



THE FUTURE OF ELECTRICITY MARKETS WITH DISTRIBUTION NETWORK CONSTRAINTS

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■ Distribution network tariffs

- Schittekatte, T., Meeus, L., 2020. *Least-cost Distribution Network Tariff Design in Theory and Practice*. IAAE Energy Journal, 41 (5).
- Govaerts, N., Bruninx, K., Le Cadre, H., Meeus, L., Delarue, E., 2019. *Spillover effects of distribution grid tariffs in the internal electricity market: An argument for harmonization?* Energy Economics, 84.
- Schittekatte, T., Momber, I., Meeus, L., 2018. *Future-proof tariff design: recovering sunk grid costs in a world where consumers are pushing back*. Energy Economics, Vol. 70, pp. 484–498.

■ Trade-off between distribution network expansion and flexibility contracting

- Nouicer, A., Meeus, L., Delarue, E., 2020. *The economics of explicit demand-side flexibility in distribution grids*. Working paper <https://hdl.handle.net/1814/67762>

■ Flexibility procurement in the sequence of electricity markets

- Beckstedde, E., Meeus, L., Delarue, E., 2021. *Flexibility procurement in the sequence of electricity markets*, work in progress
- Leonardo Meeus, 2020. *The evolution of electricity markets in Europe*. Book with Edward Elgar publishing
- Schittekatte, T., Meeus, L., 2020. *Flexibility markets: Q&A with project pioneers*. Utilities Policy, 63.
- Yemane Hadush, S., Meeus, L., 2018. *DSO-TSO cooperation issues and solutions for distribution grid congestion management*. Energy Policy, Vol. 120, 610-621.

TIM & NIELS DISTRIBUTION TARIFFS



Models used to compare tariff structures use fixed consumer profiles

- Bilevel model with DSO in the upper level and consumers/prosumers investment model in the lower level
- Upper level with step-wise investment function and multi-stage decision

DSOs advocating for capacity tariffs

- Prospective costs (forward looking charges) vs sunk costs (residual charges)
- Individual peak versus system peak

