

Grid integration of large scale wind Challenges and R&D needs

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RWE Transportnetz Strom GmbH**

Overview

- General Information
- The role of the TSOs in Germany / EEG
- Wind power fluctuations
- Grid Situation
- Wind power prediction

General Information

Subsidies EEG old/new

	EEG old [ct/kWh]	EEG new [ct/kWh]
Small Hydro	6,65 - 7,67 No Degression	3,70 - 9,67 Degression: 1 %/a
Waste	6,65 - 7,67 No Degression	6,65 - 9,67 Degression 1,5 %/a
Biomass	8,40 - 9,90 Degression: 1 %/a	3,90 - 19,50 (zzgl. 2 ct/kWh KWK) Degression: 1,5 %/a
Geothermal	7,16 - 9,00 No Degression	7,16 - 15,00 Degression: 1 %/a
Wind energy	5,90 - 8,80 Degression: 1,5 %/a	5,50 - 9,10 Degression: 2 %/a
Photo voltaic	43,40 *) Degression: 5 %/a	45,70 - 62,40 Degression: 5 bzw. 6,5 %/a



**higher Subsidies and higher
Degression**

General Information

Installed Capacity and Number of Turbines

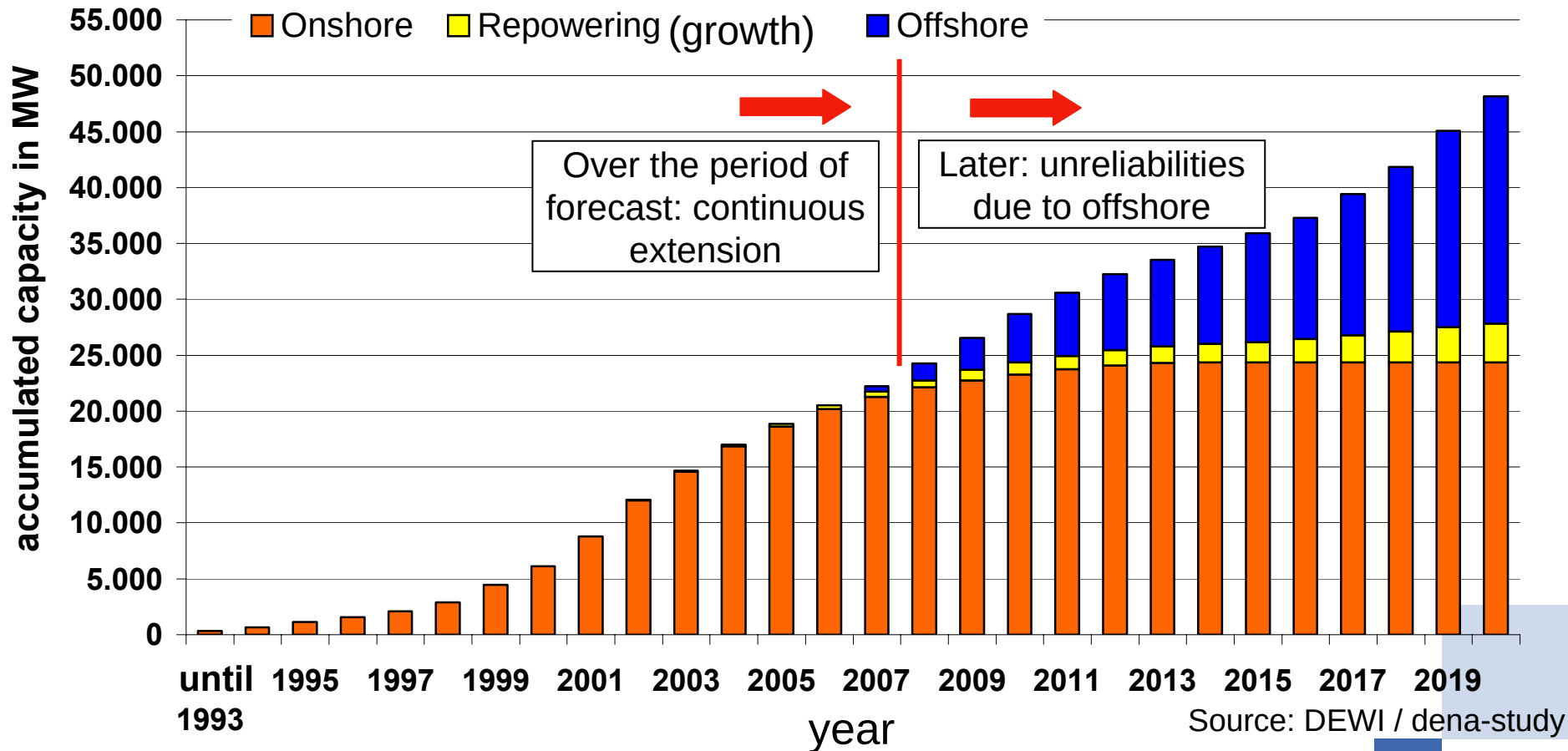


Control Area	Capacity [MW]	Number	Share
E.ON Netz AG	8006	8068	40 %
Vattenfall Europe Transmission	8021	6451	40 %
RWE Transportnetz Strom	3595	3349	18 %
EnBW	323	306	2 %
Total	19946	18178	100 %

