Integration of Electric Transportation and CIP

A Roadmap

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Definition of Terms and Acronyms

BEV – Battery Electric Vehicle, a vehicle entirely fueled by an electric battery. In general, in this paper, the shorter form acronym, EV, is used.

CARD – Conservation Applied Research and Development grant program for funding research on technologies and programs for energy efficiency

CIP – Conservation Improvement Program, the legislation organizing utility energy efficiency in MN

DOC – Minnesota Department of Commerce, whose Energy Division oversees the CIP process

DCFC – Direct Current Fast Charging, the fastest form of EV battery charging

Level 1 Charger – the slowest level of EV battery charging

Level 2 Charger – the medium level of charging at 240 Volts

Level 3 Charger – the fastest level of charging for EV batteries utilizing direct current, synonymous with DCFC

ECO Act – Energy Conservation and Optimization Act of 2021, MN legislation enacted in 2021 that allows electrification measures in CIP

EV – Electric Vehicles, vehicles powered by batteries charged

EVSE – Electric Vehicle Supply Equipment, commonly known as chargers

ICE – Internal Combustion Engine, vehicles fueled by gasoline

MPUC – the Minnesota Public Utility Commission which regulates public utilities

PHEV – Plug-In Hybrid Electric Vehicle, electrically charged vehicles to provide short driving range but primarily fueled by gasoline for longer distances

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Executive Summary

Recent passage of the Energy Conservation and Optimization Act of 2021 (ECO Act) has modernized the Minnesota (MN) utility energy efficiency resource standard within the Conservation Improvement Program (CIP). This modernization creates new focus on key areas including low-income programs, increases to overall energy efficiency goals, load management, and efficient fuel-switching. Under this legislation, utilities can implement fuel switching technology programs when the new technology would reduce overall energy usage and carbon emissions in a cost-effective manner. While there are conditions and constraints, the legislation lays the groundwork for utilities to pursue well-designed, beneficial electrification program options and recover their costs for doing so.

There is a variety of electrification technologies that utilities can consider within their CIP portfolios, but electrifying transportation may be the largest opportunity. Electric transportation in the form of electric vehicles (EVs) is a rapidly growing market globally, nationally, and in MN. There is a wide range of policy support for EVs at the federal and state level, as EVs are a significant means to meet the challenges of global climate change and to meet decarbonization goals. The policy support in MN is strong and growing under Governor Waltz's administration, as will be shown later in this paper. EV market growth is intertwined with the need for very substantial charging infrastructure at homes, businesses, fleet hubs, and in publicly available areas. Charging infrastructure, also known as EVSE (electric vehicle supply equipment), is an electric end-use already installed at hundreds if not thousands of MN homes, businesses, parking areas, and in other public locations.

In this paper, the distinction is drawn between EVSE as an electric end-use, like other end-uses (e.g., lighting, refrigeration, heating or cooling, and industrial motors) and EVs as a fuel switching measure from the perspective of the ECO Act legislation. It is important to recognize that the market trends towards an electrified transportation system are already underway with or without CIP. EVSE will become one of the largest if not the largest electric end-use within the next two decades. CIP has a traditional role to play in helping the MN market to focus on the highest efficiency options for EVSE and EVs. If CIP does not engage, or only engages late, it is likely that the EVSE build out will focus on low cost rather than high efficiency options while the EV fleet lacks focus on higher efficiency models. With EVSE potentially growing to 6% of US electric load by 2030 (Bland, Wenting, Noffsinger, & Siccardo, 2020), the related utility distribution and transmission costs should be managed downward as much as possible through CIP, helping the local and regional market to focus on high efficiency EVSE and EVs.

A rapid engagement roadmap for CIP is proposed in the Recommendations section of this paper. It includes:

- Suggested guidance to be issued by the Department of Commerce (DOC) leadership
- Initial program recommendations for utility implementation
- Two existing standards to use by utilities and the DOC to set efficiency guidelines for EVs and EVSE respectively

Rapid engagement by CIP is necessary because the markets for EVs and EVSE growing quickly; it will take time for CIP participants to learn the nuances of transportation markets, and there is so much potential at stake. It is not necessary for CIP to specifically encourage electrification of transportation, but it is CIP's role to ensure that the transition to electric transportation is as efficient as possible.

Introduction

Minnesota (MN) is not on track to achieve its overall decarbonization goal of an 80% reduction by the year 2050. The Next Generation Act of 2007 established this state-wide goal and interim goals of reduced greenhouse gases emissions of 15% by 2015 and 30% by 2025 (MPCA M. D., 2021). While decarbonization of the MN utility electric generation system has made substantial progress, other sectors, including transportation, have lagged. A key necessity for MN to gain traction on its decarbonization goal is to accelerate the adoption of electric vehicles in the state.

The Conservation Improvement Program (CIP) has been a foundational pillar of MN's energy policy for four decades. CIP has cost-effectively reduced the demand for electricity and natural gas by fostering installation of high efficiency equipment and processes in homes, buildings, and industrial facilities. Now, CIP has been enabled to take on added responsibilities with passage of the 2021 ECO Act. The ECO Act strengthens CIP's traditional leadership role to improve efficiency in buildings, but also allows it to focus assets, processes, and a portion of expenditures on electrification opportunities, potentially including electric transportation. This paper provides rationale for CIP to be active in electric transportation and describes an initial roadmap and recommendations for CIP to quickly engage in the electric transportation sector.

MN and the rest of the United States sits on the cusp of a rapid expansion in electric transportation. There are two high-level components to this expansion. First, the market for electric vehicles (EVs) is accelerating as states like MN establish goals for the transition to EVs. Second, charging infrastructure or electric vehicle supply equipment (EVSE) is also expanding rapidly. Both exhibit a range of efficiencies, which provide opportunities for addressing the large, expected impacts of EV charging on utility infrastructure. EVs will be a strong rival to the sales of internal combustion engine vehicles (ICE) in the US within this decade (BNEF, 2021). EVSE will become one of the largest electric end-uses within this decade, creating significant challenges for utilities not just from a generation perspective but also from a transmission and distribution view.

From a decarbonization perspective, electric transportation lowers CO_2 emissions compared to ICE vehicles, with the differential based on regional generation mix as shown in a Union of Concerned Scientists report. As renewable energy expands and coal generating plants close, the emissions advantage of EVs will grow (Reichmuth, 2020). By focusing on electric transportation now, CIP can encourage efficient electric transportation through education, incentives, and assistance aimed at high efficiency EVSE. CIP can also work to manage patterns of charging to limit distribution investments.

Electric transportation as a new and substantive end-use, raises important questions for CIP. Given the growing investments in EVs and EVSE, there is substantial risk in losing the opportunity to reduce energy use and emissions if the efficiency levels and charging profiles of EVs and EVSE are solely market driven. The ECO Act has changed the fundamental relationship between electrification and CIP. This raises five key questions for CIP:

- Can CIP drive the MN EVSE market to focus on higher efficiency equipment?
- What standards are available for use by utilities and the MN Department of Commerce (DOC) to measure efficiency of EVs and EVSE?
- CIP now includes load management. Is load management an option that will be useful to CIP for managing the impact of this EV and EVSE growth on utility resources and costs?
- Are there decisions that utilities and DOC could make that would hasten CIP's ability to positively impact costs and overall energy use of electric transportation?

