Operational, Technology & Engineering
4. Market Based Solution-Why, What and How
   - Market Based Solution – Why (Benefits and correlation with RE integration)
   - Market Based Solution – What (Transactive Energy Market (TEM) – Introduction, Attributes and Principles
   - Market Based Solution – How (TEM-Structure, Timelines and Functions)
5. Technology Enablers - Blockchain for TEM
6. Global Initiative to Promote RE Integration and Faster Markets
7. Roadmap-Journey to Implement TEM in India

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RENEWABLE-
THE PROMISING BUSINESS CASE

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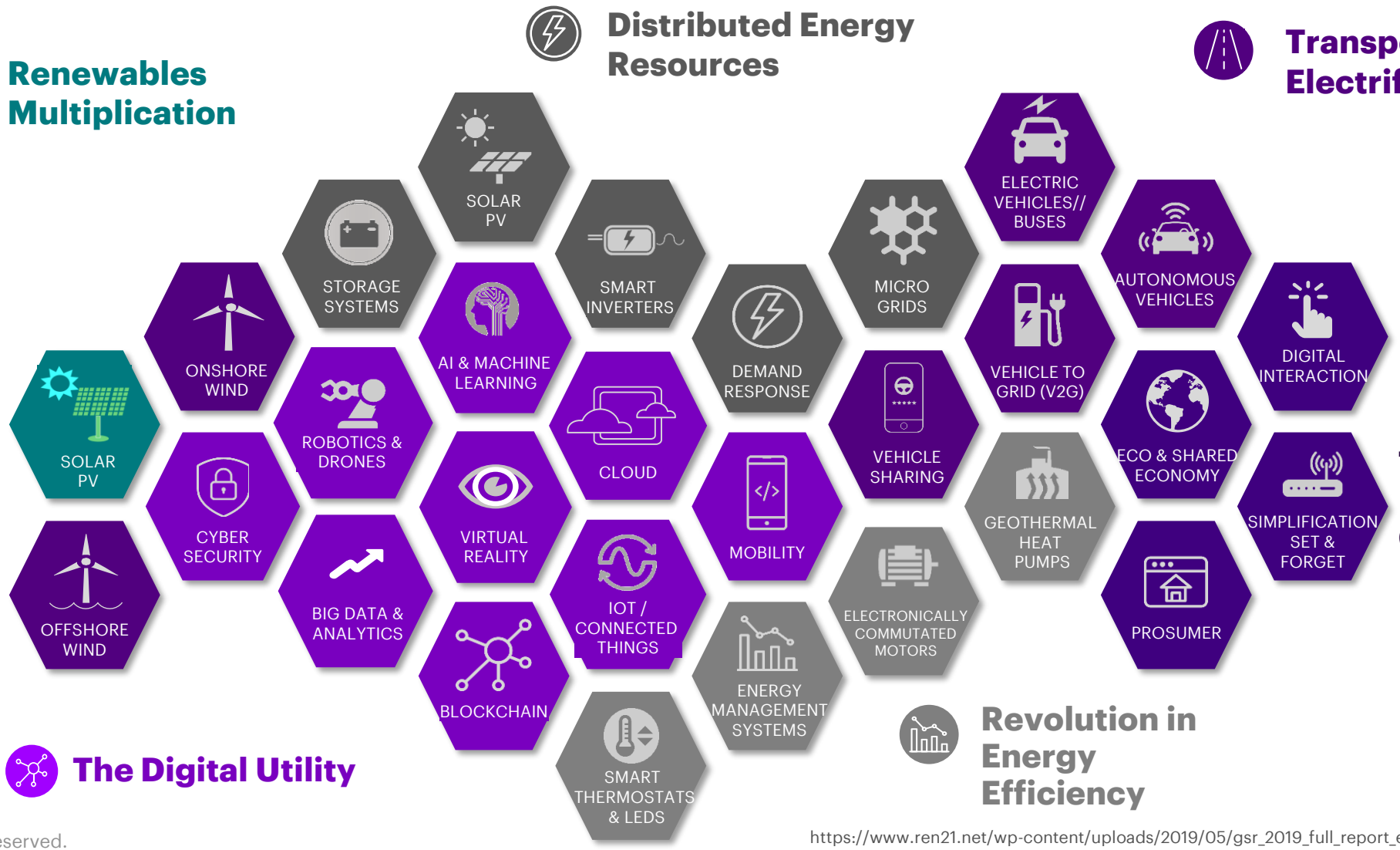
FACTORS CHANGING THE NATURE OF THE TRADITIONAL UTILITY BUSINESS

Renewables across the globe are expanding exponentially. As of 2018 the total global renewable capacity installation is 2378 GW and total investment in new RE sources in 2018 is $ 289 Billion

- Asset Performance Management
- Connected Worker
- Microgrids &DG
- Electric Vehicles
- IT/OT Security
- Blockchain
- Drones
- Solar Integration
- Regulatory



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https://www.ren21.net/wp-content/uploads/2019/05/gsr_2019_full_report_en.pdf

