

# Chapter 14: Regional Adequacy Standards

Summary of Key Findings .....	1
Background .....	2
Motivation for Developing a New Standard .....	2
Historical Approach .....	3
Adequacy Assessment Efforts Outside of the Northwest .....	3
Assessing the Adequacy of a Resource Strategy .....	4
The Pacific Northwest Adequacy Standard .....	5
Physical Adequacy, Economic Adequacy, or Both .....	5
Defining the Resource Adequacy Standard .....	6
Annual Needs (Energy Standard) .....	7
Peak Hourly Needs (Capacity Standard) .....	7
Implementing the Standard .....	7
Working with Other Entities .....	7
The Adequacy of the Northwest Power Supply .....	8
Utility Perspective on Resource Adequacy .....	11
Methodology .....	14
Analytical Tools .....	14
Reliance on Market Resources .....	16
Translating the Adequacy Standard into a Simpler Measure .....	17

## SUMMARY OF KEY FINDINGS

The 1990s saw little new resource development in the Northwest due, in part, to the emergence of an electricity market and the anticipation of deregulation. As load continued to grow, supply remained stagnant, and utility planners became concerned about the adequacy of the power system. 2001 was the second-driest year on record in the Northwest. This, coupled with a failed wholesale power market in California meant the region faced a serious threat of blackouts. Actions were taken to avoid forced curtailments, but those actions were costly and resulted in soaring electricity prices.

It was becoming obvious that a new method of assessing resource adequacy was necessary. The power system was becoming more complex, with greater constraints placed on the operation of the hydroelectric system, increasing development of variable and dispersed resources, and the growth of a Westwide electricity market. The Council recognized this need, and in its Fifth Power Plan recommended developing a resource adequacy standard. Supporting this decision was federal legislation, passed in 2005, requiring an Electric Reliability Organization (the role now filled by the North American Electric Reliability Corporation, or NERC) to assess the adequacy of the North American bulk power supply.

In 2005, the Council and the Bonneville Power Administration created the Northwest Resource Adequacy Forum to aid the Council in developing a standard, and to annually assess the adequacy of the power supply. The forum, which is open to the public, includes utility planners, state utility commission staff, and other interested parties. After nearly three years of coordinated effort, it reached consensus on a proposed resource adequacy standard, which the Council subsequently adopted in April 2008.

The standard helps to assess whether the electricity supply is sufficient to meet the region's needs now and in the near future. It provides a minimum threshold that serves as an early warning should resource development fall dangerously short. It also suggests a higher threshold that encourages greater resource development to offset electricity price volatility. It does not mandate compliance or enforcement. It does not directly apply to individual utilities – because every utility's circumstances differ. Individual utilities must assess their own needs and risks to determine their own planning targets, which are screened by public utility commissions or by their boards of directors. It would be a misapplication of the adequacy standard to infer that utilities should slow their resource acquisition activity simply because the adequacy standard for the region is being met. The Pacific Northwest resource adequacy standard can be found at: <http://www.nwcouncil.org/library/2008/2008-07.pdf>.

Over the next five-year period, the region's existing resources, in aggregate, exceed the standard's minimum threshold for annual energy needs and for winter hourly needs. However, existing resources appear to just barely fall short of meeting the summer hourly adequacy requirement by 2015, which places the region in a yellow-alert status. Under the implementation plan agreed to by forum members, a yellow-alert status calls for an adequacy report to be released and for the forum to convene to discuss appropriate actions to take. The forum has met and decided that because the summer capacity shortfall is minimal and because regional utilities are already in a resource-acquisition mode, no additional resource actions should be recommended. However, the forum did recommend that all load and resource data be reevaluated and that the methodology used to define the adequacy standard be peer-reviewed. These actions are currently under way.

## BACKGROUND

### *Motivation for Developing a New Standard*

Economic growth depends on an adequate electricity supply, and the resource adequacy standard was developed to ensure that the region's energy needs will be met well into the future. In the worst-case scenario, an inadequate electricity supply can affect public health and safety, as in a blackout. Fortunately, such events are rare, and when they do happen, they are most often caused by a disruption in the delivery of electricity, not the supply. However, there have been times – during extreme cold spells or heat waves – when supply has been tenuous. The fact that most of the region's electricity comes from the hydroelectric system presents unique challenges to the energy supply, too, since periods of drought that limit hydroelectric power production are unpredictable.

While most disruptions in supply have been short-term, the Western United States did experience an extended energy crisis in 2000-01. At its root, the crisis was precipitated by an imbalance of electricity supply and demand centered in California and the Pacific Northwest, where for years development of new energy resources had lagged behind energy demand. Ripple effects from that crisis were felt throughout the West as electricity prices and consumer rates soared to historic highs.

In addition, changes in the energy environment have made ensuring the adequacy of the region's power supply more challenging. Greater constraints on the operation of the hydroelectric system, increasing development of variable and dispersed resources, and the growth of a

Westwide electricity market have all contributed to creating a much more complex and interconnected power system. Changes in the Bonneville Power Administration's role as a power provider also mean that load-serving entities will bear more responsibility for their load growth, making regional coordination to ensure adequacy especially important.

### ***Historical Approach***

Historically, the Northwest has planned to a critical-water standard, which implies that Northwest resources, including hydroelectric generation produced under the driest water condition, should at least match the forecast load on an annual basis. This standard originated when the region was essentially isolated from the rest of the Western system by limited transmission links. Even after cross-regional interties were built, this policy continued because high oil and gas prices dominated generation markets in the rest of the West.

However, since the collapse of oil and gas prices in the mid-1980s, the region has not had to balance in-region resources and demand under critical-water conditions in order to maintain a physically adequate power supply. The reasons for this are twofold. In almost all years, hydroelectric generation will exceed production under critical-water conditions; and the Southwest should always have surplus winter energy to export (the Southwest is a summer-peaking region and the Northwest is a winter-peaking region). Thus, the region has strayed from strict critical-period planning.

Generally, reservoirs behind the dams have been drafted in the fall and early winter under the assumption that the region would realize better-than-critical water conditions. Should a dry year ensue, the region could import surplus energy from the Southwest or interrupt a portion of the direct-service industry load. These kinds of contractual agreements with the remaining direct-service industries no longer exist, but the Northwest is still connected to the Southwest. Both regions should be able to benefit from the diversity in the timing of their peak loads. A strict assessment of adequacy, therefore, should consider the ability to import power from outside the region. For resource acquisition purposes, however, reliance on market resources will depend on impacts to overall cost and customer rates.

### ***Adequacy Assessment Efforts Outside of the Northwest***

In order for a regional adequacy standard to be effective, it must be compatible with actions in the rest of the West. Therefore, working with the Western Electricity Coordinating Council (WECC) and other Westwide organizations is necessary. Most of the discussions in the region and the rest of the West have been directed toward developing some sort of adequacy standard that would apply to load-serving entities. The Federal Energy Regulatory Commission (FERC) proposed an adequacy standard as part of its standard market design. However, that standard was inappropriate for an energy-constrained, hydropower-dominated system like the Northwest's. The FERC has subsequently deferred to the states, but in the absence of state or regional action, it might attempt to reassert authority in this area. In addition, the North American Electric Reliability Corporation (NERC) has begun developing a power supply adequacy assessment standard that would apply to the WECC.

