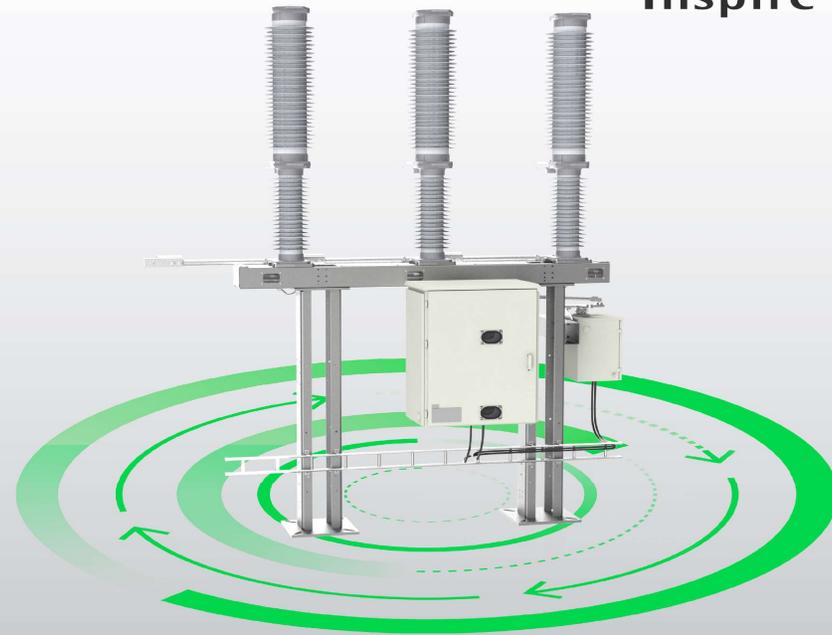


EconIQ™

The Live Tank Breaker LTA is an **eco-efficient, compact, and reliable** solution that eliminates SF₆.



High Voltage Breakers

Eco-efficient EconIQ Live Tank Circuit Breaker - LTA

April/ 2024

EconIQ™ Live Tank Breaker LTA

- Agenda
- EconIQ™ – Our promise towards a carbon-neutral future
- History and the challenges
- Products and roadmap
- Gas handling
- Life Cycle Assessment
- F-gas regulation
- Competitors
- It takes off

EconIQ™

Our promise towards a carbon-neutral future

EconIQ™ in action: Eco-efficient High Voltage Products

EconIQ high-voltage portfolio eliminates SF₆ with reliable and scalable solutions for the lowest carbon footprint

- 1** **Contains no SF₆, essentially eliminating CO₂ equivalent emissions** related to the insulation gas
- 2** **100% as reliable as the conventional solution** while delivering the lowest carbon footprint throughout the total lifecycle
- 3** **An industry standard solution** to enable utilities and industries to break free of SF₆
- 4** **Extensive portfolio of switchgear and breakers** scalable to Ultra High Voltage
- 5** **Future proof** compliant to future environmental regulations
- 6** **Over two decades of R&D** invested in eco-efficient technologies
- 7** **Pioneered the world's first** high voltage SF₆-free GIS and SF₆ replacement in existing high-voltage equipment

EconIQ high-voltage portfolio (today)



Gas Insulated Switchgear (GIS)
145 kV



Live Tank Breaker LTA
72.5 kV



Live Tank Breaker LTA
145 kV



Eco-passive elements for GIS
420 kV



Disconnecting Circuit Breaker (DCB) LTA
72.5 kV



Retrofill for Gas Insulated Lines (Service)

