DEVELOPMENT OF SCENARIOS FOR THE 2015 INTEGRATED RESOURCE PLAN

1 PLANNING FOR AN UNCERTAIN FUTURE

Perhaps the most definitive statement that can be made about the future is that it is simply not possible to make accurate forecasts about it. Past experience has repeatedly shown that predictions frequently turn out to be off the mark. Thus, Tacoma Power's portfolio of electric resources must be resilient enough to provide reliable, cost-effective, and environmentally responsible service across a broad range of potential future conditions and circumstances.

Fortunately, modern integrated resource planning methods are able to recognize various forms of uncertainty and can effectively address the risks they present to the utility and its retail customers. There are two categories of uncertainty in resource planning, with two primary methods that can be used to analyze them.

The first category of uncertainty factors can be thought of as "operational factors". These uncertainty factors vary randomly and can even be extreme events, but they relate to conditions that one would commonly expect in the day-to-day operations of the utility. Examples of operational factors include year-to-year variations in river flows or short-term fluctuations in temperature-sensitive retail electric loads. These kinds of variables are typically modeled using either simulations or statistically estimated probability distributions.

The second category of uncertainty factors do not fluctuate randomly like operational factors, but instead are "state-changes" that represent a shift in conditions. Sometimes shifts in conditions are hard to predict but can have more lasting effects. Examples of this second type of uncertainty include:

- the sudden drop in natural gas prices that began in 2008 due to the increased application of hydraulic fracturing
- the recent decline in the cost of solar voltaic generation driven by technological advances
- legislative and regulatory policy changes such as passage of renewable portfolio standards also falls within this category of uncertainty factors

Scenario planning methods provide an effective means for addressing the second category of uncertainty factors. For an integrated resource plan, the process begins by creating several scenarios, or "stories about the future". Each scenario describes a distinct, reasonably plausible set of assumptions and outcomes for multiple factors that can significantly affect the future

composition and performance of the utility's portfolio of electric resources. Then, various candidate resource strategies are modeled or "test driven" in each of the futures defined by the scenarios.

It is best to create a handful of scenarios that encompass a fairly broad range of potential futures. Four scenarios is a good number, both to keep the process manageable and to avoid having a middle scenario become viewed as a "base case" or "most likely" scenario. The scenarios should also cover a fairly broad range of potential futures, as this helps identify candidate resource strategies that are relatively more flexible and robust.

When constructing scenarios, it is also important to use logically consistent assumptions for various factors. For example, in a scenario that envisions declining population, it would not be reasonable to also include an assumption of relatively faster growth in electricity sales.

2 SCENARIO DEVELOPMENT FOR 2015 IRP

The following approach is being used to develop scenarios for Tacoma Power's 2015 Integrated Resource Plan:

1. Begin by preparing an influence diagram identifying key factors that influence the performance (e.g., reliability, cost and environmental impacts) of Tacoma Power's resource portfolio
2. Trace backward in the diagram to identify uncertainty factors that directly or indirectly affect resource portfolio performance
3. Separate the uncertainty factors into the two types –random variables and scenario variables – described above. The former are then modeled probabilistically, and the latter are modeled using scenarios.
4. For the scenario variables, review and use various information sources to identify ranges of plausible assumptions
5. Create scenarios qualitatively and prepare written narratives that tell a logically coherent "story" for each of the four scenarios
6. Select and quantify four distinct sets of assumptions and forecasts for the scenarios; within each scenario, ensure that the values for the scenario variables are logically consistent with each other, and that the scenarios encompass a broad range of potential futures

3 SCENARIO VARIABLES

The following variables are being used to construct scenarios for Tacoma Power's 2015 IRP:

Economic Growth: Tacoma Power's service territory has lagged other parts of the country in recovering from the 2008 financial crisis. The hot economy in Seattle finally appears ready to boil over into Pierce County, sparking new interest from commercial and residential developers.

Energy Demand: Energy demand forecasts across the eleven western states for all four scenarios have been based on a combination of factors including: economic growth, green building and supply chain movements, carbon mitigation, policies and legislation dealing with codes and standards, research and development in energy efficiency, and foreign competition for manufacturing, and the adoption of electric vehicles. Population growth across the Western US is assumed to be constant across all scenarios at 0.9% per year and assumptions for migration between states/nodes does not vary by scenario.

Retail Load in Tacoma: It is assumed that there is a strong link between inexpensive fossil fuels and economic growth. As economic activity increases across the western United States and in the Puget Sound region, new industrial and commercial customers are expected to investigate the possibility of locating within Tacoma Power's service territory. The uncertainty of load growth is important to consider for the evaluation of new resources.

Fossil Fuel Fundamentals: Natural Gas, oil, and coal fundamentals are difficult to forecast, are highly volatile, and have a profound impact on wholesale power prices and economic growth. Commodity prices for fossil fuels can exhibit day to day price volatility, but the focus of the scenarios will be on large-scale changes in the exploration and production of fuels. There may be no larger determinant in the outcome of our analysis and for this reason fossil fuel scenarios serve an important role in the descriptions of the narratives.

Emission Regulation: Citizens and governments are becoming increasingly focused on seeking ways to curb carbon emissions in the electricity production and transportation sectors. Successfully implemented methods for curbing carbon emissions will have a significant state-change effect on the overall wholesale price of power. Emissions regulations are likely to be costly to consumers and will require an act of political will that we have not yet seen. Scenarios should assume that there exists a relationship between the health of the general economy (price of fossil fuels) and the likelihood and intensity of emission regulations. Any form of carbon emissions regulation will promote the addition of renewable generation capacity (wind, solar) and the addition of flexible and efficient dispatchable generation (SCCT) and reduce generation from coal and inefficient natural gas units.

Renewable Portfolio Standards: State level legislation has provided fertile ground for the development and deployment of renewable generation. The future of state legislation will impact how quickly future resources shift away from conventional to renewable resources. Scenarios that provide a wide spectrum of possible changes to renewable standards over the evaluation period could be helpful to consider when we make resource selections today.

Government Incentives: Government policies and legislation to support emerging renewable generation has a strong impact on generation capacity additions and retirements in the west. Financial incentives including the Production Tax Credit (PTC) and Investment Tax Credit (ITC) have pushed some resource alternatives over the economic threshold toward viability. In scenarios where these incentives are removed, less generation capacity will be added.

Adoption of Electric Vehicles: The emergence and success of plug-in hybrid cars and battery powered electric vehicles has sparked the imagination of many energy planners who look forward to the day when a majority of transportation can be fueled by electricity. Some have even gone as far as to see a future where electric batteries in cars can be relied on as a source of network supply during capacity constrained moments, help integrate variable energy from renewable resources, and enhance overall grid stability. As penetration rates of plug-in electric vehicles increase over time, it will have an effect on the shape of load across the west even without such imaginative applications.

