Wednesday, November 20th 2013
11:35 – 12:30

Round Table & Conclusion

Chairman: Paul Pensérini, France
Rapporteur: Jean-Michel Prost, France

Round Table and Conclusion

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Participants :

- **1 - Caroline Bradley**, National Grid, UK
- **2 - Jan Brüggmann**, Amprion, Germany
- **3 - Valentinas Dubickas**, Svenska Kraftnät, SvK, Sweden
- **4 - Carl Éric Hillesund**, Statnett SF, Norway
- **5 - Jean Kowal**, MEDGRID, around Mediterranean
- **6 - Thomas Kvarts**, Energinet.dk, Denmark
- **7 - Mattia Pazienza**, Terna, Italy
- **8 - Jean-Michel Prost**, Rte, France

Round Table and Conclusion

Chairman: Paul Pensérini, France

Rapporteur: Jean-Michel Prost, France

Presentations from different European countries :

- Achievements and projects of HVDC lines in European countries: OHL, Underground or Submarine whatever the technology for insulation.
- Answer to the question : « Do you intend to use extruded cable for your future HVDC lines, why ? »

Conclusion by the Chairman:

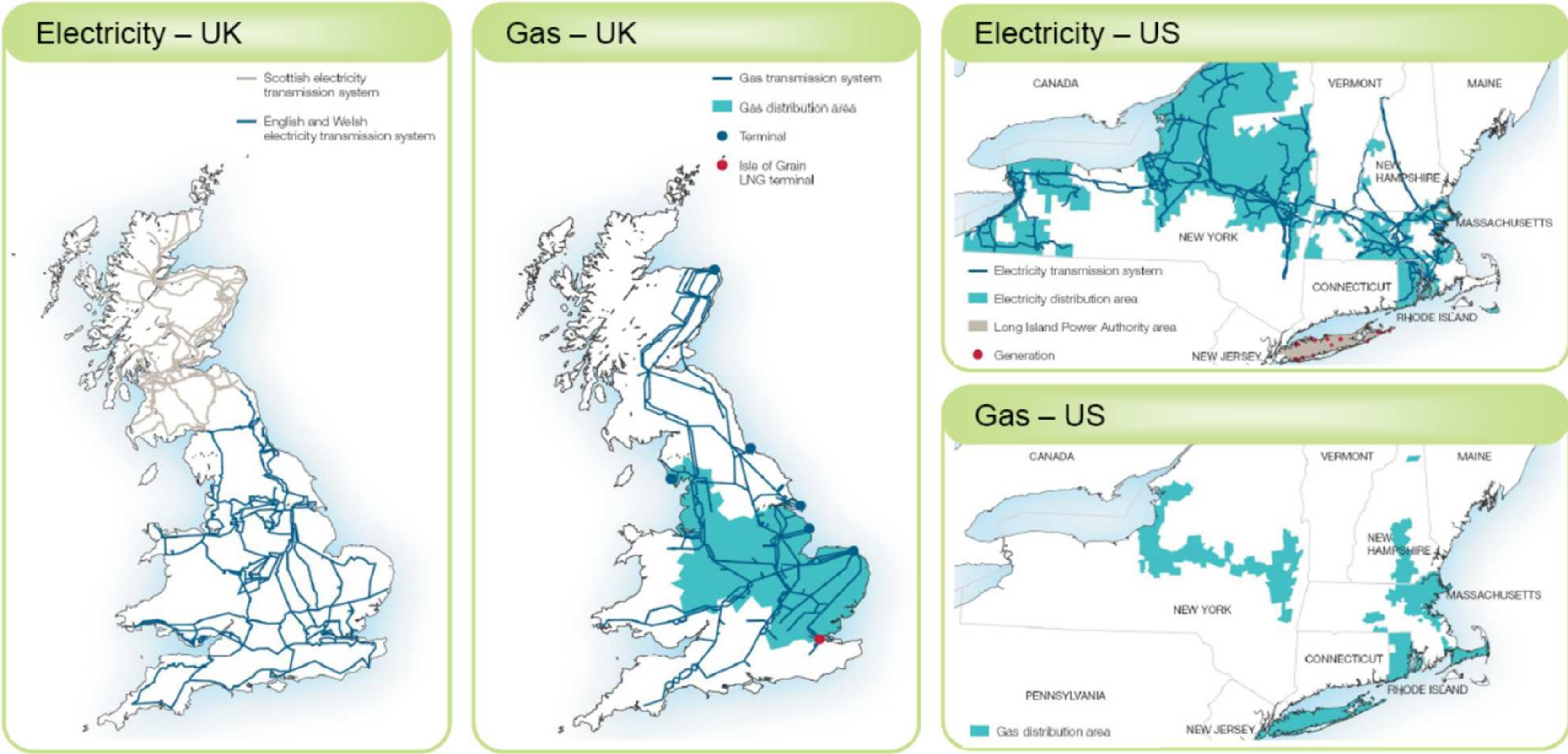
Importance of the work to do in the next decade and interest of such topic for young researchers.

HVDC Projects within the UK

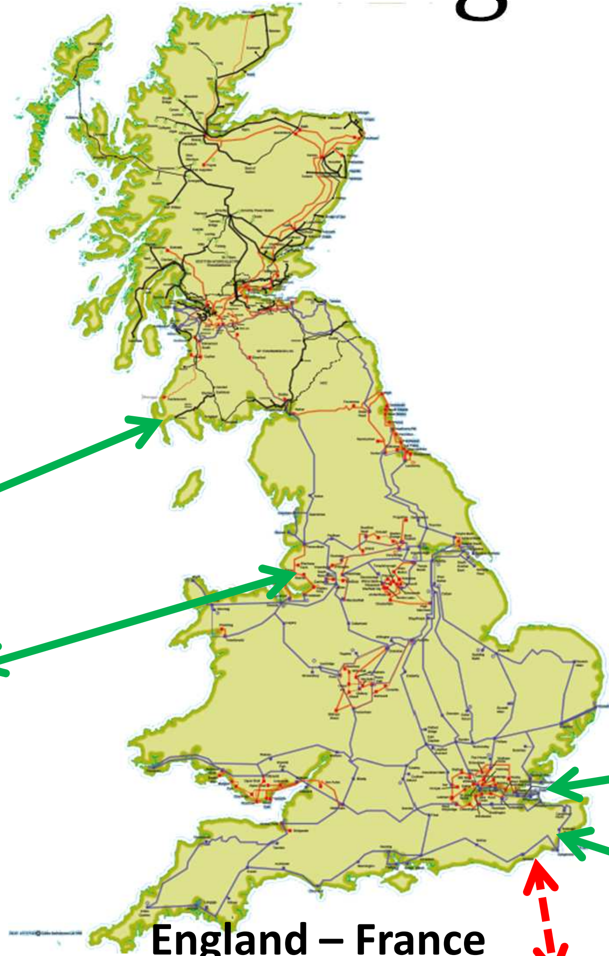
Caroline Bradley

National Grid European Business Development

Who are National Grid



Historic & Existing HVDC Links



Moyle
Commissioned 2002
450MW, ±200kV

East – West
Commissioned 2012
500MV, ±200kV

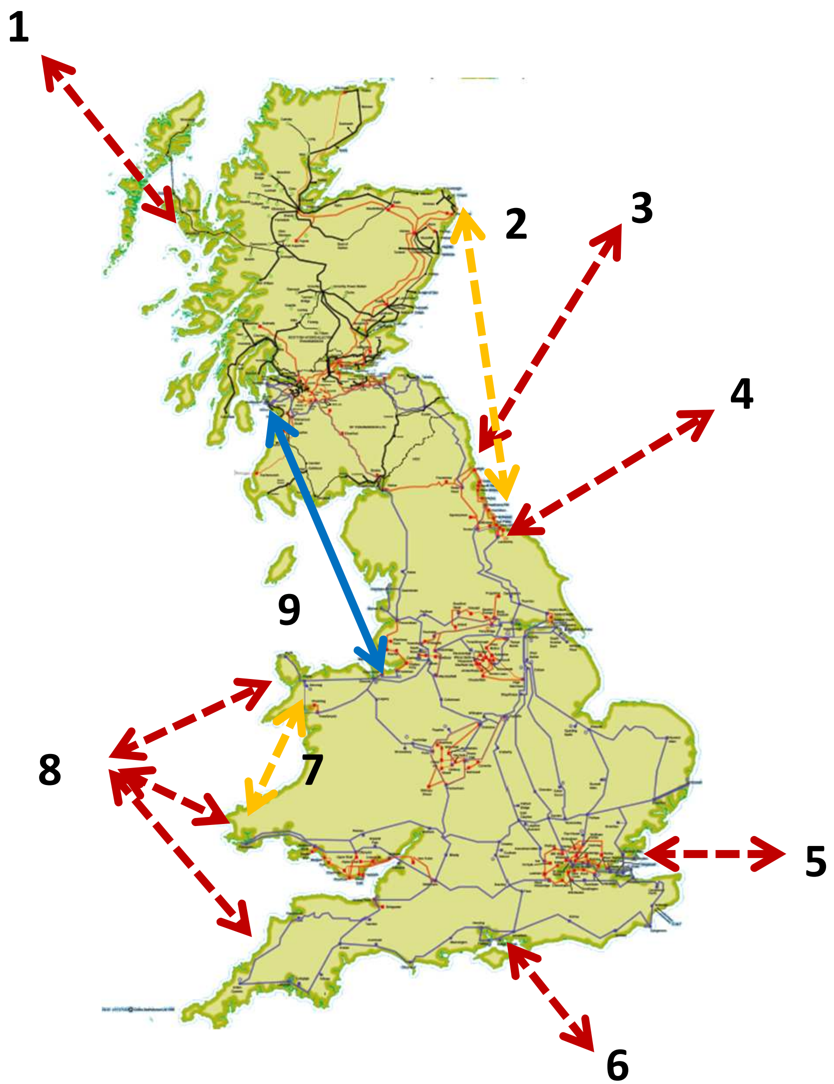
Britned
Commissioned 2011
1000MW, ±450kV

IFA 2000
Commissioned 1986
2000MW , ±270kV

England – France
Commissioned 1961
Decommissioned 1984
160MW, ±100kV

Potential National Grid HVDC Projects

Project	Capacity (MW)	Commissioning
1. Icelink UK – Iceland	1000	2020
2. Eastern Link	2000	TBC
3. NSN UK – Norway	1400	2020
4. UK – Denmark	1000	2020
5. Nemo UK - Belgium	1000	2018
6. IFA 2 UK – France	1000	2019
7. Wylfa – Pembroke	Upto 2500	TBC
8. Irish Wind UK - Ireland	Upto 5000	2017-2020
9. Western Link	2020	2016



Other Potential UK Projects

Project	Capacity (MW)	Commissioning
NorthConnect UK – Norway	1200 - 2000	2020
Eleclink UK – France	500 - 1000	2015
FAB France – Alderney - Britain	500 - 2000	2017- 2024
Western Isles Scotland	450	TBC
Shetland Link	600	2018

HVDC Projects

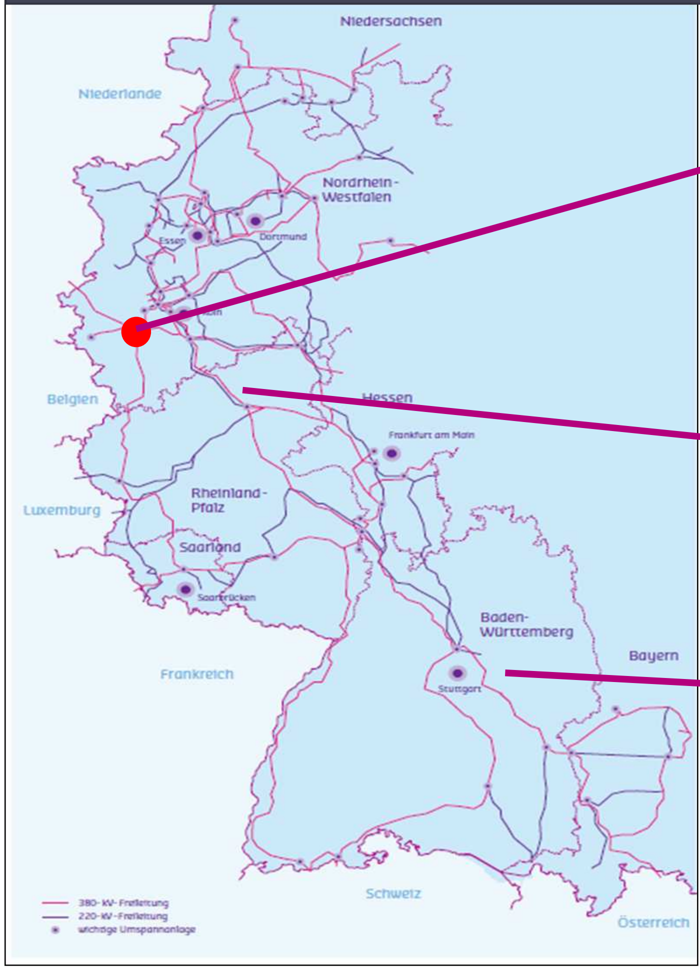
Jan Brüggmann

Amprion – A strong Grid for Energy

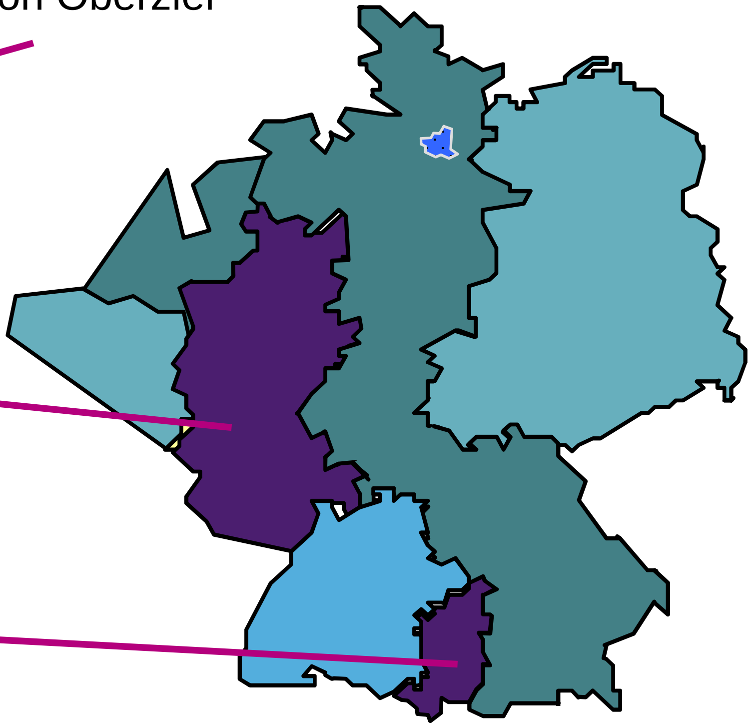
Transmission System	▪ Largest transmission system in Germany from **Lower Saxony to the Alps**, with a total network length of **11,000 km** (380 and 220-kV lines) and 160 sub-stations
Interconnected network	▪ Responsible for **one of the largest control areas in Europe**; undertakes an important task in the European interconnected network
Customers	▪ 73,100 km² of served territory equivalent to a fifth of the Federal Republic of Germany with a population of **about 27 million**
Market Platform	▪ Approx. 260 step-down transformation points to distribution system operators and industrial customers with approx. 250 balancing groups with 350 traders

