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**DISTRIBUTION
UTILITY MEET
DUM 2023**

Session : Growth of RE and EV; and the plan for enhancing grid flexibility

Major Trends in Unlocking DER and Demand-Side Flexibility

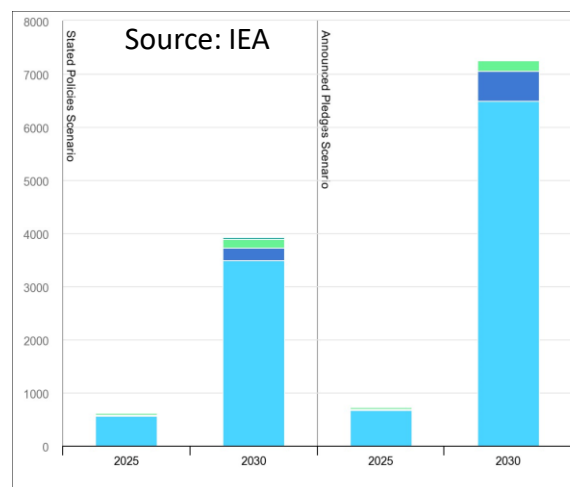
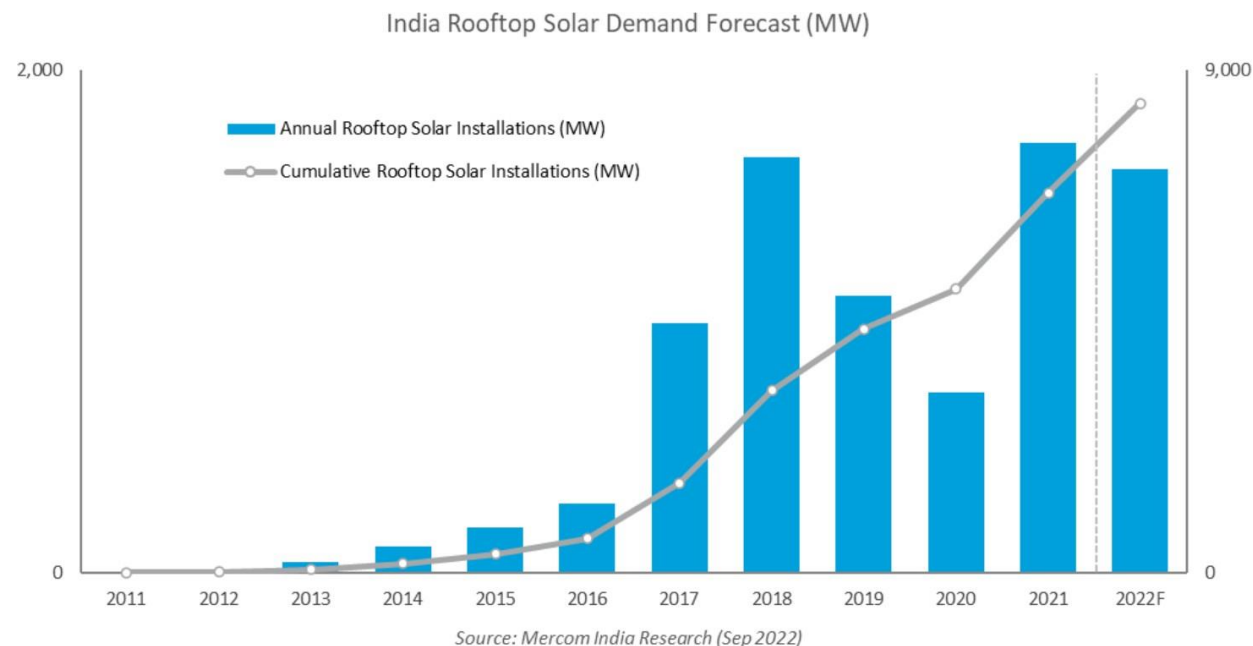
Presented By

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- India had installed close to **9 GW of rooftop** solar capacity by end of 2021, with targets for 40 GW of rooftop solar
- By March 2022 India had **>1M** EV's in India, with growth being led by 2W, 3W, and electric buses
- EV's and rooftop solar are expected to have significant growth rates. Flexibility is critical to the future power system



- IEA EV projections have two 2030 scenarios, with between 3.9M-7.25M depending on national incentives
- 2022 KMPG report estimated 45-50M EV's by 2030

