



MVDC-Collector Grids for Renewable Power Plants

Stuttgarter Hochspannungssymposium, Juni 12, 2024

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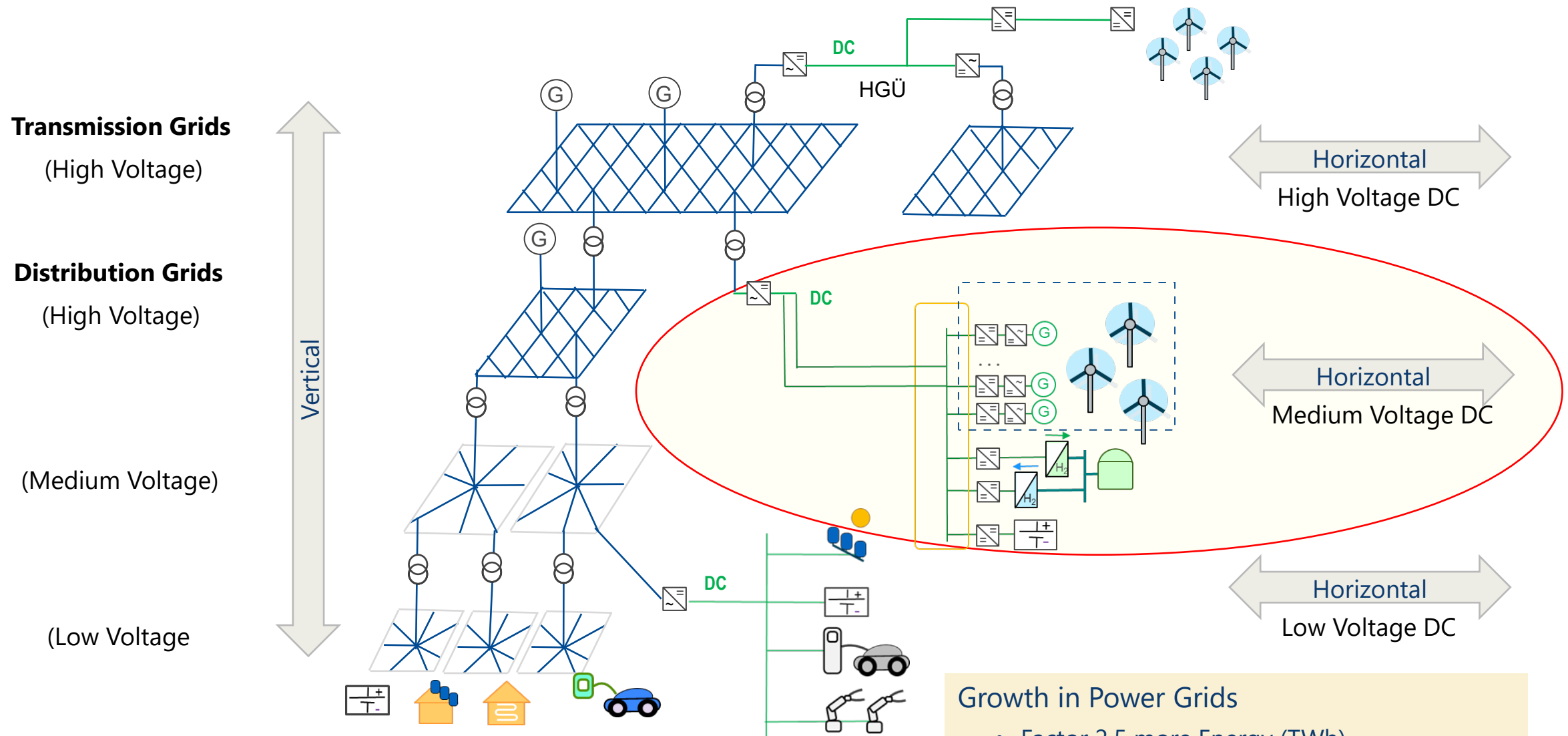


