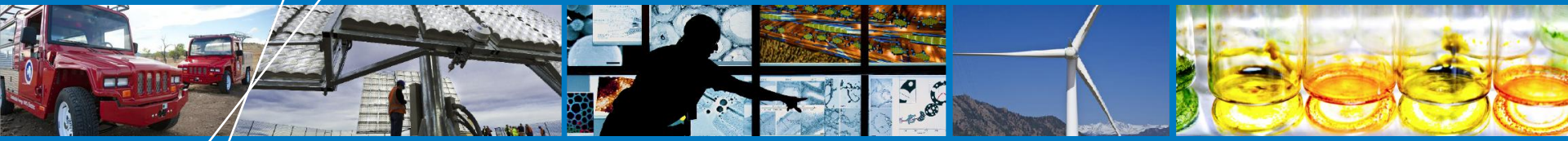
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

ESI: Policies, Regulations, and Business Models

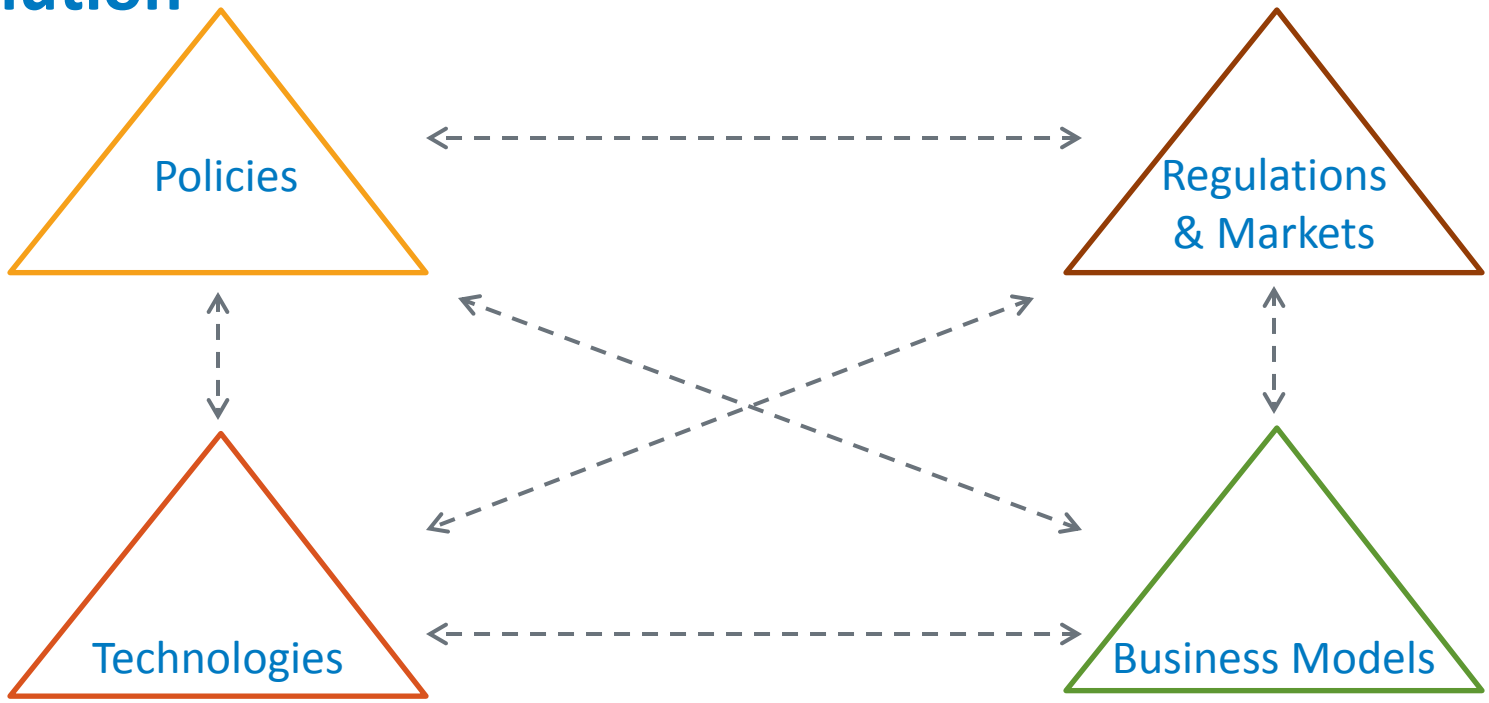


Jaquelin Cochran, Ph.D.

23 July 2014

ESI: Getting the right policies and regulations is critical

Co-evolution



We are in a time of transition:

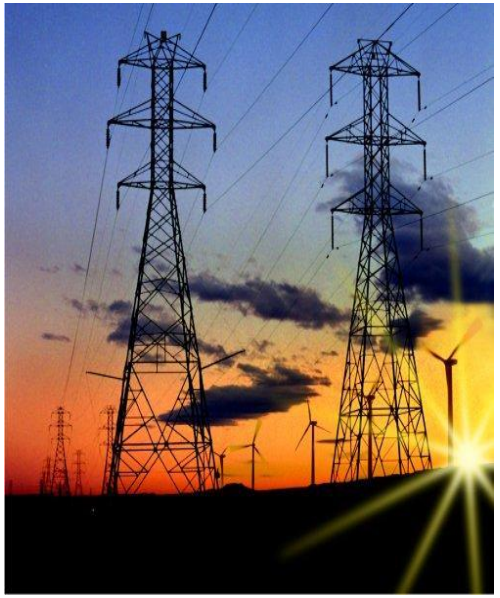
- Some energy technologies have had huge cost declines
- Technologies are opening up new business opportunities
- Regulations and business models are lagging

Evolution is especially noticeable in electricity sector

- Utilities have dominated provision of electricity
- In the historical utility business model, utilities earned revenue from:
  - Selling electrons
  - Regulated rate of return on investments
- Least-cost for a given level of reliability has been prime metric

