TACOMA POWER
TACOMA PUBLIC UTILITIES

SOARING INTO THE FUTURE

2015 INTEGRATED RESOURCE PLAN

RESOLUTION NO. U-10836

A RESOLUTION relating to the approval and adoption of the Tacoma Power 2015 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 prepare and submit an integrated resource plan ("2015 IRP"), and

WHEREAS the 2015 IRP, on file with the Clerk of the Board, recommends an acquisition of 78.7 average megawatts of energy conservation over a 20-year planning period, and

WHEREAS RCW 19.280.050 requires the governing body of the electric utility to approve such plan after public notice and hearing, and

WHEREAS the Board conducted a public hearing on the plan on December 16, 2015, and

WHEREAS Tacoma Power requests approval and adoption of the 2015 IRP by the Board; Now, Therefore,

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

Tacoma Power's 2015 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:

William C. Fosbre
Chief Deputy City Attorney

Chair

Monique Trudnowski
Secretary

Clerk

Adopted 12-16-15

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Just as this Integrated Resource Plan was going to press, our friend and colleague Ryan Hoppe passed away. Ryan was a data wizard and is responsible for the Plexos work that anchors the plan's analysis. This work is dedicated to his memory and lasting contributions to Tacoma Power.

WE MANAGE OUR RESOURCES WITH A CLEAR FOCUS ON THE LONG TERM AND A SHARP EYE ON THE BIG PICTURE

Executive Summary

OUR PAST AND FUTURE

Tacoma Power has provided clean, reliable, affordable electricity to our customers for more than 100 years. To continue delivering this value to our community, we must strike a balance between meeting future energy demands, minimizing costs to customers and risk to the utility, enhancing our environment for current and future generations and fulfilling regulatory requirements.

Tacoma Power's 2015 Integrated Resource Plan (IRP) is about planning for the future. The IRP provides a snapshot of our current resources, factors that may impact the utility, a forecast of future customer need for the next 20 years and an evaluation of resources to meet that need. Long-range planning can be tricky, but we update the IRP every two years to identify changes and adapt our strategy as new information becomes available.

HIGHLIGHTS FROM THIS YEAR'S PLANNING PROCESS

- Tacoma Power will not need to acquire new resources beyond energy conservation during the next 20 years.
- Tacoma Power plans to meet state renewable mandates with a combination of Renewable Energy Credits generated from hydropower efficiency improvements and RECs purchased from third party contracts in Washington, Oregon and Idaho.
- This IRP evaluated resources for cost, benefits, fit, flexibility, risk, environmental impact and customer equity. If an unanticipated need for new generating resources develops (for example, if a new large industrial customer locates in Tacoma's service area), the plan identifies promising resource alternatives for consideration.
- It has become clearer that climate change will affect the operation of Tacoma Power's hydropower resources as it impacts the timing of seasonal runoff, with more winter precipitation falling as rain and less as snow.
- The electric utility industry has entered a period of major change and transformation. Drivers for this change include slowing load growth, emergence of new technologies, regulations and actions to reduce greenhouse gas emissions and development of new wholesale power markets.

ACTION ITEMS

The 2015 Integrated Resource Plan also identifies several action items for follow-up during the next several years, including:

1. **Acquire 9.4 average megawatts of energy conservation in 2016-2017 to reduce retail load growth.**
2. **Continue evaluation of BPA products as more information becomes available.**
3. **Learn from small-scale resource pilot programs performed by Tacoma Power and other utilities to inform future IRPs.**
4. **Monitor and report on emerging technologies that may significantly impact retail energy demand.**
5. **Explore methodologies to incorporate estimated climate change impacts into the official long-term load forecast.**

TACOMA POWER today

The City of Tacoma is located on the Puget Sound's Commencement Bay, approximately halfway between Seattle and Olympia.

Tacoma was incorporated in 1884 and became known as the "City of Destiny" when it was designated the terminus of the Northern Pacific Railroad. Today, Tacoma is Washington State's third largest city with a population of just under 200,000 and is the center of business activity for the South Puget Sound. The city also provides a gateway to the Pacific Rim through the Port of Tacoma, a major seaport and one of the top container ports in the United States.

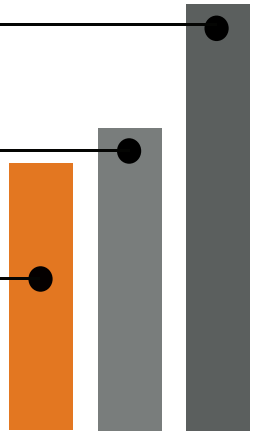
Tacoma Power was created by the citizens of Tacoma in 1893 and is one of the oldest municipally-owned utilities in the country. Thanks to Tacoma's investment in clean, low-cost, local hydropower – dating back to 1912, when the LaGrande Powerhouse on the Nisqually River came online – our residential customers enjoy some of the lowest electricity rates in the country, averaging 7.7 cents per kilowatt hour in 2014. Our service territory spans 180 square miles and includes the city of Tacoma and parts of the surrounding communities of Fircrest, University Place, Fife, Steilacoom, Lakewood, Joint Base Lewis-McChord and unincorporated Pierce County.

Tacoma Power is governed by an appointed Public Utility Board and is primarily supported by customer revenue and surplus power sales. About 60% of our electricity is delivered to commercial and industrial customers ranging from education and military to food service and manufacturing. A high proportion (about one third) of our residential customers have incomes below 200% of the federal poverty level, a common measure of low income. This is one of many drivers for Tacoma Power to deliver affordable and reliable energy to our community. Low rates are also an attraction for new commercial and industrial customers who provide employment opportunities in our service area, helping the local economy.

12.2 cents per kilowatt hour
United States average residential electricity rate

8.2 cents per kilowatt hour
Washington average residential electricity rate

7.7 cents per kilowatt hour
Tacoma Power average residential electricity rate



Source: U.S. Energy Information Administration

WHERE OUR POWER comes from

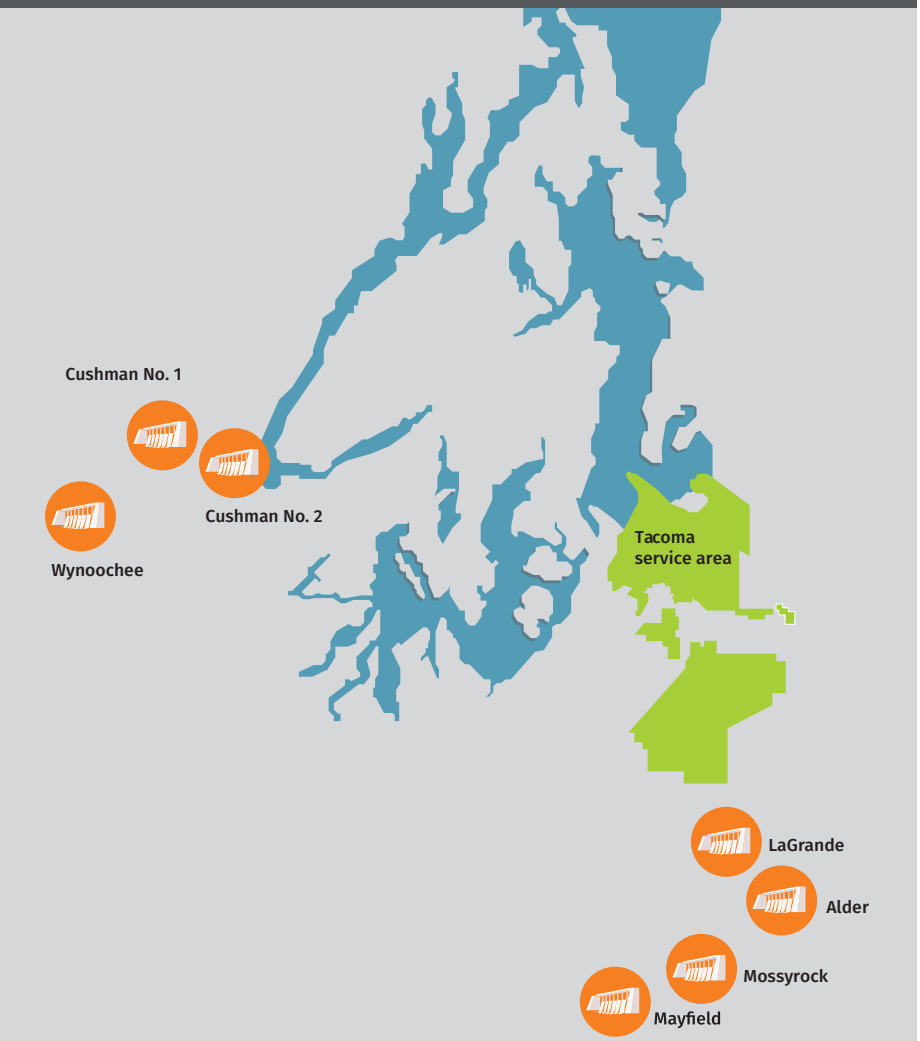
Thanks to thoughtful planning and investments made decades ago, our customers benefit today from a reliable electric system, low rates and a sustainable energy supply. Unlike many utilities, the power-generating resources owned by Tacoma Power are located close to our service area. Our system includes 7 dams, 350 miles of electric transmission lines and 2,011 miles of distribution lines. These resources make up about half of our power supply portfolio. The rest of our power supply comes from long-term contracts with the Bonneville Power Administration (BPA) and other sources. We typically generate more carbon-free electricity from hydropower each year than our customers consume, enabling us to sell the surplus to other utilities.

As a power-generating resource, hydropower has many benefits for Tacoma Power and our customers. Simply by opening valves, the water stored behind dams is routed through generating turbines to produce electricity. These turbines have great operating flexibility, with the ability to go from sitting idle to full production in just minutes. This helps us meet moment-to-moment changes in customer demand for electricity. And because the "fuel" is water, hydropower is both a clean and renewable source of energy.

Tacoma Power's hydro resources also provide non-power generation benefits to our customers and community, including flood control, fish and wildlife protection and recreation. The utility's challenge is to manage our reservoirs to meet all of these overlapping – and at times competing – objectives with variable and uncertain rainfall and snowpack. Ensuring reliable service requires both careful planning and active management of our resources.

TACOMA POWER'S owned resources

Local, reliable, affordable



Maintaining our community's resources

- In 2015, Tacoma Power earned a fourth straight **Outstanding Stewards of America's Waters Award** for collaborations with the Skokomish Indian Tribe and regulatory agencies on improving fish passage at Little Falls on the North Fork Skokomish River.
- Tacoma Power maintains four parks with year-round camping and recreation for the public.
- Our Cowlitz River fisheries management program is among the largest in Washington.
- We were named a **Tree Line USA utility** for the 10th consecutive year for the way we manage trees along our power lines.

Cushman River Project

Mason County, WA

- **Cushman Dam No. 1 – 1926**
  Peak capacity: 44 megawatts
- **Cushman Dam No. 2 – 1930**
  Peak capacity: 81 megawatts
  Unusual in that the powerhouse sits several miles below the dam along the Hood Canal

Nisqually River Project

Pierce County, WA

Emphasis on restoration and recovery of naturally-spawning salmon

- **LaGrande Dam – 1912**
  Peak capacity: 64 megawatts
  One of the first major dams in the Pacific Northwest
- **Alder Dam – 1945**
  Peak capacity: 50 megawatts

Cowlitz River Project

Lewis County, WA

Includes kokanee fishery and funding of the Nisqually Tribe's Clear Creek Hatchery

- **Mossyrock Dam – 1968**
  Peak capacity: 378 megawatts
  Tallest dam in Washington at 606 feet above bedrock
- **Mayfield Dam – 1968**
  Peak capacity: 162 megawatts

Wynoochee River Project

Grays Harbor County, WA

- **Tacoma Power powerhouse – 1994**
  Peak capacity: 13 megawatts
  Dam owned by the City of Aberdeen, powerhouse operated by Tacoma Power

OTHER RESOURCES

BONNEVILLE POWER ADMINISTRATION

Tacoma Power's largest power purchase contract is with the Bonneville Power Administration. BPA sells power from federally-owned hydropower projects on the Columbia and Snake rivers, several renewable projects in the Pacific Northwest and the Columbia Generating Station, the region's sole nuclear power plant. As a Washington State customer-owned utility, Tacoma Power is one of BPA's "preference customers" and entitled to a substantial amount of low-cost power from BPA.

Under the current contract, Tacoma Power receives energy through a hybrid slice/block product. In the "slice" part of the contract, Tacoma Power receives approximately 3% of the wholesale power that BPA markets, an amount that varies by year and by season depending on the variable streamflow conditions. In the "block" part of the contract, we are guaranteed a certain constant quantity of energy every month that does not change with streamflow conditions. The minimum amount of power that Tacoma Power receives from BPA is 384 average megawatts. In nearly all years, water conditions are more favorable for power generation and Tacoma Power will receive a larger quantity of energy.

A significant challenge associated with the "slice" portion of the contract is that hydroflows are difficult to predict. Rainfall and snowmelt can vary from month to month and year to year. As a result, operating the "slice" part of the contract is a complex process requiring specialized computer programs and a constant stream of updated information. The energy that is received from BPA has historically been less expensive than power sold on the wholesale market and a benefit to public utilities in the Pacific Northwest. However, in recent years, this price advantage has narrowed due to low natural gas prices and the growth of other low-operating-cost renewable resources.

COLUMBIA BASIN HYDROPOWER

Tacoma Power receives up to 130 megawatts from the Columbia Basin Hydropower through contracts for five hydroelectric projects on irrigation canals. Supply is limited to the irrigation season (mainly summer months) and Tacoma Power receives 50% of the actual output from each project. The contracts begin to expire in 2022 and fully terminate in 2027.

PRIEST RAPIDS & WHOLESALE MARKET

Tacoma Power also receives small amounts of energy through the Priest Rapids hydropower contract with Grant County PUD River (2 average megawatts) and from the Hood Street Canal hydropower project (0.5 average megawatts). Tacoma Power, like other utilities in the region, supplements owned/contracted resources with wholesale market purchases and sales of power.

Tacoma Power's BPA Decision

In 2016, Tacoma Power can elect to change the form of our BPA contract from the "slice/block "product to a "shaped block" product. The new product would be effective in October 2019 and extend to the end of the current contract in 2028. Preliminary analysis of the advantages and disadvantages of the new product performed as part of this IRP indicates the "slice/block" product remains the best option for the utility. Our staff will continue to evaluate the alternatives as more information comes available. A summary of the initial analysis is available in the appendix.

