Integrated Resource Plan Public Workshop 2

Key Inputs & Assumptions

March 11, 2020

TACOMA POWER
TACOMA PUBLIC UTILITIES

WELCOME!

Thanks for coming back virtually for Round 2.

TACOMA POWER
TACOMA PUBLIC UTILITIES

Outline

TACOMA POWER
TACOMA PUBLIC UTILITIES

1. Portfolio Selection Metrics
2. Tacoma Power's Current Portfolio
3. Conservation Potential Assessment
4. Base Case Load Forecast
5. Base Case WECC Build & Prices
6. Scenarios
7. Next Steps and Action Items

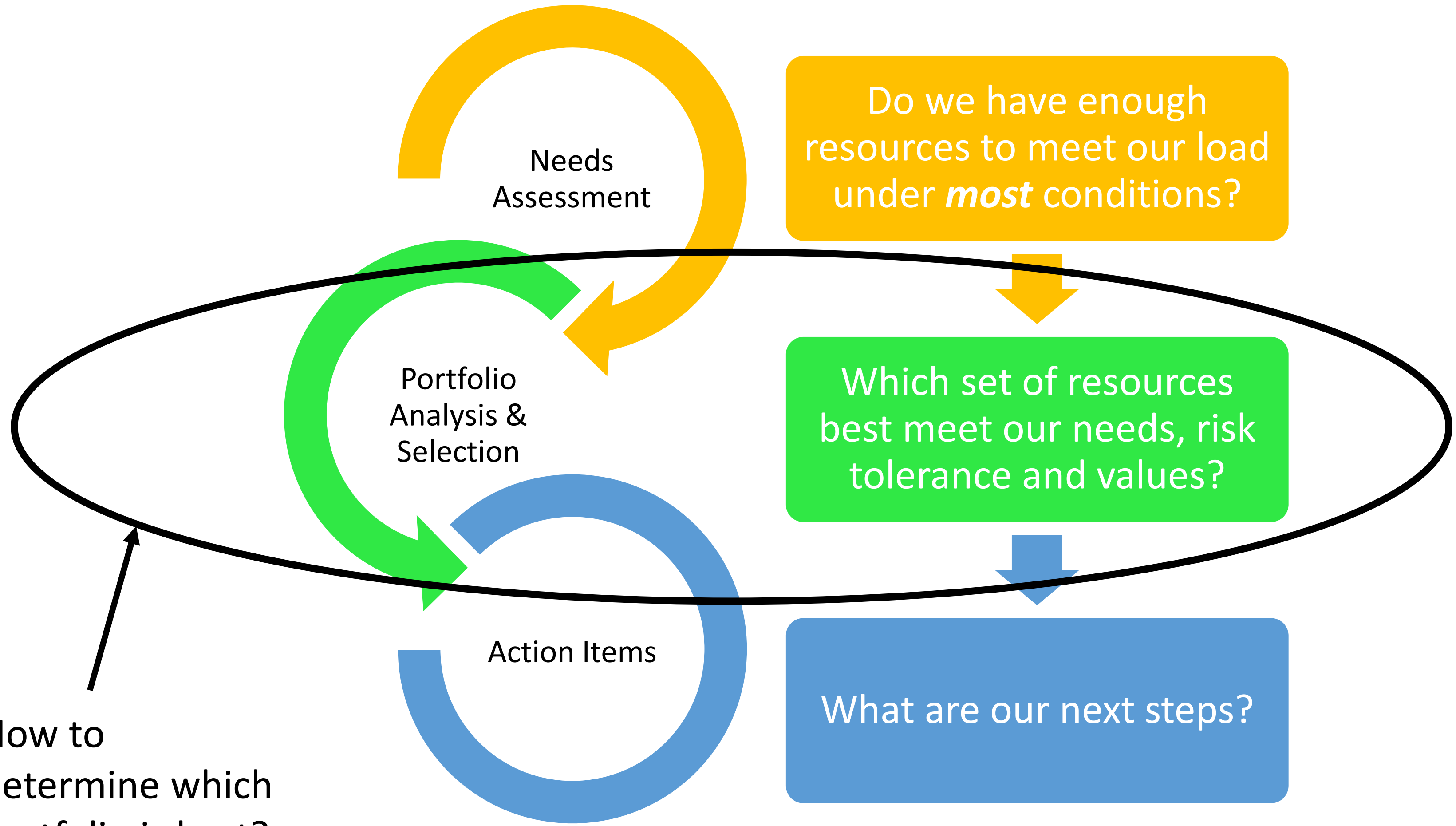
Portfolio Selection Metrics

How will we evaluate different portfolios?

TACOMA POWER
TACOMA PUBLIC UTILITIES

Reminder of IRP Process

TACOMA POWER
TACOMA PUBLIC UTILITIES



How to determine which portfolio is best?

Portfolio Selection Criteria

TACOMA POWER
TACOMA PUBLIC UTILITIES

PORTFOLIO SELECTION METRICS

Pass/Fail Criteria

Resource Adequacy

Resource Adequacy (RA) Standard

TACOMA POWER
TACOMA PUBLIC UTILITIES

What is Resource Adequacy?

- ✓ Having enough resource to serve loads

What is a Resource Adequacy Standard?

- ✓ Metric + Maximum Threshold

Example

Number of hours per year when we're short can be no more than 2.4

Metric → "Number of hours per year when we're short"

Threshold → "2.4"

Principles for a RA Standard

TACOMA POWER
TACOMA PUBLIC UTILITIES

Principles Used to Select a Standard

- ✓ Probabilistic (evaluates outcomes over all simulations)
- ✓ Choose from common standards used elsewhere
- ✓ Address three key dimensions of inadequacy events
  - Duration
  - Magnitude
  - Frequency
- ✓ Balance high reliability standards with costs

Draft Adequacy Standard

TACOMA POWER
TACOMA PUBLIC UTILITIES

PORTFOLIO SELECTION METRICS

DURATION

No more than 2.4 hours per year when we're short on average

Loss of Load Hours (LOLH) of 2.4 per year

MAGNITUDE

Shortage of no more than 0.001% of total load across the year on average

Normalized Expected Unserved Energy (NEUE) of 0.001% per year

FREQUENCY

No more than 2 days when we're short over 10 years (0.2 days per year) on average

Loss of Load Expectation (LOLE) of 0.2 days per year

ADEQUATE if all three standards are met

INADEQUATE if any of the three are not met

Portfolio Selection Criteria

TACOMA POWER
TACOMA PUBLIC UTILITIES

Pass/Fail Criteria	
Resource Adequacy	CETA compliance

PORTFOLIO SELECTION METRICS

CETA Compliance

TACOMA POWER
TACOMA PUBLIC UTILITIES

PORTFOLIO SELECTION METRICS

CETA Rule

✓ 100% of load met by non-emitting resources <u>or alternative compliance</u> 2030-2044 (up to 20% from alternative compliance)

COMPLIANT if 80% or more of load is served by carbon-free power

NON-COMPLIANT if less than 80% of load is served by carbon-free power

Portfolio Selection Criteria

TACOMA POWER
TACOMA PUBLIC UTILITIES

Pass/Fail Criteria

Resource Adequacy	CETA compliance

Metrics for Comparing Portfolios

Expected costs	Financial risk

What goes into portfolio costs?

TACOMA POWER
TACOMA PUBLIC UTILITIES

Calculate net present value (NPV) of costs for each simulation

Costs

- Capital Expenditure
- Operation & Maintenance
- Purchased Power
- Transmission
- Renewable Energy Certificates (RECs) to comply with I-937 & CETA
- Social Cost of Carbon Emissions

Offsets to Costs

- Power Market Sales less GET

PORTFOLIO SELECTION METRICS

Social Cost of Carbon Emissions

TACOMA POWER
TACOMA PUBLIC UTILITIES

Values determined by Department of Commerce rulemaking

Year in which emissions occur or are avoided	Social Cost of Carbon Dioxide (in 2018 dollars per metric ton)
2020	$74
2025	$81
2030	$87
2035	$93
2040	$100
2045	$106
2050	$113

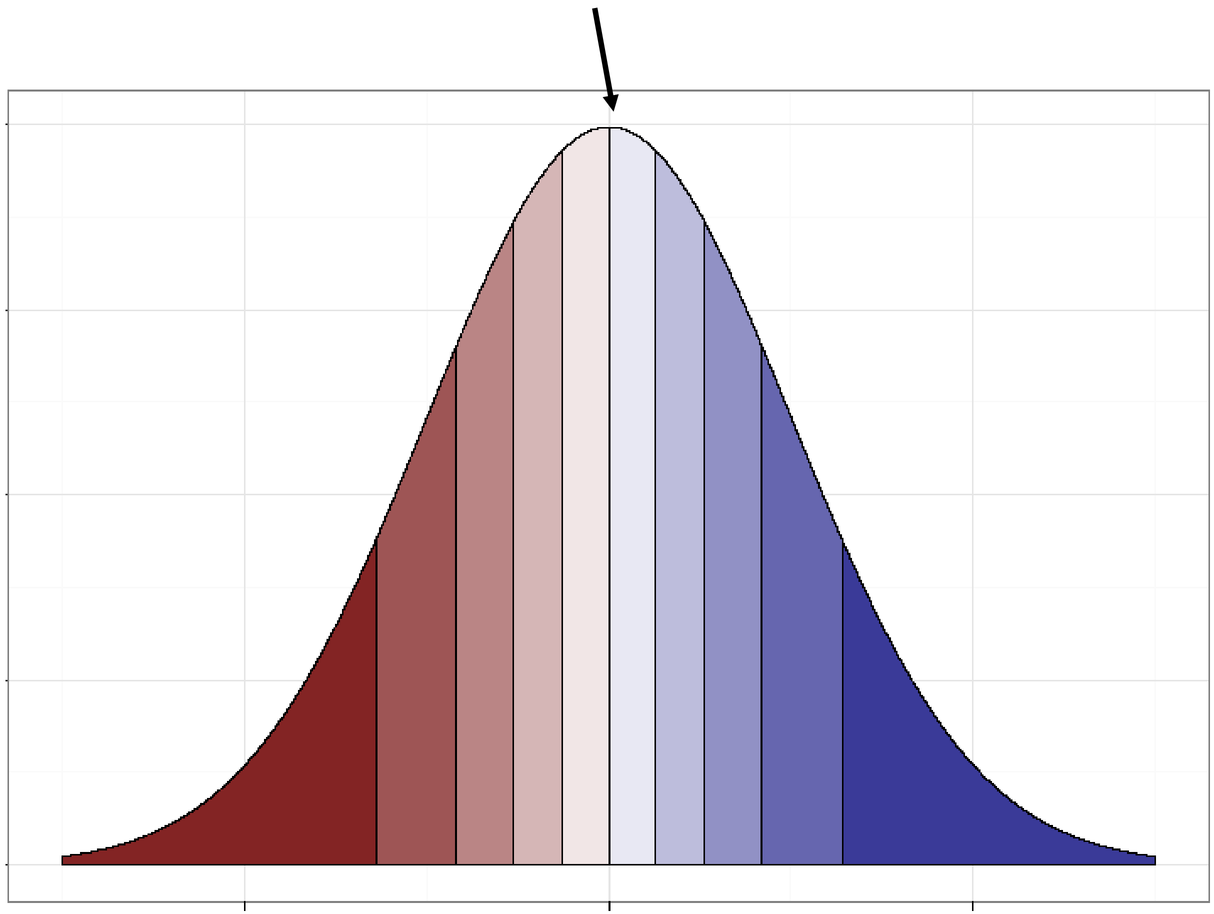
Applications

- ✓ Direct emissions from generation + leakage
- ✓ Emissions in market purchases

How do we calculate expected cost?

TACOMA POWER
TACOMA PUBLIC UTILITIES

EXPECTED COST
= average across all simulations

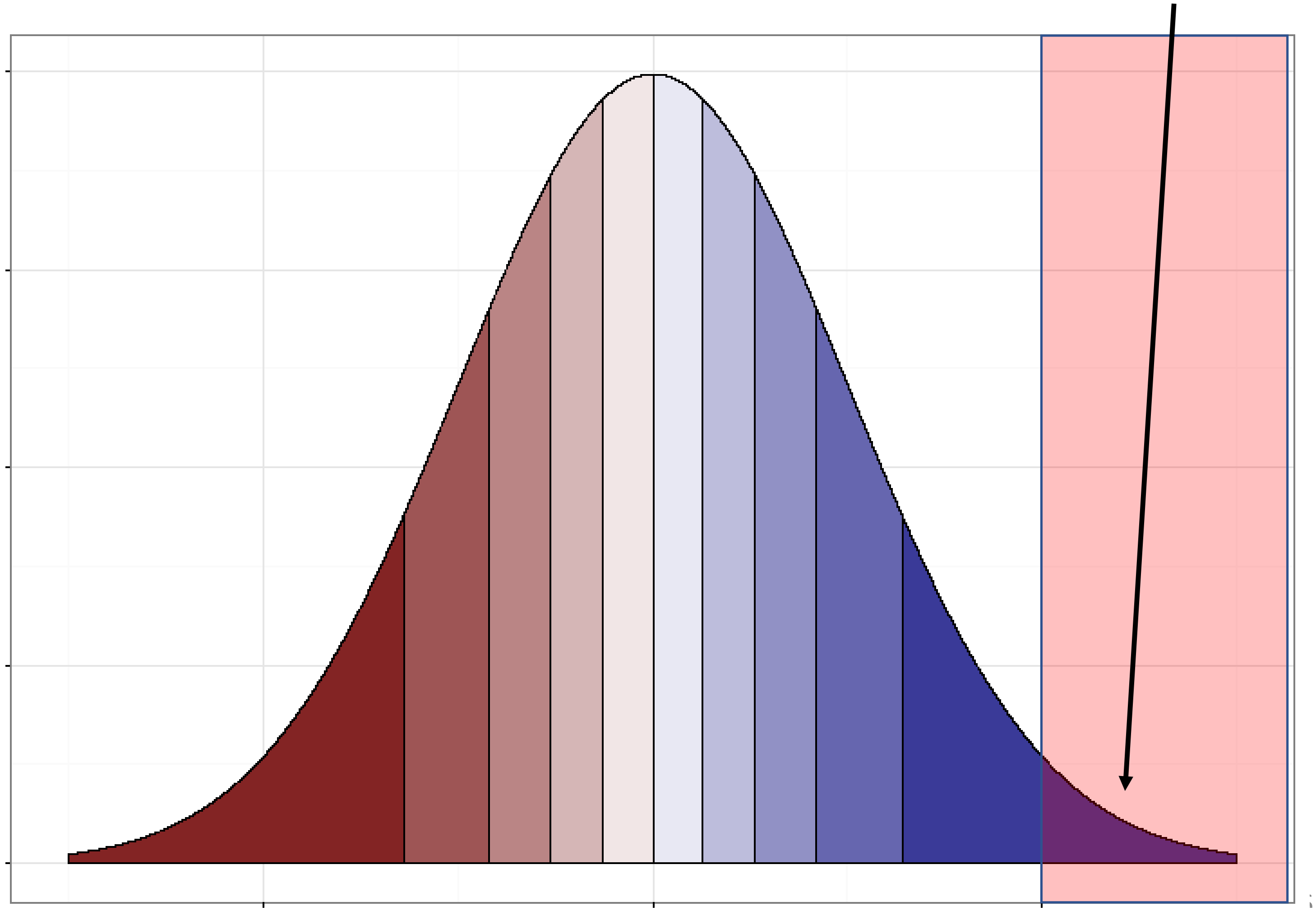


How do we evaluate financial risk?

TACOMA POWER
TACOMA PUBLIC UTILITIES

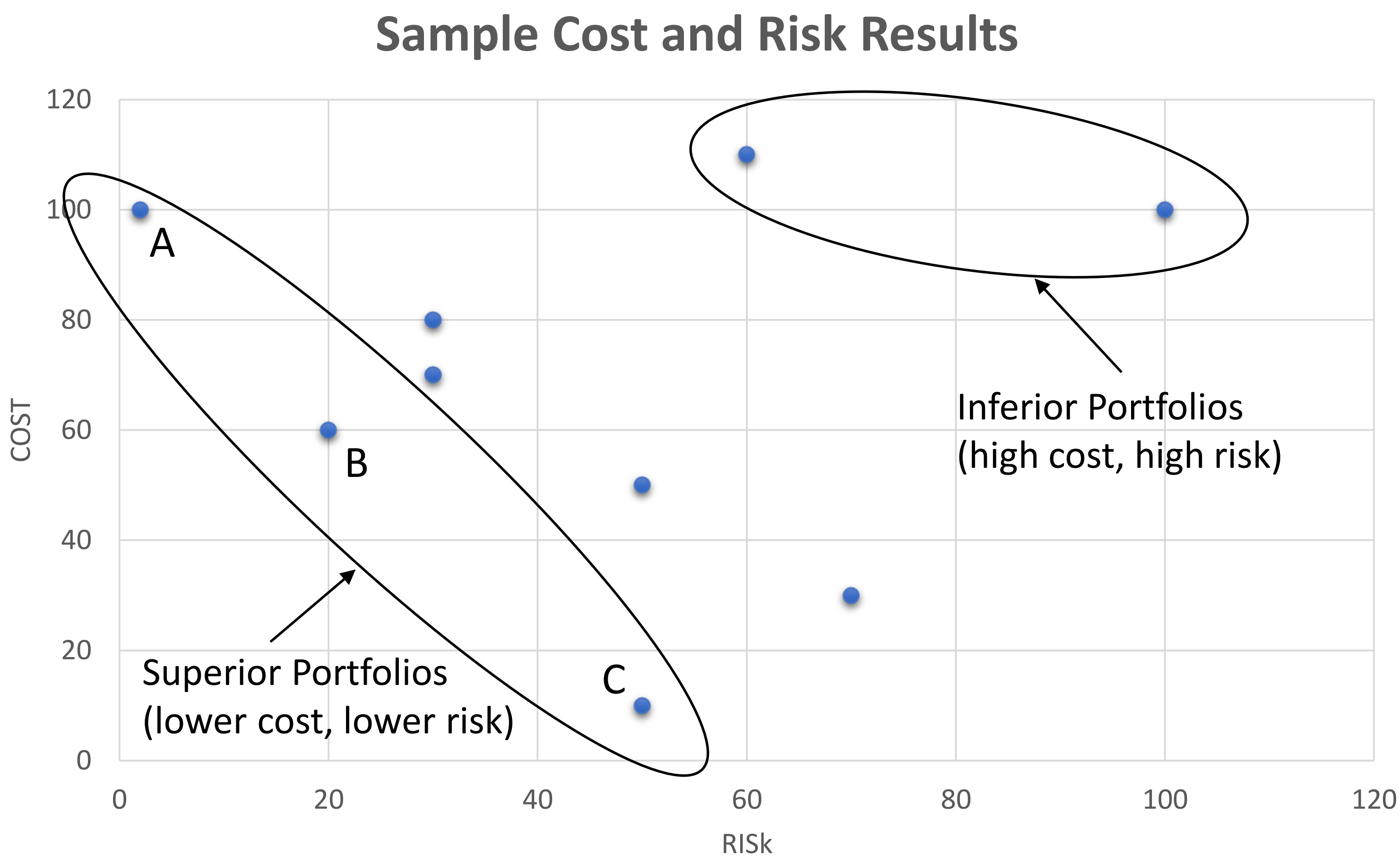
PORTFOLIO SELECTION METRICS

RISK
= average across 5% to 10% highest-cost outcomes



What do we do with the information?

TACOMA POWER
TACOMA PUBLIC UTILITIES



PORTFOLIO SELECTION METRICS

Portfolio Selection Criteria

TACOMA POWER
TACOMA PUBLIC UTILITIES

Pass/Fail Criteria

Resource Adequacy	CETA compliance

Metrics for Comparing Portfolios

Expected costs	Financial risk	Ability to change course

Ability to Change Course

TACOMA POWER
TACOMA PUBLIC UTILITIES

PORTFOLIO SELECTION METRICS

Five-point scale to qualitatively reflect the value of having flexibility to adjust to a changing world.

5
- Demand-side resources (conservation, demand response) that can be invested in piecemeal rather than all at once

4
- Short-term contracts (<10 years)

3
- Medium-term contracts (10 to 15 years)

2
- Long-term contracts (>15 years)

1
- Any large resources that we build or acquire

Portfolio Selection Criteria

TACOMA POWER
TACOMA PUBLIC UTILITIES

Pass/Fail Criteria

Resource Adequacy	CETA compliance

Metrics for Comparing Portfolios

Expected costs	Financial risk	Ability to change course	Carbon emissions

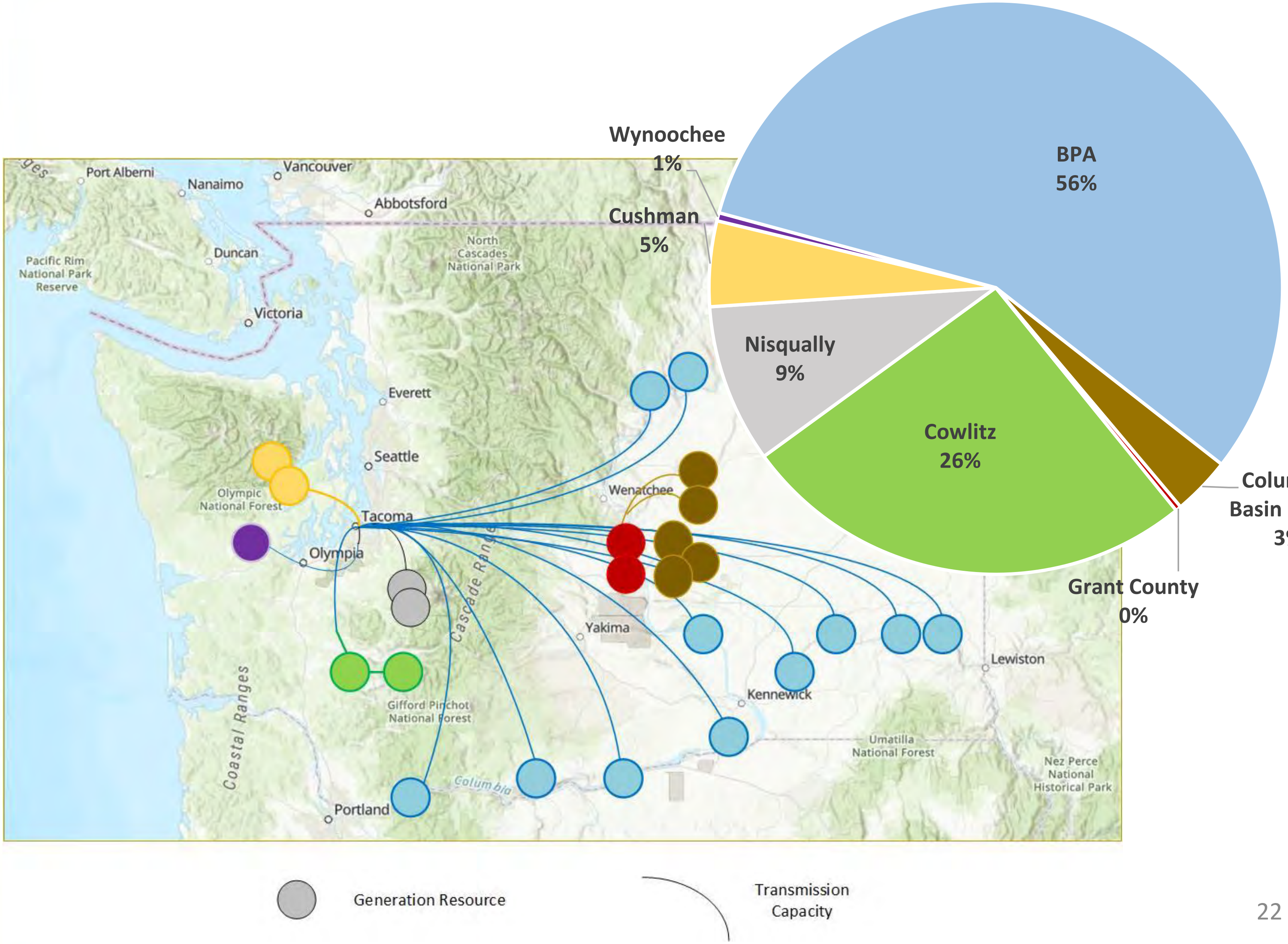
Tacoma Power's Current Portfolio

What resources do we have today?

