Northeast Regional Transportation Electrification Workshop

November 29 - 30, 2018

National Governors Association Center for Best Practices

#WeTheStates
Polling Question 1

What do you see as the biggest barriers to EV adoption?

- A: Education
- B: Cost
- C: Awareness
- D: Charging Availability

Respond at PollEv.com/ngaet062 or text NGAET062 to 22333 once to join, then A, B, C, or D.
Sue Gander, Director, Environment, Energy & Transportation Division, NGA Center for Best Practices

Welcome & Opening Remarks

#WeTheStates
State Introductions
November 29, 2018
Transportation Electrification Workshop, Northeast Regional
Crafting Incentives, Developing Policies, and Building Consumer Awareness

Moderator: Rick Tempchin, Senior Fellow, Alliance to Save Energy

Speakers:
Elaine O'Grady, Policy & Program Director, Northeast States for Coordinated Air Use Management
Rob Klee, Commissioner, CT Department of Energy and Environmental Protection
Bob Wimmer, Director, Energy and Environmental Research Group, Toyota Motors

#WeTheStates
NGA NORTHEAST TRANSPORTATION ELECTRIFICATION WORKSHOP
Crafting Incentives, Developing Policies & Building Consumer Awareness

November 29, 2018
What is NESCAUM?

**Northeast States for Coordinated Air Use Management**

The regional nonprofit association of air quality agencies in the Northeast.

Our purpose is to provide scientific, technical, analytical, and policy support to the air quality programs of the eight Northeast states.
The Multi-State ZEV Task Force

Nine states working together to identify and remove barriers to ZEV adoption

Formed by a 2013 Governor’s Memorandum of Understanding

Facilitated by NESCAUM

All member states have utilized CAA §177 authority to adopt California’s ZEV requirements
Multi-State ZEV Action Plan

Identifies 80 market-enabling actions for states, automakers, dealers, utilities, charging and fueling companies, and other partners in five key areas:

- Consumer Education and Outreach
- Infrastructure
- Consumer Purchase Incentives
- Light Duty Fleets
- Dealerships
CONSUMER EDUCATION AND OUTREACH

High Priority Recommendations for States

Support and encourage innovative state, local, and grassroots efforts to increase consumer experience with ZEVs, such as ride and rive events, car sharing, rental programs, and pop-up or permanent ZEV showrooms.

Support the brand-neutral Drive Change. Drive Electric. campaign in partnership with automakers and work to bring in other partners.
**Demographics:**
These are educated, Gen-X and Boomer men; they have been the primary drivers of EV adoption.

**EV Mindset:**
Generally favorable towards electric cars. They like the savings on fuel costs but have specific concerns with regard to vehicle performance, range and charging station availability.

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**Demographics:**
These are older millennials; they are establishing their careers and their families; they live in the suburbs.

**EV Mindset:**
They are drawn to electric cars but have concerns about “inconvenience” associated with ownership. However, once persuaded, they’re more likely to purchase electric cars throughout their lives.

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**Demographics:**
These are late Gen-X and Boomer women approaching retirement and empty nests.

**EV Mindset:**
They have the least education about electric cars. They generally appreciate lower fuel costs and environmental benefits, but express anxiety about range and charging station availability.

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**Demographics:**
These are educated, Gen-X and Boomer men; they have been the primary drivers of EV adoption.

**EV Mindset:**
Generally favorable towards electric cars. They like the savings on fuel costs but have specific concerns with regard to vehicle performance, range and charging station availability.
### TOP REASONS FOR NOT BUYING EVS

It’s not really about the car. It’s about the impact of the unknown on the everyday.

<table>
<thead>
<tr>
<th>Reason</th>
<th>Grown Up Millennials</th>
<th>Seasoned Base</th>
<th>Next Chapter Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range of driving before needing to recharge</td>
<td>23%</td>
<td>47%</td>
<td>43%</td>
</tr>
<tr>
<td>Availability of charging locations</td>
<td>26%</td>
<td>35%</td>
<td>42%</td>
</tr>
<tr>
<td>Re-charging time</td>
<td>27%</td>
<td>33%</td>
<td>28%</td>
</tr>
<tr>
<td>High upfront costs</td>
<td>29%</td>
<td>32%</td>
<td>34%</td>
</tr>
<tr>
<td>No place to charge vehicle at home</td>
<td>19%</td>
<td>21%</td>
<td>28%</td>
</tr>
</tbody>
</table>

WEBSITE & SOCIAL MEDIA CONTENT

Full torque from a standstill. Remind yourself how much fun driving should be with a new electric car.

From 0 to woooooo!

Drive Change. Drive Electric.
Switch to electric without switching up your everyday...

Convenience
Simplify your routine with an electric car that recharges while you recharge, and with driving ranges that fit your lifestyle.

Affordability
Get information on incentives to purchase electric cars and the savings from reduced operating costs.

Technology
Learn more about the technological innovations “under the hood.”

Sustainability
See how smart choices now can make a better future.

The Fun Factor
Go electric for vehicle performance that makes the drive to work almost as much fun as the drive home.

It’s cheaper to charge your car at home than it is to fuel up on gas. Need more convincing? See our affordability page: https://bit.ly/2vYI5nA

Average Fuel Costs
NEW ENGLAND

Gallon of Gas: $2.86
Electricity: $1.78

DRIVEELECTRICUS.COM

View cars by body style:
- Crossover
- Hatchback
- Minivan
- Sedan
- Sports
- Suv

View cars by drivetrain type:
- Battery Electric Vehicle
- Plug-in Hybrid Electric Vehicle

Reset
High Priority Recommendations for States

Advocate for continued availability of federal tax credits.

Continue to offer and promote existing state financial incentives, and consider new programs and outreach efforts to improve access to incentives for moderate and lower income consumers.
PROJECTED PHASE OUT OF FEDERAL EV TAX CREDIT

Federal tax credits for some EV manufacturers are starting to phase.
Purchase incentives play a crucial role in early ZEV adoption and should be maintained or expanded to promote market growth.