- How can the historic strengths of CIP focus on this emerging and rapidly growing end-use?

With the rapid growth of EV and EVSE in MN, we cannot take a long time to answer these questions. The growth in EVs and EVSE will happen with or without CIP engagement due to strong investments from the federal government, automakers, and battery manufacturers matched by strong consumer and business demand. The real issue for CIP is to assist electric transportation in MN to be as clean and beneficial as possible.

Market and Technology Trends

The transportation market is rapidly moving towards electric vehicles and other forms of electric transportation like electric bikes and scooters. In the U.S., this trend may be a bit slower than in other countries, but electrification of transportation options is now a clear and convincing trend. In Europe, there are countries where the sale of EVs has taken a substantial portion of the market share away from ICE vehicles. In Norway, for example, over 80% of vehicles sold were fully electric in the first 8 months of 2021 (Dow, 2021).

EVSE infrastructure is also growing. In the U.S., the number of public chargers has grown to over 110,000 (Niraj, Goldstein, & Woo, 2021); while in MN, there are 1,100 public charging points (PCA, 2021). In addition, there are numerous parties moving to create additional charging infrastructure across the US. The Biden Administration established a goal of 500,000 charging stations across the US while Electrify America is committed to spending $2 billion on charging infrastructure and non-branded EV marketing across the US (Electrify America, 2021).

Consumer Market

The market for EVs and EVSE can be split logically into two broad markets: consumer and commercial. In the consumer market, vehicles are used for individual and family transportation. Charging typically happens at home, work, or at public charging stations. Tesla has been the clear leader in consumer EV sales for the past five years nationally. In MN, 7,700 Tesla vehicles are registered, accounting for 64% of total registrations of battery EVs (PCA, 2021).

The Tesla dominance may decline as more traditional automakers move into the EV market. A recent report by Bloomberg New Energy Finance shows that the three large traditional automakers in the US have committed $100 billion of capital over the next five to six years to electric vehicles (Bullard, 2021). The report suggests that the traditional automakers are backing up their stated EV sales goals with the capital budgets to quickly transition to EVS. Ford and Stellantis have sales goals of 40% EV by 2030, while GM established a goal of one million EVs sold in 2026 (Bullard, 2021). Tesla's growth will continue as the company has budgeted $12 billion in capital expenditures in the 2021-2022 timeframe for US and international investment (Lambert, 2020).

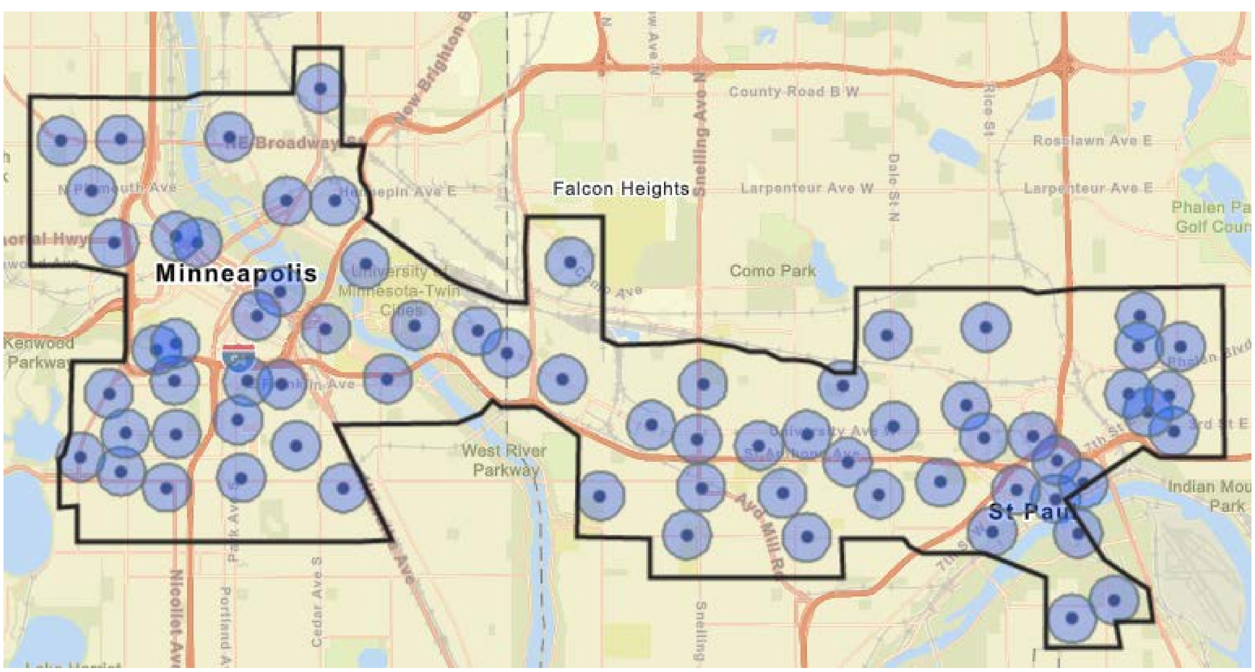
There is a wide range of charging equipment available. Chargers are rated as Level 1, 2 or 3, with Level 1 & 2 being alternating current chargers and Level 3 being direct current fast chargers (DCFC). Table 1 indicates how charging levels vary across various dimensions (Crotty, Jordan, McFarlane, Sexton, & Simons, 2019). Level 1 chargers can utilize a normal household outlet and usually supplied with each vehicle. Level 2 chargers are powered by 240 Volt electricity, like what is necessary to run a central air conditioner or electric clothes dryer.

Table 1: EV Charging Station Speed Comparison

Type of Station	Speed of Charge (Miles per Minute)	Estimated Installed Cost (USD)	Minutes of Charge to Drive 100 Miles
Level 1 - 120 Volt AC	0.1	\$500-\$1,000	1080 (18 hours)
Level 2 - 240 Volt AC	0.4	\$2,000-\$5,000	240 (4 hours)
Level 3 – 50 kW DC	2.9	\$60,000-\$100,000	35
Level 3 – 150 KW DC	8.7	\$100,000-\$150,000	12
Level 3 – 350 kW DC	20.4	> \$150,000	5

Consumer EVSE infrastructure includes at home charging devices, public charging stations, and workplace chargers. There are 1,100 public charging points in MN with 12% of those being Level 3 chargers. National charging networks are growing rapidly. Electrify America, while initially focused on California, is spending \$2 billion over eight years. In its most recent report, Electrify America was installing two DC fast charging stations every five days in the second quarter of 2021 in CA. They are expecting to install over 800 stations with 3,500 fast chargers when they are complete with their current US plans (Electrify America, 2021). Public charging network growth is supported by a variety of MN initiatives, by automakers like Tesla, and by other parties. One example of this acceleration is the upcoming launch of the Evie Spot Network in Minneapolis and St. Paul which will bring an additional seventy curbside charging hubs online over the next twelve months.

