E10047-TB10.17

Financial Management in the Energy Sector
Focus on risk and portfolio management

Ronald Huisman

Erasmus School of Economics
Energy Global

VEMW - 28 Januari 2010

Metallgesellschaft

December 1993: Metallgesellschaft AG revealed that its Energy Group was responsible for losses of approximately $1.5 billion.

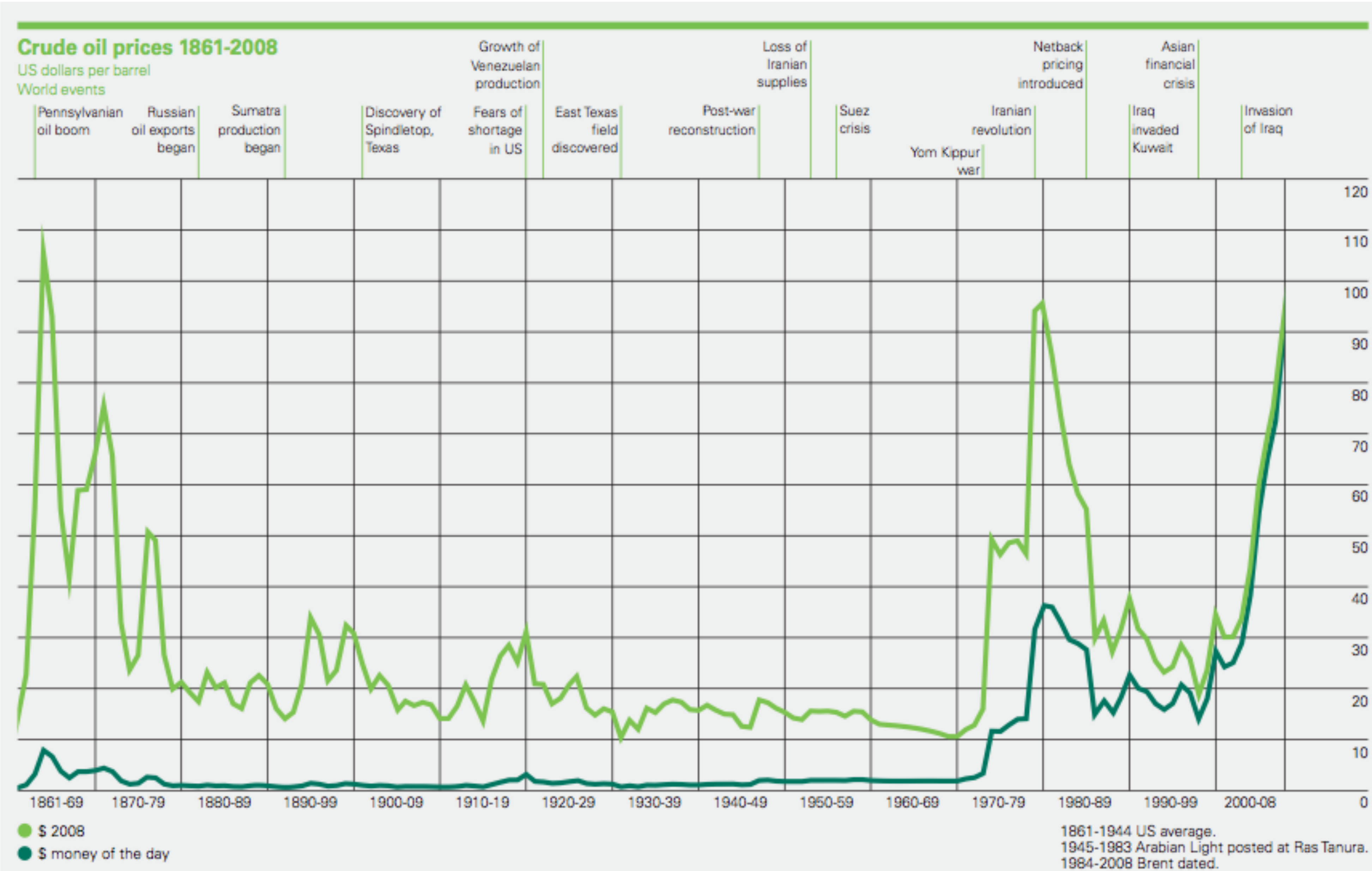
MGRM committed to sell, at prices fixed in 1992, certain amounts of petroleum very month for up to 10 years. In some cases, the profit margin was around $5 per barrel. September 1993: Metallgesellschaft has sold contracts amounting to the equivalent of 160 mio barrels (about 85 days worth of Kuwait entire output). MGRM had not sufficient refining capacity and had to purchase most in the energy markets.

In December 1993: the oil price dropped sharply and the forward curve switched from backwardation into contango.

