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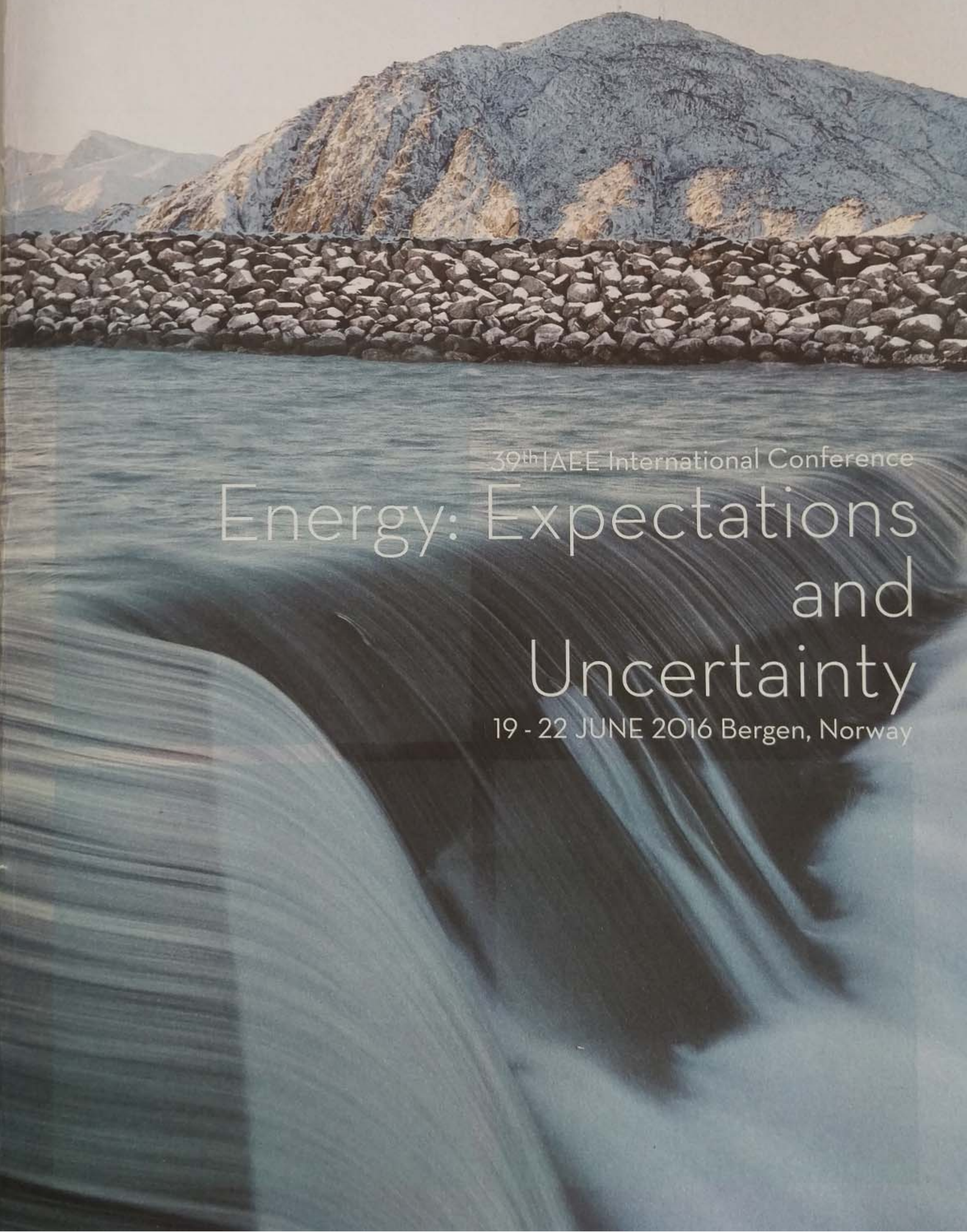


39th IAEE International Conference

Energy: Expectations and Uncertainty

19 - 22 JUNE 2016 Bergen, Norway

6. Intermittent Renewable Electricity Generation (Aud. Jan Mossin)

Thomas Leautier, *Presiding*
TSE Researcher, Toulouse School of Economics

Comparative Scenarios in Islanded Systems: Energy Supply-storage Sizing Problem Applied to Electricity and Mobility
Rodica Loisel
Lionel Lemiale
Université de Nantes, *IEMN-IAE*

Solar, Wind and Market Power in a Hydro Based Grid
Stephen Poletti
Mina Gholami
University of Auckland

Impact of Variable Renewable Energy Production on Electricity Prices Through a Modeling Approach
Cyril Martin de Lagarde
Anna Creti
Université Paris-Dauphine
Christophe Bonnery
ERDF
Frédéric Lantz
IFP EN, IFP School

Electricity Storage and Flexibility Requirements on the Road to Decarbonization in European Electricity
Clemens Gerbaulet
Casimir Lorenz
TU Berlin

Estimating Emissions Offsets of Intermittent Renewable Energy
Miguel A Castro
Michigan State University

7. Financial Risk and Electricity Markets (Aud. Agnar Sandmo)

Patrick Narbel, *Presiding*
Partner, ADAPT Consulting AS

Financial Arbitrage and Efficient Dispatch in Wholesale Electricity Markets
John E Parsons
MIT Sloan School of Management
Cathleen Colbert
California ISO
Erin Mastrangelo
Jeremy Larrieu
Taylor Martin
FERC

Zero-Variable Cost Power Systems: Implications for Electricity Market Design and Capacity Investments
Jesse D Jenkins
Nestor Sepulveda
Massachusetts Institute of Technology
Fernando J de Sisternes
Argonne National Laboratory

Risk Exposure in Electricity Markets: The Need for Intra-day Hedging
Raphael Homayoun Boroumand
Associate Professor of Economics, PSB Paris School of Business

Market and Policy Risks for VRE Investment and their Impacts on Effectiveness and Efficiency of RES-E Policy Targets - An Agent-Based Modelling Approach
Matthias Reeg
German Aerospace Center (DLR) - Systems Analysis and Technology Assessment

The Corporate Social Responsibility of Hydropower Companies in Alpine Regions - A Welfare-economic Approach
Werner Hediger
HTW Chur

8. Innovations and Technologies (Aud. Terje Hansen)

Roger Fouquet, *Presiding*
Professor, Grantham Research Inst LSE

Life Cycle Analyses of End-User Electricity Generation in Ten Major European Countries
Gorkem F Uctug
Gizem Alevli
Bahcesehir University

The Welfare Effects of Energy Services and Technologies (1700-2010)
Roger Fouquet
London School of Economics and Political Science (LSE)

Technology Implications for an Integrated European Bioeconomy
Fabian Schipfer
Reinhard Haas
Lukas Kranzl
Energy Economics Group

Structuring Public Support for Radical Low-Carbon Innovation in the Materials Sector: Bridging the Valley of Death
Vera Zipperer
Karsten Neuhoff
DIW Berlin
Gregory Nemet
University of Wisconsin-Madison

Multinational Innovation, Product Life Cycles and Intellectual Property Rights Protection: Which is the Best Place to Invent Something?
Giulia Valacchi
IHEID

