CHAPTER 5:
BONNEVILLE LOADS AND RESOURCES

Contents

List of Tables and Figures

Bonneville uses its load forecast and existing resources as a starting point to conduct a more detailed needs assessment through its Resource Program process. Due to a number of necessary adjustments made to the loads and resources used in this analysis the reader is advised not to make a direct comparison between the load and resource balance presented in this chapter with the load and resource balance presented in the BPA 2015 White Book or the PNUCC 2015 NRF report.

KEY FINDINGS

Currently, the federal power supply primarily consists of hydroelectric generation, with nearly 21,000 megawatts of nameplate capacity and about 12,000 megawatts of single-hour peaking capability (under critical hydro conditions in January). The federal system also includes 1,120 megawatts of nuclear capacity, 24 megawatts of cogeneration, and 744 megawatts of contract purchases, for a total of approximately 14,000 megawatts of single-hour peaking capability. However, some of the federal system's resources must be held in reserve for contingencies and load following. These requirements account for about 2,000 megawatts of capacity, which is subtracted from the federal system capability, to yield a net federal peaking capability of about 12,000 megawatts.

On the energy side, the hydroelectric system provides about 6,600 average megawatts of (critical period) firm energy. Accounting for the energy contributions from other generating resources yields a net firm energy generating capability for the federal system of about 8,000 average megawatts.

Bonneville's annual loads are forecast to grow from 8,050 average megawatts in 2016 to between 8,300 and 8,600 average megawatts in 2035. Bonneville's single-hour peak load is forecast to grow from about 13,000 megawatts in 2016 to between 14,000 and 15,500 megawatts by 2035, depending on future economic conditions. These forecasts are for frozen efficiency scenarios, meaning that no new energy efficiency savings are counted.

A simple deterministic comparison of federal resources and loads indicates that Bonneville is likely to experience energy and capacity shortfalls over the next twenty years. However, as described in more detail for the region in Chapter 11, this deterministic look ahead is not necessarily the best indicator of future resource needs. For example, this simple comparison of loads and resources includes only the lowest (critical period) hydroelectric capability for both energy and peak. And, while it does include firm contractual agreements for power exchanges between Bonneville and other entities, it excludes available non-firm spot market supplies from both within region and from out-of-region sources. It also does not include expected future energy-efficiency savings. So, whether Bonneville will actually face a shortfall depends on runoff conditions, spot market availability, and the success rate of implementing energy-efficiency measures. Bonneville understands this and, for its own resource needs assessment, uses a number of more sophisticated analytical methods to more precisely determine its future needs.

Unlike the data and analysis provided in Chapter 11 (for regional resource needs), the Bonneville calculations in this chapter explicitly include reserve requirements. Contingency reserves are resources that are only used during unexpected events and load following reserves are used to ensure that generation matches load every minute (balancing) and every hour (load following).

For regional analysis, balancing reserves are incorporated by reducing the amount of hydroelectric peaking capability devoted to serving firm load. The regional analysis does not subtract contingency or load following reserve requirements from resource capability. Instead, the GENESYS model assesses the amount of required contingency and load following reserve for each hour of the year and checks to see if sufficient supply is available to meet that requirement. If reserves cannot be met, GENESYS counts that as a shortfall, which contributes toward the assessment of adequacy. Reserves were left in the Bonneville calculations in this chapter because not doing so produces a capacity load-resource balance (Figure 5-3) that is misleading. The Council will reevaluate how it treats reserves for its future regional adequacy assessments.

INTRODUCTION

The Council analyzes the power system from a regional perspective, and prepares a "regional conservation and electric power plan." The Northwest Power Act also directs the Council to forecast the resource needs of the Bonneville Power Administration and identify resources available to meet those needs, setting forth in the power plan a "scheme for implementing conservation measures and developing [generating] resources" under the resource acquisition provisions of Section 6 of the Act in order "to reduce or meet the [Bonneville] Administrator's obligations." As part of this effort, the focus of this chapter is on analyzing Bonneville's loads and currently available resources. The resource strategy for future resource development for the region as a whole and for Bonneville in particular, is set forth in Chapter 3 and in the Action Plan in Chapter 4.

