

**Brussels, 21 November 2011**

## **Integrating e-vehicles into modern infrastructures**

### **EXECUTIVE SUMMARY**

Today our industry expects some 4 million e-vehicles in Europe by 2020. Although by 2020 the market share is still expected to be quite modest, our industry is seriously preparing the uptake of e-mobility in Europe. The success of electric vehicles in European markets largely depends on the availability of adequate infrastructures offering convenient solutions for the customer. This is the main focus of electrical and electronic equipment manufacturers that are providing the essential link between the e-vehicle and the electric grid.

As opposed to other alternative technologies for green mobility, the basic infrastructure for charging e-vehicles is already available in the electric grid even if it still needs some adaptations to be prepared for mass deployment of e-vehicles.

**From the very beginning the design of appropriate charging infrastructures for e-vehicles needs to be adapted to the following key requirements:**

#### **1. Highest requirements for safety (*chapter 7.3*)**

Charging points in buildings are a fully-fledged element of the electrical installation. As present EU regulations for electrical installations in buildings have brought electric safety to a very high level they must not be undermined by the introduction of e-vehicles.

#### **2. Managed charging processes (smart charging) as a general rule (*chapters 2, 4 and 9*)**

Charging an electrical vehicle is like any other electrical load for the grids but it needs to be managed. A proper load management is necessary to ease stress on the electricity grids. A proper energy management accompanied by economic incentives is recommended to entice customers to charge when “greenest” and cheapest electricity is available. This is part of the energy management for buildings and can be ensured either through mode 3 or mode 4 charging (as defined in IEC 61851 standard).

#### **3. Infrastructure availability according to the development of usage pattern over time**

According to current experiments and surveys, daily distances amount to less than 100km and the majority of charging (90%) is expected to be done at home and at work as well as in parking (shopping, train stations etc.). This suggests that low and semi-rapid power charging would satisfy most of the charging needs for the years to come.

Orgalime believes that for e-vehicles mode 3 charging from a dedicated socket outlet is best adapted to meet the three key requirements defined above. Mode 2 charging is however well adapted for the requirements of lower powered vehicles such as PHEVs and electric motorcycles.

Favourable framework conditions, non-monetary and financial incentives including R&D&I support are crucial to speed-up breakthrough innovations developed by our industries for instance in the field of energy management and battery technologies. (**Chapters 5,6,7,8**)

*Orgalime, the European Engineering Industries Association, speaks for 33 trade federations representing some 130,000 companies in the mechanical, electrical, electronic, metalworking & metal articles industries of 22 European countries. The industry employs some 9.7 million people in the EU and in 2010 accounted for some €1,510 billion of annual output. The industry not only represents some 28% of the output of manufactured products but also a third of the manufactured exports of the European Union.*

## 1. Introduction

The European engineering industries, represented by Orgalime are the only industrial sector possessing system level expertise in all parts of the system chain – from power generation and the transport and distribution of electric power, to the control and drive elements fitted to vehicles. Orgalime believes that the electric car and the associated charging and support infrastructure are an integral part of the new world of energy.

Orgalime industries wish to actively participate in policy processes and technology platforms which are dealing with the European policy framework to introduce clean and energy-efficient vehicles and modern energy and smart grid technologies with the potential to contribute to the achievement of European climate, energy and energy efficiency targets.

Orgalime therefore is looking forward to working with the European Commission and other stakeholders on the following platforms which were envisaged by the Commission in the Industrial Policy communication (COM (2010) 614):

- Clean and Energy-efficient Vehicles platform
- Strategic Transport Technology Plan

## 2. Electric vehicles will become a sustainable option for individual mobility in the future in particular combined with the introduction of managed charging

The market for automobiles is forecast to show strong growth worldwide until 2020. It is assumed that the 72 million vehicles sold 2010 worldwide will increase to 100 million vehicles sold each year by 2020. Demand will particularly grow in BRIC countries (Brazil, Russia, India and China). Policymakers therefore are looking for solutions to make this growth in mobility & transport more sustainable.