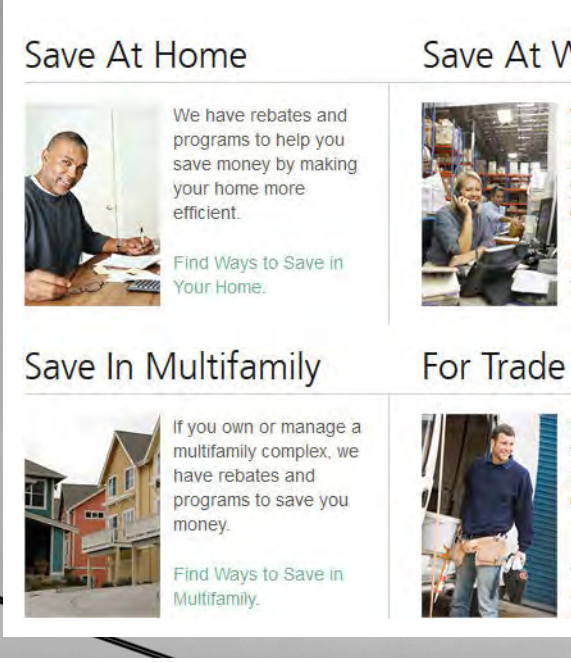
ENERGY CONSERVATION
as a resource

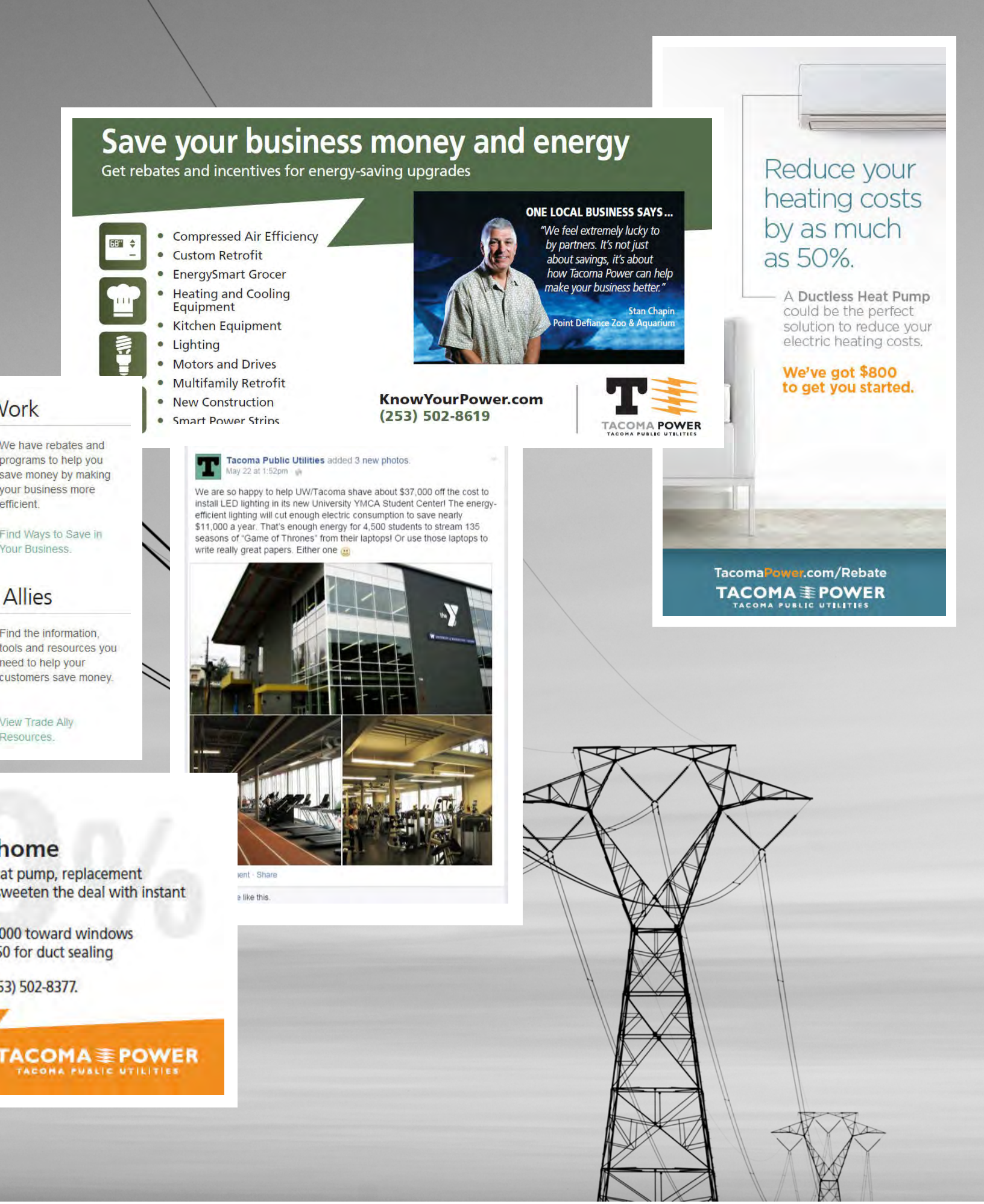
Energy conservation has been Tacoma Power's first choice for new energy resource and is the only resource that Tacoma Power has acquired for many years.

Energy conservation helps limit load growth, deferring the need to acquire costly new generating resources – resources that cost substantially more than conservation. And Tacoma Power customers also benefit directly because conservation:

- Helps customers and business reduce heating, lighting and other costs
- Provides local jobs and supports the local economy
- Is an environmentally friendly resource

Tacoma Power has been a leader in energy conservation for over 30 years. In 2011, we received the first-ever Award for Excellence in Energy Efficiency from the Bonneville Power Administration (BPA). The award recognizes Tacoma Power's "exceptional creativity, leadership and achievement in the pursuit of energy efficiency." The utility competed against other utilities and organizations in Washington, Oregon, Idaho and Montana. Since 2007, we have acquired 51 average megawatts of energy conservation.




Save your business money and energy
Get rebates and incentives for energy-saving upgrades
Compressed Air Efficiency
Custom Retrofit
EnergySmart Grocer
Heating and Cooling Equipment
Kitchen Equipment
Lighting
Motors and Drives
Multifamily Retrofit
New Construction
Smart Power Strips
ONE LOCAL BUSINESS SAYS...
"We feel extremely lucky to by partners. It's not just about savings, it's about how Tacoma Power can help make your business better."
Stan Chapin
Point Defiance Zoo & Aquarium
KnowYourPower.com
(253) 502-8619
TACOMA POWER
TACOMA PUBLIC UTILITIES
Reduce your heating costs by as much as 50%.
A Ductless Heat Pump could be the perfect solution to reduce your electric heating costs.
We've got $800 to get you started.
TacomaPower.com/Rebate
TACOMA POWER
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Work
We have rebates and programs to help you save money by making your business more efficient.
Find Ways to Save in Your Business.
Allies
Find the information, tools and resources you need to help your customers save money.
View Trade Ally Resources.
Tacoma Public Utilities added 3 new photos.
May 22 at 1:52pm
We are so happy to help UW/Tacoma shave about $37,000 off the cost to install LED lighting in its new University YMCA Student Center! The energy-efficient lighting will cut enough electric consumption to save nearly $11,000 a year. That's enough energy for 4,500 students to stream 135 seasons of "Game of Thrones" from their laptops! Or use those laptops to write really great papers. Either one
ient · Share
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home
at pump, replacement
sweeten the deal with instant
000 toward windows
50 for duct sealing
53) 502-8377.
TACOMA POWER
TACOMA PUBLIC UTILITIES

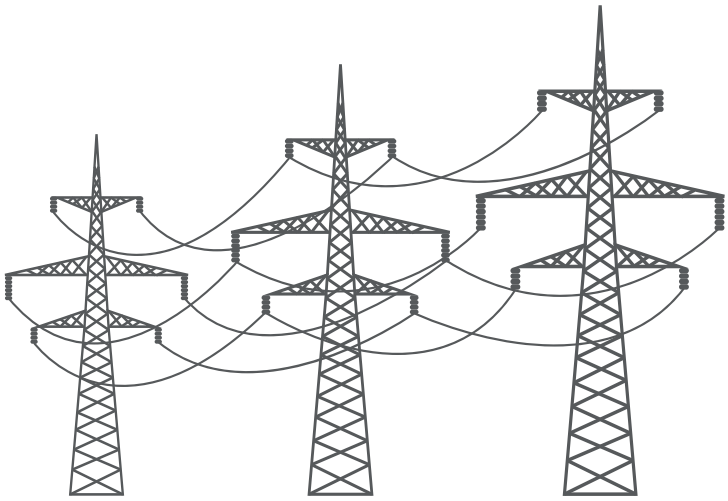
HYDROPOWER:
a renewable resource

Tacoma Power is lucky to be situated in Washington, the largest producer of hydropower in the United States.

Hydropower is a clean, renewable energy source that provides low-cost, dispatchable, electricity without carbon emissions. Dams create reservoirs that provide cost-effective energy storage, and use turbines and generators to convert flowing water into electricity, which is then fed into the electric grid. The water is not disrupted or used up in this process, and water flow is constantly recharged by captured rain and snowmelt, preventing downstream flooding.

Hydropower is recognized by the federal House Committee on Natural Resources as "more efficient than any other form of electricity generation and [it] offsets more carbon emissions than all other renewable energy sources combined."

While Washington State law identifies all hydropower as renewable, only incremental or small hydropower can be claimed as an eligible resource for Washington State's renewable portfolio compliance.



INNOVATING FOR OUR CUSTOMERS,

working to save energy statewide

Tacoma Power is committed to providing our customers with high-value, affordable products and services. When Habitat for Humanity came to Tacoma Power seeking advice on how to most efficiently heat homes they were building, our staff partnered with the non-profit organization and other regional utilities to provide ductless heat pumps (DHPs) and measure actual savings in new homes.

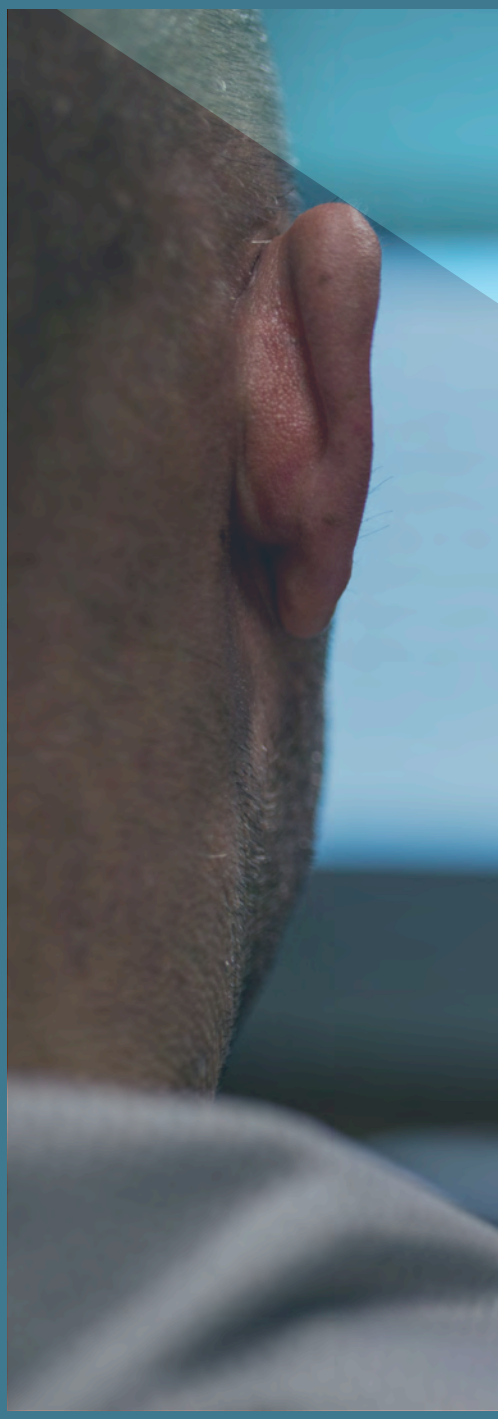
We found that the DHPs were helping Habitat homeowners reduce heating energy use by about 40% compared to baseboard heating. We used this information to submit a code proposal to the Washington State Building Code Council to make DHPs mandatory in new homes constructed with zonal electric heat to help the entire state of Washington save energy. Just before publication of this IRP, we learned the State Building Code Council included our proposal in the proposed 2015 State Building Code changes, which were forwarded to the Washington State Legislature for consideration in its 2016 session.

PUBLIC PROCESS
collaborating with stakeholders

Tacoma Power is a municipal utility, owned by the citizens of Tacoma. Throughout development of the 2015 IRP, Tacoma Power staff worked collaboratively with the public – residential customers, advocates, policymakers, business owners and other governments – to shape the plan. During four public meetings, we presented information, reviewed analyses, discussed issues and listened to valuable feedback from these stakeholders, who shared ideas, identified concerns and ensured we considered a range of topics and alternatives. Just a few of the discussions that were particularly engaging and helped to form the analysis and information contained in the IRP include:

- The future of vehicle electrification
- The relationship between economic growth and fossil fuel prices
- Using Tacoma's low electricity rates as a means to drive economic development
- The future of distributed solar generation
- New and innovative energy conservation programs

We sincerely thank the Public Advisory Committee and everyone who attended the meetings. Your efforts helped create a more robust IRP that best serves our customers.



Attendees included:

Retail Customers

- DaVita
- Emerald Queen Casino
- Franciscan Health Services
- Multicare Hospitals

Energy

- Bonneville Power Administration
- Kiewit
- Rexel Energy
- Tollhouse Energy

Environment

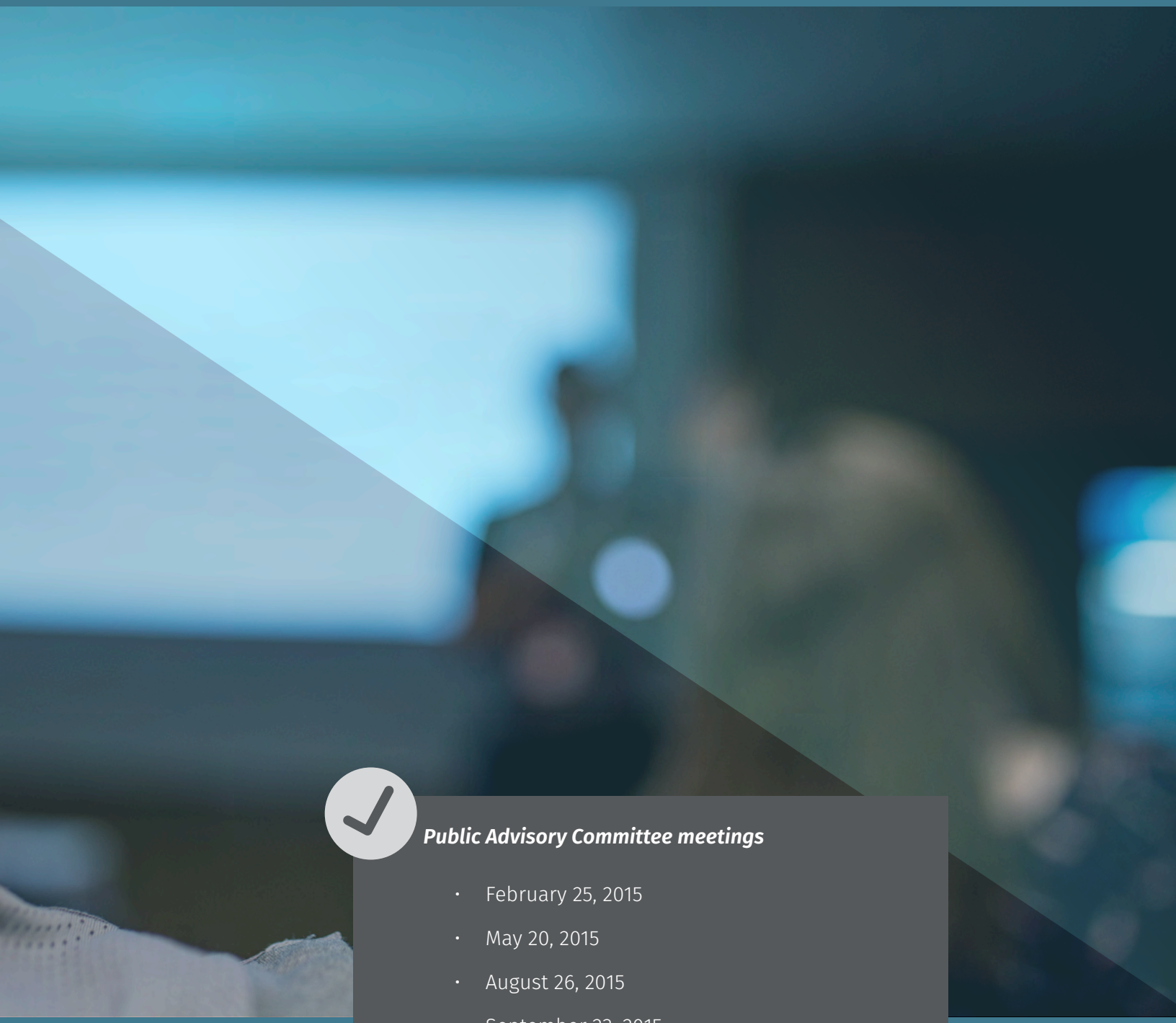
- Northwest Energy Coalition
- Northwest SEED
- Renewable Northwest
- Sierra Club

Government

- City of Tacoma Economic Development Office
- City of Tacoma Sustainability Commission
- Northwest Power and Conservation Council
- Pierce County Economic Development Board
- Tacoma Metro Parks

Education

- Tacoma Community College
- University of Puget Sound
- University of Washington – Tacoma



Public Advisory Committee meetings

- February 25, 2015
- May 20, 2015
- August 26, 2015
- September 23, 2015

Public Utility Board Study Session updates

- July 22, 2015
- October 14, 2015

THE RESOURCE planning process

The world around us is constantly changing, and there is great uncertainty about what the next 5, 10 or 20 years might look like. For electric utilities like Tacoma Power, an Integrated Resource Plan (IRP) is one way we plan for and deal with this uncertainty. Planning is an ongoing process for us, but every two years, we take a long-term look at the next 20 years to make sure we have the electricity our customers need now and in the future.

