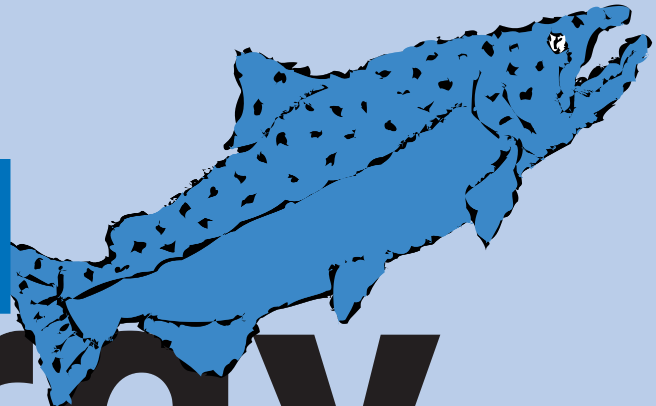
Tribal Energy VISION



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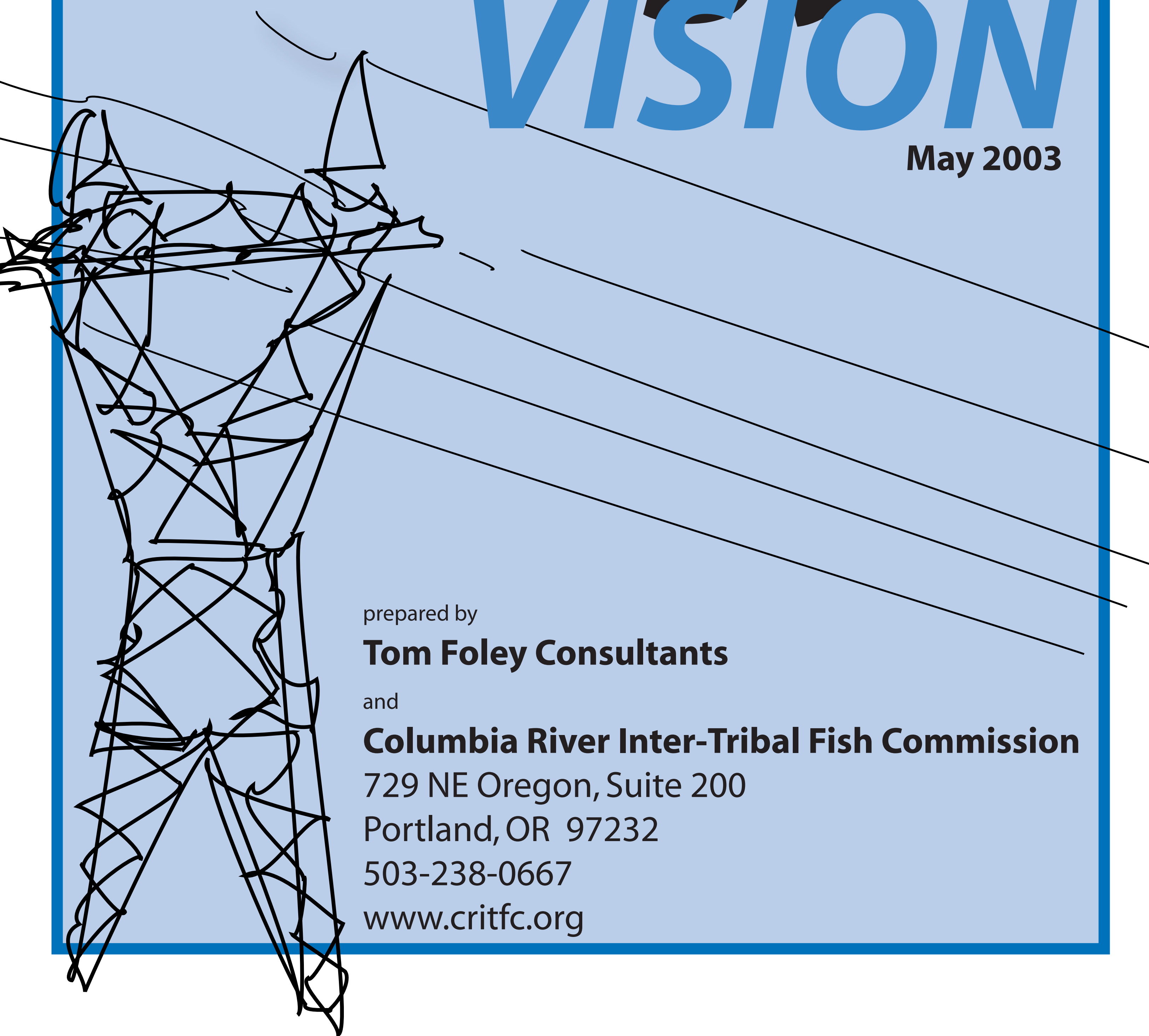

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PREFACE

The first draft of this paper was done in October 2001. It was then and remains a vision of what could be achieved if the region were to more broadly resolve issues facing power and fish and wildlife. As such this report is not meant to be predictive of what will happen, but intends to show how the region might develop an efficient electrical generation and delivery system that exists comfortably with a healthy fishery in the Columbia River Basin.

Since the draft was first released, several things have happened to move the region further along the path towards this vision. The Federal Energy Regulatory Commission (FERC) has issued orders and Notices of Public Record (NOPRs) that would allow non-conventional resources to compete with transmission, for example, and make interconnections of distributed generation simpler and less costly. These steps alone, once finalized, would move the region along towards achieving the vision described here.

Bonneville Power Administration (BPA) is revamping its transmission planning process to include non-construction alternatives to transmission. BPA has formed a Round Table of high-level regional advisors to help it move in this direction. As part of this effort, BPA has initiated three case studies to consider whether any of its planned transmission projects can be eliminated or delayed by deploying the very resources that this vision report calls for. BPA will do these studies in 2003, and has budgeted for additional pilot projects to determine the most successful strategies and resources it could deploy to delay or obviate the need for transmission construction.

The prospect of a re-regulated, more open to competition, industry has resulted in significant activity in the development of new technologies, most aimed at serving loads locally. The amount of venture capital to entrepreneurs developing new technology for the electric industry has gone from nearly zero in 1990 to over $1.2 billion at its height in 2000. This period coincided with FERC's initial efforts to "deregulate" the industry, and the booming economy of the late 1990s. Capital directed toward energy technology will rise even faster as re-regulation is implemented in this country and abroad.[*]

Having said that this report was not meant to be predictive, we have already seen movement towards the energy vision first published in a 2001 draft of the report. We hope this movement toward a more responsible energy future continues. The member tribes of CRITFC are prepared to do what they can to help the region achieve this vision.

[*]Presentation by venture capitalist Nancy Floyd at the Portland Business Alliance Industry Collaborative Series, April 9, Portland, Oregon.

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EXECUTIVE SUMMARY

The *Energy Vision for the Columbia River* has defined a set of strategies and resources that are much healthier for the Columbia Basin's fish resources, and provide better protection against unforeseen events, such as drought or other extreme weather, that affect both the environment and consumers. In addition, this report indicates how this vision can be met without raising rates in the Northwest.

The Nez Perce Tribe, the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Warm Springs Reservation of Oregon, and the Confederated Tribes and Bands of the Yakama Nation, who make up the Columbia River Inter-Tribal Fish Commission (CRITFC), believe that river's management need no longer be a fish versus power fight, where one side or the other is harmed. The region can enjoy an affordable, reliable energy system and have harvestable runs of salmon that support commercial, sport, and tribal harvests.

Our energy strategy or vision is economically and ecologically based to meet the requirements of fish and wildlife and the energy needs of the Northwest. The *Energy Vision for the Columbia River* highlights critical concerns with the region's existing energy system and defines a systematic approach to address these concerns. It is a planning document with a salmon recovery strategy that emphasizes a diverse and reliable energy resource mix, keeps energy costs similar to current costs and recovers abundant, harvestable salmon.

This vision outlines a set of resources that can be developed to meet future needs in a wise and cost-effective manner while reducing the region's energy dependency on the Columbia River hydroelectric system. It also identifies how to free the funds required to make these important changes. The *Energy Vision for the Columbia River* is a companion to our *Wy Kan Ush Mi Wa Kish Wit (Spirit of the Salmon) Plan for Columbia River Anadromous Fish Restoration*.

Hydroelectricity and Salmon
The development and operation of the Columbia and Snake rivers for electric power production, flood control, irrigation and navigation have reduced salmon and other migratory fish stocks to the point where many are at the brink of extinction. Wildlife populations and the river's ecological health have been compromised.

Over the decades the Northwest has faced numerous energy crises. When a crisis occurs, such as it did in 2001, the already dangerous conditions for Columbia Basin salmon worsen. Until the emergency passes, river regulators have been loath to provide water or alter dam operations "just for fish."

During the unplanned response to the 2001 drought and the summer's other energy problems, the tribes' and the region's salmon were left vulnerable to emergency power operations that resulted in the massive slaughter of juvenile salmon. Many of these salmon would have returned as adults in the following two to five years. This loss further eroded the treaty-reserved salmon resources the tribes rely on for livelihood and subsistence and for cultural and spiritual sustenance. Sport and commercial fisheries and United States treaty obligations to Canada were also negatively affected. In addition, electric utilities and consumers were exposed to dramatic rate spikes. Our four tribes are convinced that appropriate planning of regional resources can provide the Northwest with a robust energy system that withstands most unknown future events and keeps costs stable.

Goals and Principles

The Yakama, Nez Perce, Umatilla, and Warm Springs tribes each secured, by treaty, rights to take fish that pass their usual and accustomed fishing places. Numerous federal court decisions have affirmed these rights.[*] The four tribes founded CRITFC in 1977 to help them protect the member tribes' treaty rights to take salmon. For the tribes and CRITFC to accomplish their mission, salmon stocks must be rebuilt. The dams on the Columbia and Snake rivers continue to be the main deterrent to salmon restoration. The first goal of the tribal energy vision is to reduce the pressure of energy demand on Columbia Basin fish and wildlife resources, in other words, take energy policy off the backs of salmon and the environment that supports them.

A second goal of the energy vision is to serve utilities and ratepayers more cheaply than they are served today in order to capture the value of the Columbia River's energy system for the Northwest. A third goal is to provide better protection against unanticipated events, such as those the region faced in 2001.

Current Use of the Hydropower System

In a conventional power system, utilities build transmission and distribution lines to serve the highest peak load (the maximum amount of electric energy required during certain periods of time). Peak usage occurs infrequently and for short amounts of time. Yet more than 25% of all capital in place (including generation, transmission, and distribution) is there to serve loads that occur less than 5% of the time. This is inefficient.

Hydropower is used to serve peak loads because dams can react to demand by quickly putting more or less water through generating turbines. Serving peak loads with hydropower kills millions of juvenile salmon every year. During certain times of the year, so much water is drawn down to generate electricity that salmon redds (gravel nests where salmon lay eggs) are uncovered or dewatered and their eggs die. There are other adverse flow effects caused by accommodating peak loads. Additionally, the water held behind storage dams for future power generation—for summer air conditioning, for example—would, under natural conditions, be in the river aiding the swift and timely downstream migration of young salmon. Current operation of the Columbia Basin's

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[*] E.g. Sohappy v. Smith, 302 F.Supp. 899 (D.Or. 1969), aff'd, United States v. Oregon, 529 F.2d 570 (9th Cir. 1976); Washington v. Washington State Commercial Passenger Fishing Vessel Ass'n, 443 U.S. 658 (1979); United States v. Winans, 198 U.S. 371 (1905); Confederated Tribes of the Umatilla Indian Reservation v. Alexander, 440 F.Supp. 553 (D.Or. 1977).

hydro system does not provide the natural (or normative) river conditions needed to restore fish to harvestable levels.

Recommendations

Because the Northwest is overly dependent on hydroelectric power, the region is susceptible to many problems, as previously noted. Hydroelectric dams are located mostly in rural areas and power must be shipped over high voltage transmission lines to urban areas, sometimes over great distances. Disruption of the transmission lines can cause widespread blackouts.

An exclusive focus on hydropower production during crises such as power shortages can cause huge fish mortalities. As mentioned, during the drought of 2001, unprecedented numbers of fish were killed and power prices rose. Despite unusually good ocean survival conditions, most of the 2001 outmigration are not returning to the river as adults. If a second successive year of drought were to follow, fish would again be decimated to save hydro system operations and there would still not be enough water to meet the region's electric needs.

Whether or not the Northwest suffers additional drought years, the output of the hydro system will continue to be reduced so that water flows can be used to meet the Endangered Species Act (ESA) requirements for fish passage. As both the drought and the ESA examples indicate, the Northwest would be wise not to rely so exclusively on the hydroelectric system to meet its energy needs.

The tribal energy vision recommends the development of a more diverse energy resource portfolio to spread the risk between numerous electric power production means. Diverse production sources and other proposals in the energy vision can be used to make up for losses in power output at federal hydro projects.

- **Distributed generation**. The conventional electric utility solution has been to build large generation power plants and transmit the electricity on transmission lines regardless of distance. Instead, by no longer building transmission from centralized power plants, the money saved can be used to construct smaller, more dispersed or distributed power generation. Examples of distributed generation include small gas-fired units, solar voltaic cells and fuel cells.

- **Strategically placed gas-fired generation**. Gas-fired power is among the best alternative sources of generation the Northwest can develop to minimize its dependence on the hydro system. It is now cost-effective to build gas-fired generation units in local areas where the power is needed rather than putting up new transmission lines. In fact, transmission and distribution systems for electricity are currently constrained and new construction is very expensive. Gas-fired power plants, on the other hand, can be brought online quickly to meet peak-power needs, and can be used to provide reliable power when spill or flow is needed for fish operations.

- **True-cost pricing of peak power**. Although peak loads are much more expensive to serve, the difference is not captured in rates and is not reflected in the amount of money utilities pay for peak power. Power rates remain constant regardless of the higher costs of providing energy during peak periods. Peak power production using hydroelectric energy can kill millions of salmon. True-cost pricing of peak power would reduce peak loads and save salmon.

- **Efficiency improvements**. Readily available forms of conservation include home and business wall insulation, efficient lighting systems, efficient appliances and efficient heating, cooling and ventilation systems. These and other examples of cost efficient conservation reduce demand on the region's energy system.

