Terry Mohn - Smart Grid creates an Over-the-Counter Market for Energy Sales

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General MicroGrids
Balance Energy

About General MicroGrids

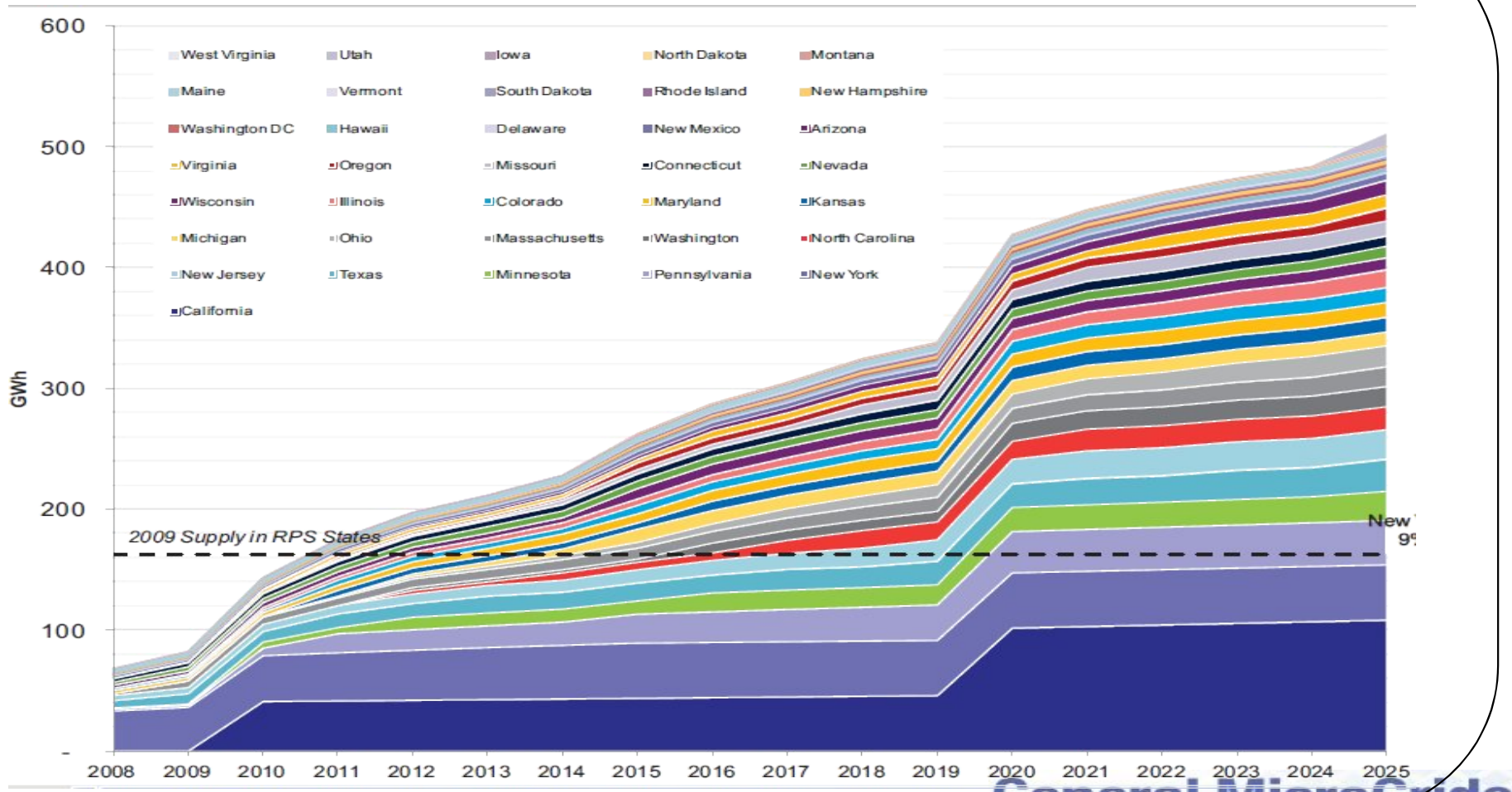
- General MicroGrids, Inc (GMI) is an end-to-end solution provider for renewable energy technologies and transformational microgrid construction.
- GMI's ***Balance Energy*** intelligent energy software platform "iESP", manages microgrid control, dispatchable renewable generation and resource control systems for campuses, industrial complexes, electric cooperatives, small communities and distribution utilities.
- Safe, controllable and reliable MicroGrids integrating renewable generation are complimentary infrastructure with customer assets that increase grid reliability, stabilize long-term energy costs, and mitigate negative environmental impact.

