Co-funded by the European Union

Battery technician

Structure and FAQ

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1.1. Course description

Not a day goes by in which we do not use batteries, from small appliances (shaver, smartphone, drone, laptop, etc.) to large applications (electric bicycle, scooter, car, bus, etc.). With the enormously rapid rise of all kinds of mobile electrical solutions and the introduction of batteries in our electricity grid, the need for battery professionals has also grown exponentially. New skills are needed related to designing, operating, testing, maintaining and replacing battery cells and packs for various applications. Whether you are a renewable energy installer, an (electrical) mechanic working with more and more electric vehicles, an electrical engineer or an electronics specialist, this training will allow you to acquire a solid knowledge of batteries, battery technologies and applications and operate battery systems.

The Battery Technician programme focuses on the new skills that are needed related to designing, operating, testing, maintaining, and replacing battery cells and packs for various applications. During the training, the different types of batteries that are already relevant today can be tested in a practical lab for their specific characteristics.

The training allows participants to choose the right technology for the right challenge, set up battery systems and evaluate battery performance. Moreover, to be able to work out a solid total solution, the Battery Management systems, the charging and maintenance of batteries and their recycling process are also discussed in more detail. Finally, sufficient attention is given to the safe handling of these electrical applications, both for the person and for the environment.

1.2. Learning outcomes

This course empowers learners to:

- Evaluate what battery technology is best suited for which application, based on its characteristics
- Analyse (dis)advantages of most used battery technologies
- Design and implement the best fit battery solution for each application
- Safely handle, test, repair and dispose of battery systems, according to legal obligations

1.3. Course structure and content

Battery technician is a blended learning programme: learners will start with a blended learning plan consisting of 4 online main parts with virtual Q&A sessions, 2 lab sessions, and 1 final assessment ***(Figure 1).***

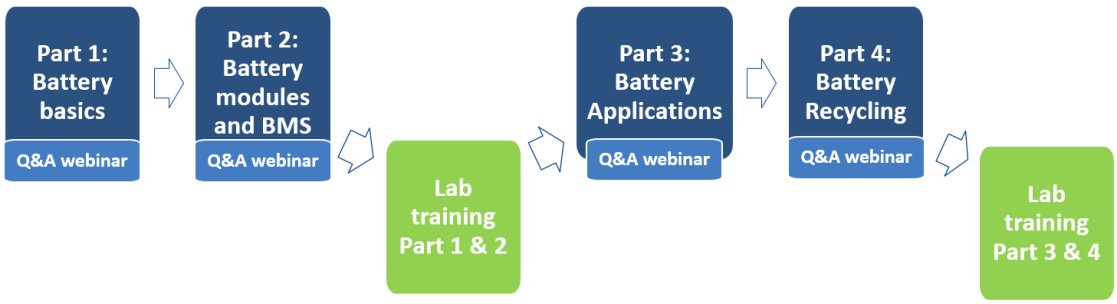

Figure 1: *Structure of Battery Technician programme*

The online learning modules are a combination of video lessons or lab demonstrations, practice activities, game activities, discussions and test your knowledge activities. Together with the self-paced learning content blocks, two practical learning sessions in the battery lab are planned where learners will have the chance to put their newly acquired knowledge and skills into practice. Finally, learners are able to take the final assessment online.

It is structured as follows:

- **Part 1: Battery basics:** This module introduces the exciting world of batteries and presents the main components and working principles of this technology, which is crucial to the clean energy transition.
- **Part 2: Battery modules and BMS:** This module shows how to distinguish the components of a Battery system and how to calculate the overall system energy efficiency in Battery applications. Moreover, it presents the norms and standards for stationary and mobile applications.
- **Lab training Part 1 & 2**
- **Part 3: Battery Applications:** This module presents the main customer benefits of home energy storage systems and describes examples of grid integration services of energy storage systems. It also digs into the main mobile applications and small electrical devices.
- **Part 4: Battery Recycling:** The last module includes an overview of the end-of-life and second life potential of lithium-ion battery technologies and introduces the two options for handling batteries reaching their end-of-life: reuse and recycling.
- **Lab training Part 3 & 4**
- **Final assessment**

