Fessenheim Feasibility Study

Overview of The Pilot Projects

Funded by

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1. Competence Group Green Batteries and Circular Economy

1.1. Battery Materials Factory (BMF)

Competence Group: **Green Batteries and Circular Economy**
Pilot name: **Pilot Project GB-BM-A “Battery Materials Factory (BMF)"**

Justification for the pilot selection / Background

Background

Lithium-ion batteries (LIBs) are a key technology for electro-mobility whereby their 2nd life utilisation can also contribute to the expansion of renewable energy-sources, by providing large-scale electrical-energy storage. Additionally, LIBs are used in mobile devices that need electrical energy (laptops, mobile phones and so forth). However, the carbon footprint of the LIB production has to be further reduced, to fully use the potential for greenhouse-gas emission reduction regarding the replacement of technologies based on fossil fuels energy sources.

Justification

The production of battery materials – active as well as inactive supporting materials – is one of the steps during battery fabrication that needs a lot of energy and contributes therefore to the carbon footprint of LIBs. A pilot plant that deals with the production of these materials focusing on a reduced energy consumption is crucial in the future development of battery materials. Additionally, the upgrading of active materials from used batteries is a great possibility for further reducing the ecological impact of battery production. The production of new materials as well as the upgrading of used materials can be realised in the same facility, since the same steps are necessary.

Pilot key goals and actions

Goals and Actions

Producing state of the art materials for LIBs is the major purpose of this battery materials factory. However, the integration of recently developed materials into the production processes is also important and a goal of this facility. The following pilot projects are conceivable for this pilot plant:

- Development and fabrication of cathode active materials (CAMs) for LIBs

Producing state of the art CAMs that fulfill different requirements regarding their application should be the goal of this project. Especially NMC CAMs with a high content of nickel and a low content of cobalt (e.g., NMC811) as well as $LiFePO_4$ should be focused. Additionally the production of CAMs that are completely cobalt free (e.g., $LiNi_{0.5}Mn_{1.5}O_4$) should be included.

- Development and fabrication of anode active materials for LIBs

Next to the state of the art graphite materials for anodes, materials that also contain silicon should be produced. The incorporation of higher silicon contents can push the capacity of the anode materials.

- Development and fabrication of electrolytes and other supporting materials for LIBs

A production of materials with a low carbon footprint should be focused in this project

- Upgrading and fabrication of recycled battery materials for LIBs

This project is important for a circular economy of battery materials. Upgrading active material from used batteries has the potential to save large amounts of energy and reduce the carbon footprint of LIBs. Additionally it helps to become more independent from suppliers of the raw materials needed for the production of new active materials

Business and funding concepts

Industry partners should be encouraged to build the respective facility/ies.

To encourage these industry partners, the green battery group presents the advantages of the Fessenheim region to them and shows the respective opportunities. With interested partners funding from the EU might be accessible to support these installations, since they fit very well to the goals of the European "green deal".

Integration in the overall Regional Development Concept

For an extended utilisation of renewable energy-sources (RES) regarding the goal to provide electricity exclusively by RES, more electrical energy storage (EES) is required. Since batteries are one of the most promising technologies for this purpose, the development of sustainable materials for them, which is one goal of this pilot project, fits very well into the renewable energy concept of the region.

The other goal of this pilot project (upgrading of recycled battery materials) is an integral part of a circular economy regarding batteries. Therefore, this pilot also fits very well to this concept.

Supporting expert and industry groups

Research Institutes

- Albert-Ludwigs-Universität Freiburg (Germany)
- Fraunhofer ISE (Germany)
- Paul Scherrer Institut (Switzerland)
- EMPA (Switzerland)
- Université Haute-Alsace (France)

Possible Industry Partners

The following companies participated in a meeting where the plans for the innovation region Fessenheim were presented from the perspective of the "green batteries" group, but there are no compulsory arrangements or specific plans yet.

- BASF
- Iolitec
- Freudenberg
- PCC

Next Steps

The three pilots Early Pilot Plant, Late Pilot Plant and a battery materials factory are interlinked.
The Early Pilot Plant will be the first, the Late Pilot Plant will then follow as a development, culminating in the construction of a battery materials factory.

SWOT analysis

Strengths	**Weaknesses**
The demand for (sustainable) battery materials will grow. Even with a lot of competition on the market it is likely that the plant will be economically successful. The processes envisioned for this facility are established The river Rhine for transportation (very central location in Europe) Available expertise in the region Sustainability is an accepted topic and supported by a large share of the society	Not all the materials developed in this facility will become commercially interesting
Opportunities	**Threats**
Take over a leading position for the development of sustainable battery materials worldwide. Become independent from critical raw materials (This also means to become independent from the countries that mine them) Jobs can be provided	A lack of funding that is necessary for the participation of interested industry partners.

1.2. Late Pilot Plant for Battery Materials

Competence Group: **Green Batteries and Circular Economy**
Pilot name: **Pilot Project GB-BM-B "Late Pilot Plant for Battery Materials"**

Justification for the pilot selection / Background

Background

The research in the field of new battery materials is an ongoing task, which was driven by improving the performance of the batteries in the last decades (higher energy density, higher power output, longer life cycles and so forth). Although these parameters are still important and need to be further improved, the focus is shifting towards "green" battery materials that are sustainable. Sustainability can be achieved by finding new materials based on respective elements as well as developing processes for their preparation that are less energy consuming.

Reusing active materials from used batteries can help to reduce the carbon footprint of lithium-ion batteries (LIBs). The upgrading of these materials that come from recycling is at its infancy and therefore holds a lot of potential to become a leading expert in this field.

Justification

Almost every material that is used in a battery can be improved regarding sustainability e.g.: Cathode active materials (CAMs), anode active materials and all the inactive supporting materials. A pilot plant that deals with these topics holds a lot of potential for innovation regarding a sustainable energy sector, which is an important part of the European "green deal". It can clearly be stated that this pilot plant strongly promotes the long-term vision of an innovation region with the focus on sustainable development.

Pilot key goals and actions

Goals and Actions

The major objective for this pilot plant is to further develop sustainable materials for batteries with a TRL from 7–9. For promising materials it is also important to find sustainable methods for their fabrication (e.g., preparation of cathode sheets), which is also a major goal followed by this pilot plant.

The following projects could be realised in a respective facility:

- Development and fabrication of CAMs for LIBs

Especially nickel-rich NMC CAMs with higher nickel contents than NMC811 are of interest. Nickel offers a high performance while being less problematic concerning abundancy than cobalt. Completely cobalt-free CAMs like LiMn2O4 should also be within the scope of this project.

- Development and fabrication of anode active materials for LIBs

The utilisation of silicon in anode materials is a promising approach to increase the capacity while using a much more abundant and therefore sustainable element. Although anodes with small amounts of silicon are already commercially available, increasing this amount further is still problematic and more research is needed.

- Development and fabrication of electrolytes and other supporting materials for LIBs

Regarding the non-active supporting materials like electrolytes, binders, separators, conductive agents and all the components of the casing, the focus should lie on more sustainable alternatives. As an example, it would be desirable to replace the fluorinated binder used for the preparation of the cathode sheets.

- Recycling of spent vanadium-based electrolytes for redox-flow batteries (RFBs)

Although the all-vanadium RFB struggles with a commercial breakthrough, due to the low availability of vanadium it is a very advanced and well-functioning technology. The all-vanadium RFB offers a very long life cycle, high round-trip efficiencies and it is very safe due to the aqueous electrolyte. An effective recycling of the respective electrolyte is therefore an important topic.

- Upgrading and fabrication of recycled battery materials for LIBs

This project is important for a circular economy of battery materials. Upgrading active material from used batteries has the potential to save large amounts of energy and reduce the carbon footprint of LIBs. Additionally it helps to become more independent from suppliers of the raw materials needed for the production of new active materials.

Business and funding concepts

Industry partners should be encouraged to build the respective facility/ies.

To encourage these industry partners, the green battery group presents the advantages of the Fessenheim region to them and shows the respective opportunities. With interested partners, funding from the EU might be accessible to support these installations, since they fit very well to the goals of the European “green deal”.

Integration in the overall Regional Development Concept

For an extended utilisation of renewable energy-sources (RES) regarding the goal to provide electricity exclusively by RES, more electrical energy storage (EES) is strongly required. Since batteries are one of the most promising technologies for this purpose, the development of sustainable materials for them, which is one goal of this pilot project, fits very well into the renewable energy concept of the region.
The other goal of this pilot project (upgrading of recycled battery materials) is an integral part of a circular economy regarding batteries. Therefore, this pilot also fits very well to this concept.

Supporting expert and industry groups

Research Institutes

- Albert-Ludwigs-Universität Freiburg (Germany)
- Fraunhofer ISE (Germany)
- Paul Scherrer Institut (Switzerland)
- EMPA (Switzerland)
- Université Haute-Alsace (France)

Possible Industry Partners

The following companies participated in a meeting where the plans for the innovation region Fessenheim were presented from the perspective of the “green batteries” group, but there are no compulsory arrangements or specific plans yet.

- BASF
- Iolitec
- Freudenberg
- PCC

Next Steps

The three pilots Early Pilot Plant, Late Pilot Plant and a battery materials factory are interlinked.

The Early Pilot Plant will be the first, the Late Pilot Plant will then follow as a development, culminating in the construction of a battery materials factory.

