

Will a North Sea DC grid need DC circuit breakers?

27 september 2019, Brussels, Kees Koreman

TenneT TSO BV



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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691714.



- ↗ Introduction
- ↗ IJmuidenVer project
- ↗ North Sea Wind Power Hub
- ↗ DC breaker Necessary?
- ↗ Preliminary conclusions



INTRODUCTION



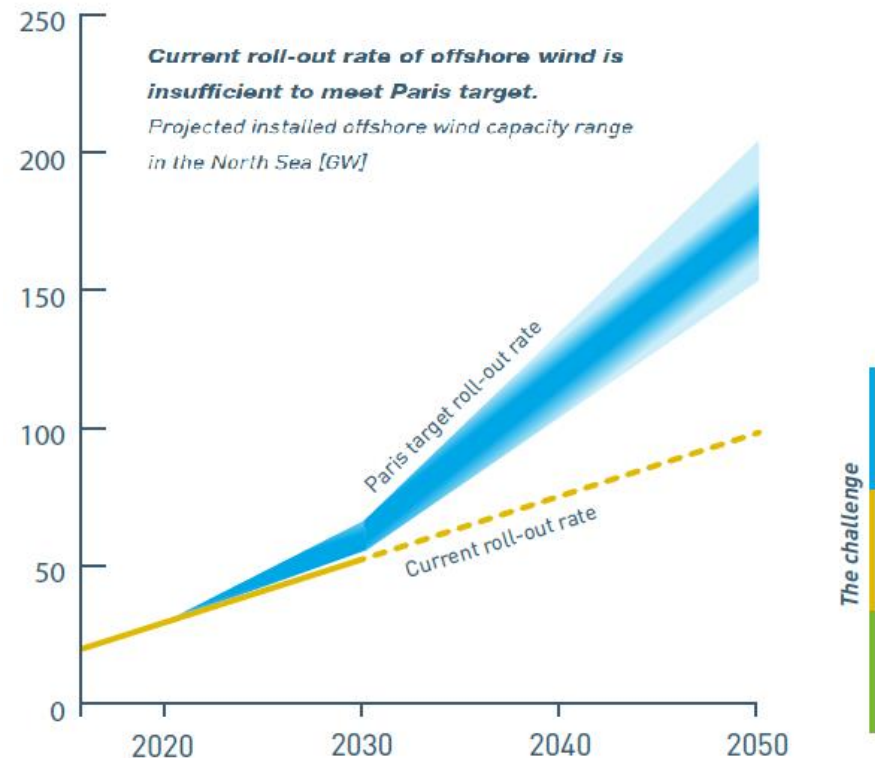
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CHAPTER 1 – INTRODUCTION

INTRODUCTION

- ↗ European ambition to develop a low carbon society
- ↗ Massive changes in the energy system needed
- ↗ Large scale wind deployment in the North Sea

- ↗ Integration of wind onshore
- ↗ Maintain Security of Supply
- ↗ Develop Regulatory framework
- ↗ Market development
- ↗ Co-ordinated Activities by TSO's





