Driving Smart Growth: Electric Vehicle Adoption and Off-Peak Electricity Rates

31st USAEE/IAEE North American Conference
Austin, 5 November 2012
Presenter: Peter E Gunther, Connecticut Center for Economic Analysis, School of Business, UConn
Approach to Economic Impacts of EVs

• Off-peak Residential Electricity Recharges EVs
• Rate on Electricity Used Is the Incremental Charges at Off-Peak
• Annual VMT - US Average of 15,000 Miles
• Substituting EVs for ICEs Generates Savings in:
  – Gasoline
  – Repairs and
  – Emissions (CO$_2$eq captured as amenity benefits)
  – Utility Investments
Basic Assumptions

• CT EV era began in 2008 - purchase of 10 Tesla Roadsters.
• Assumed to grow in each zip code (ZC) at the same rate as hybrids.
• EVs reach 90% of new sales (Not stock) in 2028 and flat to 1930.
• Early adopters of hybrids previously drove full-sized vehicles.
• Leaf with $7,500 subsidy is competitively priced.
• Given fuel and maintenance savings, incremental capital costs may also be largely offset over the first four years of operations. Based on 2010 gasoline prices of $2.92 and variable off-peak electricity rates of $0.13338.
• Uses Census and zip code data to establish commuting distances, population distribution and income distributions among ZCs.
• Electricity per EV based on GM’s specifications for Volts.
Modeling Approaches

• Two Scenarios Basic: Flat and Off-Peak Electricity Rates
• REMI’s Dynamic Equilibrium Model for CT
• Economic Changes Modeled by zip code:
  – Net Fuel savings allocated to “Household Expenditures”
  – Increased electricity consumption
  – Amenity benefits
  – Investment adjustments
Importance of Off-Peak Recharging to Utilities: Required Transformer Upgrades 2022

Flat Rates

Off-Peak Rates
Zip Codes with Concentrated Reductions in GHGs (1,000’s tonnes of CO$_{2eq}$, $n=341$)

2015  

2022  

Legend
- **High**: 88933
- **Low**: 6

GHG Reduction, 2015 (Tons of CO2)

Values

Legend
- **High**: 155071
- **Low**: 6

GHG Reduction, 2020 (Tons of CO2)
Economic Impacts at Flat and Off-peak Rates with & without Amenities

• Jobs
  – Flat and Off-Peak Rates
  – Amenities
  – With Capital Adjustments
  – With Battery Replacements
  – In-State Financing

• Current Dollar Metrics

• Impacts on Utilities
Jobs Changes (#)

No Amenities

Amenities

- Electricity at Flat Rates No Amenities
- Electricity at Off-Peak Rates No Amenities
- Electricity at Flat Rates and Amenities
- Electricity at Off-Peak Rates and Amenities
Key Sector Employment Impacts 2025
Key Sector Employment Impacts 2030
Connecticut Impacts on Capital Stock
(Millions Fixed 2005 $)

2023

2028

<table>
<thead>
<tr>
<th></th>
<th>2023</th>
<th>2028</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat Rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flat Rate and Amenities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Off-Peak Rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Off-Peak Rate and Amenities</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Actual | Optimal
---|---
---|---
Dynamics of Shortfalls between Optimal and Actual Capital Stocks: Flat Rate Case 2013-2030
Job Impacts with Replacement Batteries

Flat Rates

Off-Peak Rates

Electricity at Flat Rates, Capital Adjustment, No Amenities
Electricity at Flat Rates, Capital Adjustment & Amenities
Flat Rates, Capital Adjustment, Amenities & Batteries

Off-Peak Rates, Capital Adjustment, No Amenities
Off-Peak Rates, Capital Adjustment & Amenities
Off-Peak Rates, Capital Adjustment, Amenities & Batteries
Current Income Impacts Inclusive of Financing
(Millions Current $)

Flat Rates

Off-Peak Rates

- Personal Income, Capital Adjustments and Financing
- Personal Disposable Income, Capital Adjustments and Financing
- Personal Income Capital Adjustments
- Personal Disposable Income Capital Adjustments
Utility Output Impacts (Millions 2005 $)

Flat Rate

Off-Peak Rates

- Value Added Net of Financing
- CT Output
- Demand
Conclusions

• Off-Peak Rates Enhance EV Adoptions & Benefits
• Flat Rates Waste $600 million in Unnecessary Capital Investments
• Amenity Benefits Attract Migrants
• EVs Result in Greater Efficiencies (Capital Saving)
• Job Impacts of the Transition from ICEs to EVs Need to be Carefully modeled to:
  – Fully Capture the Capital & Amenity Adjustments;
  – Identify Timing of Battery Replacements;
  – Capital Fund Sources Internal to the State; and
  – Identify Hard Hit Sectors (e.g. Retail)