SWOT analysis

Strengths	**Weaknesses**
• The demand for (sustainable) battery materials will grow. Even with a lot of competition on the market it is likely that the plant will be economically successful • The processes envisioned for this facility are established • The river Rhine for transportation (very central location in Europe) • Available expertise in the region • Sustainability is an accepted topic and supported by a large share of the society	• A big investment is necessary
Opportunities	**Threats**
• Take over a leading position for the development of sustainable battery materials worldwide. • Become independent from critical raw materials (This also means to become independent from the countries that mine them) • Jobs can be provided	• A lack of funding that is necessary for the participation of interested industry partners

1.3. Early Pilot Plant for Battery Materials

Competence Group: **Green Batteries and Circular Economy**
Pilot name: **Pilot Project GB-BM-C "Early Pilot Plant for Battery Materials"**

Justification for the pilot selection / Background

Background

The research in the field of new battery materials is an ongoing task, which was driven by improving the performance of the batteries in the last decades (higher energy density, higher power output, longer cycle life and so forth). Although these parameters are still important and need to be further improved, the focus is shifting towards "green" battery materials that are sustainable. Sustainability can be achieved by finding new materials based on respective elements as well as developing processes for their preparation that are less energy consuming.

The materials that are on the market right now contain a lot of cobalt and graphite, which are critical raw elements. It is not very likely that the increasing demand for batteries worldwide can be satisfied using these materials. Therefore, it is important to investigate new, more sustainable materials at a low technological readiness level (TRL) to be prepared for this increasing demand.

Justification

Almost every material that is used in a battery can be improved regarding sustainability e.g.: cathode active materials (CAM), anode active materials and all the inactive supporting materials. A pilot plant that deals with these topics holds a lot of potential for innovation regarding a sustainable energy sector, which is an important part of the European "green deal". It can clearly be stated that this pilot plant strongly promotes the long-term vision of an innovation region with the focus on sustainable development.

Pilot key goals and actions

Goals and Actions

The major objective for this pilot plant is the development and characterisation of new, sustainable materials for batteries. Therefore, materials with a TRL from 1–6 are in the focus. For promising materials, it is also important to find methods for their fabrication (e.g. preparation of cathode sheets), which is also a major goal followed by this pilot plant.

Materials with a low TRL also include other battery technologies next to LIBs. Therefore, the following projects are suggested:

- Development and fabrication of CAMs for LIBs

CAMs that are solely based on the element manganese (e.g., $LiMn_2O_4$) should be focused here. Due to its high abundance, manganese can be considered sustainable.

- Development and fabrication of anode active materials for LIBs

Elemental lithium is a very attractive material for anodes. Overcoming the problems associated with the deposition of lithium and the necessary solid electrolyte interface (SEI), an increase of the anode capacity by a factor of 10 is possible. In addition, anodes based solely on silicon are very promising, but a lot of research and development is still needed.

- Development and fabrication of electrolytes and other supporting materials for LIBs

Regarding the non-active supporting materials like electrolytes, binders, separators, conductive agents and all the components of the casing the focus should lie on more sustainable alternatives. As an example, it would be desirable to replace the fluorinated binder used for the preparation of the cathode sheets.

- Development and fabrication of new electrolyte formulations for redox-flow batteries

Redox-flow batteries (RFBs) are very promising for large-scale electrical energy storage (LS-EES). Since the energy density is not as crucial for LS-EES as for electromobility, other chemistries besides the lithium-ion chemistry can be used, which is important regarding the high demand for batteries (v.s.). Since the chemistry of the benchmark RFB is solely based on the rare element vanadium, alternative chemical systems are very interesting and should be investigated.

- Development and fabrication of post-Lithium batteries (organic materials, Al, Zn, Mg and so forth)

Although LIB chemistry will probably not disappear in the future, it is also necessary to develop materials that might surpass the performance of LIBs. Multivalent metals are especially promising because of their multi-electron reactions. Although the energy density of organic materials falls behind at the moment, they can be charged extremely fast, and they are also interesting regarding sustainability.

Business and funding concepts

Industry partners should be encouraged to build the respective facility/ies

To encourage these industry partners, the green battery group presents the advantages of the Fessenheim region to them and shows the respective opportunities. With interested partners funding from the EU might be accessible to support these installations, since they fit very well to the goals of the European “green deal”.

Integration in the overall Regional Development Concept

For an extended utilisation of renewable energy-sources (RES) regarding the goal to provide electricity exclusively by RES, more electrical energy storage (EES) is strongly required. Since batteries are one of the most promising technologies for this purpose, the development of sustainable materials for them, which is one goal of this pilot project, fits very well into the renewable energy concept of the region.

The other goal of this pilot project (upgrading of recycled battery materials) is an integral part of a circular economy regarding batteries. Therefore, this pilot also fits very well to this concept.

Supporting expert and industry groups

Research Institutes

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- EMPA (Switzerland)
- Université Haute-Alsace (France)

Possible Industry Partners

The following companies participated in a meeting where the plans for the innovation region Fessenheim were presented from the perspective of the “green batteries” group, but there are no compulsory arrangements or specific plans yet.

- BASF
- Iolitec
- Freudenberg
- PCC

Next steps

The three pilots Early Pilot Plant, Late Pilot Plant and a battery materials factory are interlinked.

The Early Pilot Plant will be the first, the Late Pilot Plant will then follow as a development, culminating in the construction of a battery materials factory.

SWOT analysis

Strengths	**Weaknesses**
• The processes envisioned for this facility are established • The river Rhine for transportation (very central location in Europe) • Available expertise in the region • Sustainability is an accepted topic and supported by a large share of the society	• Development of new materials might not be successful
Opportunities	**Threats**
• Take over a leading position for the development of sustainable battery materials worldwide. • Become independent from critical raw materials (This also means to become independent from the countries that mine them) • Jobs can be provided • The demand for sustainable battery materials will grow and even with a lot of competition on the market, it is likely that the plant will be economically successful	• A lack of funding that is necessary for the participation of interested industry partners

2. Sub-Pilots: 2nd-life Subgroup

2.1. Robust and Resilient Supply Chain for EV Battery Recycling

Competence Group: **Green Battery Circular Economy**
Pilot name: **Pilot Project GB-SL-A "Robust and Resilient Supply Chain for EV Battery Recycling"**

Justification for the pilot selection / Background

The market for electric vehicles (EVs) is among the fastest growing energy-demanding markets. The batteries of EVs can be used for a limited time (or number of uses) and will then need to be changed. However, these exchanged batteries remain functional and offer a storage capacity that can be used to extend their lifetime. Moreover, not all the batteries that are taken out of EVs can be used for electricity storage. Some batteries are removed because of damage and have to be recycled. Reusing and recycling EVs batteries therefore constitute a great challenge that needs to be addressed.

Used batteries are collected from different "collection points" (car manufacturers, dealer shops, etc.). Batteries are then qualified to evaluate whether they can be used for storage in their "2nd life". If they are ready, these batteries are used in residential and industrial buildings for energy storage (energy generated locally). They can also be used in storage plants for large-scale energy storage. If they are not suitable for use, they are shipped to recycling plants.

A supply chain network needs to be studied and put in place. This supply chain needs to take into account several parameters and constraints: transportation means (road, air, river, etc.), types of collection points, location of qualification centres, regulations for EV batteries, environmental constraints among others. The supply chain will also integrate one or several battery recycling plants and storage plants.

Pilot key goals and actions

The main objective of this pilot project is to investigate several EV battery recycling supply chain scenarios in which one or several recycling and storage plants are considered. To do so, the following aspects will be considered:

- Identify and study qualification plant locations depending on demand for used battery energy, capacity and regulations for EV transportation
- Investigate how the different transportation means can be combined for EV battery transportation and the central location of Fessenheim for a global European supply chain network of EV battery recycling
- Identify and optimize the new recycling plant locations across Europe while taking into account different constraints (current plants and their capacities, collection points, EV market share, etc.)
- Establish an economic evaluation for the different scenarios for different time horizons (2025, 2030, 2040 and 2050)

Business and funding concepts

Several funding organisations have shown interest and published calls for projects on the topic. The following organisations will be solicited for this project:

- European council (EU)
- Agence Nationale de Recherche (FR)
- ADEME (FR)
- PIA4 (FR)
- BPI (FR)
- Grand Est Region (FR)
- Baden Württemberg Land (DE)
- VDE/VDI (DE)
- BMU (DE)
- BMBF/BMWI (DE).
- Moreover, several companies have shown interest

Integration in the overall Regional Development Concept

This project will contribute to the ongoing effort of creating a European supply chain of EV battery recycling. The market is still young and as the EV market share grows, so does the recycling market. The International Energy Agency expects that the EV market share will strengthen during the upcoming decade creating thus a strong demand for EV battery recycling supply chain.

The reuse and the recycling of EV batteries will have a two-fold impact on the region:

- Storage plants will allow the storage of energy generated using renewable sources reducing thus the share of fossil and nuclear sources
- Strengthen the recycling EV batteries industry to reach worldwide impact
- Contribute to the ongoing effort of creating a European industry and supply chain of EV battery recycling supporting the circular economy
- Increase renewable energy storage capacity using storage plants and reduce thus the share of fossil and nuclear sources
- Contribute to improving EV battery qualification and transportation regulations across Europe

Supporting expert and industry groups

Research Institutes

- Troyes' Institute of Services and Industries of the Future
- Lorraine University
- Fraunhofer IML
- Fraunhofer ISE
- Fraunhofer IWKS

Possible Industry Partners

- Tech3D France
- BASF`
- Opta LP
- MobEnergy

Moreover, ongoing discussions are currently held with the following companies to join the project

- Veolia Euro Dieuze Industrie
- BMW
- Peugeot
- EDF
- DHL

Next steps

The plan for the 2nd life subgroup consists of two steps. First, a qualification centre for 2nd life EV-batteries is needed. This will have to be established first, so that batteries can be assessed before being used for energy storage.

Second, a utility-scale hybrid electrical energy storage that is complemented by 2nd life batteries need to be put into place.