Changes are upending the utility business model

- Energy Efficiency (flat demand growth)
- Demand Response (elastic consumer)
- Distributed Generation (affecting demand and revenues)
- High variable RE (changing system operations)
- Third-party owned and operated energy systems



Source: NREL PIX 19498

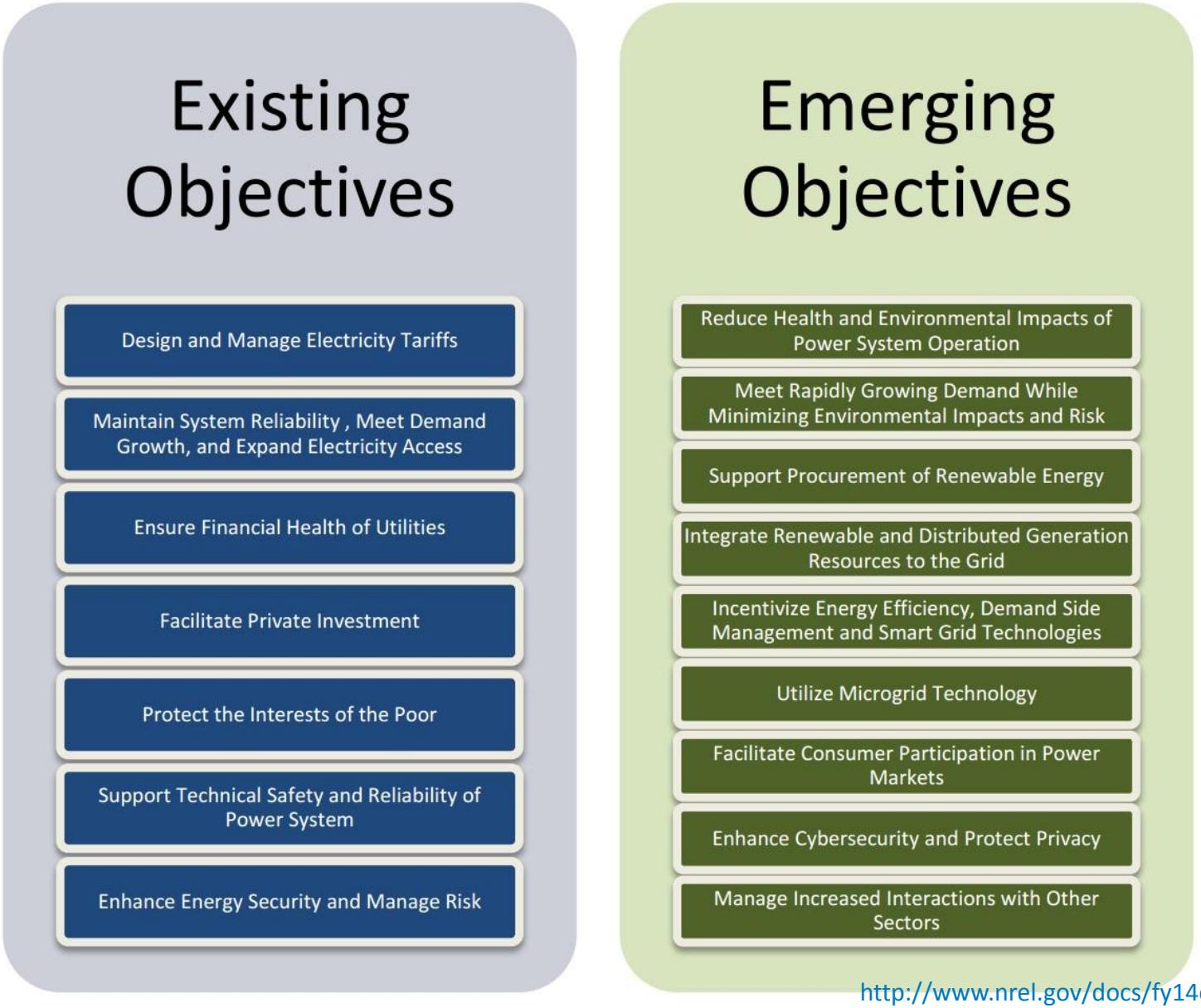
Emerging utility business models are strongly linked to regulatory models

- **Decoupling** to address EE
- **Performance based** payments (wider range of desired attributes); least cost and least risk
- **Utility as system integrator**; orchestrator (e.g., manage distribution-transmission interchanges and markets)
- **Utility as energy services** provider
- Electricity grid as a **public good**, *not a natural monopoly*

Source: RMI "Economics of Grid Defection"

New regulatory models are needed to support new business models and anticipate impacts of EE, DR, DG, VRE, & 3rd parties

