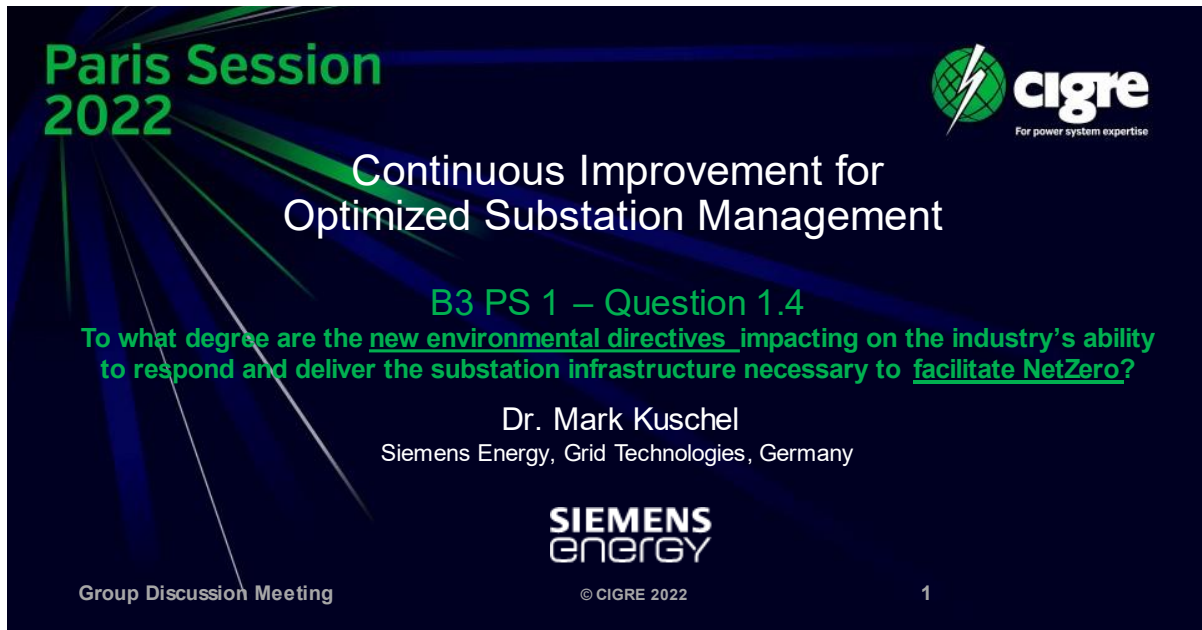
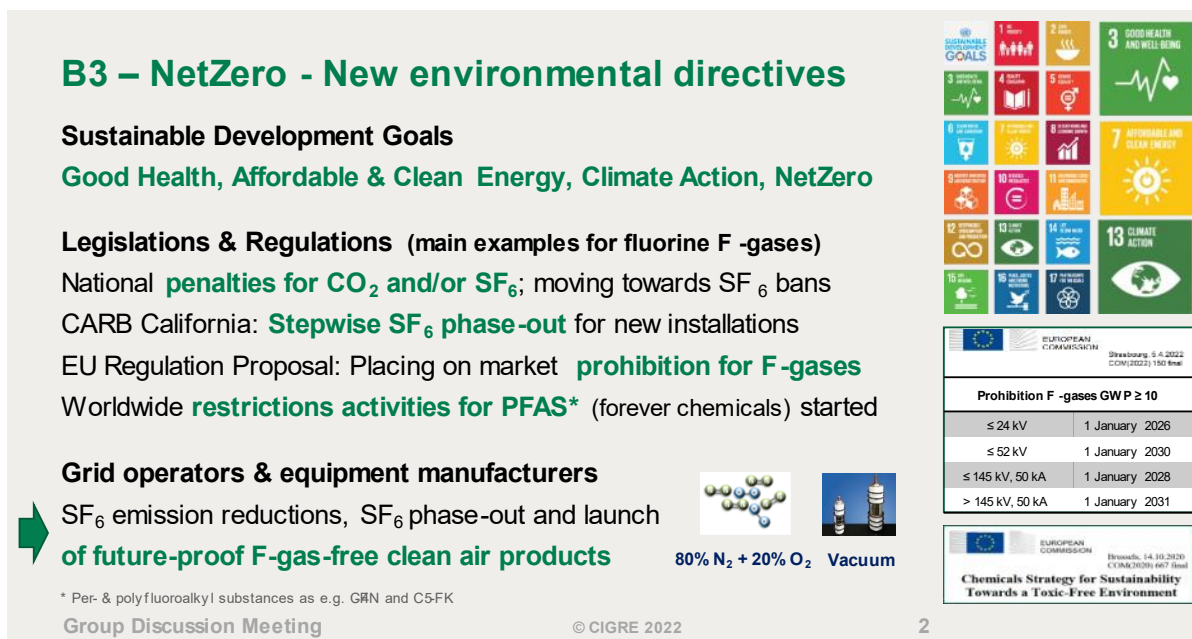


