



Kurzvorträge über die

25. CIRED – Internationale Konferenz für Stromverteilung

**von 3.-6. Juni 2019
in Madrid, Spanien**

Session: 1 – Komponenten für den Netzbetrieb

Autor: Gerhard Jambrich - AIT

Klaus Trentler – Schneider Electric

- 152 Berichte in der Session 1 - Komponenten für den Netzbetrieb
- Berichte aus Österreich:

Paper 1837: Benchmarking Linear and Non-linear Behavior of Power Inductors for Switched Mode Power Supplies (RIF).

- 4 Blöcke
- 24 Vorträge in der Main Session (je Block 6 Sessions)
- 3 Round Tables (RT)
- 1 Research and innovation Forum (RIF)
- Poster Session & interactive Poster Session

- **Session 1 - Komponenten für den Netzbetrieb**
 - Block 1: Anlagenmanagement und Zustandsbewertung von Netzkomponenten - Kabel, Freileitungen und assoziierte Komponenten (40 Beiträge)
 - Block 2: Anlagenmanagement und Zustandsbewertung bei Komponenten/Produkten für den Netzbetrieb - Netzstationen, Schaltanlagen und Transformatoren (40 Beiträge)
 - Block 3: Innovationen bei Netzkomponenten - Kabel, Freileitungen und neue Komponententypen (34 Beiträge)
 - Block 4: Innovationen bei Komponenten/Produkten für den Netzbetrieb - Netzstationen, Schaltanlagen und Transformatoren (38 Beiträge)



Organisation Session 1



Chairman:

- **Christophe BOISSEAU (France)**
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1. Block Session 1



- Block 1: Anlagenmanagement und Zustandsbewertung von Netzkomponenten - Kabel, Freileitungen und assoziierte Komponenten (40 Beiträge)
 - Neue Lösungen für die optimierte Installation und Wartung von Kabeln und Freileitungen (11 Papers)
 - Zustandsmonitoring (15 Papers) und
 - OpEx/CapEx Optimierung (14 Papers).

- Paper 0940 :Distribution Surge Arrester Monitoring



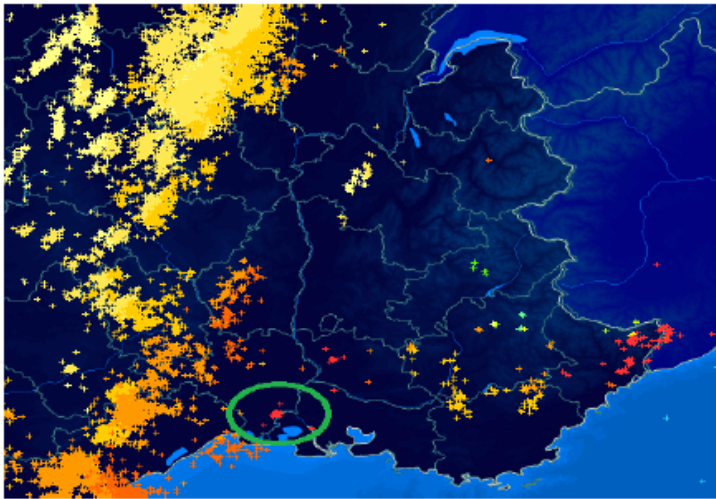
- 350.000 km MSP Freileitungen, 2 Mio. Überspannungsableiter
- Spezifisch: Verbleibender Kurzschluss wenn sie außer Betrieb sind
- Netzbetreiber muss das Netz abfahren um den fehlerhaften Überspannungsableiter zu finden

SAIDI (System Average Interruption Duration Index) wird durch Überspannungsableiter beeinflusst:

- Jedes Jahr fallen 400 Ableiter aus
- Im Durchschnitt 61 Minuten Unterbrechungsdauer je Fehler

Enedis and DERVASIL entschieden sich ein Wireless Surge Arrester Monitoring device (WSAM) zu entwickeln und zu testen.

- Paper 0940 :Distribution Surge Arrester Monitoring



- WSAM Leckstrommessungen korrelieren sehr gut mit hoher Blitzaktivität
- Induzierter Leckstrom durch Blitzimpuls wird gleichzeitig bei einigen Ableitern beobachtet (Gebiet in der Nähe des Bitzeinschlags)



- Mit Leckstrommessungen wird der Status der Ü-Ableiter bestimmt und im Fehlerfall ein Alarm gesendet (μA bis kA)
- Feldtest 11 WSAM Prototypen (2 Jahre), parallel Prüflabortests (Hochstromprüfung, Funktionsprüfungen)

- Paper 0940 :Distribution Surge Arrester Monitoring



- WSAM Gerät bringt Kostenvorteile für VNB (SAIDI-Verbesserung) → Zeitreduktion von 30% beim Prozess den Fehlerort zu lokalisieren, den Fehler vom MSP-Abzweig zu separieren und den gesunden Teil des Abzweigs wieder in Betrieb zu nehmen.
- DERVASIL propagiert eine Lösung die in allen MSP-Netzen implementiert werden kann.
- Das WSAM Gerät könnte auch für das Monitoring von anderen MSP-Komponenten wie Transformatoren und Verbundisolatoren eingesetzt werden

- Block 2: Anlagenmanagement und Zustandsbewertung bei Komponenten/Produkten für den Netzbetrieb - Netzstationen, Schaltanlagen und Transformatoren (40 Beiträge)



**PD Alert System
in MV Switchgear**




**Integrating sustainability in Asset
Management decision making**

**A case study on streamlined LCA
in asset procurement**



**AGEING BEHAVIOUR
OF
MEDIUM-VOLTAGE
SUBSTATIONS**


Petros Dalamaras
Markus Zdrallek



**SMART SECONDARY SUBSTATIONS.
A REALITY AND A BIG OPPORTUNITY FOR INNOVATIVE SOLUTIONS
FOR PREDICTIVE MAINTENANCE AND LIFE EXTENSION.**


Iñaki Apellaniz, Ormazabal (Spain) • Joseba Arostegui, Ormazabal (Spain) • José Ramón Tejedo, Iberdrola (Spain) • Juan Antonio Sánchez, Ormazabal (Spain)

