Tacoma Power 2015 Integrated Resource Plan

Resource Adequacy Standard

In Brief

This paper proposes a resource adequacy standard to be used for integrated resource planning at Tacoma Power. The resource adequacy standard includes three metrics, one metric for annual resource adequacy, one metric for monthly resource adequacy and one metric for 72-hour peak resource adequacy.

The proposed resource adequacy standard will help ensure that Tacoma Power plans, acquires, and maintains sufficient power resources to meet its electric customers' needs over the long-term. For its 2015 Integrated Resource Plan covering the period 2016-2035, the following three metrics will be used:

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.

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 exceed retail demand taking into account scheduled and reasonably expected unscheduled outages of resource

[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.

elements. Resource adequacy standards in the Pacific Northwest typically use two basic types of metrics: 1) a metric for assessing whether the utility has sufficient energy to meet retail demand, 2) a metric for assessing whether the utility has sufficient peak capacity to meet peak loads and reserve requirements[3].

What Makes a Good Resource Adequacy Standard?

A good resource adequacy standard uses available information and analytic tools to simulate future conditions and determine whether the utility's portfolio has adequate generating, contract, and demand response resources to provide reliable service. Quantitative methodologies to calculate resource adequacy metrics in the Pacific Northwest should include major operational factors that influence resource availability including: streamflow volume and timing, wind and solar generation variability, forced outage rates, variability of temperatures and its' effect on retail customer demand.

The resource adequacy standard should provide criteria that can be used to determine when (month, year) and how much additional power resource (in megawatts and/or megawatt-hours) is needed. 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. Further, resource needs and available resource alternatives change over time. As a result, the use of resource adequacy standards to identify resource need is most instructive during the earlier part of the resource planning period and diminishes after the first half of the study period, roughly the last ten years. 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.

Calculation Methodology

For Tacoma's 2015 Integrated Resource Plan, the resource adequacy standard's three metrics are being 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

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

- 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.

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 in the 2013 IRP 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, or 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. This analysis found that Tacoma's resource portfolio would be adequate to meet peak demands throughout the planning period.

Moving from Critical Water Planning to Probabilistic Simulation

The use of critical water planning was the focus of many utilities in the Pacific Northwest for many years and was not exclusive to Tacoma Power. In the past, Tacoma Power selected the 1940-1941 water year as its *critical water year*. Other utilities have selected other years to serve as their critical water year, depending on how their specific generating resources were impacted. Bonneville Power Administration has used the 1936-1937 water year consistently for analysis of regional resource adequacy.

The use of a critical water year provides a simple but effective methodology, and many feel that it has a quality of continuity and consistency over time. Planning documents were easy to compare because they used a similar metric to make decisions.

There are several reasons to adopt a probabilistic measure over a deterministic metric for resource planning in Tacoma's 2015 Integrated Resource Plan:

1. When assessing resource adequacy for a utility like Tacoma whose portfolio includes variable hydroelectric generating resources, probabilistic methods provide a more sound means for quantifying uncertainties than just using a single extreme outcome.

2. Critical water planning uses the actual hydro streamflows from a specific period in history. While it is an acceptable standard for annual operations planning, it is less useful for longer-term resource planning. The shape of streamflows within a historical year is specific to that year and is not general enough to represent the likelihood of a re-occurrence of low flows at any point in the future. Any strategic recommendation that emanates from critical water planning over the long-term runs the risk of assessing value to a particular past outcome rather than the general likelihood.

   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. Using a critical water planning standard for long-term planning assumes a single specific outcome, rather than what is in fact a probabilistic distribution of potential outcomes. Using a 60 year study set that includes 1936-1937 as the official critical water year because it was the lowest annual streamflow on record, implicitly assumes that the risk of re-occurrence of streamflows equal to the critical water year will be

p(x)=1/60=1.67%. If the critical water year is used as a standard, with each passing year it becomes an even more remote probability if it remains the lowest streamflow on record. When the historical dataset uses 80 years of observed data, the risk of repeating streamflows equal to the critical water year is p(x)=1/80=1.25%. If a utility identifies the critical water year as the lowest annual streamflows on record, that utility is accepting a progressively more conservative metric for planning.

