**Electric Vehicle Infrastructure Council (EVIC) Meeting**

**Meeting Date:** May 30, 2018

**Meeting Location:** Hary Hughes Conference Room, MDOT Headquarters, Hanover, MD

**Attendees:**

R. Earl Lewis, Jr. (MDOT TSO)
Colleen Turner (MDOT TSO)
Steve Charles (MDOT TSO)
Gary Greening (MDOT TSO)
Tim Shepherd (MDE)
Bihui Xu (MDP)
Tim Davis (City of Frederick / MML)
Dr. Andrew Farkas (Morgan State)
John Murach (BGE)
Kristy Fleischmann (BGE)
Mike Jones (MEA)
Ashley Myers (BEVI)
Frank Lee (DPW)
Scott Wilson (EVA DC)
Emily Wier (Greenlots)
Michael Wall (Clinton Electric)
Paul Verchinski (Howard County Citizens Association)
Andrew Dewey (WSP)
Josh Cohen (SemaConnect)
Lanny Hartmann (Public)
Eddie Pounds (Global Automakers)
Bob Bruninga (IEE)
Thomas Walz (MD DHCD)

*By Phone:*
Sevgi Erdogan (Smart Growth Maryland)
Dave Schatz (ChargePoint)
Mark Howard (MDOT SHA)
Justin Mabrey (MDE)

---

**Welcome and Announcements Introductions**

MDOT Deputy Secretary, R. Earl Lewis, Jr., welcomed all meeting participants.

Paul Verchinski was welcomed as a new member of EVIC, filling the role of a member of the public with expertise in transportation or energy policy.

**Public Comments**

- Bob Bruninga – Mr. Bruninga referenced a report that 97% of commuter charging can be done with 120V chargers. 2/3 EVs on the market can charge from 120V in less than 8 hours. Charging at work is important and Mr. Bruninga is requesting the State of Maryland create a policy for employees to charge at work with daily use of 120V outlets for small payments (please see attached statement).
- Lanny Hartmann – Mr. Hartmann attended an EV data-thon at the white house in 2016. He learned the integrity of the data is critical to driving public policy decisions. Mr. Hartmann noted that data from the EV Infrastructure grant program shows many chargers with 100% up time. From Mr. Hartmann's experience, that infrastructure has been temporarily inoperable. Mr. Hartmann is concerned that the data is not reliable (please see attached materials).

**Review of Notes from March 15th meeting**

- EVIC members did not have any comments to the draft notes and they will be posted to the EVIC website.

**PSC PC 44 Update**

- MEA, MDE, and MDOT participated in the PC 44 hearing, testifying in front of the PSC. As of May, MD has over 12,600 registered EVs in the state.
- During the hearing, the commissioners stressed the importance of geographic diversity of EV infrastructure and investment.
- Paul Verchiniski noted that the PSC may be worried about stranded costs, and that most EV users use a 120V line, not DC Fast Charging.
- John Murach also attended the hearing and noted that the commissioners received the message regarding the importance of EVs, and the level of support (EVSE) needed for future EV adoption in Maryland.
- Scott Wilson noted that the Office of People's Council requested further study on any rate / demand impacts.

**Committee updates**

<u>State Agency</u>
Chair: R. Earl Lewis Jr.

- MDOT developed procedures for EVIC for review by the EVIC members
  - The procedures outline the basis of EVIC and requirements, EVIC's membership, meeting procedures, and council actions and responsibilities
- State Agencies and the Communications Committee have been working on an updated website design and content for marylandev.org. The design was previewed during this meeting. Content will be updated and passed through committee to EVIC as it is developed
- MDOT is continuing to support outreach events under the MDEV umbrella and has been at several events across the state including the Maryland Chicken Wing Festival, Savor Bowie, and Ocean City Springfest
  - Interstate Wine Festival in Hagerstown will be the next and last Spring event
  - Mr. Verchinski suggested attending Wine in the Woods, in Howard County MD
- MDOT is developing a signage plan for the state, focusing first on the FHWA designated corridors
  - SHA is working on an enterprise asset management plan which will include an inventory of existing signage – including EV signage
  - Mike Wall mentioned that chargers are painting the parking stripes green and sometimes the curb, but not using EV parking only paint on the ground
- EVIC was reminded of crossover between our Council and the Maryland Commission on Climate change, which is reviewing state fleet procurement options for Maryland and reviewing the ability to deploy electric buses
- MEA – Mike Jones presented that 554 rebates have been issued so far
  - $690k Grants – about 58% of available funds, $463K of that is for commercial systems
  - June 30 is the deadline for this fiscal year

- Questions about the programs include:
  - Is a credit card reader required?
  - Questions about permitting requirements
  - Energy star system requirements
  - Can you get a rebate after previously receiving one?
  - UL or other safety certification requirements
- AFIP awards have been completed - 16 DC fast chargers at 7 locations, totaling $787k
  - Q1 2018 – Royal Farms chargers, OC and Cambridge had maintenance issues repaired in January
    - Camp Springs Royal Farms location was totaled by a car in a high-speed chase, which was replaced last week
  - FY 16 EVI chargers, mostly at city libraries, have had a number of issues. Most have been fixed. The Gwynn fall parks station had a broken meter and should be fixed within a month.
  - FY 17 EVI chargers – 3 of the 4 chargers in Frederick have had a number of service and power interruptions
  - 2 of 3 ChargePoint sites have moved due to site host issues
    - Hagerstown location should be online soon
  - EVGO also moving locations, with 6 chargers coming online soon
- MDE discussed the VW settlement – hoping for a Maryland plan release in June
- MDP is continuing their public outreach for "A Better Maryland" the State Development Plan

<u>Legislative Workgroup</u>

Chair: Dave Schatz (Chargepoint)

- Dave discussed Florida's right to charge legislation as a potential example for future Maryland legislation (see attachment)

<u>Communications</u>

Chair: Ashley Myers (BEVI)

- BEVI internship starts June 18 for the summer
- There will be six interns from UMBC, MICA, and Johns Hopkins
  - Interns will work on promotional videos
- BEVI requesting any volunteers for a guest speakers to the interns

Next Meeting July 19th 2018
2:00 p.m. – 4:00 p.m. at MDOT
Harry Hughes Conference Room

In this file photo, a public charging station for electric vehicles in Rehoboth Beach. A businessman is donating four similar chargers to the City of Lewes to turn it into a vacation destination for electric car fans. Ocean City announced Tuesday it would begin charging for the use of the stations. *(Photo: Staff photo by Megan Raymond)*

The network of charging stations remains sparse, particularly on the Shore. In Ocean City, a smattering of hotels offers places for drivers to plug in, but they are a slower variety and bring batteries to a full charge in three hours or more.

The only public fast-charging station, a so-called Level III which charges a battery in about 30 minutes, is at the Royal Farms just across the Route 50 bridge. And that station doesn't always work.

**More:** Ocean City's Orange Crush now a Seagram's flavor

The Electric Vehicle Institute plans to add a universal Level III station, the town's first, at the convention center. It also is looking to upgrade to a Level II at 125th Street and 100th Street and add a Level II at the Worcester Street parking lot. An existing Level I will be removed at Third Street.

