Ongoing works and results in the stoRE-project.

CAES in Denmark ?

www.store-project.eu

Anders N. Andersen, www.EMD.dk

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Goals set up by the Danish government
100 % renewable energy in 2050
100 % renewable energy for electricity and heat in 2035
All oil boilers removed in 2030 (mainly to be substituted by heat pumps)
Wind turbine shall produce 50% of electricity consumption in 2020

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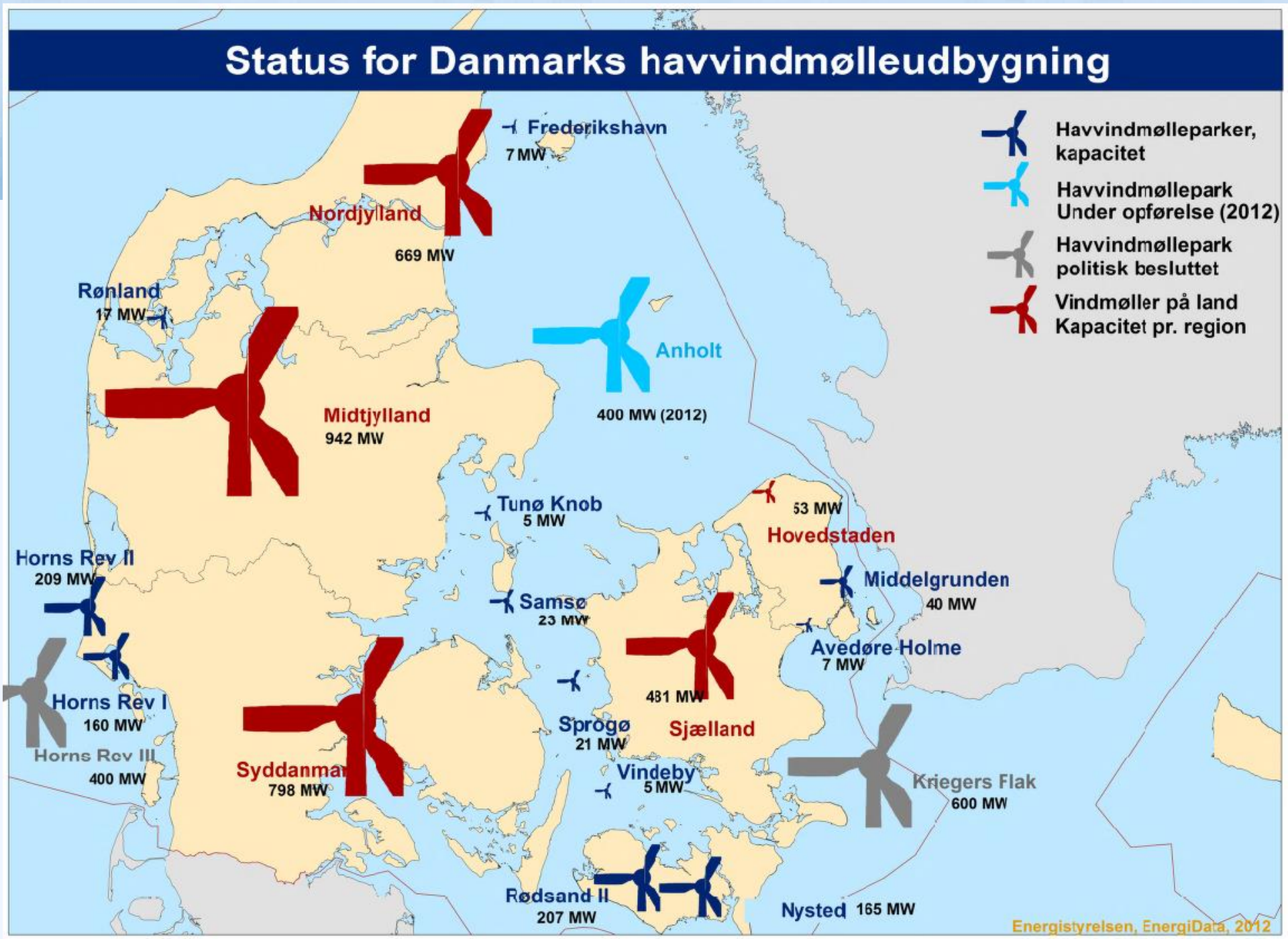
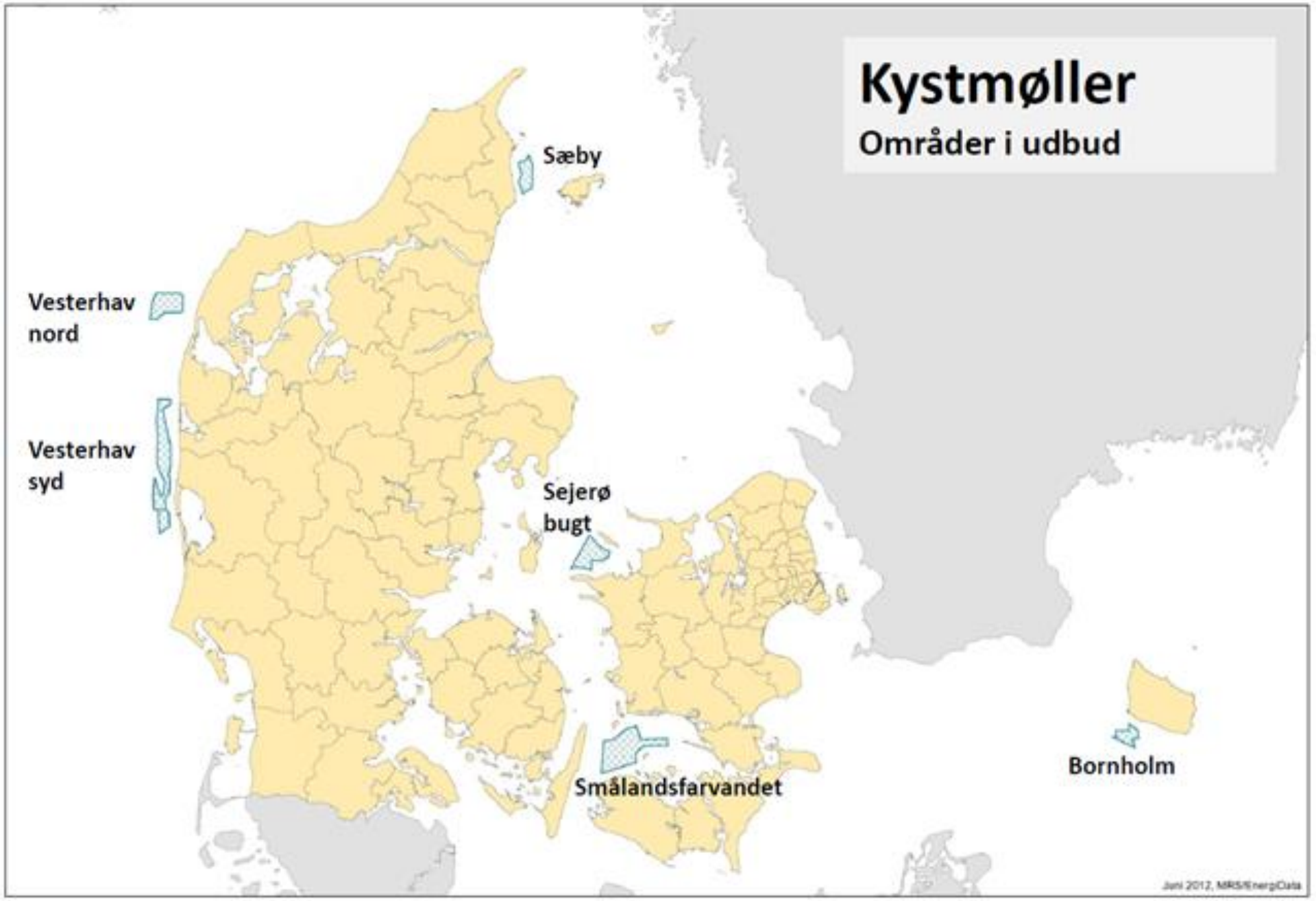
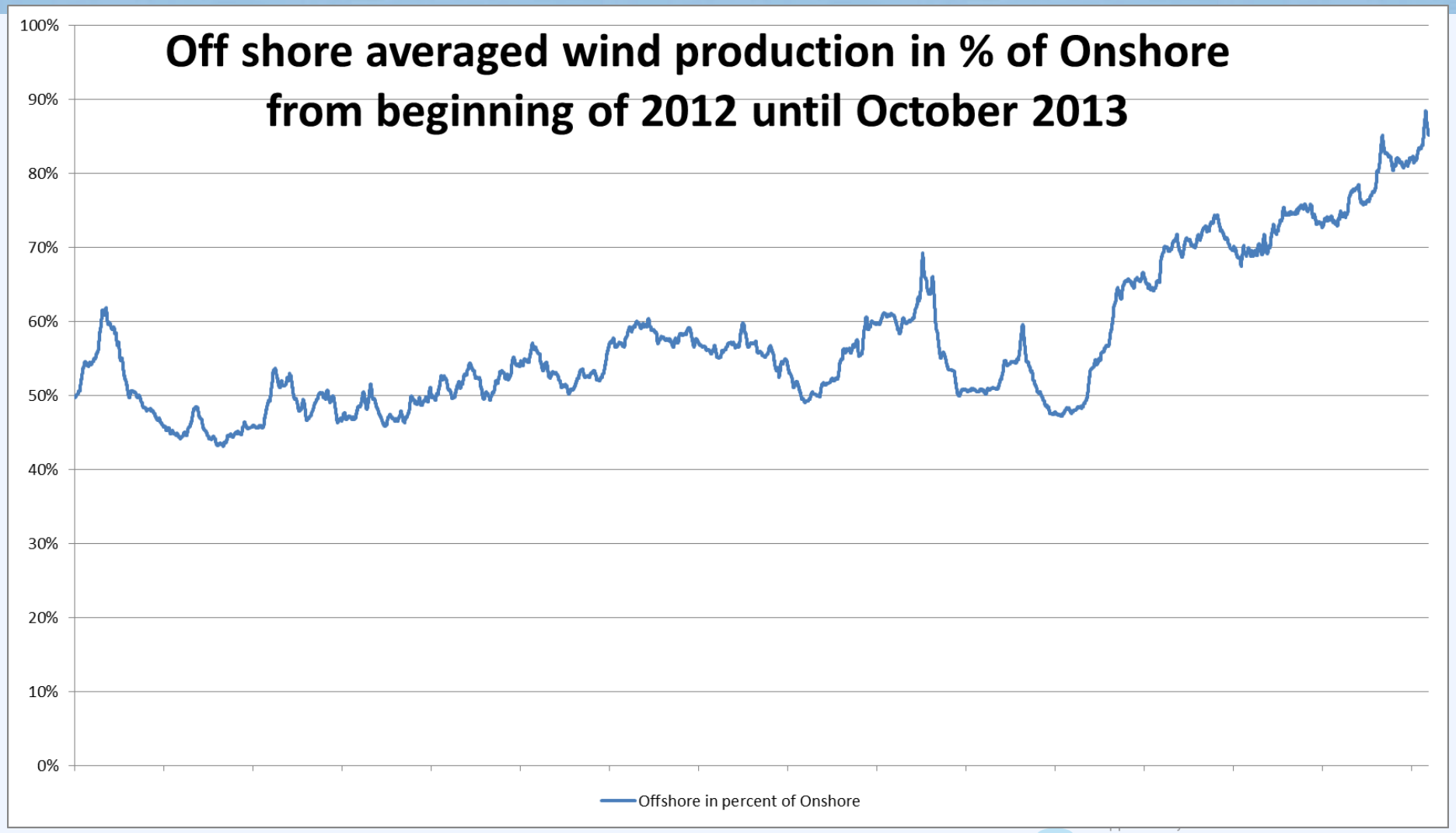

Status for Danmarks havvindmølleudbygning
Frederikshavn
7 MW
Nordjylland
669 MW
Rønland
17 MW
Midtjylland
942 MW
Anholt
400 MW (2012)
Tunø Knob
5 MW
53 MW
Hovedstaden
Middelgrunden
40 MW
Horns Rev II
209 MW
Samsø
23 MW
Avedøre Holme
7 MW
481 MW
Horns Rev I
160 MW
Sprogø
21 MW
Sjælland
Horns Rev III
400 MW
Syddanmark
798 MW
Vindeby
5 MW
Kriegers Flak
600 MW
Rødsand II
207 MW
Nysted
165 MW
Havvindmølleparker, kapacitet
Havvindmøllepark Under opførelse (2012)
Havvindmøllepark politisk besluttet
Vindmøller på land Kapacitet pr. region
Energistyrelsen, EnergiData, 2012


Kystmøller
Områder i udbud
Sæby
Vesterhav nord
Vesterhav syd
Sejerø bugt
Smålandsfarvandet
Bornholm


Off shore averaged wind production in % of Onshore
from beginning of 2012 until October 2013
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Offshore in percent of Onshore

Power balance 2012

Two synchronous areas

West:

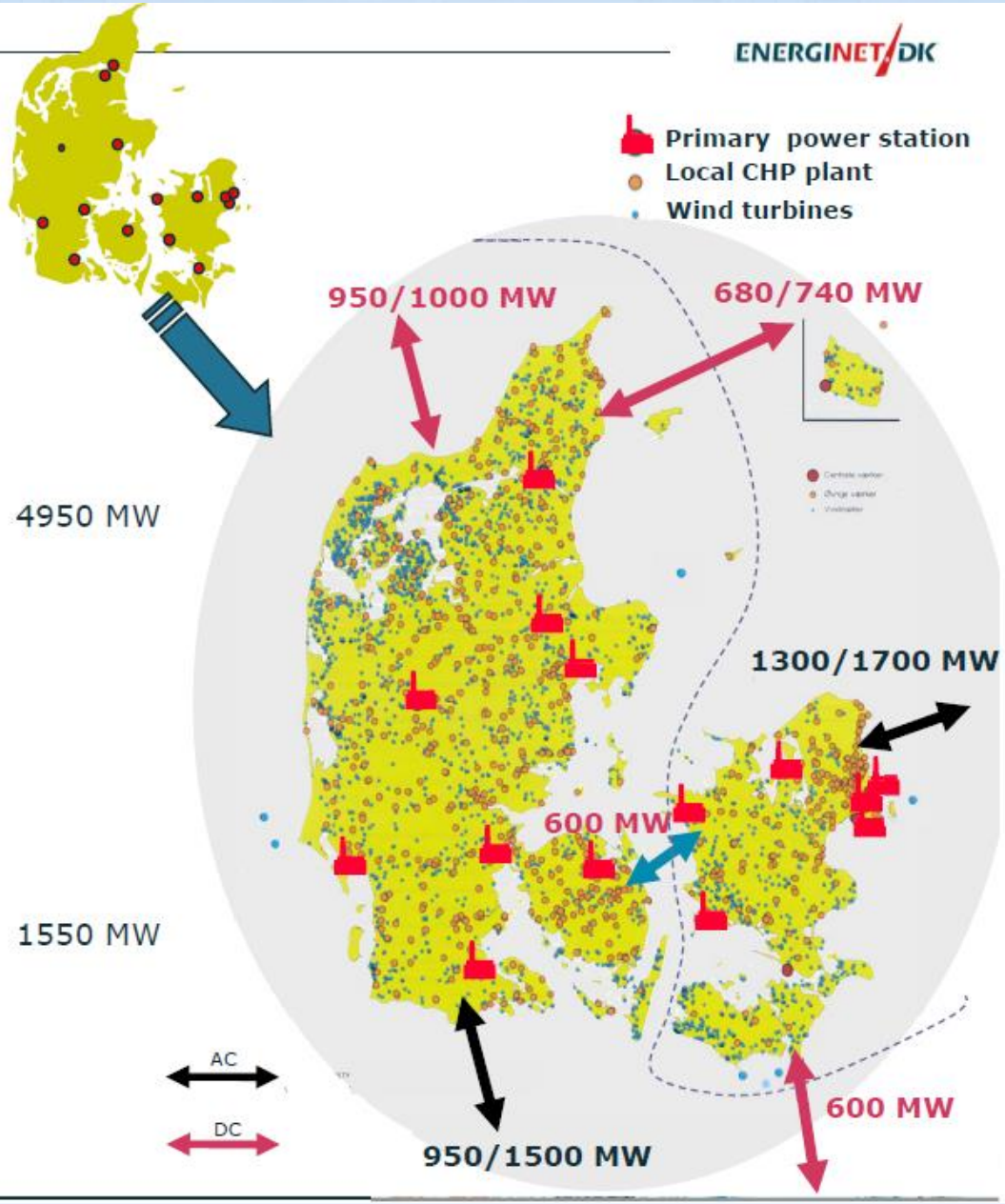
Consumption	1400 - 3700 MW
Primary power stations	3150 MW
Local CHP plants	2000 MW
Wind turbines	2950 MW

4950 MW

East:

Consumption	900 - 2700 MW
Primary power stations	3100 MW
Local CHP plants	600 MW
Wind turbines	950 MW

1550 MW



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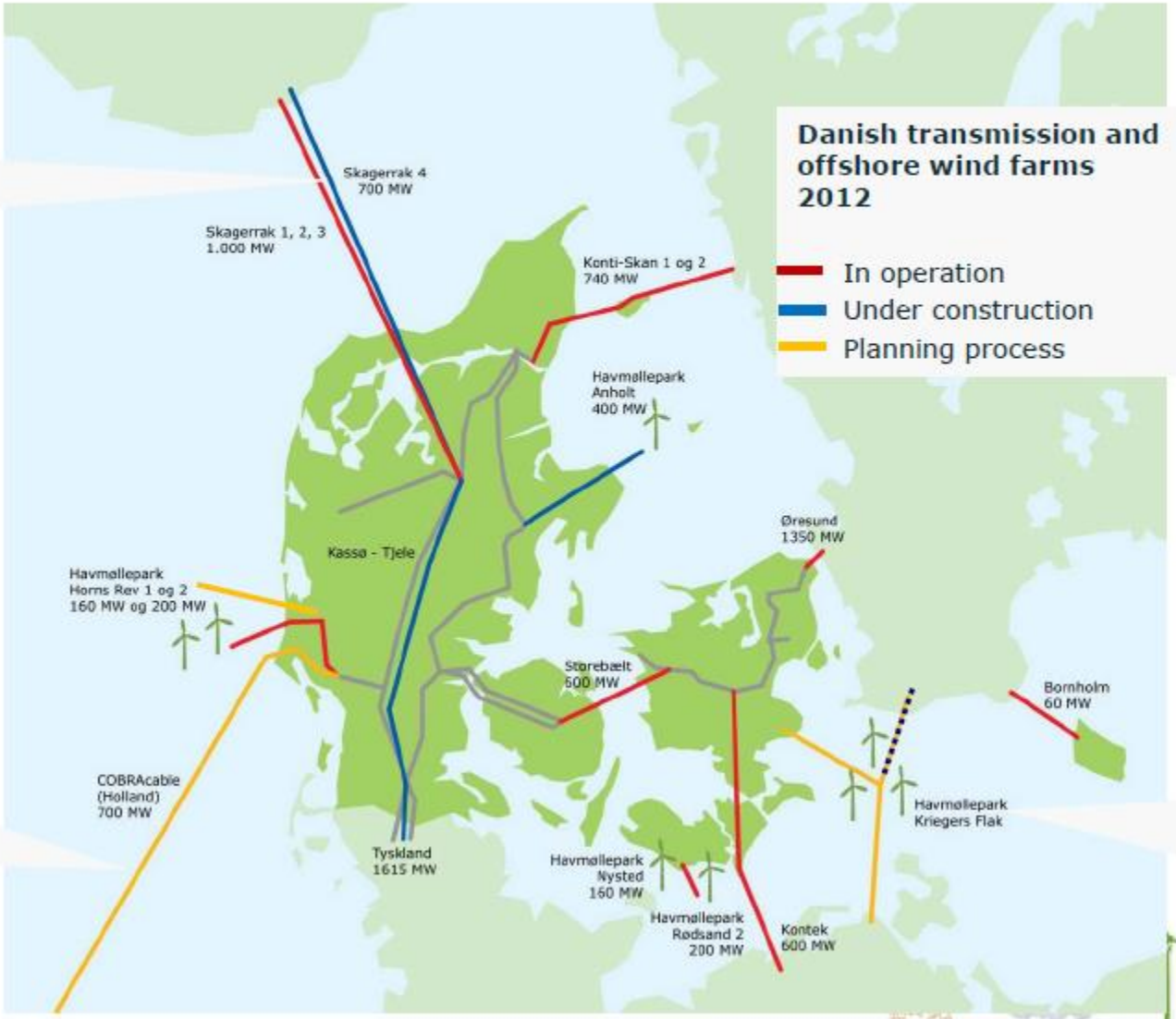
Interconnectors – planned and upcoming projects

Skagerrak 4

700 MW - HVDC

NO-DK1

HVDC - VSC



COBRA

700 MW - VSC

NL-DK1

EC co-funding

Kriege

600 MW
farm offs

600 MW

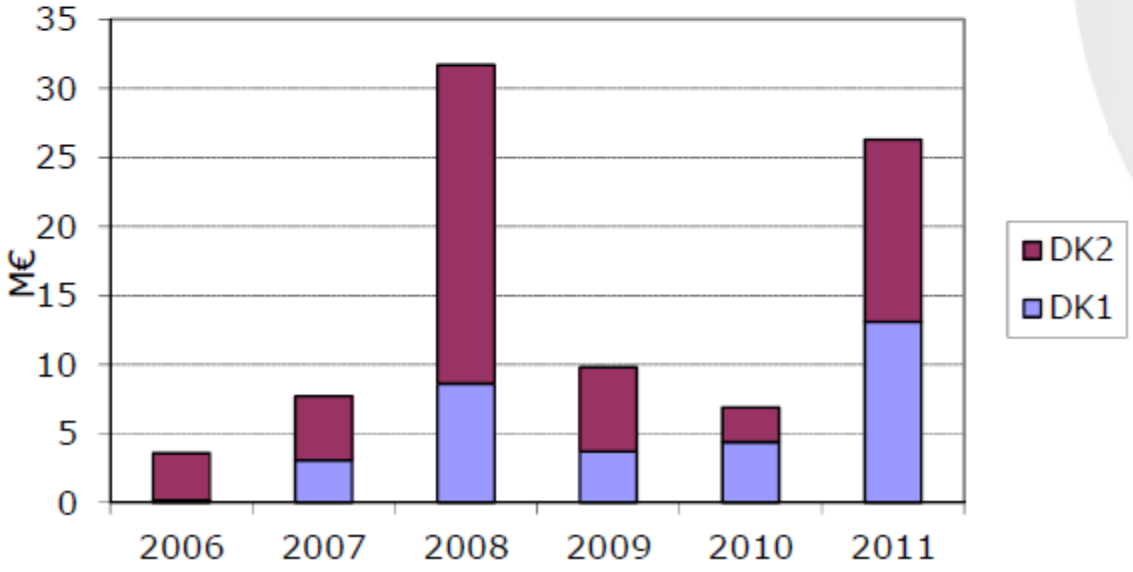
HVDC - V

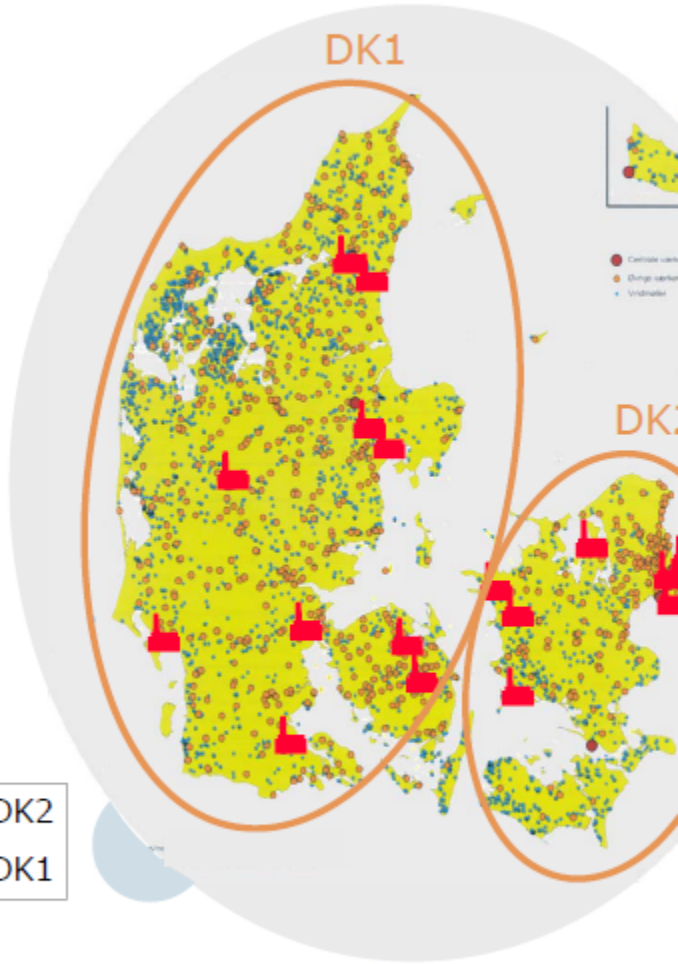
DE-DK2

EC co-fu

The must-run requirement

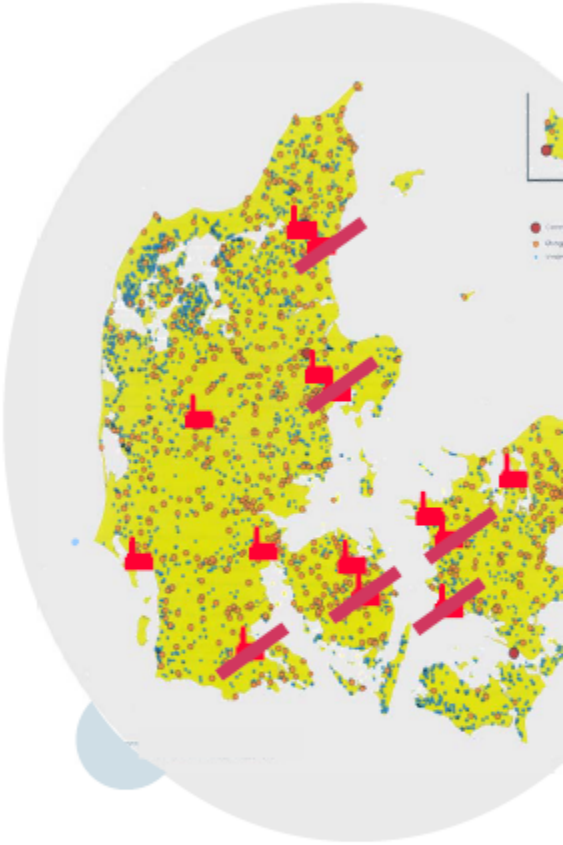
- Western part of Denmark (DK1)
  - always 3 conventional power stations
- East part of Denmark (DK2)
  - always 2-3 conventional power stations
- Based on experience and calculations
- Considerable costs





