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Session : Regulations for the Evolving Smart Energy Systems

Regulatory Framework for Ancillary Services in Evolving Smart Energy Systems Challenges and Strategic Solutions

Presented By

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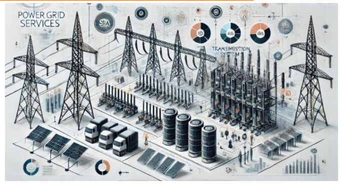
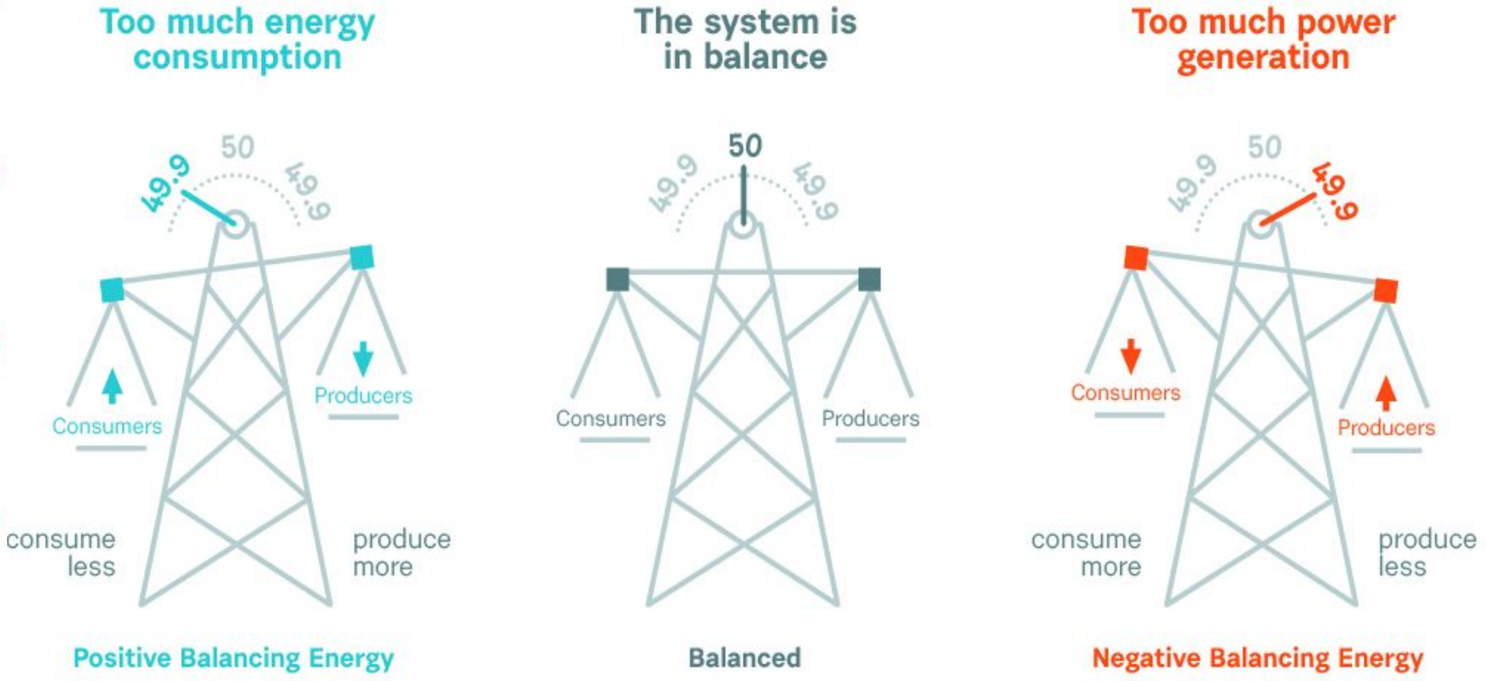
INTRODUCTION

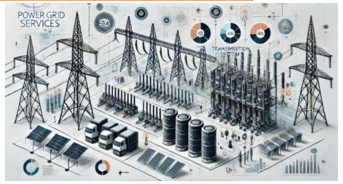


In the swift evolution of smart energy systems ancillary services are essential energy solutions that safeguard grid stability and reliability, ensuring seamless power system operations amidst dynamic supply and demand fluctuations and resultant it demands a strong regulatory framework.

