SMRT COLUMBUS

PERFORMANCE MEASUREMENT PLAN

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PERFORMANCE MEASUREMENT PLAN

This Performance Measurement Plan (PfMP) supports the Smart Columbus Electrification Project (SCEP), providing traceability, verification, and responsibility of the targeted goals that support the implementation of the SCEP initiatives. This includes overall project goals, performance indicators for projects, priorities and initiatives, and other indicators of progress. As the ultimate goal of the SCEP enabled by the Paul G. Allen Family Foundation (PGAFF) grant is decarbonization, wherever feasible the indicators are further extended to estimates of green-house-gas (GHG) reduction at the overall project level. This PfMP is organized consistent with the five primary project priorities and their related initiatives as conveyed by the SCEP agreement with PGAFF.

OVERALL OBJECTIVES, PRINCIPLES AND ORGANIZATION

1.1 – Objectives

The objective of this PfMP is to layout a framework for the reporting of quantitative progress towards accomplishing of the objectives of the SCEP, the identification and collection of various data sets, and the methodologies to process the data into performance metrics that support the execution, analysis, and reporting of performance indicators at all levels. It informs stakeholders involved in carrying out the SCEP of the required reporting and provides the required data that supports documenting the accomplishments of the program. The plan encompasses the goals, performance indicators, and trackable initiatives to be quantitatively reported, the requirements of the data that will be collected to support the reporting, and the processing of the data to create an effective performance measure indicating attainment of goals and ultimate GHG reduction to validate the success of the PGAFF grant program.

To the extent possible and within the financial resources of the contract, it is the intent of the SCEP to validate the performance indicators based on primary data, that is data directly observed or collected as part of the SCEP program activities. There are instances where secondary data sources (such as published national or regional averages) will need to be utilized because direct observations are infeasible or cost prohibitive. One such example of secondary data is the utilization of BEVs adopted by consumers in which published averages of consumer vehicle miles traveled on an annual basis will be used in the calculation of GHG benefits. However, it is the goal to use primary data for the majority of the program, ensuring that appropriate data collection and reporting are incorporated from the beginning.

1.2 – Principles and Framework

This PfMP is developed concurrently with the USDOT Smart City award which concentrates on the deployment of connected and automated vehicles and transportation infrastructure to increase mobility, increase safety, reduce energy and GHG emissions, and enhance quality of life, particularly with respect to underserved communities. Where appropriate, data from the SCEP PfMP will be part of the Smart Columbus Operating System (SCOC) which uses open data, data sharing, and an agile approach to developing software to support the program objectives. The SCOC will allow for reuse, sharing, curation, and application development.

1.3 – Roles/Responsibilities

The Smart Columbus Program Management Office (PMO) will be the central coordinator with respect to the collection, analysis, and dissemination of performance metrics and reporting described herein, and will fall under the responsibility of the PMO performance measures coordinator. It will be the responsibility of the PMO performance measures coordinator to ensure that all partners are cognizant of the PfMP, that all participants assess performance in conformity with the PfMP, and that the PfMP satisfies the needs of the projects, participants and sponsors. As such, the PfMP will be revised, when necessary, so that it is responsive to the needs of the SCEP as it evolves through implementation and feedback. It is also the responsibility of the SCEP performance measures coordinator to monitor the adequacy of the plan, and suggest revisions and extensions in collaboration with the PMO, PGAFF, project partners, and supporting working groups.

The PMO performance measures coordinator will provide templates and guidelines as appropriate to guide the multiple stakeholders in submitting data. It will be the responsibility of the performance measures coordinator to ensure the appropriate descriptors (meta-data) is available, and consistent formats are used across initiatives.

1.4 – Sharing, Preservation and Protection

The Smart Columbus PfMP resides on the project Sharepoint site along with the Key Performance Indicators, Appendix A, of this document. Project team members responsible for reporting on indicator and metric progress will work with the performance measures coordinator to update progress on Sharepoint. See the PMP for information on how the Sharepoint site functions and is managed.

1.5 – Terminology

Performance indicators are addressed at three levels: the overall project level, the five priorities (Decarbonization, Fleet BEV Adoption, Transit, Autonomous and Multi-Modal Systems in the City, Consumer BEV Adoption, and Charging Infrastructure), and the specific initiatives under each priority area.

Project, priority, and initiative indicators are provided and are hierarchical. Initiative indicators contribute directly to one of their respective priority indicators, and similarly priority indicators contribute directly to a project indicator. Progress indicators are also defined. Progress indicators encompass anything that can be numerically evaluated and reflects progress towards objectives, but does not contribute directly to either higher level indicators. Examples of project, priority, initiative and progress indicators are provided below.

Category #1: Project Indicators

EX. **Project Objective:** To measurably decrease GHG emissions originating from the Columbus Metropolitan Area (seven-county region) transportation system during the time period of the grant.

Project Indicator: Percent GHG emission reductions from baseline year.

Category #2: Priority Indicators – example from Priority 2, Fleet Electric Vehicle Adoption

EX. **Priority Goal/Objective:** Work with public, private and academic sectors to integrate a minimum of 780 electric vehicles into their fleets by the end of 2019. (300 public fleet, 450 private fleet, 30 Transportation Network Companies).
Priority Indicator: Fleet Electric Vehicles Purchased.

Category #3: Initiative Indicators – example from Priority 2, Initiative 2.1, Public Fleet Adoption

EX. **Initiative Objective:** Work with public and academic sectors to integrate a minimum of 300 electric vehicles into their fleets by the end of 2019.
Initiative Indicator: Number of BEVs purchased within public fleets.

Project, priority, and initiative indicators have overall targets for the life of the project. These overall targets are typically subdivided in quarterly targets for tracking/reporting purposes.

Category #4: Progress Indicators

All other types of report indicators apart from project, priority and initiative indicators previously explained will be progress indicators. Such indicators are quantifiable but do not directly contribute to a higher-level indicator. Progress indicators will assist the team in tracking and reporting on activities. Progress indicators also help validate if the resources invested in a specific strategy are having the expected effect on the priority indicators (which have defined targets based on objectives).

EX. Progress Indicator under Public Fleets Initiative 2.1:

Progress Indicator #1: Number of contacts made with other governments or institutions

Some progress indicators will be included within the grant agreement, but others will be developed as the program progresses and new strategies and activities are launched (for example, ongoing market assessment may result in new strategies and associated indicators to be tracked in the remaining quarters).

As appropriate for each indicator, the following are defined for performance metrics.

1. **Definitions** of terms or phrases used in the indicators. For example, in the example project indicator, what constitutes an electric vehicle? Are only light duty vehicles included in the goal, or do BEVs include golf carts or all-terrain off-road vehicles as well?
2. **Data** needed for estimating the performance measure. For example, vehicle make/model of BEVs acquired by fleets, and miles driven by each vehicle in a public fleet.
3. **Area** (or location) where data should be collected for estimating the performance measure. For example, for consumer adoption the seven-county area encompassing the City of Columbus will define the target goal. The area for most indicators will be the seven-county area unless otherwise stated.
4. **Temporal resolution or extent** of the data needed for estimating the performance measure. For example, consumer BEV registrations may be analyzed on a quarterly basis.
5. **Method** to estimating the performance measure. This may be a high-level algorithmic approach, modeling procedure, or pseudocode. In some instances, existing analytical tools may be used to estimate a measure.
6. **Baseline measure** for existing conditions. For example, the increase in consumer adoption of BEVs is factored from the number of registered BEVs as of Dec 31, 2016.
7. **Assumptions** used in estimating performance indicators.

1.6 – Organization

Starting with Section 2, this document follows as closely as possible to the order of the project, priorities and initiatives as outlined in the overall agreement. The project, priority and initiative objectives and indicators closely follow the structure outlined in the SCEP, and then additional detail (Definitions, Data, Area, Temporal Resolution, Method, Baseline Measure, and Assumption) are provided for each indicator as appropriate. Progress indicators from Section 3 of the agreement are also carried over to the PfMP for additional detail. Note, additional progress indicators may be developed as the project evolves, new information learned and new strategies are developed. As a result, as the project progresses and new strategies develop, this PfMP will be updated and will contain indicators that vary from the original SCEP.

Section 2 of this PfMP provides detail for the project level indicators.

Section 3, 4, 5, 6 and 7 provide detail for the Priorities 1 through 5 respectively, as well as the initiatives and strategies associated with each priority.

The numbering scheme used in the SCEP is used/referenced whenever possible for ease of cross-reference.

Timelines for indicators contingent upon Public Utilities Commission of Ohio (PUCO) approval will be adjusted as approval is received.

OVERALL PROJECT GOAL

Objective Statement: *The overall goal of this project is to measurably decrease light-duty transportation greenhouse gas (GHG) emissions expressed in metric tons of carbon dioxide ($MTCO_2$) as a result of grid decarbonization, Electric Vehicle (EV) fleet adoption, transit, autonomous and multi-modal systems (implemented via USDOT grant agreement) and consumer BEV adoption during grant period compared to a baseline year (2016).*

Project Indicators:

1. % GHG emission reductions from baseline year.
2. Total GHG reductions/savings from baseline year ($MTCO_2$).

Targets:

See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
GHG	Green House Gases (GHG) are comprised of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases. These gases absorb infrared radiation in the atmosphere. The majority of GHGs come from CO_2 emissions. In the transportation sector, on average, CO_2 emissions comprise 95-99% of the total GHG emissions from a passenger vehicle, after accounting for the global warming potential of all GHGs. The remaining 1-5% is CH_4, N_2O, and HFC emissions. For the electricity sector, CO_2 makes up the vast majority of GHG emissions from the sector, but smaller amounts of CH_4 and N_2O are also emitted. For the purpose of this project, only CO_2 emissions will be measured.
$MTCO_2$	Metric Tons of Carbon Dioxide (CO_2).

- **Data**
  Specific data will be listed per initiative.
- **Area**
  Unless otherwise stated, the area will include the seven counties containing and adjoining Columbus (Franklin, Delaware, Fairfield, Licking, Pickaway, Madison, Union). Exceptions to, and methods to estimate the seven-county impact from larger spatial aggregations are addressed on a case by case basis depending on the initiative/strategy.
- **Temporal**
  Updated/reported quarterly.
- **Methods**
  Each indicator is summed from contributing priorities and their respective initiatives. See the methodologies cited under priorities and initiatives. Only technical methodologies that are well published and broadly accepted in the community will be utilized.
- **Baseline Measures**

The Mid-Ohio Regional Planning Commission (MORPC) completed a study of the electricity consumption and transportation fuel consumption (energy use) estimates for the seven-county Central Ohio region (Franklin, Delaware, Fairfield, Licking, Pickaway, Madison, and Union) (see Appendix F). The study was based off the same methods used for the Franklin County Energy Study that MORPC released in 2017.To establish a GHG baseline for the seven-county region, MORPC used state-level datasets published by the U.S. Energy Information Administration (EIA) and other publicly available datasets to create county-level estimates. MORPC calculated the estimates and communicated adjustments to their estimation methodology. The most recent data available from EIA is 2015 data.

The baseline GHG emissions established for this project will account for the GHG emissions associated with electricity consumption and transportation fuel consumption and will not consider any other GHG emission sources, such as natural gas, jet fuel, or kerosene, given their lack of relevance to the program.

MORPC performed the following tasks to establish the baseline values for the seven-county region:

Task 1: Data Collection and Cleanup
- Subtask 1.1: Determine datasets to use for downscaling factors
- Subtask 1.2: Collect all data from Subtask 1.1, and document data collection and management process to include in reporting
- Subtask 1.3: Clean up data, enter into spreadsheet

Task 2: Methodology Review
- Subtask 2.1: Adapt method to current request
- Subtask 2.2: Verify methodology: apply downscaling method to Franklin County to calibrate.
- Subtask 2.3: Document methodology to include in reporting

Task 3: Estimation Calculations
- Subtask 3.1: Perform calculations for 7 counties based on methodology from Task 2.

The baseline GHG calculations include the following metrics:

- 2015 VMT for the seven-county region = 18,463,335,200 miles[1].
- Fuel consumed in the seven-county region[2] (2015).
  - Motor Gasoline = 100,268.6 BBtu
  - Fuel Ethanol = 6,462.4 BBtu
  - Distillate Fuel Oil (Diesel Fuel) = 48,598.7 BBtu
- Energy consumed in the seven-county region[3] (2015) = 75,894.0 BBtu

- **Assumptions**

  Specific assumptions will be listed per initiative.

[1] The Ohio Department of Transportation (ODOT) compiles county-by-county Daily Vehicle Miles Traveled (DVMT) for all the Federal Functional Class category road types. The total VMT was summed for Delaware, Fairfield, Franklin, Licking, Madison, Pickaway, and Union counties, 2015. Source: https://www.dot.state.oh.us/Divisions/Planning/TechServ/traffic/Pages/DVMT.aspx

[2] Provided by MORPC, February 2018

[3] Provided by MORPC, February 2018

PRIORITY 1 – DECARBONIZATION

Objective Statement: *In partnership with power providers, by 2030 install 905 MW of utility scale renewable energy generation capable of serving the Columbus region, procure a minimum of 1.2 million MWh of renewable energy for the City of Columbus between 2017 and 2022 and save an additional 0.33% of MWh consumed through energy efficiency and smart grid programs during the time period of the grant.*

Priority Indicators:

1. MW of renewable energy capacity installed.
2. MWh of renewable energy consumed
3. MWh of energy saved (new renewable energy or energy efficiency).

Targets:

See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
Renewable Energy	Energy resources that are naturally replenishing. The renewable energy sources used in this project include biomass, hydro, solar, and wind.
Renewable Energy Capacity	The maximum net generation of renewable energy capacity (MW) installed.
Renewable Electricity Consumed	Actual MWh of renewable energy utilized in the EPA's eGRID RFC West sub region.
Energy Saved	MWh of electricity saved through efforts outlined in the strategies.

- **Data**
  Each contributing initiative provides estimates of power/energy. See contributing initiative indicators.
- **Area**
  - The EPA's eGRID RFC West sub region[4] encompassing all of Ohio, Indiana, and West Virginia and portions of Illinois, Wisconsin, Michigan, Pennsylvania, Maryland, Kentucky, and Virginia is the area used to derive the carbon dioxide emission factors used in GHG calculations.
  - The detailed area of study will be specified in each individual strategy.
- **Temporal**
  Life of project extends to 2030 when all renewable power strategies in this project are anticipated to be online.

[4] EPA eGRID sub region representational map. https://www.epa.gov/energy/egrid-subregion-representational-map

- **Methods**
  See methods from initiatives and strategies. The energy and power are cumulative across the initiatives in 1.1 and 1.2.

- **Baseline Measures**
  The baseline year will be specified in each individual strategy.

- **Assumptions**
  - All AEP De-carbonization activity areas will be calculated into units of "Energy" saved or created from non-carbon sources. The units will be MWh or GWh. The "Energy" total will be converted into avoided GHG using the US EPA "Emission & Generation Resource Integrated Database (eGRID). eGRID2016 was released in February 2018 and is the most currently available source of emissions data for the electric power sector.
  - The eGRID data is collected by region. With respect to central Ohio, the appropriate sub-region is "RFC West". Using the "RFC West" sub region, the basis of calculations for GHG emission reductions will use the total output emission CO_2 conversion factor[5] of 1243.4 lb of CO_2 per MWh on an annual basis.
  - While AEP has specific GHG emission data on AEP generating facilities, the use of a broader sub-region is appropriate as electric generation serving central Ohio customers comes from a variety of generating facilities, not just those owned by AEP. Additionally, Ohio has a deregulated electricity market where customers can choose their retail provider. Therefore, AEP Ohio and other public utilities within Ohio operate for the most part as "wires-only" companies with generation supply being provided by third-parties, making a regional emission average most representative of the electricity supply mix for the central Ohio region.
  - Calculations do not include any greenhouse gases other than CO_2.
  - eGRID output emission rates do not account for any line losses between the points of consumptions and the points of generation. For example, because there are line losses, one kilowatt hour of electricity consumption requires more than one kilowatt hour of electricity generation. Following the same procedure as eGRID, line losses are not being accounted for with this project.

[5] 1243.4 lbs CO_2/MWh, 2016 eGRID GHG Annual Total Output Emission Rate for the RFC West sub region. https://www.epa.gov/sites/production/files/2018-02/documents/egrid2016_summarytables.pdf

Initiative 1.1 – Utility-Scaled Renewables

Objective Statement: *By 2030, deploy 900 MW of utility scale wind and solar in the state of Ohio, 5 MW of hydroelectric in the Columbus region and between 2017 and 2022 procure a minimum of 1.2 million MWh of renewable energy in the City of Columbus.*

Initiative Indicators:

1. Renewable energy MW capacity installed.
2. Renewable energy MWh consumed.

Targets:

See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
Utility Scale	Power generation typically defined as 10 MW nameplate capacity or larger.
Wind Power	Power generation by capturing the energy from the wind by use of a turbine.
Solar Power	Power generation by capturing the energy from the sun by use of photovoltaic (PV) panels.
Hydroelectric Power	Power generation by capturing the energy from falling water to turn a generator.

- **Data**
  Data for utility scale wind and solar will be provided by AEP. The City of Columbus' Division of Power will provide hydroelectric data.
- **Area**
  - The EPA's eGRID RFC West sub region[6] encompassing all of Ohio, Indiana, and West Virginia and portions of Illinois, Wisconsin, Michigan, Pennsylvania, Maryland, Kentucky, and Virginia is the area used to derive the carbon dioxide emission factors used in GHG calculations.
  - The detailed area of study will be specified in each individual strategy.
- **Temporal**
  The 900 MW of utility scale wind and solar is awaiting approval by PUCO. The design phase of the 5 MW of hydroelectric is to be complete in 2018, with construction beginning in early 2019.
- **Methods**
  Combined contributions from strategies 1, 3 and 5.
  1. Cumulative power capacity in MW from strategies 1.1.1 and 1.1.7.

[6] EPA eGRID sub region representational map.
https://www.epa.gov/sites/production/files/styles/large/public/2018-02/egrid2016_egrid_subregions.jpg

2. Cumulative renewable energy consumed in MWh from strategies 1.1.3, 1.1.4, 1.1.5., 1.1.6, and 1.1.7 (without double counting). The GHG reductions will be calculated using the EPA's 2016 eGRID RFC West sub region total output emission CO_2 factor. See Appendix E for example calculations.

- **Baseline Measures**
  Baseline year is 2015 (based on the MORPC baseline data).
- **Assumptions**
  - Using the EPA's 2016 eGRID RFC West sub region total output emission CO_2 factor to calculate GHG emission reductions.
  - Calculations do not include any greenhouse gases other than CO_2.
  - Calculations do not include line losses.

Strategy 1.1.1 – AEP Solar and Wind Generation

Initiative Indicator *(Contributes to overall Initiative Indicator 1.1):*

1. Capacity of new installation of combination of wind/solar combined.
   - Utility-Scale Wind Capacity Installed, MW
   - Utility-Scale Wind Energy Generated, MWh
   - Utility-Scale Solar Capacity Installed, MW
   - Utility-Scale Solar Energy Generated, MWh

Targets:
See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
American Electric Power (AEP)	AEP is a certified Competitive Retail Electric Service (CRES) provider in Ohio.
Competitive Retail Electric Service (CRES) provider	A retail electric service provider that is certified by the PUCO and competes for your business by offering alternative competitive prices, renewable energy options or other services and incentives.
Public Utilities Commission of Ohio (PUCO)	The Public Utilities Commission of Ohio (PUCO) is the public utilities commission of the state of Ohio, charged with the regulation of utility service providers such as those of electricity, natural gas, and telecommunications as well as railroad safety and intrastate hazardous materials transport.

- **Data**
  AEP to provide (where possible) metered data in MWh for generated wind and solar once installed.
- **Area**
  The EPA's eGRID RFC West sub region encompassing all of Ohio, Indiana, and West Virginia and portions of Illinois, Wisconsin, Michigan, Pennsylvania, Maryland, Kentucky, and Virginia.

- **Temporal**
  Once installed, the generated energy will be reported quarterly. Project milestones are being developed to ensure that the wind and solar projects are on track to be operational by 2030.
- **Method**
  Documentation / certification of added solar and wind capacity to be provided by AEP in collaboration with EGM working group. The GHG reductions will be calculated using the EPA's 2016 eGRID RFC West sub region total output emission CO_2 factor. See Appendix E for example calculations.
- **Baseline Measures**
  Baseline year is 2015 (based on the MORPC baseline data).
- **Assumptions**
  - Using the EPA's 2016 eGRID RFC West sub region total output emission CO_2 factor to calculate GHG emission reductions.
  - Calculations do not include any greenhouse gases other than CO_2.
  - Calculations do not include line losses.

Strategy 1.1.2 – AEP Vehicle to Home Research

No indicators associated with this strategy. See milestones/deliverable table.

Strategy 1.1.3 – AEP Distributed Generation Coordination of New Customer Installation

Progress Indicator:

1. Number of New AEP Distributed Energy Customers

Targets:

See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
Distributed Energy	Renewable technologies that use small, localized electricity generation units or energy storage units to enhance existing energy delivery systems.
Municipal Utility	A utility that is owned and operated by a city. In most cases, municipal utility rates are set at the city level, either by the municipal administration or by a local utility board or commission. In some limited circumstances, state-level regulation applies.
Electric Cooperatives (Co-Op)	An electric cooperative is a not-for-profit, member owned utility service that provides service solely to its members. A cooperative is financially independent, and its members pay the full cost of generation, transmission and distribution. Any profit is returned to its members in the form of rebates. As they are controlled by their members, electric cooperatives are not regulated by the Public Utilities Commission of Ohio.

- **Data**
  AEP to provide the number of new AEP Distributed Energy Customers and the associated total MW capacity.
- **Area**
  AEP service territory within the Smart Columbus region.
- **Temporal**
  Updates to be provided on a quarterly basis.
- **Methods**
  The estimate/measure of renewable energy through distributed power to be provided by AEP.
- **Baseline Measures**
  Baseline year is 2016.
- **Assumptions**
  - Distributed Generation customers in AEP Ohio Service area. This will not include any municipal or Co-Op customers.
  - Any non-renewable distributed generation customer projects will be removed from the total.
  - The conversion factor of 1,200 kWh/yr will be used to convert the installed capacity to energy. The reasoning for using this conversion factor is shown below:
    - Referencing EIA and NREL data, the availability of solar energy varies by a factor of 2 or more across the country. This is due to weather patterns, angle of sun, etc. Central Ohio is at the lower end of the range. Ohio is considered a northern state and weather patterns have a relatively higher number of cloudy days.
    - AEP's experience with working with various systems and reviewing data has provided the experience and basis for the 1200 kWh/yr capacity value. As a cross check, three different sources were used to determine capacity factors for our area.
      - Referencing the US DOE SunShot Solar Industry Update[7]:
        Utility Scale Solar (Ohio): 22%
        DR Solar (Ohio): 16%
        US Installed Average:19% (Note: Majority of systems in high capacity factor areas)

        $$16\% \text{ X } 365 \text{ days X } 24 \text{ hours } = \mathbf{1400 \ kWh/yr}$$

      - Referencing the NREL Annual Technology Baseline report[8], a heat map chart is included of solar irradiance. The value indicated for Central Ohio is 4.0 to 4.4 (kWh/m^2/day).

        $$4.2 \text{ kWh X } 365 \text{ days } = 1533 \frac{\text{kWh}}{\text{yr}}$$

        Assuming 0.75 on angle, site efficiencies, etc.

        $$1533 \text{ kWh/yr} \times 0.75 \ = \ \mathbf{1149 \ kWh/yr}$$

      - Referencing the NREL PVWatt Calculator[9]: For a 10kW, non-tracking system, a range of 11,290 to 12,205kWh

[7] https://www.nrel.gov/docs/fy17osti/67639.pdf
[8] https://atb.nrel.gov/electricity/2017/index.html?t=sr

The calculator lists a capacity factor of about $\mathbf{1175\ kWh/yr}$

- These three approaches result in a range of 1149 to 1400 kWh/yr capacity conversion factors. There are many assumed variables in each, including site specific conditions such as mounting angle and orientation, trees and shadows from other structures, amount of cloud cover and general maintenance and upkeep of the equipment. The use of the value of **1200 kWh/yr for each 1kW of installed solar capacity** has been demonstrated to be prudent and consistent with industry standards and experience.

Strategy 1.1.4 – Solar Generator Deployment (DC Solar)

Progress Indicator:

1. Number of deployments of mobile solar generators, electric vehicle (EV) charging ports, and lighting towers.

Targets:

See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
Mobile solar generator	A picnic table sized solar powered generator to be used for small electronics charging.
Mobile solar EV charging port	Single cord with connector emanating from an EVSE powered by solar. Each charging port can charge only one EV at a time. A charging station may or may not have more than one charging port.
Mobile solar lighting tower	Solar powered LED lighting.

- **Data**
  DC Solar to provide the number of mobile solar generators, electric vehicle (EV) charging ports, and lighting towers deployed and in use and the meter readings for consumption (kWh) for each.
- **Area**
  The Ohio Dominican University campus in Columbus, Ohio.
- **Temporal**
  Updates to be provided on a quarterly basis.
- **Methods**
  The kWh of consumption will be multiplied by the using the EPA's 2016 eGRID RFC West sub region total output emission CO_2 factor. See Appendix E for example calculations for DC Solar lighting towers and EV chargers.
- **Baseline Measures**

[9] http://pvwatts.nrel.gov/pvwatts.php

There were no previously installed solar units at the university.

- **Assumptions**
  - Using the EPA's 2016 eGRID RFC West sub region total output emission CO_2 factor to calculate GHG emission reductions.
  - The solar lighting towers operate 4 hours per day.
  - The mobile solar generator energy consumption is considered minimal and it is not included in the GHG reduction calculations.

Strategy 1.1.5 – Columbus Division of Power Green Power

Progress Indicator:

1. Total green power (MWh) consumed in service area

Targets:

See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
Green Power	Renewable energy certificates from any of the resources defined as Alternative Energy Resource, including Advanced Energy Resources and Renewable Energy Resource as defined in the Ohio Revised Code.
Attestation Form	Forms used to substantiate the chain of custody of all renewable MWh (renewable electricity or standalone RECs) used in green power.
Renewable Energy Certificates (REC)	A renewable energy certificate, or REC, is a market-based instrument that represents the property rights to the environmental, social and other non-power attributes of renewable electricity generation. RECs are issued when one megawatt-hour (MWh) of electricity is generated and delivered to the electricity grid from a renewable energy resource.
Eco-Smart Choice	An electric utility plan offered by the DOP through American Municipal Power (AMP). AMP's program allows customers to purchase RECs for up the 100% of their electricity usage.

- **Data**
  Data provided by Columbus Division of Power. When delivery occurs, it will be accompanied by an Attestation Form that specifies the Renewable Energy Resource, REC quantities, period of generation and other information.
- **Area**
  Region covered by Columbus Division of Power.
- **Temporal**
  Columbus Division of Power to provide updates on a quarterly basis.
- **Methods**

- The amount of GHG emission reduction for the City's total Green Power will be calculated based on the savings from net power purchased each year:
  GHG Emission Reduction for Net Generation, $MTCO_2$/yr
- For Biomass Energy[10]:
  Biomass and other organic matter are left to decay within the project boundary, and methane is emitted to the atmosphere, possibly with capture of landfill gas (LFG) and destruction through flaring to comply with regulations or contractual requirements. Baseline emissions shall exclude methane emissions that would have to be removed to comply with national or local safety requirements or legal regulations. See Appendix E for example calculations for biomass energy.
  - The amount of GHG emission reduction for the total MWh of renewable electricity generated annually: GHG Emission Reduction for Net Generation, $MTCO_2$/yr

- **Baseline Measures**
  2016 power sources as reported by DOP:
  - Total Power purchased = 885,000 MWH
  - Central Ohio Biofuel purchase = 8,760 MWH
  - Eco-Smart Choice = 42,000 MWH
  - O'Shaughnessy hydroelectric = 0
  - Co-Gen = 0
  - Total Green Power = 50,760 MWH
  - Percent of purchase power = 5.7%
  - **Total Non-Green = 834,240 MWH**
- **Assumptions**
  Using the EPA's 2016 eGRID RFC West sub region total output emission CO_2 factor to calculate GHG emission reductions.

