



# Energy Storage - The Power Grid's Digital Revolution

How it will change our perspective and approach,  
and increase the value of forecasting and optimization



# FERC Order 841

## Electric Storage Participation in Markets

[FERC Order 841](#) requires electricity markets to create an energy storage participation model that allows a resource to:

- Provide all capacity, energy, and ancillary services that the resource is technically capable of providing in the RTO/ISO markets
  - Both market-based and non-market-based services
- Be dispatched and set the wholesale market clearing price as both a wholesale seller and wholesale buyer
  - Generator and load at wholesale locational marginal price (LMP)
- Account for the physical and operational characteristics through bidding parameters or other means

# What are Market Participation Models?

- ISO/RTOs generally have a set of basic tariff provisions that apply to all market participants.
- The RTOs/ISOs then create tariff provisions for specific types of resources when those resources have unique physical and operational characteristics or other attributes that warrant distinctive treatment from other market participants.
- These distinct tariff provisions that are created for a particular type of resource are what FERC refers to as a “market participation model”.

# Current approach – add special “resource types” for different participation models

Increasing complexity  
and not a true hierarchy.  
Lacks full consistency of  
data structures and  
parameters.



## Battery Energy Storage Plant

*(note the extensive use of bidding parameters)*

P<sub>max</sub>=40MW, P<sub>min</sub>=-40MW, Ramp rate=20MW/s, Startup time=300ms, Max Energy Limit=160MWh, ...  
State of charge=80%, charge/discharge times, transition time between charging/discharging, ...  
(+ participate in regulation reserve, spinning reserve, online supplemental reserve, quick start, etc.) .

## Wind or PV Solar Plant

P<sub>max</sub>=forecast, P<sub>min</sub>=0, Ramp rate=100MW/min, Startup time=30 seconds, ...

## Conventional Plant

P<sub>max</sub>=500MW, P<sub>min</sub>=200MW, Ramp rate=5MW/min, Startup time=24hours, ...

## General Tariff and Bidding Parameters

Cost curves, P<sub>max</sub>, P<sub>min</sub>, Ramp rate, Startup time, ...

# The current approach slows innovation

Every new innovation that doesn't fit an existing participation model faces difficult and lengthy roadblocks to gaining market participation

1. Push RTOs and FERC to consider changes
2. Get FERC to issue Notice of Proposed Rule (NOPR)
3. Get FERC to issue a final rule
4. Get RTO market changes through the RTO/stakeholder process
5. Get FERC approval of the RTO's proposed tariff, or reject it and try again
6. Get the new tariff implemented and tested

These are barriers to innovation and the concept of open access, even when the new resource is a more flexible and a more capable resource that can provide valuable services to the ISO/RTO and ratepayers

# Alternative – One parameterized resource type

Technology-independent  
qualifications and  
performance expectations

## Idealized model of a highly flexible generator/load resource

P<sub>max</sub>, P<sub>min</sub>, Ramp rate, Startup time, Max Energy Limit, State of charge, ...

Charge/discharge times, transition time between charging/discharging...

Ancillary services: regulation reserve, spinning reserve, online supplemental reserve, quick start, ...

Software (EMS, MMS, etc.)  
implements and tests for  
this single resource type and  
full range of its parameters

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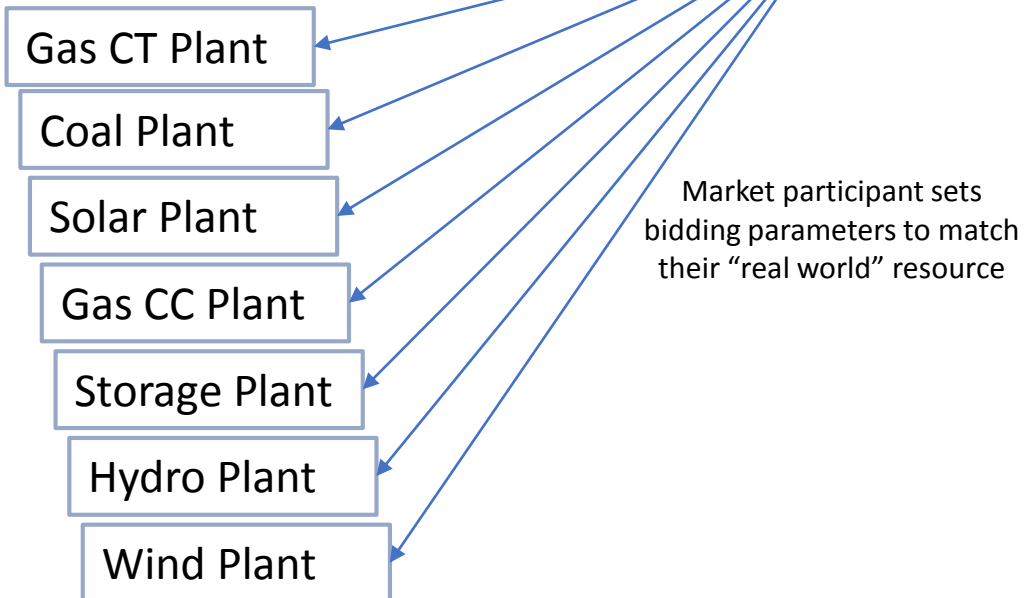
Pmax, Pmin, Ramp rate, Startup time, Max Energy Limit, State of charge, ...