Data Source: Center for Sustainable Energy Surveys (2013-2017)
High Priority Recommendations for States

Revise **building codes** to require supporting electrical infrastructure for EVSE in new construction and major renovations.

Encourage local governments to **streamline permitting** for DCFC and hydrogen fueling stations.

**Open PUC proceedings** to consider utility investments, incentivizing off-peak charging, and ways to address demand charges.

Lead by example: Add ZEVs to state fleets and offer workplace charging at state buildings.
Thank you!


For questions, please contact: Elaine O’Grady at eogrady@nescaum.org
Crafting Incentives, Developing Policies, and Building Consumer Awareness

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#WeTheStates
Vehicle Electrification

Northeast Regional Transportation Electrification Workshop

Bob Wimmer
Director, Energy & Environmental Research
Toyota Motor North America

November 29, 2018
Electrification Pathway Toward 2050

Sales Volume

2010  2020  2050

Engine

HV  PHV

Conventional

Internal Combustion Engine (ICE)
Hybrid Vehicle (ICE and Battery)

Plug-in Hybrid Vehicle (PHEV)

ICE & battery utilizing both gasoline and electricity

Zero Emission Vehicle (ZEV)

Electricity or Hydrogen

Zero Emission Vehicle Technologies

Product Regulatory Affairs
Toyota Electric-Drive Product Offerings

Toyota Global Electrification Targets

- +5.5M Electrified Vehicle Sales per year by 2030
- + 1M of those ZEV
- Electrified vehicles available for all models around 2025
- More than 10 new BEVs by 2020

Best selling PHEV in U.S.

Best selling FCEV

- Prius c
- Prius
- Prius Prime PHV
- Sora FC Bus
- Portal FC Truck (prototype)
- FC Box Truck (prototype)
- RAV 4 EV (out of production)
- RAV4 Hybrid
- Highlander Hybrid
- RX 450h
- NX 300h
- Prius Prime PHV
- Prius v
- RX 450h
- ES 300h
- GS 450h
- LS 500h
- LC 500h
- Avalon Hybrid
- Mirai FCV
- Lexus
- Hybrid
- Lexus
- Hydrogen
- Fuel Cell
- Prius Prime PHV
- Lexus
- Toyota Motor
- North America

Product Regulatory Affairs
Zero Emission Electric Vehicle Attributes

- **Zero Tailpipe Emissions**
- **Energy Diversity**
  - Fuel can be generated from variety of sources
- **Sustainable**
  - When fuel is produced from low/no carbon sources
- **Fun to Drive**
  - High torque electric drive
  - Low CG for nimble handling

- *Fuel Cell Electric Vehicle*
- *Battery Electric Vehicle*
Additional Benefits of FCEVs

- Rapid Refueling: 3-5 minute
- Long Range: 300-400 miles
- Public Infrastructure: No need for home refueling
- No significant loss of performance in cold weather
- No change in behavior needed
Light-Duty Fuel Cell Vehicle and Station Status

United States

✓ ~5000 FCEVs on the road
✓ +4,200 Mirai sold or leased
✓ 36 H2 stations open in California
  ✓ Targeting 59 by the end of 2019
✓ Stations coming on-line in Northeast
✓ Targeting NE vehicle deployment in 2019

Northern California

Southern California
The Challenge

Market Success

- Stable Regulations
- Cost Competitive Technology
- Consumer Pull
Median U.S. Household Income
$61,400

Average New Car Transaction Price
$34,000 - $35,000

Plug-in Hybrid and ZEV Pricing

<table>
<thead>
<tr>
<th>Available Models</th>
<th>MSRP Below $35,000*</th>
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<tbody>
<tr>
<td>PHEV</td>
<td>26</td>
</tr>
<tr>
<td>ZEV (EV &amp; FCV)</td>
<td>17</td>
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</table>

*MSRP does not include incentives
Stable Regulations

Background
• +5 years to bring a new vehicle to market
• New fueling infrastructure can take decades
• Investment decisions significantly influenced by regulation

Policies that influence future products
• Fuel economy/GHG regulations
• Fuel regulations (RFS, octane)
• Vehicle/technology incentives
• Carbon policy

Current Challenge
Consumer Pull

BEA: US Motor Fuel % of Personal Consumption Expenditures

Weighted Fuel Economy

Bureau of Economic Analysis 2017

Product Regulatory Affairs
California vs. Northeast ZEV Sales

California

NE ZEV States

Monthly ATV Market Share - California

Monthly ATV Market Share - NE ZEV States

PHEV | BEV | FCEV
--- | --- | ---

TOYOTA MOTOR NORTH AMERICA
Product Regulatory Affairs
California Clean Vehicle Rebate Program (CVRP)

State Vehicle Incentive Funding to Date

Plug-In Electric Vehicle Market

- CVRP (PHV)
- CVRP (BEV)
- PHV Sales (Cumulative)
- BEV Sales (Cumulative)

Fuel Cell Vehicle Market

- CVRP
- Sales (Cumulative)

Program funded by revenue from California’s Cap & Trade program
California Infrastructure Funding

Revenue for infrastructure grants comes from $4 fee on all vehicle registrations

Additional funds for charging infrastructure funds from
  • Electric utility customers (rate-based investments)
  • Volkswagen settlement funds

| H2 Infra Funding Source | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | ...
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<td>LCFS</td>
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* Actual grant spending below appropriation
Conclusions

• Technologies exists to meet both customer needs & societal CO$_2$ reduction goals

• All technologies and fuels are needed to meet consumer needs and required volumes

• Stable public sector support (regulations & incentives) are needed to
  • Accelerate sales
  • Encourage private sector investment

• Volumes, variety and time will help reduce costs and lower prices

• Rapid growth in consumer demand for electric drive needed for success
Thank You For Your Attention
Crafting Incentives, Developing Policies, and Building Consumer Awareness

Moderator: Rick Tempchin, Senior Fellow, Alliance to Save Energy

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Rob Klee, Commissioner, CT Department of Energy and Environmental Protection
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#WeTheStates
Electrifying State Light-Duty Fleets and Transit

Moderator: Jim Redeker, Commissioner, Connecticut Department of Transportation

Speakers:

Harmony Wilder, Fleet Manager, State of Vermont

Eric J. McCarthy, Senior Vice President, Government Relations, Public Policy and Legal Affairs, Proterra

Doug Holcomb, Greater Bridgeport Transit

#WeTheStates
Electric Vehicle Deployment Strategies

Northeast Regional Transportation Electrification Workshop
Hartford, CT
November 29-30, 2018

Harmony Wilder
State Fleet Manager
State Fleet Program Summary

Fleet Management Services (FMS) provides centralized management and control of the State’s vehicles, except for those exempt by statute or by Commissioner of Buildings & General Services.