Bundesministerium
für Wirtschaft
und Klimaschutz

aufgrund eines Beschlusses
des Deutschen Bundestages



Roll-out of Renewables

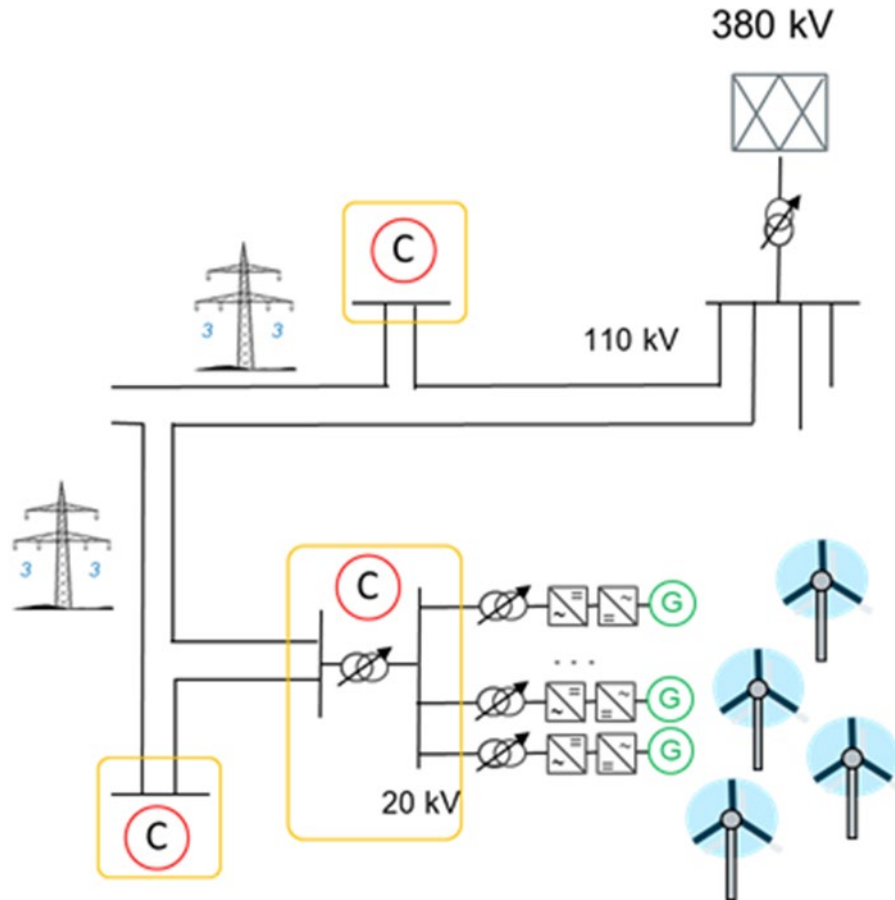


Source of numbers on growth: IRENA WETO 2023

Growth in Power Grids

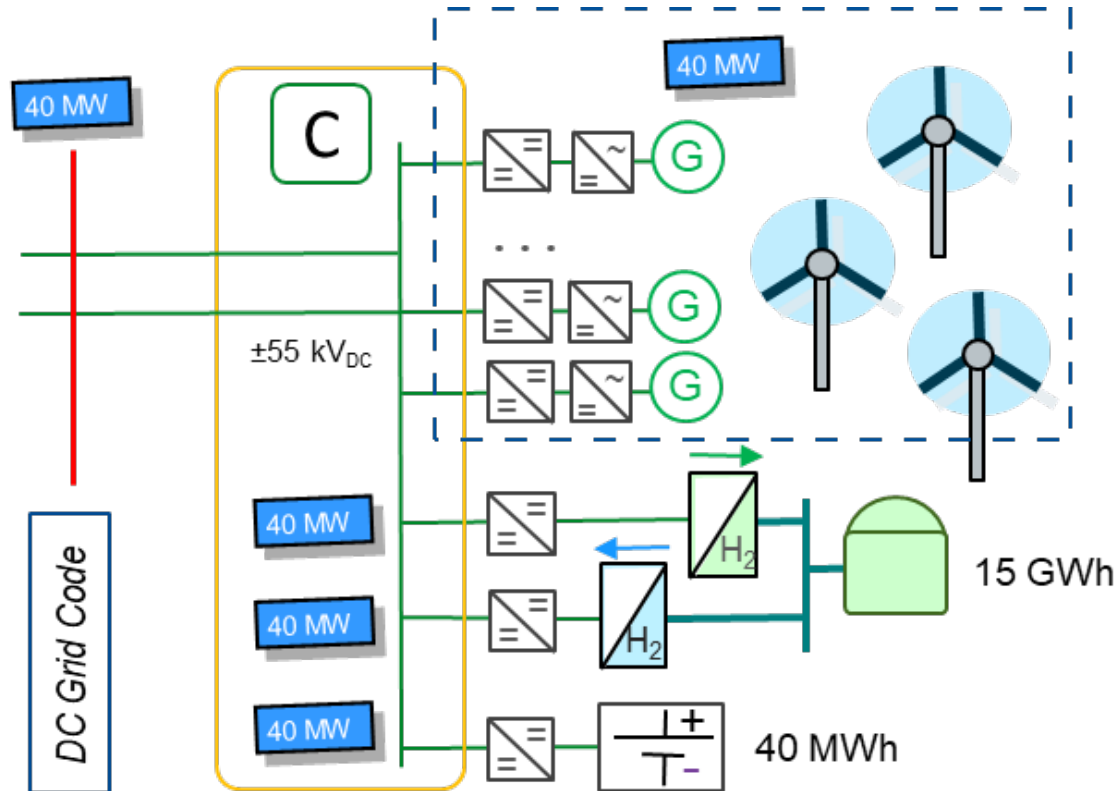
- Factor 2,5 more Energy (TWh),
- Factor 10 more power from RES (GW).

Current Practice: 110 kV AC



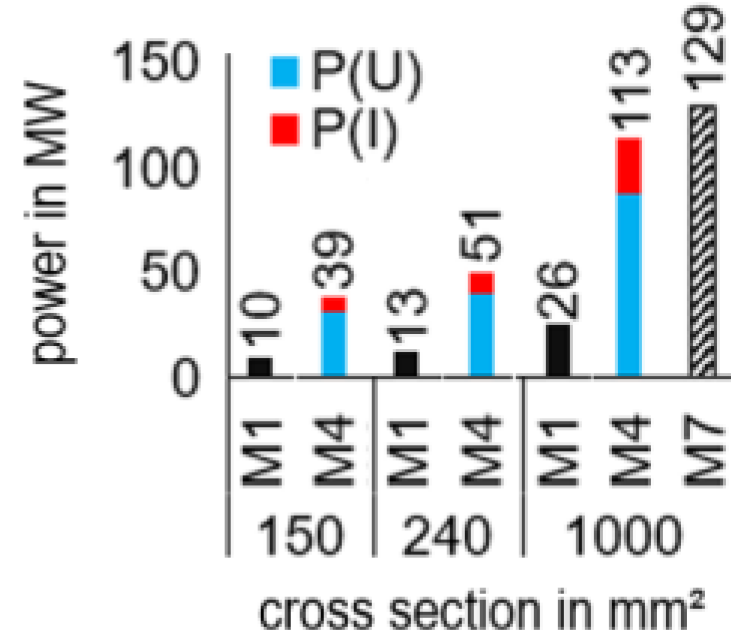
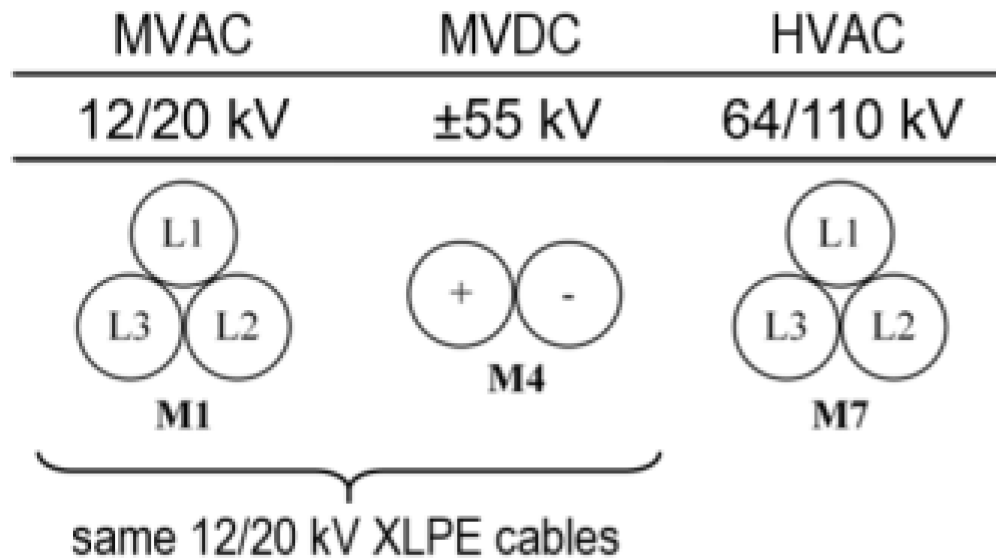
- + Windfarms connect at 20 kV
- + Substations include
 - 2 bus bars (20 kV and 110 kV)
 - transformers
 - circuit breakers
- + 110 kV distribution grid collects power and feeds into transmission

New Practice: ± 55 kV DC



- + Windfarms, battery storage, hydrolysis and fuel cells connect via DC/DC transformers
- + Substation: container with single bus bar and load breakers (no need of circuit breakers)
- + ± 55 kV DC cable distribution grid on 20 kV AC cable collects power and feeds into transmission

Qualification of 20 kV AC Cables for 55 kV DC



- + Same transport capacity as 110 kV AC systems at 3x240 mm²
- + Roll out follows common practice of 20 kV AC cable

Qualification of 20 kV AC Cables for 55 kV DC (combined test)

