INNOVATION DEAL

FROM E-MOBILITY TO RECYCLING – THE VIRTUOUS LOOP OF ELECTRIC VEHICLE

ASSESSMENT OF LEGAL AND REGULATORY BARRIERS TO THE OPTIMIZATION OF EV BATTERY LIFE CYCLE

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An assessment led by GROUPE RENAULT

In partnership with:

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INTRODUCTION

The widespread deployment of Electrified Vehicles (Battery Electric Vehicles and Plug-in Hybrid Electric Vehicles) offers an unequalled solution to reduce CO_2 and polluting emissions from road transport, but also represents a great opportunity to accelerate transition towards a 100% renewable energy system.

Electric Vehicle batteries can indeed provide valuable services to the electrical power grids during both their first life on the vehicle (through smart charging and vehicle-to-grid applications) and their “post-vehicle” second life (mainly through stationary storage applications), thus bringing a significant contribution to the incorporation of a growing share of renewable energies into the electric power mix and to the reduction of electricity-related CO_2 emissions.

These environmental benefits could offset the indirect CO_2 emissions associated with the production of EV batteries and further reduce the global carbon footprint of electric vehicles over their life cycle, thus amplifying the global reduction of transport-related CO_2 emissions achieved through the transition to e-Mobility.

Moreover, grid services provided by EV batteries during both their first and their second life will significantly reduce the total cost of ownership of electric vehicles for end users, thus contributing in turn to enhance the competitiveness of electric and electrified vehicles with traditional ICE vehicles, and accelerating the transition to e-Mobility.

The current EU legal framework, however, may jeopardize the creation of such virtuous loop by putting up regulatory barriers which could hamper a wide development of vehicle-to-grid services and second life EV battery applications.

This final version of the Innovation Deal’s first deliverable aims to identify and describe such regulatory barriers.

Part I: The virtuous loop of electric vehicles and the optimization of EV batteries life cycle

Electric vehicles will be the key driver to decarbonize the road transport sector. However, the expected benefits of electric vehicles development are not limited to the transportation sector. Indeed, the multiplication of batteries is also a true opportunity for the energy sector. It will enable to foster the energy transition towards a renewable energy mix, thanks to the flexibility that such devices will bring to the system.

I.1. CONTEXT: THE CHALLENGES OF LOW-CARBON MOBILITY AND HEALTHY URBAN LIVING

I.1.1. E-Mobility and the low-carbon transition of the transport sector

Announced in December 2015 and enforced in November 2016, the Paris Agreement set the objective of limiting the increase in the global average temperature to well below 2°C above preindustrial levels. Following this agreement, the International Energy Agency has elaborated a Two Degree Scenario (2DS) providing a 50% chance of limiting average future temperatures increases to 2°C.

According to this scenario, global CO2 emissions of light duty passenger vehicles should be halved by 2050 compared to 2005 level while worldwide vehicle stock is expected to triple in the same period, from 750 million to around 2.3 billion vehicles, buoyed by the growing demand for mobility in China and emerging countries. In this context, achieving such a reduction requires to cut by more than 80% the well-to-wheel[1] CO2 emissions per km of new vehicles sold in 2050 compared with 2005. As fuel efficiency gains on conventional powertrains and biofuels can ensure only a minor share (around one third) of this effort, alternative powertrains (and among them mostly electric vehicle) along with electricity decarbonization will represent more than half of the avoided CO2 emissions, as illustrated in figure 1.

[1] Well-to-wheel emissions of a vehicle include direct emissions during use as well as indirect emissions generated to produce the energy required for its propulsion (i.e. gasoline, gas oil, electricity, etc.).

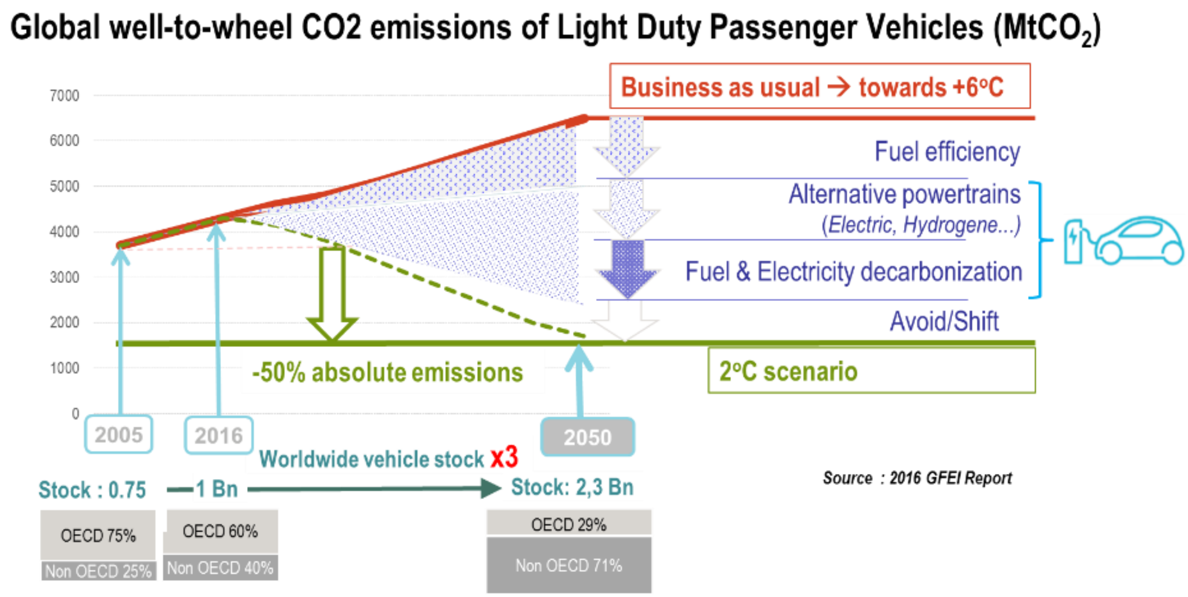


Figure 1: Expected contribution of electric vehicles to the decarbonation of road transport[2]

Indeed, if well-to-wheel CO2 emissions reduction between conventional and electric vehicles currently vary widely from one country to another as they depend widely on the national electricity production mix, it will be amplified by the growing share of renewable energies into the electric power mix and the subsequent reduction of electricity-related CO2 emissions expected in most countries, and required to maintain global warming under 2°C. Hence, according to IEA's 2-degrees scenario the well-to-wheel CO2 emissions of battery electric and plug-in hybrid vehicles should be 50 to 100 g/km lower than that of conventional and hybrid vehicles in all major markets (and even higher in countries with a low carbon energy mix such as France) by 2030, as shown on figure 2.

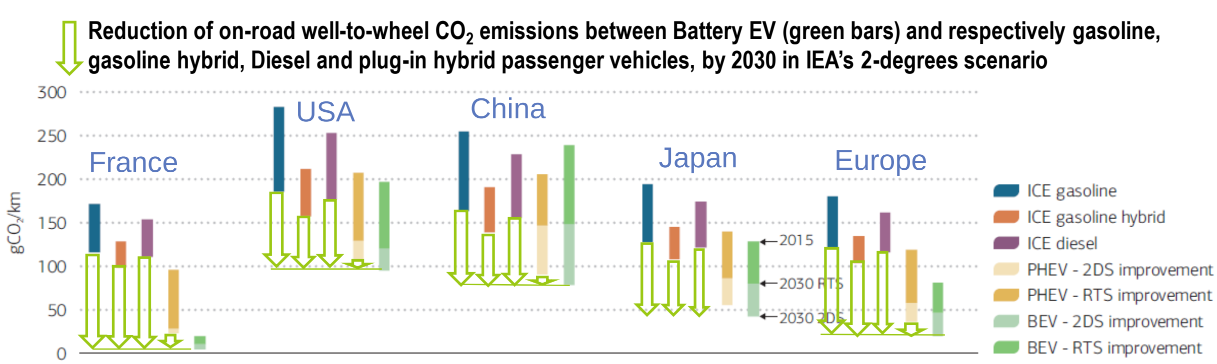


Figure 2: Reduction of well-to-wheel CO2 emissions between conventional powertrains and EVs in 2030[3]

2 Source: 2016 GFEI report.
3 Source: IEA Global EV Outlook 2017.

This is also true when considering CO2 emissions not only during the use phase of the vehicle but over its complete life cycle, from the extraction of the raw materials required to produce the vehicle (and its battery in case of an electric vehicle) to its End-of-Life recycling. In this case, however, the reduction of overall CO2 emissions between a conventional and an electric vehicle, although still significant (around 50 gCO2/km with EU's targeted electric power mix by 2030), is reduced by the indirect CO2 emissions linked with the production of the battery, especially when considering the considerable battery storage capacity required to offer a driving range in line with the requirements of the mass market, that is, not limited to urban and peri-urban trips (see illustration for a midsized sedan in figure 3).

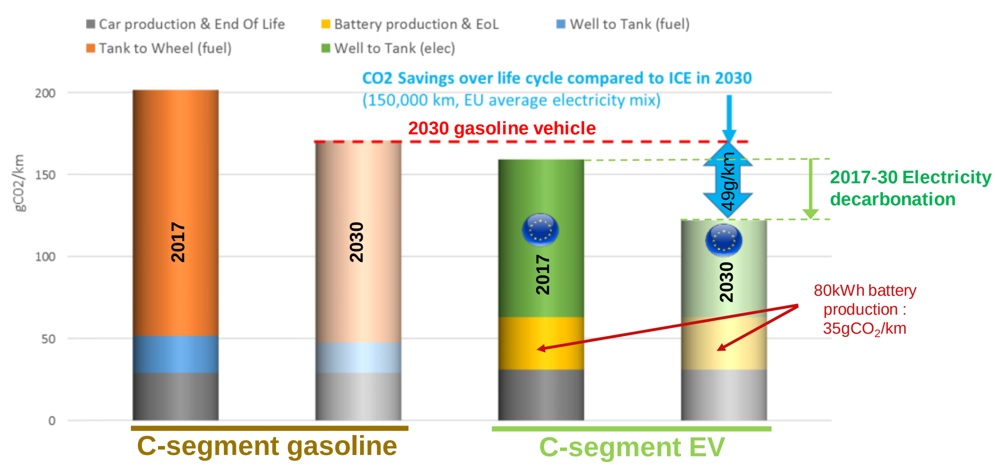


Figure 3: Life cycle carbon footprint of a gasoline and an electric vehicle in the EU, 2017 and 2030[4]

Considering the above analysis limited to the boundaries of the vehicle life cycle, one would conclude that the battery is a limiting factor to the environmental benefits provided by the transition to e-Mobility. An alternative view, however, is to consider the life cycle of the battery itself and the ways it can be optimized to maximize the environmental and economic benefits it can deliver, from its initial manufacturing to its end-of-life recycling. Such analysis shows that the optimization of EV battery life cycle (i) is a way of further improving the environmental balance of electric vehicles over their life cycle by providing additional environmental benefits during and after the "first battery life" on the vehicle, (ii) provides an unequalled opportunity to put e-Mobility at the center of the low-carbon transition not only of the transport sector, but also of the power sector by fostering the development of renewable energies and contributing to the decarbonation of the electric power mix. These concepts will be further developed in sections I.2 and I.3 of this report.

[4] Source: Renault internal LCA calculations based on 2017 EU Power mix and 2030 projection from IEA WEO 2017.

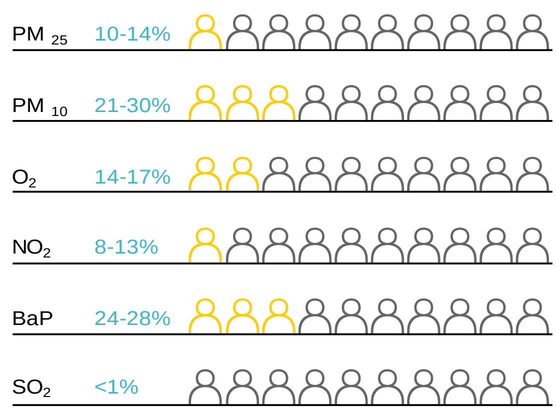
I.1.2. Potential contribution of e-Mobility to a healthy urban living

E-Mobility is a key driver of the low-carbon transition of transport, but also a real breakthrough towards a healthy urban living as it can provide a valuable contribution to the reduction of urban air and noise pollution.

Air pollution is the number one environmental cause of premature death in Europe. It also impacts on quality of life by causing or exacerbating asthma and respiratory problems.

Since the early 1970s, the EU has been working to improve air quality by controlling emissions of harmful substances into the atmosphere, improving fuel quality, and by integrating environmental protection requirements into the transport and energy sectors. In 2011 the EURO5 standard tackled automotive particulate emissions by imposing particulate filters for all Diesel vehicles, while their emission limits of nitrogen oxides were cut six-fold in ten years. As a result of such measures, emissions of many air pollutants have decreased substantially in Europe over the past decades, resulting in improved air quality across the region. However, a significant proportion of Europe's population still lives in areas, especially cities, where exceedances of air quality standards occur, as illustrated in figure 4.

Figure 4: EU population exposed to levels of air pollutants exceeding *air quality standards*[5]



The gradual substitution of conventional vehicles by zero-emission electric vehicles in cities, and most particularly in city centers, can significantly reduce population exposure to harmful levels of air pollution, as demonstrated by a study carried out by Renault in 2011 for the city of Rome. Based on a 3D modelling this study simulated the substitution of 20% of vehicles (especially the most polluting ones) by EV's in the city center and 10% in other areas and concluded that it would result in a reduction of up to 30% of population exposure to PM10 for "hot spots" and of up to 45% for NO2 in the main street network (see figure 5). In addition, 47% of inhabitants and an additional 43% of tourists would be preserved from high benzene concentrations.

[5] Source: EEA European environmental Agency.

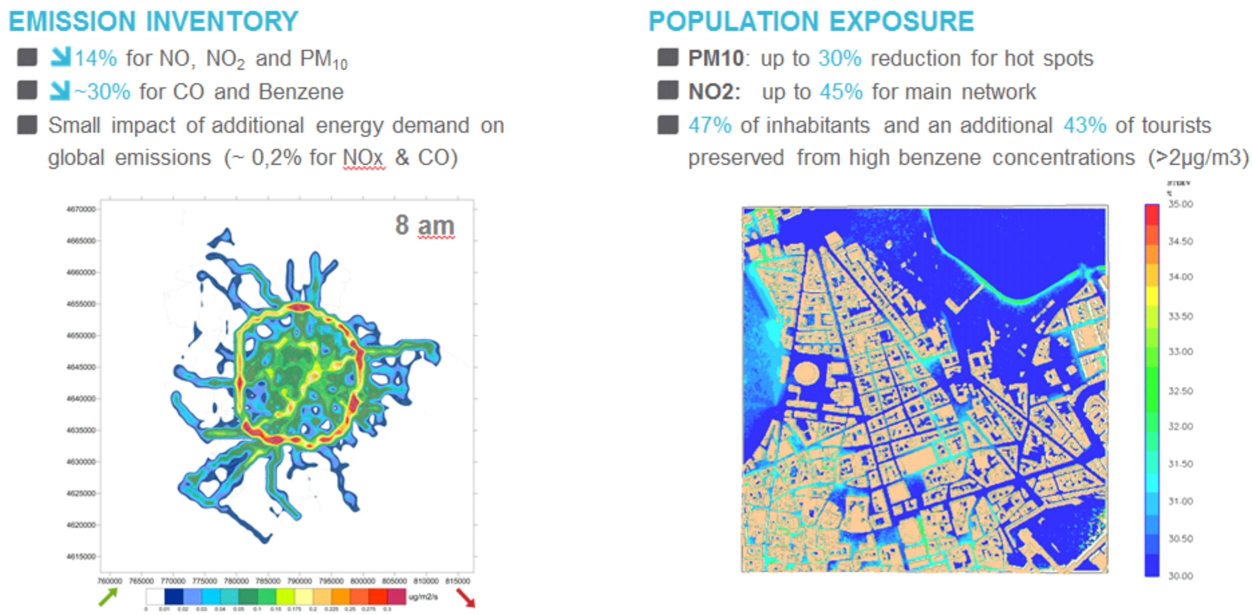
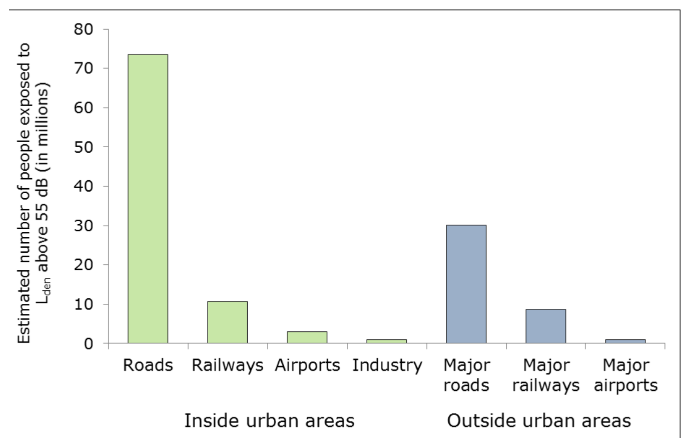


Figure 5: Potential reduction of air pollution in Rome with 20% EVs in city centre and 10% in other areas

According to the World Health Organisation (WHO) noise is the second largest environmental cause of health problems, just after the impact of air quality. More than 100 million people in the EU are affected by road traffic noise above the 55dB assessment threshold specified in the European Noise Directive (see figure 6).

