

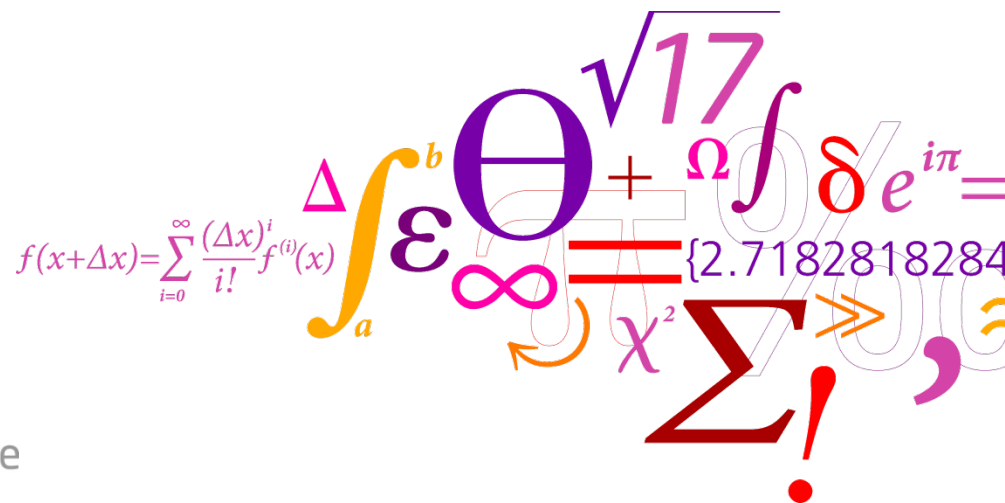
WP7 – Market Strategies for Portfolio Operation of CHP and Wind Power Units

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CITIES Consortium Meeting

DTU Lyngby

26 May 2014



Recap of WP7 Focus

1. Operational model for the coordinated participation of a CHP plant in the electricity and heat markets



2. Operational model for the participation in the electricity and heat markets of a portfolio made up of CHP plants and wind farms



3. Analysis of profitability of electric boilers and heat pumps



Recap of WP7 Focus

- Operational model for the coordinated participation of a CHP plant in the electricity and heat markets



**ROBUST
OPTIMIZATION**

- Operational model for the participation in the electricity and heat markets of a portfolio made up of CHP plants and wind farms



