Vehicle Energy Consumption Evaluation System

Developed by China and EU Cooperative Research program

Ministry of Industry and Information technology of PRC
Dr. Meng Xiangfeng

2014-02-18
Backgrounds

- Fuel consumption by vehicles has been bringing about more and more burdens on environmental protection and energy supply.
- NEVs/LCVs (Low Carbon Vehicles) are one of the common choices among international community including China and EU to solve above problems.
- Both EU and China are taking active measures to encourage the developments of NEVs/LCV.
Main activities

The Memorandum of Understanding on China and EU Cooperation
Research Project on Vehicle Consumption Evaluation System
Brussels, 2011-6

- Workshop in Oct, 2011
- Discussion and drafting from Oct, 2010 to Oct, 2012
- Distributed for comments in Dec. 2012
- Final draft was completed at the end of 2012.
Consensus and Principals

Consensus

1. Energy consumption of EVs should be measured and evaluated based on life cycle.
2. Power generation mix has an important impact of energy consumption of EVs
3. EVs do not promise much benefit in reducing CO₂ emissions currently
4. Each part of the value chain must be responsible for its relevant part – not possible to shift all responsibilities to vehicle manufacturers

Principals

1. Thorough and objective evaluation on energy consumption during the whole life-span of EVs;
2. Convenient to contrast on energy consumption of EVs and vehicles fueled by conventional gasoline and diesel;
3. Convenient for the authority to take phase-in measures at different levels.
Basic thoughts

- Comprehensive analysis on the main steps of energy consumption during the life cycle of vehicles.
- Energy losses of the upstream should be considered based on the directly measured energy consumption.
- China and EU work together to find out key factors influencing energy consumption evaluation and weight these factors according to their own situations.
life-cycle analysis

Resource: HUO Hong, Tsinghua University
Main steps

Coal Combustion > Electricity Transmission > EV Recharging > EV Operation

Oil Refinery > Gasoline Transportation > Refilling > Vehicle Operation
According to the actual measured electric energy consumption \( (E_r \text{ kWh}) \), the energy consumption of each element shall be traced upstream and deduced with consideration of loss of recharging, transmission (LL ratio), generation efficiency (thermal power only, the proportion of which among electricity is represented with ) and so forth, to calculate the total energy consumption \( (E_L \text{ kWh}) \) corresponding to the actual electric energy consumption of the vehicle.

In which, energy conversion efficiency in the procedure of generation, transmission and charging shall be taken into account, taken as “the factor of efficiency”, in \( F_e \)

\[
F_e = \frac{1}{i_{ch} \times (1 - i_{tr}) \times \left( \frac{\varphi}{s_{ge}} + (1 - \varphi) \right)}
\]
Step 1 - Power to wheel energy consumption

Electricity generation, efficiency of power generation \( i_{ge} \) and rate of electric energy consumed by power house \( i_c \) are taken into account together, which is represented with the electricity generation efficiency \( s_{ge} \), in which electricity generation efficiency of primary energy like hydroelectricity, windmill electricity, nuclear power and so forth is calculated as 100%.
Step2-Energy conversion based on energy conservation law

- The electric energy (kWh) could be equivalently converted to heat (kJ), according to $1 \text{kWh} = 3600 \text{ kJ}$.

- According to the lower heating value of gasoline and diesel, the equivalent fuel consumption of 1 kWh electric energy consumption, namely “the factor of energy”, is represented with $F_E$. 

[Diagram of industrial processes]
Taking account of loss in process, transportation, storage and filling of fuels like gasoline and diesel, the equivalent fuel consumption \( (F_{Ce}) \) is calculated with fuel consumption multiplied by the process and conversion efficiency \( (R_p) \) and the efficiency of transportation, storage and filling \( (T_p) \).
### Instructions

<table>
<thead>
<tr>
<th>Electricity Consumption</th>
<th>Fuel consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Short-term</strong></td>
<td><strong>E</strong></td>
</tr>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Mid-term</strong></td>
<td><strong>E</strong></td>
</tr>
<tr>
<td>( F_C E = E \times F_E )</td>
<td></td>
</tr>
<tr>
<td><strong>Long-term</strong></td>
<td><strong>E</strong></td>
</tr>
<tr>
<td>( F_C E = E \times F_E \times F_e \times r_p \times t_p )</td>
<td></td>
</tr>
</tbody>
</table>
Instructions

- Only for equivalent calculation between electric energy and fuel consumption of EVs and plug-in hybrid vehicles, without the consideration on pollutants and CO₂ emission.

- Differently take into account the steps in terms of development of EVs and plug-in hybrid vehicles, calculate the equivalent fuel consumption ($F_{C_e}$) of the electric energy consumption ($E$).

- Energy consumption of EVs and plug-in hybrid vehicles does not depend on vehicles only, it is influenced by energy conversion efficiency of upstream steps as well.
MIIT issued “Passenger vehicle Corporate Average Fuel Consumption Accounting Methods” on March 14, 2013, establishing annual passenger car CAFC Assessment System and implementing the unified management for all the vehicles imported and manufactured in China.

- For EV, FCV and PHEV passenger cars, the combined fuel consumption is considered to be zero. The sale volume is considered as 5 times when calculating CAFC.
- For vehicle (not including EV, FCV) whose combined fuel consumption is less than or equal to 2.8L/100km, the sale volume is considered as 3 times when calculating the corporation average fuel consumption.
Thanks for your attention!