TACOMA POWER
TACOMA PUBLIC UTILITIES

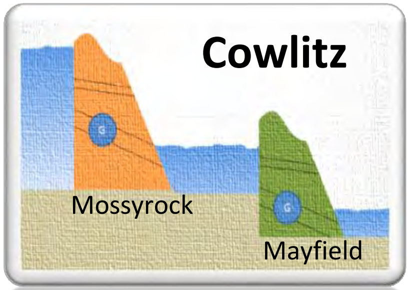
Our Resources Today

TACOMA POWER
TACOMA PUBLIC UTILITIES

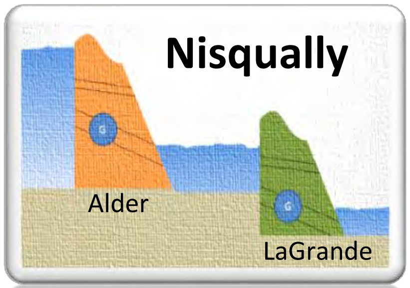


CURRENT PORTFOLIO

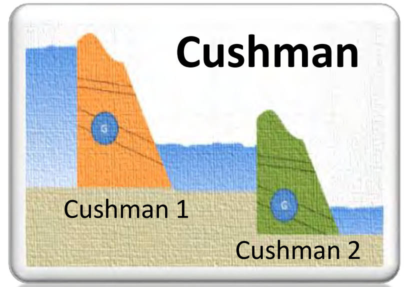
Our Hydro Projects



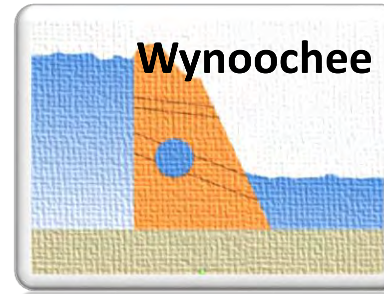
- **26%** of Tacoma's generating portfolio
- Total generating capacity = 560MW
- Significant storage and flexibility at Mossyrock
- Continuous outflow at Mayfield
- Diminished storage at Cowlitz due to Riffe Lake upper seismic operating limit*



- **9%** of Tacoma's generating portfolio
- Total generating capacity = 116MW
- Limited storage and some shaping flexibility at Alder
- Continuous outflow at LaGrande



- **5%** of Tacoma's generating portfolio
- Total generating capacity = 135MW
- Flexible when there are sufficient flows



- **1%** of Tacoma's generating portfolio
- Total generating capacity = 13MW
- Run-of-river operations

* www.mytpu.org/about-tpu/services/power/about-tacoma-power/dams-power-sources/cowlitz-river-project/mossyrock-dam

BPA Purchased Power

TACOMA POWER
TACOMA PUBLIC UTILITIES

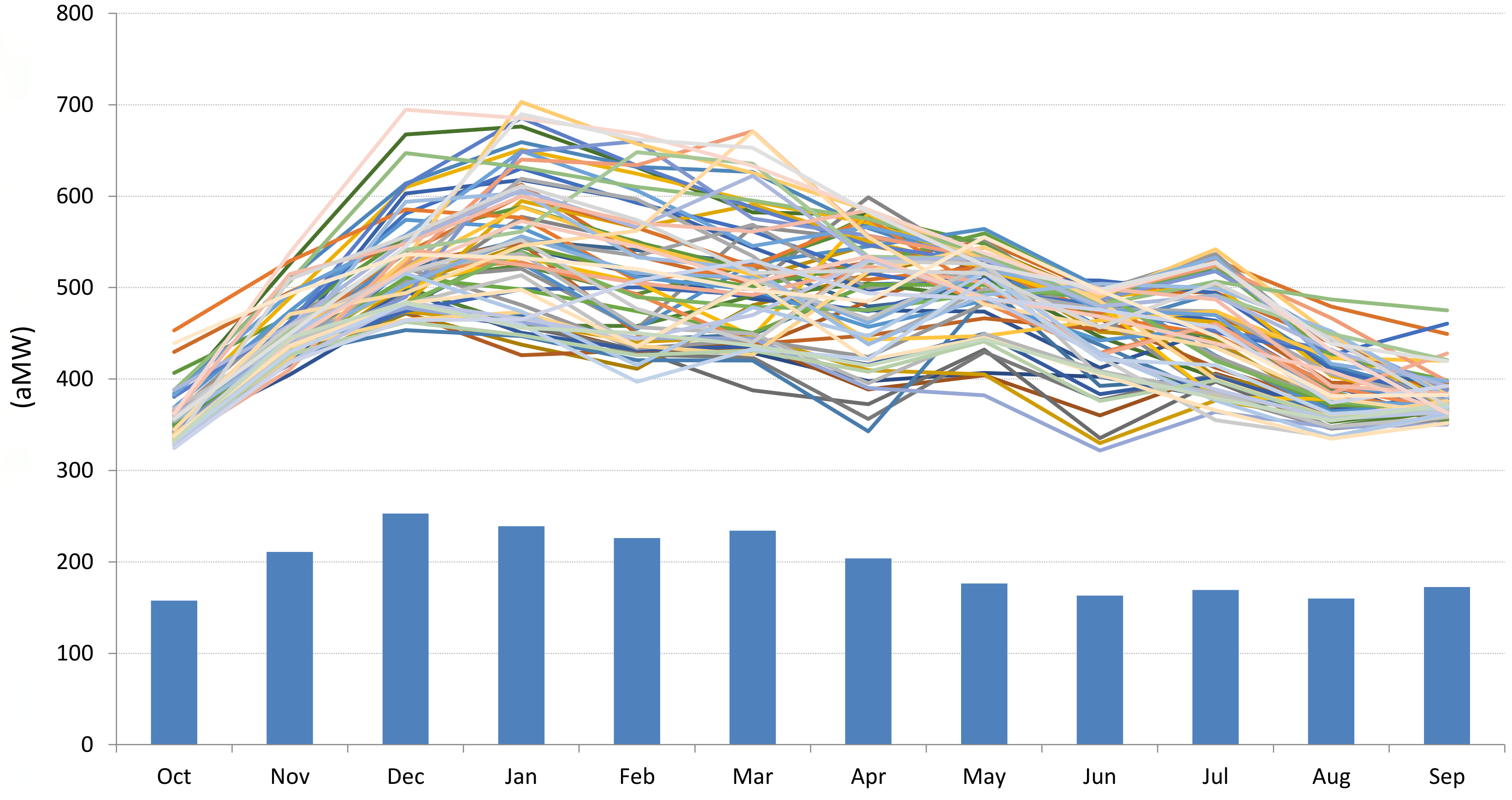
Overview

BONNEVILLE
POWER ADMINISTRATION

- BPA is a Federal Power Marketing Agency
  - ✓ 21 US Army Corp of Engineer Dams (14,650 MW)
  - ✓ 10 Bureau of Reclamation Dams (7,800 MW)
  - ✓ Columbia Generating Station (Nuclear, 1,100 MW)
  - ✓ Several Wind Generation contracts (58 aMW)
- Power is sold at cost (Currently ~ $32/MWh)
- Tacoma Power has been a BPA customer since 1940
- Tacoma Power is BPA's 4th largest customer (~$120M/year, ~5.5% of BPA's total load)
- Current Contract Expires September 2028

BPA Slice/Block Product

TACOMA POWER
TACOMA PUBLIC UTILITIES



CURRENT PORTFOLIO

BPA "Preference" Power Products

TACOMA POWER
TACOMA PUBLIC UTILITIES

BPA's statutes require it to:

- Provide power to public utilities (or "preference customers") upon request
- Amount of power is based upon the requesting utility's Total Retail Load less its own resources under "critical water" conditions ("Net Requirement")
- Net Requirement (NR) is determined annually based upon our load forecasts (Example to right):

	aMW
Total Retail Load	580
Less: Tacoma Resources (Critical Water)	185
BPA "Net Requirement"	**395**
↓	
Critical "Slice" @ 2.96%	**200**
Block (Net Requirement less Slice)	**195**

CURRENT PORTFOLIO

Columbia Basin Hydro & Grant County

TACOMA POWER
TACOMA PUBLIC UTILITIES

Columbia Basin Hydro

- 5 Irrigation Canals (Staggered Terms 2022-2026)
- ~27 aMW in months of March through October
- Pricing (~$29/MWh) = Cost (~$12/MWh) + Incentive Payment (~$17/MWh)

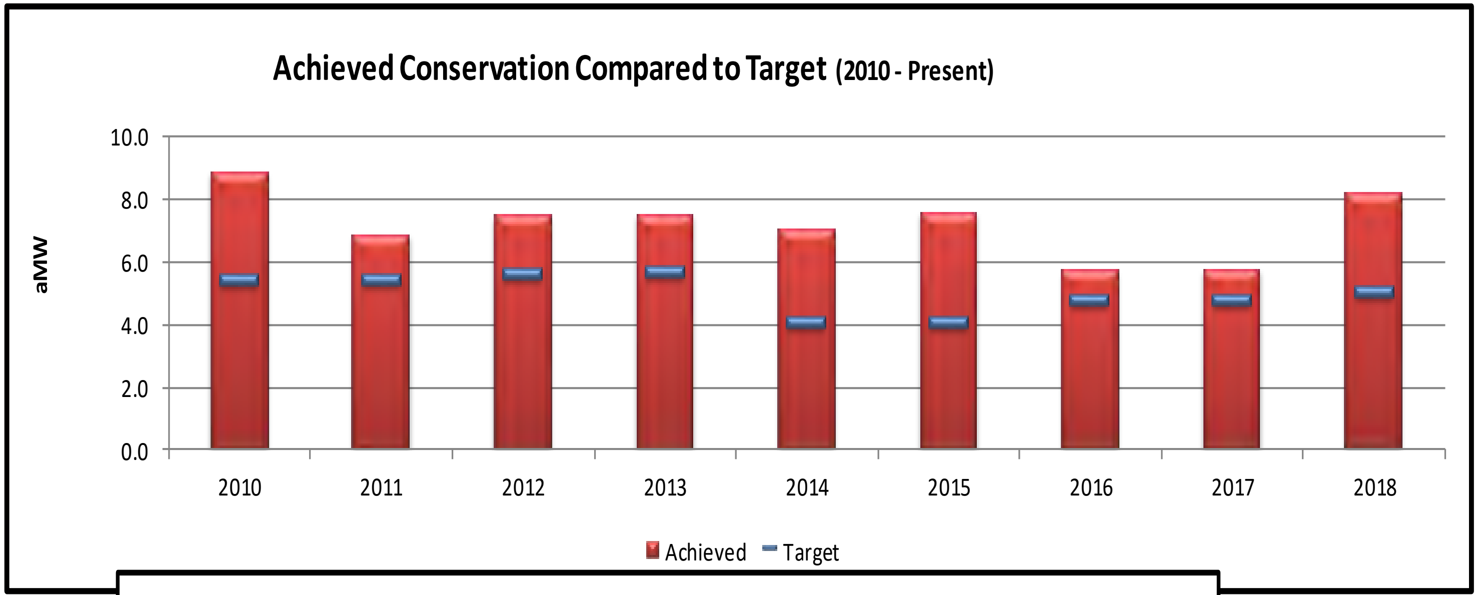
Grant County Contract

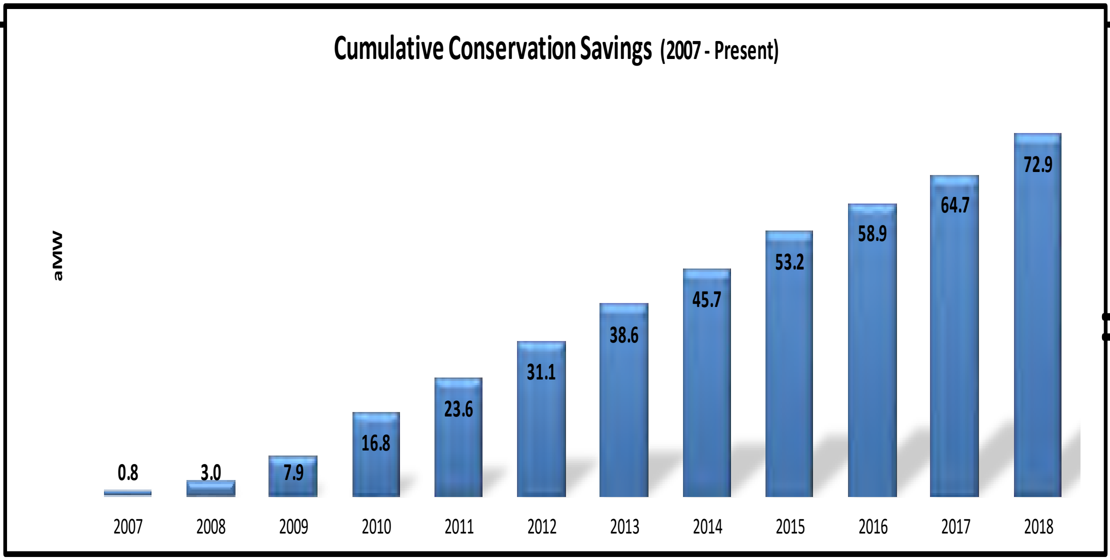
- .29% "slice" share of Priest Rapids and Wanapum Dams (expires 2052)
- ~2.5 aMW Similar in shape to the BPA Slice product
- Pricing (~$11/MWh) = Cost + Share of proceeds from auction of excess energy

CURRENT PORTFOLIO

Conservation

TACOMA POWER
TACOMA PUBLIC UTILITIES





=

CURRENT PORTFOLIO

Conservation Potential Assessment

How much conservation can we acquire?

How much should we acquire?

TACOMA POWER
TACOMA PUBLIC UTILITIES

Outline

1. Role of CPA in Planning
2. Types of Potential
3. Conservation History
4. Conservation Plans
5. Factors Impacting CPA Results
6. Recent CPA Results

Role of CPA in Planning

TACOMA POWER
TACOMA PUBLIC UTILITIES

Conservation Potential Assessment (CPA) data output used in IRP to model conservation impacts on load forecast

Identify measures

- With net benefit to the service area
- With utility costs lower than generation
- That improve the load-resource balance
- For development in conservation acquisition plan

Energy Conservation – State Law

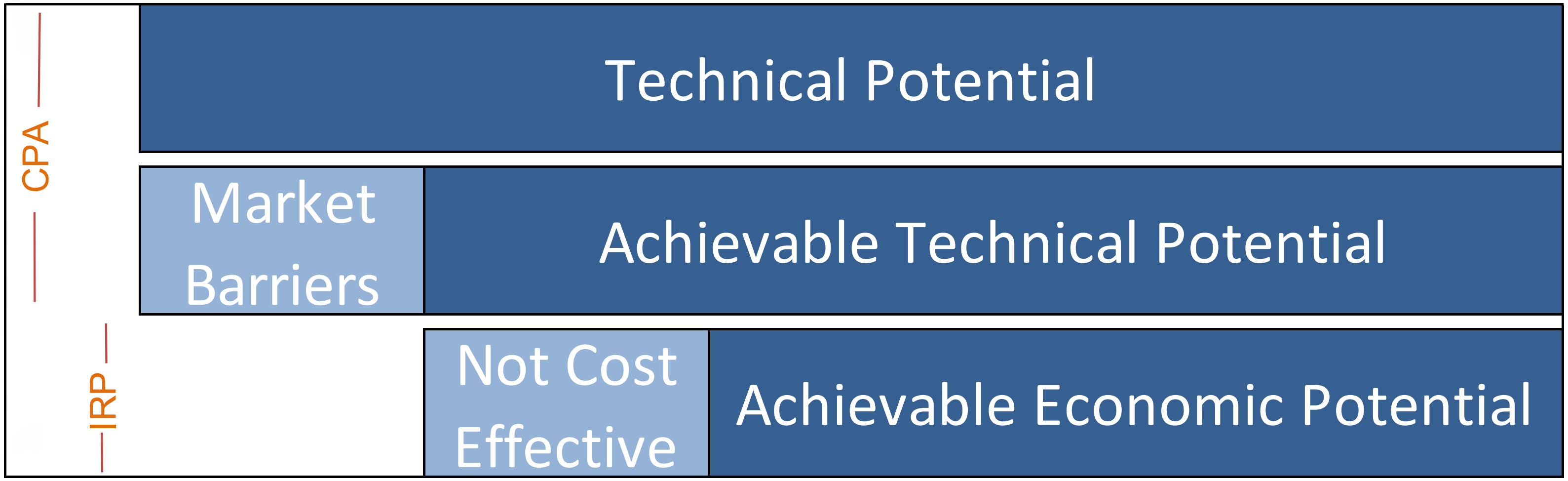
TACOMA POWER
TACOMA PUBLIC UTILITIES

The Energy Independence Act requires qualifying utilities to determine their conservation potential using "methodologies consistent with those used by the Pacific Northwest Electric Power and conservation planning council" (19.285.040(1)(a) RCW)

The Energy Independence Act is codified in WAC 194-37 which requires qualifying utilities to establish a:

- 10-year conservation resource potential every two-years
- Biennial conservation target that is "no less than its pro rata share of its ten-year potential."

Definitions of Potential



Achievable economic potential simplified here. Due to BPA contract requirements, conservation results in purchase of less BPA resource.

Conservation Accomplishments

Consistently achieve beyond our target

Getting harder to acquire savings

2019 By sector

- 29% Residential
- 71%Commercial/Industrial

Major Factors Affecting Potential

TACOMA POWER
TACOMA PUBLIC UTILITIES

End-use saturation and efficiency levels

Baselines – codes, standards, markets

Recent accomplishments

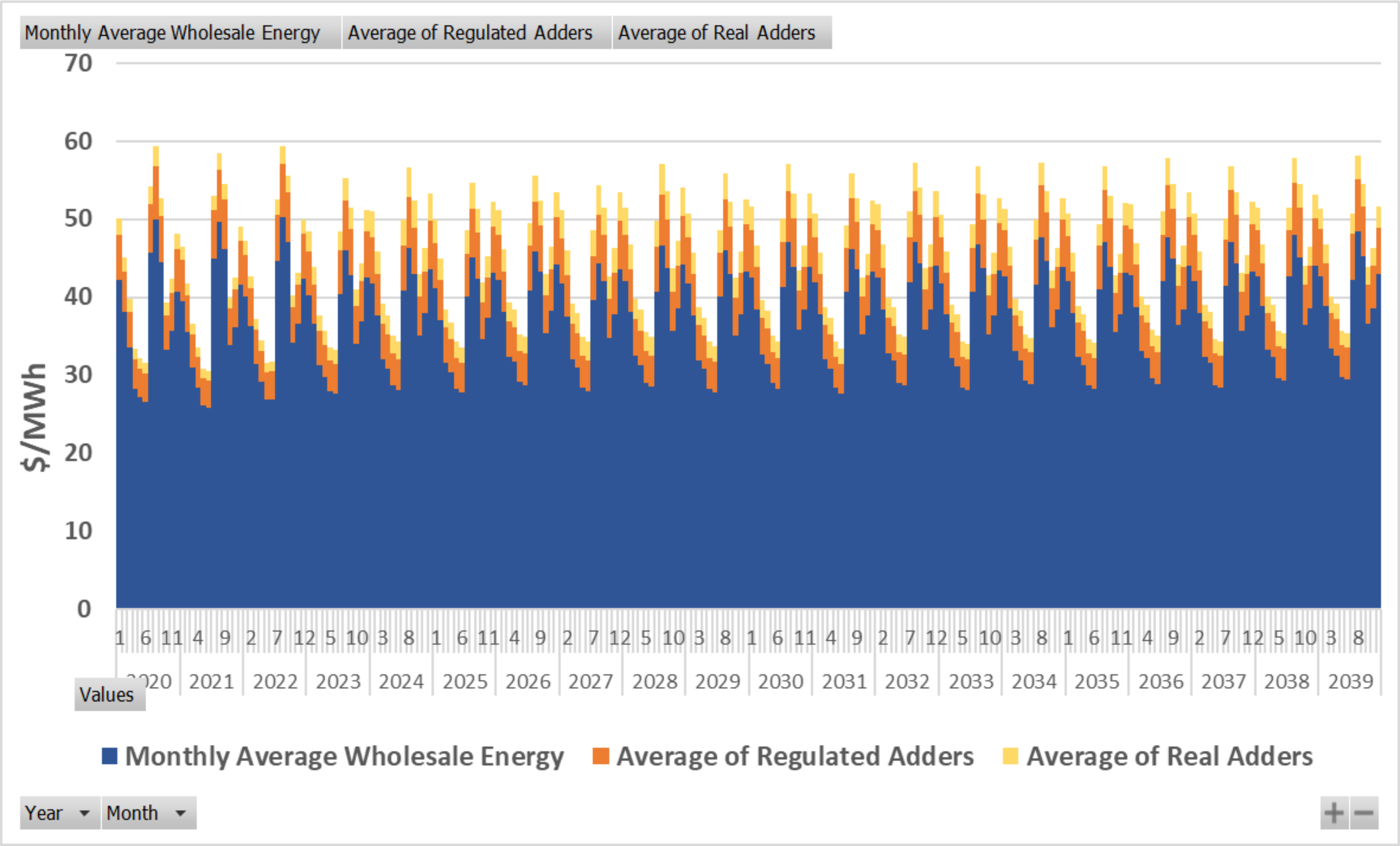
Measure assumptions

New technology

Avoided price forecasts

TRC Forecast Avoided Costs

TACOMA POWER
TACOMA PUBLIC UTILITIES



CONSERVATION POTENTIAL ASSESSMENT

Active Programs

TACOMA POWER
TACOMA PUBLIC UTILITIES

Residential

Weatherization

Heating Systems

Consumer Products

New Construction & Custom Projects

Quick Energy Savers

Hard to Reach

-Owner Occupied

-Rentals/Apartments

-Agency Partnerships

Commercial/Industrial

Bright Rebates

Custom Retrofit

Equipment Rebates

New Construction

Strategic Energy Management

Other

NEEA

Distribution Efficiency

20-Year Conservation Potential

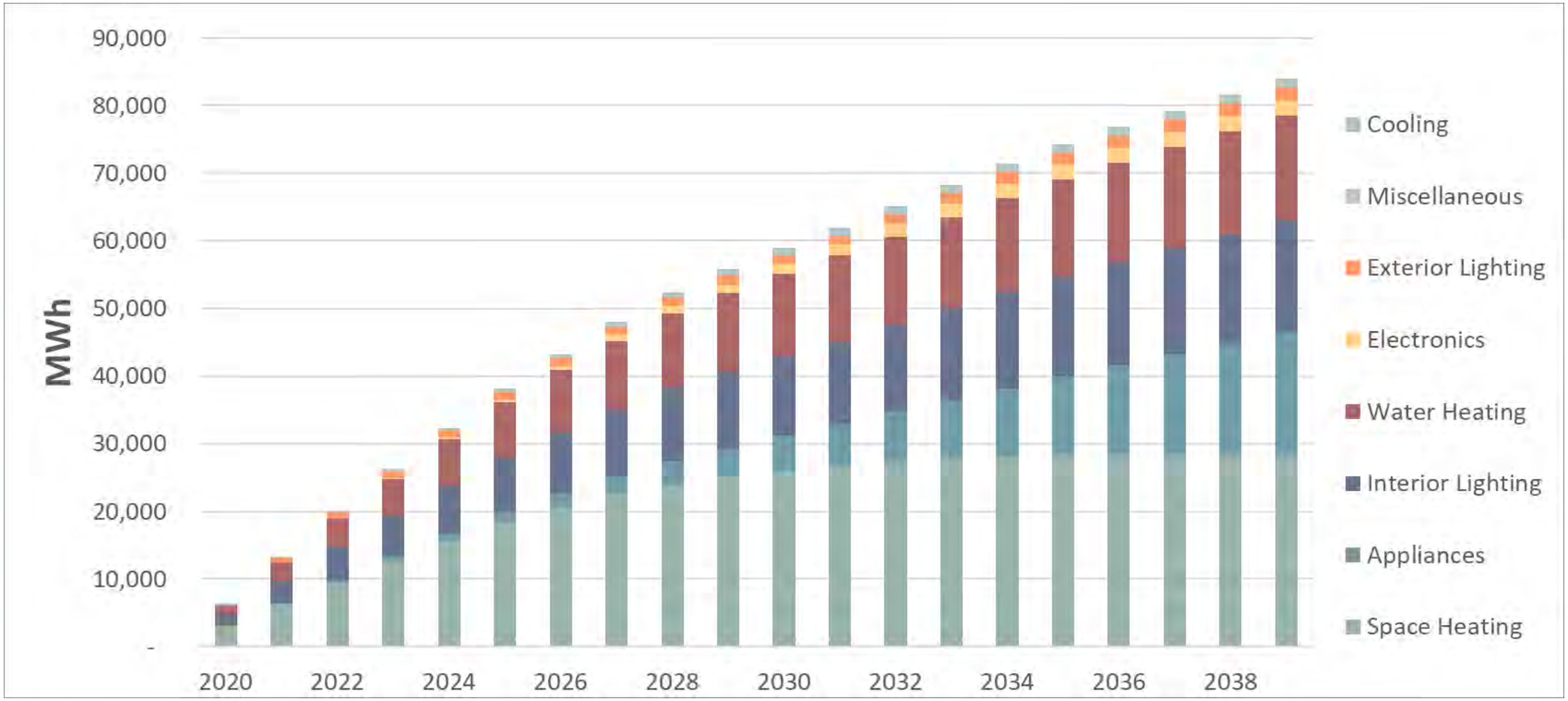
TACOMA POWER
TACOMA PUBLIC UTILITIES

CONSERVATION POTENTIAL ASSESSMENT

	Achievable Technical Potential (GWh)	Economic Achievable Potential (GWh)	Percent 2039 Baseline
Residential	355	84	4.0%
Commercial	248	171	13.6%
Industrial	115	94	5.9%
JBLM Residential	7	2	5.0%
JBLM Commercial	31	22	7.5%
Street Lighting	6	6	31.2%
Distribution Efficiency	14	11	0.2%
Total	775	389	8.0%