Our Grid

Amprion Grid

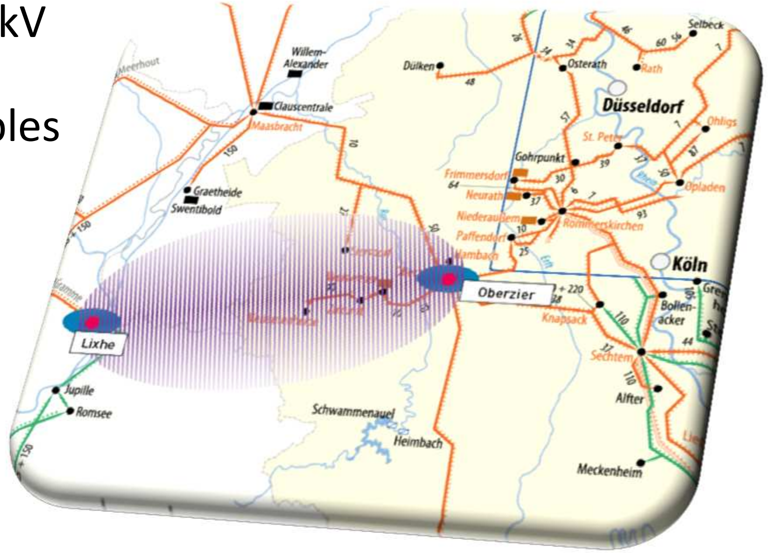


Substation Oberzier

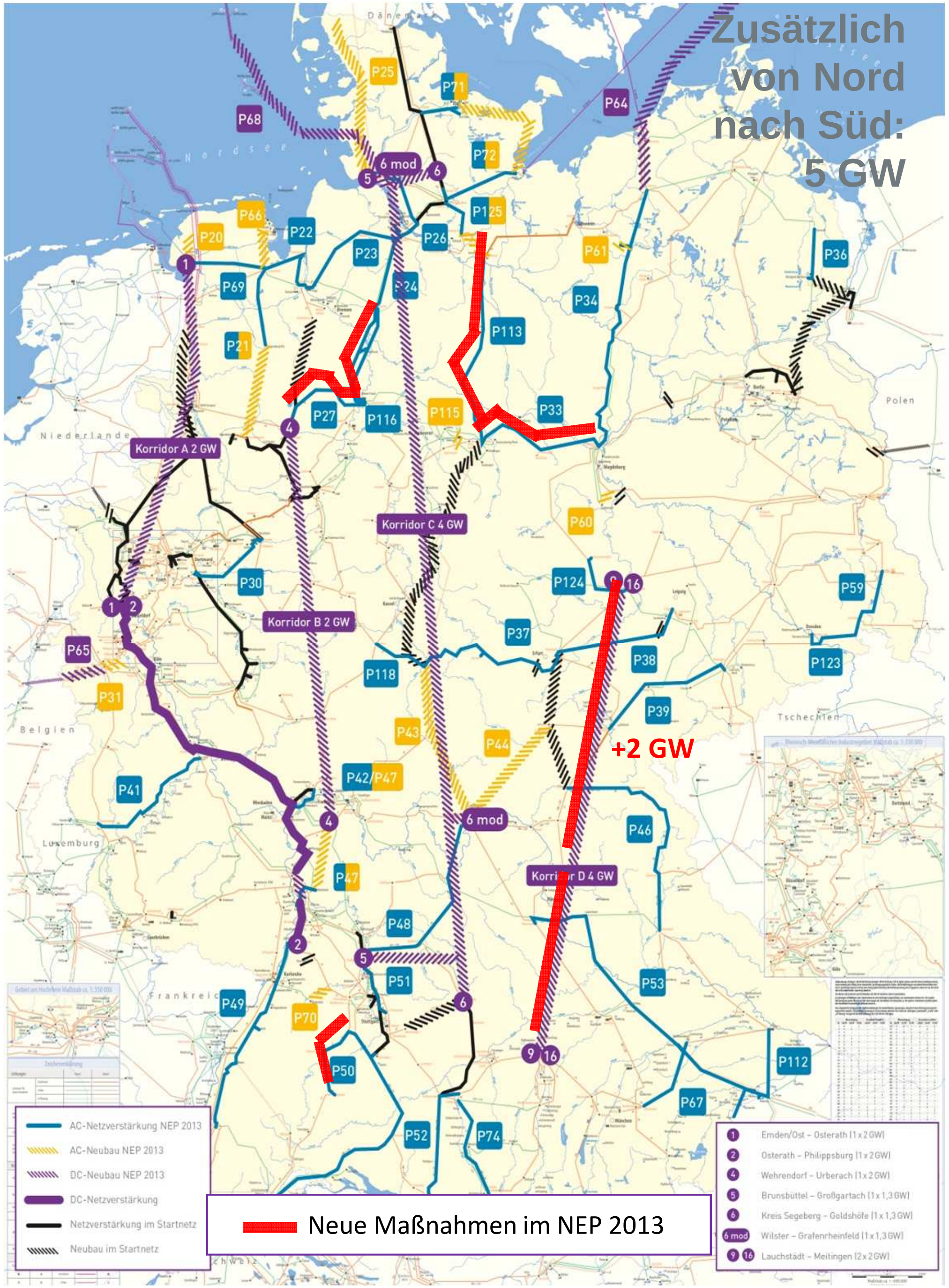


Project ALEGrO

- DC Project of the TSOs Elia (Belgium) and Amprion (Germany)
- Transmission parameters: P = 1000 MW ; U = ±*320* kV
- Route length: 100 km, ~45 km in Germany, 100% cables
- Commissioning: End of 2018
- Connection between substations Lixhe and Oberzier
- “Missing Link” between Germany and Belgium



Aachen (Aix-La-Chapelle)
Lüttich (Liège)
Electricity
Grid
Overlay



LEITSZENARIO B 2023
INKLUSIVE STARTNETZ

Thank you for your attention!

Questions?

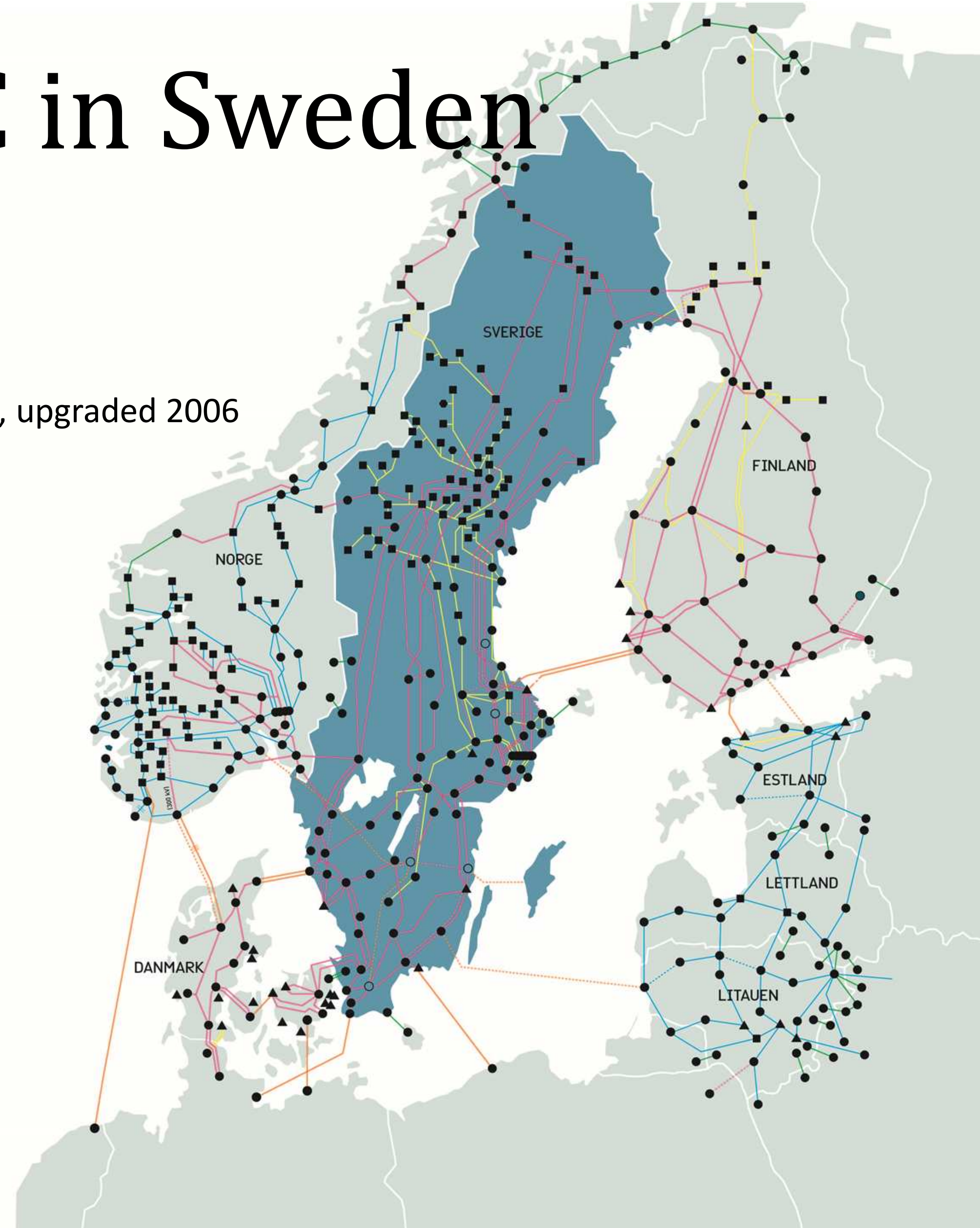
jan.brueggmann@amprion.net

HVDC cable projects at Svenska Kraftnät (SvK)

Valentinas Dubickas

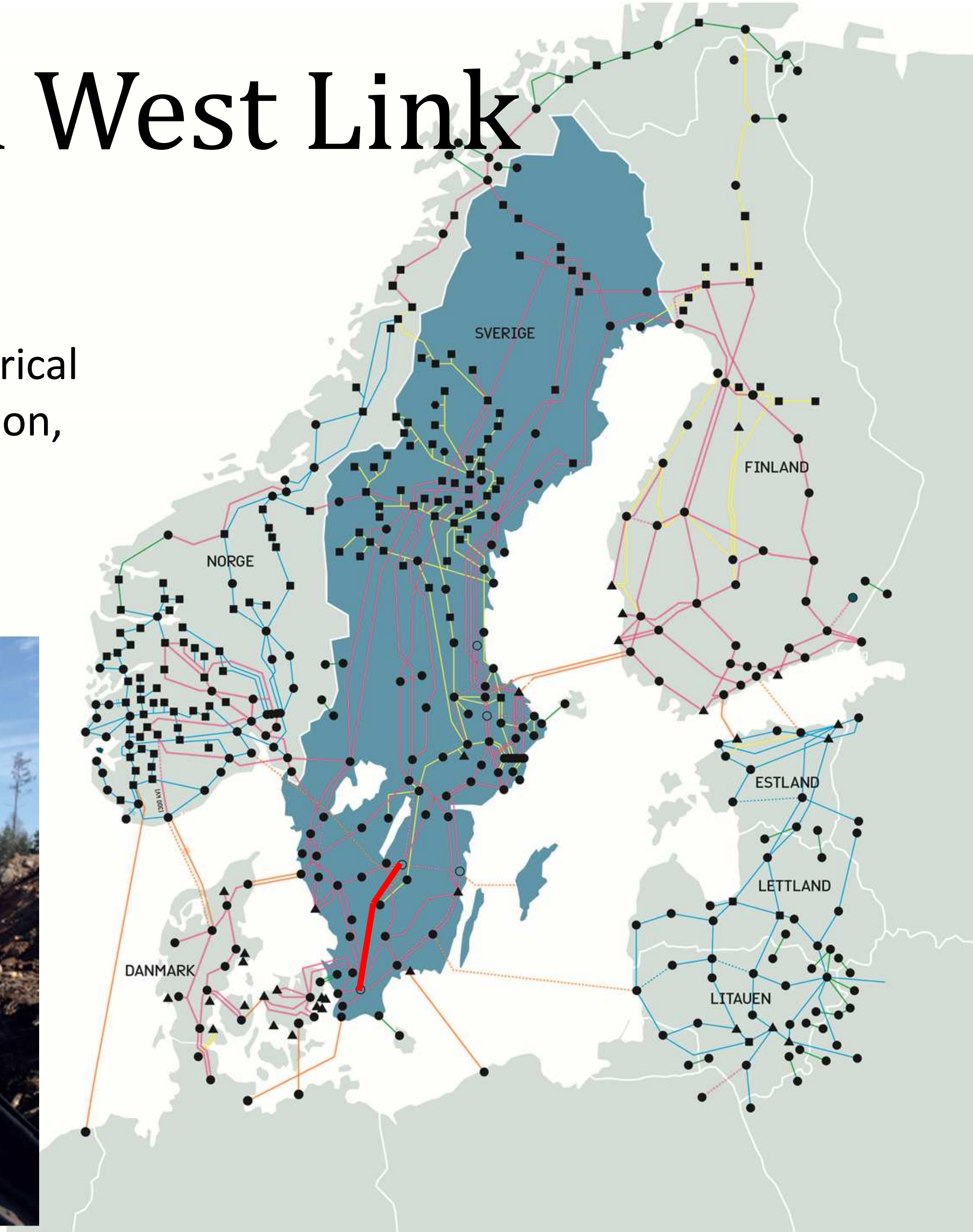
HVDC in Sweden

- Gotland 1 20 MW 100 kV 1954-1986
- Konti Scan 1-2 740 MW 285 kV 1965, 1988, upgraded 2006
- Gotland 2-3 260 MW 150kV 1983, 1987
- Fenno Skan 1 500 MW 400 kV 1989
- Baltic Cable 600 MW 450kV 1994
- Gotland HVDC Light 50MW 80kV 1999
- SwePol Link 600 MW 450 kV 2000
- Fenno Skan 2 800 MW 500 kV 2011



