TACOMA POWER

TACOMA PUBLIC UTILITIES

2008 Integrated Resource Plan

September 2008

Prepared by Power Management

Direct Comments/Questions to (253) 502-8025

RESOLUTION NO. U-10233

A RESOLUTION relating to the Tacoma Power 2008 Integrated Resource Plan.

WHEREAS Washington State law (Chapter 19.280 RCW) requires the Department of Public Utilities, Light Division (d.b.a. Tacoma Power) to create and submit to the State an integrated resource plan that identifies the resources that Tacoma Power will use to meet its customer's needs for at least the next ten years, and

WHEREAS RCW 19 280.050 requires the governing body of the electric utility to approve such plan, and

WHEREAS Tacoma Power is required to file the plan with the State Department of Community, Trade and Economic Development by September 1, 2008, and

WHEREAS Tacoma Power has completed its Integrated Resource Plan and requests approval and adoption by the Board; Now, Therefore,

BE IT RESOLVED BY THE PUBLIC UTILITY BOARD OF THE CITY OF TACOMA:

Tacoma Power's 2008 Integrated Resource Plan is approved and the appropriate officers of the City are directed to file such plan with the State of Washington in accordance with Chapter 19.280 RCW.

Approved as to form and legality:

Chair

Chief Assistant City Attorney

Secretary

Clerk

Adopted August 13, 2008

Executive Summary

From the perspective of having adequate power supply resources to serve its customers, Tacoma Power is in a fortunate position. The utility's owned hydroelectric generating resources combined with its contracts for electricity with the Bonneville Power Administration and others provide sufficient amounts of electricity to meet the needs of its customers. Under the utility's resource adequacy planning criteria of *critical water* – the lowest recorded year of river flow into Tacoma Power's owned hydroelectric projects – Tacoma Power expects to have sufficient resources throughout the majority of the 20-year Integrated Resource Planning horizon. Figure ES.1 illustrates Tacoma Power's load and resource balance under critical water assumptions. Moreover, adding the power that Tacoma Power can generate from its owned hydroelectric projects in conditions that are better than critical water results in a surplus of power. Figure ES.2 illustrates Tacoma Powers load and resource balance under *average water* assumptions. In cases when power in excess of that needed to serve load is available, Tacoma Power sells it into the wholesale power market and uses the revenues to help keep retail customer rates low.

Figure ES.1
Tacoma Power's Load-Resource Balance Assuming Critical Water

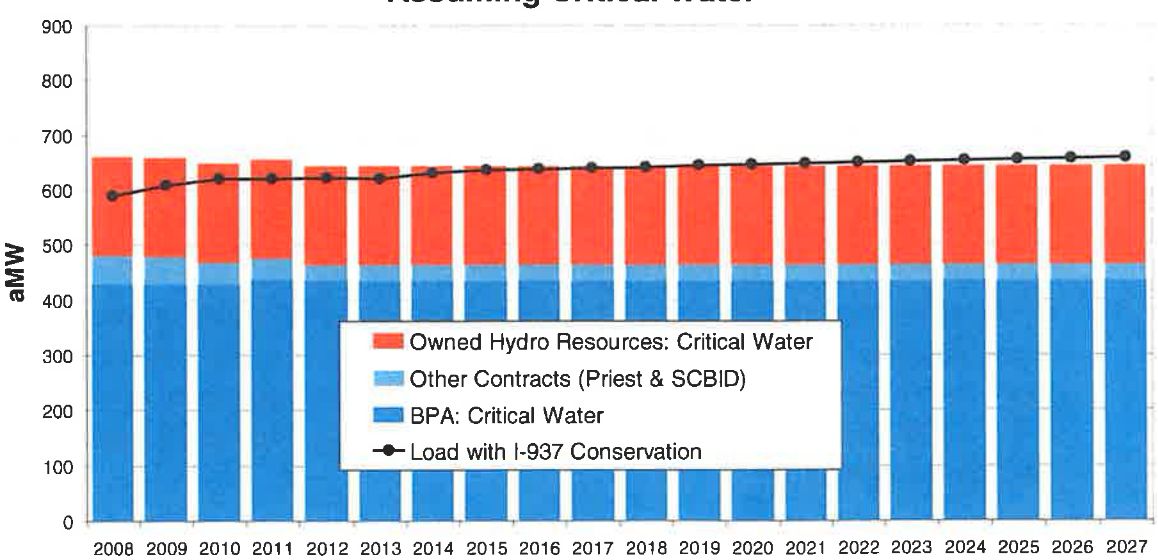
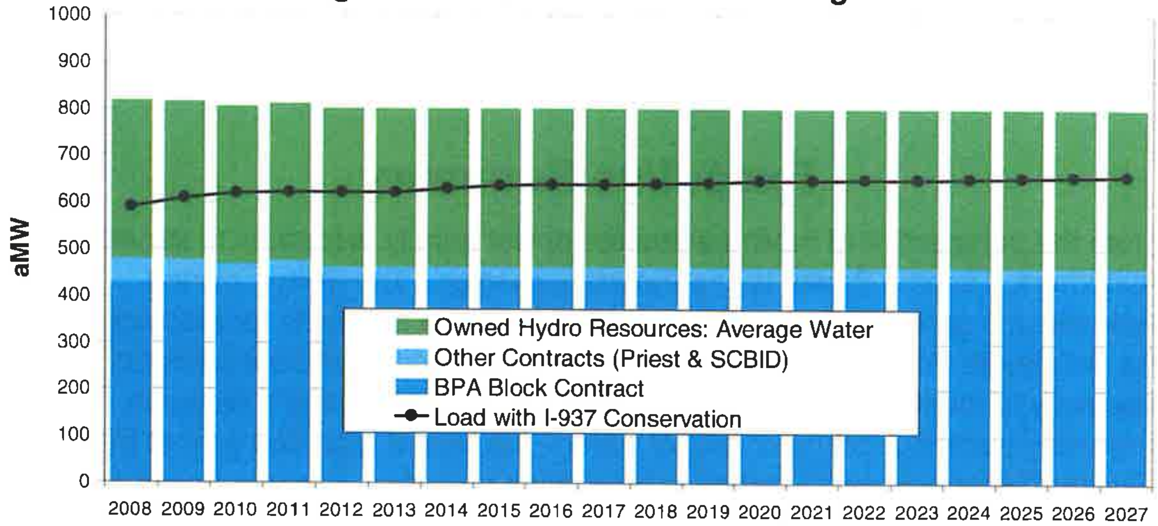


Figure ES.2
Tacoma Power's Load-Resource Balance
Assuming BPA Block Contract and Average Water



In spite of having adequate resources to serve its customers for the foreseeable future, Tacoma Power, like all electric utilities in Washington State, is facing multiple uncertainties and challenges. The utility used this Integrated Resource Plan to address three particular issues:

1. Tacoma Power must sign a new 20-year contract for electricity with the Bonneville Power Administration by the end of 2008. This new contract will replace the current Bonneville Power Administration contract that ends in September, 2011. Tacoma Power's options include a "Slice" product or a "Block with Shaping Capacity" product (See Section 3: BPA Contract). Analyses were completed in this IRP to identify which product offered is the best option for Tacoma Power.
2. The state Energy Independence Act (I-937) requires many utilities in Washington to use renewable resources or renewable energy credits (RECs) to cover at least 3 percent of retail load beginning in 2012, and higher percentages in later years. Analyses were completed in this IRP to identify a least cost and risk strategy to comply with this mandate.
3. Integrated resource planning regulations recently adopted by the State of Washington require that utilities develop a long-range acquisition plan describing the mix of generating and conservation resources needed to meet current and projected needs at the lowest reasonable cost and risk to the utility and its ratepayers. Analyses and results of this IRP comply with these regulations.

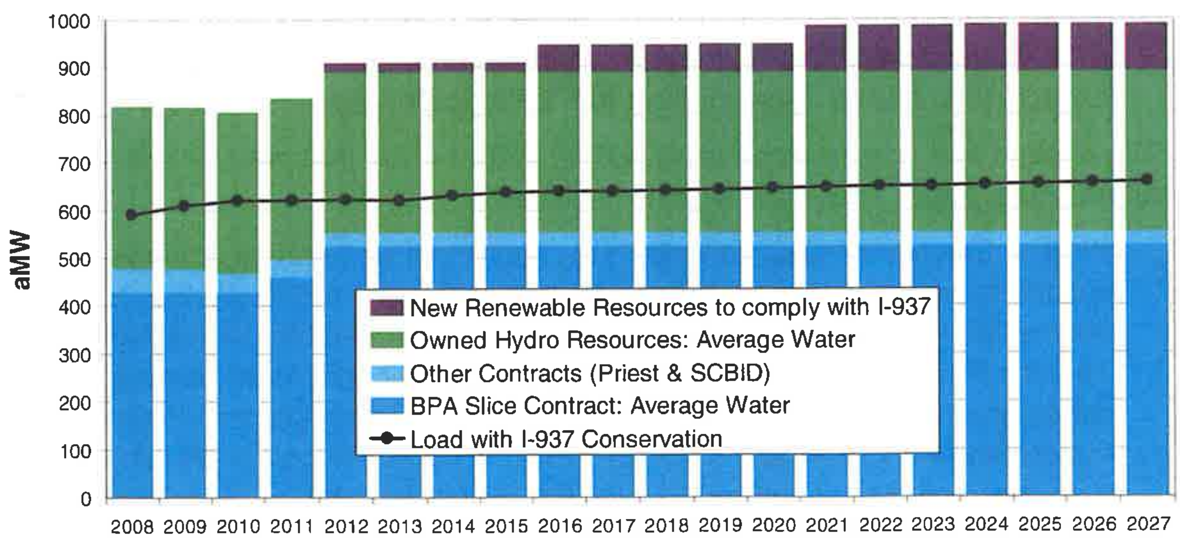
Tacoma Power used computer models that incorporated stochastic methods to systematically assess each issue. A basic objective for this Integrated Resource

Plan is to identify a course of action that limits Tacoma Power's costs over a range of potential futures. In other words, to acquire a set of resources and electricity supply contracts that are sufficiently robust that future changes in circumstances (e.g., swings in wholesale natural gas and electricity prices, load, government regulations) will not impose unacceptable costs on the utility.

With regard to Issue #1, the Bonneville Power Administration contract product choice, this IRP indicates that the Slice product is superior for Tacoma Power. The overall cost of the Slice product is projected to be about $9 million less per year than for the Block with Shaping Capacity product. In addition, the IRP analyses indicate no appreciable increase in risk to the utility associated with the Slice product.

With regard to Issue #2, this IRP indicates that the best approach to comply with the Energy Independence Act (I-937) at this time is to acquire Renewable Energy Credits. A strategy of acquiring new renewable resources was also evaluated, but found to be of greater cost and risk, mainly because it would lead to a significant oversupply of relatively expensive resources in Tacoma Power's portfolio (See Figure ES.3). The utility would not be able to use any electricity generated by a new renewable resource internally. Instead, that electricity would have to be sold in the wholesale market. This analysis indicates that the cost of Renewable Energy Credits is presently lower than the difference between the cost of electricity generated by renewable resources and the revenue Tacoma Power would receive for that electricity in the wholesale market. Therefore, it would cost more to comply with the Energy Independence Act's renewable mandate by adding new renewable resources than it would to acquire Renewable Energy Credits.

Figure ES.3
Tacoma Power's Load-Resource Balance Assuming BPA Slice Contract, Average Water and New Renewable Resources



With regard to the third issue, this IRP found that the overall best long-range resource acquisition plan is to acquire all cost-effective conservation, but no additional power-supply resources at this time. This IRP also evaluated how this strategy should be modified in the event key assumptions change in the future. For example, in the event the costs of renewable generation resources decrease significantly, and wholesale power prices remain relatively high, the IRP suggests the acquisition of about 15 aMW of renewable resources beginning in 2015. In this circumstance, the IRP projects that meeting a portion of the renewable requirement with renewable resources could save the utility money relative to a strategy solely based on a Renewable Energy Credit compliance approach. Nonetheless, current circumstances produce a recommended strategy that does not include the acquisition of additional power-supply resources at this time.

The Washington State statute requiring the preparation of Integrated Resource Plans directs utilities to identify the specific actions the utility will take to implement the findings of the plan. Tacoma Power divided this "implementation plan" into two parts. The first part describes actions the utility intends to begin, and in many cases complete, before the publishing of the next IRP. These actions include:

Conservation Tacoma Power has an annual conservation goal of 5.4 aMW beginning in 2010. Tacoma Power is ramping up in-house conservation activities with intermediate goals of 3.1 aMW in 2008 and 4.7 aMW in 2009. Tacoma Power is also starting the process to update its Conservation Potential Assessment. The results of this update may change the utility's overall conservation goal.

Renewable Energy Credit Acquisition As a result of the recommendations from this IRP, Tacoma Power is presently negotiating a long-term REC purchase agreement and expects to consummate a contract in the near future.

BPA Contract Presuming that no significant changes occur, Tacoma Power expects to finalize a Slice contract with BPA around the end of 2008.

The second part covers areas identified for further study that may, or may not affect future plans. These study areas include:

Plug-In Electric Hybrid Vehicles Any significant penetration of plug-in electric hybrid vehicles into the automobile fleet in the utility's service territory may require the utility to acquire new resources to meet the added demand. Tacoma Power will monitor technological, economic, political and social developments in this area and consider assessing the impact in a later Integrated Resource Plan. Tacoma Power expects to incorporate information from these studies as appropriate in the next Integrated Resource Plan.

Sixth Power Plan The Northwest Power and Conservation Council is beginning the development of its Sixth Power Plan. Tacoma Power will monitor the progress of the Sixth Power Plan and incorporate information from that plan into the utility's next IRP as appropriate.

Climate Change Activities Tacoma Power is monitoring several activities assessing related to climate change policy (and participating where appropriate) and will incorporate any new requirements or policy direction from Washington State into the utility's future planning activities.

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Section Three: Analysis

Section Four: Implementation Plan

Appendices

Introduction

Why Prepare Integrated Resource Plans?

Electric resources are, for the most part, both very expensive and long-lived. As such, it is important that utilities work hard to make the best possible resource acquisition decisions. Assessing whether to acquire potential new resources is a complicated endeavor that requires consideration of a wide range of factors. Some factors can be readily determined:

- How do capital and operating costs compare between different types of potential resources?
- Is transmission available to bring the power to the utility service territory?
- Does the generation profile complement existing resources and load?
- What training and upgrades of utility operations and maintenance staff will be needed to operate the generation technology?

Other factors are less certain:

- How fuel prices will vary over time
- Will utility load growth (or load reduction) justify the need for the resource?
- How do wholesale electric prices compare to the generation costs of the resource?

Adding to this uncertainty are existing and potential legislative mandates that could alter the cost to attain and operate certain resources in unknown ways (e.g., renewable portfolio standards, minimum renewable resource mandates, carbon taxes, Btu taxes, or a carbon cap-and-trade program). To determine the best resource acquisition decision requires a systematic process to assess these and other factors, prioritize their relative importance and to judge which resource(s), if any, best satisfies a utility's needs and its tolerance for uncertainty.

Tacoma Power uses an integrated resource planning process to help determine the best way to serve its customers. This process employs a comprehensive framework to identify looming deficits in the supply of electricity and to assess the alternative resources available to fill that need. This process is specifically adept at balancing two distinct and competing risks. The first risk is obvious – to ensure that the utility has sufficient resources to satisfy customer demand. The short-sighted solution to this risk is simply to acquire excess resources "just in case" load growth is more than expected. However, because resources are expensive, over acquisition of resources will drive up utility costs and retail rates. Therefore, the second risk is to minimize costs by avoiding unnecessary or premature resource acquisitions. A related cost risk concerns how resources will perform if circumstances (e.g., fuel prices) deviate from the central assumptions made during the decision making process. The integrated resource planning process helps Tacoma Power to determine the resource portfolio that appropriately balances these competing risks.

In addition to minimizing utility costs and risks, Tacoma Power has other corporate objectives. These include maintaining and enhancing system reliability, minimizing adverse environmental and societal Impacts, and expanding resource diversity. All of these objectives were considered during the development of Tacoma Power's Integrated Resource Plan.

This Integrated Resource Plan

Integrated resource planning is essentially a four-step process. The first step is to systematically assess a utility's long-term needs. Here demand projections are compared to supply of owned resources and power supply contracts to determine if and when the utility enters a deficit situation. The results of this assessment are reported in Section Two, Load Resource Balance. The second step is to identify and screen potential new resources to fill the resource gap. This screening considers the direct capital and operational costs of potential resources as well as all indirect costs such as compatibility with existing resources and operational flexibility. This screening is detailed in Section Two, Potential New Supply Resources.

The third step employs a computer model to systematically assess uncertainty and risk associated with each potential resource including, among others, fuel costs, rate of forced outages, potential environmental concerns, and significant changes in customer demand. The model uses this information to predict the cost of each resource under a range of potential futures (i.e., different combinations of wholesale electricity and natural gas prices, system load, and resource costs). This cost information is used to identify the resource acquisition portfolio that minimizes overall costs over the widest array of potential futures. The recommended resource portfolio specifies the types, amount and timing of new resources. This computer modeling is described in Section Three, Power Supply Modeling.

The final step is to create an action plan to implement the findings of the Integrated Resource Plan (IRP or plan) and to identify areas to study and incorporate into the next IRP. Section Four presents Tacoma Power's plan to implement the findings of this IRP.

An attractive attribute of integrated resource planning is that it can be tailored to meet the specific needs and requirements of individual utilities. Tacoma Power is currently facing two decisions that lend themselves well to the integrated resources planning assessment process. The first decision is to determine the best way to comply with the renewable resources requirement of the state Energy Independence Act. Section Two Renewable Energy Credit Supply Balance details the amount of renewable resources Tacoma Power must acquire to meet this requirement. The computer modeling of alternative renewable compliance strategies was integrated into the power supply modeling described in Section Three.

The second decision facing the utility is to select among the two new power supply contracts options offered by the Bonneville Power Administration (BPA). Differences between the two supply contracts are discussed in Section Two, Bonneville Power Administration while the computer modeling of the cost of each contract is presented in Section Three, BPA Power Contract Modeling.

Finally, Tacoma Power believes that public participation is important to the success of an IRP. This belief comports well with state statute that encourages "participation of [utility] consumers in development of the plans." (RCW Title 19 Chapter 285) To this end, Tacoma Power held three public meetings to describe the utility's efforts and solicit feedback on this plan. To maximize public participation, the utility made a special effort to contact representatives of major industrial customers, local environmental and citizens interest groups, and relevant local, state and federal agencies to inform them of these meetings. The first meeting was held on October 12, 2007, and discussed Tacoma Power's overall approach and objectives. The second occurred on November 30, 2007, and described the computer models and important assumptions that Tacoma Power intended to use in the analysis (e.g., conservation potential). Final meeting was on June 27, 2008, and presented the modeling results and the principle conclusions of the plan.

Section One
Planning Environment

Washington state's electric power industry is facing multiple uncertainties and challenges. The market price for electricity is high and volatile. New laws and regulations constrain operational flexibility and limit utility choices when acquiring new resources. The cost of new renewable resources is appreciably higher than conventional resources. Transmission constraints pose operational challenges, especially for intermittent resources such as wind. To this environment Tacoma Power brings a current portfolio of low cost resources that often exceeds customer demand. Continuing to provide low retail rates while meeting new regulatory mandates represents a significant challenge for the utility, its employees, and the City of Tacoma.

Tacoma Power

Tacoma Power is one of the oldest municipally owned utilities in the country. It was incorporated in 1884 as the Tacoma Light & Water Company, a private concern, and purchased by the city in 1893. Today the utility serves some 160,000 customers with an annual load around 600 average megawatts (aMW). Nearly all the electricity provided to retail customers comes from hydroelectric power plants. About two-thirds of the electricity used to serve retail customers comes from the Bonneville Power Administration (BPA), while utility owned power plants provide the rest. Because of the high year-to-year variability of hydro plant electrical production, Tacoma Power assumes critical water (See Section Two: Existing Resources) when planning to serve load. As a result, the utility typically generates more electricity than is needed to serve load. Most of hydroelectric power plants used to serve Tacoma Power's load are located outside of the utility's service territory. The utility uses a combination of owned and contracted transmission resources to bring the electricity from these hydropower plants to the utility's service territory.

First Principle

The mission of Tacoma Power is to "***provide competitive environmentally responsible electric… services through teamwork, technology, and innovation.***" The utility's first and foremost objective is to secure sufficient resources to meet the utility's retail customer load at the lowest reasonable cost. Towards this end, the utility participates in

The City of Tacoma

Tacoma is located on Puget Sound's Commencement Bay, 18 miles south of the Seattle-Tacoma International Airport, and is the economic hub of the South Puget Sound. Tacoma was incorporated in 1884 and became known as the "City of Destiny" when designated the terminus of the Northern Pacific Railroad. Today, Tacoma has grown into an international city, the third largest in the state with a population of just under 200,000. For additional information about the City of Tacoma visit the City's website at: www.cityoftacoma.org.

the wholesale electricity market, principally as a seller of any extra electricity but also as a buyer. In addition, the utility releases excess transmission capacity for use by other entities. While these and other actions provide revenue that allows the utility to keep retail rates low, they are subordinate to the preeminent goal of securing sufficient resources to meet the utility's retail customer demand.

The Regional Electricity System

Tacoma Power, with a present annual load of around 600 aMW, is a small part of a broad regional electricity system. The regional system includes about 50,700 megawatts (MW) of generating capacity, about 65 percent of which comes from hydroelectric power plants, or 33,000 MW. Under normal precipitation, these plants produce about 16,200 aMW of electricity.[1] Each month utilities trade millions of megawatt-hours (MWh) of electricity in the regional wholesale market. As a result, Tacoma Power is subject to the marketplace with little or no ability to affect wholesale market prices.

Relative to historic trends, wholesale electricity in regional markets is presently trading at very high levels of price and price volatility. As an example, on June 18, 2008, the day-ahead price for electricity delivered to the Mid-Columbia (Mid-C) trading hub ranged from $74.00 to $97.00 during heavy load hours and $2.00 to $7.00 during light load hours.[2] Forward prices for heavy load hours in the months of July and August were $98 and $123 per MWh, respectively.

One issue of special concern is the potential for near term generation deficits in certain areas of the Western Interconnection.[3] In particular, Southern California, the desert southwest, and the Rocky Mountain sub-regions appear most vulnerable to system problems, resource shortfalls or unexpected demand growth spurts.[4] As demonstrated during the 2000-2001 energy crises, the repercussions of any supply problems in these sub-regions can quickly propagate up to the Pacific Northwest.

Another concern is the potential for operational challenges arising out of the wide-spread adoption of renewable portfolio standards by states in the region.

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[1] From the Northwest Power and Conservation Council. http://www.nwcouncil.org/library/2004/2004-16/power.htm

[2] Day ahead prices from June 18, 2008 data from Intercontinental Exchange, forward prices compiled from multiple sources.

[3] The Western Electricity Coordinating Council's (WECC) service territory extends from the provinces of Alberta and British Columbia, Canada to the northern portion of Baja California, Mexico, and includes all or portions of the 14 western states in between. It encompasses an area of nearly 1.8 million square miles. The WECC coordinates and promotes electric system reliability. In addition, WECC supports efficient competitive power markets, assures open and non-discriminatory transmission access, provides a forum for resolving transmission access disputes, and helps coordinate the operation and planning activities of its members.

[4] WECC 2005 Power Supply Assessment, May 31, 2005

The mass construction of new wind resources can, due to the high variability of wind, can create difficulties for the smooth operation of the transmission grid.

But perhaps the most important concern trend is the rise of natural gas as the fuel of choice for most new resources. Electricity demand in this region and the west at large has grown to the point that it generally exceeds the generation provided by existing hydro, nuclear, and coal resources. To fill the electricity supply gap, utilities have over the last several years turned to natural gas generation as the most environmentally friendly thermal supply-side resource. As a result, wholesale electricity prices are increasingly driven by natural gas commodity prices – which in recent years have traded at or near historic highs. According to the U.S. Energy Information Agency (EIA), wholesale natural gas prices in Washington grew from $3.83/MMBtu in 2002 to $6.15/MMBtu in 2004 to $7.87/MMBtu in 2006 and are expected to be higher still in 2008.[5]

Tacoma Power and Regional Electricity Markets

Tacoma Power utilizes the wholesale power market to optimize its own portfolio of supply resources (e.g., sell when prices are high, buy when prices are low). Through careful resource management that is attentive to price differentials, Tacoma Power can maximize net wholesale sales revenues and thus reduce the amount the utility must recover through retail rates.

While participating in the wholesale market could create some risks, the utility carefully manages that risk according to the **First Principle** described above. For example, to avoid the potential to oversell electricity and retain too little to satisfy retail customer demand, Tacoma Power constantly monitors its owned and contracted hydroelectric power plants to ensure a healthy supply "cushion" is maintained sufficient to meet all reasonable customer demand. Tacoma Power also ensures that potential trading partners have the ability to pay for and/or deliver electricity promised in a contract. To manage counterparty risk, Tacoma Power maintains a set of trading guidelines and has established procedures for monitoring the continued creditworthiness of approved trading partners.

Regulations and Policies

Several recent laws in Washington state and their associated regulations significantly limit utility resource acquisition options. From Tacoma Power's

Tacoma Power's Green Power Program

In 2000 Tacoma Power launched EverGreen Options, a green power program that offers customers the opportunity to support renewable and environmentally friendly power. The program is currently supplied by green tag purchases from Bonneville owned wind plants. Washington statute required all but very small utilities in the state to offer green pricing programs for their retail customers beginning in 2002. Tacoma Power's EverGreen Options program complies with this law.

[5] Beginning 2009, the EIA projects that prices will fall due in part to an expected growth in liquefied natural gas imports. Natural gas prices found at http://tonto.eia.doe.gov/dnav/ng/ng_pri_sum_a_EPG0_PG1_DMcf_a.htm.

perspective, the most significant new laws are the conservation and renewable portfolio requirements enacted by Washington citizen's initiate No. 937 (The Energy Independence Act, or I-937) in 2006, and the greenhouse gas (GHG) emission limits included in the 2007 Washington State Senate Bill 6001. These laws are discussed in detail below.

Other important new requirements come from multiple provisions of the federal Energy Policy Act of 2005. In addition, the state has a multi-pronged approach to dealing with climate change. Washington is a founding member of the Western Climate Initiative (WCI), an effort to develop and implement a region-wide cap and trade mechanism to limit greenhouse gas emissions. The governor initiated an intra-state climate effort to develop recommendations to curb GHG emissions. This group is known as the Climate Advisory Team (CAT).

Integrated Resource Planning

Tacoma Power has long recognized the value of long-term planning. Despite generally having excess resources, the utility has periodically prepared Integrated Resource Plans – most recently in 2001 and 2004 – to ensure we adequately plan to meet the current and future needs of our customers. This planning has helped Tacoma Power achieve electricity rates that are among the lowest in Washington and the nation.

In addition, in 2006, the state of Washington established a statutory mandate requiring all utilities with more than 25,000 customers to prepare and complete an IRP every four years beginning in September 1, 2008.[6] This mandate is codified at RCW Title 19 Chapter 285. The statute directs affected utilities to "transmit a copy of its plan to the department [of Community Trade and Economic Development]." Specified elements of the plan and the location in this plan where that element is satisfied are as follows:

(a) A range of forecasts, for at least the next ten years, of projected customer demand which take into account econometric data and customer usage – Section Two, Load and Resources;
(b) An assessment of commercially available conservation and efficiency resources. Such assessment may include high efficiency cogeneration, demand response and load management programs, and current and new policies and programs needed to obtain the conservation and efficiency resources – Section Two, Potential New Supply Resources;
(c) An assessment of commercially available, utility scale renewable and nonrenewable generating technologies – Section Two, Potential New Supply Resources;

[6] The statute requires affected utilities to prepare progress reports reflecting changing conditions that affect the IRP and to update the plan every two years.

(d) A comparative evaluation of renewable and nonrenewable generating resources, including transmission and distribution delivery costs, and conservation and efficiency resources using "lowest reasonable cost" as a criterion – Section Three, Power Supply Modeling;

(e) The integration of the demand forecasts and resource evaluations into a long-range assessment describing the mix of supply side generating resources and conservation and efficiency resources that will meet current and projected needs at the lowest reasonable cost and risk to the utility and its ratepayers – Section Three, Power Supply Modeling; and,

(f) A short-term plan identifying the specific actions to be taken by the utility consistent with the long-range IRP – Section Four.

The statute also directs affected utilities to "encourage participation of its consumers in development of the plans." To this end, Tacoma Power held three public stakeholder meetings during the development of this IRP involving representatives of customers, environmental organizations and state agencies. A copy of the information provided at those meeting is provided in Appendix A.

Renewable Portfolio Standards

Renewable Portfolio Standards (RPS) are intended to increase renewable resources acquisition by utilities. Generally, a RPS will specify some minimum proportion of a utility's load that must be served by renewable resources. Currently there is a "patch-work" of state RPS laws across the country but no federal RPS.[7] Most RPS laws allow utilities to satisfy the renewable obligation by acquiring and operating their own renewable energy facilities, by purchasing electricity from renewable energy facilities owned by another party, or by purchasing Renewable Energy Credits (REC). However, important RPS compliance requirements – time frame, resource eligibility, treatment of existing resources, enforcement and penalties, whether RECs may be used, banking and borrowing provisions – vary considerably by state.[8]

In the western United States, many states have adopted an RPS including Washington,[9] Oregon and California. Table 1.1 shows the increasing percentage of load required that must be served by renewable resources in these states over time. Collectively, utilities in Washington and Oregon will have to provide an estimated 5 million MWhs of eligible renewable power by 2012 to meet existing

[7] Several RPS bills have been proposed in the U.S. Congress, but none have been enacted into law. Nevertheless, the next Congress is likely to again take up this issue.

[8] See, http://www.eere.energy.gov/states/maps/renewable_portfolio_states.cfm.

[9] Washington's RPS was enacted by citizen's initiative No. 937. It is codified as the Energy Independence Act in Chapter 19.285 RCW.
See, http://www.secstate.wa.gov/elections/initiatives/text/i937.pdf

RPS requirements. If these MWhs were all from wind resources, the installed nameplate capacity would be around 1700 MW.[10]

Table 1.1
The percentage of load that must be served by renewable resources

Year	2010	2011	2012	2015	2016	2020	2025
Washington			3%	3%	9%	15%	15%
Oregon		5%	5%	15%	15%	20%	25%
California	20%	20%	20%	20%	20%	33%	33%

The Washington RPS allows utilities in this state to apply renewable resources or RECs from Washington, Oregon, Idaho and western Montana towards its renewable requirement. The Oregon RPS allows their utilities to apply renewable resources or RECs produced in the Western Electricity Coordination Council towards that renewable requirement. Looking at the renewable generation in these two states alone, it appears that affected utilities collectively possess sufficient renewable resources to satisfy the first phase of the RPS standards beginning in 2011-2012. However, additional renewable resources will need to be procured to meet the second phase of the standards which begin in 2015-2016. Moreover, while California presently limits the ability of utilities in that state from applying renewable resources located in Washington/Oregon towards their RPS,[11] the California Public Utilities Commission is considering relaxing these restrictions. If this were to happen, competition for renewable resources would intensify likely driving up the price and value of favorable wind locations, turbines and ancillary equipment, transmission services, and the skilled labor needed to operate and maintain the facilities.

Complicating this picture is that all three states have different "safety valve" provisions. Washington's RPS specifies that a utility that spends 4 percent of its revenue requirement towards meeting the renewable requirement is in compliance with the statute. The statute specifies an Administrative penalty of $50 (rises with inflation) for each MWh that a utility falls short of its renewable target. Oregon allows utilities to use alternative compliance payments to comply with the renewable portfolio standard.[12] California's RPS also specifies a non-compliance penalty of $50 per MWh, up to $25 million per year.[13] These

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[10] Wind is the only renewable resource presently capable of generating the scale of electricity required by the Washington RPS. In the Pacific Northwest wind resources typically have a 33 percent capacity factor. Therefore, 1 MW of wind generation is approximately equivalent to 2920 RECs (= 1MW * 8760 hrs/yr *0.33).

[11] Presently, electricity from eligible renewable resources must be brought into the wholesale power grid operated by the California ISO to count towards that state's renewable requirement.

[12] Oregon Senate Bill 838, Sec.20(3).

[13] See http://www.cpuc.ca.gov/PUC/energy/electric/RenewableEnergy/compliance.htm

provisions may reduce the quantity of renewable resources utilities would otherwise be required to obtain.

Limitations on Resource Options

Senate bill 6001, a 2007 Washington state statute, limits the types of generation resources Washington utilities can acquire to meet their needs. The statute established a Carbon Dioxide (CO_2) emissions performance standard for new baseload electric sources (whether an owned generation unit or a power contract). This new standard limits emissions to 1,100 pounds of CO_2 per MWh, the approximate emissions rate for a new, relatively advanced natural gas fired combined cycle combustion turbine. The following emissions do not count against the performance standard:

- Emissions injected permanently in geological formations
- Emissions permanently sequestered by other means approved by the Washington State Department of Ecology (Ecology)
- Emissions sequestered or mitigated under a plan approved by the Washington state Energy Facility Site Evaluation Council

This statute effectively precludes utilities from acquiring coal-fired generation until and unless a process called carbon sequestration becomes commercially available. Carbon sequestration is neither technologically or economically feasible at this time. On June 9, 2008, Ecology promulgated final regulations to implement this Act: The Carbon Dioxide Mitigation and Sequestration Program for Fossil-Fueled Thermal Electric Generating Facilities, WAC 173-407; and Geologic Sequestration of Carbon Dioxide, WAC 173-218.

In addition, all new fossil-fueled electric generation facilities needing approval by the Energy Facility Site Evaluation Council must mitigate 20 percent of their expected carbon dioxide (CO_2) emissions.[14]

Other Emission Reduction Initiatives

In its recently concluded 2008 session, the Washington state legislature passed a new bill that reads, "the state <u>shall</u> limit emissions of greenhouse gases to [1990 levels by 2020, 75 percent of 1990 levels by 2035, and 50 percent of 1990 levels by 2050]" (emphasis added). This new statute requires Ecology to submit for legislative review and approval a greenhouse gas reduction plan describing the actions needed to achieve the emission reduction targets.[15] In addition, this statute directs Ecology to,

[14] See RCW 80.70.020(4).

[15] HB.2815, Sec. 3(1)(a).

> "...develop, in coordination with the western climate initiative,[16] a design for a regional multisector market-based system to limit and reduce emissions of greenhouse gas consistent with the emission reductions established in section 3(1) of this act."[17]

The City of Tacoma has also developed its own climate policies. In April 2006, the Tacoma City Council adopted a resolution supporting efforts to curb global warming and reduce greenhouse gases, while encouraging the continued growth and development of clean technology businesses in the City of Tacoma. As part of this effort, the City created the Green Ribbon Climate Action Task Force to refine reduction goals and develop specific community and government GHG reduction measures. In July of 2008, the Task Force presented its findings and recommendations to a joint meeting of the Mayor, the City Council and the Public Utilities Board. Well received at this meeting, the recommendations include:

- Reducing Tacoma's GHG emissions compared to 1990 by 15% by 2012 and by 80% by 2050.
- Creating an Office of Sustainability.
- Forming a "Tacoma Green Team" to work with other jurisdictions.
- Establishing a citizen oversight committee to hold officials accountable for carrying out the plan.

Achieving CO2 Emission Reduction Targets

A paper by the Northwest Power and Conservation Council provides some perspective on the difficulties the electric sector will face as it works to achieve these CO_2 reduction goals (Carbon Dioxide Footprint of the Northwest Power System, September 2007). The paper reported that CO_2 emissions from the Northwest's electric sector increased from 44 million tons in 1990 to a weather adjusted 57 million tons in 2005. This increase was largely due to the addition of new fossil fuel generation to meet the electrical needs associated with population growth. Moreover, the paper projects annual CO_2 emissions in 2024 will be about 67 million tons (18% higher than normal 2005 levels) even if all conservation, wind, and other resources called for in the Council's Fifth Power Plan are implemented. The addition of state renewable portfolio standards coupled with the elimination of summer spill at regional dams would still leave northwest emissions at about 62 million tons.

Conservation

The enactment of the federal Pacific Northwest Electric Power Planning and Conservation Act in 1980 established conservation as a priority resource for this region. This Act created the Northwest Power Planning and Conservation

[16] The Western Climate Initiative (WCI) is a collaborative effort launched in February 2007 by the Governors of Arizona, California, New Mexico, Oregon and Washington to develop regional strategies to address climate change. WCI is presently working to identify, evaluate and implement collective and cooperative ways to reduce greenhouse gases in the region. Part of this effort is to design a market-based mechanism to reduce CO_2 emissions. This mechanism is scheduled to be rolled out in August 2008.

[17] HB.2815, Sec. 4

Council (NWPCC) to, in part, develop coordinated conservation and resource development plans. These plans help guide regional decision makers on how to meet future electricity loads. The first plan, adopted in 1983, identified about 1,500 average megawatts of achievable conservation available in the Pacific Northwest by the year 2002. Subsequent revisions of that plan have continued to identify large amounts of conservation potential for the region.

Conservation has been an integral part of Tacoma Power's resource strategy for many years. From 1990 though 2006, the utility spent about $72.7 million on conservation. As a result of these expenditures, Tacoma Power's overall load in 2008 is an estimated 20 aMW lower than it would otherwise be. Tacoma Power aggressively seeks to implement cost-effective conservation for multiple reasons:

- It is often less expensive to reduce customer load growth through conservation than to construct and operate new generation resources or upgrade distribution systems. Conservation can delay or avoid the need for such expenditures;
- Several types of conservation are only cost-effective if acquired at specific times. For example, retrofitting buildings with insulation is much more costly than designing and erecting buildings to be energy efficient. Failure to achieve these types of conservation is known as "lost opportunities;"
- Conservation has multiple environmental benefits, from reducing air pollution to allowing more "natural" operation of hydroelectric facilities; and
- Conservation can provide "public benefits." For example, programs to weatherize homes of low income customers can improve the health and welfare of their occupants.

In addition, passage of the Washington state Energy Independence Act established new conservation requirements for Tacoma Power. Beginning in 2010, the utility must assess its 10-year potential for acquiring cost-effective conservation and set specific two-year conservation acquisition goals. The statute specifies a penalty beginning at $50/MWh and rising with inflation for utilities that fail to achieve their conservation goals.

The Federal Energy Policy Act of 2005

The Federal Energy Policy Act of 2005 (EPAct) includes the following provisions that require consideration and a response by Tacoma Power:

1. "NET METERING" Allowing customers to offset some or all of the electric energy provided by the utility to the consumer by delivering electricity to the utility's distribution system from an on-site generating facility.
2. "FUEL SOURCES" Minimizing dependence on a single fuel source to ensure that the electric energy utilities sell to consumers is generated using a diverse range of fuels and technologies, including renewable technologies.

3. "FOSSIL FUEL GENERATION EFFICIENCY" Develop and implement a ten-year plan to increase the efficiency of its fossil fuel generation.
4. "INTERCONNECTION" Allow electric customers to connect any generation on the customer's premises to the local distribution network. Interconnection regulations must be "just and reasonable, and not unduly discriminatory or preferential."
5. "TIME-BASED METERING AND COMMUNICATIONS," Vary electric rates with the utility's costs of generating and purchasing electricity at the wholesale level.

Tacoma Power has determined that state law or regulations, or existing utility policy adequately address provisions 1 through 4. However, provision 5, "TIME-BASED METERING AND COMMUNICATIONS," warrants additional attention. Tacoma Power is presently assessing the cost-effectiveness of smart meters, a fundamental component of a time-based metering and communications program. Among other items, this assessment is investigating the load characteristics by customer class, customer class price response, equipment costs and administration requirements, and costs associated with consumer education. Tacoma Power expects to conclude these studies prior to the completion of our next IRP and will include the results in that plan.

Hydroelectric Resource Variability

In addition to the utility's contract with BPA, Tacoma Power owns and operates five hydroelectric generation projects – Nisqually, Cowlitz, Cushman, Wynoochee and Hood Street – and has a contractual interest in the output from two projects – Priest Rapids and Grand Coulee Project Hydroelectric Authority. The owned projects have a nameplate capacity of 713 MW while Tacoma Power's share of the nameplate capacity of the other projects totals 56 MW. The median annual output that the utility receives from these projects totals about 3.4 million MWhs. However, at critical water, the driest 12 months over the past 72 years,[18] the electricity available from these resources totals a little more than half of the median amount. The importance of these resources to Tacoma Power's overall supply portfolio requires the utility to carefully manage this output variability.

Reserves

Tacoma Power is a balancing authority area and subject to the reliability standards of the North American Electric Reliability Corporation (NERC), the Western Electricity Coordinating Council, and the Northwest Power Pool. The standards are designed to prevent a single contingency (the loss of a power

[18] For Tacoma Power's system critical water is based on the period August 1940 to July 1941.

generation facility or major transmission) causing the electric system to fail. Each balancing authority area must provide a "contingency reserve" equal to the greater of its most severe single contingency or a percent of its on-line generation and load. A "regulating reserve" is also required to cover instantaneous load following. Contingency reserves and regulating reserves are together referred to as "operating reserves." Half of the contingency reserve and all of the regulating reserve must be spinning reserve (i.e. the unit providing the reserve must be operating and connected to the electric system). The remainder may be spinning reserve or non-spinning reserve (the utility must be able to fully access it within 10 minutes). Interruptible load or interruptible exports can also meet the non-spinning requirement. Tacoma Power is responsible for meeting these operating reserve requirements at all times.

Conclusion

The environment in which Tacoma Power finds itself in is becoming increasingly complicated and uncertain. The utility is facing substantial risks due to market volatility while current and expected environmental regulation limits operational flexibility. Satisfying these new regulatory mandates while continuing to meet our core objective to secure sufficient resources to meet the utility's retail customer demand at the lowest reasonable cost will present a significant and ongoing challenge for Tacoma Power.

Section Two
Current Situation/Knowledge

One key aspect of integrated resource planning is to assure that Tacoma Power will have adequate resources to meet expected load and all regulatory mandates. This section opens with an explanation of our load forecasting process. Next the IRP examines the multiple resources already at Tacoma Power's disposal including conservation. This analysis indicates that the utility is likely to have sufficient resources to meet retail load through around the year 2017 under expected case assumptions. This section also identifies and screens potential new resources. Finally, this section of the IRP discusses some issues related to Tacoma Power's and the regions transmission system.