- **Timing of energy consumption**. Energy consumption follows patterns in human behavior. By changing these patterns, energy consumption can drop. Lowering thermostats, turning off lights and shifting use of electricity to non-peak hours by running dishwashers, clothes dryers and washers after 9:00 p.m. are examples of changes that help reduce peak power demand. More complex measures include automated equipment that analyzes weather and market prices and adjusts consumption accordingly.

- **Wind generators**. Wind power is now priced competitively with other forms of energy production and has few environmental problems. Additionally, it provides insurance against unstable energy prices.

- **Fuel switching**. Burning natural gas to create electricity to heat an all-electric home is more expensive than heating the same home with natural gas. Where it makes sense, fuel switching would further alleviate pressure on the electric energy system.

- **Bonneville Power Administration (BPA)**. As the federal agency that sells power from federal Columbia and Snake river dams and is responsible for funding salmon recovery measures, BPA must take the lead in implementing energy measures that take pressure off the rivers and help restore salmon. As a first step, BPA can
    - Acquire 1,000 megawatts of peak reduction over the next 10 years by encouraging changes in patterns of energy consumption, using price mechanisms and supporting efficiency improvements among other methods
    - Fund 100 megawatts of distributed generation, such as gas-fired units and solar voltaic cells, as pilot projects over the next two years
    - Acquire 1,000 megawatts of reserves, such as wind power or gas-fired generation, to safeguard fish operations

Conclusion

The CRITFC member tribes are poised to implement this vision. The Confederated Tribes of the Warm Spring owns 250 MW of hydroelectric generation and is considering additional energy resource development. The Confederated Tribes of the Umatilla Indian Reservation and the Yakama Nation are exploring opportunities for new generation facilities on tribal lands. Major federal and private transmission lines and natural gas pipelines cross reservation properties under tribal rights of way agreements. Moreover, tribal governments are sharing their energy vision with other sovereign governments in the region and in Washington, D.C. and explaining how this vision meets the joint goals of Indian Country and its neighbors. The four Columbia River tribes are ready to become important partners in developing the responsible and affordable regional power system that is described in this report.

ACRONYMS AND ABBREVIATIONS

aMW	Average Megawatts
BEF	Bonneville Environmental Foundation
BPA	Bonneville Power Administration
CERT	Council of Energy Resource Tribes
CO_2	Carbon Dioxide
CRITFC	Columbia River Inter-Tribal Fish Commission
DG	Distributed Generation
DSI	Direct Service Industries
EPA	U.S. Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
FCRPS	Federal Columbia River Power System
GENESYS	Generation Evaluation System (see Glossary)
ISO	Independent System Operator
kWh	Kilowatt Hour
MWe	Megawatt of Energy
MWh	Megawatt Hour
NMFS	National Marine Fisheries Service, also now known as NOAA Fisheries
NRDC	Natural Resource Defense Council
NOAA	National Oceanic Atmospheric Administration
NOPR	Notice of Proposed Rulemaking
NWPCC	Northwest Power and Conservation Council
RTO	Regional Transmission Organization
SO_2	Sulfur Dioxide
T&D	Transmission and Distribution

1. BACKGROUND

The Nez Perce Tribe, the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Warm Springs Reservation of Oregon, and the Confederated Tribes and Bands of the Yakama Nation each secured, by treaty, rights to take fish that pass their usual and accustomed fishing places. Numerous federal court decisions have affirmed these rights.[1] The four tribes formed the Columbia River Inter-Tribal Fish Commission (CRITFC) in 1977 as their fisheries coordination service. The governing body of CRITFC is composed of the four tribes' fish and wildlife committees.

The Columbia was once the world's largest salmon producing river, sustaining the lives of Indian people for countless generations. Then, the river was developed and operated primarily for power for more than a half century, reducing salmon and other migratory fish stocks to the point where many are at the brink of extinction. Now the river supports the world's largest hydroelectric system and the salmon dependent cultures and economies of Columbia River treaty tribes have been seriously diminished as a result.

For a variety of natural and human-induced conditions, the Northwest frequently faces power crises despite having "tamed" the river for hydropower and other industrial uses. When this occurs, concerns about Columbia River salmon are set aside until the crisis passes. Arguments are made that the region or the federal government cannot let people do without or pay higher costs for electricity, and businesses must not suffer losses or fail. However, the authors of this report argue that planning now can avert future crises and provide both an affordable and reliable energy system and harvestable runs of salmon that support both commercial and tribal harvests.

If decision-makers do not develop a strategy to protect the environment by creating a robust energy system, the Northwest will continue to be at risk as it was when the unplanned response to the 2000-2001 energy crisis left the tribes' aquatic resources vulnerable to emergency power system operations. Appropriate planning of regional electric energy resources can provide a robust system able to withstand most unknown future events <u>and</u> take energy policy and management off the backs of the salmon.

This report highlights critical concerns with the existing electric energy system in the Northwest and defines a systematic approach to address these concerns. After establishing this context, it discusses the unique position of the tribes in terms of their own energy needs and their ability to contribute to regional solutions. This discussion reflects observations of the Council of Energy Resource Tribes, which coordinates with Indian tribes across the United States in addressing tribal energy needs.

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[1] E.g. Sohappy v. Smith, 302 F.Supp. 899 (D.Or. 1969), aff'd, United States v. Oregon, 529 F.2d 570 (9th Cir. 1976); Washington v. Washington State Commercial Passenger Fishing Vessel Ass'n, 443 U.S. 658 (1979); United States v. Winans, 198 U.S. 371 (1905); Confederated Tribes of the Umatilla Indian Reservation v. Alexander, 440 F.Supp. 553 (D.Or. 1977).

The tribes' energy vision includes alternatives, including a strong reliance on natural-gas fired resources, that will take pressure off the river, benefit fish and wildlife, stabilize and lower long-term rates, and generally leave the region's resource portfolio in a much safer and healthier position for ratepayers and the environment. The tribes envision a resource base better able to withstand surprises. Additionally, because the tribal vision decreases dependence on federal hydroelectric power, the region may encounter less pressure from political forces outside the region that want to acquire the output of federal dams.

This energy vision describes a set of resources that can be developed to meet future needs in a wise and economic manner while lessening demands on the Columbia River hydroelectric system. It also identifies how to free up the funds required to make these important changes.

Historically, utilities across the country have built resources that were perceived to be the cheapest at the time decisions were made. This has resulted in a lack of diversification and the risks associated with such an outcome. There has been an ongoing cycle of building only the "darling" resource of the moment, only to find the advantages do not last. For many years, the United States relied predominantly on coal plants before environmental problems, including concerns with global warming, siting of transmission lines, and long-haul trains halted their continued development. The nation then focused on nuclear generation. But the long construction lead-time, cost overruns, advances in natural gas-fired technology, and environmental risks stopped nuclear development. By the time regional leaders acknowledged that costs were exorbitant, the Northwest had incurred billions of dollars of debt developing nuclear power with little electricity generated to show for the vast expenditures.

Advances in gas-fired technology and the availability of cheap natural gas have made nuclear plants economically obsolete,[2] and for more than a decade gas-fired plants have been the resource of choice. But part of today's energy crisis is caused by the recent rapid rise in natural gas prices.[3]

While other resources, such as wind, are a good hedge against high natural gas prices, environmental damages, and global warming concerns, they have been underutilized because they cost a little more. Furthermore, resources and strategies that do not rely on transmission and distribution, such as distributed generation, load management, and pricing mechanisms, have been overlooked.

[2] Unfortunately, owing to the long lead-times required to plan and construct nuclear plants, economic obsolescence of nuclear plants occurred in some cases before construction was completed.
[3] This true today much more so than when we first drafted this report. Prices are now as much as five times what they were just one year ago, reflecting the volatility that the region could continue to see in the price of natural gas.

Virtually none of the utility executives who have presided over this development of energy resources would take such an approach with their own investment portfolios. They might take some risk by investing in growth stocks, but they would hedge that risk with lower yielding but safer investments such as Treasury bills and state and municipal bonds. They would manage their investment risks, in part, by attempting to protect against unforeseen events. Unfortunately, the electric system has not been developed in a similar fashion. The tribes believe that it is time to do so.

The regional hydropower system is currently managed and maintained to serve peak loads. To meet peak loads, power managers have overbuilt a costly regional transmission and distribution system.[4] Furthermore, as will be described, serving peak loads continue to have disastrous affects on the river's salmon stocks. The tribes' energy vision is to protect salmon while offering far less costly ways to serve peak loads. In fact, making the recommended changes will free capital earmarked for transmission and distribution investment and fish and wildlife mitigation at dams and hatcheries. This freed capital can be used to achieve our vision for the electricity system. These changes will help us to make up for the hydropower generation lost when the Lower Snake dams are removed and the Columbia River system is returned to its more normative, or natural, state.

As we will explain, if the region were successful in achieving a more normative river flow, this would save additional and considerable capital that has been budgeted to continue mitigation activities. Such savings could also be invested in achieving the energy vision articulated in this report.

1.1 The Columbia River Basin Hydropower System

The Columbia River Basin, which includes parts of Washington, Oregon, Idaho, Montana, Wyoming, Utah, Nevada and British Columbia, is the fourth largest river in North America and the dominant water system in the Pacific Northwest. Average annual runoff at its river mouth is about 198 million acre-feet. The Columbia River is a snow-charged river that fluctuates seasonally in volume. The highest volumes are between April and September. The lowest are from December through February. From its source in British Columbia at 2,650 feet above sea level, the river falls an average of more than 2 feet per mile before reaching the ocean.

The Columbia and its largest tributary, the Snake River, are the backbone of the region's electricity system and are an important part of the West Coast energy system. About 70% of the Northwest's installed generating capacity comes from hydroelectric dams. Of that, about 95 % comes from Columbia River Basin dams.

[4] Little regional investment has been made in transmission in the region over the last couple of decades. This fact indicates that: 1) the transmission system was very overbuilt when it was originally constructed, and 2) investment is probably needed soon. That new investment can be delayed indefinitely if the region can capture the resources discussed in this report.

There are 55 major dams in the Columbia River Basin. The Federal Columbia River Power System (FCRPS) includes 29 of those dams and the region's electrical transmission system. The other 26 dams are nonfederal dams, a mix of privately and publicly owned. Of the 29 federal dams, the U.S. Army Corps of Engineers owns and operates 21 dams, while the Bureau of Reclamation owns and operates 8 dams. The BPA, the Corps of Engineers and the Bureau of Reclamation coordinate operations of the FCRPS.

In good water years, the Columbia River Basin hydroelectric system can produce over 20,000 average megawatts (aMW) of electricity, and in poor water years, as little as 12,000 aMW. Under normal precipitation, the Northwest's hydrosystem can provide 16,000 aMW of electricity. However, precipitation is not the only variable in the actual amount of electricity generated by the hydrosystem. Generation also fluctuates depending on needs of the power system, which are often driven by weather. During the summer the Northwest exports electricity to California; during the winter it imports power from California. The hydrosystem is responsive to seasonal demand and market conditions. In June 2000 the Columbia hydrosystem produced 6,000 more aMW than it had during the previous June, despite the fact that 1999 and 2000 were similar water years. The additional drawdown of basin storage reservoirs was driven by power needs caused by high temperatures and low energy supplies in California.

The regional energy system includes about 47,000 megawatts (MWe) of generating capacity. The hydropower contribution to regional generating capacity is about 33,000 MWe. Most of the region's additional capacity comes from coal- and natural gas-fired plants.

The BPA owns and operates more than three-fourths of the high-voltage transmission grid in the Pacific Northwest. The total transmission system in circuit miles is 15,328. BPA markets energy and transmission to customers including public utilities and cooperatives, investor-owned utilities and a few large industries such as aluminum companies. BPA's power and transmission rates are designed to recover the cost of producing and transmitting electricity, interest on capital investment and amortization, and some irrigation costs of federal projects.[5]

Power generated from the Columbia and Snake rivers has been so cheap to electricity users and such a dominant part of the power system that it has been used without restraint to provide energy, capacity, system stability, and ancillary services. However, the low dollar cost of hydropower does not include the huge economic and cultural costs incurred by tribes who based their living on the fish, water quality, and other resources the rivers provided for tens of thousands of years. The costs to tribes represent a classic case of

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[5] Sources for information on regional energy include Northwest Power Planning Council, *Existing Generating Projects*, Oct. 15, 2002, http://www.nwcouncil.org/energy/powersupply and *Pocket Guide: The Northwest Power Planning Council's Fast facts about the Columbia River Basin*, 2002, http://www.nwcouncil.org/pocketguide; and Bonneville Power Administration, BPA Facts at http://www.bpa.gov/Corporate/KC/home/facts.

"negative externalities." Because these non-market resources have not been disciplined by prices, they have been abused as if their cost were zero and their availability limitless. They are not. Using them in such a way is simply bad economics. More importantly it does not recognize the obligations that the United States carries with regard to the tribes.

By habit or failure to analyze and take appropriate action, the region has continued to use the river to supply energy services in a manner that harms fish and water quality even though energy can be supplied more cheaply through other technologies and operational strategies that are also safer for fish and other aquatic resources.

1.2. Columbia Basin Salmon Resources

Anadromous species of the Columbia River Basin are chinook (*Oncorhynchus tshawytscha*), coho (*O. kisutch*), sockeye (*O. nerka*), steelhead and rainbow trout (*O. mykiss*), chum (*O. keta*), sea-run cutthroat (*O. clarki clarki*), pink (*O. gorbuscha*) lamprey (*Lampetra tridentate*), and white sturgeon (*Acipenser transmontanus*). Historic annual adult runs of salmon and steelhead have been estimated as between 11 and 16 million fish. Over the past decade they have ranged between 500,000 and about one million. Dams block more than 55% of the anadromous fish habitat in the Columbia Basin.[6] During the last century, Columbia River Basin salmon runs, once the largest in the world, have declined by 80-90%. Of the remaining salmon stocks, more than half are produced in hatcheries.

