Essen, Germany

October 5 – 9, 2026

ECONOMIC ANALYSIS OF NET-ZERO EMISSIONS POLICIES USING GAMS AND MPSGE

Instructors:

Christoph Böhringer
University of Oldenburg, Germany

Volker Clausen
University of Duisburg-Essen, Germany

➢ *Objectives*

To combat climate change, many countries have committed to achieving net-zero emissions by 2050. The successful transition towards a zero-emission economy will depend on the ability to power energy-related processes with electricity from carbon-free renewable energy sources.

This workshop will present state-of-the-art computable general equilibrium (**CGE**) models that are widely used in applied economic research to study the impacts of emissions reductions policies. The standard top-down framework of CGE models will be complemented by a bottom-up representation of the electricity system to capture the pivotal role of carbon-free supply and demand technologies for decarbonizing the economy as a whole.

The course will build on seminal peer-reviewed publications combining methodological expertise on hybrid bottom-up/top-down modeling with policy-relevant applications, ranging from technology-specific regulations (e.g. green subsidies, renewable portfolio standards, energy efficiency standards, technology bans) to economy-wide emissions pricing and revenue-rebating schemes (green tax reforms). Guided by a series of lectures and hands-on modeling exercises, participants will develop step by step the capacity to re-formulate model codes towards their own needs in academic research or policy consultancy.

Mathematically, the models are formulated and implemented as so-called "mixed complementarity problems" (**MCP**), stating complementarity of economic equilibrium conditions with associated economic decision variables. The fundamental strength of the MCP format (beyond the standard approach of treating equilibrium conditions as a system of nonlinear equations) is the ability to handle corner solutions and regime shifts that are central to the analysis of sorting decisions, such as discrete technology choices.

For the computer implementation of the numerical models the course uses the high-level programming language **GAMS** (Generalized Algebraic Modeling System) whose notation closely follows standard matrix algebra. The fundamental strength of GAMS lies in the ease with which mathematically defined models can be formulated and solved.

The explicit algebraic formulation of general equilibrium conditions and the parameterization of functional forms to characterize technologies and preferences can become very tedious and error-prone, in particular for more complex production and consumption patterns. **MPSGE** (Mathematical Programming System for General Equilibrium) – which runs as a subsystem under GAMS – provides a short-hand non-algebraic representation for general equilibrium models, releasing economists from the need to write down complicated equilibrium conditions explicitly as well as from the need to set up tedious calibration routines for the parameterization of demand and supply functions. The workshop will show in detail how to transform algebraic CGE models into non-algebraic MPSGE syntax, which can substantially lower the entry barriers and time cost of CGE analysis.

Material and teaching is in English. Registered participants will receive the teaching material prior to the start of the workshop such that they can prepare in advance. Teaching will combine lectures on theoretical underpinnings of policy assessment with numerical model applications based on peer-reviewed publications.

- ***Instructors***

Christoph Böhringer

University of Oldenburg

Prof. Dr. Christoph Böhringer is Professor of Economic Policy at the University of Oldenburg and expert advisor to the German government on research and innovation policies. His research focuses on the economic impact assessment of policy regulations using partial and general equilibrium models. Since 1994, he has been regularly conducting workshops on applied analysis in the fields of environmental, energy, fiscal, and trade policies. He has widely published in reputed international journals.

Volker Clausen

University of Duisburg-Essen

Prof. Dr. Volker Clausen has been Professor of International Economics, University of Duisburg-Essen, Campus Essen since 2001. Previously he worked at the Universities of Kiel and Bonn in Germany and at Indiana University, in Bloomington, Indiana (USA). He holds a Ph.D. in Economics from the University of Kiel, Germany, and a Master of Science in Economics from the London School of Economics and Political Science. His current research interests include general equilibrium modelling with a focus on open economies. His publications have a focus on international topics.

- ***Workshop contents***

Part 1: Economic Equilibrium, Mixed Complementarity and Mathematical Programming

- Economic equilibrium in mixed complementarity format
- Mathematical programs: duality and complementarity

Part 2: Bottom-up activity analysis of the electricity system

- Stylized models of electricity supply and emissions regulations
- Optimal electricity dispatch under CO_2 emissions pricing

Part 3: Integration of bottom-up electricity market models into top-down CGE models

- Standard CGE representation of an energy-economy system
- Model calibration to observed economic data (functional forms)
- A hybrid bottom-up/top-down model for climate policy analysis

Part 4: MPSGE implementation of CGE models

- MPSGE syntax
- Converting CGE models from algebraic MCP formulations into MPSGE
- From static to dynamic policy analysis

Part 5: CGE-based impact assessment of net-zero emissions policies

- Multi-sector multi-region (baseline) projections until 2050
- Build your own large-scale bottom-up/top-down CGE model calibrated to baseline data
- CGE analysis: the role of carbon backstop and negative emissions technologies for reaching net-zero emissions

***Note*:** An exact schedule as well as coverage of aforementioned topics depend on the previous experience of participants with GAMS, MPSGE and CGE modeling and their research interests. Some parts might be covered more quickly at the beginning of the workshop, which allows for more discussion and implementation of recent research toward the end of the workshop. This will be decided on the basis of the actual list of participants, who will be asked about their previous experience in the field before the workshop starts.

