

EconIQ™ high-voltage technology and innovation

Our promise towards a sustainable energy future for all

Michael A. Lane and Dr. Patrick Stoller

EconIQ™ for high-voltage products

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Eco-efficient portfolio for sustainability designed to reduce environmental impact towards a carbon-neutral energy future

01

EconIQ™ portfolio exceptional environmental performance compared to conventional solutions

02

The SF₆-free gas mixtures for high-voltage switchgear is the first big step in the EconIQ™ portfolio

03

EconIQ™ SF₆-free solutions create significant customer value

Creating value for our customers towards a carbon-neutral future



Collaborating with our customers & partners to reduce carbon footprint



Work towards a standard and scalable solution for the industry



Future-proof life cycle investments



Enable more efficient use of energy and resources

EconiQ™ gas circuit-breaker technology

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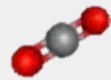
Based on well-proven gas circuit-breaker technology

LTA

For LTB application, we are using CO₂ + O₂ to replace SF₆ in all LTB applications for insulation and switching.



Eco-efficient gas mixture



CO₂
Carbon Dioxide



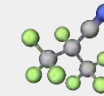
O₂
Oxygen

Metal Enclosed (MEB)

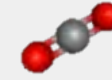
C4-FN is a synthetic gas (3M Novec™ 4710) + CO₂ + O₂ it will be our eco gas to replace SF₆ in all our metal-enclosed switchgear (GIS, DTB, PASS) for insulation and switching.



Eco-efficient gas mixture



C4FN
Fluorinated Nitrile



CO₂
Carbon Dioxide



O₂
Oxygen

The EconiQ gas circuit-breaker remains as compact as the conventional SF₆ solution.

Switchgear with C4-FN gas mixtures

C4-FN

- C4-FN: Fluoronitriles with 4 carbon atoms (C₃F₇CN)
- 3M offers C4-FN under the product name Novec™ 4710



Material Safety Data Sheets (MSDS) for C4-FN and gas mixtures



Safety Data Sheet (SDS) for Novec™ 4710 gas can be found at www.3M.com/sds.

Properties of C4-FN

- Global Warming Potential (GWP) of the gas mixture: 300 (> 99% reduction compared to SF₆ gas)*

Environmental Properties	3M™ Novec™ 4710 Insulating Gas	SF ₆
Atmospheric Lifetime (years)	30	3,200
Global Warming Potential (100-yr ITH, IPCC 2013 method)	2,100	23,500
Ozone Depletion Potential (CFC-11 = 1)	0	0

As the Novec insulating gases are mixed with an inert gas (or gases) the reduction in GHG emissions is significant compared to installations using SF₆.

- Occupational exposure limit TWA (8 hours): 65 ppmv

Familiar materials with a similar Occupational Exposure Limit as 3M™ Novec™ 4710 Insulating Gas

The table below compares the OEL of Novec 4710 gas to other commonly used materials.

Material	Common Use	OEL (8-hour TWA)
Novec 4710 gas	Dielectric insulation gas	65 ppmv
Ammonia	Ingredient in glass cleaners	25 ppmv
Acetic acid	Ingredient in vinegar	10 ppmv
Hydrogen peroxide	Component of disinfectant solutions	1 ppmv

- Non-flammable
- Chemically stable
- Boiling point: -4.7°C (at 1 bar abs.)
- Higher dielectric strength than SF₆