Residential Potential: 84,029 MWh

TACOMA POWER
TACOMA PUBLIC UTILITIES



Lighting accomplishments and federal standards impact remaining potential

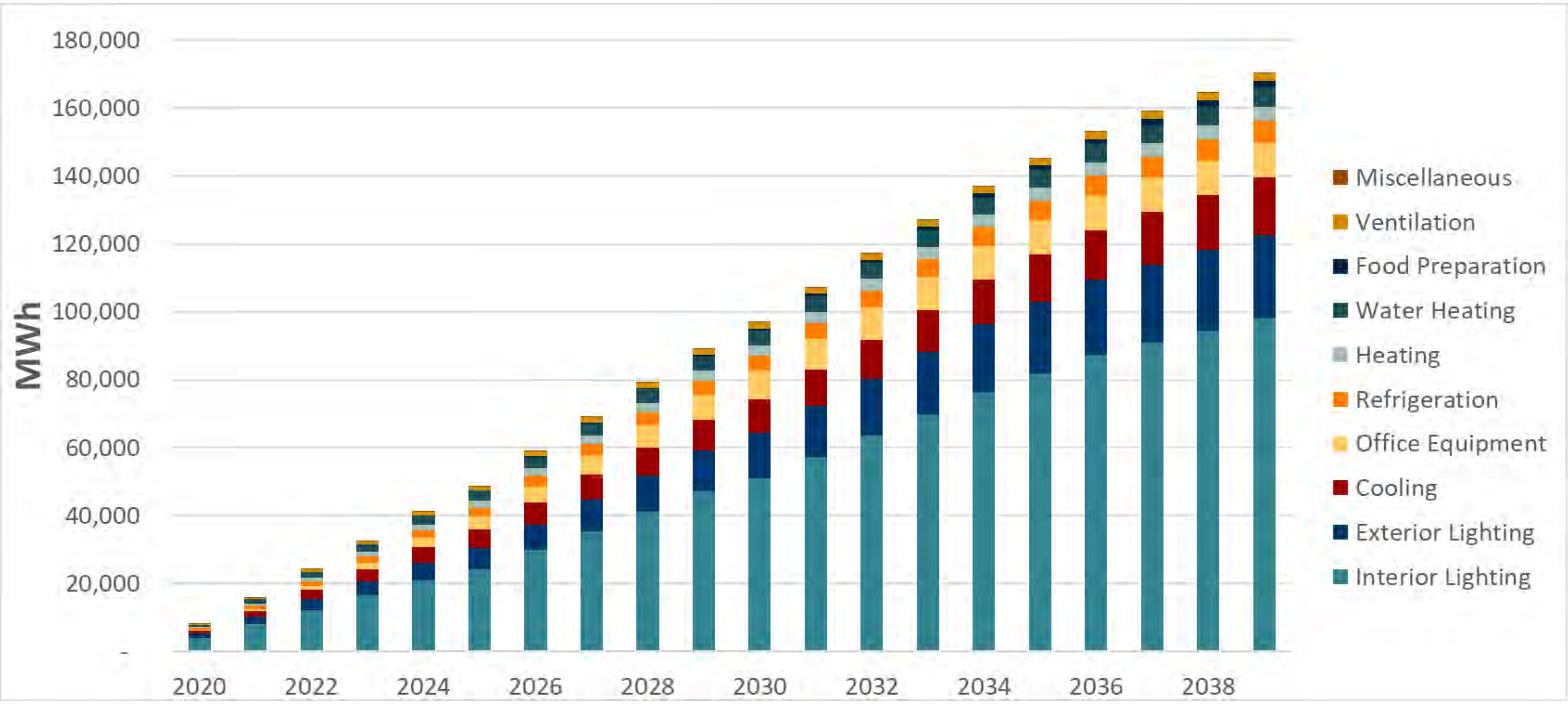
Fewer economic weatherization measures make it more difficult to implement the program

A combination of Energy Star appliances will eventually become a significant opportunity

CONSERVATION POTENTIAL ASSESSMENT

Commercial Potential: 171,549 MWh

TACOMA POWER
TACOMA PUBLIC UTILITIES



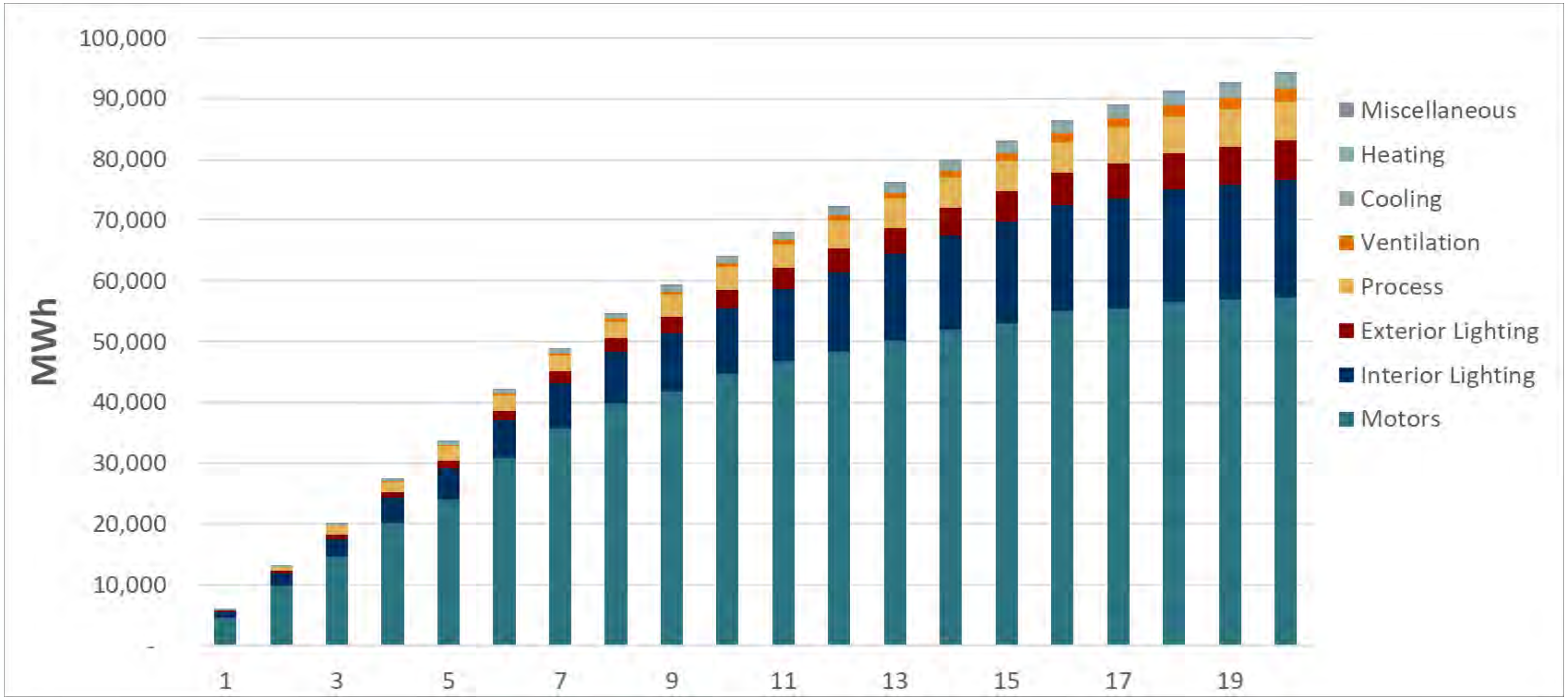
Lighting is nearly 30% of commercial consumption and 72% this sector's conservation potential

Existing buildings account for 65% of the sector potential

62% of sector potential is from office, retail, school, hospital and misc. segments

Industrial Potential: 94,397 MWh

TACOMA POWER
TACOMA PUBLIC UTILITIES

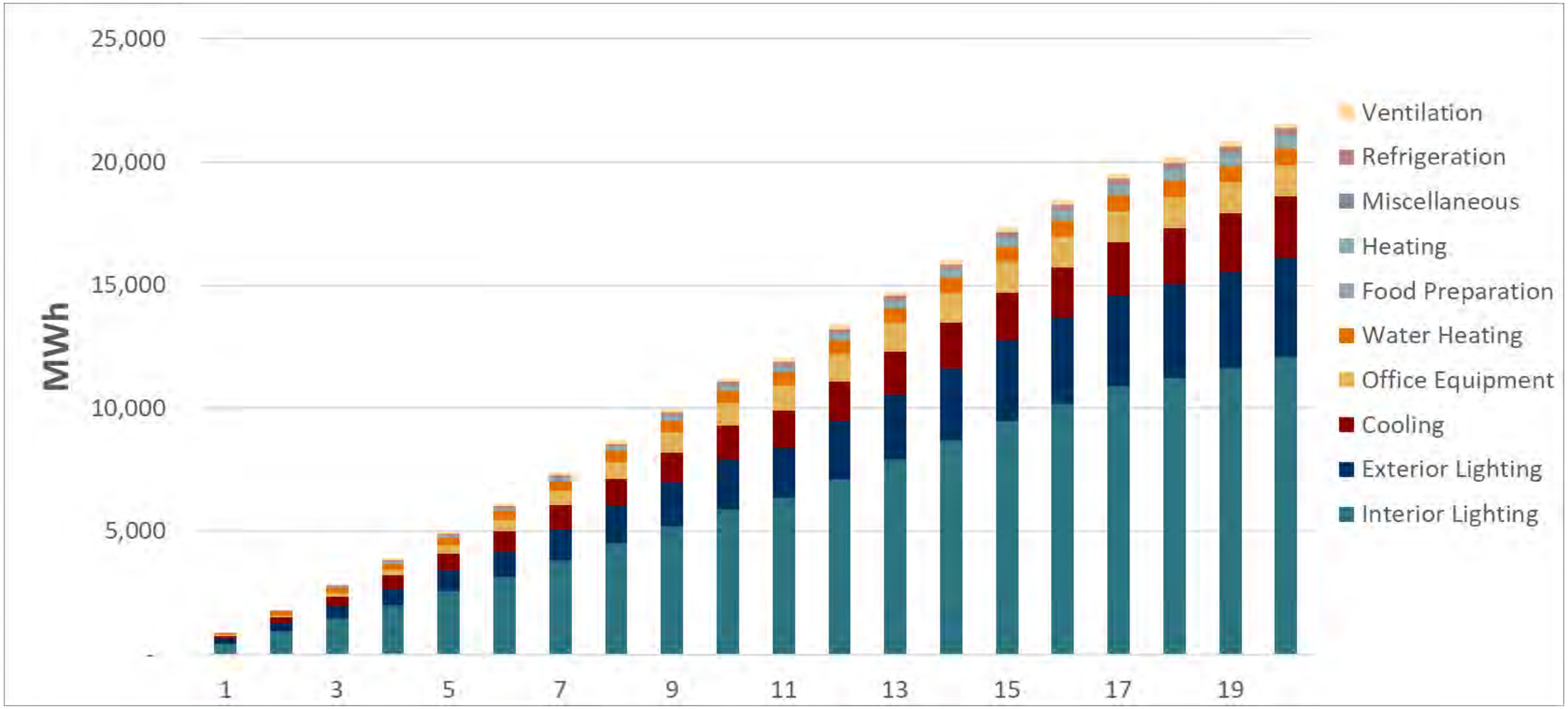


Like previous results, motors continue to dominate industrial potential, about 60% of sector potential

Lighting is a strong 27% of the sector potential

JBLM Commercial: 21,569 MWh

TACOMA POWER
TACOMA PUBLIC UTILITIES



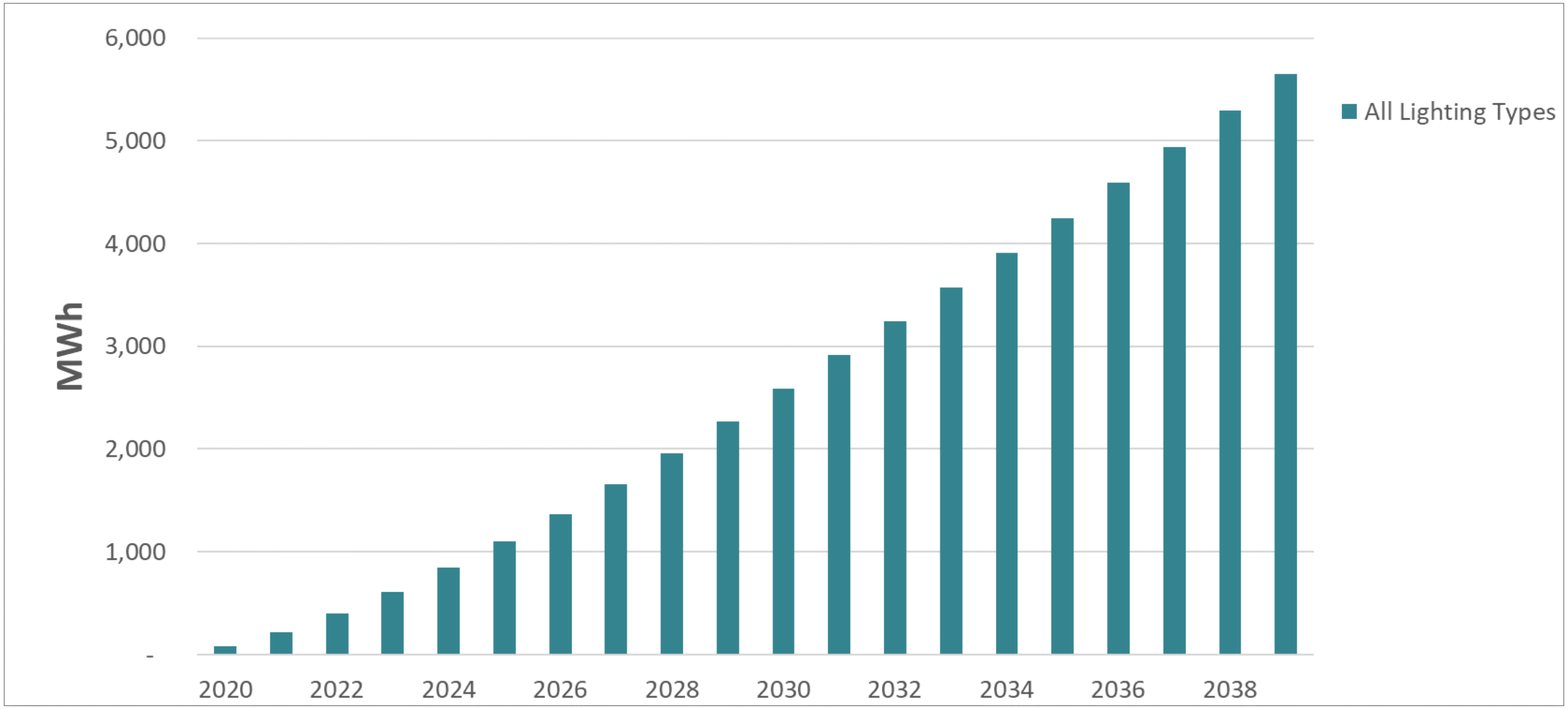
Like civilian commercial, lighting dominates at 74% of potential

Combined HVAC potential contributes 14%

JBLM potential assumes a slower implementation

On/Off Street Lighting: 5,649 MWh

TACOMA POWER
TACOMA PUBLIC UTILITIES



Spread among many different wattage and fixtures types

About 50% in the 100 and 400 watt equivalent

Codes and Standards

TACOMA POWER
TACOMA PUBLIC UTILITIES

By the year 2039, existing state building codes and federal energy standards on equipment are projected to reduce overall load by 122,119 MWh (built into the forecast)

Sector	Impact (MWh)	% of Baseline Load
Residential	44,678	~2.1%
Commercial	60,067	~4.5%
Industrial	5,727	~0.1%
JBLM	11,647	~1.0%

Base Case Load Forecast

How much load do we expect in our base case?

TACOMA POWER
TACOMA PUBLIC UTILITIES

Load Forecast Outline

TACOMA POWER
TACOMA PUBLIC UTILITIES

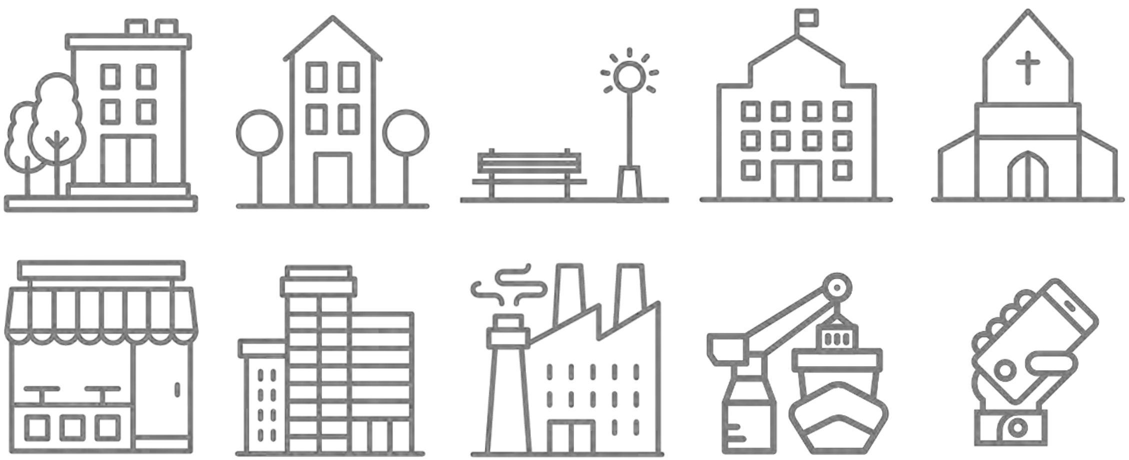
1. Introduction to Load Forecasting
2. National Trends in Electricity Use
3. Critical Drivers
4. Forecasting Methodology
5. Forecast Products

This is where we answer the question "what is a load forecast?"

Introduction to Load Forecasting

Tacoma Power is an electric power service provider.

As an electric power provider, Tacoma Power energizes everything from street lights to large industrial operations.



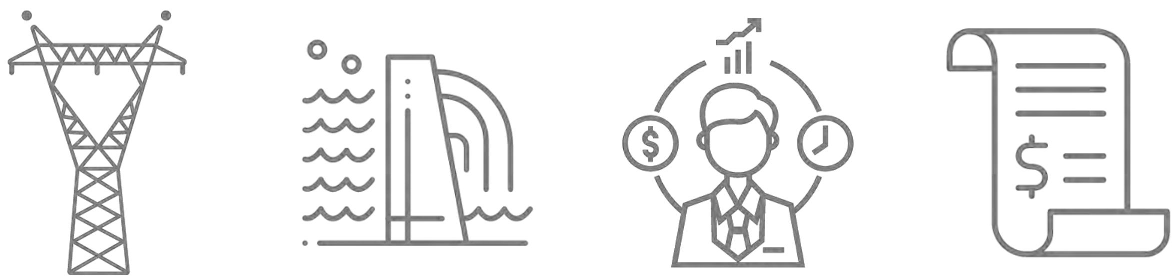
We call the collection of all our retail services our system. The electric power that's consumed on our system is called system load.

Introduction to Load Forecasting

TACOMA POWER
TACOMA PUBLIC UTILITIES

Tacoma Power stands ready to serve every customer's need at every moment.

Tacoma Power does this by securing adequate infrastructure and resources.



Transmission & Distribution

Owned Hydroelectric Generation

Wholesale Transactions

Contracts & PPAs

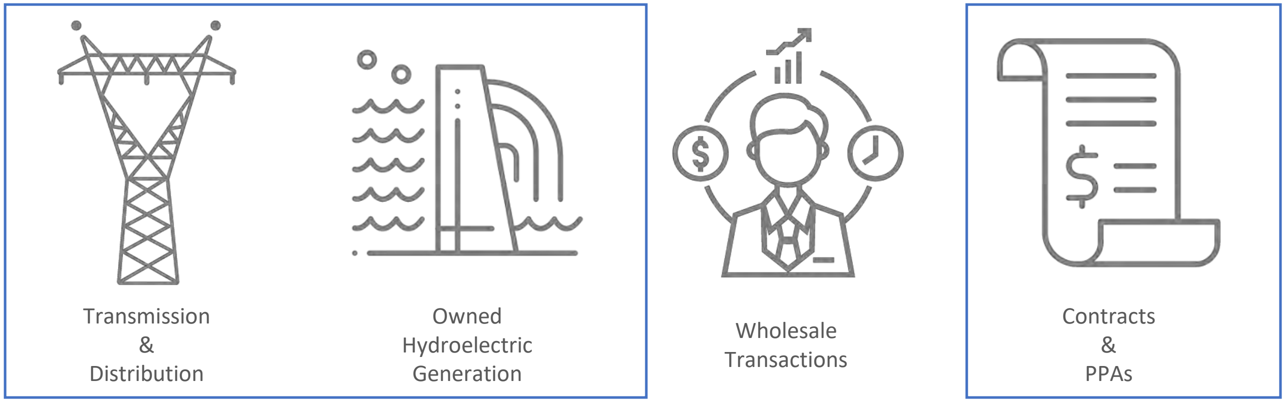
Tacoma Power relies on real-time, short-term, and long-term forecasts to know how much infrastructure and resource will be adequate at every moment.

Introduction to Load Forecasting

TACOMA POWER
TACOMA PUBLIC UTILITIES

Tacoma Power's long term load forecast is the subject of this presentation.

Generally speaking, long-term load forecasts inform long-term infrastructure and resource planning.



Utilities need long-term load forecasts because it usually takes a long time to build things like power plants, substations, and transmission infrastructure.

Introduction to Load Forecasting

TACOMA POWER
TACOMA PUBLIC UTILITIES

The long term load forecast is a projection of Tacoma Power's service requirements.

- Tacoma Power's long-term load forecast spans the next twenty years.
- The objective of the long-term load forecast is to provide a "business-as-usual case". No assumptions about new policies or technologies are included.
- The long-term load forecast is developed using a set of models that consider economic, demographic, weather, and service area trends.

All forecasts are wrong.
Some are Useful.

George Box

one of the greatest statistical minds of the 20th century

This is where we take a step back.

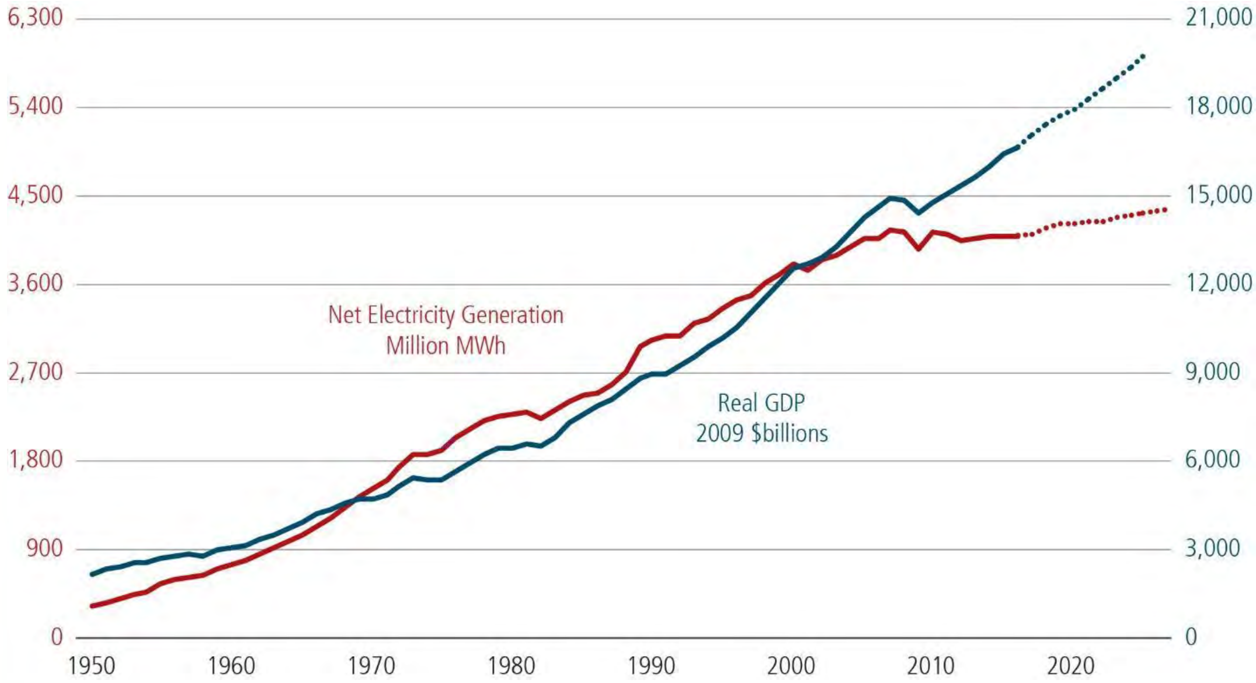
National Trends in Electricity Use

National Trends

TACOMA POWER
TACOMA PUBLIC UTILITIES

Historically, electricity demand was coupled with economic growth. Around 2000, this relationship changed.

Gross Domestic Product and Net Electricity Production
Historical (1950-2016) and Projected (2017-2027)

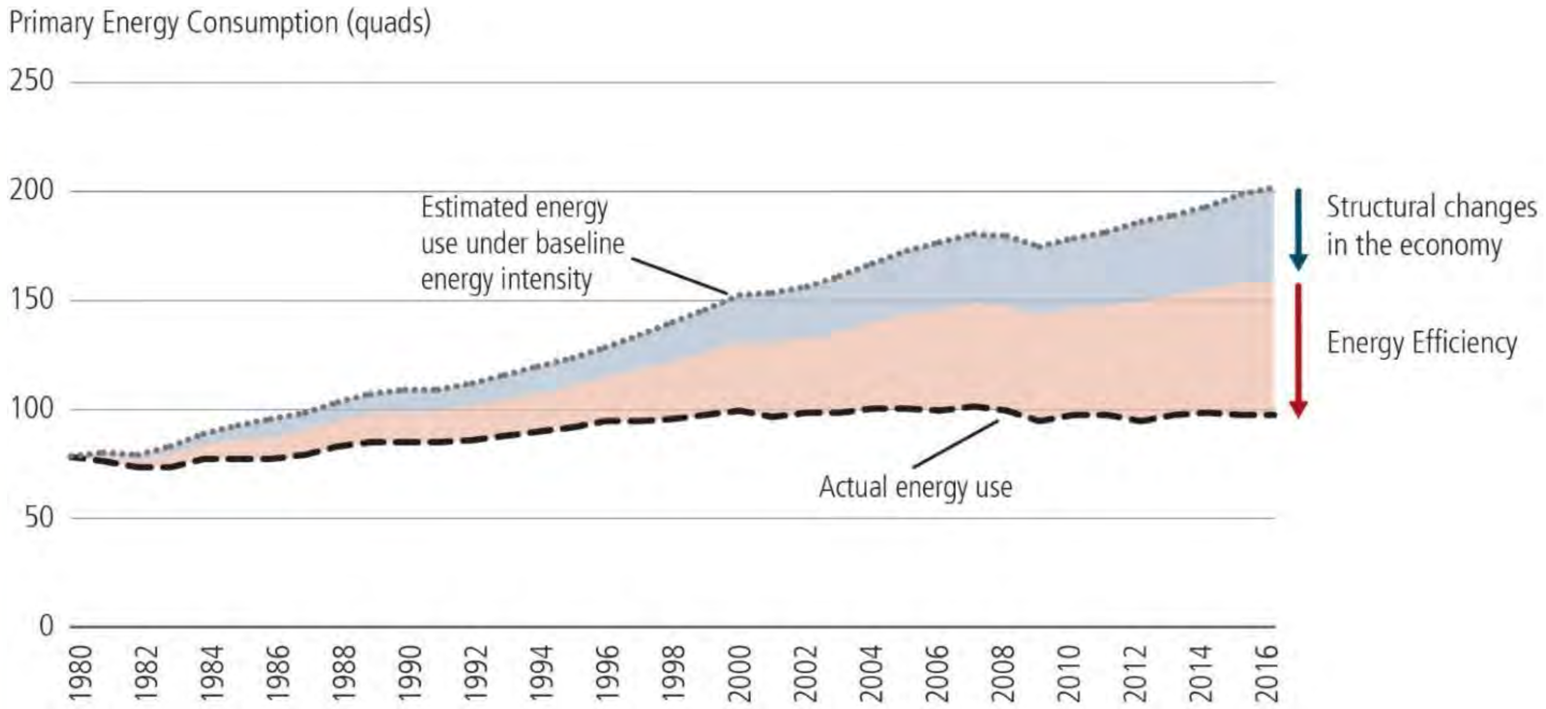


U.S. Department of Energy | Staff Report on Electricity Markets and Reliability, August 2017

TACOMA POWER
TACOMA PUBLIC UTILITIES

The decline in the demand growth rate can be attributed to a variety of factors.

