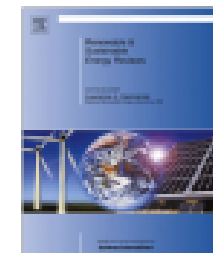


Balancing power: policy options

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Balancing power and variable renewables: Three links[☆]

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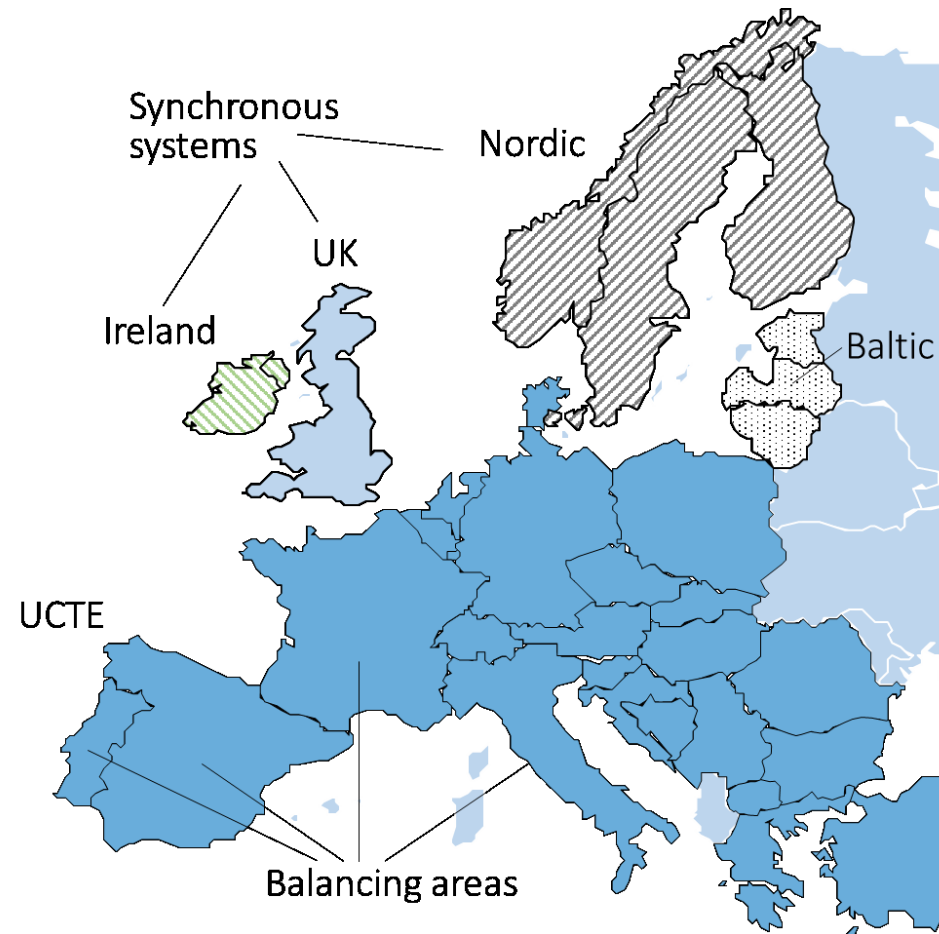
ABSTRACT

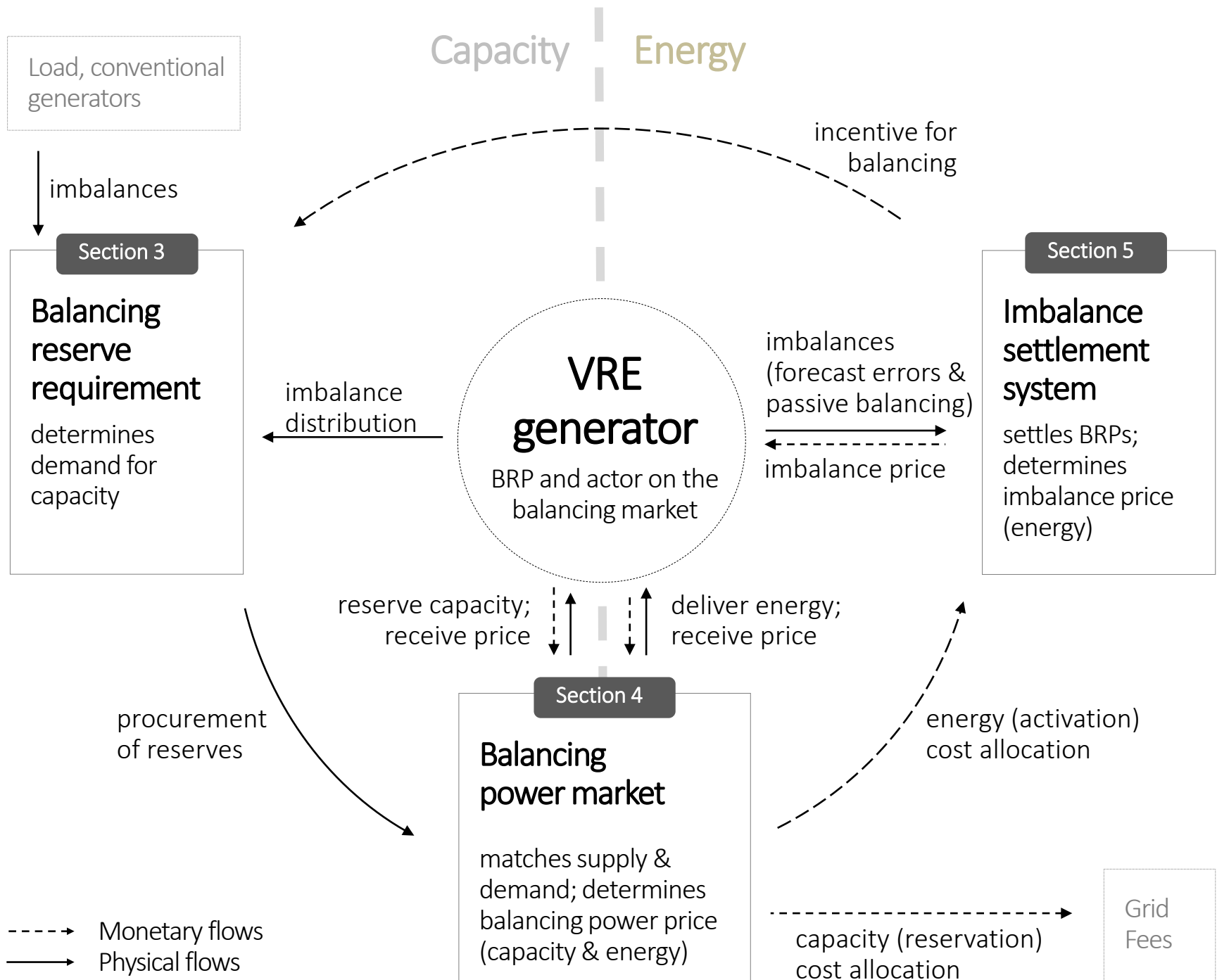
Balancing power is used to quickly restore the supply-demand balance in power systems. The need for this tends to be increased by the use of variable renewable energy sources (VRE) such as wind and solar power. This paper reviews three channels through which VRE and balancing systems interact: the impact of VRE forecast errors on balancing reserve requirements; the supply of balancing services by VRE generators; and the incentives to improve forecasting provided by imbalance charges. The paper reviews the literature, provides stylized facts from German market data, and suggests policy options. Surprisingly, while German wind and solar capacity has tripled since 2008, balancing reserves have been reduced by 15%, and costs by 50%.

