UN ECE Informal Working Group on Electric Vehicles and Environment: Questionnaire Summary and Discussion

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Tokyo, Japan
Ed Pike, PE
Acknowledgement

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Overview

- Introduction
- Summary of Information Received
- Suggested Discussion Topics
Introduction
Questionnaire

- Questionnaire covers 17 attributes for light duty vehicle (LDV) category electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEVs)
- Also received more limited information on motorcycles, medium and heavy duty vehicles, and non-plug-in hybrids
Government Responses

- California Air Resources Board
- Centre of Expertise Federal Government Belgium
- Environment Canada
- European Commission
- Federal Public Service Mobility and Transport (Belgium)
- Ministry of Industry and Information Technology (China)
- Ministry of Land, Infrastructure, Transport and Tourism (Japan)
- National Traffic Safety and Environment Laboratory (Japan)
- South Korea Ministry of Environment
- Swiss Federal Department of the Environment, Transport Energy and Communications
- US Environmental Protection Agency
- US Department of Energy
Additional Responses

- Automotive Research Association of India
- BMW (Palo Alto, California technology office)
- International Energy Agency
- International Council on Clean Transportation
- International Organization of Motor Vehicle Manufacturers (OICA)
- Japanese Automobile Manufacturers Association
- Korea Automobile Testing and Research Institute (South Korea)
- RECHARGE (Europe)
- Umicore
- Van Hool (Belgium)
Questionnaire Evaluation

- Energy Solutions compiled and evaluated responses and provided additional research
- General observations:
  - Valuable for discussion of potential information sharing and/or regulation coordination
  - Some attributes generally covered by government regulations; others generally covered by industry standards; in some cases there is a variability or few standards
Summary of Information Received
Topic Areas

- Responses regarding the 17 attributes are related to the following categories:
  - EV energy efficiency and range
  - Battery performance and durability
  - Charging and electricity supply
  - Battery/vehicle recycling
  - Regulatory and financial incentives and education
- Note: the above categories are similar to, but not exactly the same as Questionnaire organization
EV Energy Efficiency and Range

- Many commonalities between standards for measuring energy efficiency and range
- These attributes are used for CO$_2$/fuel economy regulations, type approvals for new vehicles, and labeling in countries with labeling programs
- Some elements are common between countries, some are case-by-case and some gaps exist
EV Energy Efficiency and Range

- US EPA drive cycles used in Canada, S. Korea and US
- NEDC drive cycles used in China, EU
- India, Japan set own drive cycles
- Typical testing procedures
  - Preconditioning, charging
  - Lighting, cabin climate control and other accessories turned off during tests
EV Energy Efficiency and Range

Effect of Test Cycle on Rated Range

US EPA consumer label estimate and global test cycle measurements of Nissan Leaf range (Sources: Nissan, US EPA)
EV Energy Efficiency and Range

- Heating and Air Conditioning (A/C) is significant
  - See for instance Mr. Werner Tober’s EVE #4 presentation
  - In some cases (Canada, S. Korea, US) countries specify use of heater for cold temperature testing; in other cases, not required
  - A/C operation included as part of US EPA “5-cycle” testing

- Mobile Air Conditioning Test Procedure (MACTP) working group
  - Developing light duty vehicle A/C testing procedures
EV Energy Efficiency and Range

- Working draft Worldwide harmonized Light vehicles Test Procedure (WLTP) Annex 8 for EVs

- Example parameters
  - Actual electric range, equivalent electric range, charge-sustaining mode, charge depleting mode
    > Definitions and detailed calculations
  - CO$_2$ and weighted CO$_2$ calculations
Draft Annex 8 example procedures

- Preconditioning similar to conventional vehicle
  - Does not appear to address battery stand-by temperature management energy usage

- Measurement of electricity usage at the main socket, i.e. including EV charger loses

- References drive cycles under development
  - Note that some PHEVs operate in “blended mode” to provide peak power even while battery charge remains
EV Energy Efficiency and Range

- Not covered in January 2013 draft Annex 8:
  - Cabin heating, A/C, exterior lights
  - Thermal effects on battery
  - Special purpose driver selectable operational modes

- Battery temperature correction factor
  - India AIS-039 correction factor for battery internal resistance; not identified for other countries/regions
Battery Performance and Durability

- Industry standards for performance, durability
  - IEC, SAE, ISO
  - ABC and US DOE goals and testing methods for cycle life, calendar life, maintaining discharge rate, etc
- US EPA durability requirement to ensure hybrid and plug-in hybrid emissions control
- Potential future WLTP requirement for battery aging and potential effect on vehicle range, efficiency
Charging

- **Off-board charging**
  - J1772 used in Canada, Japan, US for Level 2 charging
  - China-specific standard
  - South Korea based on IEC standard
  - DC fast charging standards

- **Potential industry wireless charging standard**
  - Also non-interference with wireless communications and potential EMF regulation

