RLS Energy Network Meeting

Actual research projects in the field of renewable fuels and bulk chemicals

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Macroeconomic Impact Assessment of renewable energy and biofuels in (Upper) Austria

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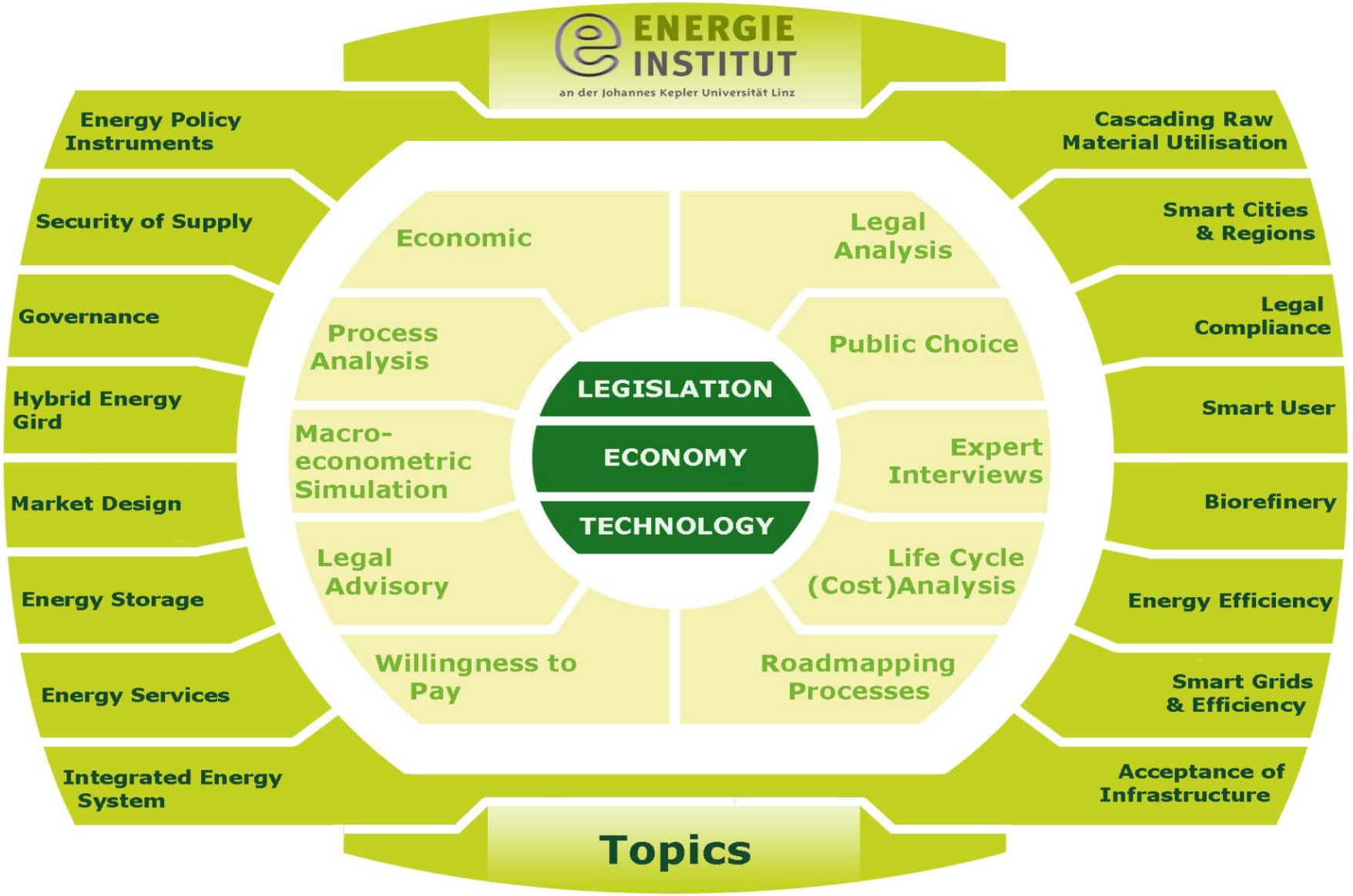
The power regions Bavaria and Upper Austria in the context of hybrid grids

Sebastian Goers
Senior Researcher at the Energy Institute Linz
Department of Energy Economics

Montreal, 24th November 2015


ENERGIE INSTITUT
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Energy Policy Instruments
Security of Supply
Governance
Hybrid Energy Gird
Market Design
Energy Storage
Energy Services
Integrated Energy System
Cascading Raw Material Utilisation
Smart Cities & Regions
Legal Compliance
Smart User
Biorefinery
Energy Efficiency
Smart Grids & Efficiency
Acceptance of Infrastructure
Economic
Legal Analysis
Process Analysis
Public Choice
Macro-econometric Simulation
Expert Interviews
Legal Advisory
Life Cycle (Cost)Analysis
Willingness to Pay
Roadmapping Processes
LEGISLATION
ECONOMY
TECHNOLOGY
Topics

Actual research projects in the field of renewable fuels and bulk chemicals

Key project topics

Recent projects

- Assessment and Technology Development

Techno-economical evaluation of renewable energy technologies

Studies, assessments and evaluations

Biorefinery technology development

Bioethanol and biogas production
Biorefinery demonstration plant

Life cycle assessment based on ISO 14040/14044

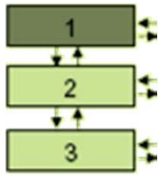
with 3 different software tools

More information on projects are available at the website:

http://www.energieinstitut-linz.at
http://www.energyefficiency.at/

What we are able to do – benefits from our work

- Improve energy efficiency
- Reduce environmental bottlenecking
- Comply with legal framework and specific regulations
- Identify green carbon credit opportunities
- Decrease raw material usages and wastes
- Identify process adjustments yielding the largest environmental impact



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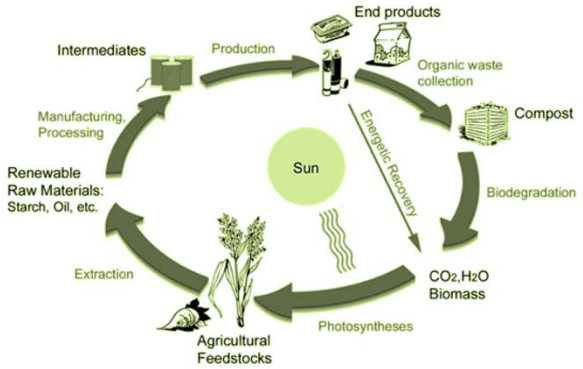
Analysis methods

- Greenhouse gas analysis – **Carbon Footprinting**
- **Cradle-to-grave analysis**

  (from raw materials to disposal)
- **Cradle-to-gate analysis**

  (from raw material to end of production)
- **Gate-to-gate analysis** (production facility)
- **Resource availability analysis**
- **Site planning**



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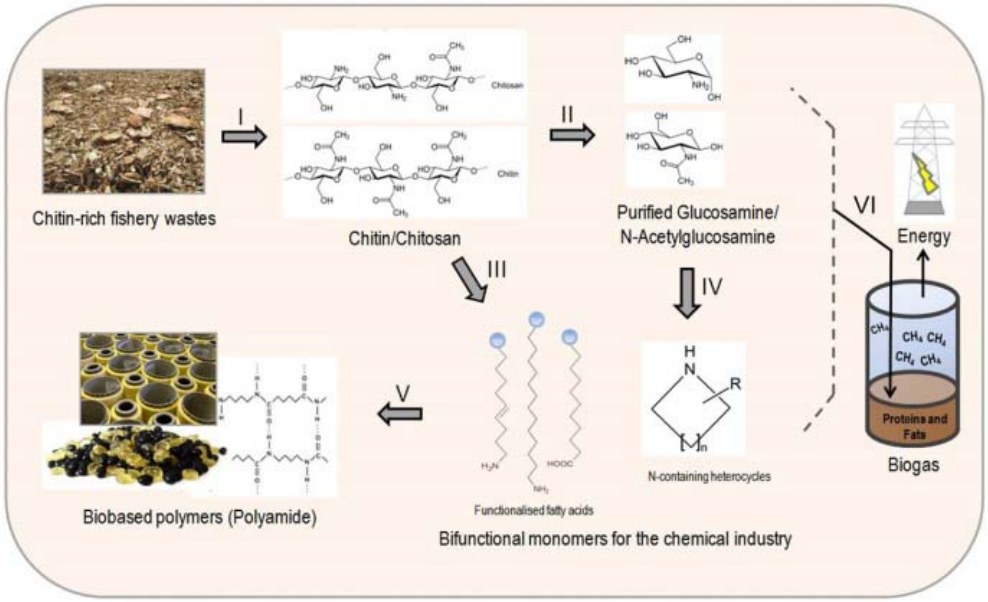
EU-Project *ChiBio*: Development of an integrated biorefinery for processing chitin rich biowaste to specialty chemicals.

Coordinators: L. Wiemann & V. Sieber, Project Group BioCat, Fraunhofer IGB (Straubing/Germany) *lars.wiemann@igb.fraunhofer.de*

Local partner contact: **The Energy Institute at the Johannes Kepler University Linz GmbH**, *lindorfer@energieinstitut-linz.at*



I) Pretreatment & stabilisation

II) Depolymerisation (chemo- and biocatalytic) to sugar polymers

III) Microbial conversion of chitin hydrolysates to lipid congeners

IV) Multi-Enzymatic conversion of sugar monomers to N-containing bi-functional monomers

V) Polymerisation & Demonstration

VI) Anaerobic digestion of protein & lipid residues to biogas/energy

EU PROJECT SUNLIQUID

CELLULOSIC ETHANOL MADE FROM AGRICULTURAL RESIDUES

EU PROJECT SUNLIQUID

CELLULOSIC ETHANOL MADE FROM AGRICULTURAL RESIDUES

PROJECT PROFILE

Project	SUNLIQUID (sunliquid® large scale demonstration plant for the production of cellulosic ethanol)
Coordination	Dr. Markus Rarbach, Clariant Produkte (Deutschland) GmbH
Funding scheme	FP7 collaborative project (FP7 ENERGY)
EU funding	€ 23 Mio.
Duration	4 years (04/2014 – 03/2018)
Website	www.sunliquid-project-fp7.eu

This project receives funding from the European Union's Seventh Framework Programme (FP7/2007-2013) under grant agreement no° 322386.

