THE MUSIC PROJECT

Materials for sUstainable Sodium-Ion Capacitors

Deliverable D3.6 Scale-up of Materials - update

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Publishable summary

The MUSIC project is dedicated to the scaling up of sustainable materials for Sodium-Ion Capacitors (SICs) and the establishment of a European value chain through collaborations between industry and research institutions. A pivotal milestone in this endeavour is Deliverable D3.5 by M42, serving this version as an intermediary step for upscaling materials, involving material selection and testing through partnerships.

As part of D3.5, BYD focused on the scale up of the positive active material, an activated carbon synthesized from Norwegian sawdust biowaste. Simultaneously, JVI and CNRS-IMN is focussing on Carbon Fibres recycled form the aeronautic industry.

Another facet of D3.5 involves CICE's efforts in the development, testing, and scaling up of a novel sacrificial sodium salt for pre-sodiation, having scaled up the synthesis to produce 1 kg of sacrificial salt.

Further, ELY has scale-up GEN0 electrolyte formulation, reaching a production of 2 litres, and delivered to all MUSIC partners.

In summary, the MUSIC project's primary goal is the acceleration of sustainable material development for SICs, and Deliverable D3.5 plays a crucial role in addressing material synthesis, pre-sodiation strategies, and electrolyte development, while navigating challenges in scaling up proprietary materials.

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Abbreviations

SYMBOL	SHORTNAME
SIC	Sodium-Ion Capacitor
HC	Hard Carbon
SAC	Super-Active Carbon
AC	Activated Carbon
LICs	Lithium-Ion Capacitors
CFs	Carbon Fibers
XRD	X-Ray Diffraction
rCF	Recycled Carbon Fibres

1 Introduction

A core focus of the MUSIC project is the scaling up of sustainable materials for Sodium-Ion Capacitors (SICs) and building the European value chain. To achieve this, the MUSIC project has organized collaborations between industry and research institutions to accelerate this development.
Deliverable D3.5 exists as an intermediary milestone for the upscaling of these materials in which material selection is performed and small-scale samples are delivered between partners for testing and verification.
D3.5 is divided into separate tasks, as detailed below.

1.1 Synthesis of advanced Active Materials

As part of the MUSIC project, novel active materials are a focus. CICE will develop advanced cathode materials in conjunction with BYD as well as advanced anode materials. CICE has produced and tested Hard Carbons from four different synthesis procedures. Simultaneously, JVI CNRS-IMN and UPS are developing Carbon Fibres and MXenes as novel anode materials.

1.2 Development of sacrificial components and pre-sodiation strategies

CICE will develop, test and scale-up sacrificial sodium salt for pre-sodiation. The pre-sodiation is a critical step in increasing the energy density of SICs, and CICE's sacrificial salt is novel and based on previously developed Lithium analogues. As part of D3.5 CICE has successfully synthesised disodium squarate in 10 g batches and begun the scaling up of this material to 1 kg. Finally 5 kg of sacrificial salt was synthesized for pilot line production of cells.

CNRS-IMN has successfully investigated sodium malate and trisodium citrate as additives to the cathode and found that these are capable of providing sodium to the cell. However, the breakdown products form insulating layers on the cathode. Nevertheless, this is a promising method for pre-sodiation.

1.3 Development of innovative electrolytes

Together with FSU, ELY will develop innovative electrolytes suitable for the characterization of high performance SICs operating at more than 4V. Important electrolyte properties such as high conductivity, high electrochemical stability, high thermal stability, high safety, low flammability and good solubility of the sacrificial salts/sodium compounds in the electrolyte are required to ensure the performance of the SICs. ELY has delivered a number of electrolyte formulations to FSU for testing. The electrolytes have been subjected to storage tests and rate tests.
ELY will scale up a 1st generation of sodium electrolytes for the activities in WP5 and WP6. ELY can upscale up to 2L (bottle) or up to 20 kg.

1.4 Scale-up of Super-Active Carbon

Super-Active Carbon (SAC) is Beyonder's (BYD) proprietary active carbon (AC) product designed specifically for use in Lithium-Ion Capacitors (LICs). Deliverable D3.5 entails bringing the production of SAC from 500 g batches up to 5-10 kg batches. However, due to a lack of market demand, this level of upscaling means that production of large quantities of SAC had to be paused. In order to satisfy the requirements of the MUSIC project, several commercially available AC materials have been assessed, and a suitable substitute has been identified. This ensures that other deliverables will not be affected, and no delays will be encountered as a result of this change.

