

Resource Adequacy

INTRODUCTION

For the purposes of the Power Plan, resource adequacy is defined as:

A condition in which the Region is assured that, in aggregate, utilities or other load serving entities (LSE) have acquired sufficient resources to satisfy forecasted future loads reliably.

This definition is not intended to include problems such as localized failures in the distribution system or outages caused by operational problems or system element failures in the interconnected transmission system. It is intended to protect against power failures resulting from not having adequate generating capacity deliverable to load or the inability to fuel generators under extreme conditions. Here in the Northwest, the primary concern has been whether there are sufficient non-hydro resources available to meet loads when the “fuel” for hydroelectric generation is limited under historically low or “critical” water conditions.

As was discussed in Chapter 1, The Western Electricity Crisis of 2001-2002 is widely believed to have had its roots in resource inadequacy. For a number of reasons, resource development in the 1990s failed to keep pace with growth in the region and, in fact, the entire West. When poor hydro conditions manifested themselves in the summer of 2000 and on into 2001, the underlying tight supply was made apparent and wholesale prices went out of control. The lights never went out in the Northwest during 2000 and 2001 but the region experienced extremely high wholesale prices. This occurred even though large amounts of load, mostly from the Direct Service Industries, were taken off the system. Consumers’ reactions to these extreme prices suggest the possibility of a different adequacy concept – that of an “economic” resource adequacy. Planning to maintain “economic” adequacy likely means building more and possibly different types of resources.

ANALYSIS

To begin to inform the discussion of an adequacy standard, the Council has undertaken two complementary analyses. One addresses physical adequacy – the ability to meet load. The other addresses economic adequacy – the avoidance of 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 hydro conditions, temperatures and generator outages. The second analysis uses the portfolio model, described in Chapter 6, to explore the cost/risk tradeoff over a large number of possible futures.

GENESYS Analysis

The GENESYS model was developed in 1999 to assess the adequacy of the regional power supply.¹ 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

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

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 stream flows, Pacific Northwest demand and generating-unit forced outages. The variation in stream flow is captured through incorporation of the 50-year (1929–1978) Pacific Northwest streamflow record. Uncertainty in demand is captured through use of a weather (temperature)-driven demand model. The demand algorithm in GENESYS uses daily average temperatures to forecast hourly demands. In order to maintain the correlation between temperature and precipitation (river flows), the model is normally run with these two variables in lockstep, meaning that the corresponding historical temperatures are used for each selection of historical water condition.

GENESYS does not model long-term demand uncertainty (not related to temperature variations in demand) nor does it incorporate any mechanism to add new resources should demands grow more rapidly than expected. It performs its calculations for a known system configuration and a known 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 demands and the corresponding new resource additions. The portfolio model (described below) deals with long-term demand uncertainty explicitly as well as other long-term uncertainties. .

Another important feature of GENESYS is that it captures the effects of “hydro flexibility,” that is, the ability to draft reservoirs below normal drafting limits in times of emergency. Hydro flexibility can be particularly important in helping address potential supply problems during extended periods of high demand associated with extreme cold events. 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 individual hydroelectric projects over 14 periods of the year (April and August are split because they are the transition months between fall-winter and spring-summer). The portfolio model has a much more simplistic representation of the hydroelectric system.

The probabilistic assessment of adequacy in GENESYS provides much more useful information to decision makers than a simple deterministic (static) counting of resources and demands. 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 identifies 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 loads is calculated for the power system being studied. This probability, commonly referred to as the loss of load probability (LOLP), is the figure of merit provided by GENESYS.

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 metric, not an economic one.

Having a model to assess the LOLP for a given configuration of the power supply is very useful but planning for future expansion cannot occur until a standard is defined. In other words, what value of LOLP defines an adequate system? While many regions in the United States use some

form of a probabilistic method to calculate a loss-of-load type of metric, no well-defined standard exists. In fact, there is a great variation in the definition of loss-of-load metrics. For example, some regions calculate a metric using resource forced outage as the only uncertain variable.

For the Northwest, we have defined an adequate system to have an LOLP no greater than 5 percent over the winter period. This means that of all the simulations run, with uncertain water conditions, temperatures and forced outages, no more than 5 percent had winters when not all demands could be met. Such a system faces a maximum 5 percent likelihood that some winter demands will not be served due to inadequacies in the generation system (not counting potential problems in the transmission network).