The topics included under the four modules are as follows:

- **Part 1: Battery basics**
    - *Section 1.1: Functioning of a battery and main types*
        - Batteries from different perspectives
        - Classification of batteries
        - Components of a single cell
        - Lithium-ion batteries
        - Lead acid batteries
        - Flow batteries
    - *Section 1.2: Basic technical battery characteristics*
        - Vocabulary of energy storage in batteries
        - Battery Capacity and Energy
        - The importance of battery testing
        - Battery definitions, datasheets, and characteristics

- **Part 2: Battery modules and BMS**
    - *Section 2.1: Battery modules and components of battery systems*
        - Series-parallel connection
        - Components of a battery system
        - Introduction to Battery Management Systems
        - Battery Management Systems Topologies

- *Section 2.2: Power converters*
  - The need for power conversion
  - Types of Switched Power Converters
  - Battery Losses and Efficiency
  - Total System Energy Efficiency in Battery Applications
- *Section 2.3: Safety and regulation*
  - Battery storage policies
  - Battery Standards and Regulations
  - Functional Safety and Security

- Lab training Part 1 & 2
  - VR game Battery workbench: build battery pack virtually
  - Battery lab: safely build your own physical battery pack with welding equipment and bring it home
  - Read datasheets
  - Charge and discharge, test a battery
  - Handle batteries while respecting safety and regulations (expedition/buying/storing batteries)

- Part 3: Battery Applications
  - *Section 3.1: Stationary applications*
    - Flexibility needs and the role of battery storage
    - A closer look into battery storage technologies
    - Grid storage application
    - Behind-the-meter application
    - Benefits of storage facilities at home
    - Benefits and challenges of local grids
    - Local energy storage to manage increasing need of EV charging
    - Home storage part 1
    - Application Example - Home Battery Storage
    - Home storage part 2 - live demo
  - *Section 3.2: Mobile applications & small electrical devices*
    - Battery for electric vehicles - price development and trends of use
    - Electrical drives in transportation: overview of technologies
    - Charging infrastructure
    - Battery storage application in mobility
    - Battery powered consumer electronics
    - Application Example - Energy Efficiency of a USB Power Bank

- Part 4: Battery Recycling
  - *Section 4.1: End-of-life, second life, and recycling*
    - Dismantling a battery pack
    - Reuse of batteries
    - EV batteries for stationary energy storage

- Battery recycling- General overview
- Battery recycling- Physical processing
- Battery recycling- Hydrometallurgical processing

- Lab training Part 3 & 4
  - Stationary batteries in the lab; watching and doing: charging, repairing, and testing
  - Dimension a PV + battery storage system with converter
  - Connect 3 types of batteries to a converter for operation
  - EV + e-bike charging, repairing, and testing
  - Charge and discharge battery packs
  - Connect charging infrastructure
  - Smaller electrical devices and traction batteries charging, repairing, and testing
  - VR game workbench Dismantle car battery
  - Dismantle battery packs for recycling

- Final assessment

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. The lab training components were built in collaboration with Syntra-T2 Campus in Belgium. Faculty for this course are:

Jorge Varela Barreras
Senior researcher at Imperial College London in the Department of Mechanical Engineering, where he works on batteries and battery management systems

Dr. Jeroen Büscher
Product Manager Electrical Storage of Vito / Energy Ville. Since 2016 Jeroen is leading the VITO team working on electrical storage technologies and is responsible for the development and execution of the related activity roadmap. Since 2011, Jeroen has been coordinating several projects within Europe on electrical storage, smart grids and e-mobility.

Jolien Despeghel
PhD student in Electrical Engineering at KU Leuven/Energyville. She is a researcher on the project Energy Storage as a Disruptive Technology in the Energy System of the Future.

