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European Commission

Future and Emerging Technologies

Workshop on Future Battery Technologies for Energy Storage

Towards a large scale EU R&D initiative in future battery technologies

Final Report

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Table of Contents

Executive summary

Battery technologies are set to play an important role in Europe's Energy Union Framework Strategy. Batteries are one of the 10 key actions identified in the Integrated SET-Plan, which sets the objective for Europe to "Become competitive in the global battery sector to drive e- mobility and energy storage forward".

On 10th January 2018, the European Commission gathered the relevant research stakeholders to identify the long-term (+10 years) scientific and technological challenges that could be addressed by a large-scale R&I initiative under the Future and Emerging Technologies programme. The focus of the workshop was on future and emerging energy storage technologies for e-mobility and stationary applications. The participants, from academia and industry, were asked to answer the following three main questions:

- What would be the grand Science and Technology challenge(s) in the area of future battery technologies?
- Why would addressing this grand S&T challenge(s) be good for Europe?
- How could Europe best address this grand S&T challenge(s)?

As a result of the discussions, it emerges that for e-mobility, the key challenge is to develop new battery technologies that can deliver high performance levels and achieve radical gains (in terms of energy density >400Wh/kg, power density, lifetime, energy efficiency, cost, fast charging and safety) and that incorporate smart functionalities from the cell to the battery system. In addition, the manufacturability and scalability of any new battery technology have to be addressed from the beginning of the development; this requires the availability of flexible pilot production facilities.

For stationary energy storage, the key challenge is to develop new technologies that achieve significant performance with regards to lifetime (cycling and calendar) and cost, with a targeted cost below 0.05 euro/kWh/cycle by 2030.

In both cases, future technologies should reduce the dependence on critical materials and should be produced along sustainable value chains from mining to recycling. Significant synergies between the two application sectors were also highlighted.

Addressing these challenges would significantly contribute to achieving many of Europe's energy, transport, industrial and environmental policy targets; e.g. by creating a sustainable and secured energy storage value chain in Europe while also providing a competitive advantage to our industry; by strengthening the EU position in the automotive e-mobility market; by tackling pressing environmental and societal issues such as air quality and climate change and by reducing Europe's dependence on critical raw materials.

The workshop confirmed that Europe has all the necessary capabilities and competences for positioning itself in this strategic sector. It also confirmed that a large-scale research initiative on next generation battery technologies could accelerate their emergence and their take-up by European industry. This long-term R&I actions should explore and mature the potential material chemistries that could provide by 2030 the needed radical improvement in terms of performances. It should adopt a multi-step approach whereby the TRL should be increased from breakthrough ideas to high TRL close to production over a 10 years period. It should focus on primarily on e-mobility while considering synergies with other sectors, like stationary applications.

Building on the promising outcome of this workshop, and other actions in the context of the European Battery Alliance, the EC called on all the research actors in Europe to work further together in order to deliver a commonly agreed long term research agenda for such an ambitious large-scale research initiative.

Introduction

Battery technologies are set to play an important role in Europe's Energy Union Framework Strategy. The Communication on an Integrated Strategic Energy Technologies Plan (SET-Plan) defines European R&I priorities for enabling the transition of Europe to a low-carbon, secure and competitive economy. Batteries are one of the 10 key actions identified in the Integrated SET-Plan, which sets the objective for Europe to "Become competitive in the global battery sector to drive e-mobility and energy storage forward".

A workshop on Future Battery Technologies for Energy Storage was organised by the European Commission's Communications Networks, Content and Technology Directorate General (DG-CONNECT) in Brussels on 10th January 2018. The aim of the workshop was to explore and identify the long-term (+10 years) emerging technologies in the field of energy storage (in particular batteries for e- mobility and stationary applications), that could be addressed by a large-scale EU R&I initiative under the Future and Emerging Technologies[1] (FET) programme.

Under Horizon 2020, FET invests in transformative frontier research with a high potential impact on technology, to benefit our economy and society. FET supports a combination of high risk, long term, multidisciplinary and collaborative frontier research, which lays the foundations for radically new, next generation technologies. It converts proof-of-concepts into industrial applications and systems. Within FET, FET-Flagships[2] are large-scale, multidisciplinary research initiatives built around a visionary unifying goal that can only be realised through a federated and sustained effort. They aim to convert scientific advances into concrete innovations with long-term impacts for European economy and society.

In this context, participants were asked to answer the following three questions in particular:

1. What would be the grand Science and Technology challenge(s) in the area of future battery technologies?
2. Why would addressing this grand S&T challenge(s) be good for Europe?
3. How could Europe best address this grand S&T challenge(s)?

