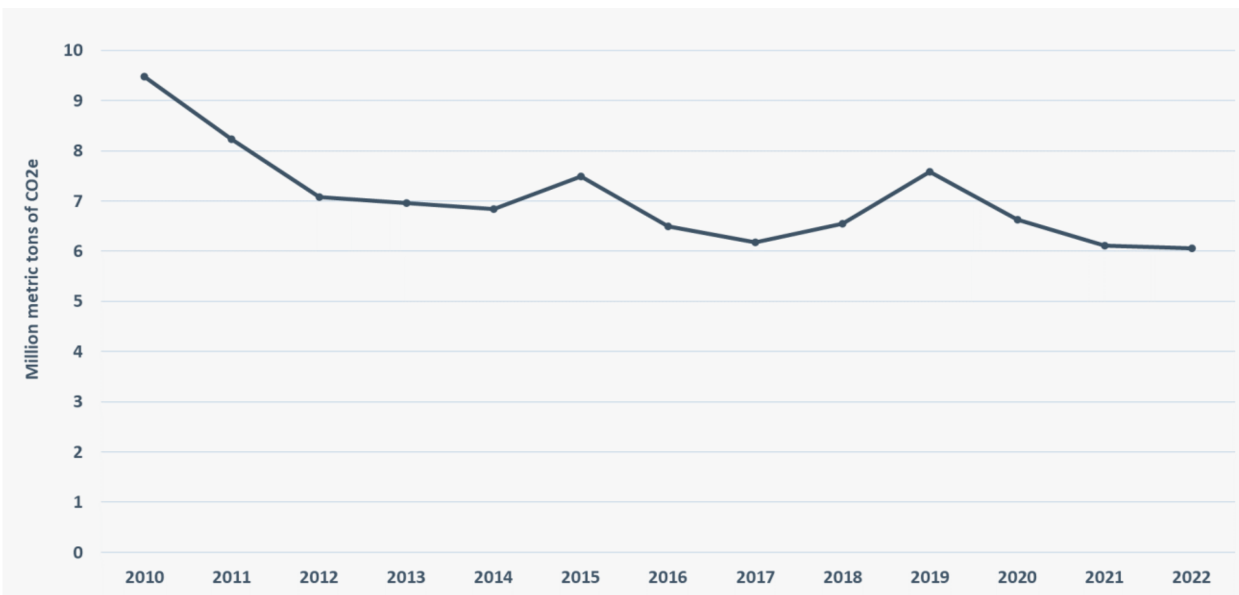
# Appendix I. C-level analysis

This appendix discusses how GHG emission levels can vary on an annual basis due to weather, hydro conditions, and other factors. It starts by looking at historical variations, and then includes an analysis on potential variations in 2030 using the IRP Preferred Portfolio.

## I.1 GHG variability in power systems

**Figure 136** shows historical PGE system GHG emissions for retail load service from 2010 through 2022. In the historical data, there are annual variations in GHG outputs. These annual variations are often due to factors outside the control of PGE, like regional hydroelectric generation levels, and different weather patterns that impact temperature as well as wind/solar generation.

**Figure 136. Historical PGE GHG emissions for retail load**




Under HB 2021 PGE must emit 1.62 million metric tons of $CO_2e$ or fewer in 2030 for serving retail load, 0.81 MMT or fewer in 2035, and zero in 2040. A challenge in planning for the emissions targets is incorporating annual GHG emission variations. For example, in year 2030 PGE may have a power system that emits 1.62 MMT of $CO_2e$ under average conditions. But the same system may emit more GHGs under extreme temperature conditions. This is due to extreme temperatures typically requiring more electricity for heating and/or cooling needs, and the extra power likely coming from a GHG emitting resource. On the other hand, a year with mild weather may see lower GHG emissions due to decreased demand. Hydro conditions also play a role in GHG emission variations. In years with higher-than-average hydropower generation there may be a reduced need to operate GHG emitting resources, and in lower hydropower generation years the need for GHG emitting generation may increase.

The Oregon Public Utility Commission (OPUC) has stated that utilities should "achieve the 2030 and 2035 clean energy targets under typical or expected weather and hydro conditions…"[478] This implies that system emissions may be higher or lower than the GHG targets due to variability, but on a one-in-two basis meet the targets. To better understand the range of GHG emissions due to temperatures and hydro variations, PGE performed a GHG variability assessment as part of the IRP. This is called a carbon-level, or C-level, analysis in the IRP.

The GHG variability assessment focuses on the annual impact of hydro and temperature variations on GHG emissions. It does not account for variability outside of temperature and hydro conditions, nor does it account for temperature and hydro excursions outside of the historical range. While it provides insight into GHG variations, actual system variations may differ.