INDIA RENEWABLE STORY

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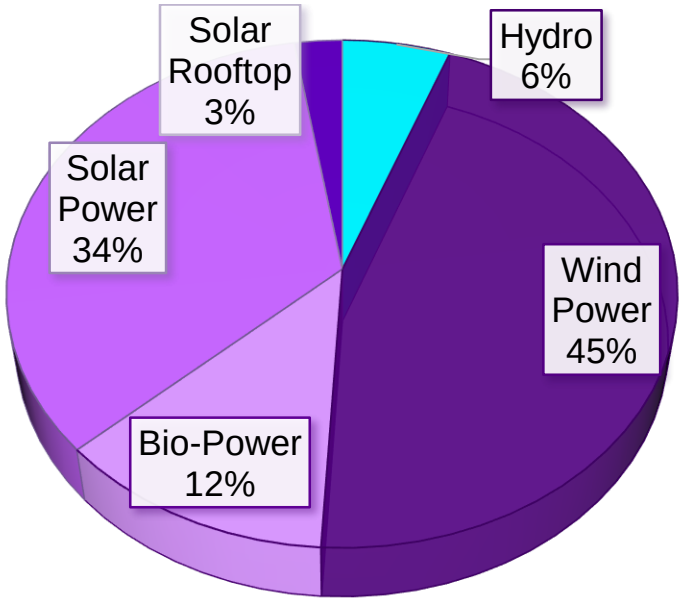
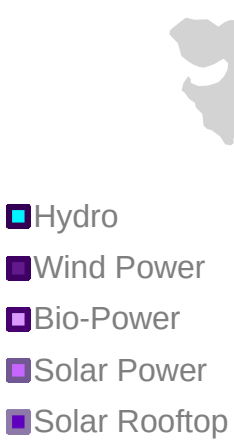
RENEWABLES - CURRENT STATE OF INDIA

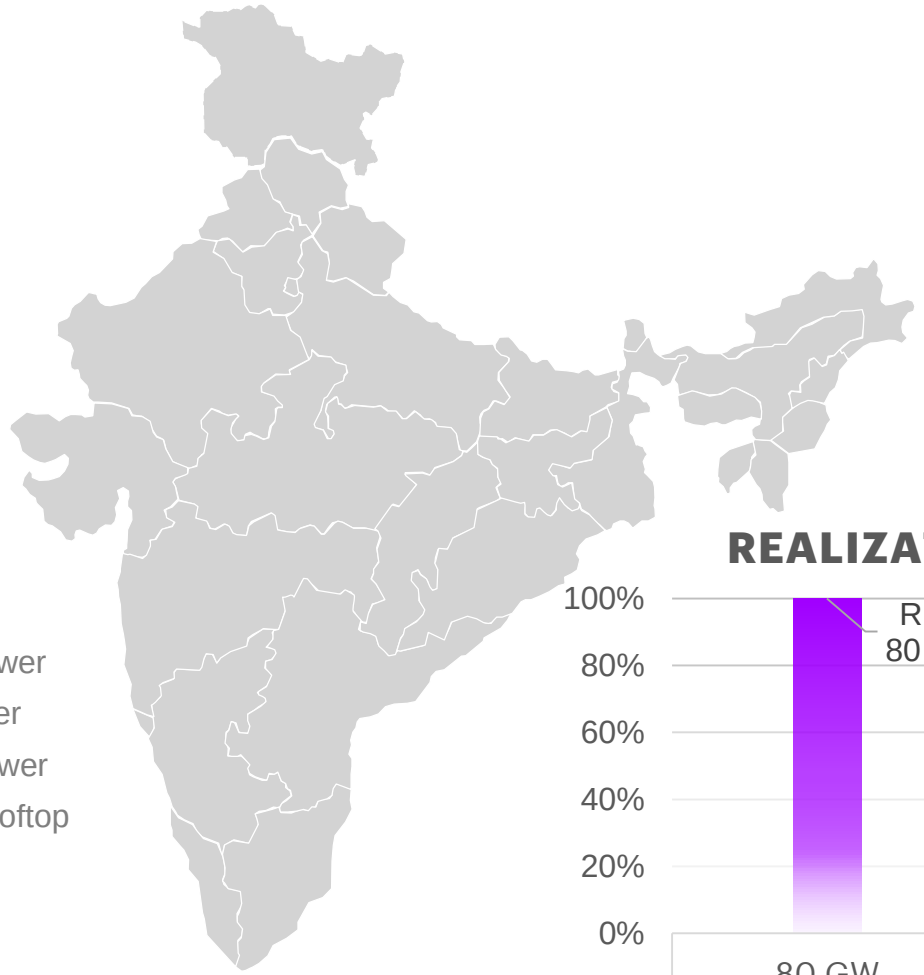
In order to remain in line with Paris Climate Agreement, by 2022, India is targeting the installation of 175GW of renewable energy capacity, an ambitious target that will require four-fold growth in the sector. In 2018, Government of India extended this target from 175GW to 225 GW by 2022