McGean said the town will begin charging drivers using the parking app, Parkmobile, which the local government already uses to collect parking fees.

Connecting to the charging stations will cost $2 per hour. That should easily cover the town's hourly $1.25 cost of electricity, McGean added.

Council President Lloyd Martin said the experiment is worth continuing until the private sector adds more charging stations around town.

"The vehicles aren't out there much yet, but I think you will see more and more of them," he said.

*410-845-4630*

*On Twitter* @Jeremy_Cox

Q3, 2017

Back Reviews Post

**BmoreTesla's Model X**

Chademo still down. J1772 very slow (8 mi/hr charge)

CHAdeMO 8/5/17, 7:36 AM

**Michael's LEAF**

System has crashed on the Chademo...have to park outside the fence of the paid lot to reach.

7/29/17, 1:41 PM

# *Electric Vehicle Infrastructure Grant Program*

## *Grantee Quarterly Operation Report*

| | |
|---|---|
| **Grantee Name:** Two Farms, Inc. | |
| **Dates Report Covers:** 1st Quarter 2018 | |
| **Report Submitted By:** Tom Ruszin | |
| **Email Address:** truszin@royalfarms.com | |
| **Report Date:** April 27, 2018 | |

**Please provide a brief narrative on the project progress, including any challenges, that occurred during the reporting period:**

Narrative provided on letter report
I'm waiting on some maintenance updates from Clinton on #107 and #131 so I can finalize operational time for the quarter.
the charger at #204 was struck by a vehicle and is totaled. We have a new unit on order.

| Station Location | | | | | |
|---|---|---|---|---|---|
| **Station Address** | **City** | **Zip** | **County** | **% of Time Operational** | **kWhs consumed** |
| **ChargePoint Report** | | | | | **(in kW)** |
| RFS 001 - 2620 Mountain Road | Joppa | 21085 | Harford | 96.7% | 311.68 |
| RFS 062 - 1818 Baltimore Boulevard | Westminster | 21157 | Carroll | 98.6% | 522.78 |
| RFS 076 - 3901 Ten Oaks Road | Glenelg | 21737 | Howard | 98.0% | 869.67 |
| RFS 096 - 500 Mechanics Valley Roa | North East | 21901 | Cecil | 98.2% | 310.23 |
| RFS 107 - 12826A Ocean Gateway | Ocean City | 21842 | Worcester | 96.6% | 14.37 |
| RFS 112 - 3505 Washington Bouleva | Halethorpe | 21227 | Baltimore | 97.7% | 1,004.23 |
| RFS 127 - 7900 Royalty Way | Salisbury | 21801 | Wicomico | 98.9% | 481.16 |
| RFS 131 - 2703 Ocean Gateway | Cambridge | 21613 | Dorchester | 87.8% | 443.53 |
| RFS 133 - 930 Cronwell Park Dr | Glen Burnie | 21061 | Anne Arundel | 98.6% | 1,068.21 |
| RFS 136 - 115 N Bohemia Avenue | Cecilton | 21913 | Cecil | 98.2% | 41.96 |
| RFS 148 - 1114 MD-3 | Gambrills | 21054 | Anne Arundel | 97.6% | 1,005.02 |
| RFS 169 - 6201 Pulaski Highway | Baltimore | 21205 | Baltimore City | 97.8% | 492.99 |
| RFS 191 - 11119 McCormick Road | Hunt Valley | 21031 | Baltimore | 98.2% | 1,766.22 |
| RFS 204 - 6210 Allentown Road | Camp Springs | 20748 | Prince George's | 91.0% | 387.97 |
| RFS 217 - 9180 Fingerboard Road | Urbana | 21704 | Frederick | 98.6% | 838.95 |
| | | | **Total** | | **9,558.97** |
| | | | **Average** | **96.83%** | **637.26** |

**From**: ChargePoint Support <support@chargepoint.com>
**Date**: May 27, 2018 at 12:45:06 PM EDT

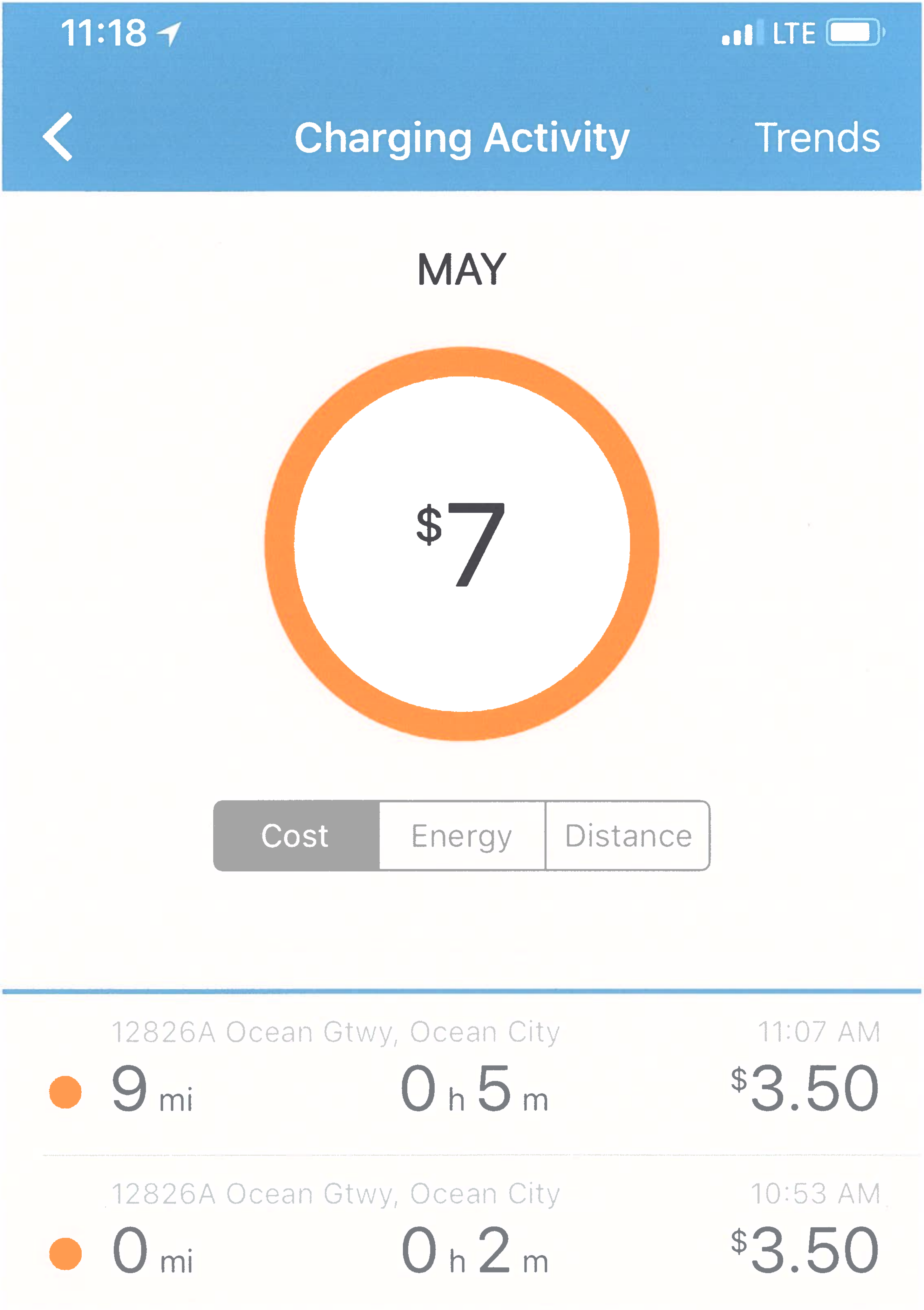
**Subject: Thanks for reaching out!**
**Reply-To**: ChargePoint Support <support@chargepoint.zendesk.com>

Thank you for reaching out! We're tracking your request under ticket number 1005155 and hope the following information is helpful.