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Balancing what? Synchronous system *and* balancing area

	Synchronous system	Balancing area
Geographic scope	Entire system (continental Europe)	Several sub-systems (countries)
Target Variable	Frequency	Area control error (ACE)
Set point	50 Hz	Zero
Rationale	Avoid damages caused by frequency deviation	Avoid interconnector overload; "polluter pays" principle





Policy proposals: overview

1. Reserve requirement

- Dynamic sizing (currently static)
- Price-elastic procurement (currently inelastic)
- Specific measures for deterministic imbalances (currently all covered by balancing reserves)

3. Imbalance settlement

- Legalize passive balancing (currently illegal)
- Price publication within minutes (currently months)
- Marginal pricing (currently average)
- Reserve costs allocated via imbalance price (currently grid fees)

2. Balancing power market

- Daily auctions (currently some weekly)
- Contract duration of one hour (currently longer)
- Marginal pricing (currently pay-as-bid)
- Use power exchange for procurement (currently proprietary platform)

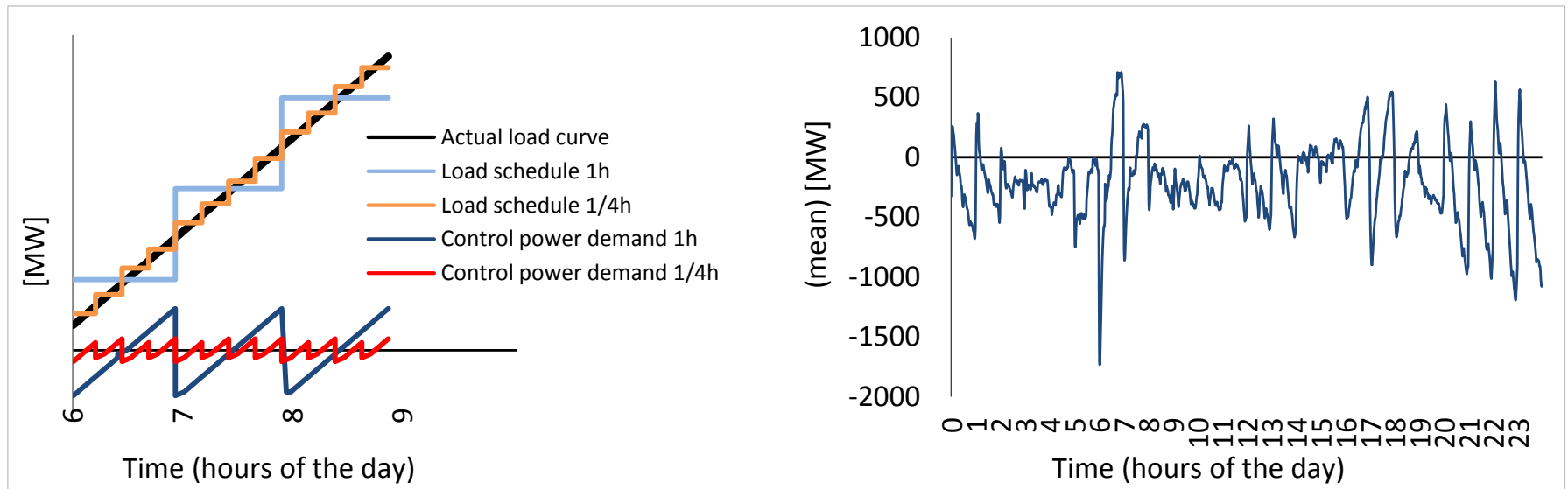
4. International market integration

- Harmonize product definitions, procurement methods, pricing rules

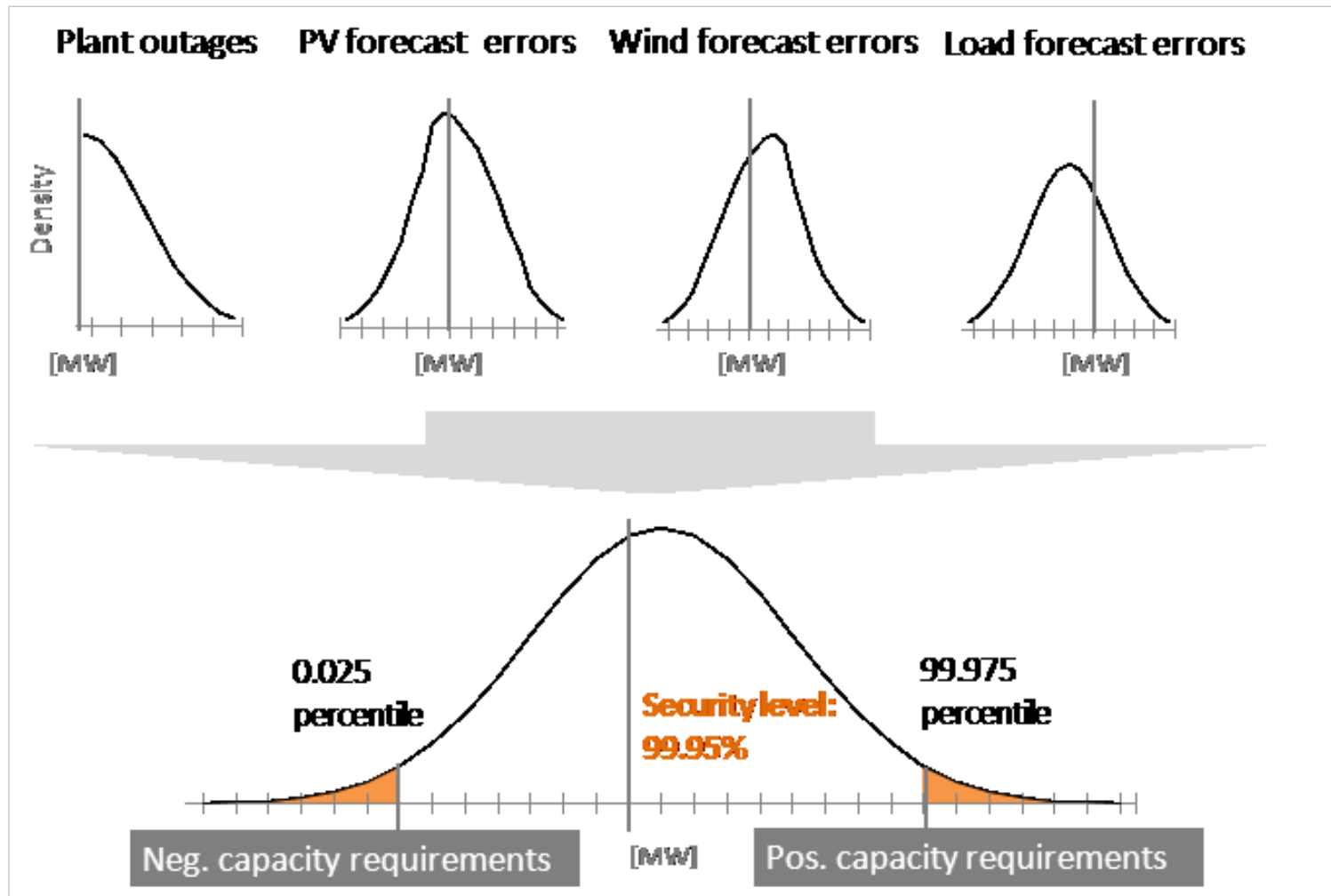
Reserve sizing

Reserve sizing

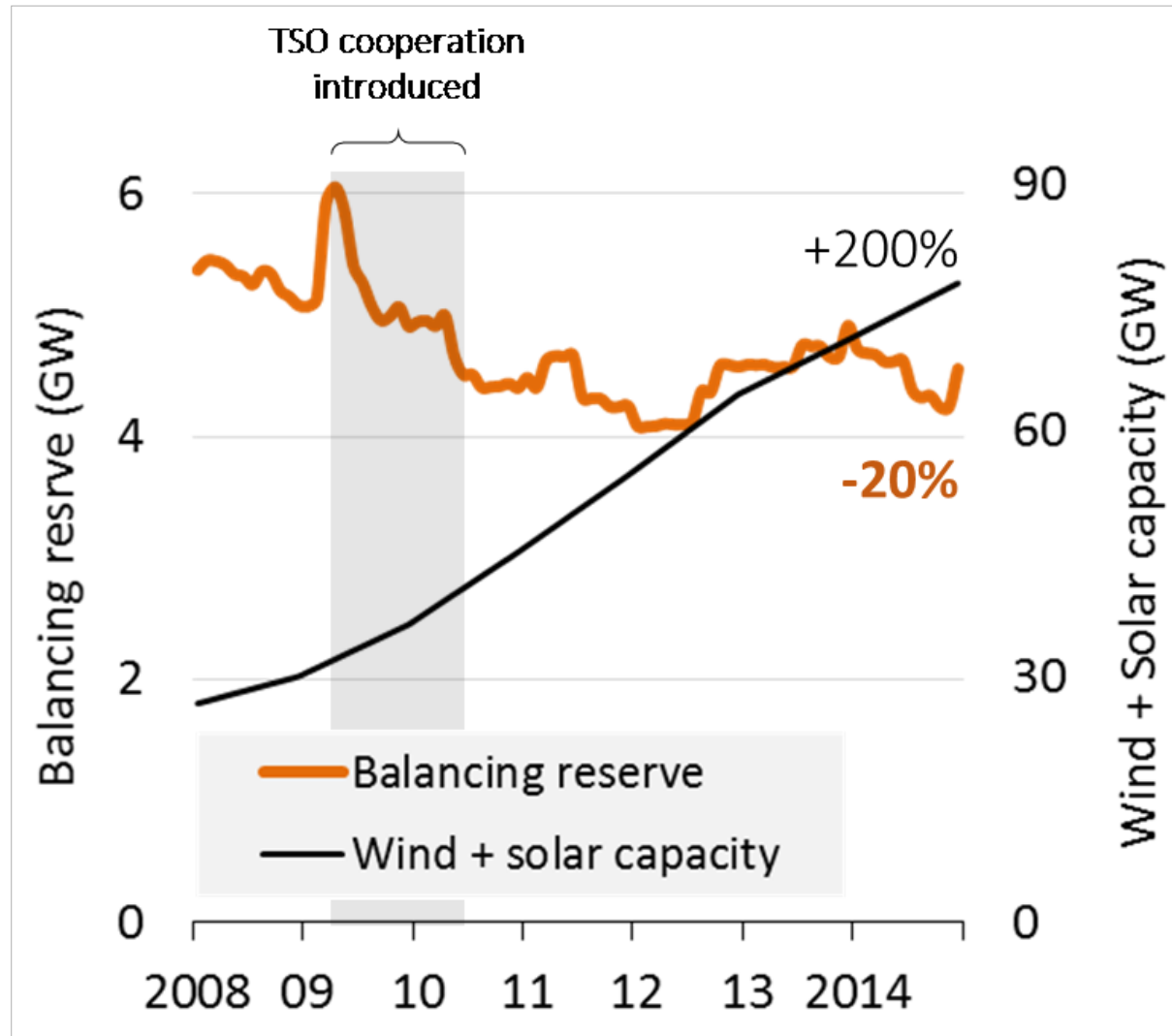
	Stochastic	Deterministic
Thermal and Hydro Generation	unplanned plant outages	
VRE Generation	forecast errors	
Interconnectors	unplanned line outages	Schedule leaps
Load	forecast errors	