Scenarios for electric vehicles focus on the penetration rate of electric plug-in vehicles for light-duty purposes, which represent roughly 60% of energy consumed in transportation. Medium and heavy-duty vehicles (which are the next 20% of transportation fuel consumption) are less likely to be electrified due to the requirements of diesel powertrains.

Forecast scenarios do not make an effort to forecast the changing electric vehicle technology. It is likely that improvements will be made in vehicle charging efficiency, vehicle range, overall manufacturing costs, and in bi-directional power supply features that may enhance the value of electric vehicles and lead to an increased adoption rate among vehicle purchasers. These improvements are impossible to forecast and are not considered part of the current analysis.

The price of fossil fuels will likely have a significant impact on the penetration rates of electric vehicles. As cheap fuel persists, the relative cost of electric vehicles makes electric vehicles a less attractive substitute to traditional gasoline powered transport.

Climate Change: For the purposes of this analysis, the analyzed effects of climate change are considered for three key areas: 1) changing temperatures for Tacoma Power's service territory, which will in turn affect customer demand for heating and cooling, 2) changing temperature and precipitation, which could alter the quantity and timing of hydro flows into Tacoma Power projects, 3) changing temperatures and precipitation and their impacts on power provided by

BPA to Tacoma Power through the Slice contract. Estimates will be quantified by the UW Climate Impacts Group in a report to be delivered this summer. The report will provide estimates of the impacts based on two scenarios: 1) high and 2) low.

Assuming that the two emissions scenarios yield statistically significant and observable differences in the three factors listed above (temperature, precipitation timing and volume for Tacoma projects, generation from BPA Slice product), the effects of the climate change scenarios will be applied to the scenarios in a logical fashion.

The four scenarios used to evaluate candidate resources in the 2015 Integrated Resource Plan will be combined with the estimated impacts of climate change for the final year of the study period; 2035. Because scenarios have not yet been computed, the calculated carbon emissions from the scenario have not been calculated. It is expected that the two scenarios associated with low emissions impacts are Smooth Sailing and Green Acres and the two scenarios associated with high emissions impacts are Foot on the Gas and Running on Empty. When the analysis is performed, this will be confirmed.

Energy Storage (e.g. Batteries): If media reports and press releases are accurate, it would appear that we may be on the precipice of a technological change in energy storage that could have a revolutionary effect on the power industry.

Home and utility-sized energy storage is the newest and most exciting topic in the news. What are the applications and impacts from this new technology and how will it affect Tacoma Power's resource decisions? Energy storage is economically useful when the wholesale market price is low and surplus energy can be stored. This energy can be added to supply a utility or the market during times of scarcity and when wholesale prices are high.

When attached to homes and businesses, storage will even out the demand of a customer across a day covering sudden spikes in usage and instantaneous shortfalls in supply. At significant levels of application, this technology could have a profound impact on the wholesale energy market and resource operations. If attached to variable energy generators (solar, wind) in quantity, batteries could provide a more consistent supply of energy, making them self-firming and reducing the contentious costs of transmission, generation, and market solutions seeking to provide the same services.

Research is currently being conducted on various configurations of energy storage including: chemical batteries, pumped water storage, compressed air, thermal (molten salt), flywheels, and others. Because the technology and applicability is still relatively unknown and barely commercially available, Tacoma Power cannot use it as the basis of a candidate portfolio for the IRP. However, we can examine the effect that such technology may have on the overall western US market.

Rooftop Solar/Distributed Generation: Government incentives at the state and federal level have made consumer installed solar panels a cost-effective form of distributed generation for a small but growing number of customers and this trend will likely continue for at least a couple more years (until the ITC diminishes from 30% to 10% in 2017). The impact on solar in Tacoma Powers' service territory is likely to be limited over the evaluation period if current state and federal incentives are not renewed. The economics of rooftop solar is less compelling in Tacoma than in other parts of the west, due to a combination of low utility power rates and the low solar efficiency due to geography and climate. The expansion of rooftop solar across other parts of the west are likely to be much more significant and could introduce significant changes to supply and demand over the evaluation period – enough to make it an important consideration for this IRP.

Resources Used in the Creation of Scenarios

Wind Focus Study (2014) – National Renewable Energy Laboratory

Renewable Energy Futures Study (2013) – National Renewable Energy Laboratory

Annual Energy Outlook 2015 – U.S. Energy Information Administration

Annual Energy Outlook 2014 - U.S. Energy Information Administration

2013 Interconnection-Wide Plan Data and Assumptions – WECC

Long Term Natural Gas Outlook (November 2014) - Wood Mackenzie

Price Forecasts for the Seventh Plan - Northwest Power and Conservation Council, Apr 2014

California Transportation Electrification Assessment (2014) – ICF International and Energy and Environmental Economics

California PATHWAYS: GHG Scenario Results (2014)

4 SMOOTH SAILING

The Smooth Sailing scenario envisions a future where today's existing conditions and trends continue onward with relatively minor changes. While it does not represent a base case or most likely outcome, the Smooth Sailing scenario provides a useful frame of reference that can facilitate comparing and contrasting with the other three scenarios.

Economic Growth

The national economy grows at about the historical average rate, real gross domestic product increasing at a real rate of 2.4 to 2.7 percent per year. The Tacoma-area economy also grows at a steady, moderate rate.

Demand for Electricity

aMW	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
WECC Load	83,127	84,093	85,060	85,724	86,388	87,017	87,645	88,101	88,558	89,034
Annual Growth		1.16%	1.15%	0.78%	0.77%	0.73%	0.72%	0.52%	0.52%	0.54%
aMW	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**
WECC Load	89,511	89,553	89,595	89,912	90,228	90,276	90,325	90,674	91,023	91,023
Annual Growth	0.54%	0.05%	0.05%	0.35%	0.35%	0.05%	0.05%	0.39%	0.39%	0.00%

Source: NREL 2014 "Low Demand" Update of the Renewable Energy Futures Study (2013).

Tacoma Power Retail Load

Demand for electricity by Tacoma Power's traditional customers grows gradually. Total demand for Tacoma Power' service territory is adjusted by the arrival of several new commercial and industrial customers, as shown in the following table.

New Large Loads	Probability	Demand (aMW)	ETA
PSE Liquefied Natural Gas Facility	80%	15	1/2018
Sawmill	90%	5	1/2018
Construction Materials Manufacturer	50%	10	1/2018
Chemical Plant	50%	7	1/2019
Cold Storage 1	80%	1	7/2017
Cold Storage 2	50%	5	7/2019
MMJ Production	50%	5	1/2017
Convention Center Hotel Complex	20%	1	1/2020
JBLM	75%	(4)	1/2018

Natural Gas Markets and Prices

Over the 20 year study period, demand for natural gas slowly increases relative to supply as more generation is fueled by natural gas and less from coal. Gas supplies experience normal depletion rates and costs increase proportionately.

