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iModBatt

Industrial Modular Battery Pack Concept Addressing High Energy Density, Environmental Friendliness, Flexibility and Cost Efficiency for Automotive Applications

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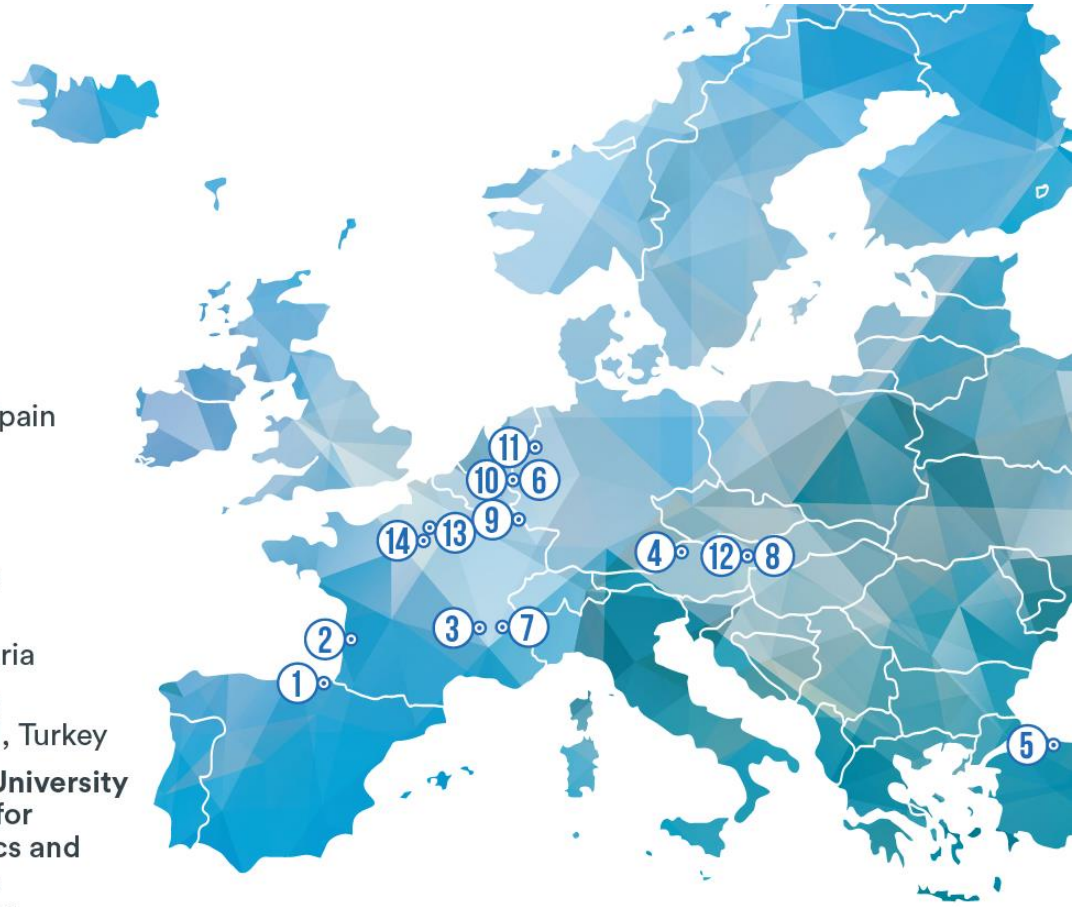
iModBatt

- Coordinator: CIDETEC Energy Storage
- Overall budget: € 6.351.473,75
- Start date: 1 October 2017
  End date: 30 September 2020
  (ext. 30 March 2021)
- Grant agreement ID: 770054

Funded under: H2020-EU.3.4. - SOCIETAL CHALLENGES - Smart, Green And Integrated Transport / GV-06-2017 - Physical integration of hybrid and electric vehicle batteries at pack level aiming at increased energy density and efficiency