SWOT analysis

Strengths	Weaknesses
• A growing demand • An already initiated industry • Several means of transportation	• Limited number of recycling plants • Limited regulations for EV battery transportation • Manufacturer-based collection of EV batteries
Opportunities	**Threats**
• Solid knowledge on EV battery recycling • A worldwide demand for EV battery recycling • A strong effort from OEMs for the industry	• Integration of storage plants to electric networks • A limited capacity for a strong demand for recycling

2.2. Concept for a dismantlement plant for used EV batteries

Competence Group: **Green Battery**
Pilot name: **Pilot Project GB-SL-B "Concept for a dismantlement plant for used EV batteries"**

Justification for the pilot selection / Background

A used battery system is not necessarily intended for recycling only. The evaluation of a 2nd life is recommended for sustainability at least on system and module level. In case of recycling and 2nd life a dismantling of the battery system is necessary. The automation of the battery disassembly, in particular for Li-Ion-batteries is crucial for several reasons like safety and efficiency. For safe operation, the electric state of the battery system and the modules have to be checked and controlled in the process. However, this task is not yet solved.

Pilot key goals and actions

Two alternative automated process concepts for safe battery disassembly:

- Robust Disassembly: Opening process for battery systems with robot-controlled waterjet cutting incl. water cooling, process water filtration (Description: cutting tests, optimisation of abrasive cutting, water cooling)
- Smart dismantling for reuse of various parts: individual non-destructive removal of the battery parts, using machine learning, integration of fast analysis methods, product data, etc.

Merging of both approaches into an optimal process: Combination of most promising steps of each process route.

- Intelligent and adaptive disassembly planning
- Layout planning for adaptable and flexible disassembly factories

A concept for decommissioning will be developed for safe handling of end-of-life systems or components, including material safety/ performance testing, discharging, safe transport, safe storage. Crucial steps:

- EoL-battery system
- EoL-module
- EoL-cell

Business and funding concepts

Consortium with a big partner as final owner/operator of a disassembly plant, permanent suppliers and R&D partners for further development and expansion. Option: public funded project on EU level (Horizon)

Integration in the overall Regional Development Concept

Disassembly is a crucial step linking the end-of-1st -life battery and the two routes "2nd life" and "recycling". In the big context this is an important part of the circular economy, since an efficient and safe disassembly / dismantling enables sustainable use and reuse of non-critical and critical materials, which is the basis for an entire economic and ecological energy concept.

Supporting expert and industry groups

- Fraunhofer IWKS (Recycling technologies, Waterjet cutting)
- Fraunhofer ISE, Fraunhofer IPA (automation, digitalisation, layout planning, disassembly strategies)
- LGIPM Laboratory/Univ. Lorraine (Automation with waterjet cutter / Robotics - Cobotics, Process digitisation)
- Knoll
- Storion
- Hydac International GmbH (Watercooling, process water filtration)
- Knoll Feinmechanik GmbH (Automation)

Supporting expert and industry groups

The plan for the 2^{nd} life subgroup consists of two steps. First, a qualification centre for 2^{nd} life EV-batteries is needed. This will have to be established first, so that batteries can be assessed before being used for energy storage.

Second, a utility-scale hybrid electrical energy storage, that is complemented by 2^{nd} life batteries need to be put into place.

SWOT analysis

Strengths	**Weaknesses**
• Increase of Recovery rate for almost all fractions • Enabling reuse/2^{nd} life • Crucial requirement for the following recycling steps regarding the need for high quality output fractions (in particular black mass or electrode precursors respectively	• Automated dismantling relies on data about individual products • Safety assessment crucial for every battery type • Individual training of robot process
Opportunities	**Threats**
• Improved throughput for expected high backflow of EoL-batteries • Safe process with minimized manual labor	• The economic efficiency might not reach that of a manual dismantling for small numbers

2.3. Methods for qualification of used battery systems, modules and cells

Competence Group: **2nd-life battery on the grid**

Pilot name: **Pilot Project GB-SL-C "Methods and deployment challenges for qualification of used battery systems, modules and cells (safety, reliability, performance)"**

Justification for the pilot selection / Background

The goal is to apply the new European policies concerning the regulation of batteries, while making sure that batteries (placed in the EU market) are sustainable and safe throughout their entire life cycle.

The sustainability and competitiveness of battery value chains need to be ensured (ensure durability and minimum electrochemical performance/energy performance requirements).

Also, the scheme for battery collection, refurbishing, reusing, and recycling activities will have to be optimized, along with the identification of the requirement for battery classification for the 2nd life applications. Additional requirements of monitoring efforts and decision support for reuse and recycling industries exist.

All the while, safety, data record, labelling and end-of-life management requirements for rechargeable batteries must also be considered.

The pilot contributes to the promotion of SDGs 7, 8, 9, 12, 13 and 17 of the UN.

Pilot key goals and actions

Main objective

Methods and integration of run-time /dynamic monitoring of states and lifetime supervision of batteries (performance, safety, and reliability) and fast lab-based verification strategies for the qualification for 2nd life applications

Goal 1: Durability and minimum electrochemical performance requirements

- Action: Identification of current performance, prediction of future performance and aging behaviour of batteries

Goal 2: Safety requirements

- Action: Tests and diagnosis of safety and reliability of battery systems

Goal 3: Labelling and information requirements

- Action: Smart battery management for monitoring, control, localisation, and tracking

Business and funding concepts

Through providing the monitoring and labelling of batteries for large European geographic areas and providing a networked data platform service for communication, identification, composition, and information of states of 1st life batteries for 2nd life battery industries, economical value can be added.

Customer and industrial service applications for collecting (support for organizing the logistics), refurbishing, reusing in 2nd life applications and recycling of batteries are additional possibilities with business cases.

Integration in the overall Regional Development Concept

- Strong impact in system integration of fluctuating renewable energies in the region by using 2nd life batteries as energy storage
- To ensure truly circular lifecycles for traction batteries, and to harness the opportunities for growth and jobs in the region
- To propose a platform for interactions with and between key industrial partners.

Supporting expert and industry groups

LCOMS

is a multidisciplinary laboratory which specialises in the development of embedded computer systems, smart networked multi-sensors with expertise for large applications such as smart renewable energy management, battery management systems (BMS), IoT systems and real time data security exchanges.

TDF Infrastructure SAS

is a company that specialises in connectivity and communication infrastructure. For radio and DTT broadcasting, mobile ultra-high-speed broadband coverage and rolling out optical fibre, TDF brings clients in-depth operational expertise, a mix of unique and ground-breaking technology and an exceptionally widespread local presence. In an ever more connected world, over the last four decades or more TDF has enabled telecoms and media companies to connect the French regions and people everywhere and faster.

BENNING CMS Technology GmbH

is a company which specialises in the new development of battery management systems (BMS) and their technical implementation for lithium battery systems. This expert company has since patented two revolutionary processes for lithium battery system operation which are more efficient and economical, and which better preserve the battery system.

The Fraunhofer Institute for Solar Energy Systems

creates the technological foundations for supplying energy efficiently and based on an environmentally sound basis in industrialised, threshold and developing countries. This expert research institute focuses on energy conversion, energy efficiency, energy distribution and energy storage, it contributes to the broad application of new technology.

Research at the Institute of Energy Systems Technology

(Hochschule Offenburg) focuses on investigations and development of systems for sustainable energy use. This institute is expert in research-and-development about smart grids, building energy technology, battery technology, photovoltaics, hydrogen technology, energy economics, and electromobility.

Next steps

First, a development phase for methodology, networks communication and electronic exchange is needed. Following, tests and further development are necessary, before an implementation can be discussed. After an initial Beta release, the final result can be released as a project.

SWOT analysis

Strengths	**Weaknesses**
• Favorable European legislation • Capacity for innovation • Technology competitiveness (Innovation of BMS, data monitoring for the management and the 2nd life) • Highly qualified employees • Strong economic activity • No required construction and industrial infrastructure (already exist)	• Low financial capacity • Dependence on battery and BMS manufacturers and their willingness to provide access to BMS data • Competence for client and industrials /manufacturers databases exist
Opportunities	**Threats**
• Fast growing market • Promote new technologies • Optimize the circular economy for batteries and sourcing of raw materials • Provide classification of batteries • Change user and consumer behaviours • Contribute to addressing to diligence obligations of companies for the supply chain of recycled raw materials • Contribution to reduction of carbon footprint • Reduction of environmental impact	• Increasing costs due to technological innovation (in the beginning) • Emerging competitors • Evolution or changing in demand

2.4. Methods and control strategies for predicting and increasing remaining useful life- time in 2nd life applications

Competence Group: **Green Battery Circular Economy**

Pilot name: **Pilot Project GB-SL-D "Methods and control strategies for managing (prediction & control) the remaining useful life-time of the Fessenheim 2nd life Battery for optimized operation"**

Justification for the pilot selection / Background

The integration of used car batteries (1st life) into stationary 2nd life battery applications has a great potential.

However, it requires a deep understanding as well as reliable prediction of the remaining useful lifetime (RUL) of the battery for this non-native EV battery usage. This development is crucial to succeed with a commercially viable integration and safe and efficient long-term operation of 2nd life battery plants.

Pilot key goals and actions

Therefore, the following key goals and actions are addressed:

- Identification of possible operational risks and corresponding mitigation of these
- Deepening the profound understanding of the non-native application specific behaviour of EV LIB by behaviour modelling and model-based diagnostics
- Development of application dependent health indicators, such as "state-of-energy/life", as a reliable key indicator of the RUL
- Guidelines and standards on safe and economic operation as well as possibilities of optimisation of long-term operations of 2nd life battery plants
- Gaining long term experience on safe and commercial operations by intensive monitoring and a closed loop optimisation of the corresponding key indicators with field data

Business and funding concepts

The development of a KPI is crucial for a successful and efficient operation of 2nd life batteries, but unfortunately not of interest to one particular company or industry section. For this reason, financing from the industry is difficult and it will require funding support of a superior entity such as the EU.

- Budget estimate: (total: 3 m. €)
- Model based diagnostics: 0,8 m. €
- Laboratory characterisation: 0,7 m. €
- Development of the KPIs: 0,5 m. €
- Monitoring and operational optimisation: 1 m. €

Integration in the overall Regional Development Concept

Keeping the lifetime extension and the minimisation of the carbon footprint of lithium-ion batteries (LIB) in mind, stationary 2nd life battery plants will play a key role in the increase of renewable energies and the energy transition for Europe.