PAPER N° 1613




**Study of new technical solutions for voltage control
of LV distribution networks in France :**

**Tests and performance analysis of LV regulators
and MV/LV transformers with OLTC**

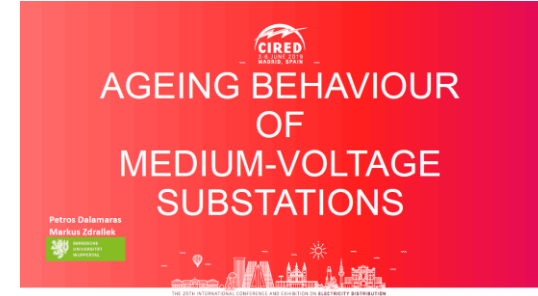


**Mitigation of lock-in effect
for compact substations with transformers
meeting future EU efficiency regulations**

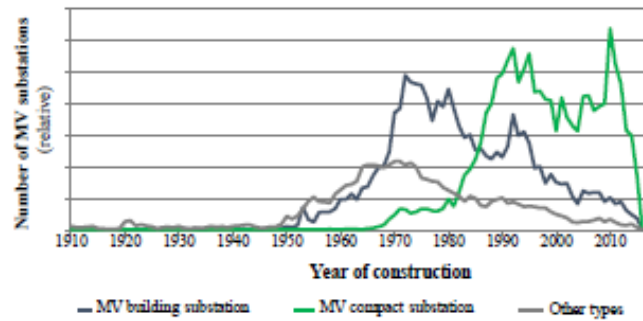




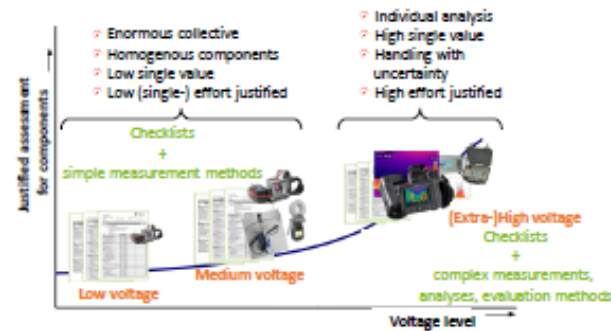
Challenges for DSOs



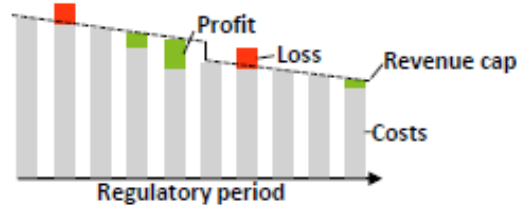
Electrical components have a greatly **increased age**



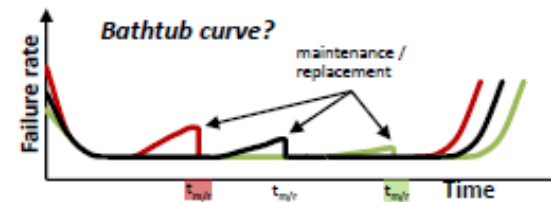
Justified **effort** depending on the voltage level



Optimized strategies to reduce **OPEX & CAPEX**



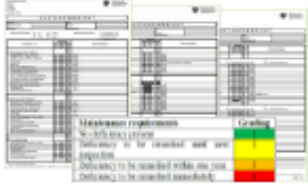
Optimized strategies to ensure **reliable energy supply**



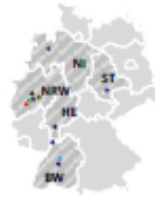


A new systematic assessment approach

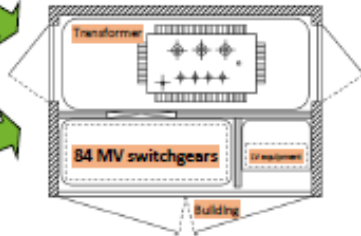
Inspection checklists
(soft facts)



11 DSOs



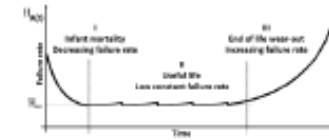
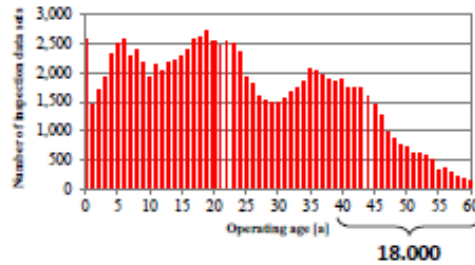
100.000 inspection checklists



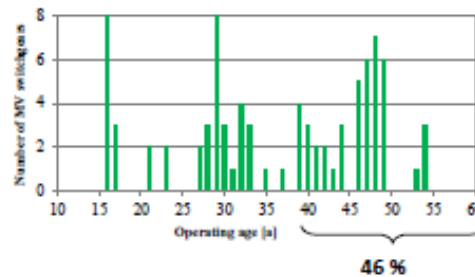
Measurement methods
(hard facts)



[2] Jöke, C.; Beerboom, D.; Zdražil, M.: Zustandsorientierte Bewertung elektrischer Industriemaschinen als Basis für moderne Anlagen- und Instandhaltungsstrategien, Fachtagung TÜV SÜD "Zustandsbewertung in der Energie und Anlagentechnik", München (2010)



