

SF6 phase out and the grid

TSO perspective: TSO 50Hertz as part of the Elia group

July 2023 | Frank Richter Offshore

Introduction

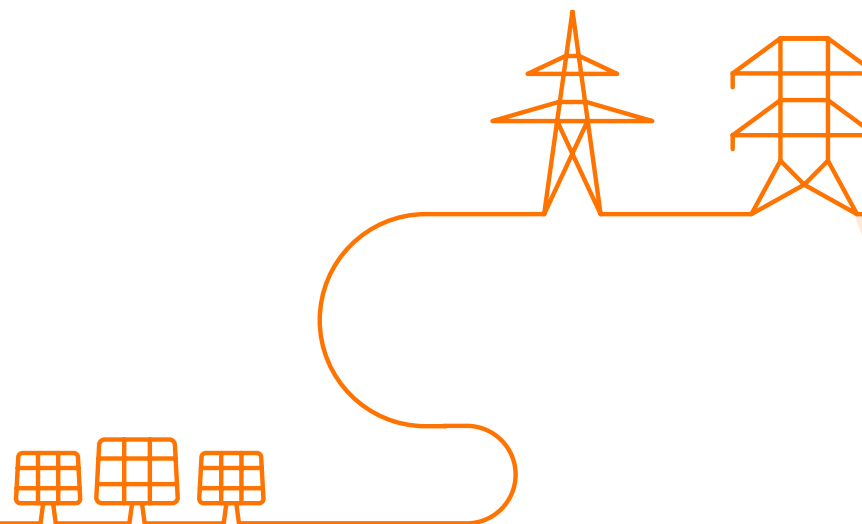


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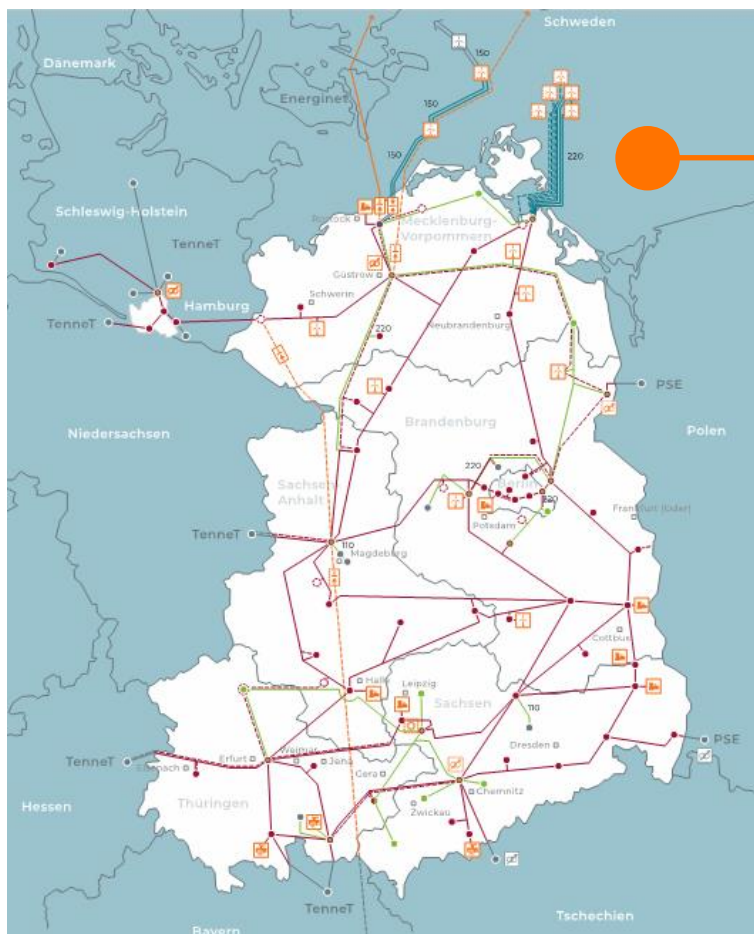
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- **Electrical engineer**
- **Employed as an Asset Manger Offshore**
- **Member of CIGRE,**
- **Member of different standardization bodies national and international**



50Hertz at a glance

in Q1/2022:
71% RE
in our grid



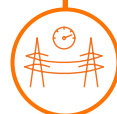
RE share of power consumption

2022

~ 65%

2010

~ 25%



Installed capacity

65,306 MW

38,354 MW

of which wind power
of which solar power

21,507 MW

11,318 MW

18,175 MW

2,418 MW



Power consumption

~ 97 TWh

~ 98 TWh



Revenue

€6.9 billion

€5.6 billion

of which grid turnover

€2.5 billion

€0.6 billion



Employees

1,594

643

Quantity of electricity
transported in 2022

111.8 TWh

Our transmission system

50Hertz offshore circuit lengths in 2022*

220-kV-AC-Kabel undersea cables	290 km
150-kV-AC-Kabel undersea cables	290 km

50Hertz onshore circuit lengths in 2022*

380-kV-AC-overhead lines	7,480 km
220-kV-AC-overhead lines	2,370 km
380-kV-AC-cables	55 km
400-kV-DC-cables	15 km
220-kV-AC-cables	3 km

In 2022, the transmission grid length of 50Hertz was over 10,500 km with ca. 90 substations



50Hertz is the TSO in the north-east of Germany.

