PRELIMINARY ASSESSMENT OF ENERGY ISSUES ASSOCIATED WITH THE KLAMATH HYDROELECTRIC PROJECT

STAFF PAPER

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Memorandum

Date: May 5, 2003
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To: Mary D. Nichols
Secretary for Resources

From: **California Energy Commission** - Robert L. Therkelsen
1516 Ninth Street Executive Director
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Subject: **KLAMATH RIVER HYDROELECTRIC PROJECT ENERGY ISSUES**

The California Energy Commission staff have prepared the attached preliminary assessment of energy issues associated with the Klamath Hydroelectric Project as requested by the Resources Agency and the State Water Resources Control Board (SWRCB). It is our understanding that Resources Agency and the SWRCB seek to better understand the energy issues associated with a potential full or partial decommissioning of the project. We also understand that the Klamath River supported the third largest salmon runs on the Pacific Coast of the continental United States, and that restoration of this fishery is an important policy objective for the State. As part of the State's work to restore Klamath River salmon fisheries, Resources Agency and the SWRCB staff may propose to the Federal Energy Regulatory Commission (FERC) that dam removal alternatives be studied as part of the proceedings on renewal of the hydroelectric licenses for the facilities in PacifiCorp's Klamath Hydroelectric Project.

The Energy Commission staff's assessment indicates that, in terms of the potential impact to electricity resource adequacy, decommissioning one or more of the dams is a viable alternative that should be examined during the proceedings on the possible renewal of the FERC hydroelectric license. We recognize that more detailed technical studies will be conducted concerning the energy and other aspects of the Klamath project as the FERC proceeding moves forward. Energy Commission staff are prepared to provide additional help and support on energy issues to Resources Agency and the other participating agencies as the relicensing proceedings progress. If you have any questions on the enclosed report, please contact Kevin Kennedy (651-8836, kkennedy@energy.state.ca.us) or Jim McKinney (654-3999, Jmckinne@energy.state.ca.us) of my staff.

Attachment

California Energy Commission
PRELIMINARY ASSESSMENT OF ENERGY ISSUES
ASSOCIATED WITH THE KLAMATH HYDROELECTRIC PROJECT

Summary

As requested by the California Resources Agency and the State Water Resources Control Board (SWRCB), Energy Commission staff has completed a preliminary electricity analysis of the possible decommissioning of one or more dams in the PacifiCorp Klamath Hydroelectric Project (FERC No. 2082). Staff's assessment indicates that, from the perspective of potential impacts to electric resource adequacy, decommissioning is a viable alternative that should be examined during the Federal Energy Regulatory Commission (FERC) proceedings on renewal of the hydroelectric license for these facilities. More detailed analyses of the energy and other aspects of the management of the Klamath system will be developed during the relicensing proceeding. That information will be needed for the parties to the proceeding to evaluate the balance among the competing goals and priorities, which include environmental protection and restoration, water supply, energy supply and reliability, and renewable energy use.

If one or more of the dams were decommissioned, replacement energy would be needed to offset foregone generation at these dams, and could be needed to address possible adverse effects on transmission system reliability at the local or utility level. This energy could be provided through local generation, transmission from PacifCorp's East Division, or purchased imports. New and proposed facilities in the vicinity are likely to address the need for local generation. These include a new 484 MW cogeneration facility that went into operation in Klamath Falls, Oregon, in 2001, and two applications for a total of over 1,500 MW in combined-cycle power plants in Klamath County currently before the Oregon Office of Energy for review. The time before the dams could be decommissioned would allow adequate time to address system-level generation needs and local transmission reliability issues. However, the cost to PacifiCorp of generating or purchasing power will be higher than for continued generation by these hydroelectric facilities.

When a more detailed technical evaluation of the energy impacts of decommissioning is needed, Energy Commission staff recommends it be completed by an energy consulting company with detailed local modeling capability. Energy Commission staff would be prepared to oversee that effort, including working to establish appropriate parameters and modeling assumptions for the study.

Introduction

As part of their work to restore California salmon fisheries, the Resources Agency and SWRCB will propose to FERC that dam removal alternatives be studied as part of the relicensing proceedings for PacifiCorp's Klamath Hydroelectric Project. PacifiCorp

would then be responsible for completing an analysis of the energy, economic, and environmental effects of removing one or more dams on the Klamath River as part of the FERC proceedings. The Resources Agency and SWRCB asked Energy Commission staff to provide an initial review of the energy issues associated with a full or partial decommissioning of the project.

