

Attachment 4



MEMORANDUM

To: Angela Long, PacifiCorp
From: Eli Morris and Kurtis Kolnowski, Applied Energy Group (AEG)
Date: January 10, 2020
RE: PacifiCorp Oregon Light-Duty Electric Vehicle Forecast Scenarios

PacifiCorp engaged Applied Energy Group (AEG) to develop forecasts of potential light-duty electric vehicle (EV).¹ Adoption in its Oregon service territory.² To accomplish this and to provide a range of potential outcomes, AEG created three separate scenario forecasts based on industry sources of varying aggressiveness. The three scenarios produce extremely similar results through 2024, suggesting that there is general industry agreement around the rate of EV adoption over the next several years. In 2025, the three forecasts begin to diverge, highlighting the large uncertainty surrounding medium- and long-term EV adoption rates and the many factors that may affect uptake. The remainder of this memorandum summarizes the inputs, methodology, and results of AEG's analysis.

Historical EV Adoption in PacifiCorp's Oregon Service Territory

According to the Oregon Department of Environmental Quality (DEQ), 27,796 light-duty EVs were registered in Oregon as of September 30, 2019,³ 5,018 of which were registered in PacifiCorp's service territory. Of the EVs registered in PacifiCorp's service territory at this time, 58% (2,897 vehicles) were battery electric vehicles (BEVs) and 42% (2,121 vehicles) were plug-in hybrid electric vehicles (PHEVs).

Figure 1 and Table 1 show the trend in light-duty EVs registered in PacifiCorp's Oregon service territory since mid-2017 based on current and previous DEQ reports.⁴ Because actual year-end 2019 data were not available at the time of this analysis, AEG used the percentage growth rate from June through September to estimate the number of vehicles that would be registered by the end of 2019. Using this methodology, AEG estimates a total of 5,558 light-duty EVs registered in PacifiCorp's Oregon service territory by the end of 2019, composed of 3,128 BEVs and 2,430 PHEVs.

¹ This memo uses the term "electric vehicle" or "EV" to encompass both battery electric vehicles and plug-in hybrid electric vehicles.

² The discussion and results presented in this memo are specific to light-duty vehicles. Medium- and heavy-duty vehicles are outside the scope of this analysis.

³ State of Oregon Department of Environmental Quality, *Electric Vehicles in Oregon – End of September 2019, Updated: December 31, 2019*. <https://www.oregon.gov/deq/FilterDocs/CFP-electricvehicles.pdf> (last visited Jan 7, 2020)

⁴ DEQ began reporting EV registrations by utility service territory in mid-2017. Reports containing data before June 30, 2019 are no longer posted online, but were provided to AEG by DEQ.

Figure 1. Cumulative Light-Duty EV Registrations – PacifiCorp Oregon Service Territory (segmented line estimated)