But what constitutes a curtailment event? Since the GENESYS model cannot possibly simulate all potentially varying parameters nor can it know precisely every single resource that is available, a threshold is used to screen out inconsequential events. Our standard is based on a threshold of 1,200 megawatt-days. This corresponds to the loss of power to a city about the size of Seattle, Washington for a period of 24 hours. It represents 28,800 megawatt-hours of curtailment. In our assessment of the LOLP for the northwest, each simulation performed that shows a total curtailment of 28,800 megawatt-hours or more over the winter period is counted as a curtailment event. More precisely then, a 5 percent LOLP means that there is a 5 percent likelihood that over a winter period 28,800 megawatt-hours of service or more will be curtailed.

The Northwest is not an island

In the past, the Northwest planned (at least in theory) to a critical-water standard, i.e., that there should be sufficient Northwest resources, including the hydroelectric generation produced given the driest historical water condition, to just meet forecasted loads. This standard originated when the Northwest was essentially isolated from the rest of the Western system by limited transmission links and was continued when high oil and gas prices dominated generation markets in the rest of the West. However, since the interties were constructed, and more recently, oil and gas prices collapsed in the mid-1980s, the region has not necessarily needed 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; 1) in almost all years, hydroelectric generation will exceed that produced under critical water conditions and 2) the Northwest is connected electrically to the southwest, which almost always has surplus winter energy to export (the southwest is a summer peaking region and the northwest is a winter peaking region).

In the past, reservoirs were operated 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. There was also the contractual ability to interrupt a portion of the Direct Service Industry load when out-of-region surplus energy was not available. These contractual agreements with the DSIs no longer exist. But, the Northwest is still connected to the southwest. Both regions should be able to benefit from the diversity in peak demand seasons. Consequently, determination of adequacy should reflect the ability to import power from outside the region. However, the implication of this is that any Northwest adequacy standard and determination must be closely coordinated with other entities in the Western Interconnection.

GENESYS models inter-regional transactions among the northwest, Canadian and southwest regions. Northwest contractual export obligations are served as though they were regional demands. During emergencies, when surplus out-of-region capacity is available, it can be dispatched to counter schedule existing exports and, if necessary, to import additional generation into the northwest.

How much should we rely on imports?

A difficult planning question is how much out-of-region surplus capacity should we rely on? Clearly, assuming that no surplus out-of-region capacity is available is too conservative and possibly too costly. Assuming the maximum amount of available out-of-region surplus may be too risky. Some level in between, calculated with the tradeoff between risk and cost in mind, would be more appropriate for planning purposes. Currently the region is over 1,000 average megawatts surplus relative to critical water generation, assuming that generation from northwest merchant resources not associated with load serving entities would be available to serve regional demand. Because of the surplus, the current estimate for LOLP is under one percent, which means that the region does not have to depend on out-of-region imports to maintain an adequate supply. However, it is important to know how the adequacy of the northwest power supply changes as the surplus goes away. At what point does the region need to take action to maintain an adequate supply?

Figure 8-1 below illustrates the relationship between the LOLP and available out-of-region surplus capacity, for different levels of load/resource balance. Generally speaking, the more surplus that is available from out of region, 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 8-1). Assuming that a 5 percent LOLP represents an adequate power supply, then the northwest would be adequate (even though the load/resource balance is negative) if at least 4,000 megawatts of surplus winter capacity were available from out-of-region utilities. If no out-of-region surplus were available, the projected LOLP would be on the order of 25 percent -- well over the standard. Even if the northwest were in load/resource balance (the far left curve with the circular points), the LOLP would be over 5 percent with no available out-of-region imports. So, the region should incorporate some level of available out-of-region generation in its planning process. The question is how much?