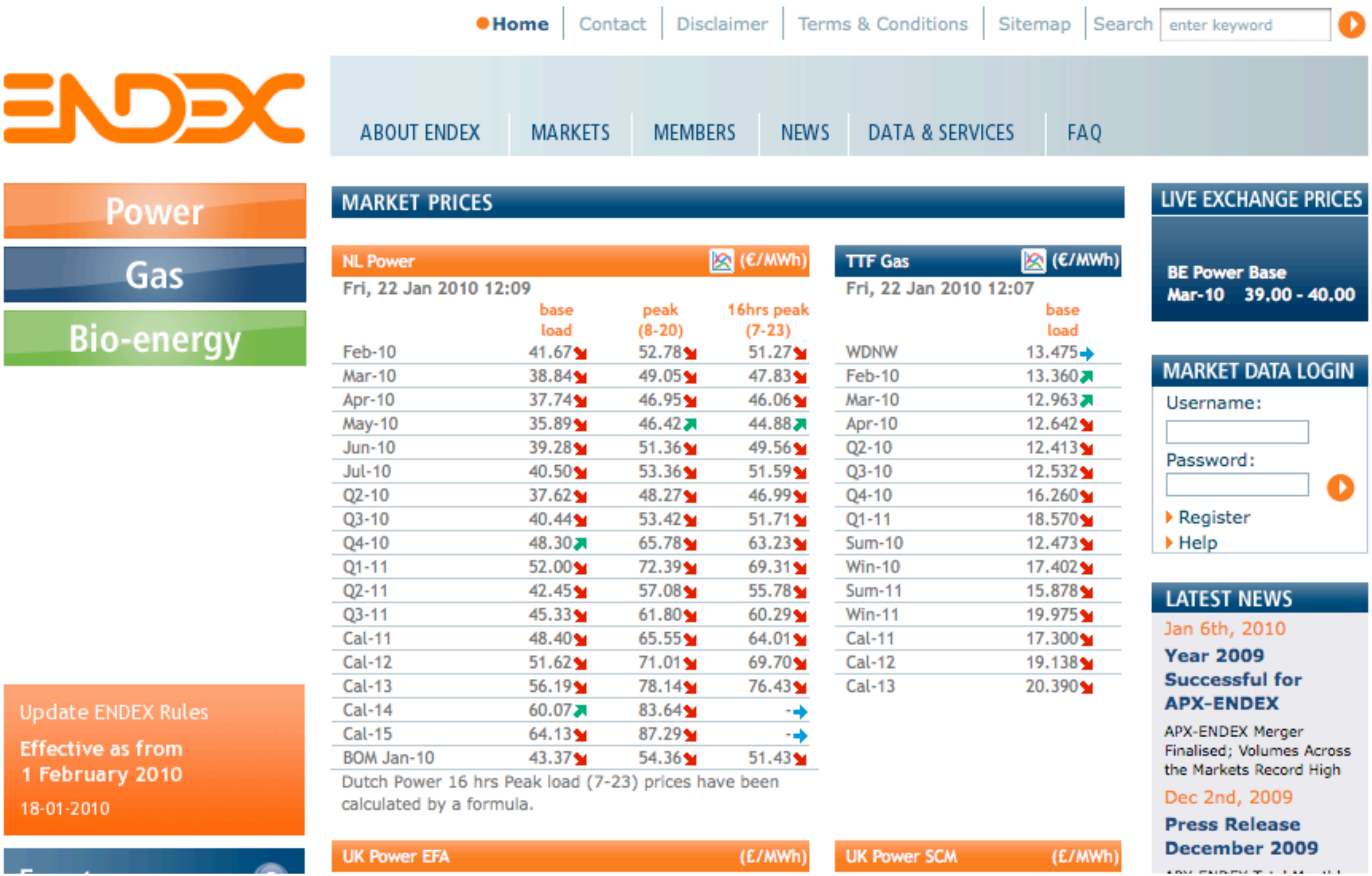
How to hedge such a position?

What triggered their losses?

History of crude oil prices



Prices of electricity forward contracts



NL Power (€/MWh) — Fri, 22 Jan 2010 12:09

	base load	peak (8-20)	16hrs peak (7-23)
Feb-10	41.67	52.78	51.27
Mar-10	38.84	49.05	47.83
Apr-10	37.74	46.95	46.06
May-10	35.89	46.42	44.88
Jun-10	39.28	51.36	49.56
Jul-10	40.50	53.36	51.59
Q2-10	37.62	48.27	46.99
Q3-10	40.44	53.42	51.71
Q4-10	48.30	65.78	63.23
Q1-11	52.00	72.39	69.31
Q2-11	42.45	57.08	55.78
Q3-11	45.33	61.80	60.29
Cal-11	48.40	65.55	64.01
Cal-12	51.62	71.01	69.70
Cal-13	56.19	78.14	76.43
Cal-14	60.07	83.64	-
Cal-15	64.13	87.29	-
BOM Jan-10	43.37	54.36	51.43

Dutch Power 16 hrs Peak load (7-23) prices have been calculated by a formula.

TTF Gas (€/MWh) — Fri, 22 Jan 2010 12:07

	base load
WDNW	13.475
Feb-10	13.360
Mar-10	12.963
Apr-10	12.642
Q2-10	12.413
Q3-10	12.532
Q4-10	16.260
Q1-11	18.570
Sum-10	12.473
Win-10	17.402
Sum-11	15.878
Win-11	19.975
Cal-11	17.300
Cal-12	19.138
Cal-13	20.390

Information in forward prices

Theory of storage

Applicable to storable assets (partially applicable to gas, depending on installed storage capacity, transportation capacity and flexibility).

