Modellierung (De-)Zentraler Energiewenden

Abschlussworkshop zu dezentralen und zentralen Aspekten zukünftiger Infrastrukturlösungen für Wasserstoff

Prof. Dominik Möst und Hannes Hobbie (TU Dresden)

Stellvertretend für das gesamte Projektkonsortium der Universität Duisburg-Essen, der TU Berlin, dem Deutschen Institut für Wirtschaftsforschung und der TU Dresden

Modellierung (De-)Zentraler Energiewenden (MODEZEEN)

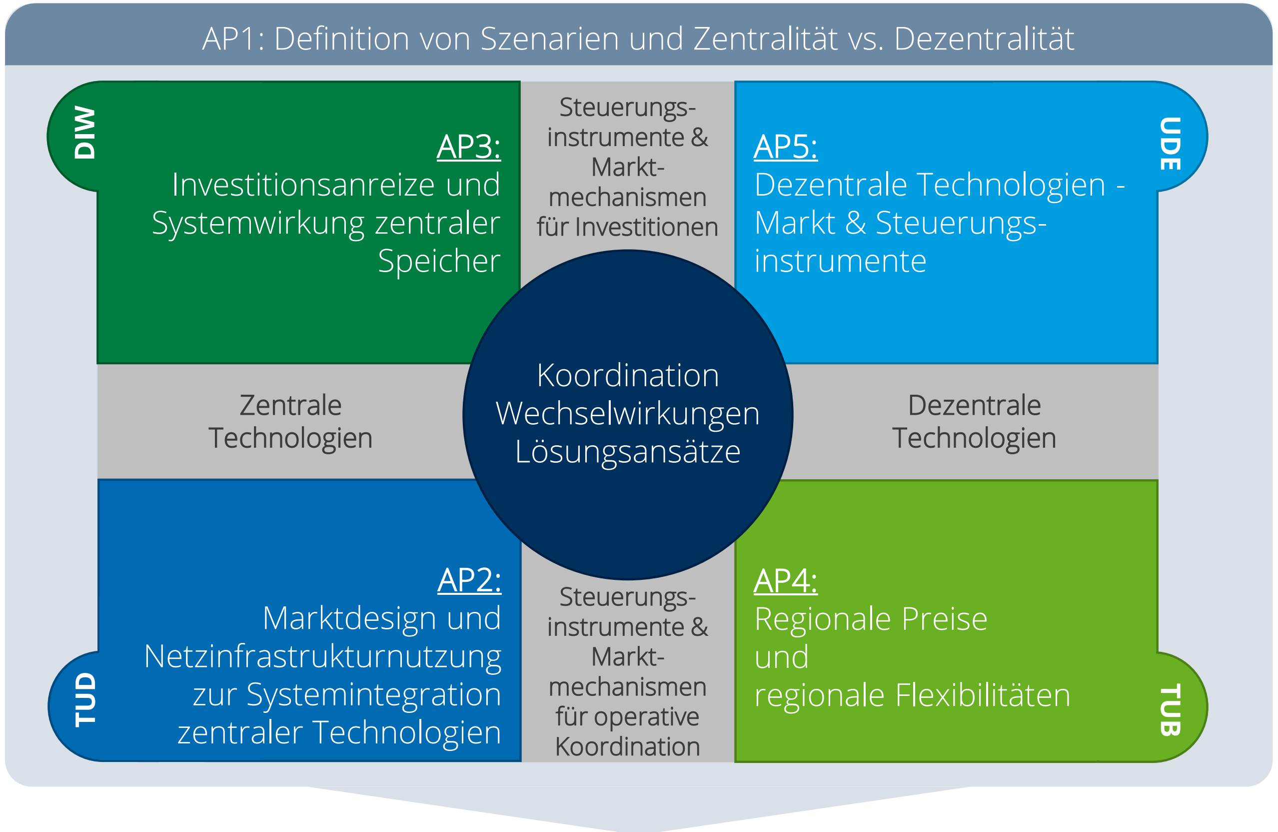
Abschlussworkshop an der TU Dresden am 28. November 2023

Ausgerichtet von dem Projektteam der Universität Duisburg-Essen, dem Deutschen Institut für Wirtschaftsforschung, der TU Berlin und der TU Dresden

Veranstaltungsort: Festsaal der Fakultät Wirtschaftswissenschaften an der TU Dresden, Hülße-Bau, Nordflügel, 3. Etage, Raum TIL 205 (Anreise)

Von 09:30	Registrierung und Kaffee
10:00 - 10:15	**Begrüßung** *Prof. Dr. Dominik Möst & Hannes Hobbie, TU Dresden*
10:15 - 10:45	**Vorstellung von MODEZEEN** *Hannes Hobbie, TU Dresden*
10:45 - 11:15	**Impulsvortrag** *Fabio Weiß, Deutsche Energie-Agentur GmbH (dena)*
11:15 - 11:30	Kaffeepause
11:30 - 12:00	**Impulsvortrag zur Rolle von Ammoniak im Energiesystem** *Dr. Philipp Hauser, VNG AG*
12:00 - 12:30	**Wissenschaftlicher Vortrag zu Wasserstoff und Markteffekten** *Dr. Dana Kirchem, Deutsches Institut für Wirtschaftsforschung*
12:30 - 13:30	Gemeinsames Mittagsessen
13:30 - 14:00	**Wissenschaftlicher Vortrag zu Wasserstoff Zentralität und Dezentralität** *Prof. Dr. Christian von Hirschhausen, Lukas Barner & Mario Kendziorski, TU Berlin*
14:00 - 14:15	**Diskussion**
14:15 - 14:45	Kaffeepause
14:45 - 15:15	**Impulsvortrag zu grenzen'*loser*' Elektrifizierung?** *Dr. Jörg Dickert, SachsenNetze*
15:15 - 15:45	**Wissenschaftlicher Vortrag zu Wasserstoff und Engpassmanagement** *Martin Lieberwirth, TU Dresden*
15:45 - 16:15	**Wissenschaftlicher Vortrag zu Wasserstoff und Investitionsanreize** *Marco Breder & Felix Meurer, Universität Duisburg-Essen*
16:15 -16:30	**Diskussion**
16:30 - 16:45	Kurze Pause
16:45 - 17:00	**Abschließende Fragerunde und Wrap-up** *Fabio Weiß, Dr. Philipp Hauser, Dr. Dana Kirchem, Lukas Barner & Mario Kendziorski, Dr. Friedrich Kunz, Martin Lieberwirth, Marco Breder, Felix Meurer*
18:00 - 22:00	Get-together in der Campus Bar, Hübnerstraße 13, 01069 Dresden (Selbstzahler)

3 ½ Jahre Energiesystemanalyse zu zentralen und dezentralen Energiewenden



Erarbeitung von Lösungsvorschlägen zur bestmöglichen Koordination zentraler und dezentraler Energieinfrastrukturlösungen

Bundesministerium für Wirtschaft und Klimaschutz

Gefördert durch das Bundesministerium für Wirtschaft und Klimaschutz

3 ½ Jahre Energiesystemanalyse zu zentralen und dezentralen Energiewenden

Bundesministerium für Wirtschaft und Klimaschutz

Gefördert durch das Bundesministerium für Wirtschaft und Klimaschutz

MODEZEEN

Open Access Modell zur Parametrierung und Abbildung von FBMC in Strommarktmodellen

Published

Advances in Applied Energy 2 (2021) 100027

Contents lists available at ScienceDirect

Advances in Applied Energy

journal homepage: www.elsevier.com/locate/adapen

ELSEVIER

Toward a fundamental understanding of flow-based market coupling for cross-border electricity trading

David Schönheit, Michiel Kenis, Lisa Lorenz, Dominik Möst, Erik Delarue, Kenneth Bruninx

Keywords:
Congestion management
Electricity trading capacities
Flow-based market coupling
Open-access model
Optimization model

of this paper are its illustrative nature and its answer to the following research questions: (1) What is the effect of (a) generation shift keys and (b) threshold choice on the selection of critical network elements? (2) What is the effect of (a) generation shift keys, (b) selected critical network elements and (c) security margins on market coupling and congestion management results? It also addresses the effect of higher shares of renewable energy and minimum trading capacities on flow-based market coupling. This analysis shows that (1) the effects of flow reliability margins and selected critical network elements dominate the effect of generation shift keys on flow-based market coupling domains, (2) power systems with an increasing share of renewable energy may necessitate re-adjusted parameters and (3) minimum trading capacities can be guaranteed by redispatch or altering the base case.