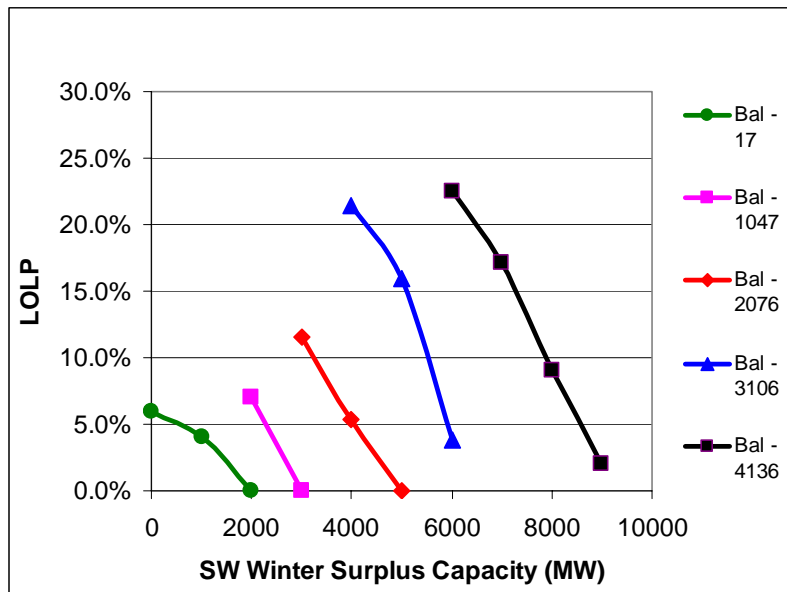


Figure 8-1: LOLP as a Function of Available SW Capacity (For Different Load/Resource Balance Conditions)

To make the relationship between LOLP and out-of-region surplus a little easier to see, the values in Figure 8-1 for all the points that cross the 5 percent LOLP level are plotted in Figure 8-2. In that figure, every point on the plotted curve has the same reliability, namely a 5 percent LOLP. Given a particular load/resource balance in the northwest (horizontal axis), this graph shows how much out-of-region surplus capacity (vertical axis) is required to maintain an adequate system. Again, using the same example as above, if the region were deficit by 2,000 average megawatts, it would require about 4,000 megawatts of surplus winter capacity in order for the northwest to maintain a 5 percent LOLP. This does not mean that the region would import 4,000 megawatts over the entire winter. In fact, the average amount of imported energy for this case is about half of that but in some hours the full 4,000 megawatts would be imported.

The question of how much out-of-region surplus the northwest should rely on for planning purposes, however, remains unanswered. If California goes forward with aggressive adequacy standards, it should mean that California should have ample surplus for years to come. However, current and potentially new air-quality concerns may limit the operation of surplus resources in California. In addition, future proposals to add a carbon tax to the operation of fossil-fuel burning resources may diminish their availability to the northwest. For the time being, with a surplus northwest, this issue is not urgent but at some point in the near future the region must assess what level of inter-regional dependence it wishes to rely on to plan future power system expansion.