Strategy 1.1.6 – City of Columbus Wastewater Treatment Plant, Co-Generation

Progress Indicator:

1. GHG reduction from estimated 5,000 MWh output from Co-Generation offset grid power requirements by year 2022.

Targets:

See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
Co-Generation	The City of Columbus will use biogas from City wastewater treatment plants as fuel for a Combined Heat and Power (CHP) plant.

- **Data**

[10] Calculation based on the Clean Development Mechanism Landfill methane recovery methodology. Source: http://cdm.unfccc.int/methodologies/documentation/1611/CDM-Methodology-Booklet_fullversion.pdf

Columbus Division of Power to provide metered data in MWh for generated energy once installed.

- **Area**
  Region covered by Columbus Division of Power.
- **Temporal**
  Columbus Division of Power to provide updates on a quarterly basis.
- **Methods**
  The amount of GHG emission reduction for each CHP system will be calculated[11] based on the energy production from one and two engines at each plant. This analysis will account for the savings from net electrical generation from CHP and the additional net natural gas usage with each system. The net GHG reduction can also be expressed by the number of typical light duty passenger vehicles removed from the road which emit 4.4 $MTCO_2$ per year[12]:
  - GHG Emission Reduction for Net Generation, $MTCO_2$/yr
  - GHG Emission Reduction for Additional Natural Gas, $MTCO_2$/yr
  - Net Reduction in GHG Footprint, $MTCO_2$/yr
  - Equivalent Annual Typical Light Duty Passenger Vehicles Removed from Roads
- **Assumptions**
  Using the EPA's 2016 eGRID RFC West sub region total output emission CO_2 factor to calculate GHG emission reductions.

Strategy 1.1.7 – Columbus Division of Power Hydroelectric Improvements

Progress Indicator:

1. MW capacity as a result of rehabilitation the City of Columbus' 5 MW hydroelectric plant located in the O'Shaughnessy Dam – *additive to overall Initiative Indicator 1.1 #1*
2. MWh generated – *additive to overall Initiative Indicator 1.1 #2*

Targets:

See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
Nameplate Capacity	The maximum rated output of a generator, prime mover, or other electric power production equipment under specific conditions designated by the manufacturer. Installed generator nameplate capacity is commonly

[11] Calculation based on Arcadis consultant CoGen study.
https://smartcolumbusprogram.sharepoint.com/Vulcan/_layouts/15/guestaccess.aspx?docid=036f2fb0e07f0402884d6de701d3871e1&authkey=AaIQzsemTGco8FN4SdPCdQM&expiration=2018-04-04T20%3a37%3a43.000Z

[12] $Typical\ Light\ Duty\ Passenger\ Vehicle\ Annual\ CO_2\ emissions\ in\ 2018 = \frac{CO_2\ per\ gallon}{MPG} \times miles = \frac{18.9\ lbs}{22.71} \times 11{,}630 = 4.4\ MTeCO_2$
See Appendix E for more information.

WORD/PHRASE	DEFINITION
	expressed in megawatts (MW) and is usually indicated on a nameplate physically attached to the generator.

- **Data**
  Columbus Division of Power to provide total hours of operation and MWh generated.
- **Area**
  Region covered by Columbus Division of Power.
- **Temporal**
  Columbus Division of Power to provide updates on a quarterly basis.
- **Methods**
  Estimate of MWh energy
  - The amount of GHG emission reduction for the City's hydroelectric plant will be calculated based on the additional MWh produced and hours of operation after improvements are implemented: GHG Emission Reduction for Net Generation, $MTCO_2/yr$
- **Baseline**
  Zero. The hydroelectric plant has not been operational since 2015[13].
- **Assumptions**
  - Plant nameplate capacity is 5 MW.
  - Using the EPA's 2016 eGRID RFC West sub region total output emission CO_2 factor to calculate GHG emission reductions.

Initiative 1.2 – Grid Modernization and Efficiency

Initiative Objective: *AEP and Columbus Division of Power will deploy energy efficiency programs, grid modernization projects, which include battery storage installations, street and area light upgrades, AEP's gridSMART 2.0 upgrade, and expanded capacity programs that support renewables and electric vehicles.*

Initiative Indicators:

1. Combined Energy Efficiency – MWh saved from strategies 1.2.1, 1.2.5, & 1.2.7

Targets:
See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
AEP's gridSMART	AEP's gridSMART 2.0 upgrade will install advanced metering infrastructure (AMI), install volt/VAR optimization (VVO) technology to

[13] The O'Shaughnessy Hydroelectric Plant generated 9,700 MWh in 2013 and 7,300 MWh in 2014. It ceased operations in 2015.

WORD/PHRASE	DEFINITION
2.0 upgrade	reduce excessive voltage levels on the distribution grid, and install distribution automation circuit reconfiguration (DACR) technology to reduce the extent and duration of outages while providing maintenance and safety benefits

- **Data**
  AEP and Columbus Division of Power to provide MWh saved.
- **Area**
  Regions covered by AEP (service territory within the Smart Columbus region) and Columbus Division of Power.
- **Temporal**
  AEP to provide updates on a quarterly basis.
- **Methods**
  Estimate of MWh energy
  - The amount of GHG emission reductions will be calculated based on the additional MWh produced and hours of operation after improvements are implemented: GHG Emission Reduction for Net Generation, $MTCO_2/yr$
- **Baseline Measures**
  See each individual Strategy for applicable baseline values.
- **Assumptions**
  AEP to provide any assumptions used.

Strategy 1.2.1 – AEP Energy Efficiency

Progress Indicator:

1. Expand energy efficiency efforts to save 160GWh per year.

Targets:

See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
Energy efficiency efforts	Residential and business programs promoting investment in the installation of energy efficient products.

- **Data**
  To be reported through AEP.
- **Area**
  AEP service territory within the Smart Columbus region.

- **Temporal**
  In conjunction with the PUCO reporting. AEP to provide updates on an annual basis (mid-May each year).
- **Methods**
  Participation is documented as numbers of customers in the Smart Columbus region who participated in Community Energy Savers programs. GWh saved are estimated from engineering analysis, billing analysis and Technical Reference Manual (TRM) equations as used in preparing annual PUCO reporting.
- **Baseline Measures**
  Baseline is the 1% of the previous three years adjusted retail sales that determined the annual benchmark target for energy efficiency savings.
- **Assumptions**
  Assumptions to be provided by AEP.

Strategy 1.2.2 – AEP Vehicle to Home Research

AEP is working to identify funding in 2018. Details will be added as they become available. There are no associated metrics with these deliverables.

Strategy 1.2.3 – AEP gridSMART 2.0 Advanced Metering Infrastructure Deployment

Progress Indicator:

1. AEP Advanced Metering Infrastructure (AMI) meters installed.

Targets:

See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
AMI meters	Advanced metering infrastructure (AMI) meters are a digital electric meter equipped with two-way communications technology that provides near real-time meter readings and the secure transfer of customers' usage information to AEP Ohio for billing and operational purposes.

- **Data**
  AEP to provide AMI meters installed, reductions in meter reading vehicles, and resulting GHG reductions.
- **Area**
  AEP service territory within the Smart Columbus region.
- **Temporal**
  AEP to provide updates on a quarterly basis.
- **Methods**
  GHG Reduction from decreased vehicle use resulting from reductions in meter reading.

- **Baseline Measures**
  - Number installed as of Dec 31, 2016
  - Number of vehicles used in 2016 to read meters, average miles per gallon and average miles driven per month.
  - The net GHG reduction will be expressed by the number of typical light duty passenger vehicles removed from the road per year which emit 4.4 $MTCO_2$ per year.
    - *Net Reduction in GHG Footprint, $MTCO_2/yr$*
    - Equivalent Annual Typical Light Duty Passenger Vehicles Removed from Roads
- **Assumptions**
  Vehicle mileage and fuel use based on averages for vehicle class used for meter reading.

Strategy 1.2.4 – AEP Microgrids and Battery Storage

Progress Indicator:

1. AEP Microgrids installed.

Targets:

See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
Microgrid	A microgrid is a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid and that connects and disconnects from such grid to enable it to operate in both grid-connected or island mode. (US DOE)

- **Data**
  AEP Ohio will provide the location and implemented technologies within the microgrid.
- **Area**
  AEP service territory within the Smart Columbus region.
- **Temporal**
  AEP to provide updates on a quarterly basis.
- **Methods**
  No direct GHG reductions associated with this indicator.
- **Baseline Measures**
  This will be one of, if not, the first resiliency microgrid installed in the region.
- **Assumptions**
  Confirmation of PUCO regulatory approval. Will provide greater levels of detail once further defined.

Strategy 1.2.5 – AEP Smart Lighting

In November 2016, AEP Ohio filed to install over 200,000 smart lights as part of the ESP III Extension plan. This item was ultimately removed from settlement negotiations; however, AEP Ohio is investigating potential pilot projects to gather learnings in preparation for future filings.

AEP Ohio remains interested in installing and operating Smart Street and Area Lighting controls on existing AEP owned street and area lights during the grant period and beyond. This effort will help enable quicker resolution on lighting that is not functioning correctly, which will lead to improved customer satisfaction. As a future goal outside the grant period, and upon the establishment of national standards, AEP will work to utilize dimming functionality of the Smart Lighting to lower overall energy consumption. This effort is contingent on securing cost recovery through PUCO.

Performance measurement data for this strategy will be developed when AEP has a clearer path forward.

Strategy 1.2.6 – Columbus Division of Power Grid Modernization

Progress Indicator:

1. Number of AMI meters installed.

Targets:

See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
AMI meters	Advanced metering infrastructure (AMI) meters are a digital electric meter equipped with two-way communications technology that provides near real-time meter readings and the secure transfer of customers' usage information to AEP Ohio for billing and operational purposes.

- **Data**
  To be reported through Columbus Division of Power.
- **Area**
  Region covered by Columbus Division of Power.
- **Temporal**
  Installations to begin in 2018. Columbus Division of Power to provide updates on a quarterly basis.
- **Methods**
  Associated GHG Emission Reduction Method.
- **Baseline Measures**
  - Number installed as of Dec 31, 2016

- Number of vehicles used in 2016 to read meters, miles per gallon and averages miles driven per day/month.
- The net GHG reduction will be expressed by the number of typical light duty passenger vehicles removed from the road per year which emit 4.4 $MTCO_2$ per year.
    - *Net Reduction in GHG Footprint, $MTCO_2/yr$*
    - Equivalent Annual Typical Light Duty Passenger Vehicles Removed from Roads

- **Assumptions**
  From the meter reading perspective, the project estimates a reduction in 24 vehicles that average 7,000 miles a year.

Strategy 1.2.7 – Columbus Division of Power Street Light Technology Conversion

Progress Indicator:

1. Number of LED street lights installed.

Targets:

See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
LED Street Light	An integrated light that used a light-emitting diode (LED) as a light source. LED lighting is considerably more energy efficient than conventional street lighting technology such as high pressure sodium (HPS) or metal halide (MH).

- **Data**
  The following data will be reported by Columbus Division of Power:
  - Number of street lights installed and operating.
  - Estimate of the nameplate/rated power (Watts) of existing luminaires.
  - Daily hours of usage.

- **Area**
  Region covered by Columbus Division of Power.

- **Temporal**
  Columbus Division of Power to provide updates on a quarterly basis.

- **Methods**
  Associated GHG Emission Reduction Method.

- **Baseline Measures**
  Number installed as of Dec 31, 2016.

- **Assumptions**
  - As of 2015, there are approximately 52,000 existing street lights that the Division of Power is responsible for maintaining. This represents approximately 65% of the city's streets.
  - Calculate the gross electricity savings by comparing the total average power of the project luminaires multiplied by project annual hours of operation, with the average power of the baseline luminaires multiplied by baseline annual hours of operation (daily hours times 365 or

other number equal to the number of days per year that the lights are expected to be operated);
- The average daily hours of operation is assumed to be 12 hours/day.
- Calculate the net electricity saving (NES) by correcting the gross electricity savings for any leakage and transmission & distribution losses.
- See Appendix D: LED Streetlight Conversion – GHG Calculation Methodology for full calculation details.

PRIORITY 2 – FLEET ELECTRIC VEHICLE ADOPTION

Priority Objective: *Work with public, private and academic sectors to integrate a minimum of 780 electric vehicles into their fleets by the end of 2019 (300 public fleet, 450 private fleet, 30 Transportation Network Companies).*

Priority Indicator:

1. Fleet Electric Vehicles purchased.

Targets:

See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
BEV	Either battery electric (BEV) or Plug-in Hybrid Electric (PHEV) on road vehicles.

- **Data**
  Reported number, type (make/model), and miles driven of fleet BEVs. See initiatives for data sources.
- **Area**
  Seven-county area encompassing the City of Columbus.
- **Temporal**
  Quarterly reporting to track the priority indicator.
- **Methods**
  Associated GHG Emission Reduction Method. See Appendix E for example calculations.
- **Baseline Measures**
  As of Dec 31, 2016
- **Assumptions**
  - For this report, the make, model, and type of BEV is not yet being considered in the calculations. Refinements are still being finalized to account for the different types of BEVs as well as PHEVs.
  - Average number of miles driven per year for typical light duty passenger vehicles = 11,404 miles per year (2016). Source: EIA Annual Energy Outlook 2018, Tables 40 and 41.
  - Average mpg of typical light duty passenger vehicles on the road = 27.7 mpg, 2016 conventional gasoline ICE car adjusted value (using factor of 0.74). Source: EIA Annual Energy Outlook 2018, Table 41.
  - Gasoline type used = E10 gasoline. Source: https://www.eia.gov/todayinenergy/detail.php?id=26092
  - 18.9 lbs CO_2/gallon of E10 gasoline combusted. Source: https://www.eia.gov/tools/faqs/faq.php?id=307&t=11

Initiative 2.1 – Public Fleets

Initiative Objective: *Work with public and academic sectors to integrate a minimum of 300 electric vehicles into their fleets by the end of 2019.*

Initiative Indicator:

1. Number of public fleet vehicles adopted.

Targets:
See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
Placeholder	Placeholder

- **Data**
  Individual public fleets to provide the following:
  - Each fleet on a quarterly basis report existing inventory of BEVs (year, make, model) at beginning of quarter.
  - Mileage over previous quarter on each BEV.
  - New BEV acquisitions in the fleet during the quarter (year, make, model), and any mileage on new vehicles.
  - Average mileage for non BEVs in the fleet on a quarterly basis.
- **Area**
  Seven-county area encompassing the City of Columbus.
- **Temporal**
  Quarterly reporting to track the priority indicator.
- **Methods**
  GHG Emissions Reduction Method
  - See Appendix B - Evaluating the effectiveness of Electric Vehicle adoption for reduction of GHG for procedure and details of methodology
- **Baseline Measures**
  Initial fleet inventory of vehicles (including number and type)
- **Assumptions**
  See Appendix E for example calculations.

Strategy 2.1.1 – Training and Technical Assistance Workshops

Progress Indicator:

1. Number of contacts made with other governments or institutions.
2. Municipal governments or institutions pledged to electrification (fleet analysis and vehicle acquisition plan).
3. City of Columbus and public partner training sessions.

Targets:
See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
Contact	Documented communication (email, written, phone), with organization explaining the Smart Columbus initiative and inviting the institution to participate through collaboration (attendance at meetings and events) and pledging support.
Pledge	Documented official communication from government or institution indicating aspirational goal of BEV committed to purchase.
Technical Training Session	Technical training for operators, technicians and first responders.

- **Data**
  Clean Fuels Ohio to directly track:
  - Number of contacts made with other governments or institutions.
  - Municipal governments or institutions pledged to electrification (fleet analysis and vehicle acquisition plan).
  - City of Columbus and public partner training sessions.
- **Area**
  Seven-county area encompassing the City of Columbus.
- **Temporal**
  Quarterly reporting to track the priority indicator.
- **Methods**
  No GHG reductions directly associated with this indicator.
- **Baseline Measures**
  NA
- **Assumptions**
  NA

Initiative 2.2 – Private Fleets

Initiative Objective: *Work with private partners to secure purchase commitments for 450 electric vehicles by the end of 2019.*

Initiative Indicators:

1. Number of private fleet vehicles adopted.

Targets:
See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
BEV	Either battery electric (BEV) or Plug-in Hybrid Electric (PHEV) on road vehicles.

- **Data**
  Private fleets to provide:
  - Each fleet on a quarterly basis report existing inventory of BEVs (year, make, model) at beginning of quarter.
  - Mileage over previous quarter on each BEV.
  - New BEV acquisitions in the fleet during the quarter (year, make, model), and any mileage on new vehicles.
  - Average mileage for non BEVs in the fleet on a quarterly basis.
- **Area**
  Seven-county area encompassing the City of Columbus.
- **Temporal**
  Quarterly reporting to track the priority indicator.
- **Methods**
  GHG Emissions Reduction Method
  - See Appendix B - Evaluating the effectiveness of Electric Vehicle adoption for reduction of GHG for procedure and details of methodology.
- **Baseline Measures**
  Initial fleet inventory of vehicles (including number and type).
- **Assumptions**
  See Appendix E for example calculations and assumptions.

Strategy 2.2.1 – Secure Purchase Pledges

Progress Indicator:

1. Number of private sector training sessions
2. Number of distributed BEV survey/assessment documents
3. New private companies pledged to electrification (fleet analysis and VAP)
4. New private fleet vehicles pledged to electrification
5. Number of completed vehicle analysis acquisition plans

Targets:
See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
Training Session	Training sessions to educate fleet managers and procurement officers (or purchasing decision makers) about using BEVs for fleets.

WORD/PHRASE	DEFINITION
BEV Survey / Assessment Document	A survey to help determine private fleet vehicle needs and evaluate BEV fleet options.
Pledge	Documented official communication from government or institution indicating aspirational goal of BEV committed to purchase.
Vehicle Analysis Acquisition Plan	A detailed plan including the following four components: - Identify current fleets vehicles that have a commercially available similar BEV replacement option - Identify charging options based on vehicle drive and duty cycles / daily needs, provide ballpark cost quotes - Gather fleet data to calculate the return on investment (ROI) and Total Cost of Ownership (TCO) of BEVs vs. conventional models (with charging investments included) - Provide recommendations of how to implement BEVs to maximize ROI and minimize TCO

- **Data**
  The Columbus Partnership to directly track:
  - Number of private sector training sessions.
  - Number of distributed BEV survey/assessment documents.
  - New private companies pledged to electrification (fleet analysis and VAP).
  - New private fleet vehicles pledged to electrification.
  - Number of completed vehicle analysis acquisition plans.
- **Area**
  Seven-county area encompassing the City of Columbus.
- **Temporal**
  Quarterly reporting to track the priority indicator.
- **Methods**
  NA
- **Baseline Measures**
  NA
- **Assumptions**
  NA

Strategy 2.2.2 – Network Development

No associated metrics with these deliverables.

Initiative 2.3 – Transportation Service Providers (TSPs)

Initiative Objective: *Work with Transportation Service Providers to place in operation a minimum of 30 electric vehicles into their fleets by the end of 2019.*

Initiative Indicator:

1. Number of BEVs purchased
2. Number of BEVs placed in operation

Targets:
See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
BEV	Either battery electric (BEV) or Plug-in Hybrid Electric (PHEV) on road vehicles.

- **Data**
  Reported directly from TSPs.
- **Area**
  Seven-county area encompassing the City of Columbus.
- **Temporal**
  Quarterly reporting to track the priority indicator.
- **Methods**
  GHG Emissions Reduction Method
  - See Appendix B - Evaluating the effectiveness of Electric Vehicle adoption for reduction of GHG for procedure and details of methodology.
- **Baseline Measures**
  Initial fleet inventory of vehicles (including number and type).
- **Assumptions**
  See Appendix E for example calculations and assumptions.

Strategy 2.3.1 – Recruit TSP Partners

Progress Indicators:

1. Number of contacts made with TSPs
2. TSPs pledged to electrification (fleet analysis and VAP)

Targets:
See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
Contact	Documented communication (email, written, phone), with organization explaining the Smart Columbus initiative and inviting the institution to participate through collaboration (attendance at meetings and events) and pledging support.
Pledge	Documented official communication from government or institution indicating aspirational goal of BEV committed to purchase.

- **Data**
  Clean Fuels Ohio to track:
  - Number of contacts made with TSPs.
  - TSPs pledged to electrification (fleet analysis and VAP).
- **Area**
  Seven-county area encompassing the City of Columbus.
- **Temporal**
  Quarterly reporting to track the priority indicator.
- **Methods**
  NA
- **Baseline Measures**
  NA
- **Assumptions**
  NA

PRIORITY 3 – TRANSIT, AUTONOMOUS AND MULTI-MODAL SYSTEMS IN THE CITY

Priority Objective: *Ensure a comprehensive, multi-modal approach to decarbonizing the Columbus region's mobility options.*

Initiative Indicator:

1. Total GHG reductions/savings from baseline year ($MTCO_2$)

Progress Indicators:

1. Autonomous Electric Vehicles deployed
2. Number of platooning truck trips
3. Number of electric bicycles deployed
4. Bike lane miles added

Targets:

See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
Placeholder	Placeholder

- **Data**
  - Number of Autonomous Electric Vehicles deployed. Data source TBD.
  - Number of platooning truck trips. Data source TBD.
  - Number of electric bicycles deployed. Reported by Columbus Police Department.
  - The City of Columbus to report bike lane miles added (bike lanes, sharrows, shared use path).
- **Area**
  Seven-county area encompassing the City of Columbus.
- **Temporal**
  Quarterly reporting to track the priority indicator.
- **Methods**
  Methods for determining GHG reductions with this priority are still being determined.
- **Baseline Measures**
  2016 Calendar Year.
- **Assumptions**
  None.

PRIORITY 4 – CONSUMER ELECTRIC VEHICLE ADOPTION

Original Priority Objective: *Increase electric vehicle market adoption (percentage of new registrations of new and used vehicles) in Columbus and the surrounding seven-county region to 1.8% by the end of the three-year grant period.*

Due to the complexities associated with tracking used electric vehicles and to better define the vehicle class for the scope of this project, the Smart Columbus Project Team has proposed to adjust the priority objective as follows. See Appendix C for further details:

Adjusted Priority Objective*: Increase electric vehicle market adoption as evidenced by the percentage of new light duty vehicle registrations in the Columbus region, comprised of Franklin and the six contiguous counties, to 1.8% of all new and used light duty vehicle registrations by the end of the three-year grant period. In this case 'new' refers to newly manufactured, not previously owned vehicles.*

Priority Indicators:

1. EV Market Penetration (EVs purchased divided by total vehicles purchased).
2. Estimated equivalent number of BEVs purchased.
3. Number of Executives Driving BEVs.

Targets:

See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
Consumer	Any person within the seven-county region who may consider purchasing a BEV or shifting their mobility patterns.
Executives Driving BEVs	BEV purchased by a c-suite executive or senior leader of a Columbus-based organization.

- **Data**
  Vehicle registration database accessed either commercially through IHS Polk or directly through Ohio Bureau of Motor Vehicles. See Appendix C. Number of executives driving BEVs as reported to The Columbus Partnership.
- **Area**
  Seven-county region surrounding Columbus (Delaware, Fairfield, Franklin, Licking, Madison, Pickaway, Union).
- **Temporal**
  Reported quarterly during the three-year period. The 1.8% market penetration rate goal is considered complete if the 1.8% is achieved within any quarter of the grant period.

- **Methods**
  GHG Emissions Reduction Method
  - See Appendix B - Evaluating the effectiveness of Electric Vehicle adoption for reduction of GHG for procedure and details of methodology.
- **Baseline Measures**
  Number of registered BEVs in the Columbus region as of Dec 31, 2016.
- **Assumptions**
  - Both BEVs and PHEVs will be reported quarterly.
  - Number of miles driven for BEVs will be based on available survey data for the region.

Initiative 4.1 – Research and Assessment

Initiative Objective: *Develop performance measures through researching and assessing the local market shifts and behavioral change related to electric vehicles in order to validate, inform, and measure the strategies and tactics undertaken as part of Consumer Adoption.*

Progress Indicators:

1. Perceived desirability, consumer likelihood, and consumer perception to own a BEV.

Targets:

See Appendix A.

Details:

Research efforts will focus on the following areas:

1. Awareness – What percent of consumers are aware that BEVs are available for purchase? What percent are aware that these vehicles are available in the Columbus market?
2. Consideration – What is the purchase consideration of consumers during specified time frames to purchase an BEV (for example, 1-2 years, 2-3, 3-5)?
3. Perceptions – BEV consumer adoption barriers are well studied. Efforts will be focused to understand any regional variances.

- **Definitions**

WORD/PHRASE	DEFINITION
Perceived desirability to own	Percent of people who rank PHEVs or BEVs as their 1st or 2nd power train preference (derived from survey question Q11).
Consumer likelihood	Percent of people who indicate they are likely to select a PEV as their next vehicle purchase or lease (derived from survey question Q20).
Consumer perception	Percent of people who have favorable impressions of BEVs and PHEVs (derived from survey questions Q19 and Q19a).
Consumer awareness	Percent of people who are aware of the car brands that offer PEVs (Nissan, Ford, Chevrolet, Toyota, Honda) (derived from survey question Q25). Percent of people who have heard of Smart Columbus (derived

WORD/PHRASE	DEFINITION
	from survey question Q46).
Consumer consideration	Percent of people who are considering a PHEV or BEV for their next vehicle purchase/lease (derived from survey question Q18).
Consumer experience	Percent of people who have ridden in or driven a PEV (derived from survey questions Q21 and Q22).

- **Data**
  Data to be provided by Navigant based on survey questions.
- **Area**
  Seven-county region surrounding Columbus (Delaware, Fairfield, Franklin, Licking, Madison, Pickaway, Union).
- **Temporal**
  Reported quarterly during the three-year period.
- **Methods**
  No GHG reduction directly associated with this indicator. Audits on product availability will be conducted. BEV inventory is built using best currently verified available practices from organizations around the country including NESCAUM, which supports the ZEV states. The inventory is sourced using online resource (cars.com and direct dealership websites) to confirm available PEV inventory in the seven-county region. The inventory data is collected once per month, and aggregated on a quarterly basis to determine which PEV models were available in the region. This method will be used going forward and will be combined with sales data that is being requested from Smart Columbus dealerships. This will create an additional verification of vehicle models available in the market on a monthly and quarterly basis.
- **Baseline Measures**
  Survey results in year one of the program to be compared with survey results from year three of the program.
- **Assumptions**
  None.

Initiative 4.2 – Increase Consumer Awareness for BEVs

Initiative Objective: *Smart Columbus will use earned and shared media to create broad awareness of electric vehicles, their benefits and Smart Columbus' endorsement of BEVs among the general population in the seven-county region, with a particular focus on early adopters. This layer of general awareness will help foster receptivity to more targeted campaigns and create a culture in Columbus that embraces mobility innovation.*

Progress Indicators:
See data table below.