Ageing behaviour
for asset simulation

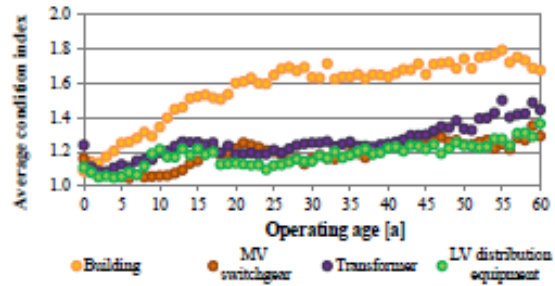


Strategic planning

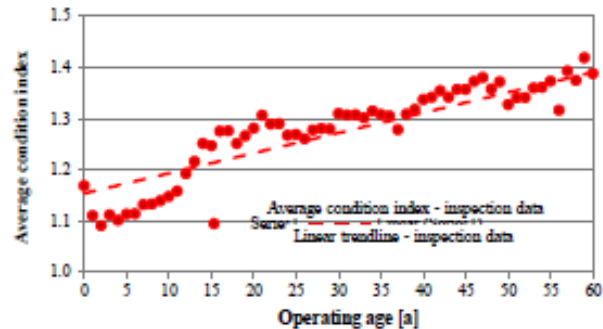


Condition-dependent ageing curves

Analyses of the inspection results

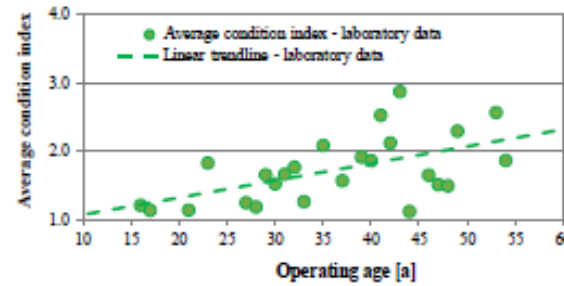


Ageing behaviour of the main components



Ageing behaviour of the MV substations

Analyses of the measurement results



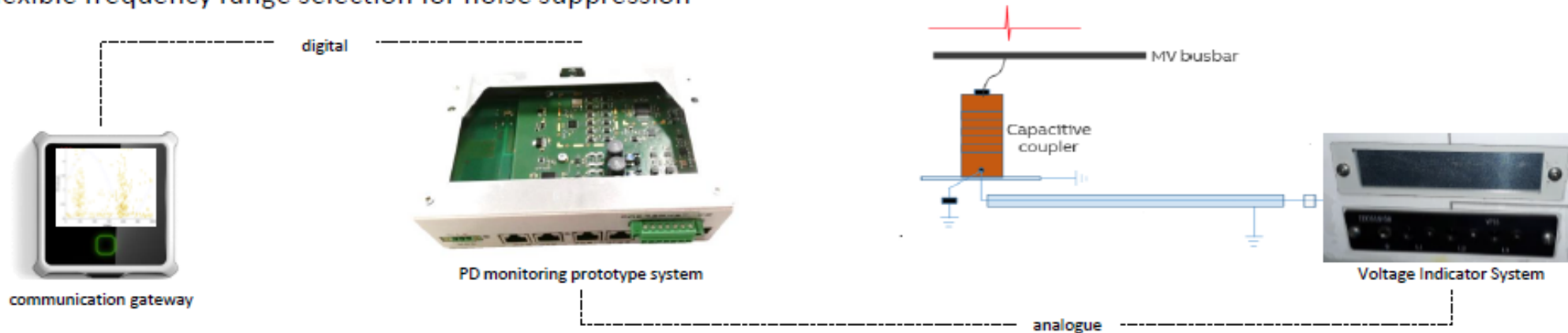
Ageing behaviour of the MV switchgears

Conclusion: No indication for a bathtub curve!
Project results show a **linear ageing behaviour** for the electrical components of the MV substations

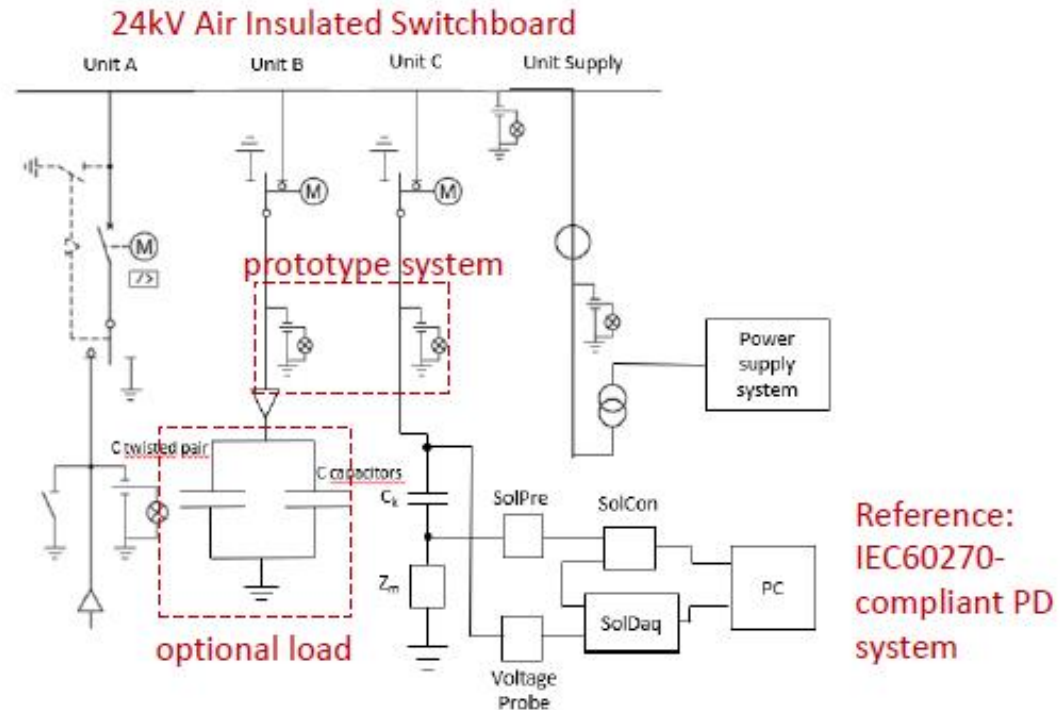
PD monitoring – prototype system for retrofit



- On-line PD monitoring prototype system
- Use the existing connection to HV: piggy-back to the “voltage indication system (VIS),” and re-use already installed coupler in order to avoid accessing the HV switchgear compartment
- Enable PD measurement **without** removing the VIS functionality
- The three phases are measured separately and simultaneously
- Flexible frequency range selection for noise suppression



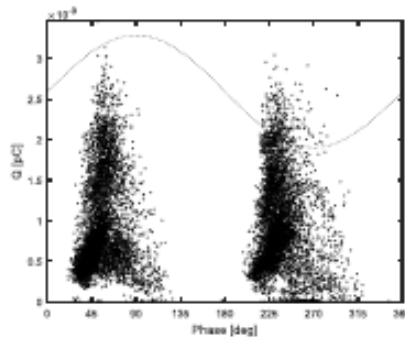
Performance – test installation



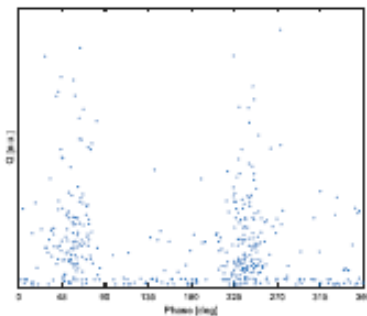
Performance – PD source & results



a laboratory surface discharge producing device



surface discharge pattern recorded by the reference system



surface discharge pattern recorded by the prototype system

- ⚡ 100pC calibration: reference and PD monitoring prototype system have both sensitivity much better than 100pC.
- ⚡ Real PD: information content and the sensitivity are similar between the reference and prototype systems.
- ⚡ Note: The PD monitoring prototype system captures less PD events due to the intermittent acquisition schedule, which is needed for keeping the VIS functionality.

