

AGENDA

14.30-15.00: Introduction to Energinet and Energinets role in Danish green transition – Peter Markussen, Senior director, International Relations

15.00-15.30: Transmission connection and development for integration of offshore wind – Anders Steen Kristensen, Head of Grid Planning

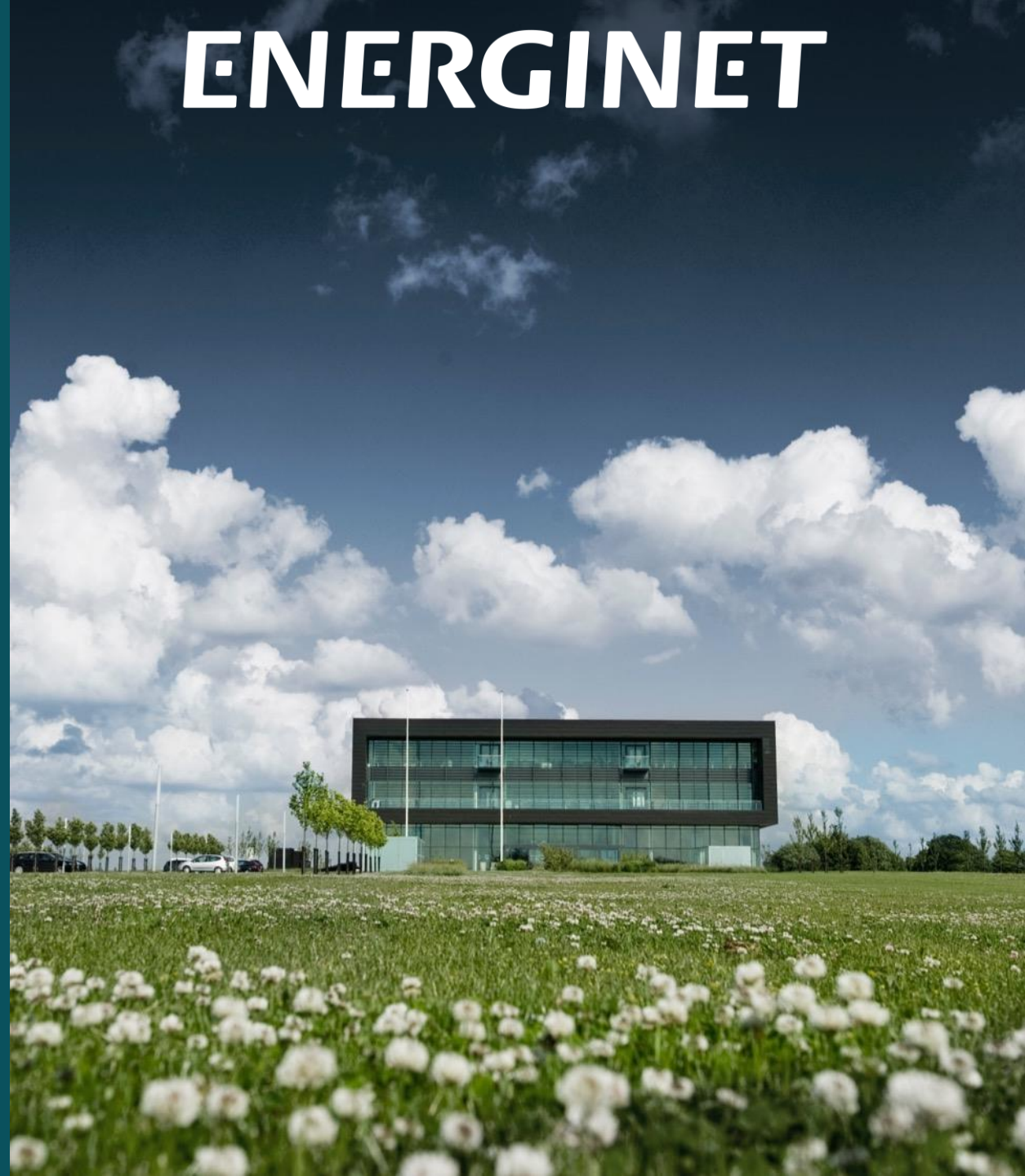
15.30-15.45: Break

15.45-16.15: Increased flexibility from cross border interconnection – Morten Pindstrup, Chief expert, Electricity Markets

16.15-16.45: Energinet experience with digitilisation and open access to energy system data – Gitte Schjøtt Kristensen, Head of Data and System Innovation

16.45-17.00: sum up

ENERGINET



ENERGINET

THE ENERGY BACKBONE

We operate and develop the transmission grids and gas pipelines in Denmark

ENSURE BALANCE

We have the day-to-day and long-term responsibility for the overall electricity and gas system in Denmark

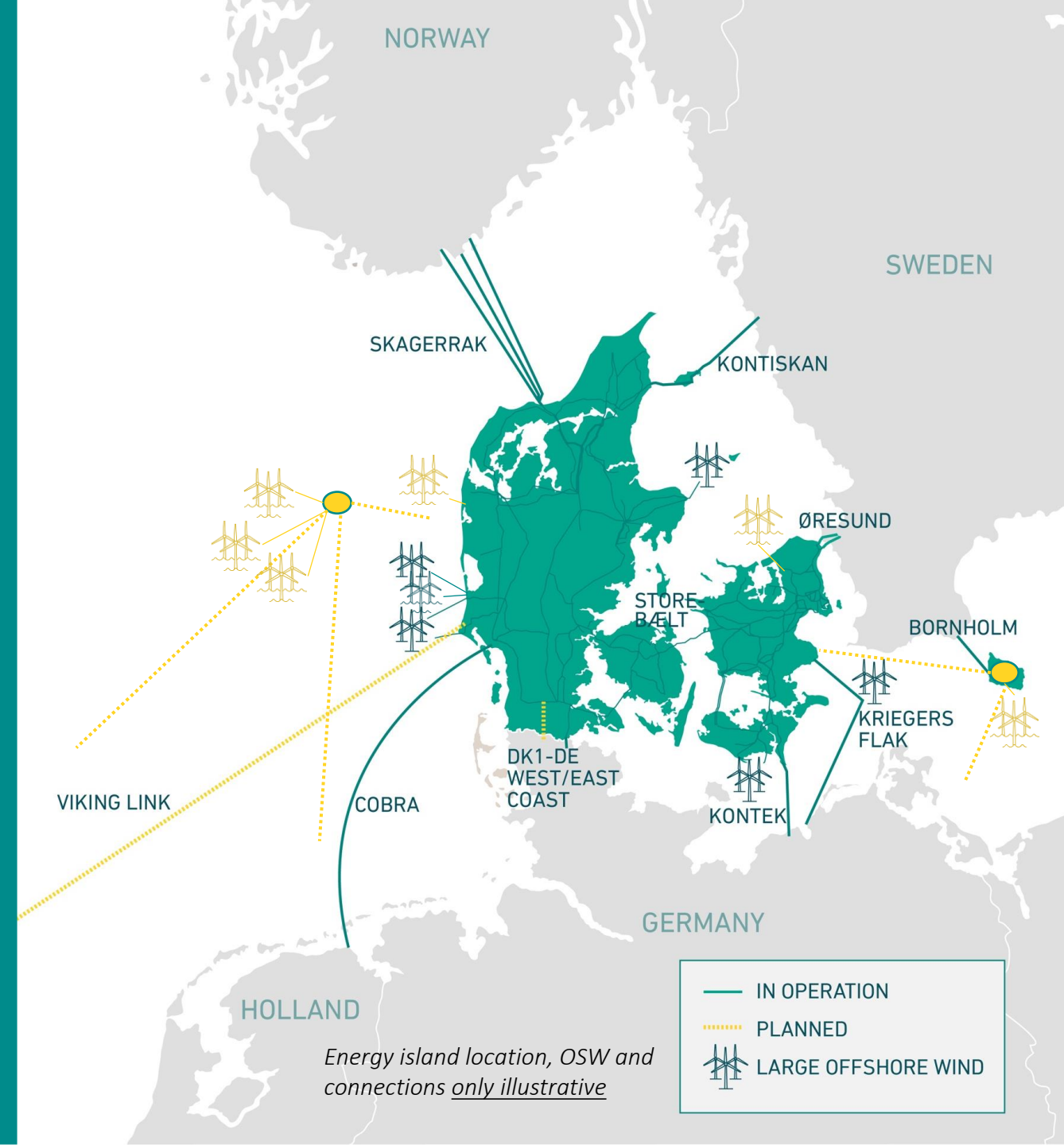
WORKING FOR THE SOCIETY

We are owned by the Danish Ministry of Climate, Energy and Utilities



VISION

GREEN ENERGY FOR A
BETTER WORLD





GREEN TRANSITION

STATUS 2020:

64% green national electricity production

50% green solar and wind electricity production

37% green energy system

2030 TARGET:

100% green electricity production

70% reduced emissions

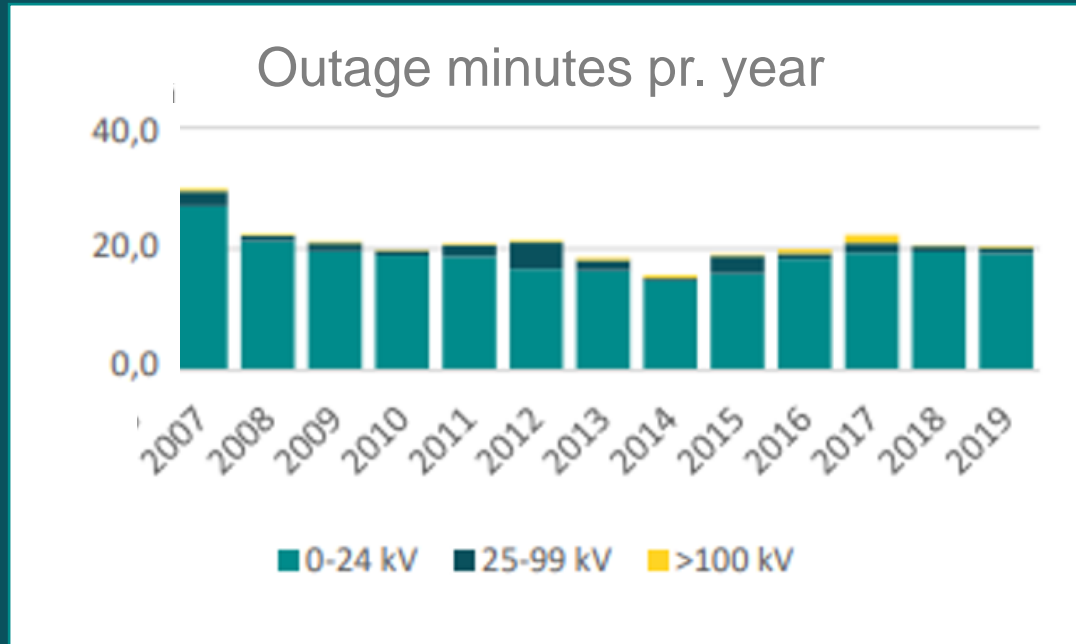
2050 TARGET:

DK=climate neutral

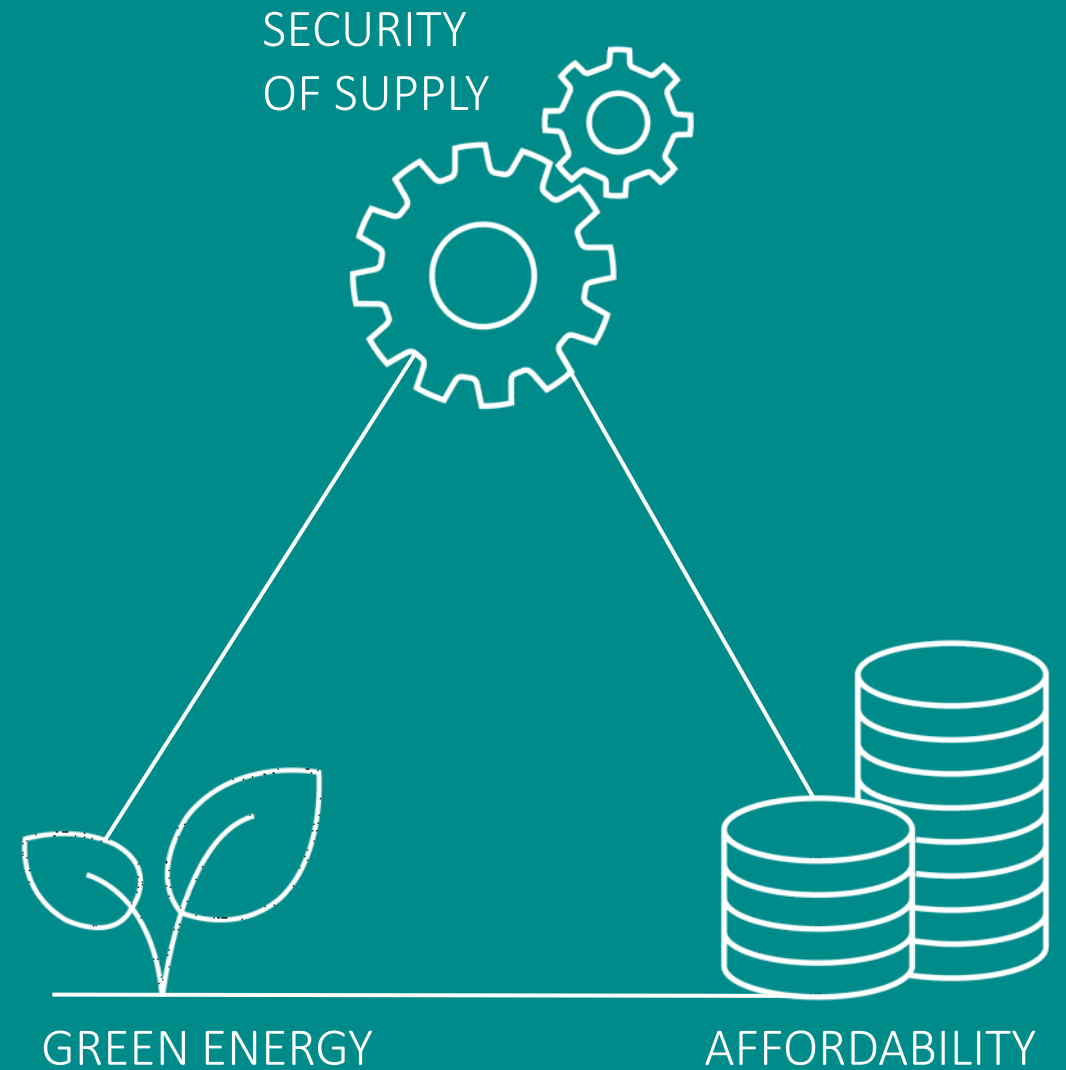
100% green energy system

WE ENSURE BALANCE MINUTE BY MINUTE

99,996% security of supply in Denmark in period with increasing share of renewables

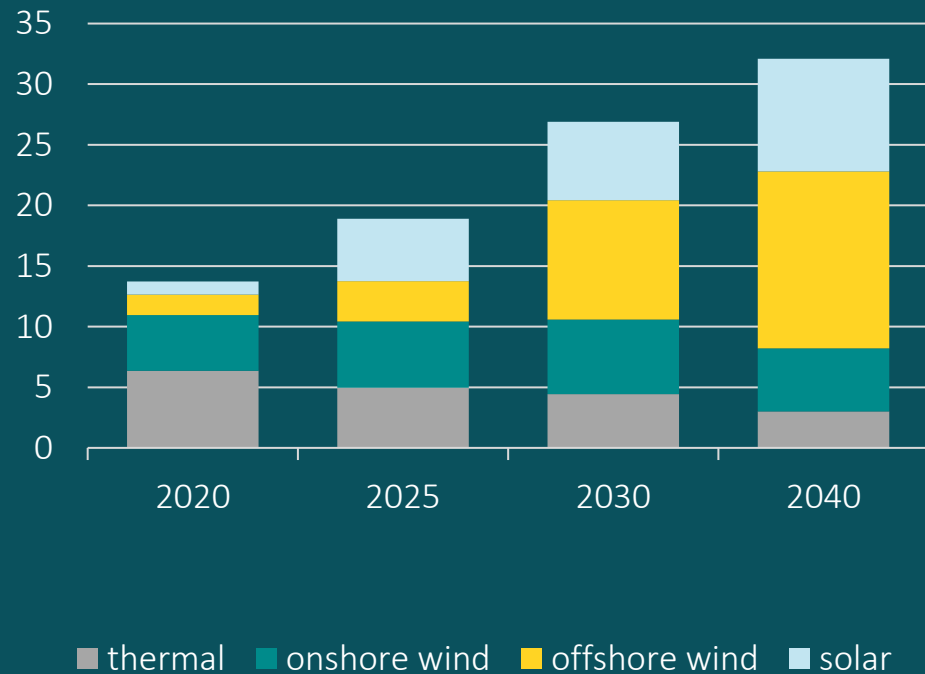


A BALANCING ACT

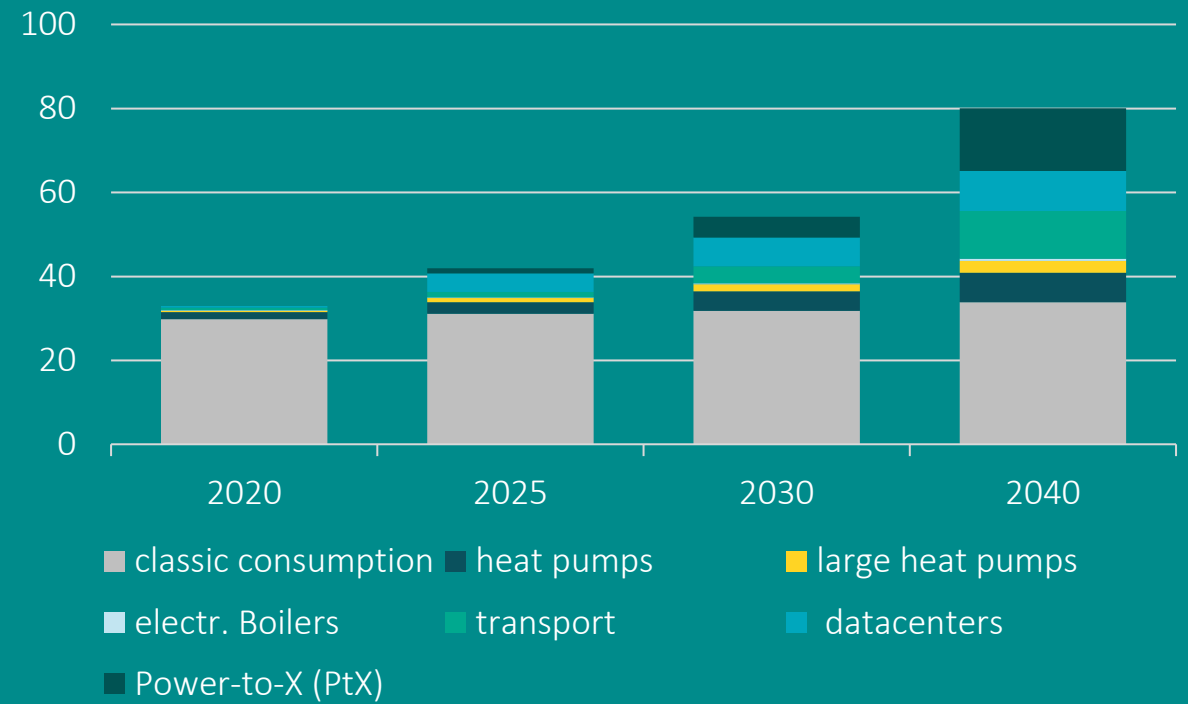


EXPECTED DEVELOPMENT OF DANISH ELECTRICITY SYSTEM TOWARDS 2030

Electricity production capacity, GW



Electricity consumption, TWh



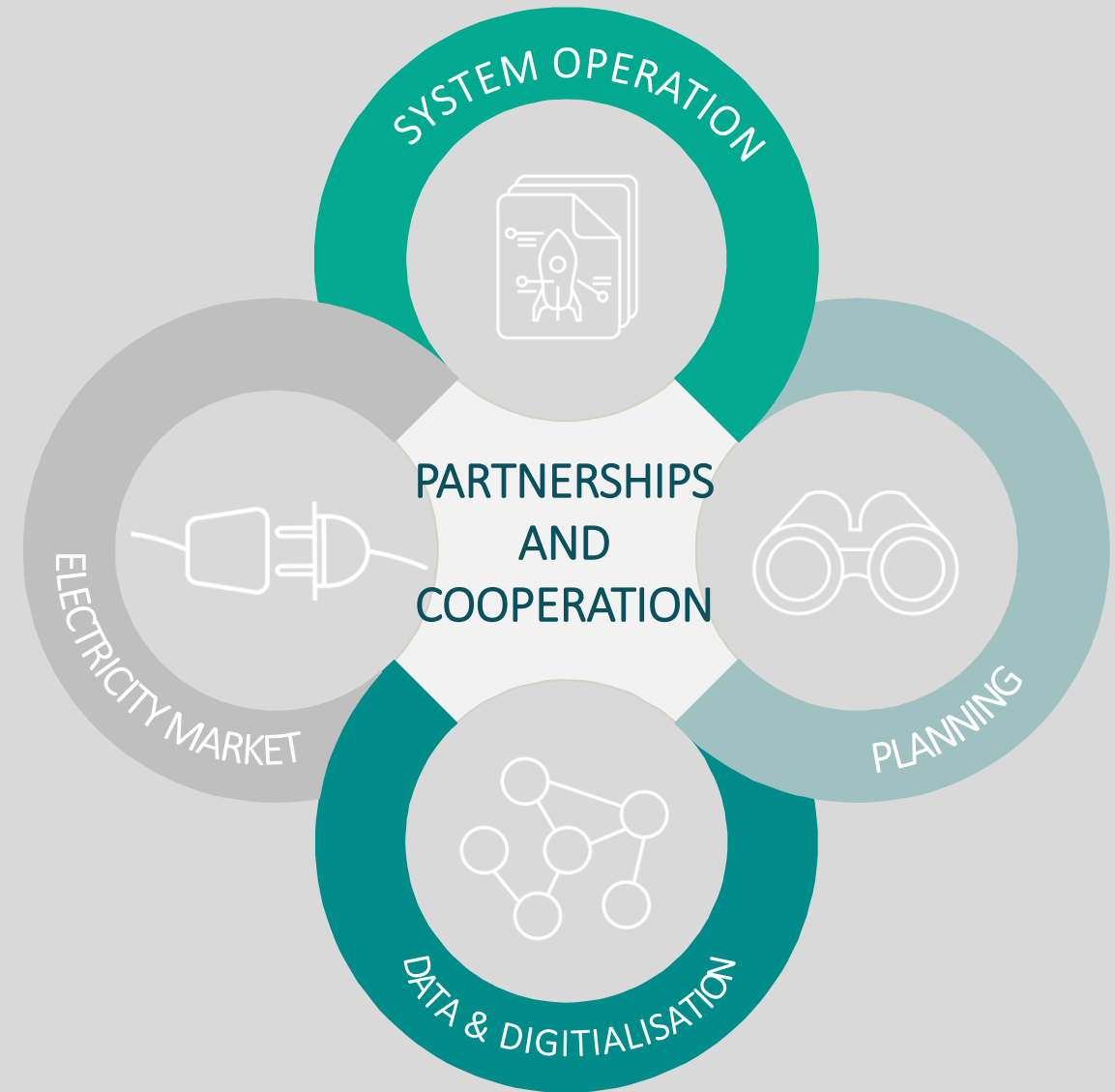
HOW TO INTEGRATE VARIABLE RENEWABLES

ESTABLISHED TOOLS

- Strong grid and interconnections
- Cross border electricity and gas markets
- Specialised analyses and models
- Long-term planning