Natural Gas Price
2016$/MMBtu

2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
$ 3.35	$ 3.22	$ 3.24	$ 3.46	$ 3.72	$ 3.60	$ 3.94	$ 3.97	$ 4.03	$ 4.23
2026	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**
$ 4.92	$ 4.89	$ 4.82	$ 4.92	$ 4.89	$ 4.85	$ 4.95	$ 5.04	$ 5.15	$ 5.25

Emissions Regulations

Effective in the year 2020, Federal law tax carbon dioxide emissions at a rate of $11.75 per metric ton, increasing at a nominal rate of six percent per year. California continues its existing cap and trade program, with allowance prices at $15.00 per metric ton in 2016 and growing at a real rate of five percent per year.

Renewable Portfolio Standards

Washington State's renewable portfolio standard is increased from its existing level of 15 percent to 20 percent in the year 2025. California increases its RPS renewable requirement from 33 percent in 2020 to 50 percent in 2030. California allows the import of out-of-state renewable energy to qualify as eligible for compliance for the incremental requirement.

Government Incentives

New federal production tax credits and investment tax credits are not adopted, and existing incentives are allowed to expire as currently scheduled. State funding incentives for rooftop and community solar photovoltaic generation are extended/renewed in several states including Washington, but at lower levels. No major changes to state net metering laws are enacted.

Adoption of Electric Vehicles

Use of light duty electric vehicles in the U.S. grows at a moderate rate, reaching 2.9 million vehicles in the west by 2035. Additional load associated with new electric vehicles is 9.3 million MWh in 2035.

Climate Change

The climate continues to warm at recent rates of change, along with changes in precipitation patterns including more rain and less snowfall. However, the climactic changes are steady rather than exhibiting major upheavals.

Energy Storage (e.g., Batteries)

California's investor-owned utilities develop 1,325 megawatts of energy storage by 2020, consistent with existing state goals. Utilities in other states observe and then begin to implement their own strategies to increase energy storage post-2020, but for much smaller amounts of capacity.

Solar Generation

Adoption of rooftop solar photovoltaic generation grows at a moderate rate. Further declines in equipment and installation cost is offset by sunset of current federal and state incentives which are assumed to be replaced with less generous terms. Additional rooftop solar capacity is added, but not at recent rates. This slightly moderates growth in utility sales of electricity.

Power Generating Fleet

Significant retirements of existing coal-fired power plants in the West occur throughout the 20-year planning period, with the oldest and highest carbon emitting units being closed earlier than more modern facilities. Other changes to the generating fleet between 2016 and 2035 are shown in the following table.

Capacity (MW)	Biomass	Coal	Natural Gas	Geothermal	Hydro	Nuclear	CSP	Solar PV	Wind	Storage
2016	1,522	28,803	87,217	3,557	50,665	7,385	4,406	6,300	19,792	0
2035	1,707	20,511	86,366	5,180	49,637	7,835	8,290	18,232	33,109	2,700
% Chg	12.2%	-28.8%	-1.0%	45.6%	-2.0%	0.0%	88.2%	189.4%	67.3%	-

Energy Efficiency

Utilities continue to implement energy efficiency consistent with recent levels of investment. Recently-adopted new federal standards for efficiency further contribute to moderation of growth in utility sales of electricity.

The load forecast incorporates the following assumptions for energy intensity gains over the base year by 2050: 30% decline in Residential, 32% decline in Commercial, 50% decline in Industrial.

5 FOOT ON THE GAS

In the Foot on the Gas scenario, abundant, low-cost supplies of natural gas foster robust economic growth, increasing consumption of electricity, and accelerating the shift from coal to natural gas for power generation. Overall emissions of carbon dioxide fall due to more rapid retirement of coal-fired power plants along with imposition of carbon taxes at the state level.

Economic Growth

Ample supplies of inexpensive natural gas and oil keep the economy running at a relatively high rate of growth throughout the 20-year planning period. The national economy expands faster than the historical average, with real gross domestic product increasing at a real rate of 3.6 to 4.0 percent per year. The Tacoma area economy also grows at a strong rate.

Demand for Electricity

aMW	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
WECC Load	83,127	84,934	86,761	88,296	89,844	91,150	93,466	93,608	94,757	95,935
Annual Growth		2.1%	2.1%	1.7%	1.7%	1.4%	1.4%	1.2%	1.2%	1.2%
aMW	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**
WECC Load	96,896	97,389	97,882	98,678	99,477	99,755	100,035	100,648	101,263	101,491
Annual Growth	1.0%	0.5%	0.5%	0.8%	0.8%	0.3%	0.3%	0.6%	0.6%	0.2%

Source: NREL 2014 "High Demand" Update of the Renewable Energy Futures Study (2013), (adjusted for economic growth).

Tacoma Power Retail Load

The buoyant local economy stimulates greater additions of new large loads in Tacoma. Overall retail sales of electricity grow by an additional 0.5% per year. While threats to supplies of crude oil from the Middle East are less of a concern, Russia becomes more belligerent amid falling energy export revenues. As a result, activity at JBLM remains strong.

The growth of new large loads is shown in the following table.

New Large Loads	Probability	Demand (aMW)	ETA
PSE Liquefied Natural Gas	100%	15	1/2018
PSE Liquefied Natural Gas Expansion	75%	15	1/2022
Saw Mill	100%	5	1/2018
Saw Mill Expansion	50%	5	1/2024
Construction Materials Manufacturer	75%	10	1/2018
Chemical Plant	75%	7	1/2019
Cold Storage 1	95%	1	7/2017
Cold Storage 2	75%	5	7/2019
MMJ Production	50%	5	1/2017
Convention Center Hotel Complex	35%	1	1/2020
JBLM	50%	2	1/2018

Natural Gas Markets and Prices

Abundant fossil fuels create a future where available supplies exceed demand over the 20 year planning period. Factors contributing to the bonanza of supply include:

- low extraction costs as technological improvements continue to be made
- continuous process improvement in sourcing, extracting, and refining fossil fuels
- financial markets provide adequate credit and financial liquidity to fund projects
- no environmental regulations prohibiting hydraulic fracturing
- no supply concentration by banks or oil majors
- additional demand is outpaced by supply

Natural Gas Price
2016$ / MMBtu

2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
$ 3.02	$ 2.90	$ 2.92	$ 3.11	$ 3.34	$ 3.24	$ 3.48	$ 3.47	$ 3.46	$ 3.51
2026	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**
$ 3.44	$ 3.37	$ 3.31	$ 3.24	$ 3.27	$ 3.21	$ 3.14	$ 3.08	$ 3.02	$ 2.96

Emissions Regulations

Although natural gas and oil prices are low, there is growing recognition that fossil fuel consumption contributes to climate change. Because more people have the economic means (employment, higher incomes), they are more willing to accept carbon emissions legislation to help curb the use of fossil fuels. Carbon taxes are self-imposed by voters at the state level.