Commission Regulation 548/2014

- ⚡ Limits on losses for distribution transformers (up to 3 150 kVA)
- ⚡ Limits on Peak Efficiency Index (PEI) for power transformers (above 3 150 kVA)
- ⚡ Tier 1 from July 2015: A_0 / C_k
- ⚡ Tier 2 from July 2021: $A_0 - 10\% / A_k$

Regulation aim: Reduction of environmental impacts (emissions) from use phase of transformers

Philosophy behind: Force limits on losses or efficiency → Encourage use of new technologies, materials, solutions for reducing transformer losses



Conclusions

- ⌚ **New transformer complies with size limitations based on original transformer**
- ⌚ Reduced footprint and weight
- ⌚ Lower Total Ownership Cost (increased energy efficiency), when considering the typical, relatively low loading pattern
- ⌚ Extended insulation life
- ⌚ Improved overload capability
- ⌚ Reduced sensitivity to high ambient temperatures or malfunctioning ventilation or cooling systems in substations
- ⌚ Reduced environmental impact by reduced consumption of raw materials
- ⌚ Reduced impact on environment by use of vegetable and biodegradable oil
- ⌚ Improved fire safety if class K ester is used

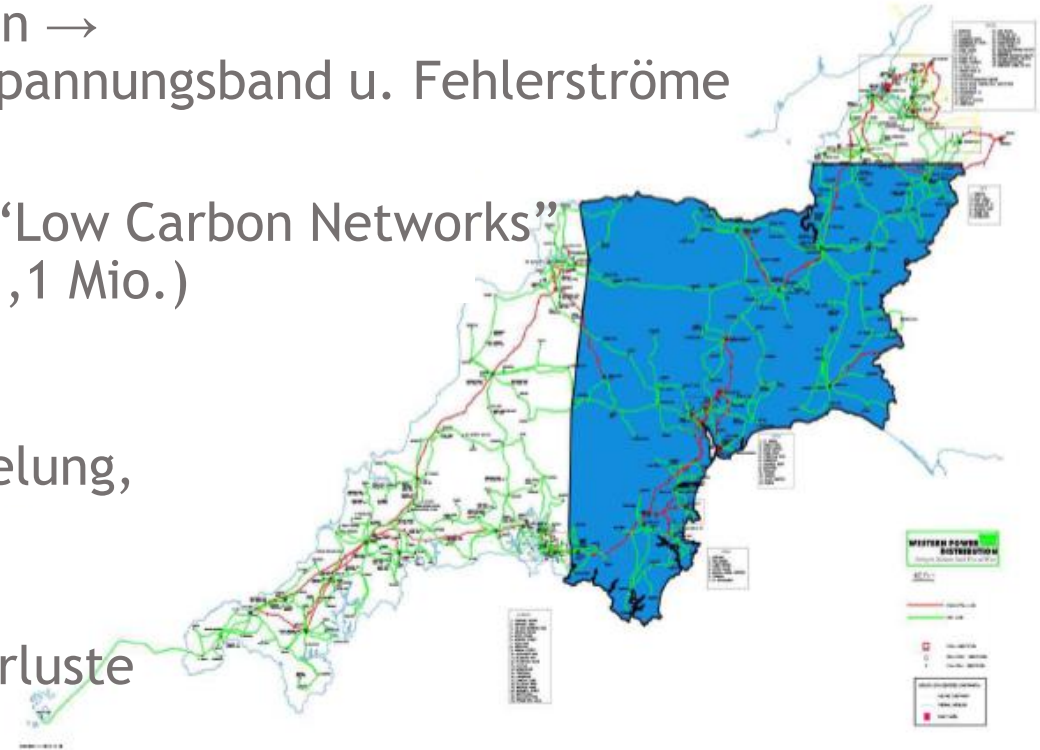


3. Block Session 1

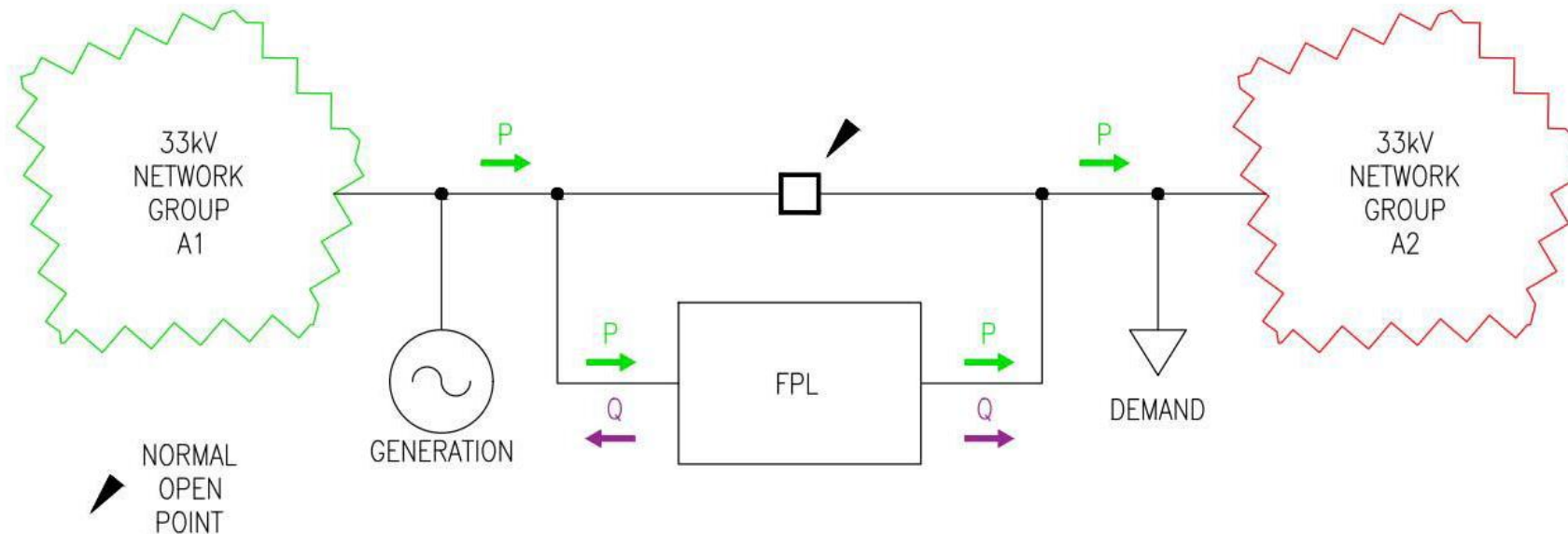


- Block 3: Innovationen bei Netzkomponenten - Kabel, Freileitungen und neue Komponententypen (34 Beiträge)
 - Neue Designs (13 Papers)
 - Dynamische Lastanpassung und thermische Modellierung (3 Papers)
 - Intelligente Zähler - Energiefluss und Qualität (8 Papers) und
 - Ausblick (10 Papers).