Existing and Emerging Regulatory Practices

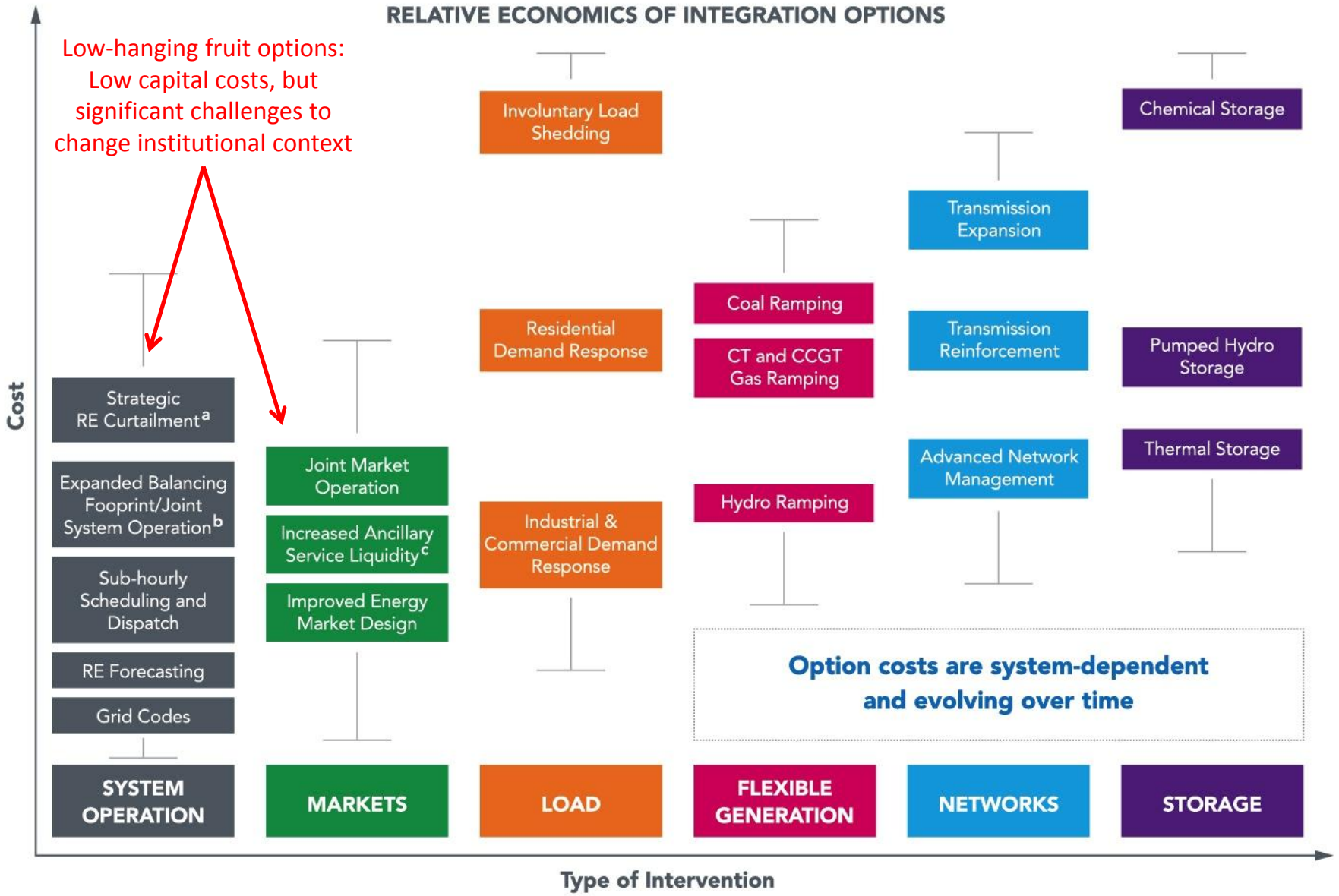


http://www.nrel.gov/docs/fy14osti/61570.pdf

Examples of changing regulatory expectations: Integrating Variable Renewable Energy

- **Power system operation must carefully consider two sources of flexibility:**
  - Physical power system: generators, transmission, storage, interconnection…
  - Institutional system: including dispatch decisions closer to real time, better use of forecasting, better collaboration with neighbors
- ***Smart grids require smart frameworks and markets***

Examples of changing regulatory expectations: Integrating Variable Renewable Energy



Examples of evolving regulatory practices: Integrating Variable Renewable Energy

	VRE Generation	Grid Infrastructure	Short-term Security of Supply: *Flexibility*	Long-term Security of Supply: *Adequacy*
Early Stage (VRE approximately < 5%[4])	Establish appropriate VRE support mechanisms Establish queue management	Establish efficient siting processes Simplify interconnection protocols	Initiate data collection efforts that will facilitate formal grid integration studies	Initiate data collection efforts that will facilitate formal grid integration studies
Intermediate Stage (VRE approximately 5-20%)	Refine VRE support mechanisms if necessary Refine siting and queue management	Establish VRE grid codes and designated transmission zones Coordinate generation and grid planning Establish distribution network standards for VRE	Initiate formal grid integration study Improve forecasting Broaden balancing-area footprints Improve system operation methods	Initiate formal grid integration study, with capacity credit or resource adequacy components as needed
Advanced Stage (VRE approximately >20%)	Encourage alignment between demand and VRE production Incentivize VRE dispatchability	Expand grid interconnection and market coupling Employ locational pricing Incentivize active network management	Employ advanced system operation Incentivize demand response (DR) Incentivize flexible generation and/or storage	Improve adequacy mechanism in accordance with predominant paradigm (e.g., capabilities market; strategic reserve requirement; full scarcity pricing)

Priority regulatory actions at early VRE

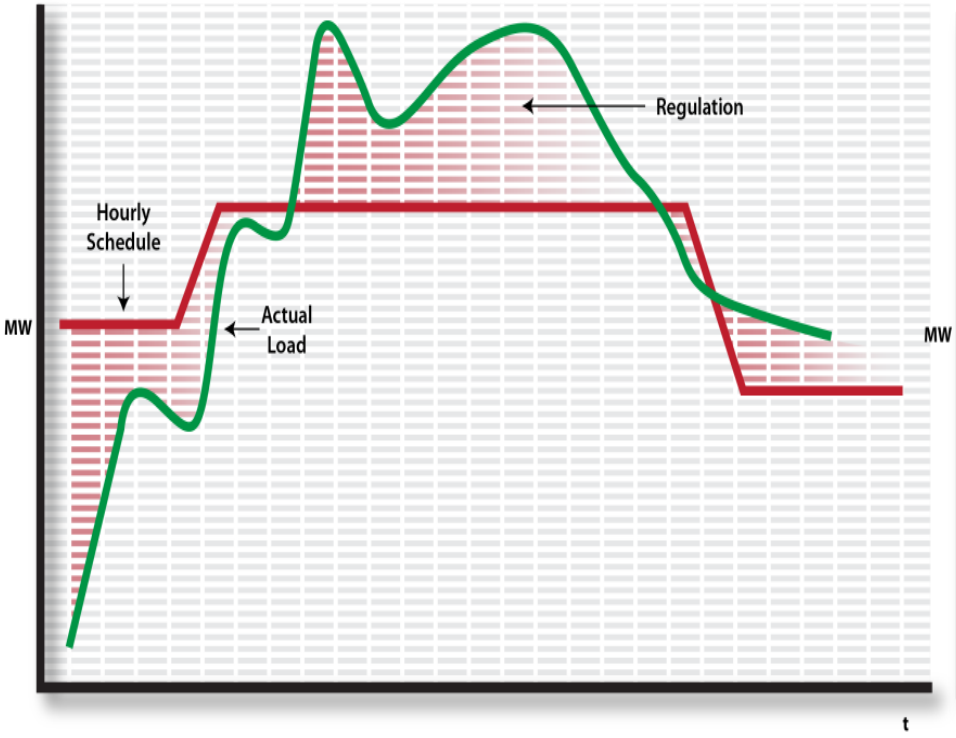
	VRE Generation	Grid Infrastructure	Short-term Security of Supply: *Flexibility*	Long-term Security of Supply: *Adequacy*
Early Stage VRE (approximately < 10%[4])	Establish appropriate VRE support mechanisms Establish queue management	Establish efficient siting processes Simplify interconnection protocols	Initiate data collection efforts that will facilitate formal grid integration studies	Initiate data collection efforts that will facilitate formal grid integration studies

