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**REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE  
COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE, THE  
COMMITTEE OF THE REGIONS AND THE EUROPEAN INVESTMENT BANK**

**on the Implementation of the Strategic Action Plan on Batteries: Building a Strategic  
Battery Value Chain in Europe**

## I. WHY EUROPE NEEDS A STRATEGIC APPROACH TO BATTERIES

Driven by the ongoing clean energy transition, demand for batteries is expected to grow very rapidly in the coming years, making this market an increasingly strategic one at global level. According to some sources, the European market potential could be worth up to EUR 250 billion annually from 2025 onwards.<sup>1</sup> This trend is further reinforced by the new and comprehensive legislative and governance framework for the Energy Union, successfully adopted under this Commission to accelerate the transition to a sustainable, secure and competitive EU economy.

Batteries have therefore been identified by the Commission as a strategic value chain, where the EU must step up investment and innovation in the context of a strengthened industrial policy strategy aimed at building a globally integrated, sustainable and competitive industrial base.<sup>2</sup>

In its long-term vision for a climate-neutral economy by 2050 – “A Clean Planet for All”, the Commission shows how Europe can lead the way to climate neutrality, providing a solid basis for work towards a modern and prosperous climate-neutral economy by 2050.<sup>3</sup> This vision makes clear that electrification is set to be one of the main technological pathways to reach carbon neutrality.<sup>4</sup> Batteries will be one of the key enablers for this transition given the important role they play in stabilising the power grid and in the roll-out of clean mobility<sup>5</sup>.

Batteries offer a very tangible opportunity to use this deep transformation to create high value jobs and increase economic output. They can become a key driver for the EU’s industrial competitiveness and leadership, notably for Europe’s automotive industry.

Huge investments are needed to this end. It is estimated that 20-30 giga-factories for battery cells production alone will have to be built in Europe and their related ecosystem will need to be considerably strengthened.<sup>6</sup> The scale and speed of investment needed means that the swift leveraging of private investment will be a key success factor.

Today the European share of global cell manufacturing is just 3 per cent, while Asia has an 85 per cent share.<sup>7</sup> If no action is taken to support the creation of a viable battery manufacturing sector, there is a risk that Europe falls irreversibly behind its competitors in the global

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<sup>1</sup> EIT Inno Energy is one of the Knowledge and Innovation Communities (KIC) of the European Institute of Innovation and Technology (.)

<sup>2</sup> European Council Conclusions, 21-22 March 2019

<sup>3</sup> COM(2018) 773 final of 28 November 2018: A Clean Planet for all – A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy.

<sup>4</sup> [https://ec.europa.eu/epsc/publications/other-publications/10-trends-reshaping-climate-and-energy\\_en](https://ec.europa.eu/epsc/publications/other-publications/10-trends-reshaping-climate-and-energy_en)

<sup>5</sup> [https://ec.europa.eu/epsc/publications/strategic-notes/towards-low-emission-mobility\\_en](https://ec.europa.eu/epsc/publications/strategic-notes/towards-low-emission-mobility_en)

<sup>6</sup> EIT InnoEnergy.

<sup>7</sup> Tsiropoulos I, et.al., Li-ion batteries for mobility and stationary storage applications – Scenarios for costs and market growth, EUR 29440 EN, Publications Office of the European Union, Luxembourg, 2018

batteries market, and becomes dependent on imports of battery cells and raw materials used in the supply chain.

To prevent a technological dependence on our competitors and capitalise on the job, growth and investment potential of batteries, Europe has to move fast in the global race to consolidate technological and industrial leadership along the entire value chain. The Commission is working together with many Member States and key industry stakeholders to build a competitive, sustainable and innovative battery ecosystem in Europe, covering the entire value chain.

This is the main objective behind the European Battery Alliance (EBA), an industry-led initiative, which the Commission launched back in October 2017, to support the scaling up of innovative solutions and manufacturing capacity in Europe. The EBA is helping to foster cooperation between industries and across the value chain, with support at both the EU-level and from EU Member States.<sup>8</sup>

This approach can be seen as a reference case for EU action in other strategic sectors to continue building collectively on Europe's industrial and innovation strengths to fill the gaps in its value chain.

In this context, in May 2018, the Commission adopted the Strategic Action Plan on Batteries as part of the third 'Europe on the Move' mobility package.<sup>9</sup> This brought together a set of measures to support national, regional and industrial efforts to build a battery value chain in Europe, embracing raw materials extraction, sourcing and processing, battery materials, cell production, battery systems, as well as re-use and recycling .

Less than a year after its adoption, significant progress has been made on the key actions set out in the Strategic Action Plan and industry has announced several major investments. This report provides the state of play on the main actions undertaken so far across the battery value chain and identifies the challenges and opportunities for the EU in this strategic sector for decarbonising and modernising the economy.

### **The drive for clean mobility will accelerate demand for battery-powered electric vehicles**

Transport in general and the automotive sector in particular will dominate growth in demand for battery cells in the mid-term, as is already the case today.<sup>10</sup> This will play a key role in driving down costs on the basis of significant economies of scale.<sup>11</sup> Currently, there are more than 4 million electric vehicles on the road globally. This is forecast to grow to between 50

