Update on the 2020 Transportation Electrification Forecast

Load Forecast Committee

Jon Black

MANAGER, LOAD FORECASTING

Objectives

- Provide an update on electric vehicle (EV) adoption forecasting activities based on recent discussions with the New England states
- Share additional details of the proposed methodology to forecast the impacts of transportation electrification on regional energy and demand as part of the CELT 2020 forecast
- Discuss the EV charging data analysis and the resulting proposed assumptions
- Obtain LFC feedback on proposed methodology and assumptions

Introduction

- Transportation electrification is expected to play a pivotal role in the achievement of state greenhouse gas (GHG) reduction mandates and goals
- As part of the 2020 CELT forecast, ISO will include forecasted impacts of transportation electrification on state and regional electric energy and demand
  - ISO discussed initial methodology and assumptions to be used in the transportation electrification at the September 27, 2019 LFC meeting
- ISO will focus its transportation electrification efforts on light-duty vehicles (LDV), including cars and light-duty trucks
  - Changes in overall electrification of other, non-LDV vehicle classes (e.g., freight vehicles, electric buses, rail, trolley) may be considered in future forecasts

General EV Forecast Framework

- There are two general components to the EV forecast:
  1. Forecast the adoption of electrified LDVs for each state and the region over the next ten years
     - Adoption values to include battery-electric vehicles (BEV) and plug-in hybrid electric vehicles (PHEV)
  2. Use data-driven assumptions to convert the EV adoption forecast into estimated impacts on monthly energy and demand by state
     - Develop monthly demand and energy impacts per EV based on recent historical EV charging data licensed from ChargePoint, Inc.

EV ADOPTION FORECAST UPDATE

Proposed Methodology - Update

Projecting Regional EV Adoption

- Since the September 27th LFC meeting, ISO held discussions with each New England state to seek input regarding the appropriate state-level EV adoption forecasts
  - Specific EV adoption guidance from some states is still forthcoming
  - Some feedback thus far suggested that the Reference Case of the Transportation & Climate Initiative (TCI) may be worthy of consideration going forward as an input to the EV adoption forecast, especially for part(s) of the region after 2022
- Unless guided to use an alternative EV adoption forecast, ISO will use Energy Information Agency's (EIA) Annual Energy Outlook (AEO) reference case New England regional forecast for light-duty vehicle sales as the assumed projection of BEV/PHEV adoption
  - State shares of regional EV registrations at the end of 2018 will be used to convert EIA's regional forecast into state-level forecasts
    - Assume state shares remain fixed over the forecast horizon
  - 2019 AEO forecast currently available; 2020 AEO forecast to be used as final 2020 EV adoption forecast
- An assumed EV turnover rate of 50% of new purchases after 8 years is proposed

2018 Registration and New Sales Data

Light-Duty Vehicles

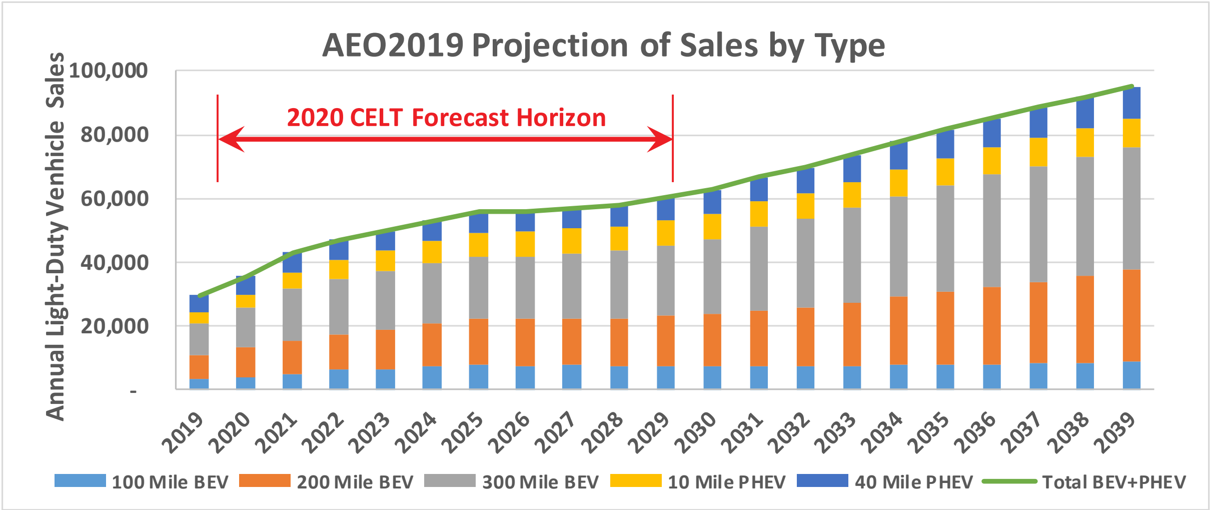
- Tabulated to the right is 2018 total LDV registrations and new LDV sales data from Alliance of Automobile Manufacturers
- Based on these data, below are related state-level statistics on BEV/PHEV registrations and new sales
  - Registration data/calculations is shaded blue
  - Sales data data/calculations are shaded orange

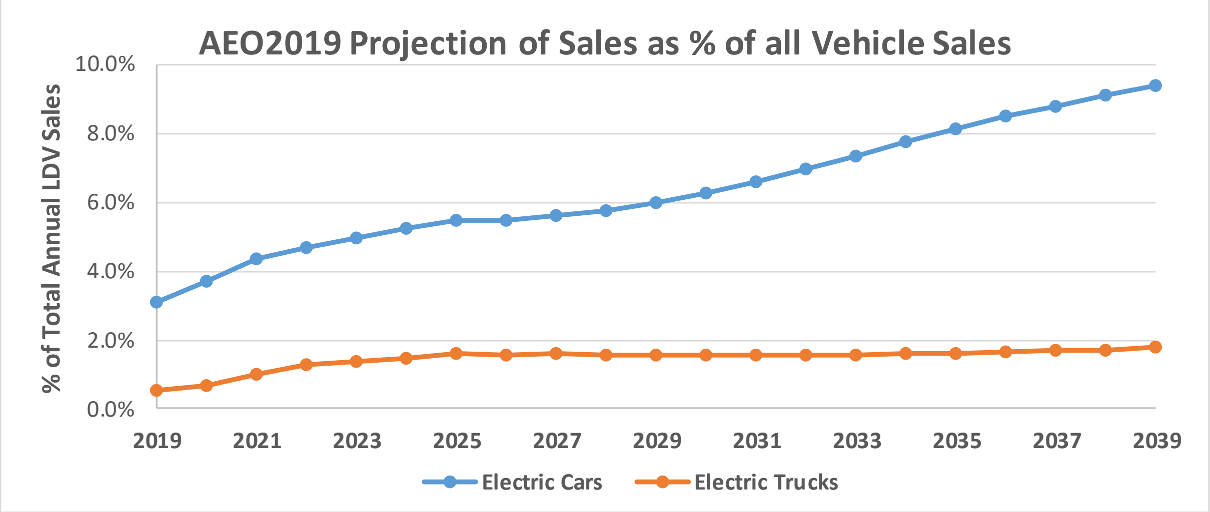
State	2018 Registrations			2018 New Purchases		
	BEV	PHEV	Total LDVs	BEV	PHEV	Total LDVs
CT	4,453	5,346	3,052,626	1,844	1,571	169,074
MA	9,763	11,495	5,382,570	4,959	4,031	355,731
ME	748	1,781	1,287,077	254	545	70,462
NH	1,125	1,974	1,306,353	579	544	97,069
RI	599	1,139	859,116	276	343	49,166
VT	1,057	1,869	564,886	355	469	42,913
NE	**17,745**	**23,604**	**12,452,628**	**8,267**	**7,503**	**784,415**