Thanks for letting us know about this issue. We'll start remote troubleshooting right away and reach out to the station owner if needed. If this was a paid session and you feel you weren't charged the right fee, call us at 1-888-758-4389 and reference the ticket number above.

Please remember, you can always use the ChargePoint mobile app to find a station near you and start a charge. If you continue to have issues, just call us at 1-888-758-4389 and reference your ticket number. We're here for you 24/7.

Charge on,
ChargePoint Support

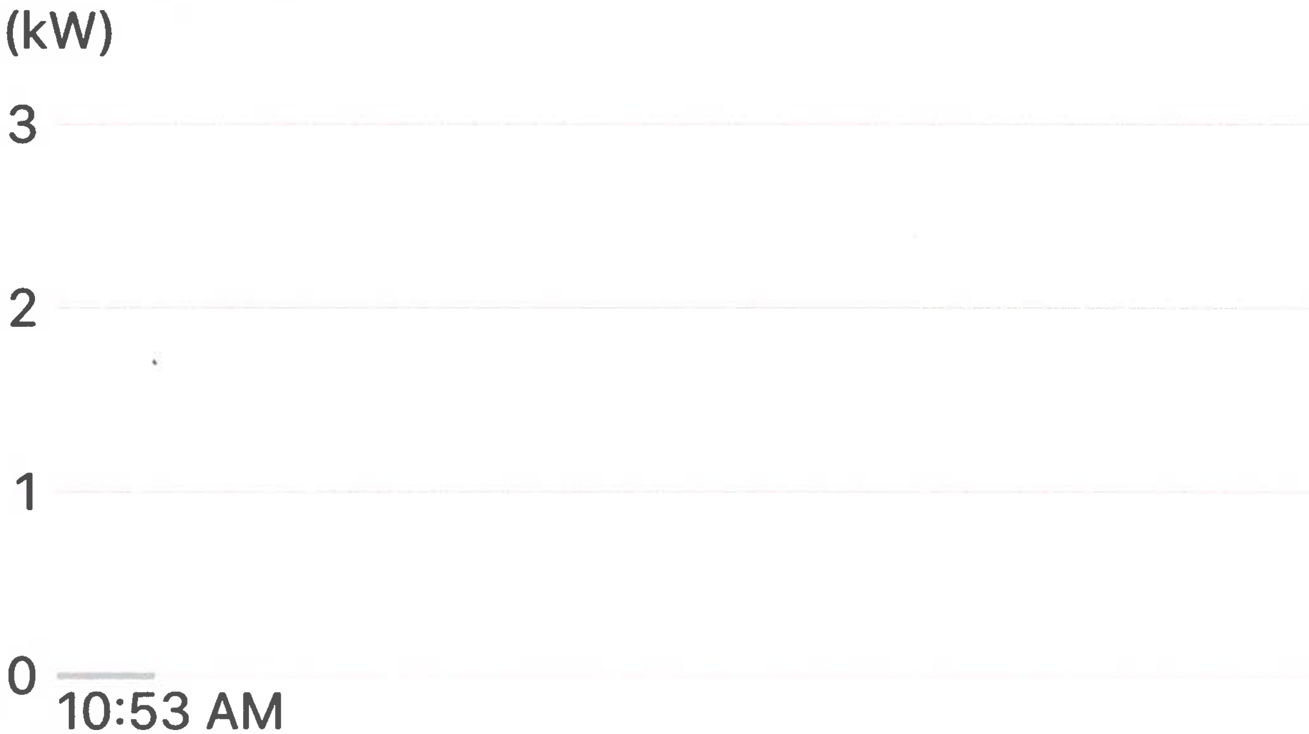

11:18
LTE
Charging Activity
Trends
MAY
$7
Cost
Energy
Distance
12826A Ocean Gtwy, Ocean City
11:07 AM
9 mi
0 h 5 m
$3.50
12826A Ocean Gtwy, Ocean City
10:53 AM
0 mi
0 h 2 m
$3.50


