BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

Order Instituting Rulemaking to Oversee the Resource Adequacy Program, Consider Program Refinements, and Establish Annual Local and Flexible Procurement Obligations for the 2016 and 2017 Compliance Years	Rulemaking 14-10-010 (Filed October 16, 2014)

COMMENTS OF THE CALIFORNIA INDEPENDENT SYSTEM OPERATOR CORPORATION

I. Introduction

Pursuant to the December 23, 2015 Assigned Commissioner and Administrative Law Judge's Phase 2 Scoping Memo and Ruling (Scoping Memo), the California Independent System Operator Corporation (CAISO) files these comments regarding the Track 2 resource adequacy (RA) issues. The Scoping Memo specifically asks parties to address the following question: "What reliability need(s) must [flexible capacity requirement]s be designed to meet?" These comments address this issue.

II. Discussion

The CAISO has several reliability needs that require flexible capacity resources to address. Specifically, the North American Energy Reliability Corporation (NERC) promulgates standards that require the CAISO (1) to maintain control performance standards (CPS1[1]) related to area control error (ACE) and frequency error, (2) to provide sufficient frequency response following any disturbance greater than 500 MW within Western Electricity Coordinating Council, (3) to maintain sufficient regulation reserve to return the system to pre-defined operating limits during normal operating conditions, and (4) to maintain adequate contingency reserve to return the system to pre-contingency limits within 15 minutes of a contingency.[2] NERC has recently highlighted the significant transformation of the power system and the need

[1] CPS1 is a statistical measure of a balancing authority area's control error (ACE) variability in combination with the interconnection frequency error from scheduled frequency. CPS1 assigns each BA a share of the responsibility for controlling the interconnection steady state frequency.

[2] See NERC BAL-001-2, R1 & R2 (for CPS1 and BAAL standards relating to ACE requirements); BAL-002-WECC-2 (relating to maintenance of contingency reserves); BAL-003-1.1 (relating to frequency response obligations).

to "explore important directional measures to help the industry understand and prepare for the increased deployment of [variable energy resources]," the retirement of conventional units and "advances in demand response technologies and other changes to the traditional characteristics of generation and load resources."[3] NERC's Essential Reliability Services Task Force (ERSTF) report specifically noted that [i]n order to maintain an adequate level of reliability through this transition, generation resources need to provide sufficient voltage control, frequency support, and ramping capability—essential components of a reliable [bulk power system]."[4] The ERSTF report executive summary is included as Attachment A to these comments. The CAISO notes that although the Scoping Memo requests that parties identify the reliability needs that flexible capacity requirements must be designed to meet, in considering flexible capacity needs, the Commission should also consider how other constraints such as renewable portfolio standards (RPS) and CAISO market implications (*i.e.*, the potential for extreme pricing events and manual curtailments to address over-supply) might impact the need for flexible capacity.

A. Background

The CAISO first brought the need for flexible capacity to the Commission's attention in January 2012 in R.11-10-023.[5] With actual experience and more study, the CAISO now better understands the details regarding why flexible capacity is needed and how it must work. The state's goals for a low-carbon energy grid have also progressed, and the corresponding transformation of the CAISO generating fleet has exceeded initial expectations. As the most obvious example, when the CAISO first identified the need for flexible capacity, it was designed to help reliably integrate variable energy resources and enable California to reach its 33 percent RPS goal. This goal has since been increased to 50 percent. Further, the penetration of non-dispatchable, behind the meter resources, such as roof top solar, has accelerated at a greater pace than expected, thereby increasing the potential load changes the CAISO must address to maintain the supply-demand balance.

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[3] Essential Reliability Services Task Force Measures Framework Report, http://www.nerc.com/comm/Other/essntlrlbltysrvcstskfrcDL/ERSTF%20Framework%20Report%20-%20Final.pdf, p. iv (December 2015).

[4] http://www.nerc.com/comm/Other/essntlrlbltysrvcstskfrcDL/ERSTF%20Framework%20Report%20-%20Final.pdf at iv.