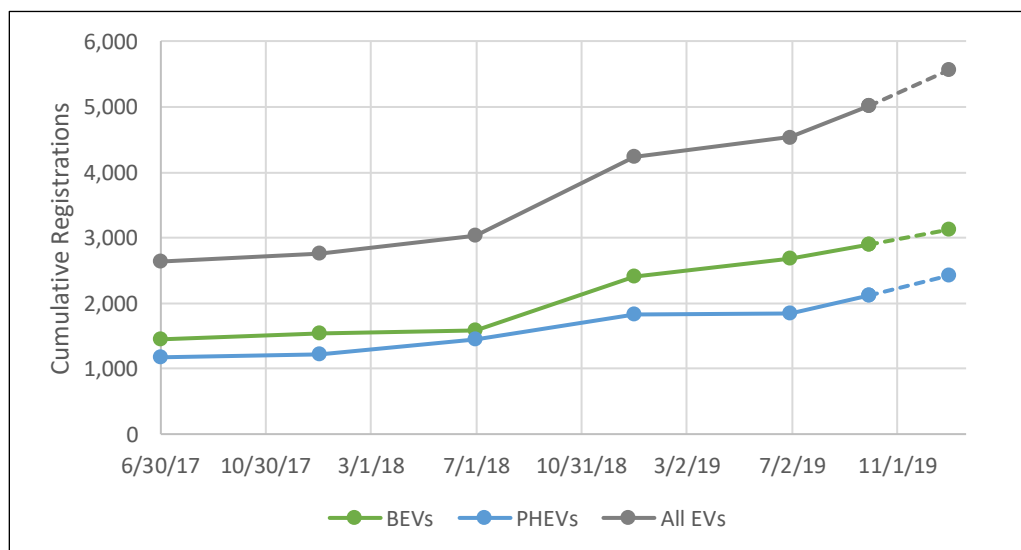


Table 1. Cumulative Light-Duty EV Registrations – PacifiCorp Oregon Service Territory

Vehicle Type	Actual						Estimated
	Jun 30, 2017	Dec 31, 2017	Jun 30, 2018	Dec 31, 2018	Jun 30, 2019	Sep 30, 2019	Dec 31, 2019
BEVs	1,455	1,544	1,587	2,410	2,683	2,897	3,128
PHEVs	1,182	1,217	1,450	1,823	1,851	2,121	2,430
All EVs	2,637	2,761	3,037	4,233	4,534	5,018	5,558

EV Adoption Forecast Scenario Sources

On a national scale, EV adoption may be influenced by many factors, including vehicle availability, cost, tax credits, range, customer awareness, and technology familiarity. When considering a specific geographical area, additional factors affecting EV adoption may include fuel costs, population density, income, local tax credits and rebates, programs and educational campaigns, and charging station availability and visibility. Because of the myriad factors that are likely to affect future EV adoption in PacifiCorp’s Oregon service territory, AEG did not attempt to develop an independent forecast of how these factors may change over time and the affect this may have on the local EV market. Rather, AEG relied on national forecasts of EV adoption from the three industry sources described below. National EV market growth rates from each source for 2020-2030 were applied to estimated year-end 2019 light-duty EV registrations in PacifiCorp’s Oregon service territory to create three potential forecasts of future EV adoption.

US Energy Information Administration Annual Energy Outlook 2019

Each year, the Energy Information Administration (EIA) publishes its Annual Energy Outlook (AEO), providing projections of domestic energy markets under a variety of scenarios.⁵ To create a forecast of future EV adoption, AEG used the reference case forecasts of national EV stock growth from AEO 2019, the most recent AEO version available at the time of the analysis.⁶ The EIA utilizes the Transportation Sector Demand Module of its National Energy Modeling System (NEMS) to project light-duty vehicle stock. This model is designed to “Endogenously incorporate the effects of technological innovation, macroeconomic feedback, infrastructure constraints, and vehicle choice in making the projections.”⁷

⁵ Current and previous versions of the AEO are available online at <https://www.eia.gov/outlooks/aeo/>. (last visited Jan 8, 2020)

⁶ Annual Energy Outlook 2019, “Table 40. Light-Duty Vehicle Stock by Technology Type” and “Table 46. Transportation Fleet Car and Truck Stock by Type and Technology” https://www.eia.gov/outlooks/aeo/supplement/excel/suptab_40.xlsx (last visited Jan 8, 2020)

⁷ Transportation Sector Demand Module of the National Energy Modeling System: Model Documentation, March 2019 at 3 (AEO 2018 Documentation) [https://www.eia.gov/outlooks/aeo/nems/documentation/transportation/pdf/m070\(2018\).pdf](https://www.eia.gov/outlooks/aeo/nems/documentation/transportation/pdf/m070(2018).pdf) (last visited Jan 8, 2020)

Of the sources discussed in this memo, AEO 2019 is the only one that presents forecasted adoption separately for BEVs and PHEVs rather than simply for EVs in total, allowing AEG to create separate forecasts of BEV and PHEV adoption. The mapping of AEO to DEQ EV categories is provided in Table 2.

