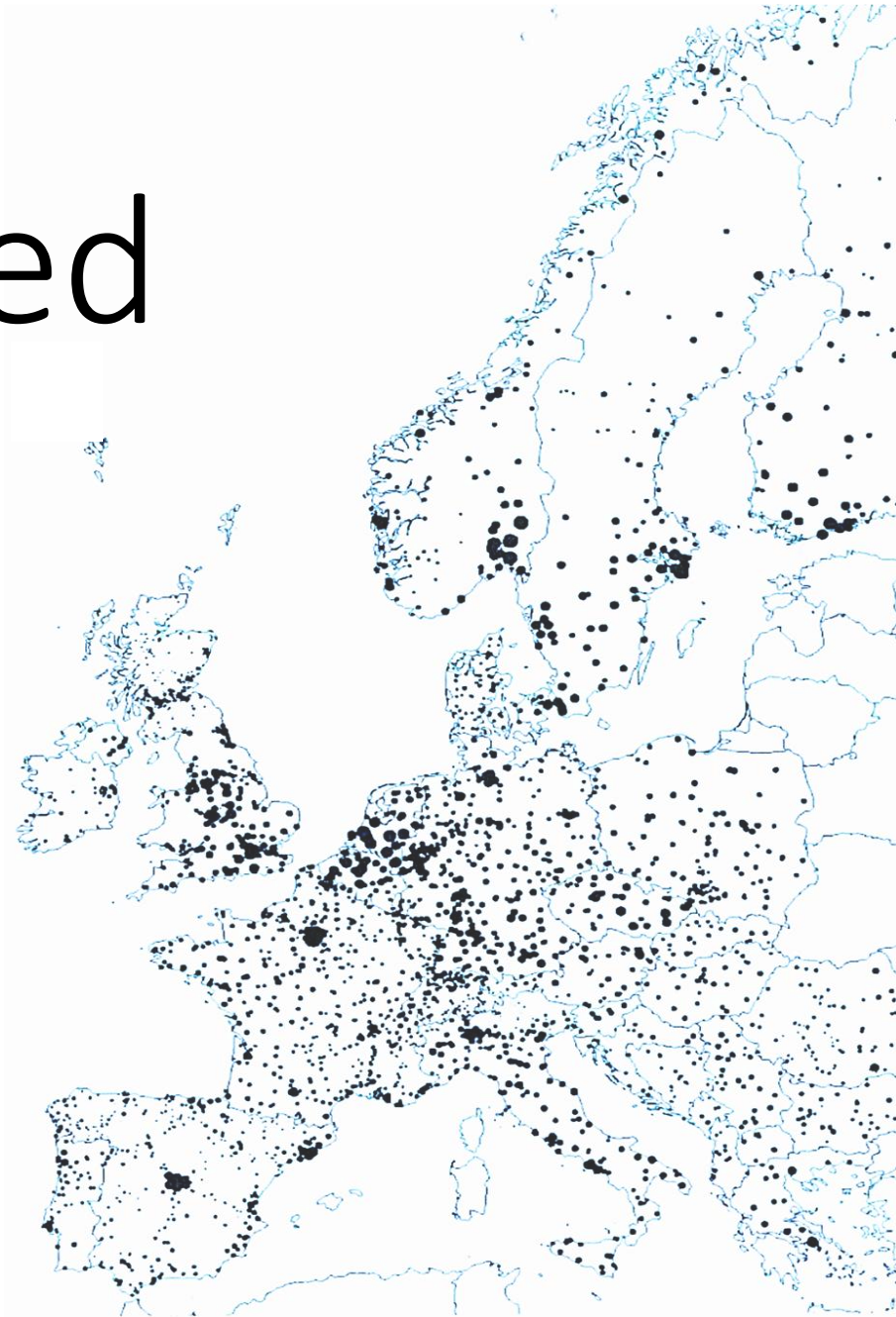


Market-Based Redispatch

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A two-year project on market-based redispatch



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Market-Based Redispatch in Zonal Electricity Markets

The Preconditions for and Consequence of Inc-Dec Gaming

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Abstract – In zonal electricity markets such as Europe's, system operators rely on out-of-the-market measures to relieve network congestion within bidding zones. One such measure is "redispatching" power plants, i.e. increasing the output of a station downstream of the congestion while lowering production of an upstream plant. Traditionally, generators have often been legally obliged to participate in redispatch and were subsequently compensated for costs incurred. In recent years numerous proposals have been made to organize redispatch through voluntary markets, including one by the European Commission. In this paper, we introduce a simple graphical game-theoretical model of a locational redispatch market within a one-zone electricity market. We solve the model explicitly by determining optimal bidding strategies and the Nash equilibrium. We show that market parties anticipate the redispatch market and bid strategically in the zonal market – this is the so-called increase-decrease game. As a result, grid congestion is aggravated, producers extract windfall profits, financial markets are distorted, and perverse investment incentives emerge. Despite claims to the contrary, we show that such gaming is possible absent any market power, i.e. under perfect competition. At the root of the problem is an inconsistent setup of power markets: combining a zonal with a locational market yields undue arbitrage opportunities that rational firms exploit. We conclude that such inconsistent market design should be avoided.