1. Introduction

A major pillar of achieving the emissions reduction targets as well as an affordable and reliable supply of electricity is the European Union's goal of a single, interconnected electricity market [17]. It builds upon the concept of market coupling, i.e., the merging of individual, national markets to render possible the trade of electricity across a large geographical area. Interconnections between market zones and internal transmission networks facilitate these exchanges. Generally, there are two major options for market clearing and price formation while accounting for network limitations: nodal and zonal markets (cf. Androcec et al. [6]). Importantly, both options consider physical constraints of the grid but in different ways and to different degrees. With nodal pricing, each grid node has a price, which reflects the cost of supplying additional electricity to this node. These local price signals inherently reflect the physical limits of the electricity grid. With zonal pricing, a uniform price forms within zones, which usually correspond to countries. The cleared price applies to the entire zone and trade between zones is enabled during market coupling. Violations of grid constraints, many of which are not reflected in zonal prices, have to be resolved by remedial actions after market coupling [36]. Both approaches have advantages, whose description is beyond the scope of this paper. At this point it suffices to say that Europe deploys zonal pricing combined with implicit coupling between zones [7].

Connecting markets, the focus of this paper, has the advantage of maintaining high levels of security of energy supply through reliance on electricity generation from neighboring countries as well as integrating electricity generation from renewable energy sources (cf. Council of the European Union and European Parliament [10]). What follows

* Corresponding author.
E-mail addresses: david.schoenheit@tu-dresden.de (D. Schönheit), michiel.kenis@kuleuven.be (M. Kenis), lisa.lorenz@mailbox.tu-dresden.de (L. Lorenz), dominik.moest@tu-dresden.de (D. Möst), erik.delarue@kuleuven.be (E. Delarue), kenneth.bruninx@kuleuven.be (K. Bruninx).

https://doi.org/10.1016/j.adapen.2021.100027
Received 21 April 2021; Received in revised form 26 April 2021; Accepted 26 April 2021
Available online 30 April 2021

https://doi.org/10.1016/j.adapen.2021.100027

Highlights:

- Bereitstellung eines Leitfadens für die wichtigsten Schritte der Modellierung und Parametrierung von lastflussbasierten Marktkopplungsmechanismen
- Bereitstellung eines frei zugänglichen Modells (Code und Daten) auf der Grundlage einer frei zugänglichen Software
- Fallstudien und Sensitivitätsanalysen auf der Grundlage eines modifizierten 118-Bus-IEEE-Netzes

Auswahl von kritischen Leitungselementen für lastflussbasierte Strommarktkopplung

Published

Applied Energy 306 (2022) 118028

Contents lists available at ScienceDirect

Applied Energy

journal homepage: www.elsevier.com/locate/apenergy

ELSEVIER

Improved selection of critical network elements for flow-based market coupling based on congestion patterns

David Schönheit [a,*], Kenneth Bruninx [b,c], Michiel Kenis [b,c,d], Dominik Möst [a]

[a] Technische Universität Dresden, Chair of Energy Economics, Münchner Platz 3, 01069 Dresden, Germany
[b] KU Leuven, Research Group Energy Systems Integration & Modeling, Celestijnenlaan 300A, B-3001 Leuven, Belgium
[c] EnergyVille, Thor Park, Poort Genk 8310, B-3600 Genk, Belgium
[d] Flemish Institute for Technological Research (VITO), Boeretang 200, B-2400 Mol, Belgium

Improved selection of critical network elements for flow-based market coupling based on congestion patterns

David Schönheit, Kenneth Bruninx, Michiel Kenis, Dominik Möst

ently comes with welfare losses [4]. Conversely, nodal pricing approaches lead to an optimal grid-constrained dispatch solution [5]. On average, zonal market clearing will result in a greater need for remedial actions, carried out in form of congestion management, e.g. redispatch and curtailment (other measures are discussed in e.g. [6]). Ensuring grid-compatible market outcomes, allowing welfare-enhancing cross-zonal trade, while respecting cross-zonal and intra-zonal grid limitations [7], has become more challenging in several European countries with the expansion of renewable energy capacities. Greater redispatch and curtailment volumes reflect this trend (cf. [8]).

Europe in 2015 with the goal of decreasing the divergence between commercial and physical flows. Its multi-step methodology accounts for grid constraints before and during market coupling by estimating grid utilization before market coupling, contained in base cases (two-days-ahead congestion forecasts), as well as changes in grid utilization due to changes in the export/import position of bidding zones, estimated by generation shift keys (GSKs). To provide appropriate cross-zonal trading capacities, flow-based market coupling monitors the flows and physical limitations of the grid elements that are most affected by trade, the so-called critical network elements (CNEs). This way, it sends

* Corresponding author.
E-mail addresses: david.schoenheit@gmail.com (D. Schönheit), kenneth.bruninx@kuleuven.be (K. Bruninx), michiel.kenis@kuleuven.be (M. Kenis), dominik.moest@tu-dresden.de (D. Möst).

[1] For a full depiction of flow-based market coupling see [1,2].
[2] Schönheit et al. [3] discuss the effect of different selection thresholds for critical network elements on market and congestion management results but remain in the standard selection process.

https://doi.org/10.1016/j.apenergy.2021.118028
Received 13 July 2021; Received in revised form 29 September 2021; Accepted 4 October 2021
Available online 20 October 2021

ttps://doi.org/10.1016/j.apenergy.2021.118028

Highlights:

- Netzüberlastungen helfen bei der Auswahl kritischer Netzelemente in der flussbasierten Marktkopplung
- Eine auf Knotenpreisen basierende Marktzonenkonfiguration identifiziert Engpasssignale
- Erkenntnisse aus neu konfigurierten Zonen helfen, die Auswahl kritischer Elemente zu verbessern

Auswirkungen minimaler Handels-kapazitäten auf Wohlfahrten bei FBMC

Published

Energy Policy 149 (2021) 112030

Contents lists available at ScienceDirect

Energy Policy

journal homepage: http://www.elsevier.com/locate/enpol

ELSEVIER

Do minimum trading capacities for the cross-zonal exchange of electricity lead to welfare losses?

David Schönheit, Constantin Dierstein, Dominik Möst

Welfare of market participants
n-1 security criterion
Generation shift keys

adjustments made to meet this criterion, in the form of augmented trading domains, lead to higher amounts of curative congestion management. To quantify the effect of increasing minRAMs on overall welfare, the markets and grids of Central Western Europe are analyzed during two representative weeks of 2016. The results show the increasing market coupling welfare is more than offset by rising congestion management costs, leading to net welfare losses. In the best case, the generation plus congestion management costs within Central Western Europe rise by 7.25% when increasing the minRAMs from the current 20%–45% and a minRAM of 70% is 6.28% more expensive compared to a minRAM of 20%. The analysis derives policy recommendations for implementing the minRAM stipulation, with a particular focus on a cost-minimizing selection of generation shift keys, in general as well as situation-dependent terms.

