Electric Vehicle Regulatory Reference Guide [DRAFT 1]

Prepared for: The United Nations Economic Commission for Europe (UNECE) Electric Vehicles and the Environment Informal Working Group (EVE IWG)

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1 Introduction

1.1 Overview of EVE IWG

The formal name of the United Nations Economic Commission for Europe (UNECE) international Electric Vehicle (EV) working group is the Electric Vehicles and the Environment Informal Working Group (EVE IWG). The working group is under the Working Party on Pollution and Energy (GRPE), which operates as a part of the World Forum for the Harmonization of Vehicle Regulations (WP.29) through the UNECE. The international EV working group was established in March 2012 to address environmental issues associated with EVs and a Terms of Reference (TOR)[i] was developed; at this time a separate group focused on EV safety was also established[ii]. Participation in the working group is open to all UNECE Contracting Parties and interested non-governmental organizations, like EV and battery manufacturers and suppliers. The working group leadership derives from 4 countries: the United States, Japan, China, and Canada. The role of each country in the leadership organization is depicted in Figure 1.

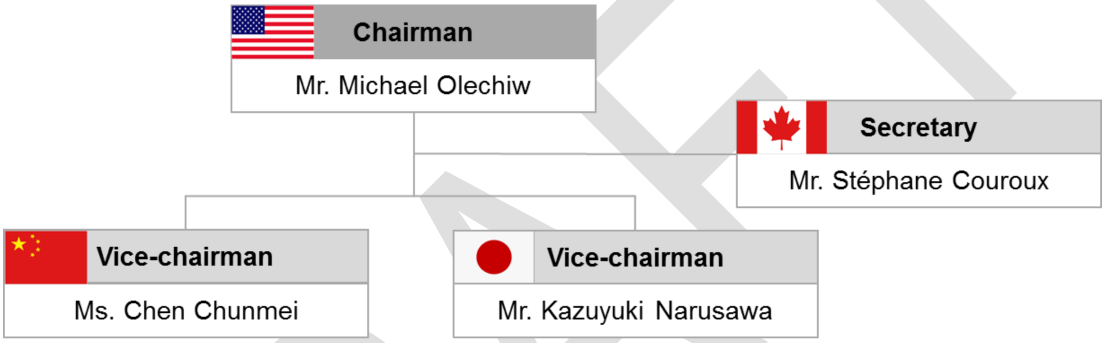

Figure 1 : Leadership Organization Chart, EVE IWG

As a working group under WP.29, the EVE IWG has the following broad goals that are stipulated in the group's TOR:

a) Exchange information on current and future regulatory requirements for EVs in different markets
b) Identify and seek to minimize the differences between regulatory requirements, with a view toward facilitating the development of vehicles to comply with such requirements
c) Where possible, develop common requirements in the form of one or more UN global technical regulations (GTR)

The following specific objectives were established by the EVE IWG in the group's TOR:

a. Develop a priority list of topics to address the most timely and significant considerations before the EVE informal working group.
b. Understand and document the current consideration of EVs under the work of other established informal working groups: EVS, WLTP, HDH, EFV and VPSD.
c. Establish a mechanism for sharing ongoing research and information sharing on topics related to EVs and the environment.
d. Develop a reference guide for regulatory activities already established or being considered by contracting parties.

Along with the above, the EVE IWG aims to stay abreast of developing concepts and implementation strategies for the development of the possible GTRs and the introduction of

EVs through regular dialogue and expert presentations. Also, EVE IWG activities are assessed for synergy and overlap with existing work already being conducted by other WP.29 informal working groups.

1.1.1 Summary of EVE activities to date

The goals and objectives noted above have been implemented through a series of EVE IWG meetings, where the following activities have taken place:

- Review and acceptance of group TOR
- Roundtable discussions to establish working priorities and methodology
- Various presentations relating to the EV questionnaire and Guide development
    - Development of the questionnaire document
    - Summary and review of responses
    - Presentation on completed questionnaires (4 presented to-date)
- Presentations aimed at information sharing
    - Presentations by representatives of related IWGs at meetings: Electric Vehicle Safety (EVS) IWG, Worldwide harmonized Light duty Test Procedure (WLTP) IWG, Heavy Duty Hybrid (HDH) IWG, Vehicle Propulsion System Definitions (VPSD) IWG, and Environmental and Propulsion Performance Requirements of L-category vehicles (EPPR) IWG
    - Presentations from industry, trade organizations, NGO's, and technical experts (10 presented to-date)
    - Presentations of national frameworks by appropriate country representatives (4 presented to-date)

1.2 Purpose of EV Reference Guide

The development of the guide is appropriate in the context of the IWG EVE's charter and objectives, as reflected in statement d of the working group's specific objectives outlined above.

1.2.1 Document aim, intended audience

The EV Reference Guide is intended to serve as a single point of reference relative to the worldwide EV environmentally-related regulatory landscape as it is today. The document captures the existence and extent of regulations relating to critical EV attributes including any standards that are available for voluntary compliance. Additionally, the guide highlights any on-going efforts to develop appropriate standards and regulations. The primary intended audiences of the document are members of government and non-governmental regulatory bodies and agencies involved in the implementation and adoption of policy and regulations relating to EVs. The guide will expose differences in regulatory requirements as well as highlight gaps in the regulatory framework, allowing these parties to put forward actions to minimize differences and narrow gaps. In addition, the guide will be part of the public domain and therefore be available as a source of information to other EV industry stakeholders such original equipment manufacturers and suppliers of EV components such as batteries, power electronics, and charging solutions.

1.2.2 Connection to WP.29, potential GTR development

The reference guide through its thorough overview of the EV regulatory landscape permits the observation of issues and gaps that could potentially be addressed via the pursuit of UN Global Technical Regulations (GTRs). The reference guide serves to highlight such opportunities that after thorough review by the IWG EVE including consideration of potential benefit and any overlap with efforts on-going in other informal working groups can be recommended to GRPE and subsequently to AC.3 for development and adoption. Actual development of GTRs is not part of the scope of the reference guide or the current working group mandate.

1.3 Outline of EV Reference Guide

1.3.1 Guide components, section logic

The layout of the reference guide focuses on an explanation of the document's purpose, the methodology employed in its creation, a thorough overview of the findings, followed by conclusions, and recommendations in response to the results of the study. A chapter outline for the guide is given in Figure 2.

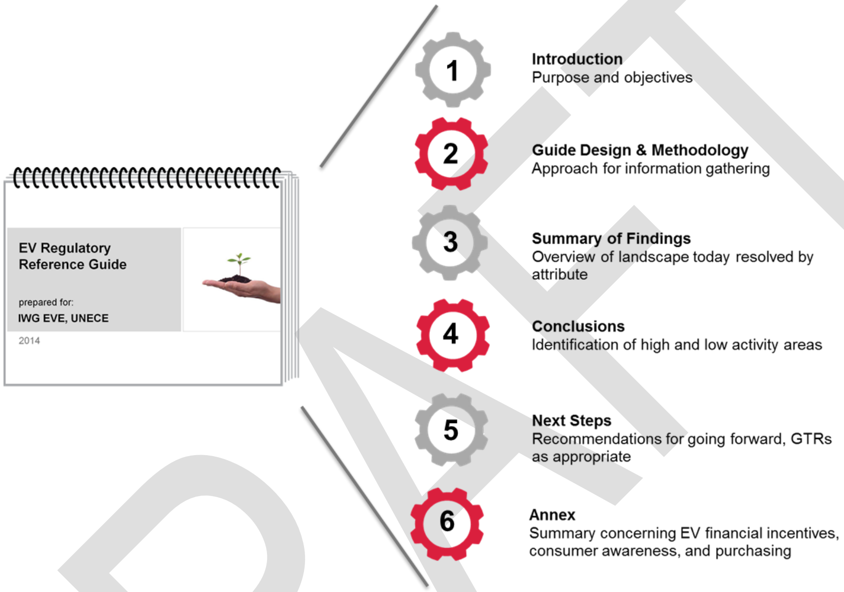

Figure 2 : Chapter Outline, EV Reference Guide

2 Reference Guide Design & Methodology

2.1 Design of the EV Reference Guide

2.1.1 Guide organization; rationale

The EV reference guide is organized according to so-called 'attributes.' An attribute is defined by the IWG EVE as a characteristic, activity or requirement related to EVs and the environment. This approach was pursued in an effort to minimize confusion related to the interpretation of wording, such as regulation, legislation, etc. Each attribute is defined. Definitions established in GTRs (2, 4, 10, 11), under development in other WP.29 working groups (EVS, VPSD, WLPT, HDH), found in WP.29 documentation (R.E.3, S.R.1), and established by other organizations (ANSI, ISO, IA-HEV) were scanned for relevance to this work and were used where appropriate.

2.1.2 Scope of guide

Attributes related to EV safety were not included (i.e. crash testing; electrical safety standards for internal wiring, etc.). Attributes are grouped by those related to vehicle, battery, charging infrastructure and market deployment support (Fig. 3). In order to remain within the scope of the WP.29 (vehicle-only related regulations), attributes related directly to the vehicle and battery were prioritized; charging infrastructure attributes related directly to the vehicle and market deployment support attributes were also included, but are of lower priority.

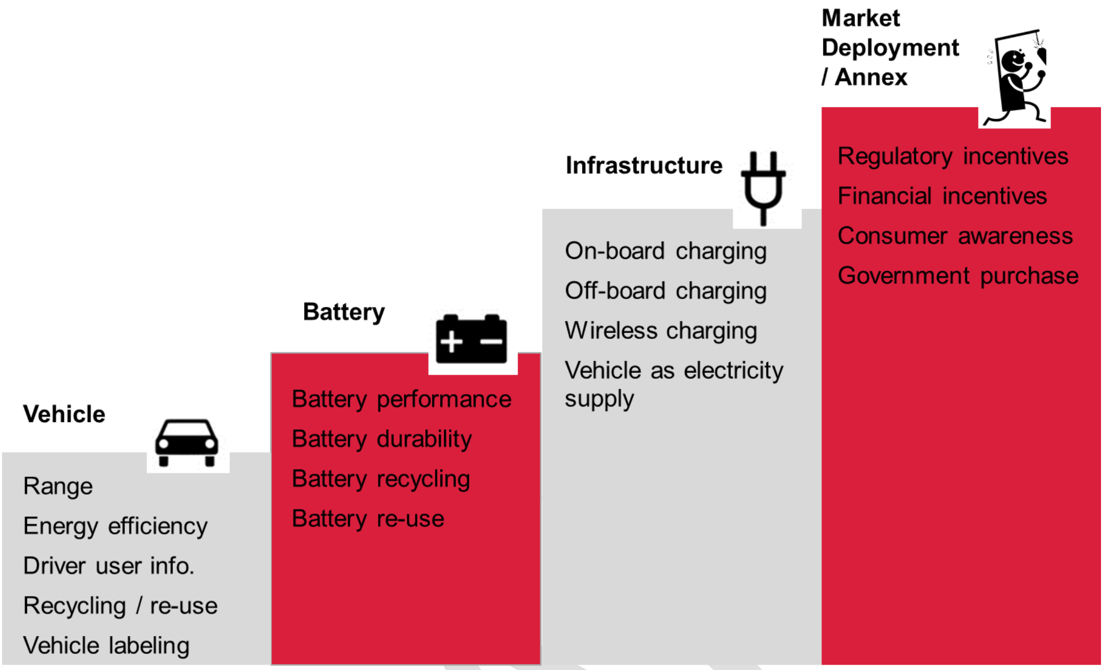

Figure 3 : Groups and Corresponding Attributes, EV Reference Guide

2.2 EV Reference Guide Methodology

In order to gather input from Working Party on Pollution and Energy (GRPE) Contracting Parties, relevant working groups, and other stakeholders concerning global EV regulations, a survey-based approach was employed. A questionnaire was developed by the IWG EVE membership, and with the aid of a consultant, subsequently deployed to stakeholders listed above for their input. Figures 4 and 5 provide an overview of parties that completed the surveys.

In-line with the attribute-focused layout of the reference guide, the questionnaire was designed to revolve around these same attributes. Although each attribute is defined in the questionnaire, it was recognized that Contracting Parties and other relevant WP.29 working groups may have slightly different definitions. In such circumstances, these parties were encouraged to contribute information for each attribute regardless of the exact definition.