NEW TOOLS

- Activation of consumers and flexibility
- Sector coupling (electricity, gas, heating, transport)
- Market incentives and operational optimisation
- New players and partnerships
- Digitalization and open access to data



SOLUTIONS FOR AFFORDABLE GREEN TRANSITION

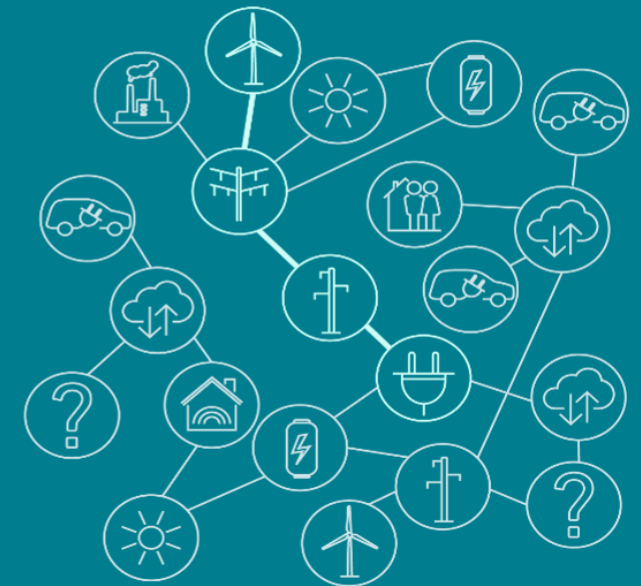
LARGE SCALE SOLUTIONS



INTERNATIONAL COOPERATION



ELECTRIFICATION AND DIGITAL TRANSFORMATION



AGENDA

14.30-15.00: Introduction to Energinet and Energinets role in Danish green transition – Peter Markussen, Senior director, International Relations

15.00-15.30: Transmission connection and development for integration of offshore wind – Anders Steen Kristensen, Head of Grid Planning

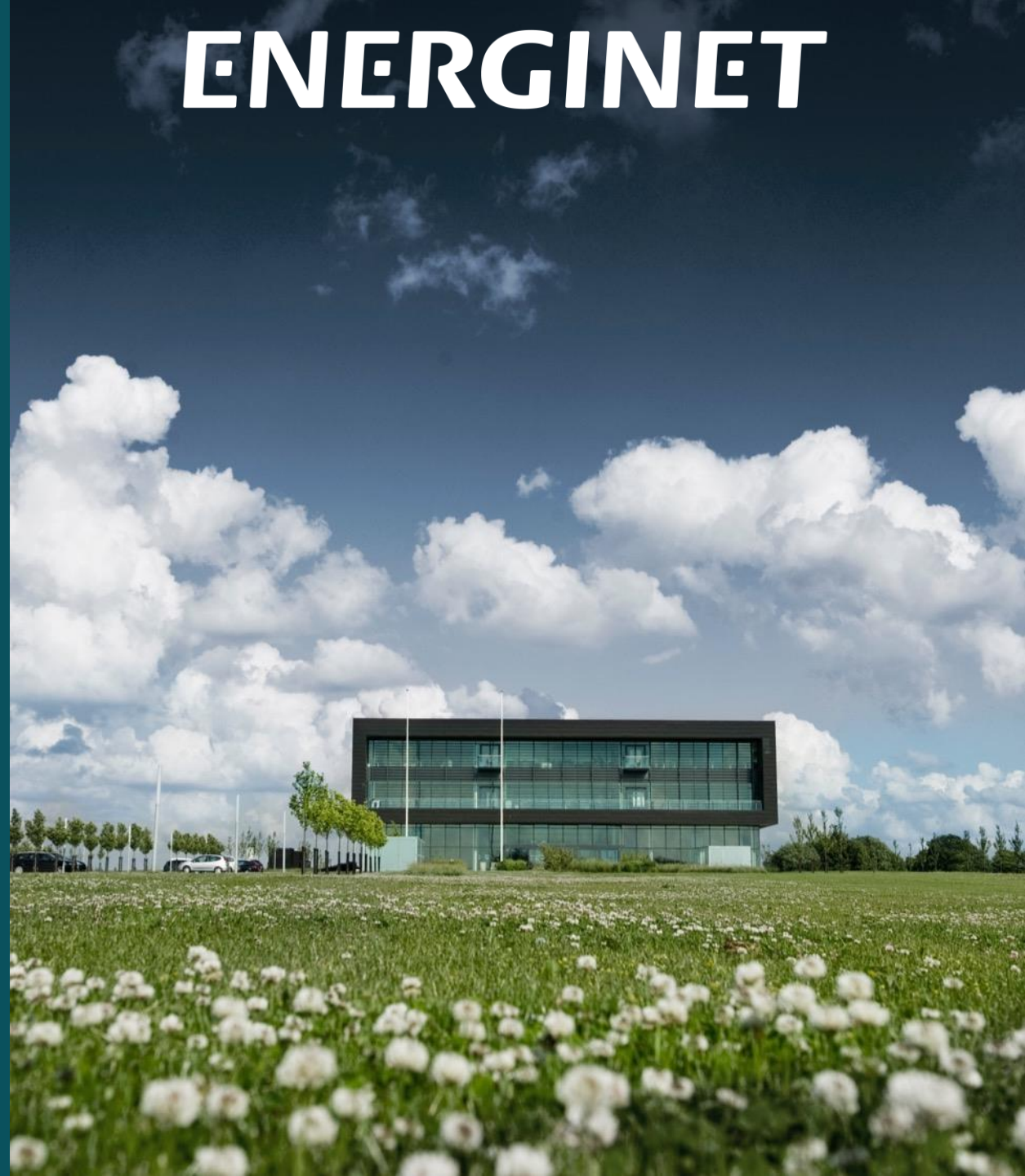
15.30-15.45: Break

15.45-16.15: Increased flexibility from cross border interconnection – Morten Pindstrup, Chief expert, Electricity Markets

16.15-16.45: Energinet experience with digitilisation and open access to energy system data – Gitte Schjøtt Kristensen, Head of Data and System Innovation

16.45-17.00: sum up

ENERGINET



WIND

Onshore and offshore



Horns Rev C - 2016



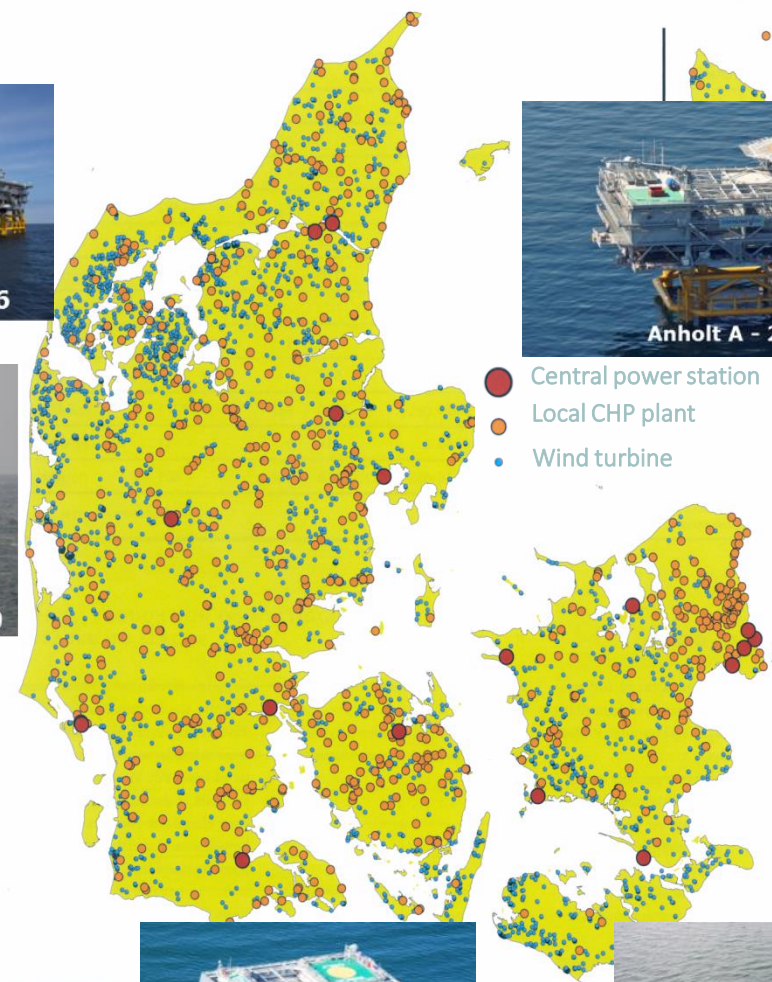
Anholt A - 2012



Horns Rev B - 2009



Horns Rev A - 2002



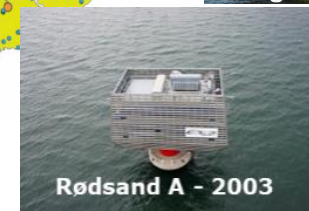
- Central power station
- Local CHP plant
- Wind turbine



Kriegers Flak 2020



Rødsand B - 2010



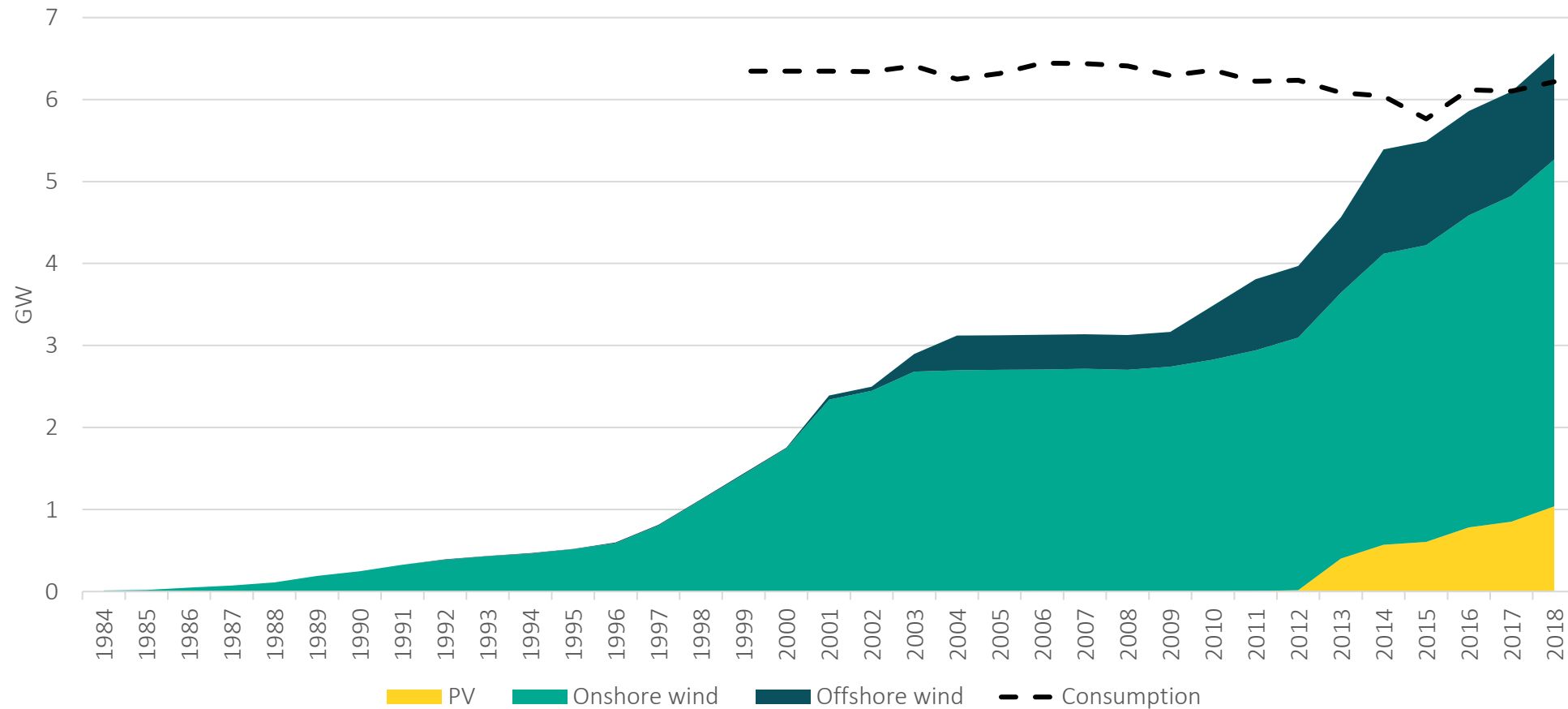
Rødsand A - 2003

KILDE: ENERGISTYRELSEN, EN
VINDMØLLEKOORDINATER, KG

<http://www.sout>

HISTORICAL GROWTH IN RENEWABLE

RE-potentiale + long term base case development



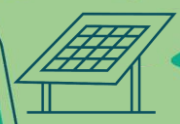
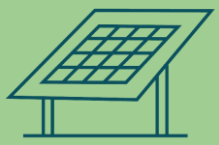
CHANGE IN PLANNING PERSPECTIVE

The North Sea:
3 GW offshore wind by
2030, later 10 GW.

- Massive amounts of PV on market terms are coming in fast
- New consumption is unknown
- From consumption dominated to production dominated
- Many reinvestments necessary

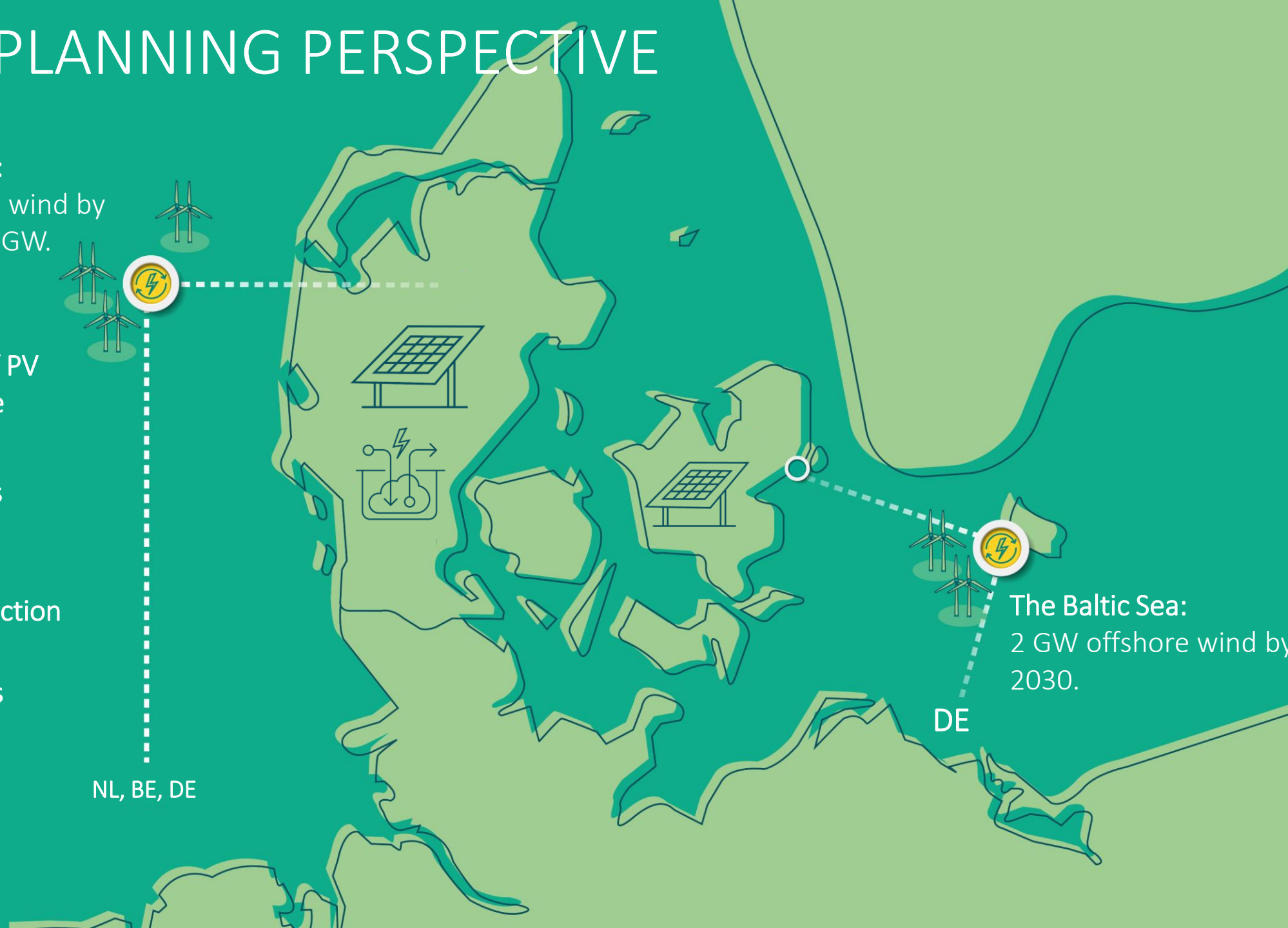


NL, BE, DE

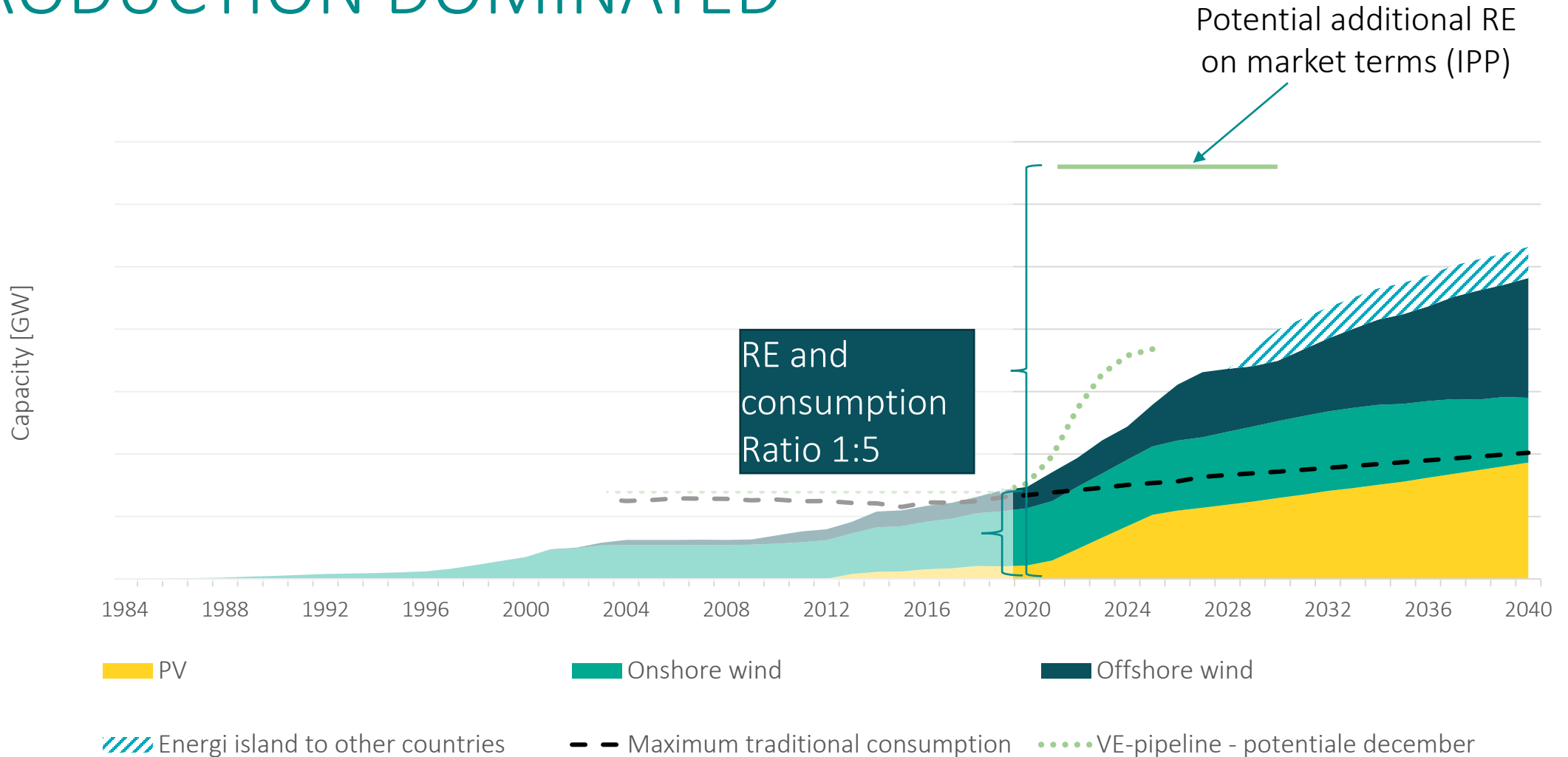


The Baltic Sea:
2 GW offshore wind by
2030.

