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Grid balancing services with electrolysers

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Centrica Energy Trading (former name NEAS ENERGY)

HyBalance - Hydrogen day 1.008
Brussels, October 8, 2019

Centrica Energy Trading

Managers of Energy: Trading and balancing responsible party (BRP)

CET is part of Centrica's Energy Marketing & Trading (EM&T) business unit. Trading power, gas and LNG

Centrica 2018: Turnover 33 bn € - 29,000 employees

CET 2018: Turnover 9.3 bn € – app. 400 employees

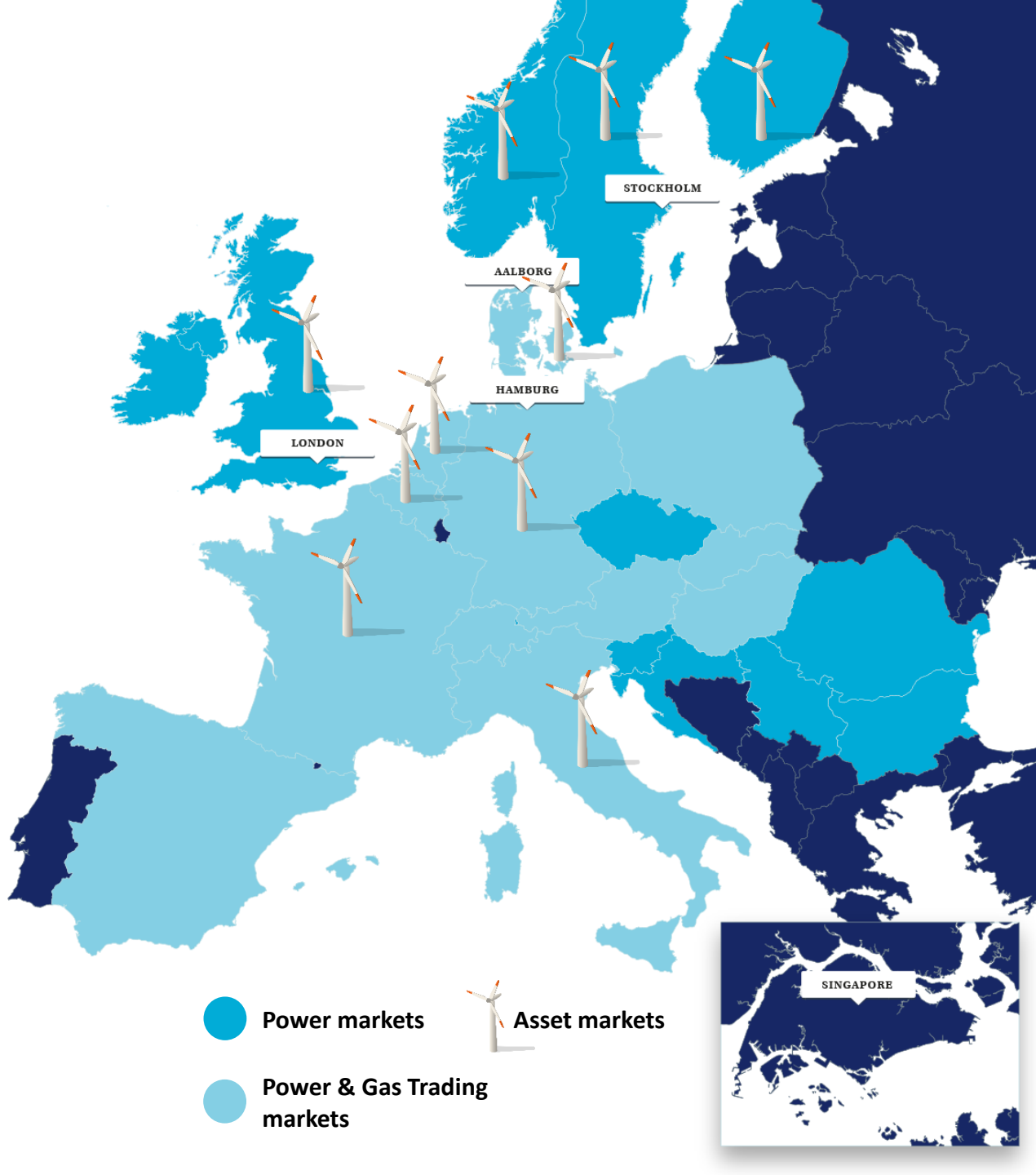
CET customers includes: Power plants, CHP* plants, renewables (wind, PV** and hydro), utilities and supply companies

