

# Hydrogen energy short training courses

This document describes the short courses on hydrogen-energy offered by **the University of Franche-Comt  and the University of Technology of Belfort-Montb liard (UTBM)** for companies and communities. These non-degree courses are based on the activities carried out within the CNRS FCLAB support and research unit and the partner laboratories, including the FEMTO-ST Institute.

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## Presentation of the institutions

The courses offered are carried out jointly by the following institutions.

### University of Franche-Comté

The University of Franche-Comté is a multidisciplinary university which welcomes nearly 30,000 learners each year on five sites: Besançon, Belfort, Montbéliard, Vesoul and Lons-le-Saunier.

With its 23 research units, its 6 federative structures and its 27 technological platforms, the University of Franche-Comté places the link between training, research and innovation at the heart of its strategy.

It develops high-level research to respond to major societal challenges. Labeled HSR4R and member of the EURAXESS network, it is recognized for providing a quality welcoming to its researchers.

Open to the world and deeply rooted in its territory, the University of Franche-Comté is a founding member of the COMUE Université Bourgogne Franche-Comté. Its commitment to the local socio-economic world, as well as its training-research-innovation expertise, also make the establishment a major player in continuing professional training and work-study programs in higher education.

The Continuing Education and Work-Study Department of the University of Franche-Comté - SeFoC'AI - provides its expertise in educational and financial engineering to advise and support private and public companies, employees, job seekers and future alternating. By relying on the added value of the university, it supports specific needs and demands in terms of skills and training. The training offer includes national diplomas (Bac+2 to Bac+8 level), university and inter-university diplomas, short courses (modular or tailor-made), as well as more than 90 courses open to work-study (contract of professionalization and apprenticeship contract). By engaging in the link with the sponsors and the beneficiaries of the training provided, SeFoC'AI offers personalized follow-up throughout the training project.

### University of Technology of Belfort-Montbéliard

The University of Technology of Belfort-Montbéliard (UTBM) is a public institution of a scientific, cultural and professional nature, created in 1999 from the merger of two higher education establishments: the National School of Engineers of Belfort (1962) and the Polytechnic Institute of Sevenans (a branch of the UTC established in Sevenans in 1985). UTBM is a member of the network of universities of technology. The UTBM is also a founding member of the Bourgogne Franche-Comté University.

It trains engineers who are quickly operational and particularly adaptable to changes in technology and changes in society. Its training is based on research activities and development. The UTBM is involved in the challenges of the future. Technologies, tools, people are constantly evolving. The passion of the UTBM teams is to train the leaders of tomorrow and to carry out cutting-edge technological research.

To meet your needs, the UTBM offers you a wide range of innovative, scientific and industrial know-how, as well as services: internships, research contract, continuing education, etc...

Our continuing vocational training offer (FTLV) is a tool available to all workers: employees, self-employed, business leaders or job seekers. It allows you to train throughout your professional career, to develop your skills and access employment, stay in employment or even change jobs. The UTBM offers you short training courses of 1 to 5 days, modular and tailor-made. These modules have been designed based on the expertise of our teacher-researchers and are based, among other things, on our research themes in the fields of Energy, high-performance surface engineering, design and mechanical optimization, ergonomics, artificial intelligence, computer science and industrial systems. Training is provided at the UTBM, in-company or remotely, depending on the case.



## FCLAB

FCLAB is a technical and scientific resource center dedicated to systems in the Hydrogen-Energy sector, with over 20 years of experience in the field. It is a joint structure of the CNRS, the University of Franche-Comté (UFC), the University of Technology of Belfort-Montbéliard (UTBM), the National School of Mechanics and Microtechnology (ENSMM) and the Federal University Bourgogne Franche-Comté (UBFC). FCLAB is located within the Hydrogène Energie platform in Belfort.

FCLAB federates the activities of more than 140 researchers and engineers through its network of partner laboratories (Institute FEMTO-ST, ICB, LEMTA, AMPERE, SATIE). Its service offering covers engineering and feasibility studies for projects and implementation, testing of hydrogen systems up to powers of 150 kW, taking into account environmental constraints in a controlled atmosphere (temperature and humidity) and in vibration. Research activities are carried out and implemented by the partner laboratories, FCLAB ensuring the dynamism of cross-functional projects of the research teams within its "Hotel" of projects.