Figure 6: Reported number of people (millions) exposed to average daily noise > 55 dB Lden in Europe[6]

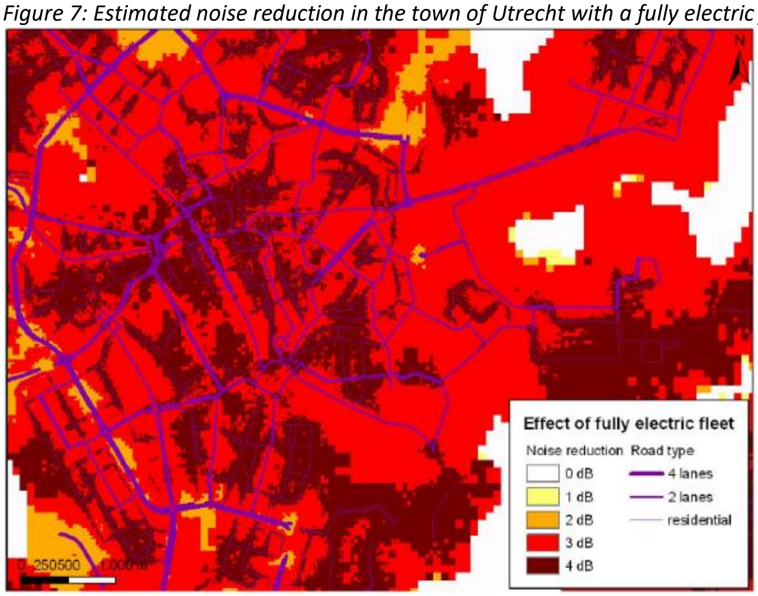


As they do not emit any powertrain noise, battery electric vehicles can bring a substantial contribution to the reduction of urban population exposure to excessive noise levels. A study carried out by RIVM (the Dutch Institute for Public Health and Environment) in 2010 simulated the noise reduction effect of the substitution of 90% of the light passenger cars and light-freight cars and 80% of the heavy trucks by electric vehicles in the town of Utrecht.

6 Source: EEA Noise in Europe 2017; L_{DEN}: Day-Evening-Night.

The study concluded that such scenario would lead to an overall noise reduction of approximately 3 dB compared to a fully conventional fleet, and up to 4 dB on low speed areas such as secondary urban roads and at crossings (the noise reduction effect being less significant at higher speeds as tire-road noise becomes dominant), as illustrated in figure 7. Combining the noise maps with geographical population data and a histogram of dose-response relationship between noise levels and the level of annoyance, RIVM calculated that such substitution of a conventional fleet by an electric one would lead to a reduction of the number of "annoyed inhabitants" (due to excessive noise levels) of 33% and of the "severely annoyed" by 36%.

Figure 7: Estimated noise reduction in the town of Utrecht with a fully electric fleet[7]



[7] Source: RIVM – Effects of electric cars on traffic noise and safety.

I.2. MAIN FEATURES AND USE OPTIMIZATION OF EV BATTERIES

Currently, lithium ion batteries are the most common type of battery used in electric vehicles. Those batteries turn out to be very flexible and may be used to store electricity and provide services to the grid (while being in the vehicle or afterwards outside the vehicle).

I.1.1. Main features of EV batteries

When initially put on the market, the main usage of an EV battery is traction and mobility. This traction battery has been designed to fulfil the basic performances, to ensure full safety at vehicle level and compliancy with local regulation.

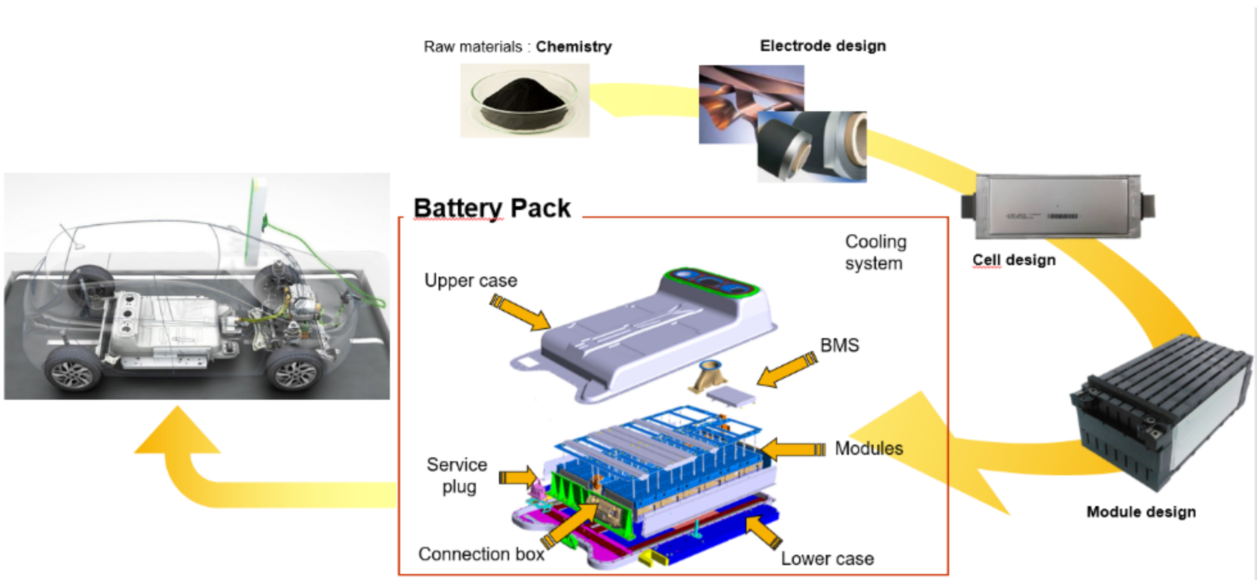


Figure 8:

Safety and durability: The battery is consequently characterized by its ability to maintain its range and safety with time. Renault is commercializing EVs since 2012 and succeeded in recording evolution of battery health with km and time. The figure below shows a sampling of 45000 Zoé first generation on market.

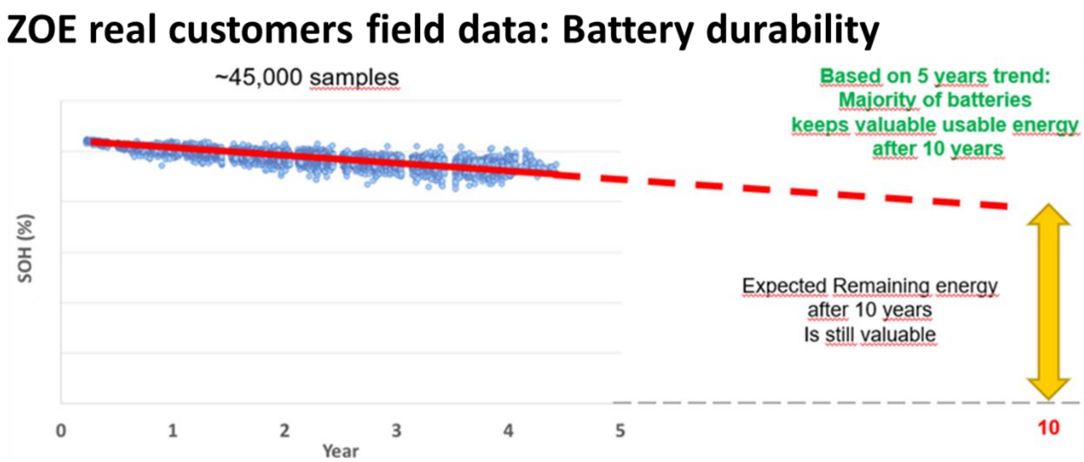


Figure 9: SOH trend for ZOE first generation on road extrapolated to 10 years.

The state of health evolution shows 2 main features. First the slope for evolution is quite flat and we can expect a large remaining energy after a long period on road. Second, whatever the time on road, the scattering is quite narrow. Concretely it means that the diversity of customer behaviors has few influence on ageing and we can expect a homogeneous evolution of SOH (state of health) in our global park. Consequently at the end of the first life, there are opportunities to recover aged battery pack highly valuable for other applications less demanding in terms of energy or power density.

In addition to the EV cell durability, the EV battery pack is designed around safety concepts. These safety concepts respect regulation and their declination to BMS (battery management system), module and chemistry.

Well-suited for electricity storage: These intrinsic features for EV designs is an asset for any other applications, especially for Vehicle to Grid or stationary application using 2nd use batteries.

Stationary applications features

The stationary applications are mainly sized through energy stored compared to power available. Considering the Li ion battery ageing, four mains triggers shall be considered for life expectations:

- C-rate[8]: The major stationary applications like frequency regulations, peak shaving, or load shifting are generally sized to provide high power for a limited time. However practically the power demand seen by the battery is rather low. Power to energy ratio is generally in

[8] The C-rate is defined as a ratio between the current in A and the maximum battery capacity in Ah. A 1C rate means that the discharge current will discharge the entire battery in 1 hour.

between 0,2 to 0,4 C rate[9]. On the contrary in vehicle application C-rate for charge and discharge are from 2 to 5. Such feature plays a role on self-heating of the battery. In stationary use, Li ion cells should be less sensitive to power demand.

- T°C: The temperature is the main ageing factor for Li ion batteries. As soon as the stationary application limits or control T°C of the battery the fading ratio is kept limited. Considering the limited C-rate ratio, the self-heating contribution in the battery T°C should be quite low and the deviation with the controlled T°C could be very limited. It means we can expect a battery T°C range between 10°C to 30°C for these applications. EV batteries have been designed to support in use T°C from -20°C to 60°C.

- SOC (State of Charge): The stationary applications like the frequency regulation are designed to swing around 50% SOC with a very limited state of charge window or depth of discharge. Ageing rate is connected to time spent at the extreme state of charges for Li ion batteries. Especially when considering charging at high state of charge or discharging at low state of charge. This sensitivity is directly connected to T°C and power demand. Considering the features above with limited C rate, narrow T°C range, the SOC should have a low impact for the battery ageing even if SOC range deviate from 50%.

- Energy throughput: The cumulated energy seen by the battery plays a role in ageing mechanisms. However, the ageing studies in literature are very limited for Li ion batteries used in stationary application. The ageing mechanisms connected to a high energy throughput (> 10MWh / year) exchanged in a limited SOC window with a low C rate has not been characterized. With a growing interest on the 2nd use application for EV batteries we expect some first clue in the coming years. The target would be to understand if cycling or exchange energy throughput in such conditions plays a significant role compared to calendar ageing[10].

Through high C-rate, wide T°C and SOC range demands, the EV batteries are designed to survive in extreme conditions. The market data shared in the Figure 2 shows this good robustness through a limited fading slope. The short qualitative description of the stationary usages above help us to be even more optimistic for life duration in a 2nd use application. The literature shows few assessments on the expected EV battery life in re-use application. However, depending on the

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9 GARRETT F. MANDEL J. MORRIS J. and TOUATI H., « The Economics of Battery Energy Storage: How multi-use, customer-sited batteries deliver the most services and value to customers and the grid », Rocky Mountain Institute, September 2015.

10 JRC Technical Reports, « Sustainability assessment of second life application of automotive batteries (SASLAB) », Final technical report: August 2018.

duty cycle and the re-use system design, 10 years or more should be considered as realistic targets[11].

Consequently the EV batteries after a first ageing period, shall be considered as technically relevant and promising for growing new businesses like local storage for photovoltaic or grid supports.

I.1.2. Use optimization: the concepts of first and second life battery

During the first life, meaning during the mobility life of the batteries, they contribute to the improvement of urban air quality by offering unequalled solutions to cut greenhouse gases and polluting emissions from road transport. They therefore support a rapid transition to a 100% renewable energy system.

In addition to that, Smart Charging and Vehicle to Grid, will bring services to the grid. In the first place, charging can be shifted based on grid loads or grid constraints and in accordance to the vehicle owner's needs. For instance, at times of high constraints on the grid customers shall be induced to reduce charging or at times of high level of production, often corresponding to negative prices in the market, customers shall be induced to increase charging.

Moreover, charging can be either mono-directional (charge or stop charging) or bi-directional, by providing energy to the Grid. Charging power can be decreased in times of scarcity or electricity can be returned back to the electrical grid by utilising bi-directional charging solutions. The utility offers electric vehicle owners monetary benefits (i.e. lower prices) in exchange for enrolment in a program that permits controlled charging at the times when curtailment capacity is needed for the grid.

Because the driving range of an electric vehicle is directly correlated with the storage capacity of its battery, batteries are removed from electric vehicles once their capacity declines past a certain point. It is estimated that this generally happens when batteries reach 70% to 80% of their original capacity. Although no longer practical for use in vehicles at this point, the batteries are still suitable for storing electricity and providing services to the electricity system.

After a first life in the vehicle, EV batteries may provide useful services to the electricity system as stationary storage devices, therefore extending their lifetime with a second life.

Where batteries are no longer sufficient to cover traction and mobility needs, they can easily be re-used in less demanding applications, such as energy storage system (ESS), as they still keep enough charging capacity.

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[11] A Second Life for Electric Vehicle Batteries: Answering Questions on Battery Degradation and Value, Neubauer, Eric Wood, and Ahmad Pesaran, NREL, SAE, 2015.

Indeed, li-Ion[12] batteries tailored for EVs are designed to provide services to the whole energy value chain of the battery. This is confirmed by the Figure 2 that shows, based on a 5 years trend, that first-life batteries remaining energy is still valuable given that their state of health related available energy would still be above 75% after 10 years.

Reusing EV batteries in second life applications is a cost-effective solution. Indeed, EV batteries can either be reused "as a whole" i.e. integrated into a new energy storage system without being dismantled, or disassembled into elements (modules, BMS…) that can be reassembled and reused into a new system:

1) In the first case the associated operations are very simple and consist mainly of battery grading (diagnosis). Associated costs are therefore very low and represent no more than 10% of the cost of manufacturing new batteries, besides logistics costs which currently remain quite significant, partly due to ADR requirements. In addition, as these second life EV batteries are a complete and fully functional energy storage system, designed and tested according to the highest performance, quality and safety standards, reusing them into a new energy storage system requires very limited redesign/reengineering expenses compared to the design of a completely new system.

2) In the second case the costs associated with modules disassembly and grading (diagnosis) are also significantly lower (well below 50%) than the cost of manufacturing equivalent new modules, and those related to modules reassembly into a new system are equivalent between second life modules or new modules.

Hence, in both cases (and most notably in the first one) the cost of operations required to enable second life application is much lower than the cost of manufacturing new batteries, provided that the legal constraints on battery transportation and associated logistics costs remain reasonable

Second life - The reuse of EV batteries in post-vehicle applications corresponds to the "***second life***" of batteries. It creates further value and amplifies the environmental benefits brought by electric vehicles and their batteries over their life cycle.

[12] Lithium-ion.

The figure below illustrates the optimized life cycle of an EV battery:

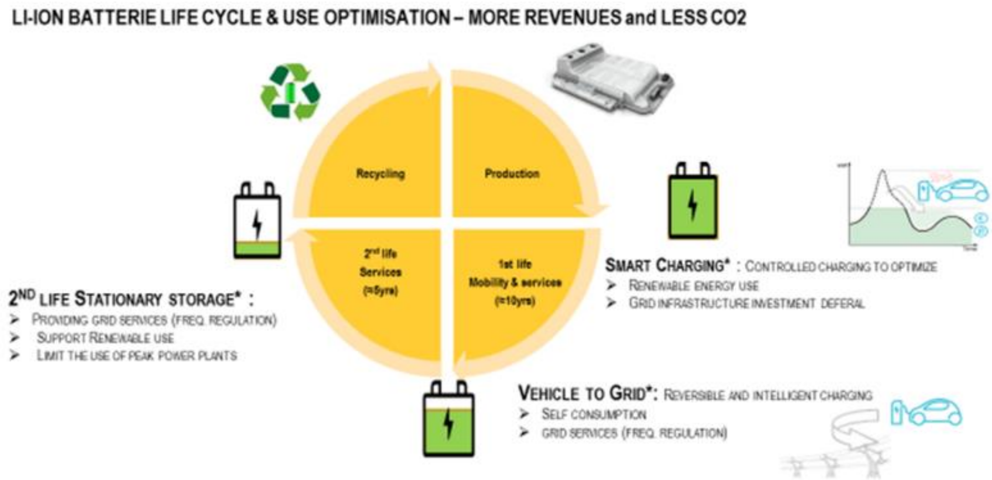

Figure 10: Li-Ion batterie life cycle

DESCRIPTION OF THE USE CASES OF SECOND-LIFE BATTERIES

The first step for re-using modules or packs in other than EV applications consists in selecting the products from the market (see Figure 11). In Renault case, the return batteries might come from End of life vehicle centres, directly from customer (under a battery leasing contract or not) and from repair networks (see figure 12). The Figure 11 summarizes the basic selection process:

- A first assessment shall be done by diagnosing the pack through a mechanical and a software inspection including the pack state of health estimation. From this first diagnostic session, the pack can be oriented to recycling, to EV use, to re-use or to more in-depth inspection.
- This 2nd step consists in module grading measured at pack level able to assess the respective state of health of each module. Perform the module grading at pack level thanks to an in-house algorithm allows to assess multiple modules in one measurement session.
- Again, after the pack disassembly, the modules can be selected for recycling or for storage. Depending on their state of health and on the re-use customer demand, they can be directly affected to re-use or re-assembly into packs for the re-use market. A second option can be to use these modules for repairing EV packs or for re-assembly complete packs for 2nd hand vehicles.