IJMUIDEN VER project

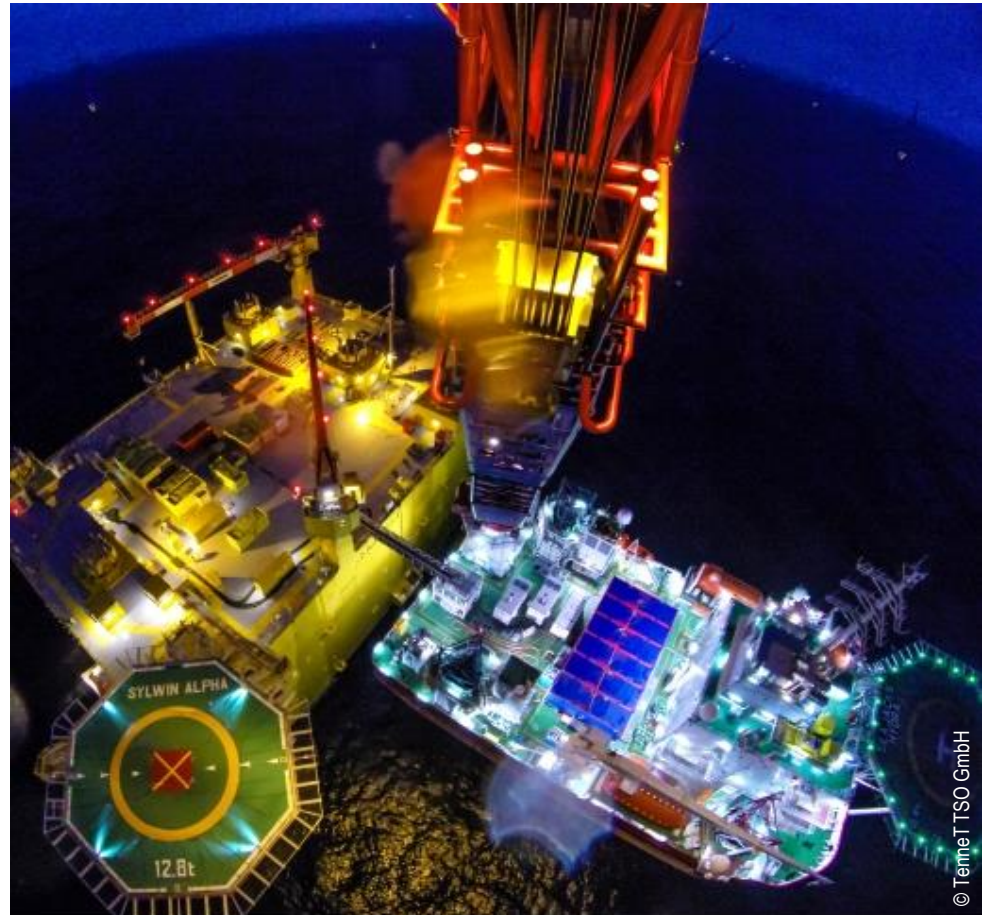


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Dutch offshore projects (AC connected)

- Four in operation 950 MW
- One in trial phase 700 MW
- Four in development 2800 MW
- Three in planning 2100 MW