Reserve sizing



Reserve sizing



Reserve sizing: proposals

Dynamic sizing (currently static)

- Idea: determine reserve requirement depending on current and expected state of the system (e.g., weather, Christmas)
- Rational: reduce size when it is not needed, save costs

Price-elastic procurement (currently inelastic)

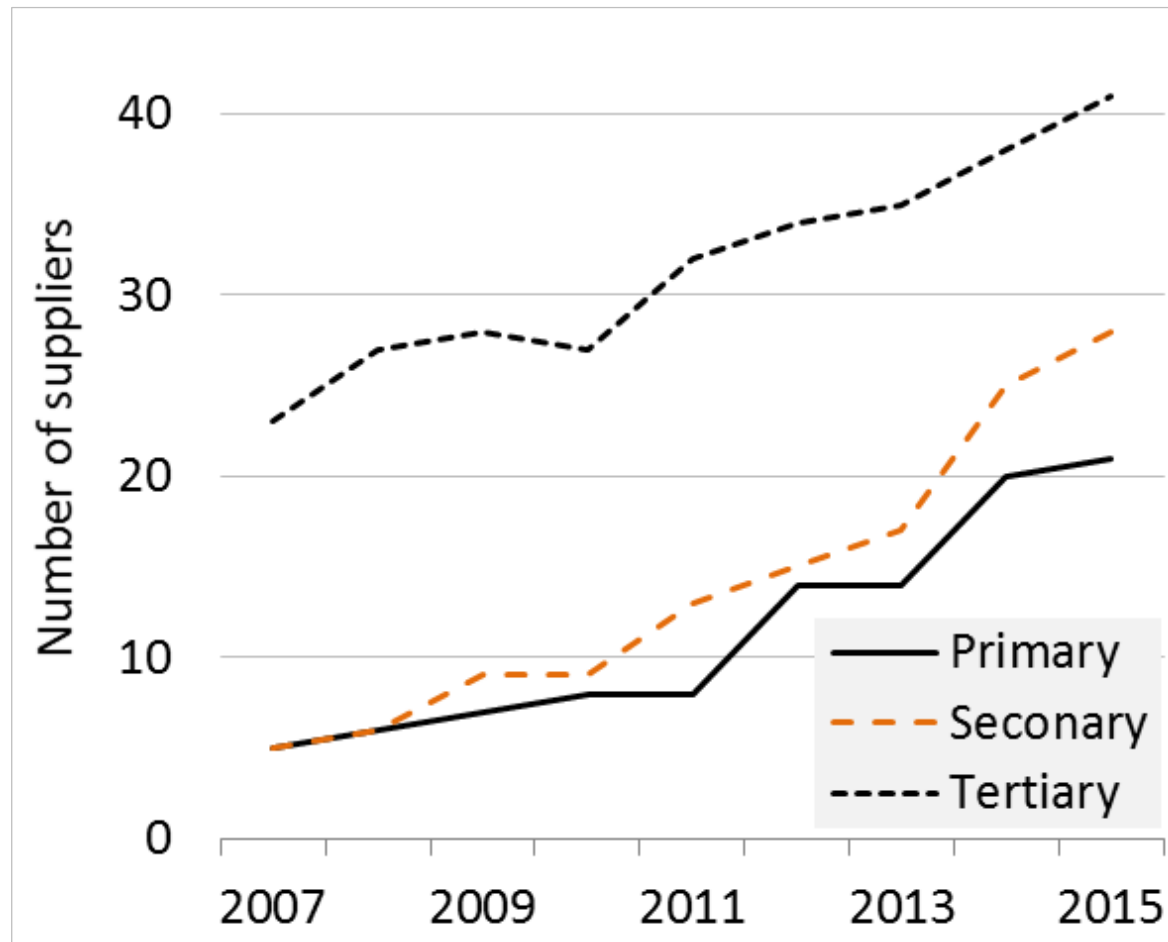
- Idea: make reserve size a function of demand
- Rational: increase security level when it is cheap to do so, reduce market power on spot markets

Specific measures for deterministic imbalances (currently all covered by balancing reserves)

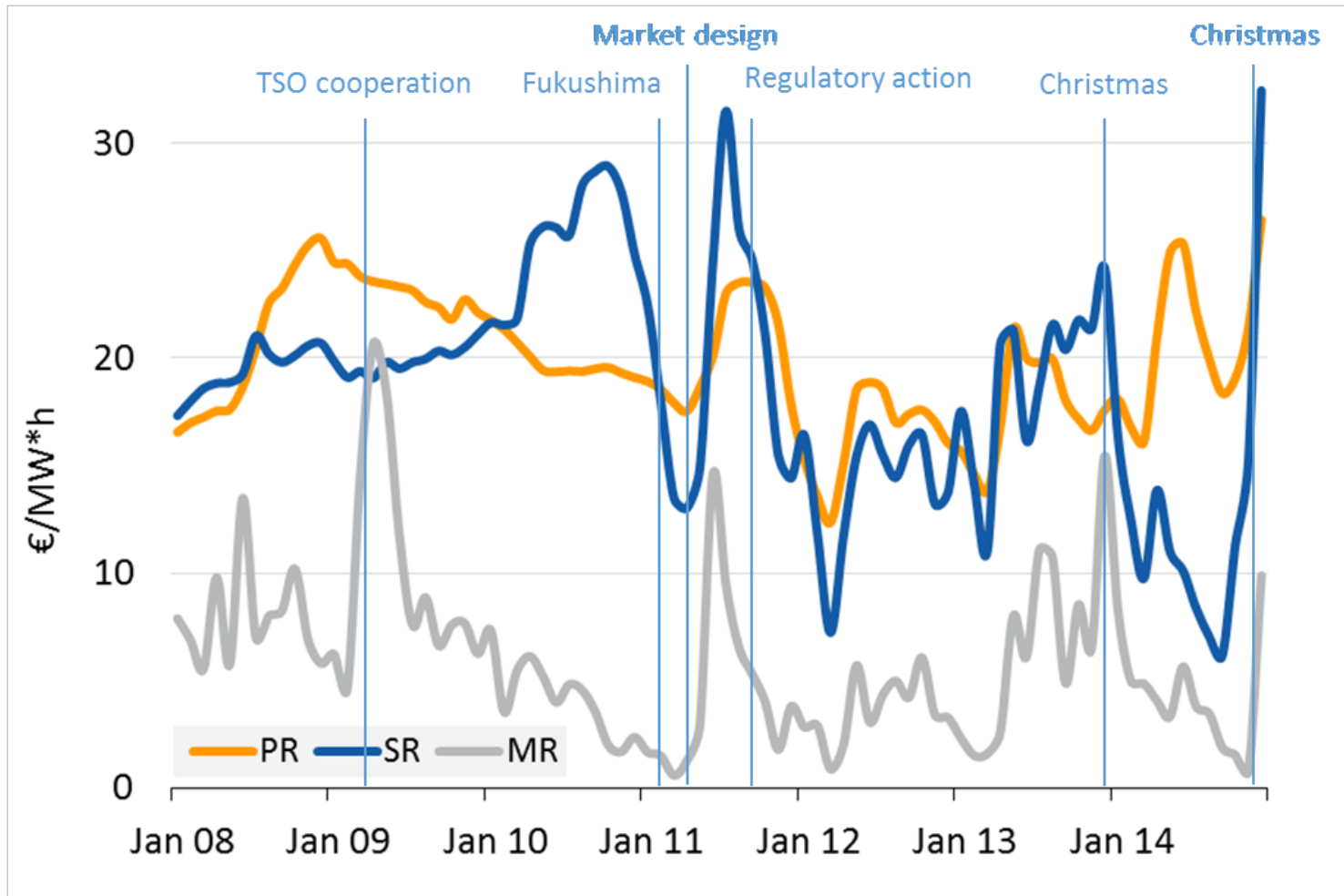
- Idea: dedicated product to schedule leaps
- Alternative: passive balancing