The analysis presented here is intended to provide preliminary answers to four questions: (1) What are the components of the Klamath Hydroelectric Project? (2) What is the projected electricity supply/demand balance in the relevant existing electricity forecasts? (3) Would decommissioning some or all of the dams in this project have potential effects on electricity resource planning? (4) How does the energy assessment fit into the larger balancing of interests in the management of the Klamath River basin and the overall Klamath relicensing process? This report does not provide detailed analysis or conclusions concerning these questions, but it is intended to provide a preliminary review based on available information.

This assessment is focused primarily on general characterizations of installed capacity and energy production for the four small hydroelectric plants owned by PacifiCorp located in California. These comments specifically do not address potential concerns about local reliability or effects on PacifiCorp ratepayers. Potential effects on resource adequacy for the utility are noted selectively, but have not been independently or comprehensively modeled or analyzed.

Primary data sources for this initial assessment include the PacifiCorp Integrated Resource Plan for 2003, information on the Klamath relicensing process from the PacifiCorp web site, the Oregon Office of Energy web site, the Northwest Power Planning Council preliminary reliability assessment for winter 2003 through 2006, the Energy Commission's most recent summer supply/demand forecast for 2003 through 2008, and the Energy Information Administration Annual Electric Utility Database. This assessment includes a preliminary estimate of the cost of foregone hydroelectric energy production for some decommissioning alternatives. The assessment does not attempt to estimate the environmental benefits or site-specific costs of dam removal, and does not consider the mitigation and enhancement measures that are likely to be required if the dams are relicensed. The assessment also does not consider the effect of removing these dams on the ability to meet the state's renewable energy goals.

Energy Commission staff has begun a preliminary analysis of the transmission system impacts of possible removal of these dams. Given the relatively small capacity of the projects in question, staff does not anticipate significant transmission issues would result from decommissioning some or all of dams that are part of this project, though limited transmission equipment upgrade or replacement would likely be required. As a first step in evaluating the transmission impacts, staff determined that the Energy Commission's information on the relevant portion of the transmission system was not up to date. Staff plans to conduct a power flow study of decommissioning once current transmission system information is received from PacifiCorp.

Klamath Basin Management

Energy production is one of a number of competing priorities for the management of the Klamath River basin. A recent water discharge permit from the North Coast Regional Water Quality Control Board for the Iron Gate fish hatchery listed the following fifteen beneficial uses of the Klamath River, not necessarily in priority order:

- municipal and domestic supply
- agricultural supply
- industrial service supply
- industrial process
- groundwater recharge
- freshwater replenishment
- hydropower generation
- water contact recreation
- non-contact water recreation
- warm freshwater habitat
- cold freshwater habitat
- wildlife habitat
- preservation of rare and endangered species
- migration of aquatic organisms
- spawning, reproduction, and/or early development

In the Klamath Basin, these competing demands for limited water supplies have made national news in recent years. In the past ten years, drought conditions beset farmers and fish in 1992, 1994, and 2001. Stakeholder factions have become more polarized and political in pursuit of their plans and priorities. In September 2002, an estimated 33,000 chinook salmon, coho salmon, and steelhead trout died in the lower Klamath River. Some blamed water diversions for irrigation as primary culprits, but post mortem scientific opinion is not unanimous. A January 3, 2003 report by the California Department of Fish and Game recognized many contributing factors, but concluded "flow is the only factor that can be controlled to any degree" (CDFG 2003, p. 52). In a paper published before that fish die-off, U.S. Geological Survey scientists modeled sophisticated water quantity and water quality obligations on the Klamath. They concluded that biological and contract requirements cannot be met in a dry year. Worse, meeting water quantity requirements as specified in Biological Opinions and FERC stipulations would still result in thermally impaired water bodies (Campbell et al. 2002).

Salmon and steelhead trout fisheries restoration is a major policy objective for the California Resources Agency, Department of Fish and Game, State Water Resources Control Board, CalFed, and their federal agency conterparts. Historically, the Klamath River had the third largest salmon runs on the Pacific Coast of North American, after the Columbia and Sacramento Rivers. Much of the salmon habitat within and above the project area is degraded, at least seasonally. Habitat improvement and restoration projects will be needed whether the Klamath dams are relicensed or decommissioned. Oregon's Department of Environmental Quality identifies water bodies that do not meet federal Clean Water Act standards set in Section 303(d). In the summer months, Upper

Klamath Lake has water temperatures and dissolved oxygen levels that are lethal to threatened and endangered fish species. All reaches of the free-flowing river fail to meet the 303(d) standard for at least one listed parameter, water temperature. Other parameters of concern, especially in summer, include chlorophyll, toxics (ammonia), and pH. Especially below Copco, adverse water quality parameters include nutrients, organic enrichment, and low dissolved oxygen. "The poor health of the Basin's waters is not disputed. Once abundant fish populations have disappeared and others are threatened with extinction. The causes of these conditions and how they should be corrected, on the other hand, is fiercely debated" (OWRD 1999, p. 23). A report prepared for the U.S. Department of the Interior stated:

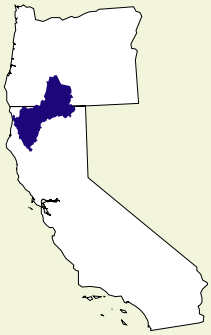
> "The decline of anadromous species within the Klamath River Basin can be attributed to a variety of factors which include both flow and non-flow factors. These include over harvest, effects of land-use practices such as logging, mining, stream habitat alterations, and agriculture. Other important factors have included climatic change, flood events, droughts, El Nino, fires, changes in water quality and temperature, introduced species, reduced genetic integrity from hatchery production, predation, disease, and poaching.
>
> "Significant effects are also attributed to water allocation practices such construction of dams that blocked substantial areas from upstream migration and have included flow alterations in the timing, magnitude, duration and frequency of flows in many stream segments on a seasonal basis" (Hardy and Addley 2001).

Klamath Hydroelectric Project

The Klamath Hydroelectric Project is a complex system that includes seven dams, including one on a tributary, Fall Creek, and seven powerhouses in two states, as shown on Figure 1. It was built from 1908 to 1962, developed jointly by the U.S. Bureau of Reclamation (USBR) and the California-Oregon Power Company (COPCO, the predecessor to PacifiCorp). In June 2003, PacifiCorp plans to file a draft application to renew their 50-year federal hydroelectric project license, which expires on March 1, 2006. This hydroelectric project is fully integrated with the Bureau of Reclamation's Klamath Project, which consists of 18 main canals totaling 185 miles, 516 miles of lateral canals, and 728 miles of drains (OWRD 1999, p. 18). Construction of that project lasted from 1905 to 1966.

PacifiCorp's Klamath Hydroelectric Project begins at Upper Klamath Lake in southern Oregon, where it operates the Link River facilities. The project area covers 64 river miles. Below the project, downstream from Iron Gate, the Klamath River is joined by the Shasta, Scott, Salmon and Trinity Rivers. On its 254-mile journey, the Klamath River flows south and west out of Oregon, through California's north coast ranges, reaching the Pacific in northern Humboldt County. Together with its tributaries, it drains an area of about 13,000 square miles.

Figure 1
Klamath River Basin



0 15 30 45

Scale in miles

MOUNT THIELSEN WILDERNESS
CRATER LAKE N.P.
KLAMATH MARSH N.W.R.
SKY LAKES WILDERNESS
WINEMA N.F.
FREMONT N.F.
GEARHART MOUNTAIN WILDERNESS
UPPER KLAMATH N.W.R.
MOUNTAIN LAKES WILDERNESS
Link River Dam
Keno Dam
Klamath Falls
Bonanza
Gerber Reservoir
CASCADE SISKIYOU N.M.
J.C. Boyle Reservoir
Lake Ewauna
Lost River Diversion Channel
Fall Creek Dam
Iron Gate Reservoir
Copco Reservoir 1 & 2
TULE LAKE N.W.R.
LOWER KLAMATH N.W.R.
CLEAR LAKE N.W.R.
LAVA BEDS N.M.
MODOC N.F.
KLAMATH N.F.
Yreka
Requa
Klamath
REDWOOD N.P.
SISKIYOU WILDERNESS
MARBLE MOUNTAIN WILDERNESS
SIX RIVERS N.F.
RUSSIAN WILDERNESS
SHASTA N.F.
MT SHASTA WILDERNESS
TRINITY ALPS WILDERNESS
TRINITY N.F.
CHANCHELULLA WILDERNESS
YOLLA BOLLY WILDERNESS

- National Wildlife Refuge (N.W.R.)
- National Park (N.P.)
- National Monument (N.M.)
- Wilderness Area
- National Forest (N.F.)
- Bureau of Land Management (B.L.M.)
- Tribal Lands
- The Nature Conservancy
- Water
- Klamath Basin Boundary
- Major Highway
- Major River
- State Boundary
- City
- Dam

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Source: The Wilderness Society/Center for Landscape Analysis

June 2003

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Hydroelectric Capacity and Annual Energy Production

The Klamath hydroelectric plants have a combined dependable capacity of 163 MW and an average annual energy output of 656.2 GWh, as shown in Table 1, with power plants listed from north (upstream) to south (downstream).