27 agencies and departments are assigned vehicles which serve a variety of needs, from administrative travel to routine off-road use.

Motor pool vehicles are provided at 8 locations throughout the state for short-term use and shared by all agencies and departments.

Currently 35% of the light-duty vehicles provided through the motor pool are plug-in electric (PHEV).

Our mission is to provide safe, economical vehicles for state business use, and reduce the environmental impact of state travel.
Policies and Goals

• Vermont Statute 10 V.S.A § 578(a) – 2006
  • 50% reduction of greenhouse gas emissions from 1990 levels by 2028 (Statewide Goal)
• Vermont Comprehensive Energy Plan – 2011
  • Vehicle electrification identified as a primary pathway to enable the state to meet its renewable energy goal
  • 25% of registered vehicles to be powered by renewable sources by 2030
• Vermont Zero Emissions (ZEV) Action Plan - 2014
  • 25% of new light-duty fleet vehicles purchased/leased will be ZEV by 2025
  • New State-building construction projects will be designed to support planned or future charging stations
Plug-In EV Deployment Considerations

Agency/Department Cooperation
- Objection to “footing the bill” for EV deployment
- Lack of resources to ensure EV success

EV Technology
- Buy now or wait for longer range/lower cost options
- Full battery electric or hybrid plug-in

Driver Reluctance
- EV range and winter performance concerns
- Prefer to take personal vehicle
- Tiered mileage reimbursement rate

Charging Infrastructure
- Electrical system capacity to accommodate charging infrastructure
- Dedicated parking
- Unit and installation cost
- Permitting/construction schedules
Value of EVs in Motor Pool

- Rapid deployment
- Exposure to more state employees (potential EV owners)
- Greater community visibility
- Educated drivers = Positive experience
- Optimize EV utilization
- Blended chargeback rates
- Monitored charging
EV Performance Measures

- Total cost of ownership
- Fuel economy
- Residual value vs actual resale
Cost of Ownership Comparison

2013 Chevy Volt Plug-In Hybrid

Projected Cost to Own

$30,259

Original Purchase Price $31,641
Expected Resale $9,300 (80% book value)

2013 Ford Focus

Actual Cost to Own

$28,339

Original Purchase Price $17,322
Actual Resale $5,200 (81% book value)
## Challenges and Improvement Opportunities

<table>
<thead>
<tr>
<th>Charging Infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Construction Delays</td>
</tr>
<tr>
<td>• Timing Vehicle Procurement</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>More robust rental system</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Automated trip matching to maximize EV use</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Identify Optimal Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Telematics for collecting driving patterns</td>
</tr>
<tr>
<td>• Identify “sweet spots” for an EV</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Limited EV models on contract</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Lease vs buy</td>
</tr>
<tr>
<td>• Cooperative purchasing</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Driver Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Seldom charge mid-trip</td>
</tr>
<tr>
<td>• Increase awareness of charging locations</td>
</tr>
<tr>
<td>• Targeted education and feedback</td>
</tr>
</tbody>
</table>
PROTERRA: REVOLUTIONIZING TRANSIT

PRESENTED BY

Eric J. McCarthy
SVP, Government Relations, Public Policy and Legal Affairs
Proterra’s Mission
Advancing electric vehicle technology to deliver the world’s best-performing heavy-duty vehicles

- Offices and manufacturing in CA and SC
- 465+ employees, with strong transportation expertise
- >90 customers; >700 vehicles sold
- >230 vehicles delivered; >6,000,000 service miles
- >33,200,000 pounds of CO2 emissions avoided

Strong Transportation Expertise

World-Class Financial Partners
HIGH-QUALITY, ADVANCED MANUFACTURING FOR RAPID EV ADOPTION AT SCALE

Burlingame, California
Battery Manufacturing
Company HQ

Los Angeles, California
Bus Manufacturing
West Coast Operation

Greenville, South Carolina
Bus Manufacturing
East Coast Operation
OUR CUSTOMERS IN 2018...

>700 buses sold to >90 customers across 41 states/provinces
NORTHEAST & MID-ATLANTIC PROTERRA CUSTOMERS

CT
GBT BRIDGEPORT

DC
DC CIRCULATOR WASHINGTON

DE
DART FIRST STATE DOVER

MA
WRTA WORCESTER
PVTA SPRINGFIELD

ME
SH-ZOOM TRANSIT BIDDEFORD
GREATER PORTLAND METRO PORTLAND

MD
BGE BALTIMORE
MCDOT ROCKVILLE

NY
MTA NEW YORK CITY
TOMPKINS CONSOLIDATED AREA TRANSIT ITHACA

PA
SEPTA PHILADELPHIA

VA
HAMPTON ROADS TRANSIT NORFOLK
THE SOLUTION: REVOLUTIONARY APPROACH TO TRANSPORT

THE ONLY TRANSIT PLATFORM DESIGNED SPECIFICALLY FOR EV PERFORMANCE

- Reliable
- Efficient
- Flexible and scalable
- Clean
- Quiet
- Demonstrable ROI

- 100+% Less Tailpipe emission
- 25+% Quieter
- 400+% More fuel efficient
- 78+% Lower lifetime fuel cost
## CATALYST 40 FT. TOTAL COST OF OWNERSHIP ADVANTAGE