- Grid Stability
- Renewable Integration
- Regulatory Challenges
- Policy Solutions



The Role of Ancillary Services in Smart Energy Systems



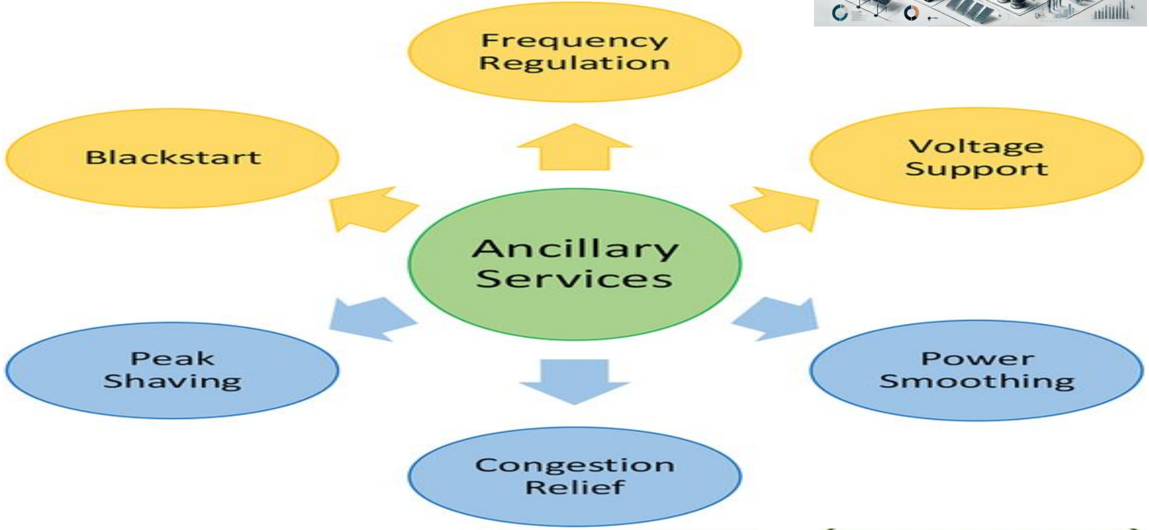
Ancillary services ensure power system reliability and stability. In smart grids, their complexity increases with variable generation, bidirectional flows, and distributed energy participation.

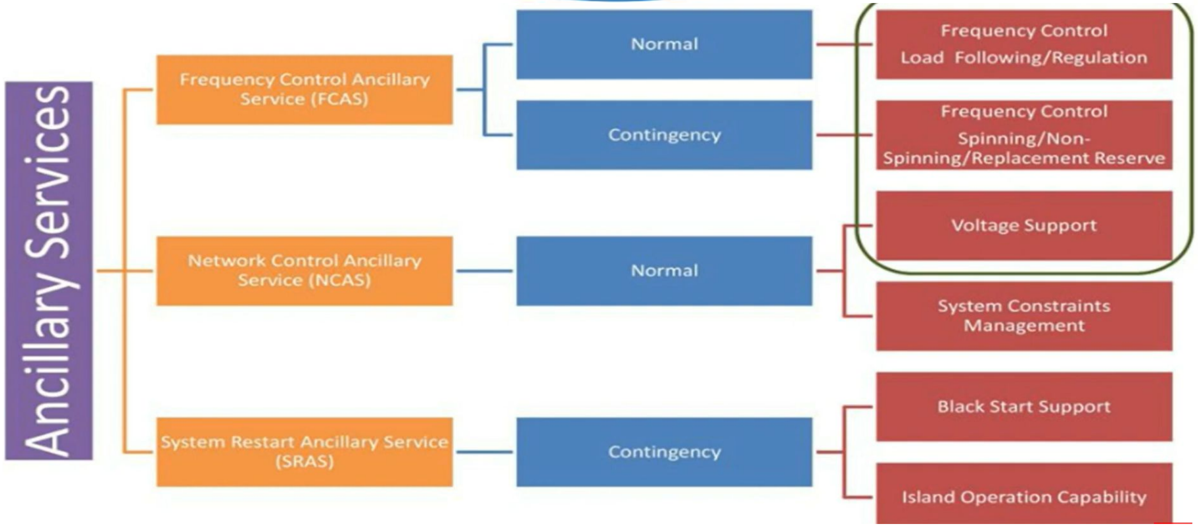
Key Types of Ancillary Services

- **Frequency Regulation**: Balancing supply and demand in real-time to maintain grid frequency.
- **Voltage Control**: Ensuring consistent voltage levels across the grid.
- **Reserves**: Backup capacity to respond to sudden demand or generation fluctuations.
- **Black Start Capability**: Restoring power after a total or partial blackout.

