Distributed CHP units in Denmark are too quickly reducing their electricity production

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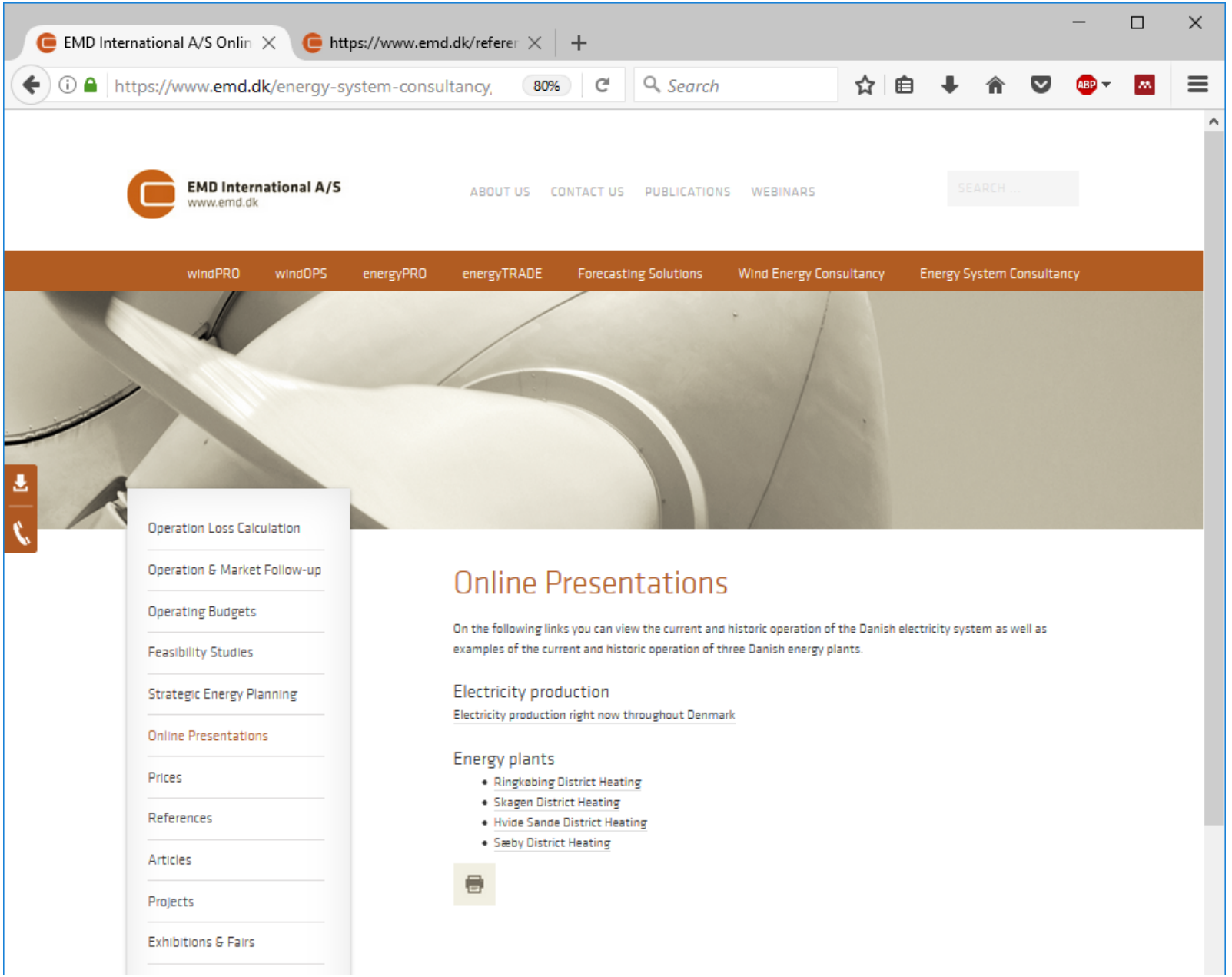
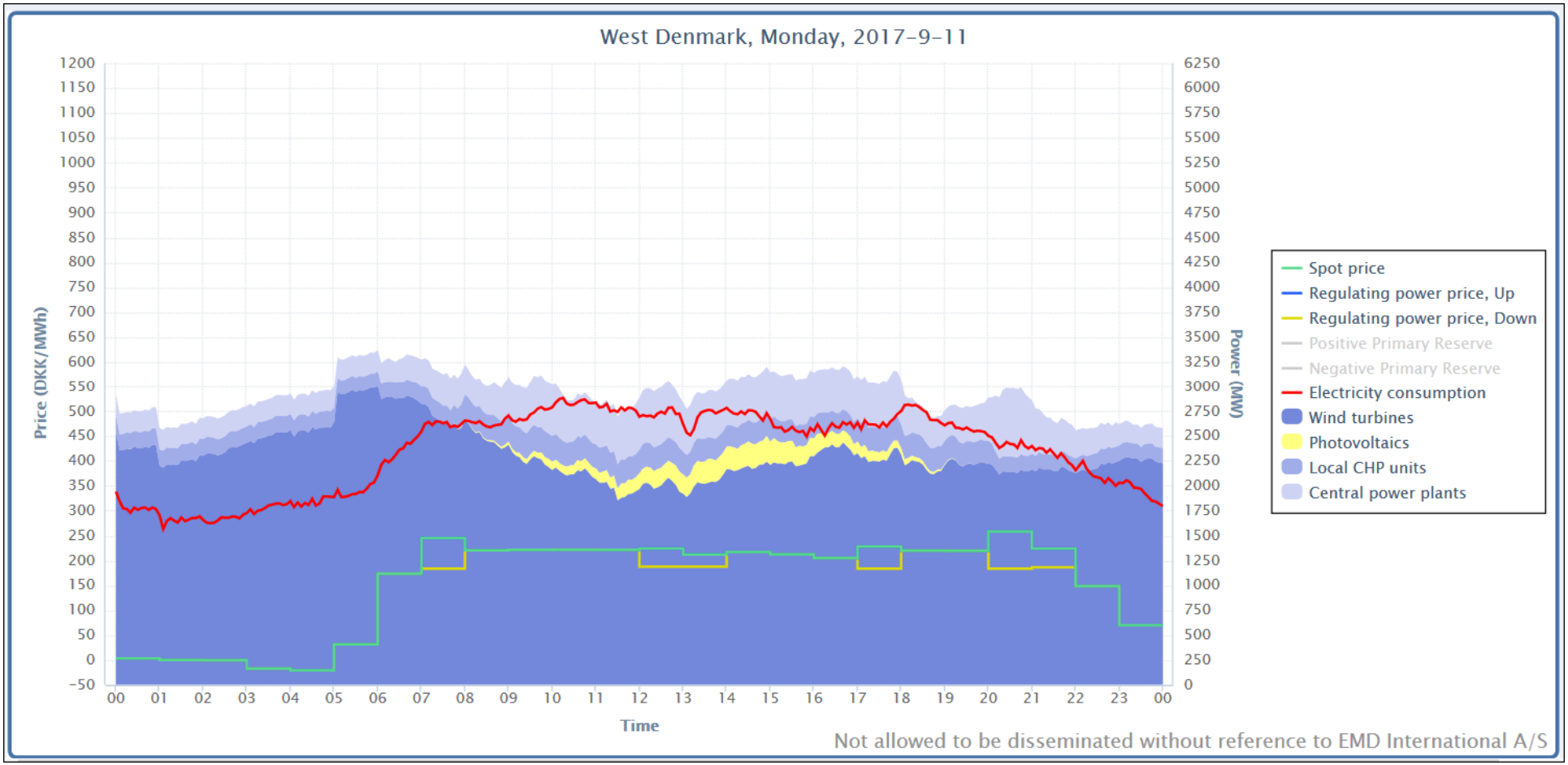
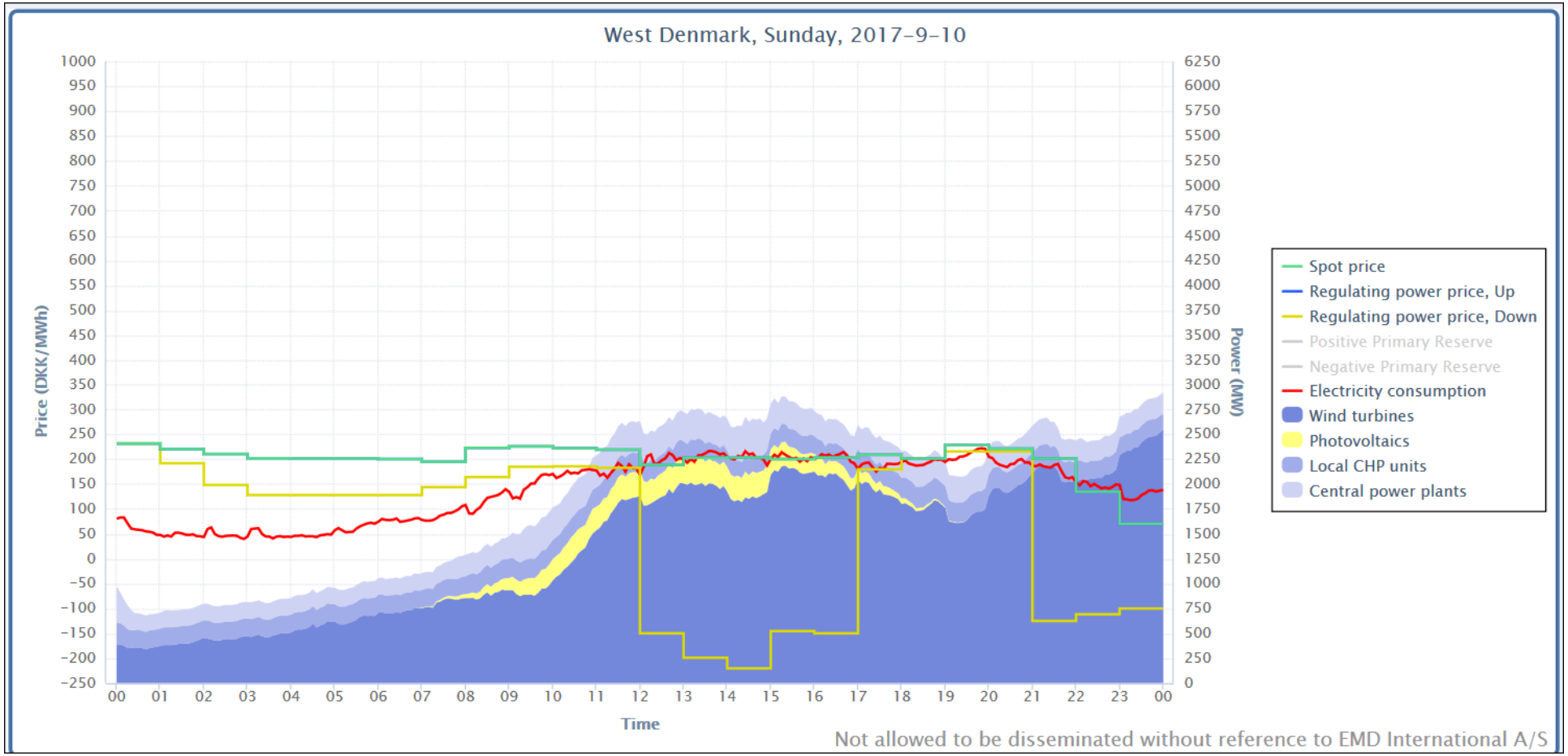