State	BEV+PHEV Registrations (2018)	State Share of Region	State Share of Total LDV Registrations	BEV+PHEV New Purchases (2018)	BEV+PHEV Share of Total New LDV Purchases
CT	9,799	23.7%	0.32%	3,415	2.0%
MA	21,258	51.4%	0.39%	8,990	2.5%
ME	2,529	6.1%	0.20%	799	1.1%
NH	3,099	7.5%	0.24%	1,123	1.2%
RI	1,738	4.2%	0.20%	619	1.3%
VT	2,926	7.1%	0.52%	824	1.9%
NE	41,349	100.0%	0.33%	15,770	2.0%

2019 Annual Energy Outlook Forecast

Energy Information Agency – Reference Case





Electric Vehicle Outlook

Incremental Sales: PHEV+BEV (LDV)

Year	ISO-NE	CT	MA	ME	NH	RI	VT
		23.70%	*51.41%*	*6.12%*	*7.49%*	*4.20%*	*7.08%*
2018 H-Cum	*41,349*	*9,799*	*21,258*	*2,529*	*3,099*	*1,738*	*2,926*
2018 H-Inc	*15,770*	*3,415*	*8,990*	*799*	*1,123*	*619*	*824*
2018	18253	4,326	9,384	1,116	1,368	767	1,292
2019	29765	7,054	15,302	1,820	2,231	1,251	2,106
2020	35,653	8,449	18,329	2,181	2,672	1,499	2,523
2021	43,199	10,237	22,209	2,642	3,238	1,816	3,057
2022	47,020	11,143	24,173	2,876	3,524	1,976	3,327
2023	49,783	11,798	25,594	3,045	3,731	2,092	3,523
2024	53,005	12,561	27,250	3,242	3,973	2,228	3,751
2025	55,737	13,209	28,655	3,409	4,177	2,343	3,944
2026	55,921	13,252	28,750	3,420	4,191	2,351	3,957
2027	57,136	13,540	29,374	3,495	4,282	2,402	4,043
2028	58,032	13,753	29,835	3,549	4,349	2,439	4,107
2029	60,197	14,266	30,948	3,682	4,512	2,530	4,260
Estimated Total	586,796	139,061	301,679	35,890	43,979	24,664	41,524

Cumulative Registrations (2018 H-Cum)

Annual Sales (2018 H-Inc)

2019 AEO (Reference) (2018–2029)

2020 CELT Forecast Horizon (2020–2029)

CHARGEPOINT DATA ANALYSIS

Using Regional EV Charging Data for Insights

- To better understand EV impacts on regional electricity consumption patterns, ISO has performed analysis of historical EV charging data licensed from ChargePoint, Inc.
- Data are from ChargePoint® Network charging stations within New England, and cover a complete year from June 2018 through May 2019
  - Dataset includes over 8 GWh of charging and reflects 26% residential charging and 74% non-residential charging (based on energy)

State	All Charging Data		Data Used in Analysis	
	Energy, MWh	State Share	Energy, MWh	State Share
MA	5,557.9	68.5%	423.0	63.0%
NH	340.0	4.2%	48.6	7.2%
VT	926.3	11.4%	127.5	19.0%
CT	769.3	9.5%	41.0	6.1%
RI	472.2	5.8%	30.6	4.6%
ME	47.8	0.6%	0.6	0.1%
Region	8,113.5	100%	671.3	100%

- ISO first filtered the data for EV drivers that had both residential and non-residential charging
  - The state breakdown of this subset of charging data is tabulated above
- The remaining subset of the data includes between 118 and 247 drivers, and better reflects ISO's expectation of the overall residential/non-residential split in charging behavior
  - 78% residential and 22% non-residential