Anna Darmani
Energy system analyst at InnoEnergy, Anna is responsible for several EU projects in the area of energy technology innovation and research. She is engaged in the road-mapping of high-potential energy technologies in the future European energy market.

Björn Jernström

CTO of Ferroamp and inventor of four different patents related to ACE technology that enables savings on grid fees and faster EV charging. He has previously founded two successful startups in the electric power industry.

Jan Verveckken
Worked, in the recent past, on the quality control department of Audi Brussels. He worked within InnoEnergy on the European Battery Alliance team, focusing on the education business line.

Johan Driesen
Full professor at the Faculty of Engineering and Science head of Subdivisie EnergyVille Electa - Driesen with years of experience in distributed generation of electricity, renewable energy, power electronics, electrical drives, electric vehicles, and smart grids.

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

Fernanda Margarido
Associate professor at Instituto Superior Técnico with a PhD degree in Materials Engineering. She has been the Principal Researcher of several national and international projects in the field of recycling of wastes and end-of-life products.

Carlos Nogueira
Researcher at National Laboratory of Energy and Geology (NLEG). His research is focused on edge physics, multi-scale turbulent transport and diagnostic development in fusion devices.

Jos Symons
Jos Symons graduated in Car Mechanics and used to teach in technical secondary education. He has worked at several private companies in the automotive sector. In 2011, he founded his own company BatteryPackService, specialised in the revision of e-bike batteries and the development of custom batteries for industry. Since 2019, he teaches in the Battery Specialist programme at T2-campus in Genk-Belgium.

Grietus Mulder
Researcher at the Flemish technological institute VITO in the unit Energy Technology. He contributes to the research of electric active components for grid governance, closely related to electric energy storage and power electronics. He has 20 years of experience in the testing, modelling, simulation, application and validation of energy storage components and systems.

1.5. Target audience

This training is beneficial both for the renewable energy installers who are increasingly receiving the demand from the customer to be able to make optimal use of their precious solar energy and for the (electrical) mechanics who are seeing their technology evolve from combustion engines to electric motors. Moreover,

for electrical engineers or electronics specialists, a thorough knowledge of batteries is of course an obvious future expansion of their working area.

In brief, it is especially interesting for technicians with affinity in one of these domains:

- electro-mechanics (automotive, garage, garden machines, cleaning machines, forklifts, etc.),
- electrical installation techniques (renewable energy installer, telecom, UPS, etc.),
- electronics & power tools (sensors, signalling, security, IT, etc.),
- small mobility (scooter, e-bike, mobility scooter)

1.6. What qualifications does a learner need to join to the Battery technician programme?

To be able to follow and benefit from the Battery Technician programme learners would need to have a knowledge of the basic principles of electricity.

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

The required time investment is around 5 hours/week on average, including the course evaluation. Below you can view a suggested timeline (**Figure 2**).