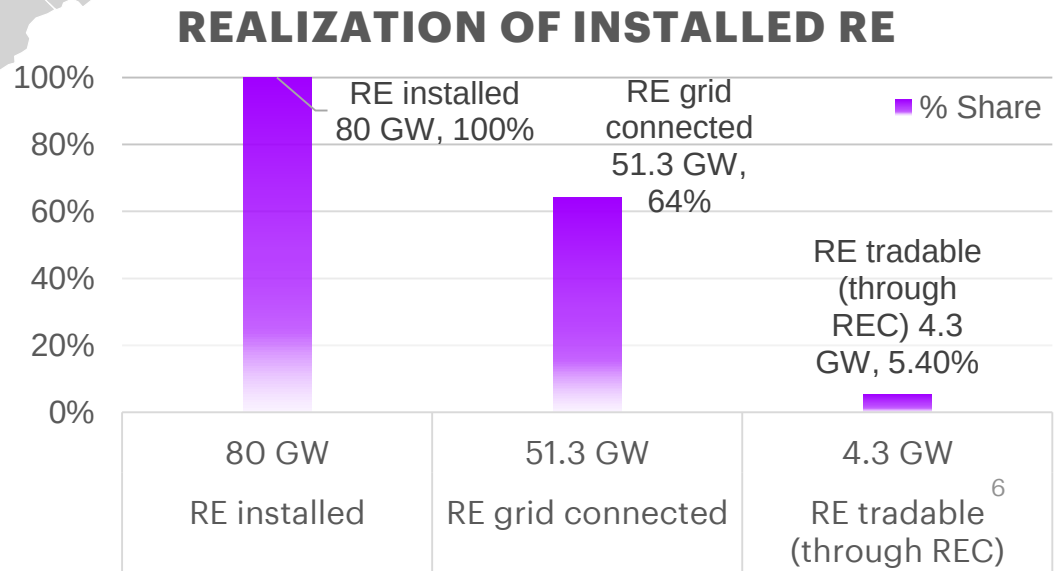
Installed capacity of Renewable Power as on 30.06.2019 is **80 GW**

Break up of Existing RE capacity









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MNRE-https://mnre.gov.in/ Report on India.

CHALLENGES AND SOLUTION

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CHALLENGES AND SOLUTION - RE INTEGRATION

Renewable resources are characterized by inherent issues like variability, intermittency, fast ramping. Also they are growing at all voltage levels, posing a big challenge for grid integration

	REGULATIONS AND POLICIES	GRID OPERATIONS	TECHNOLOGY AND ENGINEERING
Existing Challenges	• No clear definition of Roles & Responsibilities of system operators at all levels • No incentive to expedite the RE integration for grid operators • RE resources do not have access to markets • Lack of land acquisition law clarity for RE • Limited CEA guidelines for RE • No time varying pricing for retail consumer	• Network capacity constraints for target RE grid connections • Lack of visibility of accurate renewable power generation, scheduling and dispatch • Silo operations along the value chain • Lack of visibility and control mechanisms of DER resources at last mile of voltage level • Increasing uncertainty in load and power supply generation	• Inherent issues like variability, intermittency and fast ramping with RE resource • Rapidly evolving grid infrastructure technologies such as EV, Storage etc. • Heterogenous communication and interfacing protocols and multi-vendor landscape • Synchronization at equipment level • Unreliable contingency analysis, optimal power flow and dynamic security assessment
High Level Solutions	✓ RE installation & integration guidelines ✓ Defining enabling infrastructure, ownership and cost recovery mechanism ✓ Open market access to all RE generators ✓ Inclusion of RE norms in guidelines for all levels ✓ Clear land acquisition and legislative laws for RE establishments ✓ Faster trading and energy sharing platforms	✓ Technical and Commercial innovations to expedite RE connection and integration ✓ Design and deploy better forecasting and dispatching mechanism ✓ More roles and responsibilities to REMC (Regional Energy Management Centers) ✓ Better inter-state RE exchange and distributed control mechanism at all level of voltages	✓ Refined grid balancing guidelines ✓ Convening open standards and requiring interoperability for DERs ✓ Better communication infrastructure ✓ Installing energy storage devices and capacitor to reduce the variable intermittent nature of RES ✓ Implementation of advanced SCADA, DMS and DERMS IT systems

MARKET BASED SOLUTION FOR OPTIMAL RE INTEGRATION

WHY, WHAT AND HOW

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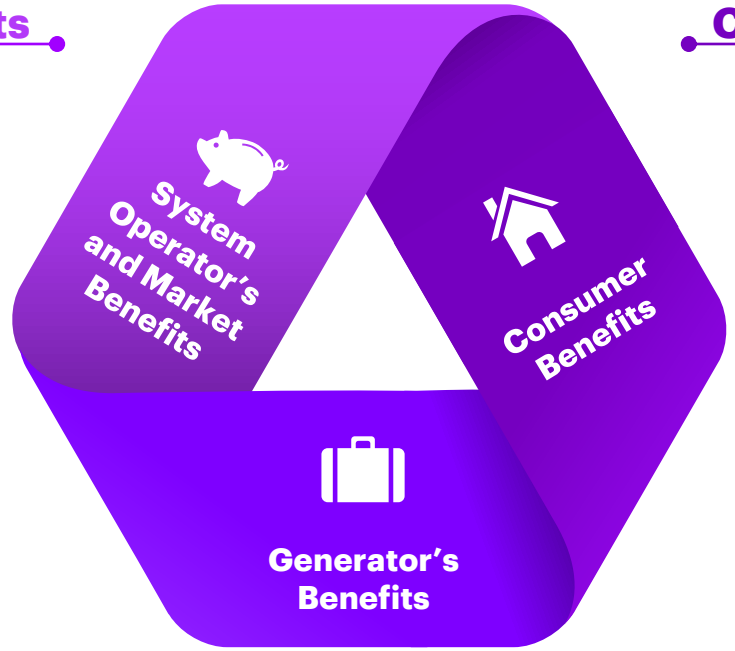
MARKET BASED SOLUTION - WHY

