Batteries on wheels: risks and opportunities around electric cars

June 2019

1. Batteries: new gold or new problem?

Are batteries the new gold? They might well be considering how key they are to the decarbonisation of large parts of the European economy, in particular the transport and energy sector. Electrifying cars, vans, buses and trucks using rechargeable lithium-ion batteries offers an effective, scalable and, if combined with renewable power, zero emission solution for transport; Europe's biggest climate problem. European carmakers have jointly committed more than €130 billion to electrification in the coming years.[1] This is a positive development, but if the rollout of electric vehicles is not properly managed - via uncontrolled grid connections or unsustainable use and sourcing [2] of materials - challenges will arise, reducing the environmental benefits and creating new problems. T&E has partnered with Enel, Iberdrola and Renault-Nissan to commission a report from Element Energy to understand the opportunities offered by electric vehicle integration, and how to turn these "batteries on wheels" into an asset, rather than a problem.

The report, published alongside this briefing:

- estimates the expected uptake of EVs and the volumes of batteries available for grid services during the vehicle life, as well as second life applications and recycling at the end of vehicle life;
- studies the impact of EV integration on EU grids and renewables penetration, with case studies of France, Spain, Italy and the UK;
- analyses the economics around innovative second life applications of batteries and presents a number of promising case studies; and
- assesses challenges and opportunities around battery recycling, as well as what is needed to spur circular economy markets in Europe.

This short brief accompanies the Element Energy report; it provides additional analysis and policy recommendations in view of the new European Commission and upcoming legislative opportunities.

2. Key results and takeaways

Dealing with climate change requires tackling all sectors of the economy. The power sector is moving towards variable renewable energy sources (VRES), such as wind and solar. These technologies, even if they are becoming cheaper than any other power source, are variable by definition. Additionally, electricity demand will continue to grow slowly, as sectors like transport electrify. Therefore, planning for this transition and integrating electric vehicles, grids and renewables is key.

2.1. How much battery capacity is there?

In the study, an uptake of electric vehicles in the main scenario is aligned with EU legislation up to 2030. Therefore, it can be considered a conservative approach, as the market might develop faster. We assumed 15% of new sales in 2030 to be battery electric vehicles (BEVs), while plug-in hybrids (PHEVs) would have a market share of 8%. Under this conservative scenario, by 2030 there would be around 11 million BEVs and 6 million PHEVs in Europe, while in 2040 there would be 62 and 32 million BEVs and PHEVs, respectively.

[1] https://graphics.reuters.com/AUTOS-INVESTMENT-ELECTRIC/010081ZB3HD/index.html

[2] On how to ensure battery materials are sourced sustainably and ethically, please see a separate T&E paper: https://www.transportenvironment.org/publications/cobalt-congo-how-source-it-better

By 2040, this would add up to 3,955 GWh of total storage capacity, or a massive "battery on wheels" as study calls it, which is equivalent to approximately half of today's daily EU consumption. By 2040, 43 GWh worth of batteries would leave the vehicle stock as cars retire, with approximately 10 GWh being recycled, and 23 GWh being available for second life applications. Our study also assumed a scenario with the higher amount of renewables in the power sector in order to decarbonise, the so-called Global Climate Action. Both EVs and incorporation of renewables into the power sector are two trends that are happening. The key is to do it right.

2.2. How can EVs help grids?

Electric vehicles can contribute in two different ways: first, they could provide flexible electricity demand, if charging is done smartly. This would minimise the investments required to upgrade the grid and for peak (fossil) plants. Secondly, they could be a giant battery on wheels, which would reduce curtailment rates and provide electricity back to the grid to minimise the need of peak plants on a daily basis.

The study analysed the costs and benefits in 4 different countries: France, Italy, Spain, and the UK. The results were very clear in all four countries: smart charging of electric vehicles would deliver benefits to the electricity system overall, as it would save money on the need of building and operating new power plants, while also saving money on operating and building the additional electricity network. The net benefit would be between ~€0.5 and €1.3 billion per year, depending on the country, even after incorporating the costs associated with additional smart charging infrastructure.