Load and Resources

Load Forecast

Tacoma Power forecasts its long-term load once per year; most recently in August 2007. The load forecast is made using a combination of econometric modeling and specific demand estimates for certain large customers. The forecast incorporates estimates of unemployment and employment, energy prices, and population. It also incorporates the latest information available concerning new large individually identifiable loads. The 2007 forecast includes estimates of the load reduction caused the Energy Independence Act (Initiative No. 937), both due to enhance conservation and to behavioral changes brought on in response to the expected higher retail rates.

Explanation of Econometric Model Tacoma Power uses econometric models to forecast retail load. Historically, the weather adjusted load predictions of these models have averaged within 1.0 to 1.5 percent of actual customer demand. The data available to date suggests that the load forecast used by this IRP falls within 1.0 percent of the actual load.

At their most basic level, the load forecast models use statistical methods to correlate historical energy sales to economic, demographic, and weather data such as heating and cooling degree-days.[19] These

Heating & Cooling Degree-Days

The weather component of the econometric model is based on actual heating degree-days (HDD) data. A HHD is calculated by 1) adding together the maximum and minimum temperatures for the day (Fahrenheit scale) and dividing the sum by two, 2) subtracting the mean temperature from 65°F. Each degree of mean temperature below 65°F is counted as one heating degree day. Cooling degree days (CDD) are also included in the specification. The CDD variable is not hugely influential in the monthly model, but can be highly significant in our daily and hourlv models.

[19] There are a variety of ways in which the equations may be set up or specified. The current equations use untransformed variables and are estimated using a generalized least squares technique.

correlations are reduced to simple algebraic equations and used to forecast future sales. Tacoma Power includes specific variables in these equations to account for the aberrations experienced during the 2000-2001 energy crises as well as to account for the emerging sensitivity of utility load to summer weather.

The major drivers for the demographic portion of the forecast are population and employment activity. Tacoma Power obtained data for these inputs from 2006 Puget Sound Regional Council projections. These data were also used to project residential, commercial and industrial customer growth for Washington's Pierce County. The local unemployment rate came from a 2007 projection by GLOBAL-INSIGHT for Pierce County. In general, Tacoma Power does not anticipate major changes in the real levels of major economic and demographic explanatory variables with the exception of real prices (prices adjusted for inflation), which are expected to grow by about 2.5 percent per year.

Table 2.1 presents the major economic and demographic annual growth assumptions used in the model.[20] Customer growth rate is estimated at 1.0 percent, and the underlying rate of inflation is estimated to average 1.9 percent.

Table 2.1
Annual Economic and Demographic Growth Assumptions of the Mode

	Customer Growth	Inflation	Unemployment	Real Prices
2008-2010	1.1%	1.9%	4.8%	0.7%
2011-2020	1.0%	1.9%	4.9%	0.5%
2021-2027	0.8%	1.9%	5.1%	0.2%

Directly Estimated Sales Tacoma Power also serves some customer classes whose sales are not good candidates for forecasts using statistical techniques. These classes include the High Voltage General (HVG) Service which includes seven customers and Contract Industrial (CP) Service with two customers. Sales projections for two military installations are derived from load growth estimates provided by instillation engineers. Estimates for the remaining HVG and CP customers come from observations of their historical consumption, as well as discussions with personnel at the various facilities regarding expected changes in operations that might affect overall electricity consumption.

Trend Estimates Sales for street lighting and traffic signals are estimated by observation using a trending analysis. Private off-street lighting is a small class and sales are expected to follow underlying residential growth rates.

Forecast Results Table 2.2 shows projected sales and inter-year growth rates for four large retail sectors (several other retail sectors not shown): Residential

[20] Sources: Customer Growth – 2006 Puget Sound Regional Council Forecast, Inflation and Unemployment – Global Insight 2007 Spring Long-term Forecast, Real Prices – EIA 2007 Energy Outlook w/adj for I-937, Employment – 2007 Puget Sound Regional Council Forecast

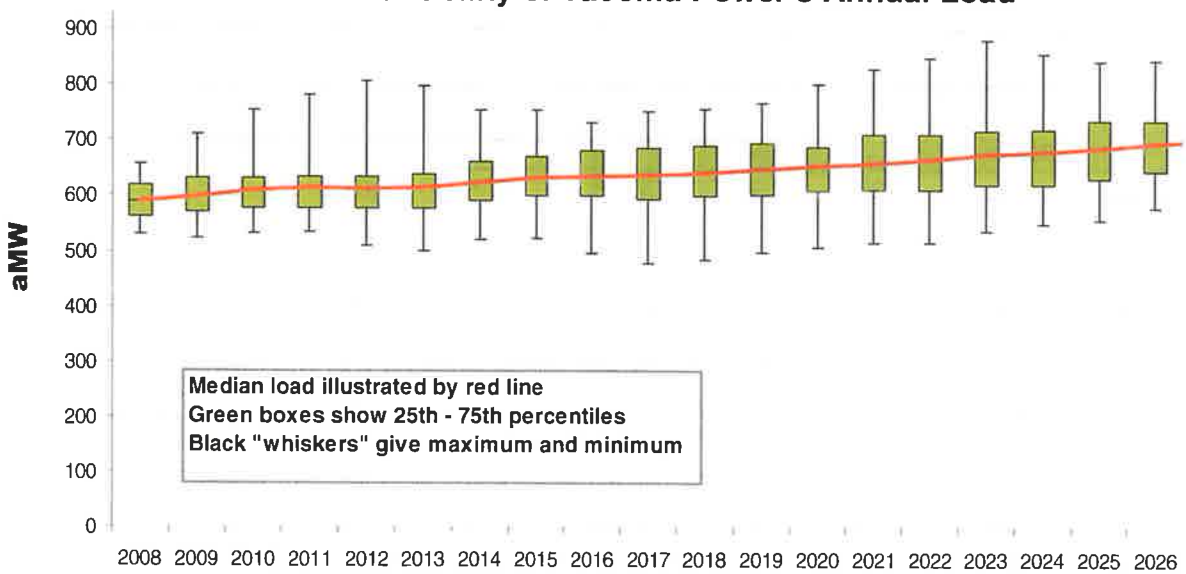
Service, Small General Service, General Service, and High Voltage General Service sectors. Overall, sector sales are expected to remain relatively flat in the near-term (2010-2013). The one exception is the projected strong growth in the High Voltage General Service class, due to the expansion at Fort Lewis coupled with the growth of the Port of Tacoma. Over second half of the forecast period, (2014-2026) sales for most classes are expected to resume growing. Again, one exception to this trend is High Voltage General Service where during these latter years relatively flat growth is expected. In addition, the General Service Class is also expected to have modest to strong growth during this time period. The overall long-term energy growth rate is projected at 0.6 percent.

Table 2.2
Projected Sales and Inter-Year Growth Rates for Select Retail Sectors

	Residential		Small General Service		General Service		High Voltage General Service	
	aMW	% Δ	aMW	% Δ	aMW	% Δ	aMW	% Δ
2008	215	1.6%	39	2.1%	205	3.0%	54	5.2%
2009	217	0.8%	39	0.5%	209	2.3%	56	3.0%
2010	216	-0.3%	39	-0.6%	213	1.5%	63	13.9%
2011	214	-0.7%	38	-0.6%	215	0.9%	66	4.1%
2012	212	-0.9%	38	-0.6%	216	0.9%	68	2.9%
2013	211	-0.9%	38	-0.6%	218	0.9%	68	-0.2%
2014	212	0.6%	39	1.4%	223	2.1%	72	5.8%
2015	213	0.7%	39	1.7%	228	2.2%	71	-0.7%
2016	214	0.1%	39	0.7%	231	1.5%	71	-0.4%
2017	214	0.3%	40	0.6%	235	1.5%	71	-0.5%
2018	215	0.3%	40	0.6%	238	1.5%	70	-0.2%
2019	216	0.4%	40	0.6%	242	1.5%	71	0.1%
2020	218	0.8%	40	0.6%	246	1.9%	71	0.1%
2021	219	0.7%	41	0.7%	251	1.8%	71	0.1%
2022	221	0.7%	41	0.9%	255	1.8%	71	0.1%
2023	222	0.7%	41	0.9%	260	1.8%	71	0.1%
2024	224	0.7%	42	0.9%	265	1.8%	71	0.1%
2025	225	0.7%	42	0.9%	269	1.8%	71	0.1%
2026	227	0.7%	43	0.9%	274	1.8%	71	0.1%

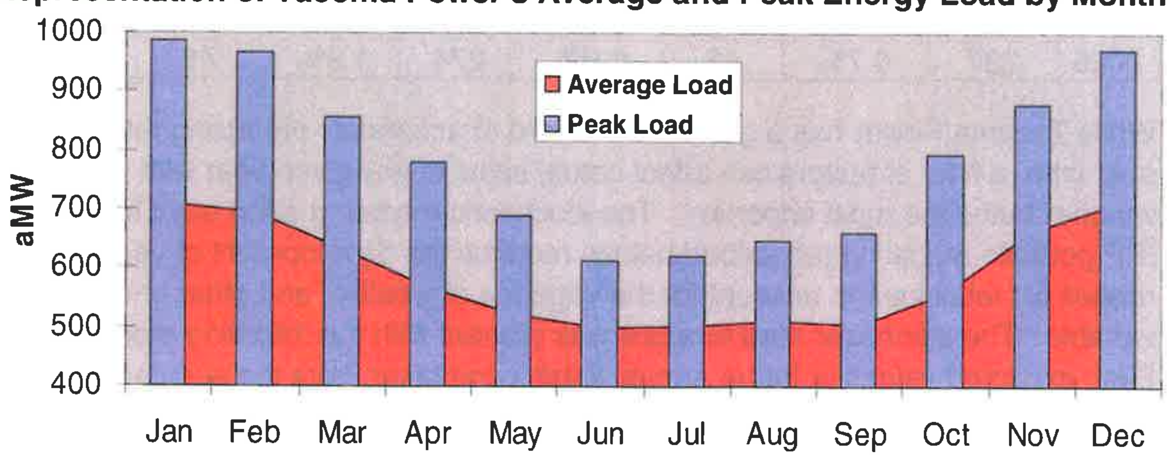
While Tacoma Power has a good track record of accurately predicting retail sales over time, a host of factors can affect actual sales in any given year with perhaps weather being the most important. The stochastic modeling effort used for the IRP portfolio modeling (described below) requires the development of yearly ranges for retail load to account for the vagaries of weather and other uncertain variable. The stochastic load forecast was created with the following process. First, expected values of future annual loads were taken from the standard Tacoma Power load forecasting process. Second, expected future month-of-year, day-of-week, and hour-of-day shapes were derived from a statistical analysis of historical load data. Third, annual volatility, as well as the volatility of month-of-year, day-of-week, and hour-of-day shapes, were derived from a statistical analysis of historical load data. Fourth, a Monte Carlo process was used to generate the stochastic load forecasts, utilizing the expected future annual loads and month-of-year, day-of-week, and hour-of-day shapes; estimates of the volatilities of these parameters; and randomly generated disturbance terms. Figure 2.1 presents Tacoma Power's estimates of the potential variability of annual load over time.

Figure 2.1
Estimated Variability of Tacoma Power's Annual Load



Another important aspect of retail load is how it varies within a year. Figure 2.2 presents a representation Tacoma Power's projected firm average and peak energy load by month. The energy load is the sum of individual rate class retail

Figure 2.2
Representation of Tacoma Power's Average and Peak Energy Load by Month



sales estimates, adjusted for losses and programmatic conservation savings (see Conservation section below). This figure clearly shows that Tacoma Power is a winter peaking utility, for both the average and peak load.

Existing Resources

Tacoma Power uses a variety of resources to satisfy its retail load. As indicated above, Tacoma Power's largest power resource is the Priority Firm Power Block Sales Agreement with BPA, which supplies more than half of the electricity used to meet Tacoma Power's retail load. The current BPA contract began on October 1, 2001 and concludes on September 30, 2011. Tacoma is negotiating the terms of the next BPA contract. For a detailed discussion of this topic, please see Section 2: The Bonneville Power Administration below.

Also as noted above, Tacoma Power owns and operates five hydroelectric generation projects – Nisqually, Cowlitz, Cushman, Wynoochee and Hood Street – and has a contractual interest in the output from two projects – Priest Rapids and Grand Coulee Project Hydroelectric Authority. (See Table 2.3).

Table 2.3[21]

Overview of Tacoma Power's Owned and Contracted Resources

Project	Facility	Nameplate Capacity (MW)	Median Energy Production (MWh / aMW)		Critical Energy Production (MWh / aMW)	
Owned Projects						
Cowlitz	Mayfield	162	726,877	83.0	349,657	39.9
	Mossyrock	300	1,114,060	127.2	530,455	60.6
Nisqually	Alder	50	247,067	28.2	127,698	14.6
	La Grande	64	369,675	42.2	198,482	22.7
Cushman (Skokomish)	No. 1	43	124,488	14.2	108,120	12.3
	No. 2	81	222,865	25.4	191,033	21.8
Wynoochee	Wynoochee	13	33,288	3.8	31,506	3.6
Hood St.		0	2,474	0.3	2,474	0.3
Contracted Share						
Grand Coulee Project Hydroelectric Authority		0	241,212	27.5	241,212	27.5
Priest Rapids		56	355,506	40.6	329,624	37.6
Total		**769**	**3,437,512**	**392.4**	**2,107,789**	**240.6**

Cowlitz Project The largest of Tacoma Power's hydroelectric projects, the Cowlitz Hydroelectric Project, consists of two coordinated hydroelectric plants, Mossyrock and Mayfield. Both plants are located on the Cowlitz River in Lewis

[21] Production figures from Tacoma Power's February 27, 2007, Official Statement associated with the refunding of certain revenue bonds. Tacoma Power's share of the output from the Priest Rapids project is expected to decline.

County, Washington. The Mossyrock powerhouse contains two generating units, each rated at 150 MW, for a total nameplate capacity of 300 MW. Both of the generating units at the Mossyrock plant (Units 51 and 52) are now beyond their design life. Around 2003, Tacoma Power staff began to comprehensively assess the best course of action with the Mossyrock facility. This assessment, which included review by an external independent consulting engineering firm, concluded that Tacoma Power should rebuild the existing units. At this time, the Mossyrock facility is undergoing refurbishment. The date of commissioning for Units 51 and 52 is October 30, 2008, and September 30, 2009, respectively.

Figure 2.3 – Mossyrock Dam

Mayfield dam, located approximately 13.5 miles downstream of the Mossyrock dam, was initially placed into operation with three generating units in 1963. A fourth unit was added in 1983. The dam includes a concrete arch and gravity dam, 200 feet high and 850 feet long, with a controlled spillway having five tainter gates. Project water is conveyed to the Mayfield powerhouse via a 37-foot diameter power tunnel, 854 feet long, and four 18-foot diameter power penstocks. The Mayfield powerhouse contains four Francis generating units, each rated at 40.5 MW, resulting in a total nameplate rating of 162 MW. Both Cowlitz Hydroelectric Project dams are operated by Tacoma Power under the terms of a single license issued by the Federal Energy Regulatory Commission (FERC).

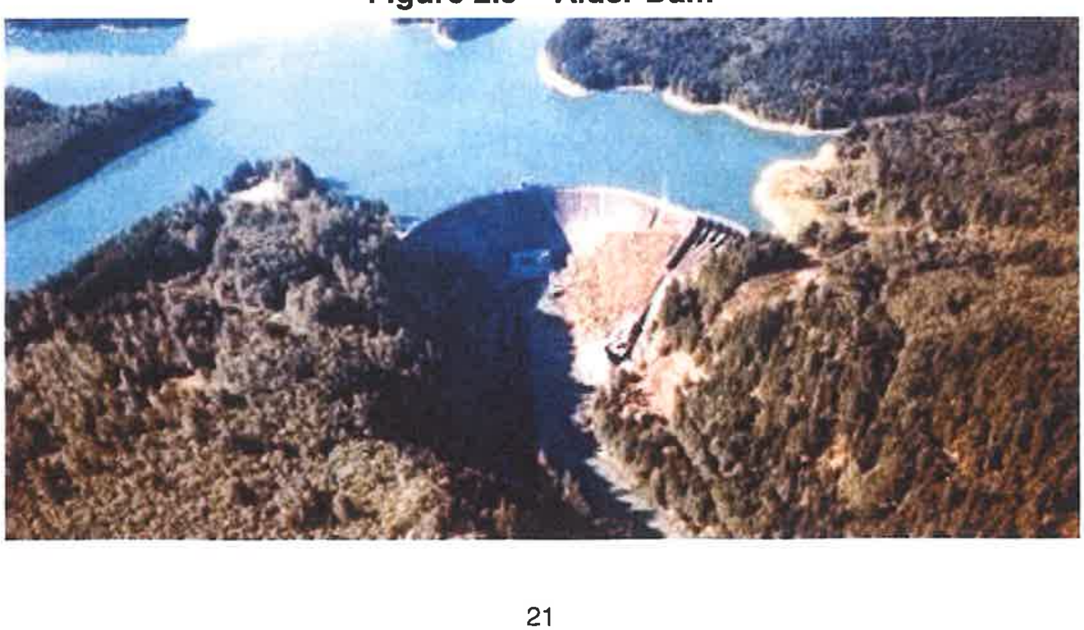
Figure 2.4 – Mayfield Dam

Nisqually Project The Nisqually Hydroelectric Project consists of two separate dams on the Nisqually River, Alder and LaGrande, located approximately 30 miles southeast of Tacoma. The Alder plant, constructed in 1945, includes a concrete arch dam and a powerhouse containing two Francis turbine/generator units having a total installed nameplate rating of 50 MW.

Environmental Stewardship

The National Hydropower Association awarded the Nisqually River Project with three annual Outstanding Stewardship of America's Rivers awards. The Nisqually River Project also has received a five-year, low impact hydroelectric certification from the Low Impact Hydropower Institute; this certification is in the process of being extended.

Figure 2.5 – Alder Dam



The LaGrande plant consists of a concrete gravity dam, a gated spillway and powerhouse. The plant was upgraded in 1944 with the construction of a new dam and the addition of a Francis turbine/generator unit for a total nameplate rating of 45 MW.

Cushman Project The Cushman Hydroelectric Project consists of two hydroelectric plants located on the North Fork of the Skokomish River in Mason County, Washington. They are approximately 36 miles northwest of Tacoma. The construction of Cushman No. 1, a concrete arch dam, created the Lake Cushman Reservoir. Cushman No. 1 was completed in 1926 and upgraded in 1987-88. Its total nameplate rating is now 56 MW.

Cushman No. 2 was constructed in 1930 with two 27 MW Francis generating units. A third 27 MW Francis unit was added in 1952. The total installed nameplate rating of Cushman No. 2 is 81 MW. Cushman No. 2 is somewhat unusual in design in that the powerhouse is 2.5 miles from the dam and is fed by a 17 foot diameter power tunnel.

Wynoochee Project The Wynoochee Hydroelectric Project consists of a concrete gravity dam, with earthen embankments. The Wynoochee Project supports a variety of purposes in addition to generation, including water supply, flood control, recreation, enhancement of fisheries and irrigation. The powerhouse was constructed in 1993 and contains a single Kaplan turbine, which has a nameplate capacity of 12.8 MW. The project's generation is transmitted to the BPA transmission grid over Grays Harbor County Public Utility District's transmission system under a contractual arrangement and over BPA's transmission grid to Tacoma Power.

FERC Licensing of Hydroelectric Plants

Federal law subjects the hydroelectric projects that Tacoma Power has interest in (4 owned and 2 by contract) to FERC licensure. To issue a license, FERC must find that a project is in the broad public interest. This requires balancing cultural, recreation, land-use, and fish and wildlife, interests with energy production. Numerous stakeholders participate in the process, including federal agencies, Indian tribes, non-governmental organizations, and local communities and governmental entities. Some state and federal stakeholders can place mandatory conditions on a license. For example, the National Marine Fisheries Service and the Fish and Wildlife Service can require the installation of fish passage facilities. The FERC license must also be consistent with certain state and federal laws, such as the Endangered Species Act and the Clean Water Act. Overall, the hydroelectric relicensing process is very complex, always political and usually controversial.

In 1997, FERC issued a 40-year license for the Nisqually project and in 2003 a 35-year license for the Cowlitz project. Wynoochee has a 50-year license that runs through 2037. A 40-year license was issued for the Cushman project in 1998; however, Tacoma Power appealed the license because the conditions were prohibitively expensive. In August of 2006, the U.S. Court of Appeals for the District of Columbia Circuit remanded the license to FERC for further evaluation. Tacoma Power is vigorously working towards an acceptable and economic license. One area of the Cushman license that has settled is the minimum flow requirement – the lessor of 240 cubic feet per second or inflow. If efforts to settle other parts of this license are not successful, Tacoma Power could refuse the license and terminate generation. Under such circumstances, Tacoma Power will need to replace the lost generation – approximately 5 percent of the utility's resource portfolio.

Figure 2.6 – Cushman No. 1 Dam

Figure 2.7 – *Wynoochee* Dam

Currently the cities of Tacoma and Aberdeen share ownership of the facilities at the Wynoochee Project. Tacoma owns the powerhouse, substation, and all improvements made by Tacoma. Aberdeen owns the dam, reservoir and all original facilities constructed by the Corps of Engineers. While Tacoma and Aberdeen are co-licensees, Tacoma handles all FERC correspondence and operates the dam and other facilities as well as the powerhouse. In 2000, Congress passed legislation permitting transfer of title from Aberdeen to Tacoma. A Memorandum of Agreement outlining the terms of this title transfer is under review by the Corps of Engineers.

Hood Street Tacoma Power owns a small generator installed at Tacoma Water's Hood Street Reservoir. The project generates an average of 2,499 MWh annually and began operating in 1990.

Priest Rapids Contract Tacoma Power purchases power from the Priest Rapids Hydroelectric Project under several long-term agreements with Grant County PUD. The agreements provide Tacoma Power the right to purchase a proportionate share of Priest Rapids generation in excess of the actual and prospective needs of Grant County PUD. Tacoma Power's share is forecasted to significantly decline as Grant County PUD load increases. In April 2008, FERC issued a new 44-year operating license for the Priest Rapids Project. Tacoma Power's agreements with Grant County PUD run for the term of this license.

Grand Coulee Project Hydroelectric Authority The cities of Tacoma and Seattle have entered into five power purchase agreements with three Columbia Basin Irrigation Districts (South, East and Quincy) for the acquisition of the output of five low-head hydroelectric projects that were constructed along irrigation canals in eastern Washington. These projects are operated by the Grand Coulee Project Hydroelectric Authority ("GCPHA," an agency of the three districts) and utilize water released during the irrigation season. Tacoma Power receives 50% of the actual output of each project. The total installed capacity of all five projects is approximately 130 MW. Over the years 2004-2007 Tacoma Power's share of the output of these projects averaged approximately 251,000 MWhs. The five agreements for the output of these projects terminate between 2022 and 2026.

The Bonneville Power Administration

The BPA is required by the Pacific Northwest Electric Power Planning and Conservation Act to offer to eligible utilities, such as Tacoma Power, sufficient power to meet the portion of the utility's firm power loads requested. The current BPA contract began on October 1, 2001 and concludes on September 30, 2011. The quantity of power supplied under this contract is determined by subtracting Tacoma's monthly forecasted demand under Heavy Load Hours (HLH) and Light Load Hours (LLH) from its own resources under critical water conditions. This amount is termed Tacoma Power's "net

The Bonneville Power Administration

The BPA was established by Congress in the Bonneville Project Act of 1937. BPA's central mission is 1) to operate and maintain a reliable regional transmission grid and 2) to market electricity at cost from federally owned and contracted facilities to Northwest utilities. This federal system represents approximately 20,000 MW of capacity and a firm energy capability of 9,590 aMW; sources include 31 federally owned hydroelectric facilities, one nuclear plant and several nonfederal power plants, such as wind plants. BPA sells electric power at wholesale rates to 127 utility, industrial and governmental customers in the Northwest. The federal system produces approximately 35 percent of the region's energy requirements. BPA's transmission system has over 15,000 miles of transmission lines, provides about 75 percent of the Northwest's high-voltage bulk transmission capacity, and serves as the main power grid for the Pacific Northwest. Its service area covers over 300,000 square miles and has a population of about 11 million.

requirement" and varies by month. In the first year of the contract, BPA delivered 385 aMW to Tacoma Power. That quantity increased over the next five years to 429 aMW, the approximate value where it remains today. The rates BPA charges for this power have declined since 2004, from approximately $29.70 per MWh to $27.30 currently. Each year of the contract, BPA and Tacoma Power review Tacoma's net requirement to determine if an adjustment to deliveries is necessary.

Regional Dialogue BPA, its customers and other regional stakeholders are participating in a Regional Dialogue to define BPA's long-term power supply and marketing role in the region. The timing is critical because current power sales contracts expire in 2011. By the end of 2008, utilities will need to determine the type of power supply contract they will enter with BPA. More importantly, they need sufficient lead time to make choices about whether to develop or otherwise secure additional resources needed to serve their load for 2012 and beyond. Tacoma Power has been a major contributor in the Regional Dialogue process with the ultimate goal of reliable service and low-cost rates for our customers.

The cornerstone of the Regional Dialogue was set in BPA's February 2005 policy paper entitled Policy for Power Supply Role for FY 2007-2011. In September 2005, BPA released a Concept Paper as a starting point for collaborative discussions on the policy issues that must be resolved before new contracts and rates can be put in place. The Long-Term Regional Dialogue Policy Proposal (Policy Proposal), released in July 2006, incorporated public comment from workshops held on the Concept Paper. Following release of the Policy Proposal, BPA held extensive regional meetings and took public comment. In July 2007, BPA published its Long-Term Regional Dialogue Final Policy paper which sets the parameters for moving forward towards BPS offering new contracts in late 2008 and establishing new rates for 2011.

2011 Contracts Several important steps remain before BPA can offer new contracts. BPA must conduct a net requirements load determination process. Part of this process is to review certain identified aspects of the treatment of utility resources (the Section 5(b)/9(c) Policy). A Section 7(i) rate process (ratemaking) is needed to establish the long-term Tiered Rate Methodology, followed by a separate 7(i) process to set the FY 2012 rates when power sales commence under the Regional Dialogue contracts. The outcome of these steps will lead to the negotiation and drafting of new contracts, and ultimately, their signing and entering into force.

Northwest Power Act: Rate Setting and Utility Eligibility Policies

Section 7(i) of the Northwest Power Act details the formal process BPA uses to set rates.

Section 5(b) sets the process by which BPA determines whether a utility is eligible to purchase power from BPA.

Section 9(c) sets out how utility owned resources are to be treated when BPA determines the amount of power utilities are eligible to purchase.

> ***BPA Tiered Rates***
>
> One of the most significant changes in the draft 2012 contracts from the current rate structure is the establishment of tiered rates. Through the proposed rate methodology, each public utility will get a High Water Mark (HWM) that defines its right to buy an amount of power at BPA's lowest cost-based Tier 1 rate. Power above the HWM must be purchased from either non-Federal resources or from BPA at a Tier 2 rate reflecting BPA's marginal cost of acquiring the additional power. BPA will not subsidize its Tier 2 power rate but does intend to offer a number of alternative Tier 2 rate options for customers who choose not to develop their own resources for load beyond their HWM.

BPA indicates that it will continue to offer its customers three product choices: Block (with an option to add Shaping Capacity), Slice and Load-Following. The Block with Shaping Capacity product is a pre-established monthly amount of HLH and LLH energy based on a forecast of the customer's net requirements. The Shaping Capacity part of this product allows customers to modify electricity delivery in the HLH periods to more closely fit their hourly requirements. Under the Slice product a customer simply receives a portion of the Federal system generation[22] under a fixed monthly rate. The Slice product is a combination of Slice paired with a simple Block (monthly shaped). The Load-Following product follows the actual loads a customer experiences. Tacoma Power is not eligible for load following service since we own resources and operate within our own balancing authority area. The Slice and Block products do not include any load-following service.

The 2011 contract negotiations must also account for a number of factors and risks that could impact BPA's costs and the amount of low-cost Tier 1 power available. These include 1) federal legislation, 2) BPA's obligations regarding its outstanding federal debt, 3) number of customers, 4) water conditions, 5) fish, wildlife, and other environmental regulations that could impact expenditures and amount of power produced at various projects, 6) Residential Exchange,[23] 7) capital needs of the Federal System, and 8) regional transmission issues. As described in Section Three: BPA Power Contract Modeling, of this plan, Tacoma Power expects to receive a minimum of about 440 aMW of electricity from BPA through this contract at Tier 1 rates.

Conservation

Energy Independence Act The recently enacted Energy Independence Act (a.k.a. I-937) requires that utilities undertake all "cost effective" conservation. To implement this requirement, the Act requires utilities to identify a 10-year achievable conservation potential and then prorate that potential into a 2-year conservation target. Beginning 2010, this target establishes the baseline against

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[22] The Slice customer then takes the risk on generation amounts based upon hydro conditions,

[23] The Residential Exchange is a program through which BPA provides money to those residential and farm customers served by our region's investor-owned utilities. Public Utilities such as Tacoma Power fund the exchange through BPA rates. The amount of the Residential Exchange has been embroiled in litigation for years.

which individual utility's compliance with the conservation requirement will be assessed. Utilities that fail to meet their conservation target will be assessed a $50/MWh (escalating with inflation) penalty for every MWh they fall short of their target. Moreover, this penalty amount increases with inflation.

Conservation Potential Assessment Prior to passage of the Energy Independence Act, Tacoma Power had issued a Request for Proposal to comprehensively assess the conservation potential within the utility's service area over 20 years. Ultimately a contract was let with Quantec LLC, of Portland, OR. Upon passage of the Act, Tacoma Power updated the scope of the contract to ensure it met the requirements of the Act. The assessment used a regionally-accepted framework to identify and screen the cost-effectiveness and implementation potential of several thousand conservation measures. (Appendix B presents a more complete overview of the Quantec methodology and results.) The resulting report is called the 2007 Conservation Potential Assessment (CPA).

The CPA identified three commonly used levels of conservation planning. The technical potential is all possible or technically feasible conservation resources regardless of cost or market barriers. The economic potential screens these technical available conservation resources to determine which are cost effective (see sidebar). The achievable potential recognizes that market barriers such as customer preferences will prevent some cost effective conservation resources from being acquired. Determining the achievable potential is difficult because it depends on incentive levels, planning horizon, and customer sector as well as difficult to predict market factors.

Overall, the CPA identified 54 aMW of cost-effective and achievable conservation in Tacoma Power's service territory over the next 10 years (See Table 2.4). The ten-year 54 aMW achievable potential prorates into a one year goal of 5.4 aMW. Tacoma Power's 2006-2007 conservation savings were just over 1.0 aMW. To meet the 5.4 aMW conservation acquisition target by 2010,

Total Resource Cost Methodology

The term "cost effective" considers more than just whether a conservation measure is less expensive than constructing a new generating facility. Rather, it also includes benefits (and costs) at a societal level. The test for determining whether a measure is cost effective is known as the Total Resource Cost (TRC) methodology. The TRC estimates the life-time direct costs of a measure or resource. These include initial, distribution, operation (e.g., fuel), waste disposal, end-of-cycle costs, and quantifiable environmental attributes. Three common TRC metrics are:

- The Benefit/Cost ratio (B/C ratio) is the present value of all benefits divided by the present value of all costs. Measures or bundles of measures with B/C ratios greater than one are accepted in the conservation potential.
- The Net Present Value is the present value of benefits minus the present value of costs. If larger than zero, the measure can be part of the conservation potential.
- The Levelized Cost metric is the sum of the present value costs divided by nominal lifetime kWh savings of the measure. The Levelized Cost metric is used to compare conservation resources considered for development.

Tacoma Power plans to develop utility and supplier/contractor infrastructure and to consolidate offerings into a mix of new and modified programs. Even with this effort, it is difficult to predict the exact amount of conservation the utility will obtain each year. Evolving economic and technological factors influence customer conservation acquisition decisions.

Table 2.4
Estimated Conservation Potential in Tacoma Power's Service Territory

Sector/Segment	Technical Potential (aMW)	Economic Potential (aMW)	Achievable Potential (aMW)
Residential	**66.6**	**42.3**	**22.7**
Existing Retrofit	54.1	33.4	
Replace Existing Equip.	5.4	4.2	
New Const. & Equip.	7.0	4.7	
Commercial	**59.7**	**34.6**	**16.8**
Existing Retrofit	43.9	24.6	
Replace Existing Equip.	4.8	3.9	
New Const. & Equip.	11.0	6.1	
Industrial	**22.6**	**22.5**	**11.6**
Military	**9.9**	**5.8**	**2.9**
Total*	**158.7**	**105.2**	**54.0**

* The figures may not exactly add due to rounding.

As is common practice in the conservation industry, the values presented reflect first year achievable savings. Some conservation measures such as fluorescent light bulbs in commercial building last a relatively short time (~3 years) others like home and building insulation will last much longer (20+ years). As a result, a portion of each year's conservation savings will carry forward to subsequent years.

In response to the Energy Independence Act mandate that utilities reassess their 10-year conservation potential every two years, Tacoma Power has begun an update of the CPA (See Section Four, Conservation Assessment Potential). Tacoma Power expects that the present 5.4 aMW annual target will change somewhat with the completion of the CPA update.

Load Resource Balance

A central component of utility planning is the Load Resource Balance (LRB). It identifies the timing and magnitude of potential future resource deficits. With this information utilities can plan on a timely basis to acquire the resources needed to serve load.

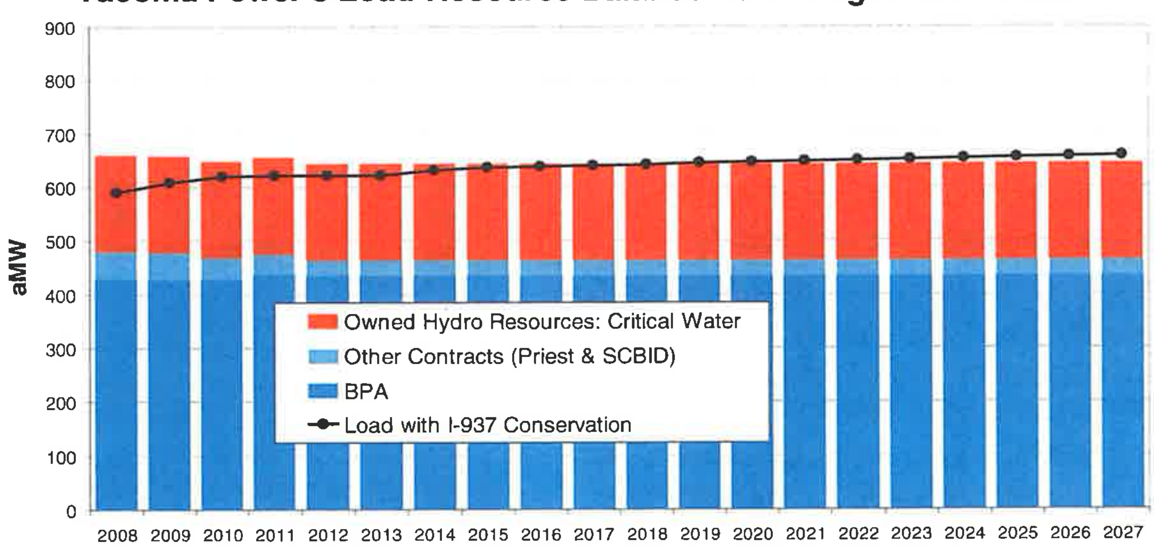
Figure 2.8 presents Tacoma Power's LRB. The bars indicate power supply resources: dark blue represents the electricity the utility receives under the BPA contract; light blue covers electricity from other contracts; red is the electricity from the utility's own hydroelectric resources (assuming critical water). The black line indicates the utility's forecasted load (including conservation). Figure 2.8 makes evident that, even assuming critical water, Tacoma Power is resource adequate throughout most or all of the IRP planning horizon, at least under expected load forecasts.[24]

> ***Resource Adequacy***
>
> When preparing the LRB Tacoma Power presumes its hydro facilities are operating under critical water conditions -- the lowest 12-months of river inflows ever recorded at the utility's hydro power plants (from August 1940 to July 1941). Tacoma Power assumes critical water to ensure the utility can meet its first principle of securing sufficient resources to meet load.
>
> Recently, the NWPCC hosted the Pacific Northwest Resource Adequacy Forum to develop a regional resource adequacy standard. On April 16, 2008, the NWPCC adopted the Forum's recommended voluntary standard. This voluntary resource adequacy standard appears less conservative than Tacoma Power's internal approach in that it allows utilities to include uncommitted Northwest Independent Power Producer resource generation in their resource availability estimates.

Figure 2.9 makes one addition to Figure 2.8. The yellow bars identify energy expected under average water conditions. Average water conditions are based on a 72-year record of river flows. It is clear that if river flows even approach average volumes, the utility is significantly surplus and looks to stay that way for the foreseeable future.

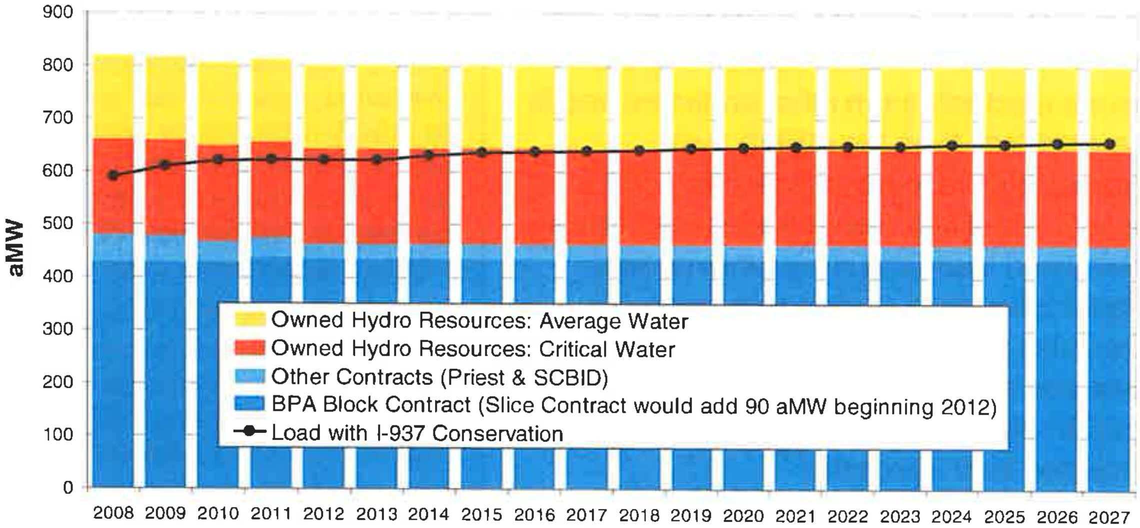
Figure 2.8

Tacoma Power's Load-Resource Balance Assuming Critical Water



[24] The IRP portfolio modeling analysis addresses the most important uncertainty regarding Tacoma Power's LRB – what happens if loads turn out to be greater than expected. See Section 3: Power Supply Modeling.

Figure 2.9
Tacoma Power's Load-Resource Balance Assuming Average Water



Renewable Energy Credit Supply Balance

As a result of passage of the Energy Independence Act, electric utilities will have to ensure that electricity from renewable resources makes up a specific proportion of the energy provided to customers: 3 percent beginning 2012, increasing to 9 percent in 2016, and 15 percent by 2020. This requirement has added a significant new component to the IRP. Instead of simply identifying the least cost and least risk resource portfolio that satisfies customer demand, the IRP must now also determine the best approach to comply with this renewables mandate. Eligible renewable resources include Wind, Solar, Geothermal, Incremental Hydro, Biomass, Landfill Gas, Ocean (wave, tidal), and Bio Diesel. As an alternative, utilities may acquire an equivalent number of RECs, or some combination of both renewable resources and RECs.

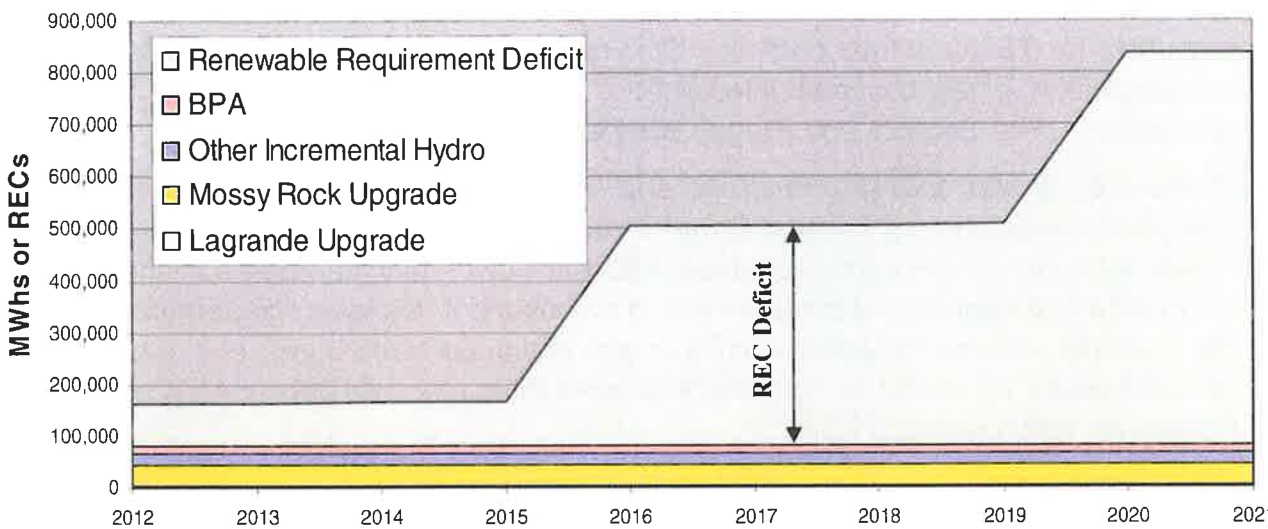
Beginning in 2012, the utility must annually provide about 165,000 MWhs and/or RECs to our customers. (See Table 2.5) A portion of this amount, up to 80,000 of combined MWhs and RECs, may come from "incremental hydropower" generated at owned hydro electric power plants and other sources. This would leave Tacoma Power about 85,000 MWhs/RECs short of the annual mandate from 2012-2015 and 425,000 RECs/MWhs short from 2016-2019. (See Figure 2.10).