Figure 1: Evie Spot Charging Network Proposed for Twin Cities



Commercial Market

The commercial market is comprised of smaller fleets where vans, trucks, or buses transport groups of goods, employees, or customers. This market also includes large fleets for commercial bus operations like the Metropolitan Transit Commission, large school districts, and delivery companies like Amazon, FedEx, UPS, and the US Postal Service. Commercial EVSE infrastructure includes public chargers but mostly charging stations established at commercial properties specifically to support an organization's fleet.

Commercial fleets are electrifying. Two recent developments in MN are highly supportive of EV fleet electrification. First, utility Transportation Electrification Plans filed with the Minnesota Public Utility Commission (MPUC) created funding and programs to support EVSE. For example, Xcel Energy's plan provides a variety of financial and other support for EVSE (Xcel Energy Transportation Electrification Plan, 2021). Second, coal plant retirement plans eliminate most of MN's the coal-based electric generation by 2030 increasing the EV greenhouse gas reduction advantage during this decade (MPCA M. D., 2021).

Companies with large fleets have committed to timelines to convert from ICE to all-electric trucks. As large fleets convert to electric vehicles, they will create substantial requirements on utilities across the US and MN. School buses, transit buses, USPS delivery vehicles, package delivery companies like UPS, FedEx and Amazon have fleets which range from dozens to tens of thousands of vehicles across the US. Charging for fleets will require distribution upgrades including localized substations and potentially new transmission facilities. Chargers for large fleets are expected to be primarily DCFC chargers, with the largest DCFC exceeding 1 MW demand levels. McKinsey has estimated that by 2030, fleet EVs would potentially consume 230 terawatt-hours of electricity, equal to 6% of current electric use in the US (Bland, Wenting, Noffsinger, & Siccardo, 2020). This assessment assumes that 15-20% of fleet vehicles would be electric by 2030.

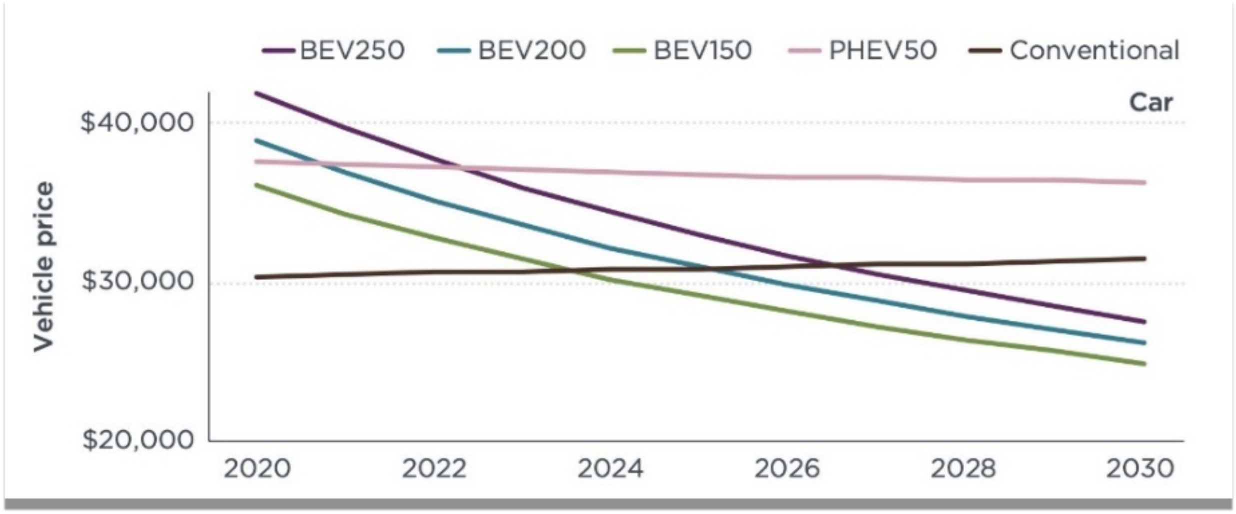
As an example, Amazon has over 60,000 delivery vehicles in its fleet as of 2019 (Shoulberg, 2019). It has ordered 100,000 Rivian electric vehicles. Amazon intends to convert its US fleet to 100% electric vehicles by 2030 (Amazon, 2019). In MN, Amazon currently has distribution centers in Brooklyn Center and Shakopee. Amazon is opening a third MN center in St. Cloud in 2021 (Wiita, 2021).

Delivery companies have already prepared regional, national, or global strategies for converting their fleets to EVs. One of their key challenges is how to work with potentially hundreds of utilities across the country and the globe to implement their strategies on timelines that meet their goals. A quote from a recent SEPA EV committee meeting is pertinent, "FedEx has already developed an electrification plan for the global basis. They just don't know how to get that info to utilities and utilities need time to build and construct, especially where large fleets require new substations or transmission." (Bettencourt, 2021)

Technology

Battery efficiency is the most important driver of EV cost parity with ICE vehicles. Battery efficiencies have been on a long-term improvement trend and studies suggest that vehicle cost parity will be achieved in the mid-2020s depending on battery range. Diagram 2 depicts this trend for battery ranges for BEVs of 250-, 200- and 150-mile ranges, and PHEVs with a range of fifty battery miles (Lutsey, 2019). Achievement of cost parity should reduce most consumer anxiety on the pricing of EVs relative to standard ICE vehicles.

Figure 2: EV Cost Parity Forecast by Vehicle Range



Managed charging and the technology to support managed charging is another rapidly evolving area. A 2019 SEPA report provides a solid overview of managed charging options, technologies, utility pilots, and challenges associated with implementing them (Hanvey, 2019). Per that report, there are two types of managed charging. The first type is 'passive,' like a time-of-use rate where customers respond to a rate structure with higher prices during peak periods or they receive incentives for voluntarily curtailing loads in response to an event announcement. The second type, 'active' managed charging involves physical equipment and communications technology. This technology allows a variety of sophisticated control capabilities including the ability to alter charging intensity or patterns depending on electric costs, capacity levels on the electric grid, or availability of renewable energy generation. Active charging can even take the form of vehicle-to-grid options where EV batteries may supply energy back to the grid.