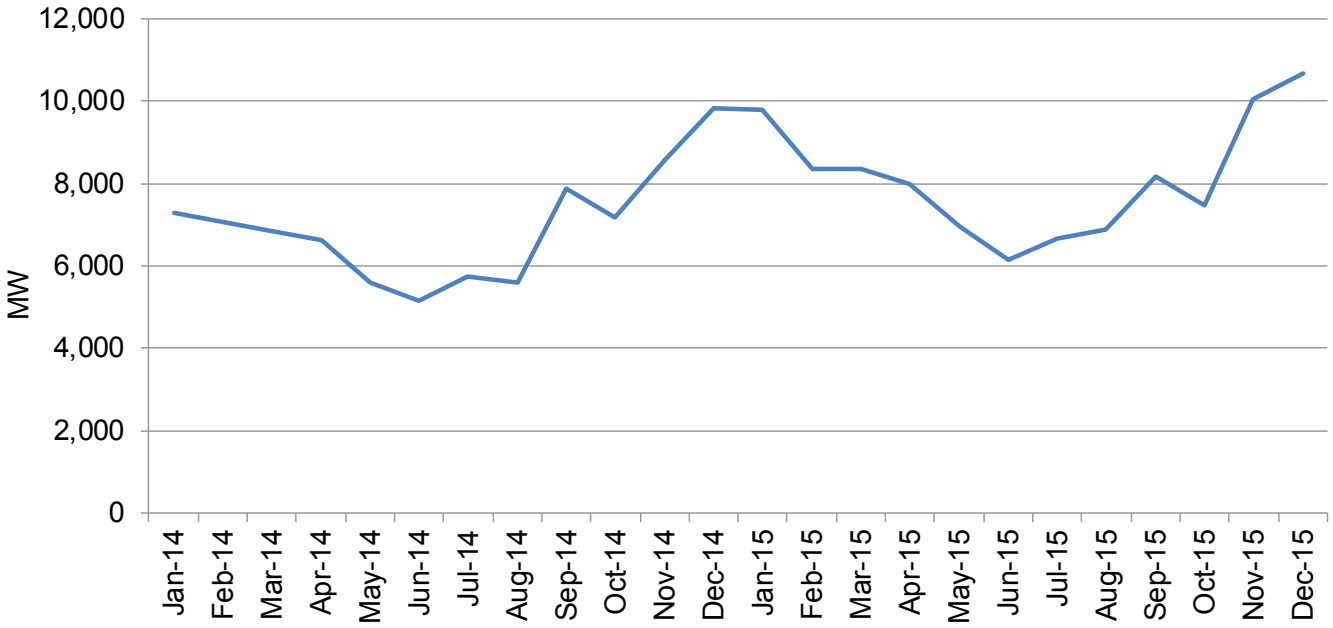
[5] See CAISO's Proposal for Phase 1 Issues. Available at http://docs.cpuc.ca.gov/PublishedDocs/EFILE/CM/157720.PDF.

The CAISO's initial "duck" chart captured many of the evolving aspects grid that need to be addressed by flexible capacity resources. Specifically, the duck chart captured the need for the following:

1) More frequent resource starts and stops due to two net load ramps per day;
2) Resources that can address a single three-hour net load ramp that could reach or exceed 13,000 MW by 2020.

The progress achieved through the development of the flexible capacity needs assessment and initial flexible capacity mechanism laid a strong foundation to directly address and resolve these reliability issues. The maximum three-hour net load ramp in non-summer months continues to increase. Figure 1 shows historic net load ramps since January of 2014. Figure 1 shows steady year-over-year increases the monthly three-hour net load ramps.

Figure 1: Historic Monthly Three Hour Net Load Ramps



The CAISO believes the existing tools should remain in place moving forward because the reliability issues have not diminished. Further, as the CAISO asserted at the beginning of the Flexible Resource Adequacy Criteria and Must Offer Obligation (FRAC-MOO) process, the product created at that time was designed as a measured first step to address flexible capacity

needs.[6] As a result, several issues remain unaddressed to date. Specifically, the CAISO continues to see a need to establish tools to address the following issues.

3) Single-hour net load ramps;
4) The need for a range of upward and downward dispatchable capacity during low net load periods and the transition between low net load periods and three-hour ramps; and
5) Five-minute upward and downward deviations during three-hour net load ramps.

