

Experience/knowledge/ideas of connecting mCHPs to the (smart) grid. Future business/technology perspective.

*Ene-Field, Steering committee meeting
Berlin – Febr. 2013.*

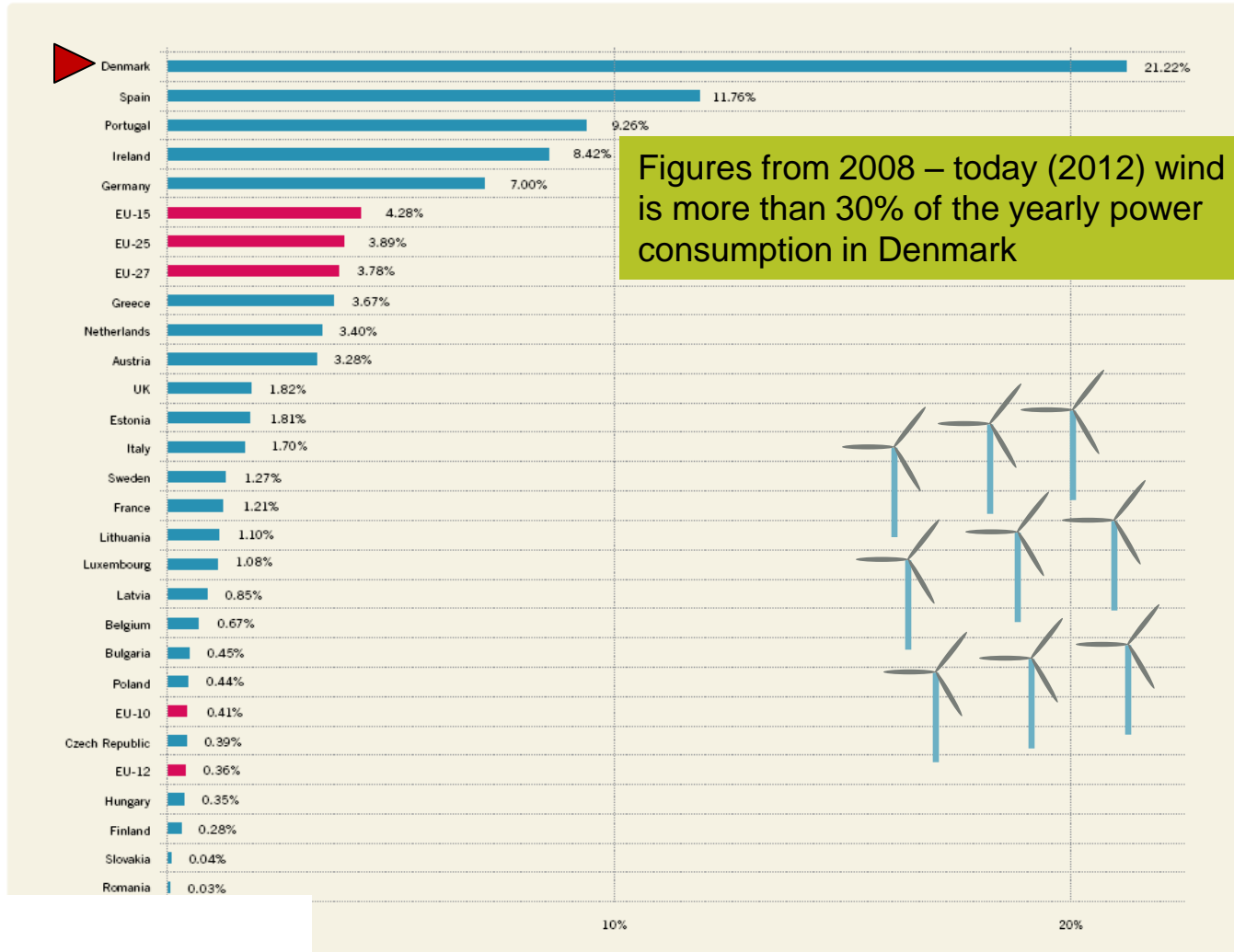
WP 3.6 – Utility Working group



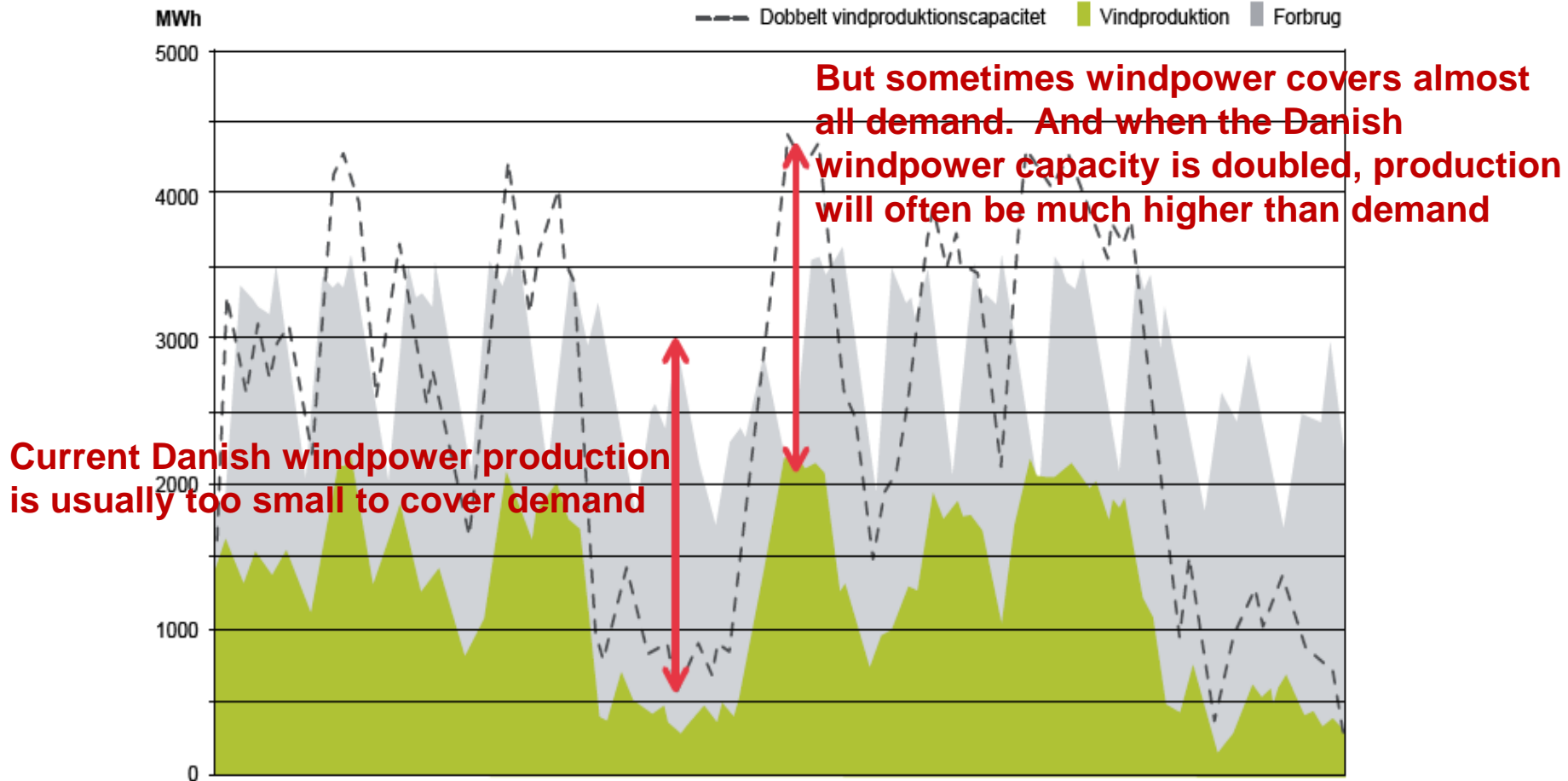
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Windpower makes up an increasingly larger share of the electricity production, and Denmark is at the forefront of this development



Wind power production varies highly, sometimes not at all sufficient, at other times exceeding demand. This variation will grow in the future