EV Charging Data Used in Analysis

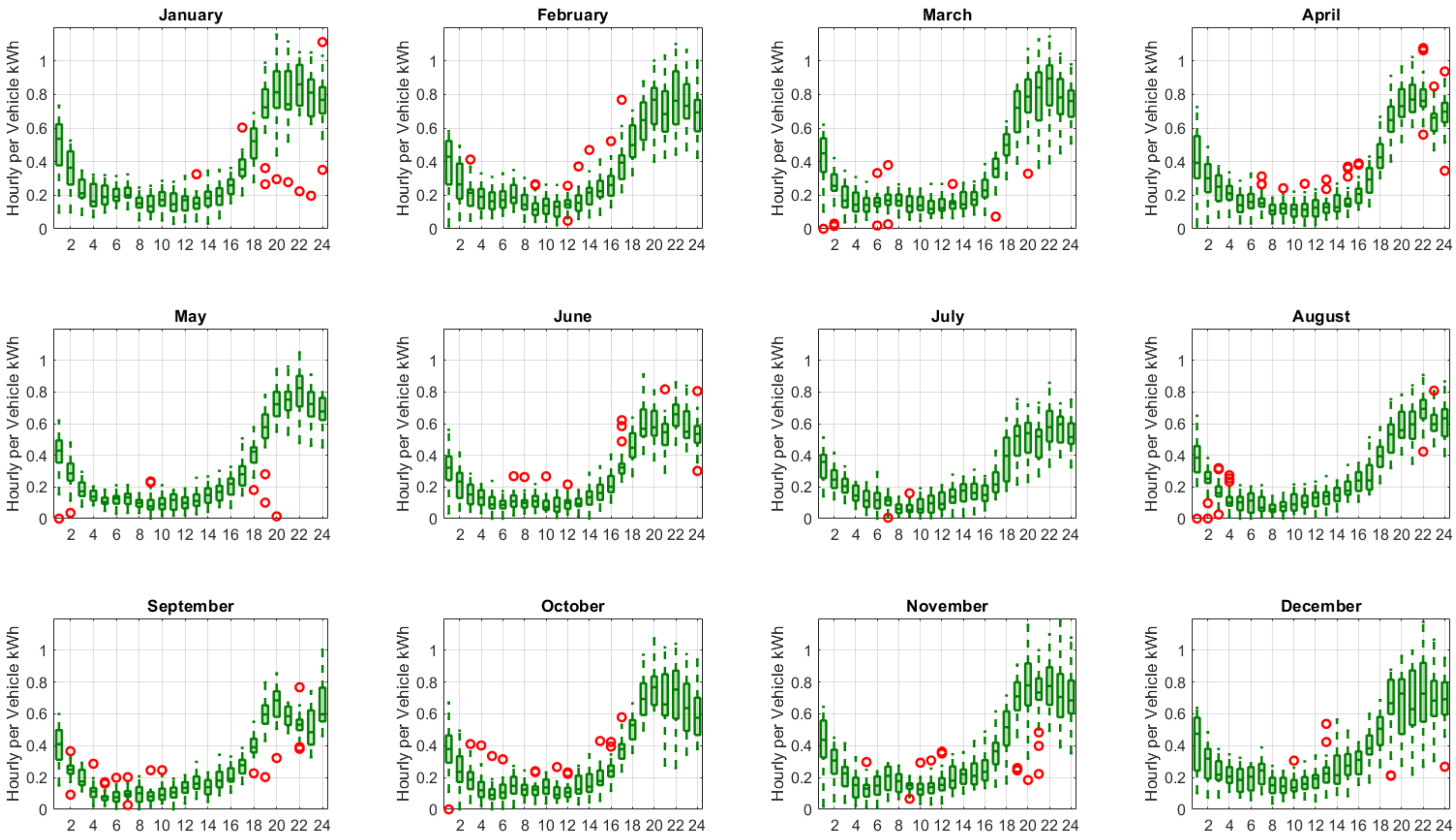
- The resulting profiles used in the analysis reflect:
  - Charging behavior native to New England
  - An array of EV technologies
  - A diversity of residential charging habits
  - A diversity of non-residential charging patterns (see table)

Non-Residential Charging Categories and Shares

Category	Share of Non-Residential Charging (%)	Description
Workplace	53	General, High-Tech
Education	14	University/College, High School/Other
Municipal	10	Municipal Parking, Municipal Workplace, Parks & Recreation, Library
Parking	8	Airport, Commercial, Mass Transit
Retail	5	Shopping Center, Auto Dealership, Big Box/Superstore, Strip Mall
Healthcare	3	Hospital/Treatment Center
Hospitality	3	Casino, Restaurant, Hotel/Resort, Winery/Brewery, Museum/Tourist Attraction
Government (Fed, State)	2	Civilian Workplace, Military Workplace
Fleet	2	Depot, Distributed, Education, Workplace, Municipal, Retail Logistics and Service, Gov't, Healthcare
Other	<1	Parks and Recreation, Utility

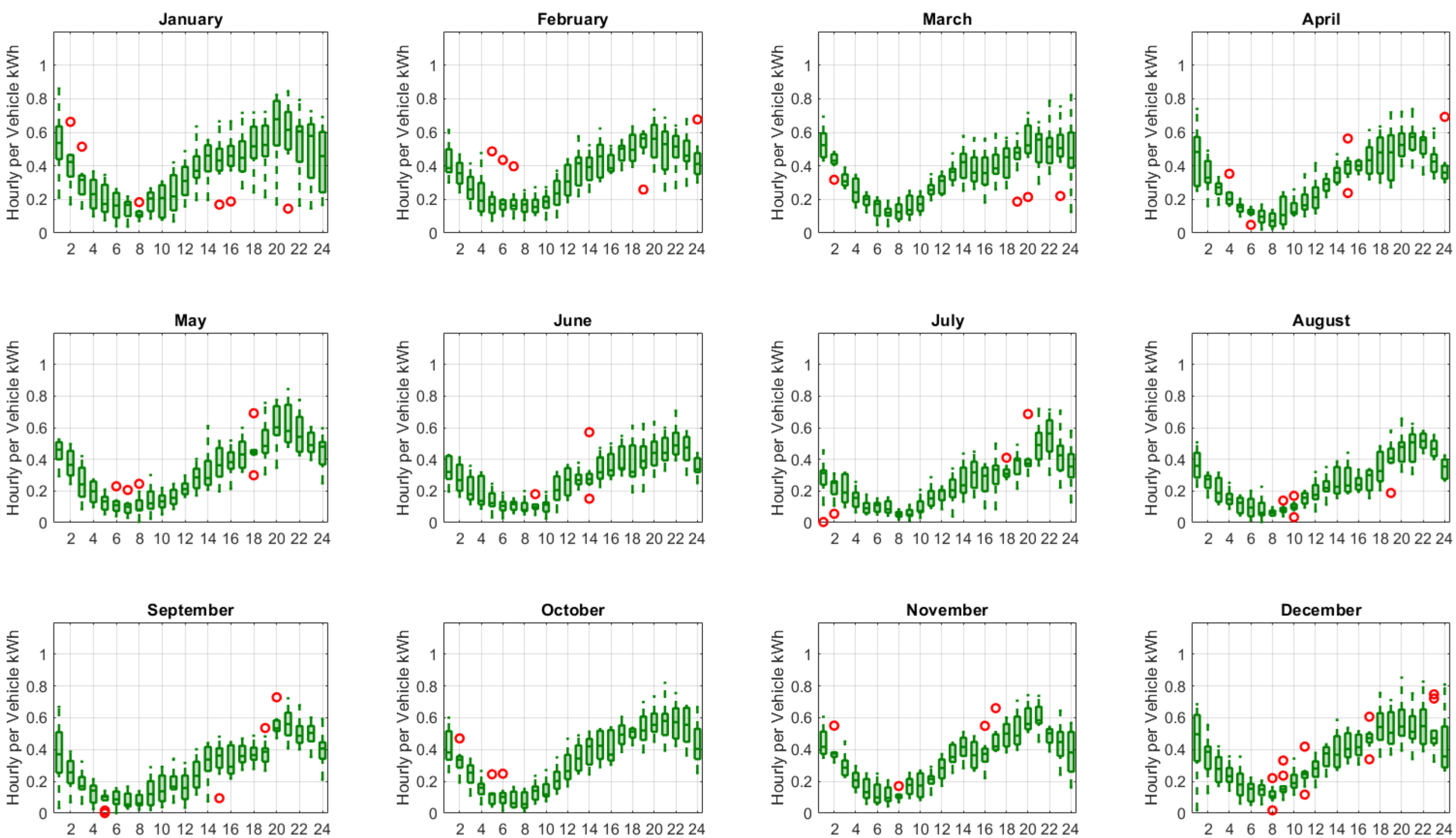
- Residential and non-residential EV charging data are illustrated in boxplots on the next slides
  - Residential hourly EV charging (weekday/weekend)
  - Non-residential hourly EV charging (weekday/weekend)
  - Aggregate (residential+non-residential) hourly EV charging (weekday/weekend)