FCLAB offers tailor-made training to its customers and partners ranging from general seminars to custom-built training including an experimental part.



# Training course catalogue

## Introduction to hydrogen energy

### Concerned public

Company employees, public institutions and local authorities with activities in hydrogen or wishing to start an activity in this field.

### Prerequisites

Bac + 2 minimum and general knowledge of energy preferable.

### Admission procedures

Talking to the training supervisor, adequacy with the prerequisites and the public concerned.

### Evaluation

Multiple Choice Questions.

### Diploma

Providing a certificate at the end of the training.

### Course Objectives

Hydrogen energy is increasingly seen as one of the tools for achieving current climate objectives. This training aims to provide an overview of associated technologies, current issues and major players in the field. It does not aim to go into detail in the technical part. After completing this training, learners will be able to:

- Explain the general operation of the main means of production, storage and use of hydrogen,
- Identify the strengths and limitations of hydrogen and associated technologies for energy transition, mobility and stationary applications,
- Name the current major players in hydrogen,
- Identify the major obstacles associated with hydrogen energy.

### Course Program

1. Round table, training objectives
2. Introduction
  1. Energy context
  2. What is hydrogen ?
  3. History
  4. Overview, from production to consumption
3. Visit of the hydrogen energy platform
4. Electrolysis
5. Hydrogen storage
6. Fuel cells
7. Hydrogen applications
  1. Mobility applications
  2. Stationary and network applications
  3. Industrial applications
8. Industrial, academic and institutional hydrogen players
9. State of the art and technological, socio-economic and regulatory obstacles
10. Evaluation in the form of Multiple Choice Questions
11. On-the-spot evaluation of the training

### Duration

1 day.



**Teaching**

- 6 hours of theory lessons,
- 1 hour visit of the Hydrogen-Energy Platform,
- Option: 3,5 hours of case study.

**Educational tools**

- Training materials (slides), provided to participants in hard copy,
- Video clips to illustrate certain projects or concepts,
- Visit of the Hydrogen-Energy Platform in Belfort.

**Location**

- If inter-company training, in our premises in Belfort.
- If training several employees of the same company, possibility of carrying out the training on its premises.
- Possibility of distance learning if the health situation requires it. In this case, the program will be adapted after discussion with the learners.

**Course supervisor**

Robin ROCHE, teacher-researcher at UTBM, member of the FEMTO-ST laboratory and partner of the FCLAB unit, Deputy Director of the Energy Department of the FEMTO-ST, [robin.roche@utbm.fr](mailto:robin.roche@utbm.fr), +33 (0)3 84 58 34 79.

**Other speakers depending on availability**

- Daniel HISSEL, teacher-researcher at the UFC, member of the FEMTO-ST laboratory and partner of the FCLAB unit, head of the SHARPAC research team at FEMTO-ST.
- Elodie PAHON, teacher-researcher at UTBM, member of the FEMTO-ST laboratory and partner of the FCLAB unit.
- Marie-Cécile PERA, teacher-researcher at the UFC, member of the FEMTO-ST laboratory and director of the FCLAB.



## How fuel cells work

### Concerned public

Company employees, public institutions and local authorities with activities in hydrogen or wishing to start an activity in this field.

### Prerequisites

Bac + 2 minimum and general knowledge of energy preferable.

### Admission procedures

Talking to the training supervisor, adequacy with the prerequisites and the public concerned.

### Evaluation

Multiple Choice Questions.

### Diploma

Providing a certificate at the end of the training.

### Course Objectives

The fuel cell (FC) is a clean and silent energy conversion solution. This training provides an overview of fuel cell technology, potential applications with a focus on transport applications, as well as the obstacles to overcome for large-scale use. More specifically, learners who have taken this training will be able to:

- Understand the operating principles of the PEM type fuel cell.
- Know the different auxiliary systems necessary for the operation of fuel cell.
- Define and size simple systems to meet particular specifications, especially for embedded solutions.
- Know the different topologies of hybrid fuel cell powertrains.
- Know the current challenges of the fuel cells.