BEUC advocating against unfair fixed charges

- Difficult to reach fairness with fixed, capacity or volumetric tariffs

European Commission for harmonize distribution tariffs

- Positive and negative spillover effects of distribution tariffs

BEAUTY OF MATHEMATICAL MODELS

E.G. NON-COOPERATIVE PROSUMER EQUILIBRIUM



T. Schittekatte et al. / Energy Economics 70 (2018) 484–498

493

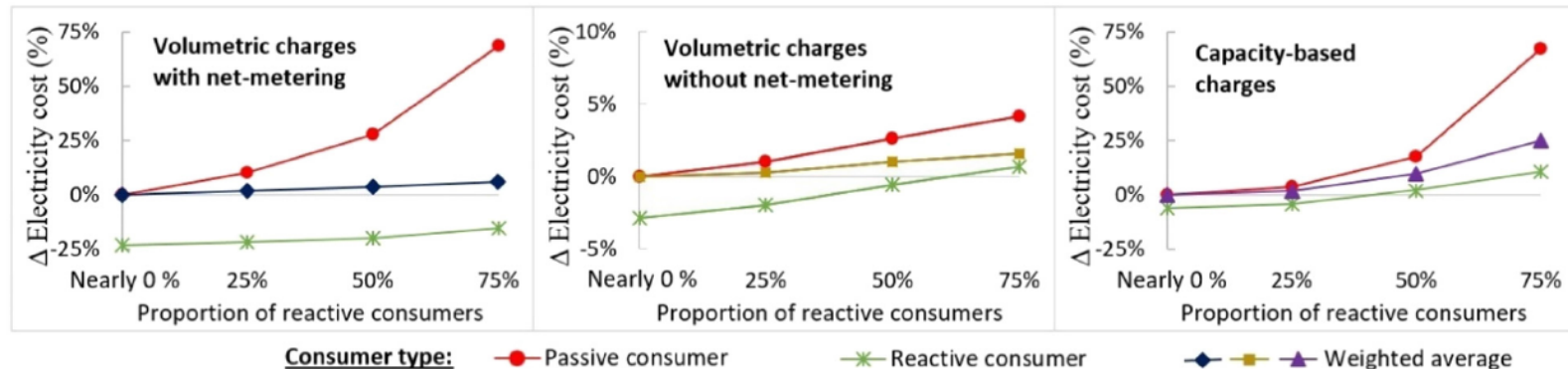


Fig. 4. Difference in annual electricity cost per consumer type for the three network tariff structures compared to the application of non-distortive fixed network tariffs. Additionally, the weighted average electricity cost (or system cost) which serves as the proxy for efficiency is shown.

ATHIR FLEXIBILITY TRADE-OFF



Add option to curtail demand in upper level bilevel model Tim and Niels

- Too expensive to use flexibility procurement to handle structural congestion
- Extend the model to include a normal day versus a critical days

Common wisdom that flexibility procurement and tariffs are complementary regulatory tools

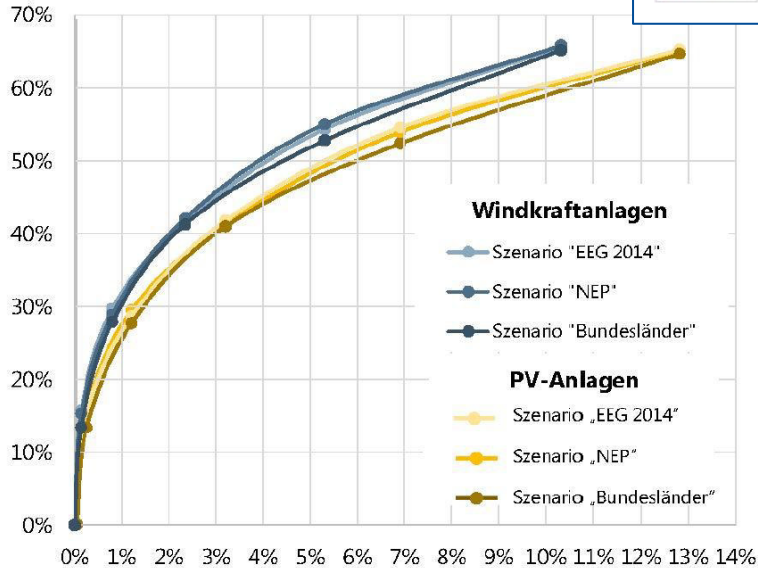
- They are complementary, but imperfect tariffs can create structural issues that are too expensive to solve with flexibility procurement