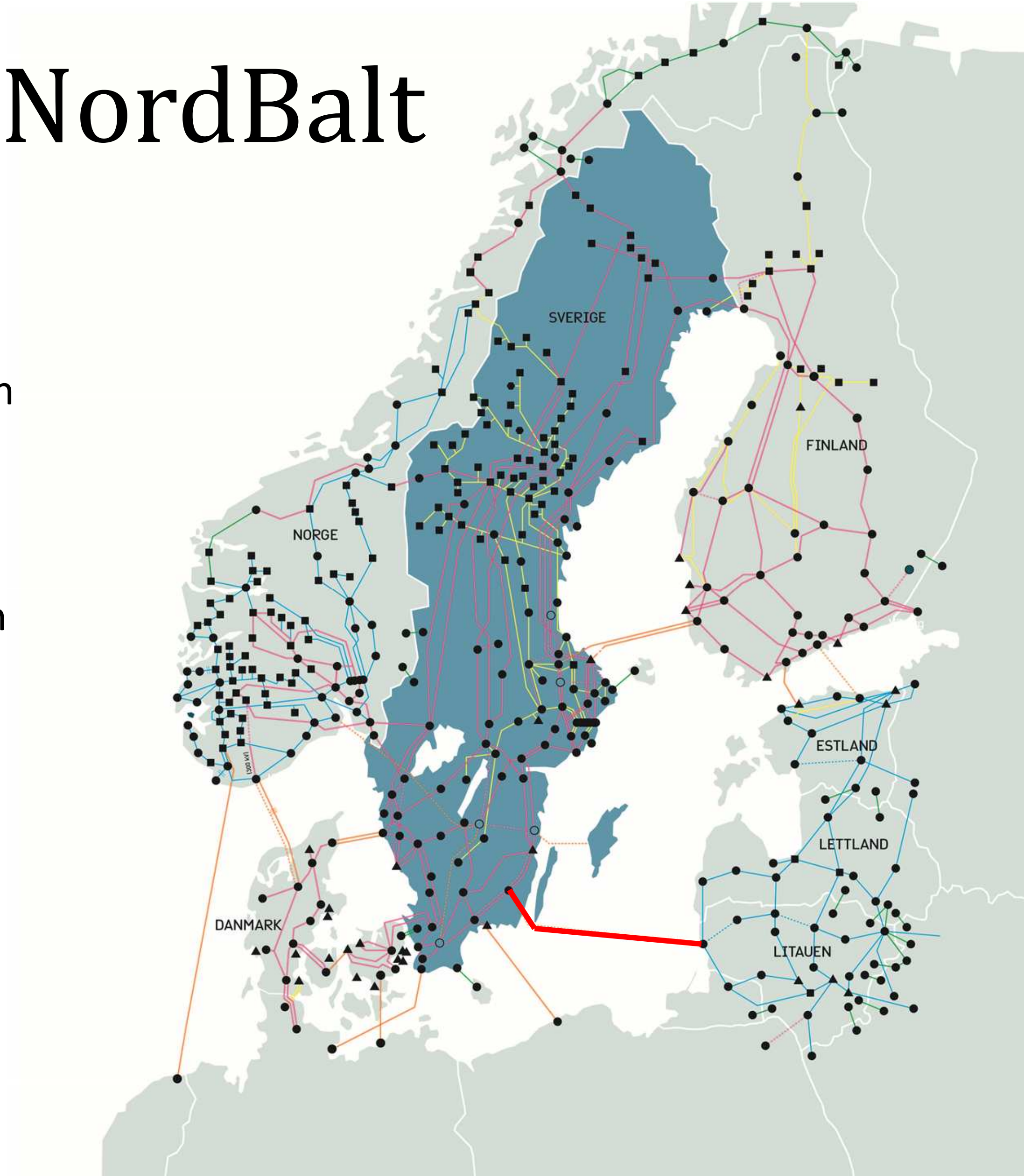
South West Link

- 1320 MW
- 300 kV XLPE
- 4 land cables in parallel (2 symmetrical monopoles) underground installation, approx. 190 km
- Commissioning 2015 Q1



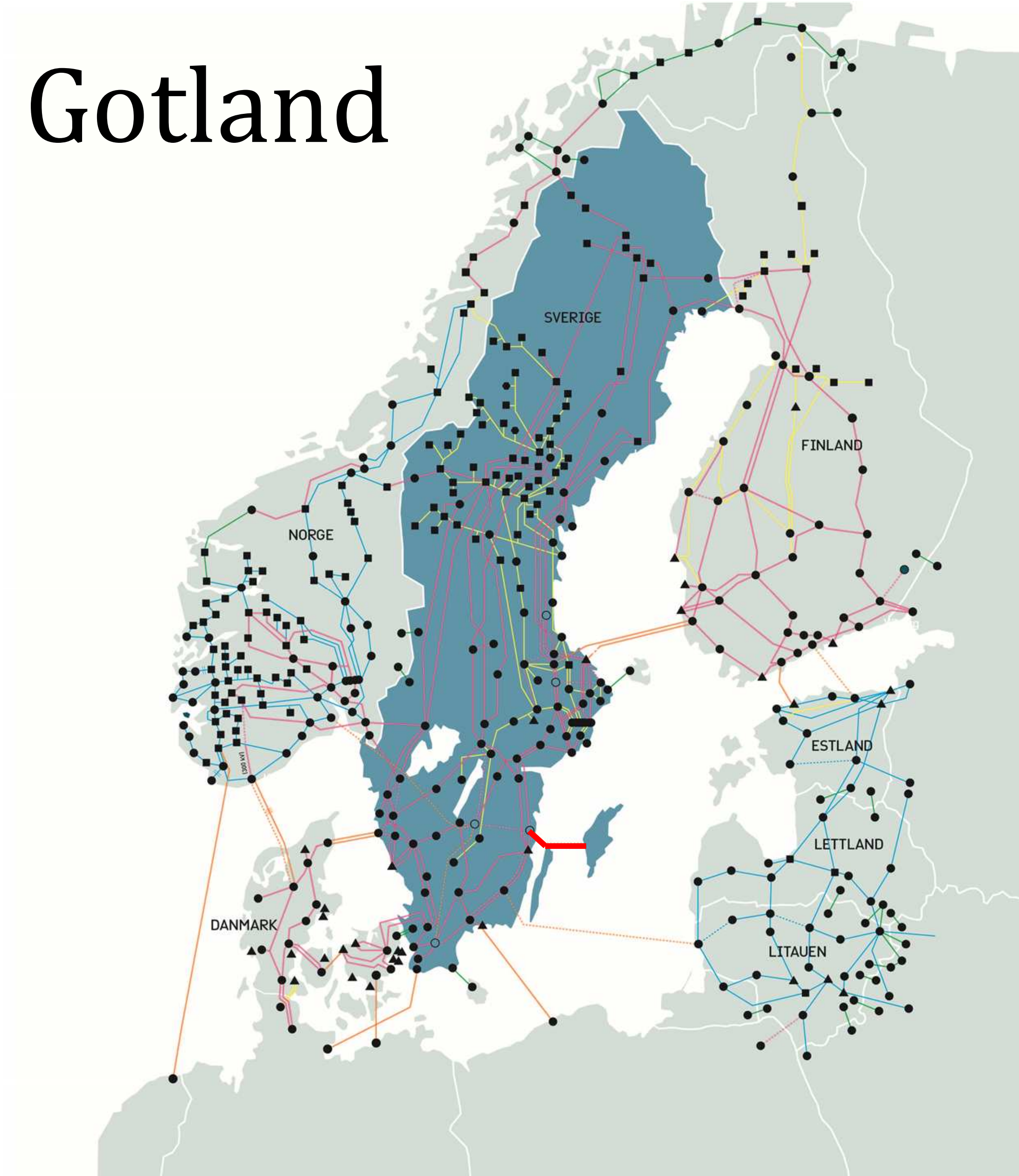
NordBalt

- 700 MW
- 300 kV XLPE, 2 land cables in parallel (symmetrical monopole), underground installation, approx. 40 km
- 300 kV XLPE, 2 sea cables in parallel (symmetrical monopole), trenched installation, approx. 400 km
- Commissioning 2015/2016



Gotland

- 500 MW
- 300 kV 2 cables in parallel (symmetrical monopole), underground installation, approx. 10 km each side
- 300 kV 2 cables in parallel (symmetrical monopole), trenched installation, approx. 100 km
- Commissioning 2018
- Plans for second 500 MW connection to Gotland



Status HVDC submarine cables Statnett

Carl Erik Hillesund

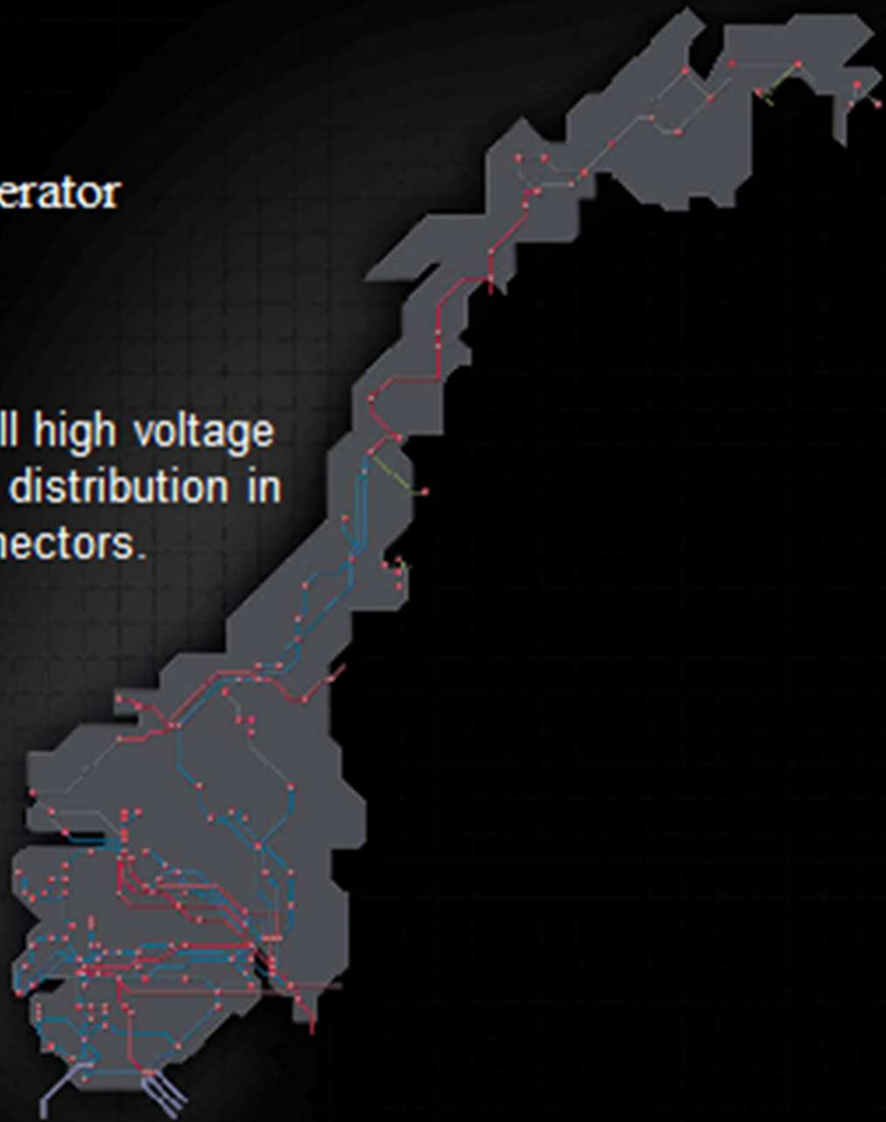
Head of cable and installation department

2013-11-20

STATNETT

Statnett is the Norwegian Transmission System Operator (TSO) and owner of the transmission grid.

Statnett is responsible for all high voltage electricity transmission and distribution in Norway as well as interconnectors.