Residential EV Charging, Weekday



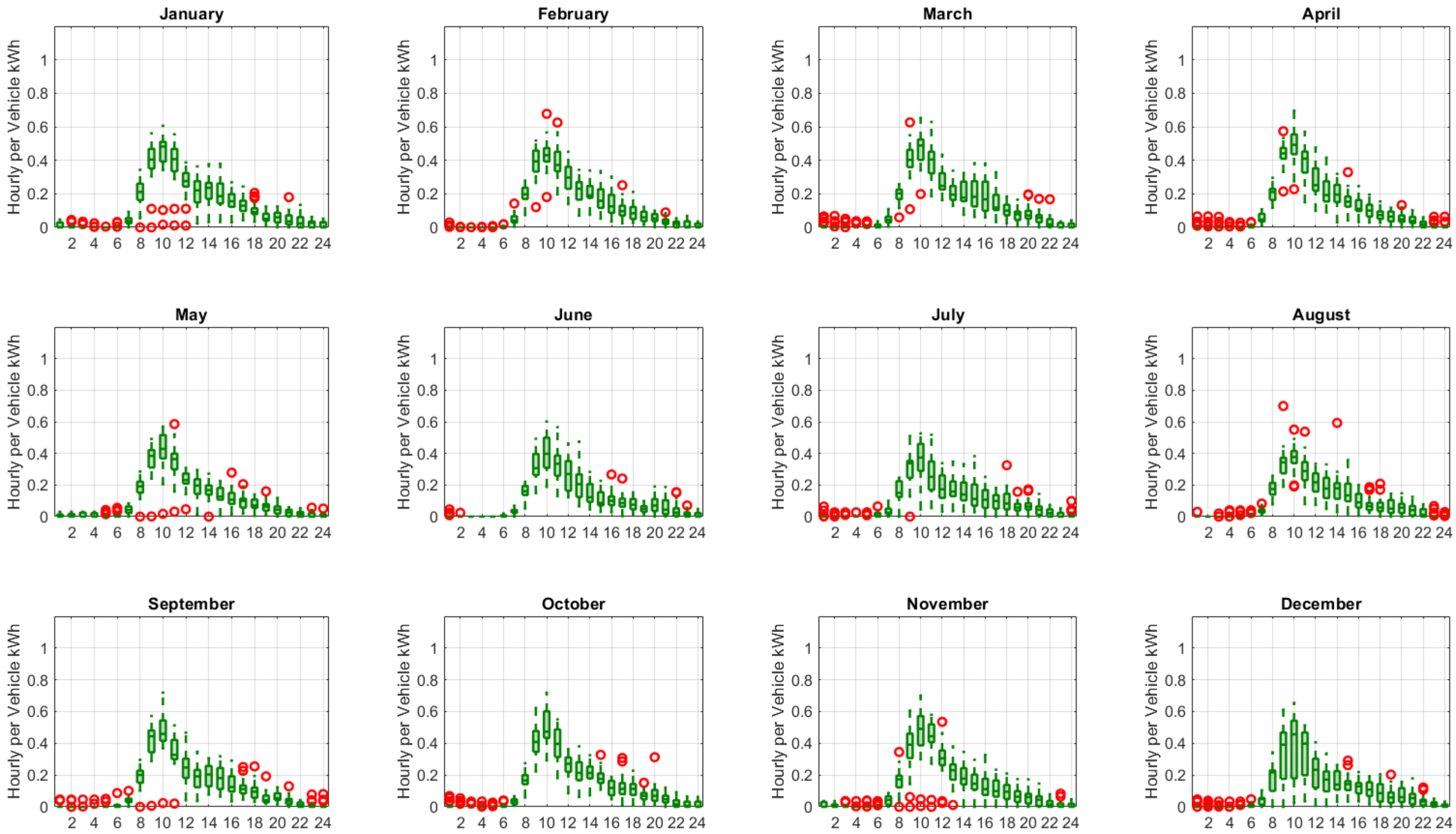
Data source: ChargePoint, Inc.

