cigre Nederland

15 april 2025

Beveiliging ontrafeld

Uitgelegd wat je altijd al wilde weten

cigre Nederland

15 april 2025

Beveiliging ontrafeld

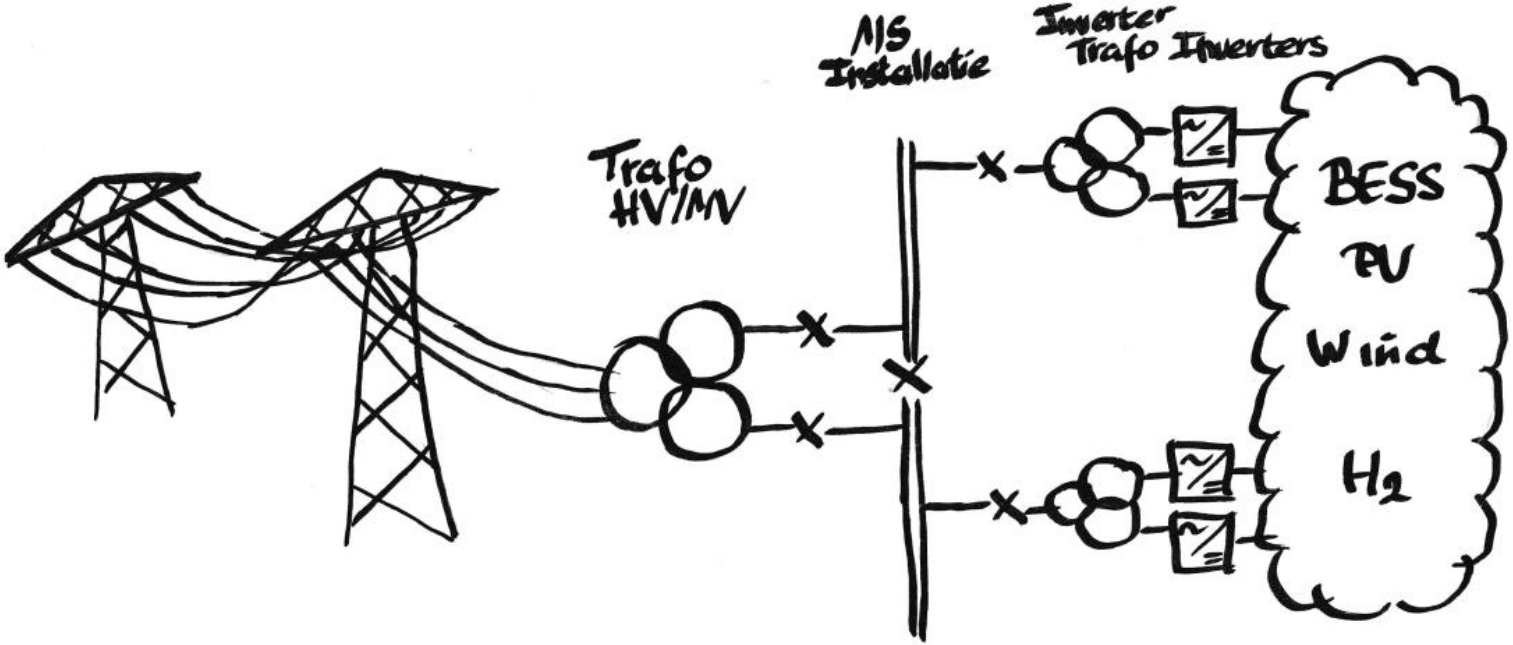
Uitgelegd wat je altijd al wilde weten

Aansluiten en Beveiligen van Renewables

Een presentatie in twee delen

- Aansluiten van renewables
  - Laurens Deterd Oude Weme – Lead Engineer - SPIE Nederland
- Beveiliging van renewables
  - Ernst Wierenga – Principal consultant - DNV Nederland

Blokschema van een renewable aansluiting



Referenties EU, ENTSOe, Netcode, Netbeheer Nederland

- Europese richtlijn (ENTSO-e www.entsoe.eu of www.eur-lex.europa.eu)
  - Verordening (EU) 2016/631 (NC RfG) (requirements for generators)
  - Verordening (EU) 2016/1388 (NC DCC) (demand connection code)
- Nationale wetten -> Netcode
  - https://wetten.overheid.nl/BWBR0037940
- Netbeheer Nederland www.netbeheernederland.nl
  - ESM compliance verification
  - RfG compliance verification by testing and simulating
  - DCC compliance verification by testing and simulating
- ACM -> Wetten en regels voor de energiemarkt
  - www.acm.nl/nl/energie/wetten-en-regels-voor-de-energiemarkt

