



TRANSFORMERS MAGAZINE'S
INDUSTRY NAVIGATOR

SUSTAINABILITY AND DIGITALIZATION

Sustainability without compromises - pioneering instrument transformers with biodegradable liquids

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6 June 2023



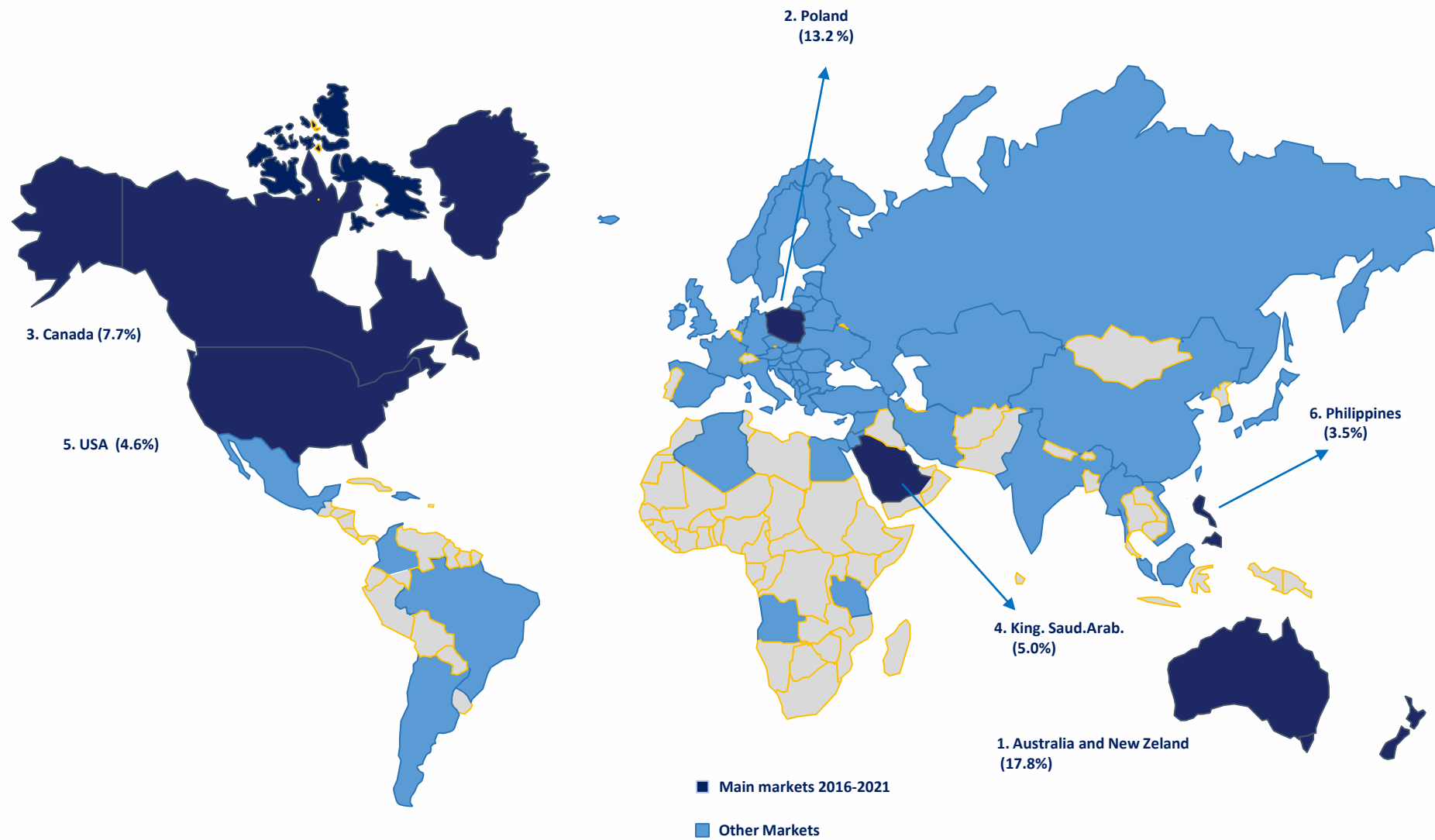


Basic information: Končar – Instrument transformers Inc.

- Part of Končar – Electrical Industry Inc. Group
- **285** employees
- Average working experience: **19 years**
- **PRODUCTION CAPACITIES:**
 - **4000 HV** transformers per year
 - **10000 MV** transformers per year
 - **Planned 60% increase in production capacities in the next 5 years**

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INSTRUMENT TRANSFORMERS





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PRESENT





Also known as....





