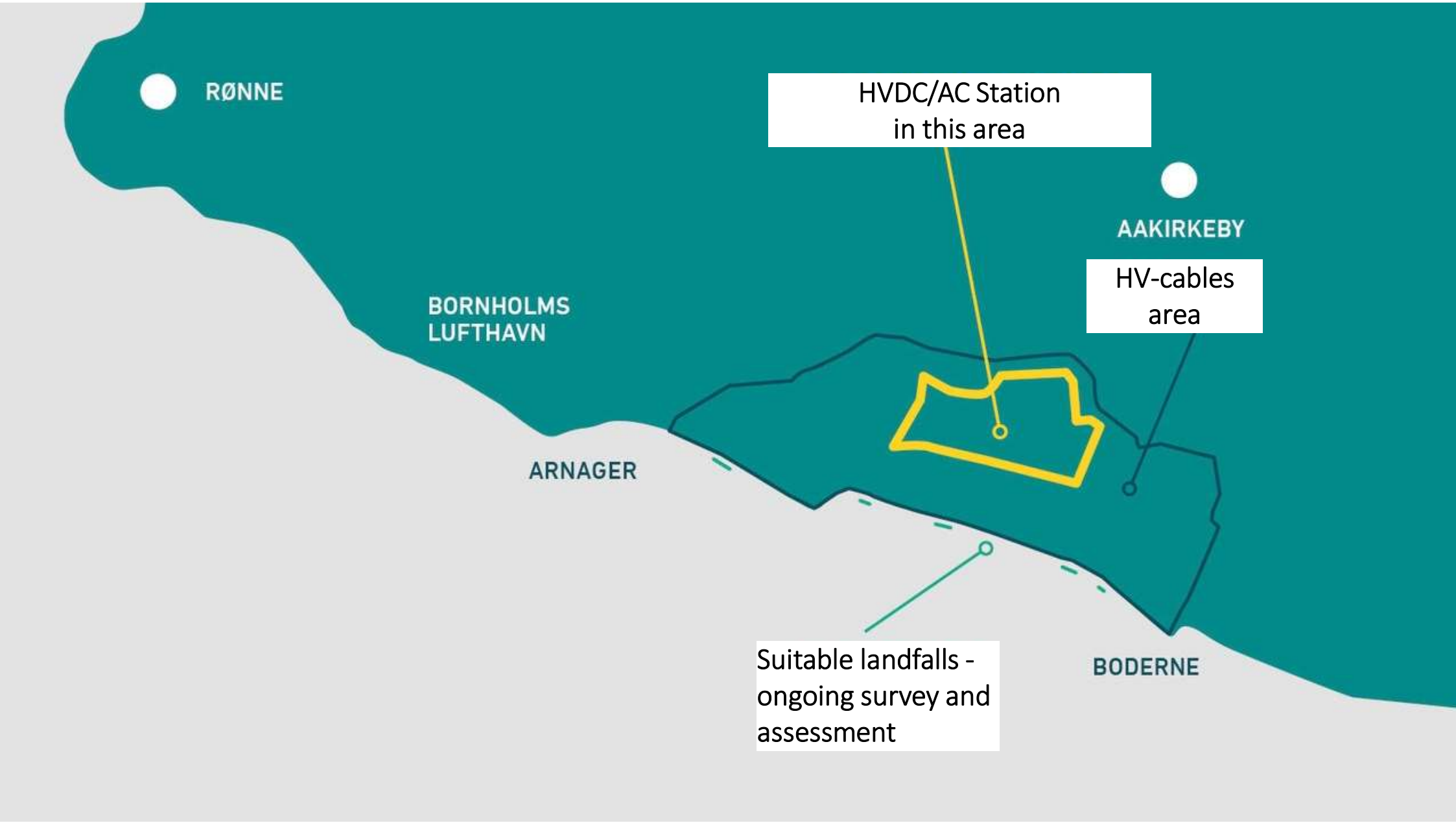
ENERGY ISLAND BORNHOLM

Land areas – planning and permitting implications

Bent Sømod - Energinet


RØNNE
HVDC/AC Station
in this area
AAKIRKEBY
HV-cables
area
BORNHOLMS
LUFTHAVN
ARNAGER
Suitable landfalls -
ongoing survey and
assessment
BODERNE

