Design Evolutions in European Day-ahead Power Markets

Mehdi Madani

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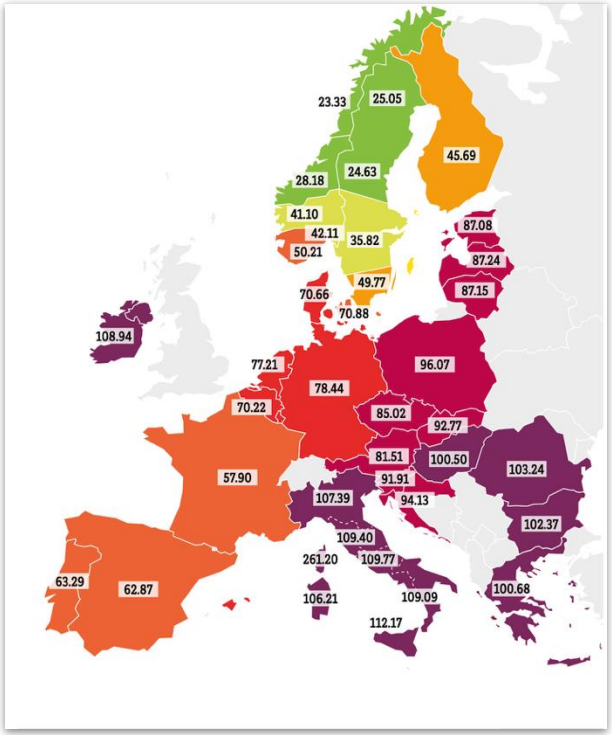
Public data

Why the Single Day-ahead Coupling (SDAC) Matters?



Average Day-Ahead Auction Prices 2024 (CACM Annual Report 2024)

Broad Geographical Scope

- 77 bidding zones (including virtual Bidding Zones),
- 30 TSOs
- 16 operational NEMOs.

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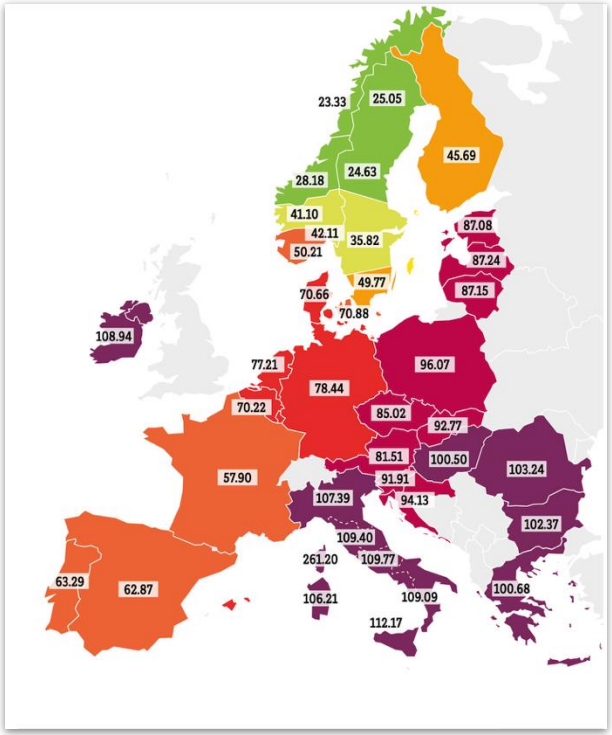

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- Daily traded value around 200-500 M€

