



## **Incontro Panel Italiano Study Committee Cigre A3**

*Luciano Martini*

*Direttore TTD*

**CESI**



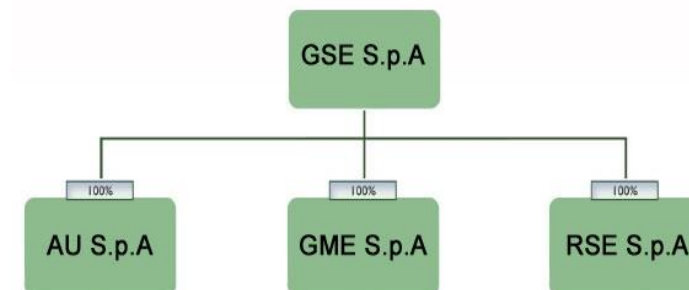
Milano, 18 Aprile 2023

# Incontro Panel Italiano Study Committee Cigre A3

Luciano Martini  
Direttore TTD

# Natura e ruolo di RSE

- Ricerca sul Sistema Energetico - **RSE** è una società di ricerca, con sede principale a Milano, controllata al 100% dal **GSE** ([www.gse.it](http://www.gse.it))
- Conta circa 300 ricercatori ed ha una dotazione importante di laboratori e strutture sperimentali
- Le attività sono finanziate in misura prevalente da programmi nazionali e comunitari, soprattutto attraverso il Fondo della **Ricerca di Sistema** per il settore elettrico (**RdS**)
- Le competenze acquisite e l'approfondita conoscenza degli aspetti tecnico-economici del sistema energetico ci consentono di svolgere il ruolo di *advisor* delle Istituzioni (in primis **MASE** e **ARERA**)
- Il tratto distintivo di RSE è l'intrinseca indipendenza e terzietà rispetto ai legittimi, diversi e talora contrastanti interessi dei diversi attori in gioco



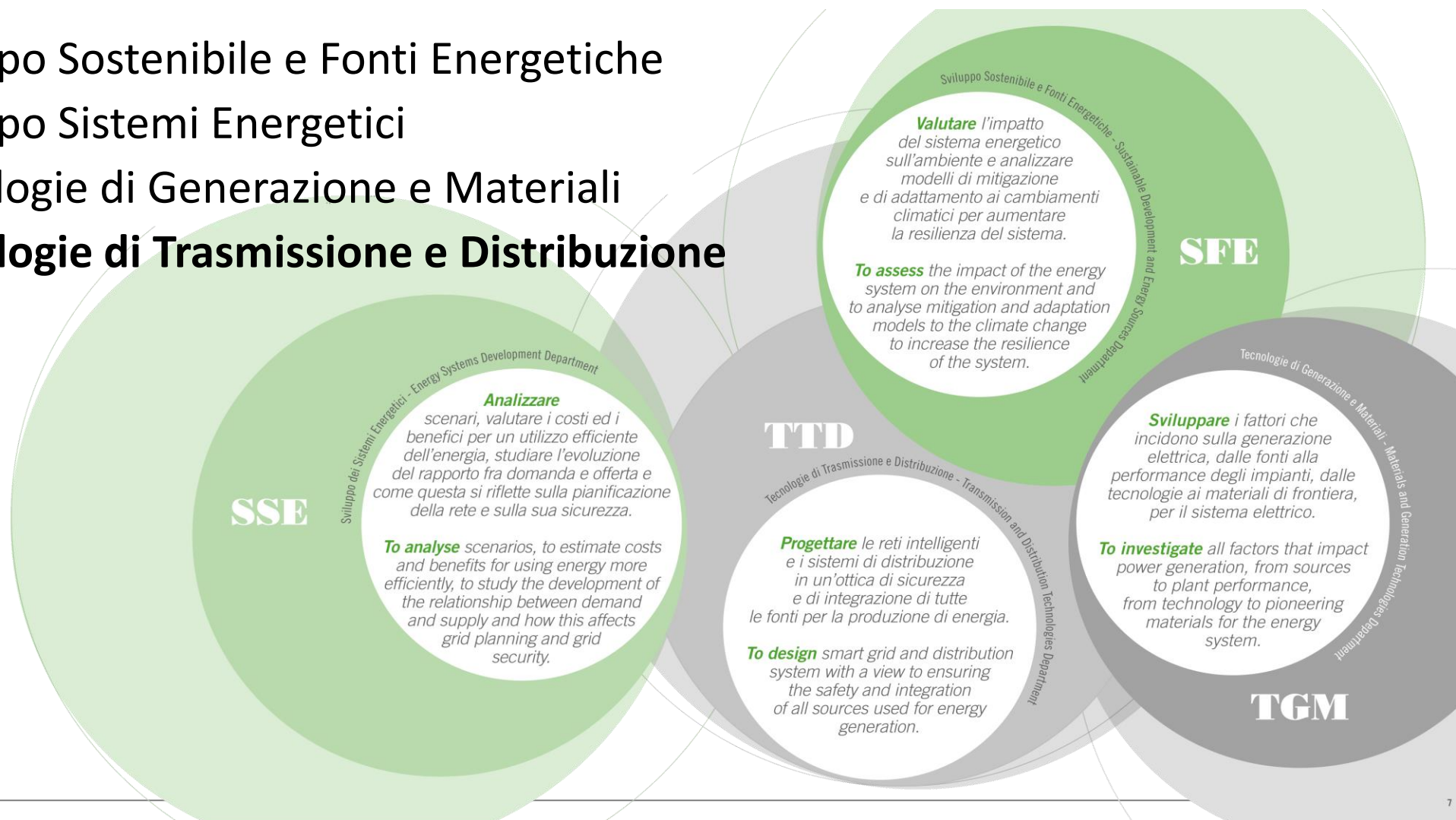
# RSE: focus delle ricerche

- RSE è un Organismo di Ricerca che sviluppa ricerche di interesse pubblico nel settore elettro-energetico ed ambientale
- Adottiamo un approccio sistemico, valorizzando le competenze multidisciplinari
- Abbiamo particolare cura per le applicazioni sperimentali (progetti pilota), che integrano la visione di sistema con l'approccio sperimentale
- Il nostro obiettivo è il beneficio del sistema elettrico nazionale: dunque gli utenti e il sistema delle imprese
- Operiamo un'ampia disseminazione dei risultati della ricerca destinata alla pubblica utilità e utilizziamo l'approccio dell'open innovation



# RSE: I 4 Dipartimenti

- ❑ Sviluppo Sostenibile e Fonti Energetiche
- ❑ Sviluppo Sistemi Energetici
- ❑ Tecnologie di Generazione e Materiali
- ❑ Tecnologie di Trasmissione e Distribuzione



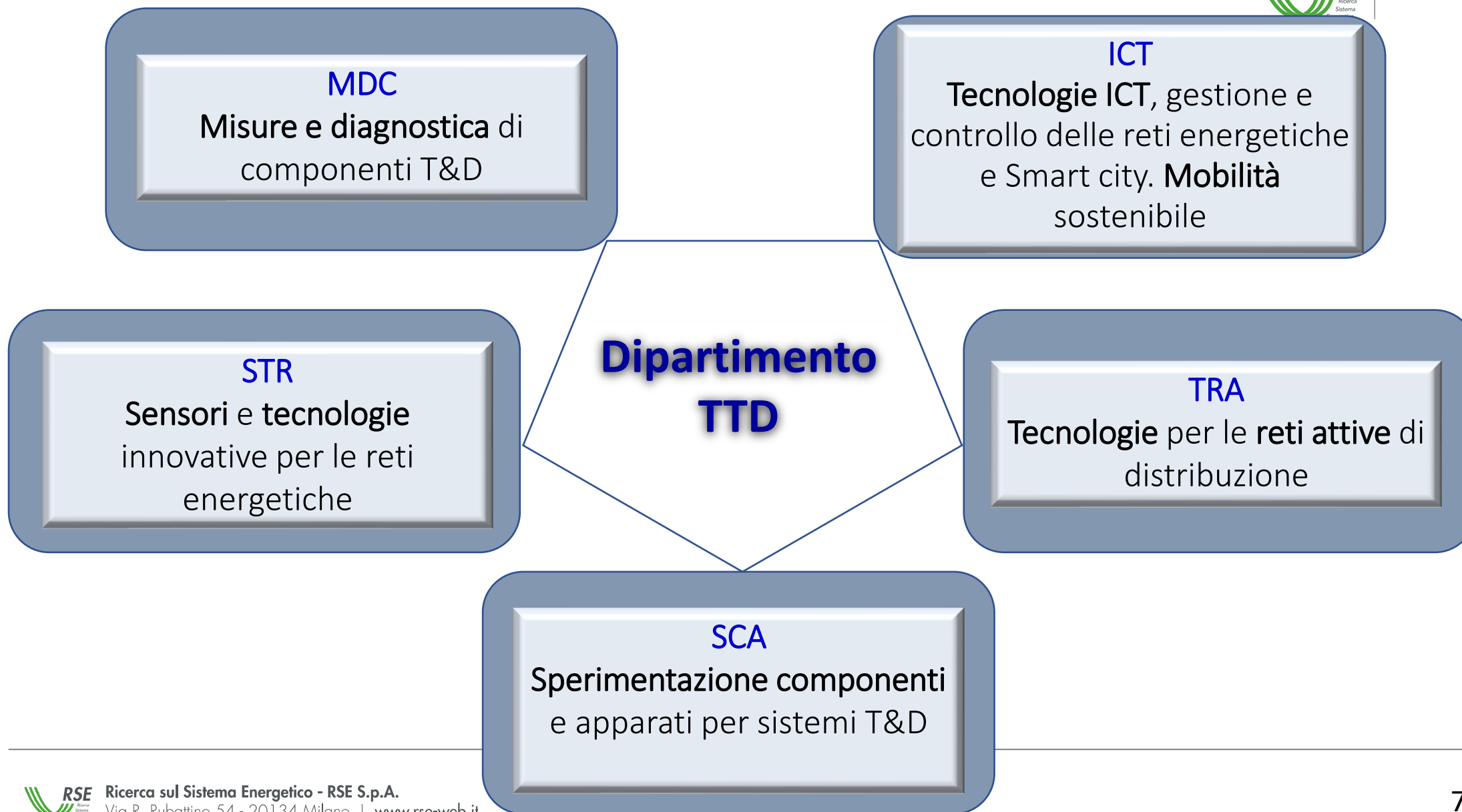
# La Missione del Dipartimento

Sviluppare **attività di studio, ricerca e sperimentazione** su **componenti elettrici di rete**, attraverso la messa a punto di **metodologie avanzate di diagnostica**, estensione della durata di vita e delle condizioni di operatività dei componenti attuali e l'analisi comparativa di tecnologie.

**Studi sulla mobilità elettrica, sviluppo e caratterizzazione di componenti elettrici innovativi e sistemi di controllo, protocolli di comunicazione e ICT** potenzialmente in grado di favorire l'evoluzione della rete elettrica al fine di incrementarne la flessibilità, la sicurezza e l'efficienza.



# L'organizzazione del Dipartimento



# TTD e i suoi Laboratori (1/2)

- Laboratorio 18 kJ per prove Dielettriche
- Laboratorio Gabbia di Faraday
- Laboratorio Polluzione piccola
- Laboratorio Diagnostica dielettrica
- Laboratorio Diagnostica oli
- Laboratorio Sensori e Strumentazione
- Laboratorio Superconduttori
- Laboratorio Prova Cavi MT
- Laboratorio Elettronica e misure diagnostiche
- Laboratorio Prove meccaniche Brugherio
- Laboratorio Taratura strumenti
- Laboratorio Tecnologie elettroniche
- Laboratorio Inverter
- Laboratorio IoT e Big Data
- Laboratorio Cybersecurity
- Sistema di Monitoraggio Qualità della Tensione





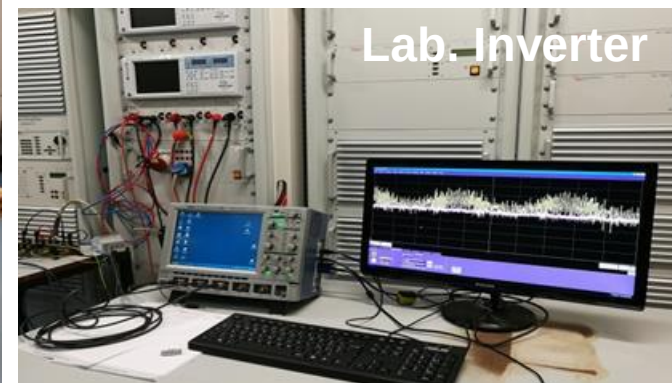


Lab. 18 kJ

# TTD e i suoi Laboratori (2/2)



Lab. Tecnologie Elettroniche



Lab. Inverter



Lab. Superconduttività



Lab. Elettroottica



Lab. Cybersecurity

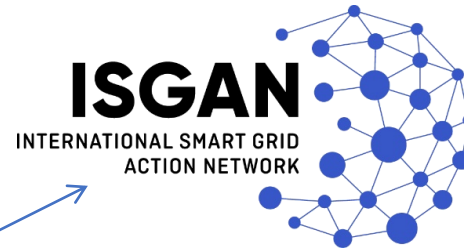


Lab. IoT e Big Data



Lab. Polluzione

# Attività Internazionale





# L'impegno RSE nella Normativa tecnica: Focus TTD

| Standardization Body                                                                | Partecipazioni                                                                            | Ruoli di coordinamento<br>(Presidenze, Segreterie, Convenor)                                                                                                                                                                             | n.<br>Partecipanti |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
|    | <b>26</b> Comitati Tecnici<br><b>1</b> Tavolo di confronto<br><b>3</b> GdL<br><b>3</b> TF | <b>1</b> Presidenza - L. Martini (90)<br><b>2</b> Vicepresidenze - R. Chiumeo (77A), P. Mazza (38)<br><b>6</b> Segreterie - G. Angeli (90), G. Dondossola (57), C. Gandolfi (320), R. Malgesini (42), G. Pirovano (7/11), L. Tenti (77A) | 32                 |
|    | <b>(26)</b> Comitati Tecnici<br><b>4</b> WG                                               | <b>2</b> Segreterie internazionali - G. Manzini (82), P. Mazza (38)                                                                                                                                                                      | (32)               |
|  | <b>9</b> Technical Committee<br><b>2</b> System Committee<br><b>18</b> WG                 | <b>2</b> Presidenze - G. Pirovano (7, 11)<br><b>1</b> Convenor - P. Mazza (TC 38 WG 47)                                                                                                                                                  | 16                 |



# L'impegno TTD nella Normativa tecnica: Esempio CT 38

| Comitato                                                                          | Gruppo            | Scopo                                                                   | Ruolo                 |
|-----------------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------|-----------------------|
|  | CT 38             | Trasformatori di misura                                                 | <b>Vicepresidenza</b> |
|                                                                                   | CT 13             | Misura energia e controllo carico                                       | Membro                |
|   | TC 38             | Instrument Transformers                                                 | <b>Segreteria</b>     |
|   | TC 38 WG 47       | Evolution of Instrument Transformers requirements for the future market | <b>Convenor</b>       |
|                                                                                   | TC 38 CAG         | TC 38 Chair Advisory Group                                              | <b>Member</b>         |
|                                                                                   | TC 38 WG 37       | Electronic Instrument Transformers - SAMU                               | Member                |
|                                                                                   | TC 38 WG 45       | Mathematical Models for Instrument Transformers                         | Member                |
|                                                                                   | TC 38 IEEE JWG 55 | Uncertainty evaluation in the calibration of Instrument Transformers    | Member                |



## IEC 1906 Award • 2013

IEC 1906 Award recognizes exceptional recent achievements related to the activities of the IEC and which contribute in a significant way to advancing the work of the Commission



Grazie per l'attenzione

*[luciano.martini@rse-web.it](mailto:luciano.martini@rse-web.it)*

# RSE – Ricerca Sistema Energetico: chi siamo



## MISSION

Ricerca sul Sistema Energetico  
a beneficio di tutti i consumatori



## PROPRIETA' e CONTROLLO

S.p.A. posseduta da MEF tramite GSE, opera su indirizzo di MASE e ARERA



## PERSONE

345 persone  
2/3 laureati, 80% ricercatori;  
sede principale Milano



## ATTIVITA' PER LA TRANSIZIONE

Ricerca di base su sistema energetico  
Modelli e scenari per strategie nazionali  
Supporto alla regolazione/normazione  
Trasferimento tecnologico  
Affiancamento all'industria  
Rappresentanza internazionale



# La collaborazione tra i Gruppi di Ricerca TTD per la Transizione energetica

## Tecnologie ICT per gestione e sicurezza reti T&D



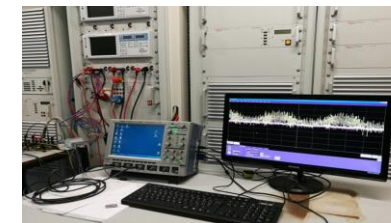
- IoT, Lora, Edge, Fog, Cloud
- Big Data, serie temporali
- Cybersecurity
- Machine Learning, Blockchain
- Infrastrutture mobilità elettrica
- Elettrificazione porti (cold ironing)
- Elettrificazione trasporti (inclusi mezzi pesanti, traghetti, motonavi)

## Misure e diagnostica di componenti T&D



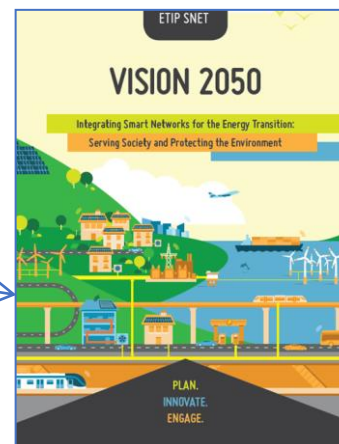
- Osservabilità
- Resilienza
- Trasformatori misura
- Fenomeni impulsivi
- SAMU, PMU
- Sicurezza

