Paper No: 22PESGM3348

UNIVERSIDAD DE MÁLAGA

Learning the price response of active distribution networks for TSO-DSO coordination

Juan M. Morales, S. Pineda and Y. Dvorkin

University of Malaga, OASYS

juan.morales@uma.es

European Research Council

Established by the European Commission

OASYS

Optimization and Analytics for Sustainable energY Systems

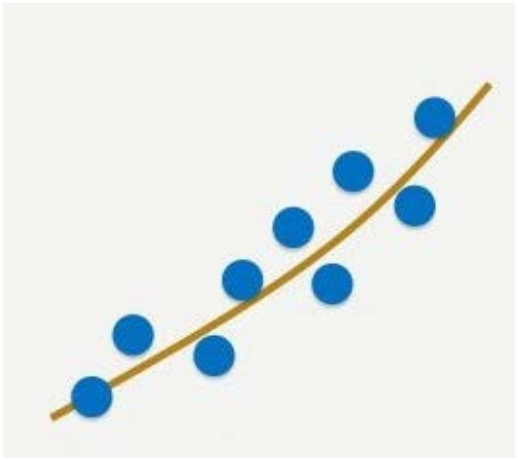
IEEE PES Power & Energy Society®

IEEE

Overview

TSO-DSO coordination	
Horizon	1-36h
Objective	Min production cost
Variables	Power dispatch Substation operation
Constraints	Generation = demand Unit technical limits Line technical limits