Estimated U.S. Energy Savings from Structural Changes in the Economy and Energy Efficiency
1980-2016

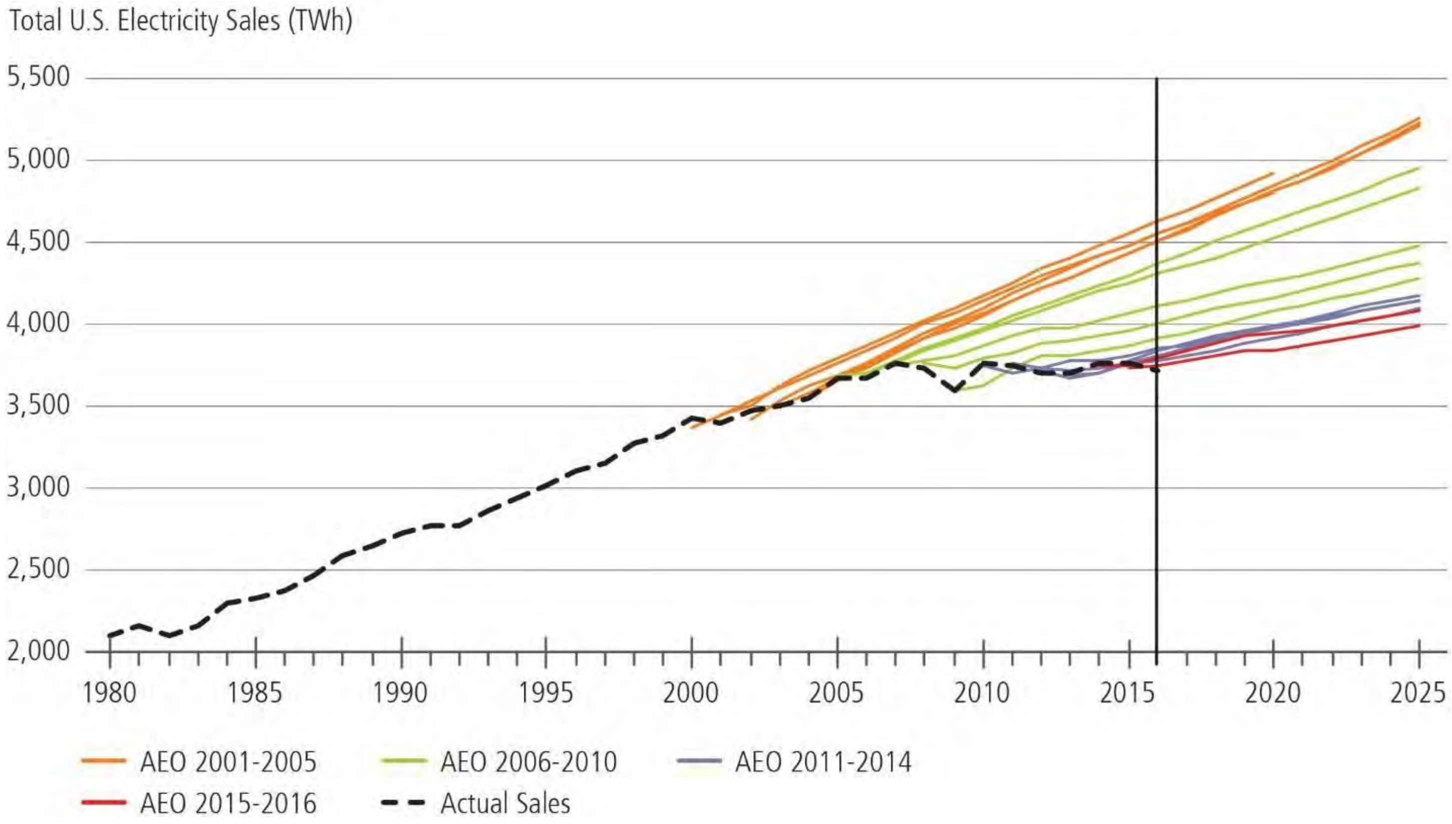


U.S. Department of Energy | Staff Report on Electricity Markets and Reliability, August 2017

TACOMA POWER
TACOMA PUBLIC UTILITIES

A changing policy and market environment has made it difficult to accurately forecast national electric load.

U.S. Energy Information Administration Annual Energy Outlook Reference Case Projections
2017-2030



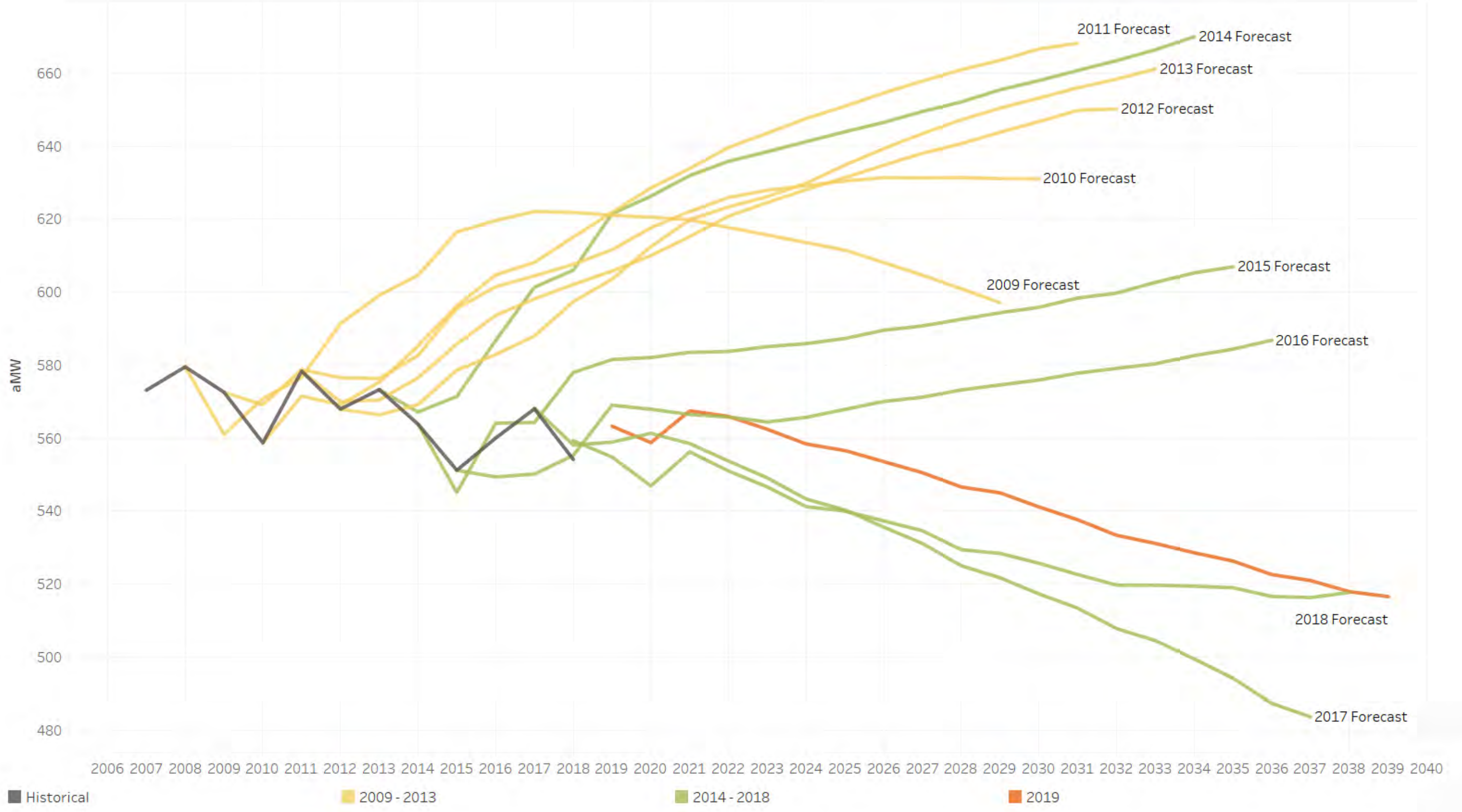
U.S. Department of Energy | Staff Report on Electricity Markets and Reliability, August 2017

National Trends

TACOMA POWER
TACOMA PUBLIC UTILITIES

The same environment has made it difficult to accurately forecast Tacoma Power's electric load.

Tacoma Power Annual Load Projections
2019-2039

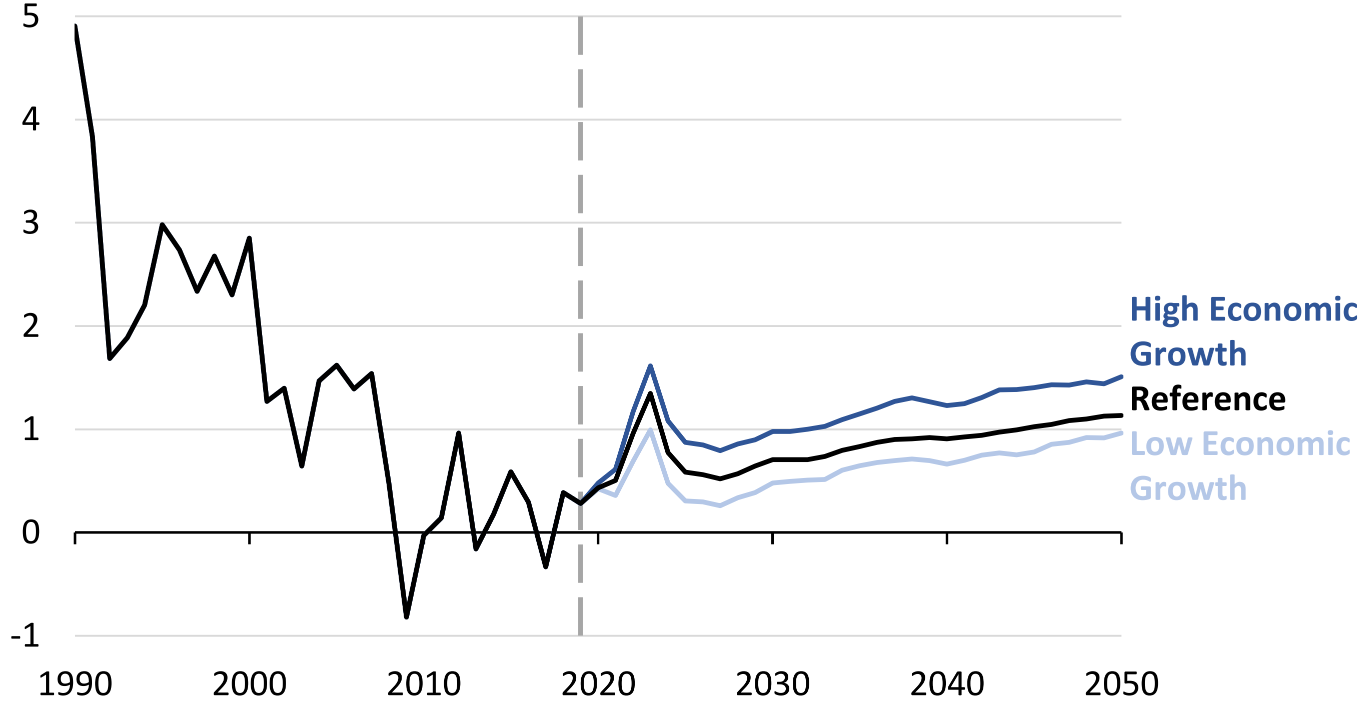


National Trends

TACOMA POWER
TACOMA PUBLIC UTILITIES

The most recent Annual Energy Outlook projects electricity demand to grow slowly through 2050.

AEO2020 Electricity use growth rate
percentage growth (three-year rolling average)



U.S. Energy Information Administration | Annual Energy Outlook 2019

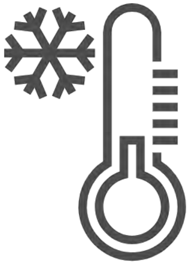
This is where we answer the question "what affects load?"

Critical Drivers

Critical Drivers

Many factors affect electric load and our forecast assumes specific values for these factors throughout the forecast horizon.

Load is most notably driven by the weather, the economy, and the demography of a service territory.

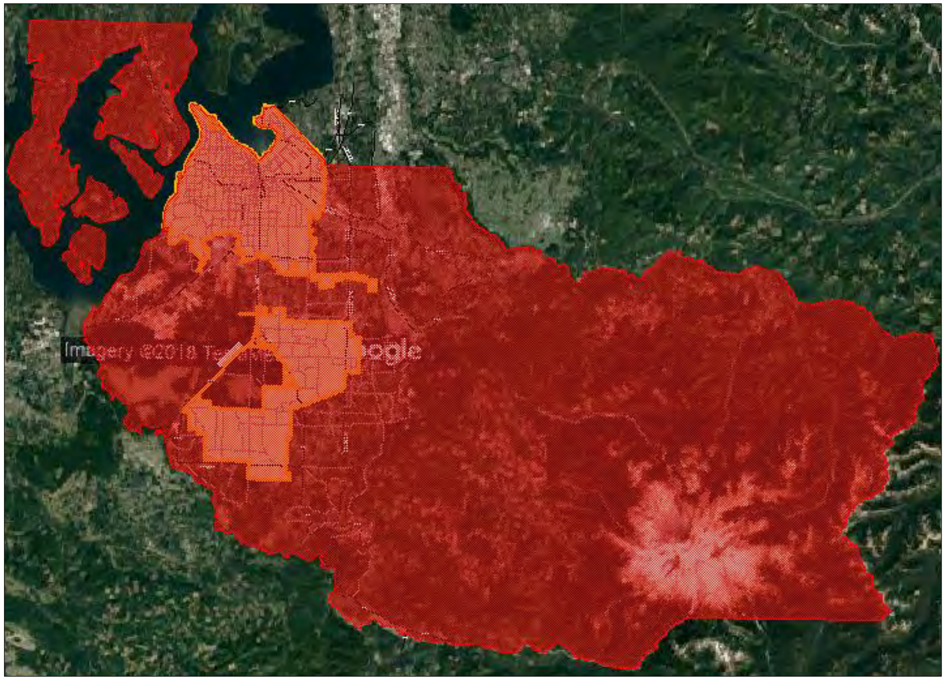


We purchase weather data from an independent firm that specializes in weather and environmental information.

We purchase economic and demographic data from an independent firm that specializes in long-term county-level economic and demographic data series.

Critical Drivers

The economic and demographic inputs considered by our models are specific to Pierce County.



Tacoma Power's service territory is contained within Pierce County.

Critical Drivers

TACOMA POWER
TACOMA PUBLIC UTILITIES

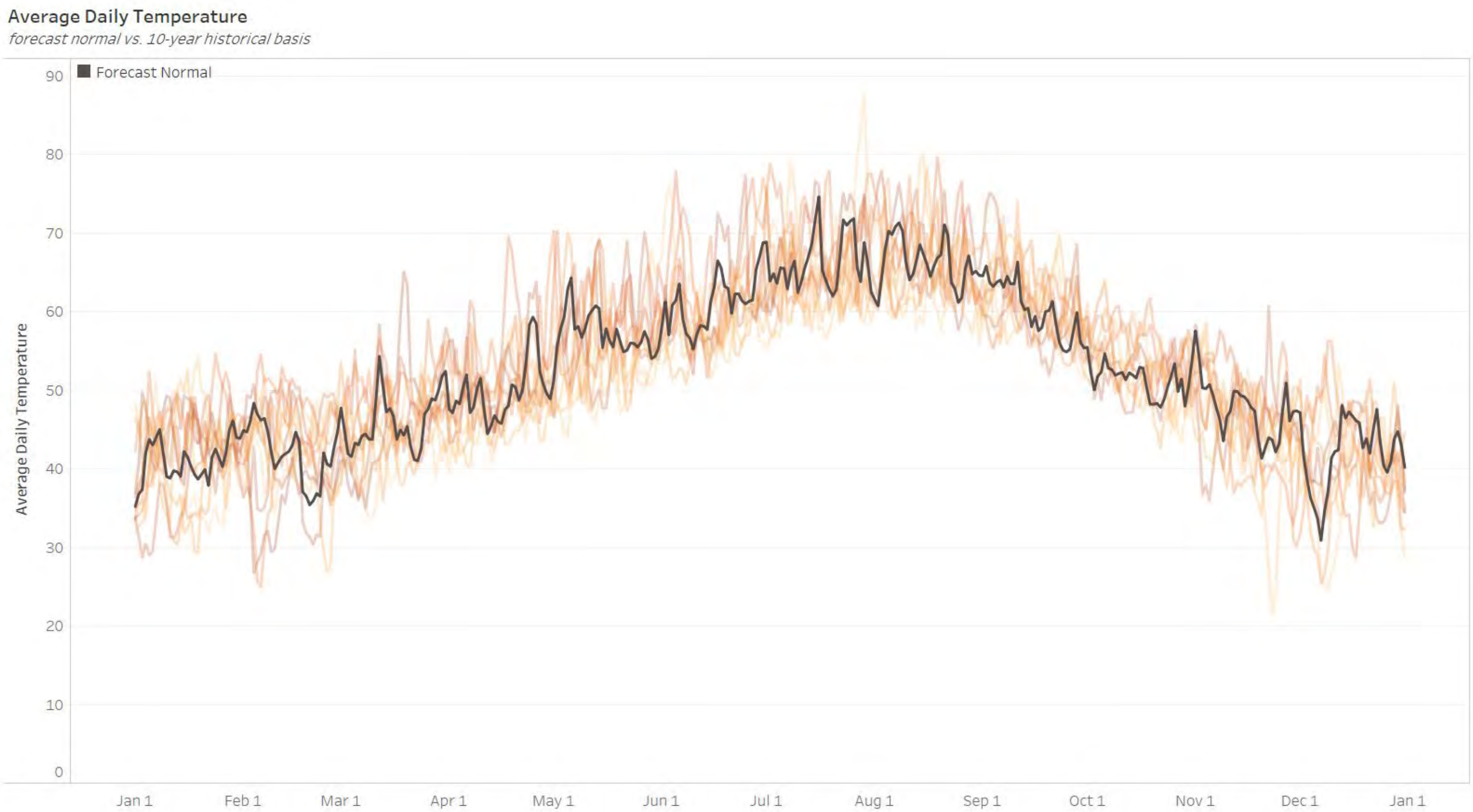
Over the historical period, the economy has experienced change. Over the forecast horizon, the economy will continue to change.

	Compound Annual Growth Rate
	Forecast Horizon
Population	1.20%
Residence Adjustment	1.69%
Non-Industrial Retail Rates	4.20%
Non-Industrial Energy Efficiency Acquisitions	1.92%

Critical Drivers

TACOMA POWER
TACOMA PUBLIC UTILITIES

The 2019 Forecast Weather Normal is based on 10 years of historical weather.



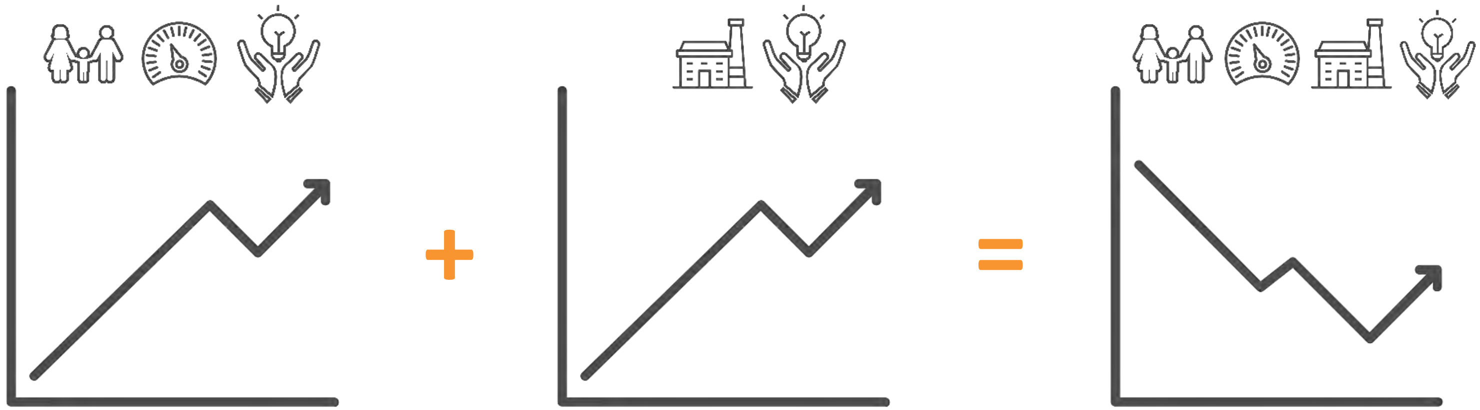
This is where we answer the question "how is the forecast derived?"

Forecasting Methodology

Forecasting Methodology

TACOMA POWER
TACOMA PUBLIC UTILITIES

Tacoma Power's System Energy Load Forecast is the sum of a non-industrial forecast and an industrial forecast.



Non-Industrial Load Forecast

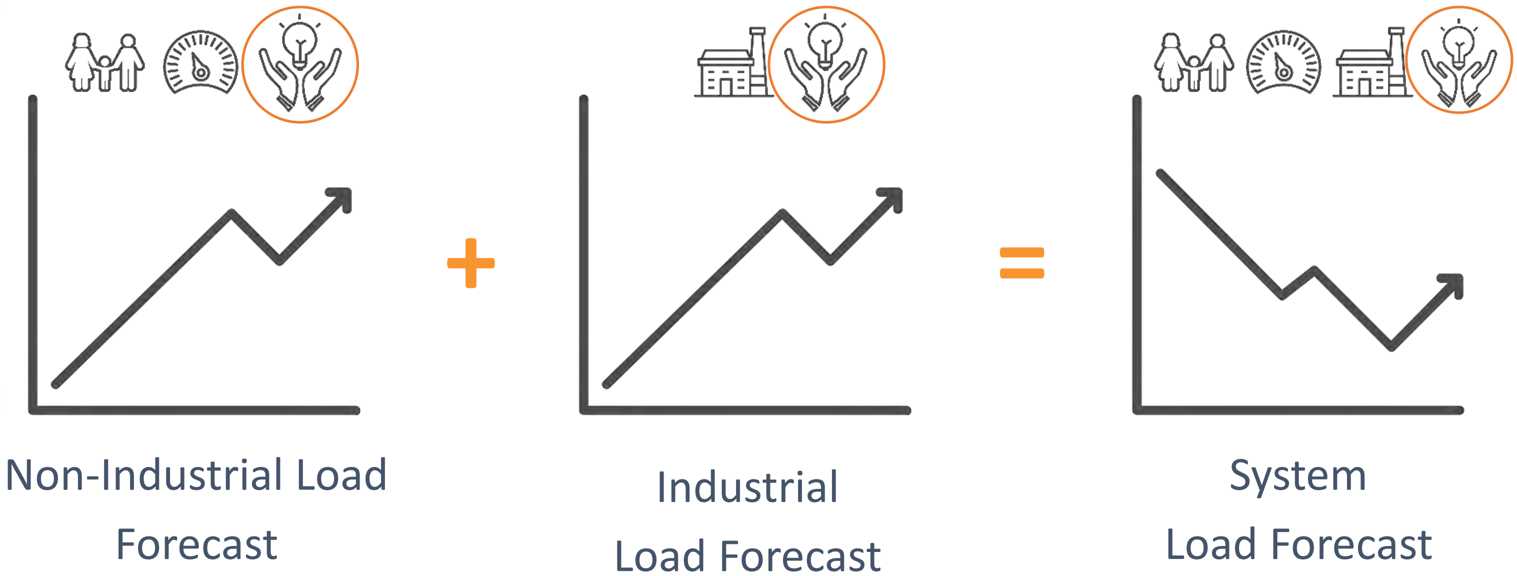
Industrial Load Forecast

System Load Forecast

Forecasting Methodology

TACOMA POWER
TACOMA PUBLIC UTILITIES

Within the non-industrial and industrial load forecasts, we account for conservation and codes & standards

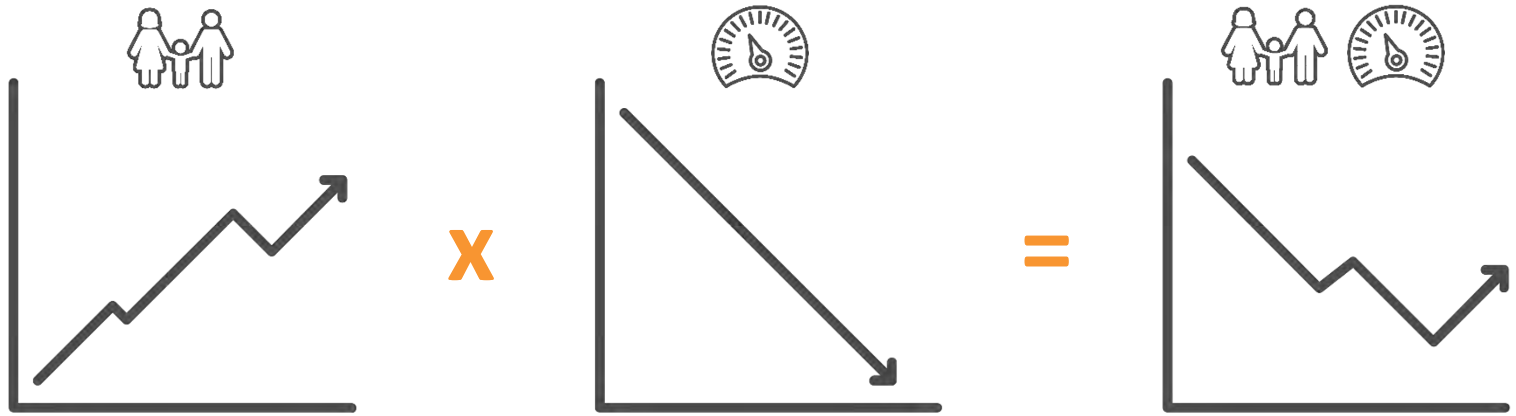


The forecasts of conservation and codes & standards are provided by Tacoma Power's Conservation Potential Assessment.