This paper builds on research undertaken with Consentec, Connect Energy Economics, Ecofys, Fraunhofer ISI and Stiftung Umweltenergierecht in the project "Untersuchung zur Beschaffung von Redispatch" for the Federal German Ministry of Economic Affairs and Energy (No. 055/17). Project findings are published as Neon & Consentec (2018, 2019), Connect Energy Economics (2018), and Consentec et al. (2019). This paper does not constitute a project deliverable. We thank Kristin Walter, Nils Santer, Christoph Maurer, Bernd Tersteegen, Marco Nicolosi, Barbara Burstedde, Markus Graebig, Eva Schmid, Frauke Thies, Simeon Hagspiel, Samuel Glisman, Mike Hogan, Anselm Eicke, Tarun Khanna, Christoph Neumann, Catrin Jung-Draschil, Bernhard Hasche, Fabio Genoese, Charles Payement, Fabian Joas, Gerard Doorman, Philip Baker, Julia Radecke, Joseph Hefele, Christian Winzer, Rebecca Lordan-Perret, and SCCER CREST and Strommarkttreffen seminar participants for inspiring discussions and helpful comments.

Zonal electricity markets with cost-based redispatch

European wholesale electricity markets are organized in bidding zones

- Price spreads may exist between zones, but not within

Internal grid congestion is solved separately from the wholesale markets

- Through out-of-the-market redispatch: regulating one plant up and another down

Redispatch in Germany

- Mandatory participation
- Compensation of costs and forgone profit

Integrating loads to cost-based redispatch is difficult

- Making loads available for redispatch would be desirable
- Essentially, regulators would need to know individual willingness to pay for electricity in every moment in time

Voluntary markets for redispatch

The idea: voluntary markets for redispatch

- System operators buy upward / downward redispatch
- Generators, consumers, storage owners can participate – voluntarily
- They are compensated based on bids for activation
- These markets must be (near) nodal in spatial granularity

Proposals come by different names

- Flexibility markets, smart markets, market-based redispatch, redispatch markets

The hope: Redispatch markets ...

- ... incentivize consumers and decentralized assets to participate
- ... turn networks into smart grids – coordinate everything from heating to batteries
- ... help avoiding expensive and complicated grid expansion
- ... save zonal European wholesale markets

Problems of market-based redispatch

Locational market power

- Some generators/loads are much more effective at solving any given congestion than all others
- Usual problems of market power: inflated prices at cost of rate payers

Inc-dec gaming / strategic bidding

- Repercussions on the zonal electricity market
- This is different from market power! (but mutually enforcing)
- More below

Strategic bidding with market-based redispatch

Two-stage market

- First stage: zonal spot market
- Second stage: locational redispatch market

Generators in the oversupplied region

- Anticipate they will be paid for ramping down – if they are available (i.e., producing)
- Bid below variable cost (underbid) in spot to be eligible for downward redispatch

Generators in the scarcity region

- Anticipate they will be paid for ramping up – if they are available (i.e., not producing)
- Bid above variable cost (overbid, “withhold capacity”)

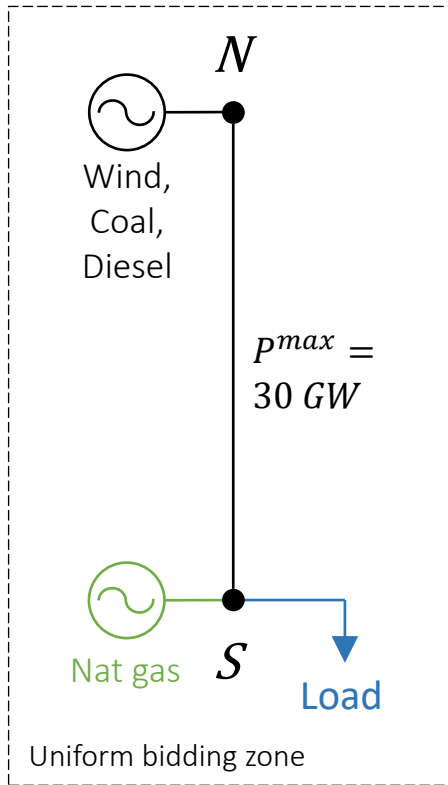
Generators have an incentive for strategic bidding