GREEN LINE

2022

TRANSFORM  EVERYDAY



We see biodegradable fluids as the future due to:

- Reduced environmental effect (on soil, water, and air)
- Improved transformer performance
- Reduction in the carbon footprint of the equipment



The situation at hand

- Instrument transformers as „frontline” equipment
 - Extreme dielectric stress due to exposure to transients and common disconnecter operation
- NO thorough experience with ITs filled with biodegradable fluids
- Need for extensive dielectric testing
 - Pioneering entails ”going the extra mile”





Biodegradable liquid "technologies"



COMMERCIALY
AVAILABLE —
2022

SYNTHETIC ESTERS
IEC 61099

[MIDEL®]
SAFETY INSIDE

BIO-BASED CARBON
ISOPARAFFINIC OIL
IEC 60296

NYTRO® BIO 300X



COMMERCIALY
AVAILABLE —
2022

NATURAL ESTERS
IEC 62770

FR3®

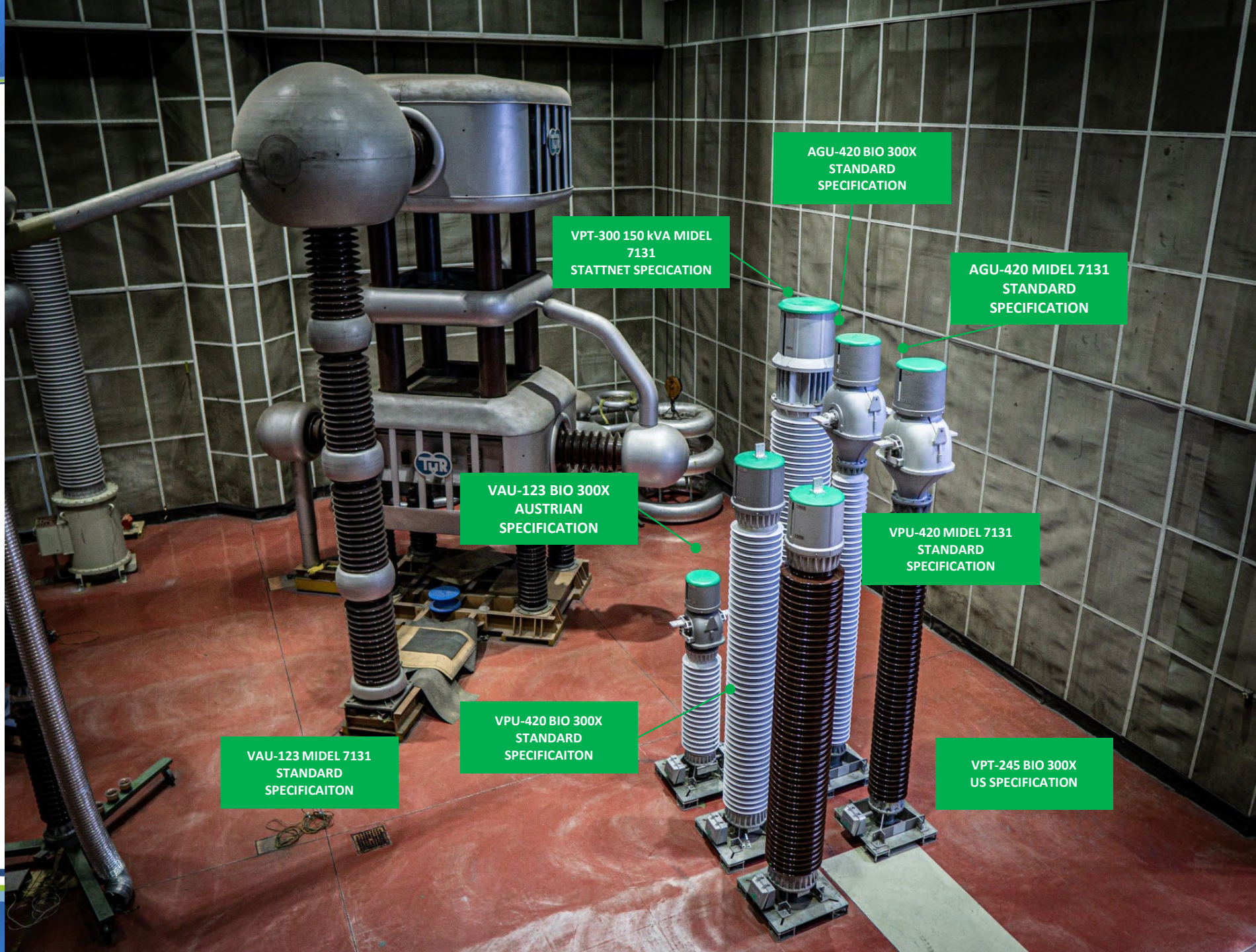
GTL BASED BIODEGRADABLE OIL
IEC 60296

SHELL DIALA S5 BD

Prototypes in
testing/verification

Prototypes in
testing/verification





VPT-300 150 kVA MIDEL
7131
STATNET SPECIFICATION

VPT-245 BIO 300X
US SPECIFICATION

VAGU-420 MIDEL 7131
STANDARD
SPECIFICATION

VAU-123 BIO 300X
AUSTRIAN
SPECIFICATION

VPU-420 MIDEL 7131
STANDARD
SPECIFICATION

VPU-420 BIO 300X
STANDARD
SPECIFICATION

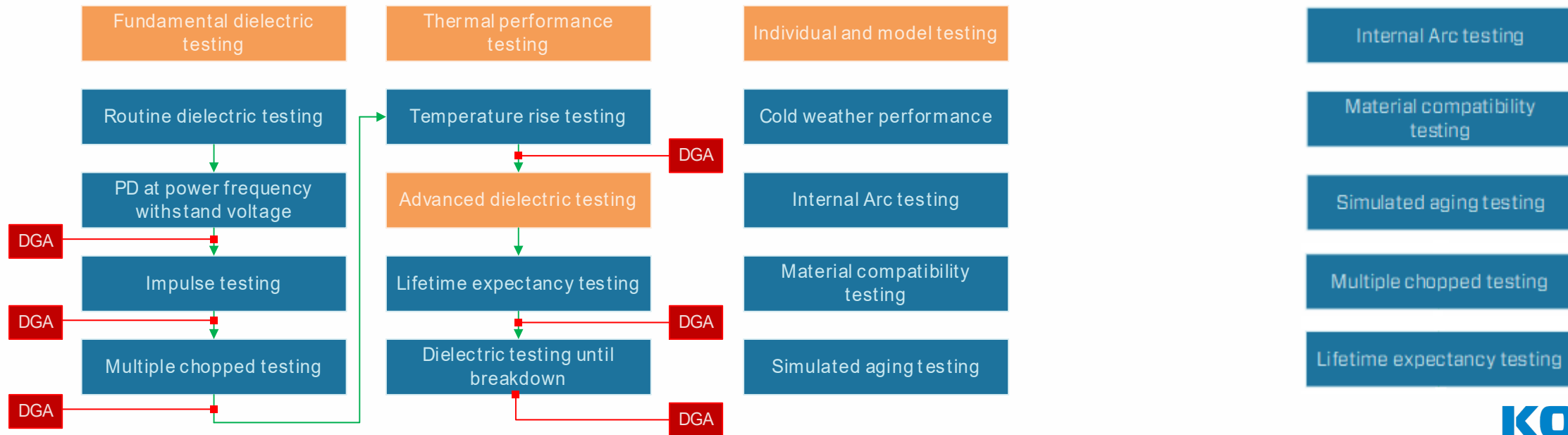
VAU-123 MIDEL 7131
STANDARD
SPECIFICATION