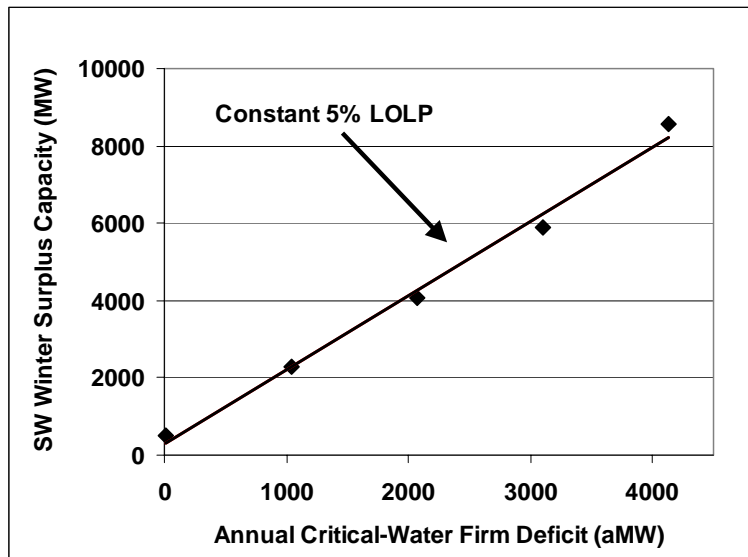


Figure 8-2: Relationship between SW Surplus Capacity and L/R Balance

As an alternative to using the relationship between available SW surplus capacity and NW load/resource balance for resource planning purposes, the relationship between SW surplus capacity and NW hydro conditions may be even more useful. Figure 8-3 below illustrates that relationship. As in Figure 8-2, each point on this graph reflects the same resource adequacy, namely a 5 percent LOLP. The curve in Figure 8-3 tells us that if no SW surplus winter capacity is available (lower right corner) then the northwest should plan to the 100 percent adverse hydro condition (or what has historically been called critical water) to assure a 5 percent LOLP. Alternatively, if 4,000 megawatts of SW surplus capacity were available, the northwest would plan its resource development based on the 78th percentile water condition to assure the same level of reliability. This is equivalent to planning to a 2,000 average megawatt firm deficit load/resource balance (as described for Figure 8-2). This alternative method, used to guide resource development in the northwest, may be more easily incorporated into individual utility's resource planning processes. Adopting such a method for northwest resource planning should have the effect of lowering costs while not sacrificing reliability (relative to planning strictly on critical water). However, the key parameter remains to be the amount of available SW surplus winter capacity that the northwest wishes to rely on.

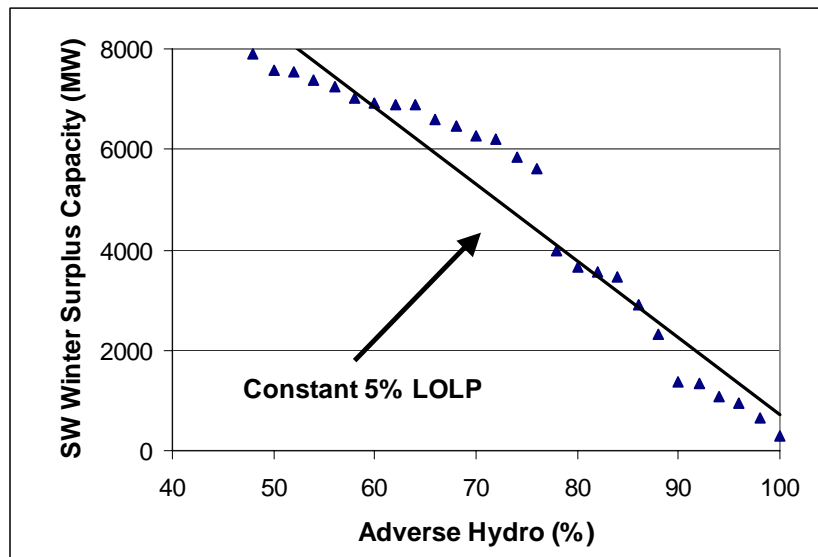


Figure 8-3: Relationship between SW Surplus Capacity and Adverse Hydro

Portfolio Analysis

As described in Chapter 6, the portfolio model tests different regional resource plans, calculating the expected cost and risk associated with those plans over a large number of possible “futures”. Those plans consist of the types, quantities and schedules for new resource development. The futures involve different patterns of load growth, hydro conditions, fuel prices and electricity market prices over the planning period. While the model calculates physical loads and resources, it makes its choices purely on economics. Does this plan lower the average net present value system cost? What is the risk? Is there a plan that lowers the risk? What is the cost? For a given level of risk, the model searches for the mix of resource types, amounts and schedule for resource development that yields the minimum expected cost over a wide range of possible futures.

In the portfolio model, the region is exposed to the market price of electricity. That market is essentially the West Coast. If there are excess Northwest resources whose variable costs are less than the market price, they can be sold into that market up to the export capability of the transmission system. Conversely, if there are insufficient Northwest resources to meet load, the region can purchase from that market up to the import capabilities of the transmission system. The average market price over all the futures corresponds to the electricity market price forecast described in Chapter 2. However, for any given future, the market price can look much different. The market price is affected by a number of factors such as natural gas prices and hydro production. And, it also reflects other factors such as possible extended forced outages of major resources outside the region, new technologies, extreme weather and even the “psychology” of the market. In addition, market prices must reflect changes in available generation relative to load. For a given load, additional generation tends to drive down electric power prices. In particular, if generation would initially exceed requirements, plus the region’s ability to export, prices will be reduced until generation equals loads plus export capability. Similarly, if generation is inadequate to meet requirements, given the region’s import capability, prices will increase until the situation is resolved, e.g., loads are reduced or the price induces sufficient

generation. The tradeoff evaluated in the portfolio model is between the risk of exposure to high market prices against the fixed costs of the additional resources to protect against that exposure.

