

SPECIALISATION SYLLABUS : Sustainable Energy Management

European Master in Sustainable Energy Systems Management

Howest University of Applied Sciences
Sustainable Energy & ICT



Energy consumption of a process or building is measured and published. This data is based on an audit or on a continuously follow up of the processes. Following research questions arise: What type of meter do we have to install and how do we get data in a secured format on the internet? Can we use a smart grid to maximize the use of renewable energy? Can we sell our energy to other companies and how does the energy market work? The specialisation semester 'Sustainable Energy & ICT' gives you the answers! We focus on energy audits, energy measurements and internet of things. Renewable energy production (electrical and thermal) gives us the opportunity to reduce the energy we buy from the grid. Smart devices and equipment combined with an energy traffic controller maximize the self-consumption of the generated energy. The data of the sensors and equipment must be secured and new devices use Artificial Intelligence or Machine Learning to maximize the energy savings. Overproduction can be stored in storage systems to be used when we have less production, or we sell the energy to others using blockchain.

<u>Contents:</u>	hours:
1 Energy Audit & Dashboarding (electrical & thermal) (6 ECTS)	60
2 Big Data & Internet of Things (6 ECTS)	60
3 Artificial Intelligence & Machine Learning (3 ECTS)	30
4 Renewables, Smart Grids & Energy Storage (electrical & thermal) (6 ECTS)	60
5 Energy Services & Legislations (3 ECTS)	30
6 Blockchain & Security (6 ECTS)	30
	270

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1. Energy Audit & Dashboarding

This module presents an overview of energy audits to identify opportunities for energy cost and energy (electrical and thermal) reduction in existing installations. Students will gain an understanding on how to procure an energy audit, how to carry out an energy audit, how to evaluate energy audits results and how to plan the implementation of the opportunities.

Students will also be able to specify, procure, and review energy audits.

Syllabus	Lectures	Tutorials	Laboratory
Energy audits	20	5	
- Measurement of thermal and electrical energy - Equipment - Setting up an energy audit - Key Factors of an energy audit			
Dashboarding	10		10
- Visualisation of energy consumption - Key performance indicators - Examples			
Project		15	
Energy audit of an industrial project			
Learning outcomes			
Module Total	30	20	10

2. Big Data & Internet of Things

Sensor & monitoring devices create a massive flood of data. In this module you learn to design an IT back-end that can handle that kind of data. Using Cloud services you collect, process, and analyze real-time, streaming data so you can get timely insights and react quickly accordingly.

Syllabus	Lectures	Tutorials	Laboratory
Connecting & collecting data	6	4	4
- Connecting & Authorizing devices - Ingesting data - Streaming & Batch data			
Storing Data	14	0	8
- Introduction to data architecture - Relational vs non-relation databases - Time Series stores			
Cloud Services	10	4	10
- Introduction to Cloud services - Cloud architecture - Cloud storage - Cloud deployment & Automation			
Learning outcomes			
Module Total	30	8	22

3. Artificial Intelligence & Machine Learning

In this module we introduce you to the world of machine learning & Neural Networks. The end result is that you can discover trends and anomalies in time series data. Also you will be able to select the right machine learning method to predict future values.

Syllabus	Lectures	Tutorials	Laboratory
Introduction	6	2	2
- Data Science - Introduction to AI use cases			
Machine Learning	12	0	4
- Regression - SVM, Hyper Parameter Tuning - Naive Bayes & Random Forests - Unsupervised Learning			
Introduction to Neural Networks	2	0	2
Introduction - Neural Networks & AI			
Learning outcomes			
Module Total	20	2	8

4. Smart Grids, Renewables & Storage

Future grids face major challenges, in this module the intention is to go deeper into those challenges and to investigate how these challenges can be tackled with new innovative technologies. By analyzing consumption and yield profiles and implementing smart control strategies and storage systems, a techno-economic optimum can be achieved.

Syllabus	Lectures	Tutorials	Laboratory
Renewables	15		5
<ul style="list-style-type: none"> - Solar energy (electricity and thermal) - Wind energy -(μ)CHP technologies - Dimensioning of decentralised production versus consumption profiles - Control strategies for optimised self consumption and self-sufficiency - Configuration of a renewable energy system - Safety and standards for integration of decentralized production - Importance of datasets for accurate data handling and dimensioning 			
Smart Grids	15		10
<ul style="list-style-type: none"> - Definition & characteristics of smart grids - Problems & challenges of future grids <ul style="list-style-type: none"> - Challenges of island grid - Impedance and load controlling of smart grids - Power quality aspects - DC- versus AC grids - Components of an smart grid - Control strategies for grid balancing (DSM, peak shaving,...) - Electric vehicles and charging/discharging strategies - HVDC 			
Energy storage	10		5

- Electrical and thermal storage technologies
 - short, medium and long term storage technologies
- Dimensioning storage systems
- Hybrid storage systems
- Control strategies for implementing energy storage
- Dimensioning an energy storage system
- Preconditions of various storage systems
- Dimensioning storage systems versus yield and consumption profiles

Learning outcomes

Students are able to describe the composition of a Smart Grid and to chose the parts. The know how the system works and how to calculate the storage system.

Module Total	40	0	20
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5. Energy Services & Legislations

This module provides insight into the specific legislation on energy in Europe. How do you buy and sell energy? Description of the energy market. Companies can work with an ESCO to achieve energy savings. How does it work? What are the possibilities and restrictions?

	Lectures	Tutorials	Laboratory
Energy market	10	5	
<ul style="list-style-type: none"> - Energy regulation - Energy Markets - Producers and consumers (and legislation) - Energy pricing - Energy contracts 			
ESCO: Energy Service Company	10		
<ul style="list-style-type: none"> - Introduction - Developing a project - Choosing an ESCO - Energy savings and benefits - Legislation - Technical and financial opportunities and restrictions 			
Project			5
Learning outcomes			
Module Total	20	5	5

6. Blockchain & Security

This module focusses on all aspects of information security. It approaches the threats of information management and data flow and provides best practices and solutions. By using a practical approach and many hands on scenario's the pitfalls of both technical and policy security for any implementation is being detailed. Blockchain technology is discussed as a novel method for sharing trusted data in a digital interconnected world.

Syllabus	Lectures	Tutorials	Laboratory
Information Security Management	7		
- European Cybersecurity NIS Guidelines - Security Management (NIST-CSF, ISO2700x) - Data Protection (GDPR)			
Practical Security Implementations	5		5
- End User Awareness, how to start - Cryptography (PKI, Certificates, Encryption ...) - System & Network Security - Web and Portal Security (Frontend threats, OWASP)			
Industrial Implementations	2		1
- Industrial & IoT Security (ICS, SCADA, ...) - Radio Frequency Threats (SDR, RFID design)			
Blockchain Technology Fundamentals	5		
- Blockchain 1.0 - Blockchain beyond cryptocurrency - Consensus mechanisms - advanced blockchain concepts			
Blockchain for Business	3		2
- Blockchain use-cases - The network economics of a succesful blockchain - Blockchain Technology landscape			
Learning outcomes			
Module Total	22	0	8