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SET Plan Secretariat

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SET-Plan ACTION n°7 –Declaration of Intent "Become competitive in the global battery sector to drive e-mobility forward"

Purpose of this document

This document[1] is intended to record the agreement reached between representatives of the European Commission services, representatives of the EU Member States, Iceland, Norway, Turkey and Switzerland, and representatives from the SET-Plan stakeholders most directly involved in industry, on the implementation of the actions contained in the SET-Plan Communication[2], and specifically the strategic Research & Innovation (R&I) targets for the priority "Become competitive in the global battery sector to drive e-mobility forward".

This agreement follows consultations with stakeholders listed in Annex A as well as a public consultation via the SETIS website[3] on an Issues Paper prepared by the Commission[4]. It takes into consideration the corresponding input papers and public comments available on the SETIS website and discussions in the SET-Plan Steering Group on 15 June 2016 with the participation of the relevant SET-Plan stakeholders.

The stakeholders agree to the ambitious targets contained in this Declaration of Intent in an endeavour to maintain global leadership in the sector, to put forward their best efforts in a coordinated way between public and private sectors, and to jointly address all relevant issues in order to attain the agreed targets.

1 This document has no legally binding character, and does not prejudge the process or final form of any future decisions by the European Commission.

2 Towards an Integrated Strategic Energy Technology (SET) Plan: Accelerating the European Energy System Transformation" (C(2015)6317)

3 Strategic Energy Technology Information System website https://setis.ec.europa.eu/

4 https://setis.ec.europa.eu/system/files/action7_issues_paper.pdf

Introduction

The Energy Union strategy [1], adopted by the European Commission and endorsed by the Council, is built on the ambition to achieve a fundamental cost-effective transformation of Europe's energy system. This will be achieved by moving to more flexible, more decentralized, more integrated and therefore smarter, more sustainable, secure and competitive ways of delivering energy to consumers. One of the core priorities of the Energy Union strategy is to speed up energy efficiency and decarbonisation of transport through Research and Innovation (R&I) in e-mobility. The strategy will put the EU at the forefront of the next generation of clean transport technologies and energy storage solutions with the aim of turning these into a motor for growth, jobs and competitiveness. Within the fifth dimension of the Energy Union strategy dealing with Research, Innovation and Competitiveness, the integrated SET-Plan will steer European energy R&I designed to accelerate the energy system transformation.

E-mobility facilitates the reduction of greenhouse gas (GHG) emissions through the electrification and consequent decarbonisation of transport. Road transport accounts for some 80% of all GHG emissions related to transport [2] and so electrification in this sector has massive potential for decarbonisation. At the same time e-mobility provides an opportunity for enhancing EU industrial competitiveness, a major enabler of future economic growth and job creation, in addition to providing benefits in terms of energy security, health and environmental protection [3].

Traction batteries are considered a Key Enabling Technology in electric vehicle (EV) drive trains [4]. Current traction batteries are to a large extent based on lithium-ion (Li-ion) chemistry, however in the future other lithium (Li) and non-Li based chemistries are expected to gain ground. In recent years the development of hybrid electric vehicle (HEV) batteries has yielded a relatively mature generation of vehicles (nearly 2 million HEVs had been sold worldwide cumulatively up to 2014 [5]). More recently the focus of battery development has shifted towards higher energy systems specifically suited for Plug-In Hybrid Vehicles (PHEV) and Battery Electric Vehicles (BEV). Since BEVs are more demanding in terms of energy density and power requirements, development of batteries for BEVs drives R&I in the field. Development of hybridization of several storage technologies may also contribute to meet these performance requirements. Different vehicle categories will benefit from these developments, mainly passenger and light duty vehicles, but also 2-3 wheelers, quadricycles, short range heavy duty vehicles (buses and trucks), and fuel cell electric vehicles (FCEV).

