Natural Gas Storage:

Tales from Two Countries

Georg Zachmann and Anne Neumann

DIW Berlin and EE^2

DRAFT! PLEASE DO NOT CITE, COMMENTS WELCOME!

CeSSA

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Agenda

1. The Issue
2. (Natural Gas) Storage – Theory and Literature
3. Case Study Rough: Strategic Storage
4. Case Study North Germany: „ Competitive“ Behavior
5. Conclusion

Continental Europe: Heterogeneous Regulation and Little Transparency in Natural Gas Storage Markets

- Article 19 of 2003/55/EC: Third party access (TPA) to facilitate downstream competition

→ 3 countries regulate (BG, IT, E), others mainly negotiated TPA

- Article 22: exemption under the condition that "the investment must enhance competition in gas supply and enhance security of supply"

- Madrid Forum: Guidelines for Good Practice for Storage System Operators (GGPSSO) agreed upon in March 2005, criticized by ERGEG (2006)

➔In a liberalizing natural gas market, storage is an essential element to provide flexibility and promote competition

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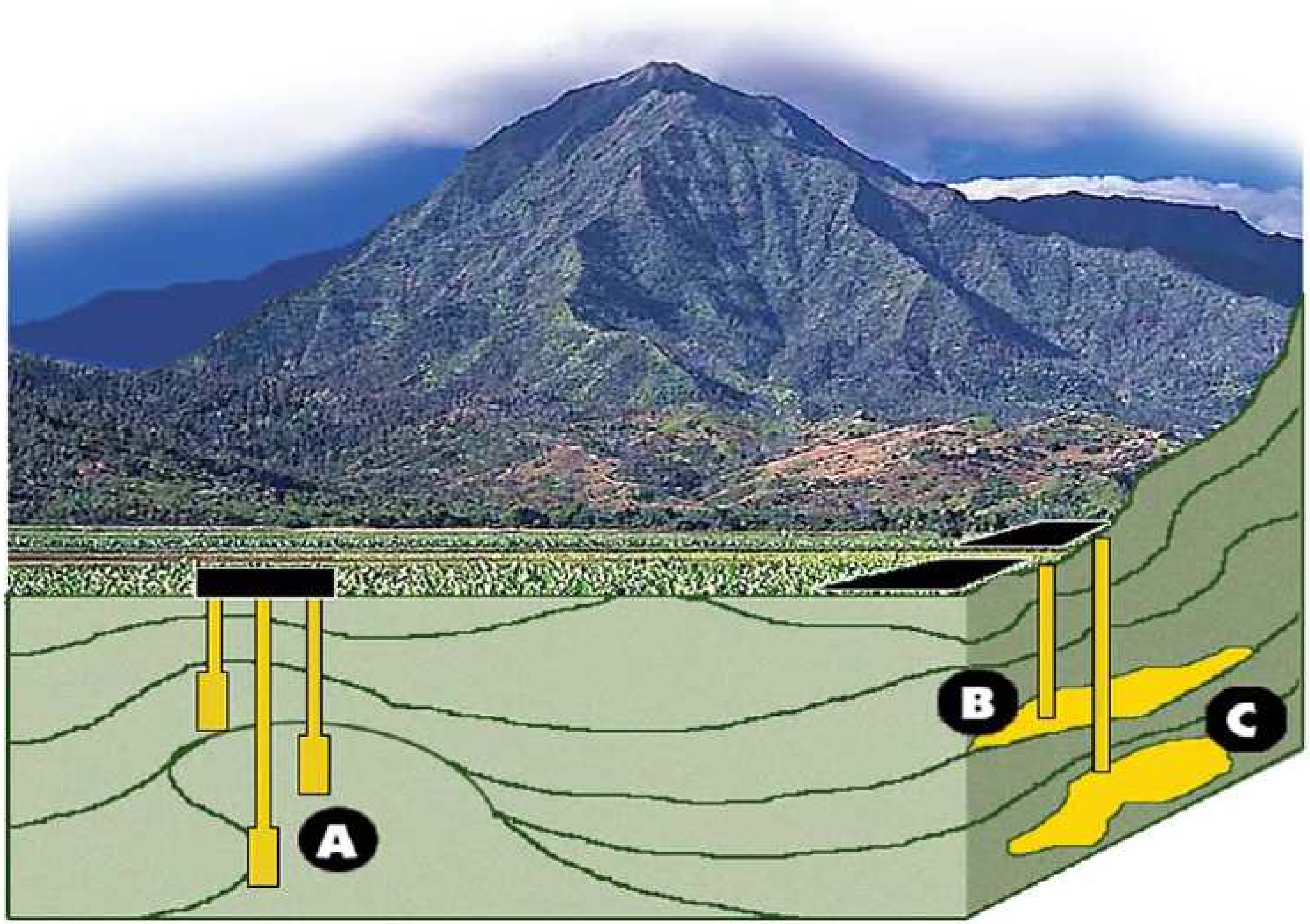
Types of Natural Gas Storage
(seasonal storage vs. peak storage)