Put simply, integrated resource planning helps us make sure sufficient energy resources are available when needed and not before. Thanks to planning decades ago, Tacoma Power's customers benefit today from a reliable electric system, low rates and a sustainable energy supply.

Why look 20 years ahead? Developing new resources is often complex, expensive and requires significant lead times. The IRP helps us take an in-depth look at how our electricity is generated and used, the influence of current and possible energy and environmental regulations, and other factors such as evolving energy markets and the overall economy that may impact the utility or our customers. Through the process, we answer important questions about the status of our existing supply of energy resources, how much electricity we think our customers will need over the next two decades and how we close the gap between current supply and this forecasted demand.

TACOMA POWER'S GOALS IN DEVELOPING THIS IRP

Develop an overall resource strategy that helps Tacoma Power maintain our ability to deliver reliable and low-cost electricity to our customers.

Fulfill the requirements of state law (RCW 19.280) to file an Integrated Resource Plan with the Washington State Department of Commerce every two years that evaluates supply, demand and available energy conservation, efficiency and renewable resources.

Minimize our environmental impacts through continued use of renewable hydropower and increased use of energy conservation.

Provide flexibility to adapt to changing power markets, government regulations, weather and other conditions.

Listen to and consider input from the public and others who have a stake in Tacoma Power's energy future.

Publish a Public Utility Board-approved action plan that identifies the specific steps the utility will take over the next two to five years to implement the resource strategy.

THE STEPS

1

Review what we believe the landscape – financial, regulatory, economic, technology – will look like over the next 20 years

2

Answer the critical question – does Tacoma Power need additional resources? And if so, how much?

3

Research potential energy resources to fill any gaps

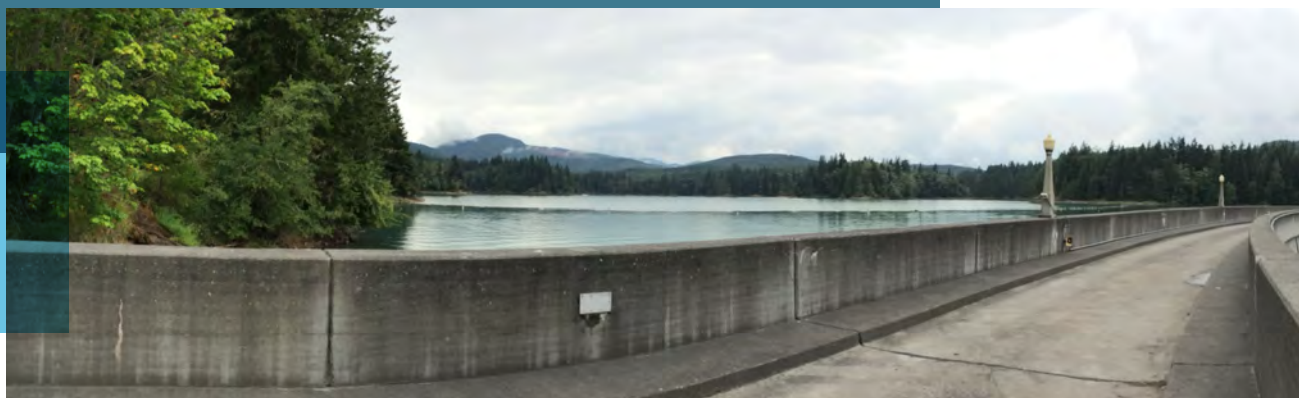
4

Analyze promising resources using plausible scenarios of the future

5

Develop a recommended resource strategy and action plan to meet our customers' needs

STEP 1
survey the future landscape



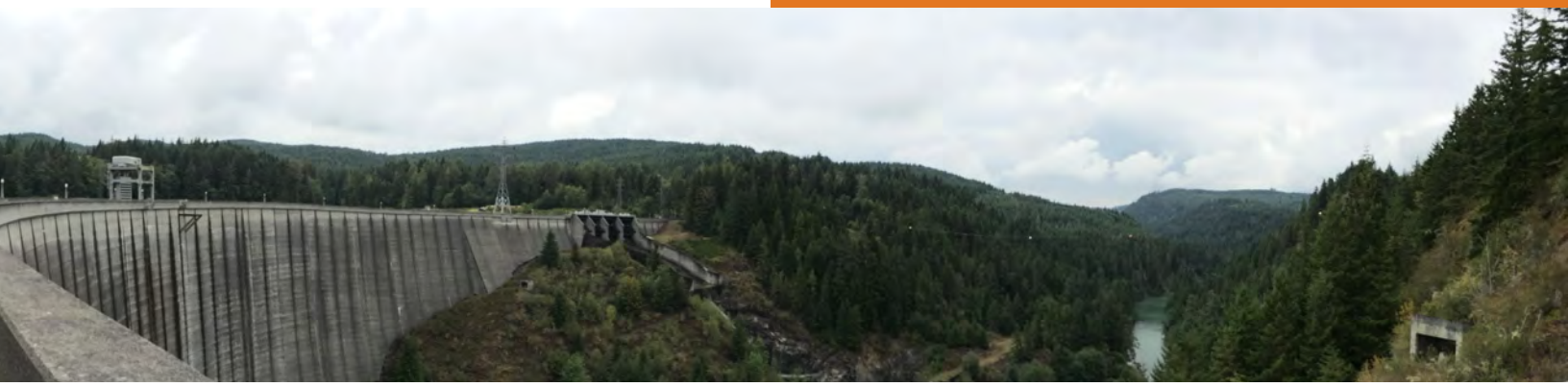
An Integrated Resource Plan forecasts the amount of electricity our customers will need over the next 20 years, reviews the outlook for our existing power resources and checks whether we need to add new resources. The plan then turns to considering how best to fill any gaps. To answer this question – especially if the need does not appear until some years into the future – the IRP must consider how changes in technology, industry and laws may influence the conditions under which we meet our customers' needs. These external influences directly impact our long-term plan.

The planning environment – the future landscape – describes major external influences that are affecting the electric utility industry and shaping the future. Electric utilities like Tacoma Power are entering a period of major transformation, with increasing complexity and uncertainty. Several forces are driving change in the industry, including slowing customer demand for electricity, emergence of new technologies, regulations and actions to reduce greenhouse gas emissions and development of new wholesale power markets. Tacoma Power must embrace the changing landscape and emerging risks and opportunities to help make decisions that most benefit our customers. This IRP organizes the planning environment into five main areas: economy, energy, political/legal, technology and climate change.

ECONOMY

Nationally

From the Great Recession of 2008 through 2014, economic growth in the United States has been sluggish and lacked the broad-based growth of previous recoveries. But over the past eighteen months, some parts of the country have shown signs of robust growth. Those areas include Tacoma's northern neighbors, the greater Seattle area and Snohomish County.



Locally

While experts anticipate some "spill over" growth as workers and businesses seek more affordability in Tacoma, there are limitations due to the lack of adequate transportation infrastructure on the I-5 corridor north of Tacoma.

Tacoma Power has recently received more interest from new large customers than at any other time in the past decade. Potential new commercial and industrial developments include a liquefied natural gas facility to fuel maritime shipping, a methanol processing plant, a wood product manufacturing facility and several cold storage warehouses.

INDOOR AGRICULTURE

Initiative 502, passed by Washington voters in November 2012, made it legal under state law for Washington residents to grow, sell and possess marijuana for recreational use. The 2013 load forecast projected the arrival of 50 average megawatts of cannabis production to arrive in Tacoma Power's service territory between 2013 and 2033.

Recent reports suggest that local cannabis production has been significantly overestimated. Regulatory and economic uncertainty has stalled the development of the cannabis industry statewide. Marijuana use remains unlawful under the Federal Controlled Substance Act, and cannabis profits have been lower than anticipated because of product oversupply and delays in setting up legal retail outlets. Producers have also concentrated growing enterprises in Eastern Washington to take advantage of lower rents and taxes. It is unclear whether this is a temporary market dislocation or a sign that long-term production levels in this area will be less than estimated.

At any level of production, cannabis offers significant opportunities for energy conservation acquisition. According to the Northwest Power and Conservation Council, regional cannabis load demand could range from 60 to 160 MW over the next 20 years, with 38% of that power used for lighting and 21% for air conditioning. However, actually acquiring energy conservation for this load may prove difficult. BPA funding or any other federal assistance is not available due to the classification of cannabis under federal law, and growers generally have not shown particular interest in energy conservation.

The most recent retail load forecast included a reduction in the estimated use by cannabis growers and production enterprises.

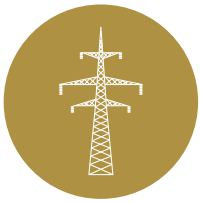
JOINT BASE LEWIS-MCCHORD

In recent years the Department of Defense had considered cutting as many as 11,000 soldiers from Tacoma Power's largest customer, Joint Base Lewis-McChord, which is also the largest employer in the Tacoma area. Losing that many jobs could depress the local economy and lead to more layoffs among military contractors and others who do business with the base. In July, the actual reductions were revealed to be 1,250 soldiers. The number of reductions in military contractors is still unknown.

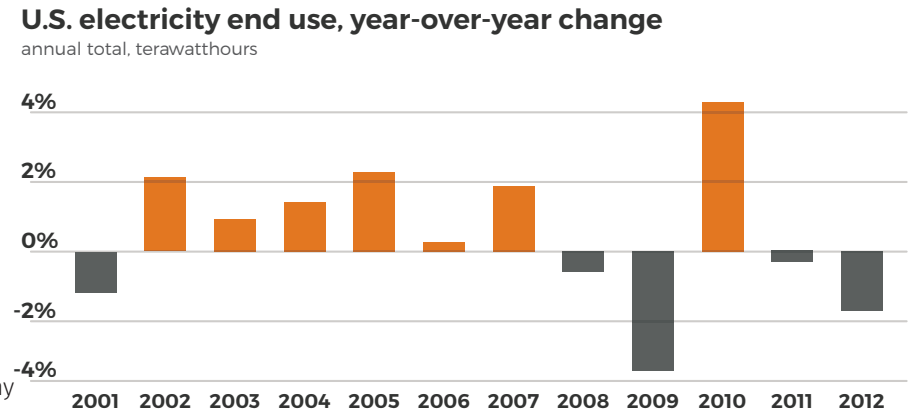
The impacts of force reductions are not as significant as once feared but this turn of events does demonstrate the potential uncertainty of military retail load. Depending on the current military objectives, forces deployed at the base could increase or decrease substantially in the future.

ENERGY

Nationally



After growing dramatically from the end of World War II until the late-2000s, consumption of electricity has flattened. Even a growing economy and population are not driving significant demand for electricity, as energy conservation is helping reduce consumers' power use. Many utilities no longer face a need to add significant quantities of new power resources.



Source: U.S. Energy Information Administration

Governments are likely to continue to institute policies that mitigate the effects of climate change through greenhouse gas (carbon) emissions regulation and increased renewable mandates. The federal government, through the EPA, is implementing the Clean Power Plan to replace coal generation with other generation types, primarily natural gas. Natural gas power generation would provide additional domestic demand for the natural gas industry and inexpensive/cleaner power, and its flexibility would promote the additional deployment of intermittent renewable generation. Although we cannot be certain about the details of these and future policies, the proportion of energy that comes from intermittent renewable energy generators like solar and wind is almost certain to increase.

Barring a revolutionary technological solution to the intermittency of renewable generation, energy markets will be forced to evolve to accommodate the growing need for dispatch flexibility. The region is investigating sub-hourly and capacity markets to allow owners of dispatchable resources to market the reserve energy services they provide to help intermittent renewable generators to effectively operate on the grid. Other changes include:

- Government mandates such as Renewable Portfolio Standards and more stringent power plant emissions regulations are reshaping the generating fleet and creating new challenges to balance the power system.
- California is installing large amounts of solar photovoltaic generation, much of it by customers and not utilities. Solar generates power with availability of sunlight and, if current growth rates continue, will create operational challenges. Baseload resources will be forced to ramp down the late morning and ramp up again in the early evening.
- In some regions with significant renewable generation, spot market prices for wholesale power approach zero during certain times of the year. This creates customer challenges for utilities whose rates have to recover the full cost of new power resources.
- Costs for distributed generation, particularly rooftop solar photovoltaic, are falling rapidly, and when combined with lucrative government incentives, are becoming cost-competitive with retail electric utility rates in regions where the cost of power is relatively high.
- In Hawaii and other areas of the country where rooftop solar is growing rapidly, some reverse power flows into the utility grid are beginning to occur, creating operational and safety issues.
- Although most utility costs are fixed, retail electric rates have traditionally been designed to recover the majority of costs through volumetric charges (electricity costs that vary due to electricity use). This increases the incentive to adopt rooftop solar and causes under-recovery of utility costs to serve consumers who adopt it.
- Stagnant load growth means that increases in a utility's costs can't be spread over increasing sales. Instead, higher costs translate much more directly into a need to raise retail electric rates.

U.S. SHALE OIL AND GAS FIELDS

Petroleum and natural gas companies responded to increasing scarcity in the early 21st century by adopting and applying hydraulic fracturing and directional drilling techniques to increase domestic supplies of natural gas and crude oil. Domestic oil and natural gas shale production improvements pushed natural gas and oil commodity prices down to the lowest price levels in the past fifteen years. Continued improvements in productivity could keep fuel prices low and help transition the economy away from coal generation. Disruption of the shale oil and gas industry could lead to higher prices and a more difficult transition. During the last five years, many analysts have been surprised that natural gas prices have remained low despite unseasonable cold weather and increased industrial demand. Whether this trend can continue into the future is unknown.

Source: U.S. Energy Information Administration

Locally

Tacoma Power has surplus generation to sell into the wholesale power market in all but the driest years. Revenues from surplus power sales are used to help keep Tacoma Power's retail rates among the lowest in the country. Wholesale revenues are difficult to predict, however. Not only is it unclear how much excess energy Tacoma Power will have to sell in a given year, but wholesale market prices are very uncertain because:

- Customer energy use (retail load) is unpredictable – much of it is related to heating and cooling systems, which is heavily influenced by temperatures.
- Natural gas generation typically sets the marginal price for power in the Pacific Northwest because it is dispatchable and serves incremental retail load. Natural gas prices have fallen steadily over the past decade, driving down wholesale power prices too.
- The amount of wind and water than can be used to generate power affects the supply of power and influences the wholesale power price. As more and more wind generation is added in the Pacific Northwest, the more variable the wholesale power price becomes.

