ACCELERATE YOUR CITY

ADVANCING FLEET ELECTRIFICATION
AccelerateYourCity.com

Best Practices and Lessons Learned on:
- EV Adoption & Charging
- Community Engagement ‘The Columbus Way’
- Mobility Shift & More

From the $10 million Smart Columbus Electrification Program
Ben Prochazka, National Director, Electrification Coalition
Bud Braughton, Project Manager, City of Columbus
John King, Assistant Administrator of Fleet, City of Columbus
The Electrification Coalition (EC) works to accelerate the adoption of electric vehicles to reduce the national security, economic and environmental threats caused by our nation’s oil dependency.
92% of U.S. transportation powered by oil...

...a resource with volatile prices that the US spends $80 billion per year to protect...

...that is a leading emissions source

U.S. transportation energy sources/fuels, 2018 ¹

1. Based on energy content

Source: EIA
The US DOT Smart Cities Challenge

Becoming a Smart City

1,400 local officials, companies, academics and nonprofits joined our webinars

800 people participated in our Smart City Forum

300 companies have expressed interest in partnering

77 applications received for the Smart City Challenge

5 Smart City Challenge Finalists to be announced in March at SXSW

1 Smart City Challenge Winner announced in June

#DOTSmartCity
www.transportation.gov/smartcity
SMART COLUMBUS ELECTRIFICATION PROGRAM
ELECTRIFICATION PROGRAM

1. DECARBONIZATION & GRID MODERNIZATION
   - 905 MW of utility scale renewable energy generation through solar and wind
   - 1.2 TeraWh of renewable energy & save 480 GWh consumed through energy efficiency

2. FLEET ELECTRIFICATION
   - 755 Electric Fleet Vehicles in Operation by 2020

3. TRANSIT, AUTONOMOUS, MULTIMODAL MOBILITY OPTIONS
   - 6 Electric Autonomous Vehicles in Operation by 2020
   - 50 Electric Bikes

4. CONSUMER ADOPTION OF ELECTRIC VEHICLES
   - 1.8% of all new vehicle sales in 2020 are electric
   - 50 Executives are driving electric by 2020

5. CHARGING INFRASTRUCTURE
   - 925 new electric vehicle chargers are installed by 2020
PROGRESS THROUGH PARTNERSHIPS

- Installed 552,000+ Smart Meters
- Installed 419 workplace chargers
- Purchased 313 electric fleet vehicles
- Opened world-class EV showcase facility
- Engaged 40% of regional car dealerships
- Conducted 12,400+ EV test drives
- Influenced 3,458 people to buy an EV in 3 years
- Forged unprecedented partnerships to increase e-mobility options
OUR GOAL:
SHIFT THE TRAJECTORY OF ELECTRIC VEHICLE ADOPTION IN CENTRAL OHIO

PEV Adoption Rate by Quarter

Goal: 1.8%
Baseline: 0.37%

Q1: 0.61%, Q2: 0.58%, Q3: 0.77%, Q4: 0.52%, Q5: 0.97%, Q6: 1.21%, Q7: 2.34%, Q8: 0.85%, Q9: 1.35%, Q10: 1.46%, Q11: 1.55%, Q12: 1.68%
FLEET ELECTRIFICATION
## SMART COLUMBUS ELECTRIFICATION PROGRAM

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DECARBONIZATION &amp; GRID MODERNIZATION</td>
<td>FLEET ELECTRIFICATION</td>
<td>TRANSIT, AUTONOMOUS, MULTIMODAL MOBILITY OPTIONS</td>
<td>CONSUMER ADOPTION OF ELECTRIC VEHICLES</td>
<td>CHARGING INFRASTRUCTURE</td>
</tr>
<tr>
<td></td>
<td>GOAL: 905 MW of utility scale renewable energy generation through solar and wind</td>
<td>GOAL: 755 Electric Fleet Vehicles in Operation by 2020</td>
<td>GOAL: 6 Electric Autonomous Vehicles in Operation by 2020</td>
<td>GOAL: 1.8% of all new vehicle sales in 2020 are electric</td>
<td>GOAL: 925 new electric vehicle chargers are installed by 2020</td>
</tr>
<tr>
<td></td>
<td>1.2 TeraWh of renewable energy &amp; save 480 GWh consumed through energy efficiency</td>
<td></td>
<td>50 Electric Bikes</td>
<td>50 Executives are driving electric by 2020</td>
<td></td>
</tr>
</tbody>
</table>
## Public Partners and Their EV Purchases