> ***Incremental Hydropower***
>
> According to WAC194-37-040 (13) &(21), a qualifying eligible incremental hydropower efficiency improvement project must be owned by the utility, located in the Pacific Northwest, and completed after March 31, 1999. Qualifying improvements include installation or modification of equipment, structures or operating protocols that increase electrical generation using the same amount of water (e.g., rewinding existing generators, installing more efficient turbines, improving hydraulic conveyance systems to decrease head loss, or changing control systems to optimize electricity generation). However, qualifying improvements do not include actions that increase pondage, elevation head, or divert additional water into the project.

Table 2.5
Tacoma Power's Projected Renewable Requirement

Year	Renewable Requirement	Projected Renewable Requirement	
		aMW	MWh or RECs
2012-2015	3%	~19.0	~165,000
2016-2019	9%	~58.0	~505,000
After 2019	15%	~97.0	~850,000

Figure 2.10
Tacoma Power's Projected Renewable Energy Credit Deficit



Potential New Supply Resources

Background

As the load resource balance indicates, Tacoma Power will not need new resources to serve load for several years. Nevertheless, this section presents the full range of resources the utility considered in this planning effort. There are several reasons for this effort. First, the information gathered through this effort was an important input to the resource modeling effort of this IRP (See Section 3: Analysis). Second, with passage of the Energy Independence Act, Tacoma Power now must acquire either renewable resources or RECs notwithstanding our ability to meet loads with existing resources. Third, unexpected load growth such as the addition of a new industrial customer could quickly change Tacoma Power's load-resource balance. Having a thorough review of resource options available will enhance the utility's ability to quickly respond to a potential future resource deficit situation. Finally, state law (RCW 19.285) requires utilities to include this assessment as part of their IRP.

Tacoma Power's comprehensive review of alternative potential resources can be found in Appendix C. Here the utility presents the criteria used to screen the alternative resource technologies and the results of that screening.

> ***Resource Comparison***
>
> Another reason given to comprehensively review new resources is to assess whether any are superior to existing owned resources. While guardedly supporting this rationale, Tacoma Power's owned hydro-resources generally have costs that are significantly lower than available new resources. Therefore, a comparison of resources was not part of Tacoma Power's motivation for identifying and assessing new resources.

Screening Criteria

Statutory Mandates The passage of I-937 and S.6001 both narrow and focus utility resources options. As indicated above, I-937 mandates that utilities add renewable resources (or RECs) to their portfolio. Conversely, S.6001 effectively prohibits the acquisition of new coal resources or contracts for the output of coal-fired generation. (See Section One, Regulations and Policies)

Compatibility with Existing Portfolio and Resource Needs Hydro-generation makes up the majority of Tacoma Power's current portfolio. As a result of this heavy dependence on hydro resources, Tacoma Power must carefully consider how well any potential new resource would complement this resource portfolio. For example, a resource whose minimum generation occurred during cold winter demand peaks would not be considered a compatible resource because Tacoma Power is a winter peaking utility.

Cost A primary goal for Tacoma Power is to maintain low consumer rates. To accomplish this goal, the utility seeks low cost supply resources and operating strategies. The utility closely scrutinizes the costs of alternative new resources under a range of operating conditions. Through this process Tacoma Power can identify low cost resources over a wide range of potential futures.

Environmental Impact A core value of Tacoma Power is to preserve and enhance environmental quality. To that end, Tacoma Power favors resources that minimize the release of greenhouse gas emissions and reduce the utility's overall carbon footprint.

Control/Ownership/Location Tacoma Power prefers to control a resource through direct ownership or tightly structured contract rather than relying on unspecified contracts or the open market. Resources located close to the utility's service territory are also preferred due to delivery risk. Other important considerations are transmission access and cost, licensing, and political issues.

Resource Flexibility Resources that Tacoma Power could dispatch as needed to meet loads are preferred.

Portfolio Diversity Tacoma Power prefers resources that add diversity to the portfolio to limit exposure to any single type of risk (e.g., carbon taxes and coal resources, high gas prices and combustion turbines, or droughts and hydro generation). To this end, the utility works to ensure that supply contracts vary in length and ending date. Similarly, Tacoma Power would not generally consider a resource whose output was highly correlated with existing hydro generation to add to portfolio diversity.

Reliability Tacoma manages a highly reliable power supply and seeks to maintain or increase reliability with each power supply action or acquisition. Tacoma Power will not pursue resources that are likely to degrade reliability.

Screening Results

Nuclear – Screened Out – Compatibility, availability, cost Nuclear has been removed from consideration due to its incompatibility with Tacoma Power's existing portfolio, cost, and risk. A nuclear project would be far too large for the utility to undertake on its own. To pursue nuclear energy, Tacoma Power would need to contract for a piece of a project controlled by some other entity, which is currently unavailable. Even if there were a contract option, however, nuclear projects tend to involve a vast amount of upfront capital investment, and some projects do not complete within the time or cost budgeted. There is also legislative risk, with little political will to carry out nuclear in the Pacific Northwest.

Geothermal – Screened Out – Availability Geothermal is a promising renewable energy source but there are currently few known sites available at this time. Tacoma Power expects that geothermal opportunities will increase in the future and would consider proposals for geothermal resources brought to the utility. However, Tacoma Power will not evaluate geothermal as a separate resource in the modeling effort. The utility will continue to monitor developments in the industry and will revisit the issue in the next IRP.

Coal – Screened Out – Statutory mandates SB 6001 prohibits new construction or contracts for pulverized coal.

Integrated Gasificantion/Combined Cycle – Screened Out – Statutory mandates Coal and petroleum coke are the two fuels most closely associated with Integrated Gasificantion/Combined Cycle (IGCC) plant. SB 6001 prohibits new construction or contracts for coal without carbon sequestration. Presently there are no utility scale technologies available to capture and sequester carbon.

Fuel cells – Screened Out – Cost, limited availability The current available fuel cell technology is prohibitively costly. Hydrogen fuel cells may have different characteristics, but they are not yet available.

Tidal – Screened Out – Availability Tidal power is a potentially promising technology, but is not yet technically available. Tacoma Power will continue to monitor developments in the industry and will revisit the issue in the next IRP.

Solar Thermal/Photovoltaic (utility scale) – Screened Out – Cost Given market prices, upfront capital costs, and amount of sunshine in the Pacific Northwest, utility scale solar projects are not currently cost effective relative to other renewable technologies.

Wind – Kept – Least cost available renewable Wind energy is booming. Developers continue to erect new projects given the proliferation of renewable portfolio standards and extension of the federal production tax credit. Wind is the least costly renewable technologically currently available on a utility scale basis.

RECs – Kept – Cost, flexibility Renewable energy credits are a potentially low risk way to meet legislative renewable energy requirements. RECs are also very attractive due to Tacoma Power's load-resource balance and lack of resource need. In addition, because RECs are not tied to certain hours, they do not prompt the peaking or ancillary services concerns of some other renewable technologies.

Incremental Hydro – Kept – Compatibility, environment, control Incremental hydroelectric projects are a practical way to improve Tacoma Power's already owned resources to make them even more efficient and environmentally friendly. Improvements to the Mossy Rock project are underway, and future improvements to other projects may occur as opportunities arise.

Biomass – Kept – Compatibility, environment, control Biomass resources are perhaps the second best approach to meet the utility's renewable requirements. The term "Biomass" encompasses a wide variety of resources each with its own attributes, costs, concerns and need to ensure that it is I-937 compliant. Moreover, biomass resources tend to be rather small in scale and are not widely available. Therefore, Tacoma Power will consider proposals for biomass resources brought to the utility but will not evaluate biomass as a separate resource in the modeling effort.

Combined Cycle Combustion Turbines and Simple Cycle Combustion Turbines – Kept – Least cost thermal In the event of unexpected load increases, there is a chance that Tacoma Power may need to rely on a Combined Cycle Combustion Turbine (CCCT) or Simple Cycle Combustion Turbines (SCT) as a resource. CCCT and SCT are generally considered the least costly and most environmentally friendly thermal resources available. Moreover, CCCT and SCT appear to comply with the S.6001 requirements.

Transmission

Tacoma Power owns and operates 416 circuit miles of 230kV and 110kV transmission. This transmission capacity is used to serve retail load and bring electricity from BPA and Tacoma Power generating projects to the utility's service territory. A minor portion of this transmission – 19 miles of 230kV line – is completely outside of Tacoma Power's service territory. It connects the Mayfield and Mossyrock hydroelectric projects to BPA's transmission grid. BPA delivers this electricity to Tacoma Power's service territory under a contract that runs through December 2021. The utility has an option to extend this contract for an additional 30 years.

Tacoma Power also has other transmission contracts with BPA that allow the transfer of power from owned resources to points outside of the utility's service territory. The expiration dates of these contracts vary, ranging from 2014 to 2037. Tacoma Power sells this transmission to third parties when it is not needed to serve retail load.

Transmission Status

Currently, Tacoma Power has sufficient transmission capacity (lines, point of interconnection with neighboring systems) to reliably serve its retail and wholesale customers. To maintain system reliability, each biennium Tacoma Power coordinates a local planning process to identify concerns and propose transmission projects to improve operational efficiency and reliability of local transmission systems. This process includes public planning meetings to coordinate with the customers, neighboring utilities, and/or interested parties the gathering of data and development of transmission solutions.

Recently completed and ongoing transmission improvements undertaken by Tacoma Power include work on the Potlatch and LaGrande lines. The 2006 Transmission & Distribution Six-Year Plan along with two system studies indicated the need for additional capacity on these lines to serve the growth occuring in South and West Pierce County. In partnership with BPA, Tacoma Power initiated capacity and reliability improvements for both these lines.

Potlatch Lines The original Potlatch Lines were built over 75 years ago to transmit power from the Cushman Project to Tacoma. In December 2006, Tacoma Power completed a rebuild of the Tacoma Narrows Crossing and adjacent transmission facilities. In addition to serving utility retail load function, BPA uses these lines to provide electricity to PenLight, a utility on the Kitsap peninsula.

LaGrande Lines The LaGrande lines were constructed to transmit power from the Nisqually Project to Tacoma Power's service territory. The existing LaGrande lines are over 65 years old; they were rebuilt in 1943 to replace wood pole lines. Over the last ten years, rapid growth has occurred in south Pierce County. New substations were constructed and connected to the LaGrande lines to serve this load. The LaGrande lines are currently near their capacity limit, especially in the

> ***A World Record***
>
> The Potlatch lines cross Tacoma Narrows via a 6,200-foot transmission span. The crossing, when originally installed in 1926, was the longest electrical crossing in the world.

Frederickson area of Tacoma Power's service area. Further, under certain planning scenarios, loss of one line could over-load the other.

To remedy the capacity constraints and improve system reliability, Tacoma Power and BPA plan to construct a new switching station (Canyon Substation) and increase the 110 kV transmission line capacity between the Cowlitz and Canyon Substations. Detailed engineering design began in 2004 and the construction phase will be in the 2009-10 biennium.

In addition to serving Tacoma Power's retail customers, BPA uses the LaGrande lines to serve five small utilities: Parkland Light and Water, Elmhurst Mutual Power and Light, Ohop Mutual Light Company, Alder Mutual Light Company and the Town of Eatonville.

Bonneville Power Administration

Tacoma Power directly connects to and relies upon the BPA transmission system. Tacoma Power closely follows BPA issues related to the transmission grid that could affect available transmission services. Presently, the two most important issues are the Wind Integration Rate Case and the Integrated Planning for an Open Season purchase of newly constructed transmission. Both of these issues could affect the resources Tacoma Power currently owns or may potentially purchase in the future.

- The FY 2009 Wind Integration Rate Case, has concluded with a BPA integration rate of $0.68 per kW per Month for new and existing wind resources in BPA's Balancing Authority. If Tacoma Power were to purchase a wind resource located within BPA's Balancing Authority this service would either have to be self provided or purchased from BPA. BPA has no posted rate for balancing Wind resources but may develop one prior to the start of the Regional Dialogue contract period in FY 2011.
- The Integrated Planning for an Open Season is a process to jointly build new transmission across constrained paths for multiple customers in BPA's transmission queue. Customers wishing to purchase transmission to a specific location or across a constrained transmission path would share the construction costs of new transmission infrastructure. The Open Season process is intended to facilitate bringing together customers to share capital costs associated with new transmission construction.

Reliability Standards

The federal Energy Policy Act substantially revised how electric reliability is governed in the United States. Prior to 2005, utilities such as Tacoma Power voluntarily complied with reliability standards, policies and procedures established by North American Electric Reliability Corporation (NERC) and Western Electricity Coordination Council (WECC). The federal Energy Policy

Act made such compliance mandatory and put the FERC in charge of reliability.

NERC and WECC conduct Reliability Readiness Evaluations designed to ensure that operators of the bulk electric system have the tools, processes, and procedures in place to operate reliably and are ready to perform under emergency conditions. The evaluations identify areas of excellence and areas in need of improvement. NERC uses the results of these evaluations to champion changes to improve the reliability performance of these transmission providers.

Western Electricity Coordination Council

The WECC is one of ten reliability organizations that compose NERC. Tacoma Power is a member of WECC and is a WECC Balancing Authority. However, none of Tacoma Power's transmission facilities are WECC "rated" paths or considered significant to the operation of the regional interconnection transmission system.

In 2007 NERC and WECC implemented Compliance Audits to measure compliance with the new standards. Tacoma Power was audited in 2007. Compared to other northwest utilities, Tacoma Power received average to above average results. Going forward, stand-alone compliance audits will be conducted every three years.

Section Three Analysis

The next step in preparation of an Integrated Resource Plan is to systematically process information from the Planning Environment and Current Situation/Knowledge sections to develop utility plan of action. Tacoma Power performed this step with the aid of several computer models. This section describes the computer models, important modeling assumptions, and the modeling results. Specifically, one model projected future electricity prices at the Mid-Columbia trading hub. These price projections were then used in two other computer models. One computer model indicated that BPA's Slice product resulted in lower costs for Tacoma Power than did the Block with Shaping Capacity product. Another computer model indicated that the utility's best strategy to comply with the state Energy Independence Act was to acquire RECs. This model also found that absent unexpected load growth, the earliest Tacoma Power should generally not acquire new resources. However, if in 2014, the cost of new wind resources is low and the cost of natural gas is high, the indicates that Tacoma Power should acquire 50 aMW of wind resources.

Price Forecasting

Projections of future prices of electricity and natural gas bear heavily on the evaluation of alternative resource acquisition strategies. Specifically, this information is necessary to assess and compare the short and long-term costs to own and operate various potential resources. Tacoma Power utilized two approaches to forecast electricity prices at the Mid-Columbia (Mid-C) trading hub: a deterministic approach using the Aurora computer model and a stochastic approach using a proprietary model. Whereever possible both approaches use identical fundamental inputs such as natural gas prices at the Henry Hub trading hub.[25] This section explains the critical elements of the price forecast methodology, the results, and the important caveats regarding uncertainties surrounding this forecast.

The Aurora model (created and maintained by EPIS, Inc.) is a fundamentals based price forecasting model in wide use across the Pacific Northwest and the nation. The Aurora model uses key market variables to identify all resources

[25] Henry Hub is a point on the Sabine natural gas pipeline system in Erath, Louisiana. It interconnects nine interstate and four intrastate pipelines. Henry Hub is the pricing point for natural gas futures contracts traded on the New York Mercantile Exchange (NYMEX), which generally sets spot and future prices for the North American natural gas market. Most North American unregulated wellhead and burnertip natural gas prices are closely correlated to those set at Henry Hub.

available to meet the regional demand for electricity. (The model also "builds" new resources to meet projected demand growth and to fill in for retired resources.) These resources are ranked according to their marginal operating costs (i.e. fuel costs plus variable operating costs). The Aurora model's preeminent assumption is that generating resources are dispatched according to costs subject to transmission and other specified constraints. The incremental operating cost of the last resource dispatched sets the market clearing price for electricity. The model is typically run to report hourly marginal prices.

The stochastic hourly price forecast was created with a three-step process. First, a proprietary fundamentals dispatch model of the western interconnect (including transmission constraints) was run using historical data of loads, marginal resource costs (operation and fuel) and hydro output to determine the predicted hourly market price of electricity. The difference between actual market prices and the predicted prices from were then determined. Second, a regression analysis was then performed in an attempt to explain these differences. Explanatory variables included the ratio of demand to system capacity, the lagged dependent variable, and month-of-year and day-of-week dummy variables. The residual "unexplained" variance was assumed to constitute the random uncertainty of market prices. This uncertainty was used to calculate a standard deviation from the expected prices. The final step began with a projection of future electricity prices developed internally by Tacoma Power. These were assumed to be the mean of an uncertainty distribution with the standard deviation calculated in step two.

Fundamental Model Inputs

Demand Tacoma Power used regional demand assumptions from the NWPCC's 5th Power Plan: 1.43% per year over 2005-2025. The utility reviewed WECC demand data to confirm this decision.

Existing Supply Resources The Aurora model includes a database of existing resources. Tacoma Power modified some data after benchmarking the information against other sources.

Fuel Price - Natural Gas The natural gas price forecast for Henry Hub was based on a comprehensive review of published government and private forecasts (e.g., the Energy Information Administration's (EIA) 2007 Annual Energy Outlook), an analyses of market fundamentals, and actual forward NYMEX transactions. Forecast transmission hub basis differentials were applied to convert Henry Hub prices to prices at various WECC trading hubs.

Fuel Price - Other Fuels Coal prices estimates are from EIA's mine-mouth coal price forecast from EIA's 2007 AEO and adjusted by basis differentials (provided by EPIS) between mine-mouth and geographic sub-regions. Tacoma Power also reviewed and validated default fuel price inputs for diesel and uranium.

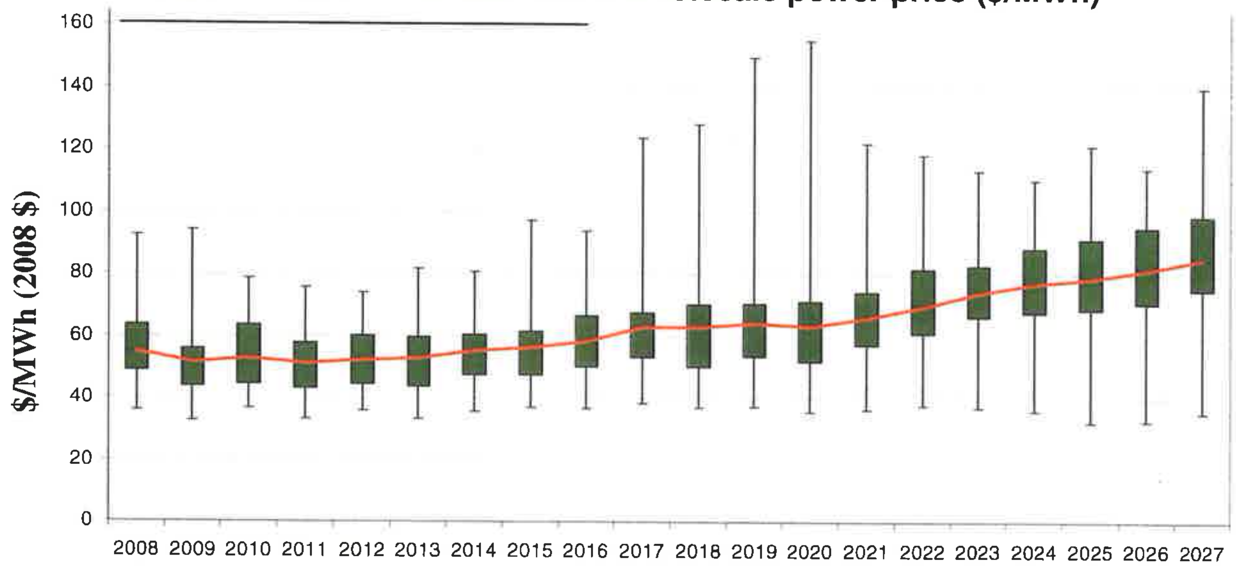
New Resources The Aurora model adds resources as necessary to meet load growth. The model begins with planned resources and then adds its own resources using a database of generic operational and cost data to predict the type and timing of new construction. Tacoma Power limited the addition of coal plants in WECC to simulate the influences of recent state regulations. In addition, new RPS requirements were modeled using wind as the proxy for all renewable resources.

Carbon Costs Although not currently regulated, many expect future CO_2 limits. Tacoma Power assumed cost of $12.50 per ton of CO_2 in 2010 rising to $17.50 in 2015 (based off of estimates from the California Public Utilities Commission).

Price Forecast Summary

Figure 3.1 presents Tacoma Power's annual wholesale power price ($/MWh) forecast for electricity traded at the Mid-C hub for the period 2008 through 2027. The red line illustrates the forecast median price. The green "boxes" show the 25th and 75th percentile prices while the black "whiskers" give the maximum and minimum forecast prices. According to this projection, in all but two years through 2015, real annual electricity prices will fall under $60/MWh in about 75 percent of all futures.

Figure 3.1
Tacoma Power's annual Mid-C wholesale power price ($/MWh)



While Tacoma Power based this forecast on the best input available in the months leading up to the final model runs, the environment in which we operate continues to evolve. Moreover, many significant variables affect wholesale electricity prices beyond fuel prices, hydro availability, and demand growth. For example, the modeling did not account for the "safety valve" provisions of the Energy Independence Act designed to prevent exorbitant implementation costs associated with renewable portfolio standards – utilities need not spend more than four percent of their revenue requirement towards meeting their renewable standard. In addition, changes to market governance rules (price caps or carbon emission limits), fuel supply disruptions and speculative, or unlawful market behavior could also significantly affect market electricity prices. Tacoma Power is closely monitorying the market for any changes with the potential to alter our resource acquisition decisions discussed below.

BPA Power Contract

Introduction

Throughout the ongoing BPA Regional Dialogue discussions, Tacoma Power has closely followed the various iterations of Block with Shaping Capacity and Slice product offerings in order to fully understand their impact on Tacoma Power's customers. The BPA products viable for Tacoma Power include a Block product with or without Shaping Capacity, or a Slice product.

Generally speaking, the Block with Shaping Capacity contract entitles utilities to a set amount of electricity that varies by month, with some HLH hourly shaping. The amount of electricity is based on customer load, utility-owned generation and BPA firm resources. Block customers also receive the benefits of BPA sales of non-firm resources in the wholesale market. The Slice contract is quite different. Utilities operating under a Slice contract receive a fixed percentage of the actual energy produced by the federal hydro system. Slice offers utilities some hourly operational flexibility as well as short-term storage opportunities. While Slice utilities will usually receive more energy on average than Block customers, they also face far more volatility in the amount of electricity supplied. Finally, Slice utilities are responsible to re-market all electricity received in excess of need.

Tacoma Power currently has a Block with Shaping Capacity contract that provides approximately 429 aMW of energy. The amount of power provided to Tacoma Power under BPA's post-2011 contracts will be based on the utility's "High Water Mark" (HWM) calculation. The HWM is calculated by subtracting from year 2010 load, the expected generation under critical water conditions by resources owned by the utility and listed in our current contract (with some minor adjustments). Table 3.1 illustrates this calculation.

Uncertainties Regarding BPA's Block with Shaping Capacity and Slice Products

BPA's Block with Shaping Capacity and Slice products have evolved during the Regional Dialogue process and are not yet fixed. Therefore, product attributes important to this evaluation could change before contracts are offered or signed. Tacoma Power is closely monitoring the Regional Dialogue to ensure that the implications of any changes to either product are fully assessed and understood.

For example, Tacoma Power recently updated the HWM estimates presented in Table 3.1. The most up-to-date HWM estimate is 440 aMW. Since this new estimate does not change the fundamental finding of this IRP and a further evolution of this estimate is likely, the utility declined to redraft this report to reflect this minor change in expectations. Similarly, some attributes of the Slice product appear to be in flux. As stated above, Tacoma Power is closely monitoring the Regional Dialogue and will fully assess the affects of any changes to BPA's Block with Shaping Capacity or Slice products.

Table 3.1

Tacoma Power's High Water Mark Calculation

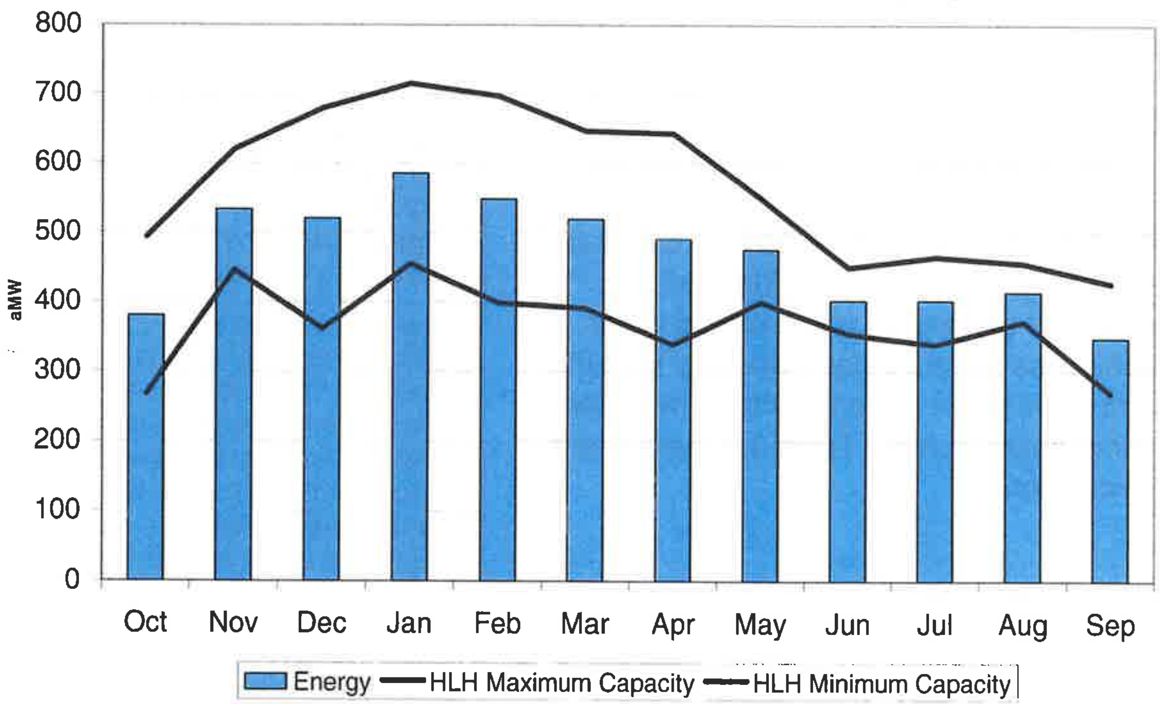
Annual Calculation	MWh	aMW
Customer Load (2010)	*5,450,695*	*617*
- Owned Generation Resources	*1,599,228*	*177*
= HWM	*3,851,467*	*435*
Percent of Federal System (435/7400)	5.9%	

Expected Benefits from BPA's Two Product Offerings

Block with Shaping Capacity As stated above, the Block with Shaping Capacity product will provide a specific amount of electricity each month with some capacity to shape the heavy load hours. Figure 3.2 represents Tacoma Power's current understanding of the approximate quantity of electricity this utility would receive through the Block with Shaping Capacity product. The blue bars represent the amount of power Tacoma Power would receive each month in all HLHs. During HLHs, the utility could, at its election, vary the amount received within the bounds defined by the black lines so long as the average amount received equaled the blue bar.

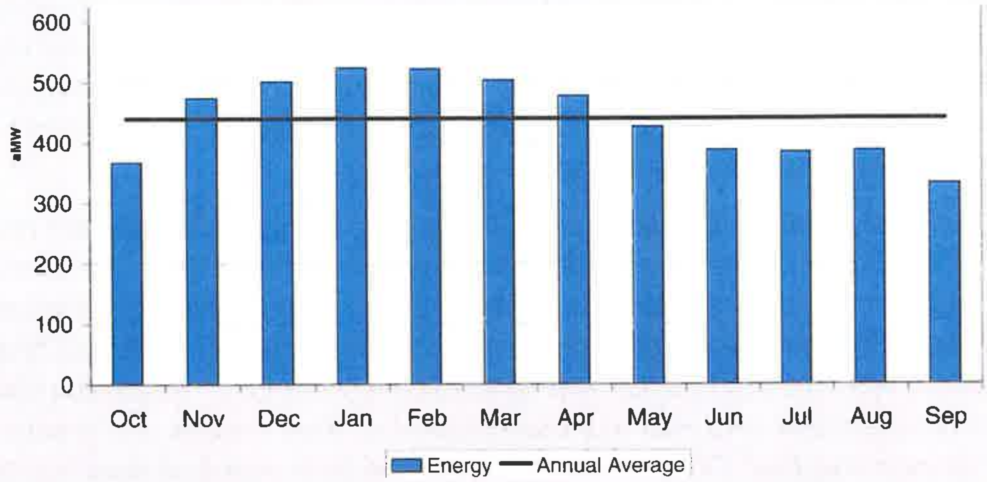
Figure 3.2

Heavy Load Hour Shaping Under BPA's Block with Shaping Product

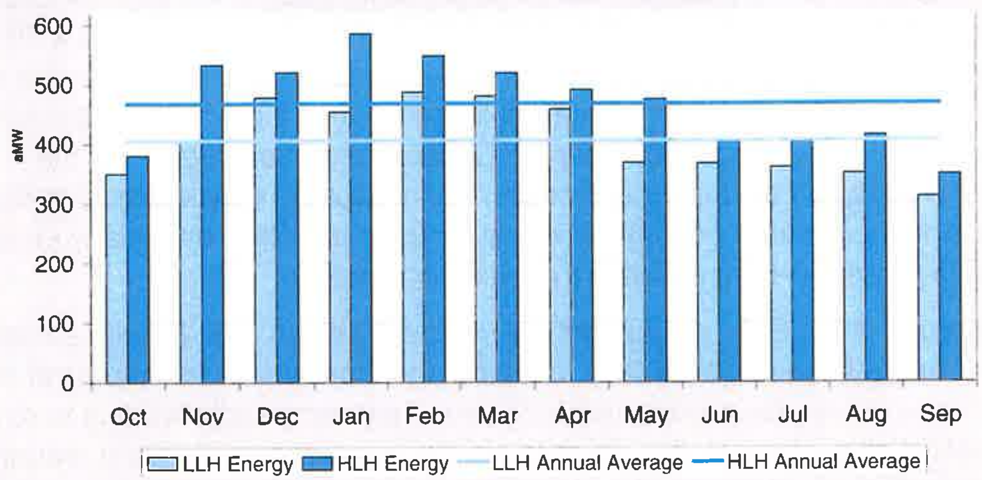


Block with Shaping Capacity Power Supply Calculation

The first step is to calculate the utility's HWM on a monthly basis – this is the monthly shape for the Block with Shaping Capacity Contract.



The second step determines the quantity of electricity to assign to HLH's and LLH's for each month by applying Tacoma Power's HLH and LLH "load factors" to the HWM. "Load factors" are simply the ratio of customers load during heavy and light load hours to the average load. (Note that the BPA "Regional Dialogue Guidebook" limits HLHs to 60 percent of the total number of hours.) So, if the October HLH and LLH load factors were 1.04 and 0.97, respectively, and the HWM was 370 aMW, the HLH apportionment would be 385 aMW (1.04 x 370) while the LLH portion would be 359 aMW (.97 x 370).



Third and final step is to determine heavy load hour shaping. This quantity is based on the ratio of the peak hour load each month to the HLH average amount of electricity in that month. These ratios are multiplied by the HLH quantities determined in step two. So if the October peak load was 600 aMW and the average HLH load was 420 aMW, the calculated ratio would be approximately 0.3 (= 1 - 420/600). Applying this ratio to the 385 aMW HLH quantity results in 115 aMW of shaping capacity. Thus in this example, for the month of October the Block product would give the utility a HLH shaping range of 260 to 500 aMW.

Figure 3.2 shows the results of this calculation by month for Tacoma Power.

The Block with Shaping Capacity product has several positive attributes. First, it pre-determines the amount of electricity a utility will receive making it easier to plan to meet both load and reserve requirements. Also, the billing rates are set for each two-year rate period, irrespective of BPA's actual costs and wholesale revenues.[26] The fixed block of power also offers some supply diversity for utilities with significant hydro resources such as Tacoma Power. Finally, the specific amount of electricity offered by the Block with Shaping Capacity contract makes it more straight-forward for utilities to plan to meet their reserve obligations.

The Block with Shaping Capacity product also has some disadvantages relative to the Slice product. First, it provides less operational flexibility. The "take-or-pay" nature of these contracts limits utility ability to coordinate the operation of other resources with these contracts in a way that minimizes overall utility costs. In addition, with this product, BPA sells its excess electricity. Because utilities have a direct relationship with end use customers, they may have a greater financial incentive than BPA to maximize revenue from non-firm electricity sales.

Slice BPA's Slice offering is a hybrid that offers both fixed and variable portions. The fixed portion is essentially a specified amount of electricity calculated using the same HWM process as used for the block contract but without any HLH/LLH differentiation or any HLH shaping. Tacoma Power modeled the fixed portion of the slice product at 30 percent or about 132 aMW (440 aMW x 30 percent). The variable portion of the slice product at 70 percent or about 4.2 percent of BPA's output (≈ 5.9 percent (Tacoma Power's portion of the federal system) x 70 percent). Over each year, the actual amount of electricity Tacoma Power would receive from a Slice contract will vary a lot but is very likely to exceed the amount provided under the Block with Shaping Capacity contract. However, the electricity provided by the Slice product may not cover utility needs in certain months or shorter time periods. It would be up to the utility to sell any excess or make-up any short-term deficit in the electricity supply.

Advantages of the Slice product relative to the Block product include a higher level of operational flexibility (e.g., shaping and storage) and control over non-firm energy sales. Disadvantages include supply uncertainty leading to market risk, potentially more onerous reserve obligations, increased cost to manage the supply portfolio, and the need for transmission to wheel non-firm power. The amount of power provided through a Slice contract is highly dependent on hydrological conditions at the federal dams.

[26] However, BPA does have cost recovery clauses available if extreme events occur within a rate period. In contrast, Slice customers are subject to an annual true-up billing to BPA's actual costs.

Figure 3.3 presents Tacoma Power's estimates of the annual amount of power provided by the Slice product based on historical river flow data from 1950 through 1997. The electricity provided ranges from a high of over 600 aMW to a low of just over 400 aMW. The median is about 530 aMW. In all but two years, the quantity of power provided by the Slice product exceeds the estimated 440 aMW provided through the Block with Shaping Capacity contract.

Water Years

One difficulty of assessing the generation potential of hydro facilities is that plant operations have changed over time due to environmental regulations, irrigation and water consumption needs and other factors. Therefore, Tacoma Power cannot simply use past river flow to generation ratios. Instead, historic generation levels must be amended to account for new operating restrictions. Such amended generation information is available up through 1997 river flow data.

However, one significant difference between the Slice and Block with Shaping Capacity products is month-to-month volatility of delivered power. As Figure 3.4 illustrates, the Slice product energy (orange "box and wiskers") is more volatile than the Block with Shaping Capacity product (the blue line). Moreover, this graphic clearly shows that it is quite possible that this utility could get less from Slice than the monthly net requirement – particularly in December and February. (The Block with Shaping Capacity amount is based on Tacoma Power's net requirement at critical water and thus represents the utility's monthly need). And, this problem could be exacerbated on a weekly or daily time frame.

Figure 3.3

Annual Power Provided by the Slice Product Based on Historic River Flow

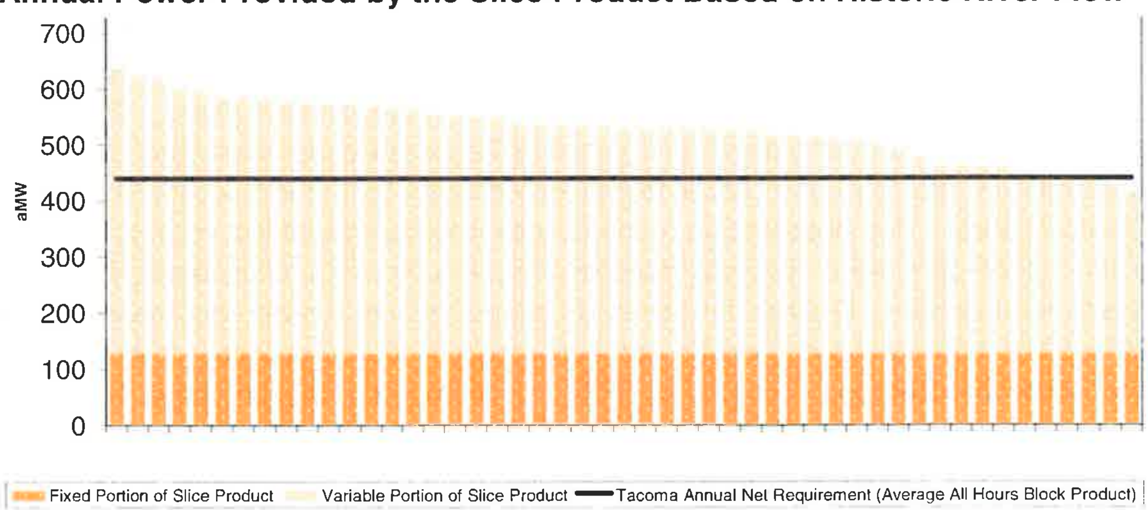
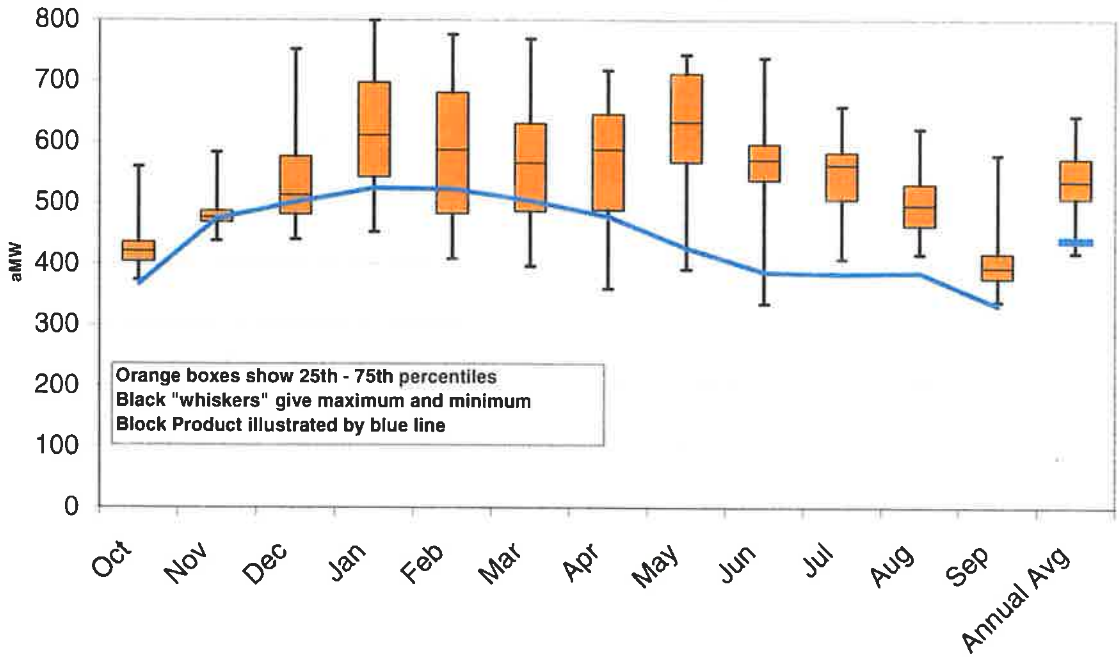


Figure 3.4
Slice Product Volatility

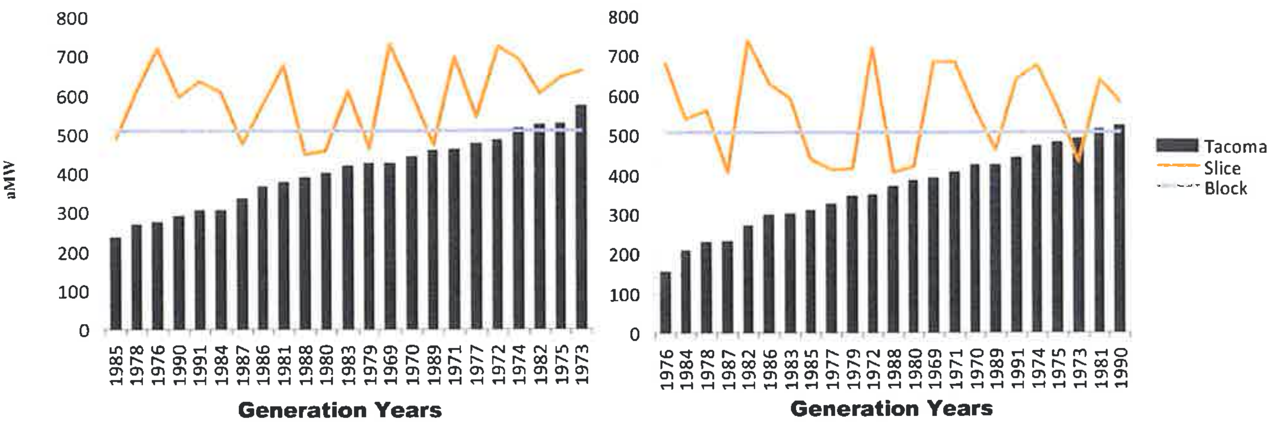


Another important consideration for Tacoma Power with regard to the Slice product is the degree of correlation between the output from the federal system and the utility's own hydro resources. While the correlation is strong on an annual basis (correlation factor = 0.78), monthly correlation appears to be considerably less, or non-existent. Figure 3.5 presents generation from Tacoma Power resources in low-water years during the months of December and February combined with to the electricity the utility would receive under BPA's Block with Shaping Capacity and Slice contracts in those same years. These graphs reveal that during most "dry" years at Tacoma Power resources, BPA generation remains above critical levels as indicated by the Block with Shaping Contract level. This observation holds for all other months of the year as well. This implies generation diversity between Tacoma Power's hydro resources and the federal system. Overall, this analysis suggests that in most "dry" years, the BPA Slice contract would provide more electricity to Tacoma Power than would the Block with Shaping Capacity contract. One caveat to this finding is that it is based on a relatively small set of actual historical data (Tacoma Power's hydroelectric projects have been in existence a relatively limited amount of time.)