Categorie van aansluiting

- Volgens ENTSOE/EU, Netcode NL en Netbeheer Nederland

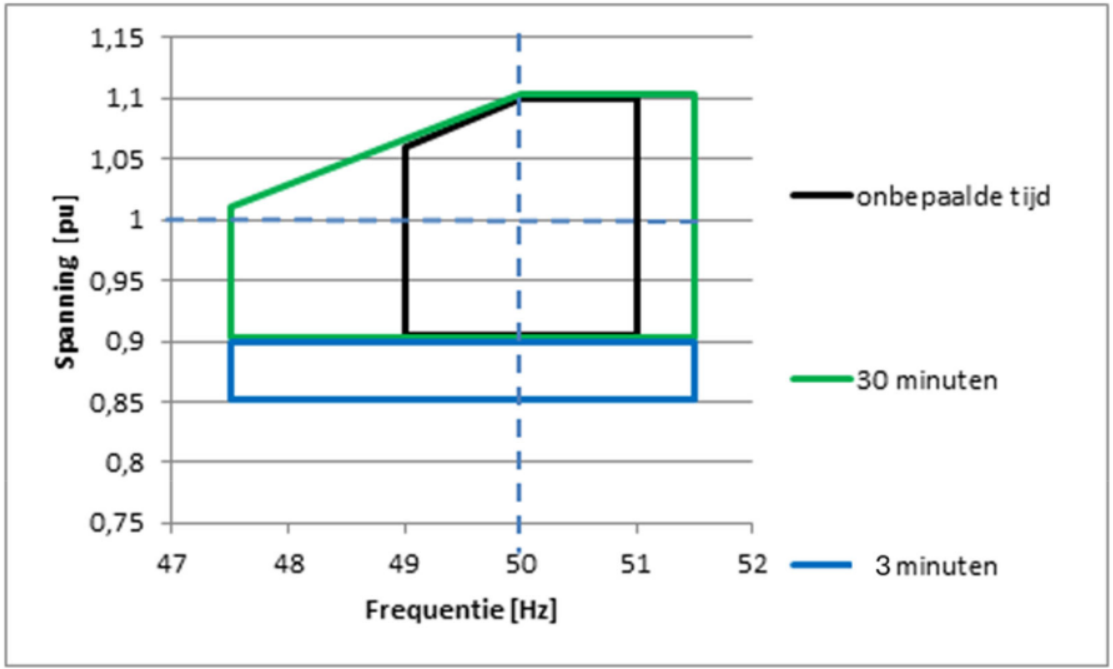
	Type A	Type B	Type C	Type D
Vermogen (Entsoe, art.5)	Van 0.8kW Tot 1 MW	> 1MW	> 50 MW	> 75 MW Of > 110kV
Vermogen Netcode NL art. 3.1	Tot 1 MW	> 1MW	> 50 MW	> 60 MW Of > 110kV
Vermogen (Netbeheer NL) ESM Figuur 1.1	Van 0.8kW tot 1 MW	Tot 50 MW	Tot 60 MW	Alles boven 60 MW

Eisen aan categorie van aansluiting

- https://www.netbeheernederland.nl/requirements-generators
- Type A : volgens “Lijst van omvormers RfG type A”, publicatie van Netbeheer Nederland (thuisbatterijen of PV aanmelden op www.energieleveren.nl)
- Type B : statement of compliance ESMD /PGMD of volgens “Lijst van omvormers RfG type B”, publicatie van Netbeheer Nederland
- Type C : statement of compliance ESMD / PGDM, invulformulier van Netbeheer Nederland
- Type D : statement of compliance EON, ION, FON (documentatie, simulatie en testen) Volgens figure 1.2 ESM notification procedure / figure 3.3 RfG notification procedure van Netbeheer Nederland

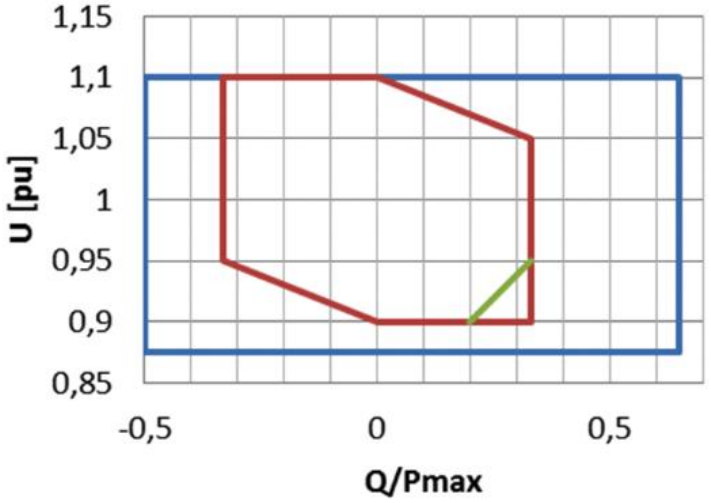
Frequentie en Spanning (type B, C en D)