Statnett

Existing and planned HVDC submarine cable projects

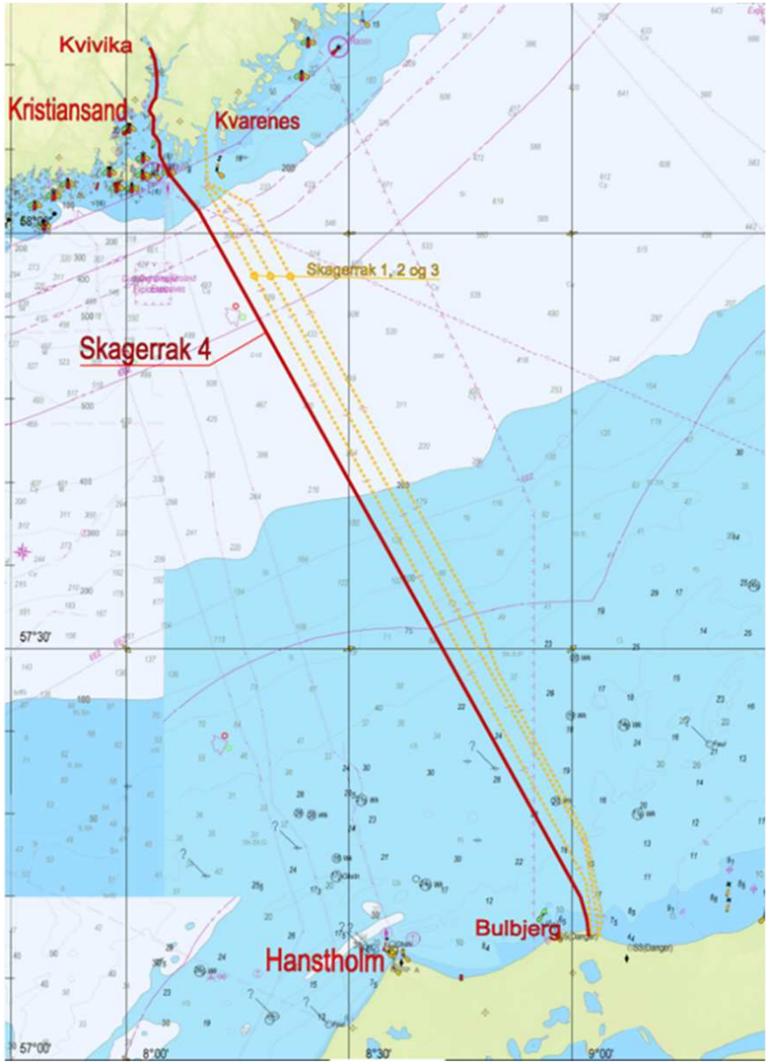
Existing HVDC submarine cables

- Skagerrak 1,2 and 3
- NorNed

Planned HVDC submarine cables

- SK4 (installed, not commissioned)
- NordLink
- NSN

Skagerrak 1,2,3 and 4
Energinet.dk and Statnett



Skagerrak 1 and 2 (2 x 250 MW)

- Went in to service in 1976 and 1977
- +/- 250 kV (LCC converter technology)
- 113 km overheadline
- 127 km submarine cable
- Max water depth 530 meters
- MI cable 800 mm2

Skagerrak 3 (500 MW)

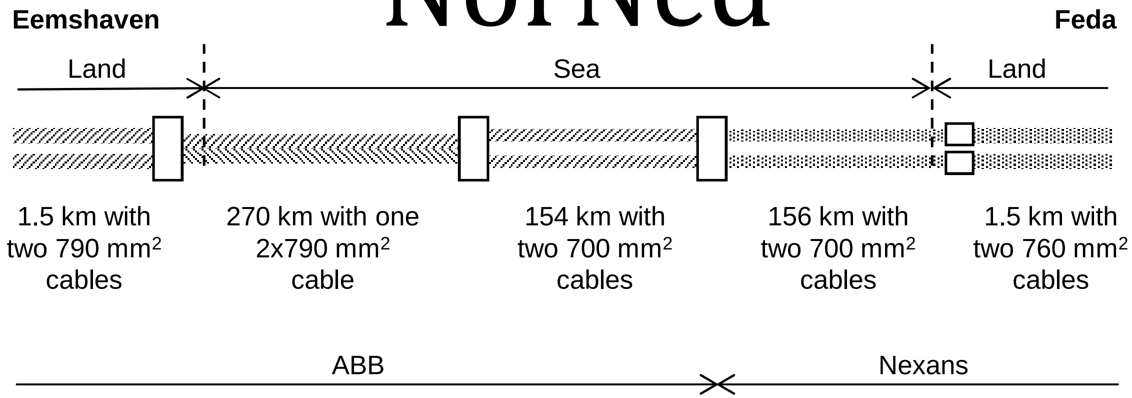
- Went into service 1993
- 350 kV (LCC converter technology)
- 113 km overheadline
- 127 km submarine cable
- Max water depth 530 meters
- MI cable 1400 mm2

Skagerrak 4 (700 MW)

- Installed, planed to be commissioned in 2014
- 500 kV (525 kV)(VSC converter technology)
- 140 km submarine cable
- 13 km land cable in Norway
- 90 km land cable in Denmark
- Max water depth 530 meters
- MI cable 1600 mm2

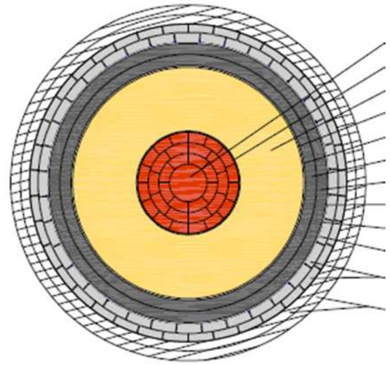
Nexans

NorNed



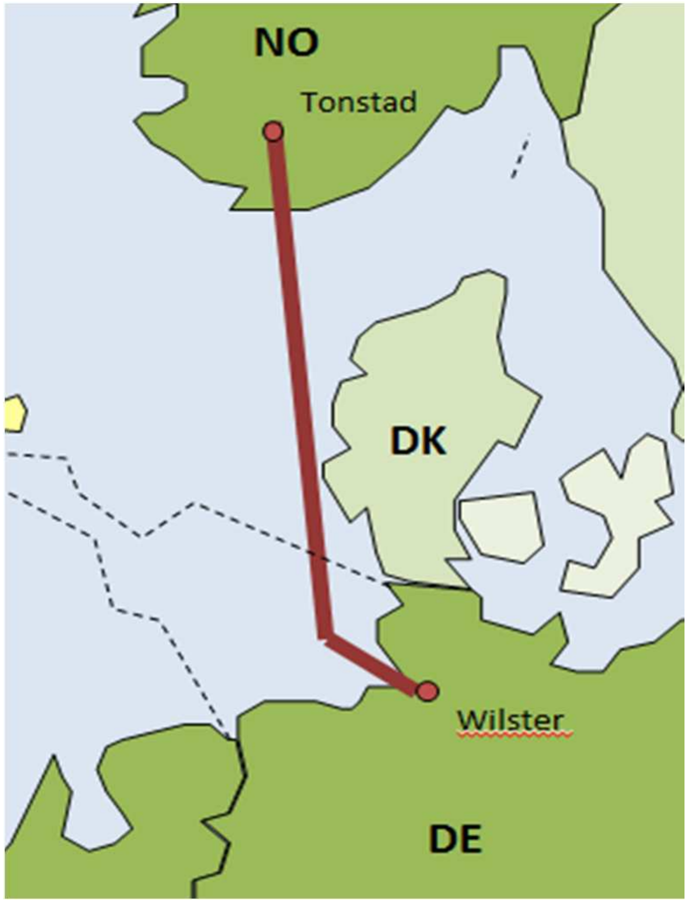
ABB

- NorNed 700 MW
- 450 kV (LCC converter technology)
- Total length 580 km
- Went into service 2008
- Max water depth 420 m



Nexans

NorLink



Interconnector to Germany

- Statnett, TenneT and KfW
- Route length; 570 km
- Landing point Norway; Tonstad
- Landing point Germany; Wilster
- 2 MI cables - 1400 MW
- Scheduled to be in operation in 2018

NSN

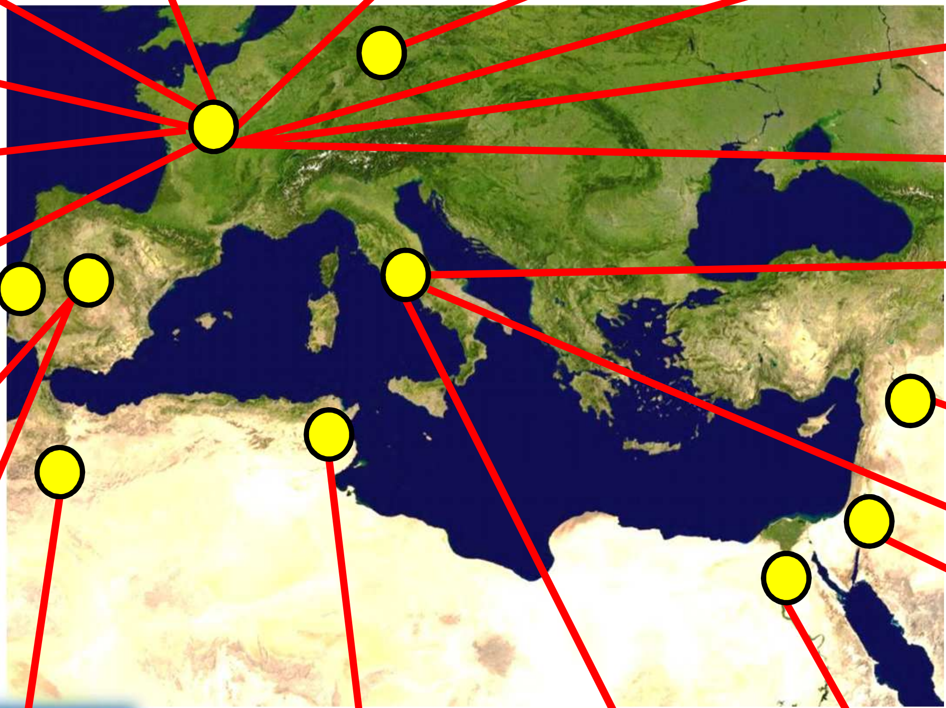
Interconnector to UK

- Statnett and NG
- Route length; 720 km (2 x MI cable)
- Landing point Norway; Kvilldal
- Landing point UK; Blyth
- 1400 MW
- Scheduled to be in operation in 2020

Promote Mediterranean interconnections

Medgrid

MEDGRID SHAREHOLDERS



EDF

cdc infrastructure

Rte

SIEMENS

Nexans

AREVA

Soitec

Atos Worldgrid

COFELY INEO
GDF SUEZ

ALSTOM

Prysmian Group

REN

WDRVM

ABENGOA

nemo
NETWORK EUROPEAN MERCHANT ORGANIZATION S.R.L.

RED ELÉCTRICA DE ESPAÑA

المكتب الوطني للكهرباء
Office National de l'Electricité

TUNUR
تونور

Terna

TAQA

PANMED ENERGY

MEDGRID OBJECTIVES

✦ **To promote and impulse the development of the Mediterranean transmission and interconnection grid**

Demonstrate that:

- it is technically feasible and environmentally acceptable

- it is economically sound

- institutional, regulatory and funding issues can be managed

and create a climate conducive to investments

Defining Optimal transfer capacity

Economic studies

Potential power exchanges (benefits)

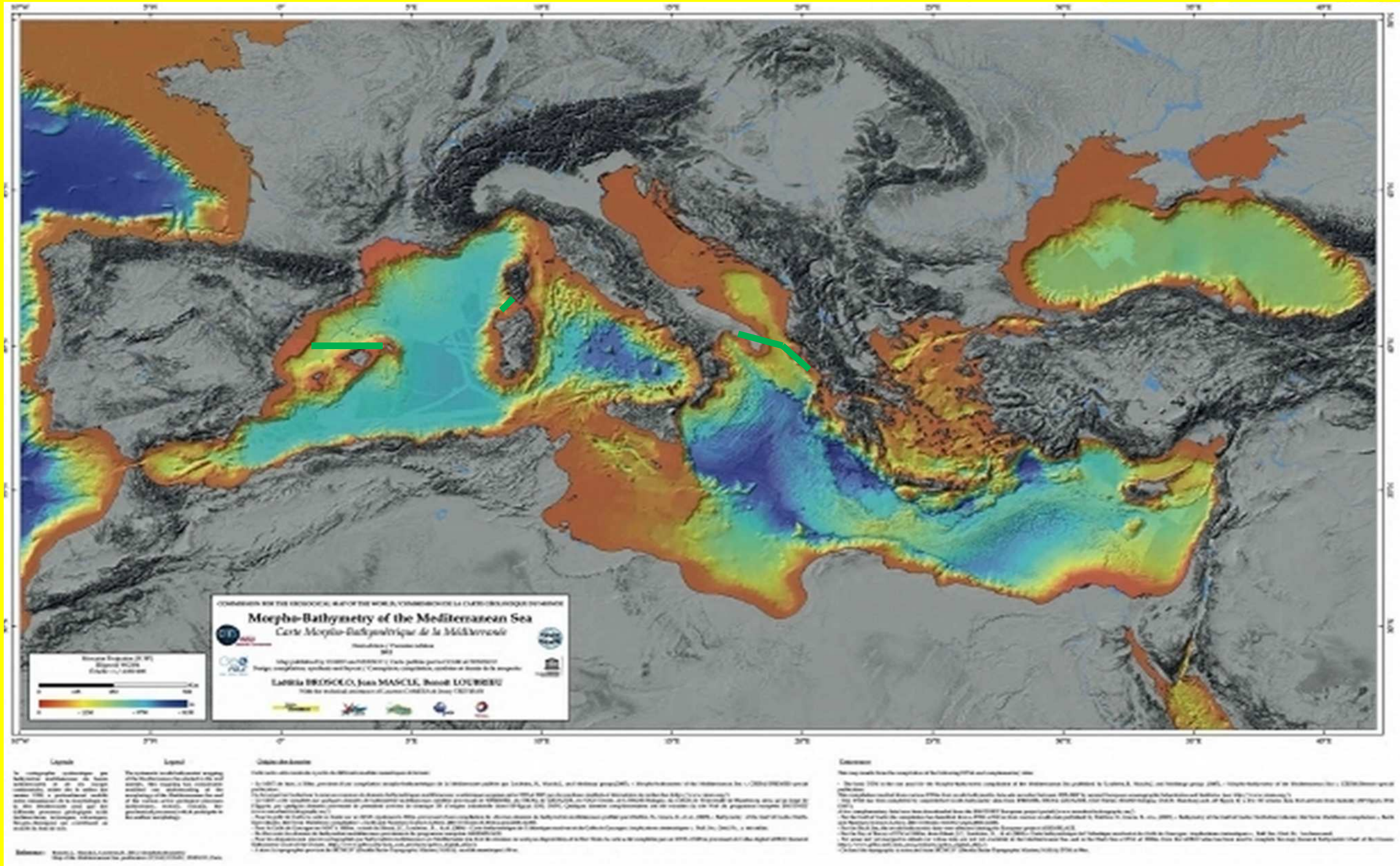
Optimization costs vs benefits

Feasible optimal grid (2020 – 2025)