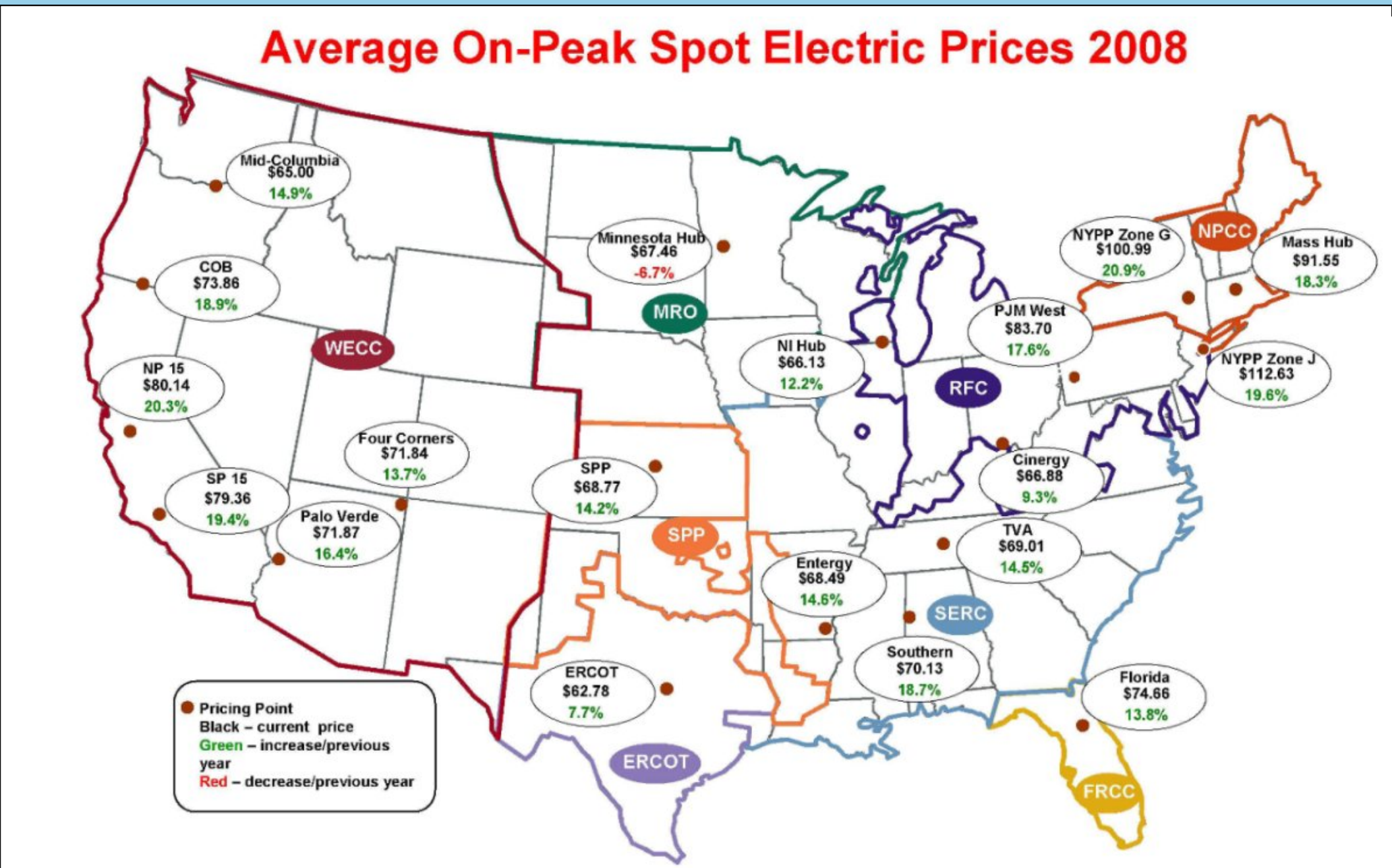
Motivating Context

- Regional and national renewable standards
- Large wind and solar farms
- Rising energy costs
- Recessionary budgets
- Expensive and delayed transmission lines
- Customers managing distributed energy resources
- Microgrids become numerous and clustered

- A need for smarter grid
  - Centrally managed
  - Locally optimized

Demand for Renewables (*US RPS Example*)





Source: Derived from *Platts* data.

Updated February 6, 2009

Utility Impact

- Increased penetration of renewable energy into the generation mix
- Technology upgrades within the utility
- New systemic impact occurring behind the meter
- Distributed energy resources will likely become the normal state; therefore, how do we integrate:
  - analog-centric power system
  - digital-centric information infrastructure
- Responding to these issues requires a new approach

What Will the Smart Grid Look Like?

- High use of renewables – 20% – 35% by 2020
- Distributed generation and microgrids
- “Net” metering – selling local power into the grid
- Distributed storage
- Smart meters that provide near-real time usage data
- Time of use and dynamic pricing
- Ubiquitous smart appliances communicating with the grid
- Energy management systems in homes as well as commercial and industrial facilities linked to the grid
- Growing use of plug-in electric vehicles
- Networked sensors and automated controls throughout the grid

Distributed Energy Resources

Benefits

- Improved grid reliability
- “Green” alignment
- Improved energy use and fuel costs
- Improved operating efficiency
- Market participation
- New revenue sources

Risks

- Slow adoption
- Lack of control systems
- No history of aggregation success
- Lack of incentives
- Few investors
- Regulatory hurdles
- Lack of education