Table 1. Capacity and Energy Production from Klamath Hydroelectric Project

Powerhouse	Nameplate Capacity (MW)	Dependable Capacity[1] (MW)	Annual Energy (GWh)
East Side (Link River Dam)	3.0	3.0	12.1
West Side (Link River Dam)	1.0	0.0	3.9
J.C. Boyle	90.0	84.0	250.6
Oregon total	**94.0**	**87.0**	**266.6**
Copco 2	27.0	30.0	135.0
Copco 1	20.0	25.0	120.0
Iron Gate	18.0	19.0	123.0
Fall Creek	2.2	2.0	11.6
California total	**67.2**	**76.0**	**389.6**
Total	**161.2**	**163.0**	**656.2**

[1] Dependable capacity is the ability to provide sustained power for at least four to six hours (coincident with hours of peak demand), on a continuous daily basis.

Resource Adequacy

PacifiCorp operates two separate control areas, West (including portions of California, Oregon, and Washington) and East (including portions of Utah, Idaho, and Wyoming). The Klamath Hydroelectric Project is located in Oregon and California, and is part of PacifiCorp's West control area. While the transmission system in the Western United States is highly interconnected, any reliability concerns arising from decommissioning Klamath dams would most likely occur within the local PacifiCorp control territory. Information on current forecasts of the supply demand balance in California and the Pacific Northwest are presented below to provide a context for the consideration of decommissioning dams on the Klamath. Also presented below is information from PacifiCorp's 2003 Integrated Resource Plan. This plan assumes that the relicensing of PacifiCorp's hydroelectric facilities, including the Klamath Hydroelectric Project, will result in reduced generation capacity. However, the plan does not consider the PacifiCorp system at a level of detail that allows specific evaluation of the local effects

of specific actions such as decommissioning dams on the Klamath River. A preliminary discussion of the local Klamath basin supply and demand balance is included below based on limited available information, but additional data gathering and analysis is needed to assess the local energy impacts of closure of these dams.

Regional Forecasts

On January 28, 2003, the Energy Commission staff released its current evaluation of the availability of electricity in California for the next few years.[2] This assessment concluded that the state's electricity demand and supply balance looks good through 2004. California appears to be in good shape in the near term in part because supply has outpaced demand in the Southwest and Northwest over the past two years by about 8,000 megawatts. In addition, 20 new power plants licensed by the Energy Commission have been constructed in recent years, adding 6,552 MW to the grid. The forecast for 2004 through 2008 shows declining reserve margins during that period due to the fact that the planning horizon for resource additions is usually only two to three years out.

From a California statewide perspective, the four California hydroelectric plants provide relatively small amounts of energy (averaging 389.6 GWh annually), from a combined 76 MW of dependable capacity. For California, which needs to add 1,200 MW or more in new generation supplies every year, adding or losing 76 MW by itself would not constitute a significant statewide impact. This fact does not consider local, regional, or service area effects on rates or reliability.

The Northwest Power Planning Council issued its current forecast for load growth in the Pacific Northwest during winter seasons through 2006 on January 14, 2003. According to the Council, reliability is reasonably assured only for this year, with a loss of load probability of under one-half percent. By winter 2004 through 2006, this probability increases to six percent for scenarios with no imports. With average imports into the Northwest (mostly from California), the loss of load probability remains small for two years, then climbs to five percent in 2006. In the Northwest, there is a growing concern about how to meet planning and operating reserve margins for 2006 and subsequent years.

These regional forecasts for the electricity demand and supply balance for California and the Pacific Northwest show declining reserve margins in coming years. New generation, transmission upgrades, increased conservation, and other activities will be needed to ensure that generation is adequate to meet load and that transmission system reliability is maintained. While reducing generation through decommissioning dams later this decade would contribute to declining reserve margins, the small capacity of the Klamath Hydroelectric Project compared to the scale of additional generation or

[2] This evaluation was presented to the California Senate Energy, Utilities, and Communication Committee, and is available at the Energy Commission web site at http://www.energy.ca.gov/electricity/index.html#demand. This evaluation for the period through 2008 is the most recent update of the Energy Commission's *2002-2012 Electricity Outlook Report.*

reduced demand growth needed means that decommissioning will not have a significant reliability impact on a larger regional scale.

