



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



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
- Output 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

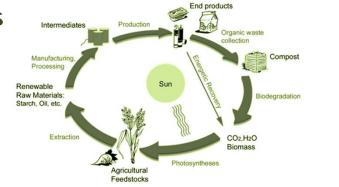
(from raw materials to disposal)

Cradle-to-gate analysis

(from raw material to end of production)

Gate-to-gate analysis (production facility)

- Resource availability analysis
- Site planning

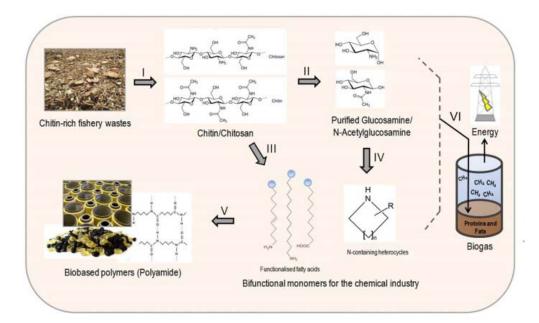


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EU-Project *ChiBio*: Development of an integrated biorefinery for processing chitin rich biowaste to specialty chemicals.

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

ChiBio

- 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

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ChiBio

EU PROJECT SUNLIQUID

CELLULOSIC ETHANOL MADE FROM AGRICULTURAL RESIDUES



EU PROJECT SUNLIQUID

CELLULOSIC ETHANOL MADE FROM AGRICULTURAL RESIDUES

PROJECT PROFILE

Project	SUNLIQUID (sunliquid $\ensuremath{\mathbb{R}}$ 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% CO₂ 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!

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



Introduction

What do you think are the two most important issues facing (OUR COUNTRY) at the moment?							
Rank							
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%					

Results of Eurobarometer survey for Austria, Spring 2015

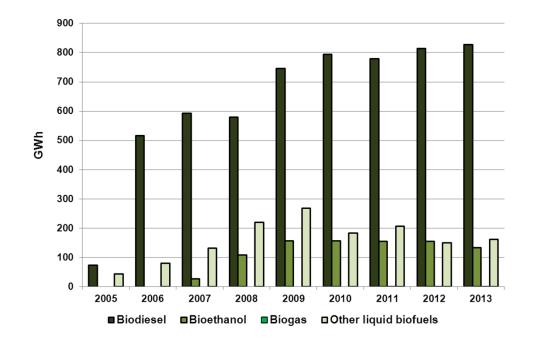
Source: European Commission, Brussels (2015).

When "green" or environmental effectiveness is not enough for citizens, firms and politicians...... 16

..... economic effectiveness may be convincing.

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. **ENERGIE** INSTITUT

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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

	Energy service: transportation			
Measures	Annual GHG reduction costs in €/ton CO ₂ e	Reduction potential in Upper Austria in 2030 in tons CO ₂ e		
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		

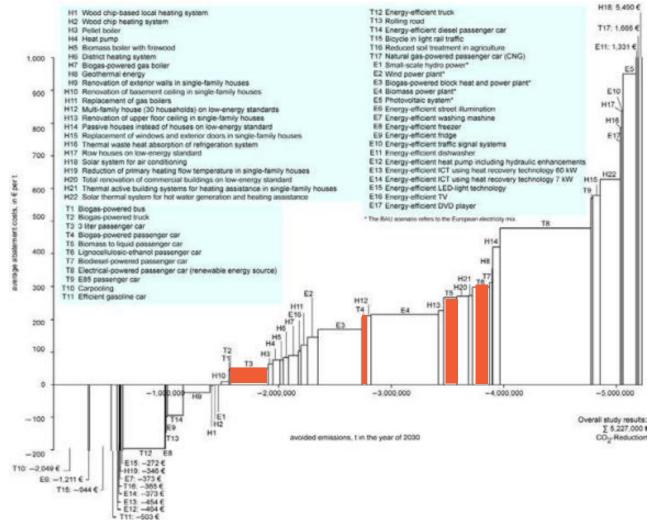
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Source: Schwarz et al. (2012).

Implementing Biofuels – What does it cost?



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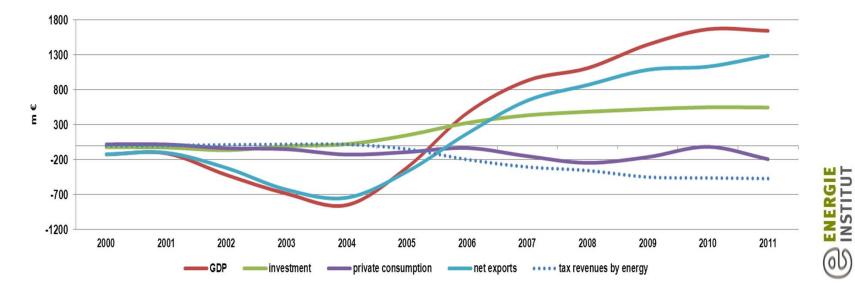
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Source: Schwarz et al. (2012).