Utility Motivation for Unlocking Flexibility

RE intermittency Peak Load Shaving Grid Upgrade Deferrals
Promoting Solar Self-Consumption Energy Efficiency Ancillary Services

- How utilities can unlock flexibility:
 - **Interconnection** agreements/requirements
 - Interconnection standards
 - Flexible interconnection
 - **Customer Programs and Demand-Side Management**
 - Incentive driven customer programs
 - Smart tariffs
 - Aggregators/Virtual Power Plants (VPPs)/Distributed Energy Resource Management Systems (DERMS)

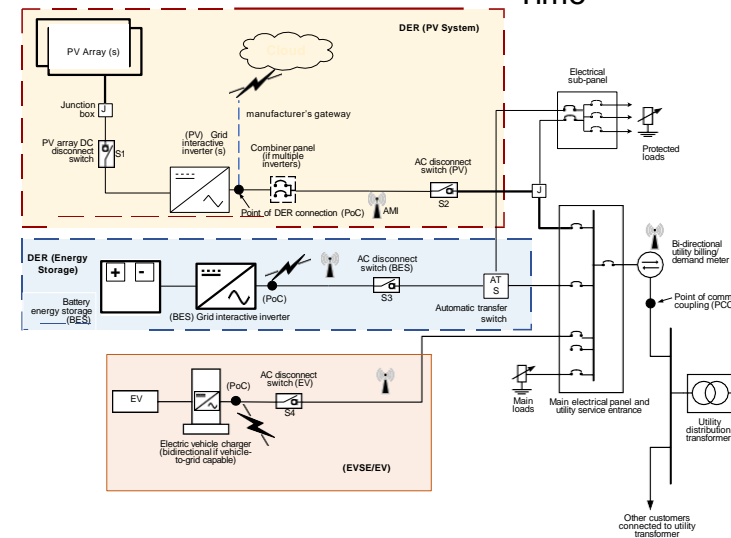
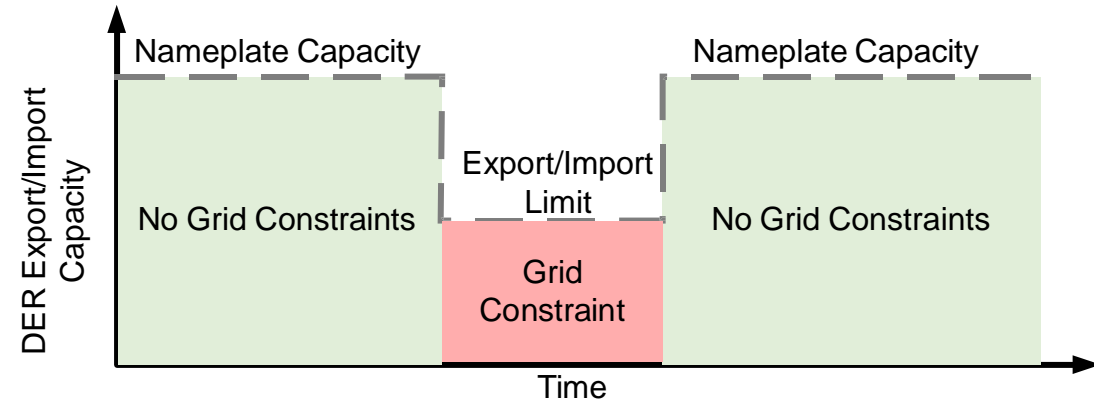
Utility Interconnection

- **Next-Generation Interconnection Process.**
- *Hosting capacity maps:* For distributed generation and electrification.
- *Interconnection Screens:* Transition from conservative heuristics to comprehensive automated impact studies
- *Next generation interconnection:* Flexible interconnection and limited generation profiles



Flexible Interconnection

- *Export/Import limited agreements (time-dependent) as a non-wire alternative / bridge-to-wires / DER/EV flexibility solution*



Increased complexity of interconnections with DER generation, storage, EVSE, metering and power control systems

DER Connectivity Standards

- DER connectivity standards must make sure that these devices provide the necessary **grid support** to provide stability and power quality of both the **transmission** and **distribution system**
- As DER continue to displace bulk generation, the response of these devices is critical to the health of the overall power system
- As of 2021 there was over 9 GW of rooftop PV installed in India

Evolution of IEEE DER Standards

IEEE 1547-2003

- Shall NOT actively regulate voltage
- Shall trip on abnormal voltage/frequency

IEEE 1547a-2014

- May actively regulate voltage
- May ride-through abnormal voltage/frequency
- May provide frequency response (frequency droop).

