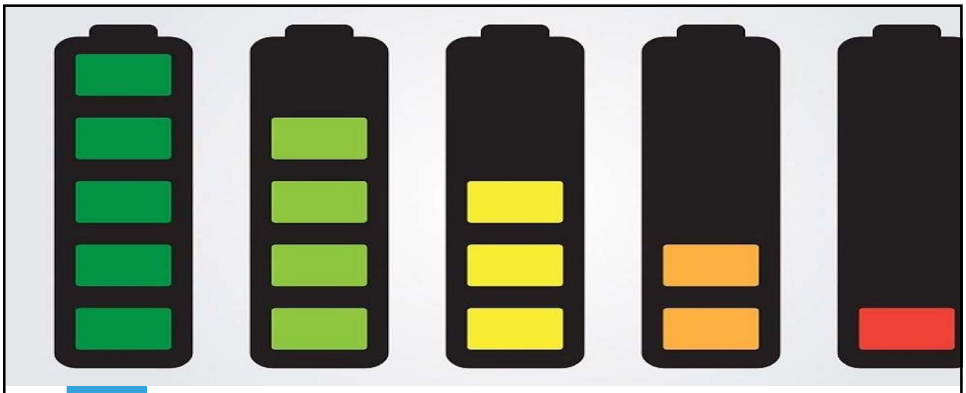

FOLLOW-UP FEASIBILITY STUDY ON SUSTAINABLE BATTERIES: STAKEHOLDER MEETING– TASK 3

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November 5th, 2019 – VLEVA, Brussels

AGENDA

1. Objective of study
2. Battery chemistries reviewed and selected
3. Modelling approach used
4. Data collection
5. Modelling parameters identified
6. Next steps

TASK 3: OBJECTIVE

Task 3: Development of Models for Rechargeable Battery Chemistries and Technologies Beyond Lithium-Ion, in compliance with the Existing Product Environmental Footprint (PEF) Category Rules

OBJECTIVE

Develop LCA models of other battery technologies and chemistries beyond Li-ion in compliance with the Product Environmental Footprint Category Rules (PEFCR) for High Specific Energy Rechargeable Batteries for Mobile Applications

TASK 3: BATTERY CHEMISTRIES REVIEWED FOR SELECTION

Existing Battery Systems

Battery chemistry	Application	Data Availability	Status
Lead-acid	Residential storage and light mobility (eg: wheelchairs, small trucks)	Publicly Available-PEF study on UPS	Not considered for this study as PEF study already exists
Sodium nickel chloride	**Residential ESS**	**Publicly Available-ZEBRA Battery Galloway and Dustmann (2003)**	**Considered in this study**
Nickel metal hydride	Light mobility (bicycles, Scooters)	Publicly available-PEF study on batteries	Not considered in this study as PEF already exists
Lithium Metal Polymer	**Car batteries. Can be used for Residential ESS**	**Contact with Blue Solutions. Data under NDA**	**Considered in this study**
Sodium Sulfur	Large ESS	Lack of data	Not considered in study
Salt water/Hybrid ion	Residential ESS	Lack of data	Not considered in study

TASK 3: BATTERY CHEMISTRIES REVIEWED FOR SELECTION

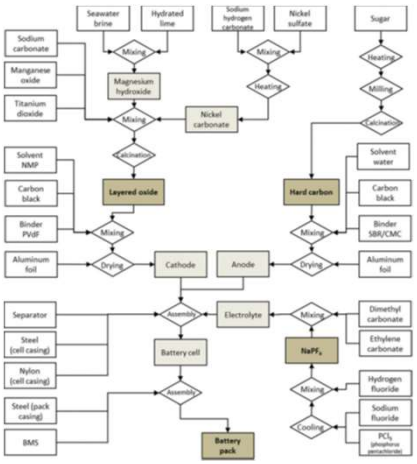
Future Battery Systems

Battery chemistry	Application	Data Availability	Status
Sodium-ion	**Residential ESS**	**Publicly Available**	**Considered in study**
Lithium Sulfur	Residential ESS, future cars	Data available for laboratory scale. Under development	Not considered in study
Solid State "Li-ion"	Cars	Questions about suitability of battery type	Not considered in study

TASK 3: PROPOSED APPROACH : SODIUM ION AS AN EXAMPLE

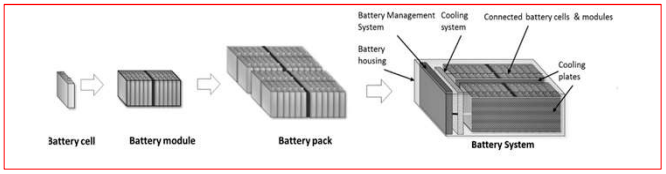
Sodium Ion Example

- Sodium ion is one example case for applying the PEFCR approach
- Activity data for production of battery sourced from Peters, Jens, et al. "Life cycle assessment of sodium-ion batteries." *Energy & Environmental Science* 9.5 (2016): 1744-1751



TASK 3: PROPOSED APPROACH: LIFECYCLE STAGES FOR SODIUM-ION BATTERIES

- **Production stage**, i.e. the sourcing of raw materials and the manufacturing process of battery system up to battery system level



- **Use phase excluded**
- **End-of-life stage**
  - Limited data availability. Peters et al (2016) ignores the EoL phase due to lack of data as Na-ion being a newer technology
  - We will use Li-ion end of life modeling as a solution for modeling future technologies

