

EC WORKSHOP: HORIZON 2050 POWER SYSTEM AND THE ROLE OF HVDC TECHNOLOGIES IN A HIGHLY DECENTRALISED RES GENERATION - BRUSSELS, 4 FEBRUARY 2020

High-voltage AirPlus™ switchgear for eco-efficiency

ABB Power Grids: Leading the way for a greener grid

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History of SF₆

Why is SF₆ so dominant today ?

High-voltage products

- SF₆ is an excellent gas in terms of dielectric insulation properties and arc quenching capabilities
- SF₆ is an indispensable element for modern high-voltage switchgear technology
- Used for all voltages in transmission application to levels as high as 1,200 kV
- Over 50 years of experience



1968: First 170 kV GIS (SF₆),
Zürich, Switzerland



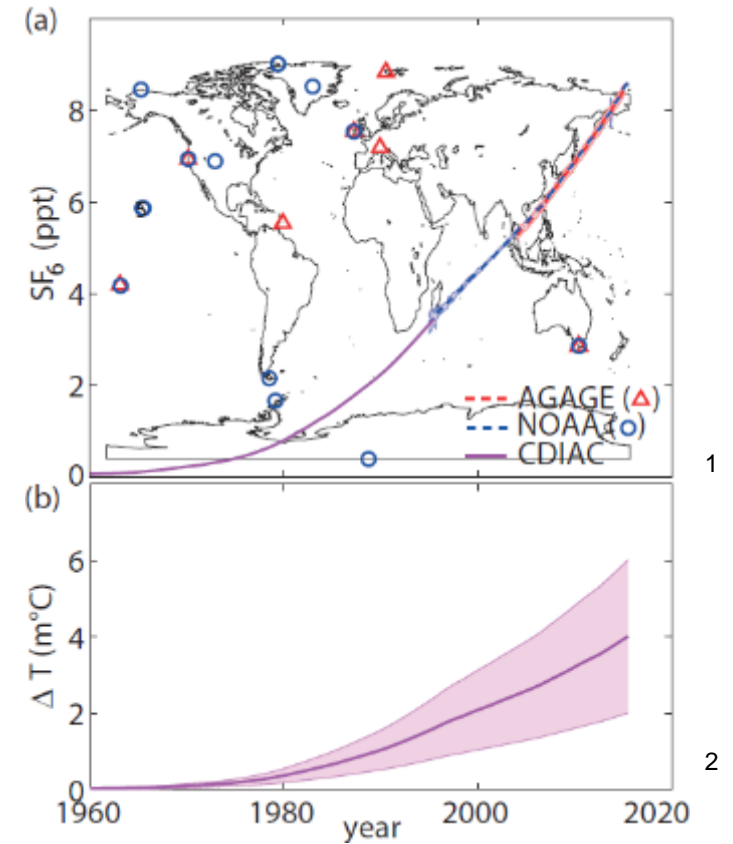
2008: First 1100 kV GIS (SF₆),
Jingmen, China

Drawback - high GWP (23,500 x CO₂)

Global SF₆ emission

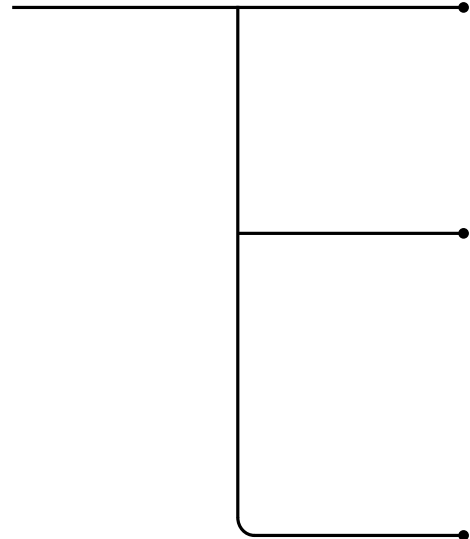
Atmospheric measurements

- Measurements confirm an increase of the SF₆ concentration in the atmosphere
- The current global warming contribution due to SF₆ is 0.004 °C
- The electrical power industry is the largest contributor to the global SF₆ emissions
- ABB has been and continues to reduce the necessary amount of SF₆ in its high-voltage equipment and minimize SF₆ emission