FLEXIBILITY TRADE-OFF

WIND AND PV CURTAILMENT



The ratio of saving investment expansion

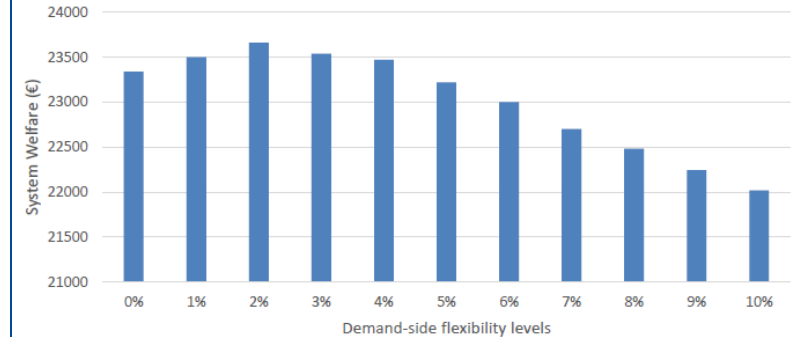


The ratio of curtailment volume

DEMAND CURTAILMENT



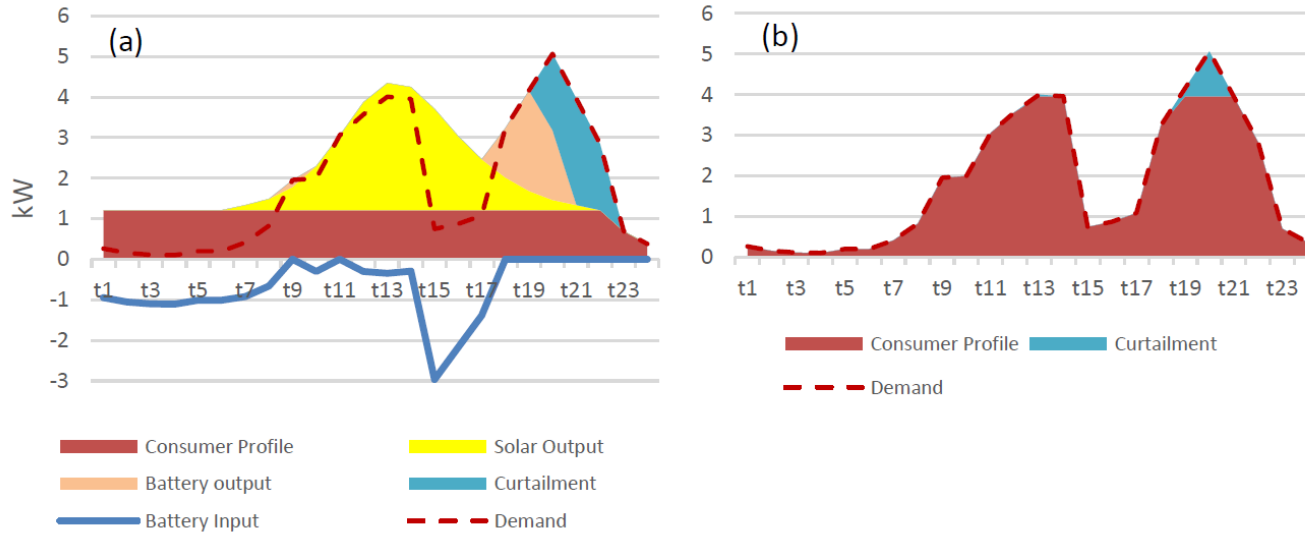
Figure 4: System welfare for different demand-side flexibility levels



BEAUTY OF MATHEMATICAL MODELS

E.G. PROSUMER GAMING HIGH COMPENSATION FOR CURTAILMENT

Figure 7: Load profile for the different types of consumers with $Comp = \text{€}5$: (a) prosumers, (b) passive consumers



ELLEN FLEXIBILITY PROCUREMENT



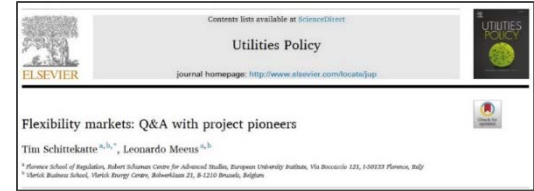
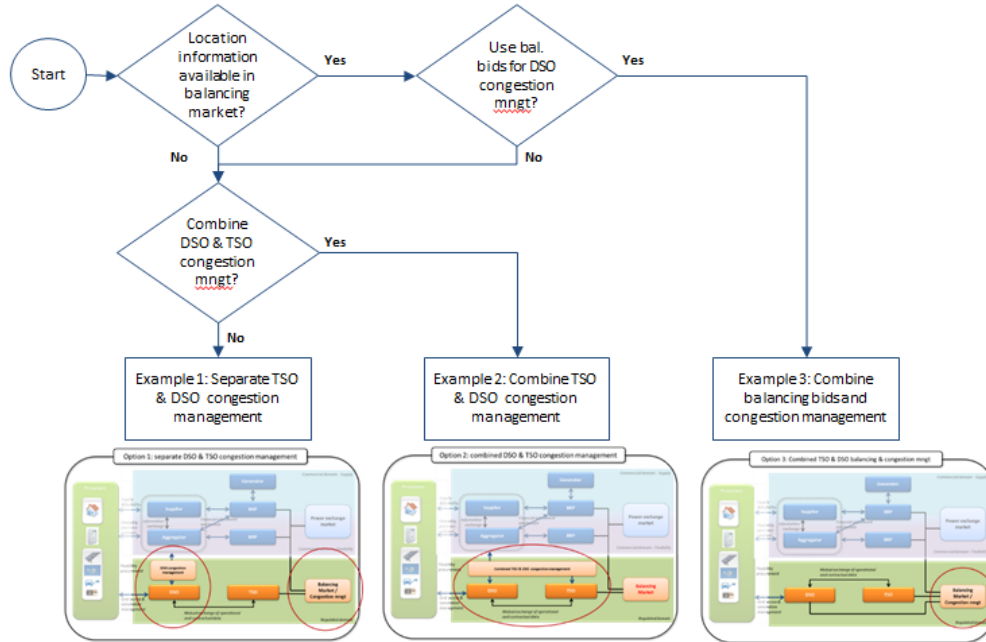
Flexibility markets in practice range from long-term contracts to intra-day markets