PacifiCorp Energy Resource Planning

PacifiCorp serves approximately 1.5 million retail customers in noncontiguous service territories covering portions of Utah, Oregon, Wyoming, Washington, Idaho, and California. PacifiCorp has 53 hydroelectric plants in Oregon, Idaho, Utah, Montana, and California, with a total capacity of 1,119 MW (PacifiCorp 2003). The hydroelectric projects account for 13 percent of PacifiCorp's installed capacity, but produce (at a minimum) only six percent of its self-provided energy. More than 86 percent of PacifiCorp's self-provided energy comes from coal. Natural gas-fired plants provide about five percent. Most of PacifiCorp's hydroelectric generation resources are concentrated in its western division (Washington, Oregon, and California). PacifiCorp recognizes that the generating value of its hydroelectricity will diminish over time in both relative and absolute terms. In its Integrated Resource Plan, PacifiCorp notes that "the resources available to PacifiCorp to serve this demand will diminish over time as supply contracts expire, hydroelectric generation facilities are subjected to relicensing conditions and thermal plants comply with more stringent emissions requirements. This creates an imbalance that is referred to as the *gap*. This gap between loads and existing resources will grow through time…. While the exact size of this gap is uncertain, PacifiCorp expects it will require an additional 4,000 MW of new resources ([demand side management], generation, and supply contracts) through 2013" (PacifiCorp 2003, pp. 3-4).

PacifiCorp is presently a net importer of energy. Detailed energy sales figures are not readily available, but data from the Energy Information Administration shows that retail sales by PacifiCorp for 2001 totaled 47,708 GWh, with 18,125 GWh to customers in California, Oregon, and Washington (EIA 2001). In terms of buying energy to supply its customers, long-term purchases provided 11.8 percent of PacifiCorp's energy in 2002, while short-term and spot market purchases supplied 20.5 percent. The company's transmission system provides access to low-cost hydroelectricity from the Columbia River, including 389 MW presently under contract from three municipal utility districts in Washington. PacifiCorp currently purchases 925 MW from the Bonneville Power Administration and 104 MW from Qualifying Facilities.

Peak loads for the PacifiCorp's West control area can occur in summer or winter. "PacifiCorp forecasts load on its system to grow by 2.2% in the East and 2.0% in the West per year, on average" (PacifiCorp 2003, p. 3). PacifiCorp has adopted a 15 percent planning margin above peak load, similar to the Energy Commission's planning reserve. "The planning margin (15%) is the target reserve level assumed to provide sufficient future resources to cover forced outages, provide operating reserves and regulatory margin, and allow for demand growth uncertainty" (PacifiCorp 2003, p. 33). By 2004, PacifiCorp will have a gap of 1,200 MW between nameplate capacity of existing resources and its forecast 15 percent reserve margin, equal to approximately

14 percent of its projected existing resources.[3] This resource deficit grows to 4,100 MW by 2014, or approximately 52 percent of projected existing resources. “The gap between load and resources is perhaps the most distinctive and important feature of PacifiCorp's current position” (PacifiCorp 2003, p. 35). While Energy Commission staff has not independently reviewed these estimates, PacifiCorp is using the estimates to develop its plans for how to meet its resource needs over the next decade.

PacifiCorp has also modeled reduced hydroelectric capacity as one of the scenarios for its 2003 Integrated Resource Plan. The model assumes a loss of energy due to operational changes and increased bypass flows in the base case for all portfolios. A stress case was run to test the impact of losing just over 200 MW of hydroelectric-generation capacity, or 20 percent of their hydroelectric-generation portfolio.

In this scenario, PacifiCorp assumed that the reduced hydroelectric capacity would be replaced by two additional simple-cycle combustion turbines totaling 230 MW (PacifiCorp 2003, p. 135). According to PacifiCorp’s evaluation, displacing existing renewable hydroelectric resources with new thermal peakers would:

- increase the present value of the revenue requirement (PVRR) by $608 million due to increase in capital and operating expenses;
- result in a $20 to $22 million increase in emissions costs contributing to the PVRR;
- result in a 16 percent increase in West market purchases, and an 8 percent decrease in West market sales;
- require new and existing combined-cycle combustion turbines and peakers in the West to run harder; and
- increase electricity transfers from the eastern portion of their territory to the western portion by 11 to 22 percent in 2014 over the base case results, and decrease transfers from the west to the east by 5 to 15 percent by 2014.

PacifiCorp concludes the analysis of this scenario by noting the value of hydro to the system resources, and that the Integrated Resource Plan assumes that all of the hydroelectric facilities PacifiCorp owns will be relicensed. PacifiCorp states that “detailed, plant-specific hydro analysis would be required to change this assumption. This will be done as plant relicensing occurs” (PacifiCorp 2003, p. 135). While Energy Commission staff has not reviewed PacifiCorp’s scenario analysis presented above, staff does concur that detailed, plant-specific analysis should be conducted as part of the relicensing proceedings for the Klamath Hydroelectric Project.