West Denmark, Monday, 2017-9-11
Price (DKK/MWh)
Power (MW)
Time
Spot price
Regulating power price, Up
Regulating power price, Down
Positive Primary Reserve
Negative Primary Reserve
Electricity consumption
Wind turbines
Photovoltaics
Local CHP units
Central power plants
Not allowed to be disseminated without reference to EMD International A/S


West Denmark, Sunday, 2017-9-10
Price (DKK/MWh)
Power (MW)
Time
Spot price
Regulating power price, Up
Regulating power price, Down
Positive Primary Reserve
Negative Primary Reserve
Electricity consumption
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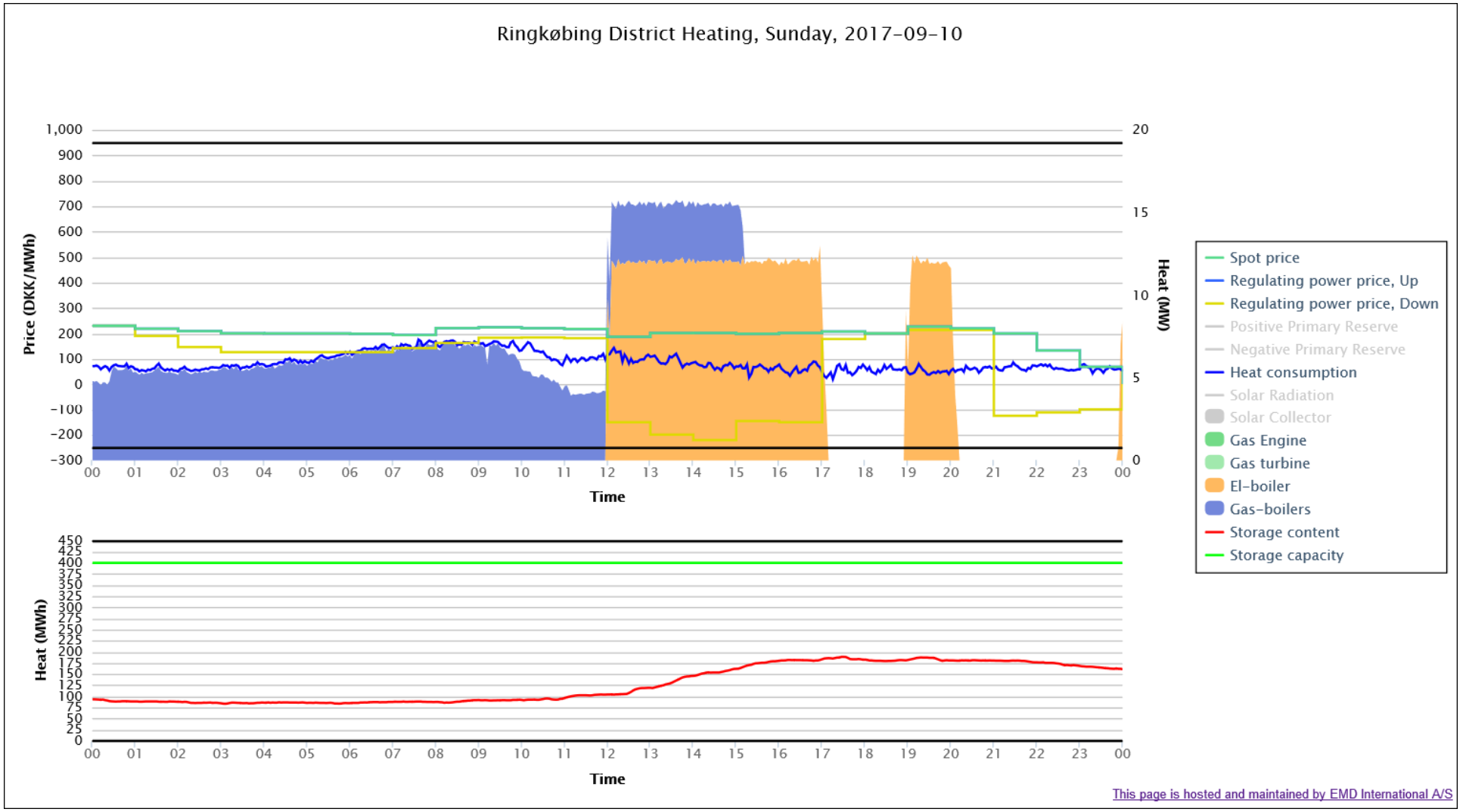
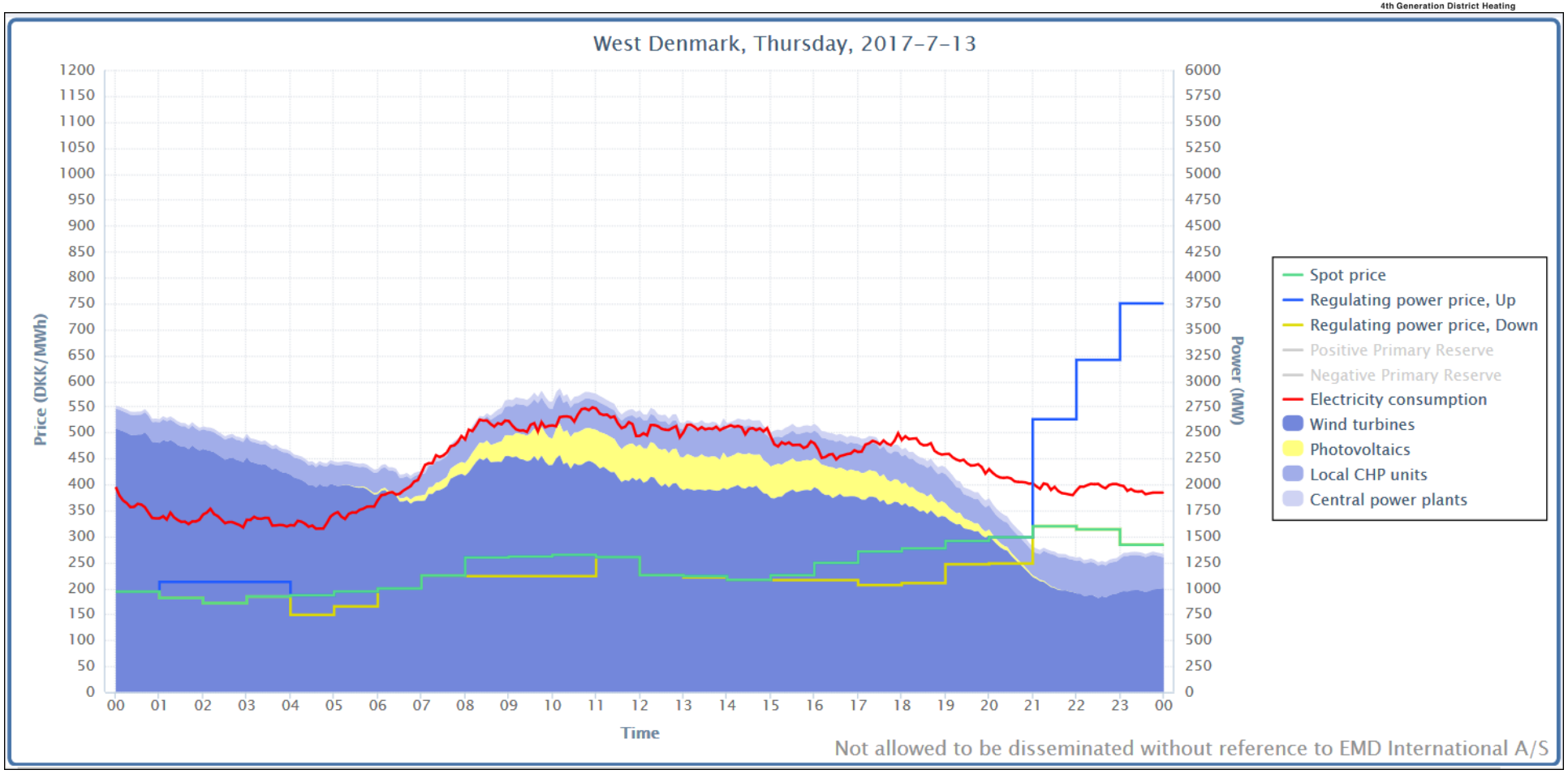
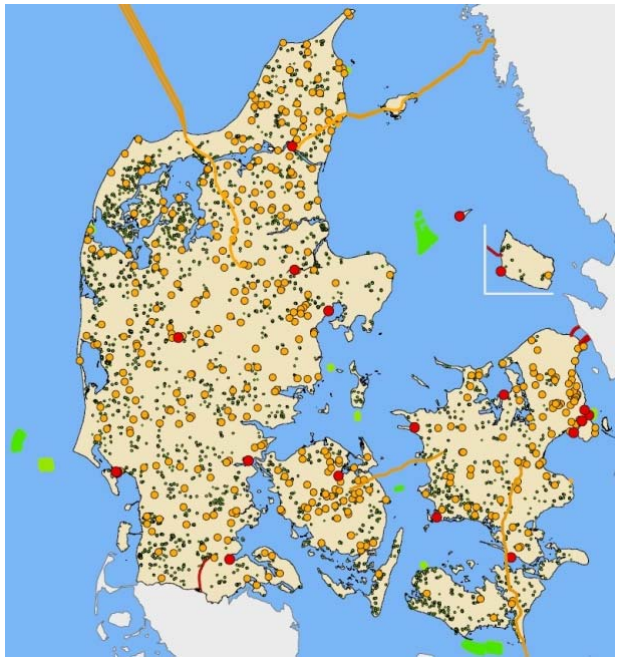