Switchgear with C4-FN gas mixtures

Gas mixture

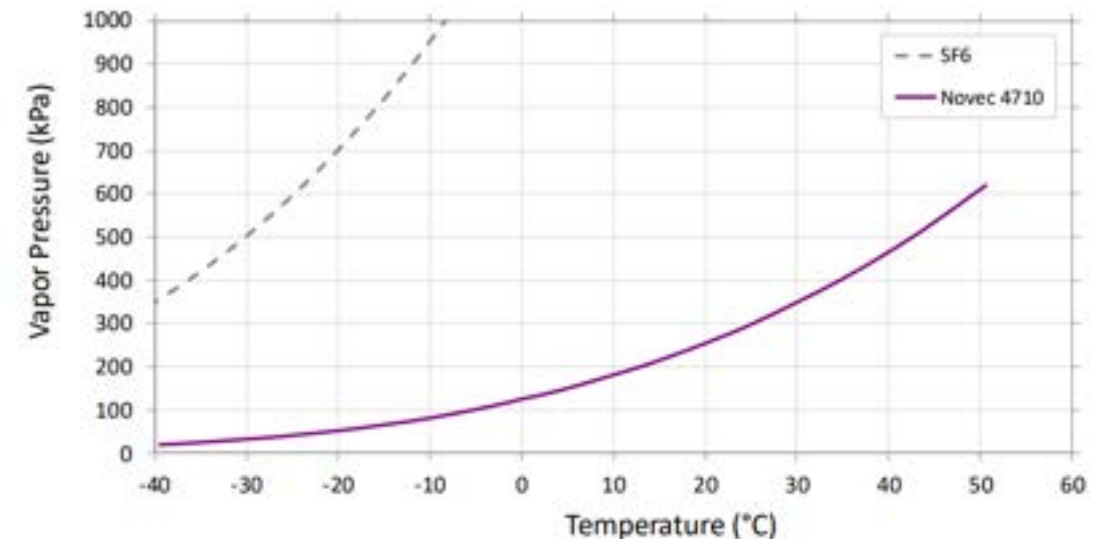
- C4-FN + CO₂ + O₂
- 3.5 mol% + 86.5 mol% + 10 mol%
- The gas mixture is the same for all voltage levels and products (including circuit breakers) and is designed for use of the products down to -30° C.

■ C4-FN

- The boiling point of C4-FN is -4.7°

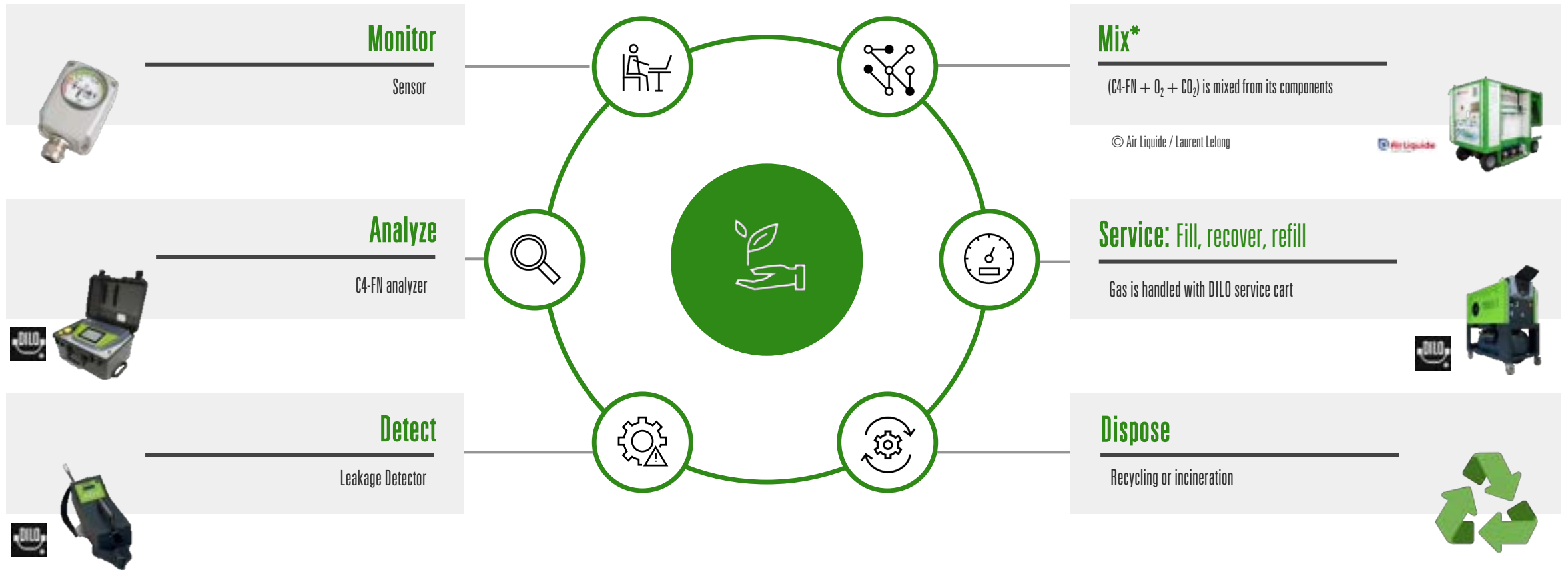
Vapor Pressure of Novec 4710 gas compared to SF₆

Not for specification purposes. All values @ 25°C/77°F unless otherwise specified



The gas mixture is standardized.