A – Salt Caverns   B – Aquifers   C – Depleted Reservoirs

Natural Gas Storage

Fee	Salt Cavern	Depleted Gas Fields
Fixed Fees (based on MMBtu of capacity reserved):		
Annual Demand Charge, $ MMBtu	1,00	0,40
Variable Costs (based on volume of throughput):		
Injection Fee, $/MMBtu	0,02	0,02
Withdrawal Fee, $/MMBtu	0,02	0,02
Fuel Expense, %	1	1
Injection Days To Fill	20	180
Withdrawal Days To Deplete	10	120
Typical Number of Cycles Per Year	4 to 5	1 to 1.5

→ **Salt Caverns exhibit more flexibility albeit at higher costs**

Source: Simmons (2005, 8)

Operation of Storage Facilities

"Store until the expected gain on the last unit put into store just matches the current loss from buying – or not selling it – now"

(Williams and Wright, 1991, p.25)

- Arbitraging potential in functioning markets

- Production and storage performed by competitive profit-maximizers is favorable for consumers

- Natural gas storage is limited by technical factors influencing operability of facilities induced by geological characteristics, and strong seasonality

Empirical Evidence in Natural Gas Markets

Uria and Williams (2005)

→ Injection in Californian facilities increases slightly with a strengthening intertemporal spread on NYMEX

Serletis and Shahmoradi (2006)

→ High inventory: large inventory responses to shocks imply roughly equal changes in spot and futures prices;
→ Low inventory: smaller inventory responses to shocks imply larger changes in spot prices than in futures prices

Chaton, Creti, and Villeneuve (2006)

→ Modeling the impact of policies on prices and quantities consumed or stored (including demand and supply shocks), taking into account seasonality of natural gas markets

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Rough Storage in the UK

	Rough
Owner	Centrica
Max. working capacity in GWh	17.735 (28.083)
Max. injection rate in GWh/day	234 (445)
Max withdrawal in GWh/day	466 (445)
Available data	Daily closing stock levels