Extra high voltage TSO (from 150 to 525 kV)

Facilitating the green energy transition, sustainability is at the core of our strategy.

We want to achieve 100% renewables in our grid by 2032.

We want to reduce SF₆ in new assets by 50% by 2030.

EU's electricity grid: Backbone of the clean energy transition

Facilitation
of the
energy
transition

- Decarbonisation of industry & society
- Electrification of mobility, heating sector,...
- Integration of renewables



Reliable operation,
reinforcement and
development of Europe's
electricity Grid

Role of
system
operators



Facts about SF₆ and electrical assets

Why are F-Gases used in the electricity grid?

- Electricity transmission and distribution system operators (TSOs and DSOs) use SF₆ (sulphur hexafluoride) as an insulation and arc-quenching medium in electrical control- and switchgear.

SF₆ special properties and handling

- Chemically reacts with very few substances
- Global warming potential (GWP) is 24.300
- Used and monitored in closed cycles (leakage < 1%)

Use in switchgear of The Grid

- APPROX. 500.000 SUBSTATIONS (10-380 KV) in Germany alone
- USED IN PLACES WITH LIMITED SPACE AND/OR DIFFICULT ENVIRONMENTS

The grid development and reinforcement projects of the next years require a substantial amount of new assets – therefore, alternatives are needed as swiftly as possible.

Switchgear in a nutshell (High Voltage >52kV)



Circuit breaker
(CB)



Instrument transformers
(IT)



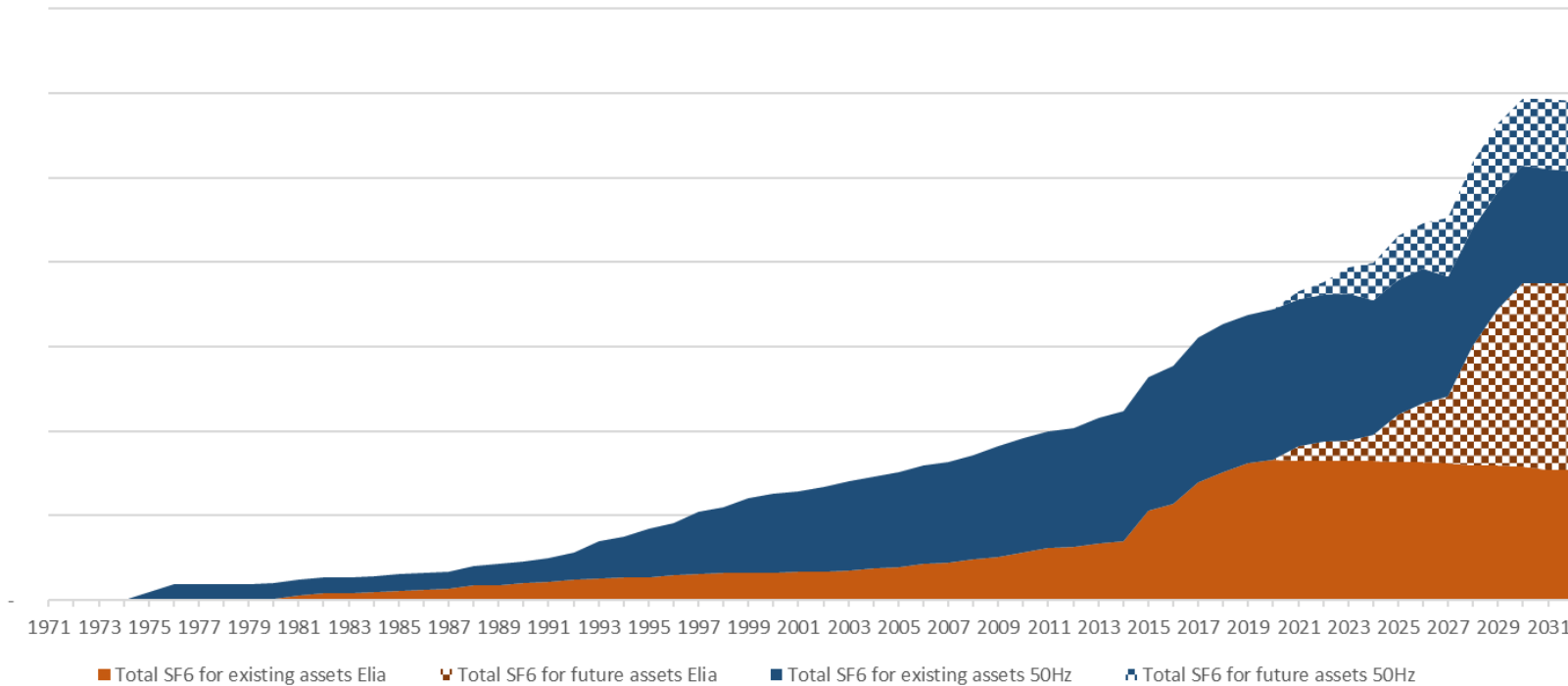
Gas insulated switchgear
(GIS)