VPT-420 BIO 300X
STANDARD
SPECIFICATION





Considered performance aspects





Dielectric performance

**LIGHTNING IMPULSE TESTS – SIMULATES A
LIGHTNING STRIKE**



**SWITCHING IMPULSE TEST– SIMULATES THE
OPERATION OF A CIRCUIT BREAKER**



EEP | ELECTRICAL
ENGINEERING PORTAL





MULTIPLE CHOPPED – SIMULATES CURRENT INTERRUPTION WITH A DISCONNECTOR



Test Requirements

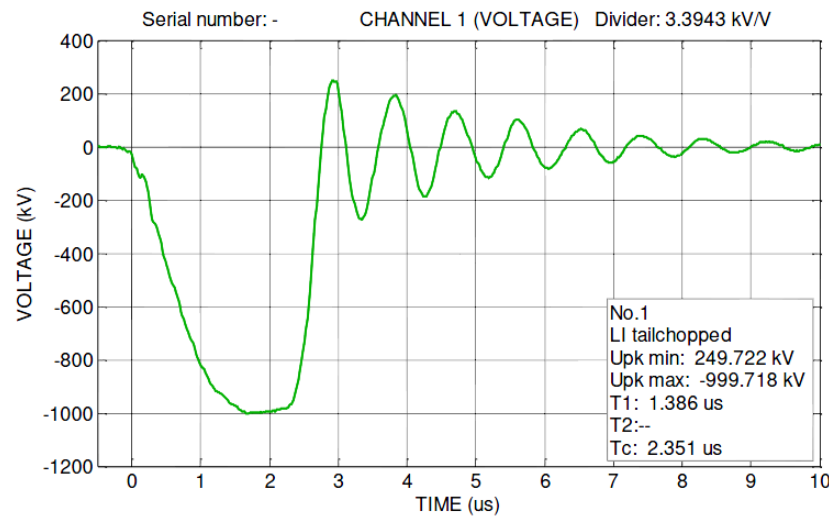
- 600 negative chopped impulses (70-80% amplitude)
- New methodology according to CIGRE WGA3.42
- No breakdown can occur
- Gas rises have to be within standard - prescribed limits