Hundreds of millions of dollars have been—and will continue to be—expended on technological "fixes" to compensate for the losses to fish and wildlife attributed to dams. However "[d]espite decades of effort, the present condition of most populations in the Columbia River Basin demonstrates the failure of technological methods to substitute for lost ecosystem functions. Normative, or more natural conditions, which provide critical habitat functions in the natural-cultural landscape, must be restored, not mitigated."[7]

To date, normative conditions have not been restored sufficiently to turn around the dramatic Columbia Basin salmon decline of recent decades. Thirty-eight anadromous fish populations throughout the basin are at less than half their former abundance and show statistically significant declining trends over a 15-year period, despite unusually good ocean conditions and adult returns over the last few years. Of these, 66% are found in the Snake River, 18% in the mid-Columbia area, and 16% in the lower Columbia above Bonneville Dam. Eighty-seven percent of the declining populations are spring chinook and 13% are fall chinook. The loss of these stocks has decimated the tribal and commercial fisheries of the Northwest. Many other populations also exhibit recent declining trends in abundance.

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6 Northwest Power Planning Council (NWPPC), *Compilation of Information on Salmon and Steelhead Losses in the Columbia River Basin*, NWPPC, 1986.
7 Independent Scientific Group, *Return to the River,* NWPPC, 1998.

The Columbia River Basin is one of the most dammed river systems in the world. Since the construction of the first dams on the Willamette and Spokane rivers in the late 1800s, a total of 136 dams for hydropower and other purposes have been built in the basin. The impounded portions of these rivers have undergone significant environmental change from their free-flowing ecology to biological and physical conditions associated with standing bodies of water. The migrations of juvenile salmon through the impounded mainstem sections of the Columbia and Snake are significantly affected as a result of the dams. For instance, juvenile salmon originating in the Lochsa River in Nez Perce Tribe's ceded area in central Idaho must traverse eight hydroelectric dams and approximately 300 miles of impounded river before reaching the Pacific Ocean.

Estimates of cumulative mortality from the effects of hydropower development and operation may be as high as 98% in the juvenile life stage.[8] Reductions in smolt-to-adult survival have coincided with increased numbers of dams, turbines, increased storage capacity, decreased spill, and decreased flow. Attempts to isolate and quantify the magnitude of mortality resulting from various components of the hydrosystem are difficult because the different sources of salmon mortality do not operate independently from one another. Nonetheless, numerous studies have addressed juvenile passage through the hydroelectric system. These studies have examined water flow, turbines, water quality, spill, transportation, and structural barriers. Additional studies are underway that attempt to distinguish hydrosystem impacts at other stages of salmon life history, with some studies indicating that juvenile salmon can suffer from 37-88% delayed mortality from passage through the hydrosystem.[9]

Operation of the Columbia River system primarily for power has caused the extinction of some fish stocks. The tribes have worked to change the flow of the river back to a fish-healthy, natural flow regime and have focused on strategies to allow passage of smolts and returning adults through the maze of man-made barriers that make up the hydropower system that threatens fish survival. These changes must be made to ensure that endangered and declining species continue to exist and rebuild to harvestable levels. To do this, modifications will need to be made not only to the Columbia and Snake River hydroelectric system but also to the entire regional power system, which is in fact the scope of this tribal energy vision.

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[8] CRITFC, *Wy-Kan-Ush-Mi Wa Kish Wit (Spirit of the Salmon): The Columbia River Anadromous Fish Plan of the Nez Perce, Umatilla, Warm Springs and Yakama Tribes*, Vol. 1, CRITFC, 1996. Also, NMFS reported in the 1995 FCRPS Biological Opinion that federal dams kill up to 99% of certain migrating juveniles.

[9] P. Budy, G.P. Thiede, N.Bouwes, C.Petrosky and H.Schaller. 2002. *Evidence linking delayed mortality of Snake River salmon to their earlier hydrosystem experience. North American Journal of Fisheries Management 22:35-51.*

1.3 Tribal Roles in the Northwest's Energy Future

1.3.1 The Columbia River Treaty Tribes

In 1855, the United States entered into treaties with the Nez Perce Tribe, the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Warm Springs Reservation of Oregon, and the Confederated Tribes and Bands of the Yakama Nation to ensure the mutual peace and security of our peoples.[10] For the four tribes' cession of nearly 40 millions of acres, the United States promised to protect and honor the rights and resources the tribes reserved to themselves under those treaties. Those resources, among them our most treasured resource, the salmon, are being destroyed largely by hydroelectric projects on the Columbia and Snake Rivers.

The four Columbia River treaty tribes have suffered from the effect of hydropower operations for many decades. Our lands have been diminished by hydropower. Our cultural resources have been diminished by hydropower. Our fisheries have been diminished by hydropower. Our very way of life has been diminished by hydropower.

Other Columbia Basin tribes have suffered economic and cultural losses because of environmental destruction and the damage to fish and wildlife caused by hydroelectric development. These tribes—the Nez Perce Tribe, the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Warm Springs Reservation of Oregon, and the Confederated Tribes and Bands of the Yakama Indian Nation—also want their natural resources restored or mitigated.

However, the Nez Perce, Umatilla, Warm Springs, and Yakama are the only tribes in the Columbia Basin to have reserved rights to anadromous fish in 1855 treaties with the United States. The four Columbia River treaty tribes secured the United States' commitment to protect their right to take fish at all usual and accustomed fishing places. This fishing right means more than the right of Indians to hang a net in an empty river. The Columbia River treaty tribes have adopted a salmon recovery plan entitled *Wy-Kan-Ush-Mi Wa-Kish-Wit* (*Spirit of the Salmon),* that comprehensively describes the actions that must be taken to restore fish and wildlife and make progress toward meeting the tribes' reserved treaty rights.[11]

The people of these four tribes have always shared a common understanding that their very existence depends on the respectful enjoyment of the Columbia River Basin's vast

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[10]Treaty with the Yakama Tribe, June 9, 1855, 12 Stat. 951; Treaty with the Tribes of Middle Oregon, June 25, 1855, 12 Stat. 963; Treaty with the Umatilla Tribe, June 9, 1855, 12 Stat. 945; Treaty with the Nez Perce Tribe, June 11, 1855, 12 Stat. 957.

[11] *Wy-Kan-Ush-Mi Wa-Kish-Wit (Spirit of the Salmon): The Columbia River Anadromous Fish Plan of the Nez Perce, Umatilla, Warm Springs and Yakama Tribes* can be viewed or downloaded at www.critfc.org.

land and water resources. Indeed, their very souls and spirits were and are inextricably tied to the natural world and its myriad inhabitants. And none were more important than the teeming millions of anadromous fish enriching the basin's rivers and streams.

The Nez Perce homeland once consisted of 13 million acres in what are now Idaho, Oregon, and Washington. The original land base included significant portions of six different drainages. Today, the reservation consists of 750,000 acres, of which the tribe owns 13%. The tribes' enrolled membership is about 3300.

When the leaders of the Walla Walla, Cayuse, and Umatilla peoples signed a treaty with the United States in 1855, they ceded 6.4 million acres of homeland in what is now northeastern Oregon and southeastern Washington. Today the population of the three-tribe confederation numbers 2300. Of the 172,000-acre reservation, almost half of which is owned by non-Indians, includes significant portions of the Umatilla River watershed.

A 640,000-acre reservation in north central Oregon is home to a confederation of three tribes: the Warm Springs, Wasco, and Paiute tribes. In their 1855 treaty, 10 million acres of aboriginal lands were ceded to the United States. Today, the enrolled membership of all three tribes totals nearly 4000. Most members reside on the reservation.

The Yakama Indian Reservation measures 1.2 million acres today. In the 1855 treaty with the Yakama, 14 bands and tribes ceded 11.5 million acres to the United States. The reservation includes portions of the Klickitat and Yakima Rivers. Enrolled Yakama tribal members number about 9500.

1.3.2 The Tribes' Salmon Restoration Plan

As a blue print for restoring Columbia River salmon and Indian fisheries, the CRITFC member tribes published *Wy-Kan-Ush-Mi Wa-Kish-Wit (Spirit of the Salmon)* in 1996. A cornerstone of the plan is the restoration of a normative river ecosystem capable of supporting productive physical and biological processes that affect anadromous fish species.

The plan covers the following fish that spawn in areas above Bonneville Dam: chinook (*Oncorhynchus tshawytscha*), coho (*O. kisutch*), sockeye (*O. nerka*), steelhead and rainbow trout (*O. mykiss*), chum (*O. keta*), lamprey (*Lampetra tridentate*), and white sturgeon (*Acipenser transmontanus*). The geographic scope of the plan extends to the Columbia River Basin and Pacific Ocean regions where these fish migrate and wherever activities occur that directly affect them.

The objectives of the *Spirit of the Salmon* plan are to halt the decline of salmon, lamprey, and sturgeon populations above Bonneville Dam within seven years. To rebuild salmon populations to annual run sizes of 4 million above Bonneville Dam within 25 years in a manner that supports tribal ceremonial, subsistence, and commercial harvests. To increase lamprey and sturgeon to naturally sustaining levels within 25 years in a manner that supports tribal harvests. To achieve these objectives, the plan emphasizes strategies and principles that rely on natural production and healthy river systems. Simply stated, the plan's purpose is to put fish back in the rivers and protect the watersheds where fish live.

The first volume of the two-volume plan sets out 13 scientific hypotheses and the recommended actions associated with each, along with 10 institutional recommendations. The second volume contains return goals for each subbasin and the watershed restoration actions that must be undertaken to achieve them.

The technical recommendations, which are aimed at increasing survival at each stage of the salmon's life cycle, are presented as scientific hypotheses that summarize various restoration problems. Organized by salmon life cycle stages, each hypothesis proposes near- and long-term actions, identifies expected results, and names the institutional and decisional processes required to carry out the recommended actions.

The plan's technical recommendations cover hydro-operations on the mainstem Columbia and Snake rivers; habitat protection and rehabilitation in the basin above Bonneville Dam, in the Columbia estuary, and in the Pacific ocean; fish production and hatchery reforms; and in-river and ocean harvests.

The recommended actions are designed to be carried out using an adaptive management strategy: Monitor and evaluate the actions taken and change the actions, if indicated. The estimated average annual cost of salmon restoration under the 25-year plan is estimated to be about a half of 1% of the region's annual personal income or about $266 million, a figure that includes the cost of breaching the four lower Snake River dams.

Most recommendations described in the Spirit of the Salmon extend beyond the means and control of the tribes changes in hydroelectric system operations and ocean fishing regulations, for example. These will require collaboration by a multitude of public and private entities. Depending on the issue, as many as five states, over 25 tribes, and two countries are involved. While this cumbersome political process has been engaged, progress is usually slow and the outcomes uncertain.

The tribes however are not waiting. While participating in regional and basin-wide discussions and decisions, they are also pushing forward on their own and within their local communities. They are accomplishing what is possible, protecting what remains, and steadily building tribal capacity for the assumption of greater responsibility and control over the management of Columbia River salmon.

Current achievements range from obliterating miles of unstable streamside roads, putting hundreds of thousands more young salmon back into their natural habitat, to securing an international agreement on chinook management.

Nez Perce crews have obliterated about 60 miles of unstable roads in the Lochsa and Lolo drainages of the Clearwater River subbasin. Unstable roads cause erosion that brings sediment pollution into streams. In the Yakima, Clearwater, and other subbasins, the tribes have added miles of fencing to prevent livestock from destroying streambanks and other riparian areas. On Satus and Toppenish creeks, the Yakama tribe completed road relocations, added culverts at stream crossings, replanted vegetation, and built fences. With help from BPA's fish and wildlife mitigation funds, the Warm Springs tribe purchased the 30,000-acre Pine Creek Ranch to further the tribes' watershed restoration work in the John Day River subbasin. These are but a few examples of tribal habitat work.

As thousands of stream miles in tribal ceded areas are restored, tribal supplementation facilities are slowly returning salmon to rehabilitated river systems. The four tribes now operate hatchery supplementation facilities, including the Cle Elum Supplementation and Research Facility (Yakima River); the Parkdale Fish Facility (Hood River); the Umatilla Hatchery Complex (Umatilla River); and the Nez Perce Tribal Hatchery (Snake and Clearwater rivers). Supplementation hatcheries rear and release salmon to return to the wild to spawn instead of to a hatchery. The tribes have or are completing numerous juvenile acclimation and release facilities on these and other rivers and smaller tributaries. Acclimation and release facilities allow young salmon to adjust to natural stream conditions and imprint the location in their sensory memories before they start their downstream journey to the ocean. These salmon will return as adults to spawn naturally in the stream or river where they were released.

Some of these efforts, along with a scaled-down Canadian fishery off Vancouver Island and several good waters between 1996 and 1998, are already making a difference.

Since 1999, returns of the Columbia's upriver fall chinook have remained strong. Snake River fall chinook, which are listed under the Endangered Species Act, returned in record numbers in 2002. Since the last of four dams were built on the lower Snake River, the counts have been less have 1000; in 2002, over 10,000 fall chinook were counted at Lower Granite Dam. The high numbers of fall chinook are partly attributable to the Nez Perce Tribe's supplementation program, which has outplanted millions of fall chinook juveniles throughout the upper Snake River basin and on the mainstem Snake River since 1996.

Returns of Columbia upriver salmon—spring chinook, summer chinook, sockeye, coho, and steelhead—all were particularly robust in 2002 and 2003, primarily due to unusually good ocean conditions. For example, the 145,000 summer chinook run was the best in at least three decades. While forecasts for salmon returns in coming years may not be as great, the accumulate effects of responsible human stewardship for the river's resources, the tribes believe, have the potential for sustaining salmon recovery.

1.3.3 The Energy Interests of the Tribes

Like many tribes across the country, the four Columbia River tribes are interested in energy for multiple reasons: The tribes would like to meet the electricity needs of their members; develop energy resources to create new economic opportunities in their communities; and see energy resources used in ways that are compatible with their environmental, cultural and spiritual values.

Because of population growth, tribes —like the rest of the nation—are experiencing increased demand for electricity. Unlike other U.S. citizens, however, tribal members spend more of their income on electricity and have the highest percentage of homes without electricity. (According to the Council of Energy Resource Tribes, one-in-seven households on Indian lands lacks electricity.[12])

The tribes also view energy as an important avenue for economic development. With reservation incomes far lower and unemployment far higher than the national average, the need is great. Tribal communities are usually served by non-tribal utilities that own both generation and transmission. Most tribal governments have little control over the service and operations of the utilities. Even though federal and private electric power transmission lines and natural gas pipelines cross reservation properties under tribal rights of way agreements, most revenues produced by the utilities are exported from the reservation. In addition, poor building construction and inefficient appliances waste much of the energy consumed in Indian communities.