- Netcode artikel 3.15 lid 10

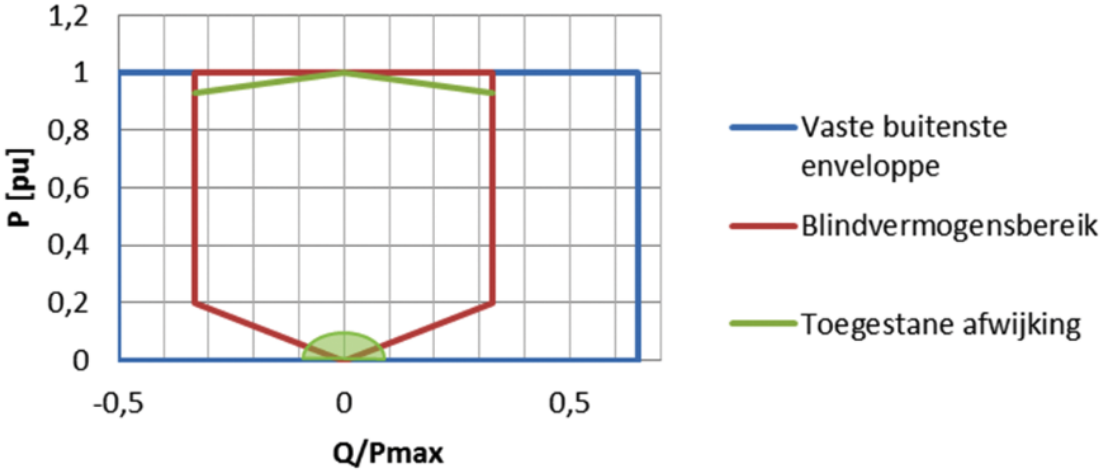


Blindvermogen, leveren en opnemen, U-Q/Pmax profiel

Artikel 3.19 lid 4 Type B
Artikel 3.26 lid 1 Type C
Artikel 3.26 lid 1 Type D < 300kV

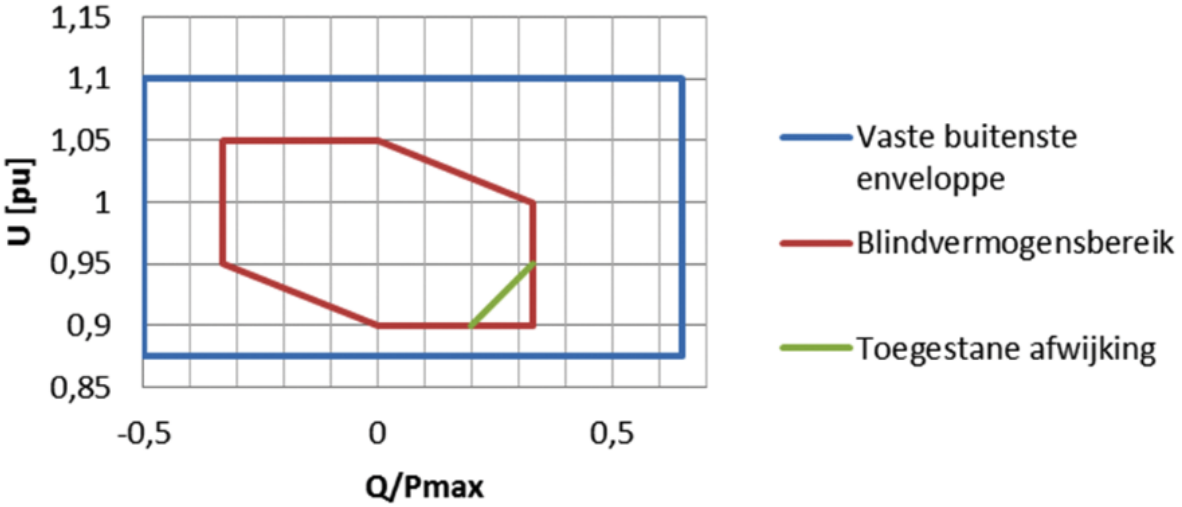


Artikel 3.19 lid 9 Type B
Artikel 3.26 lid 2 Type C
Artikel 3.26 lid 2 Type D < 300kV



Blindvermogen, leveren en opnemen, U-Q/Pmax profiel

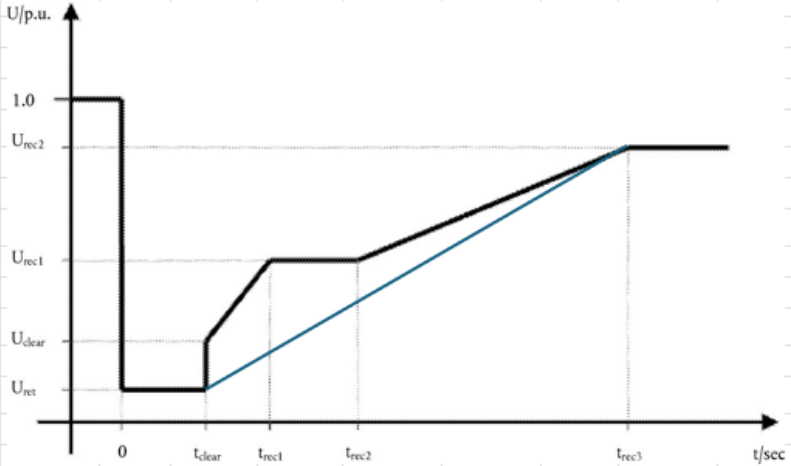
Artikel 3.30 lid 4 Type D ≥ 300kV



Fault-ride-through (Power Park Modules)