Central power plants was stopped this summer

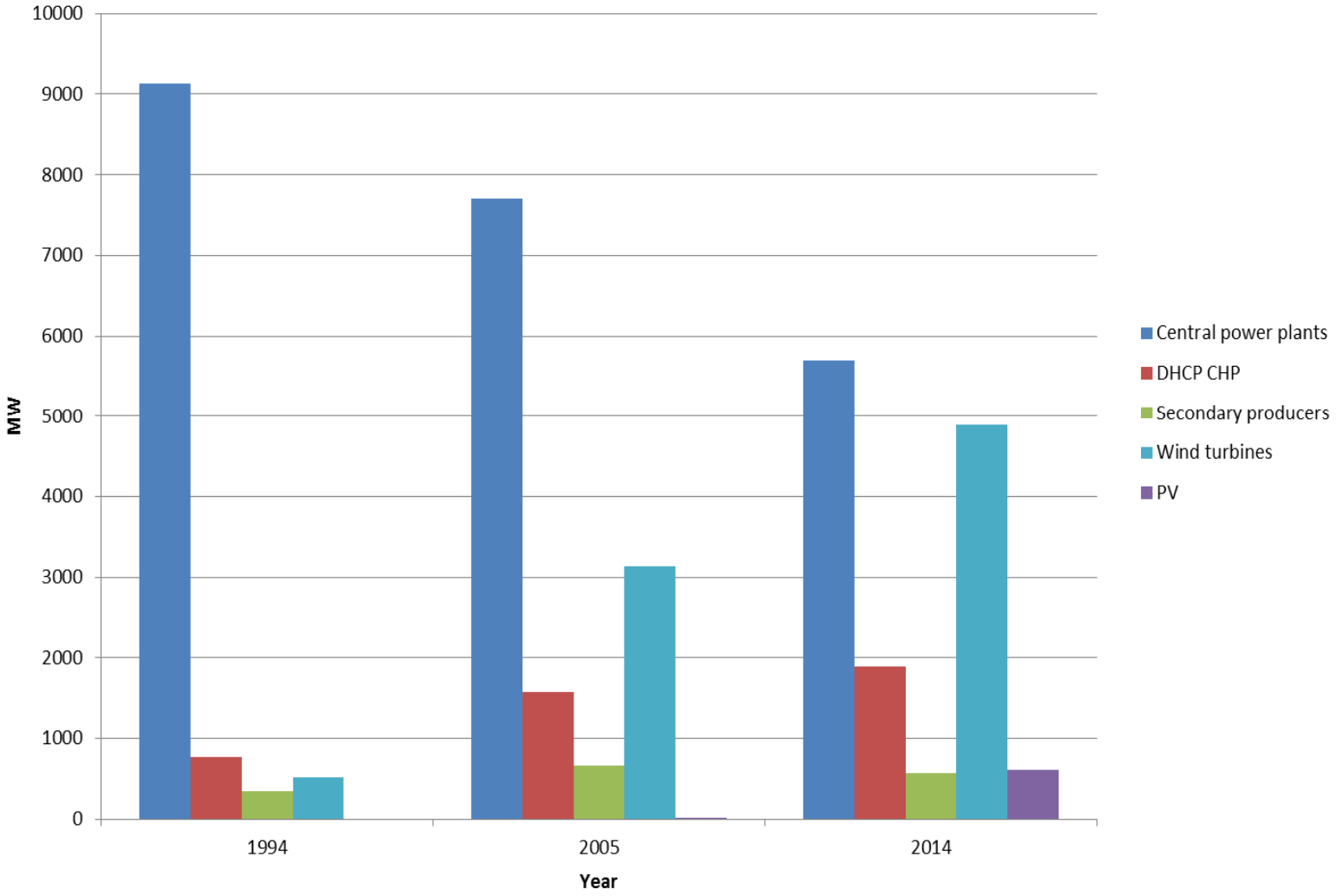


The electrical infrastructure in Denmark in 1985. Red circles indicate central power plants, yellow circles DHCP CHP and secondary producers above 500 kW

