Load Impacts from Electric Vehicles in Maine

RESULTS MEMO

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efficiency MAINE®

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Energy + Climate

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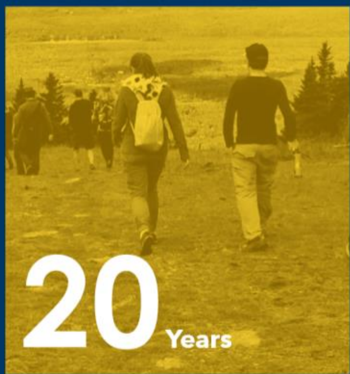
About Dunsky



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List of Acronyms

BEV: Battery electric vehicle

DCFC: Direct current fast charging

EMT: Efficiency Maine Trust

EV: Electric vehicle

LDV: Light-duty vehicle

MHDV: Medium- and heavy-duty vehicle

PHEV: Plug-in hybrid electric vehicle

V2G: Vehicle-to-grid

ZEV: Zero-emissions vehicle

1. Introduction

Efficiency Maine Trust (EMT) is preparing its Triennial Plan VI, including preparing its programs and system for increased electrification. As part of this effort, EMT wishes to update its understanding of the impact (costs and benefits) of adding electric vehicles (EVs) to the grid. Specifically, it wishes to answer the following research questions:

1. What does **typical charging behaviour** look like for EV users in Maine?
2. Given these patterns, what are the **winter and summer peak loads** and **energy period factors** associated with EVs?

This report presents the findings from this study. The scope of this research work is limited to light-duty vehicles (LDVs) and was conducted for the state of Maine as a whole. It does not include estimates of peak loads and energy period factors under managed charging scenarios.

2. Methodology and Assumptions

We reviewed typical daily charging behaviour (hourly charging load curves) available from leading studies that use modelled estimates and real-world data on charging behaviour. Two key references we used in developing hourly charging load curves are:

- California Investor-Owned Utility Electricity Load Shapes published by the California Energy Commission in April 2019 based on market and metering studies[1]
- ISO New England's Transportation Electrification Forecasts, the most recent being the 2024 Draft[2]

Building on these documents, we developed diversified 24-hour load distribution profiles for an average Maine EV's daily energy consumption. The distribution profiles are differentiated by vehicle type (BEV/PHEV), charging location (home, public and workplace), charging type, (Level 1, Level 2, and direct current fast charging [DCFC]), and season (summer/winter) and scaled to daily energy requirements for each combination.

We incorporated average efficiencies by vehicle segment shown in Table 1.

Table 1. Vehicle efficiency by segment

Variable	Cars	SUV	Trucks
Electric miles efficiency (kWh/mi)	0.29	0.36	0.48

Figure 1 shows the diversified charging distribution profiles used in this report, which are then transformed according to the jurisdiction-specific data above.

[1] CEC (2019). California Investor-Owned Utility Electricity Load Shapes.
[2] ISO NE (2024). Draft 2024 Transportation Electrification Forecast.