<table>
<thead>
<tr>
<th></th>
<th>Proterra EV</th>
<th>Diesel Bus</th>
<th>CNG Bus</th>
<th>Diesel Hybrid</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vehicle</strong></td>
<td>$749</td>
<td>$493</td>
<td>$531</td>
<td>$712</td>
</tr>
<tr>
<td><strong>Energy/Fuel</strong></td>
<td>$94</td>
<td>$381</td>
<td>$336</td>
<td>$297</td>
</tr>
<tr>
<td><strong>Maintenance</strong></td>
<td>$275</td>
<td>$450</td>
<td>$500</td>
<td>$550</td>
</tr>
<tr>
<td><strong>TCO</strong></td>
<td>$1,118</td>
<td>$1,324</td>
<td>$1,367</td>
<td>$1,559</td>
</tr>
<tr>
<td><strong>TCO $'s/Mile</strong></td>
<td>$2.24</td>
<td>$2.65</td>
<td>$2.73</td>
<td>$3.12</td>
</tr>
</tbody>
</table>

**Note:** est. over 12 year lifetime / $ in thousands, except TCO $'s/mile

- **Battery-electric vehicles** have the **lowest operational lifecycle** cost:
  - High EV energy efficiency, low electricity rates, and high annual vehicle mileage combine to create significant fuel savings
  - **30% fewer parts** dramatically reduce maintenance and operating costs
  - Electricity prices far more stable and predictable than volatile fossil fuel prices

### 12-yr Operational Savings per Bus

- **$462k vs. Diesel**
- **$467k vs. CNG**
- **$479k vs. Hybrid**
THE TRANSIT MARKET IS RAPIDLY SHIFTING TO EV

- Moving toward widespread industry adoption
- Purchase barriers eliminated due to:
  - Improved range
  - Charging standardization
  - Sharp decline in battery costs
  - Service-proven performance

Battery Electric Buses: North American Annual Sales and Deliveries

- >140 Agencies
- >1200 cumulative awards/sales
- >340 cumulative deliveries/in service

10% share of total transit

Source: CTE Center for Transportation and the Environment
Advanced battery technology cost has declined to the point of replacing fossil fuels in the transit market.

Sources: Navigant Research, green.autoblog.com, Electric Drive Transportation Association. xEV = PHEV, HEV, EREV and BEV.
### Annual Diesel Health Impacts in the US

(Numbers of cases in 2010)

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premature Deaths</td>
<td>21,000</td>
</tr>
<tr>
<td>Lung Cancer Deaths</td>
<td>3,000</td>
</tr>
<tr>
<td>Hospital Admissions</td>
<td>15,000</td>
</tr>
<tr>
<td>Emergency Room Visits for Asthma</td>
<td>15,000</td>
</tr>
<tr>
<td>Non-fatal Heart Attacks</td>
<td>27,000</td>
</tr>
<tr>
<td>Asthma Attacks</td>
<td>410,000</td>
</tr>
<tr>
<td>Chronic Bronchitis</td>
<td>12,000</td>
</tr>
<tr>
<td>Work Loss Days</td>
<td>2,400,000</td>
</tr>
<tr>
<td>Restricted Activity Days</td>
<td>14,000,000</td>
</tr>
</tbody>
</table>

**THE HEALTH COSTS OF FOSSIL FUELS**
TRANSIT ELECTRIFICATION POLICY DEVELOPMENTS

• New York’s Truck Voucher Incentive Program offers $150k per Proterra bus

• FAST Act: LowNo grants increased >100% to $55M annually; introduction of innovative procurement methods and leasing options

• Maryland Freedom Fleet Voucher program offers $20k per heavy duty vehicle; BG&E used to purchase 2 Proterra buses

• LA Metro Board passed resolution to convert its entire bus fleet to all-electric by 2030; LA DOT also moving to 100% zero emission by 2030

• Colorado now funds up to $35k per vehicle for Class 8 vehicles

• Stockton, CA announced the nation’s first all-electric bus rapid transit (BRT) route

• Indianapolis E-Bus Rapid Transit plans electrification of its biggest and most traveled corridor

• Chicago’s Drive Clean Truck Voucher Program offers $150k per Proterra bus

• King County announced the purchase of 120 electric buses by 2020
Through the Volkswagen Settlement, VW agreed to invest $2.925 billion nationwide under Appendix D - the Environmental Mitigation Trust, to reduce NOx emissions.

$720 million is allocated to the states from Maine to Virginia. Through the development of Beneficiary Mitigation Plans, these states have allocated approximately $120 million to electrify transit and school buses to date.

States investing heavily in electric buses include:
- Vermont - $5.7 million for transit and school bus electrification
- Massachusetts - $11 million for transit bus electrification (draft BMP)
- Rhode Island - $10 million for transit bus electrification
- Connecticut - $6.2 million for transit and school bus electrification
- New York - $52.4M for transit, school, and shuttle bus electrification
- Maryland - $16 million for transit and school bus electrification (draft BMP)
- Washington D.C. - $5 million for transit bus and truck electrification
- Virginia - $14 million for transit bus electrification

Furthermore, ZEV transit and school buses are also eligible for up to $131 million in additional funding through open, vehicle and fuel neutral programs across these states.
PROTERRA CATALYST® E2 MAX SETS WORLD RECORD AND DRIVES 1,101.2 MILES ON A SINGLE CHARGE

*Depending on model. Nominal range = total energy/ projected Altoona efficiency. Actual range will vary with route conditions, battery configuration and driver behavior.
Why Beneficial?

- Potential to drive down average rates through infrastructure investment in high utilization projects
- Opportunity to strengthen utility service through a smarter grid
- Optimize the load profile on the grid through smart charging and using vehicles as distributed storage devices
- More load on the grid will potentially lead to lower electricity rates or the stabilization of such rates. EVs lead to increased throughput on utility distribution assets and more balanced loads in the generation market.
- Utilities can demonstrate their support for improving air quality and local health benefits, particularly in disadvantaged communities

What Can Utilities Do?