Regulatory concerns primarily focus on:

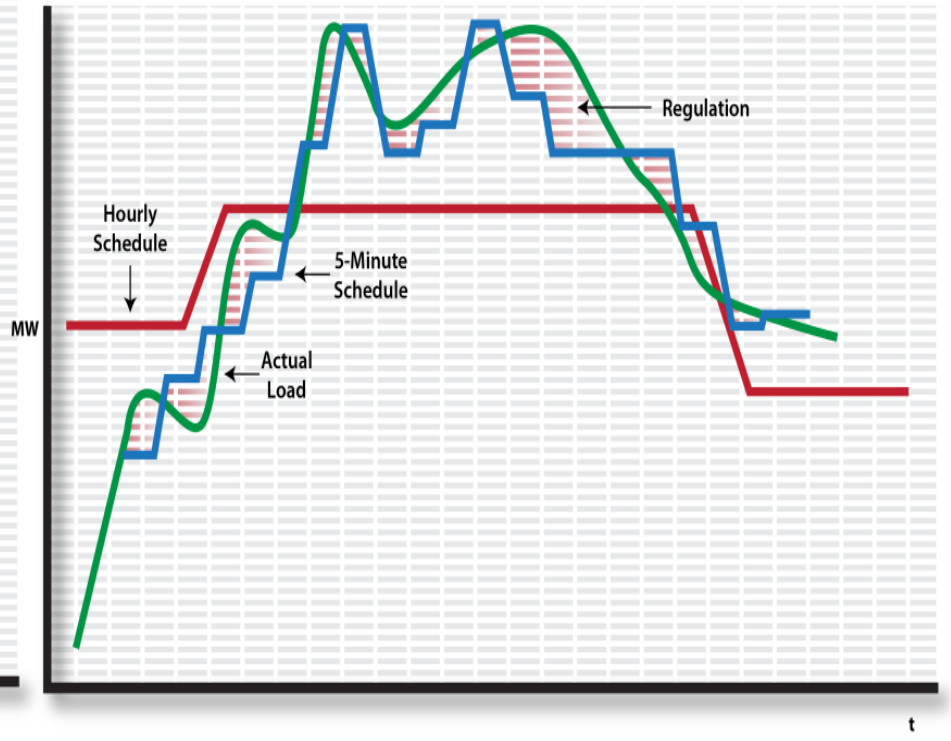
- Establishing mechanisms to procure new RE
- Defining interconnection standards