Apart from the overarching significance for Europe, the work in this pilot proposal will be seamlessly interlocked with its partner pilot (2nd life demonstration plant setup and integration) and is required to secure a sustainable and long-term usage as well as secure and safe operation in this light for a circular battery economy.

Supporting expert and industry groups

Research Institutes

- Université de Lorraine (FR)
- UAS FHNW (CH)
- UAS Offenburg (DE)
- Fraunhofer ISE (DE)

Possible Industry Partners

- Stellantis (PSA)
- possibly other OEMs

Next steps

The Project content can be divided into two parts, on the one hand the general research and development of the KPI for RUL and on the other hand the integration and operational optimisation of the partner pilot in Fessenheim. The first part can be started almost immediately, but the second part will require interaction with the other pilots, and therefore a reconciliation between the pilots is strongly recommended. The attached Gantt chart is only an exemplary pathway starting by 2022.

It outlines four major phases that are sequential with significant overlap between steps.

First, model based diagnostics need to be employed to enable laboratory characterisations in a second step. Third, the relevant KPIs will be developed. Finally, monitoring and optimisation is needed.

SWOT analysis

Strengths	**Weaknesses**
• Long track record and experience in battery state estimation and characterisation • High-end battery laboratories for testing and characterisation of battery cells and packs • World excellence and reputation of the scientific partners • Well-founded monitoring and characterisation know-how of LIB cell to multi-MW battery power plants	• 1st life might have a significant influence, that standardisation (with KPI for RUL) will be difficult
Opportunities	**Threats**
• Regional presence of OEMs (such as Stellantis or Daimler) to support development of KPIs during 1st life • Chance of developing a widely agreed KPI / standard for the identification of the RUL	• Availability of EV batteries (Stellantis) • Missing information (cycles, environmental stress) from 1st life can influence predictions quality

2.5. System set-up and grid integration of 2nd life storage Modular design, installation, grid-connection and safety concept

Competence Group: **Green Battery Circular Economy**
Pilot name: **Pilot Project GB-SL-E "2nd life demonstration plant set-up and integration"**

Justification for the pilot selection / Background

Implementation of a demonstrator grid battery consisting of 2nd life battery units, which are connected to the electricity transmission grid in Fessenheim. This approach has the following advantages:

- The demonstrator showcases the behaviour of a larger grid battery that can later be installed at the same location
- The existing electrical infrastructure at the former nuclear power plant (NPP) at Fessenheim is an ideal location for a large grid-stabilising storage device
- The proposed demonstrator can be used for grid and battery studies of the participating universities and research institutions
- The participating industry partners can develop and test new product generations. Their success guarantees the generation of new high-technology jobs in the region
- The usage of 2nd life batteries for the proposed demonstrator plant links this activity with the other steps (dismantlement, qualification, decommissioning of 2nd life batteries…) in the value chain

Pilot key goals and actions

The goal of this activity is the design and installation of a medium-size (10…50 MW) grid battery at the site of the former Fessenheim Nuclear Power Plant (NPP). This battery will serve as a demonstrator plant for a larger storage power plant that can later be constructed at this site, allowing for the stabilisation and energy balancing at this central node of the European electricity grid.

The grid battery is assembled out of individual 2nd life lithium battery packs. Therefore, an important task is the development of a safety concept for handling and operation of 2nd life batteries. A novel battery converter concept that can handle batteries of varying types and states at the same time will be developed. Additionally, this battery converter can be of the grid-forming type, a control technology that allows for the reliable operation of electricity grids even in the case of very high renewable energy penetration, thereby reducing the need for conventional must-run units.

Business and funding concepts

Since a large part of the components of the demonstrator battery are not yet commercially available but require research and development by the participating partners, public funding (preferably via EU projects) is obligatory to support its realisation. While the research partners need full support, the industry partners can contribute by shouldering a share of their individual expenses.

In the long run, the demonstrator battery can create income by participating in the electricity balancing market, which will contribute to covering the operating costs.

Expected budget:

- Construction of 2nd life grid battery demonstrator: 1,5 m. €
- Development of adapted battery converter for 2nd life batteries: 2,5 m.€
- Safety and operation concept development, grid connection and grid integration: 1 m. €

Integration in the overall Regional Development Concept

- Fraunhofer Institute for Solar Energy Systems ISE, Freiburg, Germany
- Institut National des Sciences Appliquées (INSA) Strasbourg, Strasbourg, France
- ASD Automatic Storage Device GmbH, Umkirch, Germany
- TRICERA energy GmbH, Bobritzsch-Hilbersdorf, Germany
- Hitachi ABB Power Grids (Requested)

Next steps

The development of a battery converter has to begin first and following, construction of the demonstrator can begin in parallel. The safety concept, grid connection and integration are the last steps in the process.

SWOT analysis

Strengths	**Weaknesses**
• Strong industry and research partners present in the greater region of Fessenheim • Ideal location • Strong industry support • Low environmental risk	• Business case depends on support through public funding
Opportunities	**Threats**
• Integration of novel, yet partly proven technology in a demonstrator plant • Possibility to test and compare different battery technologies • Showcase room for novel industry solutions	• Lack of political support • Support of Fessenheim NPP’s owner EDF not yet confirmed • Full integration in grid operator’s power management desirable for full usefulness

2.6. Grid-Scale Carnot Battery Technology Platform

Competence Group: **Green Battery Circular Economy**
Pilot name: **Pilot Project GB-SL-F "Grid-Scale Carnot Battery Technology Platform"**

Justification for the pilot selection / Background

The demonstration of 300 000 kWh thermal battery modules (Carnot battery) is proposed to provide long-term storage capacity for the electricity grid – an industry-driven approach backed by companies from Germany, France and Switzerland.

The Carnot Battery

The term Carnot Batteries refers to energy storage technologies based on the power-to-heat-to-power principle. Electricity is converted to heat and is stored as thermal energy, which can be done in inexpensive, environmentally safe materials, such as rocks or molten salt. The low cost of the storage material allows for mid- to long-term energy storage. To date, many different Carnot battery concepts are being pursued in different industrial contexts, but it is not yet clear which concept would offer the most favorable economic and ecological performance.

Usefulness of a Carnot Battery in the Innovation Region Fessenheim (IRF)

- Carnot batteries have a large and relatively inexpensive storage capacity. Installed at electrical grid nodes like Fessenheim, they have the ability of enabling load shifting at high-power level for periods of several hours or days. They are therefore an essential building block in the creation of a cross-border energy system with fluctuating supply.
- CNRP Fessenheim is a thermal power plant – many already existing assets can be reused on the site through the proposed pilot.
- Synergies with other planned actions: electrical batteries (for short-term storage), smart grid, district heating network. Thermal batteries are more suited to cost-effectively serve a relatively continuous load over an extended period of time. Thermochemical batteries have a very short response time to a sudden and short-term rise in electricity demand. These advantages of storing energy in electric batteries typically come with the disadvantage of a higher cost per energy.
- The IRF will serve as a technology platform for grid-scale electricity storage. The set-up of different large-scale pilots in a representative environment enables the identification of the most appropriate technology. This will allow a scale up of the technology – both at the IRF and at other sites.

Pilot key goals and actions

- Setup of 3 Carnot Battery systems, based on different technologies
- Demonstration of technological readiness of the Carnot Battery concept in a representative industrial-scale environment
- Prove economic viability to investors, stakeholders and decision-makers, in order to stimulate and incentivize replicated design at other sites
- Provide technological and operational knowledge for future large-scale projects
- Create a research platform for the participating international industry partners and research institutes
- Establish technical know-how of a technology with expected market potential for the near future in the IRF
- Promote cross-border cooperation in the development of an essential component for the future European energy system

Business and funding concepts

Under the expected future energy market conditions, operation of a Carnot battery over its total lifetime of 25-40 years is likely to be economically feasible.

Therefore, there is a certain interest from private investors who can provide partial funding.

However, the initial cost of building a Carnot battery is very high, followed by very low operating costs and stable yield. Since very few large-scale projects have been tested over a long period of time, the investment risk is currently considered too high for full private financing.
Expected budget:

- Construction of 3 storages:
  9 m. € each
- 3 Charging/discharging units:
  11 m. € each
- Civil works, power electronics, commissioning and monitoring:
  3 m.€ each
- Overall Budget: 69 m.€

Integration in the overall Regional Development Concept

The possibility to store electrical energy as heat optimally complements the generation of electricity from renewable energy sources and battery storage. The added possibility of using heat or waste heat supplied to private and industrial consumers within a district heating network is a major advantage of the Carnot Battery concept. The resulting coupling of different sectors in the region would lead to a substantial increase in energy efficiency and flexibility. Storage of electrical energy as heat fits inherently into the circular economy concept, as for the storage material, no scarce raw materials must be consumed. For the operation of the battery, no inflow of any raw material is necessary. In addition, the continued use of existing infrastructure becomes possible, which would otherwise have to be dismantled.

