MEMORANDUM

EUGENE WATER & ELECTRIC BOARD

Rely on us.

TO:	Commissioners Brown, Carlson, Barofsky, McRae and Schlossberg
FROM:	Megan Capper, Energy Resources Manager; Matthew Schroettnig, Power Planning Supervisor & Staff Counsel; Ben Ulrich, Senior Energy Resource Analyst
DATE:	March 25, 2022
SUBJECT:	EWEB's Electricity Consumption Profile and Forecasting
OBJECTIVE:	Information and Board Discussion

Issue

As part of the 2022 Integrated Resource Plan (IRP), staff will be working throughout the year to inform and engage the Board on key IRP topics. In order to plan EWEB's ideal mix of resources in the future, we must first understand the utility's electricity consumption needs. This will provide important context for the Board, which will be evaluating tradeoffs and approving an action plan at the end of this IRP cycle.

Background & Discussion

A first step in the IRP process is defining EWEB's needs. Without knowledge about EWEB's specific loads and consumption profiles, as well as a projection of these into the future, it would be impossible to determine the quantity of resources to procure, including both generation and demand-side resources. While the IRP is focused on EWEB's long-term needs to inform resource strategy, it will also include information about within-year variations in loads. This approach will allow EWEB to consider whether the utility has both enough resources to meet customers' average demand for energy over the coming years, as well as enough flexibility and capacity to meet peak demands.

Key Questions

- What is the shape and variability of EWEB's electrical consumption (i.e., load)?
- What are EWEB's peak and average energy needs?
- What is EWEB's forecast for future load?

Historic Electricity Consumption

EWEB's average energy consumption can look very different than its peak demands. This is because averaging load information mutes the variability that EWEB's system regularly sees. Using only average energy to think about EWEB's needs would lead to significant under-procurement or the selection of insufficient resources. As a former EWEB employee used to say, "you can't fly through the mountains at an average altitude."

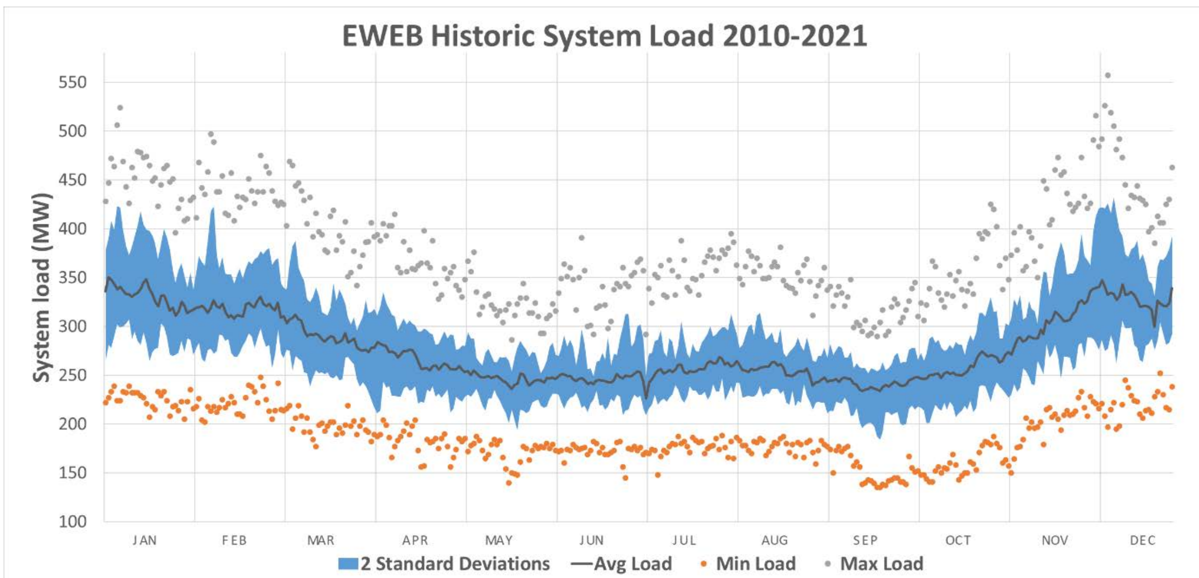
Key Concept - Peak and Average Energy:

