Resource Adequacy Technical Committee Meeting

June 23, 2011

# Notes

**In attendance:** John Fazio, Rob Diffely, Tina Ko, Pat Byrne, Gwen Shearer, Mike McCoy, Jim Litchfield, Stefan Brown, Kevin O’Meara, Nancy Baker, Dick Adams, Nicolas Garcia, Wally Gibson, Villamor Gamponia, Wendy Gerlitz, Sarang Amirtabar

**On the phone:** Tom Karier, Steve Weiss, Howard Schwartz

**Review of the Current Power Supply Adequacy Standard**

John presented a brief review of the existing adequacy standard (recommended by the Forum and then adopted by the Council in April of 2008). He defined several terms that would be used throughout the day; 1) metric – a quantity that can be measured, 2) measure – a value for a metric, 3) threshold – a limiting value for a metric and 4) adequacy level – the adequacy provided by setting a particular threshold.

John laid out a couple of key questions for the group to consider. The first was whether we should change the metric (LOLP) that we currently use to assess adequacy. The second was whether we should consider changing the level of adequacy that the standard provides. He made a point of differentiating between these two issues. We can change the metric or add additional metrics to make the assessment more helpful without changing the level of protection. But there have also been questions raised about the genesis of the 5% threshold for the current standard. Where did it come from, how much adequacy does it actually provide and, most importantly, is it the right level for the region?

Since 2008, the Forum and Council have used the existing standard to assess the adequacy of the region’s power supply. And, every year, the assessments have shown the supply to be adequate. However, that conclusion has not “meshed” well with utility integrated resource plans (IRP) or with the Council’s own resource strategy, as detailed in its 6th power plan. Having an “adequate” supply can be interpreted (incorrectly) as not needing new resources or new efficiency measures. However, utility IRPs and the Council’s 6th plan all recommend continued investment in efficiency and acquisition of cost effective resources. The apparent “gap” between the adequacy assessment and the 6th plan resource strategy highlights the difference between two similar but functionally different analyses. An adequacy assessment should address the question of “keeping the lights on” *regardless of cost*. A resource strategy should address the question of what new resources are needed to minimize both long-term cost and short-term price fluctuations (economic risk).

John said that by adding a second threshold (say an “economic” adequacy measure) to the existing standard, this gap between planning analyses and adequacy assessments might be reduced. However, John warned that there is a danger to doing this, and that is, that the “economic” standard might then be interpreted as a resource planning target, which it is not. Adequacy assessments are short term (1 to 5 years) by design and are done using physical uncertainties; water supply, temperature (short-term load variation), wind generation and forced outages. Resource planning analyses are longer term (10 to 20 years) by design and include many more uncertainties, especially economic ones, such as fuel and electricity prices, potential for carbon tax and long-term (or economic) load variation. Thus, John concluded, that there are both pros and cons to adding a secondary adequacy threshold – and this committee, along with the steering committee, will have to decide whether to do so.

John then provided more detail regarding the existing standard. The current adequacy metric is the loss-of-load probability (LOLP) and its threshold is 5 percent – meaning that a power supply with an LOLP greater than 5 percent is deemed to be inadequate. This metric is measured for winter energy, winter capacity and summer capacity.

For some unexplainable reason, the Forum left off an assessment for summer energy. John suggested that a summer energy measure should be included in the revised standard, if appropriate.

The model used to assess adequacy (GENESYS) simulates the hourly operation of the region’s hydro and thermal resources (efficiency is included in the load forecast and variable wind generation is subtracted from the load). Emergency (or small) resources are not modeled, thus the resulting curtailment record (every hour in which demand was not met) is reduced by the amount of these non-modeled resources. The energy contribution of emergency resources was assumed to be 28,800 megawatt-hours per season and the capacity contribution was assumed to be 3,000 megawatts. (These values have since changed to 93,000 megawatt-hours for energy and about 1,200 megawatts for winter capacity and about 2,000 megawatts for summer capacity – and are still under review).

The LOLP is then calculated by counting every simulated season in which at least one curtailment occurs and dividing by the total number of seasons simulated. This calculation is done for winter and summer seasons and for both energy and capacity needs. For energy assessments, any winter or summer simulation whose total curtailed energy exceeds the emergency energy limit is considered a bad simulation. Similarly, any winter or summer simulation in which any hour’s curtailment exceeds the emergency capacity limit is considered a bad simulation.