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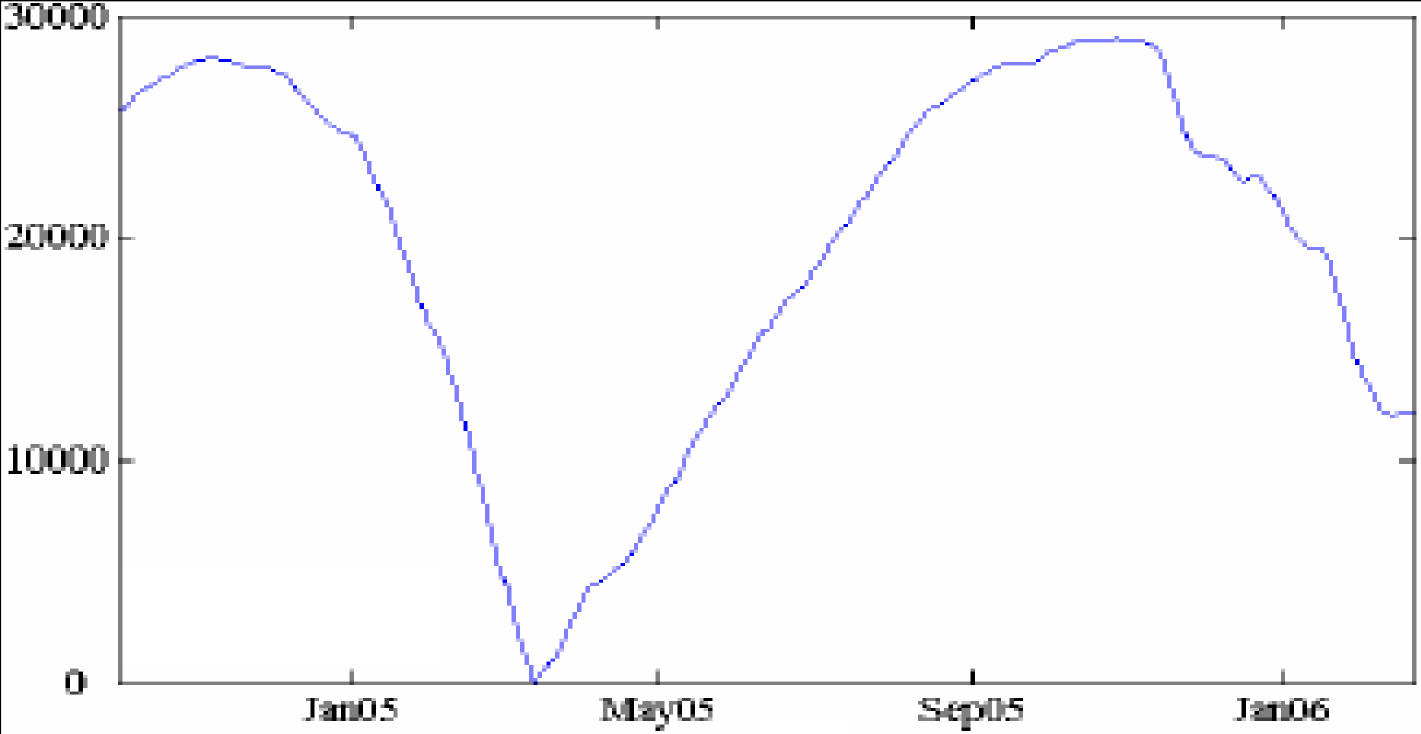
