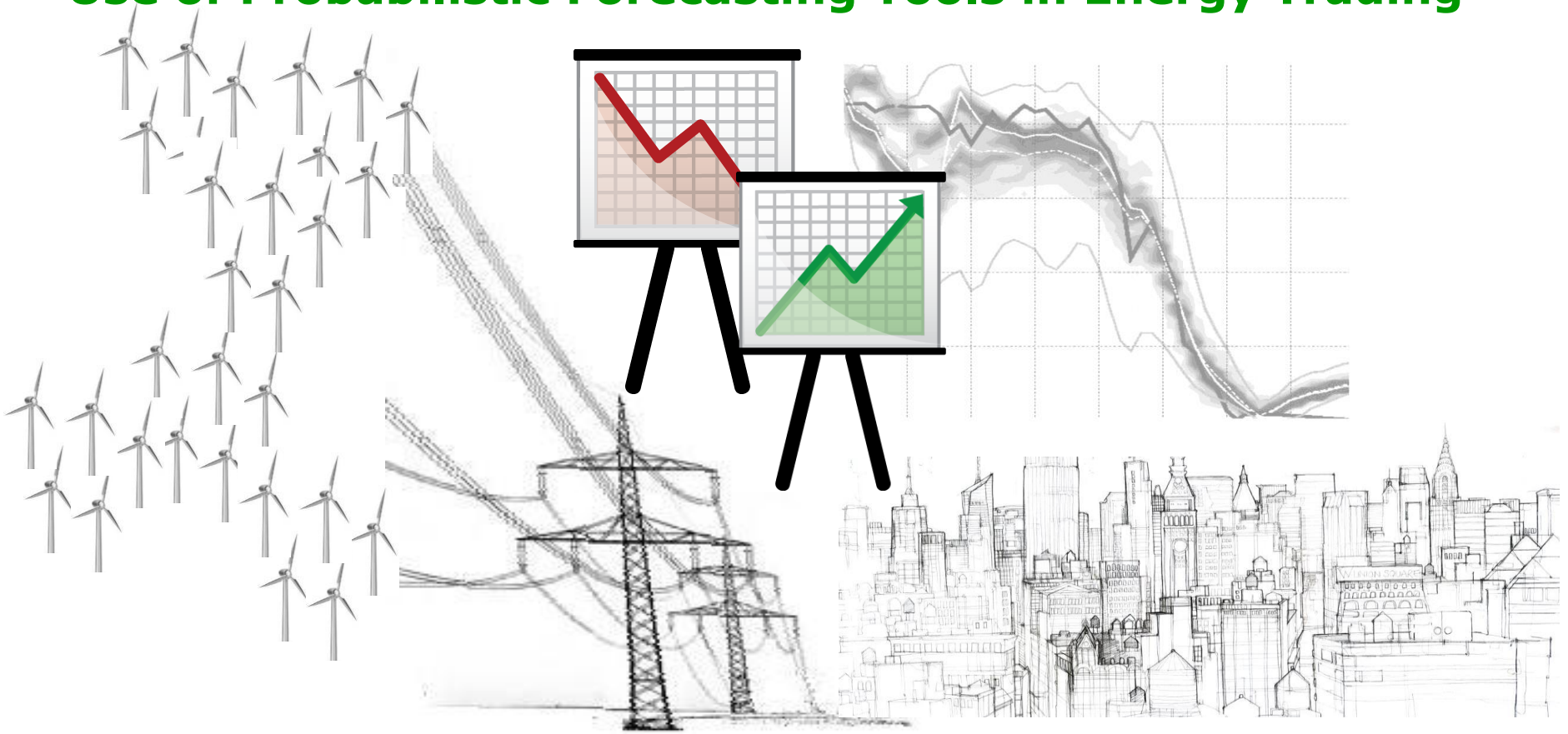
2017 UVIG Forecasting Workshop
APPLYING METEOROLOGY IN Power System Planning and Operations

Use of Probabilistic Forecasting Tools in Energy Trading



Session 7: Renewable Energy, Energy Trading, Market Evolution and the Role of Forecasting
Atlanta, GA, June 20, 2017

Dr. Corinna Möhrlen, WEPROG

WEPROG – Weather & Energy PROGnoses

Specialists in Ensemble Weather Forecasting & Wind-, Solar Power and Power market Applications

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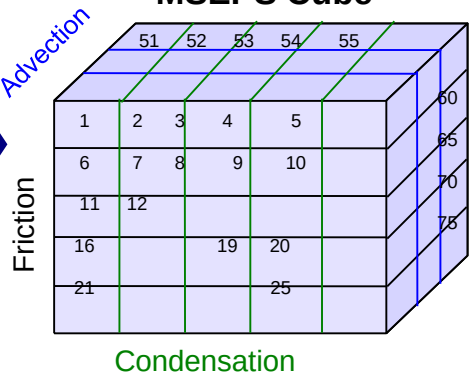
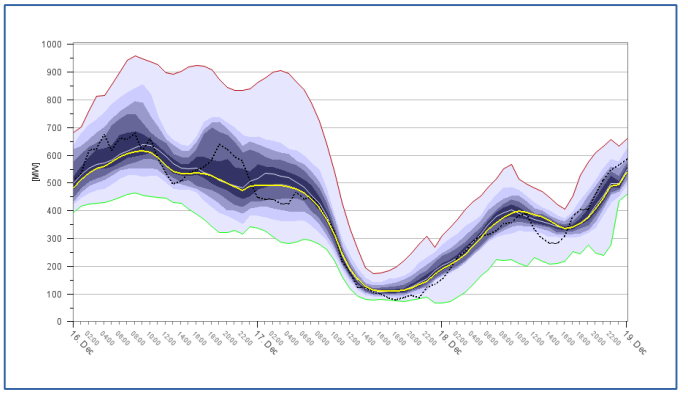


Probabilistic weather, wind & solar power forecasts



A brief history in time: Trading of Wind Power (Renewables)

A) Traditionally trading of Renewables starts at System Operator level

B) Often there are market forces that claim SO's are not efficient

A) Competition shall increase performance

--→ so far so good… but is this possible ?
Let's see what happened in two of the pioneering markets ?

=> Denmark: from 1 TSO to 3 Traders

The "association of wind farm owners" split their pool (80%) among 2
The "Bad BRP", i.e. TSO (Energinet.dk) outsources the remaining FIT farms to 1

=> Germany: from 4 TSOs to approx. 4-6 Traders

- Bonus system created 30+ trading companies to compete in the market
  → small companies should also be able to trade
- 3 years after the bonus was removed, ca. +/-5 traders are effectively trading the 90% of wind capacity

A brief history in time: Trading of Wind Power on market terms

Experiece from the privatization of trading in Denmark and Germany:

→ no real competition, but instead price "war" on forecasts

→ no more development on forecasting

→ increasing balancing costs for TSOs due to speculations

→ market manipulation (traders are not regulated as much…)

→ ….

So, while we talk about the benefits of probabilistic forecasting the - *reality looks quite different !!!*

While we wonder, why uncertainty forecasting and proabilistic methods do not "take off" - *reality looks quite different !!!*

Why is speculation against system balance in the power market contra-productive ?

It is part of the DNA of traders to look for profits -

What do you do, if you can't earn money where you should ?

If classical trading does not bring profits – speculation starts!

--→ if the entire market uses same procedures, it's easy to speculate against system imbalance !

--→ if there is no real competition and the same tools are used to balance and to trade, it's easy to speculate and manipulate !

--→ if curtailment increases, it's easy to cheat wind farm owners!

Result:
Higher balancing costs on the system (more expensive reserve…
Lower system security (missing reserve in extreme events
Ultimately higher costs for comsumers (e.g. EEX prices fall, consumer prices increase...)