Orgalime believes that electric vehicles are a promising technology for drastically reducing the environmental burden of road transport. From the perspective of low carbon policies, the benefits of electric vehicles are multiple: No CO<sub>2</sub> is emitted through the tailpipe, the electric drive uses energy more efficiently and e-vehicles can drive on a range of low carbon and renewable energy sources. If managed charging becomes a general rule, e-vehicles bring large scale low carbon mobility within reach in particular for urban environments which often struggle to fulfil European air quality directives. Furthermore with the large-scale uptake of e-vehicles in the future, the car batteries and storage may also be called upon to contribute to load management by feeding back electricity into the grids during hours of peak demand. Batteries no longer in use for automotive applications could also be used to store electrical energy which is produced by photovoltaic installations on roofs and individual homes for instance. This option could become interesting when looking at the overall cost of e-vehicles.

The basic infrastructure for charging electric vehicles is already available today and only needs some adaptations for safe and smart charging.

If Europe is to decarbonise transport and electricity production, managed charging of pure electric cars fuelled with low carbon electricity (preferably from renewables) should become the general rule. Efficient off-peak charging should clearly be preferred over charging in peak hours provided this is consistent with the e-vehicle being able to obtain sufficient charge during the peak hours. Energy and load management will help the grids to accommodate a large number of e-vehicles' charging when electricity demand is low and supply from CO<sub>2</sub> free electricity, such as from renewable sources is available. This will also enable to integrate more electricity from decentralised production and renewables which are variable in their availability.

The cost of investment into the modernisation of the grids, which will become necessary in the coming years, can be limited through more intelligent integration of ICT.

The European engineering industries, represented by Orgalime believe that the e-car and the associated charging and support infrastructure are an integral part of the new world of energy. Our industry has technologies available for smart charging and energy management and the industry invests to improve technologies that can meet transport and energy challenges of today.

### 3. The economic potential of the EV market for Europe is high in the medium to longer term

It is difficult to predict the market for electric vehicles and technologies to support e-mobility and charging infrastructures as it will depend on many factors such as fuel cost, taxation policies, changes in mobility demand and services, the maturity of technological solutions and their impact on the purchase price of the e-vehicle. Market studies show different results ranging from 5 to 20% of total vehicle sales from 2025 onwards. However there seems to be a consensus among a variety of stakeholders that there is a great market potential for e-mobility.

The **electrical infrastructure and equipment manufacturers** represented by Orgalime assume that the market potential of e-vehicles, could amount to 10 – 15% of new sales by 2020 (thereof one third pure electric and two thirds plug-in hybrid vehicles) depending on the framework conditions. This means that by 2020 some 3.5 to 4 million electric cars would be on the roads in Europe.

Electrical and electronic equipment manufacturers believe that e-mobility will become a serious business and a key driver for technological innovations in the field of energy management, the user interface with the grid, new energy management & support services and power conversion. To estimate the market potential for charging and support infrastructure providers, electrical equipment manufacturers today use a rule of thumb which assumes that on average each rechargeable e-car would require an infrastructure investment of €1000. (This is not the price of a charging station but an assumption of the average investment necessary for each new e-car sold and registered in Europe.)

The **share of electronics in the production value of a passenger car is constantly rising**. Today it is around 15% and by the year 2020 it is forecast to increase to more than 30%, even without the introduction of electric drives. Besides the electric drive, storage technologies will account for an important part of e-mobility business for the automotive suppliers represented by Orgalime.

Although **jobs created through the e-mobility business** within Orgalime industries are difficult to quantify today, it is assumed that the electric motor, the traction battery & storage technologies, (control and power) electronics, charging stations & support infrastructure, the battery system including the battery management system and thermal management, light weight construction etc. will drive employment within the electrical, electronic, IT, metal articles and machinery sectors represented by Orgalime.

E-mobility development will also create jobs in the installation and servicing of charging points which will require special qualifications and training. As the e-mobility business increases and the need for new technologies arise, employment will also be created in R&D and innovation.

Orgalime believes that new innovative technologies around e-mobility in the field of energy and production technologies must be supported to ensure the industries' technological leadership and global competitive position. Breakthrough innovations around the electrification of road transport can be applied in other areas in the future such as construction and agricultural machines and they will speed up the modernisation of energy infrastructures through smart grid technologies.