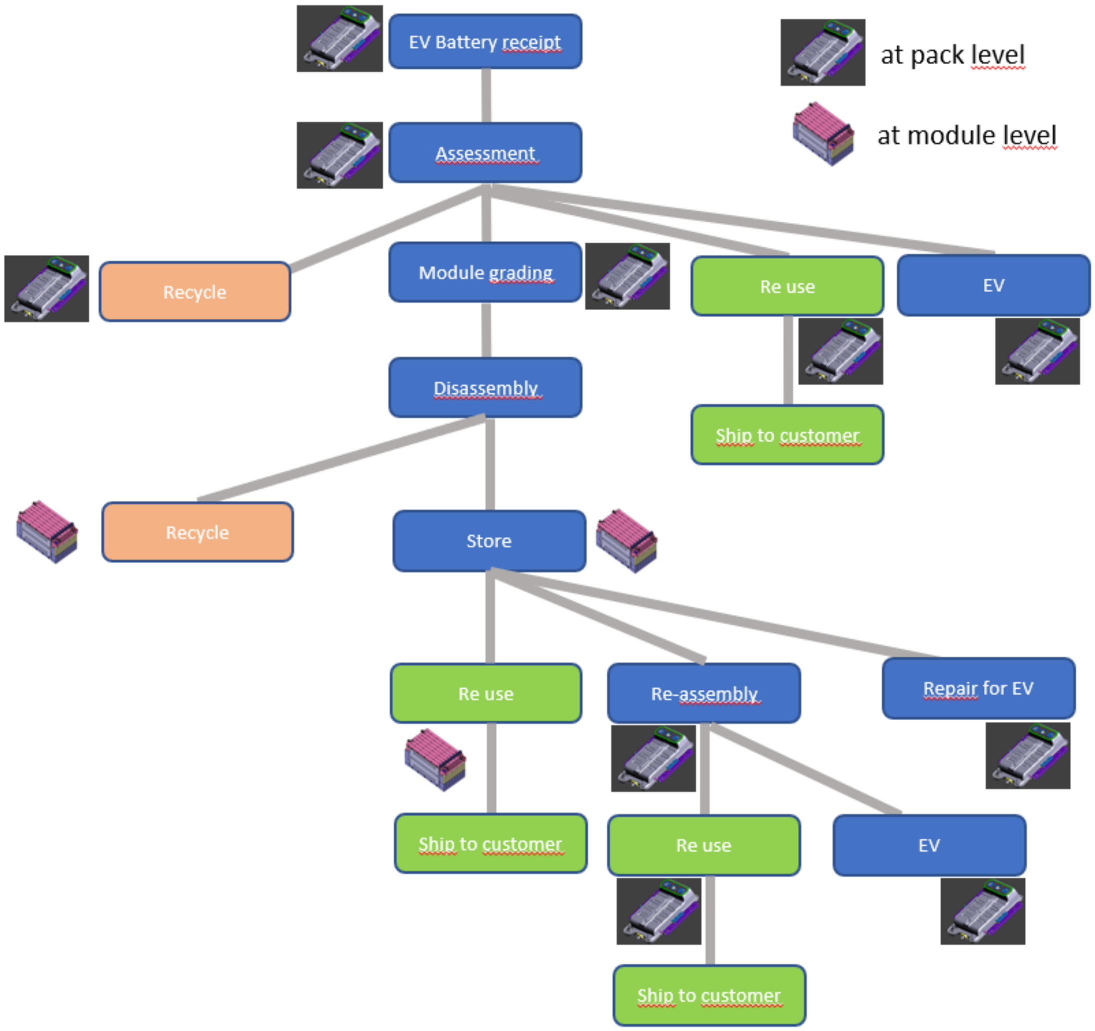

Figure 11: Affectation process for modules and packs regarding recycling, return in EV market, re-use

Second-life batteries may be used in various stationary or mobile storage applications. However, if we focus on the battery itself rather than on the environment in which it will be reused, three main use cases can be distinguished:

- ***1st use case*:** **Re-use of single original battery pack into stationary storage system**: *this use-case refers to a situation where a battery pack is taken from an electric vehicle to be re-used as such as an energy source for a post-vehicle purpose.*
- ***2nd use case:*** **Re-use of various battery packs integrated into multipack stationary storage system**: *this use-case refers to a situation where several battery packs are taken from various EVs to be re-used in a multipack stationary storage system, such as a renewable power plant storage system.*
- ***3rd use case:*** **Battery pack disassembly and re-use of battery components (modules) into a new storage system**: *this use-case refers to a situation where a battery pack is*

taken from an EV and disassembled so that the modules composing that battery pack can be re-used as a storage system, for instance as a home power storage system.

The figure below provides an overview of the different use cases and pathways that can be followed by an EV battery, from the end of its first life on the electric vehicle to its second life applications and final recycling, along with the relevant EU legislations at each stage (circular economy aspects):

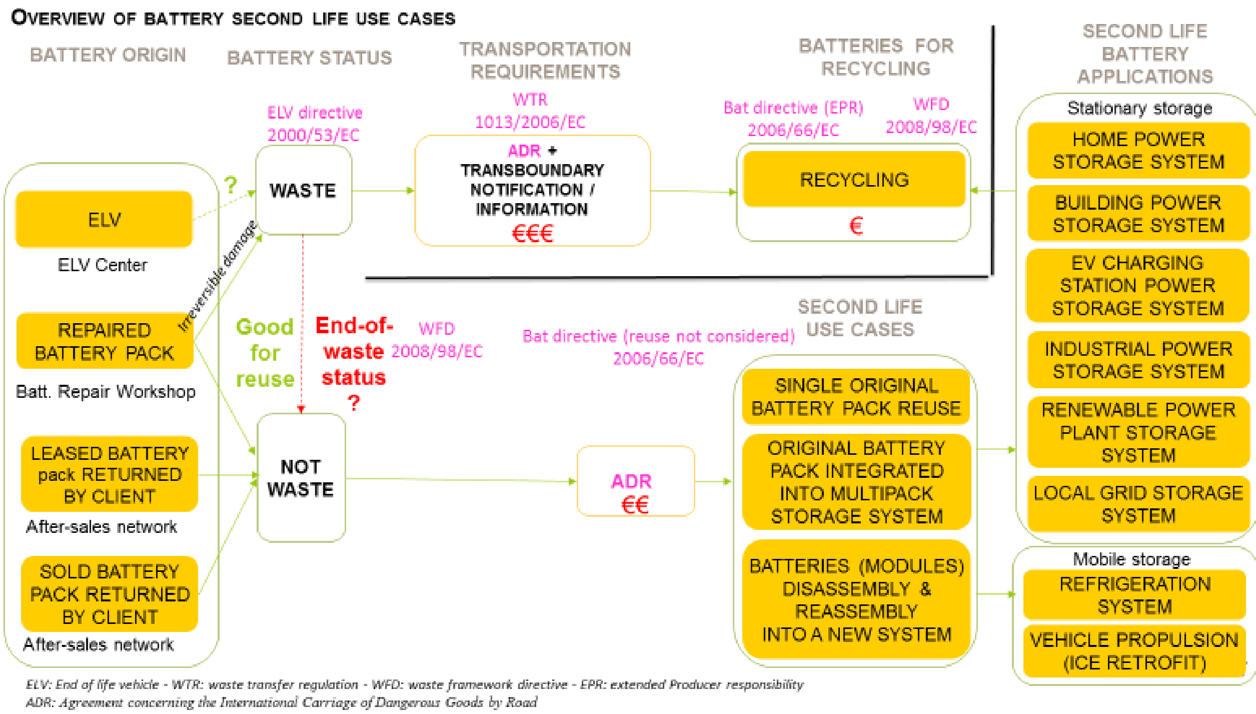

Figure 12: Overview of battery second life use cases

In such second life applications, electric vehicle batteries may serve as an efficient way to improve:

- ***Electricity production***, by smoothing the intermittencies of photovoltaic or wind electricity production ;
- ***Electricity transport***, by providing frequency regulation services in addition to or in replacement of traditional generators during peak consumption. Moreover, smart charging is essential to minimize the impact that a large deployment of electric vehicles may have on power production and distribution infrastructures ;

- ***Electricity distribution***, by avoiding existing substations and the low-voltage energy network to be overloaded, and by deferring the infrastructure upgrade cost of distribution utilities ;

- ***Electricity retail***, by offering additional buy and sell possibilities to consumers through home power storage systems (as a complement to vehicle-to-home or vehicle-to-grid services that could be provided by electric vehicles themselves) ;

- ***Electricity CO_2 emission factors***, by enabling *(i)* the self-consumption of local solar power production to be optimized in commercial, industrial and residential buildings and *(ii)* by allowing peak shaving and peak shifting possibilities to reduce energy bills.

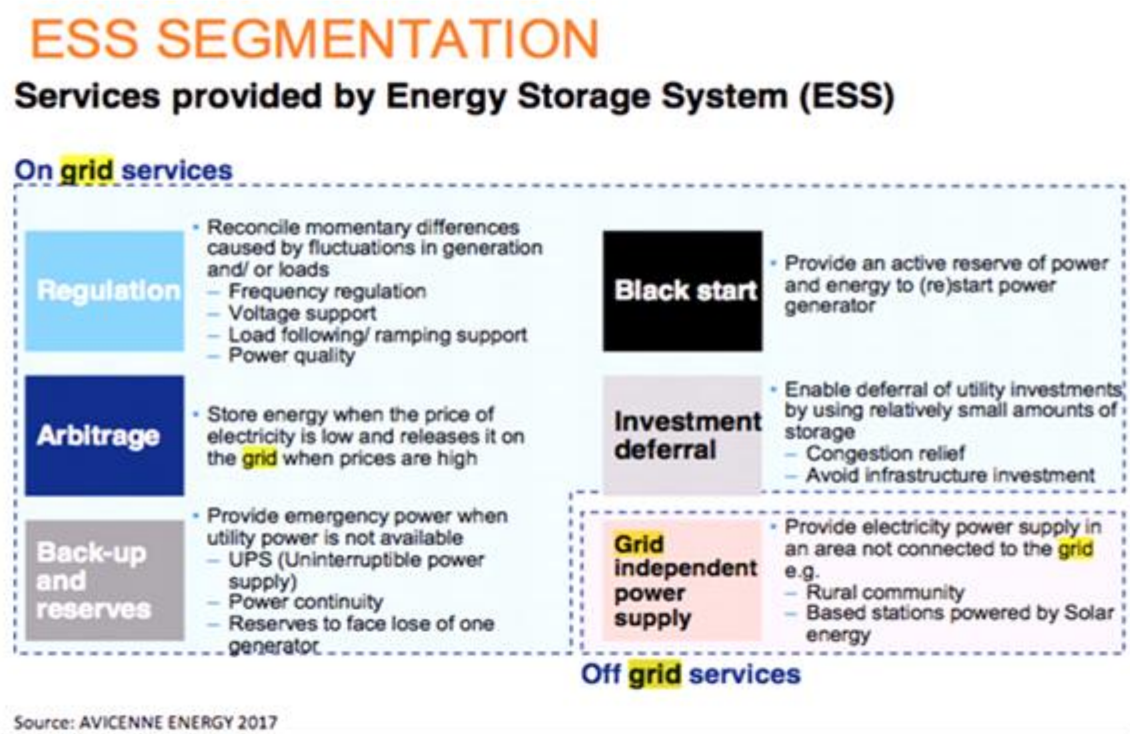

Figure 13: Services provided by ESS

For these reasons, there is a real strategic and economic interest in re-using EV batteries in stationary applications, all the more as this will trigger significant environmental and societal benefits.

I.3. BENEFITS & OPPORTUNITIES OF A LARGE-SCALE OPTIMIZATION OF EV BATTERY LIFE CYCLE

In the Explanatory Memorandum of its Proposal for a directive amending Directive 2008/98/EC on waste the Commission encourages the improvement of resources efficiency as this can bring “major economic, environmental, and social benefits”[13].

In this regard, the draft final technical report of JRC’S SASLAB14 study notes (page12) that giving a second life to EV batteries *“is fully aligned with both the waste management hierarchy (i.e. prevent, preparation for re-use, recycle, other recovery, disposal) as stated in the Waste Framework Directive 2008/98/EC (EU, 2008) and the 2015 Circular Economy action plan of the European Commission (EC, 2015c), especially concerning actions on lifetime and improved raw materials flows. In fact, this EoL option can keep the added value in products for as long as possible and minimizes waste. Resources are kept within the economy when a product has reached the end of its life, so that they can be productively used again and hence create further value“*.

The environmental and socioeconomic benefits associated with stationary applications of second-life EV batteries and more generally with a large-scale optimization of EV battery life cycle will be developed in this section.

I.3.1. From an environmental perspective

After their first use, as described in the previous section, battery pack still has available storage capacity making it suitable for numerous other applications than electric mobility.

Research studies have identified up to fourteen different services second life EV batteries can provide to four stakeholder groups at four levels, as illustrated in figure 14: off grid, behind the meter, at the distribution level, or at the transmission level (TSO: Transmission System Operators). Among these, the six types of services identified at a residential level (“behind the meter”) could also be provided by EV batteries during their first life through vehicle-to-grid applications.

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13 COM(2015) 595 final.

14 Sustainability Assessment of Second Life Application of Automotive Batteries (SASLAB), JRC Exploratory Research (2016-2017).

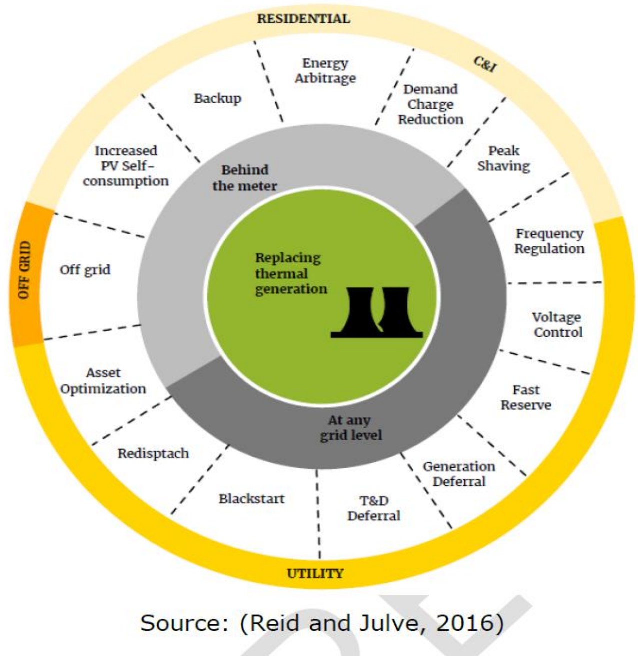

Figure 14: The spectrum of potential battery energy storage services

In most cases these battery services could replace thermal generation capacities, thus avoiding the emission of considerable amounts of CO2.

Household energy consumption, for instance, is concentrated at the end of the afternoon and beginning of the night, with some occurrences during the morning period, generating power demand peaks which generally require the operation of specific thermal power production capacities.

Load shifting through Vehicle-to-Grid (V2G) and stationary storage services, associated with demand side management (DSM) of EV charging, could contribute to attenuate peak demand by injecting power into the grid during these periods and charging the batteries during off-peak hours, as shown in figure 15.

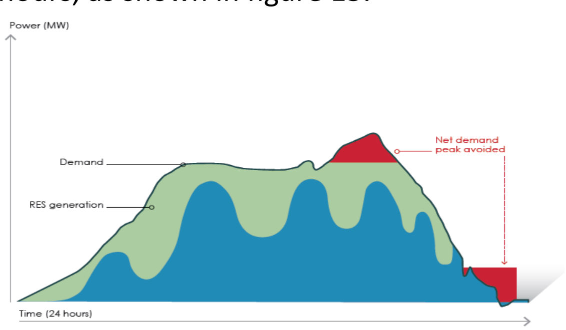

Figure 15: Peak shaving through Vehicle-to-Grid (V2G) and battery stationary storage services[15]

[15] Source: Fuelling Europe's future (2013) - Cambridge Econometrics & The European Climate Foundation.