Table 2: Examples of Managed Charging

Passive Charging	Active Charging
EV time-varying rates including time-of-use rates and hourly dynamic rates	Direct load control via the charging device
Communication to customer to voluntarily reduce charging load (e.g., behavioral demand response event)	Direct load control via automaker telematics
Incentive programs rewarding off-peak charging	Direct load control via a smart circuit breaker or panel

In a MN case study of thirty-five vehicles, Wright-Hennepin Cooperative in partnership with charging solution provider ZEF Energy assessed the value of passive managed charging (a time-of-use program option and an overnight charging option) compared to the impacts of unmanaged charging. The TOU program scenario resulted in distribution upgrade costs of $1.67 million per year. However, this was a more cost-effective route compared to the $2.9 million per year in upgrade costs estimated for an unmanaged charging environment. In looking only at distribution upgrade costs, Wright Hennepin Cooperative and ZEF Energy concluded that the utility's ROI per connected EV would be 49 years if they left member (customer) charging unmanaged. In comparison, they estimated an ROI of eight to nine years for a TOU program and fourteen years for an Overnight Charging program. The difference in ROI is based on varying levels of expected adoption, estimated grid capacity impacts, and the rates that members would pay under these programs (Hoye, 2021).

Benefits of managed charging are likely to increase in the future as EVs become more prevalent. Managed charging's benefits include improving utility system load factor, allowing charging to occur at lower cost time periods, synchronizing charging with periods of high penetration of renewable sources, and reducing consumer costs. Given the size of the current market and the changing technology, this would be a good area for MN utilities to pilot a variety of managed charging programs, technologies, and patterns of customer behavior.

Policy Context

The context for rapid integration of CIP in the growing EV/EVSE market includes strongly supporting trends in federal and state policy, including recent passage of the Eco Act.

Federal

The Biden Administration recently established two high-level policy goals related to EVs. The first is the goal to build out a national network of 500,000 EV charging stations by 2030. The second more recent goal; it is to have 50% penetration rate of low emission vehicles in the US by 2030.

In support of these goals, a patchwork of existing programs is summarized in a White House Fact Sheet April 22, 2021 (White House, 2021). The fact sheet shows multiple EV and EVSE funding, tax credit, financing and incentive opportunities from the Departments of Transportation and Energy and the General Services Administration.

Additionally, the Infrastructure Investment and Jobs Act includes provisions that will help drive the automobile market increasingly to fully electric, plug-in hybrid, and fuel cell technologies. A key provision includes substantial funding to build out EVSE across the country to support the 500,000 EV charging station goal. Assuming the legislation becomes law “MN would expect to receive $68 million over five years to support the expansion of an EV charging network in the state” (Biden-Harris, 2021). In addition, the Biden Administration along with key members of the Senate and Congress are working on an overall budget framework that includes a Clean Electricity Payment Program (CEPP) which would speed up renewable energy investment by utilities across the country.

Passage of these two bills will create huge advantages for electric transportation, first by investing in a national charging network, but also by increasing the emissions reduction of an electric transportation system. While uncertainty exists as to the final form of these bills, they aggressively create momentum towards cleaner, electric transportation standards.

Minnesota

The MN legislature, state agencies, and the MN Public Utility Commission (MPUC) are increasingly active on electric transportation. MN’s energy vision was set with The Next Generation Act in 2007 which established a goal of an 80% reduction in greenhouse gases by 2050; interim goals for a 15% reduction by 2015; and a 30% reduction by 2025 were also set (MPCA M. D., 2021). For about a decade, Minnesota did not support this goal except in the utility sector. More recently, when it became clear that MN was falling behind on the Next Generation Act goals, a concerted multi-agency effort began to create momentum for reducing greenhouse gases, but it also directly aimed at improving emissions performance in the transportation sector. Actions MN has taken since the Next Generation Act include:

- 2009 - The MN legislature allows non-utility entities to sell electricity for EV charging (MN Statutes 216B.02, 2020)
- 2014 – MN Legislature requires utilities to facilitate EV charging through specific EV rate structures (MN Statutes 216B.1614, 2020)

- 2019, February - MPUC orders that electric transportation is in the public interest; utilities should encourage electric transportation; and electric utilities should undertake a variety of measures including construction of EV charging infrastructure, educating consumers, proposing pilot programs and a variety of other activities (MPUC EV Order, 2019).
- 2019 – MPCA proposes Clean Cars MN rules.
- 2019, June – In response to MPUC order above, investor-owned utilities file Transportation Electrification Plans. These are updated annually.
- 2019, December – By executive order, Governor Walz creates a cross-agency Climate Change Subcabinet and an Advisory Council on Climate Change (Walz, 2019).
- 2019 – Walz Administration establishes goal of 20% EV penetration rate by 2030.
- 2021 – Governor Walz signs the ECO Act into law.
- 2021 – Gov. Walz announces proposals to move the state to 100% clean electricity by 2040 (Walz & Flanagan, 2021).
- 2021 - "MPCA has adopted rules that require vehicle manufacturers to deliver vehicles to the MN market that produce lower emissions of greenhouse gases (GHG) and other air pollutants. The Clean Cars MN rulemaking includes standards for Low Emission Vehicles (LEV) and Zero Emission Vehicles (ZEV)." (MPCA, 2021-2) Administrative Law Judge Palmer-Denig approved these rules on May 17, 2021 (Clean Cars Minnesota, 2021).

These changes in MN have built momentum for the advancement of EVs and support for EVSE in MN. But more support is needed, and the ECO Act provides a pathway to further build that support and focus CIP on high efficiency options.

ECO Act: Impacts on CIP

In 2005, the DOC in its regulatory oversight of CIP prohibited fuel switching from CIP programs and funding (Garvey, Edward, 2005). This guidance was intended to prevent utilities from using energy efficiency incentive money as a tool to lure customers from one utility-based fuel, either electricity or natural gas, to another fuel. One of the impacts of this prohibition is that CIP has been unable to respond to the challenges of a new growing electric end-use, EV charging, along with other electrification technologies like heat pumps and electric kitchens. At the time, this guidance was needed to limit time-consuming issues. Importantly though, DOC never updated the guidance after passage of the Next Generation Act of 2007 nor did was it synchronized with MN's decarbonization goals.

The passage of the ECO Act during the 2021 MN legislative session is the most impactful re-write of CIP since the Next Generation Act in 2007. This statute modernized CIP with substantial changes including:

- Fuel Switching: Allowed under certain criteria
- Load Management: Now eligible and desired in CIP
- Low Income Spending: Increased significantly
- Preweatherization Low-Income Costs: Included with conditions
- Energy Efficiency Resource Standard (EERS): Raised
- Utility Spending Requirements: Eliminated

Now, the ECO Act better positions the CIP framework to help MN manage the evolution to a more electrified economy. Although work remains to move from legislation to actual implementation, it is a critical advancement that the fuel-switching component of the ECO Act could include support for EVs and EVSE. The new direction and modern tools from the ECO Act better align CIP with the overall state goals on climate change, health, and equity. Later sections of this paper propose a path for engaging CIP in the evolution to electric transportation in MN.