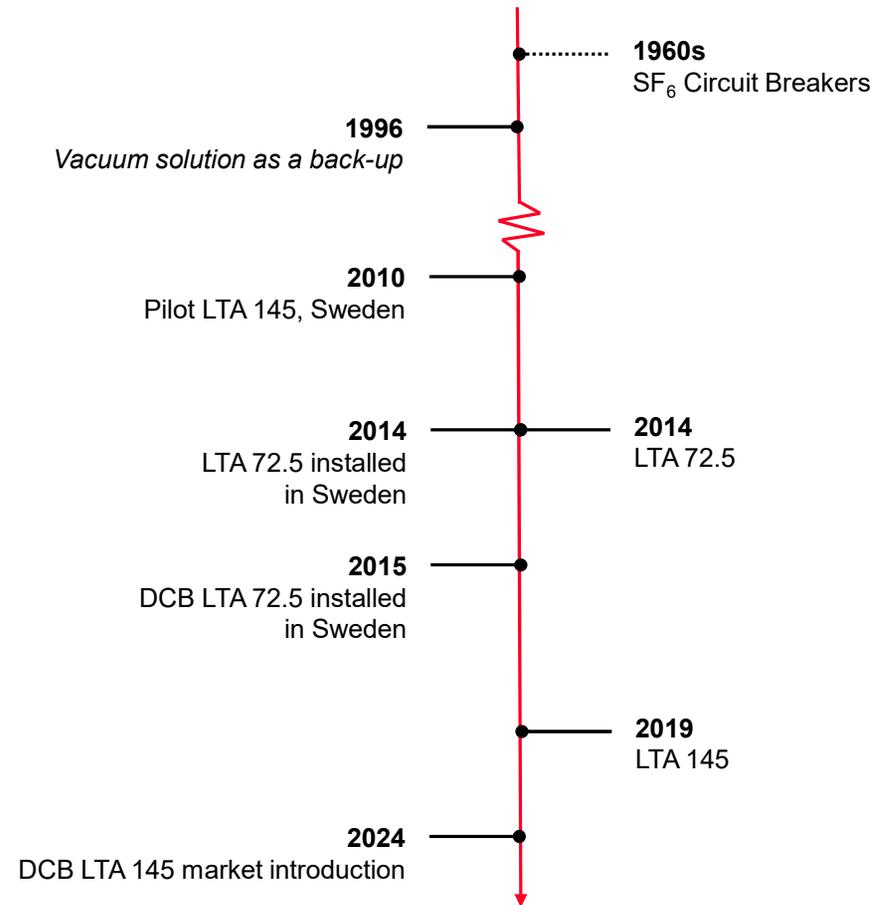
Eco-efficient EconiQ LTB – LTA

History and challenges – from SF₆ to an ECO-solution

EconIQ Live Tank Breaker – LTA

EconIQ LTA product features

- Developed from proven and tested Hitachi Energy's highly efficient SF₆ interrupter technology
- CO₂ and O₂ gas mixture is used instead of the traditional SF₆ gas
- The eco-efficient solution has the same footprint as a conventional SF₆ breaker
- Gas mixture condensation point allows to use it at very low temperatures (-50 °C)
- Scalable Circuit Breaker technology