efacec
ROYAL
FARMS
DC FAST CHARGER
ROYAL
FARMS
DC FAST CHARGER
EV
EV

10:59 LTE

# Charging Details

May 27, 2018 at 10:56 AM

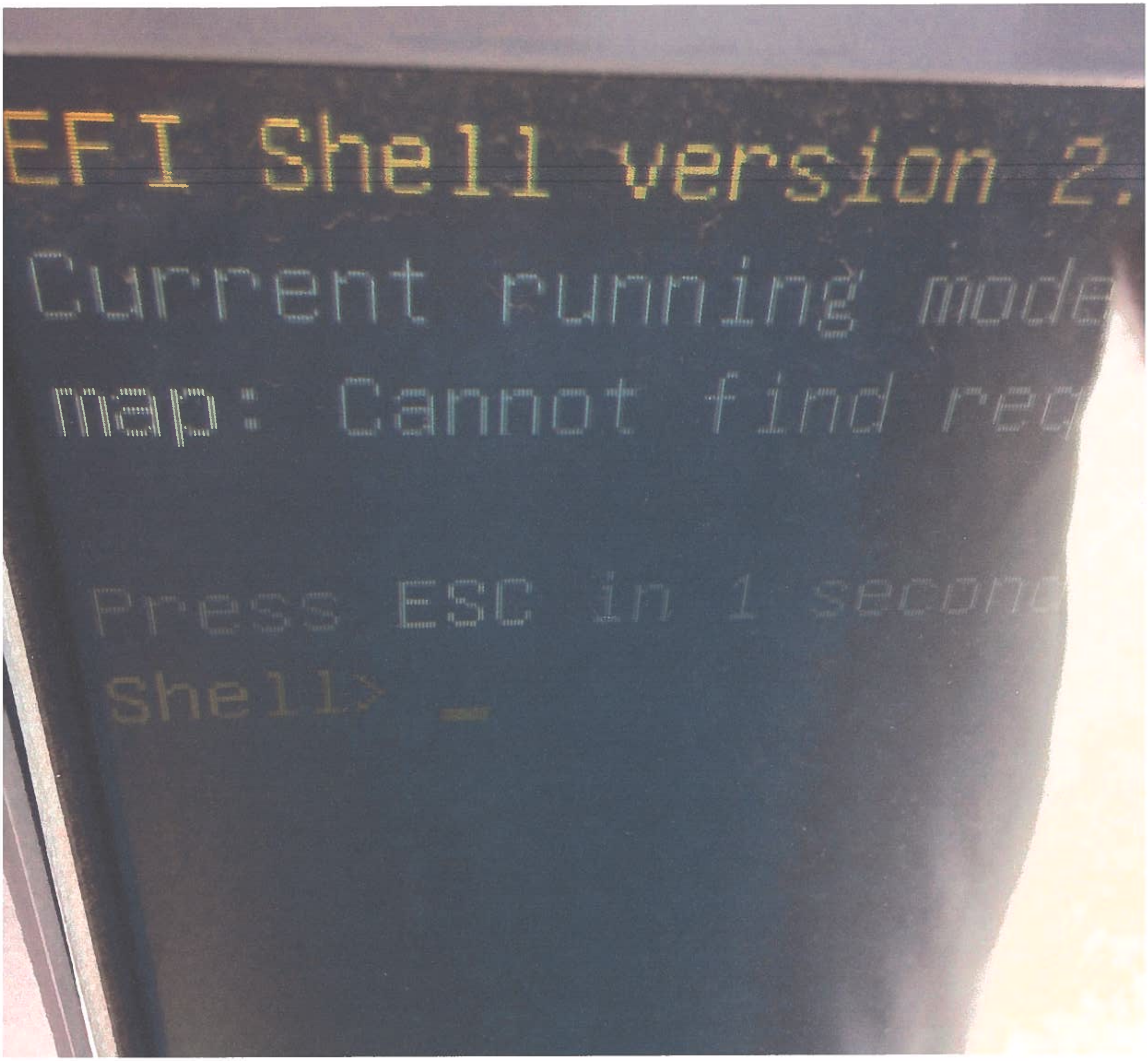



$3.50

0.01 kWh added

0

Estimated miles added


EFI Shell version 2.
Current running mode
map: Cannot find req
Press ESC in 1 second
Shell> _

## Colleen Turner

**From:** Robert Bruninga <bruninga@usna.edu>
**Sent:** Tuesday, June 5, 2018 3:34 PM
**To:** Wood, Eric; Rames, Clement; Moniot, Matthew; David.Collins@maryland.gov
**Cc:** Colleen Turner; Scott Wilson; ben.grumbles@maryland.gov; Andrew.farkas@morgan.edu; michael.jones1@maryland.gov; chris.rice@maryland.gov; John.J.Murach@bge.com; Robert Bruninga; demicheel@pepcoholdings.com
**Subject:** Comments on NREL draft report to PSC and MD EVIC
**Attachments:** Comments-on-NREL-draft-report-b.docx

NREL Authors, (PSC and MD EVIC)

At the MD EVIC June meeting, reference was made to the NREL draft report to the MD PSC that reported a requirement for "17,000 required L2 chargers at work" with no mention of existing or future L1. This figure drastically misleads the actual requirement that is possibly a mix of only 3% L2 and 97%
L1 at work as previously concluded in the 2012 MD EVIC report.

Please consider re-evaluating the final NREL report to separately identify the L2 and L1 at-work requirement due to this 30-to-1 difference with the original MD EVIC report.

The attached comment letter summarizes at least 21 un-intended consequences of conflating L2 and L1 data when the differences in cost, impact and workplace dynamics are so widely different. Also the letter includes detailed comments associated with some assumptions throughout the NREL report.

Bob Bruninga, PE
IEEE Committee on Transportation and Aerospace Policy* Instructor US Naval Academy* Climate Stewards of Greater Annapolis
310-293-6417

* This email and letter are personal opinions and do not represent the IEEE nor USNA in any way.

## Comments on the NREL report: (draft a) 5 June 2018

Bob Bruninga, PE
IEEE committee on Transportation and Aerospace*
Instructor at the US Naval Academy*
35 year EV owner and solar homeowner

Comments are personal and not endorsed or coordinated in any way by the IEEE or Naval Academy

In summary, the report's requirement for 17,400 workplace Level 2 plugs is extremely misleading because it did not address the significant value of L1 charging-at-work and assumed that all EV charging opportunities away from home were either L2 or DCFC. This is in contrast to the original 2012 MD EVIC report that showed that 97% of charging-at-work can be met with L1. We EV owners agree with the original MD EVIC report and see -no- advantage to L2's at work (other than one per every workplace for mid-day travelers) and almost nothing but disadvantages for many reasons:

1) L1 outlets cost orders of magnitude less than metered L2 (not counting installation)
2) L1 can provide a full 34 miles or more per 8 hour day while the employee is parked.
3) L2's at work must be shared and often serve only a single car at great expense.
4) Midday car movement required for L2 sharing is an extreme disincentive.
5) Remaining parked at an L2 after charge complete creates user animosity and discontent
6) L2 chargers exacerbate the employer's **demand charges** (6X peak loads compared to a steady L1)
7) Demand response and V2G cannot work unless all cars are plugged in (L1). Versus shared (L2)
8) 29 of all 45 EV's (PHEV's) on the market can be **fully** charged in under 8 hours from L1 at work.
9) These 29 EVs can satisfy the **full charging need** on L1 of MUDs who cannot charge overnight at home
10) 12 models can be **fully charged** in under 4 hours in time for lunch from L1
11) **All** 45 can fully replenish the mean MD incoming 16 mile commute by noon from L1
12) L2's provide from 80 to 160 miles charge and **require** complex metering and billing to control cost
13) Metering and billing systems cost thousands $$$ more per station and need internet connectivity
14) Thousands of L1's already exist in parking lots.
15) L1 requires no metering and billing equipment or connectivity. Payment is by the month
16) The FAST act of 2016 authorizes federal employee daily L1 charging for $6 per biweekly pay period
17) L1 slow charge rate, eliminates risk and temptation. It takes 5 hrs just to steal $1 of electiricty
18) L1 at work charging is self-policing. Other EV owners competing for outlets will report **any** abuse
19) In contrast, un-metered L2 is a temptation to theft ($1/hr) or greed ($8/day)
20) Enforcement of L1 by employer is as trivial as patrolling handicapped spots
21) Charging at work will also have a greater bias when solar growth makes daytime electricity cheapest.

**Easy Fix to the Report?** There may be an easy fix. The original draft assumed that all dwell times over 2 hours would be L2. A better assumption would add an additional condition, that all dwell times greater than 3.6 hours would imply L1. The justification for this assumption is:

- Using just an 8 hour trigger for L1 would miss everyone who took a lunch break.
- Using 4 hours to trigger L1 does not allow for the variability of lunch time breaks
- Using 3.6 hours might be ideal to capture the variability in lunch breaks
- And 3.6 hrs on L2 conveniently equals the average American mileage of 40 mi/day.
  So anything more than 3.6 hours on L2 implies a perfectly good L1 opportunity.

**Detail Comments:** What follows are excerpts from the report with **original text copied where appropriate in black**, with **highlights in cyan**, **and my comments in red**.

---

## Meeting 2025 ZEV Goals: An Assessment of Electric Vehicle Charging Infrastructure in Maryland

**Technical Report** NREL/TP-5400-xxxxx March 2018 Contract No. DE-AC36-08GO28308

## Executive Summary

…to conduct a statewide assessment of the electric vehicle charging infrastructure requirements for Maryland to meet its goal of supporting 300,000 zero emission vehicles by 2025….