The NERC Resource and Transmission Adequacy Task Force prepared a report with recommendations for both resource and transmission adequacy. The NERC adopted the report in

2004, and subsequently drafted a standard authorization request for a resource adequacy assessment incorporating the task force's recommendations. This proposed new standard requires regional reliability councils, such as the WECC, to establish resource adequacy assessment frameworks that the NERC will review to ensure compliance.

The WECC has since established a new framework that has been implemented in its annual power supply assessments for the last three years. Northwest planners continue to refine the characterization of the Columbia River hydroelectric system, both for the regional assessment and to improve the accuracy of its adequacy assessment for the Western Interconnection.

Some states, through their public utility commissions, have the ability to implement adequacy standards for the utilities they regulate. For example, the California commission adopted an adequacy standard requiring investor-owned utilities to have a 15-17 percent reserve margin over their peak load. This planning reserve includes the approximately 7-percent operating reserves required by the WECC. The California commission's order also requires load-serving entities to establish forward contracts to cover 90 percent of their summer (May through September) requirements, which would include their peak load plus the 15-percent reserve one year in advance. Some believe this standard goes beyond what is required to assure adequacy in a purely physical sense, as it is intended to limit California's exposure to the risk of extreme prices.

### ***Assessing the Adequacy of a Resource Strategy***

Assessing the adequacy of the Council's long-term resource strategy, as outlined in this power plan, is a separate issue from assessing the adequacy of the existing power system through the next five years. This section describes how those assessments differ and how the Council's resource adequacy standard is incorporated into its planning models to ensure that the resulting long-term strategy will provide an adequate supply.

The Northwest resource adequacy standard is based on a probabilistic metric defined by the resource adequacy forum that assesses whether existing resource capability is sufficient to meet firm loads through the next five years. That assessment takes into account only existing resources and new resources that are expected to be completed and operational during that time period. If a deficiency is identified, then specific actions are initiated. Those actions include reporting the problem, validating load and resource data used in the assessment and identifying potential solutions.

The process described above is intended to be an early-warning system for the region to indicate when the capability of the *existing power system* does not sufficiently keep up with demand. Although similar, an assessment of a resource **strategy** differs in significant ways. First, a resource strategy spans a much longer time period, namely 20 years for the Council's power plan. Second, a strategy implies that resource development will be dynamic, in other words, it provides a supply of cost-effective resources that the region can draw from depending on future conditions. The adequacy of a single resource plan (i.e. the resource-construction dates for a specific future simulated by the Council's regional portfolio model) can be assessed, but that is not the same as assessing the adequacy of the strategy itself.

What does it mean, then, to assess the adequacy of a resource strategy? In particular, how can we ensure that this power plan will provide an adequate supply? One approach is to assess the adequacy of each resource plan associated with each future simulated by the portfolio model (750 futures). But how many of those plans must pass the adequacy test in order for the strategy itself to be deemed adequate? If every plan is adequate, then we can be reasonably sure that the strategy is adequate. Unfortunately, that outcome is unlikely because of the number and range of uncertain variables used in the model. So, what percentage of possible future plans (derived from the resource strategy) must pass the test in order for the strategy to be deemed adequate?

The adequacy forum has not addressed this specific issue because it is somewhat outside the scope of its tasks. However, there is an alternative approach that provides a viable solution. Rather than assessing the adequacy of specific resource plans as a post process, the adequacy standard can be incorporated directly into the portfolio model. The standard is based on a probabilistic analysis that assesses the likelihood of curtailment to service (further defined in the next section). The result of that probabilistic analysis is translated into a minimum load/resource balance threshold. When a resource plan meets or exceeds this threshold, it satisfies the adequacy requirement. To ensure that the power plan's resource strategy is adequate, this minimum threshold has been added to the portfolio model as a requirement for resource acquisition. In other words, if the model's resource acquisitions (based on economic considerations) do not measure up to this threshold, it will add resources until that condition is satisfied.

## **THE PACIFIC NORTHWEST ADEQUACY STANDARD**

The adequacy forum includes representatives from the region's electric utilities and utility organizations, public utility commissions and public interest groups, as well as from Bonneville and the Council. It is made up of a steering committee and a technical committee.

The forum's overarching goal is to *“establish a resource adequacy framework for the Pacific Northwest to provide a clear, consistent, and unambiguous means of answering the question of whether the region has adequate deliverable resources to meet its load reliably and to develop an effective implementation framework.”*

To that end, the forum has forged a voluntary, consensus-based standard for the region to address both energy (annual) and capacity (hourly) needs. This standard has been designed to assess whether the region has sufficient resources to meet growing demand for electricity well into the future. This is important, because it takes time – usually years – to acquire or construct the necessary infrastructure for an adequate electricity supply.

While some interests may wish to see an enforceable adequacy standard, currently, there are no institutions in the Northwest that could enforce such a standard for all the region's load-serving entities.

### ***Physical Adequacy, Economic Adequacy, or Both***

Is the purpose of an adequacy standard to ensure that the “lights stay on” with an acceptably high probability (physical adequacy); or is it to protect against the economic and social costs of an energy shortage (economic adequacy)? The adequacy standard addresses the first level by

providing a minimum threshold that serves as an early warning should resource development fall dangerously short. The standard also suggests a higher threshold that encourages greater resource development to offset electricity price volatility -- or economic adequacy. The economic threshold is tied to the resource strategy defined in the Council's power plan. The forum has not yet fully explored this interpretation of the economic threshold nor has it made any recommendations regarding failure to meet that threshold.

Different adequacy standards could be applied at different levels. For instance, a physical standard might be most appropriately applied at the WECC level. At this level, it would provide a baseline for physical reliability and actions by load-serving entities and their regulators to address. Economic adequacy might be better addressed at the individual (or perhaps state policy) level, where different mechanisms for mitigating price risk could be put in place.

Unlike past adequacy assessments, this assessment considers the question of reliance on market supply. Physical adequacy is determined by forecast load, existing firm resources, and assessing available market supply, cost notwithstanding. Economic adequacy is determined in a similar manner, except that the region (or utility) uses an economic analysis or makes a policy decision to determine how much power to buy from the market. Utilities may want to limit their exposure to market resources for a number of reasons, price volatility being only one.

The Council's portfolio analysis results suggest maintaining a higher level of in-region resources than the adequacy standard's minimum threshold. These additional resources reduce the likelihood of having to purchase high-priced electricity. At the same time, however, the analysis also indicates that if the overall level of regional resources is sufficient, overbuilding is a riskier and more expensive alternative than some level of reliance on the market. This is true regardless of the ownership of the resources.<sup>1</sup> The challenge is to find the right balance.

