MEMORANDUM

EUGENE WATER & ELECTRIC BOARD

Rely on us.

TO:	Commissioners Mital, Schlossberg, Helgeson, Brown and Carlson
FROM:	Susan Ackerman, Chief Energy Officer, Megan Capper, Portfolio Management Supervisor
DATE:	August 4, 2020
SUBJECT:	Preliminary Results from the Electrification Impact Analysis Report (EIAR)
OBJECTIVE:	Board Feedback and Guidance

Issue

This is a session to share the preliminary results from Phase I of the Electrification Impact Analysis Report (EIAR) for Board discussion. This analysis is part of the 2020 EWEB organizational goal #6 approved by the Board in March 2020.

> *As part of electricity supply planning, develop and publish an Electrification Impact Analysis Report that assesses the effects of electrification, and related ordinances/ legislation, on EWEB's loads, generation mix, reliability, costs, compliance, energy/efficiency efforts, and community GHGs.*

Background

EWEB management and the Board of Commissioners determined that an electrification study will be the focus of the utility's near-term power supply planning work. The analysis is intended to address the growing interest in our community to understand the relationship between fossil fuels and electricity and potential transitions to address climate change.

Phase 1 of the EIAR focuses on potential changes to energy demand and consumption patterns, generation needs, and environmental impacts from electrification of small vehicles, water and space heating. The preliminary results of this analysis are included in an early draft of this Phase 1 report (see Attachment 1). As analysis continues and findings are refined, a final draft will be provided to the Board by the November 2020 meeting.

Phase 2 of the study will build on this analysis with a deeper dive into the impacts of electrification to EWEB's infrastructure and energy costs and will assess the influence of energy efficiency and demand management programs on these impacts. This work is targeted for completion in early 2021. Development of a new Integrated Energy Resource Plan is scheduled to begin in 2023.

Discussion

Staff have made significant progress developing the underlying analytical model needed to evaluate key drivers of electrification and assess potential load and carbon impacts under different adoption rates. There is tremendous uncertainty in forecasting electric vehicle adoption rates and consumer choices around space and water heating technologies as carbon policies, economic conditions, and technological advancements are in flux. With the analytical model in place, these assumptions can be readily adjusted as we learn more.

The preliminary report attached herein previews the early structure of the Phase 1 report, as well as the initial results of the analysis so far. Additional information will be added between this draft and the first publication in the fall, including potential mitigation measures, a glossary of terms and more details on our research methodology and key assumptions.

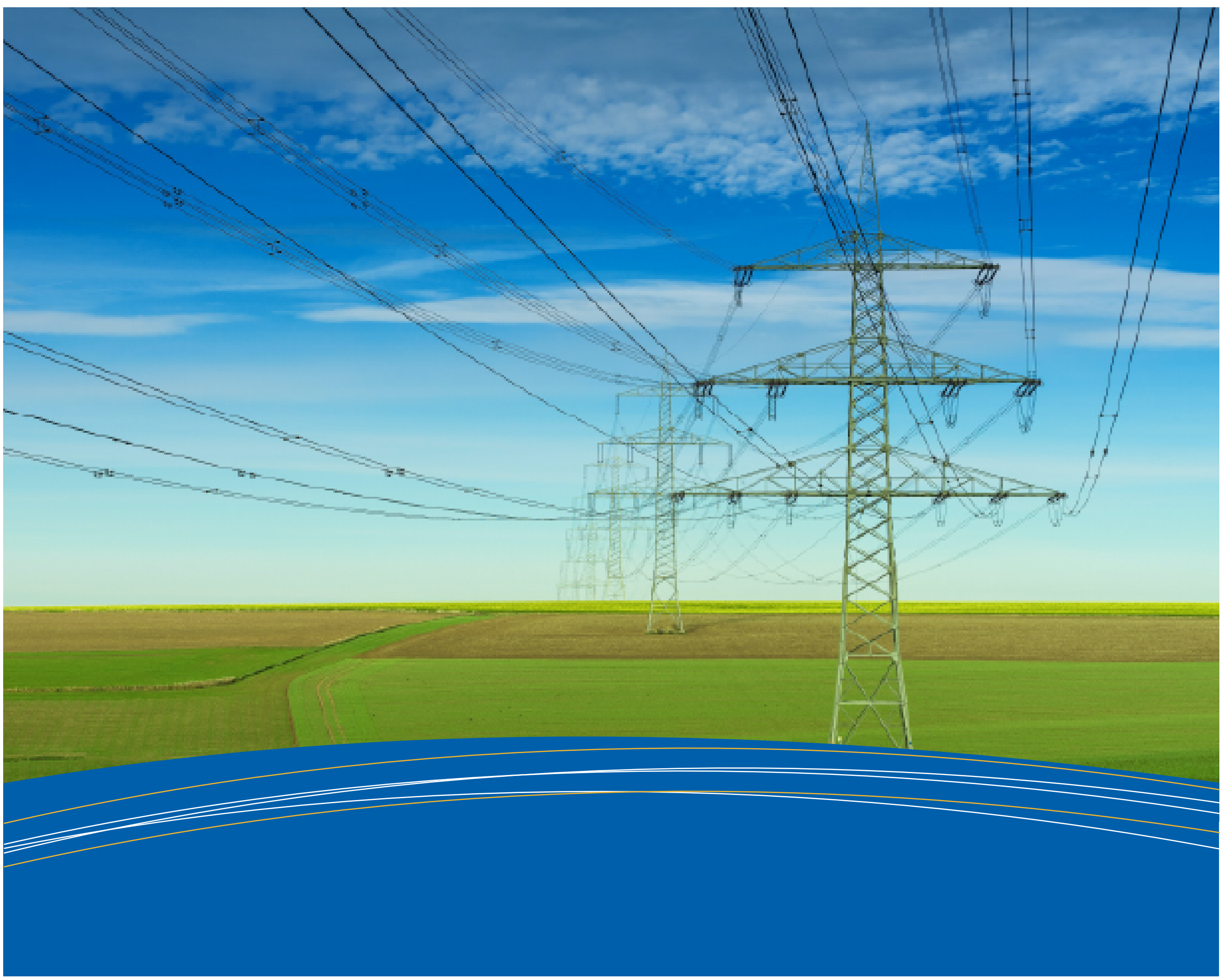
Initial results show that absent a significant change in policy or economics, EWEB's energy supply and delivery system can manage expected load growth from electrification of commercial/residential space and water heating, as well an increase in electric vehicle sales. Early analysis indicates that resulting carbon reductions are meaningful and enhanced with energy efficient technology choices, and these benefits can be improved if peak demand is managed.

Requested Board Action

Board feedback on the initial results and the underlying assumptions is requested to help guide the development of the Phase 1 report due later this year. Input for how the analysis can be adjusted or expanded to address other sensitivities to support future policy, programs or planning work is appreciated as this can be considered in either Phase 1 or Phase 2 of the Electrification Impact Analysis report.

Electrification Impact Analysis Report

Phase 1 Preliminary Findings | August 2020



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2 ABSTRACT

Electrification is a term for replacing direct fossil fuel use (e.g., natural gas, heating oil, gasoline) with electricity in order to reduce greenhouse gas emissions.

Here in Eugene, where we are fortunate to have one of the cleanest power portfolios in the nation, electrifying end-use technologies (like space heating, water heating and electric vehicles) presents the opportunity to substantially reduce our community's carbon footprint. At the same time, the impacts of electrification could be far-reaching, significantly altering how much, when and where electricity is used along with the carbon intensity of the system.

The goal of this study is to assess these impacts and help the utility prepare for various electrification futures, including the resources, technology and infrastructure that will be needed to meet customers' changing energy needs over the next 30 years.

This analysis is also intended as a data-driven framework for policy decisions and programs addressing climate change.

The study will be completed in phases, with Phase 1 focused on potential changes to energy demand and consumption patterns, generation needs, and environmental impacts from electrification of passenger vehicles, as well as domestic water and space heating. The preliminary results of this analysis are included in this document, with completion of the Phase 1 report slated for October 2020.

3 EXECUTIVE SUMMARY

Electrification of parts of the transportation and building sectors could have far-reaching impacts to the utility and its customers. The Electrification Impact Analysis seeks to quantify these impacts to help the utility's power resource planning efforts and support policy and program development to optimize the potential benefits of electrification.

Adoption rates for electric vehicles, space heating and water heating are subject to wide bands of uncertainty, with economics, technology, and legislation among the key factors influencing customer choices. This analysis forecasts varying degrees of electric end-use technology adoption over a 30-year period.

Phase 1 of the study looks at both the overall energy and peak load impacts of different electrification scenarios using a regional framework. This regional perspective will help capture the impacts of transitioning from fossil fuels to electricity, with specific attention to the carbon intensity of electricity consumed, considering a shared and integrated power grid.

Phase 2, targeted for completion in mid-2021, will analyze cost impacts from widespread electrification and evaluate how EWEB programs could strategically encourage achievement of carbon reduction policy goals.

3.1 KEY FINDINGS

1. Absent legislative action or dramatic economic changes driving consumer behavior towards electrification, average electric energy loads will increase at a manageable pace in the next five years.

2. Early analysis indicates that resulting carbon reductions are meaningful and enhanced with energy efficient technology choices, and these benefits can be improved if peak demand is managed.

3. Electric Vehicles represent a significant carbon reduction opportunity and load impact compared to space and water heating.

4. The EWEB transmission and distribution system is forecasted to maintain adequate capacity and adaptability to meet the increased demand of electrification in the near term.

4 Electrification Impact Analysis Scope

Findings from the Electrification Impact Analysis are part of EWEB's broader and on-going Electricity Supply Planning (ESP) effort. Electricity Supply Planning includes a broad set of actions, such as evaluating power portfolio options, negotiating power purchase agreements, and developing customer products and services, all with the goal continuing to serve our community over the long-term with clean, affordable and reliable power. It is key to the success of EWEB's strategic priorities of facilitating more flexible and efficient energy consumption, synchronizing supply and demand, and creating a more resilient electric grid.

The Electrification Impact Analysis aims to answer five key questions:

1. How might state and local policies influence the rate of electrification in Eugene?
2. How could widespread electrification impact electricity consumption patterns and carbon emissions?
3. What impact would electrification have on EWEB's power system (generation, transmission, distribution, etc.)?
4. What role might energy efficiency and demand-side flexibility play in mitigating challenging outcomes of mass electrification?
5. What are potential costs, benefits and impacts of various electrification futures?

Phase 1 of the analysis and the preliminary findings presented in this report concentrate on the first three topics above.

The study uses a 30-year timeframe, with results summarized for present state, 2025, 2030, 2040 and 2050. This study targets two economic sectors with high potential for carbon reductions:

- Transportation, specifically passenger and light duty vehicles
- Building space and water heating, specifically in the domestic sector

End-use applications that are deemed less likely to transition to electricity for fuel, such as freight/heavy-duty vehicles and industrial loads, are outside the scope of the study.

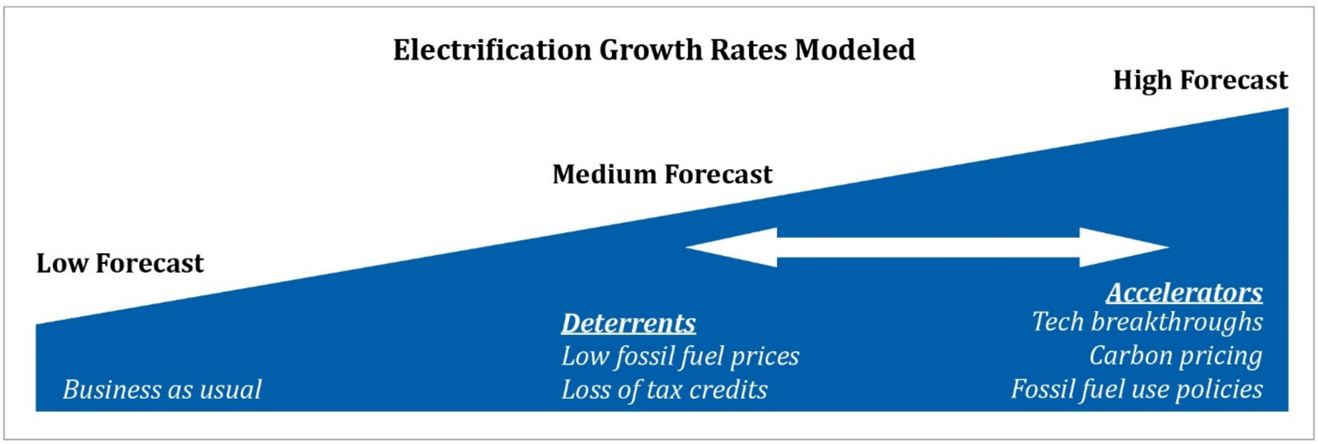
Study Scope		
	In-scope	**Out-of-scope**
Transportation sector	Passenger and light duty vehicles	Commercial freight vehicles Transit buses
Buildings sector	Residential space & water heating	Industrial space & water heating

4.1 Key Assumptions

Past behavior may be a poor indicator of future adoption trends when it comes to electrification of these particular end-uses. Therefore, as with any 30-year study, the analysis is heavily reliant on a variety of assumptions to model the future.

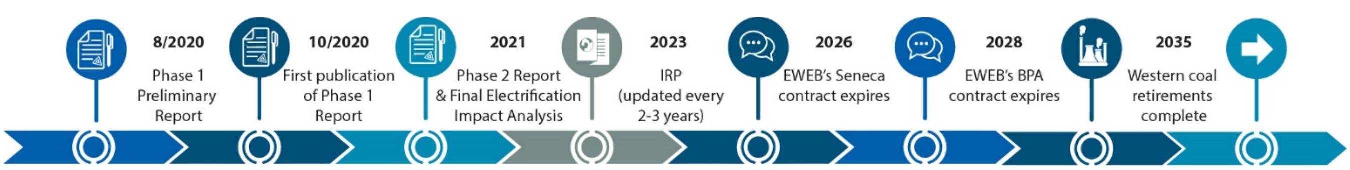
This first phase of analysis addresses this uncertainty with multiple and wide-ranging forecasted electrification growth rates. High and medium forecasts are modeled to show the effects of electrification accelerators—such as technology breakthroughs, carbon pricing, and other policies around fossil fuel use—and deterrents—like low fossil fuel prices and the loss of tax credits. Low growth forecasts project business as usual with existing policies and trends continuing into the future.

Details on the research methodology and key assumptions will be included in the final Phase 1 report.



4.2 Timeline

Phase 1 of the study looks at both the overall energy and peak load impacts of different electrification scenarios using a regional framework. This is important given EWEB's reliance on market liquidity to meet peak load needs and to balance loads and resources. It is also timely given the pace of change to Northwest power supplies as coal plants are retired. While EWEB is monitoring the adequacy of power resources in the region closely, our involvement in the Northwest Power Pool (NWPP) Resource Adequacy Program is out of scope for this study.



Phase 2 will analyze cost impacts from widespread electrification and evaluate how EWEB programs could strategically encourage achievement of carbon reduction policy goals. Phase 2 is an opportunity to model additional scenarios, such as rapid population growth and other climate-related uncertainties. The analysis will also take a deeper dive into the capacity of our power supply and delivery system.

The Electrification Impact Analysis is a precursor to the next Integrated Energy Resource Plan. As such it will assist the utility's planning efforts by modeling potential impacts to load (overall, peak and shape), our energy portfolio (resource mix, costs, carbon intensity, and compliance factors), and to our electric infrastructure. Ultimately, these planning efforts are aimed at optimizing our power resources, generating assets, infrastructure and customer products and services so that we continue to serve our community with clean, affordable and reliable power.

