Course guide
240293 - 240EN46 - Energy Modelling and Climate Policy

Last modified: 21/06/2024

Unit in charge: Barcelona School of Industrial Engineering
Teaching unit: 713 - EQ - Department of Chemical Engineering.

Degree: MASTER'S DEGREE IN ENERGY ENGINEERING (Syllabus 2022). (Optional subject).

Academic year: 2024 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: CESAR ALBERTO VALDERRAMA ANGEL

Others: CESAR ALBERTO VALDERRAMA ANGEL

TEACHING METHODOLOGY

The course teaching methodologies are as follows:
a) Flipped classroom
b) Blended learning
c) Face to face activities
d) Problem-based learning
e) Project-based learning

LEARNING OBJECTIVES OF THE SUBJECT

The 4 main Intended Learning Outcomes are:
1. Explain the role of energy and climate policy and its instruments in making energy systems sustainable.
2. Understand how energy system modelling can support the development of energy and climate policies.
3. Build computer model of national energy system and employ the scenario analysis to conduct impact assessment of achieving various energy and climate policy objectives.
4. Formulate and solve operational and investment planning problems in power systems using mathematical programming.
5. Build computer model of national energy system and employ scenario analysis to conduct impact assessment of achieving various energy and climate policy objectives.

STUDY LOAD

Type	Hours	Percentage
Hours large group	45,0	100.00

Total learning time: 45 h

CONTENTS

Module 1. Energy and climate policy

Description:
Evolution of global and European energy-climate policy, Limits to Growth and
Brundtland reports, the history of the UNFCCC and its most important protocols shaping the global and EU climate policy, scenarios depicting the evolution of primary energy demand and global greenhouse gas (GHG) emissions between 1990 and 2100, assessment of the development of energy systems in selected countries using sustainable development indicators.

Specific objectives:
To learn what is the role of energy and climate policy and what are the main policy instruments.
To trace the evolution of global climate policy (UNFCCC, COPs, etc.) and learn what are the key principles under the UNFCCC.
To trace the evolution of EU climate policy and to know present state of play.
To adopt methods for assessing whether the energy development of a country is becoming more sustainable.

Full-or-part-time: 16h
Theory classes: 9h
Guided activities: 4h
Self study : 3h

Module 2: Solving power system planning problems using mathematical programming) (2 ECTS credits)

Description:
Introducing to mathematical programming, selected types of optimization problems, formulation of the primal and dual problem in linear programming problem, systems approach to modeling power systems in the GAMS language, GAMS fundamentals (model structure, syntax, data management, variables, equations), programming environments, typical planning problems in the power system, solving selected real-world optimization problems in power systems using GAMS.

Specific objectives:
To introduce students to programming in GAMS, and present the GAMS syntax, structure and data handling.
To demonstrate a systems approach to modeling power systems in the GAMS language.
To address selected types of optimization problems.
To explain the formulation of the primal and dual problem in linear programming.
To demonstrate how to build mathematical models of basic energy systems.
To address the typical planning problems in the power system (UCED, GEP).

Full-or-part-time: 27h
Theory classes: 15h
Guided activities: 7h
Self study : 5h

Module 3: System modelling for energy planning and climate policy development (2 ECTS credits)

Description:
Modeling the development of energy systems, IEA-ETSAP TIMES model generator (objective function, decision variables, main equations and user constraints), defining Reference Energy System in TIMES, parametrization of processes and commodities, building energy scenarios with various energy and climate policy objectives, cost-benefit analysis of the scenarios and sensitivity analysis of the results.

Specific objectives:
To learn (IEA-ETSAP) TIMES partial equilibrium approach.
To familiarize with the TIMES objective function, decision variables, main equations and user constraints.
To develop a model of a Reference Energy System in TIMES.
To reflect and parametrize processes and commodities in the model.
To build energy scenario and analyse the results.
To address how the scenario results can contribute to the development of energy and climate policies.

Full-or-part-time: 22h
Theory classes: 12h
Guided activities: 6h
Self study : 4h

GRADING SYSTEM

Written exams: 20%
Progress through the course will be assessed through small assignments, quizzes, tests, etc., to verify the knowledge gained through the blended learning materials: 20%
Accomplishment of tasks during computer lab: 20%
Quality and performance of the projects: 40%

BIBLIOGRAPHY

Basic:
- Rosenthal, Richard E.. A GAMS Tutorial [on line]. [s.l.]: [s.n.], [s.d.] [Consultation: 19/09/2024]. Available on: https://www.gams.com/latest/docs/UG_Tutorial.html.
- A. Soroudi. Power System Optimization Modeling in GAMS [on line]. Cham: Springer International Publishing, 2017 [Consultation: 05/07/2024]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-3-319-62350-4. ISBN 3319623508.
- R. Loulou et al.. Documentation for the TIMES Model : Part I [on line]. [Paris]: IEA - ETSAP, 2016 [Consultation: 05/07/2024]. Available on: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://iea-etsap.org/docs/Documentation_for_the_TIMES_Model-Part-I_July-2016.pdf.
- Munasinghe, Mohan ; P. Meier. Energy policy analysis and modeling. Cambridge: Cambridge University Press, 2012. ISBN 9780511983573.
- Rosenthal, Richard E.. NouGAMS – A User's Guide [on line]. Washington, DC: GAMS Development Corporation, 2007 [Consultation: 05/07/2024]. Available on: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.un.org/en/development/desa/policy/mdg_workshops/training_material/gams_users_guide.pdf.
- Energy indicators for sustainable development : guidelines and methodologies [on line]. Viena: International Atomic Energy Agency, 2005 [Consultation: 05/07/2024]. Available on: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www-pub.iaea.org/MTCD/Publications/PDF/Pub1222_web.pdf. ISBN 9201162049.

RESOURCES

Other resources:
Software
Students will use the ETSAP and KanORS free online platform VEDA ONLINE (https://vedaonline.cloud/SignIn.aspx?status=440) />Student version of GAMS, model will be solved on NEOS server (https://neos-server.org/neos/solvers/lp:CPLEX/GAMS.html)

Teaching materials
A. Soroudi, Power System Optimization Modeling in GAMS. Cham: Springer International Publishing, 2017. doi: 10.1007/978-3-319-62350-4
A. Wyrwa, Modeling in the GAMS language, textbook for students, AGH, 2021

Software
Students will use the ETSAP and KanORS free online platform:
https://vedaonline-documentation.readthedocs.io/en/latest/pages/VO_free_academic.html

Teaching materials
https://iea-etsap.org/index.php/documentation />