Total 6550 MW



Positioning of the project

IJmuiden Ver in 2027, 2029

Project details

Voltage: 525 kV

Frequency: DC

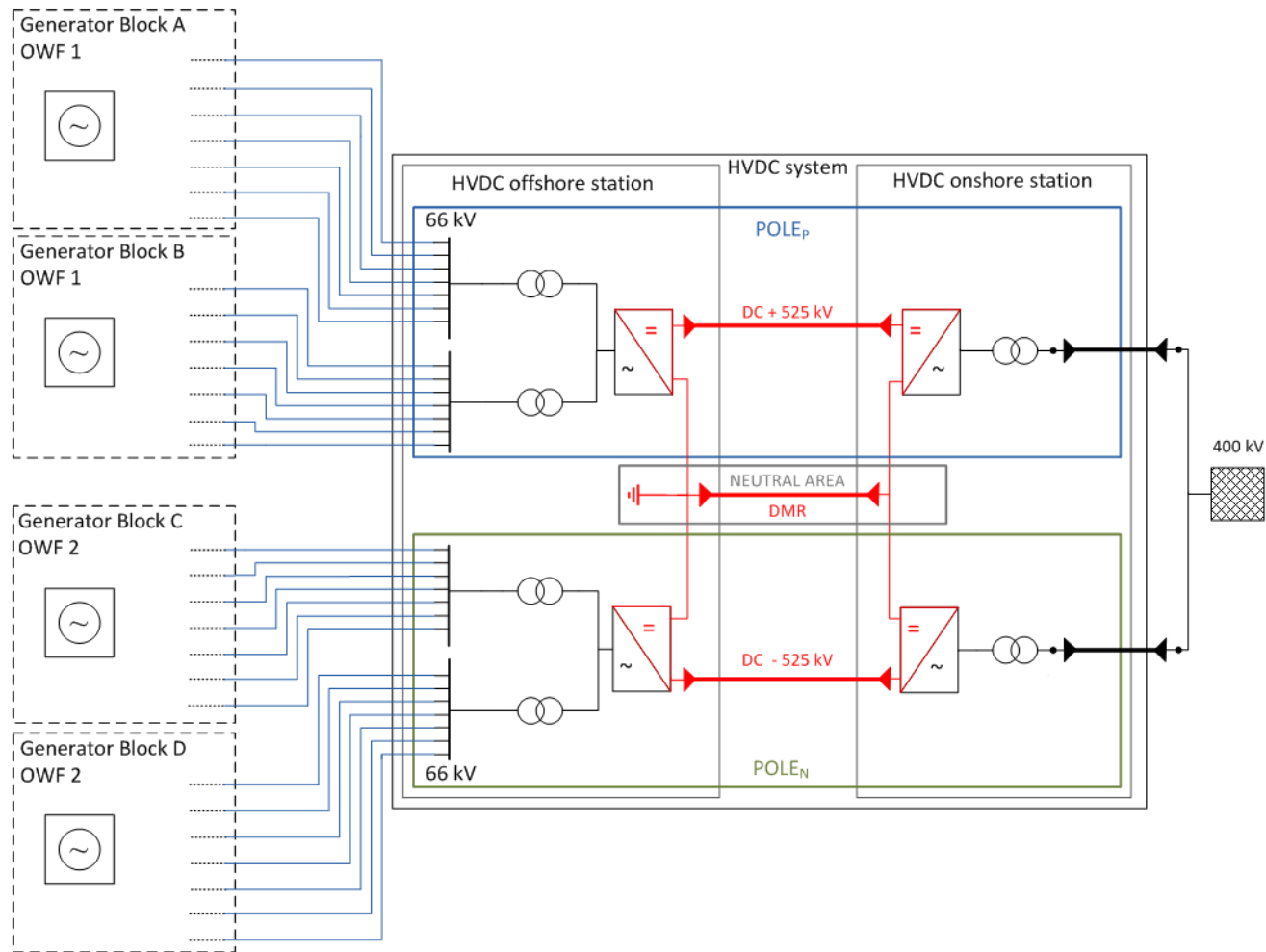
Scheme: bipole with MR

Length: 200 km, 160 km

Cable type: XLPE



Proposed solution





North Sea Wind Power Hub

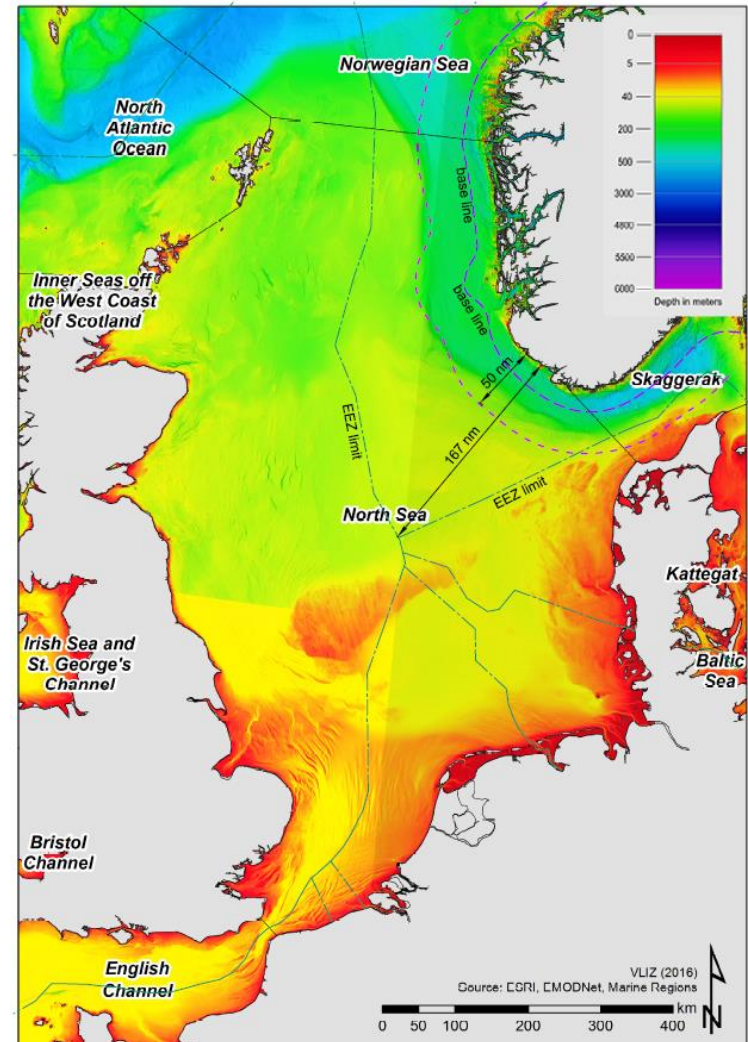