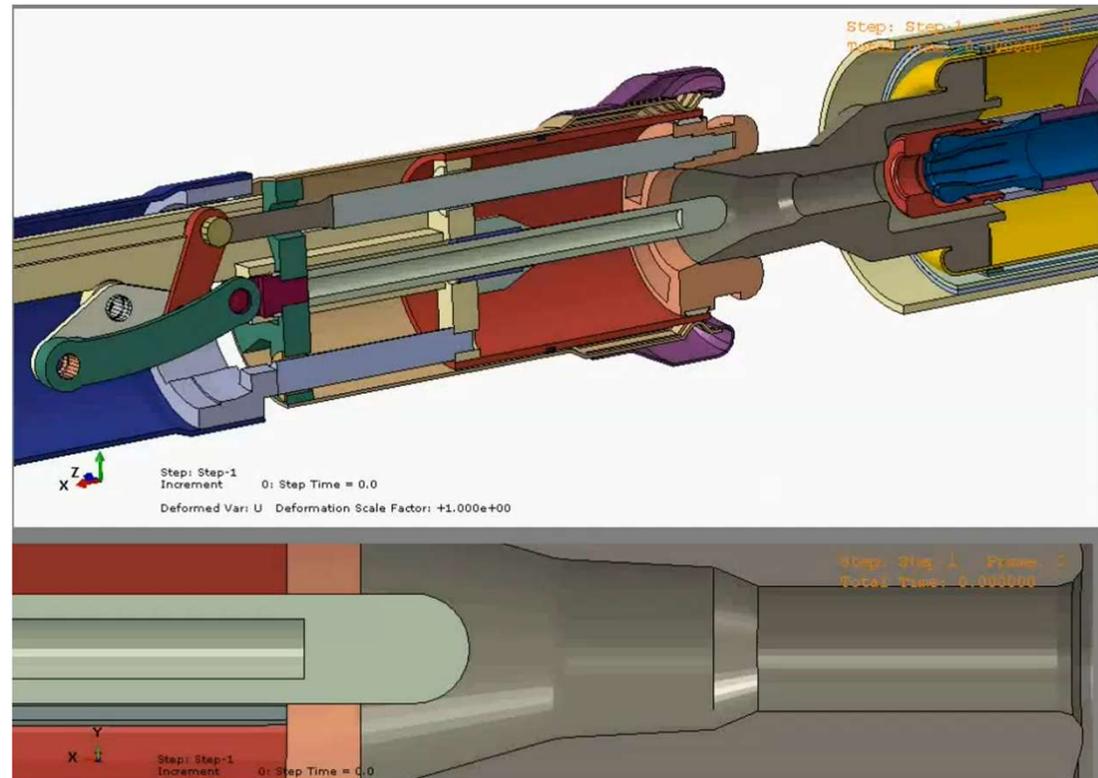


CO₂-gas – new challenges

Gas details

Gas		SF ₆	CO ₂
Molecular weight		146.06	44.01
Density	kg/m ³	5.9	1.8
Chemical stability		Stable	Stable
Dielectric strength	%	100	34

- Increased gas pressure in the product
- Increased speed of the contact system
- Tighten all areas in the arcing zone to keep the pressure during interruption
- O-rings – new material
- Insulators



Eco-efficient EconiQ LTB – LTA

Products and roadmap

EconIQ Live Tank Breaker – LTA

Scalable eco-efficient Live Tank Breakers

Combining the reliability and experience from gas type Circuit Breakers with the use of carbon dioxide (CO₂) and oxygen (O₂) as an eco-efficient insulation gas mixture



Type	LTA 72.5D1	LTA 145D1	DCB LTA 72.5D1	DCB LTA 145D1
Rated voltage	72.5 kV	145 kV	72.5 kV	145 kV
Rated current	2750 A	3150 A	2750 A	4000 A
Rated short-time withstand current	31.5 kA	40 kA	31.5 kA	31.5 kA (40kA for 123kV)
Rated frequency	50 Hz	50 Hz	50 Hz	50 Hz
Ambient temperature	-50/+50 °C	-50/+50 °C	-50/+50 °C	-50/+50 °C
Gas-mixture	CO ₂ + O ₂			

EconIQ™ High-voltage roadmap

A game-changing technology that eliminates sulfur hexafluoride (SF₆) with reliable and scalable solutions for the lowest carbon footprint.

Advancing a sustainable energy future for all



* 60 Hz will be available in 2025 | ** 63kA
 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.

Slide 10

A0 Road map need to be updated - PG working on
Author, 2024-02-27T16:01:43.903

Eco-efficient EconiQ LTB – LTA

Gas handling

Gas handling overview

Gas details

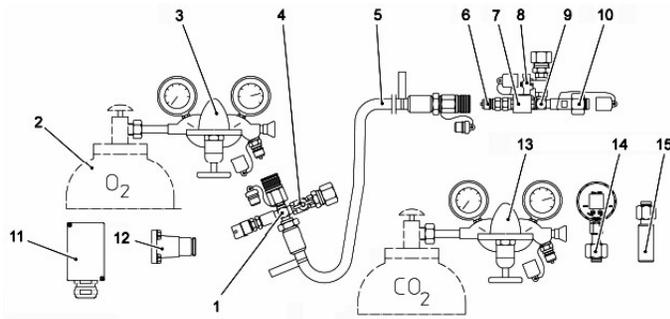
- Gas mixture: 1.08 MPa CO₂ / 0.12 MPa O₂
- Filling pressure: 1.20 MPa (vs 0.70 MPa SF₆)
- Alarm/Blocking pressure: 1.04 / 1.00 MPa
- Total gas volume is equivalent to SF₆ breaker

Gas		SF ₆	CO ₂
Molecular weight		146.06	44.01
Density	kg/m ³	5.9	1.8
Chemical stability		Stable	Stable
Dielectric strength	%	100	34



Gas filling process

- Same process as with any mixed gas breaker
- Poles are vacuum processed and filled with CO₂ at transport pressure
- Always fill up first with O₂
- Once filled with O₂, proceed with CO₂ until desired pressure is reached
- Specific valve for this gas mixture