CIP has traditionally focused on homes, buildings, and industrial facilities. Due to this focus, it has been difficult to envision CIP engagement in transportation, as our gasoline-powered transportation system is fueled by non-utility entities. Once EVs established an emergent market, there is no specific reason CIP could not engage with a focus on high efficiency charging equipment, but there has been few if any attempts to bring forward EVSE or EV focused programs. There are numerous potential reasons why CIP participants were reticent to propose such programs including:

- The DOC fuel-switching prohibition
- CIP's historic focus on buildings
- A perception that CIP EV financial incentives would only go to high-income consumers
- Lack of focus on significant differences in efficiency levels of chargers and EVs
- Uncertainty about the cost-effectiveness analysis of these programs analyzed in the CIP process
- MPUC proceedings on EVs were already underway

Consumer purchases of EVs might logically fall into a fuel switching category, but charging infrastructure is a necessity for EV owners. Thus, EVSE is a CIP eligible electric end-use even if a fuel switching prohibition were in place. Cost-effective EVSE programs could have been included in CIP prior to the ECO

Act. The existence of the fuel switching prohibition and other reasons have placed CIP in a catch-up mode when considering the growth rate of electric transportation across MN.

Now, the ECO Act supersedes these arguments and replaces any regulatory interpretation that prohibited fuel-switching. This should erase any remaining doubt as to the status of EVSE and EVs within CIP. EVs and EVSE are a growing and potentially major electric end-use which CIP should target as soon as possible.

Summary Observations

This review of the policy and market trends affecting electric transportation highlights only a sample of this fast-changing industry and policy landscape. The following summary observations describe the common trends:

- Federal and state policy strongly favor electric transportation, although there are questions as to how fully that support transfers to legislation and budgets.
- Businesses that run large vehicle fleets have forcefully committed to vehicle electrification.
- Auto manufacturers are re-directing capital budgets to the electrification of their product lines.
- Battery efficiency gains will bring EVs into cost parity with ICE vehicles in the next five years.
- Managed charging technology is available and will improve as the EV market expands.
- The transition to EVs will accelerate quickly with policy, market, technology, and consumer factors in alignment.
- CIP is now positioned to participate in the transition to electric transportation.

Benefits and Challenges for EVs and EVSE

The benefits of EVs include less energy used, lower CO_2 emissions, healthier neighborhoods due to eliminating point of use particulate emissions, fewer maintenance requirements, and reduced noise levels as compared to their ICE counterparts. In a report issued by Great Plains Institute in early 2019, EVs were already 38% less CO_2 intensive than ICE vehicles based on 2016 Midcontinent Area actual electric emissions. This emissions differential will significantly improve by 2030 to less than 50% of ICE emissions (Great Plains Institute, 2019). EVs produce 65% fewer emissions of greenhouse gases than ICE vehicles given MN's current electric generation mix (MPCA, 2021-2) and that will increase as more coal generation is retired.

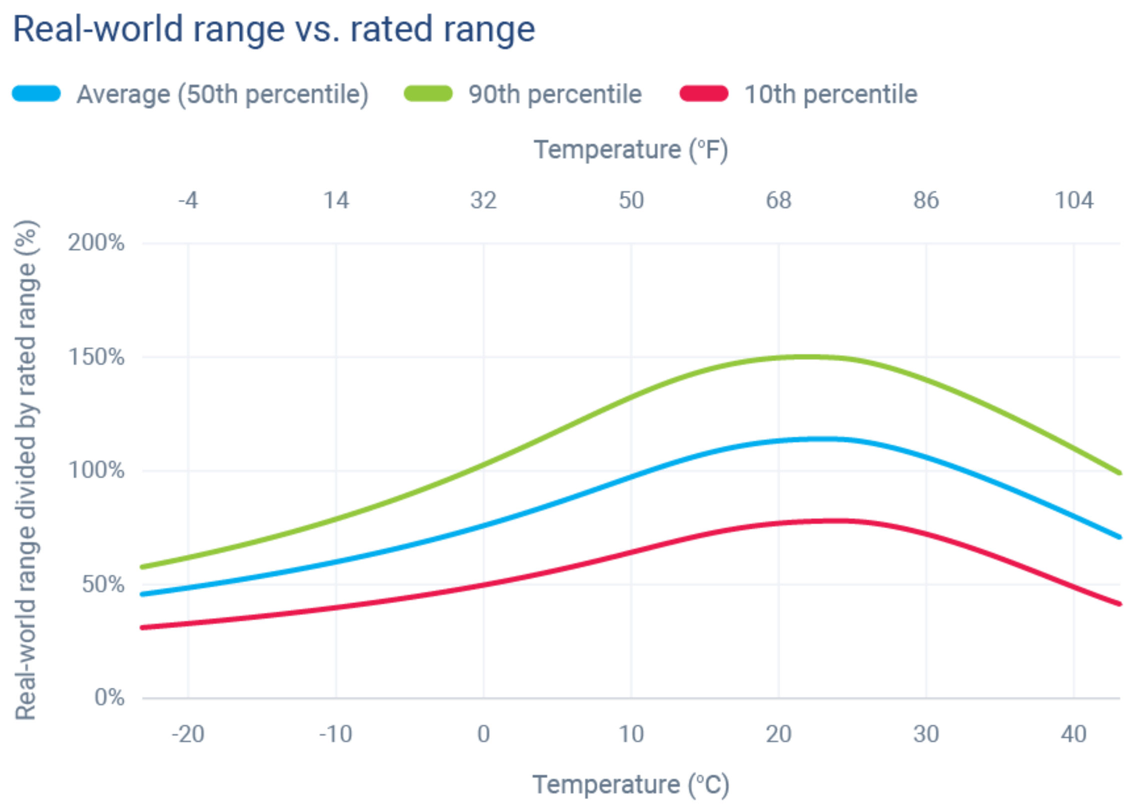
Due to the significant evolution of MN's electric generation system towards renewable energy, oil-based transportation is now the largest carbon emissions sector of the MN economy. It is highly unlikely that MN will meet is decarbonization goals without a rapid and strong contribution from EVs. There are challenges to overcome though for EVs generally and more specifically in MN. The more general issues include range anxiety where consumers worry about charging on longer trips, lack of public charging infrastructure, and low dealer interest in selling EVs.

All vehicles, but especially EVs, have been affected by global supply chain issues which reduced the availability of vehicles and chargers while lengthening the delivery times for a variety of EVSE and EV components. One of the key issues is chip shortages for electronics in EVs and EVSE which are delaying consumer purchases, public EVSE installations and fleet transitions. Until the supply chain issues are resolved, we can expect the ramp up of EVs and EVSE to go slower than desired or previously anticipated.

In MN, two specific issues exist:

- Cold Climate – We know battery performance declines in cold winter weather, but it also declines in hotter weather. There are two primary reasons for performance declines in cold weather: auxiliary loads to heat/cool occupants and the cabin, and thermal management of the battery. Geotab, a Canadian EV data analytics firm, assessed 5.2 million EV trips, by about 6,300 vehicles in Canada and compared the actual range to each vehicles rated range. Figure 3 summarizes the results showing in temperatures below -4 F, that range may erode by 50% (Argue, 2020).
- Limited Supply – MN consumers face a lack of EV supply at auto dealers, which should be partially rectified by the MPCA's Clean Cars Minnesota standards.