2 Methods and Results

2.1 Synthesis of advanced Active Materials

Carbon Fibres

The supply of rCFs was done in two phases:

- Phase1 - small quantities (around 100gr) of two sources (ex-PAN and ex-Pitch) of Carbon fibre Reinforced Polymer CFRP recycled using three methodologies (done by Apply-Carbon (*pyrolyse*), Alpharecyclage Composites (*vapothermolysis*) and Extrahive (*solvolyse*)) where procured by IRT-JV and handed to CNRS-IMN in short-cut rCFs (under 1mm) for preliminary analysis and choice (**Figure 1**). The short rCFs samples were milled (powder level), and laboratory assessment was carried out by CNRS-IMN.
- Phase2 – the results of CNRS-IMN laboratory analysis allowed the project to select two types of rCFs, and IRT-JV procured 1kg of each of these rCFs for producing higher quantities of super active carbon and scaling-up analysis (presented later in 2.4).

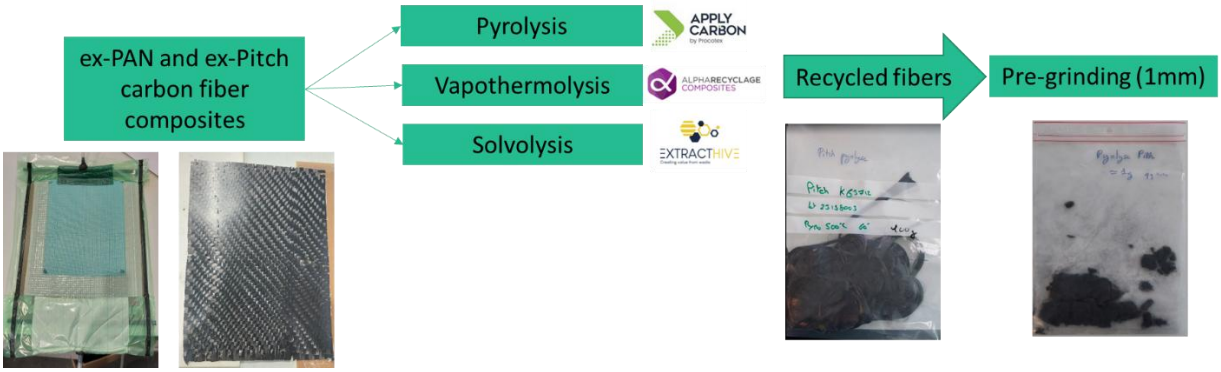


Figure 1. Methodology for supply-chain pre-selection of rCF

MXenes

Mxenes are novel materials whose viability is not demonstrated yet, and their low maturity (TRL1-2) discourages their incorporation onto prototypes.

2.2 Development of sacrificial components and pre-sodiation strategies

The scale-up of disodium squarate was externalized to a technology center located in Spain named AIMPLAS. The synthesis procedure is as follows: Disodium squarate ($Na_2C_4O_4$) is synthesized using 3,4-dihydroxy-3-cyclobutene-1,2-dione (squaric acid) and Na_2CO_3 as starting materials. They have been purchased from Apollo and Sigma respectively. The sodium carbonate is ACS reagent anhydrous with ≥99.5% purity (Ref. 222321, CAS: 497-19-8, https://www.sigmaaldrich.com/ES/es/product/sigald/222321) and the squaric acid by HPCL ≥99.7% (Ref. 54-OR28821, CAS: 2892-51-5, https://cymitquimica.com/es/productos/54-OR28821/2892-51-5/34-dihydroxycyclobut-3-ene-12-dione/).

Within a 1:1 molar stoichiometric relation, each precursor is dissolved in the required deionized water. Once both are well-dissolved, Na_2CO_3 solution is added slowly into the one of the squaric acid and stirred overnight (at least 16 hours). Then, the deionized water is removed by using a Rotavapor at 50ºC and the obtained sodium salt is dried under vacuum at 60ºC for 12 hours. Before using it, the salt is dried at higher temperature (120ºC) overnight and under vacuum just to remove any solvent that may remain.

The synthesis procedure carried out at CICe is done in 10 g batches. The synthesis procedure in AIMPLAS consisted in two batches of 500g each which were combined afterwards to reach 1kg. Quality control was carried out by XRD shown in Figure 2.

