Just in Time Capacity Acquisition through an Always on Capacity Exchange (AOCE)

A Discussion Paper

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Abstract:

This paper describes inefficiencies in both cost and performance associated with existing capacity market functions, citing ISO New England as one example, although the situation is similar across other ISO's/Control Areas. A conceptual design for an Always On Capacity Exchange (AOCE, pronounced ACE) is introduced that addresses many of the inefficiencies in the current capacity market systems by proposing a 24x7 trading platform of flexible, "Just in Time", capacity offerings that take advantage of existing, excess capacity resources, that were built in prior years, when energy demand was increasing and may no longer be acquired in current or future capacity auctions. The proposed approach recognizes the need for more granular capacity durations (hourly) within specified locations, with operating characteristics that may be important to a capacity buyer, such as rapid up/down ramping capabilities. Additional revenue making opportunities for capacity buyers are also suggested. This paper does not contain a fully designed solution as much more work is needed to define a production ready, standards-based market solution that could work across the Eastern Interconnection, or other electrically connected grid networks. The reliability, resiliency, integrity and security requirements of such an exchange may be satisfied with properly designed blockchain technologies. Hopefully, this paper will give the reader some ideas to ponder and will stimulate discussion in the quest for a more efficient, industry standard, capacity exchange solution, developed within a standards development organization, such as NAESB.

Introduction

Capacity planning and acquisition is an extremely important function that must be performed proficiently, due to its impact on reliability and the cost of electricity borne by "grid connected customers" over multiple years. ISO's, with responsibility for system planning functions, seek to secure enough generating capacity so that peak demand can be satisfied each and every hour of the day for the whole year, because they never know for sure which hour peak demand will occur. This results in a whole lot of excess generating capacity that sits idle on the sidelines most of the time, because peak demand for electricity only happens one hour out of the year. For all the other hours (the non-peak hours) the system glides comfortably along, while all this extra generating capacity sits idle on the bench, collecting capacity payments. NOTE: a consumer-friendly overview is available online[1] for those unfamiliar with capacity markets.

Under the existing ISO New England Forward Capacity Market Rules (FCM) system planners have to plan capacity acquisitions 3 years in advance. The ISO's ability to make reasonable and just capacity forecasts 3 years into the future, which is already a difficult problem, is becoming even more difficult due to the following powerful forces:

- Individual states are establishing programs to acquire large quantities of renewable generating capacity, outside of the normal planning process/capacity market
- Energy Efficiency programs continue to advance at a steady pace, reducing system demand even further
- Consumers are installing their own generating supply, i.e. Solar panels, outside of the ISO's visibility.
- Actual electricity consumption is not decreasing, as some have suggested, but is in fact increasing from electrification of automobiles and heating systems, which were once the sole domain of fossil fuels

The ISO's are trying to compensate for the changes affecting capacity planning and acquisition through FERC filings and other alternatives, i.e. ISO New England's CASPR, but these are just band-aid measures. The time is right to consider other, more flexible and strategic approaches to secure the right amount of capacity needed to meet reliability on an hour-by-hour basis, and reduce consumer costs by eliminating over-buying capacity like each day/hour is going to be the peak demand hour.

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[1] https://www.energycentral.com/c/em/could-capacity-acquistion-be-blockchain-kill-app-elerctic-industry

The Consumer Cost of Excess Capacity

There are three different perspectives[2] to evaluate "excess capacity":

- Reliability: does the current level of generation capacity satisfy demand under most conditions
- Economic: What is the consumer cost for the amount of excess capacity
- Environmental: how does the current level of coal oil and natural gas fired power generation compare to what is required to meet environmental regulations

This paper uses data from ISO New England's Forward Capacity Markets to focus on the Economic impact, i.e. excess consumer cost (ECC), of excess capacity (EC), which is defined as, the total amount of capacity acquired by an ISO, known as the Capacity Supply Obligation (CSO) for a given period (i.e. capacity commitment period), minus the actual peak demand (PD) observed during the same period, minus the amount of capacity needed to meet NERC reliability requirements (R, i.e. Reserves), as shown in the **Excess Capacity Calculation**, below:

$$EC^i = CSO^i - PD^i - R^i$$ [3]

where ^{i} represents a specific capacity commitment period (CCP); a contiguous 12-month period

and the annual excess cost to consumers (ECC) for excess capacity is calculated as EC multiplied by the clearing price (CP), normalized to megawatts, for a specific CCP, multiplied by 12, representing the number of months in a CCP, as shown below in the **Excess Consumer Cost Calculation**:

$$ECC^i = 12 * (CP^i * 1000) * EC^i$$

where ^{i} represents a specific capacity commitment period (CCP); a contiguous 12-month period