Klamath Area Demands and Resources

Available information is not adequate to determine to what extent the Klamath Hydroelectric Project serves local load. During the May 7, 2002, relicensing plenary meeting for this project, an informal estimate for “local community” load was “maybe 750,000 MWh/year” (Klamath Relicensing 2002a, p. 5). The combined output from the seven hydroelectric plants averages 656,200 MWh/year, though this energy is not all

[3] PacifiCorp’s projections of its existing resources for these purposes assume that none of its existing long-term contracts are renewed.

dedicated to meeting local load. Other local generation facilities include a 484 MW cogeneration plant in Klamath Falls operated by PPM Energy that went online in July 2001 (OOE 2002, 2003). This project is designed to achieve a capacity factor over 90 percent, which would allow it to generate over 3,800,000 MWh/year. While its actual output will depend on a number of factors and could be much lower, this cogeneration facility has the ability to produce significantly more energy than the entire Klamath Hydroelectric Project produces or local customers consume. The cogeneration plant cost $300 million to build, and operates at 62 percent overall efficiency. A temporary 100 MW expansion of that project also went online in June 2002. PPM Energy, the non-regulated arm of PacifiCorp, has also purchased 237 MW of capacity to help supply the western control area grid of PacifiCorp. Most of the balance of PacifiCorp's and PPM Energy's generation is committed under long-term contracts to public and municipal utilities including Modesto Irrigation District, Seattle City Light, and Sacramento Municipal Utility District.

Two additional applications for projects in Klamath County are currently under review by the Oregon Office of Energy. PacifiCorp has proposed a 542 MW combined-cycle plant. This application was submitted for expedited review on December 26, 2001, though the request for expedited review was withdrawn on April 23, 2002, and the Office of Energy is reviewing the application under its standard process. COB Energy Facility, LLC, is also proposing building a 1,150 MW natural gas combined-cycle combustion turbine system in Klamath County. An application for this plant was submitted on September 5, 2002.

The addition of these new and proposed local generation facilities are likely to help PacifiCorp to address the identified gap between existing resources and peak system requirements with a planning margin. While the addition of the Klamath Cogeneration Project is already incorporated into PacifiCorp's projections and decommissioning of dams on the Klamath River would increase the size of the gap facing PacifiCorp system-wide, these new and proposed facilities make it very unlikely that local load or reliability problems would result.

Economic Value of Existing Hydroelectric Energy

Economic Evaluation Approach

An economic analysis of the possible decommissioning of some or all of the dams in the Klamath Hydroelectric Project would require detailed site specific information that was not available for this preliminary analysis. To be complete, such an analysis would need to evaluate the costs associated with decommissioning dams against the costs under various relicensing scenarios. The costs would include those associated with removal or modification of dams, restoration and mitigation activities, and the relative costs of electricity generation or purchase under various operating scenarios. In addition, any such economic analysis would need to be considered in the context of the environmental and resource costs and benefits of the different scenarios, which can be difficult to quantity in economic terms. While some additional site-specific analysis

could be provided in the next few months if needed, a fuller exploration of these costs and benefits will likely have to be developed during the relicensing process itself.

In its Integrated Resource Plan, PacifiCorp notes that it agreed to decommission the Condit Dam near Mount Adams in Washington. The dam is 125 feet high, and stores water for a 14 MW powerhouse. PacifiCorp's summary of the balancing of costs and benefits that needs to be explored provides a useful context for considering these issues. For the Condit Dam, PacifiCorp determined that decommissioning was cheaper than adapting old facilities to meet new license requirements, which is a criterion PacifiCorp intends to apply elsewhere. Regarding mandatory conditions that go with re-licensing, PacifiCorp stated:

> "It is difficult to determine the economic impact of these mandates, but capital expenditures and operating costs are expected to increase in future periods while electricity losses may result due to environmental and fish concerns. As a result of these issues, for example, PacifiCorp has analyzed the costs and benefits of re-licensing the Condit Dam and has agreed to remove the Condit Dam at a cost of approximately $17 million" (PacifiCorp 2003, p. 27).

To provide a general economic context for consideration of decommissioning dams in the Klamath Hydroelectric Project, Energy Commission staff has completed a preliminary, 'back-of-the-envelope' estimation of the costs of generating or purchasing electricity to replace the foregone generation from the Klamath Hydroelectric Project. No attempt has been made to estimate either the costs of removing the dams or of possible mitigation or enhancement, including modified operations, that might be required should the dams be relicensed. For the limited purpose of this preliminary electricity assessment, staff assumed that existing hydroelectric energy production costs are less than 1 cent per kWh. An overhead cost of 0.8 cents/kWh can be posited, equal to $8/MWh or $8,000/GWh. Replacement energy can be estimated at 5 cents/kWh ($50/MWh or $50,000/GWh). These estimates have a high degree of uncertainty and some elements of risk associated with using the estimates. Baseload energy is likely to be cheaper, while peaking energy is likely to be more expensive.