- ***Target group***

The workshop is targeted to scientific researchers and policy analysts at universities, research centers, consulting companies and ministries who are interested in the economic impact assessment of policy interventions using CGE models. While the field of application for CGE models is broad, the workshop will pay special attention to the applied analysis of energy and climate policies.

- ***Your benefit***

The workshop provides you with state-of-the-art CGE modeling techniques. Application of these techniques will allow you to gain insights into economic theory with numbers and to undertake comprehensive economic impact assessment of policy reforms based on real data. At the end of the workshop, each participant should be able to run a hybrid bottom-up top-down CGE model based on empirical data to analyze decarbonization policies.

- ***Prerequisites***

Material and teaching is in English. Registered participants will receive teaching material prior to the start of the workshop such that they can prepare in advance. Teaching will combine lectures on theoretical underpinnings with worked examples on model implementation as well as hands-on sessions with exercises for participants.

Participants should be familiar with intermediate microeconomics (Master's level). In the run-up to the workshop, participants should get to know the basics of the programming language GAMS, which is used for the numerical implementation of equilibrium models as well as data management. A compact do-it-yourself GAMS tutorial will be sent out to participants in advance.

Participants are required to bring a laptop and adapters to German power supply, if necessary. The GAMS workshop license (valid for 2 months) as well as extensive course material will be provided to each participant in advance.

- ***Payment***

The fee for participating in the training workshop is 2,500 Euro and includes lectures, course material and lunches. Academic participants from accredited universities or research institutions will be admitted on a space-available basis for a discount of 20%. Graduate students from accredited academic institutions are likewise admitted on a space-available basis for a discount of 40%. Please fax or email a copy of your student ID to get the discount. There will be a limited number of scholarships (*excluding travel and subsistence expenses*) that have been set aside for qualified participants from developing countries. Deadline for the application for a scholarship is **June 12, 2026**. Preference will be given to applicants who have documented previous experience in general equilibrium modelling with GAMS. To apply for a scholarship in the form of a tuition waiver, send your CV and a research paper via email to the course coordinator Mehmet Burak Akren. A decision on the allocation of scholarships will be made until **June 19, 2026,** in order to allow for an early arrangement of flights, visa etc.

- ***Registration***

Please contact the course coordinator if you have any questions:

M. Sc. Mehmet Burak Akren
University of Duisburg-Essen
Department of Economics
45117 Essen, Germany
Telephone: +49 (0)201-18-36829
Fax: +49 (0)201-183-3974
email: Mehmet.Akren@vwl.uni-due.de

The registration deadline is **September 11, 2026**. The maximum number of participants is restricted to 16! **Slots are guaranteed only upon full payment of fees through the course coordinator.** Cancellations will be fully refunded if made prior to **September 11, 2026**. No refunds will be made after the registration deadline. ***Note the following disclaimer and limited liability:*** The program and the list of instructors are confirmed and correct at the time of publication. In case of any serious circumstances or acts of nature beyond control of the organizers, such as for example illness, death, cancellation of flights etc., the organizers aim for an adequate substitution. In the very unlikely, but still possible case, the maximum liability of the organizers is limited to the tuition. The organizers do not cover any other costs of the participants, such as travel bookings, visa fees, etc. The organizer also reserves the right, in the unlikely case of very limited enrolment, to run the workshop with one instead of two external instructors.

- ***Times and location***

Morning sessions will begin at 9am. Lunch is provided for workshop participants at noon. The afternoon sessions will run from about 1-4pm. Between 4 and 5 pm there will be time for further individual programming and consultation. All sessions take place in the **Casino Gästehaus** located in the east of the University of Duisburg-Essen, Campus Essen:

University of Duisburg-Essen, Campus Essen
Universitätsstraße 12
45117 Essen, Germany

Workshop participants must make their own arrangements for accommodation.

- ***How to prepare***

No previous knowledge of GE modeling is assumed. However, participants should be familiar with intermediate microeconomics and get somewhat acquainted **beforehand** with GAMS, which is the (rather intuitive) programming language used for computer-based model implementation. To be able to follow during the workshop, we suggest for the purpose of preparation the following introductory readings and a short do-it-yourself GAMS tutorial:

- Böhringer, C., Rutherford, T.F., Wiegard, W. (2003): Computable General Equilibrium Analysis: Opening a Black Box, ZEW discussion paper, 03-56.
- Rutherford, T.F. (1999): Applied General Equilibrium Modelling with MPSGE as a GAMS Subsystem, Computational Economics 14, 1-46.
- J.R. Markusen teaching materials for a course "Simulation Modeling in Microeconomics", especially Chapters 1-4.

Get familiar with GAMS:

- Download the GAMS User's Guide.
- Download the Demonstration Version of GAMS. The GAMS workshop license will be provided on the first day of the workshop.
- Study background material provided over the web, including:

  a) An introduction to GAMS by Jensen (2006)
  b) A GAMS Tutorial by Rosenthal
  c) Quick Start Tutorial by McCarl

- Last but not least, there are some Youtube Tutorials you should look at:

  a) A Brief Introduction to Modeling in GAMS (Transport Model as of Rosenthal)
  b) A simple first GAMS Model (Part 1) by Maindl
  c) Good modeling practice (Part 2) by Maindl
  d) GAMS and Excel - Using GDX to Transfer Data

Note: We will send out to registered participants a zip-file that features a series of five lectures with some illustrative GAMS models. Participants should then go through these lectures with the primary objective to get somewhat acquainted to the GAMS programming language.