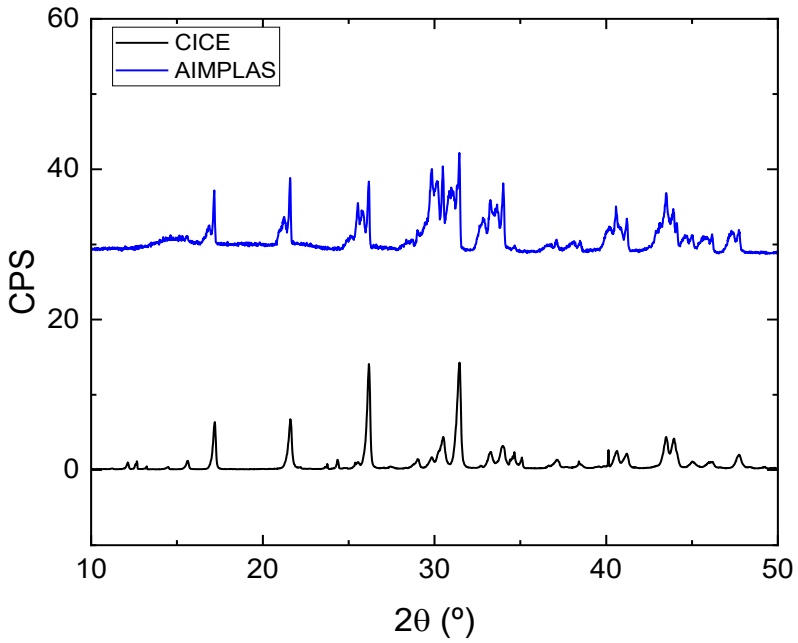


Figure 2. XRD pattern of $Na_2C_4O_4$ synthesized in CICE and in AIMPLAS

As can be observed from the XRD pattern, the peaks corresponding to the $Na_2C_4O_4$ are present in the scale-up sample. However, there are other peaks appearing in the salt, that might correspond to the original unreacted reagents, what means that the reaction was not complete, and a mixture of the sacrificial salt coexists with the initial reagents. However, this is a hypothesis that needs to be confirmed by in-depth analysis of the XRD pattern.

In ***Phase 2***, 5 kg of sacrificial salt was synthesized.

2.3 Development of innovative electrolytes

A first electrolyte generation (1M $NaPF_6$ in EC: PC (1:1 by weight) was defined with the project partners in common agreement to characterize the different components developed in WP3.

For the upscaling of the GEN1 (1M $NaPF_6$ in EC:PC 1:1 (by weight)), battery grade components were purchased and used. The major challenges were the identification of sodium salt suppliers, that can provide the material of highest quality (>99 %) and high quantities for large scale production. All components were redried before use to minimize the water content in the formulation (< 20ppm). The electrolyte formulation was carried out in a Glove box (H_2O and 0_2 < 0.1 ppm) to guarantee the production of a high quality

electrolyte. A 2-liter batch was produced to cover the electrolyte demand of the project partners. EC and PC were mixed in a weight ratio of 1:1 and the sodium salt was added to this solution and dissolved. To control quality of the components and the final electrolyte, H2O and HF values were measured (< 12 ppm). After the formulation, the electrolyte was filled into small bottles and delivered to the project partners.

For further scale-up of the electrolyte, the E-Lyte pilot line can be used to produce barrels up to 20 kg.

New electrolytes formulations have been developed together with FSU, trying to use innovative salts, solvents and additives, that not only improve the performance of the system, but also reduce the toxicity and cost production of the electrolytes.

The use of reduced fluorine content salts (NaTFSI, NaFSI), high thermal stable solvents (glyoxals) and SEI/CEI additives (FEC, VC, NaDFOB) should help to improve the performance of sodium-ion capacitors.

