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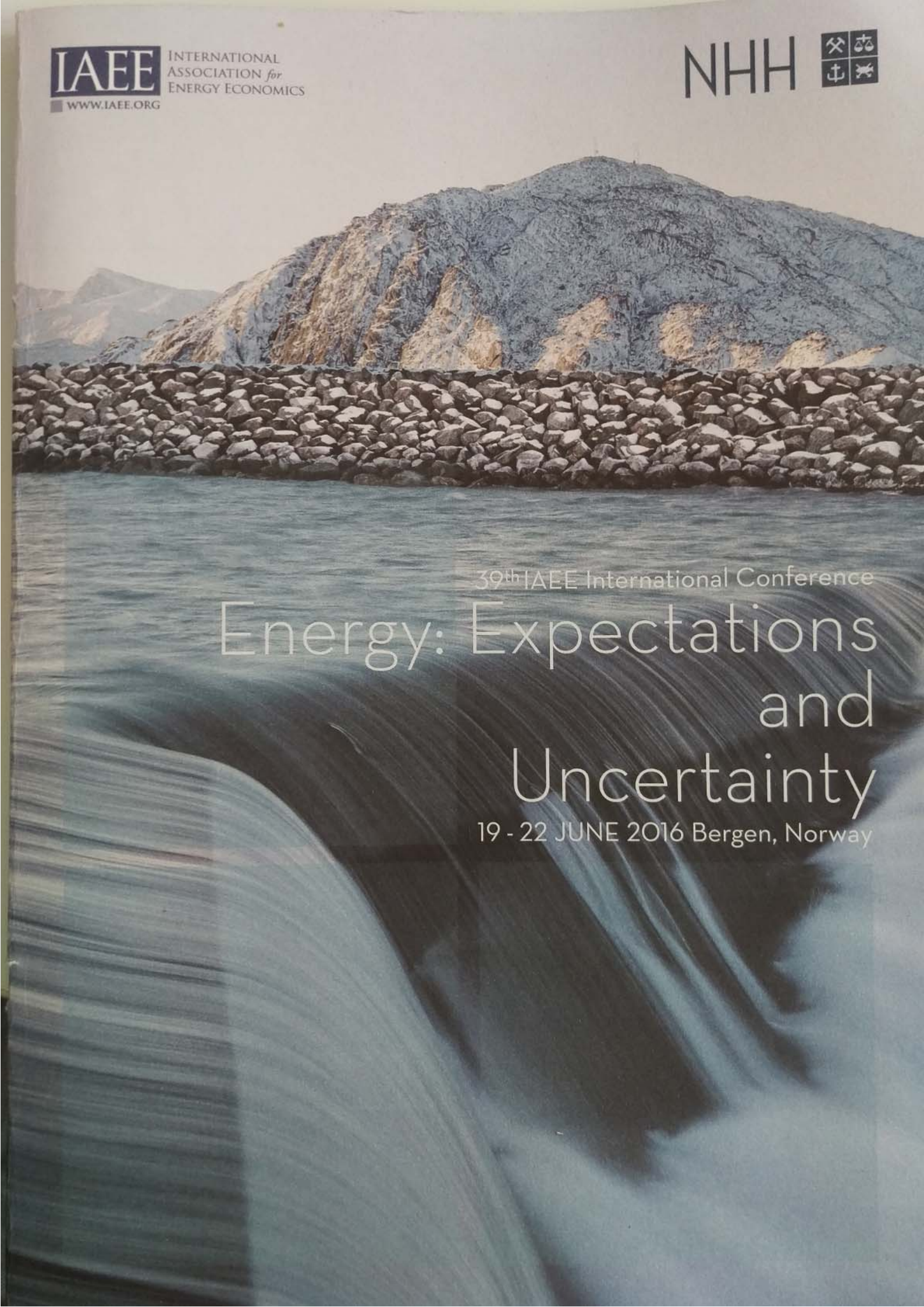

39th IAEE International Conference

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
Dodica 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
EROF
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
Rachael Homayoun Baroumand
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)

Comparison of two Methods for Finding Least Cost Solutions for Heat Saving and Heat Supply

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Keywords: Heat and energy saving in buildings, cost curve, heating system, district heating

Overview

Energy demand in buildings contributes with a large share to the total final energy demand. Existing buildings are known to provide a remarkable potential for energy savings. In this context two important questions arise: 1) which heat savings in the building stock can be reached at which costs?, and 2) what could be the optimal combination of heat savings and the supply of heat by individual heating systems or district heating? Cost curves for heat savings and for heat supply can contribute to find answers to these questions by linking heat saving costs and potentials with heat supply costs and potentials. However, there are different ways to determine and use heat saving and supply cost curves. In this paper two methods to determine the cost-optimal amount of savings versus supply via heat saving and supply cost curves are compared. In Method 1 a heat saving cost curve is developed containing selected possible renovation options and then compared with a heat supply cost curve in order to find an optimal mix between saving and supply for each building in a given building stock. In contrast, in Method 2 a combined heat saving cost curve for savings via renovation measures and change in heating systems is developed, choosing the least cost option for each building to be reflected in the resulting cost curve.

Method

The comparison of two different methods to derive cost optimal levels of savings in currently existing buildings is made for two different municipalities in Europe. The stock of buildings is structured in different building classes and building segments (Building classes are building categories like single family house, multi-family house, office buildings etc. with different construction periods and different renovation states leading to different useful energy demands; Building segments are building classes with different heating systems). In Method 1, first heat saving cost curves as well as heat supply cost curves on the basis of annualized costs for the different building classes in the stock are derived. From both curves the cheapest saving and supply options are chosen in order to meet the existing demand, thereby valuing savings as a form of supply. In Method 2 for each building segment the costs of all possible combinations of renovation measures and changes in supply technologies are calculated and compared to the resulting energy saving on the basis of net levelized costs of heat savings. For each building segment then the cheapest combination is chosen to be reflected in the resulting cost curve for the overall building stock. The calculations with both methods thereby are performed underlying the same input data regarding costs, saving options and performance of heating systems. For each of the methods the resulting savings in useful and final energy demand compared to the actual state are calculated and compared, as well as the mix of supply technologies in the resulting cost optimal solutions.

Results

The main differences between both methods is the indicator for the comparison of energy savings and supply (useful vs. final demand) and the combined vs. separated calculation of costs of savings and supply. It is expected that this leads to slight differences in the resulting optimal levels of savings and changes in heating systems. Also the visualization in form of cost curves is different in both methods: in method 1 cost curves for all different classes of buildings are derived, thus allowing an easy visualization of the resulting least cost combinations for each building; in method 2 one cost curve is derived allowing for an easy visualization of the costs and overall savings of the least cost combinations of savings and supply options for all buildings.
A detailed analysis and discussion of the difference in the results for both methods will be presented in the full paper.