<table>
<thead>
<tr>
<th>Agency</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>City of Columbus</td>
<td>200</td>
</tr>
<tr>
<td>Airport, MPO, 7 municipalities</td>
<td>11</td>
</tr>
<tr>
<td>Dublin, OH</td>
<td>10</td>
</tr>
<tr>
<td>Franklin County</td>
<td>19</td>
</tr>
<tr>
<td>The Ohio State University</td>
<td>15</td>
</tr>
<tr>
<td><strong>Total Committed</strong></td>
<td><strong>255</strong></td>
</tr>
</tbody>
</table>
June 2016
U.S. Smart City Challenge grant awarded to the City of Columbus, with goal of adding 300 EVs to public fleets, 200 of them for the City of Columbus.

May 2017
Bid (addendum 1) released by the City of Columbus for EV procurement.

November 2017
Universal Term Contract passed by the Columbus City Council.

January 2018
Purchase order for 93 EVs completed by the City of Columbus.
HIGHLIGHTS FROM THE INNOVATIVE CITY CONTRACT TO PROCURE EVS

The City of Columbus created an innovative UTC for EV procurement that allowed the City to significantly lower the acquisition cost of EVs and set an example for other cities to follow. The highlights include:

Unique Contract:
The contract is structured as a hybrid lease-purchase with a short lease period as opposed to a typical City contracts that include only a purchase option.

Secured the Tax Credit:
The City will receive half of the federal EV tax credit for each vehicle per the contract through a lease, which was more than what was proposed for a purchase.

Lower Vehicle Costs:
The hybrid lease-purchase structure results in lower costs than an outright purchase.

Encourages Further EV Adoption:
The City employees can also purchase EVs through the contract at a discounted rate. This supports the Paul G. Allen Family Foundation grant priority for Consumer Adoption.

Thinking Beyond Columbus:
Establishing the UTC enables other public entities in Ohio to take advantage of the same favorable contract terms, which may be particularly useful for public entities with smaller fleets.
Addressing High Upfront Costs for EV Procurement

“Triple-net pricing” or “triple-net dealer invoice price” is the dealer’s cost for a vehicle, minus any automaker deals, and includes all add-on options (e.g., power windows). The triple-net dealer invoice pricing strategy is more common in the private sector for large and centralized procurement efforts, which does not describe all public fleets. If achievable, the triple-net dealer pricing can reduce the cost of current and future procurement by simplifying negotiations and is easily replicable. The bid from a dealer will in actuality be an increase over the “triple net” as described at right:

**Triple Net Price Bid** = **Dealer Invoice** - **Dealer Holdback** – **Advertising** - **Fleet Discounts** + **Dealer Markup**

Where:
- **Dealer Invoice** = Vehicle invoice from the automaker
- **Dealer Holdback** = Percentage of dealer invoice or suggested MSRP
- **Advertising** = Marketing funding from the automaker
- **Fleet Discounts** = Intra-transit credit, automaker bid assistance, or fleet-specific discount. Policies for government bid assistance may vary by automaker
- **Dealer Markup** = A bid above the cost to the dealer
Overcoming Range Anxiety and Deploying Charging Infrastructure

CHARGING LEVELS

The figure below shows the three levels of charging for electric vehicles. The charging capabilities (miles per hour rates) increase moving from left to right, along with the cost of equipment and installation. Level 1 charging is the least costly option but provides an EV with less than 50 miles of range in 10 hours. Level 2 charging can require electrical system upgrades in some cases. DC fast charging requires the most extensive electrical system upgrades, but also provides the quickest charge.