DE

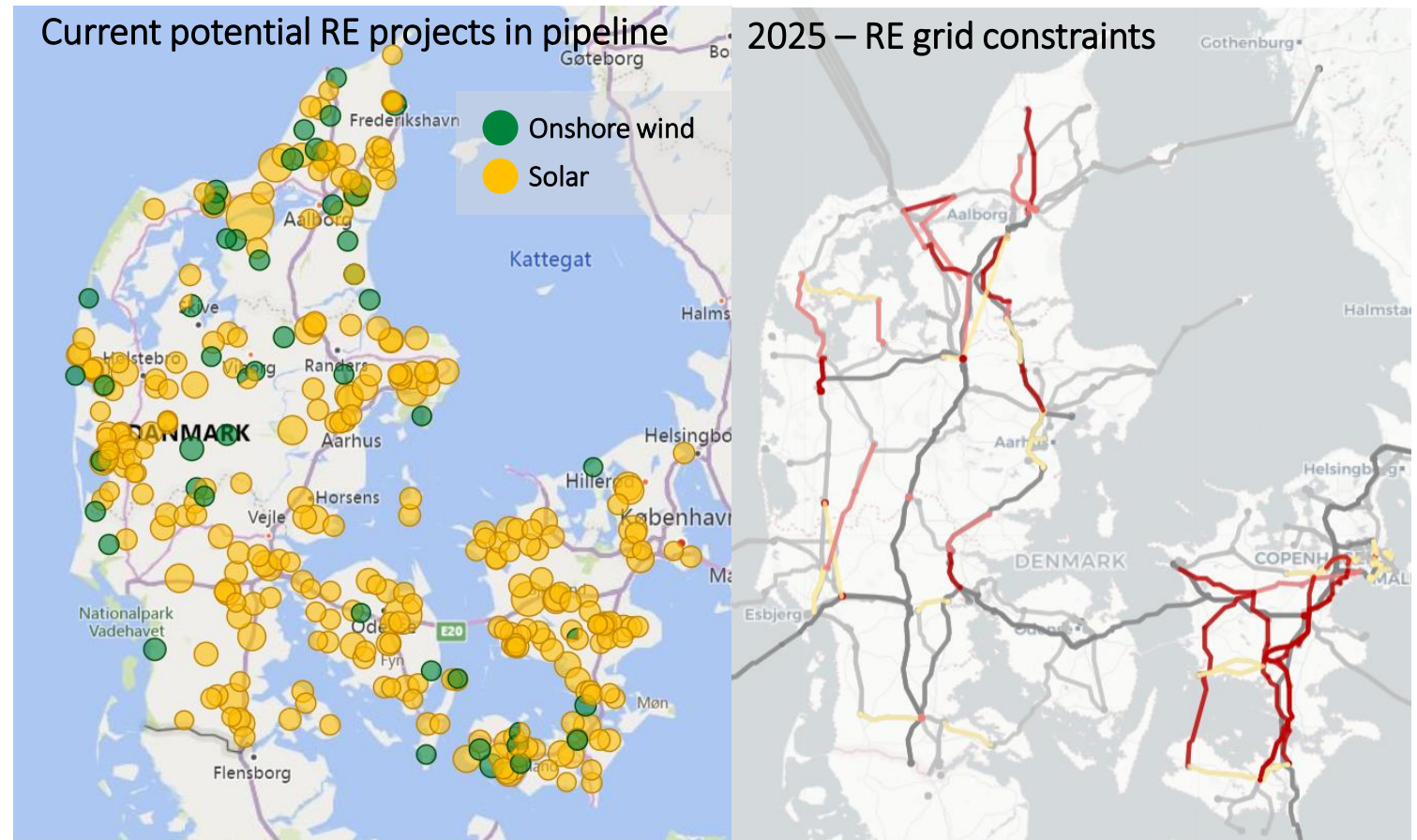


FROM CONSUMPTION DOMINATED TO PRODUCTION DOMINATED

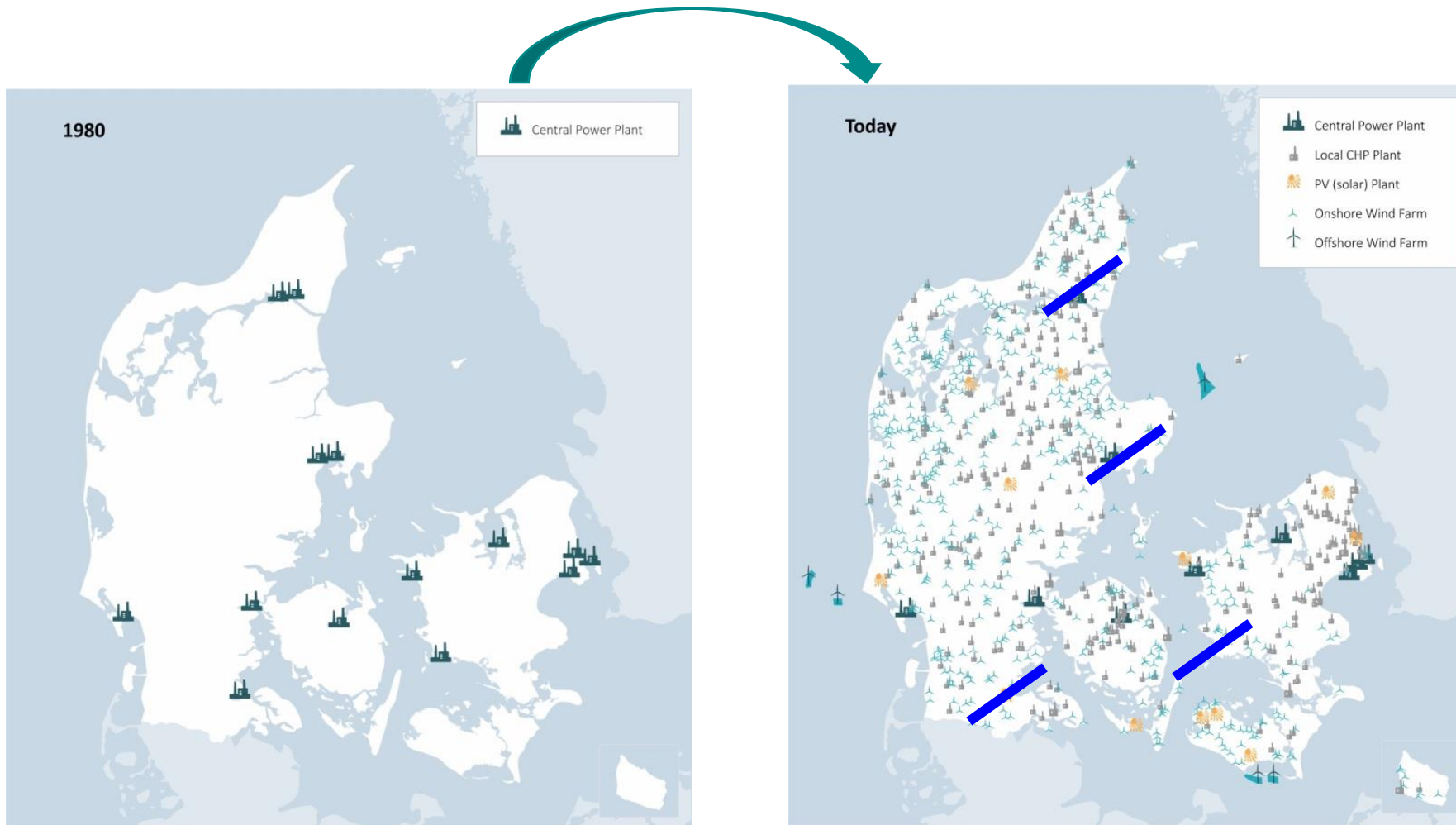


LACK OF INCENTIVES FOR OPTIMAL GRID LOCATION

- Obligated to connect
- Distribution of costs
- Compensation



PHASING OUT THERMAL POWER PLANTS




HIGH FLEXIBILITY OF FEW EXISTING POWER PLANTS

Operational range:
10–100%

Regulating rate:
3-4% per minute

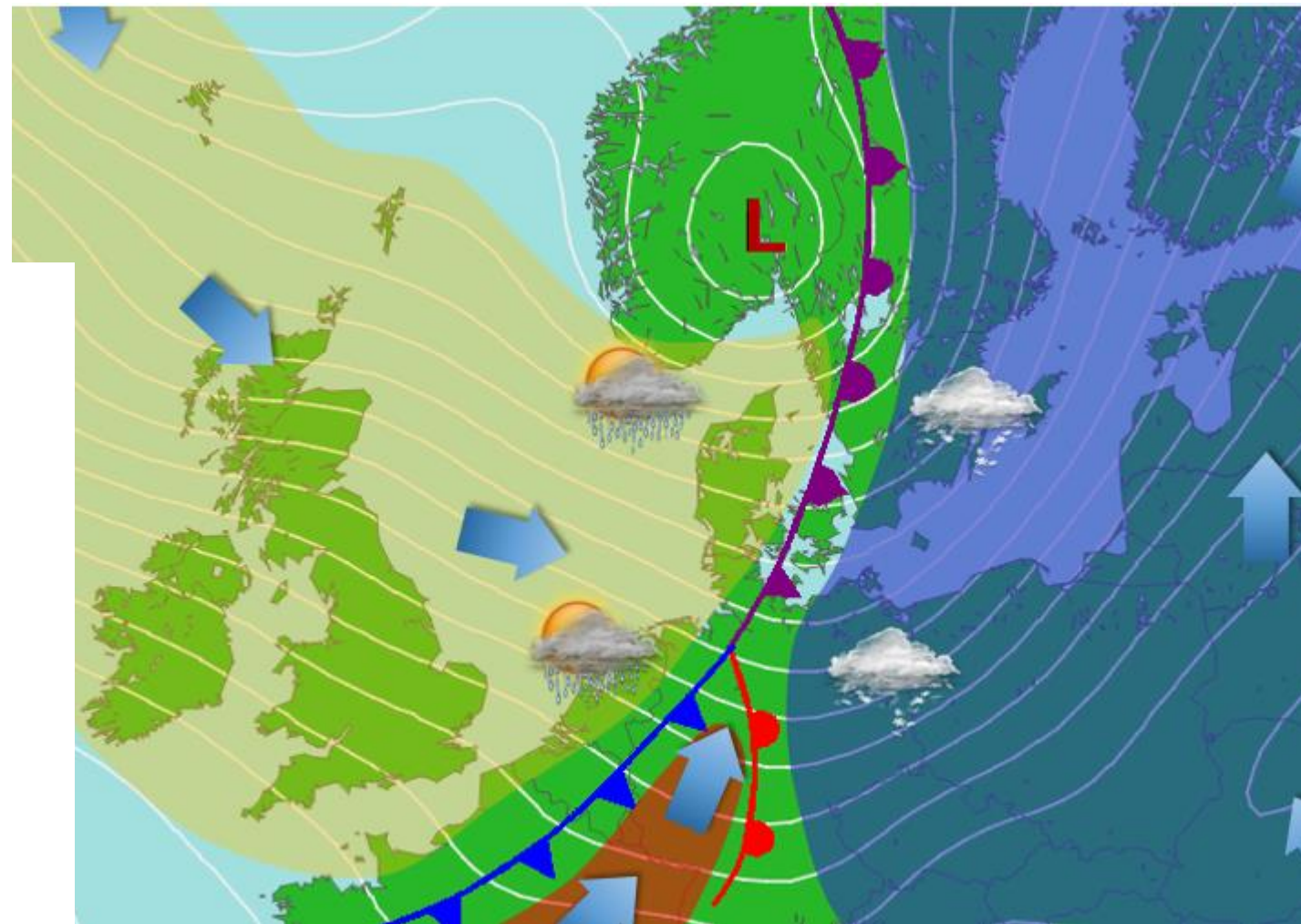
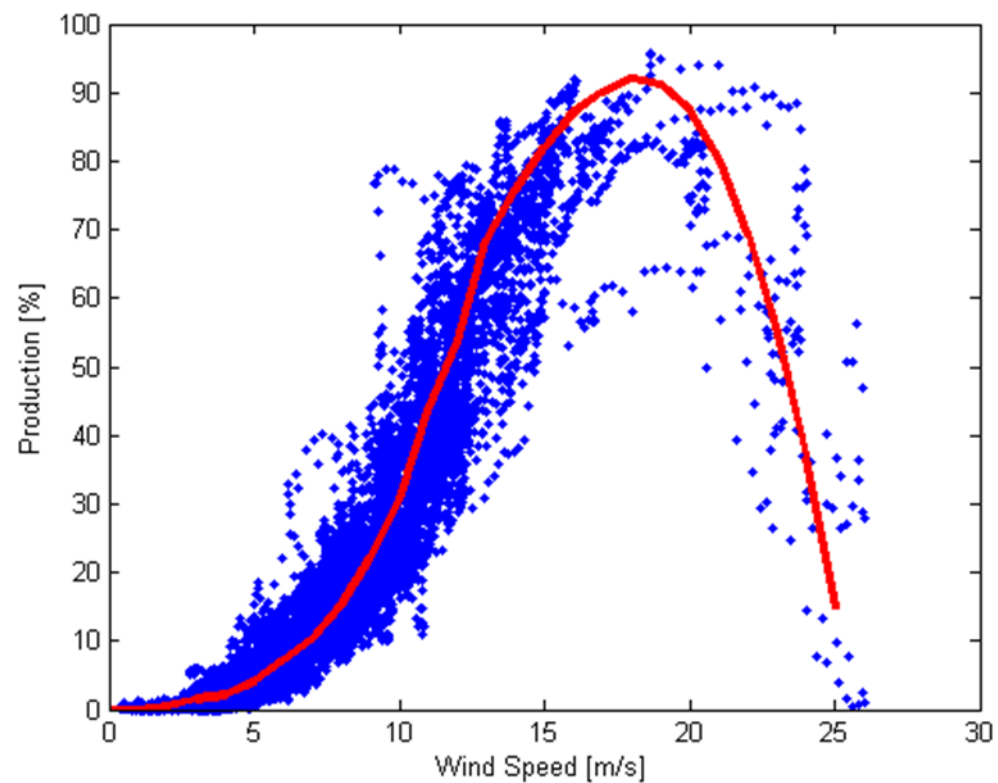
Heat accumulators and
electric boilers



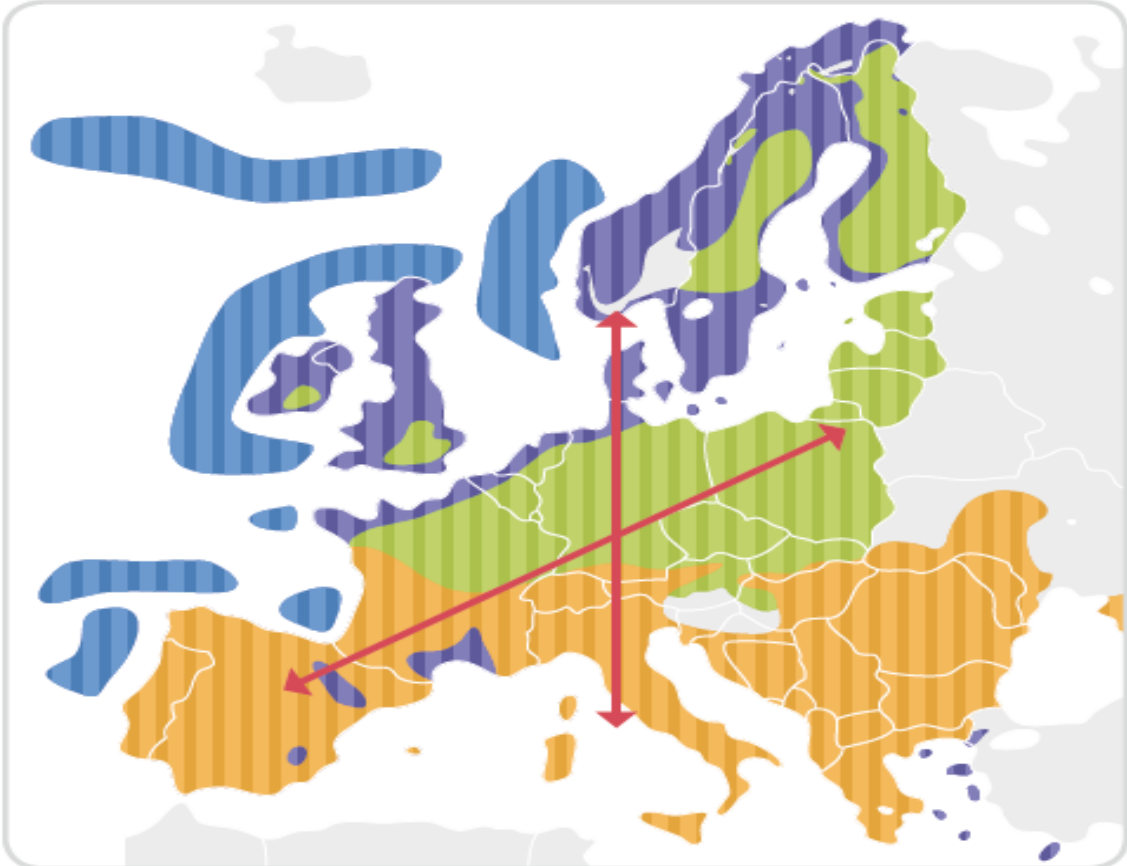
Technical key data of Esbjergværket CHP Plant	
Commissioned	1992
Max power production (net)	378 MW
Max district heat production	460 MJ/s
Coal consumption at full load	120 t/h
Oil consumption at full load	73 t/h
Steam pressure	251 bar
Steam temperature	560 °C