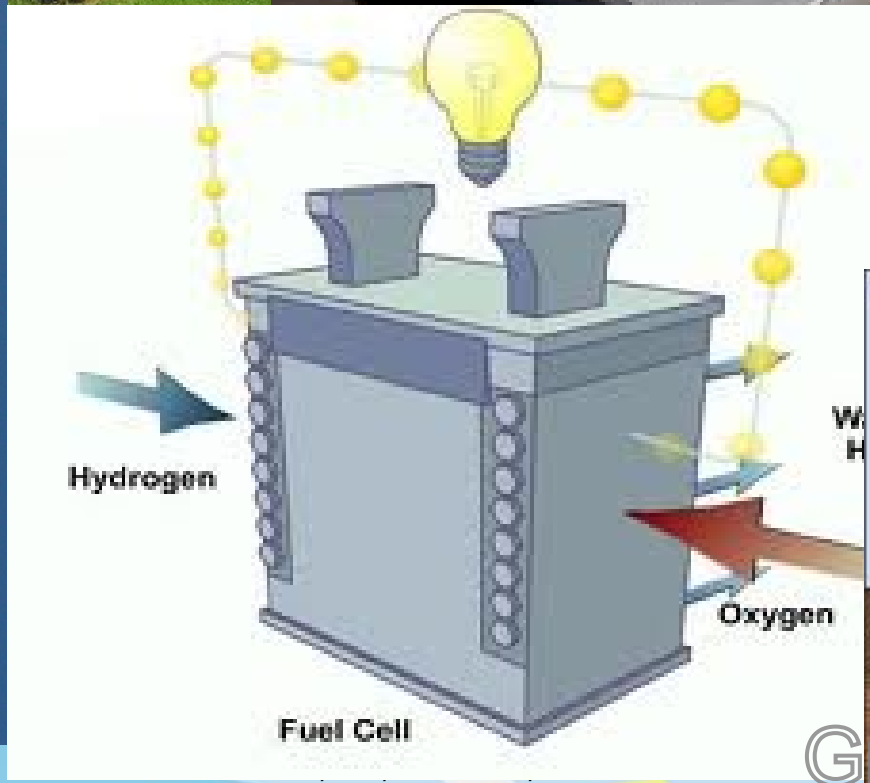
Changes in the Network

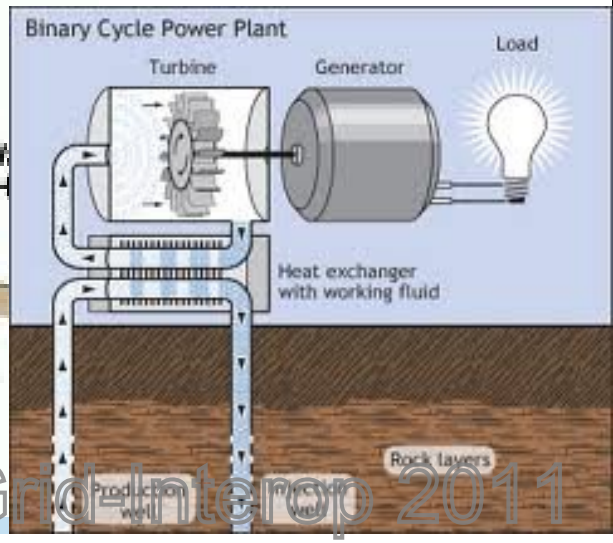
- Consumer engagement with resources to solve power issues locally
- Two-way power flow in distribution
- As prices increase, local renewables will increase in residential, commercial, and industrial
- Imperative to transform from passive to active control in distribution
- New ways for distribution to become a transmission resource

Microgrid-Based Power Systems

- Distributed resources treated as an integrated and autonomous system
- Localized to a customer, community or region
- Smart grid applied towards balancing loads with renewable's variable generation
- Must complete energy efficiency measures
- Integrate storage, load shifting, base plus variable generation with smarter grid
- Participate in power, frequency and demand markets

