



# EnergyVille

European perspective: making DC as easy as AC

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HORIZON 2050 POWER SYSTEM AND THE ROLE OF HVDC TECHNOLOGIES IN A HIGHLY  
DECENTRALISED RES GENERATION

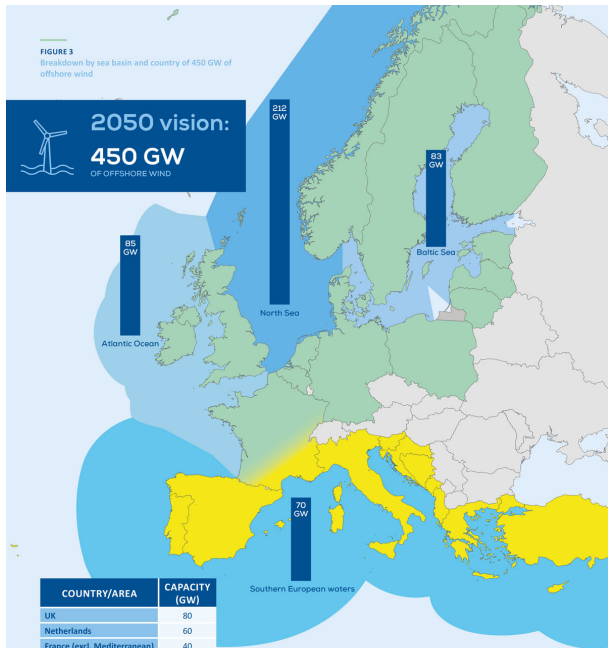
Brussels, February 4, 2020



# Background for HVDC grids

- ▶ Being smart is needed to optimize but full transformation needed to make energy CO<sub>2</sub> neutral (not only electricity)
- ▶ Over 18 GW of wind offshore installed to date
- ▶ Expected to increase up to  $\pm 100$  GW by 2030
- ▶ 200 GW in the North Sea by 2050
- ▶ 450 GW overall (in Europe) by 2050
- ▶ Connections are increasingly further from shore:
  - HVDC becomes realistic option
  - Meshing is needed
  - Needs to be integrated in the existing system (hybrid AC/DC)
- ▶ HVDC & power electronics dominated systems behave fundamentally different compared to conventional AC systems
  - Planning
  - Protection
  - Controls

# First connect to shore, then connect inland also



► Transmission and generation will be power electronics based

► Irish zone: 22 GW

► Atlantic zone: 80 GW

► (combined) Irish system: < 10 GW

⇒ Offshore interconnection

► Netherlands: 60 GW wind

► Dutch system < 20 GW

⇒ Need for (deep) inland reinforcements

# Future developments in the transmission grids

## Technical challenges and needs and the role of converters and HVDC systems

### ► Technical challenges:

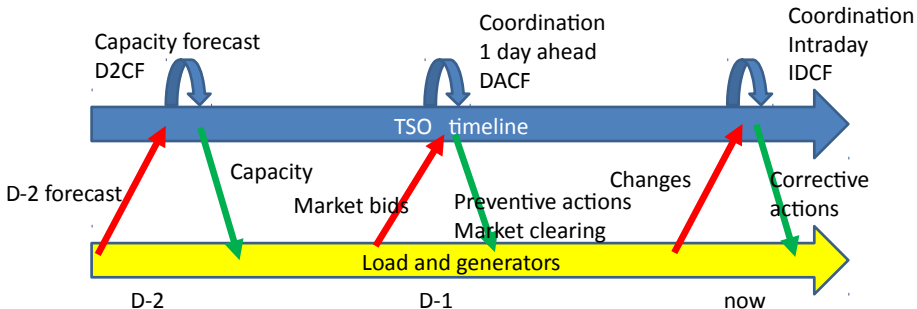
- Working much closer to real time
- Dynamic reliability through the use of vast flexibility options
- How much redundancy and in which form (meshing, bi-polar) to realise multi-GW connections
- Faster controls due to loss of inertia
- Interoperability

### ► Role of converters and HVDC systems

- First expectation: behave as we expect system elements to behave
- Main future expectation is that they behave fundamentally different!
- Provider of services: flexibility and control

# Integration of HVDC systems in AC and DC grids

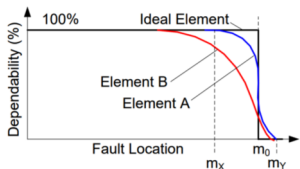
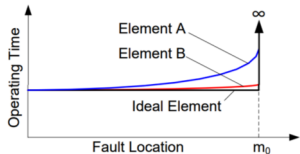
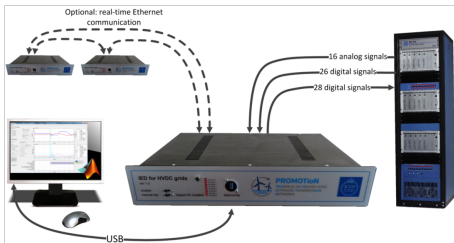
- ▶ The DC system should become an integral part of the overall systems, not an exception as they do now
- ▶ DC systems influence ALL aspects of AC grid operations
- ▶ Most grid codes are not adapted to full and fair integration of DC and AC grids
- ▶ Hybrid AC/DC systems should deliver a similar quality of service as existing system (at least a cost optimal one)



