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November 17, 2017

Ms. Kavita Kale
Executive Secretary
Michigan Public Service Commission
7109 West Saginaw Highway
Post Office Box 30221
Lansing, MI 48909

RE: MPSC Case No. U-18368 – In the matter, on the Commission's own motion to open a docket that will be used to collaboratively consider issues related to both the deployment of plug-in electric vehicle charging facilities and to examine issues germane to the use of compressed natural gas as a motor vehicle transportation fuel in Michigan in a Commission sponsored technical conference.

Dear Ms. Kale:

Included for electronic filing in the above-captioned case, please find the **Comments From Consumers Energy Company On The Issues Related To The Adoption Of Plug-In Electric Vehicles In Michigan And The Deployment Of Associated Infrastructure And Technology.** This is a paperless filing and is therefore being filed only in a PDF format.

Sincerely,

Digitally signed by
Anne M. Uitvlugt
Date: 2017.11.17
16:14:14 -05'00'

Anne M. Uitvlugt

fl1117-1-229

STATE OF MICHIGAN

BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

In the matter, on the Commission's own motion, to open a docket that will be used to collaboratively consider issues related to both the deployment of plug-in electric vehicle charging facilities and to examine issues germane to the use of compressed natural gas as a motor vehicle transportation fuel in Michigan	)	Case No. U-18368

COMMENTS FROM CONSUMERS ENERGY COMPANY ON THE ISSUES RELATED TO THE ADOPTION OF PLUG-IN ELECTRIC VEHICLES IN MICHIGAN AND THE DEPLOYMENT OF ASSOCIATED INFRASTRUCTURE AND TECHNOLOGY

1. STRATEGIC PERSPECTIVE

SUMMARY

As customers, manufacturers, governments, and electric companies align on a future that includes plug-in electric vehicles ("PEV"), Michigan must prepare for a transformed transportation system. PEVs have short-term benefits for owners in the form of reduced fuel costs, and long-term benefits for society through lower utility rates and improved environmental quality. We at Consumers Energy Company ("Consumers Energy" or the "Company") believe that regulators and utilities need to proactively identify and remove barriers that have broad societal impact. This does not mean that it is the Michigan Public Service Commission's ("MPSC" or the "Commission") role to advocate for PEV adoption, but rather that we are responsive to changes in our customers' lives that impact the electrical grid. We can help respond to the coming transformation in our transportation system by facilitating the integration of PEVs with the grid in a manner that minimizes cost and reliability impacts, and is consistent with safe operation of the grid.

In its October 25, 2017 Order, the Commission inquired as to *"whether utilities should initiate a series of targeted pilot programs designed to further explore issues related to the deployment of PEV charging stations and associated infrastructure."* We believe Consumers Energy should - and we are setting forth on a path to - initiate a series of targeted pilot programs related to PEV infrastructure. In these comments, we have provided our thinking on the key uncertainties to be explored; our approach to pilots; and our initial framework for addressing our four PEV infrastructure priority areas. These areas are: (1) customer experience, (2) utility role, (3) grid optimization, and (4) and infrastructure deployment. We will utilize a data-driven process that includes research, new initiatives, and pilots to address these important PEV infrastructure issues. Exact solutions and pilot constructs will be determined during the process. Infrastructure decisions have implications for decades, so to ensure the most optimized system and to safeguard ratepayer dollars, we will design

a PEV infrastructure program that is part of a larger strategic plan and utilizes best practices, research, and pilots to make 'small bets' and test assumptions as we navigate towards a successful system that is tailored for Michigan while remaining resilient to future changes in technology and customer behavior.

MOMENTUM IS BUILDING FOR A TRANSPORTATION TRANSFORMATION

PEVs are set to transform the transportation industry, and while timing is uncertain, forecasts are increasingly bullish on **PEV market growth** (bolded text detailed in *Appendix I*). Globally, the industry is building momentum for a massive transformation, observable through **investment, supporting policies**, and **rising adoption rates in major markets**. The parallel rises of **Autonomous Vehicles ("AV") and ridesharing** will converge with PEV, each bolstering the other and furthering the momentum. Meanwhile, **falling costs** overall and **increasing capacity** of batteries will increasingly address customer concerns over sticker price and driving range.

MARKET AND SYSTEM OBSTACLES PREVENT FULL PEV EXPANSION

Customer-facing **market challenges** have hampered growth of PEV, including range anxiety, customer education, and the complex group of stakeholders not accustomed to working together. Behind the scenes, the grid faces unique **system challenges** as it works to accommodate PEV's flexible load as an asset rather than a threat to the system (details in *Appendix II*).

UTILITIES HAVE A ROLE TO PLAY

In the face of the PEV transformation and existing barriers today, utilities are uniquely suited to **deploy the infrastructure** required to meet the needs of an electrified transportation sector, and ensure that the **grid impact** from PEVs is beneficial. Utilities can also uniquely address certain existing **customer challenges** related to charging their vehicles. There are broad **social benefits** that validate public sector investment in PEV that help to offset **cost recovery** when weighing the costs/benefits of utility involvement.

Utilities are uniquely suited to deploy PEV infrastructure

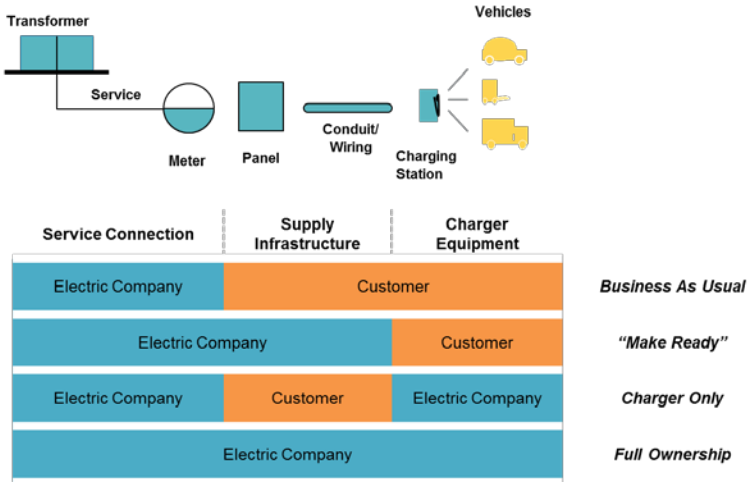
Utilities have the scale and existing systems to deploy infrastructure required to meet the needs of the likely PEV adoption trends. For PEVs to be an overall benefit to the grid and broader society, it follows that utilities, who know the system best and are adequately positioned to install infrastructure and manage flow, would take a lead role.