Source: Dong Energy

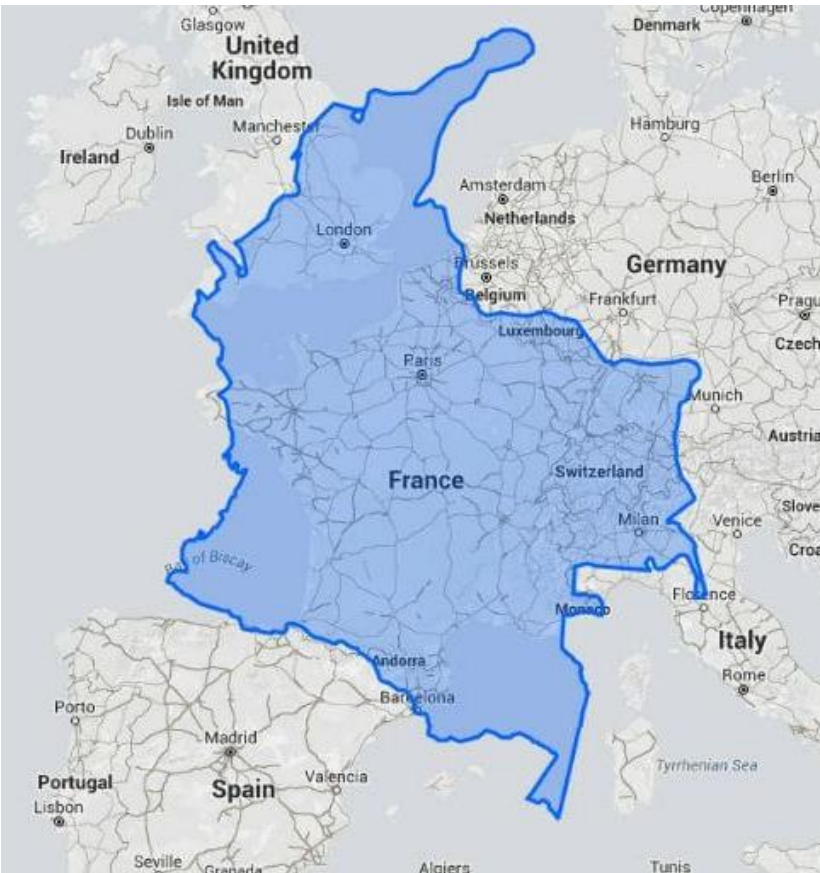
POWER CURVE



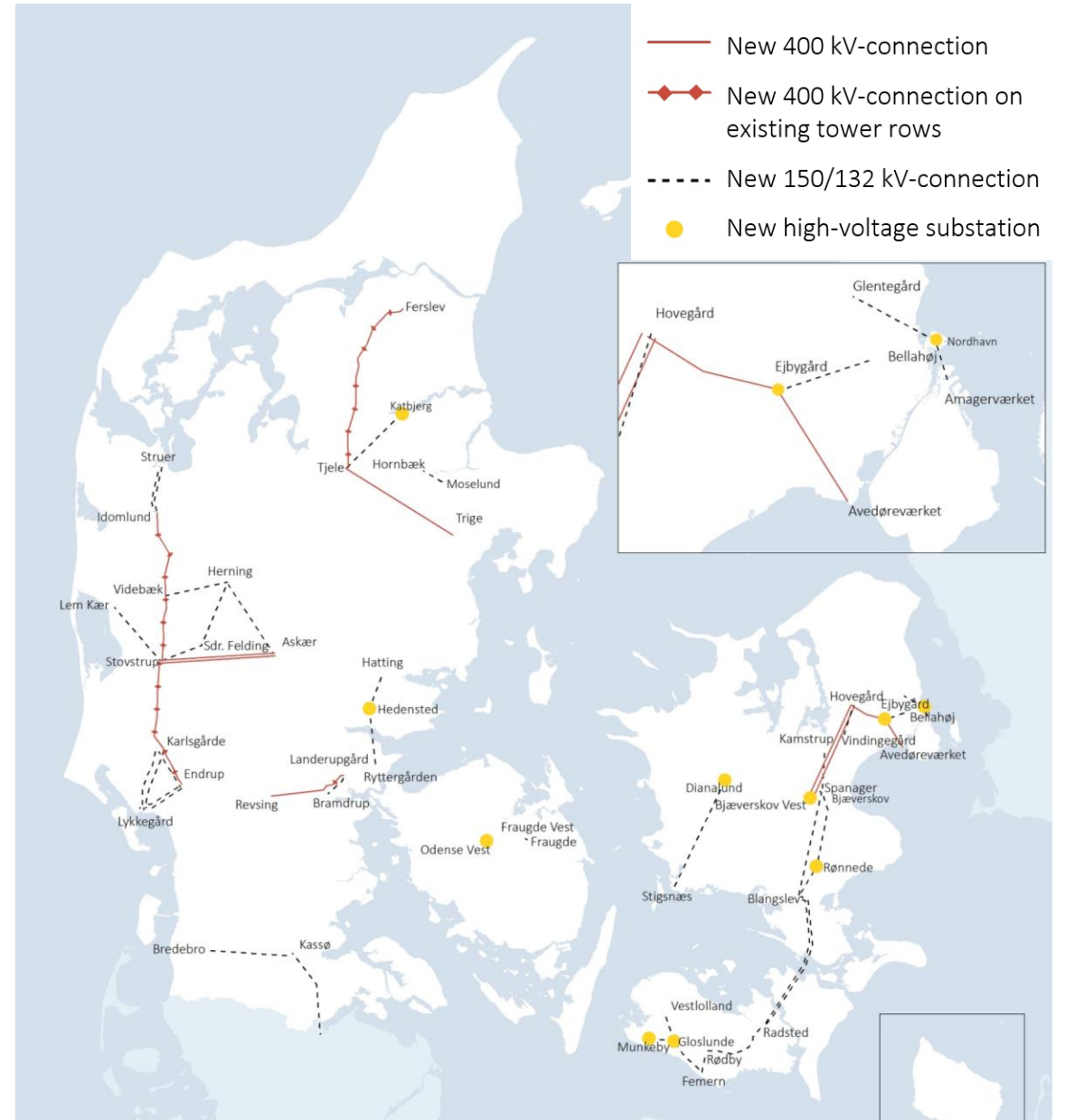
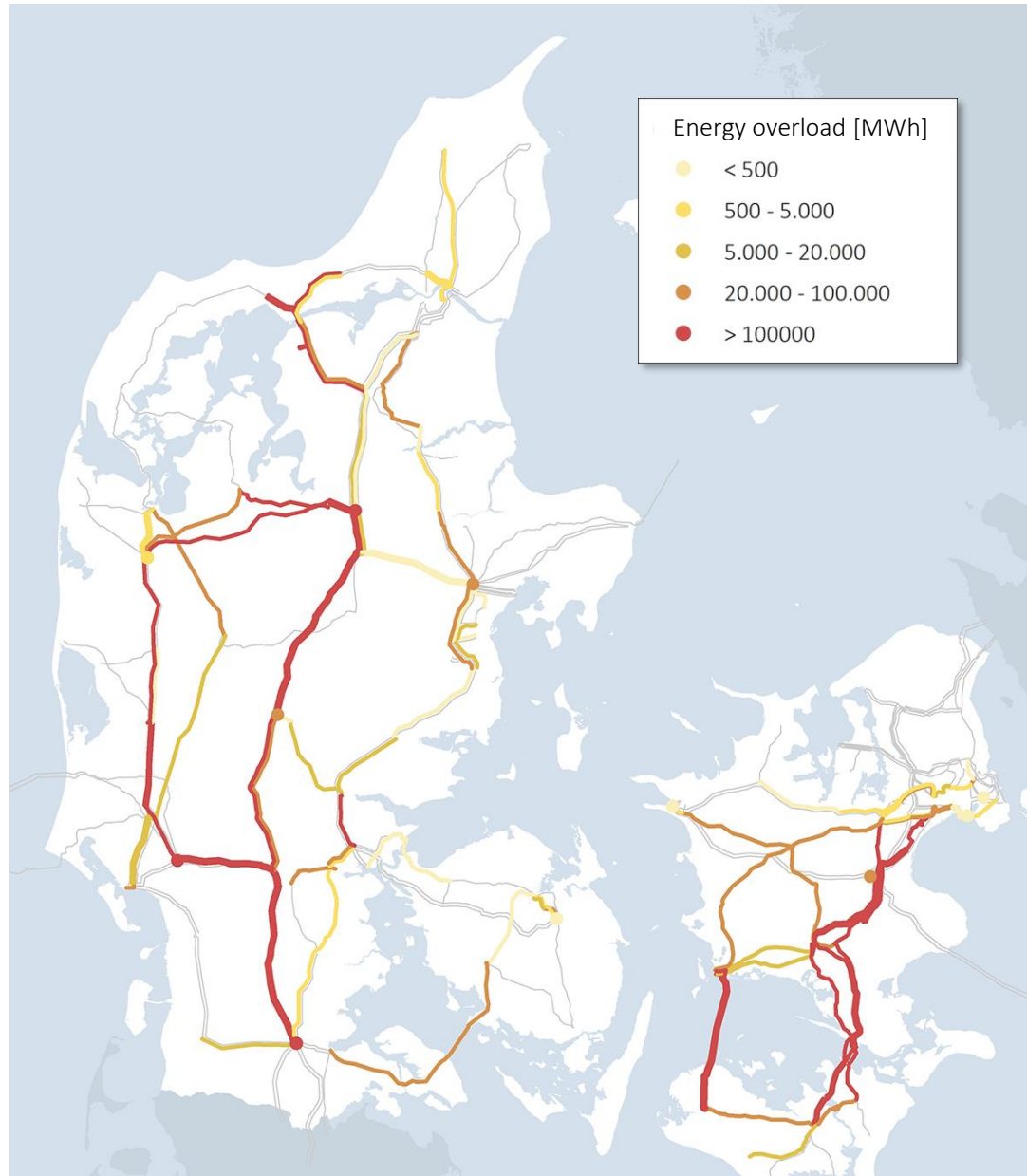
Renewable Energy Sources (RES) development by 2050:



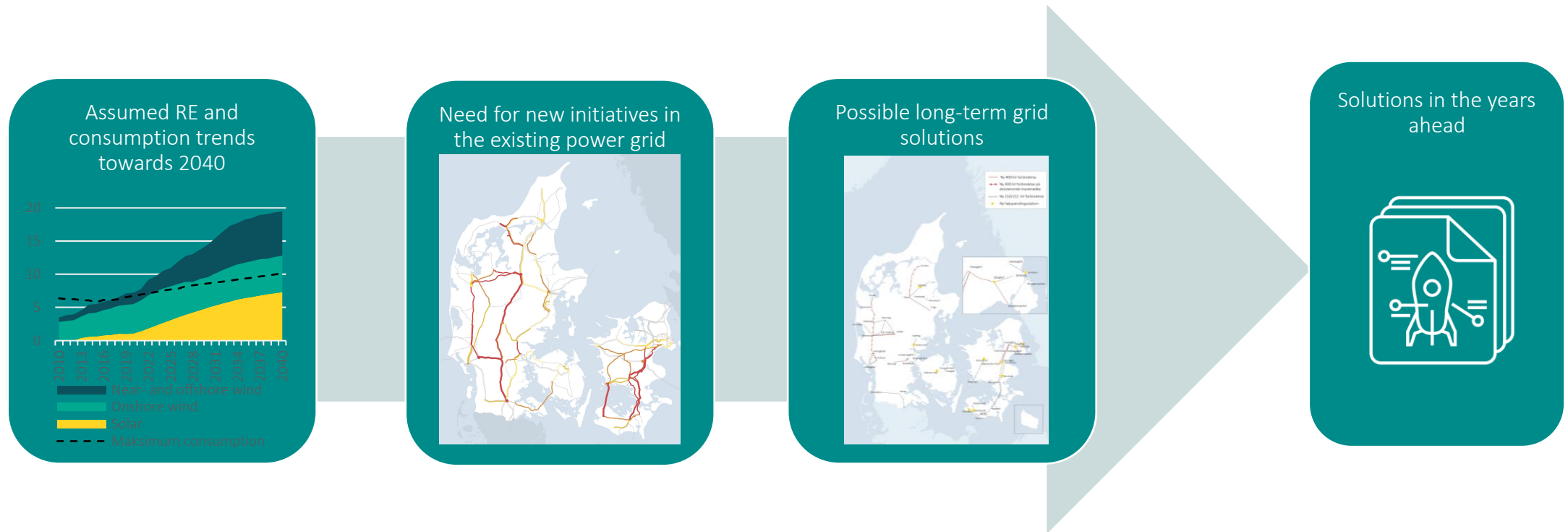
Legend for the RES development map:
■ Wave energy ■ Wind energy ↔ Electricity Highways 2050
■ Bioenergy ■ Solar energy



CURRENT LONG TERM GRID DEVELOPMENT PLAN to 2040



OVERALL PLANNING PROCESS



TRANSMISSION GRIDS

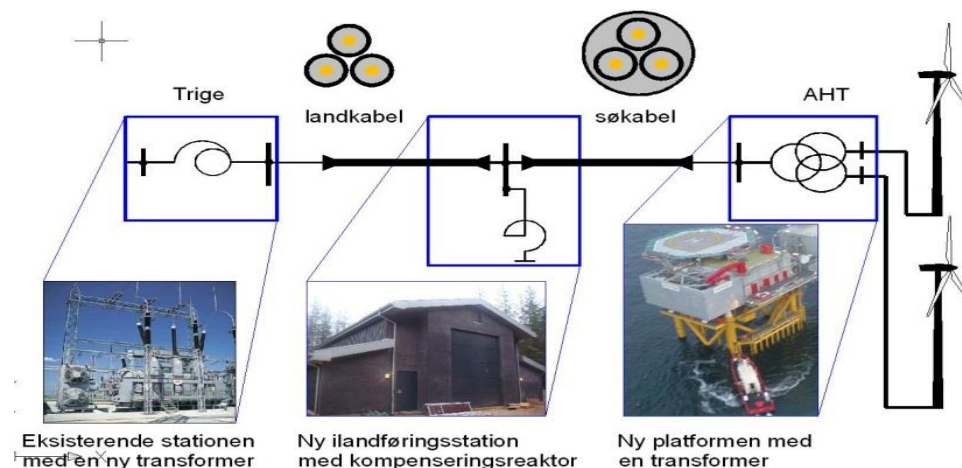
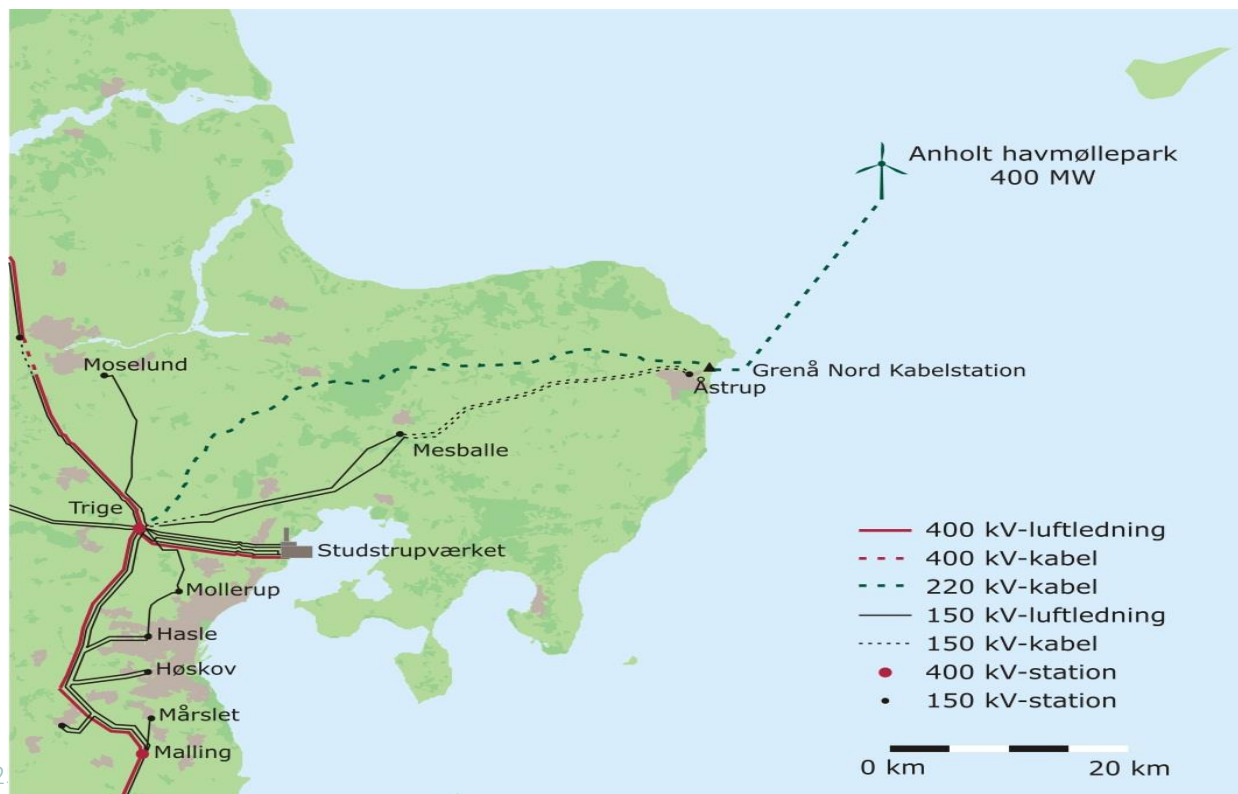
- Variable RES drives grid investments
 - Strong grids enable
 - Optimal utilization of generation capacity
 - Balancing in larger diversified areas
 - Sharing of reserves
- ⇒ A positive business case for grid investments



THE ANHOLT PROJECT – 400 MW WIND PARK

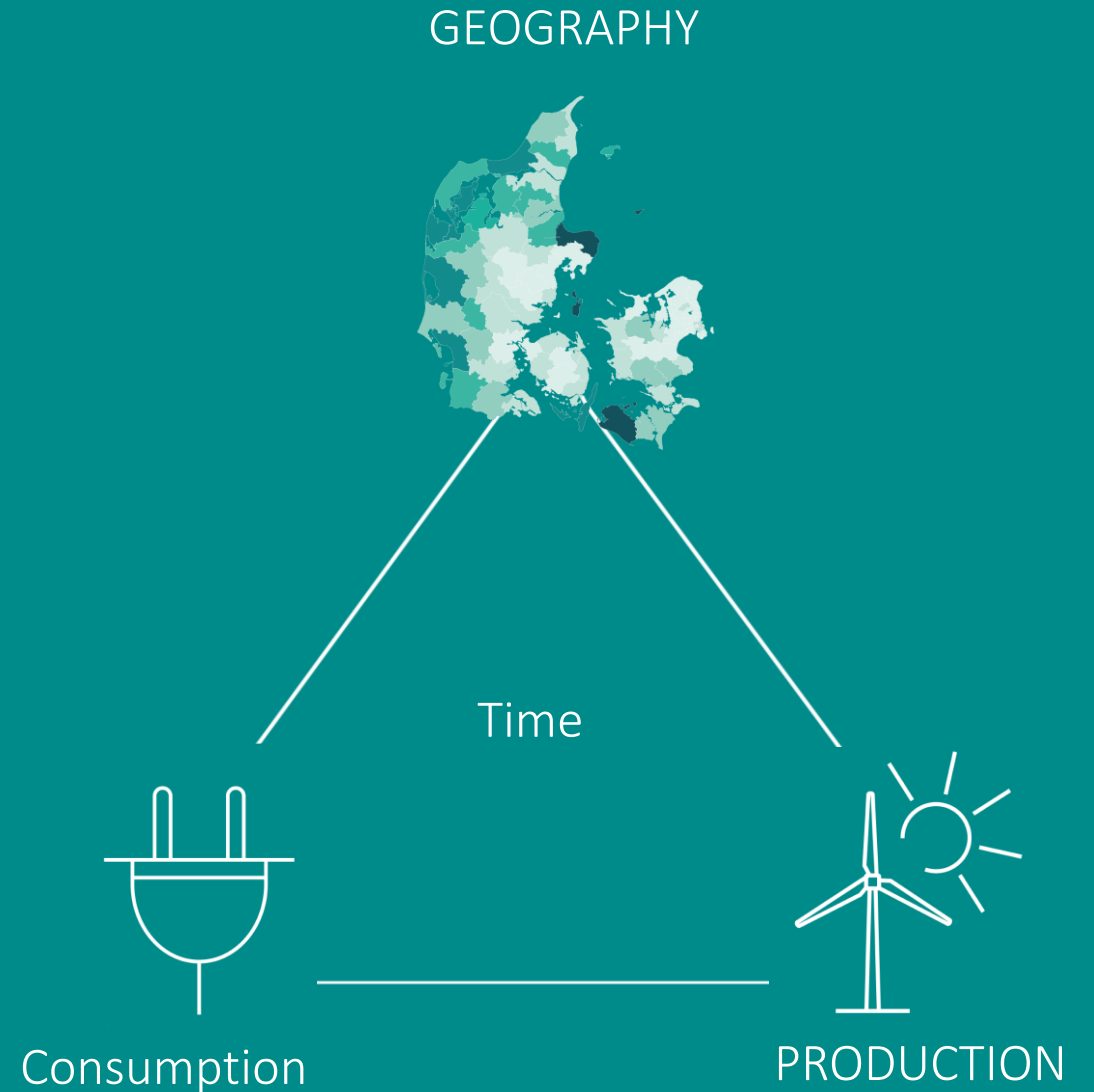
Energinet.dk is responsible for:

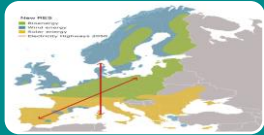
Price: approx. 200 Mio USD



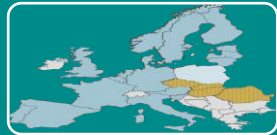
NEW PLANNING PERSPECTIVE

- Proactive coordinating consumption and production geographically and timely via tariffs, flexibility and dialog
- Utilize existing infrastructure better – e.g, accepting loss of peak production
- Energy focus rather than worst case focus



TOOLBOX FOR EFFICIENT LARGE SCALE RES INTEGRATION

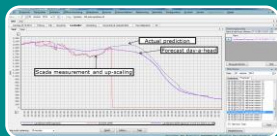
Strong transmission grids and interconnectors



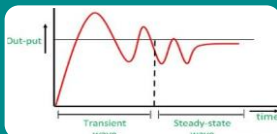
International electricity markets



Flexible generation system



Specialized forecasting and operational planning tools



Stability through grid codes and dynamic resources

SECURITY OF SUPPLY



FRAMEWORK

Security of Supply



System Adequacy



System Security



Power Adequacy



Grid Adequacy



Robustness



IT-security

AGENDA

14.30-15.00: Introduction to Energinet and Energinets role in Danish green transition – Peter Markussen, Senior director, International Relations

15.00-15.30: Transmission connection and development for integration of offshore wind – Anders Steen Kristensen, Head of Grid Planning

