2 Executive Summary

In early 2020, EWEB initiated a study of the impacts of widespread electrification in our community to understand various electrification scenarios and assess potential impacts to power supply, demand, local infrastructure, and community greenhouse gas (GHG) emissions.

Phase 1 of the study, completed in Oct. 2020, focused on potential changes to demand and consumption patterns, generation needs, and environmental impacts from electrification of small vehicles, water and space heating. Phase 2 of the Electrification Impact Analysis Report seeks to build on the analysis and context presented in Phase 1 by considering the economics of electrification.

For Phase 2, EWEB analyzed economic value from the perspective of the Customer/Participant, EWEB Ratepayers, and Society as a whole.

Like Phase 1, analysis of the transportation sector focuses on light-duty vehicle electrification. The building sector analysis focuses on space and water heating technologies for existing buildings using natural gas which can be electrified using heat pumps.

To perform this economic analysis, EWEB worked with Energy and Environmental Economics (E3). Using this financial analysis, EWEB can better understand customer choices, key variables impacting the likelihood of transportation and building electrification and impacts under a Base Case (expected future) and Aggressive Carbon Reduction (ACR) scenario.

This analysis can help EWEB refine forecasting of future electricity demand, inform Integrated Resource Planning efforts, and highlight opportunities to engage with customers around the topics of power supply, carbon reductions, consumer behaviors, and electrification impacts.

2.1 Electric and Natural Gas Supply Decarbonization

Both the electricity and natural gas sector are anticipated to decarbonize over the next 30 years due to regulatory influences, coal plant retirements, buildout of renewable resources (primarily wind and solar), the increasing use of Renewable Natural Gas (RNG) and the potential of methanized hydrogen. The costs to decarbonize electricity and natural gas can, in turn, impact consumer prices and thus influence the pace of electrification.

Whereas the rate impact in the electric sector is expected to be moderate, increasing RNG content will put strong upward rate pressure on natural gas providers. In The Challenge of Retail Gas in California's Low Carbon Future study by E3[1], the analysis indicated that California electric rates could increase 20-40% by 2050, depending on the scenario, where natural gas rates could increase by 300% over the same period.

In EWEB's Phase 2 study, the increasing use of RNG and resulting upward costs of natural gas improve the financial benefits of electrification of space and water heating improve over time.

[1] "*The Challenge of Retail Gas in California's Low Carbon Future*", authored by E3 and University of California, Irvine, Advanced Power and Energy Program Engineering Laboratory Facility for the California Energy Commission, April 2020, CEC-500-2019-055-F.

2.2 Key Findings

2.2.1 Transportation

Electrification of light-duty vehicles creates value (marginal benefit/marginal cost) from all perspectives (Customer/Participant, EWEB Ratepayer, Society) in both the Base Case and ACR scenario, indicating electrification is likely and beneficial.

While federal and state incentives help provide benefits to EV purchases today, the benefits of owning an EV are expected to dramatically improve by 2030, even as incentives expire or are eliminated.

Economic analysis indicates that EV adoption will rapidly increase after 2030, with nearly 85% of all vehicles on the road being electric by 2040. Based on the benefits to customers, the phase 2 economic analysis shows an accelerated adoption of EV's greater than the "high adoption" assumption modeled in the phase 1 study.

EVs provide benefits for owners, ratepayers, and society:

- All battery electric vehicles, regardless of size or vehicle type, are expected to become cheaper than conventional cars before 2030.
- EWEB ratepayers benefit through the increased sales of electricity realized by EV charging, the proceeds of which could be used to cover the fixed costs of the utility, reduce rates, pay for distribution infrastructure investments, or fund additional incentives for EV adoption.
- By 2040, Eugene's total carbon emissions could be reduced by 38% due to EV adoption.

Phase 2 of the study estimates a lower coincident peak of EV charging (1 kW per EV) compared to Phase 1 of the study due to increased levels of off-peak workplace and public charging in the future. The electric peak impact, while still significant, can be mitigated with managed or diversified charging behavior.

EWEB can encourage diversified charging behavior by increasing the availability of public and workplace charging infrastructure and utilizing dynamic energy price signals (like time-of-use rates) to encourage vehicle charging to shift to non-peak times. In the near term, EWEB's engagement and collaboration with electric vehicle owners and the City of Eugene to shift charging times to non-peak hours of the day when carbon benefits are highest, and costs are lowest, will be beneficial to the impact and rate of electrification.