Feasibility studies

Creating new transfer capacities (costs)

Mediterranean sea bed



Possible routes

existing

Under study

farther

Technology issues

- High voltage alternative current technologies (**HVAC**)
- High voltage direct current technologies (**HVDC**)
- Submarine power cable systems for depths up to **2500 meters**
  - **specific problem for Medgrid: field of a Medgrid study**

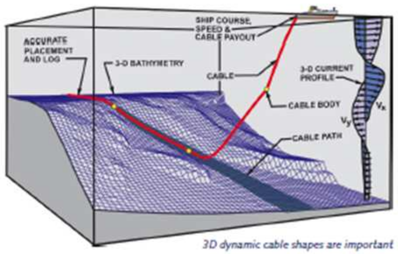
Deep water cable challenges

- Technologies for cables and joints at 2500 meters

- Laying power cables at 2500 meters

- Operation and maintenance

- Management of risks

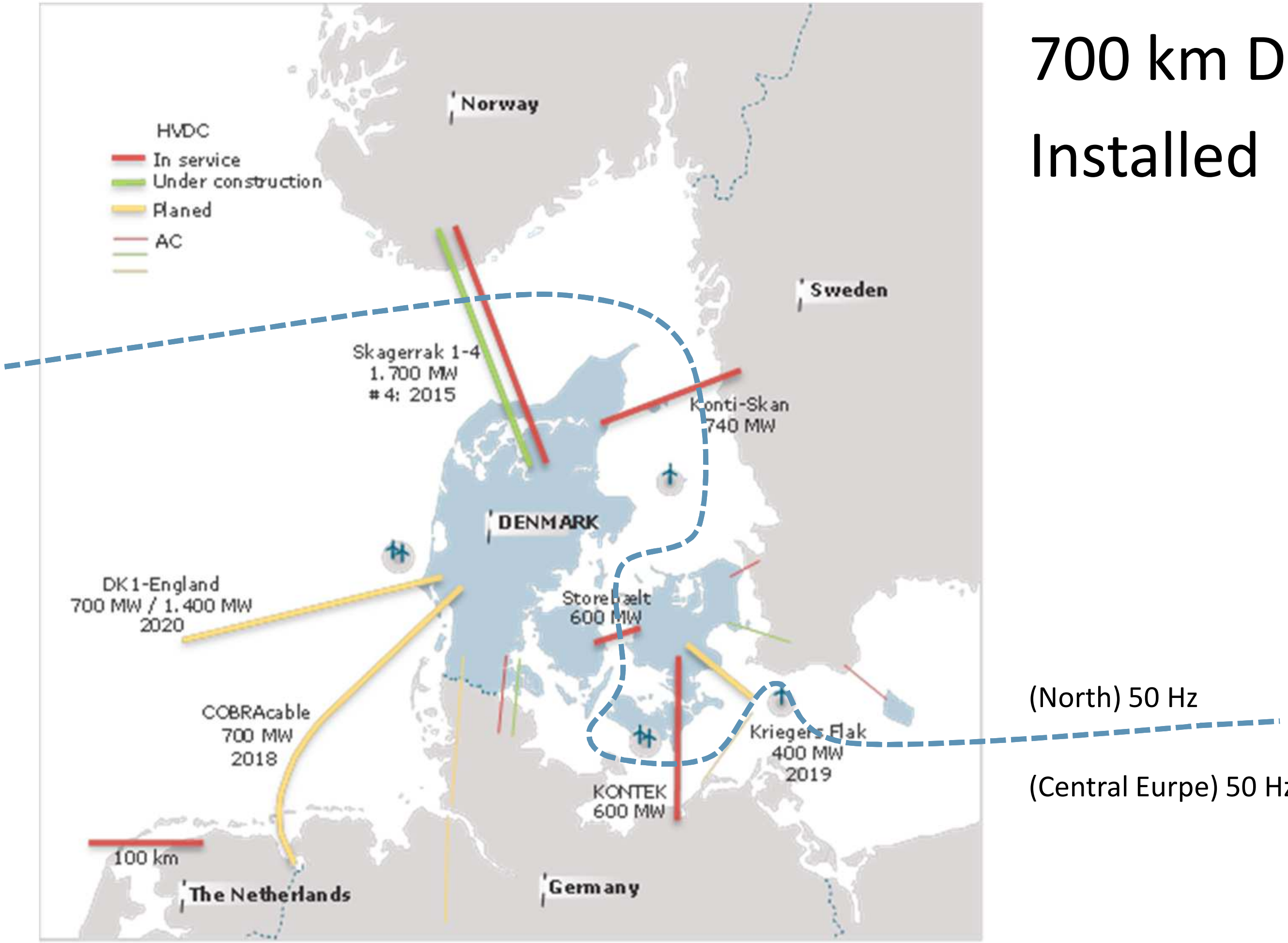


3D dynamic cable shapes are important

Thanks for your attention

www.medgrid-psm.com

Energinet.dk HVDC Links



700 km DC

Installed

(North) 50 Hz

(Central Eurpe) 50 Hz

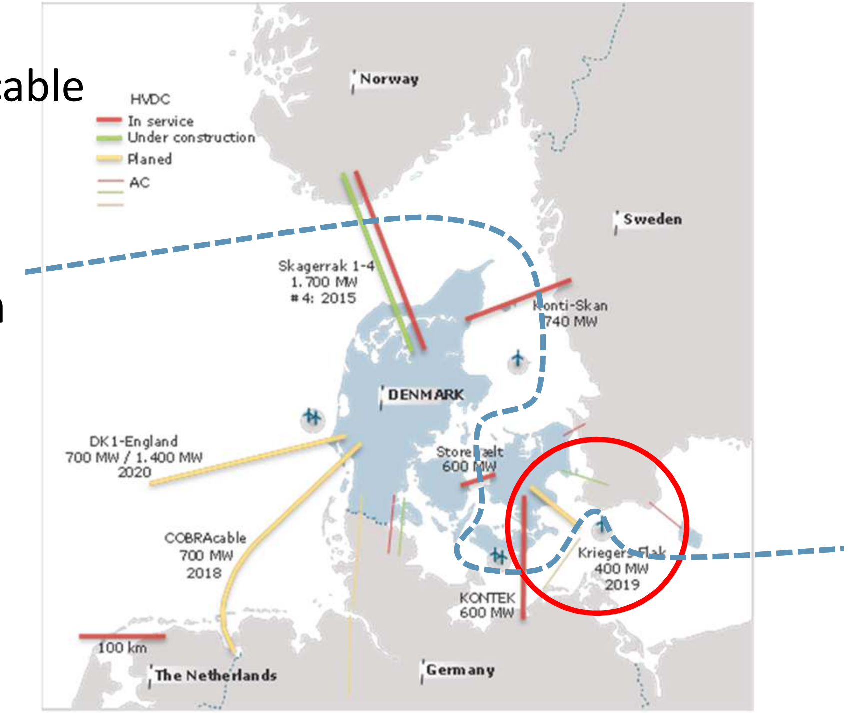
ENERGINET.DK

Krigers Flak (ITT out soon)

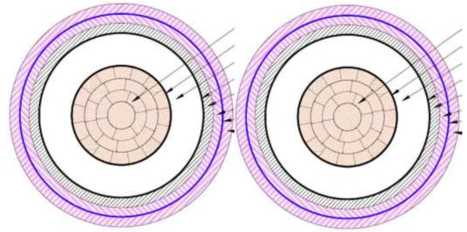
- **Kriegers Flak (VSC - bipole)**
  - Kriegers Flak
    - 2 x 82 km submarine cable
      - 2 x single core extruded HVDC cable
    - 2 x 6 km underground cable
      - 2 x single core extruded HVDC cable
    - 320kV, 600 MW

EXTRUDED BECAUSE:

- To OWF => needs to be VSC on platform
- Requirement to magnetic deviation in danish waters => Bundled cable!
- No (1) sea joints on bundled cables
- Cheaper?
- Better delivery times
- (Alternatives allowed!!)



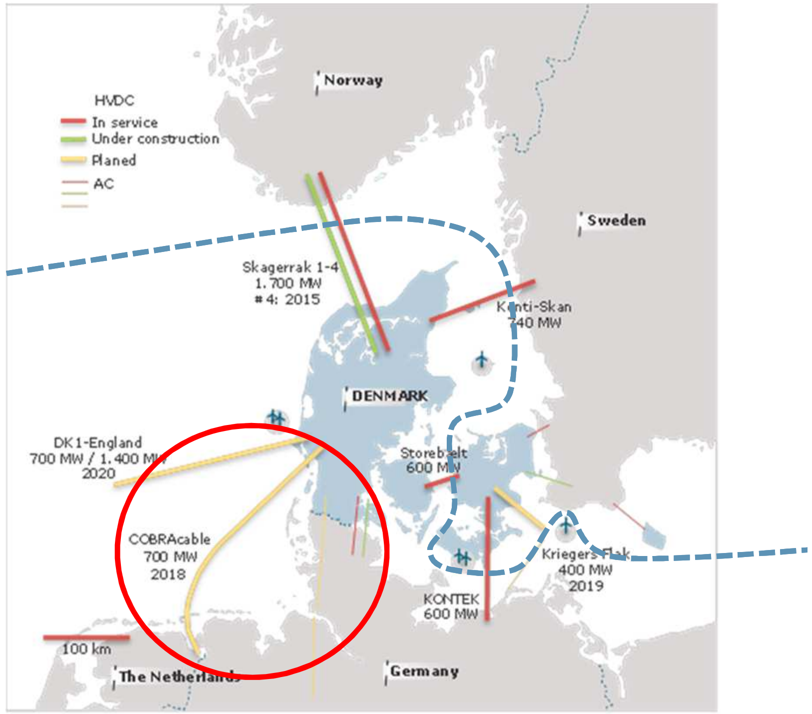
Cobra (OK in DK BOD)



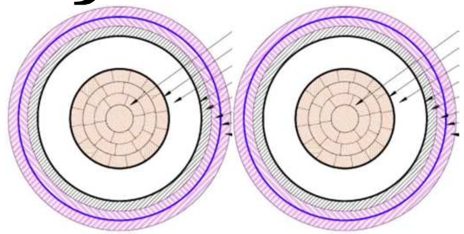
- **Connection to the Netherlands (VSC – bipole)**
  - **COBRAcable**
    - 2 x **320** km submarine cable
    - 2 x 50 km underground cable
    - 320kV, 700 MW

EXTRUDED BECAUSE:

- Probably VSC anyway
- Requirement to magnetic deviation in danish waters => Bundled cable!
- Fewer sea joints on bunled cables
- Cheaper?
- Better delivery times
- (Alternatives allowed!!)



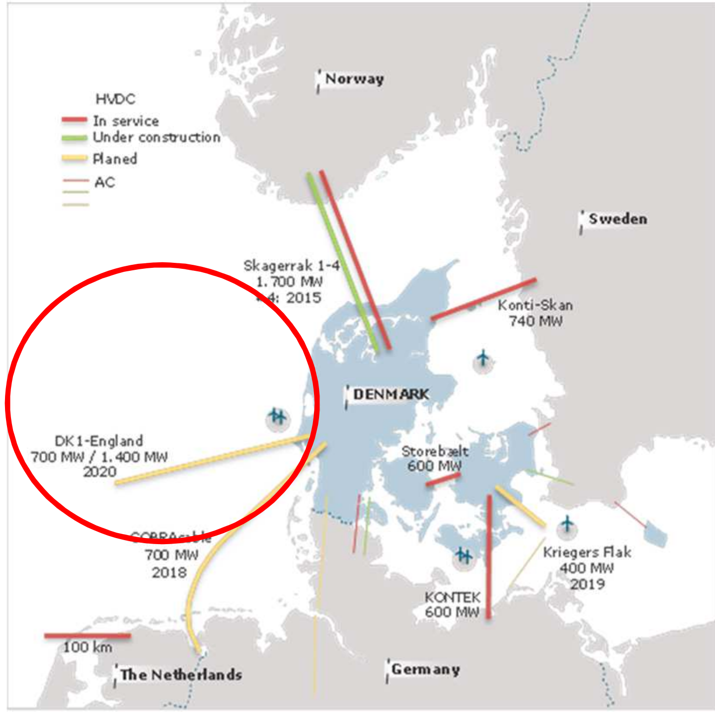
DK1-UK (under eval.)



- **DK1 – UK (VSC - bipole)**
  - DK1-UK
    - 2 x ≈**600 km** submarine cable
    - 2 x ≈ 50 km underground cable
    - 320kV, 700/1400 MW - Extruded ?