IEEE 1547-2018

- Shall be capable of actively regulating voltage
- Shall be capable of frequency response
- Shall ride-through abnormal voltage/frequency
- May provide inertial response

Future Standards

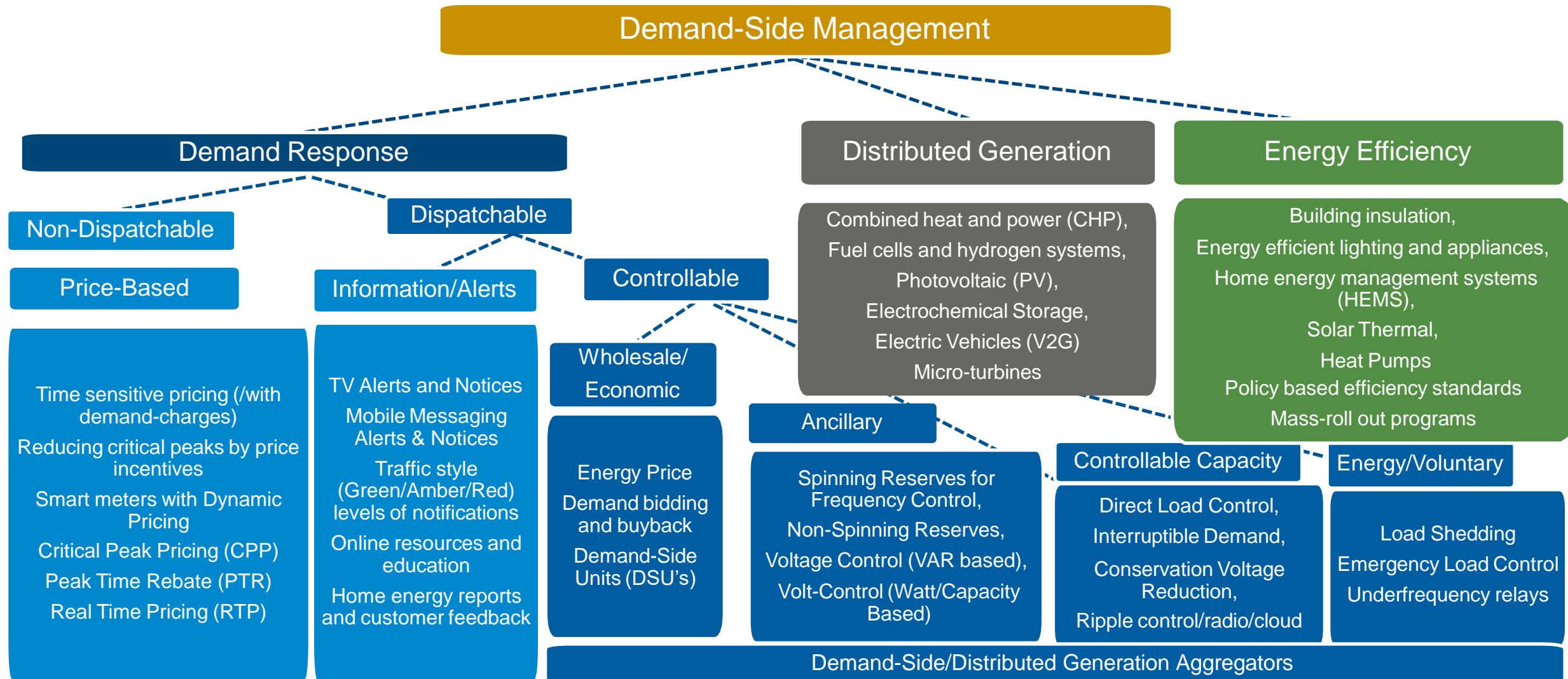
- Potential greater inclusion of grid-forming capabilities
- Potential greater consideration of inertial response
- Potential inclusion of fault-current requirements

