Welcome to ELEKTROENERGETIKA 2019
The 10th International Scientific Symposium on Electrical Power Engineering

Keynote speakers

• Reinhard Haas, Institute for energy systems, Technical University of Wien, Austria
  Heading towards sustainable and Democratic Electricity systems
• Karel Maslo, Transmission System Analysis Department, ČEPS, a.s., Prague, Czech Republic
  Dynamic Models in the Context of the EU Commission Regulations
• Michael Nowotny, University of Technologies Hiroh, Australia

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HEADING TOWARDS SUSTAINABLE AND DEMOCRATIC ELECTRICITY MARKETS

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ELEKTROENERGETIK, High Tatra
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1. Introduction: Motivation
2. Method of approach
3. How variable renewables impact prices in electricity markets
4. The core problem of capacity payments
5. The role of flexibility
6. Storing every peak?
7. Subsidizing renewables?
8. Conclusions
1. INTRODUCTION

Motivation:

* Europe: The clean energy package → energy communities

* It is not possible to force variable renewables into the system

* A strong desire of some customers to participate in electricity supply
Electricity generation EU-28

Kohle  Ölprodukte  Gas  Atomenergie  Erneuerbare

2017 und 2018 preliminary
1. INTRODUCTION

Strategic decision by European Council in 2014

-20 % Greenhouse Gas Emissions
20% Renewable Energy
20 % Energy Efficiency
10 % Interconnection

≤ - 40 % Greenhouse Gas Emissions
≥ 27 % Renewable Energy
≥ 27%* Energy Efficiency
15 % Interconnection

* To be reviewed by 2020, having in mind an EU level of 30%

New governance system + indicators
Structure of the Package

Innovative

Inter-connected

Enabling Framework

Energy Union Governance

Energy Efficiency

Renewables
- Revised Renewable Energy Directive

Electricity Market Design
- Regulation and Directive on internal electricity market; Regulation on risk-preparedness, ACER regulation

Socially fair

Digital

Safe for all

Investment-friendly

Inclusive
Core objective

... to identify the major boundary conditions to integrate even larger amounts of variable renewables into the electricity system

Very important:

Our reflections apply in principle to every electricity system world-wide

.... are based on electricity economic point-of-view
2. METHOD OF APPROACH

- Hourly resolution of residual load over a year in scenarios with large quantities of variable renewables;

- Applying a fundamental model to calculate (static) hourly electricity spot market prices;

- Integration of flexibility/elasticity in a dynamic framework for price calculation;
3 HOW VARIABLE RENEWABLES IMPACT THE ELECTRICITY SYSTEM AND PRICES IN ELECTRICITY MARKETS
Example: prices without and with PV

Price = System marginal costs

Price with PV!

Supply curve w/o PV

Supply curve w/ PV

Price with PV!
Supply and Demand

RES Production > Demand

RES Production < Demand
Key term of the future:
Residual load
(base load is “dead”)

Excess electricity

Residual load = Load – non-flexible generation
Deviation from STMC-pricing in spot markets

Scarcity prices

Electricity price spot market

New price spreads

\[ p_{t1} \]

Positive price spreads

\[ p_{t2} \]

Negative prices

\[ \rightarrow \text{These price spreads provide incentives for new flexible solutions!!} \]
The CO2-Price

![CO2 Price Chart](chart.png)
Development of electricity prices in Europe up to 2016 (1)

AT, DE, FR, CZ, PL

One market

Nordpool

Italy

[Graph showing electricity prices from 1999 to 2016 with various markets represented in different colors and trends.]
Development of electricity prices in Europe up to 2018 (2)
Classified residual load over a year

Under coverage

Surplus due to excess generation

2016

2030
Classified residual load

How to cover Cold - dark – Lull?
There are two extreme positions:

By a regulated capacity payment with STMC pricing?

or

By competition between supply-side and demand-side technologies and behaviour (incl. Storages, grid and other flexibility options) with correct scarcity pricing signals?
4 THE CORE PROBLEMS OF CAPACITY PAYMENTS

All regulatory capacity payments for power plants distort the EOM and lead to wrong price signals for all other options.

Price peaks at times of scarce resource should revive the markets and lead to effective competition.

The higher the excess capacities, the lower is the share of RES.

strive to retain system resource adequacy by correct price signals.
5 Flexible coverage of residual load

- Extension Transmission grid
- Very high prices (2000 EUR/MWh!)
- Load reduction due to Demand response to prices
- Load reduction due to Demand-side management technical (e.g. cycling)

Flexible power plants
Storages
Comparison

- Flexible power plants

Security marge
6. STORING EVERY PEAK?

Under coverage

Excess capacity

High excess capacity at very few hours!
Decreasing full-load hours of storages

- Storage 1
- Storage 2

Under coverage

Hours/year

Residual load

Excess generation
Flexible use of excess electricity

- Load increase by technical Demand-side management (incl. Power-to-heat)
- Smart Grids
- Shedding of peak power
- Extention of transmission grid
- Storage (if reasonable Fullloadhours)
- Direct marketing
- Price very low (-2000 EUR/MWh ???)
Demand for long-term storage

Long-term storage needed

![Graph showing demand for long-term storage with monthly data for various energy sources.](image-url)
Sector coupling / Sector integration

* In times of surplus generation: How to use excess electricity in meaningful way?
  
  Heating/Cooling
  
  Transport

* Vague simplified suggestions, no convincing long-term solutions

* Central (Ptx approaches, e.g. H2) vs decentral (end user level, E.g. Evs, heat pumps for heating) applications

* How to fit use with time of surplus, e.g. of PV for heating?
Sector coupling hydrogen: Storage and fuel in transport?

- Electrolyser
  - Electricity $\eta = 60-70\%$
  - $H_2$ $\eta = 27-38\%$

- Compressor $\eta \approx 90\%$
- Combined cycle $\eta = 50-60\%$

- $H_2$-Storage

- Electric vehicles
  - $E-CELL$

7. IS THE TIME FOR SUBSIDIZING RENEWABLES OVER?

As long there is no price on CO2 .....
Grid parity: PV-costs and household electricity prices

Costs

Germany

Grid parity

Cent/kWh

0 10 20 30 40 50 60


Kosten Strompreis
Tenant electricity model and Blockchain

Tenant electricity model: Contracted PV-electricity

Balancing Group/Supplier

PV-System on the roof

Customer 1

Customer 2

Customer 3

Meter

Blockchain

Tenant electricity model:
Contracted PV-electricity

Balancing Group/Supplier

Blockchain
New Thinking: Making the electricity system more democratic

Flexibility options

STO

Supplier

Grid

Prosum-agers *)

*) R. Green
8. CONCLUSIONS

• Sustainable electric. system \( \rightarrow \) integration of a broad technology portfolio & demand-side options

• No quick fix, no one size fits all solutions

• Larger market areas favourable

• Very important: correct price signals (incl. CO2)

• most urgent: exhaust full creativity for flexibility of all market participants (Erdmann)

• Capacity payments: Any CP will distort the system towards more conv. and less RES capacity

• Prospects for storage: less bright than argued

• New key players: Suppliers / balancing groups