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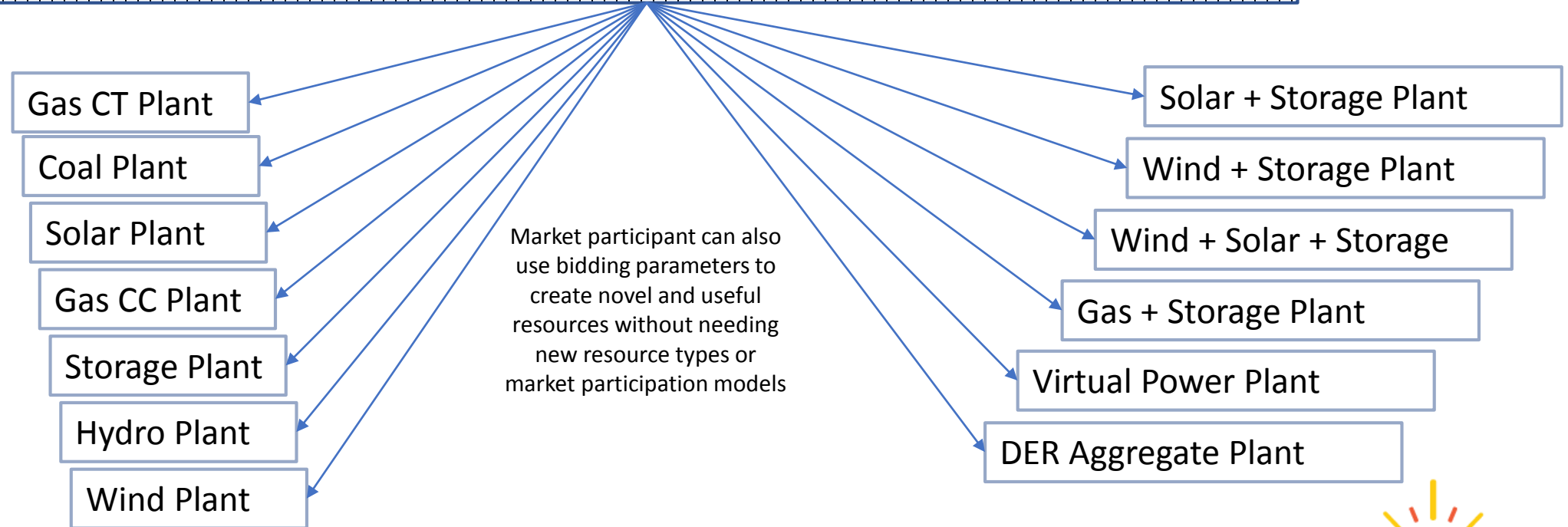
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**Energy Systems Integration Group**

*Charting the Future of Energy Systems Integration and Operations*





# Encourages focus on “essential services”

- A changing resource mix is not a concern if we understand the reliability and operating services at their core level
  - NERC Essential Reliability Services work is a good example
  - Performance-based, technology-agnostic definitions of the services that we truly need
  - Regardless of which path we take now, we’re going to need to think about this eventually
- We haven’t really done this for system operations (*especially* in ISO/RTOs??)
  - We focus on energy, capacity, reserves and reserve margins
  - We assume that whatever else we need is inherently dragged along
  - This is not a sustainable approach for the future