[2] https://www.osti.gov/servlets/purl/1344103

[3] Reliability MW values are extrapolated based on typical reserve requirements as reported in ISO New England's Morning Report

Here are the excess capacity MW and excess consumer cost results, based on ISO New England's 2016/2017 and 2017/2018 capacity commitment periods:

Table 1. All data was obtained from ISO Express; Reserve values were obtained from a typical Morning Report

CCP	CSO	Clearing Price (kw)	Peak Demand	Reserves	Excess Capacity	Monthly Cost of Excess	Excess Consumer Cost per CCP
2016/2017	36,220	$3.15	25596	2200	8,424	$26,535,600.00	$318,427,200.00
2017/2018	33,712	$7.025	23968	2200	7,544	$52,996,600.00	$635,959,200.00

As you can see from the table above the excess consumer cost for capacity totals almost $1 Billion over these two capacity commitment periods (two years) shown. **Something must be done to lower this cost.**

ISO New England, and ISO's all across North America are doing their best to grapple with a shifting landscape that is making capacity planning even more difficult than in previous years. Decreases in peak demand are not due to less consumption across the board; these decreases are largely due to other factors[4], most notably behind the meter generation and the installation of capacity outside of the ISO's planning radar. Some reduction in demand can be attributed to energy efficiency (EE) measures, but EE alone cannot explain the amount of reductions being observed in peak demand.

The main point to be made from the information presented in this document is that a new methodology is needed, to help all ISO's implement a more efficient approach, to acquire the "Just in Time" amount of grid resource capacity required to maintain reliability and meet reserve requirements, expressed as Peak Power from Grid Resources (PPGR) as economically as possible to reduce excessive consumer costs from a billion every two years to perhaps millions over ten years.

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[4] https://www.energycentral.com/c/em/factoring-behind-meter-generation-demand-forecast-algorithm-iso-new-england-and

Just in Time Capacity Procurement: The Holy Grail

Manufacturing companies learned years ago of the economic value of "Just in Time" inventory management, along with the risks of such an approach, i.e. weather events that prevent deliveries of critical parts can shut down an entire manufacturing facility. In an ideal scenario, generating capacity would be available at the beckoned call of grid operators, the moment it's needed, or "Just in Time". Unfortunately, power generators don't operate like a "light switch" that you can just turn on/off as needed. New generating capacity can take years to construct, which requires careful planning and a "best guess" forecast of the power needs years in the future. There's just no ideal solution when it comes to acquiring new capacity, it must be committed to years in advance. However, existing installed generating capacity may provide a more flexible and timely method to procure capacity.

Up until very recently ISO's had seen a growing need to add generating capacity in order to ensure adequate power to meet peak demand and reserve margins. In 2013/14 ISO New England acquired its maximum amount of generating capacity in the Forward Capacity Market, 37,501 Megawatts. The trend has been steadily going in a downward direction, with the 2018/19 capacity obligations sitting at 34,695 MW, as shown in the graph below and the requirement for the next FCA, for 2022/23 is only 33,750 MW[5], which includes an increase in reserves to 700 MW[6], up from 200 MW in past years. The reduction in capacity acquisition, starting in 2014/15 follows a similar trend with the observed peak demand number, as shown below.

[5] ISO New England refers to this number as the **net** Installed Capacity Requirement (ICR)
[6] Obtained from ISONE's FERC Filing for FCA 13: https://www.iso-ne.com/static-assets/documents/2018/11/public_er19-___-000_11-6-18_fca_13_info_filing.pdf