<table>
<thead>
<tr>
<th>LOW – AC 120 V AC LEVEL 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Primarily residential (all EVs)</td>
</tr>
<tr>
<td>• Uses standard outlet</td>
</tr>
<tr>
<td>• Power requirements similar to a toaster</td>
</tr>
<tr>
<td>• Up to 1.4 kilowatts</td>
</tr>
<tr>
<td>• Can use existing power outlets resulting in no-cost installation</td>
</tr>
<tr>
<td>• Charging rate: 3-5 miles per hour</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MEDIUM – AC 240 V AC LEVEL 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Residential, workplace and commercial (all EVs)</td>
</tr>
<tr>
<td>• Requires high-voltage circuit</td>
</tr>
<tr>
<td>• Power requirements similar to an electric clothes dryer</td>
</tr>
<tr>
<td>• Up to 19.2 kilowatts</td>
</tr>
<tr>
<td>• Equipment and installation costs vary widely (~$6,500 in public and ~$2,000 at home)</td>
</tr>
<tr>
<td>• Charging rate: 12-75 miles per hour</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HIGH – DC FAST CHARGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Community/metro and highway Corridors (BEVs)</td>
</tr>
<tr>
<td>• Power requirements are up to max power for 15 homes</td>
</tr>
<tr>
<td>• Max power varies by system (CHAdeMO: 62.5 kW, SAE Combo: 100 kW, Tesla: 120kW)</td>
</tr>
<tr>
<td>• Can have very high equipment and installation costs (up to $90,000 per station)</td>
</tr>
<tr>
<td>• Charging rate: 100-300 miles per hour</td>
</tr>
</tbody>
</table>
## Table 2: Partial List of 2017 EVs with Vehicle Specifications

<table>
<thead>
<tr>
<th>Make</th>
<th>Model</th>
<th>Type</th>
<th>Battery Size</th>
<th>Electric Range (mi)</th>
<th>MSRP</th>
<th>Available in Central Ohio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chevrolet</td>
<td>Volt**</td>
<td>PHEV</td>
<td>18.4</td>
<td>53</td>
<td>$33,220</td>
<td>•</td>
</tr>
<tr>
<td></td>
<td>Bolt EV**</td>
<td>BEV</td>
<td>60</td>
<td>238</td>
<td>$36,620</td>
<td>•</td>
</tr>
<tr>
<td>Chrysler</td>
<td>Pacifica Hybrid</td>
<td>PHEV</td>
<td>16</td>
<td>33</td>
<td>$41,995</td>
<td>•</td>
</tr>
<tr>
<td>Flat</td>
<td>500e</td>
<td>BEV</td>
<td>24</td>
<td>84</td>
<td>$31,800</td>
<td>•</td>
</tr>
<tr>
<td>Ford</td>
<td>Fusion Energi Plug-in Hybrid**</td>
<td>PHEV</td>
<td>7.612</td>
<td>22</td>
<td>$33,120</td>
<td>•</td>
</tr>
<tr>
<td></td>
<td>C-MAX Energi Plug-in Hybrid**</td>
<td>PHEV</td>
<td>7.612</td>
<td>20</td>
<td>$27,120</td>
<td>•</td>
</tr>
<tr>
<td></td>
<td>Focus Electric**</td>
<td>BEV</td>
<td>33.5</td>
<td>115</td>
<td>$29,120</td>
<td>•</td>
</tr>
<tr>
<td>Honda</td>
<td>Clarity**</td>
<td>BEV</td>
<td>n/a</td>
<td>89</td>
<td>n/a*</td>
<td>•</td>
</tr>
<tr>
<td>Hyundai</td>
<td>Sonata Plug-in Hybrid</td>
<td>PHEV</td>
<td>9.8</td>
<td>27</td>
<td>$34,600*</td>
<td>•</td>
</tr>
<tr>
<td></td>
<td>Ioniq Plug-in Hybrid**</td>
<td>PHEV</td>
<td>8.9</td>
<td>24</td>
<td>n/a*</td>
<td>•</td>
</tr>
<tr>
<td></td>
<td>Ioniq Electric</td>
<td>BEV</td>
<td>28</td>
<td>124</td>
<td>$29,500</td>
<td>•</td>
</tr>
<tr>
<td>KIA</td>
<td>Soul Electric</td>
<td>BEV</td>
<td>27</td>
<td>93</td>
<td>$32,250</td>
<td>•</td>
</tr>
<tr>
<td>Mitsubishi</td>
<td>i-MiEV</td>
<td>BEV</td>
<td>16</td>
<td>59</td>
<td>$22,995</td>
<td>•</td>
</tr>
<tr>
<td>Nissan</td>
<td>LEAF**</td>
<td>BEV</td>
<td>30</td>
<td>107</td>
<td>$30,680</td>
<td>•</td>
</tr>
<tr>
<td>Toyota</td>
<td>Prius Prime</td>
<td>PHEV</td>
<td>8.8</td>
<td>25</td>
<td>$27,100</td>
<td>•</td>
</tr>
<tr>
<td>Volkswagen</td>
<td>e-Golf</td>
<td>BEV</td>
<td>36</td>
<td>125</td>
<td>$28,995</td>
<td>•</td>
</tr>
</tbody>
</table>

2017 model EVs with battery size, electric range in miles, and MSRP in U.S. dollars. Models with "**" are those that were listed in the City of Columbus Invitation to Bid. MSRPs with an "*" were taken from the vehicle manufacturer websites. "NA" indicates the information was not available. Availability in Central Ohio as of January 2018.

