

Wind forecasting workshop, Madrid, May 2008



Wind Imbalance Management at Nuon

Frank Hochmuth – Forecasting & Imbalance Manager

Context – The Dutch Market

The TSO in The Netherlands fully relies on market mechanisms for the supply of balancing and reserve power

Program responsible party

- Submits E- and T programs (balance of on a day-ahead and intra-day basis)
- Submits bids for control and reserve power
- Carry the full financial consequence for imbalances, incl. wind

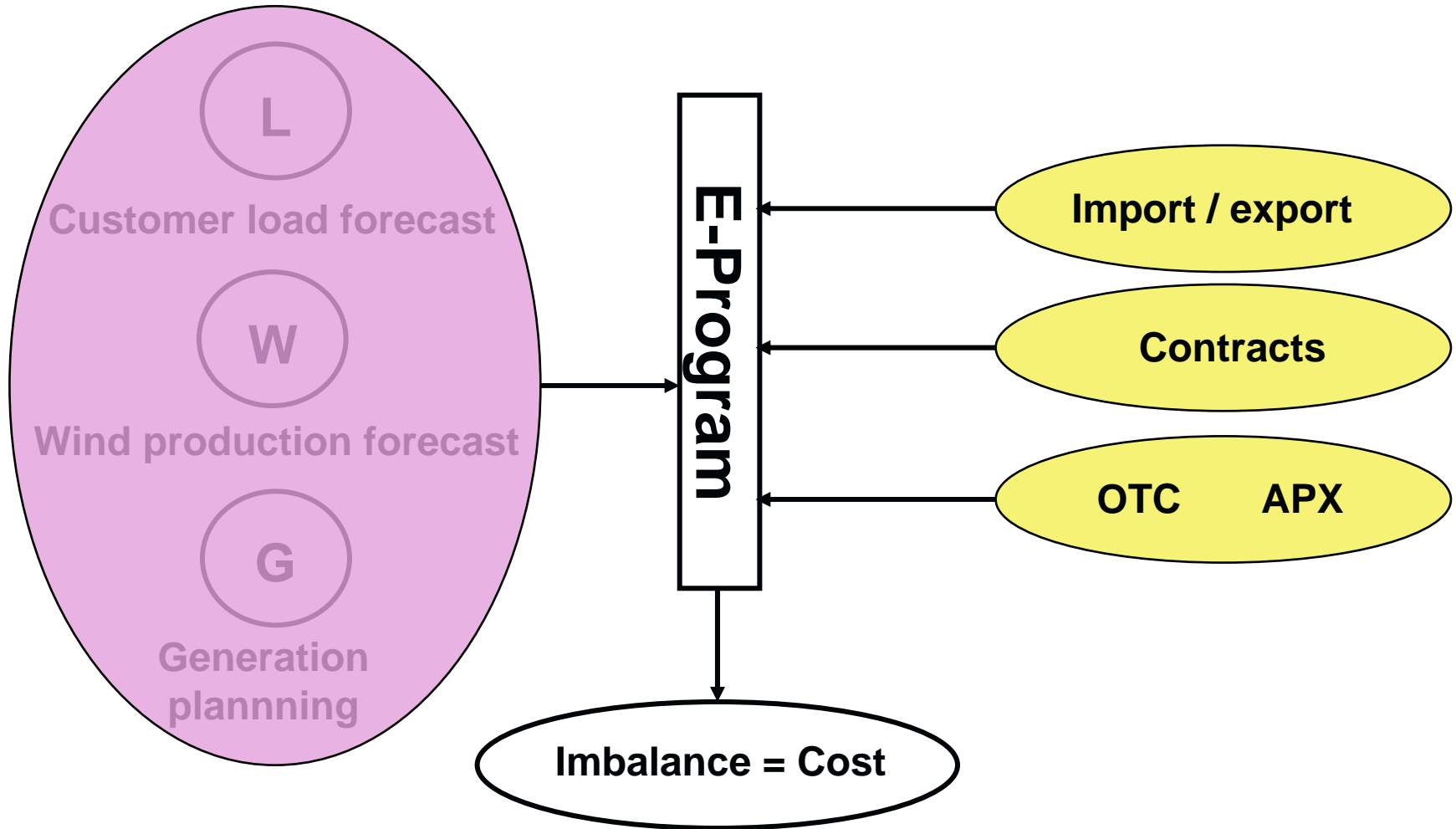
TSO

- Receives and analyses the E- and T programs from all PRPs
- Checks if sufficient control and reserve power bids are available for the next day
- Calls for additional bids if insufficient bids are received



Balancing and forecasting wind energy is to 100% the responsibility of generators and traders (through their PRP).