**DETERMINISTIC
OPTIMIZATION
(ROLLING
HORIZON)**

- Analysis of profitability of electric boilers and heat pumps



**STOCHASTIC
PROGRAMMING**

Application Example

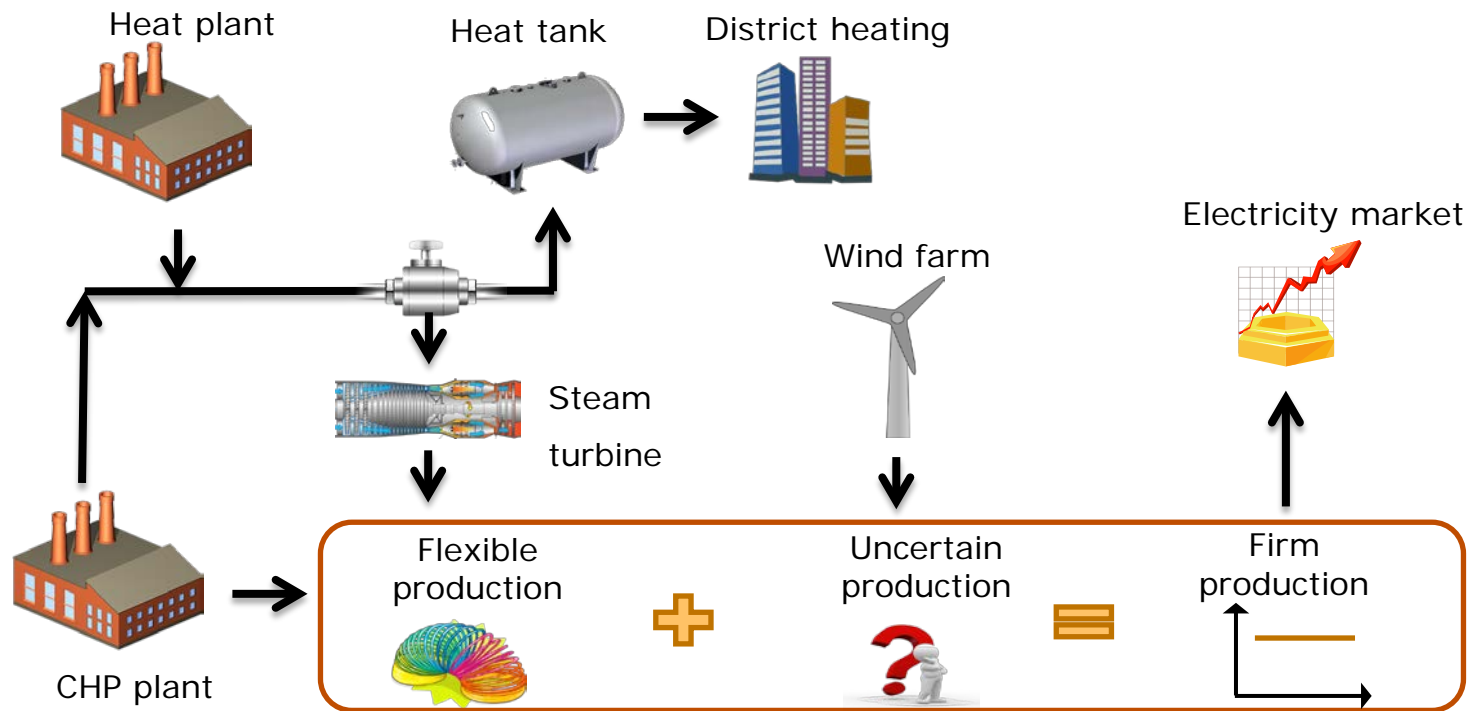
Operational model for the participation in the electricity and heat markets of a portfolio