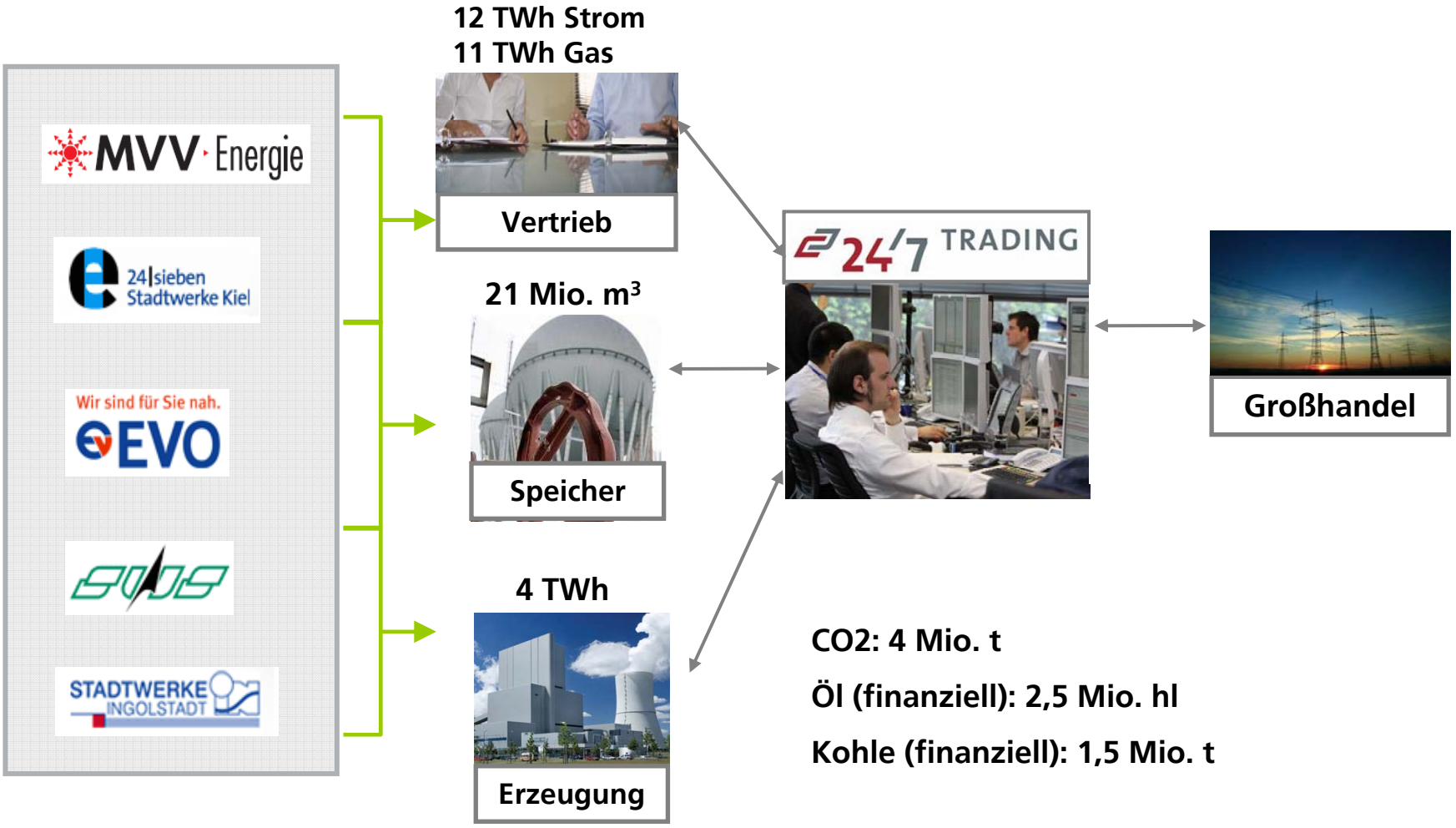
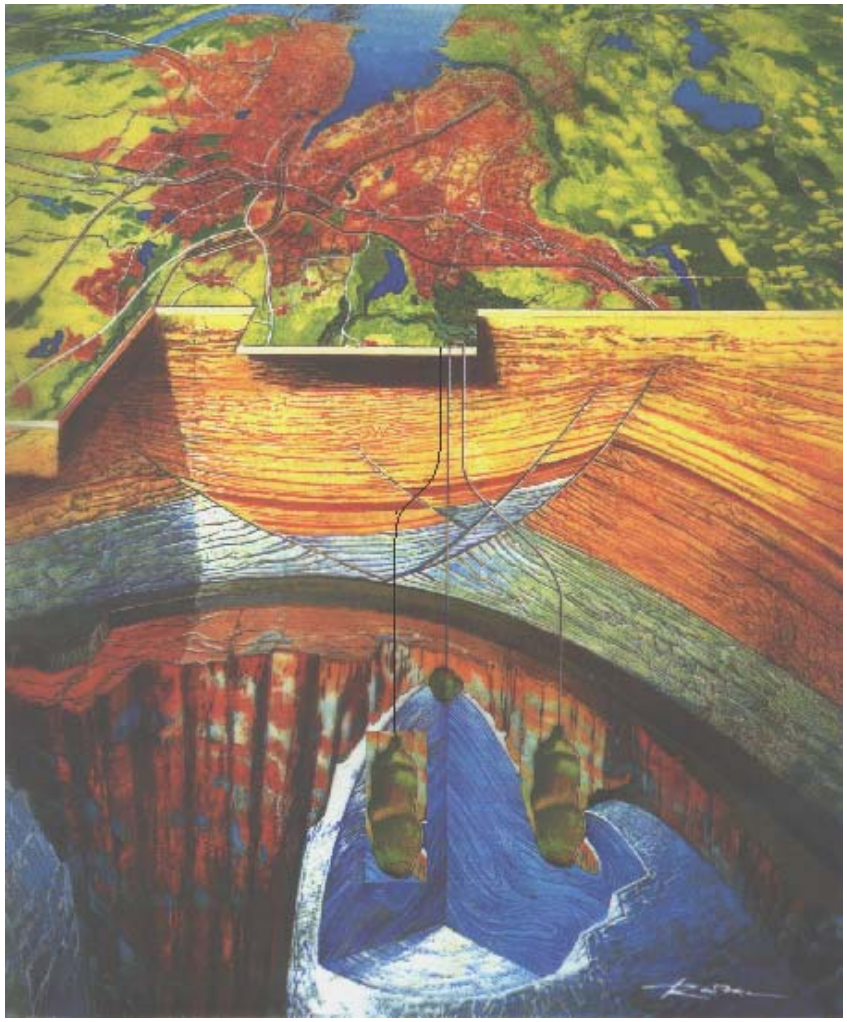
Optimizing Gas Storage from a Trader‘s Perspective