The Dutch TSO only receives the balance of production and demand through the E-program



Objective: Maximise profit and minimise risk

Wind farm owners need as much certainty on costs and revenue as possible in order to make viable, long-term investments

Costs

- Mainly fixed costs (investment costs, maintenance costs, operational costs)
-> low risk

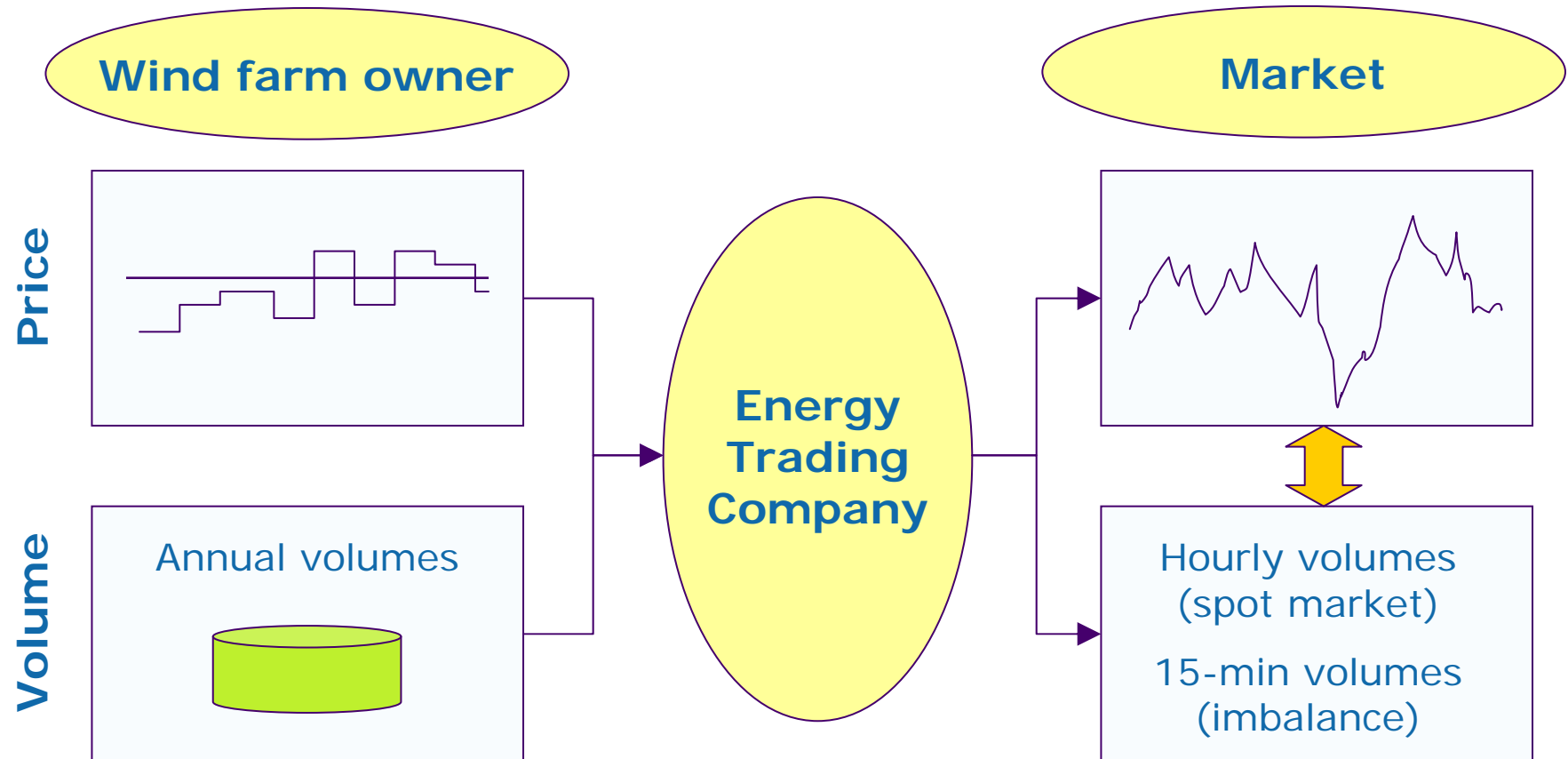
Revenue

- **Volume** reasonably certain, however, year-on-year variations of 10-20% do occur
-> Risk
- **Price** highly uncertain, linked to global energy market prices (variations of > 100%)
-> Big Risk