$F(T,t) = S(t) + I(T,t) + W(T,t) - C(T,t)$

$S(t)$ = spot price at t, $I(T,t)$ = interest rate forgone, $W(T,t)$ = storage costs, $C(T,t)$ = convenience yield

Expectations theory

$F(T,t) = E_t\{s(T)\} + p(T,t)$

$E_t\{s(T)\}$ = expected spot price in the delivery period, $p(T,t)$ is the risk premium

Note: risk premium may account for uncertainty in storage costs and convenience yields.

Fama and French (1987)

$F(T,t) = E_t(s(T)) + p(T,t) \iff$

$F(T,t) - s(t) = E_t(s(T)) - s(t) + p(T,t) \iff$

$F(T,t) - s(t) = E_t(s(T)) - s(t) + F(T,t) - E_t(s(T))$

Assume that traders make good forecasts on average: $E_t(s(T)) = s(T) + \varepsilon(t)$

Fama and French formulate two regression equation:

$s(T) - s(t) = \alpha 1 + \beta 1\ (F(T,t) - s(t)) + \varepsilon(t)$

$F(T,t) - s(T) = \alpha 2 + \beta 2\ (F(T,t) - s(t)) + \varepsilon(t)$

$\beta 1$ tells to what extent the basis reflects information on future prices

$\beta 2$ tells to what extent the basis reflects the risk premium

For perfectly storable assets, $\beta 1 = 0$.

The Fama and French outcomes

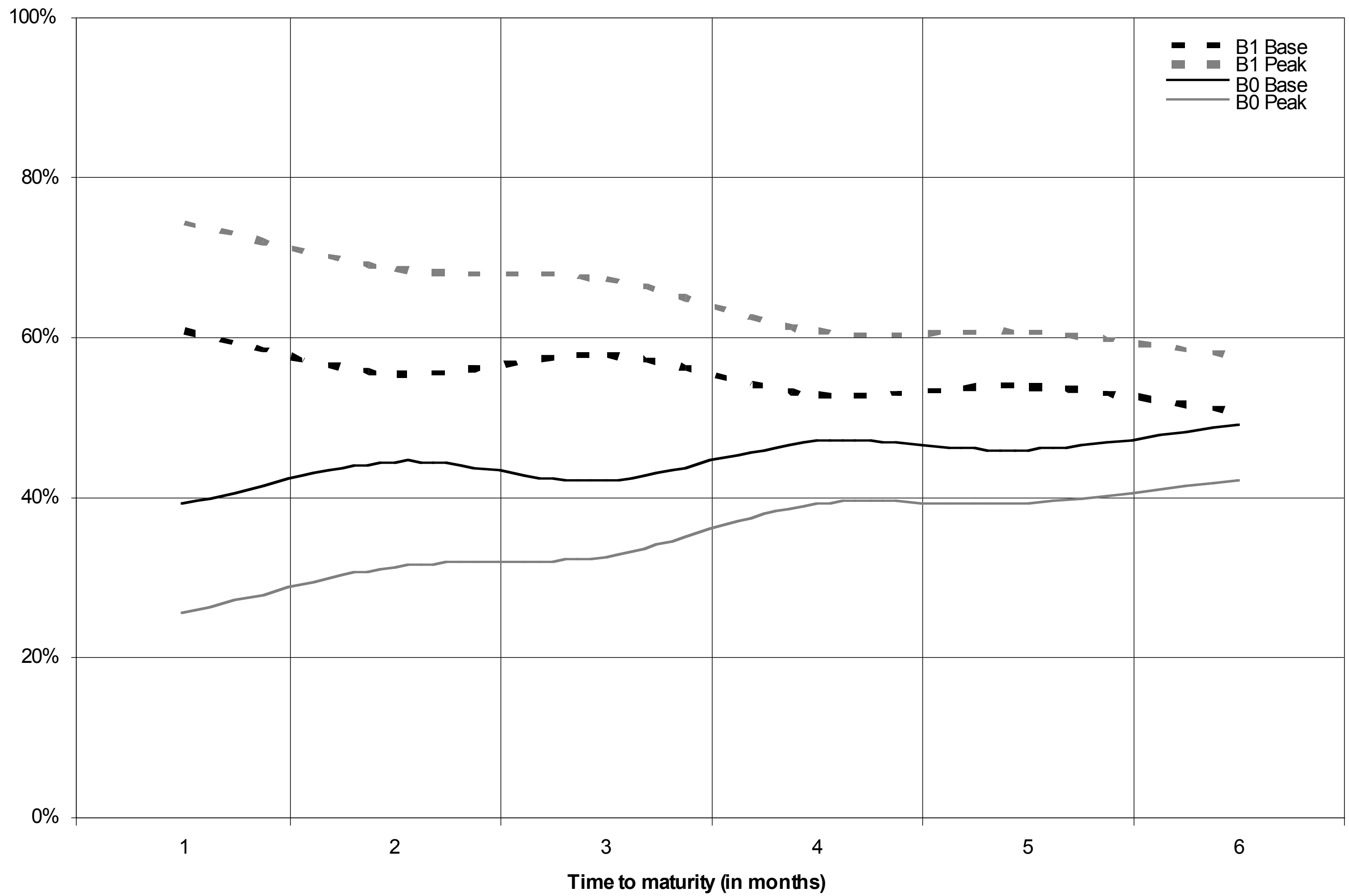
TABLE 4 **Regressions of the Spot Price Change and the Premium on the Basis:**