Evolution of CEA/MNRE Grid Codes

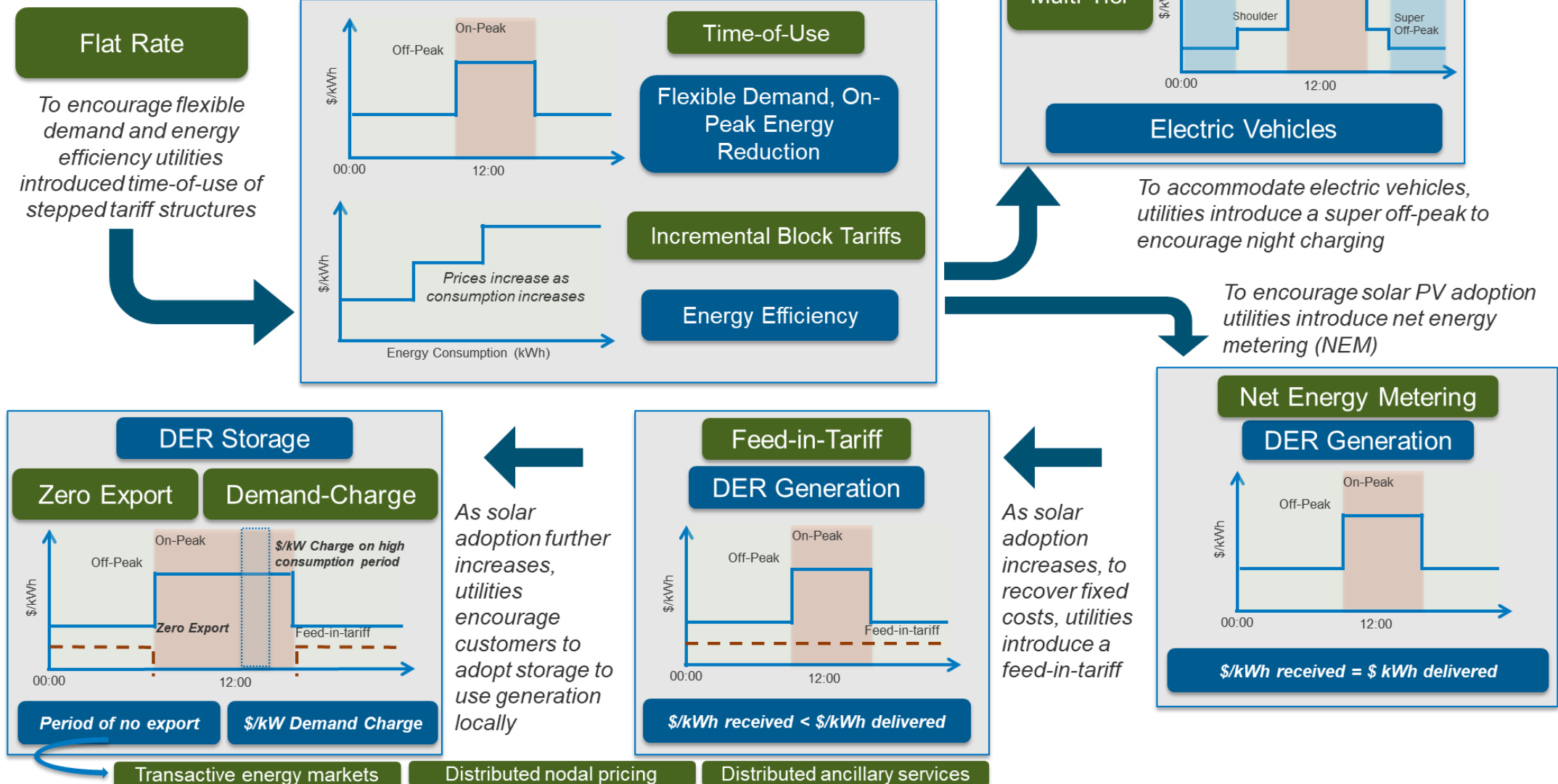
- Shall trip on abnormal voltage/frequency

- Future Indian grid codes

NREL upcoming report: Interconnection of Distributed Energy Resources in India: Consideration of IEEE 1547-2018 in a 50 Hz System and Grid Code Development