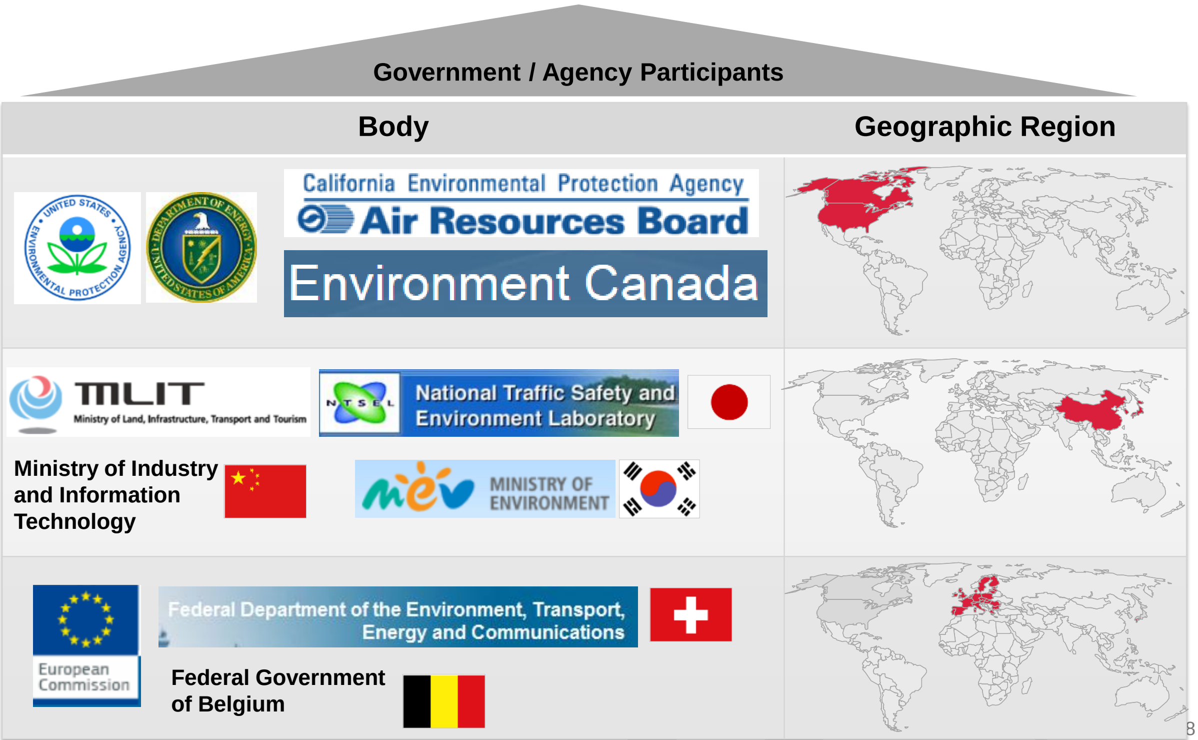

Figure 4 : Government Participants, EV Reference Guide Survey

Figure 5 : Other Stakeholder Participants, EV Reference Guide Survey

It was decided by the IWG EVE leadership that the government responses would form the foundation of the reference guide, while the other stakeholder responses would supplement this foundation. All parties were then invited to review and comment on draft versions of the reference guide. In addition to the survey responses, all relevant UNECE regulations and on-going efforts to address EV requirements through other WP.29 working groups will be captured in the reference guide. Figure 6 summarizes the various sources that will inform the content of the reference guide.

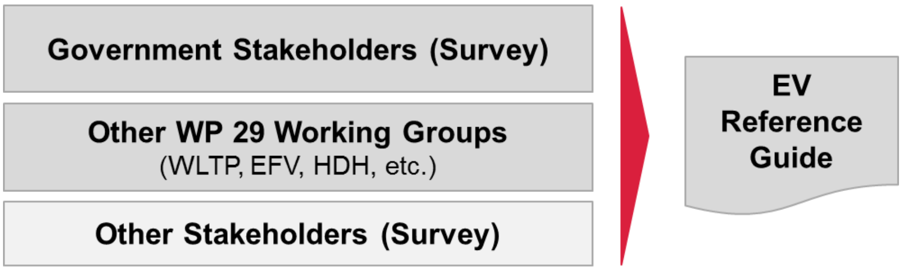

Figure 6 : Information sources, EV reference guide

3 Summary of Findings

Findings are based primarily on the survey responses and corresponding follow up communications, with additional companion research as necessary to develop a more complete picture of the selected attributes.

Vehicle Attributes

Figure 7 provides a global overview of the regulatory landscape from the standpoint of vehicle attributes. The following sections will discuss each attribute in detail.

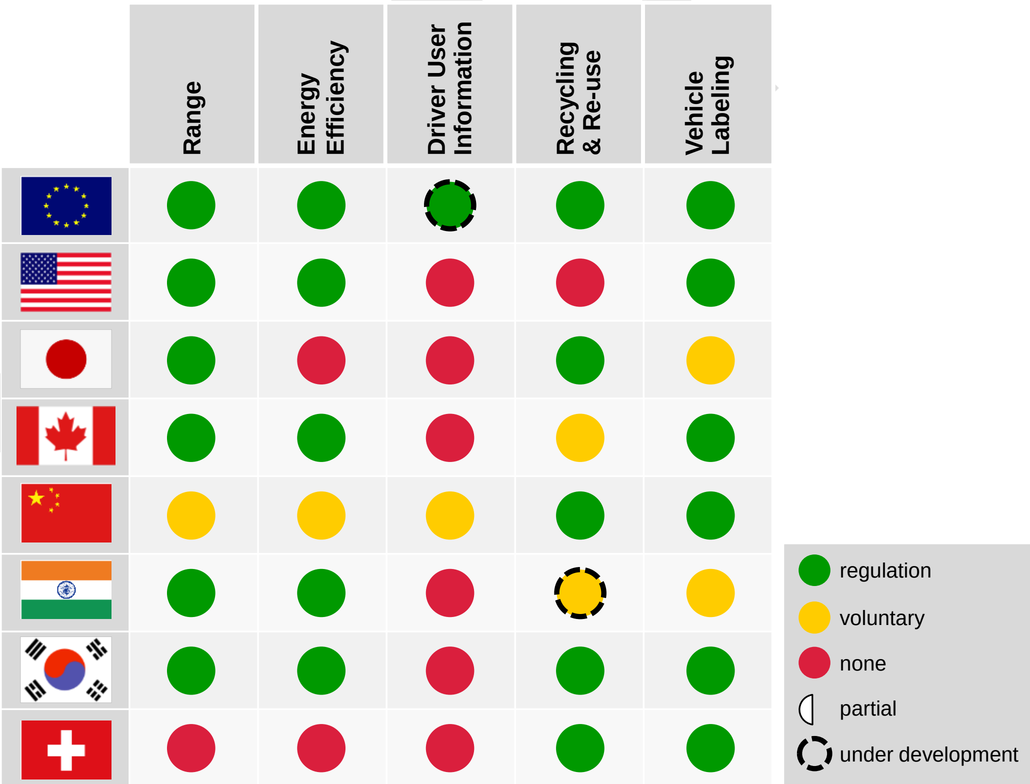

Figure 7 : Vehicle attributes, global snapshot

3.1 Electrified Vehicle Range

Figure 8 provides a global picture of the responses received concerning electrified vehicle range. This can also be observed from the first column in Figure 7.

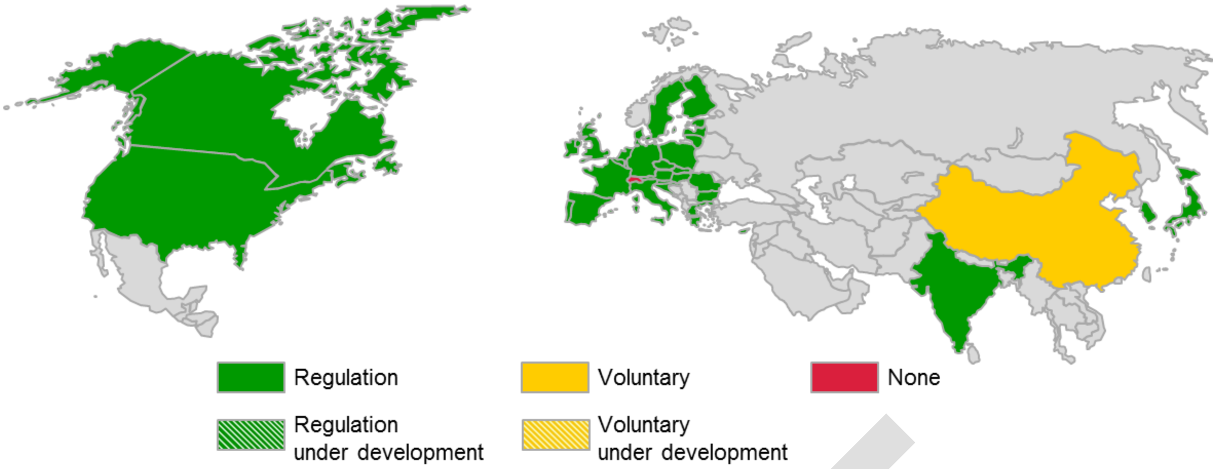

Figure 8 : Electric vehicle range requirements, world-wide view

Electrified vehicle range is widely regulated, with the SAE J1634 recommended practice adopted as the test procedure for the US EPA/NHTSA and Canada. South Korea employs a similar procedure. The California Air Resources Board (ARB) has its own range test procedure employed in determination of allowance credits in connection with its Zero Emission Vehicle (ZEV) Regulation. The European Commission determines range in accordance with UN ECE 101, Annex 9. India has adopted many aspects UN ECE 101, Annex 9 in its test own test procedure (AIS 040). Japan specifies its own test procedure based on the JC08 dynamometer test cycle (TRIAS 99-011-01). China has a voluntary Chinese National Standard that is available for adherence to (GB/T 18386-2005). Switzerland does not specify any regulations or voluntary standards in regards to electrified vehicle range. The WLTP-DTP sub-group is working on a revision of EV test procedures that will affect the measurement of electrified vehicle range. This is being accomplished through a GTR that will be finalized in 2014 (GRPE-66-02, Annex 8).

3.2 Energy Consumption/Efficiency

Figure 9 provides a global picture of the responses received concerning electric vehicle energy consumption/efficiency. This can also be observed from the second column in Figure 7.

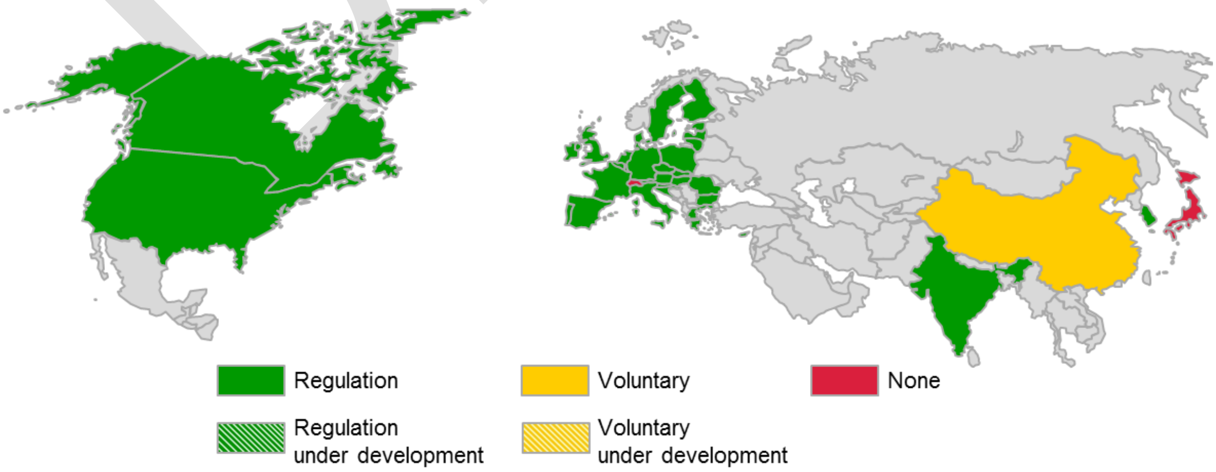

Figure 9 : Electrified vehicle energy consumption/efficiency requirements, world-wide view

US EPA/NHTSA require that electric vehicle energy consumption be determined in accordance to SAE J1634 (BEV), J1771 (HEV) and J2841 (PHEV). Canada has adopted the same requirements in its own federal regulations, and so has South Korea. California does not have separate requirements for energy consumption and is generally aligned with the preceding US Federal regulations. The EC regulates EV energy consumption through the test procedure outlined in UN ECE 101, Annex 7. India's test requirements (AIS 039) draw extensively from UN ECE 101, Annex 7. There are voluntary Chinese National Standards pertaining to energy efficiency of EVs (GB/T 18386-2005) and HEVs (GB/T 19753-2005). Japan and Switzerland do not have any requirements in place that address electric vehicle energy consumption/efficiency. The WLTP-DTP sub-group is working on a standardized EV/HEV test procedure that will impact the measurement of electrified vehicle energy consumption/efficiency. This is being accomplished through a GTR that will be finalized in 2014 (GRPE-66-02, Annex 8).

3.3 Electrified Vehicle Driver-User Information

Figure 10 provides a global picture of the responses received concerning electrified vehicle driver-user information. This can also be observed from the third column in Figure 7.

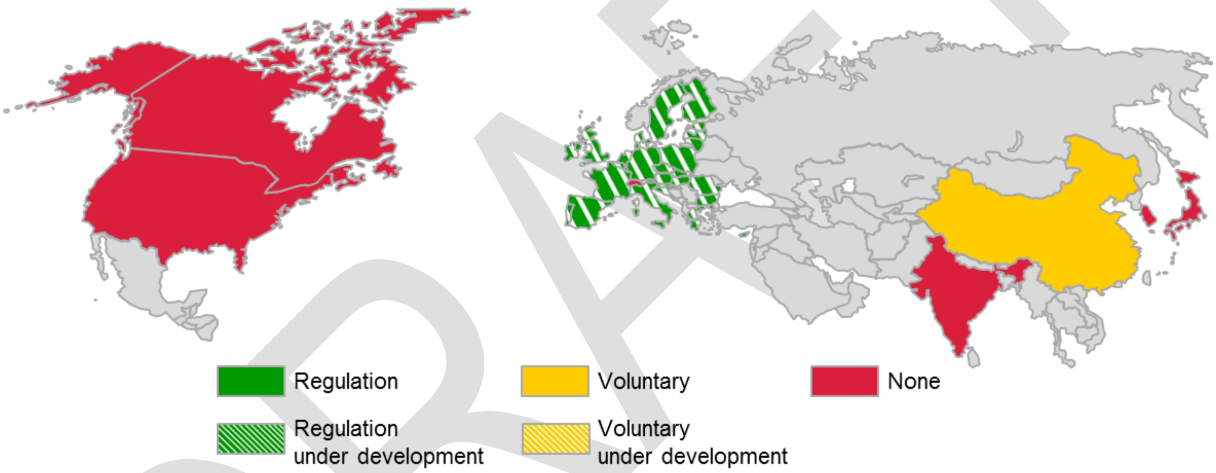

Figure 10 : Electrified vehicle driver-user information requirements, world-wide view

Driver-user information is an attribute that is largely lacking any formal regulation globally at the present time. China is the exception with a voluntary Chinese National Standard GB/T 4094.2-2005 that specifies EV-specific symbols relating to controls, indicators and tell-tales. The WLTP group plans to develop a GTR in connection with this attribute that will be released in the 2015-2016 timeframe. This GTR will be subsequently adopted into EC regulations and be available for adoption by member countries.