$$S(T) - S(t) = a_1 + b_1[F(t, T) - S(t)] + u(t, T),$$
$$F(t, t) - S(T) = a_2 + b_2[F(t, T) - S(t)] - u(t, T)$$

		2 Months							6 Months							10 Months						
Commodity	Max.	Obs.	b_1	b_2	$t(b_1)$	$t(b_2)$	R_1^2	R_2^2	Obs.	b_1	b_2	$t(b_1)$	$t(b_2)$	R_1^2	R_2^2	Obs.	b_1	b_2	$t(b_1)$	$t(b_2)$	R_1^2	R_2^2
Agricultural products:																						
Cocoa	221	56	−.03	1.03	−.07	2.09	.00	.07	36	−.08	1.08	−.16	2.26	.00	.13	54	.24	.76	.42	1.32	.01	.08
Coffee	137	38	.86	.14	1.91	.30	.09	.00	...	...	...	...	...	...	...	37	.46	.54	.65	.75	.03	.04
Corn	221	56	−.40	1.40	−.84	2.93	.01	.13	36	−.59	1.59	−.81	2.20	.02	.12	54	.48	.52	.91	.98	.03	.03
Cotton	207	53	.55	.45	1.06	.87	.02	.01	...	...	...	...	...	...	...	50	1.10	−.10	2.27	−.21	.16	.00
Oats	217	54	1.18	−.18	3.63	−.55	.20	.01	34	1.05	−.05	4.19	−.19	.35	.00	42	1.02	−.02	3.28	−.07	.29	.00
Orange juice	207	101	.28	.72	1.07	2.69	.01	.07	100	.57	.43	1.79	1.36	.06	.04	97	1.00	−.00	2.85	−.00	.20	.00
Soybeans	221	110	.80	.20	1.95	.49	.03	.00	108	.71	.29	2.36	.95	.09	.02	106	.63	.37	1.71	1.01	.07	.03
Soy meal	217	108	.44	.56	1.26	1.59	.02	.03	68	.50	.50	1.14	1.15	.03	.03	93	.65	.35	2.85	1.56	.14	.05
Soy oil	217	112	.40	.60	1.41	2.11	.02	.04	75	−.02	1.02	−.07	2.75	.00	.16	105	.01	.99	.03	2.11	.00	.14
Wheat	219	55	.18	.82	.29	1.36	.00	.03	35	−.65	1.65	−1.33	3.39	.05	.25	52	−.78	1.78	−1.62	3.69	.07	.27
Wood products:																						
Plywood	163	81	−.00	1.00	−.02	3.42	.00	.13	79	.53	.47	1.46	1.29	.06	.05	69	1.27	−.27	3.81	−.80	.34	.02
Lumber	173	86	.35	.65	1.97	3.71	.04	.14	84	.28	.72	1.35	3.55	.05	.27	52	.16	.84	.42	2.21	.01	.24
Animal products:																						
Broilers	152	108	1.22	−.22	7.68	−1.40	.40	.02	64	.93	.07	5.39	.40	.42	.00	...	...	...	...	...	...	...
Cattle	147	51	1.12	−.12	2.51	−.27	.11	.00	67	.84	.16	1.54	.30	.07	.00	...	...	...	...	...	...	...
Eggs	173	145	.80	.20	8.58	2.15	.42	.04	80	.97	.03	6.24	.18	.53	.00	...	...	...	...	...	...	...
Hogs	217	117	.72	.28	4.59	1.81	.16	.03	103	.66	.34	2.67	1.38	.12	.04	78	.80	.20	2.76	.70	.22	.02
Pork bellies	219	37	2.77	−1.77	1.95	−1.25	.10	.04	33	1.39	−.39	5.12	−1.43	.45	.06	36	1.12	−.12	5.08	−.53	.53	.01
Metals:																						
Copper	223	157	−.03	1.03	−.08	2.57	.00	.05	92	.64	.36	1.54	.88	.05	.02	98	.66	.34	1.36	.70	.06	.02
Gold	115	107	−2.20	3.20	−.80	1.17	.01	.02	55	−1.74	2.87	−.68	1.04	.02	.05	52	−2.83	3.83	−.89	1.20	.07	.12
Platinum	199	...	...	...	...	...	...	...	65	.73	.27	.82	.30	.02	.00	...	...	...	...	...	...	...
Silver	211	174	−8.56	9.56	−2.45	2.73	.06	.07	100	−7.82	8.82	−2.50	2.82	.13	.16	99	−6.12	7.12	−2.03	2.36	.14	.17