Balancing power market

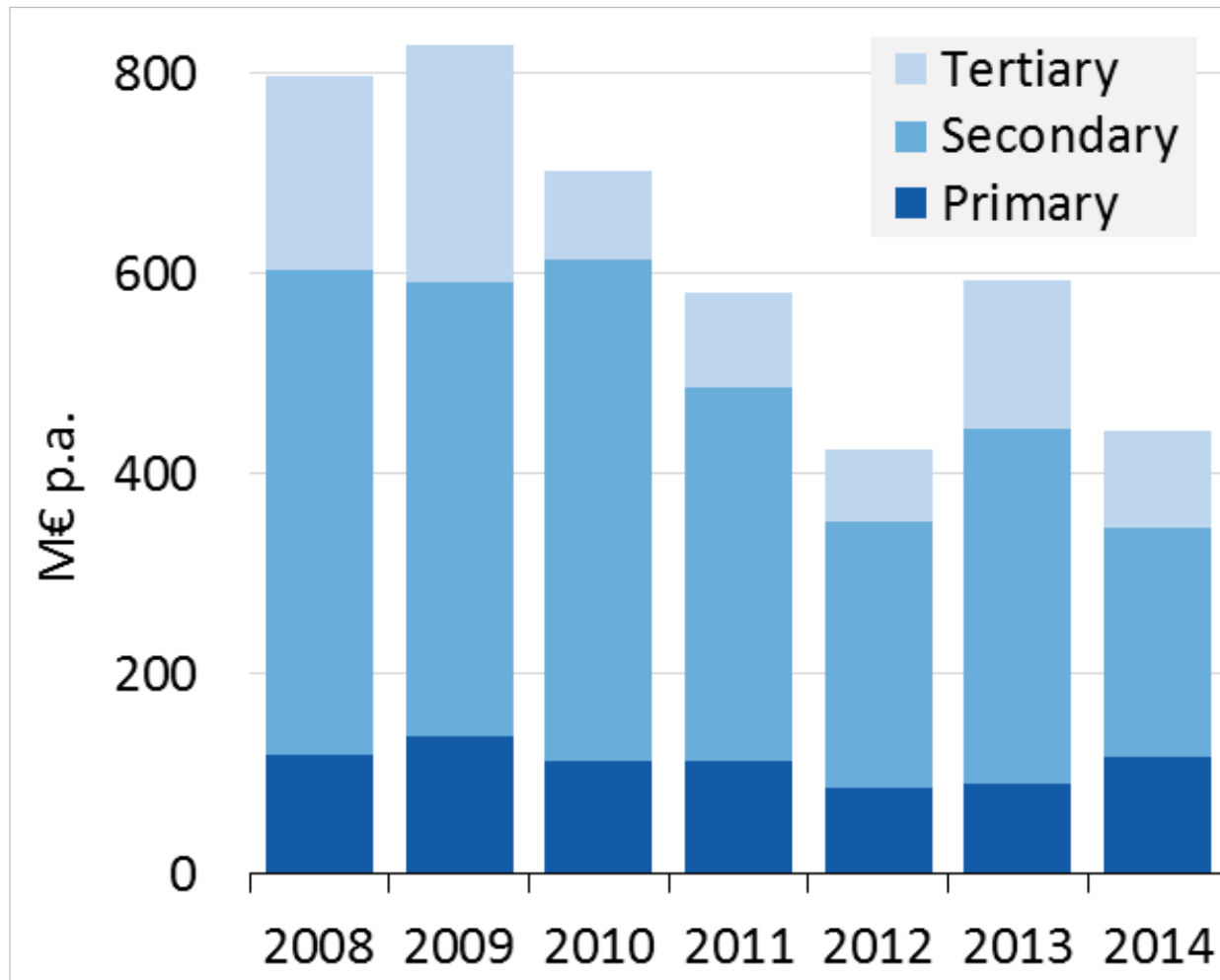
Balancing power market



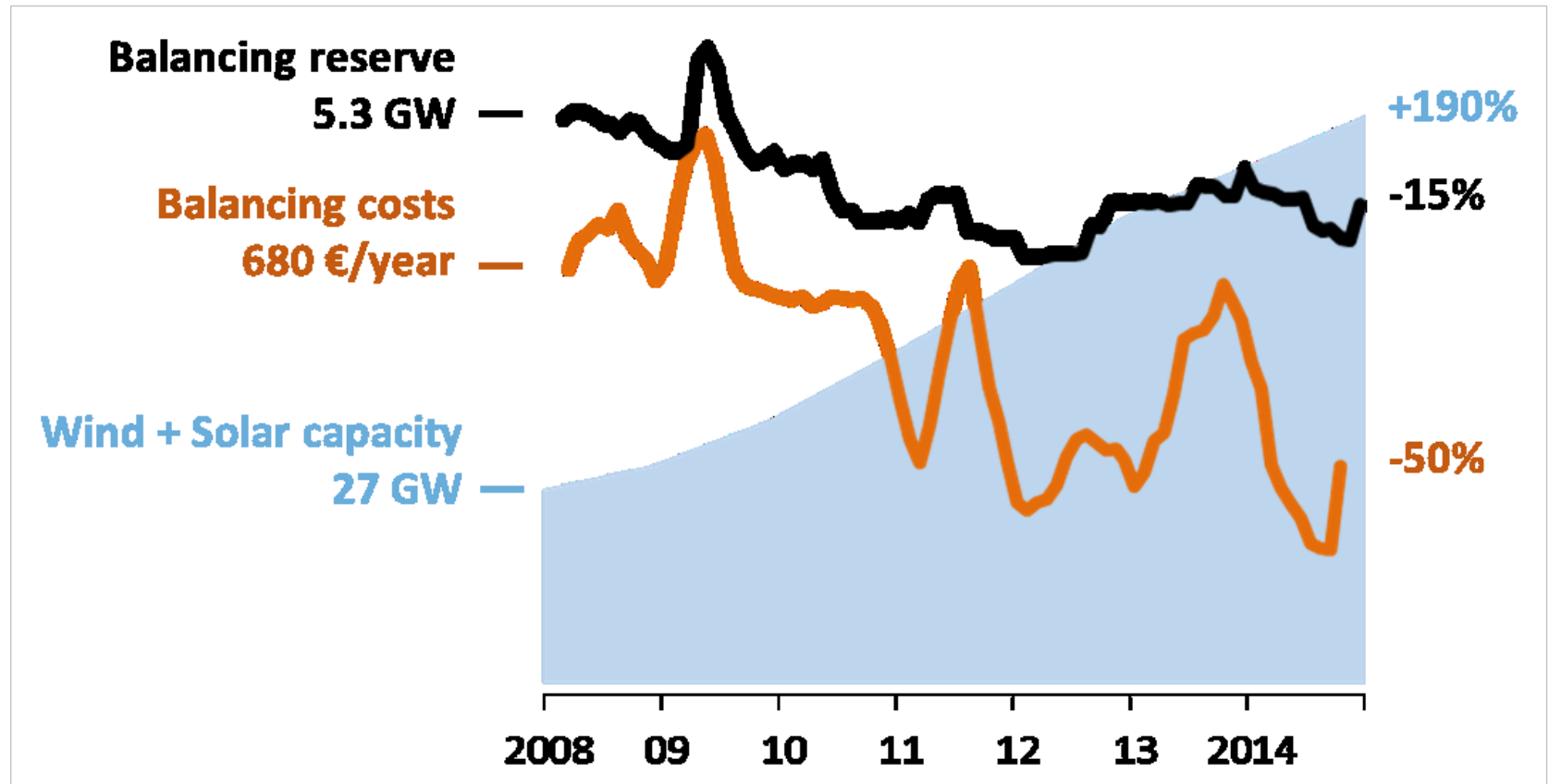