The ways in which PEVs will integrate into the transportation and electrical systems are still being defined, and while the key stakeholders are clearly defined, their exact roles are still to be determined.

The market is still too nascent to determine one set role for a utility, or to choose or exclude any choice over another. In fact, it may be that there is no 'one-size-fits-all' choice for a utility's role; the ideal option may vary across customer segments or locations (e.g. commercial versus single family home versus multi-family dwelling). For a utility to offer PEV charging infrastructure, it is helpful to consider four deployment options *(Figure 1):*

- ***Business as usual:*** Utility funds the distribution upgrades on the service connection side;
- ***"Make ready":*** Utility funds the installation and infrastructure costs up to the charging equipment, with option to provide rebate to customer for charger equipment;
- ***Charger only:*** Utility funds and/or owns the charging equipment only, utilizing the existing supply infrastructure and/or offsetting any additional installation costs;
- ***Full ownership:*** Utility funds and/or owns the full installation.

Figure 1: Electric company charging infrastructure investment models[1]



Actions taken will determine if grid impact is positive or negative

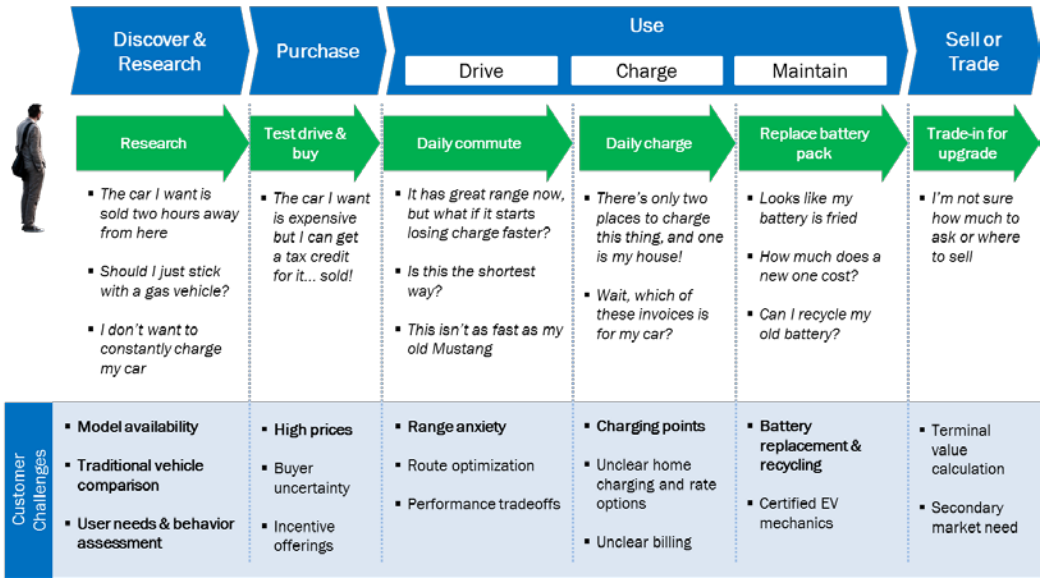
A future world with widespread PEV adoption will impact the grid – whether it is a net positive or negative impact depends on actions taken in the coming years. In the best case, PEVs are a benefit to the grid, helping to increase grid utilization and efficiency by selectively charging during off-peak hours, through incentives or smart charging technology, or by acting as batteries feeding back into the grid at opportune times, an approach called vehicle-to-grid ("V2G"). In the worst case, PEVs could potentially lead to higher system peak loads and create localized stress on parts of the electric distribution system. While the existing grid will be able to handle increased PEV usage in Michigan, at a localized level there could be vulnerable points to assess and proactively address. Utilities have the system-level view and technical capability to best address these issues.

Emerging customer challenges can be addressed today

As discussed above, the customer journey for a PEV owner has new aspects to consider, compared to a typical Internal Combustion Engine ("ICE") vehicle purchase *(Figure 2)*. Utilities are well positioned to aid in overcoming some of today's current challenges, particularly as they relate to education around rates, billing, and charger installations.

Figure 2: Unique aspects of the PEV owner customer journey, with key customer challenges highlighted

[1] Southern California Edison and Edison Electric Institute ("EEI")



PEVs provide benefits to drivers, utility customers, and the broader public

There are three categories of PEV economic and societal benefits on which research is aligning: (1) cost savings to PEV owners, (2) financial benefits to electric utility customers, and (3) value to society.

Cost savings to PEV owners are realized through fuel savings and lower maintenance expenses relative to ICE vehicles. As capital cost of PEVs comes down and infrastructure is developed, PEV owner benefits will increase.

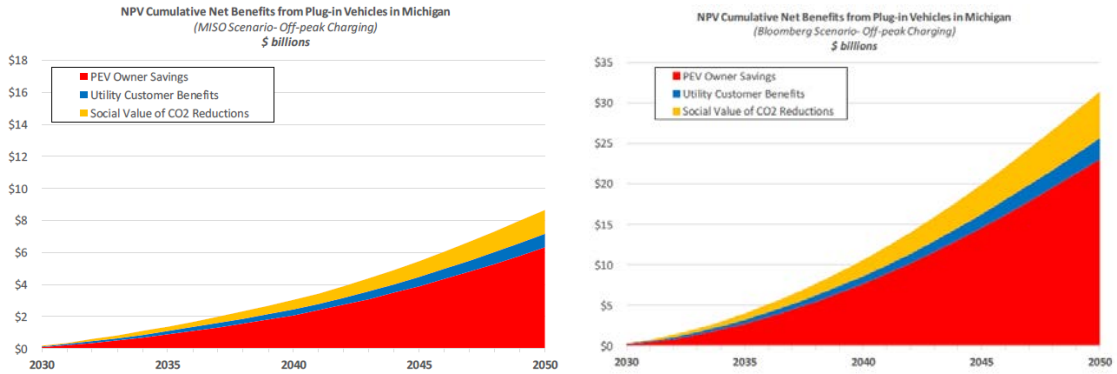
Electric utility customers benefit from increased utility revenue for PEV charging today. As technology is developed on a commercial scale, V2G frequency regulation and V2G arbitrage may provide further benefits. The utility customer base also benefits from the avoided cost of building new peaking capacity and the difference in weighted cost of energy generation when vehicles charge during off-peak hours at a lower time-of-use rate.

Benefits to the society as a whole include avoided greenhouse gas emissions from using PEVs instead of gasoline vehicles and reduced air pollutants of vehicle exhaust. While the broader societal benefits may be difficult to quantify, their qualitative value should not be overlooked.