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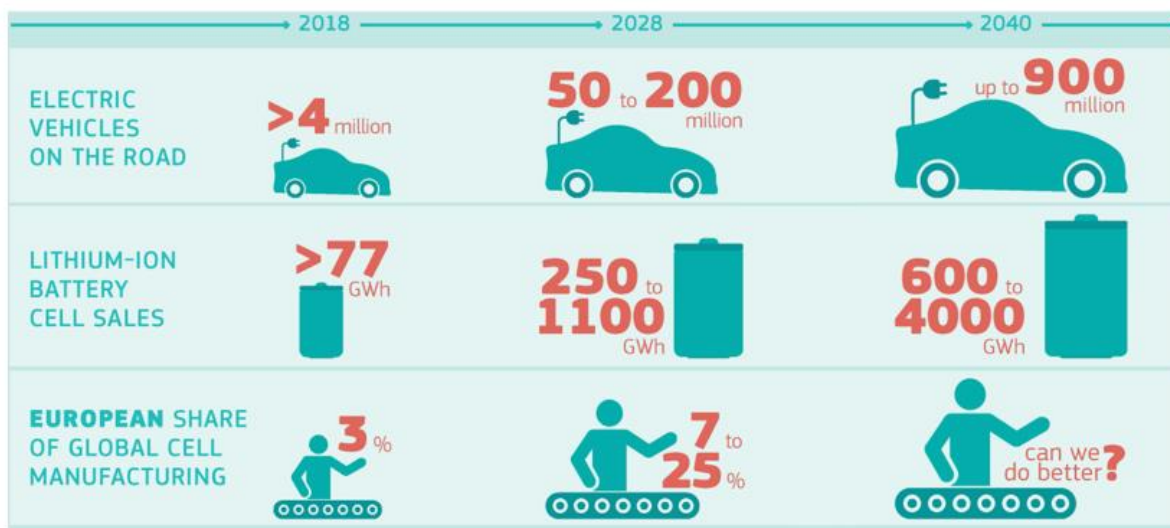
<sup>8</sup> [https://ec.europa.eu/growth/industry/policy/european-battery-alliance\\_en](https://ec.europa.eu/growth/industry/policy/european-battery-alliance_en)

<sup>9</sup> COM(2018) 293 final of 17 May 2018

<sup>10</sup> Today, the electrification of passenger road transport, short sea shipping and inland waterways is most prevalent, but the emergence of new technologies is expected to allow electrification of more modes in the future.

<sup>11</sup> With an increase in mass manufacturing, costs of battery packs are expected to fall at least 50 per cent by 2030 (JRC).

and 200 million by 2028 and to reach up to 900 million by 2040.<sup>12</sup> Batteries represent up to 40 per cent of the value of a car.<sup>13</sup>



*Global supply and demand of Li-ion batteries today and in the future and the European share in manufacturing. Source: JRC*

Legislative initiatives and enabling measures under the Commission’s Low-Emission Mobility Strategy and the three ‘Europe on the Move’ mobility packages, will have an impact on both the supply and demand for electric vehicles and therefore for batteries.<sup>14</sup> This includes the recently adopted Regulation on CO<sub>2</sub> emission standards for new cars<sup>15</sup> and most heavy-duty vehicles<sup>16</sup>, and the revised Clean Vehicles Directive, which sets public procurement targets for low- and zero-emission vehicle fleets.<sup>17</sup> The crisis surrounding car emissions and the high levels of air pollution in some cities is a cause of public concern and is stimulating demand for cleaner vehicles (significant reduction in demand for diesel-powered vehicles).<sup>18</sup> This has prompted action by governments (e.g. banning future sales of combustion engine powered vehicles, diesel vehicle restrictions and bans in urban areas), as well as an overhaul of car manufacturers’ business and investment strategies (e.g. switching production away from diesel to hybrid, electric, and fuel cell vehicles). The restructuring of transport charges and taxes to reflect infrastructure and external costs, including the application of the “polluter pays” principle in road charging, will also drive demand towards low- and zero-emission vehicles.<sup>19</sup>

<sup>12</sup> Tsiropoulos I, et.al., Li-ion batteries for mobility and stationary storage applications – Scenarios for costs and market growth, EUR 29440 EN, Publications Office of the European Union, Luxembourg, 2018.

<sup>13</sup> Environmental and Energy Study Institute (2017). Factsheet – Plug-in Electric Vehicles. Link: <https://www.eesi.org/papers/view/fact-sheet-plug-in-electric-vehicles-2017#5>

<sup>14</sup> COM(2016) 501 final of 20 July 2016.

<sup>15</sup> COM(2017) 0676 final of 8 November 2017.

<sup>16</sup> COM(2018) 284 final of 17 May 2018.

<sup>17</sup> COM(2017) 0653 final of 8 November 2017.

<sup>18</sup> Air pollution is linked to around 400 000 premature deaths in Europe every year.

<sup>19</sup> COM(2017) 0280 final of 31 May 2017.

## **Storage for renewable energy will be a major driver of battery demand**

By 2050, the share of electricity in final energy demand will at least double to 53 percent. By 2030, it is expected that around 55 percent of electricity consumed in the EU will be produced from renewables (up from the current level of 29 percent). By 2050, this figure is expected to be more than 80 percent.<sup>20</sup> For an effective integration of this renewable electricity, the whole range of energy storage technologies will be required, including pumped hydro, batteries, and chemical storage (hydrogen). The choice of solutions will depend on the location, capacity required and services to be provided.

By providing the opportunity to store electricity temporarily and to feed it back into the grid, batteries can help society make better use of variable and decentralised renewable energy sources like wind and solar power. Batteries will help to balance the electricity grid, complementing flexibility also provided by improved interconnections, demand response and other energy storage technologies. Batteries used for balancing the electricity grid can be stationary or mobile (i.e. the batteries in electric vehicles, provided that they are bi-directional<sup>21</sup>).

The global expansion of renewable energy over the past decade has already led to massive cost decreases, in particular for solar energy and on- and off-shore wind power. This means, for example, that millions of consumers around the world are now able to produce their own electricity (mostly using solar panels on their rooftops), as well as store it and sell it back to the grid.

The role and importance of energy storage, and in particular battery storage technologies, is set to increase significantly. In the medium-term, stationary batteries are expected to reach about 10 per cent of the battery market, but their role will further grow. In the 2050 perspective, storage will become the principal way of integrating renewables into the power system as thermal generation declines over time and the potential of demand-response is more fully used. Some scenarios which are assessed in the Commission's Communication on "A Clean Planet for All" suggest that annual electricity storage in 2050 could increase at least tenfold compared to 2015.