Supporting expert and industry groups

Research Institutes

- Fraunhofer ISE (DE)
- CEA (FR)

Possible Industry Partners

- Enolcon + large German utility (DE)
- MAN-ES (CH, DE)
- Bouygues Construction (FR) +
  Kraftanlagen München (DE)
- Potential additional Partners:
  Siemens (DE)
- GE (FR)
- Atlas Copco (FR)

External expert group

IEA TCP Energy Storage Task 36 – Carnot Batteries (15 countries; 56 participating organisations from industry, academia and government agencies)

Next steps

2022: Specification of the technological concept and detailed dimensioning of the pilots, planning of integration of the new infrastructure in the dismantling of the current infrastructure

2023: Clarification of the funding, acquisition of private investors

2024-2026: Construction phase

2027: Commissioning and testing

From 2028: Regular operation, long-term monitoring and service to the electric grid

SWOT analysis

Strengths	**Weaknesses**
• Very low cost of the storage material • Increased lifetime of storage medium • Possibility of using existing infrastructure on-site	• Relatively low efficiency • High price of the power unit
Opportunities	**Threats**
• Need for research with regard to efficient and uniform feed of energy into the storage medium and withdrawal of heat at high power levels • Development of energy storage systems with low-cost storage media is therefore an economically promising opportunity • Major economic opportunities of the concept exist if fluctuations in the electricity price remain high	• A local risk potential exists only due to the high temperature of the storage material. Environmental risks due to the release of harmful materials do not arise. • Smoothing of energy prices threatens economic feasibility

2.7. System integration: 2nd life, NaS battery, Redox-flow battery, Carnot battery

Competence Group: **Green Battery Circular Economy**
Pilot name: **Pilot Project GB-SL-G "System integration of the Hybrid storage: 2nd life Li-Ion battery, NaS battery, Redox-flow battery, Carnot battery"**

Justification for the pilot selection / Background

Integration of used EV batteries, which are usable for 2nd life application, into a hybrid storage system. Implementing an intelligent energy management system (EMS) to operate the innovative battery storage in an economic way and support the grid with grid services. This pilot is one key factor to support the stability level with 100% renewable energies in the system.

Pilot key goals and actions

The key goals of the pilot group are listed in the following lines:

- integrate different battery storage technologies economically into the system
- developing an energy management system (EMS) for the hybrid storage
- monitoring the hybrid system (especially the 2nd life battery in acting with the other battery systems) for better optimisation
- qualify the overall hybrid battery system
- develop and integrate quality assurance system for a save operation for the 2nd life battery
- For this pilot a TRL 7 can be reached.

Business and funding concepts

The pilot project needs funding support for implementation of this lighthouse as well as for the development of the energy management system and the implementation, test and evaluation of the hybrid battery system. Therefore, the pilot needs following funding (budget estimate):

- NAS – battery (BASF): 1,5 m. €
- Redox Flow battery (Storion): 1,5 m. €
- Grid Integration & Hybrid Battery Management (EMS): 2 m. €
- Note: Budget for 2nd Life and Carnot battery are already included in the corresponding tasks
- The long-term target will be that the battery will cover the operating costs without external funding.

Integration in the overall Regional Development Concept

With the integration of different battery technologies, companies around the greater Fessenheim area like BASF, Stellantis (PSA) or Storion can integrate and validate the battery systems and can build up their expertise with the lighthouse technologies for the way towards the European goal of climate neutral by 2050. Out of this pilot project jobs, experience, greater knowledge and connectivity between the different stakeholders can be created. Due to this extraordinary process the whole region will benefit.

Supporting expert and industry groups

Research Institutes

- Fraunhofer ISE
- University of Strasbourg
- University of Freiburg

Possible Industry Partners

- BASF
- Storion
- Enolcon
- Kraftanlagen München / Bouygues Construction
- MAN-ES
- Stellantis (PSA)

Next steps

The developed roadmap is highly dependent from the start of the project and the progress of the other pilot projects of the Competence Group: 2nd life battery on the grid.

The overall project comprises five processes. The integration of different battery storages, the development of an energy management system, the monitoring of the hybrid system, the qualification of the system and permanent project management.

SWOT analysis

Strengths	**Weaknesses**
• High engineering experience in the field of storage technologies, energy management systems (EMS) and innovative battery technology solution • Long-term experience in monitoring and analyzing and optimizing of field power plants • Well experienced in implementing hybrid battery storage technologies • Very strong consortia: High research excellence combined with very good and strong support from industrial partners	• Language barriers • Bureaucratic structure
Opportunities	**Threats**
• This lighthouse project will have a significant radiance in the field of green energy to reinforce the leadership and reputation for the upper Rhine valley in being a frontrunner of the energy transition • Creating an infrastructure which will create jobs in a future leading technology sector • Growing public interest of the topic, because of the energy transition	• Support of network operator and site owner (EDF) not yet confirmed • Availability of 2nd life batteries (Stellantis) • Potential bigger safety standard for the battery

3. Sub-Pilots of the Battery Recycling Subgroup

3.1. Dismantlemen

cf. “Sub-Pilots: 2nd life Subgroup: Robust and Resilient Supply Chain for EV Battery Recycling” Pilot Sheet

3.2. Recyclate analytics and qualification

Competence Group: **Green Battery**
Pilot name: **Pilot Project GB-BR-A "Concept for recyclate analytics and qualification"**

Justification for the pilot selection / Background

Current recycling processes focus on the recovery of the valuable metals such as Ni, Co, Mn, etc. to reach future recycling rates the industry needs to focus as well on the recycling of other materials. Using materials recovered from production or EoL waste will lead to the necessity of proper material testing and quality assurance within both R&D and production.

Pilot key goals and actions

Recyclates (regenerated electrode materials or precipitated starting compounds from production or End of Life waste) need to be qualified for a further use in batteries according to specifications that need to be defined together with the other tasks in this project.

- In general standard methods and measures are needed to provide the most precise picture of the material performance and composition and assure transparent and reliable material provision throughout the material cycle. Therefore, following key goals and actions will be addressed:
- Development and definition of methods for recyclate (from production and EoL) analytics. Therefore amongst others the following methods might be applied to analyse materials and their properties: Elementary analysis, ICP-OES, Particle classification and characterisation (size, mash-width, …), XRD, REM-EDX, TGA, DSC,…)
- Development of an evaluation process for recyclates
- Definition of certification measures for a defined process to meet materials standards

Business and funding concepts

Must be aligned with general development concepts.

Integration in the overall Regional Development Concept

Battery development and production is driven by high performance concerning capacity, energy density and lifetime. For a circular economy and a sustainable implementation of renewable energy concepts it is mandatory to qualify recyclates for the use in new batteries to keep the high standard of state-of-the art batteries. Together with innovative disassembly and recycling processes and cell production recyclate analytics offer the opportunity for the implementation of an analytics lab with researchers and technicians in the region of Fessenheim with the requirement to constantly adapt to new developments in the field batteries.

Next steps

Will be aligned with other tasks as the methodology of qualification will depend on the recovered materials.

For proper usage, both a facility for battery dismantlement and a facility for the recycling of battery materials are needed.

SWOT analysis

Strengths	**Weaknesses**
• The need for battery material qualification will constantly increase due to ongoing development in the field of batteries • Will be a basic need to enable a re-introduction of any kind of materials back into batteries	• Costs to implement testing measures must be in-line with the overall economic concept
Opportunities	**Threats**
• Standard qualification tool also for external companies and institutes • Set a baseline for future norms and standards, peer reviewed publication possible	• High dependency on input from other (sub)-tasks

3.3. Mechanical Process

Competence Group: **Green Battery**

Pilot name: **Pilot Project GB-BR-B "Development of a mechanical process for highly material-selective comminution"**

Justification for the pilot selection / Background

A used battery system is not necessarily intended for recycling only. The evaluation of a 2nd life is recommended for sustainability at least on system and module level. However, each battery reaches its end-of-life, thus has to be recycled. Currently several recycling plants exist either for pyrometallurgical treatment or for mechanical processing. For a high recovery rate and reduced energy consumption the mechanical way is required. To ensure safety and efficiency some companies work under cryogenic, inert or vacuum conditions. In this project new concepts using water will be developed and compared with the different known mechanical routes

Pilot key goals and actions

Process routes will be developed for the recycling process section from cell to black mass.

- The aim is pure black mass for a hydrometallurgical treatment that needs only a minimum of chemicals and energy.

Several wet shredding processes will be developed and tested:

- Electrohydraulic fragmentation
- Shredding with sprinkling and water bath
- Several following separation processes will be developed and tested:
- washing
- skimming & sieving
- centrifugation

Thereafter the combination of both will be optimized.

Process water treatment will be developed to keep water in the loop.

The process is evaluated and compared to other processes.

Business and funding concepts

Option for the current consortium: National funded project (eg. BMWi)

Integration in the overall Regional Development Concept

Battery development and production is driven by high performance concerning capacity, energy density and lifetime. For a circular economy and a sustainable implementation of renewable energy concepts it is mandatory to generate recyclates for the use in new batteries that can keep the high standard of state-of-the art batteries. Together with innovative disassembly concepts, recyclate analytics and cell production there is an opportunity for the implementation of a recycling plant with the requirement to constantly adapt to new developments in the field batteries.

Supporting expert and industry groups

Research Institutes

- Fraunhofer IWKS

Possible Industry Partners

- Roth international
- BASF
- BHS

SWOT analysis

Strengths	**Weaknesses**
• Reducing chemicals and energy consumption • Geopolitical independence	• Process water has to be treated
Opportunities	**Threats**
• Closing the loop for battery materials	• Purity of blackmass could not reach standard for the requirement for efficient low consumption hydrometallurgy

3.4. Hydrometallurgical Recycling

Competence Group: **Green Battery**
Pilot name: **Pilot Project GB-BR-C "Methods for the hydrometallurgical recycling of the electrode materials"**

Justification for the pilot selection / Background

Most common current battery recycling processes treat the cells pyrometallurgically, which sometimes is combined with an upstream pyrolysis and shredding. The occurring material streams such as black mass need to be treated hydrometallurgically to obtain precursors for the synthesis of new electrode materials. Here, the aim of the entire recycling process is to reach a high recovery rate, low carbon footprint, sustainable use of critical raw materials (CRM) such as graphite or phosphate and high purity of precursor material. Thus, in the linked pilot projects the development of a mechanical process is focused with the aim to achieve black mass of high purity for the presented pilot project. This is the prerequisite for developing chemical recycling with low consumption of chemicals and energy.

Pilot key goals and actions

Two ways are focused for the recovery of critical materials: leaching and precipitation of precursors for new battery materials and direct recycling.