Wind farm owners rely on the services of energy trading companies, who take over and manage large parts of the risks

Hedging wind production in a liberalised market



 The energy trading company sells forward the wind production

Tradeable contracts in the Dutch market

Traded contracts

- Year blocks
- Quarter blocks
- Month blocks
- Week blocks
- Day blocks
- Hourly

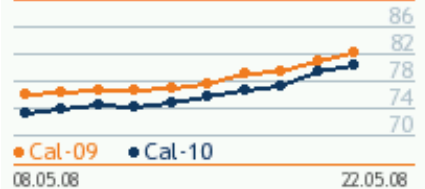
Typical liquidity (*)

- 1-2 years ahead
- 1-5 quarters ahead
- 1-5 months ahead
- 1-2 weeks ahead
- 1-3 days ahead
- 1 day ahead

- (*)
- Dependent on the liquidity of the Dutch and neighboring markets
 - Dependent on border capacity prices and availability

MARKET PRICES

NL Power Base Load



NL Power

Fri, 23 May 2008 12:12

	Base Load		Peak Load	
Jun-08	71.45	↘	94.19	↘
Jul-08	81.56	↘	110.39	↘
Aug-08	74.91	↘	100.30	↘
Sep-08	81.53	↘	108.66	↘
Oct-08	83.75	↘	106.38	↗
Nov-08	92.16	↗	121.87	↘
Q3-08	79.31	↘	106.60	↘
Q4-08	89.75	↗	117.64	↗
Q1-09	92.95	↗	122.28	↘
Q2-09	75.51	↘	98.70	↘
Q3-09	78.69	↘	103.44	↘
Q4-09	84.46	↘	112.02	↘
Cal-09	82.87	↘	109.15	↘
Cal-10	81.88	↗	107.30	↗
Cal-11	81.91	↗	106.88	↗
Cal-12	80.69	↗	105.08	↗
Cal-13	83.07	↗	110.88	↗
BOM May-08	63.50	↘	82.88	↘

Prices (€/MWh)