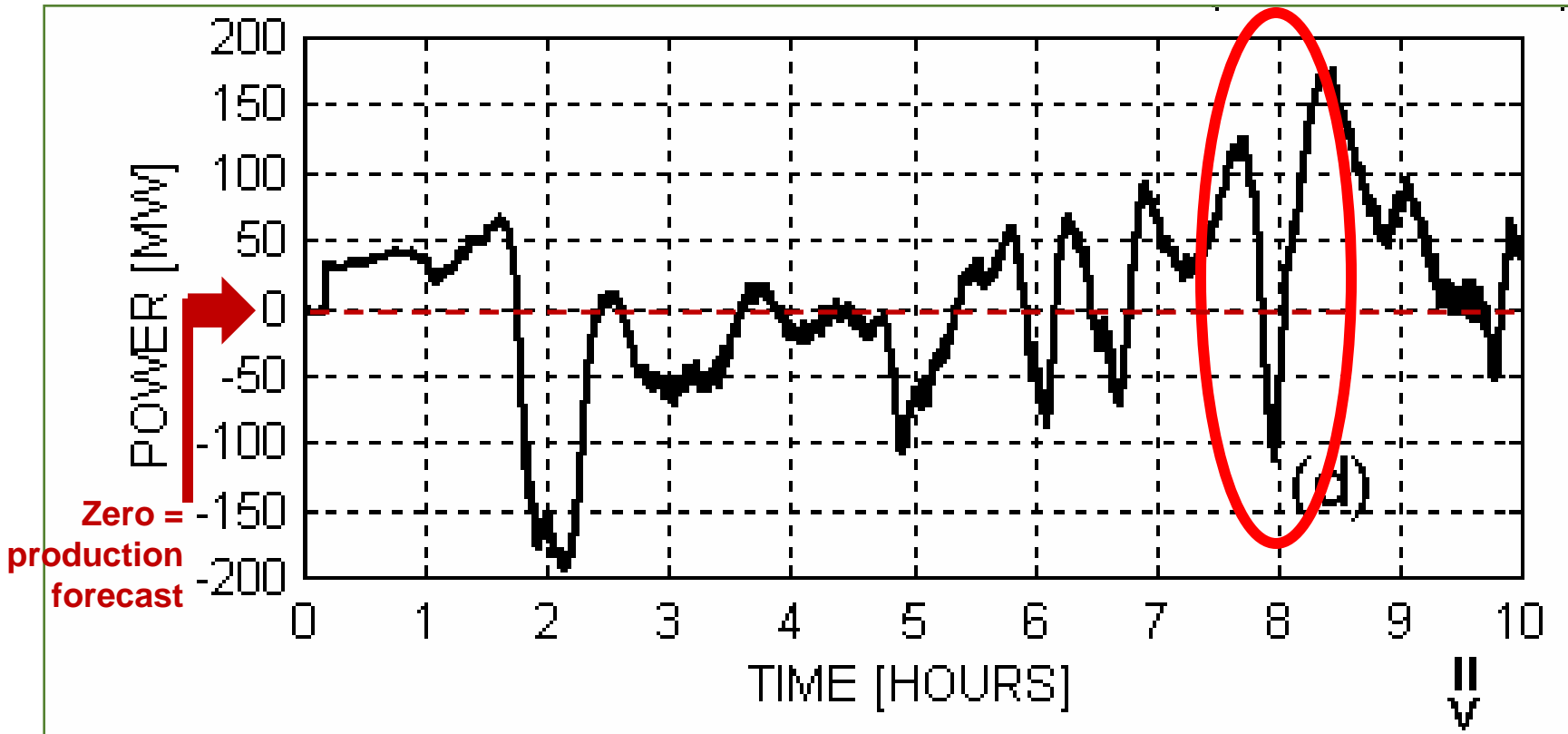


Example: 4-17 December 2006

Even across short time intervals the wind power production varies highly, creating a need for system balancing



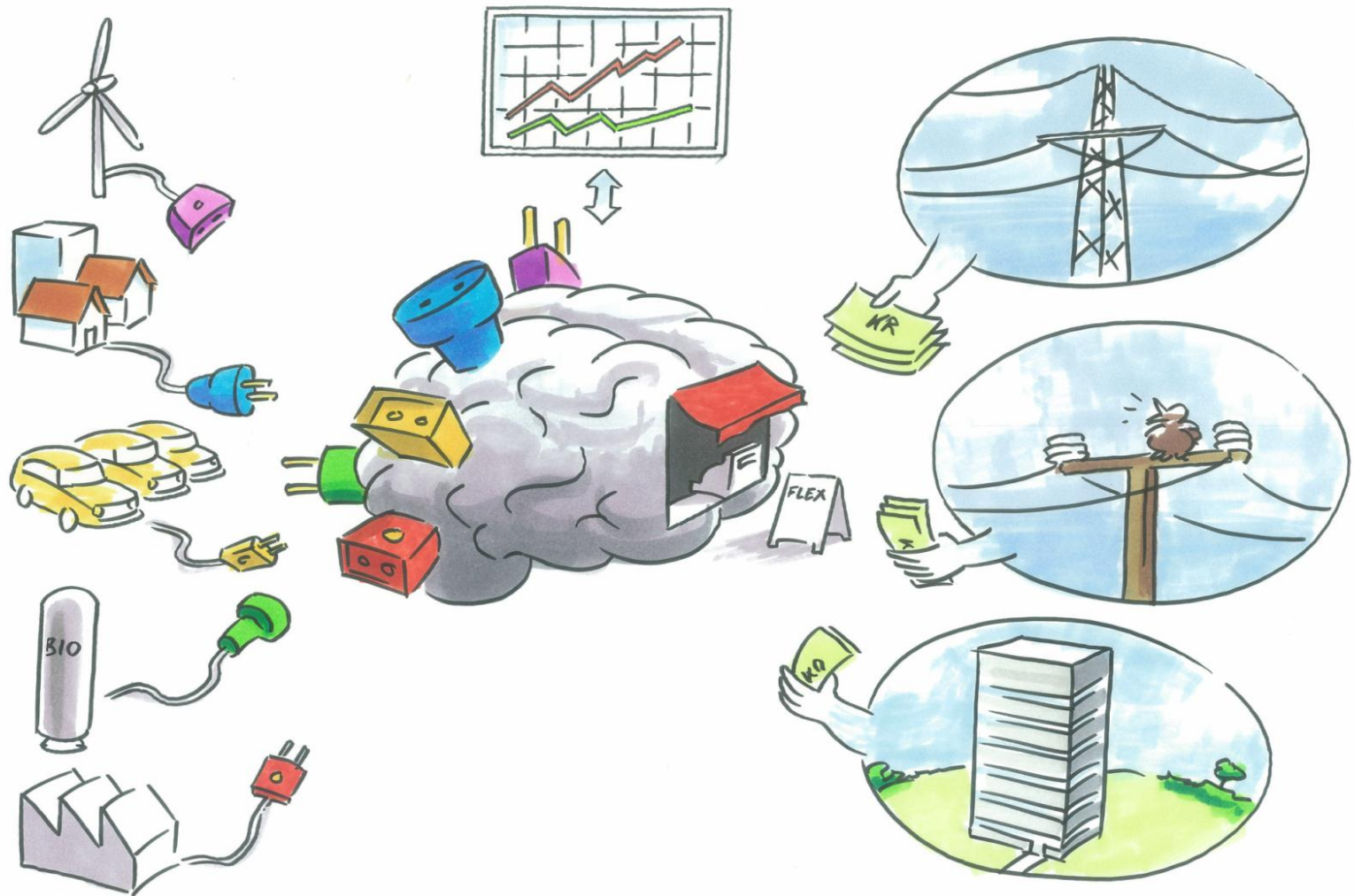
Energinet.dk: Computed power imbalance for Horns Reef 1 & 2 = 400 MW