## Tecnologie per le reti attive di distribuzione



- Monitoraggio qualità della tensione (classificazione buchi, indicatori PQ)
- Studi e simulazioni elettromagnetiche, anche Real Time
- Sistemi di controllo per apparati di elettronica di potenza
- Coordinamento delle protezioni nelle reti attive in ca e in cc
- Studio di nuove architetture di rete attive in ca e cc

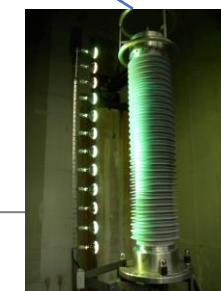
## Sistemi e tecnologie innovative per le reti energetiche



- Limitatori di corrente superconduttivi
- Sensori di campo elettrico
- Modellistica invecchiamento dielettrici
- Diagnostica oli trasformatori
- Monitoraggio conduttori



## Sperimentazione componenti e apparati per sistemi T&D



- Analisi deterioramento isolatori
- Misure di scariche parziali in cavi e giunti
- Analisi oli trasformatori
- Prove meccaniche su conduttori e componenti linee





GRAZIE PER L'ATTENZIONE

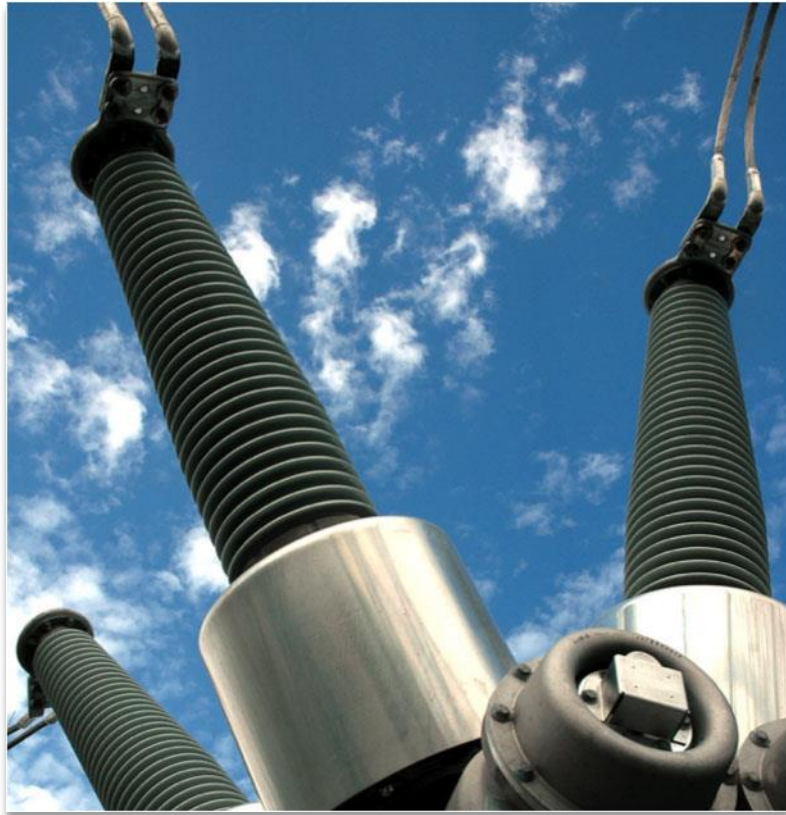
# CESI Group





# Helping Our Global Clients Winning the Energy Transition Challenges

## Original Equipment Manufacturers & Technology Developers



### **Support**

test and developement of  
innovative technologies

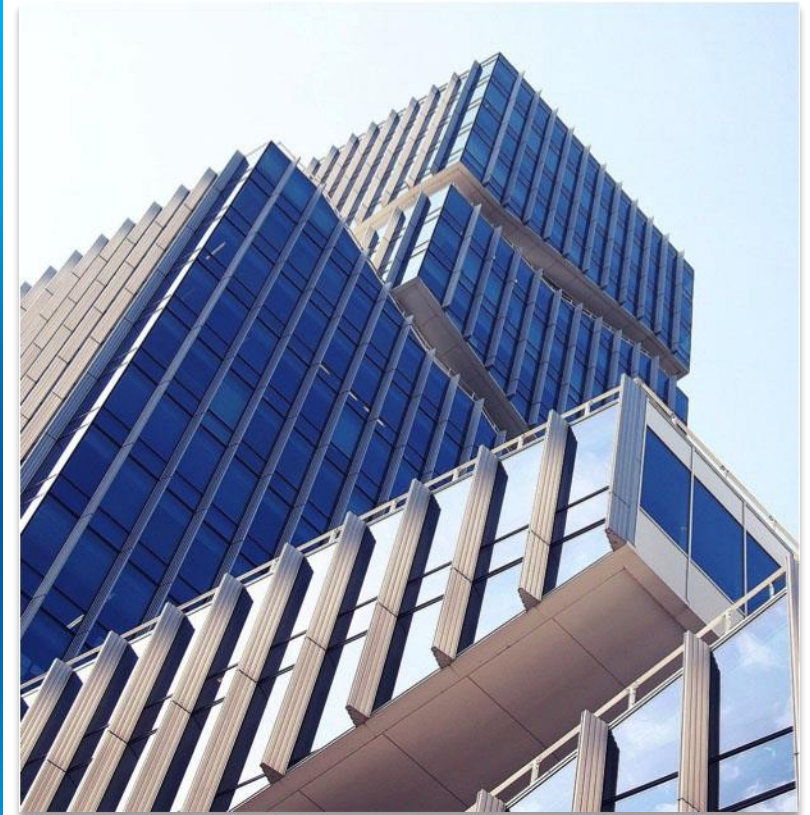
## Utilities & Energy Investors



### **Enable**

deployment, design and  
integration of large-scale projects

## Governments, Regulators & Financial Institutions



### **Advise**

on power systems, regulation, energy  
markets and feasibility studies

# High-end, Tailor Made Solutions for our Global Clients

## Testing, Inspection & Certification



**KEMA** Labs

The Global Leader in Independent Testing, Inspection and Certification for the Electricity Sector

## Energy Consulting



**CESI**

Our Expertise in The Energy Industry at Your Disposal Through Ad-hoc Consultancies

## Environmental Consulting & Civil Engineering



**ISMES**

Renewable Engineering, Remediation, Compliance and Monitoring Services to Drive Circular Economy

## Space Solar Cells



**CESI**

Production of Advanced Multi-junction Solar Cells for Space Applications



# A Global Player in Engineering, Testing and Power Systems Consulting



**~2,000**  
Professionals



**2,000+**  
Clients



**70+**  
Countries Served



**11**  
Global Sites



● Commercial Network    ● CESI Global Office    ● KEMA Labs Site

# 30.000 MVA, Close to Our Clients

## Arnhem, NL



**13,000 MVA**

- **Short Circuit HV** up to 1200 kV, 100 kA
- **High Power Trafo** up to 800 kV
- **Dielectric Test HV** up to 550 kV
- **Cable Prequalification** up to 550 kV
- **Temperature Rise** up to 25 kA

## Milan, IT



**4,000 MVA**

- **Short Circuit HV** up to 420 kV, 63 kA
- **Direct Test** up to 36kV/31.5kA
- **Dielectric Test HV** up to 1.600 kVac
- **Cable Prequalification** up to 800kV
- **Temperature Rise** up to 10kA

## Berlin, DE



**3,000 MVA**

- **Short Circuit LV** to 250kAac/150kAdc
- **Direct Test** up to 36kV/25kA
- **Dielectric Test HV** up to 550 kV
- **Cable Prequalification** up to 500 kV
- **Temperature Rise** up to 50kA

## Prague, CZ



**2,500 MVA**

- **Short Circuit MV** up to 36 kV, 25 kA
- **Power arc insulators** up to 63 kA
- **Power Trafo** up to 230 kV, 63 MVA
- **Short-time current** up to 280 kA/2.5s

## Mannheim, DE



**800 MVA**

- **HVDC cable** up to 600 kV
- **Direct Test short-circuit** up to 800 MVA
- **Dielectric Test HV** up to 800 kV
- **Cable Prequalification** up to 400 kV
- **Pollution test** up to 600 kV

## Chalfont, USA



**3,200 MVA**

- **Short Circuit MV** up to 36 kV, 25 kA
- **Short Circuit LV** up to 300 kA
- **Dielectric Test HV** up to 245 kV
- **Temperature Rise** up to 30 kA

# Full Product Lifecycle Support



**Research & Development**

**Production**

**Field Operations**



**Testing  
Laboratories**

R&D Test

Type Test

Routine Test



**On-Site  
Services**

Commissioning

Diagnostics



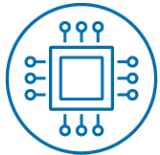
**Inspections  
& Product  
Certification**

Design Review

Qualification

Witnessing

Technical Investigation



**Digital Lab &  
Smart  
Technologies**

Cyber Modelling

Functional Compliance

Assessment

Interoperability



# Bringing Components from Development to the Field

## Tested Components



### Electromechanical components

- Circuit breakers
- Switchgears
- Transformers
- Cables
- Gas Insulated Switchgears
- Surge Arresters
- Insulators & Bushings

## Testing Services



### Type Tests

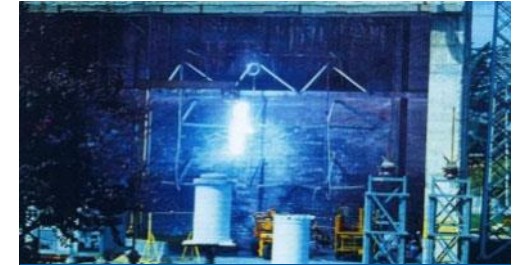


### Routine Tests



### Research & Development Tests

## Testing Areas



### Electrical



### Mechanical



### Climatic/Environmental



# KEMA Labs tests all T&D components



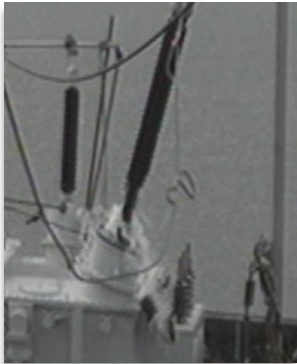


# Statistics on failure rate during type testing

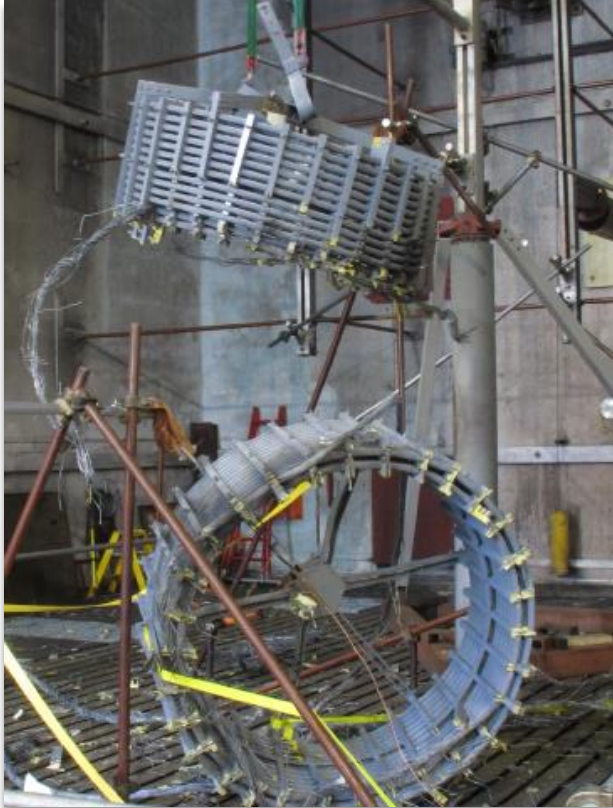
Around **25%** of test-objects initially fail to pass type-tests



Line trap



Broken bushing



Line trap



Disconnecter



Switchgear panel



Distribution transformer



Oil spill

Source: KEMA Labs, large section of components tested



- **On-site commissioning testing of transformers, generators, HV cable systems and complete substations**
- **Flexible fleet of resonant trailers** to reach out to global clients
- Acceptance tests on **extremely long offshore cables**
- More than **5.000 km Cables tested every year up to 245 kV**

## Selected Global Customers







- Guidance through the **quality assurance, conformity assessment and product certification** process
- **Highly-skilled professionals** and **5 delivery centers** worldwide
- Accredited service **according to international standards ISO/IEC 17020 and ISO/IEC 17065**
- Remote **Virtual Inspection** services

## Selected Global Customers



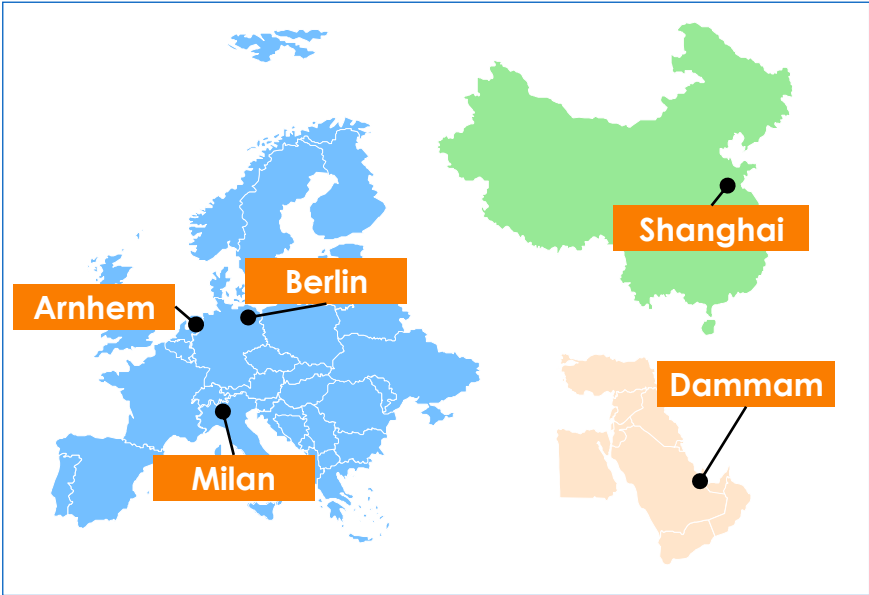


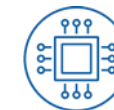
# International Quality Assurance & Quality Control Services

## Service Portfolio

|                         |                                                                                                                                                                                                    |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Suppliers Qualification | <ul style="list-style-type: none"><li>• Systems and Components Suppliers Qualification</li><li>• Technical and Organization Audits</li><li>• In Process Inspections</li><li>• Expediting</li></ul> |
| Technical Investigation | <ul style="list-style-type: none"><li>• Failure analysis</li><li>• Expertise and third party evaluations</li><li>• On site survey and verifications</li><li>• O&amp;M Assistance</li></ul>         |
| Design Review           | <ul style="list-style-type: none"><li>• Revision of Technical Specifications</li><li>• Design Review</li></ul>                                                                                     |
| Inspections             | <ul style="list-style-type: none"><li>• Factory Acceptance Testing</li><li>• Witnessing to non-KEMA Labs Testing</li></ul>                                                                         |

## Global Offices & Delivery Centers





- A Flexible platform for **Cyberphysical Systems Testing** made of **ca10 Advanced Testing Facility**
- Accredited body for **Advanced Metering, Protections and Substation Automation** Testing
- **Digital Testbed for Hardware in the Loop and Real Time Simulation**

## Selected Global Clients

e-distribuzione

Terna

ABB

SIEMENS

CISCO

KAIFA

enel x

Landis  
Gyr+

SAGEMCOM

Schneider  
Electric



# CESI Group **KEMA Labs**

# THANK YOU!



# Comitato Nazionale Italiano CIGRE

## Panel Italiano SC A3 - HV EQUIPMENT

Meeting 18 Aprile 2023



**cigre**

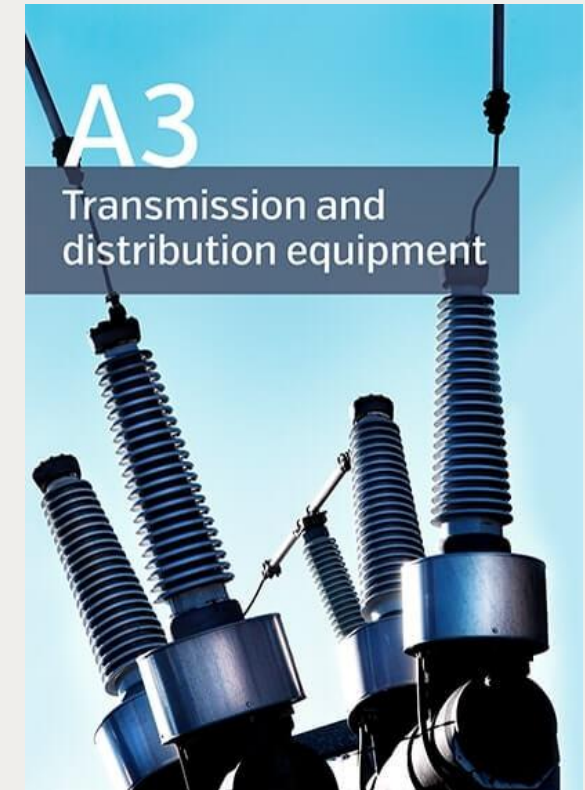
For power system expertise

Paolo Mazza  
Roberto Nicolini

# COMITATO DI STUDIO A3

## Transmission and Distribution equipment

- Indice
- Organizzazione e scopo SC A3
- Organizzazione e scopo panel SC A3
- Gruppi di lavoro attivi
- SC A3 Meeting 2022
  - Hot topics
  - CIGRE Enforcement
  - ToR in discussione
- General Discussion Meeting 2022 – Sintesi
- Session 2024 – Preferential Subjects
- SC A3 – Prossimi eventi



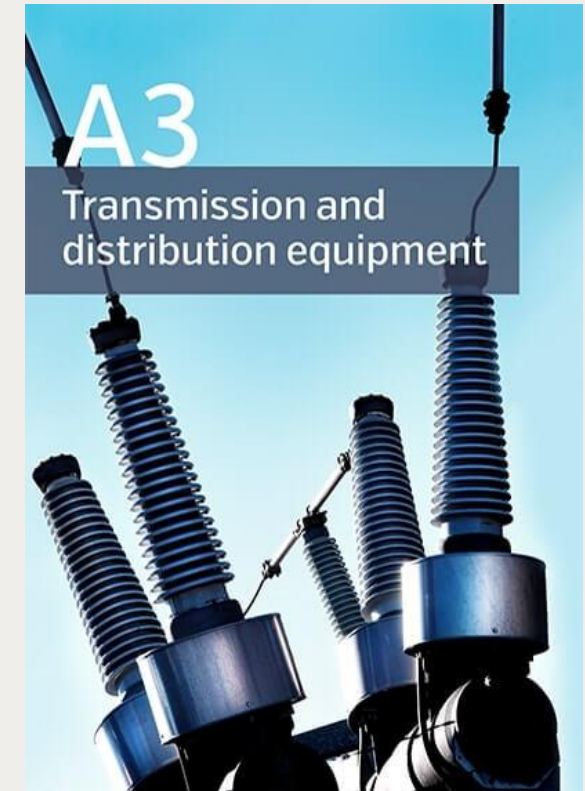
## COMITATO DI STUDIO A3

### Transmission and Distribution equipment

Il campo di attività del Comitato di Studio A3 copre le apparecchiature di commutazione, interruzione o limitazione di correnti, compresi interruttori, interruttori di manovra, *recloser*, *Ring Main Unit* (RMU), sezionatori, sezionatori di terra e fusibili limitatori di corrente, indipendentemente dalla tecnologia.