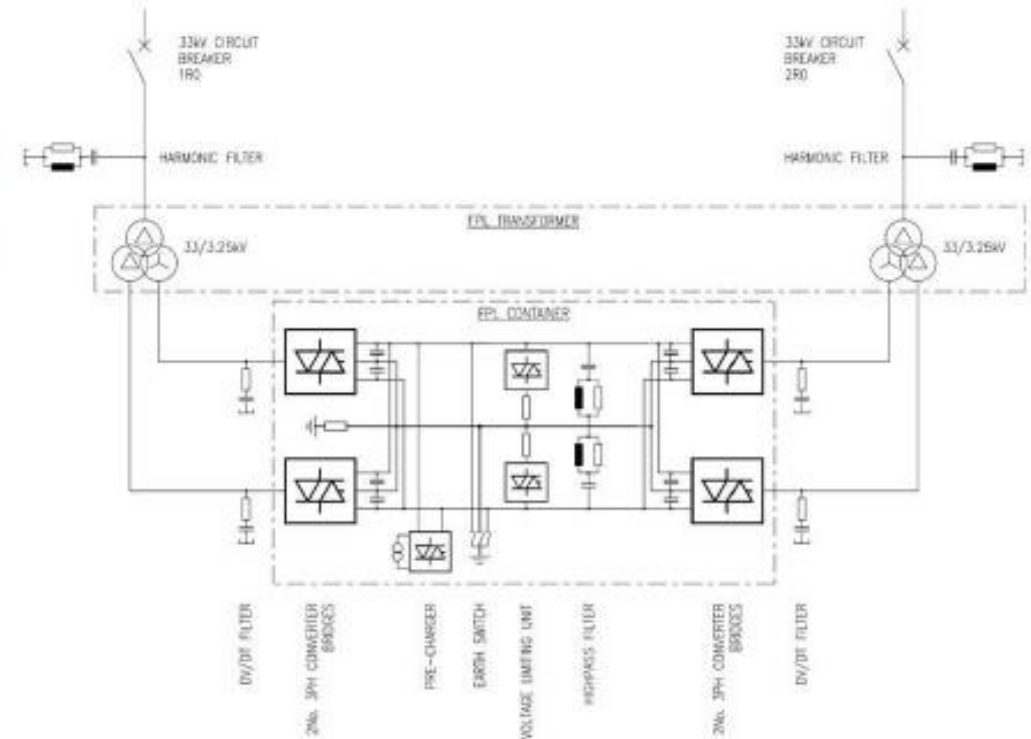
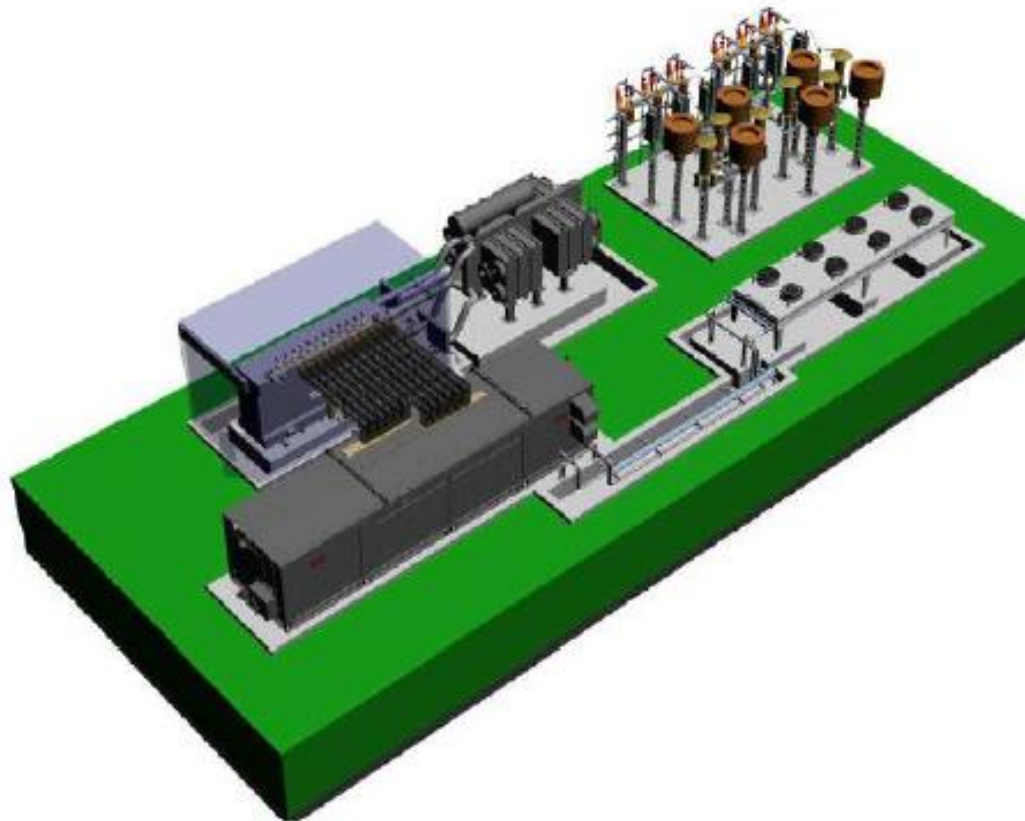
- Paper 1617: The Operational Performance and Benefits of an MVDC Device Integrated Within a 33kV Distribution Network (Project NETWORK EQUILIBRIUM South-West UK 03/2015-06/2019)
 - Thema: fluktuierende dezentrale Erzeugungsanlagen → therm. Komponentenüberlastung, Überschreitung Spannungsband u. Fehlerströme
 - gefördertes Pilot-Projekt: £13 Mio. (EUR 15,3 Mio.) “Low Carbon Networks”
Einsparung (nach Pilot): £15 - 5,6 = 9,4 Mio. (EUR 11,1 Mio.)
im Vergleich zu konventionellen Lösungen
 - Weitere Vorteile: schnelle Umsetzungszeit, PQ-Regelung, Entkopplung über DC
 - Herausforderungen: Schutztechnik, Optimierung Verluste