- This has a number of problematic consequences, e.g. it aggravates congestion

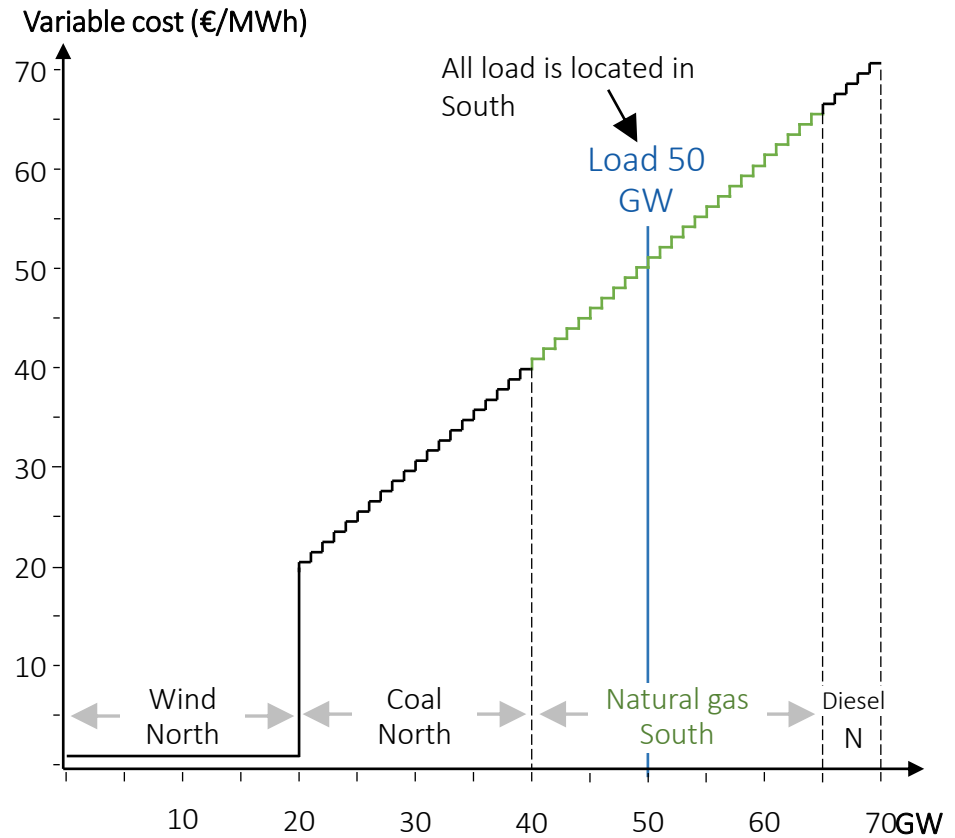
A Simple Redispatch Model

Model setup

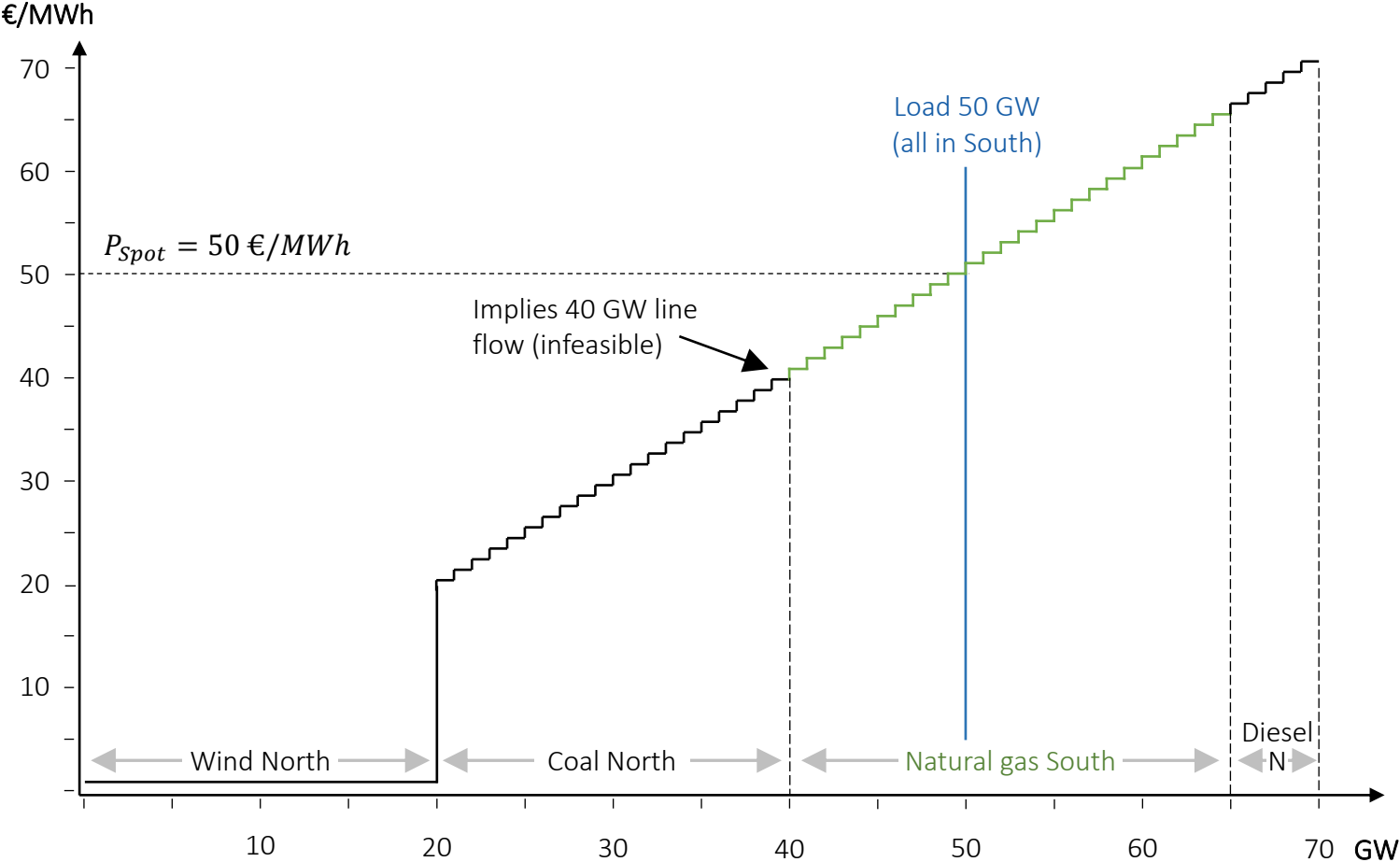
Geography



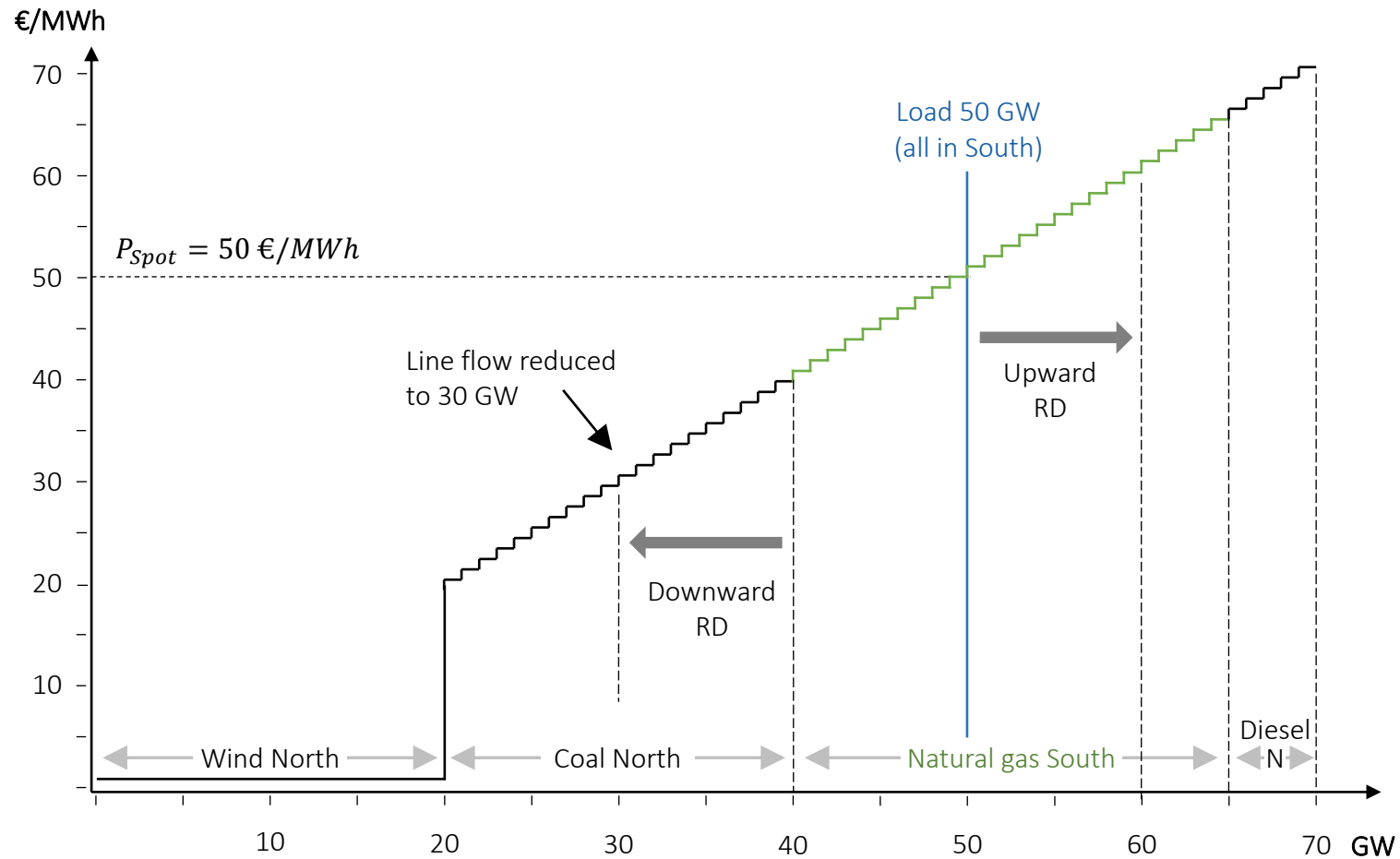
Supply and Demand



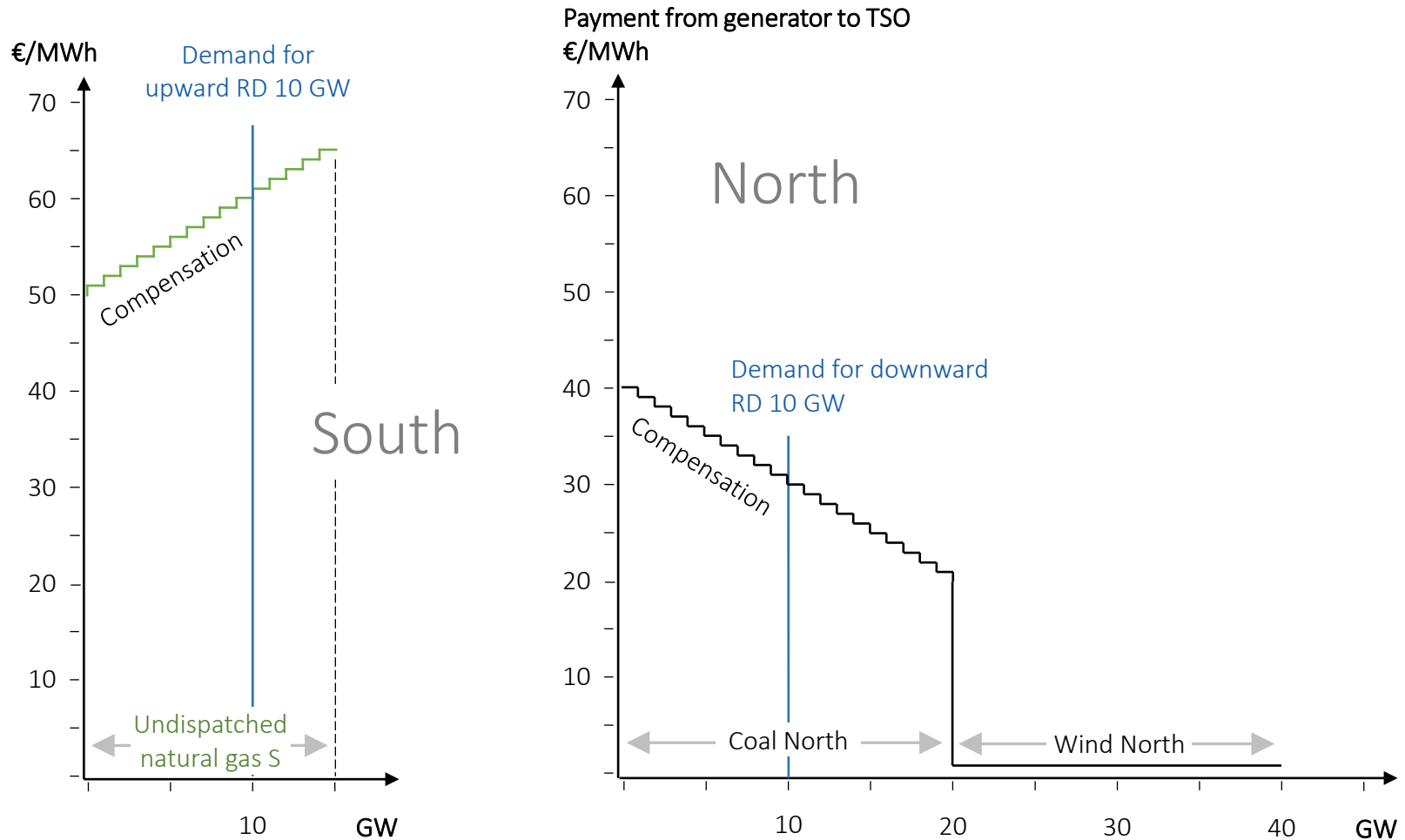
Spot market



Regulatory redispatch