These issues were only partially addressed through the current flexible capacity mechanism, and there is growing evidence that the current flexible capacity mechanism is not sufficient to fully meet these additional reliability concerns in the near future. The CAISO will discuss each of the items in greater detail below.

A. Single-Hour Net Load Ramps

The CAISO designed the initial flexible capacity product with the assumption that the three-hour net load ramp would increase at a roughly linear (or constant) rate. However, experience has shown that net load ramps are not predictably linear. Instead, ramping needs can vary significantly from hour-to-hour within the three-hour ramping period. For example, in the latest CAISO flexible capacity technical needs assessment for 2016, the CAISO forecasts maximum three hour net load ramp of 11,662 MW. The largest one-hour net load ramp is 5,020 MW, or 43 percent of the three-hour net load ramp.[7] From a flexibility need standpoint, intervals that are far greater than the average ramp rate present a reliability concern because the current flexible capacity mechanism is not designed to meet such extreme ramps in relatively short time periods.[8] Without sufficient ramping capabilities, the CAISO would not be able to keep pace with demand and ACE and CPS1 standards could fall below acceptable levels for sustained periods of time.

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[6] The CAISO has also worked on numerous day ahead and real-time market initiatives to address the need for flexible capacity, including initiatives to develop the Flexible Ramping Product (up and down), the Energy Imbalance Market, enhanced regulation from storage, and ensure adequate frequency response. However, the Commission needs to ensure that the fleet provided to the market has the sufficient capability for the market to manage.

[7] The forecasted maximum three hour net load ramp occurred on December 26 of the CAISO's forecast for 2016. The data used to calculate both of these numbers is available at http://www.caiso.com/Pages/documentsbygroup.aspx?GroupID=2B324E6E-2479-4D3B-B157-CEA1597538BF.

[8] The NERC ERSTF task force recommends a measure to track and project the maximum one-hour and three-hour ramps for each balancing area.

Ensuring there is sufficient fast ramping and fast starting resources to address these short duration (in terms of time), but very steep ramps is of growing importance, as shown by actual system conditions this year. In 2016, the CAISO experienced maximum three-hour net load ramps in excess of 10,800 MW. The maximum single-hour net load ramp on that same day was over 4,900 MW, or about 45 percent of the total three-hour net load ramp. The CAISO expects that both the three-hour and single-hour net load ramps will continue to increase in the future. The CAISO will need fast ramping resources to ensure it is able to follow these steep and growing ramps.

B. Low Net Load Periods and the Transition Period between Low Net Loads and Three-Hour Ramp.

To access a flexible resource's full ramp range, the CAISO may be required to commit the resource at its PMin[9] and/or decommit other resources prior to the net load ramp. However, if the flexible resource is able to start quickly, its ramp range may be more accessible and it may not need to be committed at its PMin in order to access its flexible capacity during the net load ramp. Resources that do require commitment at Pmin present a significant operational challenge as net loads move from low net load periods (the "belly" of the duck) to steep peak ramps (ramping up the "neck" of the duck). When the system experiences low net load periods, the CAISO must either decommit resources or reduce output to minimum operating levels. This often diminishes the ability of these resources to quickly ramp during the steep afternoon ramps.

The CAISO is already experiencing challenges meeting the NERC performance criteria, including CPS1 hourly average excursions below 100% during hours 16 through 18.[10] This shows that even with sufficient flexible capacity to meet the net load ramp, it may not be feasible for the CAISO to position all current flexible resources in a way that allows access to the full ramp range both at the beginning of the ramp in the subsequent steep upward ramp.

Resources that have a wide range of ramping capabilities between PMin and PMax provide several flexible capacity benefits. First, with a large dispatchable range between PMax and PMin, the CAISO can ramp the resource up and down easily to address a wide range of flexible capacity needs, including those discussed above. Further, such a resource is more likely

[9] "PMin" is defined in the CAISO Tariff as the minimum normal operating capability of a Generating Unit. "PMax" means the maximum normal capability of a Generating Unit.