The Act instructs the Council, after developing a demand forecast of at least twenty years, to then develop a "forecast of power resources" that the Council estimates will be required to meet Bonneville's obligations, including the portion of those obligations that can be met by resources in each of the different priority categories identified in the Act. The Council's forecast of Bonneville resource needs is to "include regional reliability and reserve requirements." The forecast is also to take into account the effects of implementing the fish and wildlife program that the Council separately develops under the Act on the availability to Bonneville of the existing hydroelectric power system. And the forecast of Bonneville's resource needs is to include "the approximate amounts of power the Council recommends should be acquired by the [Bonneville] Administrator on a long-term basis and may include, to the extent practicable, an estimate of the types of resources from which such power should be acquired."

The Bonneville "obligations" referred to in the Act include both Bonneville's contractual power sales obligations, after taking into account planned savings from conservation measures, *and* Bonneville's fish and wildlife protection and mitigation obligations called for in the Council's Fish and Wildlife Program under the Act. A number of provisions in the Act then call for Bonneville to implement conservation measures and acquire other resources to meet or reduce these obligations "consistent" with the Council's power plan, with certain specified exceptions.

The purpose of this chapter is to quantify Bonneville's forecasted load and existing resources (including reserve and reliability requirements) in order to estimate its load-resource balance over the 20-year study horizon. Bonneville develops its own resource needs assessment using data in its annual White Book publication A detailed description of potential resource acquisitions can be found in Chapter 3 and specific Bonneville action items can be found in Chapter 4.

The distinction between the regional resource strategy and the Bonneville resource strategy is greater in the 21st century than anticipated by Congress when adopting the Northwest Power

Act in 1980. A premise underlying the development of the Act was that the Council's regional resource plan would be essentially the same as Bonneville's resource strategy. The expectation at the time was that the region's utilities would largely request that Bonneville serve their growing regional loads. Bonneville would then implement conservation measures and acquire generating resources consistent with the power plan as needed to reduce or meet those growing regional loads. The costs of new resources would be spread across the region in a rate melded with the lower costs of the existing federal base system, mostly hydroelectric power resources.

As discussed in detail in the Council's Fifth and Sixth Power Plans, this approach proved unworkable in its full extent by the first part of the new century, for a number of reasons. Bonneville, the region's utilities, and the Council spent a better part of a decade crafting a new paradigm, eventually enshrined in a Bonneville policy decision and implemented through new power sales contracts and a tiered-rate mechanism. The current understanding is that Bonneville will continue to serve a portion of the region's loads with the federal base system; will reduce any need or obligation to meet growing regional loads by implementing conservation and other measures that reduce energy and capacity needs and stretch the value of the base system; and will acquire additional generating resources to meet load growth brought to Bonneville only through arrangements and a tiered-rate structure that confines as much as possible the risk and costs of those new resources to the utilities seeking the service. The only other reason Bonneville may need to acquire resources is to maintain system stability and reliability, such as to balance variable generation resources on its system. The change in expectations for Bonneville's role in the regional power system is the reason for the distinction in the Council's recent power plans between the regional resource strategy and the resource acquisition activities specifically focused on Bonneville's needs.

BONNEVILLE'S LOAD/RESOURCE BALANCE

As part of the assessment of the region as a whole, the Act requires that the Council's Power Plan focus specifically on the obligations that might be placed on Bonneville over the 20-year period covered by the plan. The plan must include at a sufficient level of detail 1) a forecast of the load that might be placed on Bonneville, as well as other obligations that might affect its system generation, including implementation of fish and wildlife program measures; 2) identification of Bonneville's existing generating resources and planned energy-efficiency savings; 3) an assessment of any potential needs to meet or reduce possible future loads and obligations; and 4) an assessment of Bonneville's share of regional reserve and reliability requirements. Bonneville's generating resources are summarized in Chapter 9 and in Bonneville's 2015 White Book. Operating and planning reserves, including Bonneville's role in future reserve requirements, are discussed in Chapter 10. Regional potential for energy efficiency, generating resources and demand response are discussed in Chapters 12, 13, and 14, respectively.

In this chapter, Bonneville's loads and resources are combined to assess a load-resource balance over a 20-year planning period. The methodology used for Bonneville is identical to that described in Chapter 11 for the region, with the exception of the treatment of reserves. Also, as emphasized in Chapter 11, a load-resource balance assessment is only the first step in a more complex process to determine resource adequacy and resource strategies to meet identified needs. Bonneville uses its load forecast and existing resources as a starting point to conduct a more detailed needs assessment through its Resource Program process. The Council works closely with the Administrator to ensure consistency and validity of all data used in that process.