The results of Phase 1 will be captured in the Electrification Impact Analysis First Publication currently planned for October. Phase 2 of the Electrification Study is scheduled to be completed in mid-2021, concluding with the Final Electrification Impact Analysis.

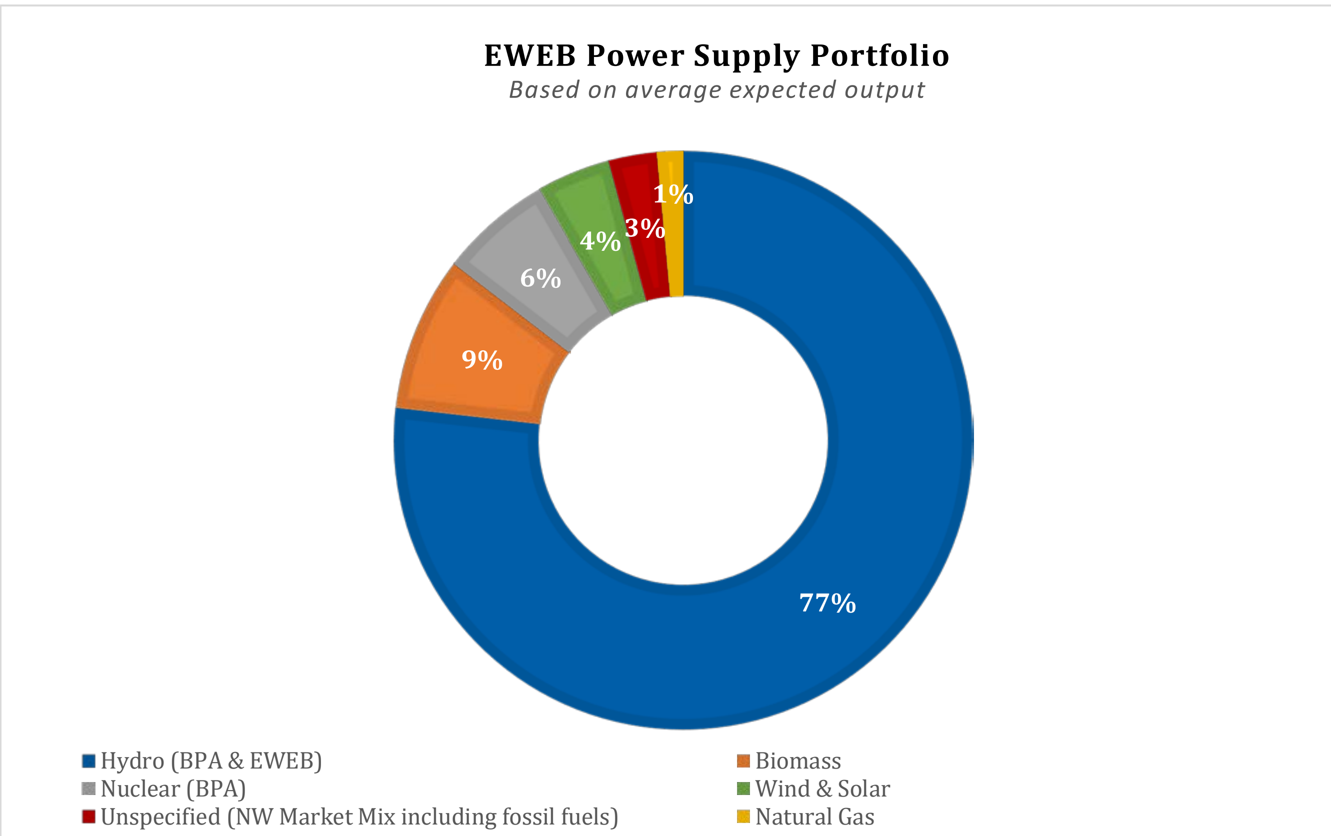
5 Key Context: EWEB Resource Portfolio and Load

HIGHLIGHT

A combination of ample, clean energy resources and a strong legacy of energy efficiency programs puts EWEB in a strong position to support electrification, both for our own customers and within the larger region.

5.1 Power Resource Portfolio

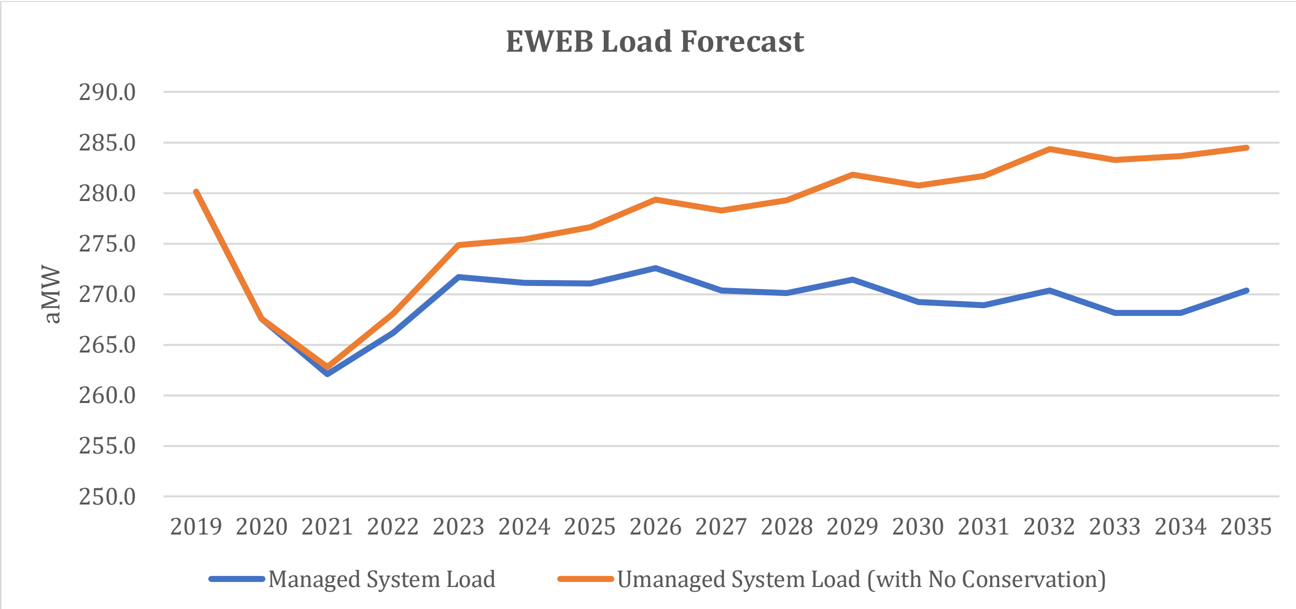
EWEB's energy portfolio is made up almost entirely of carbon-free resources. About 80% of our power comes from hydroelectric energy, while the remaining 20% comes from conventional and renewable resources. The majority of our energy is supplied through a contract with the Bonneville Power Administration (BPA); this contract is set to expire in 2028.



5.2 Load Forecasts

EWEB's recent update to the 2011 Integrated Energy Resource Plan shows that the utility continues to have adequate resources to meet customers' energy needs and can readily meet forecast load growth with energy conservation. Annual conservation targets are based on five-year average load forecasts, which continue to show little to no load growth.

The projected economic impact from COVID-19 reinforces this trend. The graph below is the most recent load forecast, with and without conservation measures in place.



Economic impacts of COVID-19 are forecasted to result in load reductions of approximately 5% through 2021. We forecast a return to average load (270 aMW) by 2023, with conservation facilitating load stability throughout the current planning horizon.

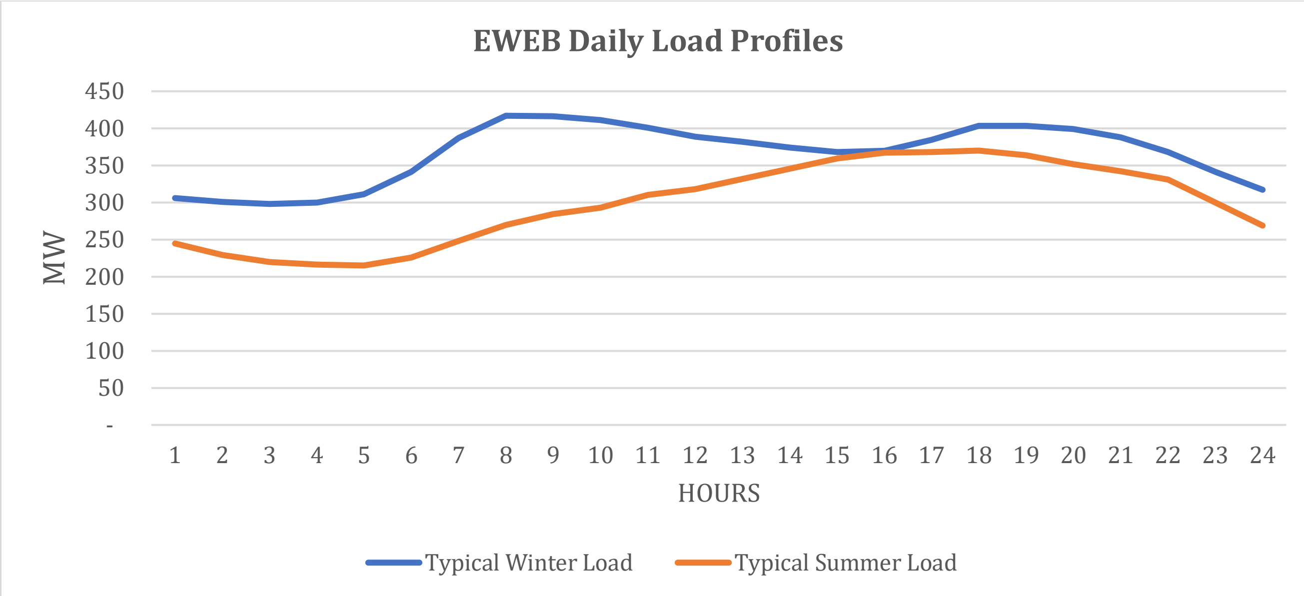
5.3 Peak Demand

When considering the value of electrification, it is critical to consider not just overall energy use, but peak demand. Peak electricity is more expensive, affecting power supply and infrastructure costs and, ultimately, customer bills.

Mitigating peak demand can be a useful strategy to delay infrastructure investments due to capacity constraints, limit the need for new resource acquisitions, and reduce reliance on "peaker plants" which are more carbon intensive energy resources in the market.

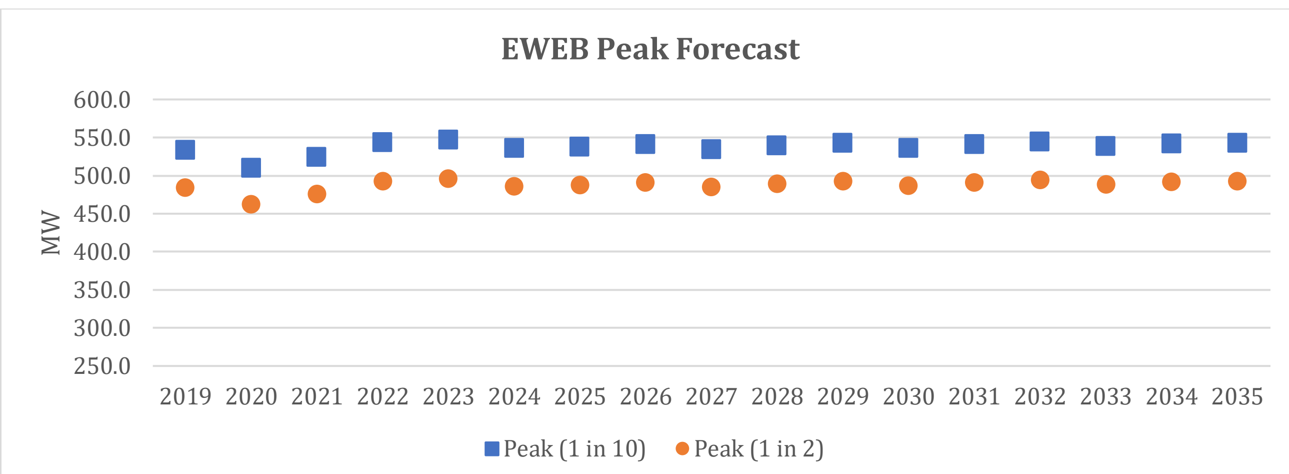
Like most Northwest utilities, EWEB experiences peak demand for power in the winter months, when space and water heating needs are highest and when the availability of renewable resources like wind and solar are diminished. The graph below shows 1-hour peak demand forecasts for a 1-in-10-year occurrence and more typical 1-in-2-year peak.

Winter peak is highly weather dependent and strongly correlated to space and water heating needs. EWEB's daily load follows a fairly predictable diurnal pattern, with a morning peak demand, and smaller secondary peak in the late afternoon coinciding with customers', especially residential customers' usage patterns.



The timing and size of electrification-based peak demand has both carbon and cost implications that require full consideration. Therefore, a central question to be answered in this study is how electrification of the building and transportation sectors will impact peak demand.

This assessment must take into account a regional perspective. At the same time that EWEB might need additional energy resources to support an increased peak demand, other utilities in the region are in a similar situation. This makes the carbon content of the power available in the Northwest grid as important, if not more, than EWEB's portfolio alone.



Taken together, these forecasts indicate that EWEB's average load will remain around 270 aMW when managed with conservation programs, and typical peak demand will hover near 500 MW.

5.4 Conservation targets

Given that conservation programs are more efficiently delivered with relatively steady targets, EWEB plans to maintain the current level of energy savings at 9,500 MWh to ensure the long-term stability of our programs.

While this amount of conservation exceeds our expected load growth in the near-term, it reflects the minimum level of activity required to be reimbursed for our conservation investment in BPA. In addition, it meets the "natural demand" for our conservation programs, where customers and contractors bring projects to us, rather than EWEB stimulating new projects through outreach and advertising.

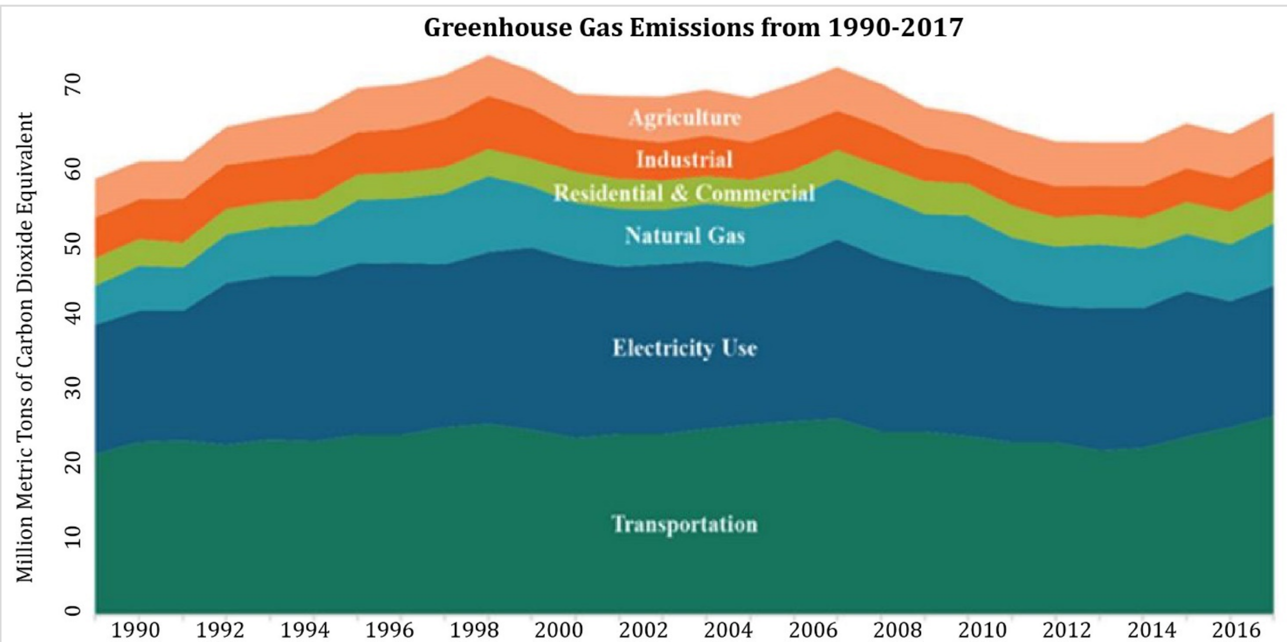
With this level of conservation and our current power contracts in place, EWEB typically has a surplus of energy resources available to serve our customers and sell on the wholesale market. The combination of ample, clean energy resources and a strong legacy of energy efficiency programs puts EWEB in a strong position to support electrification, both for our own customers and within the larger region.