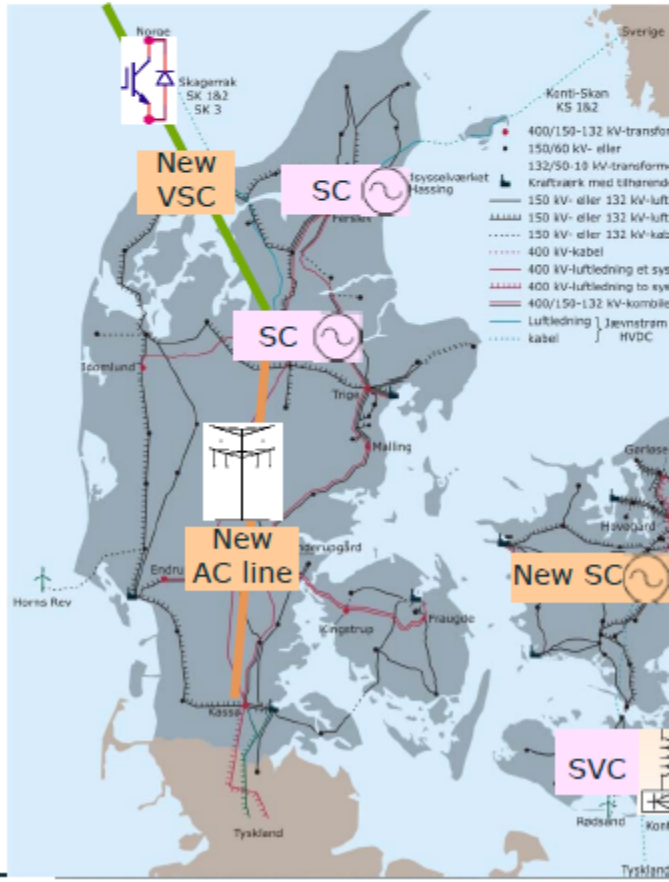
Future trends

- The wind power penetration will increase
- The market share for the conventional generation in the energy market will continue to fall
  - mothballing and decommissioning
- Cost of system support from conventional generation will increase when the main product (energy) is not demanded
- New dc lines will be based on VSC-technology and enable voltage control

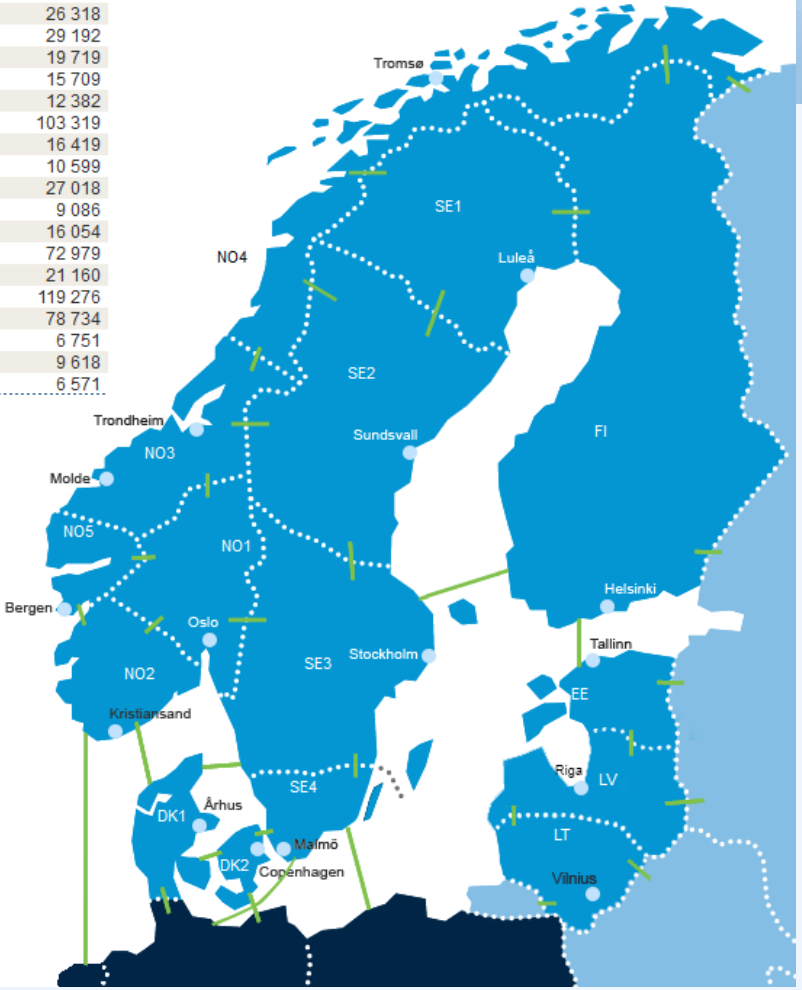


Towards a system without conventional generation

- Energinet.dk strategy
  - The necessary system support is built into the grid
- Advantage
  - A level playing field in the energy market
  - Lower socio economic costs
  - Increased security of supply
- Short term initiatives
  - Refurbishment of the two existing synchronous compensators (2010-2012)
  - 270 MVA synchronous compensator in 2013
  - 700 MW VSC to Norway (2014)
  - New double circuit 400 kV OH line (2014)



	Production	Consumption
NO1	36 040	26 318
NO2	32 553	29 192
NO3	16 306	19 719
NO4	22 974	15 709
NO5	18 654	12 382
NO	126 525	103 319
DK1	14 535	16 419
DK2	5 257	10 599
DK	19 792	27 018
SE1	19 648	9 086
SE2	29 578	16 054
SE3	71 698	72 979
SE4	3 393	21 160
SE	124 316	119 276
FI	53 978	78 734
EE	11 880	6 751
LT	3 891	9 618
LV	4 306	6 571



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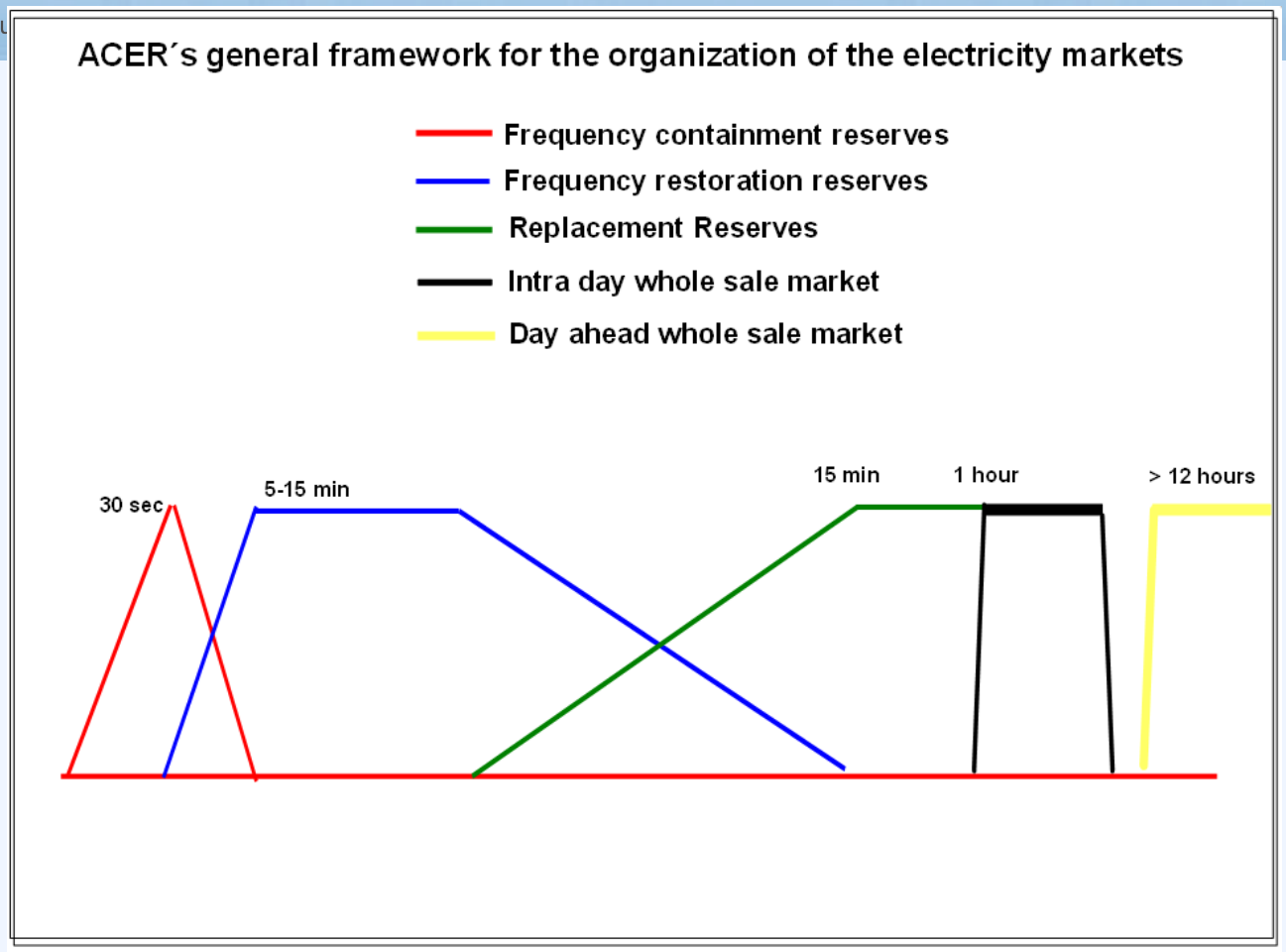

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CAES In Denmark
Environmental Challenges

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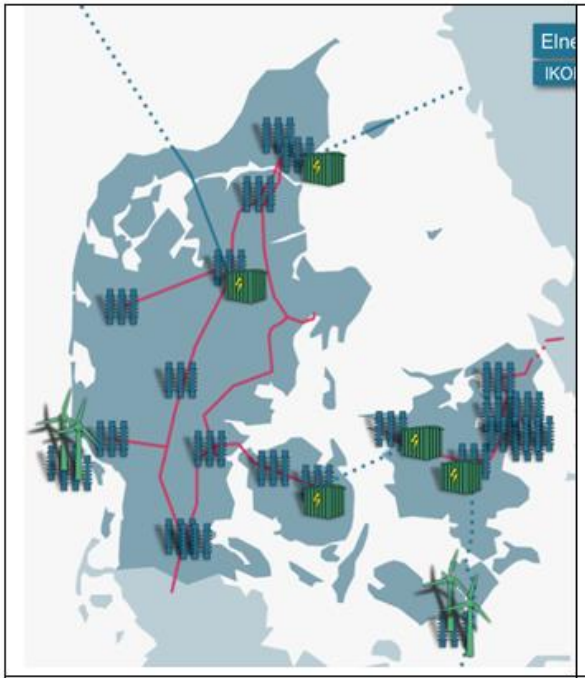
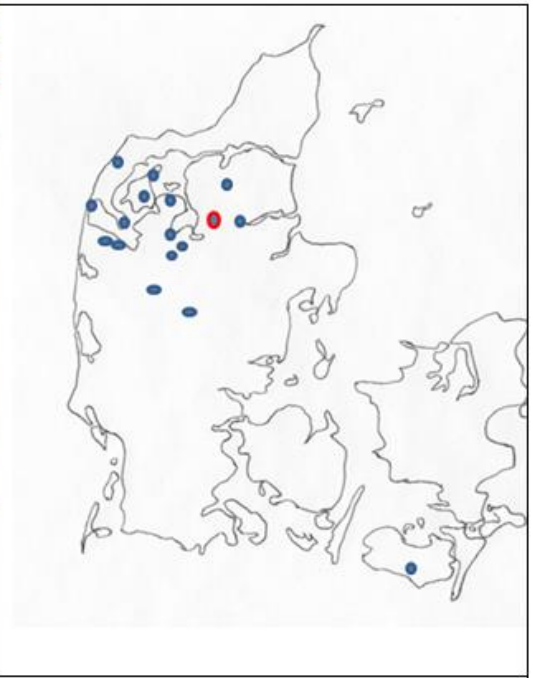
Technical Infrastructure is OK



Present Electric infrastructure

Present natural gas infrastructure



Danish Salt domes

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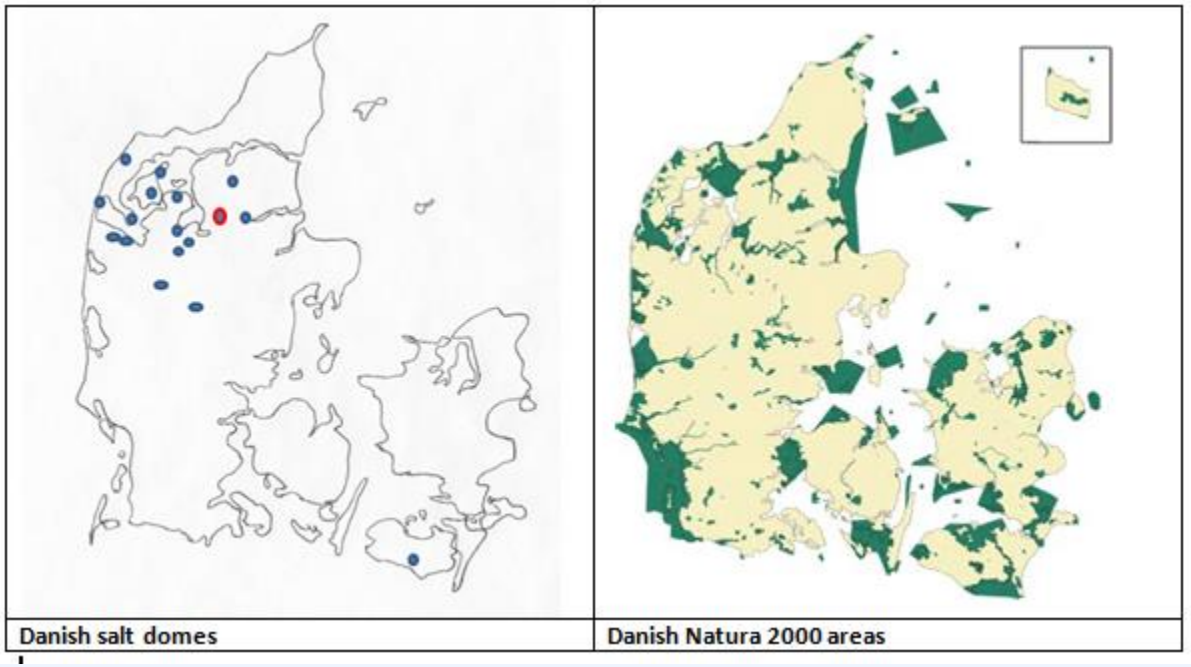
But…. Environmentally problematic