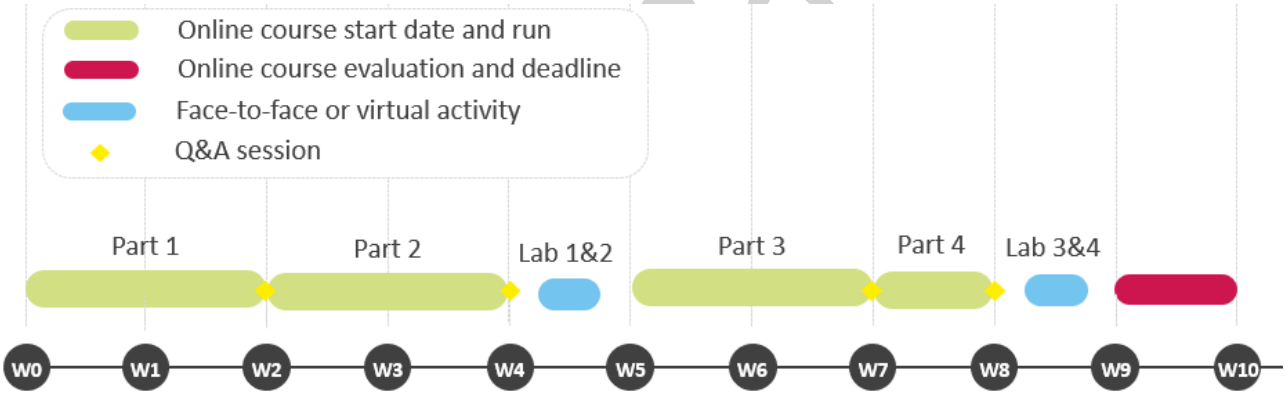

Figure 2: *Recommended timeline for the Battery Technician programme*

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

With regards to the Battery Technician programme 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. Required lab infrastructure to run the programme

Each lab included under this training has certain hardware and software requirements. Those can be found listed in the corresponding separate lab description documents.

Supported hardware platforms for the VR learning game

The VR applications of the 'Battery Workbench', including the 'Battery Pack Labo' & the 'EV Garage', are currently developed to be installed on the following platforms: Oculus (by Facebook) & HTC VIVE Pro (via Steam VR).

Oculus

The application can be easily installed on the Oculus Quest & Quest 2.

Oculus Quest

Oculus Quest 2

In order to install the application on your VR Headset, you need a laptop with SideQuest installed.

HTC VIVE Pro (using Steam VR)

The Battery Workbench VR application can be easily installed on a PC (VR game server or game laptop) running the Steam application.

The HTC VIVE Pro set consists of a Headset wired to the PC via the Link Box, (minimum) 2 Base Stations and 2 Controllers.

Instructions for installation are delivered together with digital course contents and lab activity plans.

1.10. Interaction with the course leader

It is recommended that this online course has at least one dedicated course leader (topic specialist). The course leader shall optionally be available for a (suggested) total of maximum one hour throughout the course run to answer asynchronous questions 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: Experience in working with DC electricity, a good understanding of electric circuits and of lithium-ion batteries and their behavior. Good presentation skills. Preferred to have also pedagogical experience. Experience on use of VR in a learning environment.

Moreover, during the 2 lab training parts, experts will be physically there to demonstrate the battery handling activities and coach the learners when applying these themselves. Learners will even take part in VR games to build battery packs virtually before getting their hands dirty with real battery cells. During the lab sessions, the learners will be asked to show what they learned from the online videos by naming cells, identifying faults, comparing batteries in the lab, selecting a charger for a pack, etc. The trainer profiles for the lab training parts include:

- Trainer 1: Experience in working with DC electricity, a good understanding of electric circuits and of lithium-ion batteries and their behavior. Experience with operating relevant equipment (e.g., power supply, DC electronic load, etc.). Preferred to have also pedagogical experience. Experience on use of VR in a learning environment.
- Trainer 2: Experience with battery cells, battery packs and battery system components as well as knowledge of electricity and electrical circuits. Experience with operating relevant equipment. Preferred to have also pedagogical experience.
- Trainer 3: Experience in performing diagnostics and fault repairs on batteries (particularly EV and e-bike batteries) and general experience in working and handling batteries. Knowledge of battery pack building and dismantling. Experience with operating relevant equipment. Preferred to have also pedagogical experience.

1.11. Course evaluation

To succeed in the Battery Technician programme and receive a Certificate of Accomplishment, a learner needs to obtain a minimum score of 70 points on the general assessment at the end of the programme. Online in-lesson quizzes are only meant for self-evaluation and do not count towards the final Certificate.

The general assessment serves as a test on the understanding of the course content by each learner. In the general assessment, learners will have to analyse customer needs, design the best technical and economical offer (types of cells, configuration, cost), and send in a report 2 weeks after the end of the programme. They will also have to present their solution orally via web conference to a jury of teachers and industry experts.

The certificate of Battery Technician will be awarded at the following conditions:

- Minimum score of 70 % on general assessment

- Positive evaluation by experts in the lab sessions (naming cells, identifying faults, comparing batteries in lab, selecting charger for pack etc)
- Positive evaluation by experts of final oral presentation