Targets:
See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
Impression	An estimated number of people who had the opportunity to see content.
Giveaway	Smart Columbus promotional items distributed to residents (i.e. pins, magnets, stickers, etc.).
Media impression	An estimated number of people who had the opportunity to see content or a message via a media source.
Media placement	A mention of Smart Columbus and/or electrification or decarbonization in the media.
EV assets	EV charger or EV displaying the Smart Columbus logo or brand.
Experience Center	A brick and mortar experience center established to educate and inform local residents, visitors, stakeholders and other cities and leadership delegations from around the world about how Columbus is becoming a Smart City. The space will be interactive and regularly updated with real-time program progress. The space includes an EV showroom to provide electric vehicle education and test drives to visitors.
EV Specific Events	Events at the Experience Center focused on EV adoption and/or education.
Salesperson Training	In-person training with dealership personnel on the Smart Columbus Program and PEVs.
Certified Salesperson	Salespeople identified by Smart Columbus Program as knowledgeable on PEVs, based on engagement with Salesperson Training.
Negotiated Group Purchase Rate	Agreed price reduction for specific EV models for consumers in a certain timeframe.

- **Data**

NO.	INDICATOR	DATA
1.	Local Promotion - Number of impressions at community events.	Based on attendance reporting from the event promoters.
2.	Local Promotion - Number of giveaways distributed at community events.	As provided by The Columbus Partnership.
3.	Local Promotion - Media Relations - Number of Local Media Placements.	Provided by local PR agency (Approach Marketing) using Google Alerts and proprietary tools.

NO.	INDICATOR	DATA
4.	Local Promotion - Media Relations - Number of Local Media Impressions.	Provided by local PR agency (Approach Marketing) using proprietary tools.
5.	Local Promotion - Number of Social Media Followers.	Source is the social media (FB, Instagram, Twitter) platform. Local PR agency (Approach Marketing) will report follower data.
6.	Local Promotion - Number of Social Media Impressions.	Source is the social media (FB, Instagram, Twitter) platform. Local PR agency (Approach Marketing) will report impression data.
7.	Local Promotion - Number of EV Assets with Smart Columbus branding.	As reported by COC fleet management and Acceleration Partners.
8.	Experience Center - Number of Visitors.	Reported by The Columbus Partnership. May be an electronic system, sign-in book – method TBD.
9.	Experience Center - Number of EV Specific Events for consumers in a certain timeframe.	As reported by The Columbus Partnership team.

- **Area**
  Web stats can be captured for the seven-county region (internal vs. external).
- **Temporal**
  Reported quarterly during the three-year period.
- **Methods**
  No GHG reduction directly associated with this indicator.
- **Baseline Measures**
  Initial inventory/availability of BEV vehicles (including number and type) at end of 2016.
- **Assumptions**
  None.

Initiative 4.3 – Drive Consumer Considerations for EVs

Initiative Objective: *Smart Columbus will deploy best practice interventions and targeted marketing tactics that move early adopters through the consideration phase of the consumer journey delivering (TBD by end of Q6 by marketing consultant) dealer sales leads that connect the customer to a potential purchase*

Initiative Indicators:

1. Number of Dealer Sales Leads generated.

Progress Indicators:
See data table below.

Targets:
See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
Number of Dealer Sales Leads Generated	Consumers who request to be contacted by a dealer and give permission for their contact information to be shared.
Ride & Drive Roadshow	Experiential marketing events where consumers may interact with and test drive BEVs.
Extended test drive	Overnight or longer loan of a vehicle for the purpose of promoting electric vehicle ownership.
Active Companies in Accelerator Partner Program	Accelerator Partner Pledge for engagement with Smart Columbus for the purpose of driving electric vehicle adoption and adoption of shared/alternative mobility services.
Mobility Ambassadors	A designated employee within an Accelerated Partner company assigned to leading mobility initiatives within the company.
Ignite Action Fund	The Ignite Action Fund matches up to $15,000 of company spending to deploy educational programs, and create BEV incentives and benefits.
Mobility Benefits	Offerings by Acceleration Partner companies to employees that encourage shifts in mobility behavior (i.e. free bus passes or adoption of mobility data platforms).
B2B Marketing	Business-to-business transactions brokered by Smart Columbus.
New Owner's Gift	A gift from Smart Columbus to new BEV owners designed to inspire BEV advocacy and positive word of mouth.

- **Data**

NO.	INDICATOR	DATA
1.	Number of Experience Center Test Drives Conducted.	As reported by The Columbus Partnership.
2.	Number of Ride & Drive Roadshow Events Conducted.	As reported by CivitasNow.
3.	Number of test drives conducted at the Ride & Drive Roadshow Events.	As reported by CivitasNow.

NO.	INDICATOR	DATA
4.	Number of attendees at Ride & Drive Roadshow Events.	As reported by CivitasNow.
5.	Number of Dealer Sales Leads Generated from Ride & Drive Roadshow.	As reported by CivitasNow.
6.	Number of extended test drives conducted.	As reported by The Columbus Partnership.
7.	Total Number (cumulative) of Active Companies in Acceleration Partner Program.	As reported by The Columbus Partnership.
8.	Total Number (cumulative) of Companies with Mobility Ambassadors identified.	As reported by The Columbus Partnership.
9.	Number of Ignite Action Fund Applications received.	As reported by The Columbus Partnership.
10.	Number of Ignite Action Fund recipients.	As reported by The Columbus Partnership.
11.	Number of Companies Introducing new Mobility Benefits.	As reported by The Columbus Partnership.
12.	Website - Number of unique visits to Website.	As reported by Google Analytics.
13.	Website - Average time on Website (in minutes).	As reported by Google Analytics.
14.	Website - Number of dealer referrals from Website.	Data submitted to the website as reported by Smart Columbus.
15.	Education Campaign - Number of Education Campaign impressions.	Measured by campaign analytics as reported by marketing agency (TBD).
16.	Education Campaign - Number of Education Campaign engagements.	Measured by campaign analytics as reported by marketing agency (TBD).
17.	Education Campaign - Number of Education Campaign website referrals.	Measured by campaign analytics as reported by marketing agency (TBD).
18.	Education Campaign - Number of Education Campaign dealer leads.	Measured by campaign analytics as reported by marketing agency (TBD).
19.	B2B Marketing - Number of B2B Marketing impressions.	As reported by marketing agency (TBD).
20.	B2B Marketing - Number of B2B Marketing engagements.	As reported by marketing agency (TBD).
21.	B2B Marketing - Number of B2B Website referrals.	As reported by marketing agency (TBD).
22.	Number of New Owner's Gifts distributed.	As reported by The Columbus Partnership.

- **Area**
  Seven-county region surrounding Columbus (Delaware, Fairfield, Franklin, Licking, Madison, Pickaway, Union).
- **Temporal**
  Reported quarterly during the three-year period.
- **Methods**
  No GHG reduction directly associated with this indicator. See Appendix G for a list of the Ride and Drive survey questions.
- **Baseline Measures**
  Indicator #7: Two companies pledged prior to April 2017.
- **Assumptions**
  None.

Initiative 4.4 – Improve Consumer Sales Experience for BEVs

Initiative Objective: *Engage in partnerships with local car dealerships and Original Equipment Manufacturers (OEMs) to secure a satisfactory supply of new and used BEVs and improve the sales environment of these models to satisfy the increased consumer demand created during the life of the grant.*

Initiative Indicators:

1. Total number of BEV models available in the Columbus Market
2. Ratio of models sold at dealerships in Columbus vs. models sold in the U.S.
3. Ratio of dealerships selling BEVs and/or PHEVs vs. total operating dealerships in the Columbus area
4. Ratio of OEMs supplying BEVs and/or PHEVs in Columbus vs. OEMs supplying models in the U.S.

Progress Indicators:

1. Number of Dealers Actively Engaged.
2. Number of OEMs Actively Engaged.
3. Number of Dealers Certified.
4. Percentage of Total Columbus Dealerships Certified.
5. Number of Dealer Trainings Conducted.
6. Number of Different Dealers with Trained Salespersons.
7. Number of negotiated group purchase rates.
8. Number of BEV and PHEV models eligible for group purchase rates.

Targets:

See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
Dealership	The full BEV availability analysis is tracked at the individual franchised dealership level (brand), rather than larger dealer ownership, providing more accurate tracking and reporting (verifiable by online listings).
OEM	Original Equipment Manufacturer: Parent company who owns various car brands.
Model	Particular make of vehicle sold under a marque by a manufacturer.
Total number of BEV models available in the Columbus Market	Referencing Polk data and the number of models dealers list available on their website.
Ratio of models sold at dealerships in Columbus vs. models sold in the U.S.	The ratio of BEV models identified in the Columbus market, to what is sold collectively throughout the entire U.S. referencing PlugInAmerica data. As of April 2018, there are 39 plug-in models sold throughout the US, while 18 are sold in Columbus region.
Ratio of dealerships selling BEVs and/or PHEVs vs. total operating dealerships in the Columbus area	The ratio of franchised dealers selling a plug-in model compared to the total operating franchised dealers.
Ratio of OEMs supplying BEVs and/or PHEVs in Columbus vs. OEMs supplying models in the U.S.	The number of OEMs that have supplied plug-in models to the Columbus market, compared to the total number of OEMs supplying plug-ins in the U.S.
Actively Engaged	Regular monthly communication.
Dealer certified	Dealers completing a number of activities specified within the Smart Columbus Dealer Engagement Program.
Negotiated group purchase rates	A financial discount offered by dealers or Smart Columbus partners to encourage the adoption of BEVs (i.e. AEP's discount buying a Nissan Leaf).
Significant Event	Smart Columbus focused events that are hosted by Smart Columbus – everything beyond Smart Columbus 101 (i.e. multi-modal service provider launch, visits from elected officials, economic development prospect meetings).

- **Data**
  Data to be provided by The Columbus Partnership.

- **Area**
  Seven-county region surrounding Columbus (Delaware, Fairfield, Franklin, Licking, Madison, Pickaway, Union).
- **Temporal**
  Reported quarterly during the three-year period.
- **Methods**
  No GHG reduction directly associated with this indicator.
- **Baseline Measures**
  None.
- **Assumptions**
  None.

PRIORITY 5 – CHARGING INFRASTRUCTURE

Priority Objective: *Support the acceleration of electric vehicle adoption through installation of charging infrastructure, with the goal* of 925 new charging ports by the end of the grant period.*

*AEP Ohio funded charging infrastructure through the ESP III Extension will include provisions for 300 Level 2 stations and 75 DC Fast Charging Stations. This goal is subject to adoption of the Joint Stipulation filed on August 25, 2017 and should be considered a statewide allocation. Ultimate placement of infrastructure will be determined through the yet to be established rebate process.

Priority Indicator:

1. Number of electric charging station ports operational.

Targets:

See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
Charging Port	Single cord with connector emanating from an EVSE.
EVSE	Electric Vehicle Supply Equipment, also known as electric vehicle (EV) "charging stations", provide all the equipment necessary to deliver electrical energy to an electric vehicle's battery. Units can be ground, pedestal, or wall mounted and may host multiple charging ports.
Level 1 (L1)	Charging level referring to a 120 volt AC charging power source. Example: Charging at home by plugging into a standard wall outlet.
Level 2 (L2)	Charging level referring to a 208-240 volt AC charging power source. Example: Charging at home from an EVSE supplying 240 volts AC.
DC Fast Charging (DCFC)	Minimum output rated at 50 kW. Charging level referring to at least 480 volt DC charging power source. Example: Charging from a DCFC supplying 480 volts DC at a shopping mall parking lot.

- **Data**
  Number, type, and location of chargers. See initiatives for data sources.
- **Area**
  Seven-county metropolitan region or AEP Ohio's Service Territory.
- **Temporal**
  Reported quarterly.
- **Methods**

- Maintaining a detailed database of charging ports installed during the grant period due to all project efforts.
- Charging infrastructure is considered an 'enabling technology' for BEVs so no direct GHG emissions are being calculated.

- **Baseline Measures**
  Existing inventory of publicly available charging as of Dec 31, 2016. The existing charging inventory was pulled from the Alternative Fuels Data Center website.
- **Assumptions**
  Tesla chargers are not being included in the existing inventory or as part of the project charging infrastructure due to Tesla charger incompatibility with non-Tesla electric vehicles.

Initiative 5.1 – Residential Charging

Initiative Objective: *150 charging stations will be deployed at multi-unit dwellings (MUDs) throughout the grant period. The PMO will install a total of 90 (30 in Year 1, 60 in Year 2) and AEP will install, in the AEP Ohio service territory, up to 60 Level 2 stations (pending PUCO approval) during the life of the project to support BEV adoption.*

Initiative Indicators:

1. Number of Level 2 PMO MUD charging ports
2. Number of Level 2 AEP Ohio MUD charging stations

Targets:
See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
Multi-unit dwelling (MUD)	There are at least five types of MUDs, which can be owned or rented, including apartments, condos, cooperatives, mobile home parks, and townhouses. Parking at MUDs can be shared, assigned, or residents can rely on street parking. The parking can be in a structure or a lot and can be owned by individuals, the building owner, or building associations/cooperatives.

- **Data**
  Number, type, and location of chargers is being reported by the residential developers.
- **Area**
  Seven-county metropolitan region or AEP Ohio's Service Territory.
- **Temporal**
  Reported quarterly.
- **Methods**
  Charging infrastructure is considered an 'enabling technology' for BEVs so no direct GHG emissions are being calculated.

- **Baseline Measures**
  Clean Fuels Ohio to report on existing inventory of residential charging as of Dec 31, 2016.
- **Assumptions**
  None.

Strategy 5.1.1 – Develop MUD Infrastructure Plan

Progress Indicators:

1. Number of MUD developers contacted to install EV Charging infrastructure
2. Number of MUD developers who submitted application for MUD rebates

Targets:
See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
Contact	Documented communication (email, written, phone), with organization explaining the Smart Columbus initiative and inviting the institution to participate through collaboration (attendance at meetings and events) and pledging support.
Pledge	Documented official communication from government or institution indicating aspirational goal of BEV committed to purchase.

- **Data**
  Clean Fuels Ohio to report on number of MUD developers contacted to install EV Charging infrastructure and number of MUD developers who submitted application for MUD rebates.
- **Area**
  Seven-county metropolitan region.
- **Temporal**
  Reported quarterly.
- **Methods**
  Charging infrastructure is considered an 'enabling technology' for BEVs so no direct GHG emissions are being calculated.
- **Baseline Measures**
  NA
- **Assumptions**
  NA

Initiative 5.2 – Public Access Charging

Initiative Objective: *In the life of the project, the PMO and Columbus Division of Power will work with American Electric Power to install EV charging that will be accessible to the public. Up to (pending on PUCO approval) 150 Level 2 and 25 DC Fast charging stations will be installed*

at priority locations in the Columbus region during the period of the grant. AEP will install an additional 50 DCFC stations in the AEP Ohio area.

Initiative Indicators:

1. Number of Level 2 publicly accessible charging station ports – City of Columbus
2. Number of DC fast charging stations – AEP
3. Number of Level 2 publicly accessible charging station ports – AEP

Progress Indicators:

1. Number of meetings with potential site hosts
2. Number of partnerships with site hosts and secure commitments

Targets:

See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
DC Fast Charger	Minimum output rated at 50 kW. Charging level referring to at least 480 volt DC charging power source. Example: Charging from a DCFC supplying 480 volts DC at a shopping mall parking lot.
Site Host Meeting	Contact (phone or email correspondence, or a meeting) with a potential public charging site host where, at a minimum, the public access charging initiative has been explained and there has been communication about what it means to become a site host commitment. Multiple meetings with the same company/entity are only to be counted once. A single meeting with multiple companies/entities can be counted for each company/entity in attendance.
Site Host Commitment	Signed agreement between each unique site host and Smart Columbus committing the host to install and maintain the charger(s) in return for a Smart Columbus cost share in the charger(s).

- **Data**
  The City of Columbus and AEP to report on number, type, and location of chargers.
- **Area**
  Seven-county metropolitan region or AEP Ohio's Service Territory.
- **Temporal**
  Reported quarterly.
- **Methods**
  Charging infrastructure is considered an 'enabling technology' for BEVs so no direct GHG emissions are being calculated.

- **Baseline Measures**
  Existing inventory of public access charging as of Dec 31, 2016. The existing charging inventory was pulled from the Alternative Fuels Data Center.
- **Assumptions**
  Tesla chargers are not being included in the existing inventory or as part of the project charging infrastructure due to Tesla charger incompatibility with non-Tesla electric vehicles.

Initiative 5.3 – Workplace Charging

Initiative Objective: *To install a minimum of 250 charging ports at workplaces during the grant period.*

Initiative Indicators:

1. Number of workplaces offering EV charging
2. Number of workplace charging ports by power level (L1, L2, and DC Fast)

Progress Indicators:

1. Number of partner employers signed pledge form to install EV Charging infrastructure

Targets:
See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
Workplace Charging Station	An EV charging station installed at a workplace for use by the employees.
Workplace Charging Policy	The policy that dictates how charging stations should be administered for a workplace.
Employer Meeting	A meeting with employers at a workplace about how to operate a workplace charging station.
Pledge	Documented official communication from government or institution indicating aspirational goal of BEV committed to purchase.

- **Data**
  Individual businesses to report on number, type, and location of chargers.
- **Area**
  Seven-county metropolitan region.
- **Temporal**
  Reported quarterly.
- **Methods**
  Charging infrastructure is considered an ‘enabling technology’ for BEVs so no direct GHG emissions are being calculated.

- **Baseline Measures**
  Existing inventory of workplace charging as of Dec 31, 2016.
- **Assumptions**
  None.

Initiative 5.4 – Fleet Charging

Initiative Objective: *The City of Columbus will deploy charging stations in support of their BEV fleet conversion detailed in Priority 2, Initiative 2.1: Public Fleets. Columbus will design and install 96 charging ports by the end of 2017, and 104 more by the end of the project. The PMO will work with other public agencies to install the additional 100 charging stations for their fleets by the end of the project. Private companies will install charging stations to support their own fleets as they are procured and deployed. The PMO will track public and privately installed fleet charging stations.*

Initiative Indicators:

1. Number of Level 2 charging station ports installed for Columbus and other public fleets.

Targets:
See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
Public Fleet	Group of motor vehicles owned or leased by a public entity
ICEV	Internal Combustion Engine Vehicle
BEV Fleet Conversion	Switch ICEV light duty fleet vehicles to EV or PHEV and ICEV removed from use by fleet.

- **Data**
  City of Columbus and other public fleets to report on number, type, and location of chargers.
- **Area**
  Seven-county metropolitan region.
- **Temporal**
  Reported quarterly.
- **Methods**
  Charging infrastructure is considered an ‘enabling technology’ for BEVs so no direct GHG emissions are being calculated.
- **Baseline Measures**
  Existing inventory of fleet charging as of Dec 31, 2016. Both public and private fleet charger inventory is directly obtained from the individual public and private entities.
- **Assumptions**

Tesla chargers are not being included in the existing inventory or as part of the project charging infrastructure due to Tesla charger incompatibility with non-Tesla electric vehicles.

Initiative 5.5 – Building and Zoning Changes to Support EV Charging

Initiative Objective: *Objective Statement: Develop and refine standards and codes to facilitate efficient City of Columbus EV infrastructure permitting beginning in Year 1 of grant period and share information and lessons learned with other municipalities.*

Initiative Indicators:

1. Number of site plan test cases submitted for permit.

Targets:
See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
Site Plan	Construction plans, often developed by an engineer, detailing updates needed to the charging station site in order to meet all operational requirements.
Permit	Official document giving authorization to install chargers per site plan by applicable authorities. Permits vary depending on the site location and work specified in the site plan.

- **Data**
  City of Columbus to report on number of site plan test cases submitted for permit.
- **Area**
  Seven-county metropolitan region.
- **Temporal**
  Reported quarterly.
- **Methods**
  NA
- **Baseline Measures**
  NA
- **Assumptions**
  NA

Playbook

The playbook will be an evolving portfolio of activities that facilitates knowledge transfer across all priorities. Smart Columbus will continue developing the Smart Columbus Playbook to ensure lessons learned through the Smart Columbus Program are disseminated to other cities across the United States and internationally in order to maximize the program's impact in decarbonizing urban transportation systems.

Initiative Indicators:

1. Number of people educated on Smart Columbus. Intent is to reach city officials, policy makers, business leaders and influencers.

Targets:
See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
Placeholder	Placeholder

- **Data**
  See sections below for data sources.
- **Area**
  Seven-county region surrounding Columbus (Delaware, Fairfield, Franklin, Licking, Madison, Pickaway, Union).
- **Temporal**
  Reported quarterly during the three-year period.
- **Methods**
  No GHG reduction directly associated with this indicator.
- **Baseline Measures**
  None.
- **Assumptions**
  None.

B.2.1 - Content Generation

Progress Indicators:

1. Website - Number of asset downloads, video views, webcast views.
2. Website - Number of unique annual visitors outside the Columbus region.
3. Website - Average minutes spent on site by visitors.
4. Website - Number of newsletter signups.
5. Content - Number of aggregated program archive documents published.
6. Content - Number of learning tools created and published.
7. Content - Number of organic webinars hosted.

8. Content - Number of media webinars sponsored.
9. Content - Number of webinar attendees.

Targets:

See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
Unique annual visitors outside the Columbus region	Unique individual visitors to the Smart Columbus website outside the seven-county region as measured by Google Analytics.
Newsletter signups	Newsletter signups each quarter through website, social media, Experience Center, Ride & Drives, etc. The weekly newsletter is sent every Friday.
Aggregated program archive documents published	Document created by Smart Columbus for the purpose of executing or administering the program that is published via the Playbook for the purpose of education or re-use. Includes program documentation, deliverables, and data sources.
Learning tools created and published	Assets created specifically for the Playbook to transfer key learnings to peer organizations. Includes case studies, webinars, videos, blog posts, photos and graphics.
Organic webinar	Smart Columbus-branded webinar promoted and hosted by Smart Columbus.
Media webinars sponsored	Webinars promoted and hosted by a trade organization or publication that is sponsored by Smart Columbus.
Number of webinars attended	The number of webinar logins.

- **Data**
  Indicators 1-4 are measured and reported by Google Analytics. Indicators 5-9 are reported by The Columbus Partnership.
- **Area**
  Seven-county region surrounding Columbus (Delaware, Fairfield, Franklin, Licking, Madison, Pickaway, Union).
- **Temporal**
  Reported quarterly during the three-year period.
- **Methods**
  No GHG reduction directly associated with this indicator.
- **Baseline Measures**
  None.
- **Assumptions**

None.

B.2.2 - Content Dissemination

Progress Indicators:

1. E-Book - Number of city officials, policy makers, business leaders and influencers who receive Playbook e-book distribution.
2. Conferences - Number of national or international speaking engagements on electrification at priority conferences.
3. Conferences - Number of estimated attendees at national or international speaking engagements.
4. Media Relations and PR - Number of trade media placements on electrification.
5. Media Relations and PR - Number of trade media impressions on electrification.
6. Media Relations and PR - Number of national media placements on electrification.
7. Media Relations and PR - Number of national media impressions on electrification.
8. Social Media - Number of impressions.
9. Social Media - Number of click-throughs to the website.
10. Learning Exchanges - Number of significant events hosted by Smart Columbus.
11. Learning Exchanges - Number of conferences or speaking engagements presented by Smart Columbus.
12. Learning Exchanges - Number of conferences or speaking engagements by Smart Columbus Partners, as tracked by/reported to Smart Columbus.
13. Learning Exchanges - Number of cities Smart Columbus has traveled to for learning and information exchange.
14. Learning Exchanges - Number of meetings with cities beyond seven-county region.

Targets:

See Appendix A.

Details:

- **Definitions**

WORD/PHRASE	DEFINITION
E-Book	The e-book will summarize the most impactful transferrable learnings from the electrification program, and translate them into a cohesive narrative, presented in an interactive e-book, reinforced with multimedia integration.
Priority Conferences	A panel, keynote or speaking opportunity on the Smart City Electrification Program at a national or international conference on electrification, sustainability or smart cities.
Smart Columbus Partners	Includes AEP, ODOT, MORPC, OSU and The Columbus Partnership.
Trade media	A publication focused on sustainability, BEVs, city government or similar.
Trade media placements	A mention of Smart Columbus and/or electrification/decarbonization in an article in a publication focused on sustainability, BEVs, city government, or similar.

WORD/PHRASE	DEFINITION
Trade media impressions	An estimated number of people who had the opportunity to see an article, based on the circulation of the publication.
National media placements	A mention of Smart Columbus and or electrification/decarbonization in a publication reaching a national audience.
Significant Events	Smart Columbus focused events that are hosted by Smart Columbus – everything beyond Smart Columbus 101 (i.e. multi-modal service provider launch, visits from elected officials, economic development prospect meetings).

- **Data**
  Data to be provided by The Columbus Partnership.
- **Area**
  Global.
- **Temporal**
  Reported quarterly during the three-year period.
- **Methods**
  No GHG reduction directly associated with this indicator.
- **Baseline Measures**
  None.
- **Assumptions**
  None.

APPENDIX A

KEY PERFORMANCE INDICATORS

The Key Performance Indicator (KPI) spreadsheet is used as a way to track actual indicator progress against the established targets/goals for each priority of the project on a quarterly basis. The 'Adjusted Targets' spreadsheet outlines the current goals that have been established by the project working groups for each indicator. The 'Progress' spreadsheet reports the actual progress of each indicator toward the established targets. The 'Tracking' spreadsheet simply takes the difference between the targets and progress numbers to specify how each indicator is tracking toward the goal.

The 'Progress' spreadsheet includes highlighted cells to help clarify how the spreadsheet functions. Cells that are yellow are direct inputs. Cells that are orange are calculations that are either summing values or converting values to a common unit. Cells that are green are calculations that are converting the appropriate values into $MTCO_2$ used to calculate overall GHG emission reductions.

See the *SCC-P7-Quarterly Indicators and Metric Targets-Q5.xlsx* document for more detail on the spreadsheet below. Appendix A of the Smart Columbus Electrification Program Quarter 5 Activity Report also shows the Key Performance Indicators.