Danish salt domes

Danish Natura 2000 areas

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Actual case example: Protests against flushing brine to the Limfjord from salt dome

- Plans for expansion and refurbishing of natural gas store in Danish salt dome

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Protesters

Municipalities	Viborg Kommune Skive Kommune Vesthimmerlands Kommune Limfjordsrådet (umbrella organization for municipalities round the Limfjord)
NGO - Angling/Fishing org.	Viborg sportsfiskerforning (anglers org.) Dansk sportsfiskerforbund (anglers org.) Dansk Fritidsfiskerforbund (anglers org.) Fritidsfiskerne Vesthimmerland og Han Herred (anglers org.) Løgstør Sportsfiskerforening (anglers org.) Danmarks Fiskeriforening og foreningen Muslingeerhvervet (commercial fishing org.) Sundstrup Fiskeriforening (anglers org.)
NGOs other	DN (Danish Nature Conservation Society) Friluftsrådet (umbrella organization for recreational org.) Greenpeace DOF Nordjylland and DOF NordvestJylland (birdwatcher org) Møldrupegnens Landsbyråd Fjordvenner.dk (case specific org.)
Private persons	More than fifty

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The objections / status

- Protest issues
  - Nutrients , foam creation
  - environmentally hazardous substances and metals in the salt brine
  - Consequences for international environmental protected areas (Natura 2000)
  - Terms for operation
  - Monitoring Requirements
  - Assessment methodologies

- Status
  - Expansion plan withdrawn
  - Pilot project for refurbishing of existing caverns has been completed
  - Refurbishing of remaining caverns awaiting permissions

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Environmetal framework for CAES

- If CAES shall have future in Denmark a qualified guess is that it will not be allowed, if the salt brine is discharged to inland marine waters such as the Limfjord, Mariager Fjord or other fiords.

- This leaves two discharging options.
  - The first is to discharge to open waters, which would be the North Sea or Kattegat.
  - The second option is retrieving the salt from the brine for industrial salt production.

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Pumpspeicherkraftwerk eine interessante Lösung

Details Veröffentlicht am Dienstag, 07. Mai 2013 22:37 Geschrieben von Redaktion

Die Grüne Fraktion wird sich in ihrer kommenden Fraktionssitzung am 23. Mai intensiv mit den Möglichkeiten der Speicherung von Strom aus regenerativen Energien als eine wichtige Facette der Umsetzung der Energiewende im Main-Kinzig-Kreis befassen.

Die Grünen haben dazu den Geschäftsführer des Wasserverbandes Kinzig, Holger Scheffler, eingeladen, um die technischen und finanziellen Realisierungschancen des Baus eines Pumpspeicherkraftwerks am Kinzigsee bei Ahl näher zu erörtern.

Peter Stahl, energiepolitischer Sprecher der Grünen Fraktion im Main-Kinzig-Kreis, sieht in einer modernen Speichertechnologie den Schlüssel für die Ablösung fossiler Energieträger im Main-Kinzig-Kreis. „Nur wenn man die Energie speichern kann, ist eine 100 prozentige Versorgung der Bevölkerung mit Energie zu allen Zeiten sicherzustellen, so Stahl.

Meldung: 16. April 2013

Pumpspeicherkraftwerk: Kreiskoalition will Gespräche mit Energieversorgern initiieren

FDP und CDU geben sich erneut als Bedenkenträger

Als „notorische Bedenkenträger" haben sich erneut die Fraktionen von CDU und FDP im Main-Kinzig-Kreis mit ihrer zögerlichen und - im Fall der FDP - sogar ablehnenden Haltung in der Diskussion über den Bau eines Pumpspeicherkraftwerks am Kinzig-Stausee bei Ahl gezeigt, findet die Kreiskoalition. Die Fraktionsvorsitzenden Klaus Schejna (SPD), Reiner Bousonville (Grüne) und Jürgen Heim sehen das Verhalten von CDU und FDP als weiteren Beleg dafür, dass es beiden Parteien mit der Umsetzung der Energiewende nicht ernst sei. SPD, Grüne und FW zeigen sich „verärgert", wie leichtfertig CDU und FDP die Chancen zur Umsetzung eines solchen Zukunftsprojekts im Main-Kinzig-Kreis aufs Spiel setzten.

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Simulating in energyPRO Pumped Hydro (Pumpspeicherkraftwerk) in the German Sekundärregelleistungsmarkt

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Abbreviations

- SRL: Sekundärregelleistungsmarkt
- HT: Hoch tarif, weekdays from 08 to 20
- NT: Niedriger tarif, all other periods

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Different strategies

A) Offering positive SRL in HT-time slice

B) Offering negative SRL in NT-time slices

C) Splitting up time slices: Half time slice for SRL and half time slice for Intraday trade

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Plant data

- Storage capacity 24,8 MWh
- Turbine capacity 2,6 MW
- Pumping capacity 3,0 MW
- Turbine efficiency 77%
- Pumping efficiency 82%

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Strategy A: Offering positive SRL in HT-time slice

- Offering positive SRL in 8 hours HT slice
- Buying on intraday market next NT slice
- Trading surplus capacity on intraday market

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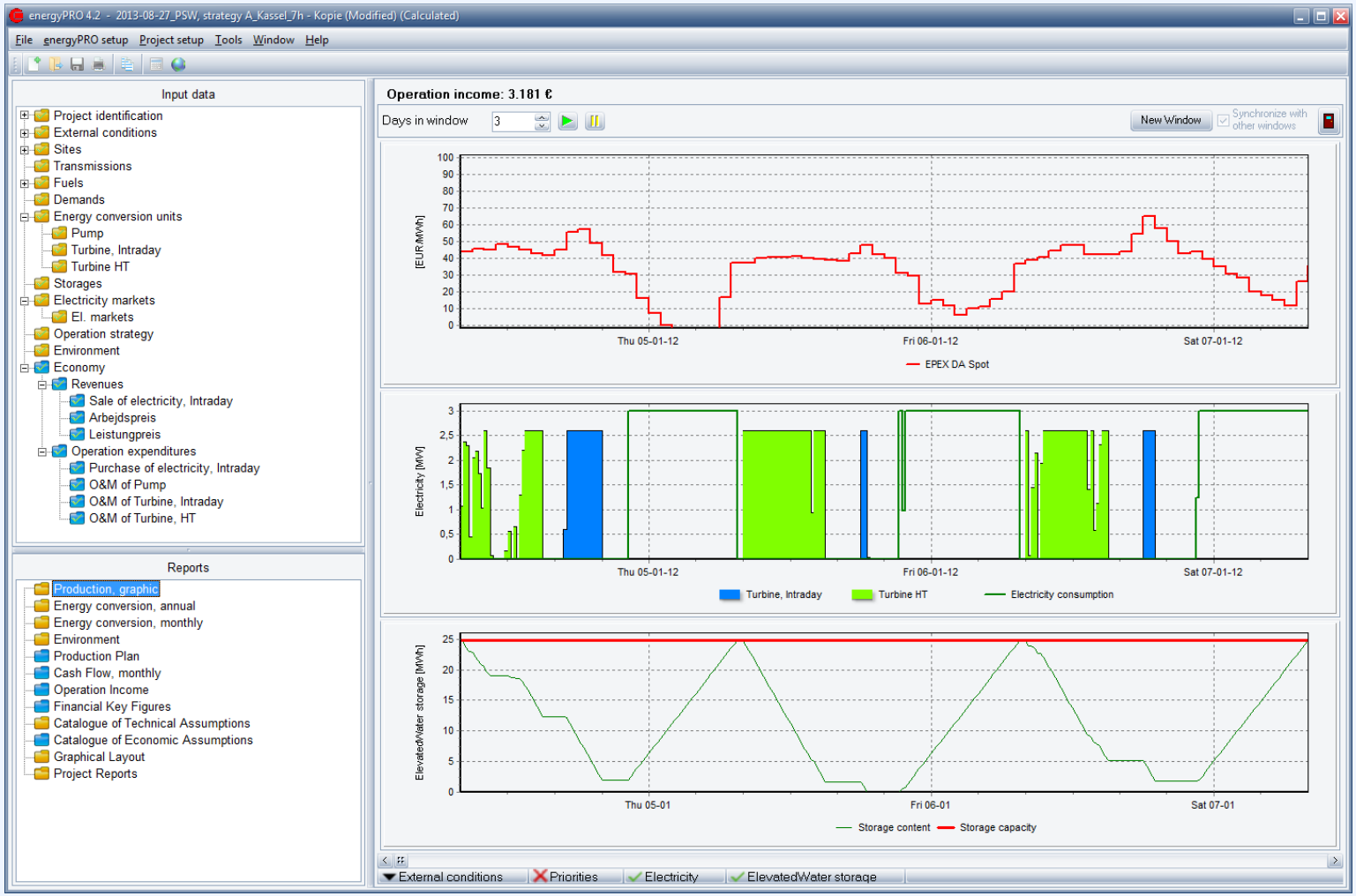
strategy A, weekdays



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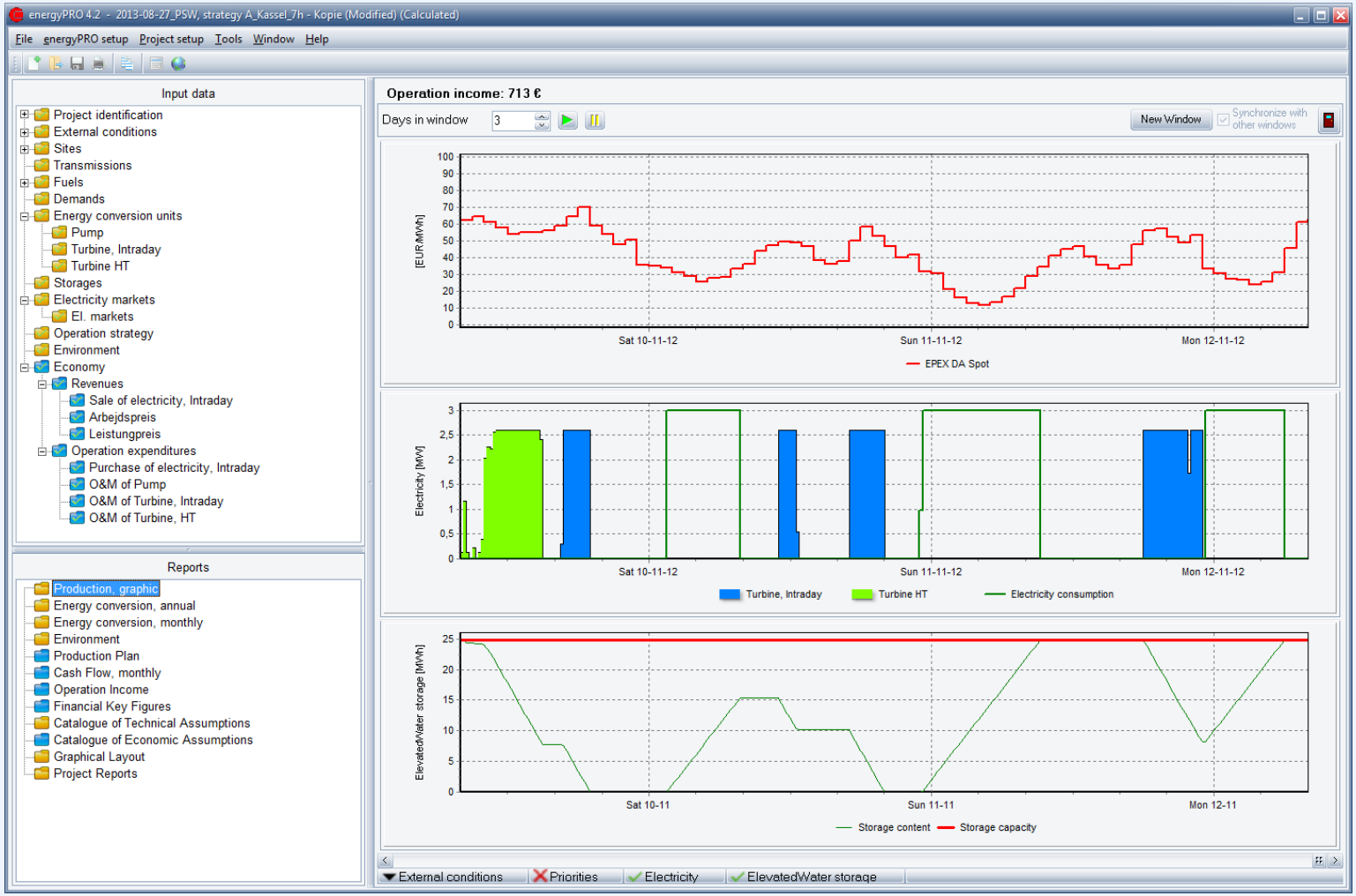
strategy A, weekend



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Strategy B: Offering negative SRL in NT-time slices

- Offering negative SRL in 8 hours NT time slices
- Selling electricity on intraday market next HT slice
- Trading surplus capacity on intraday market