Study conducted by NREL supports the hypothesis that faster (sub-hourly) and aligned scheduling & dispatch and settlement period is preferred with higher density of renewable resources

System Operator's and Market Benefits

- Incentivizes latent capacity to come online immediately
- Increases system security
- Signals investment to types of generation required – i.e. fast response
- Optimizes renewable resources utilization
- Promotes healthy competition and fair prices
- Enables carbon commitments achievement



Consumer Benefits

- Allows C&I customers to provide demand response in shorter, more workable intervals
- Allows DR to part take more directly in wholesale prices
- Increases the range of offers to aggregate and monetize investments made in behind the meter technologies
- Potential reductions in wholesale prices as price averages would reduce

Generator's Benefits

- Allows profitable bidding for new types of fast dispatchable generation
- Optimizing plant load factors
- Lesser turnaround time resulting in trading liquidity
- Aligns payments with volumes delivered at dispatch interval prices – avoids dilutive effects of average prices

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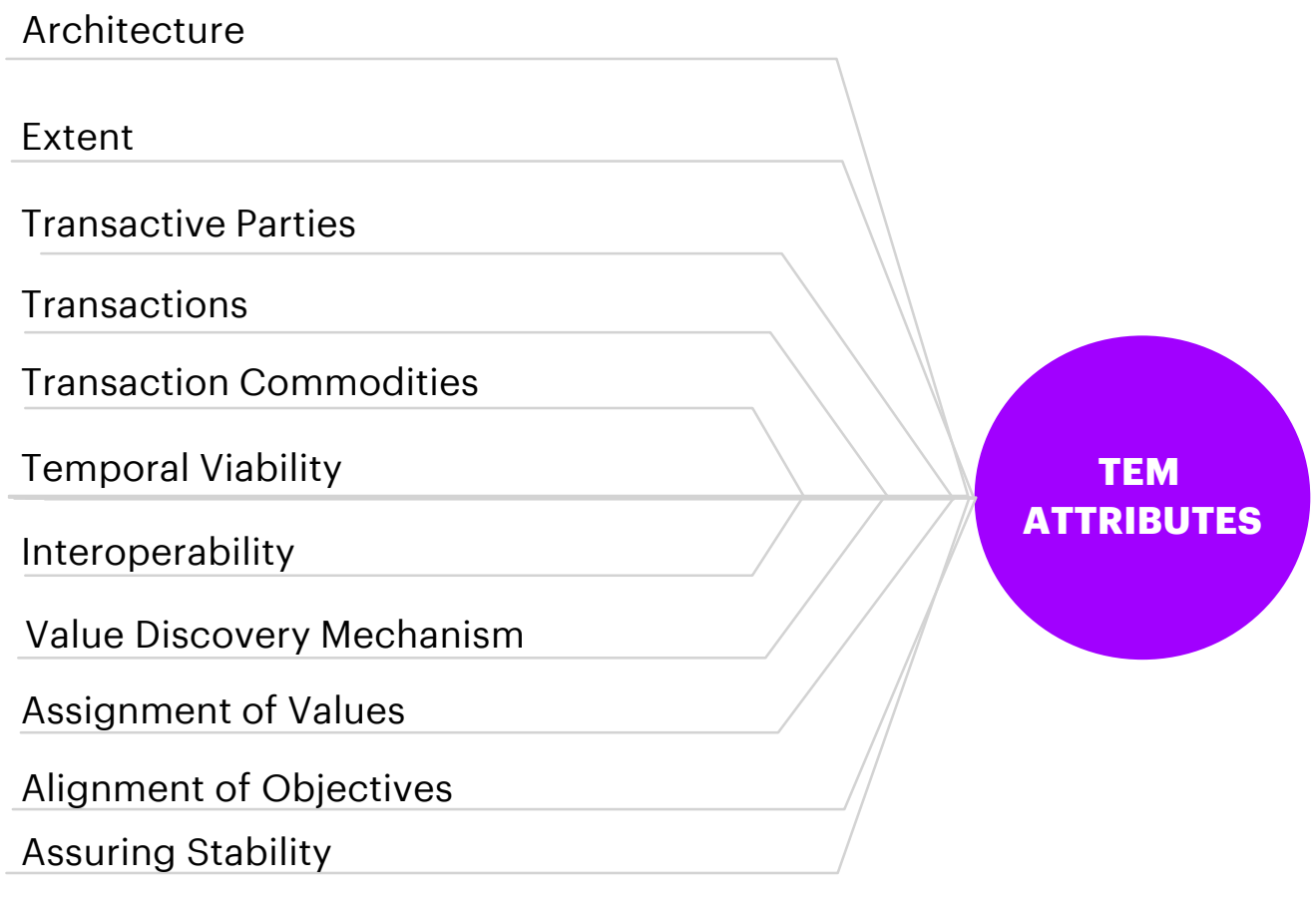
https://www.nrel.gov/docs/fy12osti/54666.pdf

MARKET BASED SOLUTION - WHAT

Transactive Energy Market (TEM)

"A system of economic and control mechanisms that allows the dynamic balance of supply and demand across an entire electrical infrastructure using value as a key operational parameter. The market that facilitates transactive energy transactions is termed as transactive energy market. Following are 11 key attributes and 6 principles identified for TEM by GridWise Architectural Council, USA" .