In fact, the re-use of EV batteries will benefit the development of renewal energies, by providing stationary storage solutions for both firms and private individuals. It will encourage firms to equip their office buildings with renewal energy for example with solar panels. In the same way, the purchase of residential solar or wind energy systems will also be boosted by the ability to store electricity at an affordable cost for private individuals living in houses or in residential buildings.

The wide scale optimization of EV battery life cycle through "first life" Vehicle-to-Grid services and second life stationary storage applications also represents a great opportunity to foster the incorporation of a higher share of renewable energies in the power production mix.

At a national grid level it can be a means of reducing renewable energy curtailment (i.e. the loss of renewable energy output when it exceeds demand) by charging batteries during periods of high renewable energy output and low demand and delivering energy into the grid during periods of high demand and low renewable energy output, as illustrated in figure 16.

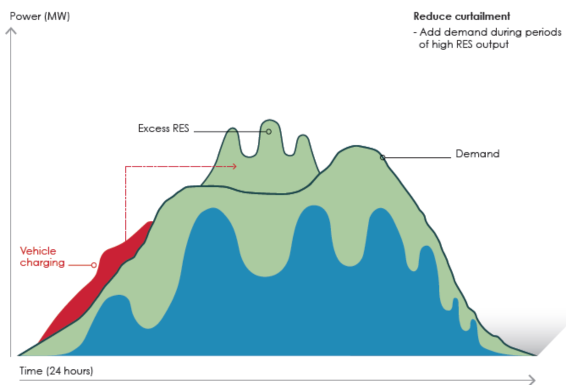

Figure 16: Reduction of renewable energy curtailment through Vehicle-to-Grid (V2G) and battery stationary storage services.[16]

Vehicle-to-grid services and second life EV batteries are also an opportunity to offer affordable local energy storage solutions at a residential level or (in case of second life batteries) for a building, a factory or a local grid in order to maximize the self-consumption of solar power production.

The environmental and most particularly climate-related benefits associated with "first life" smart charging and Vehicle-to-Grid services on the one hand, and second life stationary storage applications on the other hand have been evaluated in several studies carried out by various environmental NGOs and research institutions. Although the results can vary depending on the considered business cases and assumptions it is widely admitted that such optimizations and extensions of the life cycle of EV batteries can provide significant environmental and climate

[16] Source: Fuelling Europe's future (2013) - Cambridge Econometrics & The European Climate Foundation.

benefits and therefore significantly improve the environmental balance of the battery, and more generally of e-Mobility.

The study *« Quelle contribution du véhicule électrique à la transition écologique en France? »* (What contribution can the electric vehicle provide to the energy transition in France), carried out by the Fondation pour la Nature et l'Homme, the European Climate Foundation and Carbone 4 and which final report was released in December 2017, calculated that the CO2 gains (i.e. the avoided CO2 emissions) associated with "first life" CO2-driven smart charging, Vehicle-to-Grid services and 2nd life battery stationary storage services could reach 45% of the estimated carbon footprint of an electric vehicle in 2030 in France with "natural charging" only (see figure 17).

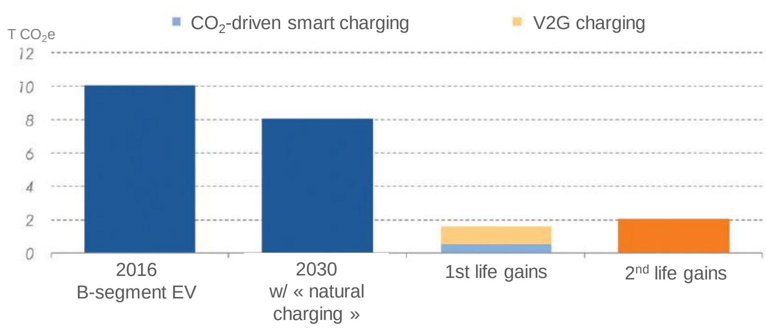

Figure 17: Potential climate benefits associated with a B-segment EV battery V2G & 2nd life services in France (in t CO2e).[17]

The ICCT carried out a similar assessment at a European level in its study "Effects of battery manufacturing on electric vehicle life-cycle greenhouse gas emissions", although with a different scope as it covers potential future changes in battery manufacturing greenhouse gas emissions due to larger battery capacity and greater energy intensity and does not evaluate the benefits associated specifically with V2G services. However, the study reaches similar conclusions on the potential benefits of second life battery applications, evaluated to 22 g/km i.e. 17% of the life cycle carbon footprint of the reference 2017 electric vehicle, which is coherent with the results of the previous French study. Based on ICCT's assumptions and calculations these second life gains would also more than compensate the additional battery manufacturing carbon footprint associated with the increased battery capacity expected for future electric vehicles to meet the driving range requirements of the market (see figure 18).

The conclusions of these two studies are consistent with the results of Renault's internal Life Cycle Assessments, which estimate the potential CO_2 gains associated with first and second life EV battery services to around 50 g/km (of which 20 to 25 g/km for second life alone). Such gains could double the reduction of the carbon footprint of an electric vehicle compared to an equivalent ICE vehicle by 2030 in Europe (see figure 19).

[17] Source: Quelle contribution du véhicule électrique à la transition écologique en France ? (FNH, ECF, Carbone 4 – Dec. 2017).

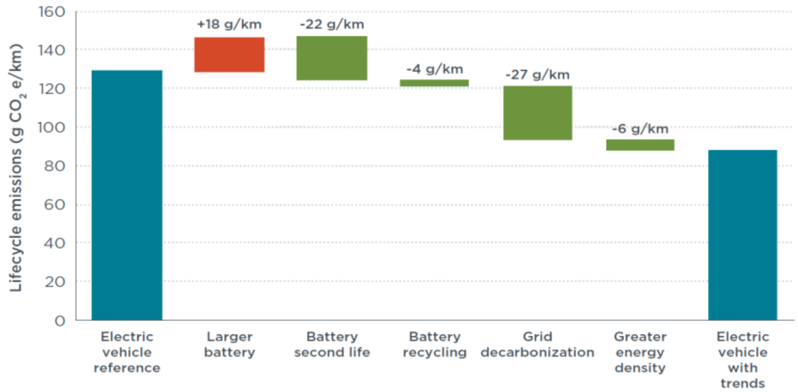

Figure 18: Potential changes in battery manufacturing greenhouse gas emissions (compared to reference 2017 electric vehicle) resulting from increased pack size and battery life cycle optimization[18]

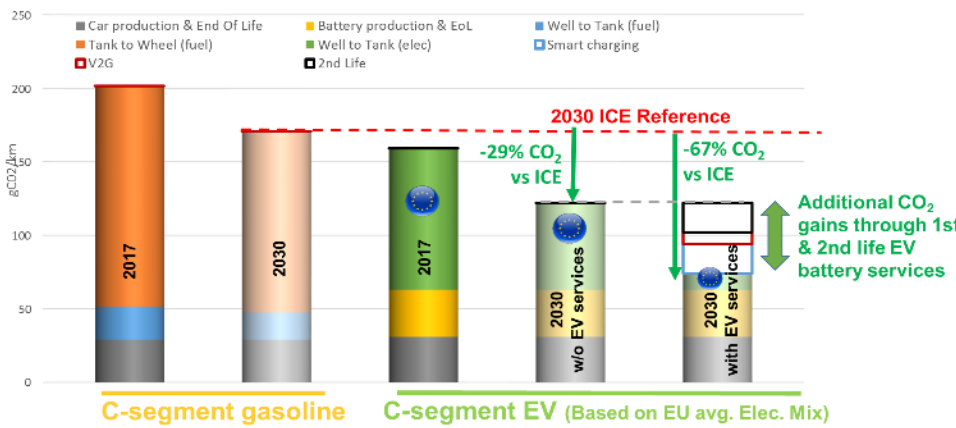

Figure 19: Additional carbon footprint reduction between a gasoline and an electric vehicle with battery life cycle optimization (i.e. smart charging, V2G and second life) in the EU by 2030[19]

The results of JRC'S SASLAB[20] study are more nuanced as the Life cycle Assessments carried out within the framework of the project did not find any net environmental benefit for the two considered stationary storage configurations (peak shaving for an office building located in Ispra, Italy and increase of photovoltaic self-consumption in a residential building located in the Netherlands), either with fresh or repurposed batteries. The report highlights, however, that the second application could be beneficial according to feed-in curtailments and that energy mix heavily affects the impacts of the assessed configurations. It concludes that environmental benefits can be observed in certain conditions and that all peculiarities of the system/battery should be considered (e.g. application, geographical boundaries, type of energy mix, battery

18 Source: ICCT – Effects of battery manufacturing on electric vehicle life-cycle greenhouse gas emissions.

19 Source: Renault internal LCA calculations based on 2017 EU Power mix and IEA WEO 2017 projections for 2030.

20 Sustainability Assessment of Second Life Application of Automotive Batteries (SASLAB), JRC Exploratory Research (2016-2017).

chemistry). The use of a battery storage to increase PV self-consumption in a stand-alone system (PV installation + diesel-electric generator), for instance, provides significant environmental benefits.

Another finding of the study is that "*the adoption of a repurposed LMO/NMC battery in place of a fresh one is beneficial from an environmental point of view for both assessed second-use applications. Higher yearly benefits are related to the increase of PV-self consumption application*". This finding confirms the relevance, from an environmental standpoint, of using second life batteries rather than fresh batteries whenever possible.

The report therefore concludes that "*the extension of the lifetime of xEV batteries through their adoption in second-use application is a credible and feasible end-of-first use recovery option, which is interesting for various stakeholders and also from a policy perspective. Moreover, significant environmental benefits from the extension of xEV batteries lifetime are generally observed*".

As a conclusion from an environmental perspective, optimizing the use of second-life batteries will provide numerous benefits among which (i) a reduction of the total carbon footprint of electric vehicles, thus amplifying the climate benefits of the transition to e-Mobility (ii) cost effective means to improve building energy management, (iii) more distributed sources for grid system services and (iv) affordable storage solutions to support the development of renewable energies.

Extending the battery life cycle beyond its original use to stationary storage applications will also avoid the use of fresh batteries for such applications and the environmental impact associated with their manufacturing. This would also reduce the need for extracting (and importing) critical raw materials such as cobalt, lithium or nickel and the associated negative environmental and societal impacts, in coherence with the waste hierarchy and the principles of resource efficiency, although these environmental and societal benefits of battery second life are not well documented in the literature.

Finally, such optimization and extension of EV battery life cycle will improve the costs/benefits balance and the competitiveness of electric vehicles (vs conventional ones) and accelerate their uptake on the market, thus triggering the virtuous loop represented in figure 20 and further amplifying the environmental and societal benefits of e-Mobility. This economic analysis will be further developed in the next section.

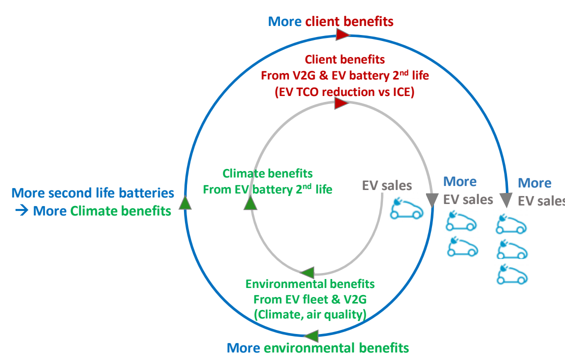

Figure 20: Illustration of the virtuous loop of energy transition that could be triggered by a widescale optimization of EV battery life cycle[21]

[21] Source: EEA European environmental Agency.

I.3.2. From a socioeconomic perspective

As seen in section I.1.1, a massive uptake of electric vehicles will be required in the next 30 years to meet the objective of the Paris agreement for climate to limit the increase in the global average temperature to well below 2°C above preindustrial levels. According to the International Energy Agency's 2-degrees scenario, 160 million electric vehicles should be added to the global vehicle stock by 2030, of which more than 30 million in Europe (see figure 21).

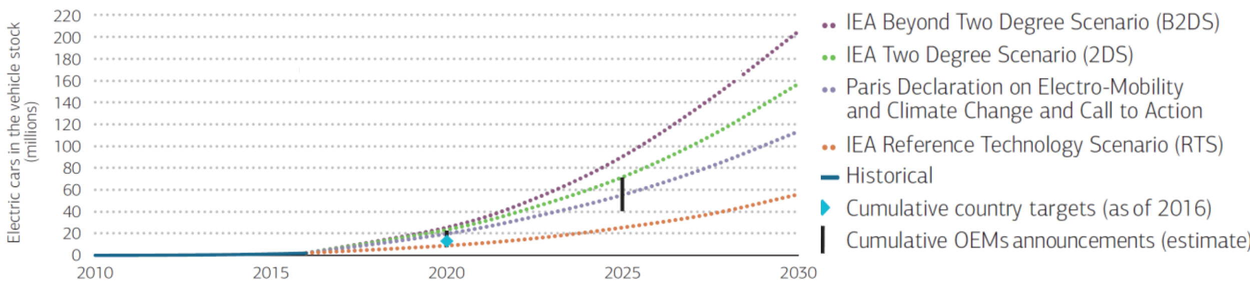

Figure 21: Expected evolution of the global EV fleet according to IEA 2DS and other scenarios [22]

Such a widespread adoption of electric vehicles, especially in urban areas, would also provide significant environmental and societal benefits, represent a significant leap ahead towards the achievement of a healthy urban living (see section I.1.2) and reduce the cost of air and noise pollution for the society.

However, because they require large batteries which involve a complex and costly production process and contain significant amounts of expensive raw materials, electric vehicles are costlier to produce than conventional vehicles, and despite technological improvements and economies of scale this should still be the case by 2030 and beyond (see figure 22).

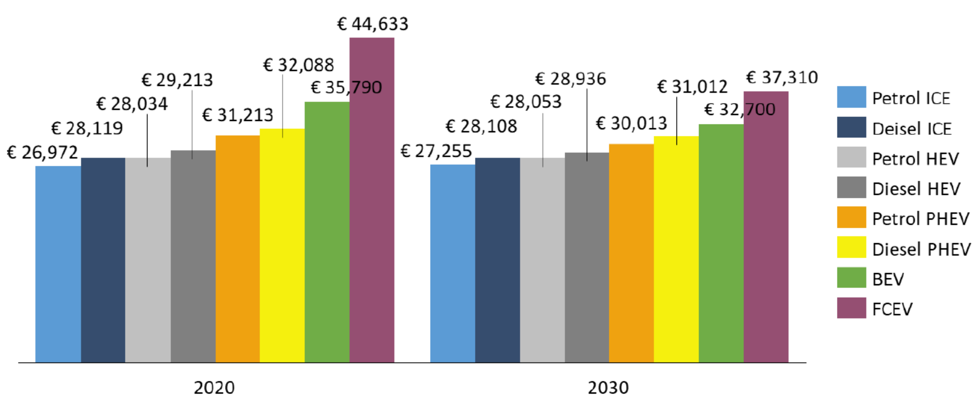

Figure 22: Capital cost of a new medium sized vehicle [23]

[22] Source: IEA Global EV Outlook 2017.

[23] Source: Low carbon cars in Europe: A socio-economic assessment – European Climate Foundation and Cambridge Econometrics.

This higher purchasing cost remains one of the main barriers to a widespread adoption of electric vehicles (along with their limited driving range compared with conventional vehicles).

As electric vehicles incur lower running costs than conventional vehicles (especially due to the lower cost of electricity compared to gasoline or gas oil) this problem can be circumvented by leasing the vehicles (or their batteries, as Renault has been doing since it launched its first lithium-ion battery electric vehicle in 2011) instead of selling them, reducing the issue to a question of Total Cost of Ownership. From this perspective, the cost of owning and running an electric vehicle is expected to be comparable to that of a conventional one by 2020, if the costs of the charging infrastructures required by the electric vehicle are not considered (see figure 23).