3.4 Electrified Vehicle Recycling and Re-use

Figure 11 provides a global picture of the responses received concerning electrified vehicle recycling and re-use. This can also be observed from the fourth column in Figure 7. The EC regulates M1 and N1 type vehicle recycling through its Directive on End-of-Life Vehicles (2000/53/EC). This same law underlies the equivalent Swiss federal regulation. 2005/64/EC is a subsequent law that further stipulates the degree of recyclability required for M1 and N1 vehicles prior to their approval for sale in the EU. Canada employs a voluntary code of conduct to guide recyclers knows as the Canadian Auto Recyclers' Environmental Code

(CAREC). China has a mandatory Chinese National Standard that governs vehicle end-of-life recycling and dismantling (GB 22128-2008). South Korea stipulates requirements for vehicle recycling through Act No. 6319 of the National Assembly of Korea. Japan governs vehicle recycling through Act No. 87 of the Ministry of Economy, Trade and Industry (Act on Recycling, etc. of End-of-Life Vehicles). India is in the process of formulating standards for vehicle recycling. It is assumed that these will initially be voluntary in nature. The US does not presently have any federal requirements that govern vehicle recycling.

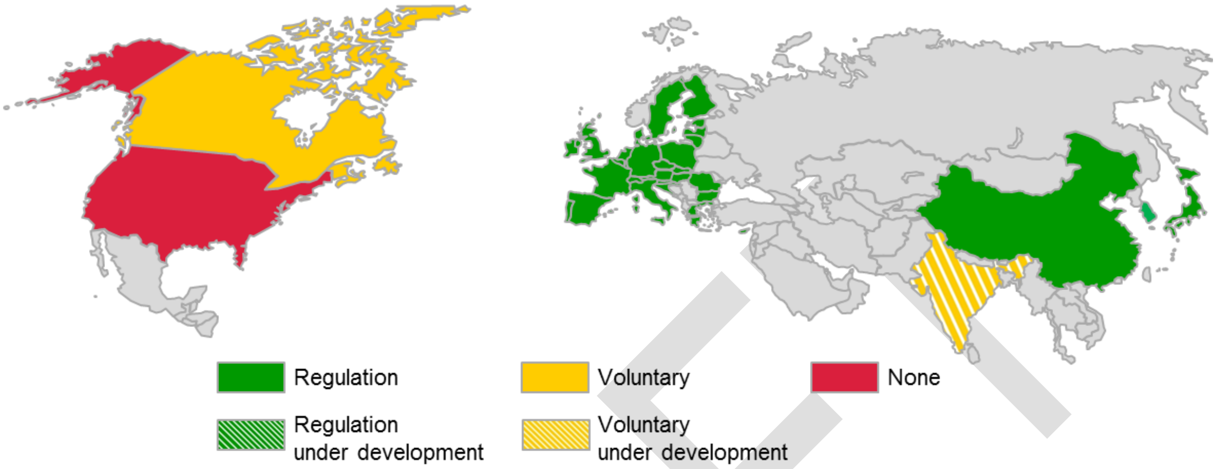

Figure 11 : Electrified vehicle recycling and re-use requirements, world-wide view

It should be noted that in addition to governing the recycling of vehicles, Japan and Korea have laws that require vehicle manufacturers to pro-actively emphasize recyclability in the design and manufacture of their products.

3.5 Vehicle Labeling

Figure 12 provides a global picture of the responses received concerning vehicle labeling requirements. This can also be observed from the fifth column in Figure 7.

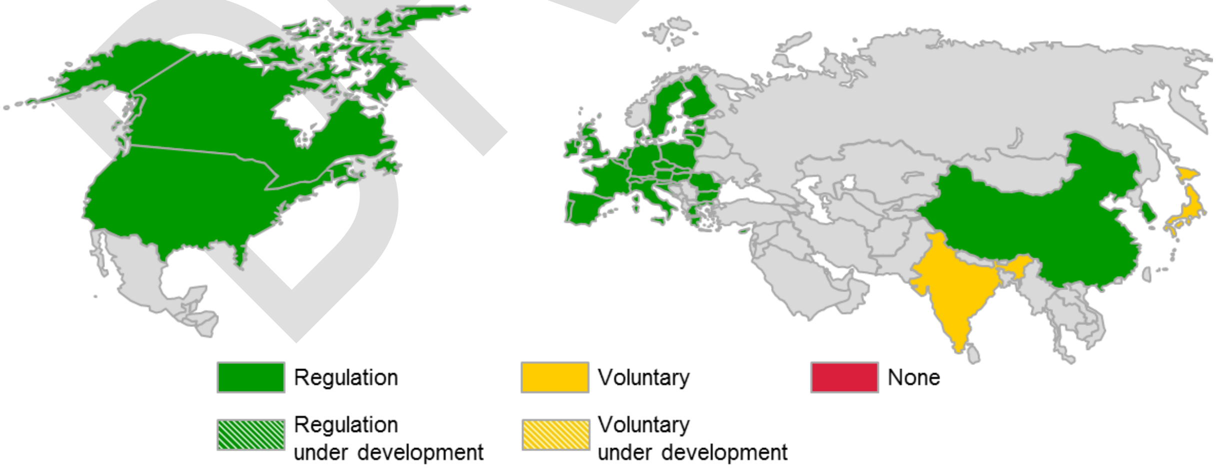

Figure 12 : Vehicle labeling requirements, world-wide view

Vehicle labeling worldwide is predominantly in relation to fuel economy, with some countries also reporting additional characteristics such as CO_2 emissions and estimated fuel costs. The US EPA employs a series of ‘fuel economy and environment’ labels that address conventional gasoline/diesel powered vehicles, flex-fuel vehicles, CNG vehicles, PHEVs (both series and blended), EVs, and hydrogen FCVs. All labels include fuel economy information, as well as greenhouse gas and smog ratings based on a relative scale of 1 to 10. Alternative fuel and electrified vehicles feature gasoline equivalent MPG (so-called MPGe) ratings to facilitate comparison activity as well as a statement of range attainable on a single tank of fuel and/or a single full charge of the on-board battery pack. Natural Resources Canada employs a basic fuel economy label that went into effect in 1990. The label provides city and highway fuel economy and a corresponding estimated annual fuel cost. There is an effort in place to enhance the labeling which will include coverage of advanced technology powertrains (including electrified vehicles). These new labels are expected to be introduced by 2015 and will align closely with present US EPA labeling practices. The EC employs a fuel economy label that provides fuel consumption, annual operating cost, and CO_2 emissions. CO_2 emissions are ranked using an alphabetized grade (A-M) system which determines the level of Vehicle Excise Tax (VET) imposed for registration of the vehicle. There are no provisions for capturing the fuel economy of electrified vehicles at this time. China's light vehicle labeling requirements are captured in a mandatory National Standard (GB 22757-2008). The label features three fuel economy ratings covering urban, suburban driving conditions and a composite of the two referred to as 'integrated operating condition.' This label only applies to vehicles equipped with conventional internal combustion engine powertrains. South Korea introduced fuel economy labels in 2005, requiring the specification of city, highway, and combined fuel economy values. A CO_2 emissions estimate is provided (corresponding to the combined fuel economy value) in addition to a numerical grade between 1 and 5, denoting the relative excellence in fuel economy (1 being best). No provisions are in place for indicating the fuel economy of electrified vehicles. Switzerland requires labels indicating fuel consumption, CO_2 emissions, and a letter grade between (A-G) denoting relative excellence in fuel economy. India does not have regulations governing vehicle labeling, there are however two voluntary label formats available for adherence to by vehicle manufacturers. The two formats are from the Society of Indian Automobile Manufacturers (SIAM) and Bureau of Energy Efficiency (BEE) respectively with both mainly focused on a single average value for vehicle fuel consumption. Electrified vehicles are not addressed by either one of these labels. Japan has voluntary fuel economy performance stickers that can be affixed to vehicles that meet or exceed federal fuel economy standards. These labels indicate that the vehicles bearing them are eligible for fiscal incentives only and do not provide any specifications or actual statement of fuel consumption. There is no label available for EVs, PHEVs, or vehicles featuring natural gas or clean diesel powertrains, despite these vehicles being included under the same fiscal incentive scheme.

Battery Attributes

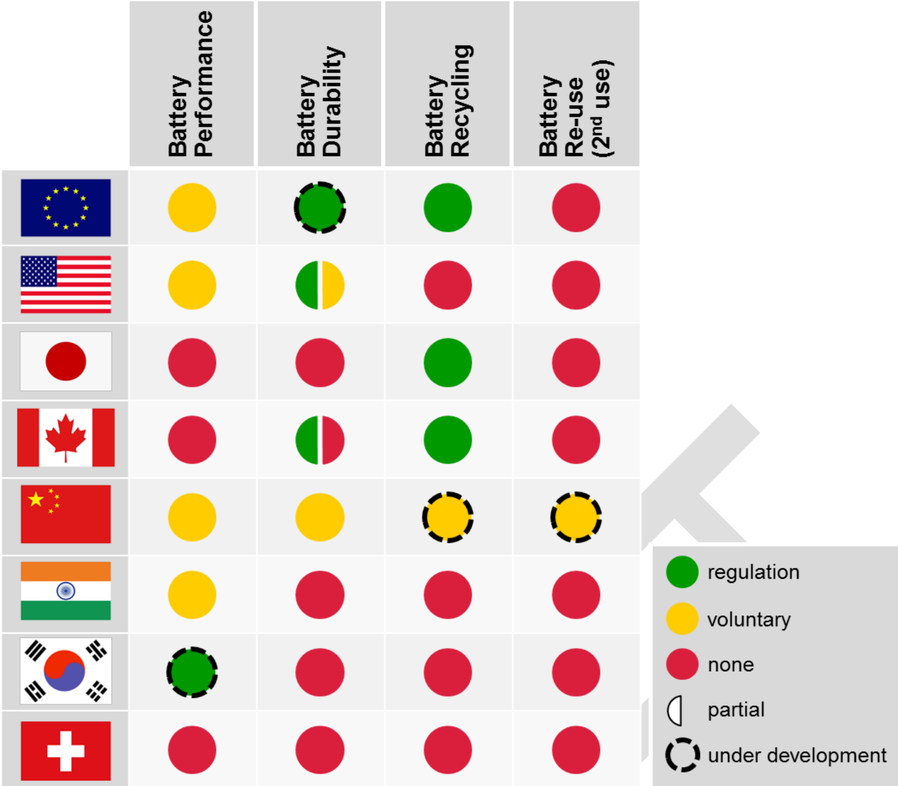

Figure 13 : Battery attributes, global snapshot

Figure 13 provides a global overview of the regulatory landscape from the standpoint of battery attributes. The following sections will discuss each attribute in detail.

3.6 Battery Performance

Figure 14 provides a global picture of the responses received concerning battery performance requirements. This can also be observed from the first column in Figure 13.

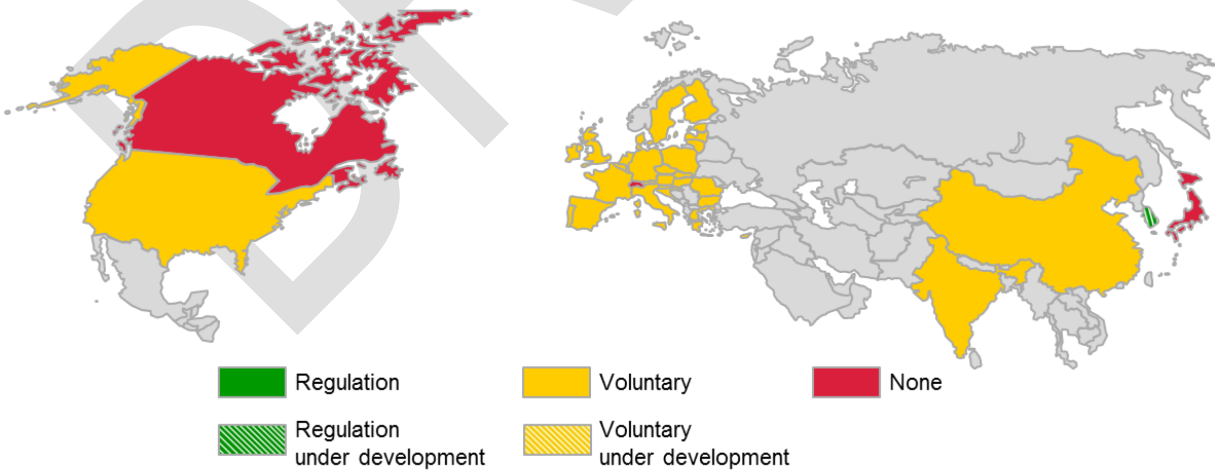

Figure 14 : Battery performance requirements, world-wide view

There are presently no US Federal regulations that specify requirements for determining battery performance. There are however voluntary procedures for battery performance testing established by the United States Advanced Battery Consortium (USABC), a collaborative effort between the big three domestic automakers (GM, Ford, Chrysler). There is also an SAE recommended practice that is currently in formulation (J1798). The EC does have stipulations concerning specifications that must be furnished for electrified vehicle battery performance through UNECE Regulation 101, Annex 2. A test procedure however is not specified at this time. ISO 12405-1:2011 (high-power applications) and ISO 12405-2:2012 are available as optional test procedures for Lithium-ion traction battery performance. IEC 62660-1 also represents an optional standard for battery performance testing. India has a voluntary standard that specifies requirements and test procedures for lead acid batteries for use on battery powered road vehicles and other applications (BIS 13514-1992). Lithium Ion batteries are not addressed by the standard. There are a number of voluntary standards relating to the performance of Lithium-ion batteries for electric road vehicles in China (QC/T743-2006, GB/Z 18333.1-2001 and others). South Korea is in the process of formulating a standard for measuring the power of traction batteries, which when completed will be adopted as a Korea Motor Vehicle Safety Standard (KMVSS). Japan and Canada do not presently have requirements in place that address battery performance.

