



Electrification of Transportation

November 29, 2017

ONTARIO**POWER**
GENERATION



OPG Leadership in Electrification of Transportation in Ontario

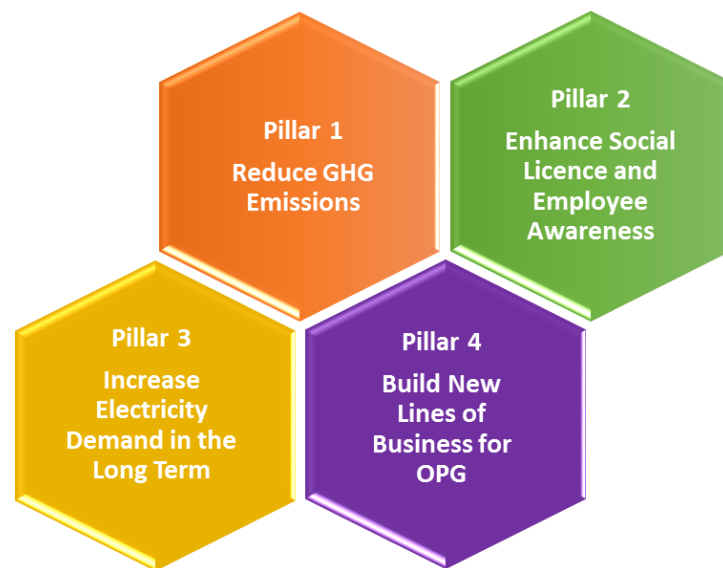
OPG is a pioneer in Ontario's EV sector

- OPG founded Plug n Drive and recently helped fund their EV Discovery Centre
- OPG partnered with GM to help launch the Volt EV in Canada



OPG has launched a 4-pillared strategy to support transportation electrification in Ontario:

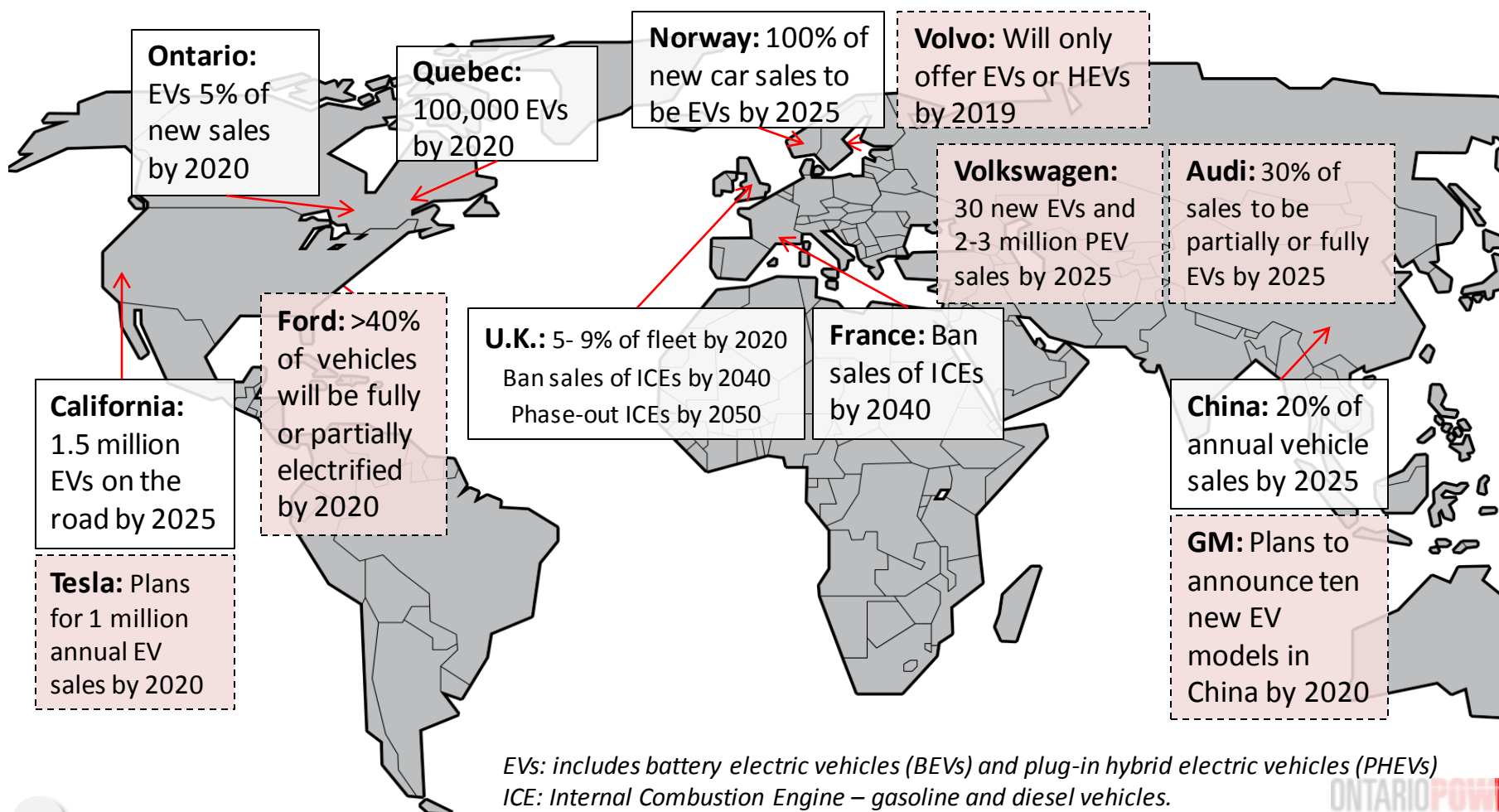
1. Leverage our clean electricity to reduce GHG emissions
2. Enhance OPG's brand, social license & employee awareness
3. Maximize use of existing investments through electricity demand growth
4. Create commercial growth opportunities for OPG