November 2006

General Information

forecast of development until 2020

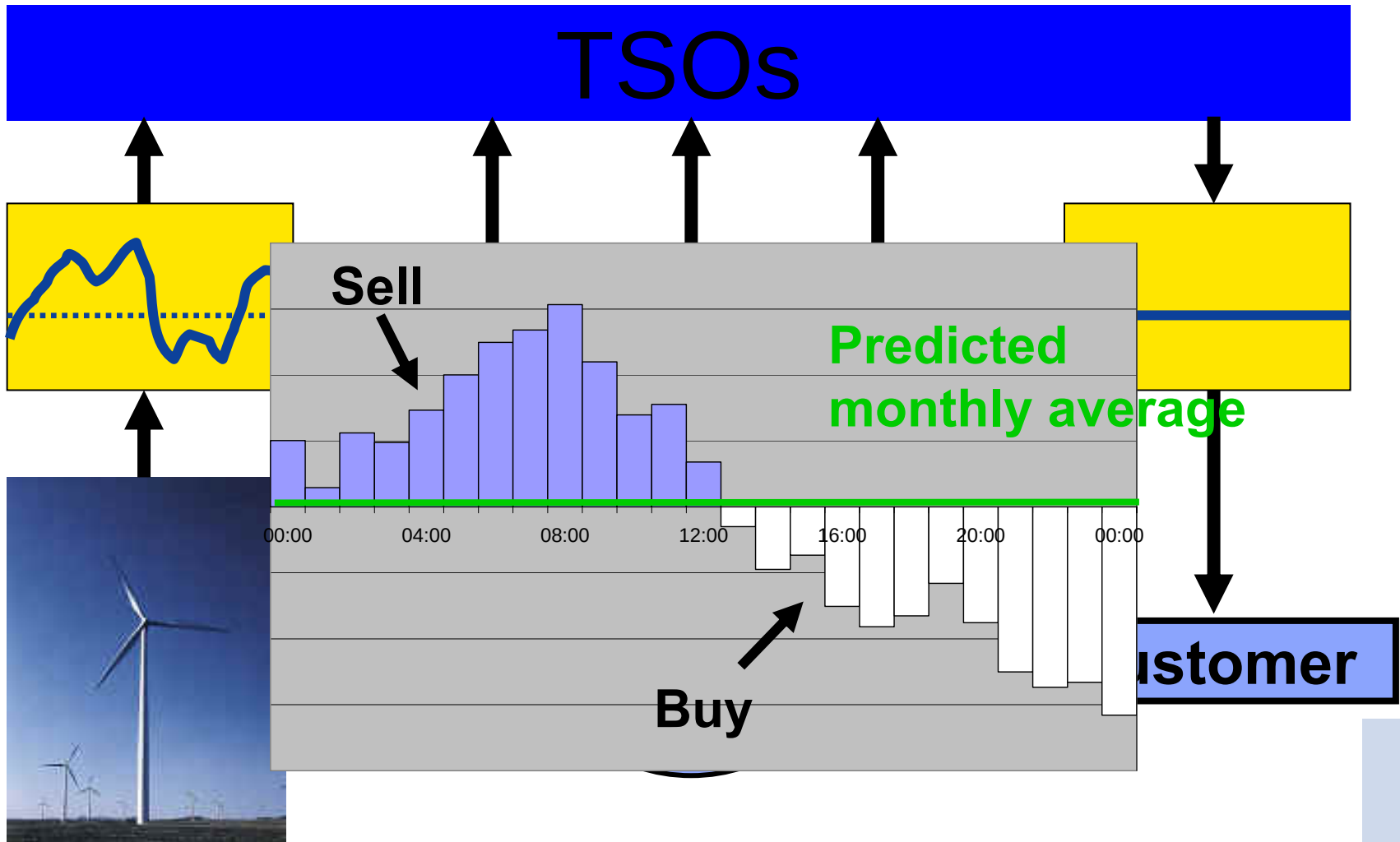


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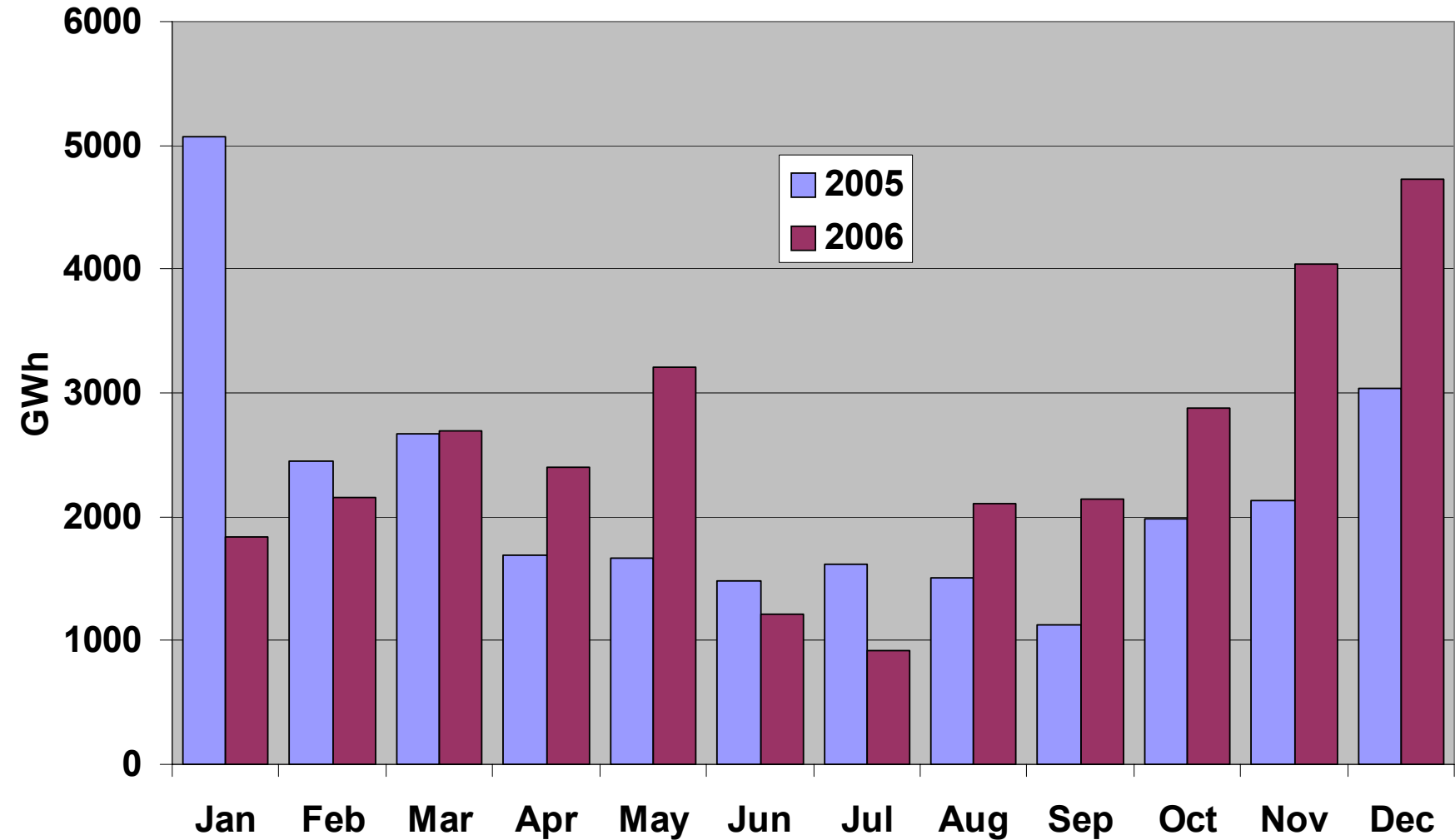
The role of the TSOs in Germany

Balancing



Monthly production

2005 & 2006



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Change in Wind Power within 15 Minutes

RWE control area

(one year)



105																				3	
100																	3	55	220	3	
95														2	1	11	66	173	53		
90														1	14	51	126	63	3		
85														15	76	119	45	15			
80											2	3	23	75	120	69	14		1		
75											7	20	92	114	70	17	3		1		
70									2	7	35	95	124	88	23	3					
65							1	7	29	106	149	97	21	3			1				
60							2	6	30	120	143	102	36	7							
55							8	32	138	181	109	41	4	1							
50							8	47	149	250	131	42	3	1							
45						2	41	185	281	145	42	2									
40					4	62	232	375	181	52	4		1								
35				3	53	263	471	236	40	4											
30			2	53	317	581	281	52	7	3											
25		2	34	424	873	347	35	5	1												
20		21	502	1322	443	37	2	1													
15	11	578	1975	509	31	3															
10	751	4103	584	17		1															
5	13555	751	11																		
0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105

Source: ISET

Change in Wind Power within one hour

RWE control area

(one year based on 15 Min data)