California Hydroelectric Plants

On average, the four California plants generate 389.6 GWh per year. For this amount, the average yearly production costs would be approximately $3,116,800 (389.6 GWh x $8,000). At a wholesale price or replacement cost of $50/MWh, there would be an annual cost of approximately $19,480,000 to provide the same amount of energy now produced by PacifiCorp's California hydroelectric plants. For the value of foregone hydroelectric generation from the California plants, the net annual cost would be approximately $16.3 million.

J.C. Boyle Powerhouse, Oregon

Removing three dams at Iron Gate, Copco 1 and Copco 2, absent other changes, would create extremely varied flows on the Klamath River below J.C. Boyle powerhouse in Oregon. Except in spring months, when flows exceed 3,000 cfs, Boyle is operated to

optimize generation during peak demand hours. At the dam, most of the water is diverted into a penstock, and supplied to the J.C. Boyle powerhouse located 4.3 miles down river. FERC has set a minimum flow of 100 cfs for the bypass reach between dam and powerhouse.

If J.C. Boyle powerhouse and dam were removed, in addition to removal of the California hydroelectric plants, an additional 20.7 miles of Klamath River would be reopened to salmon. Repeating the assumptions about the energy values cited above would yield these results. Boyle alone produces 250.6 GWh annually, on average. Assuming current electricity production costs at $8/MWh, operating and maintaining Boyle costs about $2 million per year. Replacement power at $50/MWh would cost $12.5 million per year. The net annual cost of foregone hydroelectric energy at Boyle would be $10.5 million.

To restore free-flowing conditions up to the base of Keno Dam, four dams would need to be removed: Iron Gate, Copco 1, Copco 2, and Boyle. Using the electricity production costs assumed above, the combined cost of foregone hydroelectricity production would be about $26.8 million each year.

Klamath Hydroelectric Project Management Priorities

Link River Dam

The upper end of the project is at Link River Dam, which controls the outlet of Upper Klamath Lake east of the Cascade Mountains. The dam is only 16.5 feet high, but it provides 93 percent of the active storage water for this project. The surface area of Upper Klamath Lake varies between 60,000 and 90,000 acres, making it Oregon's largest lake, though the lake is very shallow, with an average depth of just over three meters in winter. In 1917, the USBR and the California-Oregon Power Company signed a contract to build Link River Dam. Construction of a reinforced concrete-slab began in 1920, and finished in 1921. The USBR owns this dam, and controls the release of water by dictating flow schedules to PacifiCorp, the dam operator. For Link River Dam, energy production is fourth priority. The top priorities for managing the dam are: 1) maintaining Upper Klamath Lake elevations to meet Biological Opinion requirements; 2) provide needed downstream flows in the Klamath River below Iron Gate Dam; and 3) divert water supplies to USBR's Klamath Irrigation Project.

Both ends of Link River Dam have headgates for canals leading to power plants. The East Side Powerhouse generally runs continuously on 975 cfs fed by a 1-mile canal, with a 1,200 cfs maximum capacity. In this bypass reach, locally called Link River, minimum instream flows are 90 cfs. The West Side Powerhouse operates intermittently on a maximum 250 cfs, fed by a 1.2-mile canal. West Side only generates when releases from Upper Klamath Lake exceed 1300 cfs.

Keno

Keno Dam was built in 1967 by PacifiCorp to generate electricity, but generation facilities were never installed. The concrete Keno dam is just 26 feet high, and creates

a reservoir 20.1 miles long. Keno Reservoir (Lake Ewauna) immediately captures water discharges from East Side and West Side powerhouses. Keno Dam is operated to "re-regulate" river flows. Lake level fluctuates less than 0.5 foot. Adding generating capacity to Keno to supply some replacement power is among the alternatives that the National Marine Fisheries Service has recommended for study. Below Keno Dam, the river flows freely for 5 miles.

J. C. Boyle

The earthen dam J. C. Boyle is 68 feet high. Built in 1958, it created a reservoir 3.3 miles long. At the dam, most of the flow is diverted to penstocks and delivered to the powerhouse 4.3 miles down river. Minimum flows in this bypass reach are 100 cfs to 350 cfs, depending on the season.

At the J.C. Boyle powerhouse, "the first priority is to meet biological and environmental objectives" (Klamath Relicensing 2002a, p. 3). For a typical day at J.C. Boyle, "Our peak at this time is 7-10 [am] and anticipating 6-10 pm. We focus on the morning peak at J.C. Boyle, [then] back down to 100 cfs" (Klamath Relicensing 2002a, p. 3). When asked about flexibility for shaping generation to meet hourly loads, a PacifiCorp manager replied "When we're the most sensitive? The morning customer load, we're following a load shape every day. It's understood that in the summer and winter you're exposed to peak events. It would be to our advantage to have more flexibility in the summer and winter" (Klamath Relicensing 2002a, p. 4).