9. IAEE Best Student Paper Award Session (Aud. 24)

Knut Einar Rosendahl, *Presiding*
Professor, Norwegian Univ. of Life Science

Carbon Taxes, Oil Monopoly and Petrodollar Recycling
Waldemar Marz
Johannes Pfeiffer
IFO Institute for Economic Research at the University of Munich

Estimating the Potential for Electricity Savings in Households
Nina Boogen
ETH Zurich, Center of Economic Research (CER-ETH)

Reliability, Congestion and Investment in Electricity Transmission
Marten Ovaere
KU Leuven, Department of Economics

How to Sell Renewable Electricity - Interactions of the Intraday and Day-Ahead Market Under Uncertainty
Frank Obermüller
Andreas Knaut
Institute of Energy Economics, University of Cologne

10. Heat and Electricity (Aud. 23)

Benjamin Schlesinger, *Presiding*
President, Benjamin Schlesinger & Assoc LLC

CHP Plant Operation and Electricity Market Prices - Analytical Insights and Large-Scale Model Application
Björn Felten
Research Associate, University of Duisburg-Essen

Residential Energy Efficiency and European Carbon Policies: A CGE-analysis with Bottom-up Information on Energy Efficiency Technologies
Orvika Rosnes
Brita Bye
Taran Fæhn
Statistics Norway

Endogenous Power and Heat Generation Modelling in various CHP Plant Types
Andreas Bloess
DIW Berlin

Status-quo Bias and Consumers' Willingness to Pay for Green Electricity: A Discrete Choice Experiment With Real Economic Incentives
Fabian Grabicki
Roland Menges
Clausthal University of Technology

Technical-Economic Potential of PV Systems on Colombian Residential Sector
Rosa Esperanza González Mahecha
André Lucena
Alexandre Szklo
Raul Miranda
PPE/COPPE
Ferreira Paula
Universidade do Minho

11. Prospects for Nuclear Power (Aud. 22)

Christian von Hirschhausen, *Presiding*
Professor, TU Berlin

Phasing Out Nuclear Power in Europe
Rolf Golombek
Hilde H Le Tissier
Frisch Centre
Finn R Aune
Statistics Norway

Ambiguity Aversion and the Expected Cost of Rare Energy Disasters: An Application to Nuclear Power Accidents
Romain Bizet
François Lévêque
Mines ParisTech - CERNA Centre for Industrial Economics

Logistics of Dismantling Nuclear Power Plants - A Model-Based Analysis of Low- and Intermediate-Level Waste Management in Germany
Tim Scherwath
German Institute for Economic Research (DIW Berlin)
Roman Mendelevitch
Technische Universität Berlin (TU Berlin)

THE POTENTIAL ROLE OF GRID CONNECTED SOLAR THERMAL HEAT IN AUSTRIA

Andreas Müller

39th IAEE International Conference
Bergen 19.-22 June 2016

Prospective role of grid connected solar thermal energy in a future Austrian energy system

This leads to two sub-questions:

(A) Long term DH (district heating) potentials in Austria

(B) Prospects of integrating solar thermal energy in DH networks

Grid connected solar thermal energy (GcST): Proven technology under different framework conditions

International best practice country Denmark:

- DH networks with GcST are well established

Austria:

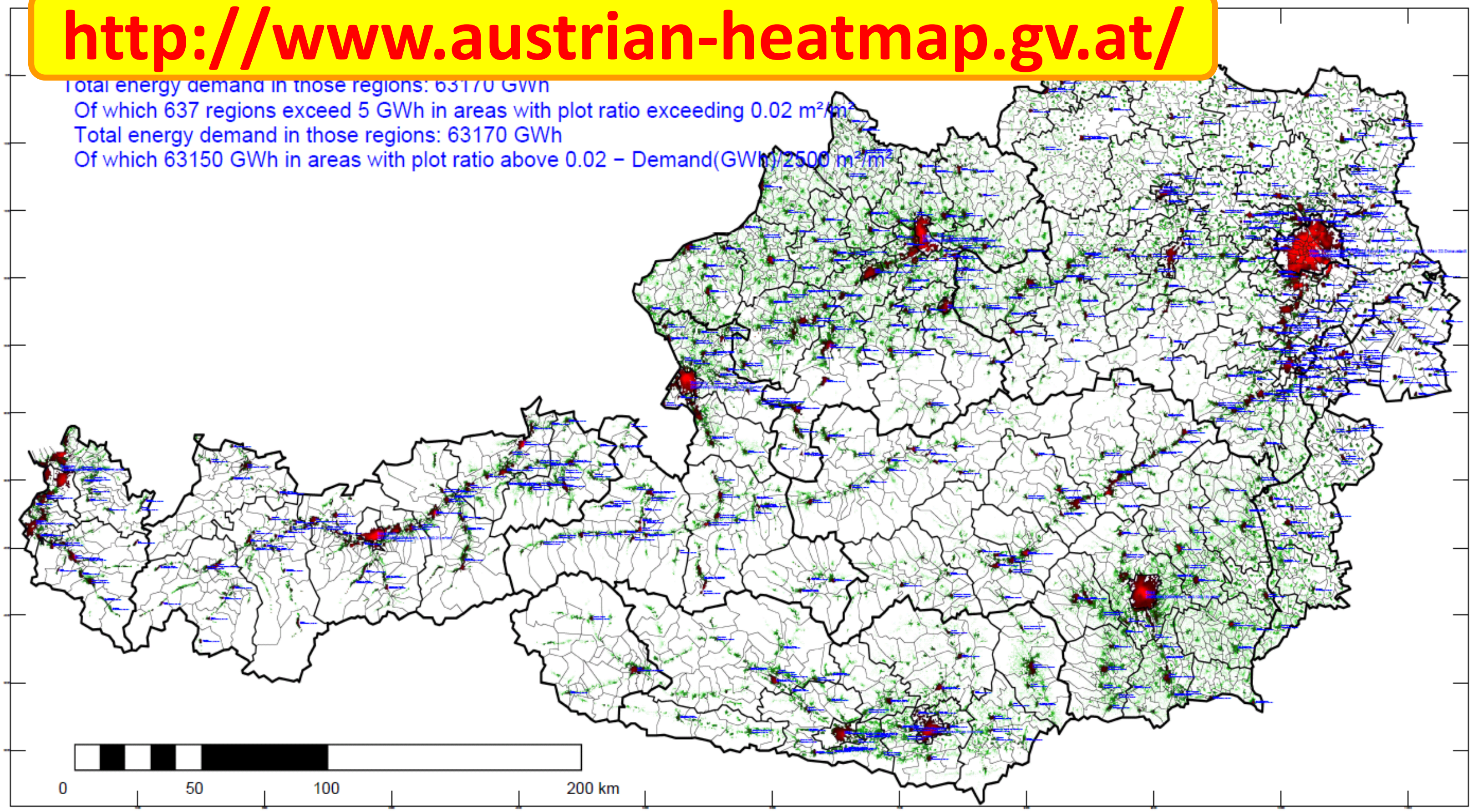
- DH is widely applied: >1500 DH networks
- GcST more popular recently, yet low solar coverage rates

Key differences between Austria and Denmark:

- Higher energy prices in Denmark
- DH temperature levels are lower in Denmark
- Lower solar radiation in Denmark

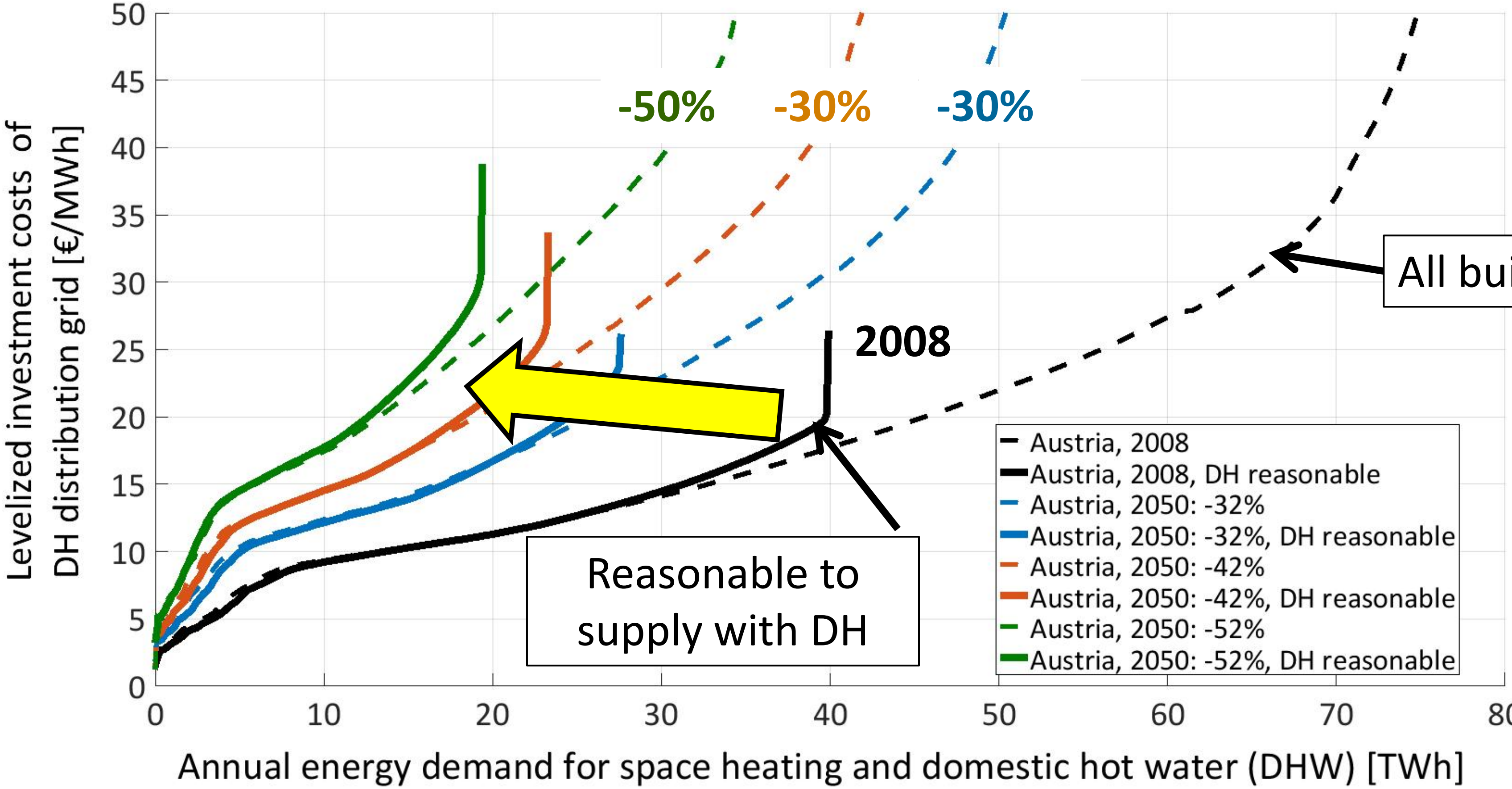
DH potentials estimated by calculating the spatial heat demand density distribution using GIS data

http://www.austrian-heatmap.gv.at/



- **Specific investment costs for the distribution network used as indicator for the DH potential**

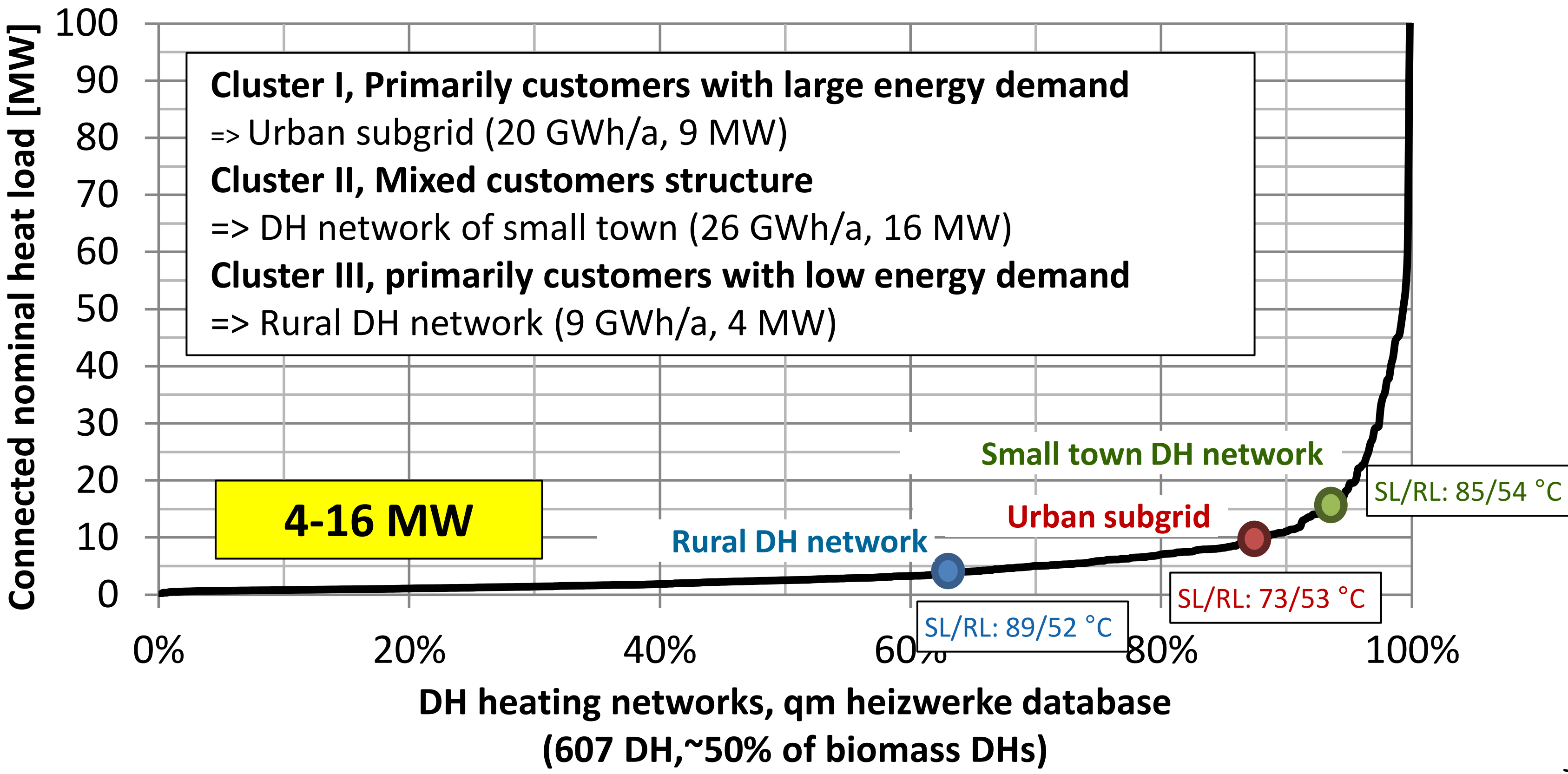
Austrian DH energy potential will decrease from 40 TWh in 2010 to 13-19 TWh in 2050