These varying influences mean that the amount of revenue Tacoma can expect to receive when it has surplus power available to sell is volatile. To mitigate this, Tacoma Power engages in Energy Risk Management procedures including wholesale market hedging to reduce exposure to sudden market price swings. However, Energy Risk Management cannot counteract the recent steady decline in wholesale power prices.

Overall, how the wholesale power market values energy is undergoing significant changes. New market mechanisms are being developed to compensate entities that can help integrate and balance intermittent renewable generating resources. At the same time, market prices for wholesale energy are depressed and may remain so for the foreseeable future. As a result, Tacoma Power faces a future where revenues from sales of its surplus hydro generation may remain variable from year to year, yet lower on average.

ENERGY IMBALANCE MARKET

Energy imbalance markets address a need for generating resources owned by multiple entities to work together more cooperatively to improve reliability. A proposed energy imbalance market could alter the way Tacoma Power sells and buys electricity in the wholesale power market. Currently most of the utility's surplus or deficit energy position is balanced by trading in the wholesale power market in three different time slices: term, daily and hourly. An EIM will establish a fourth time slice for trading energy, a 15 minute market, that will require another level of dispatch automation, technology support, generation planning and wholesale power market trading.

Tacoma Power could extract value from the new market by offering in the flexibility of our hydroelectric resources in response to sub-hourly demand. The obligations to supply energy and capacity to its customer base would not change. Currently the utility does not own wind or solar generation, and so our capacity to balance these resources could be sold to others. And although the utility would gain market value from such a 15-minute market, high implementation and operating costs could erode some or all of this benefit.

Definitions

An **intermittent energy source** is one that is not continually available due to the source instead of customer need. For example, solar energy is intermittent because it is available only when the sun is shining.

A **baseload resource** is a resource typically operated 24 hours a day throughout the year.

Distributed generation refers to electricity that is produced at or near the point where it is used. Generating power on-site, rather than centrally, eliminates much of the cost, complexity, interdependencies and inefficiencies associated with transmission and distribution.

Like most commodities, electricity is often sold through competitive bidding at a **wholesale market** before being sold and distributed to customers.

POLITICAL/LEGAL

As recognition of climate change impacts and risks grow, popular support for the reduction of greenhouse gases has resulted in increased government action. Government mandates such as Renewable Portfolio Standards, requirements for integrated resource planning and policies to reduce carbon emissions are reshaping the utility industry.

Nationally

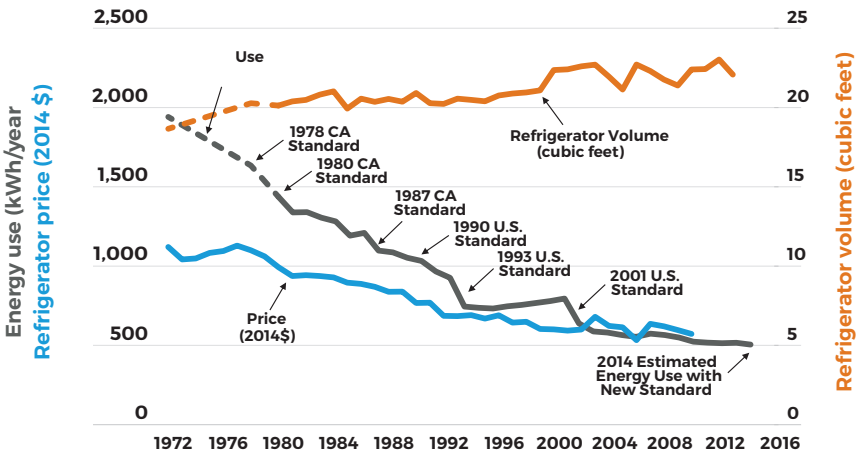
To date, legislative proposals to tax carbon emissions or to create a tradable market for carbon emission credits have failed in the face of political opposition. In response, the Obama Administration has taken Executive Action and has directed the Environmental Protection Agency to regulate and limit carbon emissions under Section 111(d) of the Clean Air Act. The EPA released its final Clean Power Plan in October 2015, which establishes state-by-state carbon targets. The rule is expected to lower national electricity sector emissions in the year 2030 to a level 30% below 2005 levels.

The federal government has provided tax incentives for the deployment of renewable generation since 1992. These financial incentives have provided short-term economic relief from the initial high cost of development until economies of scale can reduce cost. The federal Production Tax Credit (PTC) for utility scale generation projects that utilize wind, geothermal, solar, hydropower, biomass or hydrokinetic renewable energy has been expanded and extended many times by several pieces of legislation. The PTC lapsed earlier this year. While a legislative action to extend the tax credit is a possibility, this may be the end of the PTC, which is now more than two decades old. A similar incentive, known as the federal Investment Tax Credit (ITC), will decline from currently crediting 30% of installed development cost to 10% in 2016. While there are legislative efforts to maintain the ITC at the current level, given the cost reductions in renewable energy generation over recent years, support is mixed and an extension may not be successful.

The Department of Energy has resumed the review and establishment of energy efficiency standards for more than 50 categories of appliances and equipment that includes 90% of products for home energy use, 60% of commercial use and 29% of industrial use. Each standard is set to be evaluated and renewed every six years and will be a major contributor to a continuing reduction in retail electricity consumption, just as it has over the past thirty years.

Source: Appliance Standards Awareness Project

Average household refrigerator energy use, volume and price over time



California's Senate and State Assembly recently approved Governor Brown's push for additional clean energy, passing 12 climate bills that aim to increase the state's renewable power mandate to 50% and to require a 30% improvement in the building efficiency. California Assembly Bill 2514 requires three investor-owned utilities operating in the state to acquire a total of 1325 MW of energy storage technology by 2020.

Locally

The Energy Independence Act (EIA), adopted by Washington state voters in 2006 and commonly referred to as "Initiative 937," requires large Washington utilities to get at least 15% of their power from new renewable resources by 2020 and to acquire all cost-effective energy conservation. The EIA also requires that a specific minimum percentage of power delivered to customers must be generated by "eligible renewable resources." This mandate exists whether the utility needs the power or not. As an alternative, utilities may acquire the equivalent renewable attributes (renewable energy credits) in lieu of generating the power directly. Over the last few years, several attempts have been made to amend the EIA as state representatives look to address items not specifically covered in the original law.

In addition to these changes, state lawmakers have been looking for ways to encourage the development of distributed generation. State incentives supporting photovoltaic solar are set to expire in 2020, and there have been several unsuccessful attempts to extend the subsidies at a lower rate for another ten

years. These omnibus bills have also attempted to address other complex issues surrounding solar generation, including consumer protection, regulation of out-of-state third party financiers and modifications to net-metering laws.

While no state carbon tax or regulation currently exists, a state carbon tax initiative (No. 723) appears to have secured sufficient signatures to be placed on the ballot. The effect of the tax, assuming it becomes law, will be to increase the overall wholesale price of power. Any form of carbon emissions regulation will benefit the addition of renewable generation capacity (such as hydropower, wind, and solar) and disadvantage generation that is the greatest emitters of carbon (coal). Flexible and dispatchable generation should also do well under a tax.

Washington Governor Jay Inslee signed executive order No. 14-04 directing the state Department of Ecology to develop a rule to decrease carbon emissions from stationary sources using that agency's existing authority under the state Clean Air Act. The Department has initiated a rulemaking to comply with the Governor's directive.

TECHNOLOGY

Energy-efficient technology and renewable generation alternatives have evolved at a pace unexpected even a few years ago. The energy sector has become the focus of several new technologies aimed at improving energy efficiency and providing substitutes to practices that contribute to environmental damage. Consumer preferences and government standards are supporting the innovation, development, purchase and installation of efficient appliances, electric vehicles and other technology. New technologies provide new opportunities and cause shifts in consumer demand and in the preferred way of doing business. It is difficult to predict technological change, but the impacts of change can ignite sudden shifts in the market.

Retail load growth has shown signs of systemic decline over the past few years across the United States. This is in part due to efficiency improvements mandated by federal and state codes and standards. One of the biggest developments in efficiency over the past generation is the innovation in lighting. LEDs are fast replacing incandescent bulbs and CFLs. LEDs use about 15% of the electricity that traditional bulbs do and they last up to 25 times longer – and cost has dropped by 75% since 2010.

Comparison of incandescent, CFL and LED bulbs
based on 60 watt incandescent

	Incandescent	CFL	LED
Cost per bulb	$0.60	$1	$7
Typical life (hours)	850	10,000	25,000
Energy used	60 watts	13 watts	10 watts

While many emerging technologies appear to be promising, it is difficult to predict which prototypes and applications will be successful. Listed below are a few technologies that Tacoma Power is monitoring.

"Smart" equipment such as thermostats adapt to user preferences and provide detailed energy use data, so customers can make educated choices about how and when to use electricity.

Renewable energy is the fastest-growing type of generation in the United States, tripling in installed capacity since 2008. The rapid increase is driven by falling technology costs, the price of competing generation, public interest, tax incentives and legal requirements. Wind generation now accounts for 4% of annual electricity generation nationally (and 8% regionally) and solar is 0.4% nationally (and 1% regionally). Investments in renewable energy have helped bring down equipment costs to the point that in some regions of the country and, for some utilities, it is cost competitive with more traditional generating technologies.

Solar power has a diurnal and seasonal profile based on available daylight. Generation is very limited in winter months due to the reduced sunlight hours and low celestial aspect, particularly at Tacoma's latitude. The best areas for solar efficiency in the Pacific Northwest are east of the Cascade Range in Washington, Oregon and southern Idaho. On the western side of the Cascade Range, the cloud cover is more frequent and dense, significantly reducing the amount of electricity a solar generation system will produce.

Solar photovoltaic modules have reduced in cost since 2006 by 78% mostly due to declines in the price of polysilicon; the raw material used in panel production. During a shortage in 2007, polysilicon was valued at $400/kg, but an abundance of new suppliers has led to intense competition and a 94% drop in the price in 2015 to $25/kg. Other factors influencing the reduction in module cost are improvements in manufacturing technology, economies of scale and intense competition.

Over the last fifteen years, **wind generation** capacity in the Pacific Northwest has grown from pilot projects to a total regional capacity of 8800 MW with the help of government mandates and financial incentives. Wind generation is currently the most common renewable resource in the United States apart from hydropower. The large quantity of intermittent wind generation has challenged the regional electrical grid to accommodate it. To maintain system reliability, wind generation must be partnered with dispatchable generation (combustion turbines, hydro). Diurnally, wind speeds in the Pacific Northwest are often observed as being highest during early morning and late evening periods and seasonally during the spring and fall, times when retail demand is at its lowest. If Tacoma Power were to acquire a wind resource, valuable hydroelectric flexibility would be needed to integrate it. Another alternative would be to pay another party to integrate the generation for the utility.

Production advancements and economies of scale have increased over the past decade, reducing wind generator costs per megawatt by 20-40% . This has been partly achieved by increasing generator size. NREL forecasts wind generation manufacturing costs to decrease by a further 25% by 2030. Improvements in site engineering and installation techniques have also contributed to reductions of overall installed costs of $600 per kilowatt since the peak in 2009.

Energy storage is a hot topic these days. For utilities, the increase in intermittent generation such as solar and wind is behind research to develop large-scale energy storage technology. However, these new technologies are mostly applicable to storing energy for use within minutes or a few hours. The research and development of most new energy storage systems are in an early phase of development, with significant research and testing to be completed before they are cost-effective and commercially available for use in the Pacific Northwest. Pump storage provides some opportunities to hold energy for longer periods of time, but the only efficient way to store electricity between seasons is with very large, very expensive hydroelectric dams, and not all areas of the country are as blessed as the Northwest with available sites.

Electric vehicles continue to evolve towards becoming cost-competitive with gasoline power vehicles. While electric vehicles currently represent only a very small segment of the nation's automotive fleet (less than 2%), a decade of continuous rapid growth may cause energy planners to consider both the opportunities and challenges presented by electric vehicles.

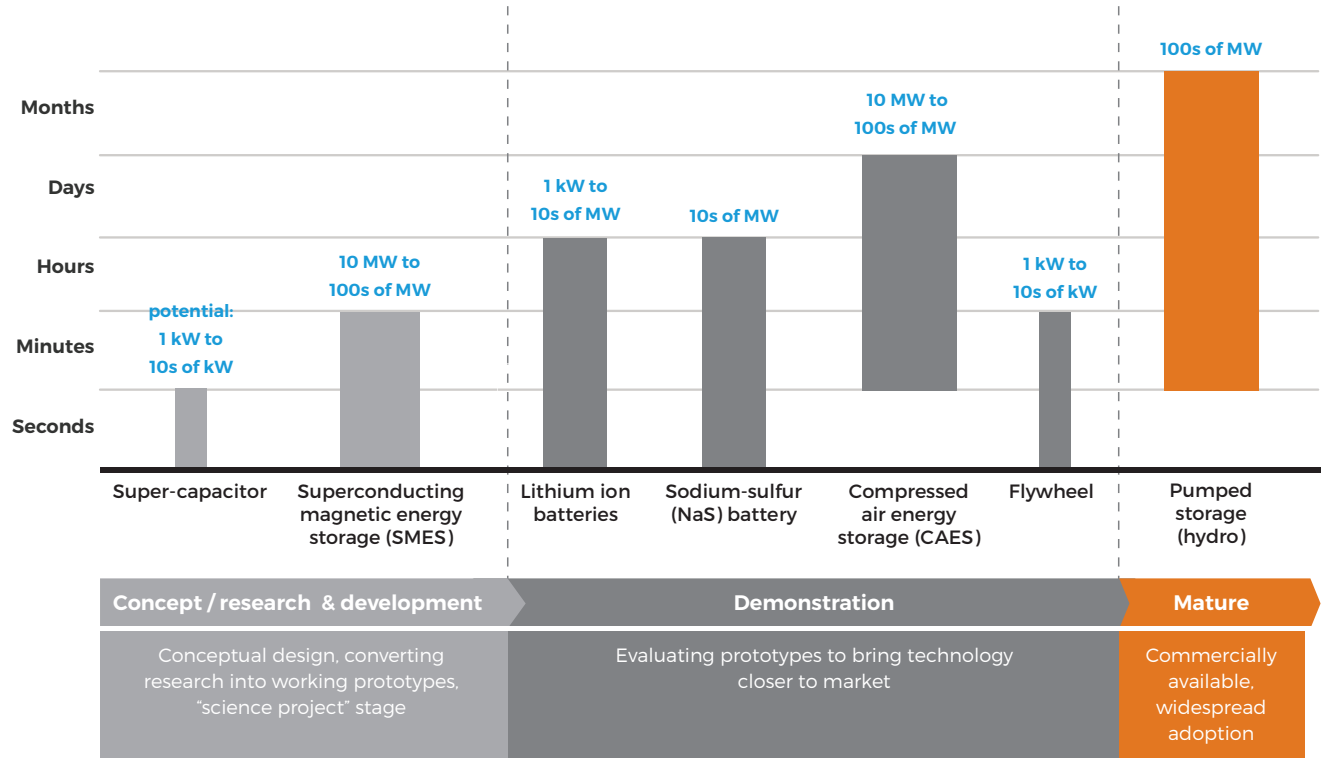
Improved battery technology, investment in public charging stations and increased fossil fuel prices are the major obstacles to increased acceptance of electric vehicles.

Electric vehicles are expected to impact electric utilities by increasing retail load during certain periods of the day, notably the evening peak (5 – 9 pm). With programmable charging capabilities, utilities might be served by implementing time of use rates to encourage late night charging. Some have suggested that electric batteries in cars can be used by utilities as a widespread source of supply when the electric grid is capacity constrained. Theoretically, the availability of car batteries through the use of two-way charging could help integrate renewables and enhance overall grid stability.