A 2017 study by M.J. Bradley & Associates quantified the costs and benefits an expanded PEV system in Michigan could bring for all electric utility customers from 2030-2050, regardless of PEV ownership *(Figure 3)*. Benefits across all utility customers and broader social benefit from decreased emissions grow over time, in addition to the benefits for PEV customers. This is in line with a broader study that found that an infrastructure investment of $17.6 billion would yield benefits of $58 billion by 2035 in the 7 states studied, with benefits outweighing costs by 3:1[2].

[2] Ceres and M.J. Bradley & Associates, "Accelerating Investment in Electric Vehicle Charging Infrastructure."

Figure 3: Cumulative net benefits of PEV adoption in Michigan, moderate (left) and high adoption scenarios (right)[3]



Numerous studies quantifying the benefits to PEV owners and electric utility customers are based on a number of assumptions that vary based on geography, population demographics and existing transportation infrastructure. More work needs to be done to quantify the benefits specific to Consumers Energy customers and to what extent the three types of benefit (driver, utility customer, and societal) should be evaluated when considering utility investment.

Consumers Energy supports a regulatory approach that strongly aligns utility incentives with customer interests to minimize total system-wide cost and fully utilize the grid. As such, innovative regulatory approaches should be considered to properly incentivize utilities, akin to energy efficiency programs. In the same way, innovative approaches to pilots/solution development would also better equip utilities to respond to the changing dynamics. Our goal with pilot programs is to nimbly respond to changes, learn faster, and reduce cost upfront (see "Approach to Strategy Formation," below for more).

PEVs at Consumers Energy Today

Since 2010, we have offered PEV-related services to our customers.

PEV Timeline at Consumers Energy

- 2010-2014: Incentive program for home chargers ($2,500/pp); reached 1,300 customers;
- 2010: Began offering PEV rates and residential/commercial customer support;
- 2016: Submitted PEV infrastructure plan with rate case (Case No. U-17990) for three-part infrastructure build at $10.6 million estimated cost;
    - Rebate incentive for at-home charging installation;
    - Level 2 public charging/workplace infrastructure installation;
    - Fast charge network set up across Michigan;

[3] M.J. Bradley & Associates, "Electric Vehicle Cost-Benefit Analysis."

- February 2017: Withdrew PEV infrastructure plan with intention to resubmit as part of broader strategic plan involving customer education and increased stakeholder engagement; and
- August 2017: Participated in Michigan Technical Conference on Alternative Fuel Vehicles.

Today, as part of Consumers Energy's PEV program, we offer PEV rates, website information, and a phone number for additional information. Currently, Consumers Energy has approximately 1,200 customers using PEV-specific rates, the majority (97%) on a one meter PEV or residential time of day rate.

While we have taken steps to respond to the customer PEV needs, there is more that can be done. We have reached approximately 1,300 customers with our initial incentive program, but only enroll 1,200 on PEV-specific rates today, suggesting that rates need to be made easier to understand and access. We must also consider how customer needs will change as PEV volumes grow in our territory.

There is a clear need for greater stakeholder engagement and customer education if the PEV market is to advance in Michigan. The August technical conference was a successful way to bring people to the table, and we anticipate that similar collaboration will continue as we work to refine our PEV strategy. We are beginning work with an automaker on innovative customer journey and smart charging initiatives. We have joined the Alliance for Transportation Electrification and are co-leading an EV initiative through the Edison Electric Institute to collaborate with stakeholders in Michigan and across the U.S. on EV strategies. We are also monitoring initiatives such as Michigan to Montana, an alternative fuel corridor project sponsored by the Department of Energy, and the disbursement of funds from the Volkswagen settlement.

Consumers Energy is committed to embracing the coming transformation sparked by PEV by integrating PEVs with the grid in a manner that minimizes cost and reliability impacts - in turn ensuring that PEV owners, utility customers, and all Michiganders are able to enjoy the benefits.

2. Priority Areas and Initial Actions

Priority Areas to Explore

We have distilled our focus into four priority areas:

- Priority Area #1: Improve the **customer experience** today
- Priority Area #2: Define the **role of regulated utilities** regarding PEV infrastructure
- Priority Area #3: Realize electrical **grid benefits** from PEVs while mitigating risks
- Priority Area #4: Build a **PEV infrastructure** system that is robust to future changes

These priority areas take into account our PEV initiatives to date, ongoing strategic work, and questions from the Commission on rate design, grid impact, customer education, and role of the regulated utility. Rate design, as a tool or means to success, will be studied as part of customer experience, in the form of simple, understandable customer-focused pricing options, and grid benefits/infrastructure, in the exploration of smart charging and other charging behavior programs.

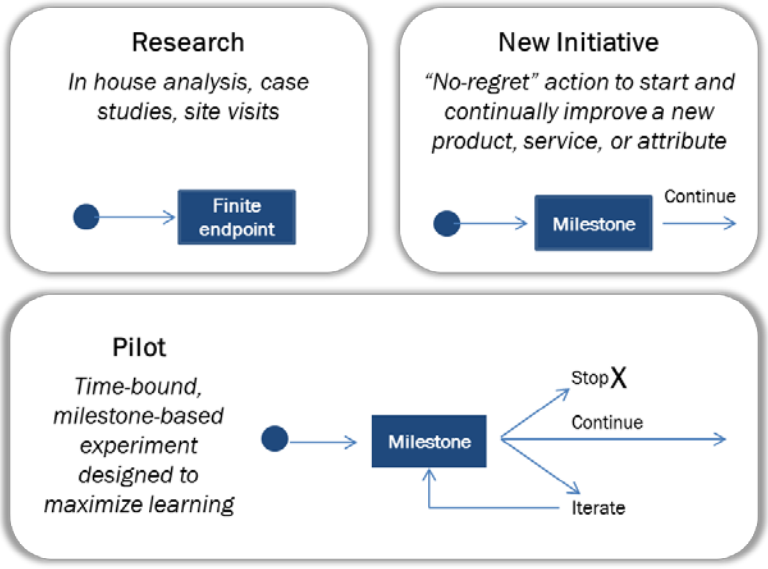
We have worked to ensure these priorities are framed around the customer/end user to encourage holistic solutions.

APPROACH TO STRATEGY FORMATION

Because we are working in an area rife with assumptions and low on experiential knowledge, every effort should be made to ensure we are operating with lean, innovative principles: **test quickly, make 'small bets', and maximize learning and flexibility rather than focus, prematurely, on final answers and conclusions.**

We will utilize three approaches to address priority areas and propose action through research, new initiatives, and pilots *(Figure 4)*. The type of approach will be decided based on the research question and intended outcome. Research will be utilized, as PEVs are a well-researched topic and much can be learned and deduced from case studies and in-house analysis. New initiatives may arise from research, where we identify 'no-regret' areas to pursue, such as customer education tools on our website. Pilots will be undertaken when a research question dictates a need for a CE-specific solution, and we are operating with a high level of uncertainty, such as with a new customer engagement model or product/service offering.