[10] Whenever the CAISO's CPS1 hourly average is below 100 percent it indicates that the CAISO is leaning on the interconnection during that hour.

to be able address these flexibility needs without unit starts and stops, which helps mitigate challenges associated with the PMin burden.

Resources with a relatively high PMin may need to be committed to capture flexible capacity benefits from the resource in one interval, but the commitment may have negative reliability, environmental or economic impacts in other intervals. For example, if a resource with a high PMin and a relatively slow start time is committed in the morning, the CAISO may be forced to keep the resource on throughout the day to ensure that its ramping capacity is available for the evening three-hour net load ramp. If this capacity remains online during the day, the CAISO may need to decommit other resources in order to balance supply and demand. If a thermal unit must be committed in this manner, low-carbon resources may need to be decommitted to maintain reliability, especially during the midday periods in shoulder months. As the RPS standard increases, the frequency of this type of decommitment is also likely to increase.

Although these comments are focused on reliability needs, the Commission should also consider RPS goals (*i.e.*, avoiding significant out-of-market renewable curtailments) and providing sufficient flexibility to the CAISO market to avoid frequent volatile price swings in its procurement decisions. To ensure RPS compliance, the Commission may need to authorize additional RPS capacity additions. As more renewables are added to the system to meet higher RPS levels, they will be subject to even greater levels of curtailment and adverse pricing outcomes if the PMin issues are not addressed. Prices during these intervals will likely drop due to over-supply, though ratepayers may see higher costs because they are required to pay for the incremental RPS capacity additions.

If rampable resources are decomitted and cannot be restarted for the evening net load ramp, then prices in the midday may remain stable and decommitments of low-carbon resources may not occur, but as the CAISO confronts evening net load ramps, several market consequences are likely. First, real-time prices may increase dramatically as the CAISO attempts to keep up with ramping needs. Second, if the CAISO is unable to dispatch resources to meet the net load ramp, it may be forced to issue an exceptional dispatch and offer the accompanying Capacity Procurement Mechanism designation.

In reviewing the ramp range and accessibility of flexible resources, the Commission should consider RPS goals and CAISO market constraints in addition to the reliability issues

identified above. These issues are necessarily interrelated. The CAISO will operate the system in a reliable manner with the resources available. To the extent that the flexible resources are not accessible or do not have sufficient range, the CAISO's reliability related actions may have negative effects on RPS goals or market prices. Because the operational realities noted above can lead to not only increased costs to ratepayers, but also reliability concerns, the Commission should not limit its review of and need for flexible capacity products to those elements specifically called out in the NERC report.

The CAISO notes that ramp range may not be as critical for resources that are able to start and ramp quickly, so long as they are not subject to prohibitive use-limitations. However, in reality many resources that are capable of frequent starts and stops are subject to use-limitations caused by environmental limits or other negotiated limits. These use limitations may require the resource to retain limited starts to serve peak load rather than to meet flexible capacity needs.

C. Downward Deviations in Net Load Ramps.

Although the net load ramp typically increases consistently during the three-hour net load ramp, there can be five-minute intervals in which the net load decreases relative to the previous interval. This means that while the three hour net load increase may be 10,000 MW, the absolute value of net load change (the sum of the absolute values of interval-to-interval net load changes) is greater than 10,000 MW. To address these five-minute deviations, the CAISO needs resources that can quickly go from upward ramping to downward ramping and back again. As load variability increases due to increases in behind-the-meter and variable energy resources, so too will the magnitude of the absolute value of these net load changes.

III. Conclusion

The CAISO appreciates the Commission's focus on first defining reliability needs that flexible capacity resources should be designed to meet. As indicated above, the current flexible capacity mechanism is designed to meet three-hour net load ramps and the need for more frequent unit starts and stops. The current flexible mechanism provided significant benefit in addressing these issues and should be retained. Additional reliability issues, are becoming increasingly apparent as additional variable energy resources come online. In these comments, the CAISO has identified three specific reliability issues that need to be addressed: (1) extreme single-hour net load ramps, (2) positioning the system during the transition period from low net

loads into the three-hour ramp, (3) downward deviations in the net load ramp. At this time, the CAISO does not advocate for a specific new flexible capacity mechanism to meet these needs, but instead maintains that these issues need to be studied closely to determine how the reliability issues can be best and most efficiently met, considering both the state's environmental goals and the operational realities of the current resource fleet.

