Technology Agnostic Participation Options in Electricity Markets

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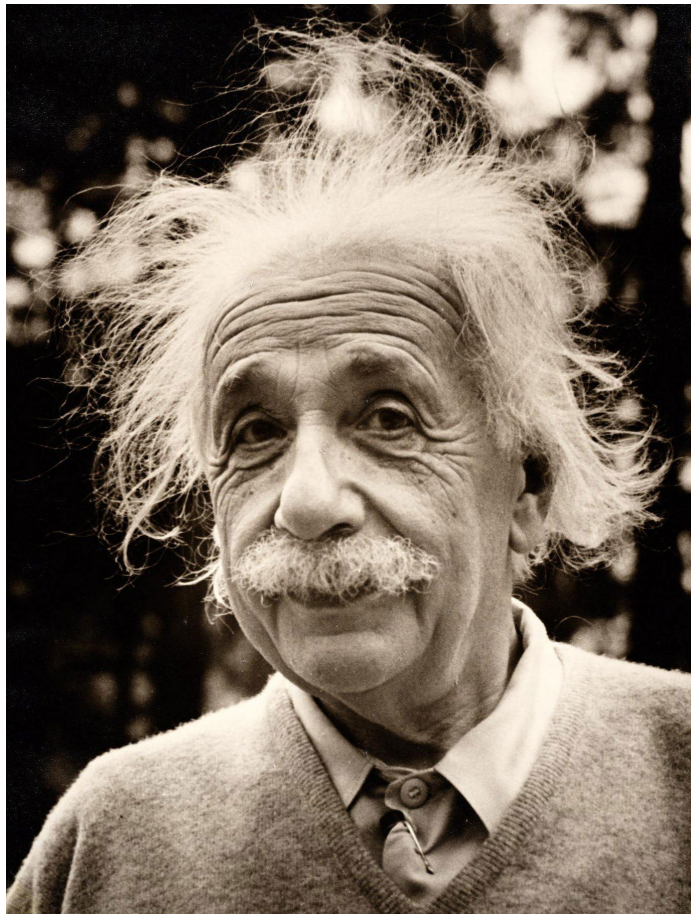
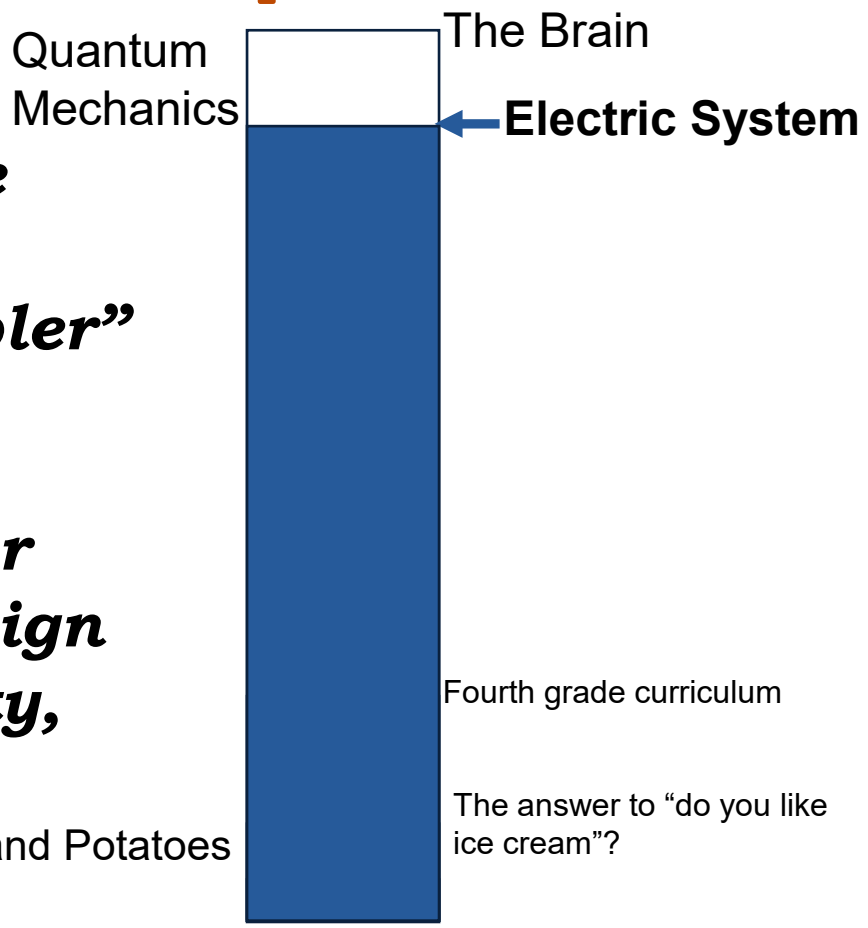
The Simple-Meter