- Should we harmonize the sequence of markets, including flexibility markets?

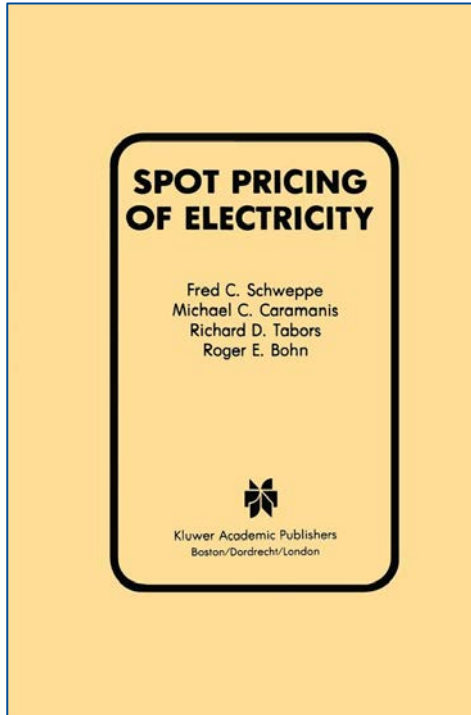
Practices of filtering of balancing bids, prequalification, and the open issue of compensation

- Modelling the competition between system operators for distributed resources

FLEXIBILITY PROCUREMENT



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Distribution Network Economics Workshop – November 7-8, 2019

Electricity Distribution Network Economics:

Spatiotemporal Marginal Cost Estimation and Use in the Co-Optimization of Network, Renewable Generation and Storage-Like DERs

The Sloan Foundation and Boston University hosted the workshop on “Electricity Distribution Network Economics: Spatiotemporal Marginal Cost Estimation and Use in the Co-Optimization of Network, Renewable Generation and Storage-Like DERs” on **November 7-8, 2019** at the Boston University campus – [Trustees Ballroom](#), 1 Silber Way, 9th Floor, Boston, MA 02215.

This event was sponsored by the [Sloan Foundation](#) and the [Department of Mechanical Engineering](#) and the [Center for Information and Systems Engineering \(CISE\)](#) at Boston University.

[Agenda Day 1](#) – November 7, 2019

[Agenda Day 2](#) – November 8, 2019

Participant [Biographies](#)

Workshop Organizers:

Michael Caramanis, Professor of Mechanical Engineering (ME) and Systems Engineering (SE), Boston University

HOW WOULD DISTRIBUTION LOCATIONAL MARGINAL PRICING WORK IN PRACTICE?