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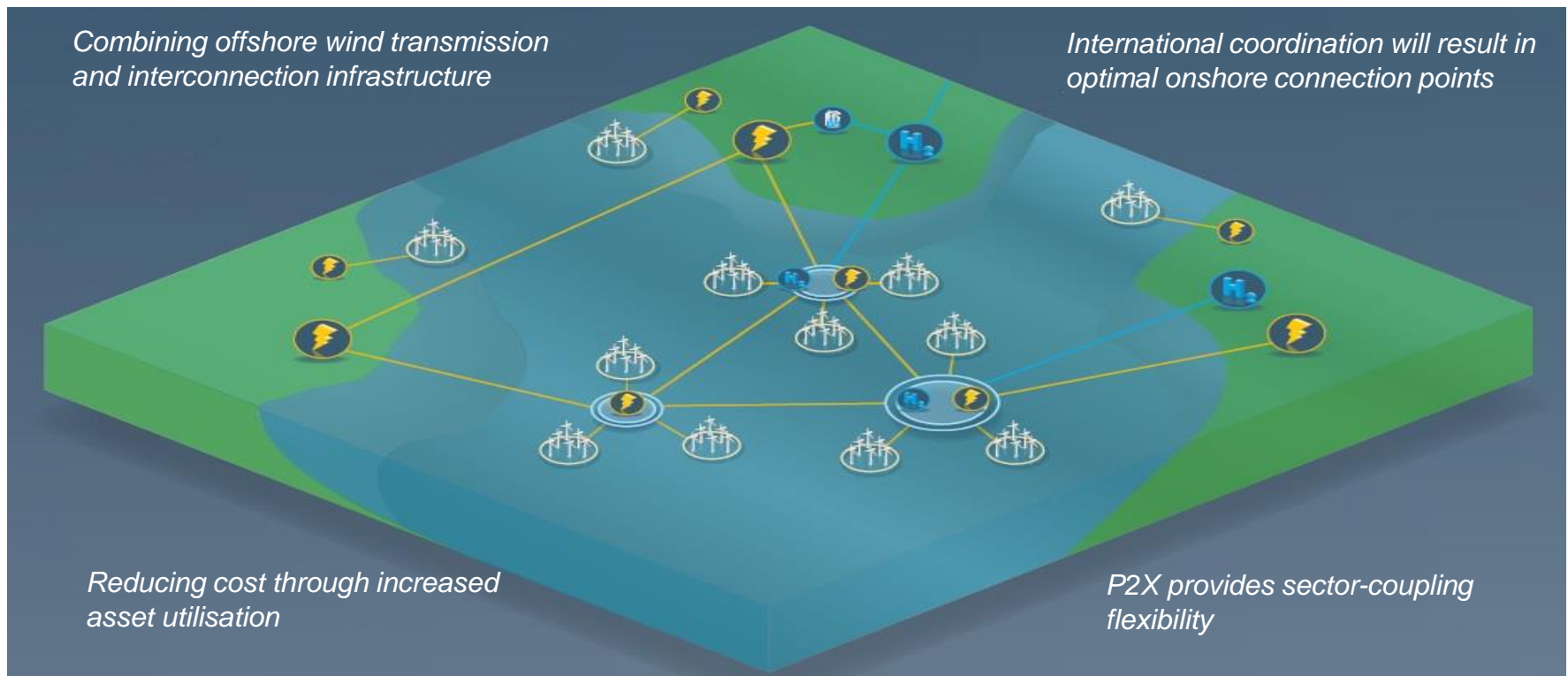
AREA OF INTEREST

- ↗ North Sea has a high potential for wind
- ↗ Area is divided into five economic zones
- ↗ Water depth is ranging from 10 - 400 m
- ↗ Two leg approach
 - ↗ North Sea International Co-ordinated Roll Out
 - ↗ Towards the first Modular Hub&Spoke project