What could prevent this situation ?

Use of uncertainty forecasts can “heal the cancer in the system”

- Traders become price makers
- Traders reduce system imbalance by bidding the “secure” part of forecast
- System operator is prepared for outliers and extremes
- System operator allocates dynamic reserve
- System operator is confident and “aware of the situation”

We can prevent speculation by

increasing the incentive to increase system balance
and
penalise generation of imbalances

How to practically change trading practices

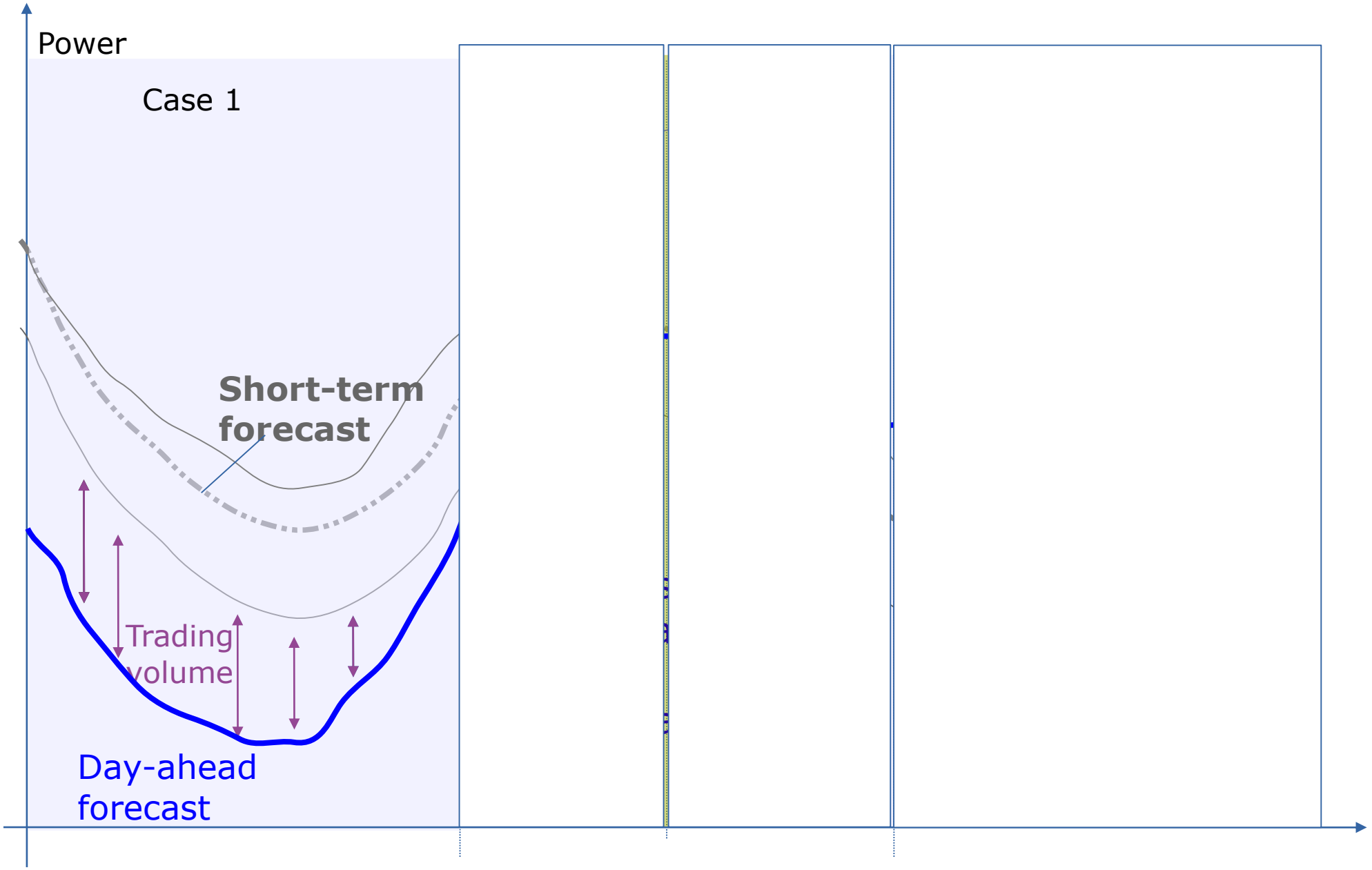
Strategic Daily Spot Market Bidding

1. Split your pool into portions and become price maker
2. Optimize your trading volume with intra-day balancing
3. Base your bids on a preliminary plan for the balance process
4. Make sure you help to avoid negative prices

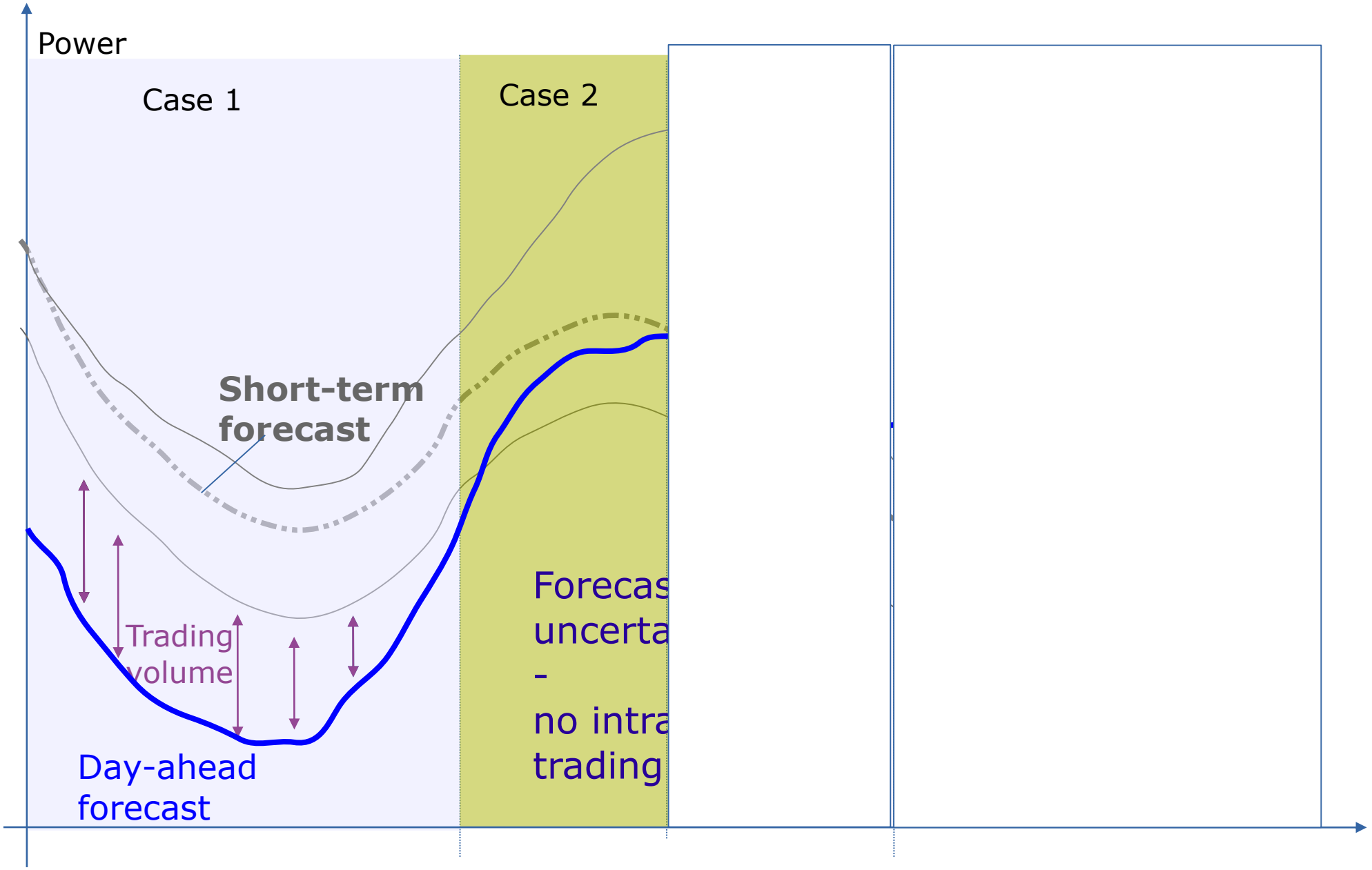
The impact of increased Intra-day Trading