- Customers are confused and unsure about large scale charging solutions; easing the customer experience through utility support can facilitate vehicle adoption
- Establish a transportation electrification group
- Support electrification efforts with lower TOU rates for charging and addressing demand charges
- Rate basing infrastructure build-out
- E.g. PECO developed model legislation that facilitates rate based long-term clean transportation infrastructure & time of use rates for the state of PA (HB 1446)
- Utilities can identify steps in interconnection and local permitting processes that can be streamlined and made more uniform
Proterra works closely with customer to recommend the appropriate charging solution for fleets and facilities planning for scale as the demand for charging increases.

Proterra technologies enable:
- Efficient charge speed
- Dynamic power sharing
- Driver-friendly stations
- Cost-effective operations
- Universal compatibility
- Serviceability
- Low maintenance costs
- High availability

Our experts provide counsel on:
- Site layout
- Energy management
- Real-time energy monitoring
- Site configurations
Proterra Introduces the DuoPower™ Drivetrain for its Catalyst® Zero-Emission Buses at APTA

New drivetrain delivers nearly twice the horsepower and acceleration of a standard combustion engine and 500 percent improvement in efficiency.

Proterra, Van Hool Venture to Build Electric Motor Coaches

Daimler invests in electric bus company Proterra; exploring electrification of Daimler's Thomas Built school buses

Edmonton transit orders 25 Proterra buses

Proterra Gives Fleet Operators More Reasons To Go Electric With New Line Of Charging Stations

Global Double Deck Bus Market Leader, Alexander Dennis, Selects Proterra to Power North America's First Electric Double Deck Transit Bus

Proterra Inks Electric Bus Deal for Toronto Transit

Emphasizing Connectivity at Scale, Proterra Introduces the APEX™ Vehicle Intelligence System for Heavy-Duty Transit Fleets
Connecticut Zero Emission Bus Project Update

Incorporating Cleaner, More Efficient Propulsion Systems, into Connecticut’s Fixed Route Fleet

Northeast Regional Transportation Electrification Workshop
Hartford, Connecticut
November 29-30, 2018
Project Background

• Partnership with CTDOT
• Deployment of 12 ZEBs in Transit Fleets, in Two Locations
• Three Applications for Low-No Funding from FTA
• Third Application Successful (Scaled Down)
• $1.4 Million for Charging Infrastructure, Project Management and Workforce Development
• Supplemented with FTA 5307 Formula Funding for Vehicles
Fleet Considerations

- 12 Years of Service
- Continuous Operation
- 20% Spare Ratio
- Service at Night
- 16 Hours of Service Daily
- Buy America Requirements
- Altoona Tested
The Project Team

• The Connecticut Department of Transportation (CTDOT)
• Greater Bridgeport Transit (GBT)
• The Center for Transportation and the Environment (CTE) - Atlanta, Georgia
• Wendel (Architects) A/E Design for Charging Stations - Buffalo, New York
• Proterra, - Greenville, South Carolina
Multiple Areas of Evaluation Underway

- Route Modeling
- Specification Development
- Charging Infrastructure and Strategy
- Facility Improvements
- Rate Modeling
- Workforce Development
Load Cases and Assumptions – ProDrive

<table>
<thead>
<tr>
<th>Battery (kWh)</th>
<th>Load Case</th>
<th>Occupants (@ 150 lb)</th>
<th>Total Weight (lb)</th>
<th>Hotel Load (kW)</th>
<th>HVAC Load (kW)</th>
<th>Total Aux Load (kW)</th>
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<tr>
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<td>Nominal</td>
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<td>32,900</td>
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<td>42 + operator</td>
<td>36,350</td>
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<td>43,650</td>
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<td>43,650</td>
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</table>

* GVWR load case not simulated.

- Vehicle weight, hotel loads, traction motor/inverter, traction battery final drive, chassis, and tires and traction battery modeled based on data provided by Proterra.
- HVAC electrical loads provided by Proterra.
- Occupant weight based on FTA standard of 150 lbs per person.
Route 15
Routes 22x & 23 – Block 150 – DuoPower 440 kWh

DuoPower 440 kWh Endurance - Block 150
Routes 22x & 23

Service Energy Remaining (kWh)

2:28 PM   2:40 PM   3:22 PM   4:22 PM   5:22 PM   6:12 PM   7:07 PM   7:23 PM   7:26 PM

New Battery  Old Battery
## Block Analysis – New Battery/Strenuous

<table>
<thead>
<tr>
<th>Block</th>
<th>Route(s)</th>
<th>ProDrive</th>
<th>DuoPower</th>
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<td>138</td>
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<tr>
<td>705</td>
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<td>Y</td>
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</tbody>
</table>
## Block Analysis – Old Battery/Strenuous

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Range by Route – ProDrive 440 kWh (mi)

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<tr>
<th>Load Case</th>
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<th>Old Battery</th>
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<td>Coastal Link</td>
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<td>107</td>
<td>137</td>
<td>130</td>
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<tr>
<td>Routes 6 &amp; 3</td>
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<td>121</td>
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<td>Route 8</td>
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<td>Route 15</td>
<td>163</td>
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<td>130</td>
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<tr>
<td>Route 22x</td>
<td>154</td>
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<tr>
<td>Route 23</td>
<td>156</td>
<td>110</td>
<td>124</td>
<td>88</td>
</tr>
</tbody>
</table>
Vehicle Specifications - The Proterra Catalyst E2

• Specifications for 35’ and 40’
• 90% Complete
• Outside Review
• Configuration – Partially Complete
• Specification Prepared for Use in other State Procurements
Charging Infrastructure

Buy-America Plug-In Chargers

ChargePoint (Managed)
- CPE Depot
  - Up to 156 kW shared between up to 16 dispensers

ABB: 150 kW
- Sequenced between up to 3 dispensers

Heliox: 50-100+ kW
- Separate dispenser option available

CPE 250
- 62.5 kW
- Or
- Up to 125 kW shared between two CPE 250s

Siemens: 30-150 kW

Proterra: 60 or 125 kW
Facility Improvements
Annual Fuel Cost (Simultaneous Charging)

- Diesel costs are based on the 5 year average ($2.72/gal)
- Based on 80% of operating time (24.33 days / month)
Annual Fuel Cost (Staggered Charging)

- Diesel costs are based on the 5 year average ($2.72/gal)
- Based on 80% of operating time (24.33 days / month)
December 12th - From Planning to Implementation

