# Professional Master's Degree

## Hydrogen Technology

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» Modality: **online**
» Duration: **12 months**
» Certificate: **TECH Global University**
» Credits: **60 ECTS**
» Schedule: **at your own pace**
» Exams: **online**

Website: **www.techtitute.com/us/engineering/professional-master-degree/master-hydrogen-technology**

# Index

01
# Introduction

In recent years, hydrogen has undoubtedly been a true revolution in the search for renewable energy sources. In the race to obtain the best technological project based on this chemical element and reduce the consumption of fossil resources, multinational companies are promoting initiatives that require highly specialized engineering professionals. That is why TECH has created this program, which will help graduates to know the most relevant scientific-technical aspects in the generation, transport or use of hydrogen, as well as the economic factors to be taken into account for its development. In addition, graduates will have access to quality multimedia teaching resources, developed by a teaching team composed of experts in the field with experience in one of the booming industrial sectors. In this way, this institution aims to boost the professional career of students who take this 100% online program.

*This 100% online university degree will lead you to specialize in the use of hydrogen as an energy vector"*

Climate change, the scarcity of fossil resources and the deterioration of the environment have led public and private institutions to promote renewable energies. Among them, hydrogen has stood out, especially in recent years. An element which is being bet on by large companies who want to maintain their share in the market through technology and innovation.

An optimal professional scenario for engineering graduates who wish to specialize in one of the sectors that has experienced the greatest boom in recent decades. However, this boost requires highly qualified personnel with technical knowledge in all processes: from production, storage, transport and distribution to end uses. In this line, TECH has designed a Professional Master's Degree that provides advanced learning and goes beyond the technical professional profile, as it provides the necessary tools to lead any project using Hydrogen Technology.

A program with a theoretical-practical approach, in which this academic institution has brought together the most specialized teaching team in this area. In addition, its experience and research capacity in R&D gives an added value to this program by providing a scientific vision on the mechanisms of hydrogen generation from biomass.

In this way, students will delve into hydrogen fuel cells, refueling stations for vehicles that use this energy, the existing market itself and the elements of regulation and safety. For this purpose, it has teaching resources that will lead them to delve in a much more dynamic way in the planning and management of hydrogen projects, their feasibility and the essential technical-economic analysis.

Therefore, engineering professionals have an excellent opportunity to advance their careers through a Professional Master's Degree, which they can study whenever and wherever they wish. They only need an electronic device with Internet connection to view the content hosted on the Virtual Campus. In addition, students have the freedom to distribute the teaching load according to their needs. An ideal academic option for people looking to balance their personal responsibilities with a high-level university education.

This **Professional Master's Degree in Hydrogen Technology** contains the most complete and up-to-date program on the market. The most important features include:

- Case studies presented by engineering experts
- The graphic, schematic and practical contents of the book provide technical and practical information on those disciplines that are essential for professional practice.
- Practical exercises where self-assessment can be used to improve learning.
- Its special emphasis on innovative methodologies
- Theoretical lessons, questions to the expert, debate forums on controversial topics, and individual reflection assignments
- Content that is accessible from any fixed or portable device with an Internet connection

*"Stand out in a growing sector that demands highly specialized engineering professionals capable of leading any technological initiative that uses hydrogen"*

*You are one step away from enrolling in a degree that will allow you to create and manage projects where Hydrogen Technology is used by applying the knowledge from this program"*

The program's teaching staff includes professionals from the sector who contribute their work experience to this educational program, as well as renowned specialists from leading societies and prestigious universities.

Its multimedia content, developed with the latest educational technology, will allow professionals to learn in a contextual and situated learning environment, i.e., a simulated environment that will provide immersive education programmed to learn in real situations.

The design of this program focuses on Problem-Based Learning, by means of which professionals must try to solve the different professional practice situations that are presented to them throughout the academic year. For this purpose, the student will be assisted by an innovative interactive video system created by renowned and experienced experts.

*No attendance or classes with schedules. This program offers you the flexibility you are looking for to pursue a 100% online university education.*

*This program will allow you to delve into the generation, transportation or use of hydrogen in innovative vehicle projects.*

02

# Objectives

The main objective of this Professional Master's Degree is to enhance the capabilities of engineering professionals for their performance in the hydrogen sector. Therefore, over the 12 months of this program, graduates will expand their knowledge of the value chain: from hydrogen generation to final uses, including its interaction with the other components that make up the energy system. The case studies provided by the teaching staff will be very useful, as students will be able to integrate different methodologies and techniques in their daily practice.



*Advanced and practical knowledge are the cornerstones of a program that will make you grow professionally in the hydrogen industry"*

## General Objectives

- Educate students in the interpretation and in-depth analysis of hydrogen.
- Compile the breadth of concepts and knowledge necessary to delve into the field of the use of hydrogen as an energy vector
- Develop specialized knowledge of the world of hydrogen and an in-depth understanding of its potential as an energy vector

*Sign up now for an education that will allow you to easily delve into the certification process of hydrogen installations"*

## Specific Objectives

### Module 1. Hydrogen as an Energy Vector

- Interpret in depth the singularities of the hydrogen environment
- Examine the existing legislative framework in the hydrogen environment
- Evaluate the hydrogen value chain players, as well as the needs to achieve the Hydrogen Economy
- In-depth knowledge of hydrogen as a molecule
- Determine the most relevant concepts of the hydrogen environment
- Analyze the integration of hydrogen in hydrogen infrastructures

### Module 2. Hydrogen Production and Electrolysis

- Determine the methods of hydrogen production from fossil fuels
- Analyze the mechanisms of hydrogen generation from biomass
- Establish the modes of biological hydrogen formation
- Differentiate the various electrolysis technologies for hydrogen production
- Examine the electrochemistry behind electrolysis processes
- Conduct techno-economic modeling of an electrolysis system

### Module 3. Hydrogen Storage, Transportation and Distribution

- Develop the different possibilities for hydrogen storage, transportation and distribution
- Determine the different ways of transporting, storing and distributing hydrogen
- Analyze the possibilities and limitations of hydrogen export
- In-depth analysis of the techno-economic analysis of large-scale hydrogen logistics

### Module 4. Hydrogen End-Uses

- Educate students in e-Fuels production processes
- Specialize students in hydrogen integration in fuel cell vehicles
- Analyze the idiosyncrasies of the hydrogen-industry relationship
- Examine the Haber-Bosch process and methanol production in depth
- Determine the relationship between hydrogen and its use in refineries and its use in steel mills
- Raise students' awareness of the need for natural gas substitution

### Module 5. Hydrogen Fuel Cells

- Analyze the chemistry that governs the operation of PEMFCs
- Educate students in the design of the PEMFC membrane-electrode assembly
- Understand the operation of the PEMFC fuel cell stack
- Analyze the characteristics of other types of fuel cells
- Establish the sizing of the fuel cell system according to the end-use application
- Determine fuel cell integration by end-use
- Conduct techno-economic modeling of fuel cell operation

### Module 6. Hydrogen Refueling Stations

- Establish the different typologies of hydrogen refueling stations
- Establish the design parameters
- Compile storage strategies at different pressure levels
- Analyze dispensing and its associated problems
- Master the concepts of safety and associated regulations
- Specialize students in modeling the operation of a hydrogen refueling station

### Module 7. Hydrogen Markets

- Understand the different markets in which hydrogen can penetrate
- Understand hydrogen sales price bands according to end-uses
- Analyze current hydrogen production and demand
- Understand hydrogen market expansion plans
- Assess actual hydrogen projects
- Explain the guarantee of origin system and the need for it

### Module 8. Explain the system of guarantees of origin and the need for it

- Study best practices for hydrogen project deployment
- Understand the introduction on the documentation required by the administration
- Delve into key application directives
- Study the safety of hydrogen installations
- Learn about the certification process of installations

### Module 9. Hydrogen Project Planning and Management

- Compile project management tools
- Explore the different parts of project planning
- Raise awareness of the importance of project risk identification and management