Volker Termath
24/7 Trading

gesamten Aktivitäten am Großhandelsmarkt über die 24/7 Trading



MVV Group‘s Storage Facility at Kiel

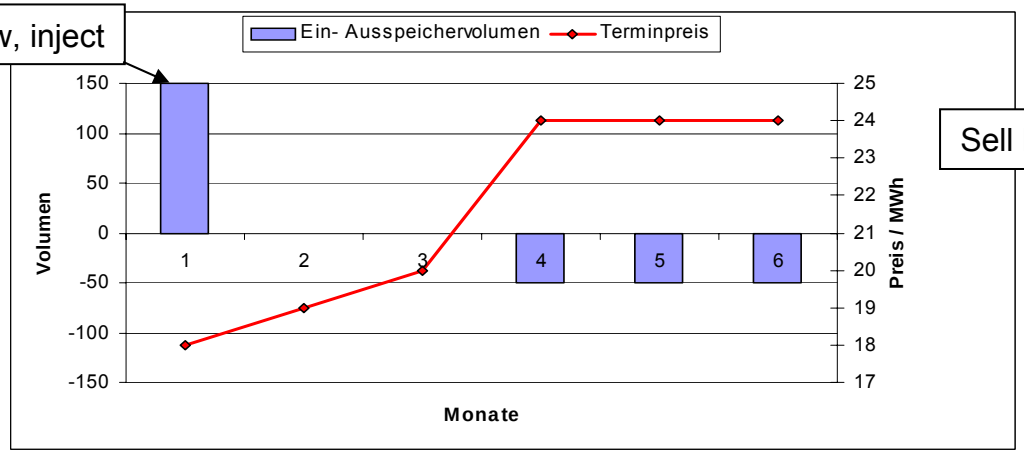


Agenda

- Valuing and Trading Storage
- Basic ideas
- Optimization
- Forward Curve und Dynamics
- Stochastic
- Results vs. Market
- Conclusions