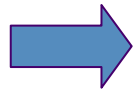
Hedging opportunities for wind

Traded contracts*

Execution

Forecasts based on Climatic data Weather FC

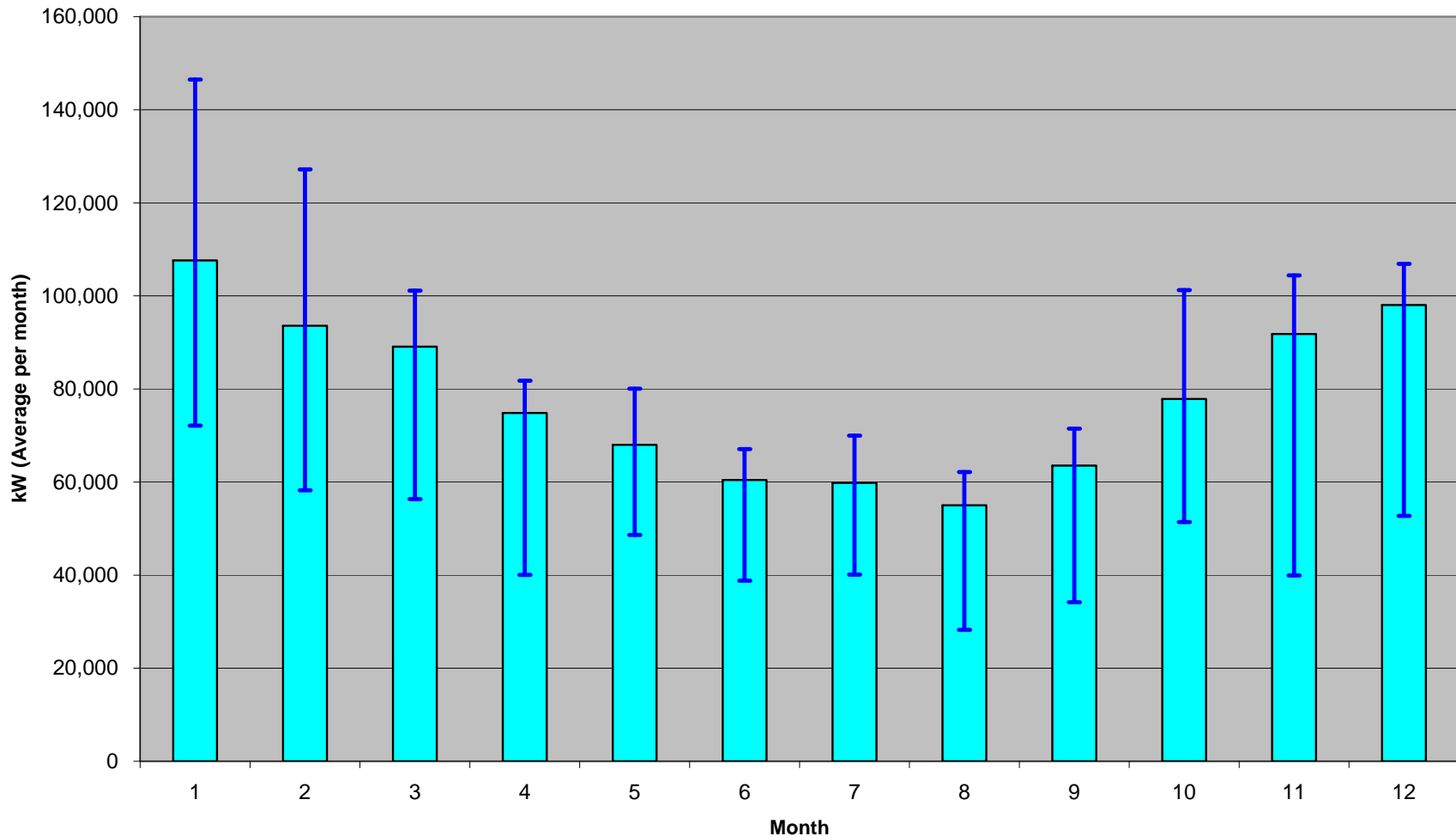
Traded contracts*	Execution	Forecasts based on Climatic data Weather FC
■ Year blocks	Preceding year	
■ Quarter blocks	Preceding year (swaps)	
■ Month blocks	Preceding month	
■ Week blocks	Preceding week	
■ Day blocks	Preceding days	
■ Hourly blocks	Preceding day	