By 2050, batteries are expected to play a far more significant role than pumped hydro storage technology, which is currently the main storage technology in the electricity system, accounting for over 90 per cent of the energy storage capacity in the EU.<sup>22</sup>

## **Overcoming Europe's energy and raw material dependency – a strategic opportunity**

Global market forecasts project demand for lithium-ion batteries to grow significantly to up to 660 GWh by 2023, 1 100 GWh by 2028 and could reach up to 4 000 GWh by 2040, compared to only 78 GWh today.<sup>23</sup> As the global market size increases, Europe is forecast to develop a

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<sup>20</sup> COM(2018) 773 of 28 November 2018

<sup>21</sup> Bi-directional battery technology allows power to flow from the electricity grid into the electric vehicle and conversely (vehicle-to-grid).

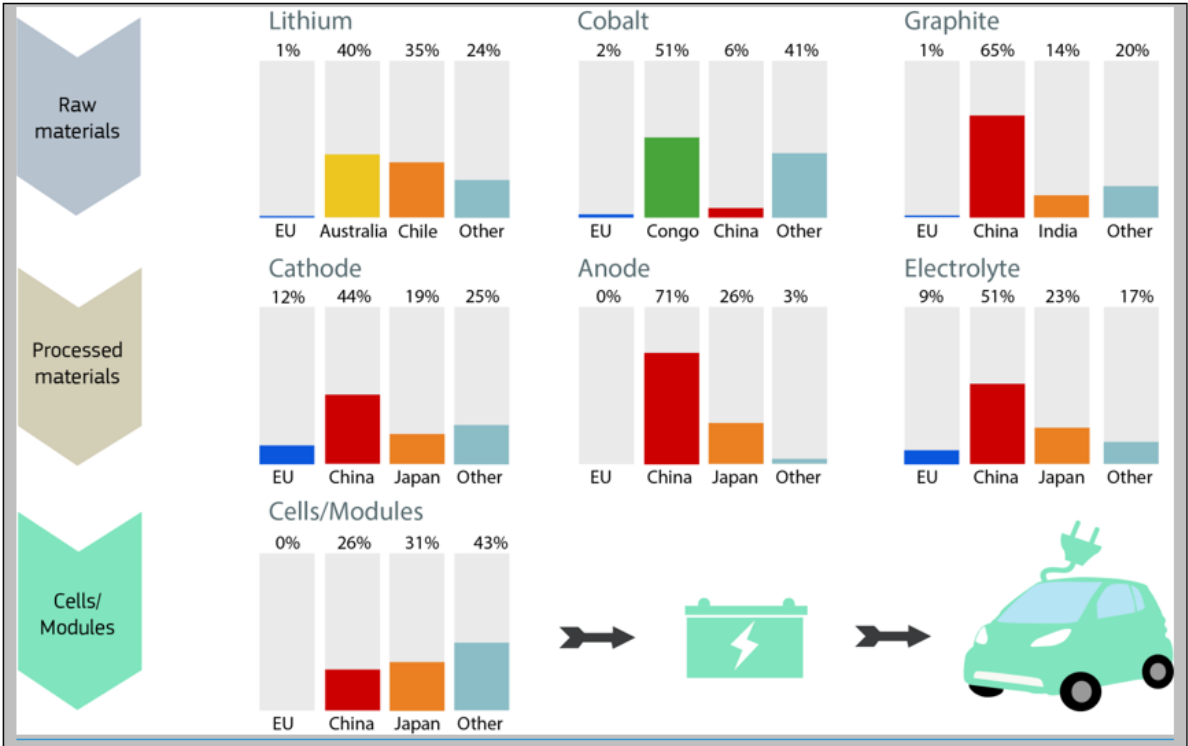
<sup>22</sup> [https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Oct/IRENA\\_Electricity\\_Storage\\_Costs\\_2017.pdf](https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Oct/IRENA_Electricity_Storage_Costs_2017.pdf)

<sup>23</sup> Benchmark Mineral Intelligence, October 2018.

capacity of 207 GWh by 2023, while European demand for electric vehicle batteries alone would be around 400 GWh by 2028<sup>24</sup>, creating at least 3-4 million jobs.<sup>25</sup>

However, today the EU’s high dependency on battery cell imports could expose industry to high costs and risks in the supply chain and undermine the automotive industry’s ability to compete with foreign competitors, notably if there is a shortage in the light of the forecast increase in demand.

This dependency is not only limited to battery cell production; access to the five essential battery raw materials (lithium, nickel, cobalt, manganese and graphite) is also a major challenge for Europe’s security of supply as they are only available from a small number of countries.<sup>26</sup> Battery-grade refining and processing facilities for almost all these materials are also currently concentrated in China, which consequently dominates the lithium-ion battery supply chain. The same applies to value chains of other key materials in electric vehicles, particularly to rare earths for high-energy density permanent magnets, which today are key to producing electric motors with the highest power densities.<sup>27</sup> In some cases, access to these raw materials may be at risk because of political instability, which could lead to access being disrupted (including exposure to high taxes and duties on exports), or being hindered by the prevalent use of unethical and unsustainable mining practices.



Supply dependency of materials along the value chain for electric vehicles’ batteries. Source: JRC

<sup>24</sup> Reuters, June 2018.

<sup>25</sup> Joint Research Centre.

<sup>26</sup> 69 per cent of the global supply of natural graphite originates from China, while 64 per cent of the global supply of cobalt is sourced from the Democratic Republic of Congo. Commission Staff Working Document, Report on raw materials for battery applications, SWD(2018) 245/2 final.

<sup>27</sup> JOIN(2019) 5 final of 12 March 2019

The expansion of the electric vehicle market will very substantially increase the demand for all of these raw materials in the next decade.<sup>28</sup> Therefore, economically and geo-strategically, the EU must make sure that it does not become dependent on primary raw materials and other processed materials along the battery value chain, sourced from abroad. The EU must diversify its sources of these materials, including domestic sources, make full use of its trade policy to ensure sustainable and secure supply, and deepen its shift towards a circular economy through recovery, re-use and recycling.