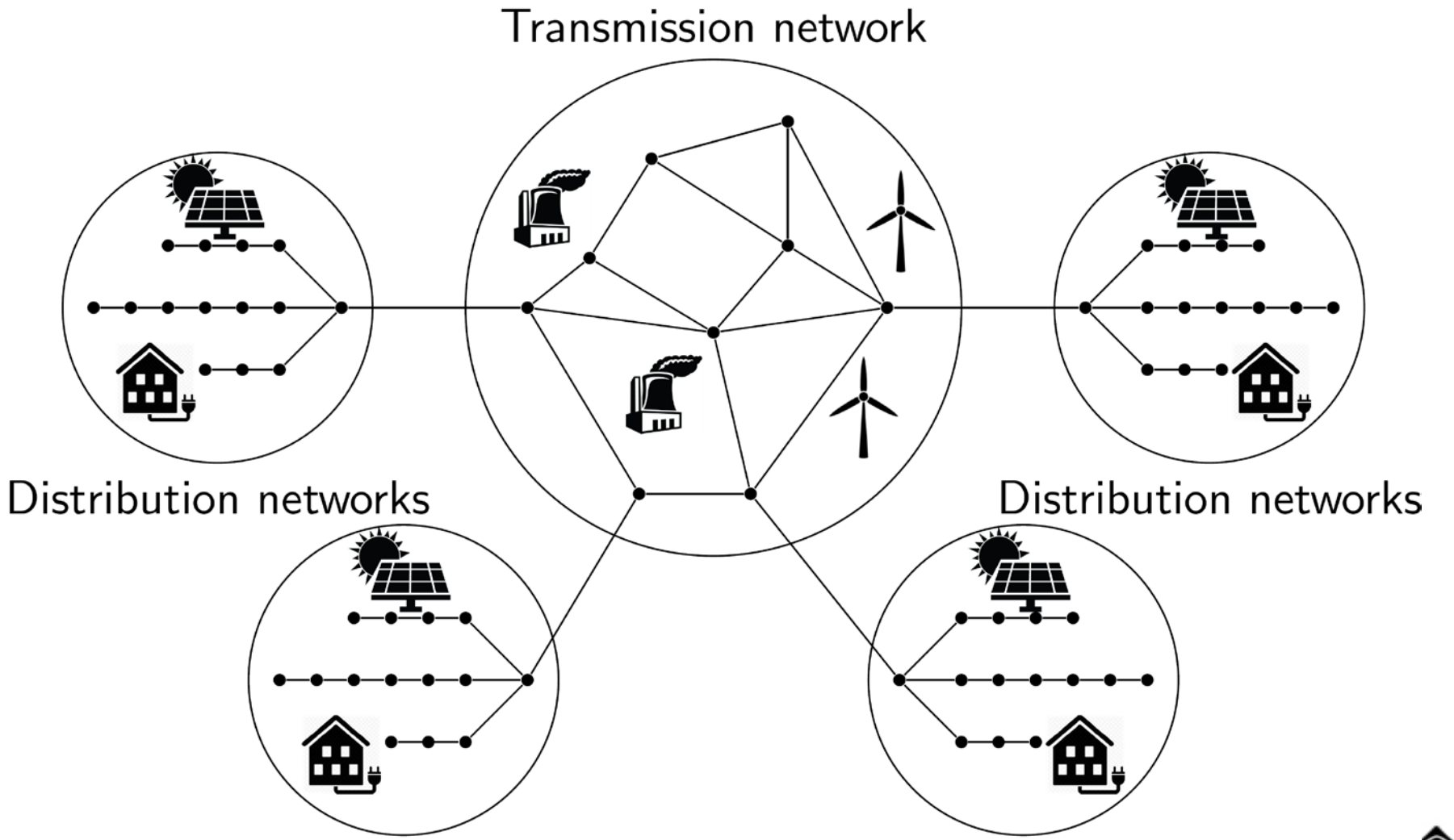
Regression



AIM

Facilitating TSO-DSO coordination by learning the response of distribution networks using contextual information

TSO-DSOs coordination

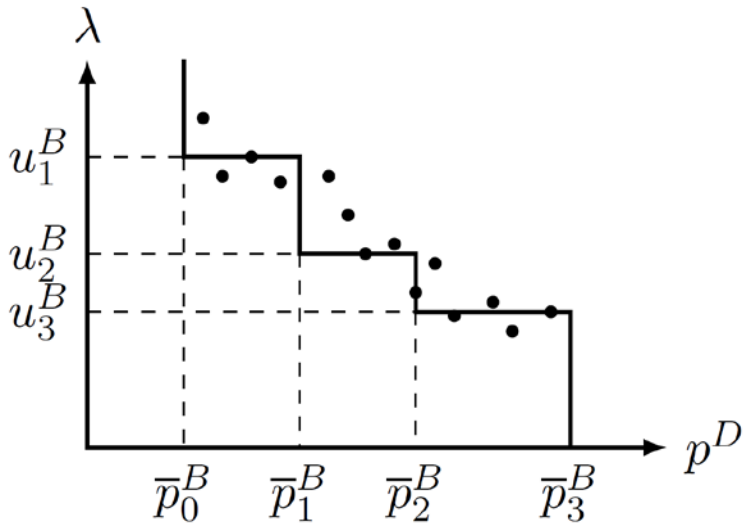


Current approaches

- **Benchmark**
  - Full representation of transmission and distribution networks (DNs).
  - Requires full access to network topology and end-users' parameters. A single entity treasures all the info.
  - Extremely costly computationally.
- **Single-bus approach (SB)**
  - All network constraints of DNs are ignored.
  - Computationally cheap.
  - Works only for uncongested DNs.
- **Price-agnostic approach (PAG)**
  - Assumes the power intake of DNs is independent of LMP.
  - Forecasts the power intake of DNs given the context.
  - Works only if distributed energy sources are inflexible.

Contextual price-aware approach (PAW)

- Determines the step-wise non-increasing function that best approximates DNs' response to price[1]