6 KEY CONTEXT: GREENHOUSE GAS REDUCTION GOALS AND CARBON CONTENT OF ELECTRICITY

HIGHLIGHTS

- Both state and local greenhouse gas inventories show the transportation sector as the largest contributor to greenhouse gas emissions.
- Because EWEB is part of an inter-connected grid with an active trading, this report utilizes a carbon emissions factor that is higher than EWEB's power portfolio.
- The City of Eugene's Climate Action Plan (2.0) forecasts that Eugene needs to reduce emissions by 790,000 MTCO2e by 2030 to meet climate goals. This translates to a 64 percent reduction in emissions from the 2017 baseline.

Transitioning from fossil fuel use to electricity while continuing to 'green' the electrical grid and pursuing energy efficiency is often cited as the critical pathway to reducing carbon emissions associated with climate change. Electrification of transportation and buildings' energy use are key components of this over-arching strategy.



Source: Oregon Department of Environmental Quality

Both state and local greenhouse gas inventories show the transportation sector as the largest contributor to greenhouse gas emissions. As the graph below indicates, despite the predominance of hydroelectricity in the Northwest, electricity is a major source as well. According to the Oregon Department of Environmental Quality (DEQ), about 75% of the greenhouse gas emissions associated with the generation of electricity comes from power imported from other states[1].

[1] "Program Options to Cap and Reduce Greenhouse Gas Emissions Final Report," Oregon DEQ, June 2020.

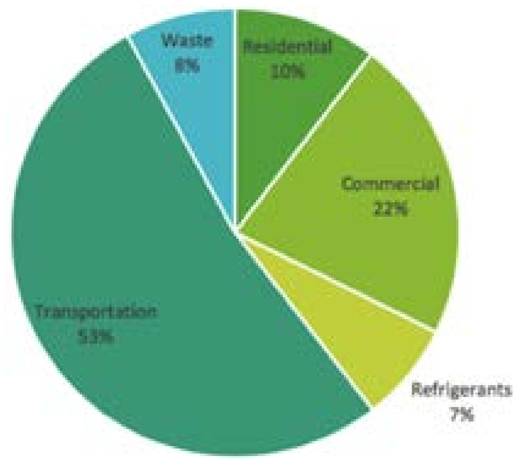
In March 2020, Governor Kate Brown signed an executive order that sets out statewide emission reduction goals that calls for Oregon to reduce its emissions at least 45 percent below 1995 levels by 2035, and at least 80 percent below 1990 levels by 2050. Further, it directs the DEQ to establish programs to reduce emissions from three key sectors: large stationary sources, transportation fuels, and all other liquid and gaseous fuels, including natural gas.

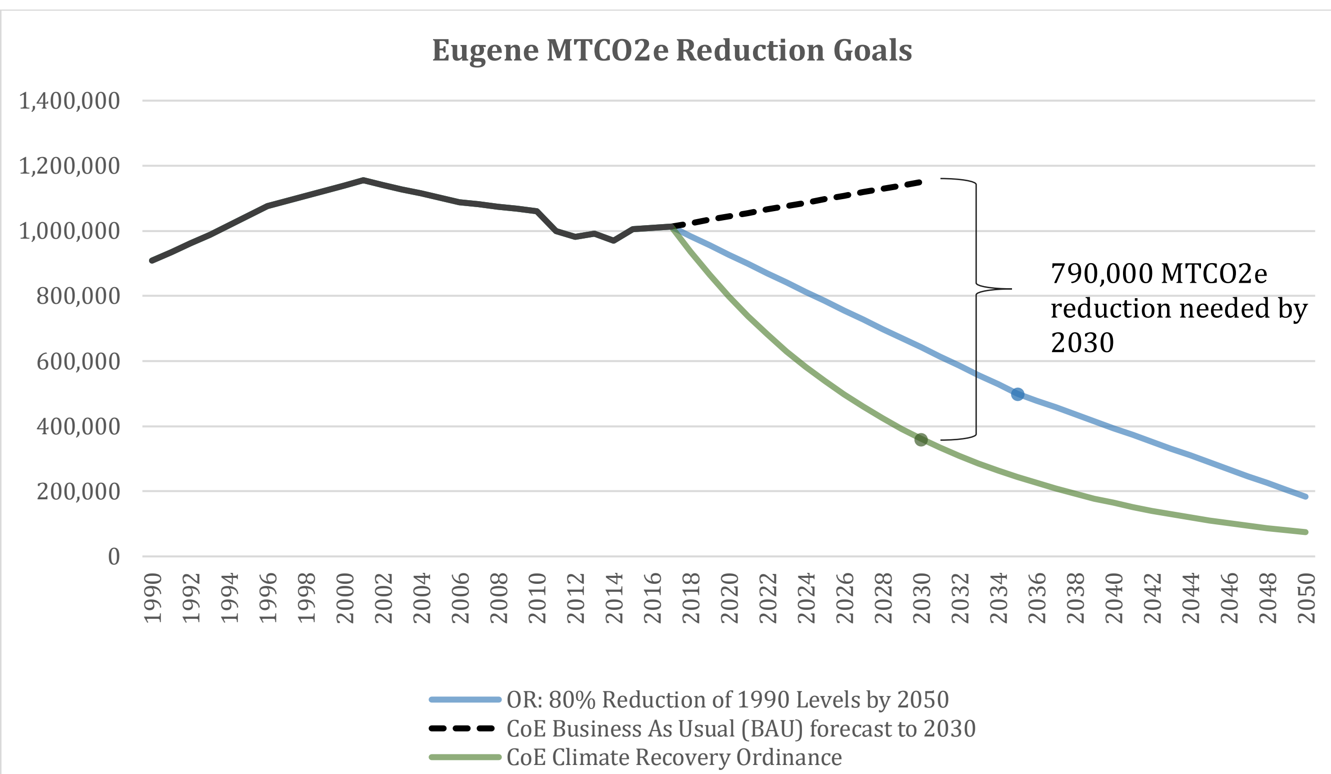
Locally, the City of Eugene has recently released its Climate Action Plan 2.0 (CAP 2.0) which also establishes science-based emission reduction goals by highest impact sectors in our community: transportation fuels, energy use in buildings and fugitive emissions (e.g. landfill waste, refrigerant leakage).

According to the City's 2017 greenhouse gas inventory, 53 percent of emissions are from transportation fuels, while 32 percent from the electricity and natural gas used to heat and cool buildings. According to the CAP 2.0, 85 percent of local greenhouse gas emissions are from fossil fuel use. Therefore, meeting the CAP 2.0 goal will require bold policy and legislative action to support the community in using less fossil fuel-based energy for transportation and in buildings.

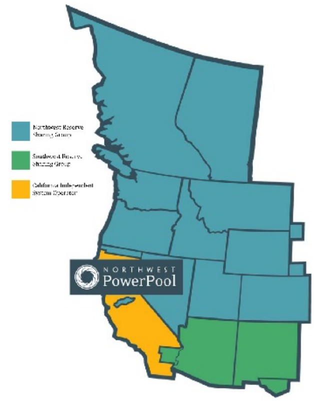
The primary goal of the CAP 2.0 is to meet the carbon reduction goals established by Eugene's Climate Recovery Ordinance (CRO). The latest version of the CAP 2.0 forecasts that Eugene needs to reduce emissions by 790,000 MTCO2e by 2030 to meet those goals. This translates to a 64 percent reduction in emissions from the 2017 baseline.

City of Eugene CAP 2.0 Sources of Emissions





The extent to which electrification of these two sectors advances carbon reduction goals depends, in part, on the amount of fossil fuel used to generate the electricity.



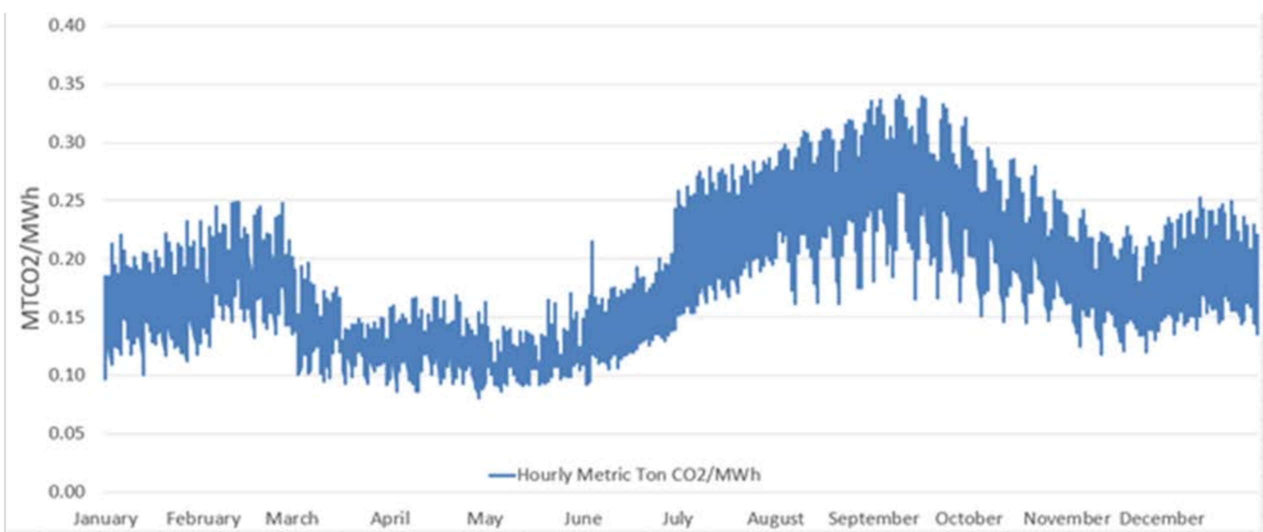
EWEB's power portfolio is made up of almost 90% carbon-free resources and has a lower annual average emissions rate than the regional grid. But EWEB is part of an inter-connected grid with an active trading floor that is buying and selling power in response to hourly demand.

This report utilizes an emission factor for the Northwest Power Pool (NWPP) to account for market activity in an interconnected grid.

Average Annual MTCO2e/MWh	
EWEB[2]	.02
Northwest Power Pool (NWPP)	.19
US Average	.45

The regional electric supply must meet actual demand instantaneously. This means that the carbon intensity of the NWPP fluctuates as various underlying resources generate in real time. The graph below indicates that regional carbon emissions are strongly correlated to the availability of hydropower generation, which declines in the summer and fall.

Northwest Power Pool Carbon Intensity



To calculate the carbon intensity associated with a particular end-use (like EV charging for example), staff analyzed hourly power consumption by end-use and multiplied it by the respective NWPP hourly carbon intensity. This hourly carbon calculation was done over the course of the entire year (8,760 hours) to factor in the seasonality of carbon emissions. This hourly methodology improves the accuracy of estimating the carbon emissions attributable to the end-use.

[2] Per Oregon DEQ GHG Reporting 2018

7 PRELIMINARY RESULTS: ELECTRIFICATION OF PASSENGER AND LIGHT DUTY VEHICLES

HIGHLIGHTS

- EV adoptions are expected to increase, but the rate and timing of adoption is uncertain.
- In all except the fastest modeled adoption rate, load growth is gradual and results in less than a 15% increase to EWEB's overall average load and less than 30% increase in peak demand.
- Customer programs to shift the timing of EV charging behavior is a promising strategy to mitigate the potential negative cost and carbon impacts of peak demand from EVs.
- EV adoption has the potential to reduce community carbon emissions in the range of 10,000 (low growth) to 100,000 MTCO2e (fastest growth) by 2030.

7.1 IMPLICATIONS OF ELECTRIC VEHICLES

The market and policy landscape for transportation electrification is changing rapidly, and these shifts have major implications for utilities and the climate.

Given the sizeable contribution the transportation sector has on greenhouse gas emissions and EWEB's clean electricity mix, increased use of electric vehicles (EVs) is a cornerstone to meaningful and cost-effective carbon reduction strategies. According to a recent report funded by the Bonneville Environmental Foundation, the Union of Concerned Scientists estimates that EVs powered by grid-average electricity in the Pacific Northwest generate an equivalent amount of carbon as a gasoline car that gets 96 mpg[3].

For EWEB, transportation electrification has impacts not only for load, but also for infrastructure planning and development of customer programs.

This study focuses on light duty vehicles recognizing their potential growth in market share as battery technology and cost-competitiveness improves, and as customer acceptance gains traction.

7.2 EV ADOPTION RATES

Several studies predict that EVs will reach cost-parity with conventional gas-powered cars in the next several years, which is considered a key "tipping point" in EV adoption.

To model the impacts of electrification of light duty vehicles in EWEB's service territory, the study first estimates future EV adoption rates.

Based on Oregon vehicle registration data, there were 1,041 and 1,328 registered EVs in EWEB's service territory in 2018 and 2019, respectively. This represents a year-over-year growth rate of 28%.

[3] Union of Concerned Scientists – How Clean is Your Electric Vehicle? http://www.ucsusa.org/clean-vehicles/electric-vehicles/ev-emissions-tool#.WXjE1ojytdg

Still, local historical data on EV adoption rates is limited, and market penetration over the next 30 years has great uncertainty.

To model a range of potential EV adoption rates in our area, staff reviewed national studies from organizations like the Electric Power Research Institute and Energy and Environmental Economics, Inc. ("E3"), and ultimately developed four projections reflecting low, medium and high and fastest growth forecasts.