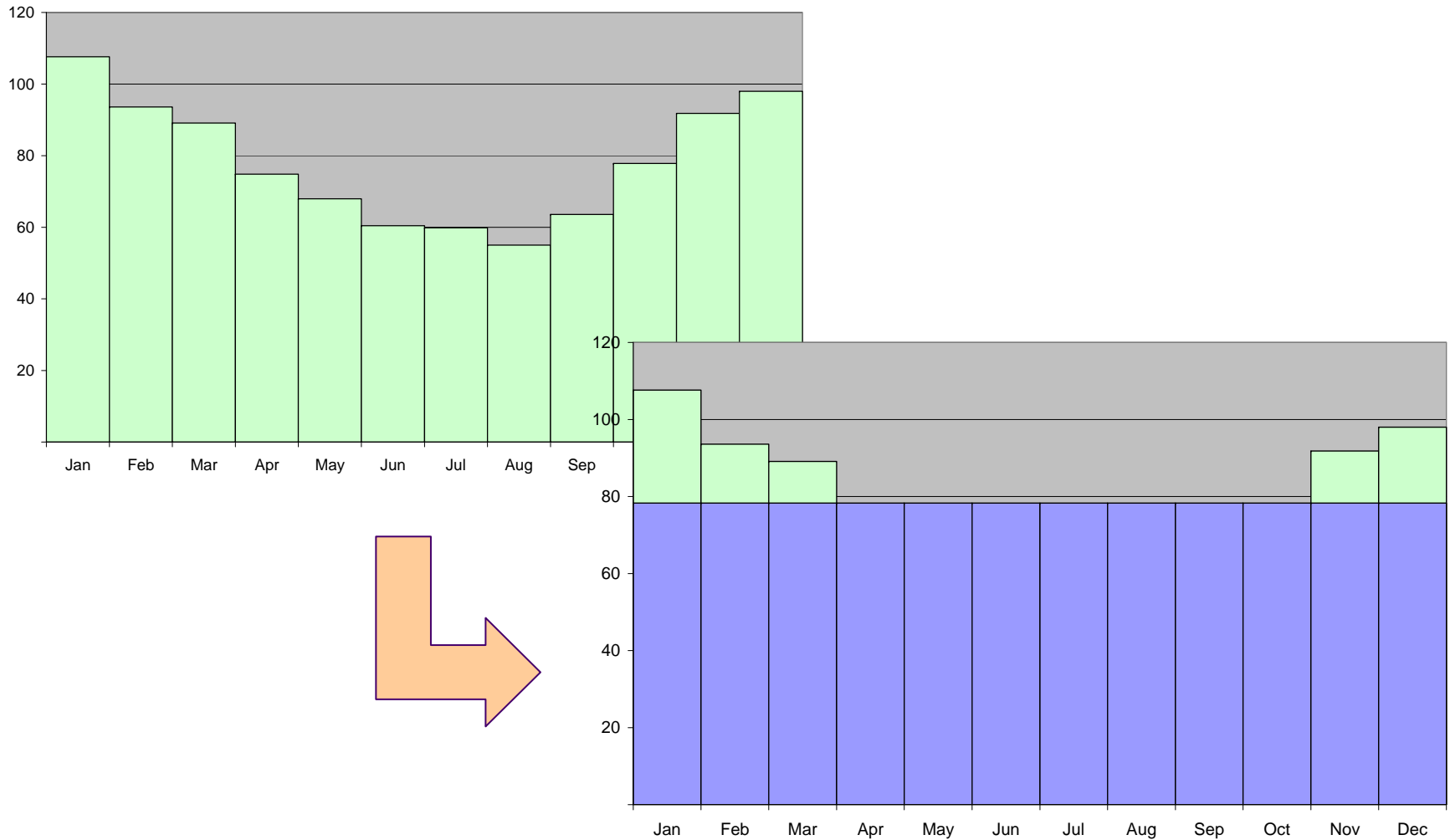
All available forward trading contracts can be used for building an efficient hedge for the price risks of wind energy production

Generally the hedging strategy is closely aligned with the purchasing contracts. This means that the forward market is not fully utilised.

Long term wind production forecast based on 40 years climatic wind speed data



Monthly profile → yearly base load block



Hedging opportunities for wind

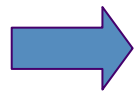
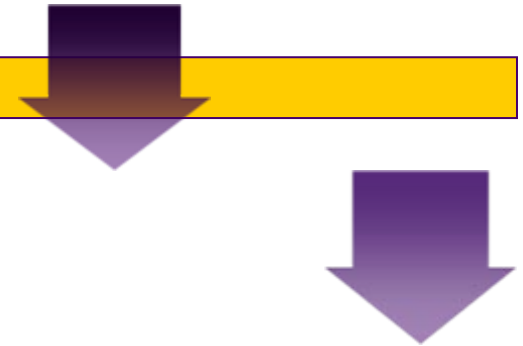
Traded contracts*

- Year blocks
- Quarter blocks
- Month blocks
- Week blocks
- Day blocks
- Hourly blocks