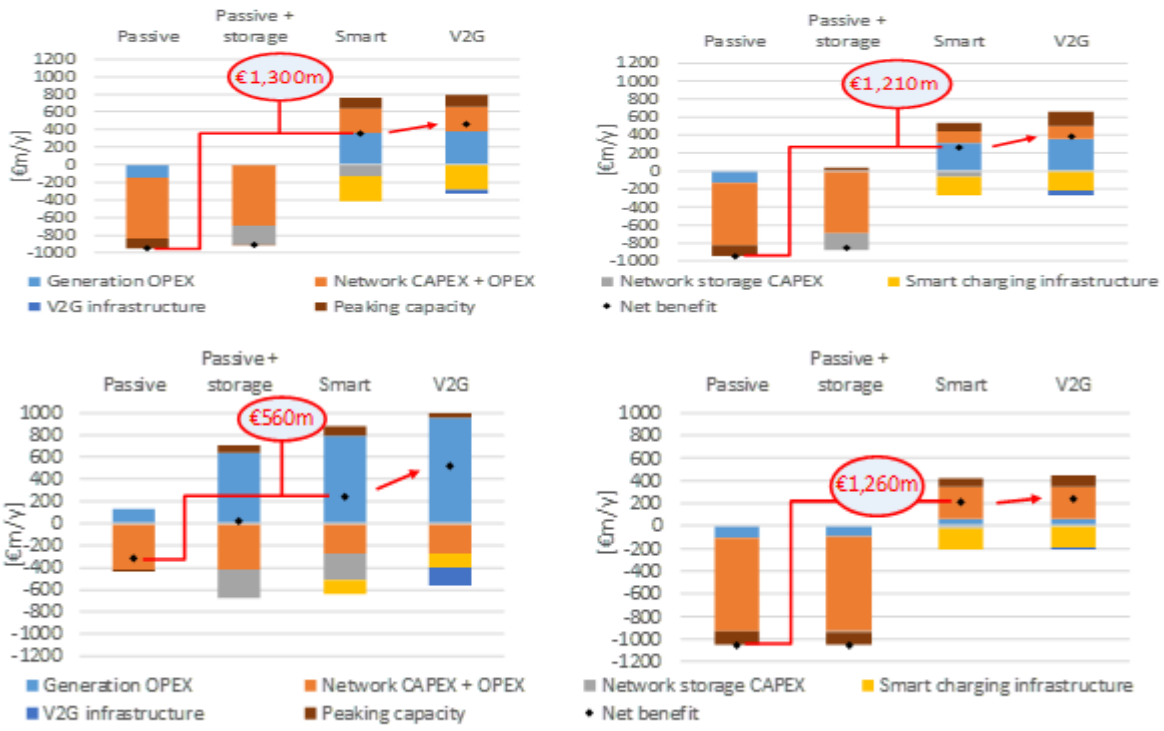


Figure 1: Whole system cost and benefits 2040, from left to right, and from top to down: UK, FR, ES and IT.

Vehicle-to-Grid (V2G)[3] technologies provide even larger benefits than smart charging alone, even if they are smaller in comparison. Only a small fraction of the total EV fleet would be used for V2G, mostly due to the small price difference between the additional infrastructure cost to provide V2G capabilities and the economic benefits it delivers, except in countries with large shares of solar energy, such as Spain.