The conventional wisdom has been that we are better off to risk some exposure to the market than to incur additional fixed costs for resources that may run relatively infrequently. That was clearly so when the market was well behaved and the resource choices tended to be highly capital intensive, had long construction lead times and were exposed to high interest rates. The Council's earlier plans devoted a great deal of attention to managing this fixed cost risk.

The current analysis suggests that this view should perhaps shift. Certainly the characteristics of most of the resources have changed in such a way as to reduce fixed cost risk – smaller unit sizes, shorter lead times, lower capital costs. In addition, interest rates are much lower than those assumed in earlier plans. However, recent experience would also lead us to believe the market may be less well behaved than it was in the past and that there is little tolerance among the public and policy-makers for price volatility. While people are aware of many of the issues that brought about the 2000-2001 electricity crisis, certainly not all them have been resolved. In characterizing the uncertainty about electricity market prices, the analysis did not include periods as severe as 2000-2001 and maintained the current \$250 per megawatt hour price cap. But it did include a number of futures with significant market price excursions.

Although not entirely comparable, the results of the portfolio analysis suggest maintaining a higher level of in-region resources than indicated in the GENESYS analysis. The role these additional resources play is to reduce the necessity of high priced market purchases. At the same time, however, the analysis also indicates that if the overall level of regional resources and access to those resources is sufficient, overbuilding is a more expensive and more risky alternative than some level of reliance on the market.² The challenge is to find the right balance.

ADEQUACY “STANDARDS”

Most of the discussion in the region and the rest of the West has been directed toward the development some sort of adequacy standard that would apply to load serving entities (LSEs). 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, hydro-dominated system like that in the Northwest. 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 Electrical Reliability Council (NERC) has begun the process of developing a power supply adequacy standard.

The NERC Resource and Transmission Adequacy Task Force of the Planning Committee recently released a report that contains recommendations for both resource and transmission adequacy. The report was adopted by the NERC Board at their June 15th, 2004 meeting. NERC is planning to follow through with the Board-adopted recommendations of its Resource and Transmission Adequacy Task Force by charging the Resources Issues Subcommittee to draft a standard authorization request (SAR) for resource adequacy incorporating the task force's recommendations. Associated with this new standard will be provisions for a compliance review process to ensure that the regional reliability councils, such as WECC, are establishing resource

² Regional resources are those resources located in the region and not contractually committed to extra-regional customers as well as extra-regional resources that are committed to regional loads.

adequacy processes. Although it is not clear how accountability to WECC for compliance with this standard will be determined, some level of accountability by sub-regional entities, such as the Northwest Power Pool or by individual LSEs, is likely. The latter are the only ones in a position to comply with such a resource adequacy requirement. While compliance is not ultimately legally enforceable, the standards would most likely be adopted and implemented anyway, as are current NERC and WECC standards. A possible approach to accountability might be similar to the approach taken to ensure transmission reliability whereby utilities have voluntarily entered into agreements with one another to abide by certain standards, even including provisions for sanctions if violations occur.³

In response to potential NERC action and work done by a group from the Committee on Regional Electric Power Cooperation (CREPC), of which the Council is a member, WECC is evaluating proposing a power supply adequacy standard, although the details have not been fleshed out. The Council has been working with others in the region to address the question of power supply adequacy for the Northwest. The Council convened the Adequacy Forum and has been working with CREPC and its Western Resource Assessment Team (WRAT). The hierarchy of options for increasing the assurance of resource adequacy that have been identified are:

- Improving the availability and transparency of relevant information;
- Enhancing the assessment of adequacy through consistent metrics;
- Establishing voluntary adequacy targets; and
- Establishing enforceable standards.