TEM PRINCIPLES

- Transactive energy systems implement some form of highly coordinated self-optimization
- Transactive energy systems should maintain system reliability and control while enabling optimal integration of renewable and DERs
- Transactive energy systems should provide for non-discriminatory participation by qualified participants
- Transactive energy systems should be observable and auditable at interfaces
- Transacting parties are accountable for standards of performance
- Transactive energy systems should be scalable, adaptable, and extensible across several devices, participants, and geographic extents

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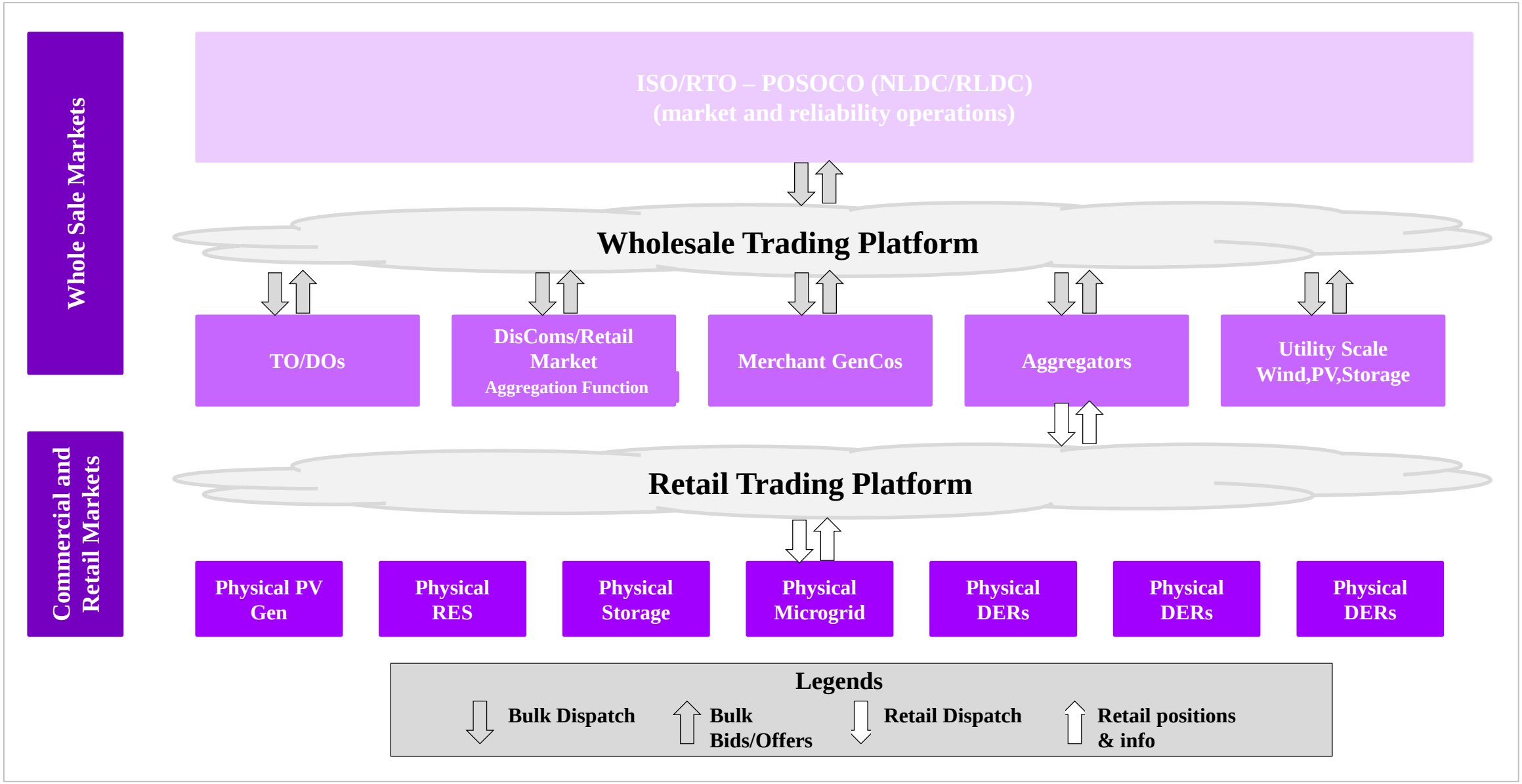
https://www.gridwiseac.org/pdfs/te_framework_report_pnnl-22946.pdf