Execution

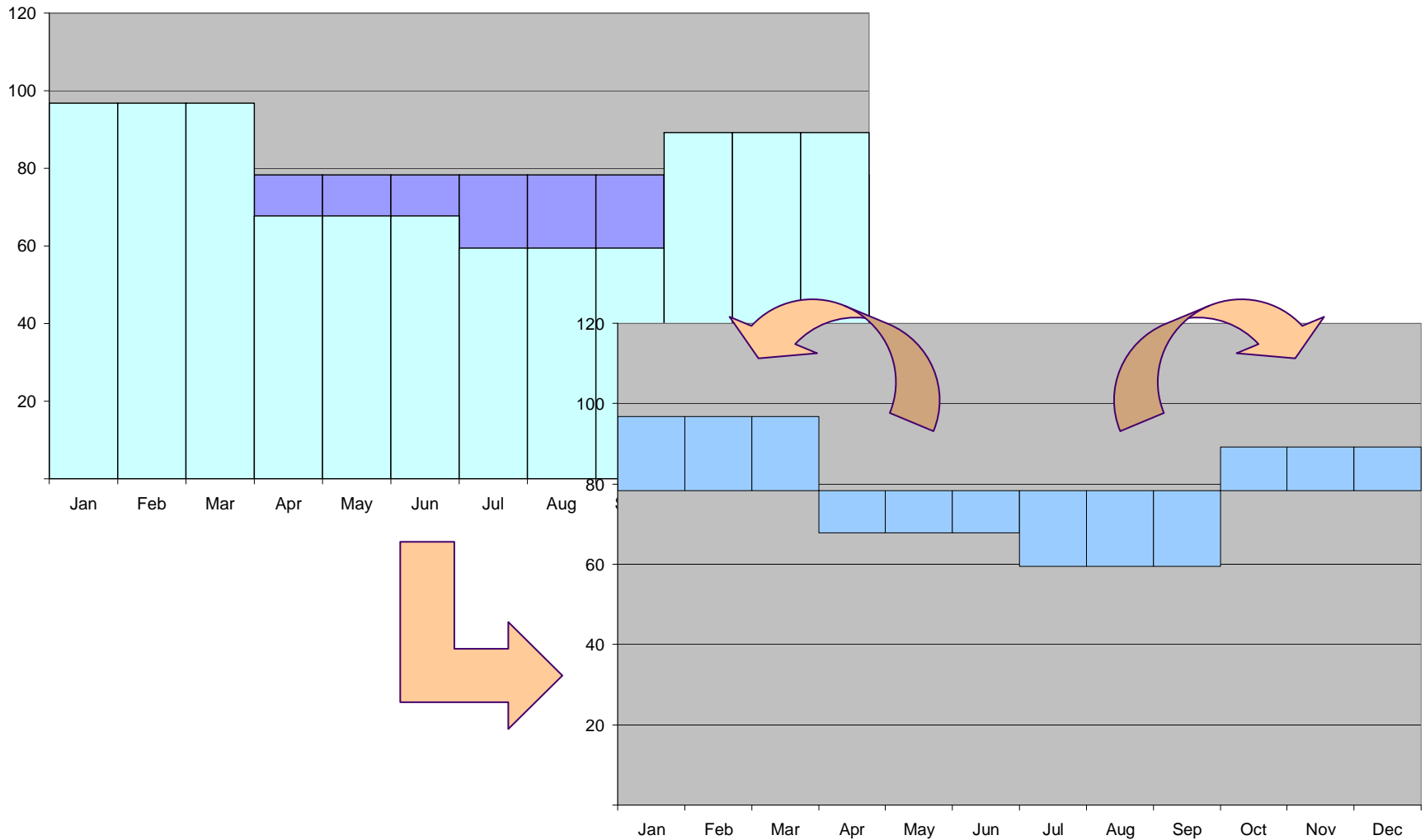
- Preceding year
- Preceding year (swaps)
- Preceding month
- Preceding week
- Preceding days
- Preceding day

Forecasts based on Climatic data Weather FC



All available forward trading contracts are used for building an efficient hedge for the price risks of wind energy production

Yearly baseload block -> Quarterly swaps



Hedging opportunities for wind

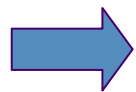
Traded contracts*

- Year blocks
- Quarter blocks
- Month blocks
- Week blocks
- Day blocks
- Hourly blocks

Execution

- Preceding year
- Preceding year (swaps)
- Preceding month
- Preceding week
- Preceding days
- Preceding day