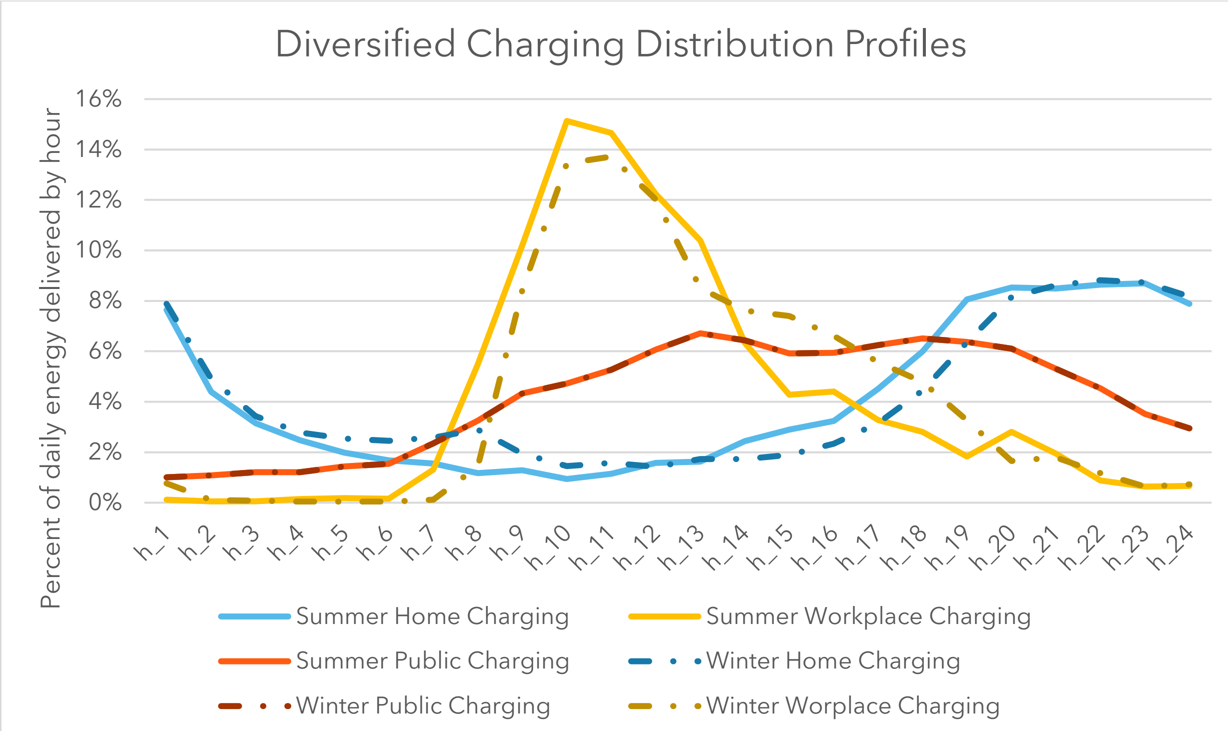

Figure 1. Diversified Charging Distribution Profiles

Based on data available to date, there is little variation across jurisdictions in *average* charging behavior (i.e., the time of day that people plug in at home, work and public charging). Instead, most of the differences between regions (like climate, driving distance, and housing type) are reflected in the *total energy demand* from EVs.

Thus, we customized the energy demand and relative shares of each distribution profile for the state of Maine by incorporating regional data, including:

- Hourly temperatures from the National Centres for Environmental Information[3]
- Average driving distance of 12,000 miles/year[4]
- Expected share of cars, SUVs and trucks in the light-duty EV fleet by 2028 (Table 2)[5]
- Expected share of BEVs (73%) and PHEVs (27%) in the light-duty EV fleet by 2028[6]
- Expected share of PHEV miles that are electric (75%)
- Expected share of all charging that Mainers do at home (85%)[7]
- Expected share of Mainers with home charging that use Level 1 and Level 2 charging at home for BEV and PHEV users (Table 3)[8]

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[3] Source: NCEI. "U.S. Climate Normals 2020: U.S. Hourly Climate Normals (2006-2020)."
[4] Source: State of Maine Clean Transportation Roadmap (2021).
[5] Source: Clean Transportation Roadmap and Dunsky professional judgement.
[6] Source: Clean Transportation Roadmap and Dunsky professional judgement.
[7] Source: American Community Survey and Dunky professional judgement.
[8] Drawn from EMT rebate recipient survey, 2024.

Table 2. Share of vehicles by segment, BEV and PHEV segments

Vehicle Segment	BEV	PHEV
Cars	35%	44%
SUVs	43%	53%
Light trucks	22%	3%

Table 3. Share of energy demand from different charging sources, BEV and PHEV users (points of divergence shown in bold)

Variable	BEV	PHEV
% of home charging	85%	85%
% of workplace charging	7.5%	7.5%
% of public charging	7.5%	7.5%
% of Home using Level 1	**15%**	**75%**
% of Home using Level 2	**85%**	**25%**
% of Home using DCFC	0%	0%
% of Workplace using Level 1	15%	15%
% of Workplace using Level 2	85%	85%
% of Workplace using DCFC	0%	0%
% of Public using Level 1	0%	0%
% of Public using Level 2	**50%**	**100%**
% of Public using DCFC	**50%**	**0%**

Next, we identified the peak winter and peak summer periods according to the future Central Maine Power peak periods provided by EMT:

- Summer on-peak is 5:00 to 9:00 pm on non-holiday weekdays in July and August
- Winter on-peak is 5:00 to 9:00 pm on non-holiday weekdays in December, January and February

3. Results

The daily energy demand for an average BEV and PHEV on an average weekday, and on the peak day, in the winter and summer seasons are shown in Table 4. These daily demand values align well with the findings in ISO New England's Draft 2024 Transportation Electrification Forecasts.[9]

Energy demand is higher in the winter primarily because of higher interior vehicle heating loads in colder temperatures.