Managed charging which will help to limit peak demand for electricity for e-vehicles charging will open new services for very efficient energy management. Therefore managed charging modes (mode 3, mode 4) consistent with the e-vehicle user being able to obtain sufficient charge during peak hours are to be preferred over non-managed charging modes (mode 1, mode 2). Mode 2 charging could be used as a home charging solution in the starting phase of e-mobility and for top-up charging of PHEVs. (See: Annex for more explanation).

As other parts of the world are starting experimentation with the electrification of transport, Europe needs to create favourable framework conditions for e-mobility very quickly, thus enabling the industry to gain market share and realise additional employment. We specify some major recommendations as well as possible incentives to speed up the development of e-mobility hereunder.

#### **4. Lessons learnt from ongoing projects: Requirements for charging and support infrastructures in the private and public areas**

A number of pilot projects and commercial projects around e-mobility have been launched in Europe and over the world. The shared analysis of these projects is crucial to understand the requirements for charging infrastructure and vehicle range including the requirements for car batteries & storage technologies from a user and industry point of view. Sharing experiences and collecting best practices will contribute to implement solutions and overcome certain obstacles for the uptake of e-vehicles and the necessary infrastructures. Sharing experience must become an ongoing exercise to learn about new market developments and requirements of the e-mobility user.

Following results from current experiments and surveys, Orgalime industries make the following recommendations:

Charging infrastructures in private homes and parkings in apartment buildings, offices, shopping centres and at stations have proved to be most important to satisfy the users' charging needs today. Solutions must be effective, user-friendly and affordable.

The importance of public charging is easily overestimated although it is important for consumer confidence in particular in the phase of market preparation.

Infrastructure must provide flexibility for effective energy management enabling off-peak charging and the capability to charge at different power levels (from 1 KW or more). Any device such as a timer in the car to control charging has shown to be insufficient for peak shaving as peaks in electricity consumption can vary from one area to another.

The e-vehicle charging infrastructure is an integral part of the electrical installation in homes and buildings where energy management will play an increasing role.

Smart metering is planned to be rolled out to all European energy customers by 2022 or earlier according to recent Commission proposals in the draft Energy Efficiency Directive (COM (2011)370). The functionalities for these installations will vary but will be based on standards developed on the basis of mandate M/441. Some functionality will enable the independent measurement of the electricity used by e-vehicles and allow for different tariffs to be used for this load. The potential use of smart metering as described will be subject to the specifications required by national governments and installed by energy utilities. It will enable different business models for electro-mobility.

## 5. The right mix of incentives and a stable framework of supportive measures are needed

The electrical vehicle, embedded in a smart grid, is a driver for technological development and innovation in Europe which will make transport and electricity production, transmission and distribution more sustainable.

Orgalime believes that it is important to incentivise the market take-up of e-mobility solutions to compensate higher purchasing cost of the e-vehicle with a lower cost of use.

To kick-start the e-vehicles' market and investment into infrastructure, direct incentives to reduce the effective purchase price of e-vehicles or of investment in charging infrastructures can be useful in particular in the market preparation and introduction phase: these should contribute to speeding up the learning process and better address the e-mobility end users' concerns. Financial incentives for the installation of mode 3 charging spots in private and public areas will speed-up the adoption of mode 3 charging (see annex). As this will allow for powerful energy management, it will also help to reduce CO2 emissions (from well to wheel) to a very low level.

In the long run e-vehicles must be able to compete with other mobility solutions. Orgalime industry assumes that the purchase cost of e-vehicles will reduce over time and vehicle and battery lifetime will increase. Thus the total cost of e-vehicles including the purchasing price and the cost of use will move towards that of conventional vehicles.