Forecasting Methodology

TACOMA POWER
TACOMA PUBLIC UTILITIES

The non-industrial load forecast is the product of two separate forecasts.



Non-Industrial Customer Forecast

Non-Industrial Use-per-Customer Forecast

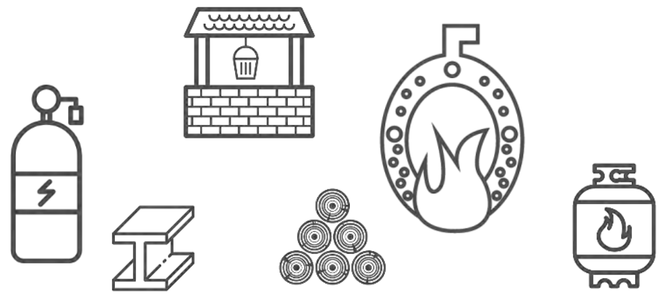
Non-Industrial Forecast

Non-Industrial loads are relatively weather-sensitive. Variability in weather can distort underlying trends in consumption. We adjust for weather-driven variability through a process called 'Weather Normalization'.

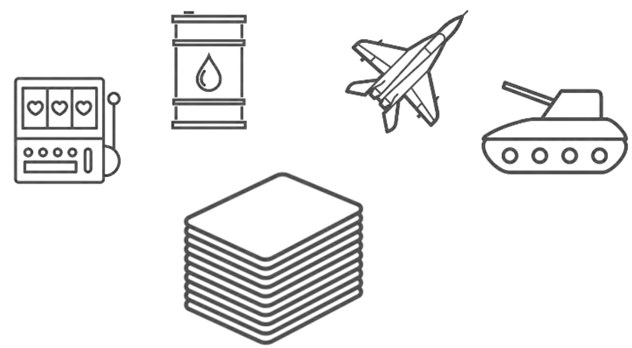
Forecasting Methodology

TACOMA POWER
TACOMA PUBLIC UTILITIES

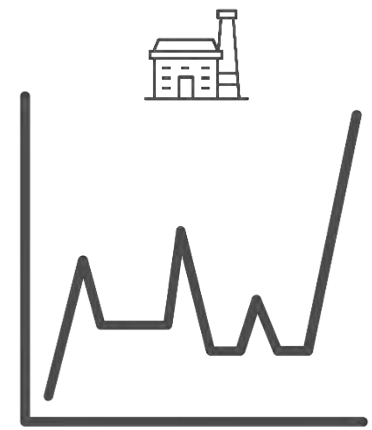
The industrial forecast is the sum of 11 forecasts.



$$\sum_{k=0}^{11} \text{Individual Industrial Load Forecasts}$$



=



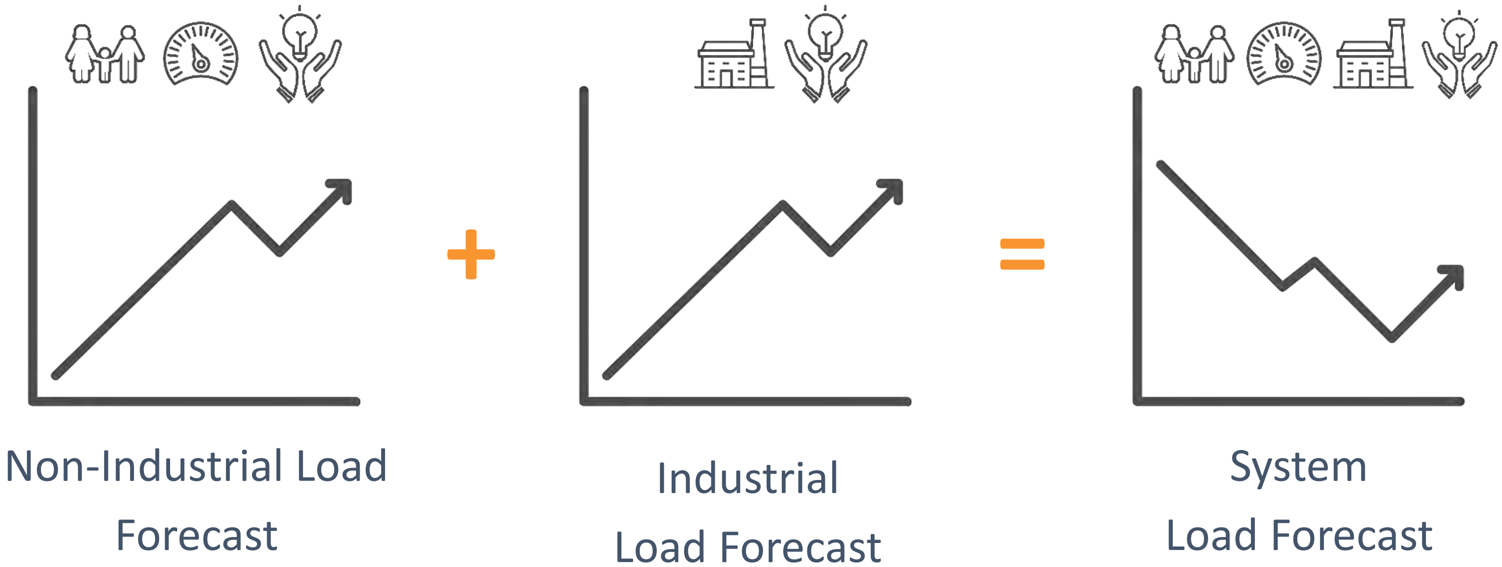
Pre-Conservation
Industrial Forecast

We create individual load forecasts for each of the industrial loads existing or expected within our service territory. Forecasts are based on historical records of consumption and account executive knowledge of customer operations.

Forecasting Methodology

TACOMA POWER
TACOMA PUBLIC UTILITIES

Tacoma Power's System Energy Load Forecast is the sum of a non-industrial forecast and an industrial forecast.



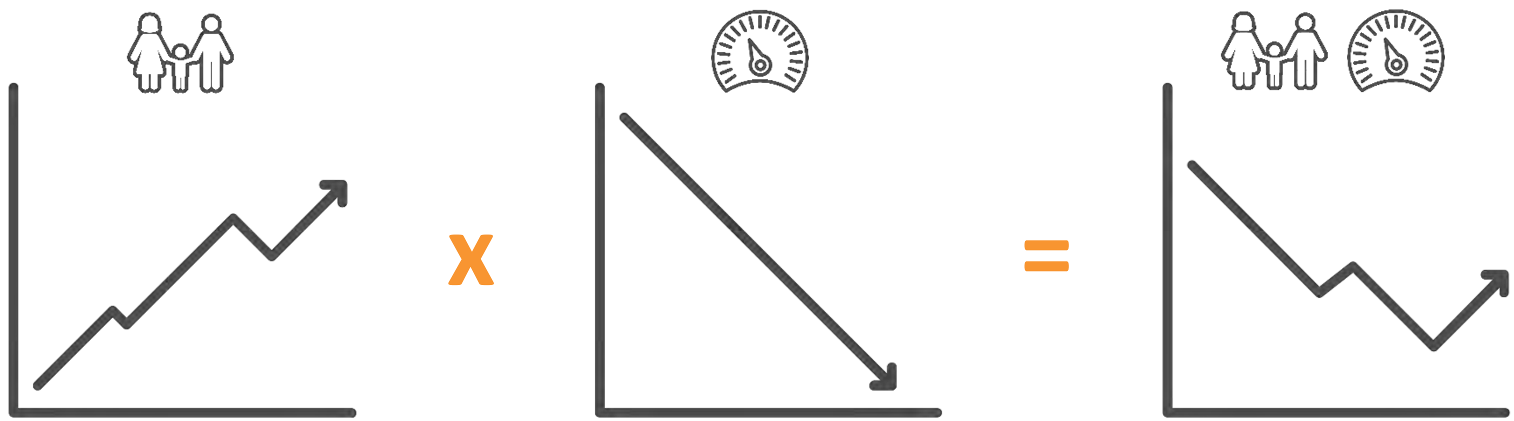
This is where we discuss the results of the forecasting process.

Forecast Products

Forecast Products

TACOMA POWER
TACOMA PUBLIC UTILITIES

Let’s begin with the non-industrial load forecast.



Non-Industrial Customer Forecast

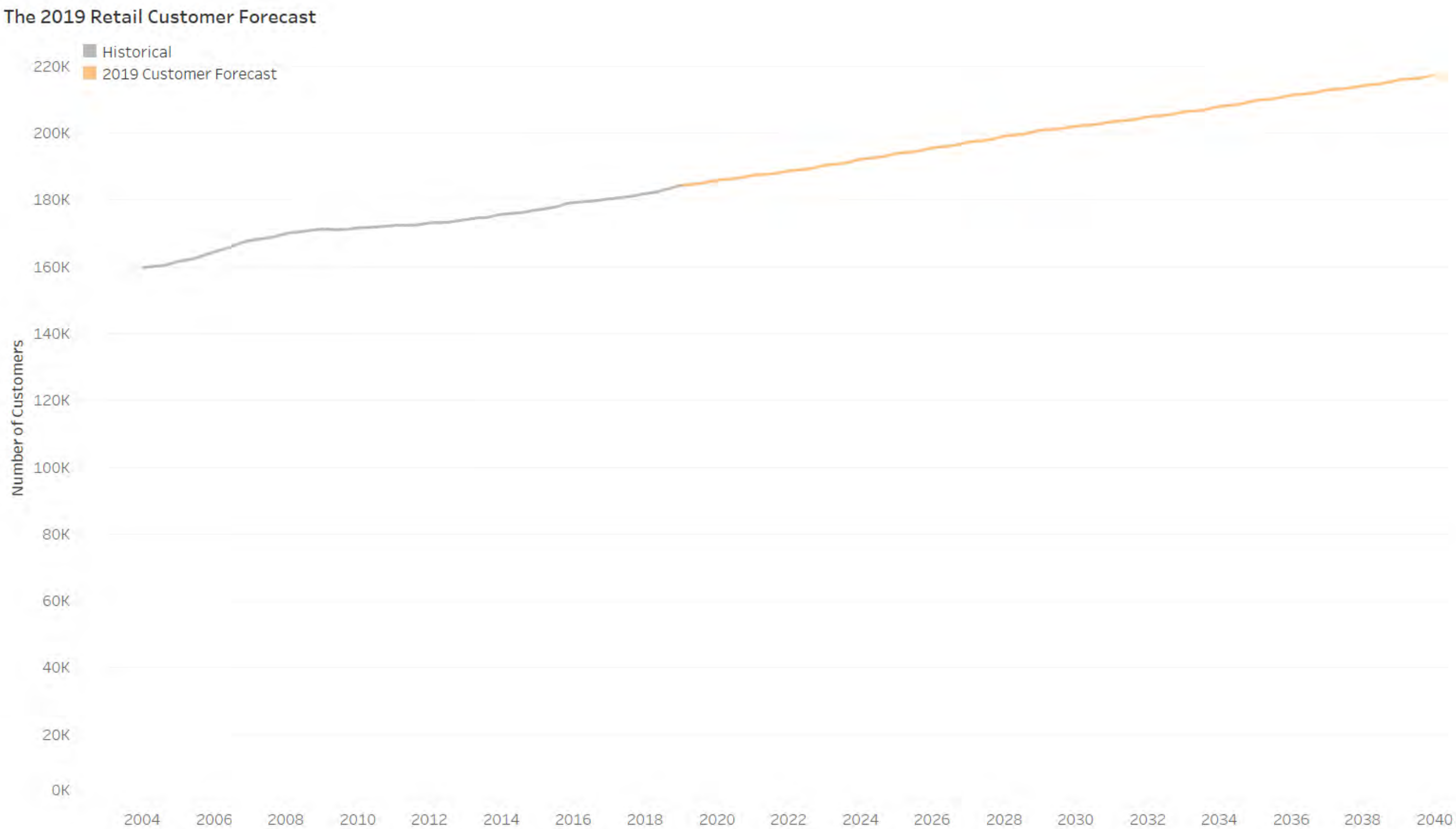
Non-Industrial Use-per-Customer Forecast

Non-Industrial Forecast

The non-industrial load forecast is the product of two separate forecasts.

Forecast Products

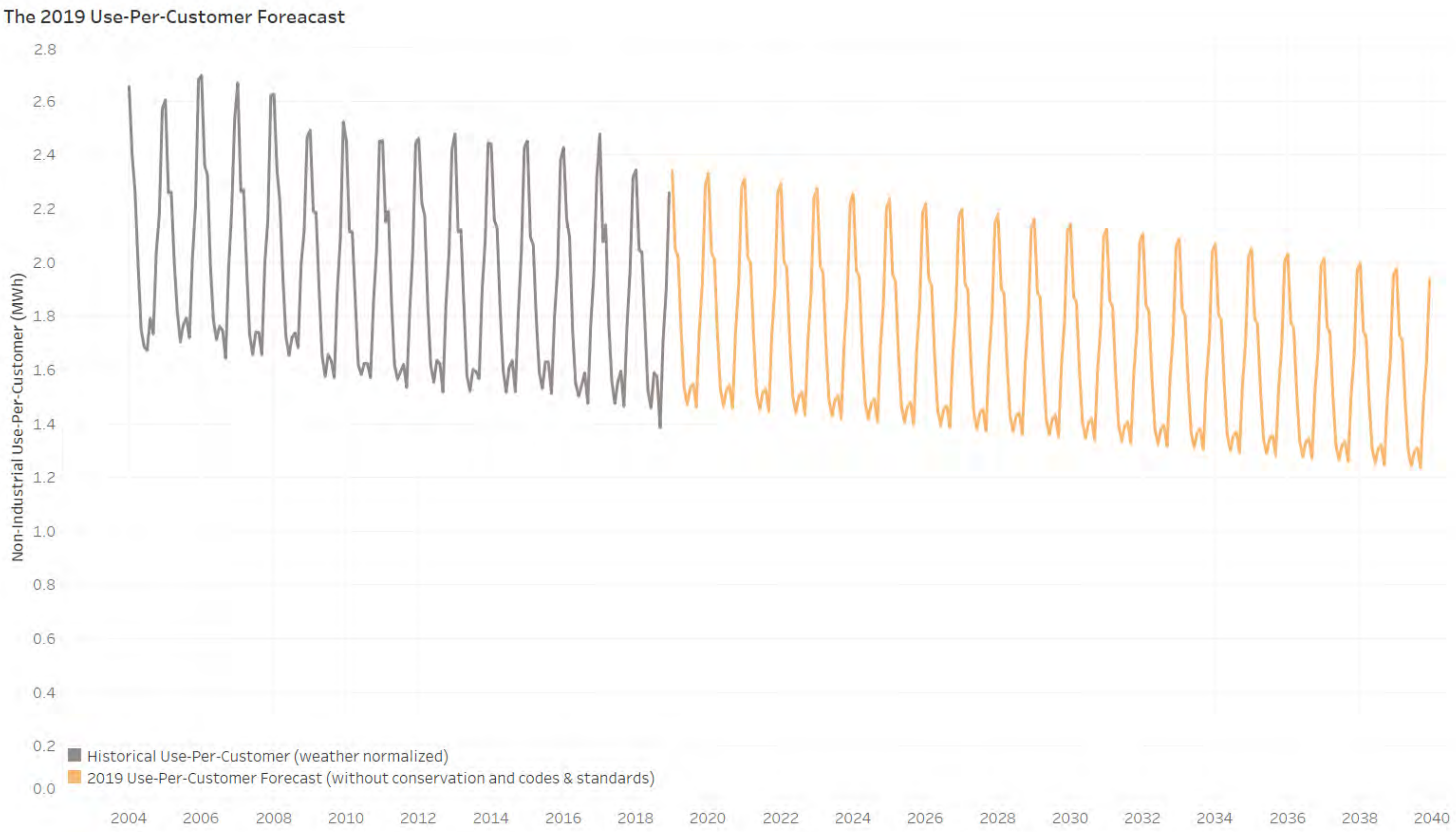
Tacoma Power's retail customer base is projected to grow over the forecast horizon.

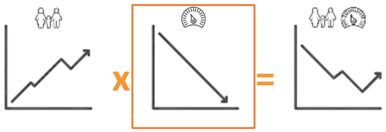


Forecast Products

TACOMA POWER
TACOMA PUBLIC UTILITIES

Use-Per-Customer is projected to decline over the forecast horizon.

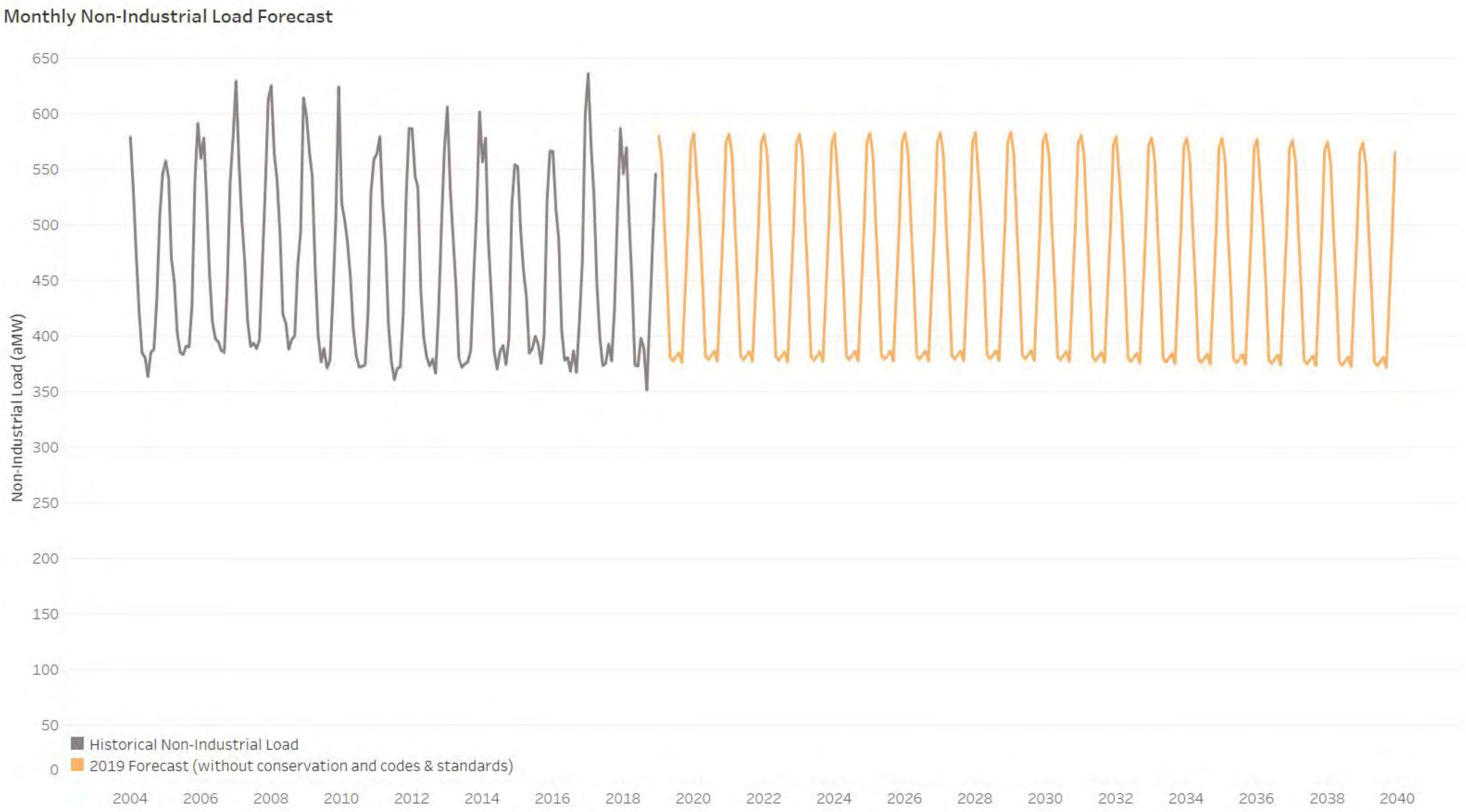


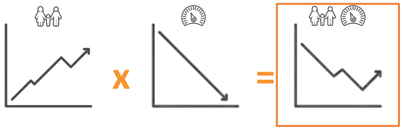


Forecast Products

TACOMA POWER
TACOMA PUBLIC UTILITIES

With the customer and use-per-customer forecasts, non-industrial load is projected to decline over the forecast horizon.





Forecast Products

TACOMA POWER
TACOMA PUBLIC UTILITIES

Recall, we account for conservation and codes & standards within the non-industrial and industrial forecasts.

Non-Industrial Load Forecast

Industrial Load Forecast

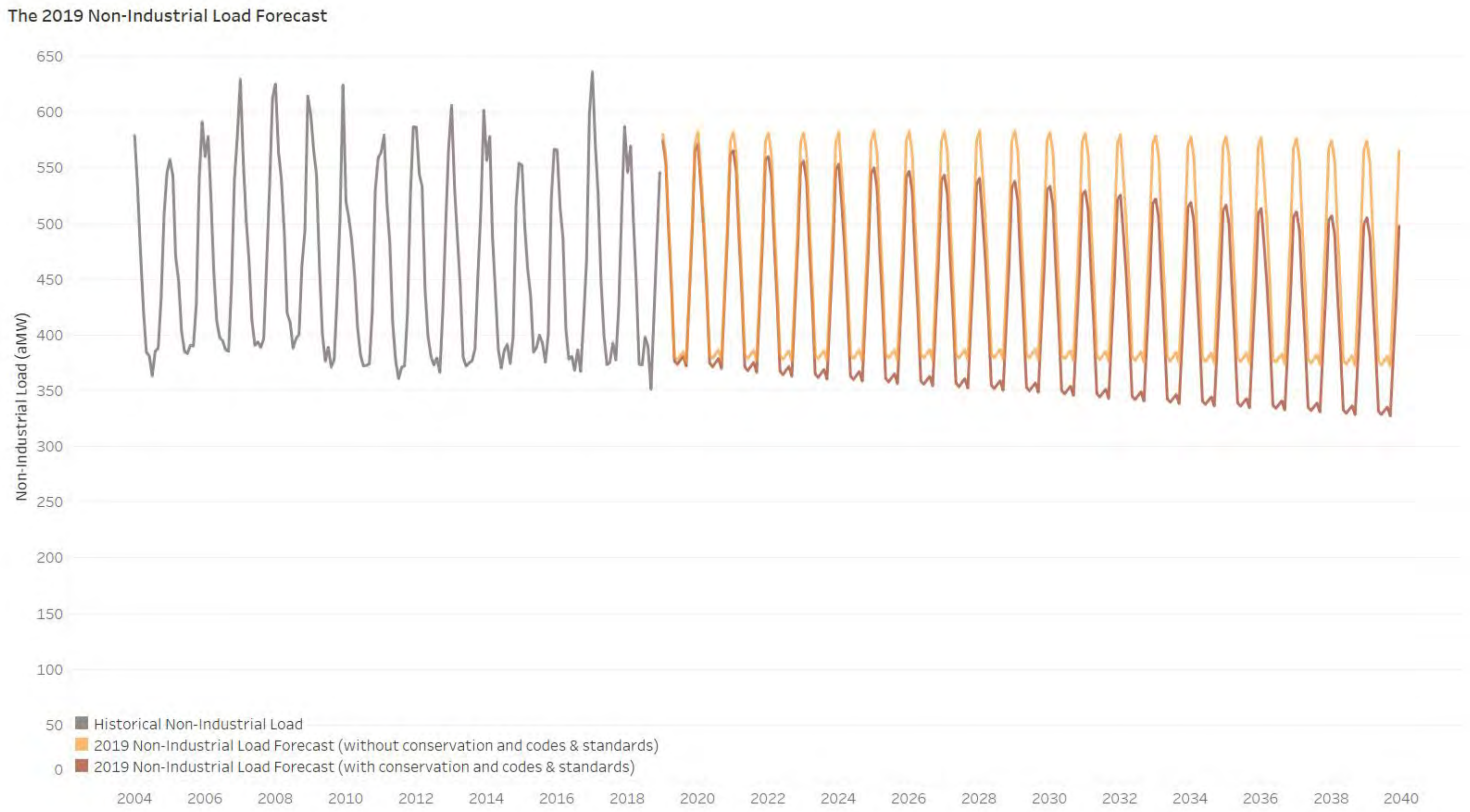
System Load Forecast

The forecasts of conservation and codes & standards are provided by Tacoma Power's Conservation Potential Assessment.