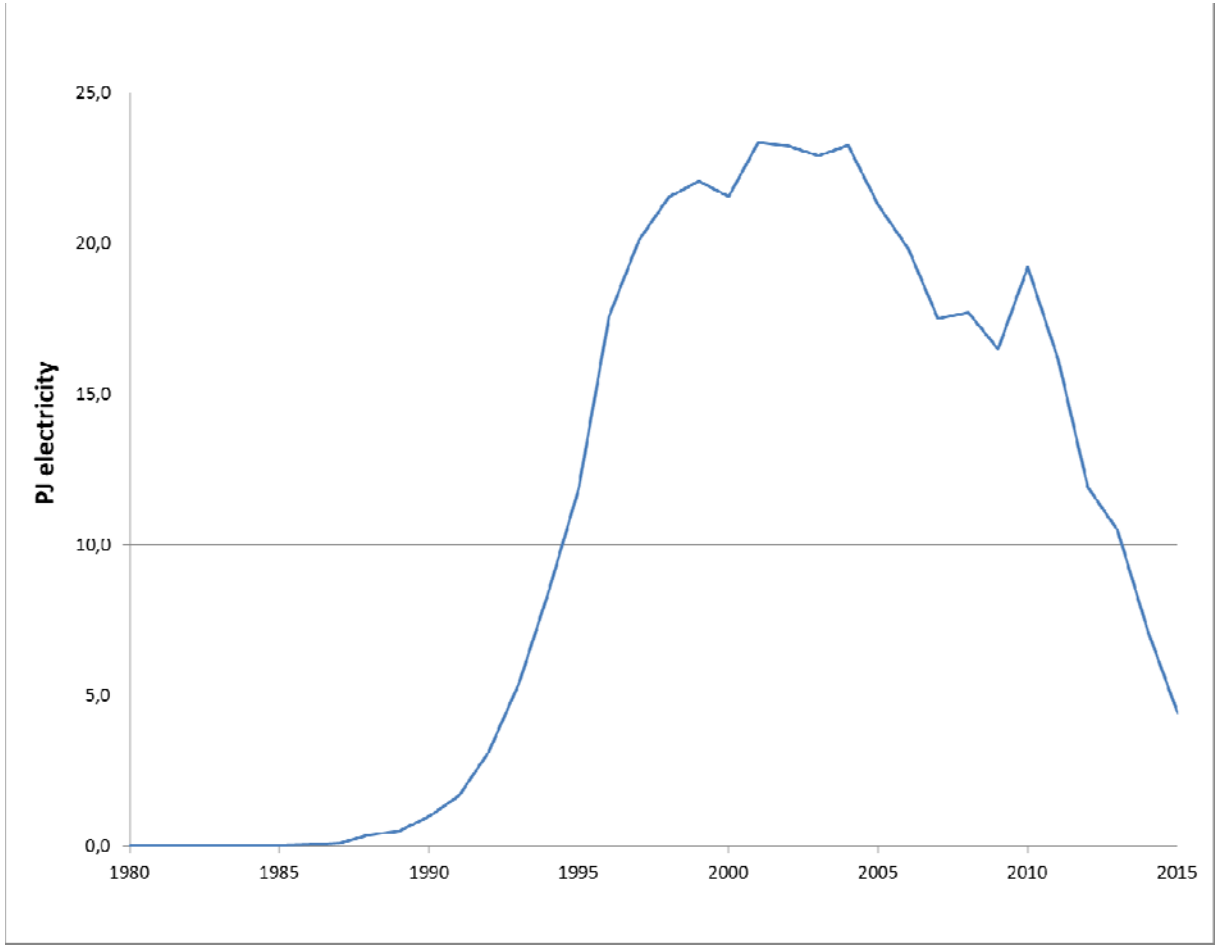
The electrical infrastructure in Denmark in 2015. Red circles indicate central power plants, yellow circles DHCP CHP and secondary producers above 500 kW

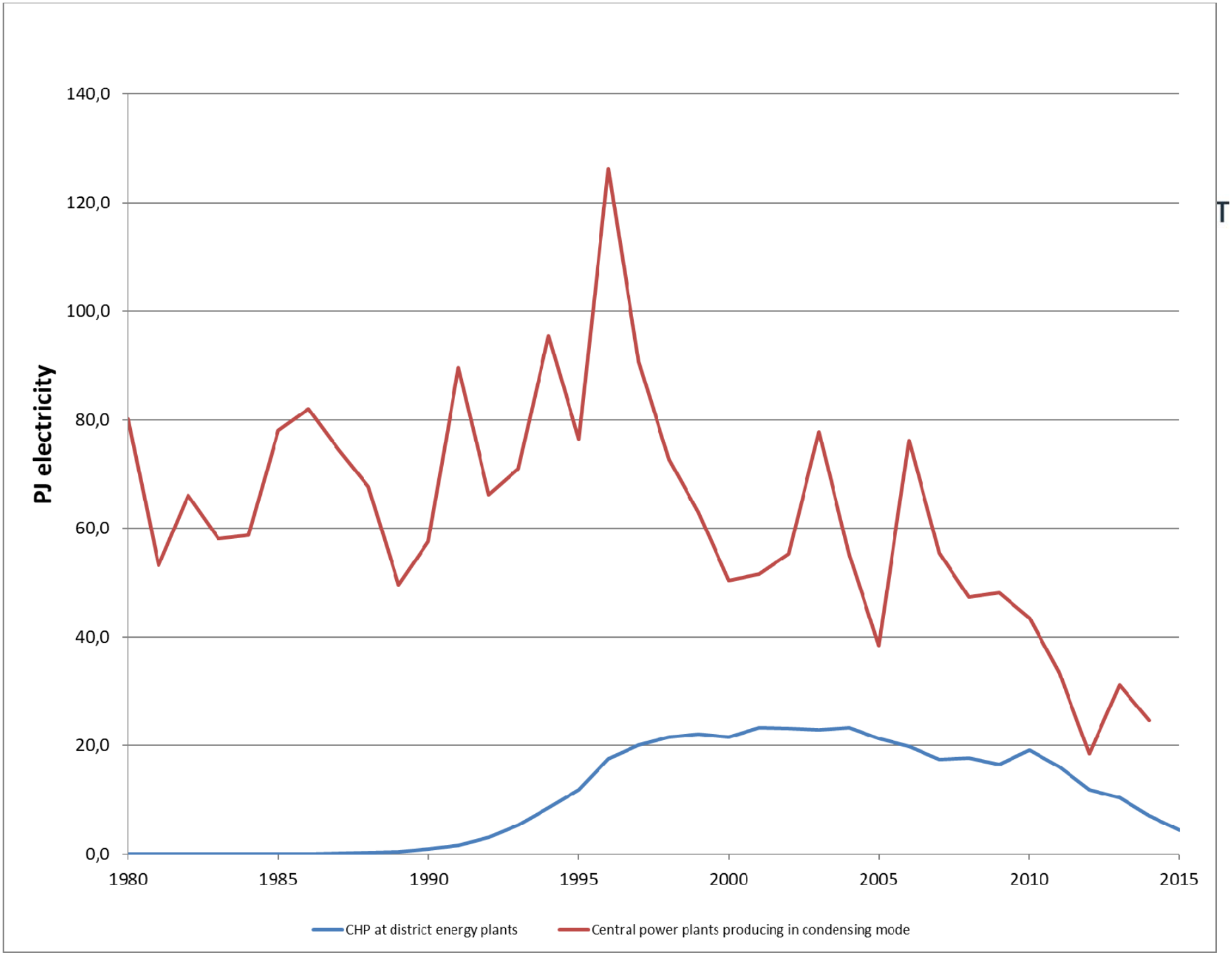


Electrical capacity in Denmark



Yearly electricity productions at Danish distributed CHP.




140,0
120,0
100,0
80,0
60,0
40,0
20,0
0,0
PJ electricity
1980
1985
1990
1995
2000
2005
2010
2015
CHP at district energy plants
Central power plants producing in condensing mode

Phase 1: DHCP CHP displaces fossil fuelled power plants

Phase 2: DHCP CHP participates in the integration of fluctuating RES

Phase 3: DHCP CHP primarily delivers needed electrical capacity in few hours

4DH
4th Generation District Heating Technologies and Systems

reINVEST

NOTICE:

There is no CHP in a 100% renewable energy system

CHP is a transitional technology

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The Danish TSO, Energinet.dk´s plans for 100% renewable energy shows that the present CHP production in Denmark of 90 PJ-heat is in 2035 down to 40 PJ-heat and in 2050 down to 5 PJ-heat.

The Danish triple tariff

- Payment for reducing fossil fuel use at power plants
- Payment for reducing variable operating costs at power plants
- Payment for reducing fixed operating costs at power plants
- Payment for reducing the need for new power plants
- Payment for reducing the need for transmission grid expansion
- Payment for reducing the need for distribution grid expansion
- Payment for reducing grid loss in transmission grids
- Payment for reducing grid loss in distribution grids