As important as they are, evolutionary and/or disruptive technology improvements achieved through R&I are not sufficient to drive EU competitiveness in the battery sector, which is explicitly targeted in this Key Action. Competitiveness in this sector also hinges on having a stable and secure battery manufacturing base. The EU has a leading position in the lead-acid battery industry with well-developed battery producing capacities. Furthermore the EU maintains a strong position in lithium-ion cells and other chemistries (sodium nickel chloride, i.e. "Zebra") for niche applications (e.g. aviation/space/military) and this could be beneficial for the e-mobility sector. However unlike in Asia, a significant European automotive cell manufacturing capacity does not exist for mainstream traction battery cells, especially Li-ion and NiMH. This despite the EU's strong car manufacturing industry which is expected to maintain its strong position also in EV production, although arguably their actions to date have not been aggressive enough compared with some newcomers who have less legacy investments to protect. To reverse foreign dominance of the battery cell manufacturing industry an opportunity exists for Europe to "break into" this by exploiting European R&I competences in disruptive battery technologies and to extrapolate these competences to the development of a corresponding battery cell manufacturing base. Where possible, synergies with existing EU battery business should be exploited for upscaling manufacturing processes to mass production.

The lack of an EU automotive battery cell manufacturing base leads to a dependence on battery cells imported from Asia, forcing EU's car manufacturing industry to purchase 'off the shelf' cells. This endangers OEM's competitive advantage because of security of supply chain issues, increased costs due to transportation, loss of part of the value, time delays, relinquished control on quality and limitations on design options. It also raises concerns related to the potential loss of Europe's knowledge base [4, 6, 7]. Initiatives have been triggered to address this situation. As an example, at least one Member State has recently started discussions to set up a national or even European cell production capacity. This can be seen in the context of a prospective alliance between certain OEMs to manufacture next-generation batteries. Another approach is to stimulate foreign investment by way of establishing foreign manufacturing plants in the EU – as Japanese and Korean companies already did. The US also followed this approach. Still, establishing a European battery cell manufacturing base is not a panacea since dependencies related to the supply of raw materials will remain [8-11].

Manufacturing capacities should however be considered over the whole battery value chain – from powder to power - including advanced materials development and production technologies, cell manufacturing, pack assembly and system integration for current lithium-ion technologies and also for emerging and future technologies. Although EU industry has a good knowledge and has some production base in all segments of the battery value chain, it is far from being self-sufficient (and hence is relying on imports) particularly for basic materials and battery cells. EU industry is however active in the production and supply of some basic materials, in cell integration and packaging, in battery control, power electronics, in battery plant manufacturing, cell integration and pack assembly, battery recycling, and system integration. In addition the EU has globally recognised academic and research institutions in the field with good links with OEMs and battery manufacturers.

To ensure EU competitiveness in the global battery sector in a strategic and cost-effective manner a holistic approach covering different aspects is needed:

- Potential uses for batteries beyond e-mobility applications need to be exploited. Examples include the use of static batteries for EV fast charging stations and battery energy storage systems in households (either standalone battery systems or EV batteries in vehicle-to-home configurations) or as utility scale grid connected assets, relevant to Key Actions 3 and 4 of the SET Plan [1], respectively. The automotive sector is leading Li batteries development and as result Li batteries have shown a significant cost reduction during last years. Li batteries for grid connected stationary applications have different requirements; however they can highly benefit from the automotive sector achievements. Exploitation of R&I synergies between these applications would facilitate the achievement of increased battery systems performance and safety while decreasing production costs and avoiding duplication of efforts. The Levelized Cost of Electricity (LCOE) of the services provided by stationary batteries to the power system will decrease thanks to the progress in the EV sector. There is also a need to establish a manufacturing chain for these different applications, which could lead to a much needed critical mass in the size of the first-use Li-ion battery market. It also opens a potentially interesting "second life" market for automotive batteries.
- Widespread deployment of any innovative, disruptive technology requires significant transformations of the product value chain, development cycles and associated technologies and services. Acknowledging this, the SET Plan [12] underpins the importance of promoting new investments at all stages of the innovation chain. For battery technologies and systems, such investments are to be done in a coordinated way to leverage European public and private investments, thereby covering the expected high cost of R&I and the upscaling of manufacturing processes to mass production scale for Li- and future non-Li based batteries, primarily for automotive but also for selected energy storage applications.
- It is important to take into account barriers such as different Member States' approaches on industrial policy, lack of fit-for-purpose standards, chronic difficulties for incubation (e.g.

access to finance), the lack of skilled and educated workforce, and specifically uncoordinated and incompatible regulatory and legal frameworks. Concerning the latter, adoption of global regulatory safety requirements for e-vehicles under development by UNECE will guarantee more regulatory stability and thereby facilitate economies of scale.