Currently, there are approximately 425 plug-in hybrid or fully electric vehicles in Tacoma Power's service area. Earlier this year, the State of Washington set a goal for 50,000 electric vehicles registered in the state by 2020. Assuming current proportions, Tacoma's share of the state goal equals 1,200 vehicles and a less than 1 average megawatt increase in energy consumption. While this quantity would not result in a significant increase in retail power demand from electric vehicles, the utility is carefully following factors that could change adoption rates such as improvements in battery cost and range, and gasoline prices (including carbon taxes). An increase in gas prices coupled with Tacoma Power's low retail power rates could provide strong incentive for customers to switch to an electric vehicle.

Energy storage technologies

Maturity levels, energy capacity and duration of storage



CLIMATE CHANGE

Climate change is one of the defining challenges of our time. There is growing recognition among policymakers and the public that human activity is changing the Earth's climate. A desire to forestall the consequences of rising greenhouse gas emissions runs up against the benefits people receive from the use of carbon-emitting fuel – benefits that include heat, transportation, cooking, cooling, industrial processes, medicine and many others.

Nationally

Electricity generation is responsible for 31% of total carbon dioxide emissions (the primary greenhouse gas responsible for climate change) across the United States. This has led to strategies and legislation aimed at carbon emissions reduction, such as the transition of electricity generation away from coal generation and toward natural gas-fired generation and increased use of renewable energy. Generating with natural gas produces less than half the carbon dioxide per megawatt hour as coal generation.

However, at least in the Northwest, there appears to be a limit to the carbon reduction benefits of new intermittent renewable resources. The draft 7th power plan released by the Northwest Power and Conservation Council indicates that "policies to reduce carbon emissions by increasing state Renewable Portfolio Standards are the most costly and produce the least energy emission reductions." Retiring coal-fired generation and the reduction of electricity demand through increased equipment efficiency have direct and significant carbon benefits.

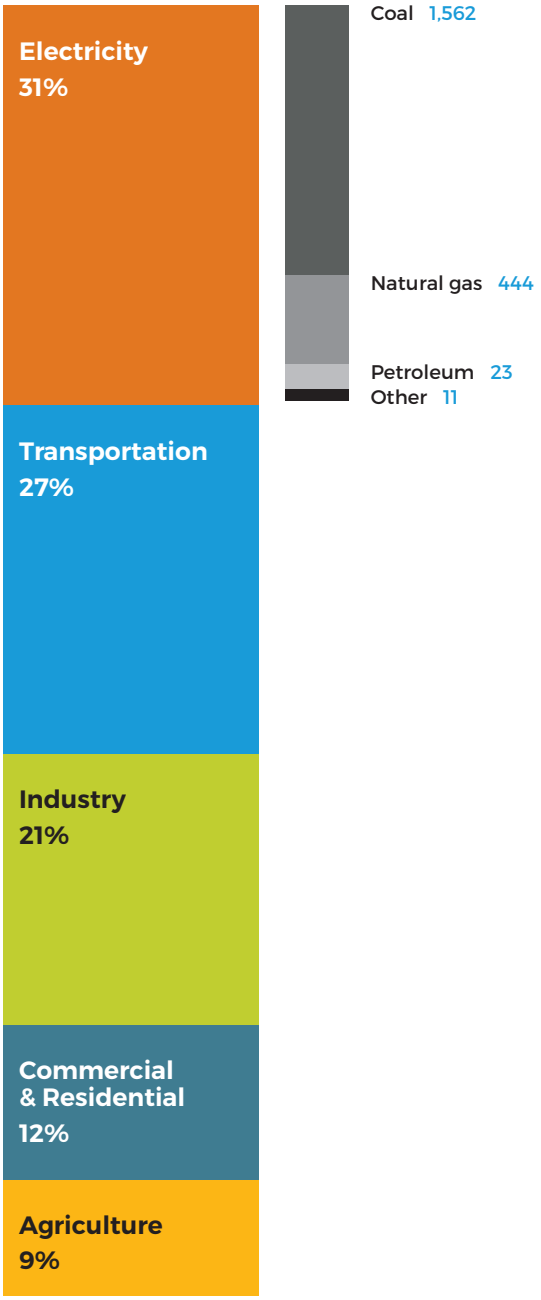
Independent of utility-sponsored energy conservation programs, the general public is taking part in actively monitoring and reducing their energy use, even when it means additional inconvenience or expense. Businesses such as Walmart and Google are voluntarily taking action to increase use of clean energy or reduce greenhouse gas emissions.

Locally

Thanks to hydropower, Tacoma Power and other Pacific Northwest utilities produce relatively few greenhouse gases. One of the fundamental questions of this IRP was how climate change will impact temperatures and water conditions in Tacoma Power's service area. A study commissioned by Tacoma Power and conducted by the University of Washington forecasts that, by the end of the 2016-2035 study period, Tacoma Power will experience a slightly reduced winter heating load and a negligible increase in summer cooling load due to climate change. Climate change will also impact the timing of seasonal runoff, with more winter precipitation falling as rain and less as snow. It is expected that this will impact the timing of spring runoff, which will coincide better with retail power demand but may also increase the risk of river flooding.

Detailed information about this study and the impacts of climate change on Tacoma Power can be found in the appendix.

Total U.S. greenhouse gas emissions by economic sector
with emissions from electricity generation by fuel source (million metric tons, 2014)



STEP 2
identify resource need

"Resource adequacy" is a fundamental necessity for every electric utility and gives customers confidence that their electric service is reliable. Resource adequacy means that a utility's mix of generating and contract resources is sufficient to meet the retail load demanded by its customers as it varies through each day, month and year. Tacoma Power has performed analysis to evaluate the gap – positive or negative – between the current long-term supply portfolio and the future needs of our customers. Tacoma Power then compares the answer to an objective resource adequacy standard to answer the critical question of whether the utility needs additional resources.

The analytical tools objectively measure resource adequacy in three distinct ways, each covering a specific type of risk. These metrics are a new resource adequacy standard developed for this IRP.

We used a commercial resource portfolio model called PLEXOS to calculate these metrics. This software models the operation of Tacoma Power's resource portfolio across the 20-year IRP period under a variety of operational conditions. For more detail on the approach and assumptions involved in the analysis, please refer to the appendix.

These three metrics indicate that Tacoma Power has no need to acquire additional resources aside from all cost-effective conservation through 2035.

Planning for *most* situations

Tacoma Power has an obligation to provide reliable service for our customers. We use resource adequacy analysis to make sure we have enough resource to cover almost any situation. Why not have the resources to cover every possible situation? Because it would be very costly and, under most situations, would leave Tacoma Power awash with surplus energy – not an efficient use of customers' money.

UPDATE FROM THE 2013 IRP

The 2013 IRP indicated that annual supply would not be adequate to meet customer loads beginning in 2025 under critical water conditions. 2025 is the year that our power purchase contracts with Columbia Basin Hydropower begin to expire. The 2013 IRP also showed significant gaps between supply and demand in the fall and winter quarters beginning in the early 2020s under low water conditions. Since that analysis, Tacoma Power has significantly reduced the retail load forecast to reflect the observed reduction in retail load growth. This reduction, coupled with changes to the calculations of resource adequacy to allow Tacoma Power to count on 50 average megawatts of market purchases and a change to a more recent critical water year (2001, from 1941), led to the 2015 IRP's conclusion that the utility will have sufficient supply resources through 2035, the end of this IRP's planning cycle.

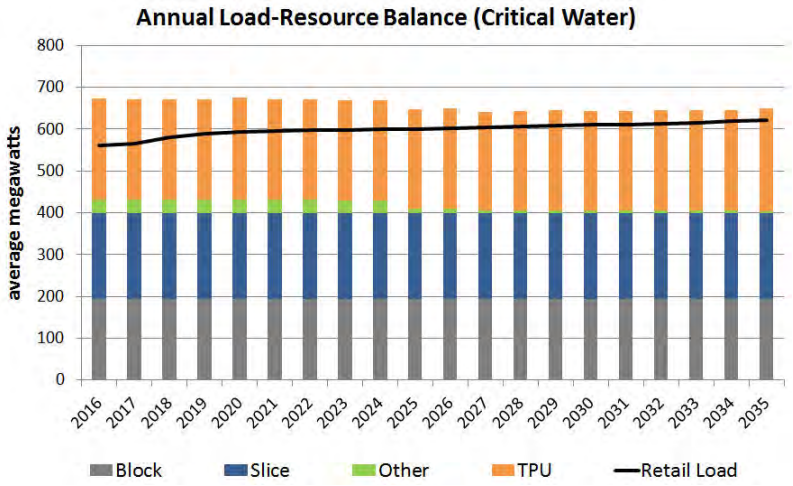
For more detail on the analysis of resource adequacy and differences in methodology from the 2013 IRP, please refer to the appendix.

ANNUAL ADEQUACY

Does simulated energy supply under critical water conditions (the historic year with Tacoma Power's lowest water conditions) exceed forecasted customer loads over a year? This metric ensures we have the baseload capacity to meet retail demand based on reasonable expectations of customer need.

Annual retail load projections, after cost-effective energy conservation, do not exceed projected supply under critical water in any study years. It is important to recognize that typically, Tacoma Power's portfolio provides a much greater quantity of electricity than the 686 average megawatts assumed under critical water conditions. For example, in 2014 (a wet year), our resources provided 830 average megawatts, while in 2015 (a drier year), our resources are projected to provide a total of 800 average megawatts.

Annual forecasted energy supply at critical water (water year 2001) exceeds annual forecast average retail energy demand in all study years (2016-2035)

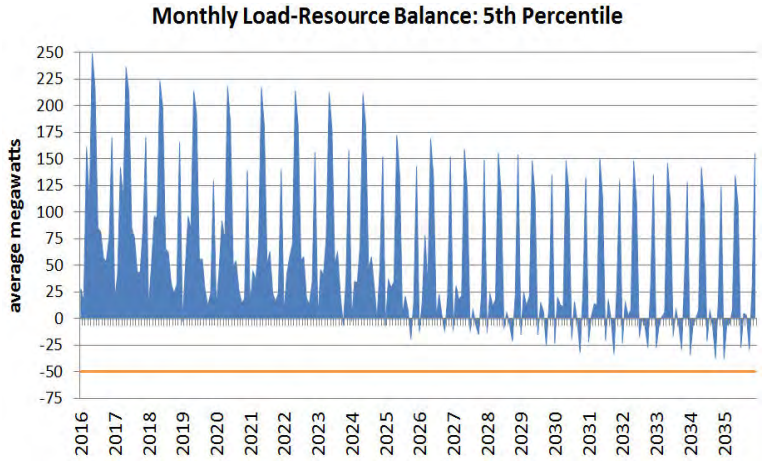


MONTHLY ADEQUACY

Does simulated energy supply exceed forecasted customer loads in every month in 19 times out of 20? This metric ensures we have the capacity to meet customer need as it varies by season and month.

The simulated monthly energy supply, plus 50 average megawatts of allowable market purchases, exceeds the simulated monthly retail demand 20 times out of 20. Again, Tacoma Power's portfolio is typically much more surplus than indicated in this graphic. Over the 20-year study period, Tacoma Power is surplus by approximately 50 average megawatts.

Simulated monthly energy supply plus 50 MW of allowable market purchases exceeds simulated monthly retail energy demand in 20 out of 20 years

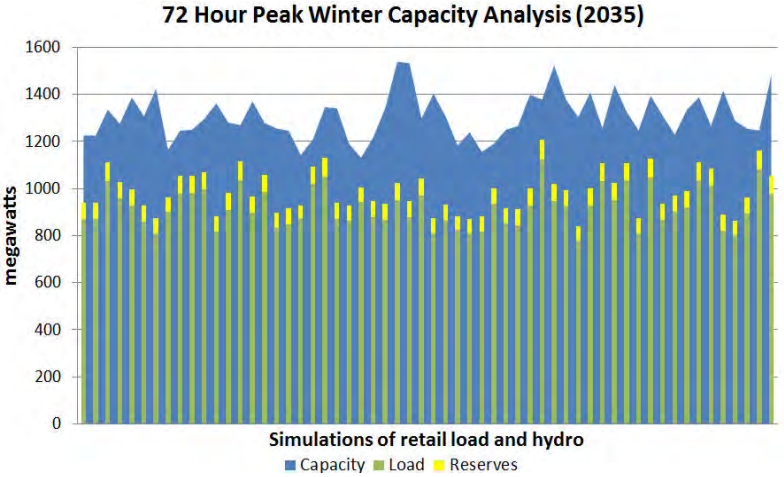


PEAK ADEQUACY

Does simulated energy supply exceed the highest 72-hour average peak ("highest"} customer load in 19 out of 20 years? This ensures we have the capacity to meet the most pressing peak demand.

This IRP ran 58 simulations of weather to estimate the highest 72 hours of retail load in the year 2035. In every simulation, Tacoma Power can reliably serve retail load over a simulated 72 hour peak retail demand. This resource adequacy metric indicates that Tacoma Power does not need additional capacity to meet peak load.

Simulated energy supply exceeds the highest 72 hour peak retail energy demand in 19 out 20 annual simulations



STEP 3
evaluate resource alternatives

Tacoma Power is in the enviable position of not needing new resources beyond cost-effective energy conservation, as indicated by the analysis described in the previous section. Nevertheless, it is important to evaluate potential resource alternatives for the following reasons:

- Future growth in electricity demand by Tacoma Power's retail customers is highly uncertain. The sudden addition of a new large retail load could trigger an immediate need for resources. If this were to happen, the 2015 IRP would be a useful launching point for assisting the utility to acquire new resources to meet the need.
- State law requires utilities to prepare a bi-annual Integrated Resource Plan that includes a comprehensive review of alternative resource technologies (RCW 19.285).
- As new technologies emerge and costs for resources change, it is important that Tacoma Power continue to update our understanding of them and evaluate their potential to improve the utility's optimal mix of resources.

Tacoma Power reviewed a broad range of resources that could be used to fill potential gaps between supply and demand. We performed an initial screening of new resource alternatives based on four criteria:

- Uses a proven technology and is commercially available right now
- Is available within the region
- Provides around 50 average megawatts at reasonable cost
- Uses an available and reliable fuel source

Resources that did not meet these criteria and were not considered viable for current consideration included biomass, coal-fired generation, fuel cells, geothermal, nuclear, off-shore wind, concentrated solar thermal, tidal and wave. Of these, biomass was closest but ultimately rejected because of size (2 megawatts), questions about availability of fuel (the organic materials that make up biomass) and uncertainty about costs and benefits. The development of biomass generation will be monitored as it continues to mature as a resource.

The list of promising resource types were discussed and reviewed extensively in the Public Advisory Committee meetings. Resources that met these criteria and were considered worthy of additional evaluation included the following:

HYDROPOWER POWER PURCHASE AGREEMENT (HPPA)

Tacoma Power could leverage our considerable experience in managing and operating hydropower generation with the acquisition of a contract for additional hydropower instead of siting, building and licensing a new hydroelectric facility. It is assumed that Tacoma Power could purchase a percentage of the generation from an existing plant located on the Columbia River or a tributary of it. In exchange, Tacoma Power would pay a fixed price based on wholesale traded power prices. A risk in pursuing a HPPA is that it would further increase Tacoma Power's reliance on regional hydropower generation, forgoing an opportunity to increase resource portfolio diversity. Also, since hydropower is the dominant generation technology across the Northwest, power production is often inversely related to power prices, a fact that can reduce the market value of the generation when there is abundance and increase market value when there is scarcity.