Our business is built on an integration of energy trading and software services to satisfy the needs and opportunities for our customers with assets in energy markets.

Our headquarter is in Aalborg, Denmark with international offices in the UK, Germany, Sweden and Singapore.

"We are our client's eyes in the market focused on Maximizing Value by Managing Risks"

*CHP: Cogeneration of heat and power. **PV: Photo voltaic (solar electricity production)



Centrica: Our global operations

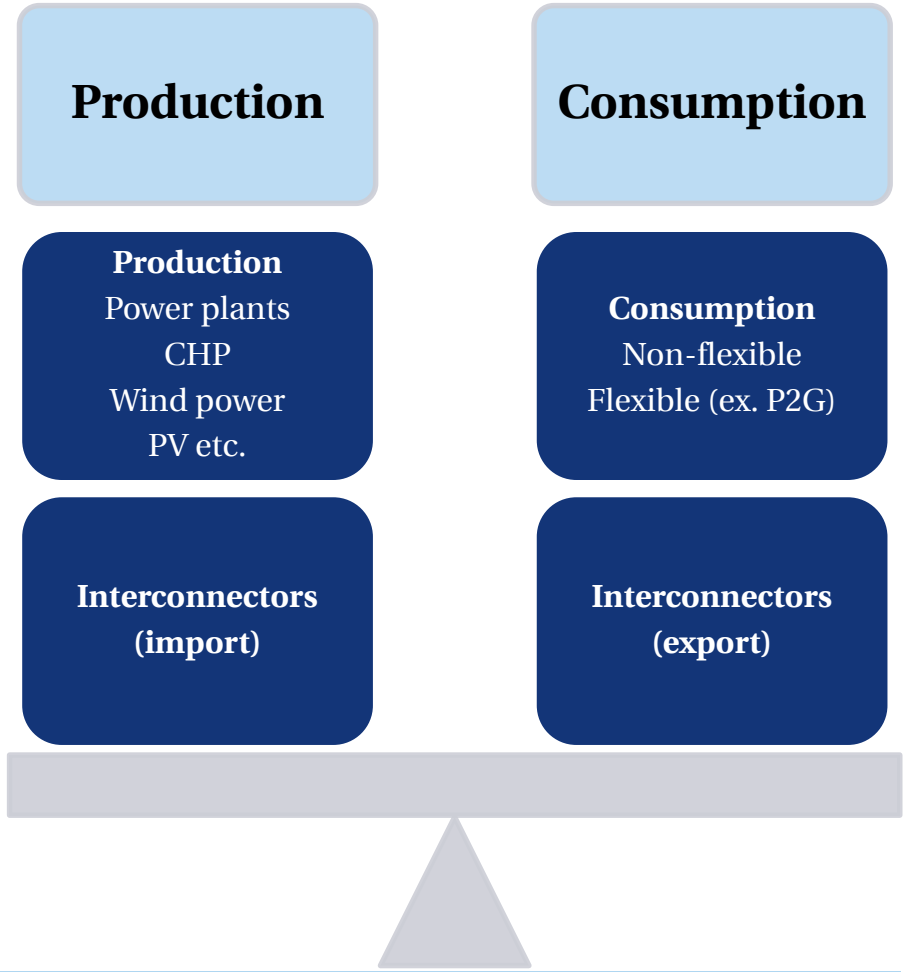
We are expanding our customer base into new geographies and markets.

Excluding dormant entities and head office support functions.

Why is Centrica Energy Trading involved in hydrogen production?