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, data for 1936-1937 is not available at the hourly level. This disqualifies the use of 1936-1937 water year as the standard for critical water planning.

Reserve Requirements in the 72-Hour Resource Adequacy Metric

Reserve requirements are a statutory obligation[4], and are used to handle short term fluctuations in power system operations. 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 matched by Tacoma Power with spinning capacity and half of which can be matched with non-spinning, but quick start capacity. Reserve requirements are obligations of resource capacity in addition to forecasts of retail demand. Because Tacoma Power is a Balancing Area and has responsibility for net interchange, its 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.

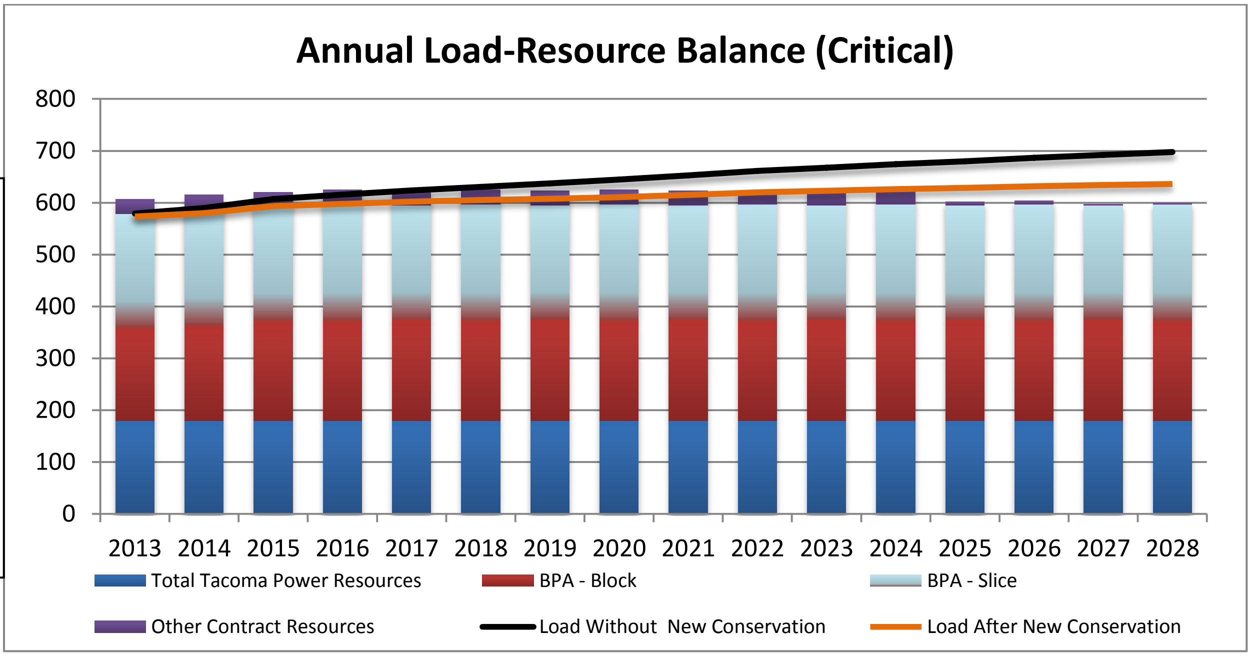
[4] Northwest Power Pool Reserve Sharing Program Documentation, May 2015 http://www.nwpp.org/documents/RSGC/NWPP-Reserve-Sharing-Doc-April-17-2015-RSG-Approved-Effective-May-1-2015.pdf

