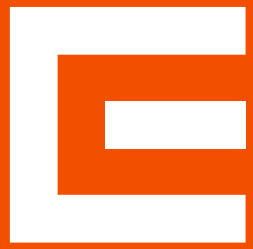

INSIGHTS INTO MODELING THE POWER MARKETS

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ČEZ, a.s.

Prague, 9th of June, 2010

GOAL OF ACTIVITIES OF ANALYTICAL TEAM IS TO GIVE OPINON ON MAKING MONEY IN ENERGY MARKETS

OUR GOAL

- Analytical Team at ČEZ Trading is located within the Front Office
- Main targets include support of ČEZ traders in power business with analytical insight into the wholesale energy markets
- Support of traders includes forecasting the outcome of the electricity price as a result of fundamental analysis of the situation in the market

OUR PERSPECTIVE OF MODELING

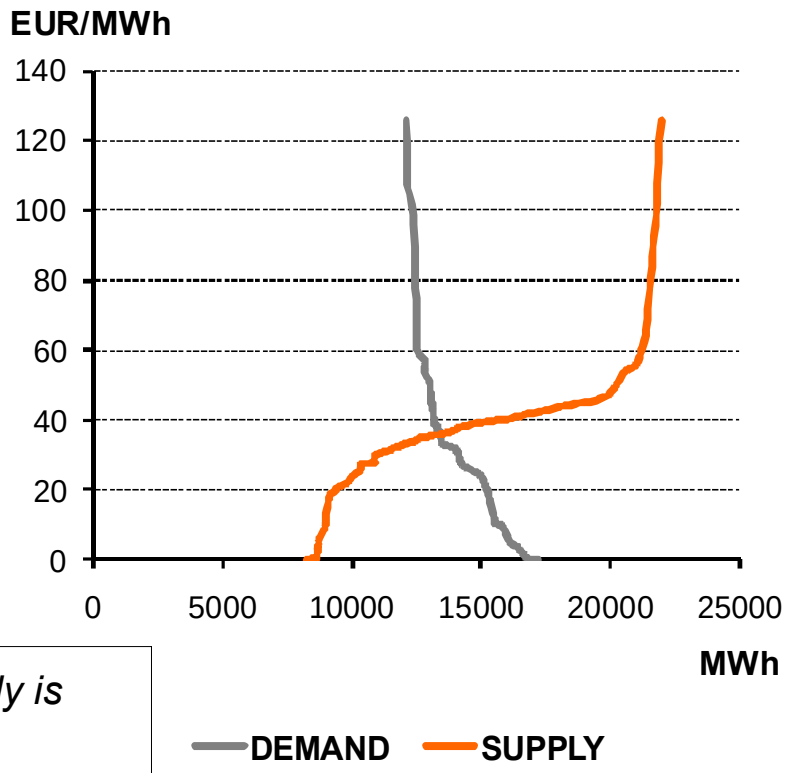
- Modeling of the price as a stochastic process (derivatives valuations, risk management etc) - **MINOR**
- Forecasting of the price outcome (a must for taking trading positions in the market) - **MAJOR**

NON-STORABILITY OF POWER MAKES EVERY PRICING BINDED TO EXPECTED SITUATION AT THE MOMENT OF DELIVERY – THE SPOT MARKET

DEMAND

- households
- industrials
- EXPORT

German Price Curves
(July 12, 2009, hour #21, EEX)



SUPPLY

- nuclear
- coal
- gas
- hydro
- wind
- other renewables
- IMPORT

Demand is very inelastic, supply is limited and volatile. Absolute requirement for constant balance makes spot prices hugely volatile!

SITUATION IN THE SPOT MARKET IS DRIVEN BY FUNDAMENTALS – BOTH ON THE SIDE OF DEMAND AND SUPLY.

DEMAND

- **Low sensitivity of demand on the price** (low elasticity) in the short-term horizon. Some sensitivity is brought by redispatch of generation resources (optimization of producers)
- **Seasonality of demand** – monthly, days in week, hours in the day, holidays etc.

Factors:

- *Short-term*: meteorological variables, day in week, hour in the day, holidays, situation in neighboring countries (exports), ad-hoc events (e.g. natural disasters proměnné)
- *Long-term*: energetic intensity of the economy, situation and development of economy.