- | | |
|---------------------------------------|---|
| 1 Cross-connection | 9 Coupling link |
| 2 Gas bottle | 10 Nipple with clamp nut |
| 3 Regulator O ₂ (0-10 bar) | 11 Density monitor (without indicator) |
| 4 Valve | 12 Circuit breaker gas valve |
| 5 Hose | 13 Regulator CO ₂ (8-28 bar) |
| 6 Plug-in nipple | 14 Precision pressure gauge |
| 7 Non-Return Valve | 15 Adapter |
| 8 Valve | |

Leakage test

- More sensitive than for SF₆ breakers (CO₂ present in the air)
- Traditional leak detectors not suitable for LTA
- D-TEK CO₂ detector has been proven to be reliable (sensitivity of 5 g/year)



Gas handling

Gas bottles

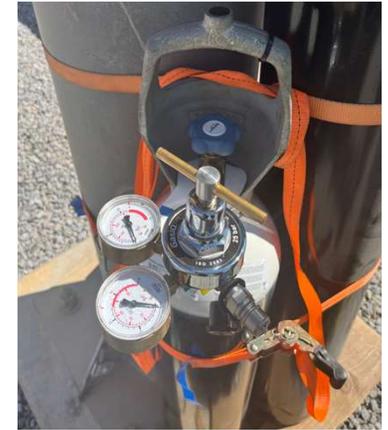
- There is not a safety distance proposed about location of CO₂ & O₂ bottles and LTA breaker however service engineers are keeping 40 meters as safety distance as per they have done before for SF₆ Breakers with Porcelain insulators.



CO₂ regulator in service position



O₂ regulator in service position



Cross-connection



DIGITAL PRECISION
MANOMETER

Installation and commissioning

Overall, same procedures as for our conventional SF₆ circuit breakers

- Same erection process as with conventional breakers
- Basic testing of contact resistance and operating times

Inspection and maintenance

Same inspection and maintenance program as for conventional SF₆ circuit breakers

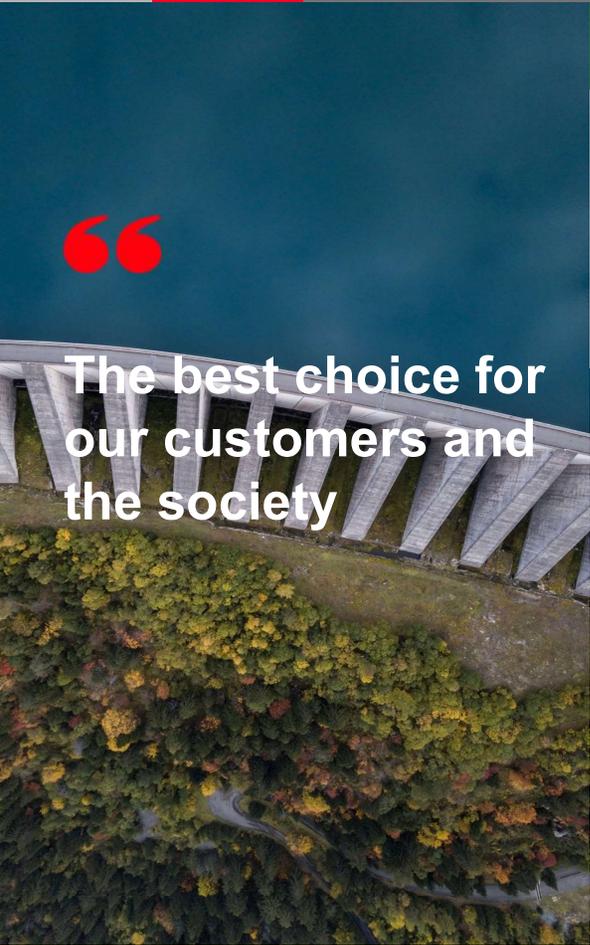
- Overhaul of complete circuit breaker and operating mechanism after 30 years or 10,000 mechanical operations



EconIQ™ Live Tank Breaker – LTA

Circuit breaker comparison and Life Cycle Assessment (LCA)

EconIQ LTA Life cycle assessment for environmental performance

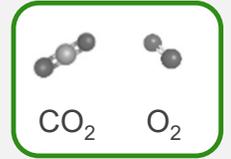


The best choice for our customers and the society

Why are we using it?