Following electrolytes have been formulated so far:

- 1M $NaPF_6$ in EC:PC 1:1 (by weight), GEN 1

- 1M NaTFSI EC:PC (1:1) (by weight)
- 1M NaFSI EC:PC (1:1) (by weight)
- 1M NaTFSI EC:PC (1:1) (by weight) + 2wt.% FEC
- 1M NaTFSI EC:PC (1:1) (by weight) + 2 wt.% NaDFOB
- 1M $NaPF_6$ in TEG:PC (3:7) (by weight) + 2wt.% FEC
- 1M NaTFSI in TEG:PC (3:7) (by weight)
- 1M NaTFSIin TEG:PC (3:7) (by weight) + 2wt.% FEC

Electrolyte samples supplied by ELY were tested by FSU using cathodic and anodic half cells, and pre-sodiated full cells. The characterization of the electrolytes so far has shown that the use of NaTFSI as electrolyte salt as well as of the different additives helped to improve the performance of lab-scale SICs. The most promising electrolyte formulation will be scaled up for the development of prototypes and cells.

All formulations developed within the project (see table 1) are fully scalable. The required materials are available in sufficient quantities, and each component can be further processed to meet the required specifications. This ensures that the electrolyte recipes can be reliably transferred to larger production scales, including batch sizes of up to 20 kg.

Table 1. Electrolytes provided by E-Lyte within the MUSIC project

Partner	Formulation	Amount
KIT	1M $NaPF_6$ in EC:PC (1:1, by wt.)	250 g (5 x 50g)
FSU	1M $NaPF_6$ in EC:PC (1:1, by wt.)	250 g (5 x 50g)
CICE	1M $NaPF_6$ in EC:PC (1:1, by wt.)	50g x4
CNRS-IMN	1M $NaPF_6$ in EC:PC (1:1, by wt.)	250 g (5 x 50g)
IRT-JV	1M $NaPF_6$ in EC:PC (1:1, by wt.)	250 g (5 x 50g)
BYD	1M $NaPF_6$ in EC:PC (1:1, by wt.)	50 g
UPS	1M $NaPF_6$ in EC:PC (1:1, by wt.)	250 g (5 x 50g)
FSU	1M NaTFSI EC:PC (1:1, by wt.)	10 g
	1M NaFSI EC:PC (1:1, by wt.)	10 g
	1M NaTFSI EC:PC (1:1, by wt.) + 2 wt.% FEC	10 g
	1M NaTFSI EC:PC (1:1, by wt.) + 2 wt.% NaDFOB	10g
	1M $NaPF_6$ TEG:PC (3:7, by wt.) + 2 wt.% FEC	10g
	NaDFOB	2 g
	2x 12g 1 M NaTFSI in TEG:PC (3:7, by wt.)	10 g
	2x 12g 1 M NaTFSI in TEG:PC (3:7, by wt.) + 2wt.% FEC	10 g
CICE	1M $NaPF_6$ in EC:PC (1:1, by wt.)	50g x4
CNRS-IMN	1M $NaPF_6$ in EC:PC (1:1, by wt.)	50g x2
UPS	1M $NaPF_6$ in EC:PC (1:1, by wt.)	50g x2
FSU	1M NaTFSI in EC:PC (1:1, by wt.)	25 g
	1M NaFSI in EC:PC (1:1, by wt.)	25 g