2.2.2 Buildings

The benefit/cost analysis of electrification of space and water heating is influenced by multiple factors, primarily building type and technology choices.

Water Heating

Even without incentives, water heating electrification has economic benefits for all three electrification perspectives by 2030. The aggregate carbon reduction benefits are small compared to other end-uses, due to relatively low energy consumption of water heaters, but so is the electric system peak impact.

For Single Family Dwellings (SFD), electrification of water heating is expected to have financial benefits in 2030 as heat pump water heaters become more cost competitive with natural gas water heaters over time.

Space Heating

The economics and impacts of space heating electrification is more complex and uncertain. Removing other variables (mandates, incentives, equity, personal choice), substantial single-family dwelling electrification of space heating is unlikely under the Base Case scenario given lack of economic benefit created for the Customer/Participant.

From this value perspective, for a residential property, electrifying with standard performance heat pump or dual-fuel heat pump technology creates the most economic value for both the participant and society. However, the standard heat pump has the most electric system peak impact, which may be more difficult to mitigate given its correlation to EWEB's existing system peaks.

For both scenarios studied, multifamily dwellings (MFD) have lower energy consumption than SFD, which makes it more difficult for the Customer/Participant to recover the upfront costs of electrifying through annual energy savings. All the space heating electrification measures studied were a net cost to the Customer/Participant, making electrification of MFD space heating unlikely.

Small office electrification was also found to be unlikely due to EWEB's commercial rate structure which includes a demand charge on peak energy use. This demand pricing signal may currently be acting as a deterrent to electrification for commercial customers.

2.2.3 Cumulative Impacts of Electrifying Transportation and Buildings

Overall, the study finds that the pace of customer-driven electrification, if based on economic value alone, will be slow in the next decade with EV adoption appearing to be the most likely and impactful form of electrification based on the large conversion potential (number of cars).

The following tables and charts summarize the cumulative electrification findings and highlight the differences between the Base Case and the Aggressive Carbon Reduction (ACR) scenarios. The cumulative energy impacts are relative to EWEB's existing system loads and existing peak demand periods. The percentage increase is based on EWEB's existing system average load of 270 aMW and a 1-in-10 peak of 510 MW, which is a common planning standard for electric utilities.

2040 - Base Case

Electrification Measure	% Electrified	Average Energy Increase (aMW)	% Increase	1-in-10 Peak Increase (MW)	% Increase
Electric Vehicle - Managed	85%	57	21%	77	15%
Electric Vehicle - Unmanaged	85%	57	21%	131	26%
Heat Pump Water Heater	50%	1	0.3%	1.5	0.3%
Standard Heat Pump	0%	Without significant incentives or mandates, impactful space heating electrification is unlikely if driven by participant economics (consumer choice).			
Cold Climate Heat Pump	0%				
Dual Fuel Heat Pump	0%				

2040 - Aggressive Carbon Reduction

Electrification Measure	% Electrified	Average Energy Increase (aMW)	% Increase	1-in-10 Peak Increase (MW)	% Increase
Electric Vehicle - Managed	95%	63	24%	85	17%
Electric Vehicle - Unmanaged	95%	63	24%	145	28%
Heat Pump Water Heater	85%	2	1%	3	1%
Min. Standard Heat Pump*	50%	8	3%	33-61	6-12%
Cold Climate Heat Pump*	50%	4	2%	17-31	3-6%
Dual Fuel Heat Pump*	50%	6	2%	Minimal	Minimal

*Space heating energy impacts shown assume 100% of space heating electrifcation assuming a single technology to illustrate that space heating technology choice matters. In reality, customers will choose a mix of the 3 different space heating technologies. Peak impacts are presented in ranges due to uncertainty regarding coincident load of units. Utilizing AMI data in the future, EWEB could better estimate the coincident load of these space heating technologies.

As mentioned in Phase 1, electrification is just one of the pillars of decarbonization. Although separate from the benefits of electrification, staff provided an estimate of the potential carbon reduction benefits of RNG based on the Eugene Climate Action Plan's 2017 carbon inventory for additional context.