EXTRUDED BECAUSE:

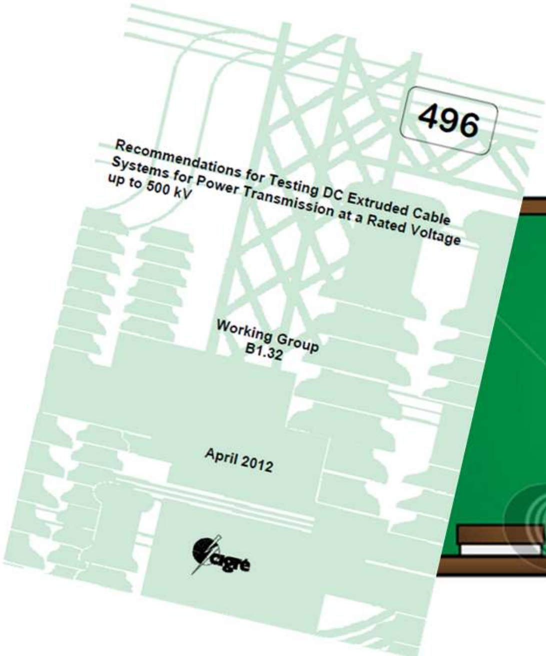
- Cable deside VSC or LCC
- Requirement to magnetic deviation in danish waters => Bundled cable!
- Fewer sea joints on bunled cables
- Cheaper – Cable
- Better delivery times
- (Alternatives allowed!!)



Extruded DC cables

What will Energinet.DK look for:

- Testing (CIGRE TB 496)
  - Development
  - Prequalification
  - Type Test
- Technical Knowledge
  - Material
  - DC fields, Space Charges
- Experience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Recommendations for Testing DC Extruded Cable Systems for Power Transmission at a Rated Voltage up to 500 kV

Working Group B1.32

April 2012

cigré

Existing HVDC links in Italy

TERNA's experience on HVDC systems

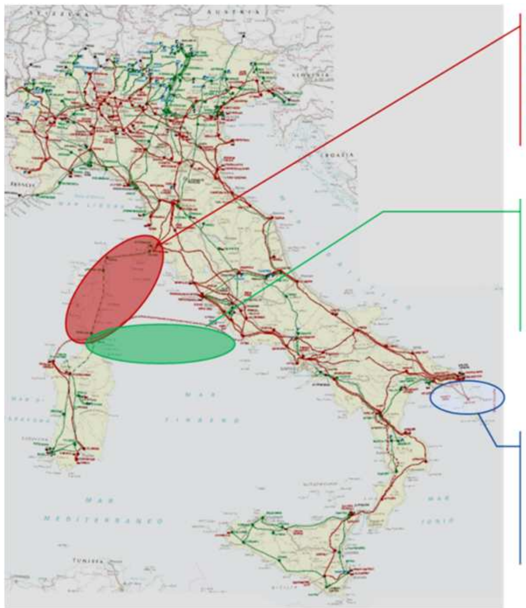
1967 | 1987 | 1992 | 2001 | 2009 2010

Biterminal connection SA.CO.I 200 MW, 200 kV between Codrongianos (Sardinia) and San Dalmazio (Tuscany), converter bridges equipped with mercury arc valves.

A third terminal, 50 MW, in Corsica was connected to the link, so SACOI became a multiterminal HVDC connection (first in the world).

SACOI

Commissioning of new connection 200 kVdc - 300 MW called SACOI 2 obtained through the renovation of the two principal converter stations adopting the new technology of thyristor



SA.CO.I.
Unipolar HVDC link (tri-terminal)
200 kV – 300 MW
(Sardinia-Corse-Mainland)

SA.PE.I.
Bipolar HVDC link
500 kV – 1000 MW
(Sardinia – Mainland)

ITALY- GREECE
Monopolar HVDC link
400 kV – 500 MW
(Puglia - Epiro)

GRITA

Commissioning of 400 kVdc-500 MW Italy-Greece connection between South Italy and Greece (world record for depth of power cable 1000 m)

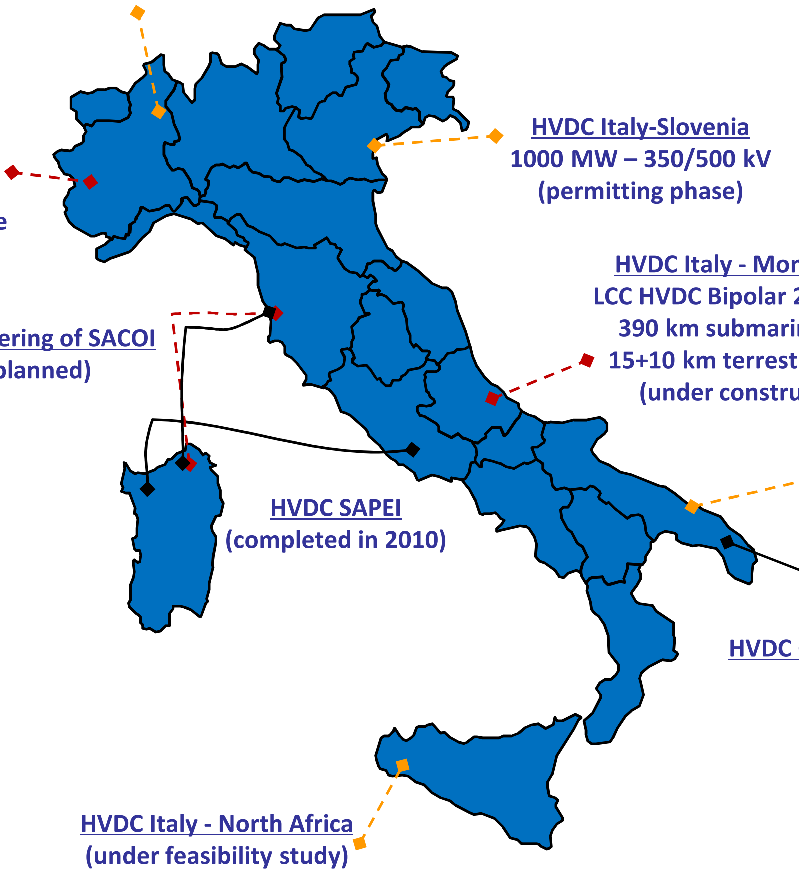
SAPEI

Commissioning of the first pole of 500 kVdc-1000 MW bipolar connection between Sardinia and Italian peninsula (SAPEI) (world record for depth of power cable 1620 m), the first pole is in operation from november 2009

Commissioning of the second pole of bipolar connection SAPEI, second pole is in operation from november 2010

Future HVDC links in Italy

Incoming HVDC projects (planned, under feasibility, permitting phase, authorized)



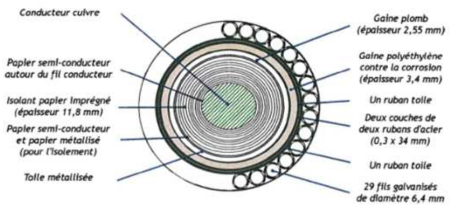
Existing submarine cable

Terna's development plan projects

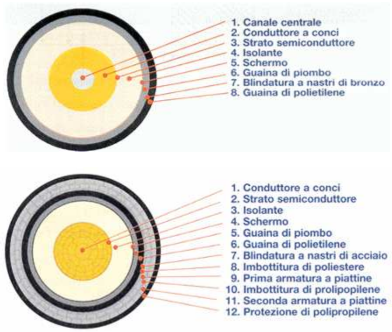
Main Projects by private founding
(ML and interconnectors)

Cables types of the Italian HVDC links

Used models of cables



SA.CO.I.		
	MARINE	TERR.
Nominal Voltage [kV]	200	200
Nominal Current [A]	750	750
Maximum depth [m]	450	
Insulation Type	MIND	MIND
Cable Section [mm^2]	Cu 420	Cu 1080

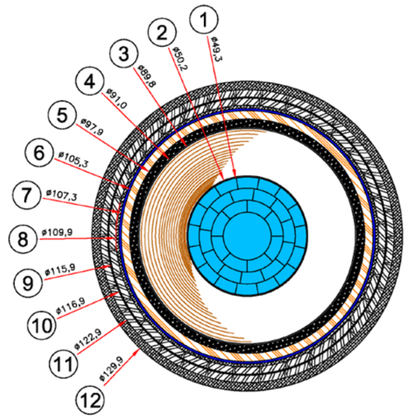


GR.ITA		
	MARINE	TERR.
Nominal Voltage [kV]	400	400
Nominal Current [A]	1250	1250
Maximum depth [m]	1000	
Insulation Type	MIND	SCFF
Cable Section [mm^2]	Cu 1250	Cu 1200

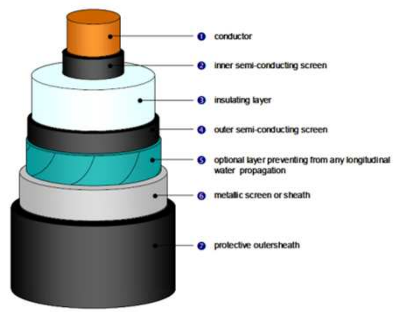
High Depth

Low Depth

SA.PE.I.			
	LOW DEPTH	HIGH DEPTH	TERRESTRIAL
Nominal Voltage [kV]	500	500	500
Nominal Current [A]	1000	1000	1000
Maximum depth [m]	400	1640	
Insulation Type	MIND	MIND	MIND
Cable Section [mm^2]	Cu 1000	Al 1150	Cu 1400



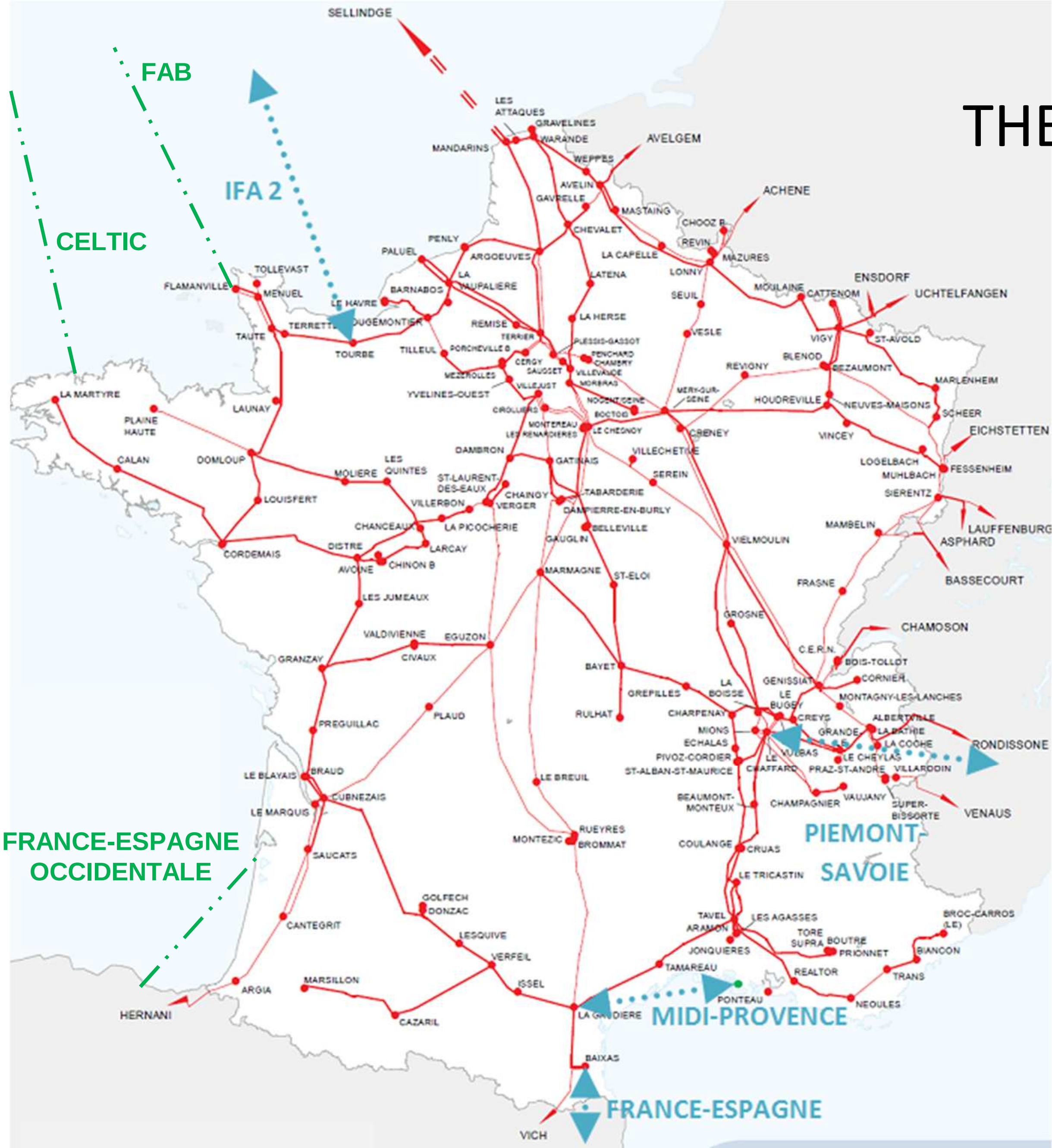
MON.ITA		
	MARINE	TERR.
Nominal Voltage [kV]	500	500
Nominal Current [A]	1200	1200
Maximum depth [m]	1200	
Insulation Type	MIND	MIND
Cable Section [mm^2]	Al 1900	Cu 1900



Piemonte - Savoie	
Nominal Voltage [kV]	320
Nominal Current [A]	950
Length [km]	200
Insulation Type	XLPE
Cable Section [mm^2]	Al 2500