Answer: The electricity system has to be in balance at all times

… and a balance responsible party (like Centrica Energy Trading) is needed



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Centrica Energy Trading - Role in HyBalance

Balance responsible party (BRP)

- Expert knowledge of all electricity markets
- BRP needed for acting in electricity markets

Tasks in HyBalance

- Framework conditions
- Modelling of business case of operation in electricity markets
- Technical set-up of equipment for grid balancing (electricity markets)
- IT-system for bidding in markets
- Presentation of possibilities in electricity markets
- Supporting operation manager with trading strategy

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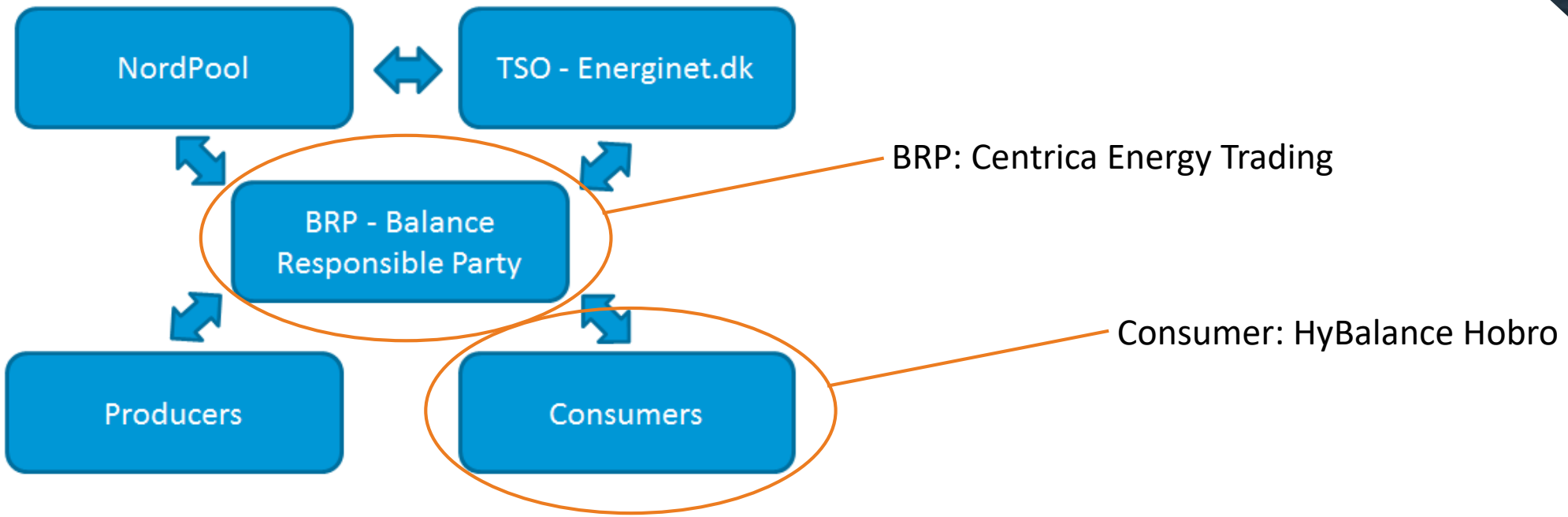
Technical set-up
Communication in the electricity system

Balance responsible party (BRP):

Communication link between system responsible TSO (Energinet), the consumers, the producers and the electricity stock market NordPool



Balance Responsible Parties (BRPs)

All trading in day ahead markets, intraday markets and ancillary services goes through the Balance Responsible Parties

The TSO (in Denmark Energinet) is responsible for the physical system balance

The Balance Responsible Parties has the economic and legal responsibilities for its own balance between:

- Production **sold** and actually **produced**
- Consumption **bought** and actually **consumed**

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Portfolio of customers (Dec. 2018)