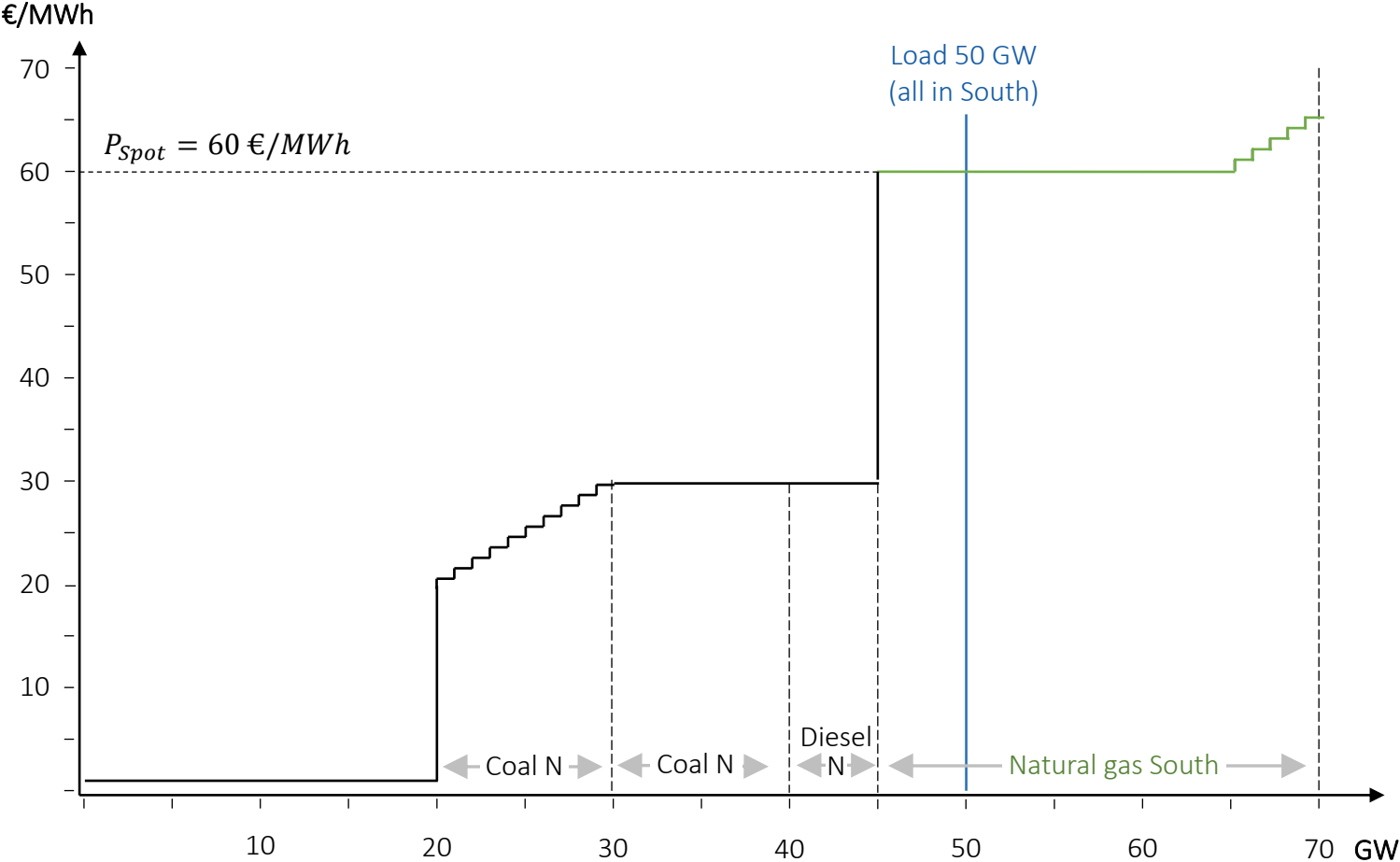


Cost-based compensation

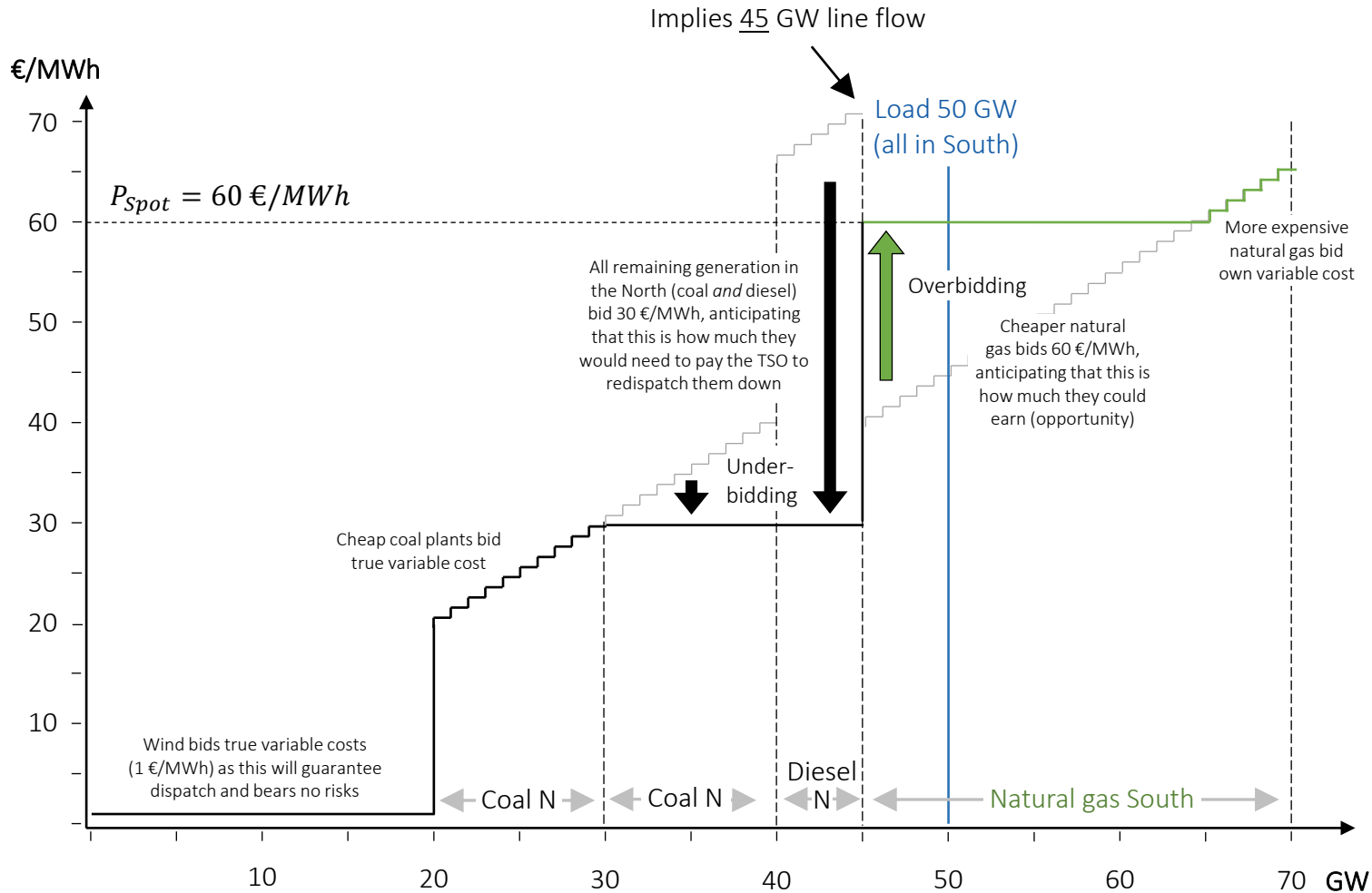


Market-based Redispatch

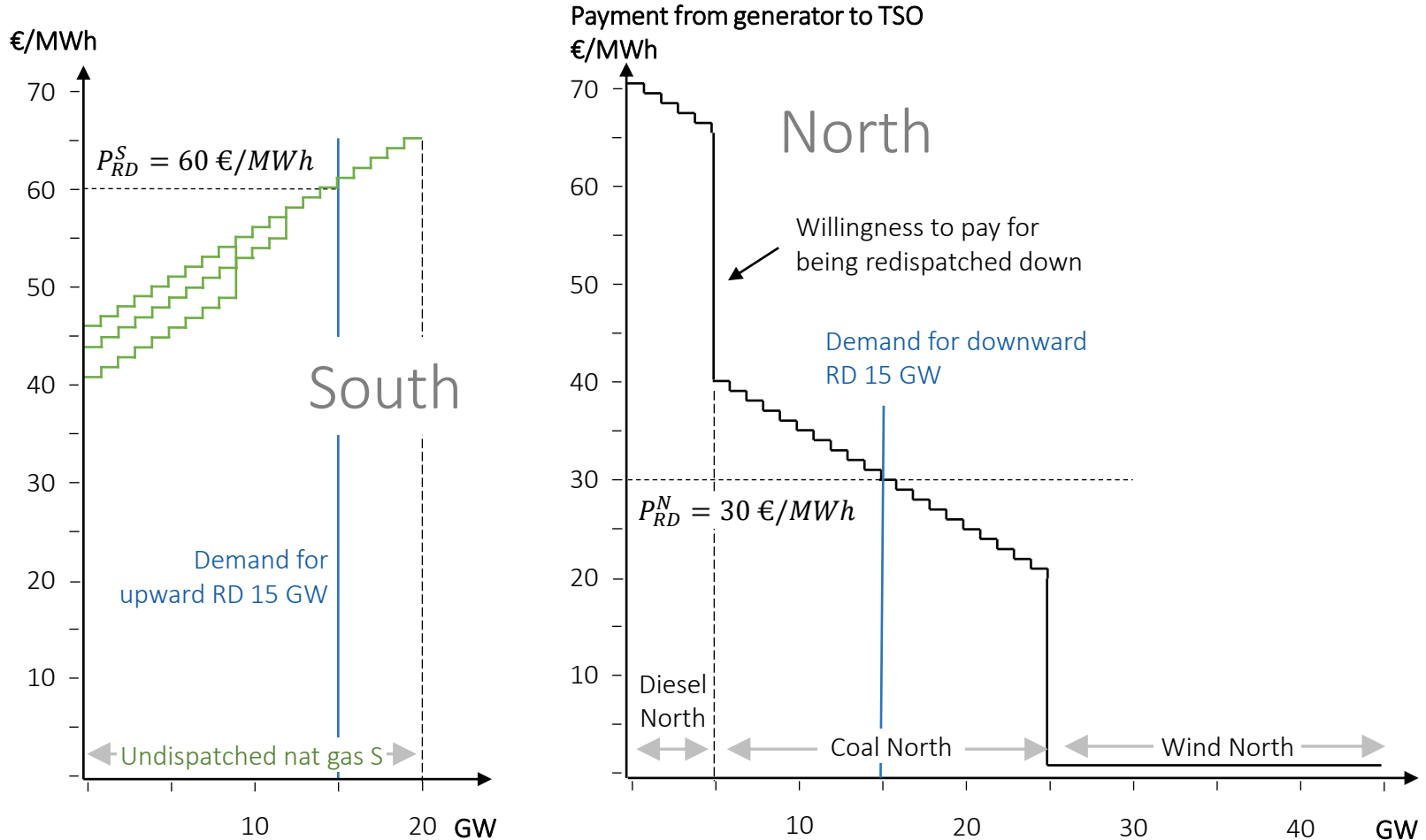
Spot market (with anticipation)



Spot market (with anticipation)



Redispatch markets (with anticipation)



Consequences

Consequences of inc-dec gaming

Congestion is aggravated

- Higher redispatch volume

Windfall profits

- Profits of generators increase, consumers pay more (mostly through grid charge)

Problematic for financial markets

- Hedging based on spot markets no longer possible (RDM will become “lead” market)

Perverse investment incentives

- “Ghost” plants which are built but never produce

Two market stages with differing locational resolution: Inconsistent

- Feedback effects / repercussions: spot is *not* independent from redispatch market

Inc-dec gaming as arbitrage trading

Market parties exploit arbitrage between two markets

- Zonal electricity market vs. locational redispatch market
- “Buy cheap, sell expensive” (depending on location: first buy and then sell back, or first sell short and then buy afterwards)

In this case, arbitrage trade does not make prices converged

- Gaming creates the demand for redispatch itself

Requirements for inc-dec strategy

No market power needed

- No market power, no collision required for inc-dec gaming
- Fostering competition will not make inc-dec gaming disappear
- Not a violation of competition law or balancing responsibilities