CALCULATION

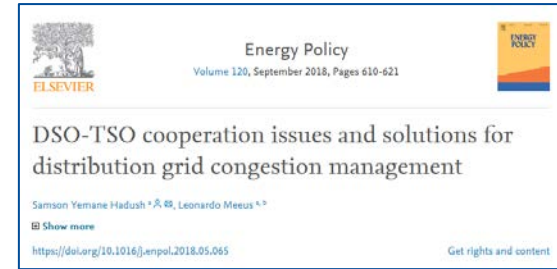
	Transmission	Distribution
Real power	Important	Important
Reactive power	Not a big deal	Need to be taken into account
Losses	Not a big deal	More significant
Loop flows	Important (meshed)	Less important (radial)

GOVERNANCE

- ISO continues to compute LMPs
- D-ISO computes DLMPs, which could be enhanced LMPs

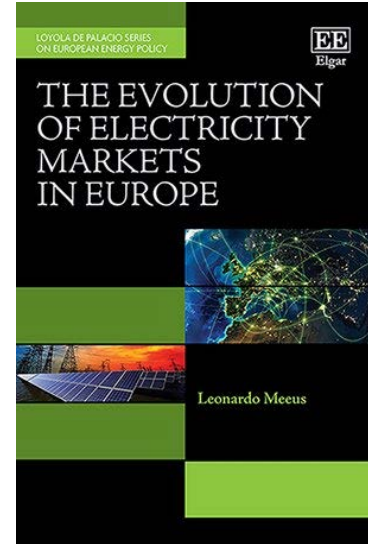
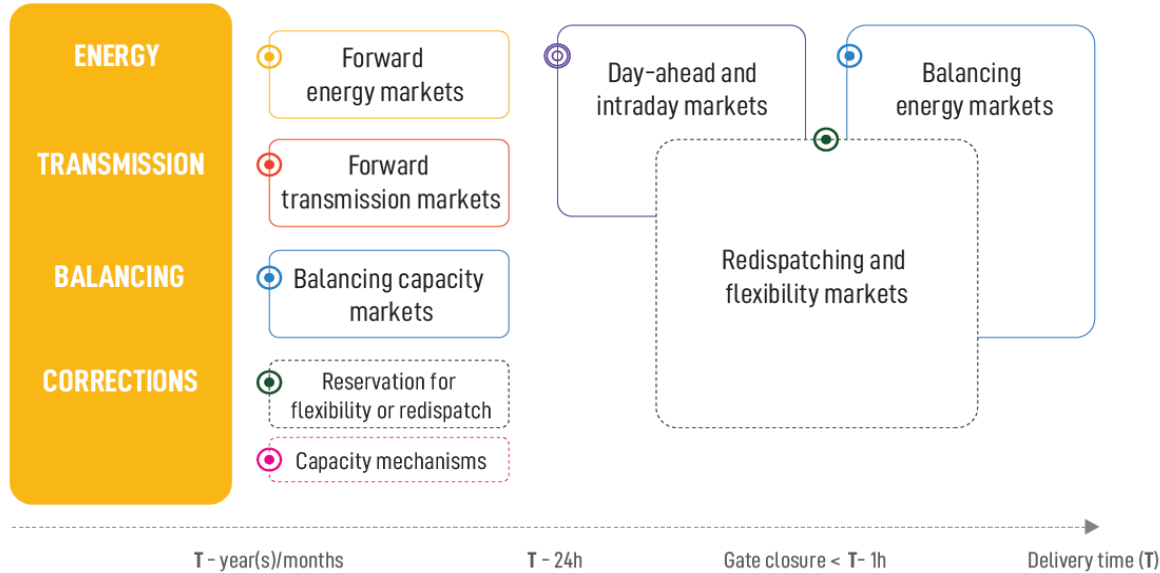
FROM FILTERING BALANCING BIDS TO ZONAL PRICING IN DISTRIBUTION GRIDS

- Filtering balancing bids is equivalent to pro-rata allocation of transfer rights on T-D border
- Next logical steps are to
 - Auction these rights explicitly and then implicitly, i.e. zonal pricing for distribution grids
 - Extend the approach from balancing to wholesale markets



BEAUTY OF SYNTHESIS

Sequence of Electricity Markets in Europe



Leonardo Meeus, 2020. The Evolution of Electricity Markets in Europe. Book published by Edward Elgar



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