Washington and Oregon each impose carbon taxes of $15.00 per metric ton beginning in 2020 and growing thereafter at a nominal rate of five percent per year. The California cap and trade program is tightened, increasing allowance costs to $20.00 per metric ton in 2020 and growing thereafter at a nominal rate of five percent per year.

Renewable Portfolio Standards

With the imposition of carbon taxes in Washington and Oregon, the public in these states concludes that higher renewable portfolio standards are not unnecessary to effect change. Meanwhile, California changes its RPS law to increase the requirement to 50 percent renewable generation by 2030, while also making imports of renewable generation from out of state eligible for compliance.

Government Incentives

Existing federal production and investment tax credits for renewable resources are allowed to expire and are not renewed or extended. No major changes to state net metering laws are enacted.

Adoption of Electric Vehicles

The market for electric vehicles grows at a slower rate than the other scenarios because gasoline powered cars continue to have a sizeable cost advantage. Use of electric vehicles in the U.S. is mainly limited to high-income consumers and reaches just over 1 million vehicles in the west by 2035. Additional load associated with electric vehicles is 2.5 million MWh in 2035.

Climate Change

The reduction in emissions from retirement of 50% of coal-fired power plant capacity is somewhat offset by increased use of natural gas-fired generation and a lackluster electrification of transportation.

Similar to Smooth Sailing, the climate continues to warm at recent rates of change, along with changes in precipitation patterns including more rain and less snowfall. However, the climactic changes are gradual rather than exhibiting major upheavals.

Energy Storage (e.g., Batteries)

Lower prices and relatively greater reliance on natural gas lead to somewhat slower investment and development of energy storage technologies. However, California's investor-owned utilities develop 1,325 megawatts of energy storage by 2020, consistent with existing state goals. Other states do not follow this example and instead shape variable energy resources with natural gas peaking plants.

Solar Generation

In comparison to the Smooth Sailing scenario, rooftop solar photovoltaic generation grows at a slower rate because retail electric rates remain relatively more affordable. However solar costs continue to decrease due to technological and market improvements.

Reduced rooftop solar growth in some states leads to further increases in overall load growth. However this doesn't cause a major change in electric loads across the West, because there is also less energy efficiency adopted by states with less solar radiation.

Power Generating Fleet

With low natural gas prices and higher CO2 emissions costs, coal-fired power plants are retired more quickly in the Foot on the Gas scenario. The loss of coal generation is replaced by additional renewable generation and natural gas-fired power plants for integration.

	Biomass	Coal	Natural Gas	Geothermal	Hydro	Nuclear	CSP	Solar PV	Wind	Storage
2016	1,522	28,803	87,217	3,557	50,665	7,385	4,406	6,300	19,792	0
2035	2,454	13,923	100,239	5,655	49,637	7,385	10,005	23,612	43,900	2,125
% Chg	61.2%	-51.7%	14.9%	59.0%	-2.0%	0%	127.1%	274.8%	121.8%	-

Energy Efficiency

Compared to Smooth Sailing, in this scenario the utilities in the West implement less energy efficiency because their avoided costs of wholesale power are lower. This effect is more pronounced in states with less solar radiation, particularly the Pacific Northwest.

6 RUNNING ON EMPTY

The Running on Empty scenario is characterized by a persistent scarcity of fossil fuels, along with relatively little success in efforts to meet energy needs from other sources. Fossil fuels are the feedstock of the economy, and with a restriction of supply, the world economy chokes and sputters to 2035. This scenario creates multiple challenges for consumers, utilities, and government.

Economic Growth

Limited supply of crude oil and natural gas commodities drive energy prices upward, causing lasting destructive effects on the world economy. The national economy grows more slowly than the historical average, with real gross domestic product increasing at a real rate of 1 to 1.5 percent per year. The Tacoma-area economy also experiences prolonged stagnation.

Demand for Electricity

As prices for electricity across the west increase and rates grow by single and double digits percentages regularly, more retail customers will try to find ways to reduce their bills. Customers in states with persistent sunshine and high rates will invest in solar panels, others will focus on improving their energy efficiency. Those with access to inexpensive power will resist efforts by others to re-design markets or mandate wider socialization of energy costs. This could lead to legislative and regulatory conflict and the formation of micro-grids that allow customers to detach themselves from their local utility and go "off the grid". Starting in 2025, an increasing number of shopping centers, industrial customers, military bases, hospitals, data centers, and schools leave the utility system (0.5%/year).

aMW	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
WECC Load	83,335	84,947	86,255	87,464	88,346	89,784	90,890	91,793	92,253	92,863
Annual Growth		1.9%	1.5%	1.4%	1.0%	1.6%	1.2%	1.0%	0.5%	0.7%
aMW	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**
WECC Load	93,024	92,964	92,360	91,970	91,042	89,752	87,819	85,998	83,580	80,830
Annual Growth	0.2%	-0.1%	-0.7%	-0.4%	-1.0%	-1.4%	-2.2%	-2.1%	-2.8%	-3.3%

Source: NREL 2014 "High Demand" Update of the Renewable Energy Futures Study (2013), (adjusted for economic growth).

Tacoma Power Retail Load

Retail electric sales decline overall and in Tacoma as a result of the initial oil price shock, and do not recover. Due to the poor economic conditions, almost no new large loads locate to Tacoma. Growing adoption of energy efficiency reduces loads even further. JBLM faces a possible shutdown.

New Large Loads	Probability	Demand (aMW)	ETA
PSE Liquefied Natural Gas	80%	15	1/2018
Saw Mill	75%	5	1/2018
JBLM	20%	(5)	1/2025

Natural Gas Markets and Prices

Scarce fossil fuels create a future where demand exceeds supply throughout the 20 year planning period. Factors contributing to a dearth of supply include:

- there is little technological innovation or improvement in sourcing, extracting, and refining fossil fuels
- resource depletion in some areas
- costs to extract supply from dwindling supply basins steadily increase
- financial shocks on Wall Street dry up financing for new projects that are viewed as risky
- environmental regulations prohibit hydraulic fracturing or restrict areas for exploration and extraction
- supplies become concentrated among a few major producers who exert market power to restrict supply, drive up prices maximize their own profits

Natural Gas Price
2016$/MMBtu

2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
$ 3.50	$ 3.49	$ 3.62	$ 3.93	$ 4.27	$ 4.37	$ 4.77	$ 5.00	$ 5.28	$ 5.63
2026	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**
$ 6.20	$ 6.49	$ 6.79	$ 7.18	$ 7.58	$ 8.03	$ 8.53	$ 9.07	$ 9.66	$ 10.06

Emissions Regulations

While climate change from carbon emissions is an important problem, more and more people have trouble making it from paycheck to paycheck. The public becomes increasingly focused on the immediate future. As a result, there is little political support or economic capability to adopt carbon taxes.