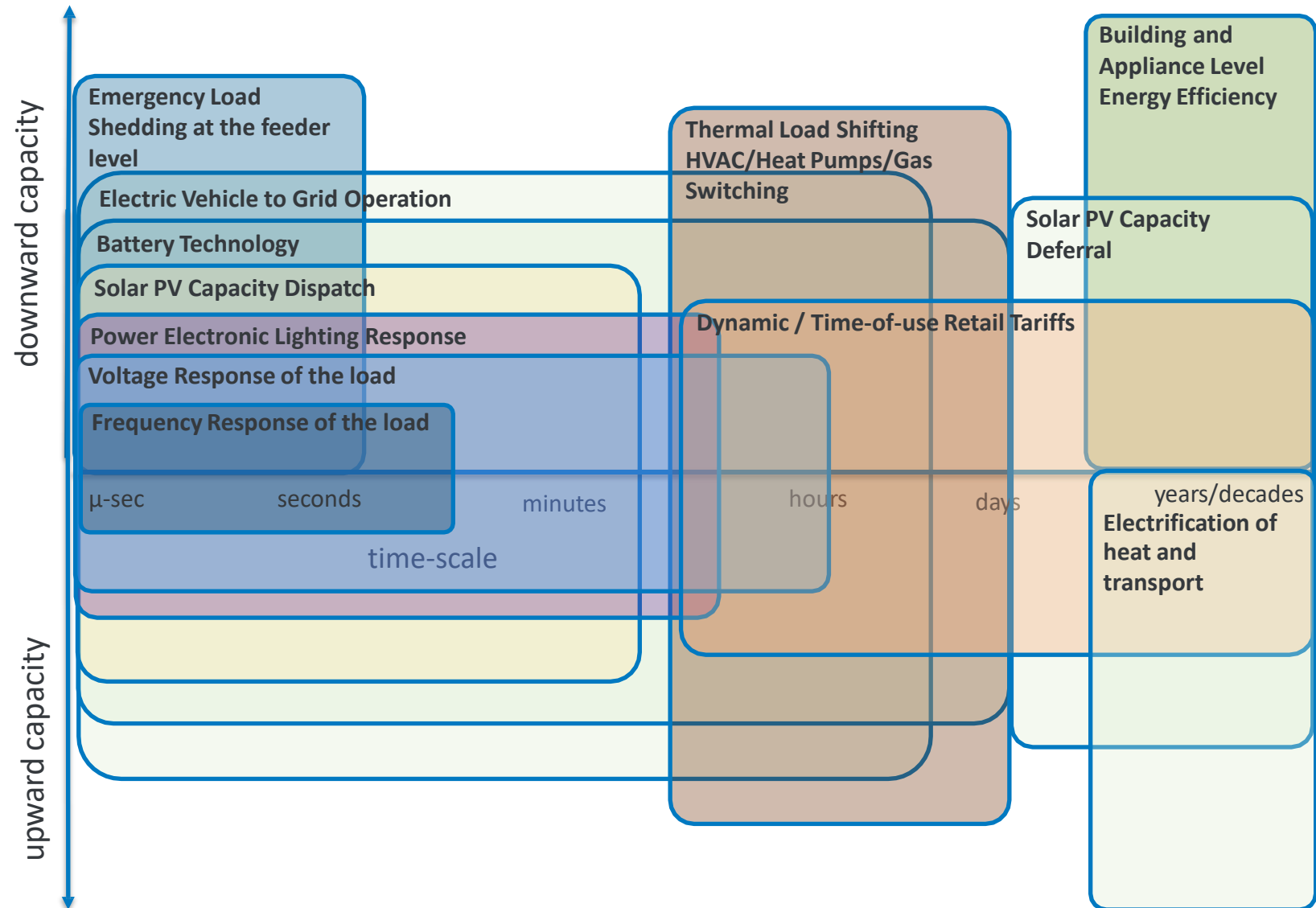


Evolution of Retail Tariffs



Potential of Load-Side Flexibility

- Loads can provide **upwards or downwards** capacity
- **Response** availability from **micro-seconds to years**
- **Low to high** levels of **capacity provision**
- Utilities need to customer programs, aggregators, and smart-tariffs are critical to unlocking demand-side flexibility