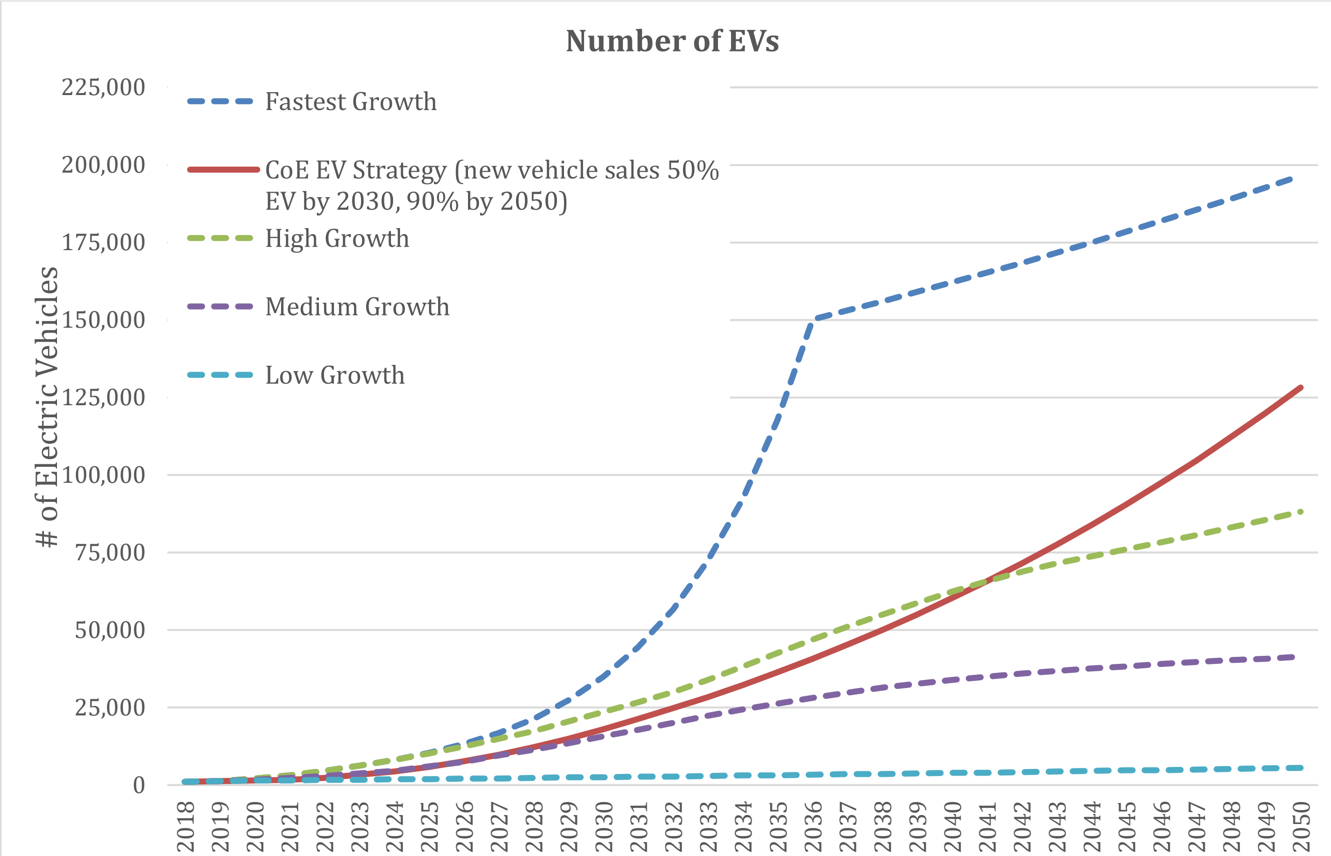
The low projection uses a slightly elevated adoption rate over the historical national trend through 2050. For the medium and high projection rates, EWEB utilized data from E3 which has been acting as a strategic advisor for this study. The fastest projection builds on the high rate and assumes Eugene's 28% year-over-year growth rate in 2019 will continue until 100% market penetration is reached in 2036.

The City of Eugene is in the process of developing an Electric Vehicle Strategy with the goal of 50% EVs by 2030 and 90% EVs by 2050. This adoption trajectory has been included as a separate EV growth rate, for additional context.

The table below translates these projections into a percentage of total vehicles sales in 2050.

Estimated EV Percent of Total Vehicle Sales by 2050	
Low adoption (business as usual)	3%
Medium adoption	21%
High adoption	45%
City EV Strategy goal	90%
Fastest EV adoption*	100%

The wide range of potential EV penetration rates is due to the significant uncertainty regarding consumer behavior. While price parity with conventional gas-powered vehicles is one economic driver of EV adoption, so too is fuel pricing, tax incentives and even marketing by automakers. Staff will continue to input local EV data in order to refine these projections over time.



**The fastest growth rate is included for reference and continues to increase past 2036 as all new vehicles sold (2% growth annually) are EVs*

7.3 EWEB Load Impacts

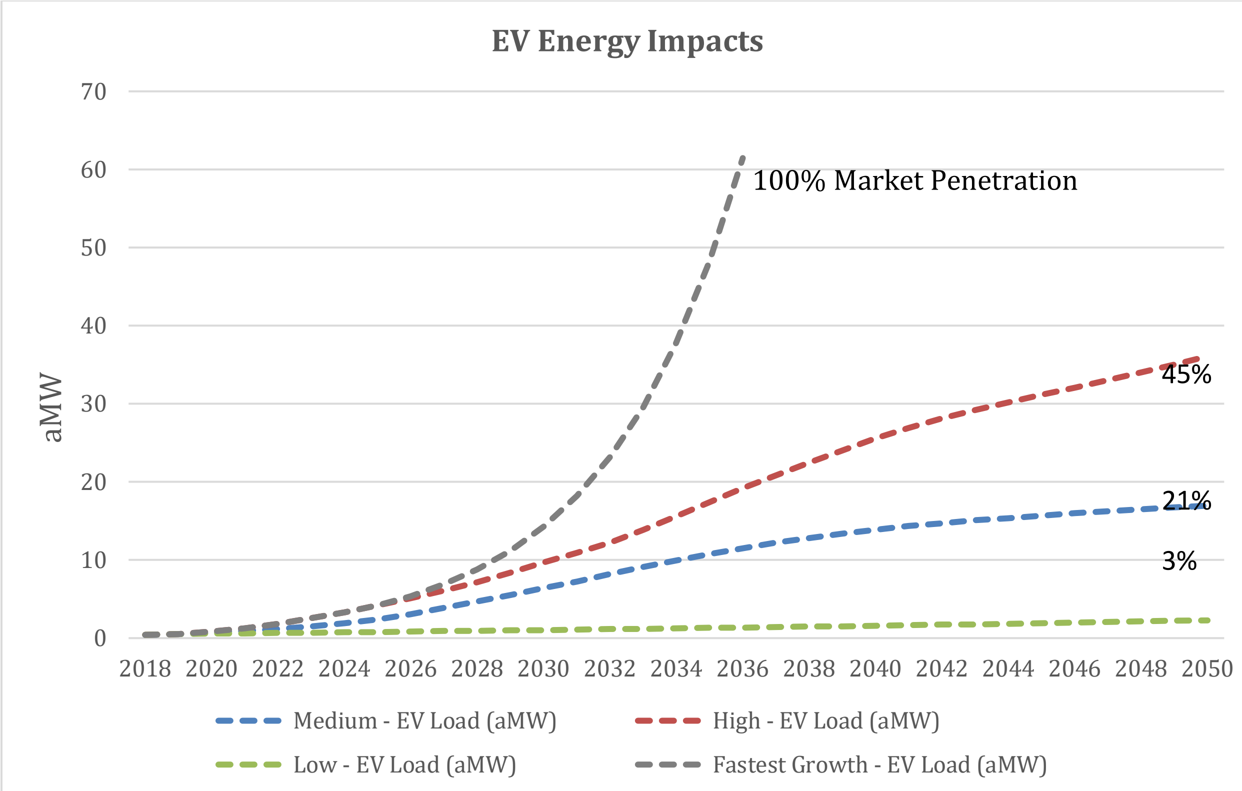
As more EVs enter EWEB's service territory, impacts to the utility's load from charging these vehicles will grow over time. To calculate these impacts, we need to determine the energy used per EV. This requires two main assumptions: 1) average number of miles driven, and 2) average amount of energy used per vehicle mile driven.

Based on national data for light-duty vehicles, the average travel distance is approximately 31.5 miles per day[4]. Energy consumption per mile driven varies depending on the make and model of each EV. Staff reviewed the MPGe of various EV's currently available today and calculated an average power consumption of .3125 kWh per mile. This yields an average energy consumption of 9.85 kWh/day[5] for each EV in EWEB's service territory. This daily consumption can be annualized and scaled based on the amount of EVs adopted over the next 30 years to forecast the energy impacts of EV adoption.

In the chart below, the energy impacts from the various EV adoption rate scenarios are shown over time in average megawatts (aMW). The market penetration rates are shown as percentages.

[4] "Highway Statistics 2018", Federal Highway Administration, 2020.

[5] Derived by multiplying miles driven per day by kWhs consumed per mile, 31.5 miles per day x 0.3125 kWhs per mile = 9.85 kWh consumed per EV per day



Recall that EWEB's overall average load is 270 aMW. **In all except the fastest adoption rate, load growth is gradual and results in less than a 15% increase to EWEB's overall average load by 2050.**

This analysis is helpful in forecasting long-term energy demand trends, but it does not reflect the full impact of EVs on the electric utility. The following sections discuss the impact of transportation electrification on peak demand.

7.4 Peak Impacts of EV Adoption

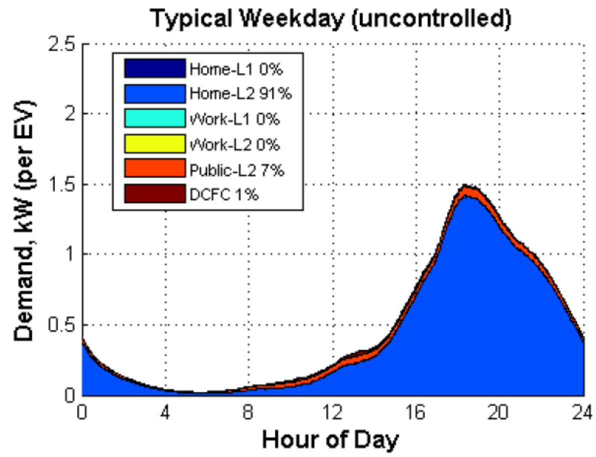
A key question this study strives to answer is to what extent EV charging behavior will alter EWEB's existing peak demand. This requires estimating the coincident peak demand, or put another way, the collective power consumption of the fleet of EV equipment over a 24-hour period. For EVs, coincident peak demand is dependent on the individual EV driver's charging habits (at home, at work) as well as the type of charging infrastructure used by the driver (level 1, level 2 or DC fast chargers).

Research shows that for a majority of early EV adopters, charging most commonly occurs at home. In a survey of over 2,800 electric vehicle drivers funded by the California Air Resources Board, 83% utilize home charging, while 11% rely mostly on nonresidential charging[6]. Regarding the type of charging equipment used at home, the study found that about 58% used Level 1 while the remainder had Level 2 charging equipment.

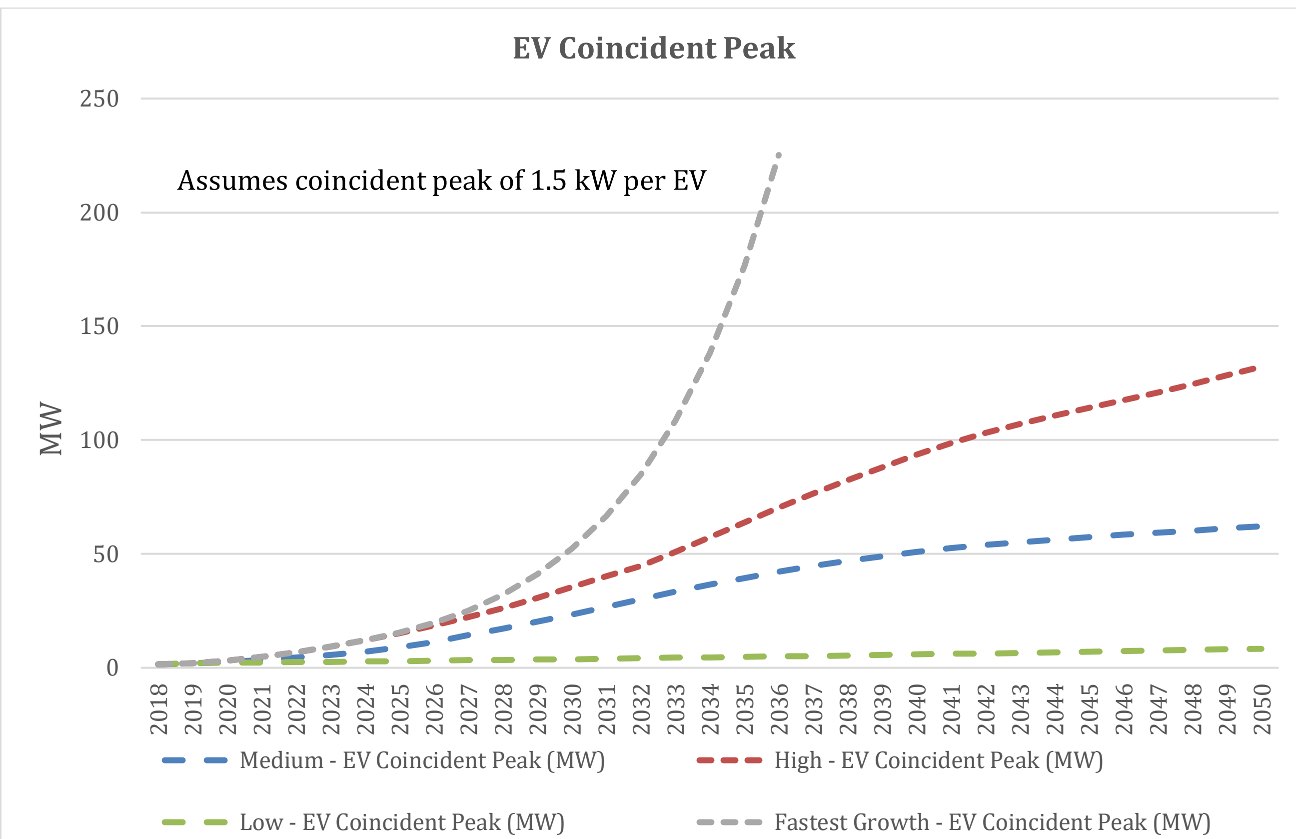
[6]Quantifying the electric vehicle charging infrastructure gap across U.S. markets https://theicct.org/publications/charging-gap-US

For the purposes of this study, EWEB analyzes Level 2 charging only as a more conservative measure of potential impacts to utility infrastructure and load.

The National Renewable Energy Lab (NREL) modeled the charging behavior of 100,000 EV users to better understand the impacts of EV charging over the course of a 24-hour period (Team, 2019). The aggregate charging demand profiles generated by NREL's modeling shows strong correlation to an 8AM – 5PM workday, with most drivers charging when they get home from work (see figure to the right). This study shows that the coincident demand reaches a 1.5 kW peak around 7PM when the majority of those 100,000 EVs are charging simultaneously.



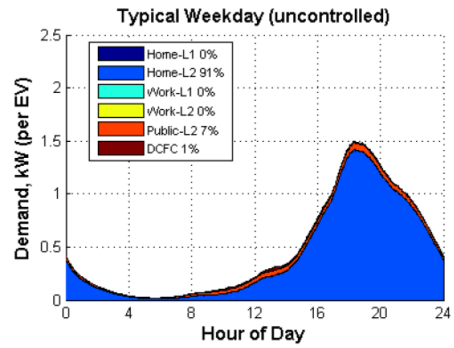
Based on the NREL data, as well as coincident EV demand information provided in industry trainings, it appears that 1.5 kW coincident demand per EV is reasonable. Using this assumption, we can now model the coincident demand of EVs over time depending on different adoption rate projections.

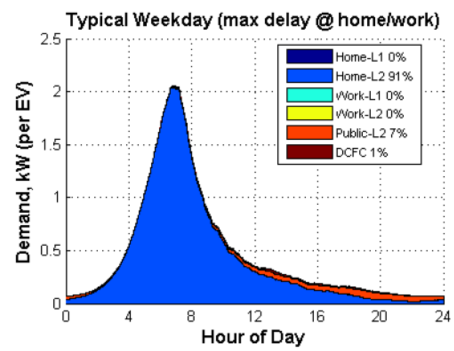


Recall that EWEB's typical peak is 500 MW. **The study shows that without mitigation measures, in all except the fastest adoption rate, peak demand increases by less than 30% by 2050, with that demand accumulating gradually over time.** The fastest adoption rate creates a dramatic and sizeable peak demand starting in 2028.