Orgalime believes that other **supportive measures nationally could play an even bigger role** when further developing the market into a mass market, such as:

- The exemption of e-vehicles from vehicle tax
- The exemption of electricity for e-vehicle charging from tax and other charges
- No taxation for company cars if they are e-vehicles
- Financial schemes that foster company fleets compounded of e-vehicles (e.g. vehicle fleets for governments, local services, taxis, urban transportation, delivery, waste collection)
- Special amortisation rules for business use
- Low interest loans/subsidies for consumers
- Preferred parking in cities
- Use of special bus and taxi lanes
- Exemption from congestion charges and parking fees in cities
- Incentives for market players to sell mobility as a service (e.g. car sharing, car rental)
- Attractive combinations of public transport and individual mobility (e.g. support e-mobility strategies of different railways, park & ride, e-bikes etc.) as the private car will always continue to play a role in the transport mix in Europe. Intermodality between short and long distance transport systems and the integration of two wheelers like e-bikes and e-scooters in personal and commercial transport systems are also a key factor for consumer acceptance.

When establishing a framework of monetary incentives **greatest attention should be given to support the R&D and Innovation efforts of European industry today and in the future.** European policymakers should, in our view, regard e-mobility as part of a smarter electricity grid which will be able to accommodate more renewables if combined with energy management, battery and other innovative technologies. As some e-vehicle technologies such as battery



development have not reached maturity yet, support needs to be increased to speed up innovation which aims at reducing battery costs, while increasing energy mass and performance.

In this context, Orgalime strongly believes that strategies to introduce e-mobility in Europe must be linked with innovative transport and energy technologies as well as production technologies from Europe. It is essential for the European Economy to enable "Lead Suppliers" to stay competitive globally and to install a "Lead Market".

Orgalime believes that it is important that Europe's national governments commit to creating a stable framework for a variety of incentives that should be valid for several years. This will encourage investors whether private households, businesses or local authorities, cities and regions. If supported, new technologies and increasing sales will lead to cost reductions and performance improvements in the coming years. If Europe is to promote energy management, incentives for the deployment of smart charging technologies - whether direct or indirect - should be included in the overall strategy.

## 6. Recommendations to create a market push for e-vehicles

The public sector should be leading by example. Setting targets within governments, public and local authorities to introduce a certain percentage of electric vehicles, including utility vehicles could help to trigger the necessary first impulse for investment into e-mobility. Such an investment push from the public sector will increase consumer confidence and help to create a second hand market for e-vehicles, which will then make e-vehicles more affordable to private consumers.

The introduction of e-vehicles in private company fleets will also create a market push for e-vehicles in particular if a stable framework of incentives is guaranteed for some time.

The promotion of e-bikes in the intermodal public transport system could be an incentive to enter the world of e-mobility.

Legal requirements for newly constructed buildings to provide electric vehicle charging points for managed charging will speed-up the deployment of sufficient and adequate charging infrastructures in private and public spaces such as apartment and office buildings, shopping centres, train stations etc.. Orgalime recommends to envisage legislative provisions that every new building should provide charging points for e-vehicles and to encourage voluntary moves in this direction.

The implementation of the European directive for public procurement of clean vehicles for publicly owned fleets (Directive 2009/33/EC) in all EU member states could create a market push for clean vehicles including electric vehicles.

## 7. A regulatory framework to drive the development and market uptake of innovative technologies in and around e-vehicles

### 7.1 Emission performance standards for cars (Regulation 2009/443/EC) are a key driver

The goal of 120g CO<sub>2</sub> per kilometre is an important step in making the car "greener" and reducing its fuel consumption.

If the review of specific emissions targets does, in effect, lead to a further reduction in CO<sub>2</sub> emission values, then the average emissions of vehicles (from well to wheel) could well be reduced in particular if the e-car is being deployed with infrastructure that allows for energy and load management (mode 3 charging).

It is clear that the European regulation setting targets for average emissions for the new car fleet (in grams CO<sub>2</sub> per km) serve to both drive technological development in conventional drive vehicles and the deployment of electric vehicles in Europe even more than monetary incentives.

## **7.2 Air quality directives will push cities and communes to consider clean transport and e-mobility concepts (Directive 2008/50/EC)**

To maintain or improve the quality of ambient air, the EU has established limit values for concentrations of certain air pollutants in the ambient air. Many larger cities are having difficulties to respect these limit values. The fact that the EU has announced stricter implementation and strengthening of this piece of legislation could drive public interest and investment into e-mobility in particular in urban environments.