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

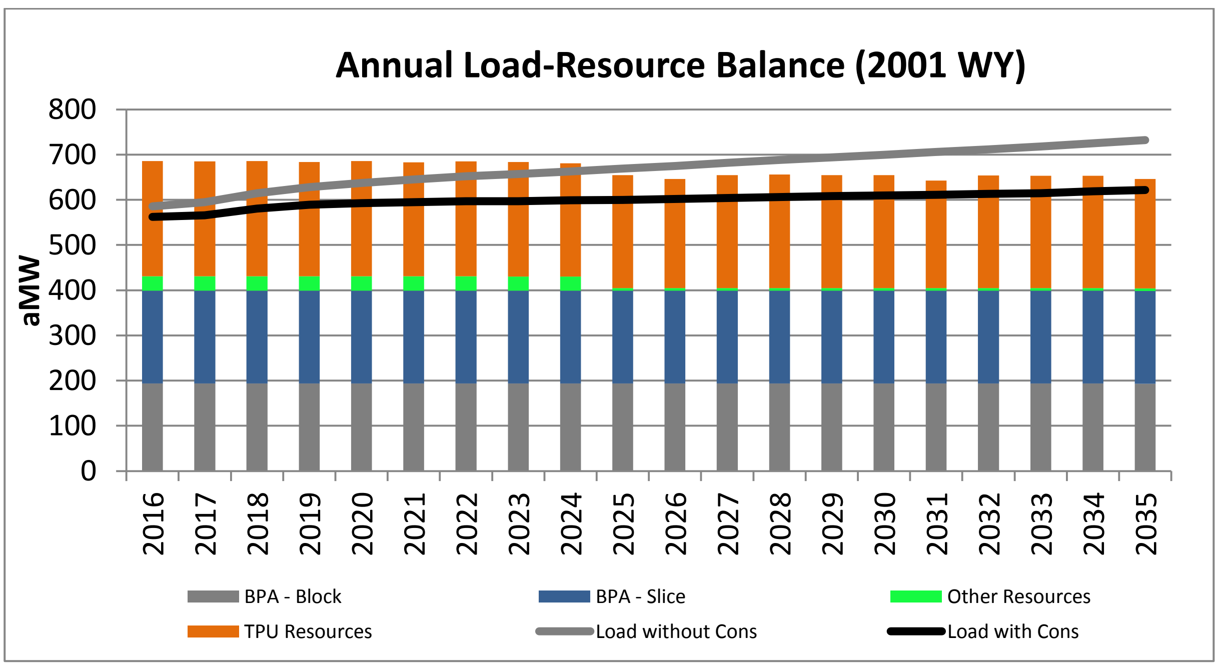
1. Annual forecasted energy supply at critical water exceeds annual forecast average retail demand.

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).