This is good. It is 5 years sooner than the targeted 300,000 by 2030 in the 2012 report.

Results indicate that significant expansion of Maryland's electric vehicle charging infrastructure will be required to support the state's PEV goal for 2025. Analysis shows that a fleet of 300,000 PEVs will require 17,400 workplace Level 2 plugs, 9,300 public Level 2 plugs, and 1,000 fast charge plugs. These estimates assume …that the majority of charging will happen at residential locations. …

The 17,400 L2 requirement is misleading by a factor of 30 or more compared to the 2012 report.

### 1 Introduction

… a convenient and effective charging network … should allow long-distance travel for battery electric vehicles (BEVs), empower residents who do not have access to residential charging, and provide convenient charging options for all PEV drivers. …– both to reduce range anxiety as a barrier to PEV sales and to ensure the effective use of private/public investments in PEV charging infrastructure.

### 2.1 Existing Vehicle Stock

IHS data report 4.73 million LDVs registered in the state of Maryland at the conclusion of 2016.
… More recent data provided by the Maryland Vehicle Administration shows a total of 10,175 PEVs registered in Maryland as of November 2017 with 57% as PHEVs and 43% as BEVs indicating a recent surge in BEV registrations (relative to PHEV registrations)….

Notice change from the 2012 report which was 30% BEVs, 30% PHEV40, and 40% PHEV10 back when the 11 mile Prius dominated. Now PHEV10 has virtually disappeared. By my count, today the ratio of the 45 EV's on the market is already 36% BEV, 38% PHEV30, and 27% PHEV15.

http://evadc.org/wp-content/uploads/2018/04/EVInfoSheet-20180403.pdf

### 2.2 Existing Public EVSE

… As of February 2018, Maryland had a total of 70 L1 plugs, 966 L2 plugs, and 172 DCFC plugs…

This count ignores the unknown thousands of existing L1 outlets at commercial, state and federal facilities and parking lots. Even the federal government recognizes the value of L1 charging at work by providing authority for the use of existing outlets and the modest installation of same which were authorized to all federal agencies by the FAST act of 2016.

Finally, note that a given charging location may have multiple charging types. A station with plugs for Level 1 and Level 2 charging is counted as both types. Thus, the total number of Level 1, Level 2, and DCFC stations reported for the state of Maryland exceeds the number of charging locations. Please refer to Appendix A for raw plug and station counts at the utility service territory and county levels.

This can be confusing. If known, the mix of L1 and L2 is important and should be documented. Also, this does not account for the thousands of existing outlets at any state, federal, or commercial workplace or parking lot.

### 2.3 Baseline PEV Scenario: 300,000 in 2025

This analysis assumes that the Maryland 2025 PEV stock is distributed as: 30% PHEV20, 20% PHEV50, 15% BEV100, and 35% BEV250 … differentiating between PEV powertrain type (BEV vs PHEV) and electric range are shown to be important factors for the analysis.

PHEV20 is probably not representative of the average PHEV that is going to want to charge away from home. The affordable 17 of 29 PHEV's on the market now average almost 30 mile PHEV's and the 12 luxury models with only 8 to 14 mile range and hundreds of gas mile range will simply never bother to charge away from home. So PHEV20 should not be used. PHEV30 is more realistic.

… existing HEV registrations are used to predict the spatial distribution of PEVs in 2025 (spatial distribution of existing HEVs by zip code is shown in Figure 8). Prior research has shown that areas with large number of HEVs are correlated with adoption of PEVs (Wood et al. 2018).

Agreed.

Assumptions regarding potential availability of residential charging at each household type are applied considering renters and individuals in large complexes having limited ability to park and charge their vehicle in a consistent location. These individuals would presumably be reliant on workplace charging and public networks to satisfy the majority of charging needs. This combination of housing data and assumptions regarding availability of home charging result in 70% of 2025 PEVs having access to home charging, with the remaining 30% classified in the remainder of the report as MUDs without access to home charging.

This would appear to be a reasonable assumption. But it assumes an even distribution of buyers without respect to the time period of this report and motivations of early adopters. Since the period covered by this report is only through 2025, and only less than 10% electrification is expected by then, the preponderance of early EV purchasers will favor Homeowners and those who can charge at home now. It is unreasonable to assume that by 2025, apartment dwellers will have equal access to charging (at work) as homeowners enjoy. This skews the numbers to require higher… On the other hand, it can be argued that this is the intent of this report, to encourage adoption by encouraging more charging at work.

## 3 INRIX GPS Travel Trajectories

…. To properly model PEV charging infrastructure requirements in Maryland, NREL acquired individual GPS travel trajectories from INRIX, … that worked with automotive manufacturers, commercial fleet operators, mobile companies, and state and local transportation departments to provide real-time traffic and mobility analytics… based on anonymized GPS data collected from hundreds of millions of devices.

### 3.2 Down Sampling and Data Processing

Prior to using the INRIX travel data subset in PEV driving/charging simulations, a number of data processing steps were completed, including:

• Removing the 1st & last vehicle-day for each device identifier (to remove incomplete travel days)
• Editing trip origins to ensure consistency with previous destination in the trip chain
• Computing trip driving distance based on adjusted origin, waypoints, and original destination
• Assessing trip destinations (i.e., home and workplace location for each device identifier)
• Implementing spatial joins on county, utility service territory, and land use data layers.

These processing steps are consistent with measures taken by NREL on a similar INRIX dataset (Wood et al. 2018). Down sampling and data processing for all LDV trips in the INRIX travel data set remove approximately 90% of the original data,…

Seems reasonable, but there could be unintended consequences if this downsizing ignored things that might be different between L1 and L2 drivers.

## 3.3 Data Validation

… Figure 10 shows the distribution of daily vehicle miles traveled (VMT) from the processed INRIX travel data and comparable distributions from the 2009 National Household Travel Survey (NHTS), the 2012 California Household Travel Survey (CHTS), and the 2011 Massachusetts Travel Survey (MTS). The processed INRIX travel data displays significantly **longer** daily distance driven compared to the traditional travel surveys from around the U.S. with up to a 10% deviation in the cumulative distribution of daily VMT (impact of daily driving distance on charging infrastructure requirements is explored as a sensitivity in Section 5.2).

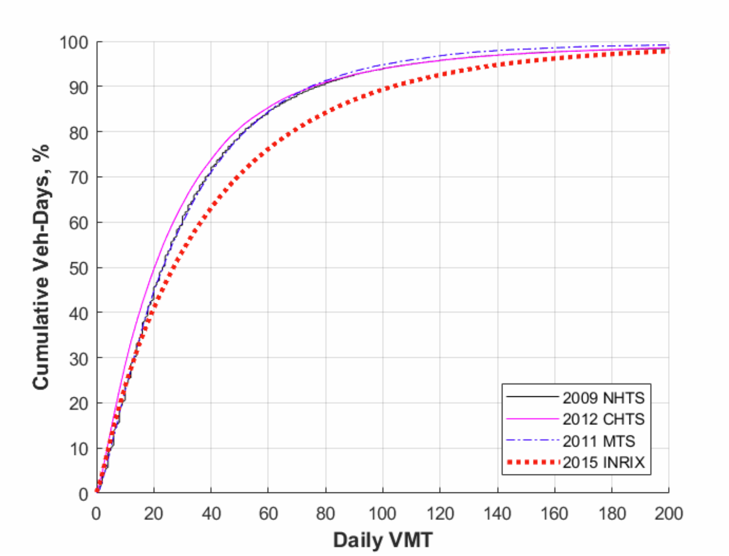



**Figure 10. Distribution of daily VMT from multiple sources.**

**"Longer"?** Note that 75% of all days are the American average 40 mile days in the 2012 report. 70% in the Massachusetts. But in this report the data shows only 63%. This assumption of **longer** travel days would significantly skew results toward L2. Looking at it in miles at the 70% travel days, this report assumes the average miles traveled is nearly 15 miles longer than the 2012 data. This is a very significant value considering the national average 40 mile day. Is it justified? Although Maryland has the longest commutes, this is in time, **not miles**. And it is only miles that significantly affects charging.