Source: Müller et al., *Solargrids.* technical report, 2014.

- Currently about 18 TWh are supplied by DH

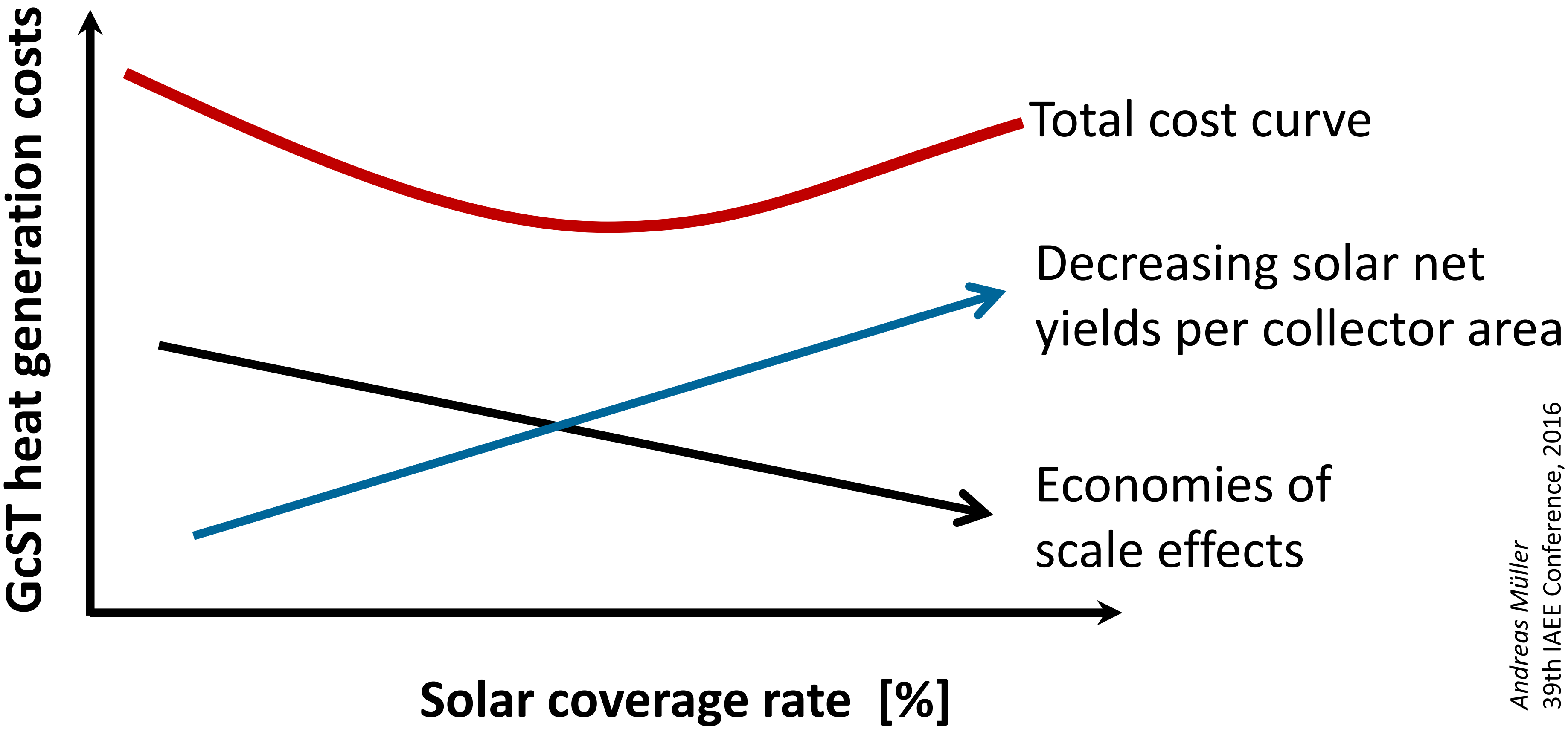
Evaluation of GcST based on thermodynamic simulation of 3 Austrian district heating networks



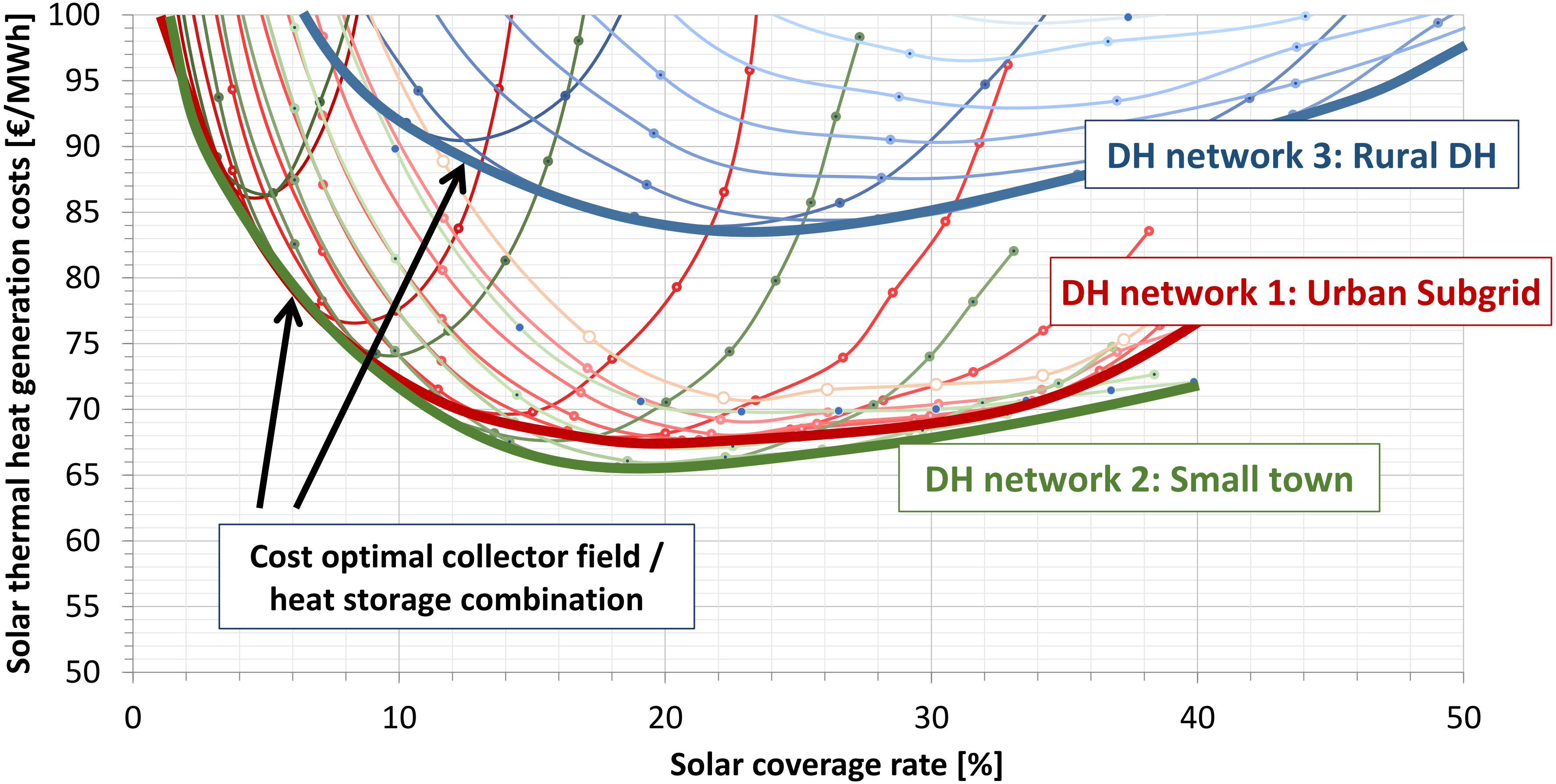
Data source: qm heizwerke database. March 2013.