Adjusted Targets

QUARTERLY INDICATORS AND METRIC TARGETS	Year 1 (2017-2018)				Year 2 (2018)					Year 3 (2019)	After Year 3	LOP
	Q1* Apr-Jun	Q2 Jul-Sep	Q3 Oct-Dec	Q4 Jan-Mar	Q5	Q6	Q7	Q1-Q7 Goal Total	Q1-Q7 To Date	2019 Total		Total
Project Goals	Result	Result	Result	Result	Result				Result			
% GHG emission reductions from baseline year	0.15%	0.15%	0.15%	0.11%	0.15%				0.72%			
Total GHG reductions/savings from baseline year ($MTCO_2$)	38,897	39,210	39,710	29,207	39,579				186,602			
Priority 1 - Decarbonization												
Priority Indicators												
#1: MW of renewable energy capacity installed	0.31	0.15	3.86	0.46	0.45	0	0	0	5.22	5	900	905
#2: MWh of renewable energy consumed	11,847	12,337	13,167	11,473	29,783	76,920	76,920	230,767	78,608	242,860	690,620	1,164,247
#3: MWh of energy saved (new renewable energy or energy efficiency)	57,000	57,023	57,090	40,122	40,235	40,000	40,000	280,000	251,470	160,000	40,000	480,000
Initiative 1.1: Utility Scale Renewables												
Initiative Indicators												
#1: Renewable energy MW capacity installed (Strategies 1.1.1, 1.1.7)	0.31	0.15	3.86	0.46	0.45	0	0	0	5.22	5	900	905
Utility Scale Wind Capacity Installed, MW (AEP) (Strategy 1.1.1)	0	0	0	0	0			0	0	0	900	900
Utility Scale Wind Energy Generated, MWh (AEP) (Strategy 1.1.1)	0	0	0	0	0			0	0	0		0
Utility Scale Solar Capacity Installed, MW (AEP) (Strategy 1.1.1)	0	0	0	0	0			0	0	0		0
Utility Scale Solar Energy Generated, MWh (AEP) (Strategy 1.1.1)	0	0	0	0	0			0	0	0		0
Capacity Installed for New AEP Distributed Energy Customers, MW (Strategy 1.1.3)	0.31	0.15	3.86	0.46	0.45			-	5.22	-	-	-
Columbus DOP Hydroelectric Capacity Installed, MW (Strategy 1.1.7, installed capacity)	0	0	0	0	0			0	0	5		5
#2: Renewable energy MWh consumed (Strategies 1.1.3, 1.1.4, 1.1.5, 1.1.6, 1.1.7)	11,847	12,337	13,167	11,473	29,783	76,920	76,920	230,767	78,608	242,860	690,620	1,164,247
MWh for New AEP Distributed Energy Customers (Strategy 1.1.3)	43	156	745	2,096	3,608			-	6,648	-	-	-
MWh of renewable energy consumed through DC Solar mobile generators*, EV charging ports, and lighting towers (Strategy 1.1.4)	0	6	8	8	8				31			
MWh of Columbus Division of Power Green Power sold (Strategy 1.1.5)	11,804	12,176	12,414	9,369	26,167	76,920	76,920	230,767	71,930	242,860	675,620	1,149,247
MWh from City of Columbus Wastewater Treatment Plant, Co-Generation (Strategy 1.1.6)	0	0	0	0	0			0	0		5,000	5,000
MWh from Columbus Division of Power Hydroelectric Improvements (Strategy 1.1.7, generated energy)	0	0	0	0	0			0	0		10,000	10,000
Progress Indicators												
#1: No. of New AEP Distributed Energy Customers (Strategy 1.1.3)	35	21	60	36	36	25	25	186	188	100	25	311
#2: Number of Deployments of mobile solar generators, EV charging ports, and lighting towers (DC Solar) (Strategy 1.1.4)	0	22	0	0	0	0	0	39	22	15		54
Number of mobile solar generators deployed* (Strategy 1.1.4)	0	1	0	0	0			0	1			0
Number of EV charging ports deployed (Strategy 1.1.4)	0	3	0	0	0			39	3	15		54
Number of mobile solar lighting towers deployed (Strategy 1.1.4)	0	18	0	0	0			0	18			0
#3: Columbus DOP Green Power sold as a percent of Total Power sold (Strategy 1.1.5) (updated)	5.7%	5.7%	5.3%	4.3%	12.5%	25%	25%	25.0%	12.5%	28.4%	29.0%	29%
Initiative 1.2: Grid Modernization and Efficiency												
Initiative Indicators												
#3: Combined MWh saved from strategies 1.2.1, 1.2.5, and 1.2.7	57,000	57,023	57,090	40,122	40,235	40,000	40,000	280,000	251,470	160,000	40,000	480,000
MWh saved from AEP Ohio Energy Efficiency Participation (Strategy 1.2.1)	57,000	57,000	57,000	40,000	40,000	40,000	40,000	280,000	251,000	160,000	40,000	480,000
MWh saved from AEP Smart Lighting Program (Strategy 1.2.5)	0	0	0	0	0				0			0
MWh saved from Columbus DOP LED street lights installed (Strategy 1.2.7)	0	23	90	122	235				470			0
Progress Indicators												
#1: GWh saved as a result of energy efficiency efforts (Strategy 1.2.1)	57	57	57	40	40	40	40	280	251	160	40	480
#2a: AEP AMI meters installed (Strategy 1.2.3)	0	6,600	3,400	72,860	99,676	150,000	100,000	399,676	182,536	128,000		527,676
#2b: AEP Micro Grids installed (Strategy 1.2.4)	0	0	0	0	0			0	0	1		1
#3: AEP Smart Lighting Program Smart controller unit installed (Strategy 1.2.5)	0	0	0	0	0			0	0	-		0
#4: Columbus Division of Power AMI meters installed (Strategy 1.2.6)	0	0	0	0	0			0	0	10,000		10,000
#5: Columbus Division of Power LED street lights installed (Strategy 1.2.7)	0	218	628	297	0			4,700	1,143	4,500		9,200

QUARTERLY INDICATORS AND METRIC TARGETS	Year 1 (2017-2018)				Year 2 (2018)					Year 3 (2019)	After Year 3	LOP
	Q1* Apr-Jun	Q2 Jul-Sep	Q3 Oct-Dec	Q4 Jan-Mar	Q5	Q6	Q7	Q1-Q7 Goal Total	Q1-Q7 To Date	2019 Total		Total
Project Goals	Result	Result	Result	Result	Result				Result			
Priority 2 - Fleet Adoption												
Priority Indicators												
Fleet Electric Vehicles Purchased	4	3	100	31	17	0	203	348	155	453	3	804
Fleet Electric Vehicles Placed In Operation	4	0	5	0	23	2	81	219	32	533	43	795
Initiative 2.1: Public Fleets												
Initiative Indicators												
No. of EVs purchased	3	3	95	12	10	0	98	206	123	98	3	300
No. of EVs placed in operation	3	0	5	0	12	2	28	135	20	168	3	300
City of Columbus - EVs purchased	0	0	93	0	0	0	70	163	93	37		200
City of Columbus - EVs placed in operation	0	0	0	0	0	0	0	93	0	107		200
The Ohio State University - EVs purchased	0	0	2	0	0	0	24	26	2	24		50
The Ohio State University - EVs placed in operation	0	0	2	0	2	0	24	26	4	24		50
City of Dublin - EVs purchased	0	0	0	4	1	0	0	4	5	3	3	10
City of Dublin - EVs placed in operation	0	0	0	0	5	0	0	5	5	3	3	10
Franklin County - EVs purchased	3	3	0	5	0	0	0	0	11	10		10
Franklin County - EVs placed in operation	3	0	3	0	5	0	0	5	11	10		10
Other Government Fleets - EVs purchased	0	0	0	3	9	0	4	13	12	24		37
Other Government Fleets - EVs placed in operation	0	0	0	0	0	2	4	6	0	24		30
Progress Indicators												
#1: Contacts made with other governments or institutions (Strategy 2.1.1)	16	34	10	40	60	13	14	122	160	40		162
#2: Municipal governments or institutions pledged to electrification (fleet analysis and vehicle acquisition plan) (Strategy 2.1.1)	0	0	5	6	5	2	2	19	16	5		24
#3: City of Columbus and public partner training sessions (Strategy 2.1.1)	1	3	1	1	4	1	1	8	10	4		12
Initiative 2.2: Private Fleets												
Initiative Indicators												
No. of EVs purchased	1	0	5	9	7	0	75	102	22	355		450
No. of EVs placed in operation	1	0	0	0	11	0	38	69	12	345	40	450
Progress Indicators												
#1: Private Sector training sessions (Strategy 2.2.1)	0	1	1	0	1	2	1	7	3	4		11
#2: Establish and distribute EV survey/assessment document (Strategy 2.2.1)	50	1,300	0	0	0	0	0	1,350	1,350	125		1,475
#3: New private company pledged to electrification (Strategy 2.2.1)	0	0	7	6	6	15	0	36	19	15		51
#4: New private fleet vehicles pledged to electrification (Strategy 2.2.1)	20	0	3	34	63	150	0	408	120	60		468
#5: Completed vehicle analysis acquisition plan (Strategy 2.2.2)	5	5	5	4	3	5	5	23	22	20		43
Initiative 2.3: Transportation Service Providers (TSPs)												
Initiative Indicators												
No. of EVs purchased	0	0	0	10	0	0	30	40	10	0		40
No. of EVs placed in operation	0	0	0	0	0	0	15	15	0	20		40
Progress Indicators												
#1: Number of contacts made with TSPs (Strategy 2.3.1)	0	0	3	5	7	4	4	25	15	10		35
#2: TSPs pledged to electrification (Strategy 2.3.1)	0	0	0	2	0	2	2	6	2	50		55
Priority 3 - Transit, Autonomous and Multi-Modal Systems in the City												
Priority Indicators												
Total GHG reductions/savings from baseline year (MTCO2)	0	0	0	0	0				0			
Progress Indicators												
#1: Autonomous Electric Vehicles Deployed (USDOT)	0	0	0	0	0				0	6		6
#2: Number of platooning truck trips (USDOT)	0	0	0	0	0				0	1,350		1,350
#3: Number of electric bicycles deployed	0	0	0	0	0			6	0	44		50
#4: Bike infrastructure lane miles added	0.30	2.46	0.90	0.00	1.10	3	2	11	4.76	7	6	24

QUARTERLY INDICATORS AND METRIC TARGETS	Year 1 (2017-2018)				Year 2 (2018)					Year 3 (2019)	After Year 3	LOP
	Q1* Apr-Jun	Q2 Jul-Sep	Q3 Oct-Dec	Q4 Jan-Mar	Q5	Q6	Q7	Q1-Q7 Goal Total	Q1-Q7 To Date	2019 Total		Total
Project Goals	Result	Result	Result	Result	Result				Result			
Priority 4 - Consumer Electric Vehicle Adoption												
Priority Indicators												
#1: EV Market Penetration (EVs purchased divided by total vehicles purchased)	0.44%	0.60%	0.58%	0.77%	0.52%	1.03%	1.10%	1.10%	0.58%	1.80%	1.80%	1.80%
#2: Estimated equivalent number of EVs purchased	115	161	147	190	135	270	290	1244	748	1639	-	2883
#3: Number of Executives Driving EVs	5	0	0	13	3	5	8	26	29	15	5	46
Initiative 4.1: Research and Development												
Progress Indicators												
#1: Perceived Desirability, Consumer likelihood, Consumer perception to own an EV (Strategy 4.1.1)	See Appendix M for Consumer Awareness Survey Findings											
Initiative 4.2: Increase Consumer Awareness for EVs												
Progress Indicators												
#1: Local Promotion - Number of impressions at community events (Strategy 4.2.1)	0	0	0	0	453,155	550,000	50,000	1,053,155	453155	1,000,000	1,000,000	3,053,155
#2: Local Promotion - Number of giveaways distributed at community events (Strategy 4.2.1)	0	0	0	0	1,502	35,000	5,000	41,502	1502	200,000	240,000	481,502
#3: Local Promotion - Media Relations - Number of Local Media Placements (Strategy 4.2.2)	0	0	0	0	100	15	15	130	100	45	50	255
#4: Local Promotion - Media Relations - Number of Local Media Impressions (Strategy 4.2.2)	0	0	0	0	3,636,448	1,500,000	1,500,000	6,636,448	3636448	4,500,000	5,000,000	19,136,448
#5: Local Promotion - Number of Social Media Followers (Strategy 4.2.3)	0	0	0	0	4,969	250	250	5,469	4969	4,000	6,000	6,000
#6: Local Promotion - Number of Social Media Impressions (Strategy 4.2.3)	0	0	0	0	142,820	30,000	30,000	202,820	142820	100,000	125,000	430,320
#7: Local Promotion - Number of EV Assets with Smart Columbus branding (Strategy 4.2.4)	0	0	0	0	93	10	10	113	93	100	50	263
#8: Experience Center - Number of Visitors (Strategy 4.2.5)	0	0	0	0	1,355	3,000	1,000	5,355	1355	5,000	200	10,555
#9: Experience Center - Number of EV Specific Events (Strategy 4.2.5)	0	0	0	0	5	2	2	9	5	10	2	21

QUARTERLY INDICATORS AND METRIC TARGETS	Year 1 (2017-2018)				Year 2 (2018)					Year 3 (2019)	After Year 3	LOP
	Q1* Apr-Jun	Q2 Jul-Sep	Q3 Oct-Dec	Q4 Jan-Mar	Q5	Q6	Q7	Q1-Q7 Goal Total	Q1-Q7 To Date	2019 Total		Total
Project Goals	Result	Result	Result	Result	Result				Result			
Initiative 4.3: Drive Consumer Consideration for EVs												
Initiative Indicators												
#1: Number of Dealer Sales Leads generated	0	0	0	0	397			TBD	397	TBD	TBD	TBD
Progress Indicators												
#1: Number of Experience Center Test Drives Conducted (Substrategy 4.3.1.1)	-	-	-	-	0	100	50	150	0	180	20	350
#2: Number of Ride and Drive Roadshow Events Conducted (Substrategy 4.3.1.2)	-	-	11	4	31	30	10	101	46	50		120
#3: Number of test drives conducted at the Ride and Drive Roadshow Events (Substrategy 4.3.1.2)	-	-	810	369	3,624	3,000	1,000	10,624	4803	5,000		13,824
#4: Number of attendees at Ride and Drive Roadshow Events (Substrategy 4.3.1.2)	-	-	923	25,000	34,714	5,000	2,000	41,714	60637	5,000		52,714
#5: Number of Dealer Sales Leads Generated from Ride and Drive Roadshow (Substrategy 4.3.1.2)	0	0	0	0	397	450	150	1,168	397	750		1,918
#6: Number of extended test drives conducted (Substrategy 4.3.1.3)	0	0	0	0	0	5	5	10	0	15		25
#7: Total Number (cumulative) of Active Companies in Accelerator Partner Program (Substrategy 4.3.2.1)	4	44	46	45	45	50	65	65	45	95	100	100
#8: Total Number (cumulative) of Companies with Mobility Ambassadors Identified (Substrategy 4.3.2.2)	0	0	0	0	38	40	50	50	38	60		60
#9: Number of Ignite Action Fund Applications Received (Substrategy 4.3.2.2)	0	0	0	0	9	0	0	9	9	15		24
#10: Number of Ignite Action Fund Recipients (Substrategy 4.3.2.2)	0	0	0	0	0	10	0	10	0	10		20
#11: Number of Companies Introducing New Mobility Benefits (Substrategy 4.3.2.2)	0	0	0	1	1	10	10	21	2	30		51
#12: Website - Number of unique visits to Website (Substrategy 4.3.3.1)	0	2,026	480	201	14,002	40,000	40,000	94,002	16709	125,000	150,000	369,002
#13: Website - Average time on Website (in minutes) (Substrategy 4.3.3.1)	0	0	0	0	2	2	2	2	1.53	2	2	2
#14: Website - Number of dealer referrals from Website (Substrategy 4.3.3.1)	0	0	0	0	0			TBD	0			TBD
#15: Education Campaign - Number of Education Campaign impressions (Substrategy 4.3.3.2)	0	0	0	0	0			TBD	0			TBD
#16: Education Campaign - Number of Education Campaign engagements (Substrategy 4.3.3.2)	0	0	0	0	0			TBD	0			TBD
#17: Education Campaign - Number of Education Campaign website referrals (Substrategy 4.3.3.2)	0	0	0	0	0			TBD	0			TBD
#18: Education Campaign - Number of Education Campaign dealer leads (Substrategy 4.3.3.2)	0	0	0	0	0			TBD	0			TBD
#19: B2B Marketing - Number of B2B Marketing impressions (Substrategy 4.3.3.3)	0	0	0	0	0			TBD	0			TBD
#20: B2B Marketing - Number of B2B Marketing engagements (Substrategy 4.3.3.3)	0	0	0	0	0			TBD	0			TBD
#21: B2B Marketing - Number of B2B Marketing Website referrals (Substrategy 4.3.3.3)	0	0	0	0	0			TBD	0			TBD
#22: Number of New Owner's Gifts Distributed (Strategy 4.3.4)	0	0	0	0	0	150	150	300	0	600	50	950
Initiative 4.4: Improve Consumer Sales Experience of EVs												
Initiative Indicators												
#1: Total number of EV models available in the Columbus Market	-	0	0	18	23	15	15	15	23	20	23	23
#2: Ratio of models sold at dealerships in Columbus vs. models sold in the U.S.	-	0%	0%	46%	58%	45%	55%	55%	58%	65%	75%	75%
#3: Ratio of dealerships selling BEVs and/or PHEVs vs. total operating dealerships in the Columbus area	-	0%	0%	51%	54%	53%	58%	60%	54%	70%	75%	75%
#4: Ratio of OEMs supplying BEVs and/or PHEVs in Columbus vs. OEMs supplying models in the U.S.	-	0%	0%	85%	100%	80%	80%	80%	100%	85%	100%	100%
Progress Indicators												
#1: Additional Number of Dealers Actively Engaged (Substrategy 4.4.2.1)	7	1	3	6	3	4	4	11	20	22	0	33
#2: Additional Number of OEMs Actively Engaged (Substrategy 4.4.2.1)	2	2	0	1	2	2	0	4	7	3	1	8
#3: Number of Dealers Certified (Substrategy 4.4.2.2)	0	0	0	0	0	5	5	10	0	15		25
#4: Percentage of Total Columbus Dealerships Certified (Substrategy 4.4.2.2)	0%	0%	0%	0%	0%	7%	17%	13%	0%	33%	33%	33%
#5: Number of Trainings Conducted (Substrategy 4.4.2.3)	2	0	0	0	0	5	5	16	2	25		37
#6: Number of Different Dealers with Trained Salespersons (Substrategy 4.4.2.3)	0	2	0	0	0	5	5	16	2	13		25
#7: Number of negotiated group purchase rates (Strategy 4.4.3)	0	2	0	0	1	0	1	4	3	2		6
#8: Number of BEV and PHEV models eligible for group purchase rates (Strategy 4.4.3)	0	1	0	0	4	0	1	6	5	2		8

QUARTERLY INDICATORS AND METRIC TARGETS	Year 1 (2017-2018)				Year 2 (2018)					Year 3 (2019)	After Year 3	LOP
	Q1* Apr-Jun	Q2 Jul-Sep	Q3 Oct-Dec	Q4 Jan-Mar	Q5	Q6	Q7	Q1-Q7 Goal Total	Q1-Q7 To Date	2019 Total		Total
Project Goals	Result	Result	Result	Result	Result				Result			
Priority 5 - Charging Infrastructure												
Priority Indicators												
Number of electric charging station ports installed	65	67	57	24	81	72	133	404	294	526	8	938
~~L1~~	39	0	0	0	0			~~73~~	39	~~7~~		~~80~~
L2	26	65	57	20	81	68	123	389	249	466	8	863
DC Fast	0	2	0	4	0	4	10	15	6	60	0	75
Initiative 5.1: Multi-Unit Dwelling (MUD)												
Initiative Indicators												
#1: Number of Level 2 PMO MUD charging ports installed	0	0	0	0	2	30	30	~~90~~ 60	2	30		90
#2: Number of Level 2 AEP Ohio MUD charging stations installed	0	0	0	0	0	5	15	20	0	40		60
Progress Indicators												
#1: Number of MUD developers contacted to install EV Charging infrastructure (Strategy 5.1.1)	10	5	0	0	0	5	5	25	15	15		40
#2: Number of MUD developers who submitted application for MUD rebates (Strategy 5.1.1)	3	0	2	0	0	2	2	10	5	6		16
#3: Number of Level 2 PMO MUD charging ports proposed in approved Site Commitments/MUD Rebate approvals	0	0	48	24	0	0	0	60		30		90
Initiative 5.2: Public Access Charging												
Initiative Indicators												
#1: Number of Level 2 publicly accessible charging station ports installed – City of Columbus	7	7	0	0	4	~~10~~ 5	~~10~~ 5	~~30~~ 25	18	30	~~0~~ 5	60
#2: Number of DC fast charging stations installed - AEP	0	0	0	0	0	4	10	15	0	60		75
#3: Number of Level 2 publicly accessible charging station ports installed – AEP	0	7	0	0	0	8	15	30	7	60		90
Progress Indicators												
#1: Number of meetings with potential site hosts	3	16	1	3	13	3	4	35	36	18		53
#2: Number of partnerships with site hosts and secure commitments	0	6	0	0	0	1	2	9	6	7		16
Initiative 5.3: Workplace Charging												
Initiative Indicators												
#1: Number of workplaces offering EV charging	3	4	8	4	4	10	20	44	23	55		100
#2: Number of workplace charging ports installed	49	49	47	24	24	20	35	129	193	135		250
L1	39	0	0	0	0	0	0	0	39	0		0
L2	10	47	47	20	24	20	35	129	148	135		250
DC Fast	0	2	0	4	0	0	0	0	6	0		0
Initiative 5.4: Fleet Charging Stations												
Initiative Indicators												
Number of level 2 charging station ports installed for Columbus and other public fleets	9	4	10	0	51	0	23	125	74	171	3	300
City of Columbus	0	0	0	0	24	0	0	96	24	104		200
The Ohio State University	1	0	2	0	12	0	23	26	15	24		50
City of Dublin	0	0	0	0	0	0	0	0	0	3	3	6
Franklin County	8	4	8	0	12	0	0	0	32	10		10
Other Government Fleets	0	0	0	0	3	0	0	3	3	30		30
Initiative 5.5: Building and Zoning Changes to Support EV Charging												
Progress Indicators												
Number of Site plan test cases submitted for permit	1	3	0	1	2	0	0	5	7	3		8

QUARTERLY INDICATORS AND METRIC TARGETS	Year 1 (2017-2018)				Year 2 (2018)					Year 3 (2019)	After Year 3	LOP
	Q1* Apr-Jun	Q2 Jul-Sep	Q3 Oct-Dec	Q4 Jan-Mar	Q5	Q6	Q7	Q1-Q7 Goal Total	Q1-Q7 To Date	2019 Total		Total
Project Goals	Result	Result	Result	Result	Result				Result			
Playbook												
Initiative Indicators												
Number of people educated on Smart Columbus. Intent is to reach city officials, policy makers, business leaders and influencers.	0	0	0	0	157,688	200,000	200,000	557,691	157688	2,000,000	2,000,000	5,000,000
B.2.1: Content Generation												
Progress Indicators												
#1: Website - Number of asset downloads, video views, webcast views (B.2.1.3)	0	0	0	0	0	500	750	1,250	0	1,750	2,000	5,000
#2: Website - Number of unique visitors outside the Columbus region (B.2.1.3)	0	0	0	0	6001	10,000	20,000	36,001	6001	70,000	150,000	256,001
#3: Website - Average minutes spent on site by visitors (B.2.1.3)	0	0	0	0	1.53	2	2	2	1.53	2	2	2
#4: Website - Number of newsletter signups (B.2.1.3)	0	0	0	0	0	250	250	500	0	1,000		2,600
#5: Content - Number of aggregated program archive documents published (B.2.1.4)	0	0	0	0	0	5	5	10	0	75	45	150
#6: Content - Number of learning tools created and published (B.2.1.4)	0	0	0	0	0	12	12	24	0	48	38	115
#7: Content - Number of organic webinars hosted (B.2.1.5)	0	0	0	0	0	3	2	5	0	8	5	18
#8: Content - Number of media webinars sponsored (B.2.1.5)	0	0	0	0	0	1	0	1	0	2	2	5
#9: Content - Number of webinar attendees (B.2.1.5)	0	0	0	0	0	200	100	300	0	500	350	1,150
B.2.2: Content Dissimenation												
Progress Indicators												
#1: E-Book - Number of city officials, policy makers, business leaders and influencers who receive Playbook e-book distribution (B.2.2.1)	0	0	0	0	0			0	0	0	1,000	1,000
#2: Conferences - Number of national or international speaking engagements on electrification at priority conferences (B.2.2.2)	0	0	0	0	7	1	1	9	7	3	5	20
#3: Conferences - Number of estimated attendees at national or international speaking engagements (B.2.2.2)	0	0	0	0	100	100	100	300	100	300	500	2,000
#4: Media Relations and PR - Number of trade media placements on electrification (B.2.2.3)	0	0	0	0	1	2	3	6	1	10	10	31
#5: Media Relations and PR - Number of trade media impressions on electrification (B.2.2.3)	0	0	0	0	8767	120,000	180,000	308,767	8767	400,000	500,000	1,308,767
#6: Media Relations and PR - Number of national media placements on electrification (B.2.2.3)	0	0	0	0	0		1	1	0	2	2	5
#7: Media Relations and PR - Number of national media impressions on electrification (B.2.2.3)	0	0	0	0	0		250,000	250,000	0	500,000	500,000	1,250,000
#8: Social Media - Number of impressions (B.2.2.4)	0	0	0	0	142820	20,000	30,000	192,820	142820	100,000	150,000	442,820
#9: Social Media - Number of click-throughs to the website (B.2.2.4)	0	0	0	0	0	1,000	2,500	3,500	0	5,000	7,500	16,000
#10: Learning Exchanges - Number of significant events hosted by Smart Columbus (B.2.2.5)	0	0	0	0	24	6	6	36	24	16	14	86
#11: Learning Exchanges - Number of conferences or speaking engagements presented by Smart Columbus (B.2.2.5)	0	0	0	0	45	18	15	78	45	60	70	275
#12: Learning Exchanges - Number of conferences or speaking engagements by Smart Columbus Partners, as tracked/reported to SC (B.2.2.5)	0	0	0	0	4			4	4			TBD
#13: Learning Exchanges - Number of cities Smart Columbus has traveled to for learning and information exchange (B.2.2.5)	5	2	4	5	6	2	3	11	22	10	20	52
#14: Learning Exchanges - Number of meetings with cities beyond seven county region (B.2.2.5)	0	0	0	0	16	4	4	24	16	12	12	60

Progress

QUARTERLY INDICATORS AND METRIC PROGRESS	Year 1 (2017-2018)				To Date			
	Q1* Apr-Jun	Q2 Jul-Sep	Q3 Oct-Dec	Q4 Jan-Mar	Q5	Q6	Q7	Q1-Q7 Total
Project Goals								
% GHG emission reductions from baseline year	0.15%	0.15%	0.15%	0.11%	0.15%	0.00%	0.00%	0.72%
Total GHG reductions/savings from baseline year (MTCO2)	38,897	39,210	39,710	29,207	39,579	0	0	186,602
Priority 1 - Decarbonization								
Priority Indicators								
#1: MW of renewable energy capacity installed	0.31	0.15	3.86	0.46	0.45	0.00	0.00	5.22
#2: MWh of renewable energy consumed	11,847	12,337	13,167	11,473	29,783	0	0	78,608
#3: MWh of energy saved (new renewable energy or energy efficiency)	57,000	57,023	57,090	40,122	40,235	0	0	251,470
Initiative 1.1: Utility Scale Renewables								
Initiative Indicators								
#1: Renewable energy MW capacity installed (Strategies 1.1.1, 1.1.7)	0.31	0.15	3.86	0.46	0.45	0.00	0.00	5.22
Utility Scale Wind Capacity Installed, MW (AEP) (Strategy 1.1.1)	0	0	0	0	0			0
Utility Scale Wind Energy Generated, MWh (AEP) (Strategy 1.1.1)	0	0	0	0	0			0
Utility Scale Solar Capacity Installed, MW (AEP) (Strategy 1.1.1)	0	0	0	0	0			0
Utility Scale Solar Energy Generated, MWh (AEP) (Strategy 1.1.1)	0	0	0	0	0			0
Capacity Installed for New AEP Distributed Energy Customers, MW (Strategy 1.1.3)	0.31	0.15	3.86	0.46	0.45			5.22
Columbus DOP Hydroelectric Capacity Installed, MW (Strategy 1.1.7, installed capacity)	0	0	0	0	0			0
Conversion to MTCO2	0	0	0	0	0	0	0	0
#2: Renewable energy MWh consumed (Strategies 1.1.3, 1.1.4, 1.1.5, 1.1.6, 1.1.7)	11,847	12,337	13,167	11,473	29,783	0	0	78,608
MWh for New AEP Distributed Energy Customers (Strategy 1.1.3)	43	156	745	2,096	3,608			6,648
MWh of renewable energy consumed through DC Solar mobile generators*, EV charging ports, and lighting towers (Strategy 1.1.4)	0	6	8	8	8			31
MWh of Columbus Division of Power Green Power sold (Strategy 1.1.5)	11,804	12,176	12,414	9,369	26,167			71,930
MWh from City of Columbus Wastewater Treatment Plant, Co-Generation (Strategy 1.1.6)	0	0	0	0	0			0
MWh from Columbus Division of Power Hydroelectric Improvements (Strategy 1.1.7, generated energy)	0	0	0	0	0			0
Conversion to MTCO2	6,682	6,958	7,426	6,471	16,798	0	0	44,335
Progress Indicators								
#1: No. of New AEP Distributed Energy Customers (Strategy 1.1.3)	35	21	60	36	36			188
#2: Number of Deployments of mobile solar generators, EV charging ports, and lighting towers (DC Solar) (Strategy 1.1.4)	0	22	0	0	0	0	0	22
Number of mobile solar generators deployed* (Strategy 1.1.4)	0	1	0	0	0			1
Number of EV charging ports deployed (Strategy 1.1.4)	0	3	0	0	0			3
Number of mobile solar lighting towers deployed (Strategy 1.1.4)	0	18	0	0	0			18
#3: Columbus DOP Green Power sold as a percent of Total Power sold (Strategy 1.1.5) (updated)	5.7%	5.7%	5.3%	4.3%	12.5%			12.5%