Balancing power market



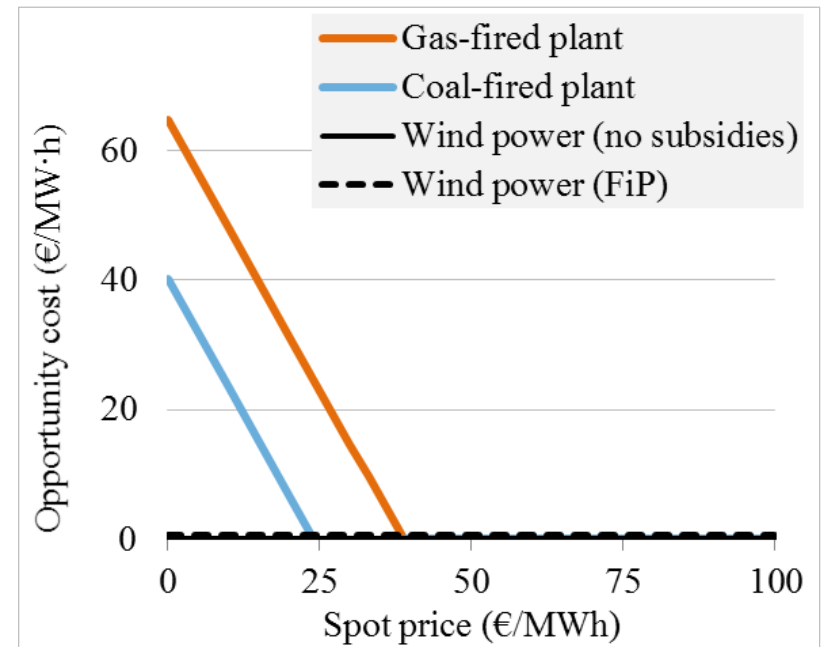
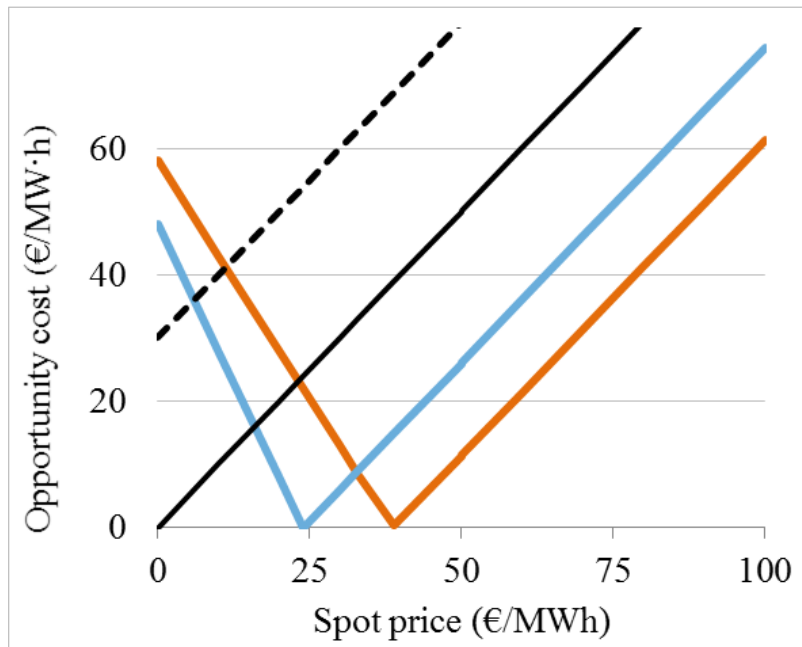
Balancing power market