1 Reduces the day-ahead schedule error with approx. 50%
2. Reduces the need of peak reserve
3. Reduces the volatility of balancing costs
4. More volume in the market
5. Small pools may not need to be 24x7 in the market

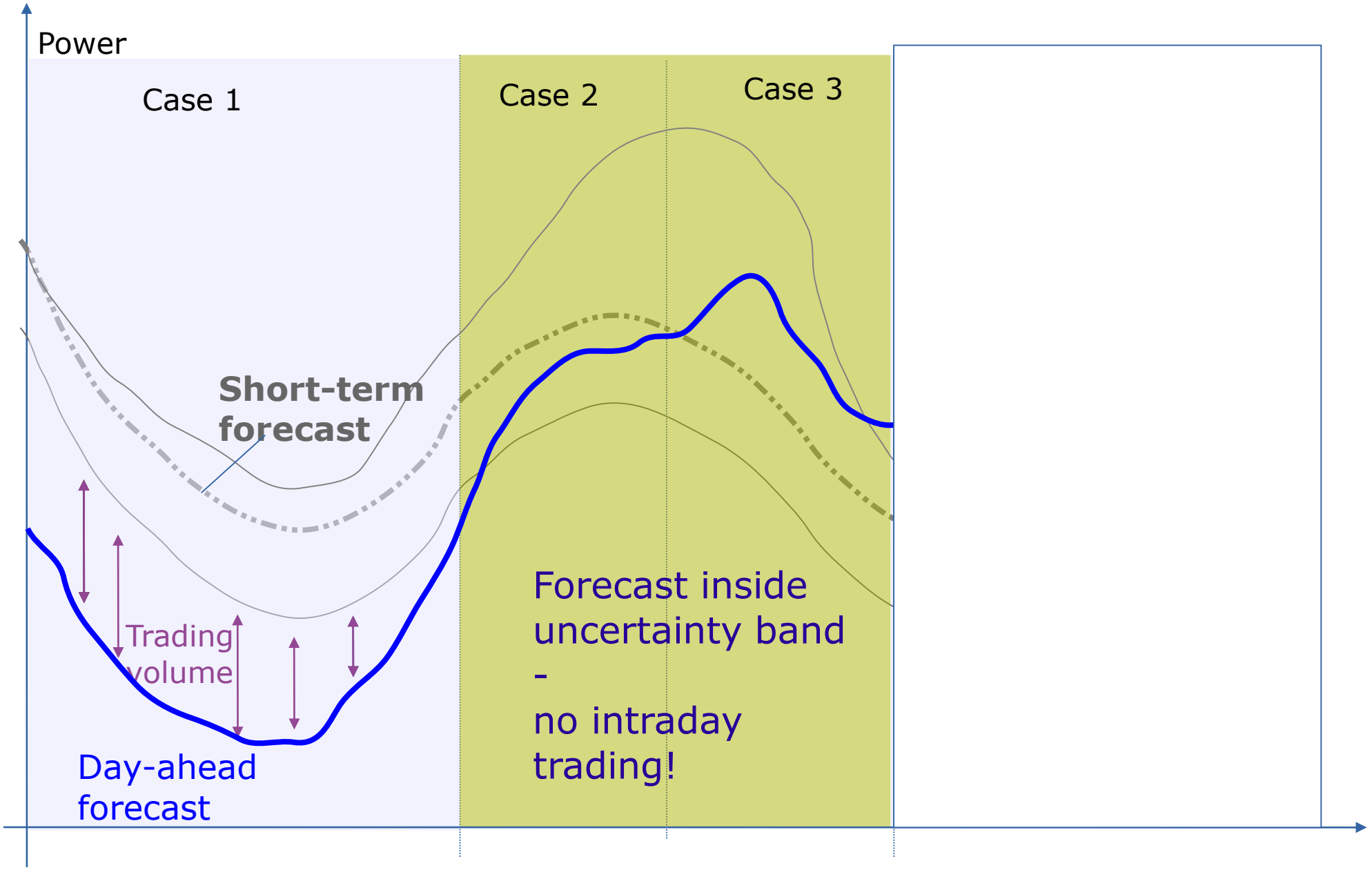
What you need to know about working with uncertainty forecasts



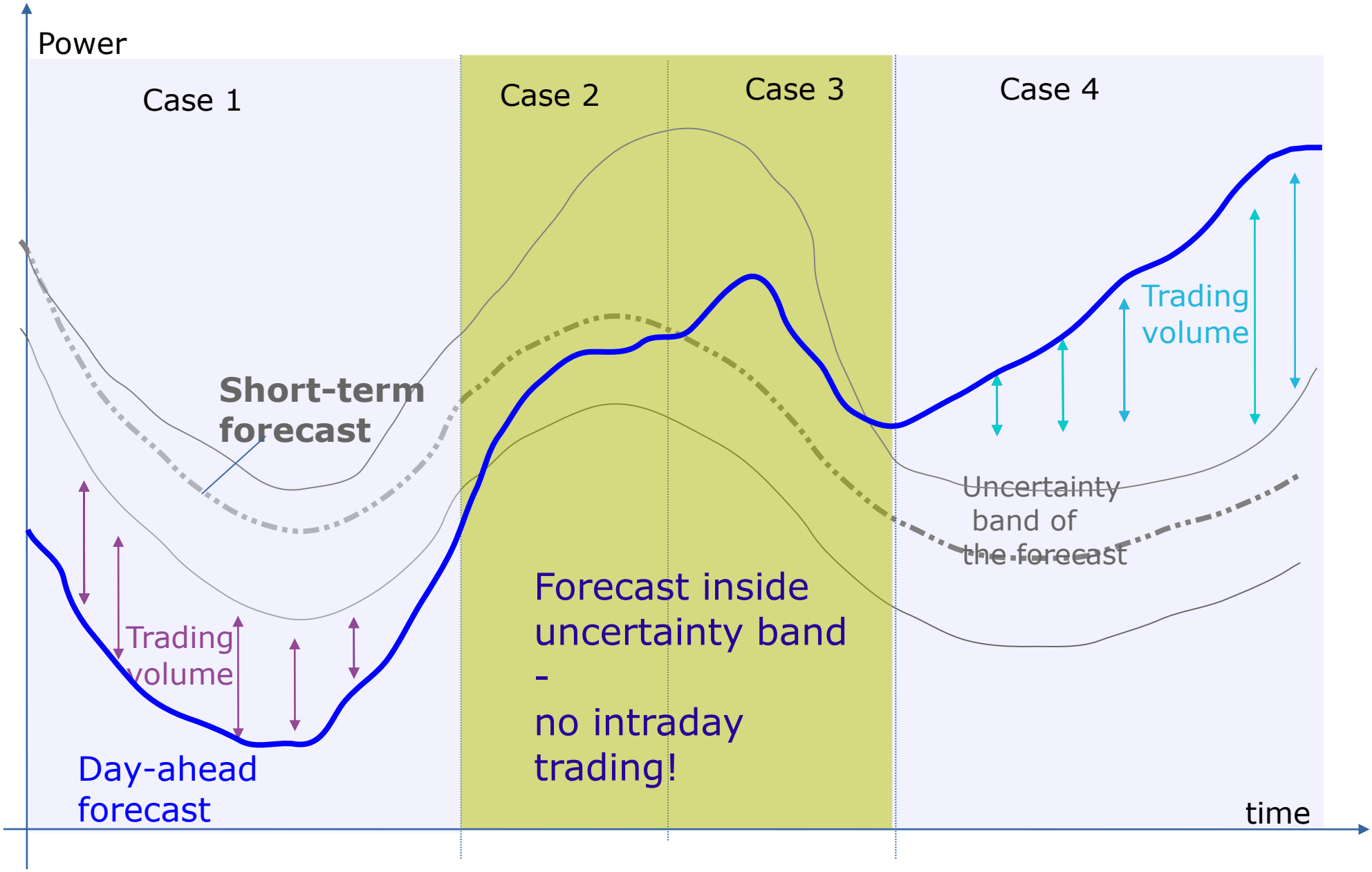
What you need to know about working with uncertainty forecasts



