Panelists:

**Pete Slowik**, Associate Researcher, International Council on Clean Transportation

**Peter Dempster**, Strategy and Market Development Lead, ReachNow

**Kelly Rula**, New Mobility, Climate, and Urban Freight, Seattle Department of Transportation

**Clement Rames**, Sustainable Mobility Systems Research Engineer, National Renewable Energy Laboratory

Moderator:

**Jon Isaacs**, Public Affairs Manager, Uber
Global electric vehicle sales

- Through 2017, cumulative global light-duty EV sales passed 3.2 million
  - Mostly the sales are in China, U.S., and Europe
  - These regions have a complex system of regulation, incentives, charging, local action

Leading global areas of electric vehicle adoption

- These 20 areas account for 40% of global electric vehicle sales
  - These areas represent just 3% of the world population and 8% of global vehicle sales
  - The areas have combination of national, state, city, and utility policies and actions
  - But are many of these in ride-hailing (e.g., Uber) and carsharing (e.g., car2go) fleets?

Based on total electric vehicles sales through 2016
Some shared fleets are starting to go electric

<table>
<thead>
<tr>
<th>Country</th>
<th>Taxis</th>
<th>Carsharing</th>
<th>Ride-hailing</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>Hangzhou, Shenzhen, Taiyuan, Tianjin</td>
<td>Beijing, Hanzhou, Shanghai</td>
<td>Beijing, Guangzhou, Hangzhou, Shanghai</td>
</tr>
<tr>
<td>France</td>
<td>Paris</td>
<td>Avignon, Bordeaux, Chamonix, Grenoble, Liège, Lille, Lyon, Lyon, Marseille, Paris</td>
<td>Paris</td>
</tr>
<tr>
<td>Germany</td>
<td>Berlin</td>
<td>Berlin, Stuttgart</td>
<td></td>
</tr>
<tr>
<td>United Kingdom</td>
<td>London</td>
<td>London</td>
<td>London</td>
</tr>
<tr>
<td>Netherlands</td>
<td>Amsterdam, Utrecht</td>
<td>Amsterdam, the Hague, Rotterdam, Utrecht</td>
<td>Amsterdam</td>
</tr>
<tr>
<td>Canada</td>
<td>Montréal, Kelowna, Port Elgin</td>
<td>Montréal, Toronto</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>Bogota, Brussels, Madrid, Rome, San Jose, Singapore</td>
<td>Brussels, Christchurch, Copenhagen, Dublin, Florence, Kuala Lumpur, Lisbon, Madrid, Milan, Oslo, Singapore</td>
<td>Bucharest, Lisbon, Singapore</td>
</tr>
</tbody>
</table>
Overcoming barriers for shared electric fleets

<table>
<thead>
<tr>
<th>Barrier</th>
<th>Electric vehicle barrier for private cars</th>
<th>Is electric vehicle adoption less or more difficult for shared fleets?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>• Higher cost</td>
<td>+ Bulk procurement, slightly lower cost</td>
</tr>
<tr>
<td></td>
<td>• Lower operating cost</td>
<td>+ Low operating cost (fueling, maintenance)</td>
</tr>
<tr>
<td></td>
<td>• Long payback period</td>
<td>+ Much higher annual driving, shorter payback</td>
</tr>
<tr>
<td>Charging convenience</td>
<td>• Mostly at home</td>
<td>- Charging time can mean downtime and lost revenue</td>
</tr>
<tr>
<td></td>
<td>• Some workplace</td>
<td>- Much more dependent on public charging</td>
</tr>
<tr>
<td></td>
<td>• Some public</td>
<td>- More rapid charging in denser urban settings</td>
</tr>
<tr>
<td>Consumer awareness</td>
<td>• Limited understanding of electric models, charging options, benefits</td>
<td>+ Companies can give car purchasing/leasing guidance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+ Allows vehicle electrification incrementally by the mile (i.e., without an electric car purchase)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+ For passengers in shared vehicles, it’s an awareness campaign</td>
</tr>
</tbody>
</table>
What policy actions can encourage shared and electric?

- **Parking, charging, permitting**
  - Dedicated EV parking/charging
  - Streamlined permitting for charging
  - Electric vehicle-ready building codes
  - Mandated shares of EV parking

- **Broader local activities**
  - City-utility-transport company provider voluntary agreements
  - Curb space
  - Low emission zones/lanes
  - Utility preferential electricity rates
More info

U.S. metropolitan area electric vehicle analysis:
https://www.theicct.org/publications/expanding-electric-vehicle-market-us-cities

World electric vehicle capitals:

New mobility: Today’s technology and policy landscape

Acknowledgements

Analysis by Pete Slowik, Dale Hall, Hongyang Cui, Nikita Pavlenko, Nic Lutsey
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Peter Dempster slides
Seattle’s Playbook for Electric and Shared Mobility
Seattle Loves Cars....