Fluctuation of -100/+175 MW in 15-20 minutes is possible.

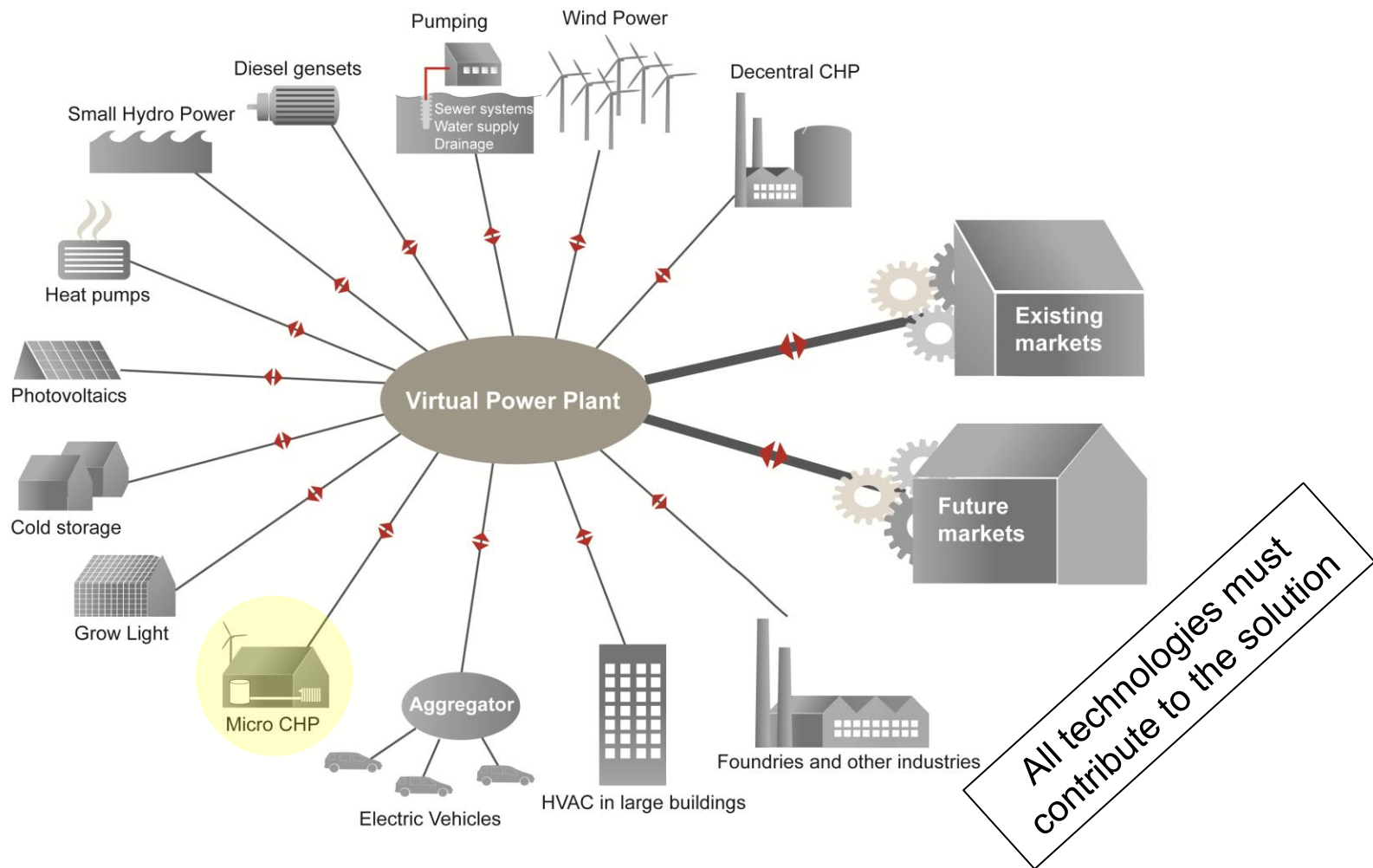
That will require $\sim \frac{1}{4}$ power plant down- and up regulated within 15 minutes.