- Average energy usage is the *average* amount of energy used over an extended period of time. This value is typically presented in average megawatts (aMW). This provides a simplified way to think about EWEB's needs, as well as a good reference point to compare long-term trends in electricity consumption or generation.
    - For example, if EWEB customers consume 2.4 million MWhs of electricity over a year, the average energy consumed over that time is 274 aMW. (2.4 million MWhs divided by 8,760 hours in a year.)
- Peak energy use refers to the *maximum* one-hour load within a specific timeframe. Peak can refer to the maximum hour in a day, week, month, or year and is typically presented in megawatts (MW). This is a good reference point for infrequent, extreme energy use.

The chart below shows 2010-2021 historical load data for EWEB's service territory and highlights the extent of recent historical load variability.

Key takeaways:

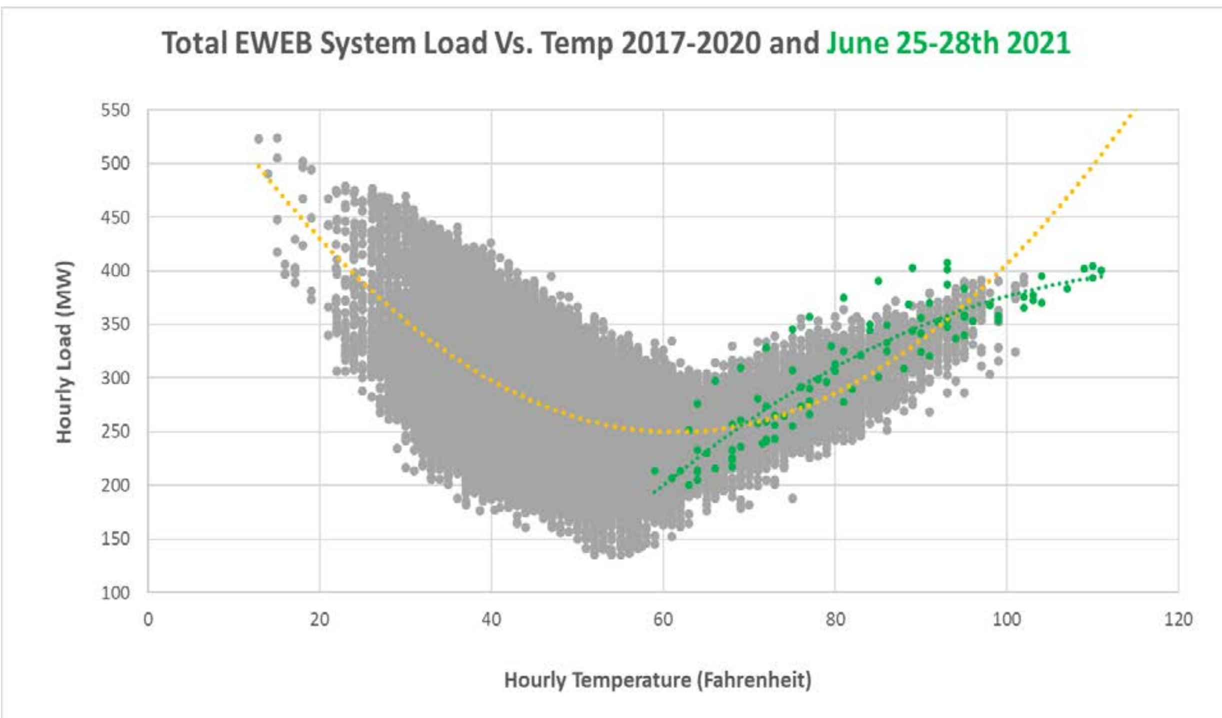
- The black line represents EWEB's average daily load.
    - EWEB's average daily load shifts seasonally, with winter loads consistently higher than summer loads. **The average daily load ranges from about 240 to 350 MW, depending on the season.**
- The shaded blue portion of the graph that surrounds the black line shows the range of average daily loads that fall within two standard deviations of average. For reference, in a normal distribution curve, two standard deviations cover about ninety-five percent of data points. This does not include within-day variability.
    - **95% of EWEB's historic average daily load falls between 200 and 400 MW.**
- The gray and orange dots represent EWEB's maximum and minimum single-hour loads.
    - **Peak hour (maximum load) events are infrequent, but they can be hundreds of megawatts higher than average loads.** Establishing planning standards to meet these events, and understanding risk tolerances, will be part of ongoing discussions as the IRP progresses.