SUPPLY

- Demand curve is represented by **sorted marginal production costs** of available generation resources (“stack curve”)

Factors:

- Generation portfolio
- Prices of the fuel mix (coal, gas, CO2 prices)
- Availability of generation resources (planned/unplanned)

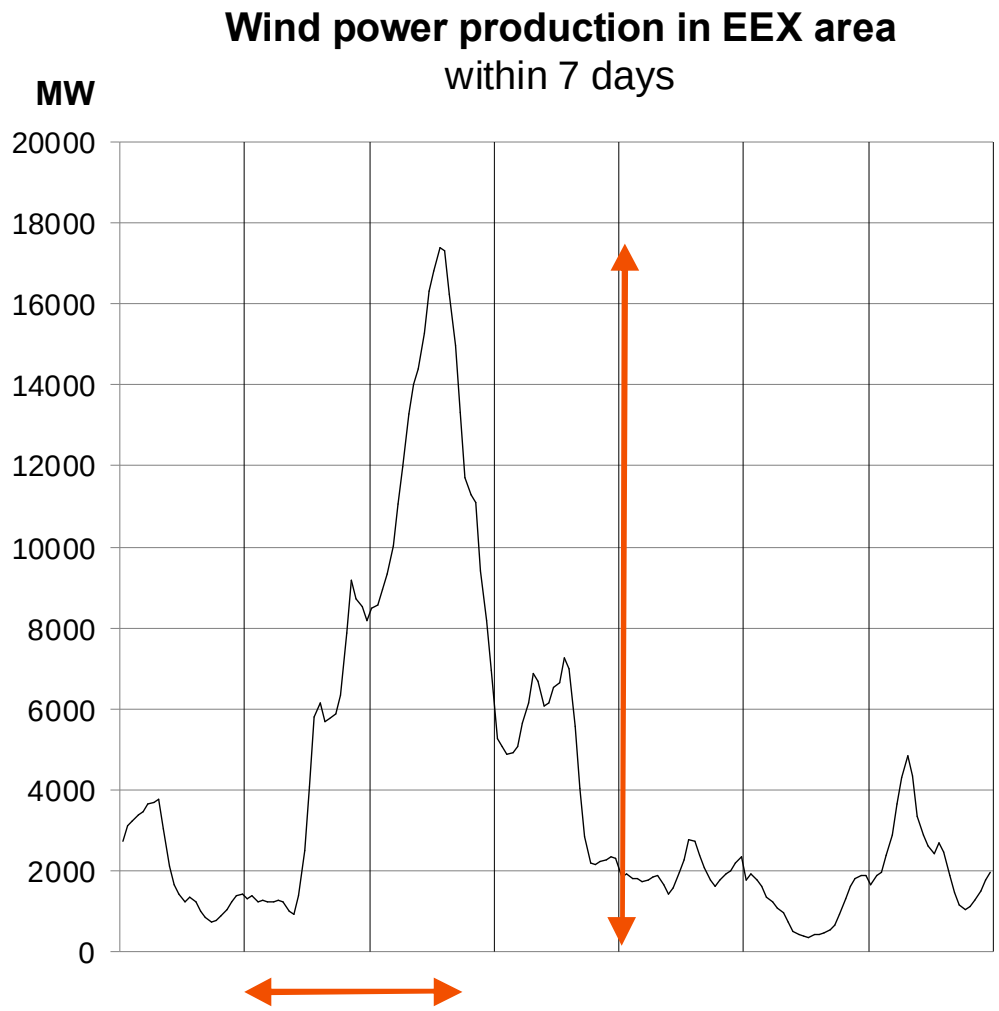
ILLUSTRATION OF THE COMPLEXITY OF THE SPOT POWER MARKET…A WINDY SITUATION IN THE EEX AREA