PLANNING

- Indication of 9 HDD at shoreline cable crossings reserved for developers HVAC cables (220 kV based)
  - (7 offshore transformerstations)
  - Plan draft include 21 landcables but up to 12 to be reserved for 4 HVDC connections
- Plan draft state minimum depth of 1 m for cable trenches and distance between cable trenches of 8 m
- Plan draft state buildings at HV-station maximum height of 25 m
- Plan draft state HV-station maximum fenced area of 90 ha

EIA PERMITTING

- Requirements in EIA-permit for architectural expression and landscape adaption of the HV-station to be expected
- Requirements for HDD at cable crossings of protected areas and streams
- Requirements for crossing of shoreline with HDD also likely, but trenching also included in permitting procedure

LOCAL PLANNING

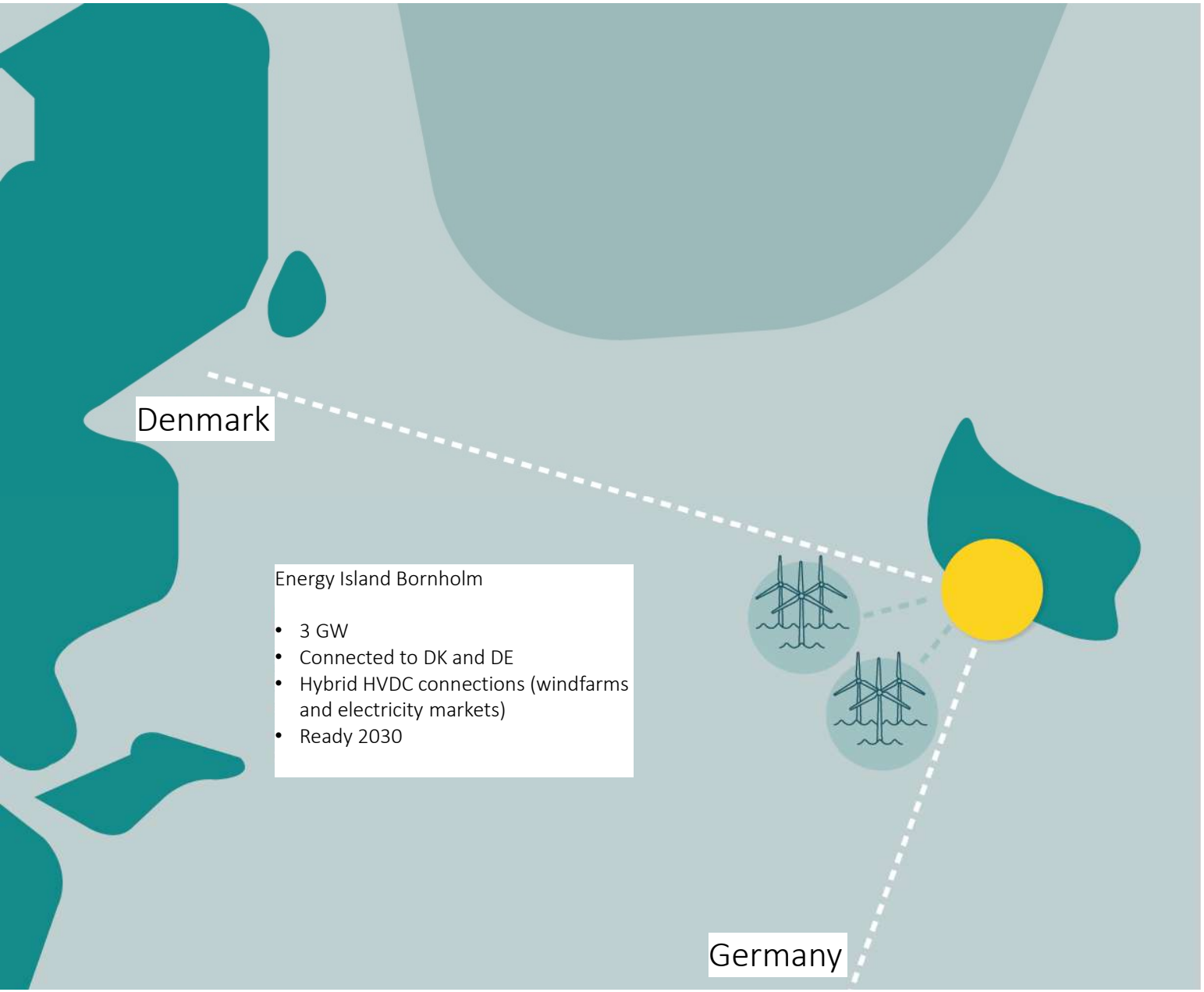
70-90 hectares reservation

- Buildings for HVDC equipment
- AC equipment
- Storage and spare parts buldings
- Facilities for administration
- Access roads, laydown area, planting and green areas, drainage, terrain
