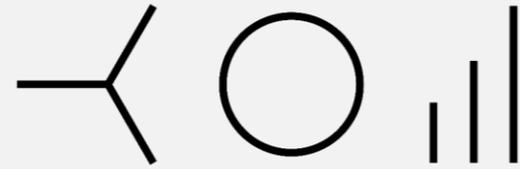# Electricity System Modeling



## About Neon

[Neon](#) is a Berlin-based boutique consulting firm for energy economics, founded in 2014. We help our international [clients](#) from the public and private sector to design and navigate power systems and markets through studies, advisory and trainings.

We work on seven [topics](#): the market value of wind and solar energy, electricity market design, redispatch, (whole) system costs of renewables, balancing energy, power market modeling and open source / open data.

## About your instructor

Prof. Dr. Lion Hirth is founder and director of Neon. He also teaches at Hertie School of Governance. Lion is energy economist and expert in wind and solar energy, power market modeling, and electricity market design. He has five years of industry experience, holds a Ph.D. in energy economics and has published a number of highly cited academic articles.

» [Curriculum vitae](#)
» [Publications](#)
» [Project references](#)

## Executive training seminar

» For energy professionals in industry, finance, policy and think tanks
» Extent your analytical understanding of electricity markets and energy economics
» Understand Europe's electricity sector during crisis, transformation and decarbonization
» Applied and relevant, yet scientifically sound and rigorous
» 100% of previous participants would recommend it to a colleague

## Pricing and booking

» Three days
» EUR 1800 + VAT
» 40% discount for NGOs and public sector
» 10% early bird discount
» English or German
» In-house seminars and group discounts
» [neon-energie.de/seminar](#)
» [hirth@neon-energie.de](#)
» [+49 1 57 55 199 715](#)

## Program overview

I. [Introduction to electricity system modeling](#)
II. [Do it yourself: Excel modeling](#)
III. [Do it yourself: GAMS modeling](#)

Day 1 provides an overview of electricity market modeling. Since the best way of understanding models is to do it your self, on day 2 and day 3 we will build our own models. This is to understand the art and the science of electricity system modeling.

# Session overview

Modeling for insights.

A three-day introduction to power system modeling for the 21st century.
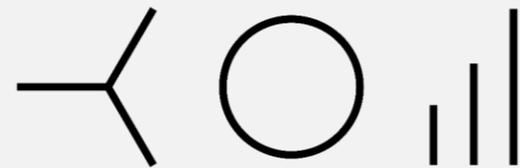
"I cannot remember when I learned so much in just three days."
– Ulla Blatt Bendtsen, Senior Advisor of Climate & Energy Economy, Danish Energy Agency

# Introduction to electricity system modeling

1. Electricity System Modeling
2. Power Market Modeling
3. Open Modeling and Transparency

## 1. Electricity System Modeling

- » Modeling for research, policy, profit
- » What is a "numerical model"?
- » Economic dispatch model, Unit commitment model, Integrated assessment model, Power market model, Capacity expansion model, Grid model, Load flow model, Greenfield model, etc.
- » How to make sense of this model ecosystem?

## 2. Power Market Modeling

- » A crash course in power market modeling
- » Core equations
- » Optimization
- » The modeling chain
- » Important limitations and caveats
- » Recognizing a good model

## 3. Open Modeling and Transparency

- » Transparency
- » Documentation
- » Open source models
- » Data sources
- » Open Power System Data

"On a scale from 1 to 5:
seminar structure 4.6,
quality of presentations 5.0,
quality of assignments 4.6,
Excel 4.5,
GAMS 5.0"
– From the course eva-
luation, Agora Energiewende

Models matter for decision-
making – in policy, industry
and finance.

A crash course in electricity
system modeling.
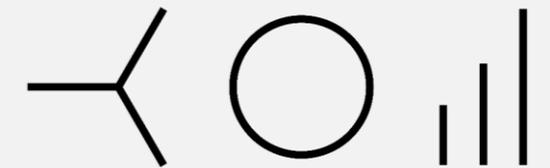
# Do it yourself: Excel modeling

4. Cost Modeling
5. Merit Order Model
6. Market Value
7. Screening Curve Model

## 4. Cost modeling

» Cost data of generation technologies
» Levelized cost of electricity (LCOE)
» Screening curves

## 5. Merit Order Model

» Optimal plant dispatch
» Generation mix
» Price determination
» Market value of wind and solar energy

## Do it yourself!

Build your own power market model in a day.

## "Ridiculously high quality across all course components (presentation, slides, Excel, GAMS)."
— From the course evaluation, Danish Energy Agency

## 6. Market Value

» The "market value" (or capture price) of wind and solar energy
» The "value factor" (capture rate)
» Deriving the market value from observed prices and from models

## 7. Screening Curve Model

» Load duration curves
» The optimal thermal generation mix
» The impact of carbon pricing
» The impact of cost shocks
» Residual load duration curves
» The impact of renewable energy
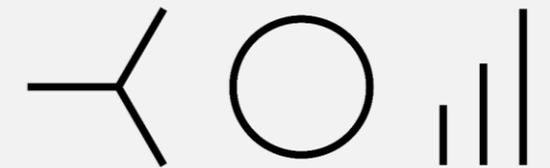
## 8. Mathematical optimization

» The principles of optimization
» The intuition behind numerical solvers

## 9. Getting Started with GAMS

» Understanding algebraic modeling
» What GAMS can and cannot do for you
» Basic GAMS syntax
» Fundamental concepts
» The structure of GAMS models
» Tips & tricks

## 10. The simplest GAMS model ever

» Building the simplest GAMS-based electricity market model in history
» Thinking in equations

Most professional energy system models are written in GAMS.

Welcome to the world of optimization!

## 11. A long-term GAMS model

» Build your own model from scratch
» A screening curve-type of model in GAMS
» Deriving the cost-optimal amount of wind and solar capacity
» Simple yet insightful

## 12. Adding Realism: Storage and Balancing

» Extending the GAMS model step by step
» Peaking plants
» Electricity storage
» Must-run constraints and balancing energy
» Looping for sensitivity studies

## 13. The EMMA model

» Don't start from scratch!
» Use a medium scale GAMS power market model
» EMMA is free and open source
» Tested and realistic
» Expand the model according to your needs