Huge change in the "cheap" wind production in EEX area

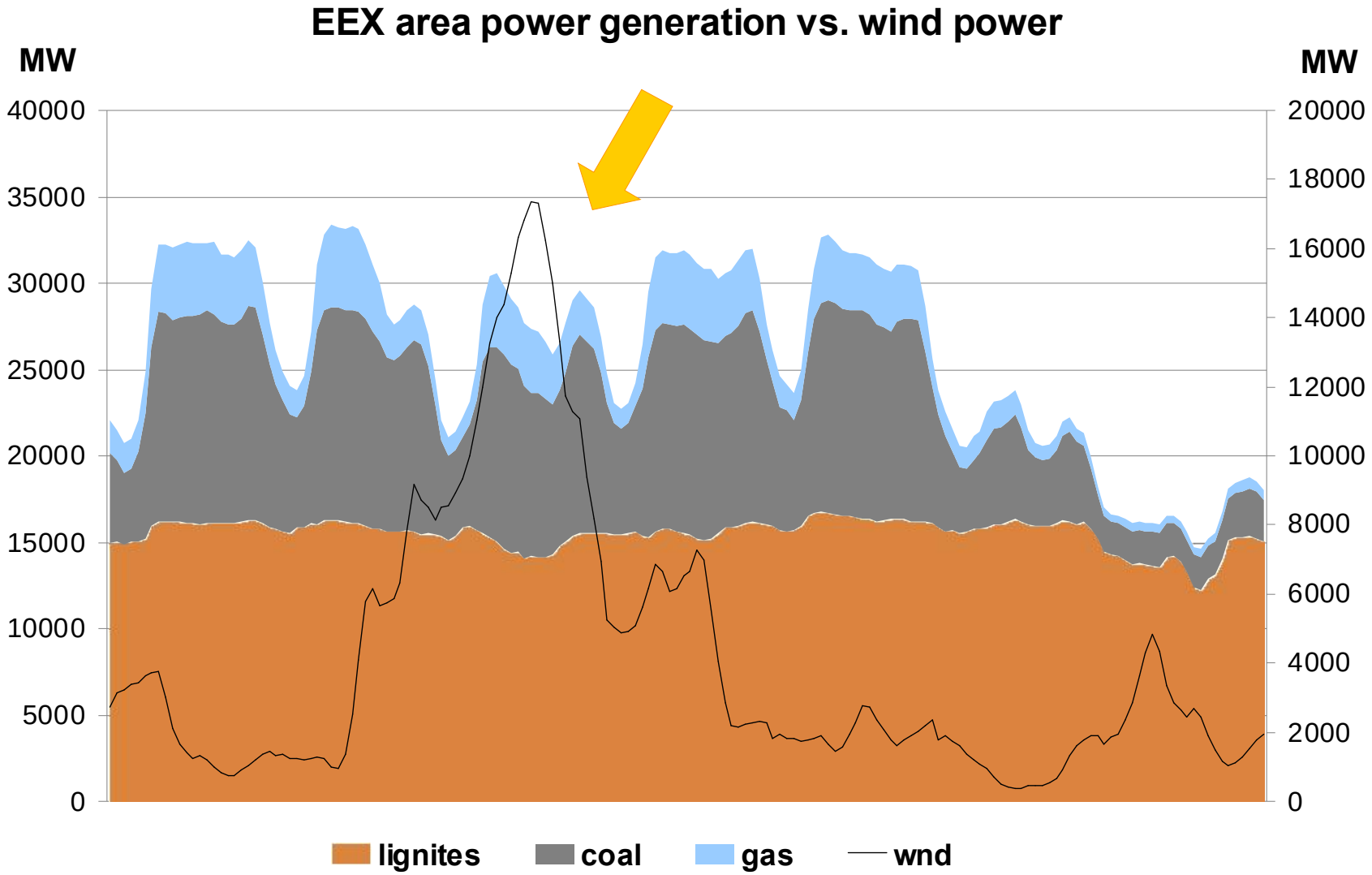
Decrease of the power production from the conventional sources (gas, coal, lignites)

