

Electric Vehicle Trends & Charging Stations @ URI

Sustainable Innovative Solutions (SIS) Lab, University of Rhode Island

US & Regional EV Trends

Electric vehicles (EVs) have significantly increased in their importance based on their market share proportion on the national and regional stage. EVs as a genre of vehicles are composed of three different kinds, which are generally classed by the degree of electricity used as their energy source: Battery Electric Vehicles (BEVs), Plug-in Hybrid Electric Vehicles (PHEVs), and Hybrid Electric Vehicles (HEVs) [1]. The battery of HEVs is charged by the internal combustion engine, whereas the battery of PHEVs can also be charged externally via the use of a plug. The battery of BEVs can only be charged via a plug at designated charging points, such as Level-1, Level-2, and DC Fast chargers.¹

Within the current decade, the sales of BEVs in the United States (US) has significantly increased from 14,650 units sold in 2012 to 104,490 units in 2017 [2–6], as seen in Figure 1a. With the initiation of the RI DRIVE rebate program (c.2016) by the Office of Energy Resources (OER) the sales/leases increased by 32% in Rhode Island (RI) thus ranking one RI dealership fourth nationally in electric vehicle (EV) sales [4, 7]. Figure 1b shows the development of the sales numbers for BEVs in New England between 2012 and 2017. Regional sales in New England show an increasing trend in the past as well, from 403 units in 2012 to 3,717 units in 2017. From 2016 (2,023 units) to 2017 the sales growth rate was nearly 84% [8], whereas the national growth rate was only 24% [9]. As of 2017 EVs and PHEVs represent 1.14% of new car sales in the US. In New England, the market share of BEVs and PHEVs of new car sales was 1.25% in 2017.

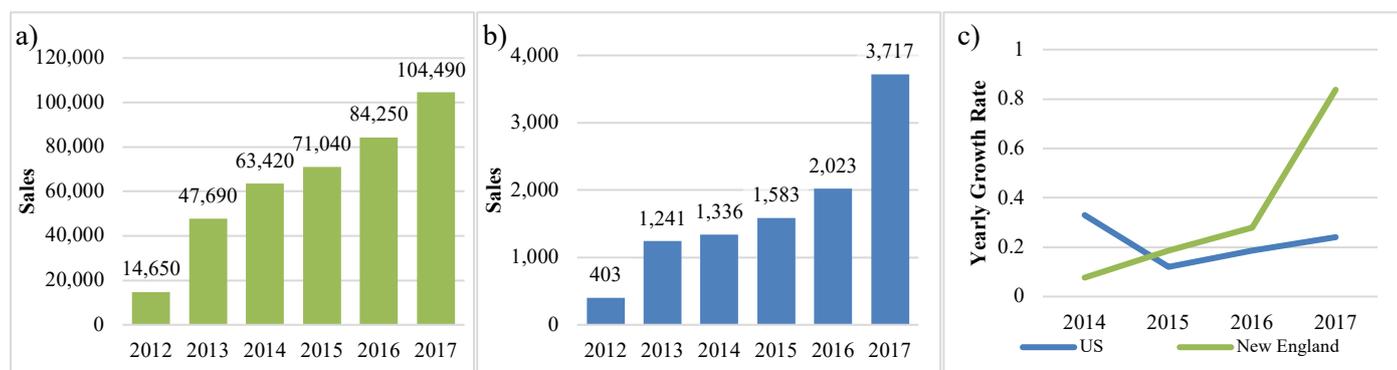


Figure 1: a) Total sales of BEVs in the US from 2012 to 2017 [8]; b) Total sales of BEVs in New England from 2012 to 2017 [9]; c) Yearly BEV sales growth rate [8, 9]

Last year's trends are expected to continue increasing, nationally and regionally. These consistent growth trends of BEVs demonstrate the importance of an enlarged charging infrastructure. Furthermore, the growth rates in New England's total BEV sales over the last four years in comparison to the national growth rates underline the increasing regional importance of EVs in the future.

URI EV Trends

A list of currently registered cars at URI was provided by the URI Department of Parking and Transportation Services. The quality of information contained in that shared list varied significantly; for example, some vehicles are registered by model, while others only the make.

To calculate the number of currently registered EVs at URI a list of EV models currently available in the US was created. This list was used as a reference. Based on the presently allocated parking permits, 16 EVs are registered at URI parking services, whereas many models cannot be identified as either BEV, PHEV, HEV, or ICE (Internal Combustion Engine) vehicles. More than 8,000 registered cars can be identified as potential Plug-In vehicles (BEVs and PHEVs) out of 38,398 total registered vehicles, based on the quality of information.