### Course Program

1. Round table, training objectives
2. Introduction to Fuel Cell Technology (FC)
  1. What is a FC ?
  2. The different types of fuel cells
  3. Operation of a PEM-type fuel cell
3. Performance of the fuel cell
4. Fuel cell system and auxiliaries
5. Fuel cell technology for automotive applications
6. State of the art of fuel cell vehicles
7. Introduction to the hydrogen economy
8. Evaluation in the form of Multiple Choice Questions (MCQ)
9. Training evaluation on the spot

### Duration

1 day.

### Teaching

- 6 hours of theory lessons,
- 1 hour visit of the Hydrogen-Energy Platform,
- Option : 3,5 hours practical work on fuel cells

### Educational tools

- Training materials (slides), provided to participants in hard copy,
- Video clips to illustrate certain projects or concepts,
- Visit of the Hydrogen-Energy Platform in Belfort.
- Samples of fuel cells components.



**Location**

- If inter-company training, in our premises in Belfort.
- If training several employees of the same company, possibility of carrying out the training on its premises.
- Possibility of distance learning if the health situation requires it. In this case, the program will be adapted after discussion with the learners.

**Course supervisor**

Elena BREAZ, teacher-researcher at UTBM, member of the FEMTO-ST laboratory and partner of the FCLAB unit, [elena.breaz@utbm.fr](mailto:elena.breaz@utbm.fr), +33 (0)3 84 58 36 46

**Other speakers depending on availability**

- David BOUQUAIN, teacher-researcher at UFC, member of the FEMTO-ST laboratory and deputy director of the FCLAB
- Fei GAO, teacher-researcher at UTBM, member of the FEMTO-ST laboratory and partner of the FCLAB unit, deputy director of the FEMTO-ST
- Daniel HISSEL, teacher-researcher at the UFC, member of the FEMTO-ST laboratory and partner of the FCLAB unit, head of the SHARPAC research team at FEMTO-ST
- Samir JEMEI, teacher-researcher at UTBM, member of the FEMTO-ST laboratory and partner of the FCLAB unit
- Marie-Cécile PERA, teacher-researcher at the UFC, member of the FEMTO-ST laboratory and director of the FCLAB.



## Fuel cell vehicles

### Concerned public

Company employees, public institutions and local authorities with activities in fuel cell vehicles or wishing to start an activity in this field.

### Prerequisites

Bac + 2 minimum and general knowledge of energy and transport preferable.

### Admission procedures

Talking to the training supervisor, adequacy with the prerequisites and the public concerned.

### Evaluation

Multiple Choice Questions.

### Diploma

Providing a certificate at the end of the training.

### Course objectives

The emergence of new technologies in the transport sector leads to the appearance of a new type of vehicle using hydrogen as the main energy for propulsion. This training aims to give the learner the keys to this technology and more particularly to:

- Know the potential applications and interests of the use of hydrogen-based energy sources in transport (automotive and rail focus).
- Know how to size, integrate and manage a traction chain including a hydrogen source in a mobility application.
- Understand the notions of well-to-wheel performance for calculating the energy efficiency of the global transport system.

### Program

1. Round table, course objectives
2. Introduction
  1. Energy context
  2. State of the art of current electric mobility offers
3. Hybrid powertrains (automotive focus)
4. Application: design of a hybrid powertrain based on a fuel cell
5. Practical case: energy efficiency calculation and comparison between a fuel cell vehicle and a standard thermal vehicle
6. Introduction to the energy management of a hybrid traction chain
  1. Focus on fuel economy
  2. Focus on the limit of component aging
7. Visit of the Hydrogen Energy platform in Belfort
8. State of the art and technological, socio-economic and regulatory barriers
9. Evaluation in the form of Multiple Choice Questions
10. Training evaluation on-the-spot

### Duration

1,5 day.

### Teaching

- 9 hours of theory lessons,
- 1 hour visit of the Hydrogen-Energy Platform,
- 3 hours of case study.





**Educational tools**

- Training materials (slides), provided to participants in hard copy,
- Matlab/Simulink software,
- Video clips to illustrate certain projects or concepts,
- Visit of the Hydrogen Energy platform in Belfort

**Location**

- If inter-company training, in our premises in Belfort.
- If training several employees of the same company, possibility of carrying out the training on its premises.
- Possibility of distance learning if the health situation requires it. In this case, the program will be adapted after discussion with the learners.