Centrica Energy Trading as BRP – Balance Responsible Party

Total - renewables

>7000 MW

Total – CHP

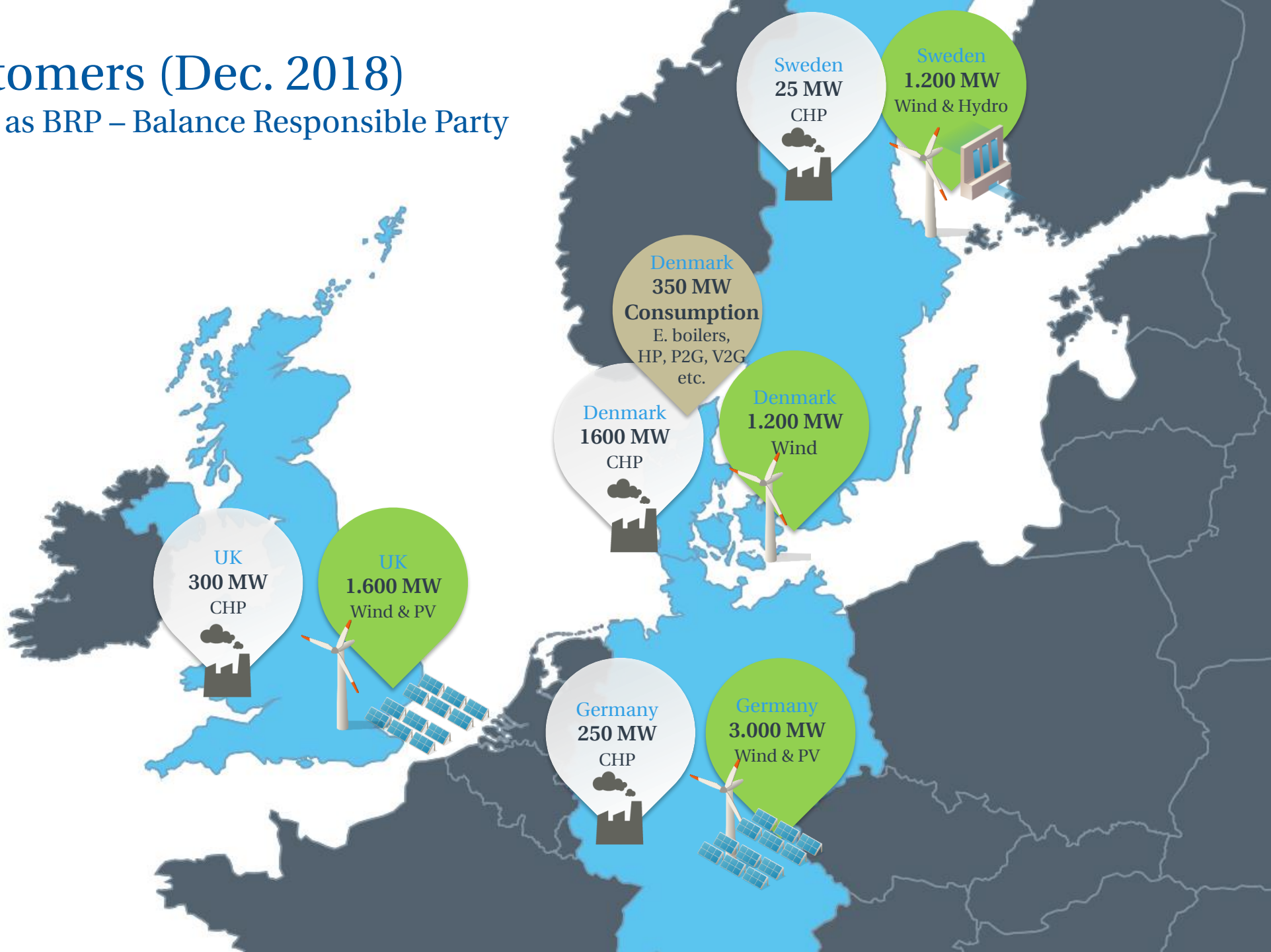
>2100 MW

Flexible consumption

> 350 MW

Total Neas customers

> 9500 MW



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Centrica Energy Trading (former Neas Energy) partner in and balance responsible party for the two large hydrogen plants in Denmark