7.5 MITIGATING PEAK DEMAND

Mitigating peak demand can be a useful strategy to delay infrastructure investments due to capacity constraints, limit the need for new resource acquisitions, and reduce reliance on "peaker plants" which are more carbon intensive energy resources in the market.





In the same NREL study, researchers shifted the aggregate charging demand profiles of 100,000 EVs on a typical weekday by controlling charge times. Per the study: "Uncontrolled charging represents the case where EVs charge immediately at full power once connected and continue until completely charged. Maximum delay represents the case where demand is shifted into the latest period that ensures the EV receives a complete charge before departure. These two cases represent both ends of the spectrum of vehicle charging."

In the NREL study, the weekday uncontrolled charging creates an evening charging peak of approximately 150 MW from 6 to 10 PM, whereas the maximum delay creates an early morning charging peak of approximately 205 MW from 6 to 10 AM. These aggregate peaks translate to 1.50 kW-per vehicle and 2.05 kW-per vehicle, respectively[7].

Customer interventions to shift the timing of EV charging behavior is a promising strategy to mitigate the potential negative cost and carbon impacts of peak demand from EVs.

Due to the limited penetration of EVs in our service territory, EWEB has taken a fairly hands-off approach to influencing charging behavior. Currently, EWEB offers incentives for Level 2 charger installation, specifically because this equipment can be programmed to charge at certain times. EWEB also has started a public education campaign to encourage customers to shift discretionary energy use, like EV charging, to off-peak hours (10PM to 6AM). Implementation of advanced metering technology will enable the utility to adopt time of use pricing, and other pricing programs, to encourage EV owners to shift charging to off-peak times. Further analysis of the potential impacts of managed EV charging behavior is recommended to help inform EWEB's future program offerings.

[7] Grid Integration Tech Team and Integrated Systems Analysis Tech Team- Summary Report on EVs at Scale and the U.S. Electric Power System – 2019, p. 7

7.6 EVs and Carbon Reduction

As State and local greenhouse gas inventories show, transportation-related emissions are a major component of our community's carbon footprint. This study aims to improve our understanding of the role electrification of transportation plays in the context of a Northwest grid. This regional perspective will help capture the impacts of transitioning from fossil fuels to electricity, considering a shared and integrated power grid, including overall energy and peak demand impacts.

To model the carbon impacts from EVs, we need to calculate the carbon intensity associated with vehicle charging.

EWEB staff analyzed typical weekday and weekend, uncontrolled, hourly charging patterns. As stated in the peak impact section above, most of the uncontrolled EV charging takes place around 7PM, a time of high power consumption across the grid.

Using these hourly charging patterns, staff multiplied the power consumed by the hourly NWPP carbon intensity for that hour. Analyzing the hourly data over the course of a year, EWEB concluded that the average annual carbon intensity of EV charging was 0.22 MT CO2e per MWh. It should be noted that this EV charging carbon intensity is higher than the average carbon intensity of the NWPP because the uncontrolled charging is taking place when overall power consumption is highest and there is increased use of fossil fuel-burning generators on the grid.

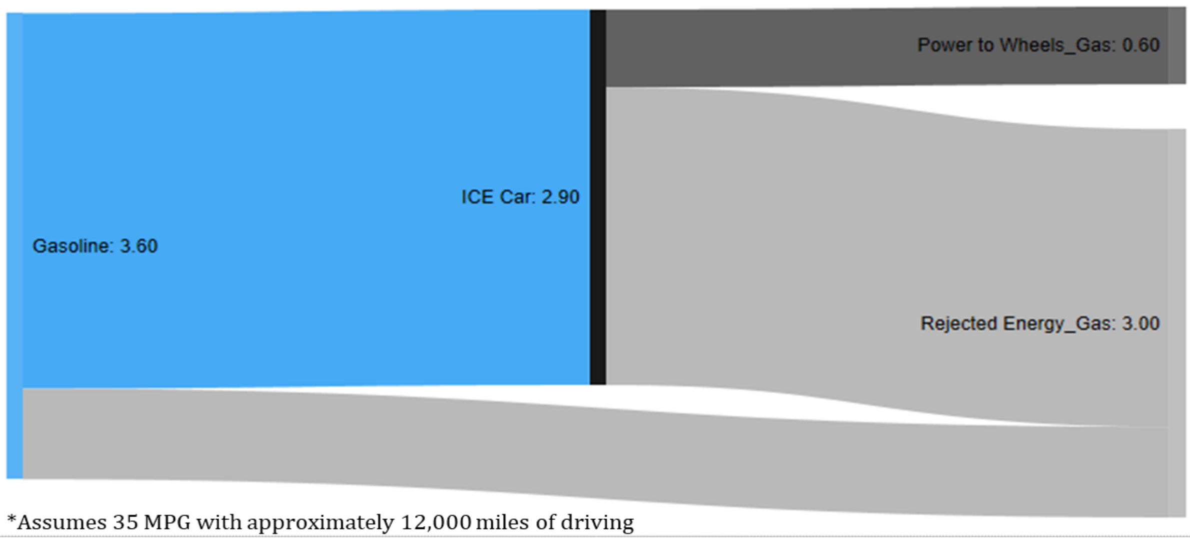
Using the daily vehicle miles traveled figure of 31.5 miles/day, and carbon intensity stated above, an EV in EWEB's service territory is expected to produce approximately 0.84 MT CO2e per year. This represents about a 75% reduction in carbon emitted when compared to a standard light-duty gasoline vehicle that meets current fuel economy standards of 35 MPG.

The annual carbon footprints of a typical passenger car compared to an EV are illustrated in the following charts. These calculations account for both vehicle energy efficiencies, upstream electric transmission energy losses, and emissions from fuel production and transportation. An average light-duty gasoline vehicle uses roughly 20%[8] of its energy to move the car forward, the rest is lost as waste heat at the tailpipe due to various internal combustion engine inefficiencies. In addition to tailpipe emissions, there are upstream emissions associated with the production and transportation of gasoline[9], which is estimated to increase vehicle carbon emissions by another 20-25%.

[8] https://fueleconomy.gov/feg/atv.shtml

[9] https://fueleconomy.gov/feg/label/learn-more-gasoline-label.shtml & https://fueleconomy.gov/feg/climate.shtml

Annual Carbon Footprint for Passenger Vehicle
Internal Combustion Engine*
Metric Tons of CO2**

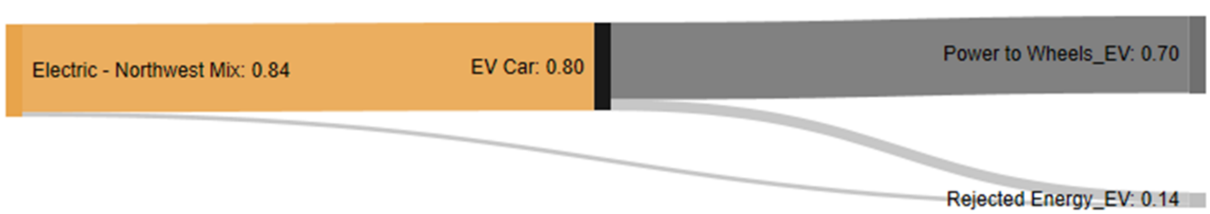


*Assumes 35 MPG with approximately 12,000 miles of driving
**Includes carbon for both tailpipe and upstream emissions under rejected energy

In total, a typical gas-powered vehicle will produce approximately 3.6 MT CO2e per year, the majority of which is associated with losses from rejected, waste, energy.

By contrast, roughly 88%[10] of the carbon created by energy that goes into an EV is used to move the car forward, after accounting for regenerative braking. The rejected energy in an EV is due to drivetrain and battery inefficiency. In order to account for upstream rejected energy, staff assumed transmission and distribution energy losses of about 6%. In total, 83% of the carbon created by an EV, using the NWPP energy mix, comes from energy that is used to move the car forward, while the rest is lost as rejected energy. Because EVs have significantly less rejected energy compared to traditional internal combustion engines, less energy (and associated carbon) is required to move the vehicle forward.

Annual Carbon Footprint for Passenger Vehicle
Electric Vehicle*
Metric Tons of CO2**



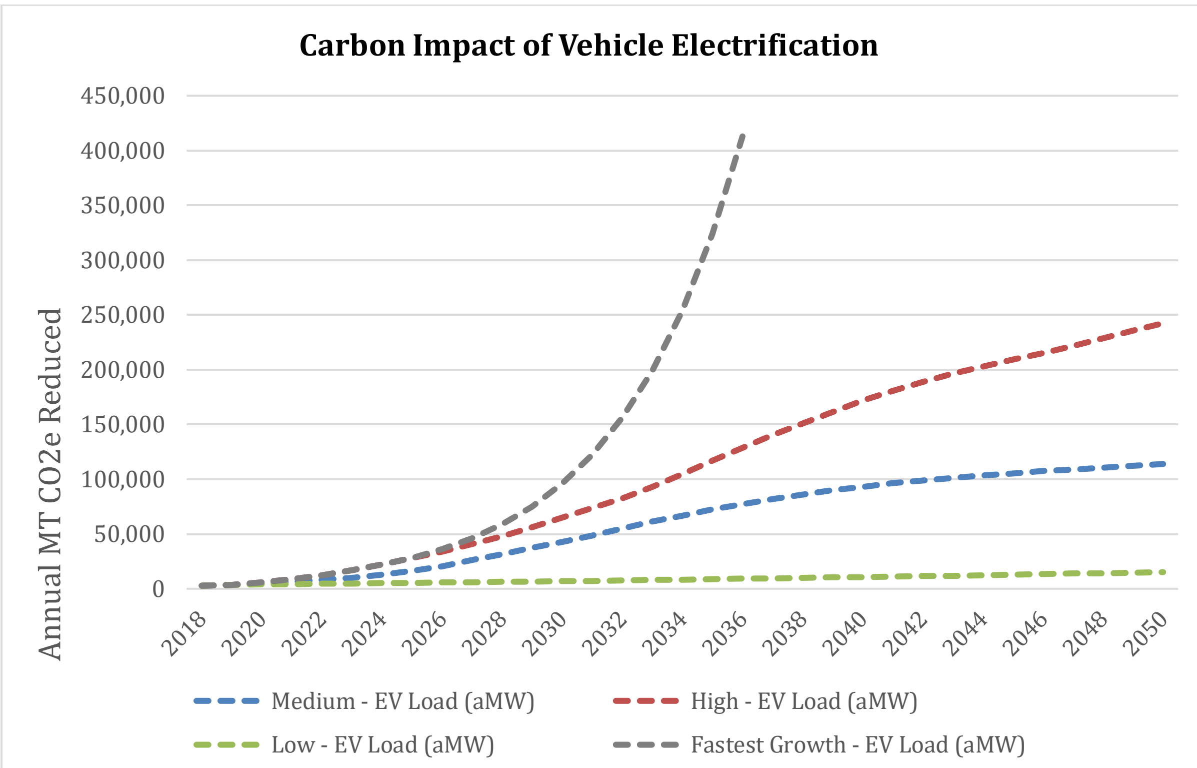
*Assumes 3.1 MPKWh with approximately 12,000 miles of driving
**Assumes an hourly, NW regional carbon intensity factor (0.09 - 0.38 mTons/MWh), 88% vehicle efficiency, and upstream transmission losses

[10] https://fueleconomy.gov/feg/atv-ev.shtml

Using these assumptions, each new EV that replaces an internal combustion engine in EWEB's service territory translates into a 2.75 MT reduction in annual carbon emissions.

Note that the actual carbon benefit of any EV will be influenced by numerous factors, including travel patterns, specific vehicle efficiencies and the carbon intensity of fuels used. This estimated carbon savings can be applied to different forecasted adoption rates to show potential community-wide impact, as illustrated in the chart below.

In the medium case (21% adoption rate) EVs would annually reduce 43,000 MT CO2e by 2030, with a wide range of possible carbon benefits depending on actual adoption rates by 2050.



To see these reductions within the context of the State and Eugene's climate goals, see the "Cumulative Carbon Reduction" section of the study.

8 ELECTRIFICATION OF RESIDENTIAL SPACE AND WATER HEATING

HIGHLIGHTS

- Approximately 75% of the residential space and water heating units in EWEB service territory use electricity.
- Even under the highest forecasted conversions from gas to electric, EWEB is expected on average to experience marginal load impacts by 2050.
- The combined impact of electrification of space and water heating under the high forecast adds less than 10% to EWEB's typical peak load.

Phase I of our electrification study focuses on domestic space and water heating for two primary reasons. First, with steady improvements in technology, replacing natural gas furnaces and water heating with electric heat pumps is gaining customer acceptance due, in part, to high efficiency and cost-competitiveness. For example, heat pumps rated for cold weather down to five degrees

Fahrenheit are now available on the market. Secondly, these end-use load shapes closely align with EWEB system peaks. Un-managed growth in this sector could add significant peak loads, with resulting cost and carbon implications.

To quantify electrification impacts from these end uses, we need to first understand our customers' current technology choices.

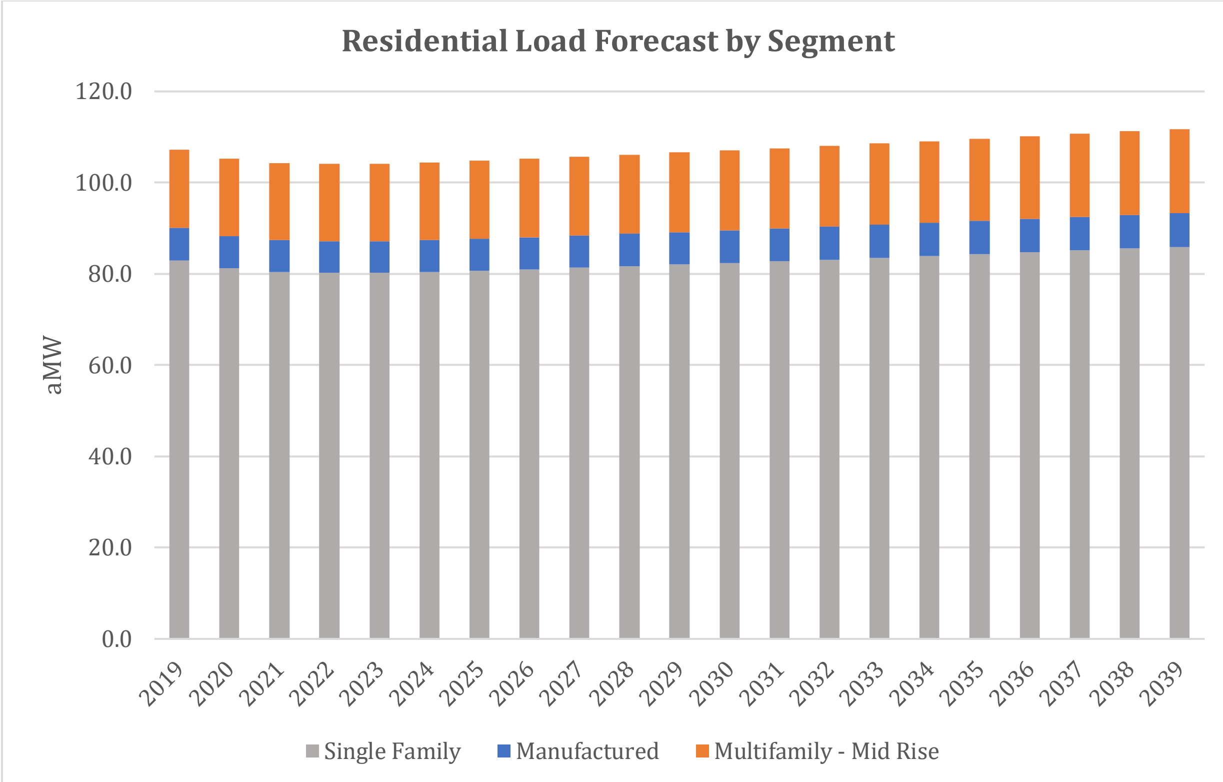
As noted earlier, this study focuses on the residential and commercial sectors of our customer base. Industrial loads and street lighting, which make up about 22% of EWEB's average annual load, are not included in this study. The University of Oregon, which has characteristics of residential, commercial and industrial loads, is included as its load shape is seasonal and correlates to weather patterns.