Flexibility as a commodity ... the artist's impression

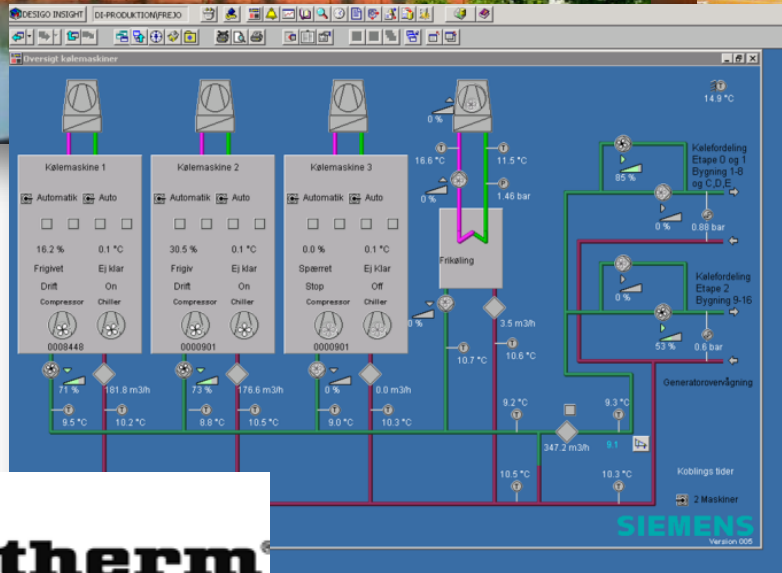
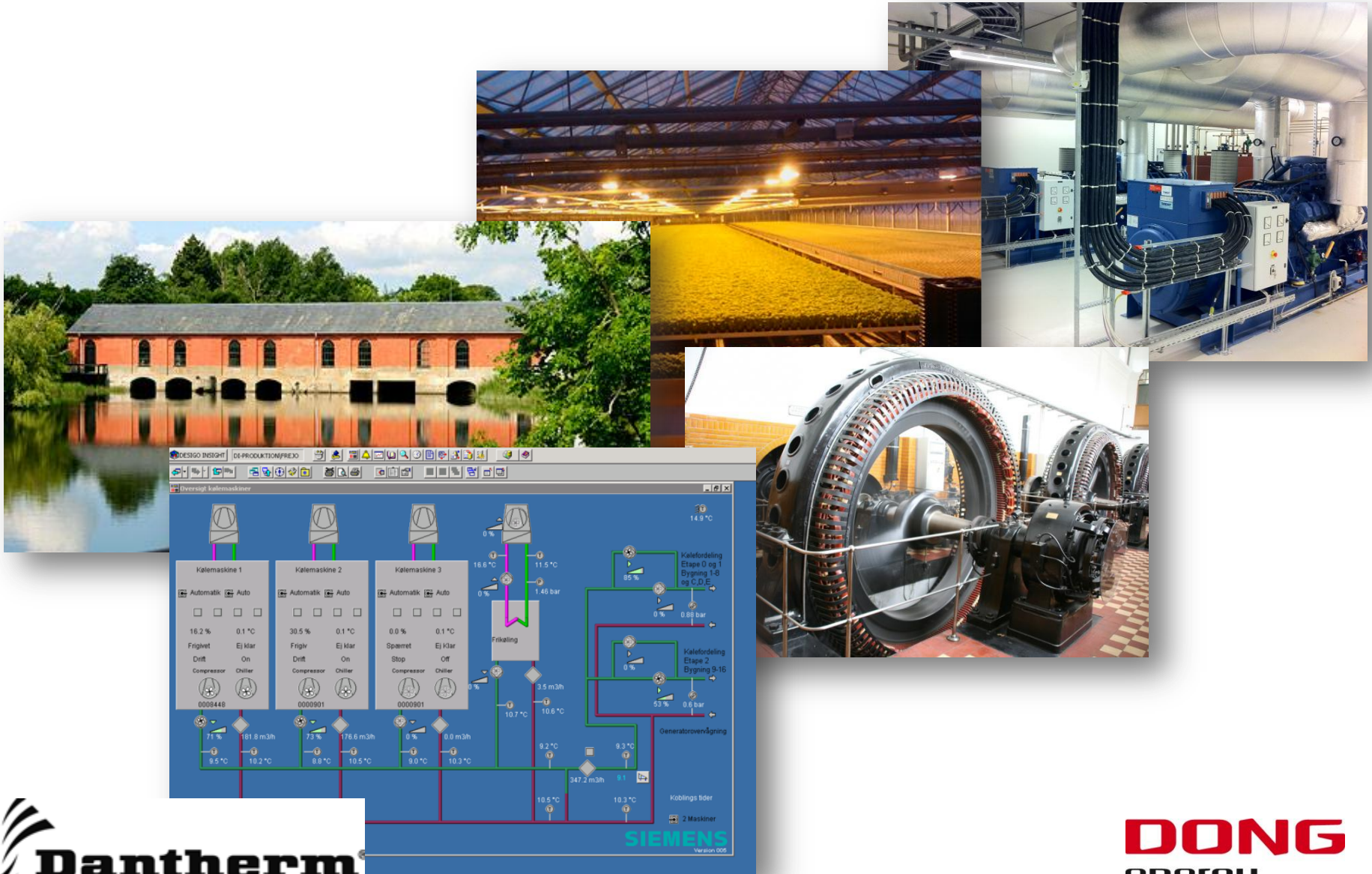


Point of departure – Why VPPs?