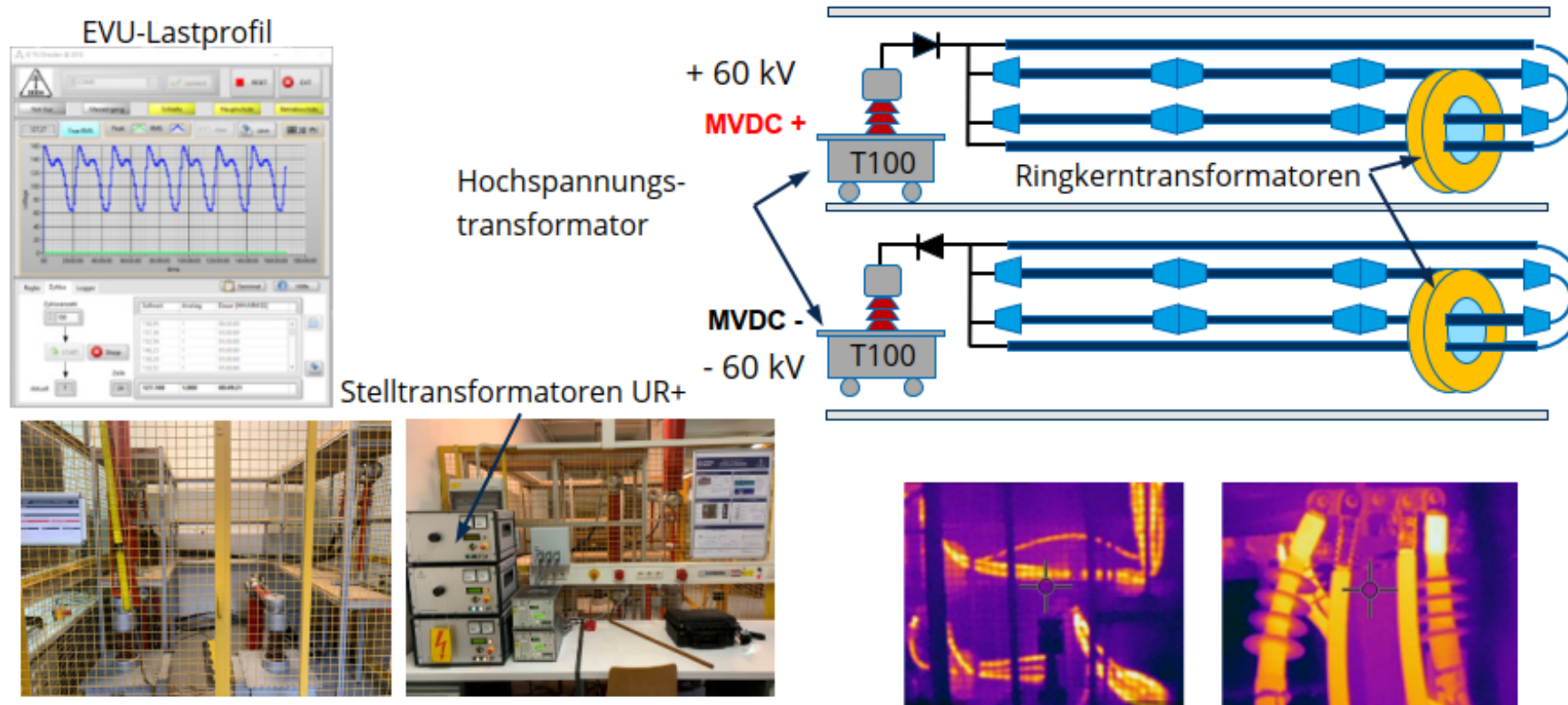
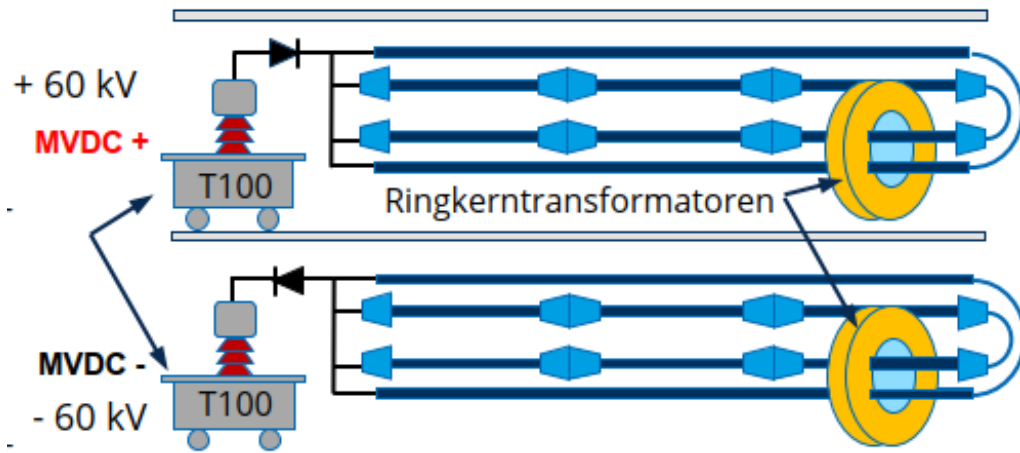


Bild 3-5: Versuchsaufbau zur Stehspannung an neuen Mittelspannungskabel (NA2XS(F)2Y) und deren Garnituren sowie VDE-gealterten VPE-Kabelproben

Qualification of 20 kV AC Cables for 55 kV DC (combined test)



	Prüfling	Hersteller	Prüfdauer (Tage)	Bemerkung
Kabel	neu	A	609	Laufzeitende
	VDE gealtert	B	570	Laufzeitende
	VDE gealtert	A	422	Laufzeitende
Garnitur	refraktiv	A	157	Ausfall
	geometrisch	A	329	Laufzeitende

Qualification of 20 kV AC Cables for 55 kV DC (ageing test)

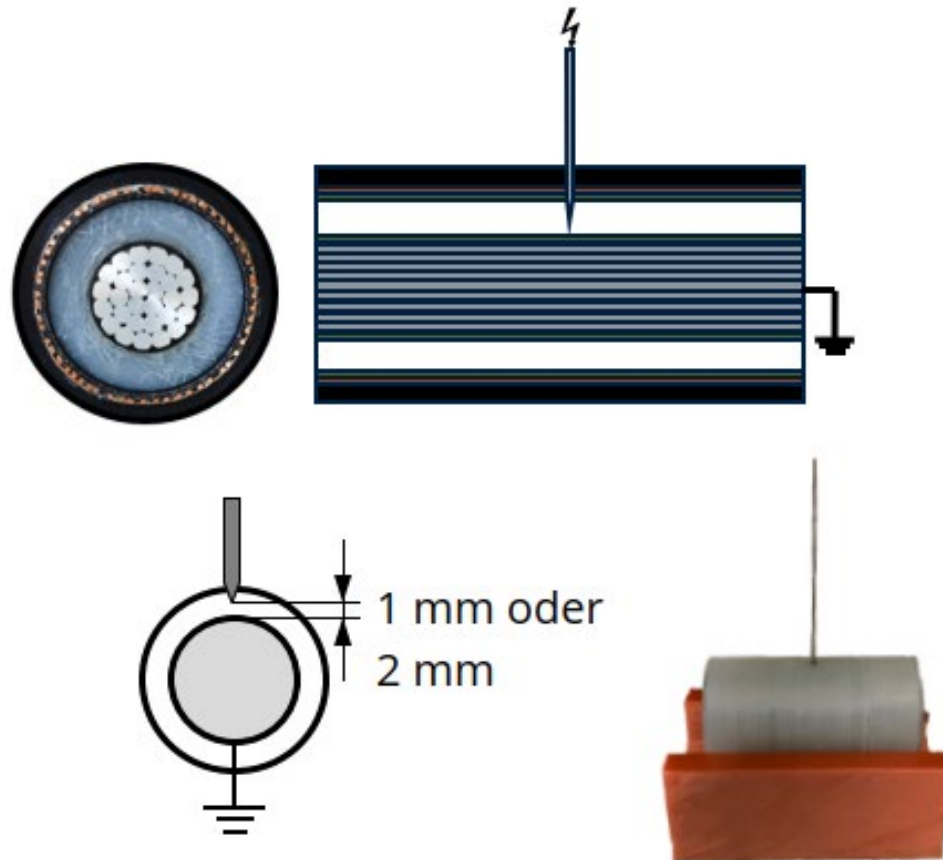


Bild 3-8: Versuchsaufbau zu den Alterungsdurchschlagversuchen an Mittelspannungskabel-Prüflingen

Qualification of 20 kV AC Cables for 55 kV DC (ageing)