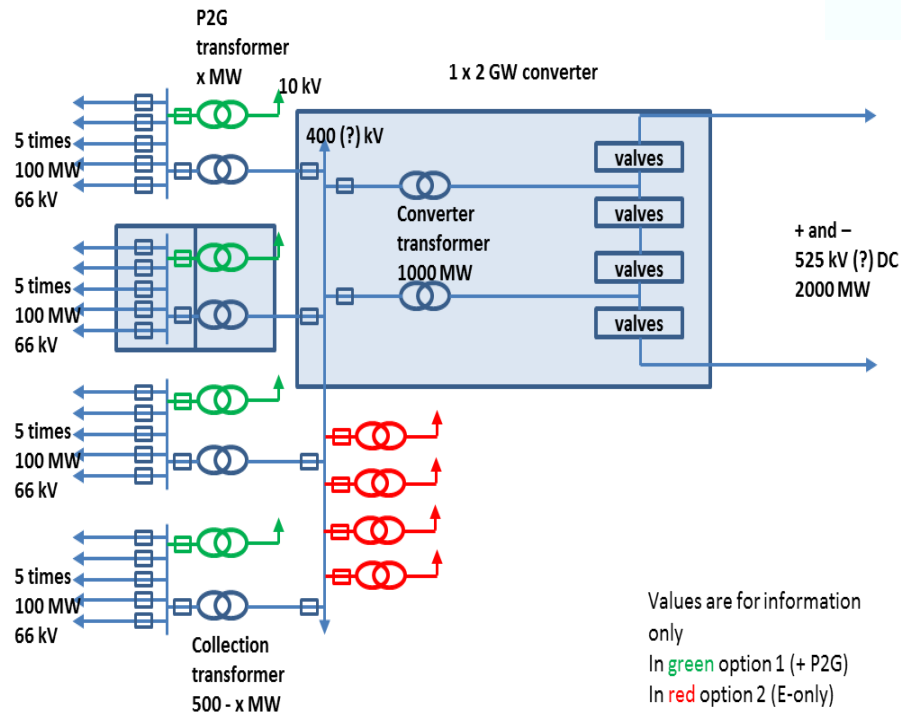
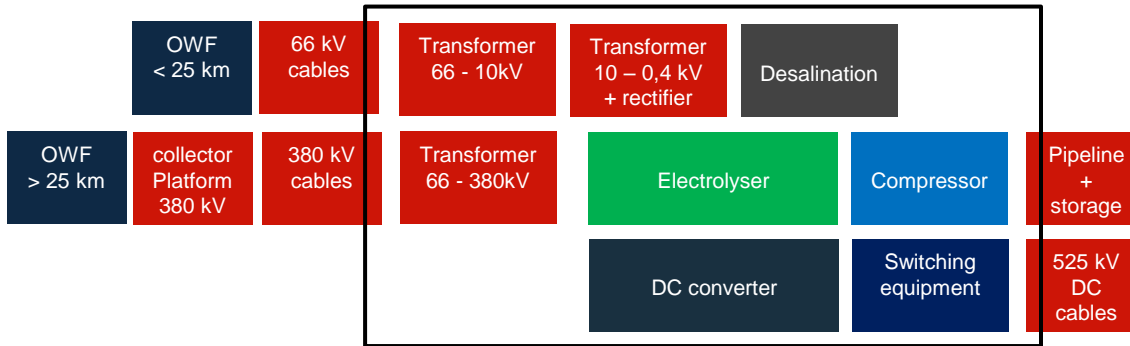


A unique concept

It provides a step-by-step approach and adaptability to balance scale, development times and environmental compatibility



The building blocks





DC breaker necessary?