The workshop was opened by Thomas Skordas, Director for Digital Excellence and Science Infrastructure, DG-CONNECT. He addressed the importance of energy storage for the European Union with a market potential of 250 billion EURO by 2025. In addition, he underlined that battery technology will play a key role towards a sustainable and green e-mobility in the EU where 12.6 million jobs are in the automotive sector. He then recalled that batteries are also very important for stationary energy storage, as they will enable a faster integration of a larger share of renewable energy sources in the energy sector.

[1] https://ec.europa.eu/digital-single-market/future-emerging-technologies-fet

[2] https://ec.europa.eu/digital-single-market/en/fet-flagships

European industry is well represented in the full value chain of energy storage. However, there is a lack of battery cell production capacity in the EU since over 90% of the production of lithium-ion cells is located in Japan, Korea and China. The need for new battery technologies with high performances, low environmental impact and radically new functionalities, is therefore a clear opportunity for Europe's industry to get back into competition with the Asian players.

Thomas Skordas recalled that in October 2017 a European Battery Alliance was launched, aiming at strengthening the entire battery value chain in Europe. This workshop contributes to the definition of the longer-term R&I activities of the Alliance taking into account the SET-Plan Key Action 7 (Action on Batteries) Implementation Plan[3] that has just been published and covers battery research priorities till 2030.

In this context, he stressed the importance of this workshop to explore and identify the long-term challenges for the next energy storage technologies that the EU could address in a large scale EU R&I initiative under the Future and Emerging Technologies (FET) programme primarily for e-mobility, but also possibly for other domains such as stationary applications or consumer electronics.

He finally mentioned the workshop organised by the Directorate General for Research and Innovation on 11-12 January that addresses the short and medium term R&I needs to be supported in the last years of H2020.

In the first half of the workshop, brief introductions were given by different stakeholders describing the industrial needs and the already existing or possible future promising technologies. A brainstorming activity was held during the second half of the workshop in order to address the three above-mentioned questions.

The agenda and list of participants are available in annexes. The presentations are available on the following Commission web page: https://ec.europa.eu/digital-single-market/en/news/workshop-future-battery-technologies-energy-storage.

Europe's needs for new energy storage technologies

Marc Steen, Joint Research Centre

Work in the framework of the Key Action 7 (Action on Batteries) of the Integrated SET-Plan and its recently endorsed Implementation Plan was presented and discussed in the context of a dynamic European policy landscape, where numerous policy actions relevant for batteries have taken place in the past 2 years. Special attention was given to research activities and flagship actions identified by the Temporary Working Group (TWG) of Action 7. This TWG was led by Member States and Industry and its members covered the whole battery value chain. The TWG produced an Implementation Plan with detailed technical fiches, which has been approved by the Commission and the SET-Plan Member Countries. Longer-term priorities of the SET-Plan inter alia aim at advancing beyond Li-ion technology for e-mobility and advancing promising technologies for stationary energy storage applications.

[3] https://setis.ec.europa.eu/sites/default/files/set_plan_batteries_implementation_plan.pdf

The Implementation Plan will serve as an input to the R&I dimension of the Battery Alliance.

Focus Area 1: Material/Chemistry:Design + Recycling
1.1 Advanced Lithium-Ion batteries for e-mobility
1.2 Influence of Fast/Hyper charging of Li-ion batteries on materials and battery degradation
1.3 Advancement of batteries for e-mobility
1.4 Beyond Li-ion/Li-based batteries for e-mobility
1.5 Develop circular economy and de-bottleneck availability of critical raw material
1.6 Lithium recovery from European geothermal brines and sustainable benefication processes for indigenous hard rock occurrences of lithium
Focus Area 2: Manufacturing
2.1 Foster development of materials processing techniques and components for fast industrializtion compatible with present mass prodcution lines
2.2 Foster development of cell and battery manufacturing equipment
Focus Area 2: Manufacturing
3.1 Hybridisation of battery systems for stationary energy storage (ESS)
3.2 Second use and smart integration into the grid
Considered the minimum necessary for achieving the targets agreed in 2016
Serve as input to the R&I dimension of the EU Battery Alliance

Figure 1. Focus areas identified the implementation Plan of Key Action 7 of the SET PLAN

Ulrich Mähr, Volkswagen

The presentation was focused on the strategy of VW, which is on how to approach the market by 2025. VW has the goal to achieve a market share of about 25% BEV by 2025. To realize this objective, there is a need for dedicated research, improvement of battery cell manufacturing know-how and an integrated approach is required from material to system level. VW invests in R&D in the following areas: fundamental understanding of materials, new materials (new chemistries), modelling, ageing, thermal management, production processes, and smart sensing technologies.

It was stated that beside a higher energy density battery cells, fast charging (15 min, 10-80% state of charge at 10 to 40°C) is a key element for their applications and customers.