Bonneville's Resources

Currently, the federal power supply primarily consists of hydroelectric generation, with nearly 21,000 megawatts of nameplate capacity and about 12,000 megawatts of single-hour peaking capability (under critical hydro conditions in January). The federal system also includes 1,120 megawatts of nuclear capacity, 24 megawatts of cogeneration, and 744 megawatts of contract purchases, for a total of approximately 14,000 megawatts of single-hour peaking capability. However, some of the federal system's resources must be held in reserve for contingencies and load following. These requirements account for about 2,000 megawatts of capacity, which is subtracted from the federal system capability, to yield a net federal peaking capability of about 12,000 megawatts.

On the energy side, the hydroelectric system provides about 6,600 average megawatts of (critical period) firm energy. Accounting for the energy contributions from other generating resources yields a net firm energy generating capability for the federal system of about 8,000 average megawatts.

Tables 5 - 1 and 5 - 2 show Bonneville's annual energy and peaking capability (from the 2015 White Book) along with its reserve requirements and estimated transmission losses.

Table 5 - 1: 2015 White Book Federal System Resources
Annual Energy (Average Megawatts) under Critical Water

Resource Type/Year	2016	2021	2026	2035
Net Hydro	6,666	6,658	6,644	6,644
Other Resources	1,145	971*	1130	957*
Contract Purchases	387	507	562	173
Transmission Losses	(243)	(242)	(248)	(231)
Total Net Resources	7,955	7,895	8,089	7,543

* This reflects partial year operation of Columbia Generating Station due to refueling requirements

Table 5 - 2: 2015 White Book Federal System Resources
Single-hour Peaking Capability (Megawatts) under Critical Hydro

Resources/Year	2016	2021	2026	2035
Net Hydro	12,056	12,619	12,599	12,710
Other Resources	1,144	1,120	1,120	1,120
Contract Purchases	744	694	969	308
Reserves & Losses	(2109)	(2133)	(2122)	(2127)
Total Net Resources	11,835	12,300	12,293	12,011

Bonneville's Forecast Obligations

In order to forecast Bonneville's future obligations (e.g. long-term contract sales, sales to federal agencies) the Council used BPA's long-term firm load obligations for 2016 to 2035 as reported in the 2015 White Book. Forecast sales in 2016 were then adjusted for Bonneville's transmission losses (2.97 percent) to compute Bonneville's system energy load. Forecast of single-hour capacity needs were also extracted from the 2015 White Book. These single-hour load obligations were then adjusted to include Bonneville's transmission loss of 3.38 percent. These reported transmission loss factors were updated as part of BPA's recent rate case. The result of this calculation indicates that obligations will be about 8,000 average megawatts by 2016, depending on regional economic growth. By 2035 the energy load forecast will likely reach 8,300 average megawatts. Capacity requirements would increase from 12,700 megawatts to about 13,000 megawatts. Bonneville's estimate of its annual energy and single-hour winter peak loads, prior to any adjustment for losses or embedded conservation, is shown in Table 5-3. Embedded conservation refers to conservation that is captured in BPA load forecast. Because BPA load forecast uses econometric methodology, it includes impact of past conservation.

Table 5 - 3: 2015 White Book Forecast of Bonneville's Annual Energy and January Single-Hour Peak Capacity Loads

Year	2016	2021	2026	2035
Annual Energy – BPA total firm obligations (aMW)	8,050	8,086	8,082	8,310
January Single-Hour Peak Loads (MW)	12,720	12,769	12,623	12,962