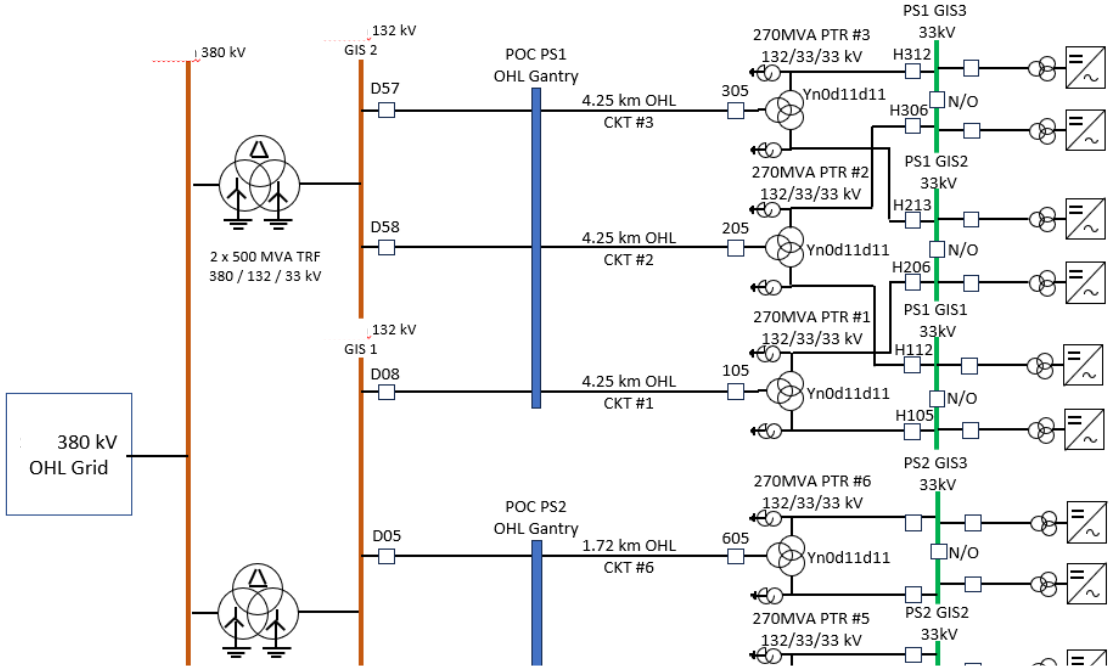
- Artikel 3.17 lid 3, Type B en C, Artikel 3.28 lid 3 Type D

0.85	0.85	U_{rec2}						
$=U_{clear}$	$=U_{clear}$	U_{rec1}						
$=U_{ret}$	$=U_{ret}$	U_{clear}						
0	0.05	U_{ret}						
p.u.	p.u.			t_{clear}	t_{rec1}	t_{rec2}		t_{rec3}
	Type B, C		s	0.2	$=t_{clear}$	$=t_{rec1}$		2.0
Type D			s	0.25	$=t_{clear}$	$=t_{rec1}$		3.0