The short contribution is dedicated to Question 4 of PS 1 and addresses the path for sustainable Net Zero substation infrastructure, slide 1:




Slide 2 gives an overview about the current main environmental directives related to fluorine (F-) insulation gases.



**B3 – NetZero - New environmental directives**

**Sustainable Development Goals**  
 Good Health, Affordable & Clean Energy, Climate Action, NetZero

**Legislations & Regulations (main examples for fluorine F-gases)**  
 National **penalties for CO<sub>2</sub> and/or SF<sub>6</sub>**; moving towards SF<sub>6</sub> bans  
 CARB California: **Stepwise SF<sub>6</sub> phase-out** for new installations  
 EU Regulation Proposal: Placing on market **prohibition for F-gases**  
 Worldwide **restrictions activities for PFAS\*** (forever chemicals) started

**Grid operators & equipment manufacturers**  
 SF<sub>6</sub> emission reductions, SF<sub>6</sub> phase-out and launch  
 of **future-proof F-gas-free clean air products** 

\* Per- & polyfluoroalkyl substances as e.g. PFN and C5FK

Prohibition F-gases GWP ≥ 10	
≤ 24 kV	1 January 2026
≤ 52 kV	1 January 2030
≤ 145 kV, 50 kA	1 January 2028
> 145 kV, 50 kA	1 January 2031

**Chemicals Strategy for Sustainability Towards a Toxic-Free Environment**

Slide 3 shows the status of introduction of zero CO<sub>2</sub> emission T&D equipment, which can be only achieved with new equipment without any SF<sub>6</sub> and with products using insulation gases based on clean air and vacuum interrupter switching technology with GWP = 0. More details can be found in e.g. [1, 2, 3, 4]

## B3 – NetZero - Introduction of F-/PFAS-gas-free products

- > Installations with GWP\* = 0 are growing rapidly worldwide
- > More than 900 units successful in operation up to 420 kV
- > More than 2500 units contracted, ~ 2.500.000 tons CO<sub>2</sub> -eq saved
- > Zero GHG\*\* emissions in grids possible (Scope1 Grid Operator)



## References:

- [1] D. Helbig et al, Transition to Climate Neutral, Safe and Sustainable Power Grids – Benefits for Society, Grid Operators and Manufacturers, Cigre Session C3, Paris 2022
- [2] Tobias Goebels et al, Investigation of the Switching Behaviour, Voltage Distribution and Post-Arc Current of series-connected Vacuum Interrupter Units for Live Tank and Dead Tank Circuit Breakers ≥ 420 kV, CIGRE A3 Session, 2022
- [3] P. Gronbach et al, Experience with F-gas-free High voltage equipment for On- and Offshore applications, CIGRE A3 Session, 2022
- [4] M. Kuschel et al, First F-gas-free and climate-neutral insulated 420 kV GIS busducts installation at TransnetBW, CIGRE B3 Session, 2022