If any of these four LOLP values is greater than 5 percent, the supply is deemed to be inadequate. The latest assessment (reported in the Council’s 6th plan) shows all of these values to be under 5 percent.

The current standard also includes a translation of the LOLP assessments into more commonly used deterministic measures, more specifically; annual load/resource balance and capacity planning reserve margin. The Forum chose to add these deterministic metrics to the standard for two reasons, 1) utility planners have historically used similar metrics and 2) adequacy assessments could then be made without running the GENESYS model. (In retrospect, including this translation in the standard may have caused more problems than it solved).

To accomplish the translation, a power supply with exactly a 5 percent LOLP is created (by adjusting loads until the limit is achieved). Threshold limits for deterministic metrics can then be derived from this “just barely” adequate supply. The annual load/resource balance is used for the deterministic energy metric. The load used is the average annual normal-weather demand (and includes efficiency reductions). Resources include regionally owned or operated thermal generators (annual average availability), critical hydro generation, 30 percent of installed wind capacity and some non-firm generation. The non-firm generation includes the availability of regional independent power producer resources (full availability in winter and only 1,000 megawatts in summer), about 200 average megawatts of out-of-region market supply and about 1,100 average megawatts of non-firm hydro. For the power supply to be adequate (for energy needs), the amount of available resources must be greater than the load or, in other words, the annual load/resource balance (as defined above) must be greater than zero.

The “planning reserve margin” is more accurately described (in the context of the adequacy standard) as the sustained-peak surplus generating capability in units of percent. It is calculated by extracting resource and load information from a power supply with a 5 percent capacity LOLP value (this is done for both winter and summer seasons). For each season, the load used is the average load across the 18 highest load hours over a consecutive 3-day period (weather normalized). The resources are added up in much the same way that they are for the energy metric, with the following exceptions; 1) for thermal units, seasonal peaking capability is used (not availability), 2) for hydro, the critical period 18-hour sustained-peaking capability (derived from another model) is used, 3) IPP resources are assumed to be fully available during winter but are limited to only 1,000 megawatts for summer, 4) out-of-region purchases are limited to a maximum of 3,000 megawatts per hour in winter and zero for summer, 5) for wind, 5 percent of its installed capacity is used and 6) 2,000 megawatts of borrowed hydro (energy below the proportional draft elevation) is assumed for winter and 1,000 megawatts is assumed for summer.

The sustained-peak surplus generating capability is calculated as the average sustained-peak generating surplus divided by the average sustained-peak load (in units of percent). A power supply with a sustained-peak surplus generating capability equal to or greater than the threshold is deemed to be adequate.

In theory, any power supply whose annual load/resource balance or sustained-period surplus generating capability (as defined above) equals its deterministic metric threshold will yield a 5 percent LOLP in a full GENESYS analysis. However, that condition only holds as long as the resources or loads do not change. Any change in the shape of load or in the availability of resources (e.g. changes in the biological opinion) will alter the translation, which means that new thresholds will have to be assessed (or calibrated). Thus, using deterministic metrics makes the adequacy assessment quick and easy but care has to be taken to ensure that the deterministic thresholds are properly calibrated (which is usually a fairly time consuming process).

John suggested that the committee consider not including deterministic metrics as part of the “official” standard but rather to provide them as additional information, if requested. He said that while most regions in the United States use probabilistic methods to assess adequacy, they all translate their probabilistic results into planning reserve margins. John said that for the sake of communication with other regions (including the WECC) we may be stuck with having to calculate some form of deterministic adequacy metric. Wally mentioned that the WECC is now moving to probabilistic methods to assess adequacy but it wasn’t clear whether they would continue to use a planning reserve margin for reporting.

Since 2008, assessing the adequacy of the power supply has been an enlightening and beneficial process. Every year, the Council’s load and resource assumptions are compared to similar data in Bonneville’s White Book and in PNUCC’s NRF publication. This process has been helpful to all participants because it provides a good crosscheck for both loads and resources. And, in fact, several errors and omissions have been discovered in the resource data (on both sides). However, a direct comparison of resource data to the NRF cannot be made because of “philosophical” considerations. The NRF has historically been a “planning” report (as opposed to an “adequacy” report) and thus, assumptions about resources are more likely to show expected capability rather than available capability. For example, a simple cycle gas peaking turbine may be reported with a 5 percent availability in the NRF but is assumed to be 100 percent available for adequacy assessments (unless of course it is on maintenance or on forced outage).