Table 2. AEO and DEQ EV Type Mapping

DEQ EV Category	AEO EV Category
BEVs	100 Mile Electric Vehicle
	200 Mile Electric Vehicle
	300 Mile Electric Vehicle
PHEVs	Plug-in 10 Gasoline Hybrid
	Plug-in 40 Gasoline Hybrid

Edison Electric Institute/Institute for Electric Innovation 2018 Forecast

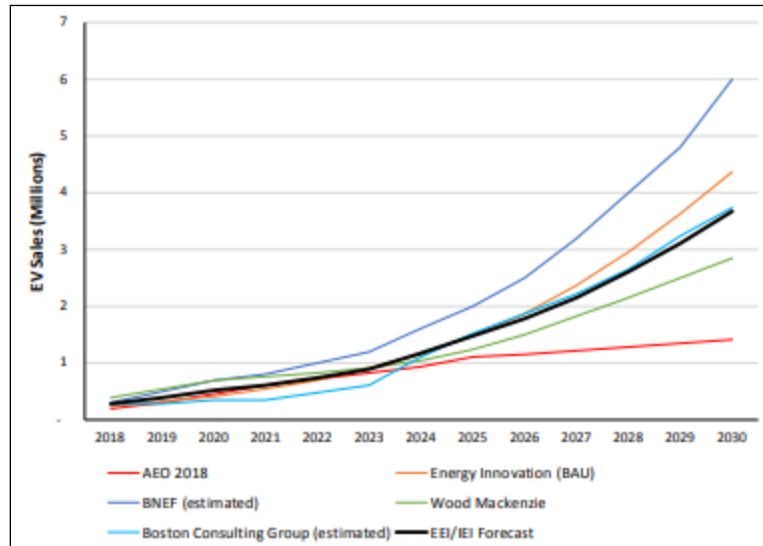
In November 2018, the Edison Electric Institute (EEI) and the Institute for Electric Innovation (IEI) jointly published a forecast of national electric vehicle adoption through 2030.⁸ The EEI/IEI forecast was developed as a composite of five independent forecasts:

- Bloomberg New Energy Finance (BNEF) – Electric Vehicle Outlook 2018 (May 2018)
- Boston Consulting Group (BCG) – The Electric Car Tipping Point (November 2017)
- Energy Innovation – Energy Policy Simulator 1.4.1 (accessed July 2018)
- U.S. Energy Information Administration (EIA) – Annual Energy Outlook 2018 Reference Case (February 2018)
- Wood Mackenzie – The Electric Vehicle Outlook Data (August 2018)

These underlying forecasts and the EEI/IEI composite are provided in Figure 2. As shown, the underlying forecasts are very similar through the mid-2020s, then begin to diverge significantly. By averaging across these forecasts of varying aggressiveness, the EEI/IEI forecast represents a middle ground between the least aggressive (AEO) and most aggressive (BNEF) forecasts.

⁸ A. Cooper and K. Schefter, *Electric Vehicle Sales Forecast and the Charging Infrastructure Required Through 2030*, Nov 2018. https://www.edisonfoundation.net/iei/publications/Documents/IEI_EEI%20EV%20Forecast%20Report_Nov2018.pdf (last visited Jan 8, 2020)

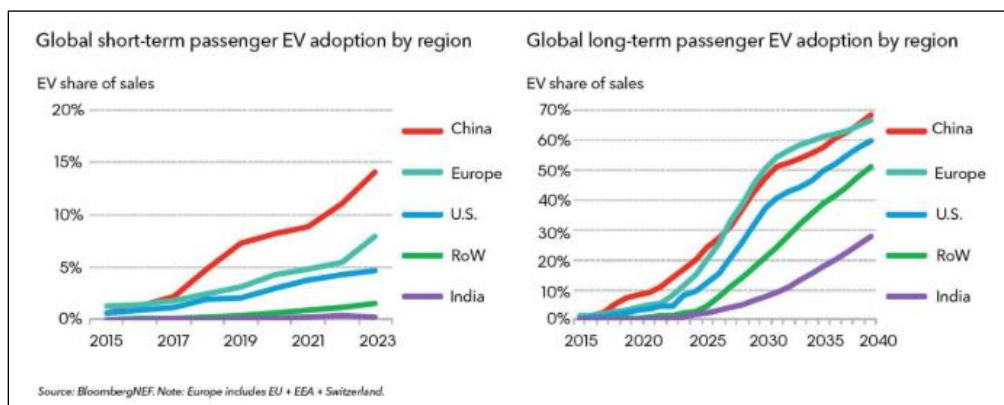
Figure 2. EEI/EIE Annual Sales Forecast Comparison ⁹