Weather – A Seasonal and Daily Driver of Consumption

Fluctuations in EWEB's loads are driven substantially by the weather due to space heating and cooling energy needs. The chart below shows the correlation between temperatures and EWEB's loads. Each gray dot represents a distinct temperature/load combination for 2017-2020, while each green dot represents the June 25-28th 2021 "Heat Dome" event last summer.

- EWEB's lowest load hours occur when temperatures are between 55 and 65 degrees, conditions with minimal need for heating or cooling.
- The yellow trend line shows the overall correlation between temperature and load. As outdoor air temperatures diverge from a normal indoor temperature "comfort range," load increases. Utilities such as EWEB use Heating Degree Days (HDD) and Cooling Degree Days (CDD)[1] to quantify deviation from the "comfort range" and estimate energy use.
- **Because of our local climate, EWEB historically and presently has more HDD than CDD and the peak winter needs are more frequent and more extreme than the peak summer needs.**
  - Even the 2021 Heat Dome (green dots), which set multiple temperature records, did not match recent winter peak loads.
- Note the variability in load at each temperature – indicating there are a lot of factors that influence load beyond just temperature. For example, **at 40°F the daily load has ranged between 175MW to 425MW.** Factors other than weather that influence load include industrial demands, holidays, day of the week and even the previous day's temperatures[2].



1 https://www.weather.gov/key/climate_heat_cool - HDD and CDD quantify deviation from the "comfort range" (defined as 65 degrees Fahrenheit). A day with a mean temperature of 76 degrees represents 11 CDDs.
2 The thermal load of a building changes at a slower pace than the air temperature changes. This can sometimes cause a lag between air temperature change and heating or cooling energy use.

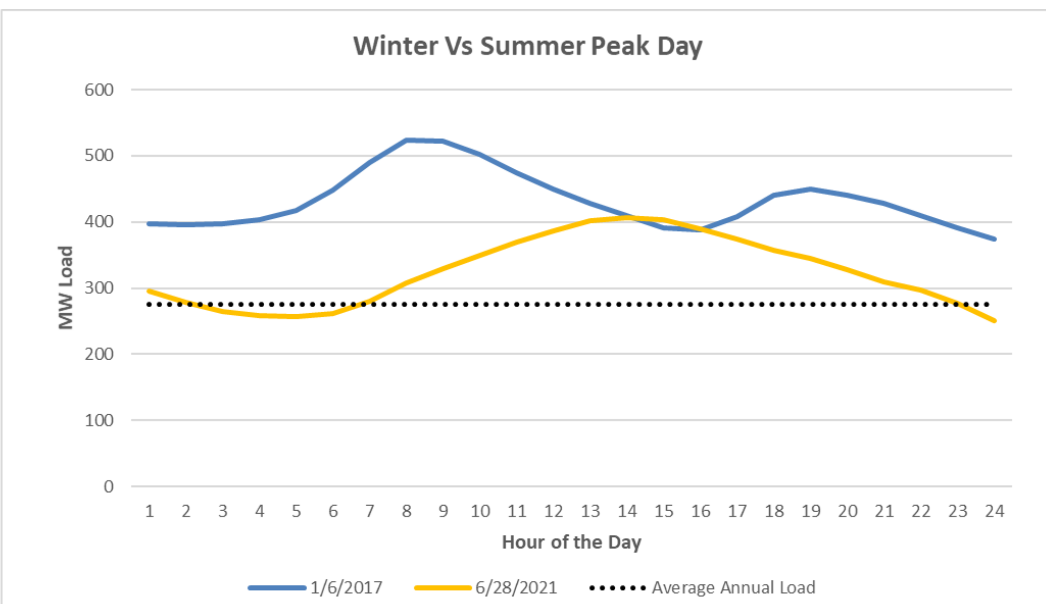
Although air conditioning is becoming more common in the Northwest, it has still not reached full saturation in the building stock. This means that heating still accounts for much more energy use than cooling. The Northwest Power and Conservation Council's 2021 Power Plan estimated that approximately 30% of residential households and 55% of multifamily households do not have air conditioning today. However, it is likely that 98% of residential buildings will have air conditioning by 2050[3] because of rising temperatures and increasingly common heat pump technology. EWEB does not have local information about air conditioning saturation within our service territory; instead, we rely on this kind of regional data to estimate energy consumption associated with cooling.