Figure 3.5

Tacoma Power Resources Relative to BPA's Slice Product

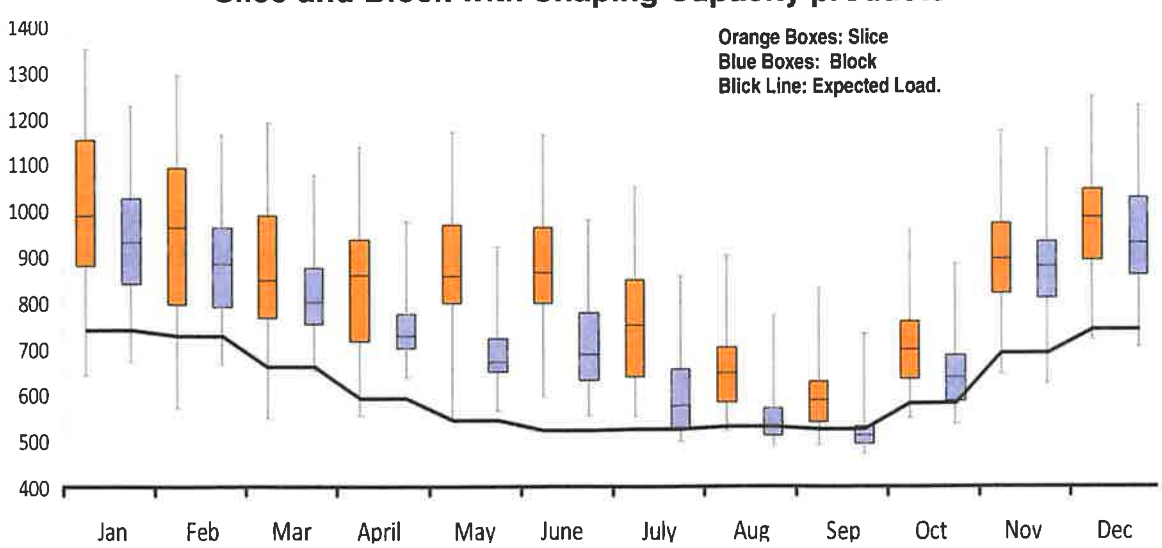
December **February**



In order to evaluate the water inflow relationship between BPA's and Tacoma Power's resources further, additional anaysis was conducted using 50 years of "modeled" generation data. Figure 3.6 combines the monthly generation of Tacoma Power's resources with BPA's Slice (orange) and Block with Shaping Capacity (blue) products in a "box and whiskers" graphic. The black line represents forecasted load in 2012. Three observations are evident from this graphic. First, the Slice product is, as expected, more variable. Second, with exception of September for the Block with Shaping Capacity product, both show high probability of monthly surpluses. Finally, there is a small probability that the electricity available to Tacoma Power during the winter months would be less under Slice than it would be under a Block with Shaping Capacity contract.

Figure 3.6

Monthly Generation of Tacoma Power's Resources Combined with BPA's Slice and Block with Shaping Capacity products



A final important attribute of the Slice contract is its attractive operational flexibility. Based on what Tacoma Power has learned through the Regional Dialogue, Slice customers will be able to call on this resource as if it were an owned hydro-project. This means that within certain operational limits, Tacoma Power could specify on an hourly basis the amount of electricity taken. Moreover, on a short term basis, this utility could "store" electricity for future use, for example. The amount of storage at present is unclear but at a minimum is likely to allow, a utility to save electricity on the weekend for use in the following week. This type of flexibility has significant value to Tacoma Power.

Economics: Block with Shaping Capacity v. Slice

To estimate the cost of the two products, Tacoma Power developed a forecast of BPA's revenue requirement over the IRP planning period and a model to price out each product based on BPA's Tiered Rates Methodology.

The Slice product is inherently more complicated and as such would require additional staffing. Tacoma Power presumes thee additional FTE's: one for day-ahead and real-time support; one for BPA Slice operations/storage analysis; and one for back office support. Other ancillary costs associated with the Slice product are transmission and risk mitigation. Presuming that BPA continues to deliver power to the Cowlitz Northeast Substation, Tacoma Power is likely to need additional firm transmission to move the expected higher levels of electricity delivered under a Slice contract either to the utility's system, or to a northwest hub for sale. The amount of additional firm transmission is not yet clear, but would likely entail a combination of firm and non-firm transmission. As a place holder for this analysis, Tacoma Power utility assumes it would need 100MW of additional Point-To-Point BPA contract transmission.

Due to its significant energy variability relative to the Block with Shaping Capacity product, the Slice product creates a higher probability that Tacoma Power could be caught in a short-term power shortage. To ameliorate this risk, this analysis assumes Tacoma Power would purchase physical options or other financial instruments that would allow it to demand a specific amount of power at a specific price. The utility expects these instruments to cost on the order of $3.0 million per year.

The last item needed to compare the two BPA products is the expected revenue from portfolio sales. Tacoma Power evaluated the benefits of BPA's Block with Shaping Capacity and Slice products using the VISTA© optimization economic dispatch model – a proprietary optimization model developed and supported by Synexus Global Inc. Tacoma Power used VISTA© to simulate utility operations over the 20-year IRP planning period. Stochastic price and load forecasts along with 48 years of probabilistic hydro generation (both for Tacoma owned hydro generation facilities and the Federal system) were some of the model imputs.

VISTA's© internal logic is to first serve utility load and then market any surplus or acquire any deficit in the wholesale market. The model results indicate that the Slice product allowed Tacoma Power to sell more excess power from its own generating resources resulting in approximately $35 million of additional revenues per year.

BPA Power and the Northwest Power Act

Under the Northwest Power Act, Tacoma Power is a preference customer of BPA. As a preference customer, the Tacoma Power is entitled to receive "electric power to meet the [utility's] firm power load." The statute directs that this power must be delivered to retail customers and may not be sold in the wholesale power market. To comply with this mandate, Tacoma Power carefully tracks power from BPA to ensure it is delivered to retail customers. Only excess power produced from Tacoma Power owned resources is sold in the wholesale market.

Conclusion: Block with Shaping Capacity v. Slice

A fair comparison of the economics of the Slice and Block with Shaping Capacity products requires accounting of all direct costs, ancillary costs and the expected revenue from selling any excess electricity produced by Tacoma Power's own generating resources. This accounting is summarized in Table 3.2 which indicates that the overall net cost of the Slice product is approximately $8 million less than the Block with Shaping Capacity product for 2012. Performing this analysis over the IRP planning period results in a cost savings projection of about $115 million associated with the Slice product (2008 dollars). This translates to an overall annual benefit of about $9 million.[27]

Table 3.2

The Economic Value of BPA's Slice and Block with Shaping Capacity Products

2012 Rates	Block with Shaping Capacity	Slice
Direct Cost (BPA Rates)	-$111.0M	-$131.0M
Ancillary Costs		
Staffing		-$0.6M
Transmission		-$2.1M
Risk Mitigation		-$3.0M
Revenue from Selling Excess Tacoma Power Generation	$70.0M	$105.0M
Net Portfolio Cost	***-$41.0M***	***-$31.7M***

[27] As noted above, ongoing Regional Dialogue discussions could change the rate design and utility costs. The design of the Slice product in particular appears to be unsettled. The calculations in this IRP assumed a 70/30 split between the fixed and variable portion of the Slice product. However, recent discussions indicate a strong possibility of the variable-to-fixed split being closer to 50/ 50. A preliminary analysis indicates a reduced incremental value of this revised Slice, but one that still exceed that of the Block with Shaping Capacity by about $6 million.

Therefore, based on Tacoma Power's understanding of each BPA product, a Slice contract appears to be most beneficial for the utility and its customers. However, as stated above, important details of each product remain to be finalized. Tacoma Power will continue to monitor and participate in the regional dialogue and update this analysis as appropriate. The utility's final decision on which product to select will reflect that updated analysis.

Power Supply Modeling

Introduction

Though Tacoma Power's load-resource balance indicates that the utility will have surplus electricity for some time to come, the utility is nevertheless enthusiastic about assessing future resource needs. This assessment allows Tacoma Power to address two important questions:

1. What future resource portfolio is "best" for the utility? Specifically, what combination of new resources (type, amount and timing), if any, best minimizes expected utility costs over a range of potential futures?
2. Should Tacoma Power acquire eligible renewable generation,[28] or renewable energy credits (RECs) to comply with the renewable requirements of the Energy Independence Act?

Tacoma Power contracted with a consultant to develop a computer optimization model to help inform our response to these two questions.

The Optimization Model

In collaboration with utility staff, the consultant developed and provided a model that employs a hybrid stochastic-dynamic optimization approach to identify the least cost resource acquisition portfolio. This model addressed the two questions above in different ways. With regard to the first question – determining the "best" portfolio of new resources – the optimization model began with some simplifying assumptions. The model considered three potential new resources: natural gas fired CCCTs, natural gas fired SCCTs, and wind generation. The

> ***Wind as a Generic Renewable Resource***
>
> For this analysis Tacoma Power considered wind as a proxy for all renewable resources. The assumed cost for wind included firming and shaping services. Tacoma Power used wind in this way because as the only widely available utility scale renewable resource, it would likely set the market price for all eligible renewable resources.
>
> When seeking to acquire an eligible renewable resource Tacoma Power would consider all cost-competitive renewable technologies a developer might propose.

[28] Eligible renewable generation includes: Incremental electricity produced as a result of efficiency improvements completed after March 31, 1999, to hydroelectric generation projects; wind; solar energy; geothermal energy; wave, ocean, or tidal power; and generation powered by biodiesel, biomass, or by gas from sewage treatment facilities or landfills.

two types of combustion turbines were considered in 20 MW increments up to a maximum of 200 MW, whereas the wind resource was considered in 50 MW increments (nameplate) up to 500 MW. The increments of these three resources were used to create 1000 potential new portfolios.[29]

As stated above, coal fired generation was not included due to the enactment of Washington state law S.6001 which effectively precludes the use of any baseline resource with per megawatt carbon emissions greater than that of a relatively efficient combined cycle combustion turbine. Nuclear generation was not included because of its high costs. Wind was used as a proxy for all renewable resources because it is currently the most readily available utility scale renewable resource in the Northwest utilities. (For more information about the resource screening process, see Section Three, Screening Criteria.)

The optimization model followed a four step process to produce a preferred resource acquisition schedule describing the type, timing and amount of resources to acquire, if any.[30] In the first step the model makes stochastic projections of fuel and power prices and utility loads for each of the next 20 years. From those projections, the model develops a number of potential futures each with a different set of year-to-year natural gas prices, market electricity prices and utility loads. In the second step the model uses a dispatch subroutine to determine the net cost to serve load for each potential future. (Deterministic inputs for the capitol cost of wind and natural gas generating resources directly affect the cost to serve.) Then, using data from all of the potential futures, the model regresses the net power costs against the fuel costs, electricity costs and load for each year. The third step applies the regression coefficients to each of 1000 previously identified resource portfolios. This allows the model to estimate the overall year-to-year cost of each potential resource portfolio (including any capital costs, REC value, and market value / cost of any surplus / deficit generation). The model then identifies the portfolio with the least overall cost for each year. Next, the model assembles each year's least cost portfolio into a preliminary multi-year acquisition strategy. The final step ensures that the preliminary acquisition strategy is rational over time. The least cost portfolio identified for each year must include all resources that were part of the previous year's least cost portfolio. In situations where the preliminary model output suggests deleting a previously identified resource, the model re-optimizes the acquisition strategy to eliminate this outcome.

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[29] Portfolio 1 was 0 MWs of CCCT, 0 MWs SCCT, and 0 MWs Wind
Portfolio 2 was 20 MWs of CCCT, 0 MWs SCCT, and 0 MWs Wind
Portfolio 1000 was 200 MWs of CCCT, 200 MWs SCCT, and 500 MWs Wind

[30] Note that a preferred portfolio with no additional resources may still impose a cost should the utility need to supplement internal generation with market purchases.

An example optimization model output is shown in Table 3.3. In this hypothetical example, the model indicates acquiring 50 MW of wind capacity (nameplate) in 2019 and another 50 MW of wind in 2023. The model also would acquire a 20 MW portion of a natural gas fired combined cycle combustion turbine in 2020.

Table 3.3
Example Model Output

Year Added	Resources			REC Price
	20-MW of CCCT	20-MW of SCCT	50-MW of Wind	
2012	0	0	0	
2013	0	0	0	$12.0
2014	0	0	0	$13.3
2015	0	0	0	$13.9
2016	0	0	1	$18.1
2017	0	0	1	$18.7
2018	0	0	1	$18.7
2019	1	0	1	$19.4

Discussion of the Optimization Model

The hybrid stochastic-dynamic optimization approach to modeling resource acquisition has several attributes that fits well with Tacoma Power's needs. First, a first principle of Tacoma Power is to minimize present and future costs for our customers. Therefore, it is important for the model to identify the specific resource portfolio most likely to be least-cost. An attractive feature of the hybrid stochastic-dynamic optimization approach is that it identifies a specific preferred resource portfolio based on the net-present value of expected utility costs.

A second basic business objective of Tacoma Power is to assemble a set of generation resources that will limit utility costs over a range of potential futures. In other words, to acquire a resource portfolio sufficiently robust that future swings in important variables such as fuel and market electricity prices will not impose undue costs on the utility. Tacoma Power believes that the hybrid stochastic-dynamic optimization model is a significant asset when making decisions under this kind of uncertainty.

The model also addresses the question of compliance with the Energy Independence Act. As part of the cost minimization criteria, the model includes cost of meeting specified minimum levels of renewable energy resources or RECs. The model estimates the market clearing price for RECs over time based on the theory that their price should equal the difference in cost of electricity from the least expensive non-renewable generation source relative to the cost of electricity from the least expensive renewable resource.

Finally, while cost is a central component when making resource acquisition decisions, Tacoma Power considers other factors as well. Issues such as environmental attributes, regulatory risks, operational compatibility and risks, effect on capital structure, fuel and market risks, and the overall operational environment also affect important resource acquisition decisions. The optimization model cannot substitute for knowledge, experience or judgment of utility management. Therefore, while the results of this computer optimization model will aid utility decision making, with Board oversight and approval, management at Tacoma Power may chose a different resource acquisition path.

Modeling Results

Resource Acquisition – Expected Load Growth Table 3.4 presents model run results. (Note that the price figures identified for wholesale natural gas and electricity prices are the median estimates of a stochastic input range for these variables.) The model indicates that under nearly all futures, Tacoma Power should not pursue new generation resources during the first half of the IRP planning horizon. Moreover, even when the utility becomes resource deficit (around 2018), the model usually turns to the wholesale market to make up this deficit. One exception to this conclusion occurs with low wind prices ($75/MWh) and high natural gas prices (>$6.70 per mmBtu). In this future, the model layers in significant amounts of wind resources beginning in 2015 leading to a significant surplus of electricity. The other exception occurs at a more realistic but still optimistic $100/MWh cost assumption for wind power along with very high natural gas and wholesale electricity prices. In this future the model picks up 15 aMW of wind in 2015. This single purchase would ensure that the utility's LRB remained positive throughout the planning period. Thus, according to the model, Tacoma Power's best resource strategy is to defer any new acquisition until 2015. At that time, if wind and natural gas prices are high, acquire 15 aMW of wind resources.

Following this resource strategy would leave the utility short of the renewable requirements of the Energy Independence Act: about 85,000 from 2012-2015 and 240,000 to 300,000 from 2016-2019. As stated above, the model also projects future REC costs. In most scenarios, the predicted future REC prices are above today's market prices. This suggests that Tacoma Power should seek to acquire RECs in the near-term. The one exception occurs with unrealistically low wind prices ($75/MWh) / high natural gas prices (>$6.70 per mmBtu) where the model forecasts REC prices below today's market costs suggesting that the

> ***Electricity and Natural Gas Prices***
>
> Tacoma Power began this modeling exercise when wholesale prices for electricity and natural gas were substantially lower than seen today. Several model runs were performed that assumed price points for these commodities that no longer appear even remotely likely. Tacoma Power decided not to report the identified optimum resource acquisition portfolios associated with these unrealistic price assumptions.

utility should delay acquiring RECs until just before they are needed. The other exception occurs at moderate wind costs ($100/MWh) / very high natural gas (>$9.00 per mmBtu) wholesale prices where forecasted REC prices approximately equal today's market costs. In this more realistic scenario, the model does not give clear direction of whether REC purchases should be made now or at the time needed.

Model Results

Table 3.5 does not include results for model runs that assume $75/MWh wind prices. Tacoma Power omitted these model due to discussions with vendors and other market participants indicating that wind resources are simply not available at costs anywhere near $75/MWh. Nevertheless, Tacoma Power is closely following the market for wind and other renewable resources. Should market prices recede to this level, the model would recommend the acquisition of 15 aMW of wind beginning in about 2014.

High Load Growth With one exception, Table 3.5 presents the results of the model based on the same base assumptions included in Table 3.4. The sole difference is that the model output in Table 3.5 assumes higher utility loads, beginning at 1 percent above the 2012 baseline and rising to 3.5 percent above the 2018 baseline. These higher loads would put Tacoma Power in a neutral LRB position around 2015 and a resource deficit of about 20aMW in 2018.

With these higher loads the model indicate that, Tacoma Power should acquire a 20 aMW share of a natural gas CCCT in 2015 under nearly all assumed price combinations. The only exception occurs with high natural gas ($9.00 per mmBtu) and wind resources priced at $100/MWh or lower. In this future, the model would add 15 aMW of wind in 2014. Both of these resource strategies would keep Tacoma Power in a surplus LRB position through 2018.

Following either resource strategy would leave the utility short of the renewable requirements of the Energy Independence Act: an average of 175,000 from 2012-2015 and 420,000 to 480,000 from 2016-2019. The higher quantity of RECs needed relative to the base case results from the higher utility loads. With regard to RECs, under all but one future, the model indicates that the utility should seek to acquire RECs in the near term. However, at the highest natural gas and market electricity prices, projected REC prices are roughly equivalent to current market prices. As such, in this one future, there is no clear indication of whether the utility should precede to acquire RECs in the near term.

Market REC Prices

On February 14, 2008, Tacoma Power issued a Request for Proposals (RFP) to acquire RECs and is currently negotiating with a respondent to that RFP. In order to protect confidential business information and to preserve Tacoma Power's ability to negotiate the best possible deal for our customers, the utility cannot release any information regarding modeling projections or actual market prices for REC. This IRP does indicate whether modeled REC prices are higher, approximately the same as, or lower then the RFP price.

Table 3.4

Model Results for New Resource Acquisitions and Energy Independence Act Acquisitions Under Expected Loads

Gas		**≈ $5.50/mBtu**			**≈ $6.70**			**≈ $9.00**		
Electricity		**≈ $41/MWh**	**≈ $47**	**≈ $55**	**≈ $50**	**≈ $58**	**≈ $67**	**≈ $67**	**≈ $78**	**≈ $91**
Wind ↓ ≈ $75/MWh	New Resources	None				15 aMW Wind in 2015	15 aMW Wind in 2015 + 30 aMW Wind 2017	15 aMW Wind in 2015	15 aMW Wind in 2015 + 30 aMW Wind 2017	15 aMW Wind in 2015 + 45 aMW Wd 2016 30 aMW Wd 2018
	I-937 Compliance	Acquire RECs Now				RECs ???	Acquire RECs when needed			
≈ $100	New Resources	None							15 aMW Wind in 2015	
	I-937 Compliance	Acquire RECs Now								RECs ???
≈ $125	New Resources	None								
	I-937 Compliance	Acquire RECs Now								

Long-Term Model Results

One component of management discretion is assessing the value and relevance of resources the model identifies to acquire far in the future. The electrical industry appears in the midst of a transitional phase whose outcome is not at all clear. Given the potential for significant changes to how the industry will operate and be governed over the next few years there appears little value in presenting long-term model results. Therefore, Tacoma Power has decided to only present 10-years of model results (up through 2018).

Table 3.5

Model Results for New Resource Acquisitions and Energy Independence Act Acquisitions Under High Loads

<table>
<tr><th>Gas</th><th></th><th colspan="3">≈ $5.50/mBtu</th><th colspan="3">≈ $6.70</th><th colspan="3">≈ $9.00</th></tr>
<tr><th>Electricity</th><th></th><th>≈ $41/MWh</th><th>≈ $47</th><th>≈ $55</th><th>≈ $50</th><th>≈ $58</th><th>≈ $67</th><th>≈ $67</th><th>≈ $78</th><th>≈ $91</th></tr>
<tr><td rowspan="2">Wind
↓
≈ $100/MWh</td><td>New Resources</td><td colspan="7">20 aMW Combustion Turbine in 2015</td><td colspan="2">15 aMW Wd in 2014
+ 20 aMW CT 2017 | + 15 aMW Wd 2016</td></tr>
<tr><td>I-937 Compliance</td><td colspan="8">Acquire RECs Now</td><td>Wait to acquire RECs</td></tr>
<tr><td rowspan="2">≈ $125</td><td>New Resources</td><td colspan="9">20 aMW Combustion Turbine in 2015</td></tr>
<tr><td>I-937 Compliance</td><td colspan="9">Acquire RECs Now</td></tr>
</table>

Model Conclusions

Overall conclusions evident from the model are:

1. Tacoma Power's surplus LRB significantly affects the addition of new resources. Under most futures, the model does not add any new resources. For the few futures where resources are added, the earliest acquisition occurs in 2014. This result is largely driven by the fact that it is highly unlikely that Tacoma Power will need new power supply resources for load. Thus, the output of any new resources will likely be sold into the wholesale market at an economic loss.
2. Resource selection:
   a. Assuming $75/MWh wind resources – which is not likely to be available over the modeling time horizon – the model adds wind resources at moderate to high gas and market electricity prices.
   b. Assuming $100/MWh wind resources – optimistic but plausible in today's market – the model adds wind resources at moderate to high gas and electricity prices under expected load growth. Assuming high load growth, natural gas combustion turbines are added under low to moderate natural gas and electricity prices while wind is added when these prices become high.
   c. Assuming $125/MWh wind resources – which best represents today's market – the model adds no resources under expected load growth for all electricity and natural gas price futures. Natural gas is the fuel of choice with high load growth, though some wind is added towards the end of the planning period under high natural gas and electricity prices.
3. Under all futures, the preferred strategy to comply with Energy Independence Act 2012-2015 renewable mandate is to RECs. The model indicates that using renewable resources will result in higher costs to the utility and its customers. Some futures (high gas cost, high electricity prices) acquire wind resources beginning in 2015 which contribute towards the renewable mandate. However, no resource portfolio supplies a sufficient number of RECs to comply for all of the 2016-2019 period.
4. Under all futures, the preferred RECs strategy for 2012-2015 is to acquire RECs sooner rather than later.
5. One factor that clearly affects the resource selection is the balance between loads and resources. A fairly modest increase in demand (or decrease in the amount of electricity provided by BPA) would significantly alter the type and timing of selected resources. Therefore, to help delay the addition of costly new resources, Tacoma Power must assure that it receives a reasonable

allotment of federal power, achieves its conservation objectives, and prudently develops cost-effective incremental hydro resources.

Scenario Analysis

As part of previous Integrated Resource Plans, Tacoma Power assessed how various scenarios of possible futures might affect utility operations. These futures consider the social, economic, diplomatic, and technologic forces that shape Tacoma Power's operating environment. These futures were created to capture a range of possible load, price and resource impacts relevant to Tacoma Power. For the 2004 plan the scenarios were:

- ***Global Conflict***: the possibility and consequences of terrorism and international strife;
- ***Joy in Competition***: a future where regulatory structures change substantially and competitive markets for energy develop and thrive;
- ***Double Dip***: the occurrence of an economic recession and the consequences thereof; and
- ***Living in the Greenhouse***: a future of adverse environmental conditions and the possible governmental and social responses.

While all these scenarios remain relevant today, much has happened in the world, this country and at the utility since 2004. Therefore, Tacoma Power determined to update and refocus two of these scenarios – they were also renamed in order to avoid potential confusion between the two plans – and to replace two with new scenarios.

The "Global Conflict" scenario was dropped. While the threat of terrorist acts and other destabilizing geopolitical events remains, their fundamental unpredictability, in time, scope, location and scale, makes it difficult to develop a scenario that describes the likely consequences to Tacoma Power. Instead, this IRP added the "Addicted to Fossil Fuel" scenario which envisions little change in fuel use despite high market prices and the emergence of electrical system reliability problems due to load growth outstripping supply. The "Joy in Competition" scenario was reworked into "Technology Succeeds." In this revised scenario, the entrepreneurial spirit of America set its sights on the energy problem and develops real lasting solutions. Taking the opposite tact, the "Double Dip" scenario evolved into "Hard Times" where economic weakness combines with high energy prices. Finally, the "Living in the Greenhouse" scenario was dropped in favor of "America Ages." Tacoma Power presumes that climate change regulation is near (either from the regional WCI effort or from the federal government), and therefore included many attributes of the former Greenhouse scenario into baseline modeling. The alternative "America Ages" scenario assumes that a gentrifying population invests little in new generation or transmission resources resulting in high energy prices, and stable consumption levels.

Addicted to Fossil Fuel

- Low Climate Change Regulation
- Slow Technology Change
- Market/regulatory structure provides eases access to resources
- High (and volatile) Electricity and Natural Gas Prices
- Transmission infrastructure stressed but adequate

In this scenario, the nation's focus is on developing carbon based resources. Generally, concerns about the economy outweigh concerns about global climate change. Efforts to adopt carbon taxes and cap-and-trade programs fail. The nation's electric power suppliers continue to rely on large central power stations and long transmission lines. Efforts to expand and reinforce the power grid are limited to addressing the most significant problems. The cost of building and upgrading the energy infrastructure is principle factor in keeping electricity prices high. Energy prices are also supported by international competition for tight oil resources from China and India.

High energy prices support some research and development into alternative energy supplies but no major breakthroughs occur. The addition of new wind and other renewable resources are limited due to their cost. The more aggressive state renewable portfolio standards are scaled back after they are found to be unrealistic and expensive.

The need for stable energy supplies keeps the United States involved in foreign affairs. Locally, the region benefits due to increased activity at Fort Lewis, growth in international trade through the Port of Tacoma, and continued strength at Boeing generally support the local economy. As a result, demand for electricity from Tacoma Power grows quickly.

The optimization model was used to assess Tacoma Power's optimal resource portfolio under the Addicted to Fossil Fuel scenario. The model indicates that from an economic perspective, the utility should seek to acquire 50 aMW of wind in 2014 and a 20 aMW share of a CCCT around 2016. The model also indicates that Tacoma Power's best approach to complying with the Energy Independence Act is near-term acquisition of RECs (assuming the statute remains in effect in this scenario).

America Ages

- Moderate climate change regulation
- Low technology development in the electric power sector

- High government market control & regulation
- Moderate electricity and natural gas prices
- Transmission infrastructure constrained

In this scenario, the social fabric of the United States changes as the Boomers enter retirement. Near term this manifests itself in substantial "Gray" political clout. This clout focuses on increased spending in health care, personal services and social safety net programs. Conversely, policy focus on infrastructure such as power generation and transmission falls. Policy makers become more willing to enact taxes that support necessary expenditures.

The primary public policy objective in the power industry is to keep rates low. As a result, investment in resources is discouraged causing an increase in reliability problems. The development of new generation and transmission system projects is heavily regulated through siting, prudence and rate-of-return regulation. Expansion of environmental policies is moderated by the desire to keep energy rates low. For example, new renewable portfolio standards and carbon "cap-and-trade" mechanisms all include "safety valves" to prevent the cost from rising too high. Energy infrastructure maintenance cuts due to high costs increases system reliability problems. Energy efficiency becomes an important factor in all new construction and appliance purchases. Overall, rates stay moderate.

International competition for commodity resources (e.g., oil, natural gas, steel, cement, etc.) keeps prices high. These higher prices tend to act as a drag on the economy. Slower economic growth moderates Tacoma Power's overall customer demand.

Tacoma Power's optimal resource portfolio under the America ages scenario is to not seek new resources. The model also indicates that Tacoma Power's best approach to complying with the Energy Independence Act is near-term acquisition of RECs.

Technology Succeeds

- Moderate climate change regulation
- Aggressive and successful technology development
- Entrepreneurial market structure
- Demand reduction lowers electricity and natural gas prices
- Transmission infrastructure adequate

In this scenario, breakthroughs in energy technologies work together to expand electrical supply and lower costs. For example, distributed solar technology becomes economically viable and utilities begin leasing systems to customers and integrating the output of this power supply into their resource plans. Improved operational procedures allow better integration of abundant wind resources into the region's supply portfolio. New domestic natural gas resources are discovered and developed to provide baseload power through very efficient combined cycle combustion turbines. The relative cost advantage of Pacific Northwest power supplies persists attracting industry to the area and expanding the local economy.

The economics of environmentally friendly generation resources significantly improves. The resulting region-wide/national drop in carbon emissions tempers the call for direct carbon regulation and allows a "free market" approach to supply development. One of the "supply" options developed is smart metering. Load shapes become smoother as customers actively manage their consumption. In addition, the wide-spread deployment of hybrid electric vehicles, which are mostly recharged at night, further flattens the diurnal demand curve. Demand response resources become more significant for utility planners.

Continued expansion at Fort Lewis, growth in international trade through the Port of Tacoma, and continued strength at Boeing bolster the local economy. Overall load at Tacoma Power grows rapidly.

The optimization model used to assess Tacoma Power's optimal resource portfolio under the Technology Succeeds scenario indicates that the utility should seek to acquire 50 aMW of wind in 2014 and an additional 100 aMW of wind around 2017. The model indicates that future prices for RECs will be low so that the best approach to complying with the Energy Independence Act is acquire RECs when needed.

Hard Times

- Climate change regulation low
- Slow technology development
- Market access constrained
- Moderate electricity and natural gas prices
- Transmission abundant

In this scenario, U.S. enters a significant and protracted recession. The economic contraction will result in high unemployment as well as business and personal bankruptcies. Regional demand for natural gas and electricity will fall in response. However, growth in international demand will fuel rising energy prices, albeit at a moderate rate. Utilities with surplus power resources – either contracts or higher cost power projects – might find themselves unable to cover their costs. Energy traders and utilities on the wrong side of long-term power deals could end up with stranded assets and potentially bankruptcy.

In this scenario, there will be no appetite for new and expensive environmental regulation. Moreover, existing regulation may be relaxed in an effort to spur economic activity. In addition, new generation and transmission resources will not be needed due to drop in demand a lack of access to capital.

Tacoma's economy will suffer along with the rest of the nation. The Port of Tacoma could suffer negative impacts as international trade contracts. Relatively low-cost hydroelectric power could provide some added support to the regional economy as would the high proportion of government sector jobs in and around Tacoma. If the economic downturn extends long enough the federal government could develop a few "New Deal"-like public works programs to rebuild some of the country's aging infrastructure.

Tacoma Power's optimal resource portfolio under the Hard Times scenario indicates that the utility should seek no new resources. The best approach to complying with the Energy Independence Act is near-term acquisition of RECs (assuming the statute remains in effect).

Conclusions

In none of the scenarios considered, should Tacoma Power acquire new resources before 2014. In two of the scenarios, the new resource should be 50 aMW of wind, the other two scenarios indicate that Tacoma Power should not seek to acquire new resources. This serves to confirm the finding of the Power Supply Modeling Section. Namely that Tacoma Power has some time before it needs to acquire new resources. Moreover, this time allows Tacoma Power the luxury of being able to reassess this finding several times through the IRP process before new resources will actually be needed.

Section Four
Implementation Plan

The statute that mandates the preparation of Integrated Resource Plans includes a requirement that utilities identify the near-term actions they will take to implement the findings of the plan. Tacoma Power sees this "implementation plan" as the synthesis of what the utility learned from the effort to develop the IRP. Tacoma Power's implementation plan has two parts. The first part describes actions the utility intends to begin, and in many cases complete, before the publishing of the next plan. The second part covers areas identified for further study that may, or may not affect or be addressed in future plans.

Actions to Implement this Plan

Conservation

The Energy Independence Act mandates that Tacoma Power implement all cost-effective conservation. The 2007 Conservation Potential Assessment quantified the utility's the ten-year cost-effective achievable conservation potential at 54 aMW. This led to an annual conservation goal of 5.4 aMW beginning in 2010. This level of conservation is substantially more than previous efforts. Tacoma Power is ramping up in-house conservation activities with intermediate goals of 3.1 aMW in 2008 and 4.7 aMW in 2009. The ramp up process will allow Tacoma Power to: 1) help develop necessary infrastructure within the engineering and contracting industry; 2) provide time for staff to review and refine program performance; and, 3) provide time for customers to incorporate Tacoma Power energy conservation opportunities into their ongoing home owner and business plans.

Renewable Energy Credit Acquisition

The Energy Independence Act also mandates that Tacoma Power annually acquire a total of approximately 165,000 MWhs of renewable energy or RECs beginning 2012. A review of Tacoma Power's resource inventory indicates that the utility may receive nearly half this amount (80,000) from owned incremental hydro projects and from RECs associated with existing contracts. The Integrated Resource Plan confirms that the best approach to meeting the overall mandate is to supplement the current eligible renewable resources with additional RECs. Moreover, the analysis forecasts long-term REC prices above current market prices suggesting that early acquisition will be the least-cost compliance strategy. Tacoma Power is presently in negotiations for a long-term REC purchase agreement and expects to consummate a contract in the near future.

BPA Contract

Based on BPA's current product configurations, Tacoma Power has determined that BPA's draft slice product provides more net benefits to the utility and our customers than does the Block with Shaping Capacity product. Tacoma Power will continue to monitor and participate in the Regional Dialogue to fully understand the implications of any change to either product. Presuming that no significant changes occur, Tacoma Power expects to finalize a Slice contract with BPA around the end of 2008.

Actions to Prepare for the Next Plan

The electricity industry faces many issues that could fundamentally change the way utilities operate. Below are a few of these issues that Tacoma Power will carefully monitor during the interim before the development of the next plan.

Plug-In Electric Hybrid Vehicles

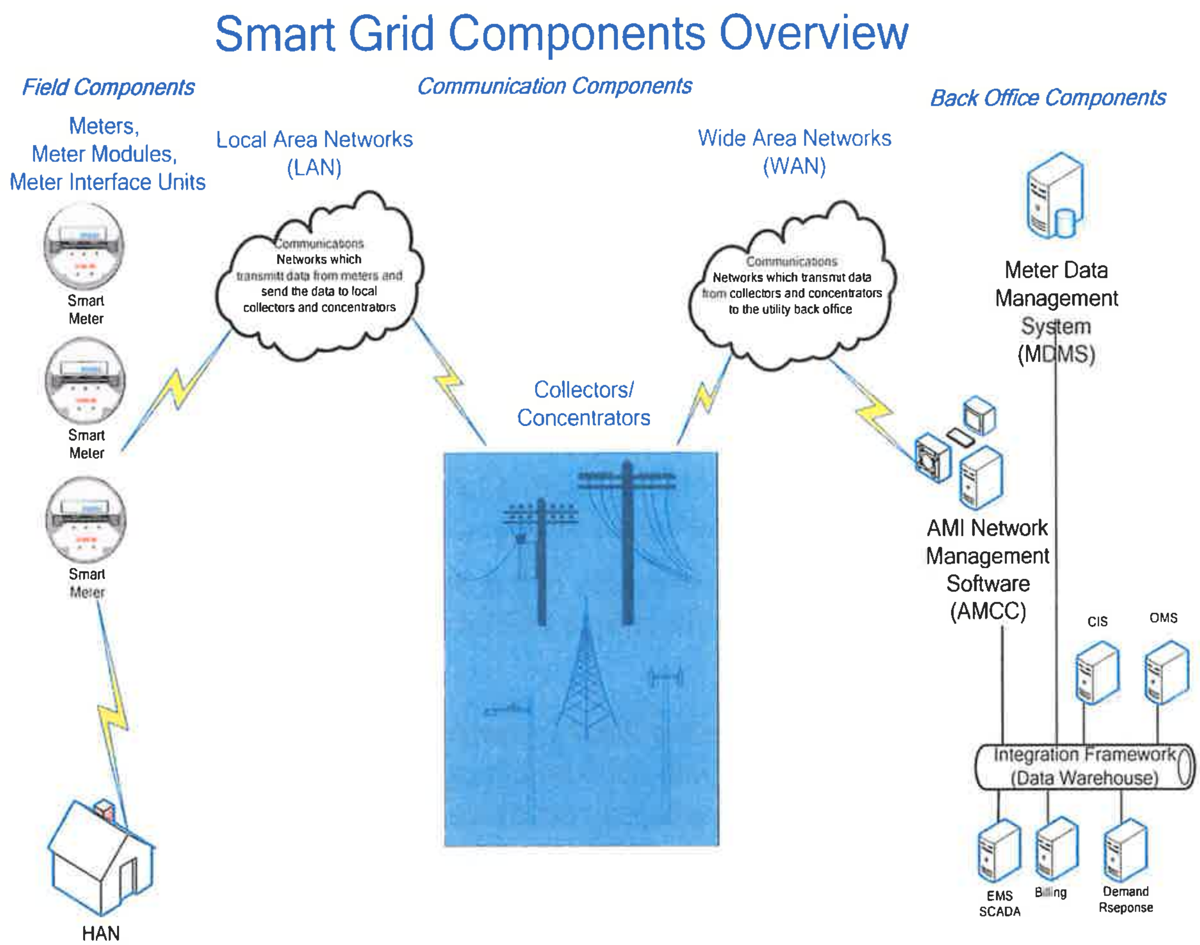
One risk not assessed in this IRP is the potential effect on customer demand resulting from the adoption and use of plug-in electric hybrid vehicles. Motivation for switching from gasoline powered to plug-in electric hybrid vehicles are high fuel prices and to reduce CO_2 emissions. Tacoma Power has not assessed whether a shift to plug-in electric hybrid vehicles would increase or decrease net CO_2 emissions. However, any significant penetration of plug-in electric hybrid vehicles into the automobile fleet in the utility's service territory may require the utility to acquire new resources to meet the added demand. If the cost of wind resources remains high, this analysis indicates that the least costly approach may be to acquire a portion of a CCCT. However, such a decision would make it very difficult to maintain or reduce Tacoma Power's emissions of CO_2 from current levels. Tacoma Power will monitor technological, economic, political and social developments in this area and consider assessing the impact in a later IRP.

Smart Metering

Tacoma Power is in the midst of assessing the cost-effectiveness of a smart meters program. Among other items, this Smart Grid Project is investigating the load characteristics by customer class, customer class price response, equipment costs and administration requirements, and costs associated with consumer education.

The Tacoma Public Utilities (TPU) Smart Grid Project (see figure 4.1) consists of smart meters and communication modules, local area and wide area networks to collect data and transport it to an Advanced Meter Control Computer (AMCC) also known as an Advanced Data Collection System (ADCS), a Meter Data Management System (MDMS), and an integration platform (data warehouse) to allow multiple legacy (SCADA, OMS, etc.) systems and applications to utilize the data for operational and conservation program purposes.

Figure 4.1



TPU is in the pilot phase of this project having installed a total of 12,000 smart electrical and water meters. This pilot phase is intended to 1) gather data which will assist Tacoma Power and Tacoma Water in refining their requirements for the meter hardware, communications interfaces, databases and computer infrastructure necessary for the Smart Grid project, and 2) determine the estimated capital and expense budgets for each alternative approach. This data will be used to develop a future Request For Proposals (RFP) leading to contracts to one or more companies for the development of the Smart Grid program. If this pilot project shows the smart meters to be cost-effective, TPU will seriously consider upgrading the remaining meters on its system.

Tacoma Power expects to incorporate information from these studies as appropriate in the next Integrated Resource Plan.

Sixth Power Plan

The Northwest Power and Conservation Council is beginning the development of its Sixth Power Plan. The Council issued an initial paper, Issues for the Sixth Pacific Northwest Power and Conservation Plan, Council Document 2007-22, that identified climate change as a special concern. Specifically, to determine how the Northwest power system could cost-effectively reduce its CO_2 footprint. A corollary objective is to assess how utilities can and should respond to various types of statutes and regulations that may be established to address climate change. For example, renewable portfolio standards and carbon control regimes such as the Western Climate Initiative. Other issues of concern identified by the Council include:

- Meeting loads on an annual, daily, hourly, and sub-hourly basis
- Expanding the menu of resource choices
- Transmission constraints and their impacts on electricity markets and resource development
- Power plan interactions with the fish and wildlife programs
- Appropriate avoided cost measures for resource decisions

Tacoma Power will monitor the progress of the Sixth Power Plan and incorporate information from that plan into the utility's IRP as appropriate.

Conservation Assessment

Tacoma Power plans to update the 2007 Conservation Potential Assessment. The next assessment will take into account changes in technologies, markets, codes and standards, and the avoided cost of electrical resources. The results of this assessment will be incorporated into the next IRP.

Climate Change Activities

Tacoma Power is monitoring several climate change activities (and participating where appropriate) and will incorporate any new requirements or policy direction from the state into the utility's planning activities:

Governor Executive Order In February 2008, Governor Gregoire issued an Executive Order that set Washington state down a path to develop a comprehensive climate change prevention and mitigation program. This Order established targets to reduce greenhouse gas (GHG) emissions to 1990 levels by 2020 (10 million metric tons below 2004 emission levels), to 25% below 1990 levels by 2035 (30 million tons below 2004 levels); and to 50% below 1990 levels by 2050 (50 million tons below 2004 levels).

The Climate Advisory Team The Order also created the Climate Advisory Team (CAT) to:

> "... consider the full range of policies and strategies for the state of Washington to adopt or undertake to ensure the economic and emission reductions goals are achieved."

Presently the CAT is working to identify a list of "promising" strategies for consideration by the Legislature or by the Executive Branch in 2009. To accomplish this task, the CAT has formed implementation working groups organized by sector:

- Transportation
- Energy Supply and Demand (including Residential, Commercial and Industrial)
- Forestry
- Agriculture

A draft interim report by the CAT served as the basis for the Governor's request legislation HB 2815 "Greenhouse Gases Emissions and Green Collar Jobs" which passed in the 2008 legislative session. This statute made the emission reduction targets state law and requires the Department of Ecology to submit a GHG reduction plan for review and approval to the Legislature describing the necessary actions needed to achieve the GHG emission reductions.

The other major requirement of HB2815 was for the Department of Ecology, in coordination with the Western Climate Initiative (WCI), to develop a design for a regional multisector market-based system to limit and reduce GHG emissions.