① **CIDETEC**
San Sebastián, Spain

② **Rescoll**
Pessac, France

③ **Tyva Energie**
Annonay, France

④ **Miba**
Laakirchen, Austria

⑤ **Hexagon Studio**
Besiktas Istanbul, Turkey

⑥ **RWTH Aachen University**
ISEA – Institute for Power Electronics and Electrical Drives
Aachen, Germany

⑦ **Freemens**
Grenoble, France

⑧ **Austrian Institute of Technology**
Wien, Austria

⑨ **Cleancarb Sàrl**
Kopstal, Luxembourg

⑩ **e.GO Mobile AG**
Aachen, Germany

⑪ **Accurec Recycling GmbH**
Krefeld, Germany

⑫ **Pro Automation GmbH**
Wien, Austria

⑬ **CEA**
Paris 15, France

⑭ **Renault**
Boulogne Billancourt, France

The aim of iModBatt is to design and manufacture, with the minimum environmental impact, a high energy density modular battery pack (BP), which is flexible enough to be used in automotive and small stationary applications.

- SO1: increase BP energy density around 20% compared to the current Renault Zoe EV BP.
- SO2: reduction of the BP integration cost > 20% if compared to semi-manual assembly methods.
- SO3: BP design is led by European industry.
- SO4: BP design is ruled by eco design recommendations & recyclability.
- SO5: BP design should enable a second life and/or reuse of BPs.

SO1: increase BP energy density by around 20% compared to the current Renault Zoe EV BP.

- Selection of Li-ion commercial high energy density cells for the defined application.

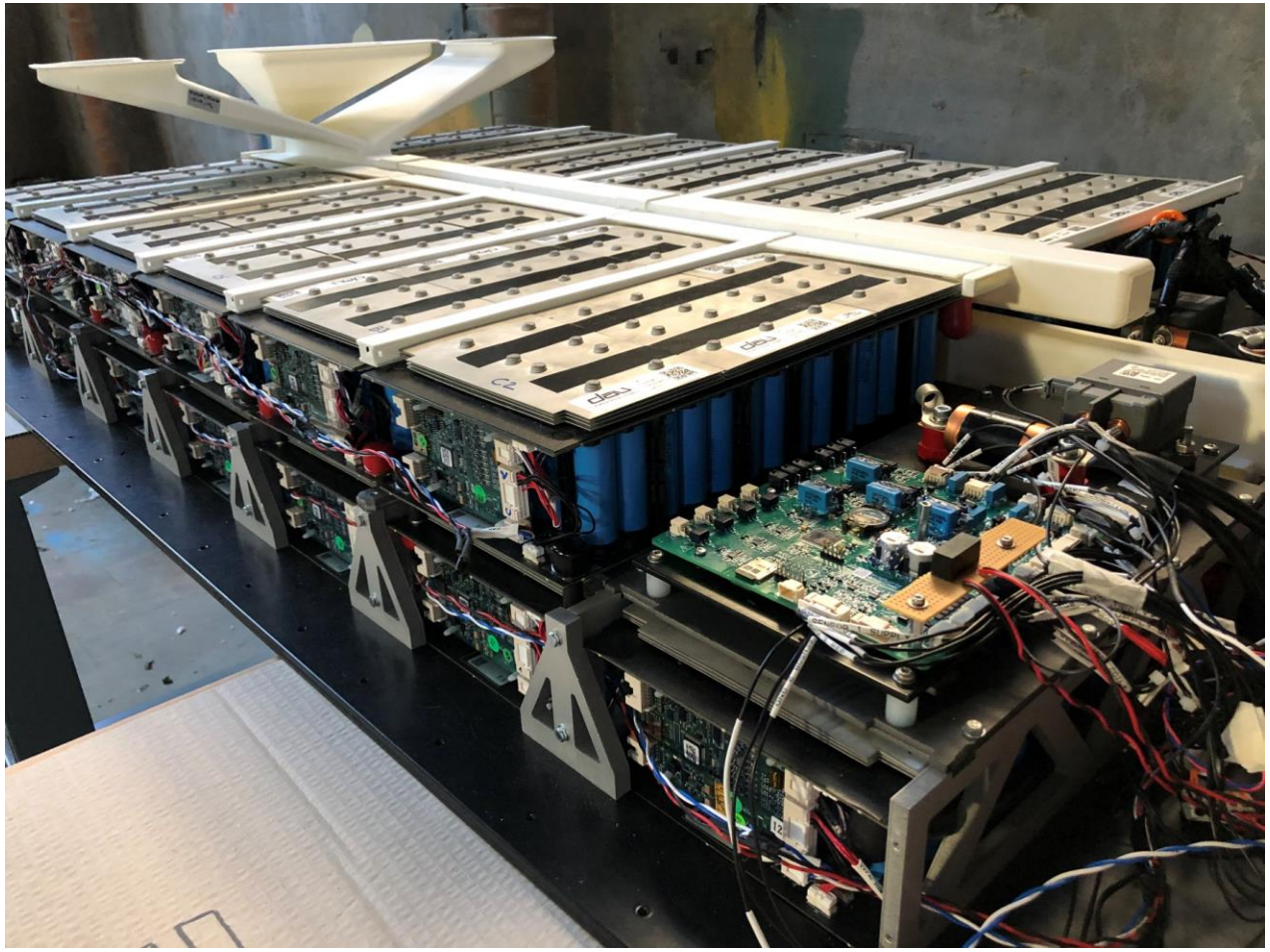
Manufacturer (distributors)	Model number	CEA	AIT	RWTH	CID
LG	INR18650 MJ1	14	12	8	6
LG	INR21700 M50	14	0	8	6+12
PANASONIC	NCR18650B	14	12	8	6
SAMSUNG	INR18650-35E	14	12	8	6
SAMSUNG	INR21700 48G	14	0	8+12	6
SAMSUNG	INR21700-50E	14	12	8	6
SONY	21700 50EL	14+12	0	8	6
SONY	21700 52EM	14	0	8+12	6