Seattle tops cities in per-capita car ownership

Among the 10 most densely populated big U.S. cities, Seattle has the most motor vehicles per person.

1. Seattle: **637 cars per 1,000 people**
2. Long Beach: **583**
3. Los Angeles: **549**
4. Miami: **465**
5. San Francisco: **444**
6. Chicago: **431**
7. Philadelphia: **384**
8. Washington, D.C.: **375**
9. Boston: **367**
10. New York City: **233**

*Includes owned or leased passenger cars, vans and pickup trucks that are kept at home and available for use by household members. Vehicles used exclusively for business, or not in working order, are excluded.*

Source: U.S. Census, 2015

AMANDA E. WELCH / THE SEATTLE TIMES
Rise of TNCs

June 19, 2018
Seattle Department of Transportation
Transportation pollution

- Seattle has a goal to become a carbon neutral city by 2050 - over two-thirds of our carbon footprint comes from transportation-related pollution.

- Seattle City Light – our municipal electric utility – has provided carbon neutral electricity since 2005.
What is SDOT doing now?

- Published a New Mobility Playbook
- Launching and learning from curbspace pilots
- Electrifying shared mobility hubs
- Encouraging investment in Electric Vehicle Chargers in the Public Right-of-Way (EVCROW)

—and-

- Creating an EVSE siting model with regional stakeholders

June 19, 2018
Seattle Department of Transportation
City of Seattle
SDOT’s Curbside Charging Pilot (EVCROW)

- Allows organizations to apply to install curbside chargers in the public right-of-way
- Goal: Dramatically increase the number of publicly-available EV chargers in the City of Seattle
DOE Grant: Electrifying Shared Mobility*

**Strategy:**
Increase EV charging access and awareness at or near Shared Mobility Hubs.

**Key Partners:**
ReachNow, Eluminocity, Seattle City Light, Western Washington Clean Cities Coalition

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**Strategy:**
Provide EVs and supporting charging infrastructure to ride-hailing vehicle fleets.

**Key Partners:**
EVgo, General Motors/Maven, NYC Mayor’s Office of Sustainability, NYC DOT, NYC Taxi & Limousine Commission

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**Strategy:**
Provide EVs directly to ride-hailing drivers and supply charging infrastructure.

**Key Partners:**
General Motors/Maven, EVgo, American Lung Association in Colorado

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**Strategy:**
Promote EV use to transportation network company (TNC) drivers coupled with access to free, unlimited charging.

**Key Partners:**
Uber, Portland General Electric, Brink

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*This material is based upon work supported by the U.S. Department of Energy’s Office of Energy Efficiency and Renewable Energy (EERE) under the Vehicle Technologies Office (VTO) Deployment Award Number DE-EE0008261.

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Thank you!

Kelly Rula
Kelly.rula@seattle.gov | (206) 549-7579

www.seattle.gov/transportation
Electrifying Shared Mobility: Insights from a Real-World Ride-Hailing Dataset

Clement Rames
EV Roadmap 11
June 19, 2018
RideAustin Dataset

Sample duration: 10 months
- Period: June 2016 to April 2017
- 4,961 unique drivers & vehicles
- 261,000 unique riders
- 1.49 million trips

Heatmap of RideAustin trip destinations
VMT Efficiency and Dead-Heading

- Dataset contains only origin/destination information for passenger trips
- Empty miles (driven without a passenger) are inferred using conservative assumptions for commuting and dead-heading
- Preliminary results appear consistent with other works

The Fine Print:
Dead-heading = distance from previous drop-off to next pick-up (includes over-heading)
Distance computed using haversine equation with correction factor of 1.419
Inferred driver’s ‘home’ location as 2D median of first pickup of every driving day
Added dead-heading trips and commutes to and from ‘home’ to each driving day
Driver Segmentation

- Segment drivers based on hours worked per week
- Majority of drivers are part-time, but only provide minority of rides
- Half- and full-time drivers provide majority of rides and are best candidate for electrification

<table>
<thead>
<tr>
<th>Part Time Drivers</th>
<th>Half Time Drivers</th>
<th>Full Time Drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 10 hours/week</td>
<td>10-35 hours/week</td>
<td>More than 35 hours/week</td>
</tr>
<tr>
<td>49% of drivers</td>
<td>40% of drivers</td>
<td>11% of drivers</td>
</tr>
<tr>
<td>14% of rides</td>
<td>57% of rides</td>
<td>29% of rides</td>
</tr>
<tr>
<td>Annualized VMT = 7k mi</td>
<td>Annualized VMT = 13k mi</td>
<td>Annualized VMT = 29k mi</td>
</tr>
</tbody>
</table>

High mileage motivates vehicle electrification
(if EVs have enough range!)
Shift Length and Electrification Potential