  - **The functional unit in PEFCR is 1 kWh of the total energy required by the application over its service life.**

TASK 3: DATA TEMPLATE- EXAMPLE SODIUM ION BATTERY

Materials and resources secondary datasets

Activity data

Inputs		
Cathode, NMMT layered oxide, for Na-ion battery	2,70E-01	kg
Anode, hard carbon-Al, for Na-ion battery	3,65E-01	kg
Separator, market for battery separator	2,12E-02	kg
Electrolyte, NaClO4 based, for Na-ion battery	1,47E-01	kg
cell container, 18650 type, for battery	2,47E-01	kg
nitrogen, market for nitrogen, liquid	1,05E-02	kg
Electricity, medium voltage, market group-EU	3,64E+00	kW
Heat, central or small scale, natural gas-EU	2,63E+01	
Transport, lorry>16t, EURO5, RER	4,20E-02	
Transport, train, market for freight train, EU	2,50E-01	
Outputs		
Waste heat	4,69E-01	MJ
Waste parts, market for wste Li-ion batteries	5,00E-02	kg
Na-ion battery cell, NMMT-HC	**1,00E+00**	**kg**

Elementary flows

COMPANY SPECIFIC VERSUS SECONDARY DATASETS

- **Company-specific datasets**
  - Directly measured or collected at a specific facility or set of facilities
  - Data shall include all known inputs and outputs for the processes.
  - All inputs and outputs need to be scaled to the reference flow of the process.
- **Secondary datasets**
  - Generic data from literature or scientific papers or average data from LCA databases, industry association reports, government statistics, etc.
  - Data sources shall be clearly documented and reported in the EF report.

TASK 3: DATA COLLECTION PROCESS

Directly contact manufacturers to gather best available information:

- **Identification of activity data** within processes for production stage for identified battery chemistries
- **Guide manufacturers during data collection process**
- **Handle confidential data carefully through gained experience**
- **Preference for primary data from manufacturers** otherwise, use secondary data sources based on desk research

TASK 3: MODELING NA ION BATTERY- PARAMETERS USED FOR STUDY

Parameter	Unit	Sodium-ion	Reference
Nominal battery system capacity according to ISO	[kWh]	10	Ecodesign Batteries-Preparatory Study-Base Case 6-Residential ESS
Economic lifetime of application (Tapp)	[y]	15	Ecodesign Batteries-Preparatory Study-Base Case 6-Residential ESS
Depth of discharge (DoD)	[-]	80%	Assumption
Energy delivered per cycle (Edc)	[kWh/cycle]	8	Calculated
Number of cycles for battery system over its service life (Nc)	[-]	2000	Peters et al (2016)-Life cycle assessment of sodium-ion batteries-laboratory test data
Average capacity per cycle (Acc)	[%]	90%	Based on standards and data from Peters et al (2016) initial capacity retention of 80%
Total weight of battery system	kg	127	Assumption- based on Ecosdesign Batteries-Preparatory Study- Base Case 6- Residential ESS
Average net capacity per cycle until EoL	[kWh/cycle]	7,2	Calculated
Functional unit over service life (Qua)	**kWh/service life**	**14400**	**Calculated as in PEFCR**
Application Service (AS)	kWh	300000	Calculated
No.of battery sytems per economic service life (Nb batt)	**[-]**	**21**	**Calculated as in PEFCR**
Reference flow (Rf)	**kg battery/kWh**	**0,01**	**Calculated as in PEFCR**

TASK 3: MODELING OF NA ION BASED ON PEF APPROACH-EXAMPLE OF ONE DATASET

Process	Dataset used (based on hierarchy of data selection)
NMMT, active material, layered oxide, for Na-ion battery	**Data created based on input from Peters et al (2016)**
Carbon black	EF compliant dataset
Polyvinylidene fluoride (PvDF) binder	EF compliant dataset
N-methyl 2-pyrrolidone (NMP) solvent	**EF compliant dataset NOT available-Ecoinvent used**
Medium voltage electricity	EF compliant dataset
Central or small scale natural gas	EF compliant dataset
Lorry>16t	EF compliant dataset
Freight train	EF compliant dataset
Metal working factory construction	**EF compliant dataset NOT available-Ecoinvent used**
Outputs	
NMP emission	**EF compliant dataset NOT available-Ecoinvent used**
Waste heat	EF compliant dataset
Cathode, NMMT layered oxide, for Na-ion battery	**Data created based on input from Peters et al (2016)**

The data that is highlighted in red is NOT available as an EF compliant dataset.

It will be listed as a process that needs to be purchased by the European Commission

TASK 3: NEXT STEPS

- Continue to model the sodium ion batteries and conduct other checks for data quality requirements, accuracy and consistency
- Highlight unit processes not available as EF compliant datasets such that the Commission can purchase them.
  - **Stakeholders are encouraged to improve the activity data list with additional materials that they may be aware of and that are not included in the list.**
- Perform a hotspot analysis to identify the life cycle phases and processes that have the highest impact
- Model the other batteries- sodium nickel chloride and lithium metal polymer as per the PEF method

THANKS FOR YOUR ATTENTION

For commenting please use form
https://ecodesignbatteries.eu/files/attachments/ED_Battery_commentsv2.docx
and e-mail it to edbatteries@vito.be
Or
Contact: Neethi Rajagopalan
neethi.rajagopalan@vito.be

Deadline for sending comments : **19 November 2019**