The WCI The WCI is a multi-state collaborative effort launched in February 2007, to develop regional strategies to address climate change. In August 2007, the WCI set regional goals for reducing greenhouse gas emissions (15% below 2005 levels by 2020, and 50-80% below 2005 levels by 2050). The WCI is presently working to design a multi-sector, cap-and-trade mechanism to help achieve these goals. The mechanism is supposed to be complete by August 2008.

Legislative Activities (state and federal)

In the next legislative session, Tacoma Power expects the introduction of several bills related to climate change including revisions to the Energy Independence Act and to implement recommendations of the CAT and WCI. Tacoma Power will monitor these bills and incorporate any new requirements or policy direction from the state into the utility's planning activities.

Appendix A
Stakeholder Meeting Presentations

TACOMA POWER
TACOMA PUBLIC UTILITIES

Integrated Resource Plan
Stakeholders Meeting 1

October 12, 2007

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Topics

- **Background on Tacoma Power**
- What is an IRP and Why Do We Do it?
- Tacoma Power 2007 IRP - Goals and Objectives
- Tacoma Power 2007 IRP - Process

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Tacoma Power Background

- Tacoma Power established in 1893 with public purchase of Tacoma Light & Water Company
- Number of Customers: 162,587
- Number of Employees: 800
- Service Territory: approximately 180 square miles
- Governed by five member Public Utility Board
- Average Cost of Power to Customers: approximately 6.19 cents

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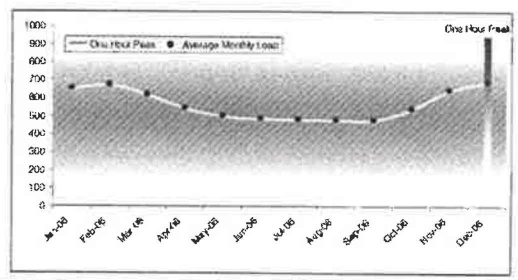
2006 Customer Load

- 2006 Approx. Peak Load: 943 MW
- 2006 Approx. Average Load: 566 aMW



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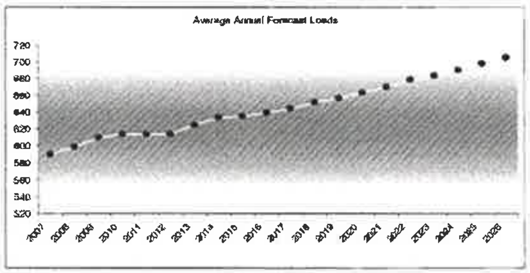
Forecast of Customer Load

- Projected Load Growth: Approximately 1.0% per year for 20 year forecast (in line with regional projected load growth)



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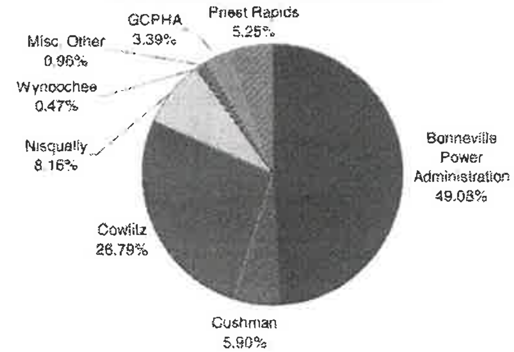
2006 Sources of Energy



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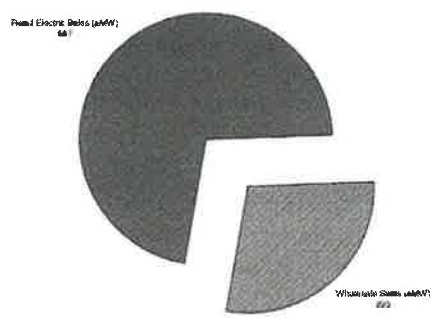
2006 Sales of Electricity



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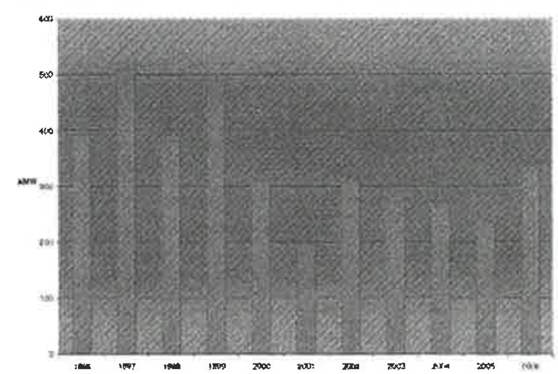
Tacoma Power Owned Hydroelectric Resources Year-to-Year Generation (1996-2006)



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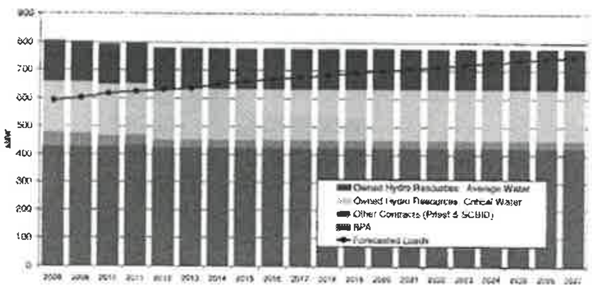
Tacoma Power Load and Resource Balance



Average Water = Annual average of 72 years of system flows
Critical Water = Annual system worst year on record (72 years)
Note: Planned conservation acquisitions not included in graphic

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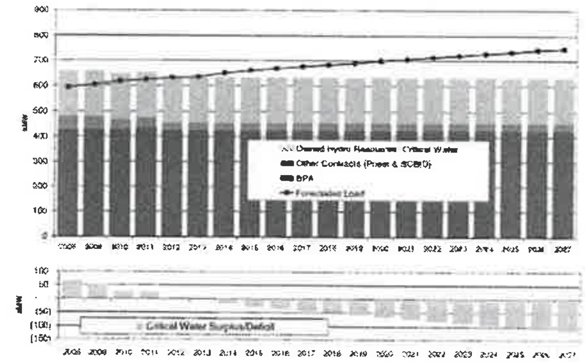
Tacoma Power Load and Resource Balance Adequacy Planning (Critical H2O)



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Topics

- Background on Tacoma Power
- **What Is an IRP and Why Do We Do it?**
- Tacoma Power 2007 IRP - Goals and Objectives
- Tacoma Power 2007 IRP - Process

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What Is Integrated Resource Planning

- Creates long-term structured comprehensive analysis framework for choosing least cost and least risk resources to meet future customer demand
- Considers combinations of supply side (e.g. power projects) and demand side (e.g. conservation) resources
- Considers future uncertainty
- Takes environmental and societal considerations into account
- Is transparent and inclusive - entails public participation
- Provides action plan for resource acquisition - types, amount and timing of new resources

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Basic IRP Process

- **Identify / Evaluate Goals and Objectives**
- **Identify Resource Need (Gap)**
  - Forecast future supply capability
  - Forecast future customer demand
  - Calculate Load and Resource Balance (Load vs. Supply)
- **Identify and Evaluate Candidate Resources**
  - Identify and characterize generic supply side resources
  - Identify and characterize demand side resources (e.g., conservation)
  - Create candidate "portfolios" of resources for analysis
- **Conduct Computer Model Simulation of Resource Portfolios**
  - Utilize methods to consider risk and uncertainty
  - Rank resource portfolios on the basis of least cost and least risk
- **Develop Short and Long Term Resource Action Plans**

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Topics

- Background on Tacoma Power
- What is an IRP and Why Do We Do it?
- **Tacoma Power 2007 IRP - Goals and Objectives**
- Tacoma Power 2007 IRP - Process

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Tacoma Power
Long Term Power Planning Goals

- **Minimize Resource Portfolio Cost (Keep Rates Low)**
- **Maintain / Enhance Reliability**
- **Minimize Environmental / Societal Impacts**
- **Maintain Resource Diversity**
- **Minimize / Manage Risk**

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Tacoma Power
Key Objectives for 2007 IRP

- **Overall Objective is to Develop a Long Term Resource Acquisition Strategy**
- **Key Objectives to Focus On**
  - Evaluate Enhanced Conservation Acquisition Opportunities
  - Develop Strategy for I-937 Compliance
  - Evaluate BPA Contract Choices
  - Enhance IRP Analyses Capability
  - Enhance IRP Public Participation Process

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Tacoma Power
Key Objectives for 2007 IRP

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  - Enhance IRP Analyses Capability
  - Enhance IRP Public Participation Process

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Key Objectives for 2007 IRP - Evaluate Enhanced Conservation Acquisition Opportunities

- **2004 IRP Action Plan recommended the development of a Conservation Potential Assessment (CPA) in order to better understand our conservation acquisition opportunities available to us**
- **The Conservation Potential Assessment is a road map that estimates the type, amount, and cost of conservation opportunities within the Tacoma Power service area.**
- **Tacoma Power retained Quantec to conduct the study**
- **Study completed January of 2007**
- **Study estimates twenty-year technical potential of about 159 aMW (across all customer sectors)**
- **About 102 aMW of this is currently "cost effective"**
- **Study will be updated on a regular basis**

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Tacoma Power
Key Objectives for 2007 IRP

- Overall Objective Is to Develop a Long Term Resource Acquisition Strategy
- Key Objectives to Focus On
  - Evaluate Enhanced Conservation Acquisition Opportunities
  - Develop Strategy for I-937 Compliance
  - Evaluate BPA Contract Choices
  - Enhance IRP Analyses Capability
  - Enhance IRP Public Participation Process

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Key Objectives for 2007 IRP
Develop Strategy to Comply With I-937 (Conservation)

Law Requires Washington Utilities to:

- Acquire All "Cost-Effective" Conservation (starting in 2010)
- Methodology for determining "cost effective" conservation targets specified by law and interpreted in subsequent rule making
  - Utilities are required to develop biennial conservation targets using methods that are consistent with those used by the Northwest Power and Conservation Council (NWPCC)
  - Quantec CPA Study used methodology consistent with NWPCC
  - Annual Targets ≈ 5 aMW

The Law specifies administrative penalties to be assessed for shortfalls - $50 per megawatt hour (2006 dollars subject to inflation)

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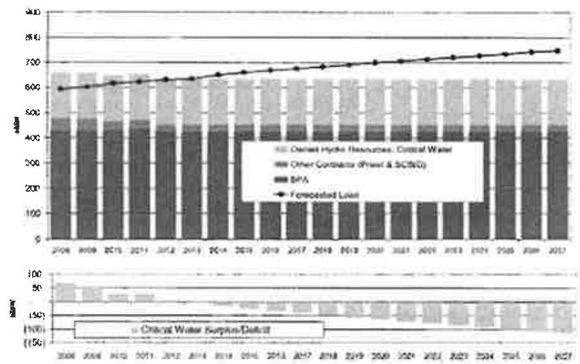
Tacoma Power Load and Resource Balance
Adequacy Planning (Critical H2O)



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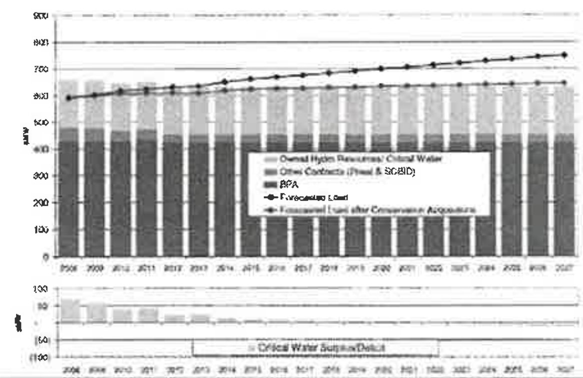
Tacoma Power Load and Resource Balance
Effect of Forecasted Conservation Acquisitions



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Key Objectives for 2007 IRP
Develop Strategy to Comply With I-937 (Renewables)

Law Requires Washington Utilities to:

2. Serve a percentage of load using eligible renewable resources
   - 3% by 2012
   - 9% by 2015
   - 15% by 2020
   - Or spend an amount equal to 4% of annual revenue requirement on the incremental cost of renewable resources
   - Utility required to comply regardless of need

The Law specifies administrative penalties to be assessed for shortfalls - $50 per megawatt hour (2006 dollars subject to inflation)

Eligible Renewable Resources

- Wind
- Solar
- Geothermal
- Incremental Hydro
- Biomass
- Landfill Gas
- Ocean (wave, tidal)
- Bio Diesel
- Renewable Energy Credits

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Estimated Renewable Acquisition Required under I-937

	Cumulative Renewable Requirement	Cumulative Requirement (aMW) based On Tacoma's Load Projections	Cumulative Estimated Acquisition (aMW) With Cost Cap*
2012	3%	18	Quantity of Renewables Associated with 4% Cost Cap*?
2013	3%	18	
2014	3%	19	
2015	3%	19	
2016	9%	56	
2017	9%	57	
2018	9%	67	
2019	9%	57	
2020	15%	85	
After 2020	15%	95+	

* The initiative includes an incremental cost cap equal to 4% of a utility's revenue requirement. Incremental cost is defined as the difference between the levelized delivered cost of the eligible renewable resource compared to the levelized delivered cost of an equivalent amount of reasonably available substitute resources that do not qualify as eligible renewable resources.

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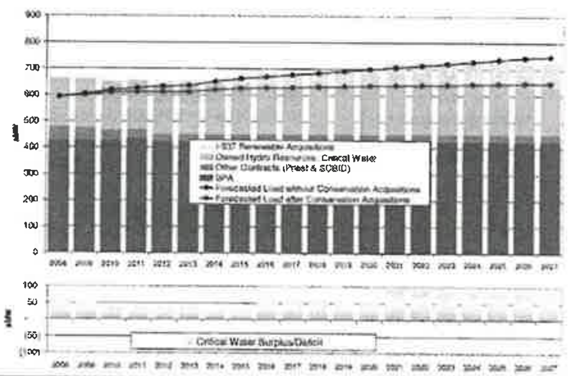
Tacoma Power Load and Resource Balance
Effect of I-937 Renewable Acquisitions



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I-937 Summary

- Required renewable acquisitions will likely exceed Tacoma Power's power supply needs, <u>even at Critical Water</u>
- Tacoma Power will likely have to acquire resources prior to need
- If the cost of producing power from renewable resources is higher than the resale price on the wholesale market, electric utility rates may increase

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Key Objectives for 2007 IRP
Develop Strategy to Comply With I-937

- **What is The Best Way to Comply with I-937 Renewable Requirements**
  1. Should we acquire renewable assets, renewable energy credits, or some combination of both?
  2. Will renewable energy credits be available? If so, at what cost?
  3. If we decide to comply by acquiring assets, when should we acquire them?
  4. If we decide to comply by acquiring assets, what types of renewable technologies make the most sense?
  5. How much renewables will we need to comply given the 4% renewable cost cap?

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Supply Side Resource Choices

- Hydroelectric
- Incremental Hydroelectric
- Wind
- Natural Gas Combined Cycle Combustion Turbine
- Natural Gas Simple Cycle Combustion Turbine
- Integrated Gasification Combined Cycle (clean coal)
- Geothermal
- Solar (thermal)
- Solar (PV)
- Biomass
- Wave
- Tidal
- Nuclear
- Fuel Cells
- Pulverized Coal

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Power Supply Resource Data

Resource	Load Service	Heat Rate	Capital Cost $/kW	Fixed O&M $/kW	Variable O&M $/MW	Fuel Costs $/mmbtu	Emissions Tons/GWh	Transmission Costs	Plant Life	Earliest On Line Date	Plant Capacity Factor
Hydroelectric	Baseload	N/A	$1,800.00	$29.59	$4.4[illegible]	$0.00	N/A		50+ years		50%
Incremental Hydroelectric		N/A							N/A		
Wind	Intermediate	N/A	$2,200.00	$30.00	[illegible]	$0.00	N/A		20 years	2008	25-40%
NG CCCT	Baseload, Intermediate, Peak	[illegible]	$980.00	[illegible]	$3.00	[illegible]	SO2~0.0[illegible] CO2~5[illegible] NOX~0.0[illegible]		15-30 years	2011	[illegible]
NG SCCT	Peak	[illegible]	[illegible]	$7.60	$11.24	$7.[illegible]	SO2~.0[illegible] CO2~5[illegible] NOX~0.01		25-30 years	[illegible]	[illegible]
IGCC	Baseload	[illegible]	$2,[illegible]	[illegible]	$4.00	$2.[illegible]	SO2 Avg CO2~791 NOX~0.[illegible]		Not available but assumed to be approximately the same as NG CCCT	2011	[illegible]
Geothermal	Baseload	[illegible]	$3,[illegible]	[illegible]	$0.00	$0.00	N/A		30 years	2011	90%
Solar (thermal)	Intermediate	[illegible]	$3,067.00	$53.7[illegible]	$0.00	$0.00	N/A		30 years	2012	[illegible]
Solar (PV)	Intermediate, Peak	[illegible]	$4,[illegible]	[illegible]	$0.00	$0.00	N/A		30-40 years	[illegible]	[illegible]
Biomass	Baseload	[illegible]	$2,150.00	[illegible]	$3.13	$4.53	SO2~N/A CO2~72[illegible] NOX~N/A		20 years	2010	80%
Wave	Intermediate	N/A	Unknown	Unknown	Unknown	[illegible]	N/A		Unknown	2012	Unknown
Tidal	Baseload, Intermediate	N/A	Unknown	Unknown	Unknown	[illegible]	N/A		Unknown	2011	Unknown
Nuclear	Baseload	[illegible]	$2,[illegible]	[illegible]	[illegible]	[illegible]	N/A		40-60 years	2016	90%
Fuel Cells	Baseload, Intermediate, Peak	[illegible]	$4,074.00	[illegible]	[illegible]	[illegible]	SO2 CO2 NOX		Unknown	[illegible]	[illegible]
Pulverized Coal	Baseload	[illegible]	$2,500.00	[illegible]	$1.8[illegible]	[illegible]	SO2~[illegible] CO2~1012 NOX~[illegible]		30-50 years	[illegible]	[illegible]

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Tacoma Power
Key Objectives for 2007 IRP

- Overall Objective is to Develop a Long Term Resource Acquisition Strategy
- Key Objectives to Focus On
  - Evaluate Enhanced Conservation Acquisition Opportunities
  - Develop Strategy for I-937 Compliance
  - Evaluate BPA Contract Choices
  - Enhance IRP Analyses Capability
  - Enhance IRP Public Participation Process

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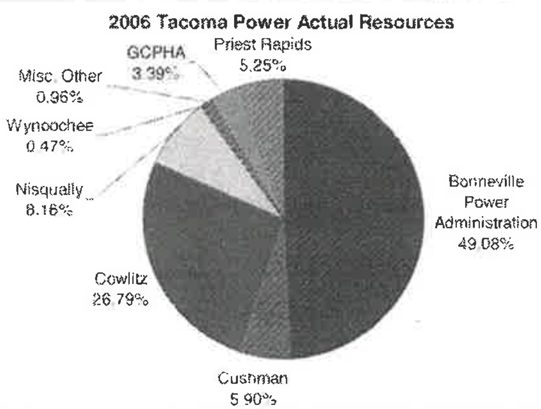
2006 Sources of Energy



35

Key Objectives for 2007 IRP
Evaluate BPA Contract Choices

- **Current Power Sales Agreement provides for:**
  - Term: 10-year contract effective October 1, 2001 through September 30, 2011
  - Quantity: 428 aMW of Power (annual average)
  - Product: Block Power with Shaping Capacity
  - Price: Average Price is approx. $27 per MWh in 2007
- **New 20 Year Power Sales Agreement contract expected to be offered in late 2008**
- **General Contract Choices**
  - Shaped Block or
  - Slice/Block Combination

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Key Objectives for 2007 IRP
General BPA Contract Choices

Block	Subscription of a predetermined *Block* (amount) of power delivered from BPA	Subscribers receive only firm portion of BPA resources (about 426 aMW for Tacoma Power?)	Subscribers receive benefits from BPA's secondary sales revenues in rates
Slice*	Subscription to receive a *Slice* (percentage) of BPA's Resources	Subscribers receive non-firm variability of the output dependent on the water year (likely more than 426 aMW on an annual basis, but could be less than needed on a short term basis)	Subscribers market surplus energy on their own

Note: "Slice" product being analyzed is 50% Block / 50% Slice.

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Key Objectives for 2007 IRP
General BPA Contract Choices

	Advantages	Disadvantages
Block	■ Supply certainty (based on load) ■ Cost certainty (fixed bill, including non-firm benefits) ■ Diversifies TP supply portfolio ■ More certain reserve obligations	■ Less operational flexibility ■ Less direct influence to maximize value of non-firm energy
Slice	■ Intra-day operational flexibility (storage) ■ Control over non-firm energy (market non-firm on own) ■ Access to BPA market information	■ Less supply certainty (based on generation) ■ More market risk ■ Increased costs to manage ■ Less certain reserve obligations ■ Potential operational restrictions ■ Transmission?

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Tacoma Power
Key Objectives for 2007 IRP

- Overall Objective Is to Develop a Long Term Resource Acquisition Strategy
- Key Objectives to Focus On
  - Evaluate Enhanced Conservation Acquisition Opportunities
  - Develop Strategy for I-937 Compliance
  - Evaluate BPA Contract Choices
  - Enhance IRP Analyses Capability
  - Enhance IRP Public Participation Process

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Key Objectives for 2007 IRP
IRP Process Enhancements

- **Enhance IRP Analyses Capability**
  - Strong internal analytical capabilities, but have not had to conduct full portfolio IRP analyses for a long time (this effort requires many resources)
  - Last few IRPs identified no need for new resources, thus no IRP portfolio analyses conducted
  - 2007 IRP Analytics
    - Stochastic forecasts of prices, loads and inflow
    - Stochastic Dynamic Program
    - Conservation Potential Assessment
- **Enhance IRP Public Participation Process**
  - Last few IRPs did not warrant significant public participation
  - Goal for this IRP is for interested parties to review, understand, and provide input to planning decisions
  - Goal for next IRP is to further enhance Public Participation Process

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Topics

- Background on Tacoma Power
- What Is an IRP and Why Do We Do it?
- Tacoma Power 2007 IRP - Goals and Objectives
- **Tacoma Power 2007 IRP - Process**

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IRP Process
Internal Work Teams

- **Developed 13 Internal Work Groups to Analyze IRP Related Issues**
  - Bonneville Contract Work Group
  - Demand Side Resources Work Group
  - Environmental Work Group
  - I-937 Work Group
  - Load Forecasting Work Group
  - Price Forecasting Work Group
  - Public Involvement Work Group
  - PURPA Work Group
  - Rate Impacts Work Group
  - New Supply Resources Work Group
  - Resource Modeling Work Group
  - Scenario Planning Work Group
  - Transmission Issues Work Group

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IRP Process
Consultant Support

- **Conservation Potential Assessment – Quantec Inc.**
- **Analytical Support – RW Beck**

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IRP Process
Public Participation / Interaction

- **Stakeholders Group Interaction**
- **Presentations to Public Utility Board**
- **Key Customer Accounts Presentation**

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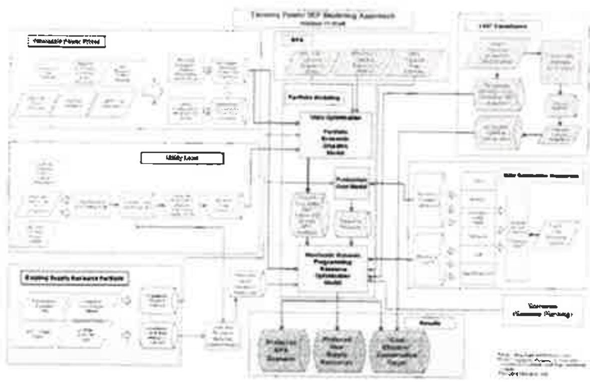
IRP Process
Analytical Process (Quantitative Analysis)



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IRP Process
Quantitative Analyses

Task	Percent Complete
Scoping of Quantitative Analysis	99%
Deterministic Price & Load Forecasts	100%
Stochastic Price & Load Forecasts	75%
Resource Adequacy (Load & Resource Balances)	100%
BPA Contract Analyses	50%
Conservation Potential / Targets	75%
Evaluation of Power Supply Resource Options	75%
Supply Side Resource Options Screening	10%
Portfolio Modeling Analyses	10%

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IRP Process
Qualitative Analyses

Task	Percent Complete
Scenario Planning	75%
Analysis of Demand Side Management Programs Other than Conservation	90%
Environmental Assessment (of Supply Side Resources)	90%
Evaluation of Regional Transmission Issues	25%
Stakeholders Participation Process	25%

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Next Stakeholder Meeting

- **Topics For Next Meeting**
  - Conservation Potential Assessment / Conservation Annual Targets
  - Power Supply Resource Characteristics and Screening Criteria
  - Other Subjects?

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Comments or
Questions?

Thanks for Attending

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TACOMA POWER
TACOMA PUBLIC UTILITIES

2007 Tacoma Power Load Forecast

IRP Stakeholders
November 30, 2007

TOPICS

- Forecast Loads
- Models & Methods
- Assumptions
- Results

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Forecast Loads

- Purpose
  - Revenue Requirements
  - Budgeting
  - Cost-of-Service
  - BPA & PNUCC Submittals
  - Integrated Resource Planning
  - Financial Modeling

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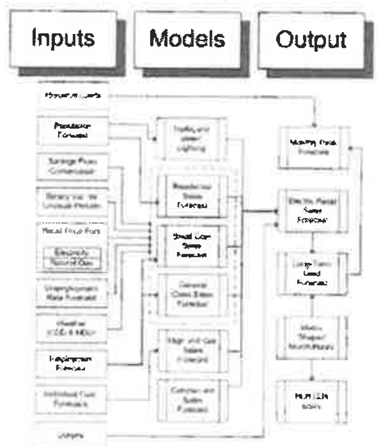

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Forecast Loads

Model Types

- Residential — Statistical
- Small General — Statistical
- General — Statistical
- High Voltage General — Individual
- Contract Industrial — Individual
- Street Lighting & Traffic Signal — Trend
- Private Off-Street Lighting — Trend

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Forecast Loads

Basic Statistical Model

- Sales are a function of:
  - Price
  - Economic Activity
  - Number of Customers
  - Weather
  - Price of Substitutes

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Forecast Loads

Key Variables

- Customer Growth
  - Puget Sound Regional Council (PSRC) Population Forecasts
- Economic Activity
  - PSRC Employment Forecasts
  - Global Insight Unemployment Forecasts
- Energy Prices
  - Energy Information Administration “Energy Outlook”

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Forecast Loads

Large Customer Estimates

- Large Customers
  - Simpson
  - Fort Lewis
  - McChord
  - Praxair
  - US Oil & Refining
  - Simpson Timber
  - Schnitzer Steel
  - Port of Tacoma

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Forecast Loads

Large Customer Estimates

- Specific estimates for each customer are based on all sources of information
  - Data Observation
  - Discussions with Customers
  - Industry specific economic data if available
- Area Specialists
  - Energy Services - Account Executives
    - Steve Craig
    - Joe Downs
  - Energy Services - Conservation
    - Rich Arneson
    - Mike Lannoye
  - T&D - Planning

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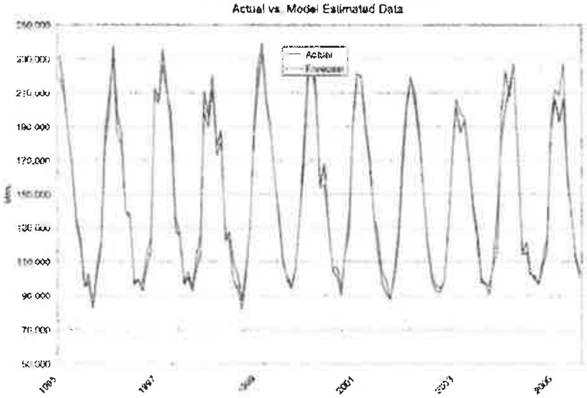
Residential Sales

Actual vs. Model Estimated Data



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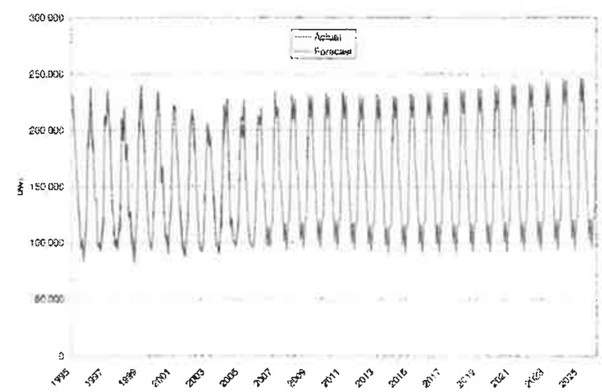
Residential Sales



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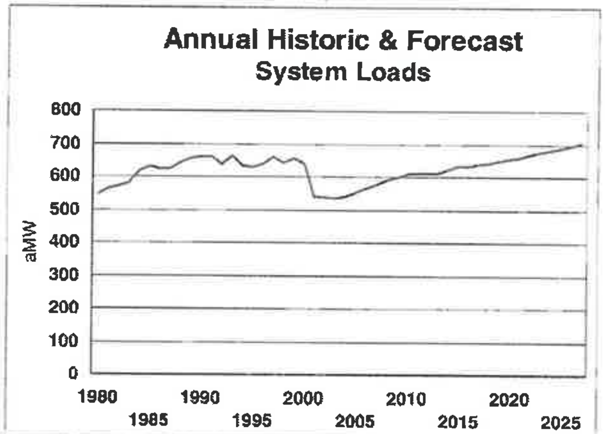

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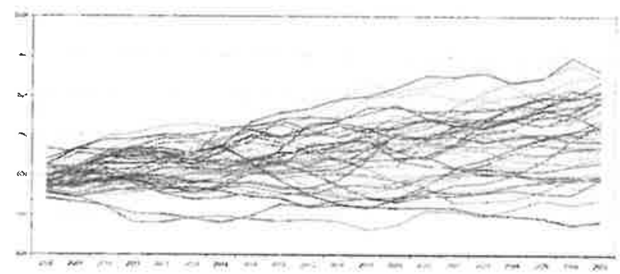
IRP Load Forecast Uncertainty



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TACOMA PUBLIC UTILITIES

Conservation/Energy Efficiency Planning

What is Energy Conservation?

- *Energy Conservation* is defined here as the ability to achieve the same amount of work with less energy
- The conservation we are discussing here is not shivering in the dark, or shuttering businesses
- Conservation accomplishments and goals are described in first year savings only

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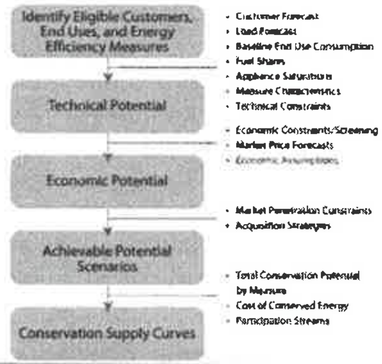
Conservation Potential Assessment
Quantec Methodology



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Conservation Potential Assessment
Quantec Methodology

- ***Technical potential*** represents the savings attributable to all measures in all technically feasible applications without regard to cost or market constraints
- ***Economic potential*** represents a subset of technical potential measures that pass a Total Resource Cost (TRC) Test
- ***Achievable potential*** reduces economic potential by applying expected market acceptance rates

66

Residential Research

- Approximately 141,500 accounts
- The classification process included
  - Links to County Assessor data
  - Account classification by building type, age, etc.
  - 2005 residential survey results
  - Residential presence of electric heat research
  - Conservation accomplishment data
  - 2000 Census demographics

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Residential
Geographic Information System

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Residential Integrated Data Set

Connect Object	Parcel Number	House #	Building Description	Finished SQFT	HVAC Description	Ratio	CP Platinum	Year Built	Year Remodel	Percent Remodel	1999 % of Families Below Poverty	Range	Township	Section	Qtr
[illegible]	2300000	3112	1 Story	2216	Electric Baseboard	2.1	00822	1919	1980	100%	6.0%	03	21	31	2
[illegible]	2290001	3007	1 Story	1107	Forced Air	1.4		1910	1950	100%	6.0%	03	21	31	2
[illegible]	2290001	3115	1 Story	1344	Forced Air	1.1		1926	1996	40%	6.0%	03	21	31	2
[illegible]	2290001	3119	1 Story	1152	Forced Air	2.6		1925	1956	100%	6.0%	03	21	31	2
[illegible]	2290001	3011	1+ Story Fin	1370	Forced Air	1.0		1911	1997	71%	6.0%	03	21	31	2
[illegible]	2290001	3111	1 Story	1662	Forced Air	6.0		1927	1956	100%	6.0%	03	21	31	2
[illegible]	2290001	3023	1 Story	1364	Forced Air	4.0		1915	1950	100%	6.0%	03	21	31	2
[illegible]	2290001	3019	1+ Story Fin	1304	Forced Air	1.5		1905	1950	100%	6.0%	03	21	31	2
[illegible]	2290001	3015	1+ Story Fin	1878	Forced Air	2.2		1900	1970	100%	6.0%	03	21	31	2
[illegible]	2300000	3110	1 Story	1604	Forced Air	2.7		1917	1980	100%	6.0%	03	21	31	3
[illegible]	2300000	3014	1+ Story Fin	1216	Forced Air	1.2		1920	1956	100%	6.0%	03	21	31	3
[illegible]	2300000	3004	1+ Story Fin	1708	Hot Water Baseboard	3.1	21740	1924	1960	100%	6.0%	03	21	31	3

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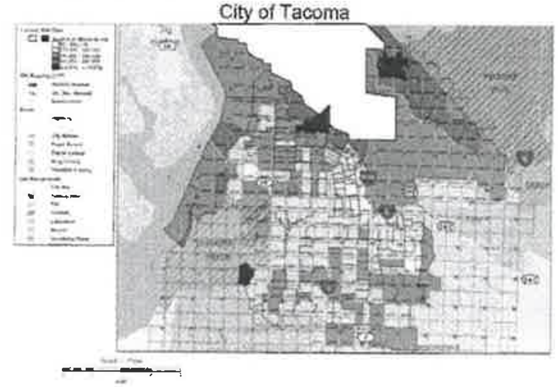
Demographics by Income

City of Tacoma



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Commercial/Industrial Research

- Approximately 21,000 accounts
- Classified 8,498 accounts - 80% of C/I load
- Ten commercial building types – 7,745 accounts
- Fifteen industrial groups - 753 accounts
- The classification process included:
  - GIS photo identification
  - Account Executive assistance
  - Dunn & Bradstreet
  - Pierce County Assessor data sets
  - Previous classification processes

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2007 Conservation Potential Assessment 20-Year Economic Potential

Sector / Segment	Economic Potential (aMW)	Percent of Potential
Residential	42.3	40%
Existing Retrofit	33.4	
Existing Equipment Replacement	4.2	
New Construction and Equipment	4.7	
Commercial	34.6	33%
Existing Retrofit	24.6	
Existing Equipment Replacement	3.9	
New Construction and Equipment	6.1	
Industrial	22.5	21%
Military	5.8	6%
Totals	105.2	
Percent of Baseline Forecast	697.4	15.1%

- Adjusted for programmatic costs, economic potential is 102 aMW
- Potential results may change with each new CPA
- This analysis is consistent with methodology used by the NWPCC

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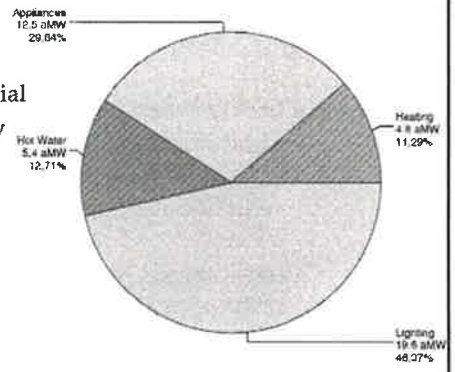
Residential Economic Potential

- 42.3 aMW of Potential
- 83.5% Single Family
- 89% Existing Construction



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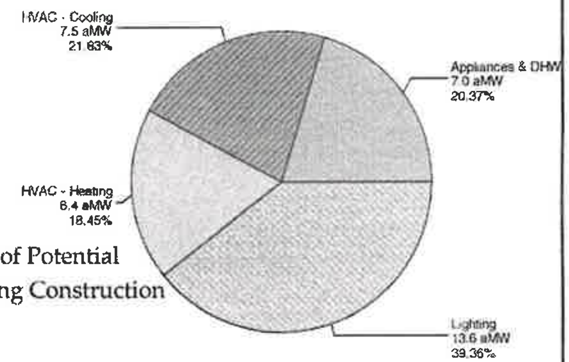
Commercial Economic Potential



- 34.6 aMW of Potential
- 82% Existing Construction

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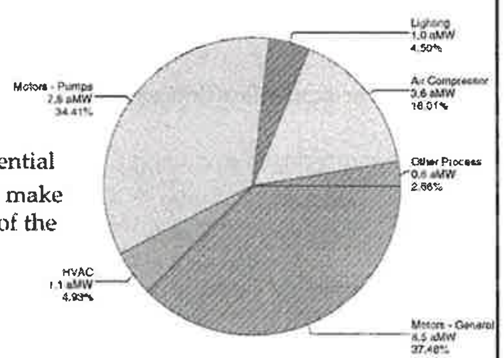
Industrial Economic Potential

- 22.5 aMW of Potential
- A few customers make up a large share of the savings



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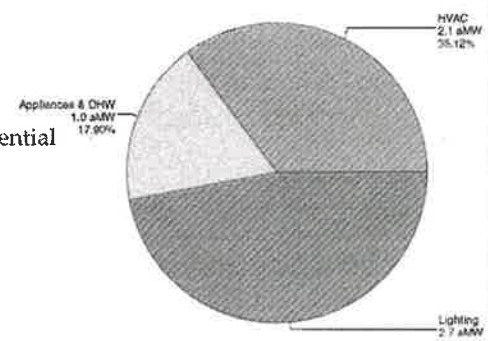
Military Facility Economic Potential

- 5.8 aMW of Potential
- 48% Office and Warehouse



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Estimating Achievable Potential

Achievable potential is that portion of economic potential that may be expected to be acquired subject to market barriers and other constraints

- It varies depending on incentive levels, planning horizon and customer sector
- It is subject to the influence of difficult to predict market factors
- It is essentially a probabilistic outcome

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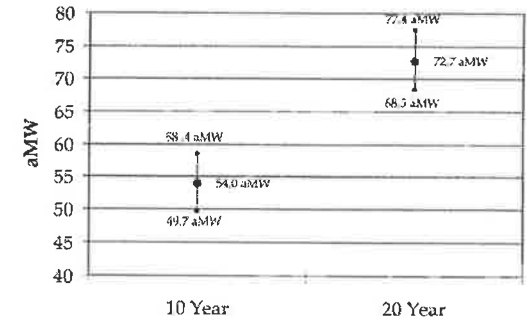
Achievable Potential Range and Distribution



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Regional Events
The Energy Security Act WAC 194-37

- Determine the ten year, cost effective conservation potential, consistent with NWPCC methodology
- Estimate 10 year achievable potential
- Conservation goal must be no less than the pro-rata share of the achievable potential
- Our actions now impact the ability to meet the goal
- State enforced penalty of $50 per MWh of conservation shortfall

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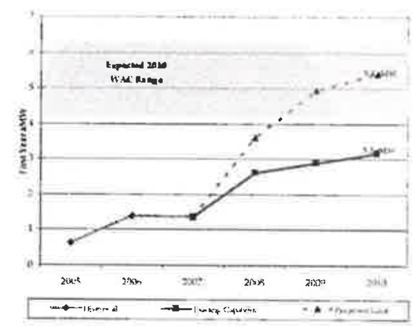
Acquisition Ramps in Perspective

Two paths considered

- **Existing Capability**
  Use existing staff & new program designs
- **Proposed Goal**
  Increase budget with new program designs



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Program Development Considerations

- Guiding principles for program design:
  - Meet customer needs
  - Develop programs to meet conservation goals
  - Meet cost effectiveness tests
  - Be consistent with neighbor utilities PSE, SCL and SnoPUD
  - Maximize trade allies as appropriate
- Challenges to overcome
  - Infrastructure to deliver conservation
  - Competition for trade allies and equipment
  - Competition for qualified staff
  - Local economy may impact conservation results
  - Customer and contractor acceptance of new technologies and programs

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Stakeholder Feedback

- What needs to be done to increase customer interest and participation in conservation programs?
- Are there specific program design features that you believe need to be incorporated?
- Are there concerns about how conservation activities are managed?
- Other questions or issues?

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Proposed Programs Commercial & Industrial

- Expanded Bright Rebates Program (lighting)
- Efficiency Options Program (custom projects)
- Energy Smart Grocer Program (contracted delivery)
- Fort Lewis & McChord Conservation Project

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Proposed Programs Commercial & Industrial

- Equipment Rebates Program (VFDs, motors, HVAC)
- Enhanced Compressed Air Program
- New Construction Program
- Building Retro-Commissioning Program
- Resource Conservation Manager Program

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Proposed Programs Residential

- Residential Lighting Program – Screw-in and Hardwired
- Energy Efficient Showerheads & Aerators
- Residential New Construction – Beyond Code

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Proposed Programs Residential

- High Efficiency Heat Pump Program
- Appliances
  - Energy Star Washwise
  - Refrigerator Decommissioning
- Weatherization (Low Income & Non Low Income)

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Residential Sector Statistics

- 86,386 Single Family Homes
  - Roughly 30,000 are electrically heated
- 2,600 Multi-Family Buildings
  - 30,400 multi-family units
  - Large majority are electrically heated
- Weatherization jobs completed (1980 -2007):
  - Tacoma Power – 18,165 (roughly half low-income)
  - Community Action Agencies – 2,321

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Residential - Low Income Services

- Qualifying income = less than 50% of the median income in Pierce County, adjusting for family size
- Estimated 60% of electrically heated SF dwellings are occupied by residents whose income qualifies as low-income.
- Weatherization – only service that certifies residents as low-income
- Weatherization Challenges - low income participation
  - Encouraging landlords to participate
  - Convincing low income tenants to document income status
  - Multi-lingual outreach
- Challenges for other services
  - Multi-lingual marketing, presentations
  - Infrastructure in low-income communities

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Comments and Questions

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TACOMA PUBLIC UTILITIES

Conservation/Energy Efficiency Planning

November 30, 2007

Agenda

- Conservation Potential Assessment
- Energy Independence Act
- Ramps in Perspective
- Research
- Program Plans and Feedback
- Summary Feedback

94

What is Energy Conservation?