Consumer owned Generation





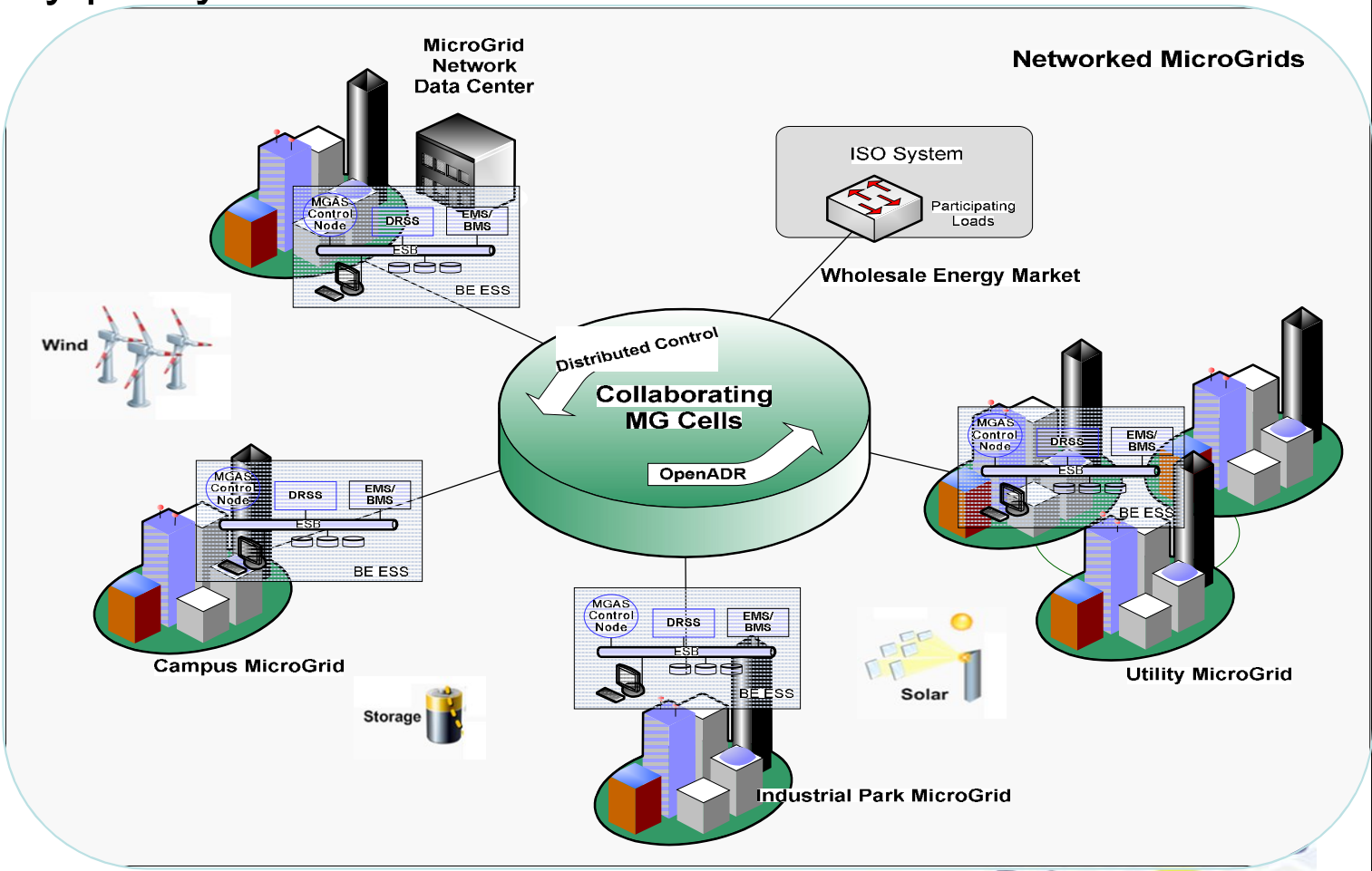
Microgrid Control Strategies

- Blend individual microgrid requirements with grid and market support
- Balance load and generation across microgrid networks
- Control both power flow and digital information

- Power flow:
  - Voltage
  - Frequency
  - Phase angle
  - Transients
- Digital Information:
  - DER
  - Monitoring
  - Markets
  - Forecasting