## **7.3 Safety requirements and market surveillance need to be highest priority**

For the first time a regular link up of vehicles to the electricity network is envisaged for the purpose of recharging batteries on a regular basis. Already from the early years in school, the population needs to understand the basics of an electric vehicle and therefore it seems important to support and coordinate communication campaigns in this regard throughout Europe (e.g. national plug-in/e-car days).

The present EU regulations for electrical installations have brought electrical safety to a very high level which must not be undermined by the introduction of e-vehicles. As charging points are a fully-fledged element of the electrical installation in buildings, it is therefore essential that the infrastructure and the charging elements comply with the requirements of electrical regulation in European countries and notably the Low Voltage and EMC directives.

For new buildings it will no doubt be simplest to embed right from the time of construction the possibility of managed e-vehicle charging. For older buildings given the increasing number and development of appliances often connected to ageing electrical installations, it will in many cases be necessary to upgrade electrical installations in buildings which were not designed to cope with lengthy charging cycles at the rating proposed for e-vehicles.

It is for this reason that Orgalime believes that a dedicated circuit with a special plug for e-vehicle charging (in mode 3 or mode 4) may often be necessary and should be actively promoted.

Furthermore national guides for the safe use of mode 2, 3 and 4 charging in private homes and for public charging infrastructure should be supported as they also help to support the safety of existing installations. N.B. Low powered vehicles (PHEVs and electric motorcycles) will have a reduced requirement for public infrastructure, therefore existing domestic installations are likely to be the dominant form of charging infrastructure for PHEVs and electric motorcycles.

To make mode 2 charging in private homes as safe as possible the option of limiting power to a maximum current should be envisaged according to the circumstances.

Orgalime also believes that the compliance of products to European safety standards must be strictly enforced through proper market surveillance authorities in Europe in order to ensure safety for consumers and a level playing field for the industry.

## **7.4 Education and training for electrical installers**

Charging installations will need to be in conformity with best industry practices in order to ensure safety of life and property. Orgalime therefore recommends that installations should be carried out by professionals.

The market promotion of completely defined solutions instead of parts being selected and assembled on a case by case basis on the spot, as well as proper maintenance could also

increase the safety of installations. Furthermore there is also a need for training of garage technicians to handle electric vehicles, their high voltage equipment and batteries. Technicians in garages must have the same level of competence as electricians as regards the electric vehicle. Education and professional training therefore also need to be considered in the context of electromobility.

In order to ensure technological leadership and keep know-how in Europe, educational and training programmes at all levels need to take into account that new qualifications will be needed to develop and implement e-mobility solutions and create business opportunities in Europe and worldwide.

Initiatives to provide and work out national codes of practice and guidance for the installation of e-vehicle charging points by electrical installers should be supported to ensure the safety of e-vehicles charging installations which are part of the electrical infrastructure in homes and buildings.

### **7.5 Securing access to resources (lithium, raw material for semiconductors, rare earths)**

Adequate supplies of certain materials, including rare earths will remain an important factor in the development of an EU-industry. European policymakers should therefore consider this in their trade policy discussions so as to ensure that export restrictions do not hamper the development of the EU's technology potential. Recycling and reusing of batteries for instance is not only important for environmental reasons; it also helps to reduce the need for imports of rare materials.

## **8. Support for R&D around e-mobility to speed up innovation and reduce costs**

Breakthrough innovations around e-mobility can be applied in other areas later on in particular if e-mobility is regarded as a chance to match renewable energies, intelligent electricity grids (smart grid), charging and support infrastructure and high quality vehicles. Innovative technologies and production processes are key to reduce the higher production cost of e-vehicles. Orgalime industries are expected to increase their already substantial investments in R&D related to e-mobility, storage technologies and system solutions such as advanced battery technologies, high temperature capacitors, system integration and semiconductor materials, rare earth recycling and power electronics.

Energy storage is a central component of electric cars in the future. Therefore it must be a long-term policy goal to establish competitive production of highly efficient energy storage also in Europe. Strategic public investment into energy storage, smart grid and e-mobility research projects will leverage additional private investment.