Figure 3: GeoTab Study: Temperature Impact on Driving Range



Points of Leverage

The DOC and the CIP process can help overcome these challenges. While other MN state agencies and departments have forcefully moved policy ahead, notably the MPCA with the Clean Car Standard, and the MN Public Utilities Commission (MPUC) with utility Transportation Electrification Plans, the CIP process has been notably lagging on EVs and EVSE. Fortunately, there are four key leverage points that can provide rapid CIP engagement in MN's drive to electrify transportation. The four key leverage points are:

- CIP's Niche in State Energy Policy
- ENERGY STAR® EVSE Standards
- DOE/EPA fuel economy ratings for EVs
- CIP Process Strengths.

CIP's Niche in State Energy Policy

CIP has been a major pillar of MN energy policy for decades. Through CIP, markets have been transformed to higher efficiency equipment with CIP-funded education, incentives and financing, assessments, and studies, building modeling, and direct installation of energy-saving equipment. By legislative and regulatory design, CIP serves a specific niche within state energy policy: the provision of cost-effective energy efficiency services across the state. This niche allows CIP to focus on efficiency while leaving other agencies to manage the broader transition to electric transportation in the state.

From an EV and EVSE perspective, CIP has a unique opportunity to help focus the EV transition in MN on the most efficient alternatives. CIP is not required to make the EV transition happen, but CIP can encourage consumers and businesses to select high-efficiency EVSE and high-mileage EVs. CIP programs can also lead on load management of charging patterns to utility distribution and transmission investments. In addition, the DOC can provide leadership across state agencies by advocating for efficiency and load management as other agencies set in place programs and regulation to foster the overall EV transition. Working this niche in the EV and EVSE markets should be freeing to CIP policy makers and utility staffs as programs can be designed to target high-efficiency models and managing charging patterns rather than the broader work of moving the entire vehicle market to EVs.

ENERGY STAR® EVSE Standards

One of the quick ways to help move markets along the energy efficiency spectrum is to set standards or, better yet, to use existing standards as a basis for incentivizing consumer and business behavior. Fortunately for MN, such a standard already exists for EVSE from ENERGY STAR®.

ENERGY STAR® has been a leading source for utility energy efficiency program standards for decades. ENERGY STAR® branding is widely used and 90% of households recognize the brand (ENERGY STAR, 2021). ENERGY STAR® certification standards are featured in utility energy efficiency programs across the country and applied to a wide variety of end uses including appliances, heating and cooling systems, office equipment, data centers, and lighting.

ENERGY STAR® originally established standards for EVSE in 2016. The standard was recently updated to include DCFC chargers up to 350 kW and to adjust for 'smart' charging capabilities (Banwell, Meyers, Montero, & Noblet, 2020). Many charger equipment vendors are still in the re-certification process but most qualifying chargers under the original version are expected to successfully re-test (Schneider, 2021). ENERGY STAR® maintains a list of qualifying EVSE on their website.

ENERGY STAR® qualified chargers use up to 40% less energy than less efficient chargers. One of the primary ways this happens is that higher-rated chargers use less energy when operating in standby mode. A typical residential charger operates in standby mode for an estimated 85% of the time.

Charging is also more efficient as the wattage level increases. Level 2 chargers are about 10% more efficient than Level 1 charging even while charging four times faster. Level 3 is inherently more efficient than Level 2. ENERGY STAR® has standards for Level 1, 2, and 3 EVSE up to 350 kW. It also provides allowances for different managed charging technologies. Level 2 and 3 chargers will require more distribution upgrades and should be paired with managed charging equipment to reduce to needed distribution investments (Banwell, Meyers, Montero, & Noblet, 2020).

MN Utility CIP programs can leverage ENERGY STAR® as an off-the-shelf, ready-to-use standard for EVSE efficiency as utilities in other states do (See Box to right). ENERGY STAR® qualified equipment saves energy compared to other equipment. In addition, consumers can be assured that they are safe and reliable. They will reduce greenhouse emissions even more than other options so they will be an adder to MN's decarbonization efforts. There are at least three ways to use ENERGY STAR®:

- As a minimum standard for qualifying equipment in utility programs.
- To recommend Level 2 and 3 equipment where appropriate because they are more efficient.
- As a focus to help assess EVSE options for managed or smart charging in load management applications.

Utility ENERGY STAR® EVSE Programs

Public Service of Oklahoma

- New Homes Rebate Program
- $250 Rebate, subject to program cap

Southwestern Electric Power Company

- $250 incentive for Level 2 chargers

Potomac Edison of Maryland

- EV Driven Program - $300 rebates
- Multi-Family Program – up to $20K of construction cost for Level 2 & 3 chargers

PNM Resources

- Level 2 chargers - $300 rebates
- Up to $1,000 for electric panel upgrades

DOE/EPA EV Fuel Economy Ratings

DOE in collaboration with EPA establishes fuel economy ratings for vehicles fueled by both gasoline and electricity. The ratings differentiate between vehicle makes and models so consumers can estimate operating costs. For EVs, fuel economy is stated in Miles Per Gallon Equivalent (MPGe), which is structured so it represents the amount of electric energy that is equivalent to the energy content of a gallon of gasoline. MPGe ratings are a measure of overall EV efficiency.

EV fuel economy ratings can be used as a standardized rating to design CIP EV programs. While there is not a readily available standard and baseline for MPGe, like there is for EVSE under ENERGY STAR®, one could be readily designed for CIP purposes in MN as shown in the example below. In this simplified example, it proposes a method for using MPGe to incent high-mileage EVs while staying within CIP budget guidelines under the ECO Act.

Using CIP for direct support of EVs is now allowed by the ECO Act. Previously, this would not have been an acceptable use of a utility's CIP funds. There are a couple of constraints though. First, any program directly targeting EVs would have to pass the four fuel-switching criteria outlined in the ECO Act:

- *The measure results in a net reduction in the amount of source energy consumed on a fuel-neutral basis.* It is likely that EVs will be able to qualify on this criteria and higher-mileage EVs will pass easily.

- *Results in a net reduction in statewide greenhouse gas emissions.* MPCA reports show that EVs reduce greenhouse gases substantially and, as MN's electric generation system becomes more renewable-based, that reduction will be grow.

- *Is cost-effective considering the costs and benefits from the perspective of the utility, participants, and society*. It is likely that EVs will pass cost-effectiveness tests from participant and societal perspectives, but specific program designs and budgets will need to be assessed on a case-by-case basis.

- *Is installed in a manner that improves the utility's system load factor*. EV and EVSE incentives when paired with managed charging will improve a utility system load factor. As the penetration of EVs increases over the next decade, managed charging programs may need to reflect changing utility system load factors as EVs and other electrification options increase.