Global EV Targets & Policies

Global policies are driving EV growth and creating new economic opportunities





OPG's Internal Electrification Plan

1. Transitioning of OPG's vehicle fleet to electric is currently underway providing cost savings & GHG reductions

Phase 1 - 2017/18

Cars and Minivans

Continue transition to plug in hybrid and proceed to full battery electric models

Phase 2 - 2018/19

SUVs

Increase adoption as additional vehicle options become available

Phase 3 – 2018/19/20

Pick up Trucks

Develop a pilot project to gain user acceptance
Transition trucks based on vehicle availability

2. **Electric Boat Pilot - 2018**

OPG will pilot electric outboard motors in 2 locations in early 2018 and will look for additional locations 2019-onward.

3. **Workplace Charging for Employees – 2017/18**

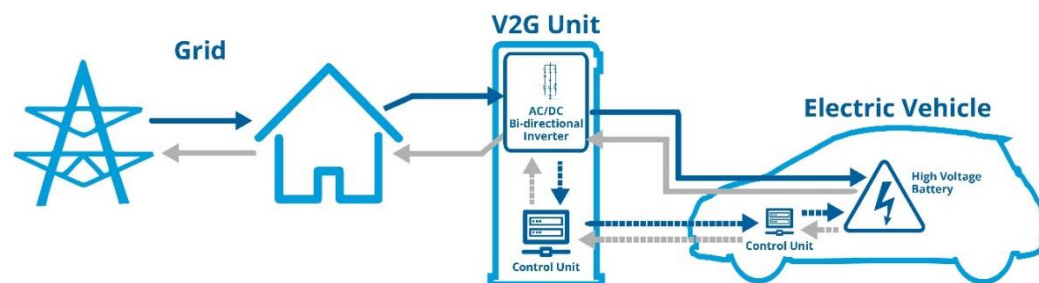
OPG is installing work place chargers in 2017/18 at key sites across our operations.