The confluence of national and tribal needs, coupled with new energy markets and technical advances, creates a potential for economic development on Indian lands that can provide broad benefits to tribes and others.

In fact, 10% of the nation's energy resources are on Indian lands, which combined is an area the size of Texas. [13] Tribes can enhance the value of these resources by using sovereign nation status to control development. There is a resonant relationship between tribal control and tribal economic growth, with progress on one front enabling progress on the other. By controlling development, tribes can set goals and direct efforts that support local needs.

Moreover, the development of indigenous resources can help meet the demand for additional energy supply in major load centers, such as California and the Pacific Northwest. In these areas energy supplies are constrained, reliability is compromised, prices are highly escalated from the norm of previous years, and tribal natural resources, such as salmon, are being unnecessarily impacted.

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[12] "Electricity Sufficiency on Tribal Lands: Opportunities, Barriers, and Policy Recommendations," 2001.
[13] See above note.

Tribes can reverse historic patterns of remote decision-making and loss of cultural integrity by using their federally mandated and sovereign authority to build, plan and market energy development, consistent with their own natural resources management needs. Tribes and their public and private partners can enjoy certain economic advantages from developing resources on tribally owned lands, including lower financing costs and state tax savings.

Three of the CRITFC member tribes are contemplating development of new generation facilities on tribal lands. The Confederated Tribes of the Umatilla Indian Reservation and several other partners, including the Eugene Water and Electric Board, are planning to site and build a 1,000 megawatts (MW) base-loaded gas-fired plant in eastern Oregon. The plant will be strategically placed within the region's transmission grid. The Yakama Nation has formed its own utility, Yakama Power, and is considering short-term and long-term energy resource acquisitions. Warm Springs Power Enterprises, a tribally chartered business enterprise of the Confederated Tribes of the Warm Springs, own hydroelectric generating facilities that produce 250 MW and is considering additional energy resource development on or near the Warm Springs Reservation.

While member tribes are these exploring opportunities, barriers to tribal energy development ranging from financial to legal and regulatory are still numerous. To address these issues, the four tribes have joined other tribes across the country to draft recommendations for Congressional legislation on energy reform. Tribal proposals include the establishment of an Office of Indian Energy Policy and Programs at the U.S. Department of Energy; requirements that all utilities provide tribal entities with interconnection and open access to transmission systems; authorization for the Department of Energy to expand and upgrade federal transmission systems so that new generation on tribal lands can interconnect and deliver electricity; funding for the U.S. Environmental Protection Agency (EPA) to support the development of tribal environmental regulations needed to manage electric generation facilities; and tax credits for the development of renewable energy on Indian lands and for buyers who purchase energy produced on Indian lands.

When tribes take charge, a new class of projects can be undertaken on Indian lands that will directly benefit tribal members, the broader local community, fish and wildlife, and environmental quality.

2. ANALYSIS OF COLUMBIA BASIN SALMON AND NORTHWEST ENERGY SYSTEM MEASURES

2.1 Current Energy Management and Fish

The Columbia River is an integral part of the region's and West Coast's power system. Power generated from these rivers has been so cheap to electricity users and such a dominant part of the power system that it has been used without restraint to provide energy, capacity, ancillary services, system stability, and more. However, the low dollar cost of hydropower does not include the huge economic, cultural, and environmental costs that have been incurred by tribes who based their living on the resources, including fish, wildlife, and water quality, the rivers provided for tens of thousands of years. The costs to tribes represent a classic case of "negative externalities." Because these non-market resources have not been disciplined by prices, they have been abused as if their cost were zero and their availability limitless. They are not. Using them in such a way is simply bad economics. More importantly it does not recognize the obligations that the United States carries with regard to the tribes.

By habit or failure to analyze and take appropriate action, the region has continued to use the river to supply energy services in a manner that harms fish, wildlife, and water quality. Energy can be supplied more cheaply through other technologies and operational strategies. As an example, this report will show that using the river to supply peaking power dramatically harms fish and is more costly to ratepayers than other options.

Hydroelectric systems are valued in large part because of their ability to respond to immediate demand; there is very little lead-time needed to call on power production from dams as there is from other generation sources. As a result of ramping the Columbia and Snake rivers up and down to follow the "peakiness" of Northwest electric loads, huge impacts are incurred by fish and wildlife populations.

The Hanford Reach of the Columbia River contains the only remaining healthy run of salmon in the Columbia Basin largely because of it is not impounded by a dam.. However, as a result of seven federal and FERC licensed dams ending at the Priest Rapids Hydroelectric Project above the Reach and the McNary Dam below the Reach, flows through the Reach are altered radically to serve peak load. During spawning and rearing periods in 2001, more than 2.1 million salmon fry were killed when they were stranded in pools as flows were dropped to save water for later peaks.

In the Snake River during the summer of 2001, in order to meet peak load, the federal hydro operators, over tribal and fishery manager objections, decided to operate the river at zero nighttime during critical adult fall chinook and steelhead runs. Most of the juvenile fall chinook were taken out of the river and transported in barges or trucks downriver, a decision that could have a disastrous outcome on adult returns for that year-class. Because there was no flow, adults struggled to find direction to their natal streams. As a result of these and other actions, adult returns to date are indicating that this year-class of salmon will be severely diminished, significantly setting back recovery.

2.2 Salmon Friendly Operational Regimes: Taking Pressure Off the Columbia River

"Despite decades of effort, the present condition of most [fish] populations in the Columbia River Basin demonstrates the failure of technological methods to substitute for lost ecosystem functions. Normative conditions, which provide critical habitat functions in the natural-cultural landscape, must be restored, not mitigated."[14]

This section forms an important part of the analysis for the tribal energy vision. In it, a comparison is made between the river's current energy production and energy production under salmon friendly operations. The tribal vision recommends three major changes to the Columbia's current hydropower operations. First, we compare power output and rates under current river operations and under CRITFC's preferred river operations (Table 1). Current river operations are prescribed as a major part of the 2000 Biological Opinion (BiOp), a National Marine Fisheries Service (NMFS) salmon protection plan required under the Endangered Species Act. The tribes believe the BiOp is inadequate and have recommended different flows and spills in a plan that is better for salmon and closer to normative river conditions.

The two different flow and spill plans result in different amounts of power production. Table 1 displays the difference between the plans in terms of month-by-month power production and rates per megawatt hour (MWh) under heavy and light load hours (HLH and LLH). [15] As is evident in the table, CRITFC-recommended operations increase power production in September, October, and June, while decreasing production in all other months.

[14] Independent Scientific Group *Return to the River,* Northwest Power Planning Council, 1998.
[15] From John Fazio, NWPPC, and Kyle Martin, CRITFC, based on GENESYS runs in 2000 and 2001. See http://www.nwcouncil.org/energy/genesys/about.

Table 1. Power and rate differences between BiOp Plan and CRITFC-preferred river plan for flow and spill

	2000 BiOp MWh	CRITFC MWh	BPA Base ($/MWh)		Adjusted Rate ($/MWh)		Rate Differential ($/MWh)	
			HLH	LLH	HLH	LLH	HLH	LLH
Sept	6,397,027	6,506,208	22.94	18.79	22.55	18.47	-0.39	-0.32
Oct	7,695,296	7,893,022	16.27	11.76	15.85	11.46	-0.42	-0.30
Nov	8,734,205	8,109,662	22.00	17.71	23.57	18.95	1.57	1.27
Dec	9,587,988	9,025,494	22.65	17.37	23.98	18.39	1.33	1.02
Jan	11,074,574	8,440,472	20.12	14.14	24.91	17.50	4.79	3.36
Feb	9,102,119	7,964,369	18.58	13.14	20.90	14.78	2.32	1.64
Mar	9,549,791	9,444,559	16.83	11.42	17.02	11.55	0.19	0.13
Apr 1	4,884,041	4,354,574	13.18	8.82	14.61	9.78	1.43	0.96
Apr 2	5,177,851	4,829,904	13.18	8.82	14.07	9.41	0.89	0.59
May	12,599,298	12,522,160	13.13	7.25	13.21	7.29	0.08	0.04
Jun	12,589,344	12,818,347	16.45	8.80	16.15	8.64	-0.30	-0.16
Jul	11,013,417	9,717,384	21.63	14.69	24.18	16.42	2.55	1.73
Aug 1	4,931,760	4,371,402	32.02	17.93	35.66	19.97	3.64	2.04
Aug 2	4,226,604	3,565,947	32.02	17.93	37.03	20.73	5.01	2.80
Total/Avg	117,563,31	109,563,50	19.31	13.05	22.30	15.07	2.99	2.02

When generation is reduced, the region must address the reductions in power supply and BPA must address revenue impacts. Table 1 shows the rate increases that would be needed to keep BPA's monthly revenues constant with the new flow regime (BPA Base - Adjusted Rate = Rate Differential).[16] The weighted average rate increase over the year would be 2.99 mills/kWh during high-load hours (HLH) and 2.02 mills/kWh during low-load hours (LLH).

Later this report identifies the resource mix that will supply the lost power and at the same time not significantly increase prices. (Because non-federal entities will likely own these resources, their costs will not necessarily flow through BPA's wholesale rates.)

The MWh reduction that would occur with the CRITFC operations regime can be determined from the bottom line (the difference between the first two columns) of Table 1. The reduction is 8.0 million MWh or 913 aMW per year.

In addition to the CRITFC operations regime for the Columbia River the tribal vision includes removal of the four Lower Snake River dams. The reduction in power from eliminating these dams is shown in Table 2. They produce about 1100 aMW. When they are removed, the region would have to replace about 1000 aMW, because of offsetting adjustments throughout the system.

Table 2. Output of Lower Snake River dams

Period	Output (MWh)
September	427,633
October	518,970
November	403,531
December	652,905
January	794,071
February	689,018
March	999,207
April 1	507,492
April 2	507,492
May	1,295,929
June	1,251,662
July	863,561
August 1	301,037
August 2	271,248
Annual Output	9,452,929 (aMW = 1,079)

[16] We assume here that BPA continues to sell the hydropower system at its costs, and other providers make up the shortfall in power, as we discuss later in this report. The costs for those resources are discussed below.

The Natural Resources Defense Council (NRDC)[17] has analyzed the costs of eliminating the four Lower Snake River dams. The goal of NRDC's report was to determine if the dams could be removed and their output replaced at a reasonable price with minimal impact on the amount of climate change gasses emitted to the atmosphere. That report found that residential electric bills would increase by less than $2 per month—a rate increase of about 2 mills/kWh—if the dams were removed and the power replaced with clean resources, mainly conservation, gas-fired resources, and wind-driven central power plants. The study assumed an average monthly residential use of 1000 kWh. With today's power prices, this estimate may be slightly different.

In summary, to replace lost power from the Snake River dams and the changed flow management of the Columbia River, the tribal plan will have to replace the equivalent of about 2000 aMW of power. To keep BPA's revenues for the hydropower system intact, BPA's preferred rate would have to increase by approximately 4.7 mills/kWh.[18] In addition, 2000 aMW of power will have to be developed to serve regional loads.

2.3 Energy System Measures to Achieve a Salmon Friendly River

Below we develop potential solutions to another related problem—the conflict between peak power production and Columbia Basin salmon. By analyzing the problems associated with serving peak loads, we find that there are not only less harmful ways to provide electricity for peak loads, but cheaper and more efficient ways that actually free capital to develop other energy resources.

2.3.1 Using the Hydropower System to Serve Hourly and Seasonal Peak Loads

The hydrosystem is used to serve peak loads because output from hydroelectric facilities can be increased and decreased instantaneously by raising and lowering river levels. Unfortunately, when the hydropower system is used in this way, conflicts with the needs of salmon often occur. River operations in 2001, discussed briefly in 2.1 Current Energy Management and Fish, provide an instructive example.

In general, when the river's water levels are drawn down to generate electricity, salmon redds may be dried out, and smolts may be stranded on riverbanks and not able to get back to the river. When water velocities are reduced, migrating juvenile and adult salmon are subject to the cumulative harmful effects of delays at critical life stages (e.g. smoltification), elevated temperatures, increased exposure to predators, disease, residualization and disorientation. With both lower river elevations and reduced water

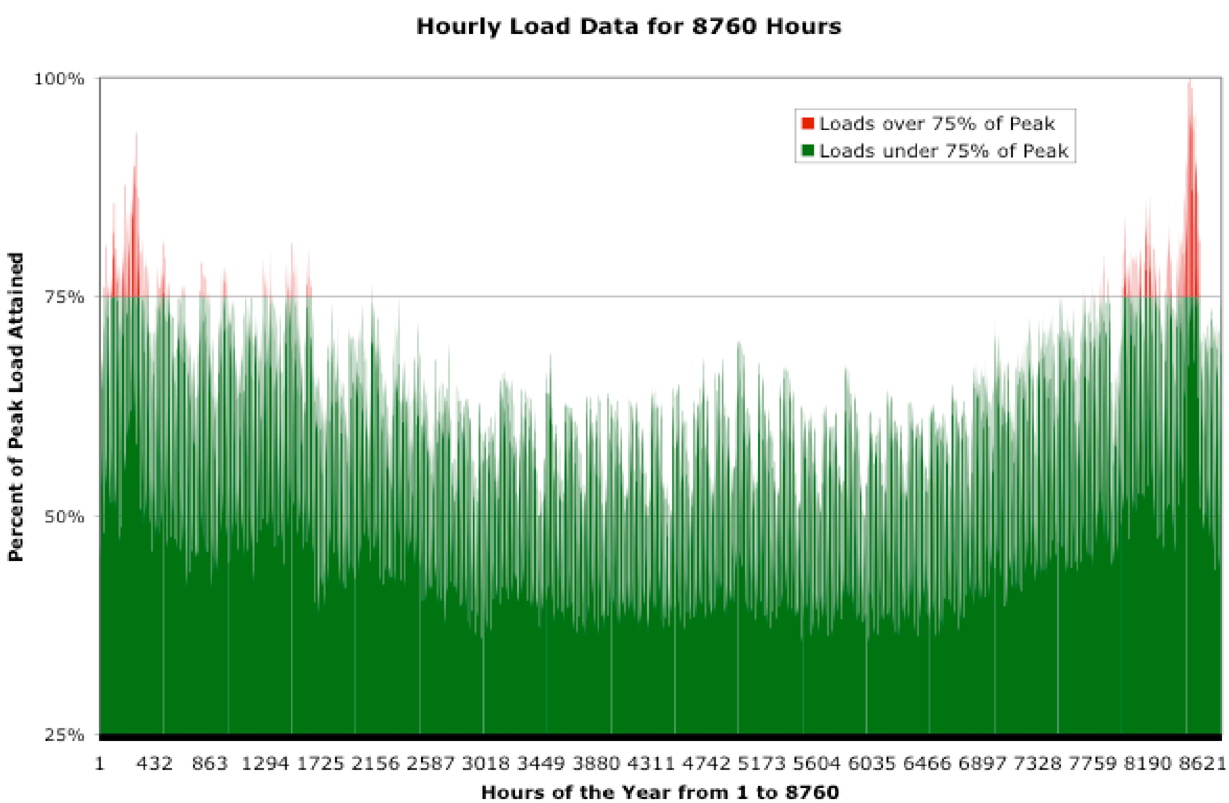
[17] Natural Resources Defense Council, "Going With The Flow: Replacing Energy From Four Snake River Dams," 2000.
[18] This estimate comes from an estimated increase of 2 (LLH) to 2.99 (HLH) mills to maintain BPA's revenue from a Columbia operating at a more normative flow regime, doubling it to account for the nearly identical loss from removing the Snake River dams, and using a 65/35 split between LLH and HLH.

velocities, the result is fewer fish and more emphasis on mitigation with its attendant costs.