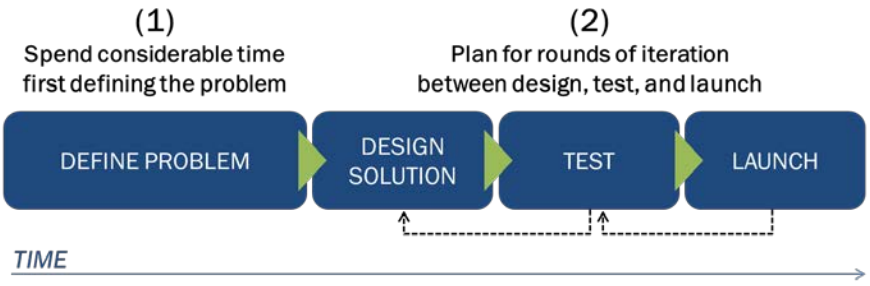
Figure 4: Research, new initiatives, and pilots will be utilized in strategy formation, depending on the situation and intended outcome



A new pilot process for a new challenge

Our pilot process is composed of four phases and has two critical characteristics: it allows ample time for problem definition and anticipates multiple iterations once an experiment has been designed and started *(Figure 5)*.

Figure 5: Our pilot process has two defining characteristics that differentiate it from new initiatives: time spent defining the problem, and the iteration that occurs after solution is designed



For example, an illustrative pilot for at-home charging installation could work as follows:

- ***Define problem:*** Conduct customer interviews and home observations to determine installation obstacles and what outcomes customers hope to achieve (3 months)
- ***Design solution:*** Work with dealerships, charging manufacturers, and local installers to set up an initial solution that offers full-service installation, accessible through Consumers Energy's website (2 months)
- ***Test:*** Offer the solution to a small group of customers, and closely monitor their experience and feedback (2 months)
- ***Design solution:*** Redesign solution, based on feedback (2 months)
- ***Test***: Retest with another small group of customers (2 months)
- ***Launch***: Roll out solution to broader group through scaled launches; be prepared to return to testing or design at each launch phase if needed

Some aspects of the existing utility pilot approach could inadvertently stifle the innovation required to address PEV issues optimally. Further work should be done with the Commission to explore how best to incentivize a healthy innovative environment that enables pilots that happen more rapidly, are more responsive and customer-focused, and are more cost-effective by driving to answers sooner. An undefined, transformative issue like PEV will result in new ways of interacting with the grid and our customers, and involves a complex group of stakeholders – indicating that a new approach is needed to best respond to these changes. Producing different results requires a new approach. PEVs have the potential to improve grid function, benefit customers and broader society, and strengthen the utility-customer relationship, and we are committed to pursuing optimal solutions.

HIGH-LEVEL ACTION PLAN TO ADDRESS PRIORITY AREAS

For each Priority Area below, we explain our initial problem statement, areas to explore, examples of related work, and our next steps.

We are early in our strategy formation. Our approach over the next several months will be to refine the problem statements, decide on and initiate activity, and maximize learning and 'small bets' over large initial spending.

Priority Area #1: Improve the customer experience today

Initial problem statement: **Unnecessary challenges exist in the PEV customer experience today that utilities can help address for both residential and commercial customers.** Current rate design can present an obstacle for residential customers who seek straightforward ways to access residential PEV rates. Second meters, used to track PEV rates present an extra obstacle and expense for PEV owners that could potentially be avoided, if the right technical and business model solution can be found. For commercial customers, worries about demand charges may cause them to balk at installing chargers for their customers.

Areas to explore are as follows but not limited to:

- Approaches to rate design that are simple and straightforward for customers and facilitate PEV adoption, rather than create barriers;
- How utility companies working individually and/or with third parties can better educate and serve potential and current PEV customers;
- Whether a second meter is necessary for a PEV rate (and to include exploration of other options that allow customers to access a PEV rate);
- Role of demand charges and the effect on PEV charging infrastructure investment and usage.

Related work: Many issues surrounding the customer journey have been studied and tested by utilities, advocacy groups, and automakers. The Regional Electric Vehicle Initiative ("REVI"), a working group composed of 6 utilities on the East Coast, studied challenges of second meters early in 2011. Today, PG&E is in Phase 2 of a sub-metering pilot program exploring alternatives to second meters for customers.

Next steps: We will begin with customer research on the current challenges of PEV ownership, partnering with automakers to leverage customer journey work and collaborate on solutions. For example, what is the buying experience like for a potential PEV customer? What is the process of getting a home charging system installed? What questions come up related to PEV rate options? Right now we have many assumptions but not enough verified knowledge to take meaningful steps forward; by learning through customer research we can better define the customer problem and craft meaningful, targeted pilots. On the commercial side, creative rate design and/or other incentives could adjust the equation for commercial customers and help the utility optimize the grid.

Priority Area #2: Define the role of regulated utilities regarding PEV infrastructure

Initial problem statement: Numerous studies have shown that the long-term benefits of PEVs and an associated investment in infrastructure extends to all utility customers and society in general, and are not limited to only PEV drivers. Utilities have a role to play, then, in helping the public realize these benefits. **Utilities have a role in ensuring that PEV infrastructure and grid interaction are deployed optimally to realize the benefits from PEV and control costs.** Utilities are uniquely situated to deploy system-wide infrastructure, and to ensure that the flexible load from PEV is a help, not a hindrance, to the grid.

Areas to explore are as follows but not limited to:

- Avenues beyond traditional ratepayer-funded infrastructure that the utility should be permitted to explore;
- Additional or specific criteria for Michigan that the Commission should use to evaluate utility involvement to justify any upfront costs;
- The outlook for the competitive market for charging infrastructure nationally and in Michigan;
- Whether there are global or localized market failures or barriers where it makes sense for regulated utilities to deploy PEV charging infrastructure;
- Cost/benefit analyses relative to cost causation, customer benefits, and potential cost recovery from customers, relative to deployment of PEV infrastructure.

Related work: This field is still developing, and stances are being determined state by state. For example, the Washington Utilities and Transportation Commission ruled that electrical companies may offer EV charging as a regulated service, subject to Commission approval. The California Public Utilities Commission ("CPUC") has received applications from the three largest utilities to spend nearly $1 billion over the next five years for transportation electrification programs, including charging stations. CPUC cites their role as developing policies that ensure that zero-emission vehicles efficiently integrate with the utility grid and have access to fair rates that encourage electrification, as part of a broader goal to help meet California's goal of reducing emissions from the transportation sector.