3.7 Battery Durability

Figure 15 provides a global picture of the responses received concerning battery durability requirements. This can also be observed from the second column in Figure 13.

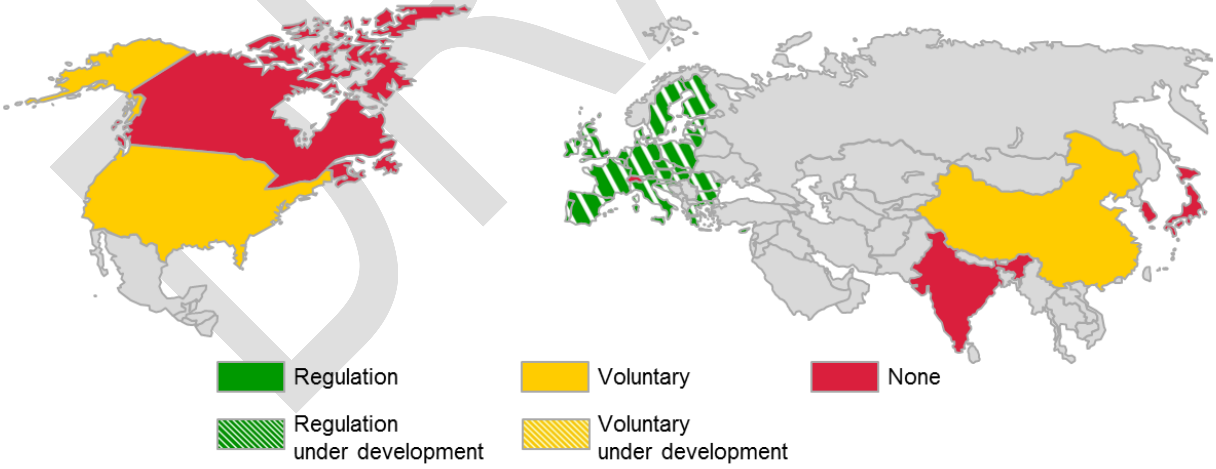

Figure 15 : Battery durability requirements, world-wide view

The US EPA/NHTSA specifies a procedure for measuring the deterioration of PHEV batteries. This is to ensure that the CO_2 emissions from the vehicle do not increase excessively over the useful life of the vehicle. The regulation requires that CO_2 deterioration not exceed 10% of a vehicles certified value at full useful life. There are no regulations in place to address the durability of battery packs in pure electric vehicles, but the USABC has voluntary test procedures that can be followed for testing these so-called rechargeable energy storage devices (RESSs). There also exist voluntary SAE standards for battery module life cycle testing (J2288) and vibration testing (J2380). The California Air Resources Board (ARB) stipulates a durability requirement for HEVs and PHEVs that is required in order to earn credits under the California ZEV regulation. This requirement is enforced through a 10 year, 150,000 mile warranty of "zero-emission energy storage device used for traction power" that automakers must provide in conjunction with the sale of these vehicles. Canada has adopted into Federal law the US procedure for PHEVs, and does not presently have anything in place with regard to battery electric vehicles (BEVs). China has established voluntary guidelines for the determination of battery reliability and durability through the QC/T 743-2006 Automotive Industry Standard. The EC does not presently have battery durability requirements, but will adopt into law durability test requirements that are planned to be developed within the framework of the WLPT. Adoption is expected in the 2015/2016 timeframe. Voluntary standards ISO 12405-1:2011 (International Standards Organization) and IEC 62660-2 (International Electrotechnical Commission) both address durability testing of Lithium Ion batteries and are expected to be referenced in this upcoming GTR. Japan, India, South Korea, and Switzerland do not presently have requirements relating to battery durability.

3.8 Battery Recycling

Figure 16 provides a global picture of the responses received concerning battery performance requirements. This can also be observed from the third column in Figure 13.

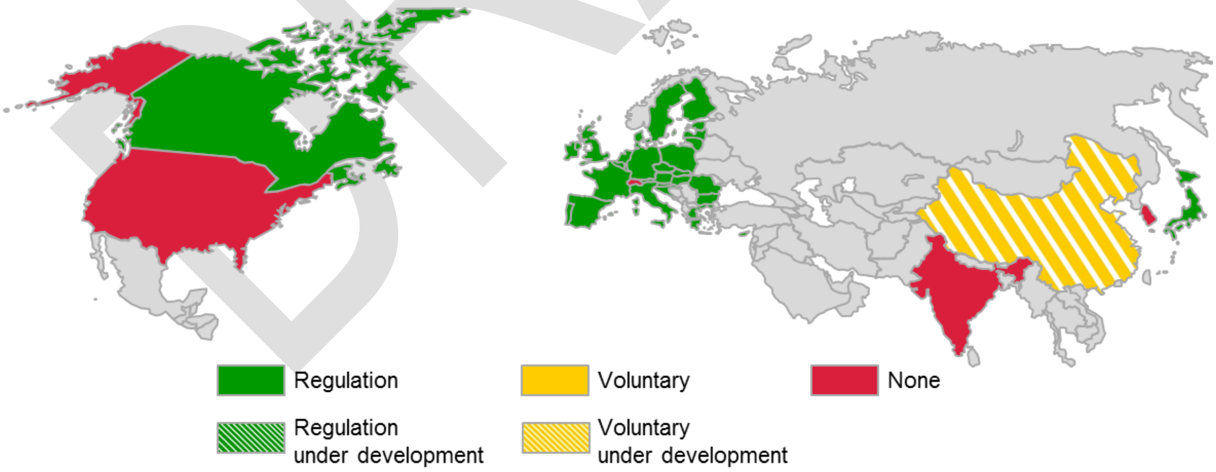

Figure 16 : Battery recycling requirements, world-wide view

In the EC, battery recycling is addressed by the same legislation addressing vehicle recycling, which is Directive 2000/53/EC on end-of-life vehicles. Additionally, directive 2006/66/EC stipulates additional battery-specific requirements relating to maximum permissible quantities of hazardous elements in the batteries themselves as well required recycling, collection and disposal procedures. Japan governs battery recycling through Act

No. 87 of the Ministry of Economy, Trade and Industry (Act on Recycling, etc. of End-of-Life Vehicles). Canada does not have a single specific requirement for the recycling of batteries but indirectly mandates the proper recycling of batteries through underlying general recycling and disposal laws including the Canada Water Act (R.S.C. 1985, c. C-11), Canadian Environmental Assessment Act (S.C. 1992, c. 37), Canadian Environmental Protection Act (1999, c. 33), Transportation of Dangerous Goods Act, and the Fisheries Act (R.S.C. 1985, c. F-14). Chinese standards relating to battery recycling do not exist at the present time, but are said to be under formulation. The US, India, South Korea and Switzerland do no presently have requirements governing battery recycling.

3.9 Battery Re-use (post-mobility)

Figure 17 provides a global picture of the responses received concerning battery re-use requirements. This can also be observed from the fourth column in Figure 13.

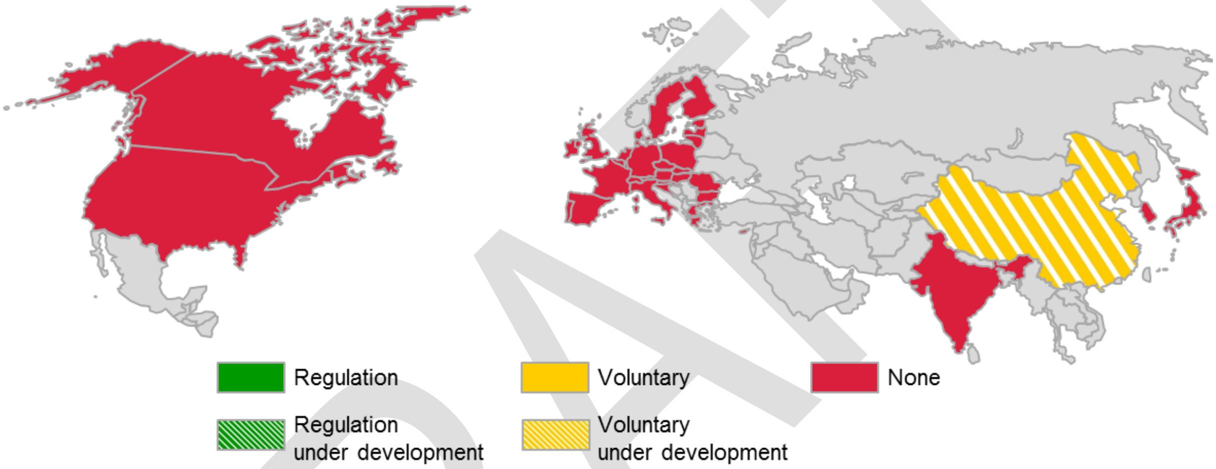

Figure 17 : Battery re-use requirements, world-wide view

There are no standards or regulations pertaining to battery re-use currently in place world-wide. China is said to be formulating battery re-use standards. Battery re-use or second-use as it is sometimes called is somewhat of a research topic at the moment. Given that batteries dominate the cost of electrified vehicles and are typically deemed unusable from a mobility standpoint after degrading to between 70 and 80% of full capacity, there is a compelling reason to take a serious look at re-using these batteries in other applications. Some believe that re-purposing of these batteries could result in an EV ownership cost reduction which could subsequently spur EV adoption rates. Automakers such as BMW, Nissan, and General Motors in partnership with companies like ABB and Vattenfall are actively exploring possible second-use applications for retired EV battery packs. Applications being studied range from home or neighborhood back-up power systems, to more advanced grid power buffering strategies (smart grid). Figure 18 shows a microgrid backup system powered by 5 used Chevy Volt batteries, which was the result of a collaboration effort between ABB and General Motors.

Figure 18 : Microgrid battery backup technology, General Motors, ABB collaboration (Source: gas2.org)

In order to ensure the success of battery re-use, guidelines and regulations that govern the implementation, as well as ensure the reliability and durability of such systems are crucial. This is likely to be challenging given that used batteries could embody a wide range of usage behaviors that can in turn influence the consistency of their performance over time.

Infrastructure Attributes

Figure 19 provides a global overview of the regulatory landscape from the standpoint of battery attributes. The following sections will discuss each attribute in detail.

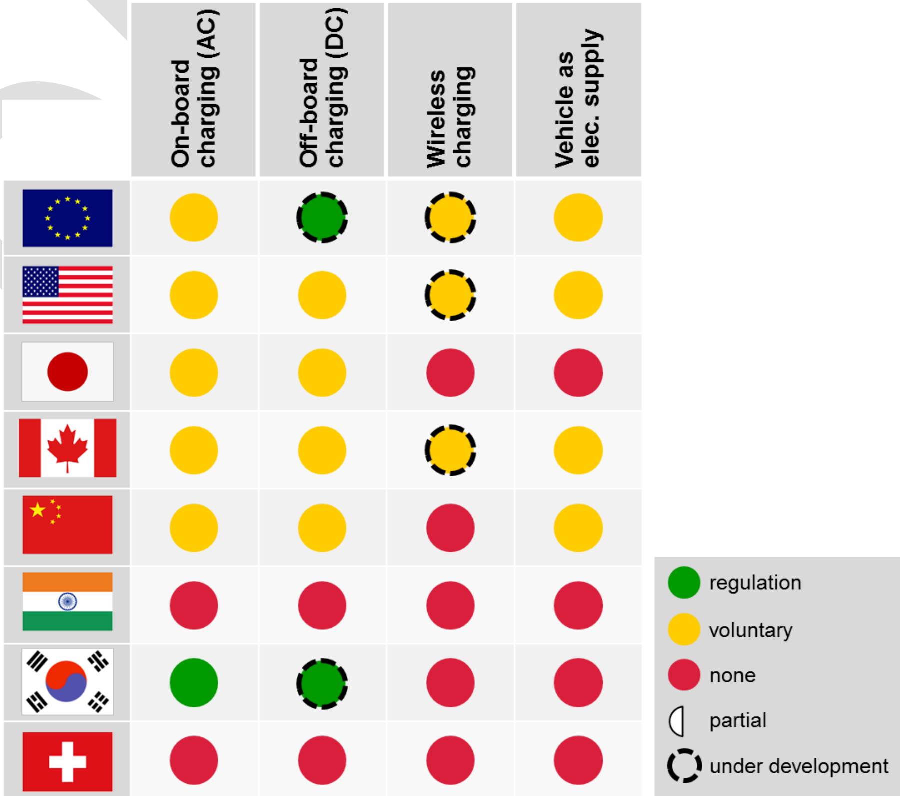

Figure 19 : Infrastructure attributes, global snapshot

3.10 On-board Charging System

Figure 20 provides a global picture of the responses received concerning on-board charging requirements. This can also be observed in the first column of Figure 19.