### ***Defining the Resource Adequacy Standard***

The Northwest resource adequacy standard<sup>2</sup> is based on a sophisticated hourly assessment of load and resources and how they might be affected by temperature (load deviations), precipitation (water supply), forced outages to generating resources, and other factors.

Historically, the region's tolerance for a significant power supply shortage has been assumed to be 5 percent – that is, the region would tolerate a significant power shortage no more than once in 20 years. This type of metric is commonly referred to as a loss-of-load probability (LOLP) and requires a complicated computer model to assess. However, not all utilities or other planning entities are willing or able to use such a tool. Therefore, the LOLP threshold is translated into a simpler and more familiar load/resource balance measurement that regional planners can use more easily. These simpler measurements are provided both for annual energy needs and peak hourly capacity needs.

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<sup>1</sup> Ownership refers to either utility ownership or ownership by independent power producers.

<sup>2</sup> The Northwest resource adequacy standard can be found at:  
<http://www.nwccouncil.org/energy/resource/Default.asp>.

### **Annual Needs (Energy Standard)**

Energy in this context refers to the annual electricity needs of the region. The measure for this is the annual average load/resource balance in units of average megawatts. The threshold for this measure is set so that the resulting LOLP assessment yields a 5-percent value. In determining resource generating capability, the standard includes hydroelectric generation available under critical-water conditions, available annual output of regionally committed thermal generators and renewable resources, and a portion of the uncommitted independent power producer generation. The standard also includes a small amount of non-firm resources such as out-of-region market supplies and non-firm hydroelectric generation. The amount of non-firm resources the region should rely on is determined by the 5-percent LOLP analysis. In determining load, the standard uses the region's average annual firm load based on normal temperatures, and adjusted for firm out-of-region energy contract sales and purchases and savings from conservation programs.

### **Peak Hourly Needs (Capacity Standard)**

Capacity in this context refers to the peak hourly electricity needs of the region. The measure for this is the planning reserve margin, or the surplus sustained-peak capacity, in units of percent. It represents the surplus generating capability above the sustained-peak period demand. In determining the planning reserve margin, the standard includes the same firm and non-firm resources used to assess the energy standard for the region. The planning reserve margin is assessed over the six highest load hours of the day for three consecutive days (sustained-peak period). This is intended to simulate a cold snap or heat wave – periods of the year when the Northwest requires the most capacity. The planning reserve margin is computed relative to normal-weather sustained-peak load. The threshold for this measure is determined by the 5-percent LOLP analysis and should be sufficient to cover load deviations due to extreme temperatures and the loss of some generating capability.

### ***Implementing the Standard***

The forum wanted to ensure it did not overstep the jurisdiction of states or the prerogatives of individual utilities in planning and acquiring resources to meet load. Because each utility's circumstances differ, it is difficult to translate a regional standard into a utility-specific standard. The forum has provided some guidance for utilities, but ultimately, they and their regulators are the decision-makers for resource acquisition. The implementation plan depends on regional sharing of information, transparency of assessment methodologies, and regional coordination. The forum believes that a voluntary approach will work because utilities and their governing bodies have a strong incentive to develop adequate resources to meet retail load.

### ***Working with Other Entities***

The Council, in conjunction with the forum, will assess the adequacy of the region's power supply on an annual basis. Demand forecast and resource assumptions will be compared to those in other regional reports, such as Bonneville's White Book and the Pacific Northwest Utilities Conference Committee's Northwest Regional Forecast. This sharing of information in a public forum should provide a favorable environment for addressing inconsistencies in data and reporting standards.

The Northwest is not alone in focusing on ensuring an adequate power supply. The NERC was expected to pick up its previously delayed work on the development of a resource adequacy assessment standard in 2009, which is expected to require the WECC to develop an adequacy assessment framework, but the standard development has since slipped. The WECC has spent the past several years developing a framework for the West's power supply, which is currently in place. The WECC's framework is not intended to override any state or regional assessments, including regional adequacy measures or their thresholds. In fact, the WECC has solicited help from regional entities to aid in its assessment of Westwide resource adequacy. The Council and the forum will continue to participate in the WECC's efforts.

## THE ADEQUACY OF THE NORTHWEST POWER SUPPLY

The adequacy standard calls for the average annual energy capability to at least equal the average annual demand. It also calls for the system's peaking capability to be able to meet expected peak-hour demand and to have sufficient surplus to cover operating reserves,<sup>3</sup> prolonged generator forced outages, and demand deviations due to extreme temperatures. Key findings of the current assessment are:

- Based only on existing resources (and those under construction), the region's power supply may fail to provide sufficient summer peaking capability by 2015 although not by much.
- This puts the region in a "yellow alert" situation, which triggers specific actions that require a review of all load and resource data and a review of the methodology used to assess adequacy. This work is underway.
- The Council and regional utilities are actively developing resource-acquisition strategies, which take economic risk, carbon-emission policies and other factors into account.
- Adding expected resource additions derived from the Council's power plan keeps the power supply adequate nearly through the entire study horizon period.

The Northwest adequacy standard, developed by the forum and adopted by the Council in 2008, specifies minimum thresholds for annual energy load/resource balance and for winter and summer surplus capacity margins. Normally the adequacy assessment is targeted for three and five years out, but in this instance the assessment is for the 20-year horizon of the power plan. Figures 14-1 through 14-3 show the assessed annual load/resource balance and capacity-reserve margins through the year 2030.

As apparent in Figure 14-1, only counting existing firm resources, the region is in about load/resource balance today, which (without any new resources) grows to a large deficit by 2030 (black line). The standard, however, includes some non-firm resources in its definition of the load/resource balance for adequacy purposes. A planning adjustment of 1,300 average megawatts is included to account for out-of-region market supplies and some amount of non-

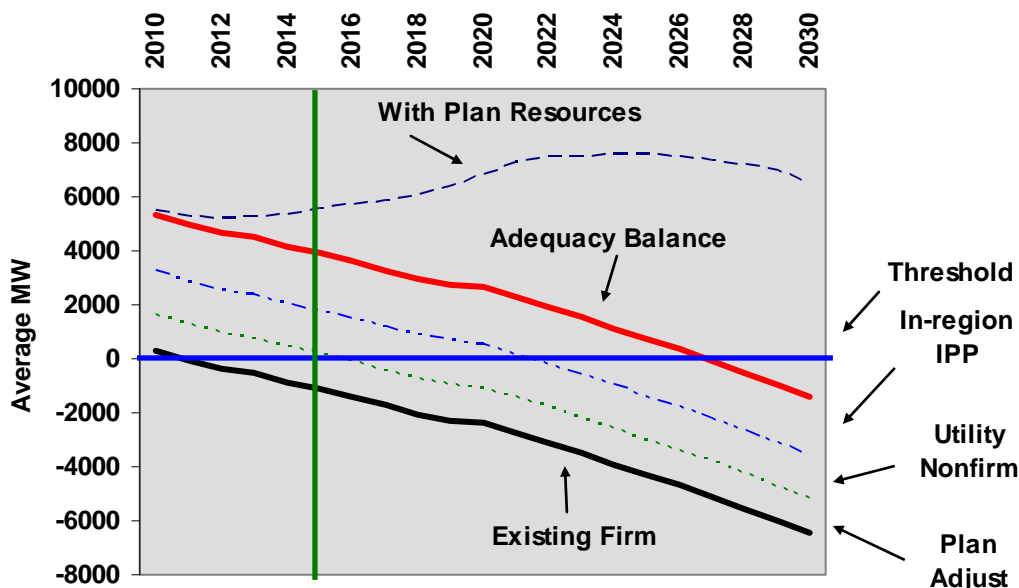
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<sup>3</sup> Operating reserves currently do not include additional regulating or load-following reserves anticipated to be needed to integrate large amounts of new wind generation into the regional power grid, primarily because these reserves have not yet been quantified. In addition, this assessment only includes existing wind facilities and those currently under construction.