"Everything Should Be Made as Simple as Possible, But Not Simpler"

"Simple as possible for electricity market design starts at mostly, pretty, complex" -EE



Participation Model Rule-of-Thumb

If is needed for reliability	• Build it
If it improves economic efficiency	• Allow it (if priorities permit)
If it does neither	• Shelf it
If it creates inequity	• Figure out a resolution, or shelf it
If it is too complex or won't solve	• Defer it, research it
If the technology is coming soon	• Build it now

Extra, depending on discussion

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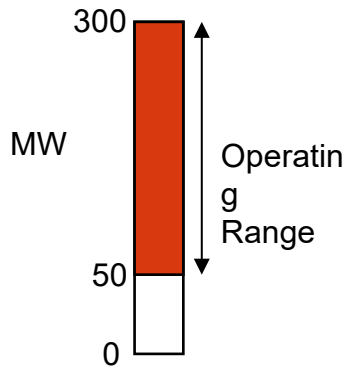
Conventional Generator Participation Model

Participation Model Characteristics

- Mathematical Modeling in Market Software
- Bidding Parameters
- Service Eligibility
- Other participation rules

Conventional Generator

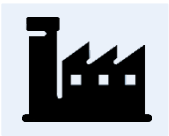
Natural Gas | Coal | Nuclear

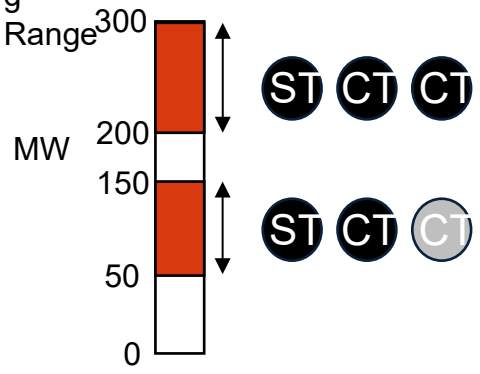


- Min and Max operating range
- Ramp rates
- Startup time, startup cost, minimum up time, minimum down time
- Need commitment variables
- Fuel-based operation
- Generally eligible to participate in all ISO services

Multi-Stage Resource

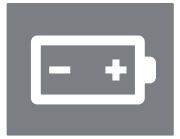
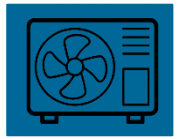
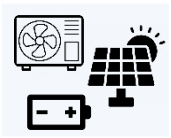
Combined Cycle





- In addition to bidding parameters of Conventional Generator, it may need transition costs, transition times, operating parameters in different configurations, etc.

Emerging Technology Participation Models

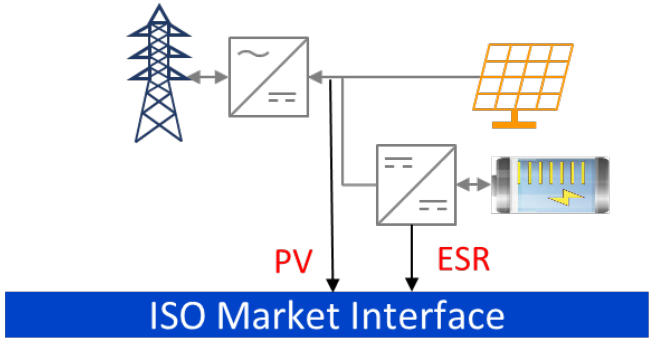
Variable Energy	Electric Storage	Demand Response	DER
Renewables 	**Battery Storage** 	**Demand Response** 	**Distributed Energy Resources** 
• Weather-based operation • Maximum available output variable with time • Needs forecasting: Day-ahead and real-time • Non-dispatchable or dispatchable up to their available output • Commitment-related bidding parameters unnecessary • Currently not eligible for reserves in most ISOs	• Injection and withdrawal • State of Charge (SOC) constraints • Self SOC Management: must bid in a way that ensures its capability • ISO SOC Management: ISO models and manages SOC in market software • No commitment-related bidding parameters	• Demand reduction with respect to a baseline • Different compensation rules (e.g., Order 745 in FERC-jurisdictional ISOs) • Allow for aggregation of load-side resources	• Allow for Aggregation of distributed energy resources • May include different resource types with injection, withdrawal, and demand reduction capabilities • Complications with certain types of resources