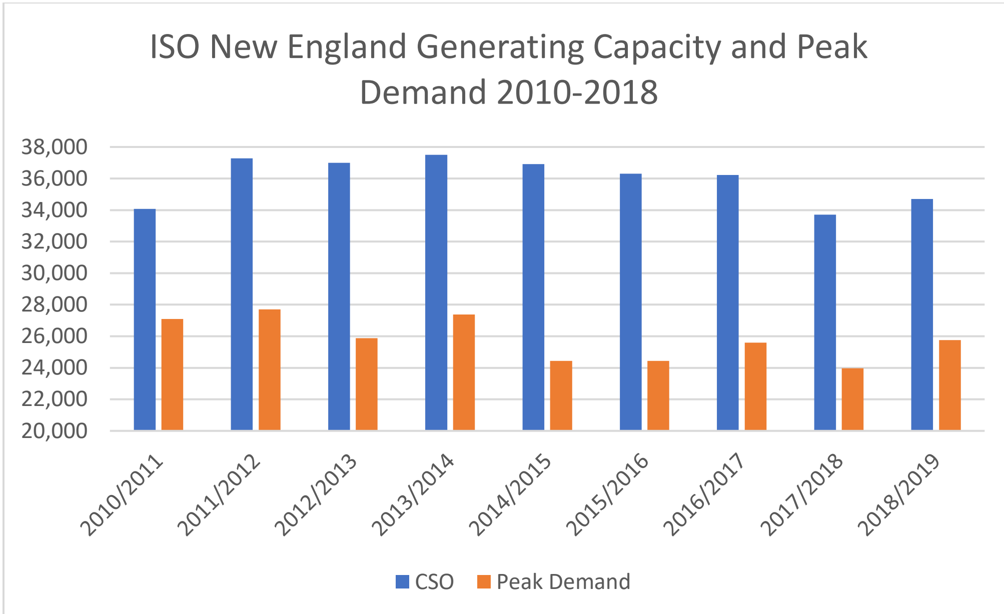


Figure 1. Capacity Supply Obligations and Peak Demand MW

It's obvious from the graph above that significantly more capacity is being acquired than what's needed to meet peak demand in each year from 2010-2018. Even adding an additional 2,200 MW for reserve requirements, over and above peak demand, would still result in a substantial amount of excess existing installed capacity being acquired. This means there is a substantial amount of "Existing Capacity" that's already been installed to meet the 2013/14 peak, that is going to sit idle on the sidelines, years into the future, assuming none of these units retire or close down. The following graphs show how capacity was utilized during these years, and the amount of excess per year:

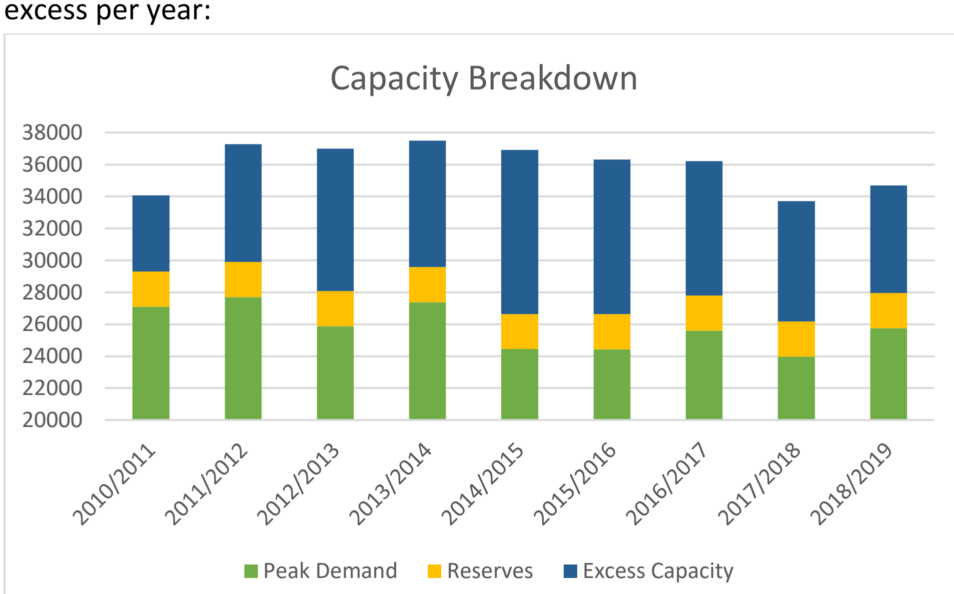
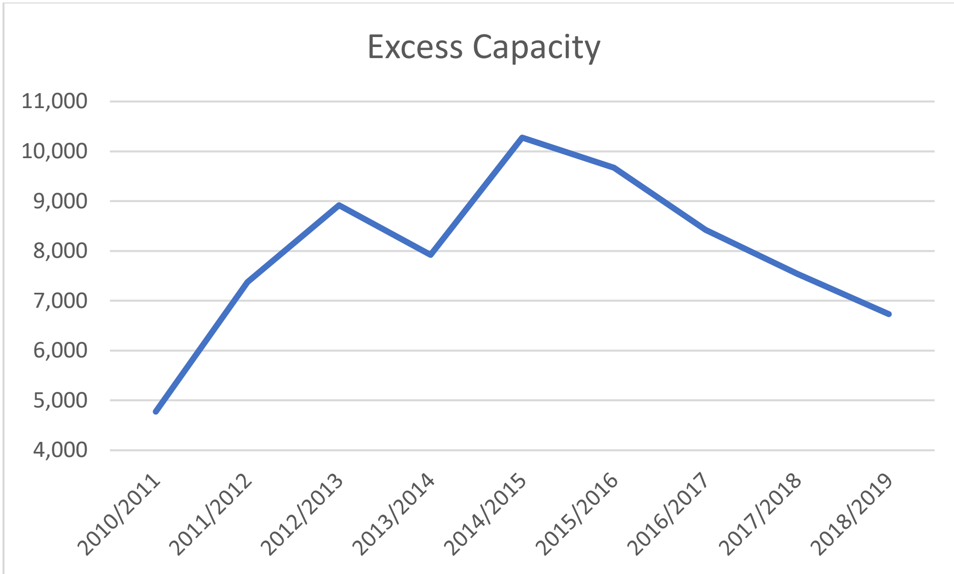