- *Energy Conservation* is defined here as the ability to achieve the same amount of work with less energy
- The conservation we are discussing here is not shivering in the dark, or shuttering business
- Conservation accomplishments and targets are described in first year savings only

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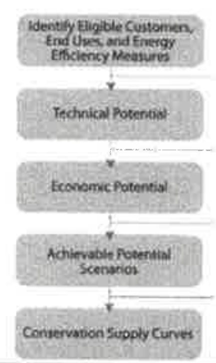
Conservation Potential Assessment Methodology



- *Technical potential* represents the savings attributable to all measures in all technically feasible applications without regard to cost or market constraints
- *Economic potential* represents a subset of technical potential measures that pass a Total Resource Cost (TRC) Test
- *Achievable potential* reduces economic potential by applying expected market acceptance rates

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Customer Research

Data sets to improve understanding of how our customers use energy
- Links to County Assessor data
- Account classification by building type or SIC
- Dunn & Bradstreet classifications
- Residential presence of electric heat research
- Conservation accomplishment data
- 2000 Census demographics

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Customer Research - Residential

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Residential Low Income Weatherization

- The current weatherization biennium budget is about $1 million and will ramp up
- Challenges facing low income participation
  - Encourage landlords to participate
  - Convincing low income people to document income status

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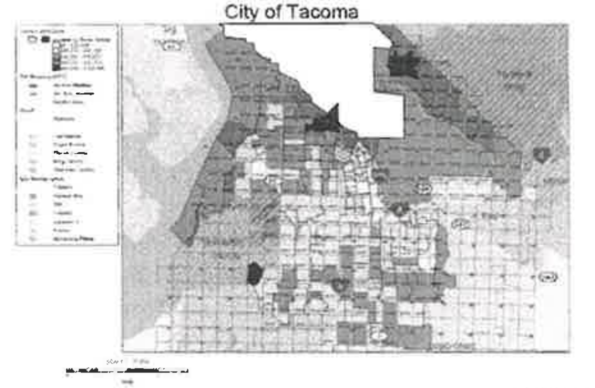
Demographics by Income

City of Tacoma



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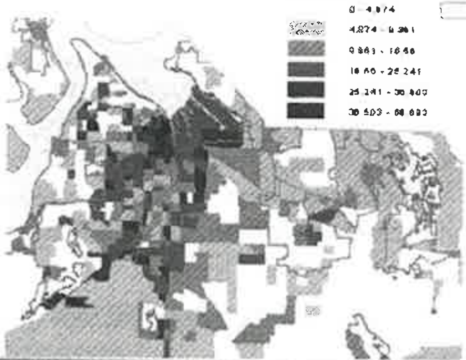
Demographics by Income – Pierce



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Customer Research - Commercial/Industrial

- Approximately 21,000 accounts
- Classified accounts for over 90% of load
- GIS photo identification
- Account Executive assistance
- Dunn & Bradstreet
- Pierce County Assessor
- Previous classification processes
- Ten commercial building types
- Fifteen industrial SIC Groups

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2007 Conservation Potential Assessment 20-Year Economic Potential

Sector / Segment	Economic Potential (aMW)	Percent of Potential
Residential	42.3	40%
Existing Retrofit	33.4	
Existing Equipment Replacement	4.2	
New Construction and Equipment	4.7	
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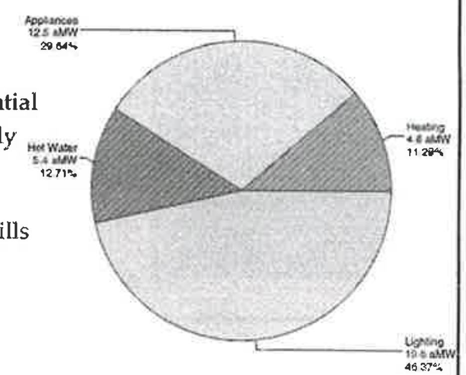
103

Residential Economic Potential

- 42.3 aMW of Potential
- 83.5% Single Family
- 89% Existing Construction
- 96% is under 60 Mills



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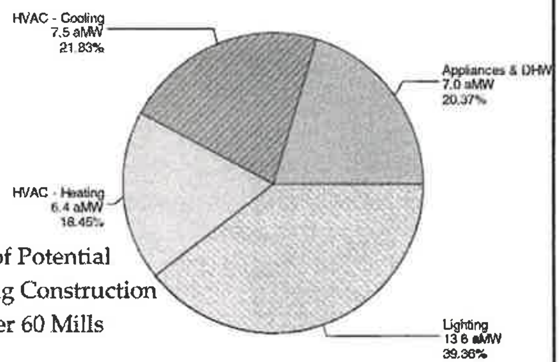
Commercial Economic Potential



- 34.6 aMW of Potential
- 82% Existing Construction
- 85% is under 60 Mills

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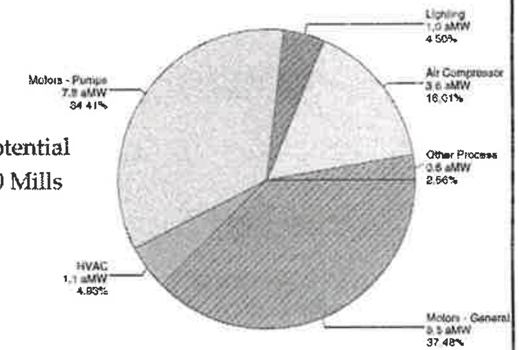
Industrial Economic Potential

- 22.5 aMW of Potential
- 95% is under 40 Mills



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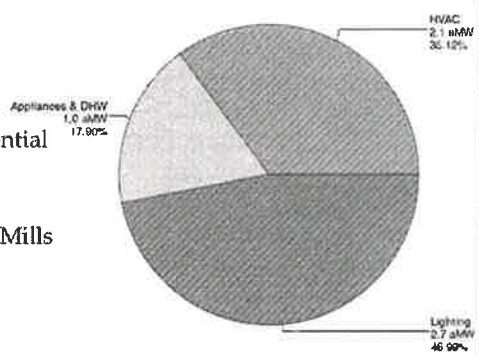
Military Base Economic Potentials

- 5.8 aMW of Potential
- 48% Office and Warehouse
- 87% is under 60 Mills



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Estimating Achievable Potentials

Achievable potential is that portion of economic potential that may be expected to be acquired subject to market barriers and other constraints

- It varies depending on incentive levels, planning horizon and customer sector
- It is subject to the influence of difficult to predict market factors
- It is essentially a probabilistic outcome

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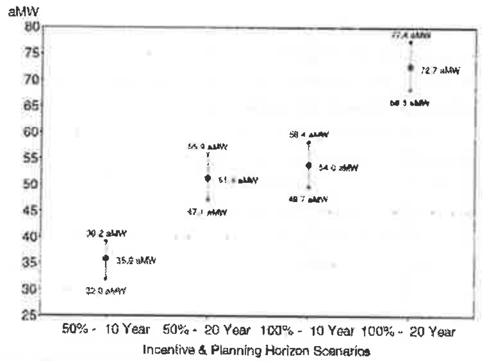
Achievable Potential by Period and Incentive Level



109

Regional Events The Energy Security Act WAC 194-37

- Determine the ten year, cost effective conservation potential, consistent with Power Council methodology
- Estimate 10 year achievable potential
- Conservation target must be no less than the pro-rata share of the achievable potential
- Our actions now impact the ability to meet the target

110

Consequences of Missing the Targets

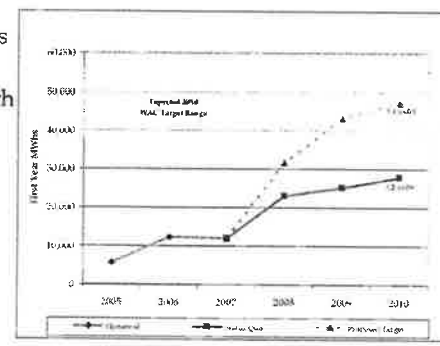
- State enforced penalty of $50 per MWh of conservation shortfall
- Achieve the next target plus acquire the shortfall from the previous year

111

Acquisition Ramps in Perspective

This draft plan considers two paths

- Status Quo: Use existing budget with new program designs
- Proposed Target: increase incentives with new program designs



112

Program Development Considerations

- Guiding principles for program design:
  - Develop programs to meet conservation targets
  - Meet cost effectiveness tests
  - Consistency with neighbor utilities PSE, SCL and SnoPUD
- Challenges to overcome
  - Infrastructure to deliver conservation
  - Competition for trade allies and equipment
  - Competition for qualified staff
  - Local Economy may impact conservation results
  - Customer and contractor acceptance of new technologies and programs

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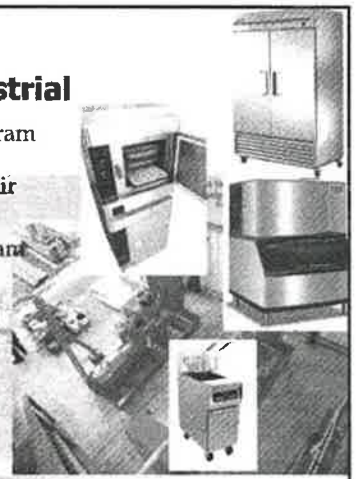
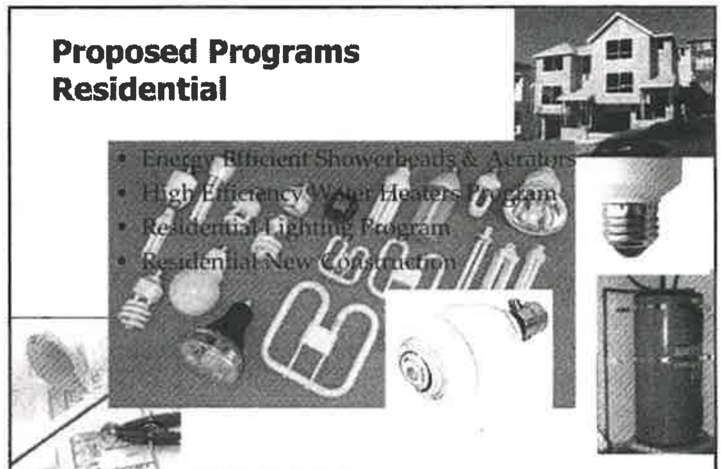
Proposed Programs Commercial & Industrial

- Equipment Rebates Program (VFDs, motors, HVAC)
- Enhanced Compressed Air Program
- New Construction Program
- Building Retro-Commissioning Program
- Resource Conservation Manager Program



115

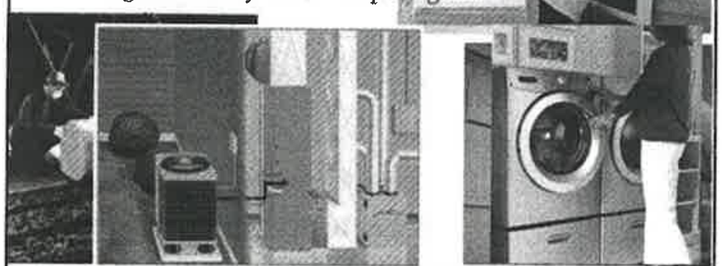
Proposed Programs Residential



116

Proposed Programs Residential

- Weatherization (Low Income & Low Income)
- High Efficiency Heat Pump Program



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Stakeholder Feedback

- What needs to be done to earn customer interest and participate in conservation programs?
- Are there specific program design features that you believe need to be incorporated?
- Are there concerns about how conservation activities are managed?
- Other Questions or Issues

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TACOMA POWER

Integrated Resource Plan
Public Meeting #3

June, 2008

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Topics

- Review
  - What is IRP and why we do it
  - Load and Resource Balance
  - Conservation Acquisition Goals
  - I-937 Renewable Acquisition Requirements
- IRP Portfolio Analysis
  - Analysis Approach
    - Resource Portfolios Considered
    - Optimization Modeling
    - Primary Model Inputs
  - Results & Conclusions
  - Renewable Energy Credits RFP
  - Future Challenges & Action Plan

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What Is Integrated Resource Planning?

- **Creates long-term structured comprehensive analysis framework for choosing least cost and least risk resources to meet future customer demand**
- **Considers combinations of supply side (e.g. power projects) and demand side (e.g. conservation) resources**
- **Considers future uncertainty**
- **Takes environmental and societal considerations into account**
- **Is transparent and inclusive - entails public participation**
- **Provides action plan for resource acquisition - types, amount and timing of new resources**

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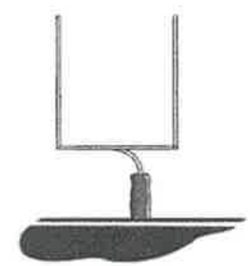
Long-Term Power Planning Goals

- **Minimize Resource Portfolio Cost (Keep Rates Low)**
- **Maintain / Enhance Reliability**
- **Minimize Environmental / Societal Impacts**
- **Maintain Resource Diversity**
- **Minimize / Manage Risk**



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Key Objectives for the 2007 IRP

- **Overall Objective is to Develop a Long Term Resource Acquisition Strategy**
  - Key Objectives to Focus On
    - Evaluate BPA Contract Choices
    - Develop Strategy for I-937 Compliance
      - Conservation
      - Renewables

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Resource Adequacy

- **Load Resource Balance - comparison of Tacoma Loads and Tacoma Resources (owned & contracted)**
  - **Internal (Tacoma Power) Adequacy Criterion is resource load balanced or better at critical water (on annual basis)**
  - **Regional Adequacy Standard also designates adequacy criterion as balanced or better at critical water, but there are some differences in how it's defined (less conservative)**
    - Allows for 1500 aMW available to region from market during winter

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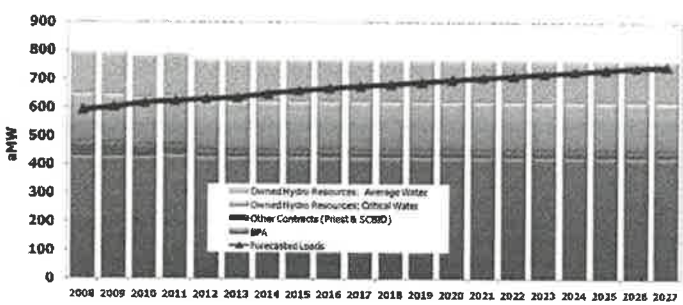
Tacoma Power's Load and Resource Balance



Average Water = Annual average of 72 years of system flows
Critical Water = Annual system worst year on record (72 years)
Note: Planned conservation acquisitions not included in graphic

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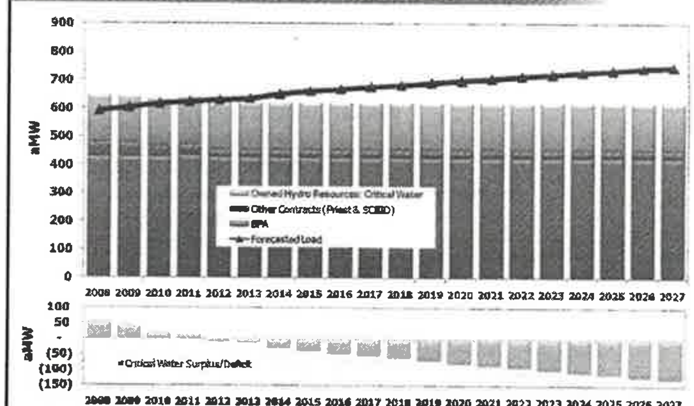
Adequacy Planning (Critical H2O)



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I-937 Compliance -- Conservation

- 2004 IRP Action Plan recommended the development of a Conservation Potential Assessment (CPA) to better understand the conservation acquisition opportunities that are available
- The Conservation Potential Assessment is a road map that estimates the type, amount, and cost of conservation opportunities within the Tacoma Power service area
- Assessment completed in January 2007 by consultant (Qauntec Inc.) using methodologies consistent with NWPCC
- Study estimates twenty-year technical potential of about 159 aMW (across all customer sectors)
- About 102 aMW of this is currently "cost effective"
- Identifies about 54 aMW of cost-effective achievable in first 10 years

Annual Targets ≈ 5 to 6 aMW

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I-937 Compliance -- Conservation

- **Law Requires Washington Utilities to:**
  1. Acquire All "Cost-Effective" Conservation (starting in 2010)
     - Methodology for determining "cost effective" conservation targets specified by law and interpreted in subsequent rule making
       - Utilities are required to develop biennial conservation targets using methods that are consistent with those used by the Northwest Power and Conservation Council (NWPCC)

The Law specifies administrative penalties to be assessed for shortfalls - $50 per megawatt hour (2006 dollars subject to infla

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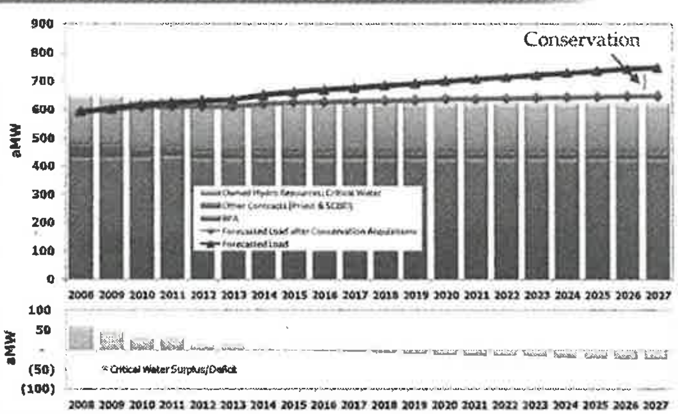
Expected Load and Resource Balance



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I-937 Compliance -- Renewables

- **Law Requires Washington Utilities to:**
  2. Serve a percentage of load using eligible renewable resources
     - 3% by 2012
     - 9% by 2015
     - 15% by 2020
     - Or spend an amount equal to 4% of annual revenue requirement on the incremental cost of renewable resources
     - Utility required to comply regardless of whether it needs power supply resources for load

The Law specifies administrative penalties to be assessed for shortfalls - <u>$50 per megawatt hour</u> (2006 dollars subject to inflation)

Eligible Renewables

- **Wind**
- **Solar**
- **Geothermal**
- **Incremental Hydro**
- **Biomass**
- **Landfill Gas**
- **Ocean (wave, tidal)**
- **Bio Diesel**
- **Renewable Energy Credits**

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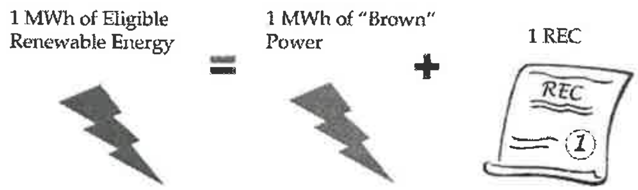
- What are Renewable Energy Credits (REC) and how do they differ from Eligible Renewable resources?
  - An REC represents the environmental attribute of a MWh of energy produced by an "Eligible Renewable" resource



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Estimated Renewable Acquisition Required Under I-937 for Tacoma Power

	Cumulative Renewable Requirement	Cumulative Requirement based On Tacoma's Load Projections aMW	MWh	Cumulative Estimated Acquisition (aMW) With Cost Cap*
2012	3%	19	165,000	Quantity of Renewables Associated with 4% Cost Cap*?
2013	3%	19	165,000	
2014	3%	19	165,000	
2015	3%	19	165,000	
2016	9%	57	500,000	
2017	9%	57	500,000	
2018	9%	57	500,000	
2019	9%	57	500,000	
2020	16%	95	850,000	
After 2020	15%	95+	650,000+	

* The Initiative includes an incremental cost cap equal to 4% of a utility's revenue requirement. Incremental cost is defined as the difference between the levelized delivered cost of the eligible renewable resource compared to the levelized delivered cost of an equivalent amount of reasonably available substitute resources that do not qualify as eligible renewable resources.

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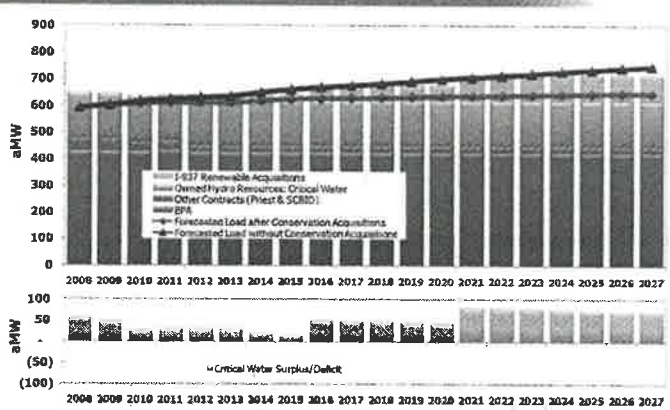
Tacoma Power Load and Resource Balance
Effect of I-937 Renewable Resource Acquisitions



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What is The Best Way to Comply with I-937 Renewable Requirements?

1. Should we acquire renewable assets, renewable energy credits, or some combination of both?
2. Will renewable energy credits be available? If so, at what cost?
3. If we decide to comply by acquiring assets, when shou them?
4. If we decide to comply by acquiring assets, what types of renewable technologies make the most sense?
5. How much renewables will we need to comply given the 4% renewable cost cap?

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What to do?

- **Options**
  - Begin acquiring eligible renewable resources
  - Begin acquiring RECs
  - Do nothing (at least for the time being)
- **Basis for Decision Making**
  - Minimize cost of compliance to our rate-payers
  - Minimize risk of non-compliance & avoid high compliance cost exposure
  - Decision consistent with results of IRP

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IRP Modeling Concept

1. Evaluate all potential power supply resources, screen out impractical choices, and develop resource "portfolios" for consideration
2. Use computer simulation model to determine which portfolio of future resources makes the most sense for Tacoma Power's rate payers
3. Run model over multiple potential futures
   - Wholesale Power & Natural Gas Prices (i.e. what we can sell / buy power for)
   - Tacoma Retail Load (i.e. how much power we need for retail load)
4. Choose resource portfolio that is lowest reasonable cost and risk

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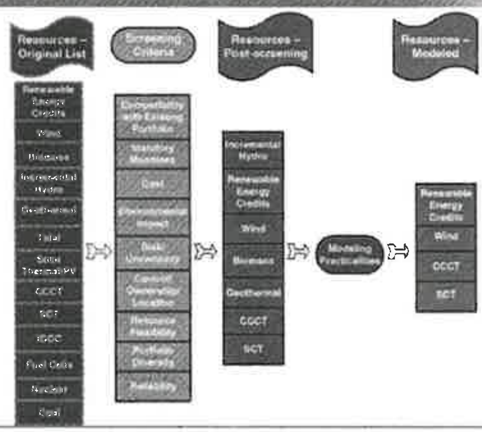
Resource Supply Screening Process



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New Resources for Consideration

- New resource need primarily driven by I-937 compliance – i.e., not needed for load under expected case
  - Modeling efforts consider futures where resources are needed (high load futures)
- Supply resources available to IRP models includes Wind, CCCT and SCCT, and REC's for compliance

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I-937 Compliance
IRP Resource Optimization Model

- The purpose of this model is to choose optimum resource portfolios on the basis of least cost / risk
  - Developed by Consultant
  - Optimization model that simulates dispatch of alternative resource "portfolios"
  - Considers 1000 combinations of varying amounts of Wind, Combined Cycle and Simple Cycle Gas generation portfolios
  - Uncertain variables are expressed as probability functions (as opposed to a known quantity)
  - Inputs include stochastic projections of fuel and power prices, and Tacoma loads
  - Also includes capital & O&M costs and operating characteristics of new power supply projects being considered
  - Adheres to user defined Resource Adequacy and I-937 Compliance requirements
  - Identifies optimal portfolio decisions chosen on the basis of cost minimization (expected NPV or risk-adjusted NPV)
  - Reports Imputed REC price and offers guidance on REC vs. Resource decision

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Wholesale Market Power Prices

- Base Case deterministic forecast developed in house using Aurora fundamental model
- Stochastic forecasts developed by consultant using combination fundamental / econometric approach
  - Marginal Cost (MC) estimated using fundamentals
  - Multi-region model
  - Inputs include fuel prices (natural gas and coal), regional load, carbon cost, hydro, regional demand, and capacity
  - Analysis of historical data to determine distributions and correlations between input variables
  - Price deviation from marginal cost estimated using econometric techniques – ratio of regional load to available capacity explains deviation from MC
  - Monte Carlo simulation on regional hydro, fuel prices, carbon cost, and regional load (50 draws for each year 2007 through 2027)
- Result is a series of market price forecasts for each year 2007 through 2027

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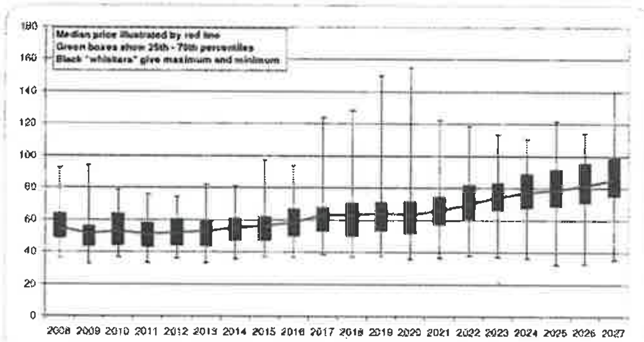
Wholesale Market Power Prices
(Annual Average $MWh)



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Load Forecasts

- Base case deterministic forecast
  - Developed in house using econometric techniques
  - Major demographic drivers are projections of population and employment (≈1% growth) from 2006 Puget Sound Regional Council (PSRC)
  - Assumes 5.4 MW conservation per year
  - Includes new expected industrial loads in next couple of years of approximately 16 aMW
- Stochastic Loads and Hourly Shapes
  - Developed by consultant
  - Analysis of Tacoma historical loads to understand volatility on annual, monthly and hourly basis
  - Benchmarked to deterministic forecast (above)
  - Takes correlation between region and Tacoma load into account
- Result is a series of load price forecasts for each year 2007 through 2027

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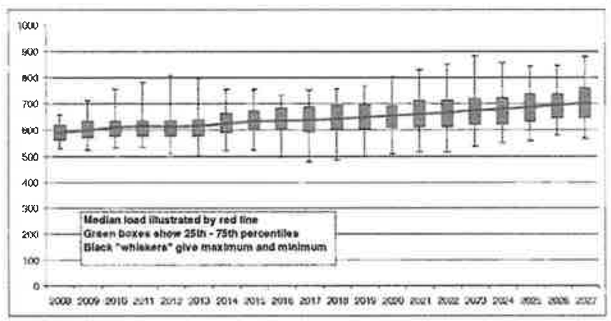
Tacoma IRP Load Forecasts Distribution (aMW)



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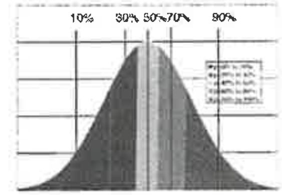
I-937 Compliance
IRP Resource Optimization Modeling

Stochastic Inputs

- Natural Gas Prices Using existing probability distributions, the module determines the 10th, 30th, 50th, 70th, and 90th percentiles for utility load, natural gas costs and implied heat rates (i.e. power prices) for each year (2008 – 2028).
- Allows user to ask what-if questions by choosing point on distribution for each input; utility load, natural gas cost and implied heat rate.



Deterministic Inputs

Model also allows user to specify certain deterministic inputs

- Wind Costs →
- Bonneville Contract High Water Mark / Net Requirements Calculation
- REC Contracts
- Others

Low	Medium	High
$75	$100	$125

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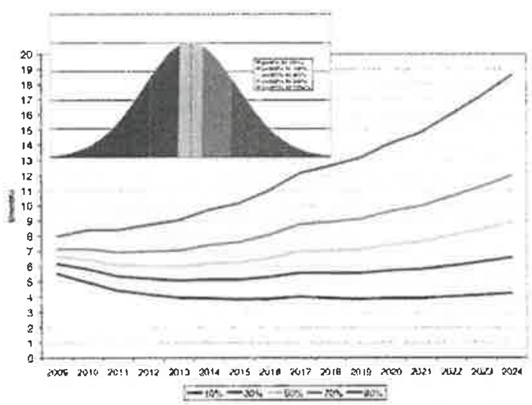
IRP Resource Optimization Modeling
Inputs – Natural Gas Price Distribution



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IRP Model – Portfolio Results – 2008 through 2020
Expected Loads, Median Implied Heat Rates

Percentile	0% to 20%	20% to 40%	40% to 60%	60% to 80%	80% to 100%
Gas	≈ $3.40	≈ $4.50	≈ $5.50	≈ $6.70	≈ $9.00
Power	≈ $29	≈ $39	≈ $47	≈ $58	≈ $78
Wind Price	RESULTS				
≈ $75	New Resources. None REC = $42 Acquire RECs for I-937	New Resources: None REC = $33 Acquire RECs for I-937	New Resources: None REC = $25 Acquire RECs for I-937	New Resources: 15 aMW Wind 2012 REC = $10 Supplement wind with RECs [illegible]	New Resources: Acquire Wind to comply & sell gen into market REC = [illegible]
≈ $100	New Resources. None REC = $66 ($58) Acquire RECs for I-937	New Resources: None REC = $58 Acquire RECs for I-937	New Resources: None REC = $50 Acquire RECs for I-937	New Resources: None REC = $41 Acquire RECs for I-937	[illegible]
≈ $125	REC = $88 ($58) Acquire RECs for I-937	REC = $79 ($58) Acquire RECs for I-937	REC = $71 ($58) Acquire RECs for I-937	REC = [illegible] ($58) Acquire RECs for I-937	REC = [illegible] Acquire RECs for I-937

REC - Imputed REC price (Green Power minus Brown Power). Current REC price less than $15
Wind Values are assumed delivered shaped/firmed and include PTC

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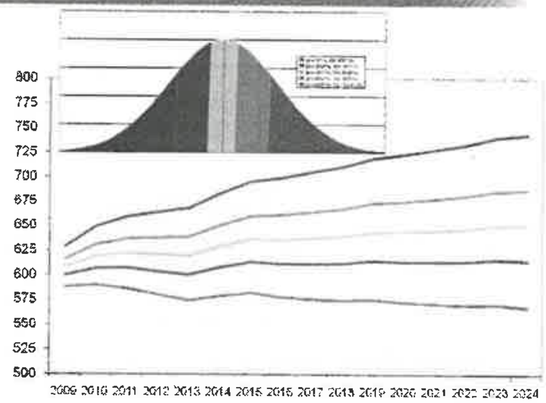
IRP Model Inputs
Load Forecast Distribution



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IRP Model – Portfolio Results – 2008 through 2020

[illegible], Median Implied Heat Rates

Percentile	0% to 20%	[illegible]	40% to 60%	60% to 80%	80% to 100%
Gas	≈ $3.40	[illegible]	≈ $5.50	≈ $6.70	≈ $9.00
Power	≈ $29	≈ $39	≈ $47	≈ $58	≈ $78
Wind Price	RESULTS				
≈ $75	New Resources: 15 aMW Wind 2014 15 aMW Wind 2018 REC = $42 Supplement wind with RECs	New Resources: 15 aMW Wind 2014 15 aMW Wind 2016 REC = $33 Supplement wind with RECs	New Resources: 15 aMW Wind 2014 15 aMW Wind 2016 REC = $25 Supplement wind with RECs	New Resources: 15 aMW Wind 2014 15 a MW Wind 2016 REC = $18 Supplement wind with RECs ???	New Resources: Acquire Wind for load & compliance REC = $3 Don't acquire RECs for I-937
≈ $100	20 aMW CT – 2015 REC = $66 ($58) Acquire RECs for I-937	20 aMW CT – 2015 REC = $58 Acquire RECs for I-937	20 aMW CT – 2015 REC = $50 Acquire RECs for I-937	20 aMW CT – 2015 15 aMW Wind 2019 REC = $41 Acquire RECs for I-937	15 aMW Wind 2014 20 aMW CT - 2017 REC = $24 Supplement wind with RECs
≈ $125	20 aMW CT – 2015 REC = $88 ($68) Acquire RECs	20 aMW CT – 2015 REC = $79 ($58) Acquire RECs	20 aMW CT – 2015 REC = $71 ($58) Acquire RECs	20 aMW CT – 2015 REC = $62 ($58) Acquire RECs	20 aMW CT – 2015 REC = $45 Acquire RECs

REC = Implied REC price (Green Power minus Brown Power)
Wind Values are assumed delivered shaped/firmed and include PTC

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What to do?

- Current Cost of new renewables (i.e., Wind) appears to be very high; over $100 / MWh

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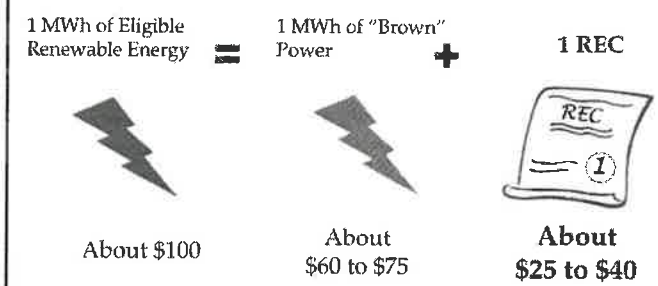
I-937 Compliance Cost

- ***Compliance via Purchase of Eligible Renewables***



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I-937 Compliance Cost

- **_Compliance via Purchase of RECs_**
- **_Tacoma Power Issued an RFP for RECs in February of 2008_**
  - _Purpose of RFP:_
    1. _Test liquidity of market_
    2. _Price Discovery_
    3. _Seek partners to Purchase RECs from_
  - _RFP was sent to 17 parties including developers, owners, marketing entities and other utilities_
  - _Opportunity to purchase REC's for less_
  - _Tacoma Power currently negotiating contract with one RFP respondent_

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IRP I-937 Compliance Conclusions

Regardless of gas prices, power prices and load growth assumption, IRP recommends immediate-term strategy to focus on REC acquisitions

- Expected Load Growth Scenario
  - Resources not needed for load
  - In the near-term the IRP strongly recommends REC strategy and avoidance of renewable generation asset acquisition
  - If renewable prices decrease over time, this should be reevaluated (if this happens it will likely be picked up in next IRP)
- Modest Load Growth Scenarios
  - Under current wind prices ($100 to $125). IRP recommends gas generation in most cases and RECs for compliance (assuming current REC price)
  - IRP recommends Wind resources if Wind prices go down
  - But nothing gets built until 2014 or 2015 the earliest (so not a part of current IRP action plan)

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Next Steps

Action Plan

- Aggressive Conservation Acquisitions
  - Ramp up to 5.4 aMW target for 2010 and after
  - Target of 3.1 aMW in 2008 and 4.7 in 2009
- Complete REC purchases
- New Conservation Potential Assessment to be conducted in 2009
- Continue to evaluate & monitor wholesale market and new power supply resource developments (renewable resources in particular)
- Continue to enhance IRP modeling capabilities
- Enhance public participation process
- Evaluate potential major changes in operating environment
  - Electricity fueled automobiles
  - Carbon related legislation
  - Smart meters
  - Sixth Power Plan Proceedings

Next Steps

- Publish IRP Document
- Present to Public Utility Board and seek resolution for adoption/approval
- Submit to CTED to comply with HB1010
- Carry out Action Plan & Start next IRP

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Appendix B
Quantec Conservation Assessment

This Appendix describes issues surrounding conservation, the process and results of Tacoma Power's Conservation Potential Assessment, and summarizes conservation acquisition plans.

Background

The enactment of the Pacific Northwest Electric Power Planning and Conservation Act in 1980 established conservation as a priority resource for this region. The Power Act created the Northwest Power Planning and Conservation Council (NWPCC) to, in part, develop coordinated conservation and resource development plans. These plans serve as a guide to regional decision makers regarding how to meet future electricity loads. The first plan, adopted in 1983, identified about 1,500 average megawatts of achievable conservation available in the Pacific Northwest by the year 2002. Subsequent revisions of that plan have continued to identify large amounts of conservation potential for the region.

Since enactment of the Power Plan, conservation has been an integral part of Tacoma Power's resource strategy. From 1990 though 2007, the utility implemented an estimated 46.7 aMW of first year energy conservation at a cost of approximately $76 million.[31,32] Tacoma Power aggressively seeks to implement cost-effective conservation for multiple reasons:

- It is often less expensive to reduce customer load growth through conservation than to construct and operate new generation resources;
- Several types of conservation are only cost-effective if acquired at specific times. For example, retrofitting buildings is much more costly than designing and erecting buildings to be energy efficient. Failure to achieve these types of conservation is known as "lost opportunities;"
- The cost of conservation often falls over time as manufactures and installers ramp-up their efforts, knowledge and manufacturing scale. Programs to support "market transformation" are expected to reduce the cost of future conservation;
- Conservation has multiple environmental benefits, from reducing air pollution to allowing more "natural" operation of hydroelectric facilities;

[31] Tacoma Power first established a conservation program in 1980. However, pre-1990 conservation expenditure and savings estimates are less certain and therefore not included.

[32] First Year Savings is an industry approach to quantify and report energy conservation savings. It is similar to the approach used to describe the annual output capability of a generating resource. Lifetime energy conservation savings will be larger because conservation typically has more than a single year life.

- Conservation can be directed to provide "public benefits." For example, programs to weatherize homes of low income customers can have the added benefit of improving the health and welfare of their occupants; and
- Conservation can delay or avoid distribution system upgrades that would otherwise be needed to meet increases in customer load.

Recent legislation has increased the emphasis on conservation as part of integrated resource planning. Washington State's Citizen Initiative No. 937 (codified as the Energy Independence Act) requires that utilities undertake all "cost effective" conservation. The term "cost effective" considers more than just whether a conservation measure is less expensive than constructing a new generating facility. Rather, it also includes benefits (and costs) at a societal level. The test for determining whether a measure is cost effective is known as the Total Resource Cost (TRC) methodology.[33]

Determining conservation potential requires a great deal of data that is unique to each service area. Using generalized regional data to describe a very small subset of the region (Tacoma represents just 3.14% of the region's energy consumption) could cause erroneous results. Typical utility specific data are, for example, saturation of electrically heated residential dwellings, total square footage and energy consumption by commercial building type, and industrial energy consumption by Standard Industrial Code (SIC) or by the North American Industry Classification System (NAICS). Each of these building types and industrial groups have different conservation opportunities that are best reflected by a utility specific Conservation Potential Assessment (CPA).

[33] The TRC methodology quantifies all costs and benefits, regardless of who accrues them. The TRC estimates all direct costs of a measure or resource over its life, including the cost of distribution and transmission to the consumer, waste disposal costs, end-of-cycle costs, fuel costs (including projected increases), and such quantifiable environmental costs and benefits as are directly attributable to such measure or resource. There are three common TRC metrics: the Benefit/Cost ratio, the Net Present Value, and the Levelized Cost.

- The Benefit/Cost ratio (or B/C ratio) is the sum of present value of benefits divided by the sum of present value of costs. As a ratio, when benefits exceed costs the B/C result is a value larger than one. When costs exceed benefits the B/C value is less than one. Measures or bundles of measures with B/C ratios greater than one are accepted in the conservation potential.
- The Net Present Value metric provides a function similar to the B/C ratio. When the present value of benefits minus the present value of costs are larger than zero, the measure or bundle of measures can be accepted in the conservation potential.
- The Levelized Cost metric is used for comparison to other resources considered for development. The levelized cost is the sum of the present value costs ($) divided by the nominal sum of the lifetime kWh savings at the bus bar of the measure or bundle of measures. [Tacoma Power also considers other Levelized Cost metrics. The Customer Perspective divides the sum of the present value of customer costs and benefits by the bus bar kWh savings. The Utility Perspective divides the sum of the present value of utility costs and benefits by the bus bar kWh savings.]

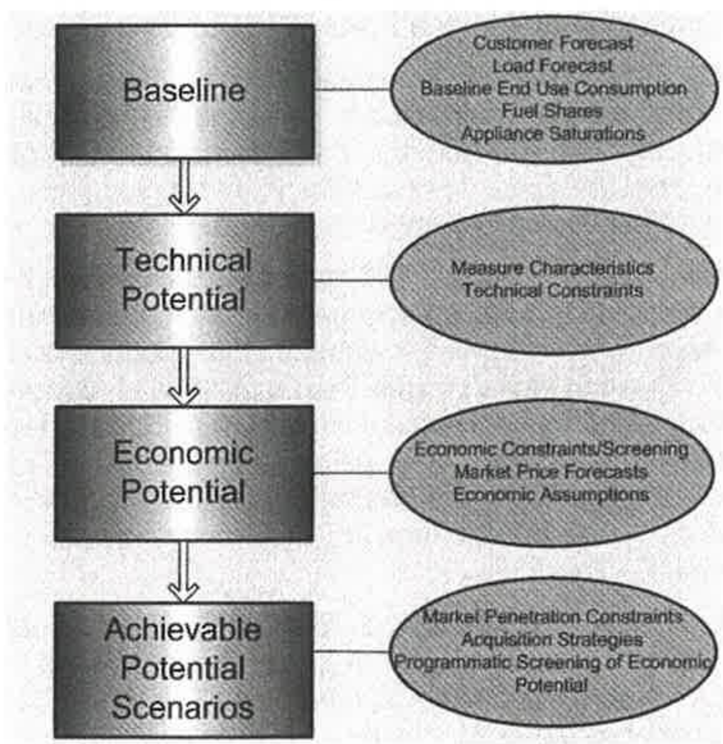
Even with this utility specific information, a CPA is still a "snapshot" estimate of the conservation potential for the utility service area based on the typical Energy Conservation Measures (ECMs) that could be used in prototype buildings. It is not a summation of individual energy conservation audits for every facility. Each time a CPA is developed for a utility service area, the results will likely be higher or lower than previously estimated. ECMs may be added or removed from the potential due to new technology, altered Federal standards, updated building energy codes, adjusted cost of ECMs, or revised forecast price of the avoided cost of electricity. Tacoma Power will periodically update the CPA to reflect these technological and economic changes.

CPA Methodology Overview

Conservation Potential Assessment

Tacoma Power commissioned Quantec LLC, headquartered in Portland, OR, to develop the 2007 CPA. That report is a comprehensive assessment of conservation potential within the Tacoma Power service area over a 20-year planning horizon. The CPA is designed to produce estimates of reasonably achievable long-run conservation potentials in the Tacoma Power service area. The methodology used is based on standard industry practices and is consistent with the methods used by the NWPCC. Figure B.1 diagrams the general process used to in the CPA.