What you need to know about working with uncertainty forecasts



What you need to know about working with uncertainty forecasts



How to practically change trading practices

There are 4 cases to consider:

Case 1: Short-term forecast is higher than Day-ahead

Action: **Sell** the **volume between minimum short-term and day-ahead**

Case 2: Short-ahead forecast is higher than day-ahead, BUT lies within the uncertainty band of short-term forecast

Action: Do nothing!

Case 3: Short-ahead forecast is lower than day-ahead, BUT lies within the uncertainty band of short-term forecast

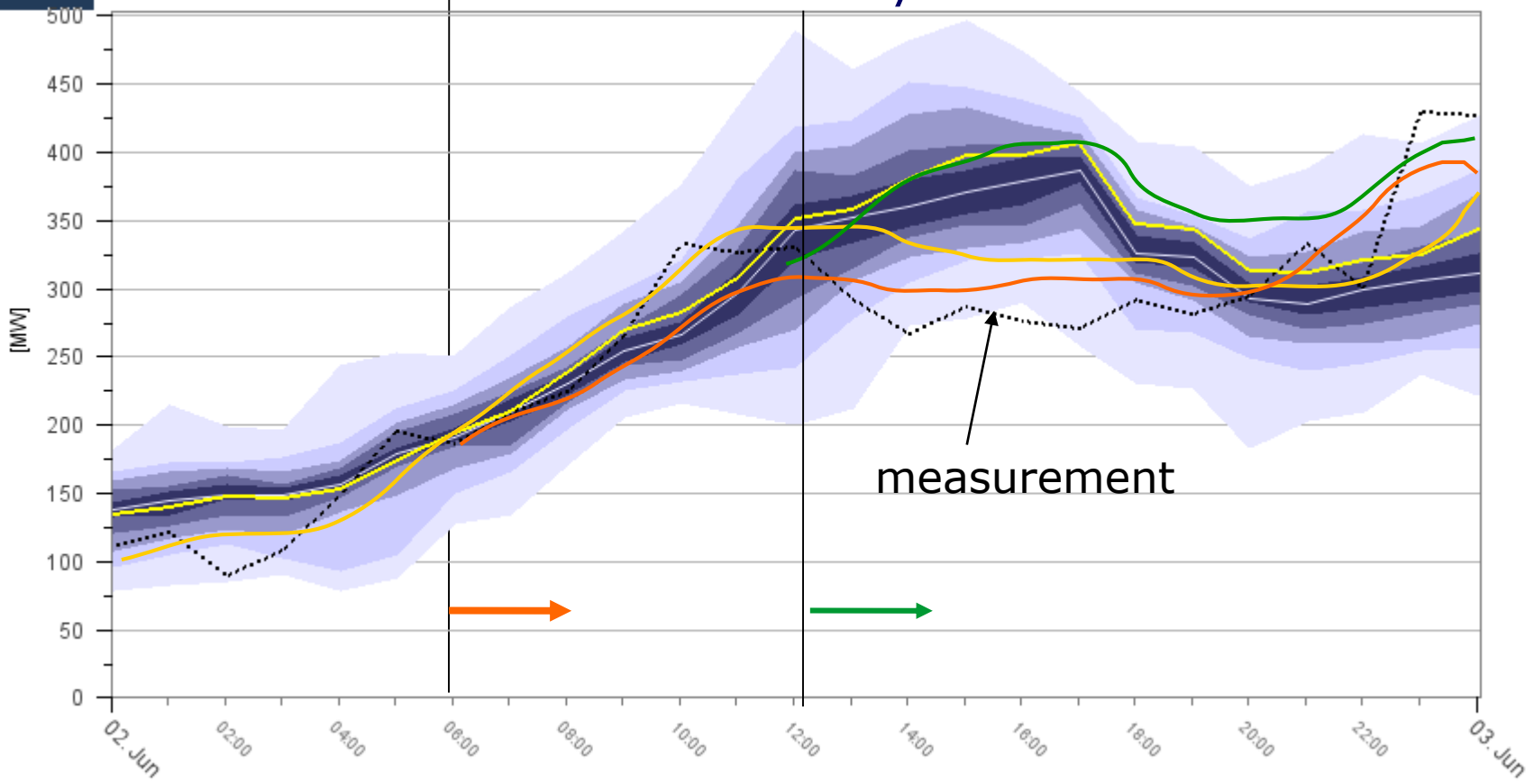
Action: Do nothing!

Case 4: Short-ahead forecast is lower than day-ahead, BUT lies within the uncertainty band of short-term forecast

Action: **Buy the volume between maximum short-term and day-ahead**

Thumb rule 1: decide objectively which forecast to trust

Forcasts change over time – the latest forecast is not always the best



Areas

- min – p10
- p10 – p20
- p20 – p30
- p30 – p40
- p40 – p50
- p50 – p60
- p60 – p70
- p70 – p80
- p80 – p90
- p90 – max

Lines

- min
- max
- measured

Last run's of LS-optim. fc:

- 18UTC run
- 00UTC run
- 06UTC run
- 12UTC run

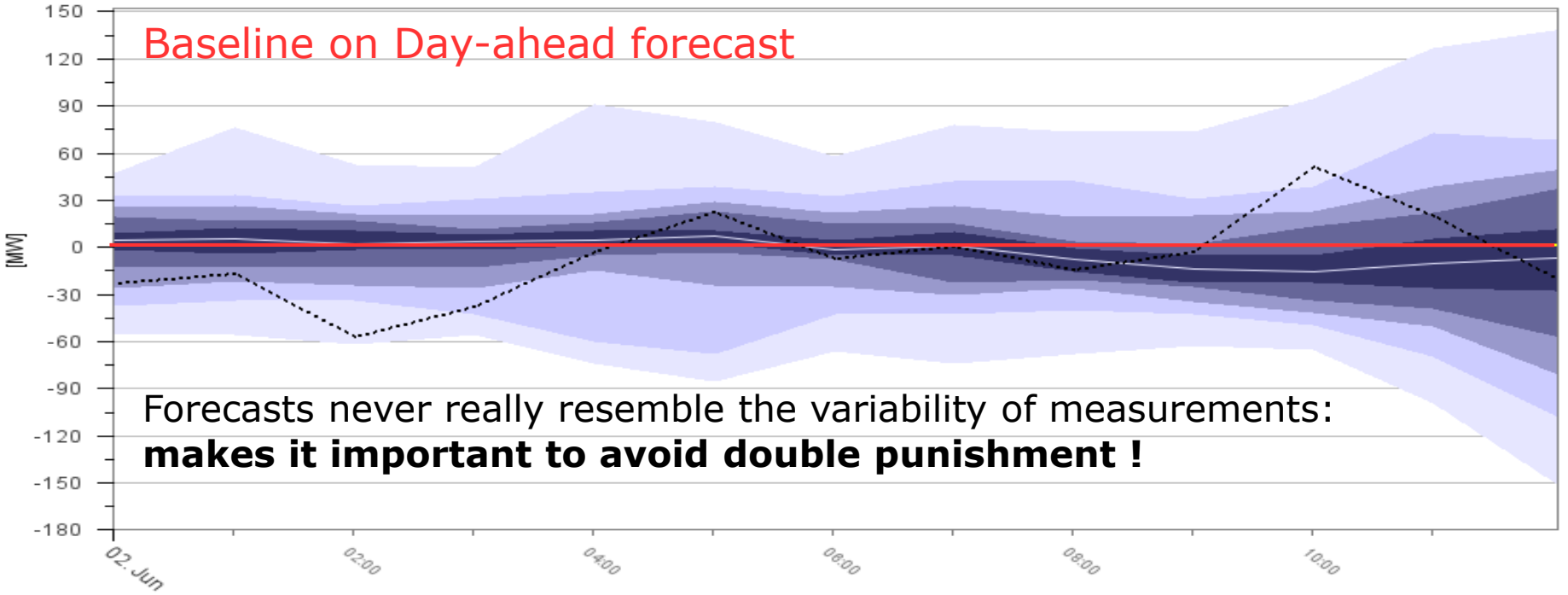
Example: large difference and uncertainty between previous and latest forecasts…*could also be different providers*

Solution:

Use physical uncertainty to make deterministic decisions
decide objectively which forecast to trust/give high weight!

Thumb rule 2: a smooth forecast avoids double punishment and provides "opportunities"

Date Hour	02. Jun 00:00	02. Jun 01:00	02. Jun 02:00	02. Jun 03:00	02. Jun 04:00	02. Jun 05:00	02. Jun 06:00	02. Jun 07:00	02. Jun 08:00	02. Jun 09:00	02. Jun 10:00	02. Jun 11:00	02. Jun 12:00
Min [MW]	78	82	84	89	77	87	126	133	169	204	215	207	199
p10 [MW]	95	104	112	102	91	104	149	165	197	225	231	236	242
p20 [MW]	107	116	122	119	136	147	167	177	211	233	239	255	269
p30 [MW]	119	125	133	131	146	168	184	185	216	242	247	267	292
p40 [MW]	131	133	145	143	152	175	187	202	222	245	258	280	321
p50 [MW]	137	143	148	148	156	179	190	209	229	254	265	296	342
p60 [MW]	142	150	156	152	162	183	196	217	237	262	275	312	360
p70 [MW]	152	154	163	156	167	194	207	223	241	269	294	328	386
p80 [MW]	158	164	167	164	172	201	214	234	256	288	303	345	398
p90 [MW]	165	171	172	176	186	211	224	250	279	298	319	379	418
Max [MW]	180	214	198	195	242	251	250	285	311	340	375	433	487
DA-FC [MW]	134	138	147	145	152	173	192	208	238	268	281	307	350
Measurement	109	120	88	106	148	194	184	208	223	264	331	325	329



How to become a price maker in the market

What are the incentives to bid in with higher prices:

increase income

generate realistic prices that mirror the real costs

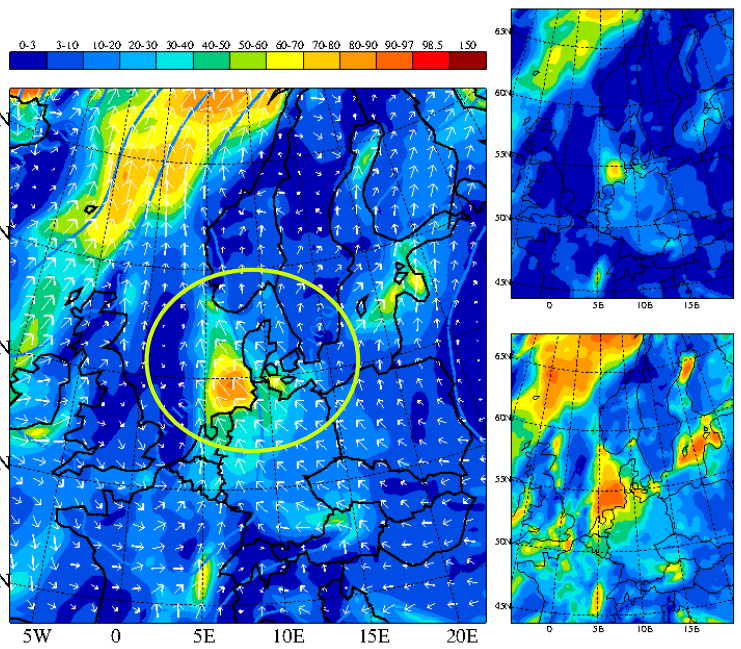
Renewables have a free resource, but also need maintenance!

avoid negative prices in high-penetration situations

in case of expected shortage to level out higher intra-day prices

in case of expected surplus to be able to sell lower at intra-day

How to become a price maker : an example



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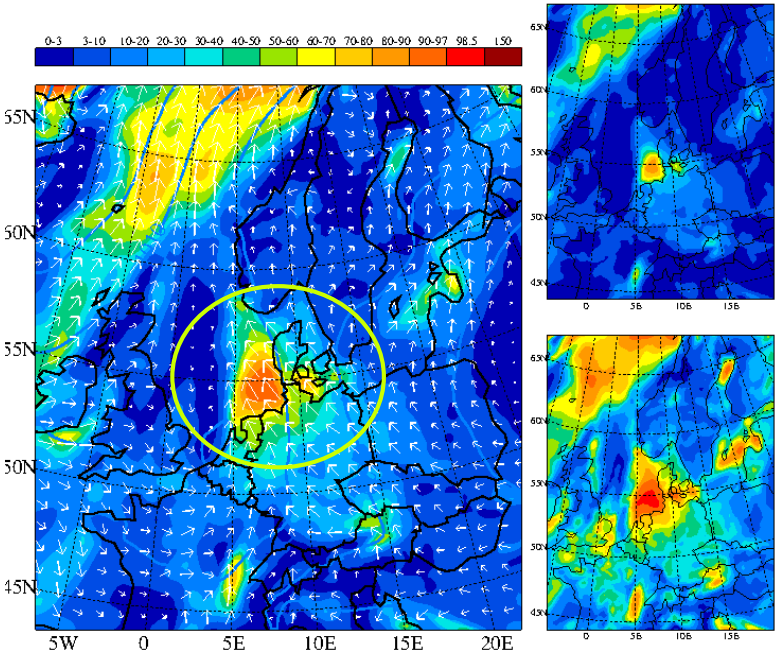
MEAN