This dewatering of the river (lower river elevations and subsequent slower water velocities) harms fish from approximately mid-November through mid-June with winter months being the Northwest's peak load season Additionally, the water held behind storage dams for future power generation—for summer air conditioning, for example—would, under natural conditions, be in the river aiding the swift and timely downstream migration of young salmon. These conflicts with salmon needs exist, but as we will demonstrate, they exist unnecessarily.

In the Columbia River hydropower system, as is customary in most power systems, transmission and distribution lines were built to serve the highest peak load (the maximum amount of electric energy required during certain periods of time). Peak usage occurs infrequently and for short periods of time. Yet more than 25% of all capital in place, including generation capacity, transmission, and distribution is there to serve loads that occur about 6% of the time. Figures 1 and 2 below show the infrequent occurrence of the highest peak loads.

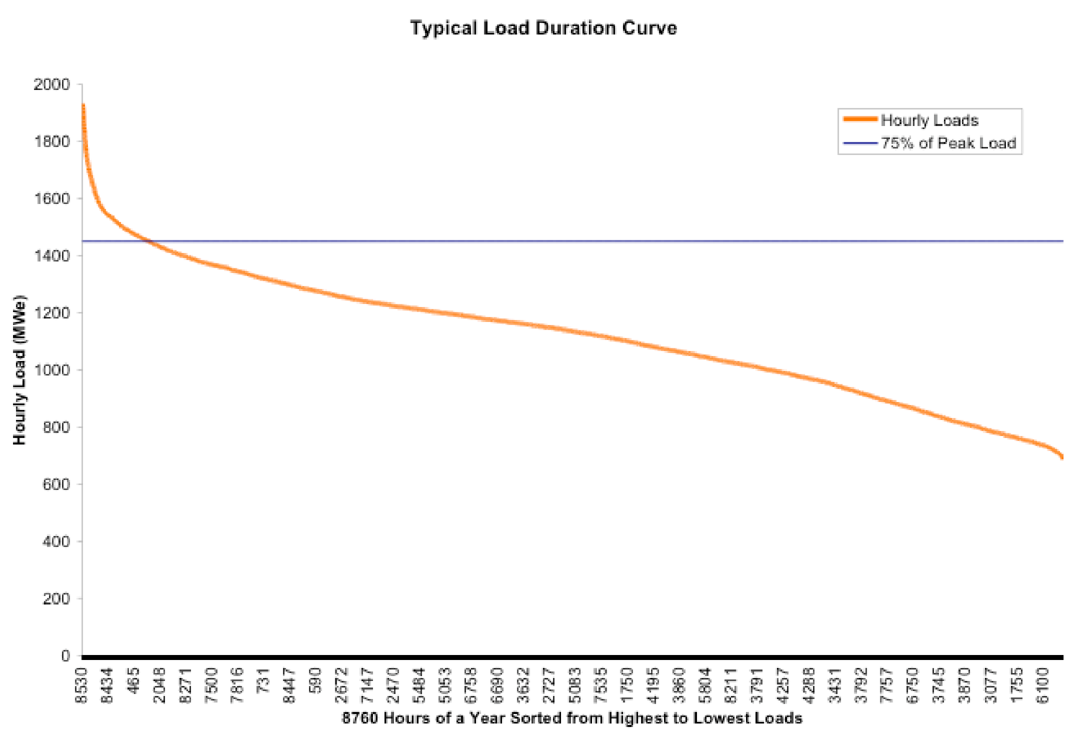
Figure 1. Hourly loads as a percentage of peak



Proponents of using the hydropower system to follow peak loads argue that it is the lowest-cost option and that the fish killed in the process is an acceptable tradeoff. However, it is a myth that using the hydropower system in this way is a low-cost way to meet peak loads. The myth has been perpetuated by average cost pricing of T&D. That is, all loads pay the same price for T&D, regardless of whether the T&D system is partially or fully loaded at time of use. Serving peak loads from any central station, distant plant (including hydropower) is expensive; it is far more expensive than other similarly reliable ways to meet peak loads.

Consider Figure 2, which contains a load duration curve for a typical northwest utility. The load duration curve is a simple structure that plots peak loads for each of the 8,760 hours in a year.[19] The loads, shown along the vertical axis, are sorted from highest to lowest-load hour; shown along the horizontal axis, the hour with the highest load is at the left of the horizontal axis and the hour with the lowest load is at the right of the horizontal axis. (Figure 1 sorts the same hourly loads over a year as a percentage of peak load attained.) An arbitrary line has been drawn horizontally at 75% of the highest peak hourly load. To serve power needs in a conventional power system, a utility has to build or contract for transmission to serve its highest load, and it also must have an adequate distribution system to meet that peak load. A typical rate for transmission in this region ranges from $15-$25/Kw/year. That is, if a utility needs to transmit a kW from a generator to load it pays $15-$25 per year, regardless of how many hours the kW is transmitted. If transmitted for only one hour, the cost is $15-$25/kWh!

Figure 2. Hourly load duration curve



[19] For purposes of understanding, a sample load duration curve is derived in the Appendix.

Distribution costs are estimated to be three times transmission costs. Thus, the total cost of transmission and distribution can range from $60-$100/kW/year. Given this information, consider the line in Figure 1 at 75% of peak load. Loads at this level and above occur about 600 hours per year. If the cost of T&D to simply deliver energy to that portion of load at 75% of peak is $60-$100, then the per kWh cost is 10-17 cents![20] In contrast, at the peak hour of the year (1 hour at 100% of peak—the extreme left edge of the graph) the delivery cost is $60-$100 per **kWh!**[21]

Table 3 shows the delivery costs per kWh for other loads that occur in the range of one to 600 hours per year. From the table, one can see that loads at 85% of peak or higher, occur only 101 hours in a year, at a delivery cost of $.59 to $.99 per kWh.[22]

Table 3. Costs of T&D to Serve Infrequent Loads

		Range of Transmission and Distribution Costs ($/kWh)	
Number of Hours	Percentage of Peak Yearly Load	60	100
1	100	$60.00	$100.00
21	95	$2.86	$4.76
43	90	$1.40	$2.33
101	85	$0.59	$0.99
209	80	$0.29	$0.48
600	75	$0.10	$0.17

The book value of transmission in the region is roughly $8.5 billion.[23] Thus, over $2 billion (25% of $8.5 billion) worth of transmission is being employed less than 6% of the time. Using the 3 to 1 ratio of distribution investments to transmission investments we used above, this means that over $6 billion worth of distribution is being used less than 6% of the time. Or, in sum, over $8 billion worth of capital invested in transmission and distribution sits idle for over 8100 hours per year.

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[20] $60-$100 kW/year divided by 600 hours per year equals 10-17 cents.

[21] Some will argue that T&D costs are sunk (the capital cost has been made and cannot be recovered) and the variable cost of more throughput (e.g., more power sold) is zero. There are two reasons why this is not the case. First, in the short term for non-transmission owning utilities, transmission costs are not sunk; they simply "rent" space on the lines. Second, in the long term, all T&D owners have planned expenditures at some time in the future. The planned expenditures have not been occurred, and delaying them, perhaps indefinitely, is worth a lot of money.

[22] Note that these costs do not include the cost of energy, which has been over $1/KWh on peak in the last few years.

[23] The book value of BPA's transmission is about $4.5 billion (BPA Annual Reports). Avista, Idaho Power Company, Montana Power Company, PacifiCorp, and Puget Energy Services combined have about $3.8 billion of book value in their transmission systems. (See FERC Form 1 data for 2000.) We have estimated that other utilities in the region not under FERC's jurisdiction make up another $.15 billion to get us to our estimate of $8.5 billion.

In summary, using the hydropower system to meet peak loads (e.g., those above 75% of peak load) is extremely costly to the power system and devastating to salmonids and the aquatic environment on which salmon and other species depend. Even without considering the huge costs imposed on fish and wildlife from raising and lowering river levels to serve peak loads, alternative means of serving these loads are cheaper than buying power and transmitting it from distant generators as is currently done. These other methods are discussed in the next section.

2.3.2 Lower Cost Alternatives to Serving Peak Load

The Northwest can serve peak loads and/or lessen peak loads more efficiently than it is doing currently. There are several resource options that will be far less expensive than using the hydropower system in tandem with transmission sized to meet peak loads. Some, alternatives such as load management (discussed below) have little or no cost. Each of these resource options will take pressure off of the T&D system as well as the river system.[24] In the next section, we will estimate the savings in transmission and distribution costs that will enable this tribal vision to be met.

2.3.2.1 Capital Cost Savings Identified

Suppose future peak loads could be lowered to, for example, 75% of current peak load[25]. These loads would not have to be eliminated overnight because the transmission system, albeit stressed, has and can continue to serve regional loads at today's levels. Peak loads could be reduced on the transmission system gradually by using the resource options described below. The reduction could be designed to be soon enough to negate much of the transmission investment upgrades driven by the need to serve peak loads, while making sure that this approach is well conceived and implemented correctly.[26]

With peaks at 75% of today's peaks, the capital earmarked for T&D upgrades to serve peak load growth could be available to invest in alternative technologies to serve peak loads. The savings would be committed to load management, conservation, clean distributed generators to serve those loads, and clean gas-fired or renewable central station resources sited strategically within the T&D system. These energy plants and strategies would be used to serve peak loads and to serve off-peak loads whenever market prices exceeded the variable costs of operating the specific plants and implementing the load management strategies.

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[24] It is well known that the transmission system is experiencing constraints. Considerable investment is needed in a business-as-usual scenario.

[25] In keeping with the theme of this report, this is not a prediction of what might happen soon, but rather a vision of what could be done with a regional focus.

[26] This is the goal of BPA as it revamps its transmission planning function, using the Round Table as an advisory group.

The magnitude of planned T&D investments that could be eliminated or delayed is significant. As previously mentioned, a rough estimate of the book value of transmission used to serve regional load is about $8.5 billion. BPA's transmission system, purchased with low cost federal debt, has a book value of about $4.5 billion, and the book value of the remaining transmission in the region is about $4 billion dollars.[27] Let's assume that replacement cost of the regional system is twice the book value, or $17 billion.

Since the region's transmission system is now constrained during many hours, new investment will be needed to serve loads if load shapes do not change. The region would need to invest about 1% of the total value of the system per year to keep up with load growth.[28] Thus, about $170 million per year will have to be invested in transmission to serve peak load growth.[29]

Book value and replacement value of distribution systems in the region has been estimated at roughly three times that of transmission. Many of the actions we include in our plan will also save distribution investments. Distribution investments are also often very costly from a social perspective because they entail digging up city streets. Large capital costs are incurred along with social costs associated with time lost in traffic jams and other even greater displacements.[30] The savings from deferring investments would be great and would allow for even more generation to be built, if necessary. If the region were to do away with transmission investments to meet load growth, it could also do away with the corresponding investment in distribution systems. Thus, an additional $510 million savings (three times that of transmission) could be realized through avoided investment in distribution.

Most of the capital budgets for fish and wildlife on the Snake River and in the Columbia River Basin would be eliminated. The U.S. Army Corp of Engineer's capital budget on the lower Snake River dams includes about $400 million for fish mitigation not yet expended and that will be the responsibility of BPA's ratepayers. Environmental investment needed to conform to the Clean Water Act in the Columbia River Basin will be around $500 million. Removing the lower Snake River dams and achieving more normative flow regime on the Columbia also would eliminate the need for most of that investment. Thus, nearly $900 million in Corp investments could be saved, resulting in an annual savings of about $90 million, which can be added to the $680 million in reduced amortization payments for T&D. This would leave the region with about $770 million annually to pay for the distributed generation and other low and no-cost resources the

[27] See footnote 22.
[28] Based on an assumption of a 2% growth in peak loads. BPA, because it has deferred investments in transmission over the last decade, has scheduled over $2 billion between 2002 and 2006.
[29] Of course, there will also be capital investment to maintain existing wires. This will be true for the distribution system also. That investment is separate from the investments to serve new load growth and generation interconnections addressed here.
[30] Reduced access to commercial ventures is an example.

region would employ to offset the loss of hydropower and to cover for rate increases from breaching the Snake River dams and modifying Columbia River flows.[31]

If the region replaced the 2000 aMW of power lost from the dams with 2,000 aMW of distributed generation, the region will save losses estimated to be about 10% of total power transmitted or about 200 aMW. At a market price of $35/MWh (a conservative estimate of power costs over the next 5-10 years), the savings would be $61.3 million/year.