### Module 10. Technical-Economic and Feasibility Analysis of Hydrogen Projects

- Develop expertise on techno-economic and feasibility analysis of hydrogen projects
- Determine the structuring of hydrogen projects and their financing
- Analyze the keys to electricity supply for green hydrogen production
- Learn how to develop a feasibility analysis and its different scenarios

03
# Skills

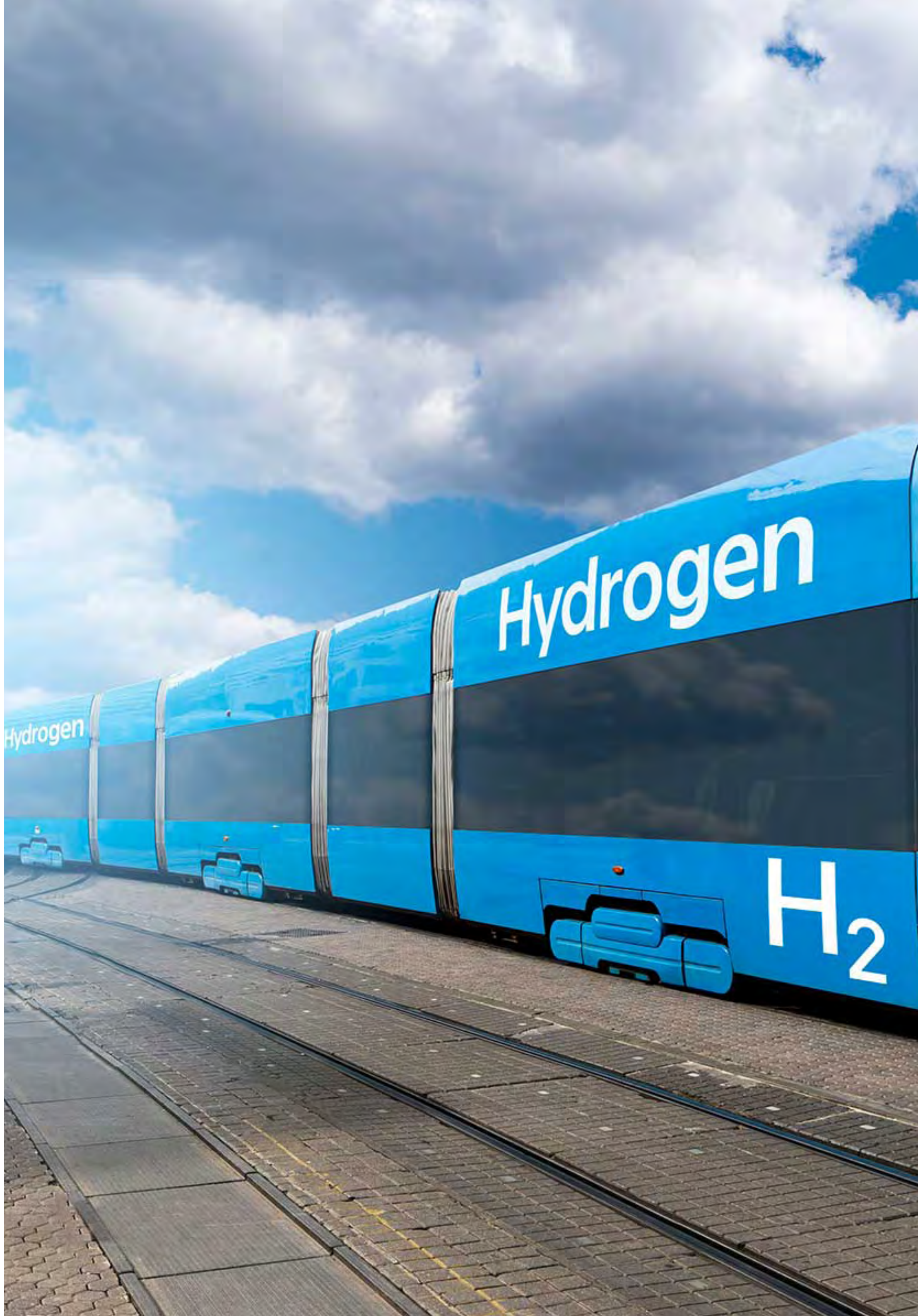
The syllabus of this Professional Master's Degree has been designed to broaden the specific knowledge of engineers in the field of Hydrogen Technology. Therefore, this program will allow them to enhance their capabilities to access positions of responsibility in which technical knowledge is a differentiating element in decision-making. For this purpose, this course provides the necessary tools to carry out a techno-economic analysis to support important investment decisions.


*Lead the future technological initiatives based on hydrogen thanks to the advanced knowledge provided by this Professional Master's Degree"*

## General Skills

- Conceptual design of a hydrogen refueling station
- Develop the techniques of cogeneration and electricity production with fuel cells and their importance
- Develop skills in analyzing the possibilities and choosing the most appropriate method of hydrogen storage, transportion and analysis and distribution for their project
- Design the complete electrolysis system

*You are looking at an educational program that will enhance your technical and analytical skills in strategic actions in the hydrogen sector"*



## Specific Skills

- Assess the possibilities offered by hydrogen
- Enhance the ability to choose the most suitable financing tool
- Efficient management of hydrogen projects
- Expand the analysis of the import and export potential of different countries
- Delve into the knowledge of Project Finance focused on the development of hydrogen projects
- Characterize and identify project costs and revenues, as well as cash flows and profitability indicators
- Analyze the EPC phase and O&M phase of a hydrogen project
- Develop expertise on the contracting phase of a project
- Learn about European hydrogen policies
- Learn about the regulations applicable to hydrogen projects

# 04
# Course Management

This academic program includes the most specialized teaching staff in the current educational market. They are specialists selected by TECH to develop the whole syllabus. In this way, starting from their own existence and the latest evidence, they have designed the most up-to-date content that provides a guarantee of quality in such a relevant subject.

*TECH offers the most specialized teaching staff in the field of study. Enroll now and enjoy the quality you deserve"*

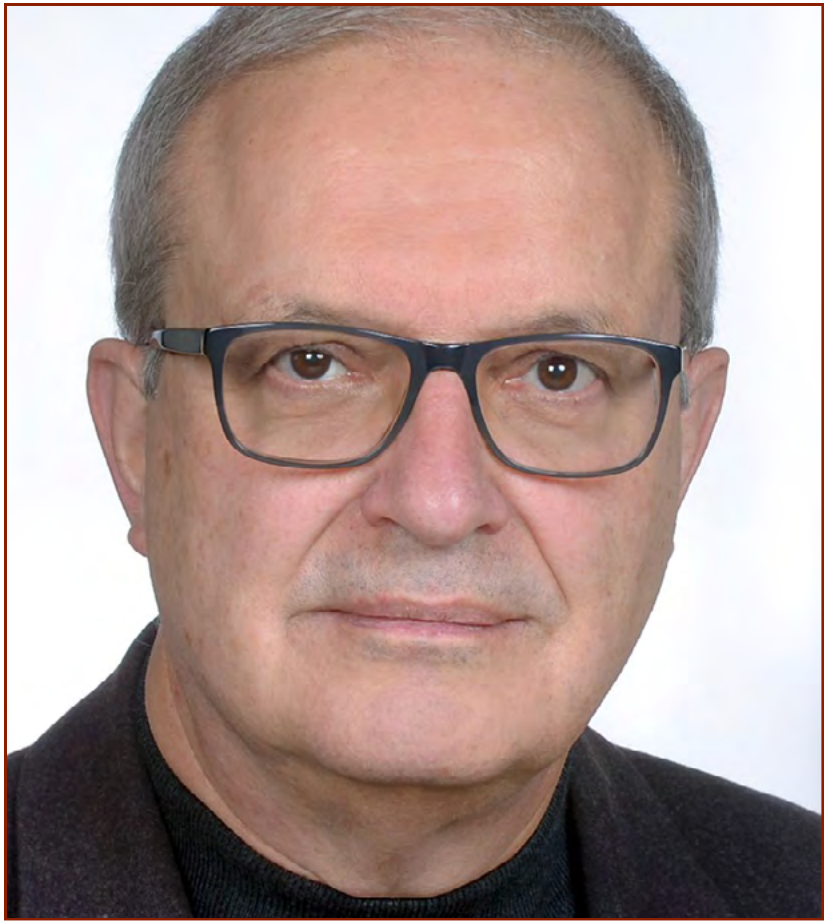
## International Guest Director

With an extensive professional background in the energy sector, Adam Peter is a prestigious **electrical engineer** who stands out for his commitment to the use of **clean technologies**. Likewise, his strategic vision has driven innovative projects that have transformed the industry towards more efficient and environmentally friendly models.