Renewable Portfolio Standards

Instead of imposing direct taxes and restrictions on carbon emissions and in the hopes of increasing new power supplies, Federal and State governments establish more aggressive renewable portfolio standards. Washington State increases its RPS requirement to 20% by

2025, and Oregon increases its RPS requirement to 30% by 2025. In 2016, California increases its RPS to 60% by 2030, and changes the rules to allow the use of out of state renewable energy for purposes of compliance.

Government Incentives

With governments facing severe budget deficits, existing Federal production and investment tax credits and State financial incentives for renewable resources are allowed to expire and are not renewed.

Adoption of Electric Vehicles

With higher fossil fuel prices, adoption of light-duty electric vehicles increases sharply, particular among higher-income consumers. Cities and counties adopt electric vehicles for their fleet use as a way of reducing fuel costs. Use of electric vehicles in the U.S. reaches 6 million vehicles in the west by 2035. The additional load associated with new electric vehicles is 21.5 million MWh in 2035. This partly offsets the decline in other types of electricity loads.

Climate Change

The increasing cost of fossil fuels has mired the economy and has made it impossible to transition to new forms of generation. Coal plant retirements are cancelled or delayed. Carbon emissions from transportation and power generation continue to rise. The global climate continues to warm, exacerbating the impacts of high prices and restricted supplies of energy. These create growing frustration among the general public.

Energy Storage (e.g., Batteries)

California's investor-owned utilities develop 1,325 megawatts of energy storage by 2020, consistent with existing state goals. However, costs are high and there are fewer funds available for research. The performance of utility-scale energy storage does not meet expectations. Other states do not attempt to replicate California's efforts.

Solar Generation

Higher-income customers in sunnier parts of the West seek to avoid paying increased utility rates by installing rooftop solar photovoltaic generation and behind-the-meter battery storage. Adoption of rooftop solar grows more rapidly than in the Smooth Sailing scenario. Customers in more affluent areas seek to isolate themselves from utilities by establishing micro-grids complete with self-supply and storage. Utilities are forced to seek cost recovery from fewer customers with reduced economic means.

Power Generating Fleet

High costs for natural gas cause delays in the retirements of existing coal-fired power plants, as well as less development of new natural gas-fired power plants. Further, more of the less-efficient existing natural gas power plants are retired. In turn, the smaller amount of flexible natural gas generation makes it more difficult to integrate new renewable generating resources. This could cause the bulk power system to become less reliable.

	Biomass	Coal	Natural Gas	Geothermal	Hydro	Nuclear	CSP	Solar PV	Wind	Storage
2016	1,522	28,803	87,217	3,557	50,665	7,385	4,406	6,300	19,792	0
2035	2,106	20,511	74,908	4,787	49,637	7,385	10,390	21,113	36,003	1,325
% Chg	38.4%	-28.8%	-4.4%	34.6%	-2.0%	0.0%	135.8%	235.1%	81.9%	-

Energy Efficiency

Consumers become more motivated to implement energy efficiency as a way to reduce their utility bills. While higher-income consumers will require fewer utility incentives, low-income consumers will continue to need utility incentives to help pay for installation of energy efficiency. Overall adoption of weatherization measures, ductless heat pumps and LED lighting increase.

There is growing use of micro-grids for small communities, corporate offices, commercial shopping areas, educational facilities, and military installations to source and supply their own power and get away from high utility rates. Due to various factors reducing their retail sales of electricity, utilities struggle with high costs and falling revenues. Unable to continue socializing utility costs leaves the poorest and those with no alternative to pay increasing utility rates.

7 GREEN ACRES

The Green Acres scenario presents a future where public opinion makes it possible for an ambitious expansion of policy intended to benefit the environment and modernize the power system. In this scenario, the nation and the Pacific Northwest region take concerted actions on multiple fronts to reduce greenhouse gas emissions from power production and transportation.

More aggressive renewable energy goals are adopted, carbon taxes are imposed, and larger incentives are provided for energy efficiency, rooftop solar generation, battery storage and electric vehicles. Funding is also provided for development of new clean energy technologies, leading to improved quality and reductions in cost. These efforts succeed in transforming the energy system and the overall economy.

Economic Growth

Tranquil foreign affairs and strong, unabated growth of the U.S. and local economies helps make this scenario possible. Favorable business conditions, high employment, and healthy tax revenues enable consumers, businesses, government, and utilities to invest in new energy infrastructure, which in turn further enhances economic performance.

Demand for Electricity

aMW	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
WECC Load	83,127	83,841	84,549	84,952	85,352	85,711	86,067	86,251	86,432	86,630
Annual Growth		0.86%	0.84%	0.48%	0.47%	0.42%	0.42%	0.21%	0.21%	0.23%
aMW	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**
WECC Load	86,826	86,598	86,369	86,405	86,439	86,214	85,989	86,049	86,108	85,835
Annual Growth	0.23%	-0.26%	-0.26%	0.04%	0.04%	-0.26%	-0.26%	0.07%	0.07%	-0.32%

Source: NREL 2014 "Low Demand" Update of the Renewable Energy Futures Study (2013), (adjusted for aggressive rooftop solar installation and increased energy efficiency).

Tacoma Power Retail Load

While strong economic conditions and vehicle electrification help maintain utility sales of electricity, these effects are mitigated by growth in rooftop solar generation and an expansion of energy efficiency programs and federal codes and standards. Advances in distributed energy technologies including battery storage, along with dynamic pricing, changes in consumer behavior, and demand response help manage peak demands.

New Large Single Load: Green Acres	Probability	Demand (aMW)	ETA
PSE Liquefied Natural Gas Facility	80%	15	1/2018
Sawmill	90%	5	1/2018
Construction Materials Manufacturer	50%	10	1/2018
Chemical Plant	50%	7	1/2019
Cold Storage 1	80%	1	7/2017
Cold Storage 2	50%	5	7/2019
MMJ Production	50%	5	1/2017
Convention Center Hotel Complex	20%	1	1/2020
JBLM	75%	(4)	1/2018

Natural Gas Markets and Prices

Government policies are enacted that significantly limit exploration and production of fossil fuels in many parts of the country. Environmentally sensitive lands are made off-limits to drilling, and in all other areas more stringent regulations require significant additional operating costs and procedures to mitigate the risk of environmental damage.