Inductive charging is another example for an area where the support for research & development and the set up of pilot projects can help to find alternative solutions to the charging of e-vehicles in road transport of tomorrow.

Orgalime believes that there is a significant potential for smart grid solutions that optimise the energy system as a whole – from production to distribution and consumption of energy – in the field of electricity, heat and transport. E-mobility is considered a first “test-case” for the smart grid. Orgalime therefore strongly appeals to all European Institutions to go towards making Research & Development & Innovation (R&D&I) the number 1 EU budget line in the long run. We therefore welcome the Commission proposal to increase the R&D budget by 46% in the next Multiannual Budget Framework and strongly urge member states to maintain this proposal.

Orgalime strongly recommends that national and EU policies increase their support for private R&D investment through a sustainable improvement of general investment conditions, tax incentives and funding for R&D. Electrification of transport should stay a priority in the Community Research Programme.



## 9. The role of standardisation for safety, interoperability and economies of scale

Standardization of electric vehicles has become an important issue at the EU level. The need for clean energy and the support provided by smart grids have led to new European policies that encourage the deployment of charging infrastructures for electrical vehicles.

As Europe needs to make sure that international standards meet European needs, including (for example) national rules for wiring, the European Standardisation Organisations have established a common CEN-CENELEC Focus Group of a large variety of e-mobility stakeholders which considered European requirements relating to electric vehicle standardization, and assessed ways to address them. In June 2011 the Focus Group has finalized a [report on Standardization for road vehicles and associated infrastructure](#) responding to the European Commission Standardization Mandate M/468 ([here](#)) concerning the charging of electric vehicles. The report includes standards recommendations regarding charging modes, connectors, plugs and sockets, smart charging, communications, batteries and EMC aspects (electro magnetic compatibility).

One of the key issues for standardisation in Europe is ensuring interoperability between regional charging infrastructure networks to make sure that investors do not end up with stranded costs and to minimise cost for retrofitting. For the user it is important that the charging infrastructure can serve all electric vehicles without discrimination.

Although a lot of work remains to be done in the relevant technical standardisation committees (TCs), Orgalime industries acknowledge the following achievements of standardisation to date:

- System standards such as the definition of charging modes, the communication between the e-vehicle and the charging spot and the application of interfaces for billing, roaming etc. are key and progress has been achieved.
- The IEC 61851 standard (system, modes of charging, interfaces) was adopted and ratified as a European Standard EN 61851 in April 2011. The charging modes are now fully standardised, and Orgalime industries can build on this.
- There is a move towards charging in mode 3 from a dedicated socket outlet. Mode 3 allows for managed charging and therefore supports energy and load management which is important from the user and the grid perspective. Also the present European domestic socket-outlet systems were never designed with e-vehicle charging in mind. Therefore the Focus Group report recommends using mode 3 for home charging and public AC charging of vehicles.
- The IEC 62196 standard defines possible types of plugs and connectors and was voted early June 2011. This vote stabilises the situation of technical choices. In Europe the choices for dedicated plug and sockets for managed charging in mode 3 has been limited to “type 2” and “type 3” for the infrastructure side and to “type 1” (until 2017) and “type 2 or type 2 Combo” for the car side.

The Focus Group has not achieved agreement among stakeholders on the choice of a unique connection to the AC mains for the charging of passenger vehicles in mode 3. However the report proposes different paths to achieve interoperability such as an additional suitable charging cable, an exchangeable head plug on the charging cable, a secured cable to the charging spot or the adaptation of “type 2” to national regulation.

Orgalime believes that standardisation in Europe should follow the basic principles listed below:

- Safety is the most important requirement for users when they charge their car. The charging mode definition and their conditions of use must be based on this absolute requirement before any other consideration
- The e-vehicle charging infrastructure is an integral part of the electrical installation and networks. Harmonised European standards are therefore of utmost importance to ensure interoperability and connectivity between the charging infrastructure and the e-vehicle.
- Solutions selected for charging infrastructure must be simple and cost effective to enable the mass uptake of e-vehicles in the markets.
- From the point of view of CO2 reduction and the optimisation of cost for new grid infrastructures, energy management must be promoted from the beginning to make the market uptake of e-vehicles become a success. Therefore managed charging (modes 3 and 4) are to be preferred even if the full scale functionalities of the smart grid will only be deployed later.