Thus, while the adequacy assessment process has benefitted regional planners, it still has many shortcomings. For one, the LOLP metric is rather limited in that it does not account for multiple curtailment events over a single simulation and it does not take into account the magnitude of potential problems.

Also, there are problems with the translation of probabilistic thresholds into deterministic thresholds. Some of the assumptions used in that process are rather “loosely” defined. For example, wind’s sustained-period capacity contribution is assumed to be 5 percent, yet that assumption is not derived from a rigorous analysis. And, assumptions regarding the available amount of borrowed hydro are also rather loosely defined. (It should be noted that these problems only occur when translating LOLP results into deterministic measures. In the probabilistic GENESYS analysis, hydro and wind resources are simulated explicitly). Needless to say, should the committee decide to continue the practice of translating probabilistic adequacy measures into deterministic ones, the assumptions will have to be more rigorously defined.

Rob mentioned that work should be done to better define the basis for wind’s capacity contribution. The current value of 5% is based loosely on anecdotal information but can be more rigorously defined by running GENESYS studies. It was noted that the capacity contribution for wind will depend greatly on the site and the power supply that it is being incorporated into. BPA staff is working to develop a temperature-correlated synthetic wind data set.

Also, Council staff is working with BPA to investigate possible effects of borrowed hydro on fish operations, in particular impacts to Chum salmon (flow levels from November through March) and to refill probabilities in spring.

**Summary of Methodology Review**

Because of these observed deficiencies in the current adequacy standard, the Forum chose to have its methodology reviewed. Thus, the Council and Bonneville contracted with the Brazilian firm Power Systems Research, Inc. (PSRI) to; 1) critique the current methodology, 2) suggest alternative adequacy metrics and 3) describe how adequacy standards can be incorporated into long-term resource planning processes.

In general, the PSRI report indicated that our methodology was appropriate but could be improved. A few key conclusions from the report include;

* Many other regions and countries use similar methods
* LOLP only looks at probability of curtailment
* Not clear how threshold is set (currently 5%)
* Better if magnitude of curtailment could also be incorporated
* Assessing adequacy separately for energy and capacity needs is appropriate
* No need to separate winter and summer periods, i.e. assess for entire year
* Using deterministic metrics is awkward and not needed

Stephen Brown (PGE) suggested that it might also be important to somehow include the number of curtailment events per simulation. John said this could be done by calculating a loss-of-load expectation (LOLE) metric, which measures the likelihood of a curtailment event over an extended period of time. (As opposed to LOLP, which measures the likelihood of a bad simulation). LOLE, in fact, is the metric most used by other regions in the US. The commonly referred to “1-day-in-10-year” threshold relates to the LOLE metric. In this case, we would calculate the total number of curtailment events over all simulations and then divide by the number of simulations. This yields the expected number of curtailment events per simulation (or per year if each simulation is one year).

PSRI suggested using the Conditional Value at Risk (CVaR) metric to account for the magnitude of potential problems. CVaR is measured as the average magnitude of the worst curtailment events. It is similar to the Council’s TVaR90 metric used in its Regional Portfolio Model (used to develop resource expansion strategies). There are many ways to define the CVaR metric. For example, we could define the energy CVaR metric as the total annual curtailment averaged over the 5 percent worst simulations. The capacity CVaR metric might be defined as the average peak (single hour) curtailment over the 5 percent worst simulations.

There are several advantages to using the CVaR metric. First, it provides a measure of the size of the problem, which should help in developing solutions. Second, it provides a measure of the likelihood of certain sized events. In the examples above, a CVaR-sized event would be expected 5 percent of the time. Third, CVaR has nice mathematical properties, which make it easy to implement into resource planning optimization programs (more on this later).