firm hydroelectric generation. The assessment also includes the full annual availability of regionally owned resources. This value is estimated to be about 1,600 average megawatts greater than the aggregate total of utility-declared firm non-hydro resources. Finally, there is a substantial amount of within-region but uncommitted generation, namely the independent power producer resources, which add about 2,150 average megawatts to the balance. Adding the non-firm resources to the calculation yields the solid red line in Figure 14-1, which shows the region well above the adequacy threshold until about 2027 (red line). Adding new resources suggested by the power plan (averaged over all futures) increases the surplus relative to a physical adequacy need (but are needed for economic and risk-aversion purposes).

**Figure 14-1: Energy Adequacy Assessment**



In a similar fashion, the winter and summer surplus sustained-peaking reserve margins can be calculated and compared to their adequacy thresholds. Figures 14-2 and 14-3 show those assessments for January and July, respectively. The sustained-peak reserve margin represents the amount of surplus generating capacity over the expected demand averaged over the sustained peak period, in terms of percent. The sustained peak period is defined to be the six highest load hours per day over three consecutive days (to reflect the duration of a typical cold snap or heat wave). As with the energy assessment, counting only existing firm resources shows the region below the January minimum capacity threshold for the entire planning horizon (black line). Adding non-firm resources, as defined in the standard (and described below), raises the reserve margin above the threshold until about 2030. Again, adding the expected generation from power plan resources makes the reserve margin even higher.

For these capacity adequacy assessments, the following non-firm resources were assumed to be available during emergency conditions. For winter months, in-region IPP generation is assumed to be fully available at 3,550 megawatts but for summer months that availability is reduced to 1,000 megawatts. Additional hydroelectric generation, in excess of critical-period generation, is assumed to be 2,000 megawatts in winter and 1,000 megawatts in summer. Finally, a maximum of 3,000 megawatts of out-of-region supply is assumed for winter but none for summer.

The story is a little different for July. Looking at Figure 14-3, the reserve margin, including defined non-firm resources, only keeps the region above the minimum threshold through about 2015. According to the standard, this puts the region in a “yellow-alert” situation, triggering specific regional actions, which currently are underway. First, regional planners are reviewing all load and resource data. Second, the methodology used to assess the minimum thresholds is being reviewed. Third, the Council and regional utilities are actively developing resource-acquisition strategies.

Adding expected new resource capability, based on the Council’s plan, to the reserve margin calculation in Figure 14-3 (topmost dashed line) indicates that the power supply should remain above the minimum adequacy threshold throughout nearly the entire study horizon. However, it should again be emphasized (see the above section entitled “Assessing the Adequacy of a Resource Strategy”) that using this type of static diagram (as in Figure 14-3) to assess the adequacy of the power plan’s strategy is inappropriate. Future resource acquisitions based on the plan’s strategy will vary depending on forecasts of future conditions. The dashed line in Figure 14-3 reflects new resource capability averaged across all futures analyzed by the portfolio model. The fact that it dips below the minimum adequacy threshold in 2029 provides no indication of the adequacy of the plan’s resource strategy. The proper use of Figures 14-1 through 14-3 is to compare the adequacy metrics (red lines), as defined by the standard, to their minimum thresholds (blue lines) over the next five-year period only. The reason the curves in these charts were extended to a 20-year period was only to indicate generally how the plan’s average resource build-out compares to the minimum thresholds -- not to assess the adequacy of the plan’s resource strategy.

**Figure 14-2: January Capacity Adequacy Assessment**

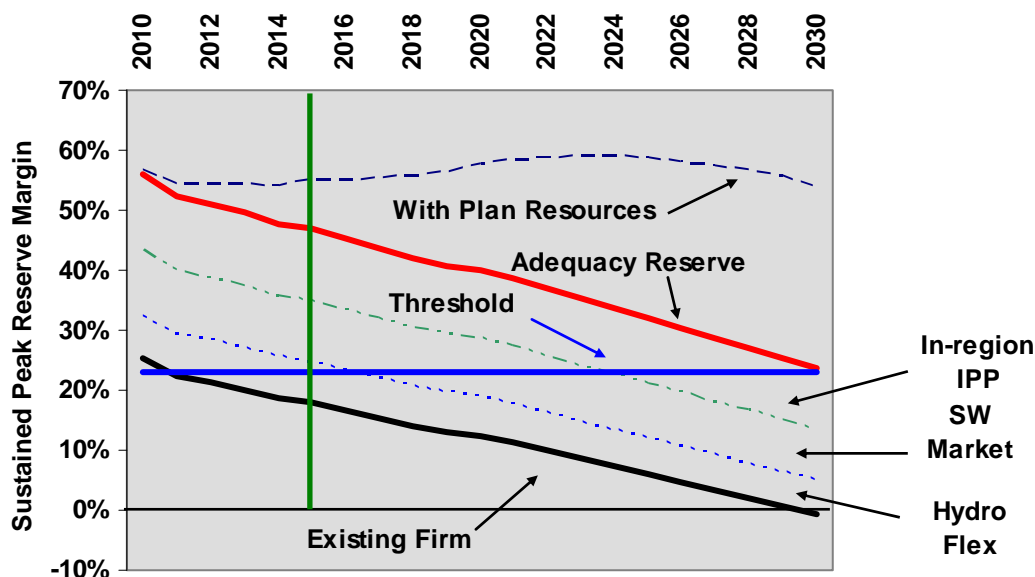
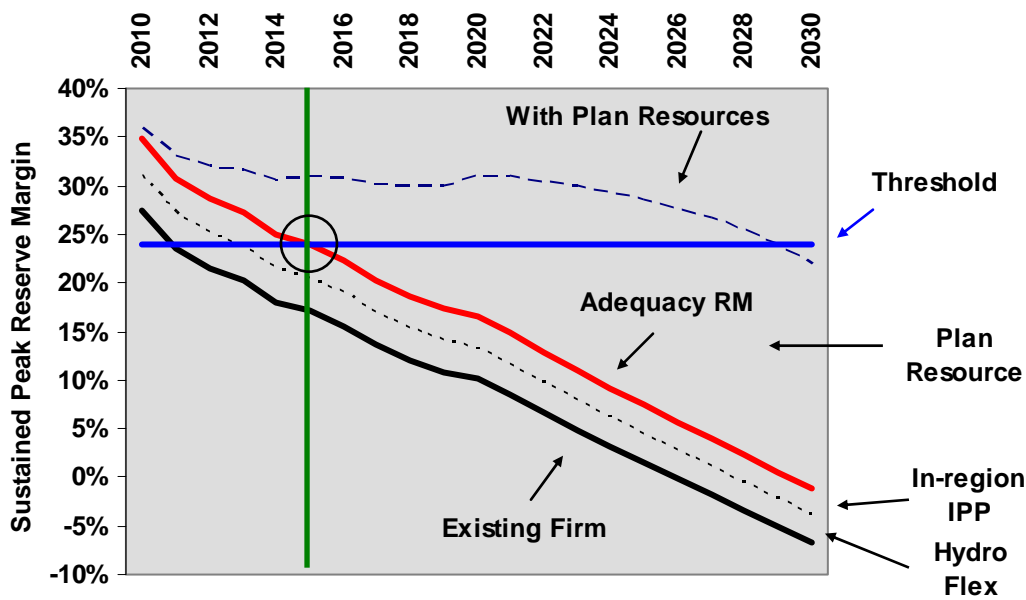