Orgalime believes that a uniform European standard plug and connector for e-vehicle inlets and infrastructure outlets is essential for the mass market of e-vehicles in the longer run. However the markets are not yet mature to determine what the logical choice is and we advise against attempting to force a political choice in this area.

Orgalime is confident in the ability of European Standardisation Organisations to achieve the goal established by the European Commission in its standardisation mandate. Decisions on standards must be taken in the relevant CEN/CENELEC Technical Committees on consensus basis and taking into consideration the recommendations of the Focus Group report of June 2011.

Electrical and electronic equipment manufacturers are proposing affordable interim solutions to improve interoperability for the charging of e-vehicles across Europe in the short term and mid-term.



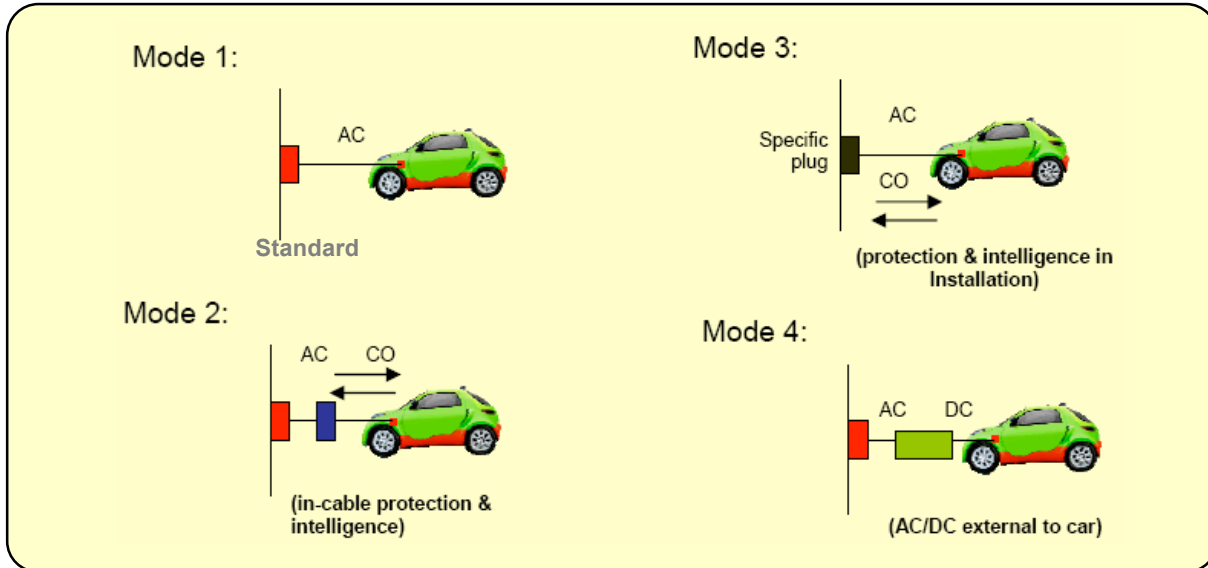
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## Annex:

Managed charging which will help to limit peak demand for electricity for e-vehicles charging will open new services for very efficient energy management. Therefore managed charging modes (mode 3, mode 4) consistent with the e-vehicle user being able to obtain sufficient charge during the peak hours are to be preferred over non-managed charging modes (mode 1, mode 2) even if mode 2 charging could be used as a home charging solution in the starting phase of e-mobility.



### NON-Managed Charging

Mode 1 and Mode 2

(Household plugs)

### Managed Charging

Mode 3 and Mode 4

## DEFINITIONS

**EV:** Electric Vehicle: Here we are referring to a vehicle in which the battery pack and electric motor replace the internal combustion engine.

**PHEV:** Plug-in Hybrid Electric Vehicle: Here we refer to a vehicle which combines both a battery pack and electric motor with an internal combustion engine. In this case the battery pack is smaller than that in an EV and the combustion engine has the ability to drive the vehicle wheels when the battery has depleted.