Faster Scheduling Reduces Expensive Reserves

Hourly schedules and interchanges



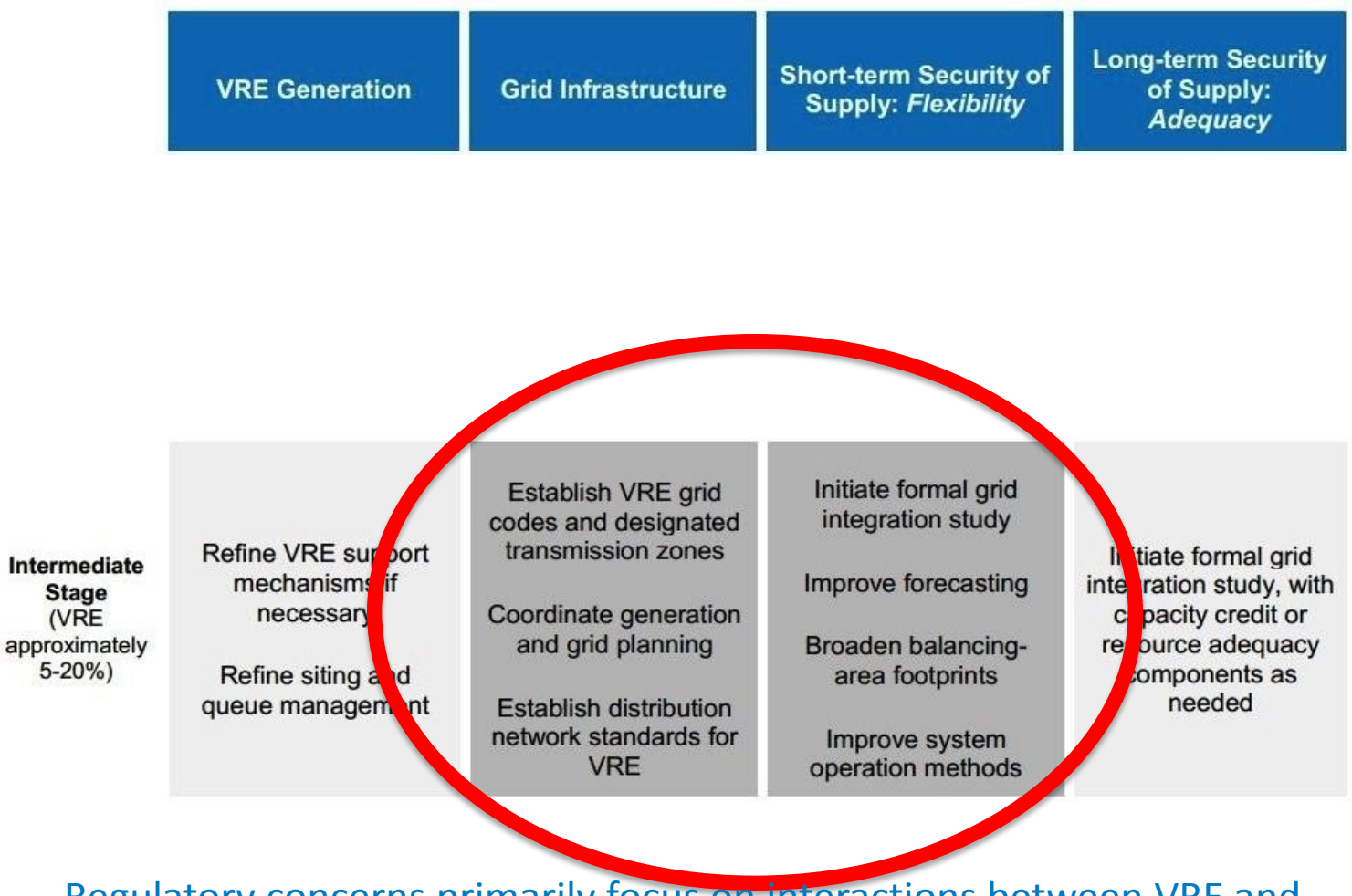
Sub-hourly scheduling



Source: NREL

Dispatch decisions closer to real-time (e.g., intraday scheduling adjustments; short gate closure) reduce uncertainty.

Priority regulatory actions at intermediate VRE



Regulatory concerns primarily focus on interactions between VRE and existing systems, e.g.:

- Cost-efficient planning for grid extension
- Identifying VRE integration needs and evaluating costs

Examples of intermediate stage VRE penetration issues: grid infrastructure

Texas "competitive renewable energy zones" (CREZ)

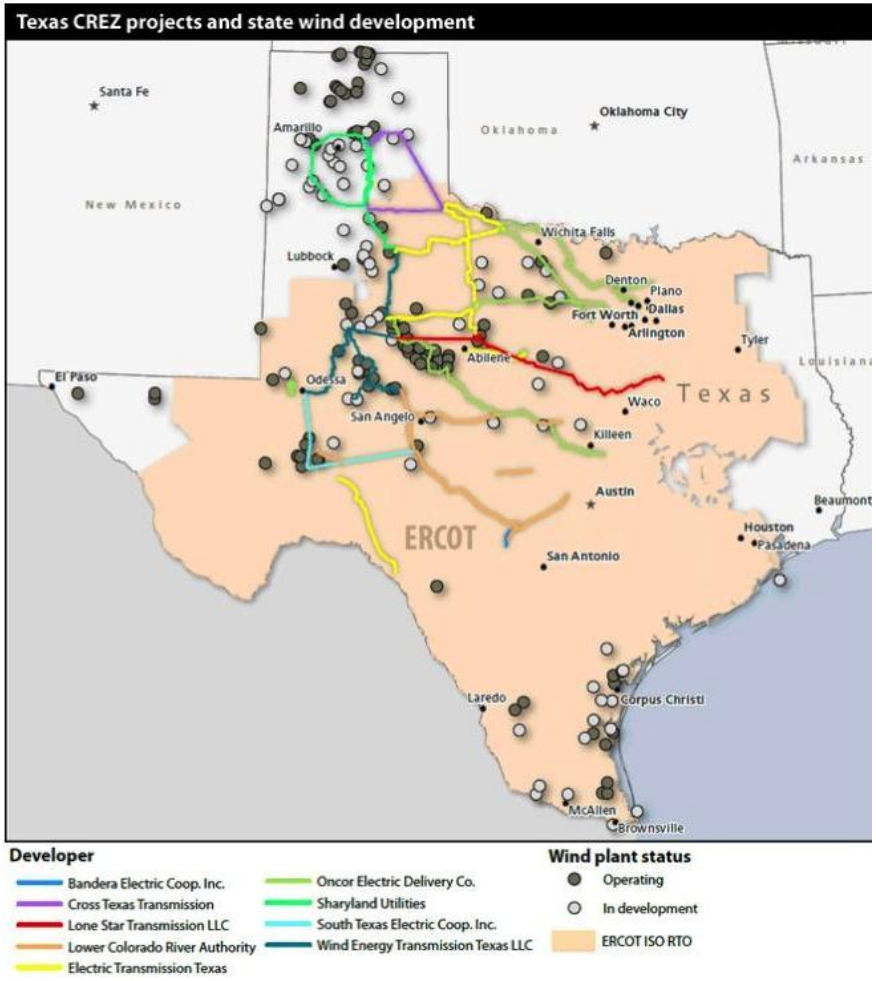


Figure 4. "Competitive RE zones" and related transmission lines in Texas
Source: SNLFinancial (2013)

Priority regulatory actions at advanced VRE

	VRE Generation	Grid Infrastructure	Short-term Security of Supply: *Flexibility*	Long-term Security of Supply: *Adequacy*
Advanced Stage (VRE approximately >20%)	Encourage alignment between demand and VRE production Incentivize VRE dispatchability	Expand grid interconnection and market coupling Employ locational pricing Incentivize active network management	Employ advanced system operation Incentivize demand response (DR) Incentivize flexible generation and/or storage	Improve adequacy mechanism in accordance with predominant paradigm (e.g., capabilities market; strategic reserve requirement; full scarcity pricing)

Regulatory concerns primarily focus on evolution of entire power system:

- Major institutional changes
- Grid infrastructure
- Conventional generation assets
- Demand elasticity
- Interactions with neighboring systems and energy systems integration

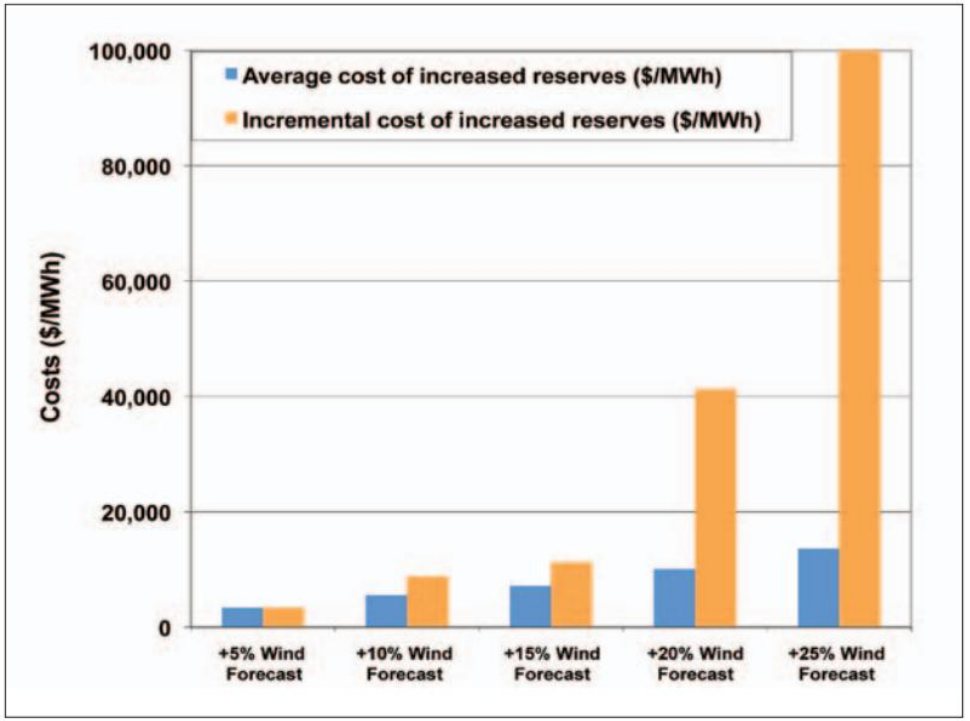
Encourage Demand Response

Demand response (DR)

- Examples: direct load control, real-time pricing
- Cost effective for extreme events and for reserves

Policy and Regulatory Options

- Allow DR to compete on a par with supply-side alternatives in utility resource planning and acquisition
- Consider potential value of enabling DR when evaluating advanced metering
- Examine ratemaking practices for features that discourage cost-effective DR – e.g., demand charges that penalize large customers for higher peaks which could occur when providing DR

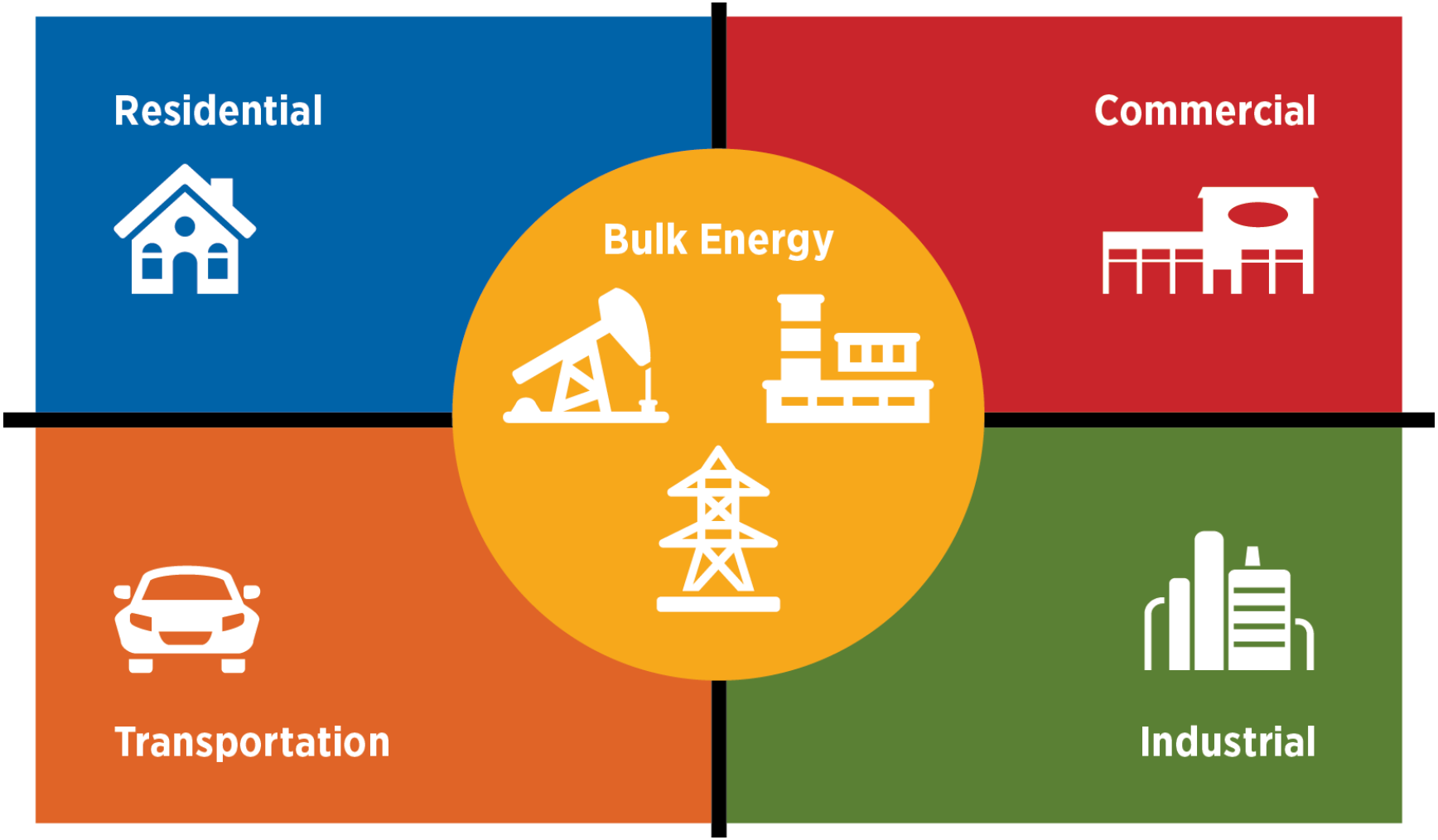


Cost of increasing spinning reserves

WWSIS Phase 1 (2010)