## **II. A BATTERY ‘ECOSYSTEM’ IN EUROPE: BUILDING COMPETITIVE, SUSTAINABLE AND INNOVATIVE STRATEGIC VALUE CHAINS**

The Commission’s objective is that the EU becomes an industrial leader and increases its strategic autonomy in the battery sector, across the value chain. Its aim is therefore to lay the ground for a sustainable, competitive and innovative battery ecosystem in the EU. Although it has been an early supporter of the development of batteries, the Commission has identified the need for a more collaborative and comprehensive approach, given the pace of change in this field.

The Commission’s renewed EU Industrial Policy Strategy highlighted the need to build on Europe’s strengths in strategic value chains in new technologies and make these more robust.<sup>29</sup> In this context, the Commission has identified batteries as a value chain of strategic importance and has proposed an industry-led approach. It has been supporting the development of cooperation between key industry players, encouraging the formation of European consortia in research, innovation and manufacturing, and facilitating more effective use of existing funding and financing mechanisms, in close partnership with the European Investment Bank (EIB) and the Member States. This approach underpins the European Battery Alliance.<sup>30</sup>

The broad nature of the challenges that the battery sector in Europe is facing calls for comprehensive and consistent measures across the value chain. The Commission’s Strategic Action Plan on Batteries has therefore put forward actions covering raw materials extraction, sourcing and refining, battery cell production and battery systems, and recycling and re-use.<sup>31</sup> The measures include securing the supply of primary raw materials for batteries from EU and external sources, increasing the contribution of secondary raw materials, supporting research and innovation, working with investors to promote scalability and manufacturing capacity of innovative solutions, and investing in specialised skills. Developing world-leading recycling technology and capabilities represents a further opportunity. Sustainable batteries – produced with responsible sourcing, the lowest carbon footprint possible and following a circular

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<sup>28</sup> Blagoeva.D., et al., Assessment of potential bottlenecks along the materials supply chain for the future deployment of low-carbon energy and transport technologies in the EU, EUR 28192 EN, Publications Office of the European Union, Luxembourg, 2018.

<sup>29</sup> COM(2017) 479 final of 13 September 2017.

<sup>30</sup> For the launch of this activity, the Commission has been supported by EIT InnoEnergy.

<sup>31</sup> At a meeting in October 2018, organised in the framework of the European Battery Alliance, EU Member States and industry leaders welcomed the approach proposed by the Commission in its Strategic Action Plan and called on all relevant actors to implement it rapidly.

economy approach, can be at the core of the EU's competitive advantage. EU-wide requirements and harmonised standards must be developed to underpin our competitive edge in this sector.

The support provided in the context of the Commission's Strategic Action Plan on Batteries complies fully with the EU's international commitments, in particular under the World Trade Organisation, and with EU efforts to ensure a level playing field and eliminate market distortions.

### **Research, innovation and demonstration: designing and deploying the next generation of battery technologies**

Europe needs sustained and coordinated efforts to support investments in research and innovation in battery advanced materials and chemistries to enhance its performance on lithium-ion (Li-ion) battery cell technologies, and to pursue leadership in the next generation of battery technologies. Current state-of-the-art batteries are largely based on lithium-ion chemistry, but the demand for higher energy density and performance requires short- to medium-term improvements, together with more radical changes towards a new generation of post-Li-ion batteries based on new advanced materials. EU companies are well placed to take advantage of these technological developments<sup>32</sup>.

In the area of batteries, the EU is mobilising all its support instruments covering the entire innovation cycle, from fundamental and applied research to demonstration, first deployment and commercialisation.

Coordinating battery-related research activities is key to harnessing the potential of this sector. Building on the collaborative efforts of the Strategic Energy Technology (SET) Plan<sup>33</sup> and the Strategic Research and Innovation Agenda (STRIA)<sup>34</sup>, the Commission has launched a European Technology and Innovation Platform (ETIP) "Batteries Europe"<sup>35</sup> to advance battery research priorities bringing together industrial stakeholders, the research community and EU Member States to foster cooperation and synergies between relevant battery research programmes. This platform enables co-operation between the numerous battery-related research programmes launched at EU and national levels, as well as private sector initiatives.

Going forward, ETIP will prepare the ground for a co-programmed research and innovation partnership on batteries with industry proposed by the Commission under the future Research and Innovation Framework Programme, "Horizon Europe", starting in 2021. The objective of the partnership is to support EU leadership by bringing together all Horizon Europe research and innovation activities under one roof so as to develop a coherent and strategic programme, in cooperation with industrial players and the research community.

The EU budget is already providing important funding opportunities to support research and innovation in batteries. The EU's Framework Programme for Research and Innovation for

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<sup>32</sup> Several European manufacturers aim, for instance, to produce solid-state batteries by 2025.

<sup>33</sup> <https://ec.europa.eu/research/energy/index.cfm?pg=policy&policyname=set>

<sup>34</sup> <https://trimis.ec.europa.eu/stria-roadmaps/transport-electrification>

<sup>35</sup> This ETIP is led by the European Energy Research Alliance (EERA), the European Association for Energy Storage (EASE) and EIT InnoEnergy. It was launched in February 2019 as part of the Clean Energy Industrial Forum.



2014-2020, Horizon 2020, has granted EUR 1.34 billion to projects for energy storage on the grid and for low-carbon mobility. In 2019, Horizon 2020 added a call to fund, under the European Battery Alliance, battery projects worth EUR 114 million. This will be followed by a call in 2020 amounting to EUR 132 million, covering batteries for transport and energy.

The European Regional Development Fund is also providing support for research and innovation to promote an energy-efficient and decarbonised transport sector.