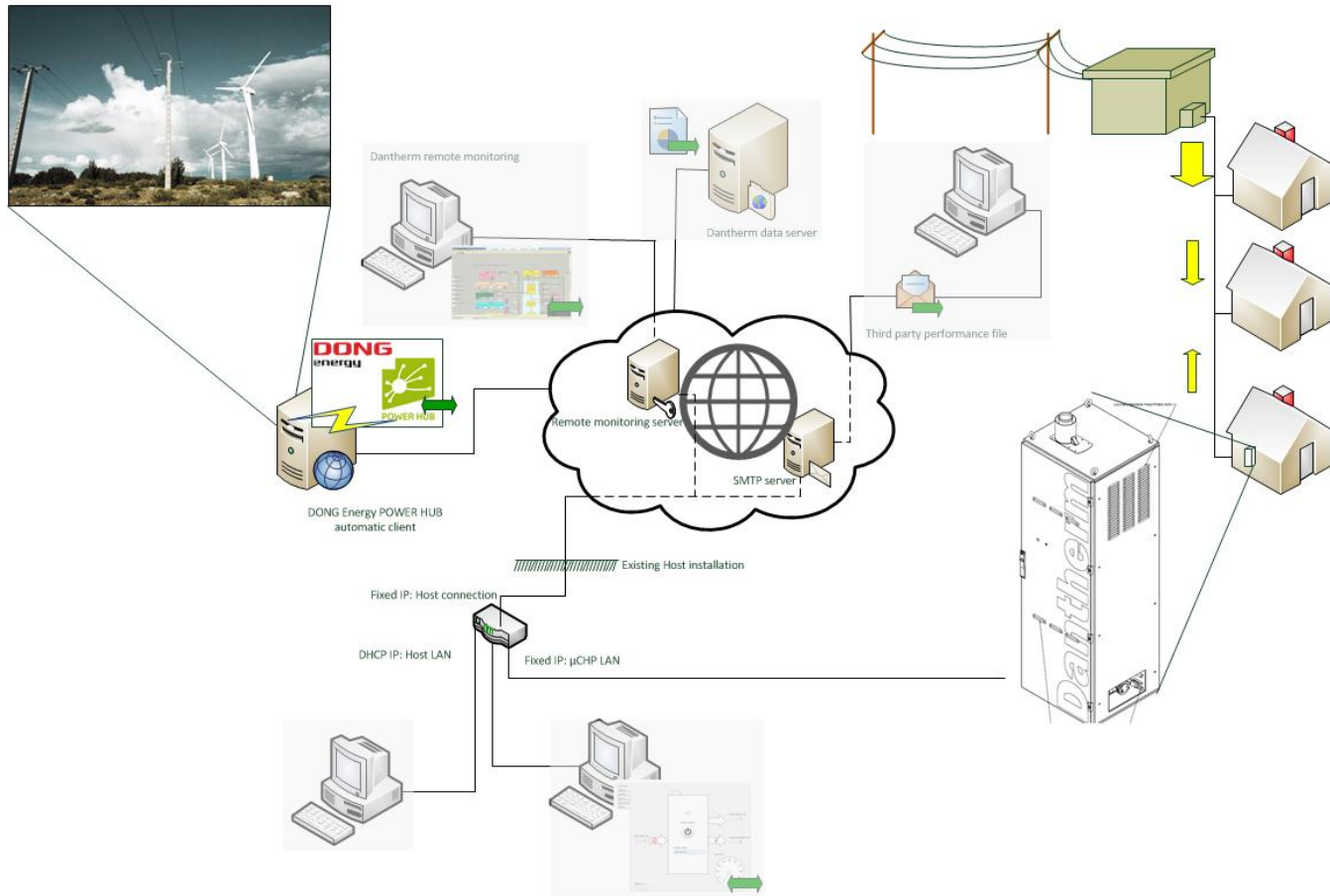
Integration and orchestration of all energy resources and infrastructures



Where do we find flexibility with our customers?



Schematic of setup



Fuel Cells in the Danish Micro Chp project

- A communication protocol - OPC-UA - was set up and successfully tested between DONG Energy's Power Hub system and one LT-PEM Fuel cell system in the second half of 2012.
- The remote control software is embedded in the Fuel Cell controller, so no additional equipment is required.
- Stability tests were initiated in December on five units at DanthermPower.
- Stability test completed in January 2013, and the necessary software updates distributed remotely to three LT-PEM systems so valuable running experiences can be collected during the first half of 2013"

Potential revenue regulating power DK1

- Ready to regulate fee 0,013€ a kW an hour
- Deliver 2-10% of sold capacity ~ 0,05€ pr. kWh

Periode	Mængde	Rådighedsbetaling
1.-6. januar 2013	+/- 90 MW	122 DKK/MW/h
7.-31. januar 2013	+/- 94 MW	120 DKK/MW/h
Februar 2013	+/- 74 MW	201 DKK/MW/h
Februar 2013	+/- 20 MW	97 DKK/MW/h

Regulating power is a free market, ready to regulate fee and price of delivered energy depends on marked bids

Elsport

- Prices
- Volumes
- Capacities
- Flow

Elbas

- Market data
- Volumes
- Initial capacity
- Flow
- Transmission capacity
- Total scheduled flow

Elsport prices

ALL SYS NO SE FI DK EE LT

- further details -

Please note that changes in the Norwegian bidding area: comparison between present and historical data might not be the [area change log pdf](#).