made up of CHP plants and wind farms



Details (hopefully) soon publicly available:

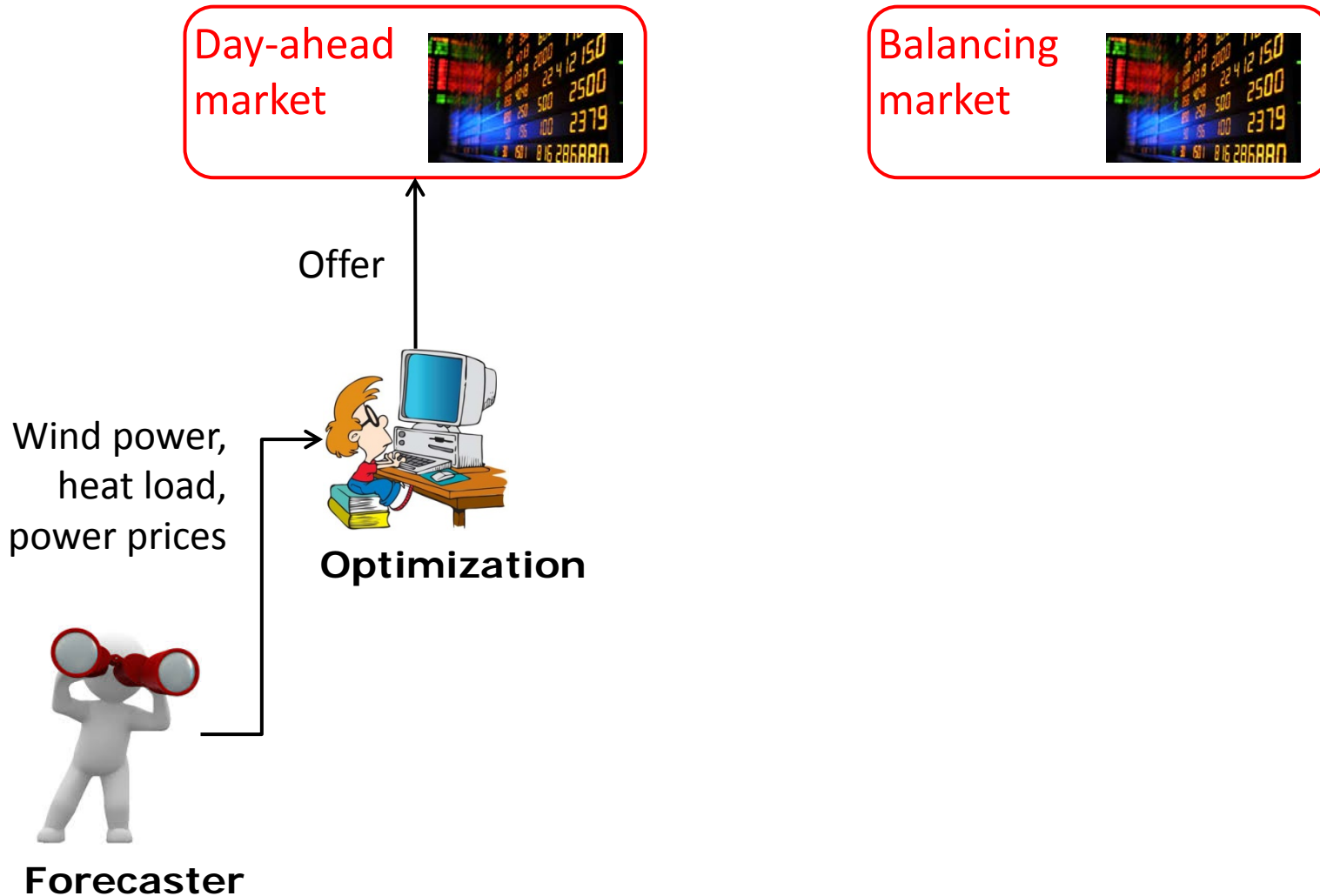
A. Hellmers, M. Zugno, A. Skajaa, J.M. Morales. *Operational Strategies for a Portfolio of Wind Farms and CHP Plants in a Two-Price Balancing Market*, submitted