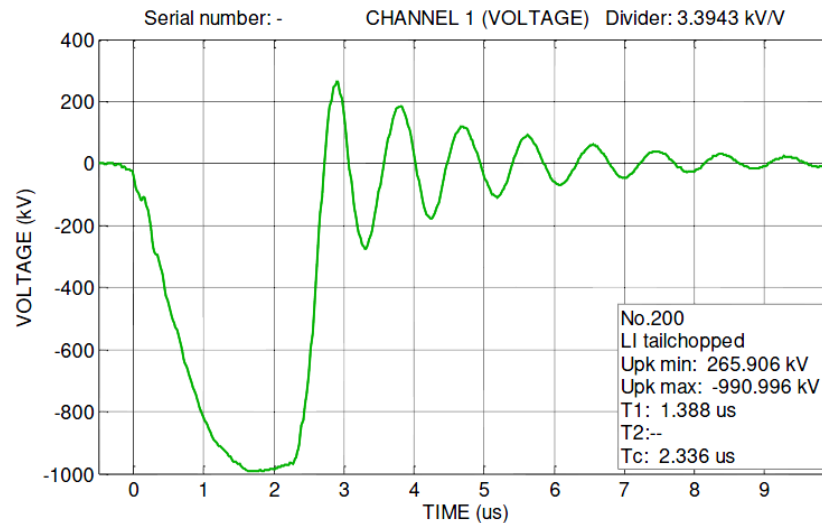


Dielectric performance —Multiple chopped test

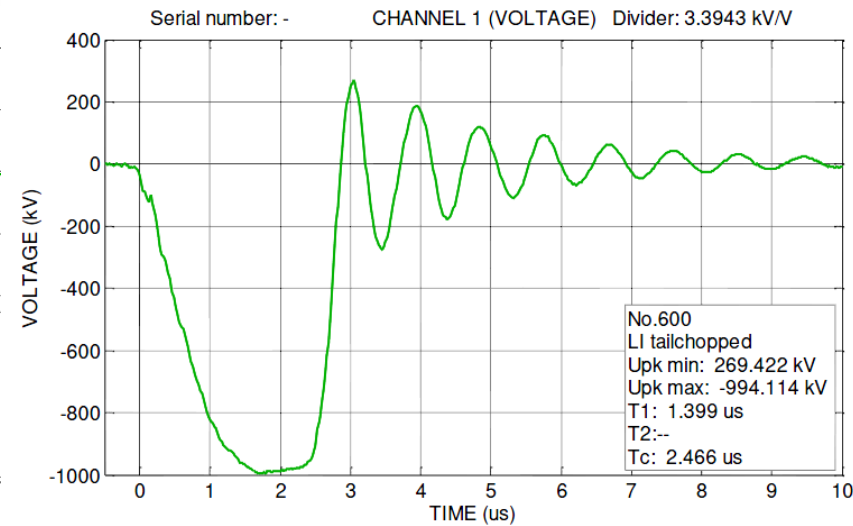
WAVEFORM EXAMPLE — IMPULSE 1



WAVEFORM EXAMPLE — IMPULSE 200