One of the advantages of being aggressive on EV programs now is that the market for EVs is still relatively small, so program cost would be manageable, but it could set long-term market behavior to better understand the importance of efficiency and load management in charging. In the example shown to the right, a $1.5 million budget is under 2% of overall CIP expenditures. Clearly if the EV market really accelerated, utilities and the DOC could adjust qualifying criteria and incentive budgets to manage overall CIP portfolios appropriately. Programs like these would have longer-term impacts through early-stage market development.

CIP EV Program Concept

1) Establish Mileage Standard for High Efficiency

- 120 MPGe targets 20% of models
- Allows for diversity of models (8) and automakers (3)
- Tesla, Chevrolet, and Hyundai
- 43 total models available in market with ratings of 70-142 MPGe

2) Set Budget and Incentive Level

- $1K per high mileage EV
- 20% of 5K vehicles sold per year
- $1M incentive budget
- Add 50% for administrative, education, marketing, dealer engagement activities
- $1.5M budget, 1-2% total statewide CIP budget

3) Downstream Change

- Raise MPGe target % of market as new models enter market

One drawback of this approach is that CIP is driven by individual utility plans and there would be potential difficulties at auto dealerships if incentive levels differed by utility or not all utilities participated. Direction from DOC may be useful to solve this issue.

CIP Process Strengths

CIP has been one of the most consistent and impactful models for utility-led energy efficiency programs across the United States. CIP has been a key part of energy policy in MN for four decades. During this time, MN consumers have benefited from direct participation in CIP programs and indirectly by cost reductions for energy infrastructure. When Cadmus assessed the economic benefit of CIP for 2008-2013, participating consumers saved $1 billion in energy bills while $3.75 in benefits was generated for MN for every CIP $1 expended (Cadmus, 2020). In addition, thousands of jobs in MN were supported by CIP.

CIP has funded the development, implementation, and assessment of hundreds of energy efficiency programs in MN over four decades. This experience provides a paradigm for EV and EVSE program development due to six assets within the process itself:

- Regulatory Process: CIP brings a strong, well-tuned regulatory process in which utilities and other parties participate. This ensures that programs are cost-effective not just for utilities but for consumers. This process also ensures that programs are aligned with legislative intent and overall state energy policy goals.

- Utility Brand Awareness: Utility programs have been in existences for four decades. Electric consumers are aware of them and have come to expect that utilities will help consumers and businesses make better decisions when buying electric and gas end-use equipment.

- Program Development and Program Management Processes and Staffing: The larger utilities in the state, especially, have trained and experienced staff who understand how to develop and manage programs. In addition, there are experienced firms in the industry that utility departments can contract with to develop and manage innovative programs if internal staffing needs assistance. If EVs and/or EVSE are included in CIP, the utilities and the energy efficiency industry are positioned to analyze markets, develop new program designs, and implement programs in the field.

- Trade Ally Networks: The CIP process has developed a network of thousands of participating vendors, contractors, electricians, and others who participate in utility-run CIP programs. This network has been trained on energy efficiency practices. Portions of the trade ally networks, especially electricians and home builders, supply a knowledgeable workforce to apply to EVSE programs. Developing auto dealer networks will be a new task for utilities, but some MN utilities are already working on dealer support for EVs and EVSE.

- Cost-Effectiveness Infrastructure: CIP uses a robust cost-effectiveness analysis which provides information for assessing programs from societal, utility, consumer, and rates perspectives. While there is an action item in the ECO Act to update this tool for fuel switching and better fuel neutrality analysis, there is a strong underlying analytical platform on which to make those changes.

- Scale: The CIP process manages over $100 million in direct utility expenditures within the state and millions more of consumer expenditures. CIP provides consumers with education, incentives, and technical expertise at a size that dwarfs most other state-managed programs and should be leveraged.

These assets have been built into the CIP process over four decades. They have been strengthened at times by modernizing the goals and policies for CIP, like The Next Generation Act in 2007, and now the ECO Act. These assets provide a springboard for EV and EVSE programs that can help formulate the initial base of programs on which to boost performance and set future market expectations for efficiency in the electric transportation sector.

Conclusions and Recommendations

In the Introduction to this paper, we raised five questions. This paper has addressed each one:

- *Can CIP drive the MN EVSE market to focus on higher efficiency equipment?* Yes, the ECO Act allows utilities to develop CIP programs focused on beneficial electrification including electric transportation options. By using the ENERGY STAR® EVSE standards and DOE/EPA fuel economy standards, CIP can quickly develop programs to move the respective markets in MN to a focus on higher efficiency chargers and vehicles. Through application of the assets that CIP has applied to other electric end-uses over the years, CIP can alter the electric transportation markets in MN.

- *What standards are available for use by utilities and DOC to measure the efficiency of EVs and EVSE?* This paper has shown that existing measures of efficiency are available. For EVs, the DOE/EPA Fuel Economy standards, measured in MPGe, can be used. For EVSE, the ENERGY STAR® standards can be utilized.

- *CIP now includes load management. Is load management an option that will be useful to CIP for managing the impact of this EV and EVSE growth on utility resources and costs?* Yes, load management, also known as managed charging, can provide large benefits by managing the scheduling and leveling of EV charging. Large scale application of EV/EVSE managed charging applications should be able to reduce utility distribution and transmission costs. In the future, it may also be possible for EVs to supply grid support in vehicle-to-grid applications.

- *Are there decisions that utilities and DOC could make that would hasten CIP's ability to positively impact costs and overall energy use of electric transportation?* Yes, needed decisions are outlined in the Recommendations section below, specifically in the 'Issue Policy Guidance' recommendation.

- *How can the historic strengths of CIP focus on this emerging and rapidly growing end-use?* CIP has strengths as described in the Leverage Points section above. Recommendations below supply specific actions regulators and utilities can take to rapidly focus on electric transportation.

Recommendations

MN electric utilities and the Department of Commerce through CIP have a responsibility to work together to consider all efficient electric end-uses, including EVs and EVSE. Utilities should develop and design effective, targeted programs to help manage EV penetration in a highly efficient manner. As MN state agencies move forward on the state's decarbonization goals, CIP should help MN implement electric transportation in ways that make the path to decarbonization as efficient as possible from an energy and a cost standpoint. Aggressively using CIP's unique assets developed over the past four decades is the fastest means for the state to help manage the efficiency of electric transportation.

Here is a set of eight recommendations that lay out an aggressive roadmap for the next couple of years to position CIP to direct the incoming EV wave. The first three are direct actions that DOC management can take and the following five are program modifications or new program concepts that utilities can propose.

1. Issue Policy Guidance: One of the most immediate actions that the DOC can take would be to issue policy guidance. This is a frequently used tool to provide utilities with direction; for example, guidance is often issued to utilities prior to each CIP triennial planning cycle. Policy guidance can jumpstart progress on moving towards high-efficiency EVs and EVSE. This guidance should include:

    - *Rescind the CIP Ban on Fuel Switching*: This ban from 2005 is still 'on the books' even with the ECO Act. Rescinding this decision will produce clarity and reduce uncertainty, not just for EV/EVSE programs, but all electrification efforts.

