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Increasing Limits of Grid Extension for Renewable Integration through Decentralized Compensation

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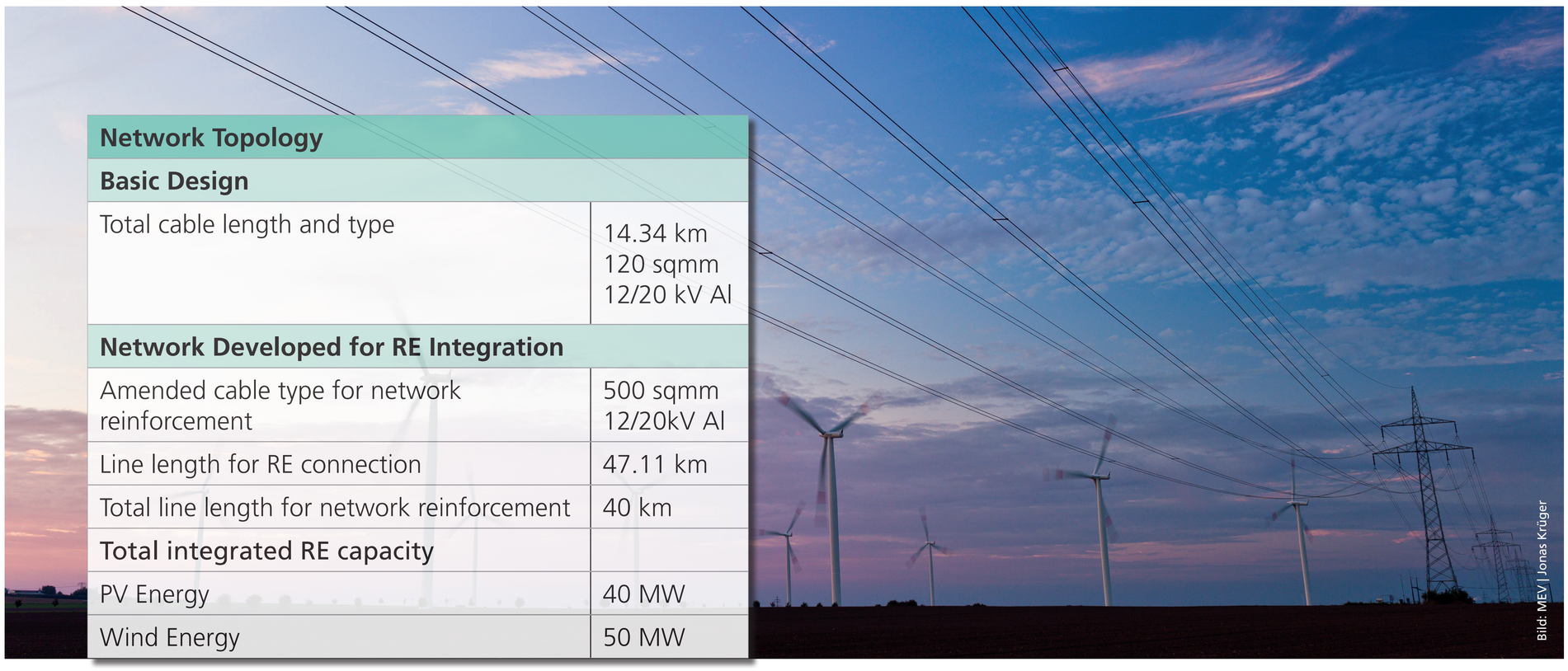


Network Topology	
Basic Design	
Total cable length and type	14.34 km 120 sqmm 12/20 kV Al
Network Developed for RE Integration	
Amended cable type for network reinforcement	500 sqmm 12/20kV Al
Line length for RE connection	47.11 km
Total line length for network reinforcement	40 km
Total integrated RE capacity	
PV Energy	40 MW
Wind Energy	50 MW

Medium Voltage (20 kV) grid network developments from basic stage to developed stage with all renewable connection

Earth-fault challenges in DER Integration

There are two main drivers increasing the share of UG (underground) cables in the grid:

A. Replacement of OH (overhead) lines with UG cable (in HV and MV level)
B. Grid extension for the integration of RE

- Long AC UG cable has significant capacitance value which increases capacitive earth fault current.
- Compensation by Peterson coil is limited by the potential earth fault current linked to the total line length.
- Decentralized compensation approach helps when safety limit is crossed.

Investigation and results

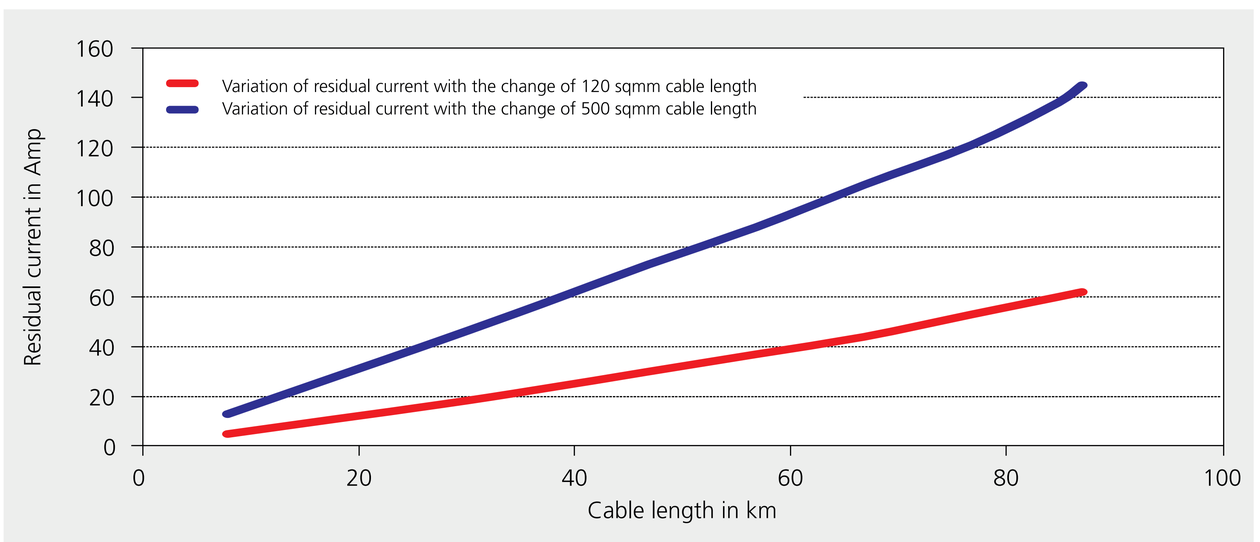
- There is a significant decrease of zero sequence resistance values from 120 mm^2 to 500 mm^2 which increases the value of residual current with the increase of cable length.
- Cable capacitance increases with both the increase of cable length and cable cross-section which increases the capacitive earth fault current.

Conclusion

- The shunt capacitance is quite proportional for long or short cable whereas the major limitation is with series impedance i.e. series resistance and inductance of the long cable.
- The fault current compensation is limited in wide extended grids using centralized compensation.
- Decentralized compensation or network splitting could be required depending on the degree of complexity and network reinforcement.
- With the decentralized compensation method, the technical needs and costs can be assigned directly to the responsible installation (consumer or generator).

Outlook

The principal feasibility and technical benefits of decentralized compensation in MV grids was shown. Next more detailed investigation on the relay co-ordination and fault detection needs to be done as well as cost benefit analysis regarding investment and operational costs.



Representation of variation of residual current with the change of cable length of different cable cross-section

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