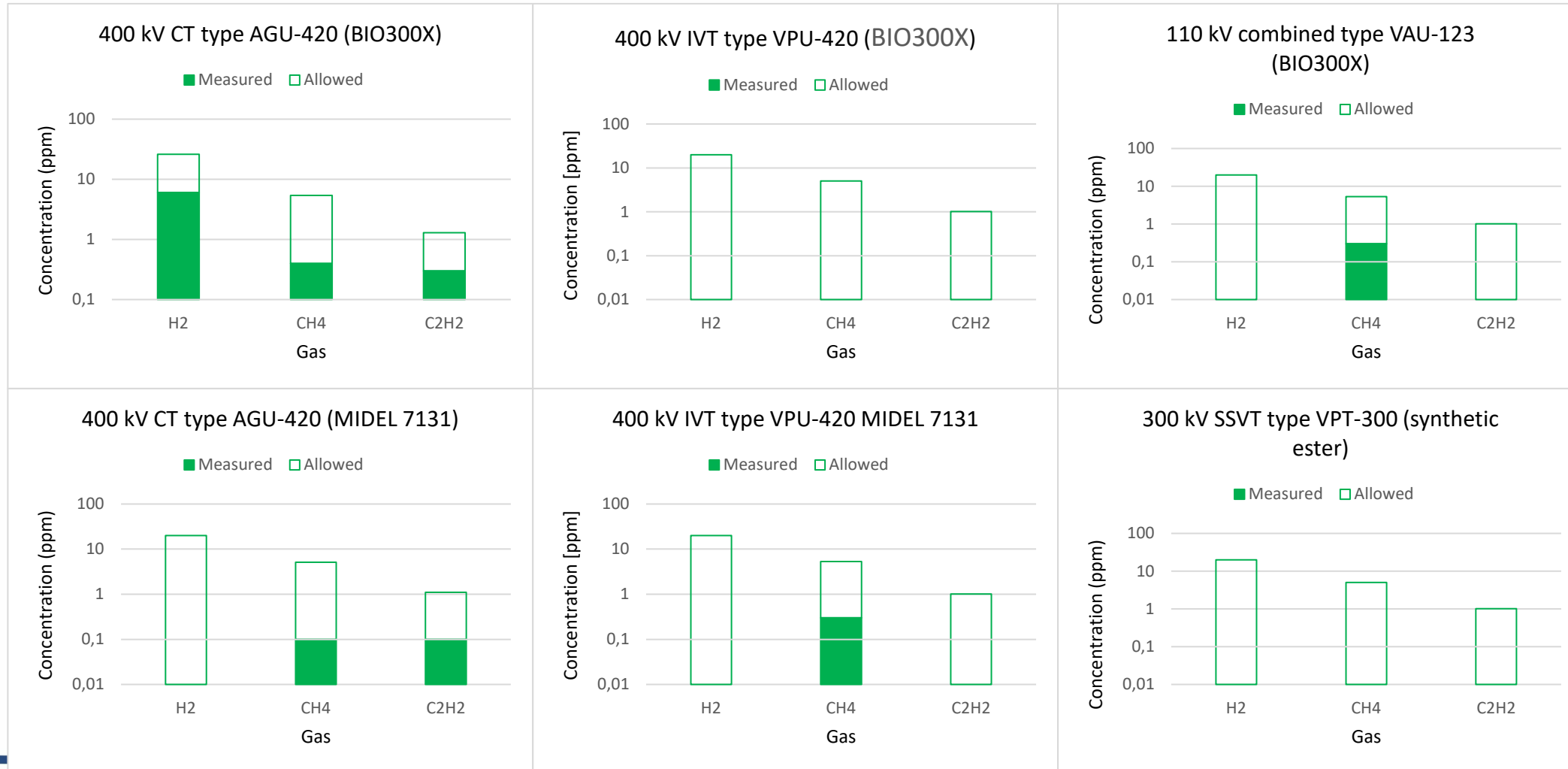


WAVEFORM EXAMPLE — IMPULSE 600





Dielectric performance — Multiple chopped test





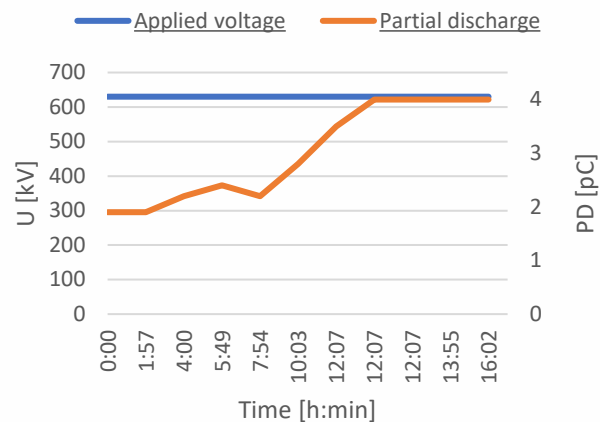
Dielectric performance: Lifetime Expectancy Test