The EU's regions have shown an interest in establishing partnerships to take forward joint projects and further develop strong innovation ecosystems in the field of batteries. One such interregional partnership, focusing on advanced battery materials for electro-mobility and energy storage, was launched in October 2018 in the framework of the Smart Specialisation Platform on industrial modernisation. This open partnership<sup>36</sup> has already expanded to include 22 regions and several pilot areas have been established across the value chain to identify battery-related projects that could lead to successful commercial businesses.<sup>37</sup>

In addition, demonstration projects and pilots are important to test out the new technologies in near-market conditions, prior to ramping up production on a commercial scale. To support first-of-a-kind commercial scale energy demonstration projects, the European Investment Bank (EIB) provides loans, guarantees and equity-type funding through the InnovFin Energy Demo Projects (EDP) facility.<sup>38</sup> The facility has already provided one loan of EUR 52.5 million to a demonstration plant in Sweden for the manufacturing of advanced Li-ion cells for batteries in transport, stationary storage and industry.<sup>39</sup> Several battery industry projects in Croatia, France, Greece and Sweden have also benefited from support under the European Fund for Strategic Investments. In the next Multiannual Financial Framework, the new InvestEU Fund is expected to bring together under one roof the existing financial instruments which will make EU support more efficient and more flexible also in the field of batteries.

The Innovation Fund established by the EU's Emission Trading Scheme should provide around EUR 10 billion in the period 2020-2030 to support pre-commercial demonstration projects in low-carbon technologies, including energy storage.<sup>40</sup> It will provide an opportunity to produce, test and demonstrate innovative battery technologies at scale, helping to bridge the gap between research and innovation results (for instance achieved in Horizon 2020), and commercial deployment of battery manufacturing, as aimed for in the European Battery Alliance. It will be implemented in full coordination with other relevant EU programmes, and, through blending could also contribute to Invest EU.

The scale of the investment challenge is such that it cannot be met by public finance alone; hence the importance of effective mechanisms to attract private capital. A combination of public and private sources is therefore essential.<sup>41</sup>

Innovative financing schemes involving the public and private sector are being used in line with the EU's objective on clean energy innovation. In October 2018, the Commission and

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<sup>36</sup> This partnership is open to other regions that may wish to join.

<sup>37</sup> <http://s3platform.jrc.ec.europa.eu/batteries>

<sup>38</sup> [EDP link](#)

<sup>39</sup> Northvolt ETT-large scale battery plant, EIB press release, 19/09/2018

<sup>40</sup> [https://ec.europa.eu/clima/policies/innovation-fund\\_en](https://ec.europa.eu/clima/policies/innovation-fund_en)

<sup>41</sup> One attempt in this direction is the current Investment Plan, to be succeeded by InvestEU, which aims at mobilising private financing thanks to guarantees provided by the EU budget.

'Breakthrough Energy' agreed to launch a new model of public-private cooperation to catalyse more direct private investment into breakthrough European low-carbon technology companies and innovators that provide solutions to climate change.<sup>42</sup> An initial equity commitment of EUR 100 million is envisaged under this joint investment vehicle. This comprises EUR 50 million from 'Breakthrough Energy (or its affiliates) and EUR 50 million provided by the Commission through InnovFin, the Horizon 2020 financial instrument managed by the European Investment Bank.

In addition, the European Battery Alliance is examining the potential for cross-border breakthrough innovation projects with a view to accessing public funding that would be compatible with the EU's State Aid rules under the Important Projects of Common European Interest (IPCEI) framework.<sup>43</sup> Several EU Member States have already launched processes to identify potential consortia and are working together to design one or more IPCEI in this field.<sup>44</sup> They aim to seek approval by the Commission as soon as possible.

### **Investing in the industrial deployment of innovative solutions along the battery value chain**

The European Battery Alliance is acting as a catalyst for creating a battery value chain in Europe. Around 260 industrial and innovation actors have joined this network. EIT InnoEnergy (a Knowledge and Innovation Community of the European Institute of Innovation and Technology) has steered this network and already announced consolidated private investments of up to EUR 100 billion, covering the whole value chain.<sup>45</sup>

This includes announcements of production of primary and secondary raw materials in the EU, and planned battery manufacturing investments from several European consortia. The consortium starting construction of a pilot line in Sweden with support from the European Investment Bank is among them. Another is investing in the development of advanced lithium-ion batteries to be followed by lithium-ion solid-state batteries, and could begin production in the next few years. Materials and recycling groups are building plants in Poland and Finland to produce key materials for electric vehicle batteries by 2020.

### **Setting the standards for clean, safe, competitive and ethically produced batteries**

The aim of making Europe a leader in sustainable battery production must be underpinned primarily by a robust legal framework complemented by European harmonised standards. The legal requirements applicable to batteries for them to be placed on the EU market and to the manufacturing processes concerned will greatly influence the development and

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<sup>42</sup> [http://europa.eu/rapid/press-release\\_IP-18-6125\\_en.htm](http://europa.eu/rapid/press-release_IP-18-6125_en.htm)

<sup>43</sup> Important Projects of Common European Interest (IPCEI) are projects involving more than one Member State contributing to the Union's strategic objectives and producing positive spillovers on the European economy and society as a whole. In case of research, development and innovation projects, such projects must be of a major innovative nature, going beyond the state of the art in the sectors concerned – see Commission Communication 2014/C 188/02 of May 2014.

<sup>44</sup> Including calls for interest published in Belgium, France, Germany and Italy

<sup>45</sup> At the time of writing, an investment plan is being set up by some of these private actors to aggregate projects and investors.

deployment of batteries technologies and the impact they will have on public health, safety, the climate and the environment.