QUARTERLY INDICATORS AND METRIC PROGRESS	Year 1 (2017-2018)				To Date			
	Q1* Apr-Jun	Q2 Jul-Sep	Q3 Oct-Dec	Q4 Jan-Mar	Q5	Q6	Q7	Q1-Q7 Total
Project Goals								
Initiative 1.2: Grid Modernization and Efficiency								
Initiative Indicators								
#3: Combined MWh saved from strategies 1.2.1, 1.2.5, and 1.2.7	57,000	57,023	57,090	40,122	40,235	0	0	251,470
MWh saved from AEP Ohio Energy Efficiency Participation (Strategy 1.2.1)	57,000	57,000	57,000	40,000	40,000	0	0	251,000
MWh saved from AEP Smart Lighting Program (Strategy 1.2.5)	0	0	0	0	0			0
MWh saved from Columbus DOP LED street lights installed (Strategy 1.2.7)	0	23	90	122	235			470
Conversion to MTCO2	32,148	32,161	32,199	22,629	22,692	0	0	141,828
Progress Indicators								
#1: GWh saved as a result of energy efficiency efforts (Strategy 1.2.1)	57	57	57	40	40			251
#2a: AEP AMI meters installed (Strategy 1.2.3)	0	6,600	3,400	72,860	99,676			182,536
#2b: AEP Micro Grids installed (Strategy 1.2.4)	0	0	0	0	0			0
#3: AEP Smart Lighting Program Smart controller unit installed (Strategy 1.2.5)	0	0	0	0	0			0
#4: Columbus Division of Power AMI meters installed (Strategy 1.2.6)	0	0	0	0	0			0
#5: Columbus Division of Power LED street lights installed (Strategy 1.2.7)	0	218	628	297	0			1,143
Conversion to MTCO2								
Priority 1 Subtotal GHG Reduction (MTCO2)	38,830	39,119	39,625	29,100	39,490	0	0	186,163

QUARTERLY INDICATORS AND METRIC PROGRESS	Year 1 (2017-2018)				To Date			
	Q1* Apr-Jun	Q2 Jul-Sep	Q3 Oct-Dec	Q4 Jan-Mar	Q5	Q6	Q7	Q1-Q7 Total
Project Goals								
Priority 2 - Fleet Adoption								
Priority Indicators								
Fleet Electric Vehicles Purchased	4	3	100	31	17	0	0	155
Fleet Electric Vehicles Placed In Operation	4	0	5	0	23	0	0	32
Initiative 2.1: Public Fleets								
Initiative Indicators								
No. of EVs purchased	3	3	95	12	10	0	0	123
No. of EVs placed in operation	3	0	5	0	12	0	0	20
City of Columbus - EVs purchased	0	0	93	0	0			93
City of Columbus - EVs placed in operation	0	0	0	0	0			0
The Ohio State University - EVs purchased	0	0	2	0	0			2
The Ohio State University - EVs placed in operation	0	0	2	0	2			4
City of Dublin - EVs purchased	0	0	0	4	1			5
City of Dublin - EVs placed in operation	0	0	0	0	5			5
Franklin County - EVs purchased	3	3	0	5	0			11
Franklin County - EVs placed in operation	3	0	3	0	5			11
Other Government Fleets - EVs purchased	0	0	0	3	9			12
Other Government Fleets - EVs placed in operation	0	0	0	0	0			0
Conversion to MTCO2	2	0	3	0	7	0	0	11
Progress Indicators								
#1: Contacts made with other governments or institutions (Strategy 2.1.1)	16	34	10	40	60			160
#2: Municipal governments or institutions pledged to electrification (fleet analysis and vehicle acquisition plan) (Strategy 2.1.1)	0	0	5	6	5			16
#3: City of Columbus and public partner training sessions (Strategy 2.1.1)	1	3	1	1	4			10
Initiative 2.2: Private Fleets								
Initiative Indicators								
No. of EVs purchased	1	0	5	9	7			22
No. of EVs placed in operation	1	0	0	0	11			12
Conversion to MTCO2	1	0	0	0	6	0	0	7
Progress Indicators								
#1: Private Sector training sessions (Strategy 2.2.1)	0	1	1	0	1			3
~~#2: Establish and distribute EV survey/assessment document (Strategy 2.2.1)~~	~~50~~	~~1,300~~	~~0~~	~~0~~				~~1,350~~
#3: New private company pledged to electrification (Strategy 2.2.1)	0	0	7	6	6			19
#4: New private fleet vehicles pledged to electrification (Strategy 2.2.1)	20	0	3	34	63			120
#5: Completed vehicle analysis acquisition plan (Strategy 2.2.2)	5	5	5	4	3			22
Initiative 2.3: Transportation Service Providers (TSPs)								
Initiative Indicators								
No. of EVs purchased	0	0	0	10	0			10
No. of EVs placed in operation	0	0	0	0	0			0
Conversion to GHG (MTCO2)	0	0	0	0	0	0	0	0
Progress Indicators								
#1: Number of contacts made with TSPs (Strategy 2.3.1)	0	0	3	5	7			15
#2: TSPs pledged to electrification (Strategy 2.3.1)	0	0	0	2	0			2
Priority 2 Subtotal GHG Reduction (MTCO2)	2	0	3	0	13	0	0	18

QUARTERLY INDICATORS AND METRIC PROGRESS	Year 1 (2017-2018)				To Date			
	Q1* Apr-Jun	Q2 Jul-Sep	Q3 Oct-Dec	Q4 Jan-Mar	Q5	Q6	Q7	Q1-Q7 Total
Project Goals								
Priority 3 - Transit, Autonomous and Multi-Modal Systems in the City								
Priority Indicators								
Total GHG reductions/savings from baseline year (MTCO2)								0
Progress Indicators								
#1: Autonomous Electric Vehicles Deployed (USDOT)	0	0	0	0	0			0
#2: Number of platooning truck trips (USDOT)	0	0	0	0	0			0
#3: Number of electric bicycles deployed	0	0	0	0	0			0
#4: Bike infrastructure lane miles added	0.30	2.46	0.90	0.00	1.10			4.76
Priority 3 Subtotal GHG Reduction (MTCO2)	0	0	0	0	0	0	0	0
Priority 4 - Consumer Electric Vehicle Adoption								
Priority Indicators								
#1: EV Market Penetration (EVs purchased divided by total vehicles purchased)	0.44%	0.60%	0.58%	0.77%	0.52%			0.58%
#2: Estimated equivalent number of EVs purchased	115	161	147	190	135			748
#3: Number of Executives Driving EVs	5	2	6	13	3			29
Initiative 4.1: Research and Development								
Progress Indicators								
#1: Perceived Desirability, Consumer likelihood, Consumer perception to own an EV (Strategy 4.1.1)	See Appendix M for Consumer Awareness Survey Findings							
Initiative 4.2: Increase Consumer Awareness for EVs								
Progress Indicators								
#1: Local Promotion - Number of impressions at community events (Strategy 4.2.1)					453155			453155
#2: Local Promotion - Number of giveaways distributed at community events (Strategy 4.2.1)					1502			1502
#3: Local Promotion - Media Relations - Number of Local Media Placements (Strategy 4.2.2)					100			100
#4: Local Promotion - Media Relations - Number of Local Media Impressions (Strategy 4.2.2)					3636448			3636448
#5: Local Promotion - Number of Social Media Followers (Strategy 4.2.3)					4969			4969
#6: Local Promotion - Number of Social Media Impressions (Strategy 4.2.3)					142820			142820
#7: Local Promotion - Number of EV Assets with Smart Columbus branding (Strategy 4.2.4)					93			93
#8: Experience Center - Number of Visitors (Strategy 4.2.5)					1355			1355
#9: Experience Center - Number of EV Specific Events (Strategy 4.2.5)					5			5

QUARTERLY INDICATORS AND METRIC PROGRESS	Year 1 (2017-2018)				To Date			
	Q1* Apr-Jun	Q2 Jul-Sep	Q3 Oct-Dec	Q4 Jan-Mar	Q5	Q6	Q7	Q1-Q7 Total
Project Goals								
Initiative 4.3: Drive Consumer Consideration for EVs								
Initiative Indicators								
#1: Number of Dealer Sales Leads generated					397			397
Progress Indicators								
#1: Number of Experience Center Test Drives Conducted (Substrategy 4.3.1.1)	-	-	-	-	0			0
#2: Number of Ride and Drive Roadshow Events Conducted (Substrategy 4.3.1.2)	-	-	11	4	31			46
#3: Number of test drives conducted at the Ride and Drive Roadshow Events (Substrategy 4.3.1.2)	-	-	810	369	3,624			4,803
#4: Number of attendees at Ride and Drive Roadshow Events (Substrategy 4.3.1.2)	-	-	923	25,000	34,714			60,637
#5: Number of Dealer Sales Leads Generated from Ride and Drive Roadshow (Substrategy 4.3.1.2)					397			397
#6: Number of extended test drives conducted (Substrategy 4.3.1.3)					0			0
#7: Total Number (cumulative) of Active Companies in Accelerator Partner Program (Substrategy 4.3.2.1)	4	44	46	45	45			45
#8: Total Number (cumulative) of Companies with Mobility Ambassadors Identified (Substrategy 4.3.2.2)					38			38
#9: Number of Ignite Action Fund Applications Received (Substrategy 4.3.2.2)					9			9
#10: Number of Ignite Action Fund Recipients (Substrategy 4.3.2.2)					0			0
#11: Number of Companies Introducing New Mobility Benefits (Substrategy 4.3.2.2)				1	1			2
#12: Website - Number of unique visits to Website (Substrategy 4.3.3.1)	0	2,026	480	201	14,002			16,709
#13: Website - Average time on Website (in minutes) (Substrategy 4.3.3.1)					1.53			1.53
#14: Website - Number of dealer referrals from Website (Substrategy 4.3.3.1)					0			0
#15: Education Campaign - Number of Education Campaign impressions (Substrategy 4.3.3.2)					0			0
#16: Education Campaign - Number of Education Campaign engagements (Substrategy 4.3.3.2)					0			0
#17: Education Campaign - Number of Education Campaign website referrals (Substrategy 4.3.3.2)					0			0
#18: Education Campaign - Number of Education Campaign dealer leads (Substrategy 4.3.3.2)					0			0
#19: B2B Marketing - Number of B2B Marketing impressions (Substrategy 4.3.3.3)					0			0
#20: B2B Marketing - Number of B2B Marketing engagements (Substrategy 4.3.3.3)					0			0
#21: B2B Marketing - Number of B2B Marketing Website referrals (Substrategy 4.3.3.3)					0			0
#22: Number of New Owner's Gifts Distributed (Strategy 4.3.4)					0			0
Initiative 4.4: Improve Consumer Sales Experience of EVs								
Initiative Indicators								
#1: Total number of EV models available in the Columbus Market	-			18	23			23
#2: Ratio of models sold at dealerships in Columbus vs. models sold in the U.S.	-			46%	58%			58%
#3: Ratio of dealerships selling BEVs and/or PHEVs vs. total operating dealerships in the Columbus area	-			51%	54%			54%
#4: Ratio of OEMs supplying BEVs and/or PHEVs in Columbus vs. OEMs supplying models in the U.S.	-			85%	100%			100%
Progress Indicators								
#1: Additional Number of Dealers Actively Engaged (Substrategy 4.4.2.1)	7	1	3	6	3			20
#2: Additional Number of OEMs Actively Engaged (Substrategy 4.4.2.1)	2	2	0	1	2			7
#3: Number of Dealers Certified (Substrategy 4.4.2.2)					0			0
#4: Percentage of Total Columbus Dealerships Certified (Substrategy 4.4.2.2)					0			0.00%
#5: Number of Trainings Conducted (Substrategy 4.4.2.3)	2	0	0	0	0			2
#6: Number of Different Dealers with Trained Salespersons (Substrategy 4.4.2.3)	0	2	0	0	0			2
#7: Number of negotiated group purchase rates (Strategy 4.4.3)	0	2	0	0	1			3
#8: Number of BEV and PHEV models eligible for group purchase rates (Strategy 4.4.3)	0	1	0	0	4			5
Priority 4 Subtotal GHG Reduction (MTCO2)	65	91	83	107	76	0	0	421

QUARTERLY INDICATORS AND METRIC PROGRESS	Year 1 (2017-2018)				To Date			
	Q1* Apr-Jun	Q2 Jul-Sep	Q3 Oct-Dec	Q4 Jan-Mar	Q5	Q6	Q7	Q1-Q7 Total
Project Goals								
Priority 5 - Charging Infrastructure								
Priority Indicators								
Number of electric charging station ports installed	65	67	57	24	81	0	0	294
L1	39	0	0	0	0	0	0	39
L2	26	65	57	20	81	0	0	249
DC Fast	0	2	0	4	0	0	0	6
Initiative 5.1: Multi-Unit Dwelling (MUD)								
Initiative Indicators								
#1: Number of Level 2 PMO MUD charging ports installed	0	0	0	0	2			2
#2: Number of Level 2 AEP Ohio MUD charging stations installed	0	0	0	0	0			0
Progress Indicators								
#1: Number of MUD developers contacted to install EV Charging infrastructure (Strategy 5.1.1)	10	5	0	0	0			15
#2: Number of MUD developers who submitted application for MUD rebates (Strategy 5.1.1)	3	0	2	0	0			5
#3: Number of Level 2 PMO MUD charging ports proposed in approved Site Commitments/MUD Rebate approvals	0	0	48	24	0			72
Initiative 5.2: Public Access Charging								
Initiative Indicators								
#1: Number of Level 2 publicly accessible charging station ports installed – City of Columbus	7	7	0	0	4			18
#2: Number of DC fast charging stations installed - AEP	0	0	0	0	0			0
#3: Number of Level 2 publicly accessible charging station ports installed – AEP	0	7	0	0	0			7
Progress Indicators								
#1: Number of meetings with potential site hosts	3	16	1	3	13			36
#2: Number of partnerships with site hosts and secure commitments	0	6	0	0	0			6
Initiative 5.3: Workplace Charging								
Initiative Indicators								
#1: Number of workplaces offering EV charging	3	4	8	4	4			23
#2: Number of workplace charging ports installed	49	49	47	24	24	0	0	193
L1	39	0	0	0	0			39
L2	10	47	47	20	24			148
DC Fast	0	2	0	4	0			6
Initiative 5.4: Fleet Charging Stations								
Initiative Indicators								
Number of level 2 charging station ports installed for Columbus and other public fleets	9	4	10	0	51	0	0	74
City of Columbus	0	0	0	0	24			24
The Ohio State University	1	0	2	0	12			15
City of Dublin	0	0	0	0	0			0
Franklin County	8	4	8	0	12			32
Other Government Fleets	0	0	0	0	3			3
Initiative 5.5: Building and Zoning Changes to Support EV Charging								
Progress Indicators								
Number of Site plan test cases submitted for permit	1	3	0	1	2			7

QUARTERLY INDICATORS AND METRIC PROGRESS	Year 1 (2017-2018)				To Date			
	Q1* Apr-Jun	Q2 Jul-Sep	Q3 Oct-Dec	Q4 Jan-Mar	Q5	Q6	Q7	Q1-Q7 Total
Project Goals								
Playbook								
Initiative Indicators								
Number of people educated on Smart Columbus. Intent is to reach city officials, policy makers, business leaders and influencers.					157,688			157,688
B.2.1: Content Generation								
Progress Indicators								
#1: Website - Number of asset downloads, video views, webcast views (B.2.1.3)					0			0
#2: Website - Number of unique visitors outside the Columbus region (B.2.1.3)					6,001			6,001
#3: Website - Average minutes spent on site by visitors (B.2.1.3)					1.53			1.53
#4: Website - Number of newsletter signups (B.2.1.3)					0			0
#5: Content - Number of aggregated program archive documents published (B.2.1.4)					0			0
#6: Content - Number of learning tools created and published (B.2.1.4)					0			0
#7: Content - Number of organic webinars hosted (B.2.1.5)					0			0
#8: Content - Number of media webinars sponsored (B.2.1.5)					0			0
#9: Content - Number of webinar attendees (B.2.1.5)					0			0
B.2.2: Content Dissimenation								
Progress Indicators								
#1: E-Book - Number of city officials, policy makers, business leaders and influencers who receive Playbook e-book distribution (B.2.2.1)					0	0	0	0
#2: Conferences - Number of national or international speaking engagements on electrification at priority conferences (B.2.2.2)					7			7
#3: Conferences - Number of estimated attendees at national or international speaking engagements (B.2.2.2)					100			100
#4: Media Relations and PR - Number of trade media placements on electrification (B.2.2.3)					1			1
#5: Media Relations and PR - Number of trade media impressions on electrification (B.2.2.3)					8,767			8,767
#6: Media Relations and PR - Number of national media placements on electrification (B.2.2.3)					0			0
#7: Media Relations and PR - Number of national media impressions on electrification (B.2.2.3)					0			0
#8: Social Media - Number of impressions (B.2.2.4)					142,820			142,820
#9: Social Media - Number of click-throughs to the website (B.2.2.4)					0			0
#10: Learning Exchanges - Number of significant events hosted by Smart Columbus (B.2.2.5)					24			24
#11: Learning Exchanges - Number of conferences or speaking engagements presented by Smart Columbus (B.2.2.5)					45			45
#12: Learning Exchanges - Number of conferences or speaking engagements by Smart Columbus Partners, as tracked/reported to SC (B.2.2.5)					4			4
#13: Learning Exchanges - Number of cities Smart Columbus has traveled to for learning and information exchange (B.2.2.5)	5	2	4	5	6			22
#14: Learning Exchanges - Number of meetings with cities beyond seven county region (B.2.2.5)					16			16

APPENDIX B

EVALUATING THE EFFECTIVENESS OF ELECTRIC VEHICLE ADOPTION FOR REDUCTION OF GHG

This project assumes that each electric vehicle (EV) adopted in the Smart Columbus Program (SCP), whether pure battery electric vehicle (BEV) or plug-in hybrid electric vehicle (PHEV), will displace the miles driven by an internal combustion engine (ICE) vehicle. The benefit in terms of reduced greenhouse gas (GHG) emissions for each displaced ICE vehicle is dependent on a number of factors including the efficiency of the EV, the utilization of the vehicle in terms of miles driven, and the upstream factors that contribute to the carbonization of the electrical supply used for recharging. The SCP will assess the GHG reduction resulting from EV adoption using scientific yet simple and straight forward methodologies as demonstrated and documented through the US Department of Energy (DOE). The DOE, through the office of Energy Efficiency and Renewable Energy (EERE), provides data and a number of tools to support the GHG performance measure reporting as well as various resources for alternative fuel vehicle adoption for cities through their Clean Cities program. Furthermore, the DOE, through the EERE office, has signed a memorandum of understanding with the US Department of Transportation in support of the Smart Cities program.

The methodology used to assess GHG reduction will consist of assessing the number and type of EVs adopted through the SCP, the general efficiency of EVs adopted, the extent of utilization of vehicles within the Columbus area, the average new vehicle fuel efficiency of combustion vehicles, and the upstream factors related to carbonization of the grid. This general method is applicable to EVs put into service in public fleets and private fleets, or by the general consumer.

Vehicle utilization measured in annual miles driven for average consumer vehicle utilization is available through national and state survey data. Aggregate average fuel economy of the existing ICE fleet is estimated based on the existing fleet composition revealed from vehicle registration records and the fuel economy rating from each vehicle model (available from fueleconomy.gov). Vehicle registration data is available either directly from the Ohio Bureau of Motor Vehicles or from data aggregators such as IHS Polk. Utilization from fleet service of any type is typically available directly from the fleet managers in terms of miles driven on a quarterly or yearly basis.

Examples using this methodology are provided through the Alternative Fuels Data Center's (AFDC) Emissions from Hybrids and PEVs page (http://www.afdc.energy.gov/vehicles/electric_emissions.php). This site provides a representative breakdown of electricity sources and annual emissions per vehicle type by geographic location as well as national averages. As an example, the current annual emissions per vehicle in Ohio are included below. The data sources and methodology used to calculate the emissions, fuel use, and electricity sources for conventional and electric drive vehicles on

this page are consistent with data and methodology that will be employed by SCP. Whereas sample calculations are provided for large geographic regions (such as Ohio statewide in the table below), the GHG performance measures for the SCP will be tailored to the jurisdictional and geographic areas impacted by the program, and will also take into account anticipated changes in the regional power generation mix.

VEHICLE DATA SOURCES

Vehicle emission calculations are time dependent as the parameters used for the calculations are changing each year with shifting vehicle efficiency rating and electric power grid emission factors.

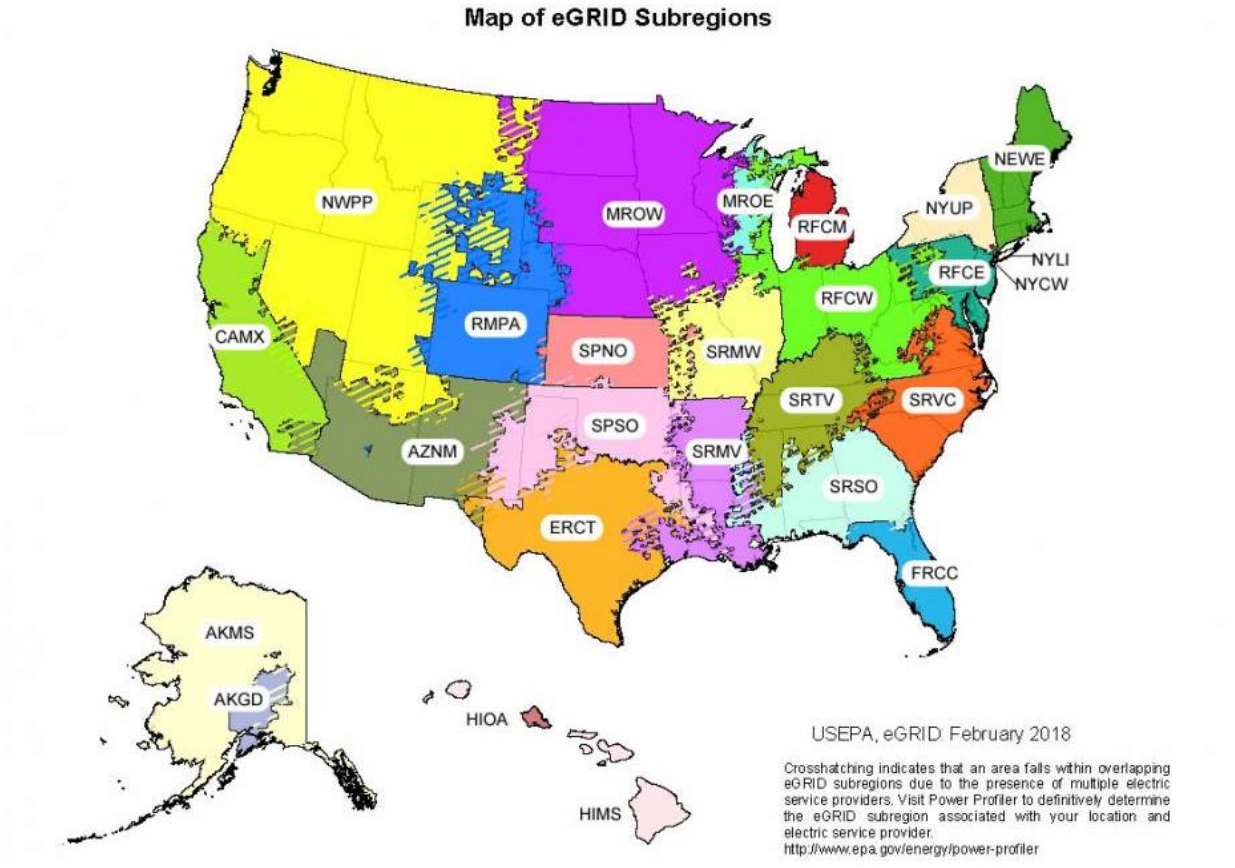
The basis for new vehicle fuel economy data is released annually by the US EPA in the 'Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends Report'. The EPA's Trends Report breaks out conventional vehicle efficiency data by make and type. Alternative fueled vehicles such as EVs, PHEVs, and FCVs are broken out further by type, make, and model. This detailed vehicle efficiency information will be used to establish overall blended efficiency values for all electric range for PHEVs (miles) and EV/PHEV efficiency (kWh/mile) values based on the actual number and type (make/model) of vehicle sales in the seven-county region. The report is time delayed by two years so the most recent data is from 2016. The fuel economy values listed in the Trends Report have already been adjusted to reflect real world estimates.

The basis for new vehicle fuel economy data after 2016 comes from the US EIA's Annual Energy Outlook data tables. These projected fuel efficiency regulations are unadjusted and do not represent real world driving estimates. To make these values consistent with the EPA Trends Report, the mpg ratings were adjusted by a factor of 0.74.

ELECTRIC GRID SOURCES

Tailoring the process to Columbus' needs also requires information on present and future decarbonization of the local grid. Reasonably current carbon intensity estimates of the local grid are available through the EPA's Emissions and Generation Resource Integrated Database (eGRID) Report. These aggregation levels include national, state, North American Electric Reliability Corporation (NERC), and eGRID sub region levels (Figure 1). The study area comprised of the seven-county region is located within the Reliability First Corporation (RFC) West eGRID sub region market.

Figure 1 – eGRID Sub Region Map



The grid emission factors for these regions and are released about every two years, generally with a two-year time delay for the reported values. For example, eGRID2016 was released in February 2018, but uses data from 2016. In order to project grid emissions for the current year and into the future, the EIA's Annual Outlook data tables contain projected trends in how the electricity grid power sources change over time (Figure 2).

The electricity generation grid mix directly impacts the emission factor used in the EV calculations. As shown in Table 1, both the national average and RFC West sub region had a reduction in the use of coal for power generation from 2014 to 2016. This decrease in fossil fuel use also decreased the emission factors nationally and for this region.