Forecasts based on Climatic data Weather FC



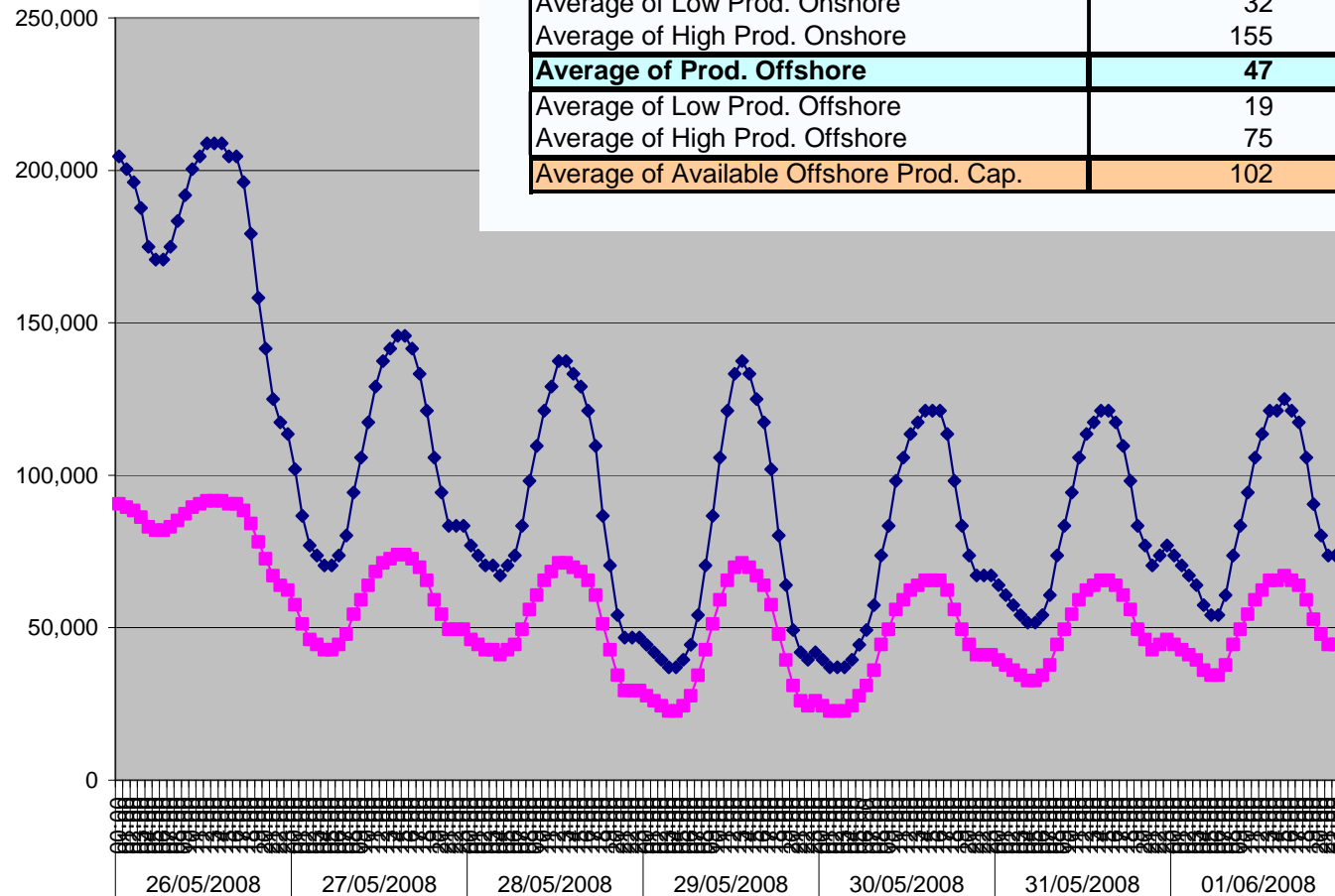
**Nowadays 10-15 days weather forecasts are available.
These can be put to good use for wind forecasting**

Week ahead wind forecast – key points

- Using 10-15 days ahead forecasts (e.g. ECMWF model output)
- Hourly resolution, but not too important
- Reliable wind turbine availability forecast is very important
- Break down into peak and off-peak trading blocks can be valuable, especially in coastal regions
- Very simple power curve model is used at the moment