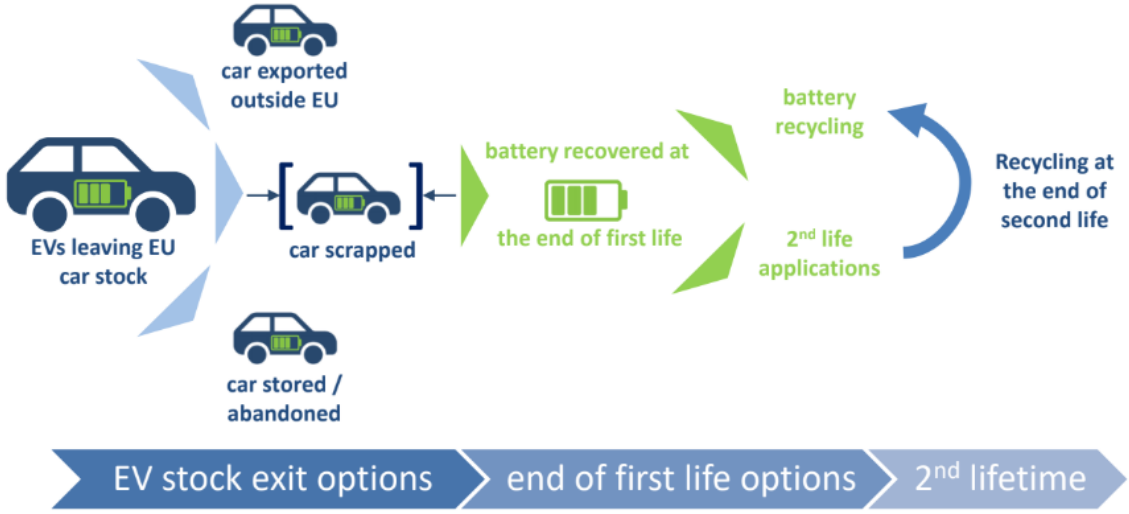
[3] V2G refers to injecting electricity from the EV battery back into the electricity grid.

Apart from economic benefits, smart charging and V2G deliver significant environmental benefits. In all countries analysed, curtailed (wasted) renewable electricity is reduced to a larger extent, displacing fossil power plants and decreasing in part the average carbon intensity of the grid. By 2040, the level of energy available in car batteries is far beyond what can be economically deployed in grid storage. The opportunity to support VRES integration with V2G is much more than would be possible with economically viable grid storage.

This all shows that, if the transition is done smartly, EVs not only do not have a negative impact on the power system, but can also play an important role to incorporate more renewables into the system.

2.3. Is there life after (vehicle) life?

The Element Energy report looks in particular at the end of life opportunities around batteries, i.e. when the battery is around 70-80% of its initial capacity. While its performance is no longer enough for a car or a truck (less range, worse acceleration, etc.), it is still perfectly adequate for less demanding applications, notably energy storage or stationary applications such as forklifts. The figure below summarises the different pathways that a battery car takes at its end of life. It is clear that beyond the challenge of reusing or recycling the battery, collecting the end of life batteries in the first place and not allowing this resource to be exported outside the EU are also a problem to be addressed.