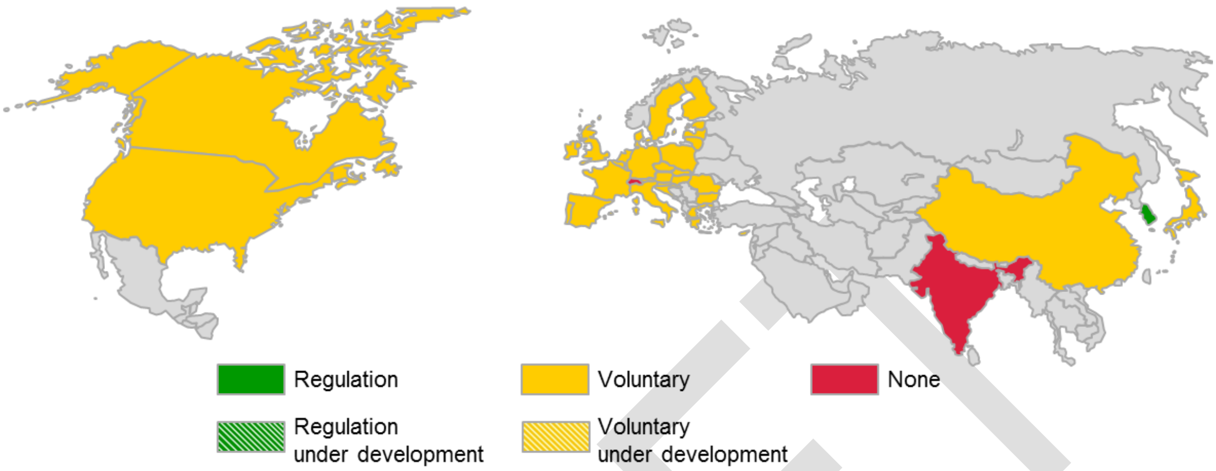

Figure 20 : On-board charging system requirements, world-wide view

Globally, on-board charging is generally guided by IEC 61851 standards (IEC 61851-1, IEC 61851-21, IEC 61851-22) that specify the general requirements and functionality of conductive charging equipment. IEC 62196 standards define charging modes and connector requirements. IEC 62196-1 and 62196-2 pertain to on-board or AC charging systems. South Korea has established on-board charging regulations based on these IEC standards (KS C IEC 61851-1, KS C IEC 61851-22). The EC generally adheres to the definitions contained in these IEC standards on a voluntary basis (European Mennekes connector). This is also true for the US and Canada (Yazaki connector / SAE J1772), and Japan (CHAdeMO connector / SAE J1772). In California, ZEVs and PHEVs must meet the requirements of SAE 1772 (AC connection) in order to qualify for ZEV credits. China has in place voluntary standards relating to on-board charging. These include a Chinese National Standards (GB/T 20234.1 2011, GT/T 20234.2-2011) and an Automotive Industry Standard (QC/T 895 2011). India and Switzerland do not presently have any requirements in place relating to on-board charging.

3.11 Off-board Charging Standard Related to the Vehicle

Figure 21 provides a global picture of the responses received concerning off-board charging system requirements. This can also be observed in the second column of Figure 19.

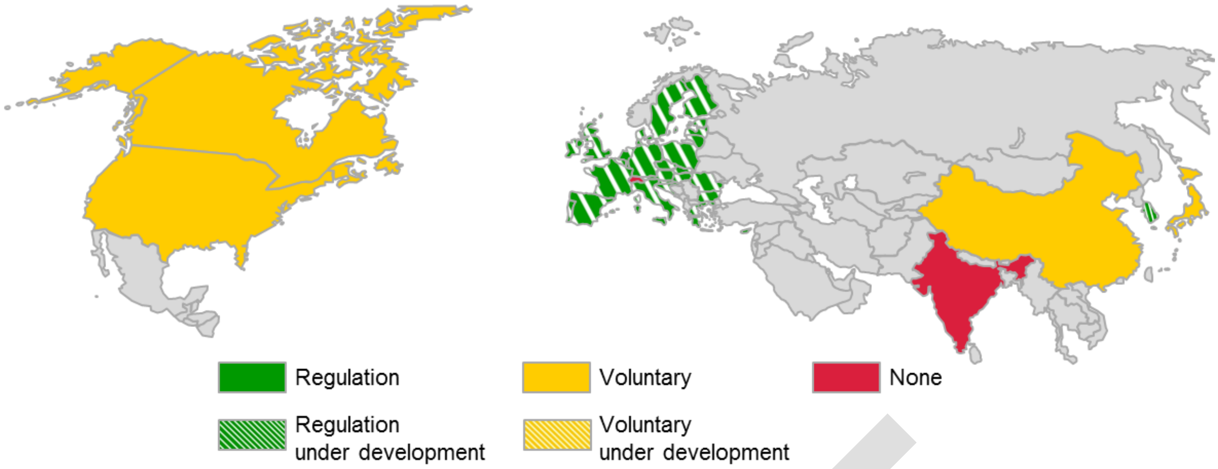

Figure 21 : Off-board charging system requirements, world-wide view

Globally, off-board charging is generally guided by IEC 61851 standards (IEC 61851-1) that specify the general requirements and functionality of conductive charging equipment. IEC 62196 standards define charging modes and connector requirements. IEC 61851-23 and IEC 61851-24 are the next anticipated standards that will define off-board charging requirements from a charging station and communication protocol perspective and are expected towards the end of 2013. IEC 62196-3 is the next anticipated standard that will define connectors and inlets for DC off-board charging. The EC is in-line to adopt this standard into law once it is released (2014-2015 timeframe). South Korea will also adopt these standards into its law. The US and Canada have voluntary standards for off-board DC charging through SAE J1772 (up to DC Level 2), and Japan through the CHAdeMO connector system (JARI/TEPCO). China maintains several voluntary standards in relation to off-board charging. These include Chinese National Standards (GB/T 20234.3-2011, GB/T 27930-2011) and Energy Industry Standards (NB/T 33001-2010, NB/T 33003-2010). India and Switzerland do not presently have any requirements in place relating to off-board charging. Figure 22 summarizes the various IEC standards governing on- and off-board charging and the anticipated timing of their release.

Year	**2010**				**2011**				**2012**				**2013**			
Quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
AC/DC				◆ 61851-1				◆ 62196-1	◆ 61851-21							
AC								◆ 62196-2	◆ 61851-22							
DC															◆ 62196-3 ◆ 61851-23	◆ 61851-24

Figure 22 : IEC standards governing on- and off-board charging

3.12 Wireless Charging

Figure 23 provides a global picture of the responses received concerning wireless charging requirements. This can also be observed in the third column of Figure 19.

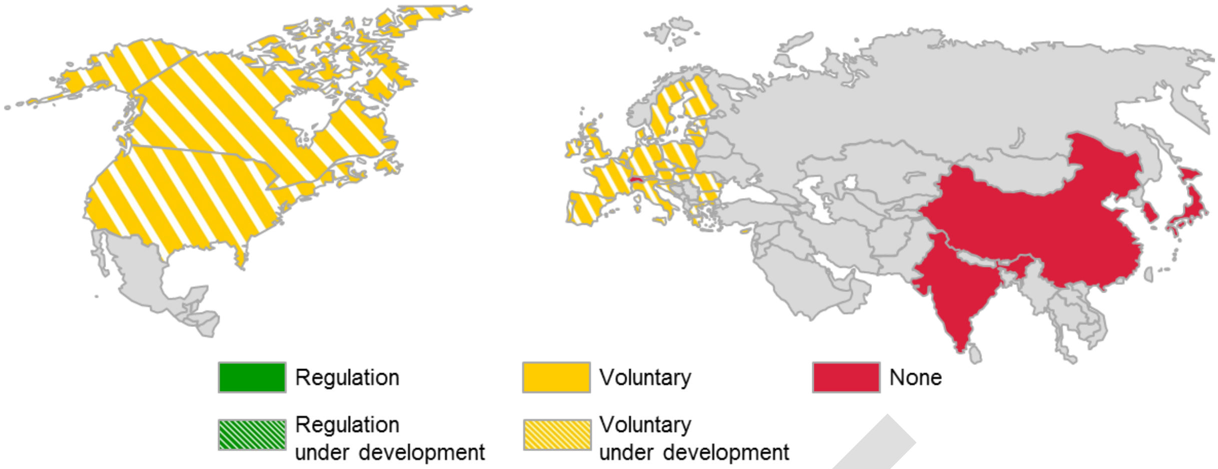

Figure 23 : Wireless charging system requirements, world-wide view

There are neither legislated nor voluntary requirements for wireless charging anywhere in the world at the present time. In the US, there is an SAE standard that is currently in formulation (efforts commenced in 2010) that will eventually lead to a published, voluntary recommended practice (J2954). Voluntary adherence with this standard is also expected in Canada. The EC will similarly be the recipient of several voluntary IEC standards stipulating requirements pertaining to wireless charging. The key standards are anticipated to be IEC 61980-1 (expected Nov 2014), and IEC 61980-3 (expected Jan 2017). Switzerland, Japan, China, India, and South Korea do not have anything in place in regards to wireless charging at the moment. It is however expected that these countries will eventually adopt in some fashion the upcoming IEC or SAE standards governing wireless charging.

3.13 Vehicle as Electricity Supply

Figure 24 provides a global picture of the responses received concerning vehicle as electricity supply requirements. This can also be observed in the fourth column of Figure 19.

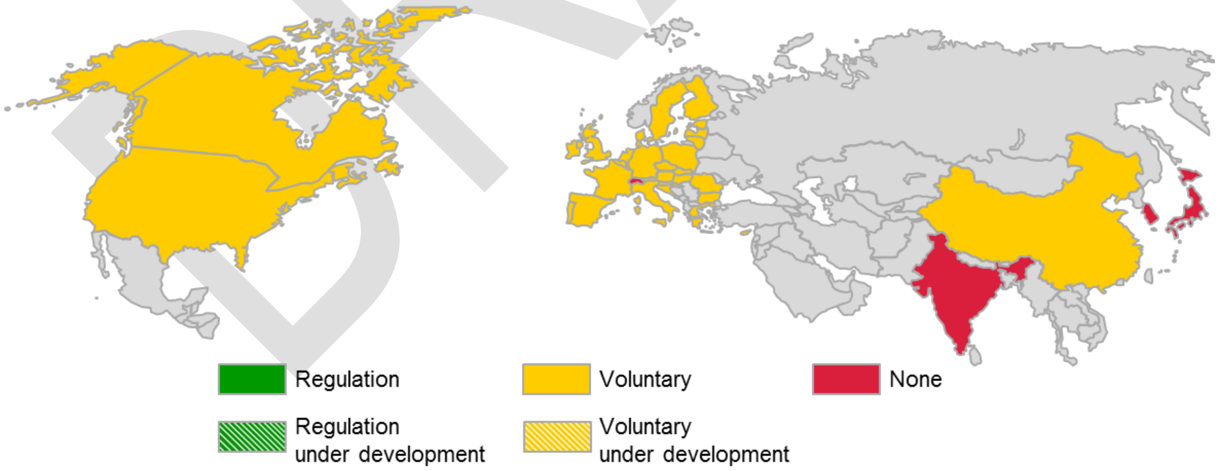

Figure 24 : Vehicle as electricity supply requirements, world-wide view

There are not yet any legislated regulations in place anywhere in the world that govern the requirements of a vehicle functioning as an electricity supply. In the US, initial voluntary standards are available in the form of SAE recommended practices J2836, J2847, and J2931 which are continuing to be developed and extended to more fully address the necessary requirements. These are assumed to apply to Canada as well in the context of voluntary adherence. In the EC, initial portions of an 8 part ISO/IEC standard (ISO/IEC 15118) are currently available while the remaining portions are in formulation. The maturity level of the ISO/IEC standards and their SAE counterparts are generally similar, with a substantial amount of remaining effort required to finalize them for their intended purpose. China does not have any national or professional standards in place, but has several so-called enterprise standards that stipulate basic requirements relating to bi-directional charging equipment (Q/GDW 397-2009, Q/GDW 398-2009, Q/GDW 399-2009). Switzerland, Japan, India and South Korea do not yet have any requirements in place relating to this attribute, but are expected to eventually adopt in some fashion the ISO/IEC or SAE standards that are presently in development.

Market Deployment

Figure 25 provides a global overview of the regulatory landscape from the standpoint of market deployment attributes. Regulatory incentives will be discussed in detail in the following section. The remaining attributes are outside the scope of WP 29 and will be summarized in the Annex.