NOTE.—R_1^2 and R_2^2 are the coefficients of determination for the change and premium regressions, respectively. Since the change and premium regressions have the same explanatory variable and the two residuals sum to .0, their slope coefficients have the same standard error. The *t*-statistics, $t(b_1)$ and $t(b_2)$, are based on standard errors adjusted for the autocorrelation of the regression residuals induced by the overlap of the observations on $S(T) - S(t)$ and $F(t, T) - S(T)$. (See Hansen and Hodrick 1980.) Obs. is the number of observations in a regression, and Max. is the number of months in the sample period

Outcomes for the EEX Month contracts (2002-2005)



R. Huisman and C. Huurman (2007)

Energy markets

Derivatives markets

Forward and futures, options and swap contracts

Delivery in future periods of time

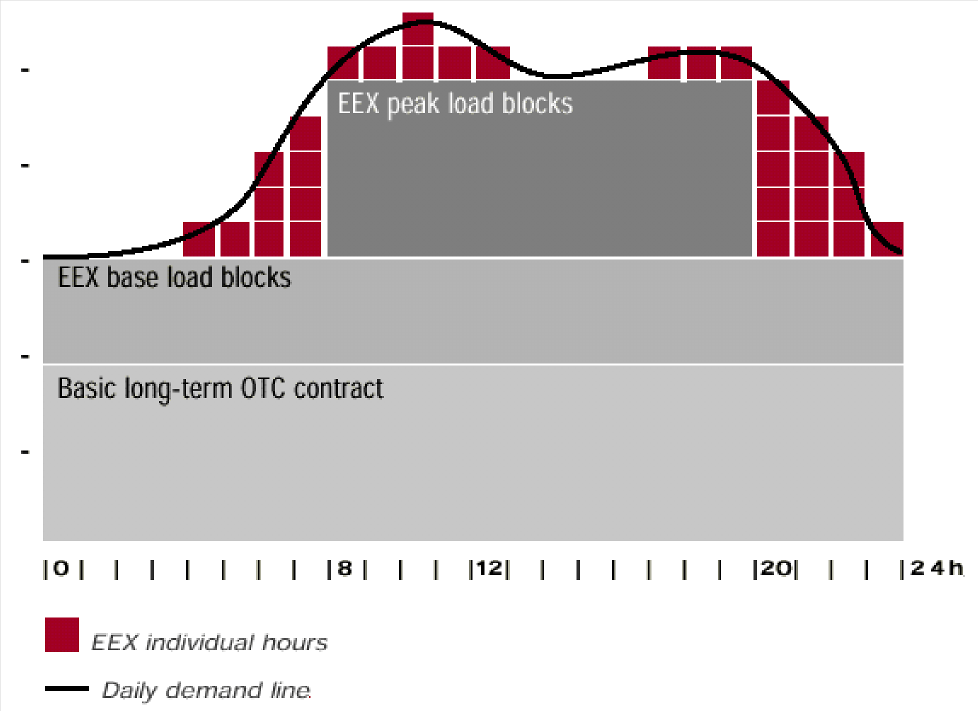
Obliged or right to deliver or purchase

Day-ahead markets

Delivery of energy for each hour in the next day.