Regulations on greenhouse gas emissions

IPCC target: Limit global climate change to $< 2\text{ }^{\circ}\text{C}$ by 2050



China

Reduce usage and leakage of SF_6



Europe¹

F-gas regulation EU 517/2014
Voluntary agreement of electrical power industry



United States¹

EPA: Title 40, Part 98
CARB: AB 32, 2006, SB 32, 2016
Total emission $< 1\%$ 2020

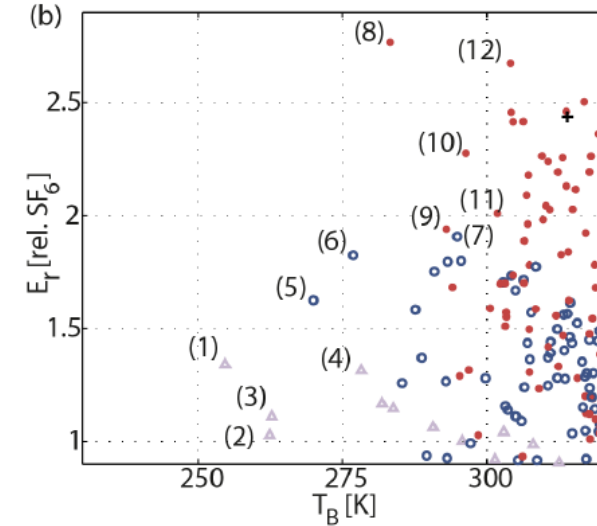
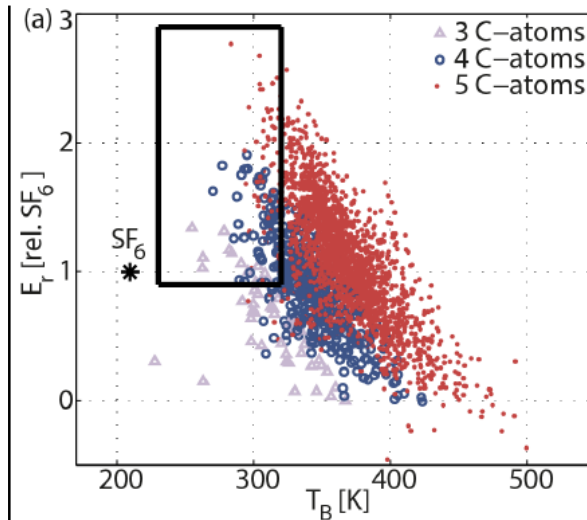


Potential SF₆ alternatives

Selection criteria for an insulation gas

Key requirements

- Very low global warming potential (GWP)
- Zero ozone depletion potential (ODP)
- Low toxicity
- Non-flammability
- Low boiling point
- High dielectric strength
- Arc quenching capabilities
- Stability and material compatibility



Global warming potential

Overview

Global warming is a gradual increase in world temperature caused by gases like carbon dioxide.

The Global warming potential (GWP) is a measure of how much heat a greenhouse gas traps in the atmosphere relative to carbon dioxide, which is standardized to 1.

Two main factors enter the calculation of the GWP:

- Lifetime of the molecule in the atmosphere
- Efficiency at which this molecule can absorb infrared radiation

GWP values IPCC AR5

	Lifetime [years]	GWP
Carbon dioxide: CO ₂	-	1
Technical Air: N ₂ and O ₂	-	0
Fluoroketones: C5-FK mixtures	0.04	<1
Fluoronitriles: C4-FN mixtures	30	400 (pure: 2,100)
SF ₆ / N ₂ (30% / 70%) mixture	3,200	16,200
Sulphur hexafluoride: SF ₆	3,200	23,500

High voltage switchgear AirPlus™

Positioning

- AirPlus™ is ABB's family of eco-efficient gas mixtures as an alternative to SF₆ for high-voltage (HV) products
- ABB's family of eco-efficient gases consists of components of air (O₂, N₂, CO₂) plus C5-Fluoroketones