[*This section (in the square brackets) was not discussed at the meeting but is relevant and could be a useful alternative use for CVaR.* CVaR can also be used to assess the likelihood of events that have a specific size. For example, instead of calculating CVaR for the worst 5 percent (referred to as CVaR95), we could calculate the CVaR *level (%)* at which the average magnitude of an event is of a certain size, say 3,000 megawatts for a single hour. The resulting CVaR *level* would give us the likelihood of observing a curtailment event of about 3,000 megawatts.]

Currently, the Council incorporates resource adequacy into its planning model (the Regional Portfolio Model) via the deterministic energy metric. The RPM will build resources if it deems them to be economic. However, regardless of the economic situation, if the resulting load/resource balance falls short of the adequacy threshold, sufficient resources will be built to maintain adequacy. This does not appear to happen often in the RPM, meaning that building a resource strategy based on economics will most often provide an adequate supply. Council staff is still considering ways to incorporate the deterministic capacity metric into the RPM. An alternative is to simply use the CVaR metric explicitly in the RPM. Staff is also exploring this possibility.

O’Mara (Tacoma) stated that probabilistic discussions with customers and regulators can be challenging (implying that a translation into deterministic metrics would be helpful in communicating with customers and regulators).

**Options for Revising the Standard**

John Fazio laid out several options for revising the current standard:

1. No change
2. No change but add a metric to measure the size of curtailments and a metric to measure the use of contingency resources (CR)
3. Same as option 2 but replace the LOLP metric with a different metric
4. Change the adequacy ***level*** (perhaps based on CR dispatch) and add a metric to measure the size of curtailments

It was suggested that we not use the term “contingency” to refer to resources that would be used only during emergencies. The suggestion was to use the term “emergency resources.” The committee agreed and in future documents we will refer to these resources as “emergency resources” or “ER.” (Any reference to “contingency resources” or “CR” in these notes should be interpreted as “emergency resources”).

John Fazio then presented a slide that identified several classes of emergency resources and the estimated tolerance for their use. In a recent adequacy analysis, the energy and capacity LOLPs for both winter and summer were all under 5 percent – indicating an adequate supply. However, emergency resources were dispatched in about 25 percent of the simulations. So, although that particular power supply was deemed adequate based on the current standard, it’s not clear whether utilities (and operators in particular) would be happy with it. Of course, there exist a great number of emergency resources, ranging from irrigation pumps that can be turned off and on with relative ease to backup generators at data centers that should seldom, if ever, be used to cover a regional shortfall.

The Forum needs to refine its assessment of emergency resources and try to estimate the tolerance for their dispatch. A paper commissioned by the Council in 2001 to do just that was distributed to the group for review. Some utilities may have already gone through such a process.

**Action Item**: Establish a subgroup to develop an emergency resource supply curve for the region. Take care to account for some resources (irrigation pumps connected to the AGC system, for example) whose contribution may already be accounted for in the load forecast.

John continued by saying that out of the 4 options listed above, number 1 (no change) and number 3 (same as number 2 but with a metric other than LOLP) are probably not viable options. That leaves option 2 (same standard but add more information) and option 4 (change the adequacy ***level*** and add more information). So, one of the key questions for the committee is whether the ***level*** of adequacy should be changed in a revised standard.

O’Mara stated that he liked keeping the current standard with a 5 percent LOLP.

Villamor Gamponia (PSE) said that option 4 would be very hard to implement because of the difficulty in determining the tolerance for emergency resource dispatch. He stated that he would prefer to keep the 5 percent LOLP, at least for the short term.

Brattebo warned about making the standard overly complicated. It leads to confusion like what happened at the Wind Integration Steering Committee.

Fazio suggested that keeping the current standard makes it easier for communication because it is what the region has been using for the past 4 years. However, he didn’t think that it was very intuitive. He could not explain, for example, where the 5% threshold originated from. John believes that informing operators how often their emergency resources are likely to be used would be a much more intuitive measure than the 5% LOLP threshold.

Mike McCoy stated that the origin of the 5% metric dates back to the 1930s. It was a political decision not an economic decision. The economic standard (i.e. what it means to not meet load) was never worked out completely. If we could pin down the cost of curtailment we would know what the standard threshold should be.