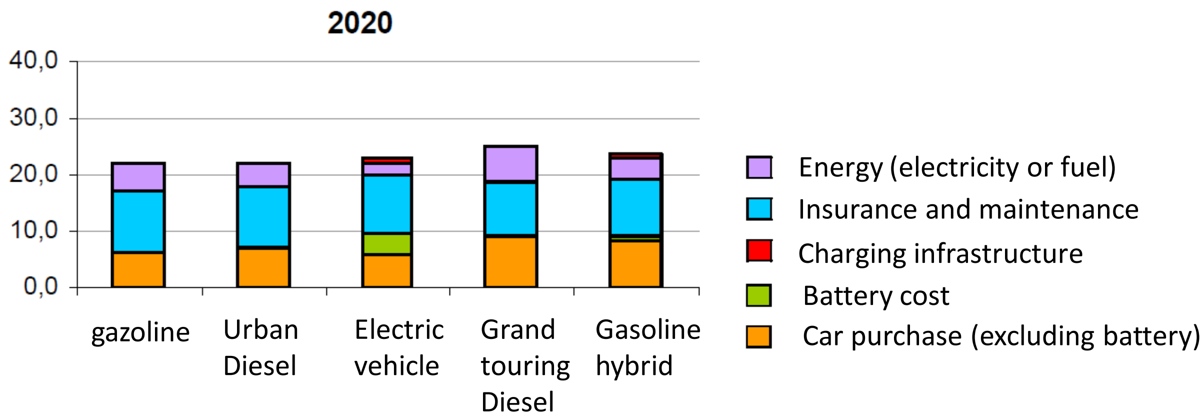

Figure 23: Total cost of owning and running a car depending on technology in France in 2020 (€/km) [24]

However, considering the additional costs and constraints associated with the need for such charging infrastructure (along with driving range limitations), achieving parity between the Total Cost of Ownership of conventional and electric vehicles alone may not be enough to trigger a massive uptake of electric vehicles in the market. In the short to mid-term fiscal incentives could tilt the balance in favour of electric vehicles, however it is common sense that their widespread adoption should not rely on such fiscal advantages in the long run.

By improving the costs/benefits analysis of electric vehicles, the optimization of battery life cycle may provide the additional economic incentive required to trigger a perennial uptake of electric vehicles on the market, independently of public subsidies, as giving a second life to batteries will enhance their residual value at the End of their first life and V2G offers may further reduce the cost of ownership of electric vehicles.

[24] Source: CGDD (French Ministry of Environment) - Les véhicules électriques en perspective, Analyse coûts-avantages et demande potentielle.

The second life battery market is not mature enough to give a sense of the extent to which it could reduce the total cost of ownership of electric vehicles, but the European Climate Foundation and Cambridge Econometrics have calculated that the provision of V2G services could represent a net benefit of more than 600 €/year for electric vehicle owners in some EU countries, depending on national energy tariffs and regulations (see figure 24).

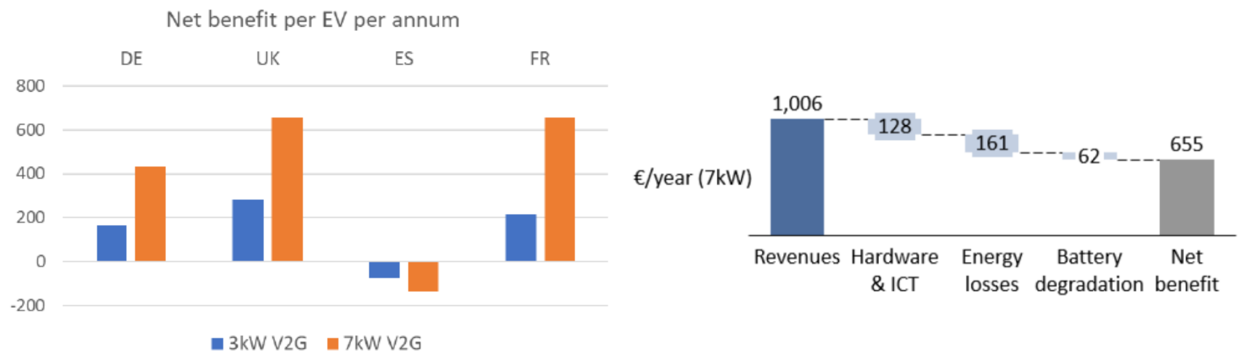

Figure 24: Net benefit of V2G service provision with a 3kW or 7kW bi-directional residential charger in 4 EU countries (with breakdown for France) in 2030 [25]

In addition, by offering more distributed sources for grid system services, supporting the incorporation of a growing share of renewable energies into the grid and reducing the need for thermal peak power production capacities, V2G services and second life EV batteries can provide considerable economic benefits to the society.

Hence, according to the study Fuelling France published in late 2015 by the European Climate Foundation and Cambridge Econometrics, intelligent management of electric vehicle charging (including smart charging and V2G services) could contribute to the creation of a net profit of €125 million in 2030 for the French energy system, while enabling greater integration of renewable energy and reducing dependency on oil and gas imports. It would also make it possible to add more than 20 million electric vehicles into France's car fleet without resorting to additional production capacity.

More generally, the report on "The potential for high-value reuse in a circular economy" published in 2015 by Nederland Circulair!, highlights how a greater economic value can be created or preserved by implementing strategies at national or European level for a greater reuse of products and components, as illustrated in figure 25. The report emphasizes that such strategies could lead to the creation of 1.4 to 2.8 million jobs in Europe, large part of this job creation comes from the greater labour needs of reuse. This also applies to the reuse of second life batteries, especially as they are currently mainly imported from Asia whereas reuse activities would mainly generate local jobs which could hardly be outsourced to non-EU countries given the high costs and constraints associated with battery transportation.

[25] Source: Low-carbon cars in Europe: a socio-economic assessment (European Climate Foundation & Cambridge Econometrics – Feb. 2018).

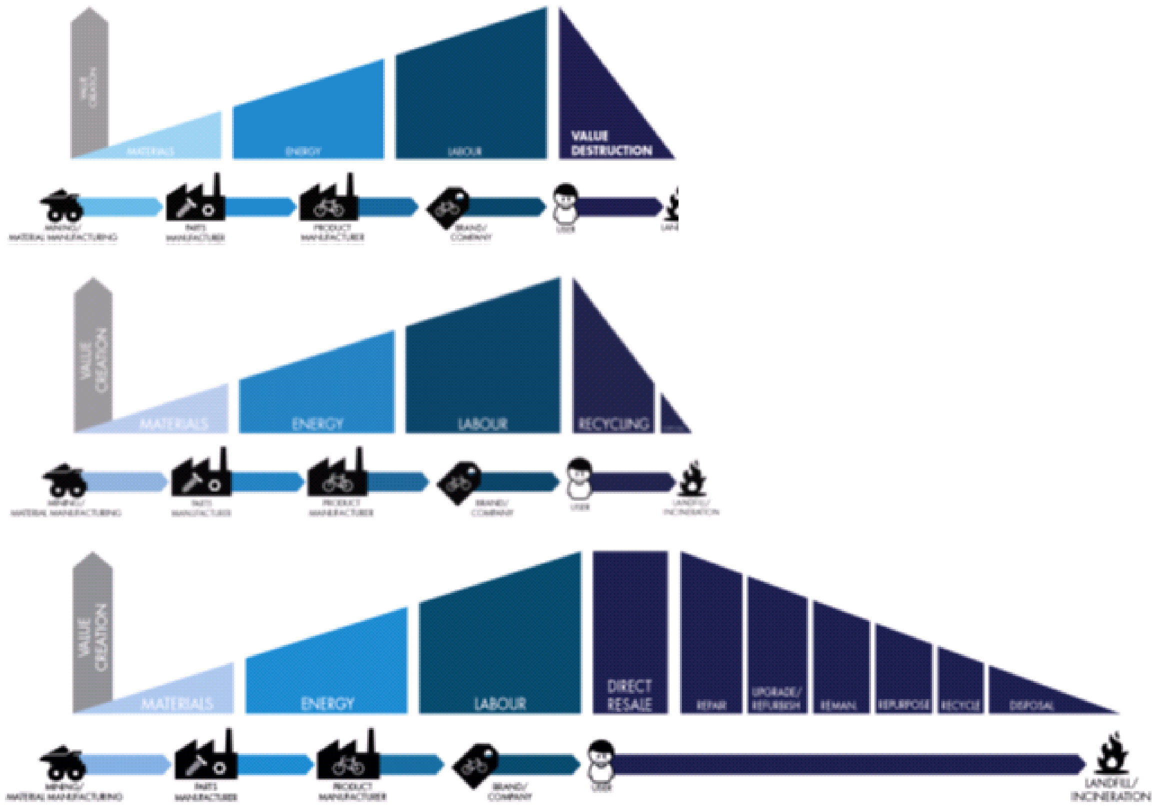

Figure 25: Value preservation for "reuse and recycle" vs "recycle only" or "landfill strategies.[26]

As a conclusion from an economic perspective, battery life cycle optimization through V2G services and second life will *(i)* significantly reduce the total cost of ownership of an EV for end users, thus setting the conditions needed for a strong and perennial uptake of e-Mobility independently of public subsidies *(ii)* provide considerable economic benefits for the energy grid and socioeconomic benefits at national and European levels (iii) create value, economic activities and non-transferable jobs within the EU.

[26] Source: The potential for high value reuse in a circular economy, Nederland Circulair! 2015.

Part II: Legal and regulatory barriers to the optimization of EV batteries life cycle

The virtuous loop of Electric vehicles described above shall not be hampered due to an inappropriate legal and regulatory framework.

EU Law and national laws shall be reviewed in order to ensure a smooth development of second life batteries.

Two areas of concern should be addressed: the first relates to the rules applicable to energy regulations and the second relates to the rules applicable to the battery itself once it has been removed from the vehicle.

II.1. LEGAL AND REGULATORY BARRIERS TO VALUE EV BATTERIES AS ELECTRICITY STORAGE DEVICES

In the following developments, the legal and regulatory provisions that may hinder or prevent the development of storage are identified. These provisions similarly affect the development of stationary and mobile storage.

II.1.1. The lack of definition of storage

Like any legal reasoning, the analysis of the legal and regulatory framework applicable to storage presupposes that this concept is defined beforehand. A legal regime cannot be established if the concept has not been previously defined.

However, when it comes to storage, definitions are rare. The lack of definition of the concept of storage is probably one of the most obvious obstacles to its development. However, the question of the scope of the definition remains open.

The need to define storage is even more important considering the development prospects of the electric vehicles. Indeed, batteries of electric vehicles will provide services to the electric system not only while being integrated into the vehicle but also once extracted from the vehicle. Therefore, it is of utmost importance to define storage and to distinguish between stationary and mobile storage.

II.1.1.1. A concept insufficiently defined in EU law and national laws

EU law. In EU law, none of the directives or regulations being part of what is called “sector specific regulation” defines storage.

The only definition can be found in the Guidelines on State aid for environmental protection and energy 2014-2020. Electricity storage is defined as:

"*facilities used for storing electricity on a permanent or temporary basis in above-ground or underground infrastructure or geological sites, provided they are directly connected to high-voltage transmission lines designed for a voltage of 110 kV or more*"

Obviously, this definition is very restrictive.

For the first time in EU law, a directive will define storage, thanks to the adoption of the Clean Energy Package. In the proposal of the Commission for a Directive on common rules for the internal market in electricity (Electricity Directive), storage is defined as:

"means in the electricity system, deferring an amount of the electricity that was generated to the moment of use, either as final energy or converted into another energy carrier" (Article 2).

National laws. The same can be said about national laws. Storage is not defined in German law. In French law, there is only one definition of storage.

Indeed, the notion of electricity storage facility has been defined by the texts pursuant to the rules governing information which must be communicated by public electricity networks operators.

Article L. 142-9-1 of the French Energy Code requires firstly that the electricity transmission system operator makes available to the Minister a national register of electricity production and storage facilities and secondly the distribution system operators (DSO) are to inform the transmission system operator (TSO) on the installations which are connected to their networks.

In that respect, Article 1 of the ministerial order of 7 July 2016[27] defines the notion of electricity storage facility for the application of rules relating to the reporting obligations of DSO and TSO.

Article 1 of the ministerial order
A storage facility is defined as a group of stationary electricity storage equipment enabling the storage of electrical energy in another form, then to restitute it as electrical energy while being connected to public distribution networks. The technology of this equipment includes the pumped energy transfer stations, storage by compressed air, storage by conversion of the electricity into hydrogen, electrochemical batteries and flywheels. The installation is connected directly to a public electricity network or indirectly, through installations belonging to a user of this network. **The means of non-stationary energy storage, notably related to means of transmission do not fall within the storage facilities pursuant to this ministerial order**

[27] Arrêté du 7 juillet 2016 pris en application des articles D. 141-12-5, D. 142-9-2, D. 142-9-3 et D. 142-9-5 du code de l'énergie.

It is interesting to note that this definition applies only to so-called “stationary storage” and not to “non-stationary storage” or “mobile storage”.

II.1.1.2. A necessary prerequisite to the development of storage

The lack of definition of storage obliges to assimilate storage to generation and consumption and may hinder its development.

Indeed, because of the lack of definition, storage is alternately considered as generation when the storage facility injects electricity on the grid and as consumption when the storage facility extracts electricity from the grid. Therefore storage must comply with two set of rules designed for very different purposes.

The cumulative application of those two set of rules (rules applicable to generation on the one hand and rules applicable to consumption on the other hand) is a clear impediment to the development of storage. This can lead, e.g. to double payment of network tariffs, double taxation or double administrative authorizations to be issued.

Moreover, some legislations will be very difficult to apply as such, as they do not provide any specific provisions for electricity storage. The REMIT regulation - on wholesale energy market integrity and transparency - provides a good example[28]. The REMIT requirements will prove very difficult to apply to electricity storage facilities. Indeed, many questions will be raised as to identify “inside information” within the meaning of this regulation related to the use of the storage facilities.

Without definition of storage, there will be no specific regime, and such difficulties may arise.

One could ask whether the assimilation of storage to generation and consumption is consistent with the general principle of equality and non-discrimination.

Indeed, this principle of equality precludes comparable situations from being treated differently, and different situations from being treated in the same way, unless the treatment is objectively justified. Treating storage as if it were consumption and generation could be contrary to this principle.

II.1.1.3. The question related to the scope of the definition remains open

According to the proposal of the Commission for a revised Electricity Directive, storage should play a major role in the electric system.

[28] Regulation 1227/2011 of 25 October 2011, OJ L 326, 8.12.2011, p. 1.

According to article 1 of this proposal:

"This Directive establishes common rules for the generation, transmission, distribution, ***storage*** *and supply of electricity, together with consumer protection provisions, with a view to creating truly integrated competitive, consumer-centred and flexible electricity markets in the Union"*.

This calls for two remarks to be made.

Firstly, for each of the four classical activities, the proposal for a revised Electricity Directive provides two definitions: one definition of the activity itself and one definition of the operator carrying out this activity:

- Transmission/transmission system operator
- Distribution/distribution system operator
- Supply/supplier
- Generation/producer

Therefore, as regards storage, the proposal of the Commission should also provide a definition of the "storage operator". Any example of the advantages from gas sector can be helpful.

Secondly, among the four classical activities, two are regulated activities (transmission and distribution) and two are non-regulated activities. According to the proposal of the Commission, storage should be a non-regulated activity. This has various consequences; one of them being that network operators (TSO and DSO) should not be allowed to own and operate storage facilities.

Ownership of storage installations and DSOs	**Ownership of storage installations and TSOs**
Article 36: 1. **Distribution system operators shall not be allowed to own, develop, manage or operate energy storage facilities.** 2. By way of derogation from paragraph 1, Member States may allow distribution system operators to own, develop, manage or operate storage facilities only if the following conditions are fulfilled : (a)other parties, following an open and transparent tendering procedure, have not expressed their interest to own, develop, manage or operate storage facilities; . (b)such facilities are necessary for the distribution system operators to fulfil their obligations under this Directive for the efficient, reliable and secure operation of the distribution system; and,	Article 56: **1.Transmission system operators shall not be allowed to own, manage or operate energy storage facilities and shall not own directly or indirectly control assets that provide ancillary services.** 2.By way of derogation from paragraph 1, Member States may allow transmission system operators to own, manage or operate storage facilities or assets providing non-frequency ancillary services if the following conditions are fulfilled. (a)other parties, following an open and transparent tendering procedure, have not expressed their interest to own, control, manage or operate such facilities offering storage and/or non-frequency ancillary services to the transmission system operator; .

(c)the regulatory authority has assessed the necessity of such derogation taking into account the conditions under points (a) and (b) and has granted its approval.	(b)such facilities or non-frequency ancillary services are necessary for the transmission system operators to fulfil their obligations under this Directive for the efficient, reliable and secure operation of the transmission system and they are not used to sell electricity to the market; and, (c)the regulatory authority has assessed the necessity of such derogation taking into account the conditions under points (a) and (b) of this paragraph and has granted its approval.

As a consequence of the EU's ownership unbundling requirements, TSOs and DSOs may be forbidden from controlling any form of energy storage facilities.

However, since TSOs and DSOs own and/or operate networks as regulated businesses, this means that they have an incentive to use network reinforcement and international interconnection to balance supply and demand rather than storage. Such an approach could therefore prejudice the development of this activity.

Currently, TSOs may, under certain conditions, own and operate storage facilities in Germany[29].

Whatever the outcome of this debate, the solution found must not be detrimental to the development of storage by non-regulated operators and should not lead to any form of discrimination against non-regulated operators as regards balancing services.