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strategy B

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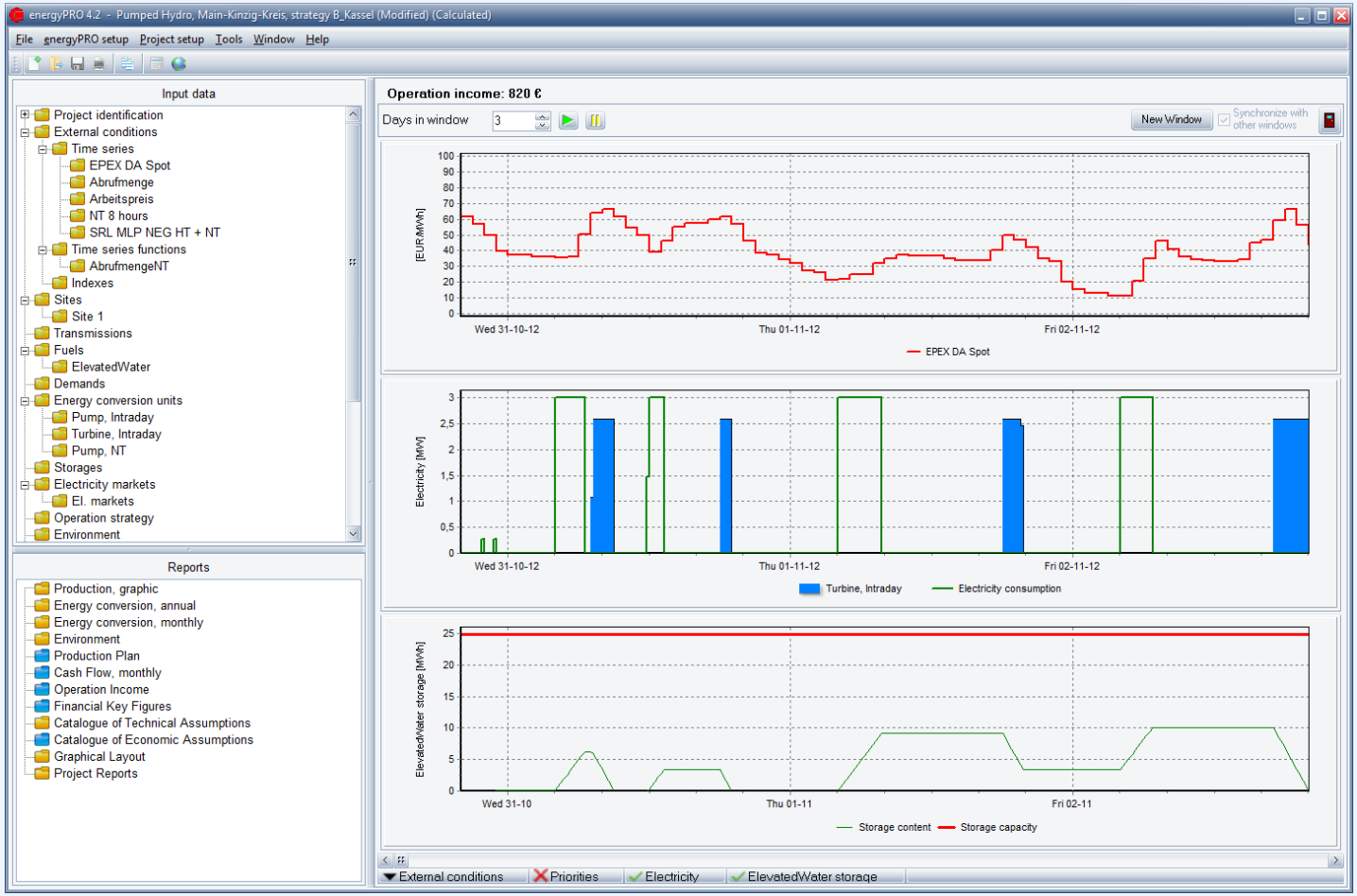
strategy B



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Strategy C: Splitting up time slices

- Offering positive SRL at first half of HT time slices
- Offering negative SRL at first half of NT time slices
- Intraday in second half of time slices

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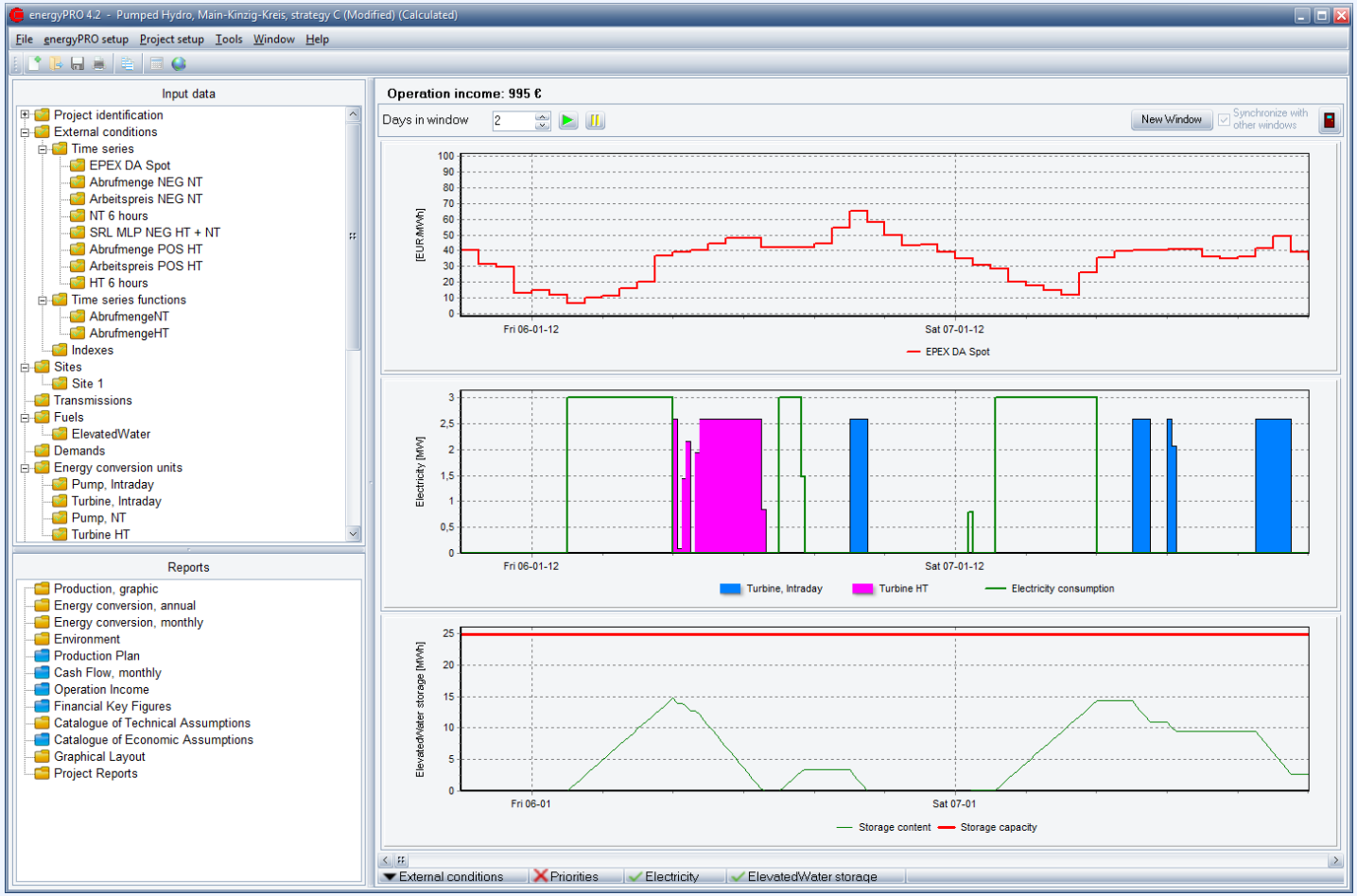
strategy C



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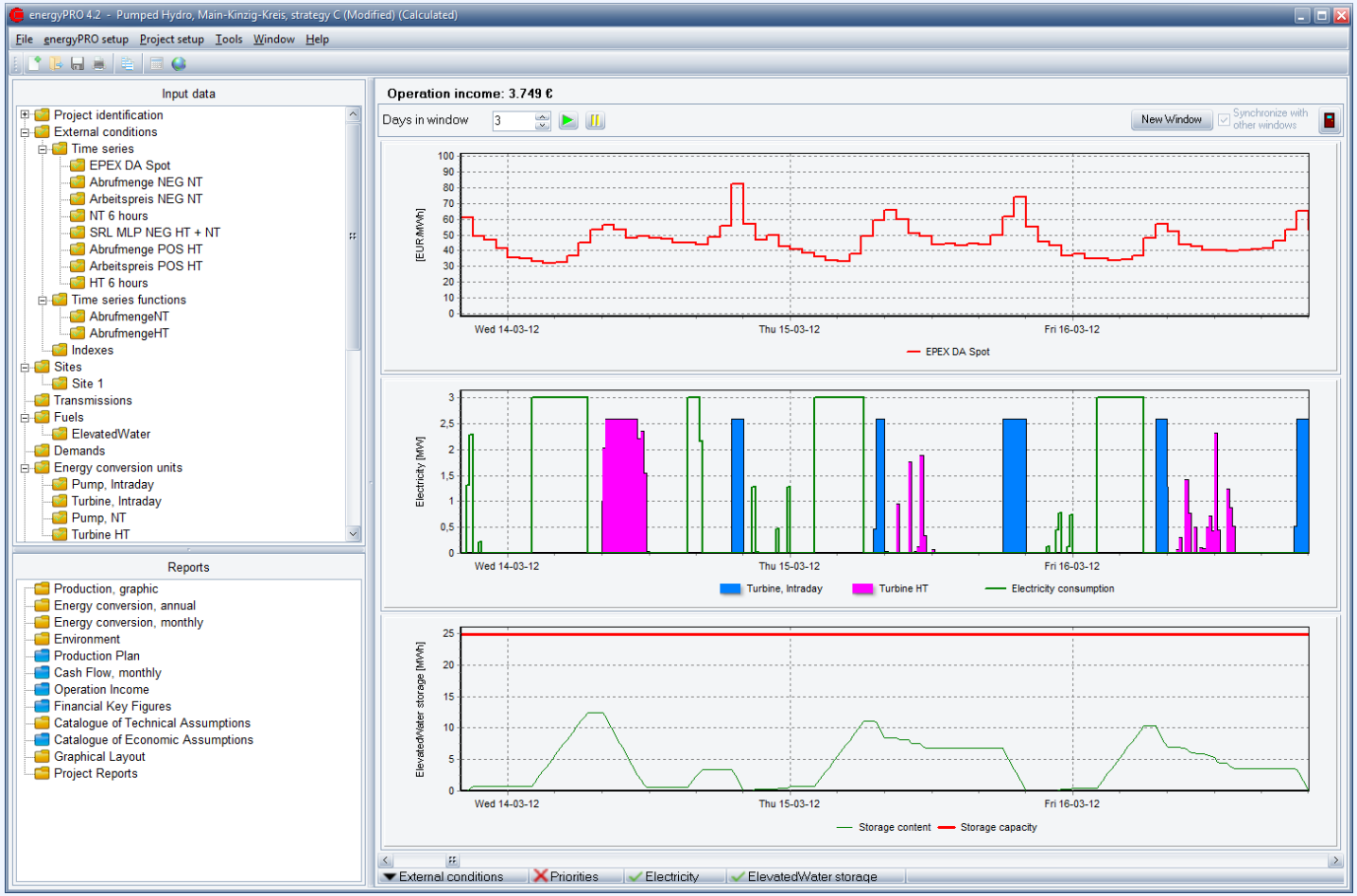
strategy C



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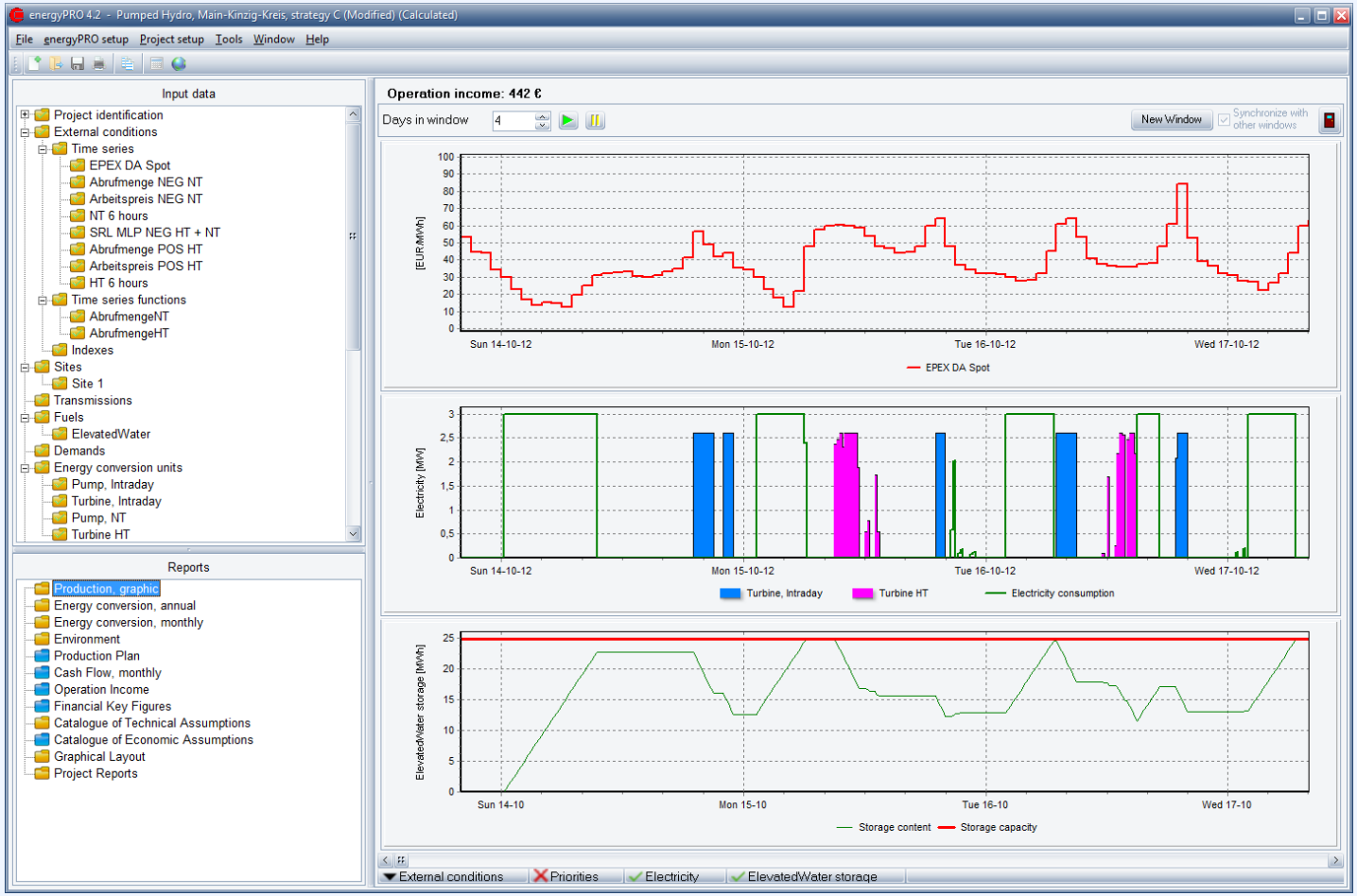
strategy C