The assessment has four steps:

1. The Sequoia model estimates annual GHG variability from temperature utilizing its hourly dispatch logic and catalog of 30 temperature years. Based on a recommendation from consultant E3, Sequoia runs without thermal resources when performing this estimate to achieve GHG-free resource optimization. With thermal generation removed from the model, there are many hours in which load (demand) cannot be served by available generation (demand). These quantities of deficit are defined as unserved energy.
2. The MWhs of unserved energy in Sequoia are assumed to be met with GHG-emitting generation. The analysis assumes that this GHG-emitting generation has an intensity rate of 0.385 metric tons/MWh.[479] Annual GHG emissions are estimated by multiplying the MWhs of unserved energy in Sequoia by 0.385 tons/MWh. For example, if a year has 3 million MWhs of unserved energy, this is multiplied by 0.385 tons/MWh to arrive at an annual GHG emissions estimate of 1.155 million metric tons. The result is 30 different annual GHG estimates based on temperature variations.[480]
3. The impact of hydro variability on GHG emissions is estimated using a 30-year historical dataset. The annual median generation of the dataset is found, and the difference between each year and the median is calculated. Some years are higher than the median,

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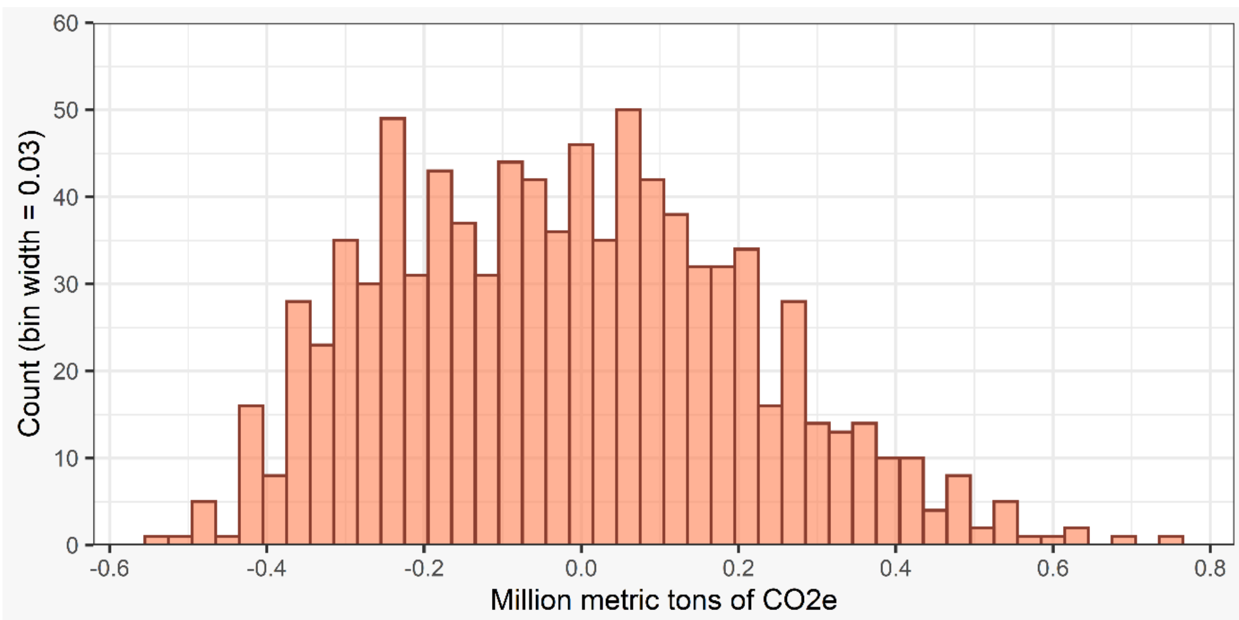
[478] Docket No. UM 2225, Order 22-446, at 31.
[479] 0.385 metric tons / MWh represents a mix of CCCT gas plants.
[480] For this analysis temperature years in Sequoia are created by grouping the initial draw data. The initial draw data sets the load bins, and Sequoia then pulls loads from the 30-year record within that bin. As a result, the synthetic load years will have similar, but not identical, temperature characteristics as the actual years.

others less than. For each year, a GHG value of 0.385 tons/MWh is assigned to each MWh of generation higher or less than the median. The result is 30 estimates of how hydro variations impact GHG emissions.

4. The hydro and temperature variations are paired together, creating 900 possible annual GHG variations, ranging from the mildest temperatures and highest hydro conditions (least GHGs) to the most extreme temperatures and lowest hydro conditions (highest GHGs). A histogram of the range is in **Figure 137**. The histogram shows the distribution of GHG emissions for retail load service above and below expected conditions in the Preferred Portfolio in year 2030. For example, the max value in the dataset is 0.74. This implies that there is a possibility of GHG emissions in 2030 being 0.74 million metric tons higher than the 1.62 million metric ton 2030 target (2.36 million metric tons).

**Figure 137. GHG histogram from Preferred Portfolio**




Using the data from **Figure 137**, PGE has created various GHG percentiles, known in the IRP as C-levels. The C-levels for year 2030 in the Preferred Portfolio are in **Table 131**. One way to use the data is to calculate how much extra GHG free energy PGE would need to acquire to shift the distribution and meet the 1.62 million metric tons of GHG target under a range of conditions. This is included in the right most column of the table, assuming each MWh of GHG free generation offsets 0.385 metric tons of GHG emissions.

**Table 131. C-Level analysis**

| C-Level | MMT of CO2e (retail) | Million MWh of CO2e free energy needed to reach 1.62 MMT target |
|---|---|---|
| **Max** | 2.36 | 1.93 |
| **90th percentile** | 1.90 | 0.73 |
| **75th percentile** | 1.76 | 0.36 |
| **Median** | 1.62 | |

The C-level analysis takes GHG variations from temperature and hydrological conditions into consideration. It does not include GHG variations from any other factors. As a result, the actual range of GHG variation is likely larger.