RESOURCE ADEQUACY STANDARD

1 IN BRIEF

This paper proposes a revised resource adequacy standard to be used for integrated resource planning at Tacoma Power. The proposal includes three metrics:

1. Annual forecasted energy supply[1] at critical water (water year 2001) exceeds annual forecast average retail energy demand
2. Simulated[2] monthly energy supply plus 50MW of allowable market purchases exceeds simulated monthly retail energy demand in 19 out of 20 years
3. Simulated energy supply exceeds the highest 72 hour peak retail energy demand in 19 out 20 annual simulations

These metrics are generally consistent with methods commonly used by Pacific Northwest utilities and the Northwest Power and Conservation Council, and reflect the specific characteristics of Tacoma Power's portfolio of resources.

The proposed resource adequacy standard appropriately balances Tacoma Power's need to plan, acquire, and maintain sufficient power resources to meet retail electric customer long-term demand against the cost to customers of acquiring resources that are seldom if ever used. Application of the proposed metrics does not alter Tacoma Power's long-term resource strategy to acquire all cost-effective conservation. As such, the proposal does not change the financial risk of either prematurely acquiring resources, or not being able to meet retail demand.

2 BACKGROUND

Due to year-to-year variability in precipitation and the resulting river flows, electric utilities dependent on hydro generation have long recognized the need for a planning standard to ensure they have sufficient electricity supplies during years with low rainfall. Many years ago, Tacoma Power adopted a "critical water" planning standard based on the water year[3] with the lowest combined annual quantity of power the utility could produce from owned hydro-generation projects on the Cowlitz, Cushman and Nisqually rivers and production from federal projects on the Columbia River. This water year began September 1, 1940 and ended in August 31, 1941.

[1] Energy supply also includes demand reduction measures including demand response, energy efficiency, etc.
[2] Where energy supplies and retail demand is simulated using 58 historical coincident hourly simulations of streamflow and temperature.
[3] For NW utilities with hydrogenation, a water year typically runs Autumn to Autumn. Tacoma Power's water year is from September through the following August while BPA's is from October through September.

More recently, the Northwest Power and Conservation Council and some regional utilities have begun to use a 1 in 20 year planning standard. That is, utilities had sufficient resources to serve expected retail load even if the lowest generation amount seen over the last 20 years reoccurred. This approach to a planning standard is somewhat less stringent and less costly than Tacoma Power's current critical water method. The cost savings occur because utilities can reduce the amount of expensive power resources they secure but rarely, if ever, use.

Recognizing that Tacoma Power's current planning standard had nearly become a 1 in 90 standard – Tacoma has river flow data dating back to 1929 – a Power Management unit goal was established for 2015 to investigate the consequences of adopting a different approach. The unit goal specifically reads:

> By end of Q3 complete an assessment of the advantages and issues associated with the "sufficient resources at critical water planning standard." Assess the financial "risk" of an alternative planning standard (e.g., resource sufficient for 5th driest year).

3 Need for a Resource Adequacy Standard

A resource adequacy standard is an important planning tool that helps ensure the utility will have sufficient power resources to serve its retail electric customers reliably. The standard is implemented using metrics that compare the energy and capacity capabilities of the utility's resource portfolio with projected retail demand. The standard provides both a methodology for calculating resource adequacy and specific criteria to identify when and how much new resources the utility may need to acquire.

Resource adequacy is achieved when supply and demand resources can meet exceed retail demand over time taking into account scheduled and reasonably expected unscheduled outages of resource elements. Resource adequacy standards in the Pacific Northwest typically use two basic metrics: 1) an assessment of whether the utility has sufficient energy to meet monthly and/or annual average retail demand, 2) an assessment of whether the utility has sufficient capacity to meet peak loads and reserve requirements[4].