With the current Li-ion technology the energy density can be further improved towards 300-350 Wh/kg with an electric range up to 500 km, through the increase of Ni content at the cathode and Si at the anode. In order to achieve 350-450 Wh/kg (electric range of 700 km), solid-state technology is one of the technologies that they are considering with a cycle life of 800.

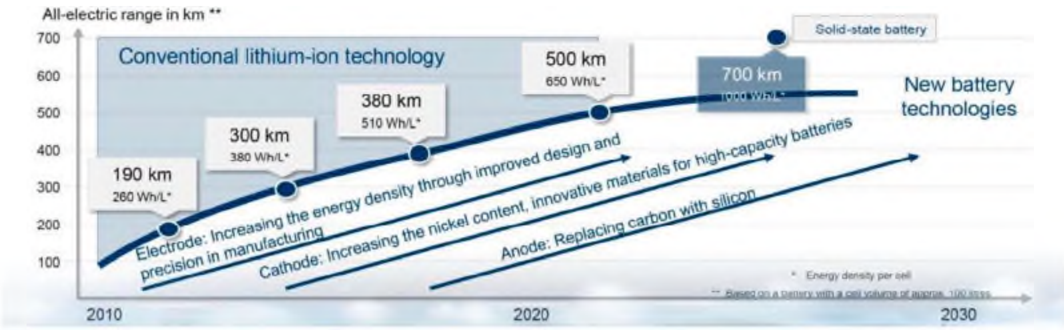


Figure 2. VW battery improvement strategy

Etienne Brière, EDF

EDF is involved over the entire value chain for battery energy storage. It is running several large scale projects in for instance the US, UK and France.

EDF's priorities for future battery technologies for stationary applications are: rechargeable Zn-air, Na-ion (organic and aqueous), solid-state and redox flow batteries. Challenges ahead are: matching performance with application, improved interoperability and recycling.

Other research areas of high interest include power electronics, algorithms, software standards, decreased CO_2 footprint of batteries; second life batteries.

Figure 3. Battery storage value chain

Francesco Gattiglio, EUROBAT

EUROBAT represents manufacturers of various types of batteries such as lead-acid, nickel, sodium and lithium. All members have a manufacturing base in Europe.

Regarding these technologies, Francesco Gattiglio gave a brief overview of current market and future potential over the next years. In addition, the different types of applications were discussed where the role of battery technologies are still important such as SLI (Starting, Lighting, Ignition) applications, motive power, stationary storage for renewables, grid stability, etc. The market potential of EV batteries is remarkable, but batteries for SLI applications still represent the largest share of the battery market, and stationary storage and electrification of industrial machineries also represent a substantial market. European companies are world leaders in these markets, and motive power and the (mild) hybridization of cars require R&I in technologies other than the energy-intensive graphite-based Li-ion cells and its lower-TRL successors. All these applications and different families of battery technology (lead, lithium, sodium, nickel) have a role to play in the decarbonisation of the EU economy and should be further developed.