- BP effective packaging to fit to the available volume in the car while keeping modularity concept and energy density optimization:
  - ✓ Renault: 13 modules in 7S28P → 2 strings 13 modules in 7S14P
  - ✓ e.GO: 13 modules in 7S14P

		N	Modules	Cells in series	Cells in parallel	Energy [kWh]	Power Ch [W]	Power Dch [W]	Max V [V]	Min V [V]	Cells per module	Module Weight [kg]	Module Width [mm]	Module Length [mm]	Module Height [mm]	Number of cells	Pack Weight [kg]	Pack Wh/kg	Pack Wh/L
~~eGo~~	~~LG-INR21700 M50~~	~~1~~	~~14~~	~~7~~	~~14~~	~~24,90~~	~~74,70~~	~~69,72~~	~~411,6~~	~~245~~	~~98~~	~~7,43~~	~~308,4~~	~~153,7~~	~~78,15~~	~~1372~~	~~104,13~~	~~239,13~~	~~411,52~~
eGo	LG-INR21700 M50	1	13	7	14	23,12	69,36	64,74	382,2	227,5	98	7,43	308,4	153,7	78,15	1274	96,69	239,13	411,52
Renault	LG-INR21700 M50	3	13	7	28	46,24	138,73	129,48	382,2	227,5	196	14,87	617,8	153,7	78,15	2548	193,39	239,13	417,42