John reminded the committee that the original proposal from the Forum was to include an “economic” adequacy level. At the time it was believed that the threshold for the economic level could be extracted from the Council’s Regional Portfolio Model. Council staff explored various methods of doing this without success. The RPM plots average system cost vs. economic risk (average cost of the 10% highest cost years) for thousands of different resource plans. Viable plans are those that lie on the efficient frontier, that is, those whose cost is lowest for a particular fixed value of risk. Choosing one plan on the efficient frontier effectively yields the Council’s resource expansion strategy. However, that plan has many different resource outcomes depending on various future uncertainties. There could be as many as 750 different sets of annual loads and resources for that plan, meaning that we would be calculating 750 different LOLP values. It was presumed that most, if not all, of those LOLP values would be less than 5% but staff did not pursue the effort. Using the expected dispatch of key emergency resources may be a better way to set the threshold for an “economic” adequacy level.

John then refocused the group by reminding them that the steering committee wanted us to reassess the standard. Has it worked? Has it been helpful to planners? Are there improvements that can be made? There seemed to be a consensus that the standard has worked and has been helpful but more information would be better. Whether the official standard should be revised or not, everyone agreed that providing information regarding the use of emergency resources would be very helpful. Also, adding information about the size of potential problems and a better indication of the frequency would be good. Tom Karier asked if we should also add information regarding the duration of events.

Fazio suggested that we could simplify the standard by only assessing a single adequacy metric for the entire year. In other words, define the characteristics of a “bad” event, then simulate every hour of the year and count those simulations that have at least one bad event as bad simulations. The LOLP would continue to be the number of bad simulations divided by the total number of simulations run. He said this would be accompanied by additional information regarding monthly statistics, magnitude measures and even frequency measures.

Dick Adams was concerned that because of variable resources, a single annual metric may not work. Villamor Gamponia agreed and supported keeping a seasonal approach. He was also in favor of adding information about the size of potential problems.

Dick Adams agreed that all of the additional information would be helpful but he continued to support defining the standard with winter and summer components.

Tom Karier stated that the original intent of the Resource Adequacy Forum was to produce an adequacy standard that would provide an early warning (e.g. smoke alarm) should resource development fall short, for whatever reason.

Villamor Gamponia said that PSE uses LOLP for planning purposes but that their definition was different. They are only looking at winter and use it to define the hourly planning margins. They have used these results in their capacity planning model. The LOLP looks at any size event and it also includes reserve sharing in the first hour. They also assume a lot of reliance on the market. He questions whether 5% is the right number. Puget has done outage cost surveys in the past but he did not elaborate on the results.

Sarang Amirtabar stated that SCL looks at LOLP over the November to February period and simulates both hydro variation and demand variation. December is the peak month for SCL and they look at single-hour events using a 95% exceedance level.

Stefan Brown stated that PGE gets asked about the Council’s standard during their IPR process.

Fazio asked committee members to consider how the standard could be made more useful for utilities.

Wally stated that communication essential. He added that the level of detail will depend on the audience. Policy makers are likely to want the bottom-line results and analysts will want all the detail. Whatever the standard turns out to be, the Forum will have to develop a way to communicate results to a number of different groups. The Forum will have to report results in a way that each group can understand. He asked, for example, what it means to satisfy a 5% LOLP threshold. Does it mean that the chance of a severe curtailment is once in 20 years or does it really mean something else?

After lunch John demonstrated a spinner spreadsheet that toggles through curtailment events for a particular study. John reminded the committee that the adequacy metrics discussed today are simply ways to summarize the anticipated set of curtailment events. The real test, he said, would be for planners to look at every simulated event (and conditions under which they occur) and determine whether they could “live” with the results. The metrics are only a means of simplifying that task. John toggled through several curtailment events, pointing out the shape, size and duration of each event and the conditions for those events (water, temperature, forced outage and wind). Most of the events were relatively small. The larger events usually coincided with poor water and extreme temperatures.

Fazio then wrote an outline on the white board to help committee members focus on the task at hand.

1. What is the purpose for an adequacy standard? Should it be just a smoke alarm or could it also be a planning aid?
2. What is the best way to accomplish the purpose?
3. How can we make the standard more useful to utilities?
4. How do we communicate results with other regions, resource planners, the press, utility operators and others?
5. Taking all this into account, what should the standard look like?
6. What other information should be provided, in addition to the standard?

Wally stated that WECC is moving to *Promod* for hydro and away from the sustained peaking concept. This is used in their yearly assessment. NERC only looks at probability around forced outages and load.