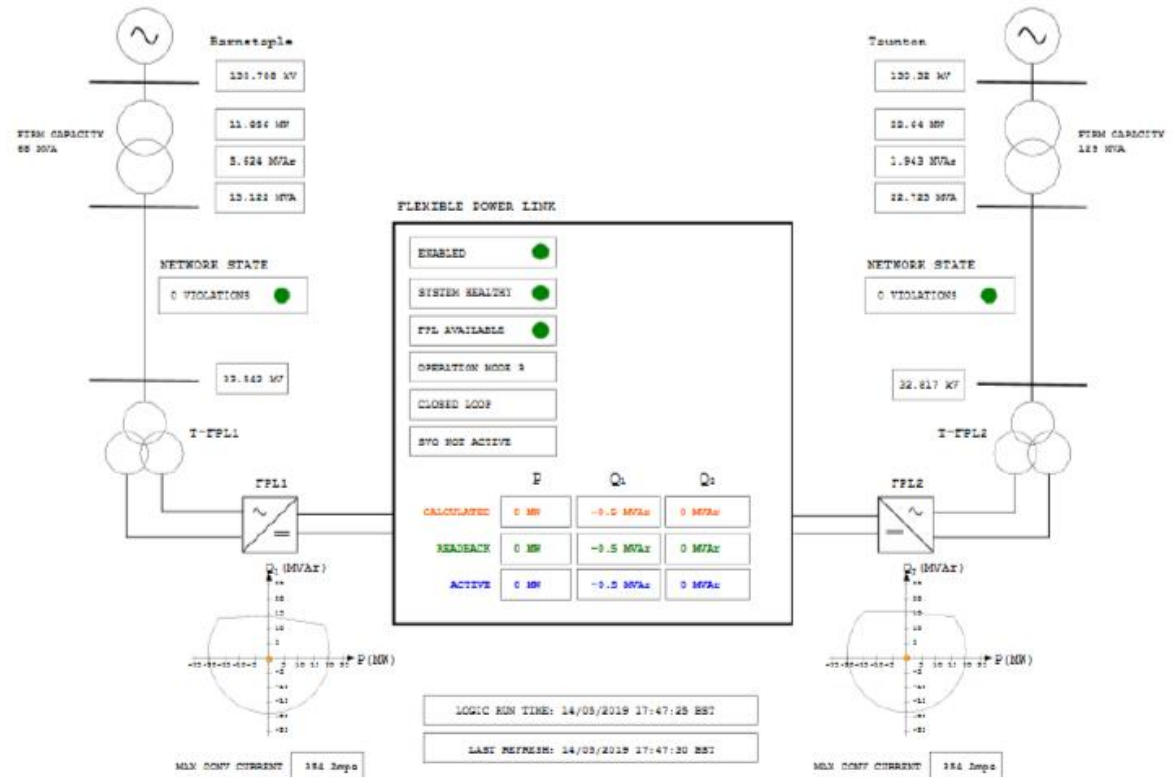
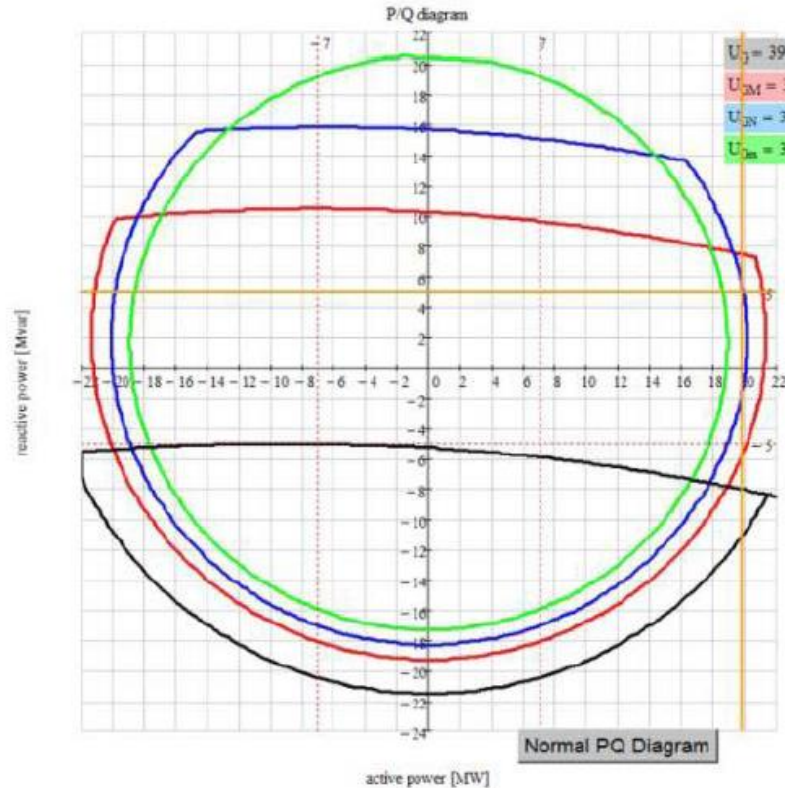
- Paper 1617 :The Operational Performance and Benefits of an MVDC Device Integrated Within a 33kV Distribution Network (Project NETWORK EQUILIBRIUM South-West UK 03/2015-06/2019)



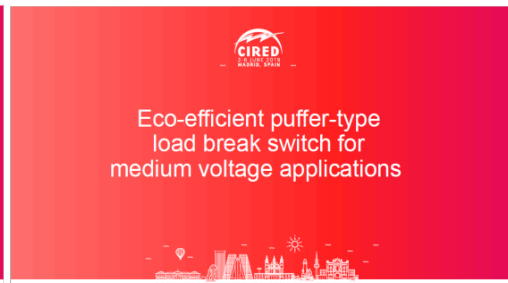
- Paper 1617 :The Operational Performance and Benefits of an MVDC Device Integrated Within a 33kV Distribution Network (Project NETWORK EQUILIBRIUM South-West UK 03/2015-06/2019)



- Paper 1617 :The Operational Performance and Benefits of an MVDC Device Integrated Within a 33kV Distribution Network (Project NETWORK EQUILIBRIUM South-West UK 03/2015-06/2019)



- Block 4: Innovationen bei Komponenten/Produkten für den Netzbetrieb - Netzstationen, Schaltanlagen und Transformatoren (38 Beiträge)
- 6 Präsentationen: Hauptfokus:
 - Alternativen zu SF₆-Gas - 3 Vorträge
 - SF₆ Schaltanlage - Unterwassereinsatz
 - Transformatoren - 2 Vorträge





Performances and safety properties of alternative gases for load break switch

Innovative SF₆ free switch with shunt vacuum interruption technology

	SF6 (1.3 bar abs)	C4F7N (0.75 bar) dry air (0.55 bar)	C5F10O (0.18 bar) dry air (1.12 bar)	CO2 (1.3 bar abs)	HFO1234 zeE (1.3 bar abs) + vacuum interrupter	air (2.5 bar abs) + vacuum interrupter
dielectric performances	100 % (ref)	120%	90%	40%	100%	100%
switching performances (630 A / 24 kV)	++	+	-	--	+++	+++
fuse switch performances at 24 kV	++	+	--	---	+++	+++
CMR risks	No	not demonstrated	not demonstrated	No	No	No
LC50 (4h) rat of the pure fluorinated gas	> 80 %	0.16 %	1.23 %	NA	> 21 %	NA
LC50 (4h) rat of gas mixtures	> 80 %	0.28 %	8.88 %	> 16 %	> 21 %	100 %
LC50 (4H) rat of the gas mixture after breaking	2.6 % << 3.8 %	< 0.02 %	0.21 %	NA	> 21 %	100 %
handling and end of life	-	---	--	+++	+	+++