II.1.2. The technical requirements acting as impediments

The effectiveness of a regulation that would merely promote storage could be jeopardized by technical modalities of participation of storage facilities in different markets.

Indeed, allowing and promoting the development of storage at the European level may turn out to be insufficient if the national legal framework is not reviewed to ensure that effective participation and development of storage is not prevented by technical modalities.

II.1.2.1. The EU legal framework may not be prescriptive enough

The proposals of the Commission for a revised Electricity Directive and Electricity Regulation promote the development of storage at different levels.

According to article 3 of the proposal for revised Electricity Directive, *"Member States shall ensure that their national legislation does not unduly hamper cross-border flows of electricity, consumer participation including through demand–side response, investments into flexible energy*

29 Sections 13 and 14 of the Energiewirtschaftsgesetz (EnWG).

generation, energy storage, the deployment of electro-mobility or new interconnectors, and that electricity prices reflect actual demand and supply".

This overall objective breaks down into a number of specific aims at different levels.

At the TSO level. Article 5 of the proposal for a revised Electricity Regulation states that *"Balancing markets shall be organized in such a way as to ensure effective non-discrimination between market participants taking account of the different technical capability of generation from variable renewable sources and demand side response and storage"*. The same idea can be found at article 40 of the revised Energy Directive proposal.

At the DSO level. The proposal for a revised Electricity Directive makes it clear that *"The network development plan shall also demonstrate the use of demand response, energy efficiency, energy storage facilities or other resources that distribution system operator is using as an alternative to system expansion"* **(article 32).**

At the wholesale markets level. Article 7 of the proposal for a revised Electricity Regulation states that: *"Market operators shall provide products for trading in day-ahead and intraday markets which are sufficiently small in size, with minimum bid sizes of 1 Megawatt or less, to allow for the effective participation of demand-side response, energy storage and small-scale renewables"*.

However, such provisions may turn out to be insufficient or ineffective if the technical rules that have been designed in a different context are not reviewed. Indeed, most of the rules related to balancing services, flexibility services or wholesale electricity markets have been designed for centralized units (i.e. nuclear plants or fossil-fuel plants). The economic and technical requirements may not be well-suited to energy provisions from different types of technology (mainly distributed energy resources) like storage and could prevent them to participate.

II.1.2.2. Business cases highlighting the importance of adapting technical modalities

Four business cases highlight the necessity of adapting technical modalities in order to prevent that such conditions hinder storage use. Three cases are related to activities or services for which the potential for recovery of storage is particularly important: i.e. balancing/ancillary services and capacity remuneration mechanism. The last business case is related to smart charging.

Balancing/ancillary services

In the current context where the share of intermittent and non-dispatchable renewable energy sources is increasing in the electricity generation mix, additional flexibility will become an increasingly valuable resource to balance generation and demand in real time.

This balance is critical to ensure the stability and security of the electric power system.

In order to ensure security of the system and the effective delivery of electricity at all times, transmission system operators must procure generation reserves to cover system imbalances. These reserves are organized into two types: frequency containment reserves (FCR) – also known as primary reserves R1 – and automatic frequency restoration reserves (aFRR) – also known as secondary reserves R2 – altoghether known as “frequency service system”.

Historically, only centralized generators were used to provide power reserves owing to their reliability and the technical constraints when energy markets were first developed. Accordingly, technical and economic rules have been built into this paradigm that may not be suited for the provision by new decentralized sources of flexibility such as storage.

1) The case of primary reserves (FCR):

FCR Cooperation is a joint call for tender for FCR procurement between Germany, Switzerland, the Netherlands, Austria, Belgium and France. FCR is procured through a weekly call for tender. Each week a tender is organised on Tuesday afternoon before the week of delivery (week from Monday 0 h to Sunday 24 h) allowing TSOs in the FCR cooperation to procure Frequency Containment Reserve for the week of delivery. National TSOs remain in charge of defining prequalification conditions and contracting with the service providers (post assessment, penalties for non-delivery…).

Balancing services providers submit their offers to their connecting TSO and TSOs pool these offers. The offers are selected by an algorithm to minimise the contracting costs.

However, offers must comply with the requirement of the unique product: symmetric, with delivery form Monday 0 am to Sunday 12 pm. Because of the length of the commitment and the necessity of symmetric offers, the design of this product is detrimental to to mobile storage.

France : There is a limit on the total amount these units can provide to the system, which has been initially set at 40 MW and recently increased at 100MW. The selection of this volume is made on the basis of a ‘first come, first served’ rule. This rule is inefficient, since providers are not selected on the basis of their operating costs, contrary to a market solution where providers have an incentive to reveal their costs.
In our knowledge, those rules are under study by stakeholders (TSO and Regulator).

2) The case of other ancillary services (France and Germany):

France:

The provision of frequency ancillary services is open to any prequalified capacity in France, irrespective of its technology and its connection point to the grid.

Participation of storage devices is possible but only through experimental and transitory rules. Indeed, rules have evolved in the last two years to allow new participants, consumers connected to the distribution network and storage units, to deliver primary and secondary reserves. These units are not subject to mandatory provision but the minimum amount of reserve they must provide is 1 MW..

Lastly, it must be emphasized that for the purpose of frequency ancillary services, **storage installations are considered to be encompassed within the definition of generation unit**. Indeed, generation unit is defined as *"Combination of rotating machines or static generators used to transform primary energy (thermal, hydro, wind, tide, solar, etc.) into electrical energy. For the purposes of these Rules, this definition encompasses storage means"*.

Germany:

For the purpose of participating in the German balancing markets, battery storage systems are treated as power generation units. This has been confirmed expressly by the the German regulator (Bundesnetzagentur) in its decision dated 29 June 2017[30].

Accordingly, Battery storage systems are entitled to participate in the German balancing markets if and to the extent they fulfil the respective requirements. These requirements are as follows:

- Fulfilment of technical conditions (pre-qualification) and granting of the approval by the competent transmission system operator[31].
- Fulfilment of minimum capacity requirements for the relevant control power: 1 MW for primary control power[32]; 5 MW for secondary control power[33]; 15 MW for tertiary control power[34].

A broadening of the conditions for participating in the German balancing markets is currently under discussion. It needs to be assessed in more detail, to which degree storage batteries could reap benefits from such broadening.

3) Capacity Remuneration Mechanism: the French case

Given the significant increase in the level of remuneration for capacity in recent auctions, it is important to consider the possibility of upgrading storage facilities on the French capacity mechanism.

30 Bundesnetzagentur, decision dated 29 June 2017, BK6-16-208.
31 The relevant documents and information can be assessed online under www.regelleistung.net.
32 Bundesnetzagentur, decision dated 12 April 2011, BK6-10-097.
33 Bundesnetzagentur, decision dated 13 June 2017, BK6-15-158.
34 Bundesnetzagentur, decision dated 29 August 2006, BK6-06-012.

As specified in the RTE Report accompanying the draft rules, the market design of the French capacity works on the principle of neutrality. Indeed, the certification methods proposed in the rules ensure equal treatment for all capacity operators (generation, demand response or storage) and prevent forms of selection that could exclude new entrants.

However, the arrangements for the participation of facilities are detrimental to storage. Indeed, the conditions participation provide that the facilities must be activated for a limited number of hours in order to receive 100% of the remuneration.

Nb of hours of activation	**0**	0,5	**1**	1,5	**2**	2,5	**3**	3,5	**4**	4,5	**5**
Kj	0%	13%	25%	35%	46%	53%	59%	65%	70%	74%	78%

Nb of hours of activation	5,5	**6**	6,5	**7**	7,5	**8**	8,5	**9**	9,5	**10**
Kj	82%	85%	88%	91%	93%	95%	96%	98%	99%	100 %

Moreover, according to the rules of the mechanism, there are only two categories of capacity: generation or demand-response. There is no recognition of storage capacity as such. Once more, storage will be included in the category of generation installations.

4) Smart charging

As previously described, smart charging enables to modulate the battery charge depending on the needs of the network. This flexibility which is possible thanks to the characteristics of the battery of the electric vehicles should be rewarded.

This can be achieved via different means.

Firstly, smart charging should reduce the cost of connection to the Grid. In France, the legal framework has evolved recently but does not go far enough. Networks connection tariffs published by Enedis and approved by the French regulator only provide that devices and facilities that allow shifting energy consumption from peak to off-peak periods in order to limit peak power consumption have to be taken into account for the choice of the appropriate capacity connection for EV charging infrastructures[35].

Secondly, smart charging should lead to adapted electricity supply prices. In this respect, the German Energy Industry Act (EnWG) is interesting. Indeed, electricity suppliers are obliged to

[35] Barème de raccordement ENEDIS (PRO-RAC_03E, §15).

offer to customers at least one electricity tariff that incentivizes flexible and reduced energy consumption[36].

Thirdly, network tariffs should take into account the flexibility offered by smart charging process. In Germany, according to section 14a EnWG, grid connections for electric vehicles can be offered to pay a reduced grid tariff if and to the extent, smart charging can be used for grid operation purposes.

Three conclusions can be drawn from the cases presented above:

- The participation of the storage can be possible in theory but made tough in practice because of technical conditions difficult to fulfil with regard to the characteristics of the equipment concerned;
- If not well-suited, the design of the product may not reward storage for the extra flexibility that it can provide to the networks or to the system.
- The features of storage facilities (stationary and mobile storage) should be rewarded and taken into account while designing the future conditions to provide services at the DSO level to ensure more flexibility. Those rules will be key for the development of the V2G.

II.1.3. No specific category of network user for storage

As already mentioned above, seen from the grid, the assimilation of storage to generation and consumption activities is detrimental to the development of storage. This leads to an overpayment of network tariffs, to a risk of double taxation and to an excessive administrative burden.

II.1.3.1. Storage and network tariffs

In its proposal for a revised Electricity Regulation, the Commission requires that network tariffs “shall not discriminate against energy storage” (article 16). However, the reference to the principle of non-discrimination remains unclear. Should the assimilation of storage to production and consumption activities be considered discriminatory in that it leads to treating different situations in the same way?

The following case may illustrate why such assimilation may be discriminatory.

French network tariffs

The tariffs for user of public electricity networks (TURPE) are the responsibility of the French regulator (Commission de régulation de l’énergie - CRE). The CRE adopts every four years two deliberations on electricity network user tariffs (one for HVA/LT and one for HVB). The last tariffs’ deliberations are called TURPE 5[37].

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36 Article 40 (5) EnWG.

37 CRE decision, 17 November 2016.

A distinction must be made between the TURPE paid by consumers and the TURPE paid by producers. The financial burden of tariffs rely mainly on consumers. Indeed, the TURPE paid by producers is almost exclusively composed of two components: the administrative management component and the metering component. There is no component for injections.

However, it must be underlined that there is no specific tariff for storage: it is alternatively treated as consumption (when the storage facility extracts electricity from the grid) and production (when the storage facility injects electricity in the grid).

It should be noted that, in the current framework designed by the CRE, network costs are largely borne by consumers. Indeed, concerning producers, the injection component is equal to 0. Nevertheless, producers are still paying some other components (e.g. the management component).

Tariffs regime applicable to storage could be summarized as follows:

Figure 26: Network tariffs & storage – the French case applicable also for Netherlands in the concept &

In other words, the peculiarities (and the benefits) of storage do not seem to be taken completely into account.

The principle of non-discrimination should lead to create a specific tariff for storage facilities.

It is worth noting that, in Germany, according to section 15 (2) of the Ordinance on Electricity Grid Access Charges[38] only the consumption of electricity (extraction) but not the injection electricity makes liable for grid tariff payments.

II.1.3.2. Storage and tax regime

Because of the dual qualification (as consumer and as producer) for electricity storage, there is a risk of overtaxation of this activity.

Moreover, according to the German Federal Supreme Court (Bundesgerichtshof, BGH) the consumption of electricity that is used to fill up electricity storage facilities has to be qualified as end consumption of electricity[39]. Therefore, all rules and regulations applicable to end consumption are initially also applicable to the consumption of electricity for operating storage facilities. This means that, in principle, all costs elements for the end consumption of electricity such as surcharges and taxes also have to be borne by operators of electricity storage facilities.

At the end of the day, taxes related to end consumption are paid twice: the first time when the electricity is stored and the second time when the electricity is definitely consumed.

Tax regime applicable to storage will also be key to the development of self-consumption.

In Germany, batteries used for self-consumption become attractive for end consumers when the overall costs of electricity generation and storage is smaller than the price offered by energy supply companies. A decisive factor in this regard is the question if the EEG surcharge (German tax to support renewables) has to be paid. Whereas formerly self-consumption without use of the general grid was exempted from EEG surcharge payments, since the new EEG 2017 the EEG surcharge is also due for self-consumption.

There are a bundle of exemptions for self-consumption that do not apply to energy supply:

- According to section 61 lit. a EEG 2017, no EEG surcharge is due if consumption of electricity is entirely from renewable sources.
- For storage of electricity from renewable sources, no EEG surcharge is due pursuant to the conditions set out in section 61 lit. k EEG.
- For small generation and storage facilities that are used for the purpose of self-consumption, section 61 lit. a no. 4 EEG foresees an exemption from EEG surcharge payments when the installed capacity does not exceed 10 kW. The surcharge exemption

38 Stromnetzentgeltverordnung, StromNEV.

39 BGH, NVwZ-RR 2010, 431.

is granted for a maximum amount of 10 MWh per year and for a maximum duration of 20 calendar years plus the year of commissioning.

The distinction between energy supply and self-consumption is not always straightforward. Unclear cases are, e.g., photovoltaic installations for apartment buildings, hotel rooms etc. In these cases, sound argumentation might increase the applicability of battery storage systems.

In the **Netherlands**, under current legislation (group prohibition and rules for congestion management from the Electricity Act and Grid Code), grid operators may not trade, generate or supply electricity. It is unclear whether grid operators may purchase flexibility from third parties. Under current regulations, grid operators may only temporarily apply congestion management. They are obliged to eliminate situations of transmission scarcity as quickly as possible by investing in grid upgrades.

On the basis of the current wording of the Environmental Taxes Act (Wbm), it can be argued that energy taxes must be charged on every charged (and 'discharged') kWh for lager storage units (small units are exempted because of the present netting rule, however that netting rule will be changed in the next few years[40].

II.1.3.3. Storage and the risk of an excessive administrative burden

Local energy communities are bound to grow (article 16 of the proposal for a revised Electricity Directive). The adoption by the French legislator of a law governing collective self-consumption is part of this trend and is a true legal innovation in Europe.

According to article L.315-2 of the energy code, *"Self-consumption is collective when the electricity exchange is made* ***between one or more electricity producers and one or more final consumers,*** *linked together by a legal entity, and from which the injection and exit points are on the same low-voltage loop of the public distribution grid"*.

In other words, to be part of a collective self-consumption program, the stakeholders must be either producers or consumers. There is no reference to a storage operator even though the battery might be key for the economics of the project.

[40] Source: PwC: Smart Charging of Electric Vehicles – Institutional bottlenecks and possible solutions (2017).

II.2. LEGAL AND REGULATORY BARRIERS TO THE REUSE OF EV BATTERIES IN POST-VEHICLE APPLICATIONS

II.2.1. Regulatory framework is unclear and unfitted to large scale use and reuse of XXIs century EV batteries

As indicated in the *joint declaration for the Innovation Deal*[41] "*there are no specific provisions at EU level dealing with the second-life of propulsion batteries and, therefore the general ones on waste apply, e.g. those laid down in the EU Waste Framework Directive*[42] *and the Batteries Directive*".

These two texts have been revised in the framework of the EU action plan for the Circular Economy. As a result, two new directives were published in the Official Journal of the European Union (OJEU) of 14 June 2018:

- Directive (EU) 2018/851 of 30 May 2018 amending Directive 2008/98/EC on waste[43] ;

- Directive (EU) 2018/849 of 30 May 2018 amending Directives 2000/53/EC on end-of-life vehicles, 2006/66/EC on batteries and accumulators and waste batteries and accumulators, and 2012/19/EU on waste electrical and electronic equipment[44].

These directives entered into force on 4 July 2018, *i.e.* 20 days following that of their publication in the OJEU[45]. However, they do not soften the main barriers identified for the development of second-life batteries. The revision of Directive n°2006/66 EC on batteries would constitute another opportunity to soften some of the identified barriers.

41 The Joint Declaration of Intent for the INNOVATION DEAL on "From E-Mobility to recycling: the virtuous loop of the electric Vehicle".
42 Directive 2008/98/EC of 19 November 2008 on waste and repealing certain Directives.
43 OJ L 150, 14.6.2018, p. 109-140.
44 OJ L 150, 14.6.2018, p. 93-99.
45 Article 3 of Directive 2018/851 and Article 5 of Directive 2018/849.

II.2.1.1. Legal uncertainties on the interpretation of the notion of "*waste*"

a) Generalities on the notion of "*waste*"

The Waste Framework Directive defines the notion of waste in Article 3(1) as "*any substance or object which the holder discards or intends or is required to discard*". This definition has not been modified by new Directive 2018/851.