- HyBalance project, Hobro
- Hydrogen production (PEM)
- Grant from FCHJU (EU) and ForskEl (DK)

- BioCat Avedøre project
- Power-to-gas (methane) plant with biological methanisation including hydrogen production (alkaline)
- Grant from Danish ForskEl

Partner in project BioCat Roslev (2018-2020). Market opportunities for a 8 MW P2G at a biogas plant – supported by Danish fund EUDP

HyBalance installations and bidding

- A remote control box has been installed at the HyBalance Hobro plant
- The performance of the box has been tested by the TSO summer of 2018
- The HyBalance plant performs very well with all requirements

- Neas Direct is accessed through the internet (Centrica Energy Trading bidding tool)
- Bids in the spot market are made the day before by HyBalance in Neas Direct according to
  - How much hydrogen production is needed the following day
  - A bidding price calculated – where the plant will make a profit on hydrogen production
- Bidding in the other markets (intraday, regulating power, frequency regulation) follows
  - Up-regulation bids when the plant is in operation
  - Down-regulation bids when the plant is not in operation

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HyBalance installations and bidding

The HyBalance plant can participate in all possible electricity markets through Neas Direct

- Spot market (day-ahead market)
- Intraday-market (intra-day market)
- Ancillary services
  - Manual reserves (mFRR reserves)
  - Regulating power market (mFRR activation)
  - Automatic reserves (aFRR)
  - Frequency reserves (FCR)

Bids will be sent from CET to NordPool and the TSO and information on the winning bids will be returned later – The operation of the plant will be planned according to bid won in the different markets

Centrica Energy Trading
…operation officer (24/7) - will keep an eye on the plant performance and can call HyBalance if the plant is not running according to bids in the markets

Monday, October 7, 2019

Point of departure

To fulfill the global Paris agreement

- …….all energy systems will see major changes in the coming years

Denmark

- 2030: CO_2 reduction of 70 %
- 2030: NO more fossil fuels in electricity and heat production
- 2050: No more fossil fuels – much more wind and solar

Need for

- More wind and sun, electrification, flexibility, sesonal storages, sector coupling

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Vision
Hydrogen for flexibility in Denmark - pioneer in wind power

- Denmark has a 2017 record of 46 % wind production compared to the annual power consumption
- 2019 the share is expected to be 50 %
- This is possible with a highly intelligent electricity system and flexibility from all production units – and cooperation with the neighbouring countries

Even more need for

- Grid balancing technologies
- Different types of storage

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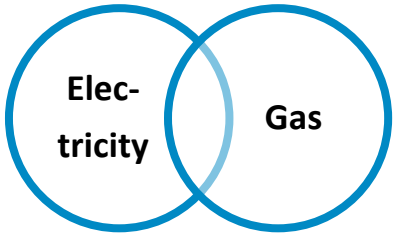
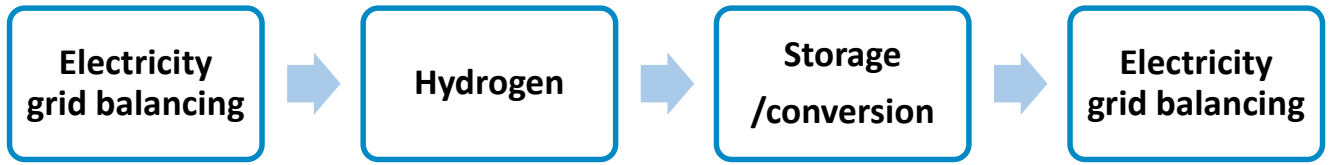
Hydrogen production, electricity and flexibility



Why power-to-hydrogen?