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Economy

- Reference, trade on spotmarket 47.145 €
- Strategy A 56.306 €
- Strategy B 132.268 €
- Strategy C 143.779 €

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Simulating in energyPRO the economy in Bulk Electricity Storage in Denmark

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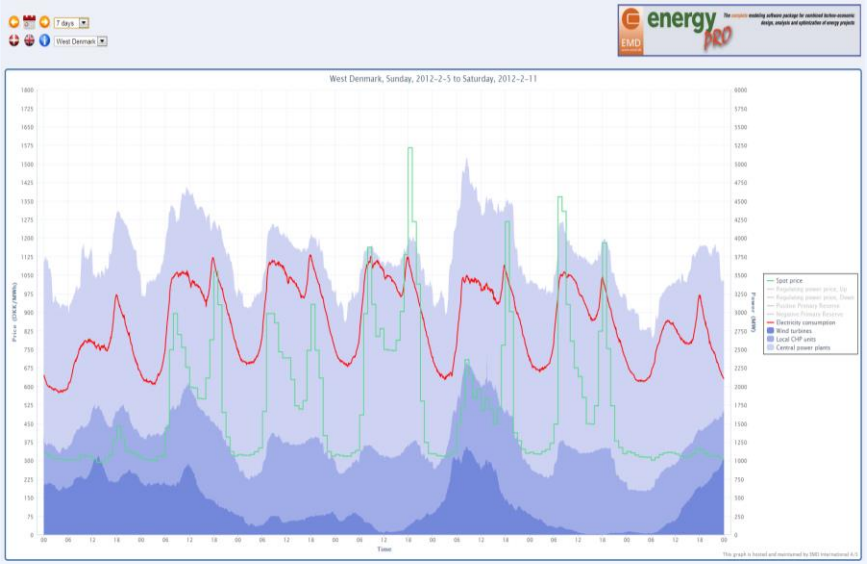
Spot market trading – example 1



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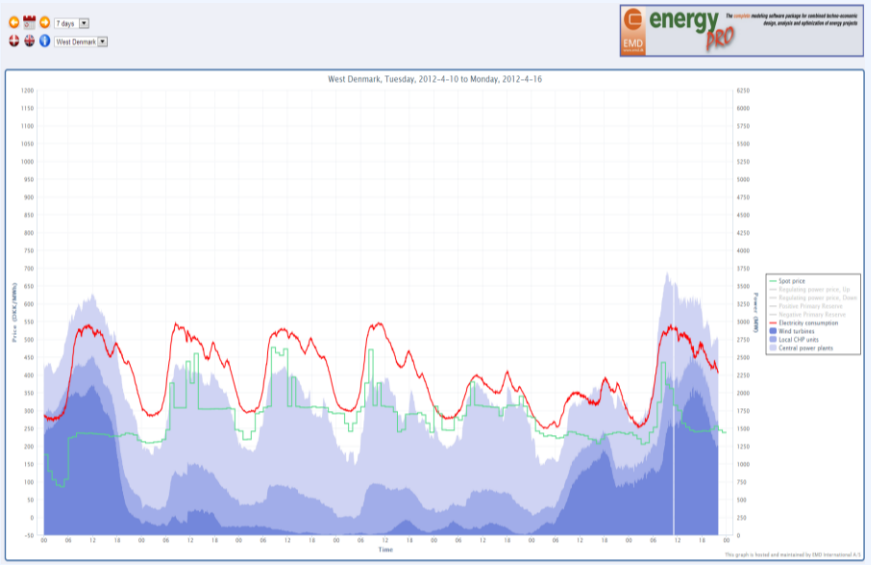
Spot market trading – example 2



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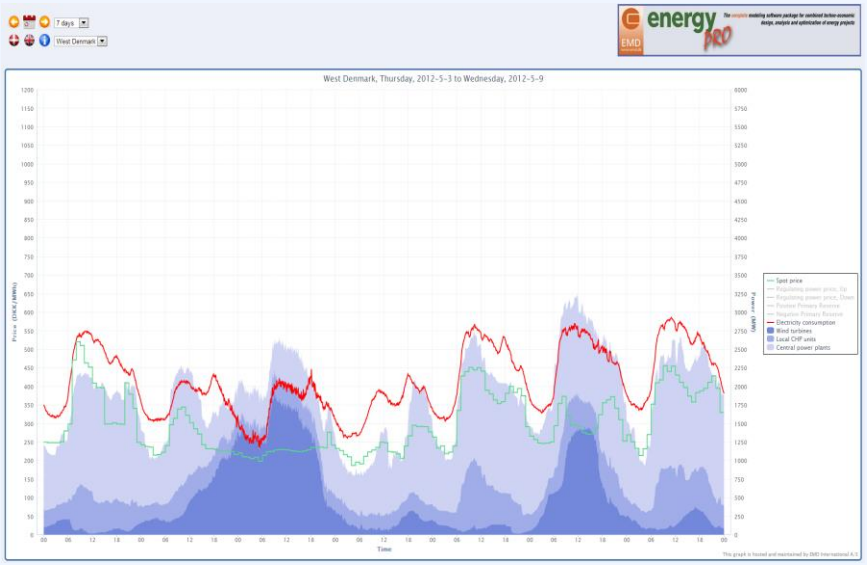
Spot market trading – example 3



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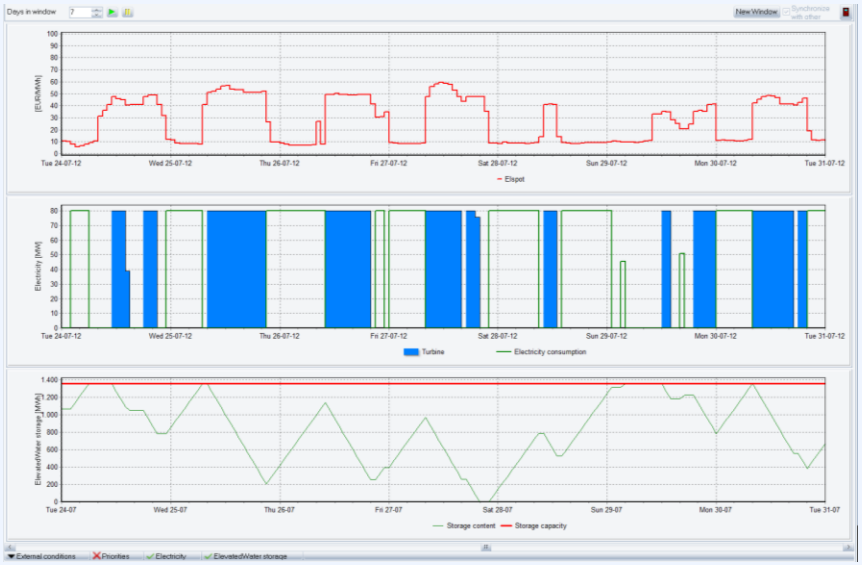
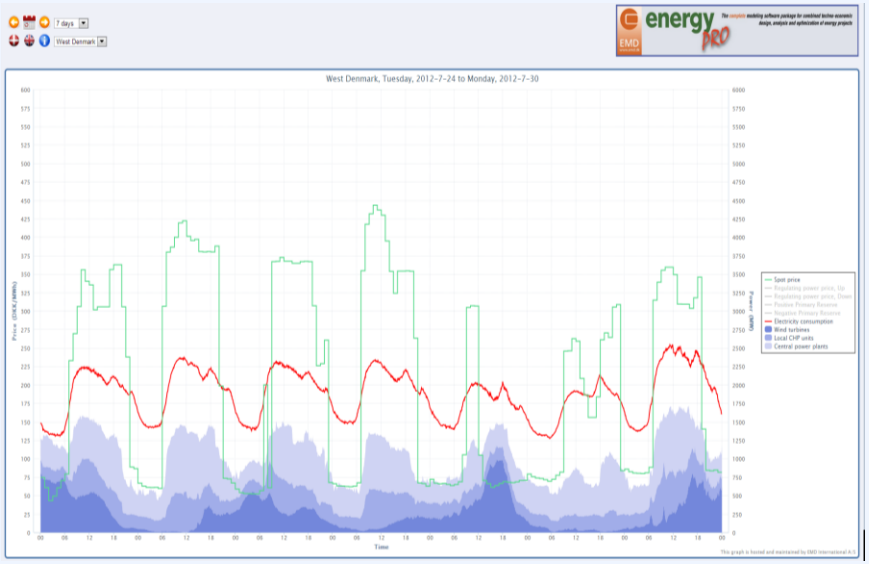
Spot market trading – example 4





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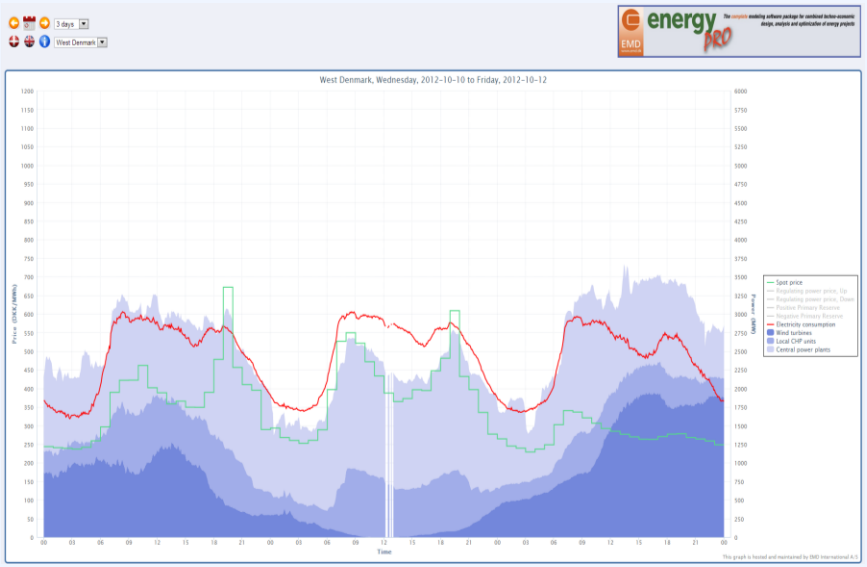
Spot market trading – example 5



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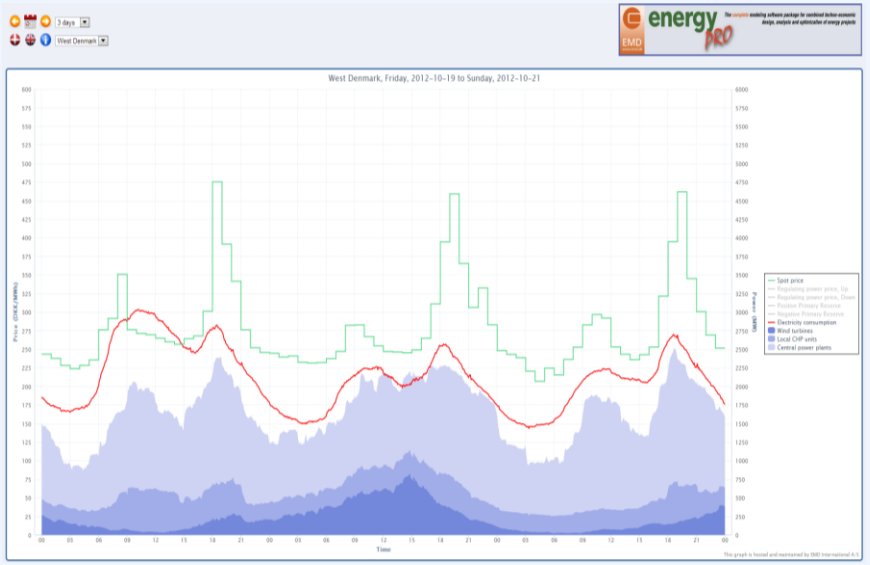
Spot market trading – example 6