1960s

For decades

SF₆ gas has been used extensively in switchgear due to its excellent dielectric insulation and current interruption properties. However, it is a greenhouse gas that requires careful handling

ABB achieved breakthrough

in research and development (R&D) with a new eco-efficient gas mixture, AirPlus, an alternative to SF₆

2010

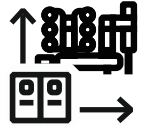


reduction of **Global Warming**
Potential almost 100 %
vs 23,500 of SF₆



Reliability
Based on well-proven
Gas-circuit breaker
technology

Scalability in voltage levels
From HV to Ultra High Voltage (UHV)
in both interruption and
insulation technology



Future proof
to comply with environmental
regulation changes



2015



World's first installation

with HV and MV gas-insulated switchgear with AirPlus at ewz Oerlikon substation in Switzerland

World's first LTB 145 kV AirPlus™ installation

Vattenfall, Sweden

Pilot installation:

- Energized successfully in March 2010
- One high-voltage 145 kV bay
- Application: Capacitor bank switching.
- Tested according IEC standards, the LTB Airplus™ carried out about 100 breaking operations per year
- The pilot breaker performed flawlessly for 7 years until the substation has been decommissioned.



LTB Airplus™

References

LTB / DCB 72.5 kV Airplus™ commercial installations since 2014

Total more than 100 units sold in:

- Sweden
- Norway
- Denmark
- South Africa
- New Zealand
- Australia

Application: Mostly replacements of old breaker



Tranås Energi, Sweden 2015 (4 units DCB LTB 72.5 kV)