EUR/MWh

	DK1	DK2
18-02-2013		
00 - 01	37,02	37,02
01 - 02	36,51	36,51
02 - 03	35,89	35,89
03 - 04	35,95	35,95
04 - 05	37,44	37,44
05 - 06	38,86	38,86

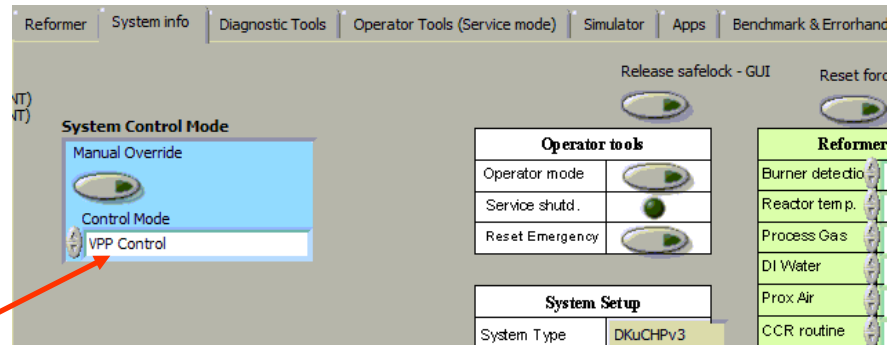
Scope of powerhub test on μ CHP demo

- Testing on four systems
- Fixed schedule and simulated price signal
- “Hands-on” experience with
 - Three different internet provider hardware
 - Capability of software to catch all transferred signals
 - Evaluation of Power Hub server to μ CHP system lag time
 - No conflicts with other use of internet connection
 - Software integration necessary for providing regulating power



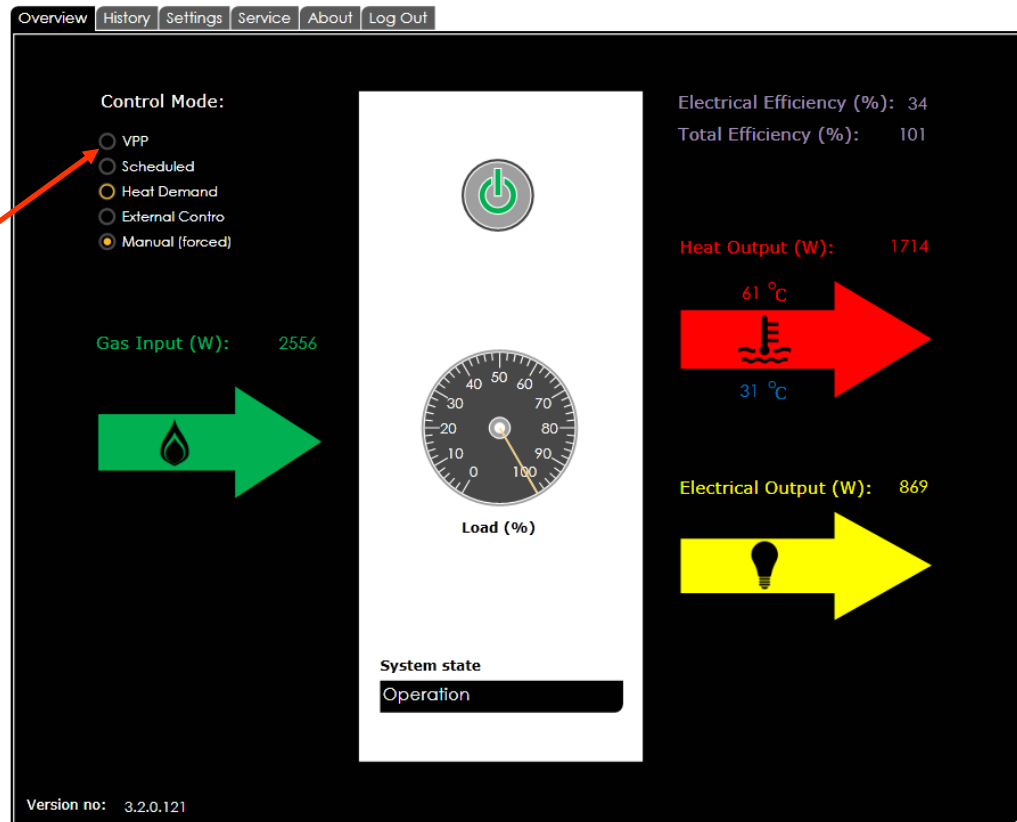
Practical installation of Power Hub integration