In this way, he has worked in leading international companies such as **Siemens Energy** in Munich. In this way, he has held leadership roles ranging from **Sales Management or Corporate Strategy Management to Market Development**. Among his main achievements, he has led the **Digital Transformation** of organizations in order to improve their operational flows and maintain their competitiveness in the market in the long term. For example, he has implemented Artificial Intelligence to automate complex tasks such as **predictive monitoring** of industrial equipment or optimization of **energy management systems.**

In this regard, it has created multiple **innovative strategies** based on advanced **data analysis** to identify both patterns and **trends** in electricity consumption. As a result, companies have optimized their informed decision-making in real time and have been able to reduce their production costs significantly. In turn, this has contributed to companies' ability to adapt nimbly to market fluctuations and respond with immediacy to new operational needs, ensuring greater resilience in a dynamic working environment.

He has also led numerous projects focused on the adoption of **renewable energy sources** such as wind turbines, photovoltaic systems and cutting-edge energy storage solutions. These initiatives have enabled institutions to optimize their resources efficiently, guarantee a sustainable supply and comply with current environmental regulations. Undoubtedly, this has positioned the company as a reference in both **innovation** and **corporate responsibility**.



## Mr. Peter, Adam

- Head of Hydrogen Business Development at Siemens Energy, Munich, Germany
- Sales Director at Siemens Industry, Munich
- President of Rotating Equipment for Upstream/Midstream Oil & Gas
- Market Development Specialist at Siemens Oil & Gas, Munich
- Electrical Engineer at Siemens AG, Berlin
- Degree in Electrical Engineering at the University of Applied Sciences Dieburg

*"Thanks to TECH, you will be able to learn with the best professionals in the world"*

05
# Structure and Content

The syllabus of this university degree will allow graduates to acquire specialized learning, which will lead them to make significant progress in their professional field. For this purpose, this Professional Master's Degree has been created, which compiles the technical contents that facilitate the design of complete installations as well as specific equipment. It also provides a holistic view of projects, including techno-economic assessment. Likewise, they will delve into a more attractive way thanks to the innovative multimedia resources that can be accessed 24 hours a day, from any electronic device with an Internet connection.

*This Professional Master's Degree will allow you to know the key and crucial points for the successful realization of a real project based on Hydrogen Technology"*

## Module 1. Hydrogen as an Energy Vector

1.1. Hydrogen as an Energy Vector. Global Context and Necessity
- 1.1.1. Political and Social Context
- 1.1.2. Paris CO2 Emission Reduction Commitment
- 1.1.3. Circularity

1.2. Hydrogen Development
- 1.2.1. Discovery and Production of Hydrogen
- 1.2.2. Role of Hydrogen in Industrial Society
- 1.2.3. Hydrogen at Present

1.3. Hydrogen as a Chemical Element: Properties
- 1.3.1. Properties
- 1.3.2. Permeability
- 1.3.3. Flammability and Buoyancy Index

1.4. Hydrogen as a Fuel
- 1.4.1. Hydrogen Production
- 1.4.2. Hydrogen Storage and Distribution
- 1.4.3. The Use of Hydrogen as a Fuel

1.5. Hydrogen Economy
- 1.5.1. Decarbonization of the Economy
- 1.5.2. Renewable Energy Sources
- 1.5.3. The Road to the Hydrogen Economy

1.6. Hydrogen Value Chain
- 1.6.1. Production
- 1.6.2. Storage and Transportation
- 1.6.3. End-Uses

1.7. Integration with Existing Energy Infrastructures: Hydrogen as an Energy Vector
- 1.7.1. Regulations
- 1.7.2. Problems Associated with Hydrogen Embrittlement
- 1.7.3. Integration of Hydrogen in Energy Infrastructures. Trends and Realities

1.8. Hydrogen Technologies. Status
- 1.8.1. Hydrogen Technologies
- 1.8.2. Technologies under Development
- 1.8.3. Key Projects for Hydrogen Development

1.9. "Relevant" Type Projects
- 1.9.1. Production Projects
- 1.9.2. Flagship Projects in Storage and Transportation
- 1.9.3. Projects for the Application of Hydrogen as an Energy Vector

1.10. Hydrogen in the Global Energy Mix: Current Situation and Prospects
- 1.10.1. The Energy Mix. Global Context
- 1.10.2. Hydrogen in the Energy Mix. Current Situation
- 1.10.3. Development Pathways for Hydrogen. Perspectives

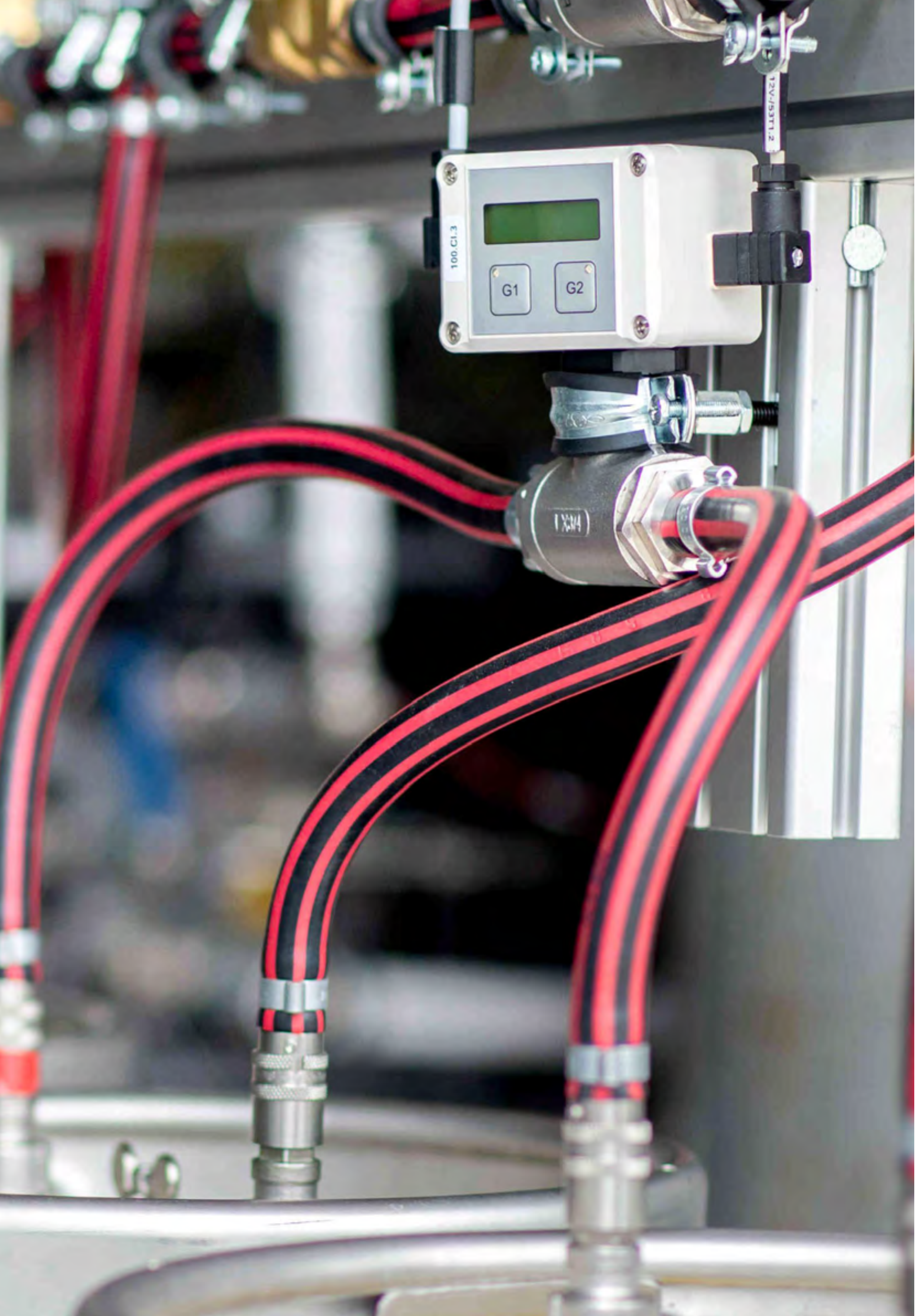
## Module 2. Hydrogen Production and Electrolysis