- Areas for concession owners/ developers substation/ equipment
- *Possible temporary extra areas outside local plan area and necessary under construction to be includede in Local Plan with bonus effect*

ENERGY ISLAND BORNHOLM

HVDC converters and technical interface

Erman Temur - Energinet



ENERGINET

Essential characteristics:

- HVDC power systems use D.C. for transmission of bulk power over long distances.
- For long-distance power transmission, HVDC lines are less expensive, and losses are less as compared to AC transmission.
- HVDC technology interconnects the networks that have different. frequencies and characteristics.
- Design of the station shall take future extensions into account.

TYPICAL COMPONENTS OF A HVDC TRANSMISSION SYSTEM

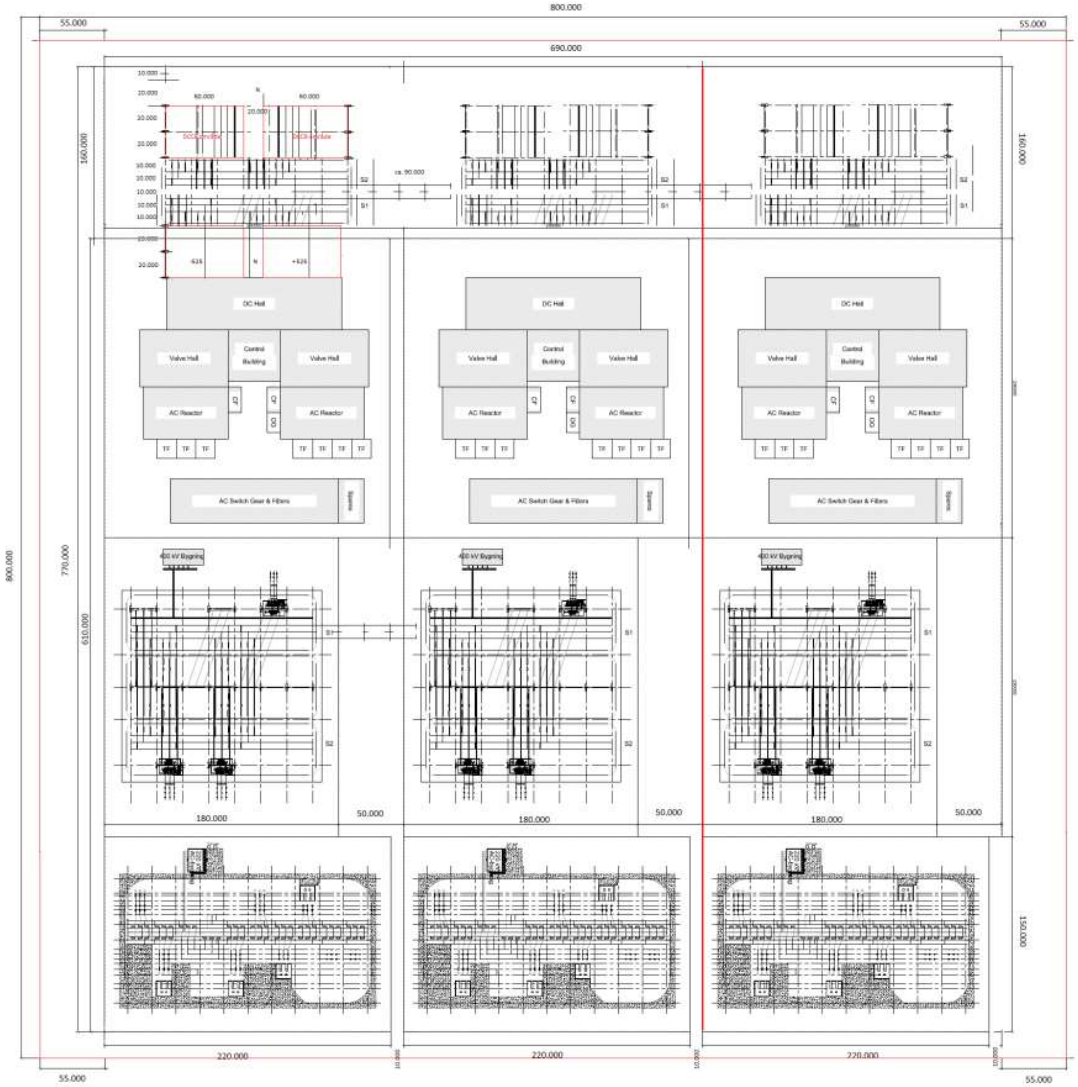
- Converter modules & valves
- Converter transformers
- Phase/ Smoothing reactor
- Cooling systems
- AC switchyard
- DC switchgear
- DC cables
- Storage & spare parts, Administration, access roads, laydown area, planting and green areas, drainage, etc.