- **On-board charging: potential safety standard under development**

Image Source: Ed Pike
Vehicle as Energy Supply, Battery Re-use Post Mobility

- Industry standards such as connection with and communications with grid
- Vehicle as energy supply and battery post-mobility use energy supply standards likely to be similar
Vehicle and Battery Recycling

- Often, but not always regulatory standards
- Battery and vehicle recycling addressed by same regulatory program(s), with specific procedures likely determined based on material type
Incentives: Regulatory and Financial Incentives and Education

- Case-by-case; varies between regions/countries and within region/country
- Examples include direct subsidies or tax incentives for vehicle purchase and/or EV charging infrastructure
  - National such as China, Japan, S. Korea and US
  - Province/state level such as Canada, China, EU, S. Korea and US

Image Source: Ed Pike
Incentives

- CO$_2$/fuel economy passenger vehicle regulatory incentives at EU/national level
  - Also California Zero Emission Vehicle regulation, Los Angeles and Vancouver standards for EV charging circuit infrastructure in new buildings
- Government consumer awareness efforts tend to focus on information resources
Non-Plug-in Hybrid Passenger Vehicles

- Typically subject to same programs as conventional vehicles
- US EPA emissions control durability requirements set standards for lifetime of hybrid batteries
Medium and Heavy Duty Vehicles (MDV/HDV)

- Plug-in specific regulations not identified
  - Hybrids in early commercialization stage, very little plug-in product yet
- Some incentives identified
  - Japanese and US examples

Image Source: Smith Electric
MDV/HDV

- GRPE GTR for hybrid HDV modeling would require battery performance inputs
- UN/ECE Regulation 101 and also potential WLTP applies to N1 goods movement vehicles up to 3.5 tonnes

Image Source: Smith Electric
MDV/HDV continued

- Commonalities with light duty vehicles?
  - Commonalities assumed more likely for battery re-use, recycling, vehicle recycling, off-board charging infrastructure (for MDVs), and vehicle to energy supply
  - Commonalities assumed less likely for vehicle efficiency, range, performance, and durability standards
Motorcycles (MC)

- GTRs in progress for motorcycle EV range and efficiency
- EU has motorcycle CO$_2$ labeling requirements

Image Source: Zero Motorcycles
Themes Related to Vehicles and Batteries

- Vehicle Efficiency and Range
  - Important aspects are not addressed or are partially addressed by existing testing standards
  - Some gaps would be covered by pending standards and others would not be covered (i.e. cabin heating, ambient temperature effects on batteries)

- Battery Performance and Durability
  - Primarily industry standards
  - Government regulations may cover certain aspects
Suggested Discussion Topics
Suggested Discussion Topics

Potential follow-up areas:

- Light duty vehicle efficiency and range
- Battery performance and durability
- Information sharing topics
- Other vehicle types
**EV Efficiency and Range Discussion**

- Is there a need for EVE additional follow-up?
- Coordinated regulatory development and/or GTR option
  - Example: Heating can have significant effect on EV range and efficiency
  - Energy consumption can vary based on climate; also technology such as heat pump vs. resistance heating or others
EV Efficiency and Range Discussion

- Regulatory coordination and/or GTR options
  - Example: US has a test procedure for A/C operation; many test procedures do not include A/C
    - EVs well suited for energy efficient heat pump and electrified A/C compressor
    - MACTP working on A/C testing for conventional vehicles
  - Example: India includes battery temperature adjustment factor, not found in other test methods
EV Efficiency and Range Discussion

- Coordinated testing and research options
  - Are stand-by battery thermal management losses significant?
  - Does battery state of charge affect battery efficiency?
  - Do current test cycles capture “blended” PHEV operation where internal combustion engine supplements battery to provide peak power?
Battery Performance and Durability Discussion

- Is there interest in additional follow-up for testing procedures and/or research for battery performance and durability?
  - US EPA durability requirement for hybrids (plug and non-plug)
  - WLTP potential GTR for durability
  - Interest in further information sharing and/or GTR?
Information Sharing Topics

Discussion

- Is there interest in additional research:
  - Vehicle charging and putting electricity back into grid (including battery re-use for energy storage)
  - Vehicle and battery recycling
  - Incentives and education
MDV/HDV Discussion

- Is there interest in areas for additional follow-up?
- Are there important cross-overs from MDV/HDV that are relevant to IWG EVE?
- Are there important cross-overs from IWG EVE to share with HDV Workgroup?
Motorcycles Discussion

- Is there interest in areas for additional follow-up?
- Are there important cross-overs from MC that are relevant to IWG EVE?
- Are there important cross-overs from IWG EVE to share with MC Workgroups?
Energy Solutions Contact Information

Ed Pike, Senior Project Manager
epike@energy-solution.com
(510) 482-4421 ext 239
www.energy-solution.com
Thank you for your participation.