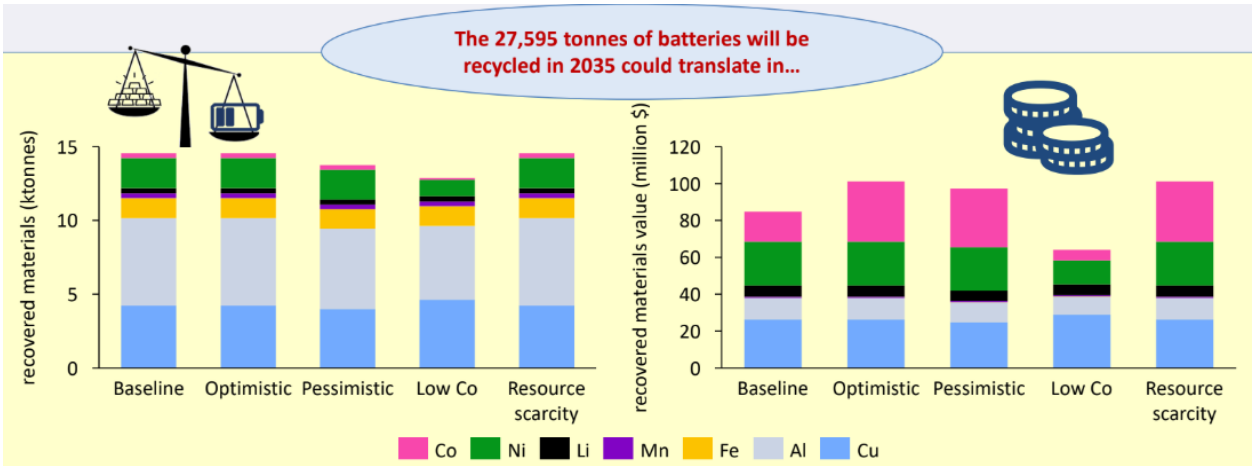
Few people today question the benefit of recycling as it helps to secure critical materials in Europe, and shaves off some of the price peaks for materials such as lithium and cobalt as new production takes time to ramp up. But the key finding of the study is that Europe today[4] is not ready to reap the potential of batteries coming to the end of life, as it has inadequate recycling capacity or expertise. **Even on a moderate EV uptake scenario, the current recycling capacity, estimated by Element Energy at 33,000 tonnes/year, will not be enough when current EV batteries will reach their end-of-life from 2030 onwards**. Equally important is the fact that there is almost no lithium battery recycling at a commercial scale in Europe today (many facilities exist in China where many batteries are sent currently) with most companies providing low-value collection or shredding only.

Rapidly changing chemistries and innovation makes the economics of large-scale recycling business difficult, as does the decreasing shares of cobalt in batteries - most valuable battery metal to recover currently. Importantly, recycling also has environmental impacts, e.g. high-energy intensity (pyrometallurgy) or use of hazardous chemicals (hydrometallurgy). The most sustainable process is direct recovery, but it is in its infancy and there are concerns over the quality of directly recovered components

[4] See table 1 on p.37 of the report.

(e.g. cathodes) or the viability to use 10-year old components in new batteries given the pace of progress in this field.

The main message on battery recycling however is that today's outdated battery recycling framework fails to take the specificities of the lithium-ion battery market into account and is not enough of a signal for recyclers to increase capacity. The new regulation is needed to ensure timely investments and ramp up. Such regulatory certainty will incentivise innovation, increased recovery efficiency, a wider range of end materials that could be recovered, as well as a reduction in the environmental impacts of battery recycling. We do not want to end up with battery recycling in 2030 where we are with the battery supply chain today, whereby the lack of timely investments by carmakers has led to some short-term availability concerns.



The report also looks into the economics of reuse and analyses a number of case studies of battery second life applications. It finds the benefits to be significant - **a 42% price reduction to the end-user compared to using a new battery for storage**. It also brings additional benefits to carmakers (recouping the costs of the car's most expensive part for longer) as well as generating a new industry, supply chain and jobs.

A promising use case for repurposed batteries would be providing distribution support to avoid high peaks in demand for large loads, for example night-time charging at an electric bus depot. Instead of costly reinforcements of the grid for short-term demand, second life batteries are used to provide, in this example, 2 MWh of storage for a 1 MW peak reduction. An overall cost reduction of about 25% for 2h duration (and about 35% for 6h duration) is achieved, alongside additional climate benefits as peak plant is often old and polluting (e.g. coal). This is an attractive solution for cities to integrate an increasing electric bus fleet into their energy systems.

3. How do we reap the benefits of batteries on wheels?

The key message of the report is that batteries will not be a problem, but rather a solution: they can reduce costly grid upgrades, allow to integrate more renewables and be a source of valuable secondary materials for future applications. Whether or not these opportunities are exploited largely depends on the policy framework that is in place: new legislative tools are just as important as robust implementation of the existing regulations.

3.1. Energy system integration

The recently approved "Clean Energy for All Europeans" package contains many elements that will help enable smart charging. For instance, it allows to provide consumers with more accurate price signals that reflect real costs when smart meters are in place. The role of aggregators is also enhanced, allowing EV owners to participate in different markets. Before, demand response could not easily compete with traditional resources (like fossil fuel plants). Now the key is to ensure that the options included in **EU**

legislation are properly implemented at national level; for instance, creating a framework for smart pricing, both for electricity and network tariffs, as soon as possible. A charging regime should ensure costs are distributed fairly, and EV users face charges that reflect the costs (or benefits) they are imposing on the system.