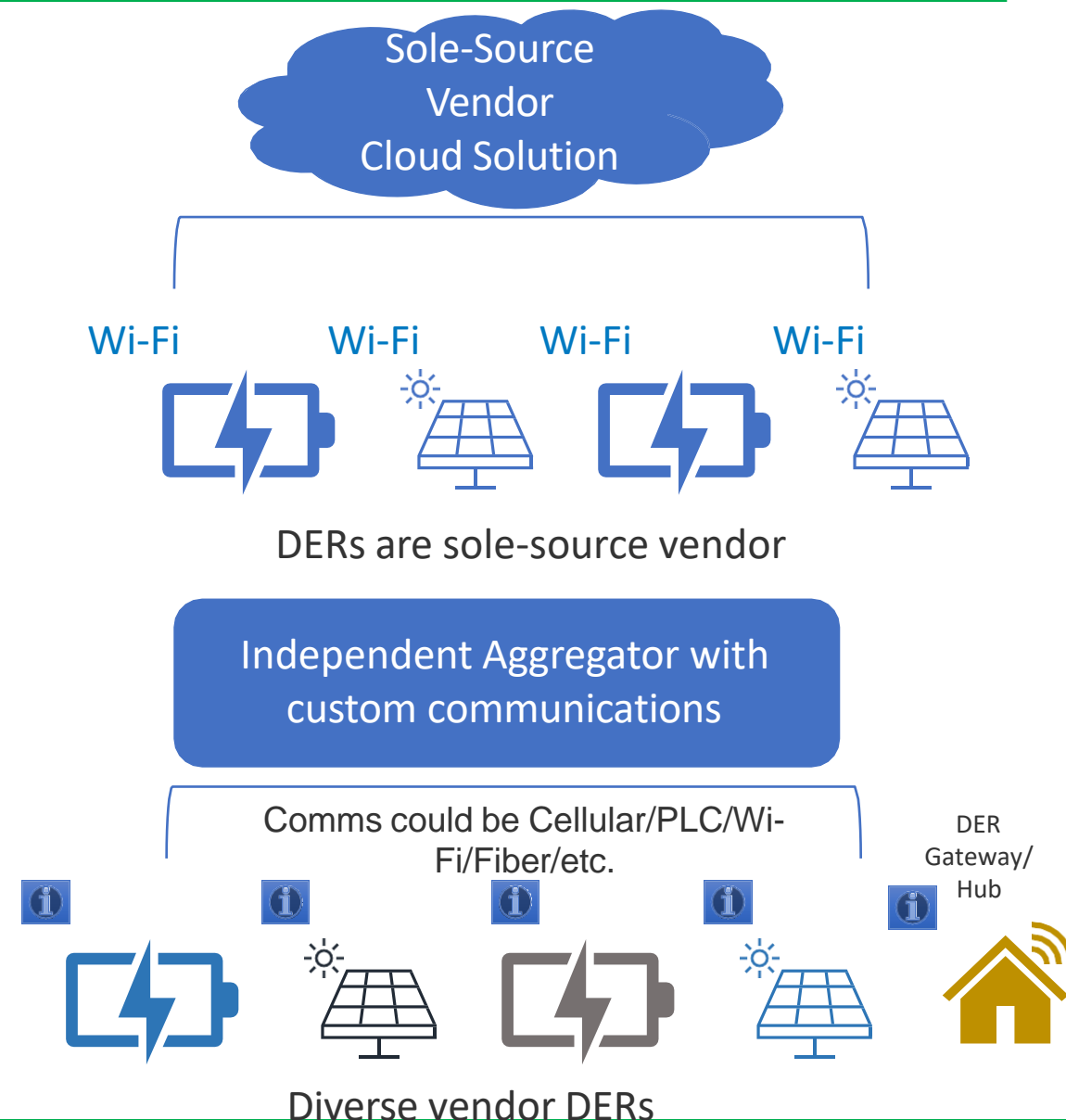


Aggregator Communication Structures

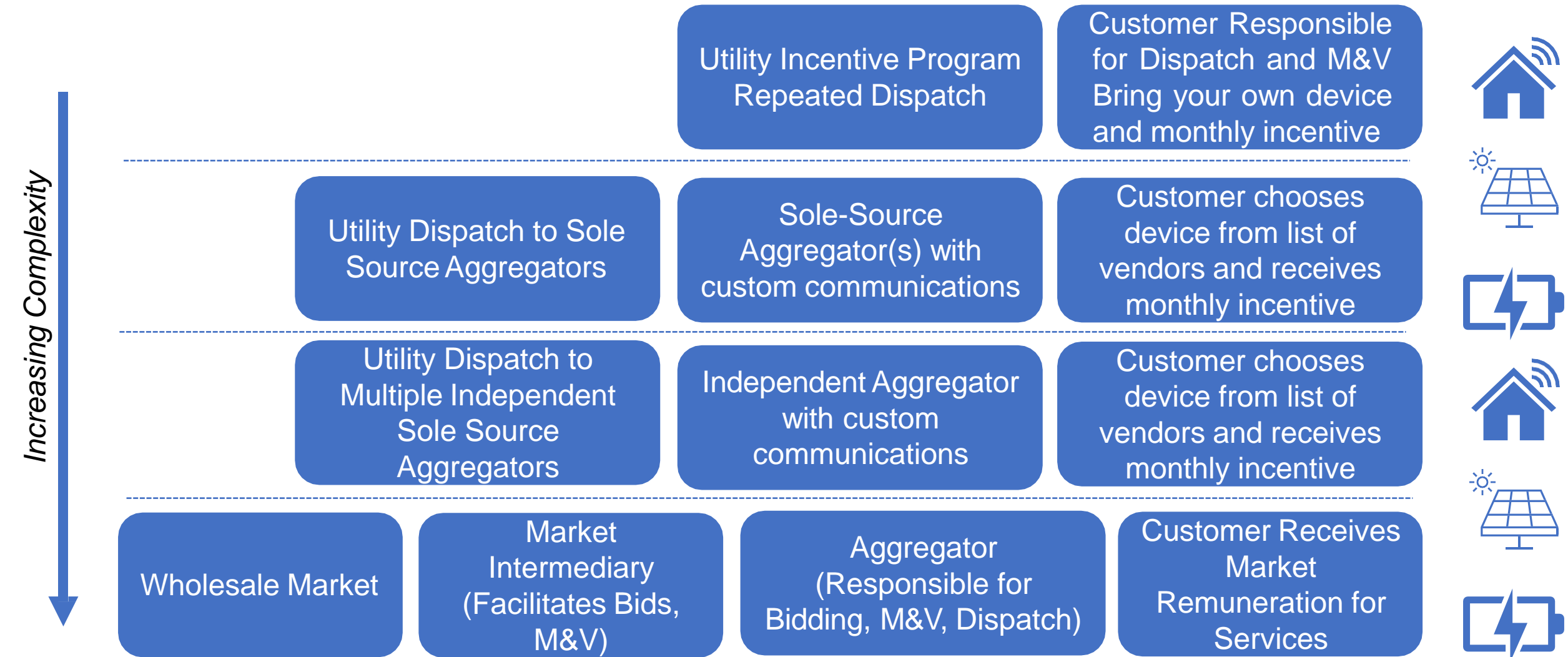
Sole source providers and vendor communication: Customer program for single vendor solution – rely on customer Wi-Fi.

Aggregators and DER gateways: Aggregator responsible for communications, likely through hub/gateway and works with DER vendors to establish communications.