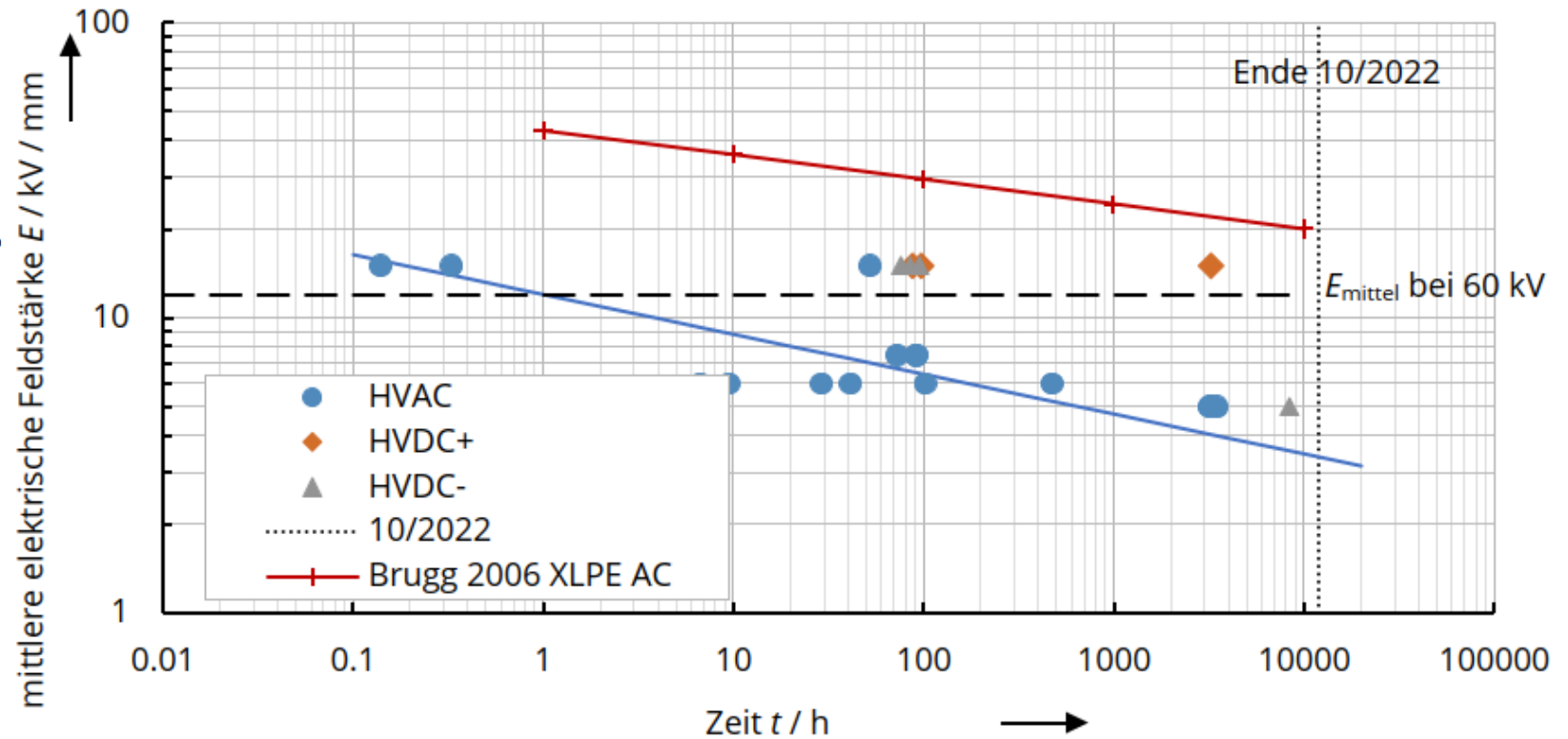
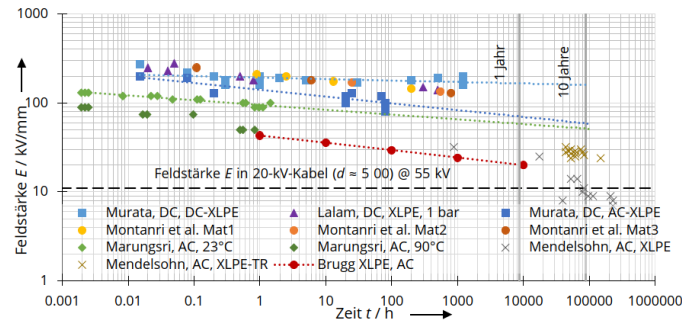
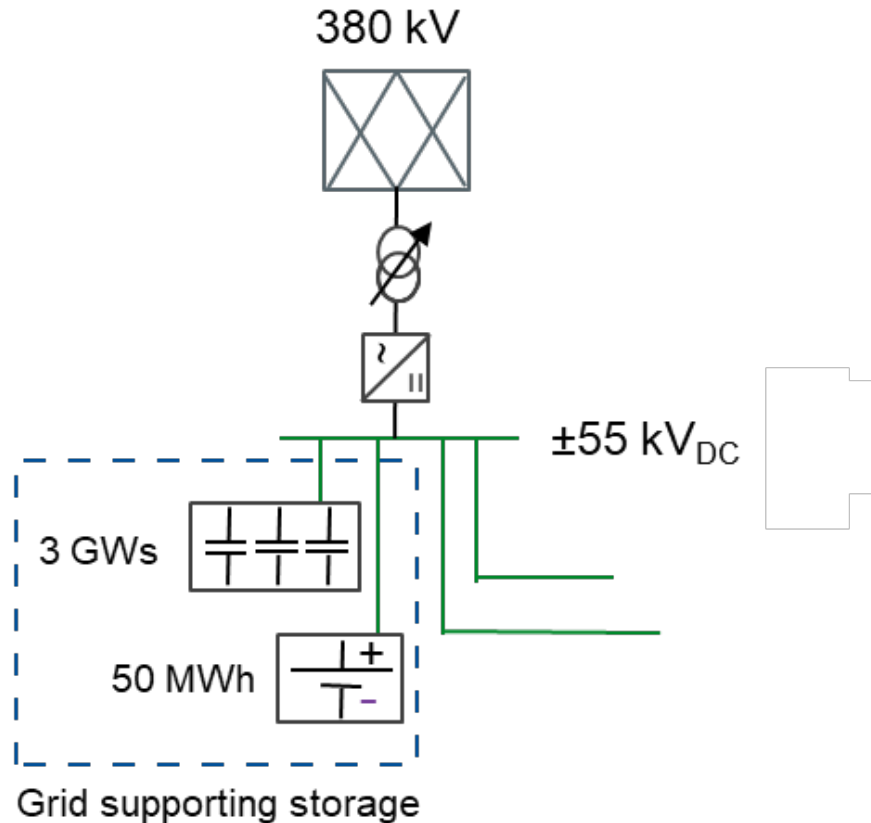


Bild 3-9: Ergebnisse der Alterungsdurchschlagversuche (Lebensdauer kennlinien) an Mittelspannungskabel-Prüflingen (NA2XS(F)2Y)-1-x-150 RM) bei AC und DC Belastungen