In Table 4, the "average weekday" is the average demand across all the days within the applicable peak season. The "peak day" is the day with the highest demand from among all the days in the applicable peak season.

Table 4. Daily energy demand per EV, BEV and PHEV

Season	Day type	Per BEV	Per PHEV
Winter	Average weekday	16.0 kWh	11.1 kWh
	Peak day	16.8 kWh	11.6 kWh
Summer	Average weekday	10.4 kWh	7.2 kWh
	Peak day	10.4 kWh	7.2 kWh

Figure 2 shows the average load profile of an average BEV and PHEV during an average day in the winter season; Figure 3 shows an average day in the summer season. These load profiles are unmanaged, meaning they do not incorporate any managed charging via demand response programs, electricity rate design, or any other measure.

[9] ISO NE (2024). Draft 2024 Transportation Electrification Forecast.

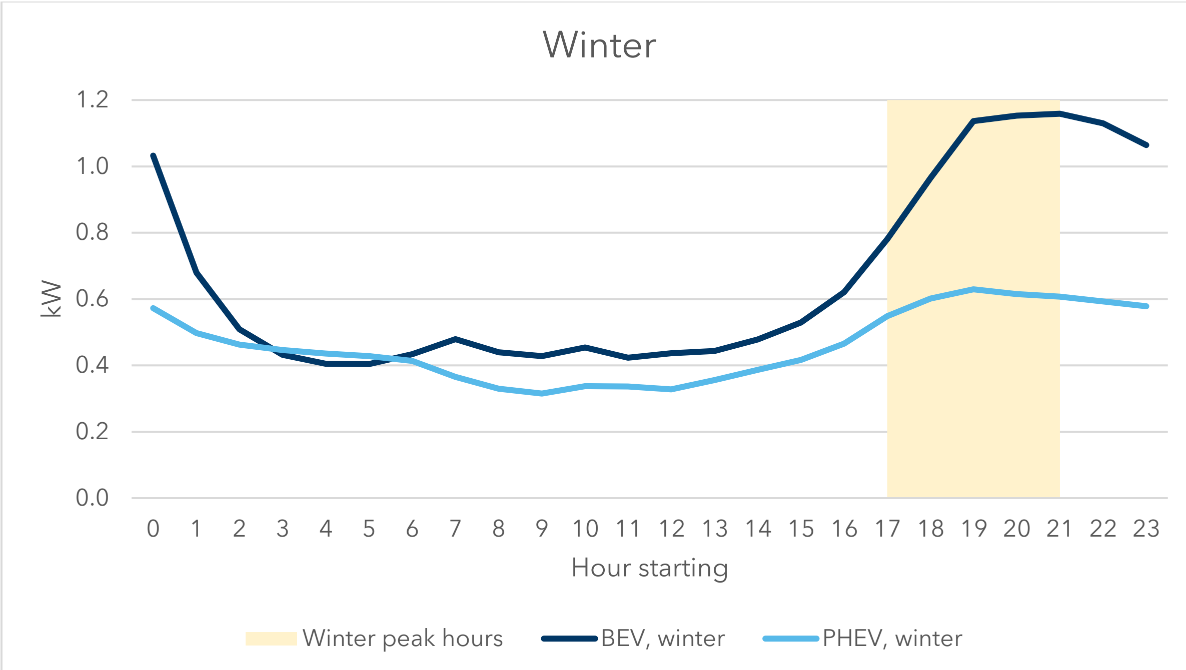

Figure 2. Unmanaged load profile per average BEV and PHEV, average winter day

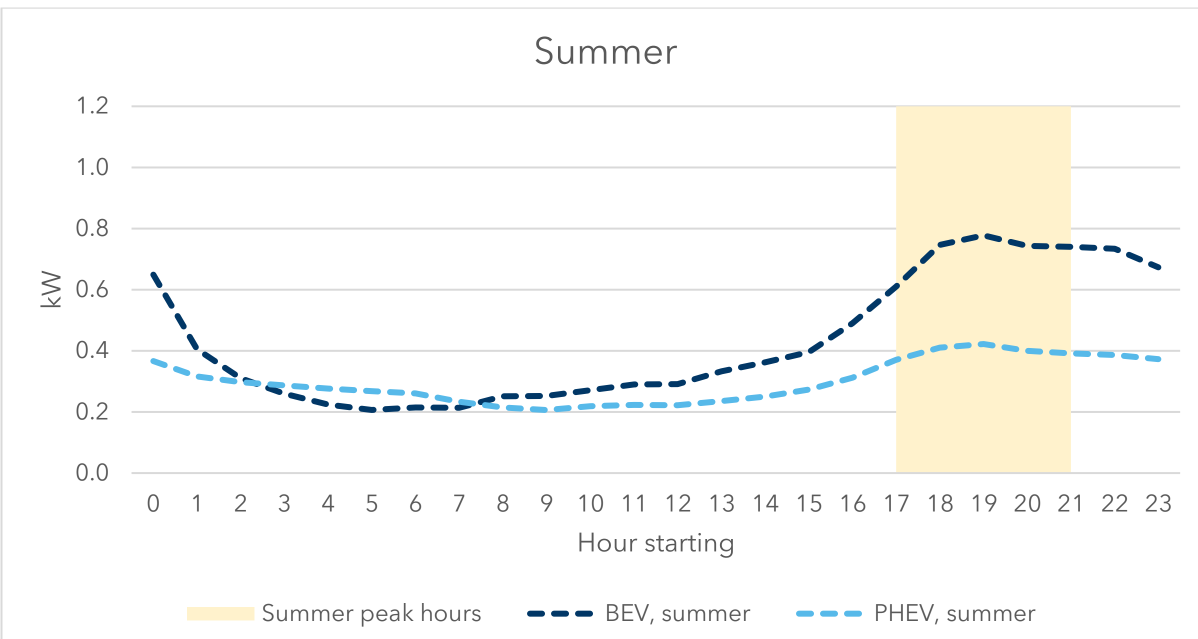

Figure 3. Unmanaged load profile per average BEV and PHEV, average summer day

The non-coincident peak load (the point at which EV demand is the highest) and the coincident peak load (the average EV demand within the utility peak) are shown in Table 5 for each season.