Residential EV Charging, Weekend



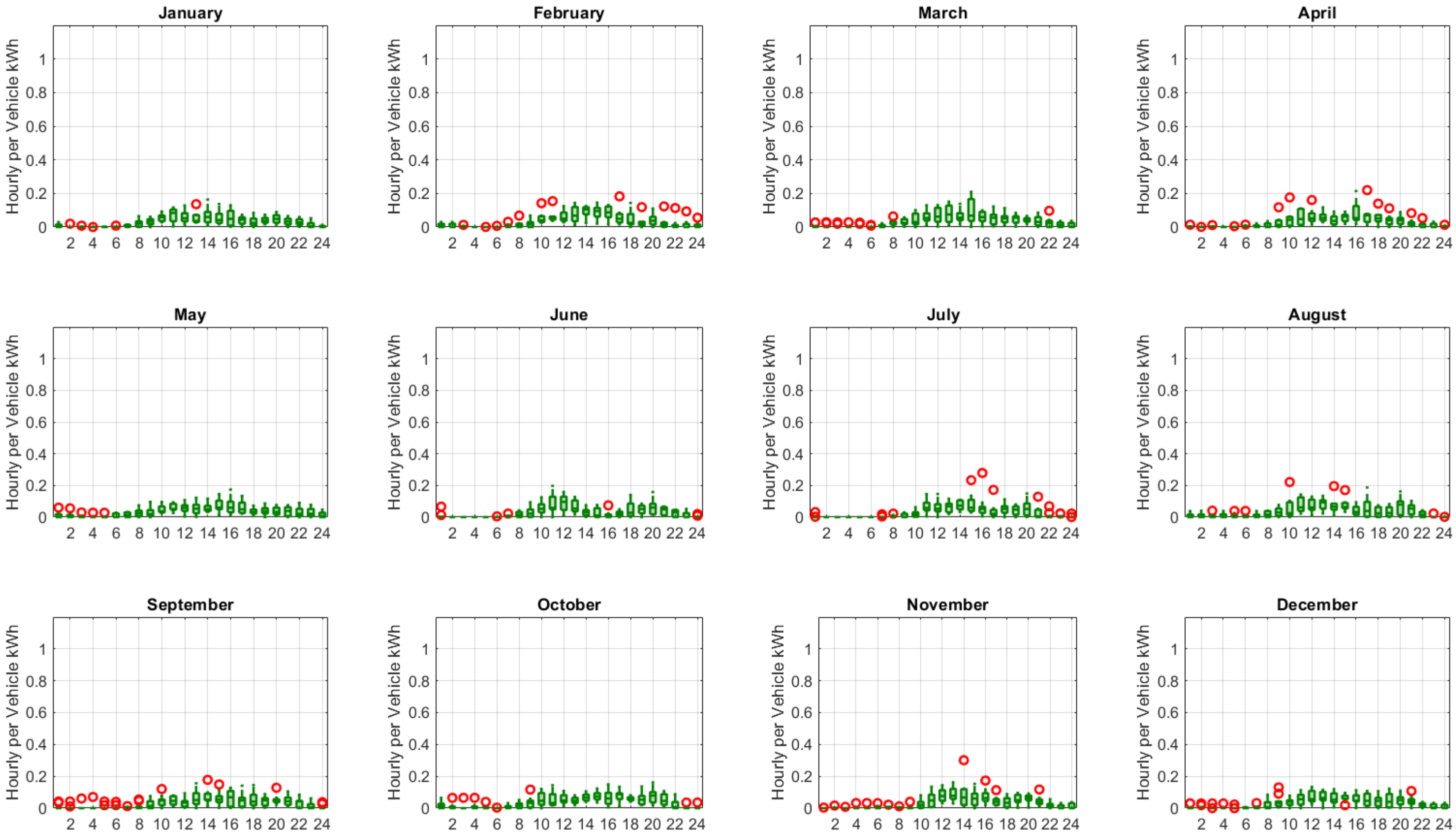
Data source: ChargePoint, Inc.

Non-Residential EV Charging, Weekday



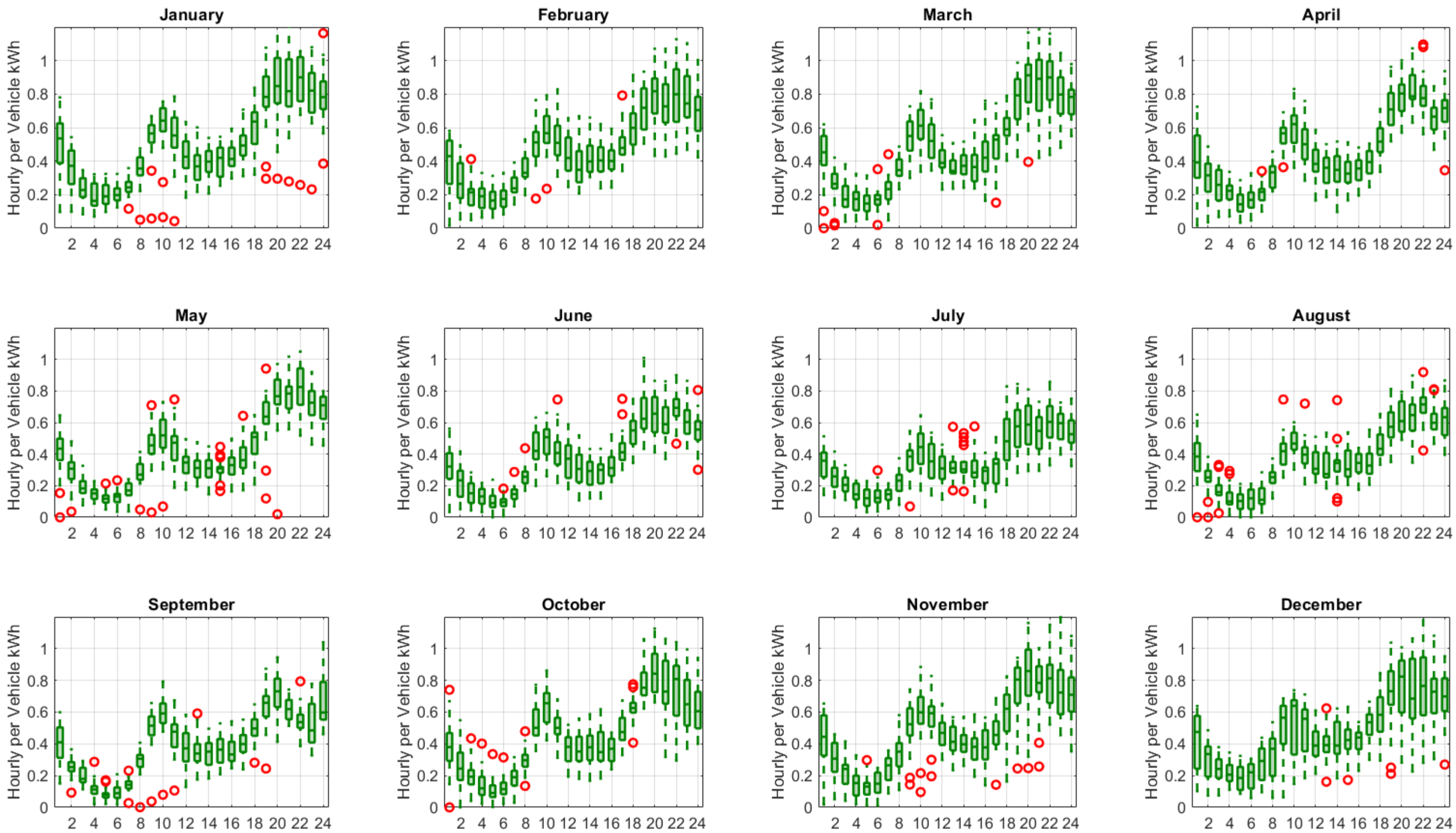
Data source: ChargePoint, Inc.