Next steps: Customer behavior, technology, and regulation will all be considered in developing an optimal approach.

Priority Area #3: Realize electrical grid benefits from PEV while mitigating risks

Initial problem statement: In the near-term, the existing electrical grid has enough unused capacity to support PEVs, particularly if usage is effectively managed through smart charging technology and tailored rate design. **However, in a future world of higher PEV saturation, the grid will need to be prepared to identify and mitigate vulnerabilities.** Additional opportunities for rate design and customer interaction may also exist in a world where PEVs are treated as an asset and their flexible load is used to optimize the electrical grid. Smart charging success has been well documented across the country – utilizing best practices we can build a tailored system for Michigan.

Areas to explore are as follows but not limited to:

- How utilities can optimize the flexible load that PEVs represent to the grid using rate design, smart charging or other methods;
- The potential grid impact of deployment of charging infrastructure/PEV adoption at various distribution system locations;
- Use of time-varying or dynamic rates for public charging infrastructure or other options to shift charging behavior.

Related work: Along with the PG&E/BMW pilots cited in *Appendix II*, other groups are starting to test the opportunity of V2G loading that PEVs offer. The Department of Defense is concluding its first pilot on V2G, conducted at Los Angeles Air Force Base using a fleet of 32 vehicles. A V2G software company is piloting with various partners in Europe, where it is licensed by a company called Nuvve, and in the U.S., where it is called eV2g.

Next steps: We will explore ways to optimize the utility investment and the flexible load from PEVs. First, we intend to reexamine our existing PEV rates to support grid optimization and customer experience. Second, we are considering a potential collaboration for smart charging that would deploy a software interface directly in vehicles with the intent being to learn how utilities can engage in smart charging to optimize the grid while also being customer-friendly. Both impact to the grid and dynamic rates for public charging infrastructure are longer-term concerns. While there is no near-term substantial impact to the grid, we can begin to understand the longer-term risks via an in-house analysis on grid reliability in the future. For public charging, the market is so nascent today that any additional complexity will likely dissuade customer adoption. We can start with small tests today to search for amicable solutions to deploy once the market has grown.

Priority Area #4: Build a PEV infrastructure system that is robust to future changes

Initial problem statement: A mature PEV market will require accompanying charging infrastructure for both private and public use, across Level 1, Level 2, and fast charging. **A successful infrastructure system will adequately meet today's needs to combat range anxiety and facilitate PEV drivers, while optimizing investment to minimize costs. In addition, any high capital investment must also be robust and capable of integrating with future technology advancements.** For example, AV technology is developing quickly, with Michigan keen to be a global leader in the space. PEV infrastructure deployed today may not be optimally suited to serve future AVs, leading to premature obsolesce and stranded infrastructure.

Areas to explore are as follows but not limited to:

- How to best deploy charging infrastructure (Level 1, Level 2, and DCFC) across Michigan to meet customer needs;
- The tailored solutions for rate design, infrastructure deployment, and customer relationships required to account for different use cases (e.g. multi-family dwellings, low-income access);
- How the individual trends or combination of AV, connectivity, ridesharing, and PEV may change drivers' charging behavior;
- How to build Michigan's PEV infrastructure to meet near-term needs while being robust against future development trends.

Related work: Increasingly, expert analysis is being published that explores how AV, connectivity, ridesharing, and PEV may change future transportation, often interacting with each other in ways that are impossible to predict today. A 2017 study from Center for Automotive Research investigated potential impacts from mobility services, autonomy, and connectivity in Michigan,

concluding with suggestions on how to plan for new transportation services and policies[4]. A 2014 study from the University of Michigan built a potential scenario, extrapolating from projected technology launch dates, growth rates, and policy[5]. Studies such as these help calibrate the most likely scenarios for future infrastructure planning.

Next steps: Over the coming months, we will refine our plan to deploy charging infrastructure across Michigan, considering specific use cases and updating where needed. We will also commence research into infrastructure resiliency planning.

3. CONCLUSION

We are in the early stages of formulating our PEV strategy, and in the coming months we will be initiating activity to address our four priority areas. Our approach over the next several months will be to refine our problem statements, determine the right mix of research, new initiatives, and pilots to maximize learning, and initiate activity. We expect to make significant progress on our PEV strategy over the coming months.

We expect to conclude our efforts with a refined strategy that:

- Addresses critical points where utilities can improve customer journey;
- Plays to the strengths and role of utilities;
- Recommends an infrastructure roll-out plan that meets needs of today and tomorrow;
- Is calibrated and prepared for future impacts to the grid.

We ask that the MPSC would consider ways to help as we adjust our approach to pilots and solution design. Lessoning the burden on pilot programs would help foster and accelerate innovation. For example, some potential paths could be:

- *Rate design 'sandbox' to iterate on experimental rate designs:* Ability to sign up a small number of customers without requiring general rate case filing;
- *Innovative regulatory treatment:* Creative solutions that incentivize minimal total system-wide cost and grid utilization (e.g., shared savings).

With your help, we will design a PEV strategy that utilizes best practices, research, and pilots that test assumptions as we navigate towards a successful system that is tailored for Michigan and is resilient to future changes in technology and customer behavior.

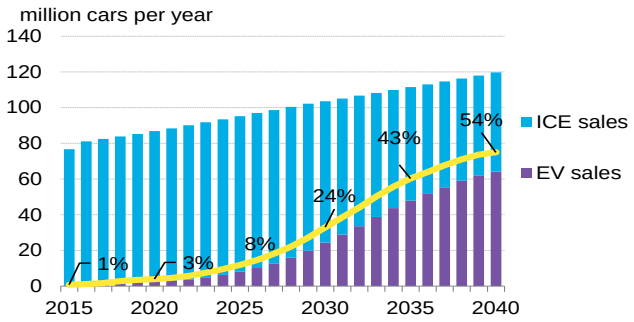
[4] Adela Spulber, et al, "Future Cities: Navigating the New Era of Mobility."
[5] Steven Underwood, "Automated, Connected, and Electric Vehicle Systems."