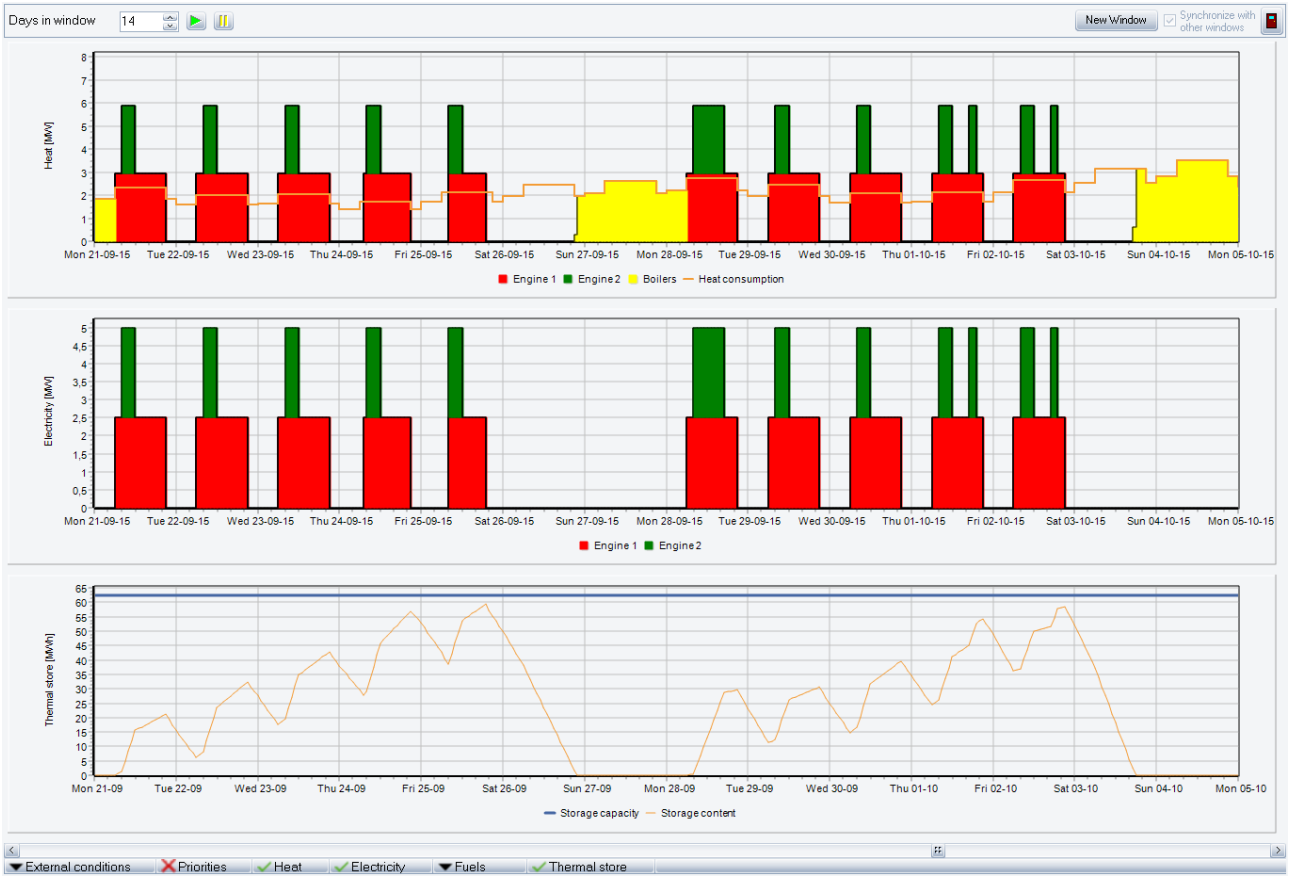
Working days	Low load	High load	Peak load
Winter (October-March)	21.00– 06.00 All holidays All weekends	06.00 – 08.00 12.00 – 17.00 19.00 – 21.00	08.00 – 12.00 17.00 – 19.00
Summer (April-September)	21.00– 06.00 All holidays All weekends	06.00 – 08.00 12.00 – 21.00	08.00 – 12.00

To be paid for distributed electricity production at the triple tariff October to December 2015			
EUR/MWh	**Low load**	**High load**	**Peak load**
Saved fuel costs at power plants	21,85	21,85	21,85
Saved variable operating costs at power plants	2,54	2,54	2,54
Saved fixed operating costs at power plants	0,00	3,92	6,30
Saved investment costs at power plants	0,00	20,44	32,82
Total saved at power plants	**24,39**	**48,76**	**63,51**
Saved grid loss at 150 + 400 kV	0,70	2,14	3,13
Saved grid expansion, 150 kV	0,00	6,46	10,36
Total saved an 150/60 kV-transformer	**25,10**	**57,35**	**77,01**
Saved grid loss at 60 kV	0,54	1,90	2,88
Saved grid expansion, 60 kV	0,00	2,15	3,46
To be paid for electricity delivered at 60/10 kV-transformer	**25,63**	**61,40**	**83,34**
Saved grid loss at 10 kV	0,36	1,70	3,02
Saved grid expansion, 10 kV	0,00	1,22	1,95
To be paid for electricity delivered to the 10 kV-grid	**26,00**	**64,32**	**88,31**
Saved grid loss at 0.4 kV	0,75	3,46	6,44
Saved grid expansion, 0.4 kV	0,00	1,22	1,95
To be paid for electricity delivered to the low voltage-grid	**26,75**	**68,99**	**96,71**

Tax free fuel consumption = Exported electricity/0,67

https://www.emd.dk/energypro/

Simulated operation of CHP production at triple tarif



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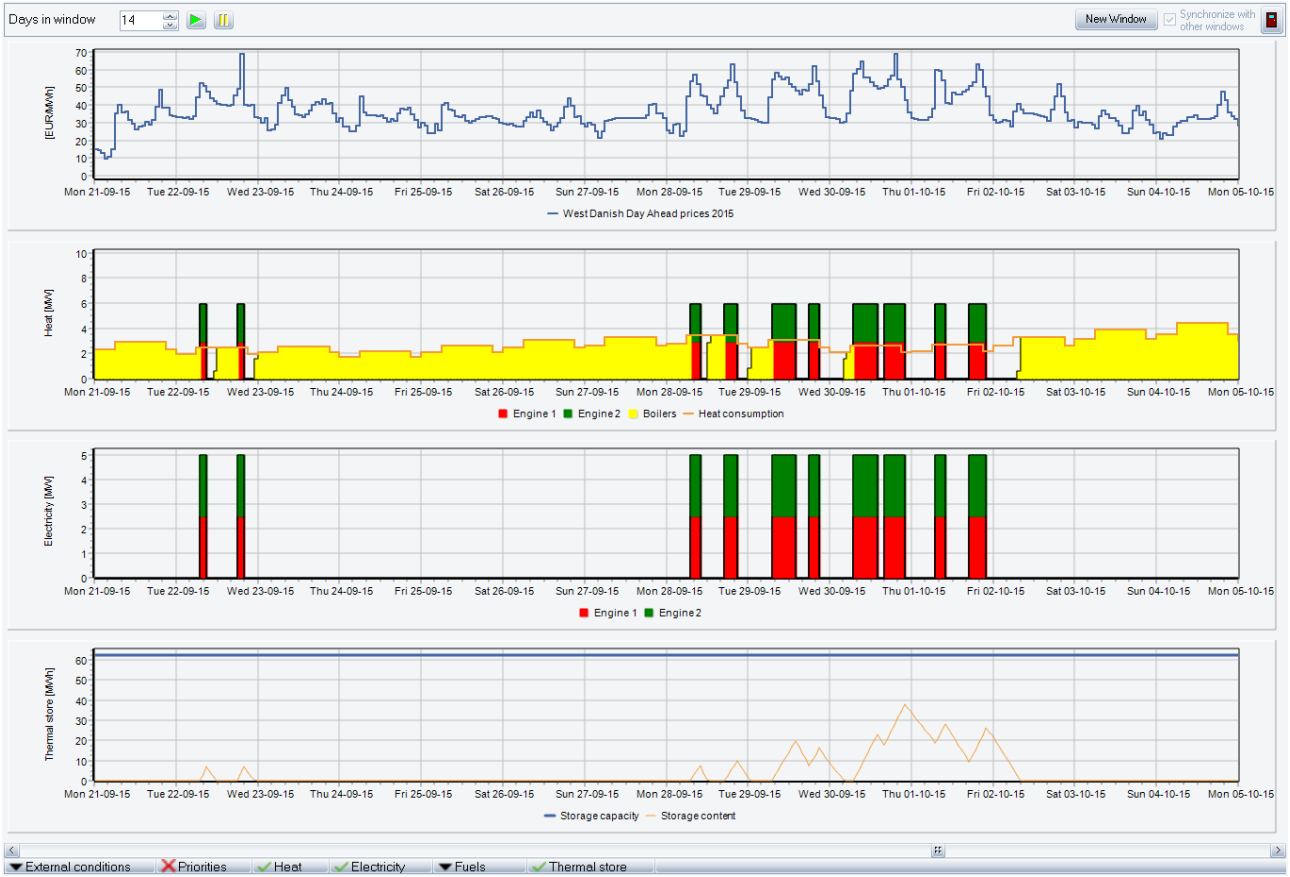
Simulated operation of CHP production at Day Ahead market