Non-Residential EV Charging, Weekend



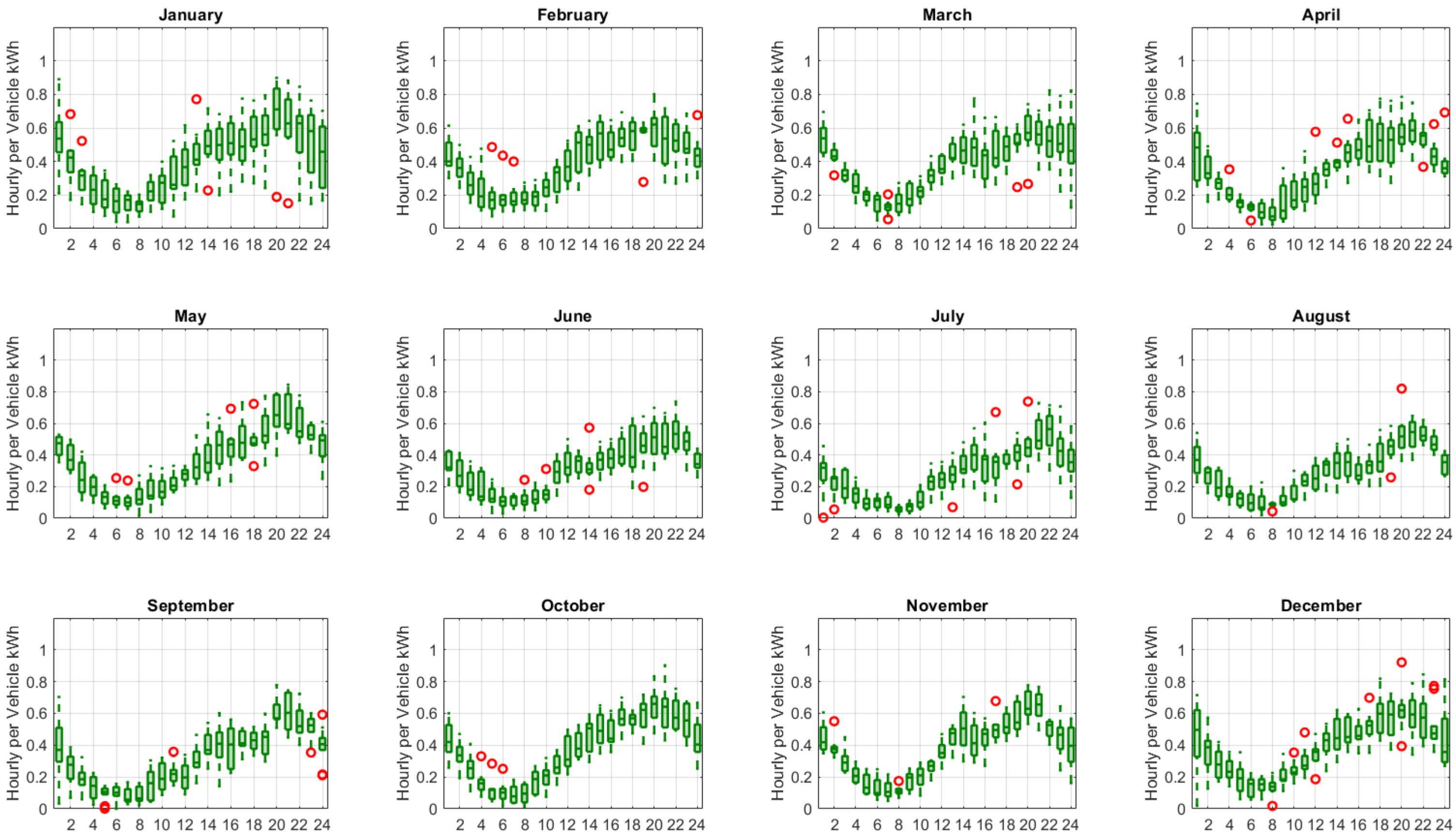
Data source: ChargePoint, Inc.

Aggregate EV Charging, Weekday



Data source: ChargePoint, Inc.

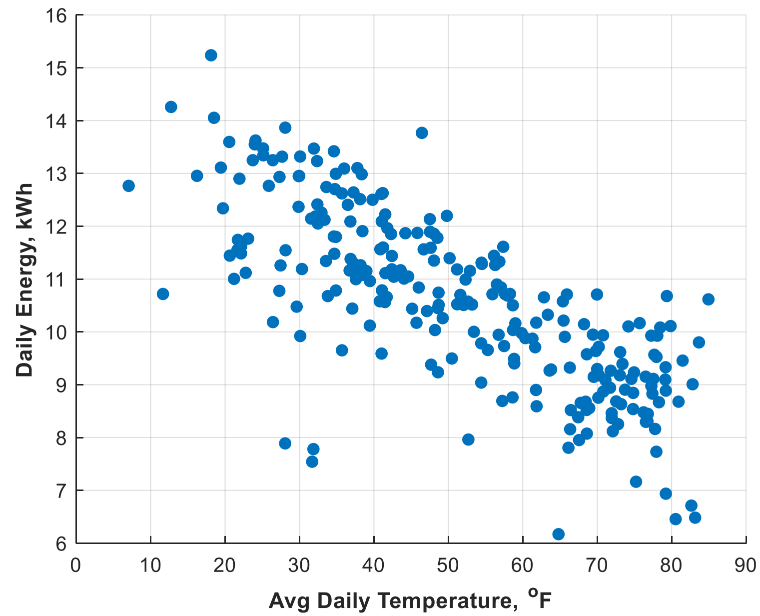
Aggregate EV Charging, Weekend



Data source: ChargePoint, Inc.

Impact of Weather on EV Charging

- Scatter plot illustrates the relationship between daily EV charging energy and daily average temperature on weekdays
  - Effects of temperature are embedded in the EV charging profiles analyzed
- Plot shows significant increases in EV energy needs during cold weather, but not during hot weather
- Cold temperature effects are likely due to the following:*
  - Electric cabin heating
  - Poorer battery performance at low temperatures



EV Charging data source: ChargePoint, Inc.

*Source: T. Yuksel and J. J. Michalek, "Effects of Regional Temperature on Electric Vehicle Efficiency, Range, and Emissions in the United States," Environmental Science & Technology, 2015, 49 (6), 3974-3980.