Gas handling for EconiQ™ switchgear



Gas handling

Gas connection

- Use of the proven DILO DN20 couplings to ensure safe gas handling.
- To avoid confusion compared to SF₆ thread M48 x 2 (SF₆: M45 x 2).
- Gas mixture information is attached directly to each gas connection as a QR code.
- Information in QR code is unencrypted and can, therefore, also be read with standard smartphones.



Prevents confusion with other gas connections.

Gas handling

Gas quality measurement

- Portable measuring device, e.g. DIL0 Multi-analyser C4-FN
- Measurement parameters
 - Gas composition (C4-FN, O₂)
 - Humidity
 - Carbon monoxide (CO)



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Gas handling

Initial filling by Hitachi Energy

- QR codes for automated, error-free set-up of gas filling equipment
- Evaporation/mixing system known in the chemical industry
- Simple operation when filling in new gas or when topping up
 - Gas mixing process controlled by PLC, touch screen with the usual modern HMI / GUI



© Air Liquide / Laurent Lelong



Gas handling

Gas filling equipment – service work*

- DILO service device C4-FN for gas work during maintenance
- Premixed gas can be obtained from DILO (DILO Certified Gas)
- Recycling of used gas is offered by DILO
- *Initial filling possible according to the same concept



Note: Pre-mixed gas can be used for top-up (temporary burping). No service device is required for this.

Gas handling

Leak detection

- Detection of C4-FN
 - Leak detection with e.g. with DILO LeakSpy C4
 - C4-FN serves as a tracer gas (same procedure is also possible for SF₆ in IEC)
- Other components (CO₂, O₂)
 - CO₂ detection possible, but imprecise due to the high proportion of CO₂ in the air
 - O₂: Rise in ambient air is too small for reliable measurement in the event of a leak



Gas handling

Monitoring sensor

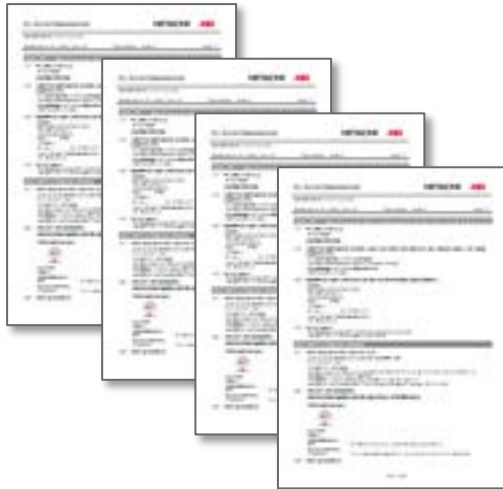
- Hybrid density monitor models proven by SF₆ available in C4-FN version
- Data transmission via Modbus (RS485) interface
- Online evaluation with MSM system
- Density and temperature



Gas handling

Safety data sheets

- Safety data sheets for the gas mixture used are provided by Hitachi Energy
- Country-specific design, according to national specifications and in the respective national language