An exception is the DCCB required for meshed grids/ MTDC. Lot of efforts are going into the technical development in order to increase the technology readiness level as to mature the technology for commercial availability. However, progress still must be made on international standards, in particular the type testing.

The DCCBs used in China have been fully type tested, either in the manufacturers' laboratories or in independent laboratories. The test procedures were agreed upon between the manufacturer and the client before the tests commenced. These tests were witnessed by the manufacturer, the client, and an independent third party. Successfully type tested DCCBs were then accepted by the client.

Topological concept

- 3 Bipole Converters
- 2 x 500MW @ 525kV each
- Space allocated for DC switching equipment/ DCCB
- 220kV and 400kV AC substations



Footprint appr. 60ha

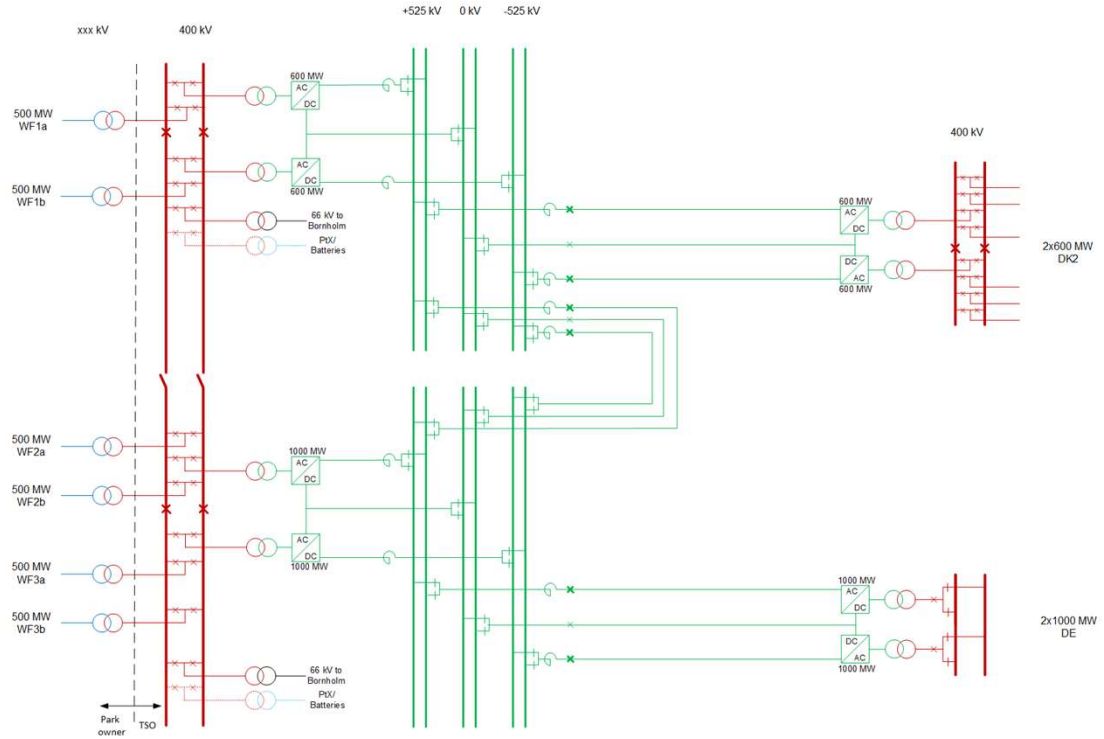
The illustrations represent only the technical layout of a possible future Converter station and does not account for local conditions such as geotechnical elements, terrain, drainage, shelterbelt planting, interim structures/areas and other restrictions or limitations. In total these conditions could signify an extra required area of up to 40 %.