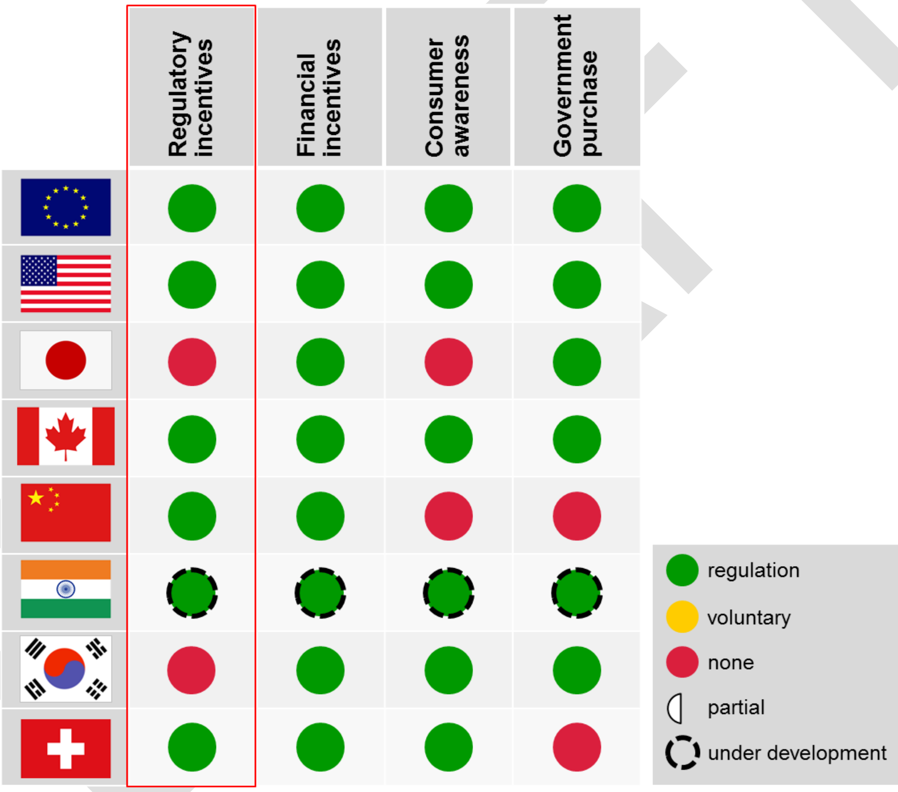

Figure 25 : Market deployment attributes, global snapshot

3.14 Regulatory Incentives

Figure 26 provides a global picture of the responses received concerning regulatory incentives. This can also be observed in the first column of Figure 25. It can be seen that in general, regulatory incentives are widely available throughout the world. In the US, EPA/NHTSA provides a zero tailpipe emission score and bonus credits to plug-in electric vehicles up to a specific cap under the national light duty vehicle GHG emissions regulations. The California zero emission vehicle (ZEV) mandate requires sales percentages of plug-in and fuel cell passenger vehicles to 2025. Credits are based on vehicle type (pure ZEV or plug-in hybrid) and ZEV range. Pure battery electric, fuel cell electric and plug-in hybrids are eligible for credits. California also has a passenger vehicle fleet average GHG standard that is coordinated with the federal GHG standards, and electric vehicles can earn credits towards the GHG fleet average standards. The California program has also been adopted by several other states.

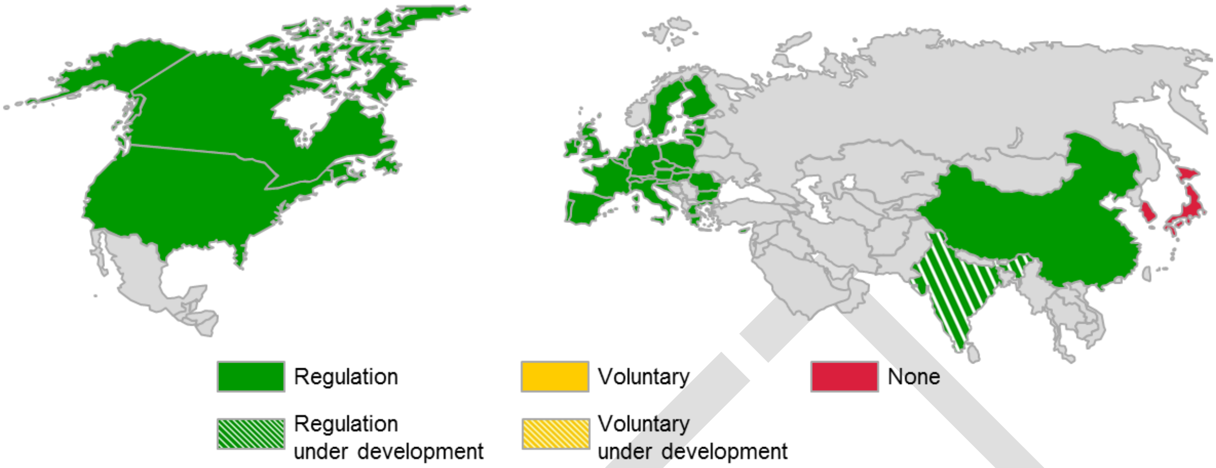

Figure 26 : Regulatory incentives, world-wide view

HOV/HOT lane exemptions are provided to PEVs by many US states to encourage adoption of the technology. The following states presently offer these exemptions: AZ, CA, CO, FL, GA, HI, MD, NC, NJ, NY, TN, UT, and VA. In the EC, regulation 443/2009/EC establishes fleet-wide CO_2 standards that encompass electrified vehicles. Specifically, super-credits are awarded to vehicles emitting below 50g/km of CO_2 between 2012 and 2016. These super credits are being considered for the future 2020 emissions targets as well. Switzerland has adopted this EC regulation into Swiss law. Canada has a pending proposal for regulations that would offer light-duty vehicle manufactures electric vehicle multipliers to promote the deployment of electric vehicle technology. This acts by lowering a manufactures fleet average by allowing the manufacturer to apply a factor of multiplication to each zero emission electric vehicle it sells. Advanced technology credits are already provided under Canadian law for both light-duty and heavy-duty vehicles. Chinese law stipulates that EVs, FCVs, and PHEVs with EV driving range of 50km and higher are assigned a fuel consumption value of zero, while vehicles with poor fuel economy are subjected to fuel consumption penalty multipliers. Advanced technology vehicles are also given priority in the context of vehicle registration and license plate quotas. India is said to have regulatory incentives under formulation as part of the National Mission for Electric Mobility being undertaken by the Government of India. South Korea and Japan do not have regulatory incentives in place at the present time.

4 Conclusions

4.1 High Activity Areas

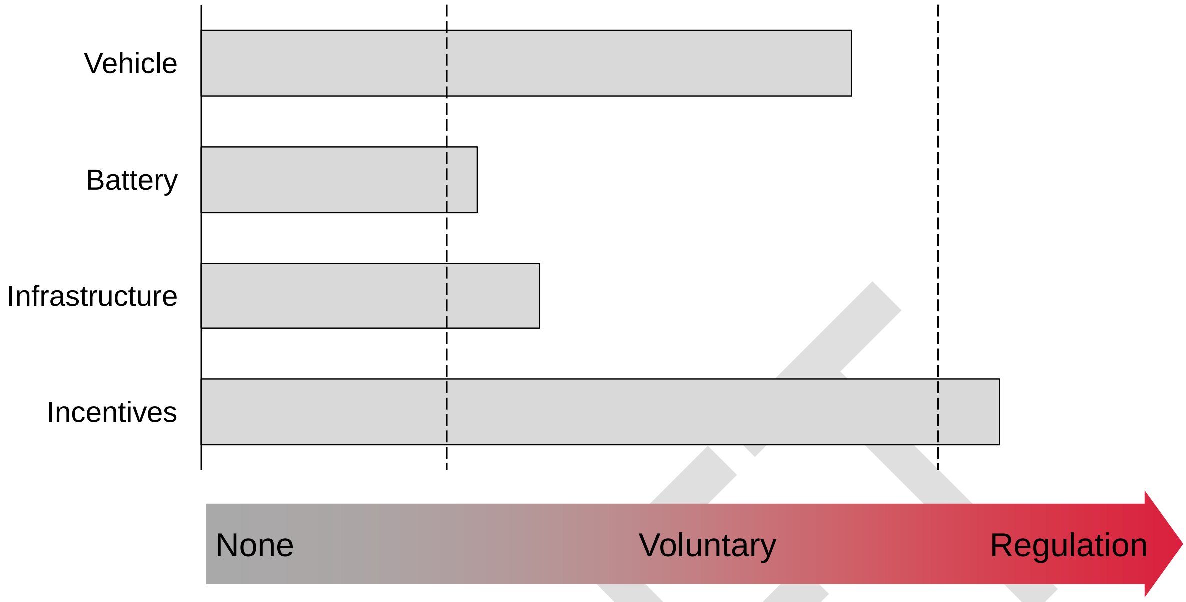

Figure 27 : Activity chart, electrified vehicle requirements

Figure 27 provides an overview of the overall level of activity by attribute, for electrified vehicle requirements. This chart and the ones that follow (Figs. 28-31) employ a simple scoring system where responses of no requirements are assigned a numerical value of 0, voluntary requirements are assigned a value of 1, and legislated requirements are assigned a value of 2.

In general the presence of requirements in the surveyed countries was high with respect to vehicle-level attributes, with the exception of driver-user information which was largely absent across the countries (China has a voluntary system in place). This is illustrated in Figure 28. The latter however will be addressed by a UNECE GTR to be released by the WLTP working group in the 2015-2016 timeframe. Once adopted into EC law, member countries have the option of harmonizing to this upcoming standard.

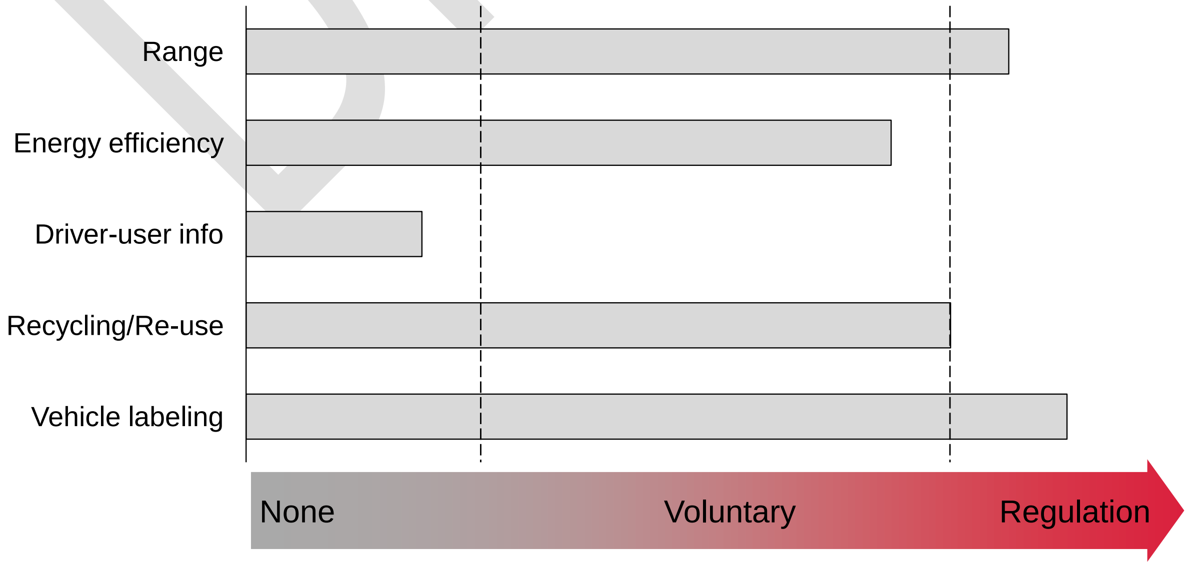

Figure 28 : Activity chart, vehicle attributes

Infrastructure attributes are also generally well represented (Fig. 29), but almost exclusively by voluntary standards.
A number of these attributes such as off-board charging, wireless charging, and vehicle as an electricity supply can be regarded as developing topics in the EV domain. Despite this, requirements to properly address these attributes are being actively and methodically pursued, in most cases through international standards (ISO, IEC, SAE).

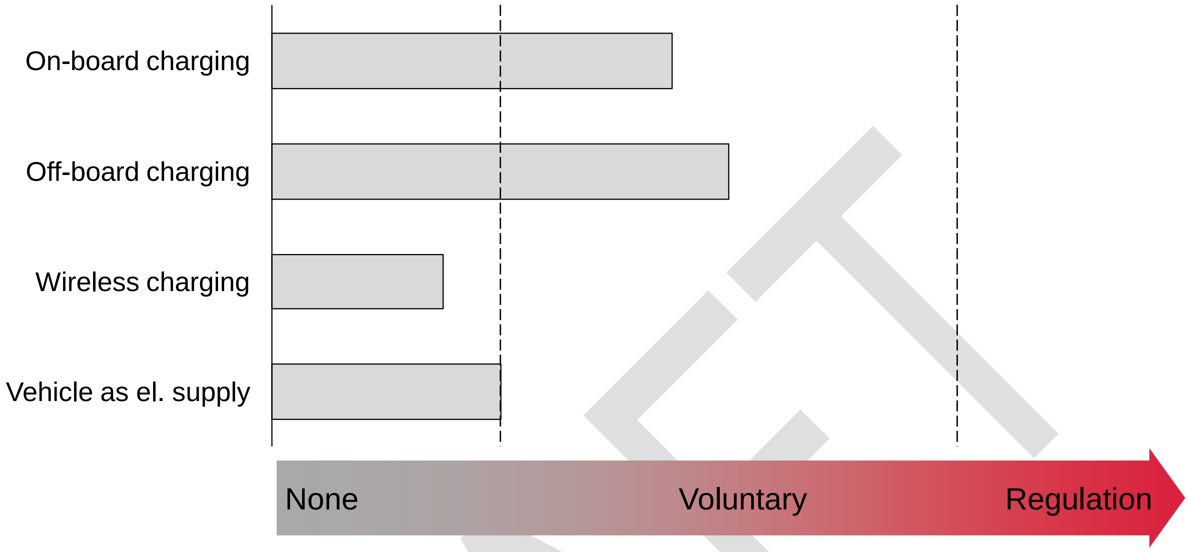

Figure 29 : Activity chart, infrastructure attributes

From a market deployment standpoint, the area of regulatory incentives was also found to be at a high state of activity, with ¾ of the countries/regions surveyed having either incentives already in place, or plans to deploy them in the future (Fig. 30).