2.1. Fossil Fuel Production
- 2.1.1. Hydrocarbon Reforming Production
- 2.1.2. Generation by Pyrolysis
- 2.1.3. Coal Gasification

2.2. Production From Biomass
- 2.2.1. Hydrogen Production by Biomass Gasification
- 2.2.2. Hydrogen Generation by Biomass Pyrolysis
- 2.2.3. Aqueous Reforming

2.3. Biological Production
- 2.3.1. Water Gas Shift Reaction (WGSR)
- 2.3.2. Dark Fermentation for Biohydrogen Generation
- 2.3.3. Photofermentation of Organic Compounds for Hydrogen Production

2.4. By-Product of Chemical Processes
- 2.4.1. Hydrogen as a By-Product of Petrochemical Processes
- 2.4.2. Hydrogen as a By-Product of Caustic Soda and Chlorine Production
- 2.4.3. Synthesis Gas as a By-Product Generated in Coke Ovens






## **Module 3.** Hydrogen Storage, Transportation and Distribution

3.3. Gaseous State Storage
 3.3.1. Problems Associated with Hydrogen Storage
 3.3.2. Types of Storage Tanks
 3.3.3. Storage Tank Capacities
3.4. Transportation and Distribution in Gaseous State
 3.4.1. Transportation and Distribution in Gaseous State
 3.4.2. Distribution by Road
 3.4.3. Use of the Distribution Network
3.5. Hydrogen Storage, Transportation and Distribution as Liquid
 3.5.1. Process and Conditions
 3.5.2. Equipment
 3.5.3. Current State
3.6. Storage, Transportation and Distribution as Methanol
 3.6.1. Process and Conditions
 3.6.2. Equipment
 3.6.3. Current State
3.7. Storage, Transportation and Distribution as Green Ammonia
 3.7.1. Process and Conditions
 3.7.2. Equipment
 3.7.3. Current State
3.8. Storage, Transportation and Distribution as LOHC (Liquid Organic Hydrogen)
 3.8.1. Process and Conditions
 3.8.2. Equipment
 3.8.3. Current State
3.9. Hydrogen Export
 3.9.1. Hydrogen Export. Necessity
 3.9.2. Green Hydrogen Production Capabilities
 3.9.3. Transportation. Technical Comparison
3.10. Comparative Techno-Economic Analysis of Alternatives for Large Scale Logistics
 3.10.1. Cost of Hydrogen Export
 3.10.2. Comparison between Different Means of Transportation
 3.10.3. The Reality of Large-Scale Logistics

## **Module 4.** Hydrogen End-Uses

4.1. Industrial Uses of Hydrogen
 4.1.1. Hydrogen at Industries
 4.1.2. Origin of Hydrogen Used in Industry. Environmental Impact
 4.1.3. Industrial Uses in the Industry
4.2. Industries and Hydrogen e-Fuels Production
 4.2.1. e-Fuel Versus Traditional Fuels
 4.2.2. Classification of e-Fuels
 4.2.3. Current Status of e-Fuels
4.3. Production of Ammonia: Haber-Bosch Process
 4.3.1. Nitrogen in Figures
 4.3.2. Haber-Bosch Process. Process and Equipment
 4.3.3. Environmental Impact
4.4. Hydrogen in Refineries
 4.4.1. Hydrogen in Refineries. Necessity
 4.4.2. Hydrogen Used Today. Environmental Impact and Cost
 4.4.3. Short- and Long-Term Alternatives
4.5. Hydrogen in Steel Mills
 4.5.1. Hydrogen in Steel Mills. Necessity
 4.5.2. Hydrogen Used Today. Environmental Impact and Cost
 4.5.3. Short- and Long-Term Alternatives
4.6. Natural Gas Substitution: *Blending*
 4.6.1. Mixing Properties
 4.6.2. Problems and Required Improvements
 4.6.3. Opportunities
4.7. Injection of Hydrogen into the Natural Gas Grid
 4.7.1. Methodology
 4.7.2. Current Capabilities
 4.7.3. Problems

4.8. Hydrogen in Mobility: Fuel Cell Vehicles
- 4.8.1. Context and Necessity
- 4.8.2. Equipment and Schemes
- 4.8.3. Present

4.9. Cogeneration and Production of Electricity with Fuel Cells
- 4.9.1. Fuel Cell Production
- 4.9.2. Discharge to the Grid
- 4.9.3. Microgrids

4.10. Others Hydrogen End-Uses: Chemical, Semiconductor, Glass Industry
- 4.10.1. Chemical Industry
- 4.10.2. Semiconductor Industry
- 4.10.3. Glass Industry

## **Module 5.** Hydrogen Fuel Cells

5.1. PEMFC (Proton-Exchange Membrane Fuel Cell) Fuel Cells
- 5.1.1. Chemistry Governing PEMFCs
- 5.1.2. PEMFC Operation
- 5.1.3. PEMFC Applications

5.2. Membrane-Electrode Assembly in PEMFCs
- 5.2.1. MEA Materials and Components
- 5.2.2. PEMFC Catalysts
- 5.2.3. Circularity in PEMFC

5.3. PEMFC Cell Stacks
- 5.3.1. Stack Architecture
- 5.3.2. Assembly
- 5.3.3. Power Generation

5.4. Balance of Plant and PEMFC Stack System
- 5.4.1. Balance of Plant Components
- 5.4.2. Balance of Plant Design
- 5.4.3. System Optimization

5.5. SOFC (Sodium Oxide Fuel Cells) Fuel Cells
- 5.5.1. Chemistry Governing SOFCs
- 5.5.2. SOFCs Operation
- 5.5.3. Applications

5.6. Other Types of Fuel Cells: Alkaline, Reversible, Direct Methanation, etc.
- 5.6.1. Alkaline Fuel Cells
- 5.6.2. Reversible Fuel Cells
- 5.6.3. Direct Methanation Fuel Cells

5.7. Applications of Fuel Cells I. In Mobility, Electric Power Generation, Thermal Generation
- 5.7.1. Fuel Cells in Mobility
- 5.7.2. Fuel Cells in Power Generation
- 5.7.3. Fuel Cells in Thermal Generation

5.8. Fuel Cell Applications II. Techno-Economic Modeling
- 5.8.1. Technical and Economic Characterization of the PEMFC
- 5.8.2. Capital and Operating Costs
- 5.8.3. Technical Characterization of the Operation of a PEMFC
- 5.8.4. Techno-Economic Modeling

5.9. Dimensioning of PEMFC for Different Applications
- 5.9.1. Static Modeling
- 5.9.2. Dynamic Modeling
- 5.9.3. PEMFC Integration in Vehicles

5.10. Stationary Fuel Cells Grid Integration
- 5.10.1. Stationary Fuel Cells in Renewable Microgrids
- 5.10.2. System Modeling
- 5.10.3. Techno-Economic Study of a Fuel Cell in Stationary Use