Partner	Formulation	Amount
	1M $NaPF_6$ in PC:TEG (7:3, by wt.)	25 g
CICE	1M $NaPF_6$ in EC:PC (1:1, by wt.)	50g x4
	1M NaClO4 in EC:PC (1:1, by wt.)	25g x2
UPS	1M $NaPF_6$ in EC:PC (1:1, by wt.)	2 x 50 g
BYD	1M $NaPF_6$ in EC:PC (1:1, by wt.)	10 x 50 g
UPS	1M $NaPF_6$ in EC:PC (1:1, by wt.)	4 x 50
KIT	1M $NaPF_6$ in EC:PC (1:1, by wt.)	2 x 50 g
CICE	1M $NaPF_6$ in EC:PC (1:1, by wt.)	2 x 50 g
FSU	1 M NaTFSI in EC:PC (1:1, by wt.)	25 g
	1 M NaTFSI in EC:PC (1:1, by wt.) + 2 wt.% FEC	25 g
	1 M NaTFSI in EC:PC (1:1, by wt.)+ 2 wt.% NaDFOB	25 g
	1 M NaTFSI in EC:PC (1:1, by wt.) + 2 wt.% FEC + 2wt.% NaDFOB	10 g
	1M NaFSI EC:PC (1:1, by wt.)	25 g
UPC	1M $NaPF_6$ in EC:PC (1:1, by wt.)	0.05 kg x 1
CICE	1M $NaPF_6$ in EC:PC (1:1, by wt.)	0.05 kg x 10
KIT	1M $NaPF_6$ in EC:PC (1:1, by wt.)	0.05 kg x 2
FSU	NaBOB	0.02 kg
	1 M NaFSI in EC:PC (1:1, by wt.)+ 2 wt.% FEC + 2 wt.% NaDFOB	0.05 kg x 4
	1 M NaFSI in EC:GVL (1:1, by wt.) + 2 wt.% FEC + 2 wt.% NaDFOB	0.05 kg x 4
	1 M NaFSI in DMC:EC (1:1, by wt.) + 2 wt.% FEC + 2 wt.% NaDFOB	0.05 kg x 4
	1 M NaFSI in DEC:EC (1:1, by wt.) + 2 wt.% FEC + 2 wt.% NaDFOB	0.05 kg x 4
CNRS-IMN	1M $NaPF_6$ in EC:PC (1:1, by wt.)	0.05kg x 4
FSU	1 M NaTFSI in EC:PC (1:1, by wt.) + 2 wt.% FEC + 2 wt.% NaDFOB	0.05 kg x 1
CICE	1 M NaTFSI in EC:PC (1:1, by wt.) + 2 wt.% FEC + 2 wt.% NaDFOB	0.05 kg x 1
HIU	1 M $NaPF_6$ in EC : PC (1:1, by wt.)	0.05 kg x 2
CICE	1 M $NaPF_6$ in EC:PC (1:1, by wt.) + 2 wt.% FEC + 2 wt.% NaDFOB	0.03 kg x 1
	0.5 M $NaPF_6$ + 0.5 M NaTFSI in EC:PC (1:1, by wt.) + 2 wt.% FEC + 2 wt.% NaDFOB	0.03 kg x 1
FSU	EC:PC (1:1, by wt.)	0.01 kg x 1
	1 M $NaPF_6$ in EC:PC (1:1, by wt.)	0.01 kg x 1
	1 M $NaPF_6$ in EC : PC (1:1, by wt.) + 2 wt.% FEC + 2 wt.% NaDFOB	0.01 kg x 1
	0.5 M NaTFSI + 0.5 M $NaPF_6$ in EC : PC (1:1, by wt.) + 2 wt.% FEC + 2 wt.% NaDFOB	0.01 kg x 1
	1 M NaFSI in EC:DMC (1:1, by wt.) + 2 wt.% FEC + 2 wt.% NaDFOB	0.01 kg x 1
	NaBOB	0.025 kg x 1
CICE	1 M $NaPF_6$ in EC:PC (1:1, by wt.) + 2 wt.% FEC + 2 wt.% NaDFOB	0.1 kg x 1

Partner	Formulation	Amount
	0.5 M NaTFSI + 0.5 M $NaPF_6$ in EC:PC (1:1, by wt.) + 2 wt.% FEC + 2 wt.% NaDFOB	0.1 kg x 1

2.4 rCF Scalability & Economic Feasibility

Phase 1 (pre-selection of rCFs) allowed to select the best rCFs for milling and then using an active carbon, the cost was low and in some cases the supplier gave as free sampling.

As for ***Phase 2*** (first scaling up level), 1kg of rCF cut under 3mm from the selected rCF-processes (CNRS-IMN) pyrolyze and vapothermolyse were purchased from their respective suppliers (**Figure 1**).

Evaluating Vapothermolyse and Pyrolysis Pathways for Activated Carbon

To evaluate the viability of utilizing recycled carbon fibers (rCFs) as precursor materials for high-performance supercapacitor activated carbon, a rigorous multi-scale scalability assessment was conducted. Given that raw Carbon Fiber Reinforced Polymer (CFRP) waste input costs are considered negligible (€0/kg) due to industrial circularity credits and landfill diversion dynamics within the European Union, the economic feasibility rests entirely on the operational configuration, regional energy grids, and process-specific thermodynamic efficiencies. Table 1 presents an estimation of the expected rCF cost for the recycling processes *Vapothermolyse or Pyrolise*, with the information supplied by the supplier.

Key Escalation Indicator: The thermal recovery profile transitions from an engineering labor-dominated cost architecture at laboratory scales to an energy-optimized, self-sustaining thermodynamic loop at continuous industrial capacities.

