INTRODUCTION TO HYDROGEN ECONOMY

Source: Introduction to hydrogen economy | FITech

Course description

Hydrogen plays an essential role in the green transition from fossil fuels towards renewable energy. Growth in the hydrogen economy is creating attractive career prospects across diverse industries. This course serves as a starting point for individuals with varied backgrounds and interests. It primarily targets adult learners holding a degree, aiming to enhance their understanding of the hydrogen economy, although degree students are also welcome to enroll.

The course provides the student a general understanding about the hydrogen economy and its value chain. It covers the integration of hydrogen economy to power and energy systems, the role of hydrogen in energy and power markets, the basics of hydrogen production, storing and utilisation, as well as the role of derivatives of hydrogen.

Course modules and lectures

The course includes lectures from teachers at different universities and two Hydrogen Cluster Finland member companies, ABB and Neste. The course materials vary in how they are presented. They may include text, videos and slides. Most of the material is in the English language, with a few exceptions that are in Finnish. However, you do not need to study the Finnish materials to finish the course. The content and material will be developed, and you can contribute your feedback in the final assignment.

MODULE I Energy resources, politics, and the role of hydrogen

The module discusses global energy resources and related political and economic questions

- Why is hydrogen so much discussed now
- What are the hydrogen economy opportunities globally and for Finland
- What is the history and future of fossil fuels
- How politics reflect on the hydrogen transition

Introduction to the topic

The Finnish Hydrogen Landscape
Guest speaker: Simo Säynevirta, Head of ABB Green Electrification ecosystem and chairman of H2 Cluster Finland (Video)

- What is the role of hydrogen in regard to climate goals
- What is the Finnish H2 value chain
- What are Finland’s opportunities to benefit from hydrogen economy
- How is hydrogen related to the circular economy
- Resource materials:
    - Finland's national climate change policy - Ministry of the Environment (ym.fi)
    - EU climate policy - Ministry of the Environment (ym.fi)

- Hydrogen cluster Finland white paper
- Hydrogen cluster Finland - clean hydrogen strategy for Finland

Fossil reserves and energy markets
Lecturer: Energy field manager for Aalto Networking Platform Sam Cross

- Contents of the lecture:
- History of energy consumption and fossil energy production
- Fossil fuel reserves and resources
- Differences between oil, coal and gas markets
- Fossil fuels - markets and demand scenarios
- EU, US and Finnish gas markets and regulation
    - Resource material: https://youtu.be/ClaNhx71XB8?si=W6dct6qIDW9UiPmf

Politics and the hydrogen transition
Lecturer: Professor Pami Aalto, Tampere University (video)

- Different scenarios and political influences
- Effects on prices and demand
- H2 strategy of the EU
- How do policies home and abroad influence the hydrogen market?
    - Resource material EU Hydrogen strategy

MODULE II Characteristics of energy generation and transmission

This module describes some basic characteristics of power generation and transmission, for example

- What are the structure and function principles of the energy market
- What are the energy production technologies
- How is energy transmitted, and what factors affect power transmission
- How are power supply and demand balanced
- What is the role of Hydrogen in the energy system and market
- What are the different energy storage types and their role in energy transition

Power market and power generation
Lecturer: Professor Matti Lehtonen, Aalto University

- The structure of the energy market - power production and networks
- The power grids
- Factors that affect power transmission

Power system and power transmission
Lecturer: Professor Matti Lehtonen, Aalto University

- Energy production technologies: fossil, nuclear, wind and solar power
- Characteristics of the production technologies
- Energy transmission

Smart grids, sector coupling
Lecturer: Professor Sami Repo, Tampere University (video)

- H2 impact on the energy system
- Technical impacts on power availability, grid congestion and power balance

- Impacts on power markets (price, demand response, risk management)
- Energy and power storage
- Resource materials: fingrid_electricity_system_draft_scenarios.pdf

Energy storages
Lecturer: Assistant Professor Annukka Santasalo-Aarnio, Aalto University

- The role of energy storage in energy transition
- Energy storage types and their characteristics
- Use of energy storages

MODULE III Basics of Hydrogen Production and Storage

Hydrogen must be produced by separating it from the other elements in the molecules where it occurs. Hydrogen can be made from many different sources in different ways. This module discusses

- The different hydrogen production technologies and their maturity
- Hydrogen cleanness and sustainable hydrogen production
- Basic hydrogen chemistry and hydrogen uses in the chemical industry
- How hydrogen can be stored and transported

Introduction to hydrogen chemistry
Lecturer: Professor Karoliina Honkala, University of Jyväskylä

- Properties of Hydrogen
- Hydrogen cleanness levels
- Hydrogen production pathways
- Current and future uses of Hydrogen

Sustainable hydrogen production
Lecturer: Professor Riitta Keiski, University of Oulu (video)

- Finland's climate policy, opportunities of clean H2 production in Finland, sustainable development goals, clean H2 market
- How to produce clean and green Hydrogen
- Conventional Hydrogen production processes
- Sustainable hydrogen production processes and their maturity

Hydrogen production and distribution
This lecture is based on a Master's thesis by Ahmed Kishk. The thesis was supervised by Professor Anouar Belachen at Aalto University. The thesis describes

- Hydrogen production technologies: from fossil fuels, biomass, renewables and electrolysers
- Hydrogen storage technologies: compressed, liquefied, cryo-compressed and hydrites
- Hydrogen transportation: pipelines, shipping and trucks
- Efficiency in different electrolyser-storage- transportation-end use chains

MODULE IV Hydrogen uses

This module discusses the different uses of Hydrogen and the related challenges and risks. To orientate to the topic, you can watch some presentations from the World Circular Economy Forum. Especially:

- Part 5, a talk by Szilvia Haide, Flexens (from min. 19:42)

- Last part: Future perspectives and opportunities Kirsikka Kiviranta & Cyril Bjamundi, VTT (from min.1:07)

The use of hydrogen, power-to-X, fuels
The lecture is based on a Master's thesis by María Hanako. The thesis was supervised by Professor Anouar Belachen at Aalto University. The thesis describes:

- Hydrogen combustion and fuel cells technologies
- Usage of Hydrogen: Power-to-x (power to gas, power to liquid, power to heat)
- Hydrogen as fuel in transportation, power generation, industry and buildings
- Challenges (technical, socio-economical and safety)

Fuel cells with hydrogen technology
Lecturer Risto Mikkonen, Tampere University (video)

- The Hydrogen boom – why now? Globally and in Finland
- Fuel cells - steps in Finland and beyond
- Fuel cells prices and markets
- Fuel cells structure and operation principles

Hydrogen safety
Lecturer: Adjunct Professor Arto Reiman, University of Oulu

- Hydrogen as chemical substance: safety, health hazards and knowledge
- Hydrogen safety and legal requirements
- Hydrogen standards
- Safety issues in the use of hydrogen
- Resource materials:
    - EU Clean Hydrogen Partnership
    - Statistics, lessons learnt and recommendations from the analysis of HIAD 2.0 database

COURSE CLOSURE

Road to Hydrogen Economy - An industrial developer's point of view
Guest speaker: Outi Ervasti, Vice President, Renewable Hydrogen, Neste and Board Member at VTT (Video)

- What is the main purpose of green hydrogen?
- Why is there such a strong willingness to develop a hydrogen-based energy system?
- Renewable hydrogen in Finland
- What will happen in the future? Which projects will succeed?
- What are the important next steps in Finland?