Forecast Products

TACOMA POWER
TACOMA PUBLIC UTILITIES

Conservation and Codes & Standards accelerate the projected decline in non-industrial load.

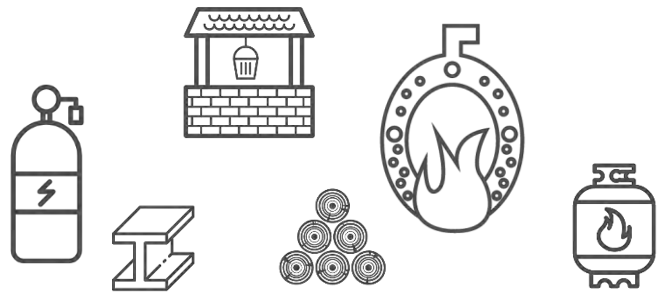


LOAD FORECAST

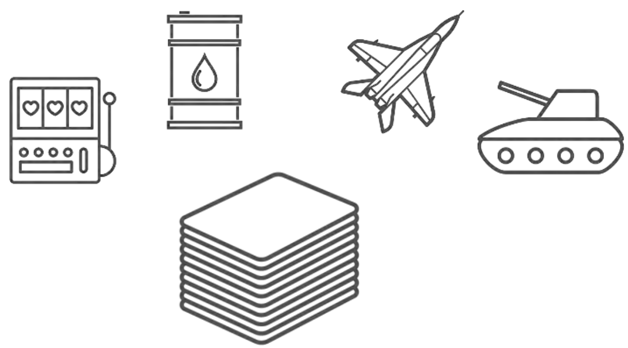
Forecast Products

TACOMA POWER
TACOMA PUBLIC UTILITIES

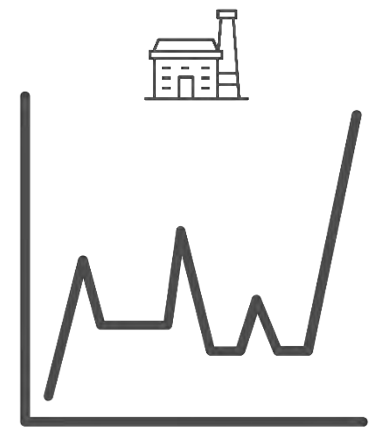
Let's now discuss the industrial load forecast.



$$\sum_{k=0}^{11} \text{Individual Industrial Load Forecasts}$$



=



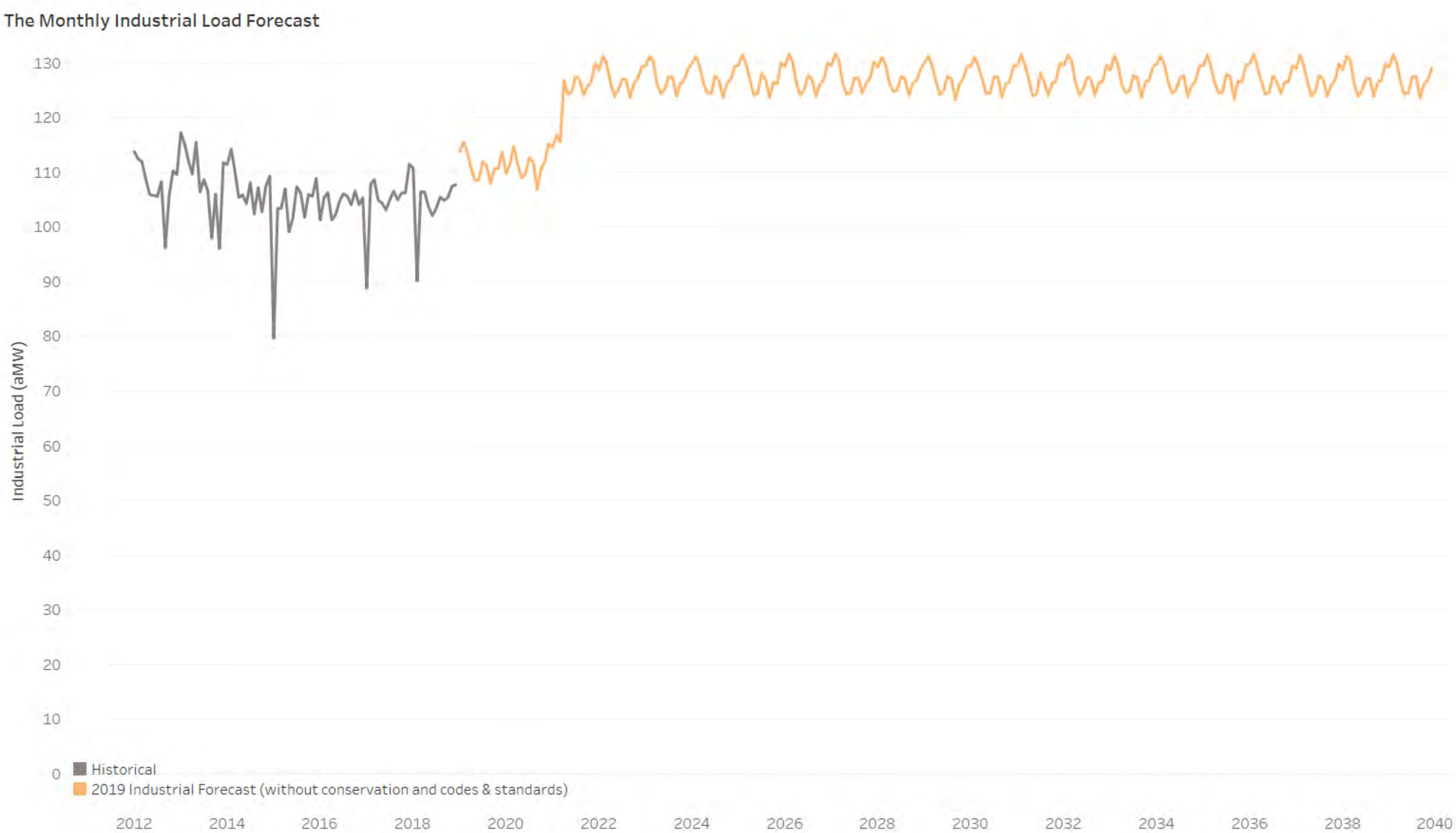
Pre-Conservation Industrial Forecast

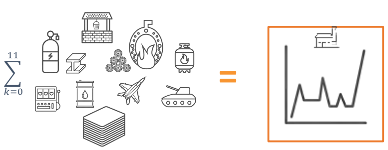
The industrial forecast is the sum of 11 forecasts.

Forecast Products

TACOMA POWER
TACOMA PUBLIC UTILITIES

Industrial load is expected to grow within the forecast horizon.

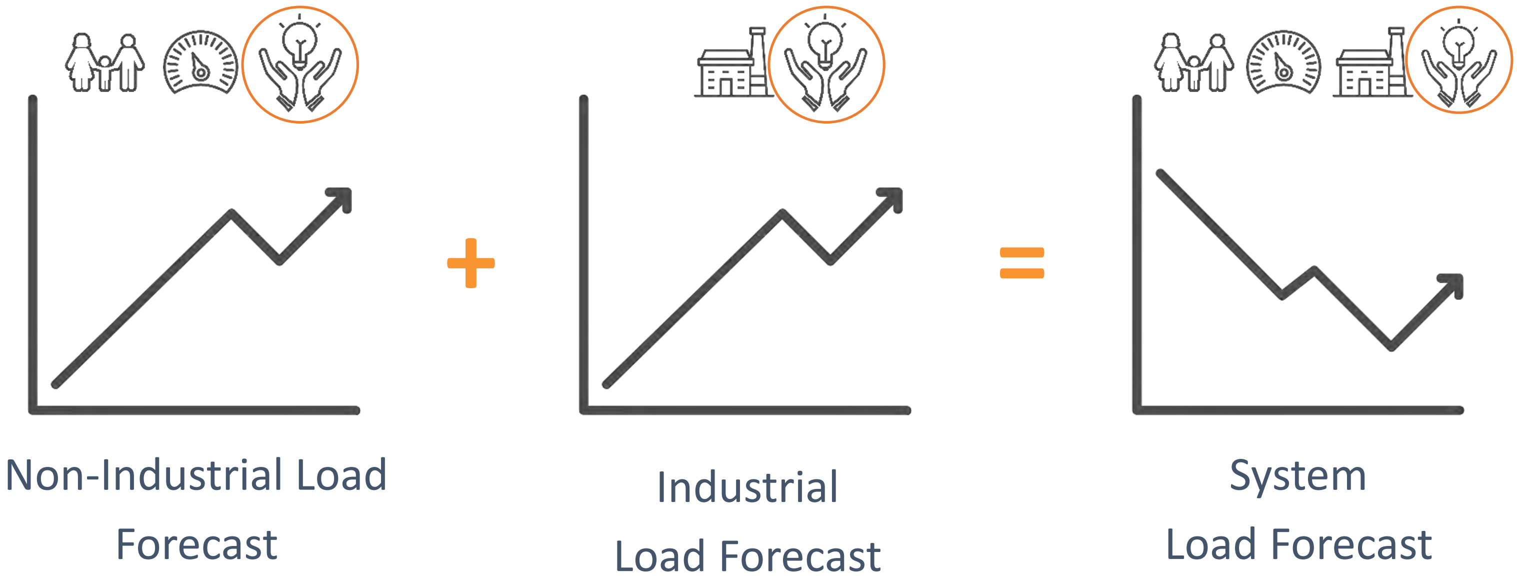




LOAD FORECAST

Forecast Products

Again, we account for conservation and codes & standards within the non-industrial and industrial forecasts.



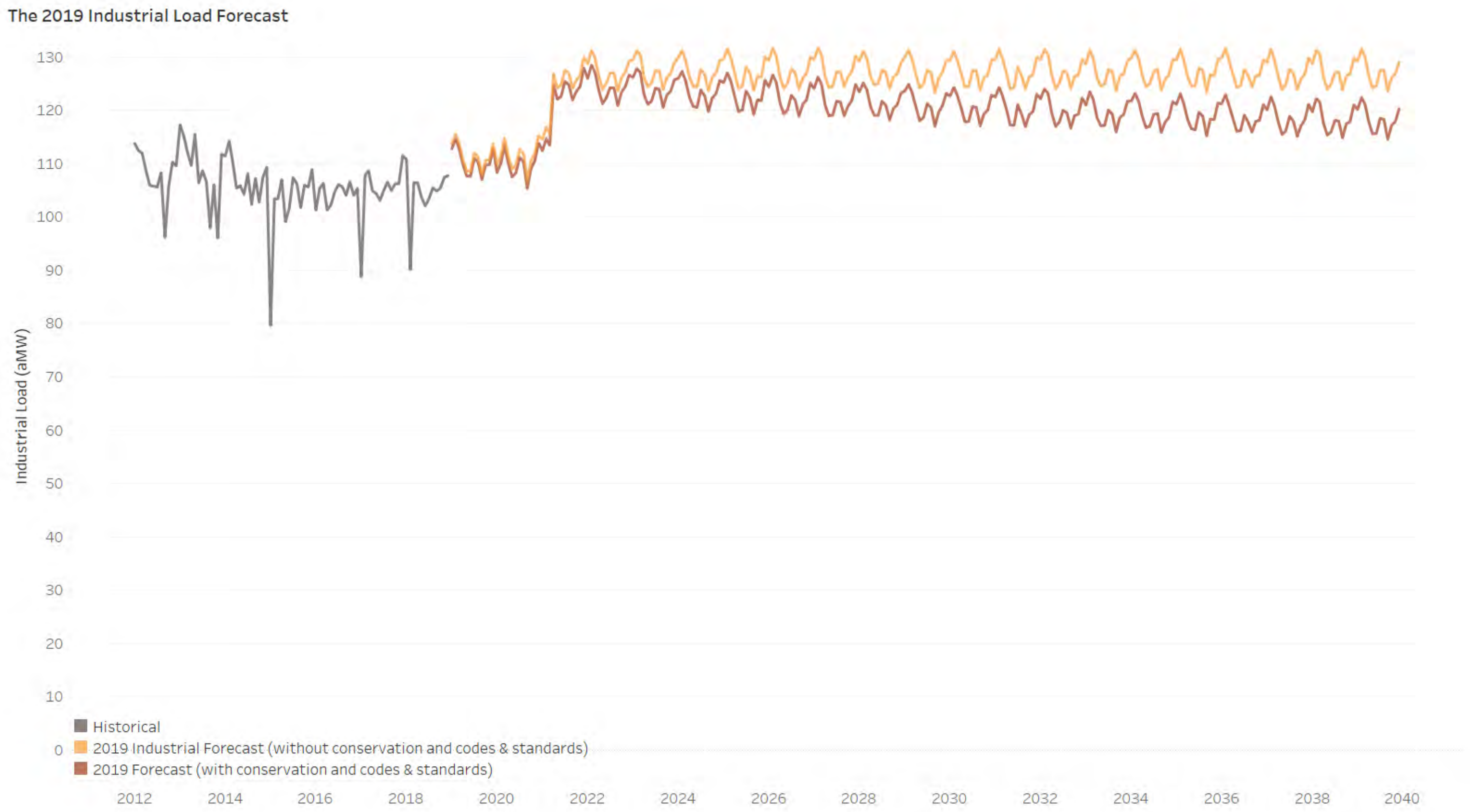
The forecasts of conservation and codes & standards are provided by Tacoma Power's Conservation Potential Assessment.

Forecast Products

TACOMA POWER
TACOMA PUBLIC UTILITIES

LOAD FORECAST

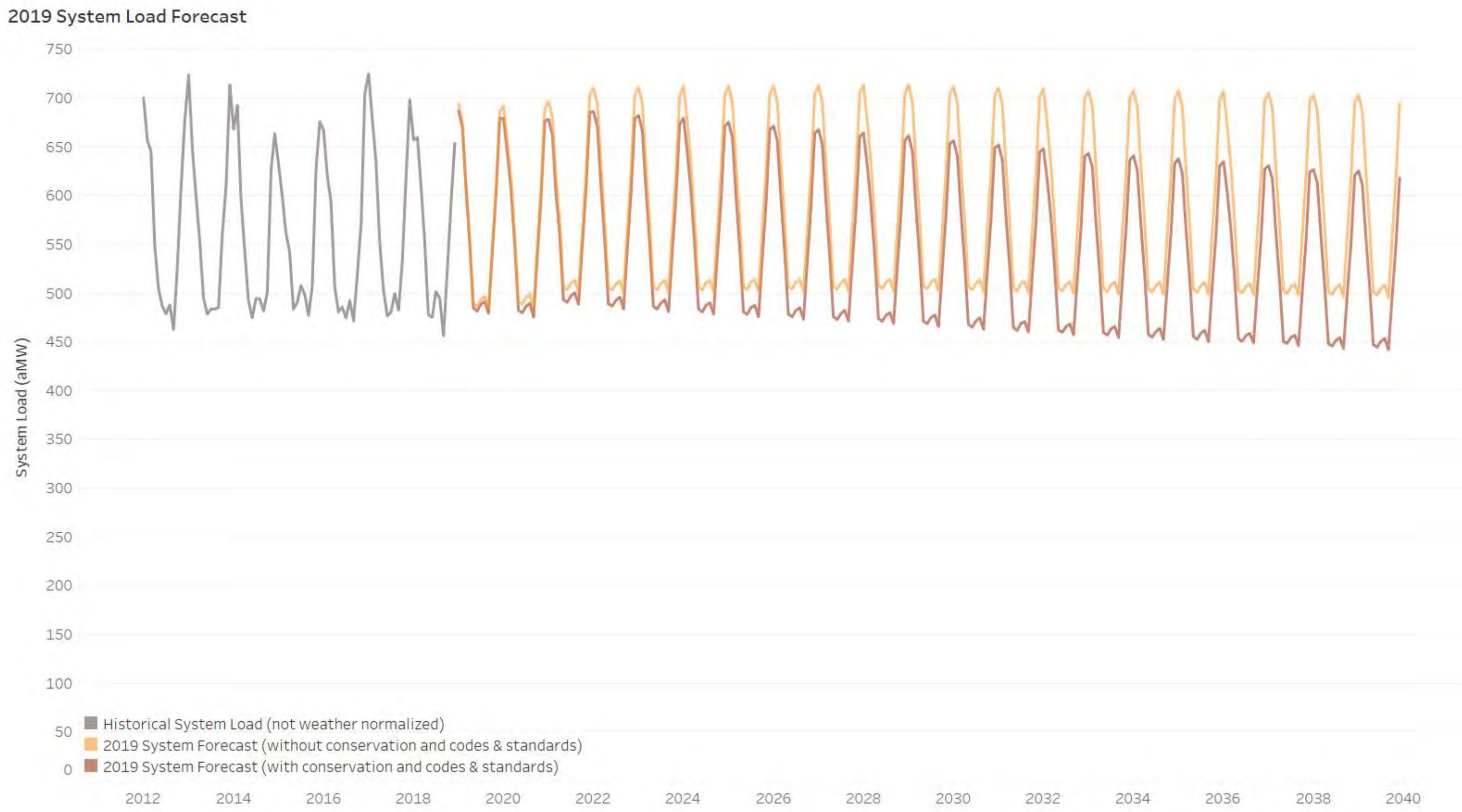
After accounting for conservation and codes & standards, the projected growth in industrial load is reduced.



Forecast Products

TACOMA POWER
TACOMA PUBLIC UTILITIES

After we account for conservation and codes & standards, system load is projected to decline.



Base Case WECC Buildout & Prices

How many resources will be built in our base case scenario?

What will prices look like in our base case scenario?

TACOMA POWER
TACOMA PUBLIC UTILITIES

Forecasting Caveat!

TACOMA POWER
TACOMA PUBLIC UTILITIES

"All models are wrong,
but some are useful."

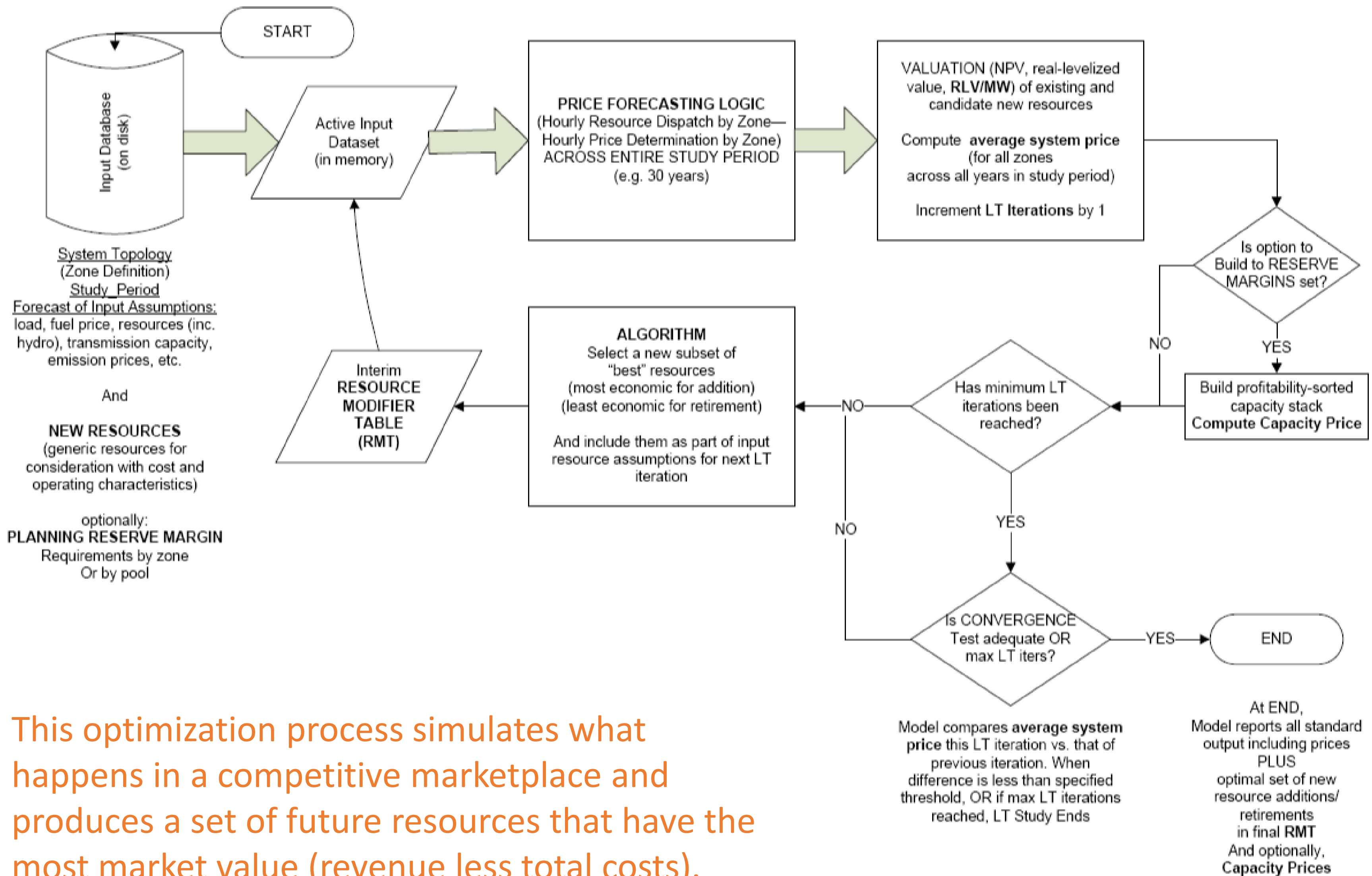
~George E.P. Box (1919 - 2013)

The AURORA model is useful when:

- **its inputs reflect actual or plausible realities**
- **its outputs are directionally accurate**

AURORA Cap. Exp. Flow Diagram

TACOMA POWER
TACOMA PUBLIC UTILITIES

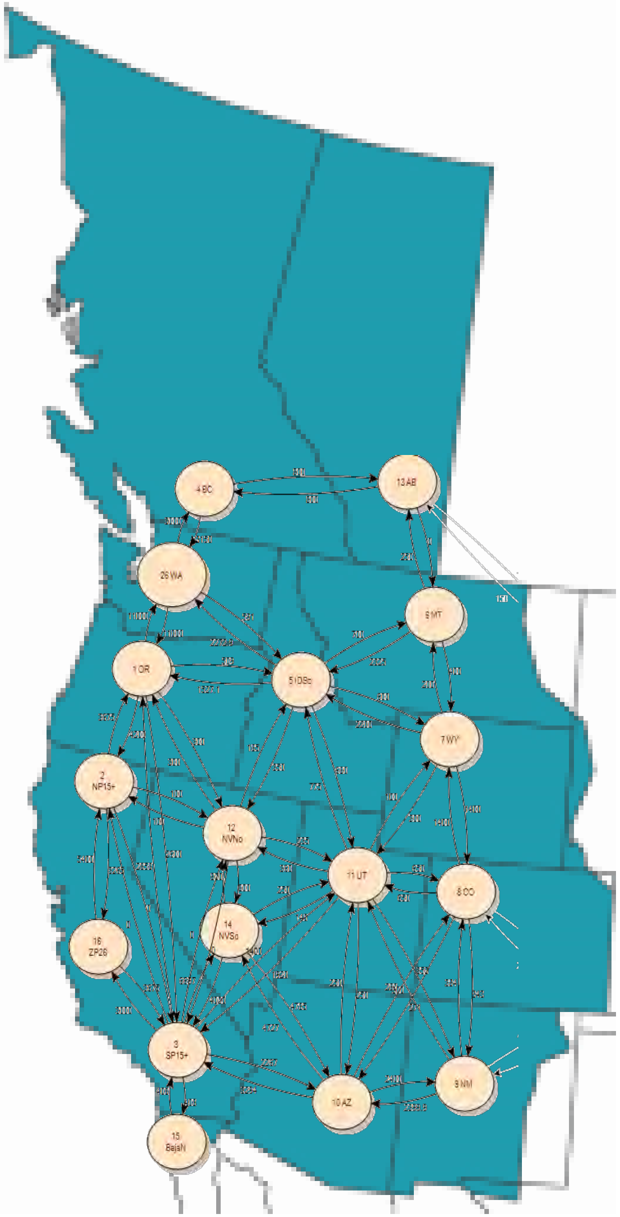


This optimization process simulates what happens in a competitive marketplace and produces a set of future resources that have the most market value (revenue less total costs).