→ Pressurised air with vacuum interrupter is the best alternative



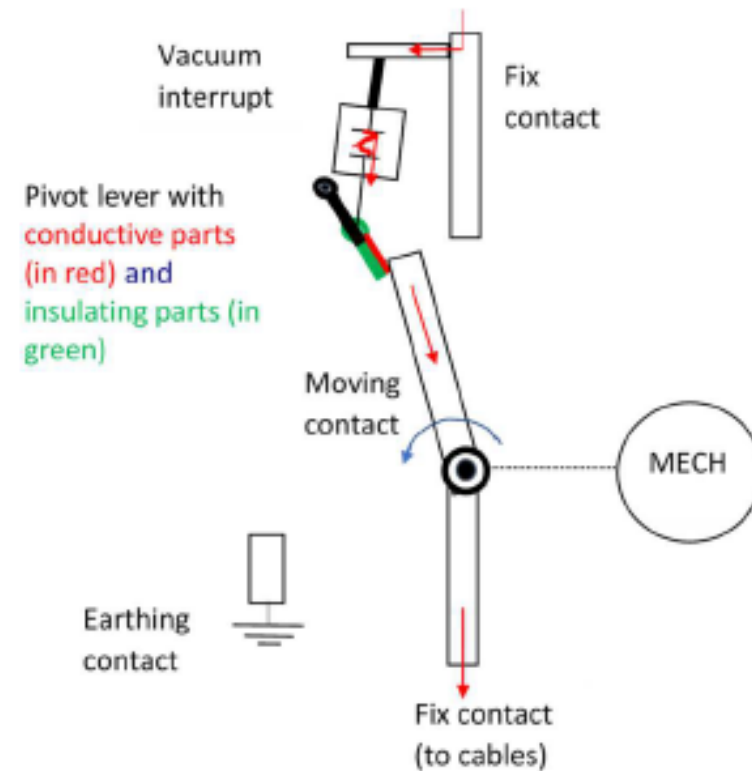
3-positions load break switch with shunt vacuum interruption technology ...

☞ Vacuum Interrupter used for breaking operation:

- Innovative breaking principle with a vacuum interrupter set in parallel of a 3-positions disconnecter.
- Breaking operation: the current is commuted to the VI

☞ Disconnecter with air gap

☞ Traditional 3-positions switch operation

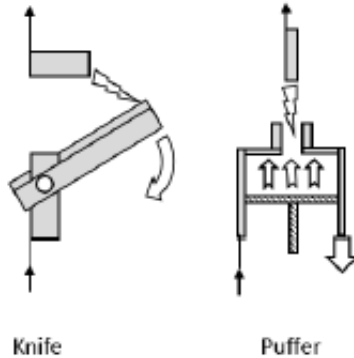


➔ ... enables to have a compact and cost effective solution



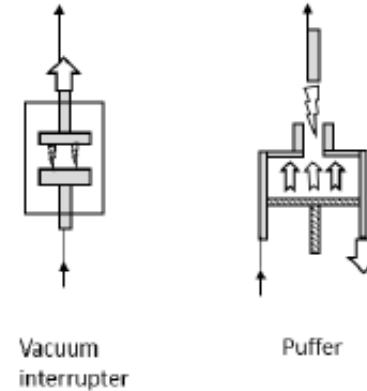
Load Current Interruption

SF6 LBS



SF6-Free LBS

(paper 0614 - CIRED 2017)



State of the art

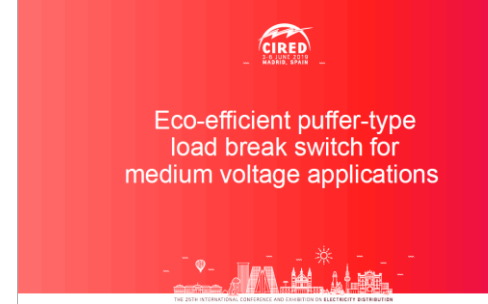
- **Knife switch:** cost effective, simple and user friendly solution for SF6 load break switches
- **Puffer switch:** especially used for higher voltages load break switches

State of the art

- **Vacuum switching technology** require an additional disconnector/earthing switch, more costly and change the operation scheme

New solution

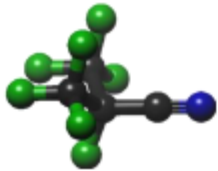
- **The puffer switch** is reliable , cost effective and user friendly solution which the downsides of vacuum switching can be overcome





g³ as an alternative to SF₆

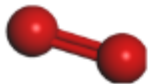
A gas mixture made of :



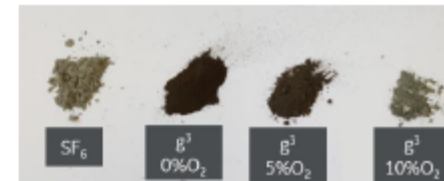
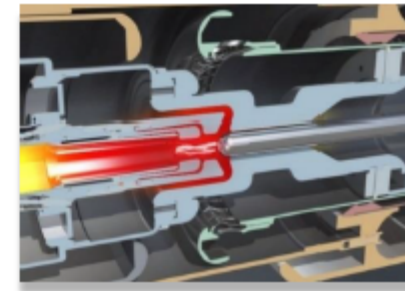
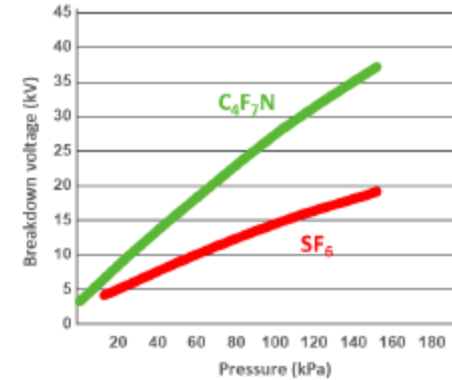
- (CF₃)₂CFCN, 3M™ Novec™ 4710 Insulating Gas: provides the dielectric strength (nitrile triple function combined with fluorine). 3 to 10%vol.



- CO₂ handles the arc interruption process. Main gas.



- O₂ Oxygen helps reducing carbon generation in arcing condition. Graphite and CO are significantly reduced. Up to 13%vol.