Note: In U.S. markets, traditional reservoir hydropower typically offer energy in a similar way to thermal resources but with daily energy limits. In IESO, there are certain parameters to reflect connected hydro facilities

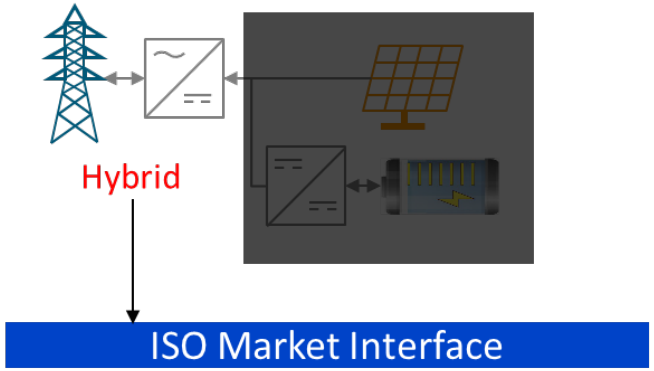
Hybrid Participation Models

Option A: 2R Independent *Co-located* Model

Separately represent each resource, with minimal changes to existing market designs



Option B: 1R Self-Managed *Hybrid* Model



Single offers and operating parameters allows participant bidding strategy flexibility

Option C: 1R ISO-Managed-Feasibility *Hybrid* Model

Add telemetry requirements to allow ISO to limit infeasible schedules during critical times

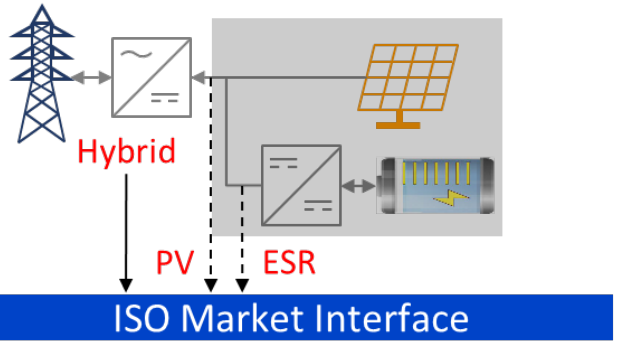
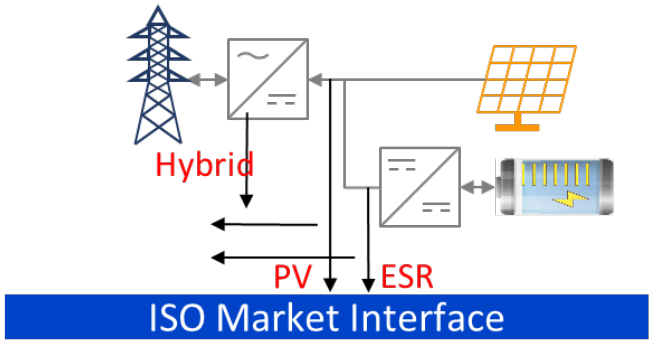


*figure illustrates dc-coupled strategy for demonstration purposes

Option D: 2R Linked *Co-located* Model



Add linking constraint to increase ISO's and asset's ability to operate and represent the resource's dependencies

Ancillary Service Compensation

- Some reliability attributes are not currently incentivized
- Sometimes auctions and market-based pricing for certain services may be impractical
- Prioritization of market design and software changes also key
  - It cost money to develop, discuss, test, implement, and administer new designs

Reasons why a market product may not be implemented	Example
Too complex to design (e.g., software complexity)	Volt/VAR support
Too specific to certain local areas (little to no competition)	Volt/VAR support
System inherently has more than sufficient amounts of the service	Synchronous Inertia
Costs for the service may be small, so cost of administrating market product may outweigh benefits	Black start (restoration) service
A specific resource requirement rather than a system-wide need	Low Voltage Ride Through

The examples are used for illustrative purposes only and the reason may not be necessarily true for each example in each region.

Markets are not needed for every service!

THANK YOU