Bloomberg New Energy Finance Electric Vehicle Outlook 2019

BNEF’s annual Electric Vehicle Outlook provides long-term forecasts of electric vehicle adoption globally and for specific geographic markets, including the United States. BNEF’s EV market share forecasts, by region, are provided in Figure 3. As shown, while the US EV market share forecasts are not as aggressive as China or Europe, they are expected to increase to over 40% of passenger vehicles by 2030 and 60% by 2040.

Figure 3. BNEF 2019 EV Market Share Forecasts ¹⁰



As stated in the BNEF Electric Vehicle Outlook 2019, “Compared to other major organizations, BloombergNEF continues to hold the most aggressive view on EV adoption.”¹¹ As such, by applying the US EV market shares from the figure above, AEG was able to create an aggressive forecast of EV adoption in PacifiCorp’s Oregon service territory.

EV Adoption Forecast Scenario Results

The forecasts of cumulative light-duty EV adoption in PacifiCorp’s service territory under the three scenarios are presented in Figure 4 and Table 3 below. As shown, all three scenarios build off the same estimate for year-end 2019 EV registrations, applying source-specific growth rates beginning in 2020. The three sources produce extremely similar results through 2024, with high and low estimates differing by only 6% in that year. The forecasts begin to diverge in

⁹ *Id.* at 5

¹⁰ BloombergNEF *Electric Vehicle Outlook 2019*, “Key Findings”, p. 5. <https://about.bnef.com/electric-vehicle-outlook/> (last visited Jan 8, 2020)

¹¹ *Id.* “Comparing EV Outlooks” at 1.

2025 and by 2030, there is a significant difference between forecasted EVs, particularly between BNEF (~104,000) and AEO (~42,000). The large difference in adoption between these two scenarios is likely driven by assumptions around price parity between EVs and gasoline vehicles, as the BNEF Electric Vehicle Outlook 2019 states that "...we expect price parity between EVs and internal combustion vehicles (ICE) by the mid-2020s."¹²