In winter, when EV energy demand is higher, the average user will plug in their vehicle more frequently in an average week. This is why, on average, the non-coincident peak is higher in the winter than in the summer (on average, more vehicles are plugged in on any given evening).

Table 5. Peak hourly load per EV

Season	Peak load type	Per BEV	Per PHEV
Winter	Coincident	1.01 kW	0.60 kW
	Non-coincident	1.16 kW	0.63 kW
Summer	Coincident	0.72 kW	0.40 kW
	Non-coincident	0.78 kW	0.42 kW

The hourly energy period factors (the share of the daily energy demand in that hour) for the average weekday during winter and summer seasons are presented in Table 6.

Table 6. Hourly energy period factors for average seasonal weekdays

	BEV		PHEV	
Hour Starting	**Winter**	**Summer**	**Winter**	**Summer**
0:00	6.4%	6.2%	5.2%	5.1%
1:00	4.2%	3.9%	4.5%	4.4%
2:00	3.2%	3.0%	4.2%	4.1%
3:00	2.7%	2.5%	4.0%	4.0%
4:00	2.5%	2.1%	3.9%	3.8%
5:00	2.5%	2.0%	3.9%	3.7%
6:00	2.7%	2.1%	3.7%	3.6%
7:00	3.0%	2.0%	3.3%	3.2%
8:00	2.7%	2.4%	3.0%	3.0%
9:00	2.7%	2.4%	2.8%	2.9%

10:00	2.8%	2.6%	3.1%	3.0%
11:00	2.6%	2.8%	3.0%	3.1%
12:00	2.7%	2.8%	3.0%	3.1%
13:00	2.8%	3.2%	3.2%	3.3%
14:00	3.0%	3.5%	3.5%	3.5%
15:00	3.3%	3.8%	3.8%	3.8%
16:00	3.9%	4.7%	4.2%	4.3%
17:00	4.9%	5.8%	5.0%	5.1%
18:00	6.0%	7.1%	5.4%	5.7%
19:00	7.1%	7.4%	5.7%	5.9%
20:00	7.2%	7.1%	5.6%	5.5%
21:00	7.2%	7.1%	5.5%	5.4%
22:00	7.1%	7.0%	5.4%	5.3%
23:00	6.6%	6.4%	5.2%	5.2%

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