1. Introduction

Transitioning toward cleaner energy and achieving the reduction of greenhouse gas emissions, while maintaining security of supply and achieving competitive energy price, necessitates the realization of a single, well-functioning and interconnected EU electricity market (cf. European Commission, 2015; Directorate-General for Energy European Commission, 2019; Council of the European Union and European Parliament, 2019). The rising expansion of renewable energy sources in Europe increasingly requires congestion management since the expansion can entail a larger geographical distance between electricity generation and demand which can make market results incompatible with the electricity grid. This not only pertains to curative measures during real-time grid operation but also preventative measures before and during market coupling.

Trading capacities, provided by transmission system operators (TSOs) to coupled markets, ideally try to account for intra- and inter-zonal congestions. Thus, the challenge lies in enabling trade to the greatest possible extent while taking into consideration grid constraints, i.e. predicting, how much electricity can be transmitted through the grid. Since 2015, flow-based market coupling (FBMC) is the stipulated method for cross-border capacity calculations in Central Western Europe (CWE) (cf. European Commission, 2015) due to welfare increases as well as high reliability, stability and robustness (Van den Bergh et al., 2016). The method incorporates the physical limits of network elements and predicts how changes in market situations (export/import positions) translate into flow changes in the grid. These predictions rely on the so-called generation shift keys which render possible a translation from zonal/market information to line flows. On a theoretical level, FBMC provides greater average trading capacities to the market, compared to the previously used NTC/ATC-method (net/available transfer capacity) (Plancke et al., 2016; Kristiansen, 2020). By the end of 2020, FBMC is supposed to go live in the Core region, encompassing CWE and Central Eastern Europe, a total of 13 countries and 15 involved TSOs.

In 2019, an increasing, minimum amount of line capacities, made available for trading, was stipulated (cf. Paragraph (119)–(130) by ACER decision 02/2019, ACER, 2019b), resulting in the so-called minimum remaining available margins (minRAMs). This minimum is

* Corresponding author.
E-mail addresses: david.schoenheit@tu-dresden.de, david.schoenheit@gmail.com (D. Schönheit), constantin.dierstein@tu-dresden.de (C. Dierstein), dominik.moest@tu-dresden.de (D. Möst).

https://doi.org/10.1016/j.enpol.2020.112030
Received 23 June 2020; Received in revised form 25 September 2020; Accepted 8 November 2020
Available online 20 November 2020

https://doi.org/10.1016/j.enpol.2020.112030

Highlights:

- Drei minRAM Level getestet für das Jahr 2016 in der CWE Region
- Wohlfahrtssteigerung werden durch erhöhte Engpasskosten konterkariert
- minRAM Levels sollten zunächst nur inkrementell gesteigert werden, um auf ungewünschte netzbetriebliche Effekte reagieren zu können

Auswirkungen dezentraler und fluktuierender Erzeugung auf FBMC

Preprint

Evaluating Policy Implications on the Restrictiveness of Flow-based Market Coupling with High Shares of Intermittent Generation: A Case Study for Central Western Europe

Richard Weinhold[a,*]

[a]*Fakultät VII Wirtschaft und Management, TU Berlin, 10623 Berlin, Germany.*

Abstract

The current stage in the evolution of the European internal energy market for electricity is defined by the transformation towards a renewable energy system. The Clean Energy Package aims to ensure that methods for capacity allocation and congestion management, that are at the center of the European internal market for electricity, align with this transformation.

Flow-based market coupling, the preferred method for capacity allocation, is first and foremost a formal process to allocate exchange capacities to the markets. However, the process also allows for many considerations of the involved parties that impact the resulting capacities. As part of the Clear Energy Package, the regulatory body enacted their ambition to increase exchange capacities by enforcing transmission system operators to allocate a minimum margin of physical line capacity with the goal of providing a higher level of competition and better integration of renewable energy sources. This study investigates this and other policy relevant consideration of flow-based market coupling.

The model results quantify the trade-off between permissive capacity allocation and increased congestion management. For high shares of intermittent renewable generation, less constrained exchange capacities are favorable, however also highlight the importance of the markets ability to integrate high shares of intermittent generation.

Keywords: Flow-Based Market Coupling, FBMC, Economic Dispatch Problem, Transmission System, Optimal Power Flow, Security Constrained Optimal Power Flow

https://doi.org/10.48550/arXiv.2109.04940

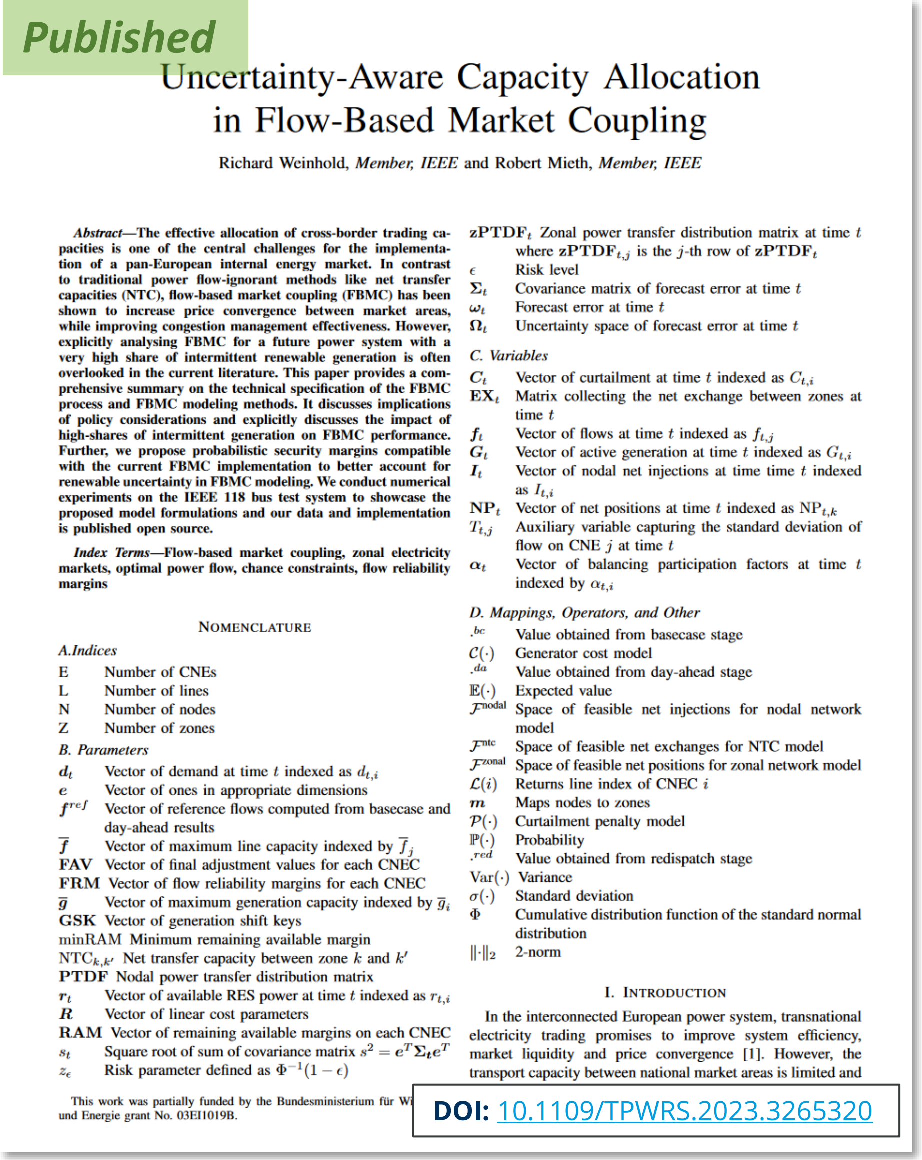
Highlights:

- Untersuchung des Einflusses von Mindesttransferkapazitäten zwischen Märkten
- Quantifizierung des Trade-offs zwischen einer liberalen Kapazitätszuweisung und verstärktem Engpassmanagement

AP 2
Zentral / Betrieb

Auswirkungen dezentraler und fluktuierender Erzeugung auf FBMC

Published



Uncertainty-Aware Capacity Allocation in Flow-Based Market Coupling

Richard Weinhold, *Member, IEEE* and Robert Mieth, *Member, IEEE*

***Abstract*—The effective allocation of cross-border trading capacities is one of the central challenges for the implementation of a pan-European internal energy market. In contrast to traditional power flow-ignorant methods like net transfer capacities (NTC), flow-based market coupling (FBMC) has been shown to increase price convergence between market areas, while improving congestion management effectiveness. However, explicitly analysing FBMC for a future power system with a very high share of intermittent renewable generation is often overlooked in the current literature. This paper provides a comprehensive summary on the technical specification of the FBMC process and FBMC modeling methods. It discusses implications of policy considerations and explicitly discusses the impact of high-shares of intermittent generation on FBMC performance. Further, we propose probabilistic security margins compatible with the current FBMC implementation to better account for renewable uncertainty in FBMC modeling. We conduct numerical experiments on the IEEE 118 bus test system to showcase the proposed model formulations and our data and implementation is published open source.**

***Index Terms*—Flow-based market coupling, zonal electricity markets, optimal power flow, chance constraints, flow reliability margins**

NOMENCLATURE

A. Indices

E Number of CNEs
L Number of lines
N Number of nodes
Z Number of zones

B. Parameters

$\boldsymbol{d}_t$ Vector of demand at time t indexed as $d_{t,i}$
$\boldsymbol{e}$ Vector of ones in appropriate dimensions
$\boldsymbol{f}^{ref}$ Vector of reference flows computed from basecase and day-ahead results
$\overline{\boldsymbol{f}}$ Vector of maximum line capacity indexed by $\overline{f}_j$
FAV Vector of final adjustment values for each CNEC
FRM Vector of flow reliability margins for each CNEC
$\overline{\boldsymbol{g}}$ Vector of maximum generation capacity indexed by $\overline{g}_i$
GSK Vector of generation shift keys
minRAM Minimum remaining available margin
$\text{NTC}_{k,k'}$ Net transfer capacity between zone k and k'
PTDF Nodal power transfer distribution matrix
$\boldsymbol{r}_t$ Vector of available RES power at time t indexed as $r_{t,i}$
$\boldsymbol{R}$ Vector of linear cost parameters
RAM Vector of remaining available margins on each CNEC
s_t Square root of sum of covariance matrix $s^2 = \boldsymbol{e}^T \boldsymbol{\Sigma_t} \boldsymbol{e}^T$
z_ϵ Risk parameter defined as $\Phi^{-1}(1-\epsilon)$
$\mathbf{zPTDF}_t$ Zonal power transfer distribution matrix at time t where $\mathbf{zPTDF}_{t,j}$ is the j-th row of $\mathbf{zPTDF}_t$
ϵ Risk level
$\boldsymbol{\Sigma}_t$ Covariance matrix of forecast error at time t
$\boldsymbol{\omega}_t$ Forecast error at time t
$\boldsymbol{\Omega}_t$ Uncertainty space of forecast error at time t

C. Variables

$\boldsymbol{C}_t$ Vector of curtailment at time t indexed as $C_{t,i}$
$\mathbf{EX}_t$ Matrix collecting the net exchange between zones at time t
$\boldsymbol{f}_t$ Vector of flows at time t indexed as $f_{t,j}$
$\boldsymbol{G}_t$ Vector of active generation at time t indexed as $G_{t,i}$
$\boldsymbol{I}_t$ Vector of nodal net injections at time time t indexed as $I_{t,i}$
$\mathbf{NP}_t$ Vector of net positions at time t indexed as $\text{NP}_{t,k}$
$T_{t,j}$ Auxiliary variable capturing the standard deviation of flow on CNE j at time t
$\boldsymbol{\alpha}_t$ Vector of balancing participation factors at time t indexed by $\alpha_{t,i}$

D. Mappings, Operators, and Other

$.^{bc}$ Value obtained from basecase stage
$\mathcal{C}(\cdot)$ Generator cost model
$.^{da}$ Value obtained from day-ahead stage
$\mathbb{E}(\cdot)$ Expected value
$\mathcal{F}^{\text{nodal}}$ Space of feasible net injections for nodal network model
$\mathcal{F}^{\text{ntc}}$ Space of feasible net exchanges for NTC model
$\mathcal{F}^{\text{zonal}}$ Space of feasible net positions for zonal network model
$\mathcal{L}(i)$ Returns line index of CNEC i
$\boldsymbol{m}$ Maps nodes to zones
$\mathcal{P}(\cdot)$ Curtailment penalty model
$\mathbb{P}(\cdot)$ Probability
$.^{red}$ Value obtained from redispatch stage
$\text{Var}(\cdot)$ Variance
$\sigma(\cdot)$ Standard deviation
Φ Cumulative distribution function of the standard normal distribution
$\|\cdot\|_2$ 2-norm

I. INTRODUCTION

In the interconnected European power system, transnational electricity trading promises to improve system efficiency, market liquidity and price convergence [1]. However, the transport capacity between national market areas is limited and

This work was partially funded by the Bundesministerium für Wi
und Energie grant No. 03EI1019B.

DOI: 10.1109/TPWRS.2023.3265320

Highlights:

- Eine detaillierte Übersicht über die technischen Details des Flow-Based Market Coupling (FBMC) Prozesses und dessen Modellierungsmethoden
- Diskussion der Auswirkungen hoher Anteile fluktuierender erneuerbarer Energien auf die Leistungsfähigkeit von FBMC
- Vorstellung eines neuen Ansatzes für probabilistische Sicherheitsmargen, die mit der aktuellen FBMC-Implementierung kompatibel sind, um die Unsicherheit erneuerbarer Energiequellen besser in FBMC-Modellen

Überblick über den Stand der Forschung zur Ökonomie von fluktuierenden erneuerbaren Energien und Stromspeichern

Published

ANNUAL REVIEWS

Annual Review of Resource Economics

The Economics of Variable Renewable Energy and Electricity Storage

Javier López Prol[1,2,3] and Wolf-Peter Schill[2]

[1]Wegener Center for Climate and Global Change, University of Graz, 8010 Graz, Austria; email: javier.lopez-prol@uni-graz.at

[2]German Institute for Economic Research (DIW Berlin), 10117 Berlin, Germany; email: wschill@diw.de

[3]Department of Economics, Yonsei University Mirae Campus, Wonju-si, Gangwon-do, South Korea

Annu. Rev. Resour. Econ. 2021. 13:443–67

The *Annual Review of Resource Economics* is online at resource.annualreviews.org

https://doi.org/10.1146/annurev-resource-101620-081246

JEL codes: C63, Q42, Q58

Keywords

energy transition, decarbonization, variable renewable energy sources, electricity storage, merit-order effect, cannibalization effect