MARKET BASED SOLUTION - HOW

Proposed TEM structure for India



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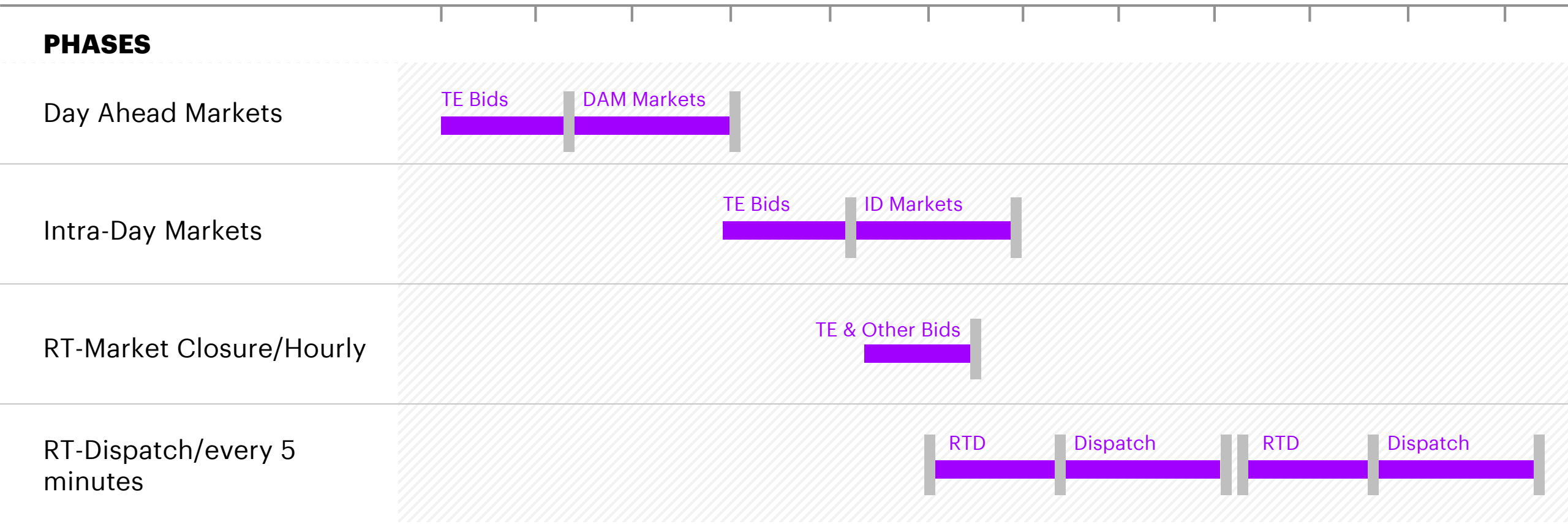
PROPOSED DISPATCH AND SETTLEMENT TIMELINES

The current timelines of 15 minutes blocks for day ahead markets and hourly trade blocks for intra-day markets can be improved up to 5 minutes dispatch and settlement



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PROPOSED OPERATING FUNCTIONS FOR DSO

Key functions those need to be implemented to promote transactive energy markets for faster renewable integration

- Aggregator Function
- Bidding system and Market algorithms
- Retail Market Clearing
- Result as retail schedules
- Results as bids/schedules to NLDC/RLDCs
- NLDC/RLDCs Interfaces
- Metering
- Pricing Mechanisms
- Contract Management, Billing and Settlements
- Communications through Standards
- Dispatch to aggregators as instructions or to devices as setpoints
- Distributed control architecture
- IT-OT systems and Processes
- Organizational Management

