Global electric vehicle market developments

Kate Blumberg and ICCT team

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I drive a battery electric vehicle (BEV)
But I still don’t have an electric car. Why?

Market barriers and some things being done to address them…

<table>
<thead>
<tr>
<th>Barrier</th>
<th>Issue</th>
<th>Addressing the barrier</th>
<th>Some examples</th>
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<tbody>
<tr>
<td>Model availability</td>
<td>• Limited volume for world markets</td>
<td>• Regulation</td>
<td>China, Europe, US (California)</td>
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<td></td>
<td>• Limited options across vehicle types</td>
<td>• Reduced import impediments</td>
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<td></td>
<td>• Limited inventory at dealerships</td>
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<tr>
<td>Cost</td>
<td>• Higher upfront cost</td>
<td>• Incentives (rebates, tax exemption, etc)</td>
<td>Norway, China (and many states and provinces)</td>
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<tr>
<td>Convenience</td>
<td>• Limited vehicle range</td>
<td>• Charging infrastructure (home, workplace, public)</td>
<td>Norway, Netherlands, California (and many states, cities, electric utilities)</td>
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<tr>
<td></td>
<td>• Availability of charging</td>
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<td></td>
<td>• Time for public charging</td>
<td></td>
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<tr>
<td>Consumer understanding</td>
<td>• Limited understanding of EVs</td>
<td>• National campaigns</td>
<td>California, Quebec, United Kingdom (and many electric utility/city/nonprofit actions)</td>
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<td></td>
<td>• Limited understanding of EV benefits</td>
<td>• Local awareness events</td>
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By mid 2017, cumulative global electric passenger vehicle sales passed 2.5 million

- Mostly the sales are in China, U.S., and Europe
- These markets have a complex system of regulation, incentives, charging, local action

http://www.theicct.org/blogs/staff/second-million-electric-vehicles. (Jan 31)
Efficiency standards provide a foundation for automaker technology investment, deployment.
California markets have 30+ EV models; most markets have less than 10
- California’s ZEV regulation requires EV uptake beyond the CO₂ standard
  - ZEV regulation increases electric vehicle model availability and automaker marketing; provides stable market signal for infrastructure investments, city policy, and utility actions
- China is developing its own EV quota system; Europe is considering quotas for EVs too

Electric vehicle public charging infrastructure

- Electric vehicle uptake is correlated with public charging infrastructure
  - Leading U.S. EV markets: 2-6 times more public charging per capita than average

See: http://www.theicct.org/leading-us-city-electric-vehicle-2017; 2016 vehicle registration data from IHS Automotive
**Innovative policies in world’s leading EV cities**

<table>
<thead>
<tr>
<th>Policy or program</th>
<th>Model city</th>
<th>Details</th>
<th>Other cities</th>
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<tbody>
<tr>
<td>City fleet goal</td>
<td>Los Angeles</td>
<td>Half of city fleet electric as of 2017</td>
<td>Oslo, Amsterdam, San Jose, New York, San Diego, Shenzhen</td>
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<td>Taxi electrification</td>
<td>Beijing</td>
<td>Replacing all 69,000 city taxis with NEVs through government subsidies</td>
<td>Taiyuan, London, Amsterdam, Hangzhou, Tianjin, Shenzhen</td>
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<tr>
<td>Electric car sharing program</td>
<td>Paris</td>
<td>Autolib’ program contains 4,000 cars and 6,000 charge points</td>
<td>Shanghai, Los Angeles, Amsterdam, London, Hangzhou</td>
</tr>
<tr>
<td>Public bus electrification</td>
<td>Shenzhen</td>
<td>All buses zero-emission by end of 2017</td>
<td>Qingdao, Tianjin, Hangzhou, Los Angeles, London</td>
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<tr>
<td>Free public charging</td>
<td>Oslo</td>
<td>Free charging with renewable energy at all Level 2 charge points</td>
<td>Stockholm</td>
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<tr>
<td>EV-friendly building and parking codes</td>
<td>London</td>
<td>1 in 5 parking spaces must have an EV charge point</td>
<td>San Francisco, Los Angeles, New York, Hangzhou, Shenzhen</td>
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<tr>
<td>Carpool or bus lane access</td>
<td>San Francisco</td>
<td>Electric vehicles may use carpool lanes and do not pay bridge tolls</td>
<td>Los Angeles, San Jose, Oslo, Bergen, San Diego</td>
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<tr>
<td>Vehicle registration benefits</td>
<td>Shanghai</td>
<td>NEVs bypass expensive license plate lottery system</td>
<td>Beijing, Shenzhen</td>
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<tr>
<td>Parking benefits</td>
<td>Amsterdam</td>
<td>Electric vehicles obtain free parking spot in city center</td>
<td>Shanghai, Utrecht, Oslo, San Jose</td>
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<tr>
<td>Local purchase incentives</td>
<td>Shenzhen</td>
<td>Local subsidies of $5000-$8000 per vehicle</td>
<td>Beijing, Shanghai, the Hague</td>
</tr>
<tr>
<td>Ultra low emission zones</td>
<td>London</td>
<td>All non-ZEVs will have to pay charge to enter the zone</td>
<td>London is the world’s first</td>
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Electric passenger vehicle costs are dropping