    - *Affirm that ENERGY STAR® compliant chargers are eligible for CIP programs*. This could be short-term policy, say two to three years, until utilities have better ability to assess the rapidly changing EVSE market.

    - *Direct the CIP Benefit-Cost Task Force to work with Department Staff* to determine the initial set of conditions to satisfy the ECO Act's four factors for passing the eligibility test for fuel switching.

    - *Provide specific direction to utilities* to rapidly integrate appropriate portions of their Transportation Electrification Plans into CIP where appropriate, including increasing existing rebates when customers install high efficiency EVSE.

    - *Encourage Load Management Options* on all aspects of EVSE-related programs or program modifications and request that utilities file pilot load management programs. This way, managed charging technologies, capabilities, and systems can be evaluated early by the CIP process so that better long-range strategies can be implemented across the state as EV market penetrations increase.

    - *Direct the Development of New Technical Resource Manual Measures* that correspond to the above guidance for EVSE.

The CIP goal setting process is grounded in detailed data provided by an energy efficiency market potential study. Such a study was completed under DOC direction in 2019 on a statewide basis (Nelson, 2018). It is an excellent source of information on energy efficiency options but, unfortunately, that study did not assess EVs, EVSE and related load management options. The next recommendation addresses that data gap.

2. Extend the 2019 Statewide Energy Efficiency Market Potential Study: The statewide energy efficiency potential study completed in 2019 is a huge resource for all involved in CIP. Now with passage of the ECO Act, CIP has two new areas of responsibility: *efficient fuel switching and load management*. By assessing the market potential of these two areas, the state would be well-served going forward. The purpose of this recommendation is to assess the technical, economic, and market potential for the new areas of responsibility. Under efficient fuel switching, EVs, EVSE, and other electrification options would be included. The analysis and datasets created through this

study would help utilities and third parties to assess program options and, for DOC staff, to estimate program sizing and appropriate baselines. The information may also inform future utility Transportation Electrification plans. This study could be funded through the Conservation Applied Research and Development (CARD) program, like the most recent statewide study.

Managing the electric load created by electrifying transportation will be key to the ability of MN's utilities to keep prices low, capital expenditures reasonable, and overall service levels high. Load management enabled as a component of CIP under the ECO Act is the way that utilities of all types will be able to respond to this dynamic new load. EV load management includes forms like time-of-use pricing, control-of-devices, smart charger communications, demand response, and potentially vehicle-to-grid support.

3. Create a Load Management Technical Advisory Group: MN's utilities have previously engaged in load management, like Xcel Energy's Savers' Switch program and cooperatives' rates encouraging thermal storage. Electrifying transportation will create massive shifts in overall electricity sales which will interact with other forms of electrification encouraged by the ECO Act. Smart, managed charging technologies are swiftly evolving and an advisory group in collaboration with the DOC and MPUC, could sort through options and better direct utility load management expenditures over time.

Utilities are responsible for meeting CIP goals and driving consumers to use higher efficiency measures and now under the ECO Act, lower CO_2 emitting technologies. CIP plans will need to include at a minimum new measures and programs for high efficiency chargers and potentially high efficiency EVs including:

4. Extend Existing Programs to Include EVSE Options: Existing CIP programs could easily include EVSE components to their incentive structures and coordinate with aspects of utility Transportation Electrification Plans.

   - New Construction Programs: All new single-family residential structures built today should include efficient Level 2 charging equipment. Multi-family structures and commercial buildings that include parking should be incentivized by utilities to install Level 2 and potentially Level 3 chargers depending on size or number of units. Utilities should request modifications to their residential and commercial new construction CIP programs to add high-efficiency ENERGY STAR® compliant EVSE to each program. There will be a significantly higher cost to retrofitting new homes and buildings for EVSE, compared to adding it during initial construction.

   - Rebate and Incentive Programs: Most installations of commercial, residential, and multi-family EVSE will be in retrofit situations for garages, parking lots, and parking ramps. Incentives to foster high-efficiency, managed charging are appropriate now.

   - Information Programs: Utilities and third parties should propose educational and informational programs to build market acceptance of high-efficiency EVs and chargers. These programs could either be included in broader CIP marketing efforts; target specific segments like dealers, technicians, or consumers; or tie into other EV and charger proposals.

There are four program areas that utilities should consider for incorporation within CIP as a direct result of the ECO Act.

5. Low-Income Transportation: Equity as a policy is a key feature of the ECO Act. Electrifying low-income transportation options could be a new program area for utilities as they focus more resources to this market. Options in such a program include incentives for used EV purchases, linking low-income consumers to electric car share or ride hailing options, electric bike rental options, and placement of EVSE in low-income neighborhoods. Innovative education approaches in collaboration with groups already serving these neighborhoods will be necessary. Low-income transportation can be an area where the social equity and the fuel switching features of the ECO Act powerfully perform together.

6. Fleet EVSE Planning and Financial Support: Fleets transforming to EVs, electric buses, or electric trucks require large-scale planning and coordination across disciplines. This is an area where utilities through CIP can target planning support and financial incentives to create forward momentum in decision-making. Large electric fleets will utilize large scale EVSE that may not qualify under ENERGY STAR® but may need custom incentives. Additionally, for companies with national and global fleets, any planning process will need to converge with their national and global plans. Managing and scheduling these charging loads in ways that are consistent with the customer's needs as well as utility load profiles will require well-designed coordination at the customer-utility interface. Given the proposed plans and visions of large fleet owners, incentives may not be necessary, but a focus on distribution upgrades and load management may be key.

7. EVSE Load Management: Utilities were required by legislation in 2014 to initiate rates for EV charging (MN Statutes 216B.1614, 2020). Now, it will be essential to manage overall costs through load management including potentially vehicle-to-grid support for peak periods. Shaping charging load to periods of high renewable generation, managing peak periods on the distribution system, and utilizing EVs as a battery source during peak periods are options that should be set in place as the transition to electric transportation accelerates.

8. High Efficiency EV Programs: After the DOC completes its fuel switching analysis and sets the technical criteria for fuel switching, direct incentives to consumers for purchasing EVs should be added to utility CIP portfolios where appropriate. These incentives may only be affordable for a limited number of years, but there is an initial need to educate consumers on EV efficiency, which is an area where CIP and utilities across the state have experience and expertise.

Conclusion

CIP has been a focal point of energy policy in MN for decades. CIP traditionally has been the engine behind energy efficiency across MN. Now with the passage of the ECO Act, CIP has new responsibilities and an opportunity to use its assets to spur decarbonization, innovation, and additional jobs in MN. MN is behind on its transportation decarbonization goals. An aggressive CIP approach to efficiency in transportation electrification provides higher levels of decarbonization and will have spillover impacts to help grow MN's economy. This paper identifies an aggressive approach for CIP intended to ignite discussion and provide direction for rapid action on electrifying MN's transportation sector in the most efficient manner possible.

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