PROJECT OBJECTIVES

The project lays the foundation for the broad implementation of advanced biofuels production in Europe and for a sustainable energy supply in the European transportation sector.

- Planning, constructing and operating a commercial first-of-its kind production plant to produce cellulosic ethanol with the sunliquid® process
- Demonstrate that the production of cellulosic ethanol with the sunliquid® technology is economically viable on a commercial scale
- Establish a highly efficient feedstock supply and logistics system
- Life cycle analysis to obtain a full-scale assessment of the product's sustainability over the entire value chain
- Fuel testing and distribution, including the development of sales and marketing tools

© Clariant/Foto Rötzer: sunliquid® -Demonstration Plant in Straubing

THE SUNLIQUID® PROCESS

- Innovative, integrated biotechnological process
- Flexible use of various lignocellulosic materials
- High yields thanks to feedstock-specific enzymes and efficient fermentation organisms
- Energy self-sufficient process
- Up to 95% CO_2 savings
- Expansion of regional feedstock base without “food or fuel“ competition

© Clariant: The sunliquid® process for the production of cellulosic ethanol from agricultural residues

Benefit for European Society

- **Reducing greenhouse gas emissions**
  - sunliquid® cellulosic ethanol saves up to 95 % of greenhouse gas emissions compared with fossil fuels
- **Increasing independence from fossil fuels**
  - Reduction of a dependence on oil-exporting countries due to local production of liquid energy sources based on renewable resources
- **Spurring economic growth in Europe**
  - New jobs due to increasing demand for skilled labour on a local basis as well as in the logistics chain
  - Additional earnings possibilities for the agricultural sector

SUNLIQUID CONSORTIUM

Clariant Produkte (Deutschland) GmbH, Germany

BayWa AG, Germany

Energy Institute at the Johannes Kepler University Linz, Austria

ExportHungary, Hungary

Industrielle Biotechnologie Bayern Netzwerk GmbH, Germany

Bavarian Research Alliance GmbH, Germany

Thank you for your Attention!

contact:

Energieinstitut an der Johannes Kepler Universität Linz

Altenberger Straße 69

4040 Linz

AUSTRIA

Tel: +43 70 2468 5653

Fax: + 43 70 2468 5651

e-mail: lindorfer@energieinstitut-linz.at

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Macroeconomic Impact Assessment of renewable energy and biofuels in (Upper) Austria

Introduction

Results of Eurobarometer survey for Austria, Spring 2015

What do you think are the two most important issues facing (OUR COUNTRY) at the moment?		
Rank	**Issue**	**Responses in %**
1	Unemployment	33%
2	Immigration	31%
3	Government debt	22%
4	Economic situation	20%
5	Rising prices/inflation	19%
6	Education	14%
7	Health	14%
8	Pensions	11%
9	Environment/Energy/Climate	9%
10	Crime	8%
11	Taxes	6%
12	Terrorism	4%

Source: European Commission, Brussels (2015).

- When "green" or environmental effectiveness **is not enough** for citizens, firms and politicians……

  ….. **economic effectiveness** may be convincing.

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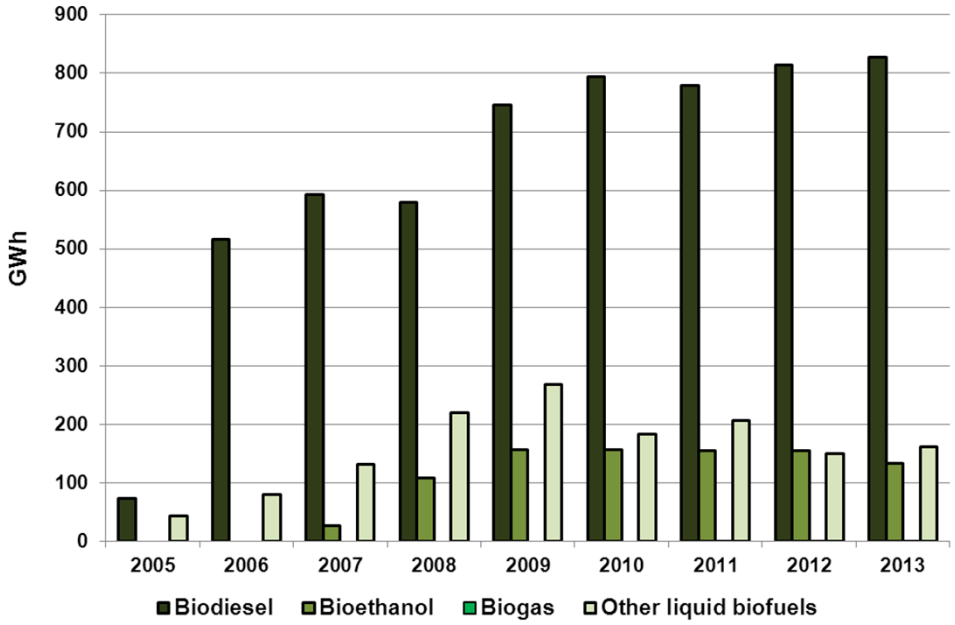
Introduction

Biofuels in the Upper Austrian transport sector



- In the following, a methodology to measure the economic effects of specific energy policies, incl. biofuels, will be presented focusing the Austrian and Upper Austrian level.

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Implementing Biofuels – What does it cost?

Abatement costs and reduction potentials in Upper Austria by the year 2030, focusing on fuel switch measures in the transport sector

Measures	Energy service: transportation	
	Annual GHG reduction costs in €/ton CO_2e	Reduction potential in Upper Austria in 2030 in tons CO_2e
Biogas-powered bus	+45	7,958
Biogas-powered truck	+50	3,316
Biogas-powered passenger car	+206	39,192
Biomass-to-liquid passenger car	+266	115,935
Lignocellulosic-ethanol passenger car	+298	148,649
Biodiesel-powered passenger car	+312	26,616

Source: Schwarz et al. (2012).

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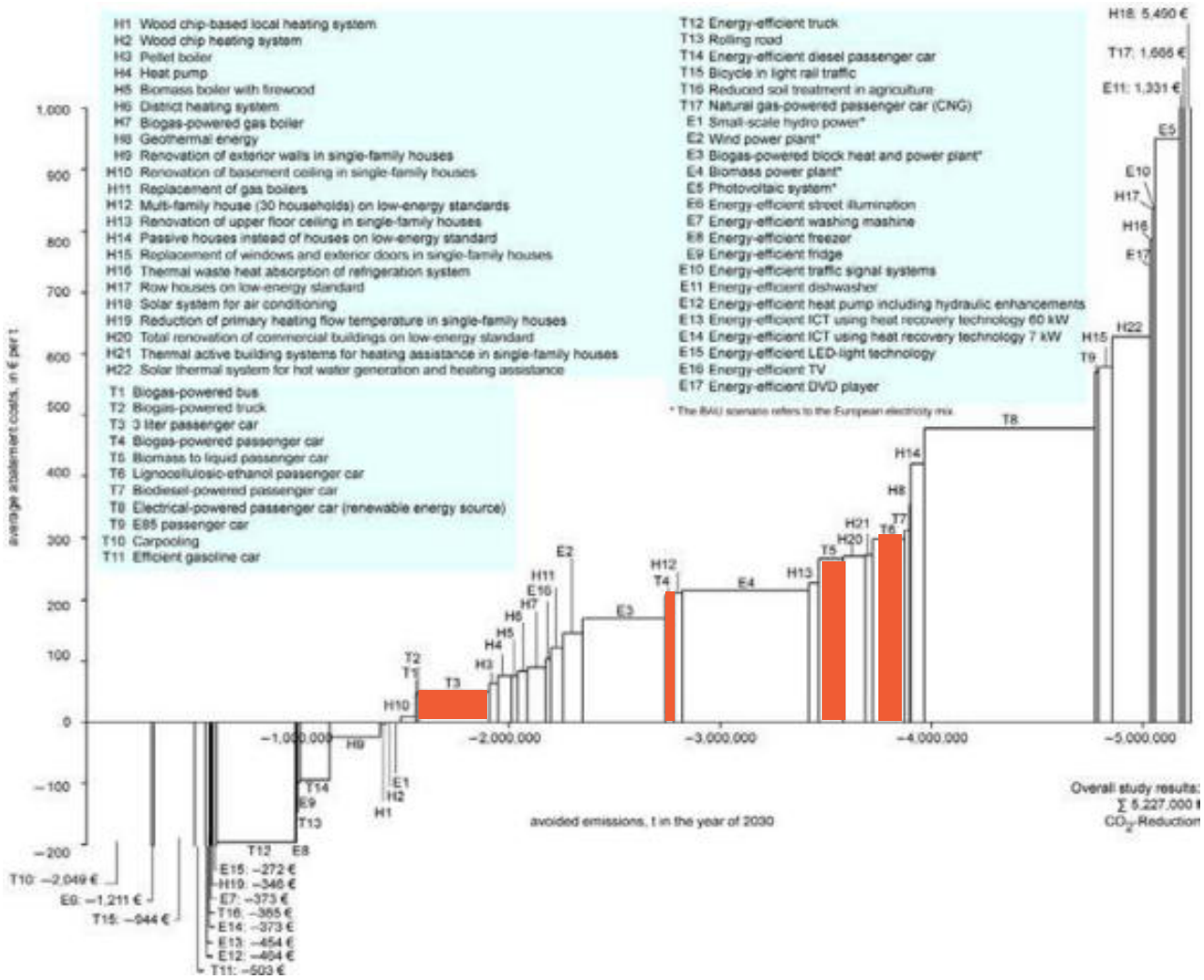
Implementing Biofuels – What does it cost?