Setup and Research Question

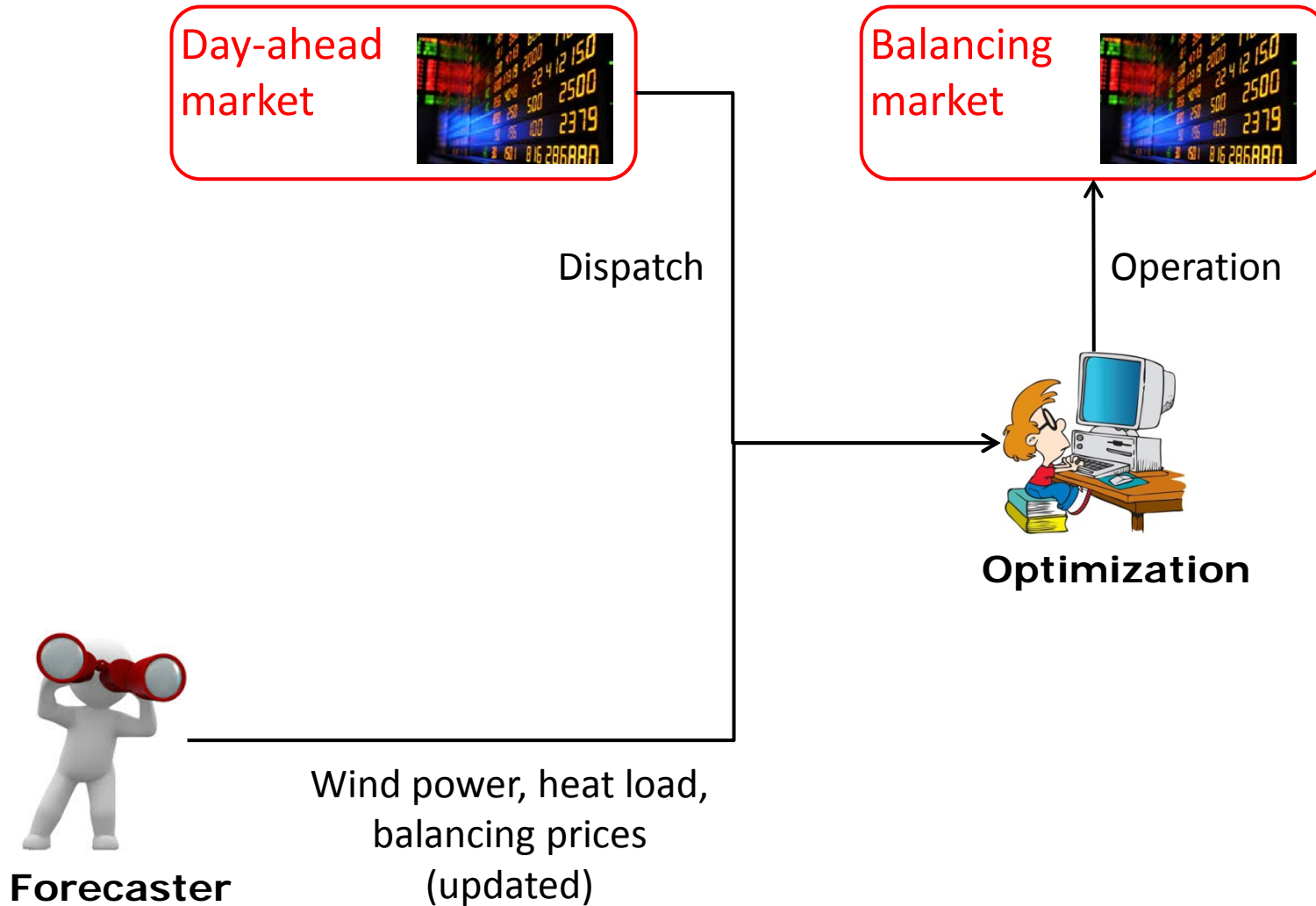


Can joint trading of wind/CHP plants power output **reduce** the overall **imbalance** and **improve profits** for the portfolio?

Decision-Making Structure

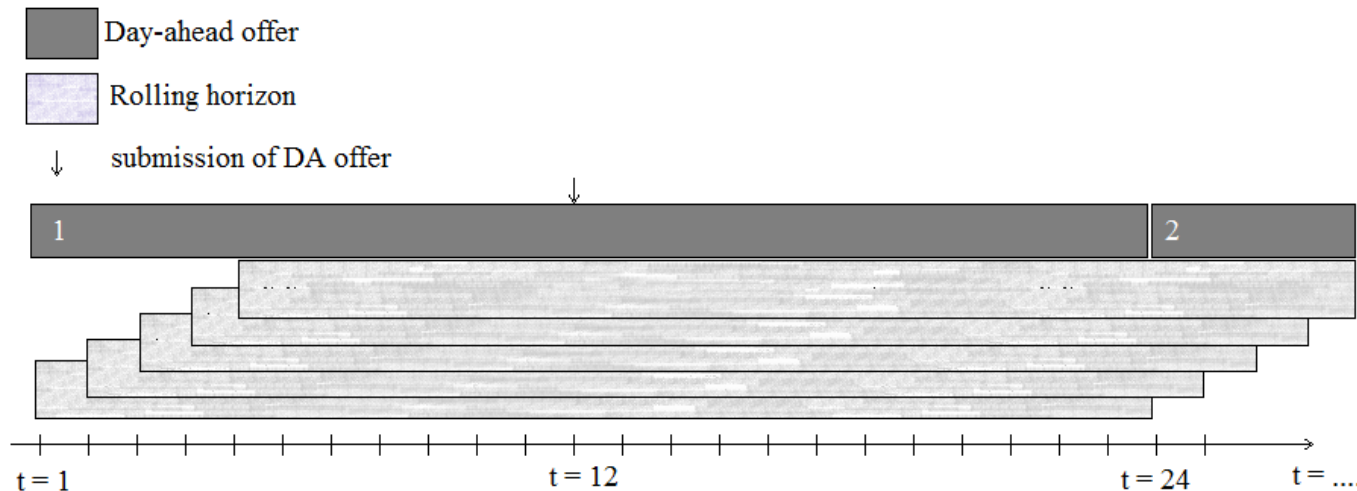


Decision-Making Structure



Optimization Framework

- Day-ahead market: 1 deterministic optimization problem (24 hourly offers decided at once)
- Balancing market: 24 deterministic optimization problems (**rolling horizon**, only first hourly decision is implemented)