Emerging Ancillary Services

- **Flexibility Services:** Managing variability from renewable energy sources.
- **Cybersecurity as a Service:** Protecting digital grid assets from cyber threats.
- **Grid Congestion Management:** Optimizing energy flow to avoid overloading transmission lines.

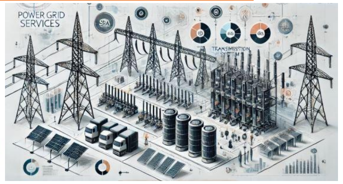




Current Regulatory Framework

The regulatory framework for ancillary services in power systems varies by region,

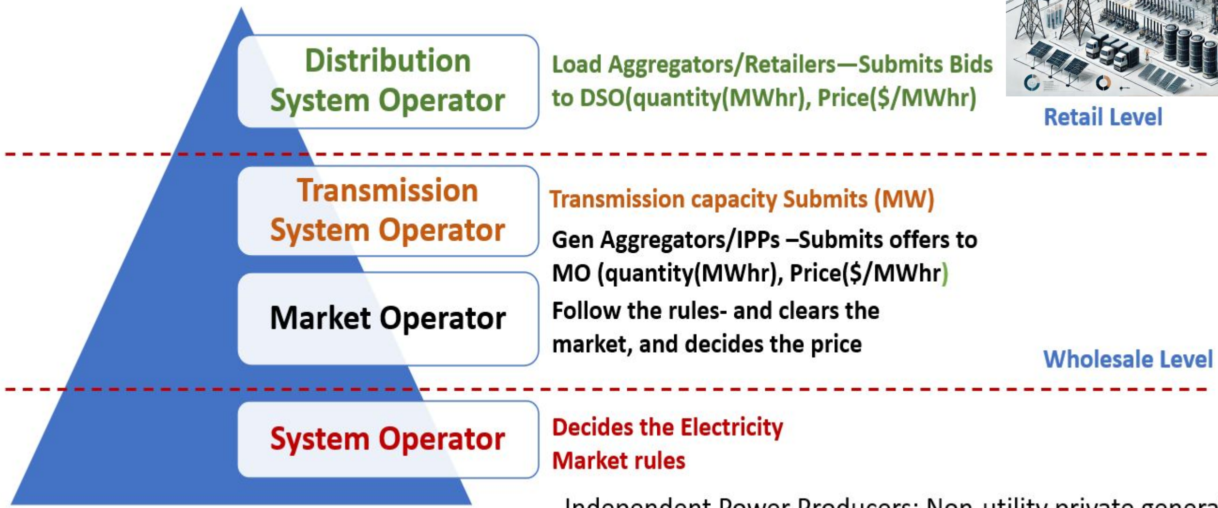
Key Components of Existing Regulations



Market Design: Ancillary services markets operate in parallel with energy markets, managed by independent system operators (ISOs) or regional transmission organizations (RTOs).

Participation Rules: Historically, traditional generators have dominated these markets, with minimal involvement from distributed energy resources (DERs).

Pricing Mechanisms: Pricing models vary by region and service type, utilizing either cost-based or market-based approaches



Independent Power Producers: Non-utility private generators will sell power to utility, or end users, or a central government buyer.