Table 1 - Electricity Generation Mix*

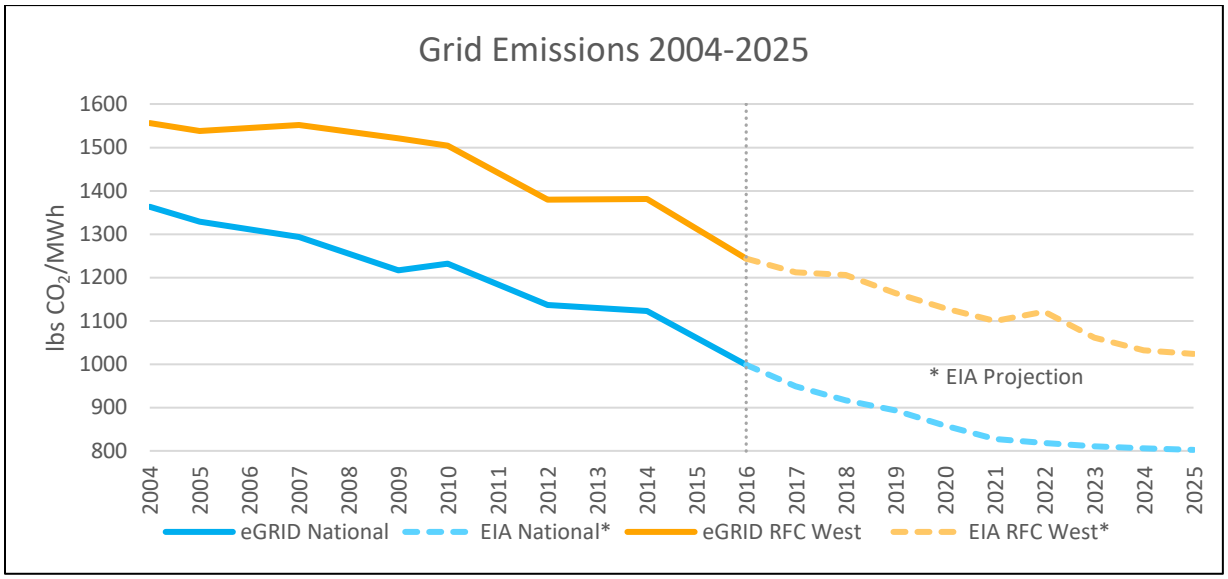
	U.S. Average Mix (eGRID2014)[14]	U.S. Average Mix (eGRID2016)[15]	RFC West Mix (eGRID2014)	RFC West Mix (eGRID2016)
Coal	38.7%	30.4%	60.0%	49.8%
Oil	0.7%	0.6%	0.5%	0.4%
Gas	27.5%	33.8%	9.3%	16.7%
Other Fossil	0.5%	0.3%	0.7%	0.7%
Nuclear	19.5%	19.8%	25.7%	27.6%
Hydro	6.2%	6.4%	0.6%	0.9%
Biomass	1.6%	1.7%	0.6%	0.6%
Wind	4.4%	5.6%	2.4%	3.2%
Solar	0.4%	0.9%	0.0%	0.1%
Geothermal	0.4%	0.4%	0.0%	0.0%
Other	0.1%	0.1%	0.1%	0.1%

* Percentages may not sum to 100 due to rounding

It's important to note that the RFC West generation mix has a considerably higher share of coal power plants than compared to the national average mix. ~~While the eGRID2016 data reports the lowest CO_2 emission factor to-date for this sub region, the projected emission factors put out by the U.S. Energy Information Administration (EIA) show an expected increase in emissions for this region. This increase is likely due to forecasted short term natural gas prices that may shift some energy generation to coal. Scheduled and projected decommissioning of nuclear-powered plants that will be replaced by fossil fuel burning plants might also contribute to the increase.~~ Figure 2 below shows how the RFC West CO_2 emissions factor has changed over time. Years 2004-2016 are reported values based off the EPA's eGRID reports. Values after 2016 are the EIA projected factors based off of the 2019 EIA Annual Outlook data tables. Previous versions of this PfMP report showed EIA projected factors from the 2018 EIA Annual Outlook Report that actually showed a short-term increase in CO_2 emission factors after 2016.

[14] https://www.epa.gov/sites/production/files/2017-02/documents/egrid2014_summarytables_v2.pdf
[15] https://www.epa.gov/sites/production/files/2018-02/documents/egrid2016_summarytables.pdf

Figure 2 – Electricity Grid Emission Factor



SMART COLUMBUS VEHICLE ASSUMPTIONS

The sources used for data assumptions to calculate vehicle emissions in the state of Ohio for 2016-2018 are shown in Table 2 below.

Table 2 – Data Assumption Sources for Emissions Calculations

Parameter	Assumption
Average annual vehicle mileage (miles)	Calculated using Table 40 and 42 of the U.S. Energy Information Administration's (EIA) Annual Energy Outlook 2018 Report using 2016 values. Assumed one-to-one vehicle replacement, such that electric vehicles replace vehicles with similar annual miles traveled at this level.
New vehicle efficiency (mpg)	From the EIA Annual Energy Outlook 2018 Table 41 using year-specific values. Adjusted using factor of 0.74.
All electric range (miles)	Using year-specific (2016-2018) national sales weighted averages from EPA's 2017 Carbon Dioxide Emissions and Fuel Economy Trends Report. To be updated with seven-county region sales weighted averages once available.
Electric vehicle efficiency (kWh/mile)	Using year-specific (2016-2018) national sales weighted averages from EPA's 2017 Carbon Dioxide Emissions and Fuel Economy Trends Report. To be updated with seven-county region sales weighted averages once available.
Percent of miles electric	Using utility factor from SAE J2841 based on R_{CD} of 41 miles in 2016, 36 miles in 2017, and 37 miles in 2018.
Pounds of CO_2 per gallon of E10	Includes upstream production emissions and combustion emissions. See Appendix E for more details.
Grid emissions (lbs CO_2/kWh)	Year 2016 calculations use eGRID2016 for RFC West sub region. Years 2017 and 2018 are calculated using Table 55.11 of the EIA Annual Energy Outlook 2018 Report using 2017 and 2018 projected values, respectively.

The following tables are snapshots of new vehicle emissions assumptions for years 2016-2018 that include assumptions specific to each year and will serve as a preview for how all EV (consumer and fleet wide) calculations will be handled. While there is an increasing trend of electrifying light trucks, passenger cars currently make up around 80% of the EV market. The following tables are specifically for passenger cars and do not include other vehicle classes such as light trucks (i.e. Tesla Model X, BMW X5, Chrysler Pacifica PHEV, Volvo XC90, etc.).

Table 3 – Assumptions for Annual Emissions per New Car in Ohio in 2016

Parameter	Gasoline Car	Gasoline Hybrid Electric Car	PHEV Car	Battery Electric Car
Average annual vehicle mileage (miles)	11,404	11,404	11,404	11,404
New vehicle efficiency (mpg)	27.7	40.3	40.0	-
All electric range (miles)	-	-	40.7	-
Electric vehicle efficiency (kWh/mile)	-	-	0.34	0.33
Percent of miles electric	-	-	63%	100%
Pounds of CO_2 per gallon of E10	25.2	25.2	25.2	-
Grid emissions (lbs CO_2/kWh)	-	-	1.24	1.24
Annual emissions per vehicle (lbs CO_2/year)	10,385	7,131	5,668	4,632
Annual emissions per vehicle ($MTCO_2$/year)	4.71	3.23	2.57	2.10

Table 4 – Assumptions for Annual Emissions per New Car in Ohio in 2017

Parameter	Gasoline Car	Gasoline Hybrid Electric Car	PHEV Car	Battery Electric Car
Average annual vehicle mileage (miles)	11,542	11,542	11,542	11,542
New vehicle efficiency (mpg)	27.5	40.0	42.7	-
All electric range (miles)	-	-	35.8	-
Electric vehicle efficiency (kWh/mile)	-	-	0.32	0.32
Percent of miles electric	-	-	58%	100%
Pounds of CO_2 per gallon of E10	25.2	25.2	25.2	-
Grid emissions (lbs CO_2/kWh)	-	-	1.32	1.32
Annual emissions per vehicle (lbs CO_2/year)	10,566	7,278	5,716	4,851
Annual emissions per vehicle ($MTCO_2$/year)	4.79	3.30	2.59	2.20

Table 5 – Assumptions for Annual Emissions per New Car in Ohio in 2018

Parameter	Gasoline Car	Gasoline Hybrid Electric Car	PHEV Car	Battery Electric Car
Average annual vehicle mileage (miles)	11,630	11,630	11,630	11,630
New vehicle efficiency (mpg)	28.2	40.7	43.5	-
All electric range (miles)	-	-	37.0	-
Electric vehicle efficiency (kWh/mile)	-	-	0.32	0.30
Percent of miles electric	-	-	59%	100%
Pounds of CO_2 per gallon of E10	25.2	25.2	25.2	-
Grid emissions (lbs CO_2/kWh)	-	-	1.33	1.33
Annual emissions per vehicle (lbs CO_2/year)	10,385	7,197	5,653	4,680
Annual emissions per vehicle ($MTCO_2$/year)	4.71	3.26	2.56	2.12

The above calculations are meant as a way to estimate the annual benefits for each year of the grant period and do not consider lifetime vehicle benefits. Considering the vehicle benefits over the average life of a vehicle, which for some fleets could be ten years or more, would account for considerably more emission savings after the grant period. Future phases of the project could change from an annual accounting benefits model to vehicle stock-turnover model to more fully demonstrate the full benefits of the Smart Columbus program.

CUSTOMIZATION TO COLUMBUS SMART CITY ELECTRIFICATION PROGRAM

With respect to the priorities and initiatives within the Smart City Electrification Plan (SCEP), the tools and methodology described above will be applied to estimate the GHG benefits resulting from EV adoption either from fleets or consumers. The availability of data needed to estimate the associated benefits will vary by program. An overview of the data inputs specific to the SCEP is shown below.

Fleet Adoption

- Public
    - Vehicle mileage data
    - Number of vehicles by type (BEV and PHEV)
    - Average vehicle class (light-duty sedan, SUV, etc.)
    - Percent use of ICE for PHEVs estimated based on SAE J2841 (or direct data as available)
- Private
    - Vehicle mileage data (confirming availability)
    - Number of vehicles by type (BEV and PHEV)
    - Average vehicle class (light-duty sedan, SUV, etc.)
    - Percent use of ICE for PHEVs estimated based on SAE J2841 (or direct data as available)

Consumer Adoption

- ODOT VMT data by county
- Number of vehicles registered by type (BEV and PHEV) from Ohio BMV data
- Average vehicle class (light-duty sedan, SUV, etc.)
- Percent use of ICE for PHEVs estimated based on SAE J2841 (or direct data as available)

APPENDIX C

EV ADOPTION ACCORDING TO VEHICLE REGISTRATION RECORDS

In the Smart Columbus Electrification Program (SCEP), goals and objectives are provided related to consumer adoption of vehicles.

> **Priority Objective**: Increase electric vehicle market adoption as evidenced by the percentage of new light duty vehicle registrations in the Columbus and the surrounding seven-county region to 1.8% of all new and used light duty vehicle registrations by the end of the three-year grant period. In this case 'new' refers to newly manufactured, not previously owned vehicles.

This goal would be assessed using data from the state vehicle registration system accessed either commercially through IHS-Polk or directly through the Ohio Bureau of Motor Vehicles (currently being pursued). The SCEP has been tracking vehicle adoption using primarily IHS Markit (formerly R.L. Polk & Co.) data, and referred to herein as 'IHS' data. This data provides a snapshot of vehicles registered in each state by accessing and then normalizing state vehicle registration data across all 50 states. Used vehicle sales can, at best, be inferred from the data, but contain uncertainty and therefore are not part of the analysis.

Assessing progress to the Priority Objective requires estimating the number of vehicle sales in the seven-county region based on the registration data available to SCEP, coming from IHS. Any vehicle purchased in the seven-county region will be registered with the state of Ohio, and ultimately reflected in the IHS data. Columbus, through its partners has access to IHS data for summary information across the seven-county region. For 2016 and prior, data from the National Renewable Energy Lab (NREL) has been used to characterize the baseline conditions for the region. For 2017 forward, IHS data purchased by the Columbus Partnership has been used to track progress towards goals. Although all data is from IHS, all are subscription based, and the level of detail and aggregation from any subscription is likely different. A top-level summarization is below:

- NREL IHS data subscription through 2016 contains attribute fields such that new vehicle sales by fuel type and model can be assessed at the zip code level, and type of registration (personal, fleet, government, etc.). Due to funding issues, 2017 and forward data is not available.
- IHS data procured through the Columbus partnership is specific to the seven-county region, is available at the zip code level, and is parsed by fuel type. Make/model of vehicles and registration type is not discernable.

IHS data from any sources is governed by licensing agreements which general restrict direct sharing of the base data. Only aggregated snapshots (such as EV adoption at the seven-county level, for example) can be broadly shared.

Baseline Data Analysis

Data available to SCEP for the base year 2016 from IHS through NREL include the date the vehicle was registered for the first time, which is interpreted to be the date of a new vehicle purchase. Although there is difference, usually measured in days, it is close enough for performance assessment purposes. The IHS records for 2016 (through NREL) do not include fields sufficient to distinguish the date when a vehicle changes ownership or is sold as a used vehicle. Total vehicle stock can be assessed, meaning of all vehicles on the road, the number and percentage that are battery electric, or plug-in hybrid electric vehicles, can be assessed.

Columbus and its partners are seeking to access the Ohio Bureau of Motor Vehicle records directly to overcome the limitations presented by IHS data. NREL is currently negotiating data use terms with the Ohio Bureau of Motor Vehicles (BMV). Estimates of the vehicle sales are limited to that available through IHS data until direct access to Ohio BMV records is obtained. The data being requested from Ohio BMV includes seven-county battery electric and plug-in hybrid electric vehicle registrations and total vehicle stock by year.

Notes concerning existing IHS data summaries from NREL:

In order to exclude non-road light duty electric vehicles, such as golf carts, that are registered with the state BMV, all neighborhood electric vehicles are excluded from the total registration counts.

Registration data was further segregated by ‘Registration Type’. This allows assessing market take of EV and PHEV in several sectors including government, large fleets, small fleets, rentals and dealerships. The data dictionary for the IHS data attributes is shown below:

- "STATE"
- "COUNTY"
- "ZIP"
- "CITY"
- "MAKE"
- "MODEL"
- "YEAR MODEL"
- "FUEL TYPE" (i.e. gas, diesel, hybrid, PHEV, BEV, FCEV, etc.)
- "REGISTRATION TYPE" (i.e. personal, fleet, government, etc.)
- "LITERS” (engine displacement)
- "SEGMENT” (i.e. luxury mid-size sedan, non-luxury compact SUV, etc.)
- "EPA MILEAGE COMBINED"
- "VEHICLE AGE IN MONTHS"
- "NUMBER OF OWNERS" (number of distinct owners during lifetime of vehicle)
- "NEW VEHICLE REGISTRATION DATE" (date vehicle was first registered)
- "GVW" (Gross Vehicle Weight)
- "VIO" (Vehicles in Operation)

The key data characteristics that inform EV and PHEV vehicle sales include:

- "YEAR MODEL" - Model year of vehicle.
- "FUEL TYPE" – Defines the main fuel source of the vehicle (i.e. gas, flexible fuel, diesel, battery electric, hybrid electric, plug-in hybrid electric, compressed natural gas, liquified natural gas, or fuel cell) – Only Plug-In Electric Vehicles (PHEVs) and Battery Electric Vehicles (BEVs) are included in the SCEP scope for total EV registrations.
- "REGISTRATION TYPE" – Defines the type of vehicle registration (i.e. personal, fleet, government, dealer or manufacturer.)
- "NUMBER OF OWNERS" (number of distinct owners during lifetime of vehicle) – reflects whether vehicle has changed hands (used) since its date of first registration.
- "NEW VEHICLE REGISTRATION DATE" – Defines the month and year when the vehicle was registered for the very first time. (date vehicle was first registered).

New purchased EVs are indicated when NUMBER OF OWNERS is equal to one, the NEW VEHICLE REGISTRATION DATA is within year of interest (i.e. 2016 for the base year), and FUEL TYPE is BEV or PHEV, and registration type is anything but 'DEALERSHIP'

Two distinct measures are defined with respect to the Consumer Adoption Priority Objective:

- Brand New EV and PHEV Vehicle Sales: This is reported both as an absolute number of vehicles as well as a percentage of all vehicles sales. New vehicle sales are identified when 'NEW VEHICLE REGISTRATION DATE' is equal to the year/month in question and 'NUMBER OF OWNERS' is equal to one for all registration types other than 'DEALERSHIP'. New vehicle sales for the seven-county region can be further disaggregated to 'PERSONAL' and other types of registration for further insight.

- Percent of total consumer fleet that are EVs: This is referred to as vehicle stock. It is the total number of EV and PHEV registrations for all registration types other than 'DEALERSHIP'. It can be reported as an absolute number or a percentage of all vehicle registrations. It can be further disaggregated by type of registration ('Personal', 'Government', 'Small Fleet', 'Large Fleet', etc.). This reflects the growth in EV vehicle stock, and will lag sales of EVs as the stock turns over.

These measures are reported using available data. It is recommended that sales of brand new vehicle be used as the primary indicator of progress towards consumer adoption goals, as it is measurable with available data.

Data Anomalies - Hilliard Area

While reviewing the 2016 baseline data queried from IHS data, an anomaly appeared for one zip code associated with the Hilliard area, in which an inordinate number of EVs (400+) were registered in comparison to other zip codes. Upon investigation, this anomaly was specific to one brand of automobile. Further investigation located the presence of a financial subsidiary of an automobile company associated with that brand in the zip code area. This accounted for all

but 24 EVs in the Hilliard area in 2016. When the data was disaggregated by registration type, the vehicles showed up as FLEET – explaining the anomaly.

Current estimates of Consumer Adoption of Electric Vehicles

Brand New Vehicle Adoption Rates / Percentages – 2014 through 2017

	EV	PHEV	TOTAL(EV+PHEV)	TOTAL SALES	
2014					
Q1	27	46	73	27310	0.27%
Q2	32	71	103	29830	0.35%
Q3	44	59	103	26600	0.39%
Q4	55	39	94	14070	0.67%
Yearly Total	158	215	373	97820	0.38%
2015					
Q1	38	58	96	26750	0.36%
Q2	34	42	76	13490	0.56%
Q3	39	62	101	37180	0.27%
Q4	59	89	148	19910	0.74%
Yearly Total	170	251	421	97320	0.43%
2016					
Q1	33	63	96	24730	0.39%
Q2	43	103	146	28330	0.52%
Q3	55	191	246	27630	0.89%
Q4	64	127	191	20880	0.91%
Yearly Total	195	484	679	101580	0.67%
2017					
Q1 Total	59	56	115	26100	0.44%
Q2 Total	93	68	161	26909	0.60%
July	32	26	58	8254	0.70%
August	18	20	38	9026	0.42%
September	27	24	51	8125	0.63%
Q3 Total	77	70	147	25405	0.58%
October	44	20	64	8004	0.80%
November	18	30	48	8123	0.59%
December	???	???	0	???	???
Q4 Total*	62	50	112	16127	0.69%
Yearly Total*	291	244	535	94541	0.57%

* Does not include December Sales

Data in the above table reflect new vehicle adoption by quarter for 2014 through 2017, with the exception of Dec 2017. Data from 2014-2016 was queried using 'baseline' procedures explained earlier. Data from 2017 was procured by the Columbus Partnership from IHS.

Vehicle Stock Percentages – As of Dec 2016

	DEALER/MAN		GOVERNMENT		LARGE FLEET		PERSONAL		RENTAL		SMALL FLEET		Total Count	Total %
Row Labels	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%		
COMPRESSED NATURAL GA	7	0.0%	6	0.0%	3	0.0%	19	0.0%		0.0%	64	0.0%	99	0.0%
CONVERTIBLE	16	0.0%		0.0%	12	0.1%	721	0.0%	1	0.0%	47	0.0%	797	0.0%
DIESEL	736	1.5%	460	2.8%	883	4.0%	20422	1.4%	87	0.7%	5890	4.3%	28478	1.7%
ELECTRIC VEHICLE	45	0.1%	2	0.0%	3	0.0%	581	0.0%	1	0.0%	88	0.1%	720	0.0%
FLEXIBLE	3417	7.0%	3431	21.1%	3176	14.3%	94138	6.3%	885	6.9%	14377	10.5%	119424	6.9%
GAS	43677	90.0%	12321	75.7%	17713	79.8%	1352602	90.9%	11842	92.0%	114321	83.8%	1552476	90.0%
HYBRID ELECTRIC VEHICLE	548	1.1%	59	0.4%	386	1.7%	18718	1.3%	52	0.4%	1154	0.8%	20917	1.2%
PLUG IN HYBRID EV	79	0.2%	6	0.0%	9	0.0%	875	0.1%		0.0%	456	0.3%	1425	0.1%
Grand Total	**48525**	**100.0%**	**16285**	**100.0%**	**22185**	**100.0%**	**1488076**	**100.0%**	**12868**	**100.0%**	**136397**	**100.0%**	**1724336**	**100.0%**

Baseline – 2016, Newly Purchased Vehicles by Fuel Type and Registration Type

	DEALER/MAN		GOVERNMENT		LARGE FLEET		PERSONAL		RENTAL		SMALL FLEET		Total Count	Total %
Row Labels	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%		
COMPRESSED NATURAL GAS		0.0%		0.0%	1	0.0%		0.0%		0.0%	3	0.0%	4	0.0%
DIESEL	43	0.8%	20	1.2%	61	2.9%	891	1.1%		0.0%	418	3.4%	1433	1.3%
ELECTRIC VEHICLE	4	0.1%		0.0%	1	0.0%	171	0.2%		0.0%	19	0.2%	195	0.2%
FLEXIBLE	237	4.6%	349	21.3%	466	22.2%	5183	6.7%	576	7.3%	1358	10.9%	8169	7.6%
GAS	4757	92.8%	1269	77.5%	1518	72.2%	69941	90.1%	7328	92.3%	10291	82.5%	95104	88.9%
HYBRID ELECTRIC VEHICLE	50	1.0%		0.0%	55	2.6%	1281	1.7%	38	0.5%	109	0.9%	1533	1.4%
PLUG IN HYBRID ELECTRIC VEHICLE	37	0.7%		0.0%		0.0%	168	0.2%		0.0%	279	2.2%	484	0.5%
Grand Total	**5128**	**100.0%**	**1638**	**100.0%**	**2102**	**100.0%**	**77635**	**100.0%**	**7942**	**100.0%**	**12477**	**100.0%**	**106922**	**100.0%**

Baseline – 2016, Newly Purchased EVs by Make/Model Registration Type

	LARGE FLEET		PERSONAL		SMALL FLEET		Total Count	Total %
Row Labels	Count	%	Count	%	Count	%		
AUDI		**0.0%**	**8**	**2.4%**		**0.0%**	**8**	**1.3%**
A3		0.0%	8	2.4%		0.0%	8	1.3%
BMW		**0.0%**	**21**	**6.2%**	**277**	**93.0%**	**298**	**46.7%**
330E		0.0%		0.0%	12	4.0%	12	1.9%
I3		0.0%	9	2.7%	96	32.2%	105	16.5%
I8		0.0%	3	0.9%	29	9.7%	32	5.0%
X5		0.0%	9	2.7%	140	47.0%	149	23.4%
CADILLAC		**0.0%**	**2**	**0.6%**	**1**	**0.3%**	**3**	**0.5%**
ELR		0.0%	2	0.6%	1	0.3%	3	0.5%
CHEVROLET		**0.0%**	**51**	**15.0%**	**2**	**0.7%**	**53**	**8.3%**
VOLT		0.0%	51	15.0%	2	0.7%	53	8.3%
FORD		**0.0%**	**66**	**19.5%**	**5**	**1.7%**	**71**	**11.1%**
C-MAX		0.0%	25	7.4%	2	0.7%	27	4.2%
FUSION		0.0%	41	12.1%	3	1.0%	44	6.9%
HYUNDAI		**0.0%**	**3**	**0.9%**		**0.0%**	**3**	**0.5%**
SONATA		0.0%	3	0.9%		0.0%	3	0.5%
MITSUBISHI		**0.0%**	**2**	**0.6%**		**0.0%**	**2**	**0.3%**
I MIEV		0.0%	2	0.6%		0.0%	2	0.3%
NISSAN		**0.0%**	**20**	**5.9%**		**0.0%**	**20**	**3.1%**
LEAF		0.0%	20	5.9%		0.0%	20	3.1%
PORSCHE		**0.0%**	**3**	**0.9%**		**0.0%**	**3**	**0.5%**
CAYENNE		0.0%	3	0.9%		0.0%	3	0.5%
TESLA	**1**	**100.0%**	**148**	**43.7%**	**12**	**4.0%**	**161**	**25.2%**
MODEL S	1	100.0%	111	32.7%	7	2.3%	119	18.7%
MODEL X		0.0%	37	10.9%	5	1.7%	42	6.6%
TOYOTA		**0.0%**	**1**	**0.3%**		**0.0%**	**1**	**0.2%**
PRIUS PRIME		0.0%	1	0.3%		0.0%	1	0.2%
VOLVO		**0.0%**	**14**	**4.1%**	**1**	**0.3%**	**15**	**2.4%**
XC90		0.0%	14	4.1%	1	0.3%	15	2.4%
Grand Total	**1**	**100.0%**	**339**	**100.0%**	**298**	**100.0%**	**638**	**100.0%**

APPENDIX D

LED STREETLIGHT CONVERSION – GHG CALCULATION METHODOLOGY

Baseline

- Estimate the nameplate/rated power (Watts) of each existing luminaire.
- Daily hours of usage.

Assumptions

- As 2015, there are approximately 52,000 existing street lights that the Division of Power is responsible for maintaining. This represents approximately 65% of the city's streets.

Emission Reduction[16]

- Calculate the gross electricity savings by comparing the total average power of the project luminaires multiplied by project annual hours of operation, with the average power of the baseline luminaires multiplied by baseline annual hours of operation (daily hours times 365 or other number equal to the number of days per year that the lights are expected to be operated);
- Calculate the net electricity saving (NES) by correcting the gross electricity savings for any leakage and transmission & distribution losses.
- Once the project is installed, the electricity saved by the project activity in year *y* is calculated as follows:

$$NES_y = \sum_{i=1}^{n} ES_{i,y} \times \frac{1}{(1 - TD_y)} \qquad \text{Equation (1)}$$

Where:

$$ES_{i,y} = \left(Q_{i,BL} \times P_{i,BL} \times O_{i,BL} \times (1 - SOF_{i,BL})\right) - \left(Q_{i,P} \times P_{i,P,y} \times O_{i,y} \times (1 - SOF_{i,y})\right) \qquad \text{Equation (2)}$$

$$SOF_{i,BL} = AFR_{i,BL} \times OF_{i,BL} \qquad \text{Equation (3)}$$

$$SOF_{i,y} = AFR_{i,y} \times OF_{i,y} \qquad \text{Equation (4)}$$

Where:

NES_y = Net electricity saved in year *y* (kWh)

$ES_{i,y}$ = Estimated annual electricity savings for equipment of type *i*, for the relevant type of project equipment in year *y* (kWh)

[16] Calculation based on the Clean Development Mechanism Demand-Side Activities for efficient outdoor and street lighting technologies methodology.

y = Crediting year counter

i = Counter for luminaire type

n = Number of luminaires

APPENDIX E

GHG CALCULATION METHODOLOGY EXAMPLES

Overall Project Goal Baseline Calculations

There are two aspects of GHG emission reductions associated with this project, (1) the utility decarbonization emissions and (2) the emissions associated with replacing an internal combustion engine vehicle (ICEV) with an electric vehicle (EV). The baseline GHG emissions reported by MORPC include electricity consumption and transportation fuel consumption. The following calculations were used to establish the baseline for the seven-county region.

The methodology for determining the 2015 total energy consumption, including the end-use consumption table for the seven-county region, has been provided by MORPC and can be found in Appendix F.

Utility Baseline GHG Calculations

The utility baseline GHG emissions can be found by applying the eGRID2016 GHG Annual Total Output Emission Rate for the RFC West sub region to the total energy consumption for the seven-county region. This emission factor accounts for the total output CO_2 emissions per MWh for the electricity resource mix in the RFC West sub region.