From the Boyle powerhouse, the Klamath River flows 11 miles to the California border. This stretch has popular Class IV and V whitewater rapids, and was given National Wild and Scenic River status in 1994. Once in California, water flows 5.4 river miles to Copco 1 reservoir, and another 5.4 miles to the dam.

Copco 1 and 2

The concrete arch dam at Copco 1 is 230 feet high and lacks any fish passage facilities. When it was built in 1917, it permanently ended fish passage to the Klamath Basin. The powerhouse is adjacent to the dam, and is not constrained by limits on reservoir fluctuation, ramp rates, or instream flow releases. "Copco 1 is generally scheduled and operated in a peaking mode…. One or both of the turbine-generators are typically started in the morning to early afternoon and ramped up to best efficiency or full load output" (PacifiCorp, Draft description of reach 7, Copco 1 Reservoir, FERC Project No. 2082). From here, water flows 1.5 miles down river to a small reservoir (73 acre-feet), Copco 2. This reservoir was created by a concrete gravity dam, 33 feet high, built in 1925. Copco 2 powerhouse is also operated to provide peak power. Water discharged from Copco 2 immediately enters Iron Gate Reservoir, 6.8 miles long.

Iron Gate

Iron Gate Powerhouse is located at Iron Gate Dam. The dam is 173 feet high, rock-filled with a compacted clay core. It was built in 1962. By design and current operation, the dam's primary purpose is to smooth out and "re-regulate" flows released immediately upstream by the Copco plants. Energy production at Iron Gate is second priority, and

will likely fall to third or fourth place after relicensing. From Iron Gate, the Klamath River flows unchecked for 190 miles to the ocean. The FERC-stipulated minimum flow releases are 1,300 cfs from September through April, 1,000 cfs in May and August and 710 cfs in June and July. The record discharge at the mouth of the Klamath River was 557,000 cfs on December 23, 1964, during a major flood.

Conclusions

Energy Commission staff's assessment indicates that, in terms of the potential impact to electricity resource adequacy, decommissioning one or more of the dams is a viable alternative that should be examined during the proceedings on the possible renewal of the FERC hydroelectric license. More detailed analyses of the energy and other aspects of the management of the Klamath system will be developed during the relicensing proceeding. That information will be needed for the parties to the proceeding to evaluate the balance among the competing goals and priorities, which include environmental protection and restoration, water supply, energy supply and reliability, and renewable energy use.

If one or more of the dams were decommissioned, replacement energy would be needed to offset foregone generation at these dams, and may be needed to address possible adverse effects on transmission system reliability at the local or utility level. This energy could be provided through local generation, transmission from PacifCorp's East Division, or purchased imports. New and proposed facilities in the vicinity are likely to address the need for local generation. These include a new 484 MW cogeneration facility that went into operation in Klamath Falls, Oregon, in 2001, and two applications for a total of over 1,500 MW in combined-cycle power plants in Klamath County currently before the Oregon Office of Energy for review. Energy Commission staff has not completed a detailed assessment of the potential effects on reliability at the local or utility level, but given the time before the dams could be decommissioned would allow adequate time to address system-level generation needs and local transmission reliability issues. However, the cost to PacifiCorp of generating or purchasing replacement energy will be higher than for continued generation by these hydroelectric facilities.

Regardless of the hydroelectric outcomes on this project, PacifiCorp will need additional generation over the next decade to meet load. PacifiCorp will need to add about 4,100 MW of new capacity to be built, secured by contract, purchased in short-term markets, or offset by demand-side management and energy efficiency programs. In addition to PacifiCorp's need for additional generation, both California and the Pacific Northwest area will also need additional generation over the next decade to meet load. From the perspective of the larger western systems, replacing 76 to 163 MW of existing PacifiCorp hydroelectric capacity with additional new thermal resources would not have a demonstrably significant effect on resource adequacy.

When a comprehensive technical study is needed, Energy Commission staff recommends it be undertaken by an energy consulting company with detailed local

modeling capability. Energy Commission staff can coordinate that effort, including assisting in developing the parameters and modeling assumptions for the study. Such a study would include modeling of potentially needed replacement alternatives for energy, capacity, and transmission; local and regional reliability concerns; and utility and ratepayer costs. This study would include characterizations of PacifiCorp's supply-demand balance for its service territory and customer base during the period when decommissioning may occur. A detailed study of these concerns, and of transmission capacity in the Klamath Basin area for replacement power, would enable authoritative testimony to be provided as inputs to the FERC proceedings.

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