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

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



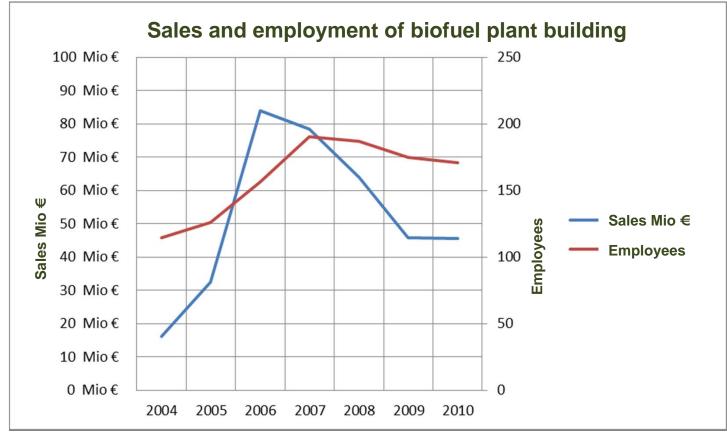
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Note: Consumption of private households = energetic + non-energetic consumption. Net exports = (energetic + non-energetic) exports – (energetic + non-energetic) imports. The compensation of lower tax revenues is disregarded in the economic effects.

Source: Bointner et al. (2013).

Growth and export potential of renewable energy technologies, Austria

21



Source: Bointner et al. (2012).

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).

an der Johannes Kepler UNIVERBELLITE

The production and usage of biofuels generates significant positive macroeconomic effects (employment, GDP/GRP) due to

investment impulses (plant building, transport technologies...)

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- <u>consumpiton</u> impulses of private households
- reduction of fossil fuel imports
- lincrease of technology exports
- Second- and third-round effects
 - □ Increase of economic performance
 - \rightarrow Employment level \uparrow
 - $\rightarrow \text{Income} \uparrow$
 - \rightarrow Consumption \uparrow
 - \rightarrow Investment \uparrow
 - \longrightarrow Exports \uparrow / Imports \uparrow



Macroeconometric analyses

Contract Provide the Model Move (2004 to 2009)



Macroeconometric analyses

MOVE2 and add-on tool "MOVE2Social":

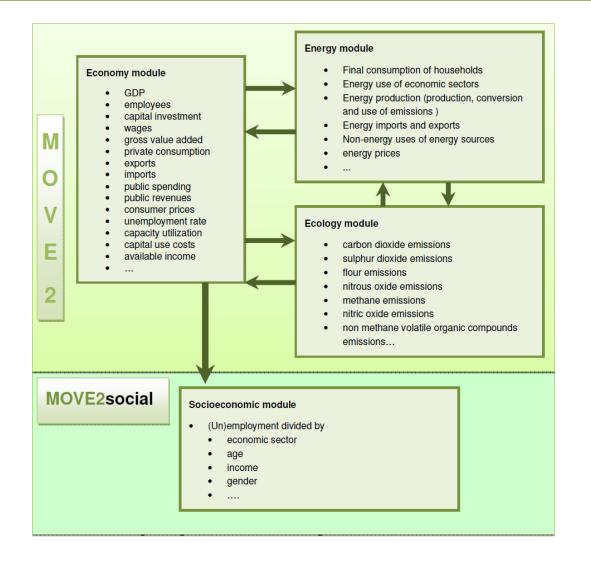
Release of **brochure** and **public presentation** in November 2014