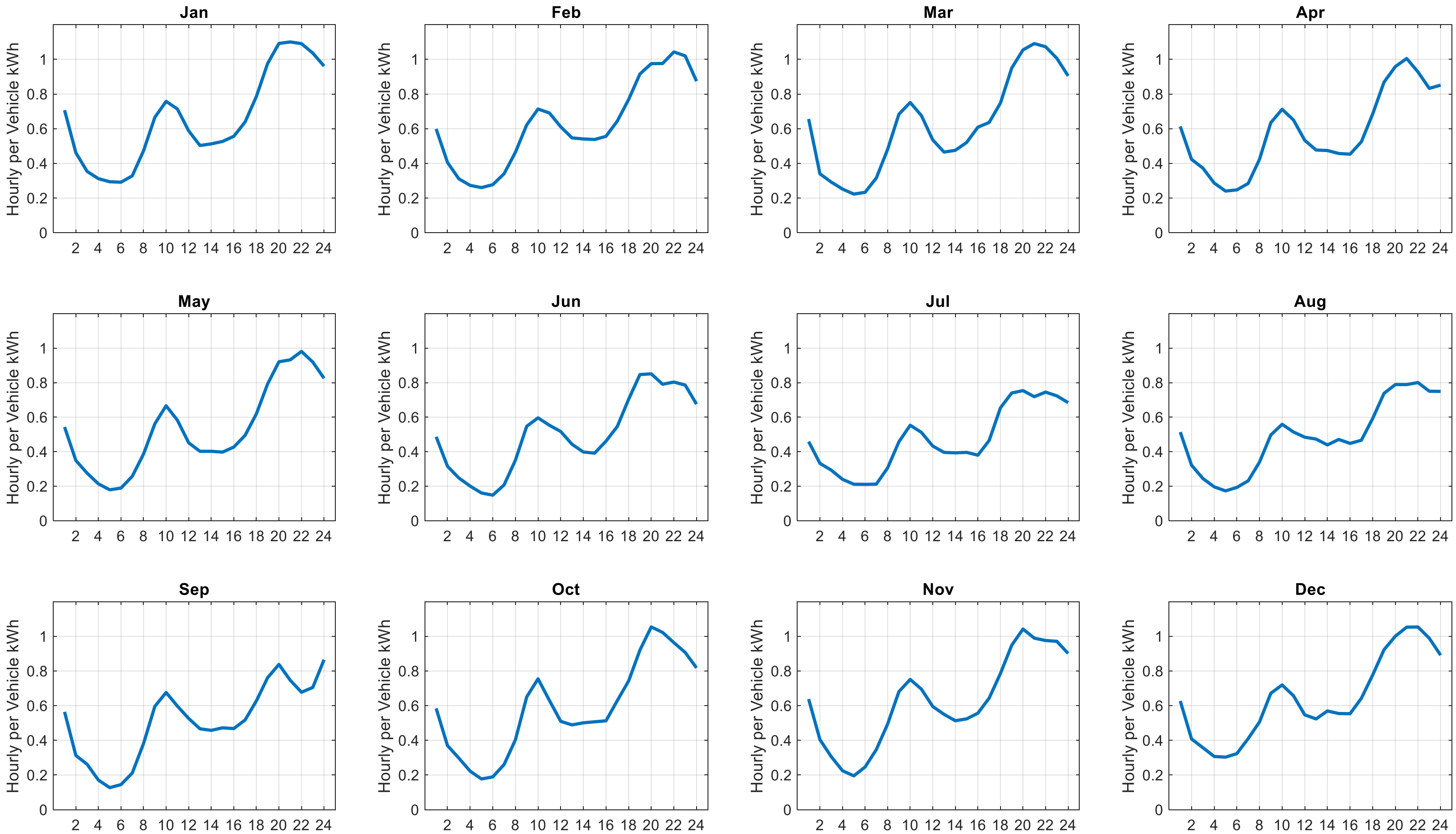
EV DEMAND AND ENERGY ASSUMPTIONS

Estimating Demand Impacts of EV Adoption

- In order to estimate demand impacts, ISO developed hourly EV demand profiles for both weekday and weekend days
- The 75th percentile ("P75") values of the aggregated hourly EV data illustrated in the monthly boxplots on slides 17-18 are proposed to be used to estimate hourly demand impacts
  - P75 values serve to capture more extreme values than averages (e.g., due to weather effects), but are not the most extreme data points, which could be more of an artifact of a relatively small EV sample size
- Demand estimates will be grossed up by 8% for assumed transmission and distribution losses, consistent with other forecast processes
- Resulting demand profiles are shown on the following two slides (all values reflect 8% gross-up)