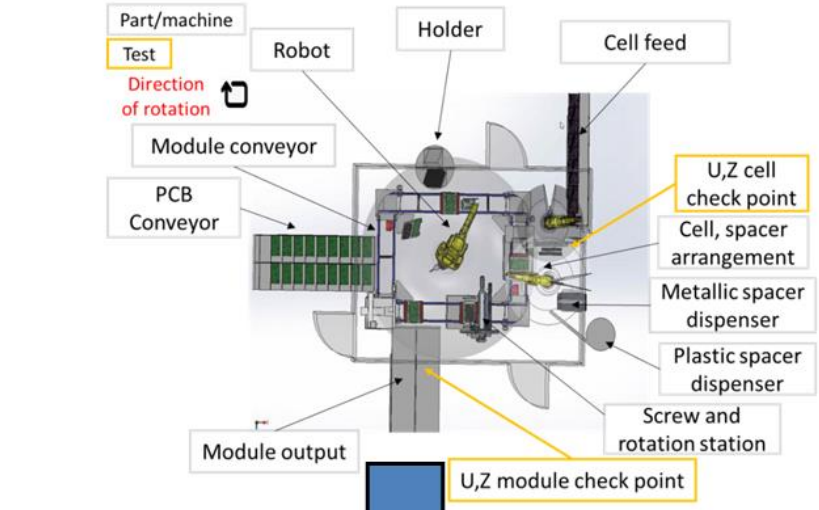
SO1: increase BP energy density by around 20% compared to the current Renault Zoe EV BP.

- Design of a lightweight modular BP structure: video.
- Reduction of wiring due to the use of aluminum or copper connection layers on PCBs.
- Use of low volume thin materials and thermal interface materials to improve thermal conductivity.
- Still evaluating the achieved energy density increase.



SO2: reduction of the BP integration cost if compared to semi-manual methods.

- Automated BP module assembly: video.
- Cell flexibility per module decreases cell availability derived costs.
- BP modularity impacts on production flexibility.
- The increase in the time value of the BP due to the expected life extension reduces the BP production cost.
- Still comparing the semi-manual vs. automated module assembly.



SO3: BP design is led by European industry.

- TYVA Energie(SME, France) is the leader of WP3 and WP5, focused on the electrical design and the module automated assembly accomplishment, respectively.

- Freemens (SME, France) lead the BMS customization and power electronics definition.

- MIBA (IND, Austria) is the leader of WP4, focused on the thermal design and more specifically, MIBA design & manufacture the main thermal HW (cooling fins-pipes device).

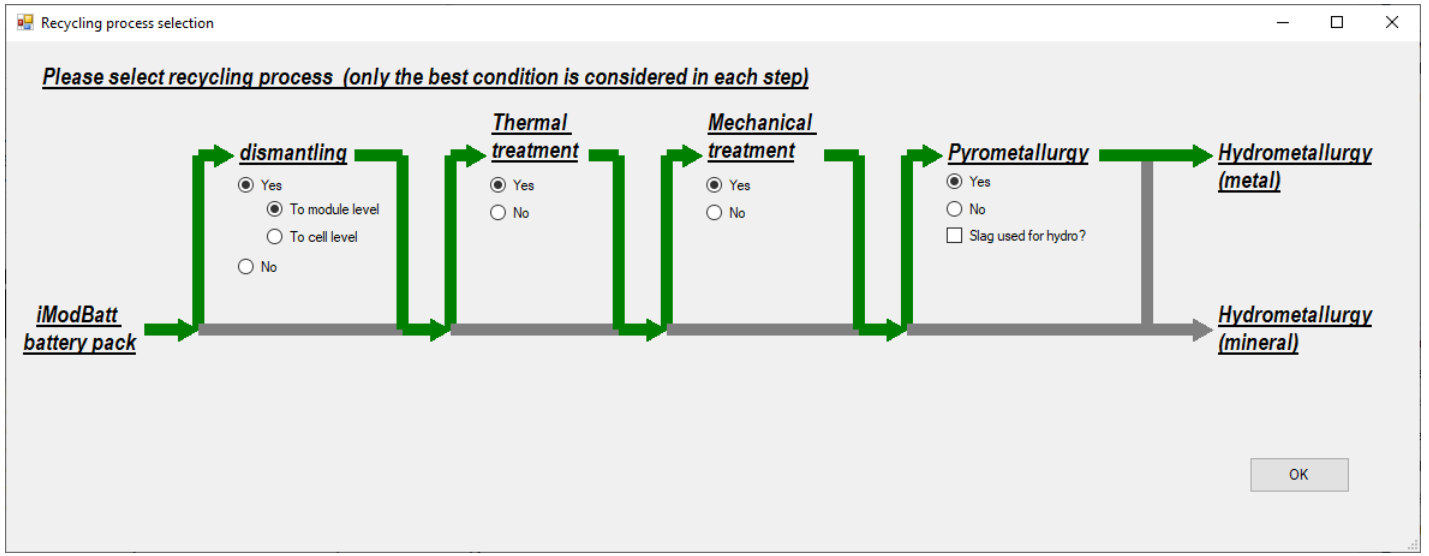
- Rescoll (SME, France) is the leader of WP7, focused on the modularity and flexibility validation for automotive application, second life and recycling.