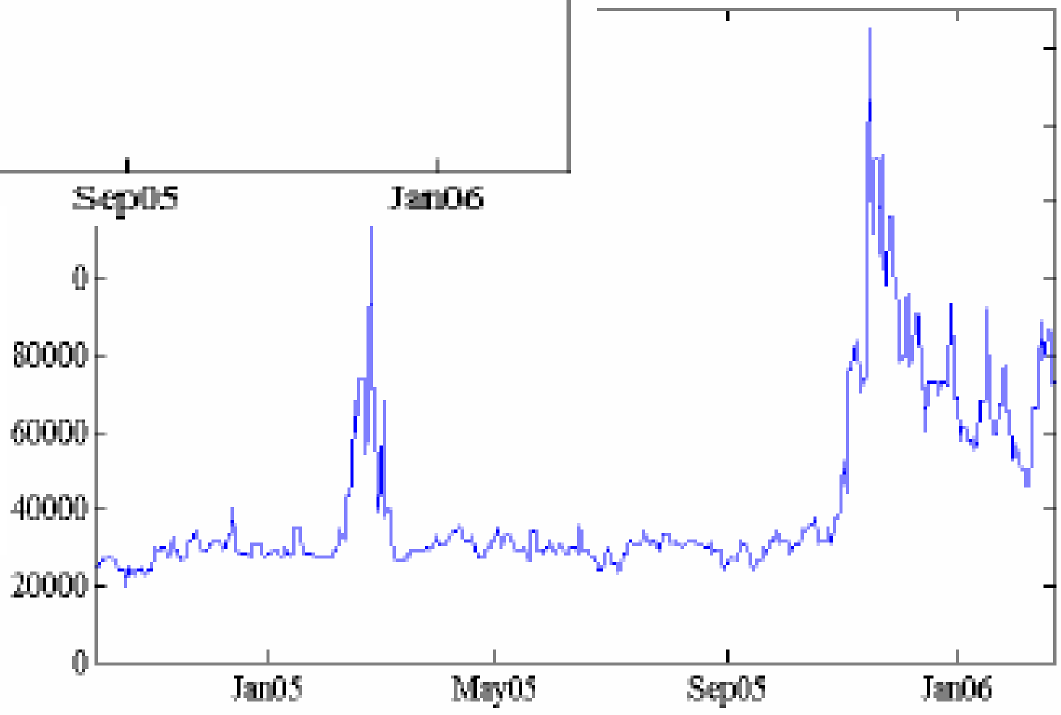
Source: IEA Natural Gas information, 2006