2013 IRP



2015 IRP

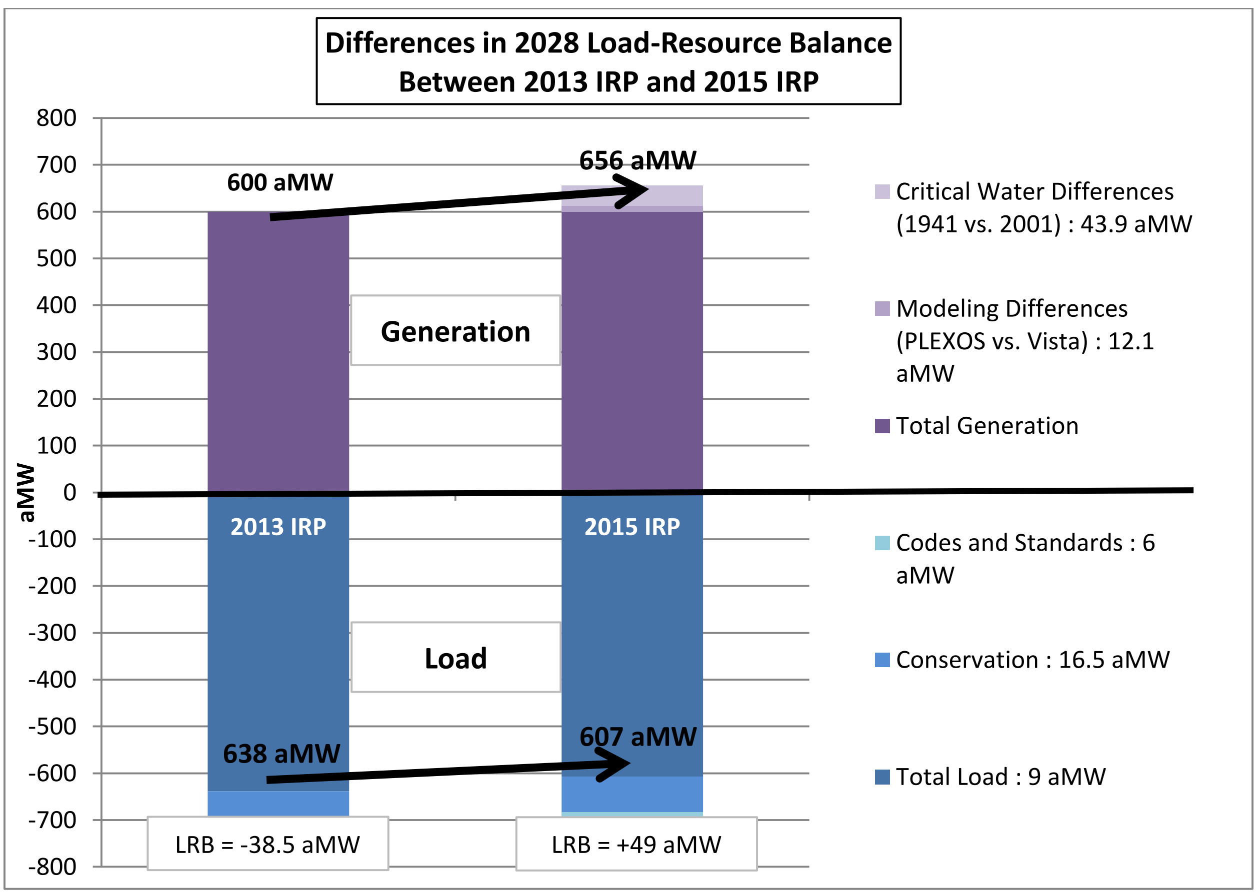


Comparison of 2013 IRP and 2015 IRP Annual Load Resource Balance for the Year 2028

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 programs planned for in 2015 IRP exceed the conservation plan from 2013 IRP by 16.5 aMW
3. Federal and State Codes and Standards are likely to contribute to an additional reduction in retail load of 6 aMW