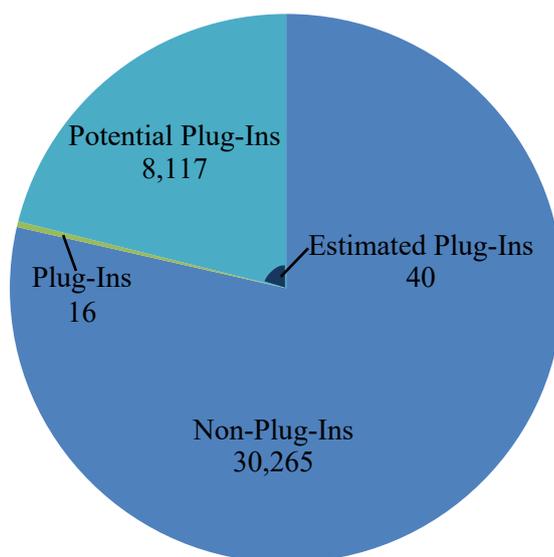


Figure 2: URI car registrations by powertrain type

¹ An overview of current charging stations and systems can be found on: <https://chargehub.com/en/electric-car-charging-guide.html>

Since the dataset is not consistent between entries, the amount of potential Plug-In vehicles needed to be calculated. Models that are available as an ICE vehicle, as well as BEV or PHEV, are possible Plug-Ins. Through the process of elimination, the number of Non-Plug-In vehicles was calculated by subtracting the number of EVs and potential Plug-In vehicles from the total number of registered vehicles at URI. This approach led to a total of 30,265 units that are not BEVs or PHEVs. Additionally, blank entries and entries labelled as “OTHER” in the column for model had to be considered as potential Plug-Ins for every make that offers those vehicles. The total number of potential Plug-In vehicles is 8,117 units. This seems extremely high, therefore an alternative estimation process occurred.

The upper boundary of Plug-In vehicles can be assumed to be the total market share of 1.25% in New England. However, the market share of new Plug-In vehicle sales does not represent the current share of Plug-In vehicles registered in total. It was presumed that 0.5% of the potential BEVs and PHEVs at URI are Plug-In vehicles to assist with estimation. Accordingly, 40 more Plug-In vehicles were possibly identified in addition to the verified 16 based on the dataset; thus, a reasonable estimate of PHEVs and EVs at URI is approximately 56.

US & RI Charging Stations Trends

The availability of public charging stations for EV owners crucially depends on their vicinity in their respective state. In urban areas, especially, there are numerous charging stations for EVs due to the higher traffic density than in rural areas. As Table 1 illustrates [10, 11], owners in Vermont, Hawaii, and Oregon currently benefit from the highest number of public charging locations. Rhode Island ranks 12th compared to all states in the United States; even though one of RI’s automotive dealers ranked in the top five for all sales in BEVs throughout the country [7].

Table 1: Charging stations per 10,000 residents per state

Rank	State		Charging Stations [10]	Population [11]	Charging Stations per 10,000 Residents
1	Vermont	VT	208	626,299	3.32
2	Hawaii	HI	265	1,420,491	1.87
3	Oregon	OR	616	4,190,713	1.47
4	California	CA	5,046	39,557,045	1.28
5	Maine	ME	158	1,338,404	1.18
⋮	⋮	⋮	⋮	⋮	⋮
10	Massachusetts	MA	586	6,902,149	0.85
⋮	⋮	⋮	⋮	⋮	⋮
12	Rhode Island	RI	86	1,057,315	0.81
⋮	⋮	⋮	⋮	⋮	⋮

A recent in-depth study of RI public charging stations found that the RI mean charging time almost equals the RI mean parking time [12]. In earlier studies, users were spending only about 10% of the time for charging out of the total time plugged into a charging station, while in the RI dataset (2013-2017) the mean charging time was very similar (1:55:52) (Speidel & Bräunl, 2014). A charging station could be occupied 100% of the time but based on the lack of charging traditionally from 11 PM to 5 AM a realistic utilization per charging station is 75% [12]. This could show a shift in usage trends.

In 2017, there are 429 public charging station users in RI. This accounts for 0.0405% of the RI population is using RI charging stations, with only 295 users in 2016, a 45.5% increase. In 57% of the charging events, users in RI are leaving the charging station within 30 minutes after they are fully charged. This behavior is not unusual since ChargePoint, the service for these chargers sends users a request to leave within 30-minutes post fully charged. However, there are no further consequences of leaving cars at the station beyond scheduled, repeated warnings. The other 43% of the charging events pertain to users staying more than 30 minutes after their EV is fully charged and using the charging spots as traditional parking spots. Institutional functional areas do perform differently than the statewide trends with 41.7% of the time being used for charging and 58.3% used for parking [12].