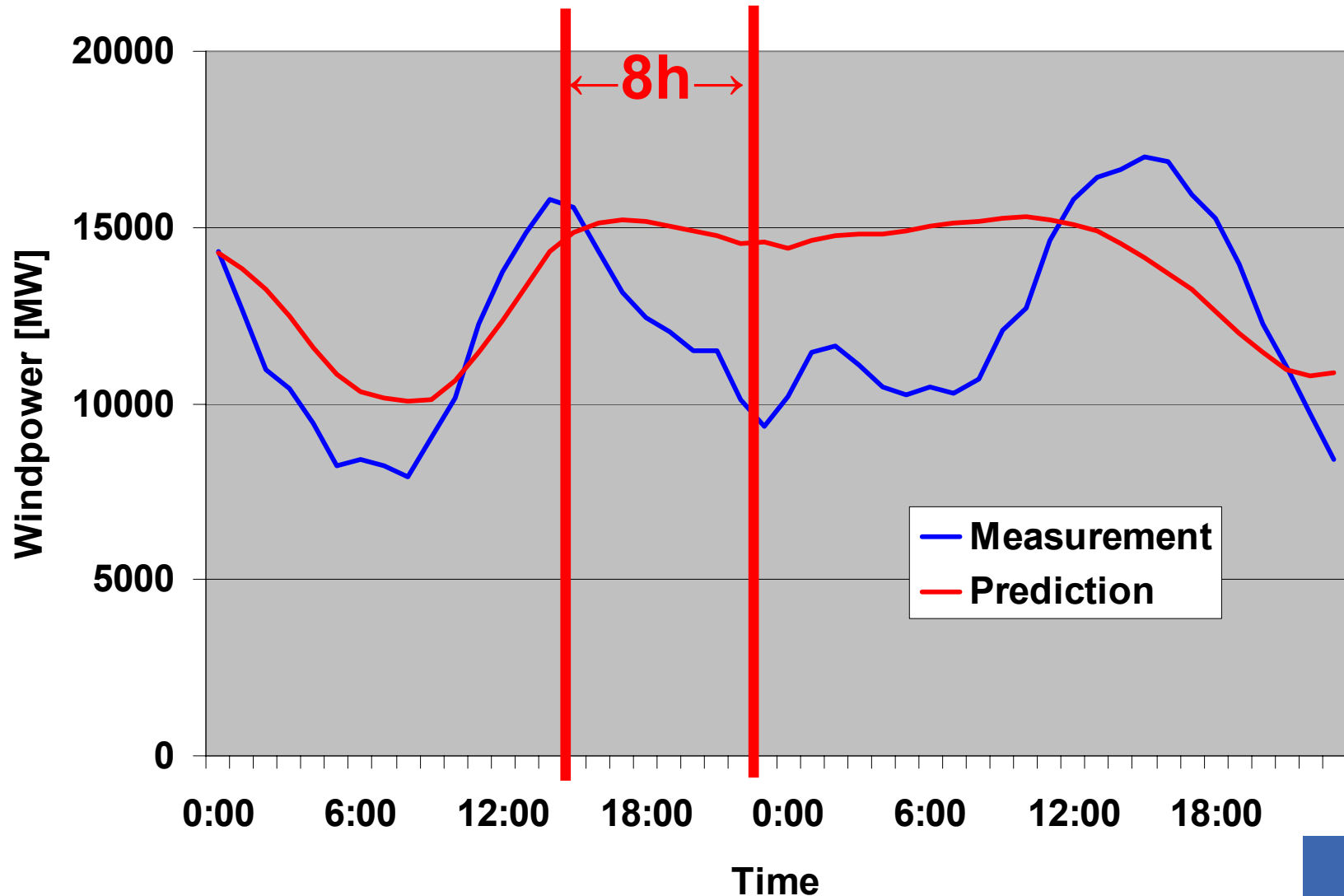


105																			1	2	
100																1	4	22	71	180	3
95														1	3	10	27	64	135	66	
90													2	6	16	31	53	82	52	16	
85											2	4	6	19	37	54	72	38	26	12	
80										1	1	9	9	38	58	88	57	26	17	3	
75									1	3	10	19	45	67	68	56	37	15	1	2	
70						1		1	4	13	18	48	82	87	64	38	16	3	2		
65								6	13	32	59	75	97	73	38	12	3	6			
60							2	21	29	70	83	94	68	45	21	10	1	1	1		
55				1		8	18	36	59	120	109	67	59	18	12	6		1			
50				2	6	24	49	85	130	137	90	67	21	14	5	1					
45			1	1	16	43	93	147	147	111	76	37	18	7	1						
40		1	6	23	54	112	197	195	163	84	45	22	6	2	1						
35	1	1	11	43	134	236	268	236	90	31	15	4									
30	1	6	46	153	318	337	247	119	42	22	4		1								
25	3	25	149	470	520	337	147	48	18	3	1										
20	7	140	622	857	487	161	35	13	2	2	1										
15	70	882	1303	641	163	29	12	3		2											
10	1329	3097	872	129	21	6	1	1													
5	12906	1302	96	8	2	2	1														
0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105

Source : ISET

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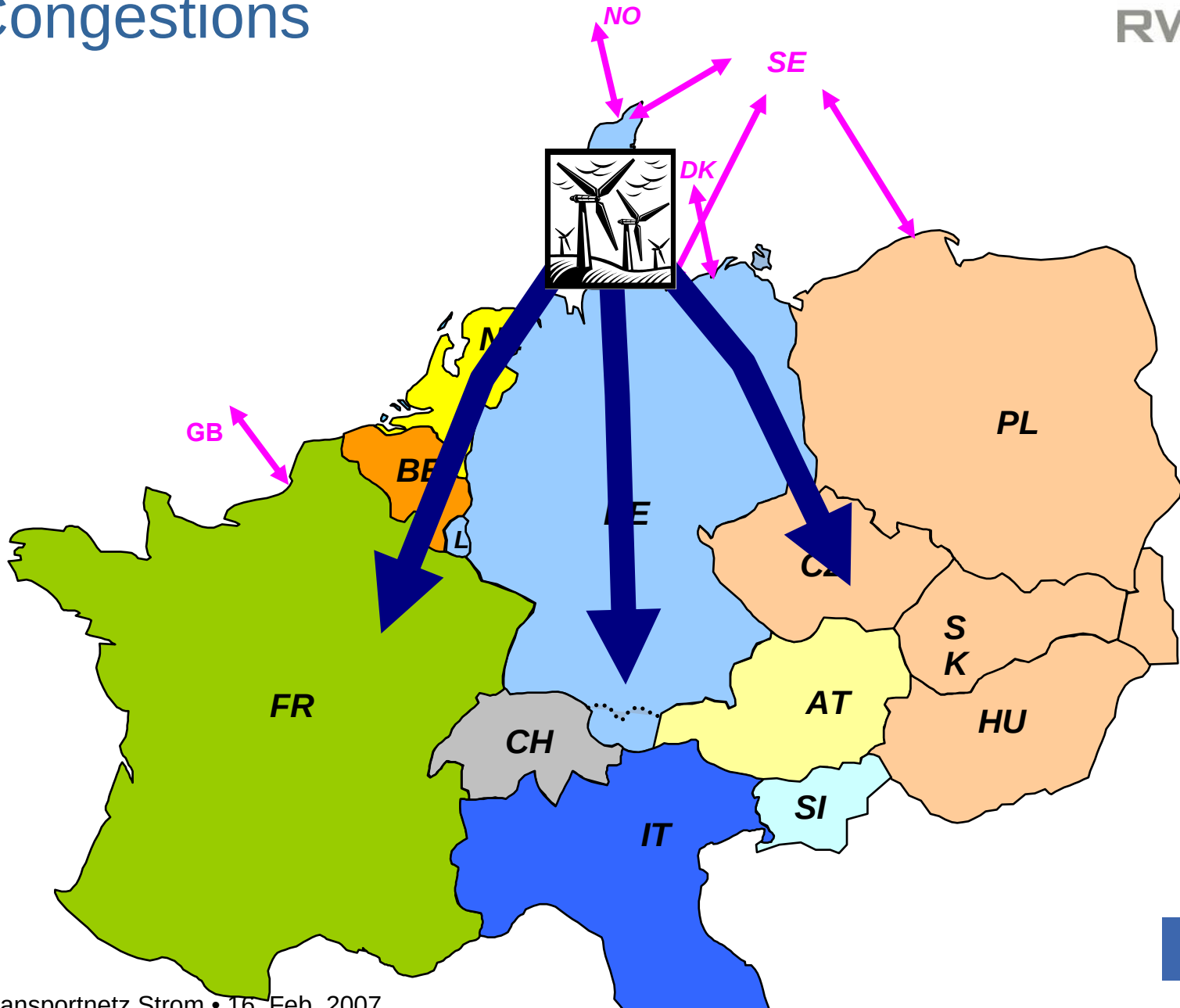
Wind power during a storm front