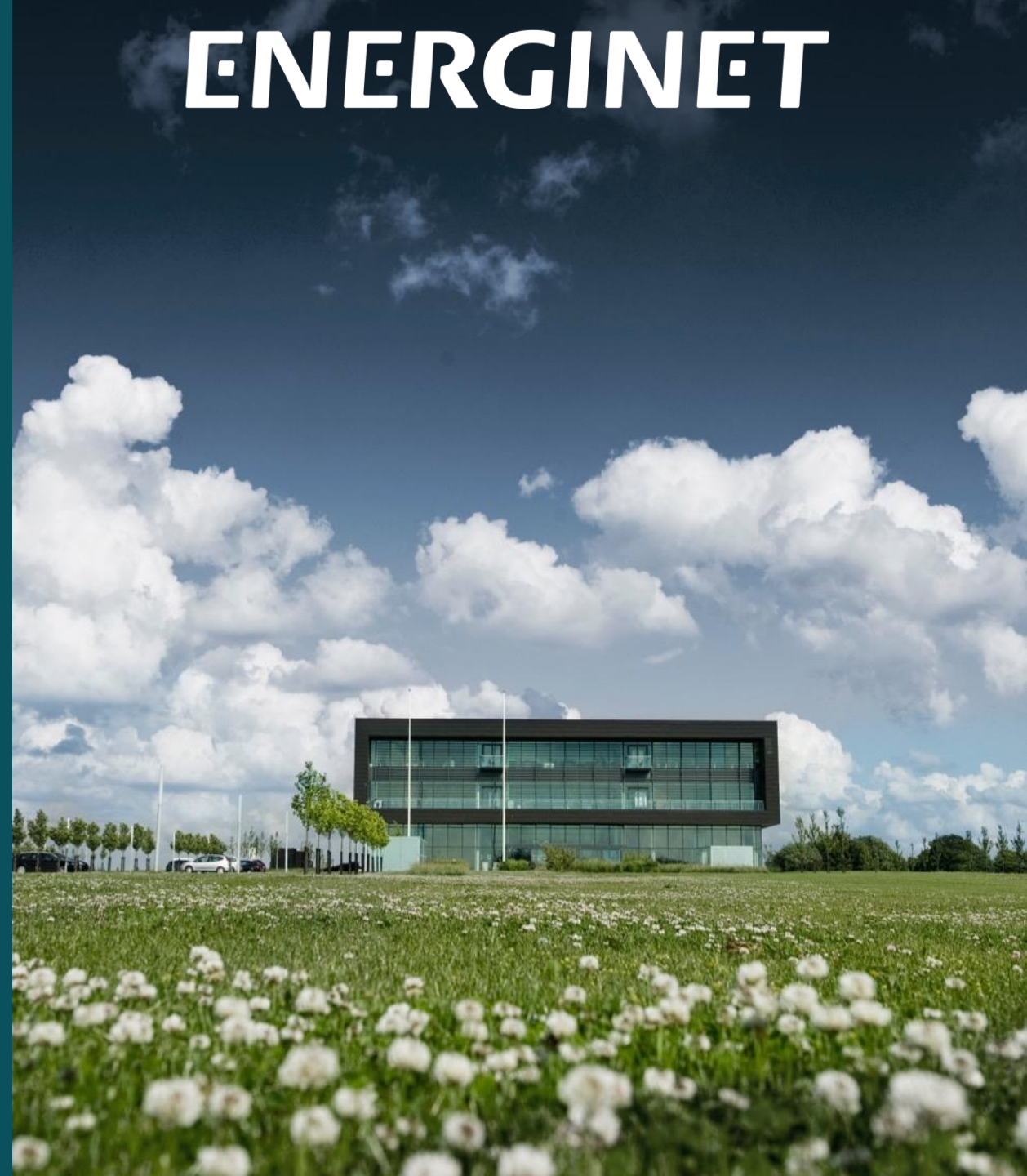
15.30-15.45: Break

15.45-16.15: Increased flexibility from cross border interconnection – Morten Pindstrup, Chief expert, Electricity Markets

16.15-16.45: Energinet experience with digitilisation and open access to energy system data – Gitte Schjøtt Kristensen, Head of Data and System Innovation

16.45-17.00: sum up

ENERGINET



A decorative graphic on the left side of the slide, consisting of a complex network of thin, light teal lines forming a series of interconnected triangles and polygons, resembling a wireframe or a stylized map of a network.

FLEXIBILITY FROM CROSS BORDER INTERCONNECTION

Integration of Renewable electricity

Morten Pindstrup, International Chief Engineer, Electricity Markets

Agenda



- Utilising the resources across Europe
- Market design
- Efficient allocation of cross border capacity
- Examples of a flexible production system

TRANSMISSION GRIDS

Variable RES and new demand drives grid investments

Strong grids enable

- Optimal utilisation of generation capacity
 - merit order dispatch
- Balancing in larger diversified areas
- Sharing of reserves



DENMARK IS WELL CONNECTED

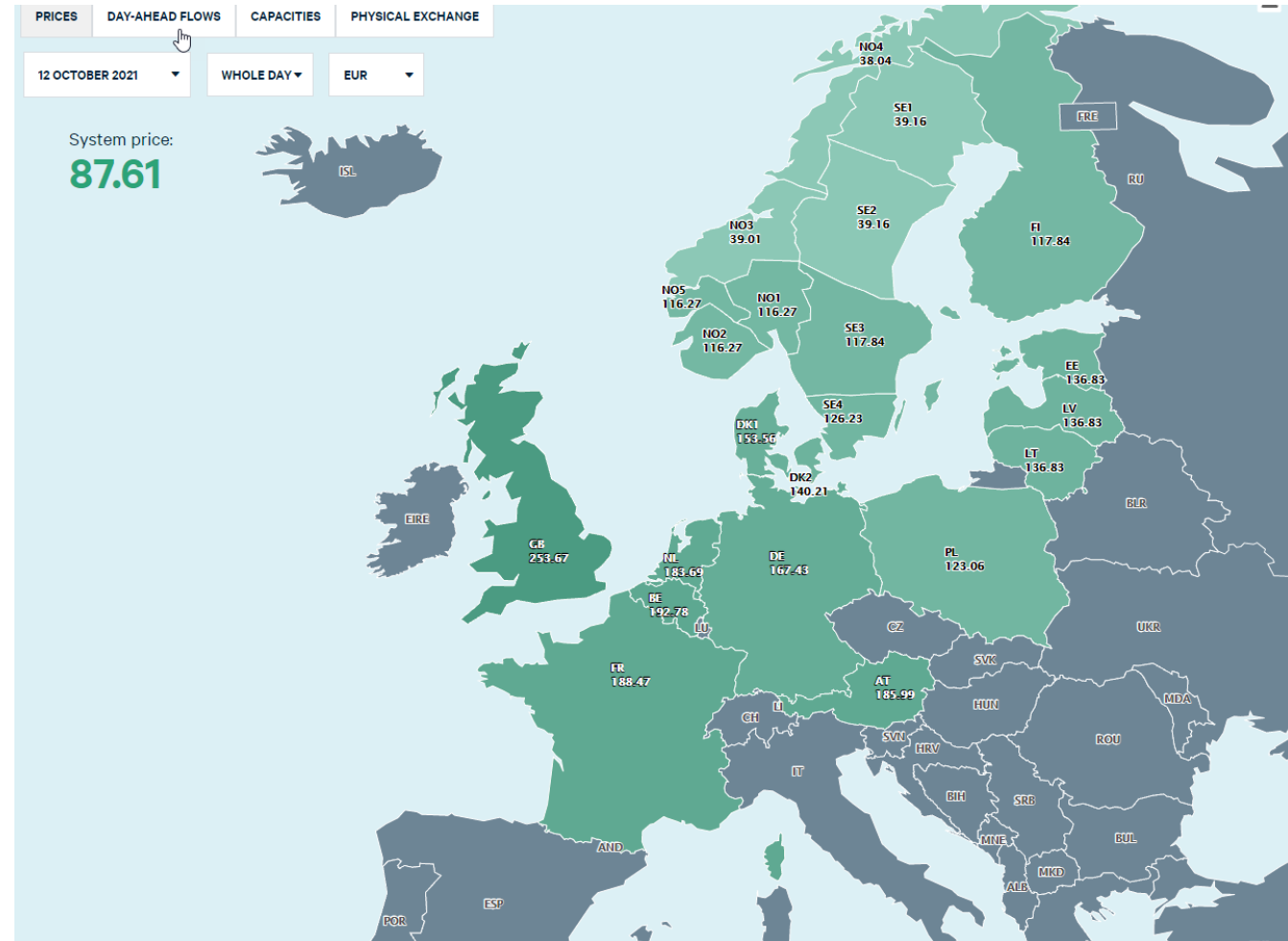
- DK is connected to very diversified systems
 - Hydro & Nuclear to the North/East
 - Thermal, PV and wind to the south
- New connections to DE and UK
 - More wind and natural gas based systems
 - Across new timezone to the west



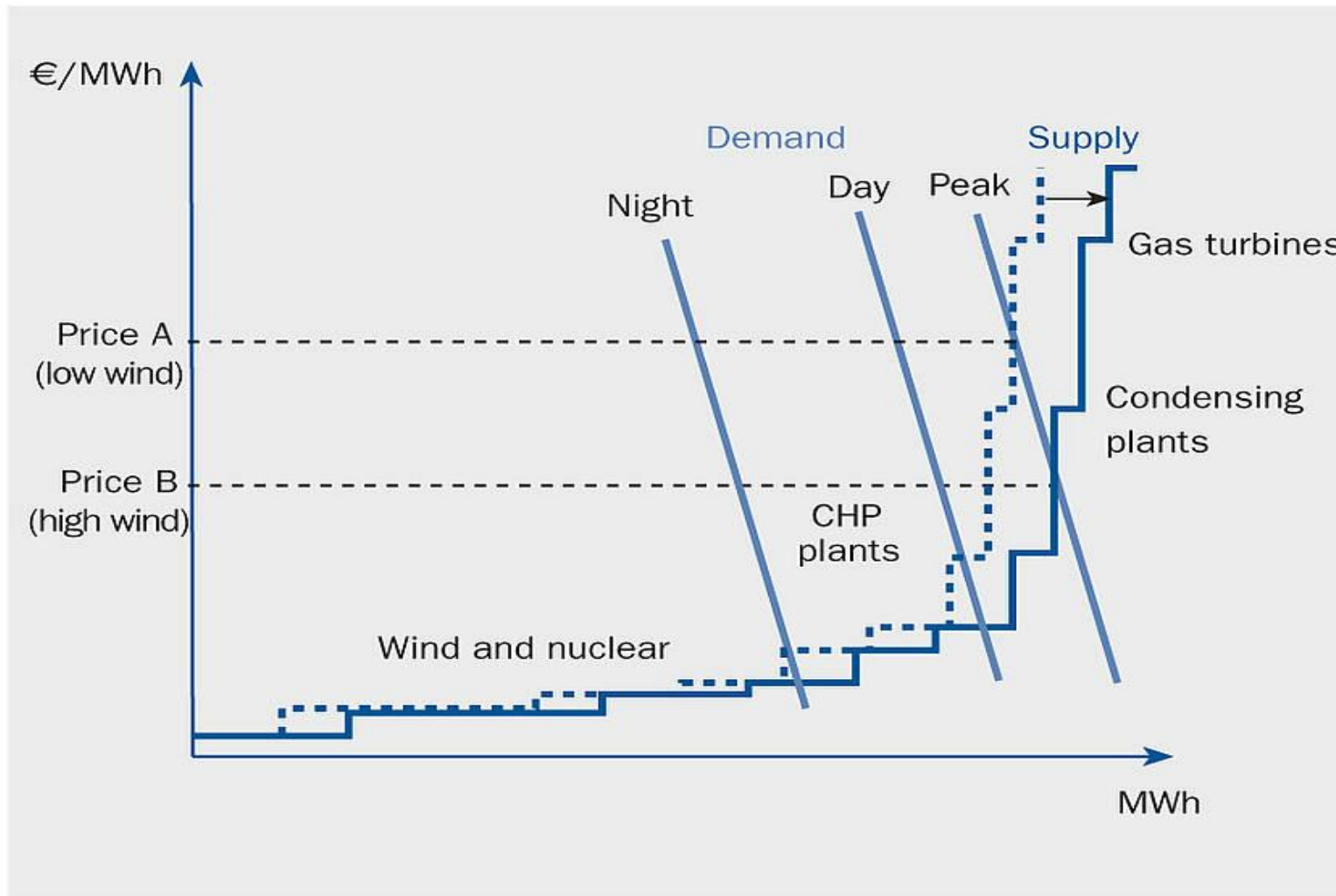
THE MARKET DESIGN IS A ZONAL MARKET

Market coupling/implicit auctions:

- The Nordic market is divided into bidding zones
- Bidding zone delimitation reflects major congestions
- Interconnector capacity is included as constraints in the price/quantity calculation at the PX:
 - Implicit auctions

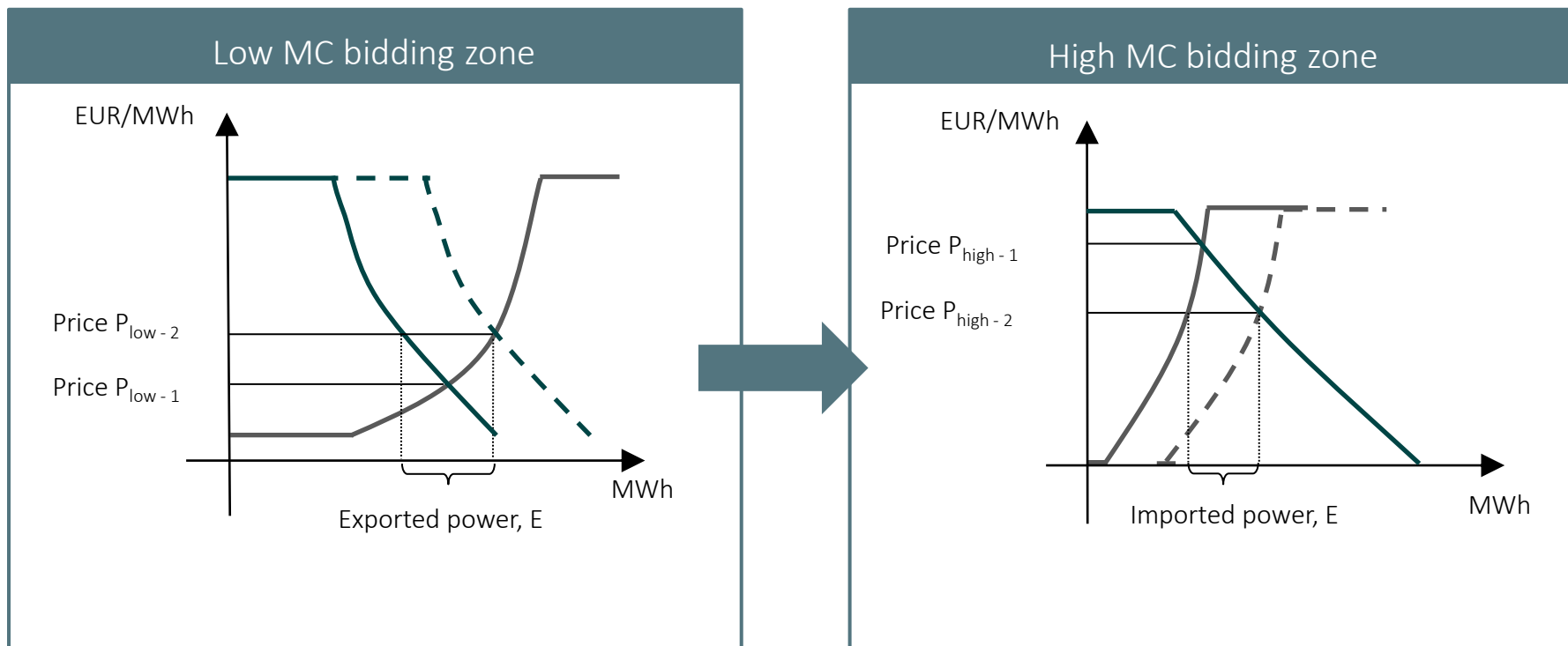


A PARTIAL EQUILIBRIUM DIAGRAM ILLUSTRATES THE PRICE/MC VOLATILITY



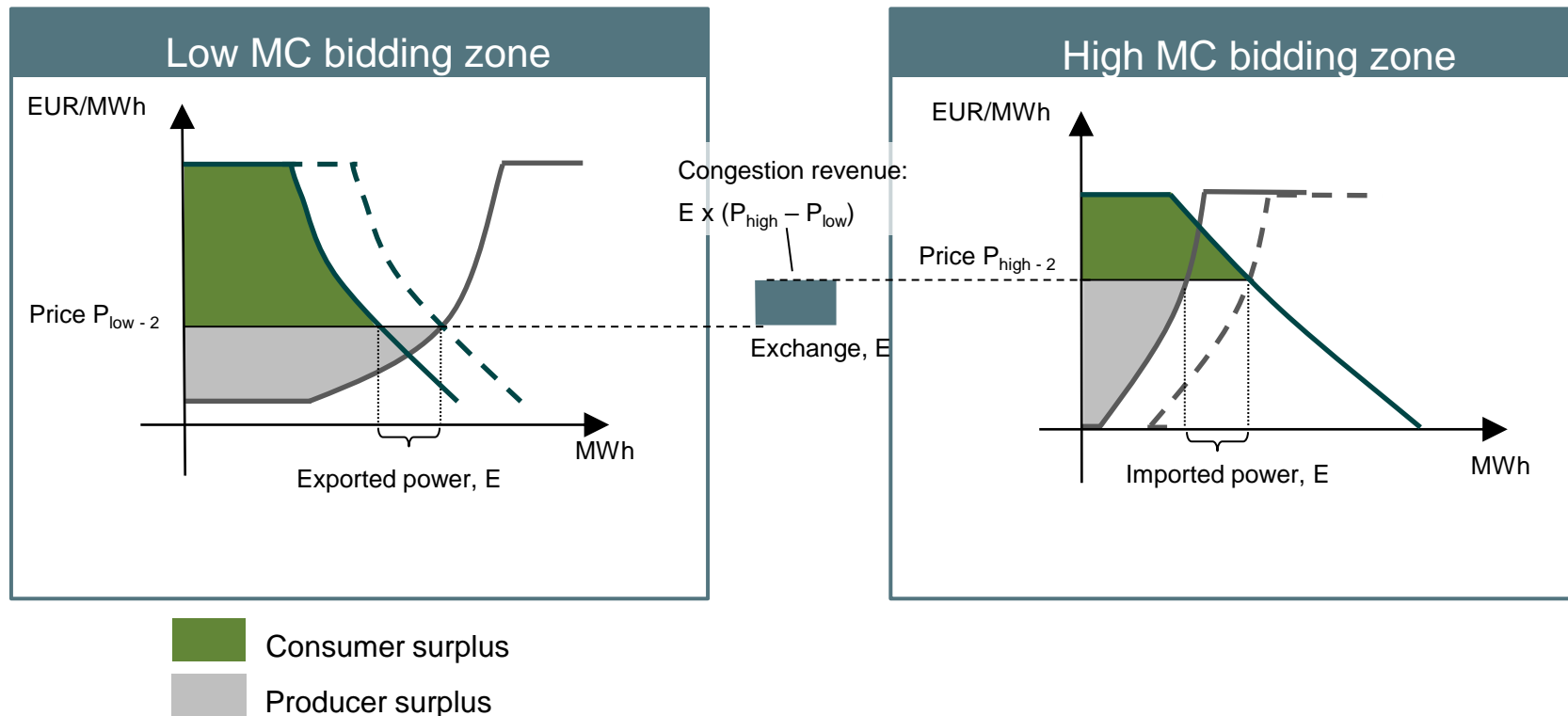
CONGESTION MANAGEMENT IN THE GRID: MARKET COUPLING

- What we would like to aim for: Regional merit order dispatch



CRITERIA FOR DECIDING ON EQUILIBRIUM PRICE AND QUANTITY – HOW IT IS DONE

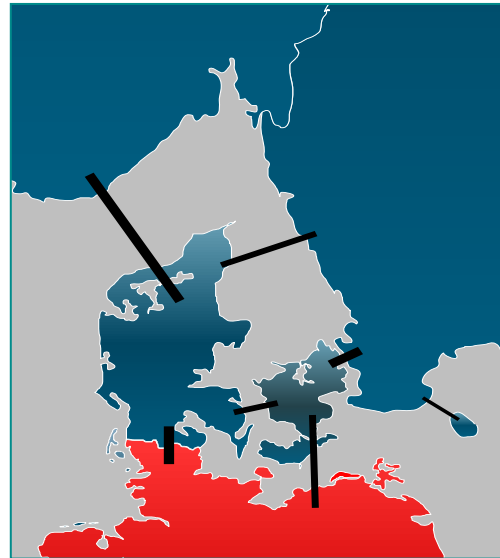
- The algorithm maximizes the sum of social welfare in the entire market, taken capacity constraints into account.
- Social welfare is the sum of consumer and producers surplus and congestion revenue.