Figure 14-3: July Capacity Adequacy Assessment



## UTILITY PERSPECTIVE ON RESOURCE ADEQUACY

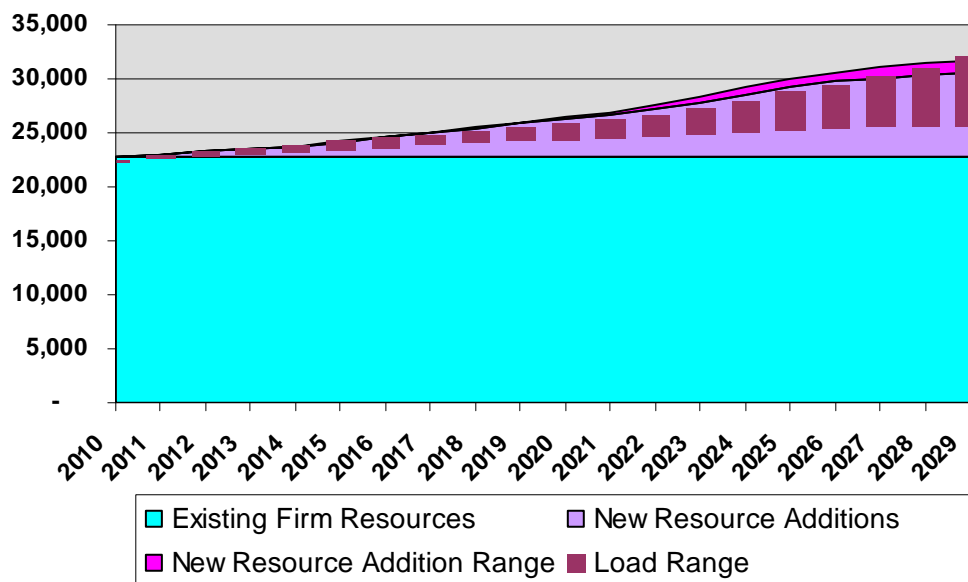
As discussed in Chapter 3, regional utilities historically have used the annual average load/resource balance as a simple metric to get an indication of their resource needs. This utility perspective compares only firm loads to firm resources (which include critical-period hydroelectric generation). The general conclusions that can be drawn from this simple metric is that when the average annual load is greater than the firm supply, additional resources likely are needed. And, as illustrated in Figures 3-13 through 3-15 in Chapter 3, the region's firm resources fall short of forecasted demand within the next five-year period, both for annual energy and hourly capacity needs. Utilities understand, however, that this is only a rough estimate at best and decisions regarding new resource acquisition must be made using more sophisticated analysis.

Nonetheless, the firm load/resource balance metric still provides a useful guide in assessing future power supply needs. Figures 14-4 through 14-6 show the balance between firm resources and load for annual energy and hourly capacity needs. These figures are identical to Figures 3-13 through 3-15 except for the addition of planned resources derived from the Council's resource strategy. Figure 14-4 indicates that on a firm basis only, existing resources combined with the expected resource development from this power plan will be sufficient to cover the entire range of load uncertainty. It should be noted that these results reflect the status of the region, in aggregate. Individual utility plans will differ based on their specific conditions and needs.

Another interesting result is reflected in the range of new resource additions. The purple area in Figure 14-4 reflects resources acquired in response to the low end of the load forecast range. The small pink area in this figure represents the additional resources acquired in response to the high end of the load forecast range. (The high end values are averaged over the top 100 futures analyzed by the portfolio model and the low end values are averaged over the bottom 100 futures). The interesting thing about this result is that almost regardless of load, the model suggests a high level of resource energy development. Most of the new resources (on the order

of 85 percent) are made up of conservation measures. Based on these results, we can infer that the model is acquiring this level of resource because it is economic to do so and because it minimizes exposure to other risks, such as carbon penalties -- not necessarily because of adequacy needs.

**Figure 14-4: Energy Firm Loads and Resources**



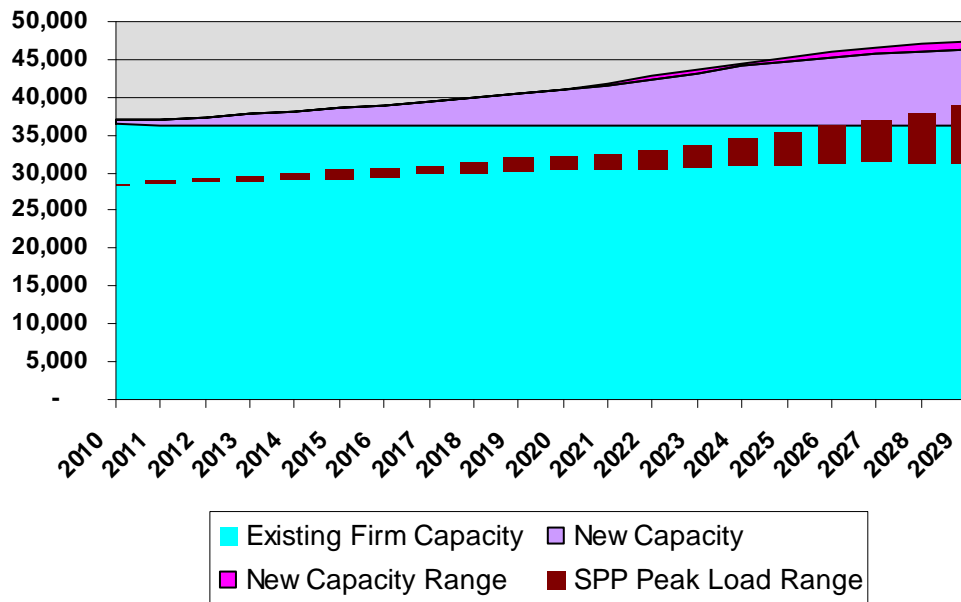
Figures 14-5 and 14-6 provide similar load and resource information for the region's winter and summer hourly needs. As in Figure 14-4, the resources depicted in these figures include only firm resources and planned resources derived from the portfolio model analysis. The generating capability of resources shown in these figures reflect their sustained-peak capability, that is, what these resources reliably can generate on average over the six highest load hours of the day for three consecutive days. The load forecasts in these figures do not include any amount of sustained-peak reserve margin requirement.