4 What Makes a Good Resource Adequacy Standard?

A good resource adequacy standard uses available information and analytic tools to simulate future conditions and quantitatively determine whether the utility's portfolio has adequate generating, contract, and demand response resources to provide reliable service. Metrics to calculate resource adequacy should include major operational factors that influence resource

[4] Operating reserve requirements are provided by the National Electric Reliability Commission (NERC) and the Western Electric Coordinating Council (WECC).

availability. In the Pacific Northwest these include: streamflow volume and timing, wind and solar generation variability, forced outage rates, variability of temperatures and its effect on retail customer demand. Good resource adequacy standards account for changes in resource availability and production capability as well as the evolution of retail demand over time.

A resource adequacy standard applies these operational factors to projected retail load to indicate: a) whether additional power is needed; b), when it is needed; and, c) and how much is needed. For example, a hypothetical adequacy assessment could find that 40 megawatts of capacity is needed during winter months beginning four years from this winter. Because new generating resources generally take five or more years to plan, design, finance, and construct, the Resource Adequacy Standard must identify resource need far enough ahead in the future to allow the utility to identify, evaluate, and select resources that can best meet the need. Resource adequacy standards come into play during the early part of the Integrated Resource Planning (IRP) process and any identified need is most relevant during the first half of the study period when the utility must decide quickly how to address the deficit. Integrated Resource Planning is a process that is repeated once every two years, so while the resource adequacy metrics can be calculated for the twenty year study period, a "no regrets" approach would limit its rigid application to the first yen years. Any resource need identified in the latter ten years of the study period should be viewed as "placeholders" for enhanced future analysis.

5 Previous Resource Planning Standards

In its past Integrated Resource Plans, Tacoma Power has relied on deterministic *critical water planning* to provide a conservative estimate of resource availability. *Load-Resource Balances* were calculated by subtracting either average or peak loads from the estimates of resource availability. The load resource balance provided a time series of surpluses and deficits, as a manner of expressing resource need.

In Tacoma Power's 2013 Integrated Resource Plan, resource adequacy was measured with two metrics; one for monthly energy and one for peak demand. The monthly energy metric was calculated for the period of 2022-2028. Monthly average load was matched with monthly generation based on 78 years of streamflow data. Resource planners calculated the load resource balance and counted the number of historical simulations where the load resource balance was net surplus and expressed it as a percentage by month. This resource adequacy metric found that for the period 2022-2028, Tacoma Power was resource adequate 96.5% of the time; slightly in excess of 19 times out of 20. The average deficit, when it occurred ranged from 11 aMW in 2023 to 26 aMW in the 2028. The maximum deficit ranged from 38 aMW in 2023 to 87 aMW in the 2028.

A peak demand metric was also calculated for the 2013 IRP, using January forecasted peak retail loads for 2017 as peak demand and matched it with critical water generation. Tacoma's resource portfolio was found adequate to meet peak demands throughout the planning period.

6 Moving from Critical Water Planning to Probabilistic Simulation

Critical water planning has been the historic approach of hydro-based utilities in the Pacific Northwest. As noted above, Tacoma Power used September 1940 through August 1941 as its *critical water year*. Other utilities have selected different critical water years based on their unique resource portfolios and depending on the impact to their specific generating resources. For example, the Bonneville Power Administration's critical water year runs from October 1, 1936 through September 30, 1937. The use of a critical water year is a simple and effective methodology, and it provides a consistent way to compare analyses over time. Planning documents are easy to compare because they used a similar metric to make decisions.

Nevertheless, Tacoma Power elected to move to a probabilistic approach for determining resource adequacy for the 2015 IRP. Tacoma's reasons include:

1. For utilities with significant variable hydroelectric generating resources (like Tacoma), probabilistic methods are a more sound means to quantify the uncertainties affecting resource adequacy than does assessing the outcome of a single extreme event.

2. Critical water planning uses the actual hydro streamflows from a specific period in history. The shape of that streamflow is specific to that historical year and may not represent the monthly shape of a future low water year. A strategic resource recommendation emanating from a particular critical water year runs the risk of the new supply being misaligned with the timing and magnitude of monthly shortages associated with a different water year.