**Course supervisor**

Alexandre RAVEY, teacher-researcher at UTBM, member of the FEMTO-ST laboratory and partner of the FCLAB unit, [alexandre.ravey@utbm.fr](mailto:alexandre.ravey@utbm.fr), +33 (0)3 84 58 37 92

**Other speakers depending on availability**

- David BOUQUAIN, teacher-researcher at UFC, member of the FEMTO-ST laboratory and deputy director of the FCLAB,
- Frédéric DUBAS, teacher-researcher at UTBM, member of the FEMTO-ST laboratory and partner of the FCLAB unit,
- Samir JEMEI, teacher-researcher at UTBM, member of the FEMTO-ST laboratory and partner of the FCLAB unit,
- Mickaël HILAIRET, teacher-researcher at UTBM, member of the FEMTO-ST laboratory and partner of the FCLAB unit, director of the FEMTO-ST Energy Department,
- Daniel HISSEL, teacher-researcher at the UFC, member of the FEMTO-ST laboratory and partner of the FCLAB unit, head of the SHARPAC research team at FEMTO-ST.





**Educational tools**

- Training materials (slides), provided to participants in hard copy,
- Matlab/Octave software,
- Video clips to illustrate certain projects or concepts,
- Visit of the Hydrogen Energy platform in Belfort

**Location**

- If inter-company training, in our premises in Belfort.
- If training several employees of the same company, possibility of carrying out the training on its premises.
- Possibility of distance learning if the health situation requires it. In this case, the program will be adapted after discussion with the learners.

**Course supervisor**

Robin Roche, teacher-researcher at UTBM, member of the FEMTO-ST laboratory and partner of the FCLAB unit, Deputy Director of the Energy Department of the FEMTO-ST, [robin.roche@utbm.fr](mailto:robin.roche@utbm.fr), +33 (0)3 84 58 34 79

**Other speakers depending on availability**

- Djafar CHABANE, teacher-researcher at UTBM, member of the FEMTO-ST laboratory and partner of the FCLAB unit,
- Alexandre RAVEY, teacher-researcher at UTBM, member of the FEMTO-ST laboratory and partner of the FCLAB unit.



## Energy storage

### Concerned public

Company employees, public institutions and local authorities with activities in energy storage or wishing to start an activity in this field.

### Prerequisites

Bac + 2 minimum and general knowledge in energy preferable.

### Admission procedures

Talking to the training supervisor, adequacy with the prerequisites and the public concerned.

### Evaluation

Multiple Choice Questions.

### Diploma

Providing a certificate at the end of the training.

### Course objectives

Energy storage is a central subject of current societies whose applications cover many areas, whether mobility or stationary applications, but also of very different sizes. This training offers an overview of the main energy storage technologies. More specifically, learners who have taken this training will be able to:

- Describe and compare the main means of energy storage.
- Choose a means of storage medium for the main stationary and on-board applications.

### Program

1. Round table, course objectives
2. Introduction
  1. Energy context
  2. Why storing energy ?
  3. Overview of storage technologies
3. Conventional fuels
4. Electrochemical accumulators and batteries
5. Supercapacitors
6. Flywheels
7. Hydrogen
8. Compressed air
9. Applications of storage for mobility
10. Stationary storage applications
11. State of the art and technological, socio-economic and regulatory obstacles
12. Evaluation in the form of MCQs
13. On-the-spot training evaluation

### Duration

1 day.

### Teaching

- 7 hours of theory lessons
- Option: 7 hours of theoretical in-depth lessons
- Option: 3,5 hours of case study
- Option: 3,5 hours of practical work on batteries
- Option: 3,5 hours of practical work on supercapacitors.

### Educational tools

- Training materials (slides), provided to participants in hard copy,
- Video clips to illustrate certain projects or concepts,
- Batteries, supercapacitors and associated equipment



**Location**

- If inter-company training, in our premises in Belfort.
- If training several employees of the same company, possibility of carrying out the training on its premises.
- Possibility of distance learning if the health situation requires it. In this case, the program will be adapted after discussion with the learners.