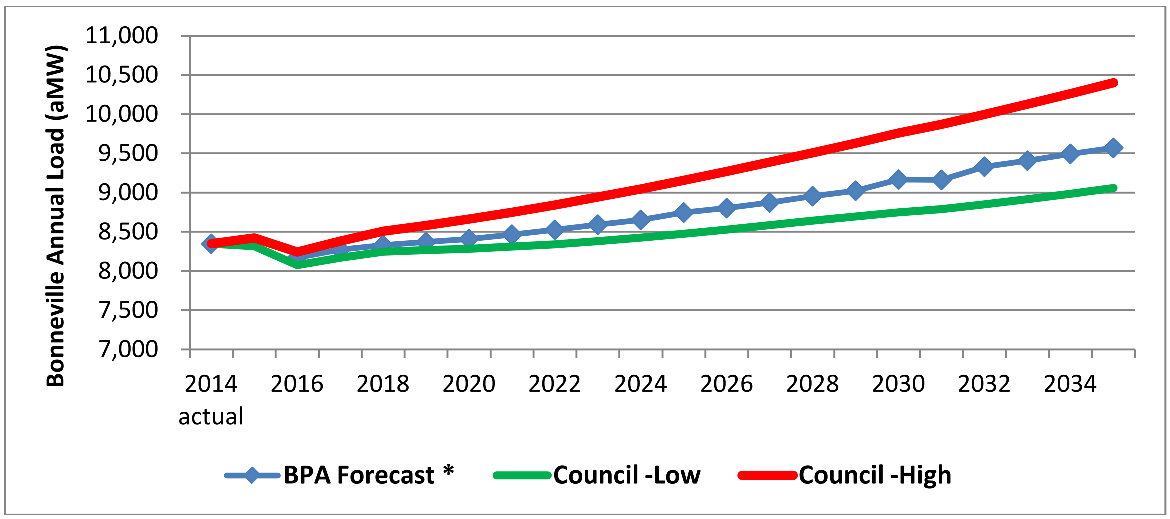
Bonneville's estimates of annual energy and peak loads shown in Table 5-3 include forecast levels of future conservation but do not include line losses. The Council's estimates of Bonneville's future obligations described above do not include prospective conservation, but do include line losses. Council analysis adds back in the losses shown in 2015 White Book for both energy and single hour January peak. The following section describes adjustments that were made so that Bonneville and Council forecasts of federal loads can be compared.

Comparison of the Council's Load Forecast and Bonneville's White Book Forecast for Obligations

Due to differences in forecasting methodologies, in order to compare the Council's forecast to Bonneville's forecast of federal obligations, three adjustments need to be made to the Bonneville forecast. These include; 1) an adjustment for line losses, 2) an adjustment for conservation embedded in the agency's load forecast, and 3) an adjustment for Direct Service Industry (DSI) loads. The Council uses a frozen efficiency load forecast when estimating its 20-year load and resource balance for the region. This approach allows for an explicit treatment of future conservation resources in the Council's planning models. Bonneville's load forecast methodology embeds the impact of future conservation savings implicitly, through use of econometric estimations. To compare Bonneville's obligations reported in the White Book with the Council's, an adjustment must be made to remove embedded conservation savings from Bonneville's forecast.

Bonneville estimates that incremental annual conservation savings embedded in their forecast is about 60 average megawatts. To compare the two forecasts, annual conservation savings embedded (implicitly accounted for in the econometric relationships) in Bonneville's forecast must be added back into that forecast as additional load. Then, since Bonneville accounts for transmission losses separately, those losses must also be added to the Bonneville forecast. Also, Bonneville obligation to DSIs has been reduced to 91 average megawatts, consistent with 2015 White Book. After making these three adjustments, the revised Bonneville 20-year load forecast is plotted in Figure 5 - 1 along with the Council's estimate of Bonneville's obligations. The drop in forecast of load in 2016 is due to Alcoa's announced idling of their smelting operations in the state of Washington.

Figure 5 - 1: Comparison of Council Frozen Efficiency Load Forecasts with Bonneville White Book Forecast, Adjusted for Losses and Embedded Conservation



*To make Bonneville and Council forecasts comparable, DSI loads of 225 aMW are excluded from BPA's obligation. BPA's most recent rate case data assumes DSI obligations of 91 aMW.

The year-by-year comparison of the Council's forecast of Bonneville's obligations and Bonneville's adjusted obligations is presented in Table 5 - 4. As evident in that figure, the forecasts are reasonably close.

Table 5 - 4: Comparison of Frozen Efficiency Load Forecasts

	2016	2017	2018	2019	2020
BPA Forecast*	8,170	8,273	8,330	8,369	8,409
Council's Low forecast for Bonneville	8,122	8,215	8,291	8,313	8,332
Council's High forecast for Bonneville	8,287	8,426	8,555	8,631	8,709

* Excludes DSI load of 225 aMW not part of BPA obligation. BPA rate case data puts DSI obligations at 91 aMW.

Figure 5 - 2 shows the Council's forecast range of Bonneville's annual energy loads and resources over the 20-year study horizon. Resources reported in the 2015 White Book, were adjusted for transmission losses (i.e. losses were subtracted from Bonneville's resource total). In this analysis, however, transmission losses are added to Bonneville's forecast of sales to get Bonneville's load at the generator busbar. This allows a more direct comparison of Bonneville's load forecast to the Council's forecast. So for this analysis, Bonneville's resources do not have transmission losses subtracted out. Table 5 - 5 shows the Bonneville load-resource balance for specific years.

