University of Cologne

Department of Economics – Chair in Economics and Energy Economics

Seminar Empirical Methods in Energy Economics

Dr. Eren Çam

Quantitative Models for Energy Systems and Markets

Summer Term 2026

Introduction

As the world enters the Age of Electricity, energy systems around the world are undergoing a profound transformation driven by electrification and the growing integration of weather-dependent renewable sources such as solar PV and wind power. As power systems transform, ensuring that electricity is secure, affordable and sustainable is becoming increasingly complex. Meeting these goals requires a strong understanding of how electricity is scheduled, balanced and delivered in real time.

This new era of electricity is characterised by a much higher need for flexibility. Variable solar PV and wind generation is balanced with dispatchable resources. At the same time, with sufficient price signals and the necessary infrastructure, various consumers can adjust their electricity consumption according to the system needs. Storage – particularly the fast-growing fleet of utility-scale batteries – adds further flexibility by charging during periods of excess supply and discharging when supply is scarce. Cost-optimal quantification and usage of these flexibilities can be done with applying the right type of techno-economic models.

A range of modelling approaches can be used to represent and simulate different stages of energy systems, such as planning, investment, and operational decision-making. These models can be customised to capture the technical characteristics of the system and its assets, typically with an objective function that minimises costs or maximises revenues. They are commonly subject to a variety of constraints, including requirements for system security and reliability, decarbonisation targets, and sometimes also thresholds designed to account for uncertainty.

This course introduces students to the fundamentals of power system operations, including the characteristics of different energy resources and the principles guiding their dispatch. It also equips students with the skills to formulate and run their own optimisation models to analyse key challenges in energy systems, illustrating how modelling can support better decision-making.

While the focus is on the power sector, the optimisation techniques taught in this course are broadly applicable across other fields such as logistics, telecommunications, economics, and finance. A background in mathematics and economics is beneficial for students taking this course.

In this course, students will be able to:

- Understand basic microeconomic concepts and apply them to quantitative models.
- Formulate optimisation problems commonly used in power system analysis (LP, MILP).
- Model economic dispatch and unit commitment under technical and economic constraints.
- Represent thermal, hydro, storage, renewable, and flexible demand resources.
- Understand market clearing mechanisms and pricing (marginal cost, LMPs).
- Implement dispatch models using modelling tools (e.g., Pyomo, GAMS).
- Interpret results for planning and policy applications (emissions, costs, congestion).
- Evaluate trade-offs between reliability, economic efficiency, and decarbonisation goals.
- Receive insights via guest lectures by experts from the International Energy Agency (IEA)
- Conduct independent data-based analysis on selected real-world topics and present the results orally and in writing

Schedule

04.05.2026 10:00-11:30 12:00-13:30	**Lectures** • Introduction to optimisation theory and types of models Location: Institute of Energy Economics, Vogelsanger Str. 321a, 50827 Cologne	
05.05.2026 13:30-15:00 15:30-17:00	**Lectures** • Introduction to power system dispatch modelling, focus on batteries Location: Institute of Energy Economics, Vogelsanger Str. 321a, 50827 Cologne	
06.05.2026 12:00-14:00	**Lectures** • Presentation and Writing Skills Location: Institute of Energy Economics, Vogelsanger Str. 321a, 50827 Cologne	
07.05.2026 10:00-11:30 12:00-13:30	**Lectures** • Practical training on developing and applying models in Python Location: Institute of Energy Economics, Vogelsanger Str. 321a, 50827 Cologne	
08.05.2026 (tbd)	**Guest lecture from the industry (tbd)** Location: online, over Zoom	
11.05.2026 (tbd)	**Guest lecture from the International Energy Agency** Location: online, over Zoom	
12.05.2026 23:59	**Deadline to Register or Withdraw from the Examination via KLIPS**	
13.05.2026 23:59	**Deadline submission of topic preferences** Please submit your seminar topic preferences to ecam5@uni-koeln.de Seminar topics will be then allocated to you by email.	
05.07.2026 23:59	**Deadline submission of presentation slides** Please submit your slides over ILIAS	
06.07.2026 09:00-12:00	**Seminar presentations** Location: Institute of Energy Economics, Vogelsanger Str. 321a, 50827 Cologne	
07.07.2026 09:00-12:00	**Seminar presentations** Location: Institute of Energy Economics, Vogelsanger Str. 321a, 50827 Cologne	
06.09.2026 23:59	**Deadline submission of final seminar paper** Please submit your seminar paper over ILIAS	

Application

A maximum number of 20 applicants can be admitted to the course. Please register on KLIPS for the seminar during the first and second registration period.

After you receive a seat in the seminar, please make sure to register for the examination on KLIPS as well. Only those who have a seat in the seminar can register for the examination! Thus, if you decide not to take the seminar, please make sure to deregister from the course, so your peers are able to enrol for the remaining spots before the exam registration phase ends.

Once you have registered for the examination, the registration is binding, and **students who do not give a presentation or do not hand in a seminar paper in time will receive a failing grade.** Thus, please make sure that you are able to hand in all documents within the deadline and attend the mandatory sessions before registering for the course.

Examination

The final grade consists of an oral and a written examination:

- Examination part A (50%): presentation of overall topic at seminar meeting (15 minutes per student – individual grade)
- Examination part B (50%): individual analysis and seminar paper on a specific research topic (max 5000 words)

Examination part A *(May – July)*:

After the introductory lectures, students will be allocated topics regarding the system integration of renewable energy sources. The aim of the oral part of the examination is to assess and develop the students' research questions and analysis approaches in the allocated topics.

Each presentation should provide a general overview of the topic, analyse the current state of literature (introduce relevant literature and the methodology used in those sources) point out interesting research questions. Special focus should be given to identifying relevant data sources, and discussing their potential in helping address the research questions at hand.

Students need to structure their topic and deliver coherent and consistent presentation slides. Each student is required to present for 15 minutes. Grading will be done based on individual performance.

Examination part B *(July – September)*:

In the written part of the examination, students will pick a research question they were able to identify during the presentation phase, in agreement with their mentor.

Focusing on this research question, the students then need to write a paper, which gives an overview of the literature, pick a methodology, identify relevant data sources, and analyse their research question in depth.

The written paper should be around 5000 words (+-10%). The analysis methods (e.g Excel sheets, Python code, and any other scripts) should also be delivered.

General Requirements

We expect students to have a basic understanding of economic concepts. Having taken other energy economics and/or energy policy courses is a plus but is not mandatory. Basic concepts of energy economics will be introduced in the introductory lectures. So those who do not prior experience will have a chance to catch up with the topic.

While the seminar topics will be distributed by the chair, students are expected to determine the main focus of their presentations and seminar paper themselves. The seminar participants are expected to gain in-depth insights into their topic independently. The emphasis within the own topic as well as the draft structure of the paper shall be discussed with the mentor at an early stage.

Active participation in the seminar discussion is expected. Attendance during all presentation days is therefore required.

We provide a guideline for the preparation of seminar papers. This includes all design requirements.

Further Information

Allocated Modules	1289MSECC3 - SM Energy and Climate Change III
Credits	6
Language	English
Examiner	Dr. Eren Çam (ecam5@uni-koeln.de, eren.cam@iea.org)
Cooperation Partners	International Energy Agency
Administration	Monika Räthe (raethe@wiso.uni-koeln.de)