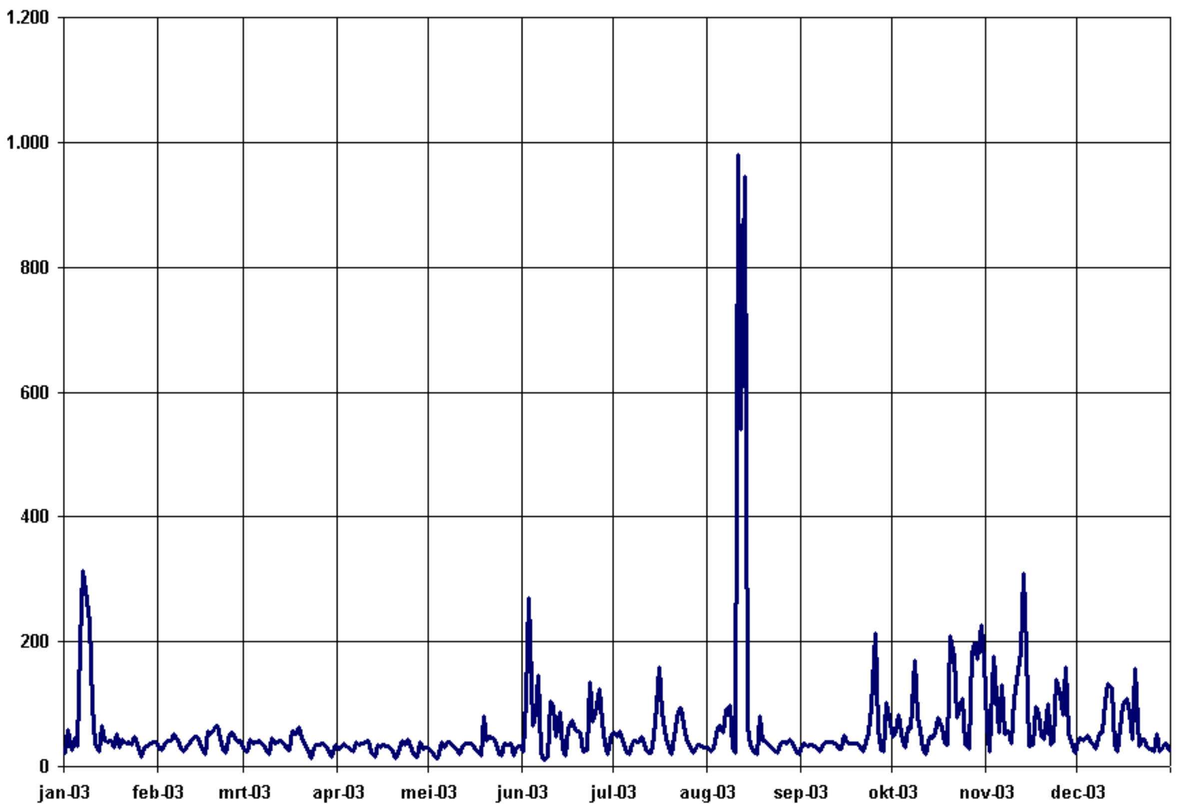
Imbalance (intra-day) markets

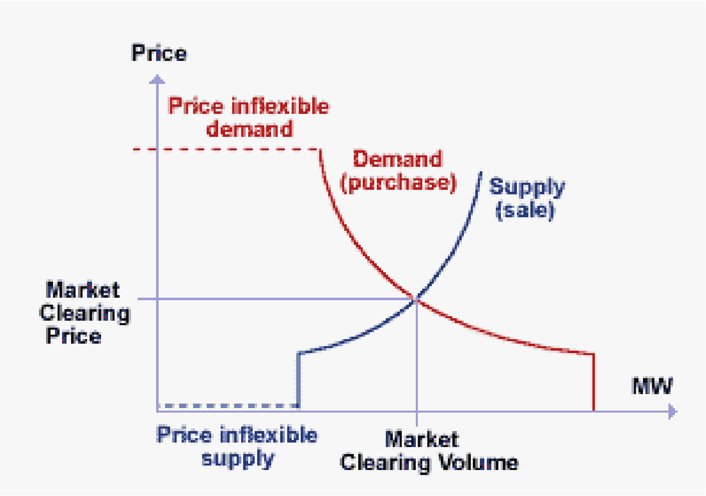
Delivery after 15 minutes



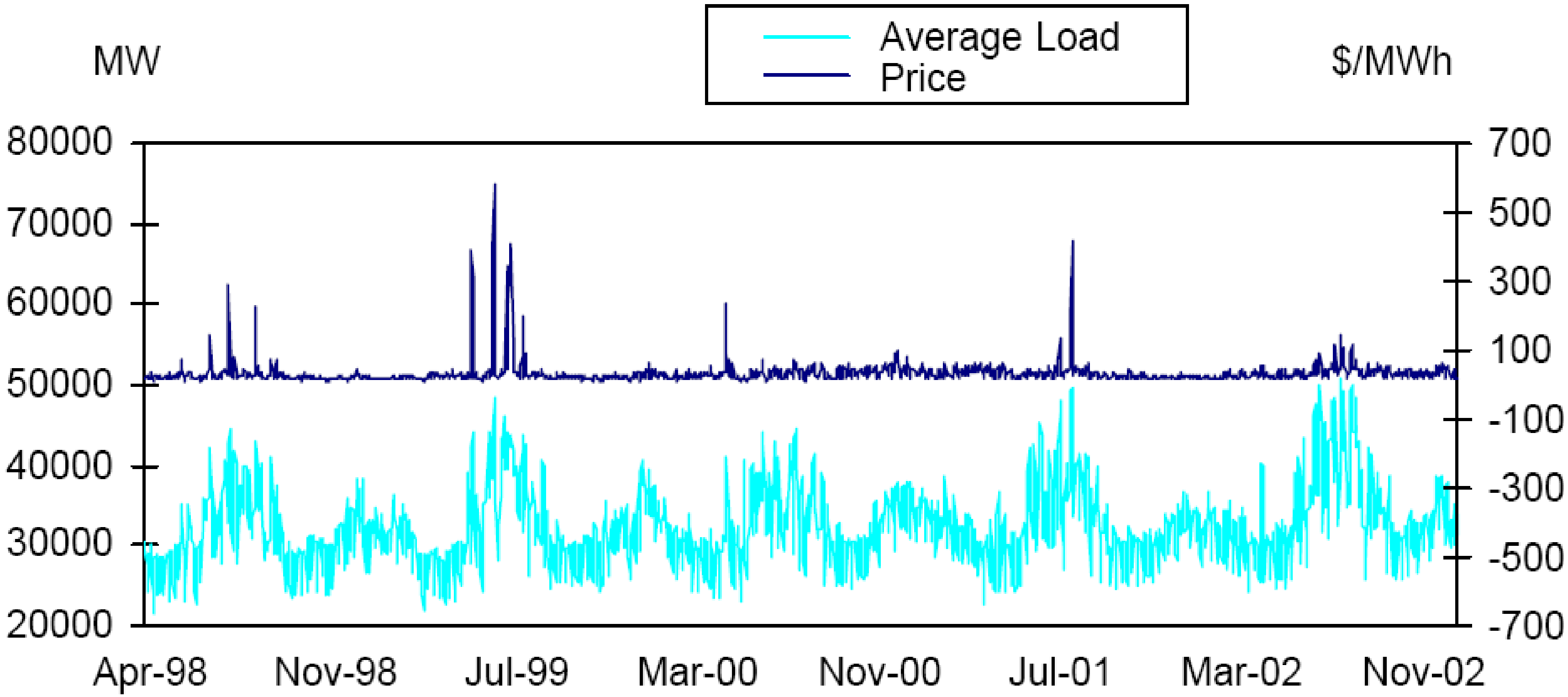
Dutch day-ahead power prices in 2003

Characteristics of power prices: mean reversion,time varying volatility, spikes, (volatility) seasonality, complex correlation with underlying fuels. Traders submit bids and offers for all hours in the next day at 11:00.