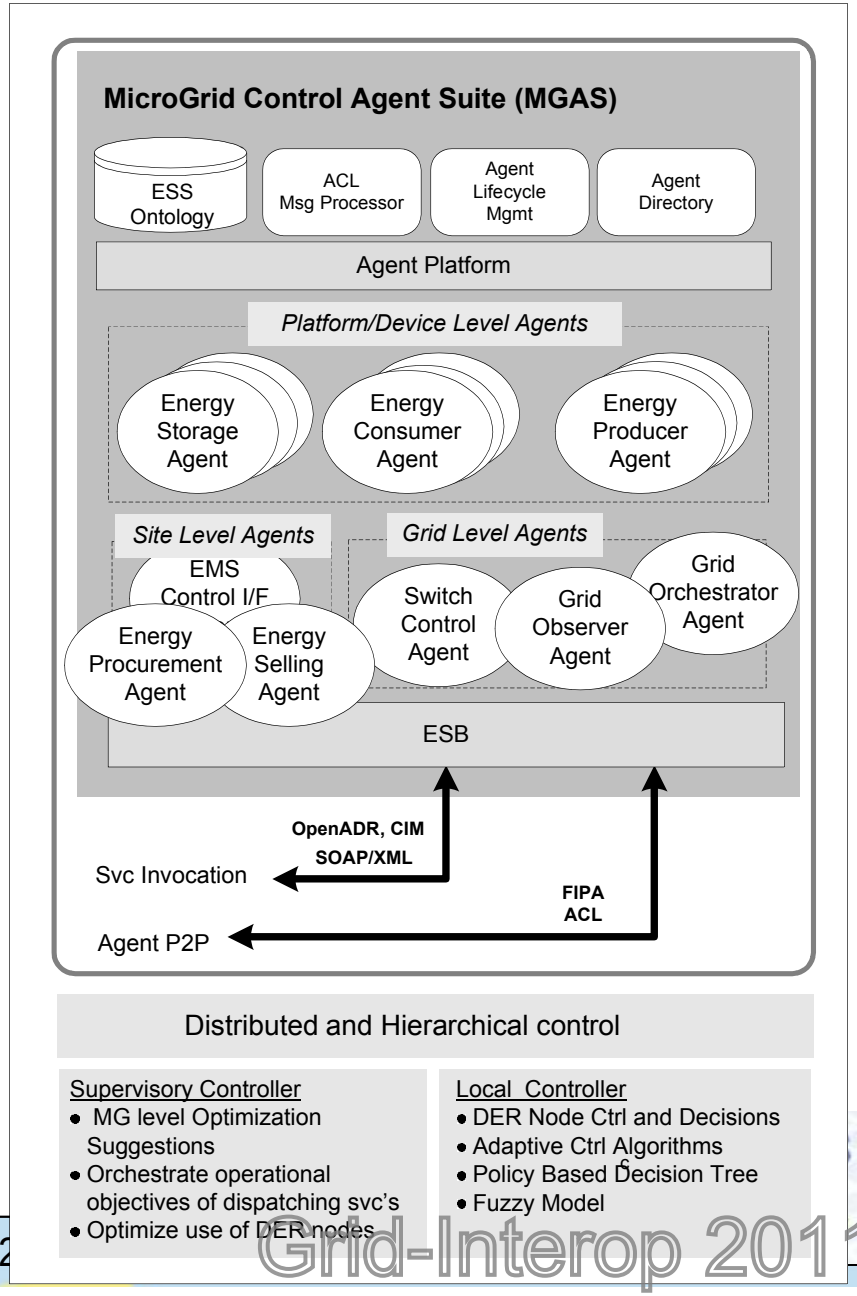
Networked MicroGrids

- Central storage
- Within municipality districts
- Possible now if there are no franchises
- Changes to regulatory policy



Microgrid Agent-Control System

- Add modern digital to legacy analog systems
- Orchestrate discrete DER with local grid and market-based distributed generation and demand response
- Arbitrate multiple microgrid cells for the benefit of grid stability
- Rules-based distributed intelligence
- Highly scalable, secure, adaptive and intelligent control system



Core behaviors inherited by all agents

- Built in support for policy based workflow orchestration which allows for configuring multiple operational criteria.
- Decision logic that incorporates analysis and response criteria based on electrical grid parametric models and rule based contingencies.
- Embedded behaviors for coordination with power analytics modules and grid protection schemes that manage grid reliability.
- Agent behaviors can be configured to operate autonomously (decisions are specific and local to the agent) or semi-autonomously (decision are collaborative towards achieving joint objectives with other agents).
- Agent control behavior implementations are based on real-time, deterministic domains (i.e. all actions have defined, bounded response times).
- Agent deployment and communications are performed using Smart Grid and Web Service standards (XML, SOAP, WSDL, UDDI, OpenADR, CIM).

Summary

- Economic, sociologic and environmental pressures require us to examine a new energy management model
- Distributed resources meet individual requirements and offer larger grid support
- MicroGrids allow generation, storage, and loads to operate autonomously, balancing out voltage and frequency issues
- MicroGrid cells are scalable and can be clustered locally as well as market opportunities
- Distribution financial transactions will accompany energy transactions to other microgrids and local utilities
- A secondary trading market will emerge

General MicroGrids

Balancing Energy for a smarter, renewable-driven grid

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