Even if this definition has been refined by the *Commission's Guidelines on the interpretation of key provisions of Directive 2008/98/CE*[46] on the one hand, and by the case-law of the Court of Justice of the European Union (CJEU) on the other, the question of "*when should an object be considered as a waste?*" remains a thorny one.

This question is crucial for the re-use of second-life batteries, as classifying a material as a waste has key implications as to how the material should be handled, what administrative procedures apply to its transportation and processing, and what costs will be incurred by its holder.

However, in many cases, economic actors and authorities still face difficulties in determining whether or when an object should become waste. The notion of waste is all the more complicated to grasp that the CJEU stated that *(i)* the concept of waste cannot be interpreted restrictively[47] and that *(ii)* any substance which undergoes a recovery/disposal operation as listed in the Waste Framework Directive should not be regarded as being a waste *per se*, but might be regarded as an evidence for being waste[48].

In addition, the fact that a product is checked, cleaned, repaired does not mean that said product has become waste, as indicated in the *Commission's guidelines on the interpretation of key provisions of Directive 2008/98/CE*[49].

In this context, one could question how far the problem lies in the definition itself or in the lack of consistency in its interpretation. In a discussion paper the British Department for Environment, Food and Rural Affairs summaries the issue as follows[50]:

> "*<u>On the surface</u>, then, it appears that there is clarity regarding the definition* of *waste and its interpretation. However, <u>experience across the re-use</u>* and *repair sector demonstrates that there is <u>some confusion and inconsistency in the interpretation of</u> the definition. It is this (rather than the definition itself) that may*

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46 June 2012 "*Not legally binding*".

47 Joined cases C-418/97 and C-419/97 ARCO (2000), paras 36 et seqq; Case C-252/05 Thames Water (2007) para 28; Case C-188/07 Commune de Mesquer (2008), para 39, 44.

48 Joined cases C-418/97 and C-419/97 ARCO (2000), para 51; Case C-9/00 Palin Granit Oy (2002), para 27.

49 EU Commission guidelines on the interpretation of key provisions of Directive 2008/98/EC on waste, p.30.

50 https://www.letsrecycle.com/wp-content/uploads/2014/11/Clarifying-the-application-of-the-Definition-of-Waste.pdf

> *have acted as* *<u>a barrier to the full exploitation of re-use</u>* *and repair across sectors, and by different waste operators*".

According to this approach most issues could be solved by a more consistent interpretation of the definition. However, when the interpretation of the rule by national, local authorities or companies is confused and inconsistent, one should never prejudge the need for the rule itself to be clarified. In other words, while it seems that there are margins of improvement for the "EU single rule book" to go further in clarifying, sometimes in a tailored way, the implementation and interpretation of the definitions, rework on the latter should not be a taboo. An interpretation of these definitions will be addressed in the following paragraphs.

To promote the re-use of second-life batteries, efforts should be made in particular to avoid the situation where products that are designed, destined and apt for re-use are misclassified as waste[51].

b) In case of second-life batteries

Renault's dealers collect used batteries from the end-users, most of which can be re-used in post-vehicle applications (second-life). The fact that Renault does not intend to discard the batteries is already particularly evident in the leasing scheme[52]. However, as a general rule, all first-life Renault batteries may be re-used in stationary / multipack / new storage systems, as defined in the three-use cases identified above.

Therefore, the fact that end-users return a used EV battery pack to a car dealer or to another collection point defined by the producer shall not be sufficient for the battery to qualify as a waste. Such interpretation should be more clearly confirmed and stabilized by national authorities and the European Commission, so as to promote the re-use of first-life batteries.

We note in this respect that Article 1(28) of new Directive 2018/851 states that "*the Commission may <u>develop guidelines</u> for the <u>interpretation of the requirements</u> set out in this Directive, <u>including on the definition of waste</u>, prevention, <u>re-use</u>, preparing for re-use, recovery, recycling, disposal*" (emphasis added).

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51 Worshop report, « Promoting Remanufacturing, Refurbishment, Repair and Direct Reuse, as a contribution to the G7 Alliance on Resource efficiency, 7-8 February 201, Brussels;
See also on this topic :
-Law for a circular economy, Chris Backes, Utrecht Centre for Water, Oceans and Sustainability Law (UCWOSL), inaugural address, 12 April 2017; University of Utrecht, UCWOSL , Eleven International publishing;
-Triple Win: the social, economic and environmental case for remanufacturing, All Parliamentary Sustainable Resource Groupe and the All-Party Parliamentary Manufacturing Group, United Kingdom, December 2014.

52 About 100 000 EV are currently used under buy-lease contracts.

Therefore, it is essential that the Commission *(i)* effectively uses this possibility to clarify the notion of "*waste*" and *(ii)* takes into account in that definition circular business models in which a material or an object is transferred from one holder to another holder without the intention to discard but to re-use[53].

In particular, a first-life battery should not qualify as a waste when the producer (or producer of the EV) intends to ensure its re-use for specific purposes which fit with the battery capacity and design (such as stationary / multipack / new storage system).

II.2.1.2. Legal uncertainties on the interpretation of the notion of "*re-use*"

a) Generalities on the notion of "*re-use*"

The notion "*re-use*" is currently defined in Article 3(13) of the Waste Framework Directive as "*any operation by which products or components <u>that are not waste</u> are used again for the <u>same purpose</u> for which they were conceived*" (emphasis added). This definition has not been modified by new Directive 2018/851.

This definition gives rise to two comments. *Firstly*, the notion of "same purpose" is too restrictive and not adapted to all possible re-use cases of vehicle batteries. Secondly, little guidance has been provided so far at EU or French level on the notion of "*re-use*" and of "*same purpose*".

In particular, the current Commission guidelines have not further clarified these two notions. Regarding the CJEU, to our best knowledge, the case-law has only conditioned the re-use to be "*certain*" and not only "*potential*" so as to allow the qualification of waste not to apply[54] but did not further clarify "same".

In this context, we have identified guidance on re-use from the DEFRA and from the Scottish Environment Protection Agency (SEPA)[55]. The SEPA guidance indicates, in particular that:

> "*where there is no change of ownership of the item, and there is certainty that the item will be re-used for its original purpose, then the item has not been discarded, and is not waste. For example: repair services (…) refit (…) refurbishment (…) lease (…) re-use systems (…).*
>
> *Where ownership transfers to a third party before passing to a new owner, this introduces a degree of uncertainty over whether the item will actually be re-used. However, if the items are checked prior to (…) acceptance, then this can give*

53 European Parliament legislative resolution of 18 April 2018 on the proposal for a directive of the European Parliament and of the Council amending Directive 2008/98/EC on waste, recital (61).
54 Aff. C-241/12 and C-242/12.
55 SEPA Guidance, Reuse activities and waste legislations, 2017.

> *certainty that the item will in fact be re-used, and waste management controls would not apply*."

Such guidance on the one hand shows that ownership transfer can be compatible with the concept of re-use subject to prior controls. On the other it does not address the notion of "*same purpose*" which is too restrictive and is even stricter: if "*original purpose*" means that the only re-use of EV battery is to plug it back in a car, this is adapted neither to second-life batteries nor to the development of a circular economy.

b) In case of second-life batteries

In case of second-life batteries, there are still uncertainties on the interpretation of the notions of "*re-use*" and "*same purpose*".

The main problem is the lack of criteria to define what "the same" is. If this notion were to be strictly applied, it could be considered that the definition of "*re-use*" could not apply to any of the use-cases identified above given that the use of an EV battery or battery pack is no more the same as soon as it leaves the car.

But this determination is based on the purpose of the vehicle rather than on the purpose of the battery itself. Indeed, one the one hand, during its first-life the energy from the battery is mainly used for vehicles' traction and mobility, while during their second-life storage of energy is their main purpose.

But on the other, it could be argued that the purpose of a "*battery*" is always energy storage, delivering, recovering, whether it is used in an EV or in storage systems. This interpretation could even be compatible with the notion of "*same purpose*", applied to the battery/pack, subject that one recognizes as clear the fair epistemological assumption that the purpose of a battery is first and foremost energy storage, delivering, recovering.

In other words, while there is no possible re-use of an electric car without batteries, there is always a possible re-use of batteries without a car. Therefore, as for the notion of waste, the interpretation to be given to the notions of "*re-use*" and "*same purpose*" should be more clearly confirmed and stabilized, so as to promote the re-use of first-life batteries, taking into account the fact that a battery has the same purpose, namely the storage and delivery of electrical power, whether it is used in electric vehicle or in a power storage system.

II.2.1.3. Legal uncertainties on the status of end-of-life vehicle parts/components

End-of-life vehicles (ELV) are defined as waste by Directive 2000/53[56] on ELV (the "ELV Directive").

However, Article 7 of the ELV Directive states that "*Member States shall take the necessary measures to encourage the reuse of components which are suitable for reuse*", reuse being defined, under Article 2(6) of that Directive, as "*any operation by which <u>components</u> of end-of life vehicles are used for <u>the same purpose</u> for which they were conceived*".

Moreover, as said above (see paragraphs 42, 43 and 46) both the purpose of batteries and the notion of re-use should be clarified, as regards in particular its application to second-life battery.

In the absence of such clarifications, some public authorities may consider that spare parts/ components (including battery) originating from an ELV should automatically qualify as waste.

II.2.1.4. Legal uncertainties on the status of "*end-of-waste*"

a) Generalities on the status of "*end-of-waste*"
Article 6(1) of the Waste Framework Directive states that certain specified wastes shall cease to be waste when they have undergone a recovery operation and comply with specific criteria to be developed, at EU or national level, in accordance with the following conditions:

- the substance or object is commonly used for specific purposes;
- a market or demand exists for such a substance or object;
- the substance or object fulfils the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products; and
- the use of the substance or object will not lead to overall adverse environmental or human health impacts.

The legal consequences attached to the status of "*end-of-waste*" are clarified in Article 6(3) of the Waste Framework Directive:

> "*Waste which ceases to be waste in accordance with paragraphs 1 and 2, shall also cease to be waste for the purpose of the recovery and recycling targets set*

56 Directive 2000/53/EC of the European Parliament and of the Council of 18 September 2000 on end-of life vehicles.

> *out in Directives 94/62/EC, 2000/53/EC, 2002/96/EC and 2006/66/EC and other relevant Community legislation when the recycling or recovery requirements of that legislation are satisfied*".

b) In case of second-life batteries

As said above, the position of the Innovators is that second-life batteries should not be regarded as waste, regarding both their "use" and condition of reuse for same or similar purpose.

Another option could be to consider such second-life batteries as deemed to fulfill the "*end-of-waste*" ("EoW") procedure. This presumed "*end-of-waste for second-life batteries*" could rely on "*criteria on the uniform application of the conditions EoW*" to be defined by the Commission implementing acts as foreseen in article the new article 6(2) of the Directive 2008/98 modified by Directive 2018/851 regarding for "*certain types of waste*".

This confirmation by the Commission of the EoW status of EV second-life batteries seems feasible based on the current conditions. Indeed, as shown above in section 2, second-life batteries are "*commonly used for specific purposes*" (see notably the use-cases), have a "*market and demand*", "*fulfil the technical and legal requirements for theses specific purposes*" (see above how batteries are designed and intended for this second-life) and do not "*lead to overall adverse environmental or human health impacts*" (to the contrary since it enhances the contribution of EV and batteries to CO_2 reduction).

However, the third condition to be met for EoW also provides that "the object *meets the existing legislation and standards applicable to products*".

This means that the product, to reach "EoW status", should comply with the legislation applicable to products, including the legislation pertaining to chemical substances (in particular, REACH). It should be noted that this condition may, in many cases, proves difficult to meet (technically and/or economically unfeasible) for second life products that were designed and manufactured a number of years before.

Indeed, as further explained in Section 4.2.5, chemicals that are legally used in products today may be later prohibited under REACH or other sectorial legislation / legislation pertaining to substances[57].

As another alternative second-life batteries could cease to be waste following an EoW simplified procedure either at national or at European Union ("EU") level. This is clearly not the favored

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57 This is the issue of "legacy substances", as mentioned in the European Commission communication on the implementation of the circular economy package: options to address the interface between chemical, product and waste legislation, January 16th, 2018, COM (2018) 32 final.

option considering the limited number of such precedent at both EU and national level and the lack of consistency of the national implementations.

At the moment, harmonized EU EoW procedures only exist for three waste streams, such as iron, steel and aluminium scrap[58], glass cullet[59] and copper scrap[60].

In the Netherlands, an EoW procedure has been recently created under Dutch law[61] for second-life batteries. This specific EoW procedure could be further examined and discussed with Dutch authorities in the next steps of this Innovation deal.

In France, to our knowledge, there are three EoW cases, related to *(i)* wood packaging shreds[62], *(ii)* fatty wastes, edible oils wastes and methyl esters of fatty acids produced from these wastes[63], and *(iii)* distillation residues of oil wastes[64].

In addition, a specific EoW status procedure for ELV spare parts was discussed in 2015-2016 with the different French stakeholders[65]. To our knowledge, such procedure was not adopted in the end, probably since many stakeholders considered that it would be redundant with the current transposition of the ELV Directive, and add further administrative burden on ELV centers. One of

58 Council Regulation (EU) No 333/2011 of 31 March 2011 establishing criteria determining when certain types of scrap metal cease to be waste under Directive 2008/98/EC of the European Parliament and of the Council, OJ L 94, 8.4.2011, p. 2-11.

59 Commission Regulation (EU) No 1179/2012 of 10 December 2012 establishing criteria determining when glass cullet ceases to be waste under Directive 2008/98/EC of the European Parliament and of the Council, OJ L 337, 11.12.2012, p. 31-36.

60 Commission Regulation (EU) No 715/2013 of 25 July 2013 establishing criteria determining when copper scrap ceases to be waste under Directive 2008/98/EC of the European Parliament and of the Council, OJ L 201, 26.7.2013, p. 14-20.

61 Factsheet: Regulatory barriers related to second-life applications of automotive Li-ion batteries in the Netherlands, Ministry of Infrastructure and water management, Netherlands [communication in the context of the Innovation deal].

62 Arrêté du 29 juillet 2014 fixant les critères de sortie du statut de déchet pour les broyats d'emballages en bois pour un usage comme combustibles de type biomasse dans une installation de combustion.

63 Arrêté du 24 août 2016 fixant les critères de sortie du statut de déchet pour les déchets graisseux et les huiles alimentaires usagées pour un usage en tant que combustible dans une installation de combustion classée sous la rubrique 2910-B au titre de la nomenclature des installations classées pour la protection de l'environnement et d'une puissance supérieure à 0,1 MW et les esters méthyliques d'acides gras fabriqués à partir de ces déchets destinés à être incorporés dans un produit pétrolier.

64 Arrêté du 10 juillet 2017 fixant les critères de sortie du statut de déchet pour les résidus de distillation des huiles usagées pour un usage comme plastifiant de bitumes dans la fabrication de membranes d'étanchéité pour toiture.

65 Ministerial Question n°79248, question published in the National Assembly Official Journal on May 12th, 2015, answer published on June 16th, 2015, page 4552; Ministerial Question n°1309 ,question published in the National Assembly Official Journal on February 9th, 2016, answer published on February 19th, 2016, page 1429.
See also “La vente de pièces de rechange VHU : une sortie virtuelle du statut de déchet?”, Yann Borel, Green Law Avocat, Sept. 2017 in L’Argus de l’Assurance.

the issues raised by the French stakeholders was that ensuring that ELV parts going through EoW procedure would comply with REACH at the end of the procedure would be unfeasible.

The above-mentioned questions would also apply in the case of a battery originating from an electric ELV: if such battery were considered fit for re-use, should it be automatically considered as waste and be subject to an EoW procedure? If so, would such EoW procedure be mandatory before reusing the battery or could the EoW status be considered for granted for specific use case?

Practically, this third best could also be implemented by using the procedure foreseen at Article 1(6) of new Directive 2018/851:

> *"The Commission shall monitor the development of national end-of-waste criteria in Member States, and assess the need to develop Union-wide criteria on this basis. To that end, and where appropriate, the Commission shall adopt implementing acts in order to establish detailed criteria on the uniform application of the conditions laid down in paragraph 1 to certain types of waste".*

In this context, **if second-life batteries originating from ELVs were to be considered as waste** (*quod non*), **measures should be taken to confirm that they fall within the "*end-of-waste status*"** foreseen in Article 6 of the Waste Framework Directive. In particular harmonized EU criteria for EV batteries should be defined at EU level[66] in order *(i)* to allow a level playing field and strengthen the internal market for such second-life products and *(ii)* avoid situations where a second-life battery would be considered as a product in one Member State but still considered as waste in another Member State[67];

If the status of "end-of-waste" were not to be applied to second-life batteries, the activities carried out on such batteries would be subject to waste legislation requirements, which would significantly impede the development of these second-life batteries, creating additional administrative burden and financial costs, in particular in case of transboundary shipment.