- Trips are grouped by vehicle into shifts (segmented by > 8 hours inactivity)
- 60% of shifts worked by full time TNC drivers are under 100 mi. (left, blue)
- ~2/3 of full time drivers never exceed 250 mi. in a given shift (left, orange)
- Full time TNC drivers cover much longer daily distances than personal vehicles from the 2009 National Household Travel Survey (NHTS)
This presentation and the work described were sponsored by the U.S. Department of Energy (DOE) Vehicle Technologies Office (VTO) under the Systems and Modeling for Accelerated Research in Transportation (SMART) Mobility Laboratory Consortium, an initiative of the Energy Efficient Mobility Systems (EEMS) Program. The authors acknowledge John Smart of Idaho National Laboratory for leading the Alternative Fueling Infrastructure Pillar of the SMART Mobility Laboratory Consortium. The following DOE Office of Energy Efficiency and Renewable Energy (EERE) managers played important roles in establishing the project concept, advancing implementation, and providing ongoing guidance: David Anderson, Sarah Olexsak, and Rachael Nealer.

Thanks! Questions?
clement.rames@nrel.gov
Opportunity for electric and shared

- Ride-hailing cars driven *much* more → *more fuel savings* from electric
- Greater daily driving → need for *more public rapid charging*

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**Five-year cost of ownership**

<table>
<thead>
<tr>
<th></th>
<th>Conventional (32 mpg)</th>
<th>Hybrid (50 mpg)</th>
<th>Electric (180 mi, $0.20/kWh)</th>
<th>Electric (240 mi, $0.10/kWh)</th>
<th>Conventional (32 mpg)</th>
<th>Hybrid (50 mpg)</th>
<th>Electric (180 mi, $0.20/kWh)</th>
<th>Electric (240 mi, $0.10/kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Private car</strong></td>
<td>$20,000</td>
<td>$24,000</td>
<td>$32,000</td>
<td>$37,000</td>
<td>$20,000</td>
<td>$24,000</td>
<td>$32,000</td>
<td>$37,000</td>
</tr>
<tr>
<td><strong>Ride-hailing car</strong></td>
<td>$5,000</td>
<td>$3,000</td>
<td>$3,000</td>
<td>$1,000</td>
<td>$16,000</td>
<td>$10,000</td>
<td>$10,000</td>
<td>$4,000</td>
</tr>
</tbody>
</table>

*Preliminary ICCT results.*

**Assumptions:** Approximate 2018 vehicle prices, battery costs will continue dropping rapidly.
- 15k mi/yr private, 45k mi/yr ride-hailing; Maintenance (per mile): $0.06 gas, $0.04 hybrid, $0.025 electric
- Shorter EV electric range is more dependent upon higher-cost rapid charging; Gasoline: $2.75 per gallon
Charging Infrastructure Scenarios

- Driving/charging simulations conducted in EVI-Pro
  - Electric Vehicle Infrastructure Projection Tool
- All simulations utilize “full-time” driver data from RideAustin simulated as BEVs with varying driving range
  - Approximately 33,000 TNC driving days
  - Presumably drivers most concerned with operating costs
  - BEVs potentially provide greatest operating cost savings
- Three illustrative scenarios are developed conflating effects of technology development and TNC BEV market growth

<table>
<thead>
<tr>
<th>Variable</th>
<th>“Yesterday”</th>
<th>“Today”</th>
<th>“Tomorrow”</th>
</tr>
</thead>
<tbody>
<tr>
<td>TNC BEV Count</td>
<td>100</td>
<td>1,000</td>
<td>10,000</td>
</tr>
<tr>
<td>BEV Driving Range</td>
<td>100 mi</td>
<td>250 mi</td>
<td>400 mi</td>
</tr>
<tr>
<td>DCFC Power</td>
<td>50 kW</td>
<td>150 kW</td>
<td>400 kW</td>
</tr>
</tbody>
</table>
EVI-Pro Model Overview

Foundational Assumptions
- Future PEVs will be driven in a manner consistent with present day gasoline vehicles
- Consumers will prefer to perform the majority of charging at their home location
- Charging at work/public L2 and corridor/community DCFC stations will be used as necessary to maximize eVMT
Sample Results from EVI-Pro

**Weekday, 100% residential charging availability**

![Graph showing EV charging load for 100% residential availability.]

**Weekday, 53% residential charging availability**

![Graph showing EV charging load for 53% residential availability.]

**Weekday, 53% residential charging availability, no public level 2 availability**

![Graph showing EV charging load for 53% residential availability with no public level 2.]

**Weekend, 53% residential charging availability**

![Graph showing EV charging load for 53% residential availability during the weekend.]

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Additional GPS Taxi Datasets

Yellow Cab Columbus Taxis

NYC Taxis (via TLC)