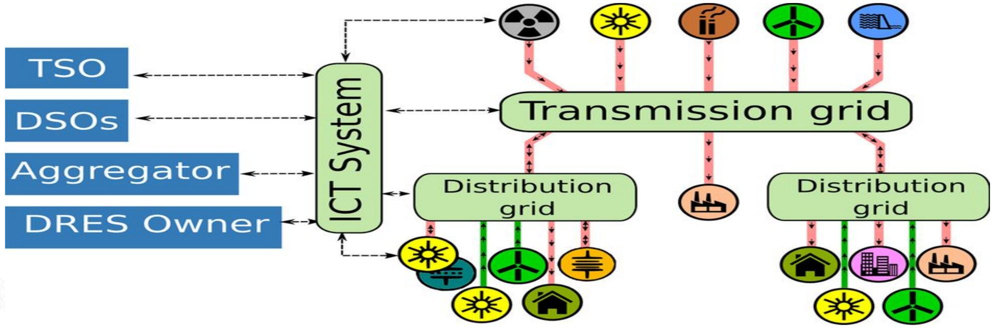
Day-ahead Energy Markets

- Clears before 24 hours in advance
- Dispatch duration 30/60 minutes
- Nodal/Zonal Markets
- Bidding Window 3 Hours

Real-Time/ Balancing/Regulating/Spot/Intra-Day Energy Markets

- Clears one hour in advance
- Dispatch duration 5/10/15 minutes
- Nodal/Zonal Markets
- Bidding Window 30 minutes

Note: Whatever the bids are not cleared in Day-ahead energy markets, will participate in real-time markets



Challenges in the Current Regulatory Framework

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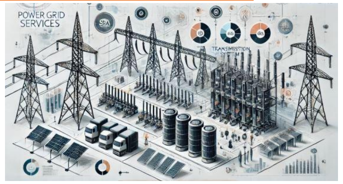
The shift to smart energy systems introduces unique regulatory challenges



Market Design and Participation

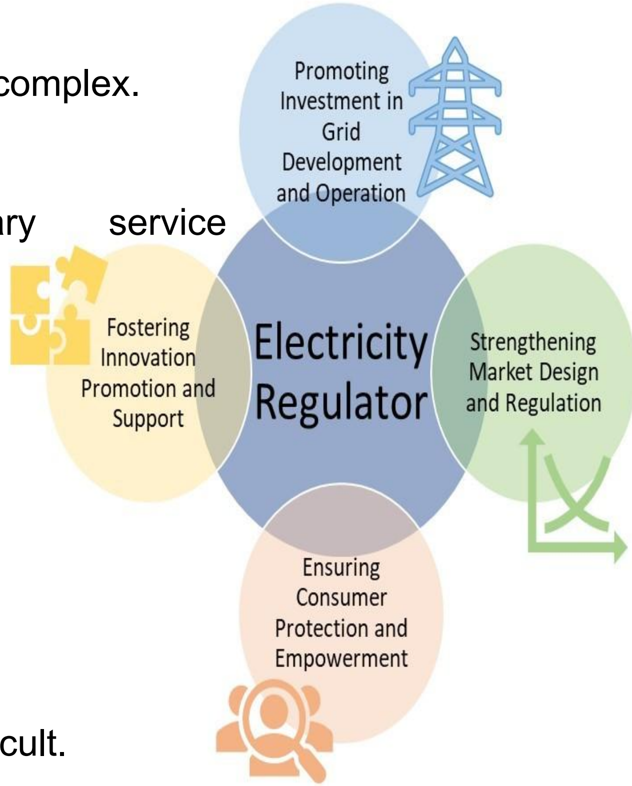
- **Integration of DERs**: Small-scale renewable generators and prosumers face limited mechanisms for market participation.
- **Transparency**: Ensuring equitable access to ancillary service markets remains a significant challenge.
- **Pricing Mechanisms**: Developing dynamic pricing models that accurately reflect real-time grid conditions is highly complex.

Technological Complexity

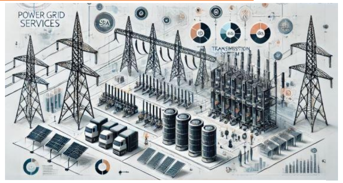
- **Intermittency of Renewables**: The variable output of renewable energy sources creates strain on traditional ancillary service operations.
- **Digitalization Challenges**: Managing large volumes of data from sensors, IoT devices, and advanced metering infrastructure demands sophisticated solutions.

Policy and Regulatory Gaps

- **Fragmented Policies**: Inconsistent regulations across regions disrupt market efficiency and integration.
- **Slow Adaptation**: Regulatory frameworks often fail to keep pace with advancements in smart grid technologies.
- **Financial and Operational Constraints**
- **Cost Recovery**: Balancing fair compensation for ancillary service providers while minimizing consumer costs is difficult.
- **Infrastructure Limitations:** Legacy systems often lack the capability to support the requirements of modern ancillary services.