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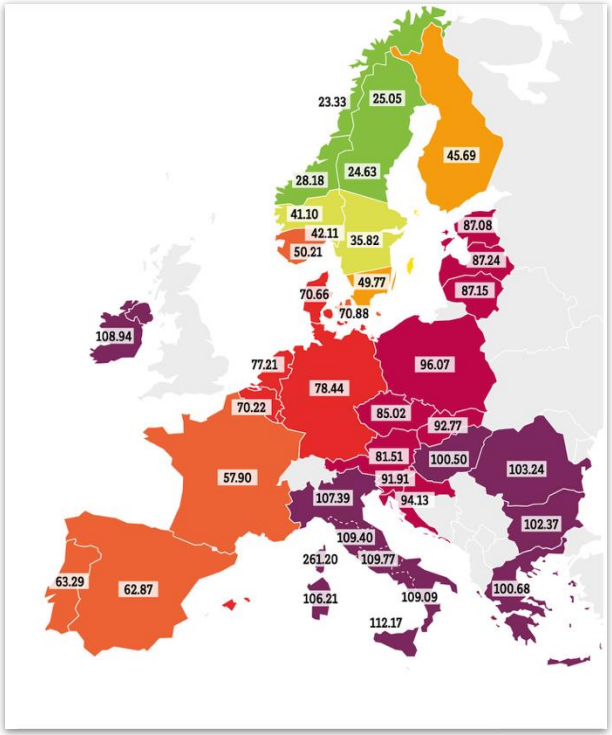

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Central Piece in the Internal Energy Market (IEM)

- Liquid (spot) reference market to settle forward contracts
- Serves as a reference price also for power purchase agreements and support schemes like contracts for difference

Why the Design of SDAC Will Evolve?
Drivers: Technological Evolutions in the Power Industry

Technology drives how efficient markets should be designed → impacts also governance and regulation

Appetite today for better optimizing generation/consumption/grid assets (= improved market participation)

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→ Optimization of Phase Shift Transformers, HVDC, line switching or alternative flow-based domains, …

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Increased need for **ancillary services** like balancing

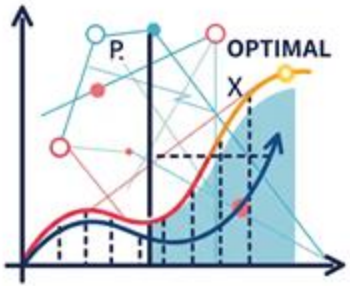
→ Co-optimized allocation of CZC / generation / demand?

Why the Design of SDAC Will Evolve?
Enablers: Progress in Computational Optimization, e.g., MIP Solvers

Progress in hardware and algorithms enable to cope with the increased computational complexity

From 2001 to 2020, speedups of 180x for Linear Problems and 1000x for Mixed Integer Programs*

Hardware speedups > 20x !



Algorithms speedups
> 9x for LP , > 50x for MIP !

Numbers from Koch, Thorsten, et al. "Progress in mathematical programming solvers from 2001 to 2020." EURO Journal on Computational Optimization 10 (2022): 100031.

* Mixed Integer Programs = optimization problems with binary/integer variables

Many Important Projects Successfully Implemented

Three Examples

Scalable Complex Orders

Improves bid expressiveness for complex orders (e.g., minimum volumes per period)
+ better algo. scalability

Go-live in 2022 in Ireland, and 2025 in Spain and Portugal

Many Important Projects Successfully Implemented

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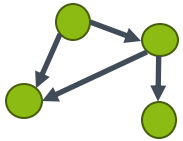

Flow-based in CWE, Nordics & Advanced Hybrid Coupling

2015: Flow-based in CWE

2020: Evolved Flow-based in CWE

2022: Core CCR (FB)

2024: Flow-based in the Nordics

AHC soon live also in Core

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15min Market Time Units

Major SDAC achievement in 2025!

Which Evolutions Could Be Aimed For in the Coming Years?

Product Expressiveness

Storage orders *supporting optimal arbitrage across MTUs*
→ See CACM Report 2024

Thermal orders? *considering multiple startup/shutdowns across the day + ramping, … (multi-part bids)*
considered by PCR in the past and again within Co-opt. R&D.

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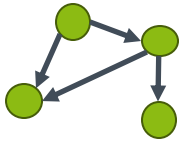

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Optimization of Power Shift Transformers tap positions?

Line switching / alternative flow-based domains?

Co-optimized CZC Allocation?

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Pricing

A switch to 'non-uniform pricing' might support future scalability improvements, beyond (marginally) improving welfare

Topic already analyzed by SDAC (and earlier by PCR), which might require more R&D in the future

Requires "side-payments" …

Conclusions

So much achieved thanks to SDAC leadership (with also the support of some great service providers)

… so much remaining in the years ahead!

Thank you for your attention!

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