- Route Modeling Completes
- Specification Package Completes
- Rate Analysis Completes
- Charging Infrastructure Decision Completes
- Conceptual Design Completes
- All Opinions of Probable Costs Complete
- Project Implementation
Connecticut Zero Emission Bus Project Update

Incorporating Cleaner, More Efficient Propulsion Systems, into Connecticut’s Fixed Route Fleet

Doug Holcomb, AICP
dholcomb@gogbt.com
(203) 366-7070 Ext. 124
Electrifying State Light-Duty Fleets and Transit

Moderator: Jim Redeker, Commissioner, Connecticut Department of Transportation

Speakers:

Harmony Wilder, Fleet Manager, State of Vermont

Eric J. McCarthy, Senior Vice President, Government Relations, Public Policy and Legal Affairs, Proterra

Doug Holcomb, Greater Bridgeport Transit

#WeTheStates
Supporting e-Mobility

Speaker:
Emily Warren, Senior Director of Policy and Public Affairs, Lime
Charging Infrastructure: What, Where, and How Many?

Moderator: Chris Nelder, Manager, EV-Grid Integration, Rocky Mountain Institute

Speakers:

David Althoff, Jr., Director, Energy Program Office, Pennsylvania Department of Environmental Protection

Patricia Bouch Readinger, Manager, Federal Government Affairs & Public Policy, Electrify America

Noah Garcia, Transportation Policy Analyst, Natural Resources Defense Council
EV Charging Infrastructure
Pennsylvania

NGA NE Regional Transportation Electrification Workshop
David Althoff Jr. – PA DEP
November 29, 2018
Sparse Public Charging Availability

• PA has over 391 publicly available charging stations, and a total of 892 “plugs” at those locations.

• NREL study projects that PA would need on the order of 13,600 workplace chargers, 9,200 public chargers, and 810 DC Fast Chargers by 2030 to reach about a 20% EV market share.

• Pennsylvania EV Roadmap – High penetration
  • PA has 1.4 million EVs on the road by 2033, and 30% of light duty sales would be EVs
  • Currently < 20,000 EVs

• Pennsylvania has a significant need to invest in workplace and public charging to reach any expansion/sales/benefit goals.
Incentives

• Drive PA Forward ($17.7 Million)
  • $3,000,000 available for Level 2 EV charging projects located at:
    • Public spaces; Work places; Multi-unit dwellings
  • $3,000,000 available for publicly accessible DC Fast and DC Fast combined with Level II located at:
    • Transportation corridors, Community hubs, Destination locations

• Alterative Fuels Incentive Grant
  • $5 million available each year for alternative energy transportation grants
    • 2018 AFIG Grant
    • Alternative Fuel Vehicle Rebate
    • 2018 AFIG FAST Act Corridor Infrastructure Grant
      • Refueling infrastructure priority given to PA Interstate Highway corridors
        • Not yet Designated I-70, I-78, I-81, I-83, I-84, I-99, and I-180
• The Alternative Fuel Vehicle Rebate Program
  • Provides rebates to Commonwealth residents to assist individuals with the costs of purchasing an alternative fuel vehicle.
  • $8 Million Since 2011
  • $967,500 for 706 EV Rebates issued since January, 2018.
    • 657 new vehicle rebates
    • 48 used vehicle rebates
    • 1 leased vehicle rebate
Awareness/Cooperation/Confidence

Problems

- Low Consumer Awareness
- Limited EV Options
- Lack of Success Stories

Solutions

- Establish Goals
  - Meet them/Celebrate them
- Dealerships.... Outreach (Utilities?)
  - Deliver support/technical assistance - they sell these vehicles!
- Signs, Signs, Everywhere Signs!
  - ...and Marketing.
- EV Ready Regional Planning
  - Practical solutions from both outside your state and inside.
Questions?

David Althoff Jr.
717-783-0542
dalthoff@pa.gov
Northeast Regional Transportation Electrification Workshop
National Governors Association; Hartford, CT
November 29, 2018
Our transformational opportunity: the largest single investment ever made in infrastructure, education and awareness, and access to drive ZEV adoption

**Our Mission**

Electrify America will be a catalyst for promoting ZEV adoption by offering transformative, customer-centric infrastructure and energy management solutions.

**Our Company**

Electrify America is a subsidiary of Volkswagen Group of America created to implement the $2 billion ZEV Investment Commitment. We have recruited talent from across diverse industries.

**Our Approach**

Electrify America is a data-driven company committed to increasing the use of ZEV technology.
Cycle 1 investment will create a robust DC charging network linking U.S. highways and major metropolitan areas

- 42 states
- 17 large metros
- 86 metros*
- 484 stations
- 2000+ DCFC
- 2800+ Level 2s

Station spacing:
- Average: 70 miles*
- Maximum: 120 miles

Chargers per site:
- Average: 5
- Minimum: 4 Maximum: 10

Charging speed:
- 3 to 20 miles per minute

* Highway sites in MSAs with more than 500,000 population

*48 miles in California
States and cities can create policy environments to encourage ZEV adoption and investment

- Sending Long-Term Signal to Market
- Reducing PEV Operational Costs
- Improving Economic Viability of EVSE
- Improving PEV and EVSE Planning
- Reducing Upfront Costs
- Increasing Awareness and Education

Analysis by NASEO and Cadmus found sending a long-term signal to the market and reducing upfront costs were the most powerful policy tools to drive ZEV adoption.

![PEV Policy Evaluation Rubric](https://naseo.org/Data/Sites/1/pevpolicyrubricmethodology_naseo.pdf)
Challenges to investment persist

1. **Permitting Delays**
   
   Current construction bottlenecks in many areas of the country, especially California, are due to lengthy permitting durations.

2. **Lack of ZEV Vehicles and Users**
   
   The higher purchase cost associated with a ZEV vs. an ICE vehicle remains a barrier to wider ZEV adoption.

3. **Need for Education & Awareness Efforts**
   
   Focused investment to raise consumer education and awareness is needed by all sectors to educate and encourage ZEV adoption.