Real storage level (GWh)



NBP spot prices (€/GWh)

→ Determine the relationship between spot prices and storage utilisation

The Model

Determine ex-post optimal storage strategy X_t with t = (1,…,T) (injection if $X_t < 0$ and withdrawal if $X_t > 0$)

- Maximize profit as a function of quantities, spot prices, injection and withdrawal fees, fixed fee and discounted foregone income

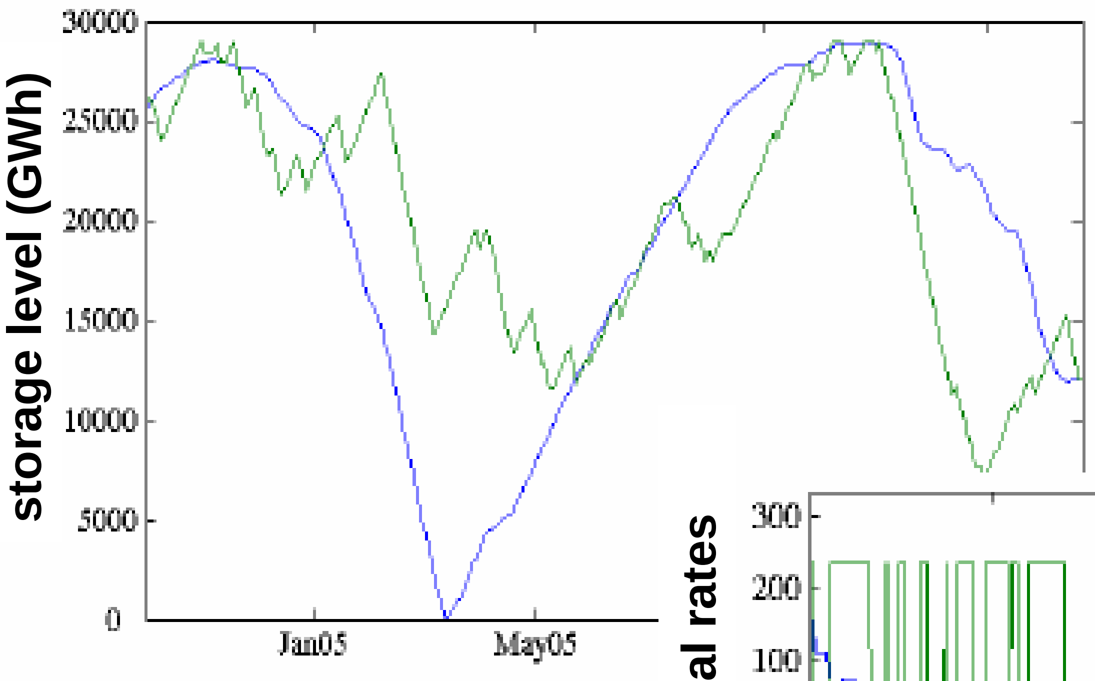
- Subject to technical constraints

    - Maximum injection and withdrawal rates

    - Maximum storage capacity

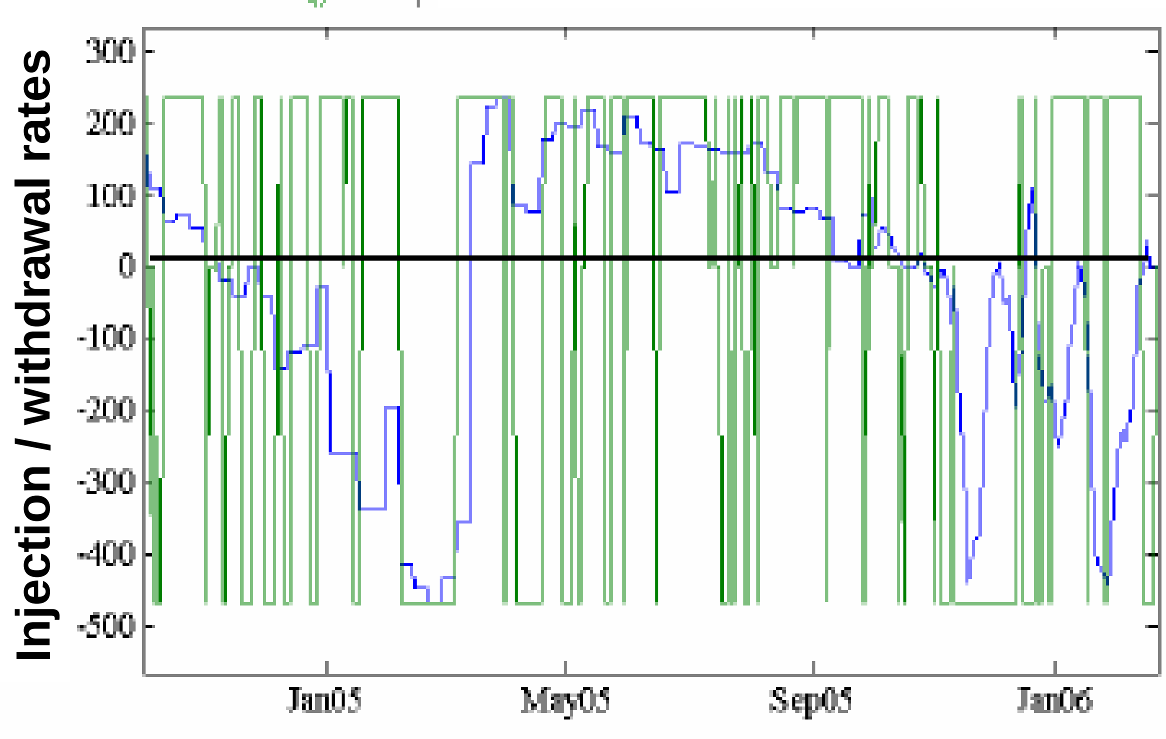
    - Given the initial and final levels of storage

Simulation Results for Rough: Strategic Storage?