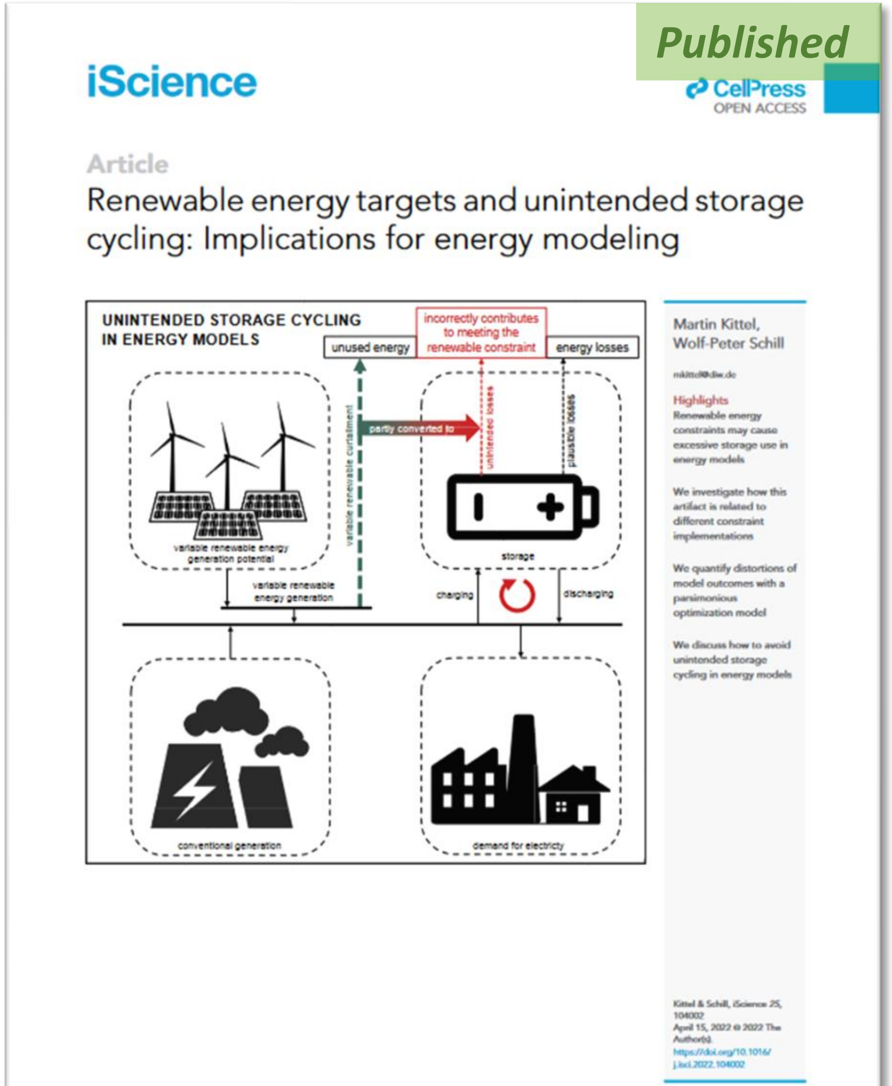
Abstract

The transformation of the electricity sector is a central element of the transition to a decarbonized economy. Conventional generators powered by fossil fuels have to be replaced by variable renewable energy (VRE) sources in combination with electricity storage and other options for providing temporal flexibility. We discuss the market dynamics of increasing VRE penetration and its integration in the electricity system. We describe the merit-order effect (the decline of wholesale electricity prices as VRE penetration increases) and the cannibalization effect (the decline of VRE value as its penetration increases). We further review the role of electricity storage and other flexibility options for integrating variable renewables and how storage can contribute to mitigating the two mentioned effects. We also use a stylized open-source model to provide some graphical intuition on these issues. While relatively high shares of VRE are achievable with moderate amounts of electricity storage, the role of long-duration storage increases as the VRE share approaches 100%.

https://doi.org/10.1016/j.isci.2022.104002

Highlights:

- Diskussion des merit order effect und des cannibalization effect, d.h. die Effekte des Ausbaus fluktuierender erneuerbarer Energien auf die Strommarktpreise bzw. auf ihre eigenen Marktwerte.
- Zentrale Speicher können beide Effekte deutlich dämpfen.
- Es zeigt sich, dass Speicher und fluktuierende erneuerbare Energien zu einem gewissen Grad komplementäre Technologien sind: ein höherer Anteil der einen erhöht den Wert der anderen.
- Illustrationen mit einer vereinfachten Version des Stromsektormodells DIETER



Published

iScience

CellPress OPEN ACCESS

Article

Renewable energy targets and unintended storage cycling: Implications for energy modeling

Martin Kittel,
Wolf-Peter Schill

mkittel@diw.de

Highlights

Renewable energy constraints may cause excessive storage use in energy models

We investigate how this artifact is related to different constraint implementations

We quantify distortions of model outcomes with a parsimonious optimization model

We discuss how to avoid unintended storage cycling in energy models

Kittel & Schill, iScience 25, 104002
April 15, 2022 © 2022 The Author(s).
https://doi.org/10.1016/j.isci.2022.104002

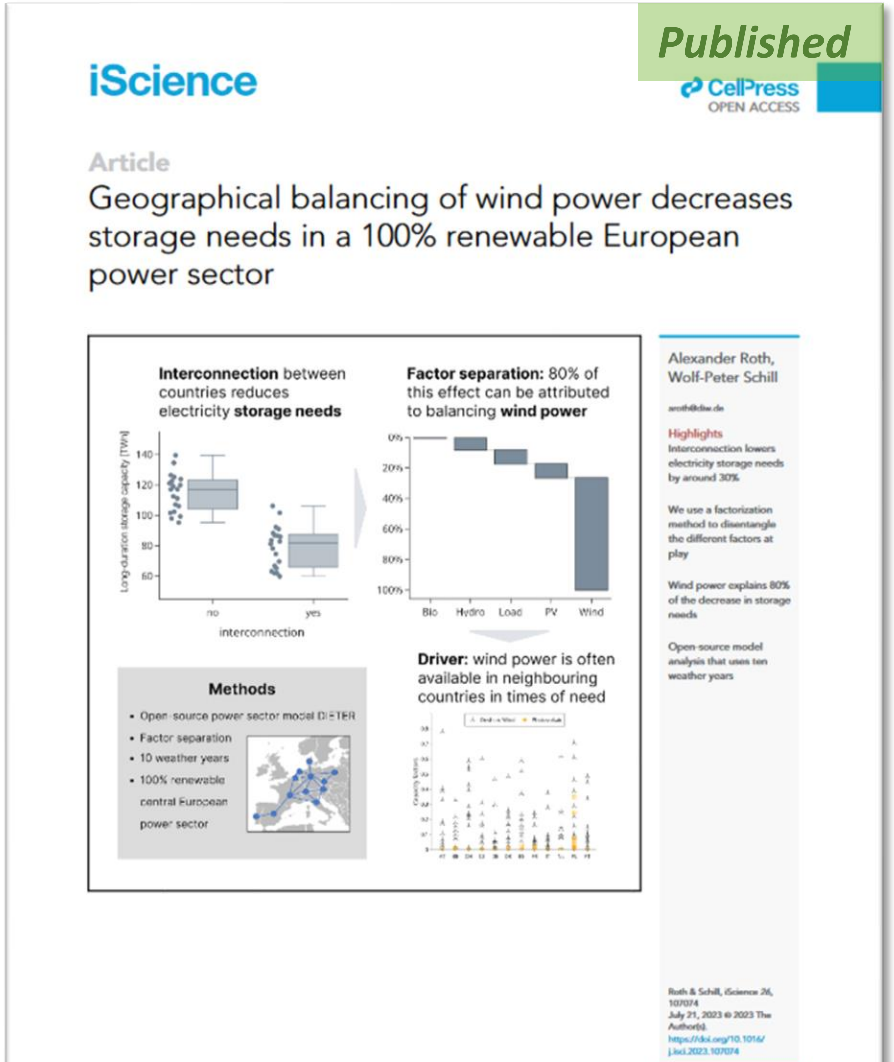
https://doi.org/10.1016/j.isci.2022.104002