Change in the flows between the countries -> more intensive exports from DE

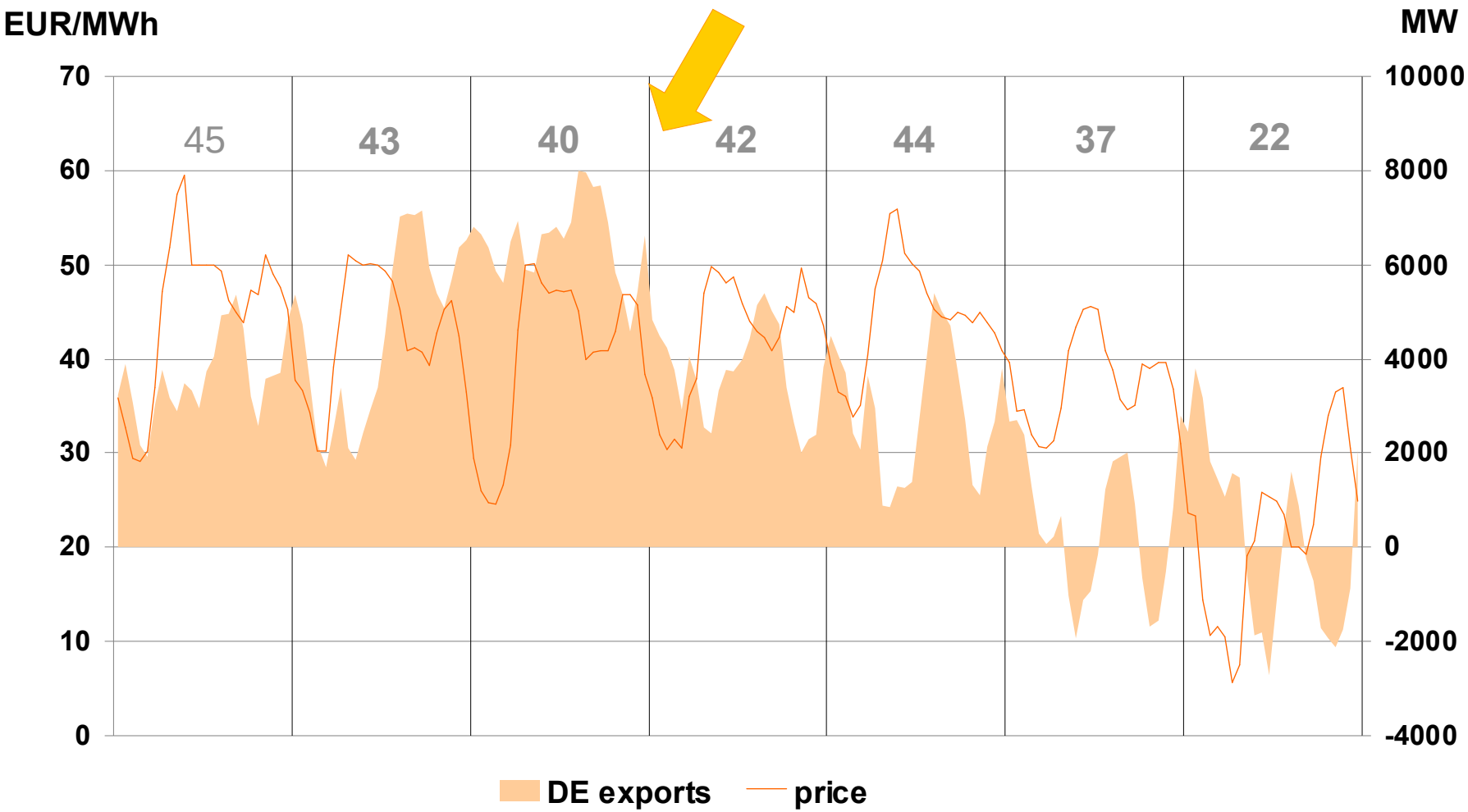
Lower spot settlement price in DE and in neighboring countries as well



WIND POWER PRODUCTION (AT ZERO MARGINAL COSTS) IS CROWDING OUT MORE EXPENSIVE CONVENTIONAL RESOURCES (GAS & COAL)



…AND PART OF THE CHEAP WIND PRODUCTION IS EXPORTED OUT. ANYWAY PRICES IN EEX AREA DROPPED



MODELING PRICE IN THE SPOT MARKET REQUIRES CAPTURING THE INTERACTION OF MANY DIFFERENT FUNDAMENTAL DRIVERS.

PROPERTIES OF THE SPOT PRICES

- Nonlinear/asymmetric price behavior
- Huge daily changes of fundamentals
- Swinging power flows across the region
- Changes in pricing of the fuel mix

By our so far experience:
fundamental-based / hybrid model is a must

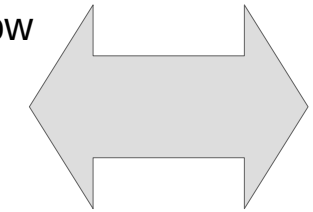
COMMENTS

- **purely statistical models** are not useful at all because of huge amount of fundamental factors and nonlinearity in price behavior
- **fundamental approach** requires exact quantification of all the production & consumption resources
- **hybrid models** use assumptions on certain persistent & justified market structures and benefit form statistical methods for precise calibration

BESIDES SOPHISTICATED DESIGN, EVERY MODEL MUST TAKE INTO ACOUNT THE AMOUNT OF INFORMATION BEING AVAILABLE IN THE MARKET

MODEL DESIGN

- Complexity of the demand structure
- Granularity of generation resources & marginal price information
- Impact of supply-demand balance on flow restrictions on interconnectors between TSOs and impact of other countries.



INFORMATION AVAILABLE

- Market Transparency – aggregated information on historical generation from power plants
- Market quotations of fuels' prices
- Historic consumption data available with rather larger delay
- Forecasts of highly volatile wind, solar, hydro generation
- Interconnectors' NTC capacities usually published at D-1.

ANALYTICAL TEAM ČEZ TRADING RUNS A HYBRID-TYPE MODEL FOR FORECASTING GERMAN EEX PRICE

ČEZ MODEL OVERVIEW

- Hybrid-type model with supply – demand balance
- Information on conventional generation from EEX Market Transparency.
- Meteorological information from external sources
- Implementation in R, with front-end & data-hub in MS Excel
- Price forecasting beats benchmark from external analytical houses

PLANNED DEVELOPMENT

- Extension to other countries of the region and improved forecasting of flows & demand
- Seating directly within Trading IT infrastructure – connection with future TDMS & more flexible connection with various data sources
- Reimplementation in Matlab