The combined savings in T&D, Army Corps expenditures, and losses total $831 million dollars per year. The region could spend this money on achieving the tribal energy vision. Next we look at the resources the region could use to replace the power lost from dam removal and from adjusting the flows of the Columbia River.

2.3.2.2 Load Management

Load management, as the term is used here, refers to behavioral changes in energy usage, such as turning off lights, lowering thermostats, and shifting some electricity using functions to off-peak hours. The changes can be achieved through manual means or through the use of automated equipment using sophisticated computers and controls. For example, weather and market prices can be used as inputs into automated computer-driven equipment that allow for automatic adjustments and more efficient use of energy.

Load management can be broken down further into programmatic activity driven by utilities or public purpose entities and those driven by market mechanisms. Load management in response to market forces would require the region's utilities and regulators to adopt electricity rates that recognize the true market value of delivered power throughout the year.

Programmatic Load Management. Utilities entered the 2001 energy crisis with little or no programmatic experience attempting to affect the behavioral side of energy use. Because of the immediate need to reduce purchases, especially during peak hours, utilities bought back power from some of its larger customers. BPA and other utilities asked its customers not to use power because of high market prices and bought the power back at a multiple of what it was sold for. Direct Service Industries (primarily aluminum companies), possessing contracts enabling them to resell power, closed down production and made large profits by selling power purchased from BPA at about $23/MWh at market prices of up to $1,000/MWh. Because it essentially pays people not to produce, buyback can only be a near-term solution.[32]

[31] It has been estimated that over 600 MWe from small temporary generating stations were installed to prepare for anticipated shortages in 2000-2001. Ignoring the fact that these are the worst possible option for generation, the region should learn from its experience trying to handle distributed generation at that level.
[32] This can be a recipe for high inflation—incomes are maintained, but no product is being produced.

However necessary this buyback program might have been during the 2000-2001 crisis, it achieved only what could have been achieved more smoothly with better-designed prices to end-using customers. With better-designed rates, new technology would have been in place, product would still be produced, and the stress on the river and the transmission and distribution systems would have lessened.

With better foresight and more time to plan, utilities might have worked with customers to install load management equipment that could be operated by the utility remotely or by customers on request from the utility to shed load. Contract terms could have included lower rates for more utility control of loads or might have contained a fixed percentage of credit for each kWh not consumed. The size of the credits would be based on market prices and flexibility.

With long-term economic incentive to control peak loads, more innovative approaches to programmatic load management would almost certainly be developed by consumers of power or entrepreneurs developing new technologies.[33]

Price Driven Load Management. The cost of supplying power changes diurnally and seasonally, sometimes dramatically. This fact is reflected in BPA's proposed 2001 power rates, which change from HLHs to LLHs and by month of the year. However, BPA's prices, which are designed only to recapture its costs, do not approach the value of power on the market. We are not proposing that BPA or any utility in the region change its rates in the near term to reflect market prices. Perhaps with a 10-year weaning program this should be done, but not now. We do believe that BPA's rates should reflect its and others <u>true cost</u> of serving loads. BPA's proposed rates for the next rate periods do not reflect the true cost of serving loads. The next few sections of the report look at the individual elements of the cost of delivered power, and explain why we suggest changes to BPA's rates.

2.3.2.3 Energy Costs

The market cost of power has been fluctuating dramatically over the last several years. Market prices of power have been as high as $1,000 per MWh ($1.00 per kWh). In the spring of 2001, futures for summer power were selling for 50 cents/kWh. Utilities, including BPA, were buying power at 20-50 cents/ kWh and selling power to end users at less than 2.5 cents per kWh. This reality has left BPA with an acute financial problem, which has implications on the protection of fish and wildlife. To avoid this problem in the future, the tribes believe that a transition program must be put into place to eventually bring retail and wholesale prices of power into alignment.[34] If the region were to accomplish this transition over the next 10 years, market prices will be much lower than they are today. Many of the resources and management strategies we discussed above and

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[33] See the brief discussion of venture capital money in the Preface.

[34] Again, the tribes are not proposing that rates immediately be changed to track the level of current market prices. That would create havoc.

below will have been installed by customers to serve part of their own loads, with the result that pressure will be taken off the market for power. Also, other technologies not yet foreseeable will likely be employed to supply power at competitive costs to markets.

2.3.2.4 Transmission and Distribution Costs

T&D costs have two components. One is the capital cost of the installations, and the second is the cost imposed by congestion on the grid. At many times of the day, season, and year, constraints exist on parts of the T&D system. Historically, BPA and other utilities have dispatched resources to move power around these constraints. The costs of doing this have been melded into an average transmission cost that in turn has been included in an average total power cost.

The end user has not paid the true cost of using either the transmission or distribution systems. As we noted previously, the cost of T&D to serve peak loads is enormous, but no end-user pays that cost. If the true costs of transmission capital and congestion were charged to end users, much of the crisis experienced in 2001 would have been averted because peak loads would have been lowered. From an economic perspective, too much transmission is built to serve peak loads that are greater than they would have been if users paid the true price of the delivered power.

Today there are calls for more transmission construction.[35] If one assumes that the trend toward deregulated markets continues, investors who build additional transmission will be at risk. Higher prices for energy and delivery at peak would drive users to look for other innovative ways to serve their peak loads, including shifting them to off-peak times when the prices of energy and delivery are lower. Much of that new investment could easily be stranded (not able to pay back development costs) when real-time prices are charged to users of power. This fate would also befall new remote generation that relies on those wires to get its product to market to serve peak loads.

2.3.2.5 Costs to Fisheries

BPA's rates include the some of the costs of fish ladders, bypass screens, hatcheries, and other technological measures that have been deployed to mitigate fish damages. The rates do not include the value of damages done to the fisheries, which has been estimated to exceed $2 billion. If they did, the rates would be high indeed. BPA's prices, however, should include some amount for fish damages. One way to start is to raise rates to help pay for the river's return to a normative, that is, more natural, flow regime.

As a public utility, BPA could modify its rates to include non-market costs to fish and wildlife. The externalities (lost and damaged resources) related to hydropower operations in the Northwest are so severe and so unique to fish, wildlife, and tribal cultures, it is

[35] As indicated earlier, BPA expects to initiate about $2 billion worth of transmission upgrades by 2006 and much more upgrading after that.

reasonable to focus an externality charge on this resource. With correct pricing to address all costs, operation of the river will move towards its natural flow as people adjust to the more accurate prices by adopting load management techniques and relying on conservation and generating resources closer to the load. Such anticipated actions by end-users will take pressure off of the river and the transmission system.

2.3.2.6 Other Environmental Externalities

Much attention has been focused on the environmental adders (the additional value of resources lost or damaged) that should be attached to energy costs to account for externalities that are not priced in the market. Typically, the adders, where they have been applied, have been used only when comparing two or more resource options. They have been used as tiebreakers.[36] With the advent of deregulation, even this weak focus on externalities has waned.

In an unregulated market for power it is difficult to attach a per kWh charge to account for externalities. But there are other, perhaps more effective, mechanisms that have been employed. We examine these mechanisms below in the section entitled Trading Mechanisms.

2.3.3 Conservation

Conservation will save energy and lower peak loads. Existing and enhanced conservation efforts are an important part of this tribal vision. Many of these measures, embodied in standards will come free to the electric industry. Conservation measures will reduce pressure on the river and the T&D systems and be cheaper than the delivered cost of power using conventional means. Some of the many opportunities to save are highlighted below.

Rates. Rates that better signal the true cost of delivered power, although not a conservation measure in and of itself is important to spur both conservation of energy and conservation of peak transmission and distribution use. Better ratemaking will help the region to uncover low or zero cost load management options, many of them have gone unidentified because of the peculiarities of electricity rate schedules. That is, end-users rarely get a signal as to the real value of the generation, transmission, and distribution services they are using. Uncovering and exploiting the values in load management will bring vast savings to customers and many utilities.

Insulation. Insulation in walls will save more energy when temperatures are severe, when loads are peaking in the Northwest and/or prices are peaking on the West Coast. Many housing units on tribal lands could benefit from increased insulation and more

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[36] Thus, if the near-term costs of a dirty resource, such as diesel-fired generation, were far less than the clean resource, such as wind power, the dirty one got built (because it was cheaper), and nobody paid the external, i.e., environmental costs.

efficient heating units. The net result would be more comfort, lower power costs, and lower T&D costs.

Energy Efficient Lighting. Energy efficient lighting saves more energy on hot summer days when prices on the West Coast are peaking, because the reduced waste heat from efficient lights reduces the stress on air conditioning systems. In the winter, efficient lights save more energy because of the greater number of hours of darkness. Thus, efficient lights make sense year round.

In bulk, compact fluorescent lights (CFLs) can sell for as little as $2.50 per bulb[37] and save 50 watts of power over each of the 10,000 hours of their expected lives. That calculates out to about .75 cents per kWh saved. Using the same assumptions, 20 lights operating throughout the peak period would provide 1 kWe of capacity and would cost $50, with no fuel costs. Gas-fired generators cost from $350 to $650 per kWe, depending on whether they are single or combined-cycle plants.

Energy Efficient Appliances. More energy efficient appliances save energy while also reducing air conditioning loads. Like efficient lighting, they give a double benefit. For example, replacing 15-year-old refrigerators with Energy Star refrigerators typically will save about 630 kWh/year and .072 kWe of on-peak capacity.[38] Replacing one million of these older refrigerators would save 72 MWe, on peak. There are several million refrigerators in the Northwest that are 15-years old or older. Conservation measures embodied in new appliances, retrofits of buildings, lights, motors, etc. are far cheaper than power generated at central station plants and shipped over wires, especially at times of peak loads.

Industrial Conservation. Industrial conservation measures are harder to specify, because of the uniqueness of each industrial process. Nonetheless, some of the biggest potential gains come from industrial customers. When industrial customers are planning system changes in their plants, it is especially important to have programs at the ready that can be customized to meet the needs of customers and save energy for the customers and the region.

Commercial Buildings. Energy efficient commercial buildings are also a source of great potential savings. Energy efficient lighting and appliances, of course, are a source of savings. But the biggest gains are related to heating, ventilation, and air-conditioning, which as a group are referred to as HVAC. Because these systems are complicated, they need continuing attention to remain efficient and tuned to the tasks for which they are designed. New buildings should all go through a building certification process to assure that they are operating as they were designed and to assure that the operation is efficient. One particular source of energy savings in commercial buildings is using outside air for cooling when the outside temperature falls below air-conditioning thermostat settings.

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[37] Costco is selling compact fluorescent lights in 6 packs for $2.44 per bulb.
[38] Energy Star is a certification program conducted by EPA to help consumers make choices about efficient appliances.

We have mentioned a few opportunities for saving energy. Other agencies, such as the Northwest Power Planning Council, the Northwest Energy Efficiency Alliance, state energy offices, have ready programs and details on opportunities to save energy. We incorporate their energy conservation programs into our energy vision by reference.

2.3.4 Strategic Plant Siting

Often plants are sited distant from load because of a local fuel source, such as mine-mouth coal plants, gas pipelines, and better wind resources or because plants were easier to site in rural communities. These plants are dependent on transmission to move power to population or load centers. Some plants were sited remotely from loads because of size or for environmental reasons such as pollution, noise, etc. But, today's gas-fired generators are smaller, more efficient and cleaner than plants of the past. Small gas turbines are quiet and clean, and can be sited near industrial users or loads.

Producing electricity from chemical reactions using a variety of fuels, fuel cells may be a reality for residential, commercial, and industrial use in the next decade or sooner. Serving a dual purpose of siding or roofing for buildings and power generation, solar photovoltaic panels may be ideal for reducing peak loads because power must be generated during daylight hours, which can coincide with normal peak demand in some service territories.

Under the category of strategically sited plants, we will first look at distributed generation, which typically constitutes small plants sited within the distribution system, usually on the customers' side of the meter. We will then look at other generation sited strategically within the network of transmission lines or grid. This category of plant is located so as to lower the cost of transmitting power by both limiting the amount of transmission congestion and shortening the transmission distances to load.

2.3.4.1 Distributed Generation

Distributed generation (DG) consists of relatively small power plants, including wind and gas-fired plants, located close to where the electricity is used. DG sited within industrial complexes and residential and commercial buildings will take pressure off of the T&D system, the hydropower system, and fish and wildlife. Interconnection standards[39] will have to be devised by utilities that allow for the safe operation of these local generators. DG will have to be deployed in sufficient numbers to eliminate the need for backup generation and T&D capacity.

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[39] FERC has a NOPR to make interconnection standards simple and uniform throughout the country. See Standardization of Small Generator Interconnection Agreements and Procedures Advance Notice of Proposed Rulemaking, Docket No. RM02-12-000, issued August 16, 2002

Generation sited closer to loads will allow for the use of waste heat from the generation process to be utilized for process heat, space heating, or hot water heating. Today, most of this heat is wasted. There are many technologies that can be deployed in this way.[40] Using the waste heat will increase efficiencies of conversion from a best of 50% for central station generators to as high as 85% if all of the waste heat can be used.[41] There is no reason why distributed generation should not be a big player in the power system within a few years.

Currently, there are no technological barriers to distributed generation that cannot be overcome. All that is needed now is the resolve to make it happen. With the appropriate numbers and locations of distributed generation, the region can achieve major transmission capacity savings, increase the conversion efficiencies from fuels to usable energy, and save fish by running the river at more normal flow regimes.

For the longer term (perhaps 10 years), there are other options on the horizon. Fuel cells are now being manufactured to power camping equipment and cell phones. It is a small step from here to imagine having each appliance with its own generator and having the wiring in buildings as the only distribution system. Battelle Northwest[42] is working to develop chips for smart appliances that will adjust how much voltage they use instantaneously as the chip detects voltage loss in the T&D system. Other technologies that are already commercialized include better load management devices designed to control loads below preset levels.

Conventional Generation Strategically Placed within the Grid

The region has delayed investments over the last decade to keep electricity rates low. Because of this, the transmission system, as previously mentioned, is under stress and congested along many of its pathways. Lower cost generators sometimes are kept from serving some loads by these transmission constraints. Loads downstream of certain constraints must often be served by higher cost resources delivered through other, non-constrained pathways to the load. With strategic siting of new, efficient plants, including wind generators, the cost of congestion can be lowered. As with distributed generation above, it may be cheaper to strategically site new plants than to build transmission upgrades to solve congestion.