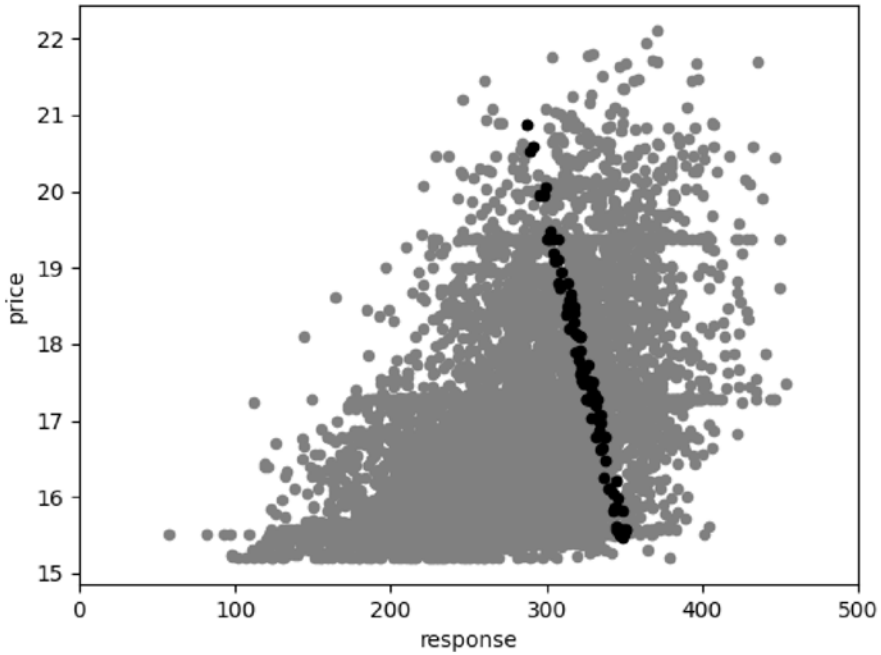


- Doesn't require topological info and preserves end-users' privacy.
- The curve can be directly processed by current market-clearing algorithms.

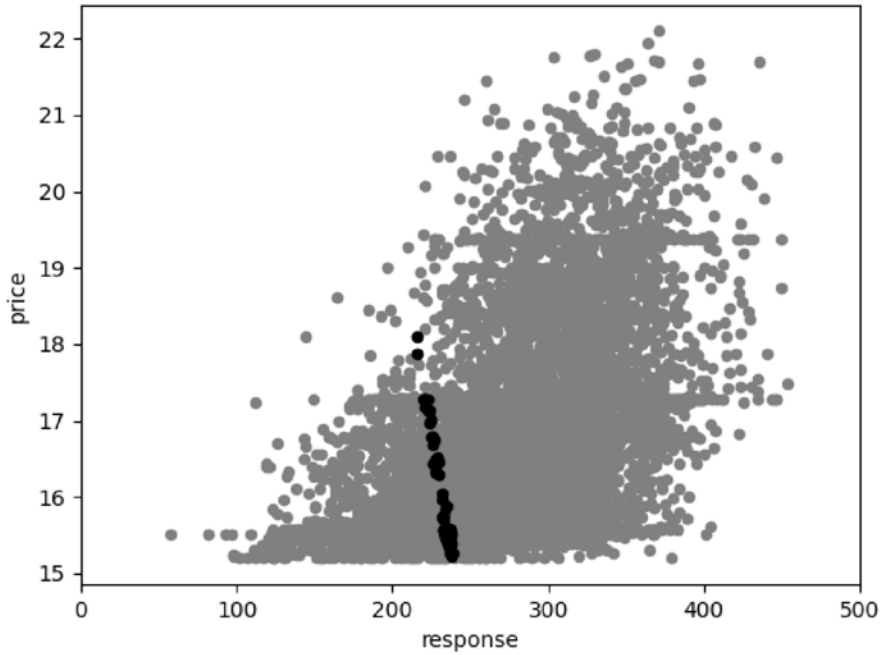
1. V. Bucarey, M. Labbé, J. M. Morales, S. Pineda, "An exact dynamic programming approach to segmented isotonic regression," OMEGA, 105:102516, 2021

Contextual price-aware approach (PAW)

Afternoon (high demand, high solar)



Night (low demand, no solar)