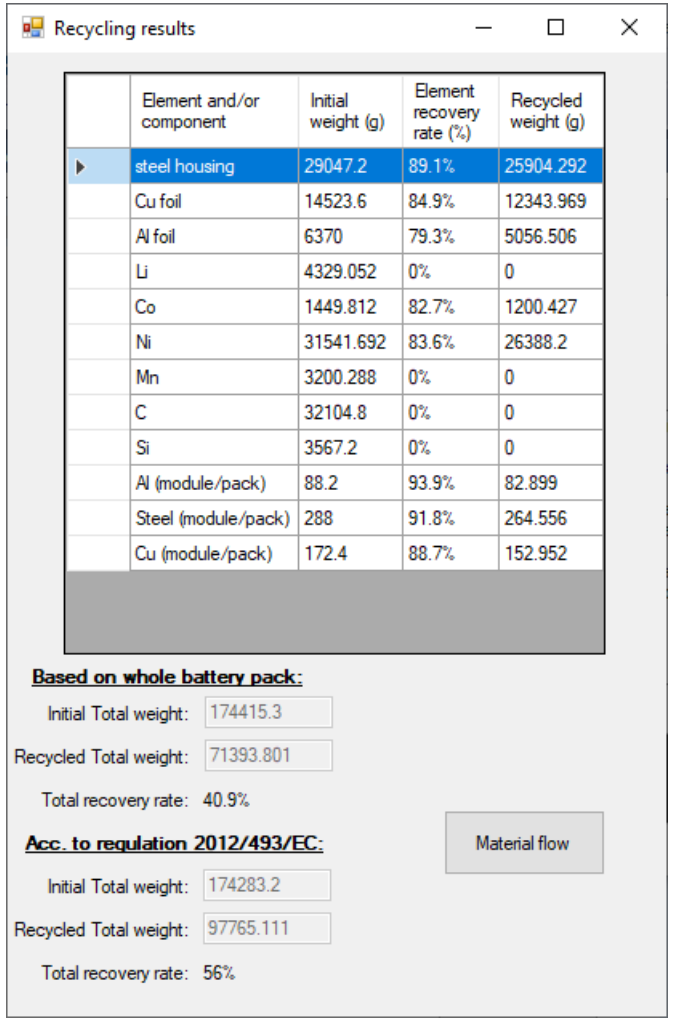
- Accurec (SME, Germany) lead the recyclability analysis of the proposed battery pack modular concept.

SO4: BP design is ruled by eco design recommendations & recyclability.

- A preliminary Life Cycle Assessment was defined and now it is being updated till the end of the project in March 2021.

- A SW has been created to obtain the recyclability degree of a BP depending on the bill of materials. The user defines the recycling process from 4 possible routes and dismantling level (until module level, cell level or do not dismantle). The SW output summarizes the materials defined as BP input and their overall recovery rate over the selected recycling process.





SO5: BP design should enable a second life and/or reuse of BPs.

▪ A potential reuse and second life scenario have been described between the REN vehicle, EGO vehicle and the TYVA power pack applications. The Consortium is now finishing this analysis to define how/when a BP should be shifted from one scenario to the next one.