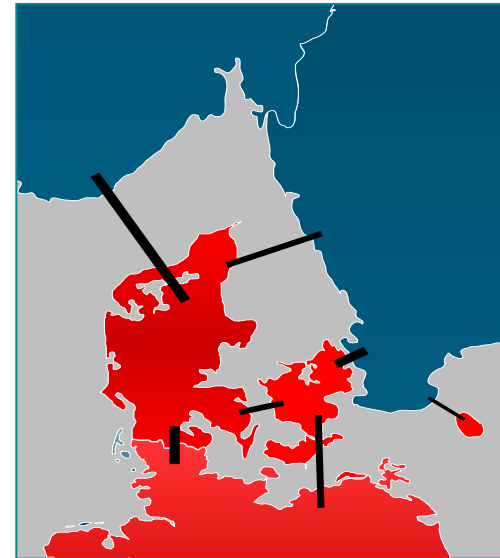
DENMARK OFTEN HAS SAME PRICE AS THE NEIGHBORS



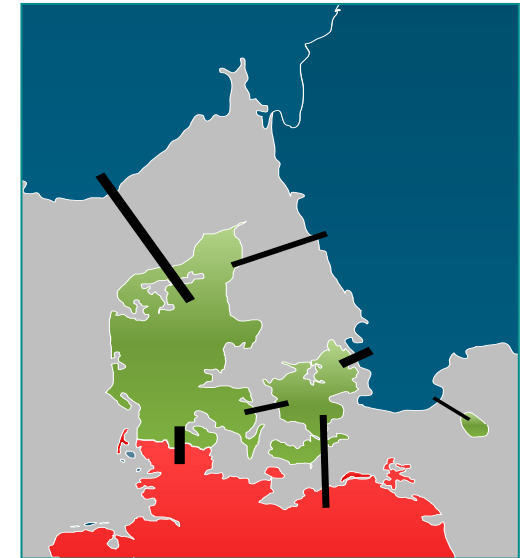
Denmark has same price as all neighboring countries
20% of the time



Denmark has same price as the Nordics
50% of the time



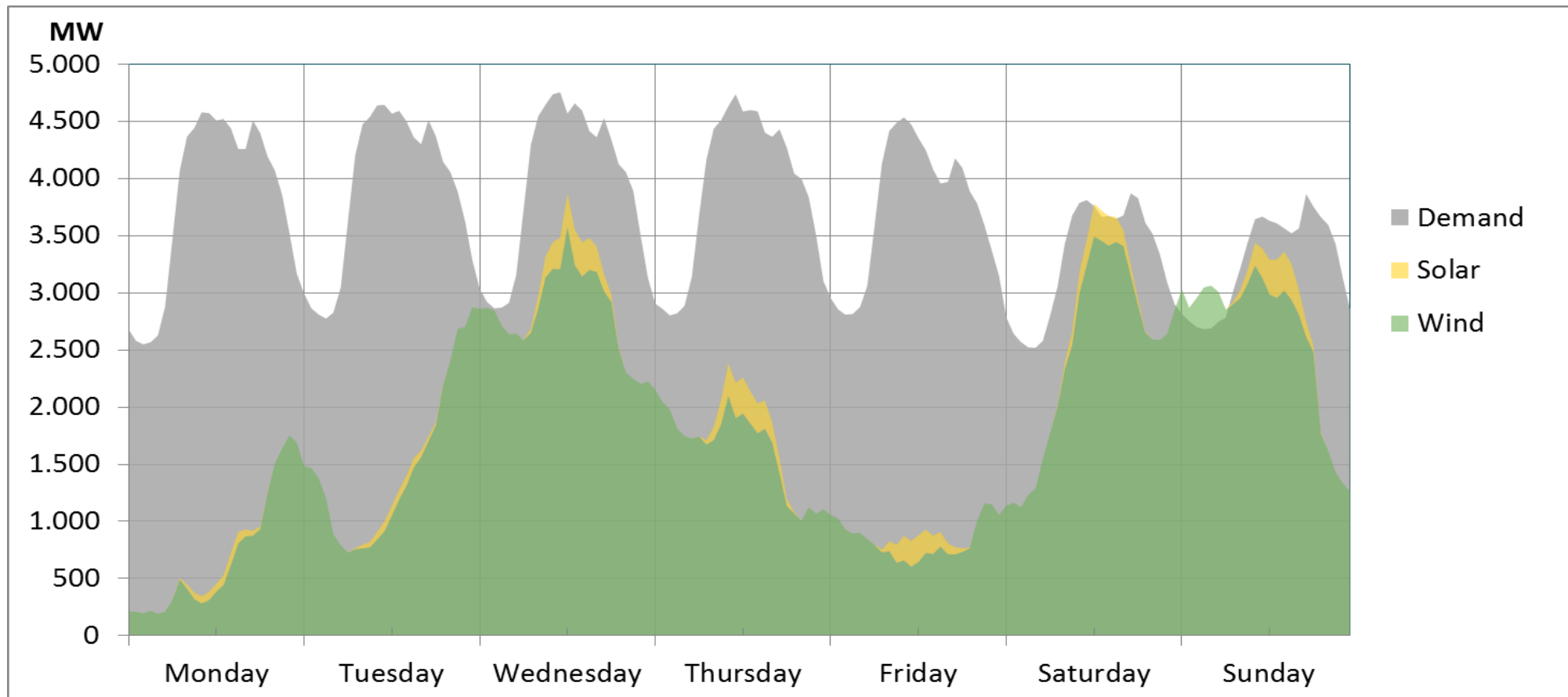
Denmark has same price as Germany
20% of the time



Denmark has its own price
10% of the time

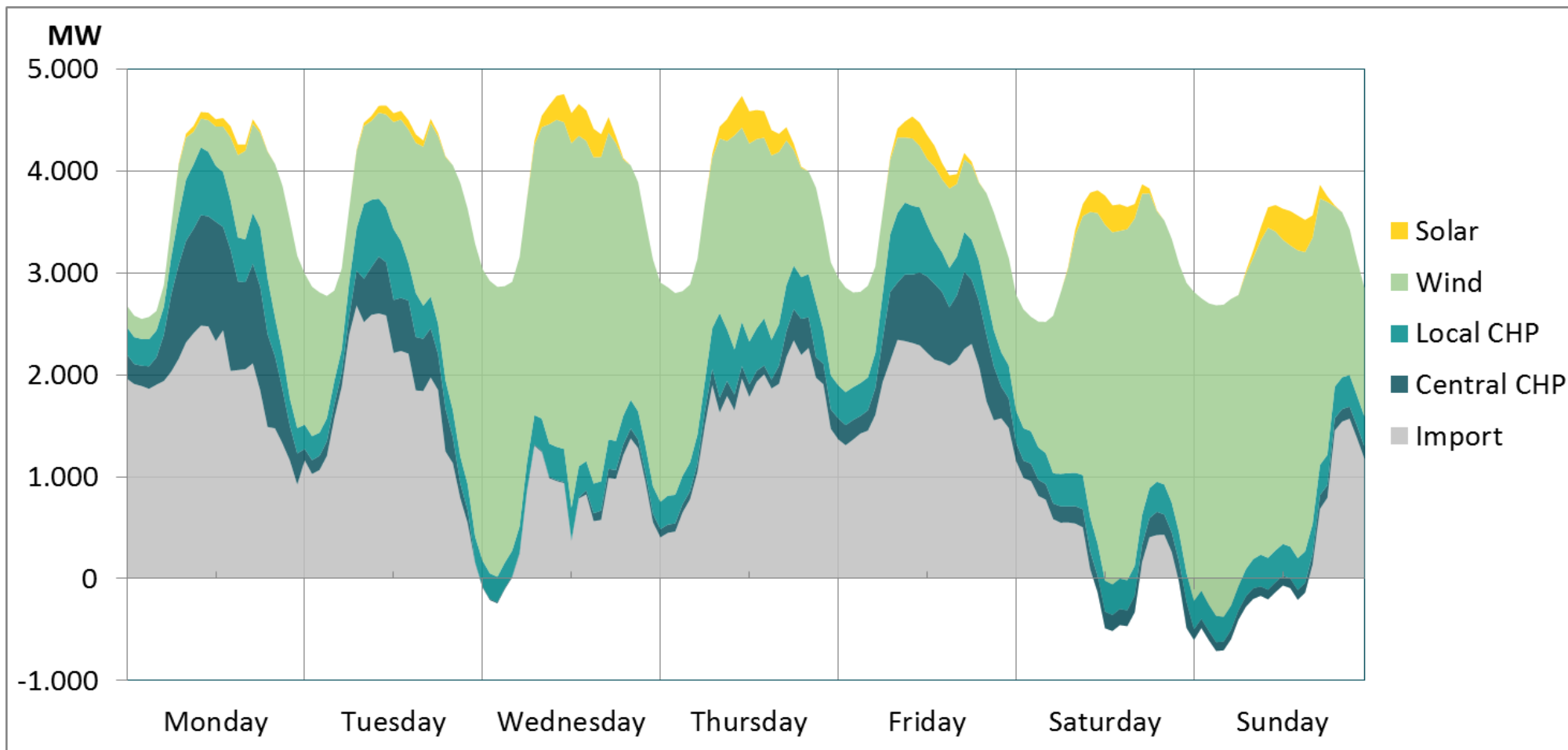
A WEEK IN SEPTEMBER

- 51% WIND AND SOLAR

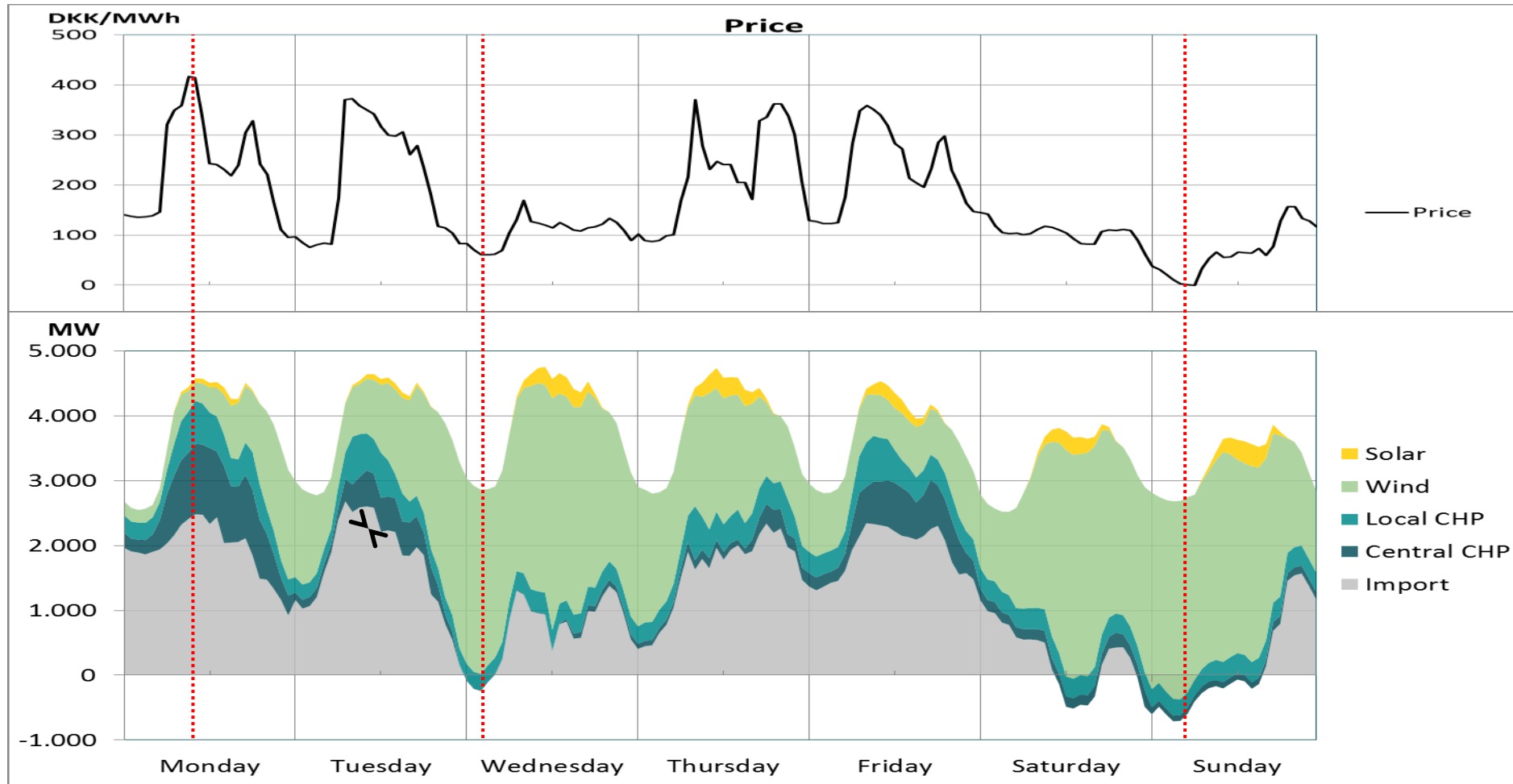


FLEXIBILITY IN THE ELECTRICITY SYSTEM

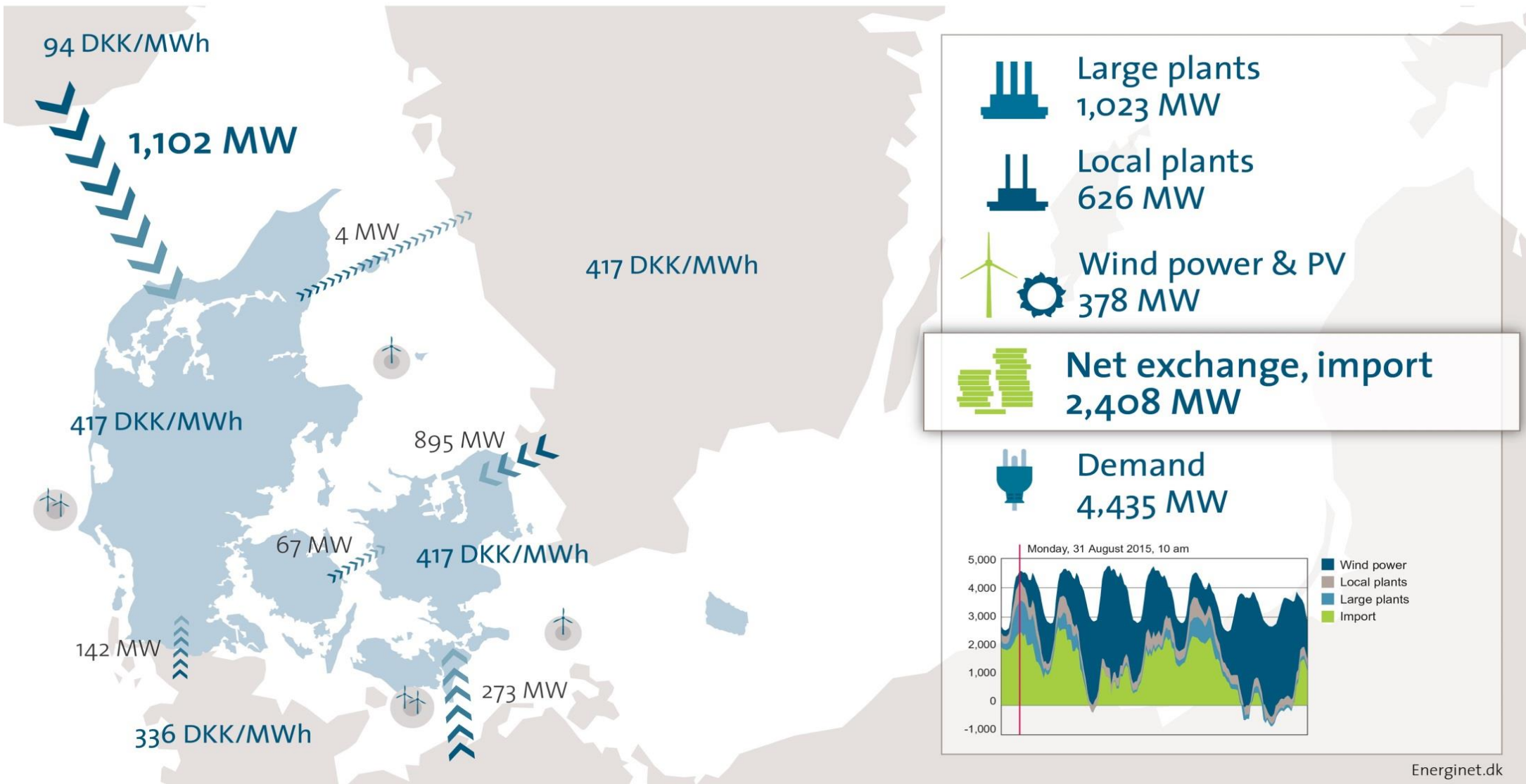
- HOURLY DISPATCH



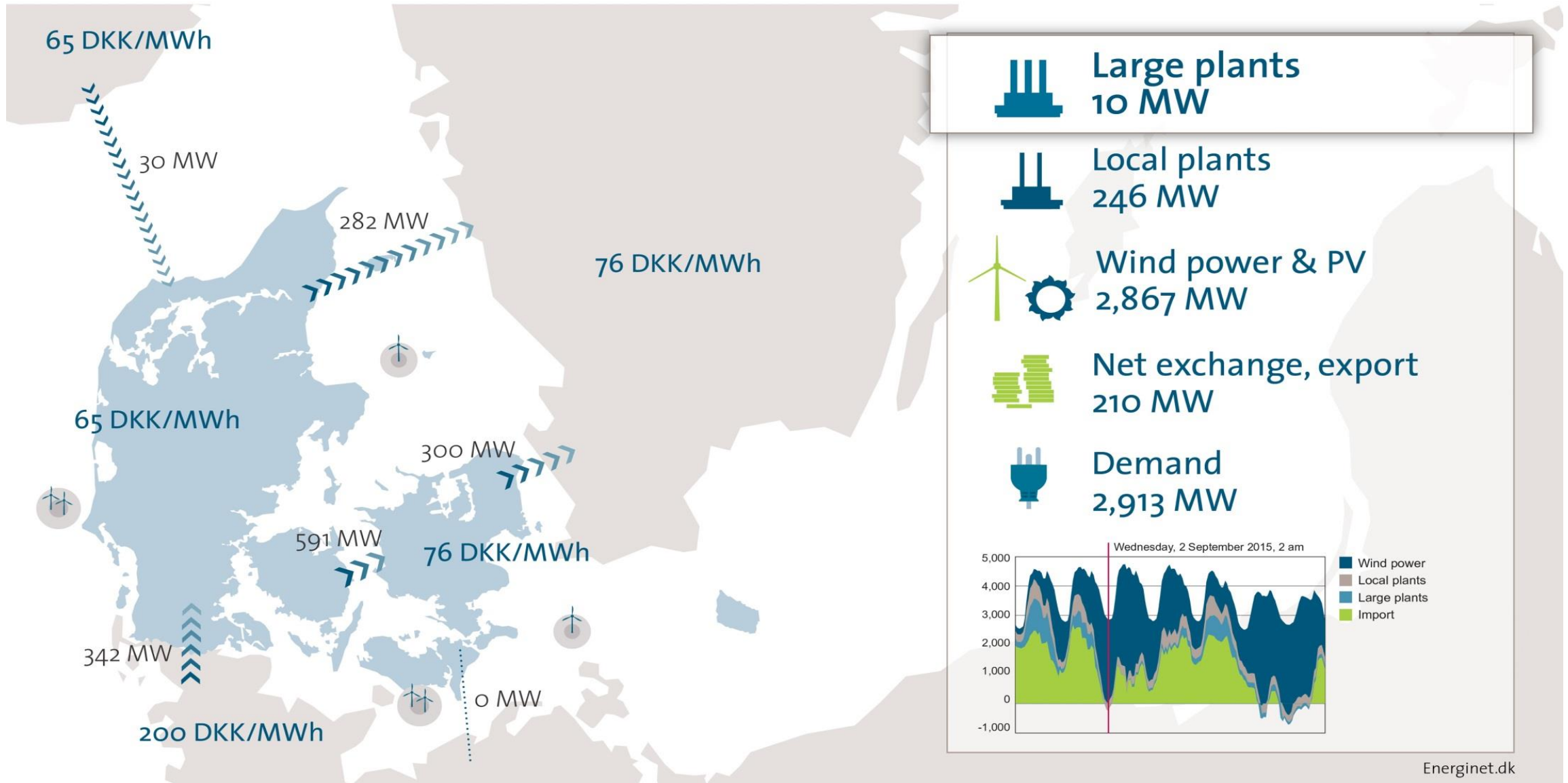
SPOT PRICE, WIND POWER AND MARKET DYNAMICS



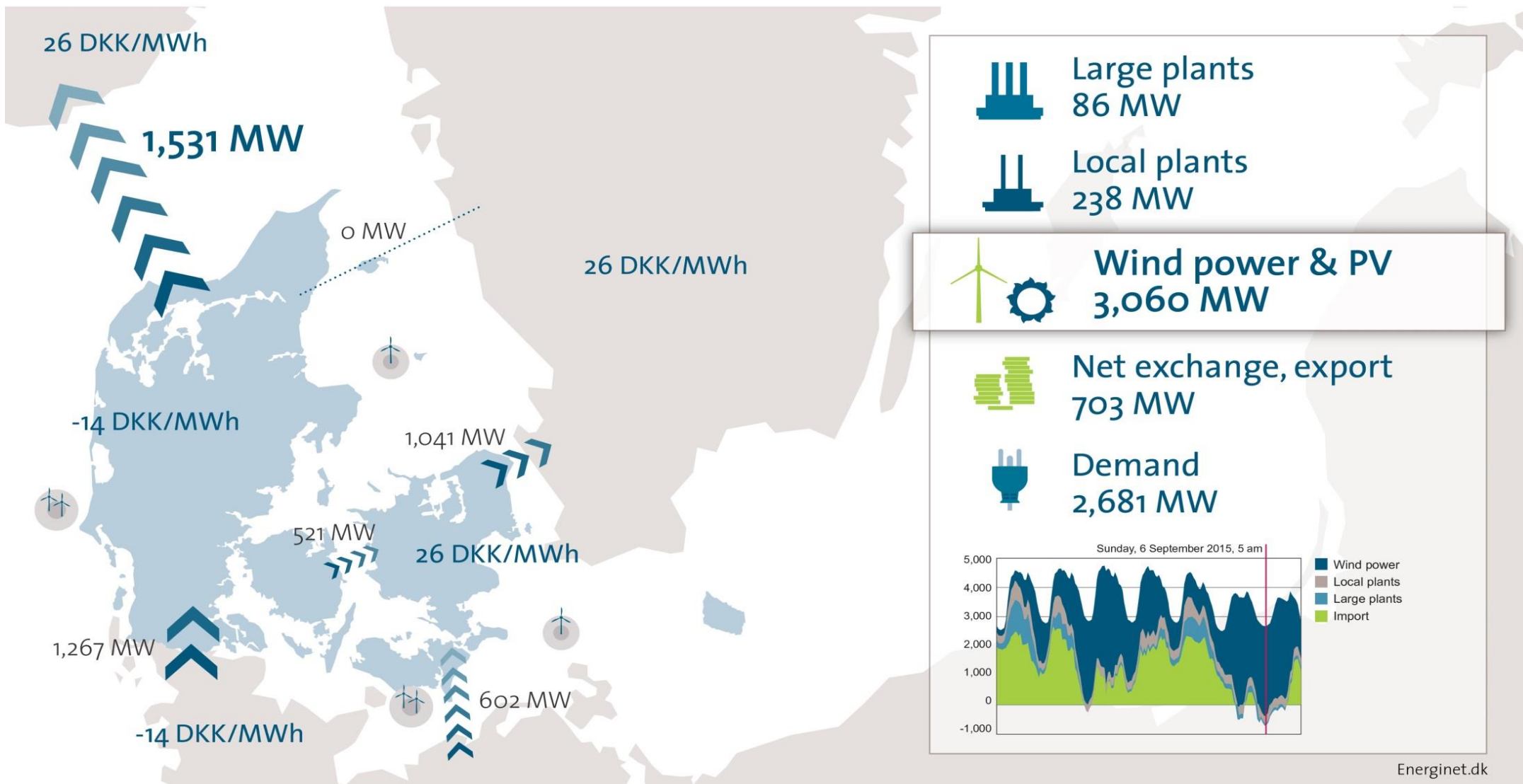
Example 1: Low winds – high prices – large imports



Example 2: High winds – low price - no large power plants



Example 3: High winds – negative price – exports and high transits



Questions?