## **Module 6.** Hydrogen Refueling Stations

6.1. Hydrogen Refueling Corridors and Networks
- 6.1.1. Hydrogen Refueling Networks. Current State
- 6.1.2. Global Hydrogen Vehicle Refueling Station Deployment Targets
- 6.1.3. Cross-Border Hydrogen Refueling Corridors

6.2. Hydrogen Plant Types, Modes of Operation and Dispensing Categories
- 6.2.1. Hydrogen Refueling Station Types
- 6.2.2. Operating Modes of the Hydrogen Refueling Stations
- 6.2.3. Dispensing Categories According to Standards

6.3. Design Parameters
- 6.3.1. Hydrogen Refueling Station. Components
- 6.3.2. Design Parameters according to Hydrogen Storage Type
- 6.3.3. Design Parameters according to the Station's Target Use

6.4. Storage and Pressure Levels
- 6.4.1. Storage of Hydrogen Gas at Hydrogen Refueling Stations
- 6.4.2. Gas Storage Pressure Levels
- 6.4.3. Liquid Hydrogen Storage in Hydrogen Refueling Stations

6.5. Compression Stages
- 6.5.1. Hydrogen Compression. Necessity
- 6.5.2. Compression Technologies
- 6.5.3. Optimization

6.6. Dispensing and Precooling
- 6.6.1. Precooling according to Regulations and Vehicle Type. Necessity
- 6.6.2. Hydrogen Dispensing Cascade
- 6.6.3. Thermal Phenomena of Dispensing

6.7. Mechanical Integration
- 6.7.1. Refueling Stations with On-Site Hydrogen Production
- 6.7.2. Refueling Stations without Hydrogen Production
- 6.7.3. Modularization

6.8. Applicable Regulations
- 6.8.1. Safety Regulations
- 6.8.2. Hydrogen Quality Standards, Certificates
- 6.8.3. Civil Regulations

6.9. Preliminary Design of a Hydrogen Plant
- 6.9.1. Presentation of the Case Study
- 6.9.2. Development of the Case Study
- 6.9.3. Resolution

6.10. Cost Analysis
- 6.10.1. Capital and Operating Costs
- 6.10.2. Technical Characterization of a Hydrogen Refueling Station Operation
- 6.10.3. Techno-Economic Modeling

## **Module 7.** Hydrogen Markets

7.1. Energy Markets
- 7.1.1. Integration of Hydrogen in the Gas Market
- 7.1.2. Interaction of Hydrogen Price with Fossil Fuels Prices
- 7.1.3. Interaction of the Hydrogen Price with the Electricity Market Price

7.2. Calculation of LCOHs and Sales Price Bands
- 7.2.1. Presentation of the Case Study
- 7.2.2. Development of the Case Study
- 7.2.3. Resolution

- 7.3. Global Demand Analysis
    - 7.3.1. Current Hydrogen Demand
    - 7.3.2. Hydrogen Demand Derived from New Uses
    - 7.3.3. Objectives to 2050
- 7.4. Analysis of Hydrogen Production and Types of Hydrogen
    - 7.4.1. Current Hydrogen Production
    - 7.4.2. Green Hydrogen Production Plans
    - 7.4.3. Impact of Hydrogen Production on the Global Energy System
- 7.5. International Roadmaps and Plans
    - 7.5.1. Submission of International Plans
    - 7.5.2. Analysis of International Plans
    - 7.5.3. Comparison between Different International Plans
- 7.6. Green Hydrogen Market Potential
    - 7.6.1. Green Hydrogen into the Natural Gas Grid
    - 7.6.2. Green Hydrogen in Mobility
    - 7.6.3. Green Hydrogen in Industries
- 7.7. Analysis of Large-Scale Projects in the Deployment Phase: USA, Japan, Europe, China
    - 7.7.1. Project Selection
    - 7.7.2. Analysis of Selected Projects
    - 7.7.3. Conclusions
- 7.8. Centralization of Production: Countries with Export and Import Potential
    - 7.8.1. Renewable Hydrogen Production Potential
    - 7.8.2. Renewable Hydrogen Import Potential
    - 7.8.3. Transportation of Large Volumes of Hydrogen
- 7.9. Guarantees of Origin
    - 7.9.1. Need for a System of Guarantees of Origin
    - 7.9.2. CertifHy
    - 7.9.3. Approved Systems of Guarantees of Origin
- 7.10. Hydrogen Supply Contracts: *Offtake Contracts*
    - 7.10.1. Importance of Offtake Contracts for Hydrogen Projects
    - 7.10.2. Keys to Offtake Contracts: Price, Volume and Duration
    - 7.10.3. Review of a Standard Contract Structure

## **Module 8.** Explain the System of Guarantees of Origin and the Need For It

- 8.1. EU Policies
    - 8.1.1. European Hydrogen Strategy
    - 8.1.2. REPowerEU Plan
    - 8.1.3. Hydrogen Roadmaps in Europe
- 8.2. Incentive Mechanisms for the Deployment of the Hydrogen Economy
    - 8.2.1. Need for Incentive Mechanisms for the Deployment of the Hydrogen Economy
    - 8.2.2. Incentives at European Level
    - 8.2.3. Examples of Incentives in European Countries
- 8.3. Regulation Applicable to Production and Storage, Use of Hydrogen in Mobility and in the Gas Grid
    - 8.3.1. Applicable Regulation for Production and Storage
    - 8.3.2. Applicable Regulation for the Use of Hydrogen in Mobility
    - 8.3.3. Regulation Applicable for the Use of Hydrogen in the Gas Grid
- 8.4. Standards and Best Practices in Security Plan Implementation
    - 8.4.1. Applicable Standards: CEN/CELEC
    - 8.4.2. Good Practices in the Implementation of the Security Plan
    - 8.4.3. Hydrogen Valleys
- 8.5. Required Project Documentation
    - 8.5.1. Technical Project
    - 8.5.2. Environmental Documentation
    - 8.5.3. Certification
- 8.6. European Directives. Application Key: PED, ATEX, LVD, MD and EMC.
    - 8.6.1. Pressure Equipment Regulations
    - 8.6.2. Explosive Atmosphere Regulations
    - 8.6.3. Chemical Storage Regulations
- 8.7. International Hazard Identification Standards: HAZID/HAZOP Analysis
    - 8.7.1. Hazard Analysis Methodology
    - 8.7.2. Risk Analysis Requirements
    - 8.7.3. Execution of Risk Analysis

8.8. Plant Safety Level Analysis: SIL Analysis
- 8.8.1. SIL Analysis Methodology
- 8.8.2. SIL Analysis Requirements
- 8.8.3. SIL Analysis Execution

8.9. Certification of Installations and CE Marking
- 8.9.1. Necessity of Certification and CE Marking
- 8.9.2. Authorized Certification Agencies
- 8.9.3. Documentation

8.10. Permits and Approval: Case Study
- 8.10.1. Technical Projects
- 8.10.2. Environmental Documentation
- 8.10.3. Certification

## **Module 9.** Hydrogen Project Planning and Management

9.1. Scope Definition: Project Type
- 9.1.1. Importance of Good Scope Definition
- 9.1.2. EDP OR WBS
- 9.1.3. Scope Management in Project Development

9.2. Characterization of Actors and Entities Interested in Hydrogen Project Management
- 9.2.1. Necessity of Stakeholder Characterization
- 9.2.2. Stakeholder Classification
- 9.2.3. Stakeholder Management

9.3. Most Relevant Project Contracts in the Hydrogen Field
- 9.3.1. Classification of the Most Relevant Contracts
- 9.3.2. Contracting Process
- 9.3.3. Contract Content

9.4. Defining Objectives and Impacts for Projects in the Hydrogen Sector
- 9.4.1. Objectives
- 9.4.2. Impacts
- 9.4.3. Objectives vs. Impacts

9.5. Work Plan for a Hydrogen Project
- 9.5.1. Importance of the Work Plan
- 9.5.2. Elements that Constitute It
- 9.5.3. Development

9.6. Key Deliverables and Milestones in Hydrogen Sector Projects
- 9.6.1. Deliverables and Milestones. Definition of Customer Expectations
- 9.6.2. Deliverables
- 9.6.3. Milestones