MVDC Collector Grids

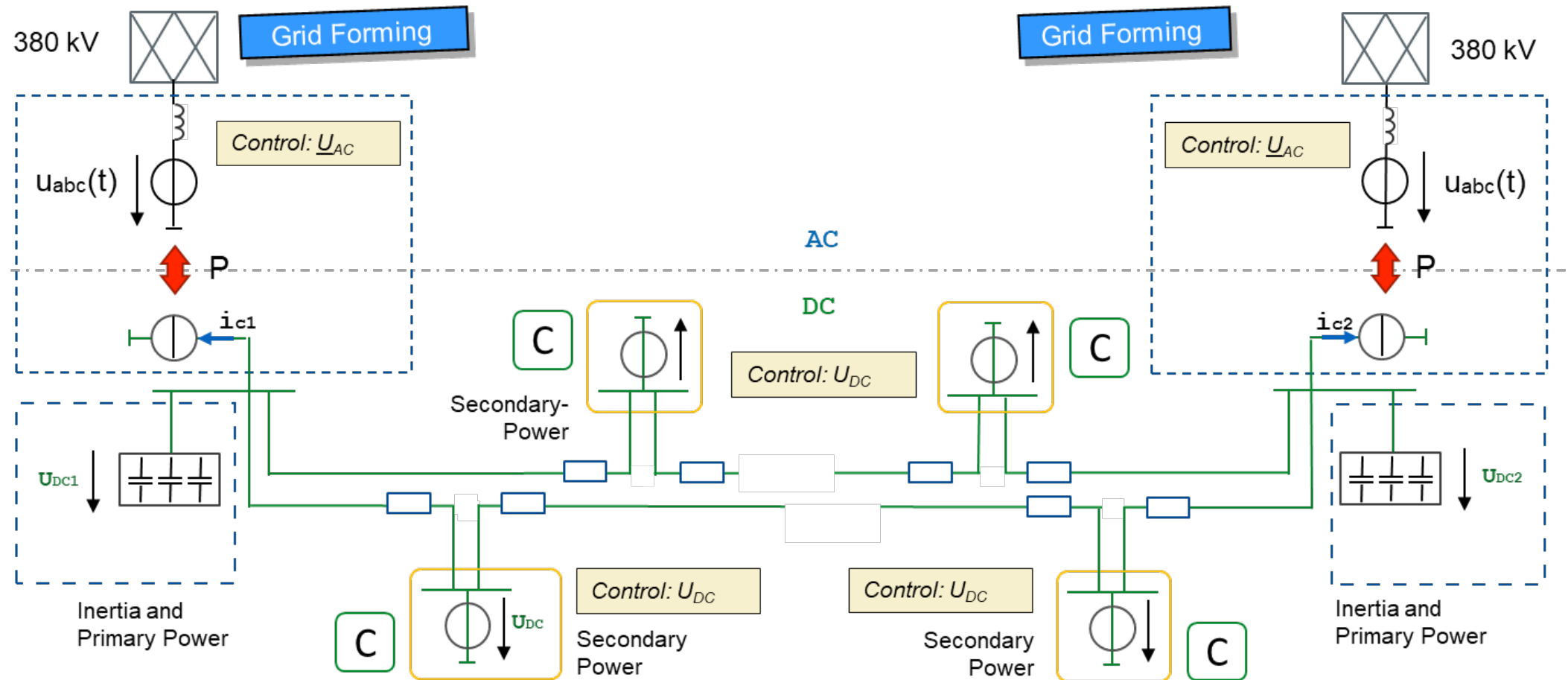


MVDC Head Stations

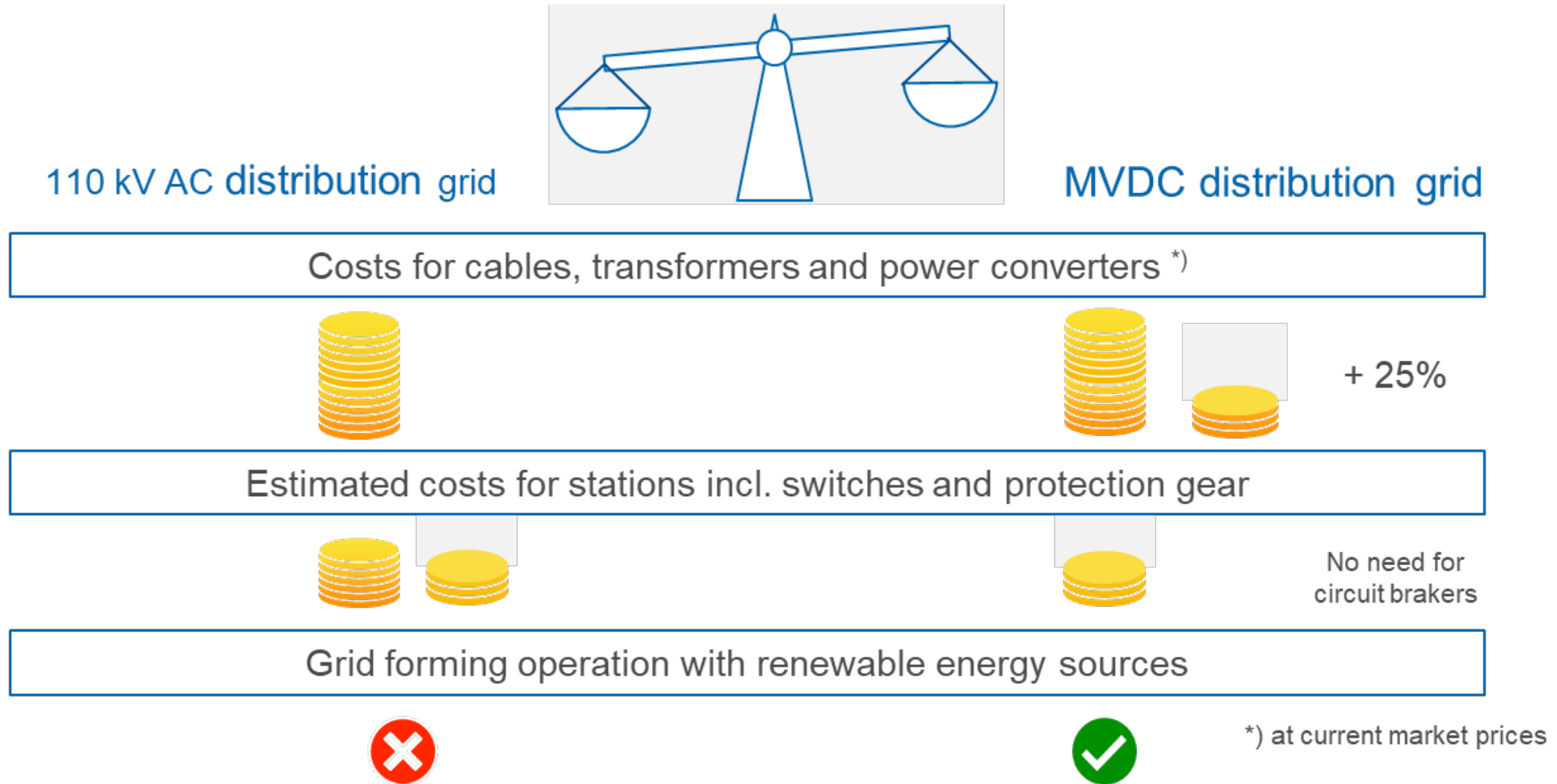


- + Feed into the transmission grid like HVDC head stations
- + Collect power from MVDC distribution grids
- + Provide inertia for grid forming operation by capacitor banks backed by battery storage