   Example*: A critical year could have normal streamflows in the months of November-January, followed by very dry months from March-June. Resource adequacy metrics using historical critical year would indicate that December and January are not a resource concern and favor a resource strategy that targeted energy supply in April-June. Using a probabilistic resource adequacy standard based on the 5th percentile of each month would more accurately describe the possible future risk; i.e. each month has a possibility of low streamflows.*

3. Critical water planning standards assume a single specific outcome, rather than what is in fact a probabilistic distribution of potential outcomes. For example, a 60 year study data set, implicitly assumes that the risk that critical water year streamflows will reoccur equals 1.67% (=1/60). With each passing year it becomes a more remote probability if it

remains the lowest streamflow on record. When the historical dataset reaches 80 years of observed data, the risk of repeating streamflows equal to the critical water year is 1.25% (=1/80). Utilities that identify the critical water year as the lowest annual streamflows on record are accepting a progressively more conservative planning metric.

4. To represent multiple factors in a more statistically rigorous framework, the 2015 IRP is using hourly historical simulations of retail load, streamflows, and temperatures. However, hourly streamflow data is not available for the first half of the last century. This disqualifies using 1940-1941 water year as the critical water year.

7 Tacoma Power 2015 IRP Resource Adequacy Standards

Tacoma Power intends to use the following three metrics to demonstrate resource adequacy:

1. Annual forecasted energy supply at critical water (water year 2001) exceeds annual forecast average retail energy demand.
2. Simulated monthly energy supply plus 50MW of allowable market purchases exceeds simulated monthly retail energy demand in 19 out of 20 years.
3. Simulated energy supply exceeds the highest 72 hour peak retail energy demand in 19 out 20 annual simulations.

7.1 Resource Adequacy Calculation Methodology

The three resource adequacy metrics will be applied using the following methodology:

- The PLEXOS model is being used to simulate generation across 58 years of historical hourly streamflow data, optimized for economic value and subject to engineering and flood control constraints
- Generation simulations include scheduled outages and reasonable expected unscheduled outages
- Retail demand simulations are created using historical hourly temperature data
- Data is kept in a time series format so that historical correlations are maintained
- The 72 Hour Peak Resource Adequacy metric was designed to represent the risk of Tacoma Power having insufficient stored water at its reservoirs to meet a peak load event. For hydroelectric utilities, instantaneous 1 hour peak demand periods are not the greatest risk, because hydroelectric generation projects are often sized large enough to handle extreme flood events. The greatest stress for a hydroelectric supply based portfolio is continued use at a high level for a sustained period of time, such as a three day cold snap.

- Operating Reserve Requirements in the 72-Hour Resource Adequacy Metric. Utilities are obligated to plan not only for the energy needs of its' customers but they are also required to meet operating reserve requirements.[5] Operating reserves are the power supplies that utilities provide "over and above" what is needed to serve the hourly average load "just-in-case" something goes wrong. Operating reserves allow utilities to continue to provide reliable service even when retail load and/or system generation experience short term (less than one hour) fluctuations.

- The calculation of reserve requirements takes into account the possibility of sudden disturbances in the power system such as an unanticipated loss of generating capacity. Currently, Tacoma Power is obligated to carry three percent of retail load plus another three percent of scheduled generation as reserves, half of which must be provided by Tacoma Power as spinning capacity and half of which can be provided with non-spinning, but quick start capacity. Reserve requirements place obligations on resource capacity in addition to forecasts of retail demand. And, as a balancing area responsible for net interchange, Tacoma Power's real time traders and schedulers are required to hold an additional 10 aMW of operating reserves for the start of each hour. Tacoma Power will include reserve requirement obligations in the 2015 IRP test for peak resource adequacy.