MIN

MAX



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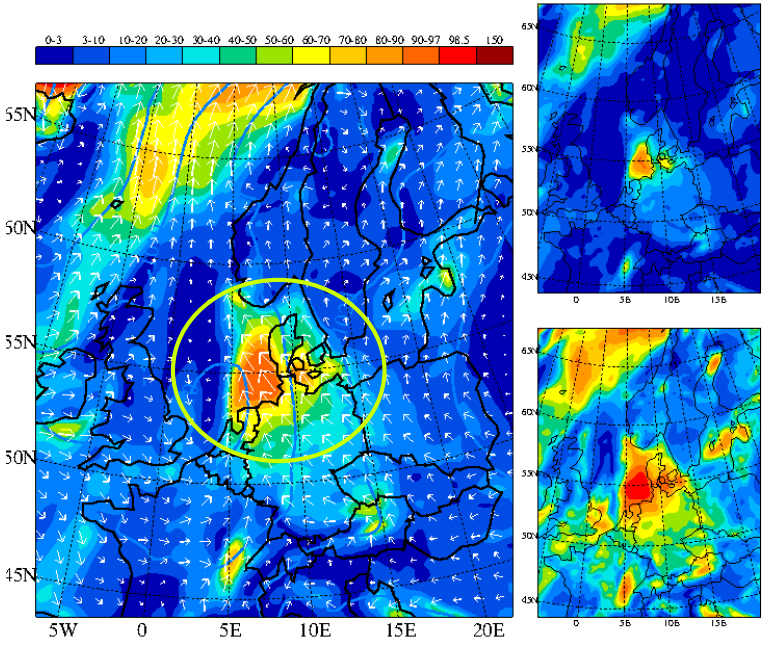

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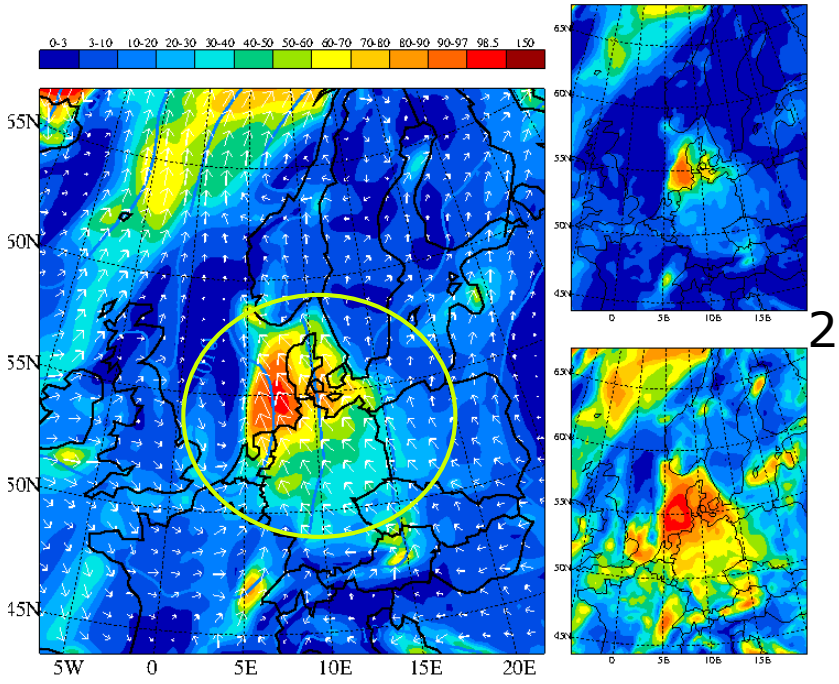

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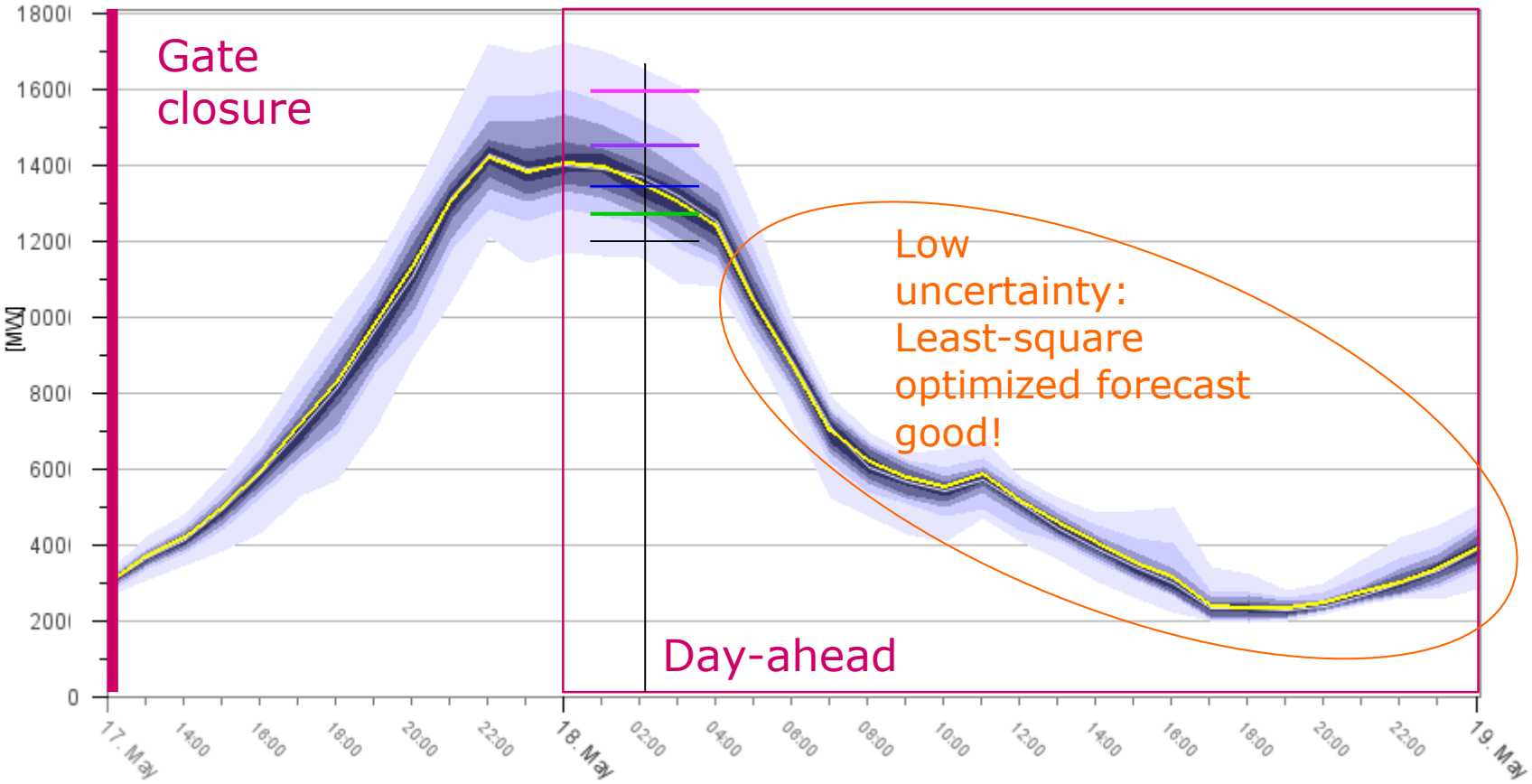
How to become a price maker in the market



Example of how to generate a price bid
Problem: risk for shortage or negative prices!