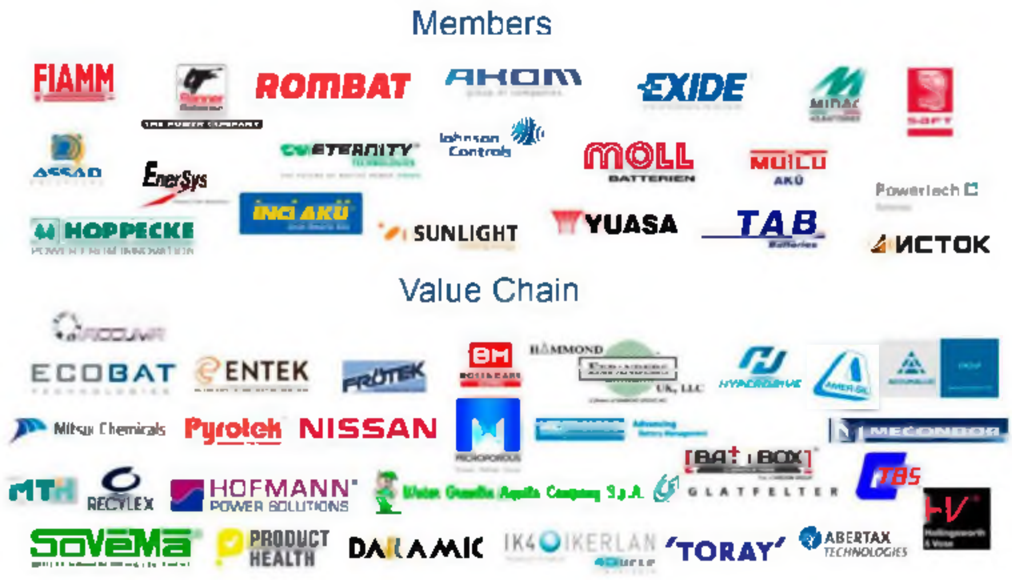


Figure 4. EUROBAT members

State of the art in EU research and R&D challenges

Christophe Aucher, LEITAT

In the presentation two dedicated EU projects were presented. The first one (ALISE) is dealing with lithium sulphur technology and another one ALION is about Aluminium ion technology. The energy density achieved at 12.5Ah cell level is 300 Wh/kg and 230 Wh/L, and maintaining 72% of the C/5 capacity at 2C for lithium sulphur technology. It was concluded that lifetime stability and power are key elements that should be considered further in the future research programmes.

Indicator	Units used	Project reference	Project objective	Current achievements
Gravimetric Energy	Wh/Kg	Material level (Swagelok)	400	120
		Pouch cell (single stack)		20
Volumetric Energy	Wh/L	Material level (Swagelok)	-	150
		Pouch cell (single stack)	-	45
Gravimetric Power	W/Kg	Material level (Swagelok)	-	43 000 (360C)
		Pouch cell (single stack)	-	6 (C/3)
Cycles	-	Material level (Swagelok)	3000	3000
		Pouch cell (single stack)		60

Figure 5. Characteristics of the developed Aluminium ion battery

Silvia Bodoardo, Politecnico di Torino

The results of the FP7 project STABLE were briefly presented and discussed. The low cycle life is the major bottleneck of the Li-air technology due to contamination of the cathode porous material (due to the logging of Li_2O_2). In order to overcome this challenge, a new membrane concept was developed in the project in order to limit the water content through the process. Nevertheless, this technology is still suffering from limitations in power performance, which is needed for acceleration in traction applications.

Figure 6. Novel developed membrane

Loic Simonin, CEA

Naiades is a Horizon2020 project dealing with the replacement of Li-ion by Na-ion. Sodium is cheap and widely available in the world. This technology is more appropriate for stationary applications where cost is a key interest. In the project, two dedicated cathode materials have been investigated ($Na_3V_2(PO_4)_2F_3$ (120 mAh/g) and $Na_{2/3}Fe_{1/2}Mn_{1/2}O_2$ (180mAh/g)). The achieved energy density at cell level is 100 Wh/kg and 200 Wh/L.

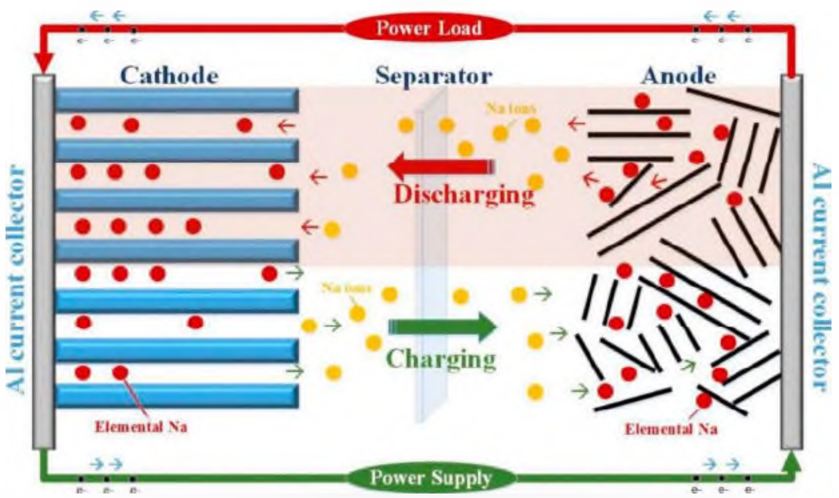
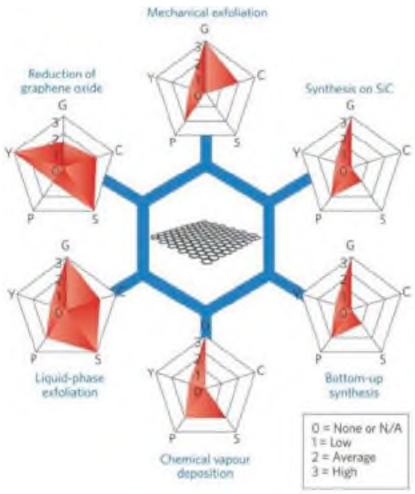


Figure 7. Architecture of the sodium ion battery technology

Vittorio Pelegrini, IIT

The activities on batteries within the Graphene FET flagship project were presented. The topics are:

- How to combine graphene and silicon at the anode? The scalability of graphene production based on liquid phase exfoliation has been further developed.
- New materials beyond graphene: MoO_3 with carbon nanotubes; black phosphorus exfoliated in acetone.
- Beyond Li-ion (Li-S and Li-air)



G Graphene quality
C cost aspect
S scalability
P purity
Y yield

Figure 8. Graphene characteristics

Bart Onsia, IMEC

IMEC is a R&D centre located in Belgium, well-known in the nano-electronic sector. IMEC researchers are working on solid-state batteries and in particular the solid-state electrolyte. Their aim is to achieve an ionic conductivity of 100 mS/cm at room temperature through a dedicated concept that they already developed.