For both January and July, existing firm and portfolio-model planned resources are sufficient to cover the entire sustained-peak load forecast range throughout the study horizon. However it is not clear whether those resources would be sufficient to satisfy reserve-margin requirements throughout the study horizon. Figures 14-7 and 14-8 chart the resulting sustained-peak reserve margin ranges for January and July, respectively. Unfortunately, no utility-perspective (firm only) sustained-peak reserve-margin requirements have been established for the Northwest. If these requirements were known, Figures 14-7 and 14-8 could be used to identify years when the power supply fails to meet its hourly needs.

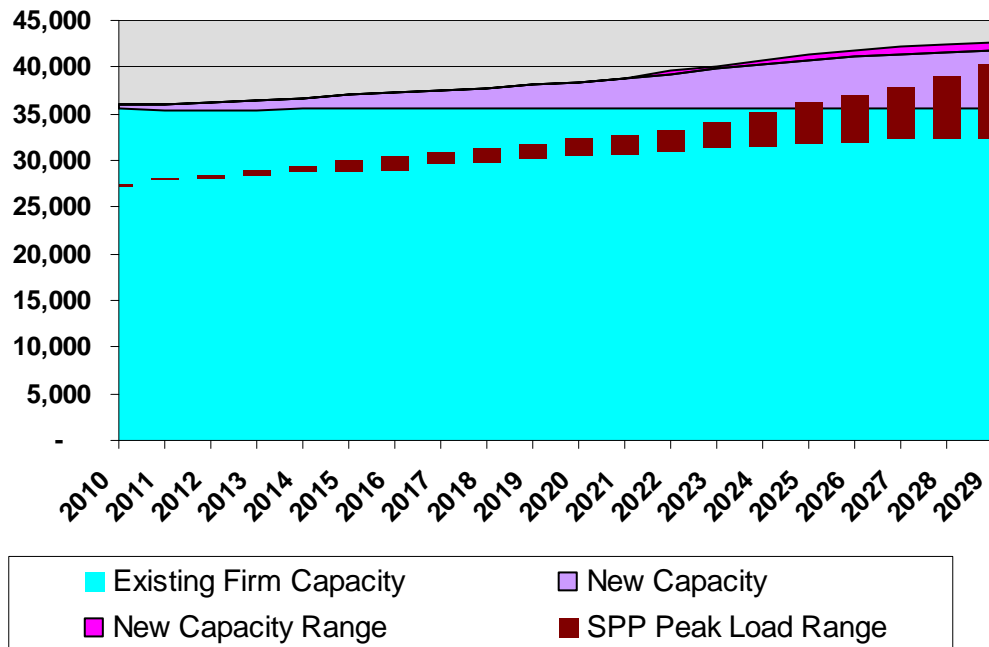
For January, in Figure 14-7, the entire range of sustained-peak reserve margin stays above the 20-percent level throughout the study horizon. If the utility-perspective sustained-peak reserve margin threshold were 17 percent (see Chapter 3), for example, then January would show no capacity deficiency, on average. Keep in mind that plan resources added to existing resources in these figures are averaged over all simulated futures, thus this conclusion cannot be made for each future condition.

For July, in Figure 14-8, the bottom end of the reserve-margin range drops below 17 percent by about 2024, which implies that existing resources plus plan resources would not be sufficient to cover loads plus reserve requirements by that year. However, these results do not provide an accurate assessment of hourly needs.

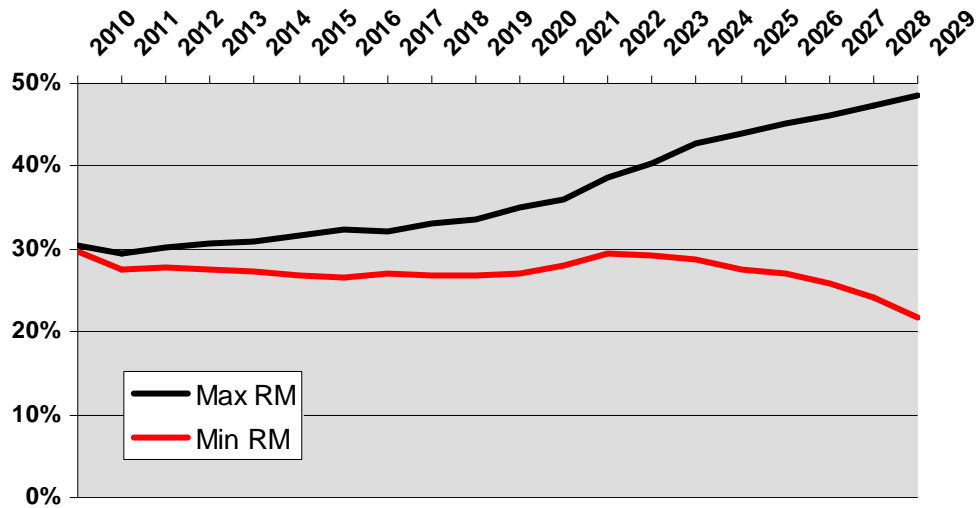
**Figure 14-5: January Sustained-Peak Period (SPP) Loads and Resources**



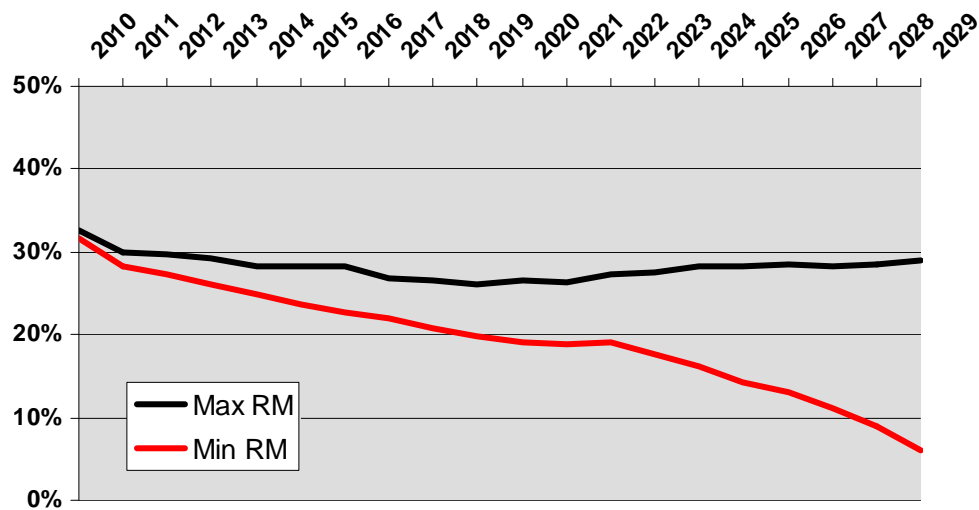
**Figure 14-6: July Sustained-Peak Period (SPP) Loads and Resources**