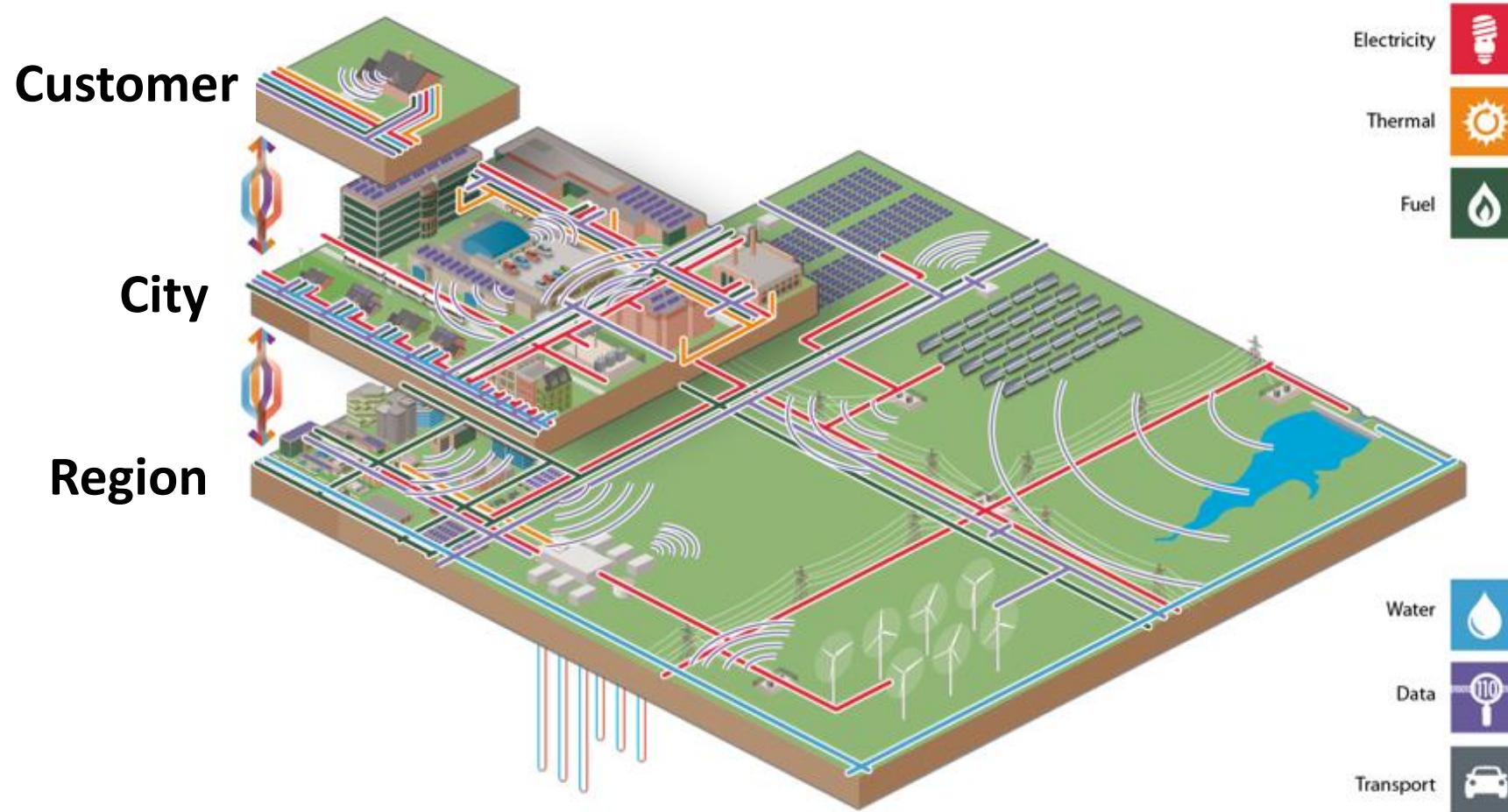
# What if we only get a storage resource type?

- We will build creative combined resources anyway, and we'll make them look like they are storage. Why?
  - The storage type will be the most flexible resource type
  - Standardized inverters will simplify the interconnection process
  - Our customers are asking for these combined resources
- A battery storage system is energy and/or load behind an inverter
  - All of that energy does not need to come from and return to the ISO/RTO's system
  - Obvious examples to pair with storage (or digitally emulated to look like storage)
    - PV solar, wind, and conventional resources
    - Distributed, load responsive, and behind-the-meter resources
    - AC tie lines, HVDC tie lines
    - HVDC lines that cross seams, or even interconnections, and could be “storage” at both ends

# Combined Resources = More Forecasting Value

- Commercial, industrial, and community choice customers increasingly want to control the characteristics and future price risk of their energy
  - If the ISO/RTO markets fully embrace the alternative approach, then most of this could be done financially using the markets
  - If not, then most of this will be done by optimizing combined projects to match desired load curves, energy characteristics, price, risk and point of delivery
- This dramatically increases the importance and value of high quality **forecasts, analytics, optimization, automation, operations and trading**

# Energy Systems Integration (ESI) will magnify these opportunities even more!



- Optimization of energy systems across multiple pathways and scales
- Increase reliability and performance, and minimize cost and environmental impacts
- Most valuable at the interfaces where the coupling and interactions are strong and represent a challenge and an opportunity
- Control variables are technical, economic and regulatory



# What's next?

- Pretending that the digital revolution doesn't change things has not been a good approach for other industries, and the digital revolution is now hitting the power industry in full force
- Conceptually, we can make any generation, load or transmission resource appear to be a storage resource, and it might even have a bit of “real” storage (if that is necessary and the most cost effective way)

*“Life finds a way.”*

Dr. Ian Malcolm (Jeff Goldblum) in Michael Crichton's *Jurassic Park*





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# FERC left it open for “more than just storage”

Charging energy is at wholesale LMP, but it never says that all charging energy must be purchased from the RTO. In fact, in paragraph 294...

- “In response to concerns about an electric storage resources being compelled to purchase all of its energy for future use from the RTO/ISO markets, we clarify that **we impose no such requirement**. Our finding regarding charging energy does not address payment of the retail rate for energy or **charging a device off of co-located generation resources**, as suggested by commenters. Also, while this finding requires each RTO/ISO to allow electric storage resources to be able to pay the wholesale LMP for their charging energy, it does not address whether they can pay some other rate, such as a retail rate or charging off of co-located generation. Finally, like other market participants that purchase energy from the RTO/ISO markets, an electric storage resource that pays the wholesale LMP for charging energy may enter into bilateral financial transactions to hedge the purchase of that energy.”