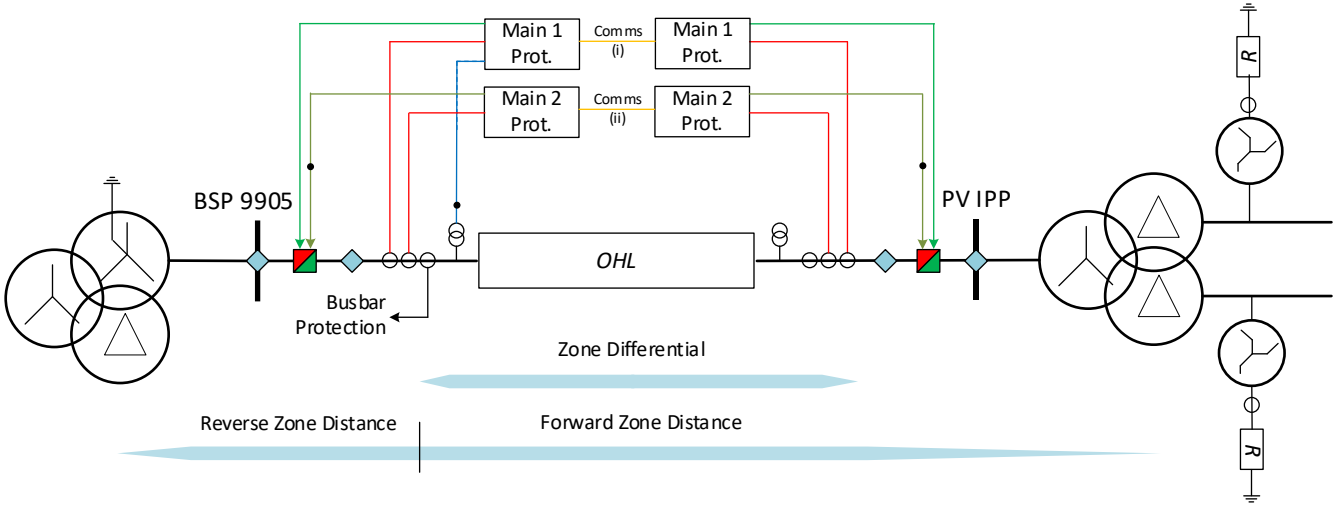


0 = begin van de fout
Clear = eind van de fout
Rec = recovery

Single line 1.4 GW Zonnepark



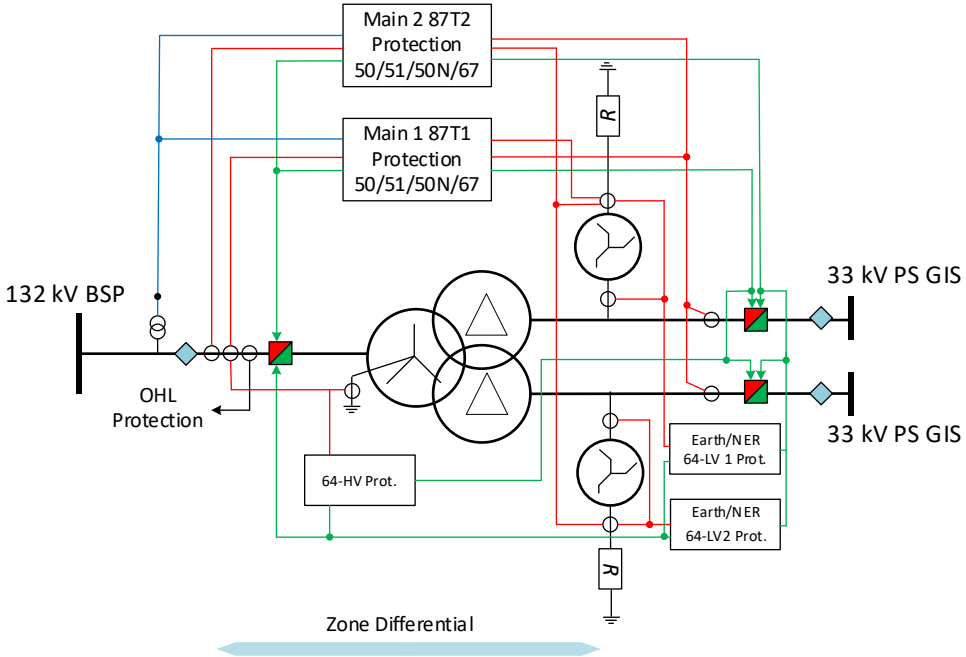
Beveiligingsconcept 132kV verbinding



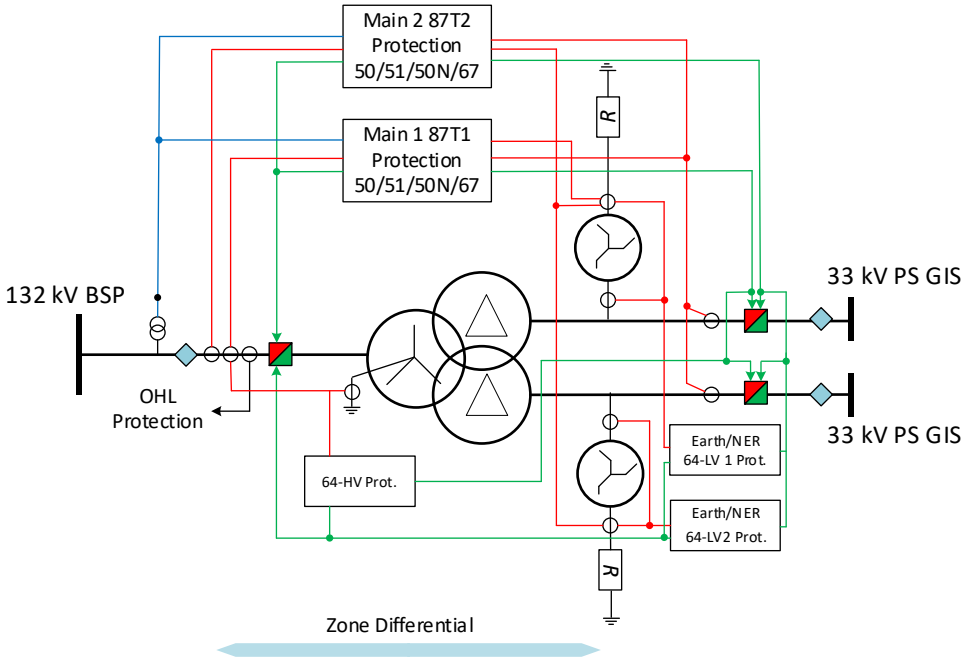
Main 1
Differential (87L)

Main 2 •
Differential protection (87L) + Distance (21)
Overcurrent protection

Protection concept 132/33/33 kV transformer

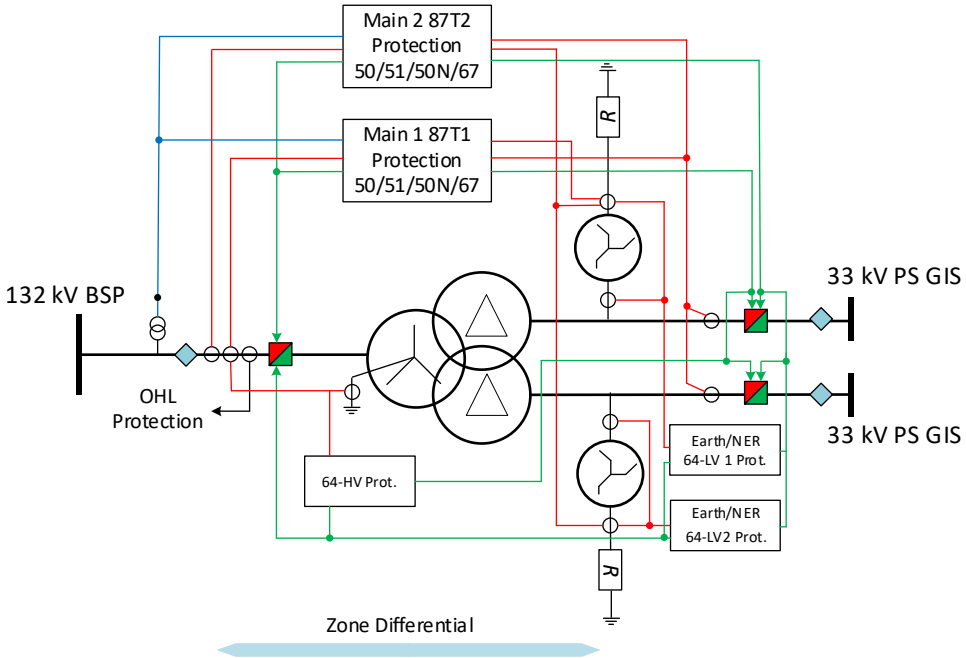


Protection concept 132/33/33 kV transformer



Main 1
Differential (87T)