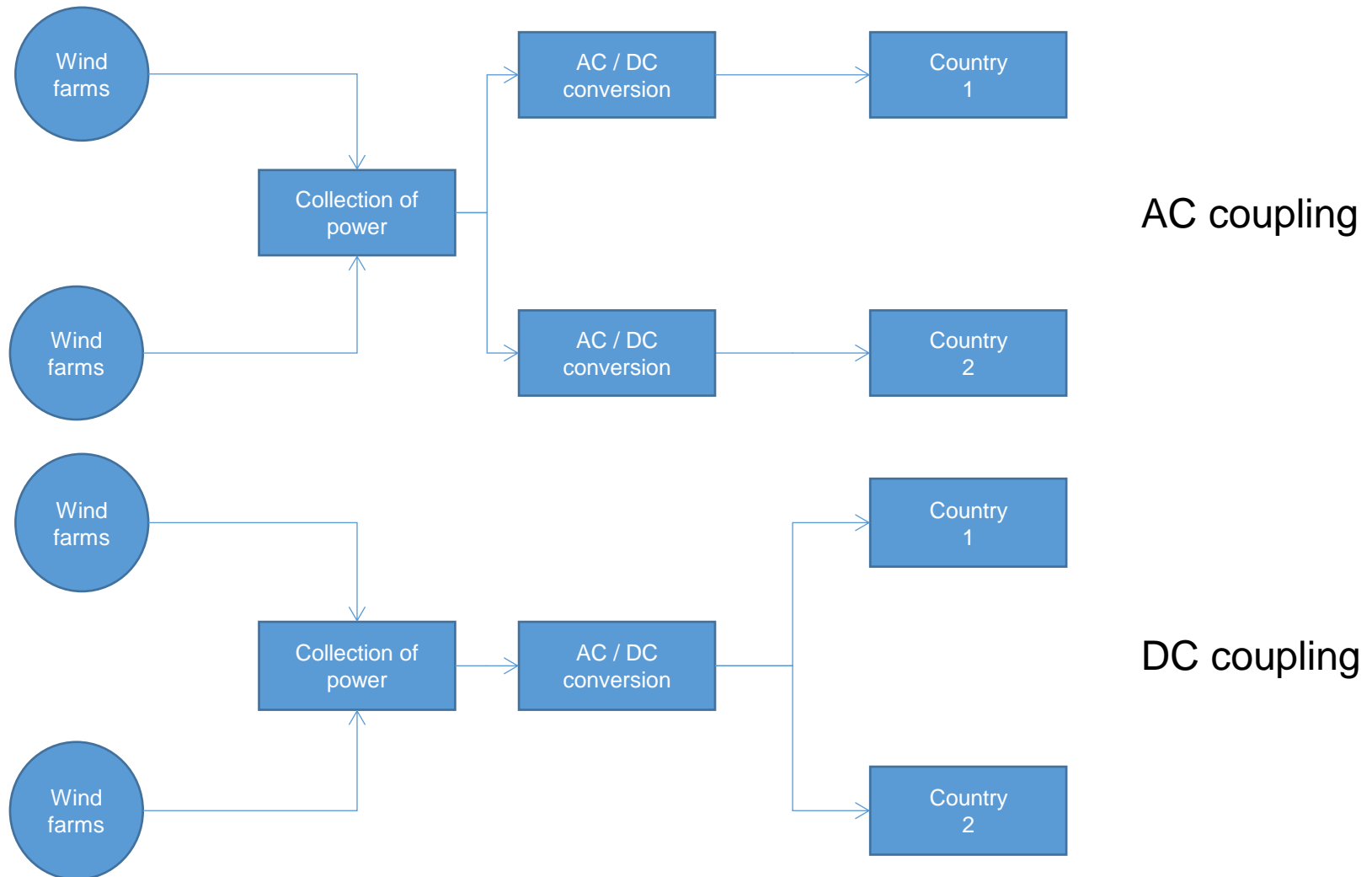
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TSO developments

- ↗ Offshore projects split in two groups
 - ↗ Windpower to shore (AC and DC)
 - ↗ Interconnection between countries (DC)
- ↗ Increased utilisation of assets
- ↗ Current projects point-to-point
 - ↗ Windconnector feasible?
 - ↗ What is needed?
 - ↗ Operating times
 - ↗ Acceptable outage duration
 - ↗ Restoration of windpower