- Communication is ethernetbased OPC-UA meaning no extra hardware on μ CHP system is required as existing internet connection is used
- Only start-stop is implemented in test



μ CHP system connection to Power Hub server is during this test, set by Dantherm personel via remote monitoring tool

Intended end installation of Power Hub integration

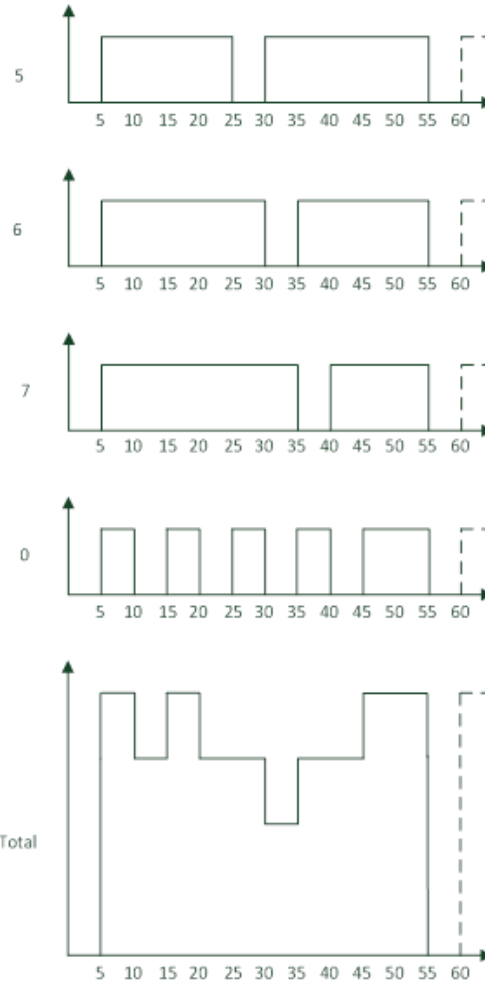


Powerhub enabled,
will be controlled on
user MMI
(Currently disabled)

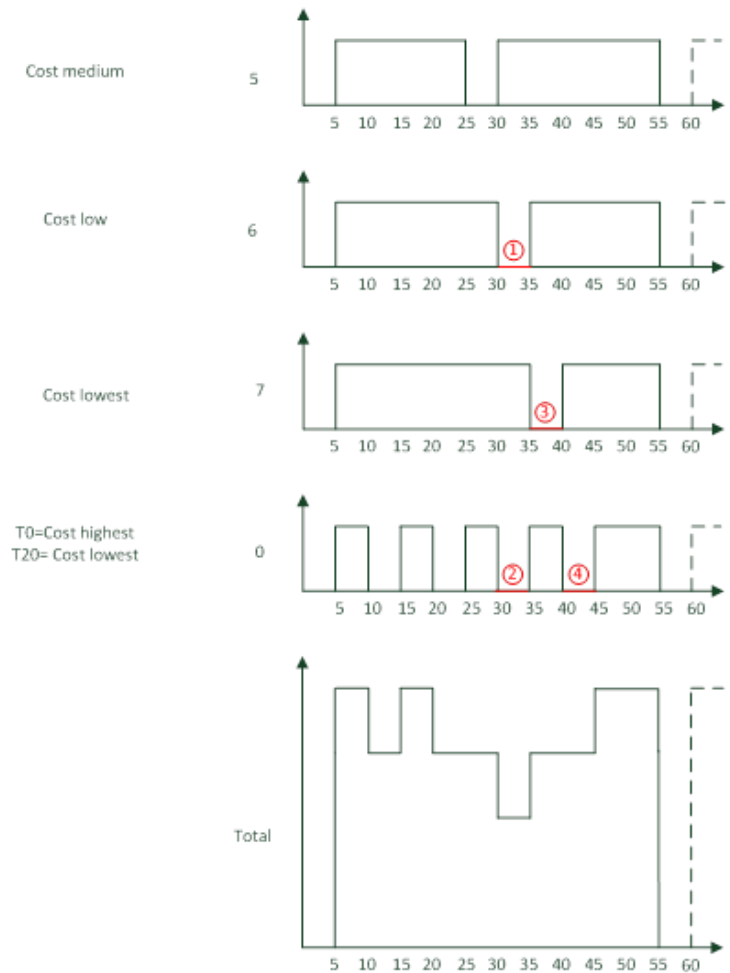
Fixed schedule- first conclusions

- 100% of Start stop signals received
- One of the selected systems had start-up problem (had just been serviced one hour prior to test start), Power Hub correctly quarantined system for 4 hours and sent restart signal
- No disruption of other ethernetbased services
- Only modulating systems will enable delivery of regulating services not start/stop

Fixed schedule- first run completed



Simulated price signal- awaiting test start



- Simulated fault forces system out of VPP
- ① Simulated to high return temperature causes system to shut down, system removes ready signal
- ② Simulated missing communication and high return temperature causes systems to shutdown
- ③ Simulated cabinet temperature causes system to perform fault shutdown and raise fault signal
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