In the current absence of a standard, a focus has been placed on improving information about the status of resource adequacy. The Northwest Power Pool is working to improve the consistency of information reported by control areas in the region so that meaningful assessments can be performed. Supported by the WRAT, WECC is currently enhancing the scope and utility of its twice-yearly resource assessments. Improvements may include using probabilistic methods to assess both peak hour and longer-term energy supply inadequacies. The aim is to provide a better description of the Western energy power supply situation as context for decisions by LSEs, commissions and developers. WECC has also established an ad hoc Resource Adequacy Workgroup under its Reliability Subcommittee to propose resource adequacy criteria by which to assess the adequacy of the Western Interconnection (WI) and sub-areas within the WI.

Some states, through their public utility commissions (PUCs), do have the ability to implement adequacy standards for the utilities they regulate. The California PUC recently adopted an adequacy standard. The order requires that the investor-owned utilities it regulates have a 15-17 percent reserve margin over their peak loads, with the requirement being phased in by no later than January 1, 2008. This 15 percent planning reserve includes the approximately seven percent operating reserves required by WECC. The order also requires that LSEs forward contract for coverage of 90 percent of their summer (May through September) requirements, which consist of

³ The reliability title of the proposed National Energy Bill prohibits the NERC successor organization and FERC from requiring resource construction as part of implementing the reliability responsibility under the bill, which would make reliability standards legally binding. Currently, standards are ultimately voluntary, but almost universally followed by the industry.

their peak load plus the 15 percent reserve, one year in advance. This requirement will be phased in during 2007 (no month specified). Some believe this standard goes beyond that which would be required to assure adequacy in a purely physical sense and is intended to limit California's exposure to the risk of extreme prices.

An Adequacy Standard for The Northwest

While activities at the NERC and WECC levels could lead to enforceable standards, the outcome is uncertain. The Council believes that other regional actions can and should be pursued. This is made more critical by the possibility of changes in the role of the Bonneville Power Administration (Chapter 11) that could result in more responsibility for the assurance of adequacy being placed on entities that have not heretofore directly had that responsibility. While some may desire an enforceable adequacy standard, there are currently no institutions in the Northwest that could enforce such a standard for the Region's entire load serving entities.

Given the institutional problems associated with an enforceable resource adequacy standard, it may be possible to build on the Northwest's tradition of regional cooperation and establish a voluntary resource adequacy standard. Such a standard would need to be supported by voluntary reporting of load, resource and power system data by regional load serving entities and could be as successful as an enforceable standard. One avenue for implementing such a voluntary standard may be through the WECC voluntary contractual approach. However, if such a voluntary approach falters, an enforceable resource adequacy framework may need to be established that draws upon existing jurisdictional authority, currently available contractual mechanisms and possibly even new legislation.

In addition, it is also clear that establishing a regional adequacy standard that is incompatible with actions in the rest of the West could be less than effective. It will therefore be necessary to continue to work in the context of the WECC and other west-wide organizations.

Physical Adequacy, Economic Adequacy or Both?

In establishing an adequacy standard, it will be essential that the purpose of that standard be well understood and agreed upon. For example, is the purpose of an adequacy standard to ensure that the "lights stay on" with an acceptably high probability or is it to protect against the economic and social costs that can accompany periods of short supply? As noted earlier, the Council's analysis indicates that the latter implies a somewhat greater level of resources than the former.

Different adequacy standards could be appropriately applied at different levels. For instance, a physical standard might be most appropriately applied at the WECC level. At this level it would act to set a baseline for expectations about physical reliability of the system and for actions by LSEs and their regulators to address those expectations. Considerations of economic adequacy might better be addressed at the individual LSE (or perhaps state policy) level, where different degrees of risk tolerance might exist and different mechanisms for mitigating price risk could be put in place.

The Council believes that the question of economic versus physical adequacy should be addressed as part of the dialog surrounding the establishment of a Western and Northwestern adequacy standard. Toward this end, the Council will establish a Northwest Resource Adequacy Forum. This forum will examine alternative adequacy metrics and standards for the Northwest and their consistency with west-wide standards being developed by the WECC and others. The

forum should consist of utility policy makers, regulatory commission representatives and other relevant parties who will help to develop standards and support their implementation. A technical subgroup of this forum will have the function of providing policy makers viable options for both metrics and standards for the northwest. The objective would be to reach agreement on appropriate adequacy metrics and standards by the end of 2005. The Council will continue to work within the WECC and other groups toward the establishment of adequacy metrics and standards on a west-wide basis.