Respectfully submitted,

By*: /s/ Jordan Pinjuv*
Roger E. Collanton
General Counsel
Anthony Ivancovich
Deputy General Counsel
Anna A. McKenna
Assistant General Counsel
Jordan Pinjuv
Counsel
California Independent System
Operator Corporation
250 Outcropping Way
Folsom California 95630
Tel.: (916) 351-4429
jpinjuv@caiso.com

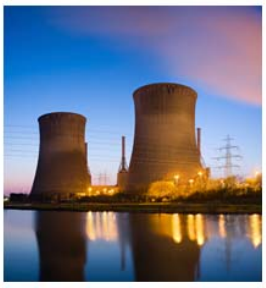
Date: February 5, 2016

NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Essential Reliability Services Task Force Measures Framework Report

December 2015

RELIABILITY | ACCOUNTABILITY

3353 Peachtree Road NE
Suite 600, North Tower
Atlanta, GA 30326
404-446-2560 | www.nerc.com

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Preface

The North American Electric Reliability Corporation (NERC) is a not-for-profit international regulatory authority whose mission is to assure the reliability of the bulk power system (BPS) in North America. NERC develops and enforces Reliability Standards; annually assesses seasonal and long-term reliability; monitors the BPS through system awareness; and educates, trains, and certifies industry personnel. NERC's area of responsibility spans the continental United States, Canada, and the northern portion of Baja California, Mexico. NERC is the electric reliability organization (ERO) for North America, subject to oversight by the Federal Energy Regulatory Commission (FERC) and governmental authorities in Canada. NERC's jurisdiction includes users, owners, and operators of the BPS, which serves more than 334 million people.

The North American BPS is divided into eight Regional Entity (RE) boundaries, as shown in the map and corresponding table below.

FRCC	Florida Reliability Coordinating Council
MRO	Midwest Reliability Organization
NPCC	Northeast Power Coordinating Council
RF	ReliabilityFirst
SERC	SERC Reliability Corporation
SPP-RE	Southwest Power Pool Regional Entity
TRE	Texas Reliability Entity
WECC	Western Electricity Coordinating Council

Executive Summary

The North American Bulk Power System (BPS) is undergoing a significant change in the mix of generation resources and the subsequent transmission expansion. Driven by a combination of factors, the rate of this transformation in certain regions is impacting planning and operating of the BPS. For example, environmental regulations are contributing to the acceleration of a significant amount of conventional coal-fired generation retirements while renewable portfolio standards and other factors are driving the development of Variable Energy Resources (VERs). This has resulted in new generation being primarily natural gas fired and an increase in the penetration of wind and solar resources. At the same time, load participation in system operations is increasing through demand response and distributed generation. These changes in the generation resource mix and technologies are altering the operational characteristics of the grid and will challenge system planners and operators to maintain reliability, thereby raising issues that need to be further examined. More specifically:

- **Impact of Retirements:** Conventional units such as coal plants provide frequency support services as a function of their large spinning generators and governor control settings along with reactive support for voltage control. Power system operators use these services to plan and operate reliably under a variety of system conditions, generally without the concern of having too few of these services available.
- **Replacement Resources:** As the generation resource mix evolves, the reliability of the electric grid depends on the operating characteristics of the replacement resources. Gas-fired units, VERs, storage, and other resources are equipped to provide similar reliability services; however, the functionality may not always be installed or made available due to costs or market rules. The controllability of new generator and load resources to maintain the balance between load and generation, especially during ramping periods, is necessary to ensure reliability.
- **Resource Capability and Characteristics:** The reliability of the BPS depends on the operating characteristics of the replacement resources. Merely having available generation capacity does not equate to having the necessary reliability services or ramping capability to balance generation and load. It is essential for the electric grid to have resources with the capability to provide sufficient amounts of these services and maintain system balance.

The purpose of this report is to explore important directional measures to help the industry understand and prepare for the increased deployment of VERs, retirement of conventional coal units, advances in demand response technologies, and other changes to the traditional characteristics of generation and load resources.