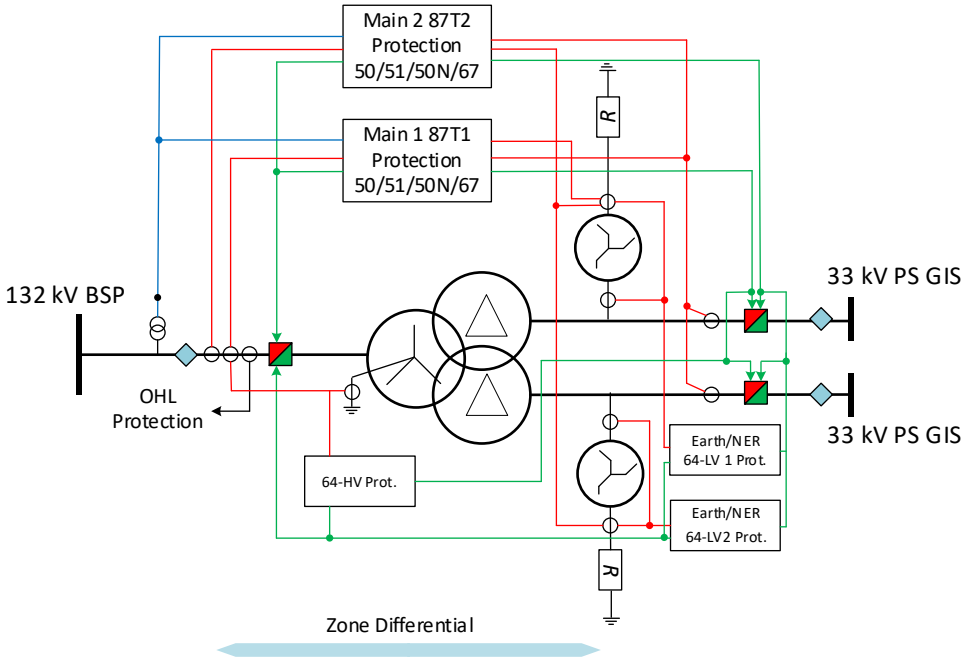
Protection concept 132/33/33 kV transformer



Main 1
Differential (87T)

Main 2 •
Differential protection (87T)
Overcurrent protection (50,50N, 51)

Protection concept 132/33/33 kV transformer



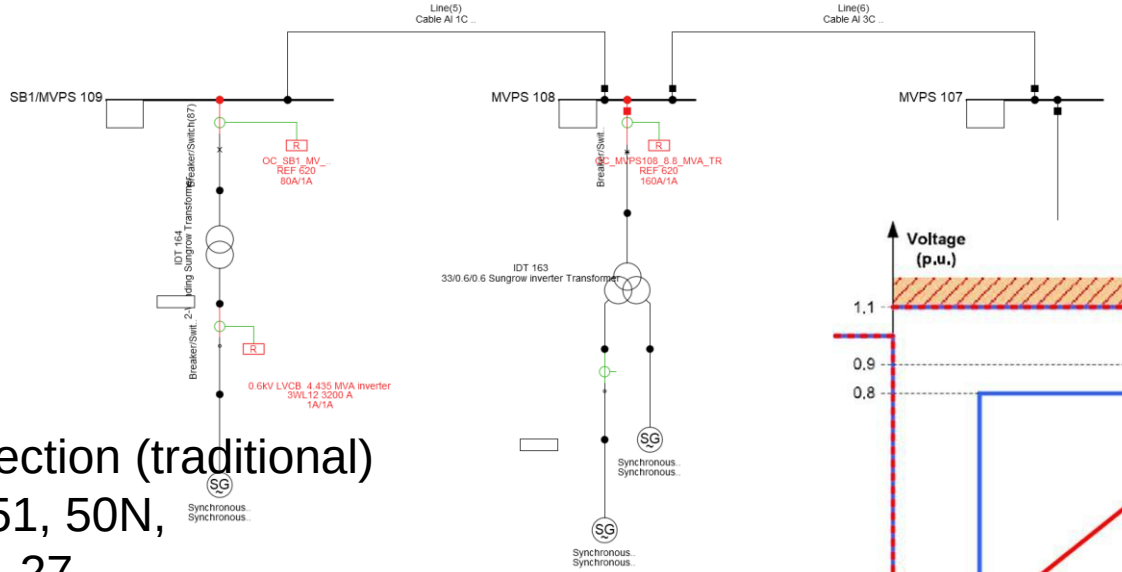
Main 1
Differential (87T)