- Leaching and precipitation: Leaching, filtration of graphite, production of chemical starting compounds
- Direct recycling: lithiation, thermal annealing

Business and funding concepts

Option for the current consortium: National funded project (eg. BMWi)

Integration in the overall Regional Development Concept

Battery development and production is driven by high performance concerning capacity, energy density and lifetime. For a circular economy and a sustainable implementation of renewable energy concepts, it is mandatory to generate recyclates for the use in new batteries that can keep the high standard of state-of-the art batteries. Together with innovative disassembly and mechanical recycling concepts, recyclate analytics and cell production there is an opportunity for the implementation of a recycling plant with the requirement to constantly adapt to new developments in the field batteries.

Supporting expert and industry groups

- Fraunhofer ICT
- Fraunhofer IWKS
- BASF

Next steps

For proper usage, both a facility for battery dismantlement and a facility for the recycling of battery materials are needed.

SWOT analysis

Strengths	Weaknesses
• Reducing chemicals and energy consumption • Geopolitical independence	• Defined materials are required, assuming that the material composition of the batteries is known • High temperature consumption of thermal processes
Opportunities	**Threats**
• Closing the loop for battery materials	• Risk of not reaching standard quality

3.5. Mechanical Process

Competence Group: **Green Battery**

Pilot name: **Pilot Project GB-BR-D "Development of a mechanical process for highly material-selective comminution"**

Justification for the pilot selection / Background

A used battery system is not necessarily intended for recycling only. The evaluation of a 2nd life is recommended for sustainability at least on system and module level. However, each battery reaches its end-of-life, thus has to be recycled. Currently several recycling plants exist either for pyrometallurgical treatment or for mechanical processing. For a high recovery rate and reduced energy consumption the mechanical way is required. To ensure safety and efficiency some companies work under cryogenic, inert or vacuum conditions. In this project new concepts using water will be developed and compared with the different known mechanical routes

Pilot key goals and actions

Process routes will be developed for the recycling process section from cell to black mass.

The aim is pure black mass for a hydrometallurgical treatment that needs only a minimum of chemicals and energy.
Several wet shredding processes will be developed and tested:

- Electrohydraulic fragmentation
- Shredding with sprinkling and water bath
-

Several following separation processes will be developed and tested:

- washing
- skimming & sieving
- centrifugation
- Thereafter the combination of both will be optimized.
- Process water treatment will be developed to keep water in the loop.
- The process is evaluated and compared to other processes.

Business and funding concepts

Option for the current consortium: National funded project (eg. BMWi)

Integration in the overall Regional Development Concept

Battery development and production is driven by high performance concerning capacity, energy density and lifetime. For a circular economy and a sustainable implementation of renewable energy concepts it is mandatory to generate recyclates for the use in new batteries that can keep the high standard of state-of-the art batteries. Together with innovative disassembly concepts, recyclate analytics and cell production there is an opportunity for the implementation of a recycling plant with the requirement to constantly adapt to new developments in the field batteries.

Supporting expert and industry groups

Research Institutes

- Fraunhofer IWKS

Possible Industry Partners

- Roth international
- BASF
- BHS

Next steps

The development of a concept and a demonstration line in 3 years.

For proper usage, both a facility for battery dismantlement and a facility for the recycling of battery materials are needed.

SWOT analysis

Strengths	**Weaknesses**
• Reducing chemicals and energy consumption • Geopolitical independence	• Process water has to be treated
Opportunities	**Threats**
• Closing the loop for battery materials	• Purity of blackmass could not reach standard for the requirement for efficient low consumption hydrometallurgy

3.6. Hydrometallurgical Recycling

Competence Group: **Green Battery**

Pilot name: **Pilot Project GB-BR-E "Methods for the hydrometallurgical recycling of the electrode materials"**

Justification for the pilot selection / Background

Most common current battery recycling processes treat the cells pyrometallurgically, which sometimes is combined with an upstream pyrolysis and shredding. The occurring material streams such as black mass need to be treated hydrometallurgically to obtain precursors for the synthesis of new electrode materials. Here, the aim of the entire recycling process is to reach a high recovery rate, low carbon footprint, sustainable use of critical raw materials (CRM) such as graphite or phosphate and high purity of precursor material. Thus, in the linked pilot projects the development of a mechanical process is focused with the aim to achieve black mass of high purity for the presented pilot project. This is the prerequisite for developing chemical recycling with low consumption of chemicals and energy.

Pilot key goals and actions

Two ways are focused for the recovery of critical materials: leaching and precipitation of precursors for new battery materials and direct recycling.

- Leaching and precipitation: Leaching, filtration of graphite, production of chemical starting compounds
- Direct recycling: lithiation, thermal annealing

Business and funding concepts

Option for the current consortium: National funded project (eg. BMWi)

Integration in the overall Regional Development Concept

Battery development and production is driven by high performance concerning capacity, energy density and lifetime. For a circular economy and a sustainable implementation of renewable energy concepts, it is mandatory to generate recyclates for the use in new batteries that can keep the high standard of state-of-the art batteries. Together with innovative disassembly and mechanical recycling concepts, recyclate analytics and cell production there is an opportunity for the implementation of a recycling plant with the requirement to constantly adapt to new developments in the field batteries.

Supporting expert and industry groups

Research Institutes

- Fraunhofer ICT
- Fraunhofer IWKS

Possible Industry Partners

- BASF

Next steps

For proper usage, both a facility for battery dismantlement and a facility for the recycling of battery materials are needed.

SWOT analysis

Strengths	Weaknesses
• Reducing chemicals and energy consumption • Geopolitical independence	• Defined materials are required, assuming that the material composition of the batteries is known • High temperature consumption of thermal processes
Opportunities	**Threats**
• Closing the loop for battery materials	• Risk of not reaching standard quality

4. Competence Group Hydrogen

4.1. Subgroup “Large scale industry supply with green hydrogen”

Competence Group: **Hydrogen**
Pilot name: **Pilot Project H2-A “Large scale industry supply with green hydrogen”**

Justification for the pilot selection / Background

There is an existing large market for green hydrogen, which could deliver strong effects in CO_2 reduction on the large scale with relatively low specific system costs. The Fessenheim region and in particular Chalampé offers unique opportunities for high quality renewable electricity, which allows usage of the production path via the mainstream electrolysis. Additionally the existing hydrogen pipeline may be used as an effective distribution infrastructure to the lead industry customers. Lacking green hydrogen may be imported via the river Rhine using the powerful harbour infrastructure and extending it with LH_2 storage and bunkering facilities. LH_2 will bridge to other large scale applications not anchored in the industrial area and connected to the pipeline, for instance as a hydrogen supply option for heavy duty transport.

Pilot key goals and actions

- Securing access to hydroelectricity power
- Selecting the optimum lake/water area for building a reference floating PV
- Finalising the land planning for a 200 MW production electrolyser with an initial installation of 40 MW with most direct connection to the existing pipeline
- Installation of the 40 MW electrolyser, producing green hydrogen at costs < 5 €/kg
- Installation of a test bed for new innovative electrolyser cells/stack/ systems for assessing new materials and components under various grid integrated conditions (operational strategies and concepts for stationary/dynamic operations of electrolyser, electrolyser as flexible load / grid balancing, etc.) and further development of electrolyser technology with regard to performance and costs
- Benchmarking with the 1 MW Grenzach-Whylen pilot plant of Energiedienst
- Further extension to 200 MW and possibly beyond

Business and funding concepts

Estimated investment of 300 m. € for large scale electrolysis (200 MW) and 2 floating PV installations (40 MW).

Industry financed with public support via suitable regulation for eligibility of the grid integration and green electricity supply.
Integration in an EU Hydrogen Valley could fund additional costs for the integration in the hydrogen hub. A call for a Hydrogen Valley by the Clean Hydrogen Joint Undertaking is expected in March 2022 with a maximum EU funding of 25 m.€.
Application for an EU OITB for the associated electrolysis test bed.

On the basis of the World Energy Outlook 2020 of the IEA (page 40) and according to studies of H2V it is estimated that based on the investment for operation of the whole system 70-200 jobs might be generated

Integration in the overall Regional Development Concept

Coupling of the electrolysis off-heat into a low heat supply network.

Marketing of the oxygen (e.g., glass, steel industry, hospitals, wastewater treatment, fish farming…)

Supporting expert and industry groups

Research Institutes

- Linde France (as industry gas supplier)
- BASF, Borealis (with huge demand for nylon and ammonia production)
- Siemens (supplier of PEMEC)
- KIT
- UNISTRA
- ISE Fraunhofer

Possible Industry Partners

- EdF/Hynamics (operation of electrolysis)
- EUROGLAS (with potentially huge demand for clean high T heat)
- McPhy, ThyssenKrupp, NEL (supplier of alkaline technology)
- ITM, Cummings, (alternative supplier of PEMEC)

Additionally there is a link to the Battery Competence Group via combining batteries with electrolysers for optimized operational concepts.

Next steps

A large-scale electrolyser needs to be set-up in the region. The capacity will initially be around 40 MW and should then be expanded further to around 200 MW. An innovative electrolyser test-bed can then be installed to test further. A final addition would be the installation of floating PV systems in the region.