Electrification of the commercial sector results in similar profiles as residential impacts provided below, with peak demand adding three times the average energy usage. The commercial sector analysis will be provided in the Phase 1 Report – Final Publication.

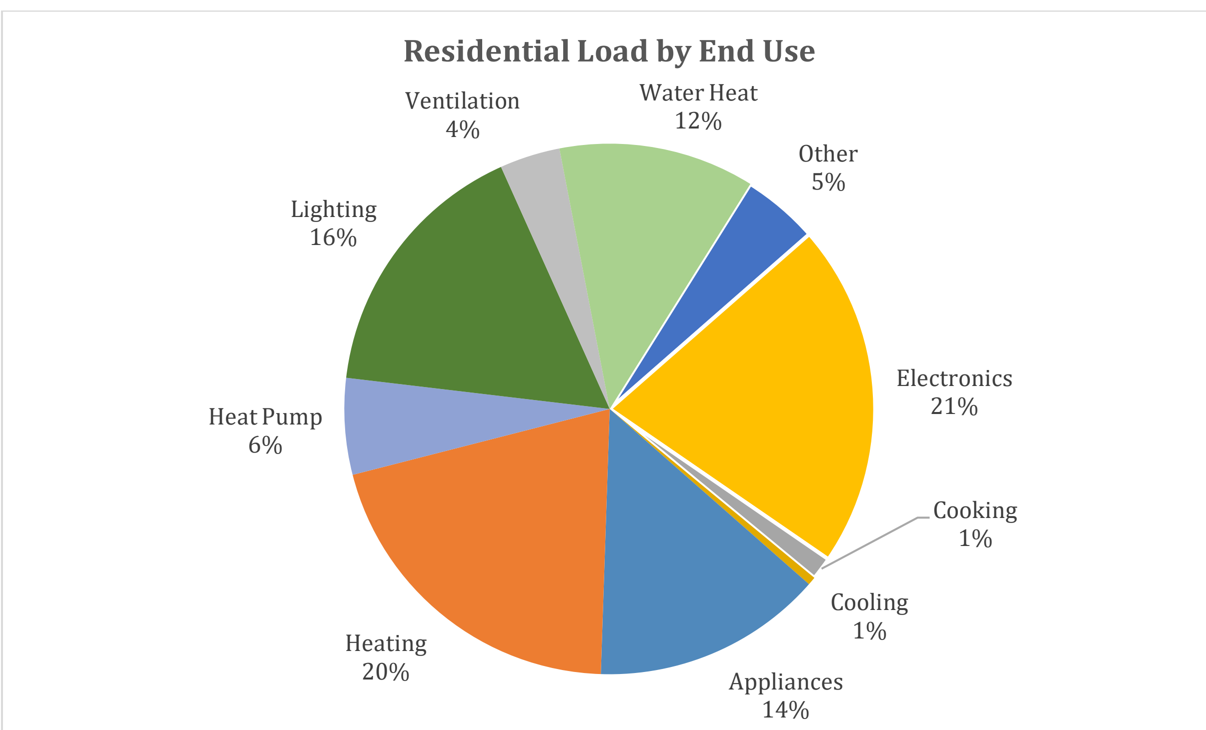
8.1 CUSTOMER SEGMENTATION

Energy used by EWEB's residential customers can be classified based on building type: single family, multi-family and manufactured homes.

As the following chart indicates, load growth in the residential sector and within each housing type is forecast to be stable over time, with single-family homes making up about three-quarters of that consumption. This forecast embeds 0.3% incremental growth due to population changes.



How energy is used within these residences can be further broken into ten basic end uses. As this chart shows, space heating accounts for about 27% of EWEB's total residential load, while water heating adds another 12%.



Based on EWEB customer data and information from Northwest Natural Gas Company (NWNG), out of about 83,200 heating units in EWEB service territory, approximately 75% use electricity. The remainder are served by NWNG, with 2-3% of customers using wood or propane for home heating.

Our end-use model starts with regional data, both hourly metered data and data collected from regional surveys. The regional data was then adjusted to reflect our current understanding of usage in EWEB's service territory. The table below reflects the most current dataset and breaks out electric space heating by both residential housing and appliance type.

Electric Space Heat in EWEB Service Territory		
Segment	**Heating Type**	**Quantity**
Manufactured	Furnace – Standard	2,450
Manufactured	Heat Pump – Federal Standard 2015	432
Manufactured	Baseboard Zonal Heating – Standard	1,009
Multifamily – Mid Rise	Baseboard Zonal Heating – Standard	14,411
Single Family	Furnace – Standard	27,516
Single Family	Heat Pump – Federal Standard 2015	4,856
Single Family	Baseboard Zonal Heating – Standard	11,330
Total		**62,005**

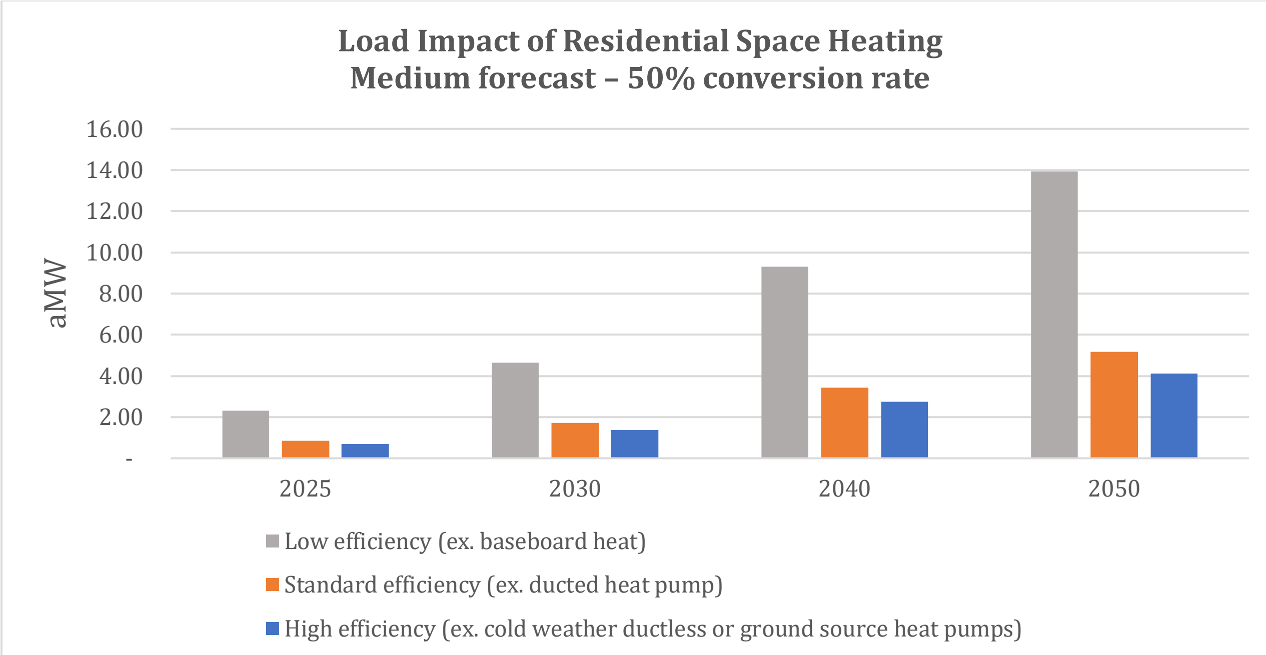
8.2 Energy and Peak Impacts of Space Heating Electrification

As the previous data demonstrates, residential customers are predominantly reliant on electricity for space heating in the EWEB service territory. To determine how moving more customers to electric technologies impacts EWEB load, we need to consider two main variables: (1) the conversion rate to electric space heating, and (2) the efficiency of that technology.

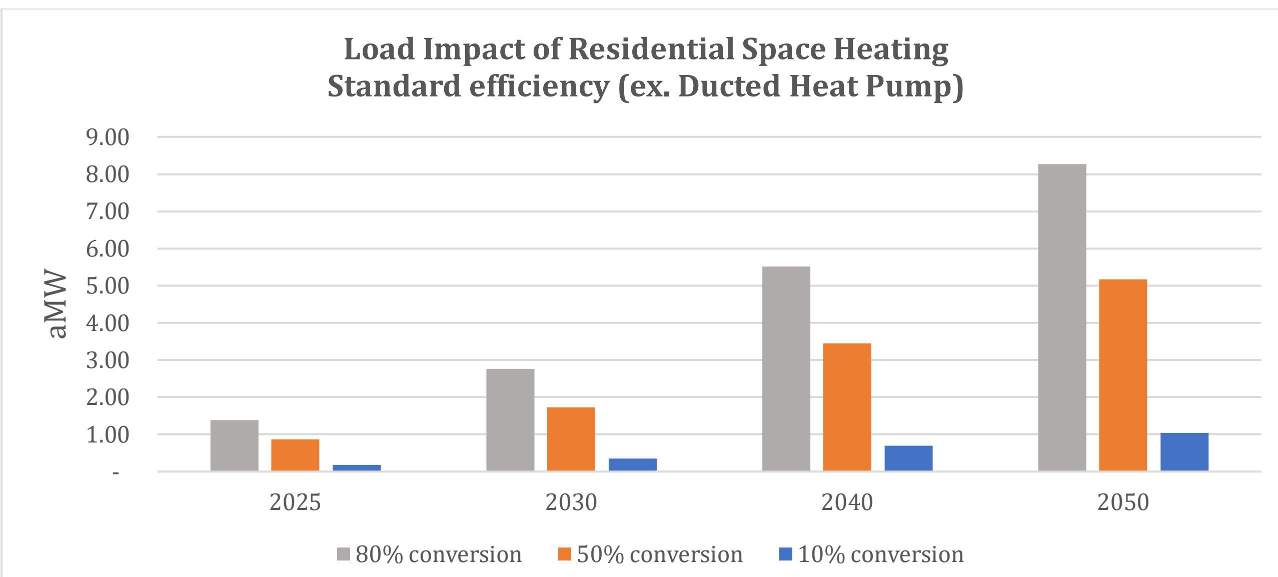
The key assumptions for the forecasts and energy efficiency levels modeled are as follows:

Forecast Conversion Rate	Technology Efficiency Ratings
Low – 10%	Low efficiency (ex. baseboard heat)
Medium – 50%	Standard efficiency (ex. ducted heat pump)
High – 80%	High efficiency (ex. cold weather ductless or ground source heat pumps)

The impacts to EWEB's load are shown in the following charts, first assuming 50% adoption rate for each technology efficiency rating. As this chart illustrates, technology choices matter when looking at load impact.

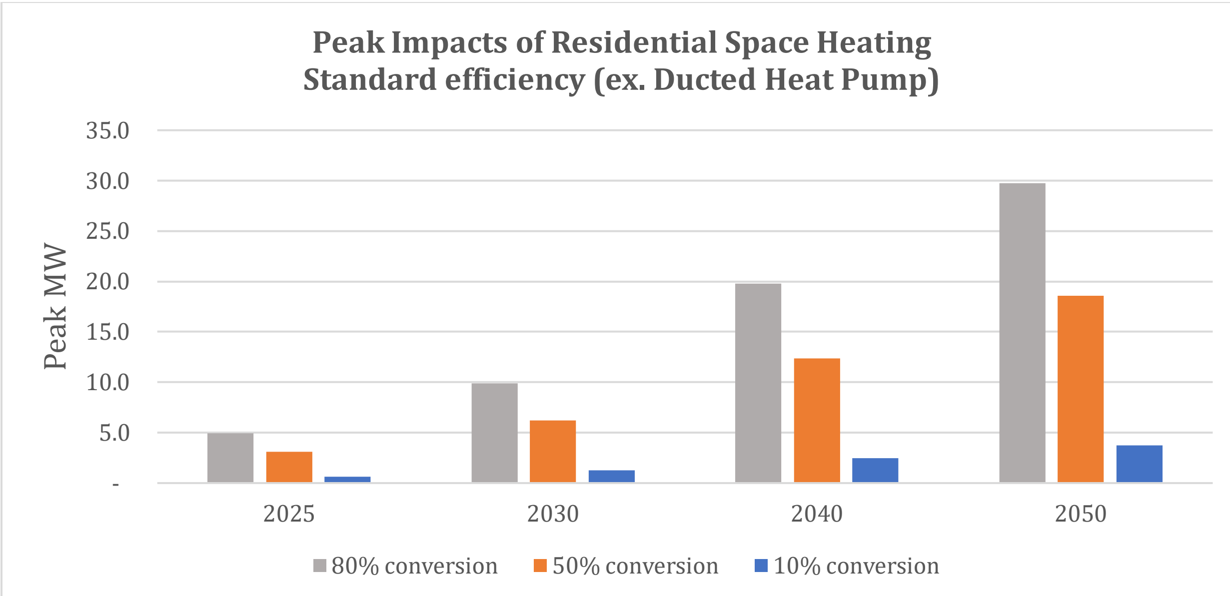


While a low efficiency case is illustrated, it is unlikely that customers will opt to switch out their natural gas heating equipment for low efficiency baseboard technology. Therefore, the next chart projects energy impacts over all three load forecasts assuming the customer adopts electric heating equipment with more contemporary efficiency ratings.



Even in the high forecast, EWEB is expected on average to experience marginal load impacts by 2050. Improved technology would further reduce that growth.

To completely capture how electrification impacts EWEB's load, a one-hour winter peak demand was also modeled, again assuming standard efficiency ratings for the equipment.



Assuming an 80% adoption rate, EWEB would need to plan for about 30 MW of additional peak demand by 2050 (about a 6% increase in current peak demand).

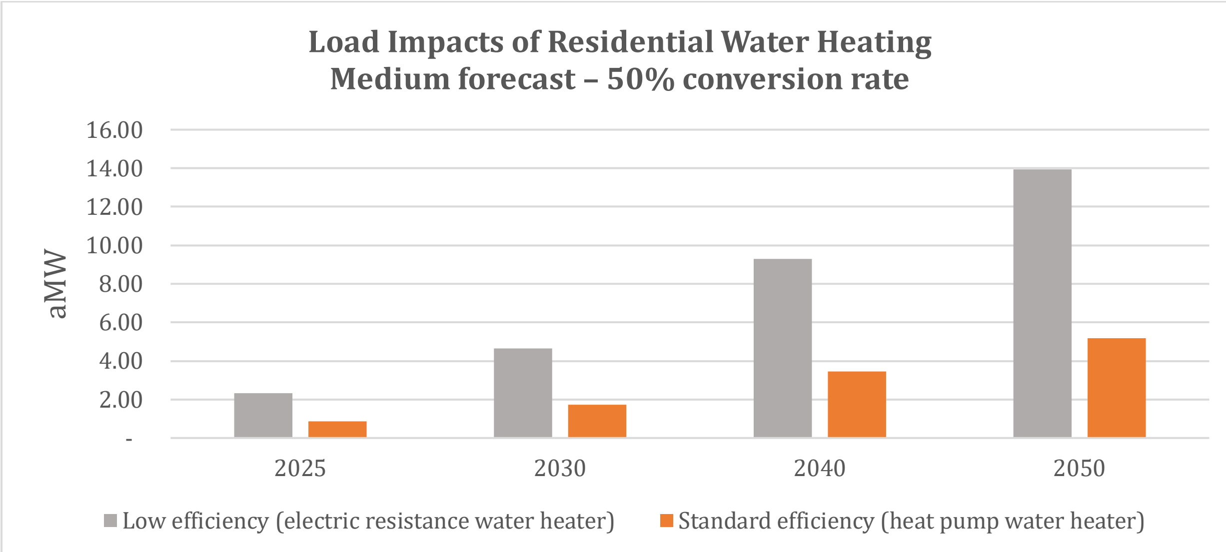
8.3 Electrification of Residential Water Heating

There are an estimated 81,000 electric water heaters in EWEB's service territory, and about 50 of those are solar assisted. In comparison, there are just under 20,000 water heaters that use natural gas and, to a lesser extent, propane. This indicates that, like space heating statistics, about 75% of EWEB residential customers have electric hot water heaters.