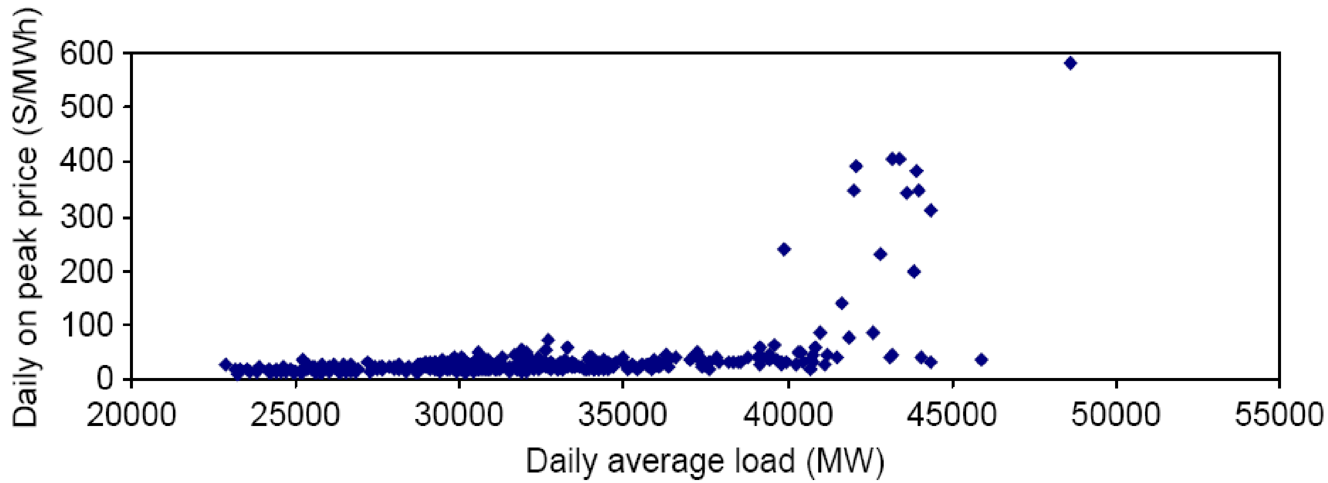


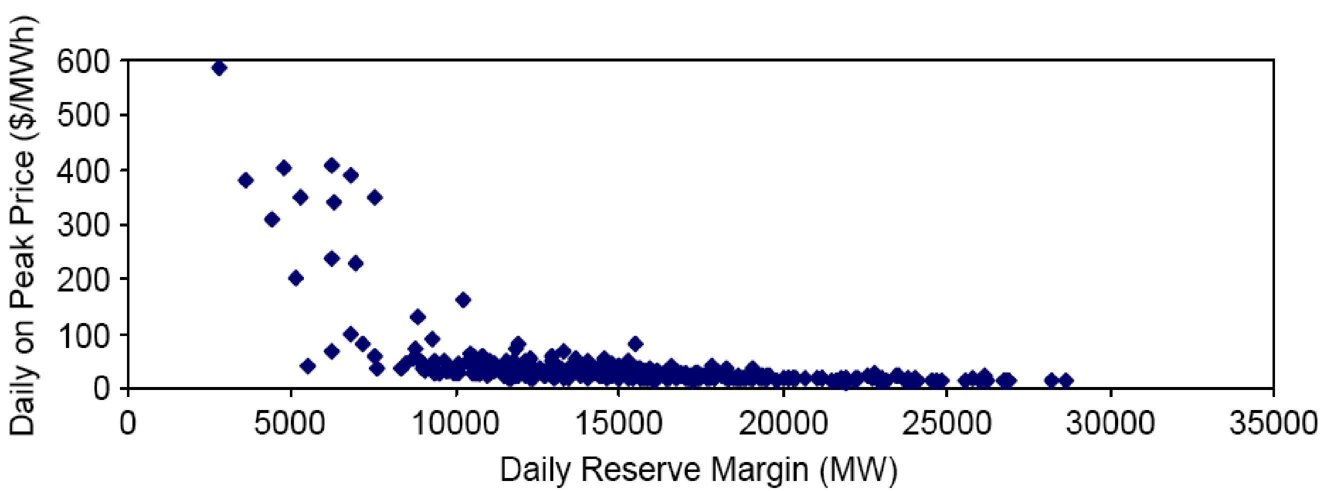
Spikes exist when reserve margin is low



The nature of a power spike. Mount, Ning and Cai (Energy Economics 2006)

Spikes exist when reserve margin is low (2)





The nature of a power spike continues. Mount, Ning and Cai (Energy Economics 2006)

Spikes and weather

Huisman (EE, 2008) shows that spikes can be forecasted using temperature.