Figure B.1



Baseline The first step in a utility specific CPA is to classify the energy consumption of customer accounts by building type or industrial process. More than 80% of all Tacoma Power's load was classified in this manner. This process draws on many types of data including saturation of electric heat, age, type and square footage of buildings. Once the energy use is aggregated by building types, it is allocated according to the typical (prototype) end-uses of each of building type:

A. Residential: At the time of the CPA there were 86,386 single family dwellings accounts, 7936 manufactured housing accounts, and 30,500 multi-family units in 2,600 multi-family buildings. The remaining residential accounts are a mix of miscellaneous non-dwelling accounts. Four dwelling types were simulated (single family, Manufactured Housing, 2-4 unit multifamily, and 5+ multi-family). For each of these building types, 13 end-uses and an array of possible ECMs were identified and simulated for potential savings. In addition, residential surveys were used to inventory the various types of electrical equipment in a dwelling and to understand the needs and trends for each customer class and building type.

B. Commercial/Industrial Accounts: CPA inventoried approximately 21,000 accounts on the utility's B, G, and HVG rate schedules. Each rate schedule is tailored to serve specific customer needs. The B schedule serves small general service customers' nonresidential load. The G schedule serves large customers with a connected load of more than 50 KVA. The High Voltage General (HVG) schedule serves very large customers who provide all of their own transformation from Tacoma Power's transmission system voltage.

   Of the 21,000 commercial and industrial accounts, 8,498, representing about 80% of the commercial/industrial load, were classified by building type or industrial process. The classification process included GIS photo identification, account executive assistance, information from Dunn & Bradstreet, and the Pierce County Assessor data sets.

   a. Commercial Sector: Of the 8,498 classified accounts, 7,745 accounts were considered commercial accounts. In the commercial sector, ten building types were identified to simulate the energy use of these accounts. Building types include Dry Goods Retail, Grocery, Office, Restaurant, Warehouse, Hospital, Hotel-Motel, School, University, and Other. A diverse array of buildings make up the "Other" category, such as churches, assisted living facilities, and health clubs. For these building types, 24 end-uses and the relevant ECMs were identified and simulated for potential savings.

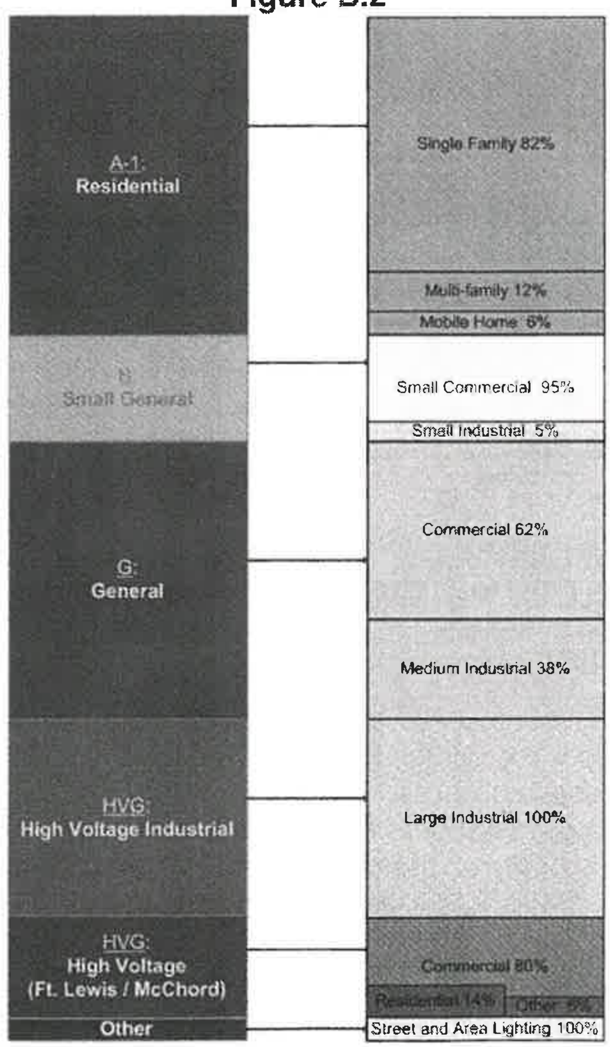
   b. Industrial: The remaining 753 classified accounts were separated into fifteen industrial groups. Industrial groups include Wood Products, Pulp/Paper, Nonmetallic Mineral, Chemical, Plastics/Rubber, Primary Metal, Fabricated Metal, Machinery, Electronic Equipment, Transportation Equipment, Computer, Food, Printing, Petroleum, and Miscellaneous. For these industrial groups, 13 end-uses and the relevant ECMs were identified. Since approximately half of the industrial groups have very small potentials, these were grouped with Other Industrial.

c. For the unclassified commercial and industrial accounts, an allocation process based on building type weighted by energy use was used.

C. Military: Tacoma Power provides electric service to both Fort Lewis and McChord Air Force Base. Individual buildings are not generally metered for energy use on Fort Lewis or McChord Air Force Base. As a result, it was not possible to estimate conservation potential based on historical energy consumption data. Consequently, through a series of on site meetings data was collected by building type, age, square footage, campus development plans, and the overall campus energy consumption. In addition, previous large scale conservation efforts sponsored and funded by Tacoma Power were also reviewed. This information served as the basis to estimate the remaining conservation potential for these accounts.

Figure B.2 illustrates the process of taking customer account information and converting it into the appropriate categories to calculate conservation potential.

Figure B.2



Conservation Potential Assessment Results

The Quantec CPA distinguishes between three distinct, yet related, definitions of energy efficiency potential commonly used in utility resource planning: technical potential, economic potential, and achievable potential.

Technical Potential Technical Potential assumes that all technically feasible conservation resource opportunities may be captured regardless of savings, costs, or market barriers. A comprehensive set of ECMs are reviewed as possible replacements for the baseline end-use stock for each building type. This matrix of options are used in a simulation process to determine which possible ECMs are applicable and how much energy could be saved from each separately and with interactive affects.

The technical potential results of this study are summarized below in Table B.1. The estimated 158.7 aMW is a cumulative 20-year technical potential in Tacoma Power's service area. (Technical potential results are a useful step in the CPA process, but the technical potential numbers are generally not directly used for any planning purposes.)

TableB.1
Conservation Technical Potential

Sector / Segment	Technical Potential (aMW)	Percent of Potential
Residential	**66.6**	**42%**
Existing Retrofit	54.1	
Existing Equipment Replacement	5.4	
New Construction and Equipment	7.0	
Commercial	**59.7**	**38%**
Existing Retrofit	43.9	
Existing Equipment Replacement	4.8	
New Construction and Equipment	11.0	
Industrial	**22.6**	**14%**
Military	**9.9**	**6%**
Totals	**158.7**	

Economic Potential Each ECM from the technical potential is screened with the total resource cost (TRC) test. This test sums the present societal value of the estimated quantitative benefits and costs from installing the ECM. If the benefits exceed the costs, the ECM is included in the economic potential.

The economic potential results of this study are summarized in Table B.2. The estimated 105.2 aMW is a cumulative 20-year economic conservation potential in Tacoma Power's service area, including both discretionary and lost opportunity economic potential. Lost opportunity economic potential is approximately 18.9 aMW, or nearly 18% of the economic potential. The 105.2 aMW represents approximately 66% of the 158.7 aMW of technical potential identified in the CPA.

The economic potential calculations do not include utility administrative costs. Some ECMs will no longer be cost effective when the utility's administrative costs are included. The economic potential adjusted for utility administrative costs to operate programs reduces the estimated economic potential to 102.0 aMW.

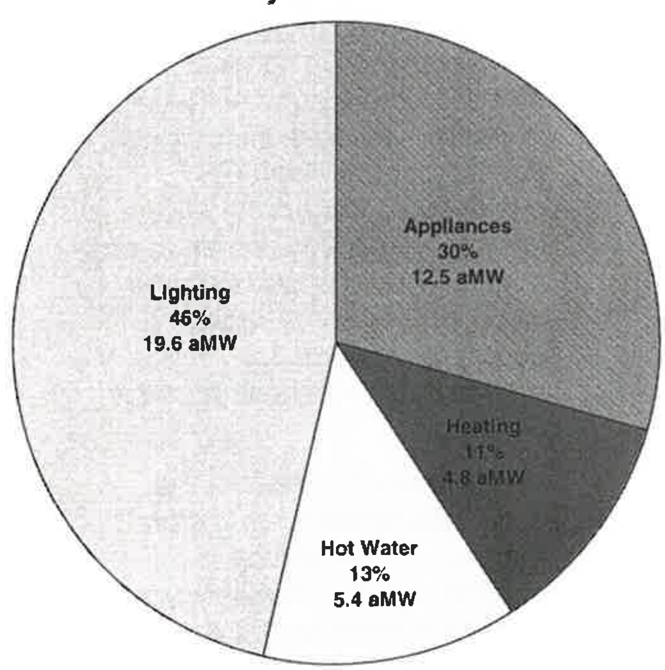
Table B.2
Conservation Economic Potential

Sector / Segment	Economic Potential (aMW)	Percent of Potential
Residential	**42.3**	**40%**
Existing Retrofit	33.4	
Existing Equipment Replacement	4.2	
New Construction and Equipment	4.7	
Commercial	**34.6**	**33%**
Existing Retrofit	24.6	
Existing Equipment Replacement	3.9	
New Construction and Equipment	6.1	
Industrial	**22.5**	**21%**
Military	**5.8**	**6%**
Totals	**105.2**	

Residential The economic conservation potential in the residential sector was estimated to be 42.3 aMW over the 20 year planning horizon. As shown in Figure B.2, the residential sector accounts for approximately 38% of the energy consumed in the service area, while residential conservation potential accounts for approximately 40% of the economic potential.

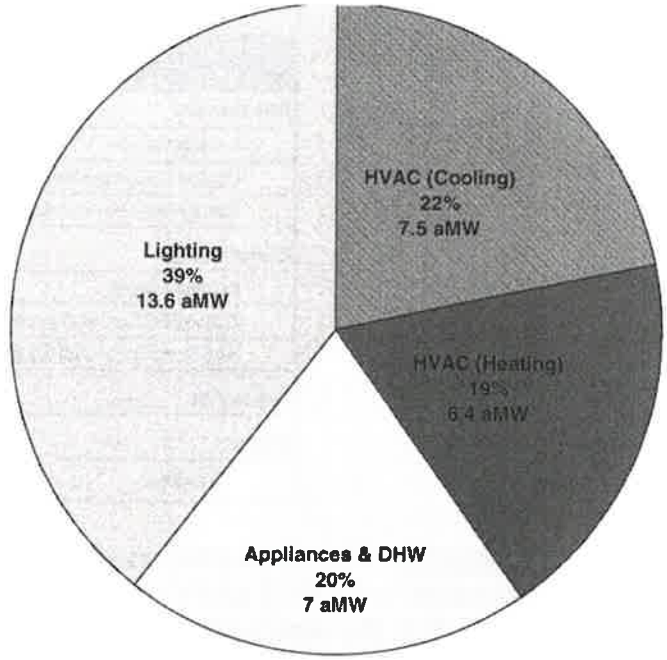
Approximately 46% of the residential potential is in lighting, reflecting the impact of compact fluorescent bulbs and fixtures. Appliances contribute 30% due to several different technologies; of this potential replacing old, inefficient refrigerators and freezers produces the most savings. The 13% hot water potential is primarily from aerators and showerheads, water-heaters, and clothes washers. The 11% heating potential includes heat pumps and weatherization (insulation). While the 11% heating potential seems to be the smallest share, the weatherization measures have the longest measure lives and actually result in most lifetime residential sector energy savings.

Figure B.2
Residential Economic Conservation Potential by End-Use



Commercial Economic conservation potential in the commercial sector was estimated to be 34.6 aMW over the 20 year planning horizon. As shown in Figure B.3, the commercial sector accounts for approximately 28% of the energy consumed in the service area while commercial conservation potential accounts for approximately 33% of the total potential.

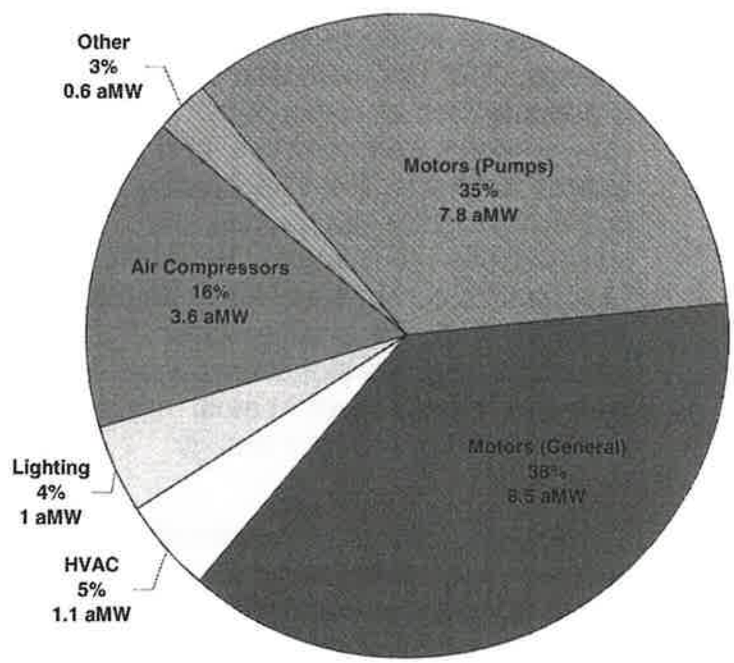
Figure B.3
Commercial Economic Conservation Potential by End-Use



Lighting accounts for nearly 40% of the commercial sector economic potential, and heating ventilation and cooling (HVAC) accounts for nearly the same percentage. Appliance and domestic hot water (DHW) accounts for the remaining 20% of the commercial potential. Appliance ECMs can include commercial kitchen technologies such as refrigeration, steamers, and fryers. It can also include software technology that manages networked computers to optimize energy consumption. With just a few exceptions, commercial potential is roughly evenly distributed among all building types, while the exact conservation opportunities can vary significantly between each of the building types.

<u>Industrial</u> Economic conservation potential in the industrial sector was estimated at 22.5 aMW over the 20 year planning horizon. Note that all of the industrial technical potential was determined to be economic potential. The industrial sector accounts for approximately 26% of the energy consumed in the service area, while industrial conservation potential accounts for approximately 21% of the total potential.

Figure B.4
Industrial Economic Conservation Potential by End-Use



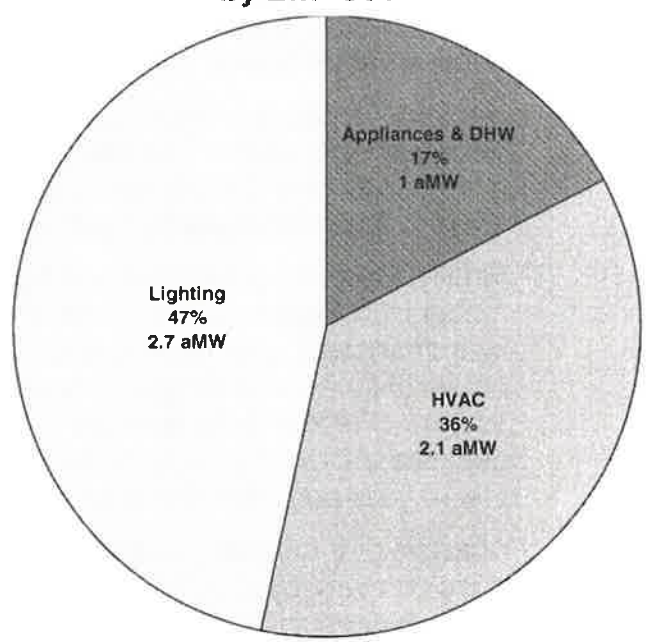
As shown in Figure B.4, the combined potential of general motors and pump motors accounts for approximately 73% of the industrial sector economic potential, while the next largest share, air compressors, accounts for just over 16% of the potential. It is important to note that use of electric motors in industrial settings is key to the performance of the overall facilities.

Convincing managers to use energy efficient options that they have no or little familiarity with will be a significant challenge. Additional challenges related to industrial conservation include competing priorities of plant managers as well as the possible impacts to production and business competitiveness.

Wood product and paper industries within the service area account for just over 47% of the industrial potential, yet only a few customer accounts make up the majority of this potential. There is considerable uncertainty associated with achieving a significant share of the industrial conservation potential when just a few decisions makers will determine the outcome. The other industry groups with large portions of the industrial potential include nonmetal mineral (16%), chemical (8.5%), and other industrial (13.25%). Other industrial includes several hundred diverse, small industrial accounts.

Military Economic conservation potential in the military sector was estimated to be 5.8 aMW over the 20 year planning horizon. The military sector accounts for nearly 7.5% of the energy consumed in the service area, while military conservation potential accounts for 6% of the potential.

Figure B.5
Military Economic Conservation Potential by End-Use



As shown in Figure B.5, the combined potential of office (19%) and warehouse (30%) accounts for nearly half of the military sector economic potential. Throughout these facilities, lighting makes up nearly 47% of the military potential, followed by HVAC (36%) and appliances (nearly 17%).

As mentioned above, the process used to estimate this potential may be subject to significant revision for the next IRP. In addition, Tacoma Power is coordinating efforts with McChord, Fort Lewis, and BPA to conduct conservation analyzes throughout the campus facilities. These efforts should yield better conservation potential information for the 2010 IRP.

Achievable Potential Achievable potential is a subset of economic potential that may be expected to be acquired subject to market barriers and other constraints. Achievable potential can vary depending on incentive levels, planning horizon, and customer sector. It is also subject to the influence of difficult to predict market factors. Accurate estimates of achievable levels of conservation are a critical element in integrated resource planning.

Market barriers refer to inherent features of the energy market that inhibit customers' energy efficiency investment. There have long been questions about the existence and magnitude of an "efficiency gap" or the difference between levels of investment in energy efficiency that appear to be cost-effective based on engineering/economic analysis and the (lower) levels actually taking place. Market barriers can be difficult to predict and can range from economic downturns for an industry to personal preference issues. Additional barriers exist for new construction markets.

Estimating achievable potentials in this study involved three steps: 1) adjusting the cost of individual or groups of measures to account for utility administration expenses, 2) recalculating economic potentials for cost-effectiveness given the adjustment, and 3) applying expected market penetration rates—obtained through a nationwide survey of demand-side management experts—to produce achievable potentials.

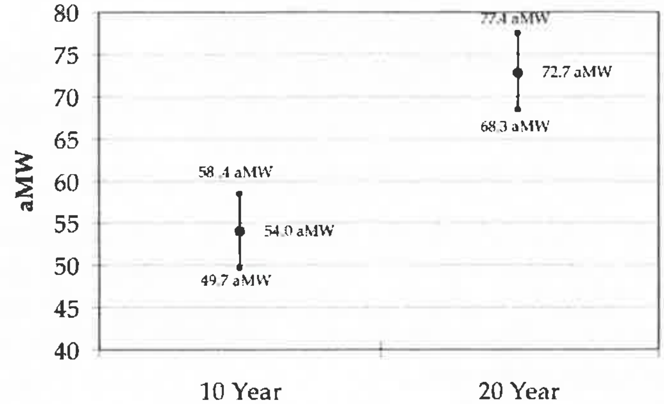
First, program administrative costs must be included with the ECM costs to accurately determine the total resource cost of a conservation opportunity. Administrative costs can include development, marketing, and on-going oversight and operation expenses. Quantec compiled and incorporated estimates of administrative cost to operate Tacoma Power programs.

Second, Quantec recalculated the economic potential that include the administration costs. The addition of these costs produced a small effect on cumulative, long-run economic potential for all sectors, reducing it from 105.2 aMW to approximately 102 aMW, a 3.1 percent difference.

Finally, Quantec developed and fielded a survey directed at a range of nationally recognized experts in the demand-side management industry. The survey instrument was structured to elicit information on expected levels of achievable potential for 10 and 20-year planning horizons, by incentive levels and by sectors. For IRP purposes, the 20-year potential is more relevant; however, because the Energy Independence Act directs large electric utilities to focus on the 10 year potential, this plan also incorporates a 10-year horizon.

Analysis of the results revealed several marked patterns. Achievable penetration rates can vary by planning horizon and by utility incentive levels. Even among conservation professionals, there are differences of opinion regarding how much conservation can be achieved given a set of circumstances. The range and mid-points of those survey responses were applied to the economic potential to produce Figure B6. Given the relatively broad range of estimates from the survey, it is reasonable to consider the ranges as a stochastic measure of uncertainty in the market acceptance for energy conservation programs.

Figure B.6
Penetration Rates of Economic Conservation Measures



While additional future research may lead to updated results, for current planning purposes Tacoma Power used the mid-point of the survey results to estimate achievable potential. These mid-point values reflect a 58% achievable factor for the 10 year horizon and a 72% achievable factor for the 20 year horizon. Using this approach results in the achievable first-year conservation estimates presented in Table B.3. These results assume full utility funded conservation programming. Overall, the CPA identified 54 aMW of cost-effective and achievable conservation in Tacoma Power's service territory over the next 10 years.

Table B.3

Sector	Achievable Potential aMW	
	10-Year	20-Year
Residential	22.7	29.3
Commercial	16.8	23.8
Industrial	11.6	15.6
Military	2.9	4.0
Totals	**54.0**	**72.7**

As mentioned above, common practice in the conservation industry is to present values reflective of first year achievable savings. Some conservation measures like home and building insulation will last many years (20+) while others, such as compact fluorescent light bulbs in commercial building, last a relatively short time (~3 years). As a result, in year 10 of the conservation program, the identified 54 aMW of first-year savings is projected to reduce the utility's overall annual load by about 51 aMW.

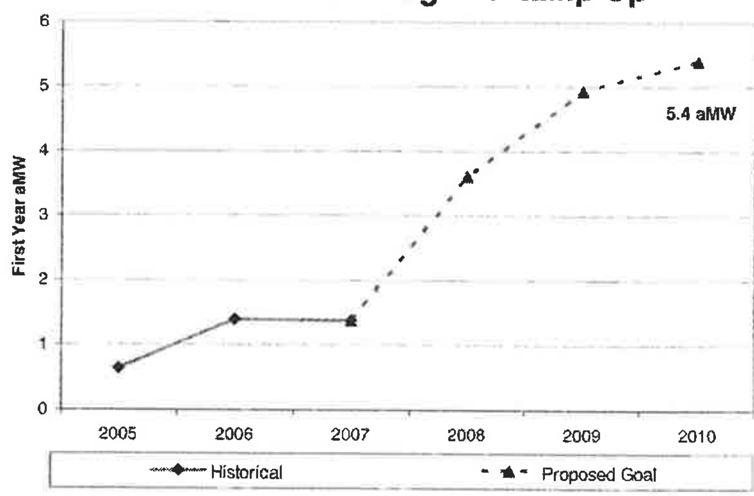
Conservation Action Plans

Targets Determined From Achievable Potential
The CPA provides a accepted framework to screen the cost-effectiveness of several thousand conservation measures by sector, building type and end-use. This detail is used to determine what and where the available resource opportunities are and hence helps in the creation of program planning.

The identified conservation targets are intended to ramp up conservation program offerings and activity levels. The near-term ramp will develop infrastructure and consolidate offerings into a mix of new and modified programs. By the year 2010 Tacoma Power should be positioned to meet a projected a 5.4 aMW conservation acquisition target.

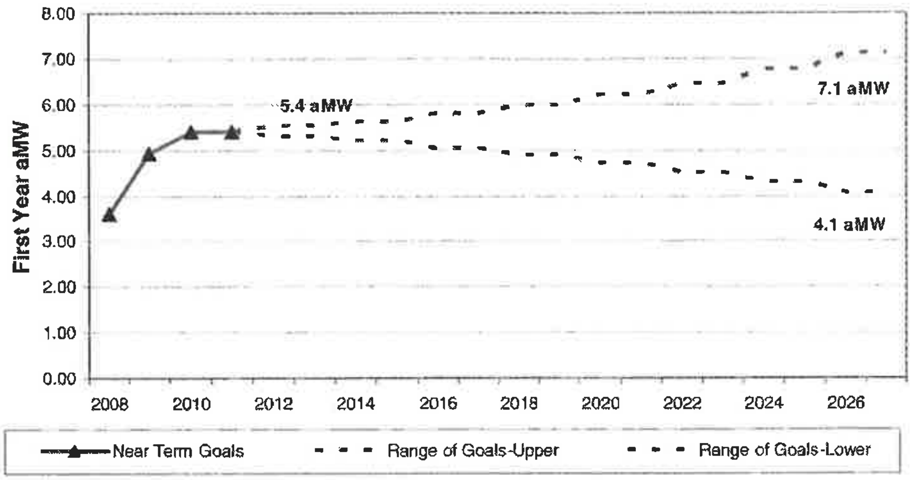
Figure B.7 provides perspective on recent and planned conservation efforts at Tacoma Power. This IRP outlines an annual conservation acquisition increase from just over 1 aMW in 2007 to 5.4 aMW in 2010. This additional workload will have some long-run effect on staffing, but programmatic changes that will increase kWh savings per FTE and the increased use of contractors are expected to provide the bulk of the incremental increases.

Figure B.7
Conservation Program Ramp-Up



Tacoma Power intends to acquire cost effective conservation throughout the IRP period. The exact amount of conservation to be acquired in each year is difficult to predict due to economic and technological factors that influence available conservation. Using the current CPA results as a starting point, a range of outcomes is summarized in Figure B.8.

Figure B.8
The Range of Potential Conservation Acquisition



Conservation Program Development Considerations

Tacoma Power is pursuing a comprehensive and systematic approach to conservation acquisition. Two expectations helped frame the development of the conservation program: the program choices, the mix of measures, and the incentive levels. First, future energy efficiency technologies are anticipated to become economically viable and ready for programmatic acquisition. Second, some programs will likely operate longer than other programs and will provide a rather stable resource. Principles that are helping to guide development of the conservation program include:

- Program cost effectiveness
- Ability to meet annual targets
- Areas of focus driven by identified conservation opportunities
- Partnering with other regional utilities and government entities in the pursuit of common energy conservation goals
- Anticipating risks and challenges, and developing response plans

This IRP signals a transition in the overall objectives and design of efficiency programs offered at Tacoma Power. The market transformation, lost opportunity, public benefits, and infrastructure maintenance conservation programs outlined in Tacoma Power's 2004 IRP are now expanded to include discretionary conservation programs. Discretionary conservation is the largest share of conservation identified in the 2007 CPA.

Overview of Programs

Each of the programs described below will incorporate opportunities to easily participate with other program offerings. The objective being to increase cross program participation, improve overall program cost effectiveness, and reduce total interactions with customer. These programs will include active marketing and close coordination with trade allies and other local electric utilities.

Tacoma Power Residential Sector Program Summaries

Program Name	End-Uses	Requirements	Description
Residential Weatherization	Space heating	Pre-1989 dwelling with permanently installed electric heat	Will offer incentives to customers and landlords who install insulation and energy efficient windows for single family and multi-family dwellings. Incentive options and levels will be researched to determine the most effective incentive offer for each sector. Considered financial incentives include rebate only incentive or loan option.
Low-Income Residential Weatherization	Space heating	Pre-1989 dwelling with permanently installed electric heat. Customer must meet specific income requirements.	Will pay up to 100 percent of job cost to customers or landlords who install insulation and energy efficient windows for single family and multi-family dwellings. Program will evaluate whether current method of implementation would be more effective if the weatherization were implemented by Community Action Program (CAP) agencies. CAP agencies may be more successful reaching low income customers due to the services they currently provide and the resulting owner or property manger relationships. Tacoma Power would provide leads, promotional support, and the funding to support the weatherization effort.
High Efficiency Heating Systems	Space heating	Heat pump is the primary heating system and meets minimum :heating season performance factor" and "seasonal energy efficiency ratio" ratings.	Customers purchasing a heat pump will receive an incentive if they upgrade to an ultra efficient heat pump and if the heating ducts meet "Performance Tested Comfort Systems" requirements. Customers will receive an incentive for the high efficiency heat pump, and the "heating-ventalation-air conditioning" contractor will receive an incentive to commission the heat pump, test seal, and certify the ducts meet "Performance Tested Comfort Systems" requirements. Mini split heat pumps are undergoing evaluation by the "regional technical forum" and may be included in future program offers.

Tacoma Power Residential Sector Program Summaries *(Continued)*

Program Name	End-Uses	Requirements	Description
Appliances	Appliance	Customers purchasing certified Energy Star clothes washers. New and existing construction	Pays a rebate to customers who purchase ENERGY STAR ® certified clothes washers. This program may also offer additional incentives for Energy Star dishwashers and refrigerators.
Refrigerator Recycling	Appliance	Existing operable refrigerators and freezers	Offers a free service to remove existing refrigerators and freezers from customer premises and also provides an incentive to customers. In addition to the incentive, this program provides the customer with a conservation kit that includes compact fluorescent light bulbs, showerhead, and faucet aerator.
Lighting	Light bulbs and fixtures	Existing and new construction	Buys down the price of compact florescent lightbulbs and ENERGY STAR® fluorescent fixtures at the retailer level. Customers will have a significantly discounted price for compact fluorescent bulbs and ENERGY STAR® fluorescent fixtures. Compact florescent lightbulbs will continue to be distributed through events and during presentations. Additional efforts include working with low income agencies to distribute and install these bulbs and fixtures in low income households. This program will work closely with other local utilities to coordinate program efforts. Light-emitting Diodes are a new and emerging technology and may be included in future program offers.
High Efficiency Water Heaters	Water heating	Existing and new construction electric water heaters	Provides a rebate to customers who purchase and install qualifying high efficiency electric water heaters in single family and multi family dwellings.
High Efficiency Showerheads and Aerators	Water heating	Existing and new construction with electric water heaters	Offers free water efficient showerheads and aerators to single and multi-family dwelling customers. It may, if cost effective, include the direct installation of the showerheads in multi-family residences.
New Construction	Complete package	New construction single and multi-family dwellings	Provides incentives in the single and multi-family construction markets to encourage installation of efficient heating, lighting, and hot water use systems.

Tacoma Power Commercial and Industrial Sector Program Summaries

Program Name	End-Uses	Requirements	Description
Equipment Rebate	Motors and specific appliances	Customers purchasing	Offers rebates for the installation of energy-efficient equipment such as variable speed motors, HVAC equipment, certain appliances, and other office equipment.
Efficiency Options	Permanently installed equipment and building	Existing and new construction commercial or industrial customer	Offers incentives for the installation of energy-efficient equipment and permanent improvements. These projects will be more complex and will require customer energy analyses to determine energy savings and incentive levels.
Building Retro-Commissioning	HVAC	Existing construction	Offers technical assistance and incentives for building modifications and for training to improve customers' building operations performance.
Lighting Program	Lighting and lighting controls	Existing commercial or industrial customers	Targets a variety of energy-efficient lighting technologies. Rebates, customer incentives, and technical assistance will be offered.
"Light Emitting Diode" Traffic Signal	Intersection traffic signals	Existing signals operated by local government.	Provides rebates to local and other government jurisdictions for replacing existing incandescent traffic signals with LED signals.

Tacoma Power Commercial and Industrial Sector Program Summaries *(Continued)*

Energy Smart Grocer	Refrigeration, controls, HVAC, lighting	Existing grocery, convenience store, and similar	Targets a variety of energy-efficient lighting technologies. Rebates, customer incentives, and technical assistance will be offered.
Compressed Air Efficiency	Compressor, motor, and related equipment	Existing air compressor systems	Includes training, distribution, supply-side and leak audits, energy monitoring, and efficient equipment incentives.
Resource Conservation Manager	All resources opportunities	Large customers, or aggregated small customers	Provides financial assistance to identify resource savings opportunities, including waste, water, and energy savings. Customers may include large commercial building owners and management companies, as well as government agencies.
Loan Program			Provides zero-interest loans for qualifying energy conservation measures in existing buildings. The term is five years. For most projects, the maximum loan amount is $500,000 or 70% of the project cost, whichever is less. Loans must be secured by sufficient collateral.

Appendix C
Comprehensive Review of Alternative Potential Resources

Tacoma Power has extensively evaluated all potential portfolio resources. Renewable resources have become especially important. Each resource herein is identified as being a baseload, intermediate or peaking resource. In addition basic technology characteristics of resources are discussed as well as cost, availability, and environmental attributes.

Hydroelectric

There are four principle types of hydroelectric projects: impoundment, run-of-river, irrigation and efficiency upgrade. Impoundment dams store water to be used in different seasons or even years to generate electricity. Impoundment dams typically serve purposes beyond power generation, including flood control, recreation, barge transportation, and irrigation. Run-of-river facilities have very limited storage capability – usually only a few hours or at most a few days. The primary purpose of run-of-river facilities is usually to generate electricity. Opportunities to construct new impoundment or run-of-river facilities are virtually non-existent due to environmental regulations and an absence of good sites. New hydroelectric facilities are more likely on irrigation canals. Electricity from these types of facilities is usually seasonal (mostly summer) and is considered of secondary importance relative to the delivery of irrigation water.

A fourth type of hydroelectric resource is efficiency upgrades. This resource adds to, refurbishes, or alters an existing hydroelectric facility to increase generation using the same amount of water. Hydroelectric efficiency upgrades are considered separately because they qualify as renewable under the Energy Independence Act. Some upgrades are as simple as changing operating protocols, while others could require major new components such as replacing turbines or adding a new powerhouse.

Three Principle Types of Resources

Baseload power sources run continuously except during repair or maintenance. They typically have low variable operation and maintenance costs as compared to other resources. Baseload sources usually have limited ability to change output with variations in demand. Hydroelectric facilities provide the majority of Tacoma's baseload resource. **Intermediate** resources are used in conjunction with baseload resources to meet all but the highest demands for electricity. Intermediate plants typically cost more to operate and are less cost efficient than baseload plants. An example of an intermediate resource would be a combined-cycle, natural gas fired combustion turbine. **Peaking** plants are the third type of resource. They are used to provide power during peak load periods. Peaking plants often trade efficiency for fast response to changes in load. The most common peaking plant is a simple-cycle gas turbine generator.

Technology The conventional hydroelectric facility uses a barrage device or dam to restrict the flow of water through a river or stream in order to store the kinetic energy of that water. Kinetic energy is then converted to electric energy through a controlled release of the water through a turbine generator.

Two types of non-conventional hydroelectric generation are low-head, pumped storage and in-stream hydrokinetic conversion. Low-head hydroelectric plants often require no barrage device, and those that do require a barrage device have a dam only a few meters high. Common low-head facilities make use of agricultural irrigation ponds or municipal water supply reservoirs. Electricity is then generated as a secondary benefit from the main use of the water.

Pumped storage uses excess night system electrical capacity to pump water into a reservoir for later use during peak load hours.

The new in-stream hydrokinetic technology uses underwater turbines to harness the natural flow of a river. This generates electricity without relying on a diversionary or impoundment device.

Project sizing The nameplate capacity of conventional hydroelectric plants varies widely from a few hundred kilowatts to several thousand megawatts, but there is little availability for new large scale hydro projects in the Pacific Northwest. Therefore any new projects will be relatively small in scale, probably less than 10 MW. Also, the majority of the new conventional hydroelectric plants proposed are extensions or additions to existing facilities.

Non-conventional hydroelectric generation plants can also vary largely in their nameplate capacity. Most low-head projects have nameplate capacities of less than one megawatt. There is, however, the possibility of larger projects at locations such as agricultural irrigation canals or the diversion channels of larger hydroelectric facilities.

In-stream hydrokinetic generation has the greatest potential for future Pacific Northwest hydroelectric generation. In 1986, New York University conducted a study that estimated the potential, creditable, river in-stream hydrokinetic resource in the United States at 110 Terawatt-hours per year (TWh/yr). No regional studies have yet been conducted, but an in-stream generation facility is potentially feasible.

In addition to building new hydroelectric facilities, improvements to hydroelectric facilities (characterized as incremental hydroelectric) can be made. Incremental hydroelectric involves improving the dispatch and efficiency of existing hydroelectric facilities. As Tacoma Power replaces equipment at its facilities, it is making incremental hydroelectric improvements. These improvements include but are not limited to: more efficient turbines, new turbines in existing dams, improved metering, station service equipment improvements, and control improvements.

Resource characteristics Due to its low cost and high capacity factors, conventional hydro power is used primarily as a baseload source. Capability also exists for its use as an intermediate source or peaking plant. Capacity can become an issue during dry years when water conditions limit river flow. When sufficient water exists, hydro facilities are normally available for generation except during routine maintenance.

Hydroelectric power produces no greenhouse gasses, but because it usually impedes the normal flow of water in a river, provisions must be made to allow for fish migration. This includes mandatory spill levels, river temperature levels and construction of fish ladders to allow safe passage for fish. Research has been limited, but current information suggests that in-stream turbines do not greatly interfere with fish migration or passage. If additional research supports this conclusion, then in-stream hydrokinetic generation may become eligible as a renewable resource.

Availability and Outlook It is unlikely that additional large scale conventional hydroelectric plants will be built in the Pacific Northwest. However additional hydro power is likely to become available from improvements to existing facilities (Incremental Hydro). The added power generated from these improvements should qualify as renewable power under I-937. In addition, in-stream hydrokinetic turbine technology could become a viable renewable alternative.

Upgrades to Tacoma Power's currently owned hydroelectric plants will not require upgrades to the existing transmission. However, depending on location, an in-stream hydroelectric generation plant may require new transmission lines or upgrades to existing transmission.

Environmental Considerations

Air and Climate Change: While hydroelectric generation produces no harmful air emissions, exhaust and dust released during construction activities can temporarily degrade the local air quality. **Impact**: Minor.

Terrestrial and Habitat Alteration: Construction of hydroelectric projects results in the permanent loss of habitat due to the placement of structures such as dams, powerhouses, and ancillary facilities. Facilities with fluctuating reservoirs may limit the establishment of riparian vegetation and habitat, and provide an opportunity for weed establishment along the reservoir perimeters. However, the land required for efficiency upgrades is generally small and is usually within the confines of an already developed area. **Impact**: Significant at impoundment and run-or-river facilities, minor at irrigation facilities and efficiency upgrades.

Water: Construction activities can discharge sediment and temporarily increase turbidity levels downstream. After construction,

Environmental Discussion

This Appendix includes a discussion of the environmental considerations associated with various energy resource options. The specific environmental effects discussed are: air and climate change, terrestrial and habitat alteration, water, view and noise, transmission, and other impacts, as appropriate. Tacoma Power acknowledges that it is impossible to list all potential impacts. This discussion focuses on the likely incremental impacts of each resource type and categorizes these impacts as significant, moderate, or minor. To accomplish this assessment, this IRP necessarily assumes generic resources. Actual environmental impacts may differ depending on the specific attributes of a generation resource and its surroundings. This appendix also identifies possible mitigation measures and whether each resource qualifies as a renewable resource under the Energy Independence Act.

impoundment dams can reduce turbidity as slowing the movement of water may allow suspended sediment to settle to the bottom of the reservoir which creates the potential for siltation problems over the life of the facility. Water flow is often improved during efficiency upgrades due to revised operating permit requirements. **Impact**: Significant at impoundment and run-or-river facilities, minor at irrigation facilities, and minor at efficiency upgrades (often positive).

View and Noise: Hydroelectric facilities alter the landscape but create minimal noise. **Impact**: Moderate.

Transmission: Hydroelectric facilities are typically in rural areas and require significant transmission to interconnect with the regional grid. Generally, not an issue for efficiency upgrades since transmission facilities exist already. **Impact**: Moderate.

Other – Fish: Hydroelectric facilities, especially those with impoundment, alter the aquatic habitat by converting terrestrial and riparian habitat to a lake environment. These facilities can prevent or hinder species migration, especially among anadromous salmonids. Downstream passage of fish through turbines can result in injury or death – although technology is reducing through-turbine fish mortality rates. Flow variations can impede fish movement and rapid flow reductions in the downstream reaches can induce fish or redd stranding along the shorelines. Nitrogen super-saturation associated with spilling water can injure or kill fish. Water impoundment can also affect water temperature, which in turn may affect dissolved oxygen levels. Facility design and operation can help mitigate these effects. The effect of an efficiency upgrade will often be positive as the facility infrastructure and operation becomes more fish friendly. **Impact**: Significant at impoundment and run-or-river facilities, minor at irrigation facilities and efficiency improvement projects.

Potential Mitigation of Environmental Concerns[34]

- Conduct pre-construction studies to properly site the facility to avoid unique or sensitive habitat areas;
- Acquire, restore, enhance, and create wetland, riparian, and other valuable habitat lost from construction. Employ erosion and sediment control measures during construction;
- Implement flow ramping limitations and minimum flows;
- Implement a fish passage program (fish ladders, trap and haul, fish guidance measures, flow adjustments) to enhance fish passage up and downstream;
- Conduct fish habitat enhancement (install gravel augmentation, construct spawning channels, add large woody debris);
- Augmentation activities including fish stocking and hatchery programs;
- Provide recreational facilities (boat launches, docks, parks, river access) to offset lost recreation opportunities; and
- Implement a weed control program.

[34] The FERC relicensing process makes includes a comprehensive assessment of the environmental impacts of hydroelectric power plants and generally includes many provisions to reduce identified issues.

I-937 Other than hydroelectric efficiency upgrades Most hydroelectric projects do not qualify as a renewable resource under the Energy Independence Act.

Wind

Wind generationed is the most widely available renewable source of power. Current utility scale wind technology generally employs large turbines with a blade sweep of 100 to 250 feet affixed to 0.5 to 2.0+ MW nacelle on a 200 to 300 foot tower – larger units are available for off-shore applications. Typically, 50 to over a 100 of these wind turbines spread over a large area will together form a single overall facility. Wind turbines are usually placed in open, prominent locations, such as ridges of hills to take maximum advantage of wind energy. In the Pacific Northwest, many of the best locations for wind-powered generation are located in rural areas near the Columbia river in eastern Washington and Oregon.

The majority of the wind resources in Washington exist along the Columbia River and in central Washington. Oregon also has its best potential wind resources along the Columbia River and in the central part of the state. Idaho has fewer potential wind resources; those that do exist are located primarily in Southern Idaho.

Technology The typical wind generation facility, or wind farm, consists of an array of wind turbines that can range in size between one and three megawatts each. As the technology has advanced, wind turbines have become taller and larger. By building taller structures, wind developers have increased the capacity and efficiency of wind turbines.