- Seasonal storage or heat pumps not considered

Cost optimal size as function of decreasing specific solar yields and increasing economies-of-scale effects

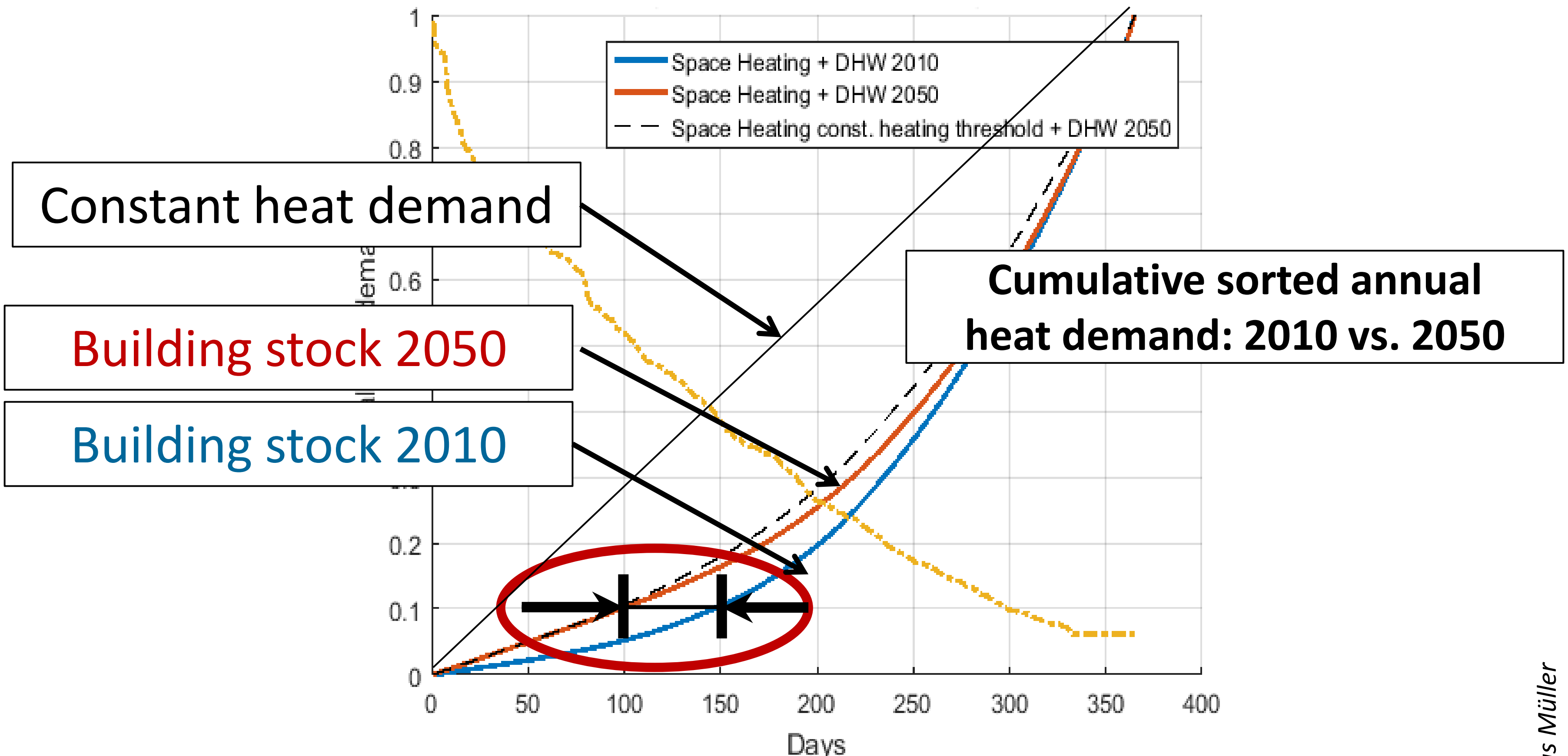


Lowest GcST heat generation costs occur at solar coverage rates of 16 – 24 %



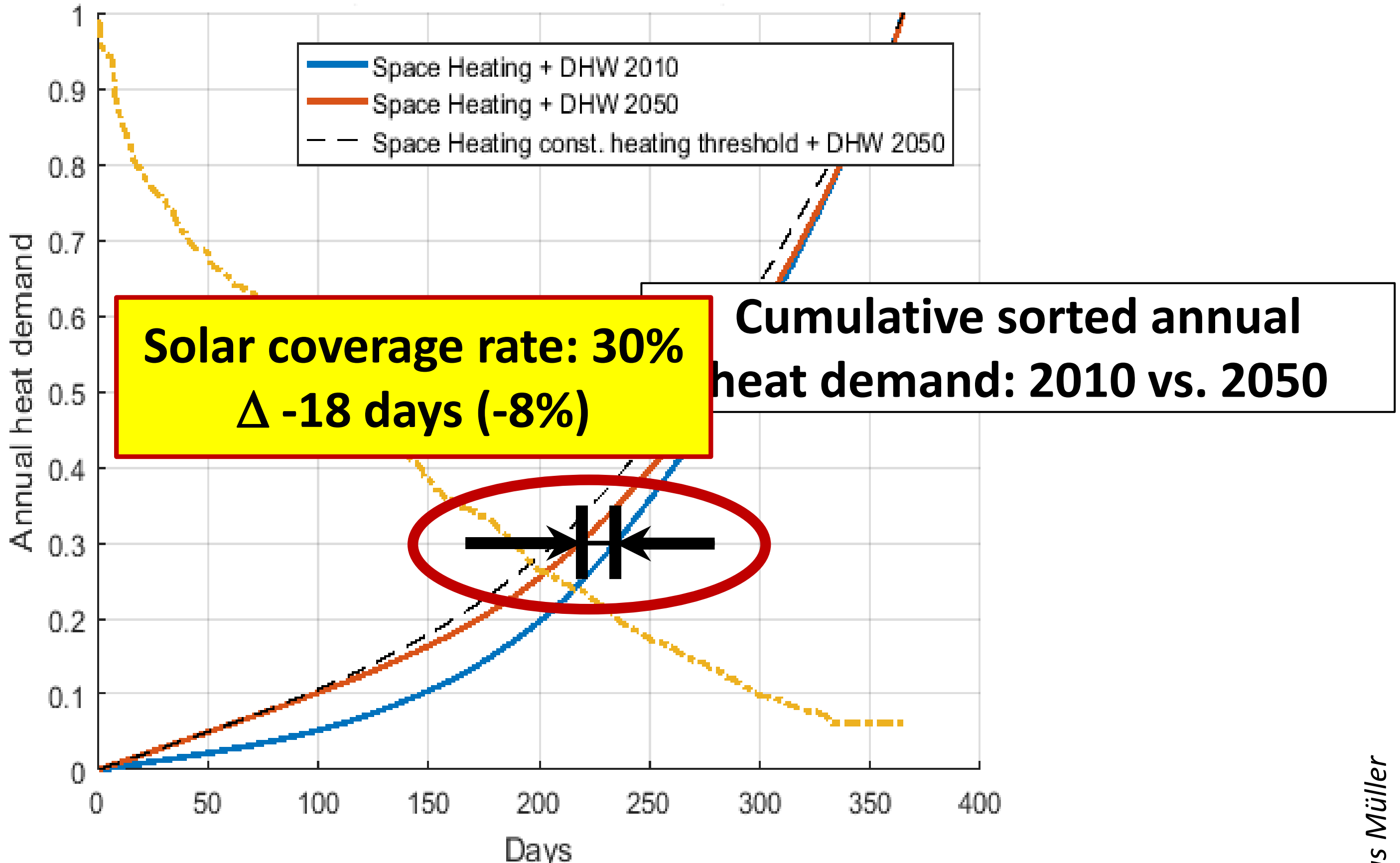
- Heat generation costs: 65 – 85 €/MWh
- Cost curve is rather flat beyond lowest costs

Retrofitting buildings leads to a better match of energy demand and supply



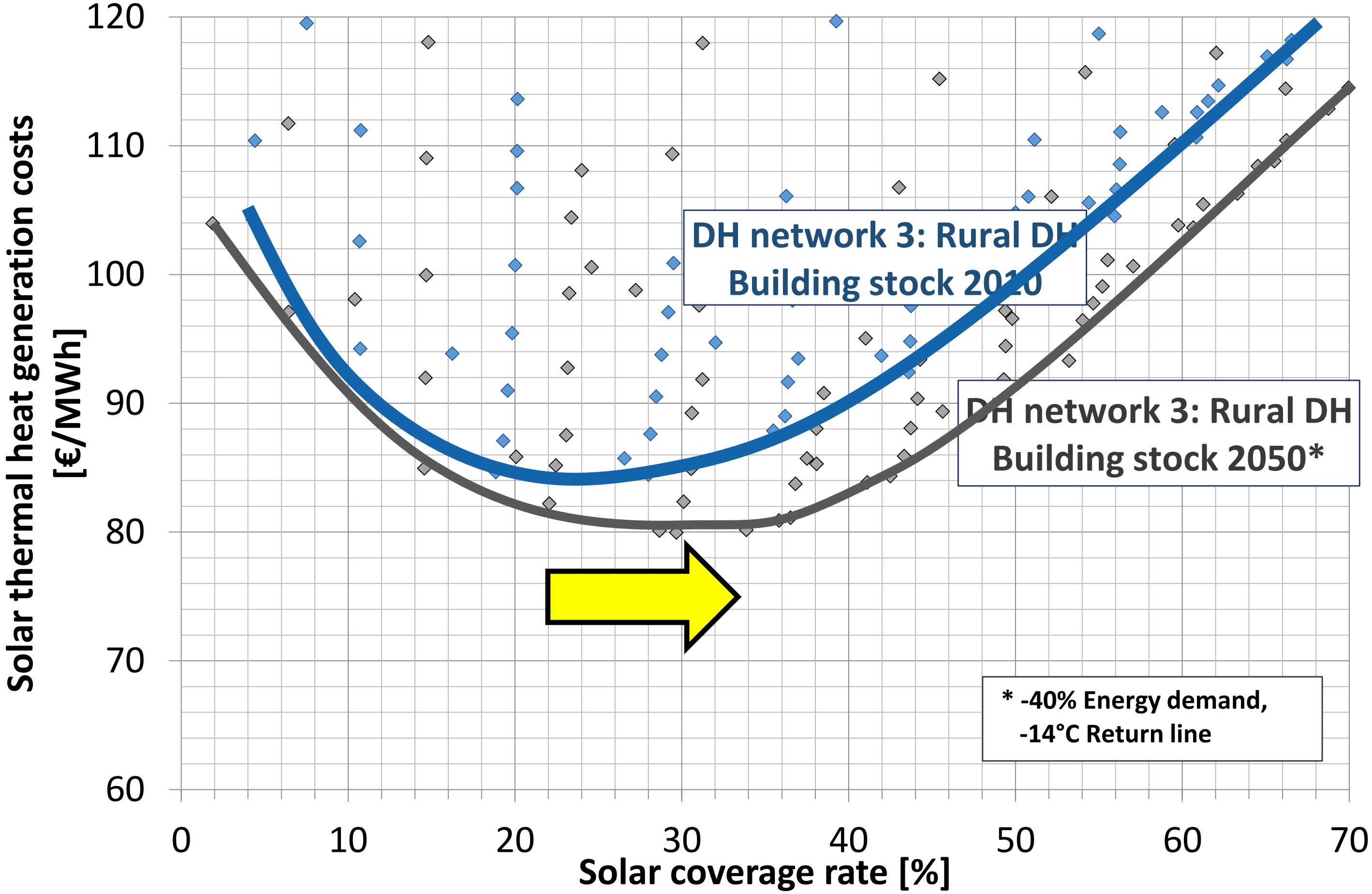
Solar coverage rate: 10%
Δ -50 days (-33%)

Retrofitting buildings leads to a better match of energy demand and supply



- However effect diminishes with increasing solar coverage rates

For retrofitted building stock, minimal GcST heat generation costs occur at higher solar coverage rates



- Only minor effect on total heat generation costs

Grid connected solar thermal energy has the potential to supply about 10% of the Austrian building-related heat demand

- In the long term, 30% of the Austrian heating and DHW is worth to be supplied by District heating (2010: ~45%)
- Currently, the lowest GcST heat generation costs occur at solar coverage rates between 16 – 24 %
- Retrofitting buildings will not reduce the heat generation costs, but shift the optimum to higher solar coverage rates in the range of 25 – 35 %
- Integration of heat pumps and seasonal storage needed to offset the effect of low costs industrial and waste-incineration waste heat

Thank you for your attention!