The "WECC"

Western Electric Coordinating Council:

- 2 Canadian Provinces
- 14 Western States (all or part)
- Northern Baja Mexico



WECC-US Utility Fun Facts:

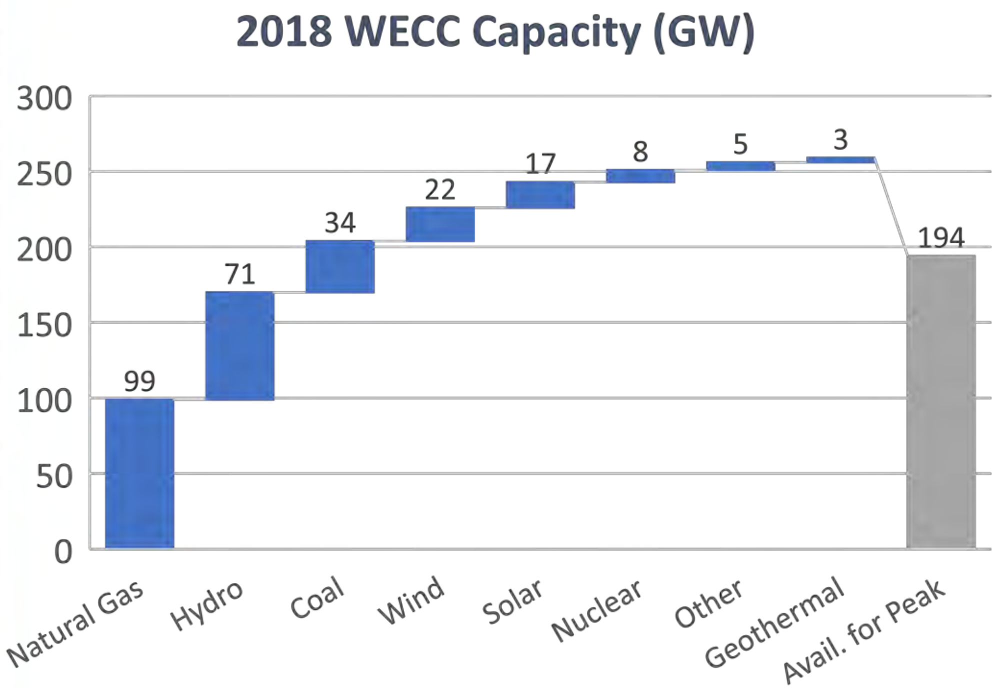
- 147 Investor-Owned (~75% of load)
- 241 Non-Investor-Owned (~25% of load)

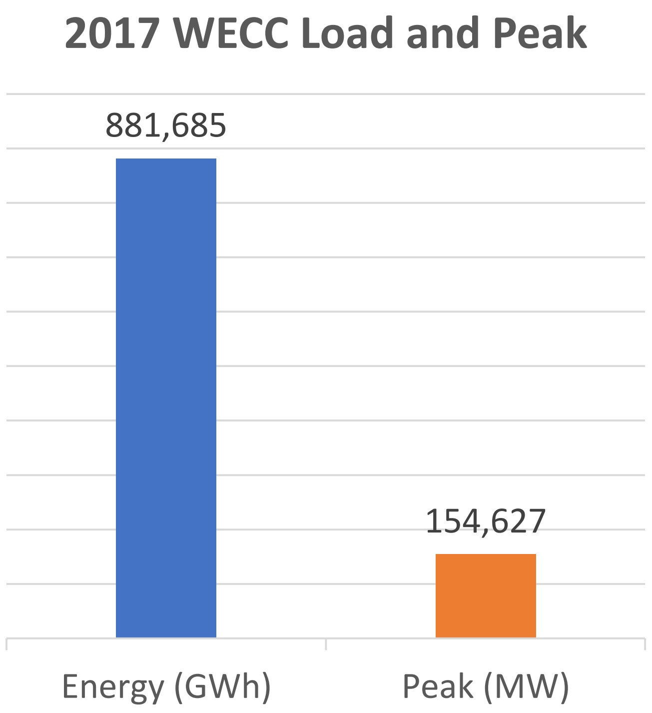
Current WECC Generation & Load

TACOMA POWER
TACOMA PUBLIC UTILITIES

In 2018, the combined nameplate capacity of all utility-scale resources in the WECC was 258 GW.

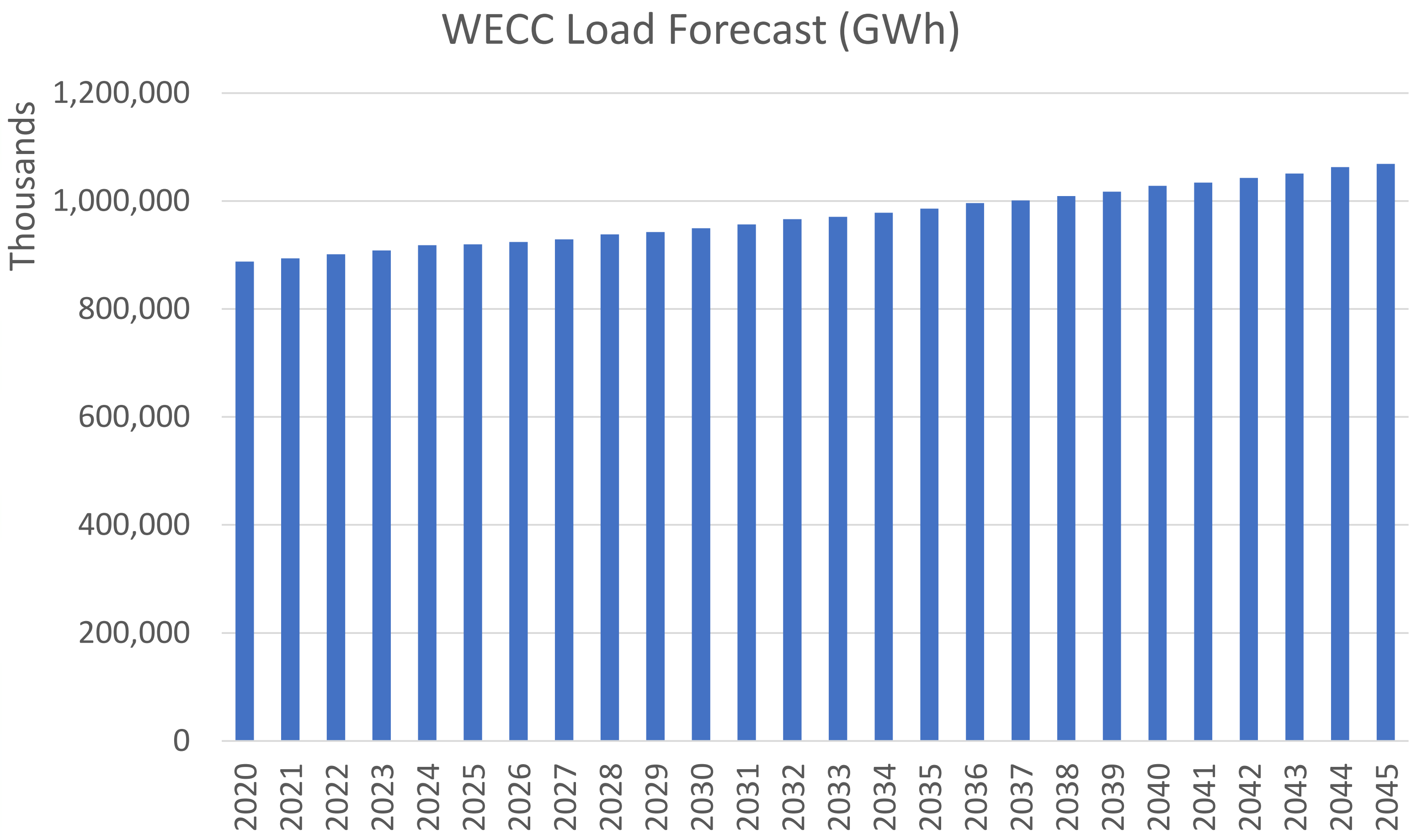
Approximately 1,300 MW of wind and solar capacity were added and natural gas capacity increased by 900 MW.





WECC Load Forecast

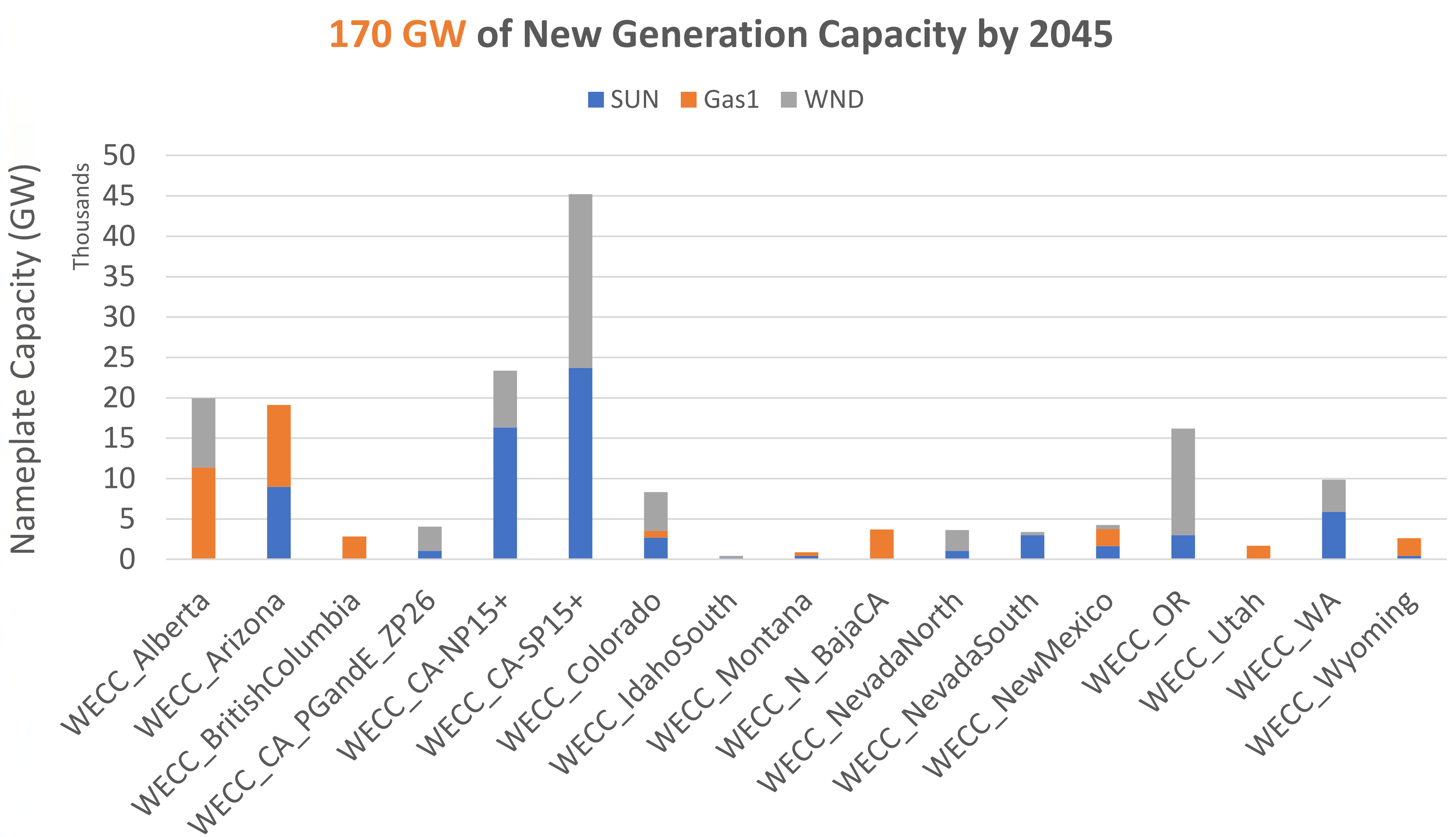
TACOMA POWER
TACOMA PUBLIC UTILITIES



*Average annual load growth of 0.7%

WECC 2045 Resource Buildout

TACOMA POWER
TACOMA PUBLIC UTILITIES



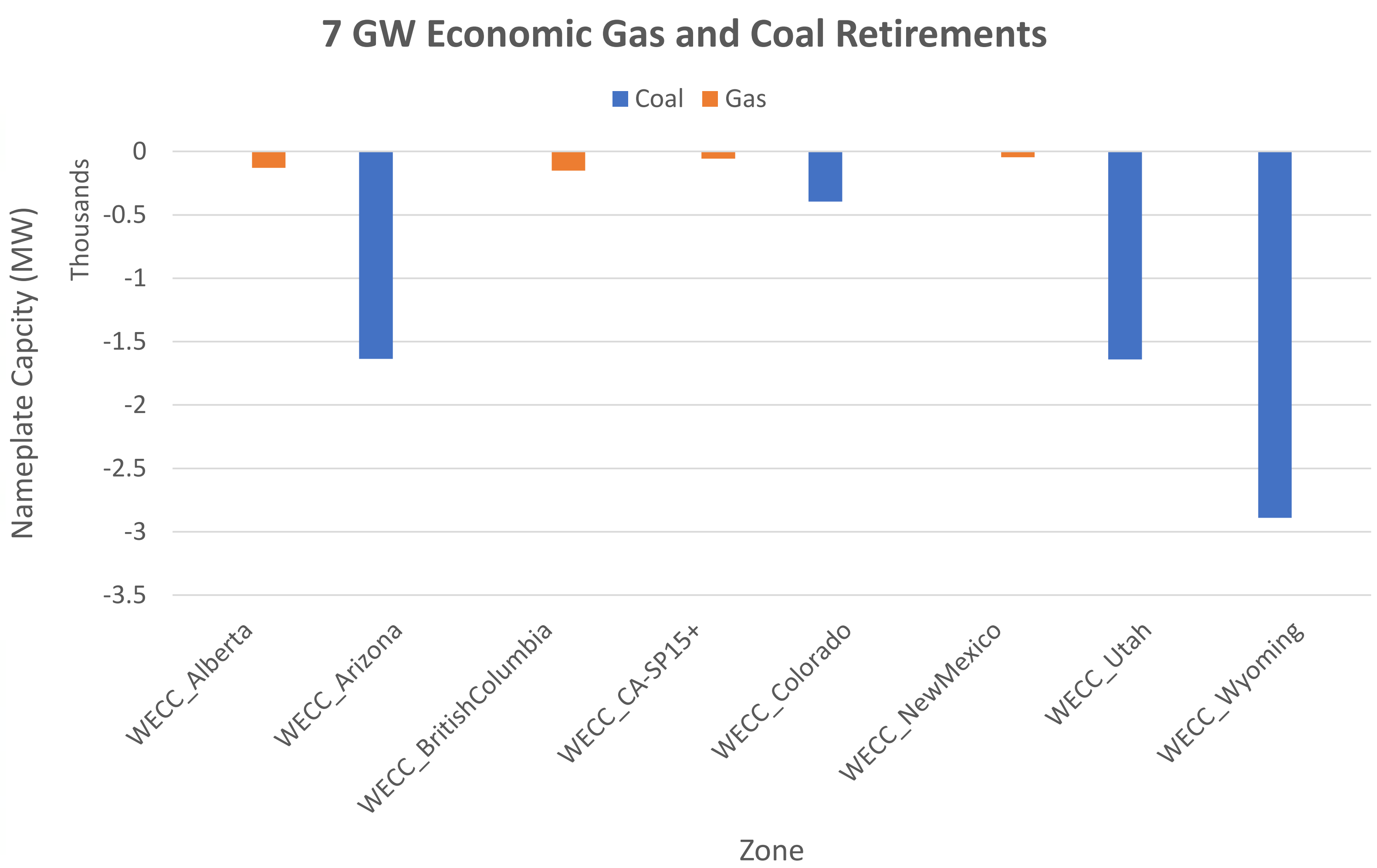
135 GW Renewables

35 GW Gas

*1.3 GW of Battery Energy Storage Assumed (CA mandate)

WECC 2045 Economic Retirement

TACOMA POWER
TACOMA PUBLIC UTILITIES



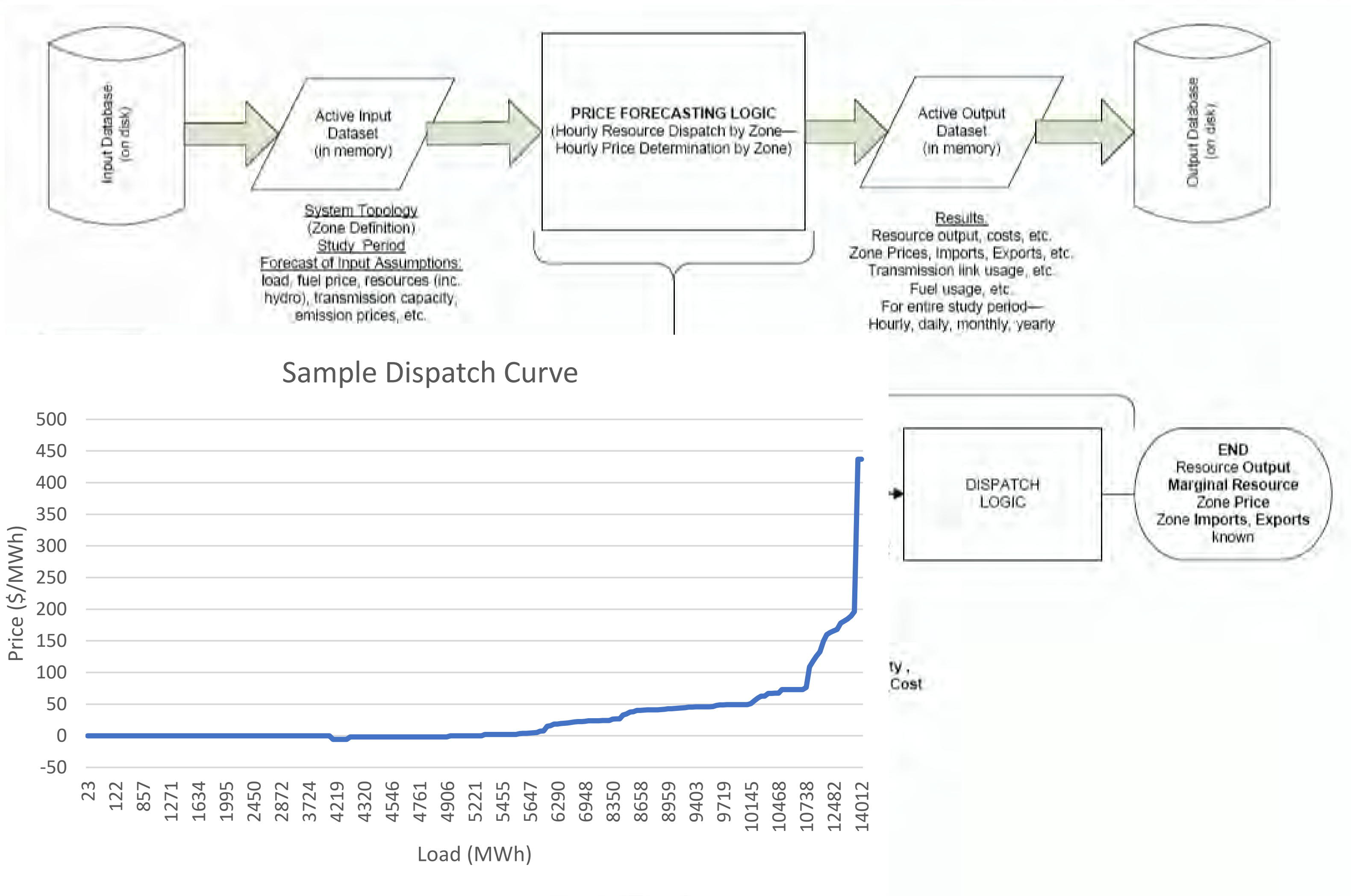
6600 MW Coal (not including 7GW of announced early retirements)
400 MW Gas

What does the Aurora model say?

Price Forecast

AURORA Price Forecast Flow Diagram

TACOMA POWER
TACOMA PUBLIC UTILITIES



Aurora simulates a competitive energy market, where at any given time, prices *should be* based on the marginal cost of production. Prices will rise to the point of the variable cost of the last generating unit needed to meet demand.

Review: Modeling Uncertainty

TACOMA POWER
TACOMA PUBLIC UTILITIES

58 Historic Weather Years

(water & load)

5 Gas Price Simulations

(historic dist.)

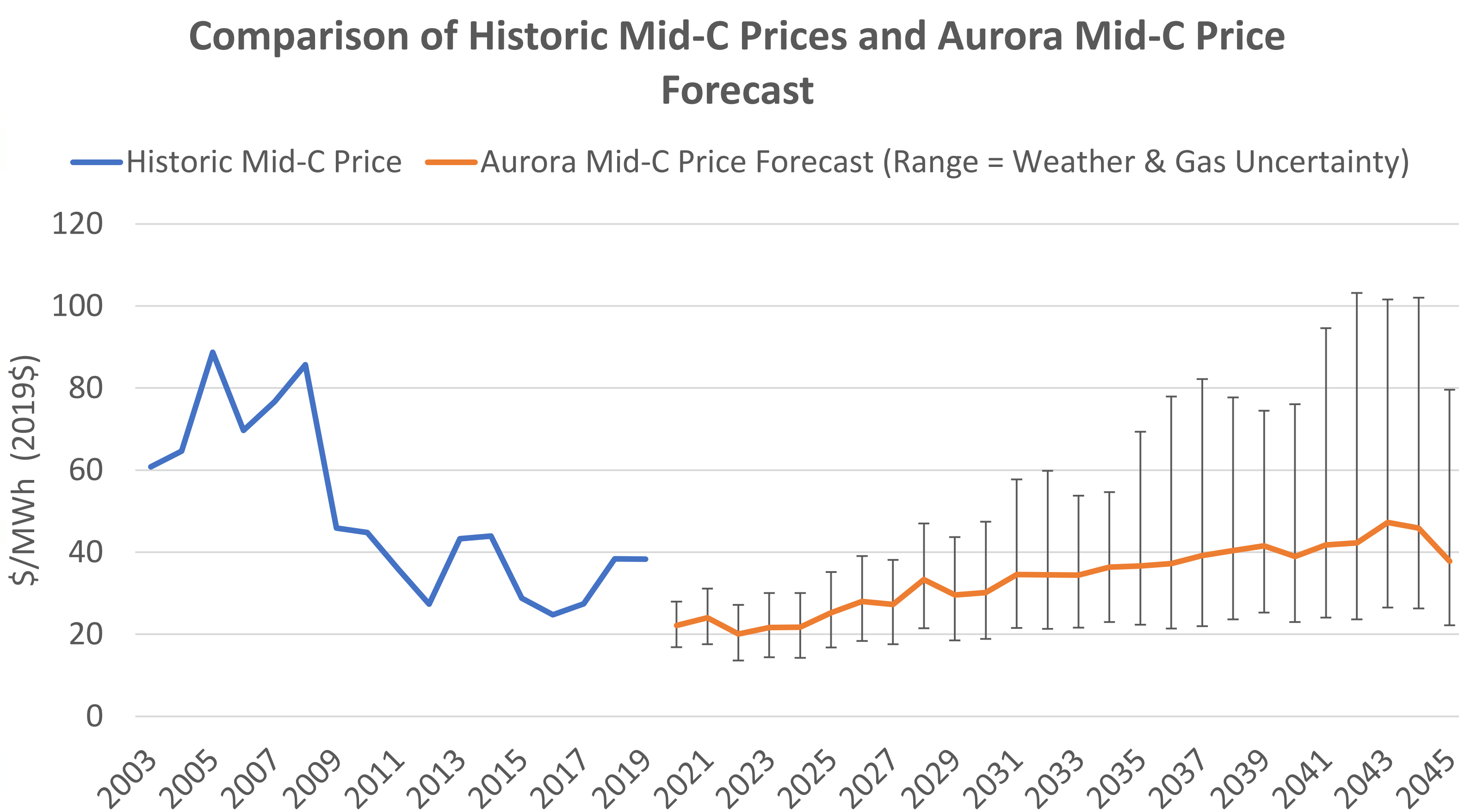
290

Unique Price Forecasts

Weather Fun Fact:
Weather adjusted loads had on average a standard deviation of about 6% of the mean. Some areas in the WECC exhibited more (or less) load sensitivity to weather.