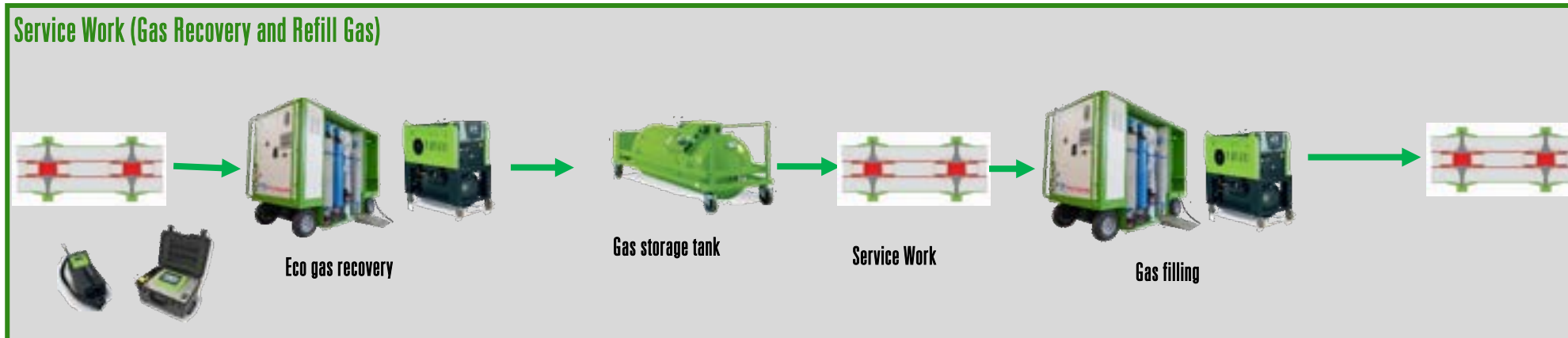
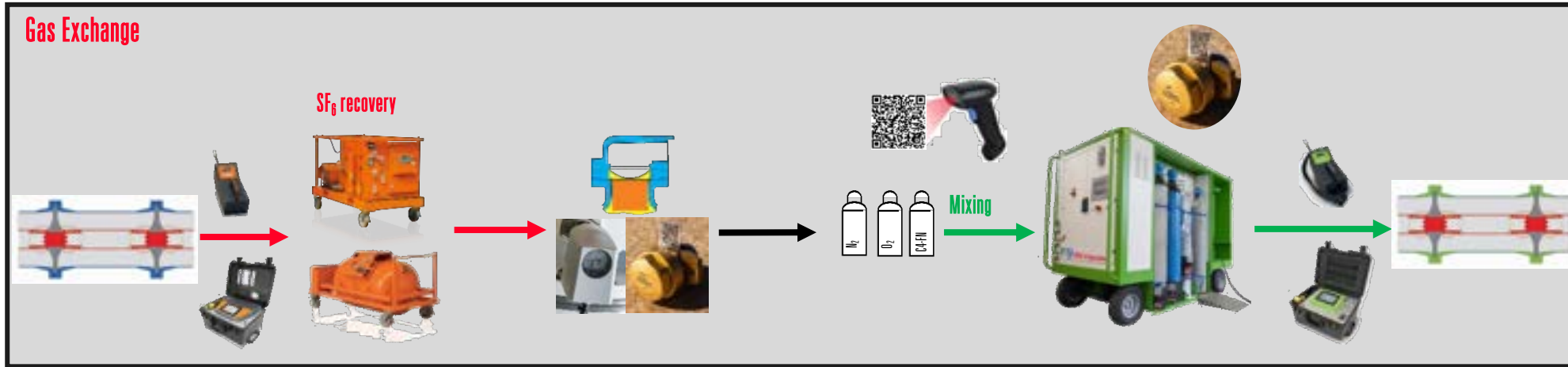
Gas handling instructions

- All gas handling procedures for safe handling of the gas are described in the gas handling instruction.



RetroFill – Concept for replacing SF₆ with eco gas

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Pilot installation: Richborough, National Grid, UK

World's first EconiQ™ RetroFill

- EconiQ™ retrofill for ELK-3 / 420 GIL
- 755 kg (1,661 lbs.) of SF₆ removed
- Replacement with C4-FN gas mixture
- <10% increase in pressure
- Fully type tested for 420 kV rating
- Successful high-voltage test at the first attempt
- Commissioning: December 2, 2021