The ERSTF is not asserting that it has developed the final answer to this complex transformation; rather, the group is presenting concepts and proposing measures based on discussions with system operators, planners and industry experts studying these issues. The task force looked closely at the BPS, especially areas that are experiencing the greatest level of change in the types of resource used to serve their load. While the behaviors of conventional generators are well documented, the task force also reviewed the capabilities of newer technology such as wind, solar, battery storage and other types of generators. The ERSTF had discussions with CAISO, ERCOT, IESO, and others experiencing significant transitions in generation resource mix. Based on these discussions and other sources of information, the ERSTF has concluded that the generation resource mix transition can and does have a profound impact on the transmission and distribution infrastructure and, while manageable, these impacts have to be accounted for in energy policy making, system planning, and system operations.

In order to maintain an adequate level of reliability through this transition, generation resources need to provide sufficient voltage control, frequency support, and ramping capability—essential components of a reliable BPS.

Creation of the ERSTF

The NERC Planning Committee and Operating Committee jointly created the Essential Reliability Services Task Force (ERSTF) in 2014 to consider the issues that may result from the changing generation resource mix; the committees and the ERSTF released an ERSTF concept paper in October 2014. The committees agreed that it was prudent to identify the essential reliability services, monitor the availability of these services, and develop measures to ensure the industry has sufficient awareness of the change in reliability services in the future. As noted in the concept paper, the key characteristics of a reliable grid can be categorized into two main categories: voltage support and frequency support. The changing generation mix raises a number of potential concerns, and the ERSTF has been asked to identify measures that should be monitored to ensure reliable operation of the BPS.

Objectives of the ERSTF

The purpose of the ERSTF is to develop measures, use data from across North America to assess the validity of these measures, and provide insight into trends and impacts of the changing resource mix. The analysis conducted by the ERSTF is focused on measures that may be monitored by NERC, the appropriate NERC registered entities (such as Balancing Authorities (BAs)), and the industry to identify potential reliability concerns that may result from the changing resource mix. These measures are intended to provide the appropriate NERC registered entities and industry with both a short-term operational view and a long-term planning horizon view that enable the identification of immediate reliability concerns and look into the future for needed adjustments. The ERSTF established three technical sub-teams focusing on 1) frequency support, 2) ramping capability, and 3) voltage support. While ramping is often viewed as an aspect of frequency support, timing differences tend to suggest different measures, and they should be reviewed as separate (but related) topics. The ERSTF also created a fourth sub-team to develop documents, such as this report, to educate and inform industry, policy makers, and regulators.

Summary of Measures and Industry Practices

The task force found that the most important essential reliability services (ERS) for reliability largely focus on the topics of managing frequency, net demand ramping, voltage, and dispatchability. At the highest level, the recommendations can be summarized as:

- **Frequency –** These recommendations relate to restoring frequency after an event such as the sudden loss of a major resource. The frequency within an interconnection will immediately fall upon such an event, requiring a very fast response from some resources to slow the rate of fall, a fast increase in power output (or decrease in power consumption) to stop the fall and stabilize the frequency, then a more prolonged contribution of additional power (or reduced load) to compensate for the lost units and bring system frequency back to the normal level. The task force recommends measures to track the minimum frequency and frequency response following the observed contingency events, track and project the levels of conventional synchronous inertia for each balancing area and the interconnection as a whole, and track and project the initial frequency deviation in the first half-second following the largest contingency event for each interconnection.

- **Ramping –** Ramping is related to frequency, but more in an “operations as usual” sense rather than after an event. Changes in the amount of non-dispatchable resources, system constraints, load behaviors and the generation mix can impact the ramp rates needed to keep the system in balance. The task force recommends a measure to track and project the maximum one-hour and three-hour ramps for each balancing area. Reporting these individual BA values at the NERC level will provide data for industry-wide trending and assessment of the interaction between BAs.