Strategic Solutions



Regulatory Innovation

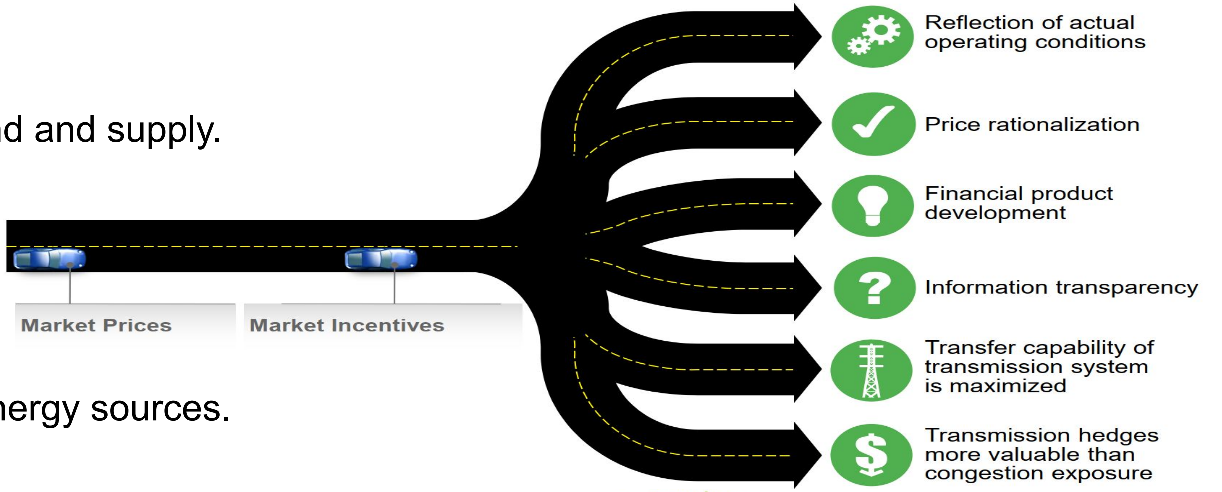
Develop standardized regulations to facilitate DER participation.

Encourage technology-neutral policies to foster innovation in ancillary services.

Market Redesign

•Implement real-time pricing mechanisms to reflect the dynamic nature of demand and supply.

•Introduce performance-based incentives for ancillary service providers.



Technology Integration

Promote advanced forecasting and AI-driven analytics for grid stability.

Encourage deployment of energy storage systems to complement renewable energy sources.

Cybersecurity Measures

Mandate robust cybersecurity protocols and regular audits for all market participants.

Develop a unified framework for data privacy and security.

Stakeholder Collaboration

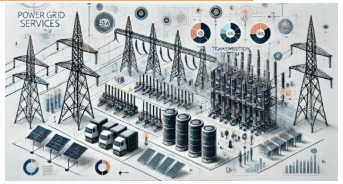
Foster partnerships between utilities, DER aggregators, and technology developers.

Facilitate regular forums and working groups to align regulatory and operational goals.

LMP Locational Marginal Pricing = System Energy Price + Transmission Congestion Cost + Cost of Marginal Losses

Benefits of a Robust Regulatory Framework

A strong regulatory framework enhances stability, ensures fair practices, safeguards consumers and investors, and upholds accountability, creating a more reliable and efficient economy.



- **Grid Reliability and Resilience**

A well-regulated ancillary service market ensures that the grid can handle variability and disruptions effectively.

- **Economic Efficiency**

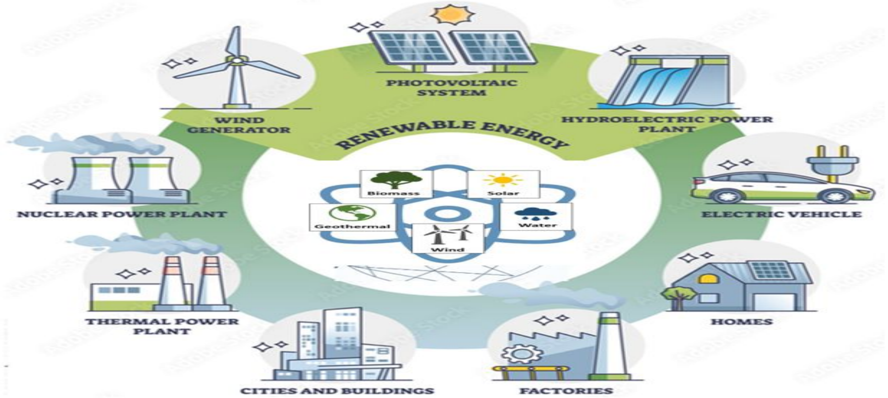
Competitive markets for ancillary services reduce costs while ensuring fair compensation for providers.