- Integration of the electricity and the gas system
- Long-term storage of electricity
- Hydrogen can be used directly for industry or transport
- Hydrogen can be converted to methane, methanol or ammonia

- Use of storage capacity in the gas system for balancing the electricity system with more intermittent production (wind and solar)



Power-to-x needs to be flexible

- To use P2X flexibility in the electricity system (grid balancing) …
- … P2X needs to participate in the **electricity markets**

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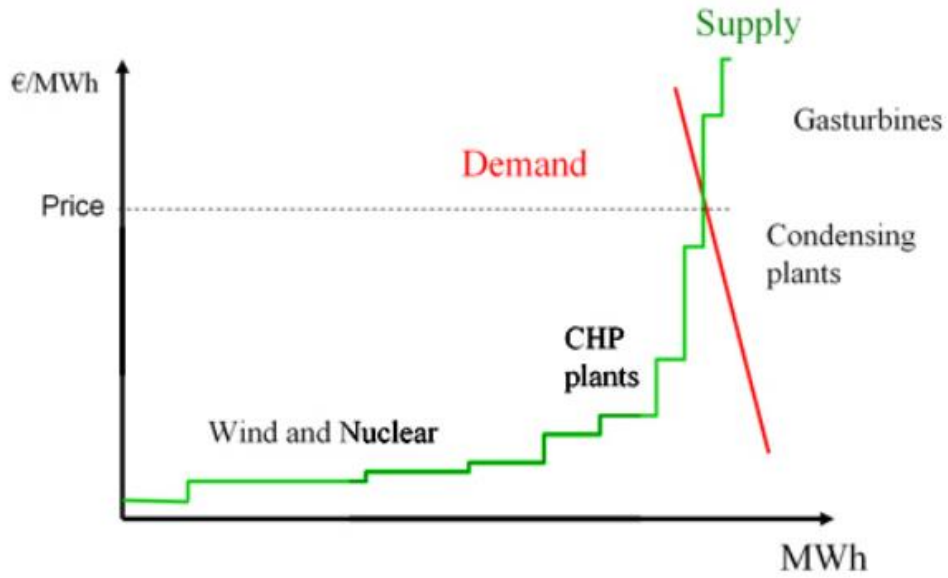
The NordPool Spotmarket

Bidding in the spot market at NordPool

Based on forecasts for production (supply) and consumption (demand) bids are places in the market

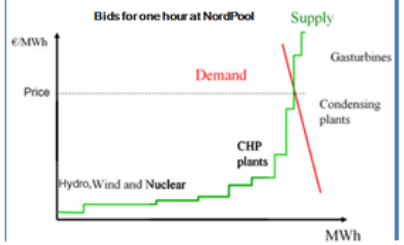
Bids are price dependent – marginal price is essential

Bids for one hour at NordPool:



Electricity markets (West Denmark - DK1)

nordpool spot (balance) | TSO: ENERGINET.DK (imbalance)

Months and years "ahead"	Day ahead	Intra day (operation day)			
Financial markets	Spot market 	Elbas	Regulating power (+ special regulation)	Automatic reserves	Primary frequency reserves
			15 min	15 min.	30 s.

The day before operation day there is a perfect balance between production and consumption for every hour tomorrow

In the day of operation there will be imbalances because of:

- **Errors in wind forecasts, errors in consumption forecasts, errors in planning**
- **Unexpected down time at production plants, unexpected down time on interconnectors between countries**

Energinet.dk maintains balance in the day of operation through different system services (ancillary)

- **Now mostly by production**
- **In the future also by consumption ex. P2G, EV's and heat pumps – that is Smart Energy**