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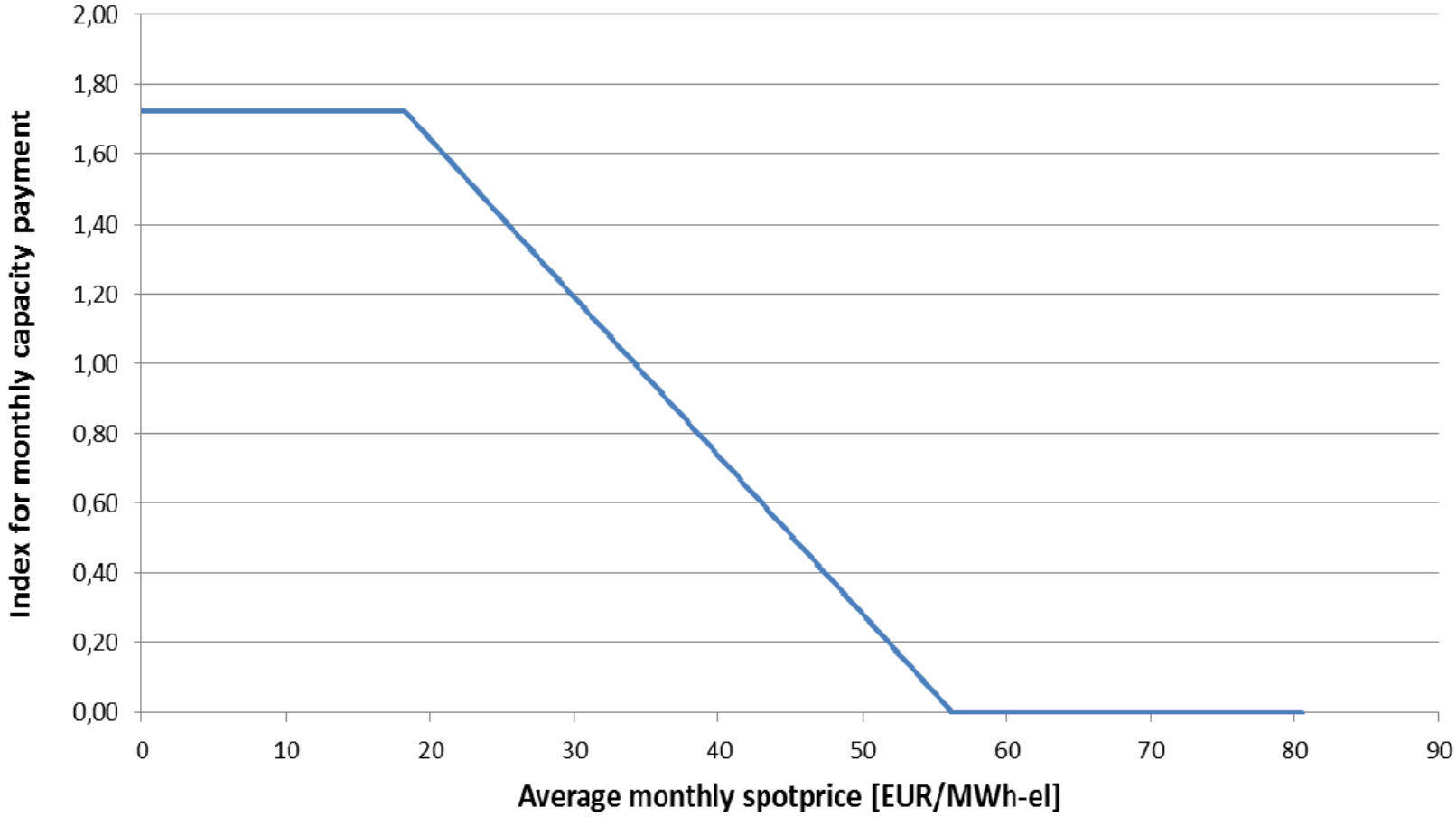
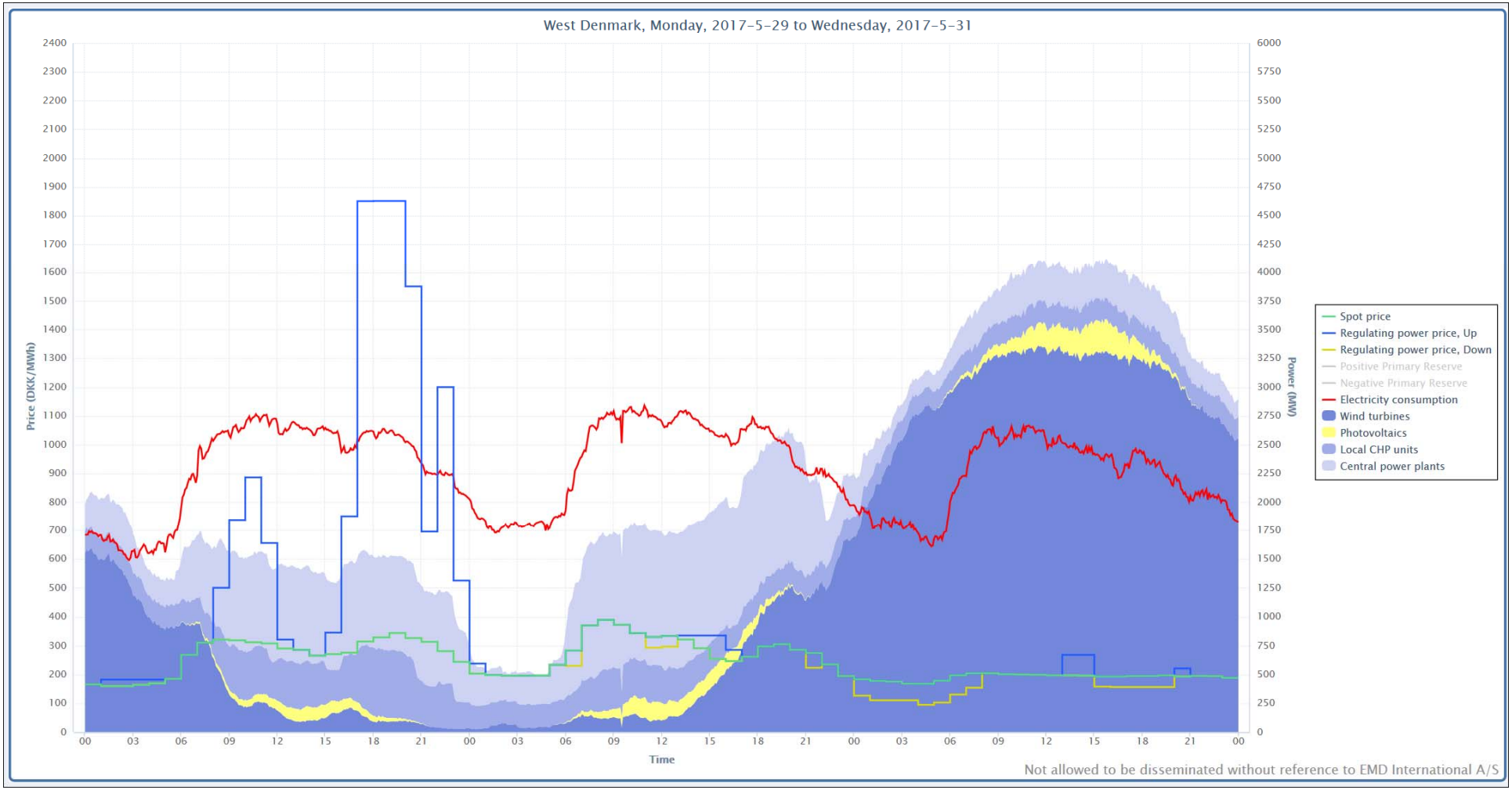
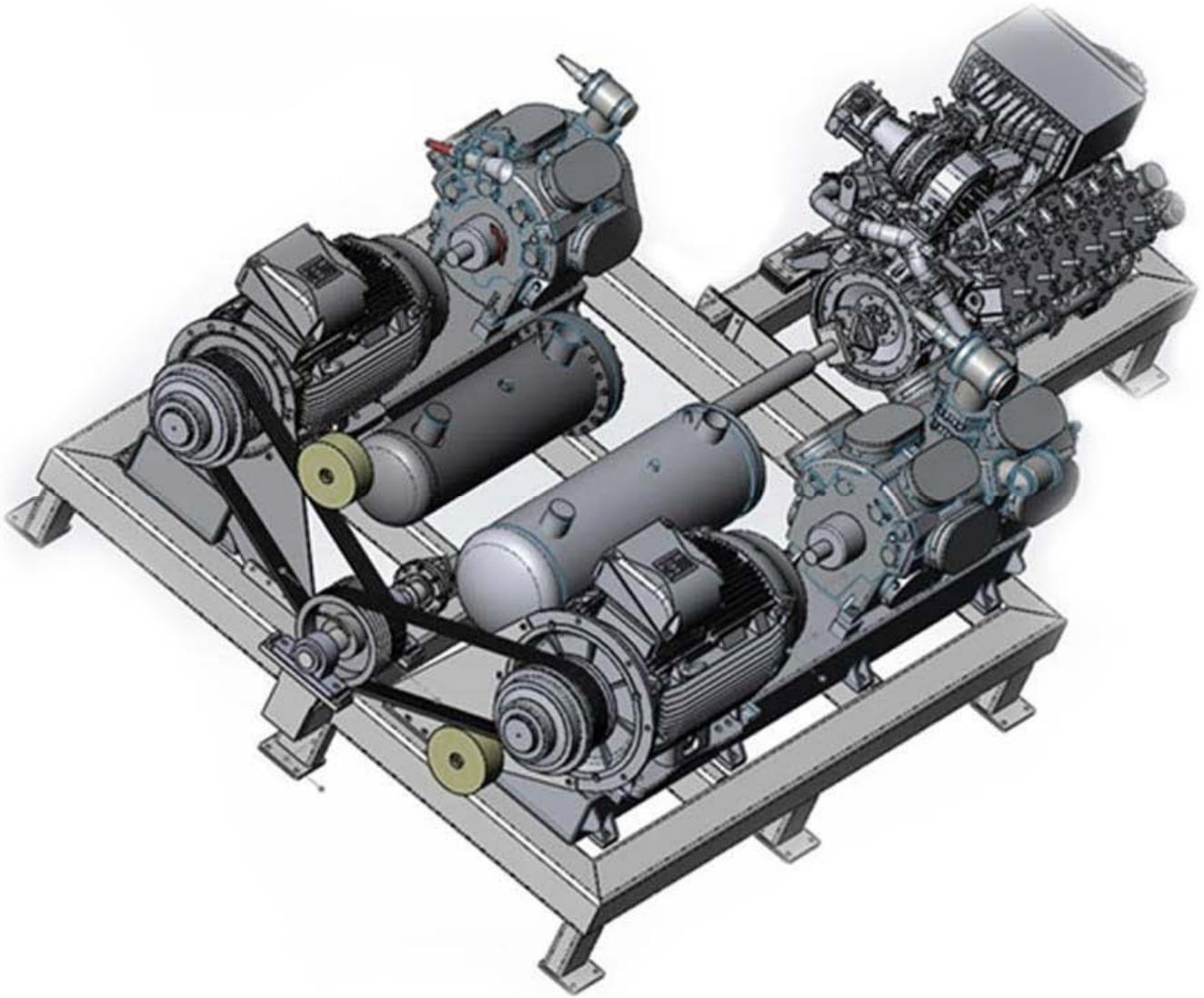
Monthly capacity payment replaced the triple tariff