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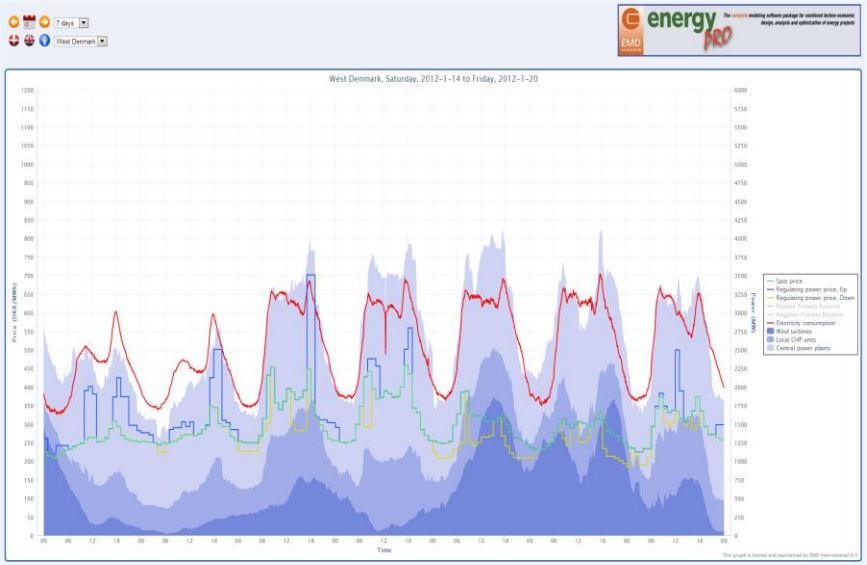
Spot market and balancing power trading – example 1



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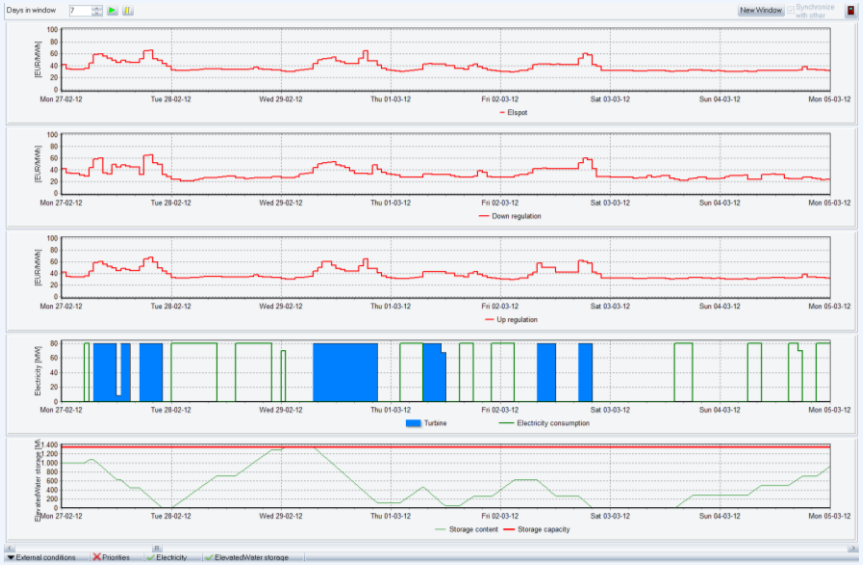
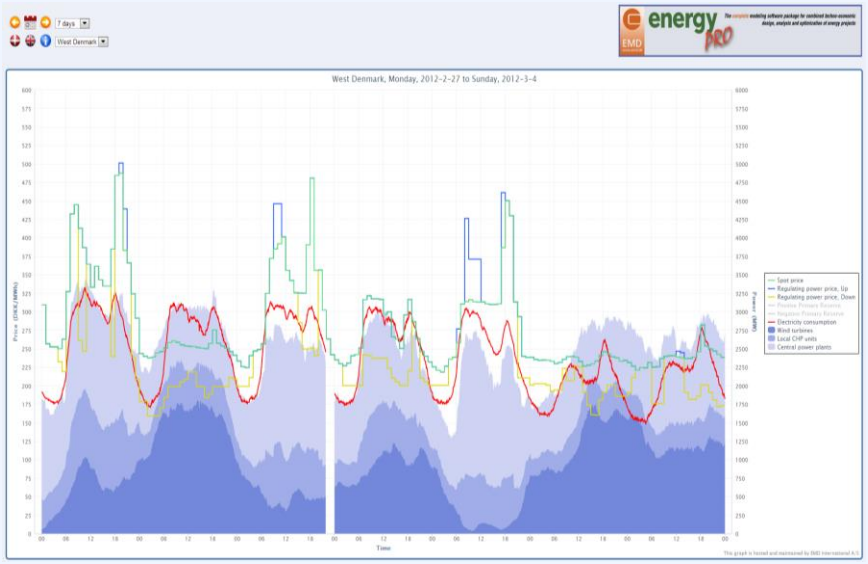
Spot market and balancing power trading – example 2





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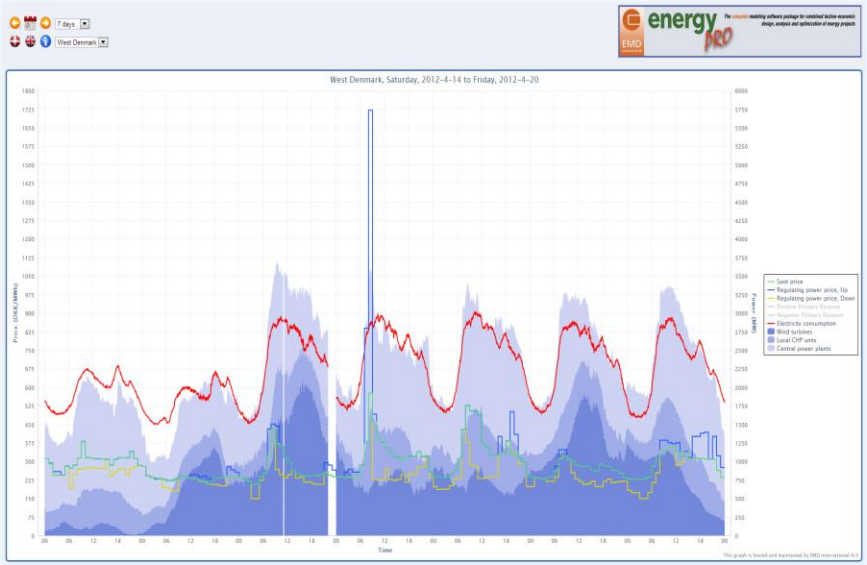
Spot market and balancing power trading – example 3



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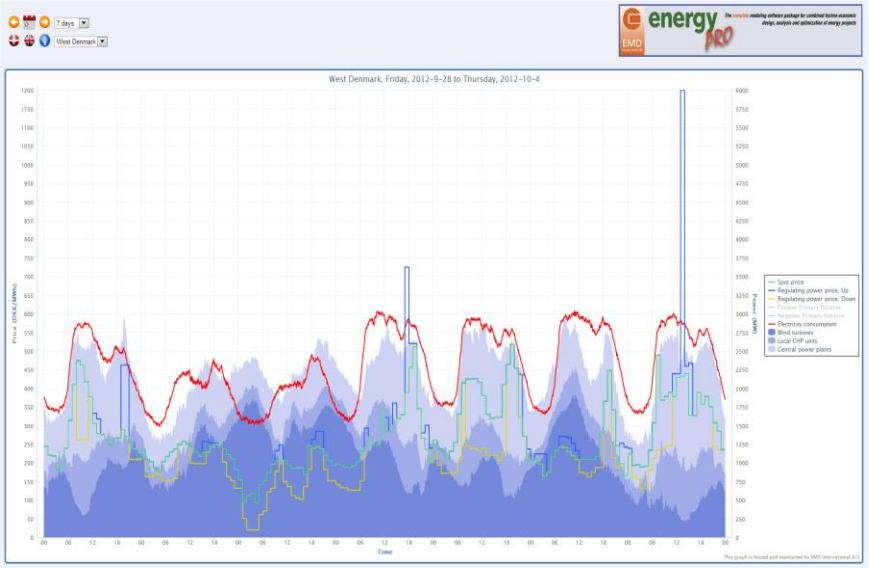
Spot market and balancing power trading – example 4



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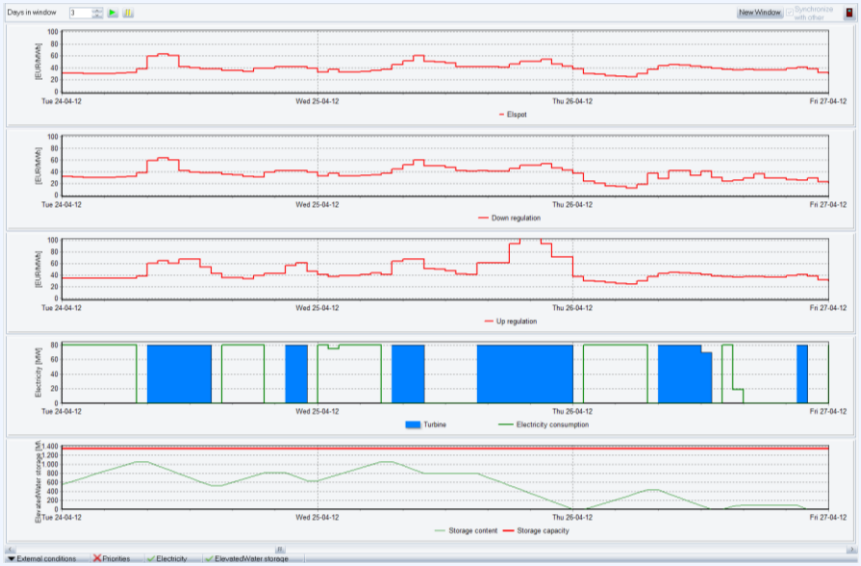
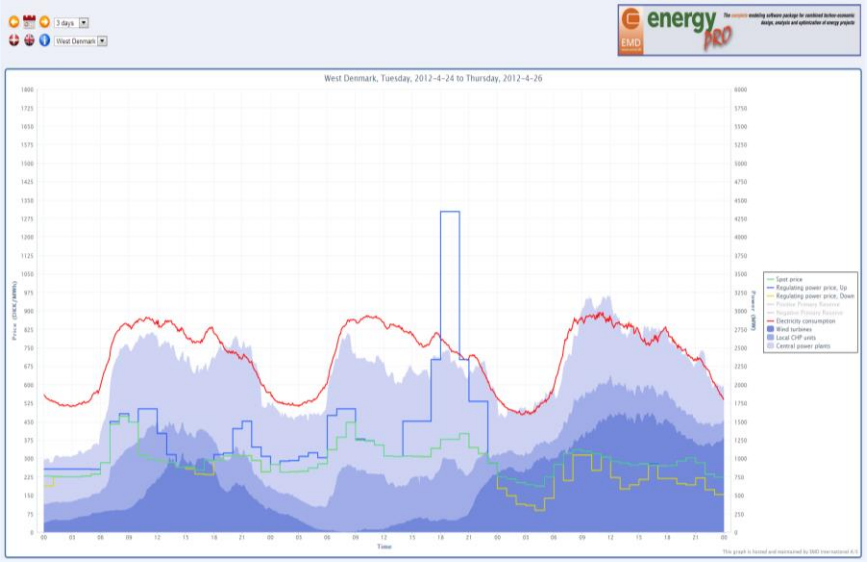
Spot market and balancing power trading – example 5





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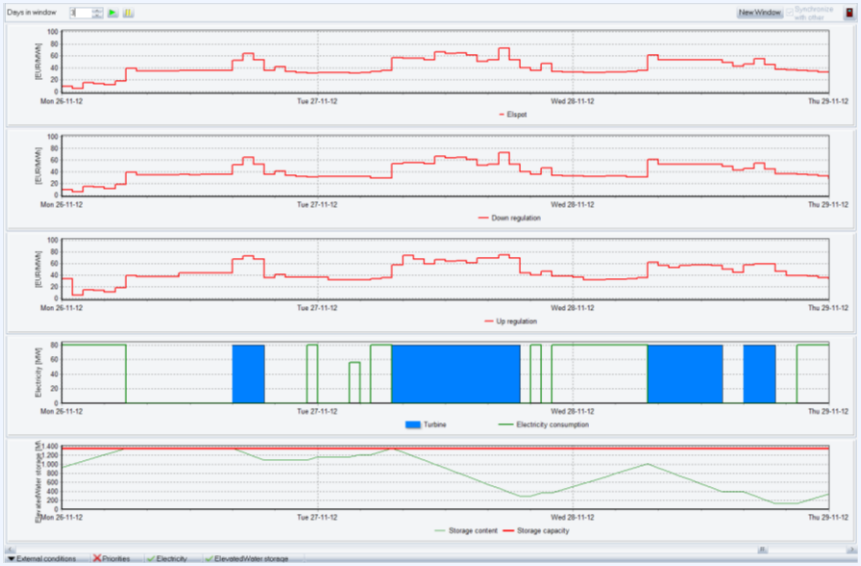
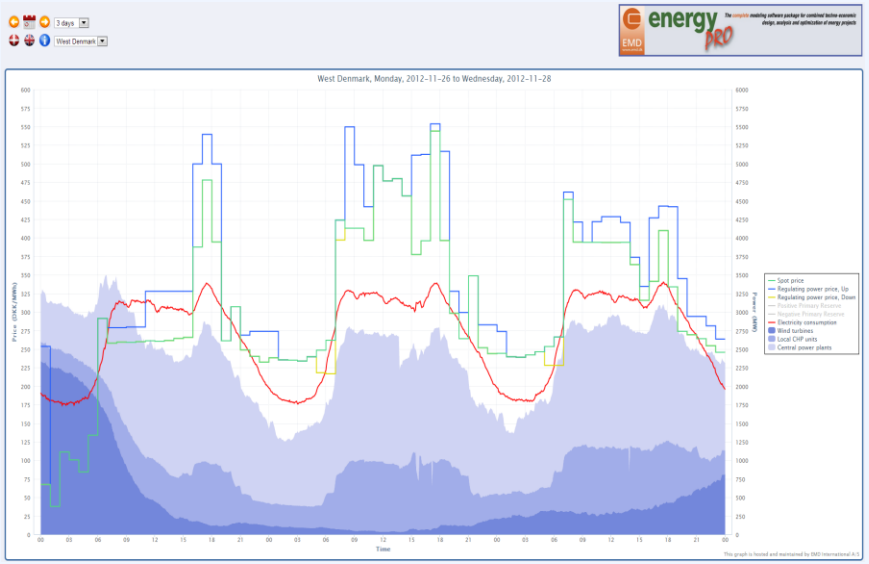
Spot market and balancing power trading – example 6





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(1000 EUR)	Spot market	Spot and Regulating power market
2012	2.226	3.550
2011	1.664	2.862
2010	1.310	2.946
2009	1.142	2.266

Sample Sub Title

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Other alternatives

Statkraft´s view

Fra vår side er det et poeng å få frem at store vannkraftmagasiner i Norge kan bidra med fleksibilitet inn i kraftsystemet selv uten investeringer i pumpekraft. Magasinene er store nok til at vi kan holde igjen store mengder energi og importere fra Danmark når det er et overskudd der, også eksportere til Danmark når det blåser mindre.

www.store-project.eu
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Statkraft´s view

Hvordan utvekslingen skjer vil være avhengig av prisforskjeller og overføringskapasitet (kabler). Skal vi benytte denne muligheten bedre er det behov for enda bedre overføringskapasitet mellom Norge og Danmark enn det er i dag.