Future regulatory requirements are likely to address battery characteristics such as safety, connectivity, performance, durability, bi-directionality, re-useability and recyclability, resource efficiency, or even life-cycle impacts such as “carbon footprint”.<sup>46</sup> These will need to be supplemented by broader requirements on the value chain in the areas of responsible sourcing, transport and storage, and waste collection and recycling. In the case of batteries, these requirements could, for example, be set in the framework of the Eco-design Regulation and the EU Battery Directive.<sup>47</sup> The results of the latter’s evaluation by the Commission are being issued together with this report.<sup>48</sup>

The Commission has also started the work on developing minimum performance and sustainability requirements for batteries. These criteria must be supported by science-based harmonised standards, which will be used by industry to document compliance with the regulatory requirements laid down in EU legislation. The Commission and the European standardisation bodies (CEN/CENELEC) are working closely together to ensure a co-ordinated and timely approach to standard development.

European battery producers have already shown their readiness to harmonise environmental requirements to calculate the environmental footprint of their products along the entire life-cycle of batteries. These agreed rules are an encouraging basis upon which to build the sustainability of the European battery sector.<sup>49</sup>

### **Labour market and skilled workforce: investing in people**

The EU labour force is highly qualified but sufficient specialised battery-related skills are still lacking, especially on applied process design and cells manufacturing. Action at EU and Member State level is being taken to help to close this skills gap and make Europe an attractive location for world-class experts in batteries development and production.

In line with the European Pillar of Social Rights,<sup>50</sup> this requires collaborative efforts between education and training establishments, social partners and the battery value chain stakeholders to design and implement training, re-skilling and upskilling programmes.<sup>51</sup>

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<sup>46</sup> Bobba S., et al., Sustainability Assessment of Second Life Application of Automotive Batteries (SASLAB): Final technical report, 2018, JRC112543.

<sup>47</sup> 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 (OJ L 266, 26.9.2006, p. 1)

<sup>48</sup> SWD(2019) 1300 of 9 April 2019

<sup>49</sup> Product Environmental Footprint Category Rules (PEFCR) for rechargeable batteries, available at: [http://ec.europa.eu/environment/eussd/smgp/pdf/PEFCR\\_Batteries.pdf](http://ec.europa.eu/environment/eussd/smgp/pdf/PEFCR_Batteries.pdf)

<sup>50</sup> [https://ec.europa.eu/commission/sites/beta-political/files/social-summit-european-pillar-social-rights-booklet\\_en.pdf](https://ec.europa.eu/commission/sites/beta-political/files/social-summit-european-pillar-social-rights-booklet_en.pdf)

<sup>51</sup> EIT InnoEnergy has made a mapping of the needs for each segment of the value chain, organised a workshop in December 2018, “building a battery workforce”, and is developing a full range of training offers dedicated to batteries and energy storage.

Therefore, the Commission has included batteries as a key topic for funding as part of the Blueprint for Sectoral Cooperation on Skills under Erasmus+ and the four-year project should start by the end of 2019.<sup>52</sup>

In parallel, EIT InnoEnergy is working with a network of competent actors (academia, training centres, etc.) to develop robust Master-level energy transition-related curricula and degrees, together with executive training for companies' staff.

To enhance the availability of training and research facilities, the Commission's Strategic Action Plan on Batteries encouraged research centres to offer access to their battery laboratories. To this end, the Commission's Joint Research Centre has already opened access to the EU's battery testing laboratories.

### **A strategic approach to securing sustainable access to battery raw materials**

Securing access to battery raw materials is essential to meet the EU's ambition to become competitive in the global battery sector. Recent estimates indicate that in 2030, just to sustain the future uptake of electro-mobility, EU demand for lithium, cobalt and natural graphite for hybrid and electric vehicles could be very significantly higher than that in 2015.<sup>53</sup> To reduce the EU's dependence on imports of batteries raw materials, access to primary and secondary EU domestic sources must be facilitated, and a secure and sustainable supply from resource rich countries outside the EU must be ensured. In line with the EU's commitments under the World Trade Organisation (WTO), measures are necessary so that such outside sourcing is carried out in a fair, sustainable, and ethical way, and is contributing positively to various Sustainable Development Goals.<sup>54</sup> In this context, the use of sustainably produced raw materials is critical for the environmental footprint of the battery and of the entire electric vehicle.

In terms of trade policy, at bilateral level, in addition to having raw materials-related provisions in Free Trade Agreements (FTA) with partners such as Canada and Mexico, the EU has proposed provisions on sustainable sourcing of raw materials in ongoing FTA negotiations with important battery material partners such as Chile and Australia. The Commission is also negotiating the removal of export duties and quantitative restrictions on raw materials in bilateral negotiations with Indonesia. At multilateral level in the WTO, the EU has already successfully challenged export restrictions put in place by China.<sup>55</sup>

The Commission is moreover examining all tariff suspension requests on a case-by-case basis to make sure that, in compliance with the Union policies, they are granted temporarily where

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<sup>52</sup> [https://ec.europa.eu/programmes/erasmus-plus/resources/documents/erasmus-programme-guide-2019\\_en](https://ec.europa.eu/programmes/erasmus-plus/resources/documents/erasmus-programme-guide-2019_en)

<sup>53</sup> Source: D. T. Blagoeva, et. al; Assessment of potential bottlenecks along the materials supply chain for the future deployment of low-carbon energy and transport technologies in the EU. Wind power, photovoltaic and electric vehicles technologies, time frame: 2015-2030; EUR 28192 EN; Publications Office of the European Union, Luxembourg, 2016.

<sup>54</sup> See Mancini, L. et al., Mapping the role of Raw Materials in Sustainable Development Goals, EUR 29595 EN, Publications Office of the European Union, Luxembourg, 2019

<sup>55</sup> [http://europa.eu/rapid/press-release\\_IP-16-2581\\_en.htm](http://europa.eu/rapid/press-release_IP-16-2581_en.htm)

it is clearly demonstrated that there are sound economic reasons for doing so, also in view of ongoing industrial projects to fill existing gaps in the EU value chain.