Overview

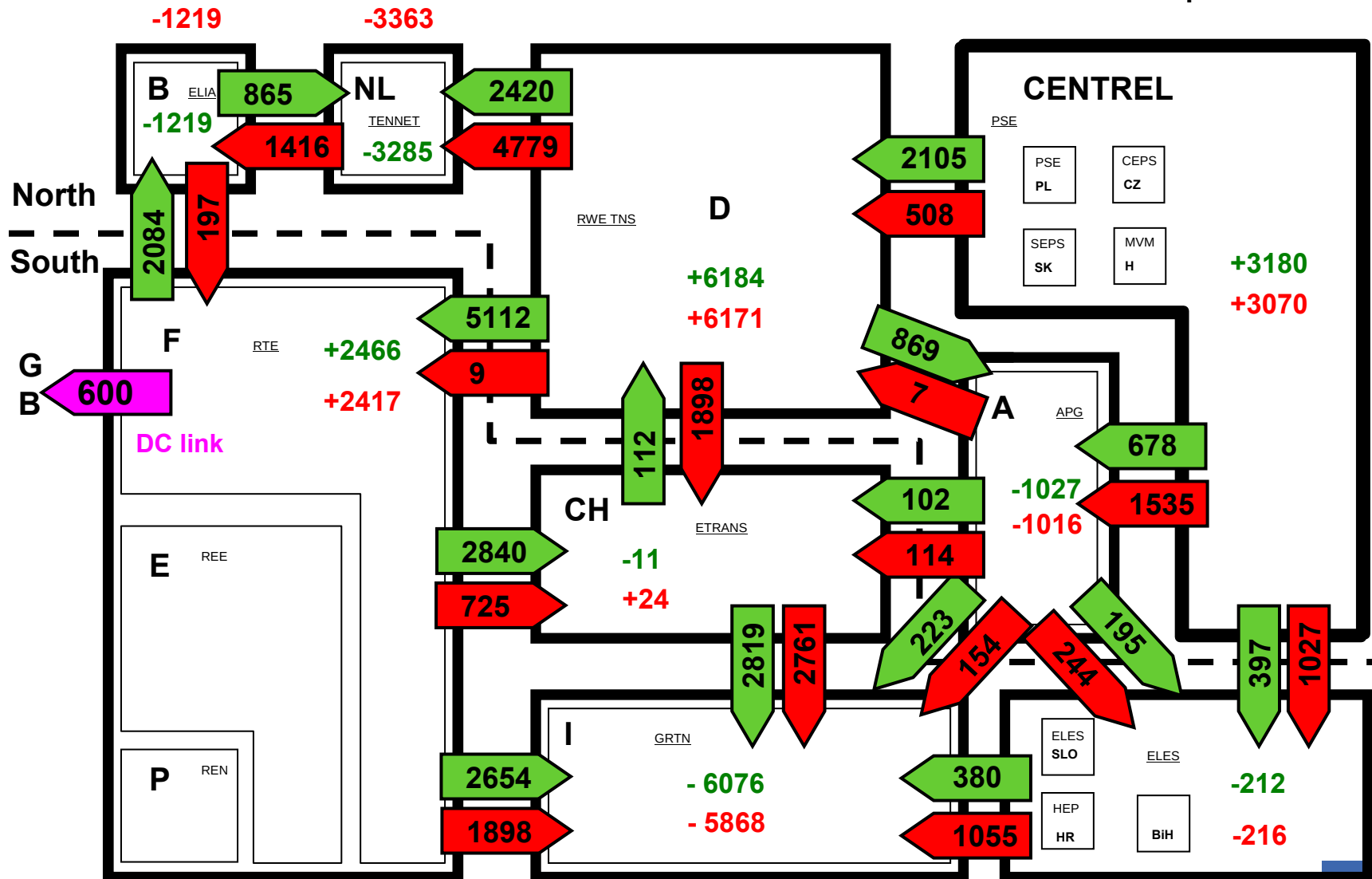
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Congestions