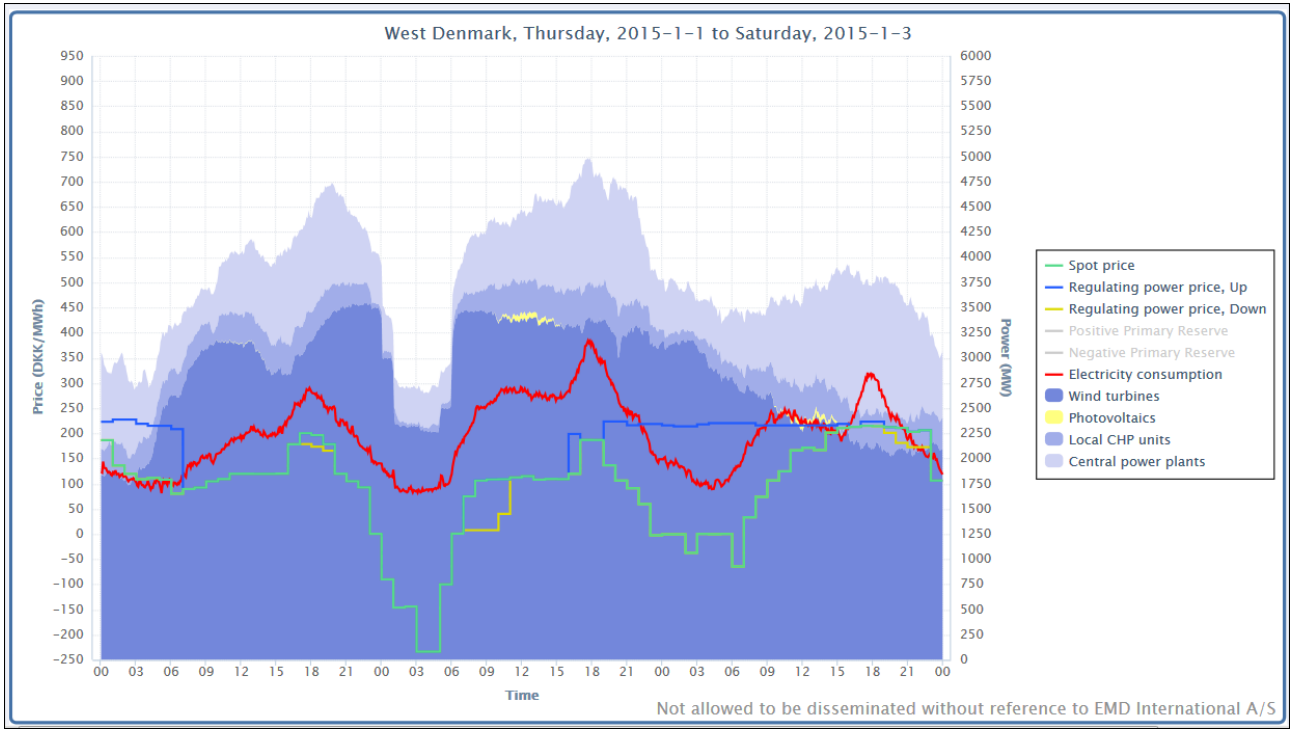


http://www.emd.dk/el/



A production unit made at https://www.emd.dk/plants/rfvv/, belonging to the future ☺





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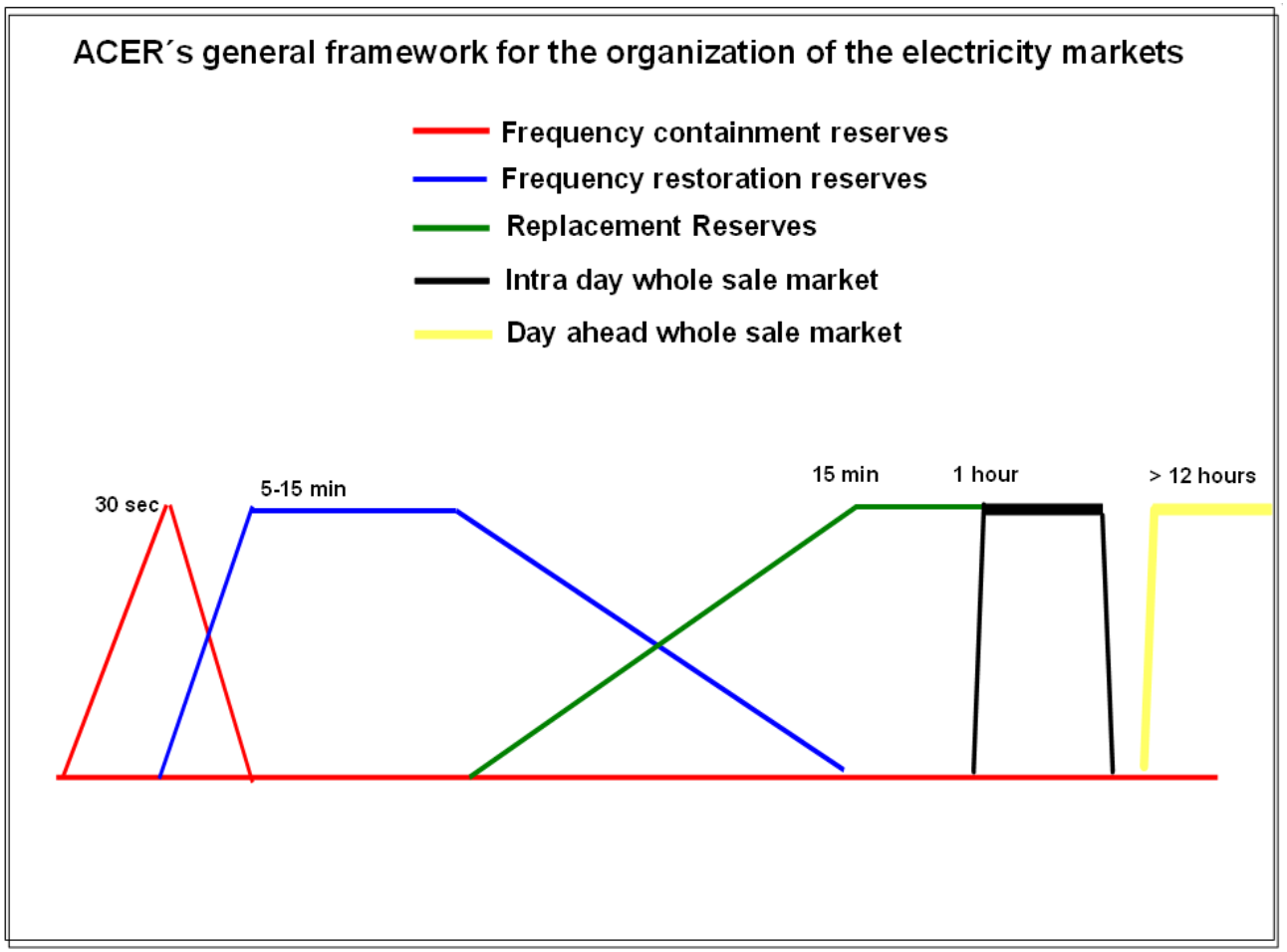
Thank you for your attention !