Cost pressures and reduced supply push retail prices for fossil fuels upward. Over time this encourages the destruction of oil and natural gas demand, which further reduces the profitability of the industry and limits the financial resources needed to invest in newer sources of supply, increasing retail prices further.

Natural Gas Price
2016$/MMBtu

2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
$ 3.35	$ 3.22	$ 3.49	$ 3.71	$ 4.22	$ 4.10	$ 4.69	$ 4.72	$ 5.03	$ 5.23
2026	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**
$ 6.17	$ 6.14	$ 6.32	$ 6.42	$ 6.39	$ 6.35	$ 6.45	$ 6.54	$ 6.65	$ 6.75

Emissions Regulations

The Western states work in a coordinated manner to reduce carbon dioxide emissions to 50 percent of 1990 levels by 2035. Washington and Oregon impose a carbon tax of $15.00 per metric ton beginning in 2020 and growing at a nominal rate of five percent per year. Meanwhile, a federal carbon tax of $20.00 per metric ton becomes effective 2021, also growing at a nominal rate of five percent per year.

Renewable Portfolio Standards

California adopts a renewable portfolio standard requiring utilities to meet 60 percent of retail sales of electricity with renewable resources by 2030. Washington and Oregon adopt RPS requirements of 40 percent by 2030. Federal RPS regulations require each state to have a minimum effective standard of 20% in 2025.

Renewable Portfolio Standard (% of Load)

State	2020	2025	2030
Arizona	0	20	25
California	33	33	60
Colorado	30	30	35
Idaho	0	20	25
Montana	15	15	20
Nevada	20	30	35
New Mexico	20	30	35
Oregon	20	25	35
Utah	0	20	30
Washington	15	20	30
Wyoming	0	20	20

Government Incentives

Government incentives for rooftop solar generation are extended, including the 30 percent federal Investment Tax Credit. A 30 percent tax credit for utility-scale renewable generation is also enacted. These subsidies remain in effect throughout the 20-year planning period. Tax incentives are provided for vehicle electrification for homes and businesses.

Adoption of Electric Vehicles

Automakers commit to large-scale production of electric vehicles, aided by breakthroughs in cost and performance of batteries. Major oil companies are provided with incentives/required

to use some of their existing distribution infrastructure to support quick charging services for electric vehicles. As a result, nearly 9 million vehicles in the west are battery-electric by 2035. Meanwhile, 3.8 million hybrid vehicles make up the other 30% of the overall fleet by 2035. Load associated with plug-in electric vehicles is nearly 44.5 million MWh in 2035.

Climate Change

The utility and transportation sectors both achieve major reductions in carbon dioxide emissions. However, global climate changes continue, keeping public pressure focused on further reducing carbon emissions from the transportation and energy industries.

Energy Storage (e.g., Batteries)

Technological breakthroughs and a rapidly maturing market for battery storage lead to widescale adoption of batteries in vehicles, homes, and neighborhoods. Costs and capabilities of utility-scale energy storage also improve significantly. These developments help integrate larger amounts of renewable resources.

Solar Generation

Rapidly improving performance and declining costs, along with increased federal and state incentives help make rooftop solar generation broadly affordable and even commonplace in areas where rates are relatively high and sun is relatively plentiful. Community solar, paired with shared energy storage and other advancing distributed energy technologies foster the growth of local microgrids.