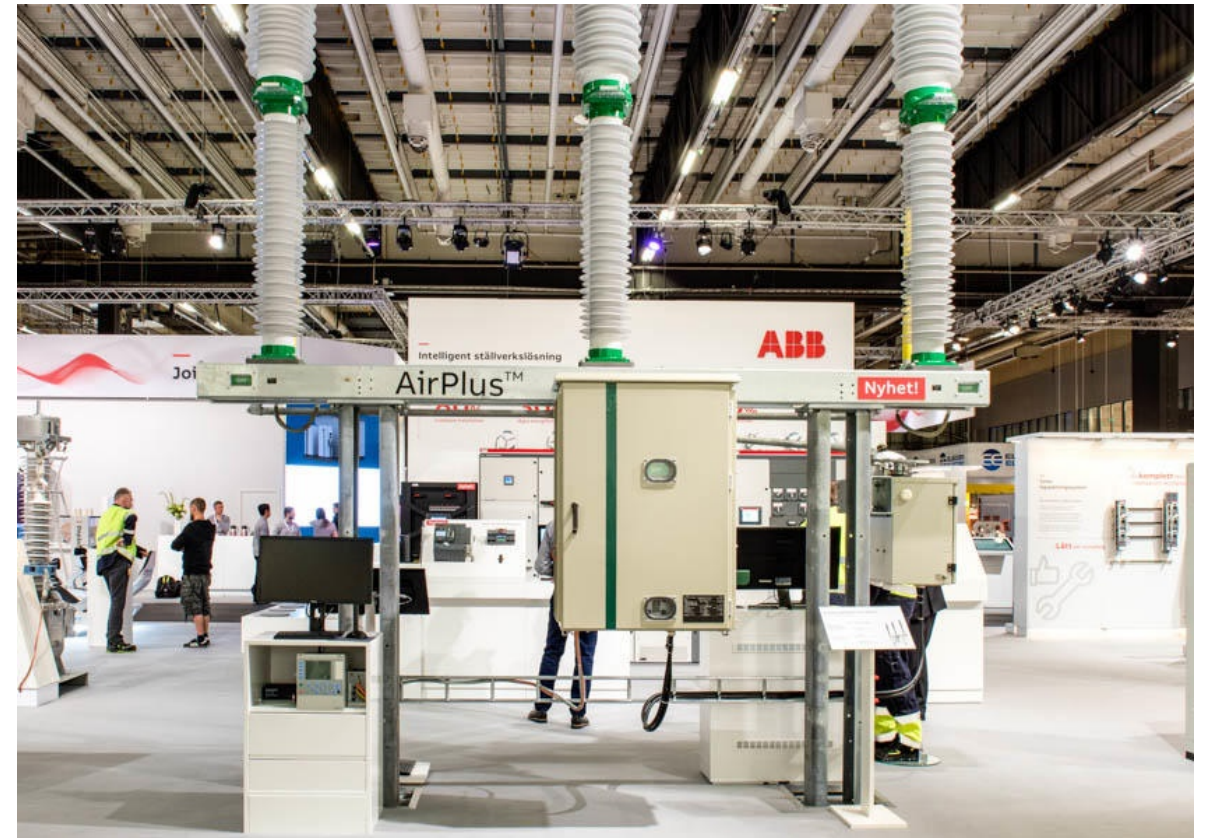
LTB 145 kV Airplus™

Launched 2019 at Hannover Fair (Germany) and Elfack (Gothenburg, Sweden)

Eco-friendly alternative solution to SF₆

Performance data:

- 145 kV rated voltage
 - 40 kA breaking current
 - 3150 kA rated current
 - -50/+40 °C ambient temperature
 - Digital interface
-
- Close to 100 percent GWP reduction compared to conventional breakers
 - Future-proof solution to comply with environmental regulation changes
 - Based on well-proven ABB's high-voltage breaker technology



World's first GIS installation with AirPlus™

World's first GIS installation with AirPlus™

170 kV/24 kV Airplus™ substation energized in August 2015

- 8 high-voltage GIS bays
- 50 medium-voltage GIS bays
- Supplying power to a district in the city of Zurich

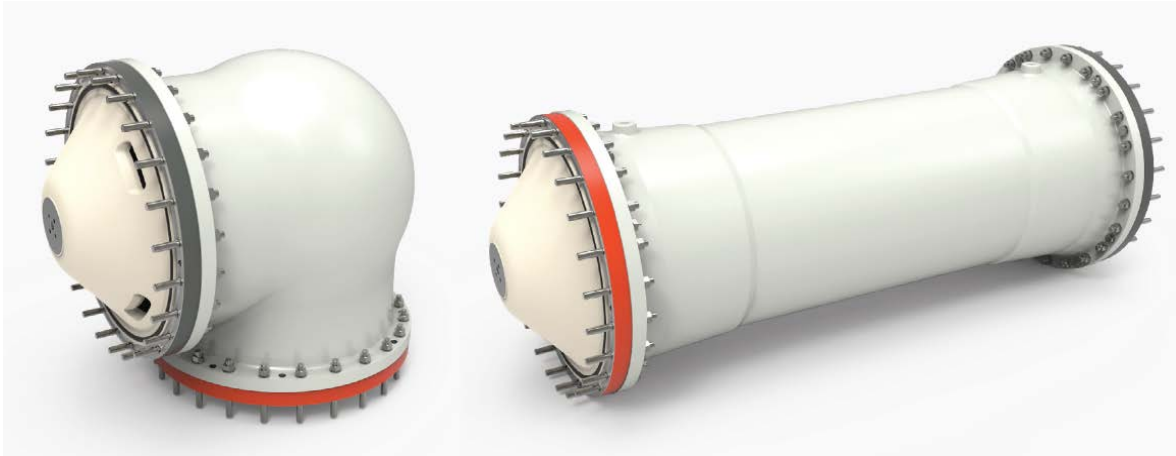


Eco-efficient GIS for 420 kV

Next steps / outlook

420 kV components with AirPlus™

- AirPlus passive connecting components for 420 kV switchgear allow savings of up to 50 percent of the total SF₆ gas volume in a standard 420 kV GIS bay
- Reliable and safe operation under the same ambient temperature range from -25 up to +40 °C as SF₆



First eco-efficient GIS for 420 kV with AirPlus™

- 380-kilovolt substation upgrade with eco-efficient gas-insulated switchgear for German utility TransnetBW¹⁾



ABB