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.

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

Establishment

Course syllabus for MJ2380 valid from Spring 2012

Grading scale

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

Education cycle

Second cycle

Main field of study

Mechanical Engineering

Specific prerequisites

Technical undergraduate degree with introductory mathematics and economics or equivalent

Language of instruction

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

Intended learning outcomes

The student should be able:

- to apply relevant energy systems models in to analyses typical stylized policy and technology assessment problems , within the main area, to a given problem
- given limited and uncertain information, independently analyze various energy system situations and appropriately distill insights
- reflect on, evaluate and critically assess the limits of standard energy systems approaches and their 'real-world' usefulness
- be able to identify specific areas of improvement needed in the field of energy systems analysis
- undertake a thorough and detailed simulation of an energy systems analysis case study, including independent data gathering, problem definition, model choice, solution and interpretation

Course contents

1. The process of 3E modeling:

- Why model?
- The role of scenarios and assumptions (forecasting, back casting etc…) and the importance of transparency
- Relationship between modeling and action (policy / investment formulation / technology development)

Examples of 'good practice' including stakeholder communication, etc.

Information flows between and organization of:

- technology characterization and data collection efforts,

- the modeling analysis

- stakeholders

decision / policy makers

- Where does modeling fit?
- Developing economically / thermodynamically / physically consistent scenarios.
- Short, medium and long term analysis and the role thereof
- Single / multi-comodity (e.g. power system expansion vs the water-food-energy nexus)
- Small scale (with a village electrification) vs large (global energy assessments)

• Socio-economic vs physical focus (e.g. welfare maximization vs resource efficiency)

2. Modeling - types and tools

Number crunching / thought experiment practice (how-to)

• Defining the questions
• The best approach given data, modeling and other constraints

application (examples)

• A series of small spreadsheet model examples of stereo-types (the student will be expected to build these simple models with guidance)

Demand projections
(based on GDP, population, output projections * service intensities * appliance/equipment efficiency etc)

- Energy service to supply analysis with emissions. 1staccounting, then cost optimal, then multi-objective.

- Input-Output economic model with energy system representation

- CGE model with energy system representation

- Econometric model with price response

- A multi-resource (Climate, Land, Energy and Water CLEW) model

- Assessment of the information requirements, model scope and outputs: especially with regard to limitations.

3. Policy, technology, economic and other questions:

• How they have technology and policy assessments (typically) been modeled? (With illustrative standard examples: Investment portfolios, technology R&D programs, RE and EE standards, energy security, GHG mitigation cost curves etc.)
• Technology and system characterization:

- Resource characterization

- Transformation

- End-use and services

- Conventional technologies

- Technologies and dispatching:

- Variable and intermittent generation; Storage; Hydro; Demand response and smart grids

- Interaction with the macro-economy

- Interaction with the environment and other resource systems (materials, water, etc)

- System integration and hybridization

Strengths and insights to be gained by different models, scenarios and processes (i.e. a

CGE gives economy wide insights, but limited technology deployment information

An accounting framework is useful for reconciling differing non-optimal views, but not good at developing ‘best fit’ trade-offs Etc…)

4. An introduction to selected ‘off the shelf tools’

OSeMOSYS introduction:

- Introduction and aim
- Standard cost minimizing application
- Applications that developing new functionality

Other tools:

- TBD.

Examination

- PRO1 - Project 1, 1.5 credits, grading scale: A, B, C, D, E, FX, F
- PRO2 - Project 2, 1.5 credits, grading scale: A, B, C, D, E, FX, F
- PRO3 - Project 3, 1.5 credits, grading scale: A, B, C, D, E, FX, F
- PRO4 - Project 4, 1.5 credits, grading scale: A, B, C, D, E, FX, F
- PRO5 - Project 5, 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.

4*1,5 credit projects and 1*3 credit project

Other requirements for final grade

To pass

4*1,5 credit projects and 1*3 credit project

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.