Visualization
3 Bipole Converters
3 x 2x 500MW @525kV


Visualization


Visualization

TOPOLOGICAL CONCEPT WITH TWO BIPOLES



MTDC SYSTEM

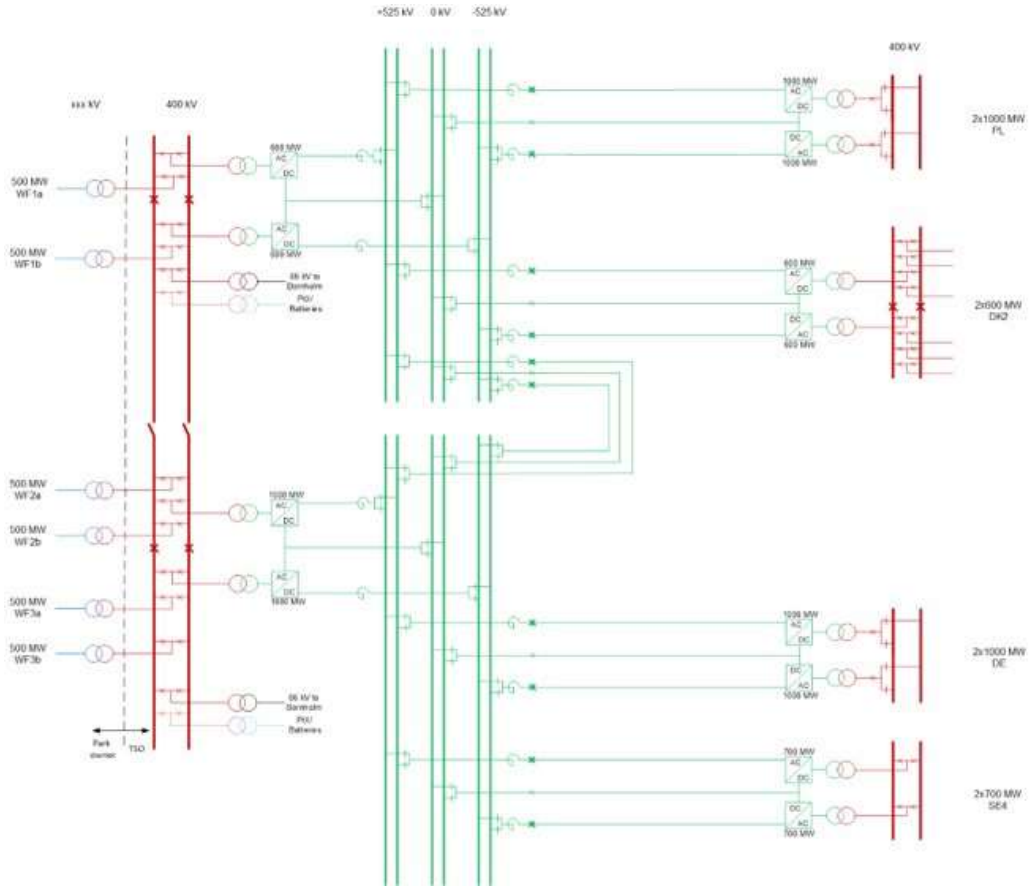
Bipole with DMR

2 x 600MW towards -> DK2

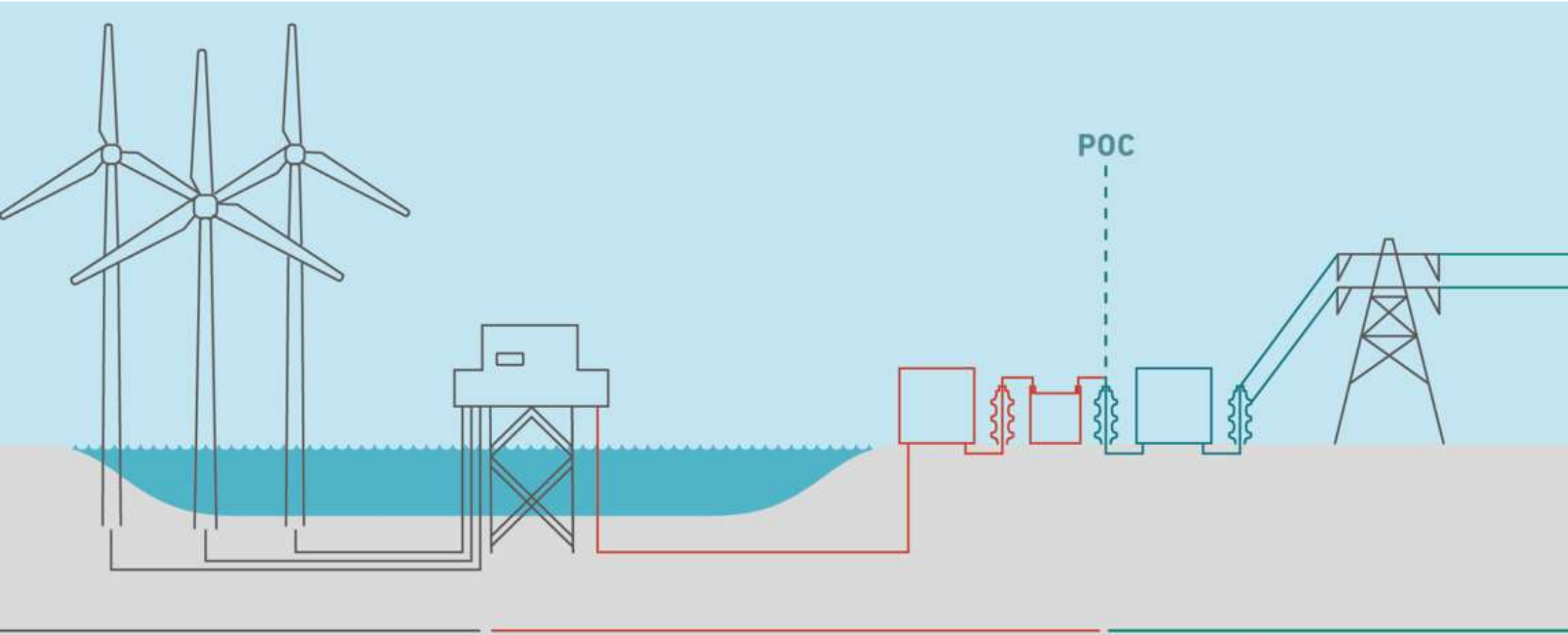
2 x 1000 MW towards -> DE

525kV DC voltage / DC busbar

FUTURE EXTENSIONS ??



Additional interconnecters enabling the transmission of the offshore power to other countries



Wind farm and array cables.
Construction and operation
by concessionaire.