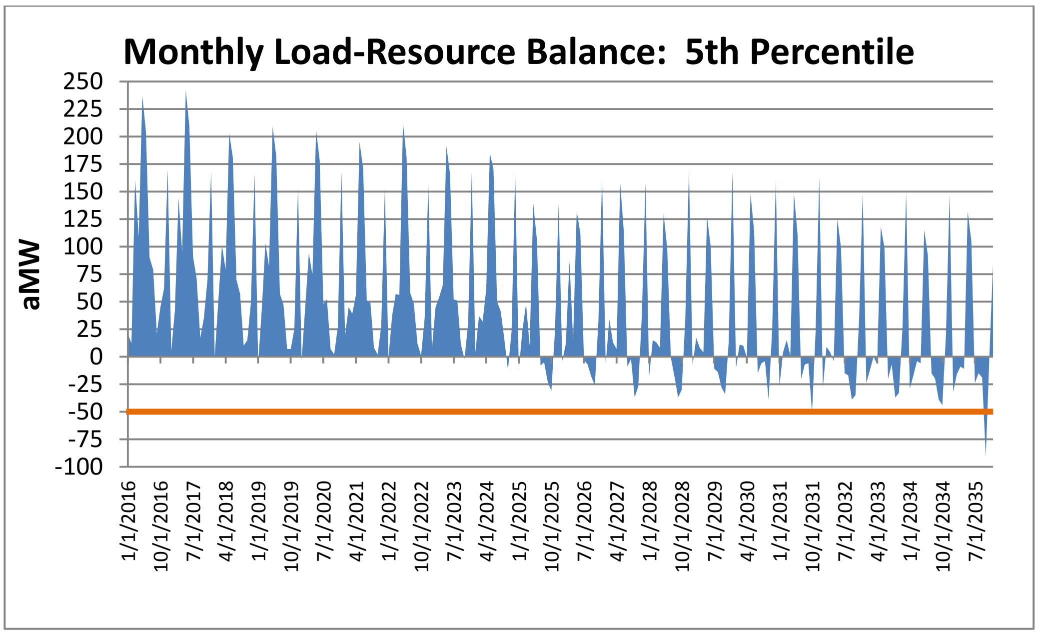
   These factors contribute to a reduction of retail demand of 31 aMW
4. The 2013 IRP used 1941 water year as a measure for critical water, the 2015 IRP uses the 2001 water year as it's measure of critical water. The difference in annual flow between these two measures is roughly 2 KCFS or 6.7%. A proportionate amount of power would equal a difference of 43.8 aMW
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.



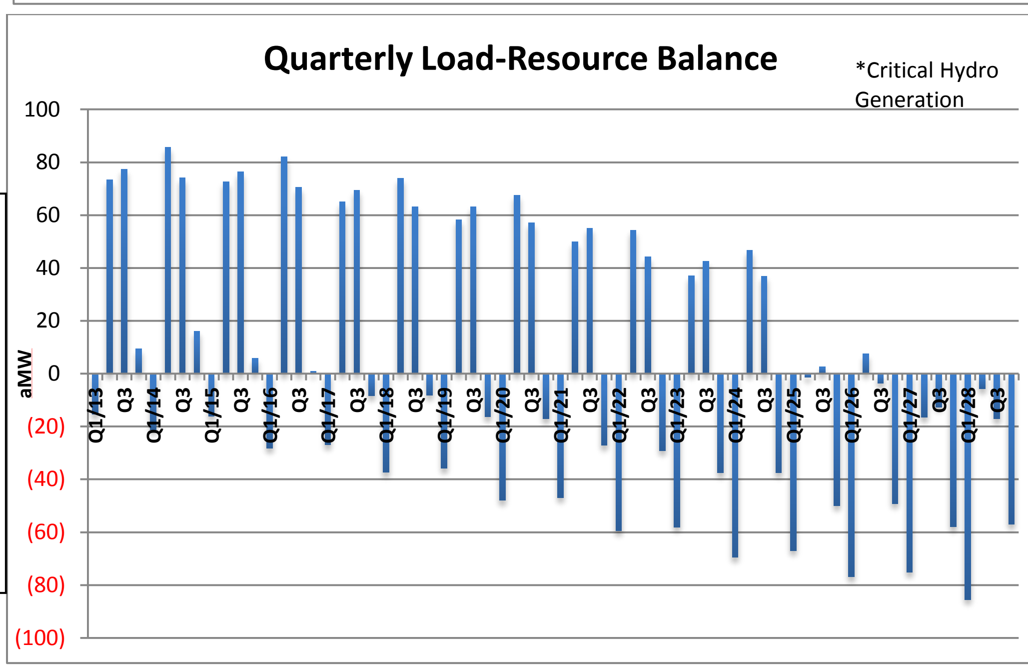
2. Simulated monthly energy supply plus 50MW of allowable market purchases exceeds simulated monthly retail energy demand in 19 out of 20 years

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.