Situation on 22.12.2004 at 17h30

scheduled power exchanges* vs. **physical power flows*** + Export
- Import



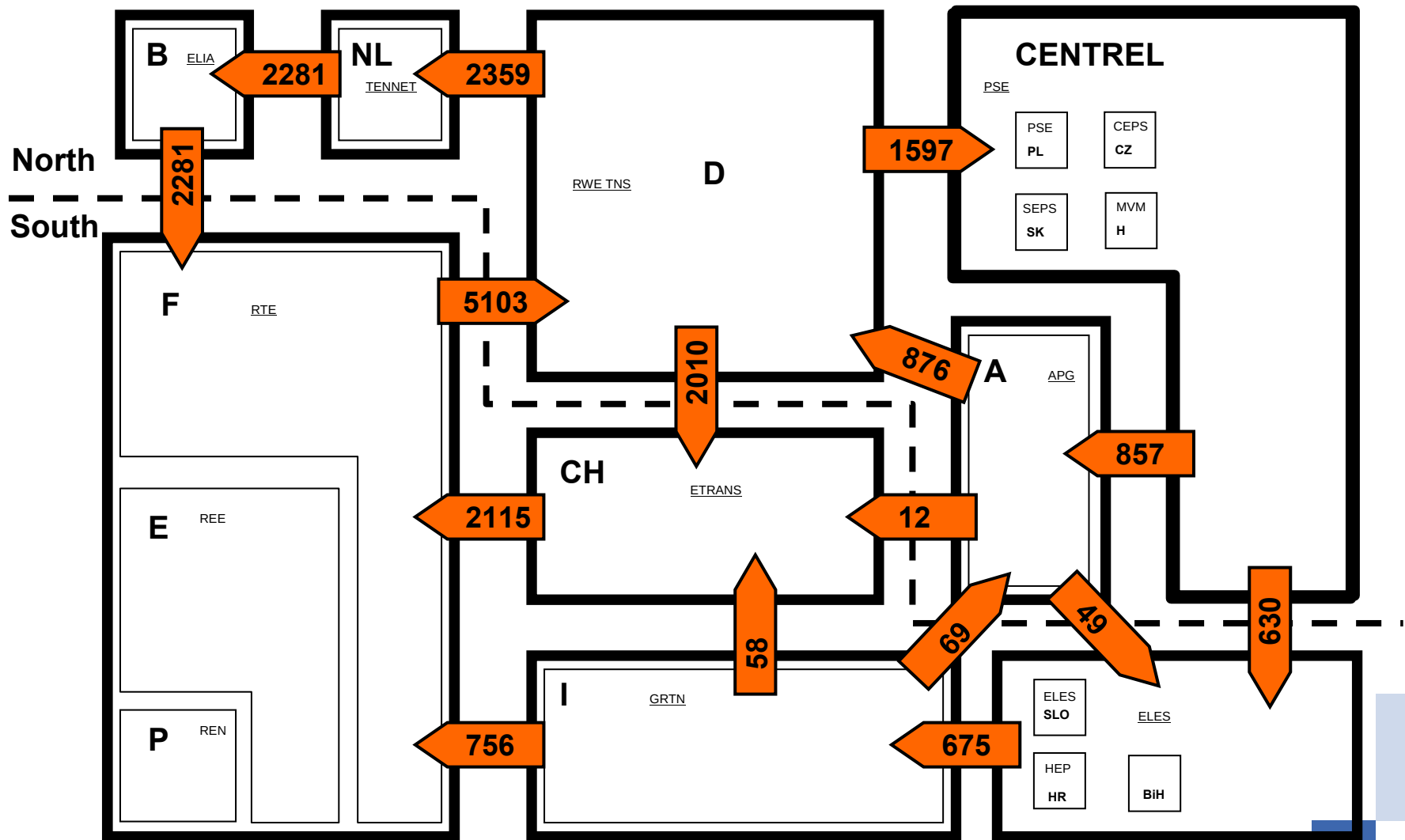
* realised values taken from VULCANUS

* simulation with adapted DACF data sets

Situation on 22.12.2004 at 17h30

resulting loop flows = physical flows - scheduled flows

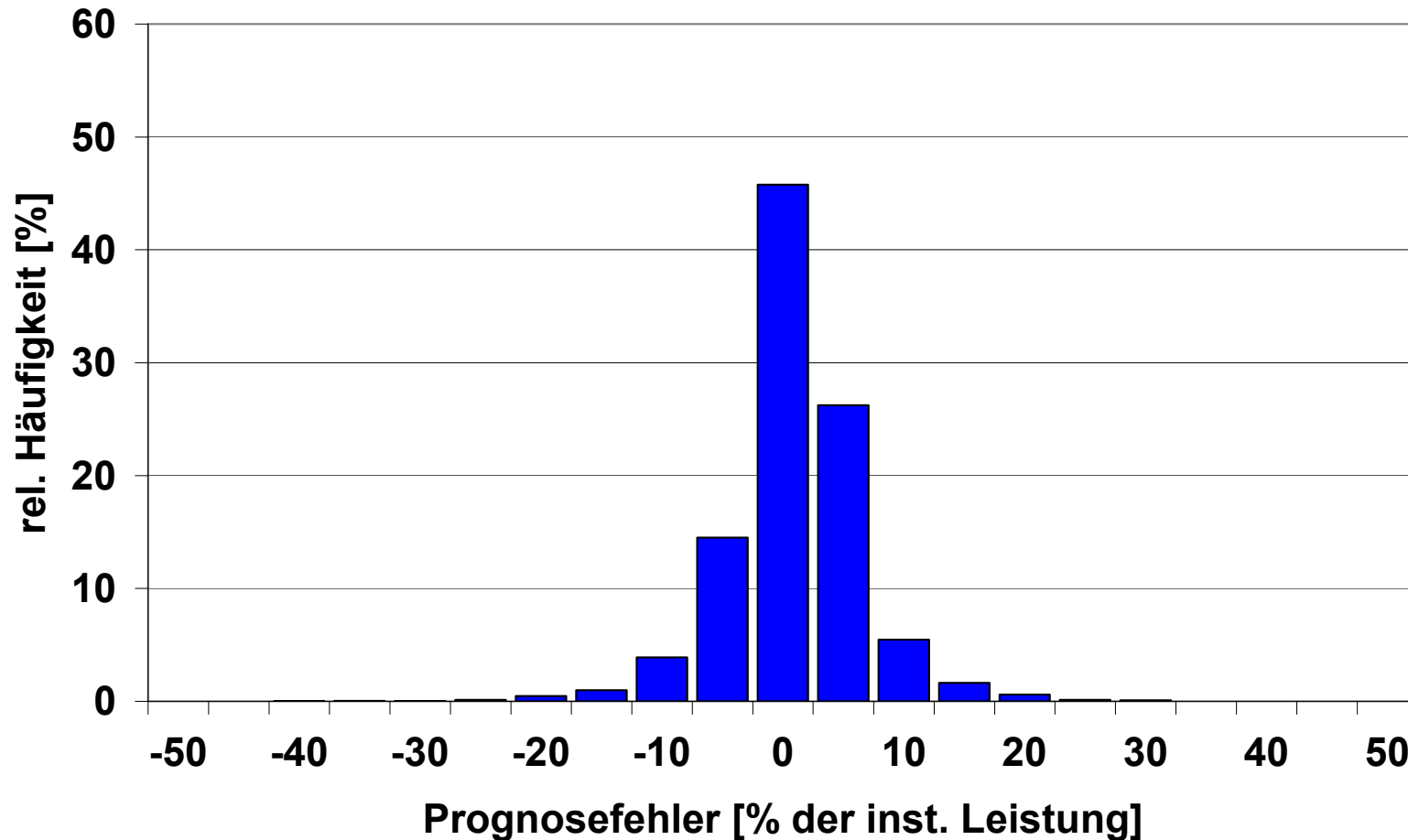
+ Export
- Import



Overview

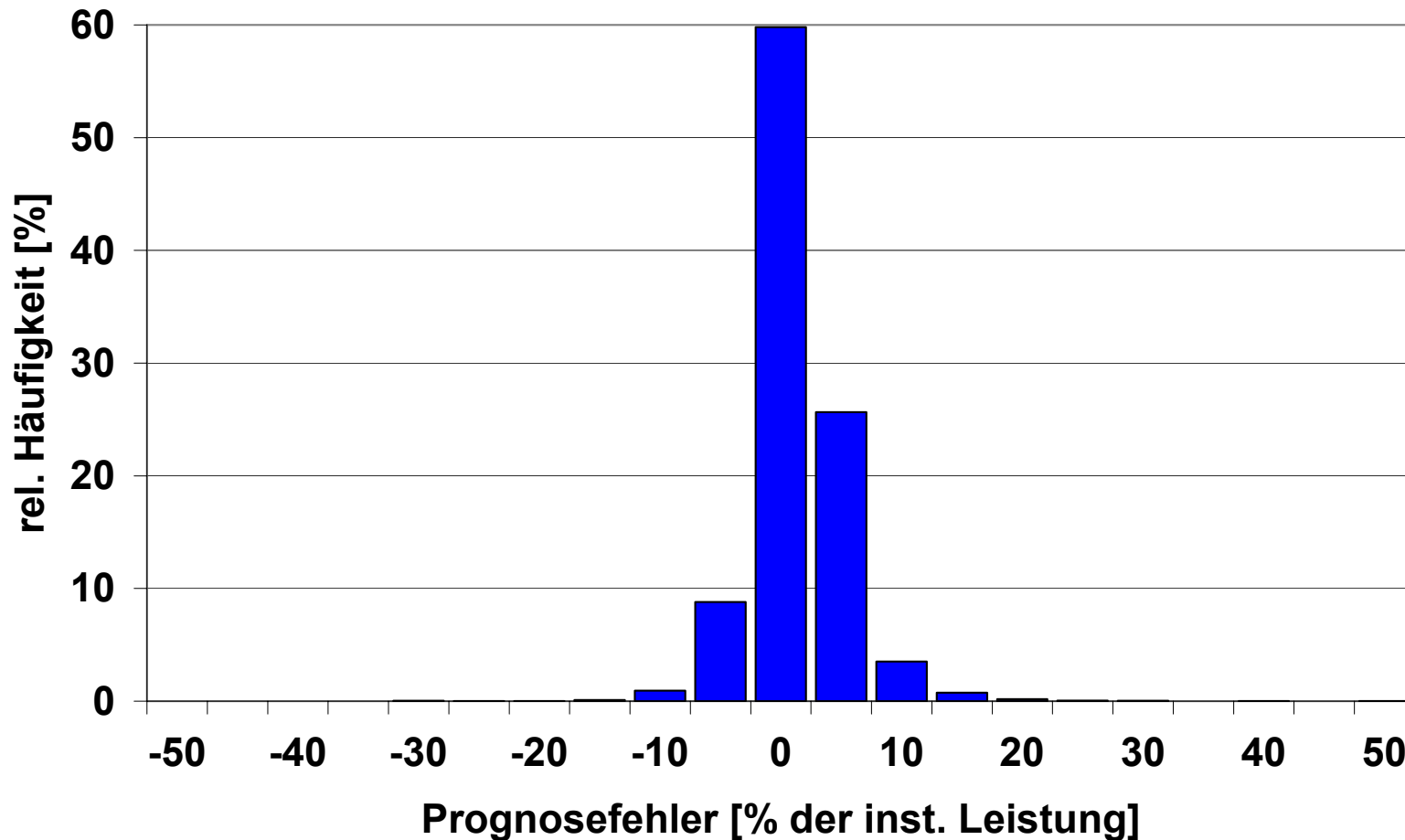
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Day Ahead Forecast



Distribution of Errors of the Day Ahead Forecast (17 – 41 hours) for the German grid area
RMSE: 5.7 % of inst. Capacity; Correlation: 0.96

Short Term Forecast (4h)



Distribution of Errors of the Short Term Forecast (4 hours) for the German grid area
RMSE: 3.3 % of inst. Capacity; Korrelation: 0.98

Source : ISET

Comparison of day ahead and 4-hour forecast

Model	Error (RMSE)	Maximum Error	Correlation
Day ahead	5.8 %	-30 % 40 %	0.950
4h ahead	3.8 %	-28 % 36 %	0.977

■ Further research for short term prediction is necessarily

■ New project with ISET just started

Funded by the German Federal Environment Ministry

Day ahead prediction

Combining different weather models

- Wind power prediction systems commonly use only one single numerical weather prediction model (NWP).
- But: The NWP models have strengths and weaknesses in different situations.
 - e.g.: convection is over-estimated by one model, which leads to increase in the predicted wind speed.
- Our approach: Combine different deterministic NWP to minimise the error of wind power forecasts with a focus on finding an optimal combination of weather models with regard to different weather situations.