Summer and Winter Daily Load Shapes

In addition to the broad trend of weather impacts to load discussed above, there are more nuanced and specific load shapes for the winter and summer. The graph below highlights a peak winter day and a peak summer day from the last five years. The winter day has a classic "double hump," which corresponds to heaters being turned on in the morning and evening. In contrast, the load during a summer day gradually increases until it peaks in the mid-afternoon when air conditioners are running the most. These shapes are typical of peak load events when heating and cooling are the major load drivers.

Key takeaways:

- The peak hour of the winter day is presently about 100 MW higher than the summer day.
- For both summer and winter days, the difference between their peaks and troughs is more than 125 MW. This indicates that resources need to be flexible enough to handle this "ramping."
- Peak events are longer than just one hour and high load events can last for days due to cold fronts. While some short-duration resources can help meet 1-hour peaks, dispatchable resources or long-duration storage are necessary to meet multi-day needs.



3 https://www.nwcouncil.org/2021-northwest-power-plan/

Daily Variability

Not only do EWEB's load and load shapes vary dramatically over the course of the year, but they can vary in unexpected ways or at unexpected times. Holidays, weekends, or events like University of Oregon football games can all impact the load shape during a day and peak usage. Some of these variables are relatively predictable, as they have been observed many times before. Others are less known, and EWEB needs to be adaptable and have access to flexible resources to respond accordingly.

One example of how customer behavior shapes load was the peak event during the Heat Dome (the Monday load profile for 6/28/2021 shown above). Because weekends typically see less commercial and industrial loads, and many people are not at work, weekends tend to have lower loads than weekdays. For this reason, although the hottest days of the Heat Dome were Saturday and Sunday, the actual peak load was on Monday, even as the temperatures began to cool. Interestingly, the 2021 summer peak was a weekday in August, which peaked at 409 MW, in comparison to 407 MW for the June Heat Dome event.

In the past, the shape and timing of these load characteristics were less important from a long-term system planning perspective than they are now, due to the relatively large amounts of dispatchable generating resources, such as coal and natural gas generation, that were available on the system. Now, because of the increasing penetration of non-dispatchable (or variable) renewable resources, the accelerating retirement of coal facilities, climate impacts on water supplies, increasing operating restrictions on hydroelectric facilities, and moratoriums on new gas and nuclear facilities in Oregon, it will be important to consider which resources best match the timing, shape, and variability of EWEB's needs.

Load forecasting – Planning for Future Load

The discussion and graphs in the materials above are all based on historical EWEB data. Historical loads provide context and understanding for what the future might look like, as well as an appreciation for the variability in loads EWEB experiences in a given year, season, day, or hour. To forecast future load, EWEB uses an econometric model with several variables, including Heating and Cooling Degree Days, expected population growth, and Lane County's unemployment rate. In addition, conservation and electrification represent two key variables that impact EWEB's load forecast. It is important to understand each of these key drivers of EWEB's load forecast in greater detail.