Comprende anche scaricatori di sovratensione, condensatori, sistemi sbarre, isolatori, trasformatori di misura, e tutte le altre apparecchiature non specificamente coperte da altri comitati di studio relativi ad apparecchiature.

Infine, sono considerati tutti i tipi di isolamento (aria, gas o isolamento solido) e mezzi di interruzione (vuoto, gas...).

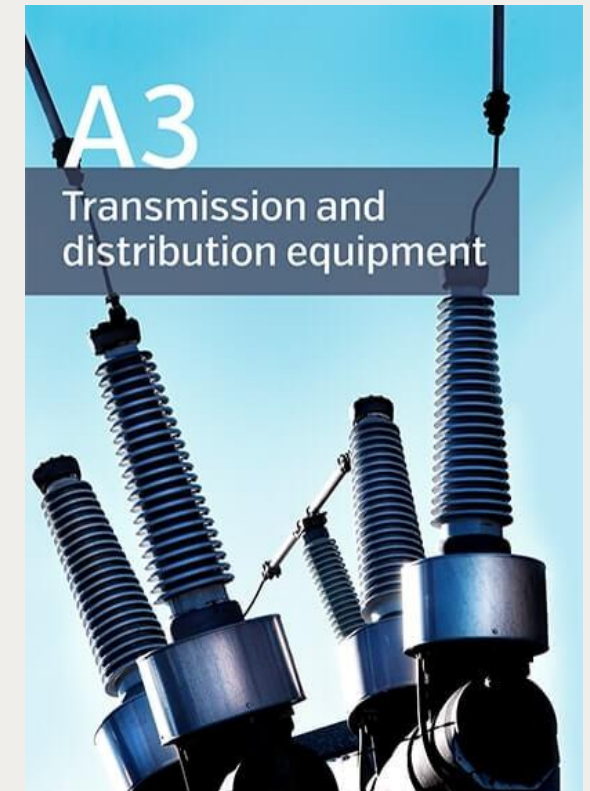




# SCOPO

Relativamente al proprio campo di attività, il Comitato di Studio A3 affronta tutte le fasi del ciclo di vita delle apparecchiature; dalla concezione alla ricerca, allo sviluppo, progettazione, produzione, distribuzione, prove, installazione, funzionamento, manutenzione e al fine vita.

In tutte le fasi, vengono affrontati gli aspetti tecnici, di sicurezza, economici, ambientali e sociali, nonché le interazioni e l'integrazione con il sistema energetico in evoluzione e con l'ambiente. Tutti gli aspetti delle prestazioni, delle specifiche, delle prove e dell'applicazione delle tecniche di prova rientrano nell'ambito di applicazione, con un focus specifico sull'impatto dovuto all'evoluzione del sistema elettrico.



## STRUTTURA

**CHAIR** Nenad Uzelac (G&W – US)

**SEGRETARIO** Frank Richter (50 Hz – Germany)

**MEMBERSHIP** 24 regular members (+6 additional)  
15 observers

**RAPPRESENTANTE ITALIANO** Paolo Mazza

**SEGRETARIO ITALIANO** Roberto Nicolini

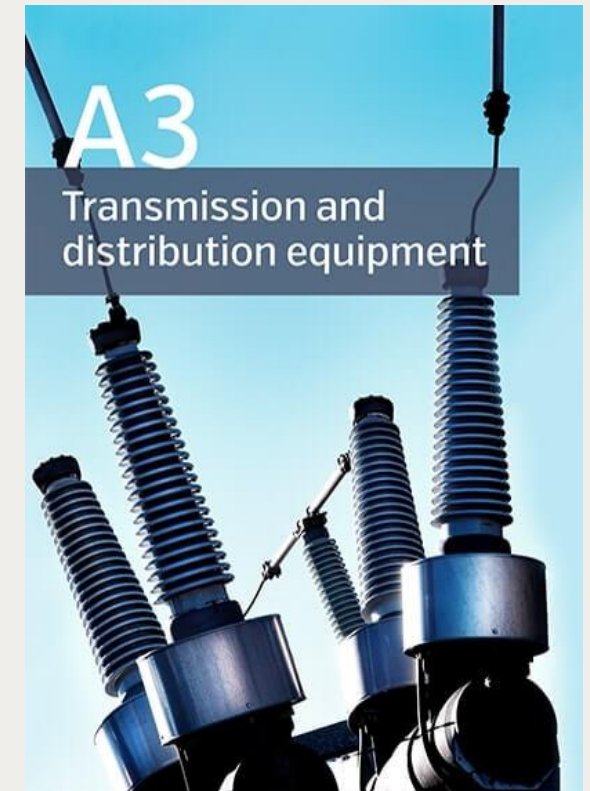
9 WORKING GROUP attivi + 5 JWG con partecipazione di A3

3 ADVISORY GROUP

AG 01 Strategic Planning (H. Ito)

AG 02 Tutorial Planning (R. Smeets)

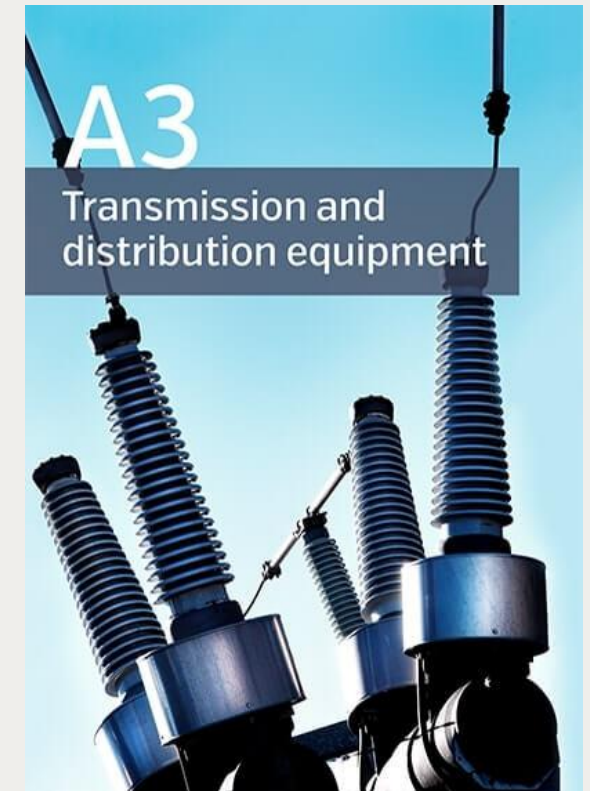
AG 03 Greenbook Project on “Switching Equipment (H. Ito)



## ORIENTAMENTO STRATEGICO

SC A3 è caratterizzato dai seguenti obiettivi strategici "3D" (Decentramento, Decarbonizzazione e Digitalizzazione):

1. Design e tecnologie innovativi (es. interruttori DC, *rating* più elevati)
2. Requisiti per apparecchiature in particolari condizioni di rete e ambientali (es. applicazioni *offshore*, condizioni meteorologiche avverse)
3. Applicazioni *smart* nelle apparecchiature di T&D (es. commutazione controllata, LPIT, tecnologie *digital twin*, *machine learning*)
4. Monitoraggio e diagnostica delle apparecchiature di T&D (es. sensori avanzati, applicazione di tecnologie non invasive)
5. Tecniche di prova innovative (es. sollecitazioni sovrainposte per apparecchiature HVDC)
6. Valutazione dell'affidabilità e gestione della vita residua delle apparecchiature
7. Focus su ambiente e sostenibilità (es. apparecchiature a minore impronta di carbonio, tecnologie SF6 *free*)





## PANEL SC A3 - ITALIA



«Il ruolo dei Comitati Nazionali è quello di diffondere informazioni tecniche tra i membri, organizzare conferenze in cui sono invitati comitati di studio o gruppi di lavoro internazionali per affiancare ingegneri locali a esperti internazionali. Il Comitato Nazionale dovrebbe istituire una struttura simile alla struttura CIGRE nella propria area, in modo da rispecchiare tutti i Comitati di Studio. **Il membro nazionale del comitato di studio dovrebbe presiedere questo sottogruppo (denominato gruppo o panel di attività regionale) e invitare membri del mondo accademico, industriale, dei servizi pubblici, delle autorità di regolazione e di altre parti interessate a prendervi parte. Lo scopo del panel è raccogliere informazioni dai membri per comprendere i loro problemi e domande, nonché fornire feedback al panel sui lavori più recenti condotti dal Comitato di Studio internazionale.** Il membro nazionale dovrebbe portare le domande e le richieste in sede di Comitato di Studio per metterle a fattor comune con altri paesi con lo stesso problema. Qualora non fosse già disponibile una soluzione, si può formulare una proposta per un Gruppo di Lavoro.»

**Rob Stephen - Presidente CIGRE: “Importance of the National Committees”, ELECTRA N°308 - Febbraio 2020**

L'elenco dei Working Group attivi e di quelli chiusi negli ultimi anni, delle Technical Brochure e dei documenti pubblicati recentemente e degli esperti italiani partecipanti ai lavori dei WG è disponibile sul sito web del Panel italiano ai seguenti indirizzi:



## **WG CHE HANNO TERMINATO L'ATTIVITÀ 2020-22**

<https://cigregrgroups.org/display/ITA3/Mirror+Panel+IT.A3+Home?preview=/51973913/141756649/Lista%20WG%20chiusi%20al%204-1-22.docx>

## **WG E JWG ATTIVI**

<https://cigregrgroups.org/display/ITA3/Mirror+Panel+IT.A3+Home?preview=/51973913/141756648/Lista%20WG%20attivi%20al%204-1-22.docx>

## **PUBBLICAZIONI 2020-2022**

<https://cigregrgroups.org/display/ITA3/Mirror+Panel+IT.A3+Home?preview=/51973913/145198896/A3-Ultimi%20documenti%20pubblicati.docx>

## **ESPERTI ITALIANI PARTECIPANTI AI WG**

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# TUTORIAL SC A3

Ultimi tutorial svolti



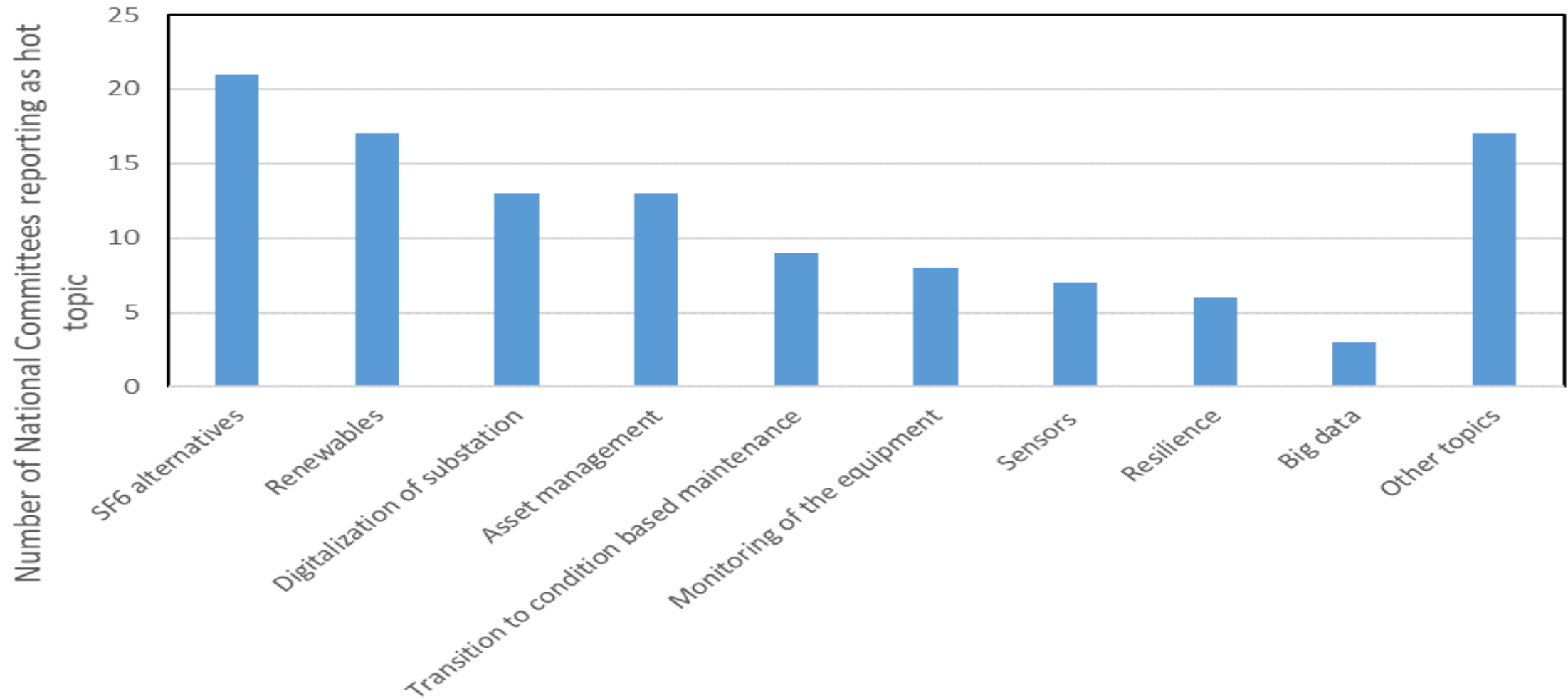
| Tutorial                                        | SC / WG   |
|-------------------------------------------------|-----------|
| A3 tutorial innovation                          | A3        |
| A3 tutorial on vacuum switchgear                | A3        |
| A3.40 tutorial                                  | A3, B4    |
| Current Zero Club interruption in SF6 alt gases | A3        |
| HVDC switchgear                                 | A3, B4.34 |
| Innovation in station equipment technologies    | A3        |
| Innovations in switching technology             | A3        |
| Non-intrusive monitoring techniques             | A3.32     |
| Reliability of HV Equipment                     | A3.06     |
| Shunt reactor switching                         | A3        |
| Switching phenomena                             | A3        |
| Trends in switching technology                  | A3        |

Attesi nella Sessione di Parigi 2022:

- tutorial su Switching vacuum interrupters – con B4
- workshop su SF6 Alternatives – con B3
- presentazione di Current zero club



## SC A3 Meeting 2022: “Hot Topics” (1)



## SC A3 Meeting 2022: “Hot Topics” (2)



- Most national committees (23 out of 29) reported hot topics related to the **environment protection** exclusively including topics from the fields SF6 alternatives and renewables. Certain topics include **lower CO2 imprint** and changing the regulation and waiting for the **limitation of SF6**. Topics from the field of renewables mostly include challenges related to **integration of distributed energy sources, PV and offshore power generation**.
- Regarding the new technologies, 13 national committees reported **digitalization of substations** (and transmission and distribution equipment) as a hot topic and 8 national committees reported as a hot topic or interest in **HV DC grid**, including **HV DC breakers**. Six national committees reported topics of **resilience of substations** (and transmission and distribution equipment) including the resilience against **natural disasters and climate change** (USA, NLD, CRO) and **cyber resilience** (NLD, SWE).

## SC A3 Meeting 2022: “Hot Topics” (3)



- Traditional hot topics are **asset management** (reported by 13 national committees) including the **end-of-life questions** (retrofitting or replacement), **transition from time-based to condition-based maintenance** and **monitoring** of the equipment in general.
- Certain national committees reported specific problems such as: **exploding CT-s in the beginning of life** (GBR), **explosive failure of instrument transformers** < 10 years (AUS), PV with battery storages and problems with harmonics (ZAF), etc.
- Additionally, some emerging topics are identified: **power supply for Data centers** (IRL, SUI), how to **manage store data, cloud data** (SUI, BRA, THA), **AI implementation into grid operation** (USA).