New Business Opportunities

OPG is also pursuing **new business opportunities** that arise from transportation electrification:

- OPG is interested in **vehicle-grid integration**
 - OPG is planning near-term projects that pilot VGI on commercial fleets

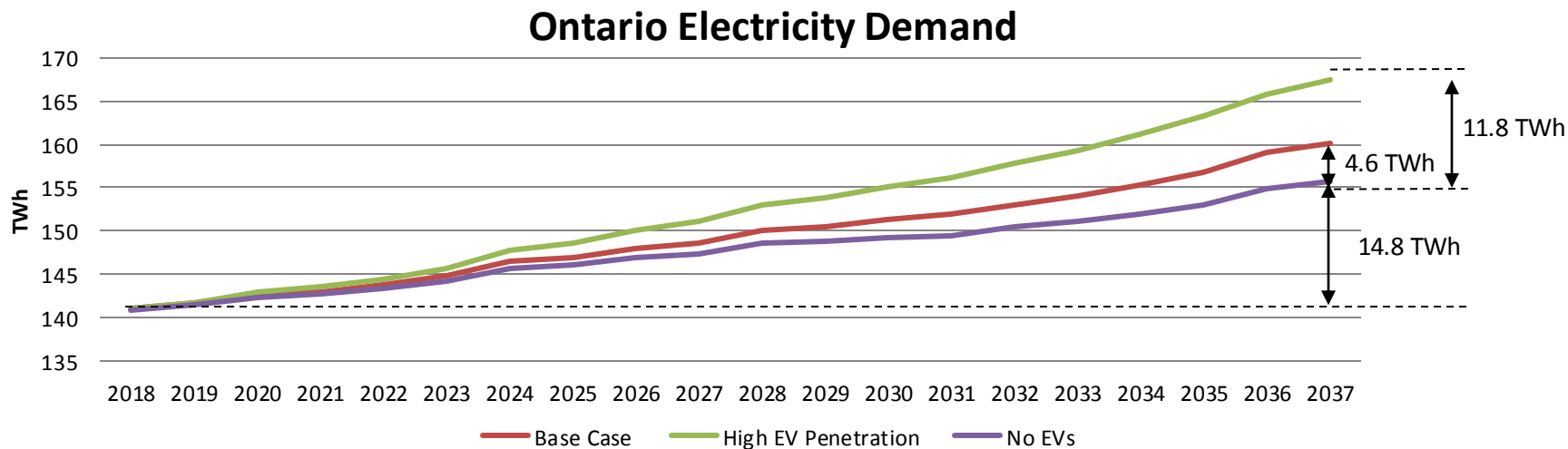


- OPG is also investigating potential for **hydrogen fueled vehicles**
 - OPG is actively evaluating electrolysis projects to produce hydrogen using clean electricity
 - OPG has offered our electricity system analytics capabilities to Metrolinx and its consultants as they assess Hydrail
- These new business opportunities are well aligned with the 2017 LTEP