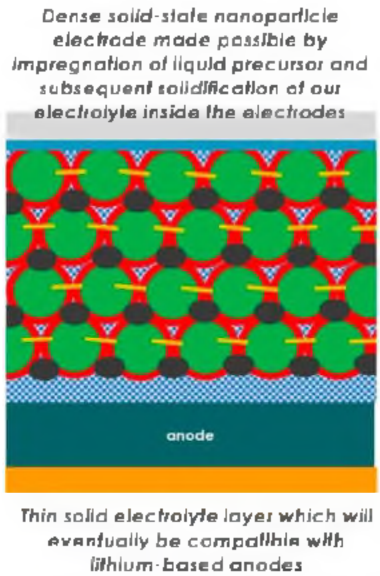


Figure 9. IMEC strategy towards solid state strategy

Adelio Mendes, Porto University

The solar redox flow technology was presented for domestic applications. Different concepts were discussed, some already on the market and some still in research phase.

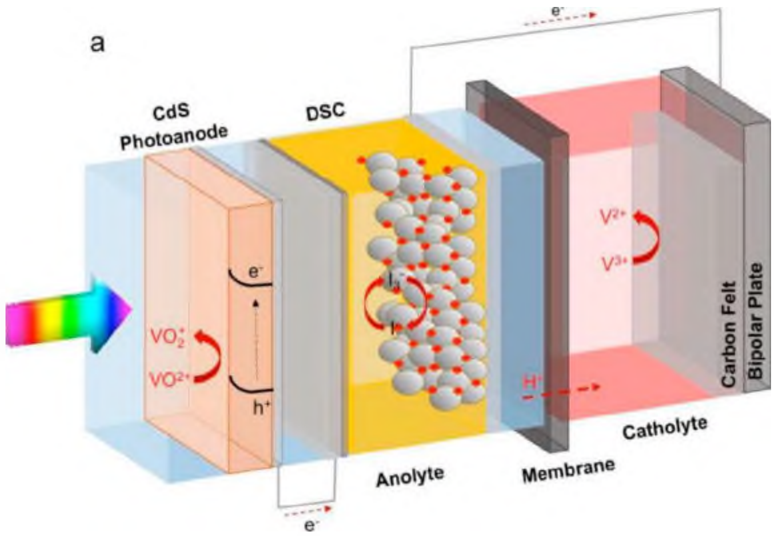


Figure 10. Solar redox flow concept

Anders Bentien, Aarhus University

Up to now battery R&D has been driven by mobile applications (consumer electronics and electric vehicles) that demand increased energy density and high charge/discharge rates. For stationary electricity storage cost and lifetime (> 15-20 years) are the primary drivers while energy density plays a smaller role. Here none of the existing battery technologies, including Li-ion, is likely to meet the breakthrough criteria of end-consumer cost of < 100 EUR kWh-1 and in particular levelised cost of electricity storage of < 5¢ kWh-1 cycle-1. Furthermore, there are many environmental challenges concerning recyclability and problematic elements/substances in the current battery technologies. Together this opens possibilities for research in new low-cost aqueous batteries chemistries and designs for stationary storage applications. Here two examples were given:

Redox flow batteries: Are easily recyclable because the redox active species are dissolved in water that is easily separated from the stack/flow cell. State-of-the-art is vanadium flow batteries that have extremely long lifetime and relatively low cost (also compared to Li-ion). The world's largest battery (800 MWh vanadium flow battery) for stationary storage is currently being built in China. The main concerns about vanadium flow batteries are cost and environmental issues, and this has sparked research in organic redox couples.

Aqueous based dry batteries: Looking at redox species that are environmentally benign, low-cost (e.g. < 15 EUR kAh-1) and within the electrochemical window of water only leaves Ti, Zn, Mn, Fe and organic redox species (e.g. Anthraquinones).

Nonetheless, within the past five years there has been around dozen of research and development publications that have demonstrated (long) cyclability of batteries based on these elements.