Phone: +45 51677869, Email: mpi@energinet.dk

AGENDA

14.30-15.00: Introduction to Energinet and Energinets role in Danish green transition – Peter Markussen, Senior director, International Relations

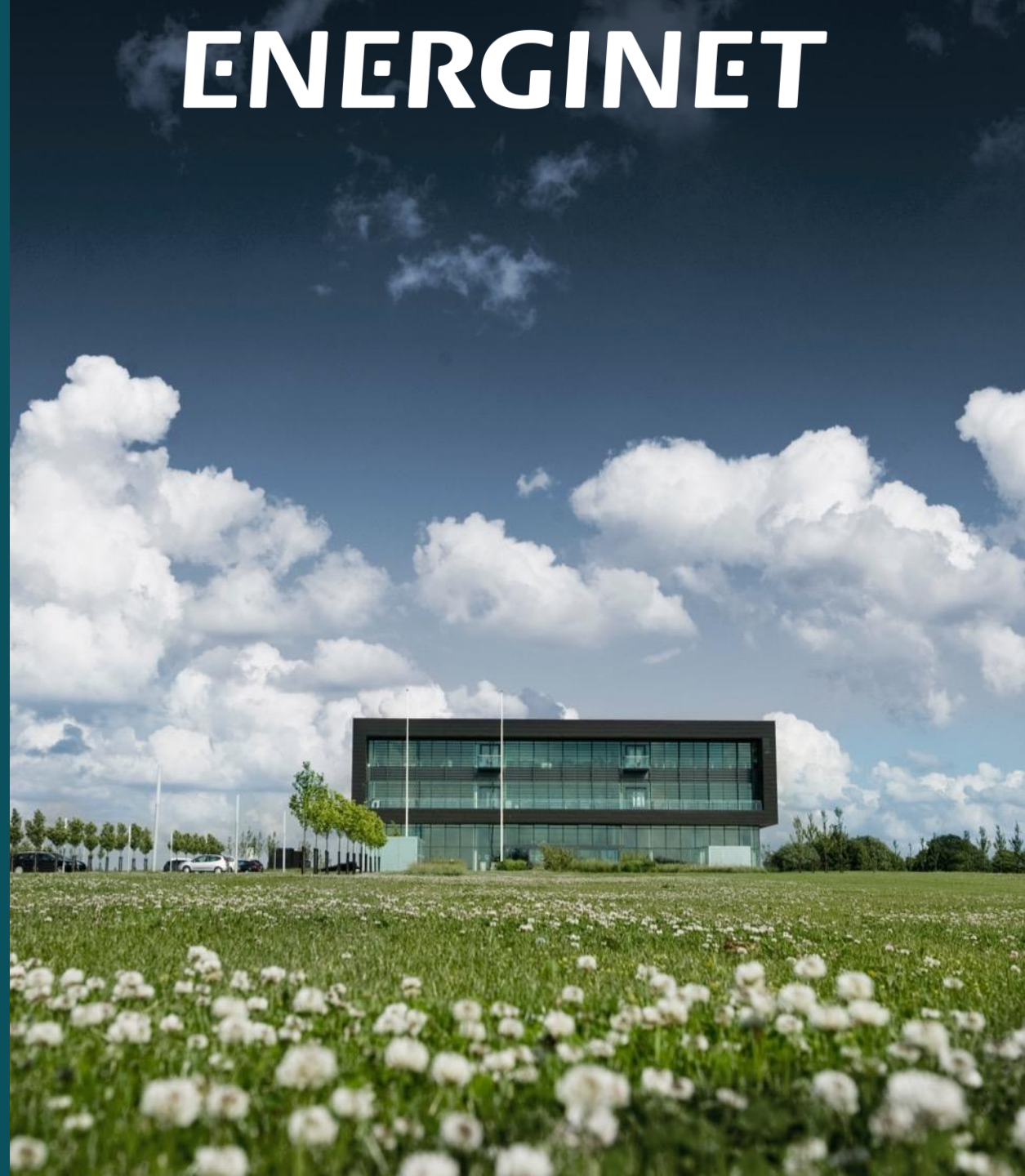
15.00-15.30: Transmission connection and development for integration of offshore wind – Anders Steen Kristensen, Head of Grid Planning

15.30-15.45: Break

15.45-16.15: Increased flexibility from cross border interconnection – Morten Pindstrup, Chief expert, Electricity Markets

16.15-16.45: Energinet experience with digitilisation and open access to energy system data – Gitte Schjøtt Kristensen, Head of Data and System Innovation

16.45-17.00: sum up



DIGITALIZATION AND INNOVATION WITH DATA

Energinets' experience with digitalization and
access to energy system data

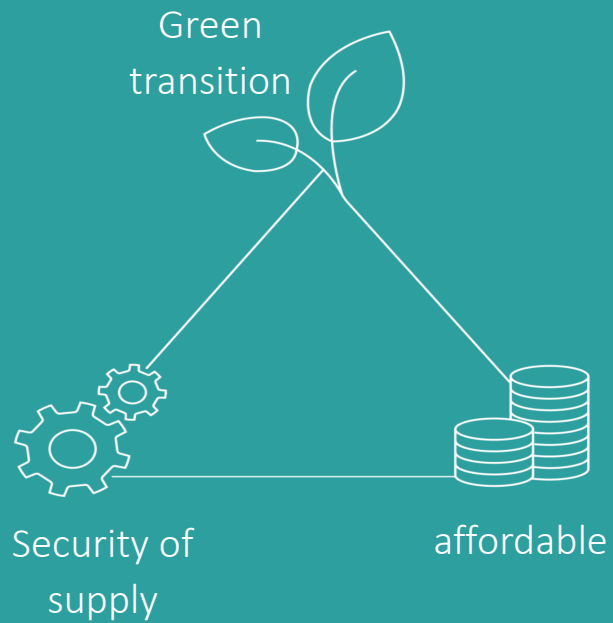
Gitte Schjøtt-Kristensen, Head of Data and Systeminnovation

Agenda



- The digital aspect of the green transition
- Digital strategic focus areas – examples from system operation
- Open access to data
- Innovation based on data

DIGITALISAZATION IS AN IMPORTANT PART OF THE GREEN TRANSITION



DATA ACCESS AND DATA PROCESSING



AUTOMIZATION



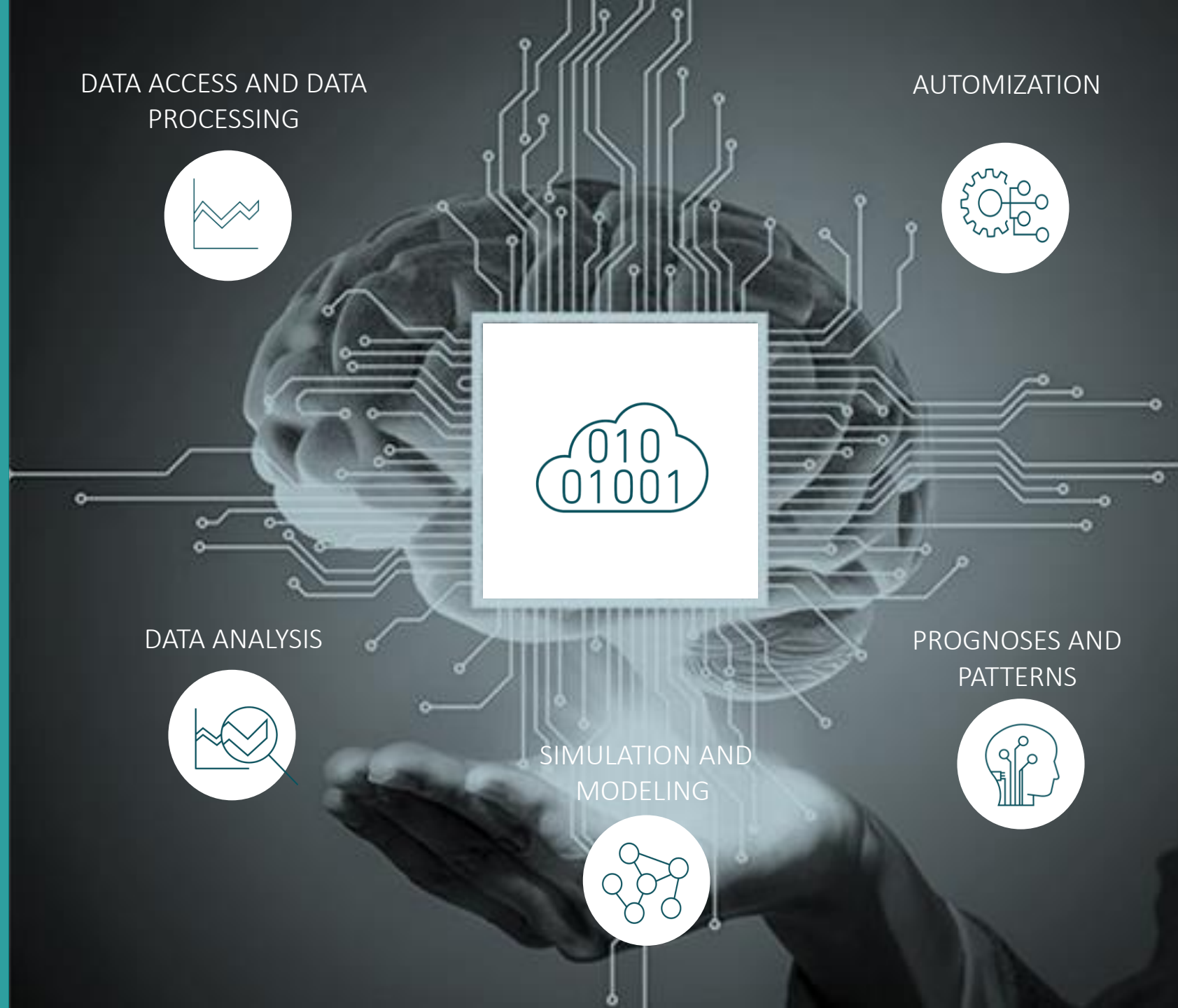
DATA ANALYSIS



PROGNOSES AND PATTERNS



SIMULATION AND MODELING



DIGITAL STRATEGIC FOCUS AREAS

SYSTEM OPERATION

DIGITAL CONTROL CENTER

Managing larger amounts of RE in combination with a larger degree of complexity and unpredictability

- Prognoses. Eg. wind and solar, defect and overload
- Visualisations
- Automation
- Data driven decisions



ACCELERATED ANALYSIS

The acceleration of the green transition calls for more and faster analysis of the grid and of the socio-economy

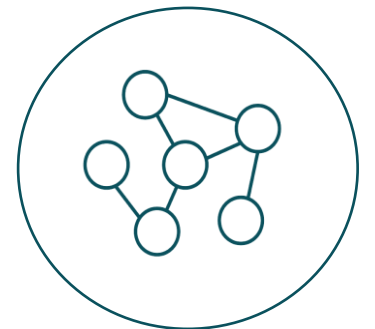
- More simple processes
- Automating the input of data from different sources
- Using Artificial intelligence for faster calculations
- Simulation models



DIGITAL MARKETS

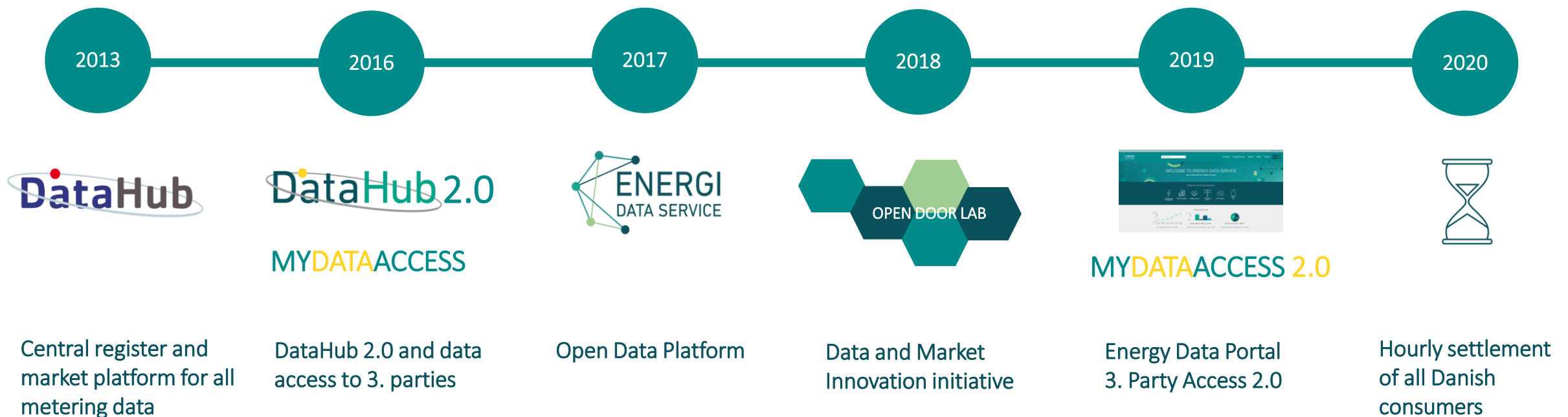
Support new market and balancing possibilities through exchange of data in digital systems

- Monitoring flexibility and reserves
- Visualization of physical components
- Coupling of sectors (PtX)



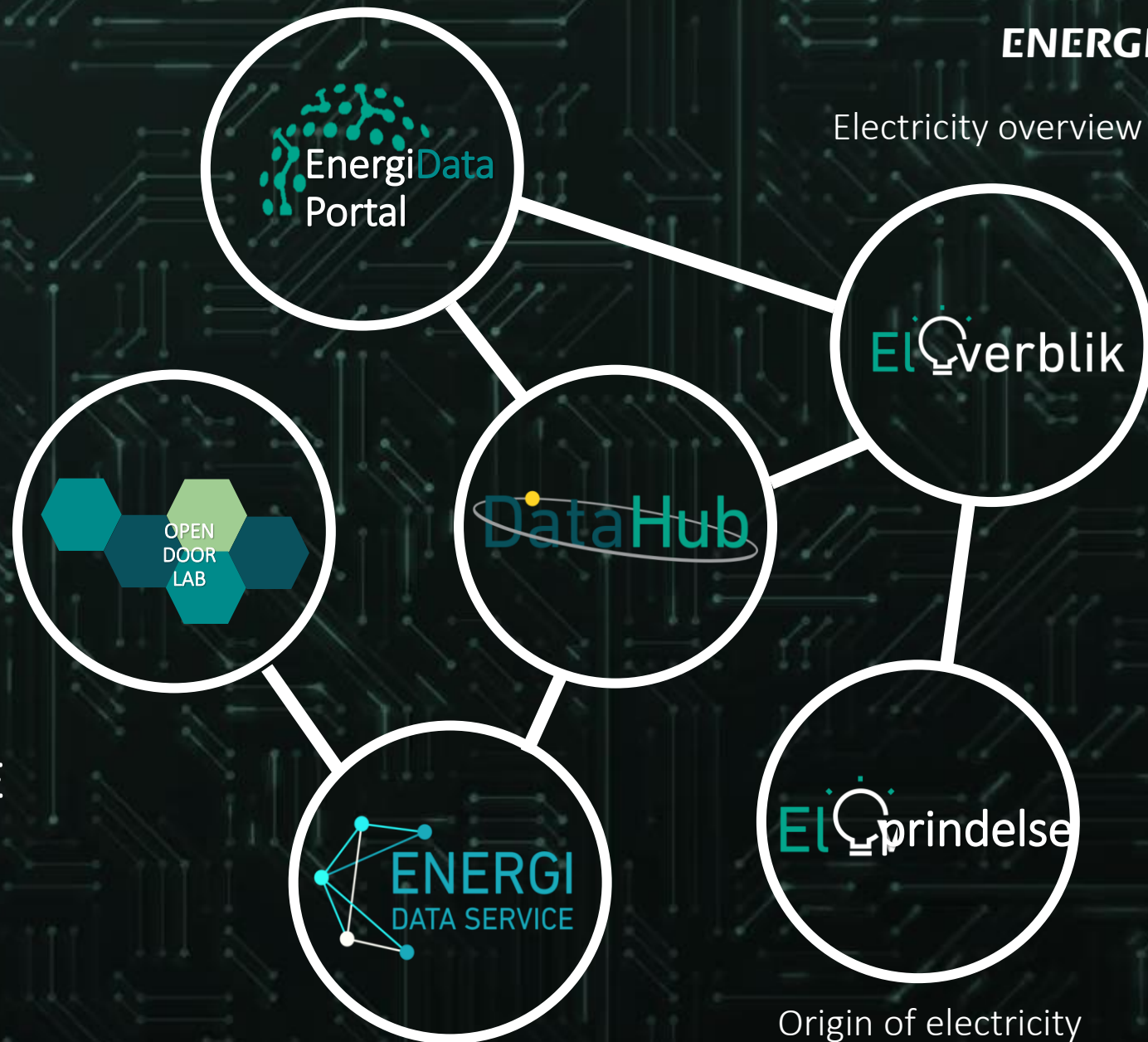
DANISH CONSUMERS OWN THEIR DATA

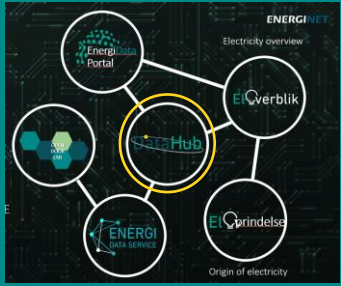
ENERGINET FACILITATES CONTROLLED AND OPEN ACCESS TO DATA – TO RELEASE THE VALUE OF FLEXIBLE CONSUMPTION IN THE GREEN TRANSITION



HOW DO WE MAKE DATA AVAILABLE TO SOCIETY ?

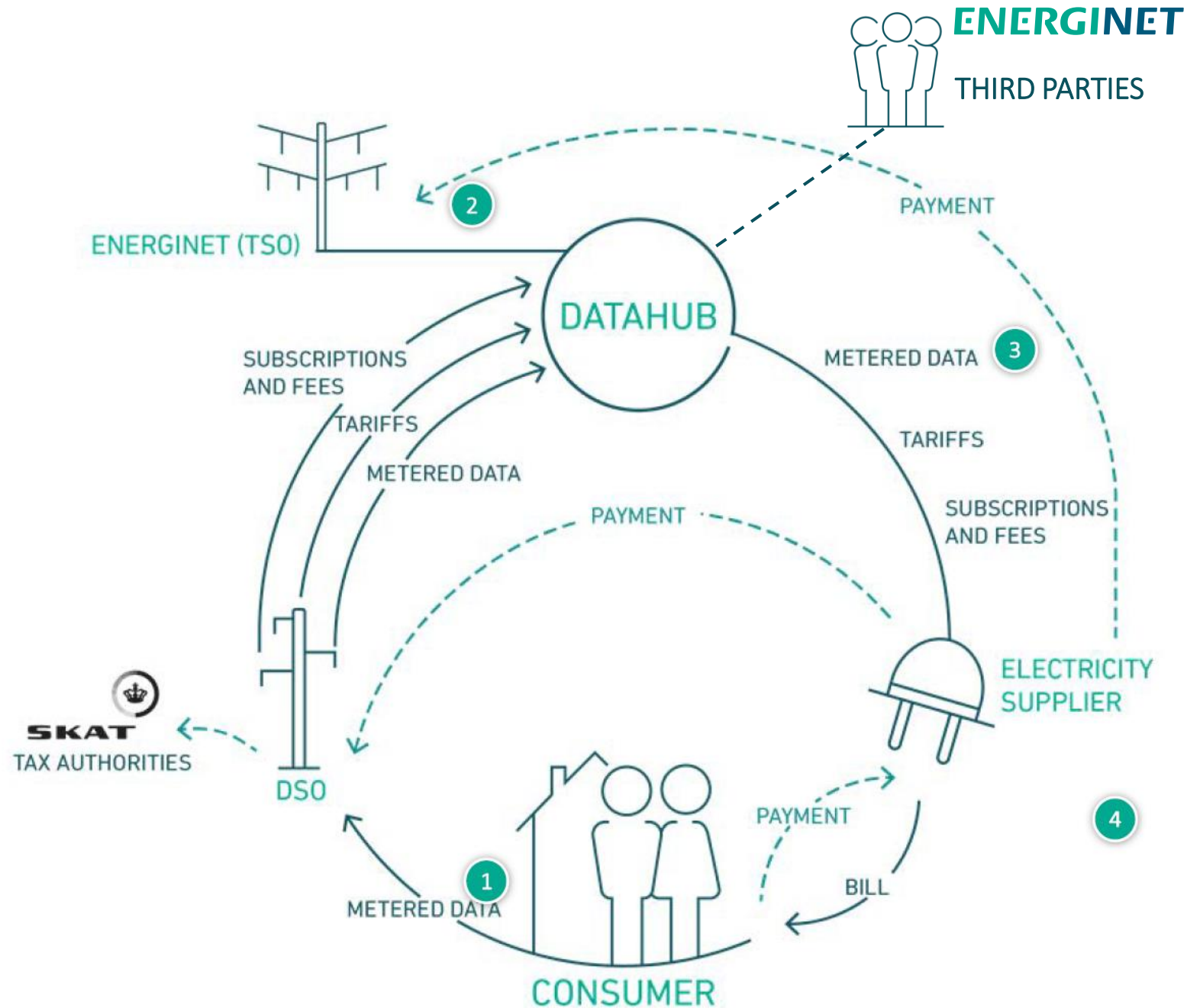
Energinet provides OPEN and FREE access to data to accelerate and support innovation in the green transition

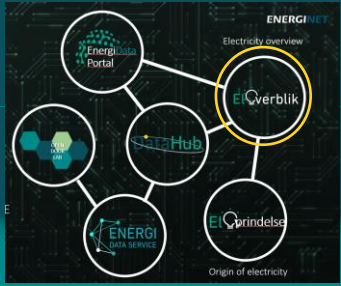




HOW DOES DATAHUB WORK ?