Electricity Demand Growth

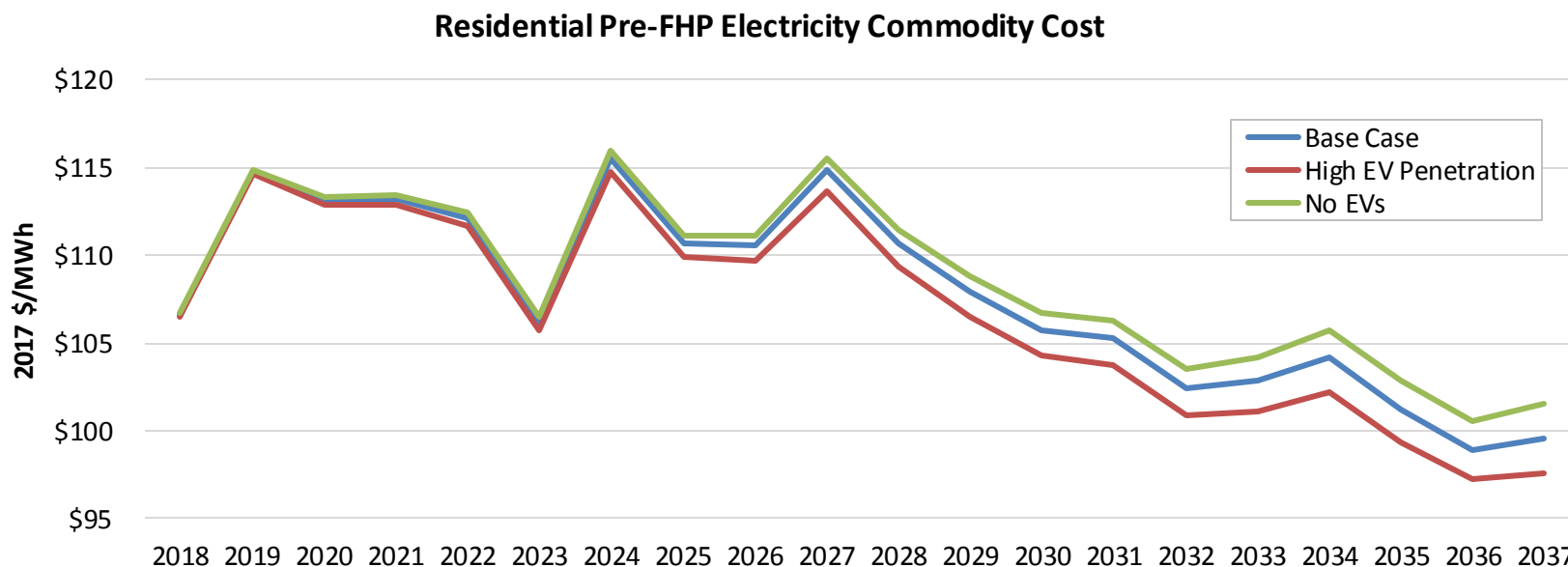
- Electricity demand is expected to remain relatively flat (0.5% growth per year) over the next 20 years
- Electrification of transportation offers a key opportunity to introduce a major new electricity use, boosting electricity demand in the long-term, lowering the price of electricity and reducing GHG emissions
- OPG forecasts that 25-45% of electricity demand growth over the next 20 years could come from EVs
 - This is supported by the IESO's Ontario Planning Outlook which forecasts EVs to provide just under 60% of demand growth in Outlook B and ~25% in Outlook C





EVs Can Lower Electricity Costs

- OPG modeling shows that growth in EVs will lower electricity rates in Ontario if their demand is focused off-peak
- High EV penetration could lead to a 4% decrease in residential electricity commodity cost by 2037
- If EV owners charge when it is convenient (i.e., charging at peak when they arrive home from work), savings will be much more limited



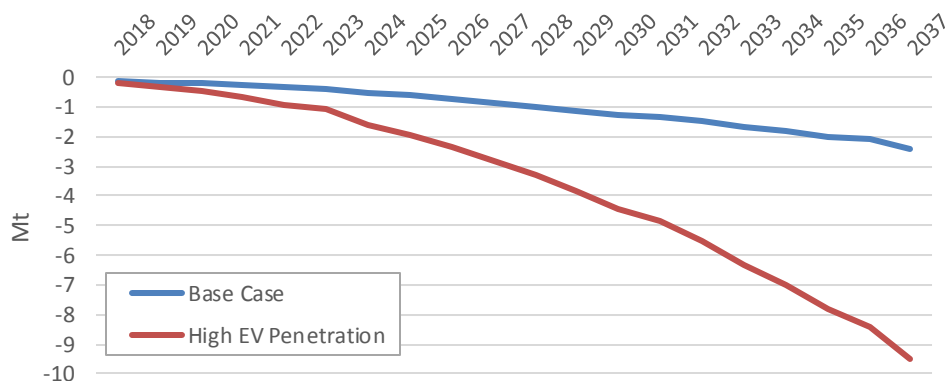
Note: Does not include cost of conservation