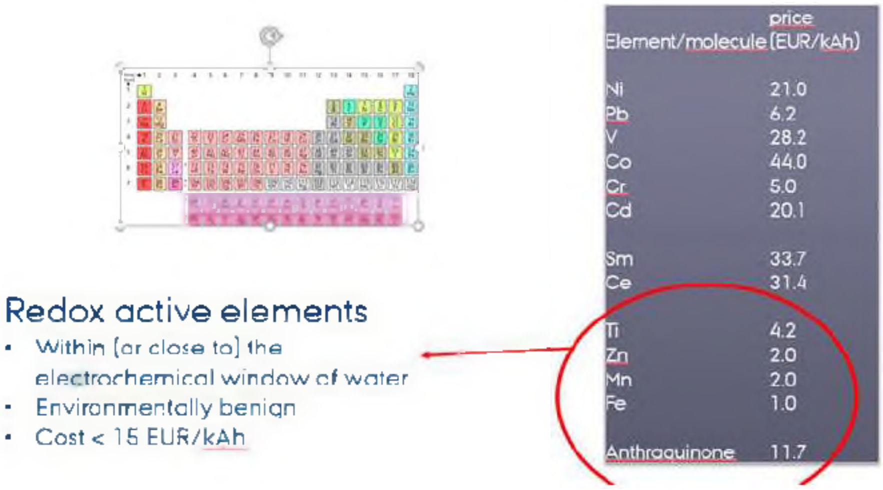


Figure 11. Low-cost, environmentally benign redox active elements within the electrochemical window of water

Opportunity for a large scale EU R&D initiative in future battery technologies

To recall, the aim was to explore and identify the long-term (+10 years) emerging technologies in the field of energy storage (in particular batteries for e- mobility and stationary applications), that could be addressed by a large-scale EU R&I initiative under the Future and Emerging Technologies (FET) programme. Participants were asked in particular to answer the following three questions:

1. What would be the grand Science and Technology challenge(s) in the area of future battery technologies?
2. Why would addressing this grand S&T challenge(s) be good for Europe?
3. How could Europe best address this grand S&T challenge(s)?

The overall group (>70 participants) was divided into four groups. Three of them were focused on e-mobility, which was moderated by Prof. Silvia Bodoardo from Politecnico di Torino, Prof. Noshin Omar from Vrije Universiteit Brussel, and Dr. Simon Perraud from CEA Liten. The 4th group, which was dealing with stationary applications, was moderated by Dr. Marcel Meeus from EMIRI. In the four sessions, there was good dynamics and interactions between the different participants.

Batteries for e-Mobility

In the three sessions focused on e-Mobility, the key elements that were addressed can be summarized as follows:

1. What would be the grand Science and Technology challenge in the area of future battery technologies?

Performances

- Development of advanced or novel battery technologies that provide significantly increased performances (energy density, power density, lifetime, fast charging, energy efficiency, safety) according to the requirements of the battery electric vehicles as indicated in the Electrification Roadmap and the SET PLAN Action on Batteries (see annex 1). The goal is to achieve the target of more than 500Wh/kg at cell level in order to achieve an electric range up to 700km. Reaching those targets will require disruptive innovation and breakthroughs, notably in terms of materials and manufacturing processes. Incremental innovation will not be sufficient to reach such very ambitious targets, which are necessary to offer the same driving range as conventional internal combustion engine vehicles.
- Fast charging capability beyond the available battery technologies on the market (>2C charging).

Sustainability

- Development of the considered battery technologies should be based on a sustainable value chain from the mining of raw materials to the recycling of batteries.
- Development of sustainable battery technologies, with a low CO_2 footprint that can be used as a label to classify the greenness of the technology, taking into account mining of the materials, processing, manufacturing and recycling.

Smart functionalities

- Development of radically new battery technology concepts based on smart materials/3D architectures, self-healing materials, sensors for state of health estimation, thermal management design, battery housing design, etc.

Technologies

- In terms of battery chemistries, the door should be open to different technologies, as long as they have the potential to reach the very ambitious performance and cost targets (for example, energy density higher than 500 Wh/kg). In the sessions, the experts clearly mentioned that the required breakthroughs could be expected not only in the field of non-Li-ion technologies (e.g., metal-air concepts, or new metal-ion concepts), but also in the field of Li- ion technologies (e.g., all-solid-state Li-ion technologies based on new material chemistries with ultrahigh energy capacity). It was also mentioned during the discussion that an extensive use of high-performance computational methods would accelerate the discovery of new material chemistries, both in the case of Li- ion and non-Li-ion technologies.