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TECHNOLOGY ENABLERS

BLOCKCHAIN FOR TEM

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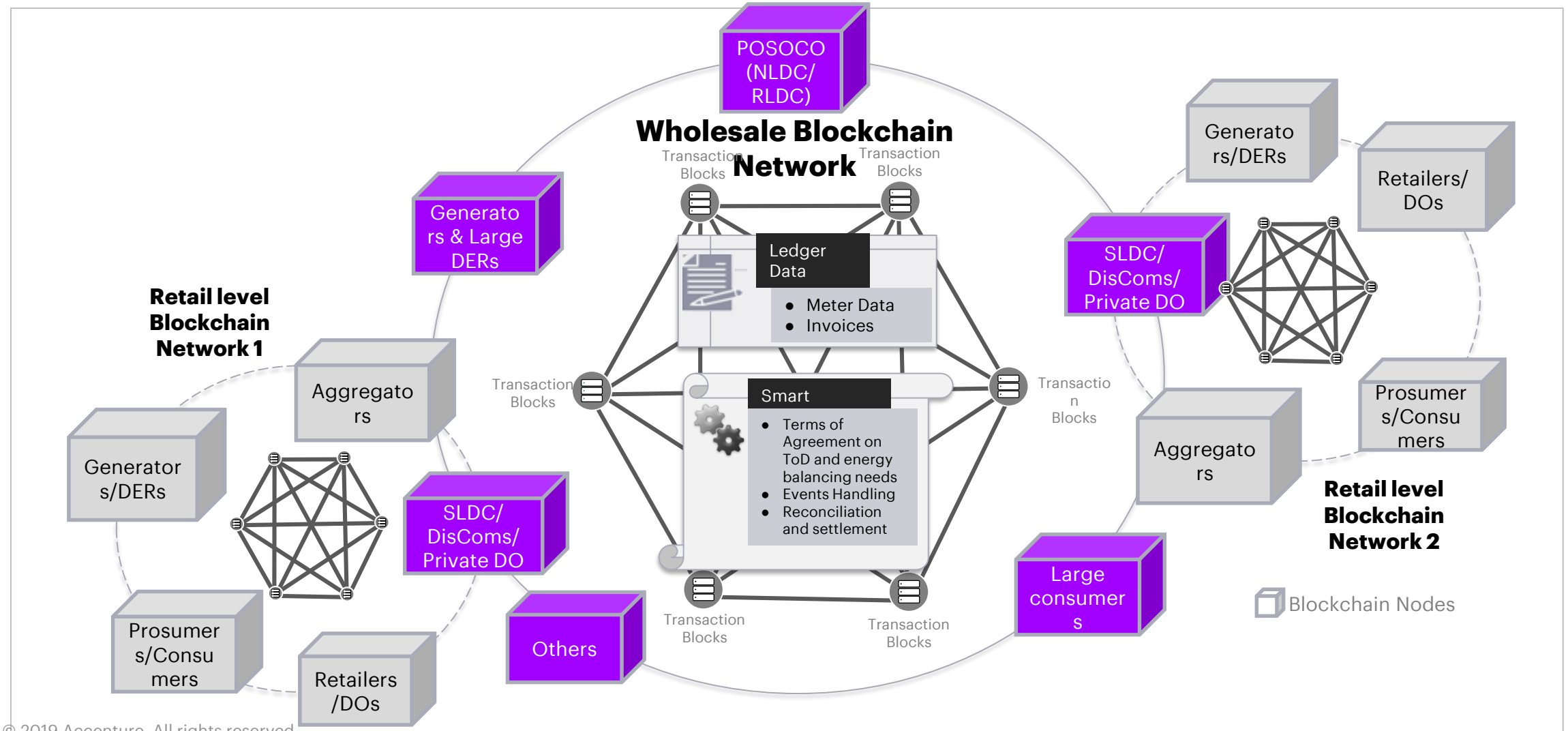
BLOCKCHAIN FOR TEM

Cutting-edge technologies those will be required to implement TEM are – Internet of Things, Big data analytics, Artificial Intelligence, Blockchain. From faster markets perspective, Blockchain is getting significant traction in western world – Trust, Transparency and Traceability

Conceptual blockchain architecture for Transacting Parties and their Extent in the TE markets of India



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GLOBAL INITIATIVES TO PROMOTE RE INTEGRATION AND FASTER MARKETS

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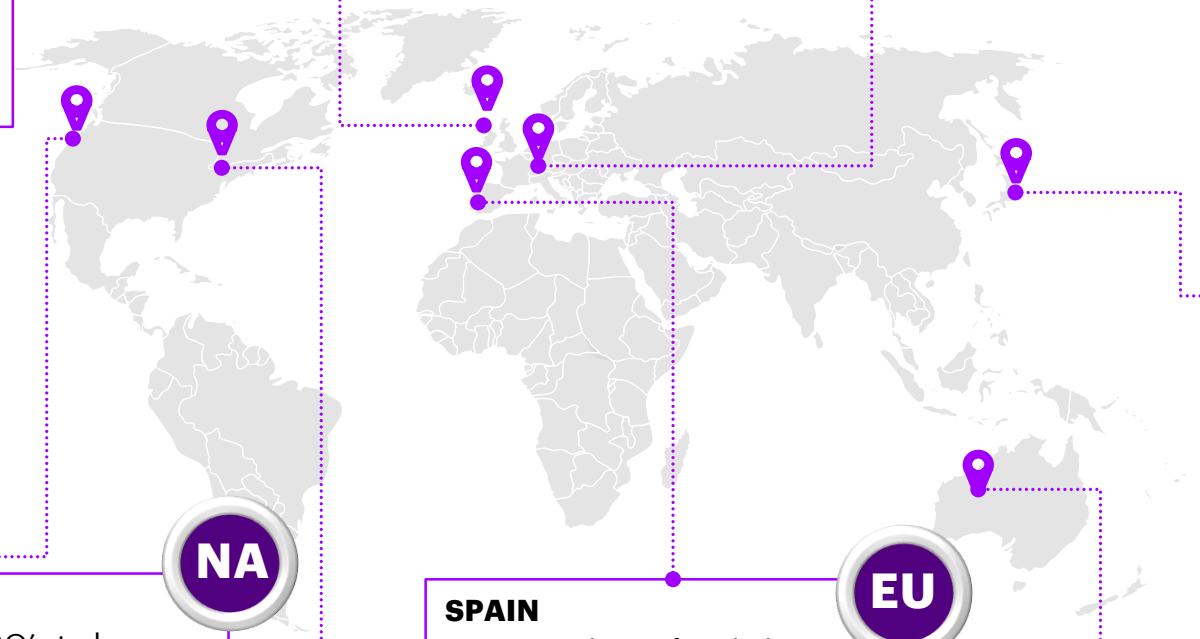
GLOBAL INITIATIVES