TSO possible solutions



PROMOTioN findings

↗ Protection algorithms are developed

- ↗ Selective schemes
- ↗ Detection methods
- ↗ Implementation in hardware

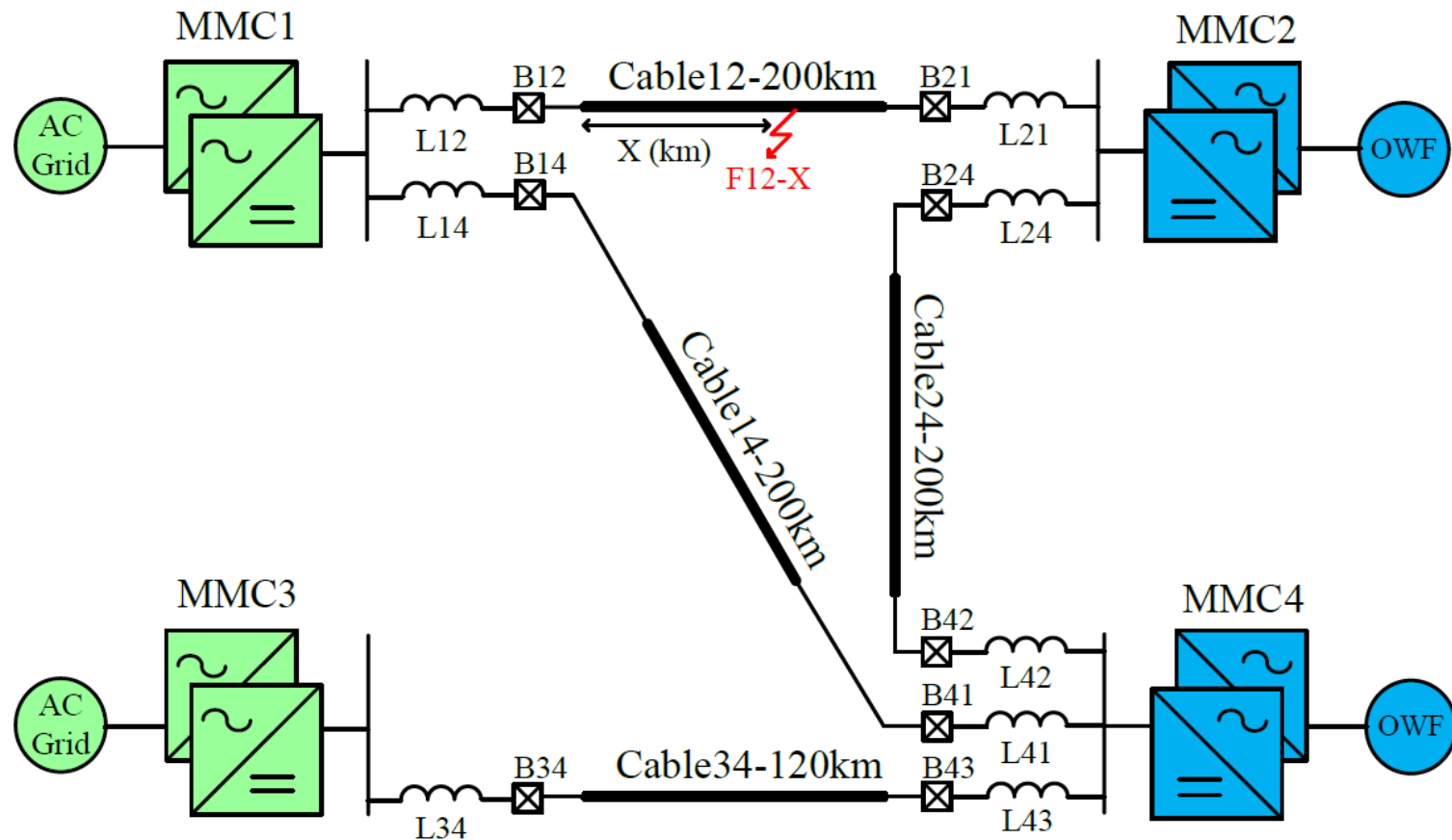
↗ Several DC breaker technologies available:

- ↗ Principle demonstrated
- ↗ Scaling investigated
- ↗ Communication described
- ↗ Actual short circuit testing performed

↗ So the ingredients are there



TSO investigations



TenneT position

↗ Ingredients for DC connections are available

- ↗ Protection schemes
- ↗ DC circuit breaker

↗ Other elements are still open

- ↗ Costs
- ↗ Requirements and specifications
- ↗ Additional ad/dis advantages

↗ Current position

- ↗ No real need for DC connections present
 - ↗ AC is a good alternative
- ↗ Benefits need to be demonstrated
- ↗ Strong support of research and development





Preliminary conclusions



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Conclusions

- ↗ Current projects mainly point-to-point
- ↗ DC fault handling techniques available
- ↗ New projects in the North Sea require radial/meshed connections
 - ↗ Exploration of windpower
 - ↗ Interconnection and coupling
- ↗ Benefits need to be demonstrated
 - ↗ Technical
 - ↗ Commercial



APPENDIX

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