Importance of interconnection standards/protocols: In the utility connection process, it is critical to ensure DERs are compliant with future communication standards to enable DERMS (IEEE 2030.11) and IEEE 1547-2018 compliant protocols (DNP3, SEP 2.0, SunSpec Modbus, TCP/IP)






Aggregator Utility Models



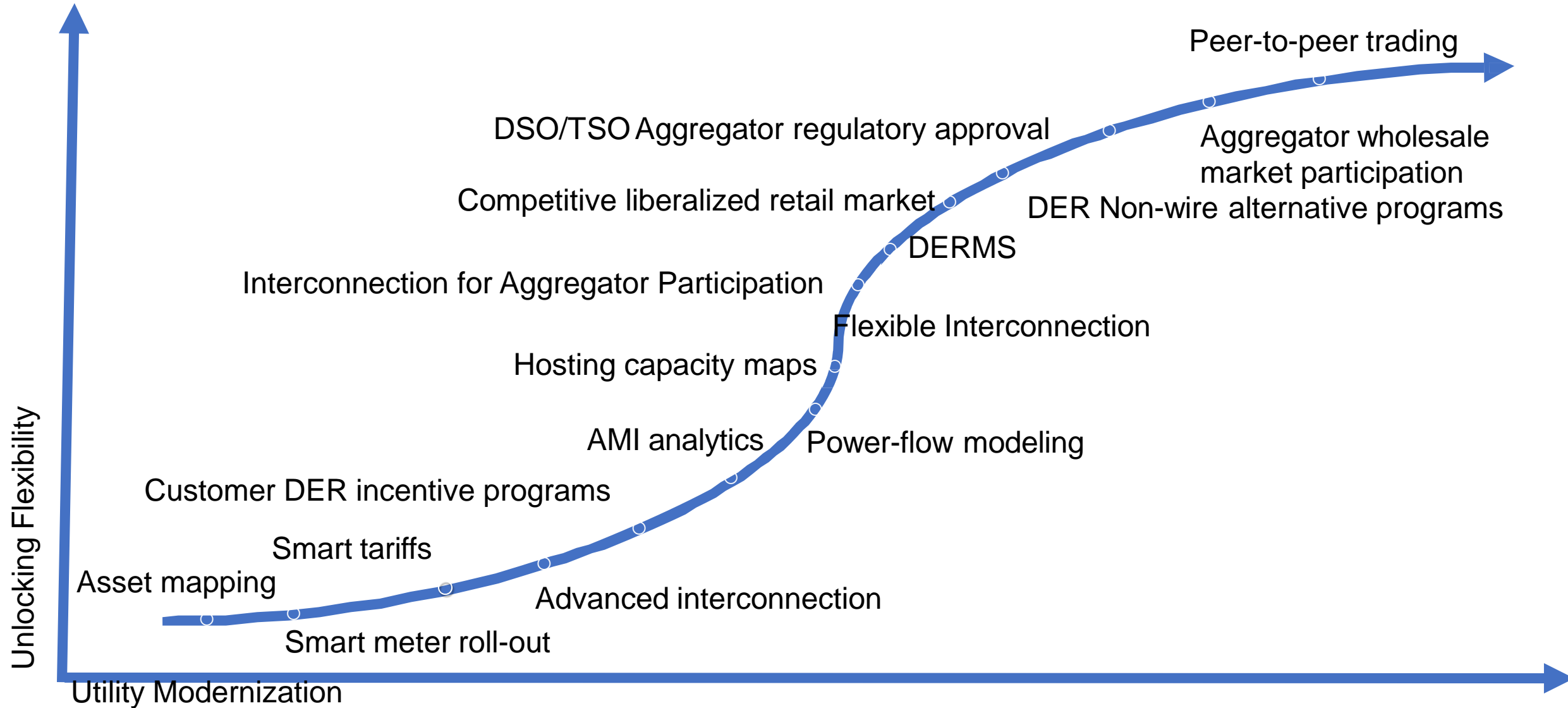
Wholesale Aggregators – A Long-term Path