2015 IRP



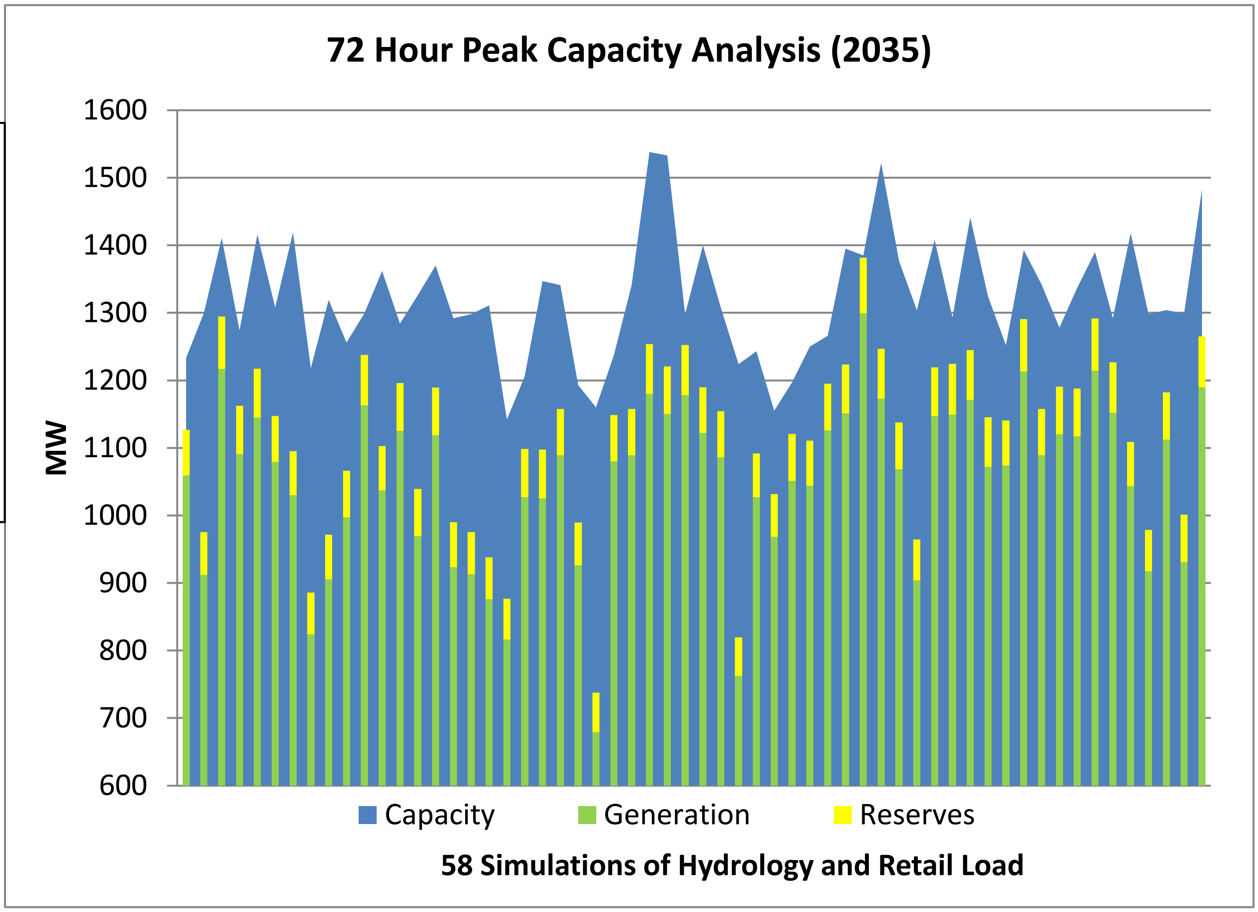
2013 IRP



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%

2015 IRP



<u>Conclusions</u>

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.