Source: [6]
City of Columbus Vehicle Procurement Process

Major process steps for the City of Columbus EV procurement program. Some steps happened concurrently, for example the assessing the city’s need for charging infrastructure was critical to identifying candidate vehicles and making vehicle purchases.
Existing Fleet Assessment

The current vehicles in the City of Columbus fleet by type. Columbus needed to understand the current vehicle types and uses as it developed its plan for replacement of conventional vehicles with EVs. At this time, only passenger cars have suitable EV alternatives for Columbus.

Source: Data provided by the City of Columbus Fleet Management Division
Identifying Vehicles for Replacement by Evaluating Vehicle Data

<table>
<thead>
<tr>
<th>Vehicle 23039 Overview</th>
<th>Estimated EV Usage Stats</th>
</tr>
</thead>
<tbody>
<tr>
<td>VMT</td>
<td>Max Daily kWh</td>
</tr>
<tr>
<td>1,041</td>
<td>24.8</td>
</tr>
<tr>
<td>Avg. Daily VMT</td>
<td>Avg. Daily kWh</td>
</tr>
<tr>
<td>55</td>
<td>14.1</td>
</tr>
<tr>
<td>Max Daily VMT</td>
<td>GHG Cut (MTCO2e)</td>
</tr>
<tr>
<td>88</td>
<td>0.28</td>
</tr>
<tr>
<td>Fuel Use (gal)</td>
<td></td>
</tr>
<tr>
<td>46</td>
<td></td>
</tr>
<tr>
<td>Avg. MPG</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Overall</th>
<th>Confidence</th>
<th>Energy Use</th>
<th>Speed</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>87</td>
<td>100</td>
<td>92</td>
<td>61</td>
<td>70</td>
</tr>
</tbody>
</table>

Suitability analysis results for an example City of Columbus vehicle provided by the Electrification Coalition. The results show that the vehicle is a good candidate for EV replacement based on daily usage. Source: [9]
Evaluating the Bids for a Universal Term Contract

<table>
<thead>
<tr>
<th>MAKE</th>
<th>MODEL</th>
<th>TYPE</th>
<th>BATTERY SIZE</th>
<th>ELECTRIC RANGE (MI)</th>
<th>MSRP</th>
<th>TAX CREDIT (BUY/LEASE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chevrolet</td>
<td>Volt**</td>
<td>PHEV</td>
<td>18.4</td>
<td>53</td>
<td>$33,220</td>
<td>$0/$3,750</td>
</tr>
<tr>
<td></td>
<td>Bolt EV**</td>
<td>BEV</td>
<td>60</td>
<td>238</td>
<td>$36,620</td>
<td>$0/$3,750</td>
</tr>
<tr>
<td>Ford</td>
<td>Fusion Energi Plug-in Hybrid**</td>
<td>PHEV</td>
<td>7.612</td>
<td>22</td>
<td>$33,120</td>
<td>$800/$2,000</td>
</tr>
<tr>
<td></td>
<td>C-MAX Energi Plug-in Hybrid**</td>
<td>PHEV</td>
<td>7.612</td>
<td>20</td>
<td>$27,120</td>
<td>$800/$2,000</td>
</tr>
<tr>
<td></td>
<td>Focus Electric**</td>
<td>BEV</td>
<td>33.5</td>
<td>115</td>
<td>$29,120</td>
<td>$1,500/$3,750</td>
</tr>
<tr>
<td>Nissan</td>
<td>LEAF**</td>
<td>BEV</td>
<td>30</td>
<td>107</td>
<td>$30,680</td>
<td>$1,500/$3,750</td>
</tr>
</tbody>
</table>

2017 model EVs offered to the City of Columbus by bidders with battery size, electric range in miles, MSRP in U.S. dollars, and tax credit savings. Note the bidder with a purchase option offered to pass along much less of the federal EV tax credit than the bidder that proposed a lease.

