12 Volt Auxiliary Load On-road Analysis

PI: Barney Carlson
Idaho National Laboratory
Energy Storage & Transportation Systems
Advanced Vehicle Testing Activity (AVTA)

June 10, 2015

2015 DOE Vehicle Technologies Program Annual Merit Review
INL/MIS-15-34808

This presentation does not contain any proprietary, confidential, or otherwise restricted information
Overview

Timeline
FY15
• Add sensors into vehicles
• Characterize individual auxiliary loads
• Collect and analyze data from on-road operation
• Publish quarterly reports of findings

Barriers
• Lack of the availability of real world, on-road driving data detailing
  • 12V auxiliary loads
  • driving characteristics

Budget
• FY15: $ 150k

Partners
• Intertek CECET, Phoenix AZ
• Argonne’s APRF (dynamometer testing)
• OEMs
  • Chrysler
  • Ford
  • GM
Objective / Relevance

• Quantify the real world, on-road auxiliary loads and driving characteristics from multiple non-electrified vehicle models
  – To support OEMs request for real world data to support advanced technology systems with respect to off-cycle fuel economy credit
    • “Off-Table” Alternative EPA-Approved Methodology

• This on-road data collection and published results
  – Can be used by OEMs / Suppliers for possible off-cycle credits for advanced technologies
  – Gain understanding of variation of auxiliary loads due to temperature, driving condition, and driving style
Milestones

- Data collection commenced after current and voltage sensors were added
  - May 2014
    - 2012 Honda Civic CNG
    - 2013 Volkswagen Jetta TDI
  - August 2014
    - 2014 Chevrolet Cruze Diesel
    - 2014 Mazda 3 i-ELOOP
- Individual auxiliary loads characterized during steady state operation
  - Examples: lights, fans, heated seats, elec. power steering, etc.
- Benchmark over standard dynamometer drive cycles (Argonne’s APRF)
- Published Fact Sheets
  - Summer 2014, Autumn 2014, Winter 2015, Project to Date
    - 2012 Honda Civic CNG
    - 2013 VW Jetta TDI
  - Autumn 2014, Winter 2015
    - 2014 Chevrolet Cruze Diesel
    - 2014 Mazda 3 i-eLoop
- Duration: Data collection is on-going for 12 months for each vehicle model
Approach:

• Leverage vehicles operating in the AVTE fleet
• Add sensors (current and voltage) to measure auxiliary loads
• Testing and Evaluation
  – Characterize each individual auxiliary load (steady state) for each vehicle model
    • Example: headlights, interior fan, heated seat, etc.
  – Benchmark auxiliary loads over standardized drive cycles
    • Argonne APRF dynamometer test facility
  – Collect on-road data during all driving conditions
  – Process and organize data into SQL database
  – Analyze data for auxiliary load and interdependence with external factors and utilization
  – Publish results
    • Quarterly basis (for seasonal comparison)
    • Summarized results
Approach: Vehicles Evaluated

- 4 of each model
  - 2012 Honda Civic CNG
  - 2013 Volkswagen Jetta TDI
  - 2014 Chevrolet Cruze Diesel
  - 2014 Mazda 3 i-ELOOP
Accomplishments:

- Characterize auxiliary loads
  - Loads are characterized from standardized dynamometer testing
  - Auto climate control set to 72°F for all tests
    - Significant A/C operation during 95°F tests
    - Significant heater operation during 20°F tests
  - Individual loads are operated in steady state condition
  - Figures shows example results of each load increase over base load from VW Jetta TDI
    - Base load with engine running and all accessories off
      - 258 watts
Accomplishments:

• Comparison of vehicle models

Notable attributes:
• Honda Civic CNG
  – No fuel pump
  – No seat heaters
  – No rear defroster
  – Hydraulic power steering
• Mazda 3
  – Fog lights

<table>
<thead>
<tr>
<th></th>
<th>VW Jetta TDI</th>
<th>Chevy Cruze Diesel</th>
<th>Honda Civic CNG</th>
<th>Mazda 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer 2014</td>
<td>796 watts</td>
<td>N/A</td>
<td>338 watts</td>
<td>N/A</td>
</tr>
<tr>
<td>Autumn 2014</td>
<td>657 watts</td>
<td>555 watts</td>
<td>297 watts</td>
<td>405 watts</td>
</tr>
<tr>
<td>Winter 2015</td>
<td>491 watts</td>
<td>570 watts</td>
<td>293 watts</td>
<td>441 watts</td>
</tr>
<tr>
<td>Overall Avg.</td>
<td>667 watts</td>
<td>562 watts</td>
<td>308 watts</td>
<td>425 watts</td>
</tr>
</tbody>
</table>
Accomplishments:

On-road auxiliary loads results

- Example:
  - Impact to avg. Auxiliary Load from change in Ambient Temperature
    - JettaTDI: 425 to 1,100 watts
  - Impact due to vehicle lighting (evening)
    - JettaTDI: avg. of 150 watts between 19:00 and 5:00
Accomplishments:

On-road driving characteristics results

• Calculated for each vehicle model
  – Average percent Idle Time
  – Time Parked (between drives)
  – Distribution of vehicle speed and acceleration

• Example from varying vehicle utilization:
  – 36.9% Idle time
    • Mostly city driving (92.9% mi in city)
  – 19.1% Idle time
    • Mostly Hwy driving (24.6% mi in city)
Accomplishments:
Example Fact Sheet

http://avt.inel.gov/ice.shtml
This project is new for this year.
Future Work:

• Continue data collection on the 4 models through a minimum of one year of data collection and analysis

• Continue to publish:
  – Quarterly fact sheets
  – Project to Date fact sheets

• Publish white paper on results and findings
  – On-road results
  – Dynamometer testing results

• Evaluate additional vehicles (non-electrified) as available through AVTE
Summary / Comments:

• Completed:
• Data collection commenced
  – May 2014 and August 2014 for the respective models
• Individual auxiliary loads characterized during steady state operation
  – Examples: lights, fans, heated seats, elec. power steering, etc.
• Benchmarked auxiliary loads over standard dynamometer drive cycles
  – Argonne’s APRF dynamometer test facility
• Published Fact Sheets
  – Quarterly
  – Project to Date (current summary of results)
• Duration: Data collection is on-going for minimum of 12 months for each vehicle model

• These results provide a referenceable and publically available source of auxiliary load and driving characteristic data
Acknowledgement

This work is supported by the U.S. Department of Energy’s EERE Vehicle Technologies Office

More Information

http://avt.inl.gov