Until recently, electric resistance technology was standard for water heating. However, Heat Pump Water Heaters, which offer much higher efficiency ratings, are now common in the marketplace.

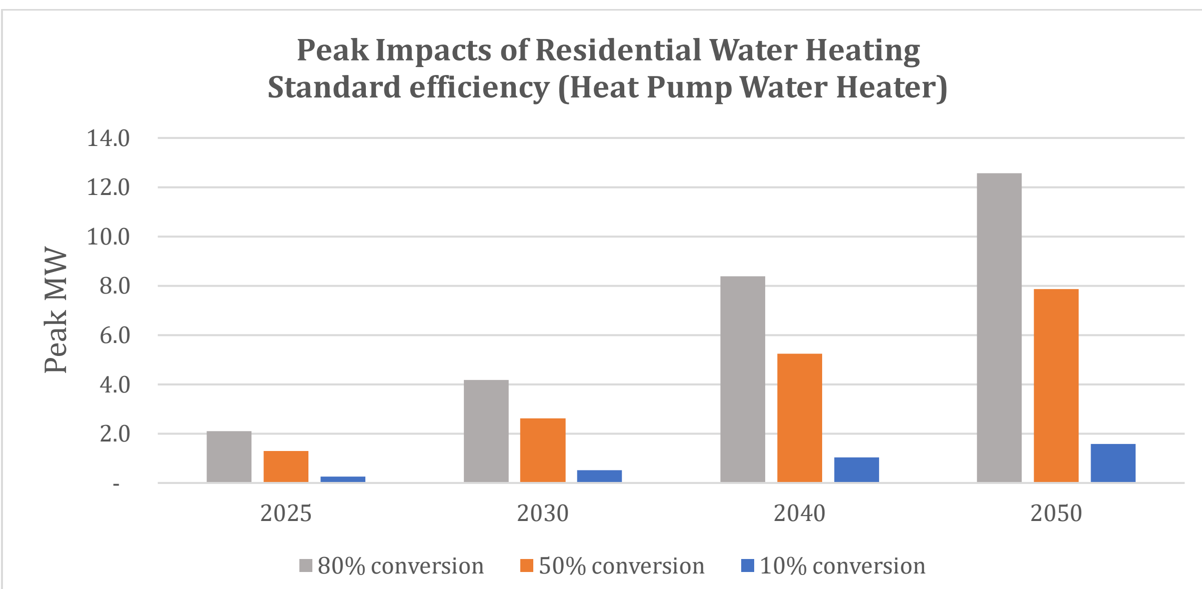
Current market penetration rates of this technology are low, but manufacturer rebates, combined with EWEB incentives, can be a strong incentive to encourage more rapid adoption of this newer technology. As of June 30, 2020, EWEB has processed 228 incentives for heat pump water heaters in 2020, a significant uptick over last year, which was largely driven by a manufacturer promotion.

The chart below illustrates the impact that technology choice can have on load, when electrifying natural gas water heaters. This demonstrates the importance of considering energy efficiency when projecting future load impacts.



If we assume that customers, choosing to electrify, select the more efficient water heating technology, then peak demand impacts can be modeled across the three adoption forecasts as show in the next chart.

Under the most aggressive forecast, EWEB would need to plan for just over 12 MW of additional peak demand by 2050 (an increase of about 2%).



9 Combined Residential Space and Water Heat Impact

Aggregating the residential space heating and water heating analysis yields the following preliminary impacts to load in 2050 using standard efficiency equipment.

Forecast Conversion Rate	Combined Energy Impact	Combined Peak Demand
Low – 10%	1 aMW	5 MW
Medium – 50%	7 aMW	26 MW
High – 80%	11 aMW	42 MW

The combined impact of electrification of space and water heating under the high forecast adds less than 10% to EWEB's typical peak load. Note that these projections do not take into account efficiency gains as customers with electric space and water heating upgrade their equipment over time.

10 Cumulative Load Impacts from Electrification of Transportation & Space/Water heating

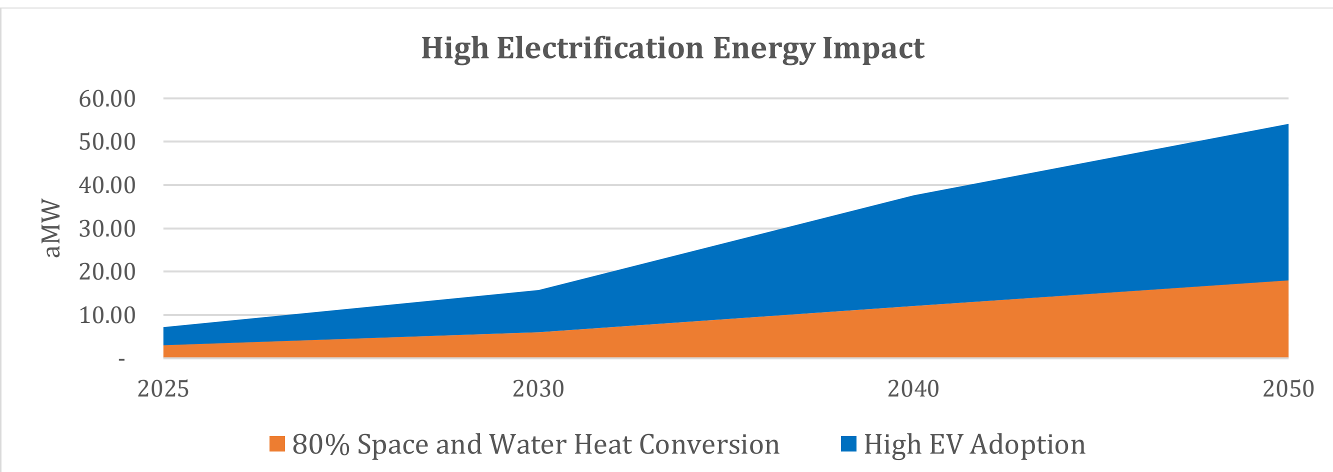
HIGHLIGHTS

- Based on available market share, EVs represent a significant electrification opportunity and load impact compared to space and water heating.
- Under the highest forecasted electrification rates, EWEB could experience load growth of 54 aMW by 2050.
- There remains a wide range of uncertainty in adoption rates and potential peak impacts.

While our analysis is still underway, the cumulative effects of electrification of space and water heating, combined with growth in EV adoption, are previewed. Note that for the purposes of aggregating available data, the energy, peak and carbon impacts from the commercial building sector are included in these preliminary results.

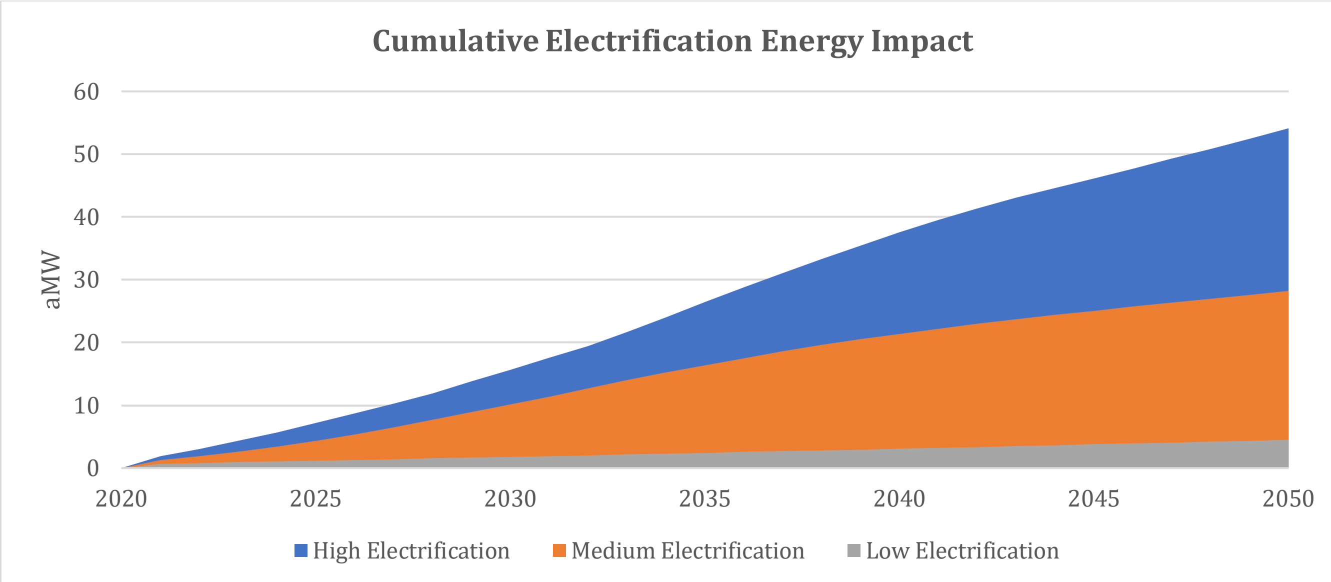
Because space and water heating systems in EWEB's service territory are already predominantly electric, the market share for conversion is relatively small. Alternatively, with EVs making up just a few percent of new vehicle sales, the transportation sector represents a significant, emergent electrification opportunity.

The chart below illustrates the increased load EWEB would experience in a high electrification scenario and the relative impacts of space and water heating conversion compared to EVs.



Note: This assumes standard efficiency technology for space/water heating

However, there remains a wide range of uncertainty as climate change policies are in flux and the on-going pandemic adds economic volatility to a high-stakes political climate. To illustrate the spectrum of potential cumulative energy impacts, all three electrification forecasts are modeled, showing 2050 load growth ranging from 5 to 54 aMW.



High Electrification *assumes 80% conversion of commercial and residential gas space and water heat and high EV adoption.* ***Medium Electrification*** *assumes 50% conversion of commercial and residential gas space and water heat and medium EV adoption.* ***Low Electrification*** *assumes 10% conversion of commercial and residential gas space and water heat and low EV adoption.*

These bands of uncertainty widen further when looking at peak demand with a 200 MW differential between low and high forecasts during a typical peak event. However, the peak impact of these electrified end uses is highly dependent on the efficiency of the end-use technologies and the timing for when these devices are used. Mitigation strategies will be explored in more depth in the next iteration of the Phase 1 analysis.

11 Cumulative Carbon Reductions from Electrification of Transportation & Space/Water Heating

HIGHLIGHTS

- EVs represent a significant carbon reduction opportunity compared to space and water heating.
- Under the highest forecasted electrification rates, EWEB could experience load growth of 54 aMW by 2050.
- There remains a wide range of uncertainty in adoption rates and potential peak impacts.

11.1 Key Context Regarding Preliminary Cumulative Carbon Results

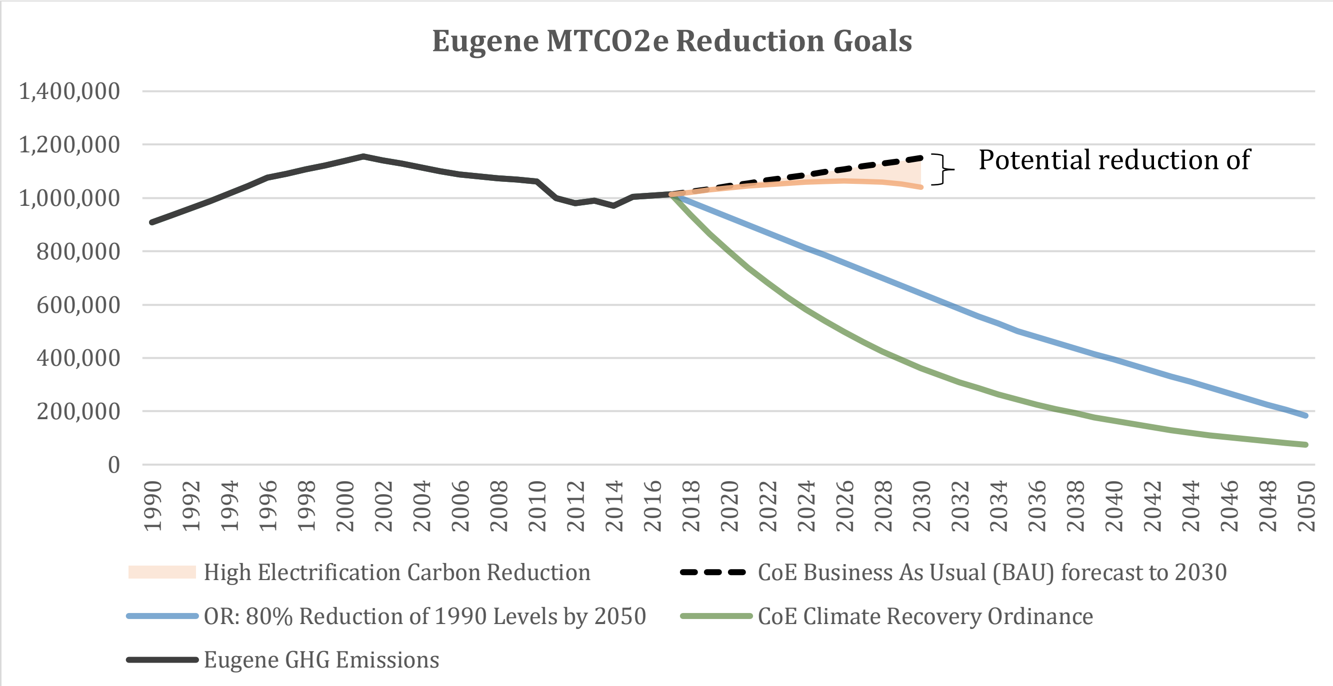
1. The cumulative carbon reductions from electrification of space, water heating and light duty vehicles are early estimates and will be refined prior to the first publication of the Phase 1 analysis. This includes a review of assumptions with our advisors at E3, Northwest Natural Gas and a discussion with City of Eugene staff to better understand the basis for EV-related carbon reductions in the CAP 2.0 report.

2. Phase 1 of this analysis uses the current NWPP electricity carbon intensity for the entire 30-year timeframe. However, we know that the Northwest resource mix will change as coal plants retire, resulting in a lower grid-related emissions. Changes to the carbon intensity of the NWPP over time will be a major factor considered in Phase 2 of our Electrification Impact Analysis.

3. The CAP 2.0 identifies a series of planned actions that will reduce our community's carbon footprint, but these actions alone do not reach the 2030 target. Community and policy-maker discussions on approaches to closing this gap are underway. The early results of this electrification study indicate that aggressive conversion of residential and commercial space and water heating plays a limited role in closing this gap. The first publication of the Phase 1 report will elaborate on these findings with the benefit of addition review and refinement of our analysis.