However, European legislation could go even further to promote smart charging and V2G. This is especially important in the first years of EV deployment. Some key recommendations are:

- Ensure that all **new infrastructure deployed is capable of smart charging**. For instance, this should be mandated for all public charging points (at least all slow charging) in the revised Alternative Fuels Infrastructure Directive (AFID), or to include it in the guidance for member states on how to implement the Energy Performance of Buildings Directive (EPBD).
- Make **smart meters mandatory** to allow consumers to benefit from dynamic pricing, at least for EV owners with home chargers. Currently, many member states argue its deployment is not cost-effective, but they are essential to ensure smart charging happens to a large extent.
- **Double-charging of taxes and levies** on electricity generated from storage facilities **should end**. Such a provision could for instance be included in a potential review of the Energy Taxation Directive.
- As part of the Governance Regulation, member states should be asked to ensure that the use of the **charging infrastructure is closely aligned with the uptake of renewable electricity generation**. For instance, countries with much solar potential should enable charging infrastructure to be rather used during the day, while those with considerable wind resources should promote charging at night.
- As with renewables, key to success is joint-up thinking from the start: member states and local authorities should **integrate energy, transport and telecommunications** planning to seek synergies and cost-effective, grid & data-friendly integration of electric vehicles. For example, mandate Transmission System Operators (TSOs) and Distribution System Operators (DSOs) to study where is best to install both fast and slow chargers, to minimise system costs for all players.
- European legislation should ensure **access to energy consumption data**, such as charging patterns of EVs, takes into account protection of consumer privacy and security.

3.2. Second life and recycling

Lack of recycling capacity and uncertainty around economics show that today's regulatory framework is in dire need of reform. The Commission has already confirmed its intention to review the 2006 EU Battery Directive. This is a once in a decade opportunity to make batteries an integral part of circular economy. The Commission should:

- Create a **separate category for lithium-ion batteries**, setting **robust collection requirements** and targets to ensure batteries are not lost or illegally shipped at the end of their life. To streamline implementation, the directive should be turned into a regulation.
- Set **ambitious targets of at least 90% recovery for individual key battery materials** such as cobalt, lithium, nickel, graphite and others. This should be supported by research and development funding into recycling process improvement, e.g. similar to the US Battery Recycling Centre launched recently.
- To ensure circularity of battery material streams and traceability, a **digital tracking and identification system should be set up for all batteries** (from cell level) produced, used and recycled in Europe. This is already done in China and allows for a transparent system to monitor battery performance over its lifetime. In particular, it allows industry and authorities to trace when and how batteries are recycled to ensure the valuable materials stay inside Europe.

- **Lines of responsibility and warranty shall be clarified to allow business models and innovative solutions** for second (and third) life applications to develop. Similarly, battery manufacturers shall incorporate easy reuse/recycling into the battery design and provide clear and standardised labelling to allow independent repurposing workshops to develop.
- To ensure energy or chemicals intensive recycling processes are scaled-up sustainably, attention also needs to be paid to process efficiency and decarbonisation. **Clean electricity should be incentivised** via measuring and verifying batteries carbon footprint. T&E recommends to set **a separate CO2 standard for the entire battery production value chain** - carbon intensity of recycling can be integrated for that purpose.

Crucially, the report presents robust evidence to show that electric vehicles are a huge opportunity for:

- Europe's grids and power sector, allowing a cost-effective and faster integration of renewables and offering new ways to support the network.
- Europe's supply of key battery materials, offering valuable resources for future batteries and closing the circular economy loop.

The ball is now in the Commission's and new Parliament's hands to make sure Europe reaps the benefits of the "batteries on wheels" potential.

Further information

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