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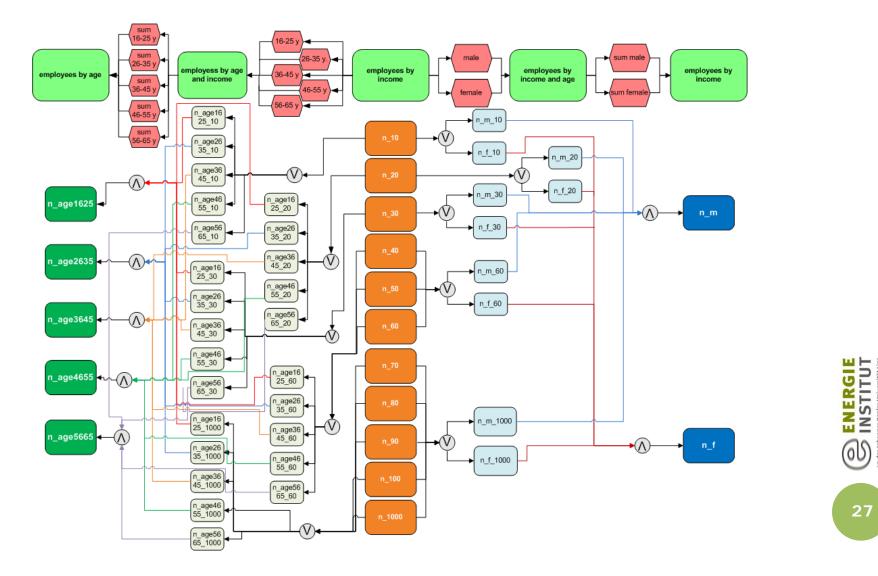
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Macroeconometric analyses





Macroeconometric analyses – MOVE2social



Working with MOVE2

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Working with MOVE2

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Equations	330
Stochastic equations	162
Identities	168
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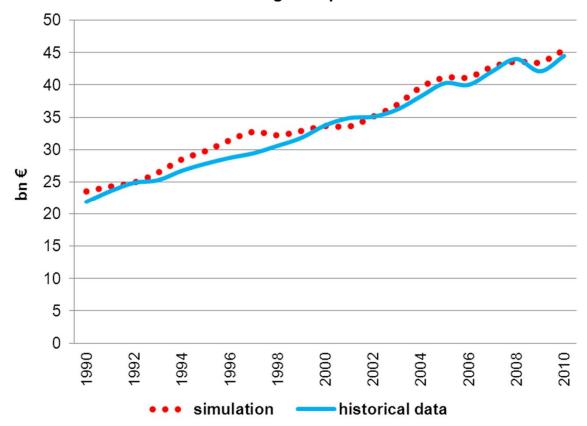
Working with MOVE2

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

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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

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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:

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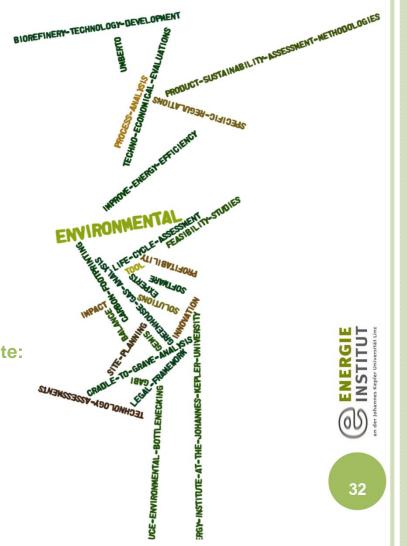
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Fax: + 43 70 2468 5651

e-mail: goers@energieinstitut-linz.at

More information on projects are available at the website:

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











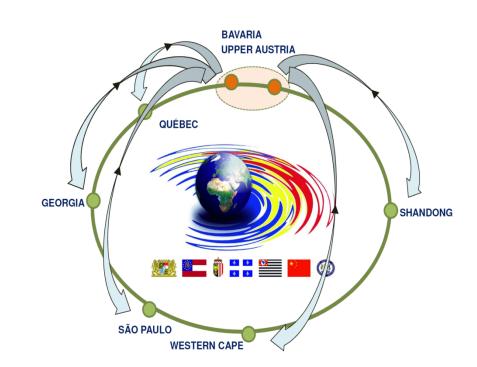
Input from the partner regions Bavaria and Upper Austria

- 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.
- In 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.
- In 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?





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."



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Basically, the following <u>overall objectives</u> are connected with the establishment of <u>hybrid grids</u>:

- 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
- In the energy system
 In the energy system
- e new transformation options
- reduction of network expansion costs or stranded investments



Be However, it is important for the establishment of hybrid grids that the <u>power nodes</u> (transition from one to another grid) are available and work accurately. Such technologies or technology components are, for example,

le electrolysis plants for producing hydrogen from water

E storage of hydrogen in gas storages

e methanation as a part of Carbon Capture and Utilization (CCU)

le high temperature heat pumps

less seasonal thermal storage for the integration of waste heat

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le 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



TECHNOLOGIEZENTRUM ENERGIE

- Realisation of a <u>Competence Centre for Energy Storage</u> 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



Contact:

Upper Austria

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<u>Bavaria</u>

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



Characteristics of MOVE:

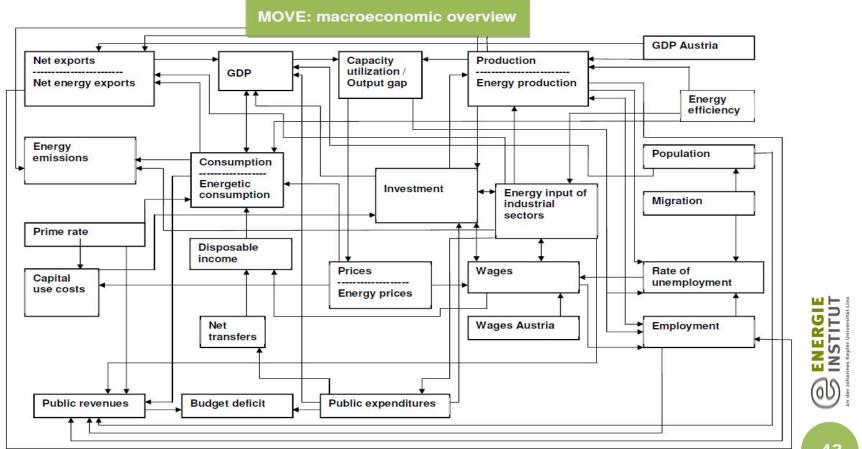
Number of sectors (including private households)	13
Number of energy sources:	24
Preferred time frame for simulations	1-10 years

Covered energy sources:

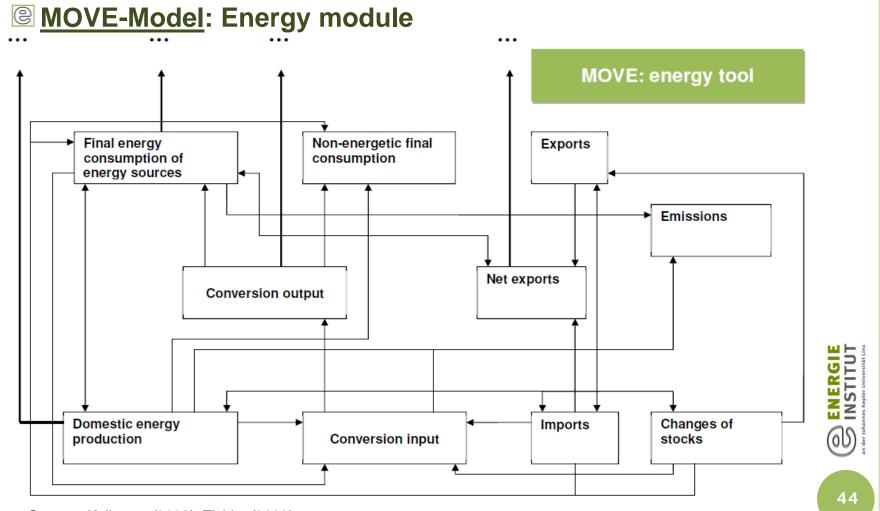
ambient heat	combustible turf	fuel oil (heavy)	orher refinery inputs
biogenic fuel	crude oil	fuel oil (light)	petrol
brown coal	diesel	hydro power	solar and wind power
coal briquets	district heat	kerosene	stack gas
coke	electric power	liquefied gas	stone coal
coke oven gas	fire wood	natural gas	waste

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MOVE-Model: Economic module

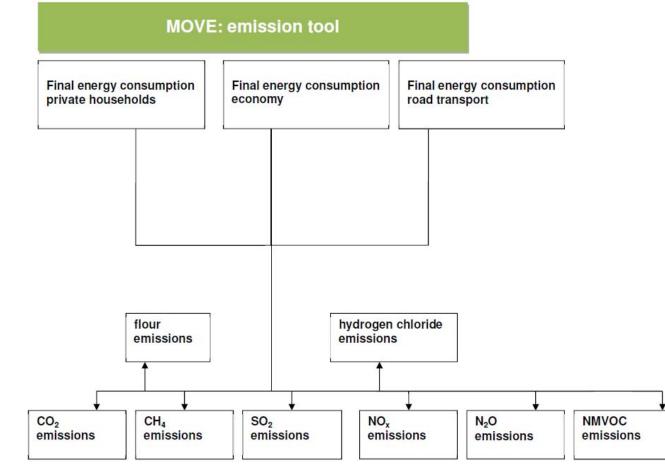


Source: Kollmann (2009), Tichler (2009)



Source: Kollmann (2009), Tichler (2009)

<u>MOVE-Model</u>: Ecologic module



Source: Kollmann (2009), Tichler (2009)

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