7.2 How Do Resource Adequacy Results Compare Between 2013 IRP and 2015 IRP?

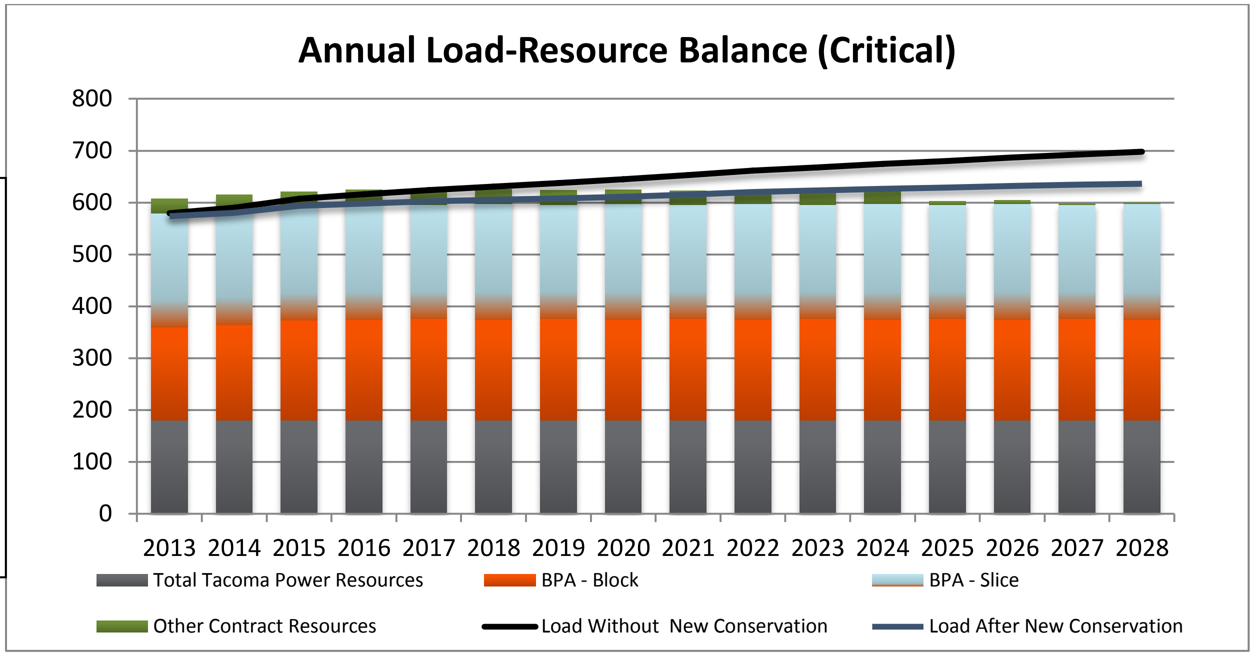
1. Annual forecasted energy supply at critical water exceeds annual forecast average retail demand.

In the 2013 IRP, annual retail load exceeded the projected supply under critical water beginning in 2025. In the 2015 IRP, annual retail load does not exceed projected supply under critical water in any of the study years (2016-2035).

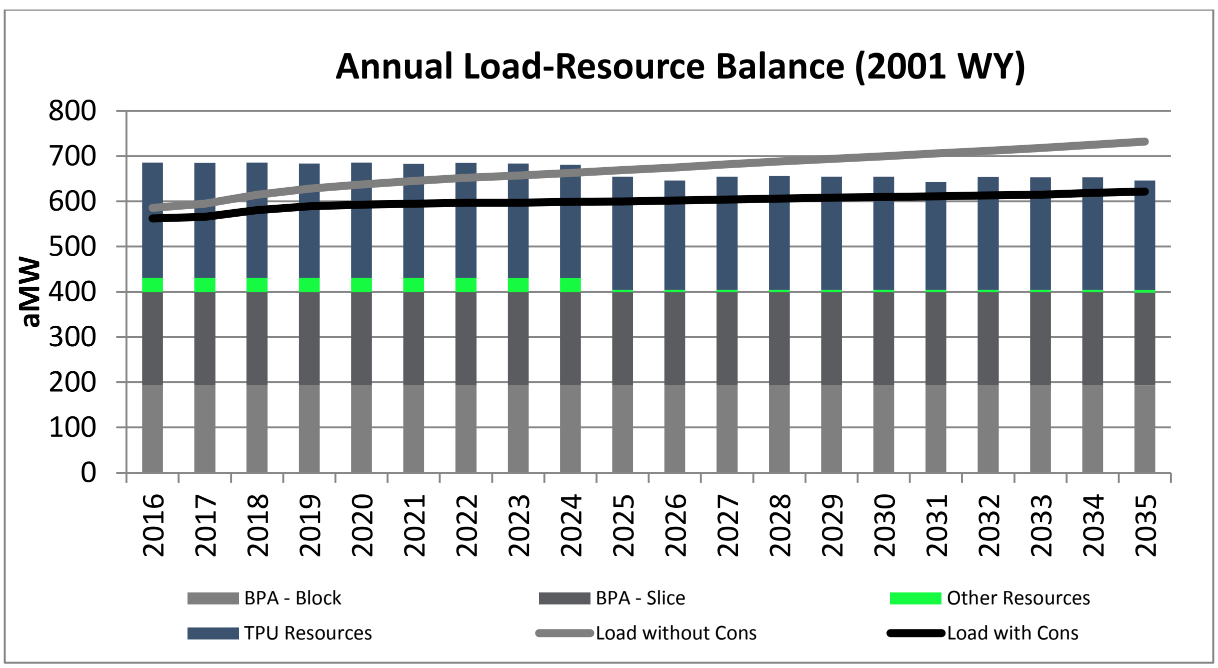
[5] Northwest Power Pool Reserve Sharing Program Documentation, May 2015 http://www.nwpp.org/documents/RSGC/NWPP-Reserve-Sharing-Doc-April-17-2015-RSG-Approved-Effective-May-1-2015.pdf