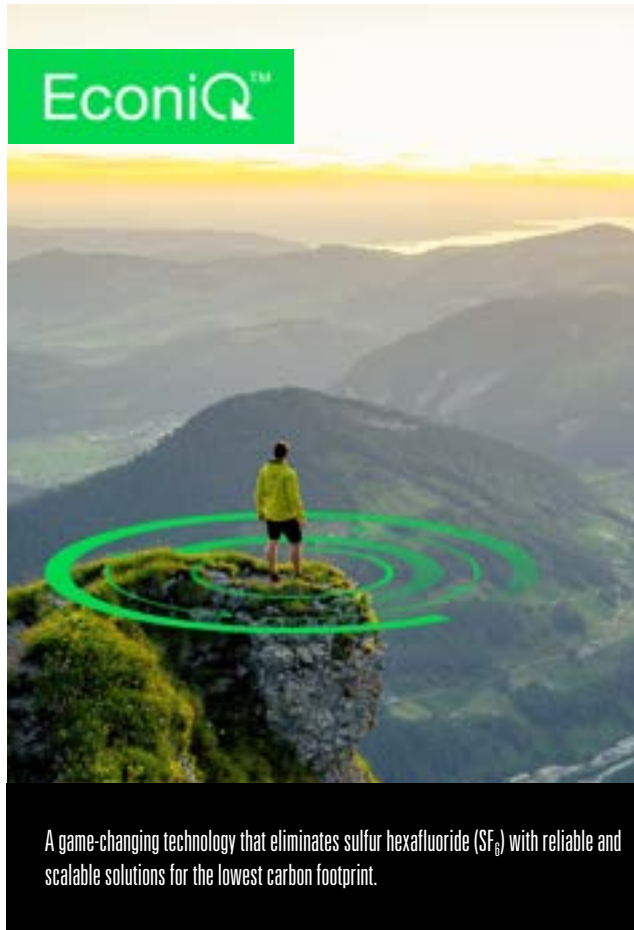
Richborough Substation



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EconIQ™ high-voltage roadmap: Advancing a sustainable energy future for all

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EconIQ high-voltage portfolio	Available now	2022	2023	2024	2025 and beyond
Live tank breaker (LTB)	72.5 kV, 145 kV			420 kV	245 kV
Dead tank breaker (DTB)		420 kV	72.5 kV, 145 kV	550 kV	245 kV
Plug and Switch System hybrid switchgear (PASS)				72.5 kV, 145 kV	245 kV
Gas-insulated switchgear (GIS)	72.5 kV*, 145 kV*	420 kV		550 kV	245 kV
Gas-insulated line (GIL)		420 kV		550 kV, 245 kV	
Retrofit for GIL (Service)				420 kV	

*Compact solution and 60 Hz will be available in 2023 and 2024. This roadmap contains forward-looking information which are based on our current best expectations, estimates and projections. We reserve the right to make changes without prior notice. ABB is a registered trademark of ABB Asea Brown Boveri Ltd. Manufactured by/for a Hitachi Power Grids company.

Key milestone: EconiQ™ 420 kV circuit-breaker

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This 420 kV breakthrough is a demonstration of our technology that is reliable and scalable to reach ultra-high-voltage levels with the lowest carbon footprint.

Markus Heimbach
Managing Director
High Voltage Products



The world's first eco-efficient 420 kV circuit-breaker



Unlocks the widest range of EconiQ switchgear applications



Breakthrough in the industry for SF₆-free solutions for higher voltage levels



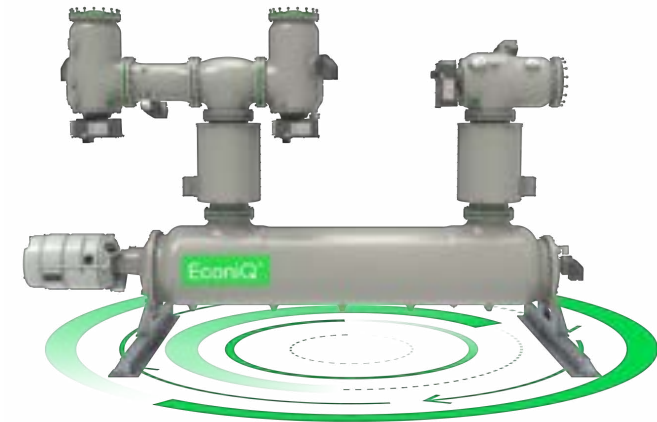
Reliable and scalable technology



Eliminates the carbon footprint of the insulation gas



Accelerates the energy transition toward a carbon-neutral future.



EconIQ™ 420 kV circuit breaker

DTB version in high voltage testing



GIS version at factory routine test facility



The 420 kV circuit-breaker is used in both dead tank breaker (DTB) and gas-insulated switchgear (GIS) 50/60 Hz using a single gas mixture for indoor and outdoor.

Questions?

EconIQ™ high-voltage technology and innovation

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