## 4.1 EVI-Pro Model Description

… EVI-Pro uses PEV market projections and real-world travel data from mass market consumers to estimate future requirements for residential, workplace, and public charging under a variety of scenarios. Outputs of the model include: anticipating spatial/temporal consumer demand for charging accounting for the impact of SUD and MUD residency, weekday/weekend travel behavior, and regional differences in travel behavior and vehicle adoption. …

…including the primary processing steps in the model: 1) conducting individual PEV driving/charging simulations over real-world 24-hour driving days, 2) spatial-temporal post processing of individual charging events to derive ratios of charging plugs to PEVs, and 3) scaling said ratios per a PEV stock goal or projection.

EVI-Pro uses a "bottom-up" approach to estimate PEV charging requirements with the fundamental element of 24-hour daily driving schedules from real-world vehicles. While these driving schedules are typically sourced from gasoline vehicles, EVI-Pro simulates each driving day as though it were attempted in a PEV. By applying real-world travel data from gasoline vehicles to simulated PEVs, EVI-Pro attempts to estimate charging solutions that enable future PEVs to serve as a direct replacement for the gasoline vehicles that represent the present-day majority of the light-duty vehicle fleet.

A reasonable starting point, but this ignores the EV Stewardship effect. It is widely reported that once drivers of EVs are aware of their daily driving miles which is typicaly 1/8$^{th}$ of the daily range of a gas car, they become more attuned to their wasteful habits and become much more efficient drivers and route planners. These drivers do **NOT report this as added range anxiety**, but rather better attunement to how they use energy. They also may tend to take public transportation slightly more often.

Charging solutions to complete individual days of driving are estimated by identifying charging opportunities that are consumer-oriented for both convenience and cost. Convenience is achieved by simulating charging events as only occurring during dwell times present in the original travel data. The EVI-Pro method implies that the mainstream PEV drivers will have a low tolerance for altering travel behavior on a regular basis to accommodate charging their vehicle. When the price of charging is equivalent for two or more locations EVI-Pro assumes that consumers prefer to charge at locations with long dwell times. … Simulated consumers in EVI-Pro are modeled as being economically efficient, preferring to charge their vehicles at locations that help minimize charging costs. ….

Seems reasonable

In addition to the objective of minimizing cost, simulated consumers are also subject to constraints on battery state of charge. For each simulated driving day in EVI-Pro, BEVs are required to maintain battery state of charge above a pre-defined level, defined as a reasonable proxy for minimizing range anxiety (a 20-mile range tolerance is assumed in this study). Since PHEVs can operate with a depleted battery in charge sustaining mode, EVI-Pro does not place a constraint on the minimum allowable state of charge for PHEVs, but instead attempts to maximize electric vehicle miles traveled (eVMT) and minimize gasoline consumption.

Seems reasonable.

EVI-Pro calculates spatial-temporal coincidence of simulated charging events by geographically aggregating charging sessions and allocating sufficient charging capacity (plugs) to prevent queuing at each individual charging location (stations).

Seems reasonable.

**Table 4. Modeled PEV Attributes**

PHEV20 might be obsolete. The 12 Luxury PHEV's (that average 14 mile EV range) have practically no interest in charging away from home and the average of the 17 of 29 reasonably priced PHEV's is almost 30 miles now. The minimum should probably be a PHEV30.

## 4.3 Simulated Infrastructure Attributes

For all simulated charging opportunities, **a minimum dwell time for the driver to consider plugging in (at all location types, including home) is also be specified (minimum dwell time of 2 hours for L1/L2 opportunities**, 30 minutes for DCFC opportunities), though simulated consumers may not plug in at every opportunity depending on their daily charging needs.

**Reasonable to assume for both L1 and L2. But there is huge difference between the two.**

This analysis considers a baseline scenario where residential charging is preferred by consumers (if available) with workplace charging, public L2 charging, and DCFC charging used to fill gaps in daily charging needs (in that order).

## 5 Simulation Results

Section 5.1 reports infrastructure requirements for a baseline scenario considering 300,000 PEVs on the road in Maryland by 2025. Sensitivity analyses around some of the key assumptions are explored in Section 5.2. Finally, several simulated load profiles are reviewed in Section 5.3 with a discussion on how PEV selection and consumer charging behavior influence simulated electrical loads from PEV charging.

## 5.1 Baseline Results

…Simulations utilized 24-hour driving days derived from 426 million miles of real-world driving data provided by INRIX [and] assumes that future Maryland drivers will attempt to utilize PEVs in a manner consistent with present day gas vehicles. (Does not include the EV stewardship effect. see previous comment)

Furthermore, EVI-Pro assumes a partial level of support for non-residential PHEV charging by residents with consistent access to residential charging (under the assumption that half of these drivers will not seek to charge away from home as a matter of convenience). A 50/50 split was assumed between PHEVs and BEVs.

A significant percent of overall charging infrastructure requirement was driven by the assumption that 30% of PEVs statewide will be owned by individuals without consistent access to residential charging. These individuals (broadly defined as MUD residents) are thus reliant on workplace charging and public networks for the majority of their daily charging needs.

Seems reasonable.

…A statewide total of approximately 27,000 non-residential L2 plugs and 1,000 DCFC plugs are estimated as necessary for supporting future consumer demand for PEV charging. Note that these estimates include a significant amount of residential charging. Despite simulating 30% of PEVs as not having access to residential charging, 66% of statewide charging is simulated as occurring at home. The percentage of residential charging increases to approximately 90% for the 70% of PEVs assumed to have access to charging at their home location).

**Table 6. Estimated plug counts by utility service territory.**
Total 17,393 WORK L2…

This 17,400 **L2** is the main issue that has ignored L1 and is the contention of my comments. This may be the total of required "charging at work" but it drastically misrepresents the effort required to meet this requirement. Since an L1 at-work that already exists or is trivially added may cost two orders of magnitude less and is less invasive to install than a typical metered/internet connected L2 charger.