Distributed Grid Forming Operation



Benefits

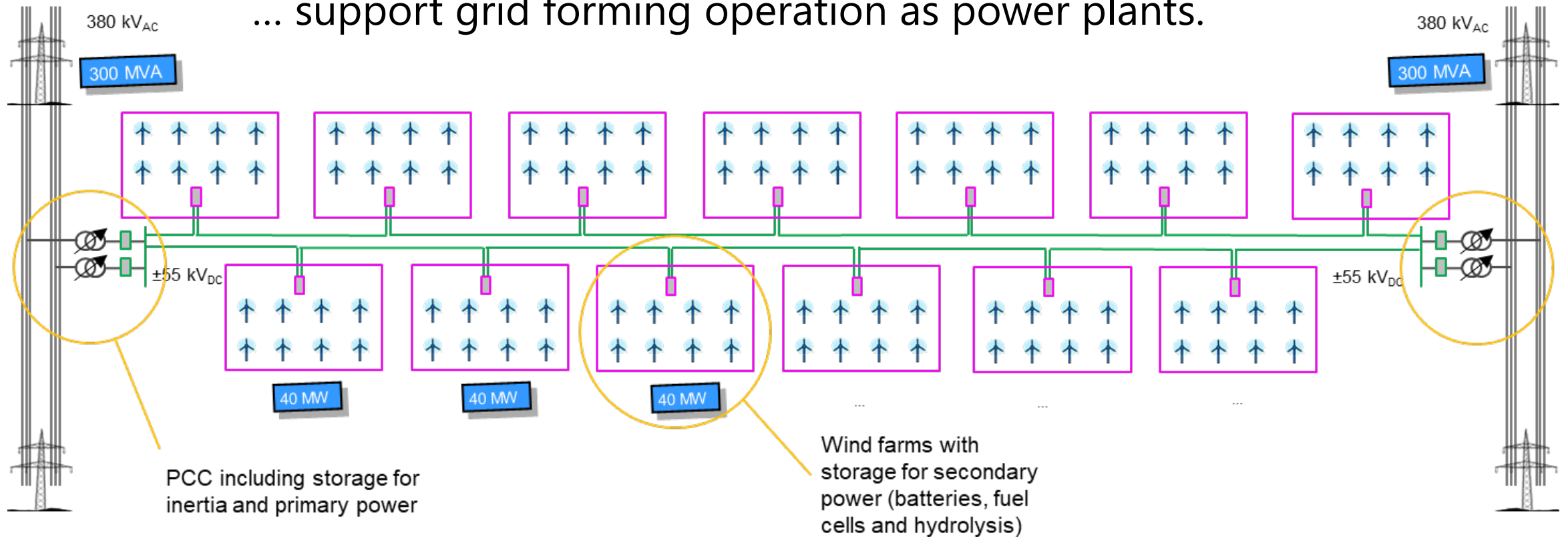


Operation and Protection



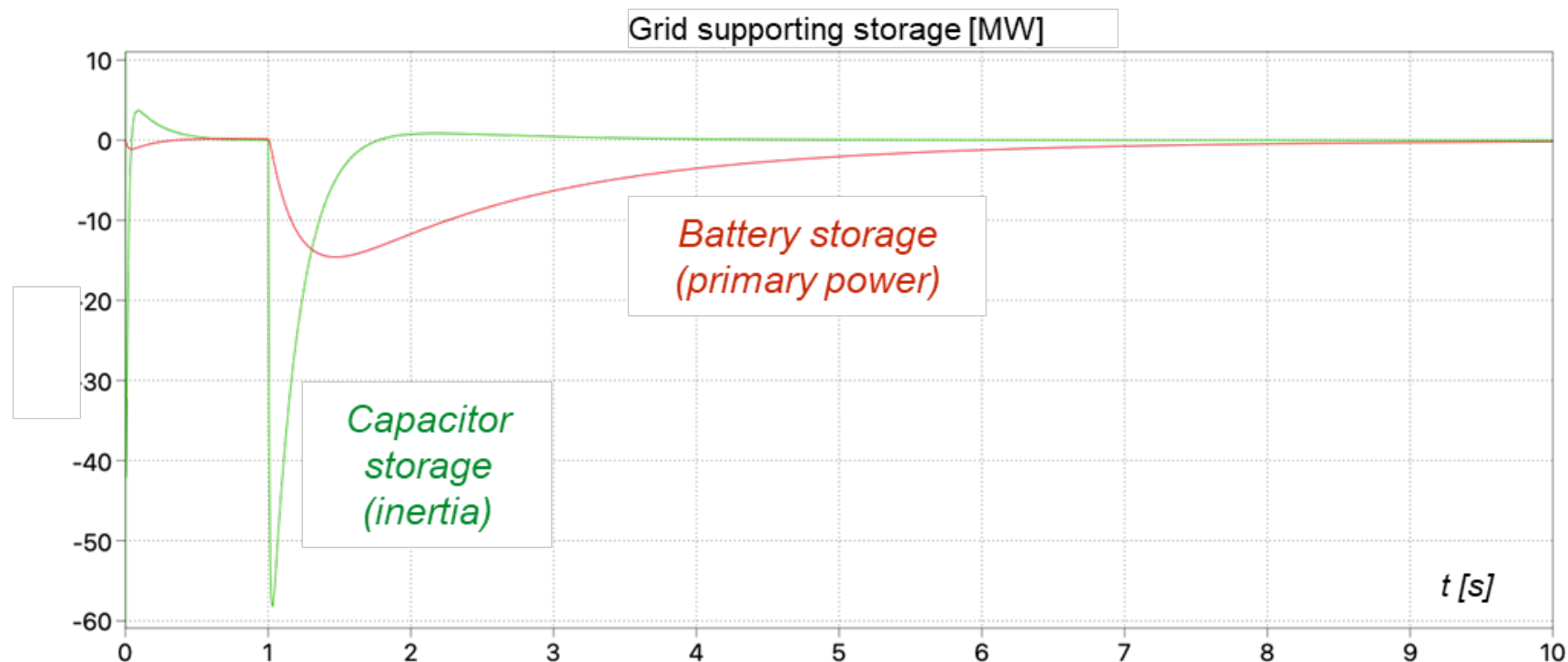
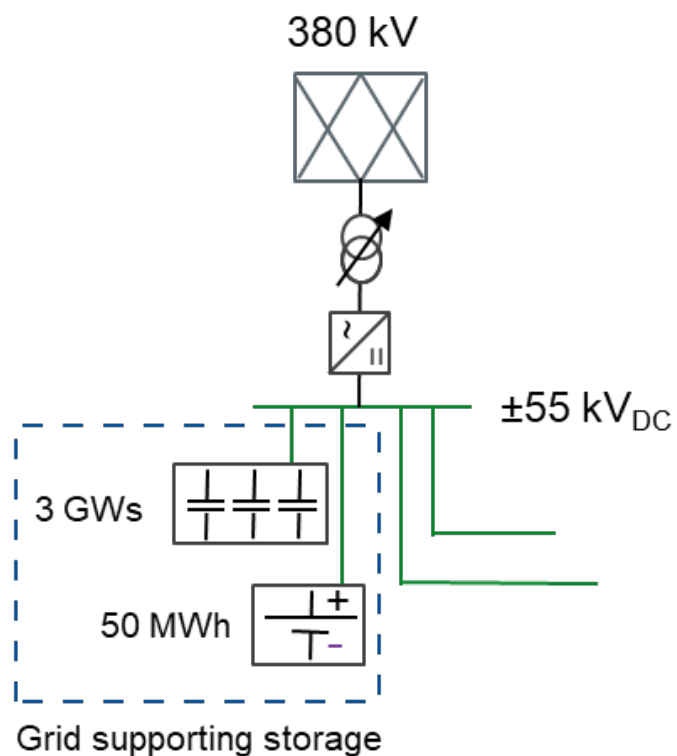
MVDC Collector Grids ...

... support grid forming operation as power plants.