# SC A3 Meeting 2022: Increasing CIGRE value and membership (1)



- *“CIGRE is the place to be to gain unbiased information. Its status may be higher than we see, and the need is clearly existing, which more expertise shifting from users to manufacturers”*
- CIGRE structure: Today driven by technologies, future: **application driven?, it isn't visible or cannot understand**
- *relationship with the standardization bodies, CIGRE does not create standards, no competition: share opinions, trends and visions*  
**impact of CIGRE onto standardization is not very visible**
- *improve a lot in our **communication strategy and style***
- **communication outside of CIGRE to authorities, ministries** *to deliver unbiased positions or provide second opinion on given statements*
- **CIGRE as Mentor:** *Study committees are the professional so they are able to provide the good consult and discussion without biased facts. Students are the young engineer who can help us to work or research the new simulation or new solution*

## SC A3 Meeting 2022: increasing CIGRE value and membership (2)



- *more involved in regional conferences*
- **increase quality and acceptance of the publications:** a) peer-reviewed and b) reports of members
- **working groups** with a **more narrow scope** and **shorter time from startup to delivery** (result not called as TB, something else)
- most difficult issue with finding **new participating members**, **participation by younger engineers** and professionals who do not feel they are an “expert” in their field yet
- WGs **need to promote dual/hybrid access** (physical and on-line) to encourage participation
  - *(CIGRE doesn't fit in the life balance of young families)*
- *New approaches like:* like moderated open-source platforms
- **Platform to create knowledge** *(New forms of finance the work)*

See also in the following slides the presentation of the Italian Panel:



# CIGRE Paris Session 2022

## Italian Panel SC A3

Study Committee Meeting 30<sup>th</sup> August 2022



**cigre**

For power system expertise

Paolo Mazza  
Roberto Nicolini

# ITALIAN NATIONAL COMMITTEE AT A GLANCE



|                                             |      |
|---------------------------------------------|------|
| <input type="checkbox"/> Establishment date | 1957 |
| <input type="checkbox"/> Collective Members | 18   |
| <input type="checkbox"/> Universities       | 8    |
| <input type="checkbox"/> Individual Experts | 277  |
| <input type="checkbox"/> Equivalent Members | 342  |



## MIRROR PANEL SC A3 - ITALY



|                               |                                 |
|-------------------------------|---------------------------------|
| ❑ (new) Establishment date    | 24 <sup>th</sup> November, 2021 |
| ❑ Launched KMS website        | 1 <sup>st</sup> February, 2022  |
| ❑ Registered experts          | 47                              |
| ▪ Regular members             | 44                              |
| ▪ Observers                   | 3                               |
| ▪ Vendor                      | 7                               |
| ▪ Utility                     | 3                               |
| ▪ Consultant                  | 15                              |
| ▪ Academic                    | 22                              |
| ❑ Experts participation to WG | 8                               |
| ❑ Last panel meeting          | 8 <sup>th</sup> July, 2022      |

## MIRROR PANEL SC A3 - ITALY



- ☐ Involvement of Experts within the professional network:
  - ☐ CIGRE Members
  - ☐ Companies
  - ☐ Advertising in the framework of National Standardisation Body activities
  - ☐ Word of mouth
  - ☐ Opening of the National Panel to the “not yet” Members: no access to the deliverables but free access to discussion and proposals
- ☐ Next Steps:
  - ☐ Involvement of professional and academic associations
  - ☐ “In person” meeting (Autumn 2022)
  - ☐ Involvement of Italian NGN and WIE panels in order to booster the participation

# KMS WEBSITE ITALIAN PANEL SC A3

## [cigre.org/display/ITA3/Mirror+Panel+IT.A3+Home](http://cigre.org/display/ITA3/Mirror+Panel+IT.A3+Home)



### Mirror Panel IT.A3 Home

Creato da Gary Williams, ultima modifica di Roberto NICOLINI il ago 01, 2022



### Benvenuti nello Spazio KMS dedicato al Mirror Panel italiano dello SC A3 Cigre "Transmission and Distribution Equipment"

Questo Spazio contiene informazioni sulle attività del Comitato di Studio Cigre A3 e consente di visualizzare le indicazioni dei Gruppi di lavoro, delle pubblicazioni tecniche e dei principali eventi legati al SC A3.

Lo Spazio riporta inoltre le proposte di creazione di nuovi Gruppi di Lavoro e permette di visualizzare i relativi ToR (Terms of Reference) per consentire di valutare e proporsi in qualità di esperto alla partecipazione ai relativi lavori.

Infine, attraverso questo Spazio è possibile accedere alle Technical Brochure in fase finale di revisione per collaborare con gli Officer del Mirror Panel alla loro verifica.

### STUDY COMMITTEE A3 – Novità e notizie in evidenza

#### 📅 17-lug-2022 📌 Creati nuovi Blog sul nostro sito! 📌

Come discusso nell'incontro del 8 luglio, è stato richiesto ai rappresentanti nazionali del SC A3 di portare propri contributi alla riunione dello Study Committee programmata il 30 agosto a Parigi durante la Cigre Session 2022. Il Segretario del SC Frank Richter ha indicato alcuni argomenti su cui siamo chiamati a rispondere e formulare nostre proposte da discutere opportunamente in sede internazionale.

Nella sezione Blog di questo sito (in fondo a questa pagina) abbiamo predisposto tre aree con altrettanti argomenti su cui vi chiediamo di esprimervi per fornirci supporto alla preparazione dei contributi del nostro Panel italiano.

Attendiamo entro il **22 agosto** i vostri preziosi contributi di cui vi ringraziamo fin d'ora!

#### 📅 15-lug-2022 **Nuovo WG A3.48 "4th CIGRE Reliability Survey on Transmission and Distribution Equipment"**

*"The scope of the fourth CIGRE reliability survey is expanded to cover generator circuit breakers, vacuum circuit breakers and MO surge arresters to provide field experience to related WGs. Dworking group will deliver a technical brochure on lifetime management of indoor medium voltage switchgear. The WG will mainly summarize and update the results and publish the reliability data on transmission and distribution equipment showing these differences in the reliability dependence on specification, design, service-year, maintenance and replacement policy, country by country (but anonymously without showing the utilities name), by comparing the new results with the previous results".*

Gli Esperti interessati a partecipare alle attività del WG sono invitati a inviare la loro candidatura al rappresentante italiano nello Study Committee e al Segretario del Panel italiano utilizzando il template scaricabile [qui](#). Si ricorda che, in base alle regole CIGRE, la partecipazione alle attività di ogni WG è aperta a un numero limitato di Membri, in rappresentanza del Comitato e del Panel Nazionali.

#### 📅 13-lug-2022 **Meeting on-line Panel italiano "SC A3 CIGRE - T&D Equipment 8 luglio 2022"**

#### Link utili

- CIGRE website
- e-CIGRE
- ELECTRA
- CIGRE SC A3
- CIGRE Italia
- KMS SC A3 Home
- CIGRE active Working Groups - Call for Experts
- Contatti membri Mirror Panel IT.A3

#### Contatti Mirror Panel A3 italiano

##### Membro delegato



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##### Segretario



Roberto Nicolini

[roberto.nicolini@cesi.it](mailto:roberto.nicolini@cesi.it)

#### Contenuto dello Spazio

[Espandi tutto](#) [Comprimi tutto](#)

- 0 IT.A3 General Instructions and Policies
- 1 IT.A3 Contact Details and Access Permissions
- 2 IT.A3 Proposte di attivazione di nuovi WG
- 3 IT.A3 Pubblicazioni recenti e documenti in corso di verifica
- 4 IT.A3 Proposte per la creazione di nuovi WG (template)
- 5 IT.A3 Eventi internazionali
- 6 IT.A3 Eventi nazionali
- 7 IT.A3 Archivio notizie
- Italy A3 engagement
- zzz-Pagine non utilizzate

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## STUDY COMMITTEE A3 – Informazioni generali

- |                                                                                                                                                        |                                                                                                                                                                                                                                                                       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>• Scope of Work</li><li>• Struttura e Officers</li><li>• Piano strategico</li><li>• Annual Report 2020</li></ul> | <ul style="list-style-type: none"><li>• Lista Working Group - <a href="#">attivi</a> / <a href="#">chiusi</a></li><li>• Technical Brochure pubblicate - <a href="#">ultime</a> / <a href="#">storico</a></li><li>• Study Committee meeting</li><li>• Eventi</li></ul> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

## MIRROR PANEL ITALIANO – Informazioni dallo Study Committee

- |                                                                                          |                                                                                           |
|------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>• Proposte di attivazione nuovi WG (ToR)</li></ul> | <ul style="list-style-type: none"><li>• Technical Brochure in corso di verifica</li></ul> |
|------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|

## MIRROR PANEL ITALIANO – Informazioni per lo Study Committee e comunicazioni interne

- |                                                                                                                                                   |                                                                                               |
|---------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>• Esperti italiani partecipanti ai WG</li><li>• Proposte di nuove attività per lo Study Committee</li></ul> | <ul style="list-style-type: none"><li>• Eventi nazionali</li><li>• Archivio notizie</li></ul> |
|---------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|

## Blog/Notizie/Avvisi

Utilizzare i tre punti vicino al pulsante <Create> per creare un nuovo Blog/Notizie

[Visualizzare tutti i Blog/Notizie per questo Spazio](#)

[Visualizzare tutti i Blog/Notizie globali \(General Resources Space\)](#)

Post nel Blog

- |                                                                                                                |                                    |
|----------------------------------------------------------------------------------------------------------------|------------------------------------|
| Contributi per nuove tematiche da portare a SC A3 nella prossima sessione di Parigi creato da Roberto NICOLINI | lug 08, 2022<br>Mirror Panel IT.A3 |
| Le apparecchiature T&D e la transizione energetica creato da Roberto NICOLINI                                  | Mirror Panel IT.A3 lug 17, 2022    |
| Contribuisci all'evoluzione del CIGRE! creato da Roberto NICOLINI                                              | Mirror Panel IT.A3 lug 17, 2022    |
| Sono aperte le iscrizioni alla sessione 2022! creato da Roberto NICOLINI                                       | Mirror Panel IT.A3 mar 30, 2022    |

## Attività recenti



**Chiara GANDOLFI**

Le apparecchiature T&D e la transizione energetica ha commentato ieri alle 12:57 PM

Le apparecchiature T&D e la transizione energetica ha commentato ieri alle 12:51 PM



**Roberto NICOLINI**

Mirror Panel IT.A3 Home aggiornato ago 01, 2022 • [Visualizza la modifica](#)



**Paolo MAZZA**

Contributi per nuove tematiche da portare a SC A3 nella prossima sessione di Parigi ha com

Contribuisci all'evoluzione del CIGRE! ha commentato lug 19, 2022

[Mostra di più](#)



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Dashboard / Mirror Panel IT.A3 Home / 3 IT.A3 Pubblicazioni recenti e documenti in corso di verifica

(M)odifica ☆ Salva f o dopo 👁 Seguendo ➦ (C)ondividi

### 3 IT.A3 Technical Brochure WG A3.41 "Current Interruption in SF6-free Switchgear"

Creato da Roberto NICOLINI, ultima modifica il lug 03, 2022

È stata pubblicata la Technical Brochure n. 871 del WG A3.41 "**Current Interruption in SF6-free Switchgear**".



The Technical Brochure of WG A3.41 deals with the technology, availability and application of SF6-free transmission and distribution switchgear. It focuses on the mainstream of upcoming SF6-free current interruption technologies, on the one hand based on interruption in natural-origin gases and their mixtures with fluoronitrile (C4-FN), fluoroketone (C5-FK), and on the other hand based on technical air-insulated vacuum circuit breakers. Despite the different physical characteristics of the SF6-free alternatives, minor modifications enable similar performance, application range and size as their SF6 equivalents, at present up to 170 kV. Products and (pilot) projects with SF6-free switchgear are reported in this Technical Brochure.

- Fare click sulla miniatura per visualizzare l'Executive Summary e l'indice del documento.
- La TB 871 può essere scaricata da "e-Cigre" per chi possiede un account. Il link da utilizzare è [questo](#).

## GOALS ACHIEVED AND WORK IN PROGRESS



- ❑ Goals achieved:
  - ❑ Participation of about 50 Experts through the KMS
  - ❑ Effective promotion and participation for the new A3 WGs
  - ❑ Good participation and answer for the 1<sup>st</sup> meeting (up to 30 participants)
- ❑ Work in progress:
  - ❑ More active participation and proactiveness needed
  - ❑ Use of KMS blog and spaces still limited (training and examples to be implemented to win the “blank page” Syndrome)!
  - ❑ Catalysers needed in order to foster the transition from passive participation to an active one: in-presence events, NGN, WIE, KMS, LinkedIn (strong coordination with CIGRE NC)
  - ❑ Support from Companies in order to promote non only individual but collective participation.

Thank you for the attention!!!

Further suggestions, proposals and exchanges are welcome!!!

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[roberto.nicolini@kema.com](mailto:roberto.nicolini@kema.com)



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## TOR in discussione (1)

- Ageing of instrument transformers - > **Approvato (A3.49)**
- Requirements for HV Equipment operating under Abnormal Weather Conditions (**Fase finale discussione Birmingham**)
- Testing requirements for MV equipment
- Partial discharge properties of non-SF6 insulating gases and gas mixtures
- On-site tests for instrument transformers (**Fase finale discussione Birmingham**)

**See the details in the following slides!**



## TOR in discussione (2)

- Requirements for HV Equipment operating under Abnormal Weather Conditions (Fast discussion Birmingham)

The new WG shall investigate levels and frequency of non-standard environmental requirements that might affect HV equipment performance with emphasis, but not restricted, to:

- earthquake above 8 in Richter scale,
- atmospheric discharges above normally expected values,
- extreme ambient temperatures, snow and ice (above and below standard values),
- heavy rains,
- wind above standard values including tornado,
- tsunami,
- flood,
- sandstorm, etc.
- Wide bibliography review on non-standardized, or values above standard are affecting HV equipment performance.
- Enquiry among utilities all over the world shall be carried out to identify actual problems.
- Environmental stresses levels not yet covered by standards, the severity level of these stresses and the expected frequency to improve existing Standards or to propose new ones.

## TOR in discussione (3)



### ■ Testing requirements for MV equipment

- Analyse of **on-site testing requirements** on MV equipment of different technologies with different insulating mediums in different countries
- Data collection on reliability on MV equipment – use existing surveys and extend the survey if necessary
- Return of experiences with the reliability of MV equipment
- Analyse of customer specifications for testing of MV equipment before putting into service and evaluate best practice
- Comparison IEC requirements vs. best practice
- Develop a proposal of testing requirements for MV equipment to increase reliability in service
- **Experiences with MV switchgear outages showed that a major part of all defects are caused by secondary equipment like voltage transformers ,connectors or missing components during the assembly.**
- **Also transport and assembly can cause defects in a GIS**
- **the on-site test of a GIS is practically always carried out with a combination of withstand AC voltage test with partial discharge measurement. Operating and testing experience also leads to the conclusion that it is advisable to include not only the busbars but also the feeders including all voltage transformers in the test.**

## TOR in discussione (4)



- Partial discharge properties of non-SF6 insulating gases and gas mixtures

The Working Group will collect and summarize the current knowledge on the partial discharge properties of major non-SF6 insulating gases which are currently proposed by the manufacturers of MV and HV equipment. Wherever required and feasible, further studies shall be conducted within the Working Group (e.g. by testing).

- Physical background of PD
- Current PD measurement techniques
- Definition of appropriate test setups
- Tests and test results, esp. PD inception and breakdown voltage
- PD impulse waveforms and spectra
- Applicability of current PD measurement techniques for non-SF6 insulating gases
- Sensitivity verification
- Estimation of criticality of imperfections
- Gas decomposition by PD and its measurement

## TOR in discussione (4)



- Partial discharge properties of non-SF6 insulating gases and gas mixtures

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## TOR in discussione (5)



### On-site tests for the verification of the accuracy and for the calibration of instrument tr

1. To present the technical background and the new applications that recommend the performance of on-site calibration.
2. To present the applicable international and regional/local technical Standards.
3. To present the accuracy requirements needed for each specific application.
4. To investigate the state of art of international regulation and/or network codes about this subject.
5. To present the technical state-of-art about the on-site assessment of the accuracy of instrument transformers (both calibration and verification of the accuracy, with instrument transformers in service or disconnected) and the international experience about this subject: methods by comparison and based on models will be considered.
6. To present the ongoing activities aimed at the on-site verification of the accuracy and calibration.
7. To analyse the benefits and limits of the available methodologies and technologies, (e.g. the impact of needing an outage versus verifying without an outage, at the voltage and current level(s) where the system naturally is);
8. To indicate the technical benefits and the opportunities for the evolution of power systems, in terms of management and observability, made possible by on-site calibration.
9. To evaluate the economical impact and benefit of the on-site calibration of instrument transformers.

