



**University of Cologne**

Department of Economics – Chair of Energy Economics – Prof. Dr. Marc Oliver Bettzüge

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## **Equilibrium and Optimization Modeling with a Focus on Energy Markets**

**Instructor: Dr. Steven A. Gabriel, Full Professor, University of Maryland, College Park, Maryland  
20742 USA ([www.stevenagabriel.umd.edu](http://www.stevenagabriel.umd.edu))**

Winter term 2014/2015

<b>Time</b>	Monday October 20 – Friday October 24 <ul style="list-style-type: none"><li>▪ Lectures 8:30-12:30</li><li>▪ Lunch 12:30-1:30</li><li>▪ GAMS or other hands-on exercises 13:30-15:30</li></ul> Friday October 31, 10:00-12:00 <ul style="list-style-type: none"><li>▪ Two-hour in-class exam, closed book, closed notes, no internet access</li></ul>
<b>Location/Room</b>	Chair of Energy Economics/Institute of Energy Economics at the University of Cologne, Vogelsanger Str. 321a, 50827 Cologne, KFR I
<b>Module</b>	<ul style="list-style-type: none"><li>▪ 15052 Empirical Productivity Analysis (Advanced)</li></ul>
<b>Module is allocated to</b>	<ul style="list-style-type: none"><li>▪ Major Economics - Spezialisierungsbereich (Markets and Institutions) (Master)</li><li>▪ Minor Institutionen und Märkte (Master)</li><li>▪ Pflichtfach Hauptstudium (Diplom)</li><li>▪ CGS course (Doctoral students)</li></ul>
<b>Credit points</b>	6
<b>Course language</b>	English

## 1. Contents (Day-by-day Schedule for Lectures (anticipated))

Monday October 20

Optimization: Review of linear and nonlinear programming including Karush-Kuhn-Tucker (KKT) conditions, necessity/sufficiency of KKT conditions, convex vs. non-convex problems, some basic GAMS programming review, existence and uniqueness of solutions to optimization problems

Tuesday October 21

Game Theory: Two-person, zero-sum games, bimatrix games, mixed games, equilibria in dominant actions, Nash equilibria, connection to optimization and other problems

Wednesday October 22

Mixed Complementarity Problems (MCPs): MCPs definition, connection to optimization and game theory problems, other MCPs related to energy/economics, existence and uniqueness of solutions

Thursday October 23

Other Equilibrium Programming (Part 1): Variational inequality (VI) problem, relationship between VI and MCP, Principle of Symmetry relating optimization and MCP/VI, generalized Nash problems and the Lagrange multipliers for joint constraints, two-level equilibrium models (Stackelberg, MPEC), selected algorithms for equilibrium programming (a subset of these topics)

Friday October 24

Other Equilibrium Programming (Part 2): " "

## 2. Requirements

Some knowledge of optimization (e.g., a first course in linear programming), microeconomics, and/or game theory. Some knowledge of the GAMS software package is helpful and GAMS should be downloaded on to the student's laptop before the course (see [gams.com](http://gams.com), use student version) and at least one program tried (see the tutorial under [gams.com](http://gams.com)) if not already familiar with this package.

## 3. Examination

- Two-hour in-class exam, closed book, closed notes, no internet access
- Friday October 31, 10:00-12:00
- Chair of Energy Economics/Institute of Energy Economics at the University of Cologne, Vogelsanger Str. 321a, 50827 Cologne
- Registration for Master and Diplom students via examination office until October 17
- Registration for doctoral students in the course

## 4. Co-ordination/Contact

Jürgen Kruse, M.Sc., [juergen.kruse@uni-koeln.de](mailto:juergen.kruse@uni-koeln.de)