Population and Unemployment

As an input to its load forecast, EWEB uses population data for Eugene provided by Portland State University (PSU). PSU forecasts that Eugene's population is expected to grow at 0.8% annually through 2045, and at 0.5% annually after that.[4] For context, since 1970, EWEB's historical population growth rate has ranged from 0.6% to 2.9% and has been about 1% for the past two decades. Increasing population correlates with a higher electricity load, so this indicates that EWEB should expect slight load growth over time due to population increases.

4 Past Forecasts | Portland State University (pdx.edu)

Unemployment data and forecasts come from Oregon's Office of Economic Analysis.[5] The COVID-19 pandemic has had a significant impact on employment over the past two years, and the Office of Economic Analysis Base Case predicts a recovery from this over the next several years. Under baseline assumptions, Oregon unemployment is assumed to remain low (4% to 5.5%) in the next 5 years of recovery before returning to the median 6.6% unemployment rate in 2027.

Electrification

Another major contributor to EWEB's forecasted load is the transition from fossil-based energy sources to electric vehicles and electric space and water heating. This process is referred to as electrification. EWEB's 2021 Electrification Study analyzed the ways in which electrification might impact EWEB. In defining EWEB's energy needs for the IRP, two specific questions posed by the Electrification Study are important:

1. Will EWEB customers transition to electric-based technologies, and at what pace?
2. How will this switch impact EWEB's peak and average energy needs?

The 2021 Electrification Study found that transportation electrification was the most likely source of electrification in EWEB's service territory. In contrast, the study found that fuel switching for heating would be less likely because individual customers would not see significant financial benefit. (This could change if mandates or legislative incentives were imposed.) To account for uncertainty around future technologies and adoption rates, the study examined both a Base Case and an Aggressive Carbon Reduction scenario. In both instances, EWEB will likely see impacts to both average and peak loads. However, it is most probable that these impacts will not materialize until 2030 or later.

The chart below highlights potential impacts by 2040:

- The *average* electric energy increase from transportation electrification is between 57-63 aMW in *both* scenarios. In other words, EWEB is highly likely to see increased load from electric vehicles.
- The impact to *peak* loads will be dependent on whether EWEB can develop policies and incentives that effectively manage customer charging behavior.
- Impacts from replacing gas furnaces with heat pumps could be material by 2040 under an Aggressive Carbon scenario, but these are expected to be less than impacts from the shift to electric vehicles.

5 forecast1221.pdf (oregon.gov)

EWEB Phase 2 Electrification Study – Cumulative Impacts

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 Performance Heat Pump	< 2%	Without significant incentives or mandates, impactful space heating electrification is unlikely if driven by participant economics (consumer choice).			
Cold Climate Heat Pump	< 2%				
Dual Fuel Heat Pump	< 2%				

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%
Standard Performance 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.

Electrification will be considered in EWEB’s load forecast for the 2022 IRP, and the assumptions will be reassessed in future IRPs as actual electric vehicle, water and space heating adoption rates are monitored.

Conservation (Energy Efficiency)

The last time EWEB conducted an IRP, in 2011, energy efficiency was the most cost-effective resource to meet growth in EWEB’s consumption needs. Since that time, it has been EWEB policy to meet 100% of new load growth through conservation. For this reason, it is by far the most common and largest demand-side management strategy that EWEB uses today. EWEB currently sets the conservation financial budget based on load growth forecasts and maximizes energy efficiency acquisition within this constraint.

As shown in the chart below, EWEB efficiency programs are effective in reducing both overall energy consumption and peak demand. In fact, while some measures are more effective than others in managing peak demand, in aggregate, EWEB conservation programs typically have two to three times the impact on peak load than on average load. Staff believe that future residential and commercial conservation efforts may be able to achieve this high ratio of peak reduction, though in industrial settings, peak load energy savings may be roughly equal to average load savings. It is likely that new demand programs will need to specifically target mitigating peak demands, either by reducing consumption or shifting it to another time.