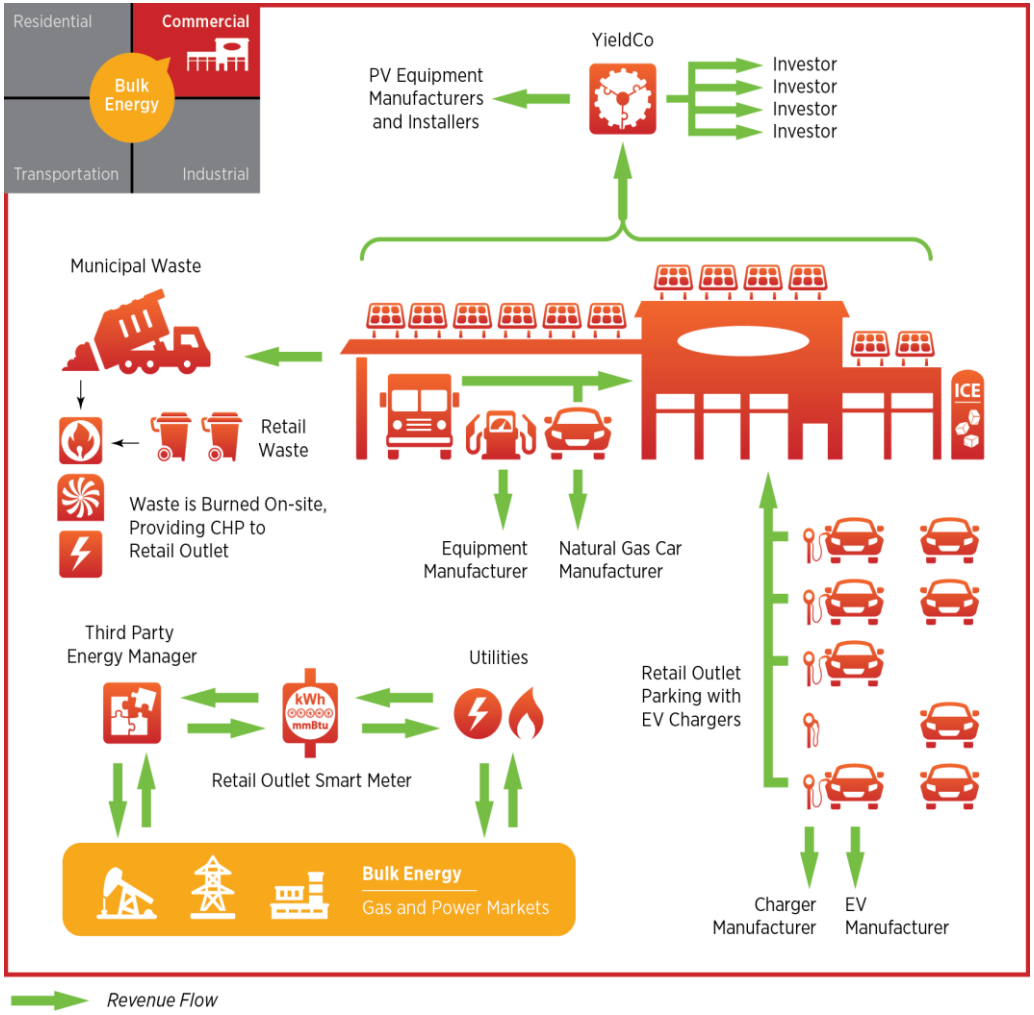
It's cheaper to pay load to turn off (demand response) for the 89 problem hours (1%) than to increase spinning reserves for 8760 hours/year.

Examples of evolving regulatory practices: Support evolving business models to provide *energy services*, not just electricity