- The business case for batteries – particularly batteries for e-mobility – needs to be supported. This can be achieved through policy-pull measures, as for instance with Directive 2014/94/EU which requires the deployment of a certain level of charging infrastructure in Member States. In fact, sales of e-vehicles are picking up in some countries such as the Netherlands and Norway which could effectively act as pioneers and lead the way to a quicker rate of e-vehicle uptake in other countries. This of course will be crucial to ensure the profitability of EU battery manufacturing capabilities once they are created or expanded. While market uptake aspects fall outside the scope of the SET Plan, they will be addressed by the Strategic Transport Research and Innovation Agenda (STRIA) – which, along with the SET Plan, will feed the Energy Union Integrated Strategy on Research, Innovation and Competitiveness (EURICS).
- It is also critical to reinforce existing and build new strategic alliances between public and private stakeholders to promote energy storage in the transport, power, gas and residential sectors and to implement the targets and priorities proposed in this Declaration of Intent. This may include initiatives to establish new business and market models and exchange knowledge to avoid duplication of efforts. Stakeholders include battery manufacturers, core materials suppliers, automakers, power electronics, battery management system (BMS) specialists, distribution systems operators (DSOs) and the general supplier industries, as well as factory builders, public authorities and research and standardization bodies. Establishment of a platform for full-scale Li-ion manufacturing capabilities should be driven by industry (materials & cell manufacturing companies in close cooperation with OEMs,TIER1s) and backed by RTD performers with national/EU support.

Agreed targets

As an overarching objective, R&I related to Key Action 7 of the SET Plan will aim at developing and demonstrating technologies, manufacturing processes, science-based standards and regulations, to increase performance and safety and reduce overall cost of battery systems used for storage purposes in the automotive and other sectors. The R&I effort will cover materials, cells, packs and systems with a focus on high energy and resource efficiency, modularity and re-configurability, while also taking into account second life and recycling (the later as regulated by Directive 2006/66/EC). In terms of chemistries, the core focus is on Li-ion batteries. Nevertheless post Li-ion technologies should also be considered for strong support, covering e.g. basic technology, materials, manufacturability, LCA, second life and recyclability).

Targets outlined in this Declaration of Intent have been agreed by all stakeholders starting from a set of values taken from a number of sources [5, 13-33]. They should steer R&I actions and guide coordination of EU and Member States funding in areas of materials research, nanotechnology, electrochemistry, manufacturing processes and manufacturing technologies. Achievement of the targets will require coordination of R&I activities, with responsibilities and efforts shared between different stakeholders during the implementation phase.

Targets are not relevant to batteries for portable/electronic equipment which falls outside the scope of this Action. Targets are differentiated into performance, cost and manufacturing targets. Considering the expected dominance of Li-ion chemistry in the coming decades for electrochemical energy storage, barring unexpected but possible breakthroughs, the performance and cost targets defined are application-specific and based on technology improvements deemed achievable for Li-ion batteries up to 2030. Targets may be exceeded through developments in other advanced technologies.

a) Performance targets

Successful deployment of batteries for automotive applications requires meeting a number of performance criteria. It is acknowledged that it may be difficult to achieve some targets concurrently, e.g. gravimetric versus volumetric energy density, gravimetric energy density versus fast charge time or energy versus power demand at cell level). Furthermore, some performance parameters are affected by use conditions (e.g. battery cycle life may strongly be strongly affected by the frequency of fast recharge). Such interdependencies need to be considered.

Table a

		Current (2014/ 2015)	2020	*2030
Performance targets for automotive applications unless otherwise indicated				
1	Gravimetric energy density [Wh/kg]			
	pack level	85-135	235	> 250
	cell level	90-235	350	> 400
2	Volumetric energy density [Wh/l]			
	pack level	95-220	500	> 500
	cell level	200-630	750	> 750
3	Gravimetric power density [W/kg]			
	pack level	330-400	470	> 470
	cell level		700	> 700
4	Volumetric power density [W/l]			
	pack level	350-550	1.000	> 1.000
	**cell level		1.500	> 1.500
5	Fast recharge time [min] (70-80% ΔSOC)	30	22	12
6	Battery life time (at normal ambient temperature)			
	Cycle life for BEV*** to 80% DOD [cycles]		1.000	2000
	Cycle life for Stationary to 80% DOD [cycles]	1000-3000	3000-5000	10000
	Calendar life [years]	8-10	15	20

*: Post-Lithium ion technologies are assumed relevant in this time frame
**: May also be relevant to stationary applications
*** Cycle life for PHEV must be bigger

b) Cost targets

The medium term target date for cost targets is set to 2022 (as opposed to 2020) to allow more time for these targets to be met.