Average Annual Mid-C Price Forecast

TACOMA POWER
TACOMA PUBLIC UTILITIES

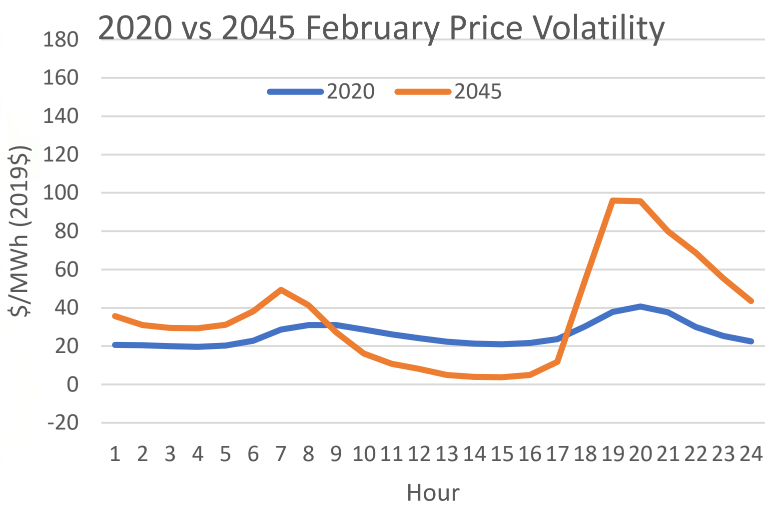


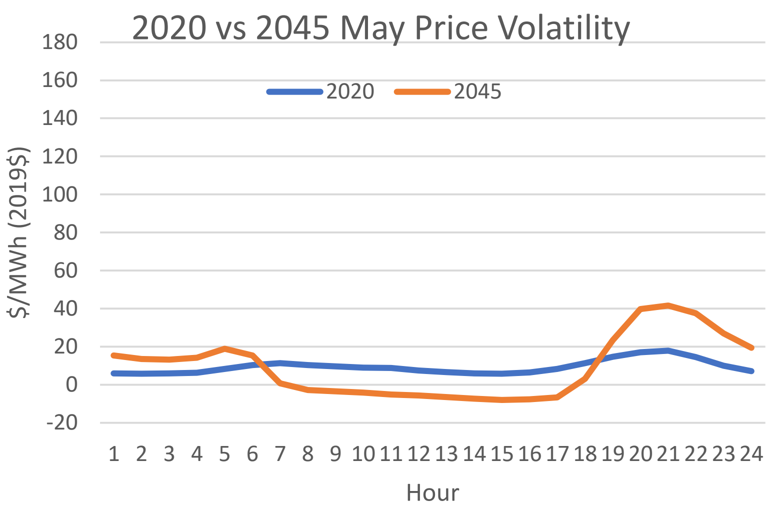
Historic:
Ave: $50/MWh
Std: $35/MWh

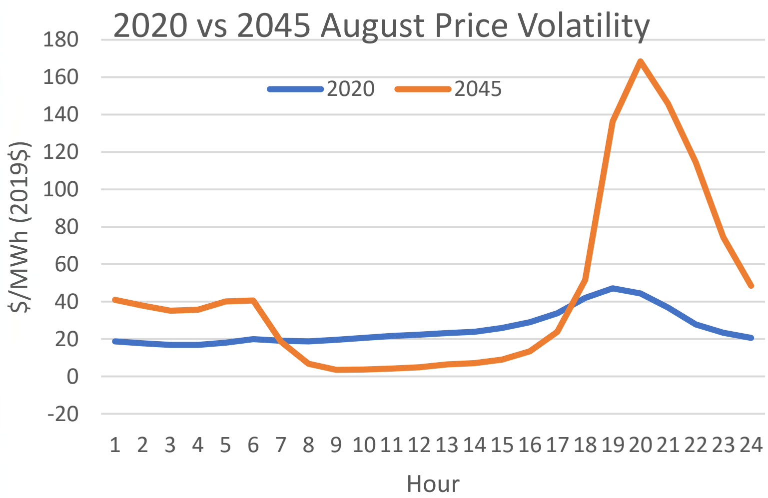
Forecast:
Ave: $33/MWh
Std: $107/MWh

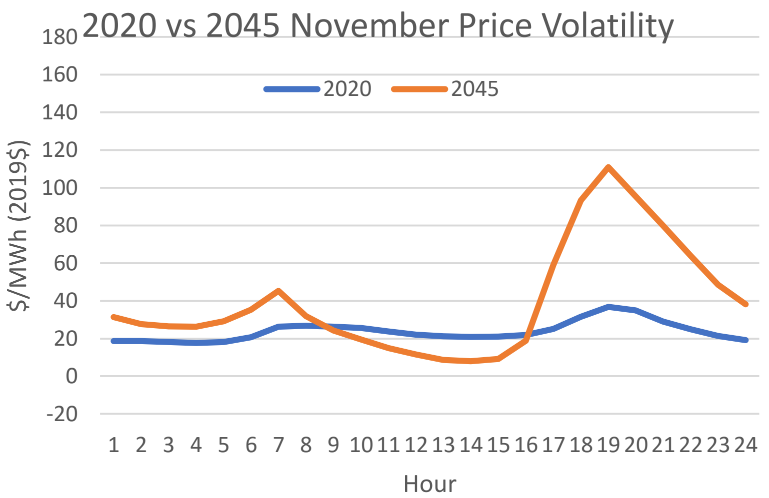
Low Price
High Volatility

Hourly Mid-C Price Forecast Volatility





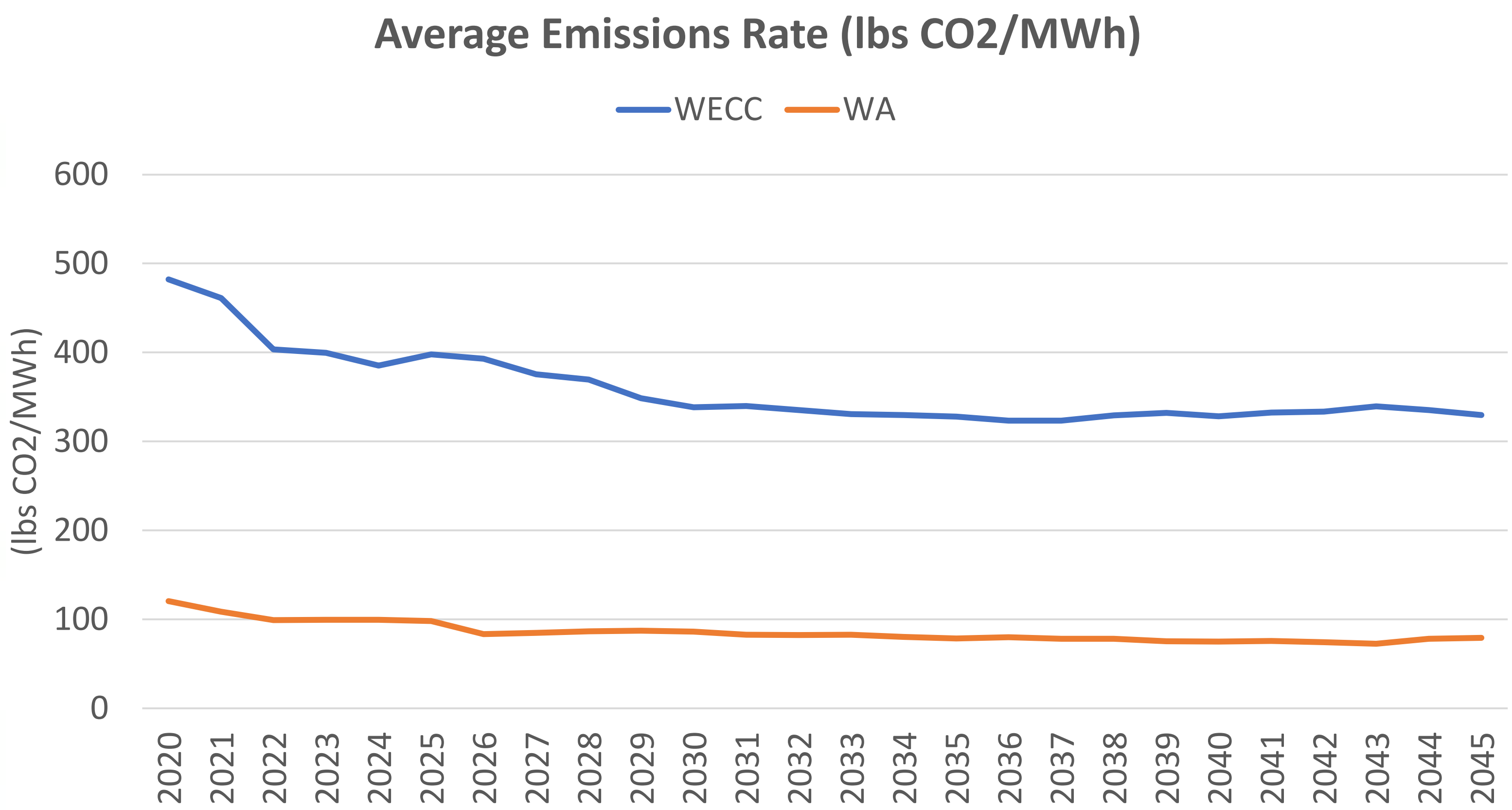




TACOMA POWER
TACOMA PUBLIC UTILITIES

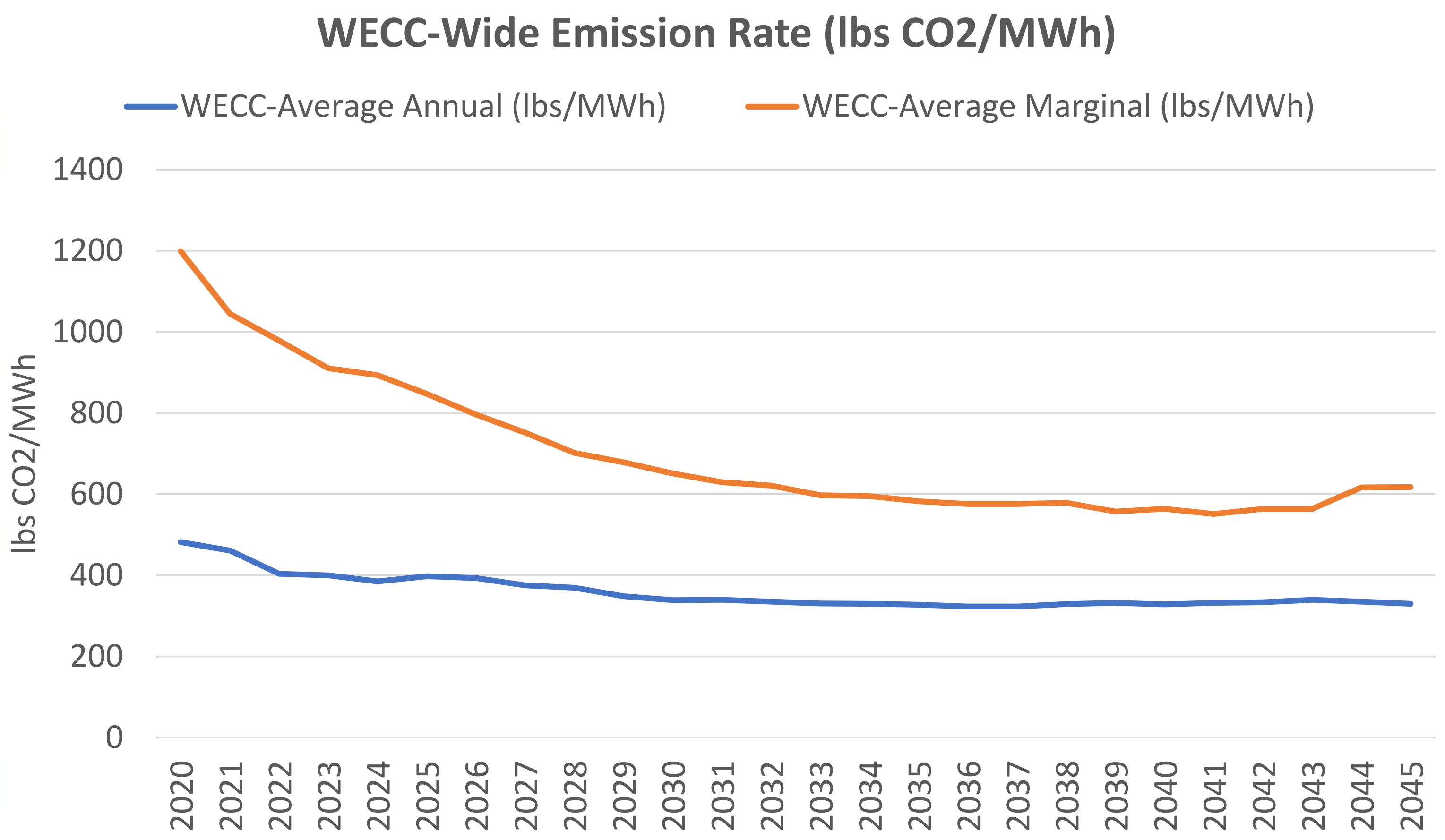
Average WECC vs WA Emissions

TACOMA POWER
TACOMA PUBLIC UTILITIES



32% reduction in average WECC emissions rate by 2045
35% reduction in average WA emissions rate by 2045

Average vs Marginal WECC Emissions



32% reduction in average WECC emissions rate by 2045

48% reduction in marginal WECC emissions rate by 2045

Preliminary Scenarios

TACOMA POWER
TACOMA PUBLIC UTILITIES

Reminder from Last Time

TACOMA POWER
TACOMA PUBLIC UTILITIES

Scenarios	Random Variability
Base Case • Business-as-usual load forecast • Existing laws and trends	Run many simulations with different weather & prices
Alternative Scenario 1 • Alternative set of assumptions 1	Run many simulations with different weather & prices
Alternative Scenario 2 • Another alternative set of assumptions 2	Run many simulations with different weather & prices

PRELIMINARY SCENARIOS

Scenario Development Process

Identify Drivers

- What factors will make our portfolio perform well or poorly?
- Brainstorming workshop & scenario survey

→

Select Critical Drivers

- Which uncertainties are the most important to model?

Drivers

TACOMA POWER
TACOMA PUBLIC UTILITIES

PRELIMINARY SCENARIOS

Resource Adequacy

- Loads
- Water supply
- Energy supply from contracted resources (BPA, etc.)

Portfolio Costs

- Market price levels
- Market price volatility
- Generation costs
- Contract costs

Critical Uncertainties

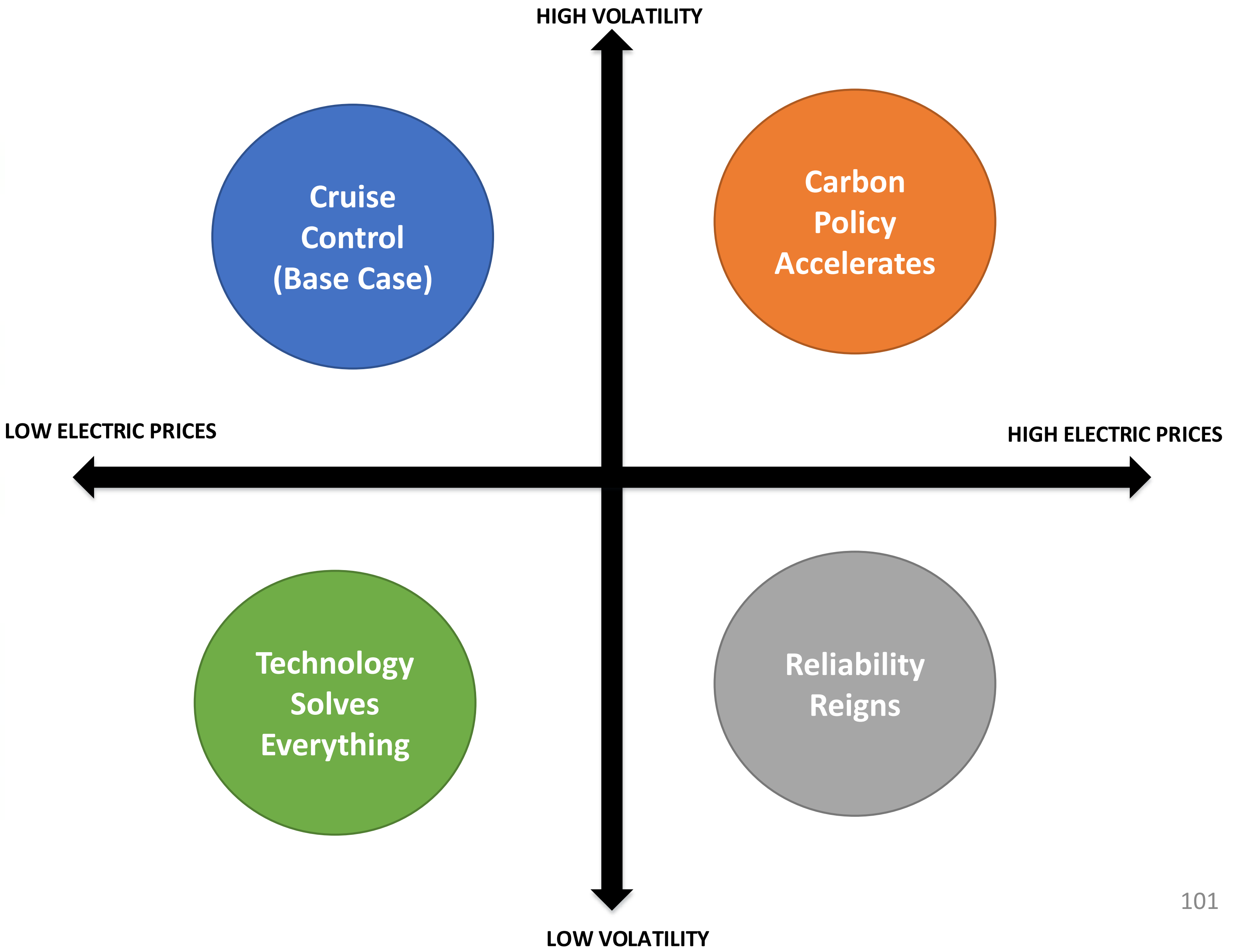
Carbon Emissions/ CETA compliance

- Market emissions rate
- CETA rules for market purchases

PRELIMINARY SCENARIOS

Creating Scenarios

TACOMA POWER
TACOMA PUBLIC UTILITIES



Scenario Development Process

TACOMA POWER
TACOMA PUBLIC UTILITIES

Identify Key Drivers

- What factors will make our portfolio perform well or poorly?

Select Critical Drivers

- Which uncertainties are the most important to model?

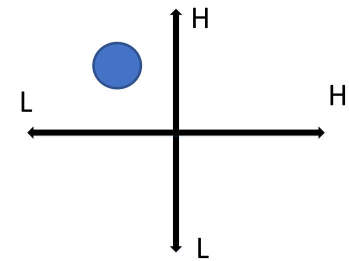
Span the Spectrum of Outcomes

- What are the outcomes we could see for our critical drivers?

Create Scenarios

- What does the world look like when these different outcomes happen?

“Cruise Control” (Base Case)



What does the world look like?

Business as usual. Policies as they exist today with no additional changes. Standard forecasts of loads, storage and renewables costs.

DEMAND

Utility load forecasts

RENEWABLES

Prices similar to current forecasts

STORAGE

Prices similar to current forecasts

CARBON POLICY

Existing policies

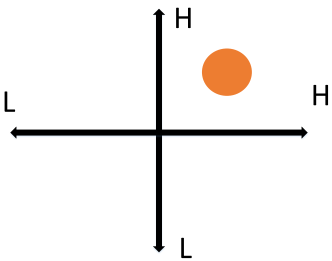
NATURAL GAS

Prices similar to current forecasts

COAL RETIREMENTS

Announced retirements + economic retirements

“Carbon Policy Accelerates”



What does the world look like?

Carbon reduction policies are extremely strong and spread to almost every state in the WECC. Policies are costly to implement due to limited options for integrating large quantities of renewables and limited attention to effective management of new electric loads. **International carbon reduction policies** have resulted in substantial increases in liquefied natural gas (LNG) exports, which cause natural gas prices to rise.

DEMAND

Electrification without widespread demand management

RENEWABLES

Prices similar to current forecasts

STORAGE

Prices similar to current forecasts

CARBON POLICY

Accelerated policies

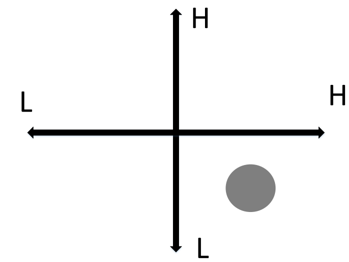
NATURAL GAS

High prices due to international competition for supply

COAL RETIREMENTS

Accelerated

“Reliability Reigns”



What does the world look like?

Poor planning and a series of gas pipeline issues lead to **rolling blackouts and price extremes**. Low income customers' access to power becomes a fundamental equity issue. With storage technology still expensive, policy makers decide to **roll back clean energy policies** in order to ensure reliability.

DEMAND

Electrification without widespread demand management

RENEWABLES

Prices similar to current forecasts

STORAGE

Prices similar to current forecasts

CARBON POLICY

Roll back of carbon policies around 2030

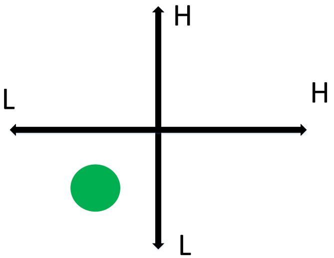
NATURAL GAS

Prices similar to current forecasts

COAL RETIREMENTS

Announced & economic retirements until around 2030

“Technology Solves Everything”



What does the world look like?

Low-cost solutions allow utilities to efficiently and cost-effectively **integrate large quantities of renewable resources**, including short and long duration storage and demand-side resources optimized for grid integration (electric vehicles, demand response, large flexible loads, etc.). Because of the **diversity of resources and significant investments in renewables**, energy market prices are both stable and low.

DEMAND

Strong reliance on demand-side resources

RENEWABLES

Accelerated decline in costs

STORAGE

Substantial decline in costs

CARBON POLICY

Existing policies

NATURAL GAS

Low prices due to low demand for natural gas

COAL RETIREMENTS

Announced and economic retirements

Other Factors

TACOMA POWER
TACOMA PUBLIC UTILITIES

Sensitivities that we will run on preferred portfolio

- ✓ **Climate change**

  Would our preferred portfolio still meet our needs under climate change?

  Are results substantially different?

  Climate change to be addressed more thoroughly in next IRP

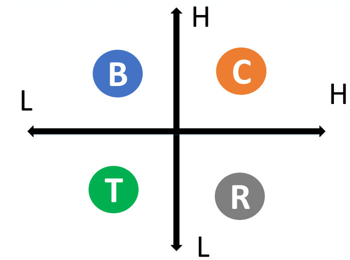
- ✓ **New large load**

  How much of a very large new load could be served by preferred portfolio?

  How big would the gaps be and when would they occur?

Survey Results

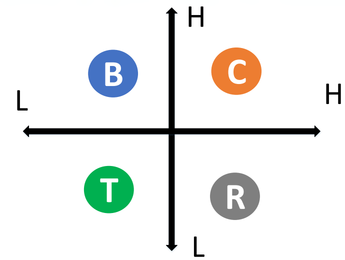
General agreement that growth is likely



Changes to Tacoma Power Service Area	Employees	%	Working Group	%	Relevant Scenario
Population growth	17	77%	5	71%	All
Acceleration of electric vehicle adoption	13	59%	4	57%	C, R, T
Changing energy usage patterns due to climate change	11	50%	4	57%	Sensitivity
Economic growth	8	36%	3	43%	All
Economic decline	2	9%	2	29%	None
Even more efficient energy-using equipment	10	45%	1	14%	T
Addition of new large load(s)	7	32%	1	14%	Sensitivity
Loss of large load(s)	5	23%	1	14%	None
Increased use of natural gas for heating	2	9%	1	14%	None
Increased adoption of rooftop solar	2	9%	1	14%	T
Infrastructure inadequacies (water & sewer)		0%	1	14%	R
Increased use of electricity for heating	6	27%	0	0%	C, R, T
Population decline	0	0%	0	0%	None
Policy changes forcing electrification	1	5%		0%	C, R
Continued gentrification and housing issues	1	5%		0%	None
Economic uncertainty	1	5%		0%	None
Utilities becoming more energy integrators than power suppliers	1	5%		0%	T
Figuring out how to use lots of power between 10AM and 2PM	1	5%		0%	T

Survey Results

Some agreement that vehicle/port electrification policies and a price on carbon are likely.

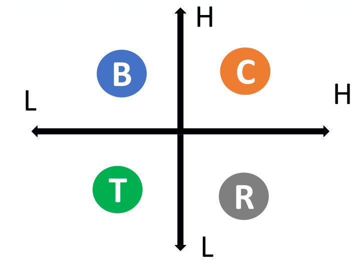


Policy Changes	Employee Survey	%	Working Group	%	Relevant Scenario
All new buildings must be built with EV chargers	14	64%	6	86%	C, R, T
All new buildings must be "solar-ready"	3	14%	4	57%	C
Adoption of a national or statewide tax on carbon	14	64%	3	43%	C
City, county or statewide requirement that all ships docked at Port of Tacoma run on electricity rather than diesel while docked	13	59%	3	43%	C, R, T
Adoption of a national or statewide cap and trade program for carbon	11	50%	3	43%	C
City, county or statewide ban on natural gas in new homes	8	36%	2	29%	C, R
Clean Fuel Standard		0%	1	14%	C, R, T
Moratorium on fracking	1	5%		0%	None
IOUs become public and controlled by the federal government	1	5%		0%	None
RA compliance laws	1	5%		0%	R
Early retirement of CGS	1	5%		0%	None

Employee Survey Results

TACOMA POWER
TACOMA PUBLIC UTILITIES

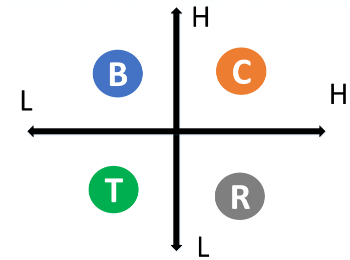
What are the biggest changes that we will see in the power industry over the next 20 years?



Types of Change	# Responses	%	Relevant Scenario
Technological solutions to integrating renewables	8	36%	T
Changing markets	6	27%	None
Electrification	5	23%	C, R, T
Acceleration of green policies/laws	5	23%	C
DERs (Rooftop Solar, Home Batteries, etc.)	3	14%	T
Climate change impacts on our hydro projects	3	14%	Sensitivity
Policies outside of WA that are bad for Tacoma Power	3	14%	None
Reductions in consumption	3	14%	B, T
Reliability challenges due to more renewables	3	14%	R
More renewables	2	9%	B, C, R, T
Changing customer expectations for information & products	2	9%	T
Cybersecurity	1	5%	None
Transmission constraints for Tacoma Power	1	5%	Addressed separately
Increased AC	1	5%	C, R
Natural gas price increases	1	5%	C

Write-in Scenarios

TACOMA POWER
TACOMA PUBLIC UTILITIES



Employee Survey

Suggested Scenario	Relevant Scenario
Large solar projects/PURPA puts (1MW+)	None
Would be good to see climate goals & Tacoma EAP considered in resource planning	Addressed separately
Power industry is nationalized	None
Massive electrification	C, R, T
No transmission into & out of Tacoma due to BPA changes to OATT practices & policies	None
Cybersecurity costs become high	None
Increased drought events (frequency & duration)	Sensitivity
Transmission constraints in Puget Sound as portfolios become more varied	C, R
Increased expectation that Tacoma Power lead the way on citywide GHG reduction	C
Reduced liquidity due to EIM participation	None

Working Group Survey

Suggested Scenario	Relevant Scenario
Energy storage, intelligent controls & utility process that easily integrate renewables	T
Infrastructure inadequacies (water & sewer)	R

Next Steps and Action Items

What are we covering next?

TACOMA POWER
TACOMA PUBLIC UTILITIES

Workshop Plan

TACOMA POWER
TACOMA PUBLIC UTILITIES

Next Steps and Action Items

Background Information → Key Inputs & Assumptions → Current Resources and Future Options → Preferred Alternative and Action Items

Workshop 1

IRP Overview

Workshop 2

Present key inputs

Present and discuss metrics

Present and discuss scenarios

Workshop 3

Review current situation

Present and discuss resource alternatives

Workshop 4

Present analysis results

Present and discuss preferred portfolio

Discuss action items

TACOMA POWER
TACOMA PUBLIC UTILITIES

Current Resource Performance and Future Options

Scenarios
- Buildout & Prices in Alternative Scenarios

Resources
- Performance of Current Portfolio
- Resource Options