	Load Reductions from Conservation Programs					
	2019		2020		2021	
	aMW	Peak MW	aMW	Peak MW	aMW	Peak MW
Residential	0.3	1	0.27	0.85	0.3	0.96
Commercial and Industrial	0.95	1.2	1.45	2.88	0.91	2.13
Total	1.25	2.2	1.72	3.73	1.21	3.09

Because conservation efforts impact the size and shape of EWEB's loads, the effect of past conservation shows up in historical data. This is important to keep in mind when thinking about EWEB's future load growth, because without conservation, current loads would undoubtedly be higher. Although conservation has been used to meet past load growth, the 2022 IRP does not presuppose that conservation will be the best option for EWEB in the future. Instead, it will be treated the same as all other new resources: If it is cost-effective, it will be selected to meet EWEB's energy and capacity needs. This distinction will be visible in the IRP load forecast, which does not include a reduction to load due to conservation purchases. The IRP's assumptions around conservation as a resource will be discussed in greater detail in August.

Impact of Climate Change on the Load Forecast

Analysis in the Northwest Power and Conservation Council's 2021 Power Plan gives some indication about how loads and resource performance may vary over the several decades due to climate change. As temperatures rise, winter loads are expected to decrease slightly on average, and summer loads are expected to increase on average. Many climate change models also show that the Northwest region will have wetter, rainier winters, and drier, hotter summers.

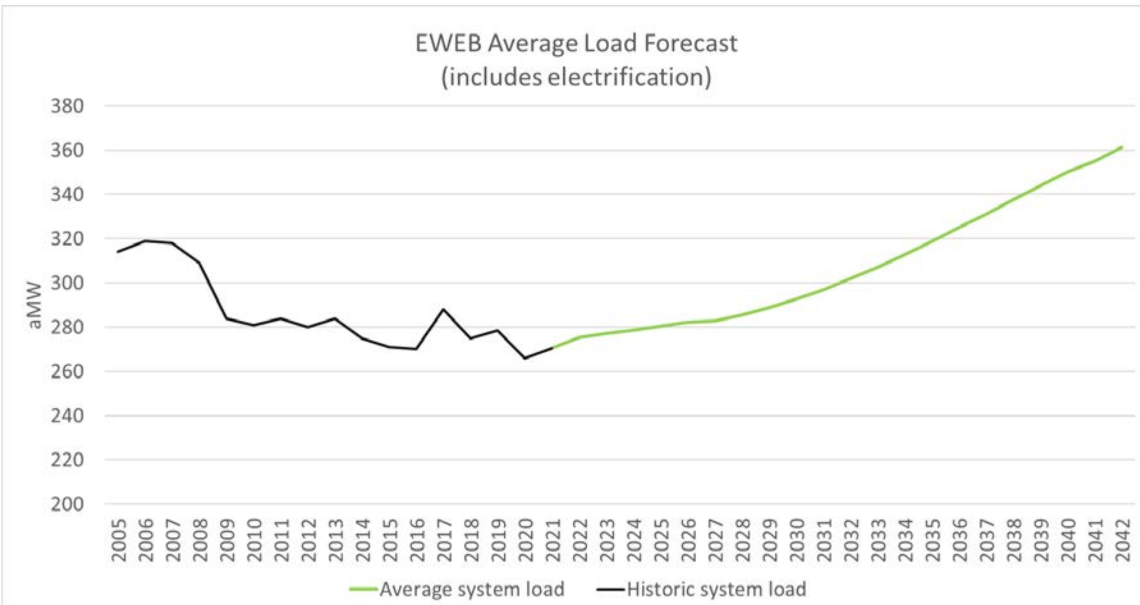
Because the region has significant hydropower resources, these trends will impact not just loads but also generation capabilities. Less water stored as snowpack, along with operational restrictions because of stricter fish and wildlife requirements, may significantly limit hydroelectric flexibility and peak capacity. Over time, with today's resource portfolio, it is likely that the risk of high market prices or reliability events in the summer will increase. Resource characteristics will be discussed in greater detail in August.