Annual Carbon Reductions	2040					
	Base Case			Aggressive Carbon Reduction Scenario		
Carbon Reduction Measures	% Electrified	MTCO2e Reduced	% Carbon Reduction	% Electrified	MTCO2e Reduced	% Carbon Reduction
Vehicle Electrification	85%	(390,000)	-38%	95%	(432,000)	-43%
Water Heating Electrification	50%	(5,700)	-1%	85%	(6,500)	-1%
Space Heating Electrification	0%	-	0%	50%	(16,000)	-2%
Residential RNG Benefits*		(19,600)	-2%		(45,100)	-4%
Commercial & Industrial RNG Benefits*		(45,300)	-4%		(104,400)	-10%
Total Annual Carbon Reductions		(460,600)	-45%		(604,000)	-60%
Total 2017 Carbon Emissions (City of Eugene CAP 2.0)		1,013,600	100%		1,013,600	100%

*The Base Case assumes a blend of 23% RNG by 2040 and the Aggressive Carbon Reduction scenario assumes a blend of 53% RNG by 2040. The estimated carbon reduction benefits of increased carbon-free RNG are shown in addition to the benefits of building electrification for context.

2.3 EWEB's Electrification Opportunities

Electrification measures can be most beneficial when they reduce carbon emissions while maintaining reliability and affordability.

Measures that add to existing system peaks may create reliability risks because they could, (1) increase utilization (reduce available capacity) of EWEB's existing local distribution network, and (2) increase reliance on the regional electric grid, where decarbonization efforts are impacting the availability of existing transmission and generation capacity. To manage the reliability risk, additional distribution, transmission, and generation assets potentially need to be procured at a cost to EWEB, which represents a risk to future customer affordability.

Economics are another factor influencing the benefits of various electrification measures. Technologies that do not produce economic benefits show lower likelihood of consumer-driven adoption and may require more resources to influence customer choices. Therefore, maintaining affordable/competitive electricity rates will have a favorable impact on electrification.

To the extent that electrification provides financial benefits to participants, EWEB programs will need to consider access to these benefits and equity among customers. Exclusion of multifamily housing incentives, for example, may inadvertently exclude low and moderate income (LMI) communities from the benefits.

The Electrification Scorecard below was developed by staff to provide high level context for the different electrification measures studied in Phase 2.

Electrification Scorecard	Carbon Reduced	Base Case 2030			1-in-10 Peak Adder	Peak Management Potential	EWEB Engagement Opportunities
		EWEB Participant	EWEB Ratepayer	Society			
Electric Vehicle							Encourage managed charging to avoid peak, increase public and workplace charging opportunities.
Heat Pump Water Heater							Consider existing energy efficiency incentive program's influence on electrification of water heating.
SFD - Standard Heat Pump							Participant benefits are neutral, making electrification unlikely. Possible incentive opportunity.
SFD - Cold Climate Heat Pump							Participant benefits are lacking, making electrification unlikely. Possible incentive opportunity.
SFD - Dual Fuel Heat Pump							Participant benefits are neutral, making electrification unlikely. Possible incentive opportunity.
Multi-Family Dwelling Space Heat							Participant benefits are lacking, making electrification unlikely. Possible incentive opportunity.
Small Office Space Heat							Participant benefits are lacking, making electrification unlikely. Consider rate design changes for commercial electrificaiton.

Electrification Scorecard	Carbon Reduced	Aggressive Carbon Reduction 2030			1-in-10 Peak Adder	Peak Management Potential	EWEB Engagement Opportunities
		EWEB Participant	EWEB Ratepayer	Society			
Electric Vehicle							Encourage managed charging to avoid peak, increase public and workplace charging opportunities.
Heat Pump Water Heater							Consider existing energy efficiency incentive program's influence on electrification of water heating.
SFD - Standard Heat Pump							Influence customer space heating technology choices to mitigate peak impacts.
SFD - Cold Climate Heat Pump							Influence customer space heating technology choices to mitigate peak impacts.
SFD - Dual Fuel Heat Pump							Influence customer space heating technology choices to mitigate peak impacts.
Multi-Family Dwelling Space Heat							Participant benefits are lacking, making electrification unlikely. Possible incentive opportunity.
Small Office Space Heat							Participant benefits are lacking, making electrification unlikely. Consider rate design changes for commercial electrificaiton.