4. **ZEV Consideration Remains Low**
   
   The higher purchase cost associated with a ZEV vs. an ICE vehicle remains a barrier to wider ZEV adoption.

   ![Graph showing ZEV Consideration](image-url)
Thank you!

Questions? Patricia.Readinger@electrifyamerica.com
Charging Infrastructure: What, Where, and How Many?

Noah Garcia
Natural Resources Defense Council
November 29, 2018
There's a (Big) Gap: EVI-Pro Lite
Utilities are Critical Partners

- The California Experience

- Approved programs: Massachusetts, Rhode Island, New York

- Pending programs: New Jersey, Pennsylvania, Delaware, Maryland, D.C.

- Transportation Electrification Accord
Steel-in-the-Ground: Necessary but Not Sufficient

- Interoperability
- Smart rate design
- Equity
- Future-proofing
- Reliability
- Signage
Thank You

ngarcia@nrdc.org
Charging Infrastructure: What, Where, and How Many?

Moderator: Chris Nelder, Manager, EV-Grid Integration, Rocky Mountain Institute

Speakers:

David Althoff, Jr., Director, Energy Program Office, Pennsylvania Department of Environmental Protection

Patricia Bouch Readinger, Manager, Federal Government Affairs & Public Policy, Electrify America

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Electrification for All

Moderator: **Elin Swanson Katz**, President of NASUCA, Connecticut Consumer Advocate

Speakers:

**Jenifer Bosco**, Staff Attorney, National Consumer Law Center

**Jennifer Wallace-Brodeur**, Director of Transportation Efficiency, Vermont Energy Investment Corporation

#WeTheStates
Affordability is crucial

One in three U.S. households faces a challenge in meeting energy needs

People in Households Without a Vehicle, by Income (2016)

Electrification for All

Moderator: **Elin Swanson Katz**, President of NASUCA, Connecticut Consumer Advocate

Speakers:

**Jenifer Bosco**, Staff Attorney, National Consumer Law Center

**Jennifer Wallace-Brodeur**, Director of Transportation Efficiency, Vermont Energy Investment Corporation
VT Transportation Expenditures: Impact on Household Budgets
VEIC is a sustainable energy organization with a mission to enhance the economic, environmental, and societal benefits of clean and efficient energy use for all people. We design, deliver, and evaluate programs throughout the United States and conduct special projects in several international locations. We specialize in advancing energy efficiency, transportation efficiency, and renewable energy, and we are committed to finding solutions that reduce the energy burdens of low-income people.
Nissan Dealership Locations

All Dealers within ~100 miles of White River Jct, VT

LEAF Certified Dealers
Nissan Dealership Locations

All Dealers within ~100 miles of White River Jct, VT

LEAF Certified Dealers
Electrification for All

Moderator: Elin Swanson Katz, President of NASUCA, Connecticut Consumer Advocate

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Jenifer Bosco, Staff Attorney, National Consumer Law Center

Jennifer Wallace-Brodeur, Director of Transportation Efficiency, Vermont Energy Investment Corporation

#WeTheStates
State Team Time

#WeTheStates
Scooter Test Rides

Lime Scooter test rides will be offered tomorrow afternoon following the final session.
State Team Report Out
Who Owns, Operates, and Pays for the Infrastructure?

Moderator: Nick Nigro, Founder, Atlas Public Policy
Speakers:
Paul Allen, Senior Vice President, M.J. Bradley & Associates
Kevin Boughan, Manager, Business Development & Research, Eversource Energy
Colleen Turner, Assistant Director, Office of Planning & Capital Programming, Maryland Department of Transportation
Managing the Grid

Moderator: Nancy Seidman, Senior Advisor, Regulatory Assistance Project

Speakers:

Nancy Ryan, Partner, Energy and Environmental Economics
Tony Markel, Senior Engineer, National Renewable Energy Laboratory
Tim Roughan, Director of Energy and Environmental Policy, National Grid
Katie Dykes, Chair, Connecticut Public Utilities Regulatory Authority

#WeTheStates
Regional Electrification Coordination

Speakers:

Matthew Goetz, Electric Vehicle Program Manager, Georgetown Climate Center
Elaine O’Grady, Policy & Program Director, Northeast States for Coordinated Air Use Management

#WeTheStates
Regional and Multi-state Planning for Transportation Electrification

NGA Northeast Regional Transportation Electrification Workshop

November 2018

Matthew Goetz
Electric Vehicle Program Manager
Georgetown Climate Center
Georgetown Climate Center:
A Resource for State and Federal Climate Policy

• Launched in 2009 as a resource to states
• Works at the nexus of federal-state policies
• Supports states and other stakeholders through research, facilitation and convening
Multi-state Collaboration to Accelerate Transportation Electrification

MEMORANDUM OF UNDERSTANDING
Between
Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah and Wyoming
Regional Electric Vehicle Plan for the West

MULTI-STATE ZEV TASK FORCE

WEST COAST ELECTRIC HIGHWAY

3.3 MILLION ZERO-EMISSION VEHICLES
BY 2025

UNITED STATES CLIMATE ALLIANCE

TRANSPORTATION & CLIMATE INITIATIVE
Of the Northeast and Mid-Atlantic States

GEORGETOWN CLIMATE CENTER
A Leading Resource for State and Federal Policy
Benefits of Regional Coordination on Electric Vehicles and EV Charging

- Close geographic and economic connections
- Interconnected highway and transit networks
- Important to create consistent experience for drivers and businesses
- Can create efficient build-out of EV charging network
Opportunities for Regional Coordination

- Incentives for vehicles and charging stations
- Public fleet electrification
- Interstate corridor planning
- Charging station industry requirements and consumer experience
- Consumer outreach & education
Incentives for Drivers, Businesses, and Fleets

Opportunities for regional coordination?