Real data

Projected behavior



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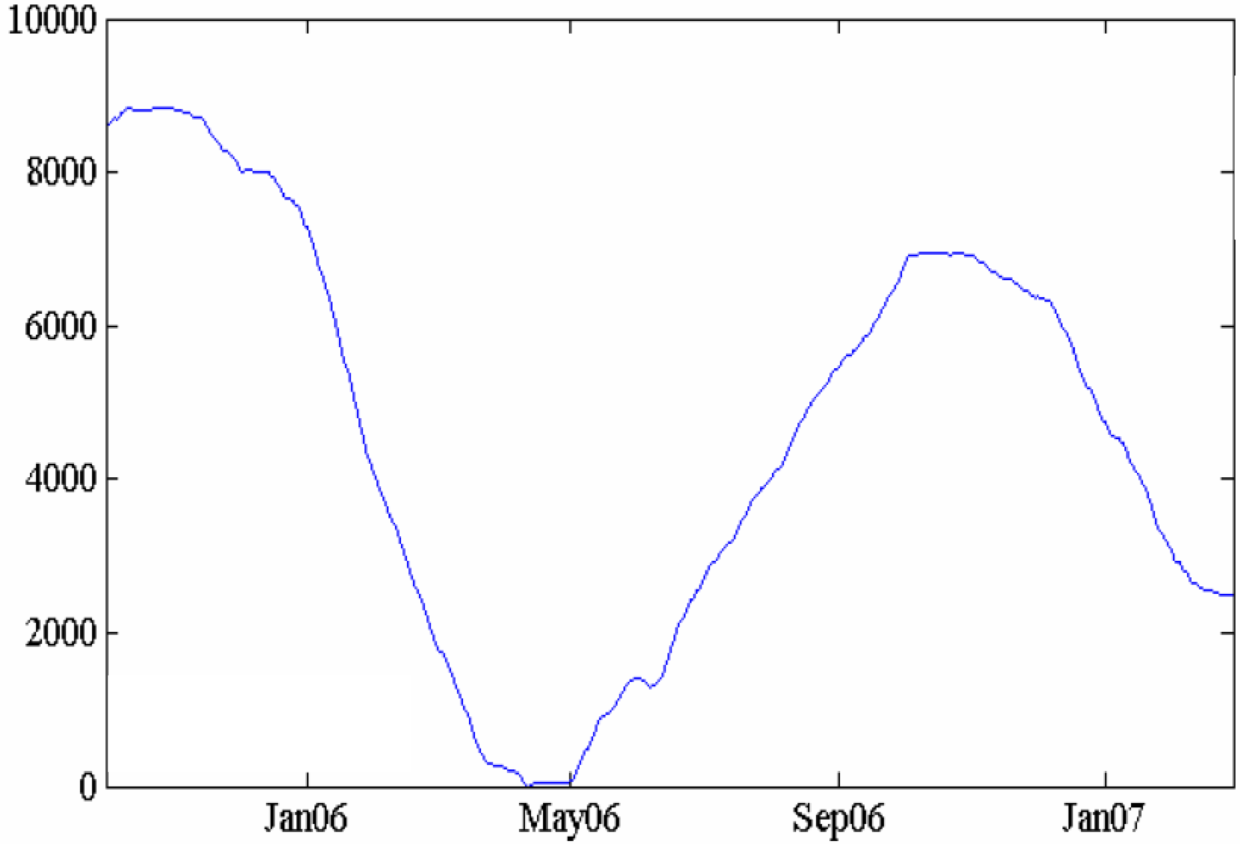
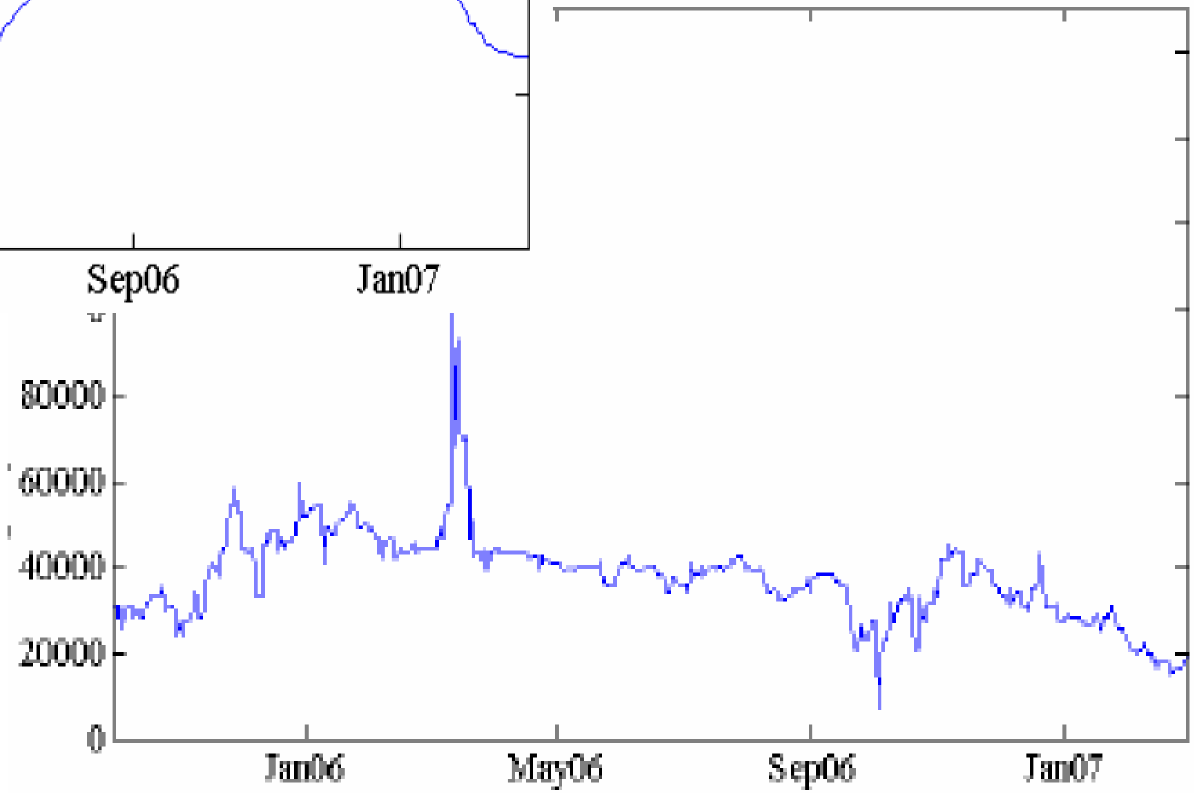
Dötlingen in Germany

