Battery storage value chain

Structure and FAQ

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1.1. Course description

The shift to sustainable energy hinges on improving both our environmental and our economic footprint. That means moving from a linear to a circular value chain: from sourcing raw and processed materials to assembly through to end of life, through to recycling and reuse. And it means understanding the risks, the challenges, and the opportunities involved.

The Battery Storage Value Chain course gives learners a rock-solid overview and understanding of the full battery value chain, production processes, and end-of-life scenarios. They will understand how a Li-ion battery is produced following the different steps in the battery value chain. They will look at both large-scale battery production and the laboratory manufacturing process and understand the steps required to turn materials into battery cells. To evaluate whether we can use the full potential of batteries while in use and, at the same time, regain value from end-of-life batteries, learners will learn about state-of-the-art scenarios related to batteries end-of-life in particular re-use and recycling.

1.2. Learning outcomes

This course empowers learners to:

- Understand the battery industry value chain
- Identify the main challenges of raw materials extraction, supply, and options for end-of-life batteries
- Design a process flow for the production of a Li-ion battery cell
- Describe each step of production of a Li-ion battery cell and discuss its function and challenges
- Appraise the main challenges faced by large-scale production of Li-ion batteries concerning supply chain and manufacturing process
- Discuss the importance of recycling for a circular battery value and pinpoint the relevant steps

1.3. Course structure and content

Battery storage value chain is a fully online course that consists of four self-paced online modules (***Figure 1***) and optionally a follow-up by a topic specialist. The learners will have the possibility to share their opinion and thoughts on relevant topics via the discussion elements throughout the course.

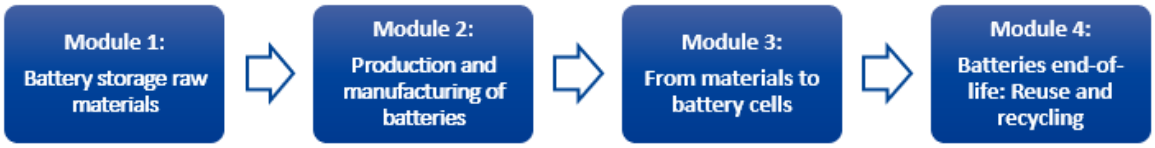

Figure 1: *Structure of Battery storage value chain course*

- Module 1: Getting an overview of the raw materials that are needed for lithium-ion batteries, how critical they are, and how lithium is extracted
- Module 2: Understanding the general industrial perspective on Li-ion battery production, focusing on supply chain and the manufacturing process in large scale facilities
- Module 3: Reviewing the key concepts of battery cells and an in-depth view of the manufacturing process

- Module 4: Exploring the battery end-of-life, reuse, and battery recycling

The topics included under the four modules are as follows:

- Module 1: Battery raw materials
  - Raw materials
  - How is lithium extracted?
- Module 2: Production and manufacturing of batteries
  - The battery supply chain step by step
  - Battery manufacturing process
- Module 3: From materials to battery cells
  - Vocabulary of energy storage in batteries
  - Electrochemical cell: the elementary building block of a battery
  - Porous electrodes
  - EMF, energy & measurable voltage of a cell
  - Lithium-ion battery technology
  - Lithium-insertion materials
  - Synthesis of Lithium-insertion materials
  - Cell design for lithium-ion batteries
  - Slurry formulation and mixing
  - Electrode coating
  - Electrode drying and calendaring
  - Electrolyte & separator
  - Cell assembly
  - Formation cycles
- Module 4: Batteries end-of-life: reuse and recycling
  - Reuse of batteries
  - EV batteries for stationary energy storage
  - Battery recycling- General overview
  - Battery recycling- Physical processing
  - Battery recycling- Hydrometallurgical processing

1.4. Who are the experts in the course?

This course was developed in collaboration with experts from the EIT InnoEnergy ecosystem, authorities in sustainable energy from the worlds of research and industry. Faculty for this course are:

<u>An Hardy</u>

Full Professor at Hasselt University, Institute for Materials Research (IMO) & EnergyVille. Specialised in the designed synthesis of inorganic and hybrid (nano)materials for various applications including energy storage and conversion.

<u>Momo Safari</u>

Associate Professor, Department of Engineering Technology, Hasselt University & EnergyVille. The main area of activity is advanced battery technologies and the fundamental research centres around experimental/theoretical investigation of thermodynamics, kinetics and transport phenomena in batteries.