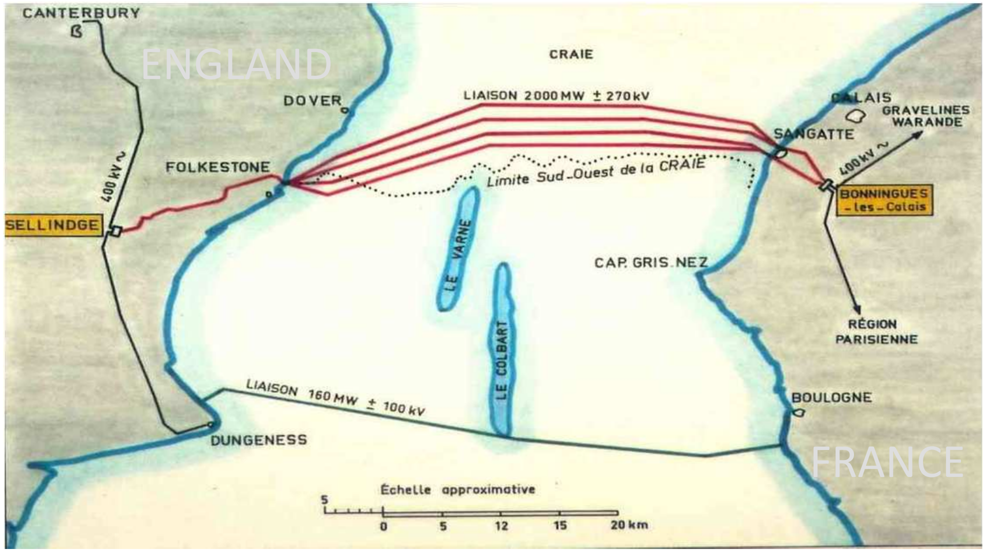
FRENCH HVDC LINKS IN SERVICE…
…AND TO COME

THE FRENCH 400kV GRID AND HVDC LINKS



- 400 kV substation
- 1 circuit line
- 2 circuits 400 kV per line or more with at least 1 circuit in 400 kV
- HVDC link in service
- Decided and ongoing HVDC link
- HVDC link under study

France to England, **Underwater** HVDC link – In service



- Commissioning : 1986
- 2 000 MW : 2 bipole of 1 000 MW
  4 cables / bipole
- +/- 270 kV
- LCC converter station
- 73 km including 46 km of submarine route

- *Submarine cables* :
  Copper conductor, MI insulation
- *Underground cables* :
  Copper conductor, OF insulation
- Cable manufacturer : Nexans
- Maximal water depth : 55 m

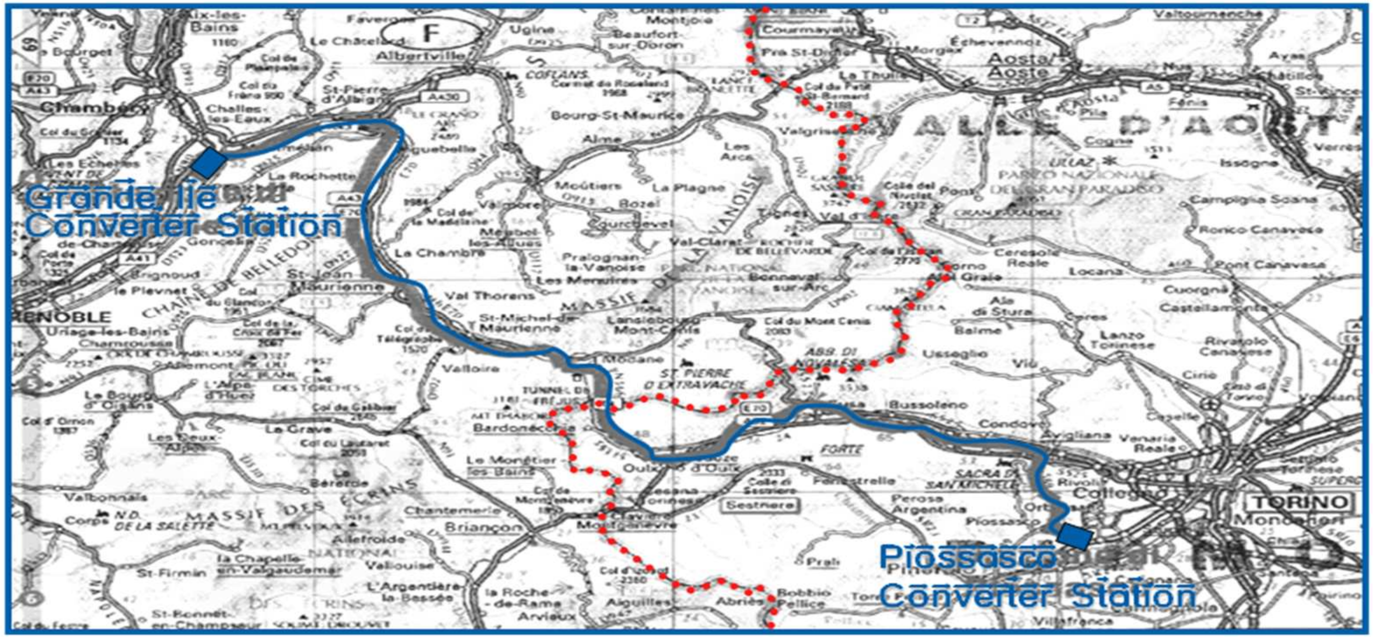
FRANCE - SPAIN

Underground HVDC link – Ongoing

- Expected commissioning : 2014
- 2 000 MW : 2 bipole of 1 000 MW
  2 cables / bipole
- +/- 320 kV
- VSC converter station
- 65 km including 40 km in France
- 2 500 mm² Copper conductor and XLPE insulated cables
- Cable manufacturer : Prysmian

PIEMONT - SAVOIE

France to Italie, **Underground** HVDC link – Ongoing



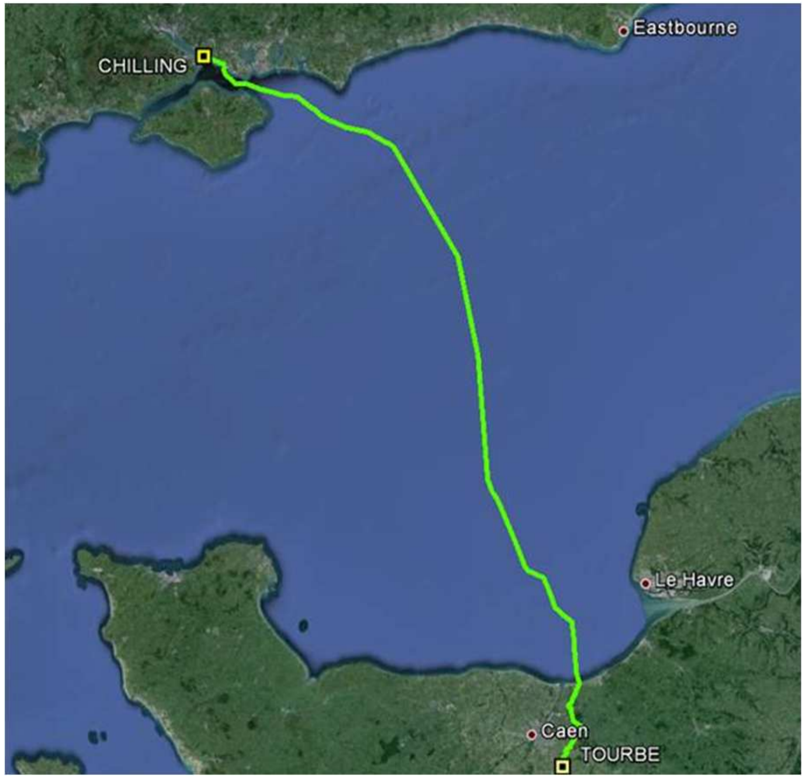
- Expected commissioning : 2019
- 1 200 MW : 2 bipole of 600 MW
  2 cables / bipole
- +/- 320 kV
- VSC converter station
- 190 km including 95 km in France
- Cables : Aluminum conductor, XLPE insulation

MIDI-PROVENCE

Midi region to Provence region, **Underwater** HVDC link – Ongoing

- Expected commissioning : 2020
- 1 000 MW : 1 bipole of 2 cables
- +/- 320 kV
- VSC converter station
- 190 km including 160 km of submarine route
- Maximal water depth : 100 m

France to England, **Underwater** HVDC link – Ongoing



- Expected commissioning : 2020
- 1 000 MW : 1 bipole of 2 cables
- +/- 320 kV
- VSC converter station
- 280 km including 220 km of submarine route
- Maximal water depth : 100 m