**Figure 14-7: January Sustained-Peak Period Reserve Margins**



**Figure 14-8: July Sustained-Peak Period Reserve Margins**



## METHODOLOGY

### *Analytical Tools*

The Council used two complementary analyses to develop the adequacy standard. One addresses physical adequacy – the ability to meet load. The other addresses economic adequacy – avoiding extremely high costs that can result from tight supply conditions. The first analysis uses the GENESYS model, which performs a detailed simulation of the Northwest power system to

assess the ability of the system to meet load with variations in future conditions. The second analysis uses the portfolio model, described in Chapter 9, to explore the cost/risk tradeoff over a large number of possible futures.

The GENESYS model was developed in 1999 to assess the adequacy of the regional power supply.<sup>4</sup> One of its most important features is that it is a probabilistic model, that is, it incorporates future uncertainties into its analysis. Each GENESYS study involves hundreds of simulations of the operation of the power system. Each simulation is performed using different values for uncertain future variables, such as precipitation (which affects the amount of water for hydroelectric generation) and temperature (which affects the demand for electricity).

More precisely, the random (or uncertain) variables modeled in GENESYS are Pacific Northwest streamflows, Pacific Northwest demand, generating-unit forced outages, and variability in wind generation. The variation in streamflow is captured by incorporating the 70-year (1929–1998) Pacific Northwest streamflow record. Uncertainty in demand is captured by using the Council’s short-term (temperature-driven) demand model.

GENESYS does not model long-term demand uncertainty (unrelated to temperature variations in demand) nor does it incorporate any mechanism to add new resources should demand grow more rapidly than expected. It performs its calculations for a known system configuration and a known long-term demand forecast, which can change over time. In order to assess the physical adequacy of the system over different long-term demand scenarios, the model must be rerun using the new demand and the corresponding new resource additions. The portfolio model deals with long-term demand uncertainty explicitly, as well as with other long-term uncertainties.

Another important feature of GENESYS is that it captures the effects of hydropower flexibility, that is, the ability to draft reservoirs below normal drafting limits during emergencies. Hydropower flexibility can be particularly important in helping address potential supply problems during extended periods of high demand from extreme cold events (or heat waves). In order for GENESYS to properly assess the use of this emergency generation, a very detailed hydroelectric-operation simulation algorithm was incorporated into the model. This logic simulates the operation of the hydroelectric system on an hourly basis. The portfolio model has a much more simplistic representation of the hydroelectric system and simulates resource dispatch on a seasonal basis.

The probabilistic assessment of adequacy in GENESYS provides much more useful information to decision-makers than a simple deterministic (static) comparison between resources and demand. Besides the expected values for hydroelectric generation and dispatched hours for thermal resources, the model also provides the distribution (or range) of operations for each resource. It also includes situations when the power supply is not able to meet all of its obligations. These situations are informative because they identify the conditions under which the power supply is inadequate. The frequency, duration, and magnitude of these curtailment events are recorded so that the overall probability of not being able to fully serve load is calculated. This probability, commonly referred to as the loss-of-load probability (LOLP), is the figure of merit provided by GENESYS.

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<sup>4</sup> *Northwest Power Supply Adequacy/Reliability Study Phase 1 Report*, Council Document 2000-4, March, 2000. <http://www.nwcouncil.org/library/2000/2000-4.pdf>

It should be noted that in determining the LOLP, an assumption is made in GENESYS that all available resources will be dispatched in economic order to “keep the lights on,” no matter what the cost. As such, the LOLP is a physical, rather than an economic, metric.

For the Northwest, the Council has defined an adequate system to have an LOLP no greater than 5 percent. This means that of all the simulations run, with uncertain water conditions, temperatures, forced outages, and variable wind, no more than 5 percent had significant curtailments. Such a system faces a maximum 5-percent likelihood that some demand will not be served due to inadequacies in the generation system (not counting potential problems in the transmission network).

But what constitutes a significant curtailment event? Because the GENESYS model cannot possibly simulate all potentially varying parameters or know precisely every single resource that is available, a threshold is used to screen out inconsequential curtailment events. This threshold is commonly referred to as a “contingency” resource and depicts the amount and characteristics of additional generation available to utilities during emergencies.

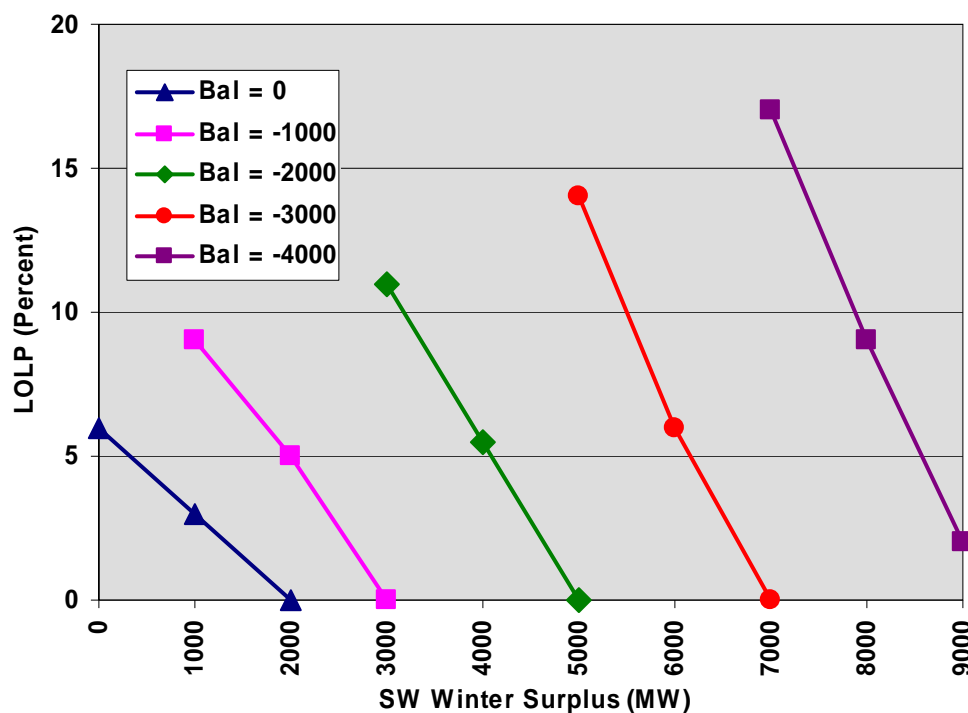
### ***Reliance on Market Resources***

Assessing power supply adequacy is very sensitive to assumptions regarding market supplies, whether they come from within or outside the region. But how much of the market supply should the region rely on for adequacy? Assuming that no supply is available is probably too conservative, as it will result in greater resource acquisition and be more costly in the long run. And although relying more on market supplies could lower long-term costs, year-to-year price volatility could be extreme. Therefore, some level in between, calculated with the tradeoff between risk and cost in mind, is used for planning purposes.