Manufacturing

- The manufacturability and scalability of the new battery technologies have to be addressed from the beginning of the development. New manufacturing processes have to be developed and demonstrated at a relevant industrial scale, in particular using disruptive pilot lines.
- The battery technology and the new battery manufacturing processes should be cost competitive compared to the Asian technologies and it should be more environmental friendly.
- There is a clear lack of knowledge in the EU in terms of large battery manufacturing. In addition, the EU does not have the flexible production facilities to deal with the upcoming battery technologies.

2. Why would addressing this grand S&T challenge be good for Europe?

- To contribute to achieving Europe's energy, transport, industrial and environmental policy targets.
- To create a sustainable and secured energy storage value chain in the EU and not to be dependent of the Asian players, which are dominating the market with over 90%.
- To strengthen the EU position in the automotive e-mobility market, which represents 12.6 million jobs.
- To stimulate cross-sectorial synergies, whereby the knowledge and manufacturing of batteries for e-mobility will have a positive impact on the stationary market and traction applications such as forklifts, ships and aviation.
- To tackle the environmental and societal challenges such as air quality and climate change.
- To promote the circular economy.
- To choose technologies that can reduce Europe's dependence on raw materials.
- To replace critical materials by sustainable ones which will have a low CO_2 footprint.
- To provide a competitive advantage to EU industry by investing in a domain offering strong IP generation potential

3. How could Europe best address this grand S&T challenge?

- The selection of the technologies should be in agreement with the EU roadmaps and developments should address new EU directives.
- There is a need for a multi-step approach whereby the TRL should be increased from the breakthrough ideas to high TRL close to production (7-8).
- The duration of the initiative should be sufficient (i.e. 10 years) to tackle the science and technological challenges.
- A strong collaboration between academia and industry to accelerate the development process and to convert innovative ideas into products.
- Secured IP protection (FAIR data): the collaboration between academia and

industry should be supported by secured IP rules whereby the industry can act in a favourable and clear environment (shared data, patents, publications, common results, etc).

- Flexible management and strategy, which can fulfil the market needs.
- The EU education programme should be adapted according to the industrial needs and in particular towards the process and manufacturing of batteries, where there is a clear lack of knowledge.

Batteries for stationary storage

1. What would be the grand Science and Technology challenge in the area of future battery technologies?

- Lifetime (cycling and calendar) improvement of battery technologies (e.g. Na-ion, metal-air, etc.) since this is one of the most critical criteria in stationary applications.
- The energy storage cost should be improved with a target below 0.05 euro/kWh/cycle.
- The safety and durability of any new energy storage technologies for stationary application should be at least equal to those of technologies currently existing on the market.
- Scalability of technology to the TWh challenge for enabling security of electricity supply 24/365.

2. Why would addressing this grand S&T challenge be good for Europe?

- To become a leader in stationary battery technologies and serve the whole value chain including second use and recycling.
- To develop the game changer electricity storage technologies for a transition to clean and environmentally friendly technologies.
- To develop significant impacts and synergies with other application sectors.
- To provide a competitive advantage to our industry by investing in a domain offering strong IP generation potential.
- To replace critical materials by sustainable ones which will have a low CO_2 footprint.

3. How could Europe best address this grand S&T challenge?

- Na-ion, solar fuels, RedOx flow technologies free of critical raw materials potentially coupled with photovoltaic.
- Hybridisation of technologies – combining different technologies (high power and high energy) at system level.
- Hybrid battery-electrolyser ('battolyser') for static electricity storage and conversion to hydrogen. Synergy with artificial/solar fuels, seasonal storage and clean chemistry.
- Microorganisms for power generation.
- Through R&I long-term projects to advance from low TRL levels to higher.

Most promising battery technologies for long-term research

The requirements (in terms of energy density, power density, lifetime, cost, fast charging) for the different automotive and stationary applications have been defined in different European Roadmaps such as Electrification Road Transport, EERA and more recently in the implementation plan of SET Plan Action on Batteries.

There are large numbers of battery technologies that can be used for e-mobility. However, some of these technologies are more mature and close to the market such as high nickel rich NMC (811) cathodes, silicon based anodes and to some extent lithium sulphur batteries. Nevertheless, the most promising battery technologies that have a high potential to be integrated in the long- term EU automotive applications and can fulfil the e-mobility applications' requirements can be summarized as:

- Solid-state batteries based on inorganic (glass, ceramic, glass-ceramic) or composite concepts, with a clear focus on improving the ionic conductivity, interface optimization, understanding of failure/ageing, interface characterization/modelling, processing and manufacturing skills and competences. Solid-state technology is an extremely promising but very challenging technology.
    - In this domain, *the short and medium-term R&I actions should focus on developing solid-state technologies based on existing material chemistries*. The first challenges to be addressed are related to the development of new cell manufacturing processes and to the control of interfaces, therefore it will be more efficient to rely on known material chemistries.
    - *The long-term R&I actions, as supported by the FET program, could focus on solid-state technologies based on novel material chemistries* (e.g., novel high energy capacity active materials), in order to make the needed radical improvement in terms of performances. The discovery of the novel material chemistries will be accelerated by the use of new computational methods.
- Lithium sulfur with protected metallic lithium and eventually polymer or solid-state electrolyte with acceptable cycle life.
- Lithium metal or lithium alloy with a high specific capacity towards 4000mAh/g.
- Lithium-air or Aluminium-air with acceptable power performances and cycle life stability.
- Lithium-magnesium.
- High voltage cobalt free cathode materials such as high voltage spinel.
- Advanced 3D nanostructured architectures.
- Self-healing materials.