To account for the impact of climate change on load, EWEB staff are currently proposing to use the most recent 10 years of summer load data, rather than a full historical data set. Historical climate events such as the 2021 Heat Dome will be factored into modeling as part of the input data. However, forecasted impacts of future climate change on EWEB's loads are not going to be directly modeled in the 2022 IRP. The 2022 IRP is foundational in nature and future iterations of the IRP can include more complex modeling scenarios.

There are several other important things that we know about climate change and EWEB's load that we can use in our IRP planning. First, as described in many of the charts and graphs above, EWEB is a winter-peaking utility. Even with outlier events such as the 2021 Heat Dome, winter loads are consistently higher than summer loads, and outlier winter events drive EWEB's peak load far more than summer events. Additionally, the unpredictability of either summer or winter outlier events will be far more impactful on EWEB's ability to plan and meet load than a gradual shift in annual average temperatures. This means that flexibility and peaking capacity throughout the year are essential when considering generation and demand-side resources.

System Load Forecast: Average Energy

The 2022 system load forecast is prepared by analyzing the key drivers discussed above. With forecasted population increases and electrification, and without a significant increase in commercial/industrial consumption, EWEB expects to see moderate load growth over the next two decades. As described above, our IRP modeling will include electrification but will not assume that conservation purchases will remain at current levels. Instead, our modeling work will examine load (demand) by incorporating population growth and electrification, but will treat conservation as a resource (supply) that can be used to meet that demand.



Forecasted population growth and electrification alone are not estimated to increase average energy use beyond 2006 levels (which included approximately 20 aMW from the large Hynix semiconductor plant that closed in 2008) until 2035. Current conservation programs can help mitigate the pace of growth as new resource options are considered before 2028. However, staff recognize that EWEB has seen load decreases over the past fifteen years and the load forecast assumptions have uncertainty. The IRP modeling work can include sensitivities to recognize uncertainties around load growth and the resources the utility may need in the future. These sensitivities can provide guideposts within which to make future resource decisions.