Table b

TARGETS		Current (2014/ 2015)	2022	2030
Cost target				
1	Battery pack cost for automotive applications [€/kWh]	180-285	90	75
2	Cost for stationary applications requiring deep discharge cycle [€/kWh/cycle]		0,1	0,05

c) Manufacturing targets

Table c

TARGETS		Current (2014/ 2015)	2020	2030
Manufacturing targets				
1	Automotive (Li-ion and next generation post-lithium) battery cell production in EU [GWh/year][1] (% supporting EU PHEV+BEV production)	0,15 – 0,20	5 (50% of the 0.5 M EVs with 20 kWh)	50 (50% of the 2 M EVs with 50 kWh)
2	*Utility Storage (Li-ion and next generation post-lithium) battery cell production in EU [GWh/year]	0,07 – 0,10	2.2	10
3	Recycling			
	**Battery collection/take back rate	45% (Sept 2016)	70%	85%
	Recycling efficiency (by average weight)	50%	50%	50%
	Economy of recycling	Not economically viable	Break even	Economically viable
4	Second Life	Not developed	Developed	Fully established

* The energy storage capacity in GWh depends strongly on the implementation rate of intermittent renewable electricity sources and market models behind those.

** These targets are based on numbers defined in Directive 2006/66/EC. This Directive is being revised and targets should be consistent with the revised Directive.

For stationary energy storage the SET-Plan R&I will aim at developing and demonstrating technology, manufacturing processes, standards and systems, which have the potential of driving high-efficiency (>90%) battery based energy storage system cost **below €150/kWh** (for a 100kW reference system) and a lifetime of thousands of cycles by 2030 to enable them to play an important role in smart grids. This will require development of a variety of battery chemistries and supercapacitors to cope with varying operation modes. For stationary storage systems the cost of electrochemical modules (in €/kWh), the cost of the inverters / power electronics (in €/kW), and the cost of installation/integration (in €) need to be considered. Efforts should cover materials, cells, modules but with a focus on battery systems targeting modularity and re-configurability and considering as well second life and recycling aspects.

In addition to the targets above, there are other requirements for which it is more difficult to set SMART targets. Such requirements include enhanced safety through risk mitigation as well as increased efficiency, reduction in the use of critical materials, reduced environmental impact and implementation of Eco-design (energy savings and solvent reduction) for advanced battery materials/components manufacturing processes. Furthermore, interoperability, system integration

[1] Two assumptions were made when defining this target value, based on projected global sales for PHEV+BEV in 2020 and 2030 of 2.5M and 10 M vehicles respectively: (a) the percentage for EU OEMs production of PHEV+BEVs is assumed to be maintained at the current level of 20% for both 2020 (with an average energy capacity of 20 kWh) and 2030 (with an average energy capacity of 50 kWh); (b) EU battery manufacturers will supply half of the cells needed for the PHEVs+BEVs produced by EU OEMs.

at pack level, standardization, regulations, workforce and education – as outlined e.g. in [23, 25, 28, 30, 34] - are important.

Next steps

The stakeholders agree to develop within 6 months a detailed implementation plan for the delivery of these targets, determine joint and/or coordinated actions, identify the ways in which the EU and national research and innovation programs could most usefully contribute, identify the contributions of the private sector, research organizations, and universities, identify all issues of a technological, socio-economic, regulatory or other nature that may be of relevance in achieving the targets, and report regularly on the progress with the purpose to monitor the realisation of the targets and take rectifying action where and whenever necessary.

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ANNEX A:List of stakeholders who have provided Input Papers

EASE - European Association for Storage of Energy
EERA – European Energy Research Alliance
EGVIA - European Green Vehicles Initiative Association
EMIRI – Energy Materials Industrial Research Initiative
ETP Grids - Smart Grids European Technology Platform
EUA-EPUE - European Platform of Universities in Energy Research & Education
EURELECTRIC – Union of the Electricity Industry
EUROBAT - Association of European Automotive and Industrial Battery Manufacturers