What Traders do: Arbitrage

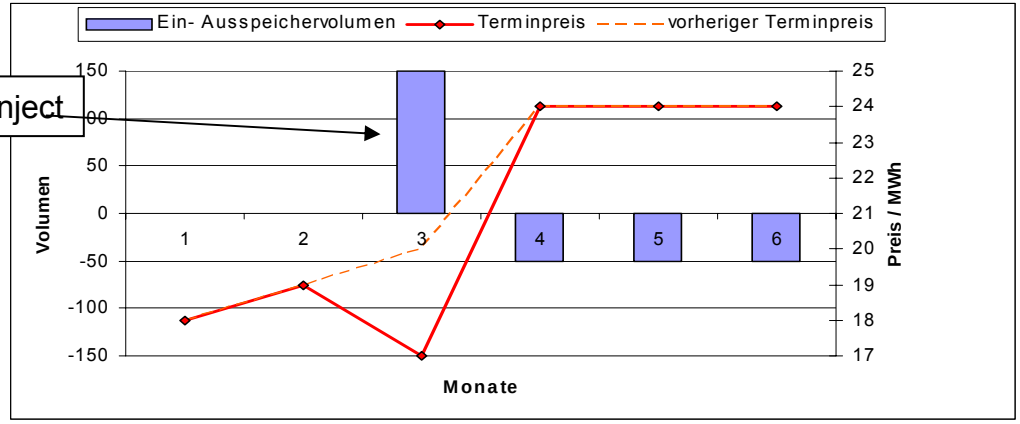
Buy low, inject



Sell high, withdraw

Todays Forwardcurve and Hedge

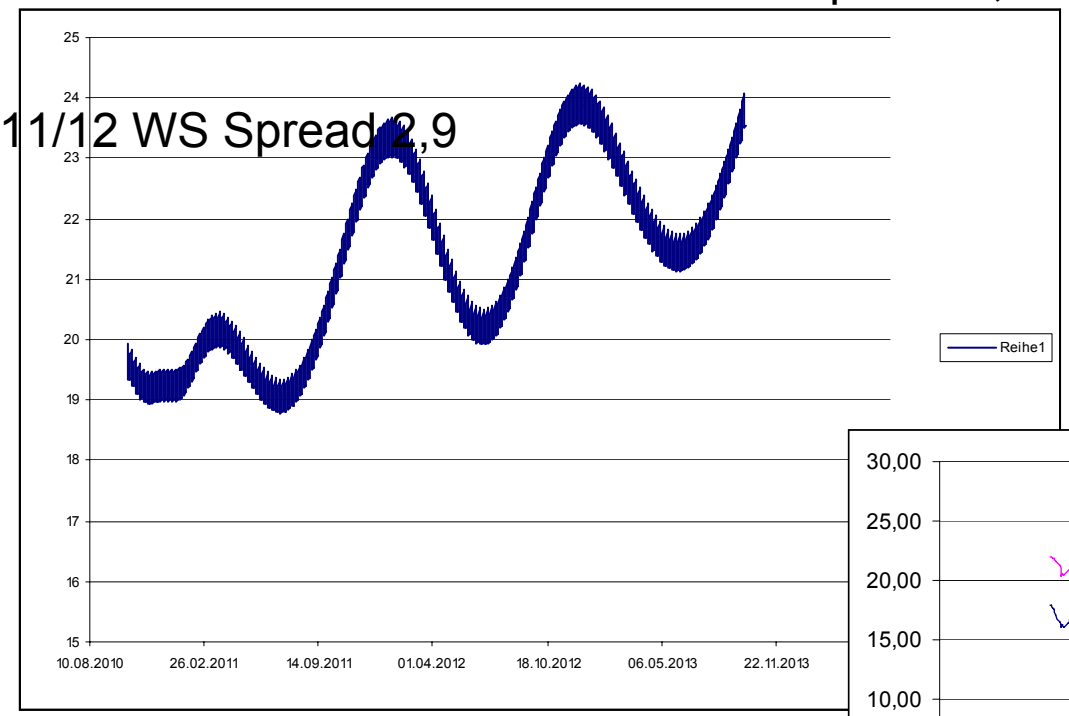
Sell, Buy lower, inject

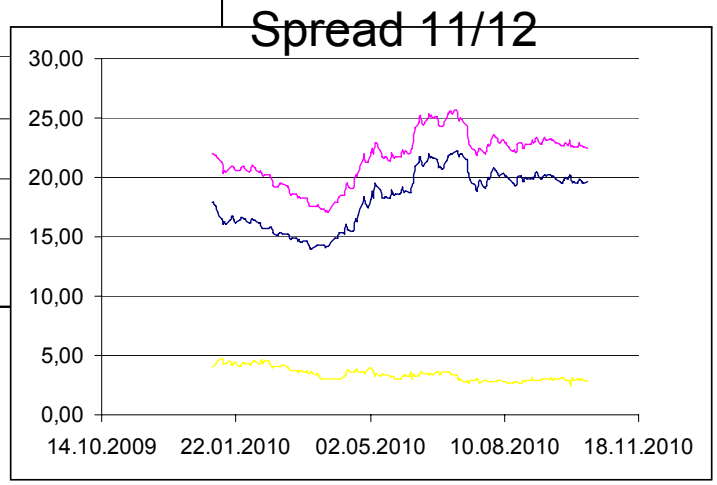


Tomorrows Forward Curve and new Hedge; Profit: +150 Euro

Rolling intrinsic Hedge

PFC 14.10.2010

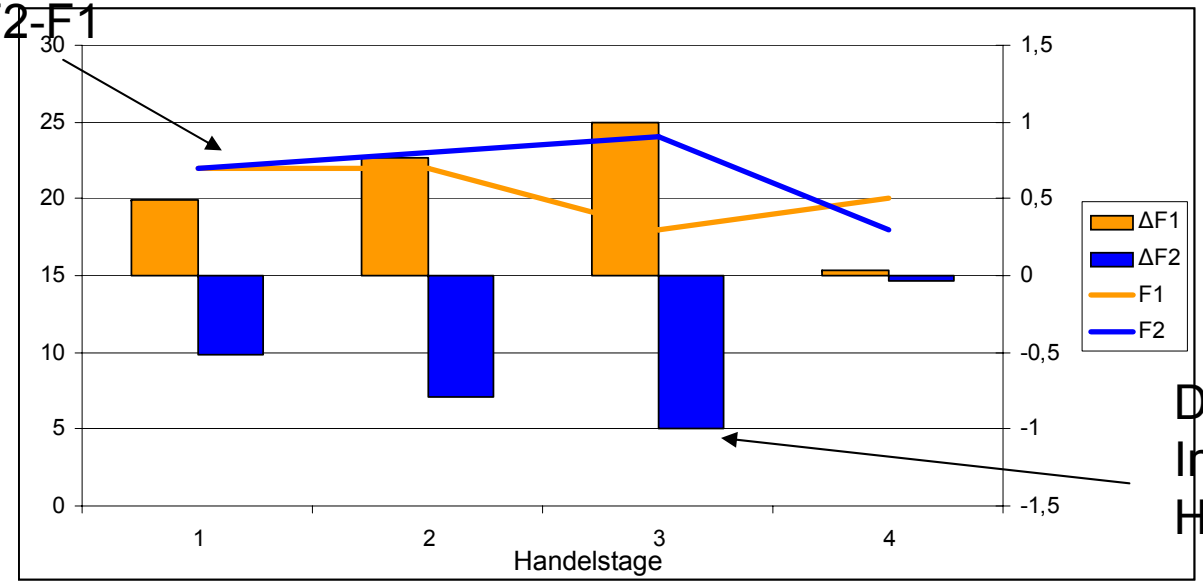




Delta Hedge: value of time spread

Winter Summer Spread:

F2-F1



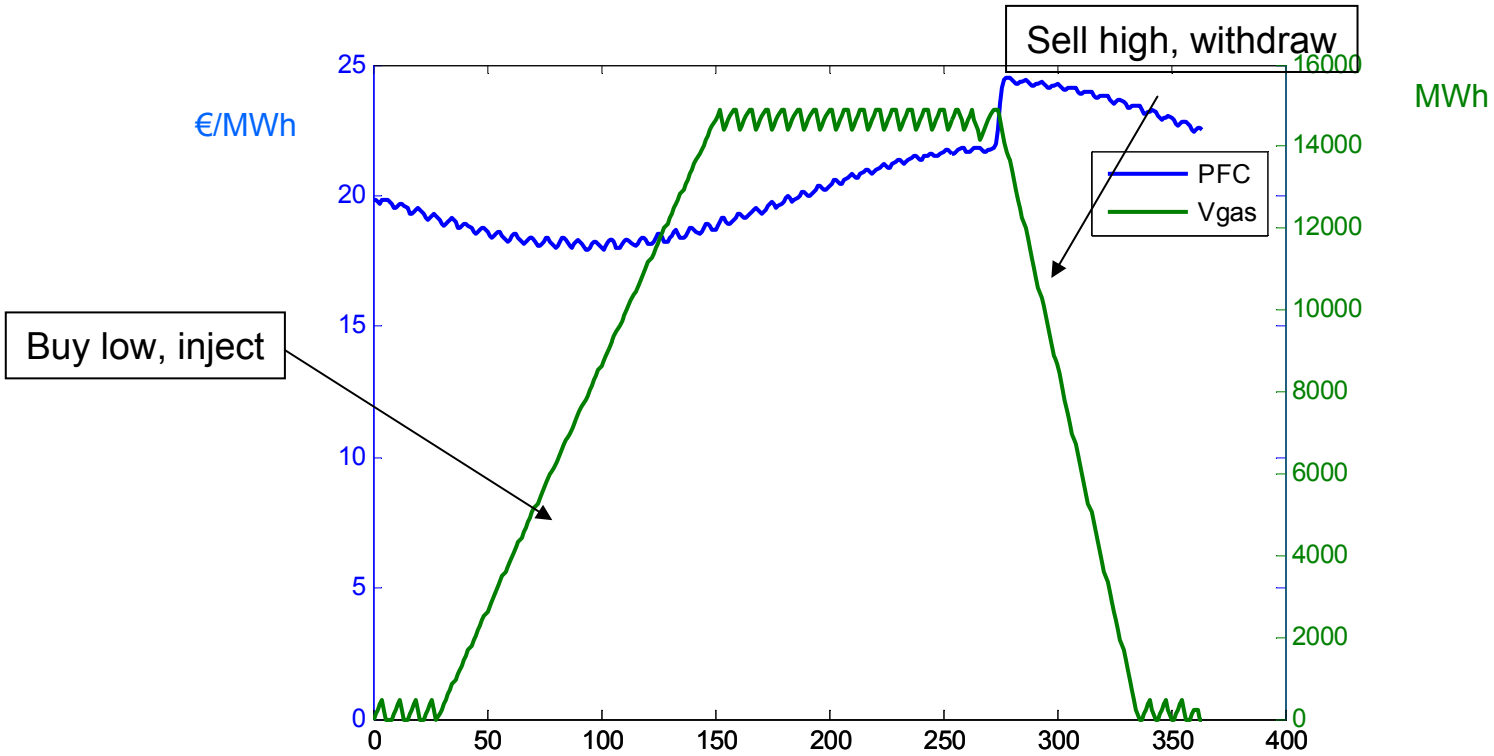
Delta Position:
Inject-Wdraw :
Hedge Forward curve

	Premium		Delta		MtM Hedges
	F1	*F2*	*C*	*ΔF1*	*ΔF2*	
at the money	22	22	0,50665667	0,486921229	-0,513078771	0,575465946
In the money	22	23	1,164520796	0,769465366	-0,788886594	1,216153611
deep in the money	18	24	6,00000007	0,999999629	-0,999999737	6,00000036
out of the money	20	18	0,014680066	0,031562527	-0,036638288	0,028238652

Model: Spread Option, Margrabe,
Korrelation 0,5

Do it like the traders do

- Storage trading: buy low, sell high against Gas PFC
- Do it on a daily basis
- Realize Cash Flow today
- Move on to tomorrow

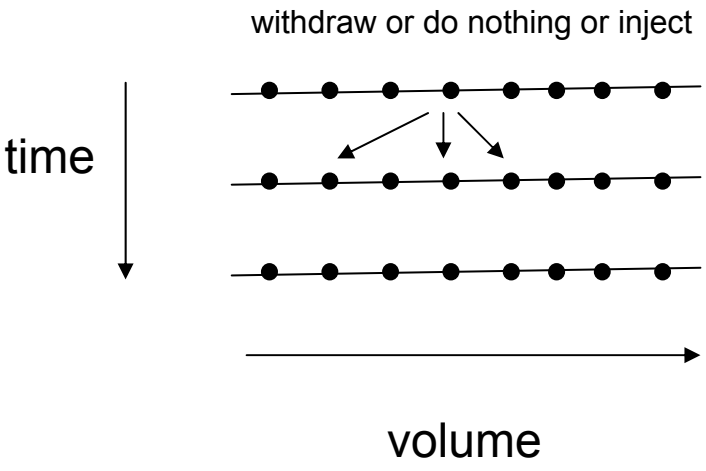


Algorithmics: Optimization

$$C(t, j) = \max_{k=\{\max(-j,-1);0;\min(J-j,2)\}} [C(t+1, j+k)e^{-r\Delta t} + (P(t) - sign(k) * bo) * v * k]$$

