
Wind and RET Integration via the Smart Grid: *What's Possible and What's Practical?*

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Smart Grid and Renewable Energy: *Revolutionizing the Bulk Power System*

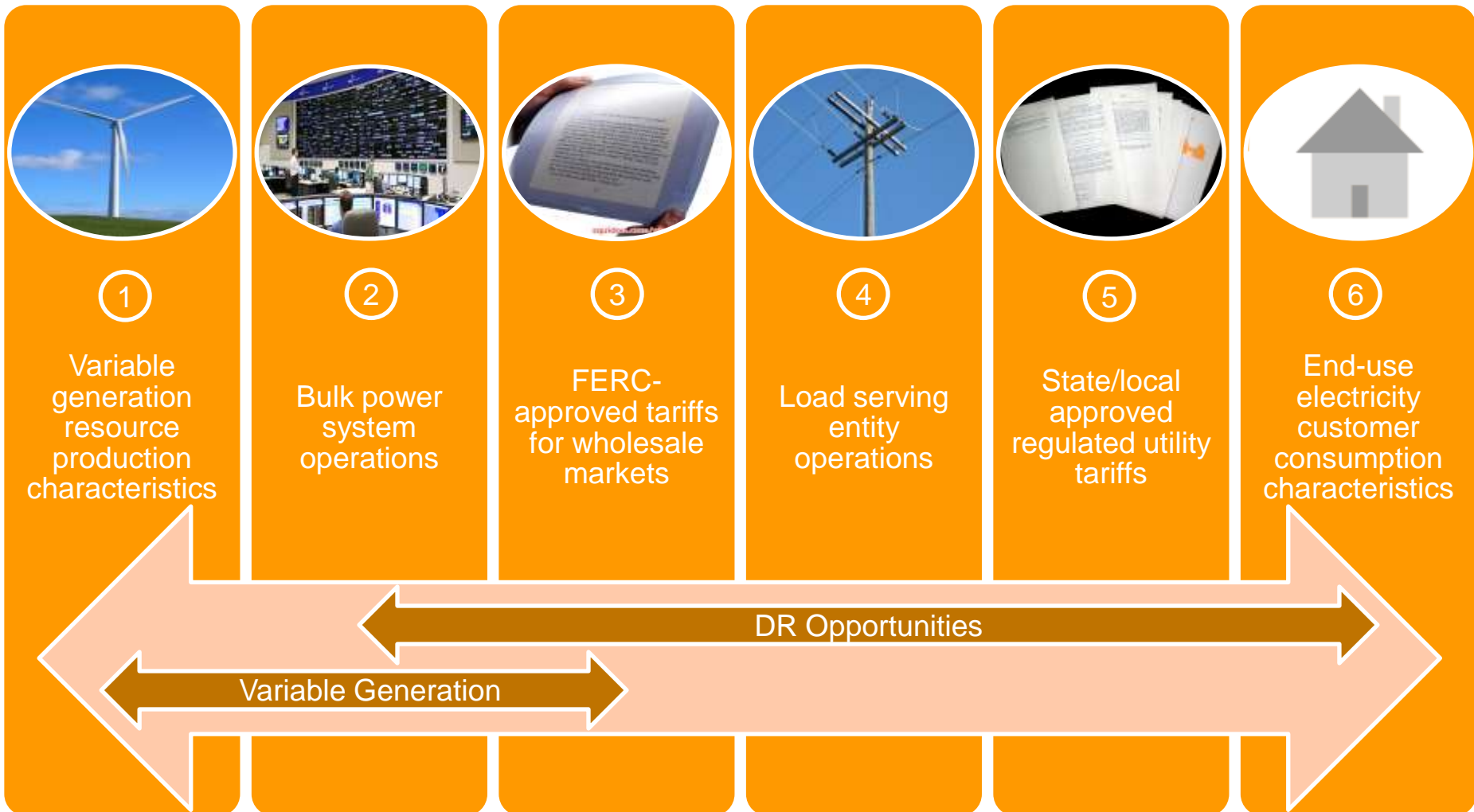
- The promise of Smart Grid is that it will revolutionize the way we consume electricity by adding sensing, computing and communications technology to the power grid ... so say its staunchest proponents
- The promise of renewable energy is that it will revolutionize how we generate electricity by ending our dependence on foreign oil, providing a locally available source of electricity, and reducing the level of pollutants ... so say its staunchest proponents

Is the Smart Grid the “Silver Bullet” for Renewable Integration Issues?