Victoria Flexer
Researcher at CONICET and Professor at the National University of Jujuy. She has a Ph.D. in Chemical Sciences and her work ranges from sustainable mining techniques to the development of state-of-the-art batteries

Yann Laot
Director of Services, Support, and Solutions for Energy Storage Solutions at SAFT. Specialties are Li-ion topics, i.e. markets, products, technologies, manufacturing, and competitive landscape analysis.

1.5. Target audience

This course is beneficial for anyone interested in understanding potential business models attached to battery storage and its applications as well as how to prepare for developing a relevant business model.

1.6. What qualifications does a learner need to join to the Battery storage value chain course?

In order to be able to follow and benefit from the Battery storage value chain course learners would need to have a basic general background knowledge on chemistry and the energy system.

1.7. What is the expected time investment by each learner?

The required time investment is around 7-8 hours/week on average, including the course evaluation. Below appears a suggested timeline (***Figure 2***).

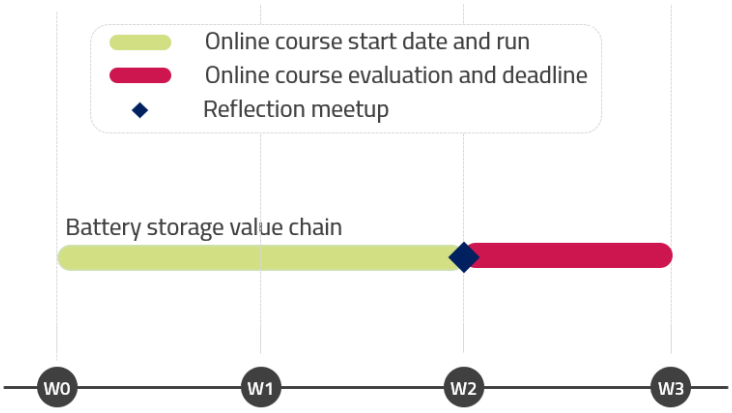

Figure 2: Suggested timeline for the Battery storage value chain course

1.8. What is the meaning of the deadline of the course?

With regards to the Battery storage value chain course dates:

- The online course's general assessment date is fixed, and learners would need to respect this. The online contents will be available at a certain start date and learners can start pursuing the contents at their usual study location, at a pace and rhythm that meets their schedule, while respecting the course's general assessment deadline. An end date is recommended to finalise the course content and allow enough time to submit the assessment.

- The submission of the general assessment is required by the deadline. It is recommended that learners are able to save their answers and come back later for submission prior to the respective deadlines.
- The contents of the course will remain open for the learners for a specific time period after the deadline and the end of the online course.

1.9. Interaction with the course leader

This online course has a dedicated course leader (topic specialist). The course leader shall be available for a (suggested) total of two hours throughout the course run to answer questions and give further explanations on the course content. Out of these two hours, one refers to a Reflection meetup (live session) at a predefined slot and the remaining one hour to asynchronous Q&A via the learning platform or other means. This is recommended to take place in a forum where all learners have access and can benefit from the answers or any discussion.

The course leader's profile is expected as follows: Knowledge/experience on the life cycle of a battery from battery materials (raw and active materials) to battery cell manufacturing and battery recycling from mainly a technical perspective. Good presentation skills. Preferred to have also pedagogical experience.

1.10. Course evaluation

To succeed in the Battery storage value chain course and receive a Certificate of Accomplishment, a learner needs to obtain a minimum score of 75 points in the general assessment. This general assessment serves as a test on the understanding of the course content by each learner. In-lesson quizzes are only meant for self-evaluation and do not count towards the final Certificate.

- The general assessment is composed of both automatically graded questions and open questions. The assessment requires an estimated time effort of 2-3 hours.
- It is recommended that the number of points per section is visible throughout the assessment.
- The automatically graded questions include multiple-choice, single choice, and association questions.
- The open questions are graded by the course leader, and it is recommended that the results are available 1 week after the deadline.
- There is no negative grading. A wrong answer simply gives 0 points.
- If a learner does not pass the general assessment with the first attempt, it will be possible to retake it once more. It is recommended that the retake is available a week after the general assessment deadline of the last course and remains open for 1 additional week.