Figure 2. Reserve values are extrapolated based on Morning Report data



It's also important to point out that the meaning of peak demand, once considered the total amount of electricity consumption by consumers at a given moment in time, is morphing into something closer to "Peak Power from Grid Resources" (PPGR)[7], reflecting the fact that some local demand is being met by locally distributed energy resources, many of which are supplied by the end consumer themselves, i.e. rooftop solar panels. This reduction in peak demand is occurring at the same time other areas are turning from fossil fuels to electricity, i.e. plug-in electric vehicles and heat-pumps replacing oil/gas fired furnaces used for heating. This is like burning the candle at both ends, real consumption is actually increasing at a time when capacity acquisition is reducing, raising the potential for some very difficult system operating conditions. System operators are going to need rapid ramping capacity, both up and down, that can be secured closer to the time it will be needed, not years in advance, but perhaps days in advance, when a more accurate load forecast is possible.

The challenge is, how to make capacity acquisition flexible enough to be secured days, or even hours (for fast start units) in advance, as opposed to years in advance. The current ISONE Forward Capacity Market is not designed to accommodate this level of flexibility. But what to do with all that installed, existing capacity from the 2013/14 peak totaling 37,501 MW, that won't be receiving any capacity supply obligations because they "appear" to no longer be

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[7] https://www.energycentral.com/c/em/factoring-behind-meter-generation-demand-forecast-algorithm-iso-new-england-and

needed in the next FCM auction (FCA 13), scheduled for February 2019, to acquire 33,750 MW of capacity for the 2022-23 commitment period.

What if an "Always On Capacity Exchange" (AOCE) existed that enabled the trading of capacity contracts, like trading stock options, 24x7, as a replacement for the current annual and monthly capacity auctions that treat every hour like peak demand is going to happen and require purchasing capacity years in advance. Then, these installed, existing resources with no future CSO's, along with some portion of the excess capacity that was acquired between 2010-2018, see figure 1, could be traded through an exchange where ISO's and other qualified parties could buy/sell capacity as needed for use across the entire Eastern Interconnection.

AOCE Conceptual Overview

NOTE: This section is intended to stimulate discussion in the search for a more flexible, cost effective and timely method to buy and sell electric generating capacity than what exists in the current ISO New England Capacity Market. This section does not describe a fully functional solution that can be implemented today, but it will, hopefully, start a conversation amongst industry stake holders, consumer advocates, policy makers and regulators to seek out a more efficient and economic, industry standard solution to acquire capacity, developed within an industry wide standards development organization, such as NAESB. The described approach only pertains to installed, existing capacity resources. New resources, which must be planned years in advance may require a different approach to buying/selling new capacity in the future.