FIGURE 1: 2013 IRP AND 2015 IRP ANNUAL LOAD RESOURCE BALANCE PROJECTIONS FOR THE YEAR 2028

2013 IRP



2015 IRP



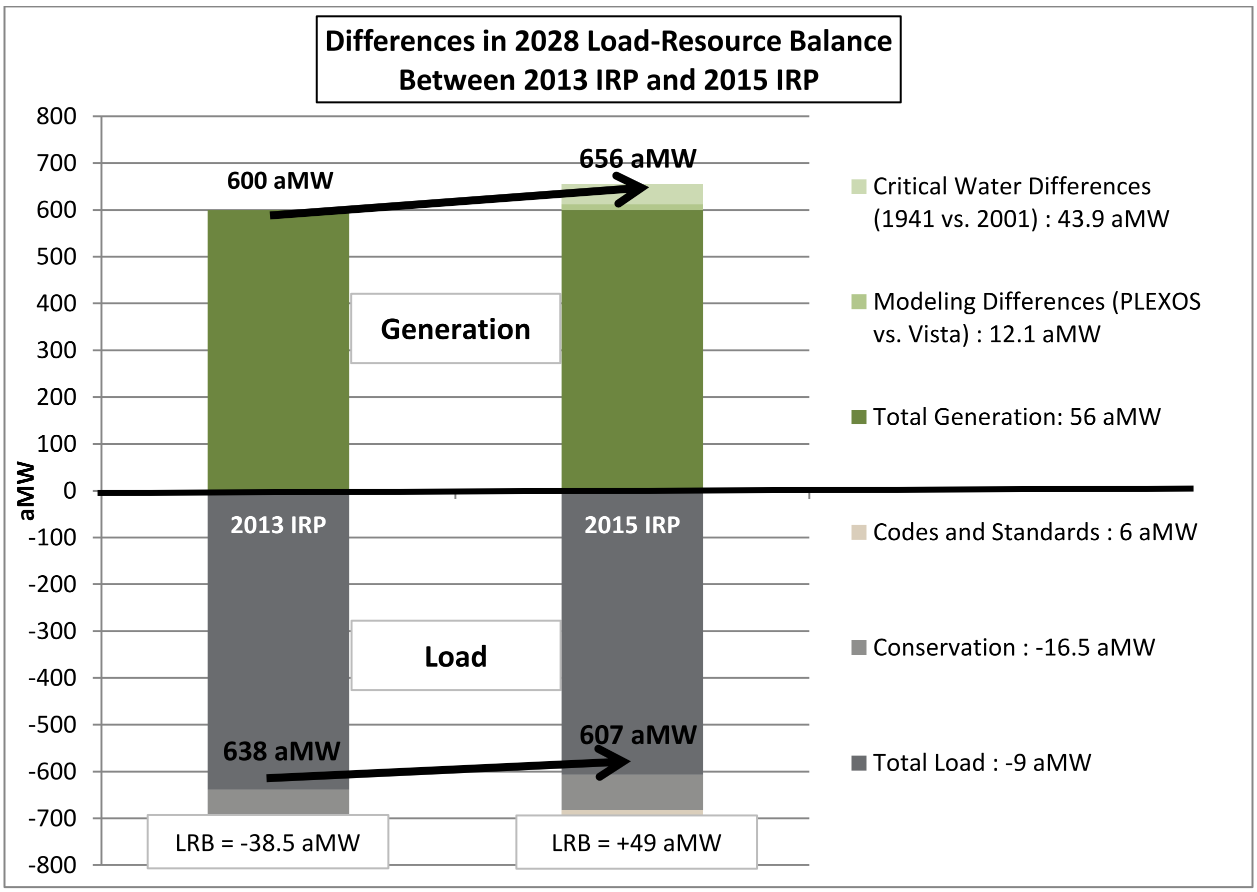
Differences exist between the two IRPs in the methodology used to identify resource adequacy. A comparison of a common year (2028) helps explain the differences:

1. The 2013 IRP had a lower overall pre-conservation load forecast (9 aMW)
2. Conservation levels in the 2013 IRP understate levels currently assumed by 16.5 aMW

3. The 2013 IRP used 1941 water year as a measure for critical water, the 2015 IRP uses the 2001 water year as it's measure of critical water. The difference in annual flow between these two measures is roughly 2 KCFS or 6.7%. A proportionate amount of power would equal a difference of 43.8 aMW
4. Federal and State Codes and Standards are likely to contribute to an additional reduction in retail load of 6 aMW

   These factors contribute to a reduction of retail demand of 31 aMW
5. The remaining differences in generation can be attributed to differences beween the two modelling techniques. Differences in modeling include software differences (Vista vs. PLEXOS), data granularity (monthly vs. hourly), and number of simulations. Differences attributable to modelling equals 12.1 aMW.

FIGURE 2: DIFFERENCES IN 2028 LOAD-RESOURCE BALANCE

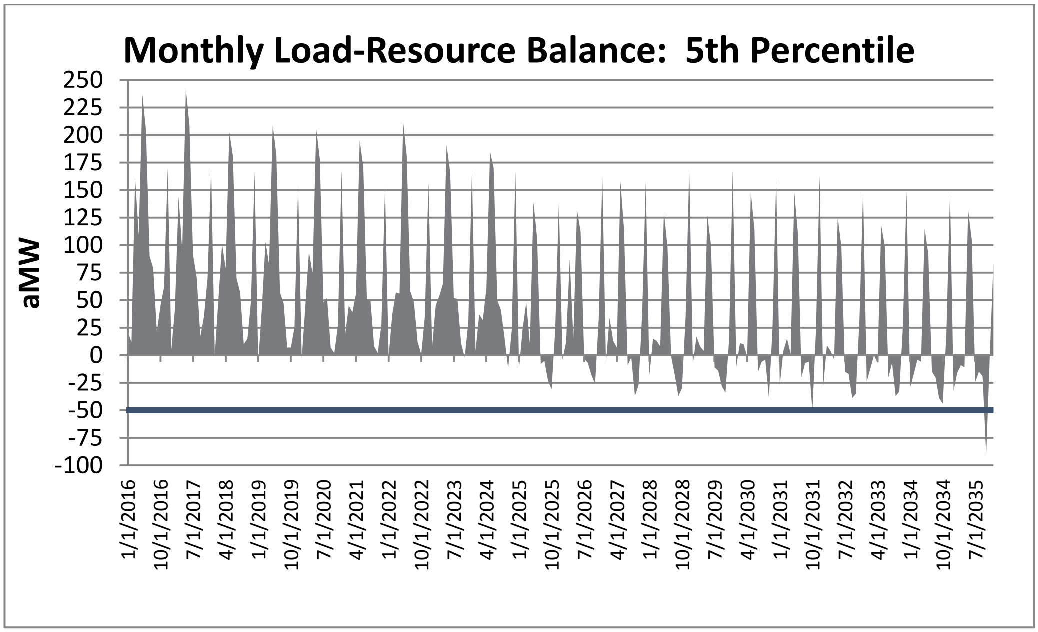


2. Simulated monthly energy supply plus 50MW of allowable market purchases exceeds simulated monthly retail energy demand in 19 out of 20 years