http://www.nrel.gov/docs/fy14osti/60052.pdf

Energy Integration: Commercial



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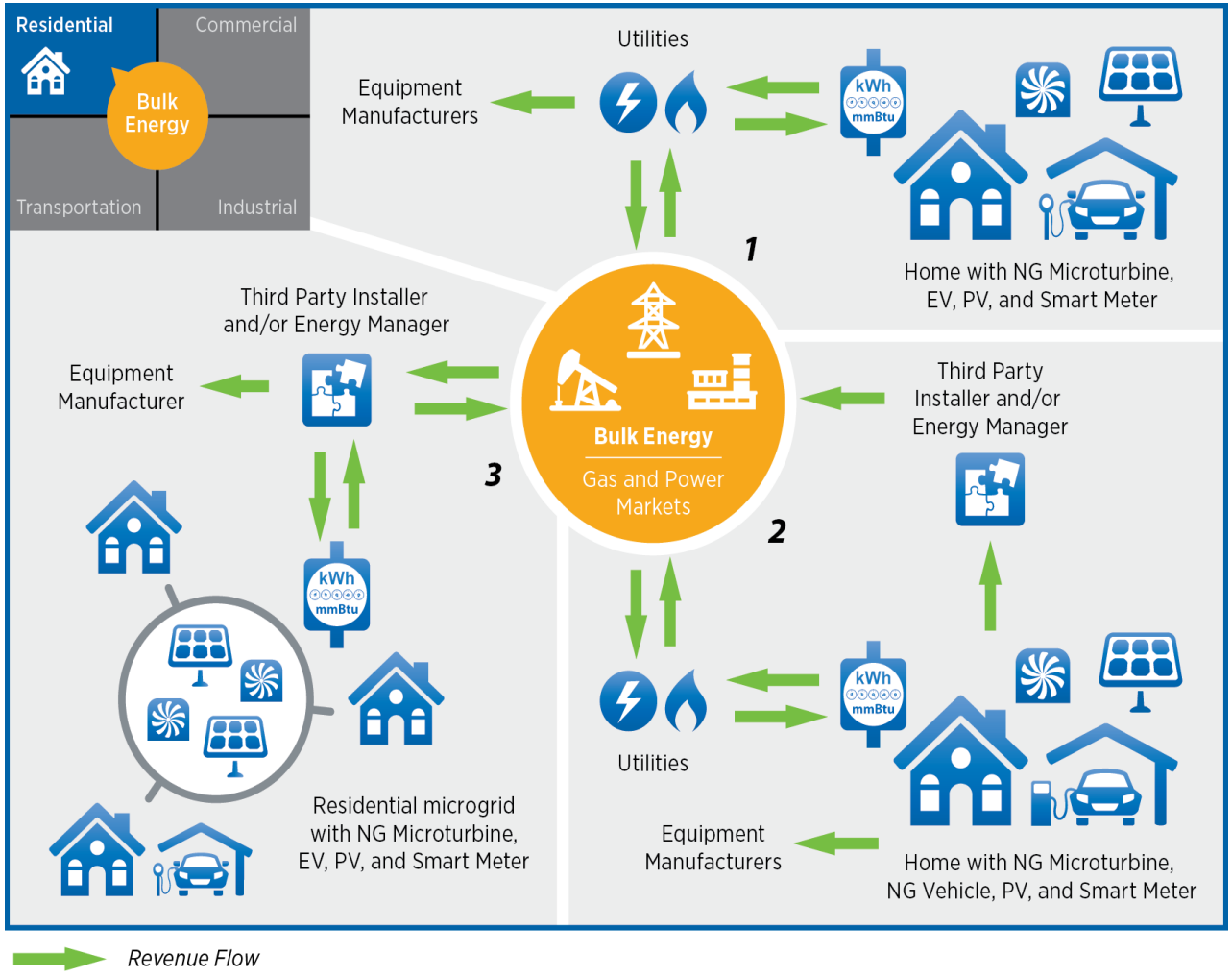
Energy Integration: Residential



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These scenarios require new regulations

Regulatory actions:

- Facilitate consumer participation in power markets
- Expansion of market products, such as facilitating wholesale market participation (aggregation) and financing energy services and equipment
- Help set values on different types of traditionally regulated services (e.g., grid as backup for high DG scenarios)
- Create legal framework for different types of ownership (e.g., for microgrids that historically have been utility-only)
- Approval of new infrastructure (e.g., siting of in-home NG refueling; rate basing public refueling)

Photo by Invenergy LLC, NREL 16037

Which need to occur in a wider policy context

Policy actions:

- Shift the basis of pricing from commodities to services
- Incentivize the modernization of the generation fleet
- Explore new utility business models
- Create metrics for an energy system for 2050

Which need to occur in a wider policy context

Policy actions:

- Shift the basis of pricing from commodities to services
  - Better reflect costs and benefits of supply, delivery, and demand-side resources
  - But how to value:
    - Reliability
    - Flexibility
    - Externalities?
- Incentivize the modernization of the generation fleet
- Explore new utility business models
- Create metrics for an energy system for 2050

Source: NREL PIX 26461

Which need to occur in a wider policy context

Policy actions:

- Shift the basis of pricing from commodities to services
- Incentivize the modernization of the generation fleet
  - How can risks be reallocated to incentivize retirements of inflexible plants?
- Explore new utility business models
- Create metrics for an energy system for 2050

Photo from iStock 72283000

Which need to occur in a wider policy context

Policy actions:

- Shift the basis of pricing from commodities to services
- Incentivize the modernization of the generation fleet
- Explore new utility business models
- Create metrics for an energy system for 2050

Source: NREL PIX 21394

Which need to occur in a wider policy context

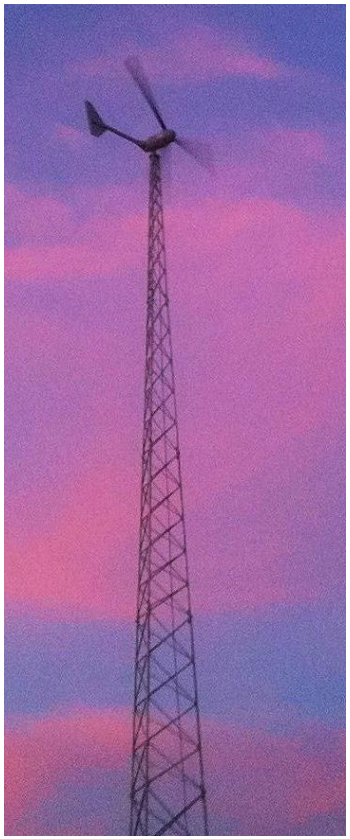
Policy actions:

- Shift the basis of pricing from commodities to services
- Incentivize the modernization of the generation fleet
- Explore new utility business models
- Create metrics for an energy system for 2050
  - What are the goals? What level of reliability? What ratepayer protections? What level of carbon?
  - Metrics can help provide investment certainty

Source: NREL PIX 10923

Closing remarks

- Policies, regulations, and business models for energy are evolving, in response to many factors, including:
  - Climate mitigation
  - Declining technology prices
  - Information technologies
- Clear and predictable policy and regulation will increase investment certainty, giving developers access to capital markets
- Clear policies will also open up creative ways to provide energy services
- Exciting time to be in this field!



Source: NREL PIX 19915