As reported by MORPC, the total energy consumption for the seven-county region in 2015 was 75,894.0 BBtu. This value is the end-use energy (ultimate sale to customers) after transmission and distribution losses. The eGRID2016 GHG Total Output Emission Rate is used for the net generation output and does not include transmission and line losses (the losses between the power plant and the customer). To account for these losses, the eGRID2016 Summary Tables[17] provides the grid gross loss for this region as 4.49% to apply to the energy consumption value provided by MORPC.

$$Preliminary\ 2015\ Seven\ County\ Region\ Electricity\ Output = \frac{75{,}894.0\ BBtu}{(1 - 0.0449)} = 79{,}556.1\ BBtu$$

As reported by MORPC, there was 11.567 BBtu of hydroelectric power generated at the O'Shaughnessy Reservoir in 2015 and consumed within the seven-county region. Since this renewable energy has no GHG emissions, the power generated from the hydroelectric plant can be subtracted to calculate the total electricity output:

$$2015\ Seven\ County\ Region\ Electricity\ Output = 79{,}556.1\ BBtu - 11.567\ BBtu = 79{,}544.5\ BBtu$$

$$2015\ Baseline\ Utility\ GHG\ MTeCO_2 = Total\ electricity\ output\ for\ seven\ county\ region\ in\ 2015\ (MWh) \times\ eGRID\ regional\ emission\ factor^{18}\left(\frac{lbs\ CO_2}{MWh}\right) \times \frac{1\ MT}{2204.62\ lbs}$$

[17] https://www.epa.gov/sites/production/files/2018-02/documents/egrid2016_summarytables.pdf

Convert BBtu to MWh for emission calculations:

$$Total\ Electricity\ Output$$
$$= 79{,}544.5\ BBtu \times \frac{1{,}000{,}000{,}000\ Btu}{1\ BBtu} \times \frac{0.00029307107017\ kWh}{1\ Btu} \times \frac{0.001\ MWh}{1\ kWh}$$
$$= 23{,}312{,}192\ MWh$$

Calculate MTCO2 using RFC West emission factor:

$$2015\ Baseline\ Utility\ GHG\ MTCO_2 = 23{,}312{,}192\ MWh \times 1243.4\ \frac{lb\ CO_2}{MWh} \times \frac{1\ MT}{2204.62\ lb}$$
$$= 13{,}148{,}016\ MTCO_2$$

Vehicle Baseline GHG Calculations

Typical Light Duty Passenger Vehicle Annual CO_2 Emissions (using 2018 data):

A light duty passenger vehicle is defined as an on-road vehicle with a gross vehicle weight rating equal to or less than 8,500 pounds. Automobiles, motorcycles, minivans, SUVs and other small pickups fall into this category. A typical light duty passenger vehicle on the road in 2018 emits 4.4 $MTCO_2$.

$$Typical\ Light\ Duty\ Passenger\ Vehicle\ Annual\ CO_2\ emissions\ in\ 2018$$
$$= \frac{CO_2\ per\ gallon^{19}}{MPG^{20}} \times average\ annual\ miles^{21} = \frac{18.9\ lbs}{22.71} \times 11{,}630 = 4.4\ MTCO_2$$

As a way to compare the validity of the vehicle baseline GHG calculations, two methods were applied. The first method is based on fuel consumption data for the seven-county region based on information compiled by MORPC. The second method is based on the annual Vehicle Miles Traveled (VMT) from the seven-county region.

Method 1 (using fuel consumption data):

The two types of fuel being considered for fuel consumption related emissions include motor gasoline and distillate fuel oil (diesel). Motor gasoline is comprised of an ethanol blend (known as E10 gasoline) so the fuel consumption of ethanol is also included with gasoline:

[18] 1243.4 lbs CO_2/MWh, 2016 eGRID GHG Annual Total Output Emission Rate for the RFC West sub region. https://www.epa.gov/sites/production/files/2018-02/documents/egrid2016_summarytables.pdf

[19] 18.9 lbs CO2/gallon of E10 gasoline combusted. Source: https://www.eia.gov/tools/faqs/faq.php?id=307&t=11

[20] 22.71 mpg, average light duty vehicle stock in 2018. Source: Table 41, https://www.eia.gov/outlooks/aeo/tables_ref.php

[21] 2018 Total U.S. Light-Duty Vehicle VMT = 2,835,552,734,000 miles
2018 Light-Duty Vehicle total stock = 243,808,105 vehicles
2,835,552,734,000 miles / 243,808,105 = 11,630 miles
Source: Table 42, https://www.eia.gov/tools/faqs/faq.php?id=307&t=11

$$E10\ Gasoline\ Consumption = Sum\ of\ Motor\ Gasoline^{22} + Sum\ of\ Fuel\ Ethanol^{23}$$
$$= 100{,}268.6\ BBtu + 6{,}462.4\ BBtu = 106{,}731\ BBtu$$

$$2015\ Baseline\ E10\ Gasoline\ Vehicle\ MTCO_2\ for\ seven\ county\ region$$
$$= E10\ gasoline\ consumption\ for\ seven\ county\ region\ in\ 2015$$
$$\times\ lbs\ CO_2\ per\ gallon\ of\ E10\ gasoline\ combusted^{24,25} \times \frac{1\ MT}{2204.62\ lb}$$

$$2015\ Baseline\ E10\ Gasoline\ Vehicle\ MTCO_2\ for\ seven\ county\ region$$
$$= 106{,}731\ BBtu \times \frac{1{,}000{,}000{,}000\ Btu}{1\ BBtu} \times \frac{1\ gallon\ E10}{120{,}476\ Btu^{26}} \times \frac{18.9\ lb\ CO_2}{1\ gallon\ E10}$$
$$\times \frac{1\ MT}{2204.62\ lbs} = 7{,}594{,}831\ MTCO_2$$

$$2015\ Baseline\ Diesel\ Vehicle\ MTCO_2\ for\ seven\ county\ region$$
$$= diesel\ consumption\ for\ seven\ county\ region\ in\ 2015^{27}$$
$$\times\ lbs\ CO_2\ per\ gallon\ of\ diesel\ combusted^{28} \times \frac{1\ MT}{2204.62\ lb}$$

$$2015\ Baseline\ Diesel\ Vehicle\ MTCO_2\ for\ seven\ county\ region$$
$$= 48{,}598.7\ BBtu \times \frac{1{,}000{,}000{,}000\ Btu}{1\ BBtu} \times \frac{1\ gallon\ diesel}{137{,}452\ Btu^{29}} \times \frac{22.4\ lb\ CO_2}{1\ gallon\ diesel}$$
$$\times \frac{1\ MT}{2204.62\ lb} = 3{,}592{,}426\ MTCO_2$$

[22] Motor Gasoline Consumption = 100,268.6 BBtu. Source: Seven-county energy estimates for energy use, provided by MORPC in February 2018.
[23] Fuel Ethanol Consumption = 6,462.4 BBtu. Source: Seven-county energy estimates for energy use, provided by MORPC in February 2018.
[24] Reasoning for using E10 gasoline. Source: https://www.eia.gov/todayinenergy/detail.php?id=26092
[25] 18.9 lbs CO_2/gallon of E10 gasoline combusted. Source: https://www.eia.gov/tools/faqs/faq.php?id=307&t=11
[26] 1 gallon gasoline = 120,476 Btu. Gasoline sold in the US, with about 10% ethanol content by volume. https://www.eia.gov/energyexplained/index.cfm?page=about_btu
[27] Distillate Fuel Oil Consumption = 48,598.7 BBtu. Source: Seven-county energy estimates for energy use, provided by MORPC in February 2018.
[28] 22.4 lbs CO_2/gallon of diesel fuel combusted. Source: https://www.eia.gov/tools/faqs/faq.php?id=307&t=11
[29] 1 gallon diesel fuel = 137,452 Btu. https://www.eia.gov/energyexplained/index.cfm?page=about_btu

$$2015\ Baseline\ Total\ Fuel\ Consumption\ Emissions\ for\ the\ seven\ county\ region$$
$$= E10\ Gasoline\ Consumption + \ Distillate\ Fuel\ Oil\ Consumption$$
$$= 7{,}594{,}831\ MTCO_2 + 3{,}592{,}426\ MTCO_2\ = 11{,}187{,}257\ MTCO_2$$

Overall Project Goal Baseline GHG Calculations

The overall seven-county GHG baseline is determined by combining the GHG emissions associated with energy consumption (residential, commercial, industrial) and the GHG emissions associated with vehicle operation (transportation) in the seven-county region in 2015.

$$Overall\ 2015\ Baseline\ GHG\ Emissions\ for\ the\ seven\ county\ region\ (MTCO_2)$$
$$=\ 2015\ Baseline\ Utility\ GHG\ MTCO_2 + \ 2015\ Baseline\ Vehicle\ GHG\ MTCO_2$$

$$Overall\ 2015\ Baseline\ GHG\ Emissions\ for\ the\ seven\ county\ region\ (MTCO_2)$$
$$=\ 14{,}658{,}356\ MTCO_2 + \ 11{,}187{,}257\ MTCO_2 = \mathbf{25{,}845{,}614\ MTCO_2}$$

Utility GHG Reduction Calculations

Utility Scale Renewables (Wind, Solar, Hydroelectric) Installed (strategies 1.1.1 and 1.1.7)

The power generated by renewable sources is considered emissions saved since fossil-fuel power production methods are not being used. The eGRID2016 GHG Annual Total Output Emission Factor for the RFC West sub region is applied to the renewable electricity that is generated to calculate total GHGs saved.

$$MTCO_2\ saved\ by\ generating\ power\ with\ renewables$$
$$=\ MWh\ generated^{30} \times eGRID\ regional\ emission\ factor^{31}\left(\frac{lbs\ CO_2}{MWh}\right)$$
$$\times \frac{1\ MT}{2204.62\ lbs}$$

$$MTCO_2\ saved\ by\ generating\ power\ with\ renewables$$
$$=\ 1{,}511{,}100\ MWh\ \times 1243.4\ lb\frac{CO_2}{MWh} \times \frac{1\ MT}{2204.62\ lbs} = 852{,}257\ MTCO_2$$

DC Solar Lighting Towers Installed (strategy 1.1.4)

The DC Solar lighting towers use stored solar energy generated during the day to power LED lights after dark. This energy is considered as emissions saved from typical power generation

[30] This value will be reported quarterly by AEP or DOP.

[31] 1243.4 CO_2/MWh, 2016 eGRID GHG Annual Total Output Emission Rate for the RFC West sub region. https://www.epa.gov/sites/production/files/2018-02/documents/egrid2016_summarytables.pdf

methods. Using the kW consumption of the lighting towers and the hours of operation per day with the eGRID2016 emission factor, the GHG emissions saved can be calculated.

$$MTCO_2\ saved = \ number\ of\ solar\ lighting\ towers\ in\ use\ \times \\ solar\ lighting\ tower\ power\ consumption\ (kW) \times \frac{1\ MW}{1000\ kW} \times \\ hours\ of\ operation\ per\ day\ \times \frac{91.25\ days}{quarter} \times\ eGRID\ regional\ emission\ factor\ \left(\frac{lbs\ CO_2}{MWh}\right) \times \\ \frac{1\ MT}{2204.62\ lbs}$$

$$MTCO_2\ saved = \ 18\ \times 1.5\ kW \times \frac{1\ MW}{1000\ kW} \times \frac{4\ hrs}{day} \times \frac{91.25\ days}{quarter} \times 1243.4\ \frac{lbs\ CO_2}{MWh} \\ \times \frac{1\ MT}{2204.62\ lbs} = 5.6\ MTCO_2\ saved\ per\ quarter$$

DC Solar EV Chargers Installed (strategy 1.1.4)

The DC Solar EV chargers are similar to the lighting towers using photovoltaic panels to produce energy from the sun. The energy produced for these units is used to charge EVs through charging ports. Since a typical EV charging station gets power from the electric grid, a solar EV charger represents a savings in emissions compared to typical fossil-fuel power generation methods.

$$MTCO_2\ saved\ per\ quarter\ per\ port \\ = \ solar\ EV\ charger\ average\ power\ consumption\ (kW)^{32} \\ \times\ hours\ of\ operation\ per\ day^{33} \times \frac{91.25\ days}{quarter} \\ \times\ eGRID\ regional\ emission\ factor\ \left(\frac{lbs\ CO_2}{MWh}\right) \times \frac{1\ MT}{2204.62\ lbs}$$

$$MTCO_2\ saved\ per\ quarter\ per\ port \\ = \ 3\ kW\ \times \frac{15\ hours}{day} \times \frac{91.25\ days}{quarter} \times\ 1243.4\ \frac{lbs\ CO_2}{MWh} \times \frac{1\ MWh}{1000\ kWh} \\ \times \frac{1\ MT}{2204.62\ lbs} = 2.3\ MTCO_2\ saved\ per\ quarter\ per\ port$$

[32] DC Solar mobile charging units supply an average of approximately 3 kW to EVs while charging based on data acquired from DC Solar.

[33] 15 hours of operation per day will be assumed until DC Solar installs the telemetric devices on the units for more accurate readings.

Biomass Energy Calculations (strategy 1.1.5)

The biomass energy project consists of three types of emissions:

- CO_2 emissions from fossil fuel or electricity used by the project activity facilities in $MTCO_2$ ($PEpower_y$)
- Emissions from flaring or combustion of the gas stream in $MTCO_2$ ($PEflare_y$)
- Emissions from the landfill gas upgrading process in $MTCO_2$ ($PEprocess_y$), where applicable

The sum of these emissions represent the total biomass emissions for year y:

$$PE_y = PEpower_y + PEflare_y + PEprocess_y$$

LED Street Lights Installed (strategies 1.2.5 and 1.2.7)

The GHG emissions saved from installing LED street lights can be found by taking the difference between the existing fixture wattage and the replacement LED fixture wattage and applying the eGRID2016 GHG Annual Total Output Emission Rate for the RFC West sub region to calculate GHG savings.

$$MTCO_2\ saved = (MTCO_2\ produced\ from\ existing\ fixture) - (MTCO_2\ produced\ from\ LED\ fixture)$$

First, determine the emissions associated with the existing fixture:

$$MTCO_2\ produced\ from\ existing\ fixture = number\ of\ existing\ fixtures \times existing\ fixture\ line\ wattage\ (W)[34] \times \frac{1\ kW}{1000\ W} \times \frac{1\ MW}{1000\ kW} \times operating\ hours\ per\ day[35] \times \frac{365\ days}{year} \times eGRID\ regional\ emission\ factor\ \left(\frac{lbs\ CO_2}{MWh}\right) \times \frac{1\ MT}{2204.62\ lbs}$$

$$MTCO_2\ produced\ from\ existing\ fixture = 1 \times 138\ W \times \frac{1\ kW}{1000\ W} \times \frac{1\ MW}{1000\ kW} \times \frac{12\ hours}{day} \times \frac{365\ days}{year} \times 1243.4\ \frac{lbs\ CO_2}{MWh} \times \frac{1\ MT}{2204.62\ lbs} = 0.3409\ \ MTCO_2\ per\ year$$

Second, determine the emissions associated with the LED fixture:

[34] The existing fixture line wattage is the sum of the lamp wattage and the ballast wattage. The line wattage of 138W is used as an example in this calculation. The line wattage will vary based on the fixture type.
[35] An average of 12 operating hours per day is assumed for all calculations.

$$MTCO_2\ produced\ from\ LED\ fixture$$
$$= number\ of\ existing\ fixtures\ \times\ equivalent\ LED\ fixture\ line\ wattage\ (W)^{36}$$
$$\times\ \frac{1\ kW}{1000\ W} \times \frac{1\ MW}{1000\ kW} \times operating\ hours\ per\ day\ \times \frac{365\ days}{year}$$
$$\times\ eGRID\ regional\ emission\ factor\ \left(\frac{lbs\ CO_2}{MWh}\right) \times \frac{1\ MT}{2204.62\ lbs}$$

$$MTCO_2\ produced\ from\ existing\ fixture$$
$$= 1\ \times 60\ W \times \frac{1\ kW}{1000\ W} \times \frac{1\ MW}{1000\ kW} \times \frac{12\ hours}{day} \times \frac{365\ days}{year} \times 1243.4\ \frac{lbs\ CO_2}{MWh}$$
$$\times\ \frac{1\ MT}{2204.62\ lbs} = 0.1482\ \ MTCO_2\ per\ year$$

Finally, take the difference between the two for emissions saved:

$$MTCO_2\ saved = (MTCO_2\ produced\ from\ existing\ fixture) - (MTCO_2\ produced\ from\ LED\ fixture)$$

$$MTCO_2\ saved = (0.3409\ MTCO_2\ per\ year) - (0.1482\ MTCO_2\ per\ year)$$
$$= 0.1927\ MTCO_2\ per\ year$$

Electric Vehicle GHG Reduction Calculations

The following are examples of GHG calculations associated with EVs, applicable for Priorities 2 and 4. This method for determining GHG reductions from replacing miles traveled by an ICEV with an EV or PHEV uses the EPA Greenhouse Gas Emissions from a Typical Light Duty Passenger Vehicle[37] calculation to determine the tailpipe emissions. The general method is as follows:

$$EV\ MTCO_2\ savings =$$
$$(MTCO_2\ emitted\ from\ an\ ICEV) - (MTCO_2\ emitted\ from\ charging\ an\ EV)$$

$$PHEV\ MTCO_2\ savings =$$
$$(MTCO_2\ emitted\ from\ an\ ICEV) - (MTCO_2\ emitted\ from\ a\ PHEV)$$

For tailpipe emission during vehicle operation, an ICEV produces GHGs for every gallon of motor fuel combusted, while an EV has zero tailpipe emissions during vehicle operation. There are however GHG emissions produced from charging an EV. The electricity that is generated to power an EV (energy production) has its own GHG emissions which could be considered as upstream emissions.

[36] The existing fixture line wattage is the sum of the lamp wattage and the ballast wattage. The line wattage of 60W is used as an example in this calculation. The line wattage will vary based on the fixture type.
[37] EPA Greenhouse Gas Emissions from a Typical Light Duty Passenger Vehicle. https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100LQ99.pdf

Since the upstream emissions for EVs are being accounted for, the upstream emissions for ICEVs should also be considered. The upstream emissions associated with powering an ICEV are the GHG emissions released during the production of motor fuel.

Blends of petroleum-based gasoline with 10% ethanol, commonly referred to as E10, account for more than 95% of the fuel consumed in motor vehicles with gasoline engines.[38] To determine the emissions related to the production of E10 gasoline, the EPA's Office of Transportation and Air Quality release a Summary table of Lifecycle Greenhouse Gas Emissions for Select Pathways[39] listing the kg CO_2e per mmBtu associated with the production of various types of fuel. As E10 fuel contains 90% gasoline, the emissions related to gasoline production account for 19.2 kg CO_2e per mmBtu. A large portion of ethanol fuel is derived from corn starch using the dry mill process heated by natural gas. The upstream emissions from this type of ethanol produce about 75.1 kg CO_2e per mmBtu.

Using the EPA's Emission Factors for Greenhouse Gas Inventories[40], the heating value can be converted to a per gallon basis (Motor gasoline at 0.125 mmBtu per gallon and ethanol at 0.084 mmBtu per gallon). The percentage share of gasoline and ethanol in E10 fuel is used to determine the fuel production (upstream) emissions of an ICEV (kg CO_2 per gallon of E10 fuel).

The tailpipe emissions are calculated using the EIA's estimates of burning a gallon of E10 fuel - about 18.9 pounds of CO_2 produced when a gallon of E10 is combusted.[41]

The sum of the upstream emissions and the tailpipe emissions are used to determine the total emissions of an ICEV.

New Internal Combustion Engine Vehicle Emission Calculations (2016 values)

$$MTCO_2\ emitted\ from\ an\ ICEV = upstream\ emissions + tailpipe\ emissions$$

$$= \left[\left(\frac{Average\ number\ of\ miles\ driven\ per\ year\ for\ typical\ light\ duty\ passenger\ vehicles^{42}}{Average\ mpg\ of\ typical\ light\ duty\ passenger\ vehicles\ on\ the\ road^{43}}\right) \times kg\ CO_2\ per\ gallon\ of\ E10\ gasoline\ produced\ \times \frac{1\ MT}{1000\ kg}\right]$$

$$+ \left[\left(\frac{Average\ number\ of\ miles\ driven\ per\ year\ for\ typical\ light\ duty\ passenger\ vehicles}{Average\ mpg\ of\ typical\ light\ duty\ passenger\ vehicles\ on\ the\ road}\right) \times\ lbs\ CO_2\ per\ gallon\ of\ E10\ gasoline\ combusted^{44} \times \frac{1\ MT}{2204.62\ lbs}\right]$$

[38] https://www.eia.gov/todayinenergy/detail.php?id=26092

[39] Baseline gasoline production-related emissions = 19.2 kg CO_2e per mmBtu, Ethanol production-related emissions (corn starch feedstock, dry mill process using natural gas) = 16.5 + 27.8 + 3.0 + 27.9 = 75.2 kg CO_2e per mmBtu, Source: https://www.epa.gov/sites/production/files/2016-07/documents/select-ghg-results-table-v1.pdf

[40] https://www.epa.gov/sites/production/files/2018-03/documents/emission-factors_mar_2018_0.pdf

[41] https://www.eia.gov/tools/faqs/faq.php?id=307&t=11

[42] 11,404 miles per year (2016). Source: EIA Annual Energy Outlook 2018, Tables 40 and 41.

[43] 27.7 mpg, 2016 conventional gasoline ICE car adjusted value (using factor of 0.74). Source: EIA Annual Energy Outlook 2018, Table 41.

[44] 18.9 lbs CO_2/gallon of E10 gasoline combusted. Source: https://www.eia.gov/tools/faqs/faq.php?id=307&t=11. Additional reasoning for using E10 gasoline. Source: https://www.eia.gov/todayinenergy/detail.php?id=26092

$$MTCO_2\ emitted\ from\ an\ ICEV =$$

$$\left[\left(\frac{11{,}404\ mi}{27.7\ \frac{mi}{gal}}\right)\times\left(0.9\frac{gallon\ gasoline}{gallon\ E10}\times 19.2\frac{kg\ CO_2}{mmBtu\ gasoline}\times 0.125\frac{mmBtu}{gallon\ gasoline}\right.\right.$$

$$\left.\left.+\ 0.1\frac{gallon\ ethanol}{gallon\ E10}\times 75.2\ \frac{kg\ CO_2}{mmBtu\ ethanol}\times 0.084\frac{mmBtu}{gallon\ ethanol}\right)\times\frac{1\ MT}{1000\ kg}\right]$$

$$+\left[\left(\frac{11{,}404\ mi}{27.7\ \frac{mi}{gal}}\right)\times 18.9\ \frac{lbs\ CO_2}{gal}\times\frac{1\ MT}{2204.62\ lbs}\right]=\mathbf{4.7\ MTCO_2\ per\ ICEV\ per\ year}$$

New EV Emission Calculations (2016 values)

Since an EV has no tailpipe emissions, the upstream emissions come from energy production and are calculated for 2016 using the eGRID2016 GHG Annual Total Output Emission Rate for the RFC West sub region. Calculating grid emissions for subsequent years uses the EIA forecasted values for the RFC West sub region. The 2016 emissions to charge an EV in the RFC West region is shown below:

$$\frac{grams\ CO_2}{kWh}\ to\ charge\ an\ EV$$

$$=eGRID\ regional\ emission\ factor^{45}\left(\frac{lbs\ CO_2}{MWh}\right)\times\ \frac{1\ MWh}{1000\ kWh}\times\frac{453.592\ grams}{1\ lb}$$

$$=1243.4\ \frac{lbs\ CO_2}{MWh}\times\frac{1\ MWh}{1000\ kWh}\times\frac{453.592\ grams}{1\ lb}=564\ \frac{grams\ CO_2}{kWh}$$

$$MTCO_2\ emitted\ from\ charging\ an\ EV$$

$$=Average\ number\ of\ miles\ driven\ per\ year\ for\ passenger\ vehicles$$

$$\times average\ EV\ \frac{kWh}{mi}{}^{46}\times\ \frac{1\ MWh}{1000\ kWh}$$

$$\times eGRID\ regional\ emission\ factor\ \left(\frac{lbs\ CO_2}{MWh}\right)\times\ \frac{1\ MT}{2204.62\ lbs}$$

$$MTCO_2\ emitted\ from\ charging\ an\ EV$$

$$=11{,}404\ mi\ \times 0.33\frac{kWh}{mi}\times\frac{1\ MWh}{1000\ kWh}\times 1243.4\frac{lbs\ CO_2}{MWh}\times\ \frac{1\ MT}{2204.62\ lbs}$$

$$=\mathbf{2.1\ MTCO_2\ per\ EV\ per\ year}$$

[45] 1243.4 lbs CO_2/MWh, 2016 eGRID GHG Annual Total Output Emission Rate for the RFC West sub region. https://www.epa.gov/sites/production/files/2018-02/documents/egrid2016_summarytables.pdf

[46] 0.33 kWh/mi. 2016 National sales-weighted average EV car efficiency (excluding light trucks). Will update for seven-county region once BMV data is received. Source: EPA 2017 Carbon Dioxide Emissions and Fuel Economy Trends Report

The overall GHG saving associated with replacing miles driven by an ICEV with miles driven by an EV is found by taking the difference between the ICEV upstream and tailpipe emissions from the EV upstream power production emissions for charging.

$$EV\ MTCO_2\ savings =$$

$$(MTCO_2\ emitted\ from\ an\ ICEV) - (MTCO_2\ emitted\ from\ charging\ an\ EV)$$

$$EV\ MTCO_2\ savings =$$

$$(4.7\ MTCO2\ per\ ICEV\ per\ year) - (2.1\ MTCO_2\ per\ EV\ per\ year) =$$
$$\mathbf{2.4\ MTCO_2\ per\ EV\ per\ yr}$$

PHEV Emission Calculations (2016 values)

A PHEV combines an internal combustion engine with a large rechargeable battery, allowing them to drive an extended distance using just electricity. While the PHEV is in electric mode, there are no tailpipe emissions. There are however tailpipe emissions when the battery is depleted and the vehicle is primarily using the internal combustion engine to power the vehicle. Some PHEVs are able to operate on electricity and gasoline simultaneously. The tailpipe emissions associated with these types of PHEVs are more difficult to calculate without detailed information about that make and model of PHEV operates. For the purpose of this project, it is assumed that none of the PHEVs operate on electricity and gasoline at the same time. The assumptions for how many miles a PHEV drives on electricity versus the internal combustion engine is calculated annually based on the annual weighted sales average all electric range of the actual make/model of PHEVs sold. This national weighted average [47]of the all electric range is used to calculate the percent of miles driven using the electric motor, also known as the utility factor, according to the SAE J2841 standard.

$$MTCO_2\ emitted\ from\ a\ PHEV = ICE\ emissions + charging\ emissions$$

[47] To be updated once make/model data is obtained for the seven-county region. The J2841 standard will be used for each vehicle model then the eVMT values will be sale weighted.

