Electrifying Transport and the Cost of Mitigation

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November 2018
Integrated Assessment Modeling Consortium Annual Meeting
Seville, Spain
Our question

• How would the electrification of transportation affect the global energy system and greenhouse gas emissions mitigation?

Source: https://energy.gov/eere/vehicles/plug-electric-vehicles-and-batteries/
Both examples use the JGCRI Global Change Assessment Model (GCAM)

### Scenario Assumptions
- Socioeconomic assumptions (population, GDP)
- Energy, land use, and water technologies
- Policies
- Resources

### Scenario Outputs
- Prices and production quantities:
  - Energy sectors
  - Transportation
  - Primary energy resources
  - Agricultural products
- Land use
  - Crops (by type)
  - Pasture
  - Unmanaged
- Water demand
  - Raw demand by sector
  - Response to scarcity
- Atmosphere-Climate
- Economic indicators
  - Economic losses
  - Income transfer
Existing GCAM elements

Materials Sector (KLEM)

New GCAM-Macro elements

GDP

NOTATION
Lm = labor used for materials production
La = labor used in agricultural production
I = investment
K = capital stock
GDP = gross domestic product

Existing GCAM elements

Land

Energy

Water
Experimental design

• All scenarios assume SSP2 (Middle of the Road) underlying socioeconomic drivers

• Policy assumptions
  • Current policies only
  • 2-degrees

• Transport technology pathways
  • SSP2 transport technology
  • Accelerated electric vehicles
  • Phase out of non-electric vehicles

Source: http://viola.bz/your-life-is-your-road/life-is-a-road-5/
Transport technology pathways

<table>
<thead>
<tr>
<th>Technology Scenario</th>
<th>Technology Assumptions</th>
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<tr>
<td><strong>SSP2 transport technology</strong></td>
<td><strong>Passenger Light-Duty</strong>&lt;br&gt;BEV Capital Cost: 10 - 50 % greater than ICE&lt;br&gt;BEV Fuel Efficiency: ~3 x better than ICE</td>
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<td><strong>Accelerated electric vehicles</strong></td>
<td><strong>Passenger Bus and Freight Truck</strong>&lt;br&gt;BEV Capital Cost: Equal to ICE by 2035&lt;br&gt;BEV Fuel Efficiency: ~3x better than ICE</td>
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<td><strong>Phase out of non-electric vehicles</strong></td>
<td><strong>Phase Out ICE by 2050 for</strong>&lt;br&gt;Passenger Lt-Duty&lt;br&gt;Passenger Bus&lt;br&gt;Freight Truck</td>
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Final Energy Consumption
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Transportation Services

Passenger (10^{12} Pass–Km)

- Base
- MixedBEV
- BEVonly
- 2.6_Base
- 2.6_MixedBEV
- 2.6_BEVonly

Freight – Land (10^{12} Ton–Km)

- Base
- MixedBEV
- BEVonly
- 2.6_Base
- 2.6_MixedBEV
- 2.6_BEVonly
Global Transport, Power and Total CO$_2$
Global Transport, Power and Total CO$_2$
Global Transport, Power and Total CO$_2$

**Transportation Sector CO$_2$ Emissions**

- **Base**
- **MixedBEV**
- **BEVonly**
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**Electricity Production**

- **Base**
- **MixedBEV**
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Global Transport, Power and Total CO$_2$
GDP Effects: No Policy

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-12%  -8%  -4%  0%
GDP Effects: 2 Degrees

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0%
Electrification lowers the cost of reaching a 2-degree goal

- The core approach to mitigation
  - Increase efficiency
  - Decarbonize power
  - Electrify whatever possible
- Electrifying transport turns a problem sector into part of the solution.

Cost Reduction from Electrification of Transport

- 19% in 2050 (Mixed BEV/ICE)
- 27% in 2050 (Full Transition to BEV)
- 42% in 2100 (Full Transition to BEV)
Discussion