ACER´s general framework for the organization of the electricity markets

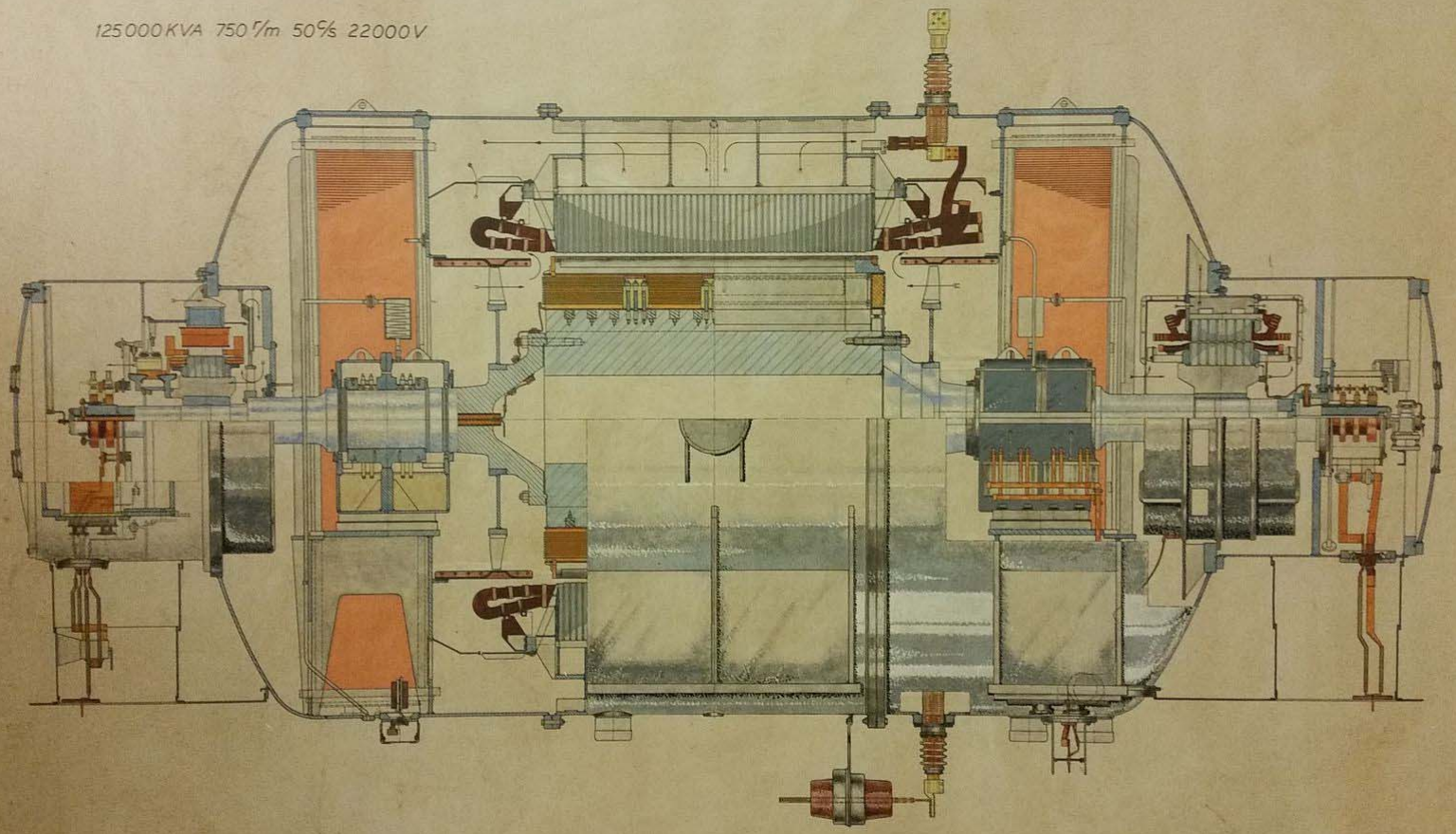


Often these three reserves are numbered:
Frequency containment reserves = Primary reserves
Frequency restoration reserves = Secondary reserves
Replacement Reserves = Tertiary reserves

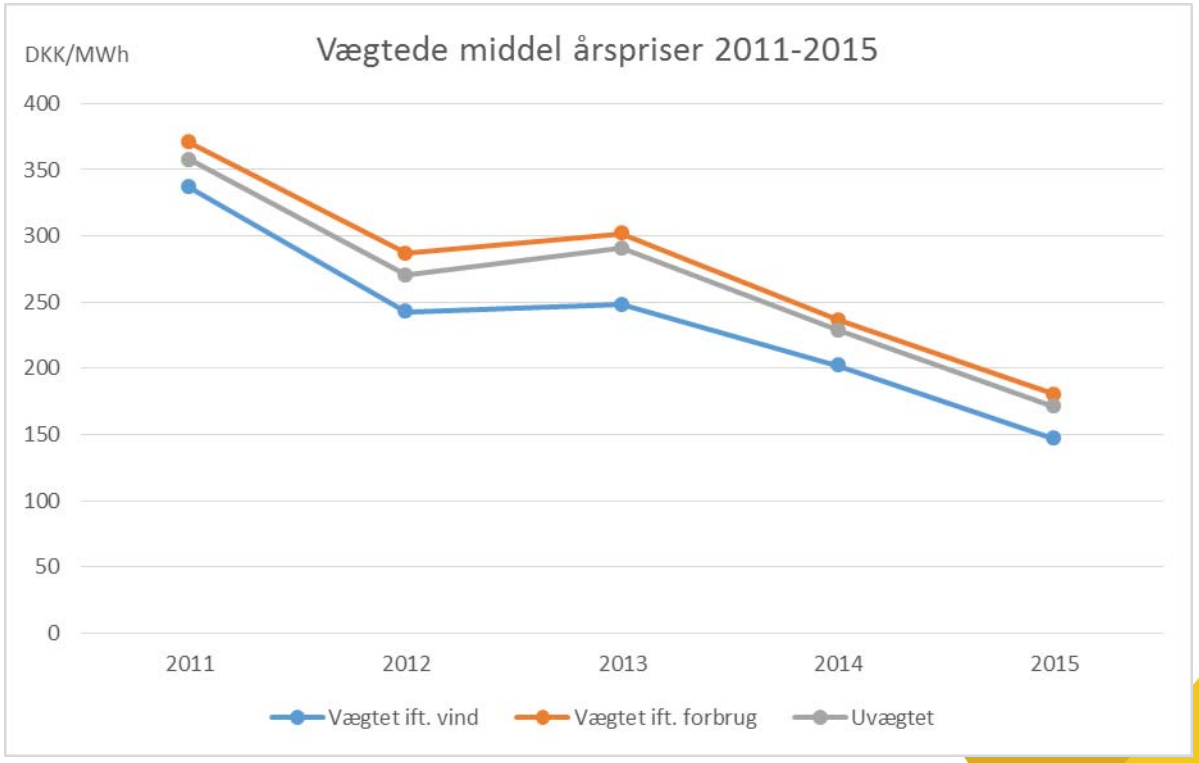
SEC VICTORIA

SYNCHRONOUS CONDENSER

125000 KVA 750 r/m 50% 22000 V



ASEA LAMS-62324-MG148 GU11 4423 027
Assembly


Vægtede middel årspriser 2011-2015
DKK/MWh
400
350
300
250
200
150
100
50
0
2011
2012
2013
2014
2015
Vægtet ift. vind
Vægtet ift. forbrug
Uvægtet

Den optimale løsning kan være en kombination af central produktion på værket og booster produktion i de enkelte bygninger.

Contents lists available at ScienceDirect

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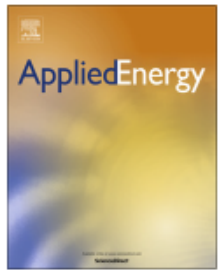

Booster heat pumps and central heat pumps in district heating

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