On the domestic front, the Commission has launched a dialogue with EU Member States to map the availability in Europe of raw materials for batteries, including cobalt, lithium, natural graphite and nickel. The outcome shows that despite having geological potential in Europe, extraction of battery raw materials is limited and concentrated in a few European countries. Greater use of this potential would reduce the risk to security of supply of raw materials for batteries.<sup>56</sup> Furthermore, while processing capacity exists in Europe for cobalt and nickel, there is none for battery-grade lithium compounds or natural graphite. That would mean that even if lithium and natural graphite extraction can be increased in Europe, all materials - at least in the short term - would have to be shipped to countries outside Europe for processing into battery-grade materials. The Commission is working with the European Investment Bank (EIB), key industrial actors and Member States to address this gap in the value chain.<sup>57</sup>

Sustainable mining is a prerequisite for clean battery value chains. The Commission will facilitate work to develop a common set of principles for a socially and environmentally sustainable mining sector in Europe and will encourage Member States to integrate these into their raw materials strategies. The Commission will also explore options for including existing sustainable mining benchmarks in the Sustainable Finance taxonomy to guide investors towards mining projects, which comply with high sustainability standards.

Given the high import reliance in this sector, downstream industry plays a major role in creating the necessary market expectations for clean battery raw materials, for example through responsible sourcing. The Commission will help to develop a sustainability code of governance for European Battery Manufacturers that commit to comply with recognised international responsible business conduct and sustainability standards such as the OECD Guidelines for Multinational Enterprises and the OECD Due Diligence Guidance for Responsible Mineral Supply Chains. It will explore developing a model contract clause for suppliers in clean battery value chains to promote similar commitments along the battery value chain. The Commission will also look at options for including sustainable sourcing elements with regard to battery minerals in the Non-Financial Reporting Directive and make available the Commission's SME Support System on Conflict Minerals Due Diligence also to companies in the battery supply chain using other metals and minerals.<sup>58</sup> A Horizon 2020 call in relation to "responsible sourcing of raw materials in global value chains" will provide expertise on how to strengthen existing industry schemes, ensure data transparency for clean battery value chains and monitor progress. The Commission will continue to work closely with the OECD in this area.

### **Deepening the Circular Economy: securing access to battery secondary materials**

Recycling used batteries can significantly aid in securing access to raw materials for batteries. Thus, for instance, the contribution from recycling of electric vehicle batteries to meeting the

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<sup>56</sup> It is projected that in 2025, provided a favourable regulatory and enabling framework is in place, and assuming that all ongoing EU projects are in place, EU lithium production could cover up to 30 per cent of the world total.

<sup>57</sup> With the support of the EIT Raw Materials

<sup>58</sup> [https://ec.europa.eu/growth/content/support-smes-mineral-supply-chain-due-diligence-implementation-phase\\_en](https://ec.europa.eu/growth/content/support-smes-mineral-supply-chain-due-diligence-implementation-phase_en)

needs of cobalt within the EU could reach around 10 per cent in 2030, superior to the contribution from the EU mining sector, if an appropriate regulatory framework is in place.<sup>59</sup>

Europe has the potential to create a world-leading industry for the safe and environmentally responsible handling of end-of-life batteries. As markets rapidly expand for key types of batteries such as lithium-ion used in electric vehicles (for which recycling is currently almost non-existent), correspondingly large volumes of end-of-life batteries will be generated downstream in Europe and worldwide, prompting the need to manage these waste streams properly and recover valuable materials. The Commission has been assessing the opportunities to develop a circular economy in Europe for these batteries.<sup>60</sup> The Batteries Directive, for example, establishes targets for collecting waste portable batteries and defines minimum levels of efficiency for the recycling of waste batteries, in order to attain a high level of material recovery. The Commission has evaluated whether the Batteries Directive is delivering on its objectives and whether it appropriately covers new batteries technologies and chemistries (e.g. lithium-ion batteries), new uses of batteries, and the second life of batteries.<sup>61</sup> The Commission also assessed the coherence between Directive's provisions and EU policies on the circular economy and raw materials. This exercise has included the assessment of the Directive's contribution to the rational use of resources and to the implementation of low-carbon policies. If appropriate, the Commission will make proposals to revise the Directive.

Re-use of batteries in stationary applications can reduce environmental impacts over the life-cycle.<sup>62</sup> The Commission has, for example, signed an Innovation Deal on batteries to investigate whether current legislation at the EU or Member State level allows the re-use of batteries.<sup>63</sup> In addition, the Commission continually monitors the coherence of other regulatory instruments (e.g. REACH and CLP (classification, labelling and packaging of substances and mixtures) Regulations) relevant for raw materials from recycled batteries.

### **Regulatory and enabling measures driving demand for batteries for storage and e-mobility**

The 2019 State of the Energy Union report shows the progress made on a broad range of regulatory and enabling measures to bring about a transition to a low-carbon, secure and competitive EU economy.<sup>64</sup> These include initiatives adopted as part of the Low-Emission Mobility Strategy and the Clean Energy for all Europeans package that are relevant to batteries for both energy storage and clean mobility.

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<sup>59</sup> Alves Dias P., et., al., Cobalt: demand - supply balances in the transition to electric mobility, EUR 29381 EN, Publications Office of the European Union, Luxembourg, 2018.

<sup>60</sup> cf. JRC report on the Circular Economy perspectives for the management of batteries used in electric vehicles.

<sup>61</sup> SWD(2019) 1300 of 9 April 2019

<sup>62</sup> Bobba S., et al., Sustainability Assessment of Second Life Application of Automotive Batteries (SASLAB): Final JRC technical report, 2018, JRC112543.