# SC A3 General Discussion Meeting – GDM 2022 (1)



- The 2022 group discussion meeting of Study Committee A3 was held on 02nd of September 2022 in room Bordeaux at the Palais des Congrès, Paris, France in a morning and afternoon session.
- The Discussion Group Meeting was chaired by the Study Committee Chairman, Nenad Uzelac (US), with Rene Smeets (NL), Nicola Gariboldi (CH), Tadao Minagawa (JP), Wayne Pepper (AU), Erik Sperling (CH) as Special Reporters and Frank Richter (DE) as SC A3 Secretary. Martin Kriegel (CH) act as the interactivity manager. Rene Smeets who coordinated the work led the team of special reporters.
- As already described in the Special Report, the papers received for the 3 preferential subjects were categorized into four groups with 20 questions in total. The discussion was also clustered into these groups, which were named as follows:
  - 1. Miscellaneous T&D equipment and systems (16 papers) moderated by Tadao Minagawa and Wayne Pepper
  - 2. SF6 alternatives (18 papers) moderated by Rene Smeets
  - 3. Asset management, monitoring and diagnostics (9 papers) moderated by Nicola Gariboldi
  - 4. Instrument transformers and digitalization (9 papers) moderated by Eric Sperling
- The advantage of dividing into topics instead of ordering them into Preferential Subjects is that the experts can be addressed better and more specifically due to the large variety of the scope handled in SCA3. This resulted in a very good average participation rate.
- The special reporters explain the procedure of the group discussion. Each topic is presented by an introductory lecture. Hereby, invited experts presented topic 2 and 4:
- Topic 2 – SF6 Alternatives, by Nina Stoa-Aanensen and
- Topic 4 - Instrument transformers and digitalisation, by Paolo Mazza.
- The beginning was made by the Next Generation Network talk. Abigail Zafris gave an excellent contribution about “Monitor Data Management for Asset Failure Prevention”.

## SC A3 GDM 2022 (2)

The special reporters explain the procedure of the group discussion. Each topic is presented by an introductory lecture. Hereby, invited experts presented topic 2 and 4:

- Topic 2 – SF6 Alternatives, by Nina Stoa-Aanensen and
- Topic 4 - Instrument transformers and digitalisation, by Paolo Mazza.

The beginning was made by the Next Generation Network talk. Abigail Zafris gave an excellent contribution about “Monitor Data Management for Asset Failure Prevention”.

# SC A3 GDM 2022 (3)



## TOPIC 1: MISCELLANEOUS T&D EQUIPMENT AND SYSTEMS (Special Reporters: Tadao Minagawa/ Wayne Pepper)

- 16 reports were categorized into this topic and six questions were raised in the special report.
- Generator circuit breaker (GCB) was dealt with in two reports and two prepared contributions about delayed current zero in the doubly-fed induction generator were presented. The convenor of WG A3.46 put words about present situation of the study on the issue as a spontaneous contribution.
- Two reports describe HVDC switchgear and relevant technical challenges in relation to standardization, and they were discussed by five prepared contributions.
- To the question in association with three reports on “metal vapor deposition in vacuum interrupter”, “controlled switching with high-resolution/high-bandwidth measurement” and “high-temperature superconducting fault current limiter”, improvements of technologies for new generations of T&D equipment were discussed by four prepared contributions.
- The experiences related to “Safety with use of digitalization”, which was described in three reports, were introduced by two prepared contributions. A question about “Overstress”, Commissioning” and “Service life” in terms of equipment management was asked in the special report, and experiences on the issue were introduced by four prepared contributions. Two reports describe technical challenges for data management in monitoring, and the considerations on monitoring and diagnosis of disconnector associated to a pollution severity were presented in a prepared contribution.



# SC A3 GDM 2022 (4)



## TOPIC 2: SF6 ALTERNATIVES (Special Reporter: Rene Smeets)

- Eighteen (18) reviewed reports were falling in this topic. In the GDM, seven questions from the Special Report were discussed by 20 prepared contributors from six countries. Prior to this, an overview on the urgency and the actual status of the technology in this topic was given by Nina Støa-Aanensen from Norway, being a key member from WG A3.41 on current interruption in SF6-free switchgear.
- The questions were on the following subjects:
  - 1. The possible impact of increased filling pressure (four prepared contributions in the GDM)
  - 2. Retro-fill issues and the role of sealings/gaskets (one contribution)
  - 3. The impact of the “new gases” on temperature rise performance (three contributions)
  - 4. Multi-break circuit breaker applications (two contributions)
  - 5. Size, weight and footprint of HV SF6-free switchgear (three contributions)
  - 6. Alternative gas management (two contributions)
  - 7. Harmonisation of the variety of new mixtures into one-fits-all solution? (five contributions)
- Two contributions were on MV switchgear, all others covered HV equipment, including LPIT. Seventeen (17) contributions were from manufacturers and were mainly oriented to remove possible concerns. One was from a TSO and two were on behalf of a national manufacturer’s organization.
- Spontaneous contributions (around 15 short ones) was mainly directly from the audience, SparkUp was not used very much to transfer question to the contribution authors or the auditorium.

### **TOPIC 3: ASSET MANAGEMENT, MONITORING AND DIAGNOSTICS (Special Reporter: Nicola Gariboldi)**

- Nine (9) reports were grouped into this category from six countries. Three questions were proposed in the special report, two of which were discussed in six (6) contributions.
- Controlled switching was quite a treated topic addressing different aspects like detailed quantitative evaluation of the Rate of Decrease of Dielectric Strength (RDDS), limitation of overvoltage at shunt reactor switching, capacitor bank insertion, limitation inrush currents while energizing power transformers.
- The outlook seemed to be the integration into IEC 61850 as a configurable software module in a control and protection device. Question 14 given in the special report about controlled switching technology and the possibility to be integrated in IEC 61850 digital substations were answered by three contributions from France, Sweden and Australia. Integration through IEC 61850 and the use of type “Point On Wave” relay for various CB brands was confirmed to be the outlook. The increasing demand for this technology is due to the fact that it is becoming more and more trusted and has proven to be the most efficient solution for limiting overvoltages for various applications. Some concerns exist regarding commissioning and appropriate training.

### **TOPIC 3: ASSET MANAGEMENT, MONITORING AND DIAGNOSTICS (Special Reporter: Nicola Gariboldi)**

- Specifically on Asset management, monitoring and diagnostics five reports focused on different aspects like health indexing and reliability assessment methods for SF6 circuit breakers based on commonly available parameters, applications of Artificial Intelligence (AI), new wireless sensors, Internet of Things (IoT) and pattern recognition. For all the aim is to enhance the asset reliability by means of more the efficient use of resources and controlling the costs. There is also a proposal for the more traditional off-line test for high voltage circuit breakers. It is shown that, in contrast to current practice, the high voltage circuit breaker can remain grounded on both sides to improve the hazard and safety of the test personnel.
- Continuous monitoring with online access to data enables faster response and data transmission for post-processing and analysis. Wireless communication allows for easier installation, but requires special adaptation to ensure that all components in the substation are reached.
- Regardless of the strategy or technology used, it was confirmed that improving maintenance efficiency and reducing costs were the driving motivations. One contribution was an increase of more than 70% in the labour efficiency of circuit breaker inspections. Another case study example showed that the inspection interval could be extended from 6 to 24 years.

### **TOPIC 4: Instrument transformers and digitalisation (Special Reporter: Eric Sperling)**

- Prior the discussion started, Paolo Mazza (Italy) introduced the topic with an impulse lecture and showed the challenges in the application and standardization of instrument transformers of different types.
- Nine reports were summarized in the topic four. Six reports on conventional or low-power instrument transformers were transmitted. Three reports focus on monitoring aspects, machine learning and digital twins, as well as risk-based replacement of ITs.
- In the Special Report four questions were formulated which were answered by seven contributions.
- Finally, the chair closed the session, thanked all participants for the discussions and gave the hint to continue the discussions at the next two planned events in Birmingham (UK) and Cairns (AUS).



## SC A3 General Discussion Meeting 2022 (7): Conclusions

- 51 prepared contributions were shown.
- Several spontaneous contributions were given during the group discussion meeting.
- A discussion followed most of the contributions.
- The Sparkup tool for interactive participation of the auditorium was an enrichment.
- Spontaneous contributions and suggestions provided many interesting ideas.
- The session was of interest to all participants from a technical viewpoint. The number of participants was over 130 (during the morning session), averaged more than 70.

## SC A3 General Discussion Meeting (8): Contributo italiano

- 1 Invited speech (Paolo Mazza, Lorenzo Peretto)
- Many spontaneous contributions (Eros Stella, Alberto Pigini)
- 2 Articoli:

### **Sizing and testing of HVDC disconnectors from the dielectric point of view**

**Eros STELLA<sup>1</sup>, Marco NOSILATI<sup>1</sup>, Francisco CHACON<sup>2</sup>, Alberto PIGINI<sup>3</sup>**

<sup>1</sup>GE Italy; <sup>2</sup>GE UK; <sup>3</sup>Consultant

### **Instrument Transformers and bushings using alternative and eco-friendly high voltage insulation systems**

**Lorenzo GIOVANELLI<sup>1</sup>, Udo PRUCKER<sup>2</sup>, Esseddik FERDJALLAH KHERKHACHI<sup>3</sup>**

<sup>1</sup>TRENCH Italia Srl; <sup>2</sup>TRENCH Germany GmbH; <sup>3</sup>TRENCH France SAS

# PREFERENTIAL SUBJECTS SESSION 2024



## PS1: Energy transition involving T&D equipment

- Innovative technologies to reduce total cost of ownership and to foster the energy transition.
- **Novel applications especially DC** and increased duties on equipment due to DER.
- Improvement of grid resilience due to climate change: the impact on equipment requirements.

## PS2: Lowering the carbon footprint of T&d equipment

- Performance & maturity of Sf6 alternatives – report on industry experience.
- Life cycle assessment of T&D Equipment.
- Life cycle management and life extension of existing equipment.

## PS3: maintaining and management T&d assets

- Smart sensors, low power instrument transformers, monitoring, condition assessment and application of IoT.
- Digital twin and equipment reliability modelling also covering new / higher load profiles.
- Big data management and data ownership, with respect to equipment condition assessment

## PROSSIMI EVENTI COMITATO STUDIO A3

- Colloquium A3 & B3, Maggio 2023, Birmingham - UK
- Symposium A3, B1, B3, B5, C1, C2, C4, C5, C6, D1, D2, Settembre 2023, Cairns, Australia
- Session 2024, Settembre 2023, Parigi, Francia
- Colloquium A3, Proposta India 2025



# Grazie per l'attenzione

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# Comitato Nazionale Italiano CIGRE

## Panel Italiano SC A3 - HV EQUIPMENT

18 Aprile 2023

WG A3.39 - Application and field experience of Metal  
Oxide Surge Arresters



**cigre**

For power system expertise

Alberto Sironi

Nicola Gariboldi

## **WG A3.39: “Application and field experience of Metal Oxide Surge Arresters”**



Il gruppo di lavoro Cigre A3.39 si occupa di applicazioni e esperienze di esercizio di scaricatori ad ossido metallico.

Il Gruppo A3.39 ha cominciato l'attività nel 2017 e si è riunito in meeting fisici cinque volte dal 2017 al 2019 prima dell'avvento del Covid. L'ultimo meeting fisico ha avuto luogo in CESI Milano nel 2019.

Al Gruppo appartengono 29 membri di cui due italiani: Nicola Gariboldi e Alberto Sironi.

Mr. Robert le Roux di ESB Ireland è il Convenor

## WG A3.39: Attività in corso

Il gruppo ha prodotto ad oggi un draft della brochure finale.

I contributi riguardano particolari applicazioni di esercizio (scaricatori HVDC, protezione di condensatori per compensazione serie, applicazioni che richiedono livelli di protezione particolarmente ridotti, etc) e sistemi di monitoraggio in esercizio.

E' stato predisposto e sottoposto alle utilities un questionario ben dettagliato relativo ai sistemi diagnostici utilizzati in esercizio, ai criteri di sostituzione degli scaricatori e ai guasti riscontrati in esercizio. Il ritorno dalle utilities purtroppo è stato modesto.

E' presente inoltre un contributo di CESI relativo al «failure rate» riscontrato in laboratorio durante prove di tipo basato su un campione di oltre 700 type test.



# Survey presso utility in merito alla affidabilità in esercizio di scaricatori per sistemi oltre 52 kV



E' stato prodotto e sottoposto alle utility un questionario ben dettagliato per ottenere informazioni in merito ai metodi diagnostici utilizzati, ai criteri di sostituzione e al failure rate riscontrato in esercizio

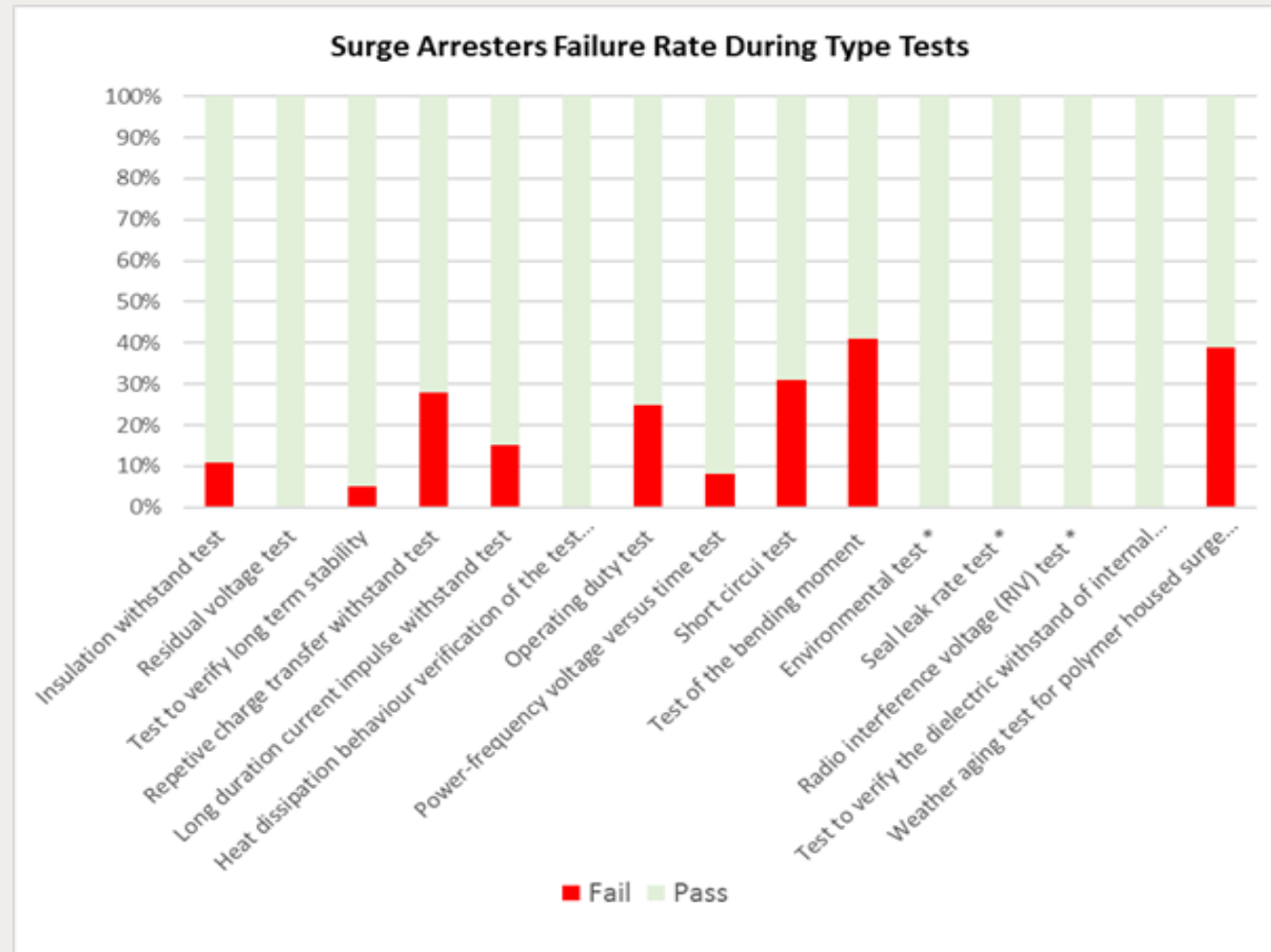
Purtroppo il ritorno è stato modesto e limitato a sole quattro utility per un totale di circa 9.500 scaricatori installati, non sufficiente per considerazioni statistiche di validità generale

Le poche informazioni confermano che gli scaricatori sono un componente generalmente affidabile. Il «failure rate per year» risulta spesso nullo oppure limitato a pochissimi casi ogni 1000 scaricatori installati

Alcune utilities basano la «replacement policy» sull' età degli scaricatori che vengono sostituiti dopo 30 o 40 anni in esercizio. In questo caso le misure diagnostiche effettuate in esercizio sono spesso limitate a ispezione visiva e con telecamera a infrarossi

Altre utilities basano la «replacement policy» sulle condizioni rilevate con metodi diagnostici. Tipicamente alcuni parametrici considerati significativi (corrente e sua componente resistiva o di terza armonica, perdite etc.) vengono periodicamente rilevati e confrontati con valori di soglia critici indicati dal costruttore

# Failure rate during type tests



## **WG A3.39: prossime scadenze e eventuali opportunità di partecipazione**

Dal 2020, anche a causa del covid-19 l'attività del gruppo si è arenata e non hanno avuto luogo ulteriori meeting fisici o via web sino ad oggi.

Un meeting web è previsto in data 20 e 21 Aprile, 2023

La pubblicazione della brochure dovrebbe avvenire entro il 2023 secondo quanto indicato dal Convenor.