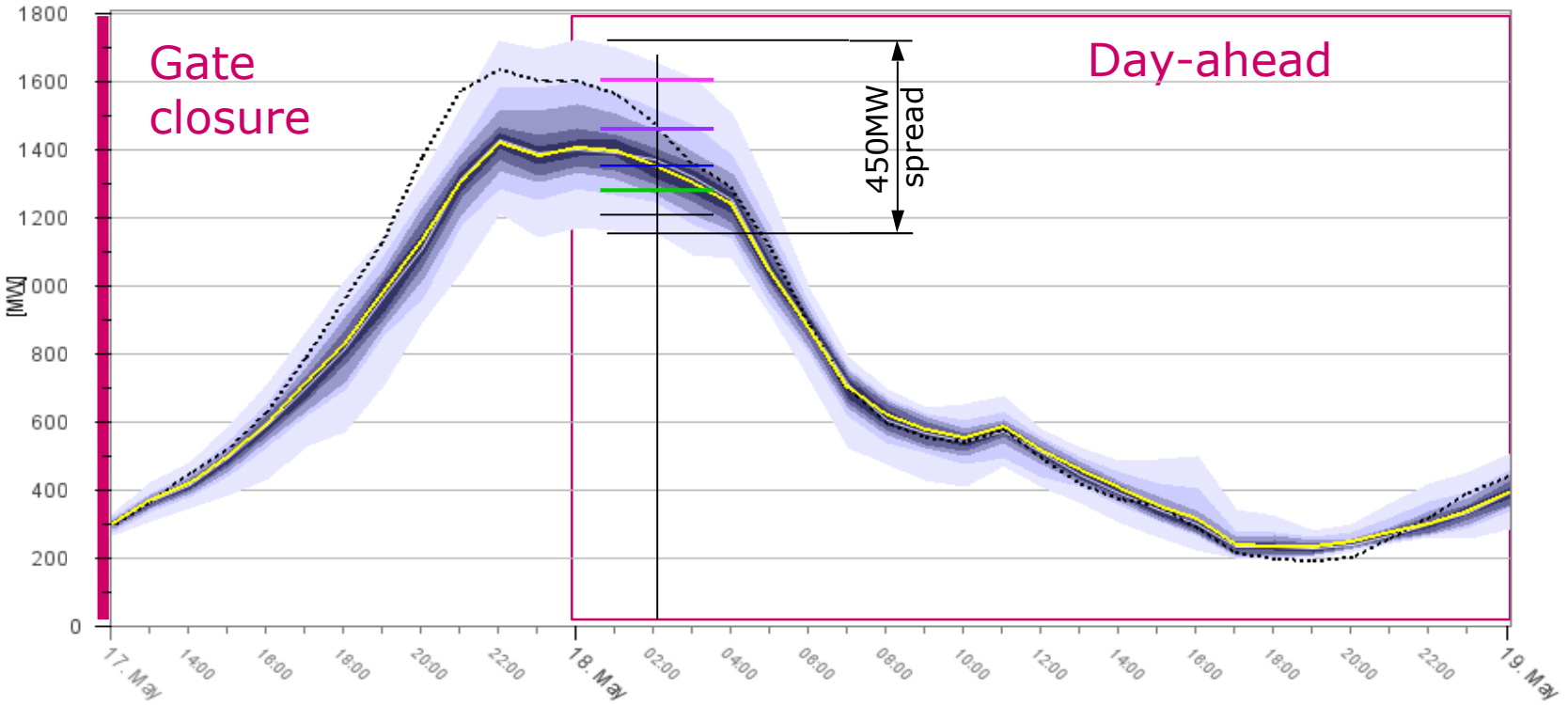
- My pool: 200 MW controllable power
- uncertainty (MAX-MIN): 450MW
- LS-optimised FC: 1200MW

=> strategy: bid safe and add some small risk volume for profit and balance

Example at hour 1:

Bid unlimited	1200MW
Bid price 1 (=0)	80MW
Bid price 2 (>0)	60MW
Bid price 3 (>>0)	40MW
Bid price 4 (>>>0)	20MW

How to become a price maker in the market



Example at hour 1:

Bid unlimited 1200MW → market price

Bid price 1 (=0) 80MW → has to prevent negative prices

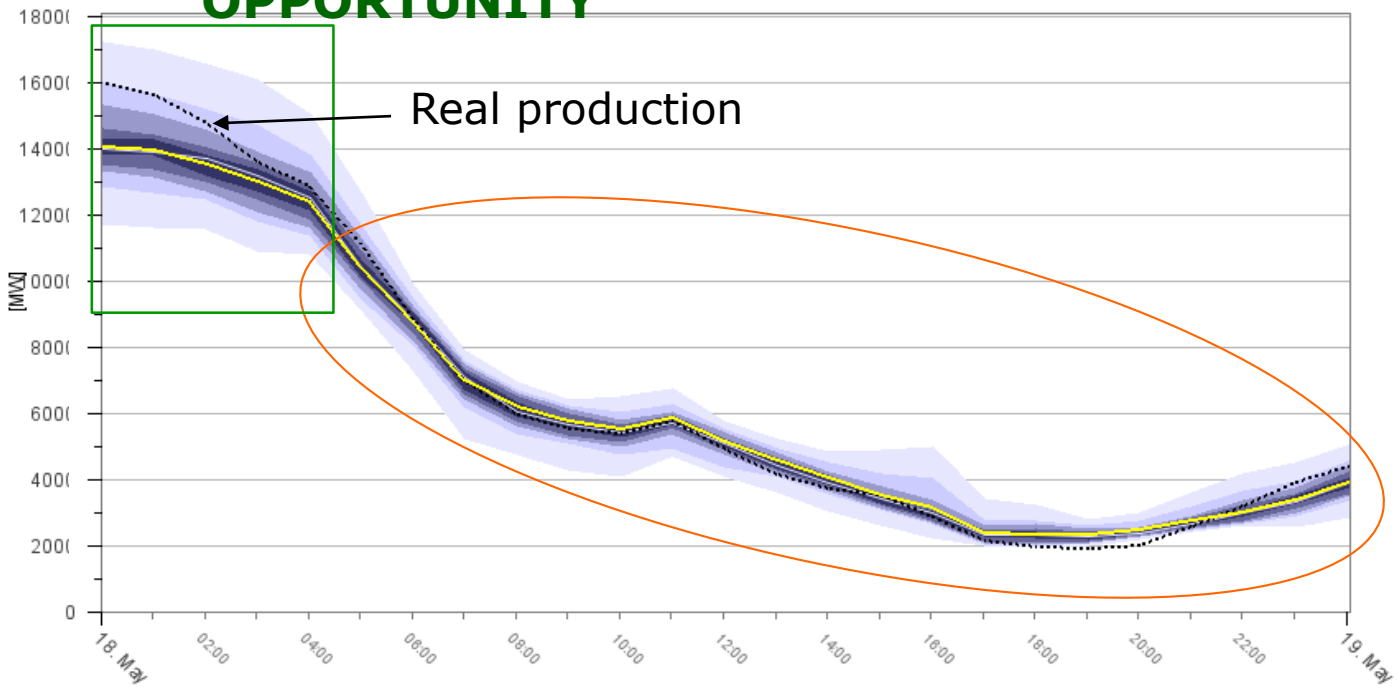
Bid price 2 (>0) 60MW → has helped increase the market price

Bid price 3 (>>0) 40MW → ...