Source: [6]
A mix of gasoline-powered passenger cars are being replaced with EVs for several divisions within the City of Columbus.

Source: City of Columbus
City of Columbus
- 200 EVs
- 18 divisions
- 18 sites
- 167 charging ports
- 3-phase installation process
Overview

• 350 Committed EVs
• 45 Fleet Analyses Completed
• 200+ businesses and organizations engaged
FLEET ELECTRIFICATION WORKPLAN

01 WEEK 1: INITIAL FLEET MEETING
Schedule meeting to discuss the importance of electrification.
Goal: Determine what operational data is available to help with procurement decision.

02 WEEK 2: FOLLOW UP DISCUSSION
Set up follow up call to ensure collection of fleet information.
Goal: Set expectation for electrification commitment.

03 WEEKS 3 - 4: EV ANALYSIS
Electrification Coalition to conduct an electric vehicle analysis.
Goal: Compare internal combustion engine and electric vehicle options.

04 WEEK 3: COMMITMENT
Commit to fleet electrification.
Goal: Determine the number of vehicles and timing needed.

05 WEEKS 3 - 5: EVSE SITE IDENTIFICATION
Determine possible locations for EVSE; conduct site surveys.
Goal: Recommend cost-effective charging equipment and infrastructure upgrades.

06 WEEK 4: REVIEW VEHICLE OPTIONS
Review EV analysis and determine any special factors for vehicle selection.
Goal: Maximize fleet opportunity for electrification.

07 WEEKS 6 - 8: DETERMINE VEHICLES
Determine electric vehicle model(s) desired and order or bid on vehicles.
Goal: Maximize electric vehicle options over plug-in electric vehicles if possible.

08 WEEKS 6 - 8: REVIEW NEEDED EVSE
Determine charging infrastructure required, purchase, and schedule installation.
Goal: Maximize networked charger opportunity for improved data capture.
Aggregated fleet operational data used to establish a baseline TCO, identify which vehicles look like good candidates “on paper.”

![Vehicle Cost per Mile (Nominal)](image)
EV CHARGING INFRASTRUCTURE NEEDS

Where, when, and how long a vehicle parks is critical to charging needs.

Routinized parking at various facilities helps optimize EV: EVSE ratio.

(Driver X) most often ends and begins driving from the facility at 123 E. Main St, Anytown, ST 12345 where access to overnight charging would be necessary in order to transition to an EV.
Key Learnings

• Finding Light-Duty Fleet Vehicles within Region

• Aligning Procurement Windows/Timing

• Identify Internal Champion to Drive Initiative
**TSP REBATES**

- **April 2017**: Electrification Plan Approved, Implementation Begins
- **April 2017**: TSP Rebate Program RFP Round 1 Released
- **March 2018**: TSP EV Adoption Survey Released
- **March 2018**: CYC creates Taxi University to train drivers in EV adoption and charging
- **January 2019**: Received 40 applications total from the TSP Rebate Program
- **January 2019**: $30,000 Awarded to Yellow Cab of Columbus for 10 Chevy Bolts
- **April 2020**: Program Ends

- **April 2017**: Yellow Cab of Columbus purchases 10 Tesla Model 3's
- **April 2020**: Yellow Cab of Columbus activated two dual-port 50k DC Fast Chargers
- **February 2018**: Clean Fuels Ohio & Yellow Cab of Columbus awarded USDOE Decentralized Mobility Ecosystem funding
WHAT’S NEXT IN FLEET ELECTRIFICATION
Viable Fleet Options on the Horizon

- Fleet electrification has been our most challenging goal, due to lack of model availability in the US.

- There are new models coming online over the next 2 years that will disrupt the industry, including:
  - Rivian R1T Pickup
  - Ford F-150 EV
  - Atlis Pickup
  - Mercedes-Benz EQV Van
  - Tesla Pickup
  - Tesla Semi
  - Proterra Transit Bus
Batteries in new EVs will hold longer and longer charge, making it more desirable by customers and also changing charging use and need.

Time to charge at a fast charger will substantially decrease as technology enables higher voltage transfer.
AccelerateYourCity.com

Best Practices and Lessons Learned on:
• EV Adoption & Charging
• Community Engagement ‘The Columbus Way’
• Mobility Shift & More

From the $10 million
Smart Columbus Electrification Program
THANK YOU

Please join us on August 18th at 3pm for the next webinar, Driving Consumer Adoption through Public/Private Partnerships.