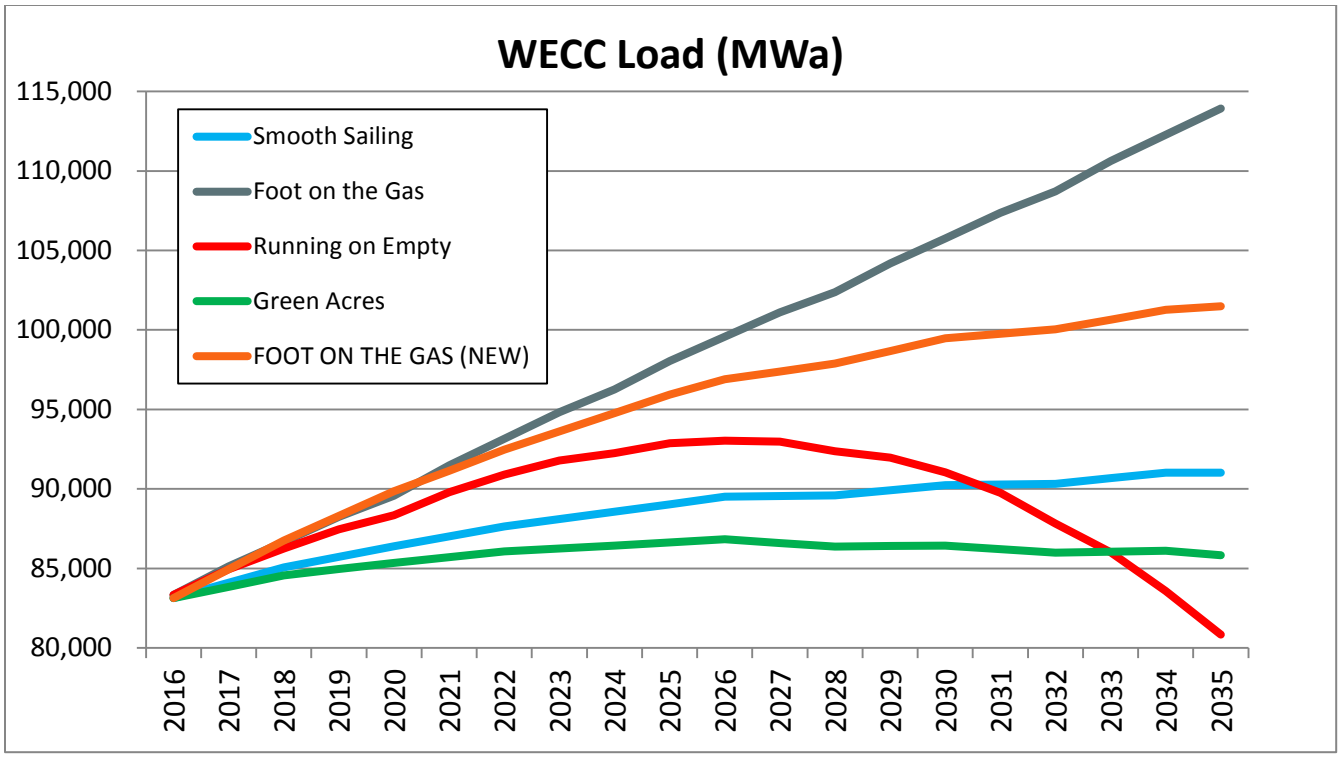
Power Generating Fleet

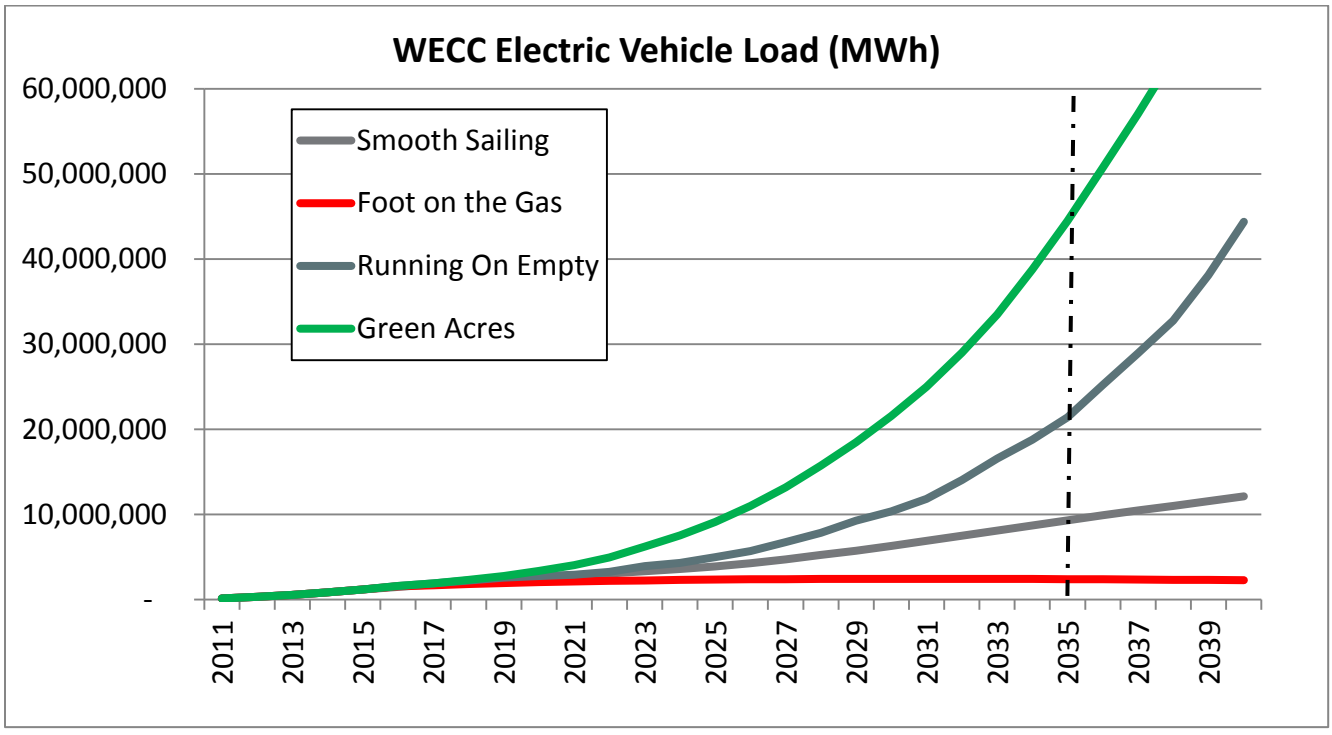
Utilities successfully comply with the more aggressive renewable portfolio standards using a mix of solar, wind, geothermal and other renewable generating resources. All coal-fired power plants in the West are retired by 2035. Improvements in design and materials reduce the costs of nuclear power, leading to moderate development of new nuclear power plants at the end of the study period in remote locations of the west. Nuclear power is used to replace coal as a source of baseload generation. Deployment of natural gas-fired power plants is mainly to balance the power system and integrate renewable generation.

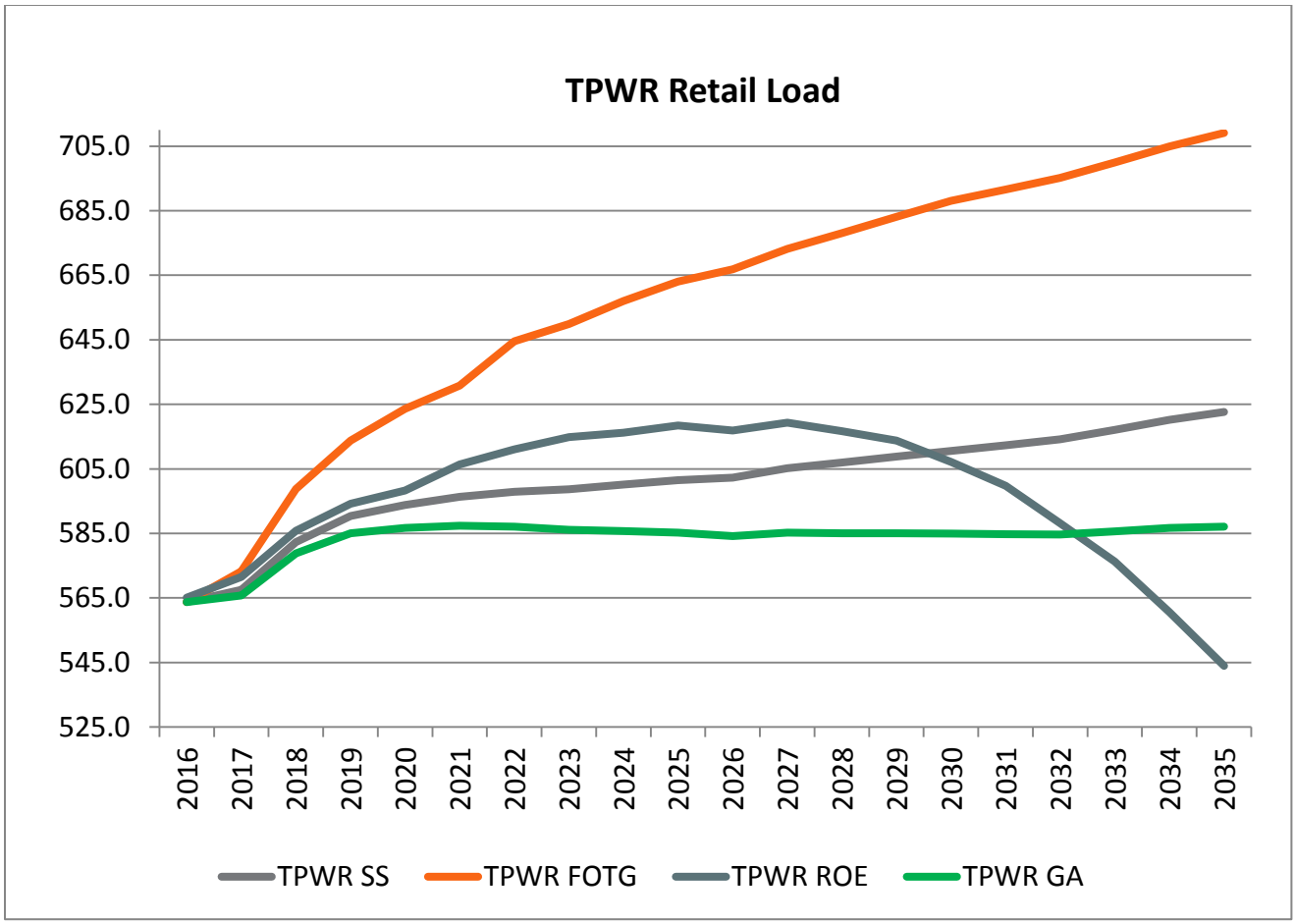
	Biomass	Coal	Natural Gas	Geothermal	Hydro	Nuclear	CSP	Solar PV	Wind	Storage
2016	1,522	28,803	87,217	3,557	50,665	7,385	4,406	6,300	19,792	0
2035	1,852	0	94,449	5,883	50,999	14,785	11,655	20,578	47,004	8,100
% Chg	21.7%	-100%	8.3%	65.4%	0.7%	100.2%	164.5%	226.6%	146.9%	-