The central register and market platform for all metering data which is the basis of all settlements





ABOUT US

HELP

CONTACT

DK EN

(Electricity Overview)

DIRECT ACCESS TO YOUR ELECTRICITY OVERVIEW



LOG IN TO ACCESS YOUR MASTER DATA AND METERED DATA



PRIVATE CUSTOMERS

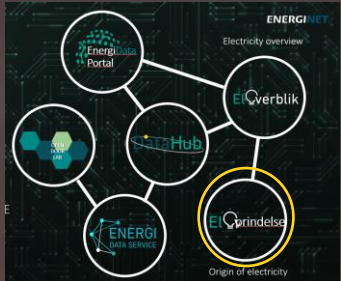


BUSINESS CUSTOMERS



THIRD PARTY

- Provides access to ...
- ✓ Customer data
 - ✓ Meter master data
 - ✓ Meter readings
 - ✓ API-access
 - ✓ Third Party Access



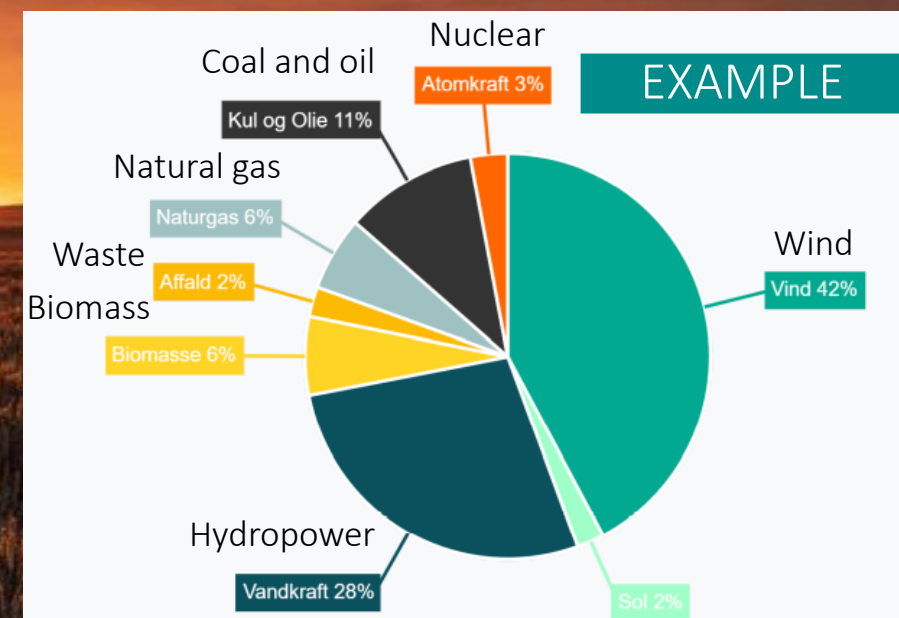
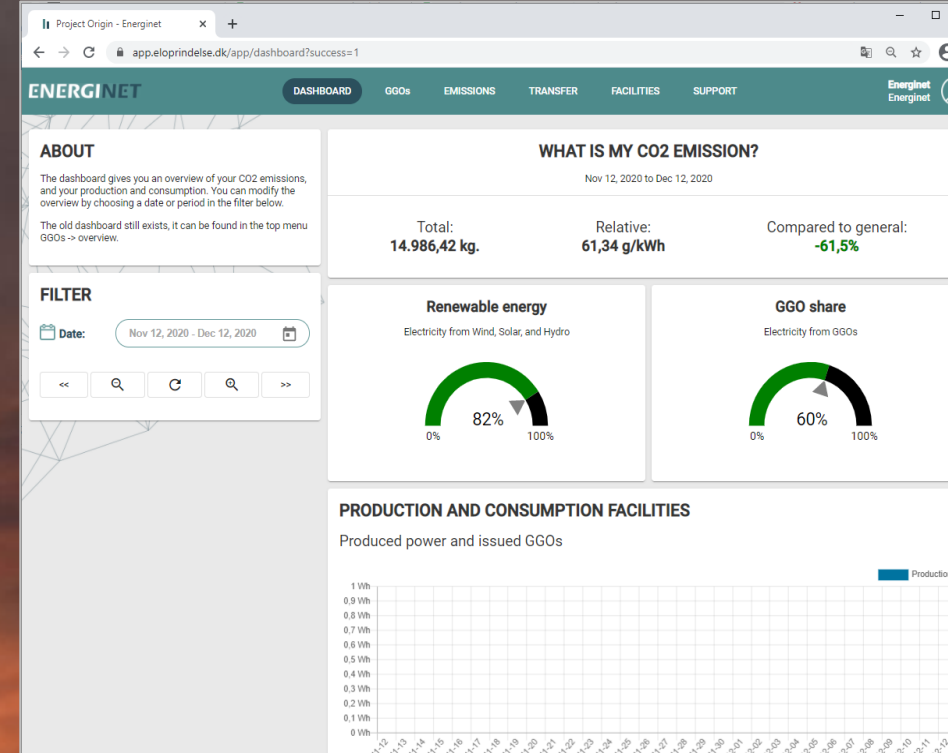
Eloprindelse/Origin of electricity

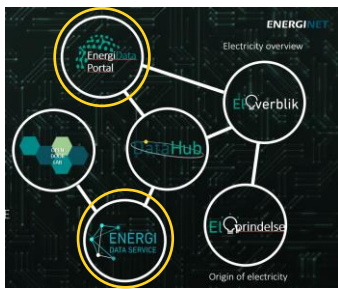
Documenting the “green value” from RES-production all the way to the final end-user

Provides people and companies with individual (personal) electricity declarations based on their actual hourly consumption of one or more specific meters.

Data sources

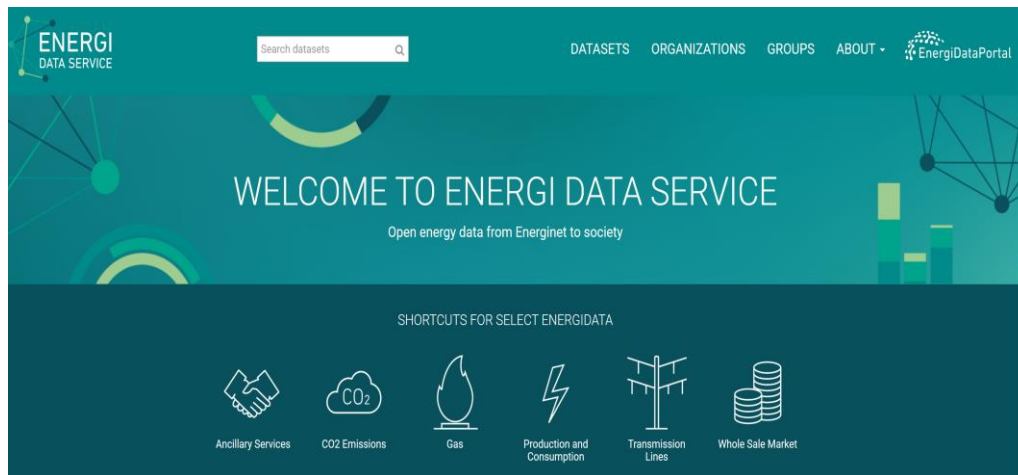
- Hourly meter readings (from specific meters)
- Declaration, Emission per Hour
- Declaration, Consumption coverage per Hour





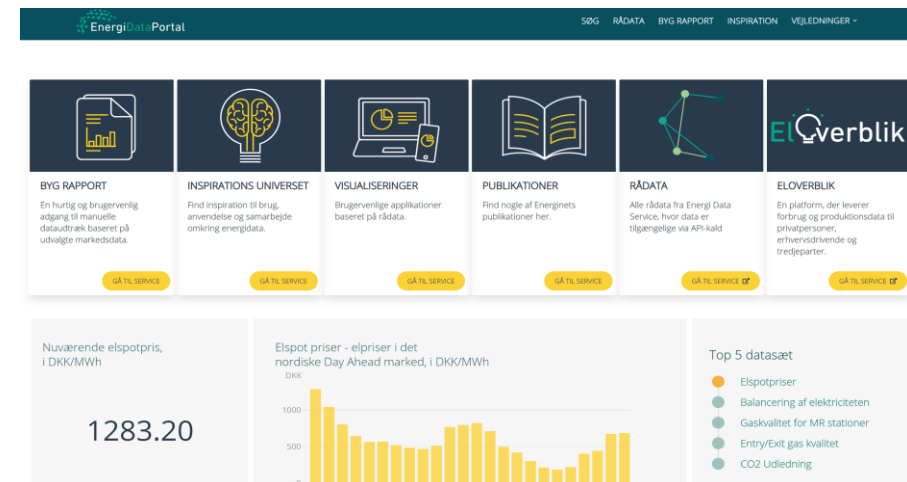
TWO DATA PORTALS

The "raw" Energi Data Service and our exhibition window Energi Data Portal



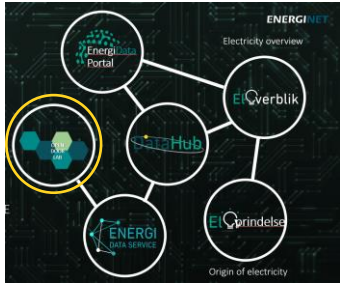
Energi Data Service

- API motor for sharing data
- Generic user interface for manual extraction



Energi Data Portal

- The exhibition window for data
- Simple extractions of data and reports



INNOVATION

OPEN DOOR LAB

ENERGINET

- Source of balancing
- Reduce bottlenecks
- Ensures power adequacy and security of supply
- Reduce costs of ancillary services



BUSINESSES

- Enter the electricity market
- Energy optimization
- Green profiles and accounts
- New business models in and across sectors



A collaboration and innovation initiative that helps new digital initiatives on their way

- Promotes and strengthens data-driven innovation in the electricity and gas system
- A framework for co-creation with external actors around innovative solutions in the electricity and the gas system
- Creates better access to data and systems in the electricity and gas markets and reduces market barriers and the use of new technologies
- Increases preconditions for and promotes flexibility in the electricity markets regarding supporting the green transition

INNOVATION CHALLENGES

OPEN DOOR LAB SPRINTS



HOW can cooling contribute to flexibility and system services?



HOW can we use data to develop consumption profiles?



HOW can data be used to monitor consumption that responds flexibly?



HOW can digital layers and platforms support multiple devices to intelligently contribute flexibility?



FLEXIBILITY

ANCILLERY SERVICES FROM PRODUCTION AND CONSUMPTION



SECTOR SYNERGIES AND BUSINESS MODELS

CO-CREATION AND INCREASED INNOVATION



UPCOMING SPRINTS
HOW can P2X contribute with flexibility?

WHAT do the green digital business models of the future look like?

WHAT framework for virtual digital meters supports the development?



MARKET FRAMEWORK

EFFICIENT MARKET FRAMEWORK FOR NEW ACTORS AND TECHNOLOGIES

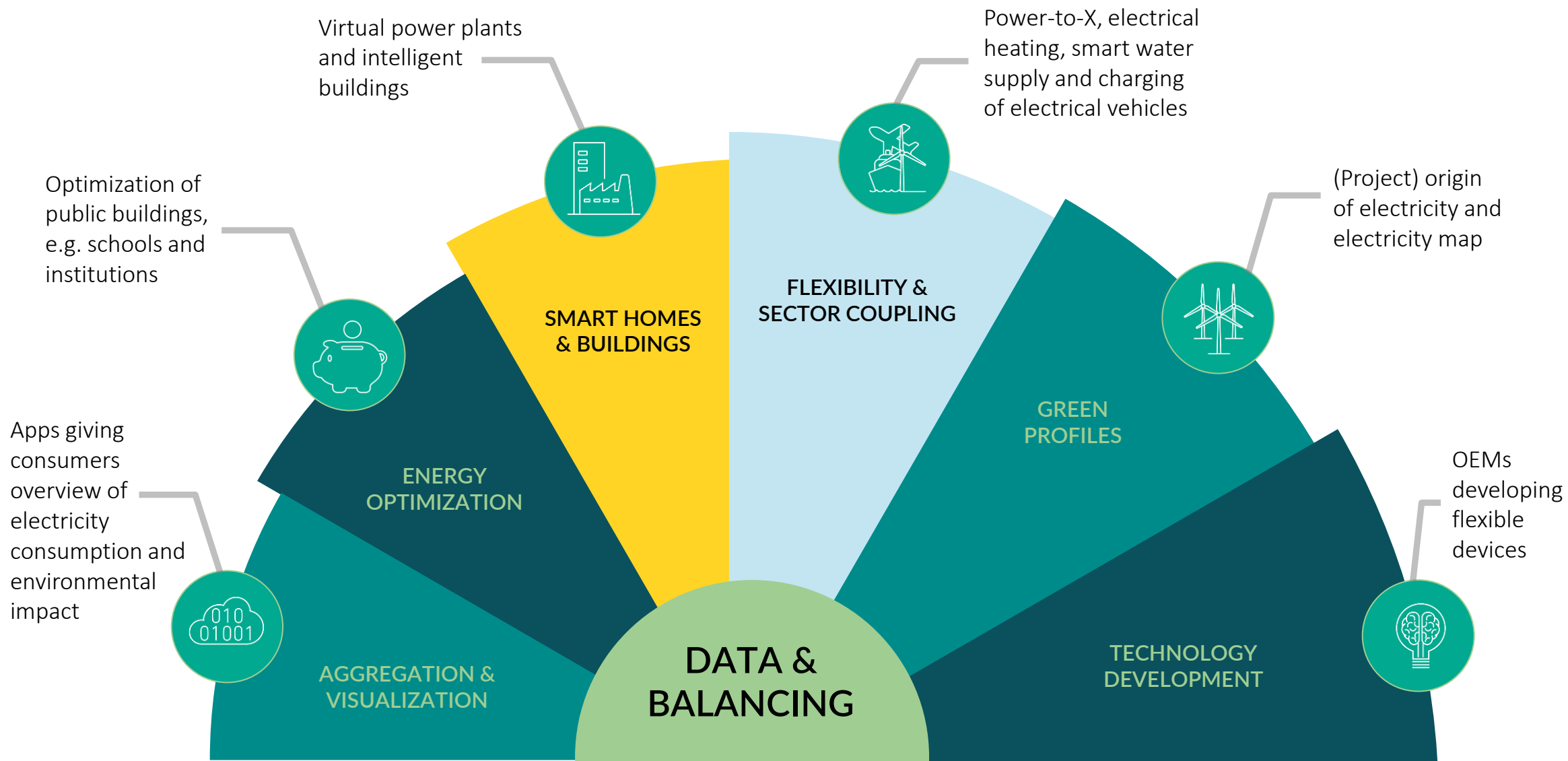


HOW can you anonymize data so you can access more data?



HOW do we make it easy, smart and simple to become a market player?

VALUE FROM DATA THROUGH NEW GREEN BUSINESS MODELS



DIGITALIZATION TOGETHER WITH THE SOCIETY



The next generation is **digital natives**. New opportunities within e.g. digital forms of communication, digital awareness, digital tools and **open-source** are gaining ground.



Data volumes are growing and **contexts** where energy data can be used are increasing. Energinet is experiencing an **increased demand** from external parties regarding data and know-how



Green digital solutions must be created through **co-creation** in the fields between **open systems, open data access** and active collaboration - with the involvement of internal and external stakeholders.

AGENDA

14.30-15.00: Introduction to Energinet and Energinets role in Danish green transition – Peter Markussen, Senior director, International Relations

15.00-15.30: Transmission connection and development for integration of offshore wind – Anders Steen Kristensen, Head of Grid Planning

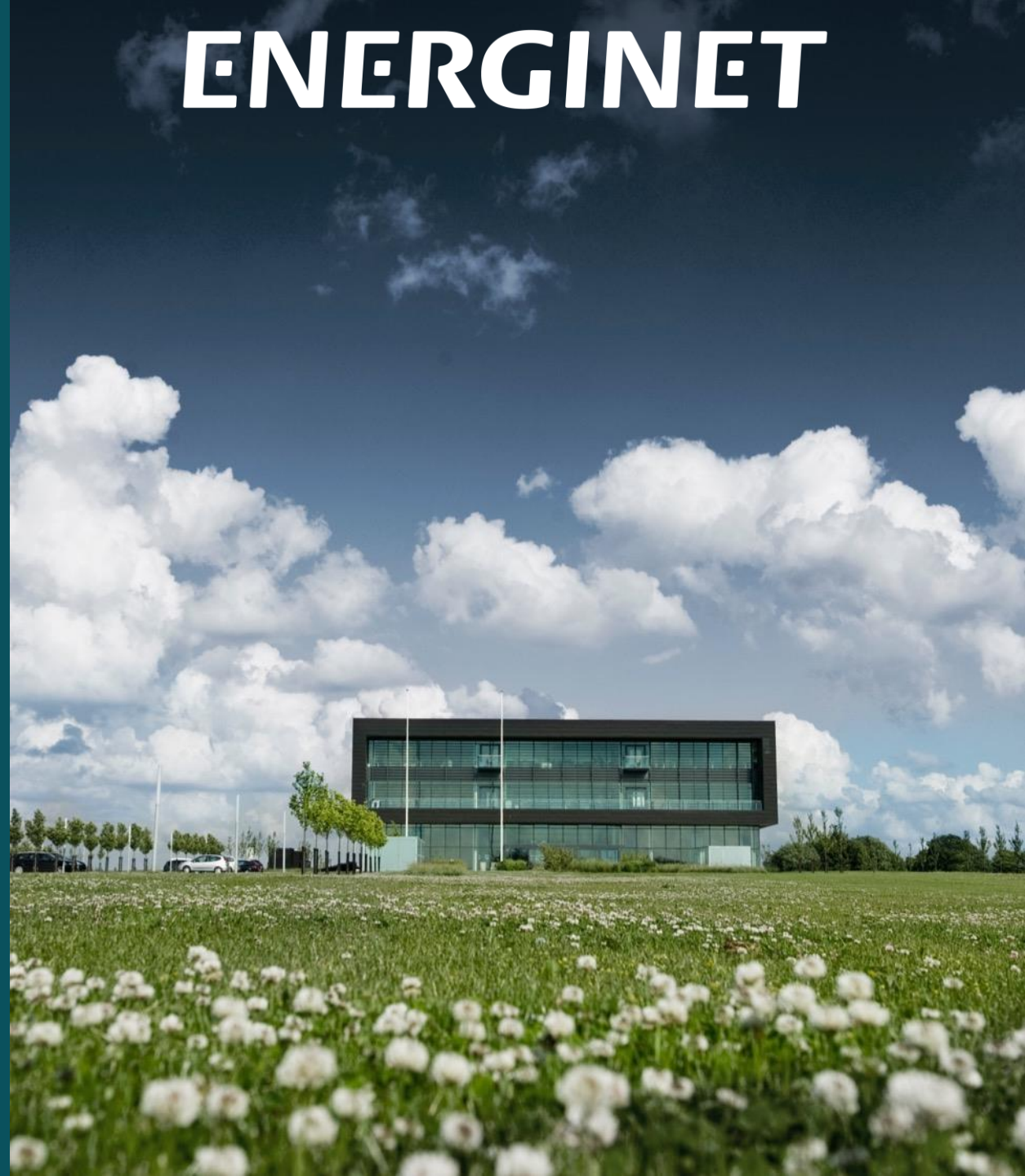
15.30-15.45: Break

15.45-16.15: Increased flexibility from cross border interconnection – Morten Pindstrup, Chief expert, Electricity Markets

16.15-16.45: Energinet experience with digitilisation and open access to energy system data – Gitte Schjøtt Kristensen, Head of Data and System Innovation

16.45-17.00: sum up

ENERGINET



Thank you for
your attention



Phone: +45 61244353, Email: pmr@energinet.dk