Economic Scaling Matrices Across Processing Volumes

The table below outlines the projected processing costs inside the European economic framework, comparing traditional thermal pyrolysis with advanced Vapothermolyse (superheated steam cracking). Calculations incorporate European industrial labor estimated rates (≈€35–€45/hr), stringent water purification mandates, and chemical safety protocols regarding airborne carbon particulates. **Table 2** presents an estimation of costs for upscaling the production of rCFs not including cutting down to under 3mm. This estimation is approximative and was drawn from data from 2 suppliers plus a cost interpretation by IRTJV, it is not exact, nevertheless it shows the right trend.

Table 2. scaling up estimated cost for rCFs obtained from vapothermolyse or pyrolysis.

rCF Volume	Cost per Unit (€/kg)	Total Campaign Cost (€)	Primary European Operational Setting & Scaling Drivers
1 kg	€600	€600	**R&D Lab:** Manual preparation, unoptimized thermal batch loss.
10 kg	€100	€1000	**Pilot Scale:** Tech incubator campaigns, high manual sorting and mechanical resizing labor.
100 kg	€30	€3000	**Batch Contract:** Small industrial custom run; system idle and cleanout cycles penalize throughput.
1,000 kg	€15	€15000	**Continuous Plant:** Automated shredding, continuous gas recycling, maximized heat integration.

Process Differentiation and Scaling Dynamics

At the 1 kg and 10 kg thresholds, costs are skewed by manual intervention required to process irregular composite scraps into uniform dimensions compatible with laboratory tube furnaces. Furthermore, heating a batch reactor to 500°C – 600°C for minimal output results in extreme energy inefficiency. At these low ranges, Vapothermolyse exhibits a minor cost premium due to the necessary superheated steam infrastructure and condensed water filtration loops governed by *European REACH regulations*.

A transformative economic inflection point occurs when transitioning to the 1,000 kg continuous industrial scale. At this volume, the cost plummets to around €15 per kg. This scaling efficiency is achieved by capitalizing on internal thermodynamic feedback loops: the volatile organic compounds (VOCs) and epoxy resin fractions cracked during thermal treatment are captured, scrubbed, and routed back to the burner units as syngas. This effectively insulates the facility from European grid natural gas volatility.

Supercapacitor Integration Outlook

Given that virgin carbon precursor fibers command European market rates between €30 and €60 per kg, scaling rCF processing to ≥ 1,000 kg provides a highly lucrative margin for activated carbon synthesis. While Vapothermolyse demands precise steam management, it yields remarkably clean, uncharred fiber surfaces. This significantly reduces the downstream chemical activation energy and acid-washing volumes needed to

achieve the high specific surface areas (>2,000m²/g) required for competitive supercapacitor electrodes.

Strategic Conclusion: *Scaling rCF-derived activated carbon production is economically non-viable at batch levels <100 kg. R&D emphasis must prioritize direct integration into continuous industrial multi-ton streams where automated sizing and syngas recycling establish a sustainable cost floor.*

2.5 Scale-up of Super-Active Carbon

Beyonder has developed a series of patented approaches towards producing high-performance activated carbons, initially on the gram scale. These have predominantly been conducted using chemical activation, where a chemical activating agent is mixed with the precursor (Sawdust) and, heat treated with selected oxygen scavengers under a controlled atmosphere to optimise the porosity generation. This activated method led to the production of activated carbons with a surface area beyond 3000 m^2/g and Volumetric capacitance above 90 F/ cm^3.

Upscaling this process proved challenging due to the corrosive nature of the chemical reagents, flow problems compounded by the plasticisation of the chemical agent/precursor mix and, in summary, incompatibility of the activation method with the rotary kiln. Beyonder, therefore, diversified into developing an alternative activation method, this time using a milder two-step activation process involving the use of a chemical reagent and a second physical activation step to optimise the porosity. This alternative activation method was indeed compatible with the rotary kiln, and the AC production capacity was increased from a few g's to above 500 g per processing batch.

The properties of the activated carbon produced using this method were comparable to commercial alternatives, with a specific surface area of around 2000 m^2/g and specific capacitance above 100 F/g. More effort was required to improve the purity after extensive analysis of the structure revealed remnant chemical reagents trapped in the micropores and high metal content inherited from the precursor. More investments were therefore needed in the washing step, along with the purchase of equipment suitable for larger-scale activation processes.

In summary, the technology for the upscaling has been demonstrated and is available but activation process equipment capable of producing 10's of kg of the activated carbon is needed to effectively upscale the process.