# Grazie per l'attenzione

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# Comitato Nazionale Italiano CIGRE

## Panel Italiano SC A3 - HV EQUIPMENT

18 Aprile 2023



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WG A3.40

Technical requirements and field experiences with MV  
DC switching equipment

Marco Riva



# WG A3.40: introduction

- Approved by the SC in 2018 (1<sup>st</sup> meeting in Aug 2018)
- 21 members from 12 countries  
Convenor: Christian Heinrich
- Objective
  - State of the art of MV DC switching equipment up to 52 kV
  - Experience in operation and monitoring with MV DC switching equipment
  - Technical requirements for MVDC switching equipment
  - Recommend testing requirements for MVDC switching equipment.
- Technical Brochure: aim to be published in 2023



## WG A3.40

# Technical requirements and field experiences DC switching equipment

### Background

- 2013 - CIGRE WG B4.52 published TB 533 “HVDC Grid feasibility study”
- 2017 - CIGRE JWG A3/B4.34 published TB 683 “Technical requirements and specifications of HVDC switching equipment”
- 2015 - CIGRE WG C6.31 published TB 793 “Medium Voltage Direct Current (MVDC) Grid Feasibility Study” (2020)

## WG A3.40

# Technical requirements and field experiences DC switching equipment

### The scope of the working group

- 1. Collect the field experiences of MVDC switching equipment to interrupt the DC load and fault current in MV applications up to 52 kV
- 2. Review the existing prototypes and state of the art of MV DC switching equipment up to 52kV
- 3. Review experiences of monitoring and diagnosing the interrupting performance with MV DC switching equipment
- 4. Investigate the technical requirements for MVDC switching equipment used in different system configurations such as a point-to-point or multi-terminals MV grids, and understand the switching phenomena in MVDC grids
- 5. Summarize the technical requirements for the MVDC circuit breakers (compared with those for AC circuit breakers and HVDC circuit breakers)
- 6. Recommend testing requirements for MVDC switching equipment

# Motivation for use of MVDC

## 4 general areas of application

### A1: Independent / confined networks

- Railway
- Ships
- Micro grids
- Electrophysical research facilities

### A2: To strengthen existing AC grid

- Power quality, voltage stability
- EV charging infrastructure with high power
- Storage integration

### A4: Combine DC sources and loads

- optimize network layout,
- flexible operation
- reduced losses (conversion)

### A3: Interconnection / power transfer

- HVDC / MVDC
- Point-to-point connections
- Soft-links to control voltage profile and active-reactive power flow
- DC collector grids, connection of additional generation (PV, wind)



## WG A3.40

# MVDC switching equipment various types to be considered

- Circuit breaker for load switching and short circuit protection
  - Load break switch
  - Contactor
  - Recloser or reclosing function
  - DC breakers can also be used in AC systems as current limiting switch
- Disconnecter
- Earthing switch
- Fuse
  - Current limiting devices using explosive activation
- Commutation or transfer switch
- Fast Make Switch



## WG A3.40

# Technical requirements and field experiences DC switching equipment

### Status

A first draft of the TB has been prepared in a way that can be hand over by SC review

### Next steps

- Collection of the feedbacks from SC
- Discussion about comments and remarks: review to address the completion of the TB chapters.

# Grazie per l'attenzione

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# Comitato Nazionale Italiano CIGRE

## Panel Italiano SC A3 - HV EQUIPMENT

Webmeeting 18 Aprile 2023

WG A3.42

**Failure analysis of recent AIS instrument transformer incidents**



**cigre**

For power system expertise

Lorenzo Giovanelli

## WG A3.42 – Scopo

### “Failure analysis of recent AIS instrument transformer incidents”

I Trasformatori di misura sono componenti cruciali per la corretta operativita' degli impianti di alta tensione e l'affidabilita' dell'isolamento carta/olio è ben nota agli utilizzatori finali

Nel 2018 alcune utilities in Brasile hanno segnalato un incremento anomalo di prodotti difettosi installati ( Trasformatori di Corrente 500kV ) con conseguente esplosione degli stessi durante il servizio

Una prima ipotesi fu quella di fenomeni di invecchiamento precoce dell'isolamento di alta tensione dovuta ad esempio a ripetuti VFTO ( Very Fast Transient Overvoltages ) , tipicamente originati dalle ripetute manovre dei sezionatori

La normativa attuale in vigore IEC61869-1 prevede gia' uno special test che indirizza questa problematica

|       |                                                                   |    |
|-------|-------------------------------------------------------------------|----|
| 7.4   | Special tests .....                                               | 45 |
| 7.4.1 | Chopped impulse voltage withstand test on primary terminals ..... | 45 |
| 7.4.2 | Multiple chopped impulse test on primary terminals .....          | 46 |

Su richiesta delle utilities brasiliane SC A3 ha stabilito questo WG con lo scopo di studiare i casi di guasto , suggerire adeguate contromisure e sistemi di diagnostica .

Inoltre sulla base dei risultati del WG si verificheranno anche eventuali suggerimenti di modifiche alle normative in essere al fine di ridurre la possibilita' di guasti di questo tipo

# WG A3.42 : Partecipanti

## Team Iniziale 2018

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## Team Attuale 2023

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## WG A3.42 : stato attuale e prossimi steps

### Team set-up :

- Convenor → Mr. Zoltan Roman ( GE )
- Segretario → Mr. Fernando Lagos ( GE )

### Meetings :

- Ultimo meeting a Novembre 2022
- Prox meetings 20 Aprile 2023 e poi un altro e' gia' fissato per 10 Maggio 2023 e Settembre 23

### Stato attuale :

- Si sta ancora lavorando sulla raccolta dati dai Clienti ma purtroppo sono dati che includono tutti i «failure mode» e comunque i dati dei Clienti indicano % di failures molto basse anche su parchi installati molto vecchi confermando che l'affidabilita' media dei TA/TV e' molto alta e il problema in BR sembra localizzato
- Per quanto riguarda le prove Pfiffer e GE hanno presentato ricerche su modi alternativi per simulare questi fenomeni in alternativa e/o a completamento di quanto gia' previsto dalla norma attuale IEC 61869 -1
- Il Convenor sta cercando di focalizzare il team sul problema specifico mentre i Clienti sono piu' focalizzati sui problemi dei TA/TV in generale e questo ha dilatato i tempi di discussione

# Grazie per l'attenzione

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# Comitato Nazionale Italiano CIGRE

## Panel Italiano SC A3 - HV EQUIPMENT

18 Aprile 2023

WG A3.43 - Tools for lifecycle management of T&D switchgear based on data from condition monitoring systems



**cigre**

For power system expertise

Nicola Gariboldi

Alberto Sironi

## WG A3.43 - “Tools for lifecycle management of T&D switchgear based on data from condition monitoring systems”



### Scope

1. Identify critical condition indicators of T&D switchgear
2. Providing user's experiences of using continuous condition monitoring systems and periodic diagnostics into the existing T&D switchgear
3. Establish criteria for development of an analytical tool for Switchgear Health Index (SHI)
4. Provide user's experiences of end-of-life of T&D switchgear
5. Identify future trends in end-of-life management
6. Compliance with digital substation for collecting data via process bus (SC B5 support)

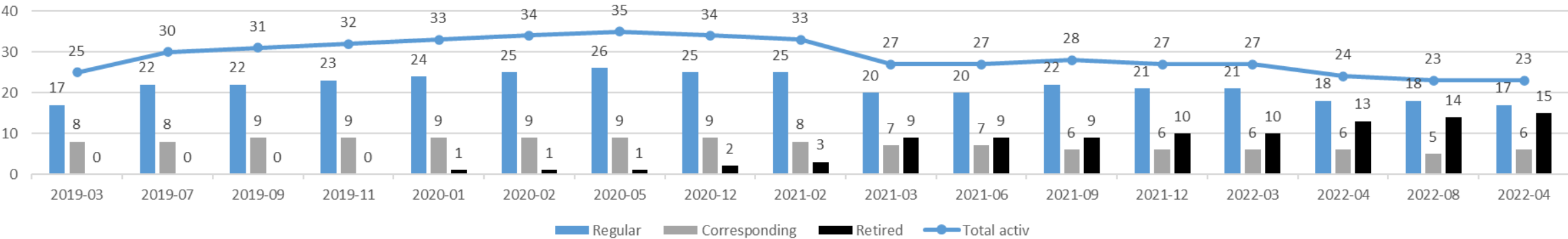
| Milestone                                 | Planned  | Forecast   | Actual Date |
|-------------------------------------------|----------|------------|-------------|
| Initial Approval from Technical Committee |          |            | Nov 2018    |
| Final Draft TB for SC review              | Jun 2021 | Dec 2022   |             |
| Electra Article                           | Sep 2021 | Mar 2023   |             |
| Final draft                               | Dec 2021 | June 2023  |             |
| Technical Brochure published              | Mar 2022 | Dec 2023   |             |
| Tutorial Presentation                     | Jun 2022 | March 2024 |             |

# WG A3.43: Membership

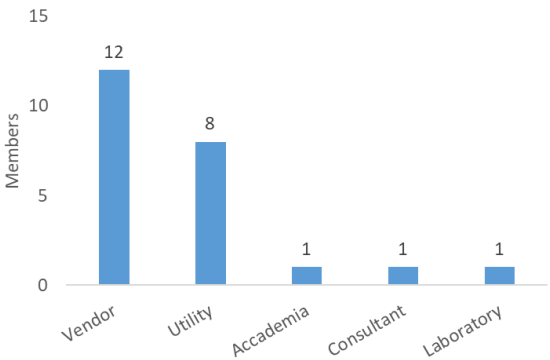


Present status: 23 Members, 17 regular, 6 corresponding, 15 retired

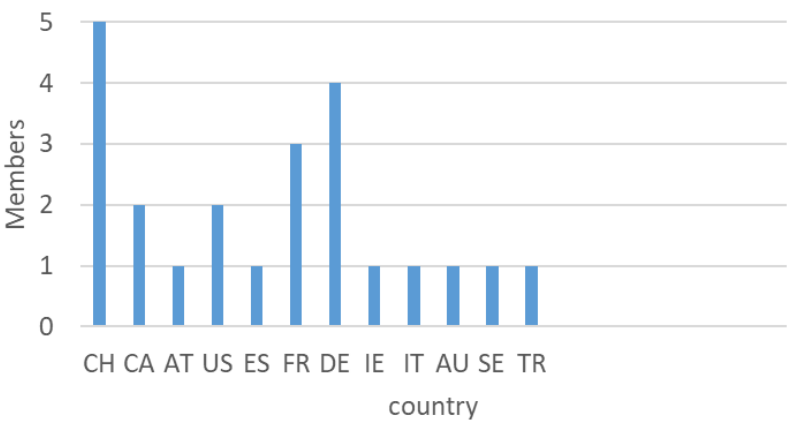
A3.43 membership



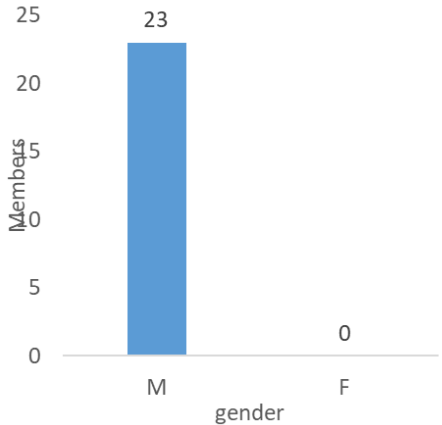
Working field



Country distribution



Male/Female





## WG A3.43: Membership

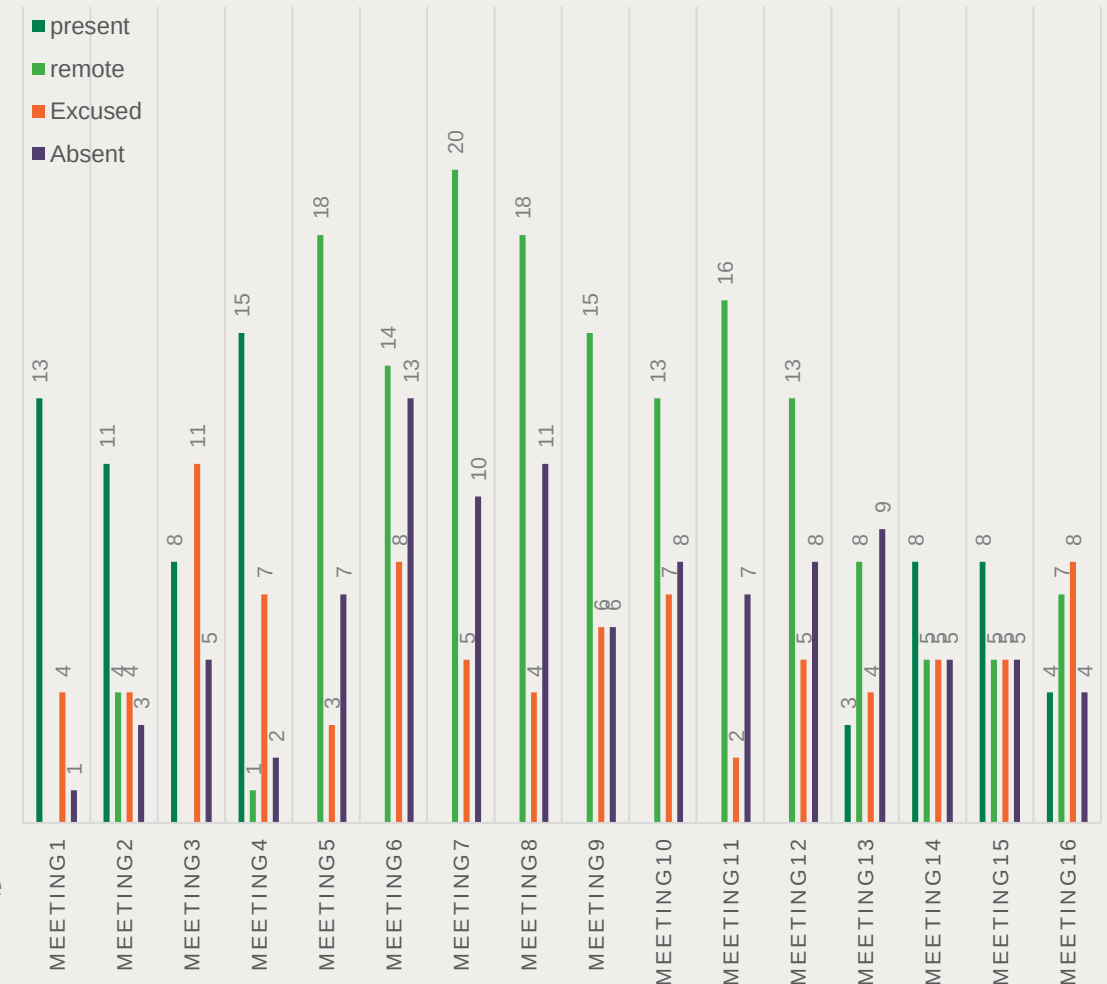


|    |                     |           |               |    |                                        |
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| 23 | Corresponding       | Kedar     | Pandya        | CH | Hyundai-electric                       |

## WG A3.43: Meetings

### 16 meetings until now

- ✓ 1st Meeting: March 2019 Klaus Omicron - A
- ✓ 2nd Meeting: July 2019 Dublin ESB - IR
- ✓ 3rd Meeting: September 2019 Montreal IREQ - CA
- ✓ 4th Meeting: February 2020 Milan CESI - IT
- ✓ 5th Meeting: June 2020 Online
- ✓ 6th Meeting: August 2020 Online
- ✓ 7th Meeting: December 2020 Online
- ✓ 8th Meeting: February 2021 Online
- ✓ 9th Meeting: June 2021 Online
- ✓ 10th Meeting: September 2021 Online
- ✓ 11th Meeting: December 2021 Online
- ✓ 12th Meeting: March 2022 Online
- ✓ 13th Meeting: June 2022 Piteå - SE and online
- ✓ 14th Meeting: August 2022 Paris – FR and online
- ✓ 15th Meeting: November 2022 Baden – CH and online
- ✓ 16th Meeting: Feb – March 2023 Lyon – FR and online
- **17<sup>th</sup> Meeting: June 2023 Berlin – DE and online**



## WG A3.43: Ongoing activities, main focus

### ▼ 5 Technical Brochure

#### ▼ Tools for lifecycle management of T&D switchgear based on data from condition

- Executive Summary
- 1) Introduction
- 2) Literature Review

• 3) Condition Indicators of T&D Switchgear

➤ **4) Tools and Criteria for lifecycle management - Switchgear Health I**

• 5) Compliance with Digital Substation Data Management

➤ 6) User's experiences of end-of-life of T&D switchgear

• 7) Future Needs and Trends

- Conclusions
- Appendix A Bibliography and References
- Appendix B Definitions, Abbreviations and Symbols
- Example template page

- Correlation Condition indicators vs. Potential degradation mechanisms
- Uses of the table
- Diagnostic process and Examples
- IEC 61850, Comtrade format, basic architecture for monitoring applications
- What methods are utilities/operators currently using with such installed systems?
- What are future trends (Online, Offline, Digital Substation, Visualization, Artificial Intelligence etc) and what are hurdles?

[illegible]

## WG A3.43: next steps



- Continue providing examples of diagnostic applied to specific real cases
- Health Index Inputs according to the methodology defined in TB TB 858 - Asset health indices for equipment in existing substations
- Tutorial for CIGRE Colloquium in Birmingham June 9<sup>th</sup> 2023
- 1<sup>st</sup> Technical Brochure Draft by June 2023



# Grazie per l'attenzione

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# Comitato Nazionale Italiano CIGRE

## Panel Italiano SC A3 - HV EQUIPMENT

Webmeeting 18 Aprile 2023

JWG A1/A2/A3/B1.44 - *Limitations in Operation of High Voltage Equipment Resulting of Frequent Temporary Overvoltage's*



**cigre**

For power system expertise

EROS STELLA

# **JWG A1/A2/A3/B1.44**

## ***- Limitations in Operation of High Voltage Equipment Resulting of Frequent Temporary Overvoltage's (22 partecipanti)***



Il campo di attività di questo JWG copre tutte le apparecchiature di stazione comprese quelle di commutazione, ma anche generatori trasformatori di potenza di misura, cavi, scaricatori.

L'esigenza di questa attività nasce da una operatività della rete che sta cambiando alla luce di nuovi codici di rete. La rete dunque può essere esercita a tensioni superiori ad  $U_m$  per un numero di volte non limitato superiormente dal codice. Questo comporta potenzialmente la possibilità di sollecitare l'apparechiatura di stazione a delle sovratensioni transitorie(TOV) aumentate rispetto alle condizioni passate e di progetto std.