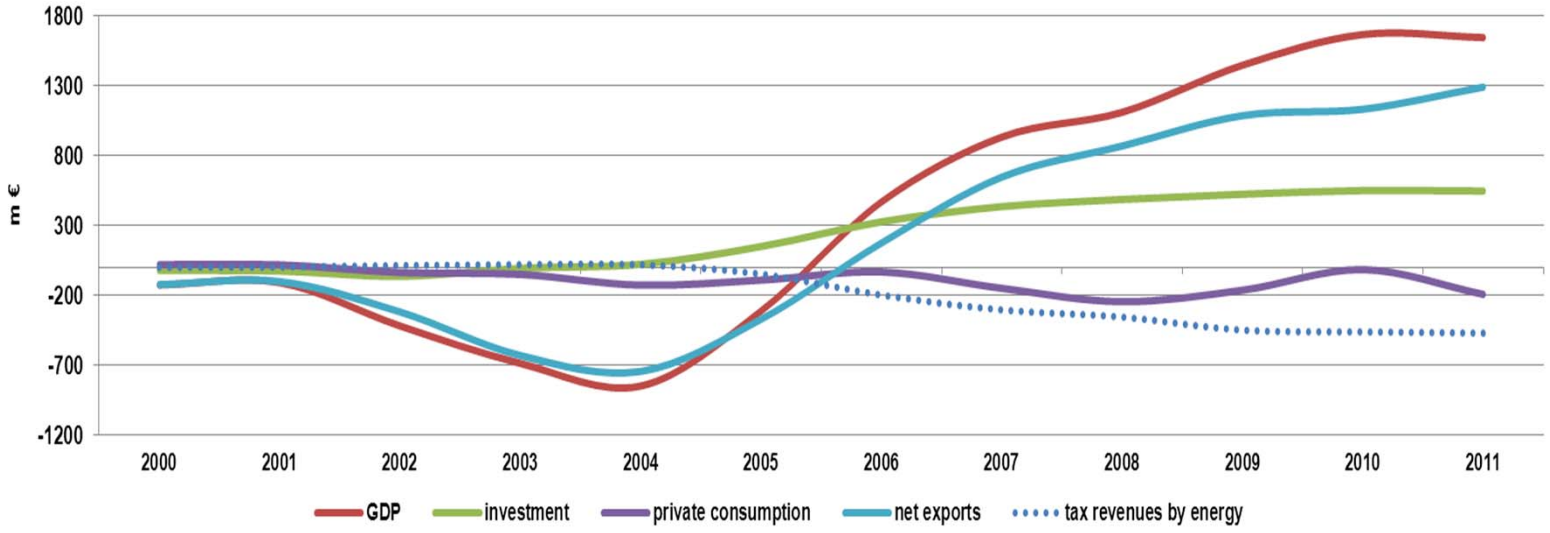


Source: Schwarz et al. (2012).

Renewable Energy – Indirect and dynamic effects

- Direct costs and benefits of renewable energy from a (short term) business perspective often are not convincing.

Quantification of macroeconomic effects by the Austria energy system's changeover from fossil to renewable energy (2000-2011)

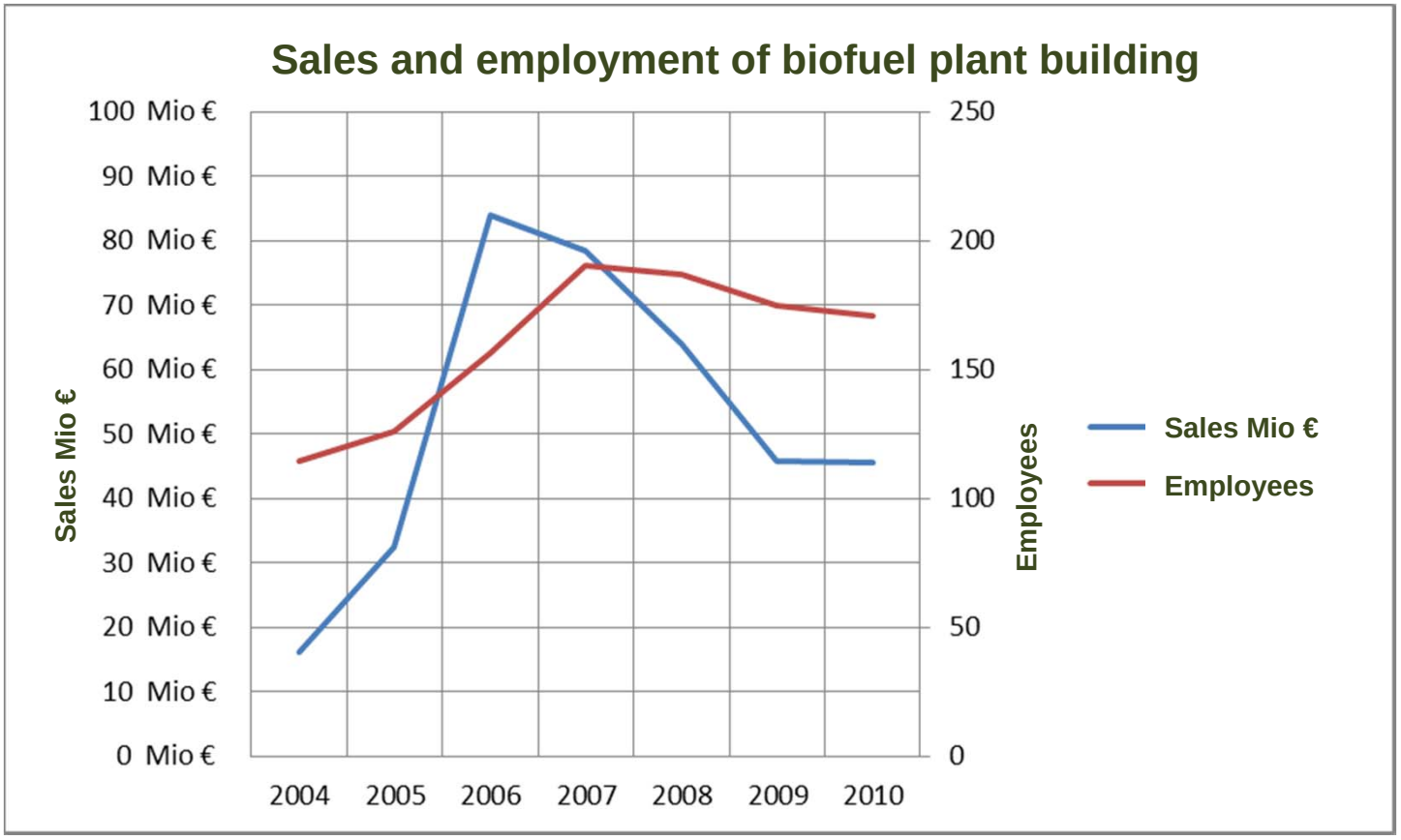


Note: Consumption of private households = energetic + non-energetic consumption. Net exports = (energetic + non-energetic) exports – (energetic + non-energetic) imports. The compensation of lower tax revenues is disregarded in the economic effects.

Source: Bointner et al. (2013).

Renewable Energy – Indirect and dynamic effects

Growth and export potential of renewable energy technologies, Austria



Source: Bointner et al. (2012).

Renewable Energy – Indirect and dynamic effects

Growth and export potential of renewable energy technologies, macroeconomic effects, Austria, 1997-2010

Variable	unit	Effect per year, including secondary effects
GDP	*m €*	3.466
Employees	*persons*	24.700
Investment	*m €*	860
Private consumption	*m €*	581
Net exports	*m €*	2.026

Source: Bointner et al. (2012).

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Renewable Energy – Indirect and dynamic effects

- The production and usage of biofuels generates **significant positive macroeconomic effects** (employment, GDP/GRP) due to
  - investment impulses (plant building, transport technologies…)
  - consumpiton impulses of private households
  - reduction of fossil fuel imports
  - increase of technology exports
  - second- and third-round effects
    - Increase of economic performance