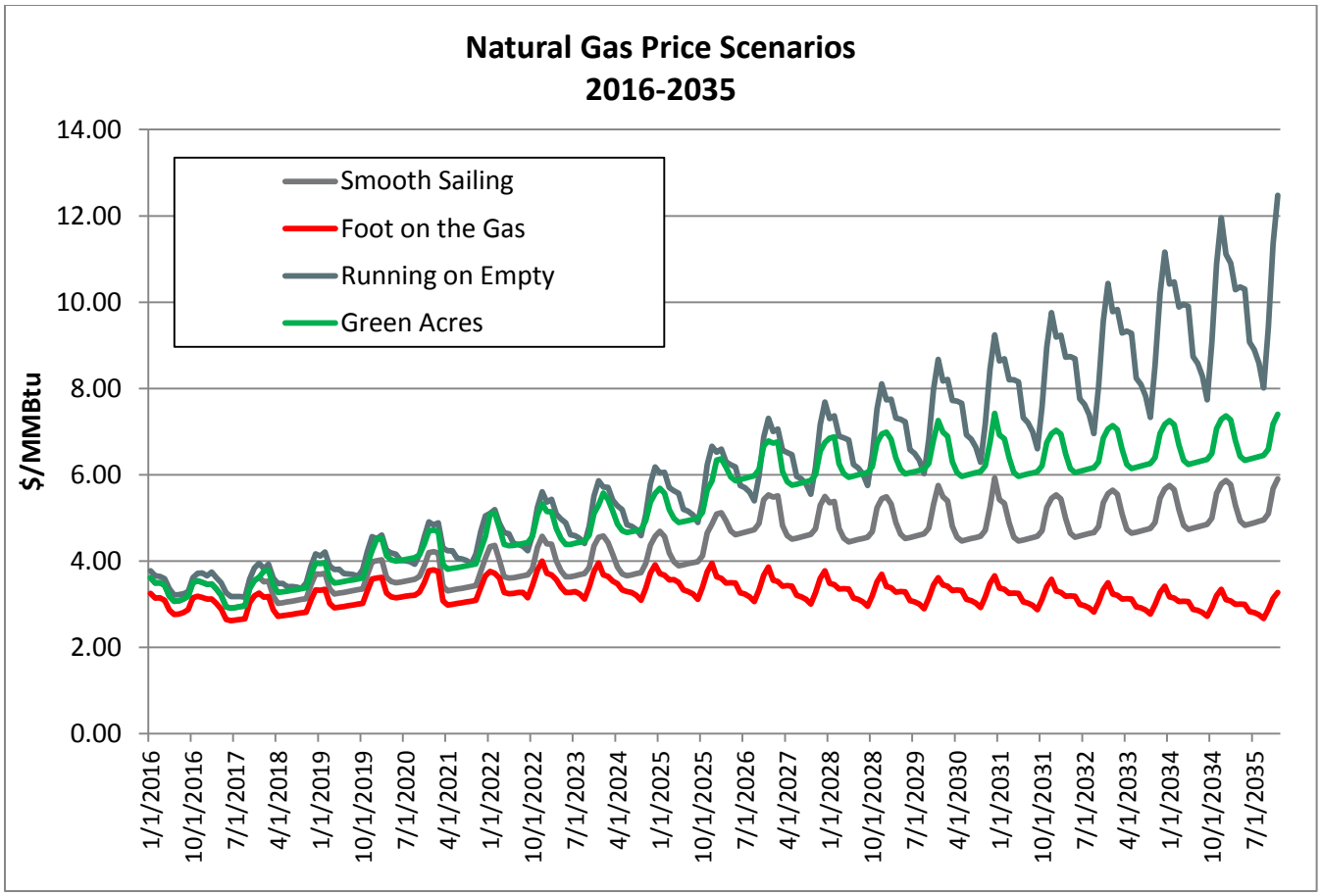
Energy Efficiency

Utilities, consumers and businesses accelerate implementation of energy efficiency and demand response. For example, energy and peak demand savings grow throughout the West at double the rate shown in the Smooth sailing scenario.


WECC Load (MWa)
115,000
110,000
105,000
100,000
95,000
90,000
85,000
80,000
Smooth Sailing
Foot on the Gas
Running on Empty
Green Acres
FOOT ON THE GAS (NEW)
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035


WECC Electric Vehicle Load (MWh)
60,000,000
50,000,000
40,000,000
30,000,000
20,000,000
10,000,000
-
Smooth Sailing
Foot on the Gas
Running On Empty
Green Acres
2011
2013
2015
2017
2019
2021
2023
2025
2027
2029
2031
2033
2035
2037
2039


TPWR Retail Load
705.0
685.0
665.0
645.0
625.0
605.0
585.0
565.0
545.0
525.0
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
TPWR SS
TPWR FOTG
TPWR ROE
TPWR GA


Natural Gas Price Scenarios
2016-2035
$/MMBtu
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Smooth Sailing
Foot on the Gas
Running on Empty
Green Acres
1/1/2016
10/1/2016
7/1/2017
4/1/2018
1/1/2019
10/1/2019
7/1/2020
4/1/2021
1/1/2022
10/1/2022
7/1/2023
4/1/2024
1/1/2025
10/1/2025
7/1/2026
4/1/2027
1/1/2028
10/1/2028
7/1/2029
4/1/2030
1/1/2031
10/1/2031
7/1/2032
4/1/2033
1/1/2034
10/1/2034
7/1/2035

Influence Diagram

2015 Integrated Resource Plan