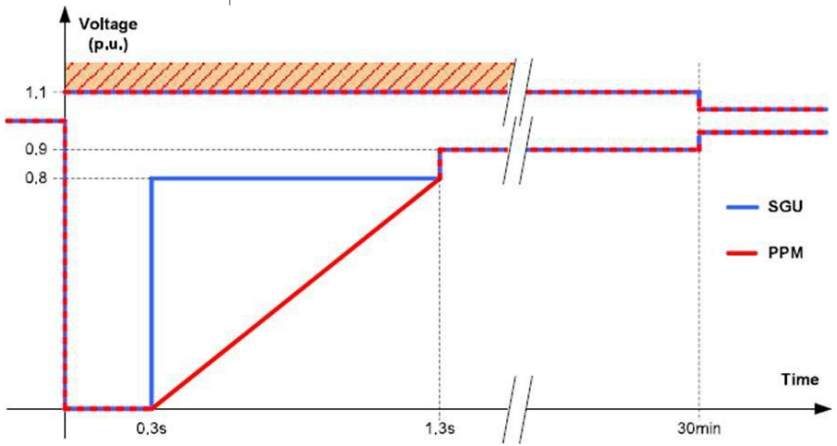
Main 2 •
Differential protection (87T)
Overcurrent protection (50,50N, 51)

Restricted Earth Fault protection (REF)
High impedance:
64 HV, HV side of the transformer, overcurrent protection (I50NS: Hi Z REF)
64 LV1/ 64 LV2, Both 33 kV MV sides of the transformer, overcurrent protection (I50NS>Hi Z REF)

Low Impedance :67REF

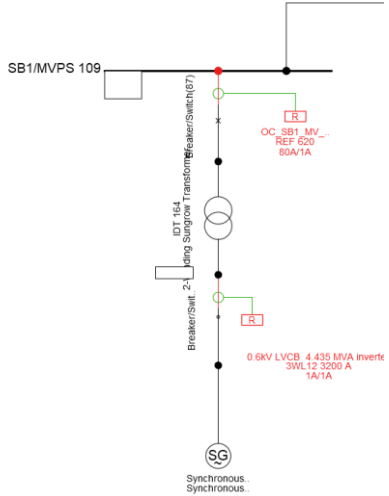
Protection concept 33/0.4 kV inverter transformer





Protection (traditional)
50, 51, 50N,
51N, 27

Protection concept 33/0.4 kV inverter transformer



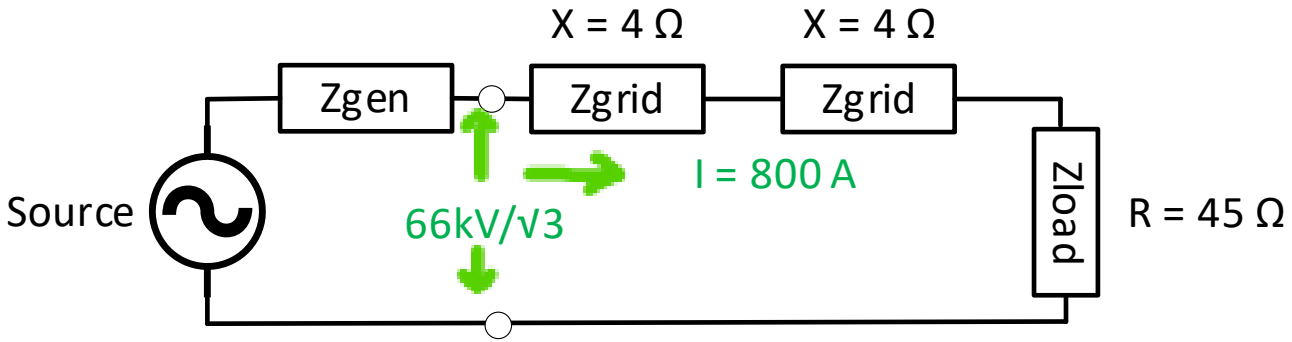
Challenge connection renewables

- Short-Circuit (SC) contribution depends on connected panels/turbines
  Min SC=0; Max SC=1.1xInom
- No zero-sequence (issues earth faults)
- Low Voltage level during SC

