

## Transition to Climate Neutral, Safe and Sustainable Power Grids

C3 PS 1 – Q1.16

What are the development pathways to adopt SF<sub>6</sub>-free equipment?  
What R&D and pre-normative activities are deemed important in view of the deployment of such technologies?

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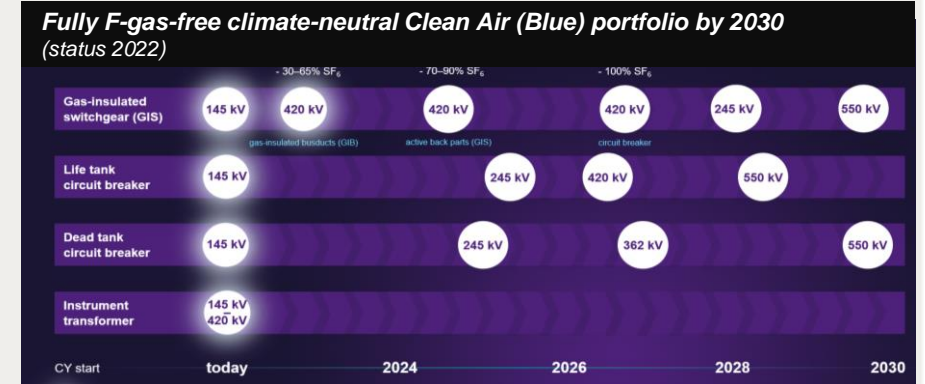
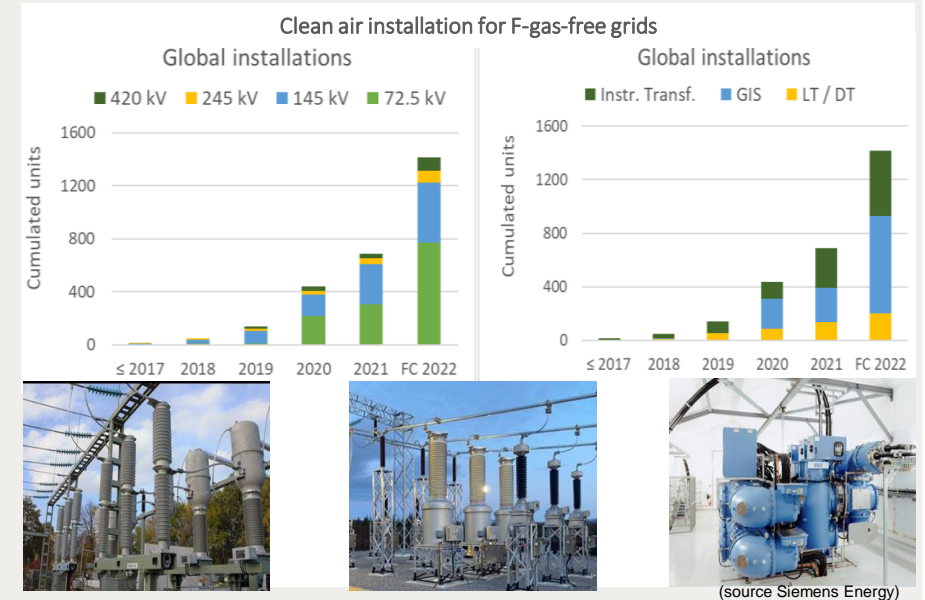
**SIEMENS**  
ENERGY

# C3 PS1 -Q1.16. Development pathways to adopt SF<sub>6</sub>-free equipment

- The number of SF<sub>6</sub> free installations worldwide is growing rapidly.
- Today, a full SF<sub>6</sub>-free and F-gas-free (*Clean Air*) portfolio up to 145 kV and Instrument Transformers up to 420 kV is available and in operation.

- According to the Clean Air roadmap, the full F-gas free portfolio (GWP=0) will be available
  - up to 420 kV in 2027
  - up to 550 kV in 2030
 which is in line with GHG-regulations in California and proposed EU F-gas regulation with GWP < 10.

Group Discussion Meeting



# C3 PS1 - Q1.16. Important R&D and pre-normative activities

## Manufacturers:

Focus on SF<sub>6</sub>-free product development to realize all voltage levels in the transition time jointly developed with grid operators

## Grid operators:

- Sustainable specifications beyond technology and price including HSE, Operation, Maintenance and Total cost of ownership.
- Early installation of SF<sub>6</sub> free substations to gain experience for a smooth transition to GWP = 0.

## Society, Countries and Regulators:

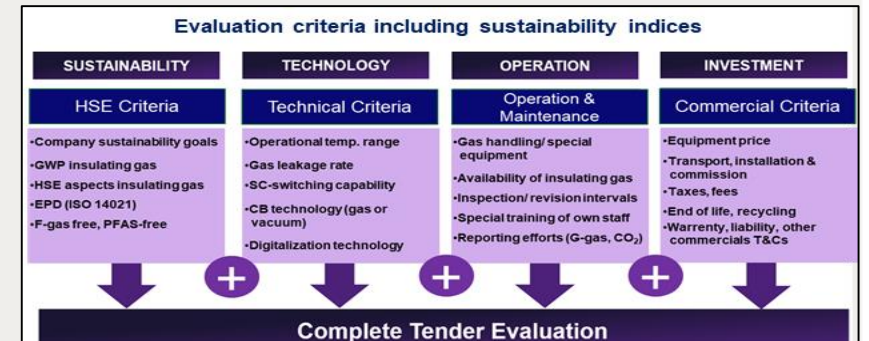
Innovative regulations, like the Californian GHG-regulations or the European F-gas regulation to phase out SF<sub>6</sub>, will accelerate the transition for SF<sub>6</sub> to GHG- and F-gas-free grids to achieve climate neutral economies.

Group Discussion Meeting

Position Paper: Transition Times from SF<sub>6</sub> to alternative technologies for HV and EHV applications; ENTSO-E and T&D Europe, October 2021

Transition times needed before the POM <sup>5</sup> prohibition for SF <sub>6</sub> equipment			
From the entry into force of the F-Gas Regulation (presumably from 01.01.2023)			
Voltage and application classes	Manufacturer time	User time	Transition time (synergy potential taken into account, if applicable)
<b>Standard applications</b> 52 < U <sub>m</sub> ≤ 72.5 kV	Available from various manufacturers, international operating experience available	5 years	5 years
<b>Standard applications</b> 72.5 < U <sub>m</sub> ≤ 145 kV		6 years	6 years
<b>Standard applications</b> 145 < U <sub>m</sub> ≤ 420 kV*	3 years Especially devices with circuit breaker function require longer development times	8 years Synergy potential of 2 years**	9 years
<b>Special and limit value applications</b> 52 < U <sub>m</sub> ≤ 420 kV	2 years Especially devices with circuit breaker function require longer development times	Open	Limit applications should be considered in a later, renewed review of the F-Gas Regulation

<sup>5</sup> Placing On Market  
SF<sub>6</sub> will also be needed beyond 2050 for the maintenance, repair, and extension of existing equipment.



California regulation for reducing GHG emissions from Gas-Insulated Equipment - Phase-Out dates for SF<sub>6</sub> GIE with Voltage Capacity >38kV

Voltage Capacity (kV)	Short-Circuit Current Rating (kA)	Phase-Out Date
38 < kV ≤ 145	< 63	January 1, 2025
	≥ 63	January 1, 2028
145 < kV ≤ 245	< 63	January 1, 2027
	≥ 63	January 1, 2031
> 245	All	January 1, 2033