IRRIGATION PROJECT POWER PURCHASE AGREEMENT (IPPA)

When water travels through irrigation channels to agricultural crops, turbines can be installed to generate hydropower. This generation coincides with the growing season, beginning in early spring and gradually increasing until it reaches peak generation during warm and rainless summer months, then tapering off in autumn. During this time, the generation from an IPPA is steady and predictable. No generation is provided during the high retail demand months of November through February.

COMBUSTION TURBINES

A combustion turbine burns natural gas to turn a mechanical generator. Sometimes the waste heat is used to produce steam to turn a turbine and produce even more electricity. Gas turbines are one of the most common types of electrical generators in the US because they are efficient, flexible and have relatively low capital costs. Their costs are subject to the volatility of natural gas prices and the risk of future carbon emissions taxes.

RECIPROCATING ENGINES

A reciprocating engine generator is powered by an internal combustion engine fueled by diesel, natural gas, propane or gasoline. They are small in size and may provide peaking capability, but air quality regulations generally limit how much a reciprocating engine can operate. Reciprocating engines can provide a great deal of operational flexibility and quickly ramp up or ramp down power generation to create a broad range of output levels without sacrificing fuel efficiency.

RENEWABLE RESOURCES

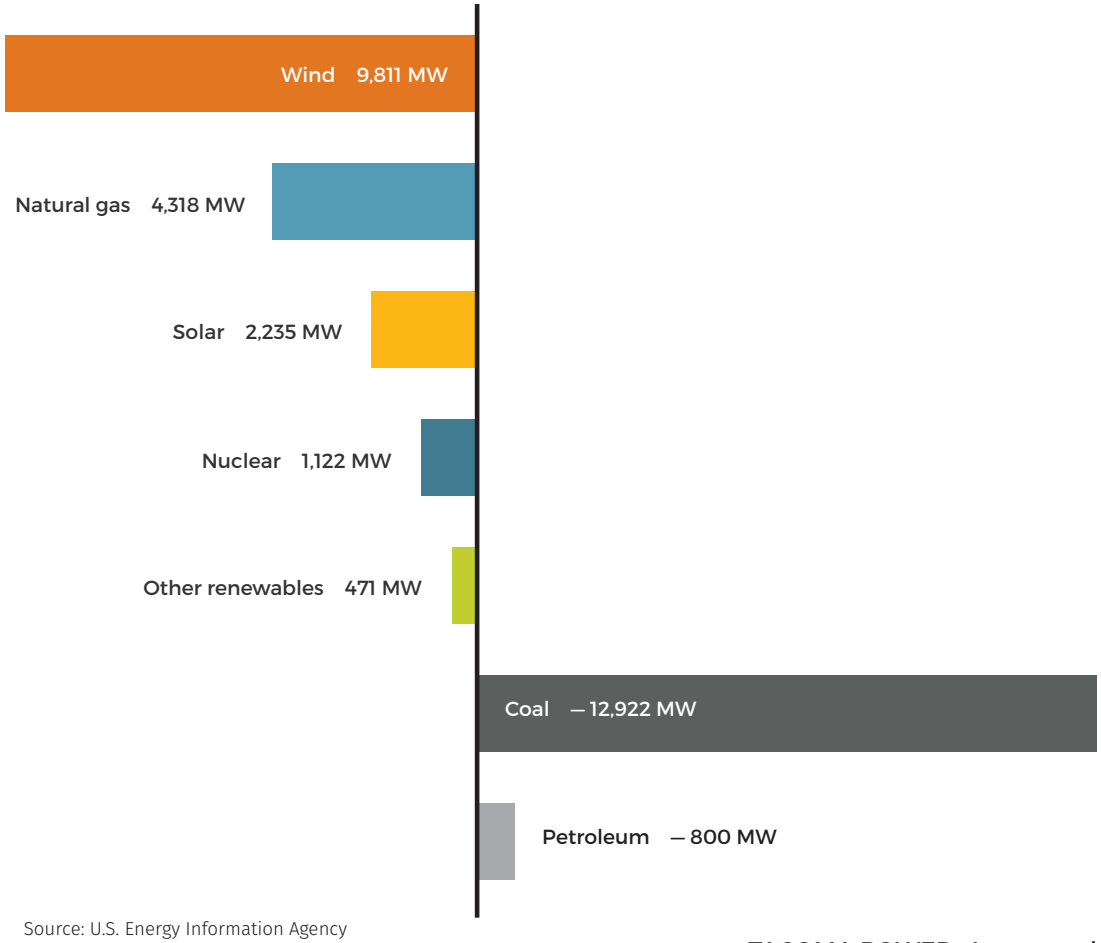
While there are many types of renewable resources, wind and photovoltaic solar are the dominant generation technologies at the utility scale. Public support, policy requirements and tax incentives have led to renewable energy becoming the fastest-growing source of new generation in the United States in 2015.

While growing across the country, renewable energy faces difficult challenges in the Pacific Northwest. Wind speeds in the Pacific Northwest are often highest during early morning and late evening periods and seasonally during the spring and fall, while solar provides power only during the day. These limitations pose a problem because they do not match up with Tacoma Power's retail demand profile.

Wind turbines are collectively grouped together in a farm. The Tacoma Power service area does not have a suitable site on which to build a wind facility, and so this generation would need to be located in an area with inexpensive land and good wind conditions. Generation would be dynamically scheduled into our service area, which would incur additional transmission and integration costs.

If Tacoma Power were to acquire wind or solar resources, valuable hydroelectric flexibility would be needed to integrate it. Another alternative would be to pay another party to integrate the generation for the utility.

Scheduled U.S. electricity generation capacity additions and retirements in 2015



Source: U.S. Energy Information Agency

INCREMENTAL HYDRO EFFICIENCY

In addition to efficiency improvements that have already been implemented at the Cowlitz, Nisqually, and Cushman Projects, Tacoma Power may have an opportunity to build small scale (2 average megawatts) run-of-the-river generation capacity at the Barrier Dam as part of a larger reconstruction project. This project would not impound any water or provide additional dispatch capability.

ENERGY CONSERVATION

Energy conservation has been the centerpiece of Tacoma Power's resource strategy as the first and best choice to meet future demand since we developed our first IRP in 1992. Since 2007, the utility has spent over $46 million on energy conservation programs and has reduced overall retail load growth by about 51 average megawatts – enough electricity to power approximately 36,000 homes for one year. Tacoma Power is required under statute to assess the ten-year potential for acquiring cost-effective energy conservation and set a specified two-year acquisition goal with a detailed supporting plan describing the measures that the utility will launch to achieve that goal. This year's energy conservation potential assessment determined a 10-year potential of 47 average megawatts and a 2-year target of 9.4 average megawatts. This IRP assessed whether a case could be made to acquire greater levels of energy conservation to reduce utility risk.

BPA PRODUCT SELECTION

As a publicly-owned utility in the Pacific Northwest, Tacoma Power has rights to power generated by the Bonneville Power Administration (BPA) through a 17-year contract that went into effect in October 2011. At that time, Tacoma Power had a choice of the product type that dictated how this energy would be provided to the utility. Tacoma Power specified that it wished to receive power in a slice/block product, where nearly half of Tacoma's right to power from BPA is provided in a fixed-quantity monthly "fixed block" and the remainder is provided as a percentage or "slice" of the Federal Columbia River Power System.

The contract also specified that an alternate product offering would be made available to public power customers, who have the option to select it before May 31, 2016. The new product offering has been called "shaped block" and incorporates many of the qualities of "fixed block" with some ability for the public power utility to specify the shape of it up to several days before delivery. Details about the product from BPA are still pending, so only rudimentary analysis has been possible. More information about that product and the preliminary analysis performed to date is provided in the appendix.

SMART GRID

Smart grid is a loose term that describes a distribution system that has the ability to send and receive information as well as energy. The value of smart grid systems is in programs that use real-time information to improve efficiency, responsiveness and improved security. In areas where the distribution system is near peak capacity, programs to reduce load, send pricing signals and alert utilities of service interruptions can be very important. Tacoma Power is currently assessing the value proposition offered by smart grid and the degree to which it might be able to complement the utility's energy conservation efforts.

DEMAND RESPONSE

Demand response is a strategic load-management tool used by some utilities to help manage peak-load capacity constraints through voluntary customer load reductions. Some programs are designed to enable customers to contribute to energy load reduction during times of peak demand. Depending on the program, the reduction in customer load can transfer energy usage from times of constraint to times of energy surplus. Smart grid can also provide the basic infrastructure through real-time price information to promote consumers to modify energy consumption.

Even though Tacoma Power is not capacity constrained, we are investigating demand response opportunities and potential benefits, including integrating variable energy resources, peak-load management and distribution system operations. Tacoma Power is currently producing a business case analysis to justify a pilot program that would begin in 2016.

The types of benefits that demand response programs can bring include:

- Avoided generation capacity costs
- Avoided transmission & distribution costs
- Electric reliability through improved outage management
- Environmental protection resulting from less water spills from our hydro dams
- Customer benefits in the form of lower costs, lower prices and technology upgrades like in home displays and programmable controlled thermostats

STEP 4
develop planning scenarios

Tacoma Power uses scenarios – stories about the future – to "test drive" how its resource portfolio will perform after new resource alternatives are added.

The scenarios represent possible – and intentionally divergent – futures that could unfold over the next 20 years. They describe credible assumptions, events and risks that may impact the supply and use of our resources. The promising resources are then fed into a computer modeling system to evaluate how they respond to the stresses and pressures identified in the scenarios.

As the great Yogi Berra once said, "It's tough to make predictions, especially about the future." The role of the scenario is not to predict the future, but to offer us the opportunity to use an imagined future as a dress rehearsal. A candidate resource that demonstrates versatility and cost-effectiveness across multiple futures is worthwhile of consideration.

The scenarios are examined in detail on the next two pages.

Smooth Sailing

This scenario envisions a future where today's existing conditions and trends continue onward with relatively minor changes.

Economy	Average economic recovery and growth.
Energy	Gradual growth in customer load due to new large industrial customers. Demand for natural gas slowly increases. Utilities continue with current level of energy conservation. California allows import of out-of-state renewable energy, California's investor-owned utilities develop 1,325 megawatts of energy storage by 2020, existing coal-fired power plants in the West are retired.
Political/legal	Federal law taxes carbon dioxide emissions, Washington's Renewable Portfolio Standard increases to 20% effective in 2025. Existing federal incentives for renewables expire.
Technology	Slow uptake of electric vehicles. Adoption of solar generation grows slowly.
Climate change	Climate continues to warm at recent rates of change, along with changes in precipitation patterns including more rain and less snowfall.

Green Acres

A more optimistic view of the future. In this scenario, the nation and the Pacific Northwest take concerted actions on multiple fronts to modernize the energy system and reduce greenhouse gas emissions. More aggressive renewable energy goals are adopted, carbon taxes are imposed and larger incentives are provided for rooftop solar generation, battery storage and electric vehicles. Funding is also provided to develop new clean energy technologies, leading to major breakthroughs. These efforts succeed in transforming the energy system and the overall economy.

Economy	Strong growth of the overall U.S. and local economies.
Energy	Strong sales of electricity, but effects are mitigated by growth in rooftop solar generation and energy conservation measures. Government restrictions significantly limit exploration and production of fossil fuels, increasing their scarcity and raising prices. Rapidly improving performance and declining costs, along with increased federal and state incentives, help make rooftop solar generation broadly affordable and even commonplace. Community solar, paired with shared energy storage and other advancing distributed energy technologies, fosters growth of local microgrids.
Political/legal	The Western states work in a coordinated manner to reduce carbon dioxide emissions to 50% of 1990 levels by 2035. The federal government, Washington and Oregon impose a carbon tax; Washington and Oregon adopt RPS requirements of 40% by 2030; California increases RPS to 60% by 2035. Government incentives for rooftop solar generation are extended, including the 30% federal tax credit. A 30% tax credit for utility-scale renewable generation is also enacted.
Technology	Technological breakthroughs and a rapidly maturing market for battery storage lead to wide scale adoption of batteries in vehicles, homes and neighborhoods. Costs and capabilities of utility-scale energy storage also improve significantly. Automakers commit to large-scale production of electric vehicles.
Climate change	The utility and transportation sectors both achieve major reductions in carbon dioxide emissions. However, global climate changes continue due to past emissions of greenhouse gases, keeping the pressure on to further decarbonize the energy system. Forecasts indicated continued success in stabilizing climate change in the next century.

Foot on the Gas

Abundant, low-cost supplies of natural gas foster low-cost power environment with robust economic growth and increasing consumption of electricity. Inexpensive natural gas and imposition of carbon taxes at the state level accelerate the shift away from coal generation. Overall emissions of carbon dioxide fall.

Economy	High rate of economic growth. Buoyant economy due to new large industrial customers. Deployment levels at JBLM remains strong.
Energy	Lower prices and relatively greater reliance on natural gas lead to somewhat slower investment and development of energy storage technologies. Coal-fired power plants are retired more quickly. Available supplies of natural gas exceed demand. Utilities in the West implement less energy conservation because their avoided costs of wholesale power are lower.
Political/legal	Consumer angst/guilt over increased fossil fuel consumption leads to carbon taxes are self-imposed at the state level. The public in Washington concludes that higher Renewable Portfolio Standards are not necessary. Existing federal incentives for renewables expire.
Technology	Slow uptake of electric vehicles. Adoption of solar generation grows slowly.
Climate change	Carbon emissions decrease slightly as coal generation is retired. The climate continues to warm at recent rates of change, along with changes in precipitation patterns including more rain and less snowfall.

Running on Empty

Characterized by a persistent scarcity of oil and natural gas, along with relatively little success in efforts to meet energy needs from other sources. Economic growth stagnates. This scenario creates multiple challenges for consumers, utilities and government.

Economy	Prolonged stagnation, Limited supplies of low-cost crude oil and natural gas drive their prices upward, causing lasting destructive effects on the world economy.
Energy	Retail electric sales rates in many areas that rely on natural gas generation increase. Electric sales decline as a result of the rising energy costs and do not recover. Growing adoption of rooftop solar photovoltaic generation and increased adoption of energy conservation reduce loads even further. Tacoma Power is relatively better off because costs are dependent on hydropower. Scarce fossil fuels create a future where demand exceeds supply.
Political/legal	While climate change from carbon emissions is an important problem, more and more people have trouble making it from paycheck to paycheck. As a result, there is little political support or economic capability to adopt carbon taxes. Instead of regulating carbon emissions to help transition toward new power supplies, federal and state governments establish more aggressive Renewable Portfolio Standards. With governments facing severe budget deficits, existing federal production tax credits and investment tax credits and state financial incentives for renewable resources expire and are not renewed.
Technology	With higher fossil fuel prices, adoption of electric vehicles increases sharply, particularly among higher-income consumers. Higher-income customers in sunnier parts of the West seek to avoid paying increased utility rates by installing rooftop solar. If possible, customers will add energy storage and form microgrids to escape from utilities altogether.
Climate change	Climate continues to warm at recent rates of change, along with changes in precipitation patterns including more rain and less snowfall.

STEP 5
analyze resource performance

Having developed a list of promising resources, the next step is to assess their performance based on our key criteria of fit, flexibility, cost, benefits, risk, environmental impact and customer equity. Performance is determined using a computer simulation model called PLEXOS. The PLEXOS model was configured to represent Tacoma Power's hydropower projects, retail load profile, regional weather conditions and the regional energy market. Each resource was "test driven" under the economic, energy, political/legal, technology and climate conditions represented in each of the four scenarios.

To make the comparison easier, each resource was sized to provide approximately 50 average megawatts of energy annually. All resource strategies were implemented beginning January 1, 2025 and evaluated over a ten year period. The quantitative analysis performed is summarized in the descriptions as a rating of 1 to 4 for each of the criteria, with a rating of 4 being the best.