For the Dutch APX market, spike probability increases when temperature is higher than expected in summer months and when temperature is lower then expected in winter months.

Table 1. Parameter estimates of the temperature regime switching model.

Parameter	Parameter	Parameter
μ_1	mean log. price level	3.885* (0.058)
β_1	weekend	-0.441* (0.093)
β_2	temperature elasticity summer	0.009* (0.005)
β_3	temperature elasticity winter	-0.007** (0.005)
α	mean reversion	0.145* (0.024)
σ_1	volatility normal regime	0.198* (0.006)
μ_2	mean spike regime	0.441* (0.093)
σ_2	volatility spike regime	0.607* (0.034)
λ_1	stationary transition probability from normal to spike regime	-3.320* (0.155)
λ_2	temperature effect on spike probability during summer	0.226* (0.088)
λ_3	temperature effect on spike probability during winter	-0.255** (0.138)
λ_4	stationary transition probability from spike to normal regime	1.538* (0.168)
LogLikelihood		-162.712

Asymptotic standard errors are presented in parenthesis.

* significant at 5% confidence level

** significant at 10% confidence level

Observations: average day-ahead prices in peak hours on the Dutch APX market from January 1st, 2003 through August 31, 2006 (1,339) observations; daily temperature observations were obtained from the KNMI.

Risk management:
dealing with gaps in the risk balance sheet

Assets	Liabilities
Energy portfolio • physical assets (power plants, gas storage) • contracts (derivatives, VPP) • risk buffer	Energy delivery obligations • sold delivery contracts • expected consumption • optionality
Total risk (market, credit, operational)	Total risk (market, credit, operational)

offsetting

Risk management

Risk differs from uncertainty.

Risk occurs from known events that occur with a probability and that have a certain impact on P&L. Therefore, risk can be calculated and managed.

Risk management's goal is to make sure that the amount of risk the firm takes is in line with the firm's risk appetite.

Broad risk categories: market risk, credit risk, and operational risk.

The risk appetite

The firm's risk appetite specifies how much risk the firm is willing to take.

The risk appetite can be expressed in the following terms:

- state the loss tolerance
- specify how the firm reserves sufficient capital as a risk buffer
- specify the firm's target credit rating

Risk / capital allocation

How much capital to allocate to the risk buffer?

Capital is needed mostly for collateral / margining payments. Adverse price movements might lead to severe cash flow problems. Some companies have adopted the Basle Committee framework and link capital to risk for open market risk positions using the Basle guidelines:

capital = k x VaR

where VaR is the average value at risk of the portfolio over the last 60 trading days. The factor k is set by the regulator; minimum is 3 and the size depends on the accuracy and quality of implemented risk management and measurement practices.

For credit risk, Basle sets capital requirements related to the credit ratings of counter parties.

Value at risk

Risk reflects the probability of a loss. Therefore, we need a risk measure that reflects this.

Value at Risk (VaR) is a measure for risk proposed by the Basle Committee and therefore often used in financial markets. VaR is the maximum amount of money that may be lost on a portfolio over a given period of time, with a given level of confidence.

In practice:

Ex-post: the risk manager calculated that the portfolio currently has a 10-day 95% VaR equal to $ 1 mio.

Ex-ante: the board has defined the following risk appetite:in no more than 5 out of 100 years the board accepts a loss bigger than $ 10 mio (99% 1-year VaR).

Assets and liabilities management at pensionfunds

Timing \ Selection	Actual	Passive
Actual	(IV) 9.01%	(II) 9.44%
Passive	(III) 9.75%	(I) 10.11%

Active Returns Due to:	
Timing	−0.66%
Security selection	−0.36
Other	−0.07
Total active return	−1.10%

Table 7. Percentage of Total Return Variation Explained by Investment Activity, Average of 91 Plans, 1973–1985

Timing \ Selection	Actual	Passive
Actual	(IV) 100.0%	(II) 95.3%
Passive	(III) 97.8%	(I) 93.6%

	Variance Explained			
	Average	Minimum	Maximum	Standard Deviation
Policy	93.6%	75.5%	98.6%	4.4%
Policy and timing	95.3	78.7	98.7	2.9
Policy and selection	97.8	80.6	99.8	3.1

Brinson, Hood and Beebower (Financial analysts journal, 1986).

Strategy is much more important than tactics. First: structure the portfolio around the liabilities. Second: apply room for tactics.