Despite the fact that L2 charging outnumbers DCFC by a factor of 26 in these estimates, [and that L1 out numbers needed L2 at work by a factor of 30] readers are cautioned against regarding L2 infrastructure as more valuable than DCFC [or L1], as this is not necessary true. Fundamentally, each type of charging infrastructure plays a unique role in supporting the PEV market. EVI-Pro simulations typically provide the majority of L2 [and L1] charging in order to support increased eVMT of PHEVs, which are simulated as not being capable of fast charging. As PHEVs are equipped with a gasoline backup for quickly replenishing driving range, non-residential L2 charging [for PHEV's] can be considered a relatively soft infrastructure requirement. DCFC infrastructure on the other hand is a relatively hard requirement for BEV drivers who have no other alternative for quickly replenishing driving range. In fact, the mere presence of DCFC stations is critical for providing BEV drivers with a safety net against infamous range anxiety concerns.

OK - with my added comments included. But range anxiety vanishes with each new EV driver who learns the complete value promise of EV's that charge while parked (out of mind) and begin most every trip with a full available EV range. The range anxiety assumption should be made to taper proportional to EV growth.

Estimated L2[/L1] requirements at workplaces are nearly twice as great compared to public locations. EVI-Pro finds that commuting distances to workplaces and dwell times for vehicles parked at workplaces on average provide superior charging opportunities for supplementing residential charging for residents of SUDs and for serving as the primarily charging solution for residents of MUDs. In additional to favorable travel pattern characteristics, workplace charging results are bolstered by the EVI-Pro baseline assumption that consumers prefer L2[/L1] charging at work as opposed to public locations when both alternatives are viable options.

**AND, EV owners that charge at work far prefer a dedicated L1 all day while parked compared to having to share an L2 and even worse, to have to move their cars every few hours in the parking lot and find another space to accommodate sharing (every day for the rest of their lives)…**

## 5.2 Sensitivity Analysis

**…** In addition to the number of PEVs on the road, the types of PEVs that get adopted also has a significant impact on charging infrastructure requirements. The "PHEV:BEV" and "Range Preference" sensitivities manipulate the mix of PEVs while holding the statewide total constant. PHEV:BEV ratio is swept from 4:1 (80% PHEV) to 1:4 (80% BEV) and results in a ±16% swing for non-residential L2 and a ±60% for DCFC. Range preference is swept from a "short" setting (comprised of 50% PHEV20 and 50% BEV100) to a "long" setting (comprised of 50% PHEV50 and 50% BEV250). This sensitivity results in a ±10% swing in non-residential L2 and a -14% to +32% for DCFC. These two sensitivities directly relate PEV attributes to infrastructure requirements. For instance, PHEVs are not simulated as DCFC capable, thus increasing PHEV shares decreased DCFC demand and increased L2 demand. Similarly, PEVs with longer electric driving ranges generally decrease infrastructure requirements as they can accommodate the majority of their charging needs with an overnight charge at home.

Agreed.

Consumer preference for fast charging is explicitly considered in the "DCFC Preference" scenario (though not directly coupled to market success of long range BEVs or high power fast charging in the sensitivity analysis). This scenario assumes that consumers place sufficient value on the convenience of fast charging such that they seek it out ahead of L2 for public charging opportunities (however residential and workplace charging remain preferred to fast charging). This sensitivity results in a 13% decrease in demand for non-residential L2 and a 28% increase in demand for fast charging.

**Disagree**. **There is a huge difference in L2 vs DCFC charging *besides time***. L2[/L1] is done while the car is parked and out of mind. DCFC is a stressful, while-you-wait scenario that mirrors the obsolete gas-tank/gas-station legacy model. The value promise of EV's (most overlooked by non EV owners) **is avoiding public charging of any type**. Most cars spend more than 90% of the day parked usually at home and at work which are ideal charging opportunities. These **charging-while-parked** scenarios offer a very fast 10 second per day overall impact.

Five seconds to plug in, and later, 5 seconds to unplug.  This beats the inconvenience and time of DCFC and Gasoline tanks drastically.

Similarly, the "Workplace Preference" scenario manipulates consumer charging preferences such that public charging (both L2 and DCFC) is preferred above workplace charging. To some degree the non-residential L2 effects of this scenario are offsetting (demand for workplace L2 decreases and public L2 increases) however on net non-residential L2 demand decreases by approximately 14%. Conversely, DCFC demand experiences a 11% increase, essentially covering the lost demand for workplace charging that cannot be met by public L2.

Public L2 and at-work L2 are totally different.  Public charging is while-in-use and workplace charging is while-parked.  Not at all comparable.

While not impacting consumer demand for DCFC, the "PHEV Support" sensitivity has a dramatic impact on consumer demand for non-residential L2. Consumer demand for nonresidential L2 infrastructure decreases by 57% in the "No Support" scenario and increases by 43% in the "Full Support" scenario. These scenarios represent extreme conditions regarding demand for non-residential charging by PHEV owners with access to home charging (a segment of consumers with relatively soft demand for charging away from home).

I'm not sure I understand this topic.  Will defer to later…

The role of MUDs is of unique importance to estimation of charging infrastructure requirements in Maryland given the state's relatively high urban population. Recall that the baseline scenario in this analysis assumes 30% of PEVs are adopted by individuals without consistent access to residential charging (broadly referred to as MUD residents in this report). The "MUD PEV Share" sensitivity explores the impact of decreasing this assumption from 30% to 0%, which results in decreases for non-residential L2 and DCFC demand of 22% and 37% respectively.

Not sure I understand the true significance here, but MUD's would be ill advised to consider any PHEV (without charging at work) since their small EV range demands frequent daily charging.

Given that MUDs are simulated in the baseline as not having access to home charging, this result is relatively intuitive. It is also worth noting that this sensitivity is largely consistent with a scenario in which MUD charging access at home is enabled (non-residential infrastructure requirements for PEVs with access to home charging are roughly independent of residence type)…. Recall from Figure 10 that the cumulative distribution of daily VMT for the INRIX data from Maryland exceeds the national average by up to 10%. The "Daily VMT Distribution" sensitivity conducts a new set of EVI-Pro simulations using a subset of the INRIX GPS data which more closely resembles the national distribution of daily VMT. As expected this scenario decreases infrastructure requirements overall; by approximately 18% for both non-residential L2 and DCFC.

As noted before, I am concerned about how this assumption arose.  Yes, MD has longer commutes (in minutes) than every other state, but I can find nothing that implies a longer distance.  In fact, I might assume the distance is actually shorter than the USA average but cannot find any references to distance.  Since EV's do not waste energy while going slow or stopped, then it is **not** correct to assume longer commutes implies the same longer distance.

## 5.3 Simulated Charging Loads

…This section presents simulated load profiles by time of day and location type from the baseline scenario presented in Section 5.1.  Figure 14 shows … the weekday profile representing approximately 3,200 MWh of electrical demand at residential and non-residential charging stations across Maryland (66% residential) with a peak load of approximately 275 MW at 6 p.m. Note that simulations assume uncontrolled charging and do not consider any mechanisms for shifting load off-peak or for integration with renewable resources. In reality, Maryland utilities are likely to provide consumers with incentives for favorably aligning charging with non-PEV loads and constraints on the electrical grid (e.g. time of use rates).