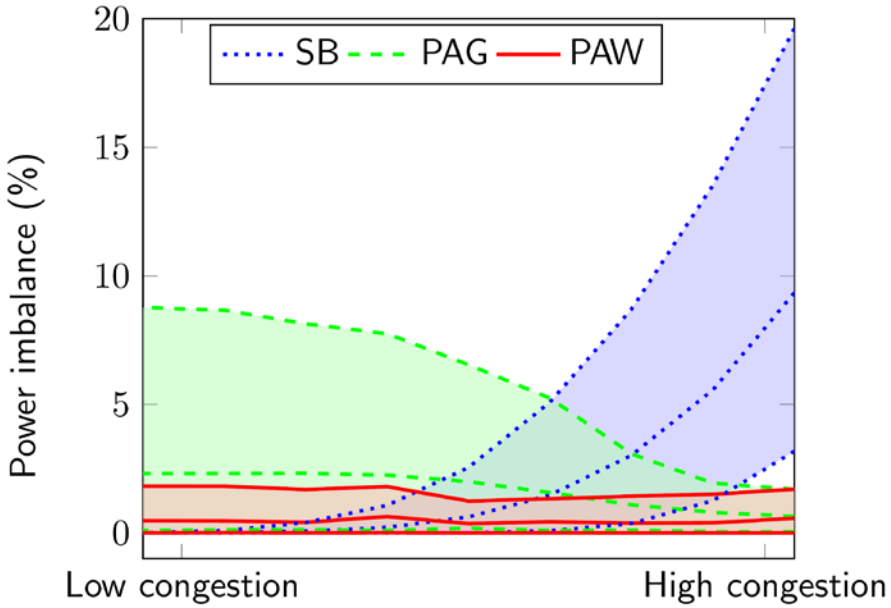


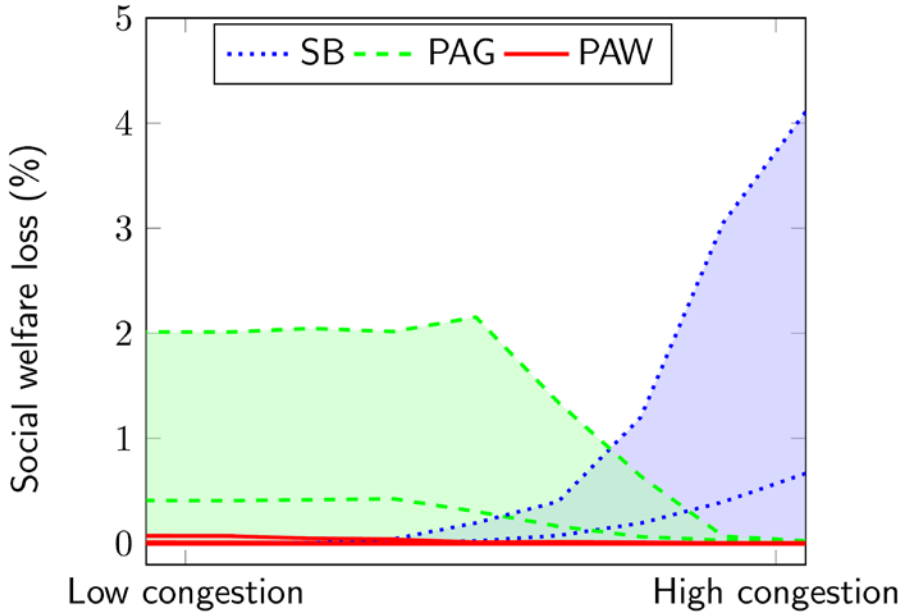
The curve changes with the context

Case study

- Transmission network with 118 buses and 186 lines.
- 91 distribution networks with 32 buses and 32 lines each.
- DNs include flexible consumers and solar power units.
- DNs' parameters are varied to simulate different congestion levels.
- 8760 hours for training and 100 hours for testing.

Results





- SB works for low congestion (network can be disregarded)
- PAG works for high congestion (response independent of price)
- PAW works for both low and high congestion. Average imbalance < 0,7%

- Maximum loss for SB and PAG are 4% and 2%, respectively
- Maximum loss for PAW is 0.1%