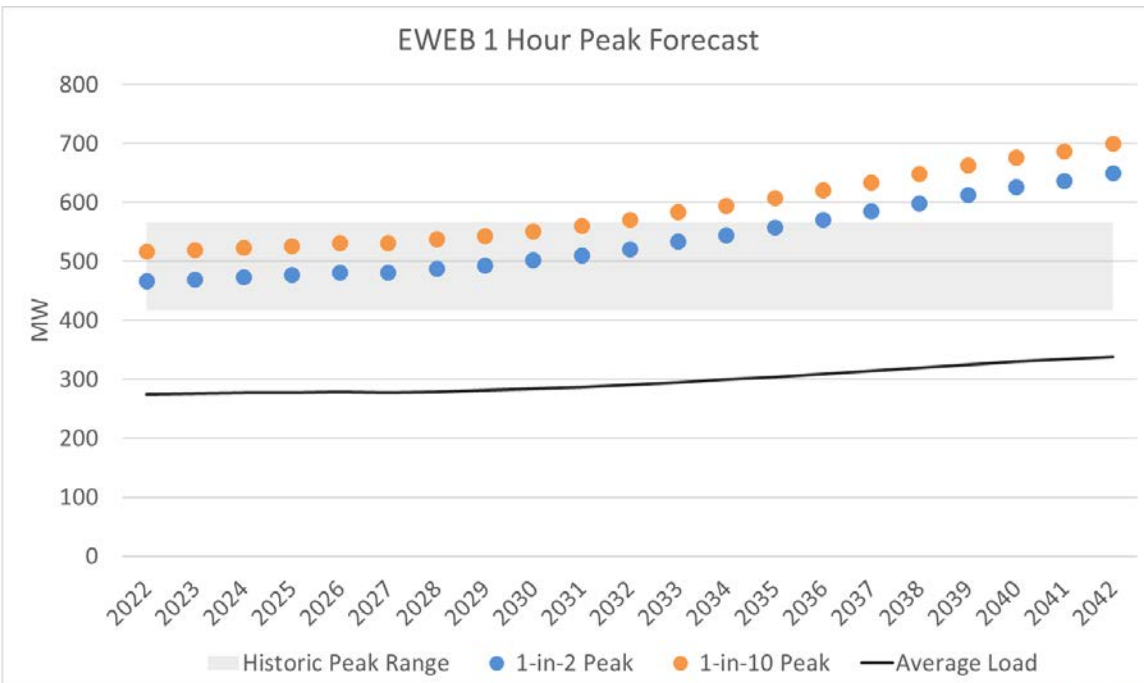
System Load Forecast: Peak energy

Key Concept – Peak Load Probabilities

- Utility planners use “1-in-2” and “1-in-10” to speak about the likelihood of a specific event occurring. A 1-in-2 peak event is expected to occur once every two years – in other words, it has a 50% chance of occurring in any given year.
- A 1-in-10 peak event only happens once every 10 years – it has a 10% chance of occurring in a given year.
- EWEB uses 1-in-2 and 1-in-10 peak events to analyze how many resources we need in a typical year or under more extreme and infrequent conditions.

As noted earlier, the annual average forecast is a simplified metric that is useful for planning long-term energy needs but does not represent the load variability that EWEB experiences throughout the year. The chart below shows the typical (1-in-2) and less frequent (1-in-10) single-hour peak forecast. It provides a comparison between the average load EWEB experiences and the typical 1-hour system peak.

- EWEB's peak load is expected to grow as average load increases.
- Electric car charging is the primary driver of load growth over time.
  - Demand-side resources such as conservation, demand response programs and time-of-use rates are tools that can be used to "manage" the peak.
  - Many of these programs are considered resources in the IRP, and will be discussed further at the August board meeting.



All peak data presented above represents "unmanaged" load without the influence of EWEB demand-side programs. Unmanaged peak assumes no conservation programs and unmanaged EV charging behavior where customers do not make any effort to shift their charging away from EWEB's system peaks.

Using peak energy to assess EWEB's resource needs is a way to ensure that the utility has secured enough resources to meet higher, infrequent (1-in-2) energy needs without routinely relying on energy markets. However, at the same time, purchasing more resources to meet *very* infrequent events (like 1-in-10 peaks) is often not cost-effective. EWEB has historically utilized energy markets to meet the most infrequent peak load needs and to balance our loads and resources. This strategy helps reduce costs but does expose the utility to purchasing energy from the market, which can be costly when the entire Northwest region faces scarcity. Staff plan to explore EWEB's long-term peak planning standards and market exposure further as the IRP modeling work continues.

Key takeaways

The shape of EWEB's energy needs vary from day to day and season to season:

1. EWEB is a winter peaking utility. Our biggest needs occur on cold days between December and February, and the typical summer peak is 80% of the typical winter peak. These winter peak needs can last for days or weeks, depending on the duration of the cold snap.
2. EWEB's average annual load of 275 aMW only tells a small part of the story. Our system commonly sees loads fluctuate between 200MW and 400MW throughout the year primarily due to customer behavior and temperature variation.
3. The load for the typical annual peak hour is 1.7 times greater than the annual average load. Planning for 1-in-2 peak energy usage can help us plan for infrequent events.
4. The shape, timing, and daily variability of EWEB's load will be important to consider as we analyze which resources best match EWEB's needs.

EWEB's energy needs are likely to grow:

1. EWEB expects to continue seeing population growth, which will drive load growth.
2. Transportation electrification is likely to increase both peak and average loads in the coming decades.
3. Uncertainty around future load growth can be handled with sensitivity analysis in the IRP.

Recommendation & Requested Board Action

No action is requested at this time. The information is provided to facilitate Board understanding and discussion.