Life at REN

- REN purchase a BP to TYVA.
- The REN BP is integrated by REN in their vehicles.
- The vehicles are sold to the customer by REN.
- The BMS reports as soon as the BP reaches the limits defined by REN.
- The customer can decide if he wants to replace the BP for extra costs.
- If yes, REN will install the refurbished BP (also supplied by TYVA).
- If no, REN sell the BP to TYVA.

Refurbishment after life at REN

- The old REN BP is returned to TYVA and the costs are invoiced. The condition of the BP has to be evaluated.
- TYVA refurbish the old REN BP with completely new modules and build up a new REN BP.
- TYVA sell the refurbished REN BP to REN (**Reuse of REN BP for REN BP**, modules not within).
- TYVA remove the old modules and tests them. Depending on this analysis modules can be suitable for EGO or TYVA's stationary application.
- TYVA build an EGO BP from the recovered modules (the cells should be in the same condition). Ideally, two EGO BPs can be built from one REN BP.
- TYVA sell the EGO BP to EGO (**Reuse of REN modules for EGO BP**).
- TYVA sell the remaining cells / modules of the old REN BP, not suitable for EGO for recycling to ACC or for another use: TYVA's stationary application, if suitable.

Life at EGO

- EGO purchase a refurbished BP to TYVA.
- The EGO BP is integrated by EGO in their vehicles.
- The vehicles are sold to the customer by EGO.
- The BMS reports as soon as the BP reaches the limits defined by EGO.
- If the EGO BP is not reused by EGO, it is sold to TYVA.

Refurbishment after life at EGO

- The old EGO BP is returned to TYVA and the costs are invoiced. The condition of the BP has to be evaluated.
- TYVA build an EGO BP from recovered old REN modules (cells should be in the same condition).
- TYVA sell the refurbished EGO BP to EGO (**Reuse of REN modules and EGO BP for EGO BP**).
- TYVA remove the old modules and tests them. Depending on this analysis modules can be suitable for TYVA's stationary application or must be recycled.
- TYVA build a TYVA stationary application BP from the recovered modules (cells should be in the same condition). Ideally, 4.33 TYVA stationary application BPs can be built from one EGO BP.
- TYVA sell the stationary application BP to the stationary application representative (**Second life of EGO / REN modules in TYVA's stationary application**).
- TYVA sell the remaining cells / modules, not suitable for TYVA to ACC for recycling (**Recycling**).

Next steps in iModBatt till the end of the project in March 2021:

- BPs will be tested at lab level and integrated in the REN vehicle.
- The automated module assembly unit will be used to build a battery module as proof of concept.
- The LCA will be updated according to the final data.
- The BP reuse and second life use scenarios will be finished.
- Key figures of iModBatt will be evaluated and discussed.

- **What are the future research needs identified thanks to your EU-funded project?**

✓ iModBatt included a side chapter on direct liquid cooling that could be interesting to foster.
✓ iModBatt focused on the design and manufacturing of an automated module assembly Unit, but work on the whole BP automated system would be necessary.
✓ Modularity and easy assembleability present some challenges for the BP integrity.

- **How far are you from a market introduction?**

✓ A more specific analysis on the selected structural materials would be necessary: optimize the amount of parts, material selection and their shape (thickness): < 6 months.
✓ The module and pack design need to be reviewed in order to fulfill the high demanding automotive business standards: < 1 year.

- **What are the consortium plans to ensure a follow-up to the project activities?**

✓ iModBatt might be the starting point for new coming Horizon Europe proposals in 2021.
✓ Two patent requests have been launched and could be the seed of new products.

- **How much time has been gained thanks to the EU-financial support?**

✓ Specially new expertise has been gained due to iModBatt. Partners faced new challenges that can now open up new business possibilities in new fields.

Thanks for your attention!

iModBatt would be not possible without the team:

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