APPENDIX I: MOMENTUM IS BUILDING FOR A TRANSPORTATION TRANSFORMATION

PEV market is projected to grow year over year

The Bloomberg New Energy Finance's ("BNEF") global EV forecast expects to see a 20% CAGR between 2016-2040 *(Figure 6).* In the U.S., the market is still relatively small (1% of vehicles in the U.S. in 2016), but is growing quickly (36% YOY)[6]. Globally, though still small overall compared to ICE, PEV ownership is growing in the world's major automotive markets. While 95% of electric cars are sold in just 10 countries, 5 of those 10 are part of the largest automotive markets in the world – China, US, France, Germany, and Japan.[1]

Figure 6: Annual global light duty EV sales[7]



Global EV sales are projected to overtake ICE market share in 2040, capturing 54% market share. The U.S. is expected to overtake ICE in the same year, with a marginally higher market share of 58%, suggesting that the U.S. market will likely track with global markets.

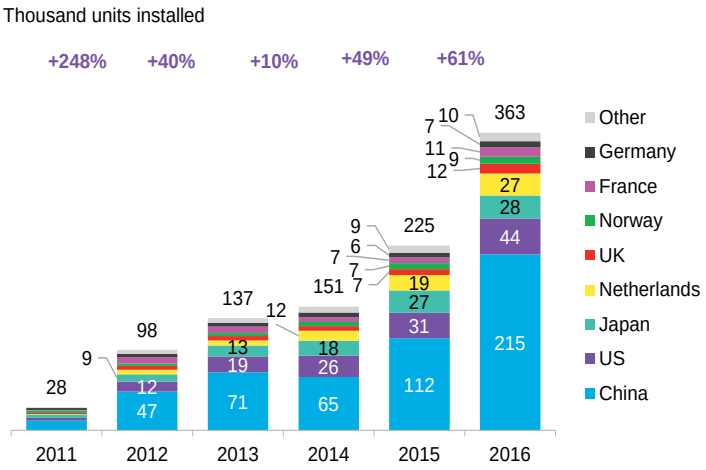
The U.S. PEV market is expected to grow from 51 models today (25 Battery Electric Vehicles ("BEV") / 26 Plug-in Hybrid Electric Vehicles ("PHEV")) to 83 by 2020 (45 BEV / 38 PHEV). Globally, the market is expected to expand from 152 models today to 219 in 2020.[7] In July of this year, Volvo committed to selling only electric or hybrid vehicles by 2019, the first major auto manufacturer to do so.

Global investment in electric vehicle space is rising

Global investment in PEVs, batteries, and charging infrastructure continues to rise *(Figure 7).* China, in particular, is making major investments in the EV space.

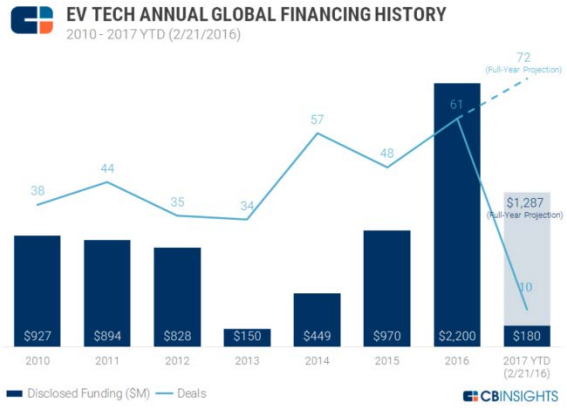
[6] McKinsey
[7] BNEF

Figure 7: Cumulative number of public EV charging points installed by country[7]



Private sector investment is seeing a large jump in PEV investment, from vehicle and charging components to software solutions *(Figure 8)*. 2016 was the peak year for both number of deals and total funding, with 2017 predicted to surpass in number of deals. Tracking deal flow and early stage investment is instructive in identifying momentum of a market.

Figure 8: Deal activity in early-stage EV technology, globally[8]



State and national policy-makers increasingly enacting policies to support EV

National governments are setting policy around the world to phase out ICE vehicles in favor of EVs.

- Britain: Banning sales of new gasoline and diesel cars by 2040; all cars with zero emissions by 2050
- France: Banning sales of new gasoline and diesel cars by 2040; hybrid vehicles allowed
- India: Publicly committed to sell electric vehicles only by 2030

[8] CB Insights

- Norway: Currently offering subsidies up to 45% of EV price[6]; requiring that all new passenger cars and vans sold in 2025 should be zero-emission vehicles[9]
- China: Currently offering subsidies up to 23% of EV price[6]; considering a requirement to zero emission vehicles by 2040[10]

In the U.S., federal and state governments have instituted a variety of EV policies, mostly as price reduction instruments for both individual retail sales and fleet purchases. Tax credits comprise the majority of incentives offered and are mostly based on the EV purchase price (*Figure 9*). The federal IRS tax credit is $2,500-$7,500 per new EV purchased for use in the U.S., and has been a subject of debate as to whether the tax credit should remain active.

Figure 9: Incentive type by U.S. State[11]

Price Reduction Instrument	States
Rebates	CA, IL, MA, NY, PA, TX
Tax credit	CO, GA, LA, MD, SC, UT, WV
Sales tax exemption or reduction	CO, NJ, WA
Fee exemptions or reduced fee	AZ, IL
Loans	NE, OK, OR, VA
Grants	CT, MD, NY, NC, UT

Autonomous vehicles and ridesharing will likely impact EV in the future

While the EV market matures, technology for AV is keeping stride. For a number of reasons, these two technologies will mutually benefit each other's development. Both technologies aim to save money on fuel and operational costs. EVs offer practical benefits for AV as well – it is easier for the AV system to interact with and drive an EV versus the variety of mechanical components in an internal combustion engine vehicle, and it would be far easier for an AV to refuel by driving onto an inductive charging station rather than navigate filling up a tank of gas.[12]

When you consider adjacent trends in urban living and ridesharing, these synergies only intensify. Urban centers are where much of the efforts around AV/ridesharing are expected to play out, and as more people continually move to urban areas, the demand will grow for EVs as well.

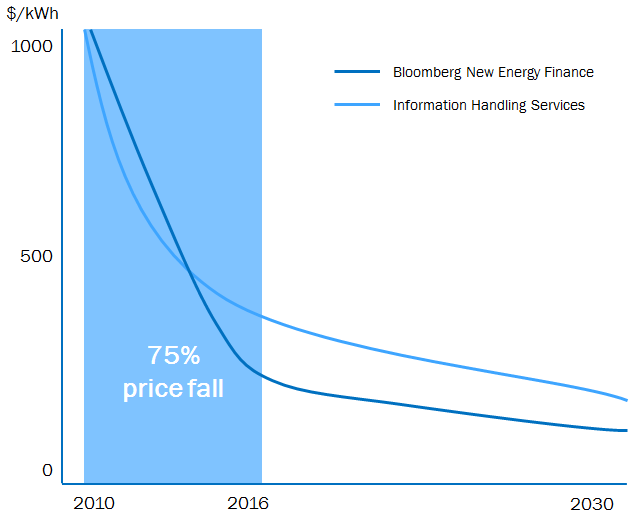
The combination of AV and ridesharing could have a major public benefit as well - unlocking the market for today's non-consumers who do not own cars today due to disability or income. As EV, AV, and ridesharing are complimentary trends, bolstering the EV sector would also contribute to the societal benefits for non-consumers today, contributing to quality of life and increased productivity.