- Simulates dielectric aging of the transformers
- Continuous testing at PFWV (20 – 24 h)
- PD, Capacitance and $\text{tg}\delta$ are measured continuously

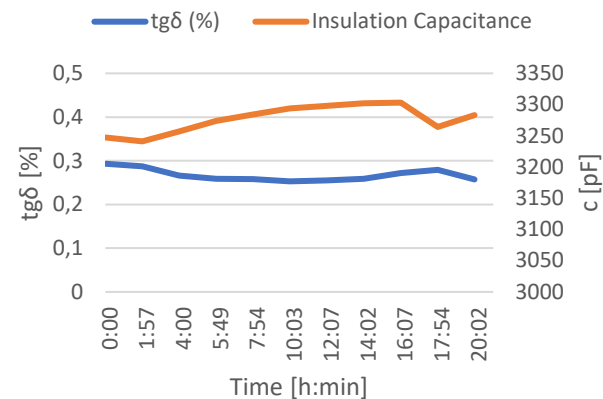
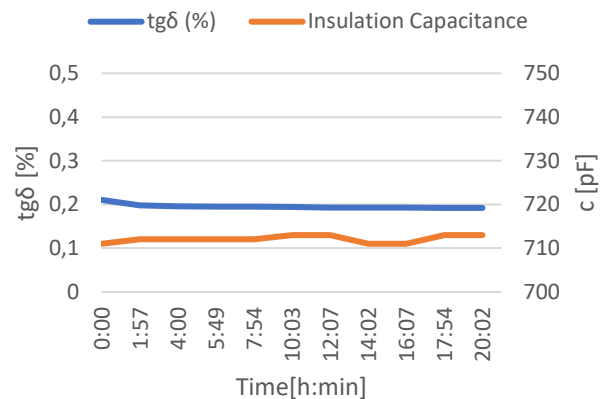
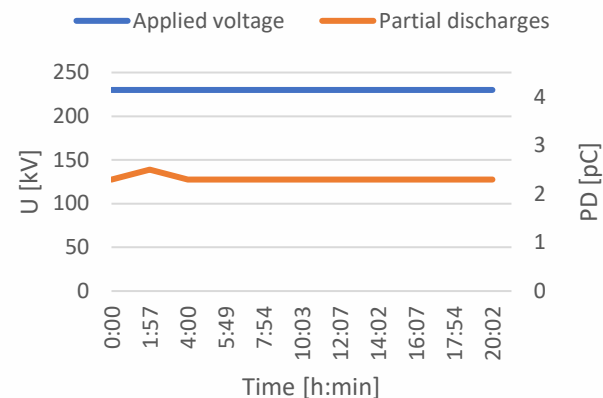