SWOT analysis

Strengths	Weaknesses
• Green hydrogen is key for defossilisation of several processes in industry on large scale • Large scales come at low specific costs (however, still above conventional hydrogen) • Electrolysis is a mature technology coming at low investment costs (Alkaline electrolysis TRL= 9)	• No visibility • A Relatively small number of jobs created per investment • No operating partner identified to this date
Opportunities	**Threats**
• Existing applications and infrastructures (e.g. pipeline) of "grey" hydrogen may be easily converted to "green" • Large scale effects in CO_2 reductions at relatively low specific costs • Industry scaled hydrogen production might supply other more distributed use cases like transport with hydrogen at a highly attractive price level • Electrolysis might use existing infrastructure • Industry will generate new highly profiled jobs • Synergies with the other actions • EU-wide political willingness to develop renewable H2 production	• Threats • Neither suitable regulation, nor a business case for EdF for accessing hydroelectric power • Required additionality and locality might impede the use of hydroelectric power • Insufficient opportunities for additional floating PV • General run on electrolyser technology might delay the purchase, delivery and installation • Production costs still higher than conventional hydrogen • Lack of regulations of the green H2 industry considering its novelty

4.2. Subgroup "Virtual Pipeline"

Competence Group: **Hydrogen**
Pilot name: **Pilot Project H2-B "Virtual Pipeline"**

Justification for the pilot selection / Background

Import infrastructure for green hydrogen needed as local production of green H2 might be limited. Real pipelines are long-term projects binding huge investments, and are not very flexible. Besides the plans for connecting the Fessenheim region with the European hydrogen backbone transport grid foresee connection only in ~ 2040

Pilot key goals and actions

Demonstrate functionality of „Virtual Pipeline" consisting of:

Two Rhine harbour installations (one at Ottmarsheim and one at Karlsruhe) with LH_2 bunkering and large-scale storage.

- Low water capable, FC hybrid electric transport vessel for ISO containers in operation.
- Build „Green liquefier" (highly efficient, green H2 and electricity) at Fessenheim (1 t/d capacity).

Business and funding concepts

Estimated investments of 140 m.€ in total (100 m.€ liquefier , 30 m.€ storage+bunkering, 10 m.€ container vessel FC refit)

- Apply for public support/funding (Hydrogen Valley call in 02/2022)
- Involve interested Industry: Liebherr, MTU, Air Liquide, Miro, BASF, Stolt Tankers, DST...
- Close connection to planned projects, in particular BW model region,…
- Specific link to Fessenheim: existing harbour infrastructure, potential large scale electrification, bridging to Switzerland …
- Participation in H2Global

On the basis of the World Energy Outlook 2020 of the IEA (page 40) it is estimated that based on the investment for operation of the whole system up to 500 jobs might be generated.

Integration in the overall Regional Development Concept

LH_2 in particular allows multiple coupling with superconducted electricity (LIQHYSMES, icefuel concepts) and cooling demand. It provides a basis for trading green energy on longer distance, but could also serve as an economic option for seasonal storage of green energy

Supporting expert and industry groups

Research Institutes

- KIT
- UNISTRA
- ISE Fraunhofer
- University of Applied Science Karlsruhe

Possible Industry Partners

- Air Liquide for bunkering system
- Linde France for liquefier
- CryoStar as Mulhouse based supplier for cryo-equipment
- MTU for green harbour infrastructure and FC drivetrain of container vessel
- BASF as lead customer for additionally imported hydrogen

Next steps

Steps should be taken to build an enhanced pipeline system for storage and transport of hydrogen. A container based bunkering facility will aid in this endeavour. An FC driven container vessel will then be employed in the region. A hydrogen liquefier and corresponding LH_2 storage are necessary additions.

SWOT analysis

Strengths	**Weaknesses**
• Increase scale and improve economy by import capability • Integrating Fessenheim in a larger community by using existing infrastructures and the unique location D/F/CH at the river Rhine	• LH_2 technologies are expensive equipment that requires important investments
Opportunities	**Threats**
• Establishing Fessenheim region as central trading point/dispatching center for green energy via LH_2 might serve as a template for other regions	• No/limited funding available • Liquid is not seen as attractive option

4.3. Subgroup "Heavy Duty Transport"

Competence Group: **Hydrogen**

Pilot name: **Pilot Project H2-C "Heavy Duty Transport"**

Justification for the pilot selection / Background

The CO_2 reduction required by European regulation will induce the introduction of hydrogen as a fuel for heavy duty transport especially for long distance and energy intensive transport services. The important infrastructural location of the southern Fessenheim region, i.e. Ottmarsheim, connecting Northern Switzerland, Grand-Est of France with the South-West of Germany has led many transport companies to operate branches in this area. Tax law specifics in Switzerland have already allowed an industry-led consortium to commercially operate a fleet of Hyundai fuel cell trucks. The Fessenheim region could be developed as a strategic extension of this project.

Pilot key goals and actions

Proper land and supply planning for large State-of-the-Art fueling station (initially 1 t/day finally 5 t/ day) in the area Ottmarsheim

Set-up of the State-of-the-Art fueling station for heavy duty trucks

Design and conduct and initially predominant research and testing program before the actual operation of the station for fleet fueling services

- Establishment of the service company selling H2 based clean transport
- Negotiating best conditions (taxation, hydrogen pricing,…) and selling of packages to customers
- Actual commercial operation of the system, consisting of station and fleet
- Plan for end-of-life

Business and funding concepts

Estimated investments of 10 m. € in total (7 m. € for state-of-the-art LH2 based heavy duty fueling station with research interfaces; 3 m. € for 20 HD trucks)

On the German side public programs currently cover 80% of the additional costs for trucks and fueling stations compared to conventional solutions (invest). The operational costs might be close to current costs with conventional (even with costs for hydrogen > 5 €/kg fueled).

ADEME call for projects on the French side: up to 55% of the additional costs for trucks and fueling stations compared to conventional solutions. To get the funds, at least 50% of the off takers must be identified.

Copying the Swiss business model with a service entity offering clean transport on a (ton*km) basis to the customers, consisting of forwarding/shipping companies and other major industry customers with high transport demand seems to be the most promising approach.

On the basis of the World Energy Outlook 2020 of the IEA (page 40) it is estimated that for the fleet and fueling station operation 40 - 50 jobs might be generated.

Integration in the overall Regional Development Concept

The heavy duty fueling station might be combined with fast charging points for battery based heavy-duty distribution trucks or battery based buses.

The liquid hydrogen stored might cool superconducting charging points or other high power systems.

It should be openly accessible to demonstrate safety and to "share" the technology with the public.

Supporting expert and industry groups

Research Institutes

- KIT (ITES, ITAS) (Aufzählungszeichen fehlt)
- Troyes' Institute of Services and Industries
- of the Future
- University Hohenheim
- FhG- ICT Pfinztal
- FhG-ISE (Karlsruhe)

Possible Industry Partners

- Fuel supplier: Linde France, Air Liquide
- Refueling station operator: Shell, Total
- CryoStar
- Truck suppliers: Hyundai, Daimler Trucks
- Logistics: Grieshaber, Schenker and JCL Logistics

Next steps

A heavy duty refueling station is needed as a prerequisite for other undertakings. Interfaces for refueling protocols, metering, etc. will then have to be researched and developped. A fleet of heavy-duty hydrogen vehicles can then be deployed on a wider scale.

SWOT analysis

Strengths	Weaknesses
• Close proximity to Germany where a strong HRS network already exists (about 100 HRS) • High heavy duty traffic: up to 13.000 trucks per day (see p.36 in the SudAlsace study) • International highway, intersection of the A5 (DE) A35 (FR) and A36 (FR) at Ottmarsheim • Large scale with huge potential impact on CO_2 footprint in heavy duty transport • Assuring the future of transport companies with a strategic function in this special location • Realisation of CO_2 free multi-modal transport	• No commitment of the nearby PSA site • Little to no interface with the public, as the concerned trucks are mainly operated on highways • Lack of data concerning the daily refueling of trucks in the Ottmarsheim region
Opportunities	**Threats**
• Rise of the costs for oil, reduction of tolls for zero emission vehicles • Rise of the carbon tax by more than 100% in France between 2018 and 2030 • Hydrogen more profitable than Diesel at this time • Using the hydrogen fueling station also for a bus fleet in Mulhouse • Establishing the stations as a test bed for future, innovative fueling concepts • Expected ban of new diesel vehicles by 2040 • Expected subsidies for H2 vehicles adoption	• Important costs for transport companies which might choose to not invest in H2 trucks • Fueling stations might become a stranded asset with an unresolved "chicken and egg" problem (as happened for the > 100 hydrogen stations in Germany with too few hydrogen fuel cell cars) • Swiss concept might fail because of different regulation, taxation etc.

4.4. Subgroup “Distributed production and use in agriculture”

Competence Group: **Hydrogen**

Pilot name: **Pilot Project H2-D “Distributed production and application of green hydroge in agriculture”**

Justification for the pilot selection / Background

The overall potentials of agriculture and forestry as one backbone of a hydrogen-based society and economy are complex, significant, but often completely underestimated. Because cities could not harvest renewable energy in sufficient amounts, it is up to the landscape to pervade the increase of renewable energy. To integrate agriculture and forestry as one major player in a win-win approach could lead Europe into a promising future. With well thought-out approaches, it is possible to demonstrate in the region around Fessenheim, both technical utilisation and application possibilities of hydrogen technology as well as synergy effects for demonstration. Valuable pathways need a concentration on essential core elements and objectives:

1. The use and benefit of biomass for the production of hydrogen (e.g., methane-cracking by plasmalysis)
2. The use of hydrogen in agriculture (e.g., combustion engine and fuel cells, H2 and CH4)
3. Synergetic effects and harmony of the use of renewable energy on agricultural land (e.g., transparent solar panels)
4. Decentralised character in future and increasing independence (regional approach)
5. Transfer of outcomes to similar areas

The emission of methane (e.g., through livestock) is an additional aspect to be addressed. Methane as a climate-damaging gas used to produce hydrogen. Simultaneous production of carbon-based materials that either can be used on agricultural soils (closing the carbon cycle) or carbon based materials for technical products. The potential is high for both, deposition of carbon and synthesising of specific carbon based materials (as basic materials) for further processing.

In addition, results achieved (e.g., technological and engineering solutions) transferable to other types of similar areas, through the direct use of methane produced, e.g., by wastewater treatment plants, landfills. Specifically novel technological approaches in producing hydrogen from bio-methane for instance by plasma-driven technology (methane-cracking) can build the basis of decentralised hydrogen production in midterm.