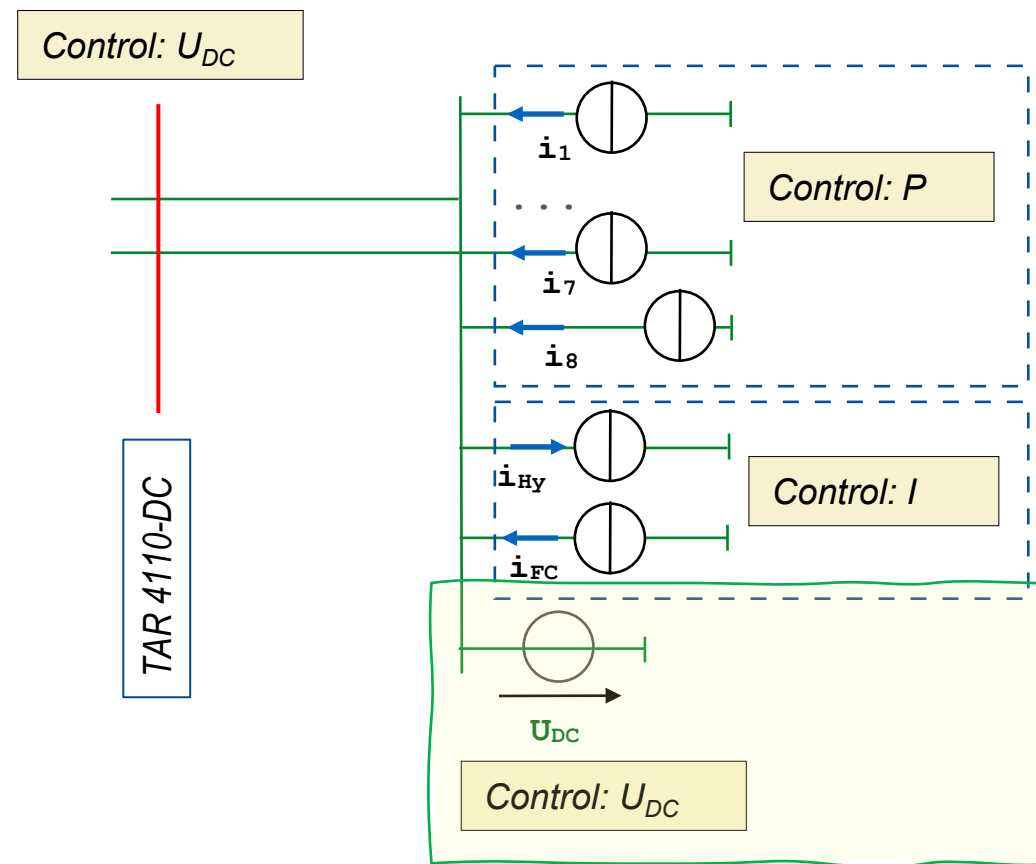
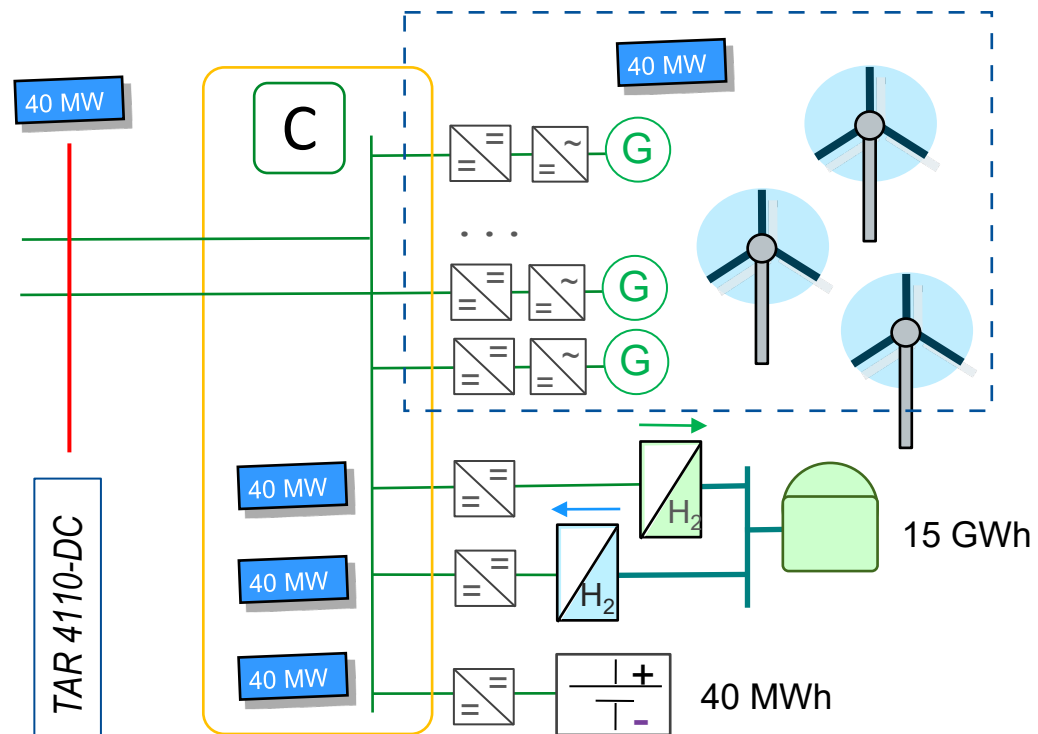


Grid supporting storage ...

... inertia and primary power.

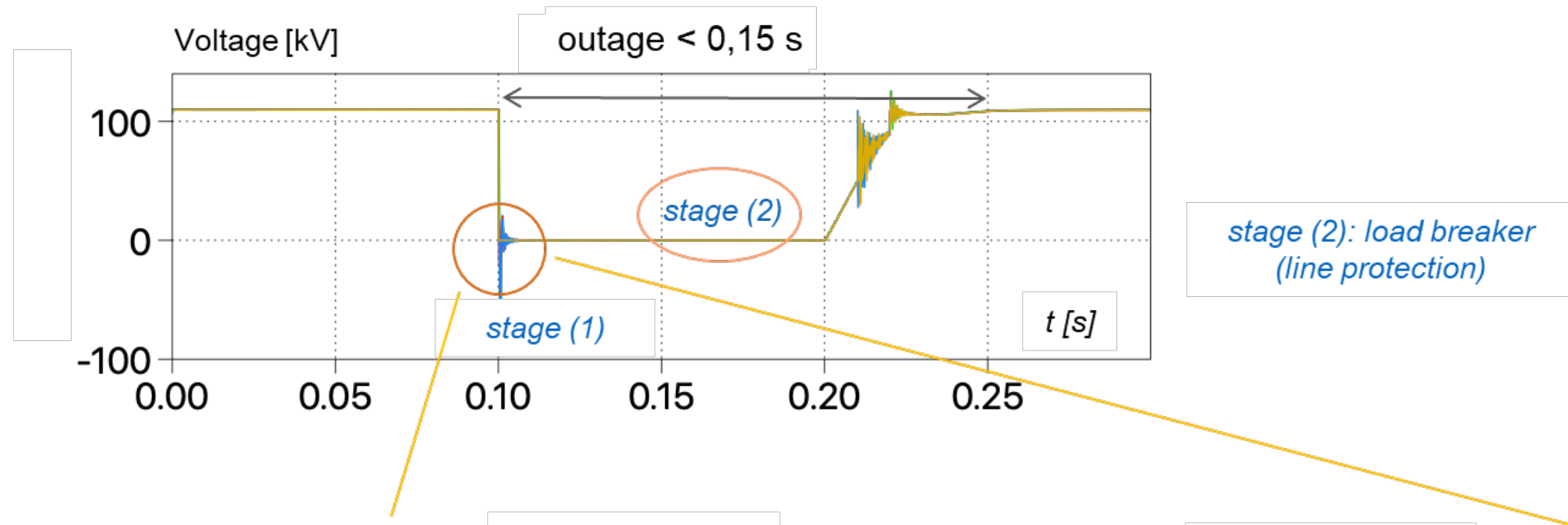


Operating Wind-Farms on the Grid ...