There is also a need to address these additional long-term challenges:

- Fundamental understanding of the specific reaction mechanisms in the novel battery technologies,
- Interface characterization and advanced modelling,
- Advanced multiscale modelling from atomistic to macroscale,

- Fundamental understanding of ageing, failure and mechanical stress factors,
- Integration and optimization of different battery materials,
- Processing, upscaling, production and manufacturing capabilities towards higher TRL level,
- Flexible pilot lines.
- Low CO_2 footprint manufacturing,
- Smart sensing and algorithms to estimate battery state function,
- Advanced electronic monitoring and control system,
- High recycling efficiency,
- Battery technology designed towards second life applications,
- Smart battery system design,
- Training of a new generation of young researchers and engineers.

Conclusions and next steps

In their conclusions, Clara de la Torre, Director for Transport at DG RTD and Thomas Skordas, Director for Digital Excellence and Science Infrastructure at DG Connect, emphasised the importance of this workshop and of a possible large scale R&I research initiative, which would address the long-term S&T challenges. Such an initiative should be complementary to the current ongoing RTD-funded projects regarding battery cell production and contribute to the forthcoming Battery Alliance.

They thanked the academia and industry representatives for engaging in the debate on why and how Europe should take the battery challenge. The workshop has further confirmed that battery technologies are indeed essential for the future of the transport and energy sectors in Europe; batteries will become more and more important for our daily lives, be it in our cars, in our homes or in our electricity grid infrastructure. They stressed that Europe has all the necessary ingredients for positioning itself in this strategic sector and that a large-scale research initiative on next generation battery technologies could accelerate their emergence and their take-up by EU industry.

Building on the promising outcome of this workshop, and other actions of a shorter time nature taken in the context of the European Battery Alliance, they encouraged all the research actors of Europe – academia, Research & Technology Organisations and industry – to work further together in order to define, within the next few months, an ambitious research initiative focusing on the main research challenges and priorities to address and deliver a commonly agreed long term research agenda. The results of this preparatory work and the roadmap should be presented in the coming months for instance in the context of a follow-up workshop.

ANNEXES

Set Plan targets

		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

	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

	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

Figure 12. Defined requirements for batteries in Set Plan Action 7[4]

[4] https://setis.ec.europa.eu/system/files/integrated_set-plan/action7_declaration_of_intent_0.pdf
https://setis.ec.europa.eu/sites/default/files/set_plan_batteries_implementation_plan.pdf

Agenda

9:30 - 9:50:	***Welcome and aim of the workshop***
	Thomas Skordas, Director for Digital Excellence and Science Infrastructure, DG Connect
9:50 - 10:50:	***Europe's needs for new energy storage technologies***

- *The Strategic Energy Technology (SET) Plan, Marc Steen, Joint Research Centre*
- *Ulrich Möhr, Volkswagen*
- *Etienne Brière, EDF*
- *Francesco Gattiglio, EUROBAT*

10:50 - 11:15: *Coffee*

11:15 – 12:30: ***State of the art in EU research and R&D challenges***

Speakers from EU projects:

- *Christophe Aucher, LEITAT*
- *Silvia Bodoardo, Politecnico di Torino*
- *Loic Simonin, CEA*
- *Vittorio Pellegrini, IIT*
- *Bart Onsia, IMEC*
- *Adélio Mendes, Porto University*
- *Anders Bentien, Aarhus University*

12:30 – 13:30: *Lunch*

13:30 – 15:00: ***Parallel sessions: Opportunity for a large scale EU R&D initiative in future battery technologies***

- What would be the grand Science and Technology challenge in the area of future battery technologies?
- Why is it good for Europe?
- How to best address this grand Science and Technology challenge?

15:00 – 15:15: *Coffee*

15:15 – 16:15: ***Summary of parallel discussions***

16:15 – 16:30: ***Conclusions and next steps***

- *Clara de la Torre, Director for Transport, DG Research and Innovation*
- *Thomas Skordas, Director for Digital Excellence and Science Infrastructure, DG Connect*

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