**Caution over the long term:** But off-peak will eventually no longer be at night! As solar penetration explodes, the cheapest electricity will eventually be **during the day**. See California Duck's-back-curve where the cheapest electricity in California in the Spring and Fall in the day is already cheaper than at night. **And this demands emphasis on charging at work**. And since 8 hours equals an almost full EV daily range on only L1 (97% of workplace charging) then *eventually* this forces L1 as the most economical solution and lowest cost and least peak demand. **Though this will probably not occur in Maryland before the 2025 scenario of this report.**

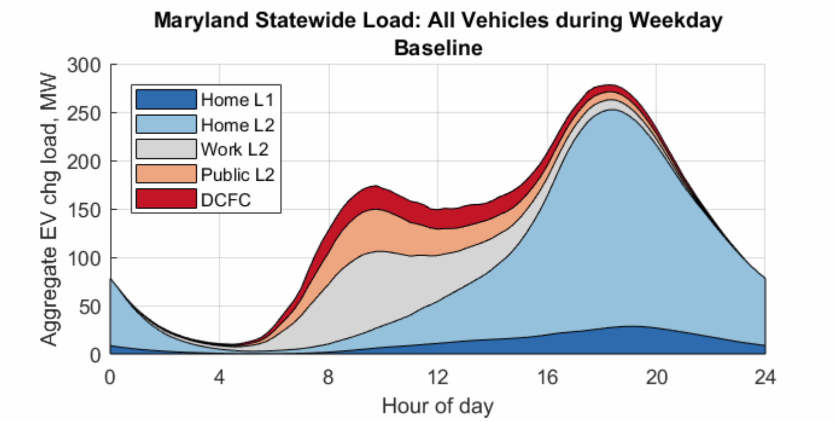



**Figure 14. Aggregate statewide load profiles for a weekday, baseline.**

**Redraw this to include the 97% (or updated number) of the WorkL2 being L1**

Figure 15 decomposes the statewide charging load between residents of SUDs and MUDs (70% and 30% of 300,000 PEVs respectively). The SUD profile takes a familiar shape with approximately 90% of charging at home locations, primarily concentrated between 4 p.m. and 8 p.m. The MUD profile is exclusively non-residential (by definition) and concentrated between 8 a.m. and 12 p.m.

Agreed.

Figure 16 further decomposes the statewide load…. Note that the BEV250 almost exclusively relies on L2 charging at home, resulting in a sharp peak in aggregate load in the early evening hours.

This will eventually change due to solar when utilities will offer cheaper charging at work during the day than the homeonwer can get at night. *Though this will probably not occur in Maryland before the 2025 scenario of this report.*

## 6 Summary

… As of November 2017, 10,175 PEVs were registered in Maryland with 57% as PHEVs and 43% as BEVs. As of February 2018, Maryland had a total of 70 L1 plugs, 966 L2 plugs, and 172 DCFC plugs publicly accessible to PEV drivers.

…

EVI-Pro simulations estimated that 17,400 workplace Level 2 plugs, 9,300 public Level 2 plugs, and 1,000 DCFC plugs are necessary to support 300,000 PEVs in Maryland by 2025.

**This is the main issue:** That conclusion assumed that 100% of all charging at work was L2. It did not address the fact that the vast majority of daily EV charging-at-work can be met with L1 at drastically lower cost and infrastructure. A possible error by a factor of 30 to 1. Many people and the original MD EVIC report conclude that 97% of all charging-at-work can be met with L1 charging. And the cost of infrastructure for L1 can be two-orders-of-magnitude less than L2 since no hourly metering (and credit card and internet access) is needed. So a simple L1 opportunity at each parking spot and a $15 national average monthly allotment per employee can do the same job (in 97% of the cases) as a $4500 metered L2 charger.

---

Here are a few more personal insights to consider regarding L1/L2 ratios.

1) Every employer with employee parking should have **at least have one** L2 charger. There are at least 128 Maryland employers with more than 1000 employees. This should extend down to employers in the 100 size as well (that number should be found).

2) Our local EV club (EVADC.org, one of the oldest in the country) has settled on a recommendation of at least a dozen L1's for each L2 at work.

3) At the Naval Academy with about 1000 employees (still with zero employee charging), we currently have 27 EV driving employees, but only 2 indicate a real solid need to charge-at-work daily and these would both be very satisfied with an L1 capability. Most fear the unintended-negative-consequences of blind installation of metered L2's in place of the far more practical and numerous L1's

4) Use caution. Of course if you ask any EV owner whether she would want an L1 or an L2 at-work, the quick answer will almost always be L2 because its "faster" and he does not have to pay for it nor has probably not considered all the negative unintended consequencies.

While my comments are generally biased to emphasize the value of L1 to the employee and employer for charging at work, they should at least be fairly considered as suggesting a second look at some of the assumptions used by NREL in their draft report.

Sincerely,

Bob Bruninga, PE
IEEE Committee on Transportation and Aerospace Policy*
Instructor US Naval Academy*
410-293-6417

*These comments are personal and not endorsed or coordinated in any way by the IEEE or Naval Academy

**FL Condo Bill as Passed**

(8) The Legislature finds that the use of electric vehicles conserves and protects the state's environmental resources, provides significant economic savings to drivers, and serves an important public interest. The participation of condominium associations is essential to the state's efforts to conserve and protect the state's environmental resources and provide economic savings to drivers. Therefore, the installation of an electric vehicle charging station shall be governed as follows:

(a) A declaration of condominium or restrictive covenant may not prohibit or be enforced so as to prohibit any unit owner from installing an electric vehicle charging station within the boundaries of the unit owner's limited common element parking area. The board of administration of a condominium association may not prohibit a unit owner from installing an electric vehicle charging station for an electric vehicle, as defined in s. 320.01, within the boundaries of his or her limited common element parking area. The installation of such charging stations are subject to the provisions of this subsection.

(b) The installation may not cause irreparable damage to the condominium property.

(c) The electricity for the electric vehicle charging station must be separately metered and payable by the unit owner installing such charging station.

(d) The unit owner who is installing an electric vehicle charging station is responsible for the costs of installation, operation, maintenance, and repair, including, but not limited to, hazard and liability insurance. The association may enforce payment of such costs pursuant to s. 718.116.

(e) If the unit owner or his or her successor decides there is no longer a need for the electronic vehicle charging station, such person is responsible for the cost of removal of the electronic vehicle charging station. The association may enforce payment of such costs pursuant to s. 718.116.

(f) The association may require the unit owner to:

1. Comply with bona fide safety requirements, consistent with applicable building codes or recognized safety standards, for the protection of persons and property.

2. Comply with reasonable architectural standards adopted by the association that govern the dimensions, placement, or external appearance of the electric vehicle charging station, provided that such standards may not prohibit the installation of such charging station or substantially increase the cost thereof.

3. Engage the services of a licensed and registered electrical contractor or engineer familiar with the installation and core requirements of an electric vehicle charging station.

4. Provide a certificate of insurance naming the association as an additional insured on the owner's insurance policy for any claim related to the installation, maintenance, or use of the electric vehicle charging station within 14 days after receiving the association's approval to install such charging station.

5. Reimburse the association for the actual cost of any increased insurance premium amount attributable to the electric vehicle charging station within 14 days after receiving the association's insurance premium invoice.

(g) The association provides an implied easement across the common elements of the condominium property to the unit owner for purposes of the installation of the electric vehicle charging station and the furnishing of electrical power, including any necessary equipment, to such charging station, subject to the requirements of this subsection.