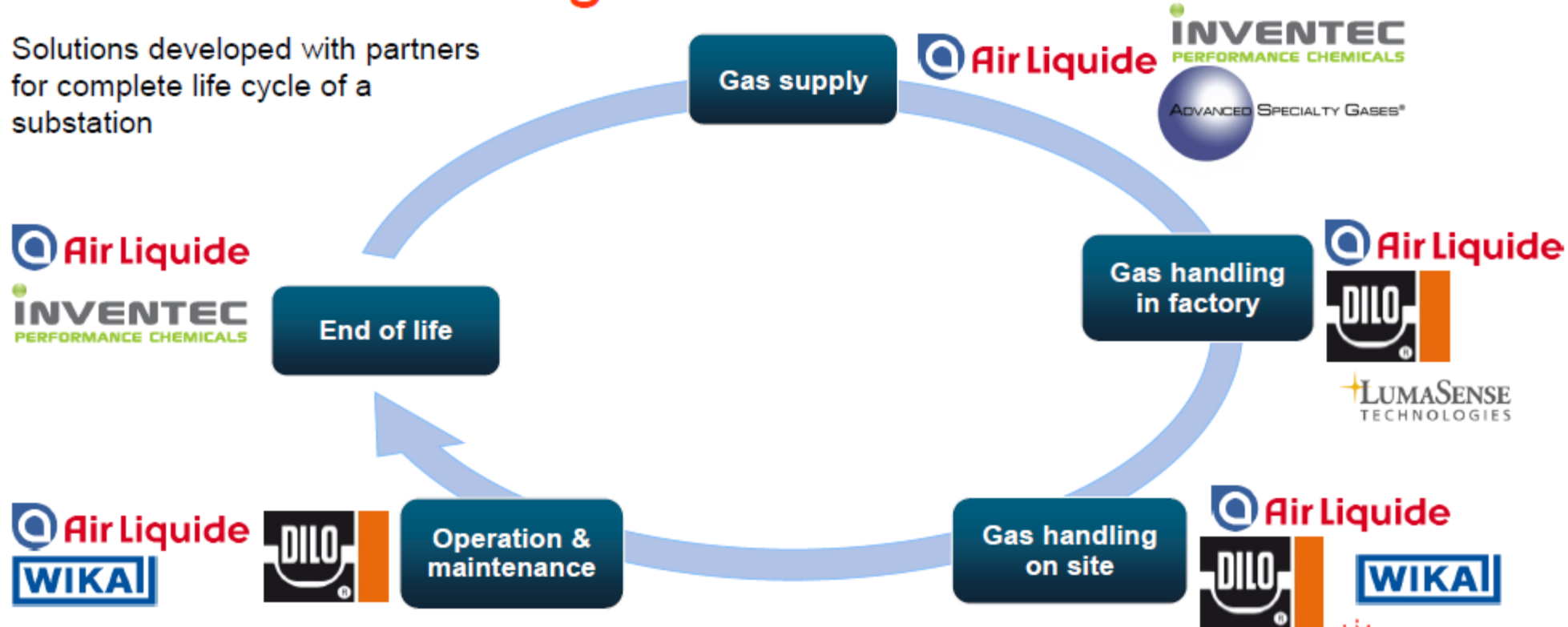


SF₆ Alternative -
What to learn from
the HV experience ?



Gas management

Solutions developed with partners for complete life cycle of a substation





Gas handling tools

Gas carts for gas filling, recovery and topping-up



Gas quality check (humidity, ratio)



Gas leakage detection



PPE



- Poster Session:

- 590 e-posters
- Jede Session hat einen Tag Postertour

511 – ASSESSING POSSIBLE ALTERNATIVES TO SF6 IN MV SWITCHGEAR

THE 20TH INTERNATIONAL CONFERENCE AND EXHIBITION ON ELECTRITY DISTRIBUTION

IN MV SWITCHGEAR

Jesús O'CARA Ormazabal, Spain Javier LARRIETA Ormazabal, Spain José Manuel INCHAUSTI Ormazabal, Spain Sergio SEBASTIÁN Ormazabal, Spain

Introduction
This paper presents some tests results a behaviour of different selected gas mixtures low GWP, as alternatives to SF6, during a lasting up to 46,5 months in an experiment.

Dielectric capability under AC voltage
For making a preliminary selection one equipment with a hermetic cell provides electrodes was implemented for compare dielectric strength of selected mixtures. Different pressures from 1000 to 1500 n MV switchgear) were tested and compare vector gases (N₂, CO₂, synthetic air...) at SF6. Some findings were:

- C4-FN gas mixtures had higher dielectric than CS-FK gas mixtures for the same volume of doping product, for tested gas
- Doping with HFO-1234zeE gas mixture air and CS-FK increases the dielectric strength

Checking the stability of gas mixture operating AC voltage
Installed in an experimentation network permanent 30 kV AC voltage has been a prototype MV switchgear cubicles filled selected different gas mixtures. See Figure 1.

Gas mixture	Dielectric strength (kV)
N ₂ 30% CS ₂ + CO ₂	100
N ₂ 70% HFO-1234zeE + CO ₂	110
N ₂ 30% CS ₂ + synthetic air	100
N ₂ 30% CS ₂ + 2% HFO-1234zeE + synthetic air	110

Table 1 – Gas mixture used in the cell during long term tests under permanent voltage.

770 – Innovative SF6-free Switch with Vacuum Interruption Technology

THE 20TH INTERNATIONAL CONFERENCE AND EXHIBITION ON ELECTRITY DISTRIBUTION

770 – Innovative SF6-free Switch with Vacuum Interruption Technology

Christophe PRIVE Schneider Electric - France Romain MALADEN Schneider Electric - France Daniel PICCOZ Piccoz SASU - France

Introduction
SF₆ is a greenhouse gas with a GWP of 22 800. It is a suitable technology for the development of clean MV and LV equipment.

Characteristics and behavior of g₃ High-voltage equipment

Environmental

- SF₆ is included in Global Warming Potential (GWP)
- Save equipment knowledge as SF₆ switchgear has been the subject of 40 years of experience

Performance

- Same temperature range as SF₆ (0 to 55 to 110 °C)
- No leakage of current (no SF₆)

Safety

- Class B technology – same safety class as SF₆

g₃ High-voltage equipment

145 kV GIS 420 kV GIS

CIRED 2019 Poster Session – Paper 05

VI in serie with a 3-positions disconnecter
This is a traditional well known solution. For load break switch application, VI ensures the dielectric withstand, the short-circuit making capacity, the current switching, the short time current withstand (with its peak value) and the continuous current withstand. However, this architecture has some drawback such as:

- the manner to operate is different from a SF₆ 3-positions switch as the opening/disconnecting is made with 2 operations.
- the cost of the solution is high: standard VCB is in serie with a disconnecter




Figure 1 – VI in serie with a 3-positions disconnecter

VI in parallel with a 3-positions disconnecter
In this innovative system, the use of vacuum interrupters in parallel of a 3-positions disconnecters enables to have a compact and cost-effective solution. This solution is based on a traditional 3-positions disconnecter: current breaking operation is ensured by vacuum interrupters and disconnection is made by a gas gap between conductors.

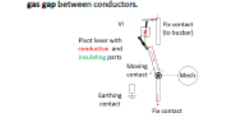
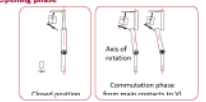


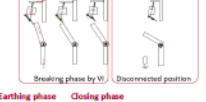
Figure 2 – VI in parallel with a 3-positions disconnecter

Operation of shunt vacuum interrupter system

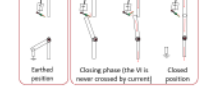
Opening phase




Breaking phase by VI



Earthing phase



Closing phase



Conclusion
Shunt vacuum interruption technology in pure air enables to propose a safe, compact and cost-effective 3-positions load break switch and AIS/GIS switchgear with same dimensions than SF₆ ones.

Life is On Schneider Electric

CIRED 2019 Poster Session – Paper 770 – Session 1



Besten Dank für die Aufmerksamkeit!

Kontakt: www.cired.at / cired@ove.at