$$ICE\ emissions = (1 - \%\ of\ PHEV\ annual\ miles\ driven\ on\ electricity) \times (upstream\ fuel\ production\ emissions + tailpipe\ emissions)$$

$$= \left[\left(\frac{Average\ number\ of\ miles\ per\ year^{48} \times \left(1 - \%\ of\ PHEV\ annual\ miles\ driven\ on\ electricity^{49}\right)}{Average\ mpg\ of\ PHEV^{50}}\right) \times kg\ CO_2\ per\ gallon\ of\ E10\ gasoline\ produced \times \frac{1\ MT}{1000\ kg}\right]$$

$$+ \left[\left(\frac{Average\ number\ of\ miles\ driven\ per\ year}{Average\ mpg\ of\ PHEV}\right) \times\ lbs\ CO_2\ per\ gallon\ of\ E10\ gasoline\ combusted^{51} \times \frac{1\ MT}{2204.62\ lbs}\right]$$

$$ICE\ emissions = (1 - 0.63)\left[\left(\frac{11{,}404\ mi}{40.0\ \frac{mi}{gal}}\right)\left(0.9\ \frac{gallon\ gasoline}{gallon\ E10} \times 19.2\ \frac{kg\ CO_2}{mmBtu\ gasoline} \times 0.125\ \frac{mmBtu}{gallon\ gasoline}\right) + \left(0.1\ \frac{gallon\ ethanol}{gallon\ E10} \times 75.1\ \frac{kg\ CO_2}{mmBtu\ ethanol} \times 0.084\ \frac{mmBtu}{gallon\ ethanol}\right) \times \frac{1\ MT}{1000\ kg}\right] +$$

$$\left[\left(\frac{11{,}404\ mi}{40.0\ \frac{mi}{gal}}\right) \times 18.9\ \frac{lbs\ CO_2}{gal} \times \frac{1\ MT}{2204.62\ lbs}\right] = 1.22\ MTCO_2$$

$$Charging\ emissions = \%\ of\ PHEV\ annual\ miles\ driven\ on\ electrcity \times \left(Average\ number\ of\ miles\ driven\ per\ year \times average\ PHEV\ \frac{kWh}{mi}^{52} \times \frac{1\ MWh}{1000\ kWh} \times eGRID\ regional\ emission\ factor^{53}\ \left(\frac{lbs\ CO_2}{MWh}\right) \times \frac{1\ MT}{2204.62\ lbs}\right)$$

$$Charging\ emissions = 11{,}404\ mi \times 0.63 \times 0.34\ \frac{kWh}{mi} \times \frac{1\ MWh}{1000\ kWh} \times 1243.4\left(\frac{lbs\ CO_2}{MWh}\right) \times \frac{1\ MT}{2204.62\ lbs} = 1.35\ MTCO_2$$

[48] 11,404 miles per year (2016). Source: EIA Annual Energy Outlook 2018, Tables 40 and 41.
[49] Percentage of PHEV annual miles driven using electricity = 63%. Percentage is based off the SAE J2841 standard using 2016 national sales weighted average for PHEVs sold of 41 miles all electric range.
[50] 40.0 mpg, sales weighted average of 2016 national PHEV sales. Source: EPA 2017 Carbon Dioxide Emissions and Fuel Economy Trends Report.
[51] 18.9 lbs CO_2/gallon of E10 gasoline combusted. Source: https://www.eia.gov/tools/faqs/faq.php?id=307&t=11. Additional reasoning for using E10 gasoline. Source: https://www.eia.gov/todayinenergy/detail.php?id=26092
[52] 0.34 kWh/mi. Based on sales weighted average of 2016 national PHEV sales. Source: EPA 2017 Carbon Dioxide Emissions and Fuel Economy Trends Report.
[53] 1243.4 CO_2/MWh, 2016 eGRID GHG Annual Total Output Emission Rate for the RFC West sub region. https://www.epa.gov/sites/production/files/2018-02/documents/egrid2016_summarytables.pdf

The overall GHG emissions from a PHEV are calculated by taking the amount of emissions associated with the internal combustion engine and the amount of emissions associated with charging the battery of a PHEV.

$$MTCO_2\ emitted\ from\ a\ PHEV = ICE\ emissions + charging\ emissions$$
$$= 1.22\ MTCO_2 + 1.35\ MTCO_2 = \mathbf{2.6\ MTCO_2\ per\ PHEV\ per\ year}$$

To compare the GHG savings from replacing an ICEV with a PHEV, take the difference between the two.

$$PHEV\ MTCO_2\ savings =$$
$$(MTCO_2\ from\ an\ ICEV) - (MTCO_2\ from\ a\ PHEV)$$

$$PHEV\ MTCO_2\ savings =$$
$$(4.7\ MTCO2\ per\ ICEV\ per\ year) - (2.6\ MTCO_2\ per\ PHEV\ per\ year) =$$
$$\mathbf{2.1\ MTCO_2\ per\ PHEV\ per\ yr}$$

GHG Reduction Calculations Associated with Priority 3

Platooning Truck Trips

GHG reduction calculations associated with platooning truck trips are still being developed.

E-Bike Deployment

GHG reduction calculations associated with E-Bikes are still being developed.

Bicycle Lane Miles Added

"No studies provide direct evidence of the impact of bicycling strategies on greenhouse gas (GHG) emissions. Translating bicycling increases into GHG emissions reductions requires two steps: translating increases in bicycling into reductions in VMT, and converting reductions in VMT into reductions in GHG emissions. An increase in bicycle trips does not necessarily translate into a 1-to-1 decrease in vehicle trips, depending on whether bicycle trips are made instead of, or in addition to, driving trips (Krizek, et al. 2009). The resulting reduction in GHG emissions also depends on the nature of the VMT eliminated (e.g. speeds, acceleration, deceleration, times vehicle is started) and the types of vehicles owned by individuals who switch from driving to bicycling."

Source: https://www.arb.ca.gov/cc/sb375/policies/bicycling/bicycling_brief.pdf

APPENDIX F

SMART COLUMBUS ENERGY CONSUMPTION ANALYSIS METHODOLGY, AS WRITTEN AND PROVIDED BY MORPC

Background

The Department of Energy has long collected energy consumption and prices for each state in the State Energy Data System (SEDS), which is open and available to the public. It is important to note that much of the data is calculated or otherwise estimated based upon assumptions that are generally accepted within the industry. As such, the values provided should be utilized to give the user a concept of the general order of magnitude of fuel consumption and costs, and are meant to be used for policy and planning purposes, rather than specific and strategic interventions.

The methodology used for this analysis was the same methodology used to calculate energy consumption, expenditures, and emissions in the Franklin County Energy Study. This analysis utilized the same approach for the seven counties within the Smart Columbus Region, and downscaled state-level data by applying factors derived from Census, Federal Aviation Administration (FAA) and Ohio Department of Transportation (ODOT) data. Where possible, actual consumption data was used, although this was limited in its availability.

A table of datasets used follows the description below.

Residential Methodology

Data Sources Used

- SEDS
- American Community Survey (ACS)
- Residential Energy Consumption Survey (RECS)

Methodology

SEDS data were collected to provide the initial data to be downscaled. Average Site Energy Consumption values from RECS are used to assign a baseload of electricity consumption, losses, solar and geothermal to each home in the study area (using the non-heating components of Site Energy Consumption). Occupied Housing Units as well as House Heating Fuel data for each county were also collected in order to apportion the consumption values by fuel for the space and water heating portion of energy use (this includes the remainder of electricity and losses).

Commercial and Industrial Methodology

Data Sources Used

- SEDS
- US Census County Business Patterns (CBP)

Methodology

SEDS data were collected to provide the initial data to be downscaled. CBP data for Ohio and each county were collected to develop downscaling values based upon the annual payroll for each 2-digit North American Industry Classification System (NAICS) code. NAICS codes 0 through 42 were used to represent industrial; 44 through 99 were used to represent commercial (less 48 through 49). The portion which a county contributed to that sector's payroll for the state, was considered to be the portion of the State's energy consumption for every fuel.

Transportation Methodology

Data Sources Used

- SEDS
- ODOT
- FAA Airport Master Record (5010-1)
- Columbus Regional Airport Authority (CRAA)

Methodology

SEDS data were collected to provide the initial data to be downscaled. For Franklin County, actual data for John Glenn and Rickenbacker were provided by CRAA. County/private airport fuel use was based on the number of airports, type, and operations for each county (portion of state total). VMTs by car and truck were used to downscale non-aviation fuels, by attributing the county's portion of the State total VMTs.

Passenger vehicle data used to downscale: Electricity, Electricity Losses, Motor Gasoline and Ethanol

Truck data used to downscale: Distillate Fuel (Diesel), LPG, and Lubricants

The blended VMT (both cars and trucks) used to downscale: Natural Gas

Airport data used to downscale: Aviation Gasoline and Kerosene-Type Jet Fuel for county airports and smaller private airstrips.

Data Source Table

Geographic Level:	County	
Geographies:	Delaware, Franklin, Fairfield, Pickaway, Licking, Union, Madison	
	Data	Year
Variable(s):	Energy Use	2015
Data Source:	EIA SEDS	
Table:	Consumption Data, 2015	
Field(s):	Data_Status, State, MSN, Source, Sector, Type, Year	
Release Date/Currency:	June 30, Annually for 2 years before	
Sector:	All sectors	
Notes:	State level data used as the basis for downscaling. Ohio SEDS distributed to counties based on downscaling factors.	
Variable(s):	Household Energy consumption averages by state/geographic region	2009
Data Source:	RECS (Residential Energy Consumption Survey)	
Table:	Table CE3.3 Household Site End-Use Consumption in the Midwest Region, Totals and Averages, 2009	
Field(s):	Average Site Energy Consumption: Total, Space Heating, Water Heating, Air Conditioning, Refrigerators, Other	
Release Date/Currency:	Last released in 2013 using 2009 estimates. Next release coming 2018 for 2015 estimates.	
Sector:	Residential	
Notes:	Used to determine average HH share of statewide consumption.	
Variable(s):	Occupied Households, House heating fuel types	2015
Data Source:	2011-2015 American Community Survey 5-Year Estimates	
Table:	Table S2504, Physical Characteristics for Occupied Housing Units	
Field(s):	HC01_EST_VC01, HC02_EST_VC01, HC03_EST_VC01, HC01_EST_VC49, HC01_EST_VC50, HC01_EST_VC51, HC01_EST_VC52, HC01_EST_VC53	
Release Date/Currency:	December, Annually. See Schedules for precise date	
Sector:	Residential	
Notes:	Used to determine number of occupied HH, average HH share of statewide consumption for home heating based on fuel type.	

Variable(s):	Number of Bus. Establishments, payroll by NAICS, by County	2015
Data Source:	American Fact Finder	
Table:	2015 Business Patterns	
Field(s):	GEO.id2, GEO.display-label, NAICS.id, NAICS.display-label, YEAR.id, ESTAB, PAYANN	
Release Date/Currency:	April, for 2 years prior (based on County Business Patterns)	
Sector:	Commercial, Industrial	
Notes:	Uses payroll as a proxy for business size. Downscaling factor is county's share of Ohio's payroll by broad sector (commercial, industrial) multiplied by the state's share of fuel type consumption by broad sector. Factfinder Business Patterns are another place to find County Business Patterns (a product of the Census Bureau).	
Variable(s):	VMT for State, Counties	2015
Data Source:	ODOT Fact Book	
Table:	Historical VMT Overall, Car and Truck VMT by County	
Field(s):	County, Total VMT, Car VMT, Truck VMT	
Release Date/Currency:	annual	
Sector:	Transportation	
Notes:	Downscale factor (car VMT % of state total, truck VMT % of state total) multiplied by state totals of relevant fuel type from SEDS. For example, cars were assumed to use motor gasoline and trucks were assumed to use distillate fuel (diesel)	
Variable(s):	Airport Operations	2015
Data Source:	FAA	
Table:	National Data Flight Center Facilities	
Field(s):	State, County, AirportStatusCode, OperationsCommercial, OperationsCommuter, OperationsAirTaxi, OperationsGALocal, OperationsGAItin, OperationsMilitary, OperationsDate	
Release Date/Currency:	Current through 2017	
Sector:	Transportation	
Notes:	We received data which did not differentiate between take-offs and landings so we sent a follow-up request	
Variable(s):	Airport Fuel Use	2015
Data Source:	CRAA	
Table:	Provided to MORPC by data request	
Field(s):	All	
Release Date/Currency:	By request	
Sector:	Transportation	
Notes:		

Energy Consumption

2015 End-Use Energy Consumption by County, values in BBtu								
Energy Type*	Delaware	Fairfield	Franklin	Licking	Madison	Pickaway	Union	Grand Total
Aviation gasoline	0.4	0.1	137.7	0.2	0.0	5.8	0.2	144.4
Asphalt and road oil	346.7	204.9	2,327.3	183.8	416.3	147.3	451.8	4,078.1
Coal	1,288.3	747.2	8,662.2	662.0	1,511.9	531.6	1,633.5	15,036.8
Crude Oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Distillate Fuel Oil	4,810.5	2,048.0	26,973.6	4,886.4	5,564.9	1,989.7	2,325.5	48,598.7
Electricity	7,072.3	4,233.4	51,768.9	3,309.3	3,982.2	1,777.0	3,750.8	75,894.0
Electricity Losses	15,414.5	8,214.3	109,715.5	7,300.7	8,092.4	3,482.9	7,883.9	160,104.3
Fuel ethanol, excluding denaturant	705.2	374.6	3,714.8	717.5	350.6	258.5	341.3	6,462.4
Geothermal	54.1	35.7	171.7	37.2	15.4	12.1	15.4	341.6
Hydropower	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kerosene	6.0	5.4	10.8	5.0	2.6	2.2	2.0	34.0
Kerosene-type Jet Fuel	0.0	0.0	23,041.3	0.0	0.0	1,128.3	0.0	24,169.7
LPG	400.2	295.9	1,227.5	418.4	237.7	225.8	342.4	3,147.9
Lubricants	245.5	121.7	1,506.1	203.1	297.1	105.3	211.1	2,690.0
Motor gasoline	10,917.9	5,799.2	57,727.6	11,108.5	5,428.7	4,002.2	5,284.5	100,268.6
Motor gasoline blending components	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Miscellaneous petroleum products	33.1	19.6	222.4	17.6	39.8	14.1	43.2	389.8
Natural gasoline	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Natural gas	11,693.7	6,235.4	84,021.8	6,317.5	6,055.7	2,644.1	6,045.9	123,014.0
Other petroleum products	827.7	489.3	3,881.4	438.8	994.1	351.6	1,078.9	8,061.9
Petroleum Coke	225.7	133.4	1,515.1	119.7	271.0	95.9	294.1	2,654.9
Residual Fuel Oil	25.6	15.2	172.1	13.6	30.8	10.9	33.4	301.6
Solar	1.5	0.7	22.4	5.2	2.5	0.6	0.3	33.3
Special Napthas	124.6	73.6	836.3	66.0	149.6	52.9	162.4	1,465.4
Still Gas	442.4	261.5	2,970.3	234.6	531.4	188.0	576.6	5,204.7
Unfinished Oils	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wood	392.7	334.4	1,567.9	524.1	261.5	164.0	329.5	3,574.0
Waste	239.1	139.1	619.4	123.5	281.6	99.1	304.5	1,806.4
Waxes	7.3	4.3	49.0	3.9	8.8	3.1	9.5	85.8
Wind	3.0	1.8	20.4	1.6	3.7	1.3	4.0	35.8

*The highlighted energy sources were used for this project.

APPENDIX G

RIDE AND DRIVE SURVEY QUESTIONS

The list of Ride and Drive survey questions will be provided at a later date.

Pre-Drive Registration Survey

THE OHIO STATE UNIVERSITY

On average, how many miles do you drive per day?

Below 5 miles	5-10	11-30	31-50	51-75	Over 75 miles

Do you currently drive an Electric Vehicle (EV)?

Yes	No

Do you plan to purchase or lease a vehicle in the next....?

Year	Two years	Three years	Four years	Five or more years	I have no plans to purchase or lease a new vehicle in the foreseeable future	Don't know

On a scale of 1 – 7 (1 = not at all important, 7 = extremely important), please indicate the importance of each of the following vehicle features in your next vehicle.

	1 Not at all important	2	3	4	5	6	7 Extremely important
Semi-automated driving functions (e.g., braking, lane following)	○	○	○	○	○	○	○
Internet connectivity	○	○	○	○	○	○	○
Acceleration	○	○	○	○	○	○	○
Navigation	○	○	○	○	○	○	○
All-wheel drive	○	○	○	○	○	○	○
Handling	○	○	○	○	○	○	○
Fuel economy	○	○	○	○	○	○	○
Zero emission driving capability	○	○	○	○	○	○	○

On a scale of 1-7 (1 = strongly disagree, 7 = strongly agree), please indicate how strongly you agree or disagree with the following statements about electric vehicles (EVs):

	1 Strongly disagree	2	3	4	5	6	7 Strongly agree
Driving an EV means that I'm an environmentalist	○	○	○	○	○	○	○
Driving an EV means that I am doing the right thing	○	○	○	○	○	○	○
Driving an EV means that I am a trendsetter	○	○	○	○	○	○	○
Driving an EV means that I am tech savvy	○	○	○	○	○	○	○
Driving an EV means that I am doing right by my family	○	○	○	○	○	○	○
Driving an EV means that I am patriotic	○	○	○	○	○	○	○
Driving an EV means that I am a good community member	○	○	○	○	○	○	○
Driving an EV means that I am socially responsible	○	○	○	○	○	○	○
Driving an EV means that I make practical choices	○	○	○	○	○	○	○
Driving an EV demonstrates to others that I care about the environment	○	○	○	○	○	○	○

What is your overall opinion of EVs?

Not for me	For me	No opinion

How likely are you to consider purchasing or leasing an EV for your next car?

Very unlikely	Unlikely	Likely	Very likely

If you were able to charge your car at work, would you be more likely to consider purchasing an EV?

Yes	No	Not applicable

What is the highest degree of education you completed?

Less than high school	High school graduate	Technical school or some college	2 year college degree	4 year college degree	Graduate school (Master's or Doctorate)

What was your annual household income in 2017 before taxes?

Less than $50,000	$50,000 to $100,000	$100,000 or more	Prefer not to answer

What is your gender?

- Male
- Female
- Other
- Prefer not to disclose

The Ohio State University (OSU) is a partner of Smart Columbus. If you are interested in participating in OSU research, please answer these additional survey questions on your opinions, preferences, and views about EVs. They will take an average of 3 additional minutes to complete. Your participation in this research is entirely voluntary. You may quit the study at any time at no penalty to you.

The Ohio State University's Office responsible Research Practices has reviewed this research through the IRB review process according to applicable state and federal regulations and University policies designed to protect the rights and welfare of participants in research. For questions about your rights as a participant in this study or to discuss other study-related concerns or complaints with someone who is not part of the research team, you may contact Ms. Sandra Meadows in the Office responsible Research Practices at 1-800-678-6251. Additionally, please contact Dr. Atar Herziger at herziger.1@osu.edu if you have any concerns or questions.

- Yes
- No

Please rate your level of agreement with the statements below:

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
EVs are impractical	○	○	○	○	○
EVs are a "green" option	○	○	○	○	○
EVs are not suitable for my lifestyle	○	○	○	○	○
A driver of an EV stands out in a crowd	○	○	○	○	○
EVs are for people who want the best things in life	○	○	○	○	○
When driving an EV, I would always be worried about running out of charge	○	○	○	○	○

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
EVs are generally a very exciting new technology	○	○	○	○	○
I would feel embarrassed to drive an EV	○	○	○	○	○
EVs have inferior performance	○	○	○	○	○
EVs are safe for the environment	○	○	○	○	○
EVs are similar to other cars in most respects	○	○	○	○	○
Driving an EV says something about the kind of person you are	○	○	○	○	○

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I would feel proud of having an EV outside my house	○	○	○	○	○
EVs are very pleasant to drive	○	○	○	○	○
People use EVs as a way of expressing their personality	○	○	○	○	○
I would prefer not to drive an EV	○	○	○	○	○
EVs are good value over the longer term	○	○	○	○	○
EVs are a responsible alternative	○	○	○	○	○

Please indicate to what extent you *anticipate* experiencing each of the below feelings and emotions immediately after completing the EV test drive:

	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
Proud	○	○	○	○	○
Pleased with myself	○	○	○	○	○
Content	○	○	○	○	○

Think about the reason or reasons you have chosen to participate in the Ride and Drive event. The items below concern your impressions or opinions of this cause or causes of your participation. Choose one number for each of the following questions.

Is the cause(s) something:

	9	8	7	6	5	4	3	2	1	
Under the power of other people	○	○	○	○	○	○	○	○	○	not under the power of other people
Other people can regulate	○	○	○	○	○	○	○	○	○	other people cannot regulate
Over which others have control	○	○	○	○	○	○	○	○	○	over which others have no control
You can regulate	○	○	○	○	○	○	○	○	○	you cannot regulate
Stable over time	○	○	○	○	○	○	○	○	○	variable over time
That reflects an aspect of yourself	○	○	○	○	○	○	○	○	○	reflects an aspect of the situation
Unchangeable	○	○	○	○	○	○	○	○	○	changeable
Over which you have power	○	○	○	○	○	○	○	○	○	over which you have no power
Inside of you	○	○	○	○	○	○	○	○	○	outside of you
Something about you	○	○	○	○	○	○	○	○	○	something about others
Manageable by you	○	○	○	○	○	○	○	○	○	not manageable by you
Permanent	○	○	○	○	○	○	○	○	○	temporary

Please rate your level of agreement with the statements below:

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I would not buy a more efficient car just because it is environmentally friendly	○	○	○	○	○
I often influence other people's opinions about cars	○	○	○	○	○
I often seek out information about new cars	○	○	○	○	○
I am not the type of person to worry about being 'green'	○	○	○	○	○

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
In general, I am among the first in my circle of friends to buy a new car	○	○	○	○	○
In general, I am the first in my circle of friends to know about the newest car releases	○	○	○	○	○
If I heard that a new car was available, I would not be interested enough to buy it	○	○	○	○	○
I like magazines/websites about new cars	○	○	○	○	○

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
Being environmentally responsible is an important part of who I am	○	○	○	○	○
Reducing my car's environmental impact would make me feel good	○	○	○	○	○
When I am choosing a car, I find myself spending a lot of time checking out different models	○	○	○	○	○
When other people are choosing a car to buy, they turn to me for advice I	○	○	○	○	○

Post-Drive Survey

THE OHIO STATE UNIVERSITY

Select the photo of the person who was your right seat driver


Click to write Choice 1


Click to write Choice 4


Click to write Choice 2


Choice 5

How likely are you to consider purchasing or leasing an EV for your next car?

Very unlikely	Unlikely	Likely	Very likely

What is your overall opinion of EVs?

Not for me	For me	No opinion

How likely are you to recommend an EV to a friend, if they were considering purchasing a new car?

Very unlikely	Unlikely	Somewhat likely	Likely	Very likely

How much more are you willing to pay for a new EV compared to a conventional gasoline/diesel powered vehicle?

I am not willing to pay more	Up to $2,000 more	Up to $5,000 more	Up to $10,000 more	Up to $15,000 more	Up to $20,000 more	Other

Would you like someone from the local dealership to contact you with more information?

Yes, and I give you permission to share my contact information for this purpose
No

Please indicate how strongly you agree or disagree with the following statements about EVs:

	1 Strongly disagree	2	3	4	5	6	7 Strongly agree
Driving an EV means that I'm an environmentalist	○	○	○	○	○	○	○
Driving an EV means that I am doing the right thing	○	○	○	○	○	○	○
Driving an EV means that I am a trendsetter	○	○	○	○	○	○	○
Driving an EV means that I am tech savvy	○	○	○	○	○	○	○
Driving an EV means that I am doing right by my family	○	○	○	○	○	○	○
Driving an EV means that I am patriotic	○	○	○	○	○	○	○
Driving an EV means that I am a good community member	○	○	○	○	○	○	○
Driving an EV means that I am socially responsible	○	○	○	○	○	○	○
Driving an EV means that I make practical choices	○	○	○	○	○	○	○
Driving an EV demonstrates to others that I care about the environment	○	○	○	○	○	○	○

If you were able to charge your car at work, would you be more likely to consider purchasing an electric vehicle (EV)?

Yes	No	Not applicable

How would you rate your right seat driver's knowledge and engagement?

How would you rate your overall experience at the Ride and Drive Road Show?

Poor	Good	Very good	Excellent

Have you participated in a Smart Columbus Ride & Drive event prior to this one?

Yes	No

Anything else you would like to tell us about your experience or viewpoint on Electric Vehicles?

The Ohio State University (OSU) is a partner of Smart Columbus. If you are interested in supporting OSU research, please consider answering these additional survey questions. Questions will take an average of 2 minutes to complete.

Yes

No

The Ohio State University (OSU) is a partner of Smart Columbus. If you are interested in participating in OSU research, please answer these additional survey questions on your opinions, preferences, and views about EVs. They will take an average of 3 additional minutes to complete. Your participation in this research is entirely voluntary. You may quit the study at any time at no penalty to you.

The Ohio State University's Office responsible Research Practices has reviewed this research through the IRB review process according to applicable state and federal regulations and University policies designed to protect the rights and welfare of participants in research. For questions about your rights as a participant in this study or to discuss other study-related concerns or complaints with someone who is not part of the research team, you may contact Ms. Sandra Meadows in the Office responsible Research Practices at 1-800-678-6251. Additionally, please contact Dr. Atar Herziger at herziger.1@osu.edu if you have any concerns or questions.

Yes

No

Please rate your level of agreement with the statements below:

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I often seek out information about new cars	○	○	○	○	○
Being environmentally responsible is an important part of who I am	○	○	○	○	○
In general, I am the first in my circle of friends to know about the newest car releases	○	○	○	○	○
I like magazines/websites about new cars	○	○	○	○	○

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I would not buy a more efficient car just because it is environmentally friendly	○	○	○	○	○
In general, I am among the first in my circle of friends to buy a new car	○	○	○	○	○
Reducing my car's environmental impact would make me feel good	○	○	○	○	○
I often influence other people's opinions about cars	○	○	○	○	○

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
If I heard that a new car was available, I would not be interested enough to buy it	○	○	○	○	○
When I am choosing a car, I find myself spending a lot of time checking out different models	○	○	○	○	○
I am not the type of person to worry about being 'green'	○	○	○	○	○
When other people are choosing a car to buy, they turn to me for advice I	○	○	○	○	○

Please rate your level of agreement with the statements below:

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
EVs are generally a very exciting new technology	○	○	○	○	○
I would prefer not to drive an EV	○	○	○	○	○
A driver of an EV stands out in a crowd	○	○	○	○	○
EVs have inferior performance	○	○	○	○	○
EVs are impractical	○	○	○	○	○
EVs are good value over the longer term	○	○	○	○	○

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
When driving an EV, I would always be worried about running out of charge	○	○	○	○	○
EVs are safe for the environment	○	○	○	○	○
I would feel embarrassed to drive an EV	○	○	○	○	○
I would feel proud of having an EV outside my house	○	○	○	○	○
EVs are a responsible alternative	○	○	○	○	○
EVs are very pleasant to drive	○	○	○	○	○

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
People use EVs as a way of expressing their personality	○	○	○	○	○
EVs are similar to other cars in most respects	○	○	○	○	○
EVs are not suitable for my lifestyle	○	○	○	○	○
Driving an EV says something about the kind of person you are	○	○	○	○	○
EVs are for people who want the best things in life	○	○	○	○	○
EVs are a "green" option	○	○	○	○	○

Please indicate to what extent you are experiencing each of the below feelings and emotions after completing the EV test drive:

	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
Proud	○	○	○	○	○
Pleased with myself	○	○	○	○	○
Content	○	○	○	○	○

How likely are you to consider riding or driving in an EV again?

Very unlikely	Unlikely	Likely	Very likely

Think about your experience today. Please rate your level of agreement with the statements below:

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
Learning to operate an EV was easy for me	○	○	○	○	○
My interaction with the EV was clear and understandable	○	○	○	○	○
It would be easy for me to become skillful at using an EV	○	○	○	○	○

Please rate how you feel at the moment about your experience with the EV:

I dislike it	○ ○ ○ ○ ○ ○ ○	I like it
I find it pleasurable	○ ○ ○ ○ ○ ○ ○	I find it unpleasurable
I enjoyed it	○ ○ ○ ○ ○ ○ ○	I hate it