[9] CNN
[10] Forbes
[11] UCLA Luskin School of Public Affairs
[12] Govtech.com

Falling costs and increasingly better performance of batteries propel EV growth

Automotive companies are developing faster and better performing batteries and chargers. Established tech giants, like Samsung and Toshiba, as well as startups are experimenting with battery solutions, all aiming to increase the capacity and/or decrease charging time.[8] Meanwhile, the cost of the dominant lithium-ion battery, a favorite for EV, continues to fall *(Figure 10)*.

Figure 10: Lithium-ion battery module price outlook[13]



As costs come down, manufacturers are working to improve fast charging speeds, with the goal to recharge a PEV as quickly as one can fill a tank of gas today. Companies like Tesla and Porsche are both working on increasing vehicle range while decreasing charge time. Tesla plans to roll out its Model 3 with the capability to go 170 miles after 30 minutes of charging.[14] Porsche is working on a 2019 model that will go 250 miles after a 15 minute charge on a specialized fast charger.[8]

Some EV models today are not built to handle the higher voltage from fast chargers, though that compatibility can typically be purchased as an upgrade. Newer EV models are likely to accommodate the fast chargers. The 2017 Chevy Bolt can handle the fast charger under ideal temperatures (up to 55 kW).[15] It is reasonable to expect that costs will fall and speed will increase for fast charging, as they will for the other parts of the battery/charging supply equipment.

With reductions in battery costs, automakers are focusing on extending ranges rather than lowering the overall vehicle price. While EV prices have been rising since 2012, the cost per mile has decreased from $579/mile in 2012 to $358/mile in 2016.[16] However, by as early as next year, the Rocky Mountain Institute estimates that annual all-in costs for a fully electric vehicle may be $1,000 less than an ICE vehicle, regardless of government subsidies *(Figure 11)*.

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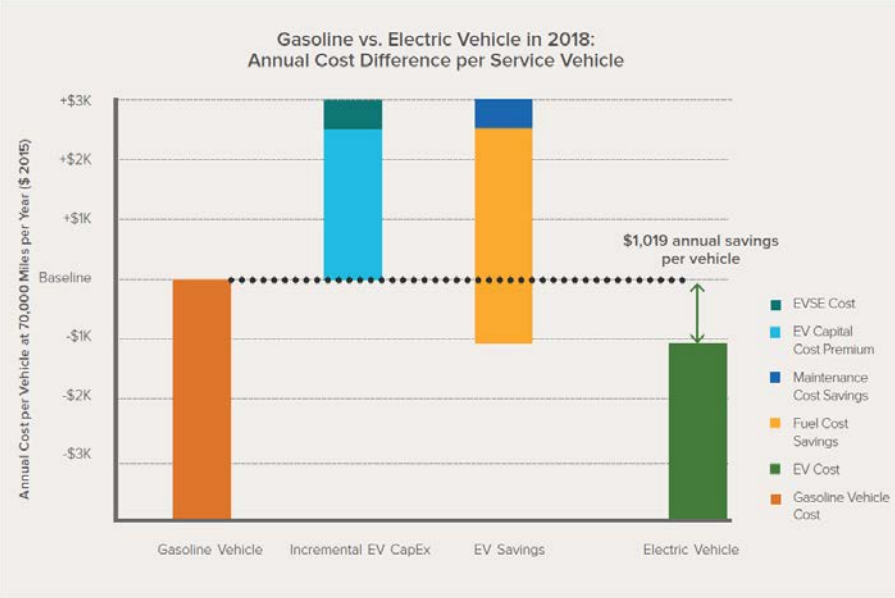
[13] BNEF and Information Handling Services
[14] ThinkProgress
[15] hybridCARS
[16] International Energy Agency

Figure 11: Annual cost differences in gasoline vs. EV, without government subsidies[17]



[17] Rocky Mountain Institute

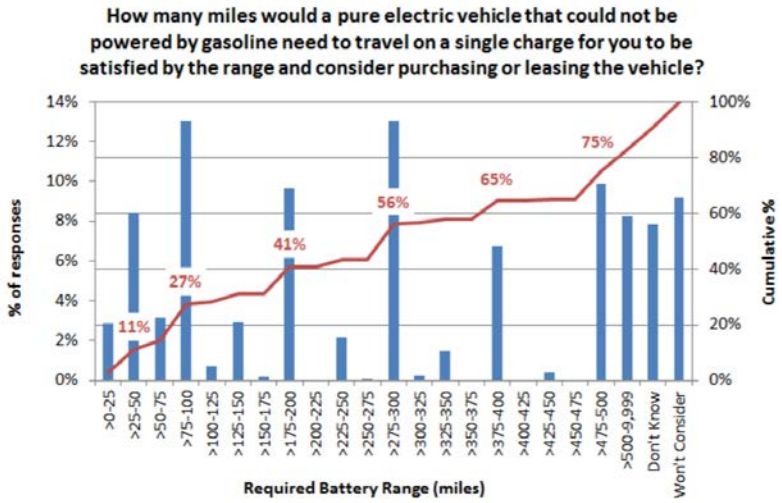
APPENDIX II: MARKET AND SYSTEM OBSTACLES PREVENT FULL PEV EXPANSION

Market challenges remain for customers concerned about fully shifting to batteries

Range anxiety remains a concern among potential car owners, particularly for BEVs that rely solely on an electric motor. One aspect of that concern is at the vehicle level. A 2015 survey that studied consumer attitudes toward PEV found that the majority of drivers (75%) are anchored in current ICE vehicle standards, wanting an EV vehicle to go 500 miles on a single charge, or roughly the distance an average tank of gas gets you today *(Figure 12)*.[7] Interestingly, the expectations are much higher than actual daily mileage – as low as 30 miles/day on average.[18] Today, the majority of PEV cars in market have a range of 100-200 miles per single charge, enough to handle most drivers' daily requirement *(Figure 13)*[19].