Unintended storage cycling: Illustration eines bisher nicht beschriebenen Modellartefakts und wie es behoben werden kann

AP 3
Zentral / Investitionen

Highlights:

- Die Berücksichtigung eines Mindestanteils erneuerbarer Energien ist in vielen Energiesystemmodellen eine relevante Randbedingung
- Ein relativer EE-Mindestanteil kann allerdings zu einem Modellartefakt führen, das den Einsatz zentraler Speicher sowie Investitionen verfälschen kann
- Es wird analysiert, wie dieses Phänomen mit verschiedenen Implementierungen von Randbedingungen zusammenhängt und wie es behoben werden kann
- Quantifizierung der Verzerrungen von Modellergebnissen am Beispiel einer einfachen Version des Stromsektormodells DIETER



https://doi.org/10.1016/j.isci.2023.107074

AP 3
Zentral / Investitionen

Analyse von Einflussfaktoren für sinkenden Stromspeicherbedarf im EU-Verbund

Highlights:

- Die Nutzung des europäischen Stromverbundes senkt den Bedarf für zentrale Stromspeicher um rund 30 %
- Verwendung einer neuartigen Faktorisierungsmethode, um verschiedene relevante Faktoren zu separieren
- Der Ausgleich der Windkraftprofile über mehrere Länder erklärt 80 % des Rückgangs des Langfrist-Speicherbedarfs
- Analyse mit einer zentraleuropäischen Version des Stromsektormodells DIETER

Published


DIW Wochenbericht 41 2023

AUF EINEN BLICK

Nationale Wasserstoffstrategie konsequent und mit klarem Fokus umsetzen

Von Martin Kittel, Dana Kirchem, Wolf-Peter Schill und Claudia Kemfert

- Bericht analysiert die überarbeitete Nationale Wasserstoffstrategie und zeigt Unterschiede zur alten Strategie auf
- Überblick zu Erzeugungs- und Einsatzmöglichkeiten von Wasserstoff und Derivaten
- Analyse der Mengenplanung für das Jahr 2030 mit verschiedenen Verbrauchs- und Importszenarien von Wasserstoff
- Für 2030 anvisierte Wasserstoffmengen stellen erhebliche Herausforderung dar und bringen große Unsicherheiten mit sich
- Hochlauf bei heimischer Erzeugung und Importen mit klarer Fokussierung auf bestimmte Anwendungen beschleunigen

Bedingungen für den Erfolg der Nationalen Wasserstoffstrategie sind ...

Quelle: Eigene Darstellung. © DIW Berlin 2023

ZITAT

„Die neue Wasserstoffstrategie der Bundesregierung konkretisiert künftige Anwendungsbereiche, enthält aber noch große Unsicherheiten bei den geplanten Wasserstoffmengen. Die Importziele für das Jahr 2030 scheinen derzeit nur schwer erreichbar."

MEDIATHEK

Audio-Interview mit Martin Kittel

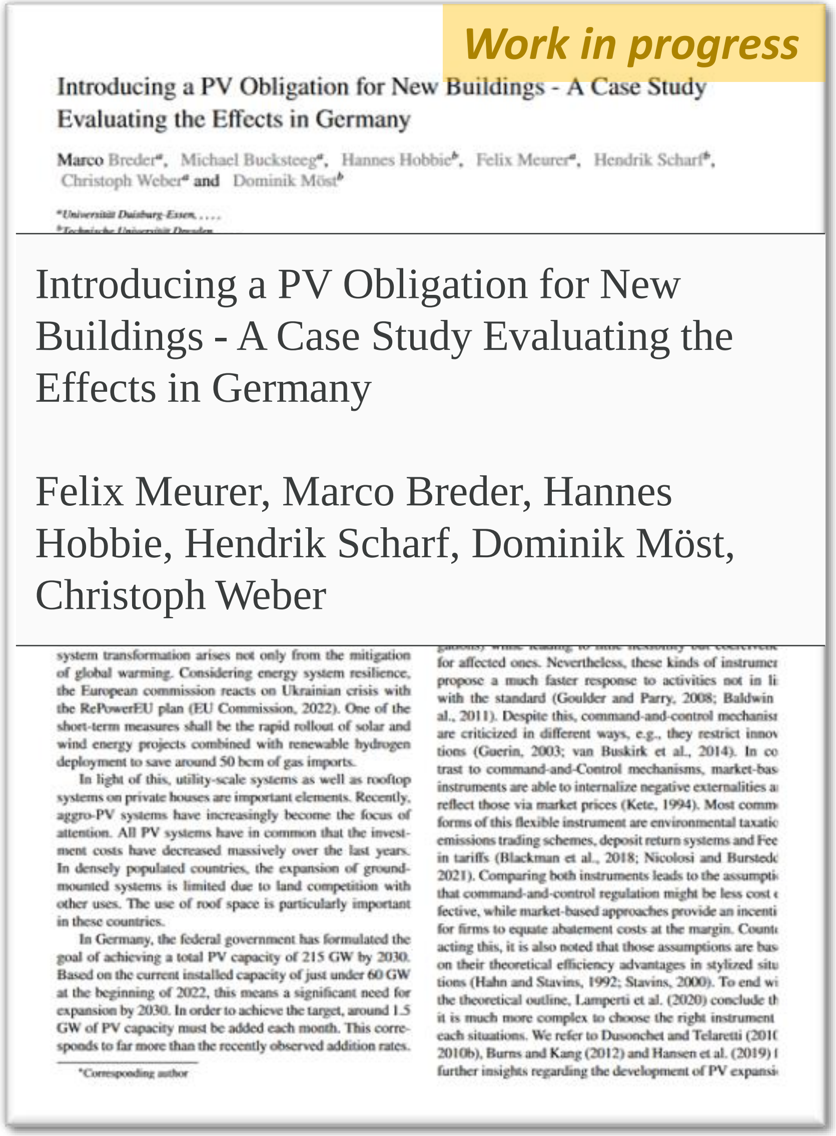
https://doi.org/10.18723/diw_wb:2023-41-1

AP 3
Zentral / Investitionen

Analyse der Fortschreibung der Nationalen Wasserstoffstrategie mit Fokus auf Mengenplanung und Importszenarien

Highlights:

- Für 2030 anvisierte Wasserstoffmengen stellen erhebliche Herausforderung dar und bringen große Unsicherheiten mit sich
- Hochlauf bei heimischer Erzeugung und Importen mit klarer Fokussierung auf bestimmte Anwendungen sollte beschleunigt werden
- Entwicklung von zentralen und systemdienlichen Elektrolyseuren sowie Speichern und anderer Wasserstoff-Infrastruktur hat stark an Bedeutung gewonnen gegenüber früherer Strategie



Work in progress

Introducing a PV Obligation for New Buildings - A Case Study Evaluating the Effects in Germany

Marco Breder[a], Michael Bucksteeg[a], Hannes Hobbie[b], Felix Meurer[a], Hendrik Scharf[b], Christoph Weber[a] and Dominik Möst[b]

Introducing a PV Obligation for New Buildings - A Case Study Evaluating the Effects in Germany

Felix Meurer, Marco Breder, Hannes Hobbie, Hendrik Scharf, Dominik Möst, Christoph Weber

system transformation arises not only from the mitigation of global warming. Considering energy system resilience, the European commission reacts on Ukrainian crisis with the RePowerEU plan (EU Commission, 2022). One of the short-term measures shall be the rapid rollout of solar and wind energy projects combined with renewable hydrogen deployment to save around 50 bcm of gas imports.