- **Voltage –** Voltage must be controlled to protect the system and move power where it is needed. This control tends to be more local in nature, such as at individual transmission substations, in sub-areas of lower voltage transmission nodes and the distribution system. Ensuring sufficient voltage control and “stiffness” of the system is important both for normal operations and for events impacting normal

operations (i.e., disturbances). The task force recommends a measure to track and project the static and dynamic reactive power reserve capabilities to regulate voltage at various points in the system. The task force also recommends that industry monitor events related to voltage performance, periodically review the short circuit current at each transmission bus in the network, and do further analysis of short circuit ratios when penetration of nonsynchronous generation is high or anticipated to increase.

The ERSTF sub-teams worked to define potential measures for study and consideration that will assist in evaluating the impacts on reliability services as a result of the change in generation mix. Each potential measure was assigned a reference number as shown in Table 1. The numbers are solely for the convenience of the task force and are not meant to suggest a priority or level of importance. The general goal when forming each potential measure was to define a value that could measure historical performance, project future performance, and be plotted for the detection and understanding of trends.

After analysis and discussion, the task force recommended that each potential measure be identified as a Measure, Industry Practice, or No Further Action item.

- A Measure means that the task force recommends that values should be calculated by the appropriate entity on a regular basis and tracked by the appropriate NERC committee, subcommittee, or task force going forward.
- An Industry Practice means that the analysis has value for the appropriate entity and its use is recommended, but the value is highly dependent on the context of the specific entity, so it is less useful to report and monitor the values at the NERC level.
- A No Further Action item may provide a useful example, but was not moved forward as a recommendation for the industry at this time.

General Recommendations

Overall, the ERSTF represents a focused approach to understanding system behavior that exists today, how this behavior may change in the future, what the system will require from resources in the future, and how to make the transition in a reliable way. New resources may have different operating characteristics but can be reliably integrated with proper planning, design, and coordination. Maintaining reliability is embodied in the predictability, controllability and responsiveness of the resource mix.

Recommendations include:

1. All new resources should have the capability to support voltage and frequency. Automatic voltage regulators and governors have been standard on conventional generators for decades, and comparable capabilities are currently available for new VERs and other resources. Ensuring that these capabilities are present in the future resource mix is prudent and necessary.
2. Monitoring of the Measures and investigation of trends. The Measures are intended to highlight aspects of reliability that could suggest future reliability concerns if not addressed with suitable planning and engineering practices.
3. Planning and operating entities should use the Industry Practices. While the results of Industry Practices will be system specific and difficult to quantify or compare between different regions, they will help ensure that emerging concerns are addressed with suitable planning and engineering practices.
4. While beyond the formal scope of the ERSTF, the task force recognized that Distributed Energy Resources (DERs) will increasingly affect the net distribution load that is observed by the BPS. The ERSTF recommends coordination of NERC Reliability Standards with DER equipment standards such as IEEE 1547. Pursuant with NERC's reliability assessment obligations, the ERSTF further recommends that NERC

establish a working group to examine the forecasting, visibility, control, and participation of DERs as an active part of the BPS. With prudent planning, operating and engineering practices, and policy oriented to support reliability, DERs should be able to be reliably integrated into BPS operation.

5. Open sharing of experiences and lessons learned. The reliability of the system can be maintained or improved as the resource mix evolves, provided that sufficient amounts of essential reliability services are available.

Recommended Ongoing Efforts

Under the coordination of the NERC Planning and Operating Committees, a clear approach should be established to ensure ongoing analysis and reporting of the Measures and to encourage the use of Industry Practices. The ERSTF believes that the Measures provide useful trends and insights into the current challenges in certain areas of North America as related to the changing resource mix that should be monitored going forward. Additional metrics should also be investigated and monitored as the appropriate subcommittees and working groups continue their review consideration over time. The ERSTF expects to see ongoing enhancements to the Measures and additional recommendations from the other working groups to provide NERC with even greater clarity going forward.

The ERSTF has also developed materials that can be shared with policy makers, regulatory agencies, industry executives, and others to explain the issues and measures. Given the nature of essential reliability services and the significance of such services for energy policy making, system planning, and system operations, NERC should anticipate the need for ongoing information sharing and support for a wide variety of stakeholders. Federal, state, and local jurisdictional policy decisions have a direct influence on changes in the resource mix, and thus can affect the reliability of the BPS. Planning and operations analysis of these emerging changes must be done to ensure continued reliable and economic operation of the BPS.