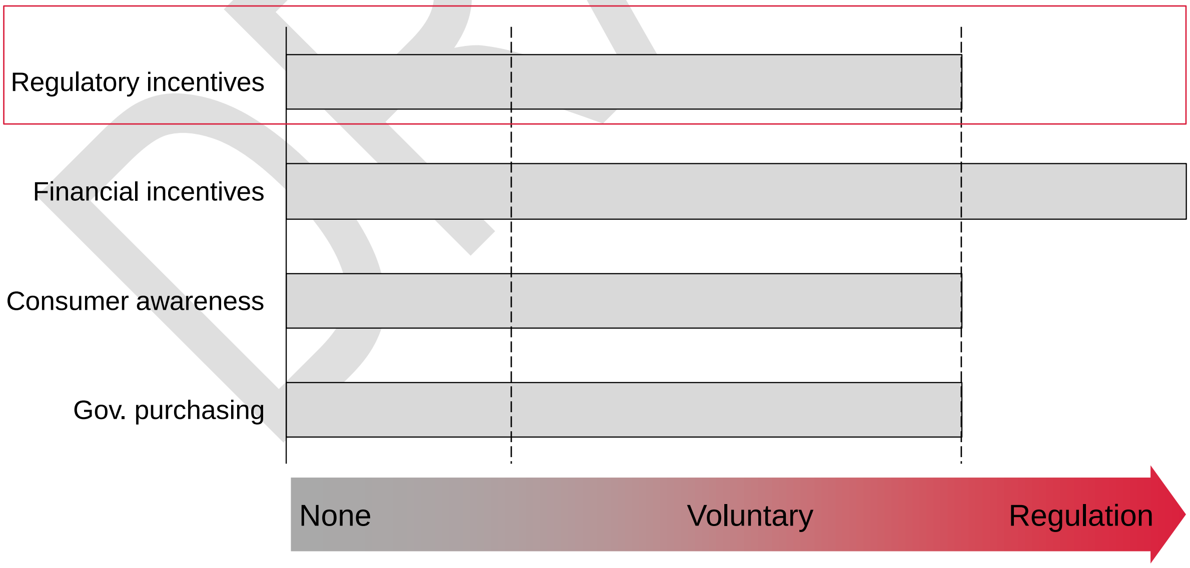

Figure 30 : Activity chart, market deployment attributes

4.2 Low Activity Areas

In general, requirements pertaining to battery-level attributes were low on the activity spectrum (Fig. 27). Figure 31 illustrates the activity level of each sub-attribute. Battery re-use in particular is at present largely without any requirements whatsoever. The exception is

China which is said to be in the process of formulating appropriate standards relating to battery post-mobility use.

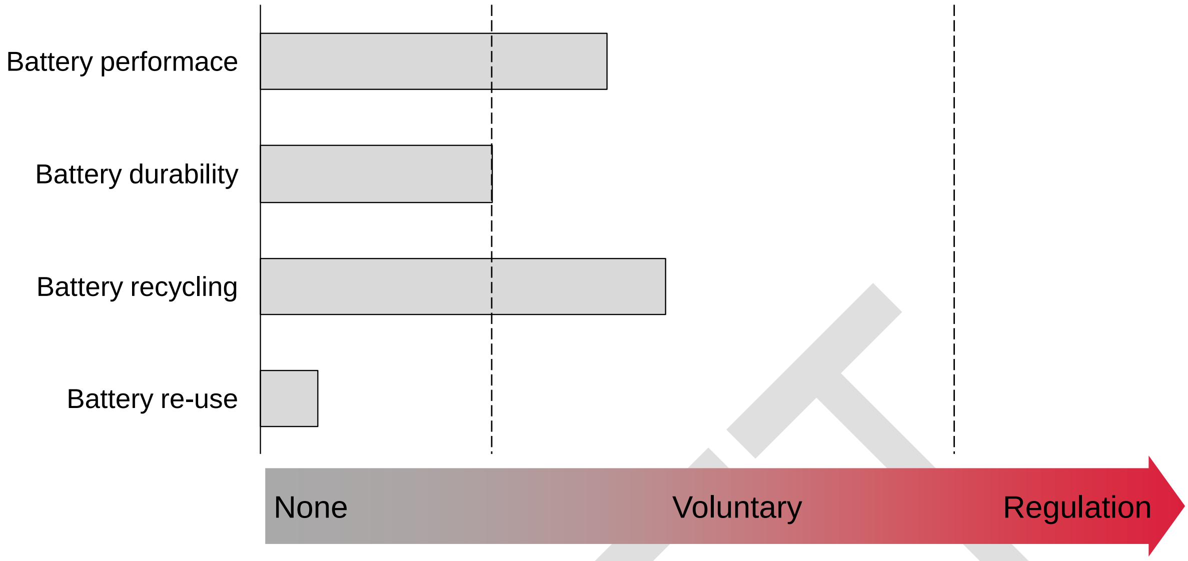

Figure 31 : Activity chart, battery attributes

Battery durability is somewhat unaddressed by present standards, the exceptions being partial coverage (PHEVs) by US and Canadian laws and optional Automotive Industry Standards in China. The activity level is expected to increase however with plans to develop battery durability requirements within the framework of the WLTP, which will be subsequently adopted into EC law (2015/2016). These requirements will not only address battery lifecycle determination, but the impact of partially deteriorated batteries on CO_2 emissions / fuel economy.

Battery recycling is partially addressed, but through largely country-specific protocols and with therefore little standardization from a global perspective. These requirements are also generally non-battery-specific and tend to take the form of general end-of-life vehicle recycling guidelines. The exception is the EC which stipulates battery-specific requirements pertaining to permissible quantities of hazardous materials as well as specific required recycling procedures.

Battery performance is partially addressed, and by a range of largely voluntary standards established by international organizations (SAE, ISO, IEC). There is therefore lack of standardization in regards to the required procedures and hence outcome of battery performance testing.

4.3 Gaps and Implications of the Analysis

4.3.1 Vehicle Attributes

Vehicle-level attributes despite their high global activity level, do feature some gaps. The fact that vehicle-level attributes such as range and energy efficiency are among key consumer buying criteria highlights the need for uniformity in their determination. Further, against a backdrop of increasing globalization and a largely international market for import and export of vehicles, it is essential that this uniformity be as global in nature as possible, so that consumers can expect some reasonable degree of commonality in critical vehicle performance attributes world-wide. Energy efficiency and range are also critical input parameters to other key events such as CO_2/fuel economy standards compliance determination, new vehicle type approvals, and vehicle labeling (principal method for consumer gathering of purchasing information mentioned previously). Vehicle range and fuel economy is generally determined in accordance to SAE procedures in the US, Canada, and South Korea. European Union member countries employ procedures stipulated in current UNECE regulation 101, with India borrowing key aspects of the regulation in its own procedure. Japan and China specify their own procedures. The challenge here is lack of global uniformity in regards to drive cycle and test procedures for determination of key vehicle performance criteria. This disconnect was identified by the UNECE and is the subject of Phase 1 of a GTR being developed under the framework of WLTP working group. The latter features the development of a so-called Worldwide Harmonized Light Duty Driving Cycle (WLTC). Besides uniformity in the drive cycle itself, standardization of test procedures is critical. One key aspect of this is ambient temperature which has been shown to drastically impact range and efficiency of electric vehicles. Phase II of the GTR is expected to include provisions to address the impact of both low ambient temperatures as well as high altitude conditions on range and energy efficiency. A gap still exists in accounting for the use of accessories, in particular air conditioning, cabin heating, and vehicle exterior lighting. There are currently a range of practices concerning the operation of these auxiliary systems. For instance, South Korea requires the heater to be operated at its maximum setting during cold testing, and US standards capture A/C operation by default through its 5-cycle testing procedure. Besides these differences, there is also a general lack of provisions corresponding to advanced thermal management systems such as heat pumps or infra-red heating. The efficiency impact of such comfort systems compared to resistive heating may influence vehicle range and efficiency substantially. Active battery management systems employed by different OEMs / battery pack manufacturers as well as driver selectable operating modes (sport, eco etc.) are also aspects that are generally not yet addressed.

Vehicle labeling, while widely practiced globally (high activity), overwhelmingly excludes electrified vehicles (US is the exception) representing another significant gap.

4.3.2 Battery Attributes

Battery performance determination is largely non-standard, with a mix of voluntary standards (USABC, SAE, ISO, IEC) and some country-specific ones existing or in development (China, South Korea). Considering that battery performance is a crucial factor effecting fuel economy, range, and therefore the ultimate value proposition of an electrified vehicle to a customer, this disparity in requirements represents a gap. The battery is also the most expensive component in an EV which adds emphasis to the importance of accurately determining its performance.

Battery recycling by virtue of its widely differing requirements globally can be considered to be gapped as well. There are also a number of countries that simply do not have any requirements in place pertaining to battery recycling.

Battery re-use post mobility represents a wide gap that will be challenging to govern given the highly variable nature of battery wear and inherent differences in chemistry, construction, and power management.

4.3.3 Infrastructure Attributes

Infrastructure attributes are generally on the right path towards well specified, thorough requirements. This effort is being led by a roadmap of ISO/IEC standards that govern the systems and communication protocols, and a generally well harmonized set of standards that govern the connectors. The gap here is one that is temporary and continuing to close with time.

4.3.4 Market Deployment Attributes
There are no gaps that exist in the context of regulatory incentives.

5 Next Steps

5.1 Vehicle Range & Efficiency Testing
It is recognized that EV range is affected substantively by vehicle speed and driving behavior, ambient temperature, and the operation of climate control systems. Figure 32 shows the variability in range resulting from the variation in these factors[iii]. The data corresponds to a BEV and the baseline is the range capability over the LA4 cycle (shown as 100%).

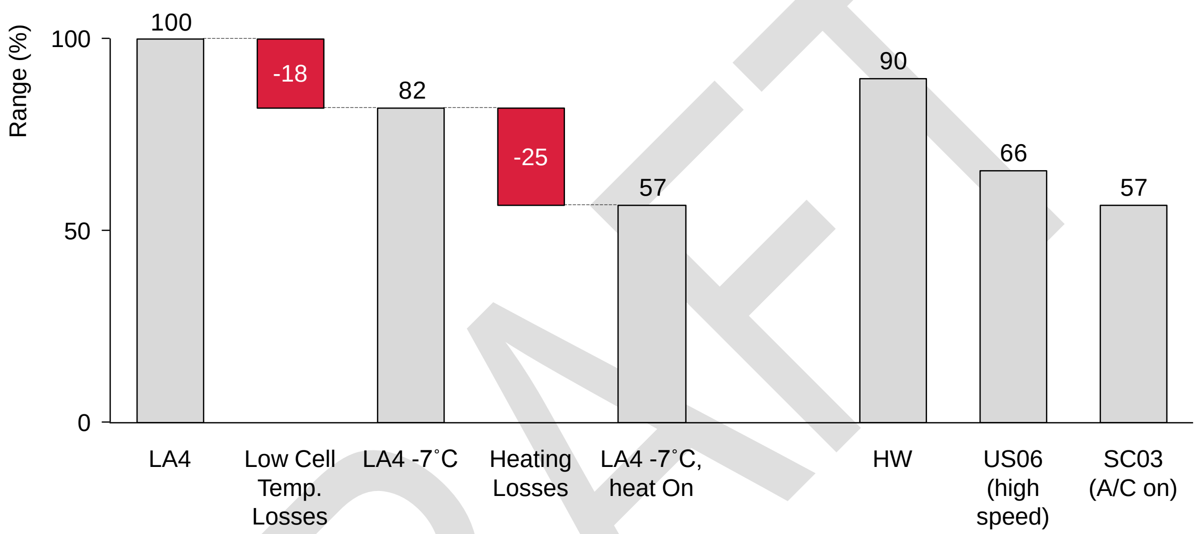

Figure 32 : Variability in range, various factors

It is recommended that testing procedures for EVs include cold ambient temperature testing with cabin heating in operation. The following general provisions are recommended:

- Heating be set to achieve (as quickly as possible) and subsequently maintain a specified, standard cabin temperature
- Requirements flexible enough to accommodate both resistive heating element and heat pump systems
- Requirements flexible and extensible enough to accommodate future radiant heating solutions such as infra-red panels and foot wells
- Requirements flexible enough to factor in additional luxury features that accomplish passenger heating – heated seats, heated steering wheel

Properly accounting for cabin heating is crucial, not only to ensure that consumers are provided with realistic estimates of electric vehicle range, but so that EVs equipped with advanced, efficient HVAC systems are able to prove their effectiveness and justify any potential cost differential between them and more conventional resistive heating systems. It is understood that Phase 2 of the GTR being pursued by the WLTP working group aims to address low temperature ambient conditions. Should the preceding recommendations go beyond the scope of those efforts, a separate future GTR could be considered.