EV Hourly Demand

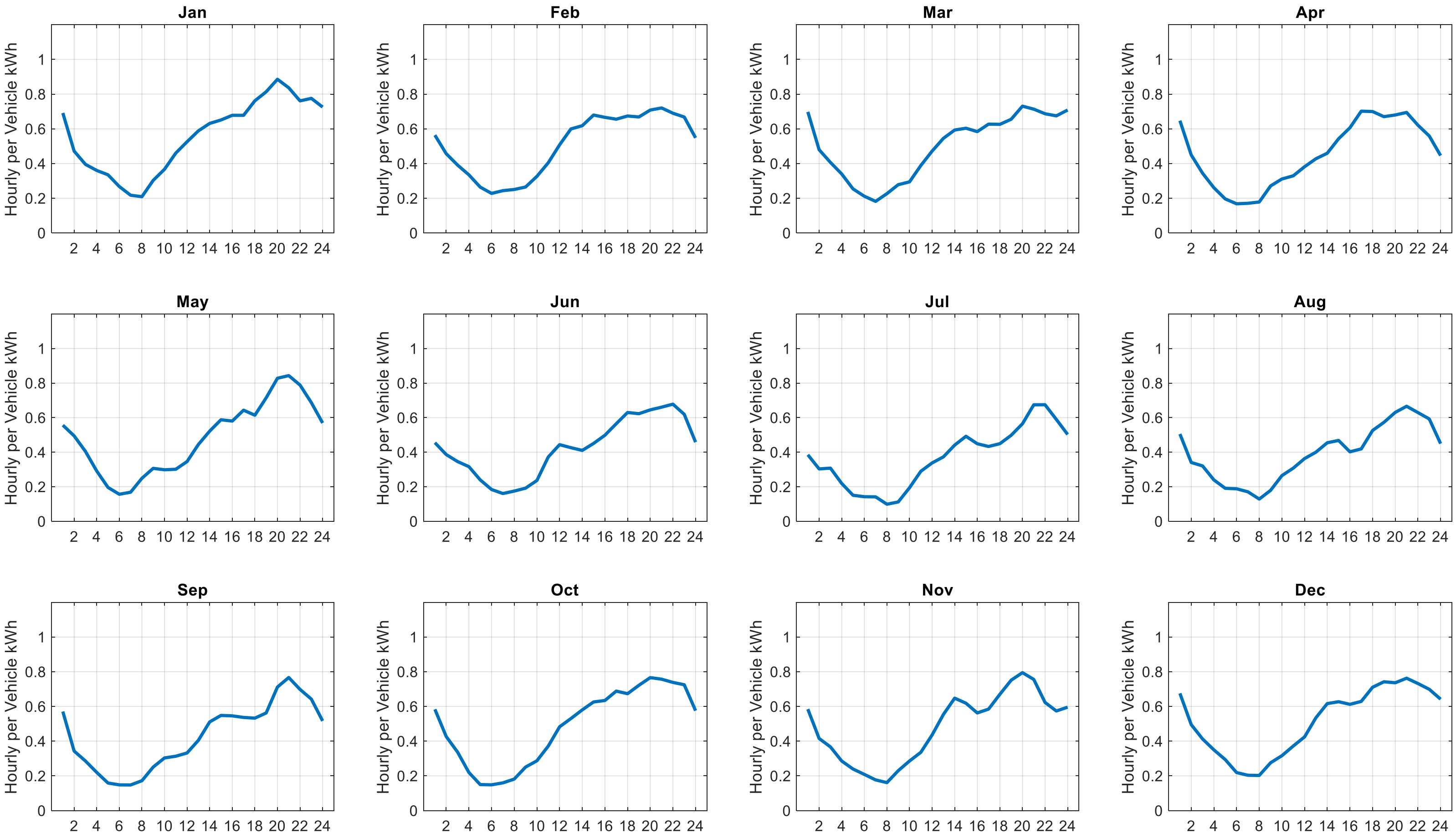
Weekday



Data source: ChargePoint, Inc.

EV Hourly Demand

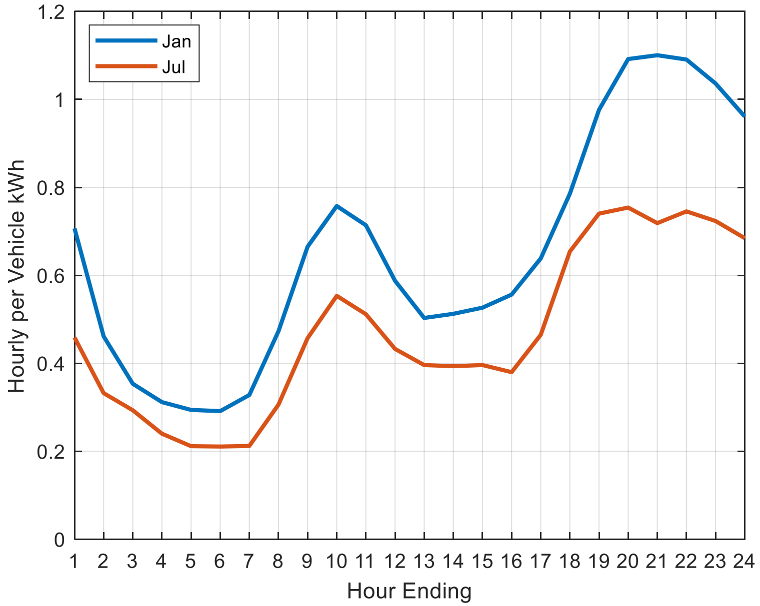
Weekend



Data source: ChargePoint, Inc.

EV Demand Profile Highlights

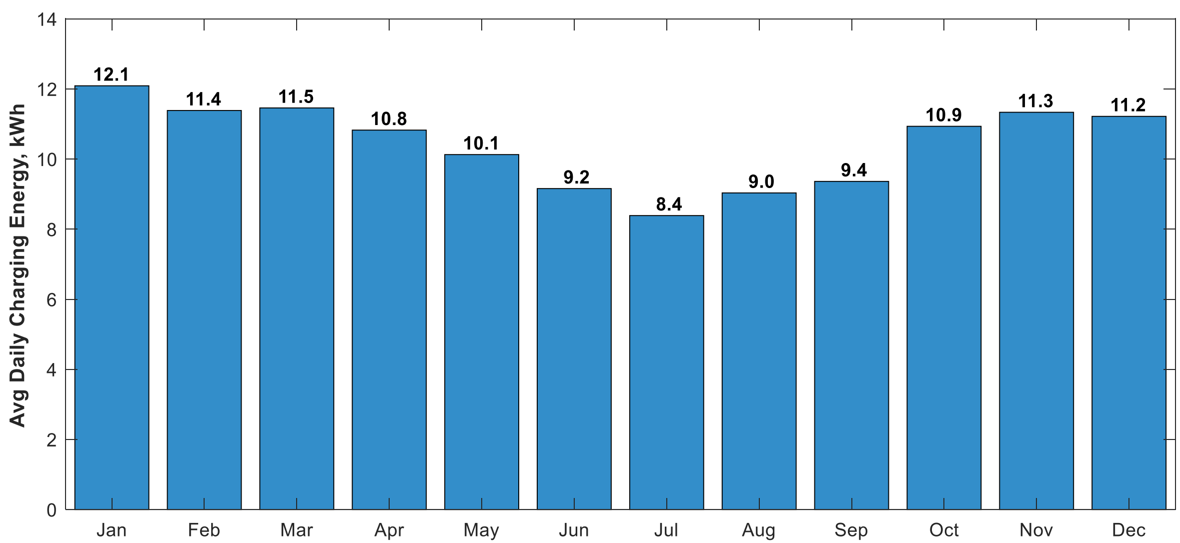
- The estimated winter peak demand impacts may range from approximately 0.75-1.0 kW per EV (HE 18-19)
- The estimated summer peak demand impacts may range from approximately 0.4-0.75 kW per EV, depending on the timing of the summer peak load
  - The EV load shape demand impacts warrant further consideration in tandem with BTM PV impacts on the timing of the peak load
  - This issue will be discussed further at the December LFC meeting



Data source: ChargePoint, Inc.

Estimating Energy Impacts of EV Adoption

- ISO will use data-driven energy assumptions rather than the approach proposed on September 27th (i.e., total miles and miles/kwh assumptions to estimate energy impacts)
  - This enables the forecast to capture seasonal differences in energy consumption and the overall weather sensitivity shown on slide 19
- Monthly energy will be based on the analysis of ChargePoint data, and will reflect a 6% gross-up for assumed transmission and distribution losses
  - The bar chart below illustrates the monthly kWh/day values



Data source: ChargePoint, Inc.

Next Steps

- ISO will continue to coordinate with the states to receive guidance on the appropriate state-level EV adoption forecasts
- ISO will present a draft transportation electrification forecast for the region and states at the December 20, 2019 LFC meeting
  - Will be based on some combination of 2019 AEO and state input data
- A finalized transportation electrification forecast will be included in the 2020 CELT gross load forecast
  - Will be updated to reflect 2020 AEO input data where appropriate, which will be available in late January 2020

Questions