Pilot key goals and actions

- Investigating the potentials for production of hydrogen by methane-cracking by use of novel technology to be developed, plasmalysis and optional pyrolysis (low TRL) operated by use of renewable energy
- Selecting potentials for hydrogen driven applications on farms and business environment (e.g., combustion engines tractors and towing vehicles, mews etc.)
- Investigating synergies between market gardening and use of transparent PV installations (protections exhaustive solar radiation, volley, dry out of soils, etc.)
- Installation of a test PV bed for new innovative technology in hydrogen production out of bio-methane
- Option to operate with bio-methane in HT Fuel Cells
- Benchmarking pilot plant of Energy Service on local areas
- Further extension to MW scale and possibly beyond

Business and funding concepts

The interaction between agriculture, forestry, rural communities, energy suppliers and renewable energy and hydrogen technology based industry must be introduced to funding organisations more appropriate and promising. Some funding organizations have open opportunities to cover the aspects. Potential interest for those kinds of projects (demonstration projects):

- European council (EU)
- Agence Nationale de Recherche (FR)
- Grand Est Region (FR)
- Baden Württemberg Land (DE)
- BMU (DE)
- BMBF/BMWI (DE)

Integration in the overall Regional Development Concept

This project will contribute to the decarbonisation of agriculture, harvesting renewable energy by PV, producing hydrogen by bio-methane, deposition of carbon and introducing hydrogen technology in rural areas. This will also lead to more visibility and public acceptance.

The market is still not existing, but technology developed and ready to get installed and tested (low TLR level)

Specifically, the use of carbon based materials for deposition on agricultural soils and/or forestry as well as usage of basic materials for technical products could lead to breakthrough application.

- Contribute to the ongoing effort of creating a European industry and supply chain of hydrogen applications
- Use of carbon to support the circular economy (decarbonisation)
- Increase the use of renewable energy and hydrogen production
- Synergies between agricultures and energy harvesting

Strengthen the interconnection of renewable energy and agriculture (farming and forestry) reach a European (maybe) worldwide impact

Supporting expert and industry groups

Research Institutes

- KIT (ITES, ITAS)
- Troyes' Institute of Services and Industries of the Future
- University Hohenheim
- FhG- ICT Pfinztal
- FhG-ISE (Karlsruhe)

Possible Industry Partners

- Farmers and Forests House
- Energy supplier
- FCH-Industry
- Industry using carbon based materials
- PV-Industry (production of solar panels)
- Pural communities

Next steps

The construction of a prototype biogas-based production plant is the first step, followed by the installation of fuelling stations for agricultural machines. With both of these in place, a deployment of a fleet of hydrogen driven agricultural machines is possible.

SWOT analysis

Strengths	Weaknesses
• Green hydrogen as key for decarbonization of agriculture • Deposition of carbon on soils (potentially with impact) • Prevention of uncontrolled emission of methane • Decentralized production of hydrogen out of bio-methane • New market for applications (FCH technologies) • Increasing independence of local communities • Synergies between agriculture and energy harvesting (renewable energy)	• Low TLR levels (e.g., plasmalysis methane-cracking and potential use of pyrolysis) • Less knowledge of depositing massive carbon based materials on agricultural soils • Less visibility • A Relatively small number of jobs created per investment • Low acceptance from the general public and farmers, thus need to communicate on the potential gains
Opportunities	**Threats**
• Combustion engines based on hydrogen for tractors and towing vehicles • Capacities for storage systems (hydrogen and methane) • Hydrogen through methane cracking by means of pyrolysis or plasmalysis • Prevention of market gardening • Large scale effects at relatively low specific costs • Industry scaled hydrogen production might enable other more distributed use cases • Synergies with the other actions • Deposition of carbon based materials and potential positive effects	• Less knowledge about effects of depositing carbon based materials on agricultural soils • No business case for Energy suppliers • Technology for methane-cracking on low TLR • No acceptance of approach or technology • Costs won't come down compared to conventional hydrogen

5. Competence Group Smart Grids

5.1. Twin Quarter Pilot

Competence Group: **Smart Grids**
Pilot name: **Pilot Project SG-A "Twin quarters Mulhouse - Karlsruhe"**

Justification for the pilot selection / Background

In the city of Mulhouse there are two possibilities of integration of smart grids. The first one in the Fonderie quarter which includes industrialists and the second one in the DMC quarter with a mix of uses in development.

In Karlsruhe, such a project is ongoing in the East quarter for the energy transition in the city; this project is in collaboration with the KIT and Seven2one.

For the Fonderie quarter. The city of Mulhouse is planning to set up businesses and the idea is to create a sustainable quarter between already existing smart grid quarters in Karlsruhe and Mulhouse to create an exchange of expertise between both.

Pilot key goals and actions

Goals

- Reduce energy consumption, efficiency
- Integrating renewable energy and storage
- Couple electricity, heat and cold
- Develop e-mobility
- Analyze the uses, creation of learning databases
- Develop respectives business models
- Create an exportable model (ex: EcoRhena)
- Labellisation ISO 50 001, Energy Management
- Both become "climate cities"

Actions

- Create a consortium for Mulhouse (already existing at Karlsruhe)
- Define common objectives (sharing of competences and ideas)
- Develop acceptability and economical model
- Join grids simulation (ex: RDTS / OPAL-RT)

Business and funding concepts

Funding organisations to be solicited:

- ADEME (FR)
- BPI (FR)
- Grand Est Region (FR)

Integration in the overall Regional Development Concept

The installation of smart grids in a district with industrial potential will make it possible to reduce electricity consumption thanks to the analysis of uses.

Supporting expert and company groups

Research Institutes

- University of Mulhouse
- University of Strasbourg
- University of Freiburg
- Fraunhofer ISE
- Karlsruhe Institute for Technology

Possible Industry Partners

- Seven2one (Smart East quarter in Karlsruhe)

Next steps

In a first step, local authorities (m2A, ville de Mulhouse) were contacted. On the German side, this has taken place already as well (Karlsruhe Smart East). The Mulhouse delegation visited Karlsruhe in January. A French-German consortium then needs to be established. Finally, applications for funding to calls have to be submitted.

SWOT analysis

Strengths	**Weaknesses**
• Experience and knowledge in Energy Management • Several contacts with local companies	• Data collection (ex: smart meter)
Opportunities	**Threats**
• Data collection (ex: smart meter)	• Data collection (ex: smart meter) • no investment by the quartier

5.2. European Grid Pilot

Competence Group: **Smart Grids**
Pilot name: **Pilot Project SG-B "European Grid Development"**

Justification for the pilot selection / Background

Solving the problem of stability of electric power distribution including the connection of the German and French networks with electric interconnections development: high level (some GW) middle level (less than 1 GW)

Tackle the issue of energy mix integration on the grid at an European level

Pilot key goals and actions

Goals

- Robust stability of the grid, keep the frequency close to 50Hz
- Optimize the energy mix towards decarbonisation
- Integrate local grids with transnational grid
- Enhance the commercial transaction balance

Actions

- Collaboration between NetzeBW/ TransNetBW and RTE (already existing thanks to the Fraunhofer ISE)
- Define the scientific open questions
- Join grids simulation (ex: RTDS / OPAL-RT)

Business and funding concepts

Funding organisations to be solicited:

- The European Structural and Investment Funds (ESIF)

Integration in the overall renewable energy and circular economy concept for the region towards CO_2 neutrality

Integrate a stability of the German and French network

Supporting expert and industry groups

Research Institutes

- University of Mulhouse
- University of Strasbourg
- University of Freiburg
- Fraunhofer ISE
- Karlsruhe Institute for Technology

Possible Industry Partners

- RTE (FR)
- NetzeBW (DE)
- TransNetBW (DE)
- EDF (FR)

Next steps

A meeting with NetzeBW, TransNetBW, RTE and EDF has to be organised, because of the closure of the Fessenheim plant.

SWOT analysis

Strengths	**Weaknesses**
• Experience and knowledge in Energy Management • Several contacts with local companies • existing cross border lines	• Data collection (ex: smart meter) • political will
Opportunities	**Threats**
• Data collection (ex: smart meter) • a more integrated energy market • better grid stabilization • better electricity management	• regulative barriers • investments into the grid

5.3. EV Charging Grid Pilot

Competence Group: **Smart Grids**
Pilot name: **Pilot Projects SG-C "Electric vehicles charging stations grid"**

Justification for the pilot selection / Background

Management of the location of electrical charging stations, charging strategy, development of charging points numbers in cities.

One concrete example in Mulhouse Agglomération (m2A) with 150 new points of electric charging stations.

Also, maybe Black Forest could be a prototype region because of advantage of electromobility due to recuperation when driving down.

Pilot key goals and actions

Goals

- Optimize the charging station network of a district, a city or a road network
- Reduce power peaks with battery (2nd-life battery)
- Optimize the coupling between the charging load network and the distribution network
- Develop a profile and a usage model
- Standardisation of charging network

Actions

- Create a consortium (ex: "Daimler", "Stellantis", Enedis, EDF…)
- Application of metaheuristics & stochastic search algorithms
- Define topology
- Develop simulations

Business and funding concepts

Funding organisations to be solicited:

- ADEME (FR)
- Grand-Est Region (FR)

Integration in the overall renewable energy and circular economy concept for the region towards CO_2 neutrality

Reduce the impact of carbon emissions through the installation of electric charging stations for vehicles

Supporting expert and company groups

Research Institutes

- University of Mulhouse
- University of Strasbourg
- University of Freiburg
- Fraunhofer ISE
- Karlsruhe Institute for Technology

Possible Industry Partners

- Daimler (DE)
- Izivia (FR)
- EDF (FR)
- Enedis (FR)
- INPUT 2.0
- LAMA

Next steps

Contact to EDF (and Izivia) and m2A has been established. Next, it is necessary to apply to calls for projects by m2A.

SWOT analysis

Strengths	**Weaknesses**
• Experience and knowledge in Energy Management • Several contacts with local companies • electricity charging stations are planned	• no clear investment commitments • industry not yet involved
Opportunities	**Threats**
• testbed installations	• data protection • no good business model