HVDC cable technology

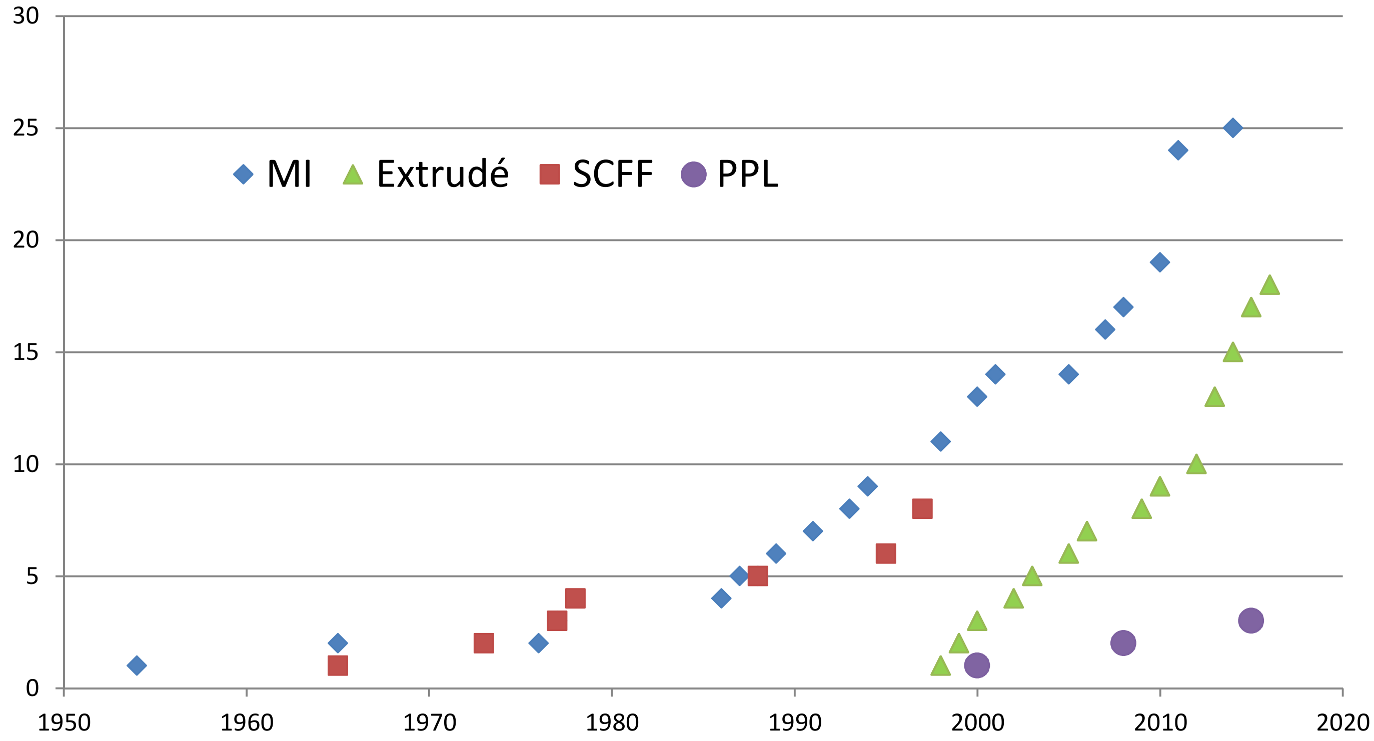
Extruded

MI

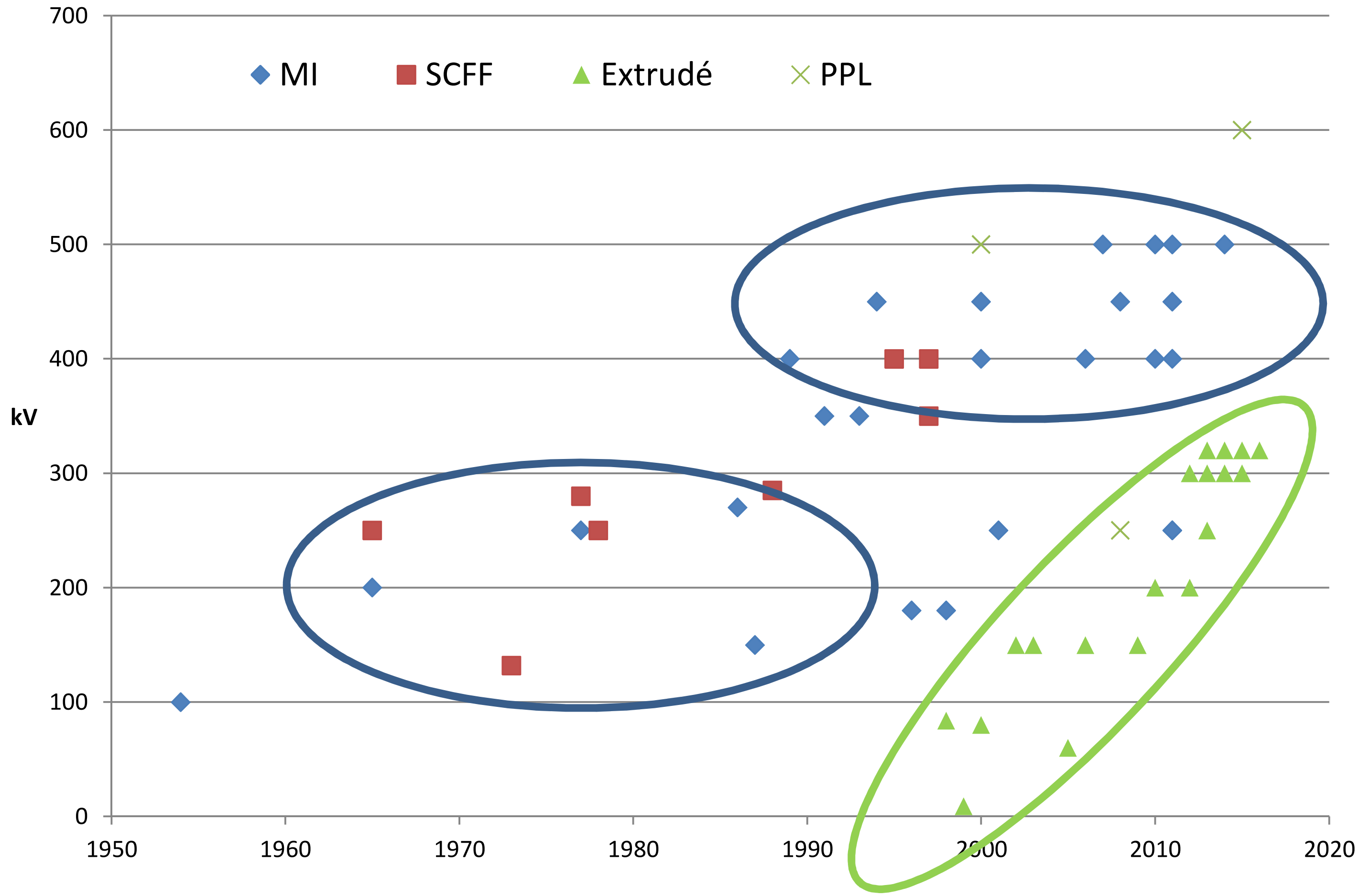
SCFF/PPL

PPL: polypropylene/paper laminate

Cumulated number of HVDC projects



Increase of HVDC cable voltage

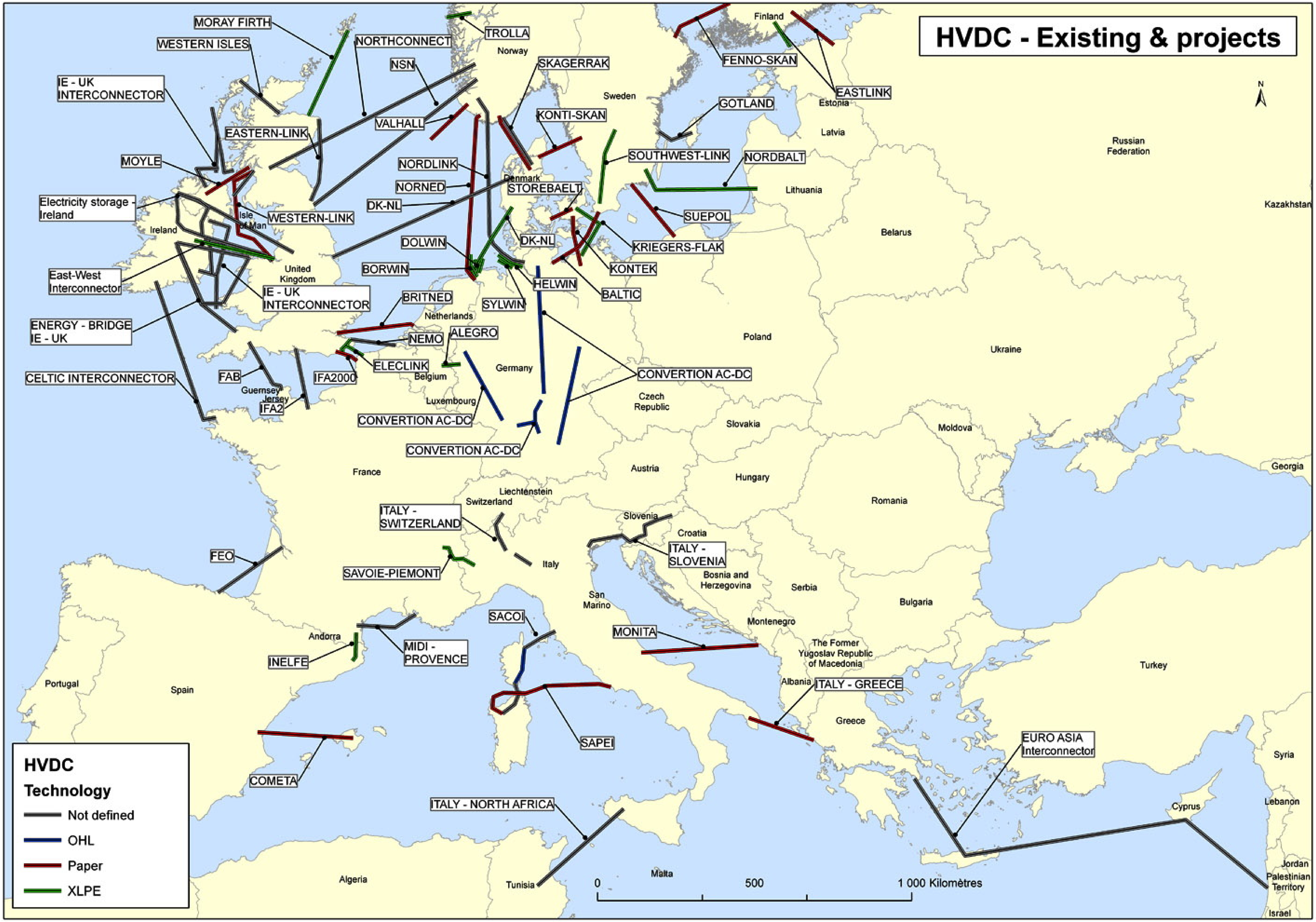


Existing HVDC
TROLLA - 84 MW / 60 kV
FENNO - SKAN 1 & 2 - 500 + 800 MW / 400 & 500 kV
EASTLINK - 350 MW / 150 kV
SKAGERRAK 1 - 2 - 3
VALHALL - 78 MW / 150 kV
KONTI SCAN 1&2 - 300 MW / 285 kV
GOTLAND 2 & 3 - 260 MW / 150 kV
MOYLE - 500 MW / 250 kV
SwePol LINK - 600 MW / 450 kV
NORNED - 700 MW / 450 kV
BORWIN 1 - 400 MW / 150 kV
BALTIC - 600 MW / 450 kV
STOREBAELT - 600 MW / 400 kV
KONTEK - 600 MW / 400 kV
East - West interconnector - 500 MW / 200 kV
IFA 2000 - 2000 MW / 270 kV
BRITNED - 1000 MW / 450 kV
SACOI - 300 MW / 200 kV
COMETA - 400 MW / 250 kV
ITALY - GREECE 500 MW / 400 kV
SAPEI - 1000 MW / 500 kV
Finland
Norway
Sweden
Estonia
Latvia
Russian Federation
Lithuania
Kazakhstan
Denmark
Isle of Man
Ireland
Belarus
United Kingdom
Netherlands
Germany
Poland
Ukraine
Belgium
Jersey
Luxembourg
Czech Republic
Slovakia
Moldova
Austria
France
Hungary
Georgia
Liechtenstein
Switzerland
Romania
Slovenia
Croatia
Italy
Bosnia and Herzegovina
Serbia
San Marino
Bulgaria
Montenegro
Andorra
The Former Yugoslav Republic of Macedonia
Albania
Turkey
Portugal
Spain
Greece
Syria
Cyprus
Lebanon
Malta
Algeria
Tunisia
Jordan
Palestinian Territory
Israel
0
500
1 000 Kilometers
N
HVDC
Technology
Not defined
OHL
Paper
XLPE


Commissioning date < 2017
WESTERN ISLES - 450 MW / 150 kV
MORAY FIRTH - 1200 MW
IE - UK INTERCONNECTOR - 3200 MW
WESTERN LINK - 2200 MW / 600 kV
SKAGERRAK 4 - 1640 MW / 500 kV
EASTLINK 2- 650 MW / 450 kV
South West LINK - 1320 MW / 300 kV
NORDBALT - 700 MW / 300 kV
HELWIN 1 and 2 - 576 + 690 MW / 250 - 320 kV
BORWIN 2 - 800 MW / 300 kV
SYLWIN 1 - 864 MW / 320 kV
DOLWIN 1 and 2 - 1700 MW / 320 kV
ELECLINK - 1000 MW / 320 kV
INELFE - 2000 MW / 400 kV
Norway
Sweden
Finland
Estonia
Latvia
Lithuania
Russian Federation
Kazakhstan
Denmark
Isle of Man
Ireland
United Kingdom
Netherlands
Germany
Belgium
Luxembourg
Jersey
Poland
Belarus
Ukraine
Czech Republic
Slovakia
Moldova
France
Austria
Hungary
Romania
Georgia
Liechtenstein
Switzerland
Slovenia
Croatia
Italy
Bosnia and Herzegovina
Serbia
San Marino
Bulgaria
Montenegro
Andorra
The Former Yugoslav Republic of Macedonia
Portugal
Spain
Albania
Turkey
Greece
Syria
Lebanon
Cyprus
Algeria
Tunisia
Malta
Jordan
Palestinian Territory
Israel
0
500
1 000 Kilometers
HVDC Technology
Not defined
OHL
Paper
XLPE

Commissioning date 2017 to 2020
N
Norway
Sweden
Estonia
Latvia
Lithuania
Russian Federation
Kazakhstan
Belarus
Denmark
Ireland
Isle of Man
United Kingdom
Netherlands
Belgium
Luxembourg
Germany
Poland
Ukraine
Czech Republic
Slovakia
Moldova
Guernsey
Jersey
France
Austria
Hungary
Romania
Georgia
Liechtenstein
Switzerland
Slovenia
Croatia
Bosnia and Herzegovina
Serbia
Bulgaria
Italy
San Marino
Montenegro
The Former Yugoslav Republic of Macedonia
Albania
Greece
Turkey
Andorra
Portugal
Spain
Syria
Lebanon
Cyprus
Jordan
Palestinian Territory
Israel
Algeria
Tunisia
Malta
Electricity storage projects in Ireland - 1200 MW / 320 and 400 kV
Electricity storage projects in Ireland - 1300 MW / 500 kV
NSN - 1400 MW / 500 kV
NORDLINK - 1400 MW / 500 kV
GOTLAND - 500 MW - 300 kV
KRIEGERS - FLAK - 600 MW - 320 kV
DENMARK - NETHERLANDS - 700 MW / 320 kV
DOLWIN 3 - 900 MW / 320 kV
ENERGY - BRIDGE IRELAND - GB 5000 MW / 320 and 500 kV
NEMO - 1000 MW
ALEGRO
CONVERSION AC-DC
IFA2 - 1000 MW / 320 kV
FEO - 2000 MW / 300 or 500 kV
SAVOIE - PIEMONT - 1200 MW / 320 kV
MONITA - 1000 MW / 500 kV
MIDI - PROVENCE - 1000 MW / 320 kV
EURO ASIA INTERCONNECTOR - 2000 MW - 600 kV
ITALY - NORTH AFRICA
0
500
1 000 Kilometers
HVDC
Technology
Not defined
OHL
Paper
XLPE


Commissioning date > 2020
NORTHCONNECT - 1400 MW
DK - UK - 1400 MW
EASTERN LINK - 2000 MW
CONVERSION AC-DC
FAB - 1000 or 1400 MW / 320 kV
CONVERSION AC-DC
CELTIC INTERCONNECTOR - 700 MW / 320 kV
CONVERSION AC-DC
ITALY - SWITZERLAND
ITALY - SLOVENIA
SACOI
HVDC
Technology
Not defined
OHL
Paper
XLPE
0
500
1 000 Kilometers
Finland
Norway
Sweden
Estonia
Latvia
Russian Federation
Lithuania
Denmark
Kazakhstan
Isle of Man
Ireland
Belarus
United Kingdom
Netherlands
Poland
Ukraine
Belgium
Germany
Guernsey
Jersey
Luxembourg
Czech Republic
Slovakia
Moldova
France
Austria
Hungary
Georgia
Liechtenstein
Switzerland
Romania
Slovenia
Croatia
Italy
Bosnia and Herzegovina
Serbia
San Marino
Bulgaria
Montenegro
Andorra
The Former Yugoslav Republic of Macedonia
Turkey
Portugal
Spain
Albania
Greece
Syria
Lebanon
Cyprus
Malta
Algeria
Tunisia
Jordan
Palestinian Territory
Israel



HVDC - Existing & projects
HVDC
Technology
Not defined
OHL
Paper
XLPE
MORAY FIRTH
WESTERN ISLES
NORTHCONNECT
TROLLA
NSN
SKAGERRAK
FENNO-SKAN
EASTLINK
IE - UK INTERCONNECTOR
EASTERN-LINK
VALHALL
KONTI-SKAN
GOTLAND
MOYLE
NORDLINK
SOUTHWEST-LINK
NORDBALT
NORNED
STOREBAELT
Electricity storage - Ireland
DK-NL
WESTERN-LINK
SUEPOL
DOLWIN
DK-NL
KRIEGERS-FLAK
BORWIN
KONTEK
HELWIN
East-West Interconnector
IE - UK INTERCONNECTOR
BALTIC
BRITNED
SYLWIN
ENERGY - BRIDGE IE - UK
NEMO
ALEGRO
ELECLINK
CONVERTION AC-DC
CELTIC INTERCONNECTOR
FAB
IFA2000
IFA2
CONVERTION AC-DC
CONVERTION AC-DC
ITALY - SWITZERLAND
ITALY - SLOVENIA
FEO
SAVOIE-PIEMONT
SACOI
MONITA
MIDI - PROVENCE
INELFE
ITALY - GREECE
SAPEI
EURO ASIA Interconnector
COMETA
ITALY - NORTH AFRICA
0
500
1 000 Kilomètres
Norway
Sweden
Finland
Estonia
Latvia
Russian Federation
Lithuania
Denmark
Isle of Man
Ireland
United Kingdom
Belarus
Kazakhstan
Netherlands
Poland
Ukraine
Germany
Belgium
Guernsey
Jersey
Luxembourg
Czech Republic
Slovakia
Moldova
France
Austria
Hungary
Liechtenstein
Switzerland
Romania
Georgia
Slovenia
Croatia
Italy
Bosnia and Herzegovina
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Tunisia
Malta

Conclusion

•HVDC is the future of UG and SM lines in association with converter technologies for long distance power transmission (1 to 2 GW)

•Jicable in Perpignan has been for three days the « center » of the world of HVDC :

Hundreds of experts and researchers discussed projects of hundreds of km, hundreds of kV and hundreds of M€.

•HVDC technologies are on the move rapidly and continously and much is still to be done.