Similarly, it is recommended that testing procedures for EVs include testing at elevated ambient temperatures with air conditioning in operation. The following general provisions are recommended:

- Air conditioning to be set to achieve (as quickly as possible) and subsequently maintain a specified, standard cabin temperature
- Requirements flexible enough to accommodate both electric air-conditioner systems as well as heat pumps
- Requirements flexible and extensible enough to accommodate future advanced solutions featuring smart materials

There is also a need to understand and document the degradation in attainable range and vehicle energy efficiency (and hence CO_2 emissions) over the operating lifecycle of the vehicle. This is principally a function of battery durability and will be addressed by a UNECE GTR within the framework of the WLTP working group and subsequently adopted into EC law (2015/2016). It is recommended that information developed through this upcoming battery durability requirement be leveraged to develop correction factors that can be used to project range and energy efficiency over the operating lifecycle of the corresponding electric vehicles that receive these batteries.

5.2 Vehicle Labeling

It is recommended that an effort to harmonize vehicle labeling world-wide be considered. The timing is appropriate for such an effort as most countries with the exception of the US do not yet address electrified vehicles in their vehicle labeling activities. Two phases of adoption are proposed:

- Phase 1 – Adoption of a world-wide label that lists the following critical attributes:
    - Type of powertrain
    - Energy efficiency
        - For conventional ic engine powered vehicles
            - MPG, gallons/100 miles, L/100 km
            - MPG equivalent, L/100 km equivalent for CNG
        - For series PHEV
            - Gasoline or diesel only MPG, gallons/100 miles, L/100 km
            - Electricity only MPG equivalent, L/100 km equivalent, kWh/100 miles, kWh/100 km
        - For blended PHEV
            - Gasoline or diesel only MPG, gallons/100 miles, L/100 km
            - Combined MPG equivalent, L/100 km equivalent, kWh/100 miles, kWh/100 km
        - For EV
            - MPG equivalent, L/100 km equivalent, kWh/100 miles, kWh/100 km
    - Range
        - For series PHEV
            - Electric only range in miles and km
            - Gasoline/diesel only range in miles and km
        - For blended PHEV
            - Combined electric and gasoline/diesel range in miles and km

                - Gasoline/diesel only range in miles and km
        - For EV
            - Electric range in miles and km
    - Values measured in accordance to country-specific test procedures and drive cycles
- Phase 2 – Phase 1 but with the following amendments:
    - WLTC test procedure which will allow world-wide comparison
    - Six different sets of values listed to illustrate full range of possible characteristics
        - Summer
            - City
            - Highway
            - Combined
        - Winter
            - City
            - Highway
            - Combined
- Future phase – include deterioriation factors that can be applied to all 6 sets of energy efficiency and range values to estimate reduced performance at 75,000 miles and 150,000 miles of operation (will need to apply data generated through battery durability testing).

5.3 Battery Performance

UNECE 101 specifies test procedures for measurements of the energy consumption and range of electric vehicles in Annex 7. Annex 2 specifies required battery performance information that should be reported, but a specific battery performance test procedure is lacking. An SAE recommended practice is in progress (J1798), while there are a number of ISO and IEC standards, as well as Chinese voluntary standards in place. India has standards pertaining to lead-acid batteries while Souh Korea is in the process of defining a procedure for battery power determination. Based on this mixed state of voluntary standards, it is recommended that uniform propulsion battery test procedure be pursued through a GTR. This would be in line with current plans to pursue a battery durability standard via GTR and would more fully complete the definition of requirements for propulsion batteries. It is recommended that currently available international standards be used as references in this work, in particular ISO 12405-1 and 12405-2 which are the most elaborate of the standards that have been released to-date. Figure 33 provides an overview of some of the major existing standards governing the performance of Lithium Ion battery packs.

	EV/PHEV			HEV	
PARAMETER TESTS	IEC 61982-3	ISO 12405-2	QC/T 743-2006	ISO 12405-1	VDA
Standard Cycle		C/3 RT	C/3 RT	1C RT	1C RT
Capacity/Energy	Dynamic cycle RT	C/3, 1C, 2C -25, -10, 0, RT, 40 °C	20 °C: C/3, 1.5C (high energy), 4C (high power) -20 °C: C/3 55 °C: C/3	1C, 10C, 20C -18, 0, RT, 40 °C	1C, 10C, 20C -25, RT, 40 °C
Power/Resistance		$I_{disch\text{-}max} \leq$ 400 A Pulse: 0.1, 2, 10, 18, 18.1, 20, 30, 60, 90, 120 s SOC: 90, 70, 50, 35, 20% -25, -18, -10, 0, RT, 40 °C	N.A.	$I_{disch\text{-}max} \leq$ 400 A Pulse: 0.1, 2, 10, 18 s SOC: 80, 65, 50, 35, 20% -18, 0, RT, 40 °C	$I_{disch\text{-}max} \leq$ 400 A Pulse: 2, 10, 18 s SOC: 80, 65, 50, 35, 20% -10, 0, RT, 40 °C
Self discharge with out load		48, 168, 720 h SOC: 100% RT, 40 °C	(1) SOC: 100% 20 °C 28 day (672h) (2) SOC: 100% 55 °C 7 day (168h)	24, 168, 720 h SOC: 80% RT, 40 °C	1, 6, 24, 48, 168 h; SOC: 70% 0, RT, 40 °C
Self discharge during Storage	N.A.	N.A.	SOC: 100% 20 °C 90 day (2160 h)	N.A.	N.A.
Efficiency	SOC: 100 - 0%	Fast charge efficiency: Charge: 1C, 2C, I_{max} 0 °C, RT	N.A.	Profile: Disch: 20C, 10 s + Rest: 40 s + Charge: 20 C, 10 s 0, RT, 40 °C SOC: 35 , 50, 65%	Discharge: 1C, 10C, 20C -25, RT, 40 °C

Figure 33 : Overview of major battery performance standards[iv]

5.4 Battery Recycling & Reuse

Global battery recycling requirements are presently either lacking completely or where they exist, differing substantially in practice, and/or depth of coverage. This represents a gap, but one that is likely to be challenging to close on a global basis due to the complex nature of both practices, and attitudes towards recycling worldwide. Pursuit of a GTR is therefore not recommended at this time. What is recommended is that resources be allocated to evaluate the value of developing manufacturing-for-recyclability requirements. Having well thought and standardized requirements in this area is likely to make actual recycling requirements easier to specify (in a second phase) and more effective in the long term. Such a feasibility study will need to look closely at current battery manufacturing practices, while accounting for differences in materials and chemical composition from manufacturer to manufacturer. Any cascading impact such requirements may have on the performance or durability of batteries will also need to be evaluated with care.

Battery reuse post mobility represents a substantial gap in that no requirements are known to exist globlly at the time of this writing. This is however a crucial area of consideration because re-use applications can increase the residual value of used battery packs, swaying the economics in favor of greater EV adoption. The challenge here is in ensuring consistent performance from used battery packs that have been subjected to a variety of duty cycles and driving behaviors during their mobility life. Robust requirements cannot be developed to govern the re-use of batteries until the behavior of batteries under these different possible conditions is fully understood. For this reason a GTR is not recommended at this time. Most of the research on durability behavior of batteries to date has also focused on the 70% or greater remaining charge portion of the lifecycle. Little work has been done to understand battery characteristics below this mobility-feasible threshold. In order to develop requirements addressing battery re-use, battery behavior below this threshold also needs to be better understood. A study is recommended to look at these open questions through a carefully formulated matrix of empirical tests. The findings of such a study could then be considered in developing requirements for re-use. A possible future requirement for battery re-use would be a type of certification process that would require post-mobility batteries to display certain minimum performance characteristics to be eligible for use in re-use applications. Other possibilities include mechanical and electrical inspections, and minimum, required refurbishement requirements.

6 Annex

Figure 34 summarizes the responses concerning market mobilization requirements besides regulatory requirements, which were already captured in section 3.14. Specifically addressed are financial incentives, consumer awareness efforts, and government purchase requirements.

6.1 Financial incentives

As evidenced in Figure 30, financial incentives are the most widely supported market deployment attribute across the countries and regions surveyed. These types of incentives are generally available in some form in all countries with the exception of India, which is said to be formulating incentives at present. The incentives are a wide mix of purchase subsidies (all countries except India and Switzerland), and reductions or exemptions in taxes and charges associated with owning and operating vehicles (license fees, registration fees, ownership fees, import taxes). Numerous countries also offer infrastructure subsidies (all except China, India, and Switzerland), generally offered as rebates or income tax reductions for costs associated with the installation of charging stations. Column 1 of Figure 34 provides specific details of the programs by country.

6.2 Consumer Awareness

Consumer awareness is also generally well supported throughout the countries surveyed. The US and Canada in particular show a very strong commitment to increasing consumer awareness and understanding of EV technology options with multiple, extensive web-based resources, fact sheets, calculators, and purchasing guides offered. All other countries with the exception of Japan and China also have campaigns in place to create consumer awareness. Column 2 of Figure 34 provides specific details of the programs by country.

6.3 Government Purchase

Government purchase requirements are also in place in many of the countries surveyed (all except India, China and Switzerland). The US is the most noteable in its efforts to require the adoption of alternative fuel vehicles both on a Federal and state-wide basis. The US has stipulated targets both for fleet adoption percentages as well as overall fuel consumption reductions. South Korea also stipulates an adoption percentage of low pollution vehicles required for new vehicle purchases made by government and public institutions. Most other countries have more general policies in place encouraging the adoption of fuel efficient vehicles. Column 3 of Figure 34 provides specific details of the programs by country.

	Financial incentives	Consumer awareness	Government purchase
	▪ Guideline on financial incentives for member states (Set of mandatory and recommended principles) ▪ Purchase subsidies ▪ Further tax incentives: reduction/exemption of – fuel consumption tax – vehicle/registration tax – road tax ▪ Infrastructure subsidies: tax reduction on public charging stations	▪ Numerous campaigns – varies by member states	▪ Various member states have purchase initiatives ▪ EU Directive 2009/33/EC
	▪ Federal and State incentives/subsidies ▪ Purchase subsidies (up to $7500) ▪ Reduced vehicle license tax/fee ▪ Discount on electricity used for charging ▪ Infrastructure subsidies: rebates/grants on EV charging stations ▪ Grants in CA (ARB)	▪ Fuel Economy Guide ▪ Fuel Economy Website (www.fueleconomy.gov) ▪ Green Vehicle Guide (under development) ▪ “Consumer Readiness” initiative (DOE) ▪ Promotion through “clean city” initiative ▪ CA consumer buying guide (www.driveclean.ca.gov)	▪ Federal/State fleets: 75% alternative fuel vehicles ▪ Alternative fuel provider fleets: 90% alternative fuel vehicles ▪ Federal fleets: fuel consumption reduction 2% per year, requirement to purchase PHEV when lifecycle cost comparable to non-PHEV ▪ CA – 25% of fleet
	▪ Subsidies (up to $2700) relating to acquisition and weight/owner taxes) ▪ Infrastructure subsidies: tax benefits equal to 50% of charging stations costs	▪ none	▪ Basic policy on procurement of eco-friendly vehicles ▪ Every gov. organization required to publicize procurement targets based on basic policy
	▪ Varies by province ▪ Purchase subsidies (up to $8500) ▪ Infrastructure incentives: rebates on EV charging equipment (up to $1000)	▪ Nat. Resources Canada – Tech. roadmap, promo. material, calculators etc. (www.canmetenergy.nrcan.gc.ca) ▪ Trans. Canada - website	▪ No federal requirements, but a Policy on Green Procurement is in place – HEV and BEVs recommended for personnel trans/service delivery
	▪ Purchase subsidies – BEV up to $9600 – Commercial BEV up to $80000 ▪ Reduction/exemption of vehicle and vessel tax	▪ none	▪ none
	▪ Incentives under formulation	▪ Promotion of electric vehicles (government and academia)	▪ Public EV procurement plan under formulation (takes effect ~2015)
	▪ Purchase subsidies – BEV up to $14000 – EV bus up to $91000 ▪ Subsidies for charging system installation (100% of costs, up to $7300)	▪ Information on EVs and charging stations (www.evcis.or.kr)	▪ Gov. administration and public institutions required to purchase low-pollution vehicles >30% of all new vehicle purchases
	▪ No import taxes for BEV ▪ Reduction/exemption of vehicle tax (varies by canton, function of vehicle energy efficiency)	▪ Promotion of energy efficient cars (www.ecocar.ch, www.forum-elektromobilitaet.ch) ▪ Pilot and demonstration projects	▪ none

[i] IWG EVE Final Terms of Reference, Informal Document EVE-02-23
[ii] Proposal ECE/Trans/WP.29/2012/36
[iii] Data from: Meyer, Whittal, Christenson, Loiselle-Lapointe, "The Impact of Driving Cycle and Climate on Electrical Consumption & Range of Fully Electric Passenger Vehicles", EVS26 – International Battery Hybrid and Fuel Cell Electric Vehicle Symposium, May 6-9, 2012
[iv] "Analysis and Comparison of Norms and Standards for the Application of Electric Vehicles and Vehicle Batteries in China and Germany/Europe," German Chinese Sustainable Fuel Partnership (GCSFP), November 2010