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[66] The efficient functioning of waste markets in the European Union, legislative and policy options, final report, Arcadis and Trinomics, 2016; see p. 51 and following.

[67] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the regions on the implementation of the circular economy package: options to address the interface between chemical, product and waste legislation, January 2018.

II.2.2. Barriers deriving from potential waste status

II.2.2.1. Second-life batteries would be subject to general waste legislation requirements

If second-life batteries were considered as waste, the activities of re-using first-life batteries would be subject to waste legislation requirements:

- said activities should only be carried out by operators holding the environmental authorizations/ permits required under national law to handle waste ;
- the transport of the second life batteries (even on the same national territory) would need to be carried out by an operator authorized to transport waste.

Such requirements would not be justified from an environmental point of view, considering the nature of such activities (repairing/checking used products), and generate additional administrative and financial costs on the concerned operators.

II.2.2.2. Barriers deriving from Waste Shipment Regulations

Regulation 1013/2006[68] on shipments of waste

If second-life batteries were considered as waste (*quod non*), the transport of such batteries from one country to another would be subject to the Waste Shipment Regulation, which would add significant burdens.

In addition, the classification of second-life batteries as waste may lead to a deadlock since Article 16 e) of the Waste Shipment Regulation requires, for waste subject to the notification procedure, that a certificate of completion of the waste recovery be provided to the competent authorities, which in the case of second-life batteries would result impossible as the batteries would in fact be re-used, not recycled.

Although the heart of the Innovation deal is the re-use of batteries, this is also the opportunity to address, in the context of the revision of the Batteries Directive, some difficulties faced in the recycling phase, namely waste classification difficulties and costs deriving from the Waste Shipment Regulation.

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[68] Regulation (EC) No 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste.

- **Waste classification difficulties (hazardous/ not hazardous waste)**

Depending on their chemistries, EV batteries may be classified as hazardous or not hazardous waste.

Such classification may be complicated to carry out in practice: battery manufacturers are reluctant to communicate the comprehensive list and quantities of substances contained in the electrolyte, which is usually classified as confidential information due to its highly competitive nature, and divergences may exist from one Member State to another on such classification.

Clarification and harmonization at EU level on the classification of EV batteries waste is needed.

- **Administrative and financial costs deriving from the Waste Shipment Regulation as barriers to an efficient recycling of EV batteries within the EU**

EV battery waste must be collected in every EU Member State but efficient recycling facilities are only available in few countries. Hence, producers need to manage multiple transboundary transportation streams, thus facing a heavy administrative burden and extra recycling costs in case of batteries which would be considered subject to the notification procedure pursuant to Waste Shipment Regulation. Such constraints are not justified by environmental benefits and do not foster an efficient recycling of EV batteries.

Although recycling of EV batteries is not the heart of this innovation deal, the above mentioned issues should be discussed, so as to identify **how the rules applicable to the shipment of waste could be simplified and better tailored to facilitate the recycling of EV batteries**, with due respect to the principles of proportionality and safety.

II.2.2.3. Barriers deriving from Directive n°2006/66/EC[69] ("Batteries Directive")

a) Lack of any clear provision concerning the "*re-use*"

According to the waste hierarchy, prevention, in particular through re-use, should be preferred to recycling. The ELV Directive consistently asks Member State to take the necessary measures to encourage the reuse of component suitable for reuse. However, the Batteries Directive, which defines EV batteries as "*industrial batteries*"[70], focuses on the recycling of batteries[71].

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69 Directive 2006/66/EC of the European Parliament and of the Council of 6 September 2006 on batteries and accumulators and waste batteries and accumulators and repealing Directive 91/157/EEC.

70 Article 3 (6) of the Batteries Directive: "*industrial battery or accumulator means any battery or accumulator designed for exclusively industrial or professional uses or used in any type of electric vehicle*".

71 Ex-post evaluation of certain waste stream Directives, final report, Bio Intelligence Service, Arcadis, Institute for European Environmental Policy, 18 April 2014.

b) Registration of producers

Article 17 of the Batteries Directive provides that producers of batteries shall be registered, and sets a number of procedural requirements for such registration in Annex IV.

However, such requirements do not include any mention relating to potential re-use or second life of the batteries.

The producers' registration procedures should allow to indicate whether batteries have been transferred for re-use/ second life.

In addition, the extended producer responsibility foreseen in that Directive, as well as in the Waste Framework Directive, may raise additional issues in case of second-life batteries.

c) Barriers deriving from the extended producer responsibility

- **Generalities on the EPR**

Extended Producer Responsibility (EPR) is a policy approach that extends the producer's responsibility for a product beyond their current scope – for worker health and safety, consumer safety and production costs – to also include the management of their subsequent waste after the product has been used by consumers[72].

New Directive 2018/851 clarifies in this respect that an “"*extended producer responsibility scheme” means a set of measures taken by Member States to ensure that producers of products bear financial responsibility or financial and organisational responsibility for the management of the waste stage of a product's life cycle*”.

The EPR is expressly laid down in Article 8 of the Waste Framework Directive and applies to “*any natural or legal person who professionally develops, manufactures, processes, treats, sells or imports products (producer of the product)*”. EPR is going to be completed by new Directive 2018/851 that adds a new article 8a foreseeing general minimum requirements for EPR schemes.

In the Batteries Directive, the EPR implies that producers of industrial batteries set up schemes to provide for the treatment and recycling of waste batteries and finance the net cost of collecting, treating and recycling such batteries. For sake of clarity, producers are defined in Article 3(12) of that directive as:

> “*any person in a Member State that, irrespective of the selling technique used (…) places batteries or accumulators, including those incorporated into appliances or vehicles, on the market for the first time within the territory of that Member State on a professional basis*”.

[72] http://www.europen-packaging.eu/policy/9-extended-producer-responsibility.html

The Batteries Directive also provides in Article 16(5) that "*producers and users of industrial (…) batteries may conclude agreements stipulating* [other] *financial agreements*".

Under French law, Article R.543-130 of the Environmental Code provides that industrial batteries producers may comply with their obligations (as transposed in national law from the Batteries Directive), in whole or in part, by entering into direct agreements with users of industrial batteries they placed on the national market, setting, in particular, the conditions under which the users would ensure, in whole or in part, the management of waste batteries[73].

However, such possibility is not necessarily equally reflected in all Member States' legislations, which may cause obstacles to trade within the European Union.

In addition, EPR implies obligations which are not only financial, but also organizational and administrative[74], although the Batteries Directive only mentions "financial agreements" between producers and users of industrial batteries.

- **In case of second life batteries**

The fact that the EPR makes the producer responsible for the costs of collection, treatment and recycling of products could represent an obstacle to the development of second-life batteries, as regards in particular the three use-cases identified above.

In this regard, Commission is invited to define a unified methodology on reporting of EV battery re-use within the implementing acts foreseen by new article 9(7) of the modified WFD. It should also focus on ELV parts re-use when defining its measure to encourage re-use products and subsequent report and proposal as foreseen by article 9(9) of the modified WFD.

For what concerns the Batteries Directive, two situations have to be distinguished given that, as indicated above, the concept of EPR focuses on the producer, as being the person who places the battery on the market for the first time in one Member State:

- If the battery is placed on the market for a second use on the territory of another Member State, then the second-life operator would become, under the current Batteries Directive, the new producer of such battery ;

73 Article R.543-130 V. , French Environmental Code : *« Les producteurs de piles et accumulateurs industriels peuvent remplir tout ou partie des obligations qui leur incombent au titre du présent article en passant avec les utilisateurs des piles et accumulateurs industriels qu'ils mettent sur le marché sur le territoire national des accords directs qui fixent notamment les conditions dans lesquelles les utilisateurs assurent tout ou partie de la gestion de ces déchets selon les obligations déterminées à l'article R. 543-131 ».*

74 Guidance on Extended Producer Responsibility (EPR), Final report, Bio Intelligence Service-Deloitte, with Arcadis, Ecologic, Institute for European Environmental Policy (IEEP), Umweltbundesamt (UBA), 2014.

- However, if the battery is re-used on the territory of the same Member State (where it was first placed on the market), the principle set by the Batteries Directive is that the EPR stays on the initial producer.

Taking into account the multiple lives of a product/ whole life cycle while defining the EPR would enhance circular economy activities relating to batteries. In particular, if other professional actors economically benefit from the battery's subsequent lives, such actors should also play a role in the EPR and bear responsibility[75].

On the contrary, keeping the full responsibility for the collection, treatment and recycling of the batteries at the end of their second-life on the initial producer would represent an obstacle to the development of second life applications (low incentive for the initial producer).

II.2.2.4. Barriers deriving from the Substances Regulation

a) Generalities on REACH

Firstly, Regulation n°1907/2006/EC[76] on the registration, evaluation, authorization and restriction of chemicals ("REACH") contains different requirements function of the hazard of substances:

- Registration: Any substance placed on the European Union custom market must be registered. This obligation imposes to maintain the traceability of the substances or mixtures in the part. However, as batteries are recent "articles", as defined under REACH, such traceability is available.

- Authorization: The regime consists in identifying substances of very high concern ("SVHCs"), banning their use (i.e. processing, formulation, consumption, storage, keeping, treatment, filling into containers, transfer from one container to another, mixing, production of an article or any other utilization) and in some cases authorizing companies to make specific uses under determined conditions.

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[75] As indicated in the Development of Guidance on Extended Producer Responsibility (EPR), Final report, Bio Intelligence Service-Deloitte, with Arcadis, Ecologic, Institute for European Environmental Policy (IEEP), Umweltbundesamt (UBA), 2014, the responsibilities and roles of each actor should be clearly defined throughout the whole product life cycle (second guiding principle on shared responsibilities).
See also : Un regard renouvelé sur la responsabilité élargie du producteur, Institut Sapiens, mars 2018.

[76] Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC.

- Restriction: The restriction regime imposes conditions or prohibitions on the manufacture, the use or the placing on the European market of articles containing certain substances.

- Information communication on substances of very high concern: The requirement of substances information communication to professional customers or consumers imposes to maintain the traceability of the substances or mixtures in the parts.

In the context of the innovation deal use-cases, we will focus on the authorization and restriction regimes which seem to be the more difficult requirements to implement.

REACH and the circular economy needs to be reconciled so that REACH better takes into account the specific constraints and characteristics of the circular economy. Chemicals that are legally used in products today may be subject to authorization or restriction under REACH in the future, which creates uncertainty on the conditions of their re-use.

Additionally to REACH regulation, Regulation n° 850/2004 on Persistent Organic Pollutant (POP) has the same impact as the restriction regime.

b) In case of second life batteries

In the use-cases, the batteries or their components have already been placed on the European market a first time (REACH definition of "placing on the market") before a potential future authorization, therefore their further re-use as articles should not be impacted.

In the case of a restriction or if the substance is subject to the POP Regulation, an exemption should be requested so that the restriction does not apply to products which have already been placed on the market/are already in use and which are destined for reuse. If no exemption is granted, reuse (and even recycling) will be prohibited and the disposal of batteries will be mandatory.

In any case, for both restriction and authorization, the supplier of the re-used battery will have to ensure traceability on substance information.

II.2.2.5 Barriers deriving from Directive 2008/68[77] on the inland transport of dangerous goods

Directive 2008/68/CE makes an explicit reference to ADR. Article 4 indeed states "*The transport of dangerous goods between Member States and third countries shall be authorised in so far as it*

[77] Directive 2008/68/EC of the European Parliament and of the Council of 24 September 2008 on the inland transport of dangerous goods.

complies ***with the requirements of the ADR****, RID or ADN, unless otherwise indicated in the Annexes*" (emphasis added).

The ADR was concluded at Geneva on 30 September 1957 under the United Nations Economic Commission for Europe, and entered into force on 29 January 1968. It has been amended several times since then, the last consolidated version being applicable as from 1 January 2017.

In practice, the implementation of ADR, and most notably the use of a specific ADR packaging for the transportation of lithium batteries requires a number of additional logistics operations, leading to significant additional logistics costs and related environmental impacts (i.e. additional transport operations and/or packaging waste), as illustrated in the figure below :

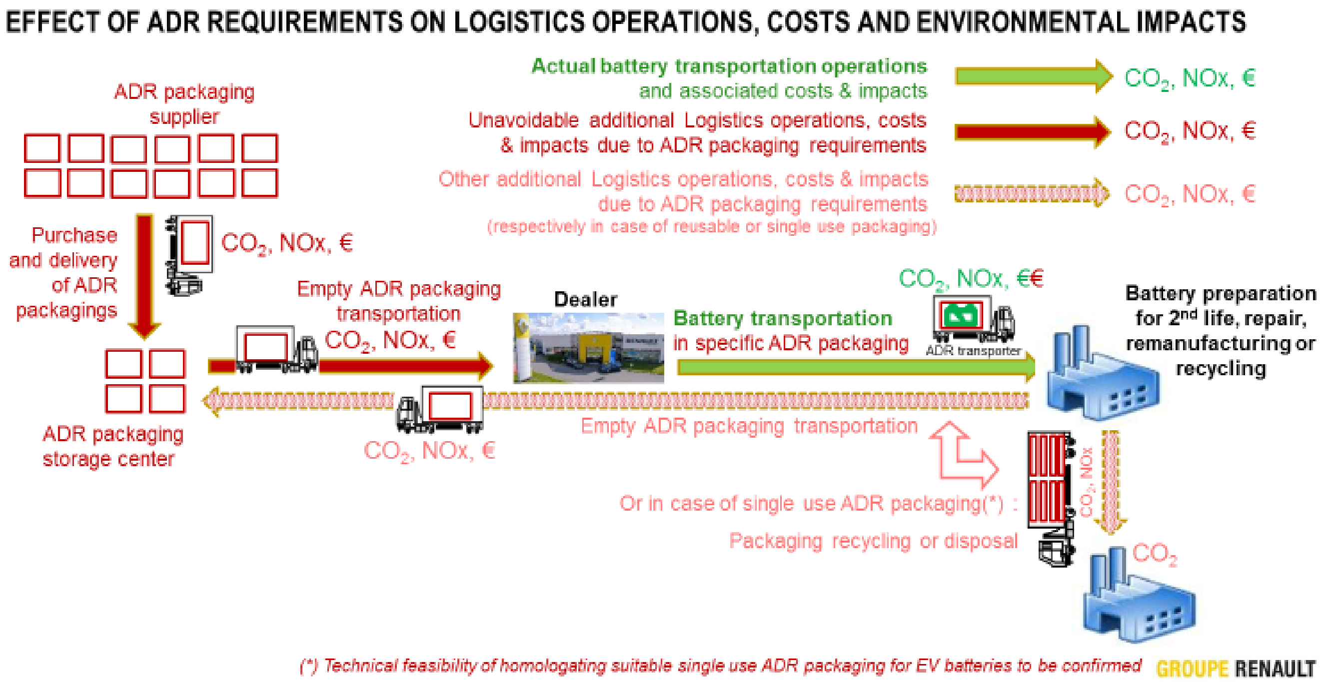

Figure 27: Network tariffs & storage – the French case

This issue shall be further analysed and discussed during the next steps of this innovation deal.

CONCLUSION: The following table shows the main legal and regulatory barriers and their consequences and impacts.

	Barriers	Consequences	Impacts
ENERGY	Lack of definition of storage	- If no specific definition, there can be no tailor-made regime for storage (stationary storage and mobile storage) - Existing regimes applicable to generation and consumption are unsuitable - Compliance with the principle of non-discrimination is questionable	€ ⚖
	Lack of status of storage operator	Because there is no specific status for storage operator, it is difficult to make a clear difference with the rules applicable to other stakeholders (i.e. producer, consumer and network operator)	⚖
	Technical conditions related to minimum capacity or minimum activation length	Most of the rules related to technical conditions have been designed for centralized units and are unsuitable for stationary or mobile storage	📖 🛠
	No specific network user category for storage	Seen from the grid, storage is transparent. This obliges to deal with it as if it was either consumption or production with a risk of: - Double payment of network tariffs - Over or double taxation - Overload of administrative burden	€ 📖
BATTERIES	Legal uncertainties on notions such as waste, re-use or end-of-waste	Possible misclassification of second life batteries as waste	€ ⚖ 🕒
	Risk of misclassification of second life batteries as waste	- Obligation to hold authorizations and permits to deal with the batteries - Difficulties of cross-border transportation (that may hinder the integration of this new market at the EU level)	€ 📖 🕒
	Extended producer responsibility / status of "producer" under the Batteries Directive in the context of second life batteries	Keeping producer responsibility on the initial producer during the entire life cycle of the battery would mean low incentive for the initial producer to promote second use of the battery by other actors (property transfer)	€

⚖	Legal risk/litigation
€	Risk of extra costs
🕒	Risk of delay
🛠	Maintenance or manipulation required
📖	Risk of administrative overload

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