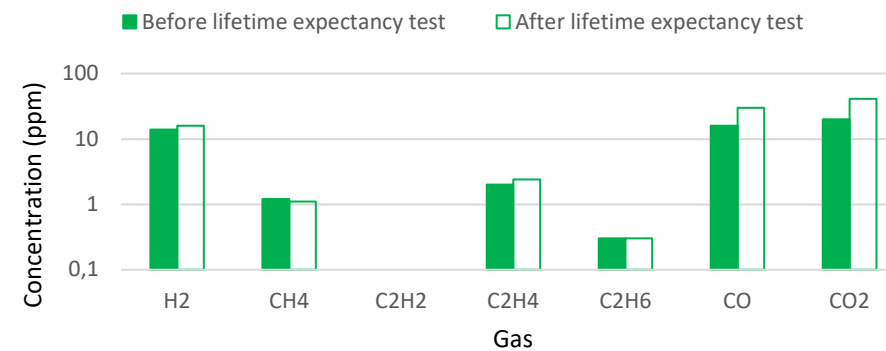
AGU-420 – BIO300X



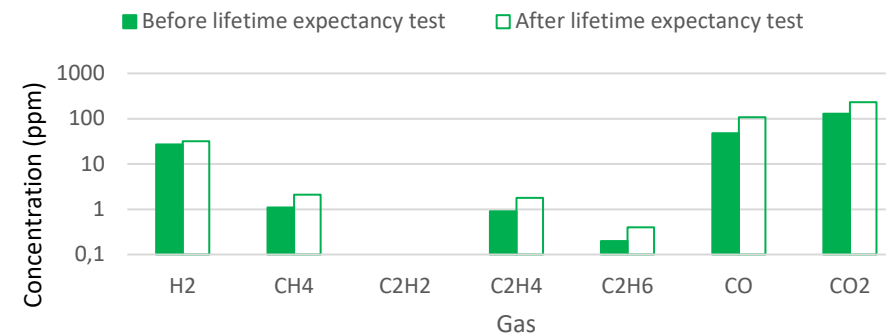
VAU-123 – BIO300X



400 kV CT type AGU-420 (BIO300X)



110 kV combined type VAU-123 (bio-based hydrocarbon)





Dielectric performance: Conclusions of Lifetime Expectancy Test

BIO 300 X

- Units filled with BIO 300 X exhibit excellent performance during the test – better than mineral oil
- Gas increases are not pronounced after the test

MIDEL 7131

- Unit filled with MIDEL 7131 also exhibited a satisfactory performance
- Gas increases are not pronounced after the test

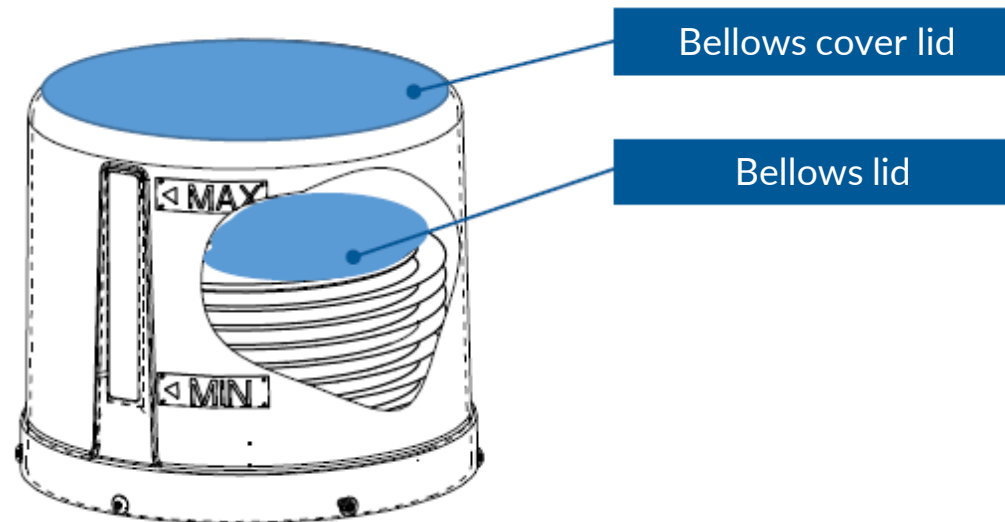




Internal arc

- 50 kA – 0,3 s
- **Class II** for MIDEI, BIO 300X and mineral oil
 - Standards are not conclusive on the point of pressure relief
 - The key is not to have any lateral projection of parts

Internal arc fault current r.m.s. value kA	Protection stage	Arc fault duration s	Internal arc fault protection class I	Internal arc fault protection class II
< 40	1	0,2	Fracture of the housing and fire permitted, but all projected parts to be confined within the containment area	No external effect other than the operation of suitable pressure relief device
	2	0,5		No fragmentation (burn-through or fire acceptable)
≥40	1	0,1		No external effect other than the operation of suitable pressure relief device
	2	0,3		No fragmentation (burn-through or fire acceptable)