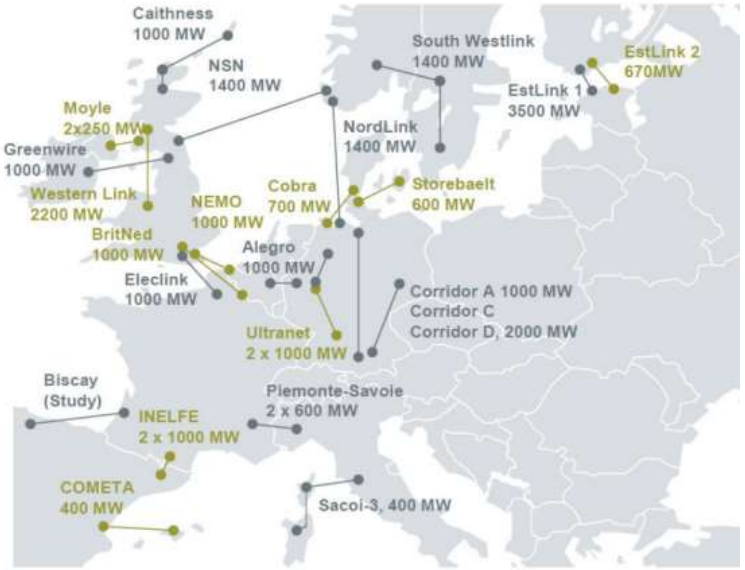
Export facility.
Construction and operation
by concessionaire.

Grid connection.
Interconnectors,
construction and
operation by
Energinet.

FIGURE: Responsibility of the concessionaire includes all facilities up to and including the connection in the 400 Kv bays provided by Energinet.

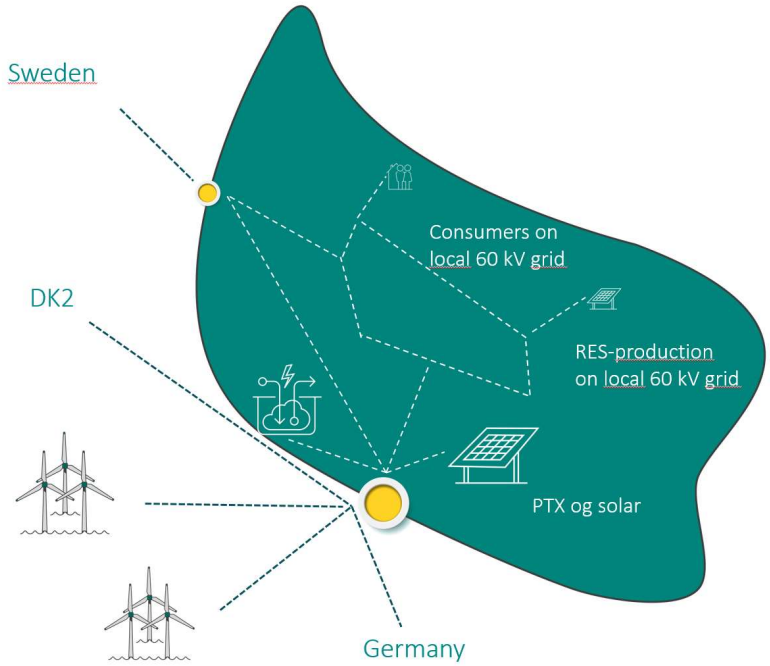
CURRENT TECHNOLOGY IS CHALLENGED !

- HVDC is an established technology that has been in commercial use for 60 years (Point to Point)
- There is very limited international experience in MTDC (Multi Terminal Direct Current) or in these type of systems. No standards for securing stability and interoperability.
- The components needed are commercially available but integration of high quantities of offshore wind into an isolated grid without any stabilizing power generator will be a huge challenge.
- Bornholm Energy Island is a much more complex project as multiple offshore wind parks will be connected together with multiple HVDC systems and an island with small power consumption
- Sharing of information and models without violating the IPR is and will be a challenge.
- Developing new methods, innovative and cutting-edge technologies and products is the key to pave the way for realizing Bornholm Energy Island.