Figure 14-9 illustrates the relationship between the LOLP and available market supply (presented in units of capacity), for different levels of Northwest firm load/resource balance. Generally speaking, the more the market supply, the lower the LOLP will be. For example, consider the case where the region is 2,000 average megawatts deficit on a firm basis (the curve with the diamond-shaped points in Figure 14-9). Assuming that a 5-percent LOLP represents an adequate power supply, the Northwest would be adequate (even though the load/resource balance is negative) if at least 4,000 megawatts of market supply were available. If no market supply were available, the projected LOLP would be on the order of 25 percent -- well over the minimum threshold of 5 percent. Even if the Northwest were in load/resource balance (the far left curve with the triangular points), the LOLP would be slightly over 5 percent with no available market supply.



**Figure 14-9: Illustrative Example: LOLP as a Function of Available Southwest Capacity for Different Load/Resource Balance Conditions**

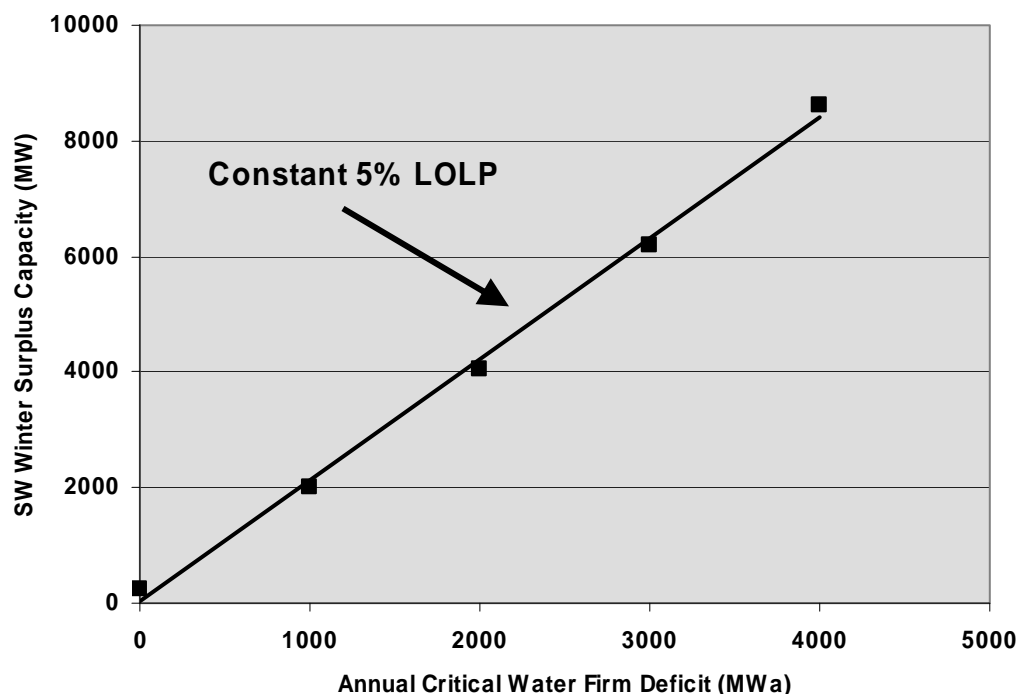


### *Translating the Adequacy Standard into a Simpler Measure*

To make the relationship between the LOLP and market supply a little easier to see, the values in Figure 14-9 for all the points that cross the 5-percent LOLP level are plotted in Figure 14-10. In that figure, every point on the plotted curve represents the same adequacy, namely a 5-percent LOLP. Given a particular load/resource balance in the Northwest (horizontal axis), this graph shows how much market supply (vertical axis) is required to maintain an adequate system.

Again, using the same example, if the region was deficit by 2,000 average megawatts (on a firm basis), it would require about 4,000 megawatts of market supply from the Southwest surplus in order for the Northwest to maintain a 5-percent LOLP. This does not mean that the region would import 4,000 megawatts, but it does mean that in some hours the full 4,000 megawatts could be imported.

**Figure 14-10: Illustrative Example Relationship between SW Surplus Capacity and Load/Resource Balance**



The question of how much out-of-region surplus the Northwest should rely on for planning purposes, however, ends up being a policy question. If California goes forward with aggressive adequacy standards, it should mean that California will have ample winter surplus for years to come. However, current and potentially new air quality concerns may limit the operation of surplus resources in California. In addition, the potential of a future carbon tax may diminish their availability to the Northwest. Based on recent analysis, the current (arguably conservative) analysis assumes a 3,000-megawatt supply of out-of-region surplus capacity during winter months and no surplus capacity during summer months.

The in-region market supply is composed of independent power producer (IPP) resources, which are sold to the highest bidder, whether inside or outside the region. Current estimates show about 3,500 megawatts of such resources in the Northwest. During winter months, assuming that the Southwest is surplus, all of the IPP market supply should be available for Northwest use. However, during summer months, when Northwest utilities must compete with Southwest utilities for access to IPP generation, only a portion of their generation is assumed to be available for adequacy assessments. An estimate of available summer IPP generation for Northwest use is determined by their access to interregional transmission. IPP resources that have no direct access to interregional transmission are assumed to be available for Northwest use. Current adequacy assessments assume that 1,000 megawatts of IPP generation is available for summer use. Thus, for capacity assessments, 3,500 megawatts of IPP generation is assumed for winter and 1,000 megawatts are assumed for summer. For energy assessments, about 2,100 average megawatts of IPP annual average generation is assumed.

By using the relationship in Figure 14-10 and assuming that 3,000 megawatts of out-of-region surplus capacity is available, regional planners can assess the minimum balance between resources and loads that will yield an adequate supply (5 percent LOLP). Based on current analysis, that minimum for annual energy needs is a 1,300-average-megawatt deficit. In other words, counting only Northwest firm and IPP resources, the region's power supply can be no lower than 1,300 average megawatts less than firm loads in order to maintain an adequate supply. This means that, on average, the region can depend on 1,300 average megawatts from non-firm hydroelectric power and out-of-region supplies. A similar analysis and relationship is used to assess the minimum threshold for hourly needs.