    → Employment level ↑

    → Income ↑

    → Consumption ↑

    → Investment ↑

    → Exports ↑ / Imports ↑

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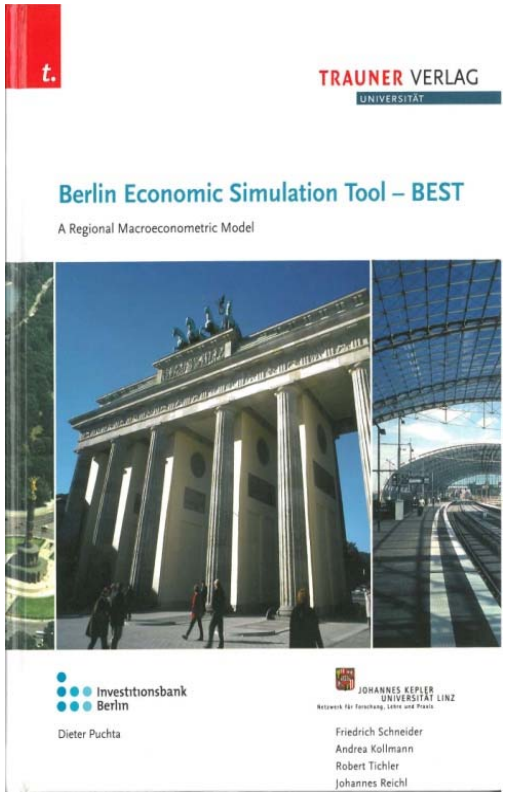
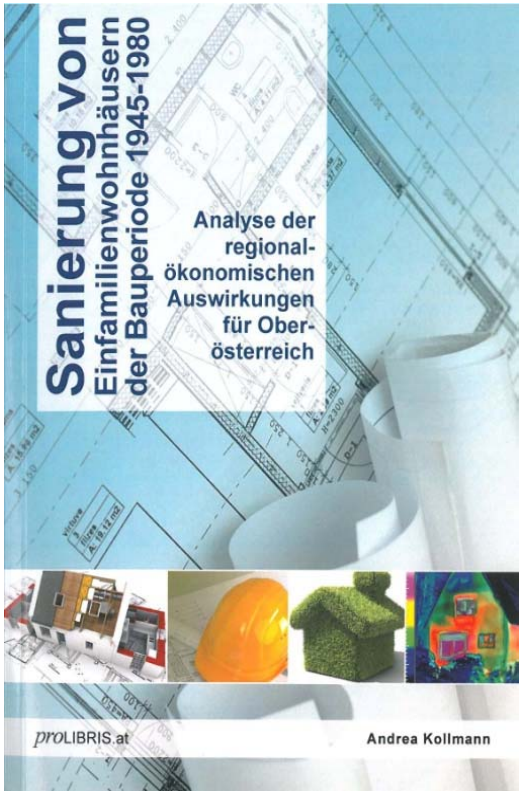
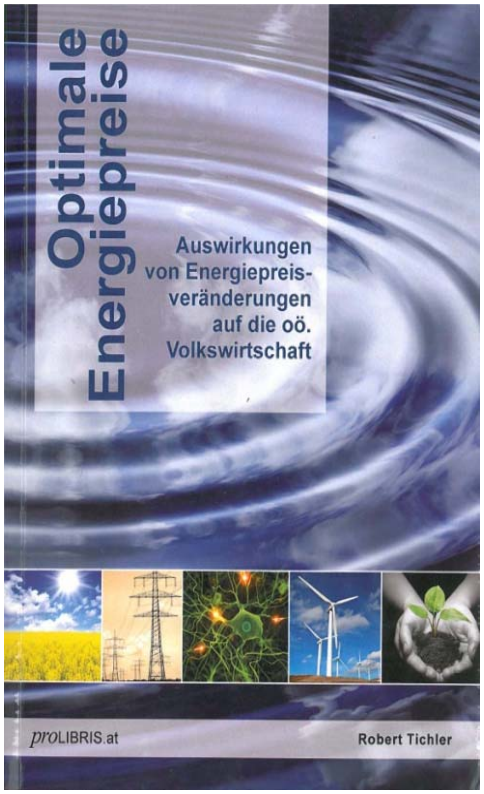
Macroeconometric analyses

- Development of the model MOVE (2004 to 2009)







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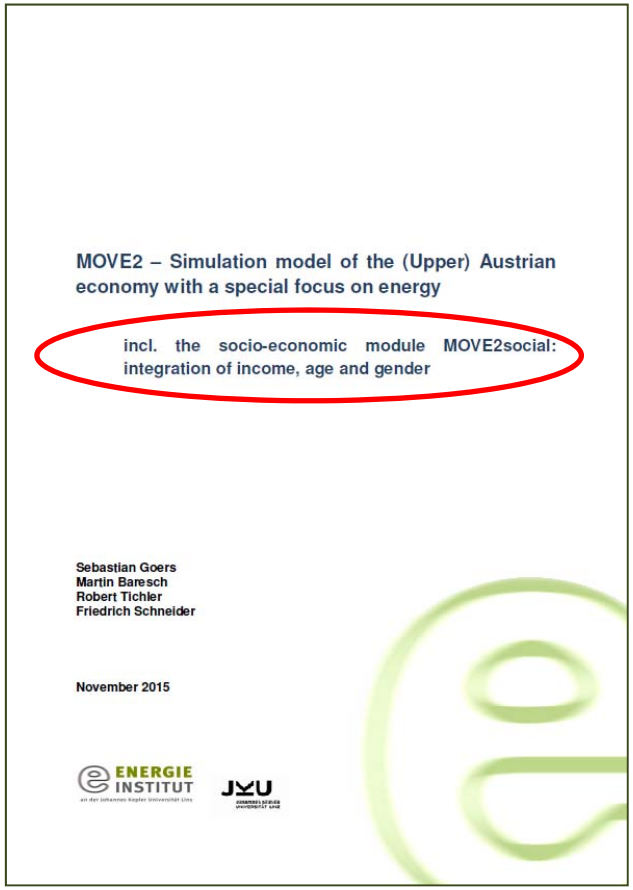
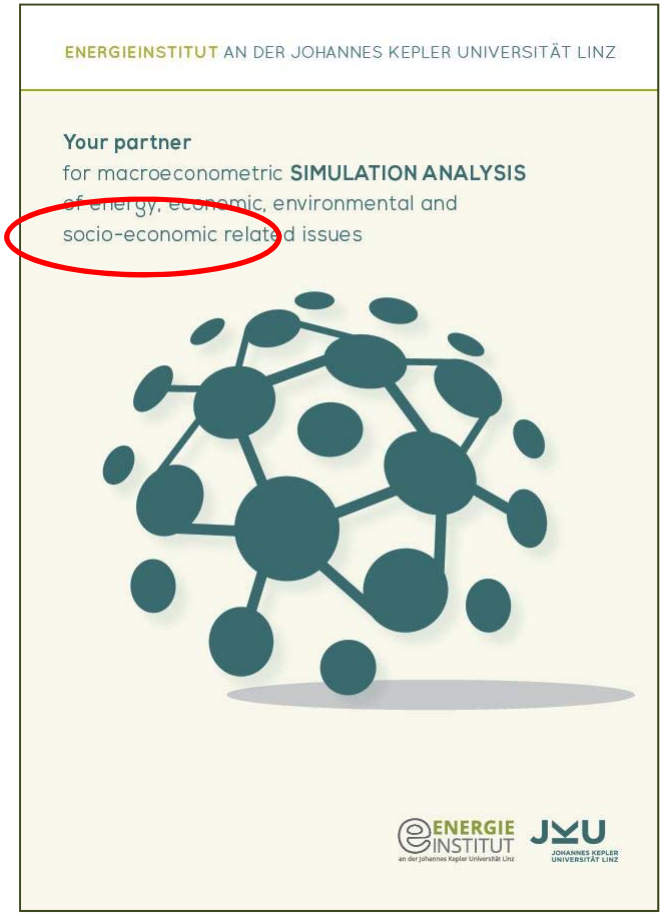
Macroeconometric analyses

- MOVE2 and add-on tool “MOVE2*Social*”:

  Release of **brochure** and **public presentation** in November 2014





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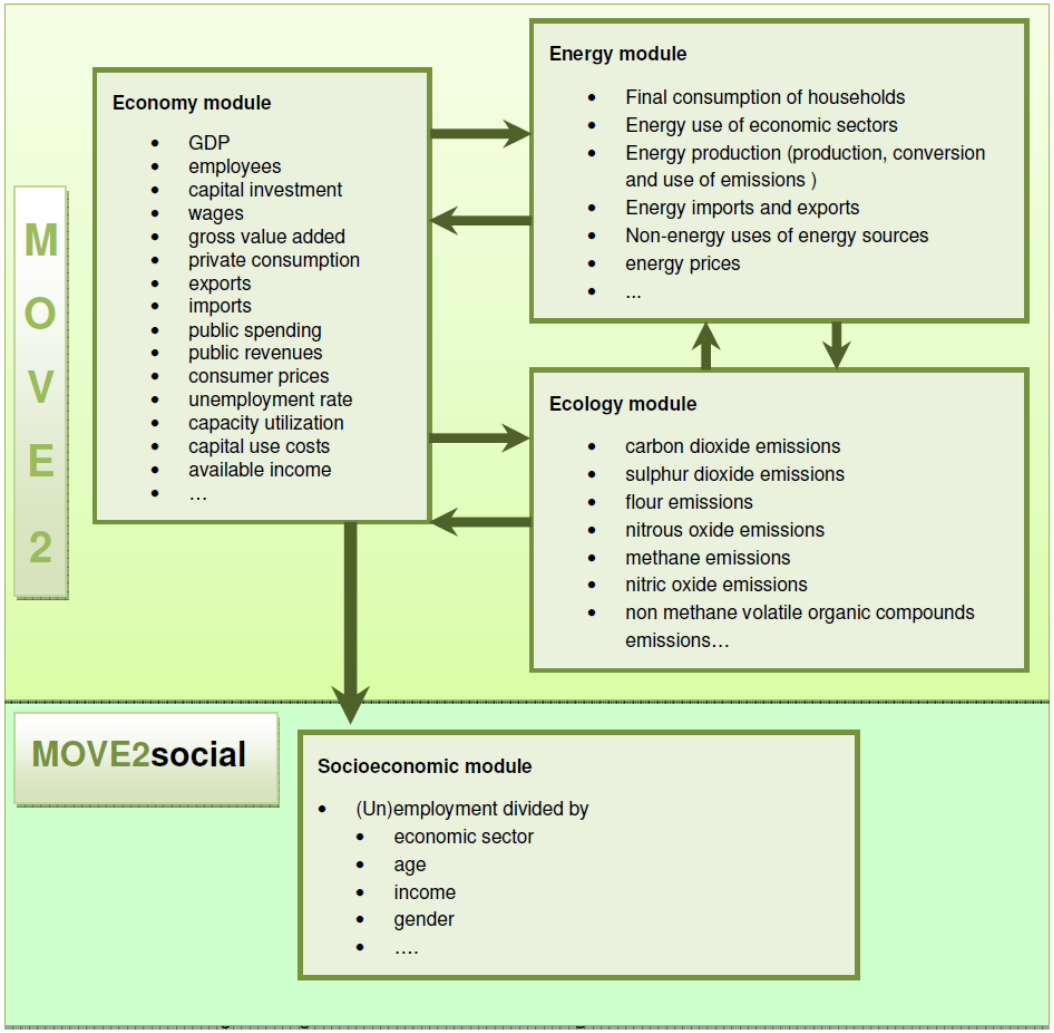
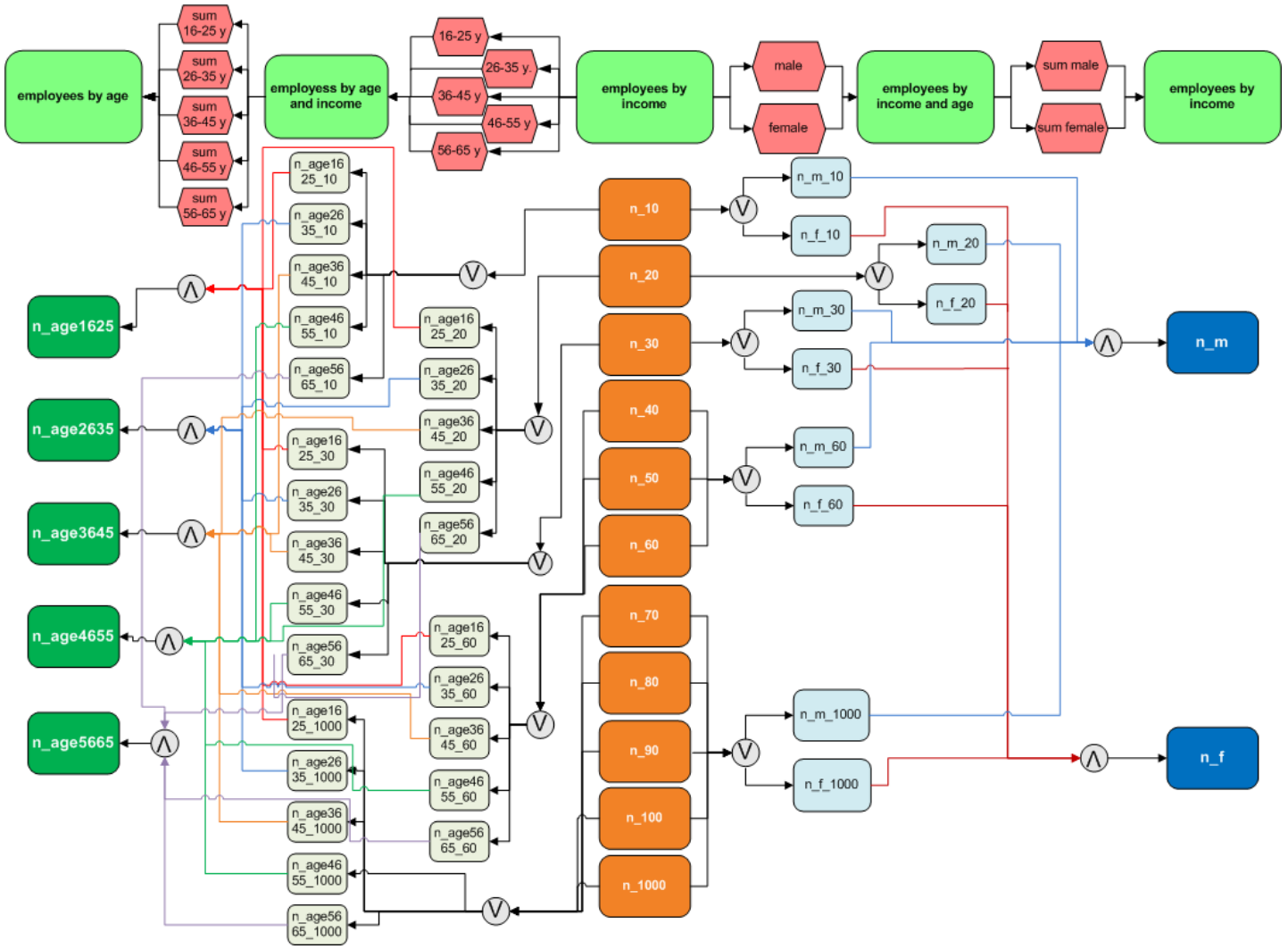
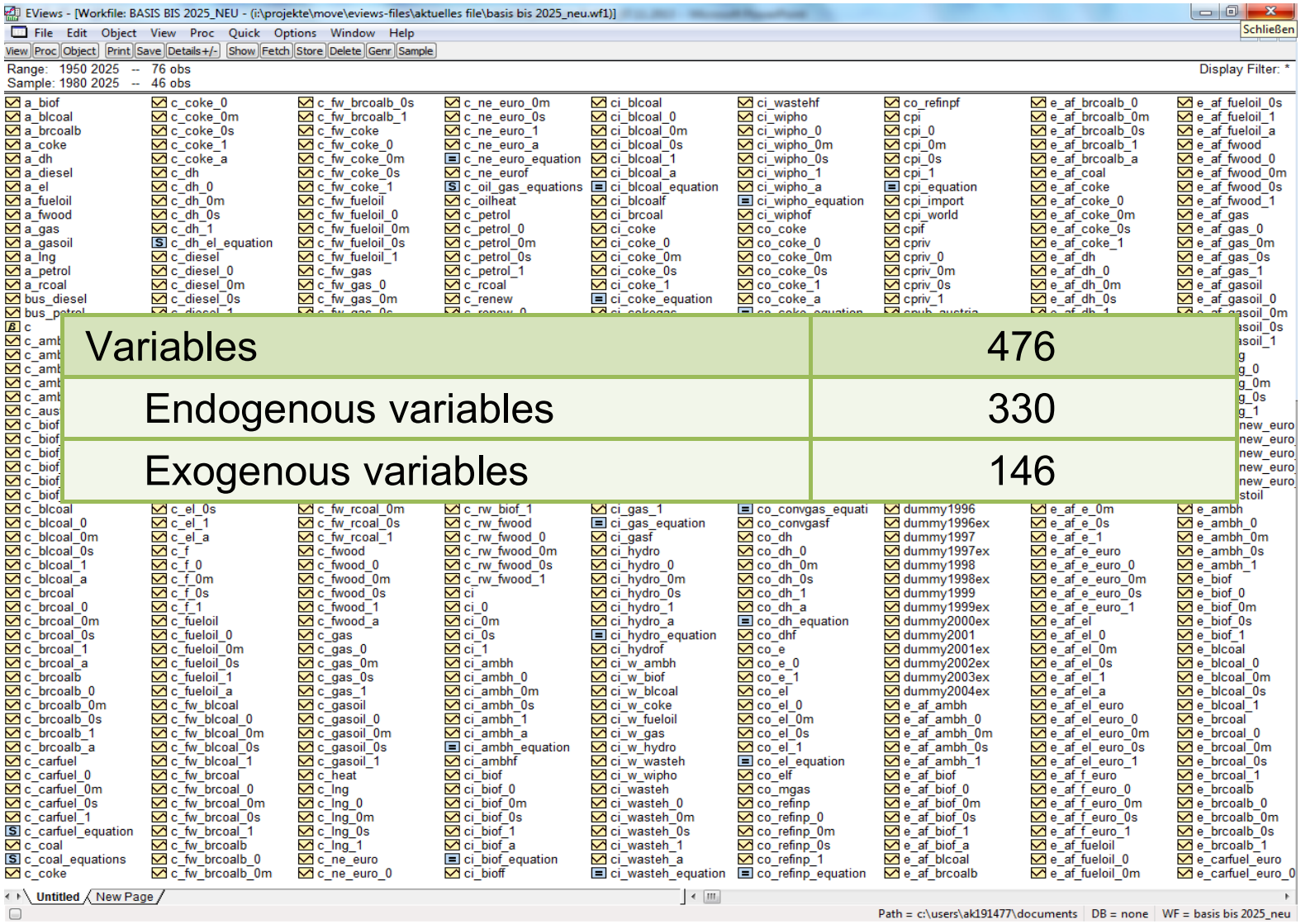
Macroeconometric analyses