3 Discussion and Conclusions

In general, task 3.5 in WP3 is progressing well. D3.5 is linked to Key Project Result of the project, KPR9, where the scale up of i) carbon fibers ii) super activated carbon (10kg) iii) pre-sodiation agent (10kg) iv) electrolyte (1L).

i) Carbon fibers

The two-phase evaluation successfully validated the transition of recycled carbon fibers (rCFs) from laboratory screening to larger-scale precursor materials. Phase 1 allowed CNRS-IMN to rigorously filter various CFRP sources and recycling methodologies, directly enabling the strategic selection of optimized materials for Phase 2 scaling analysis.

Economically, the process hits a transformative inflection point when transitioning from manual, energy-inefficient small batch scales (1–10 kg) to continuous industrial volumes (100–1,000 kg), where costs are estimated from suppliers to plummet to approximately €10/kg. By leveraging negligible waste input costs and recycling cracked volatile organic compounds as syngas, the system establishes a self-sustaining thermodynamic loop that insulates production from European grid volatility, proving both Pyrolysis and Vapothermolyse pathways to be economically viable at scale.

ii) Super activated carbon (SAC)

The main issue encountered in this WP is with the scale-up of SAC. The scale-up feasibility has been demonstrated up to 500 grams, but larger scale up to the range of kilograms requires to adapt the scale-up process to the equipment. Obtention of SAC requires first the obtention of HC, which is the active material of the negative electrode. Research will focus first on the obtention of HC as a previous step before moving to SAC obtention.

iii) Sacrificial salt

The scale up of the production of the sodium sacrificial salt necessary for WP6.2. in a 5 kg batch has been successfully achieved.

iv) Electrolyte

The production of a 1 L electrolyte batch was achieved.

4 Recommendation

BYD has shifted its carbon development to focus on the development of HC for sodium and lithium-ion batteries. It is therefore recommended that the goal of scaling up SAC be changed to instead focus on HC. The MUSIC project will incorporate a new partner focused on the up-scaling of HC, with the support of the MUSIC-HOP-ON project (proposal no. 101159544), submitted as part of the HORIZON-WIDERA-2023-ACCESS-06-01 topic and selected for funding by the European Commission. However, BYD has expertise on the development and up-scaling of carbon materials specifically for sodium storage purposes, which makes it a valuable partner for the upscaling of HC. It is therefore recommended that BYD act as a go-between for CICE (who are developing HC on lab scale) and the new incorporated member, providing expertise and input to aid the scale-up process. This will reduce the risk of potential delays in up-scaling. Meanwhile, BYD will purchase the AC necessary to complete this project without incurring delays.

5 Risk register

Table 3. Risk Register

Risk No.	What is the risk	Probability of risk occurrence[1]	Effect of risk[2]	Solutions to overcome the risk
3.5.1	Activated carbon upscaling to 10kg is not feasible within project timeframes	1	3	The project can be run with commercially available ACs

[1] Probability risk will occur: 1 = high, 2 = medium, 3 = low

[2] Effect when risk occurs: 1 = high, 2 = medium, 3 = low

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Project partners

Table 4. Project Partners

#	PARTICIPANT SHORT NAME	PARTNER ORGANISATION NAME	COUNTRY
1	CICE	CENTRO DE INVESTIGACION COOPERATIVA DE ENERGIAS ALTERNATIVAS FUNDACION, CIC ENERGIGUNE FUNDAZIOA	Spain
2	EUR	CLANCY HAUSSLER RITA	Austria
3	KIT	KARLSRUHER INSTITUT FUER TECHNOLOGIE	Germany
4	CNRS	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS	France
4.1	IMN	NANTES UNIVERSITE (Affiliated)	France
5	UPS	UNIVERSITE PAUL SABATIER TOULOUSE III	France
6	FSU	FRIEDRICH-SCHILLER-UNIVERSITAT JENA	Germany
7	IRT-JV	INSTITUT DE RECHERCHE TECHNOLOGIQUE JULES VERNE	France
8	ELY	E-LYTE INNOVATIONS GMBH	Germany
9	BYD	BEYONDER AS	Norway
10	BCARE	BATTERYCARE S. L.	Spain
12	TALGO	PATENTES TALGO SL	Spain
13	UPC	UP CATALYST	Estonia

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