- EconIQ LTA will replace the conventional SF₆ gas Circuit Breakers due to its excellent insulating and arc-extinguishing properties.
- Essentially eliminates the carbon footprint of the insulation gas.
- Life Cycle stages were included in the analysis: Production, Use and End of Life including all relevant transports, gas leakage during use phase and losses during the dismantling (EoL).

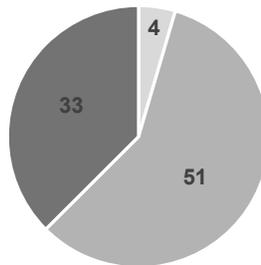
Eco gas mixture



Life cycle assessment (LCA)

Example: Carbon footprint of LTA 145 kV

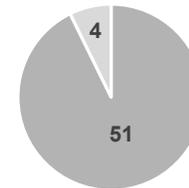
SF₆ LTB 145
88 tons CO₂ eq.



Legend

- Insulation gas losses
- Materials
- Power losses

EconIQ LTA 145
55 tons CO₂ eq.



Power losses over lifetime

Eco-efficient EconiQ LTB – LTA

F Gas Regulation

EU F-Gas Regulation – General Information

- The EU Council and EU Parliament negotiators reached a provisional political agreement on the F-gas regulation* on 05.10.2023.
- The agreed text has been published on 20.10.2023 by the Council.
- The Parliament did some changes on 09.01.2024. The Council must formally adopt the text before it can enter into force.
- With the F-gas regulation the EU intends to regulate the usage of F-gases with long decomposition times and a high potential of environmental impact.
- It will be valid with different starting dates at different voltages.
- The rules apply for SF₆ and mixed gases with C4-FN additives.

PE-CONS No/YY – 2022/0099(COD)

REGULATION (EU) 2023/...
OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of ...

on fluorinated greenhouse gases, amending Directive (EU) 2019/1937 and repealing Regulation (EU) No 517/2014

(Text with EEA relevance)

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty on the Functioning of the European Union, and in particular Article 192(1) thereof,

Having regard to the proposal from the European Commission,

After transmission of the draft legislative act to the national parliaments,

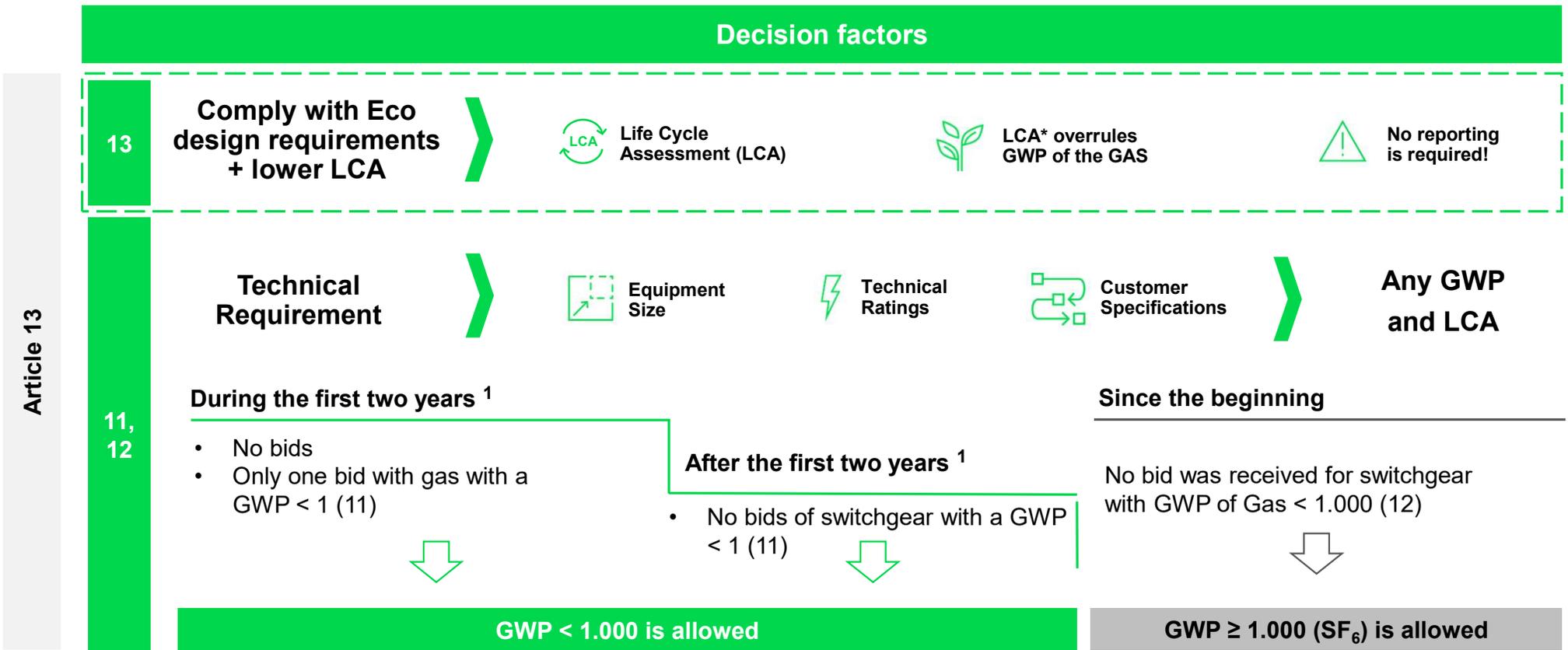
Having regard to the opinion of the European Economic and Social Committee¹,