	Number* of CB needed by 2030	Total additional SF ₆ volume in kg	Number* of IT needed by 2030	Total additional SF ₆ volume in kg	Number* of GIS-Bays needed by 2030	Total additional SF ₆ volume in kg	Percentage
380kV	570	33,800	1200	72,000	75	120,000	91%
220kV	165	3,800	105	5,250	30	7,750	7%
110kV	250	2,000	400	1,360	25	2,060	2%

*estimated numbers for 50Hertz needs until 2030

Our conflict: Necessary grid expansion with simultaneous SF6 minimization by 2030

If all new equipment is installed with conventional SF6 technology, the amount of SF6 would double by 2030.



Share of SF6-free solutions in new assets

50%
until 2030

- Shifting away from SF6
- Continue to improve SF6 leakage management to remain well below 0.25%

Action plan for SF6 savings

Savings by new assets

- New assets with alternative gasses as many as possible, as soon as possible
- Define GIS & GIB, Instrument transformer and circuit breaker pilot projects
- Require lower leakage rate of new assets

Savings through project design

- Replace planned GIS 380kV substations by AIS solutions (if possible)
- Optimize GIB length
- For existing AIS keep AIS as much as possible until GIS alternatives gasses are available
- Systematic check of the CO₂ impact of different project options

Savings through portfolio management

- Postpone 380kV circuit breaker replacements until alternatives are available
- Postpone full scope EoL replacement projects until GIS with alternative gasses are available

Savings through Maintenance

- Better leakage follow-up on compartment level (via new software tool)
- Gas leakage monitoring for earlier leak detection

First Steps: pilot installations SF6 free Circuit breaker

Vacuum with clean Air in different applications:

30 kV – Reactor switching

POC in construction phase (commissioning planned 08/2023)

Equipped with a system for measuring transient voltages

70 kV – Line switching

In service since 11/2021

Equipped with a fault recorder

110 kV-Transformer switching

POC in construction phase (commissioning planned 2024)

Equipped with a system for measuring transient voltages



First steps: pilot installations SF6 free instrument transformers

Pilots installed in grids with different rated voltages

123 kV – Combined Instrument transformer / Clean Air

POC in operation since 2022

380 kV – Combined Instrument transformer / Clean Air

POC in construction phase

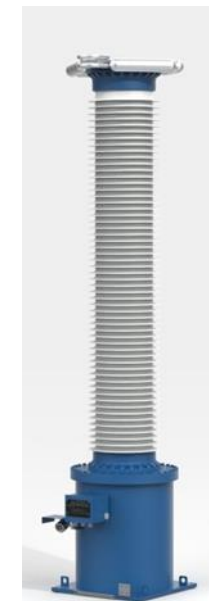
Commissioning planned in 2024

123 kV – Voltage transformer / Clean air

POC in operation since 12/2022)

380 kV - NCIT / Nitrogen

POC in operation since 04/2018



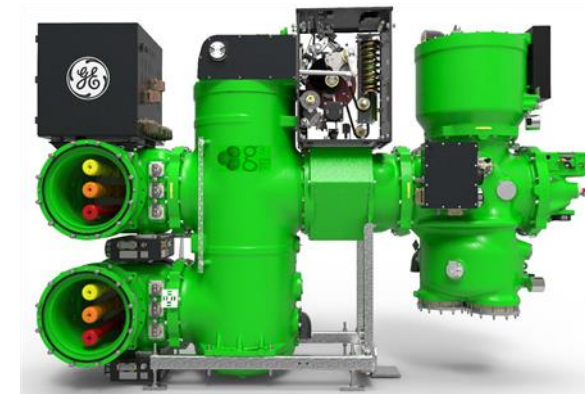
First steps: Pilot installations SF6 free gasinsulated switchgear

Pilots with different solutions installed

123 kV – GIS with C4FN mixture

POC in Operation since 03/2021

Transformer connected via long cable



70 kV – GIS with clean air and vacuum

POC in construction phase

commissioning planned in 2024



Criteria for New assets

- Type tested acc. to IEC and fulfills our technical specifications
- Need for **all new technologies** in the mid term, especially **in order to be able to realize our 2030 SF6 ambition** and that a maximum of niche applications could be covered
- No implementation of an alternative solution with a risk of obsolete technology in the mid term.
Long-term OEM support is needed in order to guarantee the LT security off supply of the network
- sufficient market availability: acceptable/plannable delivery times and delivery in sufficient quantities
- Comparison of the different solutions by TCO (total cost of ownership) analysis
- In the long-term aim is to use equipment with gases of natural origin

Thank you!