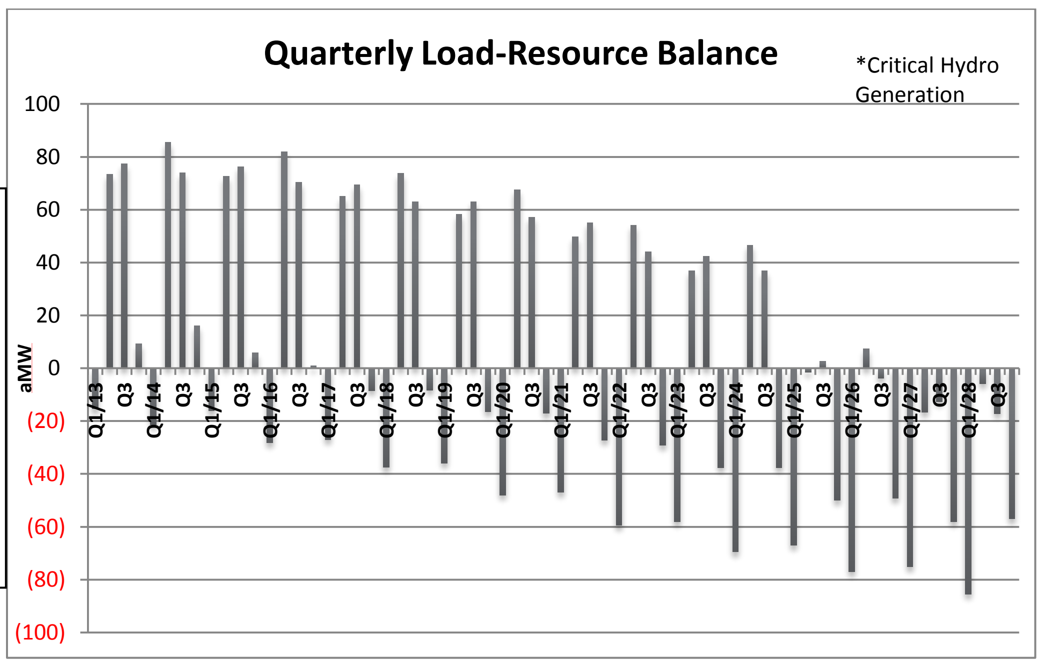
In the 2013 IRP, quarterly Load-Resource Balances showed significant deficits in certain quarters (Q4, Q1) in the early 2020's. In the 2015 IRP, monthly Load-Resource Balances show monthly deficits less than the allowable 50MW market purchase thresholds until the final year of the study, 2035. Simulated monthly energy supply plus 50MW of allowable market purchases exceeds simulated monthly retail demand 19 years out of 20.