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Statkraft´s view

Jeg håper at stoRE prosjektet tar med seg at stor vannkraft med store magasiner kan bidra med lagring og fleksibilitet også uten pumper. Om ikke annet så bør det tas med i en anbefaling for videre arbeid, ettersom det ikke er en del av mandatet til prosjektet.

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Firefox

Hvide Sande Fjernvarme

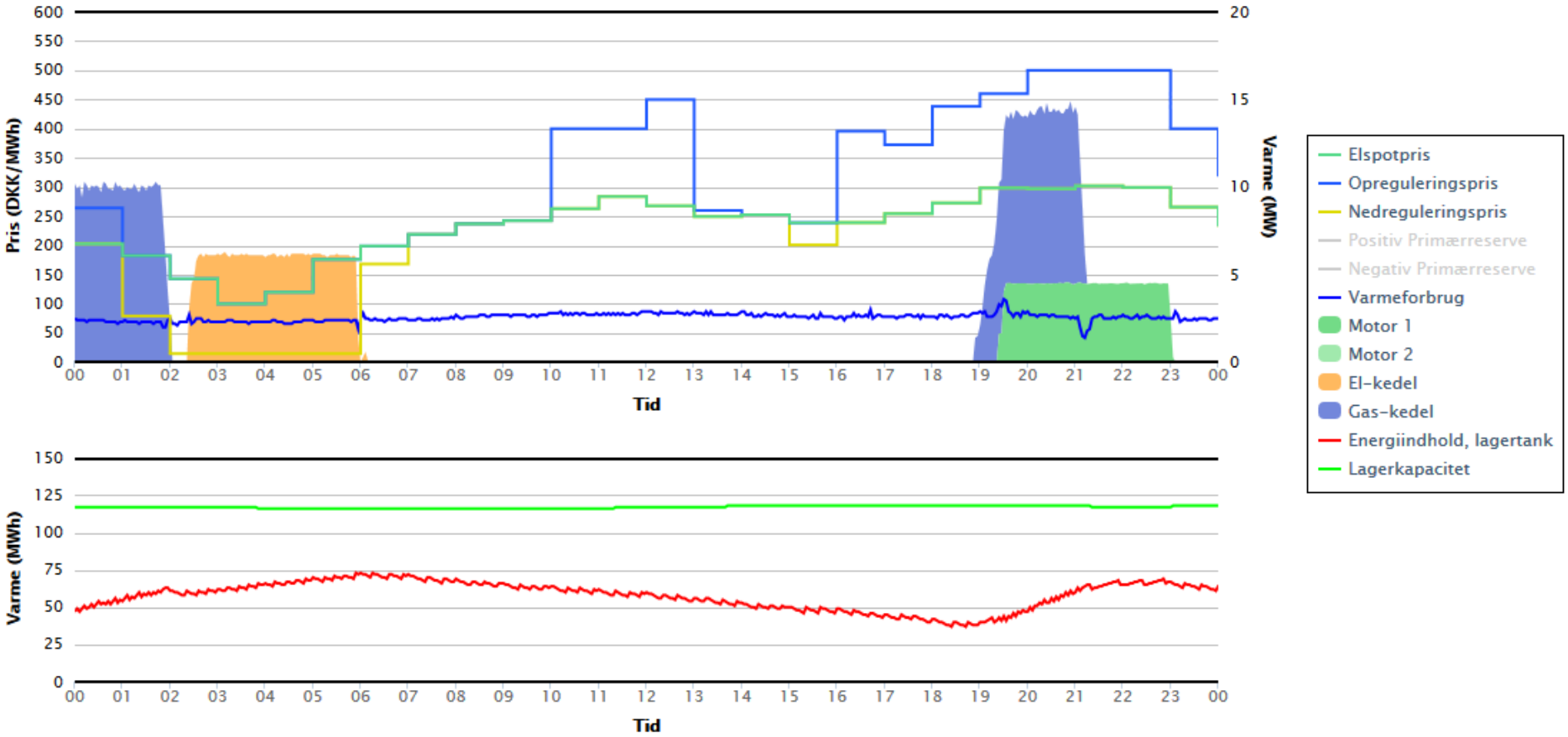
www2.emd.dk/plants/hvidesande/

Google

1 dag

Lige nu

Hvide Sande Fjernvarme, mandag, 20. maj 2013



Denne side hostes og vedligeholdes af EMD International A/S

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We have made live test of the economic benefit for a 21 MW wind farm of offering themselves downward regulation to the TSO

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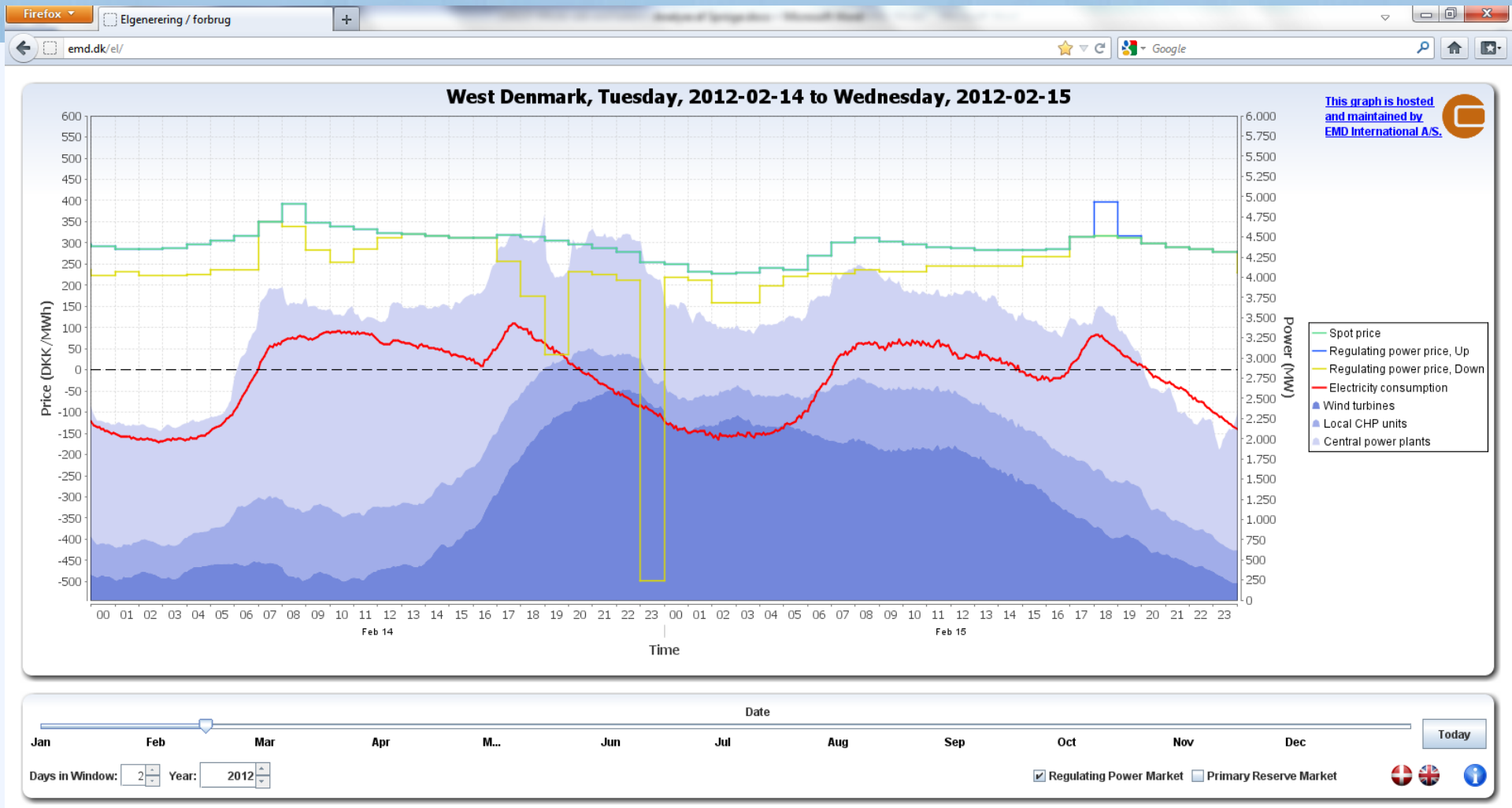
http://emd.dk/el/



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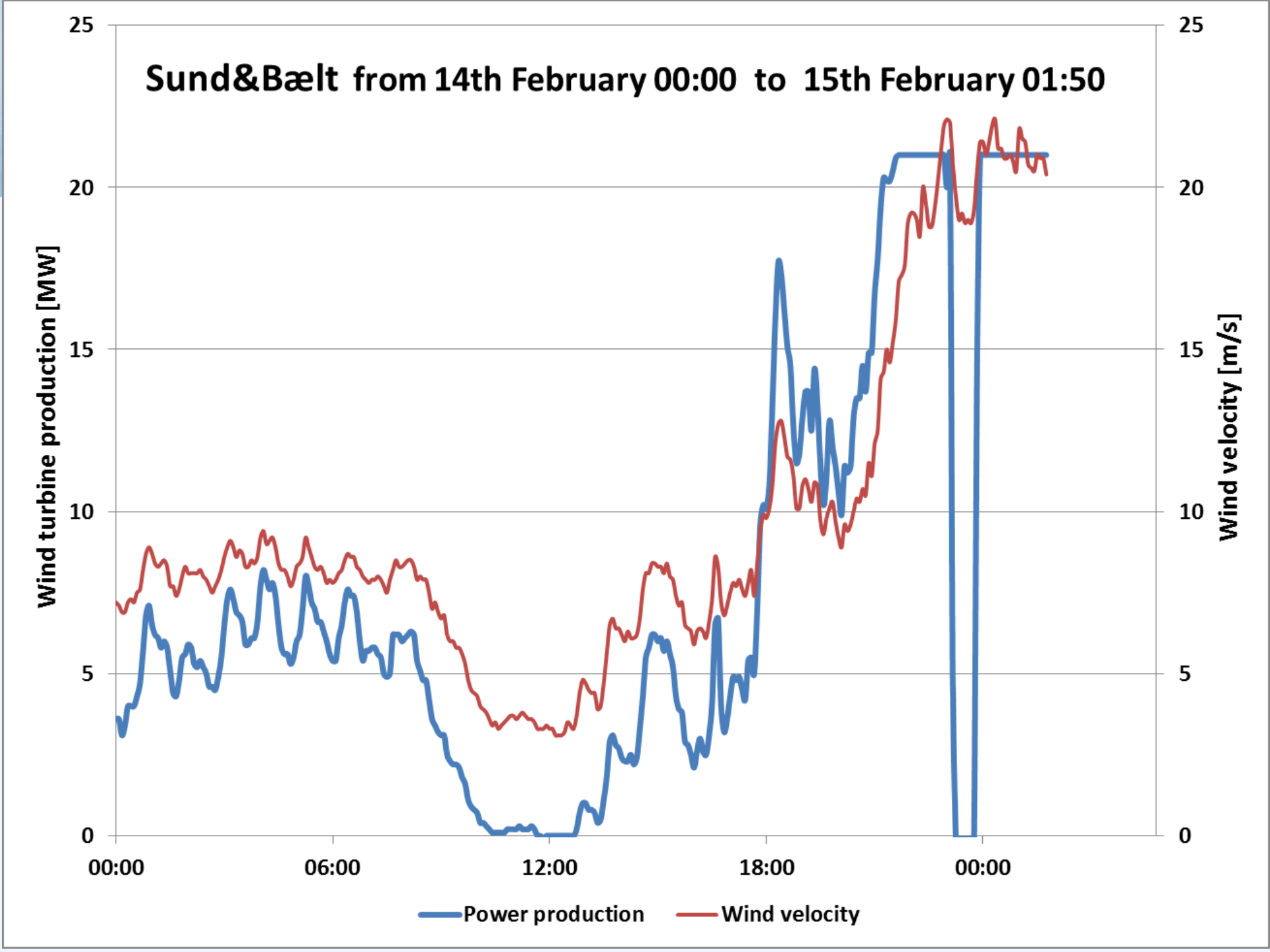
Sund&Bælt from 14th February 00:00 to 15th February 01:50
Wind turbine production [MW]
Wind velocity [m/s]
25
20
15
10
5
0
00:00
06:00
12:00
18:00
00:00
Power production
Wind velocity

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END.

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