Leverage Ontario's Clean Electricity System to Reduce Transportation Emissions

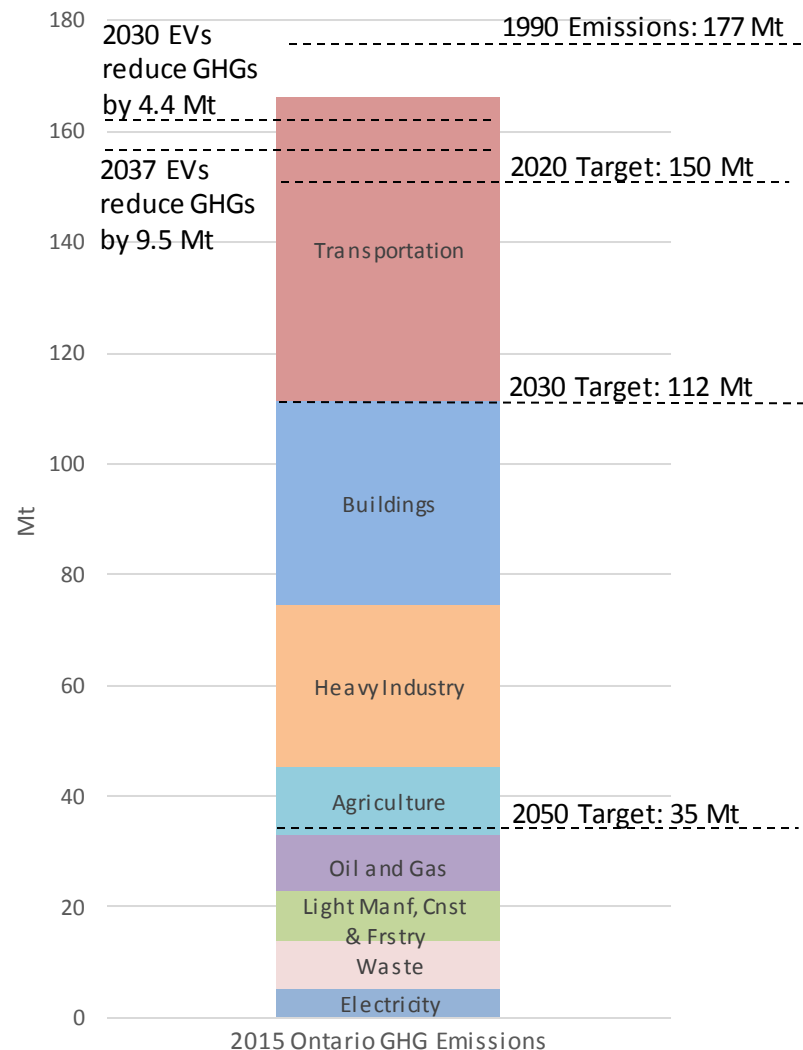
- The transportation sector is the largest emitter of GHGs in Ontario
- High EV penetration could reduce annual Ontario GHG emissions by 9.5 Mt in 2037 or 6% of Ontario's total 2015 emissions
- Adding more non-emitting generation in the medium to long-term could lead to an even greater reduction in Ontario GHG emissions from EVs

Net Annual Reduction in Ontario GHG Emissions



Note: This graph accounts for changes in emissions from converting ICE vehicles to EVs in both the electricity and transportation sectors.