- Large scale deployment of renewable energy, because of its variable and often times unpredictable production characteristics, poses integration challenges for bulk power system operators
- The Smart Grid has the ability to better link end-use consumption of electricity with the bulk power system ... but will that be sufficient to mitigate ALL integration challenges or just some subset
- Understanding that the promise of renewable energy and the Smart Grid won't be realized for some time, the question is:

In the near-term, what role can the Smart Grid play in helping to integrate greater penetration of renewable energy resources?

Relationship Between Variable Generation Production and Customer Consumption



Can the Smart Grid Harness the Diversity and Flexibility of Mass-Market DR?

- The two-way communications capabilities of the Smart Grid provide the opportunity to expand the treatment of mass-market demand response (DR) as a fleet of distributed resources
- Current situation: PUC-approved DR tariffs' of many electric utilities (LSEs) place severe restrictions on differentially and selectively dispatching end-use customers as a fleet of resources
- Aggregators of Retail Customers (ARCs) are not bound by same limitations; their business model allows aggregation and selective dispatching of many disparate customers to meet a wide array of system needs

Expanding Customer Aggregation Through Retail Market Regulatory Changes

- **Removal of LSE tariff restrictions on differential dispatching of DR resources would offer more flexibility**
 - Removal requires careful consideration of potential differential impacts on customers
 - LSE's may not take advantage of flexibility
- **FERC Order 719 provides ARC's with access to mass-market customer and ISO/RTO markets, but some states are not complying or severely restricting this access**
- **Regulated LSEs can also select ARCs as 3rd Party providers of their DR programs**
 - ARCs have the technology to readily aggregate and manage customers as a fleet of resources
 - But, will they be bound to same restrictions as LSEs



Expanding Customer Aggregation Through Wholesale Market & Reliability Rule Changes

- Rules for wholesale markets and reliability were designed under a “generator-only” paradigm
- Capturing full value of DR opportunities requires changes to reliability rules and access to wholesale power markets
 - **Some ISO/RTOs and reliability councils have expanded product definitions to allow DR resources to provide ancillary services**
 - ◆ ERCOT: spinning reserve, supplemental reserves, and balancing up energy.
 - ◆ PJM: spinning reserve and regulation
 - ◆ Western Electric Coordinating Council (WECC): Allows PacifiCorp’s DLC program to satisfy requirements for non-spinning reserves
- Experience with DR must be sufficient for system operators to gain confidence that customer-based DR resources can perform well and/or predictably during times of need

Limited Ability for Time-Based Rates to Affect VG Integration Issues

Variable Generation Integration Issue	TOU	CPP	PTR	DA-RTP	RT-RTP
<1 Min. Variability					
1 Min. to 5 – 10 Min. Variability					
Short-term Forecast Error					●
Large Multi-hour Ramps		●	●	●	●
Daily Energy Profile	●			●	●
Long-term Forecast Error				●	●
Seasonal Energy Profile	●			●	●

- Weak political support in the U.S. and operational limitations will substantially restrict the ability for time-based rates at the mass-market level to affect Variable Generation (VG) integration issues
- If these issues can be overcome, in the future, residential and small C&I customer response from time-based rates could contribute more to mitigate VG integration issues

Portfolio of Incentive-Based Programs can Mitigate Multiple VG Integration Issues

Variable Generation Integration Issue	DLC	I/C	Emergency	Capacity	Energy	Ancillary Services
<1 Min. Variability						●
1 Min. to 5 – 10 Min. Variability	●					●
Short-term Forecast Error	●	●	●		●	●
Large Multi-hour Ramps	●	●			●	●
Daily Energy Profile	●				●	
Long-term Forecast Error	●				●	
Seasonal Energy Profile	●			●	●	

- Many incentive-based DR programs rely heavily on control and/or automation technology to achieve the desired level of aggregate response
- Mass-market customers' acceptance of the types of control technology envisioned will dictate DRs ability to expand its role in mitigating VG issues

Conclusions

- **Largest variability and uncertainty in variable generation is over time periods of 1-12 hours; time scales that are amenable to most DR opportunities**
- **Time-based rates, under current designs for mass-market customers, will likely not be as effective as incentive-based DR programs in mitigating VG issues**
 - **Rates with the greatest potential have the least political and regulatory support**
 - **Portfolios of incentive-based programs can address a broad spectrum of VG issues**
- **Accessing diversity and flexibility of customer demand may require revising retail market restrictions, wholesale market designs, and reliability rules for DR**

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