MJ2380 Introduction to Energy Systems Analysis and Applications 9.0 credits

Introduktion till Energisystemanalys och tillämpning

This is a translation of the Swedish, legally binding, course syllabus.

Establishment

On 15/10/2024, Director of First and Second Cycle Education of the ITM School has decided to establish this official course syllabus to apply from spring term 2025 (registration number M-2024-1872).

Grading scale

A, B, C, D, E, FX, F

Education cycle

Second cycle

Main field of study

Mechanical Engineering

Specific prerequisites

Bachelor of Science in Technology

Knowledge of sustainable development and system analysis corresponding content in courses MJ2413 "Energy and Environment" or MJ2508 "Energy Systems for Sustainable Development"

Knowledge of Linear Algebra, corresponding content in course SF1624 "Algebra and Geometry"

Language of instruction

The language of instruction is specified in the course offering information in the course catalogue.

Intended learning outcomes

Upon successfully completing this course, the student should be able to:

1. Evaluate common energy systems modelling and scenario analysis approaches, critically discuss their key strengths and limitations in addressing Sustainable Development issues.
2. Design a linear energy system optimization problem with economic and environmental constraints.
3. Apply a selected energy systems modelling tool in the analysis of stylized long-term sustainable energy planning problems.
4. Analyze various sample energy system situations, appropriately distill insights, given limited and uncertain information.
5. Design and construct a thorough and detailed analysis of a selected national energy system, including independent data processing, problem definition, generation of solutions and interpretation of the results in light of the country's Sustainable Development challenges.
6. Analyse the links between climate action, land use, energy infrastructure development and access to clean water in an energy system model, discuss solutions for coherent planning with reference to real-world challenges.

Course contents

The overall objective of this course is to provide the student with solid ground knowledge of Energy Systems Modelling theory and its application to problems of sustainable development planning. This includes the creation from scratch and understanding of an energy system model and its underlying dynamics.
Below an overview of the topics.

Energy system Analysis
What is it needed for?
How does it support sustainable energy planning?
What is an energy system and how can it be represented?
What does sustainability mean in the context of an energy system and how can it be measured?
What are energy system models needed for? What is their role in supporting sustainable energy planning?

Types of energy system modelling tools
Bottom-up and top-down modelling tools

Categorisation of energy modelling tools
Long-term optimisation modelling tools

Designing an energy system optimization problem
Structure of linear optimization energy system models
Creating the algebraic formulation of a linear optimization energy system model from scratch, with inclusion of economic and environmental constraints

Modelling selected impacts of the energy system on the environment, economy and society
Modelling impacts on the economy
Modelling links with climate
Modelling the water-energy-food nexus

Scenario analyses
Types of scenario analyses used in energy systems analysis (normative, explorative, predictive)
Examples and outcomes of published scenario analyses

Use of models in technical assistance programs to shape the global agenda
Use of open source energy and integrated modelling tools in the public and private sector, in collaboration with governments, international organizations and companies. Case studies, success and challenges.

Creating an energy and integrated system model
Work with the OSeMOSYS systems modelling tool, to create and deeply analyse the dynamics of an energy and integrated system model.

Examination

- HEM1 - Home assignment 1, 1.5 credits, grading scale: A, B, C, D, E, FX, F
- TEN1 - Individual oral examination, 3.0 credits, grading scale: A, B, C, D, E, FX, F
- HEM2 - Home assignment 2, 1.5 credits, grading scale: A, B, C, D, E, FX, F
- HEM3 - Home assignment 3, 3.0 credits, grading scale: A, B, C, D, E, FX, F

Based on recommendation from KTH's coordinator for disabilities, the examiner will decide how to adapt an examination for students with documented disability.

The examiner may apply another examination format when re-examining individual students.

If the course is discontinued, students may request to be examined during the following two academic years.

Ethical approach

- All members of a group are responsible for the group's work.
- In any assessment, every student shall honestly disclose any help received and sources used.

- In an oral assessment, every student shall be able to present and answer questions about the entire assignment and solution.