A discussion followed on the use of emergency resources in the model. Emergency resources (some of which may already be reflected in the load forecast) are real resources. If some of these resources are expected to be used often, then perhaps we should quantify them and simply subtract their contribution from the curtailment values.

What about hospital and data center generators? Should their use be limited to some arbitrary probability? What is the appropriate level of tolerance for their use?

O’Mara stated in regards to the use of emergency resources that we need to make it clear exactly how often and for how long these resources may be needed.

Stephen Brown and Mike McCoy suggested that many utilities already keep list of emergency actions, which they would implement during emergencies.

Fazio said that the easiest revision would be to keep the standard the same but to add additional information that could be very useful to planners, operators and policy makers.

Wally disagreed with keeping the standard the same. He suggested going to a single metric and threshold. His reasoning was that if we have a problem during a particular simulation, it doesn’t really matter whether it happens during the winter or summer or whether it is a capacity or energy shortfall. Any of those types of problems would classify that simulation as “bad” and it would count toward the LOLP calculation. The additional information provided would allow planners to figure out what the problem was, when it occurred, what it looked like, etc.

**Action Item:** Fazio said that he would run a base case scenario and calculate the values for a variety of different adequacy metrics. He will present that to the committee at its next meeting. He hoped that by doing so members would get a better feel for the relationship among the different metrics that have been discussed.

**Action Item**: Fazio will send an inquiry out regarding a potential meeting date for this committee’s next meeting. He will look at dates in the latter half of August.

O’Mara agreed with Wally and suggested that there may be too many components to the current standard (i.e. summer and winter periods for both energy and capacity). Does having all those LOLP values make it harder to communicate the results?

Sarang Amirtabar (in regards to #3 on John’s white board list) stated that it would be helpful to have a unification of the mechanics and methodologies.

**Action Item**: Continue the process of vetting the GENESYS model. Many committee members would like to know more about how the model works and would like a more robust benchmark of its simulation.

Puget suggested separating demand response from efficiency (conservation). John replied that the model’s infrastructure can already do that and in fact, should be done that way because demand response is dispatchable, whereas conservation is not. Someone asked whether our modeled conservation was temperature correlated. John said that because our loads are derived from an econometric model, some temperature effects will be included. However, this is an area that should be examined further.

**Action Item**: Investigate conservation’s correlation to temperature and ensure that regional load forecasts include a proper representation for efficiency.

John emphasized that Sarang’s comment is critical. The standard can be useful to utility planners because of the methodology and mechanics, not because of the regional metric or its threshold. He stated that a utility cannot implement the regional standard by simply prorating the threshold based on its own service area. There are no utilities in the region whose loads and resources look exactly like the region’s loads and resources. But, although the threshold may not be transferable to individual utilities, the methodology certainly is. Each utility is encouraged to use probabilistic methods to evaluate their own exposure to shortfall conditions and to come up with thresholds that are meaningful for them. Recall that the original purpose for the standard was to help the region avoid situation like those that led to the 2001 energy crisis. John reminded the group that had the standard been in place during the 1990s, the alarm would have gone off in about 1995. Once the alarm has sounded, regional analysts and planners need to meet to determine if the alarm was real and if so what actions to take.

**Action Item**: Establish a subgroup to investigate ways in which utilities can incorporate the regional methodology into their own adequacy assessments and resource planning processes. John said utilities don’t need the GENESYS model per se, but they do need a tool that can perform chronological simulations using Monte Carlo methods.

SCL said that it uses regional results to get a feel for market supply. They generally look at the November through February period and focus on single hour problems. Their random variables include hydro conditions and demand. December is their peak month and they use a 95% exceedance level to assess the status of their supply.

Tacoma said it looks at the regional assessment to gauge basic economic conditions relative to resource supply. It doesn’t intend to use the standard explicitly for economic assessments. They would become concerned if the regional assessment fell below the threshold.

Fazio added that adding a secondary level of adequacy measure, such as an economic level discussed earlier, could be misleading. There has always been a gap between adequacy assessments and resource planning strategies because they satisfy different purposes. A secondary adequacy measure that tries to bridge that gap could be misinterpreted as being a planning tool. However, resource planning strategies should be based on methods that also incorporate economic and other variables not used in GENESYS.

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