**Course supervisor**

- Daniela CHRENKO, teacher-researcher at UTBM, member of the FEMTO-ST laboratory and partner of the FCLAB unit, [daniela.chrenko@utbm.fr](mailto:daniela.chrenko@utbm.fr), +33 (0)3 84 58 39 85

**Other speakers depending on availability**

- David BOUQUAIN, teacher-researcher at UFC, member of the FEMTO-ST laboratory and deputy director of the FCLAB.



## Battery energy storage

### Concerned public

Company employees, public institutions and local authorities with activities in batteries or wishing to start an activity in this field.

### Prerequisites

Bac + 2 minimum and general knowledge in energy preferable.

### Admission procedures

Talking to the training supervisor, adequacy with the prerequisites and the public concerned.

### Evaluation

Written test/Multiple Choice Questions.

### Diploma

Providing a certificate at the end of the training.

### Course objectives

Batteries are key components for energy storage in stationary and on-board applications. This training should provide knowledge and skills in the field of batteries, from their operating principle to various applications. More specifically, learners who have taken this training will be able to:

- Describe how the main battery technologies work,
- Characterize and model the performance of a battery,
- Compare these technologies for a stationary or on-board application.

### Program

1. Round table, course objectives
2. Introduction
3. Energy storage
  1. Interest of storage
  2. Means of storage
  3. State of the art
4. Battery fundamentals
  1. Definition and main parameters
  2. Equivalent circuits
5. Battery types
6. Lithium-ion batteries
7. Battery life and use
  1. Aging
  2. Charge, discharge and storage
  3. Transport and recycling
8. Batteries testing
9. Battery packs
10. Battery management systems
11. Batteries for on-board applications
12. Assessment in the form of MCQ or written test
13. On-the-spot training evaluation

### Duration

1 day.

### Teaching

- 7 hours of theory lessons,
- Option: up to 14 hours of theoretical in-depth lessons,
- Option: 3,5 hours of practical work on batteries.



**Educational tools**

- Training materials (slides), provided to participants in hard copy,
- Video clips to illustrate certain projects or concepts,
- Batteries and associated equipment

**Location**

- If inter-company training, in our premises in Belfort.
- If training several employees of the same company, possibility of carrying out the training on its premises.
- Possibility of distance learning if the health situation requires it. In this case, the program will be adapted after discussion with the learners.

**Course supervisor**

Daniela CHRENKO, teacher-researcher at UTBM, member of the FEMTO-ST laboratory and partner of the FCLAB unit, [daniela.chrenko@utbm.fr](mailto:daniela.chrenko@utbm.fr), +33 (0)3 84 58 39 85

**Other speakers depending on availability**

- David BOUQUAIN, teacher-researcher at UFC, member of the FEMTO-ST laboratory and deputy director of the FCLAB.



## Register for a course

### Registration

- For any registration or question, contact: [formations.h2@femto-st.fr](mailto:formations.h2@femto-st.fr)
- Adjustments are possible according to the needs expressed:
  - Language of instruction (French or English),
  - On our premises, in company or remotely,
  - Period of the year,
  - Deepening on specific subjects (optional),
  - Work on case studies (optional),
  - Practical work (optional).

### Tarifs

Number of people and costs	Price list
Individual	750 € HT / day / person
Group of the same company (5 to 9)	675 € HT / day / person
Group of the same company (>=10)	500 € HT / day / person
Contributors travel expenses	According to estimate
Lunch meals in Belfort	According to estimate

### Disability

#### Physical disability

The buildings of the 3 UTBM sites are accessible to people with reduced mobility, the “disabled” parking spaces are indicated. The university restaurant on the Sevenans site is also suitable for people with reduced mobility. A secure waiting area in the event of fire has been created in Buildings A and F on the Belfort site.

#### Hearing impairment

No specific measures put in place apart from flashing lights indicating an evacuation order in the sanitary facilities of building A in Belfort and building M in Montbéliard.

#### Visual impairment

The majority of elevators are equipped with Braille writing as well as voice control.

#### Facilities

Regarding staff, positions can be arranged according to the disability.  
For student learners, special arrangements can also be made, particularly for exams.