Figure 5 - 2: Bonneville's Annual Energy Loads and Generating Capability (Frozen Efficiency)

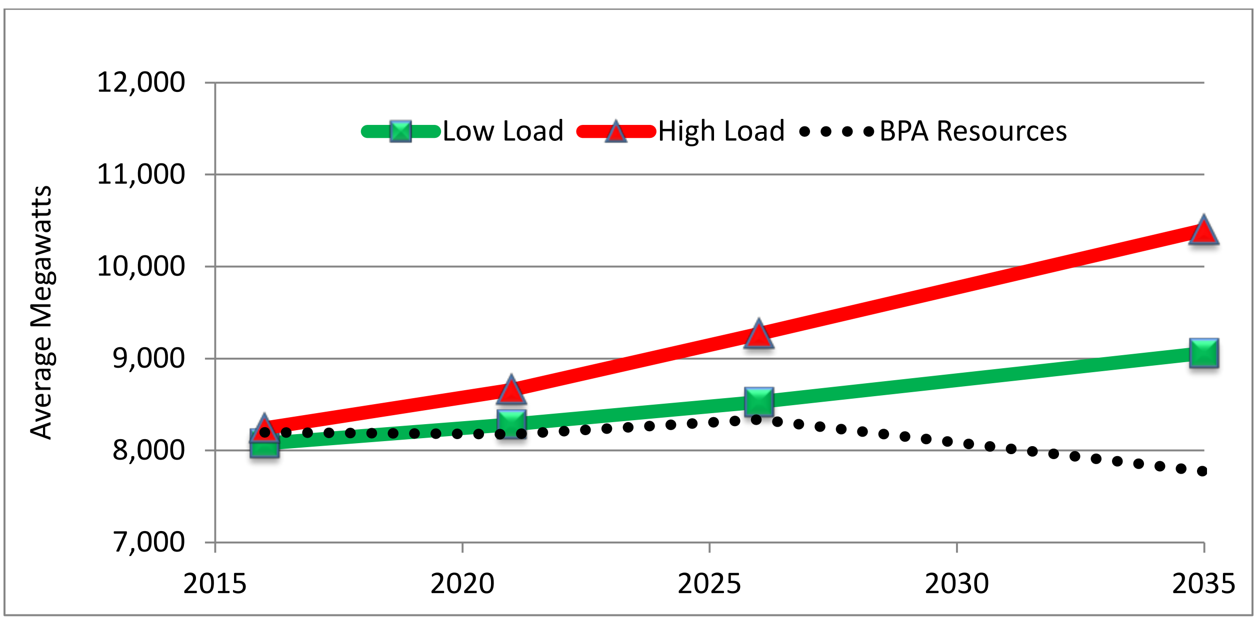


Table 5 - 5: Bonneville's Energy Load-Resource Balance (Frozen Efficiency)

Forecast	2016	2021	2026	2035
Low (aMW)	122	-108	-191	-1285
High (aMW)	-43	-485	-933	-2625

Comparison of Bonneville and Council's Peak Load Forecast

Bonneville's peak load is coincident with the region's peak load, which typically occurs during the winter. To compare BPA's single-hour load forecast with the Council's, the same approach was taken as used to compare the energy load forecasts. Bonneville's forecast of single-hour peak load presented in the 2015 White Book was adjusted for transmission losses (3.38 percent of single-hour peak load) and adjusted for the conservation savings on peak (using a two-to-one ratio for winter peak hour savings relative to energy savings). Then the adjusted single-hour peak load for 2016 was projected forward using the Council's annual growth rate to get the frozen efficiency peak-load forecast.

Table 5 - 6: Comparison of Frozen Efficiency Single Hour Winter Peak Forecasts

	2016	2017	2018	2019	2020
BPA Forecast – 2015 White Book	12,960	13,609	14,063	15,446	12,960
Council's Low forecast for Bonneville	12,363	12,471	12,558	12,571	12,579
Council's High forecast for Bonneville	12,706	12,883	13,046	13,133	13,222

The single-hour winter peak load for Bonneville is shown below in Figure 5 - 3 along with Bonneville's resource peaking capability over the same time span. Table 5 - 7 provides Bonneville's projected capacity load-resource balance. Bonneville's adjusted single-hour load forecast with frozen efficiency is in line with the Council's estimate for the high load growth frozen efficiency forecast. Note that these forecasts do not include any new conservation acquisition targets identified in this plan.