Macroeconometric analyses – MOVE2social

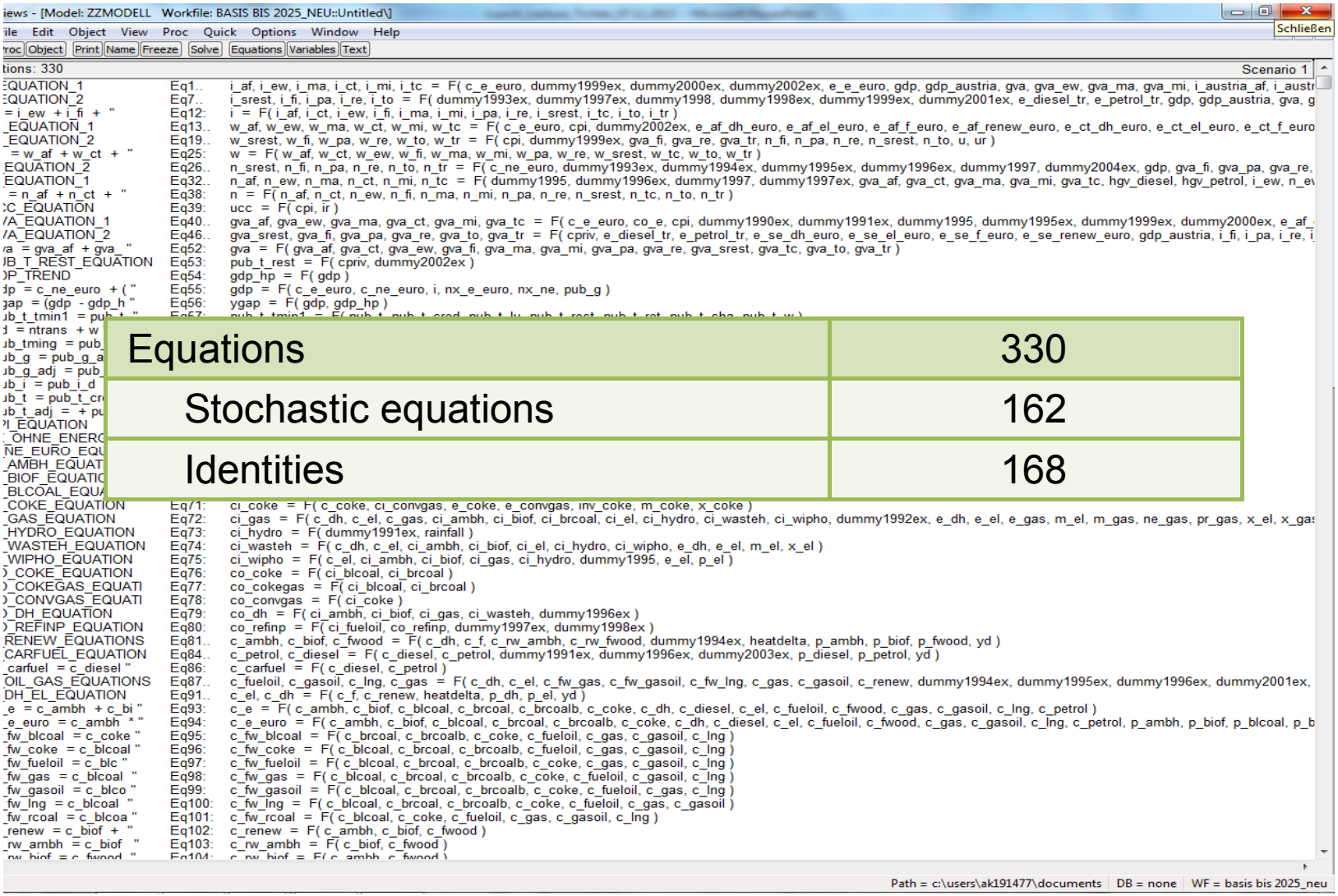


Working with MOVE2



Variables	476
Endogenous variables	330
Exogenous variables	146

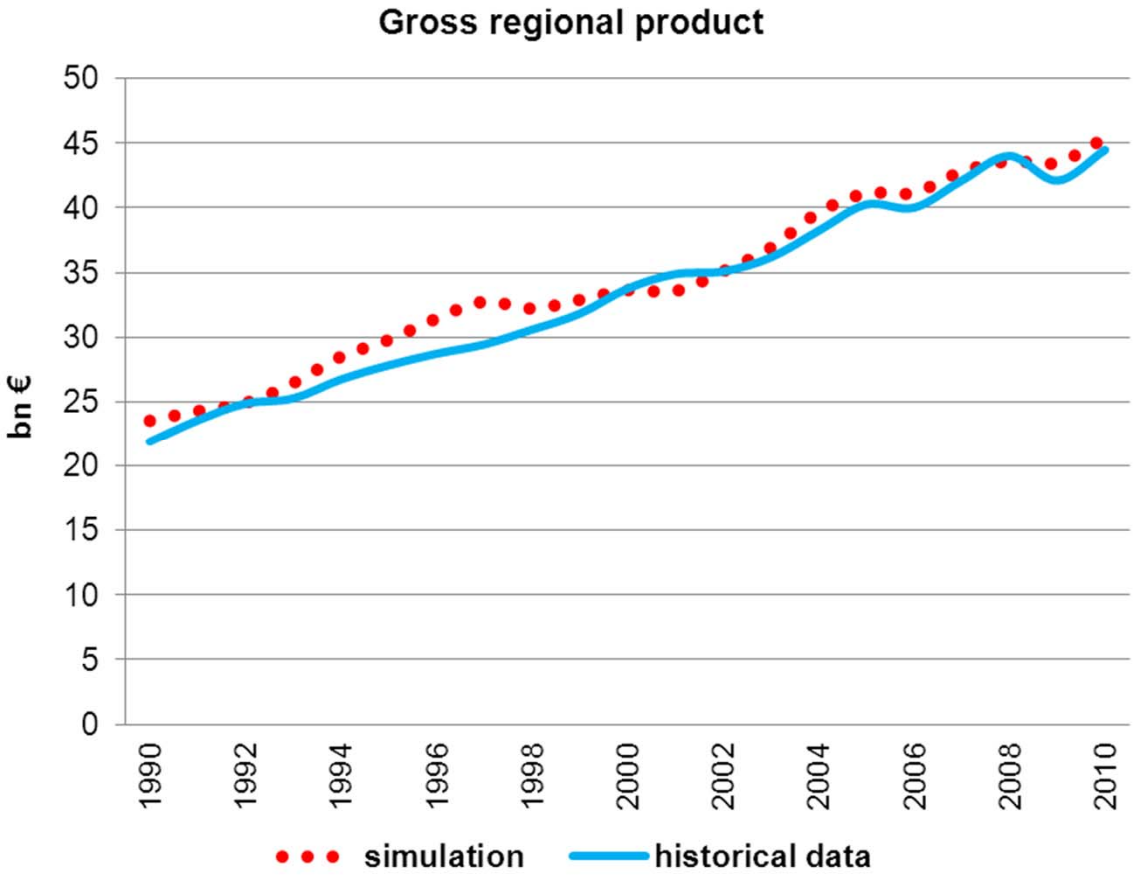
Working with MOVE2



Equations	330
Stochastic equations	162
Identities	168

Working with MOVE2

Historical and simulated (business-as-usual scenario) curves of the variable „Gross Regional Product“



Selective simulation overview

Economic and financial impacts in Austria of a new GHG target in Europe for 2030

Funding body: Federal Ministry of Science, Research and Economy, the Economic Chamber of Austria, the Federation of Austria's Industries and the Interest Group 'Austria's Energy'

Integrated Assessment of Financial Policy Instruments for the Reduction of GHG-Emissions in Road Transport

Funding body: Austrian Climate and Energy Fund
Project Partners: University of Natural Resources and Life Sciences Vienna, Federal Environment Agency, Herry Consult

Economic Analysis of the Program 'Energy Future 2030' of the Upper Austrian Provincial Government

Funding body: Upper Austrian Government
Project Partners:
Energy Economics Group, Technical University Vienna
University of Natural Resources and Life Sciences Vienna

Thank you for the attention!

contact:

Energieinstitut an der Johannes Kepler Universität Linz

Altenberger Straße 69

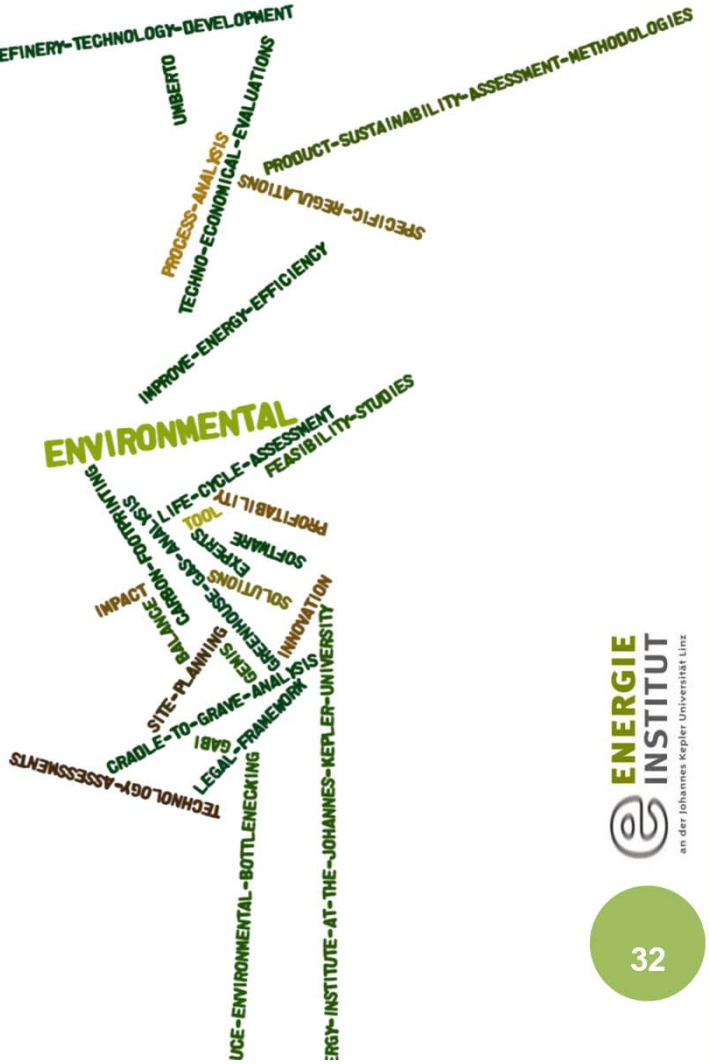
4040 Linz

AUSTRIA

Tel: +43 70 2468 5654

Fax: + 43 70 2468 5651

e-mail: goers@energieinstitut-linz.at



More information on projects are available at the website:

http://www.energieinstitut-linz.at

http://www.energyefficiency.at/

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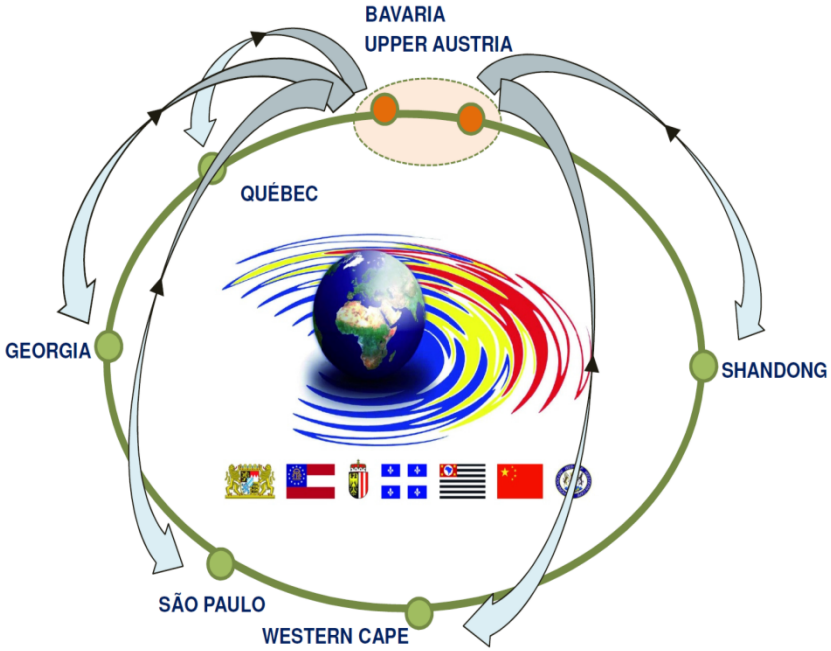
The power regions Bavaria and Upper Austria in the context of hybrid grids

Input from the partner regions Bavaria and Upper Austria

- Scientists of the power regions Bavaria and Upper Austria are planning a cooperation association as a starting point for bilateral and multilateral cooperation which could be open to all partner regions.
- **The nucleus of content is covered by core technologies of the future energy system of the partner regions.**
- ***Future energy system =*** *National, regional and local energy systems are in the transition. There is an increasing need for a new strategy and technologies to address security of energy supply and decarbonisation in both local and global environments.*
- The derivation of differences and similarities of the concepts of an optimal energy supply within the partner regions might offer the possibility to carry out scientific activities and transfers.

Input from the partner regions Bavaria and Upper Austria



Source: Florence Gauzy, Regional Leaders Summit – Energy Workshop, Cape Town, March 2014

How is an optimal energy system defined in each partner region?

Which differences arise?

Which technologies can be transferred (in the context of biofuels?)

Which bilateral and multilateral cooperation arise?

The power regions Bavaria and Upper Austria in the context of hybrid grids

- Several studies, which are illustrating 100 % scenarios of renewable energies, are referring to a strong connection between power, gas and heat. This leads automatically to hybrid networks in order to reuse losses in one energy system as sources in the other one.

"A hybrid network refers to a through (new) interface technologies strongly connected / integrated power system of various energy networks (eg electricity, gas, heat) which are bidirectionally coupled."

The power regions Bavaria and Upper Austria in the context of hybrid grids

- Basically, the following overall objectives are connected with the establishment of hybrid grids:
  - **increase of the resource efficiency** (incl. the optimization of production and consumption, increasing the load shift potential in the energy system
  - **storage of fluctuating energy**
  - **new transportation options** in the energy system
  - **new transformation options**
  - **reduction of network expansion costs or stranded investments**

The power regions Bavaria and Upper Austria in the context of hybrid grids

- However, it is important for the establishment of hybrid grids that the power nodes (transition from one to another grid) are available and work accurately. Such technologies or technology components are, for example,
  - **electrolysis plants** for producing hydrogen from water
  - **storage of hydrogen in gas storages**
  - **methanation** as a part of Carbon Capture and Utilization (**CCU**)
  - high temperature **heat pumps**
  - seasonal **thermal storage** for the integration of **waste heat**
  - **battery storage**
  - installations for the **recovery of biogenic waste materials** for the production of electricity, heat and fuels
  - **information and communication infrastructure**

Energy Institute Linz

- **Energy Cell** (PEM fuel cell and hydrolyser) as a basis for the self-sufficient energy supply of households and as a way to integrate wind and solar power in the mobility sector - ***Fronius***
- **Underground Sun Storage** (storage of 10% hydrogen, together with methane in a pore storage) - ***RAG***
- Seasonal thermal storage integrating waste heat - ***Linz AG, voestalpine***
- Increased **production of biogas from organic waste** in a two-stage fermentation process by integrating electrolysis and methanation
- Analysis of system components (photovoltaic, battery storage, thermal storage, P2G plants) in a hybrid system as an important component in the transition to a **Smart City**
- **Smart meter offensive:** More than 140,000 smart meters and load switching devices were the end of 2014 in real use. As of October 2014, the roll-out with another 300,000 meters was continued – ***Energie AG***
- The Upper Austrian funding scheme supports the use of **stationary battery storage systems together with a photovoltaic system** and aims at the market and technology development of battery storage systems. The province of Upper Austria provides impulse funds around € 600,000. Hence, around 200 stationary solar storage can be promoted.

Technology Center for Energy (TZE), University of Applied Sciences of Landshut

- Realisation of a **Competence Centre for Energy Storage** together with the **University of Applied Sciences of Upper Austria** (EU-Project CompStor, about 6.6 Mio. € of investment in two laboratory locations on both sides of the Bavarian-Austrian border)
- **Integration of several battery technologies** (e. g. Redox-Flow batteries, modern Lithium-technologies, saltwater batteries, ...) into the business infrastructure and testing environment of the **Technology Centre for Energy (TZE)**
- Creating test capacities to investigate the parameters **of storage systems which are intended for the use in houses, small industries and local grids**.
- Developing a **test plant** for the investigation of a **hybrid-system**, consisting of CHP and Photovoltaics, coupled with heat- and powerstorage systems, covered with an intelligent control system for ressource-efficient operating.
- Laboratory cell assembly line for research on key technologies of all steps of **Lithium cell production** and of all materials needed therefore.
- **Low-temperature Methane separation and liquefacation**.
- Developing a **research platform for Flow Batteries**, i.e. Redox-Flow Systems, together with the Czech Institute NTC (New Technologies Centre) of University Pilsen/Prag.
- Research on **developing energy efficient systems** (housing and production), with strong coupling to the usage of energy management systems

The power regions Bavaria and Upper Austria in the context of hybrid grids

Contact:

Upper Austria

Dr. Horst Steinmüller
CEO, Energy Institute Linz
steinmueller@energieinstitut-linz.at

Dr. Sebastian Goers
Senior Researcher (Department of Energy Economics), Energy Institute Linz
Scientific coordinator of Upper Austria – RLS Energy Network
goers@energieinstitut-linz.at

Bavaria

Dr. Reinhart Schwaiberger
CEO, Technology Center Energy
University of Applied Sciences Landshut
reinhart.schwaiberger@haw-landshut.de

MOVE - Overview

Characteristics of MOVE:

Number of sectors (including private households)	13
Number of energy sources:	24
Preferred time frame for simulations	1-10 years

Covered energy sources:

ambient heat	combustible turf	fuel oil (heavy)	orher refinery inputs
biogenic fuel	crude oil	fuel oil (light)	petrol
brown coal	diesel	hydro power	solar and wind power
coal briquets	district heat	kerosene	stack gas
coke	electric power	liquefied gas	stone coal
coke oven gas	fire wood	natural gas	waste

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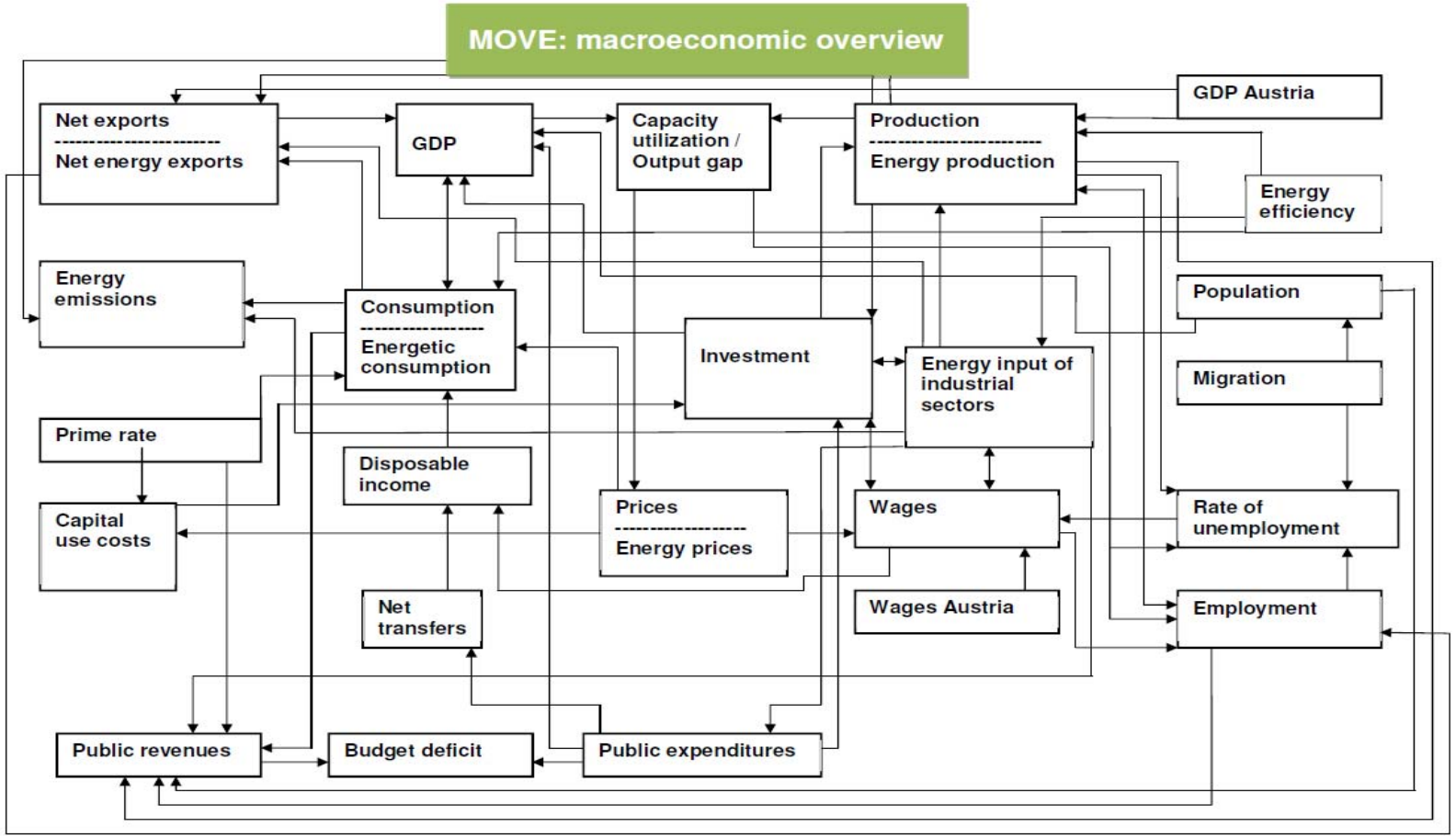
MOVE - Overview