Some foresight of congestion required

- Currently in Germany: structural congestion can be quite easily predicted
- Each call-up is an opportunity to learn and calibrate: 8760 opportunities a year

All forms of locational “extra” markets are concerned

- Not confined to marginal clearing pricing: pay-as bid is no solution
- Not confined to generation: loads can also bid strategically
- Not confined to transmission grids: distribution grids could be even worse

Historical cases

Theoretical academic literature

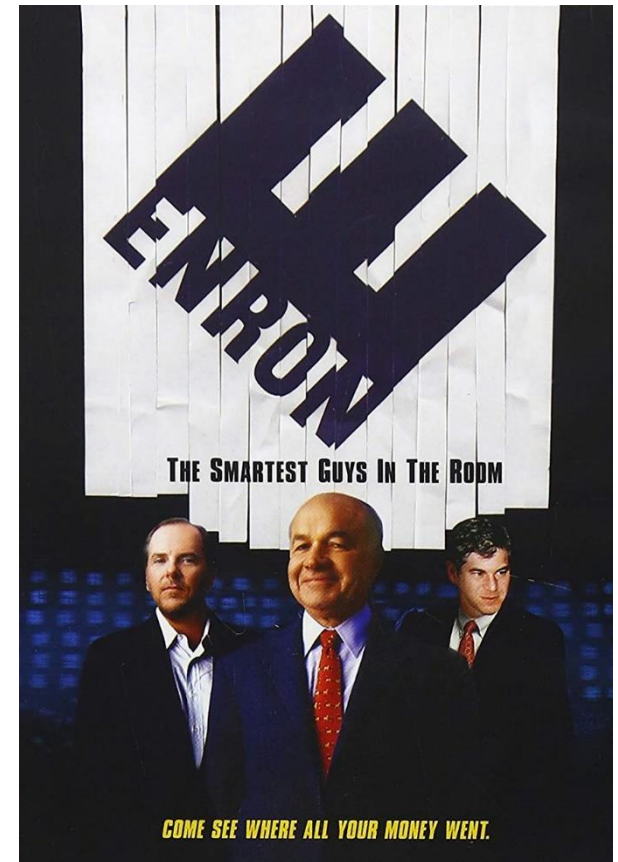
- Holmberg & Lazarczyk (2015), etc.

California

- Inc-dec gaming contributed to the energy crisis 2000/01, rolling blackouts
- Introduced nodal pricing in 2009
- Hogan (1999, 2001), Brunekreeft et al. (2005), CAISO (2005), Hobbs (2010)

Great Britain

- Inc-dec gaming at Scottish-English border
- “Transmission Constraint License Condition” introduced in 2012, similar to cost-based RD
- Ofgem (2012, 2018) Konstantinidis & Strbac (2015)



“They make money, in essence, for doing nothing”

Practically: Mitigating inc-dec gaming is very difficult

Various strategies for regulatory mitigation have been proposed

- Decrease transparency → would be harmful, roll back transparency legislation
- Increase competition → does not avoid inc-dec gaming
- Regulate bids → severe information asymmetry – same as for cost-based redispatch

Regulation will always diminish the benefits of market-based redispatch

- Regulating bids will decrease the incentives

Fundamentally: Forbidding inc-dec economically questionable

Inc-dec strategy is the rational behavior of profit-maximizing firms

- Firms simply price in opportunity costs (cf. balancing markets)
- Introducing incentives and then punish those who respond to them seems odd

Forbidding inc-dec means discriminating between generators – hard to justify

- Low-cost plants (“in the money”) would be denied the locational rent
- Expensive plants (“out of the money”) would reap locational rent

Distorted investment incentives prevail

- Incentive to build less efficient plants

Conclusions

Conclusions and recommendations

Market-based redispatch is likely to have severe side effects

- Increased congestion, windfall profits, distorted financial markets, perverse investment incentive
- If congestion can be predicted (which, in Germany, is the case)
- Large effects: in 2030 redispatch volume approx. +200-600%, costs +200% (model-based estimate by Consentec)

Mitigating inc-dec through regulation seems infeasible

- The incentive problem is fundamental

It's a trade-off

- Market-based RD has benefits (integrate loads) and costs (market power, gaming)

We recommend refraining from activation-based redispatch markets

- At least in Germany for the foreseeable future

What can we do instead? Potential alternatives

A fundamentally different electricity market: Nodal pricing

- No incentives for inc-dec gaming, but (many, fundamental) other problems

Integrate loads to redispatch: Capacity-based, longer-term contracts

- Voluntary participation
- Parties need to be economically indifferent w.r.t. being activated (which implies they need to be compensated with opportunity cost, which is private information)
- Participation incentives stem from longer-term contracts based on capacity
- Activation is limited in frequency
- This would strongly reduce incentives for inc-dec (but has its own problems)

Alternative locational investment incentives

- Steer generation, storage, consumer investments to the “right” location in the grid
- Deep connection charges, locational grid usage charges, support schemes, ...
- These incentives do not incentivize gaming (but have their own problems)

Implications for cross-border redispatch

Cross-border mandatory redispatch is difficult to imagine

- At least if bidding zone borders coincide with jurisdictions: who should force market parties to participate?

Incentives are similar

- Details differ
- But incentives for inc-dec gaming and congestion-aggravating behavior exist