Balancing power market



Balancing power market



Balancing power market: proposals

Daily auctions (currently some weekly)

- Rational: reduce uncertainty, align with day-ahead spot auction, allow wind and solar generators to participate (more suppliers)

Contract duration of one hour (currently longer)

- Rational: align with spot, reduce opportunity costs for thermal plants, allow solar to participate (more suppliers)

Marginal pricing (currently pay-as-bid)

- Rational: more robust against uncertainty, market power, information asymmetry

Use power exchange for procurement (currently proprietary platform)

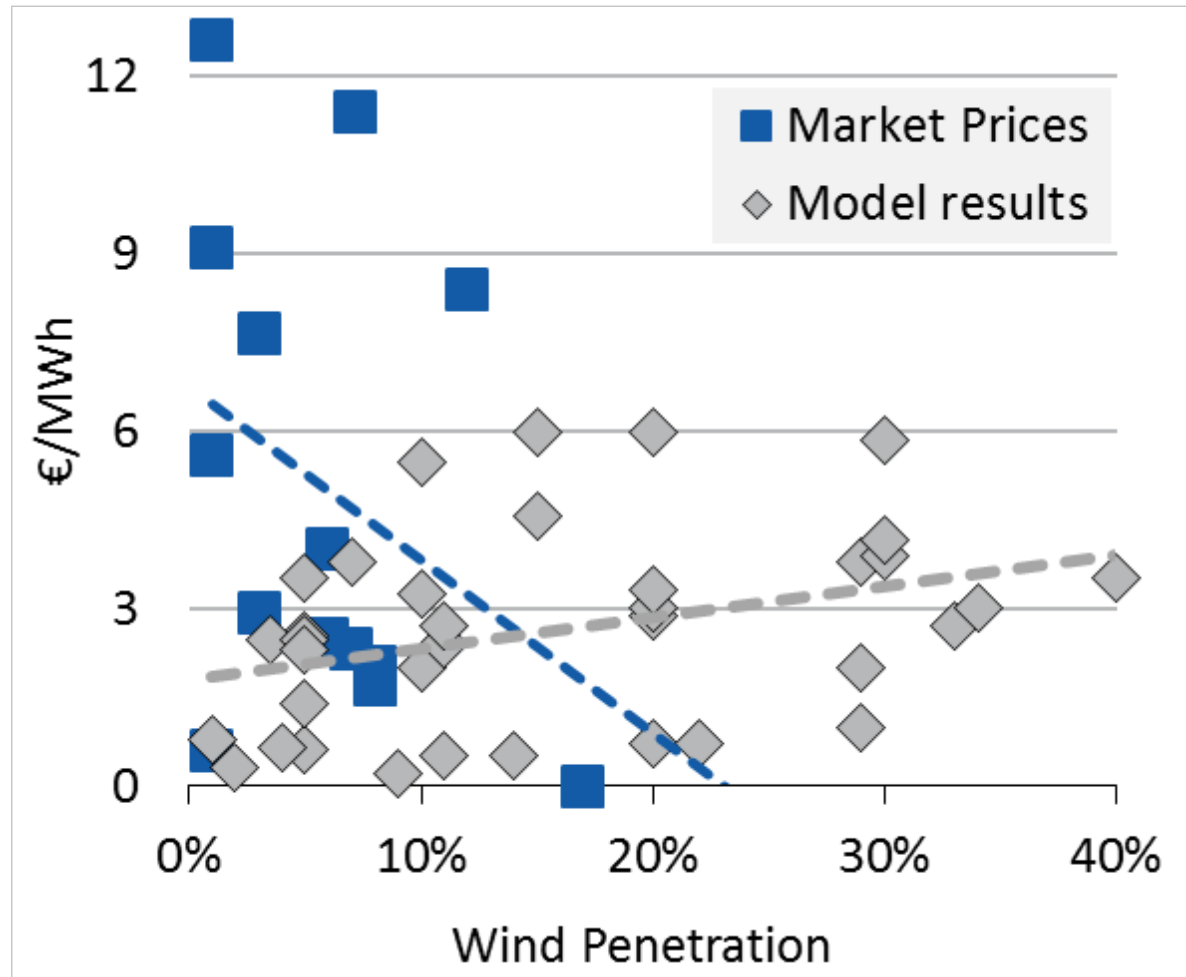
- Rational: reduce transaction costs, prepare joint bids