Based on a time series, ARIMA approach for 156 weeks (Dec. 2020), the model forecasts the upper and lower prediction limits of charging events throughout the state ahead until 2020. There is a steady upwards trend noticeable at the beginning of 2018, followed by a slighter upwards trend, visualized with upper and lower prediction limits. The last week of the year 2020 could have 462 charging events (lower limit: 80%: 327, 95%: 256; upper limit: 80%: 597, 95%: 688).

URI Charging Station Trends

As of 2017, Figure 3 shows a map of where charging stations are located in Rhode Island; different colors are used to represent their functional areas [12]. This map shows each of the 50 charging stations as dots, colored according to their area type and their size representing how many charging events occurred in 2017. The URI charging station is well accepted, and the demand for the charging station is high based on the dot's relative size to the other stations.

The charging behavior in Institutional Areas follows a specific pattern. Figure 4 shows that the number of charges based on the hours of the day starts increasing at 6:00 AM and reaches a peak between 8:00 AM and 09:00 AM [12]. It can be assumed, that this a coincidence caused by the arrival time at work in the morning when members of the URI community charge their vehicles directly. A local maximum can be seen at 12:00 PM, followed by a slight variation over the day. This slight variation can be the result of the four-hour maximum limit to charging at this particular station. Between 8:00 PM and 5:00 AM, during night time, there is little to no demand for charging at the URI station [12].

The currently installed charging station at URI registered 99 different users from 2013-2017. 71.7% of the users charged their car less than ten times and are assumed to be visitors. Only 28%, with 28 different frequent users, used the station greater than ten times or more.

Recommendations

The demand for charging based on the estimated total of 56 Plug-In vehicles at URI cannot be satisfied currently, even based on 2017 levels of demand. One charging station was added to the new URI Visitor Center to help assist with the visitors' demand but not actively available at this time. Therefore, the station behind the visitor center should be commissioned to serve visitors and provide them with ample opportunity to charge their vehicles. This would allow for a friendly welcome to URI as visitors are not actively in competition with the URI community for these precious spots. One charging station for visitors, however, does seem to assist with the highly competitive nature of the current station outside the URI Mallon Outreach Center.

In order to maximize the utilization and service of charging station at URI, it is suggested to extend the number of charging stations on campus. Additional charging stations should be installed next to the current URI community charging station in front of the URI Cooperative Extension Education Center (Kathy Mallon Outreach Center), resulting in an exclusive parking and charging lot for URI EV and PHEV drivers. Not only would this assist with: (1) the current demand projected from 2017 numbers, but appropriately adjust for the 2018's possible charging outcomes and beyond, and (2) easier parking policing from non-Plug-In owners taking up the parking slots illegally on a regular basis. Furthermore, a single lot in prime parking territory on campus would serve as a sustainability symbol on URI's Kingston campus about what the university values.

References

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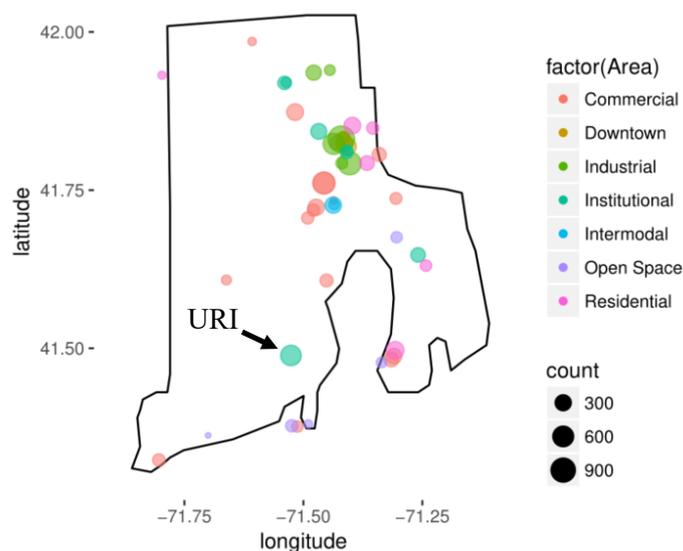


Figure 3: Charging station locations and classified areas in Rhode Island [12]

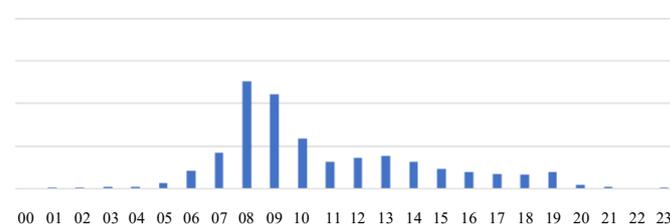


Figure 4: Number of charges by hours of the day in institutional areas [12]