9.7. Project Schedule in Hydrogen Sector Projects
- 9.7.1. Preliminary Steps
- 9.7.2. Definition of Activities. Time Window, PM Efforts and Relationship between Stages
- 9.7.3. Graphic Tools Available

9.8. Identification and Classification of Risks of Hydrogen Sector Projects
- 9.8.1. Creation of the Project Risk Plan
- 9.8.2. Risk Analysis
- 9.8.3. Importance of Project Risk Management

9.9. Analysis of the EPC Phase of a Hydrogen Type Project
- 9.9.1. Detailed Engineering
- 9.9.2. Purchasing and Supplies
- 9.9.3. Construction Phase

9.10. Analysis of the O&M Phase of a Hydrogen Type Project
- 9.10.1. Development of the Operation and Maintenance Plan
- 9.10.2. Maintenance Protocols. Importance of Preventive Maintenance
- 9.10.3. Management of the Operation and Maintenance Plan

**Module 10.** Technical-Economic and Feasibility Analysis of Hydrogen Projects

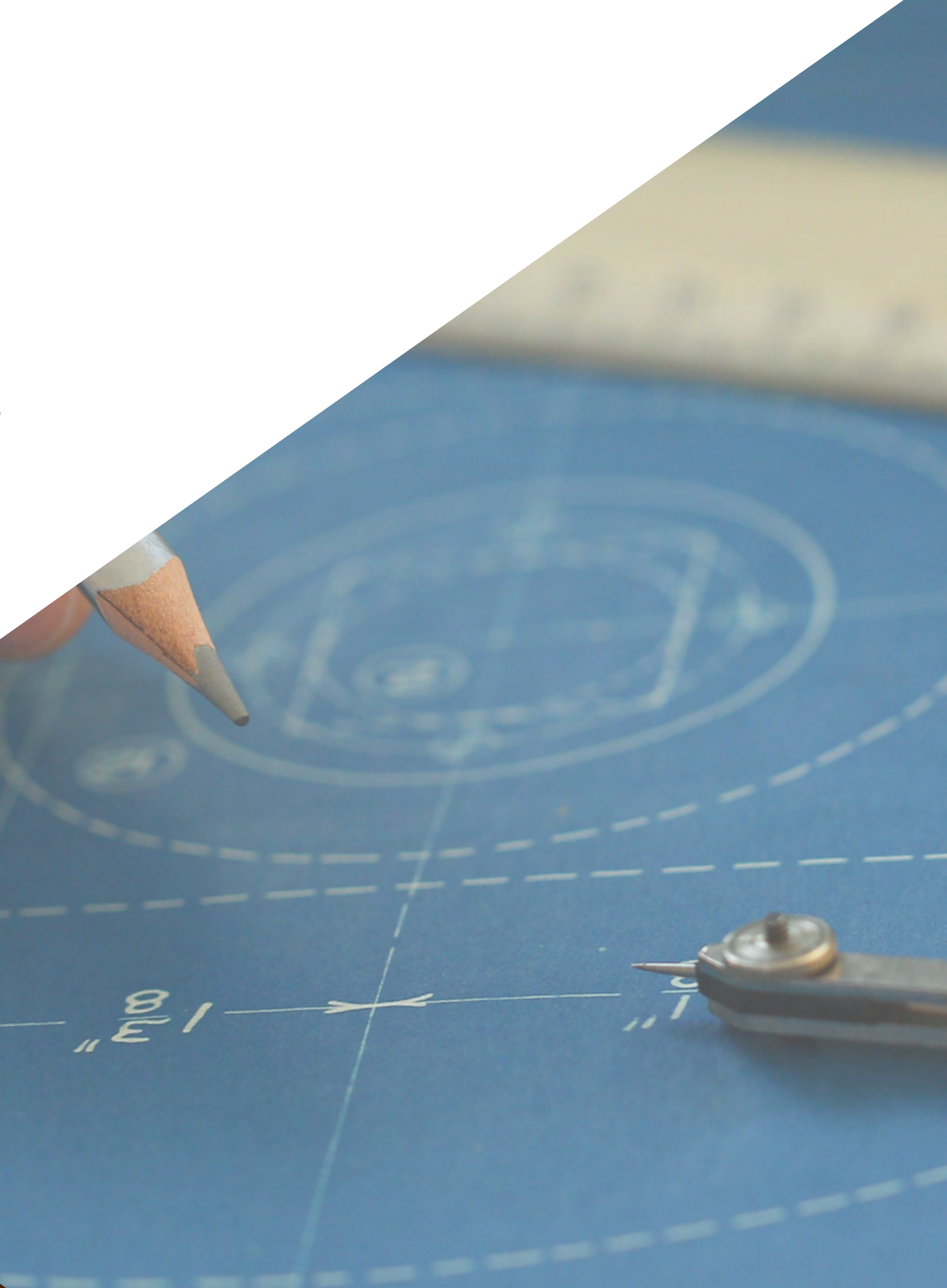
10.1. Green Hydrogen Power Supply
 10.1.1. The Keys to PPAs (Power Purchase Agreement)
 10.1.2. Self-Consumption with Green Hydrogen
 10.1.3. Hydrogen Production in Off-Grid Configuration
10.2. Technical and Economic Modeling of Electrolysis Plants
 10.2.1. Definition of Production Plant Requirements
 10.2.2. CAPEX (Capital Expenditure)
 10.2.3. OPEX (Operational Expenditure)
10.3. Technical and Economic Modeling of Storage Facilities according to Formats (GH2, LH2, Green Ammonia, Methanol, LOHC)
 10.3.1. Technical Assessment of Different Storage Facilities
 10.3.2. Cost Analysis
 10.3.3. Selection Criteria
10.4. Technical and Economic Modeling of Hydrogen Transportation, Distribution, and End-Use Assets
 10.4.1. Transportation and Distribution Cost Assessment
 10.4.2. Technical Limitations of Current Hydrogen Transportation and Distribution Methods
 10.4.3. Selection Criteria
10.5. Structuring of Hydrogen Projects. Financing Alternatives
 10.5.1. Keys to the Choice of Financing
 10.5.2. Private Equity Financing
 10.5.3. Public Funding
10.6. Identification and Characterization of Project Revenues and Costs
 10.6.1. Revenues
 10.6.2. Costs
 10.6.3. Joint Assessment
10.7. Calculation of Cash Flows and Project Profitability Indicators (IRR, NPV, others).
 10.7.1. Cash Flow
 10.7.2. Profitability Indicators
 10.7.3. Case Study
10.8. Feasibility Analysis and Scenarios
 10.8.1. Scenario Design
 10.8.2. Scenario Analysis
 10.8.3. Scenario Analysis
10.9. Use Case Based on Project Finance
 10.9.1. Relevant Figures of the SPV (Special Purpose Vehicle)
 10.9.2. Development Process
 10.9.3. Conclusions
10.10. Assessment of Barriers to Project Feasibility and Future Prospects
 10.10.1. Existing Barriers to Hydrogen Project Feasibility
 10.10.2. Assessment of the Current Situation
 10.10.3. Future Perspectives

*"A program designed for you to discover the great potential of the green hydrogen market and enter it with guarantees"*

06

# Methodology

This academic program offers students a different way of learning. Our methodology uses a cyclical learning approach: **Relearning.**
This teaching system is used, for example, in the most prestigious medical schools in the world, and major publications such as the **New England Journal of Medicine** have considered it to be one of the most effective.



*Discover Relearning, a system that abandons conventional linear learning, to take you through cyclical teaching systems: a way of learning that has proven to be extremely effective, especially in subjects that require memorization"*

## Case Study to contextualize all content

Our program offers a revolutionary approach to developing skills and knowledge. Our goal is to strengthen skills in a changing, competitive, and highly demanding environment.