In addition to land based wind generation, developers are considering offshore wind generation. Off shore wind generation would be more efficient because offshore turbines are expected to be 3-5 MW compared to the 1-3 MW size for land based wind turbines.

Project Sizing As previously stated, land based wind farms consist of arrays of wind turbines. These arrays typically have name plate capacities of 100-300 MW.

Off shore wind generation facilities will more likely be in the 300-800 MW range. This is largely due to the ability to use larger turbines. Larger scale is also necessary to make offshore generation cost effective.

Resource Characteristics Wind power uses no fuel and releases no greenhouse gasses. The big drawback to wind generation is that it has a low capacity factor, typically around 30 - 35%. Capacity factor is a measure of how often a plant is generating electricity at capacity. The result of this low capacity factor is that wind power is an intermediate, not a baseload resource. Utilities using wind generation must have other sources of electricity available to meet their system load should the wind resource not be available. In some cases, this capacity can be met with hydroelectric reserves. In other cases, the reserve energy requirement must be met using a fossil fuel source such as a single cycle combustion turbine. Another drawback is variability, wind turbines have been known to cycle from no generation to full generation back to no generation within a single hour.

Availability and Outlook The majority of wind generation currently available in the Pacific Northwest is being provided to regional utilities through long-term power purchase agreements. Because wind generation continues to be an attractive renewable resource for the area's utilities, significant construction is underway and/or planned.

The biggest obstacle to building wind generation is the inability of turbine manufacturers to meet the demand of the worldwide industry. For this reason, many planned wind farms will not be built for three-to-five years.

Another barrier to wind generation is the fact that the best wind generation sites lie primarily in Central Washington and Oregon, far from the urban areas that need the power. Making this situation more difficult is the fact that serious constraints either exist or are forecast in the near future for transmitting wind power over the Cascades into Western Washington. The result is that new and/or upgraded transmission lines will need to be built. The cost of this new transmission is estimated to be in the billions of dollars.

One final known obstacle comes from nearby residents opposing the construction of wind farms in proximity to their homes. A strong "Not in My Back Yard" reaction is common when wind turbines obstruct coveted views, are perceived as a threat to flying animals (e.g., birds and bats), or are seen to blight sensitive wilderness.

Even with these obstacles, wind generation remains the most likely renewable source for meeting I-937 requirements in the foreseeable future. The Northwest Power and Conservation Council predicts that in the next three years, an additional 2,400 MW of wind generation will come on-line in the Pacific Northwest. They also predict that up to 6,000 MW of cost-effective wind generation is possible.

Offshore wind generation, however, remains too expensive as a generation source for the foreseeable future. Preliminary estimates by the Ocean Renewable Energy Group in Canada put offshore wind generated electricity at over $250/MWh, a prohibitively expensive price.

Environmental Considerations
Air and Climate Change Wind-generated electricity produces no harmful emissions. **Impact**: Minor.

Terrestrial and Habitat Alteration The footprint of a wind support tower is relatively small. In addition, these units are usually placed on plains and ridges of hills with little or no tall vegetation, minimizing or eliminating the need for vegetation management. Moreover, many times they are place on farms or cattle ranches that already have disturbed habitat. Construction of access roads and other ancillary facilities could have minor impacts. **Impact**: Minor.

Water Other than for cleaning, wind facilities consume no water. **Impact**: Minor.

View and Noise View degradation is a common impact associated with wind projects. Since wind turbines usually spread over a large area to efficiently utilize the resource, they create the potential to affect views from a large surrounding area. Wind turbines also produce noise. The severity of these effects depends largely on how close these facilities are to towns and other population centers. **Impact**: Minor to moderate.

Transmission A new wind power generation facility will require the construction of a transmission line to connect the facility to the grid. Because the tower footprints are generally small and the towers widely spaced, the amount of habitat eliminated is relatively small for any given area. The areas where wind is sited usually have naturally low growing vegetation. As a result, the largest transmission habitat impact will be the construction of a service access road. Unless placed underground which is usually very expensive, new transmission lines often impact views to some degree. New transmission lines sometimes include perching/nesting platforms to keep birds away from energized lines. Nevertheless, transmission lines can create an electrocution and collision risk. **Impact**: Moderate.

Other – Birds Early experience with wind power produced concerns regarding a collision risk for bats and birds – especially raptors. Newer designs employing larger blades turning at slower speeds and turbine support structures without perching opportunities have substantially reduced collisions. Today, impacts to birds and bats are minor at most existing U.S. wind farms. Nevertheless, careful attention must be paid during site selection and individual turbine placement planning to avoid migration routes and natural constrictions that could direct birds towards the spinning blades. **Impact**: Moderate.

Potential Mitigation

- Conduct pre-construction wildlife studies; properly site facility to avoid bird/bat high use areas and animal migration routes;
- Utilize existing roads and disturbed areas to minimize habitat impacts;
- Design to minimize collisions and discourage bird nesting and perching;
- Maintain low-growing native vegetation and control weeds in transmission line corridors; and
- Locate the facility away from popular view corridors.

I-937 Wind is a renewable resource under the Energy Independence Act. Because it is the most technically advanced and widely available renewable resource, wind generated electricity is likely to make up the bulk of eligible renewable resources in the near future.

Natural Gas Combined Cycle Combustion Turbines

Natural Gas Combined Cycle Combustion Turbines (CCCT) combine traditional combustion turbines with a secondary steam turbine to capture and utilize waste heat. This allows CCCTs to operate at very high heat efficiencies. CCCTs typically serve as baseload resources and usually have high capacity factors. However, they are also flexible enough to be used as a peaking resource.

Recent legislation in Washington state (SB 6001) sets CCCT generation as the benchmark for fossil fuel emissions. For this reason, CCCT is currently the only viable option for fossil fuel generation in the state.

Technology CCCTs generate electricity in two stages. In the first stage, natural gas is burned and the combustion gasses are used to turn a turbine generator. In the second stage, the combustion gasses boil water into steam. This steam is then used to turn a steam turbine and generate electricity. Because of this two stage process, CCCT generation is significantly more efficient that generating power from combustion only.

Project sizing CCCT power plants vary in size between 10 MW to more than 1,000 MW. Typically they are between 300 and 600 MW.

Resource Characteristics These facilities require a relatively small amount of land and need to be sited near a major natural gas transmission line. A CCCT plant has an industrial look. CCCT plants are known for being highly reliable and have availability factors of 90% or more. A typical CCCT facility takes between three-to-five years to construct and typically cost between $870 and $1,000/kW in capital costs to build.

Combined cycle power plants can use any combustible material as fuel, but fuels such as biomass and coal must undergo a gasification process first. (This process is discussed later under Integrated Gasification Combined Cycle (IGCC) generation.) Natural gas is the most common fuel, but diesel fuel is also fairly common.

Natural gas fired combustion is highly efficient and among the cleanest of all fossil fuel generation. It emits less pollution per MWh than any other combustion technology. Primary emissions are carbon dioxide (CO_2), nitrogen oxides (NO_x), particulates, methane (CH_4), and negligible amounts of sulfur dioxide (SO_2).

Availability and Outlook The passage of the Energy Independence Act and the recent increases in the cost of natural gas, have made CCCT plants less attractive as sources of electricity. However, if the projections of wind development in the Pacific Northwest prove correct, it is likely that new CCCT plants will be needed to provide reserve capacity and to firm and shape wind resources.

Environmental Considerations

Air and Climate Change When burning natural gas, the typical CCCT plant emits approximately 400 tons of CO_2 per GWh of electricity. Other emissions include SO_2 at a rate of .002 tons/GWh and NO_X at .039 tons/GWh. Compared to a pulverized coal generation facility, a CCCT plant emits less than 50% of the amount of CO_2, 10% of the amount of nitrous oxides, and 0.003% of the amount of SO_2. **Impact**: Moderate.

Terrestrial and Habitat Alteration While the establishment of any new facility can impact habitat and displace wildlife, CCCT plants are relatively small and are often located in industrial areas. Therefore their habitat impacts are usually limited or nonexistent. **Impact**: Minor.

Water Natural gas CCCT power generation requires water consumption for cooling and combustion energy. Water usage can range from about 40 gallons to 20,000 gallons per megawatt hour depending on the type of natural gas CCCT (once-through, re-circulate, or dry). Discharged wastewater, which is usually at a higher temperature than when withdrawn, may alter the quality of the water body receiving the in flows. **Impact**: Minor.

View and Noise A CCCT will typically produce noise and visual impact comparable to an industrial facility. **Impact**: Minor.

Transmission A CCCT will generally require a new transmission line to interconnect with the grid. The habitat consequence of this new transmission will depend on the location of the CCCT. A facility located in an industrial area close to a major transmission line would pose minimal impact. A more rural and forested area could pose a more significant environmental consequence. **Impact**: Minor to moderate depending upon site location.

Other The extraction and transmission of natural gas may result in vegetation and soil disturbance, geologic alterations, and depletion or contamination of groundwater (extraction). **Impact**: Unknown.

Potential Mitigation.

- Conduct pre-construction studies; properly site the facility to avoid unique or sensitive habitat areas;
- Reuse cooling water, use dry cooling techniques, or recycle reclaimed wastewater to reduce water usage; and
- Use Best Available Control Technology and Lowest Achievable Emission Rate techniques to reduce pollution emissions.

I-937: A natural gas CCCT does not qualify as a renewable energy resource under the Energy Independence Act.

Integrated Gasification Combined Cycle (IGCC)

IGCC generation was designed as a "clean coal" technology, but it can also use fuel other than coal. It is a two-stage process in which the fuel is first converted to a synthetic gas ("syngas"), composed primarily of hydrogen and carbon monoxide. The syngas is cleaned to remove sulphur compounds, ammonia, metals, alkalytes, ash and other contaminates. The syngas is then burned in a combined cycle generation plant. Although gasification technology has been in use since the 1920s, generating electricity using syngas is a relatively new development. Presently, electric generation IGCC technology is under commercial development – only a few plants have been constructed.

Technology Integrated gasification combined cycle generation plants incorporate two technologies. The first technology uses steam and oxygen to convert coal (or some other organic material) into syngas. The gasification converts the coal into a mixture of carbon monoxide, carbon dioxide and hydrogen plus minor amounts of other gasses and solids. The carbon monoxide and hydrogen are then separated for use in the combustion turbine. Because the other products are removed prior to combustion, IGCC has the potential of having fewer emissions than natural gas CCCT plants – but only if the CO_2 removed during the gasification process is sequestered.

The second technology used in IGCC generation is a combined cycle generator, similar to the natural gas CCCT described previously. However, because the gasses being burned are CO and H_2, the emissions from the combustion process contain minimal amounts of CO_2 and water vapor.

Project Sizing Since the technology is nearly the same as that for natural gas CCCT plants, an IGCC plant is likely to have a similar generating capacity. However, because land needs to be dedicated to the gasification process and also to the sequestration process if used, IGCC could be smaller in areas where real estate costs are high.

Resource Characteristics IGCC plants are used as baseload energy sources. Their availability and capacity factors are also comparable. Because of their likely size, new IGCC generation facilities will usually need new and/or upgraded transmission lines to handle the additional capacity.

IGCC plants make use of the most abundant fossil fuel, coal. Because the United States and the world in general have such large deposits of coal, the fuel costs for IGCC are relatively low compared to other fossil fuels.

Air emissions, most notably NOx, SO_2, and CO_2, are the predominate environmental consequence of IGCC plants. Generally, IGCC emissions of NOx are on par with CCCT generation, while SO_2 and CO_2 are higher. A significant advantage of IGCC plants over those fired with conventional coal is a lower cost to capture CO_2.

Availability and outlook Recently passed legislation in Washington state caused Energy Northwest to table its planned 600 MW IGCC facility in Cowlitz, WA until carbon sequestration technology can be perfected and the plant emissions can be brought close to or below the levels associated with a natural gas combined cycle generation plant. Three other plants have been proposed in the Northwest; one in Oregon, one in Southern Idaho and one in Montana. In all cases, renewable portfolio standards will delay or possibly stop construction of these plants until acceptable levels of carbon sequestration become feasible.

Environmental Considerations

Air and Climate Change Without carbon sequestration, IGCC generation emits approximately 1600 lbs of CO_2 per MWh of electricity. This falls in between the emissions for a regular pulverized coal burning plant and CCCT plant. Nitrous oxide emissions are approximately 200 lbs per MWh, and SO_2 emissions are negligible. With sequestration, CO_2 emissions could drop below that of natural gas CCCT plants. **Impact**: Moderate.

Terrestrial and Habitat Alteration While the establishment of any new facility can impact habitat and displace wildlife, the key question for habitat is plant location. Most likely, an IGCC plant would be located at an industrial or brown-field site and pose limited habitat impacts. However, a green-field site could create more significant impacts. **Impact**: Minor.

Water IGCC plants require water usage for both steam production and cooling. Water usage is comparable to CCCT facilities and generally requires 300 to 800 gallons per megawatt hour. Discharged wastewater, which is usually at a higher temperature than when withdrawn, may alter the quality of the water body receiving the in-flows. **Impact**: Minor.

View and Noise The degree of noise and visual impacts of an IGCC plant is location-dependent. Generally, the overall consequence will be comparable to other industrial facilities. **Impact**: Minor.

Transmission Plant location would dictate the need for additional transmission lines. As with CCCT plants, IGCC plants are not limited to particular locations and so may be sited near existing transmission lines. Therefore, the number of new transmission lines necessary is likely to be minimal. **Impact**: Minor to moderate depending upon site location.

Other – Extraction Coal mining can adversely affect water quality, hydrology, vegetation, soils, and habitat. However, the added impact of increasing coal production at existing mines to fuel a new IGCC plant would likely be minimal. Coal mining can also release methane gas. Finally, coal contains low levels of radioactive materials which are released through coal-fired generation. **Impact**: Moderate – but can vary considerably depending on project-specific conditions.

Potential Mitigation

- Conduct pre-construction studies to properly site the facility to avoid unique or sensitive habitat areas;
- Reuse cooling water, and/or reclaimed wastewater to reduce water usage;
- Use low sulfur coal;
- Use Best Available Control Technology and Lowest Achievable Emission Rate techniques to reduce pollution emissions.

I-937: A natural gas IGCC does not qualify as a renewable energy resource under the Energy Independence Act

Geothermal

Geothermal electric generation uses the earth's heat to generate electricity. Water from underground reservoirs or injected into dry caverns is heated by molten magma from the Earth's core. Three different technologies can then be used to turn this hot water into electricity. All three technologies are well known and have been widely used in the United States over the last 25 years.

These plants must be located at specific sites, often in rural areas. Geothermal plants are currently located in five states (California, Alaska, Hawaii, Nevada and Utah) and have a total of 2,830 MW of installed capacity. The Geothermal

Energy Association estimates that nationwide, energy from geothermal sources could provide 20,000 MW of electricity by 2025.

Technology The three methods used to generate electricity from geothermal sources are flash steam, dry steam, and binary-cycle. Flash steam technology takes high pressure water and injects it into a low pressure tank where it "flashes" into steam that is then run through a turbine. The exhaust steam is condensed and re-injected into the thermal well. Flash steam technology requires the water temperature to be 300° F or greater.

Dry steam takes the steam directly from the earth and puts it through a turbine generator. This method has limited use since it requires locating a thermal source at or very close to the surface, such as a geyser. It also can have significant maintenance costs as this type of steam often contains many impurities. The caustic and debris laden steam give dry steam turbines a very short useful life.

> ***Ground Source Heat Pumps***
>
> Another type of geothermal technology does not generate electricity but is an efficient conservation source. The geothermal heat-pump uses a series of tubes in the ground where the temperature is a relatively constant 40°F. An electric heat pump then pumps water through the tubes where an exchange of heat is made. The direction of system operation determines whether the unit heats or cools. According to Energy Star, a government-backed program promoting superior energy efficiency, geothermal heat-pumps are 40-60% more efficient than standard heat-pumps. While the cost of installation is high, the cost of operation is the lowest of all heating and cooling methods.

The third method, binary-cycle, is the newest technology and can use water temperatures less than 300° F. This method takes hot water from the geothermal source and uses it to heat a secondary fluid. This secondary fluid can be water but is typically another material with a lower boiling point. Because of advances in binary-cycle technology, thermal wells with water temperatures as low as 160°F can be used to generate electricity.

Project Sizing These facilities come in a wide range of sizes, but most seem to range from 10 to 25 MW. The Geothermal Energy Association reports that up to 250 MW of geothermal capacity is under construction at 11 projects in 5 states. (May 2007 Update on US Geothermal Power Production and Development).

Geothermal generation plants are unique among renewable sources because they are a large baseload source of renewable power. Depending on the characteristics of the site, geothermal plants can have nameplate capacities in excess of 100 MW. In addition, multiple geothermal sources are frequently located within a small geographical area. For example, The Geysers in northern California contains 21 sites producing over 1000 MW of electricity.

Resource characteristics Geothermal energy has the potential to become one of the largest renewable resources in the Pacific Northwest. According to United States Geological Service estimates, identified resource sites may contain 22,000 MW of potential power and unidentified sites may contain an additional 100,000 MW of potential power. According to the Western Governors' Association Geothermal Task Force, approximately 13,000 MW of geothermal energy could be developed on specific sites within a reasonable timeframe. Of this 13,000 MW, 5,600 MW is considered to be viable for development by 2015 and 1,300 MW is in the Pacific Northwest. This represents only the known potential resources. Unknown resources could greatly increase this number.

Geothermal power is attractive because it is a renewable source that can be used for baseload generation and has a capacity factor of 90-98%. Another benefit of geothermal generation is that geothermal plants have very small installation footprints.

Drawbacks of geothermal power include high upfront capital costs and site location. Most Pacific Northwest identified sites are in rural locations far from existing transmission lines. Therefore significant amounts of capital would be needed to build the transmission lines necessary to connect the plant to the grid. These costs are comparable to those expected to connect future wind resources.

Availability and outlook: The most likely locations for new geothermal development are in southern Idaho and eastern Oregon. Few sites have been proposed for development, but this will likely change with both Oregon and Washington having aggressive, mandated renewable portfolio standards.

Environmental Considerations

Air and Climate Change Geothermal facilities generally produce no harmful air emissions. However, naturally occurring hydrogen sulfide (H_2S) and CO_2 are components of the steam emitted at some sites. **Impact**: Minor.

Terrestrial and Habitat Alteration Geothermal plants require a relatively small footprint compared to other power generation resources. While the amount of habitat loss would be relatively small, geothermal sites located in undeveloped natural areas could lead to loss of high value habitat. In addition, exploratory drilling performed during site development could adversely affect habitat. **Impact**: Minor to moderate depending on habitat value and extent of exploratory drilling.

Water Significant environmental concerns associated with geothermal projects are water consumption and water quality degradation. Prior to site development, exploratory drilling necessary to locate a suitable site can adversely affect hydrology. Construction of geothermal generation facilities has the potential for similar but more concentrated impacts as compared to those caused by exploratory drilling. Geothermal facilities use about 5 gallons of water per megawatt hour, a small amount. **Impact**: Moderate.

View and Noise Noise is generally not a particular concern with geothermal plants. Conversely visual impacts can be significant, particularly for facilities located in rural, undeveloped areas. **Impact**: Moderate.

Transmission Plant location would dictate the need for additional transmission lines. As noted above, geothermal plants must be located at remote sites. A rural site would likely require fairly extensive additional transmission. However, geothermal plants are typically rather small, and therefore new transmission could be sized accordingly. **Impact**: Moderate.

Other Geothermal projects can result in geologic alteration. **Impact**: Unknown.

Potential Mitigation.

- Process sulfide gas into elemental sulfur and hydrogen;
- Utilize existing roads and disturbed areas to minimize habitat impacts;
- Conduct a thorough geologic and soils survey of the area to assure suitable facility location;
- Maintain low-growing native vegetation and control weeds along transmission line corridors;
- Avoid discharging wastes from geothermal sources into surface water bodies; re-inject gases and groundwater into original sources; and
- Utilize a non-geothermal water source for water that will be discharged to a surface water body.

I-937 Geothermal resources qualify as a renewable resource under the Energy Independence Act.

Solar

Solar power is a viable but expensive renewable energy source. There are two methods for converting solar radiation into electricity, photovoltaic and thermal. Electricity from both these types of facilities is directly correlated with sunlight, though some solar thermal systems have limited heat storage capabilities.

While large scale solar generation facilities have been built, solar power is more commonly thought of as a distributed generation source. This is because it can easily and unobtrusively be installed on the roofs of commercial buildings and personal residences. To a lesser extent, solar power is also used to replace or augment an electric or gas fired hot water heater.

Technology The best known type of solar power generation uses photovoltaic cells to convert solar radiation into DC voltage. While photovoltaic cells are not as efficient as solar-thermal generation, they have many other advantages. The primary advantage is that they can transform the sun's rays directly into electricity. With the use of a converter, this energy can be used immediately to meet demand at the point of generation. Photovoltaic solar panels can be installed on building roofs and the power generated can be used on site, reducing demand from the electrical distribution system. Designs now allow solar panels to blend into the existing roofing, making them more attractive. The ability to be installed anywhere makes photovoltaic generation the best choice for a distributed generation source.

With thermal generation, solar radiation is focused toward a central point using parabolic mirrors. To increase efficiency, the mirrors are often designed to track the sun's progress through the sky. The first large scale design for a commercial thermal power plant was Solar One in California. It used an array of mirrors that focused solar radiation on a specific area of a central tower. The focal point was a black receiver that contained liquid sodium. This liquid sodium was used to create steam that could run a turbine. The design proved to be efficient and the Solar One model was upgraded in the 1990s.

Another thermal technology uses an array of parabolic troughs whose focal points are tubes containing a thermal oil. This design has proven to be more cost effective than the tower used in Solar One. Like the liquid sodium, the thermal oil is used to create steam that can be used to run a turbine generator.

Both thermal generation and photovoltaic generation have advantages and disadvantages. Thermal generation is more cost effective, but it requires large areas of land in locations that receive significant amounts of sunlight year round. Photovoltaic generation is around 50 percent more expensive per kW of power generated than thermal solar, but it can more easily be incorporated into a distributed generation strategy by installing the equipment on rooftops.

Project sizing: Thermal solar generation plants can range in size from 10 MW to several hundred megawatts. The primary restriction lies in the amount of land available. For commercial photovoltaic generation, land is also the main restriction. A large photovoltaic plant can generate up to 11 MW of electricity but takes up 150 acres of land.

Resource Characteristics: Solar power's primary benefit is that it is a 100% renewable source. However, it is highly dependent on the weather and, in the case of photovoltaic generation, is limited to daylight hours for power production. Thermal solar generation stores solar thermal radiation in a secondary medium, but the length of storage time varies. These limitations give solar power relatively low capacity factors.

Photovoltaic panels have the highest dependability of any generation source at better than 99%. This, along with their ease of use as a distributed generation source, makes them good candidates as renewable sources.

Availability and outlook: Solar power is best used as a distributed resource. While areas of central Washington and Oregon and Southern Idaho have climates appropriate for solar generation, winter generation capabilities above the 40° north latitude line are limited. This limitation reduces the capacity factor for commercial plants and makes them lest cost effective.

Environmental Considerations

Air and Climate Change Solar power generation facilities produce no harmful emissions. **Impact**: Minor to none.

Terrestrial and Habitat Alteration Solar thermal systems are often larger scale projects that require substantial amounts of land. This creates the potential for habitat impact. Photovoltaic technologies, on the other hand, are often used as distributed systems and are mounted on buildings. Thus they do not require additional land and have very few environmental consequences. **Impact**: Moderate for solar thermal, minor for photovoltaic.

Water Solar thermal systems consume little water, and photovoltaic systems are water free. **Impact**: Minor.

View and Noise Noise is not a concern with solar facilities. Conversely, visual impacts can be significant, particularly for solar thermal facilities located in rural, undeveloped areas. **Impact**: Moderate.

Transmission Solar thermal facilities require a significant amount of land and must be located at sites with high amounts of annual sunshine. This usually results in rural sites that require transmission. Photovoltaics, as distributed resources, require no additional transmission and may actually reduce the need for transmission. **Impact**: Moderate for solar thermal, minor (and potentially positive) for photovoltaic.

Other None.

Potential Mitigation.

- Conduct pre-construction studies to properly site facility; avoid unique or sensitive habitat areas;
- Acquire and enhance other habitat areas to offset habitat impacts; and
- Maintain low-growing native vegetation and control weeds in transmission line corridors.

I-937 Solar electrical generation qualifies renewable energy sources under the Energy Independence Act.

Biomass

Biomass is a family of generating technologies and fuel sources, each of which has its own attributes, consequences and advantages. This diversity makes it difficult to assess the "average" or "typical" environmental attributes of biomass generation. The most common forms of biomass are wood waste, landfill gas, solid waste digester gas and municipal solid waste. The most common form of electricity production is from direct combustion. Direct combustion is used to generate electricity from municipal solid waste, landfill gas and also from the residue of timber harvesting. In many cases, electricity is a by-product from a co-generation facility where the combustion process creates steam for heating or for use in an industrial process as well as for electricity production.

Also, biomass can be used to make syngas (synthetic gas) for use in an IGCC generation facility. At municipal waste facilities, biomass can be processed using an anaerobic digester to produce methane gas. The methane is then burned in a combustion turbine to generate electricity.

Still another use of biomass uses is creating ethanol via a fermentation process. The ethanol can then be used as a fuel additive or in rare cases directly combusted to generate electricity.

Technology Biomass has been used for many years in co-generation facilities. Washington state currently has several co-generation facilities operated by companies such as Weyerhaeuser and Kimberly-Clark.

In Tacoma's service territory, there is one anaerobic digester facility in operation. It supplies the power to the central municipal waste treatment plant. The by-product of the digester is sold as sterile compost, a product more rich in nutrients than compost created from gardeners' standard composting process.

Project sizing Biomass facilities vary greatly in size from about 100 kW to more than 50 MW depending on the fuel source. The most typical biomass facility in the Pacific Northwest is a co-generation facility between 10 and 30 MW. The smaller facilities tend to be anaerobic digester facilities less than 1 MW in size.

Resource Characteristics Biomass plants have high dependability, especially when they use natural gas as a backup fuel supply. (While the plant burns natural gas the electricity produced is not eligible as a renewable resource.)

Biomass facilities tend to be economical only in areas where there is no cost involved in transporting fuel. Anaerobic digesters are ideal facilities to locate at the site of waste collection. Sites that can best profit from digester facilities are dairy farms where the compost material from the digester can be used to top dress fields and improve grazing land. Putting anaerobic digesters at agricultural facilities also has distributed generation benefits, improving electric distribution system security.

Availability and outlook The Pacific Northwest has several opportunities for biomass energy production. Within the Tacoma Power service area, there are agricultural facilities that produce enough biomass to support small digesters. There is also a plan to further expand the generation capabilities at the City of Tacoma central municipal waste treatment plant.

Environmental Considerations
Air and Climate Change Air emission is a prominent environmental impact associated with biomass electrical generation. The amount and types of emissions vary with the fuel source and generation technology, but the primary emissions of concern are typically NOx, particulates, carbon monoxide (CO), and CO_2. NOx emissions vary depending upon the nitrogen content of the fuel. Particulate emissions are substantial for wood-based biomass energy without control features. On the other hand, biomass generation can actually lower greenhouse gas emission. Left to decompose naturally, biomaterials produce methane, a more potent greenhouse gas than CO_2. The diversion of this material to electric generation fuel breaks this cycle. Moreover, because plants consume CO_2 during their life, biomass fueled generation contributes little or no net gain of atmospheric CO_2 as long as the fuel growing cycle is sustained. **Impact**: Minor with appropriate emission control technology.

Terrestrial and Habitat Alteration Biomass power generation land requirements are comparable to other fossil fuel generation plants. Because the fuel source is often a byproduct or waste from other operations, there are generally no additional habitat impacts associated with fuel acquisition like there would be with most other steam generation facilities. However, the wood residue collected from logging operations would potentially expose erosion-prone soils, interrupt nutrient cycling, and degrade wildlife habitat. Also, fuel-producing crops displace wildlife habitat and disturb soils during planting and harvesting. However, this effect is less worrisome if the land would have been used for non-fuel-crops anyway. **Impact**: Minor.

Water Water requirements for biomass plants are comparable to those of conventional coal-fired plants: about 20,000 to 50,000 gallons per megawatt hour. This level of consumption can reduce river flows and/or groundwater supplies. Discharge of wastewater, which is usually at a higher temperature than when it was withdrawn, can alter water quality and flows in the receiving water body. **Impact**: Moderate.

View and Noise The degree of noise and visual impacts of biomass power plants is location-dependent but generally comparable to other fossil-fuel generation plants. **Impact**: Minor.

Transmission Plant location would dictate the need for additional transmission lines. Biomass plants tend to be located near the fuel source, and this often means a rural site. A rural site would likely require fairly extensive additional transmission; however, biomass plants are typically rather small and therefore the new transmission could be sized accordingly. **Impact**: Moderate.

Other - Odor, Groundwater and Surface Water Biomass includes using animal waste to produce electricity. This process is very environmentally positive. It removes a product that is associated with stream and river contamination. Also, it substantially reduces the odor associated with animal waste. **Impact**: Moderate - positive.

Potential Mitigation

- Conduct pre-construction studies to properly site facility; avoid unique or sensitive habitat areas;
- Utilize a fuel source, such as wood waste destined for landfills, which has a secondary positive environmental effect and does not produce additional impact associated with its acquisition;
- Provide a cooling system that does not release water with elevated temperatures; and
- Use Best Available Control Technology and Lowest Achievable Emission Rate techniques to reduce pollution emissions such as particulates.

I-937 Biomass generation qualifies as a renewable energy source under the Energy Independence Act for that portion of the generated electricity that was not powered by treated wood chips, wood derivatives from old growth forests, municipal waste, black liquor from pulp mills and other sources, or supplementary fossil fuels.

Ocean Energy

There are several technologies in development which will convert energy from the oceans into electricity. The two technologies that are most applicable to the Pacific Northwest are tidal stream and tidal barrage. Tidal stream facilities utilize tidal-generated currents to turn turbines, whereas tidal barrage facilities harness the energy associated with rising and lowering water levels. Both types of ocean energy facilities could provide highly reliable generation as they follow well known and dependable tidal patterns. However, ocean energy is not dispatchable and thus would provide only a limited contribution to system capacity. In addition, ocean energy is not yet commercially available, and many questions persist regarding its cost and technological reliability.

Technology: A tidal stream power plant would consist of an array of turbines, most likely similar to wind farm turbines, installed on the seabed of the Narrows or other sites where there are regular current flows. The turbines would convert the currents produced by the diurnal tides into electricity. The technology to generate electricity from the tides is relatively new. However, because the concept is similar to the technology used to generate power from wind, in-stream tidal turbine developers will be able to draw on the lessons learned from the early wind developers.

Tidal barrage is another emerging technology that taps the energy of the ocean. Tidal barrage energy conversion devices are even more widely diverse than those being developed for tidal energy conversion, but they all work to convert the kinetic motion of waves into electrical energy.

Resource Characteristics Of the emerging renewable technologies, in-stream tidal power offers a benefit that few other renewable sources can: It is a 100% predictable renewable energy source. Once the tidal currents have been measured, the amount of electricity available can be predicted hundreds of years into the future. Final predictions would depend upon the limitations of how much energy can be extracted, turbine efficiency, and environmental impacts, all of which are still being investigated.

Energy from ocean waves could likely become the largest, most available environmentally friendly resource on the planet. Wave energy is completely renewable. There are, however, two drawbacks to wave energy conversion. First, the cost of installing submarine transmission cables as far as five miles off shore and in water several hundred feet deep may be prohibitively expensive. Second, since the size of the waves is totally weather dependent, predicting the amount of available electricity may be difficult.

Availability and outlook There are no ocean energy resources currently available. However, there are numerous local feasibility studies in progress. First and foremost is Tacoma Power's own recently concluded effort to research tidal stream generation opportunities in the Tacoma Narrows.[35] This study concluded that the cost of tidal power is currently not competitive with other resource opportunities. Snohomish County PUD and Clean Current of British Columbia are also conducting tidal studies.

For wave energy conversion, there are several major projects underway. Finevera LTD's Makah Bay Project is currently being developed using the new limited FERC licensing process. There are also several projects being studied off the coast of Oregon. Additional wave energy projects will likely begin in the next few years.

Environmental Considerations
Air and Climate Change Ocean Energy facilities produce no harmful emissions. **Impact**: Minor to none.

[35] Tacoma Narrows Tidal Power Feasibility Study, available on the Tacoma Power web site: http://www.tacomapower.com.

Terrestrial and Habitat Alteration The footprints for each tidal stream turbine are relatively small and are situated in relatively deep water where no rooted vegetation occurs. Construction and operation could injure and displace bottom-dwelling marine fauna at each turbine site. The extent of substrate impact depends on the facility's location, number of turbines, and size of each footprint. Tidal stream projects could injure or kill marine life in a manner similar to the way that wind farms harm birds and bats. However, tidal-powered turbines turn considerably slower than wind turbines and conventional hydropower turbines. They also have an open configuration, and so it is easier to avoid tidal-powered turbine blades than hydroelectric project turbine blades. **Impact** The effects on marine life from ocean energy projects are assumed to be minor, but, given the few tidal projects in existence, there has been little study of the overall impacts. Tidal Barrage have been shown to have major environmental impacts such as completely altering the marine environment (e.g., eliminating the tidal flood plains).

Water Ocean energy facilities consume no water in a conventional sense. Also, ocean energy facilities can alter natural ocean currents, velocities, or direction. However, the changes are expected to be minimal. **Impact**: Minor to moderate.

View and Noise Noise is not a concern with ocean energy facilities. Because the majority of the infrastructure is underwater, the potential for visual impacts is low. However, that portion of the facility above water could impact views near shore areas. **Impact**: Minor.

Transmission Underwater cable placement for electricity transmission could affect marine environments. Greater distances from shore would necessitate more cable placement. However, the effects associated with underwater cable placement would be temporary if the cable is buried as is the usual practice. Underwater cable placement typically has the greatest impact in the near shore areas where marine flora and fauna are most prolific. **Impact**: Minor.

Other - Fouling: The passing current could potentially result in build-up of drifting kelp and other marine flotsam on the facility. The facility could also be prone to fouling from barnacle attachment. The use of anti-fouling paint could result in leaching of pollutants. **Impact**: Minor.

Potential Mitigation.

- Conduct pre-project studies to locate the facility away from areas with unique or sensitive marine habitat;
- Bury underwater cables to reduce substrate impacts and route cables away from productive near shore areas such as eelgrass beds and important shellfish habitats;
- Conduct pre-construction marine fauna studies to site facilities away from high use areas and migration corridors to minimize the potential for collision-related impacts;
- Use non-fouling paint that does not leach toxic materials; and
- Design turbines with the minimum above water structure necessary.

I-937: Ocean energy projects qualify as renewable energy sources under the Energy Independence Act definitions.

Other Potential Resources

There are several other potential sources of electricity, but many are not viable options in the Pacific Northwest. The following resources were examined but deemed unlikely to meet Tacoma Power's needs:

Nuclear

Nuclear power generation facilities utilize uranium to power an atomic reaction that generates heat. This heat is used to create steam that turns a conventional electric generating turbine. Nuclear facilities are very large baseload plants that are generally located in remote locations. Most currently operating nuclear facilities enjoy very high capacity factors and relatively low production costs.

Some consider nuclear energy a renewable energy source because the nuclear fuel can be created in a laboratory. However, there remains much debate about proper treatment of nuclear facilities' radioactive waste. In addition, the upfront capital costs and the large gap of time between licensing and bringing a facility on-line can make nuclear facilities risky investments. If the technology to recycle spent fuel rods is perfected, or if new legislation emerges, nuclear power may become more attractive.

Environmental Considerations

Air and Climate Change Properly contained nuclear facilities produce no harmful emissions. In fact, coal-fired power plants actually release more radiation than normally operating nuclear power plants. **Impact**: Minor.

Terrestrial and Habitat Alteration Nuclear power plants impact habitat and displace wildlife. The consequences of those impacts depend on the size and location of the facility. It is highly likely that for the foreseeable future, all new nuclear plants will collocate at existing nuclear plant sites, minimizing the habitat impacts. While uranium mining can impact vegetation, water quality and soils, increasing uranium production at existing mines to fuel a new nuclear plant would likely cause minimal adverse effects. **Impact**: Minor.

Water Nuclear power plants require large amounts of water for cooling and generating steam to power turbines. Therefore, they must be situated near a reliable water source. The amount of water usage is dependent upon the size of the facility, but is typically greater than fossil fuel powered generation plants. Water usage can adversely affect stream flow and groundwater resources. **Impact**: Moderate.

View and Noise Nuclear power plants produce little noise, but create potential view impacts. **Impact**: Minor.

Transmission Plant location would dictate the need for additional transmission lines. However, siting concerns would likely drive any new facilities to collocate at existing nuclear sites with existing transmission lines. Therefore, the extent of transmission impacts is likely to be upgrading or replacing transmission facilities along already existing transmission corridors. **Impact**: Minor.

Other – Radioactive Waste The greatest environmental threat from nuclear power generation plants is the radioactive waste. Because radioactive waste contains hazardous levels of radiation for an estimated 10,000 years, it requires special handling and storage. A large nuclear reactor produces 25 to 30 tons (about 3 cubic yards) of spent fuel each year. Spent fuel rods are initially stored in shielded basins of water and then after a few decades are transferred to a long-term dry storage facility. A malfunction with the storage facility or an accident during handling could result in a radiation release that could contaminate the soil and groundwater and pose health risks to humans and wildlife. The handling and storage of nuclear waste is designed to prevent such a release. **Impact**: Unknown but potentially significant.

Potential Mitigation

- Conduct pre-construction studies to properly site the facility;avoid unique or sensitive habitat areas;
- Reduce radioactive waste through reprocessing to shorten the substantially radioactive period from 10,000 years to roughly 300 years.
- Provide long-term, secure waste storage facilities that allow retrieval of waste for reprocessing by more effective methods that may yet be discovered.

I-937 Nuclear power does not qualify as renewable energy sources under the Energy Independence Act.

Single Cycle Combustion Turbines

Natural Gas Single Cycle Combustion Turbines (SCCT) utilize a traditional combustion turbine to generate electricity. SCCTs operate at relatively low thermal efficiencies and are used predominately as peaking resources. SCCTs typically range in size from 10 to 150 MW. These facilities need to be sited near a major natural gas transmission line. A CCCT plant has an industrial look.

Environmental Considerations

Air and Climate Change Natural gas fired combustion is amongst the cleanest of all fossil fuel generation. The primary emissions from SCCTs include NOx, CO_2, particulates, CH_4 and negligible amounts of SO_2. However, the overall impact from air pollutants is low because these plants are typically used only a few hours each year to meet peak loads. **Impact**: Minor.

Terrestrial and Habitat Alteration While the establishment of any new facility can impact habitat and displace wildlife, SCCT plants are relatively small and are often located in industrial areas. Therefore their habitat impacts are usually limited or nonexistent. **Impact**: Minor.

Water Natural gas CCCT power generation requires water consumption for cooling and combustion energy. Water usage is usually in the range of about 400 gallons per megawatt hour. However, because of the plants' limited use, the overall water consumption impact is likely to be small. **Impact**: Minor.

View and Noise A SCCT will typically produce noise and visual impact comparable to an industrial facility. **Impact**: Minor.

Transmission A SCCT will generally require a new transmission line to interconnect with the grid. The habitat consequence of this new transmission will depend on the plant's location. **Impact**: Moderate.

Other – Extraction The natural gas extraction process may result in vegetation and soil disturbance, geologic alterations, and depletion or contamination of groundwater. **Impact**: Unknown.

Potential Mitigation

- Conduct pre-construction studies to properly site the facility; avoid unique or sensitive habitat areas;
- Reuse cooling water, use dry cooling techniques, or recycle reclaimed wastewater to reduce water usage; and
- Use Best Available Control Technology and Lowest Achievable Emission Rate techniques to reduce pollution emissions

I-937 Single Cycle Combustion does not qualify as renewable energy under the Energy Independence Act.

Fuel Cells

Fuel cells use a chemical process to produce electricity by combining hydrogen and oxygen (from the air) to form water. Current methods used to obtain hydrogen typically involve fossil fuel consumption and/or the use of nuclear reactors. Fuel cells are relatively small units, approximately 1 MW. However they can be installed in an array to increase overall output. Fuel cells are an emerging commercial technology with relative high cost and uncertain reliability. Fuel cells use is presently limited to off-grid and back-up power applications.

Fuel cell technology has advanced a great deal since its development in the 1960s, but the cost of generating electricity from fuel cells is currently prohibitively expensive. In particular, the cleanest fuel cells use pure hydrogen as fuel, and at this time there is no economical, environmentally friendly way of producing pure hydrogen.

Environmental Considerations

Air and Climate Change Fuel cells produce no harmful emissions. The environmental impacts from fuel cells are largely dependent upon the process used to obtain the fuel source, typically hydrogen. The use of a fossil fuel-driven process will contribute to the release of air emissions, typically NOx, SO_2, CO_2, particulates, mercury, and CH_4. The use of nuclear reactors to extract hydrogen will produce radioactive waste that poses environmental threats if not properly handled and stored. **Impact**: Moderate.

Terrestrial and Habitat Alteration Because fuel cells are located on already developed sites, they pose no additional risks to habitat. **Impact**: Minor.

Water Fuel cells generally consume negligible amounts of water. **Impact**: Minor.

View and Noise Fuel cells produce little noise and have minimal visual impact. **Impact**: Minor.

Transmission Fuel cells, as distributed resources, require no additional transmission and may actually reduce the need for transmission. **Impact**: Moderate (positive).

Other None.

Potential Mitigation

- Use solar, wind, or other "clean" power sources to produce hydrogen fuel.
- Establish fuel cells at the user sources to eliminate the need for a separate facility and transmission lines.

I-937 Unless the fuel source is processed using a "clean" method, fuel cells are not considered a renewable resource and do not qualify as such under the the Energy Independence Act definitions.

Pulverized Coal

Pulverized coal is the traditional and most common electric generating resource. Though the technology has evolved significantly to maximize electric output and minimize emissions, coal fired generation still emits far more pollution per MWh than any other major resource. Coal fired generation plants typically range in size from 500 to 2000 MW. These are large facilities that require significant amounts of land. **New pulverized coal plants are effectively prohibited by Washington state law (S.6001) without carbon capture and sequestration, and this technology is not currently available. As a result, there is little likelihood that this resource technology will be available to Tacoma Power during the planning period of this IRP.**