2D Grid:
- t: time 1…T
- j: volume 0 …J*v

P: price
bo: b/o spread



Initialisation: C(T+1, j) = 0 or Penalty

Theory: Curve Dynamics

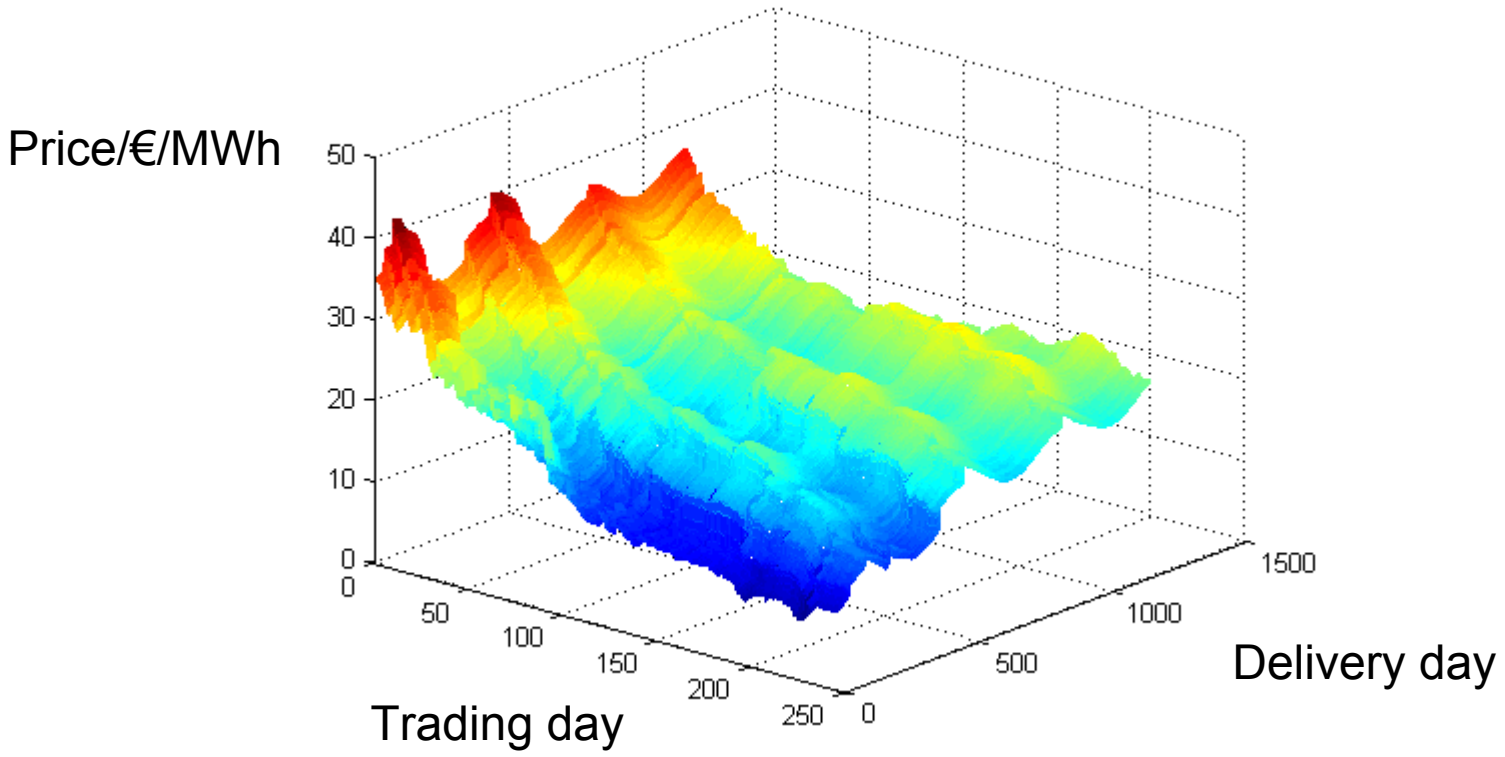
- We choose uncorrelated, normal distributed Shocks dZ to model the return of the Forwardkurve F

$$\frac{dF(t,T)}{F(t,T)} = \sum_{i=1}^{N} \sigma_i(t,T) dZ_i(t)$$

- Shape and number of volatility functions σ are calculated based on a principal component analysis PCA
- Propagation of the curve in time uses the integation scheme:

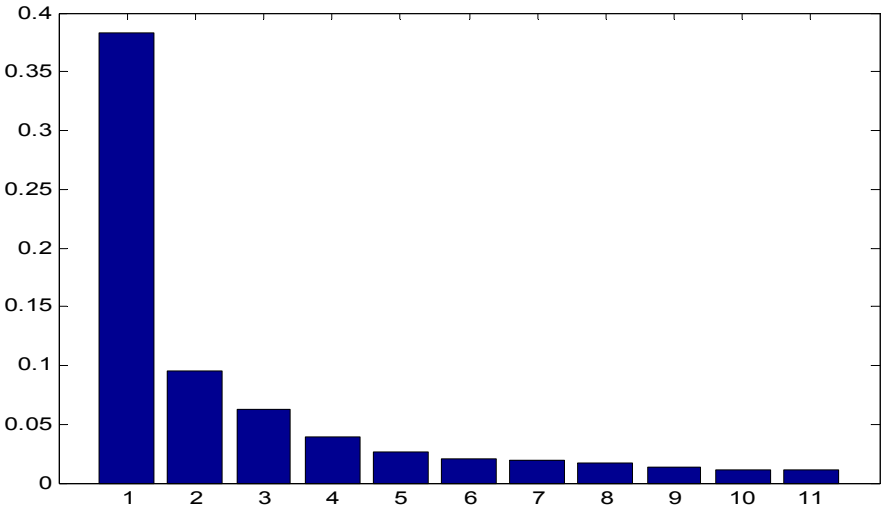
$$F(t+\Delta t,T) = F(t,T)\exp\left\{\sum_{i=1}^{N}\left(\sigma_i(T-t)\sqrt{\Delta t}\cdot\tilde{\varepsilon}_i - \tfrac{1}{2}{\sigma_i}^2(T-t)\Delta t\right)\right\}$$