2.3.5 Trading Mechanisms to Limit Environmental Concerns

[40] *Combined Heat & Power: A Federal Manager's Resource Guide Final Report Prepared for: U.S. Department of Energy Federal Energy Management Program*, Washington, DC. Prepared by: Aspen Systems Corporation Applied Management Sciences Group 2277 Research Boulevard Rockville, MD 20850 March 2000

[41] See above note.

[42] Personal communication with Battelle and BPA staff interested in this technological advance.

In an unregulated market for power where energy producers, for example, are not charged for environmental losses or damages, attaching a per-kWh charge to account for externalities is difficult. But there are other, perhaps more effective, mechanisms that have been employed.

The most well known trading mechanism to control pollution is the United States' sulfur dioxide (SO_2) emission reduction program, operated through Title IV of the Clean Air Act. Administered by the EPA, the primary goal of the program is to reduce annual SO_2 emissions by 10 million tons below 1980 levels over the life of the program. The Act also calls for a 2 million ton reduction in oxides of nitrogen (NO_X) emissions by 2000. The SO_2 and NO_X programs together constitute the EPA's Acid Rain Program.

In brief, the scheme involves distributing permits to SO_2 emitters that allow them to emit a certain amount of SO_2. Permits may be bought, sold or banked. Emitters wishing to emit more than the level of their permits must purchase permits from other permit holders or else reduce their emissions. At the end of each year, each emitter must hold an amount of permits at least equal to its annual emissions of SO_2.

Recently, leaders from the City of Chicago and from the automotive, chemical, commercial real estate, environmental services, electric power generation, electronics, forest products, municipal, pharmaceutical, and semiconductor industries have joined to form a North American voluntary private sector program to reduce and trade greenhouse gases. The goal of the Founding Members of the Chicago Climate Change (CCX®) is to set up a "voluntary cap-and-trade program for reducing and trading greenhouse gas emissions. In an unprecedented voluntary action, these entities have made a legally binding commitment to reduce their emissions of greenhouse gases by four percent below the average of their 1998-2001 baseline by 2006, the last year of the pilot program.[43]"

Oregon has taken a different approach for limiting carbon dioxide (CO_2) emissions. Plants are limited to a set level of CO_2 emissions. Above that, generation owners either have to mitigate for the excess emissions or pay a sum per unit of excess emissions into a non-profit Climate Trust. The trust will then embark on programs to limit CO_2 emissions in the cheapest way available. So far the Climate Trust has dedicated over $6 million to projects that prevent or mitigate the emission of CO_2 and other greenhouse gases.

[43] See http://www.chicagoclimatex.com/pdf/CCXPressRelease011603.pdf. The founding members of CCX include American Electric Power (AEP), Baxter International Inc., the City of Chicago, Dupont, Equity Office Properties Trust, Ford Motor Company, International Paper, Manitoba Hydro, MeadWestvaco Corporation, Motorola, Inc., STMicroelectronics, Stora Enso North America, Temple-Inland Inc. and Waste Management, Inc. For more information contact rmarques@chicagoclimateexchange.com

The Bonneville Environmental Foundation (BEF) has entered into an agreement with the BPA on an innovative way for energy producers to receive credits toward their required reductions of CO_2 emissions. The BEF's "Green Tags" program lets government agencies and corporations as well as energy producers purchase the green power attributes of qualifying wind, geothermal, solar, or biomass resources. The Bonneville Environmental Foundation is marketing Green Tags to large retail purchasers, government agencies, corporations, and others. The proceeds go toward creating additional revenue to expand renewable resource development.

To achieve our vision we will look for additional innovative opportunities such as these to both clean up pollution and to protect fish and wildlife. One could imagine, for example, a program similar to the Green Tags program, but to specifically protect fish. Any measure that moved the river towards more normative flows would get a "fish tag," representing the underlying value of the measure in protecting fish. The entity holding the fish tag would be able to market it as is done with green tags for renewable resources.

2.3.6 The Effect of the Tribal Vision on Rates

We believe that our vision can be achieved with little or no rate increase and provide better protection against future rate increases while protecting fish. A key part of the tribal energy vision is the removal of the Snake River dams and the return of the Columbia River to a more normative flow regime. Together these actions will remove 2000 a MW from the system and will require BPA to raise rates by about 4.7 mills/kWh on its reduced core resources. This rough estimate is consistent with the NRDC estimate that removal of the Snake River dams alone would require about a 2-mills/kWh increase. We identified earlier in this report a cumulative $831 million dollars per year of savings in T&D, U.S. Army Corps capital savings, and load loss reductions.

To pay for the rate increase it would require about $350 million per year.[44] This leaves $481 million to pay for the 2000 MWh of lost power. One could purchase 2000 aMW per year with $481 million if the cost of the power is no more than $.027 cents per kWh.[45] The tribes are confident that with a broad portfolio of conservation measures aimed at saving energy and peak, load management options driven by more accurate pricing of power, distributed generation, and strategically placed generation as discussed above and below, the region could get power at a weighted average of $.027/kWh. Further, we believe that these changes in aggregate will have the net effect of lowering costs in the near term as the mechanisms to achieve the vision are begun and significantly lower costs and rates in the long-term.

In summary, instead of using the $831 million annually to amortize new wires, to mitigate for fish at dams, and to pay for line losses, our vision would use this capital to pay for strategically placed gas-fired generators to relieve transmission congestion, for

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[44] 8500 aMW x 8760 hrs/yr x 1000 kw/Mw x $.0047 mills/kWh = $350 million
[45] $481 million/(2000 aMW x 8760 hrs/yr x 1000 kw/MW) = $.027/kWh

clean, distributed generation to minimize the needs for transmission and distribution upgrades, and for conservation and load management strategies to serve peak loads locally at little cost.[46] At the same time the region could compensate for the increased rates resulting from removal of the Snake River dams and returning the Columbia to a more normative flow regime.

3. A Diversified Portfolio to Meet Energy Needs and Restore Columbia River Salmon

In this report, we have defined a set of strategies and resources that will serve loads more cheaply than they are served today, provide better protection against unforeseen events, and be much healthier for the region's fish and wildlife resources. Our vision can be implemented without raising rates in the Northwest. In fact, over the long-term we believe that our vision contains a more robust set of resources and will lead to lower prices for power. We also know that it will not be achieved without convincing key regional players such as BPA and the NWPCC that it is superior to the current system. We will ask them to use their vastly superior resources and unsurpassed technical resources to analyze the efficacy of our vision to meet tribal and regional needs.

The portfolio of new resources and strategies that can achieve our vision is described briefly below.

3.1 Normative Flows

Return the Columbia River to a more normative flow regime. Achieving this part of the vision will remove capital costs targeted at fish and wildlife in the basin.

Breach the dams on the Snake River. Achieving this part of the vision will save about $400 million from the Corp's budget. Removing the four Lower Snake River dams will also reduce power output in the basin by 1000 aMW. The power will be replaced with strategically located generators, including distributed generators, conservation, and load management. Capital to pay for these resources will be made available by reduced need to invest in T&D.

3.2 Generation Resources and Strategies

Strategically placed gas-fired generation. Transmission and distribution systems are constrained. Strategically locating central station generators when and where needed to serve load is important. It is too expensive to build resources without regard for how they

[46] Implicit in this assumption is that capital can be moved from one component to another. We understand that BPA cannot switch its capital from transmission to building distributed generation. Nonetheless, the region's ratepayers will be footing the bill for these resources regardless of where the capital comes from. Our vision tries to incorporate the best use of capital for the region and its citizens.

affect the system. Savings will derive from minimizing transmission investment or non-economic dispatch of resources to serve loads.

Wind Generators. Wind resources now produce power at a competitive price, have few environmental concerns, and provide a hedge against unknown fuel and environmental costs. However, T & D constraints involving costs, access and other issues could jeopardize the future development, particularly of smaller wind generators.[47] Some of the problems, such as T & D congestion, would be addressed by using the tribes' proposed strategies to decrease the stress on the system from peak loads.

Recently in the Northwest, wind developers have built about 496 MWe.[48] The new Stateline Wind Energy Center, near Walla Walla, Washington, has a generating capacity of 263 MWe. PacifiCorp Power Marketing bought the project's entire output, which will be transmitted over PacifiCorp and BPA lines. When fully built to 300 MWe, it will be one of the world's largest wind farms. In 2001 PacifiCorp Power Marketing signed a 20-year wind power supply contract with Seattle City Light, the municipal utility for Seattle. Seattle City Light began taking delivery of 50 megawatts of clean wind energy in January 2002 and will gradually ramp up to 175 megawatts by August 2004.

As of 2002, nine new wind projects are being developed. They are scheduled to add some 867 MWe of capacity to the 496 MWe from six wind projects already in operation in Washington and Oregon. However, future development and use of wind energy may depend on favorable access to regional transmission lines. In 2002 BPA exempted wind power resources from a 100-mill penalty charged when generation falls short of what the producer scheduled for transmission. Because wind is an intermittent resource, it is often difficult for wind energy producers to schedule their power output with great accuracy.

Wind producers need to be able to buy affordable transmission rights close to real time (when the wind is blowing). This requires efficient and flexible (liquid) markets for transmission capacity and clearing transmission congestion. Other transmission-related obstacles are potentially ahead, particularly for small and other operators who need to secure space on the lines.[49] However, adopting the tribal energy vision would relieve T&D congestion, making wind even more viable than it is today. (Also see Distributed Generation below.)

Distributed Generation. The electricity system in use today uses capital inefficiently. It is by far the largest industrial user of capital in the country. The gas and oil extraction industry, which is the second largest industry in terms of its invested capital in the U.S., has in place about 50% of the capital investment of the electric utility industry. The

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[47] See note 23.
[48] Provided by the Renewable Northwest Project.
[49] We have not specifically addressed this issue in this vision paper; however, it is important for wind developers and is an ongoing issue as the region develops its Regional Transmission Organization (RTO) West. See RTO West home page at http://128.242.83.219/index.htm.

capacity factor of the system is about 43%, while over 25% of all capital in place (G, T, & D) is there to serve loads that occur about 6% of the time. Moving some generation closer to loads will eliminate much of the planned costs for expanding the T&D system. These costs are large. Further, it is cheaper to transport fuels to DG close to loads than it is to transport the equivalent amount of electricity. Transportation gains of gas over electricity come from fewer losses in conversion, fewer losses in transmission, and in lower capital costs.

In addition, generation closer to loads allows for the use of otherwise wasted heat, a byproduct of combustion. We have not included these additional dollar savings in our calculations, as it not clear what percentage of them will derive from reduced electricity use. But the dollars are real savings to the end-users of power and are not insignificant.

Resources in the category of distributed generation include fuel cells, varying sizes of small gas-fired units, net-metered small renewable resources, and small wind farms. Owners of net-metered small renewable resources, including solar photovoltaic applications, can sell power back to the local utility at retail prices. Small wind farms of two to ten machines can be placed strategically within the grid and not necessarily where the wind is the greatest, but where the combination of strategic placement and the wind resource yields the highest benefit to the electricity system. This benefit would show up as income to the wind developers. In Denmark, small wind farms on farmlands predominate, in part because of federal incentives to developers. In Holland, building-sized wind machines are being deployed. These units are not read for widespread commercialization, but could be in the next decade or so.

3.3 Management and Regulatory Improvements

Load management. Load management is perhaps the most important near-term activity for relieving congestion and for managing exposure to rogue electricity markets. With proper pricing strategies, load management would happen as a matter of course. But until such time as end users see more representative market prices for power and T&D, <u>programmatic</u> load management represents a major opportunity. Similar to distributed generation, load management options will take the "peakiness" out of the system. Both DG and load management will eliminate the need to serve peak loads using the hydropower system, with large gains in lower T&D costs and in saved fish and wildlife.

Efficiency improvements. Efficiency improvements save energy and capacity in all end-using applications. They save energy at costs that are often far less than the delivered cost of power, produce little or no pollution, and can be installed in infinitely small quantities. Weather-related measures save more under extreme weather conditions than under normal conditions. And measures embedded in appliance standards and building standards save more during economic boom times when more of these items are purchased. They continue to be a most robust, cost-effective way to "produce" power from our scarce resources. They are designed to save both energy and capacity.

Strategic Pricing of Retail Power. As we described earlier, loads that occur when the system is at peak are much more costly to serve than are off-peak loads. Yet, most utilities do not capture this cost difference in rates. Doing so would reduce peaks and the associated strain on all capacity employed throughout the system. Proper prices would smooth the way for the strategies and resources that help achieve our vision.

4. Recommendations

4.1 Generation and Load Management

DG Pilot Projects. BPA shall fund a minimum of 100 MW of pilot projects of DG resources development over the next two years. BPA shall design the projects to be dispatched remotely. This will serve peak loads and protect fish spill.

Peak Reduction. BPA shall acquire 1000 MW of peak reduction over the next 10 years, based, in part, on the results of the DG pilot project referenced in Recommendation #1 above. Peak reduction can come from a diverse set of technologies and strategies, including DG, load management, and conservation. These combined activities should consider capital savings as an important management objective. The BPA Administrator shall also establish a Conservation Business Line, independent from the Transmission Business Line and Power Business Line so that BPA's conservation efforts can focus on avoided transmission and power costs.

Backup Generating Capacity. BPA shall acquire 1000 MW of generating capacity as backup reserves to assure that a potential lack of regional energy resources do not constrain fish operations. Outside of potential spill times, the plants could be called upon as needed, but in emergencies the plants could only be run to allow for spill, when spill would otherwise be endangered.

4.2 Power Pricing

Truer Cost Pricing. BPA should adopt pricing policies for its energy sales that reflect true costs to fish and market conditions. Over the next 10 years BPA should also begin to transition to market-based rates. BPA must protect fish during the transition of energy markets. Further, during the weaning period, FERC should adopt caps whenever it sees prices far exceeding costs that would occur in a well functioning market.