Scopo del WG è analizzare per i vari tipi di apparecchiature il potenziale impatto di questa eventualità dando delle linee guida sugli effetti a breve medio e lungo termine e le relative azioni di mitigazione possibile. Un survey è circolato al fine di raccogliere best practice dalle utility e esperienze dal campo maturate in questi ultimi anni a livello globale

# JWG A1/A2/A3/B1.44 –update 2023- - Limitations in Operation of High Voltage Equipment Resulting of Frequent Temporary Overvoltage's



## Members:

| Members of CIGRE JWG A1/A2/A3/ |             |              |                |        |            |
|--------------------------------|-------------|--------------|----------------|--------|------------|
| N                              | Name        | Surname      | Feedback Jan23 | Feedba | Activiti   |
| 1                              | Bartos      | Rusek        | Yes            | x      | Active     |
| 2                              | Wen         | Tao          | Yes            | x      | Inactive   |
| 3                              | Jordan      | Tsvetanoff   |                |        | Inactive   |
| 4                              | Jon         | Rogers       |                |        | Inactive   |
| 5                              | Kim         | Jihong       |                |        | Inactive   |
| 6                              | Wieslaw     | Gil          | Yes            | x      | Active     |
| 7                              | Angelica    | Rocha        | No             |        | Left JWG   |
| 8                              | Faavian     | Moore        | No             |        | Mail not a |
| 9                              | Benoit      | Godeau       | No             |        | Left JWG   |
| 10                             | Samuel      | Nguefeu      | Yes            | x      | Active     |
| 11                             | Eros        | Stella       | Yes            | x      | Active     |
| 12                             | Jan         | Debus        | Yes            | x      | Active     |
| 13                             | Christian   | Remy         | Yes            | x      | Active     |
| 14                             | Jorge       | Amon         | Yes            | x      | Active     |
| 15                             | Stefanie    | Reincke      | Corresp.       | x      | Active     |
| 16                             | Radu-Marian | Cernat       | Yes            | x      | Active     |
| 17                             | Jean-Noel   | Marquet      | No             |        | Left JWG   |
| 18                             | Kostas      | Velitsikakis | Yes            | x      | Active     |
| 19                             | Richard     | Parke        | Yes            | x      | Active     |
| 20                             | Amit        | Kothari      | Corresp.       | x      | Active     |
| 21                             | Ariz        | Shadab       |                |        | Inactive   |
| 22                             | Pallem      | Chandra      | Yes            | x      | Active     |
| 23                             | Michael     | Lukas        |                |        | Inactive   |
| 24                             | Marios      | Zarigakis    | Yes            |        | Inactive   |
| 25                             | Demmig      | Sven         | Yes            | x      | Active     |
| 26                             | Vinas       | Thierry      | Yes            | x      | Active     |
| 27                             | Trautmann   | Frank        | Yes            | x      | Inactive   |
| 28                             | Seong Eon   | Kim          | No             |        | Left JWG   |
| 29                             | Peng        | Jinsheng     | No             | x      | Left JWG   |
| 30                             | Wijnhoven   | Thomas       | Corresp.       | x      | Active     |
| 31                             | Loehning    | Gunnar       | No             | x      | Active     |

## Task forces:

- Meetings TF1 CT&VT
- Meetings TF2 Switching Equipment
- Meetings TF3 Transformers
- Meetings TF4 Cables
- Meetings TF5 Generators
- Meetings TF6 Voltage Stresses
- Meetings TF7 Survey
- Meetings TF8 Surge Arresters

## Presence Meetings:

- JWG Meeting #1 17-18.02.2020 Cologne
- JWG Meeting #2 2022.08.29 8:30-10:30 Paris

## Web Meetings:

1. [xxxxx](#)
2. [2023.03.09 JWG in March](#)
3. [2023.01.13 JWG in February](#)
4. [2023.01.13 JWG in January](#)
5. [1. 2022.11.xx JWG in November](#)
6. [2022.09.22 JWG in September](#)
7. [2022.05.12 JWG in May](#)
8. [2022.04.06 JWG in April](#)
9. [2022.03.07 JWG in March](#)
10. [2021.12.09 JWG in December](#)
11. [2021.11.17 JWG in November](#)
12. [2021.09.16 JWG in September](#)
13. [2021.07.12 JWG in July](#)
14. [2021.06.15 JWG in June](#)
15. [2021.04.14 JWG in April](#)
16. [2021.03.09 JWG Meeting in March](#)
17. [2021.01.13 JWG Meeting in January](#)
18. [2020.11.12 JWG Meeting in November](#)
19. [2020.10.08 JWG Meeting in October](#)
20. [2020.09.17 JWG Meeting in September](#)
21. [2020.08.20 JWG Meeting August](#)
22. [2020.08.06 TF Insulation ageing](#)
23. [2020.06.16 JWG](#)
24. [2020.05.06 JWG](#)
25. [2020.03.31 JWG](#)

## **JWG A1/A2/A3/B1.44 Attività in corso, scadenze, partecipazione (*17 partecipanti attivi*)**

- Iniziativa la stesura dei vari paragrafi della Technical Brochure obiettivo di pubblicazione fine 2023. Pochi Survey ricevuti .  
Timeline:
- 2020 Q1 – start
- 2022 Q1 – Start of the surveys **(1Q delay)**
- 2022 Q4 - content related to literature and analysis of background knowledge drafted
- 2023 Q1 – incorporation of survey results
- 2023 Q2/3 – final drafting of the brochure
- 2023 Q4 – start of the brochure review process and publication



# JWG A1/A2/A3/B1.44 Attività in corso, paragrafi della TB

- [1 Introduction](#)
- [2 Voltage stresses](#)
- [3 Survey results](#)
- [4 TF CT and VT](#)
- [5 TF Generators](#)
- [6 TF Switchgear](#)
- [7 TF Cable](#)
- [8 TF Transformers](#)
- [9 TF Surge Arrester](#)
- [10 t.b.d](#)
- [Appendix A Bibliography and References](#)
- [Appendix B Definitions, Abbreviations and Symbols](#)
- [Appendix C Title](#)
- [Appendix D Task Forces](#)
- [Appendix TOV and Earth Faults use case USA](#)
- [Example template page](#)
- [Executive Summary and Conclusions](#)

# JWG A1/A2/A3/B1.44 Attività in corso, 2-Voltage stresses

- 2.1. Voltage definitions
- 2.2. Summary of the network code on requirements
- 2.3. Typical network conditions resulting in temporary overvoltages
- 2.4. Examples of the influence of TOV on typical switching operations - A Basic Theoretical Approach
  - 2.4.1. Transient Recovery Voltage (TRV)
    - 2.4.1.1. Initial magnitude of the TRV
    - 2.4.1.2. Terminal Fault (point A)
    - 2.4.1.3. Short-line Fault (point B)
    - 2.4.1.4. Maximum (peak) TRV values
  - 2.4.2. Switching of Capacitive / Small-Inductive Currents
    - 2.4.2.1. Capacitive Switching
      - 2.4.2.1.1. Opening of shunt capacitors banks
      - 2.4.2.1.2. Opening of no-load transmission lines
      - 2.4.2.1.3. Switching of Small-Inductive Currents
  - 2.4.3. Interruption of Induced Currents by Earthing Switches
  - 2.4.4. Influence of TOV on Short-Circuit Currents with Delayed Zeros
- 2.5. Voltage profiles
  - 2.5.1. Belgian
  - 2.5.2. German
- 2.6. THE PROCEDURE INSULATION OF COORDINATION PRESCRIBE Safety Factor KS
- 2.7. TOV withstand capability of equipment
- 2.8. Requirements in the European Network Codes vs. TOV definition in the IEC standard

# **JWG A1/A2/A3/B1.44 Attività in corso,**

## **4- TC and VT**

4.1. Introduction - Accuracy

4.2. Ferro-resonance

4.2.1. Classification of Ferro-resonance oscillations

4.2.1.1. Single phase Ferro-resonance

4.2.1.2. Three phase Ferro-resonance

4.2.2. Behaviour of Ferro-resonance oscillations

4.2.3. Countermeasures

4.2.3.1. Theoretical aspects

4.2.3.2. Practical implementation of countermeasures

4.3. Insulation

4.4. Conclusion

## **5-TF Generators**

5.1. 1/Standards used for old and new power plants, depending on the generator types

5.2. 2/Description of methods used for the voltage control and requirements from TSOs regarding operations during transient overvoltages

5.3. 3/Impacts on transient voltages on ageing of generators

# **JWG A1/A2/A3/B1.44 Attività in corso, 6- Switchgear**

- 6.1. Basic functions of switching equipment
- 6.2. Impact of the TOV on the dielectric performance of the switching equipment
- 6.3. Impact of the TOV on the current carrying performance of the switching equipment
- 6.4. Circuit breakers
- 6.5. Disconnectors
- 6.6. Earthing switches

## **7-Cable ( 8 paragrafi non ancora confermati)**

## **8-Transformers**

- 8.1. Introduction
- 8.2. Used abbreviations
- 8.3. Bushing
- 8.4. Windings
- 8.5. Core
- 8.6. Tap changer
- 8.7. Cooling

## **9-Surge Arresters**

- 9.1. Surge Arresters Selection and Application in USA
- 9.2. Typical Electrical Requirement for Gapless Metal Oxide Surge Arresters in Brazil – Rev. 1 (Nov. 17th. 2020)
- 9.3. Germany
- 9.4. Excell Tool to check SA dimensioning for Um
- 9.5. Aging aspect

# Grazie per l'attenzione

[eros.stella@ge.com](mailto:eros.stella@ge.com)



# **CIGRE WG A3.48**

## **4<sup>th</sup> CIGRE RELIABILITY SURVEY ON TRANSMISSION AND DISTRIBUTION EQUIPMENT**

**Convenor:** HIROKI ITO  
**Italian Member:** GIANCARLO GUENZI

**Time Schedule:** Start in June 2022      **Final Report:** March 2024

**4<sup>th</sup> CIGRE RELIABILITY SURVEY ON TRANSMISSION AND DISTRIBUTION EQUIPMENT**

**I CIGRE Reliability Surveys sono la principale referenza internazionale per la valutazione della affidabilità dei componenti dei sistemi di potenza.**

**Sono utilizzati come referenza anche dalla IEEE Std 493 – Reliable Industrial and Commercial Power Systems.**

**I dati del survey vengono utilizzati per Studi di Affidabilità al fine ridurre al minimo i disservizi, e ottimizzare:**

- Comparazione e Scelta di Alternative di Schema e di Sistema.**
- Criteri di Operazione dei Sistemi.**
- Manutenzione Programmata - Reliability Centered Maintenance**

## **CIGRE WG A3.48**

### **4<sup>th</sup> CIGRE RELIABILITY SURVEY ON TRANSMISSION AND DISTRIBUTION EQUIPMENT**

#### **SCOPE (estratto da TOR)**

- 1. Update the recent population and major failure frequency on different transmission and distribution equipment serviced from 2014 to 2017 in different countries.**
- 2. Provide failure frequency on equipment classified into specification, design, service-year, maintenance and replacement policy, country by country**
- 3. Compare the recent results with the previous CIGRE reliability survey**
- 4. Equipment ageing consequence throughout the lifetime with identical specific design and operating conditions**
- 5. Background information on difference in reliability among the countries**
- 6. Failure lessons to prevent a similar failure from reoccurrence**
- 7. Plan the next reliability survey on equipment serviced in 2024-2027 and the scope of investigations**

**4<sup>th</sup> CIGRE RELIABILITY SURVEY ON TRANSMISSION AND DISTRIBUTION EQUIPMENT**

**POTENTIAL BENEFIT OF WORK (Estratto da TOR)**

|          |                                                                                                                                           |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1</b> | <b>Commercial, business or economic benefit for industry or the community can be identified as a direct result of this work</b>           |
| <b>2</b> | <b>Existing or future high interest in the work from a wide range of stakeholders</b>                                                     |
| <b>3</b> | <b>Work is likely to contribute to new or revised industry standards or with other long term interest for the Electric Power Industry</b> |
| <b>4</b> | <b>State-of-the-art or innovative solutions or new technical direction</b>                                                                |
| <b>5</b> | <b>Guide or survey related to existing techniques. Or an update on past work or previous Technical Brochures</b>                          |
| <b>6</b> | <b>Work likely to have a safety or environmental benefit</b>                                                                              |

## **CIGRE WG A3.48**

### **4<sup>th</sup> CIGRE RELIABILITY SURVEY ON TRANSMISSION AND DISTRIBUTION EQUIPMENT**

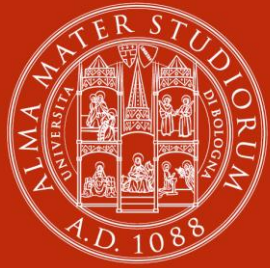
#### **DELIVERABLES (estratto da TOR):**

- **A series of Technical Brochures and Executive Summary in Electra**
- **Electra report, Session papers**
- **Tutorial**

#### **Contributo (tentativo):**

- **Analisi dell'impatto dei Sistemi di Autodiagnostico.**
- **Correlazione tra Guasti e Stress Operativi**
- **Per i Componenti con funzione di Protezione (Interruttori e Scaricatori):  
Suddivisione dei guasti in Operazione Normale e On Demand, e revisione dei modelli affidabilistici.**





ALMA MATER STUDIORUM  
UNIVERSITÀ DI BOLOGNA

# Aging effects on accuracy class of Instrument Transformers CIGRE WG A3.49

**Roberto Tinarelli**

Dipartimento di Ingegneria dell'Energia Elettrica e  
dell'Informazione

# Motivazioni

- La corretta gestione delle reti elettriche è affidata all'elaborazione di informazioni provenienti dai trasformatori di misura.
- Ai tradizionali trasformatori di misura induttivi si sono aggiunti recentemente i cosiddetti LPIT, che spesso si fanno preferire per larghezza di banda, risposta dinamica, ingombri e peso.



- La stabilità delle loro caratteristiche metrologiche nel tempo, che possono cambiare per l'invecchiamento, è un parametro critico.
- Essa deve essere assicurata dai produttori di IT in quanto la verifica periodica di la loro classe di accuratezza è un compito complesso che richiederebbe uno sforzo enorme.
- Studi sull'invecchiamento degli asset elettrici sono in corso da anni ma nulla o quasi è stato fatto per i trasformatori di misura.
- Il poco materiale riguarda quelli induttivi.



- Finché, nonostante l'invecchiamento, il trasformatore di misura permane dentro la sua classe di accuratezza non ci sono problemi.
- Non appena ne esce, deve essere considerato guasto, in quanto non in grado di svolgere la sua funzione.
- Ciò porta ad affrontare il problema in termini di affidabilità e relativi modelli di degradazione.
- E' quindi cruciale e di estrema rilevanza per il mercato indagare e raccogliere risultati sperimentali e modelli teorici volti a descrivere i meccanismi che portano a un degradazione delle caratteristiche di accuratezza di tutti i tipi di IT.



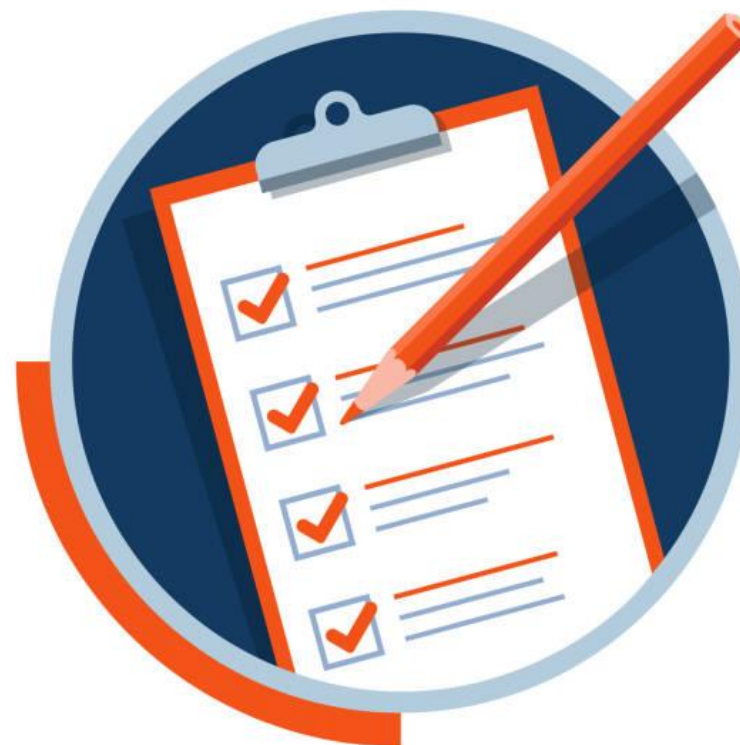
# Scopo

- Il gruppo di lavoro produrrà un documento tecnico sugli effetti dell'invecchiamento sulle prestazioni metrologiche dei trasformatori di misura.
- Si prenderanno in considerazione le condizioni ambientali, i meccanismi di degradazione dei componenti all'interno dei trasformatori stessi e naturalmente le condizioni operative elettriche (grandezze primarie sinusoidali o distorte).