• Private fleet incentives

• HOV access

• Workplace charging for regional businesses

• Collaboration on pre-owned EV incentive design
Public Fleet Procurement Coordination

- Multi-state EV procurements demonstrate interest and expand availability
- Climate Mayors EV Purchasing Collaborative launched in 2018
- Regional coordination on transit fleet electrification

Image credit (Climate Mayors EV Purchasing Collaborative): https://driveevfleets.org/
Image credit (transit bus): CurbedNY.com
Multi-state Collaboration on Regional EV Corridor Planning
- 12 Northeast and mid-Atlantic states and D.C.
- State energy, environment, and transportation agencies
- Clean vehicles & fuels, regional emissions transportation policies, sustainable communities, freight, and resilience
Regional Coordination on Electric Vehicle Charging Infrastructure
Transportation and Climate Initiative
Regional EV Corridor Planning & Analysis

• Share best practices and technical expertise

• Engage with other jurisdictions and key stakeholders

• Analysis to inform EV Fast Charging infrastructure planning
Existing Public Fast Charging Along Corridors
TCI Corridor Analysis Sample Results

Highway exits ranked using “Fill Gaps” method of assessment

https://www.georgetownclimate.org/transportation/development-ev-corridors.html
TCI EV Corridor Analysis Results for “Fill Gaps” Method

Highway exits ranked using “Fill Gaps” method of assessment

https://www.georgetownclimate.org/transportation-development-ev-corridors.html
TCI EV Corridor Analysis Results for “Fill Gaps” Method
Transportation and Climate Initiative
Regional Policies Development

• Analysis and convenings to inform
development of potential regional policies

• In 2018, held public listening sessions to
discuss opportunities and challenges of a
low-carbon transportation system:
  – Albany, NY (April 9)
  – Hartford, CT (May 21)
  – Wilmington, DE (June 6)
  – New York, NY (July 24)
  – Largo, MD (August 27)
Questions and Discussion

Matthew Goetz
Electric Vehicle Program Manager
Georgetown Climate Center
goetz@georgetown.edu

www.georgetownclimate.org
Appendix: TCI Regional EV Corridor
Analysis Metrics

Traffic Volume (AADT)

Population Density (census tract)
Appendix: TCI EV Corridor Analysis Results for “Fill Gaps” Method

Highway exits ranked using “Fill Gaps” method of assessment

https://www.georgetownclimate.org/transportation/development-ev-corridors.html
Appendix: TCI Corridor Analysis Results for “Through Traffic” Method

Highway exits ranked using “Through Traffic” method of assessment

- High Suitability/Rank
- Medium Suitability/Rank
- Low Suitability/Rank
Objective

Northeast Corridor EV Charging Infrastructure Strategy

Provide guidance and direction to public and private investments to ensure they are coordinated, well-informed and complementary in order to build out a robust and reliable charging network that will meet the region’s emerging needs.
Coordinating Infrastructure Investments

While other investments by utilities, OEMs, EVSE providers, and businesses and workplaces are expected (and will be needed to meet state and regional goals), there are three major sources of known funding:

**APPENDIX D FUNDS**

Under the Volkswagen settlement, the Northeast Corridor States may invest up to $108 million on ZEV charging and hydrogen fueling infrastructure.

**Electrify America**

Pursuant to the Volkswagen settlement, Electrify America is investing $2 billion to promote ZEVs, which will include substantial infrastructure investments in the Northeast Corridor.

**UTILITY PROPOSALS**

Utilities in the region are starting to invest in transportation electrification, with proposals in DE, DC, MD, MA, NJ, NY and RI, representing an investment of roughly $750 million.
Why Develop a REGIONAL Strategy?
Public and private investors should work together to:

- Inspire drivers to choose ZEVs through effective education, outreach, and exposure to ZEVs;
- Make workplace and public charging the norm;
- Provide viable charging options for residents in MUDs and single family homes without access to off-street parking; and
- Install ZEV charging and fueling infrastructure in high density areas and along travel corridors.

**Common Vision**

**Manageable Scope**

- Plug-in Electric Vehicles
- Light Duty
- 2018-2021 Timeframe
Northeast Corridor Steering Committee identified overarching issues, key investors and their roles, and priorities for different charging use cases.

<table>
<thead>
<tr>
<th>CHARGING USE CASES</th>
<th>KEY INVESTORS</th>
<th>OVERARCHING ISSUES</th>
</tr>
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<tbody>
<tr>
<td>• Home</td>
<td>• State and local governments</td>
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<tr>
<td>• Workplace</td>
<td>• EVSE Providers</td>
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<tr>
<td>• Around Town</td>
<td>• Utilities</td>
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</tr>
<tr>
<td>• On the Road</td>
<td>• Automakers</td>
<td></td>
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Charging Use Case Priorities

**Home:** Lower cost of installing and using EVSE at home, especially at MUDs

**Work:** Incentivize EVSE at workplaces, conduct outreach, and recognize business leaders

**Around Town:** Deploy EVSE at airports, train stations, strategically located charging hubs, and highly visible sites with longer dwell times

**On the Road:** Expand DCFC network along interstate and state highway corridors

**Destinations:** Deploy EVSE at key destinations such as beaches, mountain resorts, state parks, historic sites, etc.
Examples of Key Roles

**States:** Policies to address overarching issues; workplace charging incentives; L2 in highly visible places around town and at destinations

**Electrify America/EVSE providers:** DCFC for long distance charging, strategically placed community charging hubs, and at airports and train stations (for TNCs)

**Utilities:** Lower cost of charging at home, especially MUDs, and help deploy DCFC (at a minimum siting and make-ready)
Northeast Corridor Regional Strategy
for Electric Vehicle Charging Infrastructure
2018 – 2021

The regional strategy is available at:

For questions, please contact:
Elaine O’Grady at eogrady@nescaum.org
Regional Electrification Coordination

Speakers:

Matthew Goetz, Electric Vehicle Program Manager, Georgetown Climate Center
Elaine O’Grady, Policy & Program Director, Northeast States for Coordinated Air Use Management
Brainstorm Activity: Regional Approaches

Rooms
Working Lunch: Reconvene and Regional Report Out

Moderator: Patricio Portillo, Policy Analyst, NGA

#WeTheStates
Scooters will be available for test rides outside the hotel on Haynes Street
Sue Gander, Division Director, NGA

Wrap Up

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