- Supplier competition, innovation, and volume → cost are dropping
  - Battery pack costs drop from $200-$300/kWh in 2016 to ~$150/kWh in 2020-2025
  - Short- (100 mi) and medium-range (150 mi) electric vehicles become cost competitive
  - Challenge: Sustain incentives, build infrastructure, educate consumers, regulate

Chart shown for U.S. From Slowik et al (2016). Evolution of incentives to sustain the transition to a global electric vehicle fleet: [http://www.theicct.org/evolution-incentives-electric-transition](http://www.theicct.org/evolution-incentives-electric-transition)
Range of electro-mobility options
GHG emissions of battery-electric buses depends on electricity sources

![Graph showing GHG emissions (gCO₂e/km) for different fuel sources and technologies, with Costa Rica highlighted.]
Total cost of ownership for BEV buses already lower than standard technology

- Total cost of ownership lower even at current BEV prices for large bus

Inputs for Bangkok, while the purchase price is higher, the total cost of ownership is lower than purchasing standard diesel buses.

Preliminary results are subject to change. Please do not cite or distribute.
Over 20 megacities, BEV offers lower direct costs and lowest social costs

Cumulative cost of ownership, without and with social costs, for buses purchased from 2018–2027

Preliminary results are subject to change. Please do not cite or distribute.
Reflections

- Electric vehicle technology prospects
  - More models across vehicle types by all automakers
  - Innovation, volume → lower cost and higher range EVs

- Electric passenger vehicle uptake so far offers clues for success
  - Regulation: Long-term CO₂ + EV regulations ensure industry investment
  - Incentives and tax exemptions: Address short-term (~5 year) market cost barrier
  - Charging infrastructure: Convenience, consumer confidence, education, low cost
  - Cities: Promote electric vehicles locally (fleet procurement, preferential access, ultralow emission zones)

- Electro-mobility is broader than cars
  - Buses: Total cost of ownership already competitive with traditional technologies
  - Lower cost individual transport options: smaller & lower range cars; motorcycles and scooters; bicycles, skateboards, etc; sharing
¡Gracias!

EV team: Nic Lutsey, Pete Slowik, Dale Hall, Mike Nicholas
Soot-free bus team: Ray Minjares, Tim Dallman, Josh Miller
Kate Blumberg
kate@theicct.org
+1-415-640-6352
Extra slides
These 20 markets account for 40% of global electric vehicle sales

- These areas represent just 3% of the world population and 8% of global vehicle sales
- The markets have combination of national, state, city, and utility policies and actions

**Leading global electric vehicle markets**
Leading markets tend to have more public charging, more available electric vehicle models, consumer incentives, and local promotion actions.

Most major automakers now in the game: 16 with 20k+ annual sales
- Global annual 2015 to 2016 electric vehicle growth ~40%
- Battery production more concentrated (5 companies make up 3/4 of production)

Due to all the battery pack cost reductions, incremental performance standards for 2025+ timeframe push electric vehicles into the market.

**Challenge:** 2025-2030 regulation is a major uncertainty for technology investments.

*Assumes adopted 2025 standards and hypothetical 2026-2030 standards at 4%-6% lower CO$_2$/year*.

The challenge: Transition to electric drive

- Major governments have signaled the need to fully transition to electric drive in the 2025 to 2050 timeframe to achieve climate, air quality, and energy goals
  - National: France, Germany, India, Netherlands, Norway, United Kingdom
  - States/Provinces: British Col., Calif., Conn., Maryland, Mass., New York, Oregon, Québec, Rh. Isl, Vermont
  - Cities: Many registration and circulation restrictions, low emission zones, discussions of bans

See: ZEV Alliance COP21 announcement: [http://zevalliance.org/content/cop21-2050-announcement](http://zevalliance.org/content/cop21-2050-announcement)
Clear energy benefits of electric buses