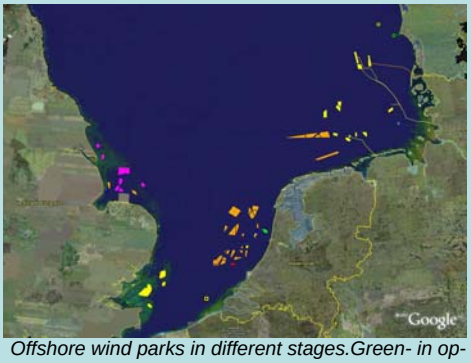
Network of offshore wind farms connected by gas insulated transmission lines?

A. Drews[1], C. Rathke[1], M. Siebert[1], D. Heinemann[1], B. Hühnerbein[1], L. Hofmann[1], H. Koch[2], H. Kunze[2], H.-J. Hoppensack[3], H. Lohrenscheit[3], T. Roggenberg[3], F. Wendt[3]

[1]ForWind - Center for Wind Energy Research, Institute of Physics, Oldenburg University & Institute of Electric Power Systems, Hannover University, Germany; [2]Siemens AG, Power Transmission and Distribution, Erlangen, Germany; [3]ILF Consulting Engineers GmbH, Munich, Germany

Future offshore wind power

Nearly 45 GW of offshore wind power are in operation, under construction, approved or applied for in the North Sea. Another 70 GW are in an unknown planning status. Potentially, more than 12000 turbines are waiting to be built within the next 20 years.



Offshore wind parks in different stages.Green- in operation, blue- under construction, orange - apllied for, yellow- approved, red - rejected, purple - unknown

These immense offshore capacities need a grid that transports the generated power onshore to those areas that have high energy demands.

Network of wind farms

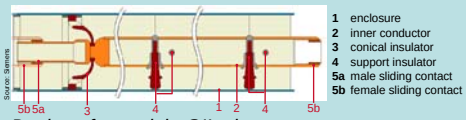
Wind power generation offshore faces the challenge of reliable and low-loss transmission to the grid onshore. Considering the existing and focusing on the planned capacities in the North Sea, in this EU-funded project „North Sea Network using GIL Technology“ the feasibility of connecting these offshore wind farms by gas insulated transmission lines (GIL) is investigated. Aim is to introduce GIL as an option to bundle the lines that transmit the generated power to the high voltage grid onshore. The technical advantages of GIL that match exactly the offshore needs are presented.

Study area bundling offshore wind farms in one line over the German island Norderney.

What is a GIL?

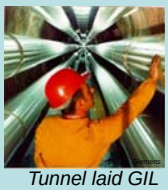
Cross-section of a GIL (one of three phases)

GIL is an AC transmission system for high and extra high voltage. It is based on coaxial pipes of aluminum, with the inner conductor at high voltage centered by solid insulators within an outer earthed enclosure. It is filled with a pressurized insulating gas mixture (80%/20% N/SF6 at 0.7 MPa). Due to its very high conductor cross-section the domain of GIL is high power transmission with currents exceeding 2000 A.



Design of a straight GIL element

The assembly of GIL is similar to the laying of pipelines. Highly standardized elements are used to install a GIL in every spatial direction, even vertical. Single pipes are welded together by an automatic welding machine. GIL can be laid above ground, installed in tunnels or directly buried.



Tunnel laid GIL

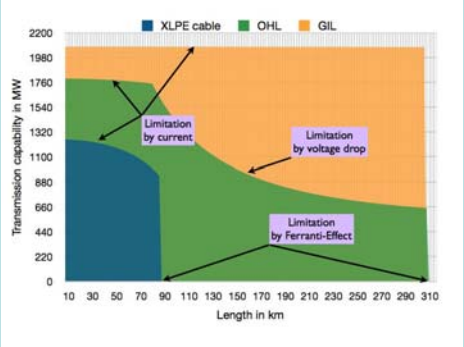
Why GIL?

The superior electric behavior of GIL enables to collect the generated power of several wind farms to transmit it to the grid onshore.

- highest ampacity - up to 4000 A at 500kV
- low capacities - no compensation for long lengths
- electrical behavior similar to OHL - auto re-closure capable
- highest personal and operational safety - no burn through of the enclosure
- low radiation - no external electric field and very low electromagnetic radiation
- well known three phase AC technique – easily applicable in existing structures
- very robust design – benefit for the offshore environment
- long lifetime – more than 50 years

Comparison with other transmission systems

The possible length of HVAC cables is strongly limited due to their high capacitance and low thermal permissible power. GIL does not have this disadvantage because its capacitance is significantly lower and its permissible power is much higher. Therefore, it is from a technical point of view the best HVAC transmission line for long distance applications.



AC transmission capability of OHL, GIL, and XLPE cables depending on transmission line length.

Compared to HVDC systems, the benefits of GIL are the higher power capacity and the robust three phase technique, which does not demand huge converter stations.

Conclusion

Compared to other transmission technologies, the characteristics of GIL show a very high potential to contribute significantly to the needed infrastructure, which is mandatory for the effective use of the offshore produced wind power. Since no offshore experience with this technology is on hand, this feasibility study, running till September 2009, will answer therewith associated questions.

Acknowledgements

The Project is funded by the European Commission in the Trans European Energy Networks (TEN-E).

Corresponding author: anja.drews@forwind.de