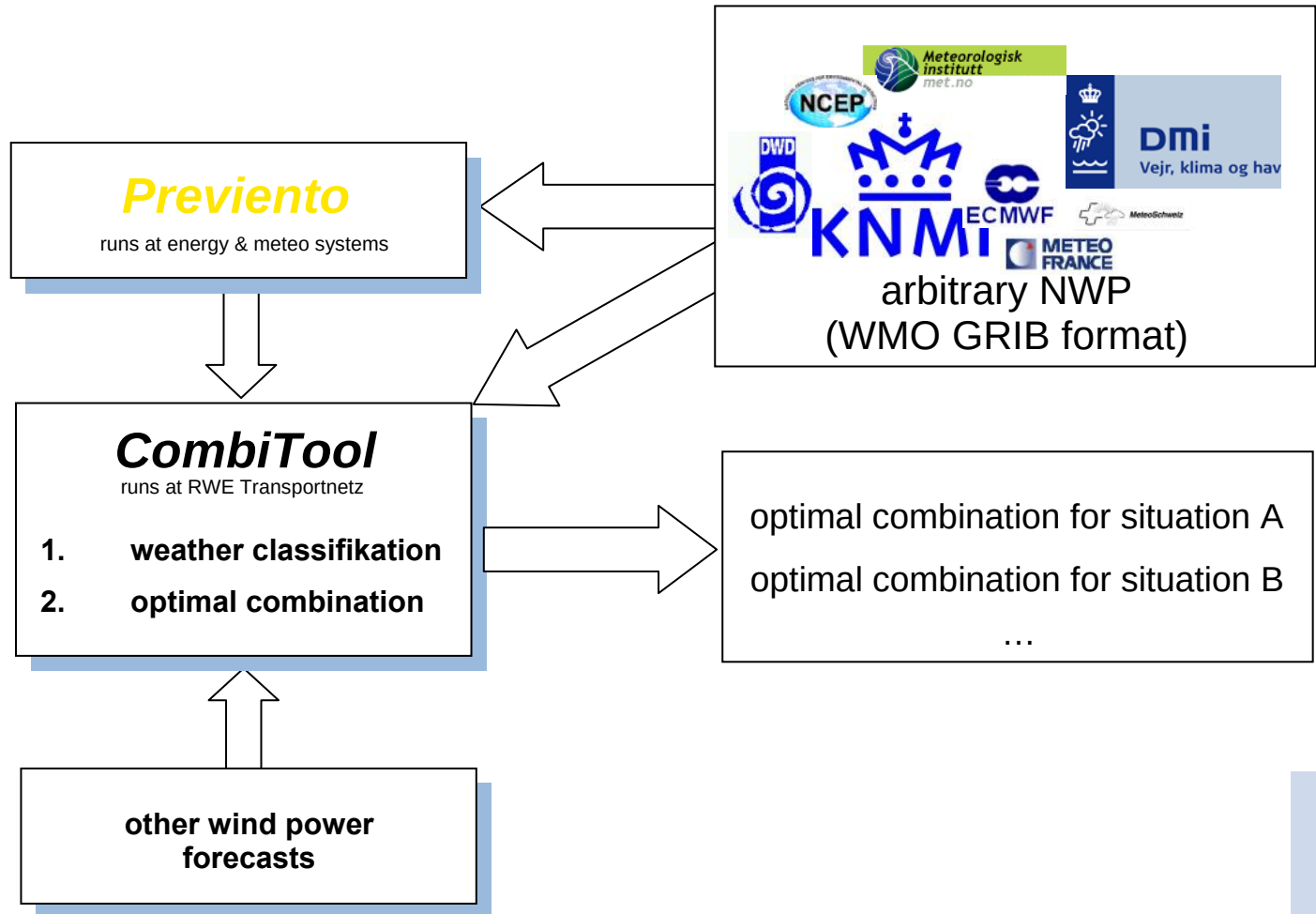
- **Coordinator/ Developer of „CombiTool“**
 - **energy & meteo systems GmbH**

- **Operational use:**
 - **RWE Transportnetz Strom GmbH**

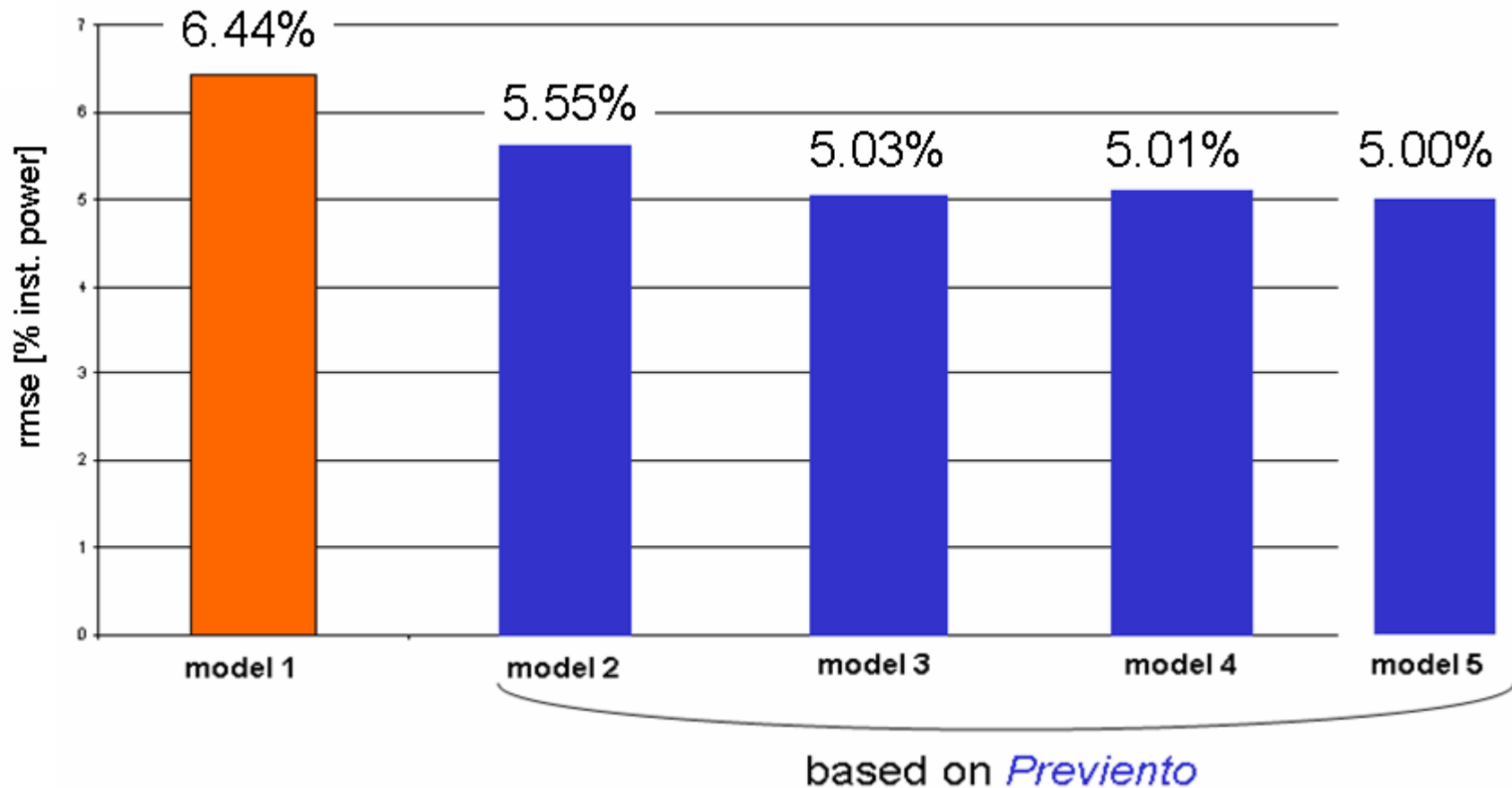
- **Project partner:**
 - **Deutscher Wetterdienst (DWD)**

The project is partly funded by the German Federal Environment Ministry.