For further information or questions:

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www.eeg.tuwien.ac.at/solargrids

www.austrian-heatmap.gv.at

www.entranze.eu

www.briskee.eu/

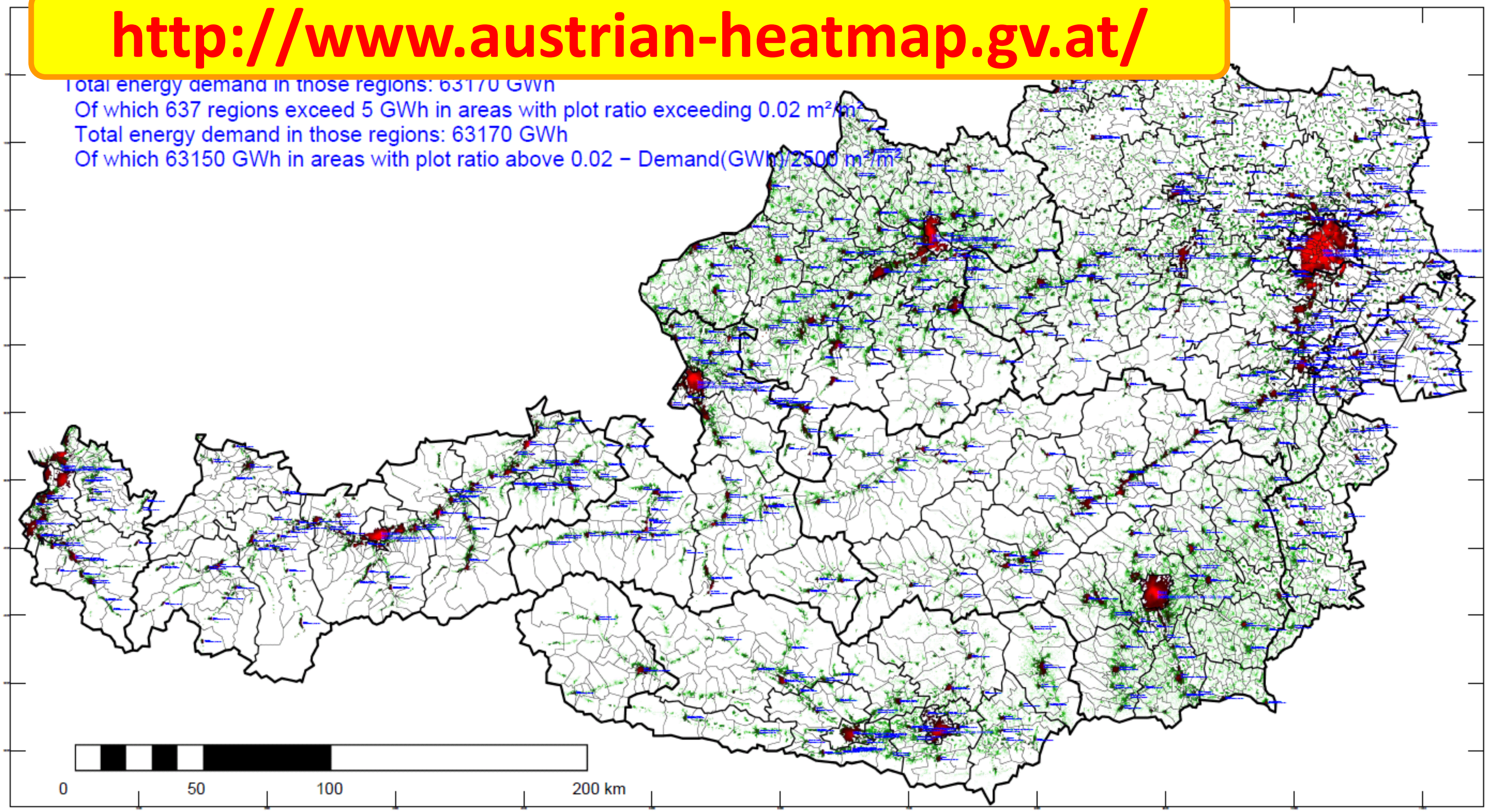
The project „Solargrids" was supported by the Austrian Climate and Energy Fund

Backup slides

Estimating the DH potentials based on a calculated spatial heat demand density distribution

1. Calculating the generic plot ratio (floor area per land

http://www.austrian-heatmap.gv.at/



Estimating the DH potentials based on a calculated spatial heat demand density distribution

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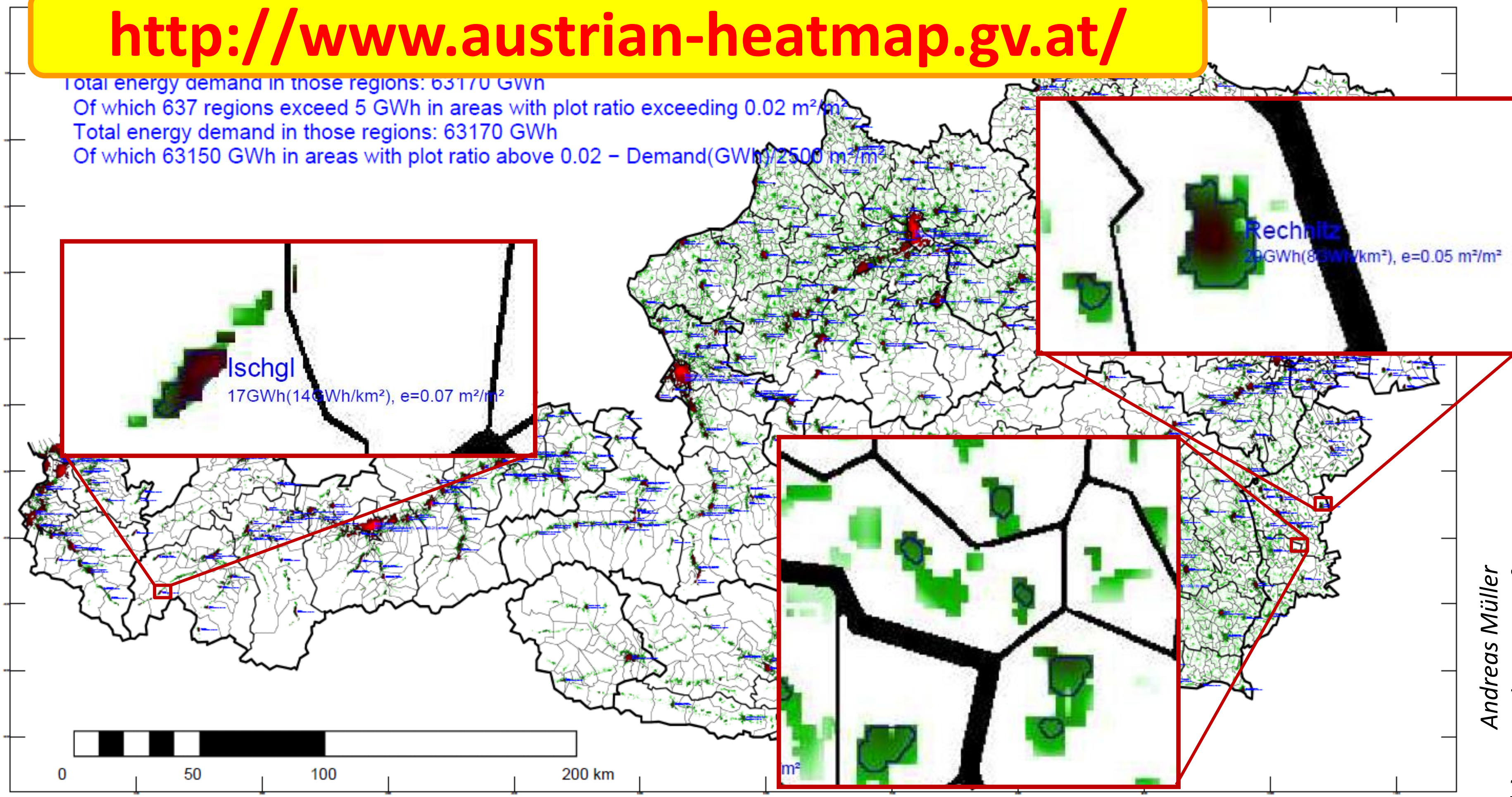