<sup>63</sup> [https://ec.europa.eu/info/research-and-innovation/law-and-regulations/innovation-friendly-legislation/identifying-barriers\\_en](https://ec.europa.eu/info/research-and-innovation/law-and-regulations/innovation-friendly-legislation/identifying-barriers_en)

<sup>64</sup> COM(2019) 175 final of 9 April 2019

The revised Renewable Energy Directive will bring to 32 per cent the share of renewables by 2030 with a possible upwards revision in 2023.<sup>65</sup> This is likely to boost demand for batteries as batteries can further contribute to a better use of variable renewable energy sources like wind and solar power, e.g. in the context of large-scale production and self-consumption related to small-scale facilities, such as solar panels on roof tops. Both stationary and mobile batteries will supplement flexibility coming from improved interconnections, demand response and other energy storage technologies.

The EU's CO<sub>2</sub> emissions performance standards for the post-2020 period will push the industry towards developing more zero- and low-emission vehicles, including hybrid or full electric vehicles. Demand for electric vehicles will be further supported as EU Member States, regions and cities increase their clean transport services to citizens by promoting clean vehicles, such as electric buses, in public procurement tenders. At the same time, the new renewable energy legislation stemming from the Clean Energy for All Europeans package will ensure progressive decarbonisation of the electricity mix. This is a key pre-condition for decarbonisation of the transport sector, especially road transport.

Demand for low- and zero-emission vehicles and the roll-out of infrastructure go hand-in-hand. An accelerated market uptake of low- and zero-emission vehicles, including electric vehicles, depends on the availability of an easy-to-use, comprehensive and interoperable recharging infrastructure. Directive 2014/94/EU on the deployment of alternative fuels infrastructure already provides a common framework of measures.<sup>66</sup> The Commission will publish its assessment of the performance of this Directive by the end of 2020, with a view to revising it if necessary. It will assess to what extent the current planning for roll-out of alternative fuels infrastructure as stipulated in National Policy Frameworks under that Directive is in line with the expected acceleration of low- and zero-emission vehicle uptake in the period post-2020. It will also assess to what extent infrastructure deployment meets interoperability needs, for example in payment systems, and to what extent services for using the infrastructure are consumer-friendly.

The Commission has also adopted additional measures to accelerate the roll-out of alternative fuels infrastructure. As part of the Second Mobility Package in 2017, the Commission adopted an Action Plan, which included an additional EUR 800 million for financing alternative fuels infrastructure on the main Trans-European Transport Network and nodes under the Connecting Europe Facility (CEF).<sup>67</sup> The Commission has granted EUR 317 million to 31 actions in the area of innovation and alternative fuels infrastructure, mobilising up to EUR 2 billion in total investment. Beyond 2021, support for clean energy and transport infrastructure will continue from the CEF and the new InvestEU Fund. In addition, the recently amended Energy Performance in Buildings Directive includes provisions to require

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<sup>65</sup> Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (OJ L 328, 21.12.2018, p. 82–209)

<sup>66</sup> Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure (OJ L 307, 28.10.2014, p. 1–20)

<sup>67</sup> COM(2017) 652 finL of 8 November 2017: Towards the broadest use of alternative fuels - an Action Plan on Alternative Fuels Infrastructure under Article 10(6) of Directive 2014/94/EU, including the assessment of national policy frameworks under Article 10(2) of Directive 2014/94/EU

the development of the infrastructure necessary for the smart charging of electric vehicles and, eventually, for vehicle-to-building or vehicle-to-grid services.<sup>68</sup>

By providing services to the grid, batteries in electric vehicles can not only help to integrate renewables into the electricity system, but also help reduce the operational cost of the vehicle for consumers. In that respect, major progress towards facilitating the clean energy transition was achieved in December 2018 when the co-legislators agreed a new Electricity Regulation and Electricity Directive establishing new rules for making the EU's electricity market work better. These provisions should enable new market players, including energy storage operators, to provide the system flexibility required and benefit from new business opportunities, particularly in the renewable energy sector. However, aspects such as interoperability and access to vehicle battery data may require additional attention at EU level.

### **III. CONCLUSIONS: THE WAY FORWARD**

The Commission's strategic approach to batteries is helping to ensure that progress is made simultaneously on a variety of interlinked issues in a coordinated way. This includes developments in relation to connected and automated vehicles, energy storage, the deployment of infrastructure, consumer-friendly interoperability, raw materials, trade and investment, as well as jobs and skills. This approach is also helping key actors at different levels – both public and private sector, at EU, national and regional level – to work better together to achieve these objectives. New collaborative platforms and partnerships for cooperation with industry and stakeholders, taking into account the role of cities and regions are proving essential to deliver on these objectives successfully.

Further challenges and opportunities, associated with the emergence of new business models and integration of the energy and mobility sectors lie ahead. EU Member States will now need to carry out significant work to implement the Clean Energy For All Europeans package and, in particular, the electricity market design legislation, which will allow new market players, including storage operators, to benefit from new business opportunities, and which will give consumers an important role in producing and storing renewable energy themselves.

The Commission's approach to batteries is also a test case for the EU's twenty-first century industrial strategy. In March 2019, the European Council invited the Commission to present, by the end of 2019, a long-term vision for the EU's industrial future, with concrete measures to implement it. To remain globally competitive in key technologies and strategic value chains, the EU needs to encourage more risk-taking and step up investment in research and innovation, as well as facilitate the implementation of Important Projects of Common European Interest, while ensuring a level playing field, as well as a regulatory environment and State-aid framework that are conducive to innovation. The batteries and energy storage sector present a good example of how to combine the ambition of strong environmental and climate-friendly standards with increased competitiveness across sectors and value chains, as well as the creation of sustainable jobs and growth. It can offer a new deal for consumers, ensuring that mobility in the future is cleaner and affordable for all, and show that climate

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<sup>68</sup> Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency (OJ L 156, 19.6.2018, p. 75–91)



action and the modernisation of the economy towards circularity are two sides of the same coin.

Finally, it showcases a novel way of working together across different levels of decision-making (including EU, national, regional, and cities), and with a diversity of industrial actors and private investors throughout the value chains, with one overriding objective: to ensure Europe remains a global frontrunner rather than a follower in this strategic sector, thus providing long-term quality jobs and services to European citizens.