PCA I: NCG Data



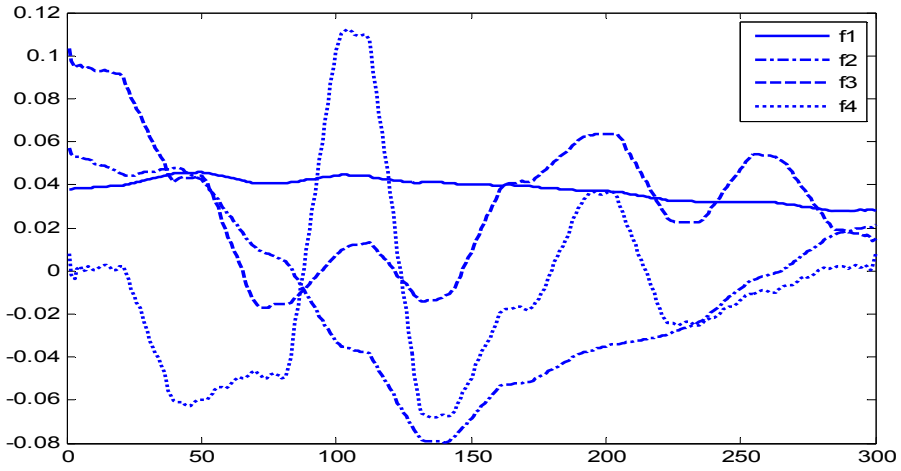
Plot of PFC along Gasyear 08/09 for NCG

PCA II: results



Weight of volatilty function fn in total expansion(f1..f5 > 80%)

Interpretation of fn
- f1: parallel shift
- f2: bend
- f3: symmetric twist
- f4 asymmetric twist



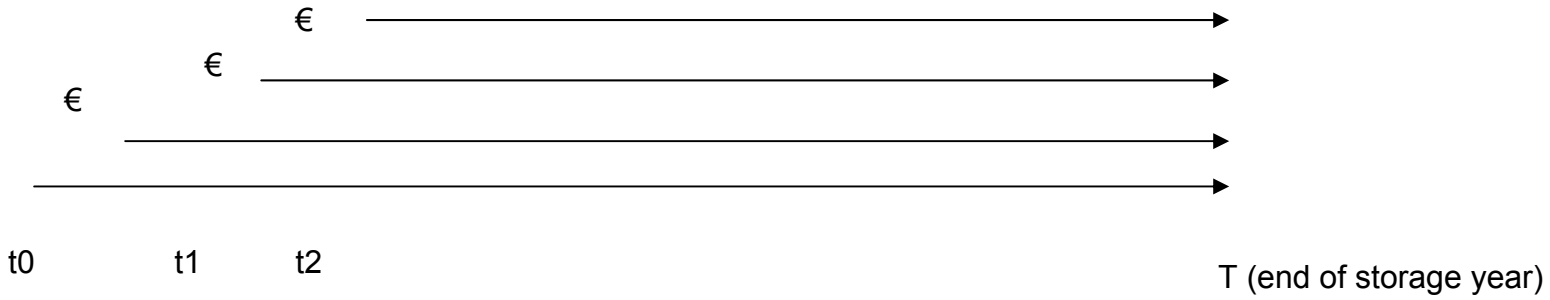
Rolling daily intrinsic Optimization

Decision at t:
- Inject
- Withdraw
- Do nothing

Realise optimal Cash Flow, discount, sum up

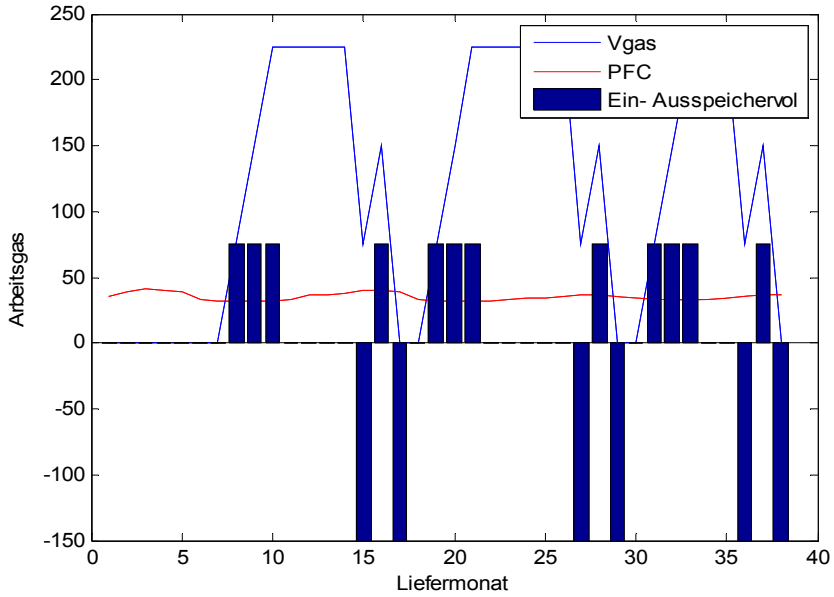
t = t +1

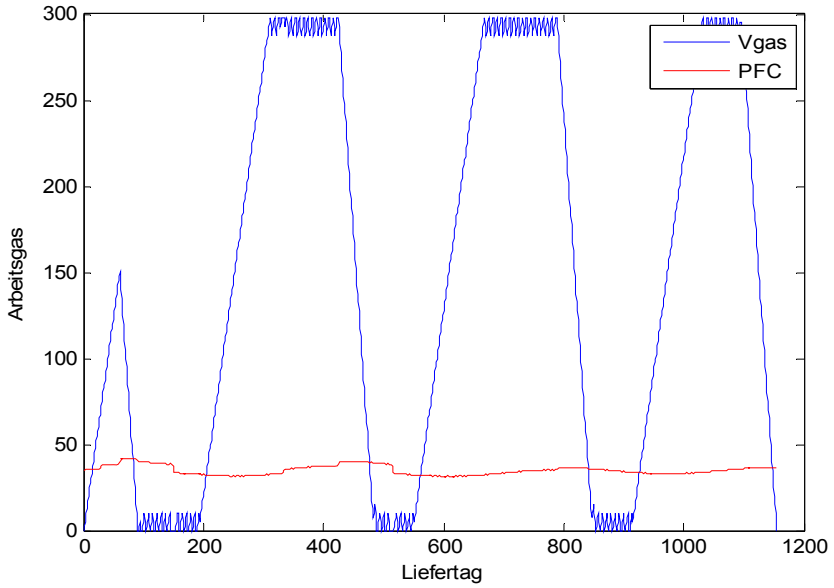
propagate PFC



Calculation I

- Intrinsic monthly against monthly PFC (static)
- Intrinsic, daily against PFC (static)
- SBU: 300 MWh working gas, Vinj 1,25 MWh/d,Vwithdraw 2,5 MWh/d