In light of this, utility-scale systems as well as rooftop systems on private houses are important elements. Recently, aggro-PV systems have increasingly become the focus of attention. All PV systems have in common that the investment costs have decreased massively over the last years. In densely populated countries, the expansion of ground-mounted systems is limited due to land competition with other uses. The use of roof space is particularly important in these countries.

In Germany, the federal government has formulated the goal of achieving a total PV capacity of 215 GW by 2030. Based on the current installed capacity of just under 60 GW at the beginning of 2022, this means a significant need for expansion by 2030. In order to achieve the target, around 1.5 GW of PV capacity must be added each month. This corresponds to far more than the recently observed addition rates.

*Corresponding author

Auswirkungen einer PV-Pflicht für Neubauten in Deutschland

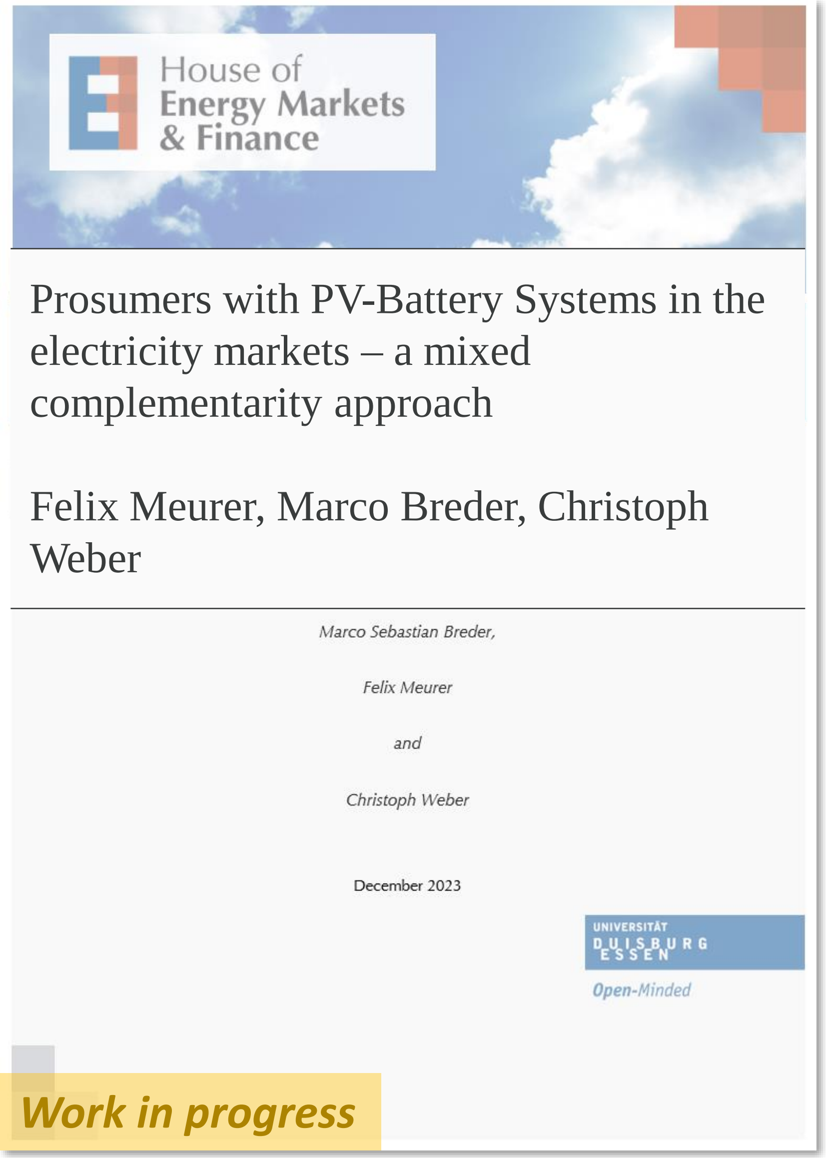
AP 5
Dezentral / Investitionen

Highlights:

- Eine PV-Pflicht für Neubauten kann einen signifikanten aber begrenzten Beitrag zum Erreichen der Ausbauziele leisten
- Das Ausbaupotenzial bei Neubauten im Nichtwohngebäudesektor ist größer als im Wohngebäudesektor
- Das Ausbaupotenzial im Gebäudebestand ist größer als bei Neubauten

Universität Duisburg Essen – Offen im Denken · House of Energy Markets & Finance · Technische Universität Dresden · ee2 · MODEZEEN

Wirkung unterschiedlicher Tarifdesigns bei einem hohen Anteil an Prosumage-Haushalten


House of Energy Markets & Finance

Prosumers with PV-Battery Systems in the electricity markets – a mixed complementarity approach

Felix Meurer, Marco Breder, Christoph Weber

Marco Sebastian Breder,

Felix Meurer

and

Christoph Weber

December 2023

UNIVERSITÄT DUISBURG ESSEN

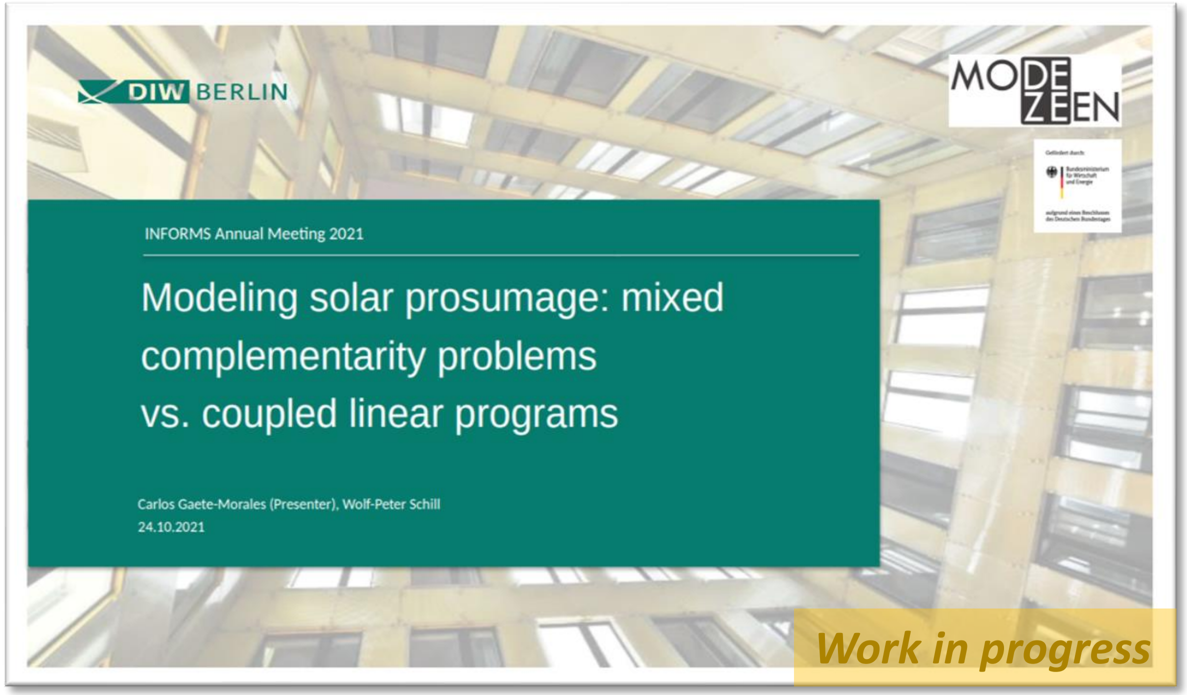
Open-Minded

Work in progress

Highlights:

- Identifikation von regulatorischen Rahmenbedingungen, die zu einer systemorientierten Nutzung dezentraler Flexibilitäten führen
- Entwicklung eines partiellen Gleichgewichtsmodells als Mixed-Complementarity-Problem (MCP)
- Explizite Modellierung eines Retailers mit endogener Tarifgestaltung

Methodische Überlegungen zur Modellierung von Prosumage



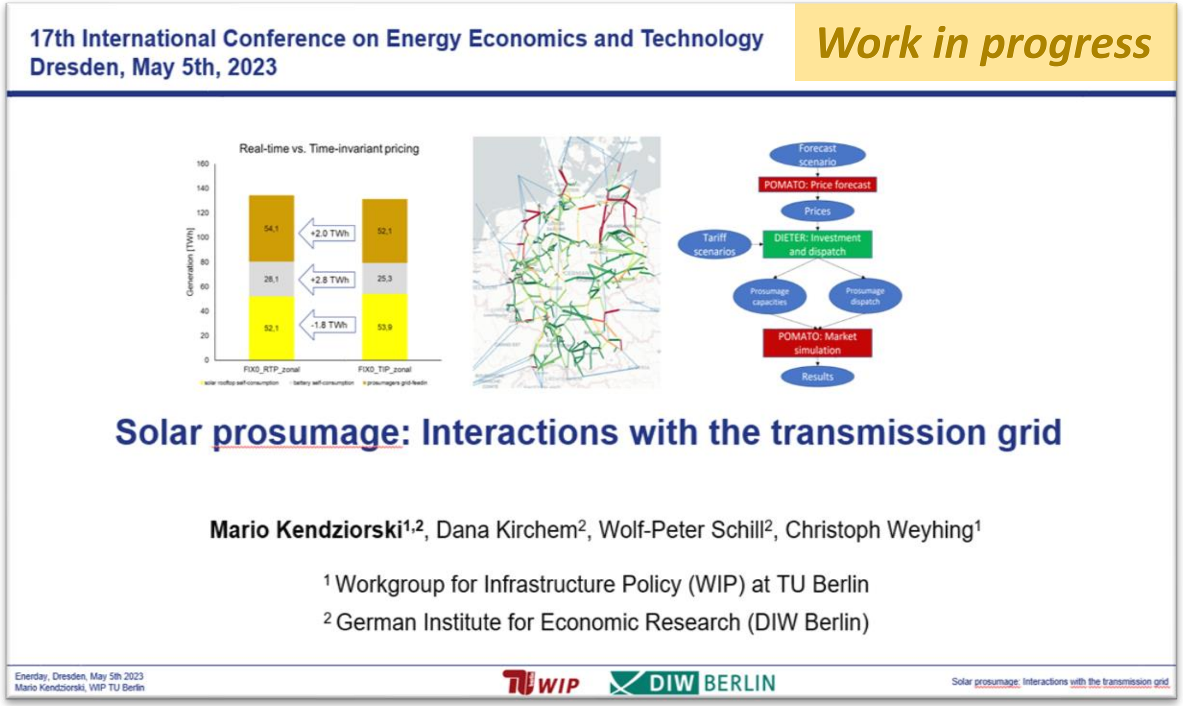
Präsentiert in: INFORMS Annual Meeting 2021, Anaheim, 24.10. 2021

Highlights:

- Die Eigenverbrauchs-Optimierung dezentraler Prosumer in einem ansonsten kosten-minimierenden Strommarkt kann grundsätzlich mit Mixed-Complementarity-Modellformulierungen beschrieben werden.
- Entsprechende Modellformulierungen müssen jedoch sehr stilisiert bleiben, um in akzeptabler Zeit numerisch gelöst werden zu können
- Um detailliertere Modelle rechnen zu können wird alternativ eine iterative Lösung zweier linearer Probleme exploriert

AP 4
Dezentral / Betrieb

Auswirkungen des Verhaltens von dezentralen Solar-Prosumern auf das Übertragungsnetz



Präsentiert in: 17th International Conference on Energy Economics and Technology (Enerday), Dresden, 05.05.2023

Highlights:

- Prosumage-Modul des Models DIETER erlaubt die Ermittlung der aus Prosumer-Sicht optimalen Investitionen in dezentrale PV- und Batteriespeicherkapazitäten
- Eine anschließende Netzmodellierung mit Pomato zeigt, wie sich die Prosumer-Entscheidungen auf die Auslastung des Übertragungsnetzes auswirken
- Verschiedene Tarifgestaltungen beeinflussen die Investitionen in PV-Anlagen und Batteriespeicher (Nodale Preise, Real-time pricing)

Untersuchung verschiedener Ausgestaltungsformen dezentraler Flexibilitätsmärkte

AP 4
Dezentral / Betrieb

Work in progress

How to deal with strategically acting aggregators? Toward understanding market equilibria at locational markets for congestion management

Hannes Hobbie[a,*], Ramteen Sioshansi[b], Dominik Möst[a]

[a]Chair of Energy Economics, TU Dresden, Germany
[b]Department of Integrated Systems Engineering and Department of Electrical and Computer Engineering, The Ohio State University, United States

How to deal with strategically acting aggregators? Toward understanding market equilibria at locational markets for congestion management

Hannes Hobbie, Ramteen Sioshansi, Dominik Möst

Problem

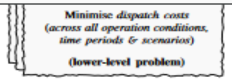


Figure 1: Optimisation problems and bilevel structure of the modelling framework

3.1. Bilevel modelling framework

As alluded to in Section 1, the research question can be expressed as a hierarchical sequence of optimisation problems, in which one optimisation problem (agent-decision making) is subject to two other optimisation problems (day-ahead market equilibrium and real-time congestion management). In order to model these dynamics, the mathematical structure of a bi-level optimisation problem is exploited. The upper and lower level problems are represented as illustrated in Fig.1.

Upper level problem

The upper-level problem represents the optimisation problem of the aggregator to serve the loads associated with his customer's flexible load applications at the sub-node where the regional flexibility market is put in place. The aggregator's objective is to derive a purchase schedule for the activation of flexible loads that minimises his energy procurement cost (Eq. 1). Additionally to the day-ahead market expenses for satisfying his (flexible) demands (Eq. 2), he can earn an extra income by providing redispatch capacity by demand-side shifting (Eq. 3). The market expanses are calculated based on the wholesale market price (dual from zonal market balance), and the additional earnings take into account a price for flexibility provision (dual from nodal market balance). Electricity prices and assumed flexibility prices are determined during the day-ahead market clearing and congestion management optimisation, thus part of the lower-level problem. The aggregator must further meet the total amount of flexible loads over the course of a day to satisfy the customer's power requirements (Eq. 4). Moreover, the activation of flexible loads is constrained to an activation limit in each hour, some specific maximal electrical load (Eq. 5). The aggregator's optimisation problem is formulated with the following equation system:

$$\min \quad C^{a} = C^{a,da} - E^{a,rt} \tag{1}$$

$$C^{a,da} = \sum_{n',t} H^{da}_{n',t} \cdot \pi_t \tag{2}$$

*Corresponding author

Preprint submitted to European Journal of Operational Research *November 27, 2023*

Highlights:

- Modellierung eines mehrstufigen Ansatz zur Abbildung von Aggregator-Verhalten
- Anwendung von Spieltheorie auf Marktmodellierung
- Ableitung von Implikationen zu verschiedenen Markträumungsformen und der potenziellen Ausübung von lastseitigem Inc-Dec-Gaming