- **Renewable Energy Integration**

Enhanced regulation enables higher renewable penetration without compromising grid stability.

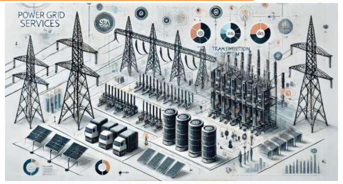
- **Consumer Empowerment**

Prosumers and DER operators can actively participate in the grid, fostering a participatory energy ecosystem.



Global Best Practices

Regulatory reforms in the U.S., UK, Australia, and Germany have enabled energy storage, DERs, and advanced grid services, enhancing flexibility and stability. Modern policies drive competition, reduce costs, and improve cross-border energy coordination.



- **California Independent System Operator (CAISO)**

CAISO has pioneered real-time markets for ancillary services, effectively integrating high levels of renewable energy.

- **European Network of Transmission System Operators for Electricity (ENTSO-E)**

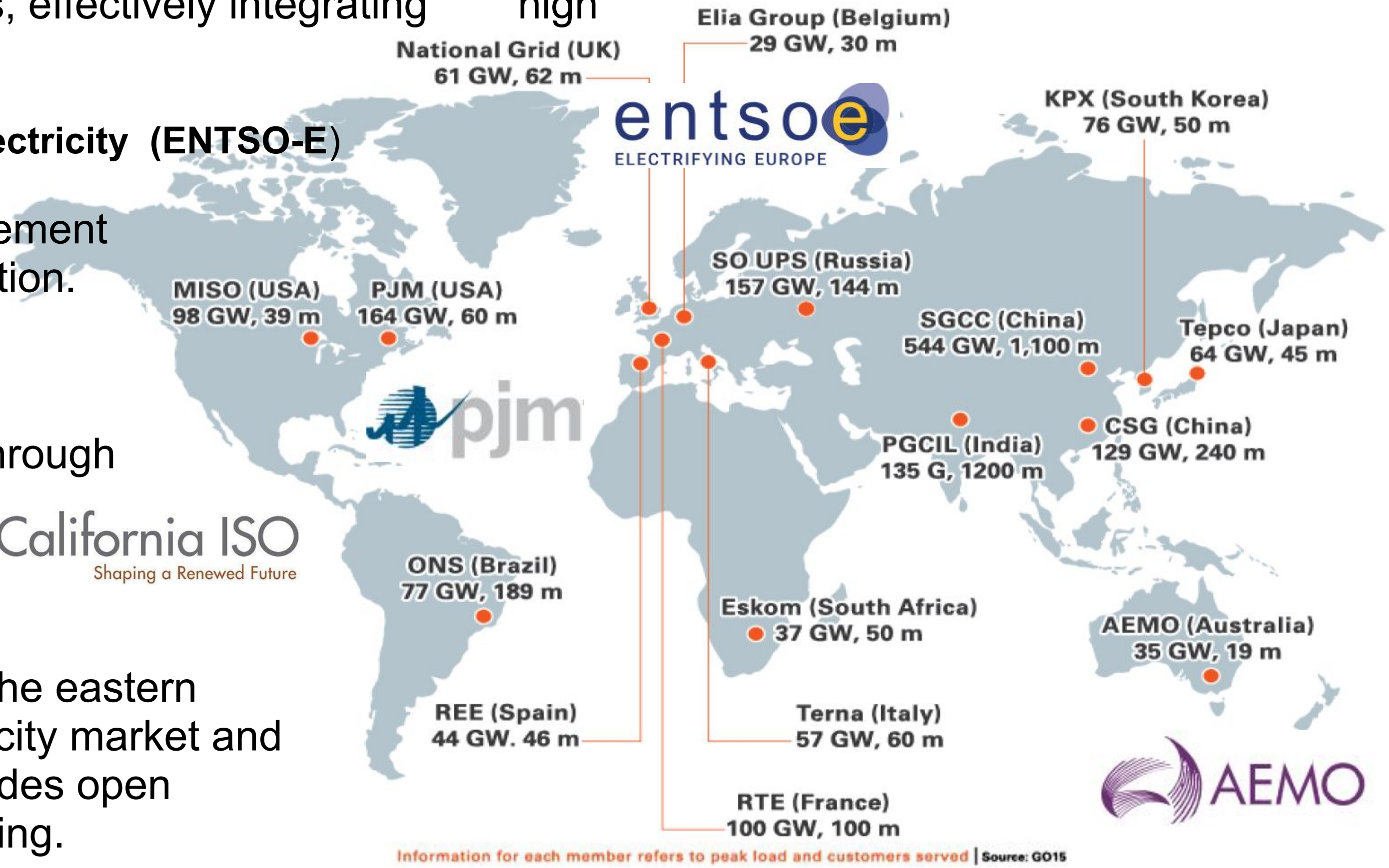
ENTSO-E's harmonized approach to ancillary service procurement across EU nations provides a model for regional cooperation.