Having regard to the opinion of the Committee of the Regions²,

Acting in accordance with the ordinary legislative procedure,

¹ OJ C, , p. .
² OJ C, , p. .





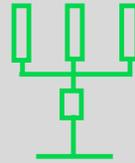
EconIQ gas-mixture enables the lowest carbon footprint in HV

EconIQ

Gas-mixture for EconIQ™ portfolio

Based on well-proven
gas circuit-breaker
technology

LTA Breakers



CO₂

+

O₂

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

Metal-enclosed
breakers



+

C4-FN

3.5%

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

GE

Main messages on F-gas regulation

EU F-GAS REGULATION FROM GWP TO LCA

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EU F-gas regulation outcome



The provisional agreement of the regulation has been **approved** by EU Council & EU Parliament ENVI committee

Final vote mid Jan. '24, no modification of the text foreseen.



Main take away:

- **Phase out dates clearly defined:**

SF6 phase out dates if SF6-free solutions available	Ratings
1/1/2028	52 kV < Ur ≤ 145 kV & I _{sc} ≤ 50 kA
1/1/2032	145 kV < Ur & 50 kA < I _{sc}

- **Lifecycle carbon footprint** is prevailing on gas GWP thresholds.

g³ products are supported by the new F-gas

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4

Eco-efficient EconiQ LTB – LTA

Success stories

EconIQ LTA breaker in Tranås substation, Sweden

HITACHI
Inspire the Next



Challenge

Tranås Energi was replacing its aging 30-year-old SF₆ Circuit Breakers and was searching for an eco-efficient alternative.

Solution

Live tank circuit-breaker (LTA) based on CO₂ technology reduces carbon footprint by 100%. Almost 100% of reduction in global warming potential (GWP) compared to SF₆ without any compromise on quality and reliability.

Impact

Our technology help minimize the substation's environmental impact and regulatory procedures for SF₆ such as gas handling, monitoring and inventory management will be avoided.

EconIQ breaker contributes to Norway's journey towards carbon-neutrality

HITACHI
Inspire the Next



“

We are excited to join forces with Hitachi Energy to bring new and innovative EconIQ technology that reinforces our strategy for sustainable operations.

Atle Isaksen
Head of Grid Development, BKK Nett

Challenge

Rebuilding a substations with an eco-efficient sulfur hexafluoride (SF₆) alternative to meet the growing electricity demand and support Norway's decarbonization plans

Solution

The eco-efficient EconIQ™ Live Tank Breaker (LTA) is a reliable solution to eliminate 100% of the CO₂ equivalent emissions related to the insulation gas and strengthens the Norwegian grids

Impact

Contributing to Norway's plans to cut at least 50 percent of its greenhouse gases by 2030 with the target to achieve carbon-neutrality by 2050



HITACHI
Inspire the Next 