*At TECH, you will experience a learning methodology that is shaking the foundations of traditional universities around the world"*


*You will have access to a learning system based on repetition, with natural and progressive teaching throughout the entire syllabus.*

*The student will learn to solve complex situations in real business environments through collaborative activities and real cases.*

## A learning method that is different and innovative

This TECH program is an intensive educational program, created from scratch, which presents the most demanding challenges and decisions in this field, both nationally and internationally. This methodology promotes personal and professional growth, representing a significant step towards success. The case method, a technique that lays the foundation for this content, ensures that the most current economic, social and professional reality is taken into account.

> *Our program prepares you to face new challenges in uncertain environments and achieve success in your career"*

The case method is the most widely used learning system in the best faculties in the world. The case method was developed in 1912 so that law students would not only learn the law based on theoretical content. It consisted of presenting students with real-life, complex situations for them to make informed decisions and value judgments on how to resolve them. In 1924, Harvard adopted it as a standard teaching method.

What should a professional do in a given situation? This is the question that you are presented with in the case method, an action-oriented learning method. Throughout the program, the studies will be presented with multiple real cases. They will have to combine all their knowledge and research, and argue and defend their ideas and decisions.

## Relearning Methodology

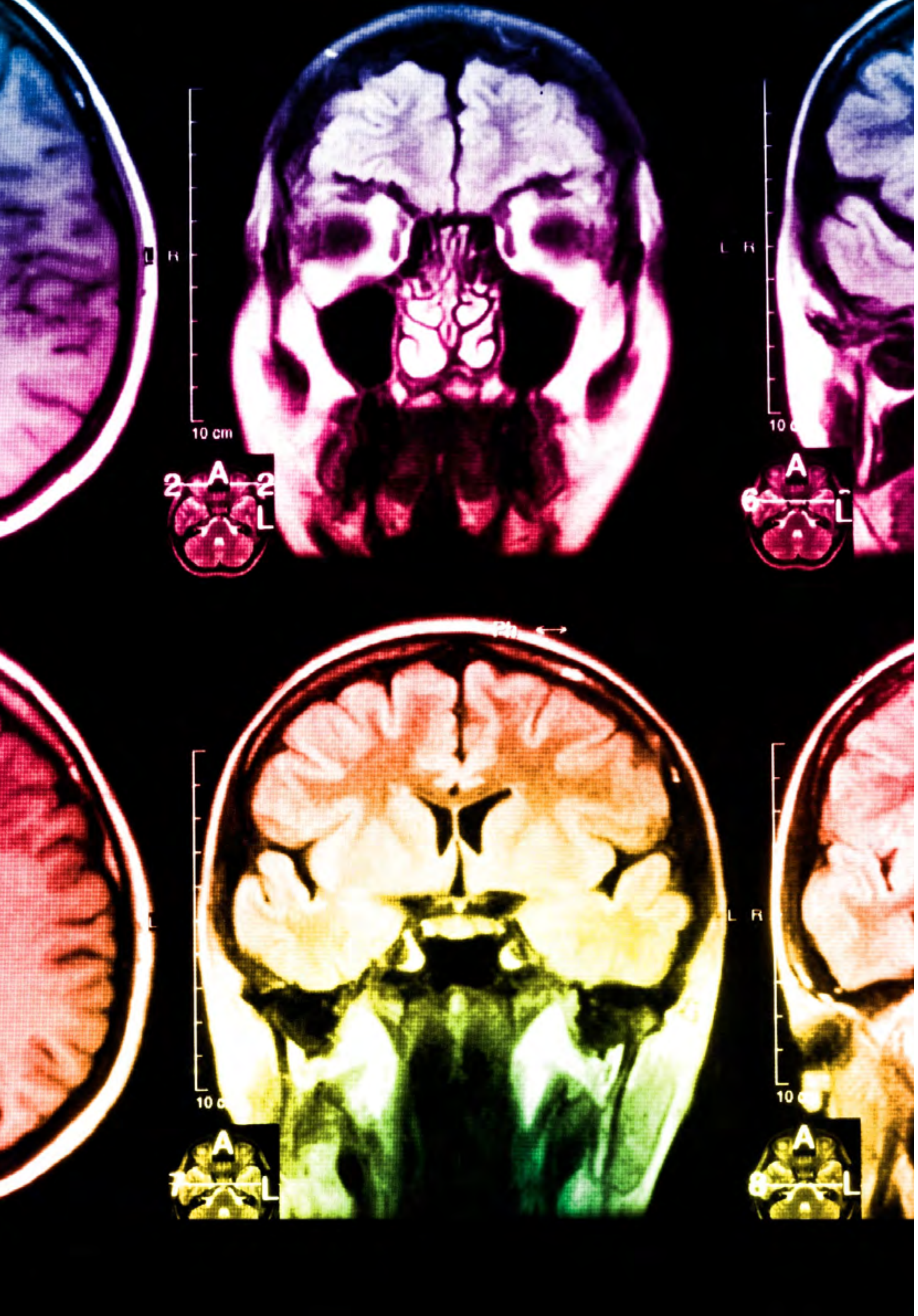
TECH effectively combines the Case Study methodology with a 100% online learning system based on repetition, which combines 8 different teaching elements in each lesson.

We enhance the Case Study with the best 100% online teaching method: Relearning.

*In 2019, we obtained the best learning results of all online universities in the world.*


At TECH, you will learn using a cutting-edge methodology designed to train the executives of the future. This method, at the forefront of international teaching, is called Relearning.

Our university is the only one in the world authorized to employ this successful method. In 2019, we managed to improve our students' overall satisfaction levels (teaching quality, quality of materials, course structure, objectives...) based on the best online university indicators.




In our program, learning is not a linear process, but rather a spiral (learn, unlearn, forget, and re-learn). Therefore, we combine each of these elements concentrically. This methodology has trained more than 650,000 university graduates with unprecedented success in fields as diverse as biochemistry, genetics, surgery, international law, management skills, sports science, philosophy, law, engineering, journalism, history, and financial markets and instruments. All this in a highly demanding environment, where the students have a strong socio-economic profile and an average age of 43.5 years.

*Relearning will allow you to learn with less effort and better performance, involving you more in your training, developing a critical mindset, defending arguments, and contrasting opinions: a direct equation for success.*

From the latest scientific evidence in the field of neuroscience, not only do we know how to organize information, ideas, images and memories, but we know that the place and context where we have learned something is fundamental for us to be able to remember it and store it in the hippocampus, to retain it in our long-term memory.

In this way, and in what is called neurocognitive context-dependent e-learning, the different elements in our program are connected to the context where the individual carries out their professional activity.

## This program offers the best educational material, prepared with professionals in mind:

### Study Material

All teaching material is produced by the specialists who teach the course, specifically for the course, so that the teaching content is highly specific and precise.

These contents are then applied to the audiovisual format, to create the TECH online working method. All this, with the latest techniques that offer high quality pieces in each and every one of the materials that are made available to the student.

### Classes

There is scientific evidence suggesting that observing third-party experts can be useful.