	Dötlingen
Owner	BEB
Max. working capacity in GWh	8.847 (17.899)
Max. injection rate in GWh/day	109 (217)
Max withdrawal in GWh/day	135 (217)
Available data	Daily aggregated injections and withdrawals

Source: IEA Natural Gas information, 2006



Real storage level (GWh)



TTF spot prices (€/GWh)

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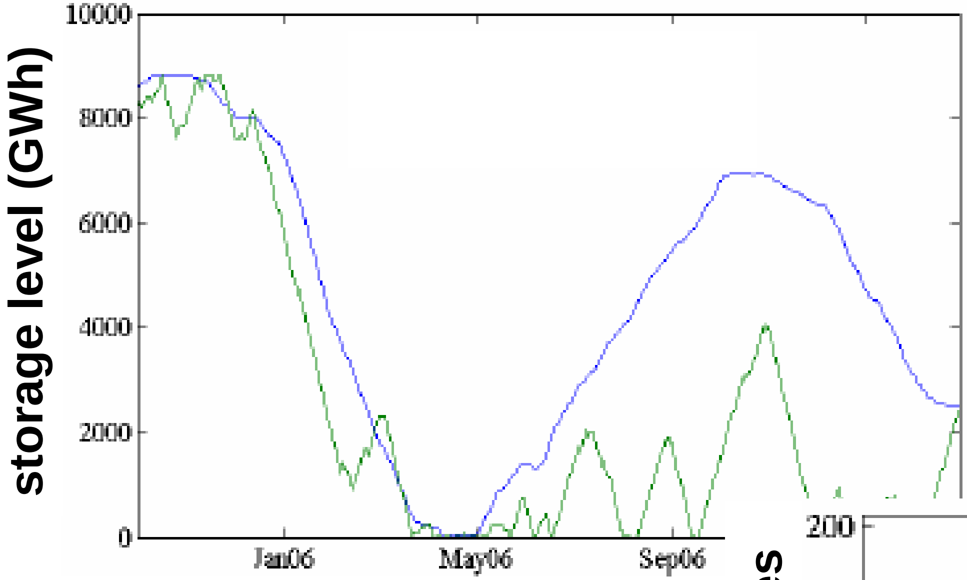
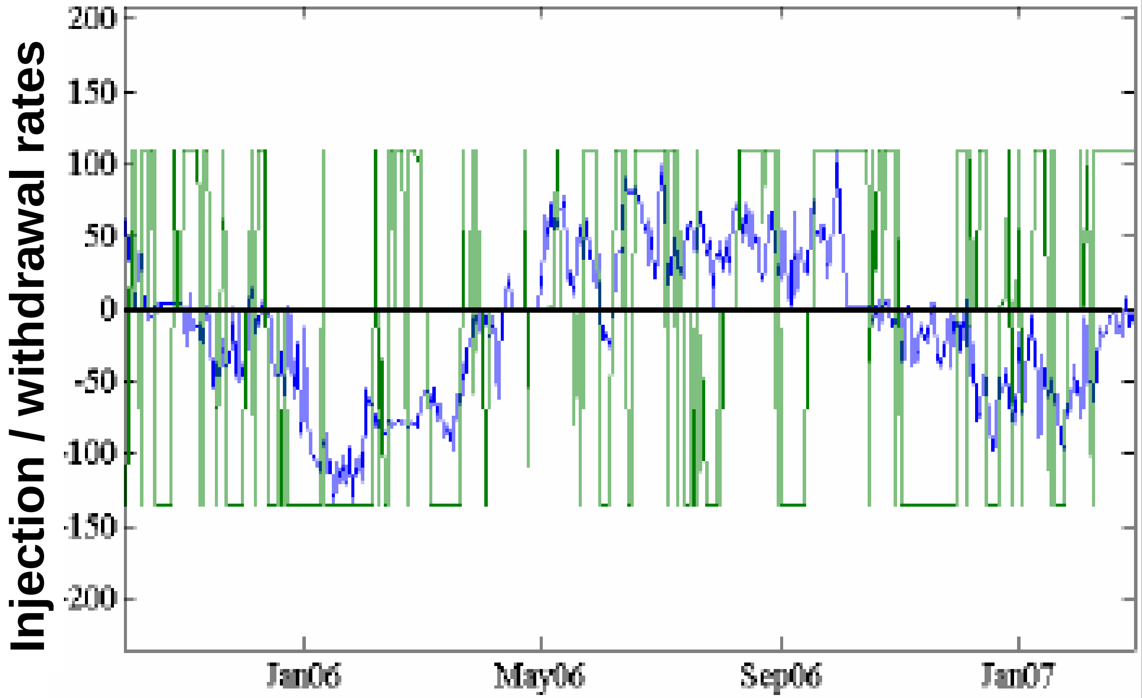
Simulation Results for Dötlingen: Competitive Storage?





Real data

Projected behavior

Comparison of Rough and Dötlingen

	Germany	UK
Sample	10/2005-9/2006	10/2004-9/2005
Profit of the optimal strategy (in M€)	140	213
Profit of the observed strategy (in M€)	96	121
Foregone Profit	46%	76%
Correlation of observed and optimal strategies injections/withdrawals.	49%	28%
Correlation of observed and optimal strategies storage levels	96%	73%
Variance of the real flow data explained by the optimal strategy*	23%	8%
Variance of the real storage level data explained by the optimal strategy*	92%	53%

*$R^2=Cov(X,Y)^2/(Var(X)*Var(Y))$, where X is the observed and Y the optimal strategy.

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Conclusions

- Natural gas storage in Europe in need for harmonization and transparency

- Arbitraging potential should favor the emergence of commercial storage operators

- Storage facilities are used differently in European countries

- Observed storage usage for Rough (UK) and Dötlingen (GER) largely deviates from ex-post optimal strategy

- Storage activities are not purely carried out on a merchant basis