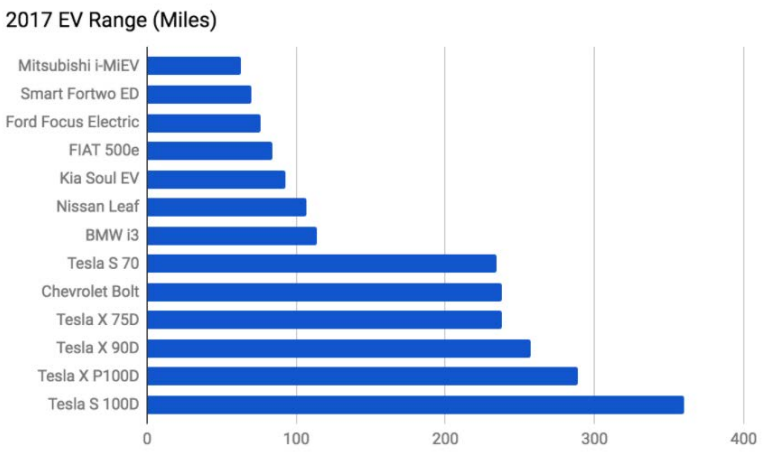
Another aspect of range anxiety is the system level concern on availability of chargers. In the U.S. today, there are about 45,000 EV charging points (BNEF) across the country compared to around 150,000 gas stations[20,21]. In Michigan, there are 11 public DCFC stations and 230 public Level 2 stations containing 465 ports.[22] Range anxiety must be addressed before the PEV market will accelerate in Michigan.

Figure 12: Majority of survey participants (75%) want a PEV to travel as far on a single charge as an ICE vehicle travels on a full tank of gas today[23]



[18] American Automobile Association
[19] FleetCarma
[20] BNEF
[21] NACS Online
[22] Alternative Fuels Data Center, cited in "Comments of DTE Electric Company and Consumers Energy Company," July 2017.
[23] National Renewable Energy Laboratory

Figure 13: Summary of EV ranges available in 2017 shows variety, though none are yet equivalent to the range of a full gas tank today[19]



While PEVs are used for the same purpose of ICE vehicles, aspects of the customer journey are very different when considering a PEV. Car-buyers accustomed to assessing costs by checking gas prices and auto repair shops now have to research electric rates, battery warranties, and software maintenance. Before bringing a new PEV home, charging infrastructure needs to be installed, which raises a host of new questions for a consumer (e.g. what equipment to buy, how it is installed).

A number of customer education and outreach programs and pilots centered on EV have been proposed by utilities across the country. In Oregon, for example, Senate Bill 1547 has directed all electric companies to file applications for programs to accelerate transportation electrification. In response, Pacific Power has proposed an 'Outreach and Education Pilot' that will test the effectiveness of different outreach tactics on accelerating transportation electrification, through direct communication with customers, online tools and resources, technical assistance for non-residential customers considering infrastructure projects and partnership at community events. Portland General Electric ("PGE") is taking a slightly different outreach approach by collaborating with customers, industry partners and other electric companies, to reach more customers with less. PGE plans on disseminating EV educational materials through their existing channels as well as through partner channels to touch a wider range of customers at a lower cost. These are only a couple of examples of the many pilots that have been proposed throughout the country to inform customers about new BEV and PHEV technologies, available vehicle models, federal and state incentives for vehicle purchases or leases, and options for home and public charging. Simple, customer-focused outreach and resources such as these will be critical to unlocking the PEV market in Michigan.

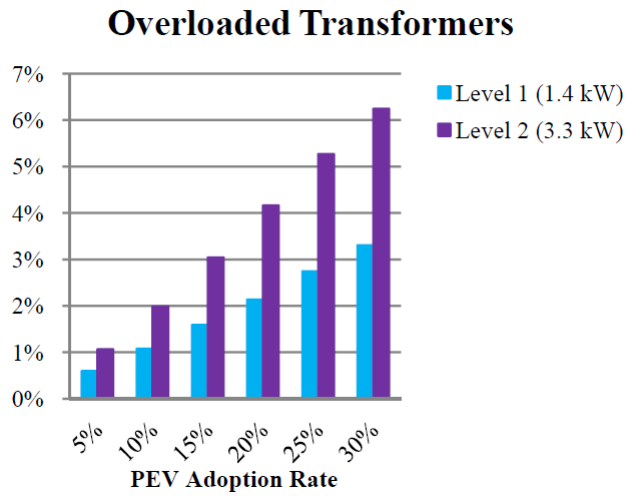
Finally, PEV will bring a new ecosystem with a complex group of stakeholders working together in new ways. In Michigan, the August 2017 technical conference and the work leading up to and after the conference is a promising sign of collaboration amongst our varied stakeholders. Utilities, OEMs, battery manufacturers, software companies, environmental advocacy groups, and multiple government agencies must collaborate to enable a PEV market in Michigan.

PEVs will interact with the grid in new ways, prompting system challenges

For most of its existence, the electric grid was accustomed to supplying a predictable, centrally-controlled electric load. The rise of renewable energy sources has required the grid to allow for unpredictable, disaggregated loads. PEV will require a third evolution for the grid – a flexible load that, depending on how it is managed, could be predictable, and for the first time, could operate as both supply and demand to the grid.

While recent long-term EV sales forecasts have moved substantially higher, projected load growth due to EVs remains modest over the next decade. For example, a DTE study found that if 30% of all vehicles were PEV, charging at on-peak times at home, just 6% of distribution transformers would be overloaded *(Figure 14*). Given forecasts for EV growth and assumptions on car usage, we estimate that it will be sometime between 2030-2035 that PEVs will start to significantly increase the electric load (by 10-15%).

Figure 14: The 2011 DTE study predicted that with 30% adoption rate, at most 6% of transformers would be overloaded[24]



However, it is important to assess and plan for a point when PEVs do begin to impact the grid. In the near-term, it is important to experiment while the PEV market is still small and nimble in Michigan. It is important to focus on how best to address the flexible load that PEV offers as this could be a benefit or burden the grid, depending on how it is managed. For example, Pacific Gas and Electric Company ("PG&E") and BMW completed an 18-month pilot in December 2016 focused on smart charging and demand response using vehicle-to-grid (V2G) technologies. Also in 2016, Nissan, Enel (an Italian utility), and Nuuve, a California-based energy technologies and smart grid company, are experimenting with V2G charging units in Denmark, Italy, and at the University of California San Diego that allow electric Nissan vans to both receive and provide energy to the grid when plugged in.

[24] PHEV Pilot Program Final Report, 2011

Determining the best ways for utilities, PEV, and customers to work together will take iteration and time, but as these examples show, there are ways to test and learn at a small scale while the market is still nascent.