Unique Power System

- An isolated electrical system which is fully power electronic based
- A modular and expandable offshore power system
- A multi-vendor multi-stakeholder environment
  - ensure stable and robust operation
- A multi-purpose system
  - Power generation,
  - Transmission,
  - Local consumption
  - Future PtX innovation



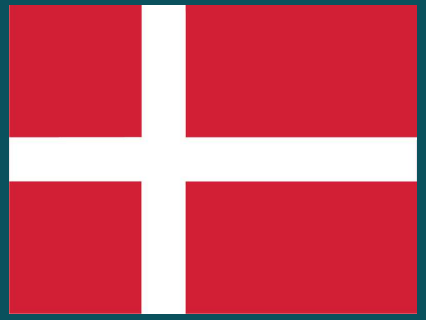
ENERGY ISLAND BORNHOLM

Grid Connection

Flemming Brinch Nielsen - Energinet

GRID CODES

Regulation for grid connection -
DC connected PPM
Slide 1/6



Bornholm Energy Island

- COMMISSION REGULATION (EU) 2016/1447 of 26 August 2016 establishing a network code on requirements for grid connection of high voltage direct current systems and direct current-connected power park modules
- All relevant appendix, approved by the National Utility Regulator, available on Energinets website
  - DC connected PPM (article 38 – 45)
  - Isolated AC system
    - Energinet will be relevant TSO and relevant system operator
    - Operational modes/regimes are not developed yet
  - POC at 400 kV busbar

GRID CODES

Regulation for grid connection - DC connected PPM

COMMISSION REGULATION

Slide 2/6

- COMMISSION REGULATION (EU) 2016/1447 of 26 August 2016
  - DC connected PPM (article 38 – 45)
  - HVDC systems, POC and grid specific analysis. Part of connection agreement
  - Frequency range and duration (39.2.a/Annex VI)
  - Voltage range and duration (40.1.a/Annex VII)
  - Reactive power capabilities (40.2.b.i)
  - General system managements requirements (45)
- National implementation
- COMMISSION REGULATION (EU) 2016/631 of 14 April 2016 establishing a network code on Requirements for grid connection of Generators
  - Relevant references included

GRID CODES

Regulation for grid connection -

DC connected PPM

Additional national requirements

Slide 3/6

- Special requirements - part of connection agreement
  - POD
  - OVFRT (OVRT)
  - Energization
    - Breaker sync, Zero-miss, Voltage change
  - And more… if needed

- Energinet - Spec and requirement review
  - DC connected PPM -> Reactive power

GRID CODES

Regulation for grid connection - DC connected PPM

Future evolution of requirements and regulation

- Requirements in general
  - International working group, EG_CROS
    - Impact Specifications on DC connected PPM
    - Lead to general revision of COMMISSION REGULATION (EU) 2016/1447
- Revision on national connection requirements
  - Revision starts on COMMISSION REGULATION (EU) 2016/631
  - COMMISSION REGULATION (EU) 2016/1388
- General ACER revision starts September 2022
  - COMMISSION REGULATION (EU) 2016/631 and
  - COMMISSION REGULATION (EU) 2016/1388

GRID CODES

Regulation for grid connection - DC connected PPM

Legislative challenges

Slide 5/6

Legislative challenges

- Initially an energy island
- Isolated AC system - DC connected PPM
- Multi vendor – multi stakeholder (optional)
- Additional connection of
  - Demand facilities (and distribution systems)
    - Regulation (EU) 2016/1447 does not apply
  - Energy Storage facilities
    - Regulation 2016/1447 does not apply
  - Direct connections
    - Regulation does not apply
  - …

GRID CODES

Regulation for grid connection - DC connected PPM

Operational notification

Slide 6/6

https://energinet.dk/El/Nettilslutning-og-drift/Regler-for-nye-anlaeg#Nyeproduktionsanlaeg

https://en.energinet.dk/Electricity/Rules-and-Regulations/Regulations-for-new-facilities#Generationfacilities

- Connection of new DC-connected power park modules (article 60 – 64)
  - Energization operational notification (EON)
  - Interim operational notification (ION)
  - Final operational notification (FON)
  - (Limited operational notification (LON))

- Planning of ION and FON
  - When concession winner is known
  - When OWF is known in needed details