MINERAL OIL



NYNAS NYTRO
BIO 300X



MIDEL 7131





Influence on maintenance and diagnostics

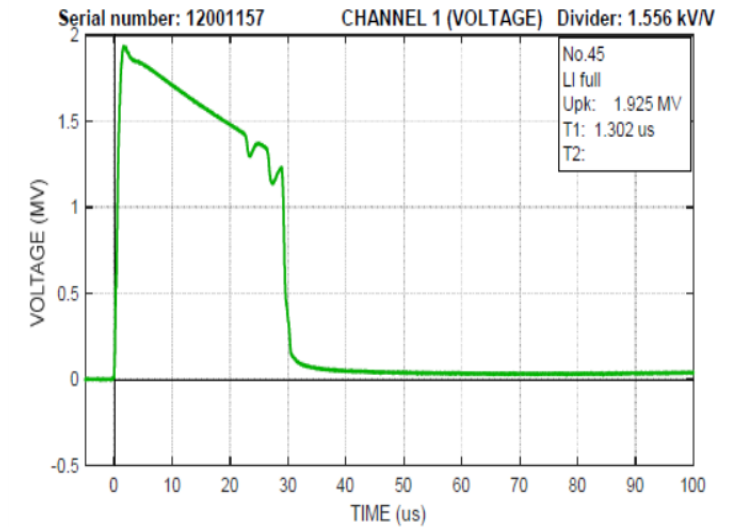
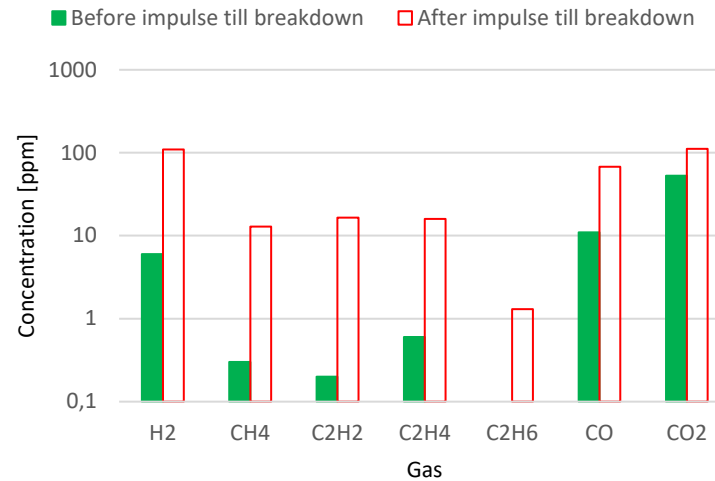
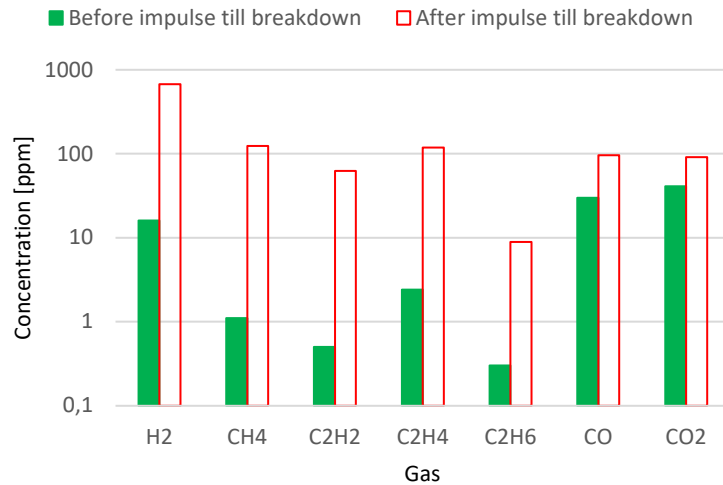
Influence on diagnostics

- A higher level of $\text{tg}\delta$ is expected for ester fluids
- The known DGA criteria are generally applicable
- We are continuously performing tests to gather as much data as possible
- Electric breakdown is visible in the same way as with mineral oil






Dielectric testing until breakdown



- Start of the test at 1425 kV – raised in 5% steps (3+ & 3-), testing until breakdown
- BIO300X filled units
 - Breakdown at 1925 kV (135%)
- MIDEL filled units
 - Breakdown at 1780 kV (120%)



Conclusion

- Implementation of both dielectrics – complete
 - Commercial deliveries started in Q1 2022 (Croatia, Philippines, EU...)
 - Q1 2023 – 400 kV prototype units filled with natural ester and GTL based biodegradable oil
 - We believe that BD liquids are the future, and we want to be a frontrunner in that category, remaining objective and impartial in the selection of adequate dielectric
 - We want to have them all, but also clearly understand which is the "best" and why
 - Končar Instrument transformers Inc. aims to offer a fully biodegradable scope from 2027
- 
- The logo for Končar Instrument Transformers, featuring the letters 'KO' in a large, bold, blue font, with the word 'INSTRUMENT TRANSFORMERS' in a smaller, blue, sans-serif font underneath.





TRANSFORM EVERYDAY

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