Electrification of light-duty vehicles and space and water heating can support meaningful contributions towards community carbon reduction goals. The size and speed at which these benefits can be achieved is a timely question, particularly considering the targets set forth in the City of Eugene CAP 2.0 report.

This preliminary analysis indicates that even under a high forecasted adoption rate, electrification of these end-uses falls far short of reaching the 2030 goal. Put another way, EVs and electric space and water heating are only one small part of the solution. These early results show that the largest potential carbon reductions come from the transportation rather than the space and water heating sector. As noted earlier, this is due to the higher market penetration rate potential for EVs, whereas 75% of the space and water heating sector already uses electric technologies.



Eugene MTCO2e Reduction Goals
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
2042
2044
2046
2048
2050
Potential reduction of
High Electrification Carbon Reduction
CoE Business As Usual (BAU) forecast to 2030
OR: 80% Reduction of 1990 Levels by 2050
CoE Climate Recovery Ordinance
Eugene GHG Emissions

12 Infrastructure Impacts

HIGHLIGHTS

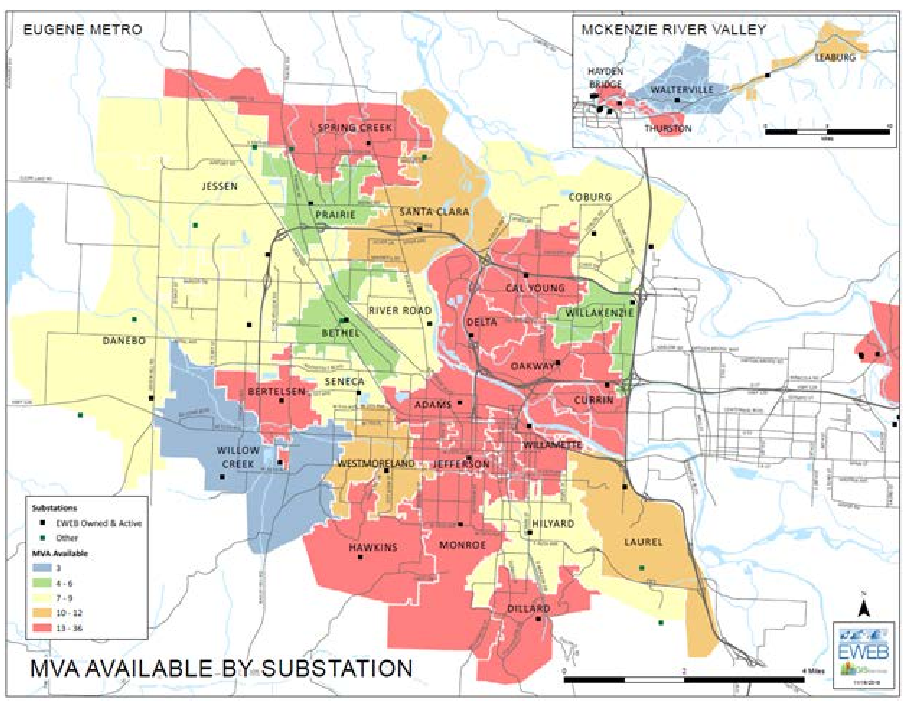
- Early assessments indicate that EWEB's electric system has the capacity and flexibility to manage low-to-moderate electrification levels.
- EWEB has multiple options to address future capacity constraints, adapting as the load changes, regardless of the underlying causes for load change.

As Eugene's population and industry makeup has fluctuated over the decades, EWEB has both anticipated and reacted to our obligation to serve. Almost two-thirds of EWEB's present-day transmission lines and substations were constructed during Eugene's explosive growth in the 1960s and 1970s.

From 1955 - 1980, load was growing at an average rate of over 19 MW per year. The growth was extremely predictable, creating a planning environment that supported adding capacity. However, this abruptly changed in 1980 when our community entered a deep economic recession and load growth dropped to less than 1 MW/year.

EWEB continues to experience minimal load growth due to a combination of factors including changes to the make-up of our local economy, increased energy efficiency and the penetration of natural gas in new residential and commercial development.

As a result of these two dramatically different growth periods, the EWEB electric system is diverse in its build-out over time. In the south and northeast areas of Eugene, the system has capacity to handle additional load, while large swaths of the western portions of our service territory are more limited in terms of available capacity. The map illustrates which areas within EWEB's service territory have significant available capacity (red) compared to those that are near capacity (blue) at the substation level.



One option to address capacity constraints is to build new substations, and EWEB has purchased two properties in West Eugene for this purpose. But this is an expensive solution, especially if predicted load growth does not occur in that area of our system.

Another option is to reconfigure the transmission system to move existing load from one substation to a nearby underserved substation to free up capacity where new growth is anticipated. This more cost-effective solution to adapt the system's existing assets was just completed in the industrial area near the Eugene airport, readying the Jessen substation for future growth. Such opportunities exist elsewhere in our system.

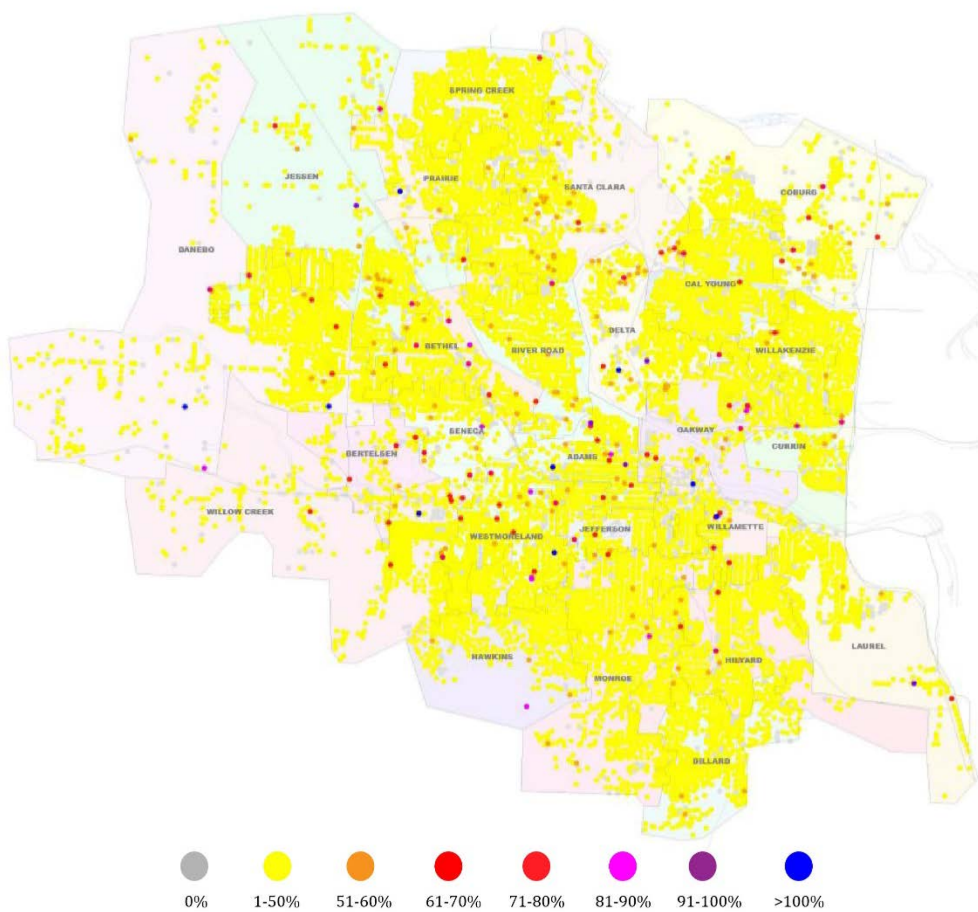
The impacts of electrification on infrastructure at the neighborhood, or distribution level, requires specific analysis. When new load is requested, or when load changes, the affected distribution assets are reevaluated according to current EWEB standards. Additionally, an ongoing inspection program, based on compliance obligations, is employed to systematically review the distribution system.

Each year, about ten percent of EWEB's distribution system is evaluated for compliance upgrades the following year; the resulting work includes conductor, transformer, pole, and other modifications required to meet clearance and other standards (NESC, PUC). Due to this ongoing work, the distribution system has regular and recurring opportunities to adapt as the load changes, regardless of the underlying causes for load change.

A review of transformer loading in 2015 showed that less than 1% of EWEB's approximately 15,000 transformers were loaded over 90%. The vast majority (over 80%) were loaded at 50% or less.

Taken together, our early assessment of infrastructure at the substation and neighborhood level indicates that the electric system has the capacity and flexibility to manage low-to-moderate electrification levels. A more in -depth assessment of the impacts to the transmission and distribution system, including transformer loading from different electrification scenarios, is planned for Phase 2 of this study.

EWEB In-town Transformer Loading (2015)



13 Electrification Study Glossary

aMW	Average megawatt is calculated by totaling the annual power consumed in a year (in this case megawatts or MW) and dividing that total annual consumption by the number of hours in given year (typically 8,760 during non-leap years). In Electricity Supply Planning, the average megawatt can provide useful context for understanding the average energy required to meet demand on an annualized basis.
Coincident Demand	The sum of two or more demands that occur in the same time interval[11].
Carbon	Short for Carbon Dioxide, a greenhouse gas produced by burning fossil fuels and other sources.
Carbon Intensity	The amount of carbon emitted per unit of energy consumed.
Climate Change	The rise in average surface temperatures on Earth due primarily to the human use of fossil fuels, which releases carbon dioxide and other greenhouse gases into the air.
Coefficient of Performance (COP)	An efficiency ratio that measures useful heating or cooling provided relative to the work required. In electric heat pumps, this is the relationship between the power (kW) that is drawn out of the heat pump as cooling or heat, and the power (kW) that is supplied to the compressor.
Demand	The rate at which energy is being used by the customer.
Diurnal	Diurnal variation refers to daily fluctuations.
Electric Vehicle (EV)	A vehicle that derives all or part of its power from electricity supplied by the electric grid. Primary EV options include battery, plug-in hybrid, or fuel cell. • Battery Electric Vehicles (BEV) typically do not have an internal combustible engine (ICE) or fuel tank and rely solely on its battery charged by electricity to operate the vehicle. Typical driving ranges are considerably less when compared to other vehicle options but newer models coming out with advanced battery technology support higher ranges. • Plug-in Hybrid Electric Vehicles (PHEV) are powered by an on-board battery and gasoline with the ability to operate solely on its battery, ICE, or a combination of both. When the battery is fully charged and gasoline tank full, the PHEV driving range is comparable to a conventional ICE vehicle. • Fuel Cell Electric Vehicles (FCEV) run on compressed liquid hydrogen. Combining hydrogen with oxygen generates the electrical energy that either flows to the motor or to the battery to store until it's needed. FCEVs have a driving range comparable to a conventional ICE vehicle.
Electric Vehicle (EV) Charging Stations	EV charging stations typically fall under three primary categories: Level 1, Level 2, and Level 3 also referred to as DC Fast Chargers[12]. • Level 1: Provides charging through a 120 V AC plug and does not require installation of additional charging equipment. Can deliver 2 to 5 miles of range per hour of charging. Most often used in homes, but sometimes used at workplaces. • Level 2: Provides charging through a 240 V (for residential) or 208 V (for commercial) plug and requires installation of additional charging equipment. Can deliver 10 to 20 miles of range per hour of charging. Used in homes, workplaces, and for public charging. • DC Fast Charge: Provides charging through 480 V AC input and requires highly specialized, high-powered equipment as well as special equipment in the vehicle itself. (Plug-in hybrid electric vehicles typically do not have fast charging capabilities.) Can deliver 60 to 80 miles of range in 20 minutes of charging. Used most often in public charging stations, especially along heavy traffic corridors.

[11] https://www.eia.gov/tools/glossary

[12] https://www.energy.gov/eere/electricvehicles/charging-home

Energy Efficiency	Refers to programs that are aimed at reducing the amount energy used in homes and other buildings. Examples include high-efficiency appliances, lighting, and heating systems.
Generation	The process of producing electricity by from water, wind, solar, fossil fuels and other sources.
Greenhouse Gas (GHG) Emissions	GHG emissions are gases, such as carbon dioxide, that trap heat in the atmosphere. The largest source of GHG emissions from human activities in the U.S. is from burning fossil fuels for electricity, heat, and transportation[13].
Grid	The electricity grid, or grid, refers to the system that moves electricity from its source through transformers, transmission lines, and distribution lines to deliver the product to its end-user, the consumer.
Heat Pump	Heating and/or cooling equipment that, during the heating season, draws heat into a building from outside and, during the cooling season, ejects heat from the building to the outside. Heat pumps are vapor-compression refrigeration systems whose indoor/outdoor coils are used reversibly as condensers or evaporators, depending on the need for heating or cooling[14].
Light-duty Vehicles	Light-duty refers to gross vehicle weight rating and includes passenger cars, SUVs, trucks, and vans that weigh up to 10,000 pounds.
Load	The amount of electricity on the grid at any given time, as it makes its journey from the power source to all the homes, businesses.
Megawatt (MW)	The standard term of measurement for bulk electricity. One megawatt is 1 million watts. One million watts delivered continuously 24 hours a day for a year (8,760 hours) is called an average megawatt.
MPGe	Miles per gallon of gasoline-equivalent. Think of this as being similar to MPG, but instead of presenting miles per gallon of the vehicle's fuel type, it represents the number of miles the vehicle can go using a quantity of fuel with the same energy content as a gallon of gasoline. This allows a reasonable comparison between vehicles using different fuels[15].
MTCO2e	Metric tons of carbon dioxide equivalent is a unit of measurement. The unit "CO2e" represents an amount of a GHG whose atmospheric impact has been standardized to that of one unit mass of carbon dioxide (CO2), based on the global warming potential (GWP) based on the global warming potential (GWP) of the gas.
Noncoincident Demand	Sum of two or more demands on individual systems that do not occur in the same demand interval[16].
Peak Demand	The largest instance of power usage in a given time frame.
Peaker Plant	Peaker plant, also known as a peaking power plant or simply peaker, is a power plant that generally runs during times when demand for electricity is high or at its peak time. Peaker plants are typically gas turbines that burn natural gas.
Power	The rate of producing, transferring, or using energy, most commonly associated with electricity. Power is measured in watts and often expressed in kilowatts (kW) or megawatts (MW)[17].
Resource Adequacy	Ensuring there are sufficient resources when and where they are needed to serve the demands of electrical load in "real time" (i.e., instantaneously). An adequate physical generating capacity dedicated to serving all load requirements to meet peak demand and planning and operating reserves, at or deliverable to locations and at all times.
Resource Portfolio	All of the sources of electricity provided by the utility.

[13] https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions
[14] https://www.eia.gov/tools/glossary
[15] https://www.epa.gov/fueleconomy/text-version-electric-vehicle-label
[16] https://www.eia.gov/tools/glossary
[17] https://www.eia.gov/tools/glossary

Scenario	A projection or forecast that provides a framework to explore plausible outcomes. Scenario analysis is the process of analyzing plausible outcomes and typically includes base-case, expected-case, and worst-case scenario analysis.
Segment	Customer segmentation or segment means separating the diverse population of end-use customers in groups based on similarities in customer needs and preferences.
Sensitivity	Sensitivity analysis is a method to determine how changes in methods, models, values of variable or assumptions may lead to different interpretations or conclusions by assessing the impact, effect or influence of key assumptions or variable.
Transmission	An interconnected group of lines and associated equipment for the movement or transfer of bulk energy products from where they are generated to distribution lines that carry the electricity to consumers.
Wholesale Market	The market for buying and selling of electricity before it is sold to the end-user.