Bid price 4 (>>>0) 20MW → did not get a contract || need to balance in intraday

How to become a price maker in the market

OPPORTUNITY



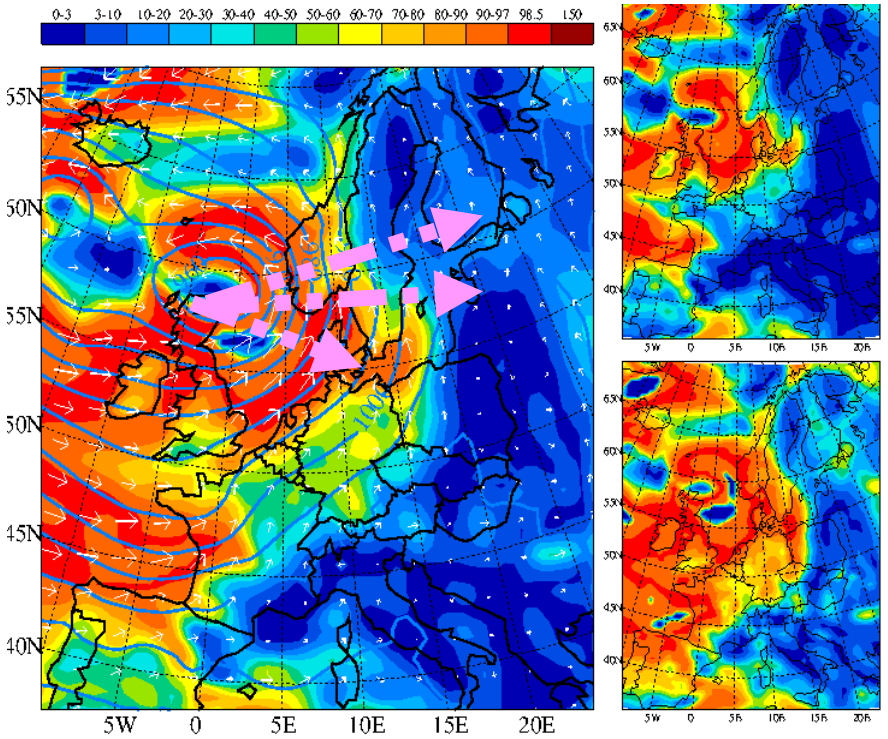
Low uncertainty:
Least-square optimized
or MEAN forecast good!

High uncertainty:
Opportunity to

- reduce imbalance costs
- increase income
- avoid negative prices

Date Hour	18. May 00:00	18. May 01:00	18. May 02:00	18. May 03:00	18. May 04:00	18. May 05:00	18. May 06:00	18. May 07:00	18. May 08:00	18. May 09:00	18. May 10:00	18. May 11:00	18. May 12:00
Min [MW]	1167	1158	1154	1086	1079	911	726	523	475	427	406	470	405
p10 [MW]	1281	1262	1245	1178	1137	948	802	617	538	506	472	495	435
p20 [MW]	1330	1310	1271	1205	1160	975	817	639	561	521	498	538	476
p30 [MW]	1350	1334	1295	1245	1184	1002	843	657	572	532	514	553	489
p40 [MW]	1376	1378	1316	1269	1211	1014	868	671	586	552	525	565	497
p50 [MW]	1398	1390	1367	1317	1248	1040	**881**	**707**	**604**	**564**	**540**	**571**	**508**
p60 [MW]	1426	1427	1379	1334	1270	1058	896	721	629	573	555	580	513
p70 [MW]	**1459**	**1442**	**1403**	**1354**	**1286**	**1086**	903	732	648	596	565	592	522
p80 [MW]	1531	1503	1457	1389	1324	1126	918	743	659	612	578	604	540
p90 [MW]	1598	1562	1517	1470	1379	1164	939	756	671	622	603	625	549
Max [MW]	1721	1699	1657	1607	1502	1267	985	788	691	640	651	672	576
DA-FC [MW]	1403	1391	1350	1296	1238	1039	873	699	618	574	552	581	513
Measurement	1596	1558	1473	1355	1284	1113	886	691	591	548	537	573	488

Thumb rules for Trading in DK-NO-SE and DE-AT



Meteorologically insignificant small differences in path of low pressure system **impact market price!**

Key factors to consider in any strategy:
- system imbalance
- negative prices
- curtailment

North of Denmark: too much wind → **risk of negative prices**

South Sweden: no production → **high imbalance (cost)**

Baltics: congestion from high northsea offshore production
→ system imbalance high reserve costs, **curtailment**

How to become a price maker in the market

Recipe:

Know your pool's controllable and non-controllable generation

Use **appropriate uncertainty forecast intervals** to:

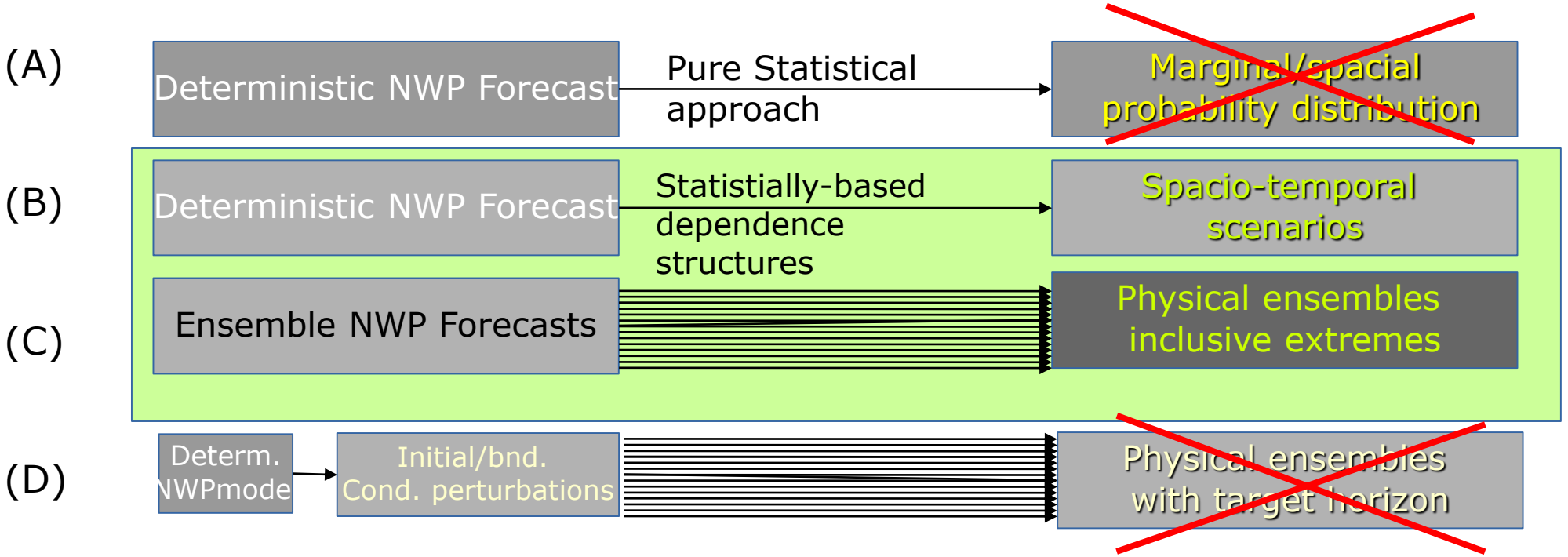
- trade the "safe" part with a mean or determinsitic day-ahead forecast
- trade uncertain parts with higher prices and control curtailment yourself
- trade in the intra-day market only difference outside uncertainty band

Design price levels considering

- time of the day
- current weather situation
- liquidity in the market
- expected load
- risk for negative proces
- risk for curtailment

How to become a price maker in the market

Know, which methodology works for your target problem !



For trading purposes you need an **hour-to-hour uncertainty**, approach:

(A) generating only a spacial probability distribution lacks the time dimension

(D) with target horizons needs calibration for the time component

Thumb rules for trading with uncertainties

Use the **appropriate approach** for your target:

- one that is looking forward in time
- not a statistical/climatology based forecast
- not one that has specific target times

The **incentive** MUST be **avoidance of imbalance costs** while increasing your income

Become a price maker to **reflect real system costs**

Only **trade when it make sense**

→ avoid trading every hour/time interval

→ only trade within the uncertainty band

→ the most current forecast is not always the best !!!

THANK YOU FOR YOUR ATTENTION

Contact me:
Corinna Möhrlen
WEPROG

com@weprog.com