The approach described here is significantly different from the current approach used by ISO New England to acquire and shed existing capacity. The existing system uses a combination of annual and monthly auctions, plus bilateral arrangements to enable the buying and selling of capacity. The existing system also enables a resource owner to delist (remove a unit from an auction) due to retirement or other reasons. The AOCE (pronounced ACE) approach provides capacity owners with existing, qualified generating resources the ability to sell their capacity, and interested buyers the ability to buy and/or trade capacity in the form of Smart Contracts, on a capacity exchange service that operates 24x7. A comparison of the two approaches appears below:

Feature	Current Auction Approach	AOCE Approach
Buy/Sell opportunities	• Once per capacity commitment period (FCA) • Annual reconfiguration auctions (ARA) • Monthly reconfiguration auctions (mRA)	Anytime, 24x7
Obligation duration	One capacity commitment period of 12 months or a monthly commitment via the mRA	Determined by buyer/seller, minimum of 1 hour
Cost Setting approach	By auction	Bid/Offer between buyer and seller
Varying contract characteristics	No differentiation; all capacity is treated equally	Yes; specified by buyer/seller
Settlement of Funds	ISO	ISO
Resource Capacity Qualification	ISO	ISO
Market Maker/Manager	ISO	ISO
Support for New Capacity	Yes	May be possible with enhancements
Support for Existing Capacity	Yes	Yes
Treats every hour like peak demand is possible	Yes	No

Example Offer

Data Field	Value
Offer ID	1
Seller ID	100
Capacity MW	10
Start Date	6/1/2019
End Date	6/15/2019
Available Hours	10,11
Asking Price per MW	$10/day
Cap Location	Albany, NY
Exportable	Yes
Export Interfaces	NYISO AC
Fuel	Solar
SOx	0
NOx	0
Carbon	0
Operating Pollutants	None
Eligible Credits	10% of REC
Energy Revenue	10% of wholesale LMP at location 777
Ramp Up rate/minute	10 MW
Ramp Down rate/minute	10 MW
Many more TBD	Defined by standards committee

Example Bid

Data Field	Value
Bid ID	1000
Buyer ID	500
Capacity MW	10
Start Date	6/1/2019
End Date	6/15/2019
Hours	10,11
Bid Price per MW	$8/day
Sink Location	Boston, MA
Importable	Yes
Import Interfaces	NYISO AC
Fuel	Solar
SOx	0
NOx	0
Carbon	0
Energy Revenue	As offered
Ramp Up rate/minute	10 MW
Ramp Down rate/minute	10 MW
Many more TBD	Defined by standards committee

In the AOCE approach, described above, any qualified party may bid to acquire a capacity offer. The capacity associated with an offer must be backed by an existing qualified resource capable of meeting contracted terms. The ISO is responsible for qualifying resources to participate in the AOCE. The owner of these qualified resources may submit one or more capacity offers into the exchange by specifying the details of each contract, as shown in the example Offer 1, above. Potential buyers submit bids which may be accepted or rejected by the offering party. It is anticipated that the ISO's themselves would be the largest buyer of capacity in the exchange, followed by Load Serving entities and market traders. This approach provides the ISO with much greater flexibility in acquiring capacity, closer to when it's actually needed and in quantities that more accurately reflect real peak demand for each hour, at a reasonable cost. For example, peak demand in Vermont at 2:00 AM on a Monday in June is considerably less than peak demand in Boston at 2:00 PM on a Thursday in June. The amount of capacity acquired should align with these differences in demand. Note: Resellers of capacity, i.e. traders, cannot alter any aspect of the originally acquired offer, except for the offer price and Energy Revenue items.

Buyers of capacity may also place unsolicited bids to acquire capacity for which no offer currently exists. In this case a party with a qualified resource may offer to satisfy the bid terms and conditions, provided the resource has been qualified by the ISO managing the location in which the resource is located, and is capable of delivering the capacity specified in the bid at the required location, possibly via inter-area tie-lines. The location of the resource supplying capacity and the capacity delivery point must be electrically connected, with appropriate arrangements (i.e. e-tags) in place for import/export between the two points, i.e. the Eastern Interconnection.