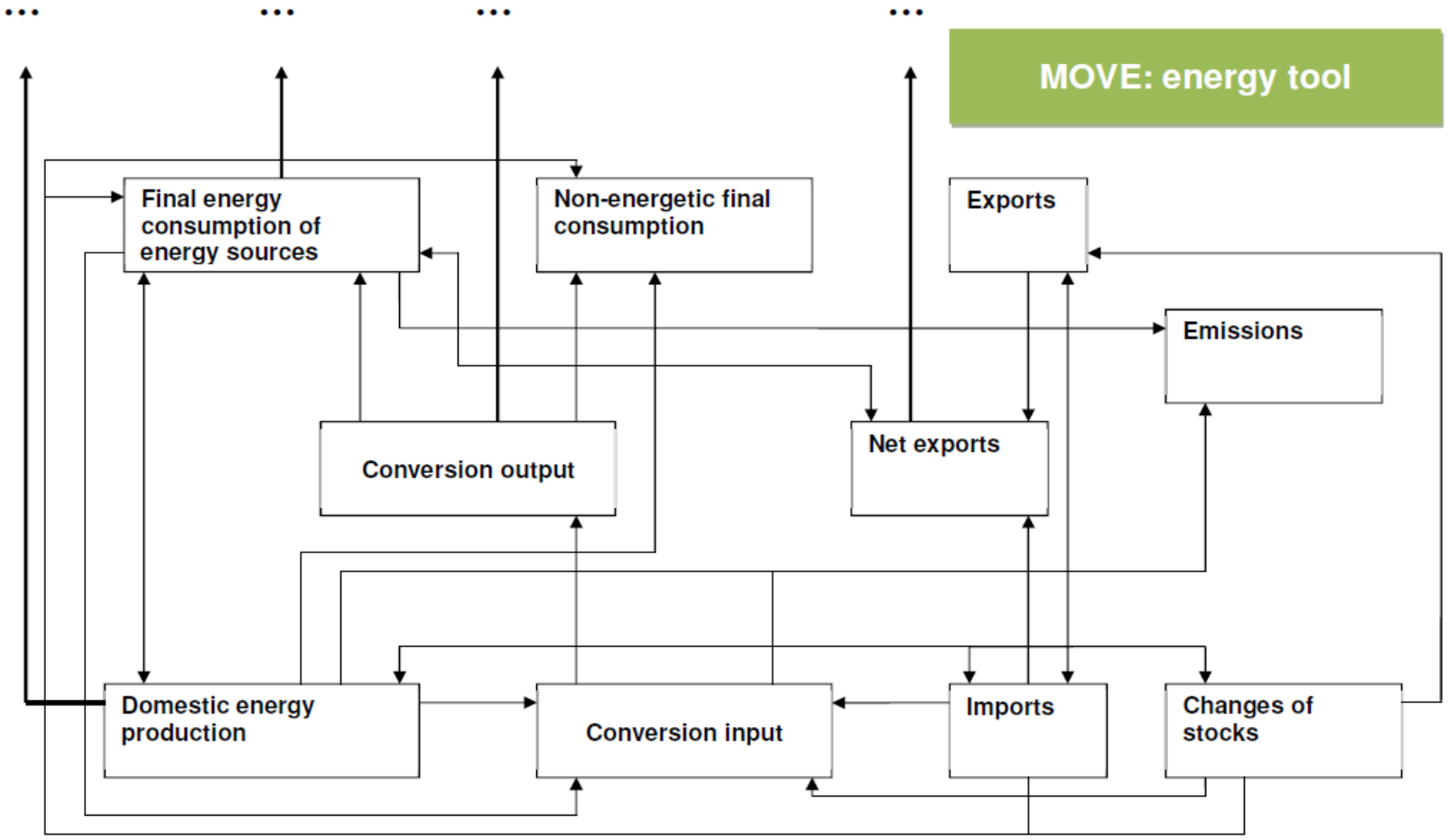
MOVE-Model: Economic module



Source: Kollmann (2009), Tichler (2009)

MOVE - Overview

MOVE-Model: Energy module



Source: Kollmann (2009), Tichler (2009)

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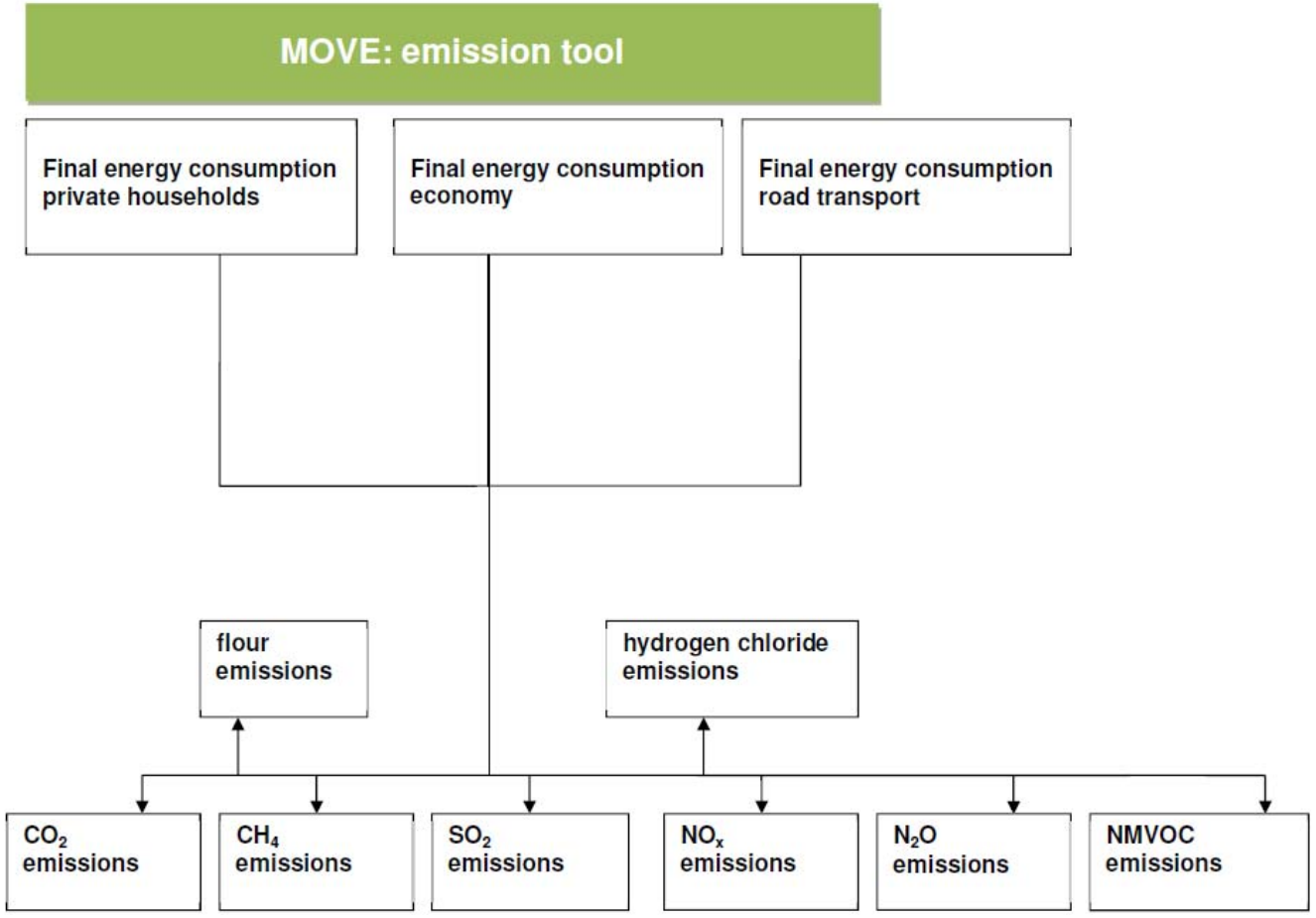
MOVE - Overview

MOVE-Model: Ecologic module



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