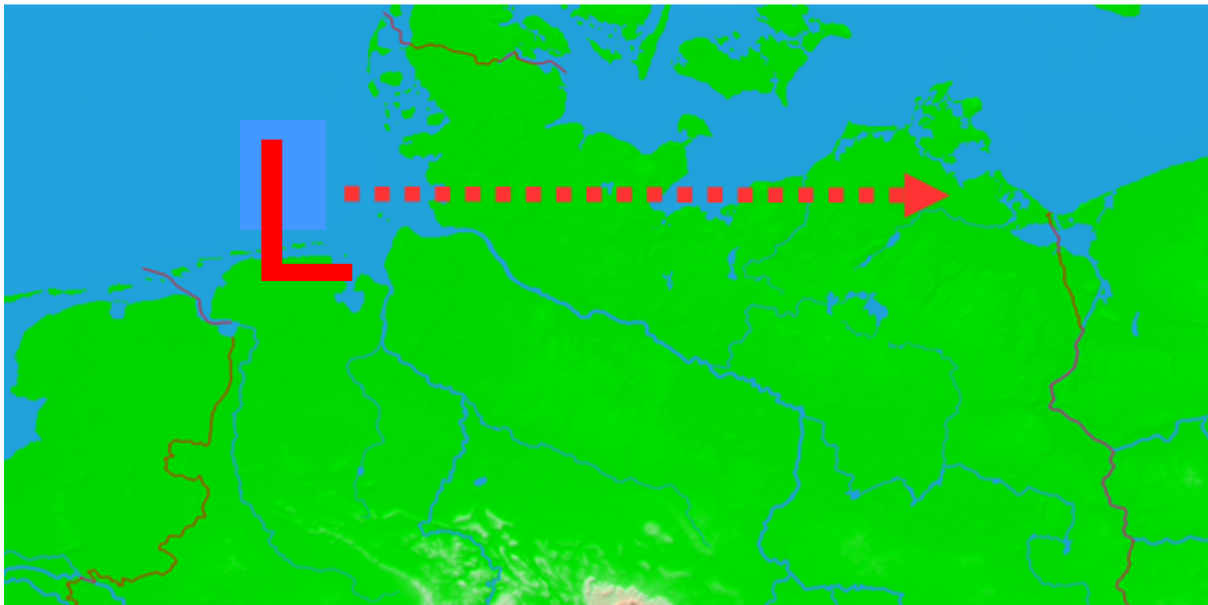
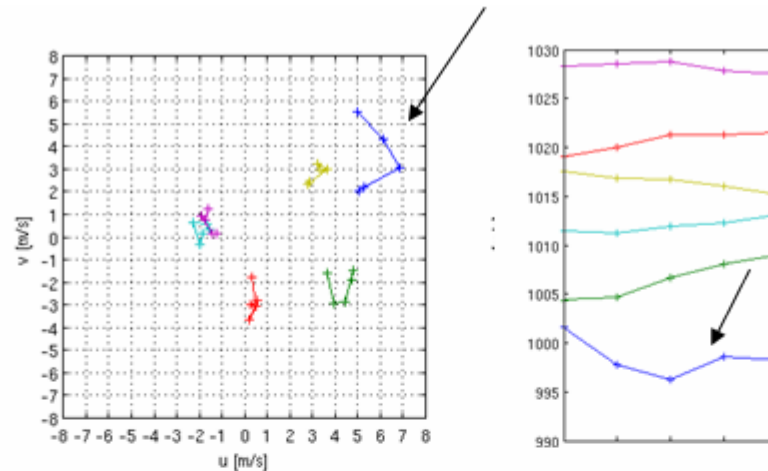
What the CombiTool does



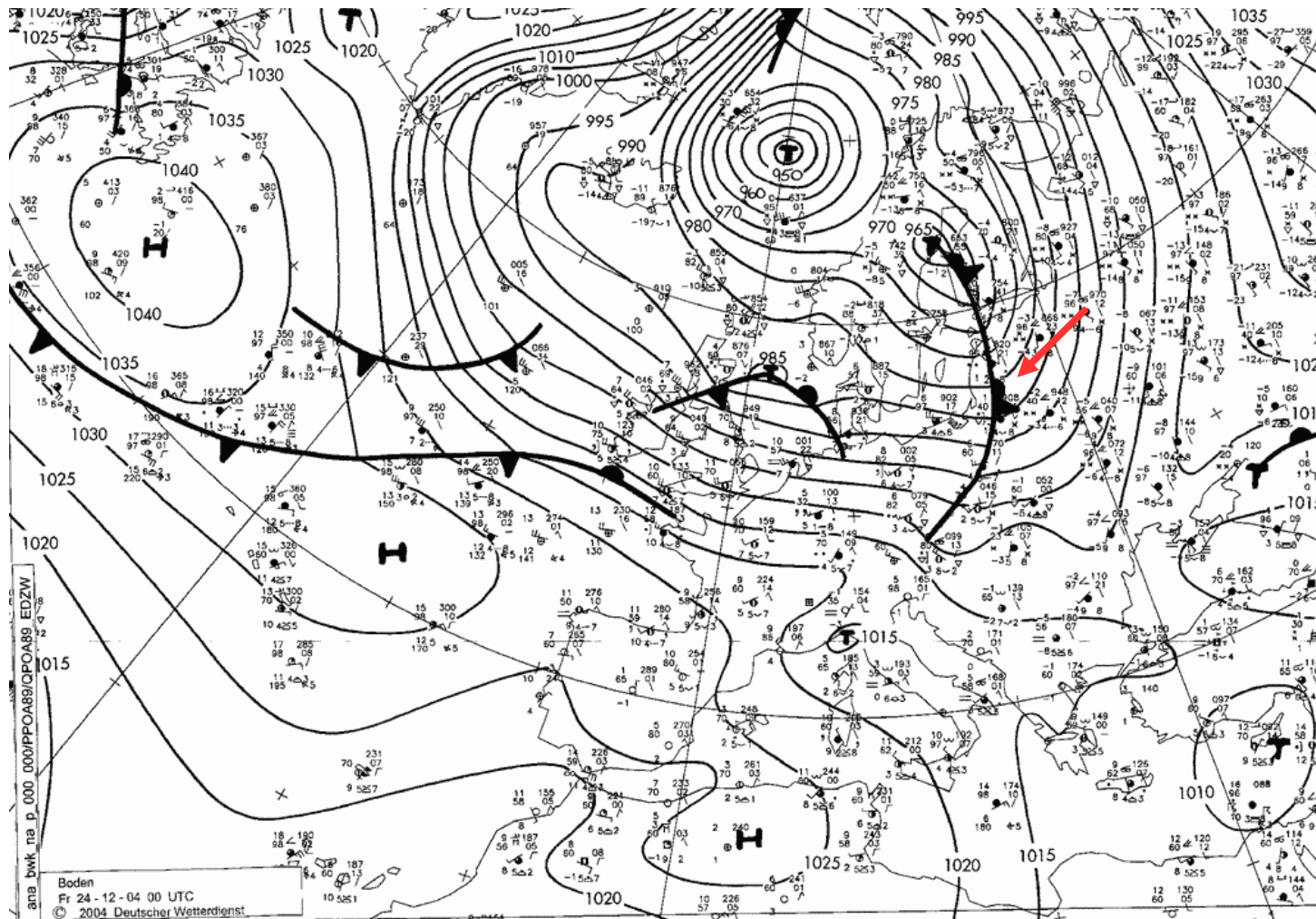
Root mean square error (rmse) dayahead-forecast January-October (all control Areas)