Ontario GHG Emissions

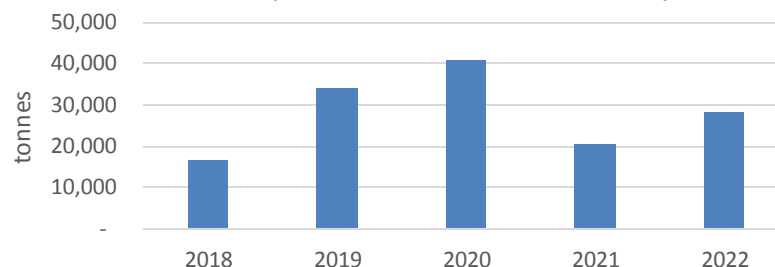




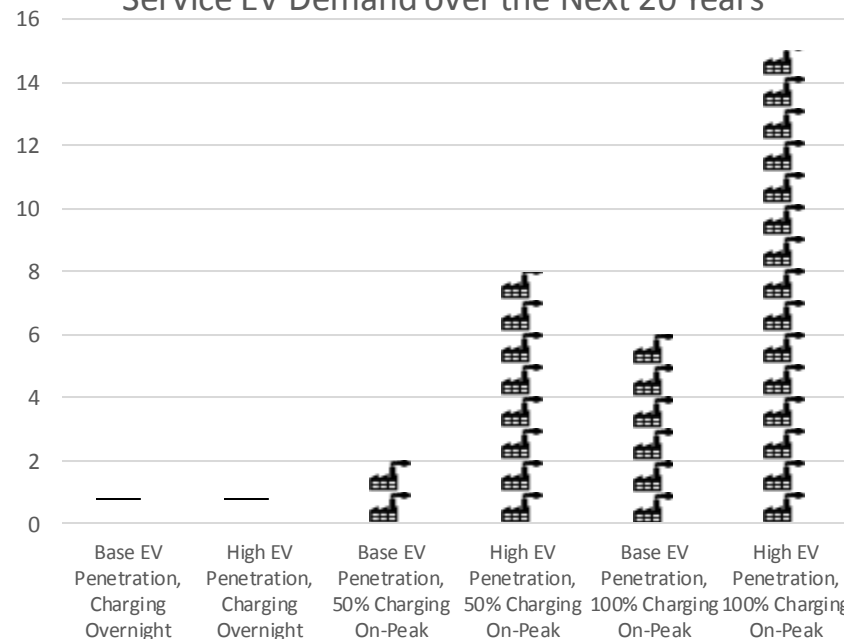
Unmanaged EV Demand Will Increase Costs and GHGs

- On-peak charging will increase electricity system GHG emissions as gas-fired generation is used to meet incremental peak demand
- As EV demand grows, up to 15 new gas-fired generators could be required to meet peak demand, increasing electricity bills for consumers above OPG's base forecast

Incremental GHG Emissions from Charging On-Peak (OPG Base EV Penetration)

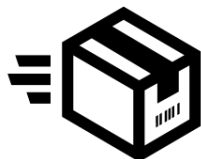


of New Peaking Gas Plants Required to Service EV Demand over the Next 20 Years





Managing EV Demand Across Ontario



- Telematics device that can simply be plugged into any EV's data port by the user to record its charging behaviour. Data transmitted to program manager via cellular network
- Device can be shipped directly to users who then plug-in the device by themselves
- EV drivers reimbursed for overnight charging with rewards points that can be redeemed online
 - Optionality to provide participants with money transfers, prepaid credit cards or gift cards at major retailers
- App to provide insight and analysis into driving and charging patterns and compare to other EV drivers
- Program avoids any regulatory or infrastructure changes making it simple, cost-effective and quick to implement



A Cost-Effective Solution

OPG can operate the program province-wide

- OPG operates throughout the province, allowing EV owners to participate regardless of where they live and which LDC they connect to
- By operating a province-wide program, OPG could leverage economies of scale to reduce program costs by about 50%

Manage EV Demand Cost-Effectively

- Estimated program cost of \$425 per vehicle per year, including the cost of electricity and program operation, is an extremely cost-efficient way of delivering the program
- Total funding of about \$20 million for 2018-2020 would accommodate 30,000 EVs at peak

Cost Offset by Savings for Electricity Ratepayers

- Incenting EVs to charge overnight is forecast to reduce electricity system costs by \$10 million from 2018-2020, largely offsetting the cost of the EV Demand Management Program
- Cost reductions will be achieved by eliminating unnecessary incremental use of natural gas to meet EV demand at peak