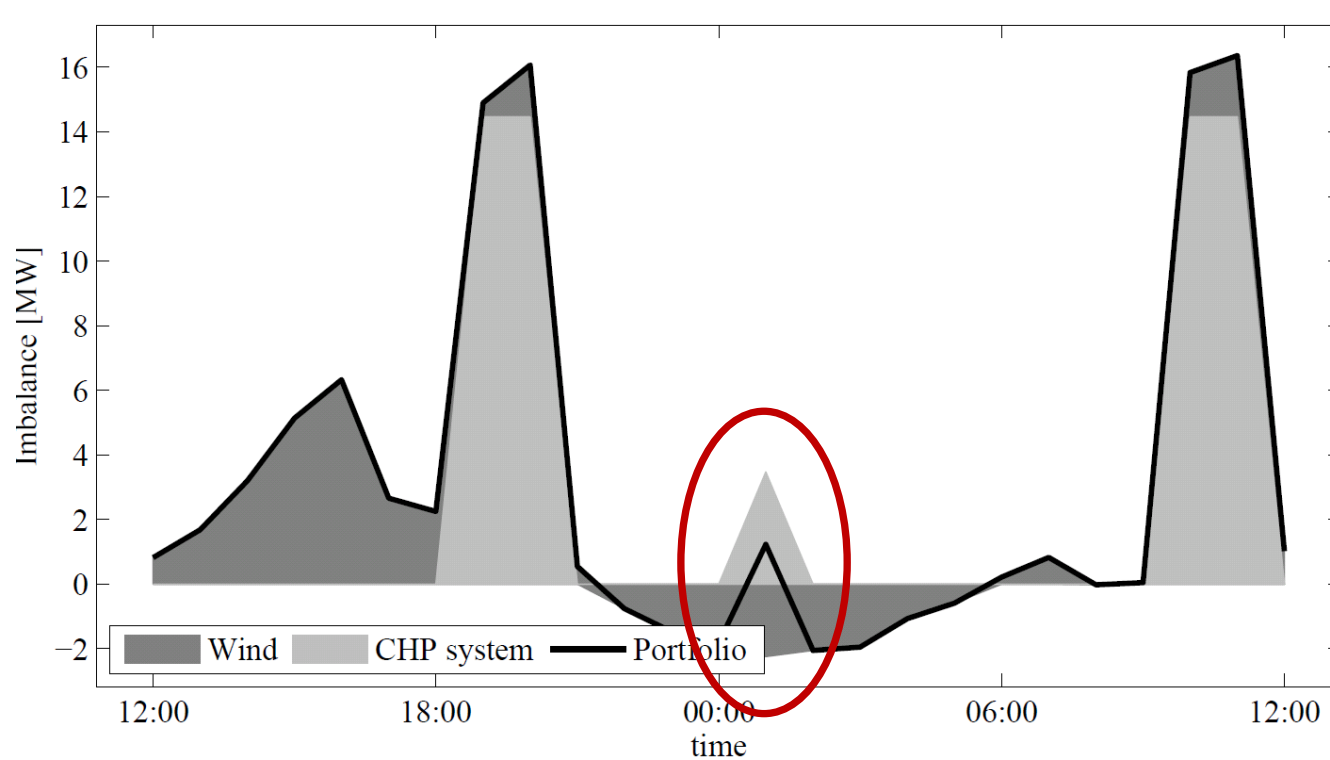


A Realistic Case-Study

- Real data for heat/power system (DONG Energy)
- State-of-the-art (point) forecast for uncertainty
 - Wind power production
 - Heat demand
 - Power prices (day-ahead/balancing)
- Rolling-horizon approach with hourly forecast update
- Historical data used in evaluation