Imbalance settlement

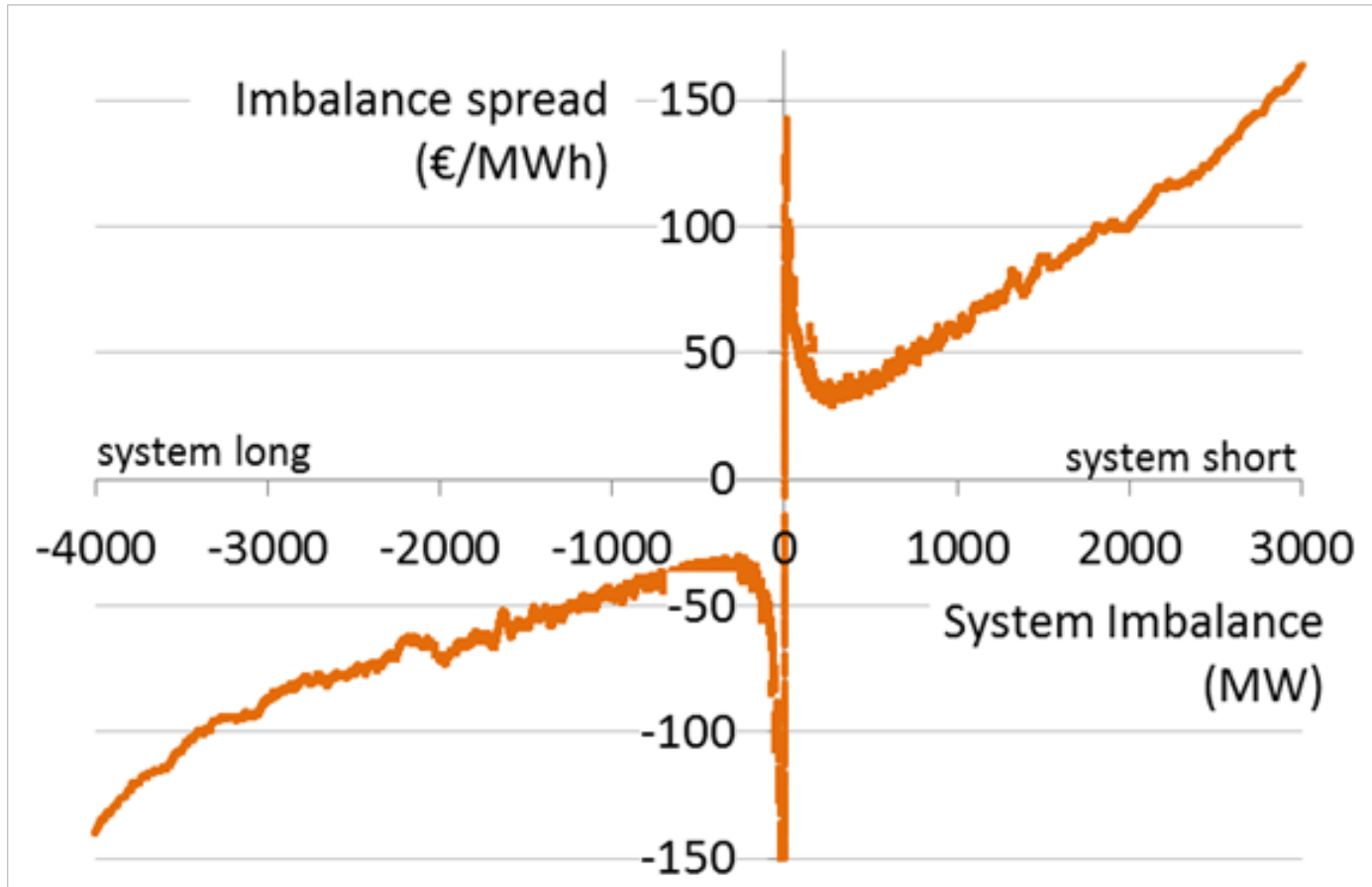
Imbalance Settlement

- two-price system (dual price) v. one-price system (single price)
- imbalance price calculated from balancing costs or from spot price
- whether or not capacity cost is included
- average v. marginal pricing
- cost-based or without punitive mark-ups (constant or variable costs; mark-ups at high imbalances, or minimal incentives)
- non-discriminatory pricing or a differentiated price for generators and loads
- settlement intervals: 15 min, 30 min, 60 min
- publication lag: time between end of settlement interval and publication of the imbalance price
- whether or not there is a legal obligation to be balanced

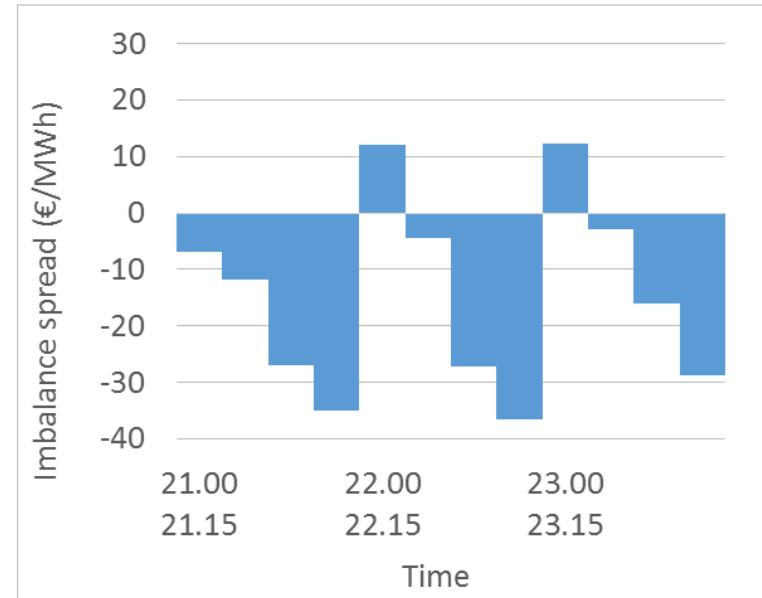
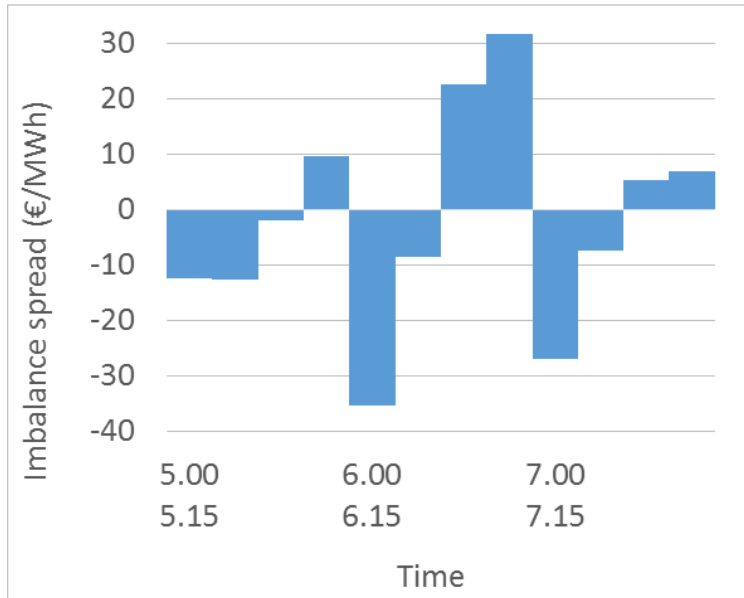
Imbalance Settlement



Imbalance Settlement



Imbalance Settlement



Balancing power market: proposals

Legalize passive balancing (currently illegal)

- Idea: reduce system imbalance
- Rational: make passive balancing possible

Price publication within minutes (currently months)

- Rational: reduce uncertainty, get more precise signal, reduce asymmetry among firms

Marginal pricing (currently average)

- Idea: imbalance price should reflect the marginal costs of balancing the system
- Rational: Economically efficient price signals to BRPs (for portfolio management, intra-day trading, forecast improvements)
- Alternative: marginal pricing on imbalance market

Reserve costs allocated via imbalance price (currently grid fees)

- Idea: imbalance price should reflect the marginal costs of balancing the system
- Rational: Economically efficient price signals to BRPs (“causer pays principle”)

Balancing power: policy options

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