Uniform Interconnection. The NWPPC should encourage, and RTO West should adopt, uniform mandatory interconnection standards for all transmission utilities to assure interconnection of generating resources. This would allow development of the resources needed to relieve pressure on the Columbia River, including distributed generation and other strategically placed resources. Current transmission interconnection standards vary from investor-owned utilities to public utility districts to cooperatives. The current inability to interconnect poses difficulties for siting new generation in areas where peaking problems occur. All regional entities should support FERC's attempt to establish uniform and simple interconnection standards.

Encourage Liquidity. The NWPPC should encourage, and RTO West should develop, liquid markets for constrained transmission. This will facilitate the adoption of peak reduction measures to uncover the value of constrained transmission paths.

Fish Operations as Hard Constraint. Fish operations will be submitted as a hard constraint to the Pacific Northwest Power Agreement. Emergency limitations on fish operations will occur only when Northwest energy reserves fall below 1.5%, the equivalent of a stage three emergency in California.

4.3 Emergency Measures

We recommend that the actions of regional energy operators and managers conform to the three-part definition of emergency—generation emergency, transmission emergency, and other emergency—described below. Deviations from operational requirements for anadromous fish should only be allowed in the event of an actual emergency.

It is appropriate to define emergencies as they apply to the operation of the FCRPS. Emergencies are unique situations that have the potential for many types of impacts. These generally require some type of action or response to minimize or eliminate impacts. An emergency may involve the need to operate the FCRPS outside of the requirements contained in the Biological Opinions or the associated Records of Decision issued by the operating agencies.

However, it is important to distinguish emergencies from "planned risks." In operating a complex system such as the FCRPS, federal managers assume certain risks every day. Future conditions are uncertain. Operational decisions rely on predictions, forecasts and probabilities. If an extreme circumstance occurs, it is not necessarily an emergency even though it was sudden and urgent, and required the taking of an immediate action.

For this protocol, emergencies are categorized into three types. They are restricted to power emergencies only. We describe each type below and illustrate with examples.

Generation Emergency: The actual insufficiency of electrical generation to satisfy electrical demand or load in a particular geographical area, as measured by the real-time drop of reserves to a level of less than 1.5% of actual loads, equivalent to a stage three emergency in the ISO.

> For example, a generation emergency may be caused by an unanticipated loss of a generating resource – a project/unit forced outage; or by a restriction in the amount of water available for project discharge – reducing on-site generation; or by a loss of electrical transmission capability used to import electricity into a particular geographic area – a transmission line restriction or shutdown.

Transmission Emergency: The potential or actual loss or limitation in the ability to move electricity from the site of generation to the actual consumer or end-user.

For example, a transmission line may fail, shut down or otherwise be unavailable to transmit any electrical energy—a line outage. Or a physical condition may exist that prevents or limits effective and reliable transmission—insufficient reactive power (VARs) to overcome the inherent losses in long-distance transmission; or a temporary limitation on transmission line capability that restricts the export of electricity—which causes a generation surplus in one area, thus reducing overall generation levels but also causes a shortage in another area as noted above in the description for a generation emergency.

Other Emergency: The existence or result of extenuating circumstances that fall outside the range of normal operations, was unanticipated, and may have resulted in catastrophic impact, physical damage or failure to part of the physical power system.

For example, all natural disasters fall under this category of emergency—earthquakes, floods, and fires; or human caused failures—ship or barge strandings, facility failures (e.g., locks, gates, outlets, etc.), chemical spills into the river, train derailments impacting the river and terrorist acts; or overriding circumstances or needs that require operations to exceed normal limits such as a police investigation, a rescue operation, and a project operation specifically designed to prevent damage to or protect other parts of the FCRPS.

In the event that emergencies constrain fish operations, the value of the energy produced from this operation will be paid into an account at BPA to be expended within one year of accrual for fish and wildlife mitigation.

GLOSSARY

Anadromous: Species of fish that hatch and initially grow in freshwater, migrate to and mature in the ocean, and return to freshwater as adults to spawn (such as salmon and steelhead trout).

Average megawatts (aMw): The unit of energy output over a year, equivalent to the energy produced by the continuous operation of one megawatt of capacity over a period of time; also an average of one million watts transferred over a period of time (often a year, thus average annual megawatts).

Bonneville Power Administration (BPA): The federal power marketing agency under the Department of Energy responsible for marketing wholesale electric power from 30 federal dams and one non-federal nuclear plant throughout Washington, Oregon, Idaho, and western Montana and portions of California, Nevada, Utah, and Wyoming. BPA also sells and exchanges power with utilities in Canada and California.

Capacity: The maximum load that a generator, piece of equipment, substation, transmission line, or system can carry under existing service conditions. Sometimes used interchangeably with capability, although not a synonym.

firm capacity: Capacity whose availability is assured to the purchaser. The purchaser is usually required, under contract provisions, to replace the energy associated with the delivery of firm capacity.

peak capacity: The maximum capacity of a system to meet loads. Also called peak-load capacity.

peaking capacity: 1) The generating capacity available to assist in meeting that portion of the load that is above baseload. 2) The maximum output of a generating plant or plants during a specified peak-load period.

Cogeneration: The sequential production of more than one form of energy such as heat and mechanical energy, or heat and electricity, or mechanical energy and electricity.

Combined Cycle Generation: The use of a combustion turbine and a steam turbine in an electrical generation plant so that the waste heat from the combustion cycle provides heat energy for the steam cycle to increase its efficiency.

Consumer: An ultimate user of electricity for specific purposes such as heating, lighting, running equipment. May or may not be identical with party billed by a utility (for example, a commercial building owner may be billed for electricity use in a single building with many independent shops). Also referred to as an end user. Also see customer.

Dam Breaching: The removal of earthen barriers built to hold back a river's natural flow.

Customer: A utility, large industry, or federal agency that buys power or transmission services directly from BPA.

Direct-Service Industrial Customers (DSIs): Industrial customers, primarily aluminum smelters, that buy power directly from BPA at relatively high voltages.

Distribution: The transport of electricity to ultimate use points, such as homes and businesses, from a source of generation or from one or more substations. Also see generation.

Endangered Species: Under the Endangered Species Act, animals, birds, fish, plants, or other living organisms whose existence is determined to be in danger throughout all or a significant portion of its range because its habitat is threatened with destruction, drastic modification, or severe curtailment, or because of overexploitation, disease, predation, or other factors.

Endangered Species Act (ESA): A 1973 Federal law, amended in 1978 and 1982, to protect troubled species from extinction. The National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) decide whether to list species as threatened or endangered. Federal agencies must avoid jeopardy to and aid the recovery of listed species. Similar responsibilities apply to non-federal entities. (NMFS is also now known as National Oceanic Atmospheric Administration (NOAA) Fisheries.)

End-Use Load: A final, discrete use of electrical energy, such as lighting, space heating and cooling, refrigeration, and office equipment.

End User: See Consumer.

Externalities: In resource planning, the value of what is lost or damaged when power generation adversely affects the environment.

Firm Load: See Load.

Generation: 1) The act or process of producing electricity from other forms of energy, such as hydro, coal-fired steam turbines, or photovoltaic conversion systems. 2) The amount of electrical energy produced.

GENESYS: The generation evaluation system (or GENESYS) is a new hydro-generation computer model that simulates the hydrology and generation of the Federal Columbia River Power System (FCRPS) for longer-term studies. It can reveal uncertainties in future power generation and aid in managing the region's water resources.

Kilowatt (kW): An electrical unit of power; one kilowatt equals 1000 watts.

Kilowatt hour (kWh): The common unit of electrical energy equal to one kilowatt of power supplied to or taken from an electric circuit for one hour.

Load: The amount of electric energy delivered or required at any specified point or points on a system. Load originates primarily at the energy-using equipment of consumers, such as heaters, air conditioners, lights, and motors. At BPA, load includes delivery to direct-service industries. (Note: load is slightly larger than metered energy because of normal transmission and distribution losses in delivery from generator to consumer. Because loads are used to determine resource requirements, forecasts of electricity use are converted to loads). Also see end-use load.

Firm Load: The load that is served, on a guaranteed basis, 100 % of the time, and that BPA or another supplier has a contractual obligation to serve.

Peak Load: The maximum load in a stated period of time. It may be the maximum load at a given instant in the stated period or the maximum average load within a designated interval of the stated period of time.

Load Management: Methods or programs to reduce, reshape, or redistribute electrical loads to match available resources and comply with long-term objectives and constraints. Generally, attempts to shift load from peak use periods to low use periods.

Demand-Side Management: The strategies that focus on influencing when and how customers use electricity, with an emphasis on reducing or leveling load peaks, such as conservation measures and rate incentives for shifting peak loads, and energy storage schemes for reducing, redistributing, shifting, or shaping electrical loads.

Median Streamflow: The rate of flow of a stream (usually expressed in cubic feet per second or cubic meters per second) for which there are equal numbers of greater and lesser flow occurrences during a specified period.

Megawatt hours (MWh): Electrical energy equal to one megawatt of power supplied to or taken from an electric circuit for one hour (1 MWh = 1000 kWh = 1,000,000 watt hours).

Megawatt, average (aMW): The amount of energy produced by one MWe operated for 8760 hours (one year).

Megawatt of Capacity (MWe): The electrical unit of power equal to 1000 kilowatts, or 1,000,000 watts.

Mills/kWh: The common expression of the cost of electricity; one mill per kilowatt-hour equals one dollar per megawatt hour.

Mitigate: In environmental usage, to either reduce or avoid an adverse environmental effect through various measures that seek to make the effect less severe, less obvious, or more acceptable.

Pacific Northwest Coordination Agreement (PNCA): A 1964 agreement among a group of U.S. utilities and agencies controlling power generating facilities in Washington, Oregon, and parts of Idaho, Montana, and California designed to make optimal use of the water and storage resources of the region.

Power Peaking: Also know as "load following" it refers to the daily cycle of water releases from storage reservoirs, timed to meet hourly power demand. High peaking periods coincide with early morning and evening power uses. Daily swings in flows can be dramatic as a result of power peaking. For example, flows below Grand Coulee can range from near zero to 160 kcfs over a 24-hour period. These wide flow swings can strand many juvenile salmon and dewater redds. Zero nighttime flow is a power peaking operation.

Ratepayer: 1) A utility, large industry, or federal agency that buys power from BPA. 2) More generally, anyone who pays for the end use of electricity.

Record of Decision (ROD): The document notifying the public of a decision taken by a federal agency on a proposed action, together with the reasons for the choices entering into that decision.

Redd: Gravel nest created by female salmon or trout where its eggs are laid, subsequently hatched, and fry emerge.

Regional Transmission Organization West (RTO West): Independent authority that BPA and other Northwest transmission utilities are forming, which would act as an independent system operator throughout the Northwest to provide a one-stop shopping for transmission access throughout the region.

Salmonids: Fish belonging to the family of salmonidae, including salmon, trout char, whitefish, and allied freshwater and anadromous fish.

Smart Appliances: Energy efficient appliances.

Smolt: A young salmon or steelhead migrating to the ocean and undergoing physiological changes to adapt its body from a freshwater to a saltwater environment.

Spill: Water that goes over the spillway of a dam rather than through turbines.

forced spill: Water for which there is no storage capability in the system reservoirs and flows exceed turbine capacity.

inadvertent spill: Over generation spill; water which could have been used to generate electricity but was not because of lack of available market, and inability to store for later use.

programmed spill: planned spill; water intentionally passed through a dam without producing electricity, usually for the benefit of fish; not the same as water budget.

Spillway: The channel or passageway around or over a dam through which water flows, or is spilled, past the dam without passing through the turbines.

Transmission: The bulk transport of electricity from large generation centers over significant distances to interchanges with large industries and distribution networks of utilities.

Transmission Grid: An interconnected network of transmission lines including associated equipment for the transfer of electric energy in bulk between points of supply and points of demand. The BPA transmission grid includes some 22,500 circuit kilometers (14,000 circuit miles) of lines connecting more than 400 substations in the Pacific Northwest. The main grid consists of 500-kV, 345-kV, and 230-kV lines.

Transmission Line: A high voltage, extra-high-voltage, or ultra-high-voltage power line used to carry electric power efficiently over long distances.

APPENDIX

Derivation of Sample Load Duration Curve

This exercise describes for the layperson how a load duration curve is developed from hourly load data. For simplicity we will take a period of 10 hours. Table 1 shows the load achieved in each of the 10 hours of this period.

Table 1. Hourly loads from hour 1 through hour 10

Hour	Load (MWe)
1	100
2	105
3	110
4	150
5	180
6	200
7	195
8	190
9	185
10	155

The first step is to sort the loads from the highest hourly load to the lowest. This process yields Table 2.

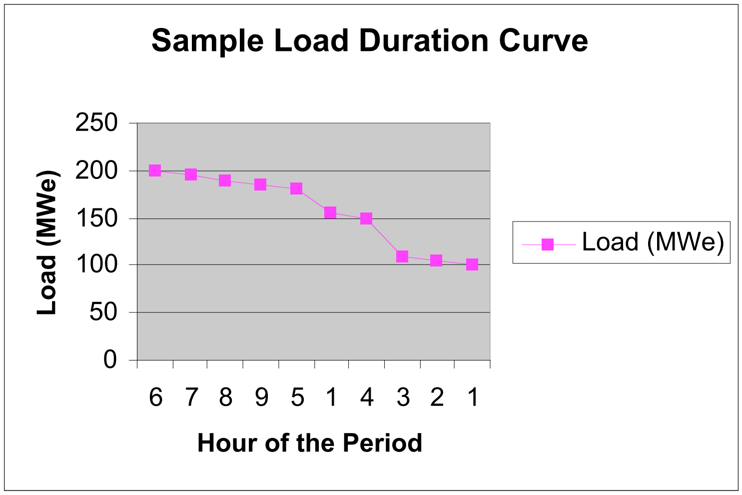
Table 2. Hourly loads from hour 1 through hour 10
(Sorted from highest to lowest load)

Hour	Load (MWe)
6	200
7	195
8	190
9	185
5	180
10	155
4	150
3	110
2	105
1	100

The final step is to plot the loads from highest to lowest, showing all ten hours on the graph.

That step yields the following graph.

Figure 1. Sample load duration curve



The load duration curve used in the report contains all of the 8760 hours in a year, but the concept and construction is identical to the sample produced.