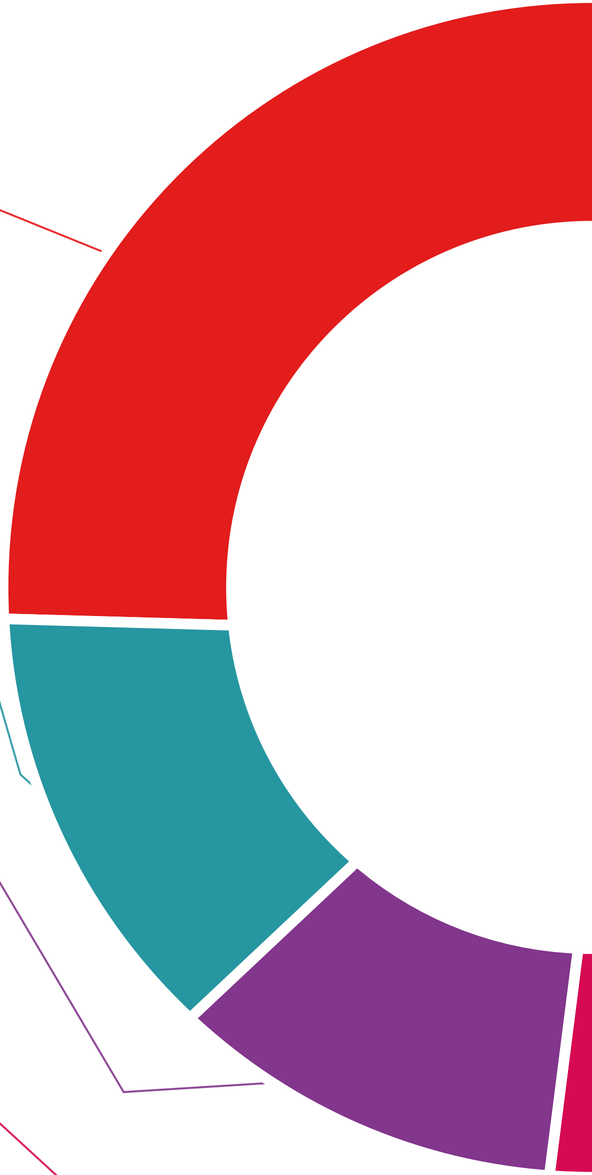
Learning from an Expert strengthens knowledge and memory, and generates confidence in future difficult decisions.

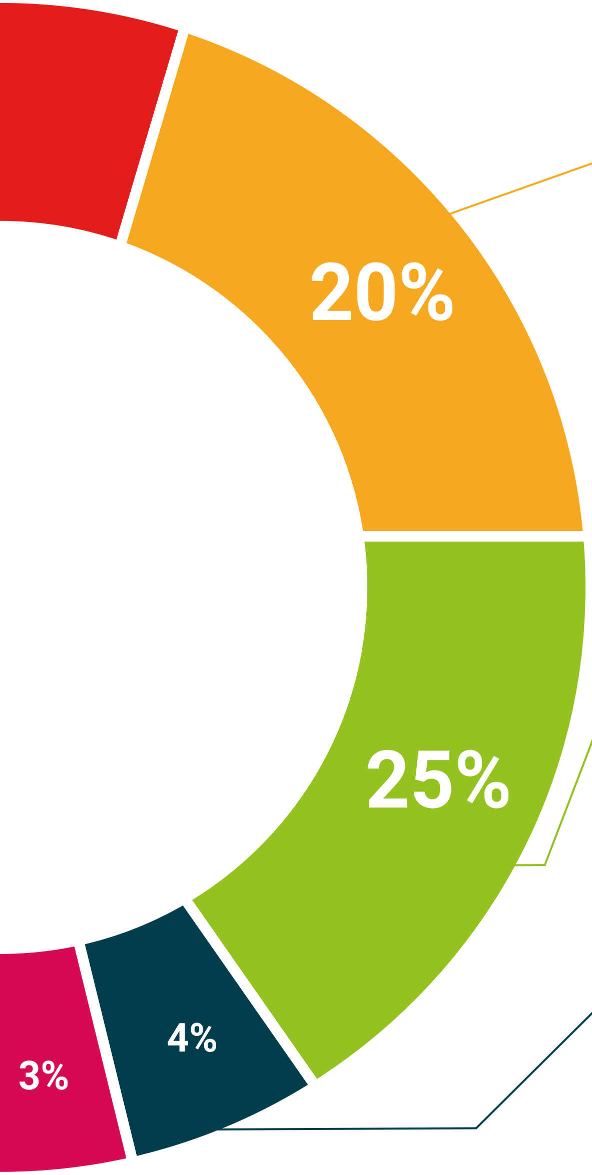
### Practising Skills and Abilities

They will carry out activities to develop specific skills and abilities in each subject area. Exercises and activities to acquire and develop the skills and abilities that a specialist needs to develop in the context of the globalization that we are experiencing.

### Additional Reading

Recent articles, consensus documents and international guidelines, among others. In TECH's virtual library, students will have access to everything they need to complete their course.






**Case Studies**

Students will complete a selection of the best case studies chosen specifically for this program. Cases that are presented, analyzed, and supervised by the best specialists in the world.

**Interactive Summaries**

The TECH team presents the contents attractively and dynamically in multimedia lessons that include audio, videos, images, diagrams, and concept maps in order to reinforce knowledge.

This exclusive educational system for presenting multimedia content was awarded by Microsoft as a "European Success Story".

**Testing & Retesting**

We periodically evaluate and re-evaluate students' knowledge throughout the program, through assessment and self-assessment activities and exercises, so that they can see how they are achieving their goals.

07

# Certificate

The Professional Master's Degree in Hydrogen Technology guarantees students, in addition to the most rigorous and up-to-date education, access to a Professional Master's Degree issued by TECH Global University.

*Successfully complete this program and receive your university qualification without having to travel or fill out laborious paperwork"*

This program will allow you to obtain your **Professional Master's Degree diploma in Hydrogen Technology** endorsed by **TECH Global University**, the world's largest online university.

**TECH Global University** is an official European University publicly recognized by the Government of Andorra (***official bulletin***). Andorra is part of the European Higher Education Area (EHEA) since 2003. The EHEA is an initiative promoted by the European Union that aims to organize the international training framework and harmonize the higher education systems of the member countries of this space. The project promotes common values, the implementation of collaborative tools and strengthening its quality assurance mechanisms to enhance collaboration and mobility among students, researchers and academics.

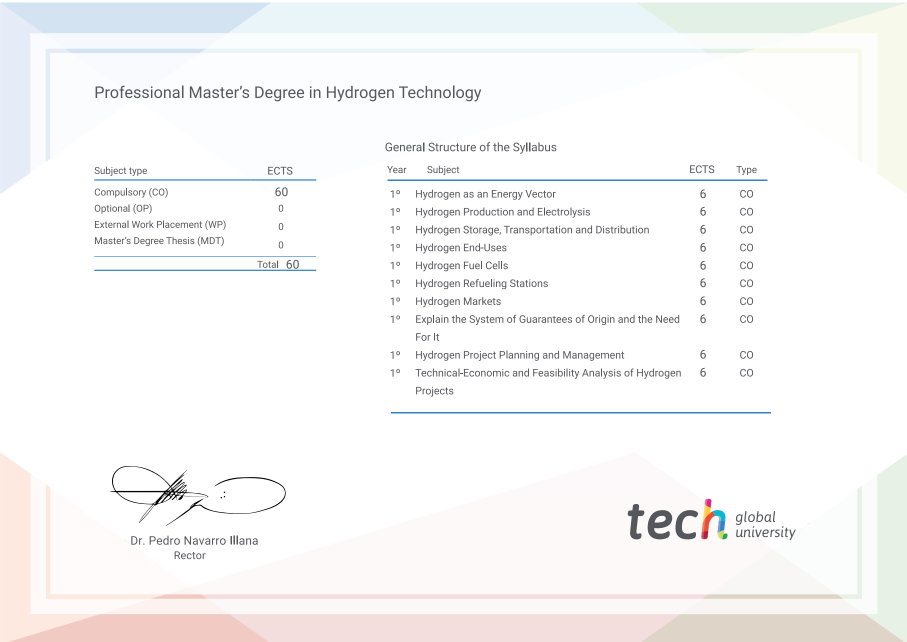
This **TECH Global University** title is a European program of continuing education and professional updating that guarantees the acquisition of competencies in its area of knowledge, providing a high curricular value to the student who completes the program.

Title: **Professional Master's Degree in Hydrogen Technology**

Modality: **online**

Duration: **12 months**

Accreditation: **60 ECTS**


*Apostille Convention. In the event that the student wishes to have their paper diploma issued with an apostille, TECH Global University will make the necessary arrangements to obtain it, at an additional cost.

# Professional Master's Degree
## Hydrogen Technology

» Modality: **online**
» Duration: **12 months**
» Certificate: **TECH Global University**
» Credits: **60 ECTS**
» Schedule: **at your own pace**
» Exams: **online**

# Professional Master's Degree
## Hydrogen Technology