CRITERIA DEFINED

FIT

Does the resource provide the right amount of energy at the right time, both seasonally and at the right hour of the day? Not having power when you need it or having too much power when you don't are equal problems because it exposes Tacoma Power to the volatility of the wholesale energy market.

FLEXIBILITY

Customer loads continually move up and down within the hour and over the day with changes in customer behavior and in temperature. Can the resource be dispatched quickly to provide electricity to meet these changing conditions?

Some resources, such as contracts that provide a fixed amount of energy, are not dispatchable. Intermittent resources such as wind must be partnered with dispatchable resources to ensure energy is available when needed.

COST

Does the resource provide reliable energy at a minimum cost? Tacoma Power's goal is to maintain the low retail rates we currently offer our customers. To do this, we must make smart resource acquisition choices, evaluating all resource expenses including start-up, operation and maintenance, transmission and fuel costs.

BENEFITS

Does the resource provide Renewable Energy Credits, transmission and distribution gains, or other benefits?

RISK

How well does the resource respond to a variety of potential risks? The future holds significant uncertainties, including customer need, water conditions, the availability of fuel to power supply resources, operational reliability, conditions in the wholesale energy market and changes in legislation that impact energy utilities.

ENVIRONMENTAL IMPACT

What is the cost of the resource to the environment? Tacoma Power seeks to preserve and enhance our environment for current and future generations. Our preference is for resources with no/low greenhouse gas emissions and low water and waste impacts.

CUSTOMER EQUITY

Is the resource fair and equitable to all customers? Tacoma Power values resources that neither benefit nor disadvantage any political, economic, social or cultural category of customers.

PORTFOLIO ANALYSIS:
energy conservation

Tacoma Power is required by Washington State law to acquire in a two-year period, a pro-rata share of the 10-year economically achievable energy conservation potential. Tacoma Power prepared a Conservation Potential Assessment for the utility's service territory. Based on that assessment, the Tacoma Public Utilities Board adopted a ten-year potential beginning in 2016 of 46.8 average megawatts and a two-year target for 2016-2017 of 9.4 average megawatts. All of the following resource strategies include these amounts of energy conservation.

The numbers show the score this resource received out of a total of 28 points.

score 1 2 3 4

FIT

Energy conservation measures are deemed to be cost-effective based on a calculation of avoided cost. Measures that reduce load during hours that have higher prices are more cost-effective.

FLEXIBILITY

Energy conservation measures are neutral on resource flexibility. While they are not dispatchable, they are somewhat predictable and, depending on the measure selection, can dampen peak load events. Energy conservation measures also provide resource diversity because they are not correlated to the generation of hydropower that dominates Tacoma Power's portfolio.

COST

At a levelized cost to the utility of $31/MWh, energy conservation programs are less expensive than all other resources.

BENEFITS

Energy conservation reduces retail load, making more hydropower available to sell into the wholesale market, which can indirectly reduce the need for carbon emitting generation elsewhere. Conservation also reduces Renewable Energy Credits needed for compliance with the Energy Independence Act. Because energy conservation programs reduce retail load they also provide transmission and distribution benefits.

RISK

Energy conservation programs are not subject to significant cost changes depending on which scenario of the future we experience. In all cases, the cost of the resource is stable. It is possible the benefits of energy conservation may improve in certain scenarios, but that would be considered a happy accident.

ENVIRONMENT

Energy conservation is positive for the environment because it can be used to indirectly reduce carbon-emitting generation through wholesale market sales.

CUSTOMER EQUITY

Energy conservation measures are selected for cost-effectiveness. In many cases, utility subsidization of energy conservation measures provides benefit to the customers participating in programs. A significant number of the most cost-effective programs are for multifamily rentals buildings, which are disproportionately the homes of the less-affluent in our community.

PORTFOLIO ANALYSIS: wind

- Eastern Washington location
- Integration: BPA shaping services to provide up-to-the-hour shaping for $1.20/kw/month in 2016 and escalating with forecast power prices **OR** Tacoma Power to set up the systems to allow for dynamic scheduling so that Tacoma Power could instantly adjust generation to compensate for ebbs and flows in wind energy production
- Transmission to Tacoma's system or the Mid-Columbia trading hub using BPA PTP transmission
- Tacoma Power owns the renewable energy credits
- Capacity factor at 32%

points 1 2 3 4

FIT

Wind generation is essentially random. While seasonally, wind production is highest in the winter, its availability at any given time during the day is highly uncertain. On a diurnal basis, there is only slightly more generation on average during dawn and dusk hours than in the middle of the day. Since there is no discernible correlation between wind generation and retail load, wind generation is not a great fit for the portfolio.

FLEXIBILITY

Wind generation is mostly random. Generation at any given time can range from zero to full capacity of the turbines and is more variable than all other resources –a difficult situation for operations staff. Wind dispatchability is limited to turning it down or off. Wind generation may provide some resource diversity because Tacoma Power does not currently have any direct wind farm generation.

COST

Wind generation requires the use of integration services to increase the reliability of generation before loading transmission lines to reach our service territory. It has significant capital cost. There are no fuel costs or CO2 emission costs but there is some variable and fixed O&M. All together the levelized cost of installed wind generation is $66.00/MWh which puts this resource toward the higher end of resource costs.

BENEFITS

Wind generation provides Renewable Energy Credits and would help Tacoma Power comply with I-937. Wind generation is not useful to dispatch to load, but instead allows the utility to reduce hydro generation and save fuel at certain times. This fuel then can be used at more valuable times to sell into the market or avoid market purchases.

RISK

Under certain futures, the beneficial value of Renewable Energy Credits was higher or lower but not a significant difference in the overall cost of the resource. Wind generation would provide some protection should the state choose to increase the current renewable performance standard.

ENVIRONMENT

Generating power with wind produces no carbon emissions, does not significantly affect wildlife populations and reduces hydropower dispatch at certain times which can indirectly substitute for fossil fuel generation if sold through the wholesale energy market.

CUSTOMER EQUITY

Wind generation does not disadvantage any population groups in any known ways, except that some people feel strongly that wind farms present an eyesore to nearby residents.

PORTFOLIO ANALYSIS:
solar

- Eastern Washington location
- Integration: BPA shaping services to provide up to the hour shaping for $0.21/kw/month in 2016 and escalating with forecast power prices **OR** Tacoma Power to set up the systems to allow for dynamic scheduling so that Tacoma Power could instantly adjust generation to compensate for ebbs and flows in solar energy production
- Transmission to Tacoma's system or the Mid-Columbia trading hub using BPA PTP transmission
- Tacoma Power owns the renewable energy credits
- Capacity factor at 15%

points 1 2 3 4

FIT

On a seasonal basis, provides the most energy between April and September. This is not well suited to Tacoma Power's load requirements. April-June are generally when Tacoma Power and the region have the greatest quantity of surplus energy. Additional energy during this time would exacerbate an already difficult situation where hydropower owners try to off-load power to a very weak wholesale power market.

FLEXIBILITY

Solar energy almost matches how poorly wind generation performs when considering randomness, persistence and predictability – especially during cloudy winter months. Between the two resources, it is slightly preferable but still a significant drain on flexibility when added to the portfolio. Solar power does also provide some resource diversity benefits.

COST

Requires the use of integration services to provide reliable hourly service. However, solar integration services are less costly than those for wind resources. Solar generation has significant capital cost, but this has been declining over the last few years. There are no fuel costs, variable O&M, fixed O&M or CO2 emission costs for solar generation. The levelized cost is $95.00/MWh which puts this as the highest of all resource costs.

BENEFITS

Solar generation provides Renewable Energy Credits and would help Tacoma Power comply with I-937. Solar generation is not useful to dispatch to load, but instead allows the utility to reduce hydro generation and save fuel at certain times. This fuel then can be used at more valuable times to sell into the market or avoid market purchases.

RISK

Under certain futures, the beneficial value of Renewable Energy Credits was higher or lower but not a significant difference in the overall cost of the resource. Solar generation would provide some protection should the state choose to increase the current renewable performance standard.

ENVIRONMENT

Generating power with wind produces no carbon emissions, does not significantly affect wildlife populations and reduces hydropower dispatch at certain times that can indirectly substitute for fossil fuel generation if sold through the wholesale energy market.

CUSTOMER EQUITY

Solar generation on a utility scale does not disadvantage any population groups in any known ways.

PORTFOLIO ANALYSIS:
tolling agreement for combustion turbine

Given the size of resource being assessed, acquisition of a Combined Cycle Combustion Turbine is technologically unrealistic. Instead, this assessment assumes that Tacoma Power contracts for a portion of an existing CCCT's capacity. Attributes:

- Assumed heat rate of 6,700 Btu/KWh
- Integration - This resource is completely dispatchable and can be used for purposes of providing spinning or non-spinning reserves
- Costs would include fuel (at the Sumas Natural Gas trading hub) and fuel storage costs and may include abatement for carbon emissions or other environmental effects. Other costs include a reservation fee for the owner of the CCCT generator of 15% of the annual levelized capital cost. This is an estimate that covers the cost of capital, the cost of natural gas scheduling, transport, delivery, and storage.
- BPA balancing area location
- Transmission to Tacoma's system or the Mid-Columbia trading hub using BPA PTP transmission
- Uses BPA PTP transmission to bring to Tacoma Power's load or wholesale market.

points 1 2 3 4

FIT
Tolling agreement provides power when it is economical. It is a dispatchable resource so therefore, a perfect fit for Tacoma Power's retail load requirements.

FLEXIBILITY
The tolling agreement is dispatchable and therefore adds 100% flexible capacity to the portfolio. The use of this flexibility can provide additional options to resource operations staff who can then find ways to get more efficiency out of other Tacoma Power assets.

COST
Cost would be equal to the annualized fixed cost plus 15% margin as a reservation fee to pay the owner a cost of capital plus for services related to the storage, transport, and nomination services for providing the natural gas. Combustion turbines are dispatched only when economically advantageous and never provide unwanted energy. Fuel costs, reservation fees, CO2 emission taxes, variable and fixed O&M charges are also included.

BENEFITS
A combustion turbine would provide the utility with additional flexibility which could result in greater portfolio output and additional wholesale power sales.

RISK
Considering multiple futures where natural gas prices are significantly higher and lower, and CO2 taxes are higher and lower, significant change in the western U.S. generation fleet and power price volatility, there is considerable risk associated with this resource.

ENVIRONMENT
This resource would emit carbon dioxide and other pollutants.

CUSTOMER EQUITY
Depends on location of the CCCT. Assuming it is located in an industrial area away from residential areas, a tolling agreement would not disadvantage any population groups in any known ways.

PORTFOLIO ANALYSIS:
Columbia River hydropower power purchase agreement

Run-of-the-river project located on the Columbia River or one of its tributaries. A non-dispatchable project that has no pondage or ramping capabilities. Streamflows for the project are based on flows at the Mid-Columbia projects and correlated to the 58 historical water simulations. Attributes:

- Eastern Washington location
- No Renewable Energy Credits are assumed to be included in the purchase
- Transmission to Tacoma's system or the Mid-Columbia trading hub using BPA PTP transmission
- Does not contribute to calculations of available reserves
- The long term price of this contract reflects a variable, non-dispatchable generation similar to a floating-for-fixed contract. It is therefore valued at 95% of the forecasted long-term price of power.

points 1 2 3 4

FIT

Generation from a Columbia River hydropower plant is fairly consistent across the year, roughly approximating our retail load. The range of hourly generation is much tighter around expected load than with wind or solar. One benefit is that in situations where peak load is occurring, dispatchable hydro operations will automatically increase generation, helping to provide additional energy when needed.

FLEXIBILITY

The definition of a Columbia Hydropower PPA describes the resource as a run-of-river and non-dispatchable. This contract would not add flexibility to the portfolio. The generation schedule from the project is likely to be highly predictable because Columbia River operations are well forecasted and understood. One issue with acquiring even more hydro generation is that it does not improve resource diversity.

COST

The cost was calculated based on current power prices and expected delivered energy. Because the quantity of energy delivered is uncertain, the purchaser pays a 'fixed' amount negotiated before contract execution and the seller provides a 'floating' amount of energy. Tacoma Power in this instance pays only 95% of the wholesale market value of the contract. There is no fixed or variable O&M, no fuel costs, no CO2 emissions taxes.

BENEFITS

It is assumed that this contract contains no Renewable Energy Credits. There is also no shaping capability, and therefore additional optimization of the supply portfolio for increased financial performance is not possible.

RISK

The value of the energy would fluctuate with the value of the wholesale power market. There are no CO2 taxes for a carbon-free resource, no Renewable Energy Credit variability from political change, no changes to fuel prices.

ENVIRONMENT

Since the project already exists and new water is being impounded, there are no new impacts to fish habitat. There are no greenhouse gas emissions. No environmental impact.

CUSTOMER EQUITY

A Columbia River hydropower PPA would be associated with an existing hydroelectric project. As such, the PPA would not create any additional disadvantages for any population groups.

PORTFOLIO ANALYSIS: irrigation power purchase agreement

Run-of-the-river projects on irrigation canals follow a profile shape that extends from March to October, with the bulk of the generation occurring during the runoff and agricultural seasons of May through August. Attributes:

- Eastern Washington location
- Non-dispatchable resource
- No renewable energy credits are expected to be included in the purchase
- Transmission to Tacoma's system or the Mid-Columbia trading hub using BPA PTP transmission
- Does not contribute to calculations of available reserves
- The long term price of this contract reflects a variable, non-dispatchable generation similar to a floating-for-fixed contract. It is therefore valued at 95% of the forecasted long-term price of power.

points 1 2 3 4

FIT

Irrigation generation occurs between March and October, which is not well correlated to Tacoma Power's retail load requirements. With a significant amount of the generation occurring during the runoff period, Tacoma Power could have additional energy when it is not needed and be exposed to wholesale market sales. Output for November to February is zero and cannot contribute to satisfying Tacoma Power peak retail loads.

FLEXIBILITY

Generation is steady and dependable because the pumping of water in irrigation channels is not related to river flows or retail load schedules. This is an advantage for integration into portfolio operations. While the water for the generating units may originate in the Columbia River, they are unrelated to flows on the Columbia River and therefore provides resource diversity.

COST

The cost was calculated based on current power prices and expected delivered energy. Because the quantity of energy delivered is uncertain, the purchaser pays a 'fixed' amount negotiated before contract execution and the seller provides a 'floating' amount of energy. Tacoma Power in this instance pays only 95% of the wholesale market value of the contract. There is no fixed or variable O&M, no fuel costs, no CO2 emissions taxes.

BENEFITS

It is assumed that this contract contains no Renewable Energy Credits. There is also no shaping capability and therefore additional optimization of the supply portfolio for increased financial performance is not possible.

RISK

The value of the energy would fluctuate with the value of the wholesale power market. There are no CO2 taxes for a carbon free resource, no Renewable Energy Credit value variability from political change, no changes to fuel prices.

ENVIRONMENT

Since the project already exists and new water is being impounded, there are no new impacts to fish habitat. There are no greenhouse gas emissions. No environmental impact.

CUSTOMER EQUITY

An irrigation hydropower PPA does not disadvantage any population groups in any known ways.

Ranking the portfolios

Under current conditions, there is no immediate need for Tacoma Power to invest in a new resource to meet expected retail loads or provide additional capacity.

In the event that a new, large commercial or industrial customer located to Tacoma Power's service territory, an estimate of retail load would be acquired and new analysis would be performed to evaluate the need for a resource. If sufficient need for a new resource was identified, an evaluation of new resource alternatives would also be conducted.

Based on the current evaluation, the candidate resource strategies are ranked in order as:

1. **Energy Conservation** – This strategy is low cost, low risk and fits retail demand well. It does not reduce the flexibility of the portfolio. Our goal to acquire 9.4 average megawatts of energy conservation provides many indirect benefits by reducing retail load. Energy conservation programs benefit our customers directly. Tacoma Power has a team of experienced professionals who are proficient at acquiring energy conservation savings efficiently.