Figure 5 - 3: Bonneville's Winter Single-Hour Peak Load Forecast and Single-Hour Peaking Capability (Frozen Efficiency)

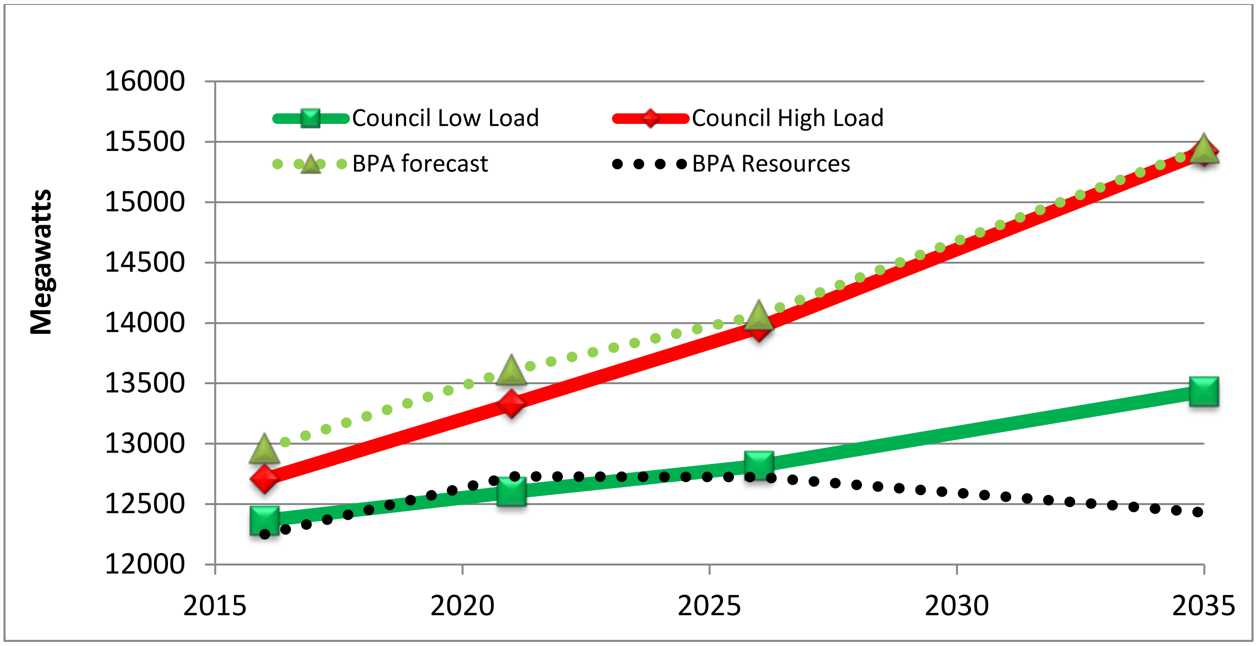


Table 5 - 7: Bonneville's Capacity Load-resource Balance (Frozen Efficiency)

Forecast	2016	2021	2026	2035
Low	-114	131	-94	-1002
High	-456	-597	-1240	-2986

BONNEVILLE RESOURCE ACQUISITION AND ACTIVITIES

Bonneville's Needs Assessment defines the timing and scale of the difference between forecasted federal loads and existing resources using multiple metrics. Bonneville will prepare a more precise and specific resource needs assessment based on forecasted federal loads and existing resources as described above. Bonneville then determines the specific timing and amount of new resources needed to meet its federal obligations through its Resource Program development process. Bonneville's Resource Program should be consistent with the Council's Seventh Power Plan taking into account its obligation to provide an adequate, reliable, and cost-effective power supply while maintaining its ability to implement the fish and wildlife measures identified in the Council's Fish and Wildlife. Specifically, Bonneville is expected to acquire its share of all cost-effective energy efficiency, evaluate and develop demand response resources, and examine the availability and cost of generating resources (if needed). In addition, Bonneville is expected to continue to explore ways to provide operating and balancing reserves in the most economic manner. A more detailed description of the Council's recommendations for the region and Bonneville's resource strategy can be found in Chapter 3 and specific Bonneville action items can be found in Chapter 4.