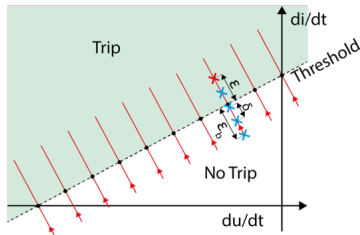
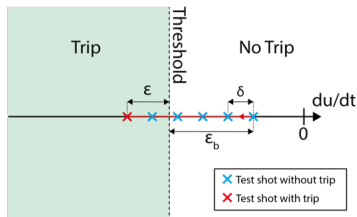
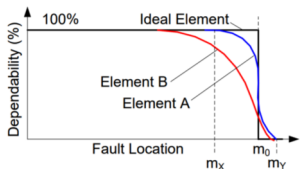
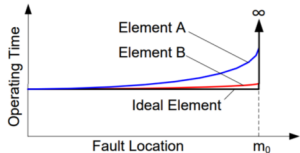
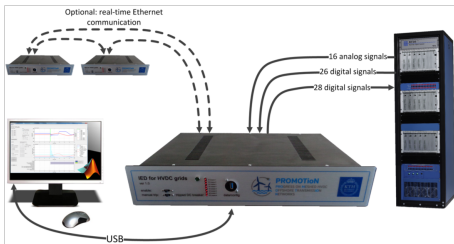
# Interoperability for enhanced DC grid solutions

- ▶ **Interoperability is a characteristic of a product or system, whose interfaces are completely understood, to work with other products or systems, at present or in the future, in either implementation or access, without any restrictions. (Wikipedia)**
- ▶ We require multi-vendor compatibility
- ▶ We require multi-generation compatibility
- ▶ Limited standards available, including testing standards
- ▶ Interoperability:
  - Converters: DC ↔ DC and AC ↔ AC control interactions
  - Converters ↔ grid harmonic interaction
  - Protection equipment and algorithms
  - Cables
  - ...
- ▶ Need for clear rules... which allow innovation

# Interaction studies and compliance testing



# Interaction studies and compliance testing





# Optimised interfaces and processes

- ▶ Need to go to near real-time power system operations
- ▶ Power system operations able to integrate all controls of the HVDC link
- ▶ Towards risk based operation of the power system
- ▶ Integration of preventive and corrective actions

# Conclusions

- ▶ HVDC and HVDC grids cause fundamental changes to power systems, across all time domains
- ▶ With the projected growth of RES (wind), the dependance energy provided through HVDC will increase
- ▶ Hybrid AC/DC operations has more degrees of freedom, requires additional and new studies
- ▶ HVDC allows better use of the overall system, including services
- ▶ Reliability is a consequences of choices made, a design choice
- ▶ **Realising similar reliability will not be achieved using AC concepts**

# IEEE summit on sustainability – Vision towards 2050

- ▶ March 24, 2020, Brussels
- ▶ <http://ieee-summit.org>
- ▶ Keynote: Prof Paul Komor
- ▶ The Green Deal: Through Electric Energy Transition?
- ▶ Digital for a European Green Deal
- ▶ Incentivising Tech Development



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## IEEE Summit on Sustainability Vision towards 2050

Brussels, Tuesday, 24 March 2020

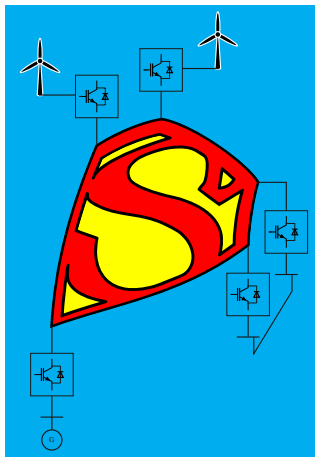
This IEEE Summit on Sustainability – Vision towards 2050 will bring together leading technologists and policymakers in an attempt to develop a joint vision on the policy needed to accelerate technology development contributing to sustainability and their deployment.

The crucial topics that will be at the core of this summit are:

- The Green Deal: Through Electric Energy Transition?
- Digital for a European Green Deal
- Incentivising Tech Development

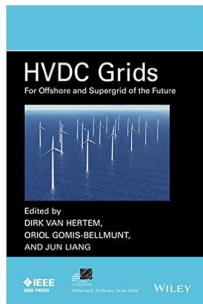
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# Questions?



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<http://as.wiley.com/WileyCDA/WileyTitle/productCd-1118859154.html>



Supported by H2020 project Promotion



Supported by the “Energietransitiefonds”,  
Project Neptune.

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