



**AUTUMN LANE
ENERGY CONSULTING LLC**

Future Grid – Further Thoughts on a Path Forward

NEPOOL MC/RC – July 1, 2020

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Presented with the endorsement of NEPOOL Members NRG Energy and Sunrun



Overview

- **Our themes from last month:**
 - Will our current market designs support a reliable, low-carbon system?
And if not, what should we do about it?
 - Any 'gap analysis' should be looking for directional indicators, not precise specifications
 - Begin a parallel effort to educate each other and vet potential solution options
 - **Today's topics:**
 - Dissecting the big questions
 - Identifying gaps is an input, not an output
 - Given what we already know, the general outlines of the 'gaps' are evident
 - Collaborative investigation of solution options → parallel track
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Dissecting the Big Questions

- Will our current market designs support a reliable, low-carbon system?
And if not, what should we do about it?
 - ‘current market designs’ – LMP-based energy market, co-optimized reserves (and ESI), forward capacity
 - ‘support’ – will these markets produce sufficient revenues for investors and resource operators to commit their capital, engage their energy demand, or develop innovative technologies and business models to take part in contributing to balancing supply and demand?
 - ‘reliable’ – ensuring the system can successfully balance supply and demand at all relevant time-scales – momentary to hourly to daily to seasonal to annual to several years forward
 - ‘low carbon’ – regardless of the precise metric or state policy target, the future power system must have substantially lower net carbon emissions than today’s
 - ‘what should we do’ – what system and resource characteristics and capabilities are going to be important and valuable in that future system, especially those things that are not explicitly recognized as important/valuable in today’s markets?
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There is no model that will ‘identify gaps’

- Models simulate what is or what might be, not what isn't
- In order to get a model to help us identify gaps in our markets, we need to hypothesize what those gaps are and use models to test our hypotheses
- A good example – the recent NESCOE Economic Study of Ancillary Services
 - The study request asked ISO to look at “new grid opportunities [that] may be identified to address challenges, including load following, regulation, operating reserves, and operation during low-load periods ...”
 - ISO analyzed the ancillary services we are familiar with as well as other physical quantities that ISO measures and tracks, and found that in many respects the existing products and quantities are insufficient to support a high-renewables system
 - In addition to potentially more of our existing A/S and potentially new ones, the study results also point to ‘balancing’ as a key system function that may be challenged in a high-renewable future



Hypothesis – Where are the gaps likely to be?

- **What system characteristics and capabilities do we take for granted today that may be in short supply in a future with a high-renewable resource mix?**
 - Rotating inertia for stability
 - Rapid and frequent ramping capability to adapt to changes in net demand
 - Energy availability in all seasons
 - Seamless ability to integrate distributed resources and flexible demand
 - **What capabilities are becoming technically and economically feasible that could alter future system dynamics?**
 - Grid-scale energy storage with fast response times
 - Distributed resources and demand response (both dispatchable and autonomous)
 - Electrification of transportation and heating sectors
 - Advanced inverters and power electronics
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What gaps do we already know exist?

- **The value of carbon, or of avoiding carbon and other GHG emissions**
 - Today's markets do not include a value for carbon commensurate with the value that state policies imply for it
 - **Ancillary services**
 - A more distributed, digital and inverter-based fleet has different physics than the 20th century resource mix
 - Where will system inertia and stability come from?
 - How will the system handle extended periods of no wind or sun?
 - What other aspects of system operability and reliability have we taken for granted that will need to be explicitly valued in the future?
 - **System Architecture**
 - How do we effectively integrate distributed resources into planning and operations?
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Shared education and solution vetting

- **At the August meeting we hope to begin discussions on these and other topics -**
 - **Carbon**
 - Carbon fee/price/tax? Carbon cap-and-trade/invest? Electric sector only? Broader application to other sectors?
 - Forward Clean Energy Market
 - Relationship to RPS? Relationship to FCM and other ISO markets? Relationship to existing contracts? Roles of ISO, states, others?
 - **Ancillary Services**
 - New products? Re-defined/expanded products? How to establish quantity requirements? Role of NPCC/NERC?
 - **There may be other options to discuss, and there are certainly countless more questions on each of them that warrant discussion even before we know the full results of the gap study**
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Next Steps

- **Qualitative inventory of ancillary service and other ‘gaps’ as hypotheses for study**
- **Draw on existing studies of high-renewable systems as the basis for exploring and confirming those gaps**
- **Interactive collaborative sessions to explore sources of value in a reliable low-carbon system**



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