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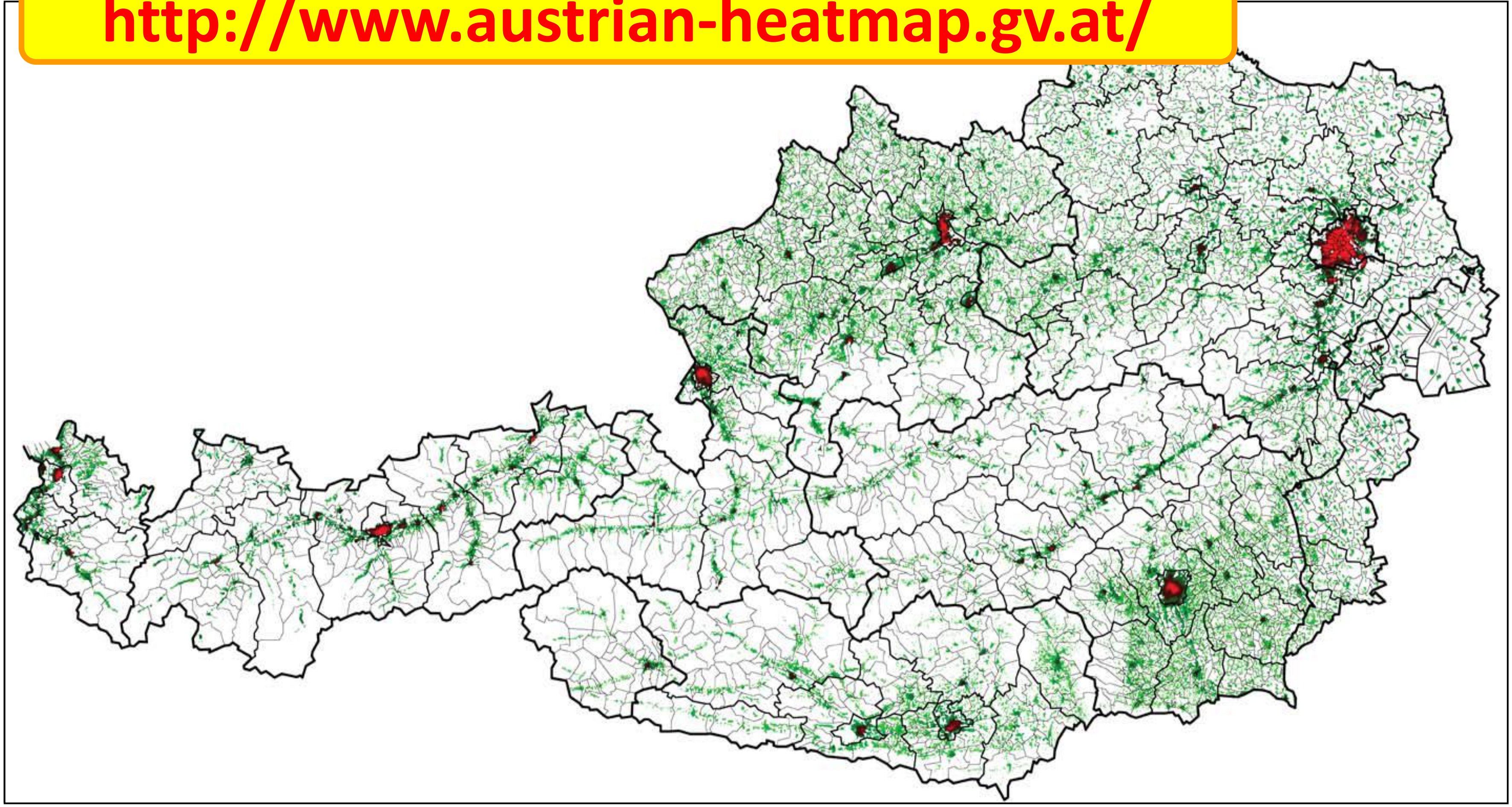
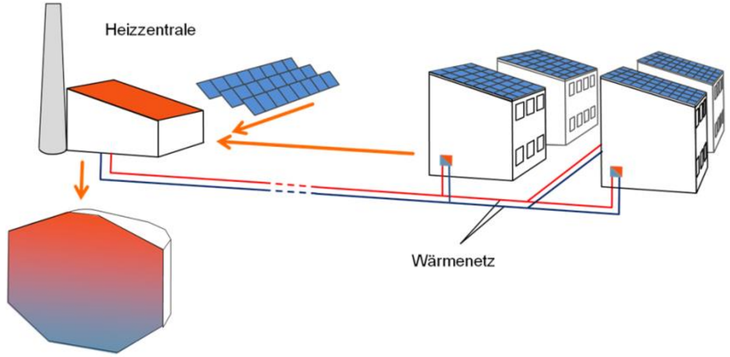


Andreas Müller
39th IAEE Conference, 2016

Methodology

- **Three simulation tools**
  - **Simplex**-Model, **TRNSYS, Invert/EE-Lab**
- **Integration of solar thermal system**
  - Integration of single central collector field and heat storage
  - Prioritizing heat from solar thermal collectors
  - Focus on feeding into return line temperature
  - No heat pumps or seasonal storage considered
- **Simulation of ~1400 variations**
  - 13 collector fields , 9 heat storage tanks
  - 3 DH networks, 4 building stocks configurations



Estimating the DH potentials based on a calculated spatial heat demand density distribution

1. Calculating the generic plot ratio (floor area per land area) and heat density distribution using publicly available GIS & building census data
   - Generic 50x50 meter grid for Austria (~34 mio. grid cells)
2. Cluster grid cells to potential DH networks
3. Calculate scenarios for the evolution of the building stock
4. Calculate the investment costs for the DH distribution network

➢ **Specific investment costs used as indicator for the DH potential**