Protection concept 33/0.4 kV inverter transformer

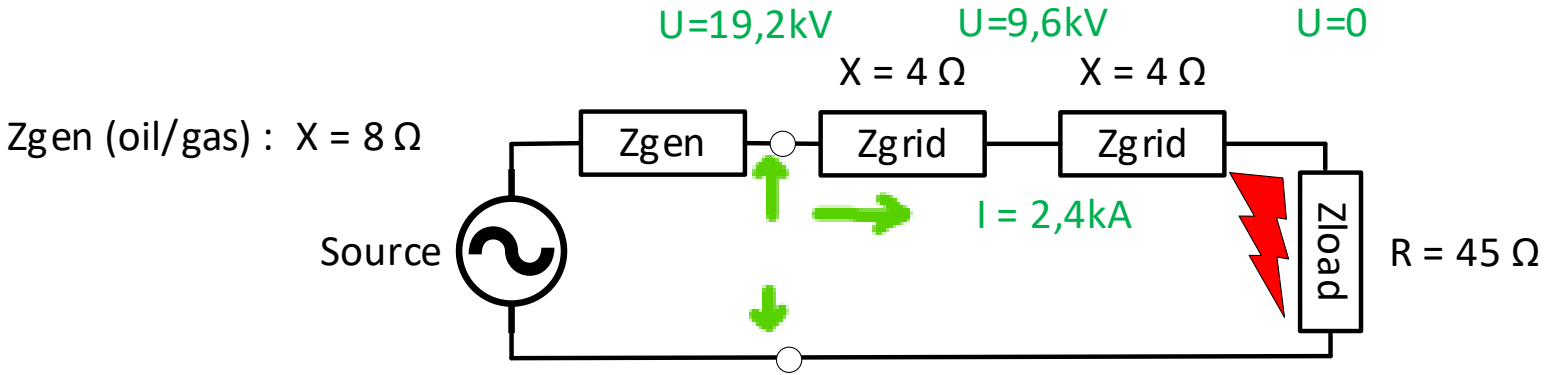
Low Voltage level

Loadflow situation



Protection concept 33/0.4 kV inverter transformer

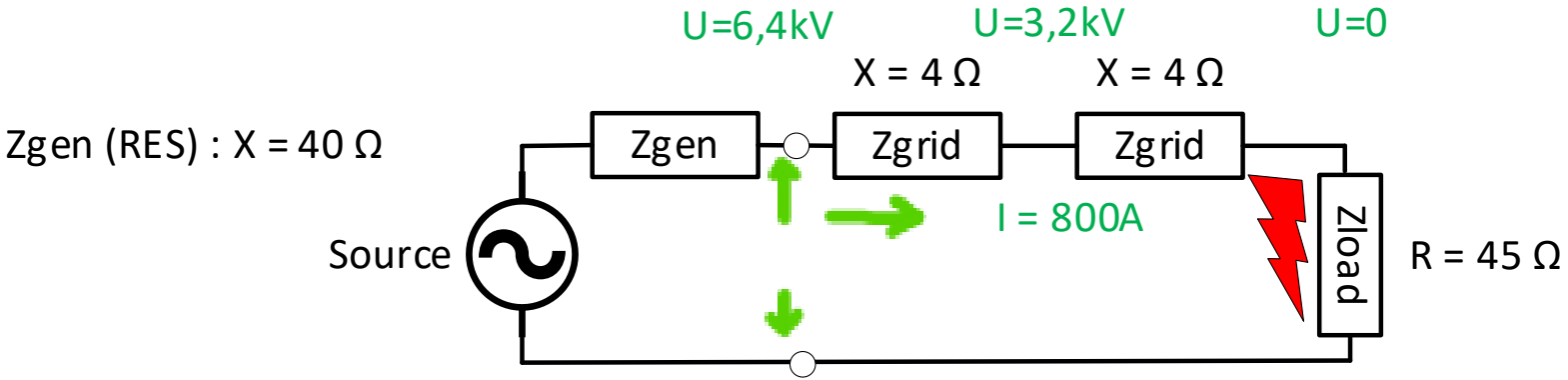
Low Voltage level during SC



Fault-ride-trough support at 30% Un = 11,43kV

Protection concept 33/0.4 kV inverter transformer

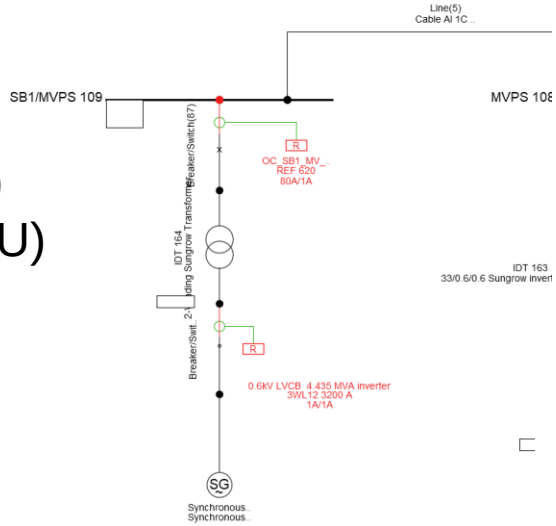
Low Voltage level during SC

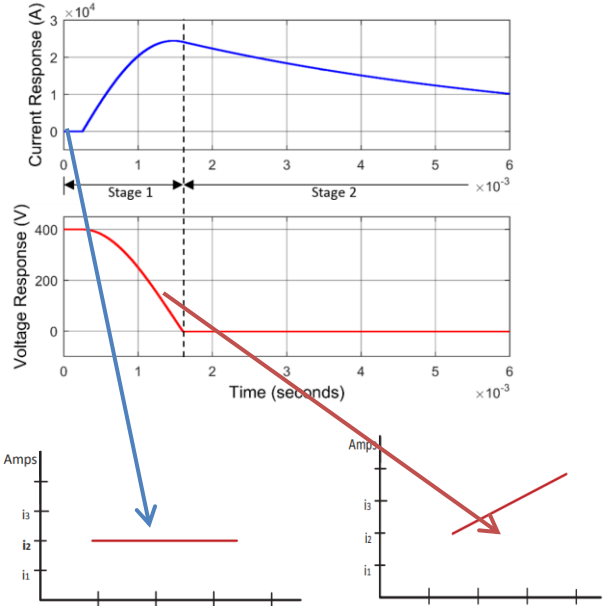


Fault -ride through support at 5% Un = 1,9kV

New protection concept 33/0.4 kV inverter transformer

Protection
- Differential
- dI/dt (ROCOI)
- dU/dt (ROCOU)
- PMU





Pre-fault condition

Post-fault condition

BEDANKT VOOR UW AANDACHT

cigre Nederland


cigre
Nederland


cigre
Nederland

cigre
Nederland