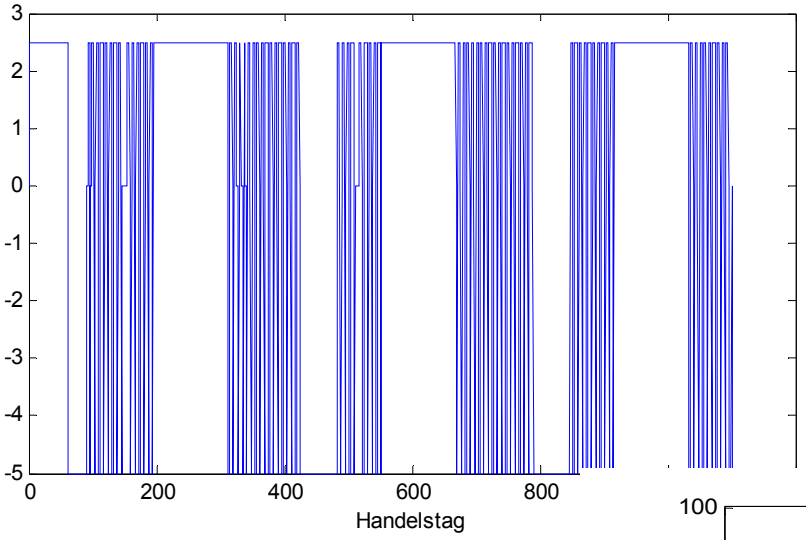




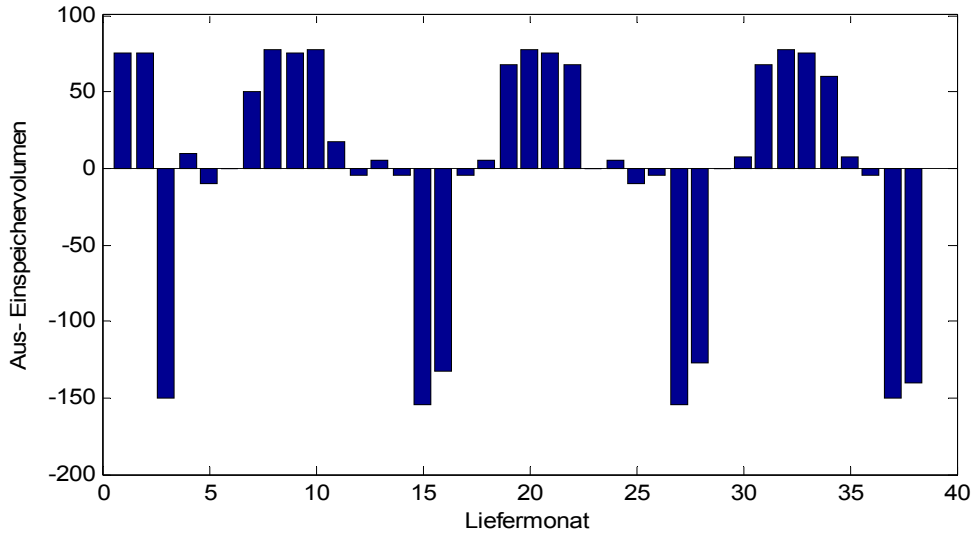
4,30 €/MWh WG/a

6,30 €/MWh WG/a

Volumetric Hedge



Products

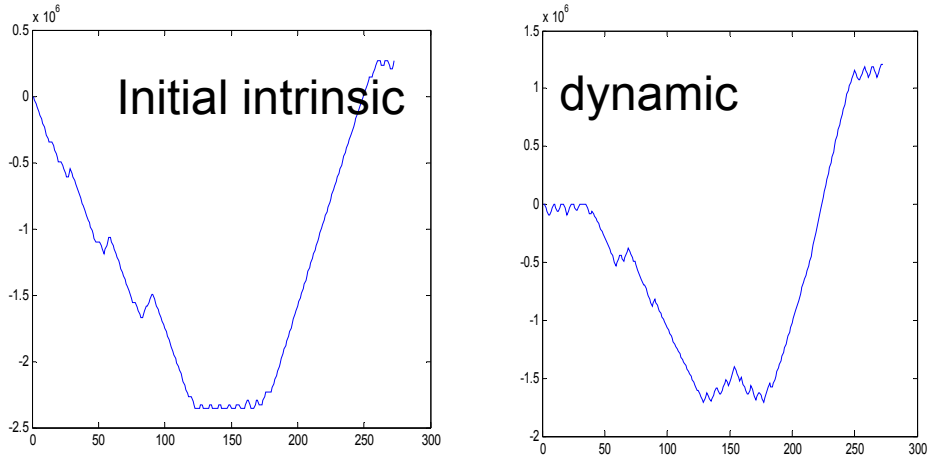


Cash Flow 5,75 €/MWh WG/a

Calculation I

- Rolling intrinsic to the end of the storage year: 6,70 /MWh AG

cumulated Cashflows



Monte Carlo

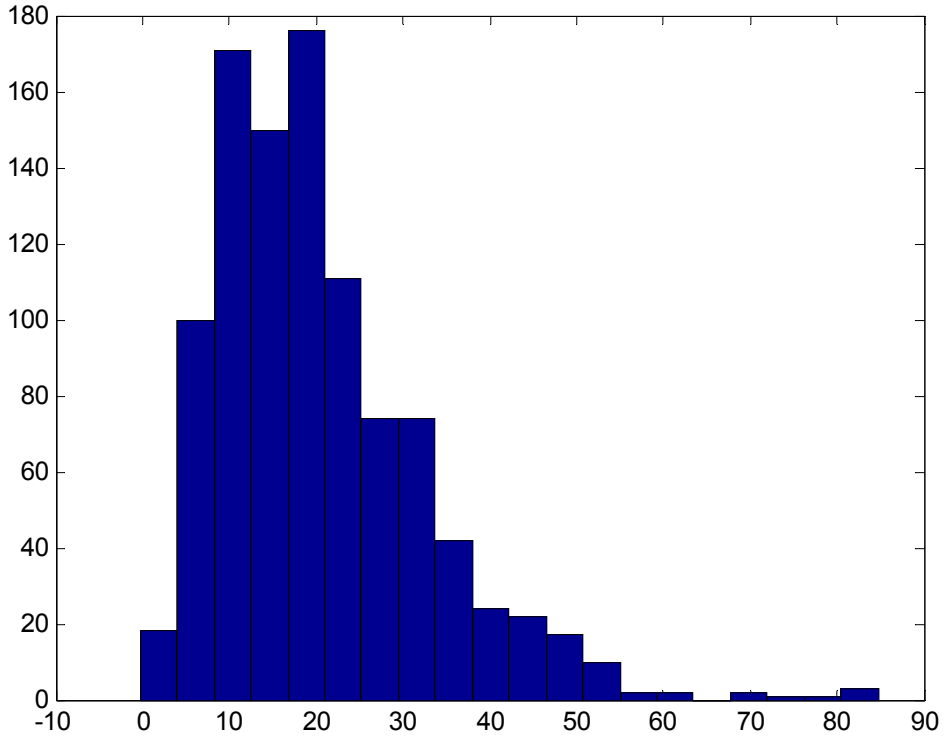
-> full time value: Monte Carlo with N runs of PFC propagation and rolling intrisic heging

Implementation

Plain Matlab using

1. Vectorized expressions whenever possible