FIGURE 3: DIFFERENCES IN LOAD-RESOURCE BALANCE

2015 IRP



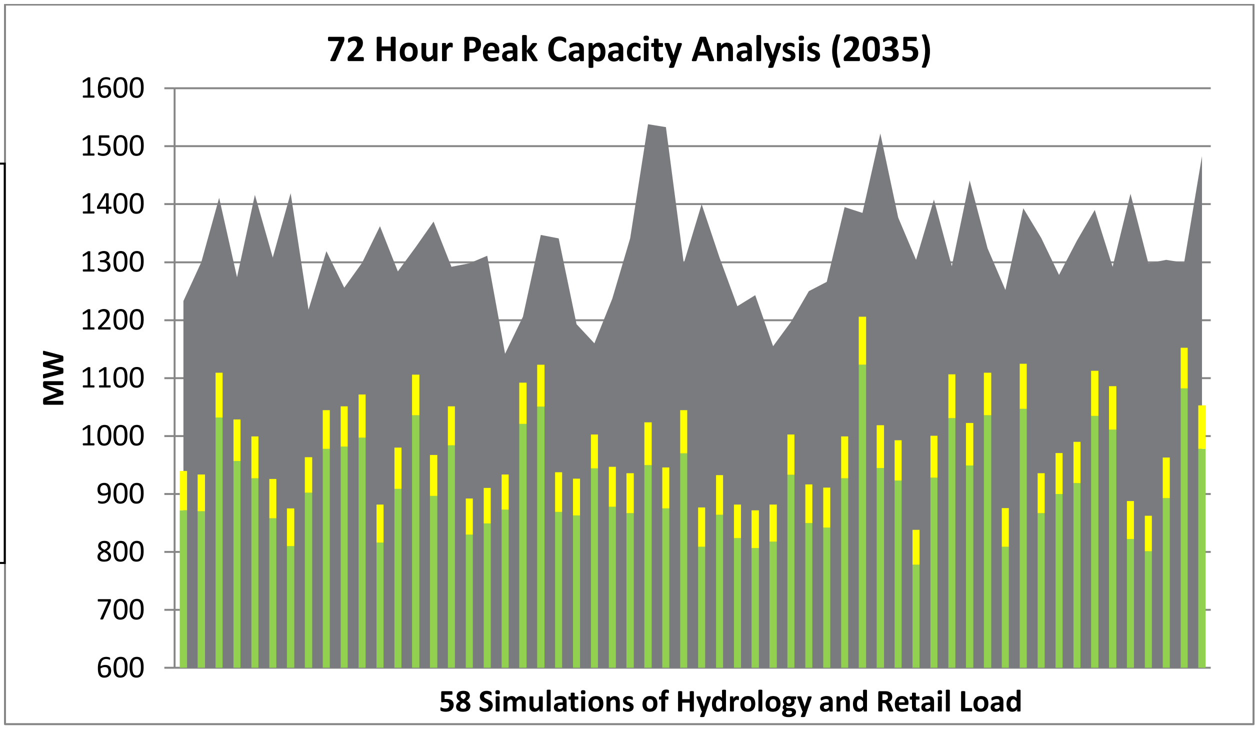
2013 IRP



3. Simulated energy supply exceeds the highest 72 hour peak retail energy demand in 19 out 20 annual simulations

In the 2015 IRP, simulated energy supply for a 72 hour peak capacity event is greater than the 72 hour peak retail demand in 19 out 20 simulations for all years of the study. Incidents of insufficient capacity range from 0% to 1.7%

FIGURE 4: 72 HOUR PEAK CAPACITY ANALYSIS (2035)



7.3 FINANCIAL IMPACTS OF THE PROPOSED RESOURCE ADEQUACY STANDARD

Proposed Resource Adequacy Metrics are more stringent in comparison to previous methodologies because they utilize simulated rather than average retail demand and use a probabilistic measure of peak capacity analysis.

The overall effect is to make the metrics more sensitive to changes in retail load and peak resource availability, which should provide resource planners with more advanced notice of impending resource adequacy issues. More notice for resource planners can result in more time to make decisions and allocate resources, thereby reducing financial risk.

The proposed changes to Resource Adequacy Metrics do not signal an immediate need for additional supply resources and does not direct the utility to change it’s current long-term resource strategy – the acquisition of all cost-effective conservation only. In supporting the current Resource Adequacy Standard even with more stringent tests results in this proposal not adding to the utility’s financial risk of pre-mature resource acquistion.

8 CONCLUSIONS

The three proposed resource adequacy metrics serve resource planning by providing indicators for when additional resources may be needed to maintain reliability for Tacoma Power’s retail customers.

The three proposed metrics indicate that through to the last year of the study (2035), Tacoma Power has sufficient resources and is not obligated by energy or capacity needs to immediately pursue resources in excess of all cost-effective conservation.