As mentioned previously, the AOCE concept described above is not a fully functional technical or market design. The intent of this paper is to stimulate industry discussions by parties with a vested interest in a successful, cost effective, efficient, flexible, standards-based solution to buy and sell capacity across an electrically interconnected area for existing qualified capacity resources. This approach may not be appropriate for the acquisition of new capacity.

The technical requirements for such an AOCE approach must consider the need for reliability, resiliency, security and integrity of the exchange, along with traditional performance and functional requirements. Today's distributed ledger technology (blockchain) contains many of the characteristics needed to meet these AOCE requirements and may be the most viable technology platform to consider for implementation. This would allow each ISO operating within the Eastern Interconnection to operate an AOCE exchange for the qualified, existing capacity resources in their control area and enable the free exchange of this capacity between control areas. For example, an offer for qualified capacity registered in the PJM exchange could be acquired by a party making a bid in the ISO New England exchange, provided the import/export requirements are met between the capacity source and destination, i.e. e-tags secured for the route, are specified in a "Binding Transaction Record" linking the bid and offer in a smart contract.

A standards development organization, such as NAESB, should be engaged to define industry wide/recognized standards for AOCE that are eligible for adoption by a regulatory body, such as FERC.

Summary

This paper describes inefficiencies in both cost and performance associated with existing capacity market functions, citing ISO New England as one example, although the situation is similar across other ISO's/Control Areas. A conceptual design for an Always On Capacity Exchange (AOCE, pronounced ACE) is introduced that addresses many of the inefficiencies in the current capacity market systems by proposing a 24x7 trading platform of flexible, "Just in Time", capacity offerings that take advantage of existing, excess capacity resources, that were built in prior years, when energy demand was increasing and may no longer be acquired in current or future capacity auctions.

The proposed approach recognizes the need for more granular capacity durations (hourly) within specified locations, with operating characteristics that may be important to a capacity buyer, such as rapid up/down ramping capabilities. Additional revenue making opportunities for capacity buyers are also suggested. This paper does not contain a fully designed solution as much more work is needed to define a production ready, standards-based market solution that could work across the Eastern Interconnection, or other electrically connected grid networks, with excess existing capacity. The reliability, resiliency, integrity and security requirements of such an exchange may be satisfied with properly designed blockchain technologies. Hopefully, this paper will give the reader some ideas to ponder and will stimulate discussion in the quest for a more efficient, industry standard, capacity exchange solution, developed within a standards development organization, such as NAESB.

About the Author

Richard "Dick" Brooks is a Professional Software Architect with over 30 years of software engineering accomplishments, primarily serving the Energy industry. He was co-founder and Chief Technical Officer of Group 8760 where he led development of the Company's market leading B2B software product, Inside Agent, a NAESB EDM software package, that reliably processes $65 Billion in transactions annually. He gained international acclaim as a co-author of the UN/CEFACT - OASIS ebXML Message Service Specification and was appointed to serve as the liaison assigned to the World Wide Web consortium where he coordinated the convergence of ebxml and SOAP. Serving under Dave Darnell of Systrends he worked as an Advisor to Eirgrid, the ISO for Ireland, where he developed a framework for the Company's Security Architecture. In 2004 he joined ISO New England as the Company's Enterprise Architect, serving under Eugene Litvinov, where he developed, and successfully implemented the Company's enterprise wide Service Oriented Architecture, co-authored the Company's Smart Grid white paper, co-authored an award winning DOE Smart Grid funding proposal to install PMU devices, served as a software architect for ISO New England's Forward Capacity Market Clearing Engine, and led industry wide standards development at NAESB, which earned him an ANSI Meritorious Service Award, and the ISO/RTO Council (Enterprise Architecture Standards V1.0). As a Technical Lead and Principal Information Architect he led development of ISO New England's Business Intelligence and Data Analytics platform over eight years and created the most widely utilized analysis used throughout ISO New England, the Market Monitoring Department FPA Viewer. After an early retirement from ISO New England in 2018 he started Reliable Energy Analytics. He has been a member of the IEEE and ACM for over 30 years. He currently serves as co-chair of the FERC/NAESB e-forms sub-committee and is an active member of NAESB's cybersecurity sub-committee, responsible for the WEQ-012 PKI standards. He can be reached at dick@reliableenergyanalytics.com