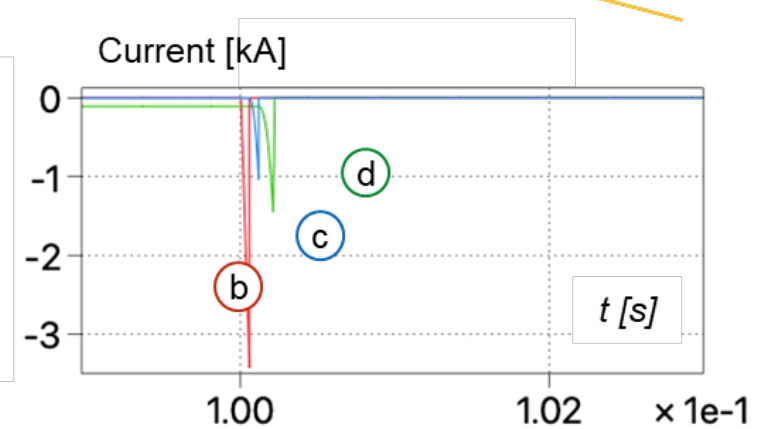
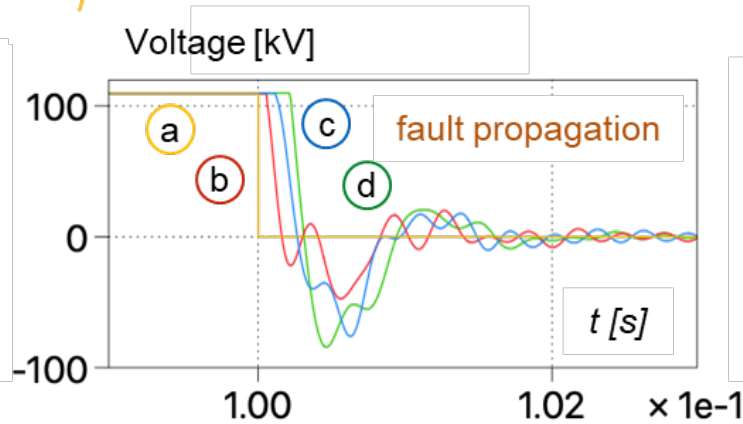


... by grid forming battery converters distributed on the MVDC-grid.

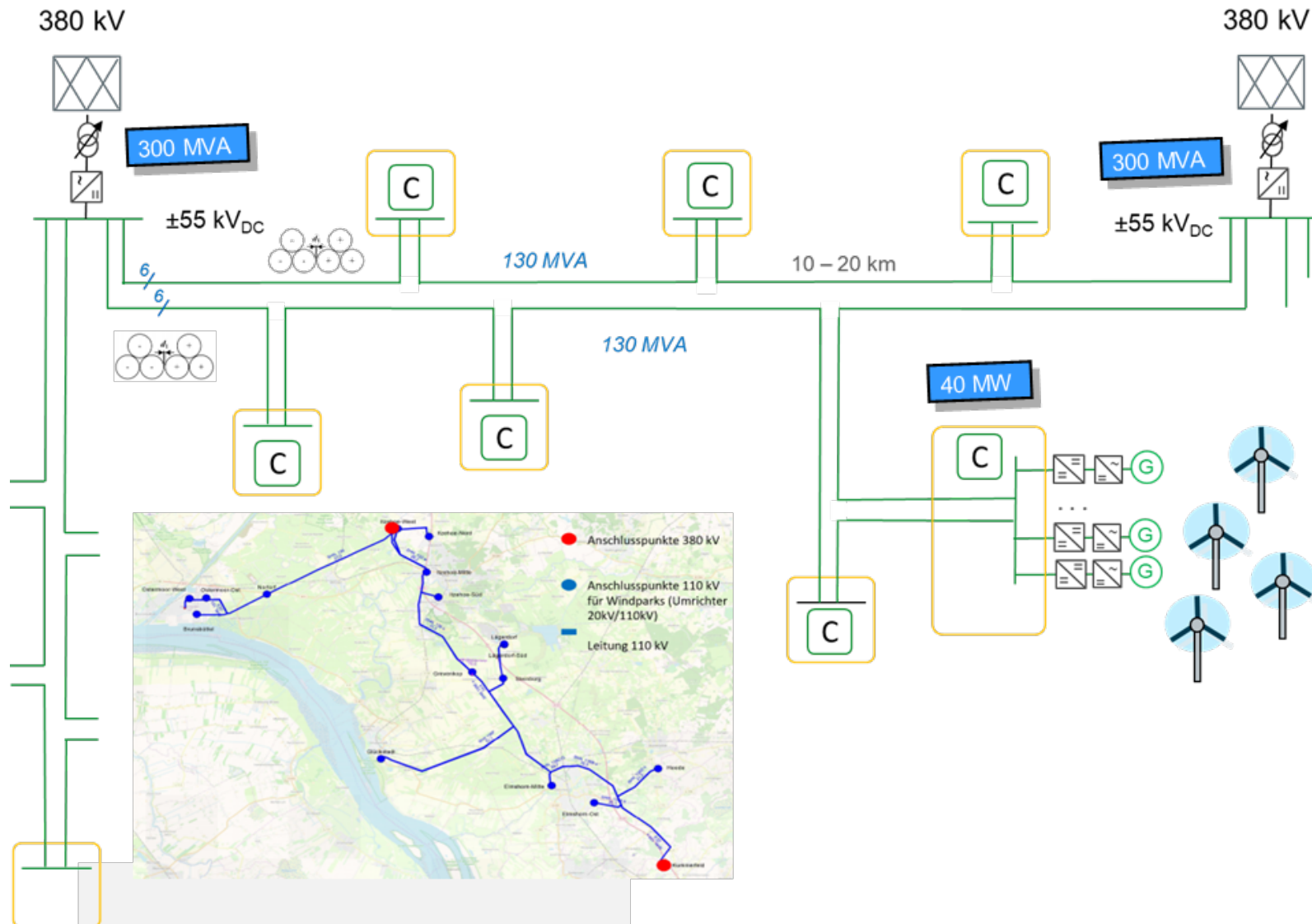
Two-stage protection



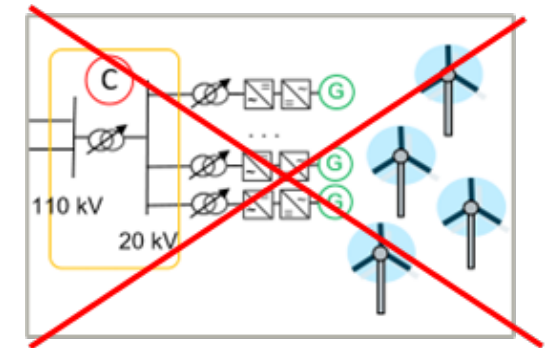
stage (1):
semiconductor
(device protection)



Planning and Roll-Out



- + Same topology as 110 kV AC
- + Using 20 kV AC cables
- + w/o need to construct substations





Summary and Outlook

- + MVDC distribution grids
 - Represent an alternative to 110 kV AC grids
 - Use 20 kV AC cables to carry up to 60 kV DC
 - Speed-up the roll-out by use of container stations
 - Represent a more economic way of grid extensions
 - Allow operating renewables in grid forming mode.
- + Next Steps: Field trials to proof technical feasibility



Thank you for your attention.

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