Figure 4. PacifiCorp Oregon Light-Duty EV Adoption Scenarios

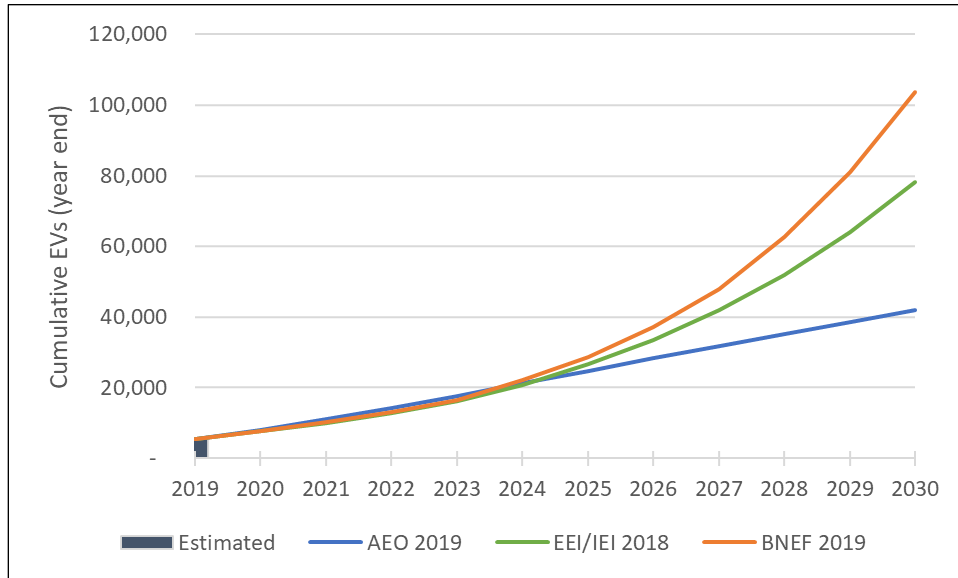


Table 3. PacifiCorp Oregon Light-Duty EV Adoption Scenarios

Scenario	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
AEO 2019	5,558	7,977	10,986	14,301	17,649	21,152	24,778	28,263	31,692	35,037	38,452	41,901
EEI/IEI 2018	5,558	7,582	9,940	12,822	16,279	20,819	26,516	33,432	41,828	51,957	64,012	78,311
BNEF 2019	5,558	7,627	10,228	13,158	16,386	22,057	28,596	37,260	47,918	62,492	80,995	103,734

As discussed above, AEO is the only source that provided separate adoption forecasts for BEVs and PHEVs, allowing AEG to forecast adoption separately for these two vehicle types. The AEO scenario forecast by vehicle type is provided in Figure 5 and Table 4. As shown, the AEO 2019 scenario projects that the share of EVs that are BEVs will grow from 56% in 2019 to 75% in 2030.

¹² *Id.* "Key Findings" at 1.

Figure 5. AEO Scenario Adoption Forecast by EV Type

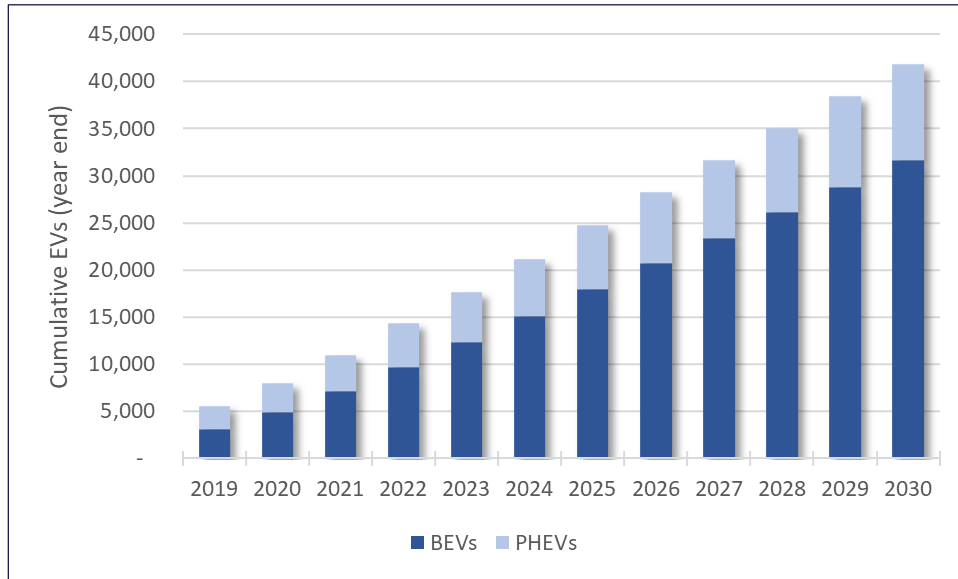


Table 4. AEO Scenario Adoption Forecast by EV Type

Scenario	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
BEVs	3,128	4,920	7,172	9,709	12,296	15,042	17,906	20,671	23,406	26,084	28,821	31,602
PHEVs	2,430	3,057	3,815	4,593	5,353	6,110	6,872	7,591	8,286	8,954	9,632	10,299
All EVs	5,558	7,977	10,986	14,301	17,649	21,152	24,778	28,263	31,692	35,037	38,452	41,901