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Energy: Expectations
and
Uncertainty

19 - 22 JUNE 2016 Bergen, Norway

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

Thomas Leautaud, *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 Marin de Lagarde
Anna Creti
Université Paris-Dauphine
Christophe Bonneray
ERDF
Frédéric Lantz
IFP EN, IFP School

Electricity Storage and Flexibility Requirements on the Road to Decarbonization in European Electricity
Clemens Gerbaulet
Casmir 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 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 Kranz
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 Mendeleevitch
Technische Universität Berlin (TU Berlin)

COMPARATIVE ANALYSES OF RESOURCE ADEQUACY OPTIONS IN EUROPEAN AND U.S. ELECTRICITY MARKETS

Hans Auer, Energy Economics Group (EEG), Vienna University of Technology, +43 1 58801 370357, auer@eeg.tuwien.ac.at
Audun Botterud, Energy Systems Division, Argonne National Laboratory, +1 630-234-8854. abotterud@anl.gov

Overview

At present, in many regions/countries worldwide electricity markets are confronted with major challenges. Among others, there is the controversially discussed question on how to maintain long-term resource adequacy in a system with high shares of (financially supported) renewable electricity generation putting downward pressure on wholesale electricity prices. As an immediate result of the increasingly visible short-term profitability problems of many electricity generators a comprehensive resource adequacy discussion has been triggered in recent years. In general, there exist many different policy options to maintain resource adequacy (also apart from incentives for generation and transmission investments). Some of the options are linked to a particular electricity market design, others are independent. The motivation of this paper, therefore, is to conduct a comparative analyses in this context between the European and U.S. electricity markets, because these market designs in these two continents are characterised by many similarities, on the one hand, but also some fundamental differences, on the other hand.

Methods

The comparison of current and future resource adequacy options in the European and U.S. electricity markets mainly relies on a qualitative assessment. However, the analysis is not only of comparative, qualitative nature, but also underpinned by some empirical and quantitative analyses. In addition, emphasis is put on also addressing the significant interdependences between long-term resource adequacy and short-term reliability in electricity markets. The analysis in the paper is set up as follows:

- (i) Comparisons of the different drivers for the current resource adequacy discussions in Europe and the United States (supported by some empirical analyses to strengthen different arguments)
- (ii) Discussion of the different policy options and barriers to mitigate the resource adequacy challenges in Europe and the United States. The policy options investigated include measures targeting generation investments such as capacity markets, capacity payments, strategic reserves, and scarcity pricing in energy only markets. However, the analysis is conducted against the background of different designs for short-term electricity market operations (e.g. zonal versus nodal pricing, ancillary services markets), different roles and responsibilities of market participants (e.g. TSOs versus ISO in terms of transmission ownership and operation of different market segments), different incentive schemes for renewable generation, the level of demand side participation, and many others.
- (iii) Qualitative assessment (supported by different metrics) of different policy options in terms of (i) long-term adequacy risk, (ii) implementability in existing electricity market structures, (iii) financial risk allocation to different market participants, (iv) support of retail competition and/or decentralised energy resources including energy storage, (v) impact on short-term electricity system operation and reliability, (vi) support of other policy options (e.g. dynamic tariffs, energy efficiency), others.

Results

Our first preliminary assessments show that there are many similarities which triggered the resource adequacy discussion in the European and U.S. electricity markets. However, there are also significant differences and particularities which need to be considered. In the following just some selected examples are listed to briefly indicate the multifacetedness of the challenges ahead:

- Certainly, there is a significant impact of renewable generation on wholesale electricity prices in both markets (triggered mainly by e.g. feed-in tariffs in Europe and production tax credits in the US) resulting in significant short-term profitability problems and – dependent on the existing power plant portfolio in regional/national markets – to long-term adequacy problems.
- Also both market areas have been confronted with unexpected macro economic events (e.g. the recent recession and corresponding reductions in load) leading to similar challenges discussed above.

- Whereas the European electricity markets relies on zonal pricing based on national TSOs (with increasing cross-border cooperations in several electricity market segments), the U.S. market has implemented nodal pricing based on an ISO structure. This has led to an even more fragmented and decentralised wholesale electricity market structure and thus also to an even more diversified discussion in terms of possible capacity remuneration mechanisms in Europe (i.e. including different decentralised policy options in this context).
- In many European electricity markets, power exchanges were established for trading of short-term (typically day-ahead) to long-term (multiple years ahead) products. Standard contracts along with large price zones facilitated some liquidity in long-term markets, which contribute to lower investment risks. In contrast, the U.S. ISO market design with prices in individual may be a challenge from a long-term liquidity perspective. Interestingly, recent developments in Europe with more dynamic handling of transmission congestions and pricing zones in short-term markets may create similar challenges in Europe.
- For reason of shortness it is not elaborated on further aspects here in detail (but in the paper and conference presentation) as there are e.g. (i) role of historical transmission investments and redundancy on transmission grid level facilitating efficient electricity markets (with less congestion), (ii) role of dynamic tariff structures sending the correct price signals to customers, (iii) share of distributed PV generation and innovations triggered in a smart distribution grid context in general, (iv) others.

Conclusions

Certainly, no singular solution can be recommended; rather the pros and cons need to be balanced for different possible solutions to overcome the short-term missing money/profitability problem and the long-term (physical) adequacy problem in both electricity market designs. Moreover, sometimes the approach that is best in theory may not be implementable in practice. The U.S. electricity market design with ISOs controlling planning and operation over a large geographical region has certain benefits in terms of centralized coordination and control, but the more fragmented European markets may encourage more innovation in terms of distributed solutions.

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