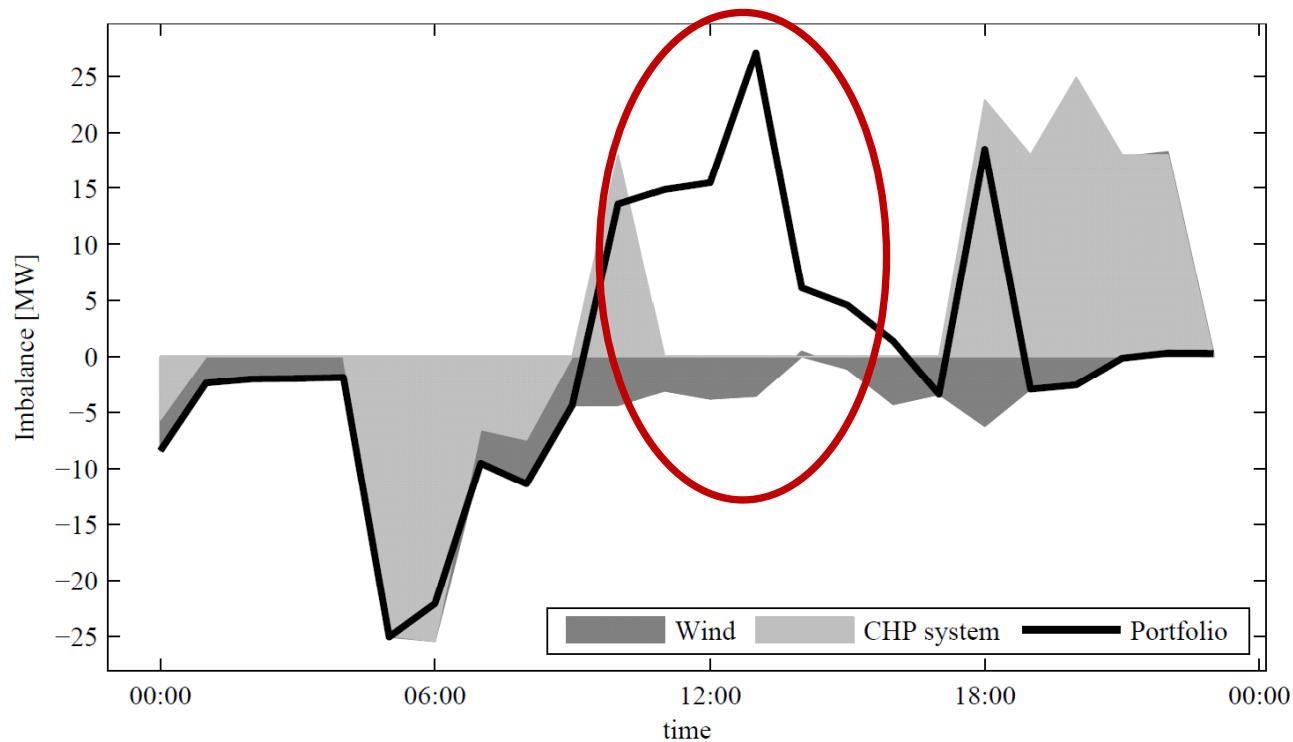
Setup that mimics the actual operation of the system!

Example: Reducing Imbalances (1)



Imbalances in opposite direction cancel out.
Improvement from **setup**

Example: Reducing Imbalances (2)



Very costly regulation for wind: CHP output is increased.
Improvement from **optimization**

Optimization Criteria



1. **Profit-seeker:** maximize market revenue at any cost (in terms of imbalance)



2. **Imbalance-averse:** minimize imbalance at any cost (in terms of profit)



3. **Balanced:** maximize revenues as long as portfolio imbalance not greater than the wind power imbalance alone

Market Performance (2012)

Operation mode	Criterion	Profit (M€)	Imbalance (GWh)
Independent	Profit-seeker	12.67	62.04
	Imbalance-averse	-37.97	18.61
	Balanced	10.48	25.98
Portfolio	Profit-seeker	12.74	51.91
	Imbalance-averse	-33.36	8.56
	Balanced	10.50	15.25



Thanks for your attention!

Questions?