- Complex aggregator models have many technical, regulatory, and stakeholder requirements that need to be met (e.g., FERC 2222)
- However, more simple aggregator models do exist and are being practiced

TECHNICAL REQUIREMENTS 	Hardware: <ul style="list-style-type: none">• Controllable load and supply assets such as energy storage, electric vehicles and distributed generation• Smart meters (to provide real-time power consumption and production), home gateways (energy boxes) and smart appliances for energy management, to enable VPP operation
	Software: <ul style="list-style-type: none">• Aggregation software, algorithm to calculate the optimal operation of each unit• Real-time communication between the aggregator and the hardware system• Advanced demand and supply forecasting models/platforms for optimised scheduling of dispatchable distributed energy resources
	Communication protocols: <ul style="list-style-type: none">• Common interoperable protocol for co-ordination among system operators, network operators and prosumers
REGULATORY REQUIREMENTS 	Wholesale market: <ul style="list-style-type: none">• Participation of aggregators should be allowed in electricity wholesale markets and ancillary service markets• Introduce regulations allowing decentralised sources to provide services to the central/ local grids• Clear price signals to guide the aggregators' operations• Regulations to mandate implementation of smart meters and smart grid infrastructure
	Distribution: <ul style="list-style-type: none">• Establishment of local markets for DSOs to procure services to avoid grid congestion and ensure grid stability• Data collection, management and sharing rules for DSOs to ensure consumer privacy
	Retail market: <ul style="list-style-type: none">• Regulators should define a standardised methodology for computing dynamic prices that can be adopted by retailers.• Functioning retail markets could provide innovative products and pricing models for various customer needs. For example, in Finland innovative products are being introduced, and customers can opt to choose the product and pricing method best suited to their needs (such as hourly dynamic pricing, retailers buying excess solar photovoltaic generation as a marketbased solution, ToU tariffs, etc.).• Regulation should set clear roles and responsibilities for market parties. Long-term foreseeable regulation is needed.• Liberalised markets, as opposed to regulated markets, could facilitate the market entry
STAKEHOLDER ROLES AND RESPONSIBILITIES 	System operation: <ul style="list-style-type: none">• Defining rules for co-ordination between distribution and transmission system operators
	Aggregators: <ul style="list-style-type: none">• Provide grid-related services to DSOs, if a market is established• Information exchange with DSOs related to capacity, location, type of DERs Distribution system operators: <ul style="list-style-type: none">• Ensure a level-playing field for all flexibility providers• Procure market-based flexibility services from aggregators• Securely share consumer and grid-related data with third parties as per applicable data privacy and sharing norms• Better forecasts for DER services based on past data or historical performance and weather forecasts

Source: IRENA (2019)

Unlocking Flexibility: Evolution *not* Revolution



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[Links/References \(If any\)](#)

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