Week ahead wind forecast - example

Week number 22



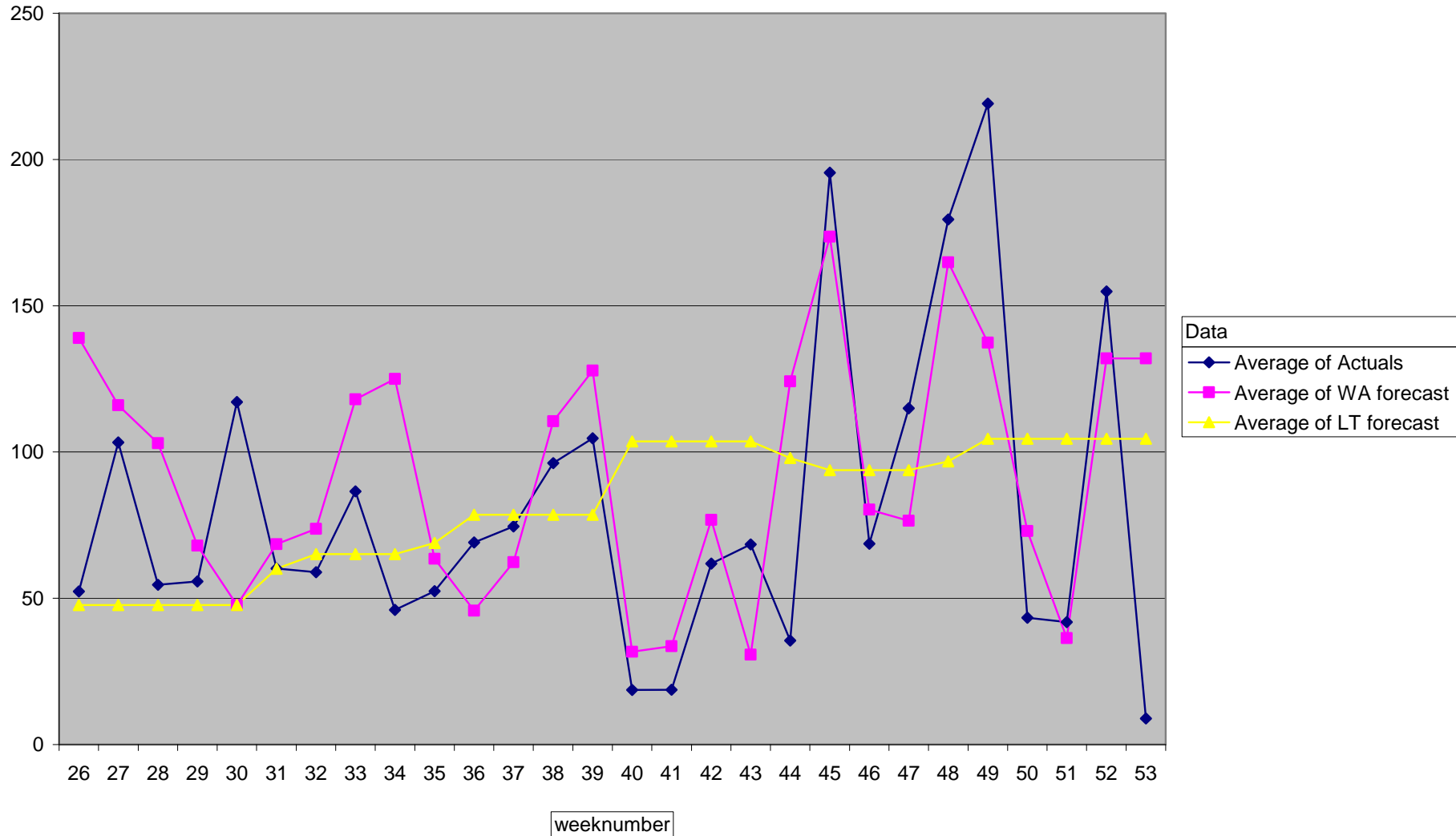
Data	POP		
	Offpeak	Peak	Grand Total
Average of Prod. Onshore	84	117	99
Average of Low Prod. Onshore	32	57	44
Average of High Prod. Onshore	155	190	172
Average of Prod. Offshore	47	62	54
Average of Low Prod. Offshore	19	33	26
Average of High Prod. Offshore	75	85	79
Average of Available Offshore Prod. Cap.	102	102	102

Data

- ◆ Sum of Prod. Onshore
- Sum of Prod. Offshore

Date Hour

Results (second half of 2007)



Summary and conclusions

- Forecasting wind production week ahead is very useful as final volumes to be traded on the spot market are significantly reduced.
- The effect of the negative correlation between wind production and market prices is reduced
- Risk is reduced and profit is maximised by selling wind forward
- Forward hedging of wind production proves to be a valuable service to wind farm owners in liberalised markets
- The value of wind energy is increased, not least because wind is generally well correlated with demand.

Thank you for your interest and
your feedback!

Questions?