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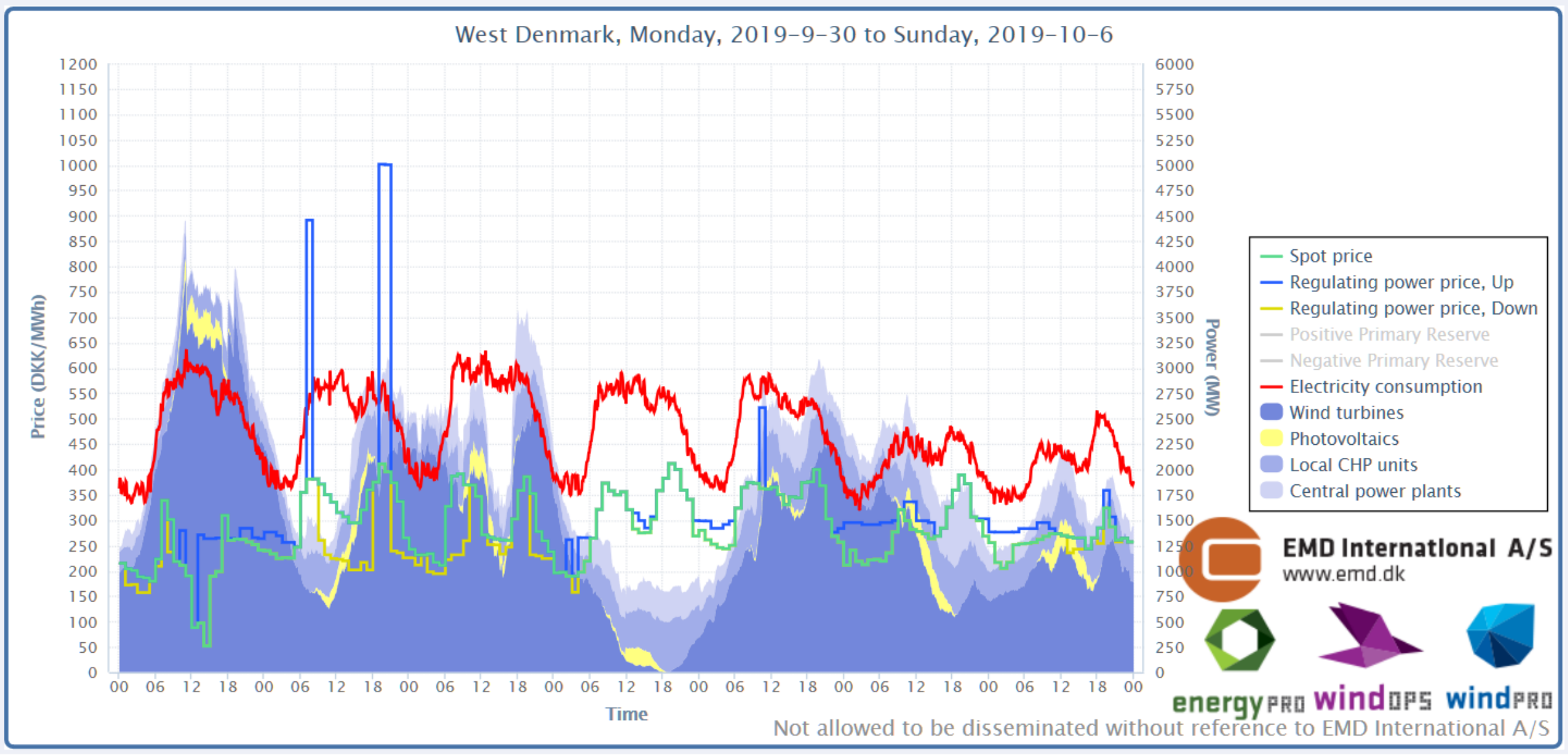
Week 40-2019 in the spot and regulating power markets in Denmark West (DK1)



Source: www.emd.dk/el

Conclusion
Participating in grid balancing (day-ahead/ intraday/ancillary services electricity markets)

Power-to-hydrogen can participate in all the different electricity markets

….to increase profits….

We are ready to advice on market trading strategies valuable for our customers

Operation strategy

There are many different electricity markets that can increase the value of flexibility

It is possible to participate in different markets in the same hour

Please also be aware: Differences in tariffs (fx time-of-use-tariffs) can increase the value of flexibility

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Neas Direct

Managing production and consumption in Neas Direct allows access to advanced tools and data to plan and operate generation and consumption on optimal conditions for maximum value with a minimum of risk and uncertainty.

The software gives access to Centrica Energy Trading's 24/7 operation and trading services:

Forecasting
- Power prices
- Gas prices
- Weather forecasts

Operation
- Scheduling
- Planning
- Remote control
- Reporting

Optimisation
- Production plans
- Day-ahead
- Intraday
- Ancillary services

Thank you very much
for your attention

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