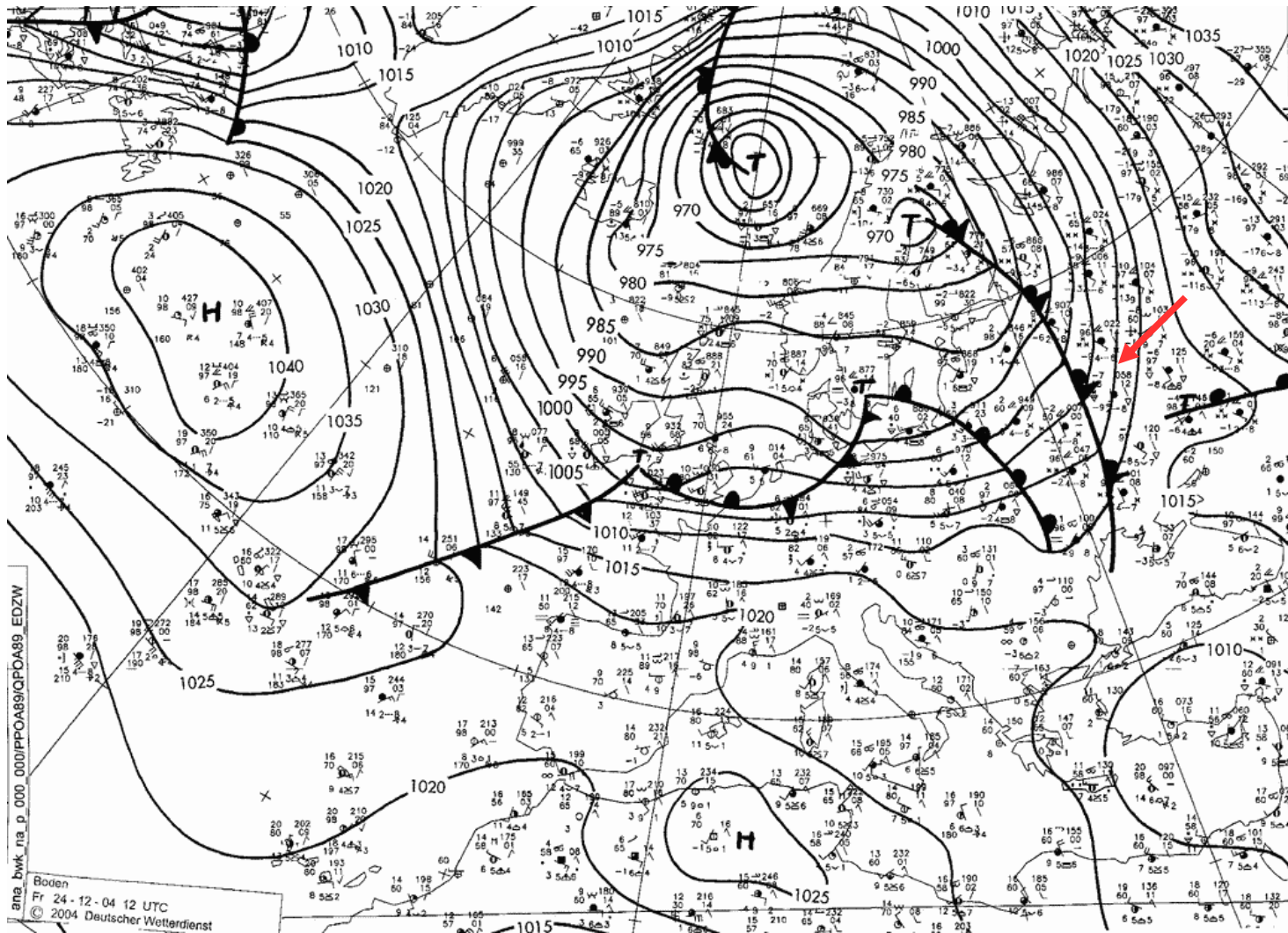
Example: Weather cluster „Cyclone passing – type A“



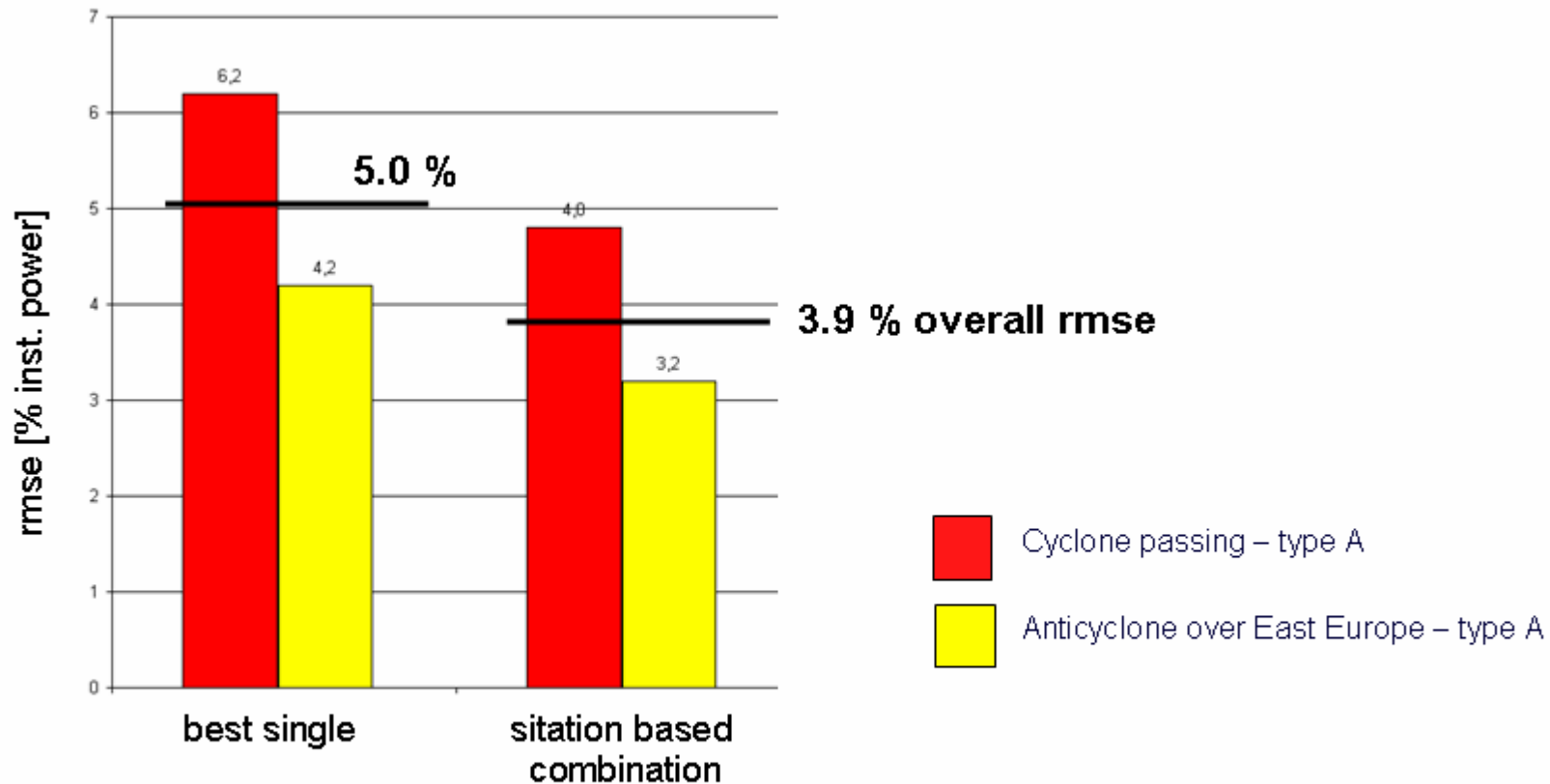
Weather cluster „Cyclone passing – type A“



Weather cluster „Cyclone passing – type A“



Accuracy in individual weather situations



- using optimal weights for each weather situation leads to considerable improvement

Summary of R&D Needs and Activities

- Improvement of short term predictions (1-8 hours).
- An automatic classification scheme, based on methods from synoptic climatology generates useful weather classes.
- Optimal combination of weighted NWP based on weather classification (day ahead prediction).
- Usage of ensemble prediction.
- Calculation of a confidential interval.
- Predicting network losses and congestions based on wind power forecast.

Thank you for your attention!