- **Australia's National Electricity Market (NEM)**

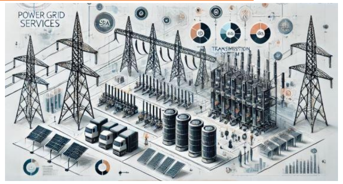
The NEM incorporates DERs into ancillary service markets through innovative aggregation models.

- **Pennsylvania-New Jersey-Maryland(PJM)**

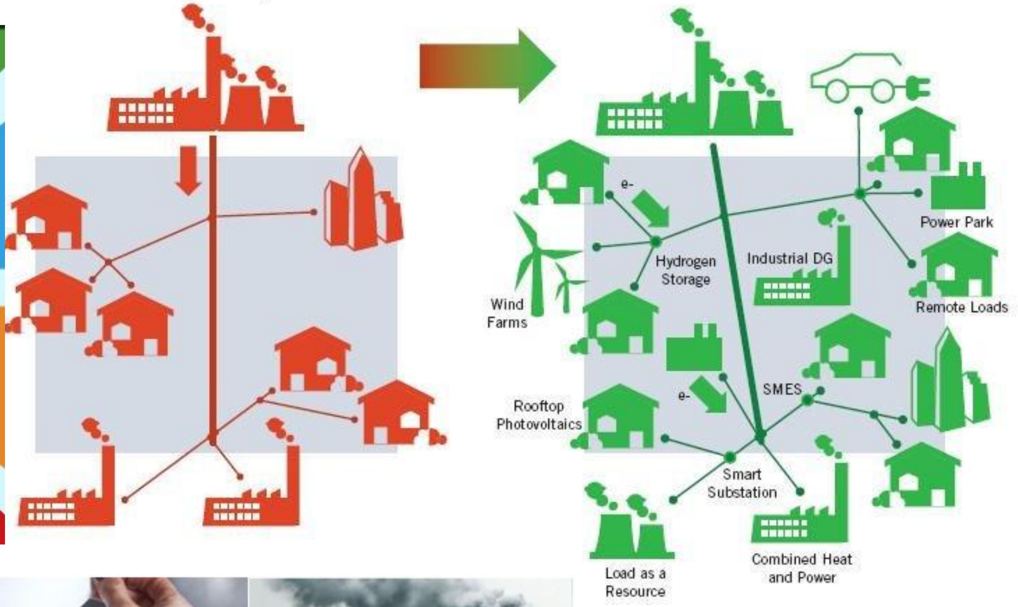
PJM refers to a regional transmission organization (RTO) in the eastern United States, It operates a competitive wholesale electricity market and manages the reliability of its transmission grid. PJM provides open access to the transmission and performs long-term planning.



KEY TAKEAWAYS



The evolution of smart energy systems requires bold regulatory reforms. Integrating renewables, enabling DERs, and ensuring cybersecurity will strengthen grid resilience, while innovative policies drive sustainability and targeted CO_2 reduction.



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THANK YOU

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