Initiatives are taken across the world to promote DER and RE integration with grid



UNITED KINGDOM/IRELAND (EU)
- Feed-in tariffs for renewables facing significant reductions
- Piloting smart electrical thermal storage and smart water heaters for energy storage to shave system and circuit peak load

GERMANY (EU)
- Renewable energy hit record high 77% of total produced on 22nd April 2019
- Trading liquidity manages the highly variable renwable generation effectively

CALIFORNIA (NA)
- Vision for DSO's to become the "network platform" creating a market for DER
- Shifting to long-term planning for DSO's and debate over utility ownership of DER and role of retailers
- Mandates for storage and community solar

NEW YORK (NA)
- Vision for DSO's to become "Distribution System Platform Providers" creating a market for DER
- Shifting to long-term planning for DSO's

SPAIN (EU)
- Proposed new fixed charges of €8.9/kW for solar and zero net metering price, reducing the appeal of self-supply and challenging the economics of energy storage

JAPAN (AP)
- Nationwide reform of electricity system, introducing competition
- Neutrality of distribution, retail choice, and stimulus for wholesale electricity market

AUSTRALIA (AP)
- AEMO has approved 5 min settlement for all the energies bought or sold in wholesale market to promote DER traction
- All the meter recordings, settlement calculation and Dispatch & market information is aligned towards 5 mins SLA

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ROADMAP
JOURNEY TO IMPLEMENT TEM

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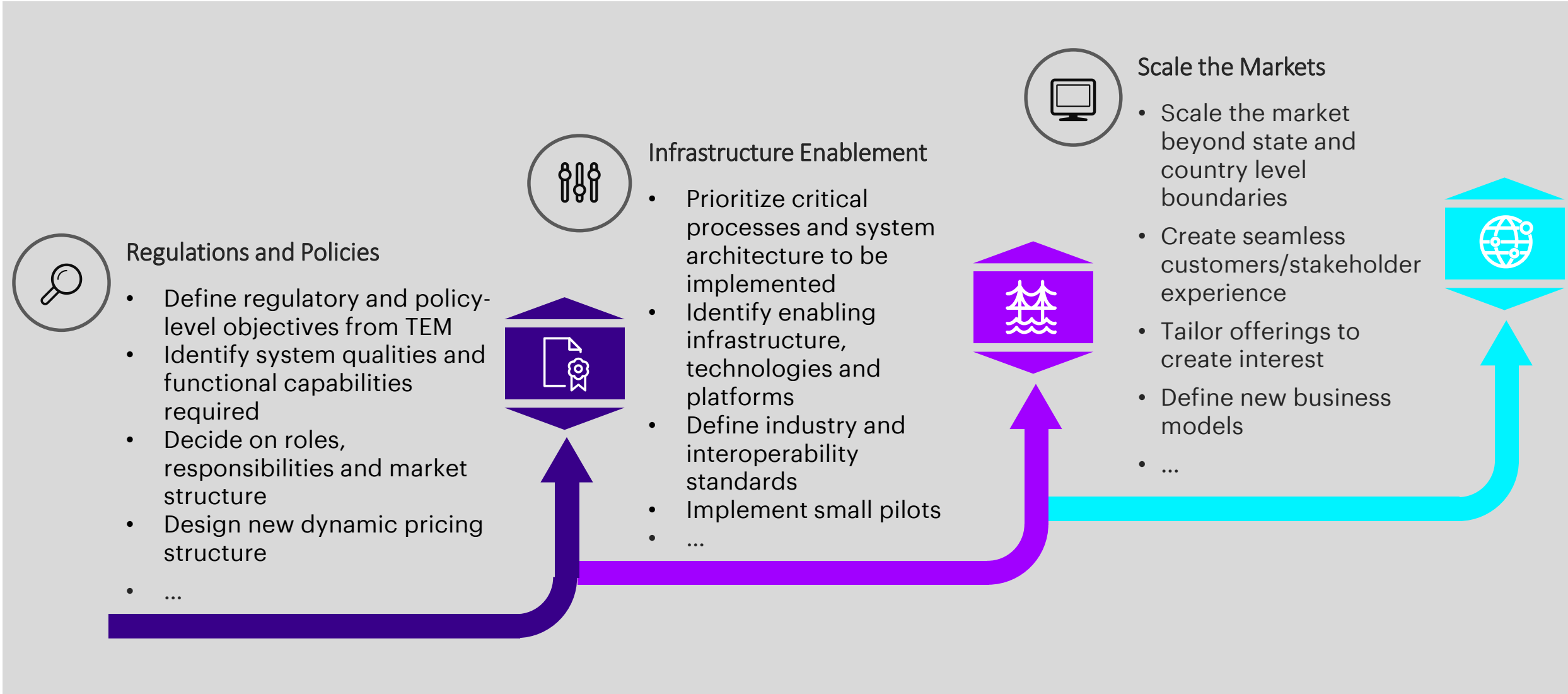
PROPOSED ROADMAP TO IMPLEMENT FASTER MARKETS IN INDIA

A journey towards optimization of RE integration



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THANK YOU

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