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

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April 11, 2013

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Acknowledgement

Energy Solutions gratefully acknowledges the support of Environment Canada, the IWG EVE leadership group and the International Council on Clean Transportation.

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

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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

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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

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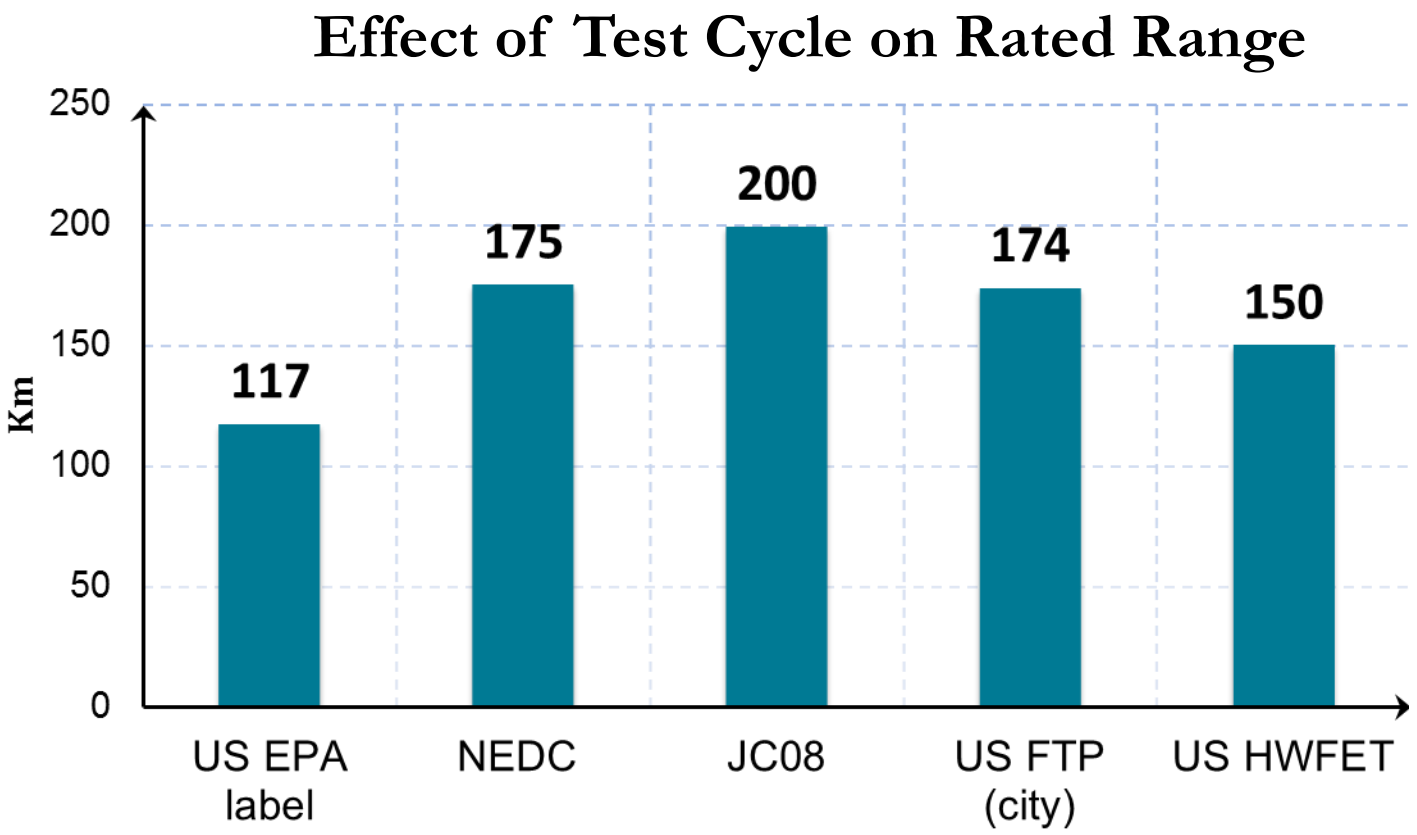
EV Energy Efficiency and Range

- 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



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

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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

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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

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EV Energy Efficiency and Range

- 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

Image Source: Ed Pike

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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?

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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

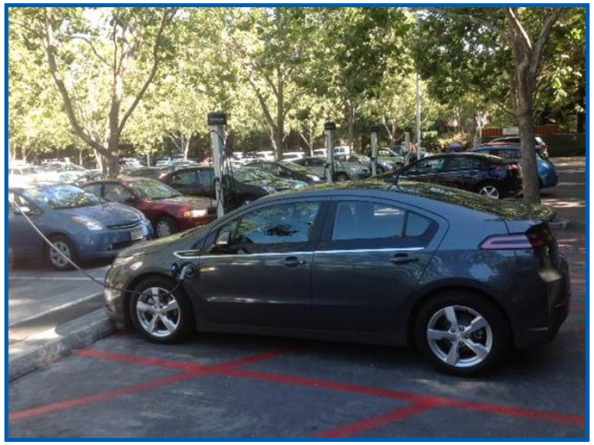

Image Source: Ed Pike

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 ?

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Thank you for your participation.

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