2. Matrix algebra wherever possible

Monte Carlo

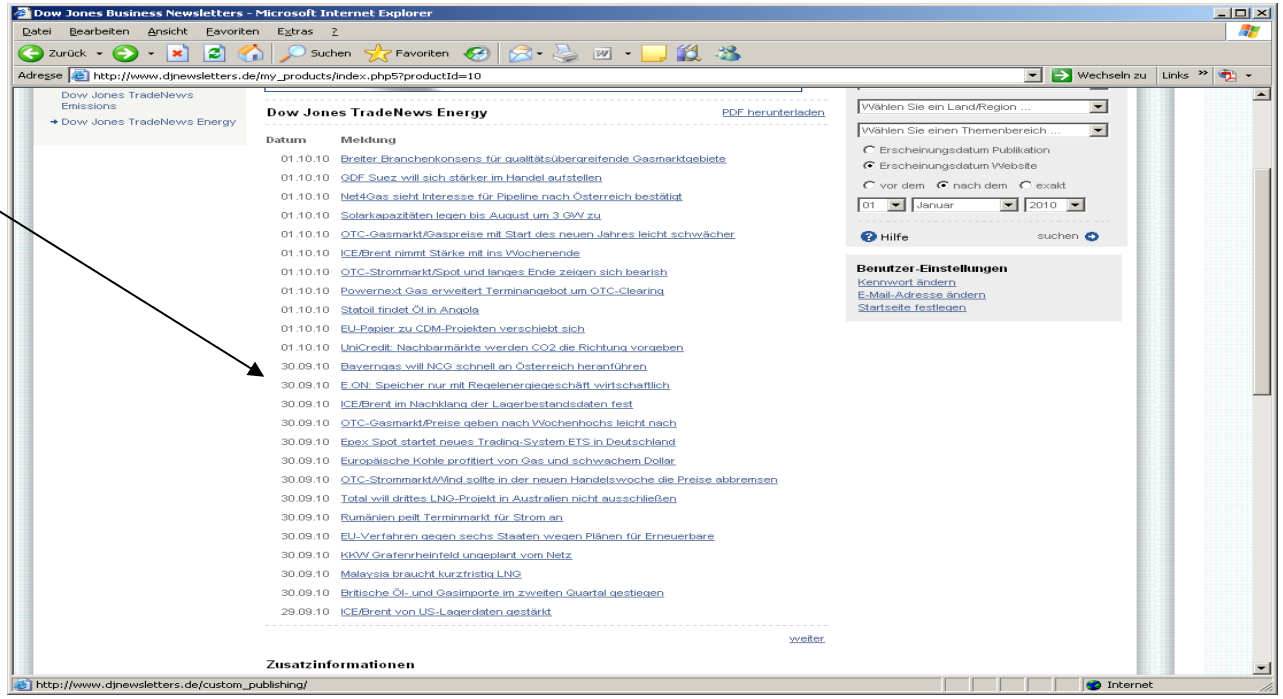


Pinj = 1.25 MW ,
P wdrawal = 2.5 MW,
WG 300 MWh
PFC scaled to Gasjear 08/09

Runs: 10000, 7 s / intrinsic rolling Optimization for 1 year
Value 12,7 €/MWh WG

Conclusion

- Reasonable implementation
- Reasonable results compared to market
- Unreasonable German gas market who does not really cover storage costs



Acknowledgements

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Thank you for your attention