   Given the selection of energy conservation as the preferred and only resource to acquire, the IRP assessed whether the utility could justify a higher target. The results indicate that the next available energy conservation measures were significantly more expensive and provided minor additional energy savings. Therefore, the IRP retained the 9.4 average megawatts energy conservation acquisition target.
2. **Columbia River Hydropower PPA** – Adding low-cost, carbon-free hydropower to our portfolio leverages the expertise of our operations and trading staff. A power purchase agreement for Columbia River hydropower may not be the most effective form of adding resource diversity but under nearly all water conditions it will provide energy useful for meeting retail load obligations throughout the year. Hydropower sourced generation is a low-risk alternative form of generation that does not expose the utility to fuel price volatility, carbon emissions costs, or any costs or risks that would come with siting and permitting a new resource.
3. **Irrigation Hydropower PPA** – While the profile of irrigation hydropower does not match Tacoma Power's retail demand forecasts, it can be helpful as an addition to the portfolio. In the long-term future when summer cooling load increases and climate change is affecting the availability of hydro flows in spring and summer, a resource with this seasonal profile may be worth much more than it does currently. Low cost, low-risk hydropower from irrigation projects does provide resource diversity for the portfolio without adding exposure to fuel price volatility, carbon emissions costs, or any costs or risks that would come with siting and permitting a new resource.
4. **Tolling Agreement for Combustion Turbine** – The future is very uncertain. The structure of retail demand, resource supply, government action, energy markets and the industry itself is difficult to forecast at this point. There is significant risk and great possible benefit to having the flexibility of a dispatchable supply resource in the portfolio. With a contract for a small portion of a combustion turbine, the utility could hedge our exposure by holding a versatile option that would add confidence to resource operations. There is considerable risk that fuel prices, emission regulations and energy markets may not favor a choice to add fossil fuel generation – but contracting for a small piece of one is a way to get much of the benefit for very little cost.
5. **Wind** – Engineering and design continue to improve the efficiency of wind generation, but currently compared to other alternatives, wind generation is too costly. The usefulness of wind is that it saves hydropower "fuel." It requires the use of a great deal of portfolio flexibility which can translate into suboptimal hydropower operations and reduced wholesale revenues. The benefits provided by wind generation include Renewable Energy Credits. By being carbon free, it avoids future risks of CO2 emission taxes.
6. **Solar** – Although panel manufacturing costs have declined steadily over the past decade, utility-scale solar generation in Washington State is still too costly compared to other alternatives. While solar generation appears to be well suited to parts of the country, it is not particularly efficient or a good fit for Tacoma Power's retail load. Depending on the rate of deployment of utility and rooftop solar in California and the desert southwest, markets across the western U.S. may experience significant reductions in wholesale power prices when solar generation is greatest, making investments in solar generation a poor value. Solar generation does provide beneficial Renewable Energy Credits and is carbon free. The deployment of solar generation could be made more effective with improvements in utility scale energy storage.

STEP 6
long-term resource strategy & action plan

The future of the energy industry is uncertain. The next 20 years will be shaped by trends and events that are still being formed.

Economic conditions, changing technologies, energy policy, evolving energy markets, transitioning customer demands are all in a state of flux. No one can predict what technology, government policy or market conditions will prevail.

Tacoma Power is in an enviable position, confident that its current resource portfolio of low-cost, low-risk, carbon-free resources are sufficient to meet forecasted loads. This allows the utility the luxury of holding firm and being able to monitor how the future will unfold before making any decisions to commit to the significant capital expense of a new, and possibly unneeded generating resource.

Continuing to acquire energy conservation is the lone, prudent exception to this approach. Energy conservation remains Tacoma Power's best resource strategy – it is the least-cost, least-risk path forward. It minimizes the risk of needing to purchase or build new resources. We have a long and successful history of using energy conservation to help customers use energy more wisely and meet their electricity needs. Additional benefits include:

- Incentives are provided to customers, who use energy conservation programs to reduce their electricity bills, saving them money
- Energy efficiency helps limit greenhouse gas emissions
- Reduces the cost of acquiring Renewable Energy Credits used to comply with state law
- Provides maximum savings during Tacoma Power's expected peak load periods
- Money invested into energy conservation programs are spent through local businesses, which help supports the local economy

With energy conservation, Tacoma Power will maintain a position of having energy supply resources in excess of retail demand and will be in the advantageous position of being able to sell this carbon-free hydropower into the wholesale market. The revenue from these sales reduces the amount of money the utility must recover from retail customers and helps to keep rates low.

ACTION PLAN

Tacoma Power's IRP reviewed our current mix of supply resources, forecast the future electricity needs of our customers and identified a strategy – energy conservation – for meeting the gap between supply and demand. The next step is developing an action plan that identifies the key steps and activities we should take in the next few years to begin implementing the resource strategy.

1. **Acquire 9.4 average megawatts of energy conservation in 2016-2017 to reduce retail load growth.**

   Energy conservation is Tacoma Power's best resource and we are obligated by the Energy Independence Act to implement all cost-effective energy conservation. The 2016 Conservation Potential Assessment identified our ten-year cost effective achievable energy conservation potential as 46.5 average megawatts. A pro-rata share sets Tacoma Power's target for the 2016-2017 biennium at 9.4 average megawatts.

2. **Continue evaluation of BPA Products as more information becomes available.**

   By May 2016, Tacoma Power must decide whether to remain with the current Slice/Block product from BPA or switch to a proposed Shaped Block project. The current analysis suggests remaining a Slice/Block customer, but additional evaluation should be conducted using a new approach and incorporating additional information from BPA.

3. **Learn from small scale resource pilot programs performed by Tacoma Power and elsewhere to inform future IRPs.**

   New applications of emerging and existing technology are providing new alternatives for power generation. As new generator types are tested in prototype projects, new information can be collected and understood that will help us grasp a glimpse at the future. Tacoma Power is well positioned to meet its retail demand obligations with existing resources. By observing other possible alternatives, resource planners will be well prepared to consider alternate arrangements to continue to serve our customers in the best way possible.

4. **Monitor and report on emerging technologies that may significantly impact retail energy demand**

   Several emerging technologies are gathering significant interest from policy makers, customers, and utilities for their potential impact on future retail load growth. Electric vehicles, home energy storage, energy management systems and distributed generation (rooftop solar) are all examples of recent technological applications that could eventually influence Tacoma Power resource decisions. Due to Tacoma Power's low rates and abundant energy supply, it is unlikely that Tacoma Power's service territory will be a primary landing point of significant technological change over the next two years. However, there may be opportunities for resource planners to follow events happening in areas such as California where technological change and innovation may bring significant change. Understanding the emerging application of new technology in other sections of the country will help Tacoma Power prepare for and adapt to change that could eventually arrive here.

5. **Explore methodologies to incorporate estimated climate change impacts into the official long-term load forecast.**

   Results of the study provided by the University of Washington Climate Impacts Group (appendix) have indicated that Tacoma Power can expect to see a change in average annual temperature in the future of approximately 2.7 to 3.3 degrees F between 1990 and 2035. Current 20-year retail load forecasting methodologies utilize a constant temperature based off a 30-year normal. This process will overestimate winter peak and average retail loads. Many processes and decisions utilize the 20-year retail load forecasts, and a systemic error in the approach could affect many decisions in a significant way. Resource planners will assist retail load forecasters with an approach to use projected temperature change into retail load forecasting.

RENEWABLE ENERGY COMPLIANCE

Current renewable energy position

To comply with State Law (19.285.030 RCW) established by the Washington State Energy Independence Act (I-937), Tacoma Power must be prepared to acquire a number of Renewable Energy Credits equal to 9% of annual retail load between now and 2019, and then 15% of retail load in 2020 and thereafter.

Renewable Energy Credits (RECs) are the environmental attributes of electricity generated by eligible renewable resource as defined in the law. Examples of eligible renewable resources include wind, biomass, biodiesel, geothermal, solar, tidal, wave and efficiency improvements to hydropower projects. Traditional hydro generation, like the resources Tacoma Power has in abundance, is considered a renewable resource in state law (19.29A.010 and 19.285.030 RCW) but is not part of the list of eligible resources that utilities can use to comply with the Energy Independence Act's mandates.

In 2016, retail load is projected to be 556 average megawatts and the projected RECs to be acquired are approximately 50 average megawatts. In 2020, estimated retail load is 585 average megawatts, and Tacoma Power will need nearly 88 average megawatts of RECs to be in compliance.

Tacoma Power plans to meet renewable mandates with a combination of RECs generated from hydropower efficiency improvements and RECs purchased from third party contracts in Washington, Oregon, and Idaho.

Tacoma Power generates RECs from five separate sources of "incremental hydro", power generation that comes from improvements that increase the power generated using the same amount of water. Most of Tacoma Power's RECs from incremental hydro are sourced from the rebuild of turbines at Mossyrock Dam completed in 2010, which provides 41,041 MWh of additional energy without impounding more water. Tacoma Power receives bonus RECs provided for using apprenticeship labor, increasing the RECs generated to 49,249 MWh. Other small hydro efficiency improvements provide approximately 32,000 MWh per year.

Change in requirement since the 2013 IRP

Since the 2013 IRP, reduced growth in the retail load forecast also decreases the amount of renewable energy credit requirements we must acquire under state law by 2.1 million RECs between 2016 and 2035.

Market for RECs 2020-2030

Through legislative action, Renewable Energy Credits were created as a tradable paper commodity. As with all other commodities, they are subject to the market forces of supply and demand. Tacoma Power must manage our regulatory exposure by either generating or purchasing RECs to comply with the law while maintaining low rates for customers. The future price of RECs is presently unknown and will depend on the supply of deployed renewable generation and the demand for RECs from utilities, which is in turn based on retail load growth, or lack thereof.

In the 2008-2012 period, soon after I-937 was enacted, prices for RECs sharply declined, caused by overdeployment of renewable energy generation in the Pacific Northwest by regional companies and California-based investors who sought to import renewable energy into California. With California Public Utility Commission changing the rules to limit the applicability of out-of-state imports in compliance with California's Renewable Portfolio Standard, the price of regional RECs declined even further into single-digit territory. Without government action to raise state Renewable Portfolio Standard requirements, it is difficult to

see RECs rising in price significantly without sudden retail load growth. As discussed in previous sections, while Tacoma Power's service territory could see sudden retail load increases due to the arrival of a new large industrial or commercial customer, load growth in the region is expected to decline overall.

The overall market for RECs may shift over the next 20 years if the trend toward rooftop solar generation continues in California and the desert southwest. As more solar generation is added by customers behind the meter, utilities will have less retail load and will need less RECs to comply with state law. Many expect that state governments, particularly California will likely adjust state renewable energy requirements to maintain REC value and continue support for renewable energy. But if state governments fail to adjust state renewable energy requirements, REC prices are likely to fall.

Based on the likelihood of REC prices staying steady or possibly declining further, there is no reason that Tacoma Power should pursue the acquisition of addition of renewable generation for purposes of compliance with I-937.

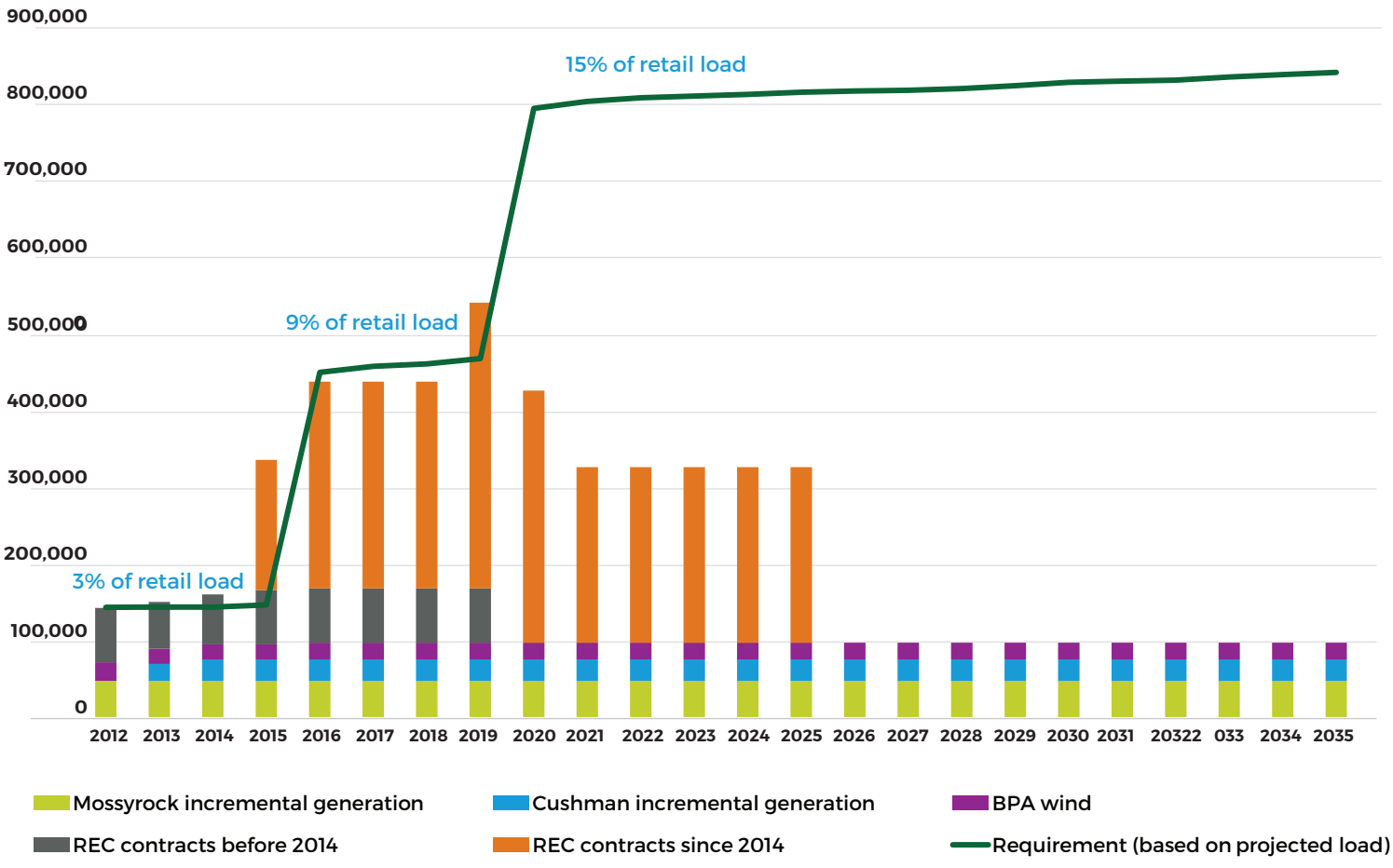
Recommendation for the future

The recommendation for compliance with I-937 is to continue to acquire all cost-effective energy conservation, as this has the benefit of reducing exposure to REC prices, and to remain vigilant for:

1. Changes to Renewable Portfolio Standards in the western United States.
2. Sudden increases in retail load due to new large commercial or industrial customers.
3. The penetration of solar generation in California and the desert southwest.

I-937 renewable requirement and compliance strategy

Megawatt-hours



Technical Appendix

The Technical Appendix contains additional information about specific sections of Tacoma Power's 2015 Integrated Resource Plan, including an assessment of resource adequacy and the utility's climate change study.

The appendix is available online at mytpu.org/IRP.

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Questions & Comments

Thank you for reviewing Tacoma Power's 2015 Integrated Resource Plan. If you have questions or comments, please contact Cam LeHouillier at clehouillier@ci.tacoma.wa.us or 253-502-8482.