1. Discussioni sui principali effetti che possono influenzare le prestazioni dei trasformatori di misura nel tempo (condizioni meteo, campo elettrico, campo magnetico, componenti ad alta frequenza, transitori,...)
2. Discussioni teoriche sui meccanismi di invecchiamento sia negli isolanti che in altri componenti chiave degli IT che possono contribuire all'accuratezza.
3. Definizione di "Affidabilità" dal punto di vista metrologico, definizione di "guasto metrologico" e come valutarlo attraverso modelli di degradazione.
4. Progettazione di esperimenti per la realizzazione di prove accelerate su trasformatori di misura per testare l'invecchiamento e stimare sperimentalmente l'MTTF (Mean Time To the First Failure)



# Deliverable

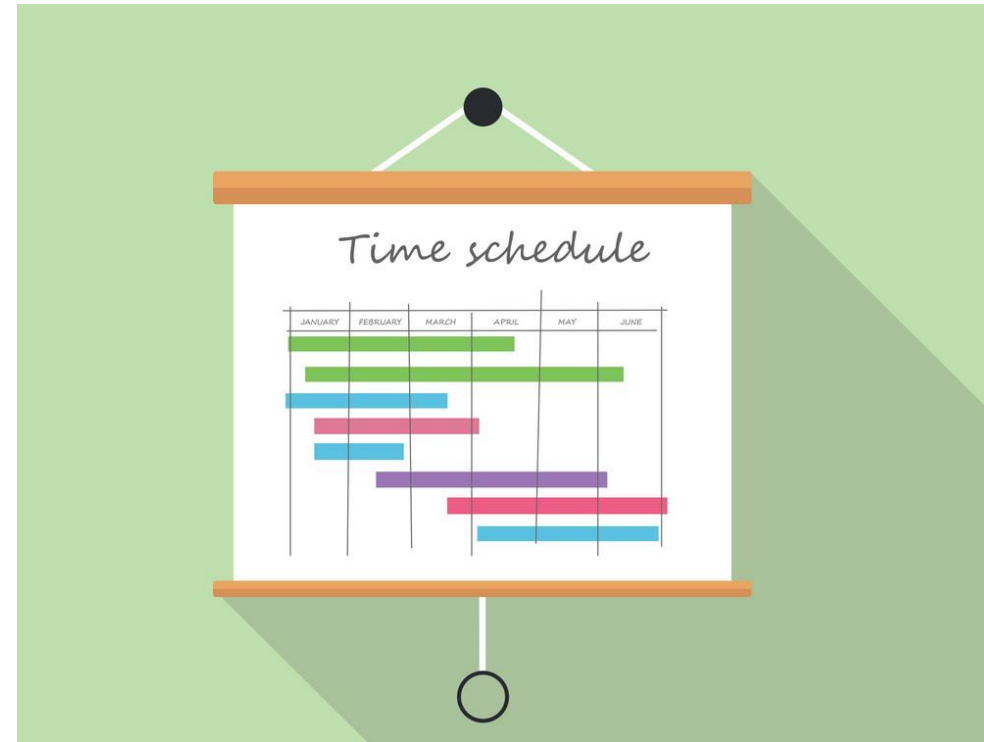
- Annual Progress and Activity Report to Study Committee
- Technical Brochure and Executive Summary in Electra
- Electra Report
- Tutorial
- Webinar

**RESULTS**



# Time schedule

|                                       |         |
|---------------------------------------|---------|
| Recruit members (National Committees) | Q4 2022 |
| Develop final work plan               | Q1 2023 |
| Draft TB for Study Committee Review   | Q2 2025 |
| Final TB                              | Q3 2025 |
| Tutorial                              | Q4 2024 |
| Webinar                               | Q2 2022 |



## Situazione attuale

- 12 membri (di cui 1 convenor e 1 osservatore) + 2 in attesa
- 3 Australia
- 1 Thailandia
- 1 Brasile
- 1 Regno Unito
- 3 Italia
- 1 Germania
- 1 Stati Uniti
- 1 Cina
- In attesa: 1 Francia, 1 Austria





ALMA MATER STUDIORUM  
UNIVERSITÀ DI BOLOGNA

**Roberto Tinarelli**

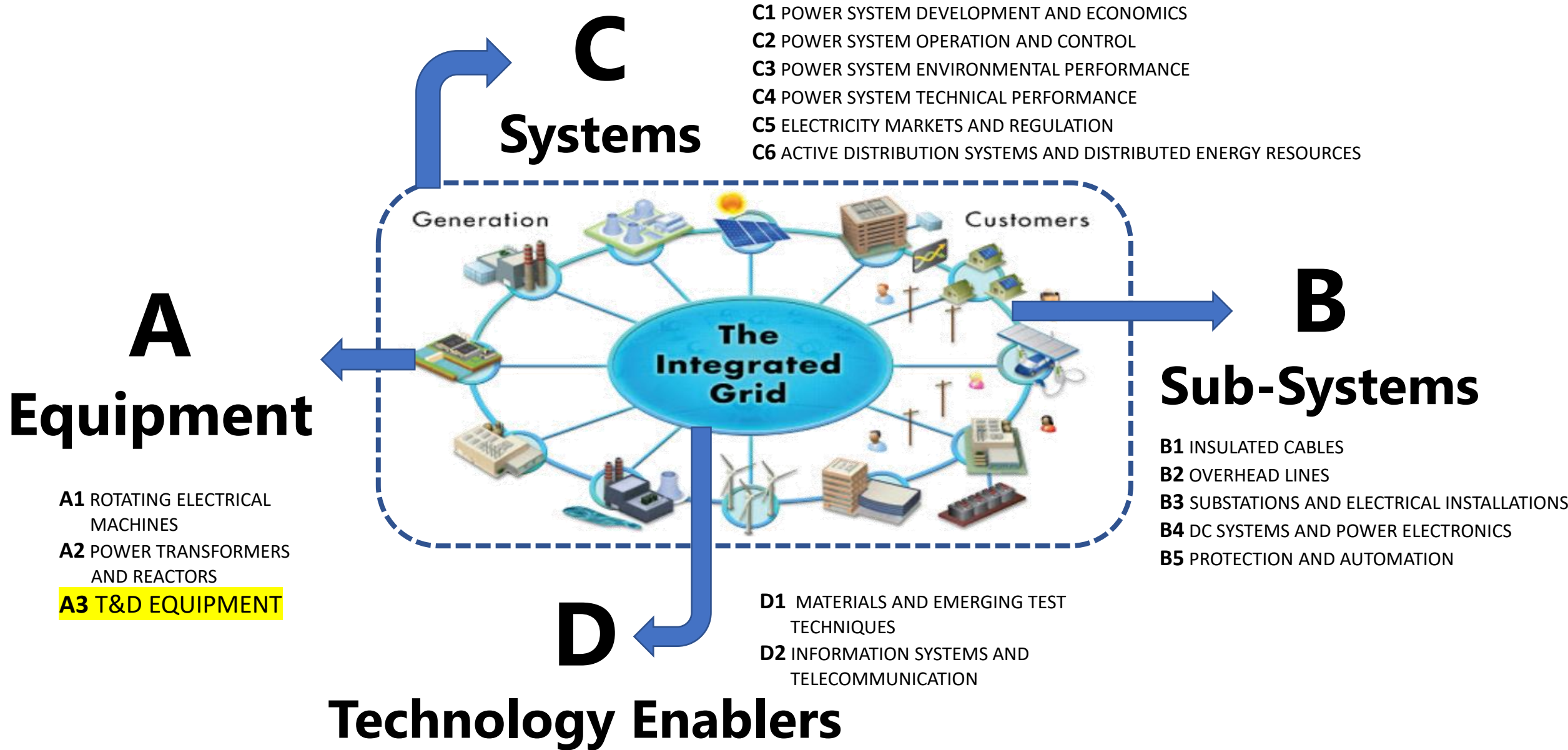
Dipartimento di Ingegneria dell'Energia Elettrica e dell'Informazione «G. Marconi»

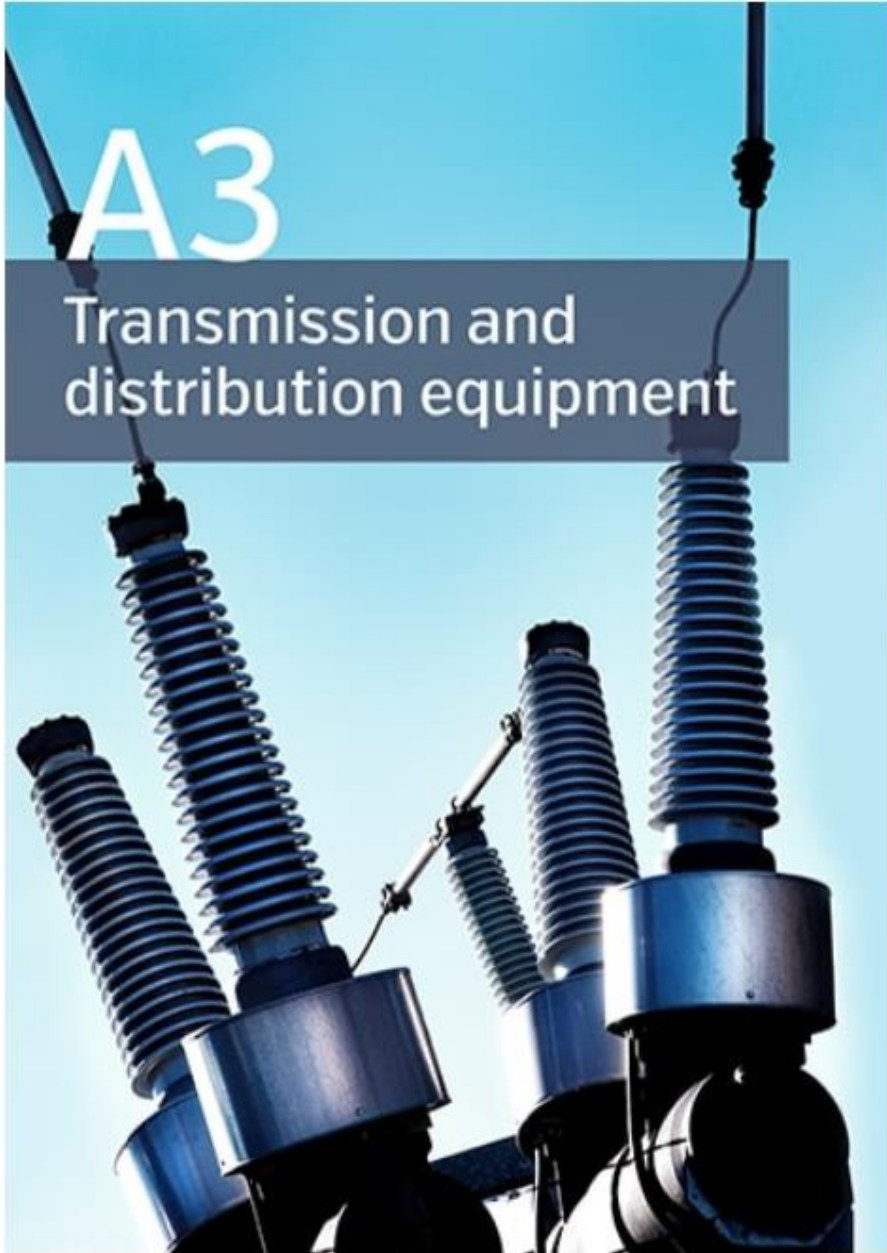
roberto.tinarelli3@unibo.it

[www.unibo.it](http://www.unibo.it)

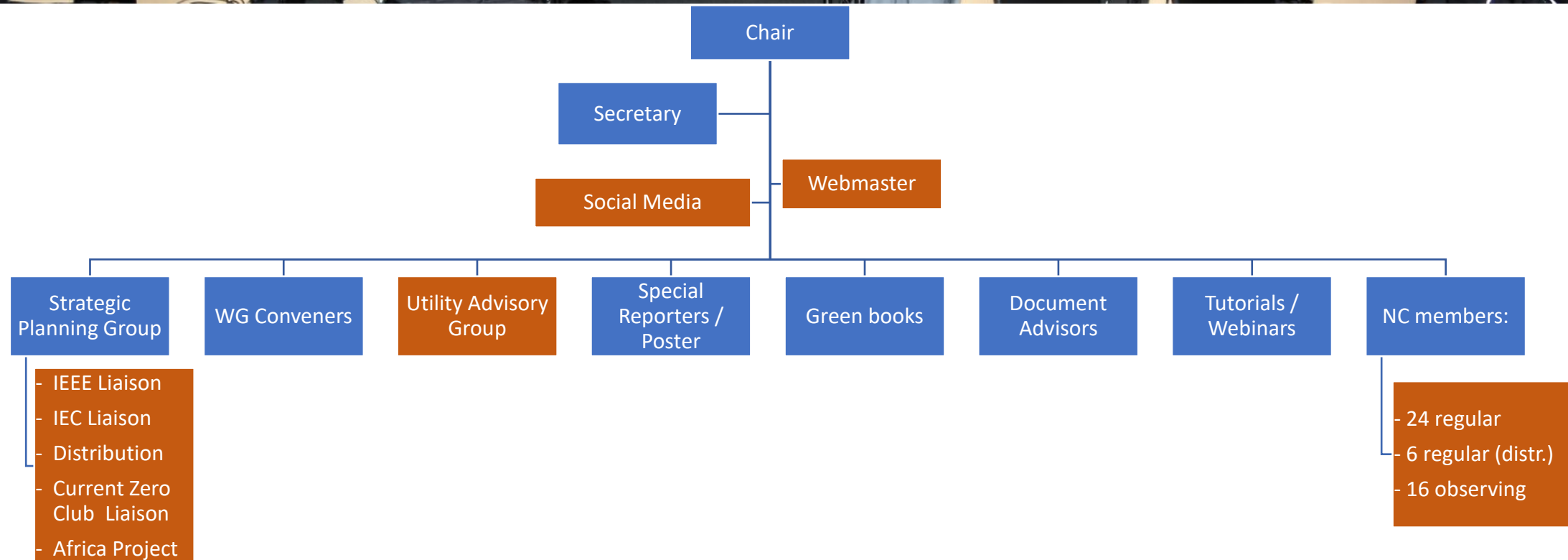


# CIGRE Technical Committees (E2E)





- Devices for switching, interrupting, or limiting currents
- Surge arresters,
- Capacitors,
- Busbar and equipment insulators,
- Instrument Transformers,
- Bushings,
- Other T&D equipment not specifically covered under another study committee's scopes



# Utility Advisory Board (UAB)

## **Chair**

Robert LeRoux  
ESBI International  
[robert.leroux@esb.ie](mailto:robert.leroux@esb.ie)

- The 'Voice' of utilities
- UAB consists of Cigre members employed by utilities
- Foster discussion of utility members
- Advise Cigre of the requirements of utilities (focus on A3)
- Always looking for new members.

# Highlights & Technical Directions of SC A3

- **Highlights in '22**
  - Paris 2022
  - Workshop on SF6 alternatives
  - 7 running WGs and 1 JWG active under A3, participation in 4 JWG under other SCs lead, one new WG established
  - 2 WG disbanded in 2022 (TBs were published: No. 871 and 873)
  - 327 members, 17 female, 19 young (more members in total, but less female and young members compared to 2022)
- **Important activities '23:**
  - Take part on CIGRE Events: March Muscat (Oman), May Birmingham (UK), September Cairns (Australia)
  - 2 technical brochures shall be published: A3.39 and A3.43
  - Tutorial together with current zero club (CzC),
  - Next workshop on SF6 alternatives
  - **Further tutorials in conjunction with the planned events**
- **Technical Direction:**
  - Impact of renewables on T&D equipment: *Highlight Equipment for DC application*
  - Environmental and climate impact on T&D equipment: *Highlight SF6 Alternatives*
  - Sustainability in the whole lifecycle of T&D equipment
  - Digitalization & automatization
  - Advanced sensors and data analytics
  - Asset management / Condition assessment



## 2023 TC Highlights and looking ahead

### A3

#### A3 TRANSMISSION&DISTRIBUTION EQUIPMENT

- Innovative design and technologies for changing network conditions, like HVDC and MVDC and off shore equipment. Need for higher ratings, higher reliability, faster, smaller and smarter equipment.
- Focus on environment and climate change . Deployment of lower carbon footprint equipment, like SF6 alternatives. More resilient equipment capable of withstanding flooding, high winds, extreme temperatures, ice storms, forest fires.
- Embedding intelligence into T&D equipment, high accuracy sensors, digital equipment with built in IoT, AI, machine learning.
- Reliability assessment and lifecycle management of ageing equipment. Monitoring and diagnostics, Condition assessment, determining End of Life, Digital Twin concept.

# CIGRE - International Council for Large Electric Systems

Comitato Nazionale Italiano

**Gruppo NGN Cigre Italia**

Aprile 2023

*Ing. Anna Satta - Terna*



**cigre**

For power system expertise

# Focus attività



## Next Generation Network

Il comitato NGN è stato istituito nel 2019 per **favorire il coinvolgimento di studenti e giovani professionisti under 35** e per fornire loro risorse tecniche e opportunità di networking utili per uno sviluppo professionale.

Attualmente nel Mondo sono 25 i Paesi che hanno costituito un gruppo CIGRE NGN.



*Dal 4 dicembre 2019 opera il **Comitato Next Generation Network (NGN) Italia***



### Obiettivi NGN Cigrè Italia

- Incoraggiare l'adesione attiva a CIGRÉ Italia NGN e offrire opportunità di sviluppo personale e tecnico
- Organizzare e promuovere attività tecniche e scientifiche come ad esempio visite guidate, tutorial, seminari, e opportuni eventi di networking
- Incoraggiare la partecipazione ai Comitati di Studio (SC) e Gruppi di lavoro (WG) CIGRÉ
- Incoraggiare a tutti i livelli la partecipazione femminile alle attività CIGRÉ, CIGRÉ Italia ed NGN
- Costruire connessioni e condividere esperienze con altri comitati nazionali e gruppi di giovani membri sui successi e i fallimenti dei programmi per incoraggiare e promuovere CIGRÉ a ingegneri e professionisti nelle prime fasi della loro carriera nel settore elettrico ed energetico

**Circa 90 membri**

# Focus attività

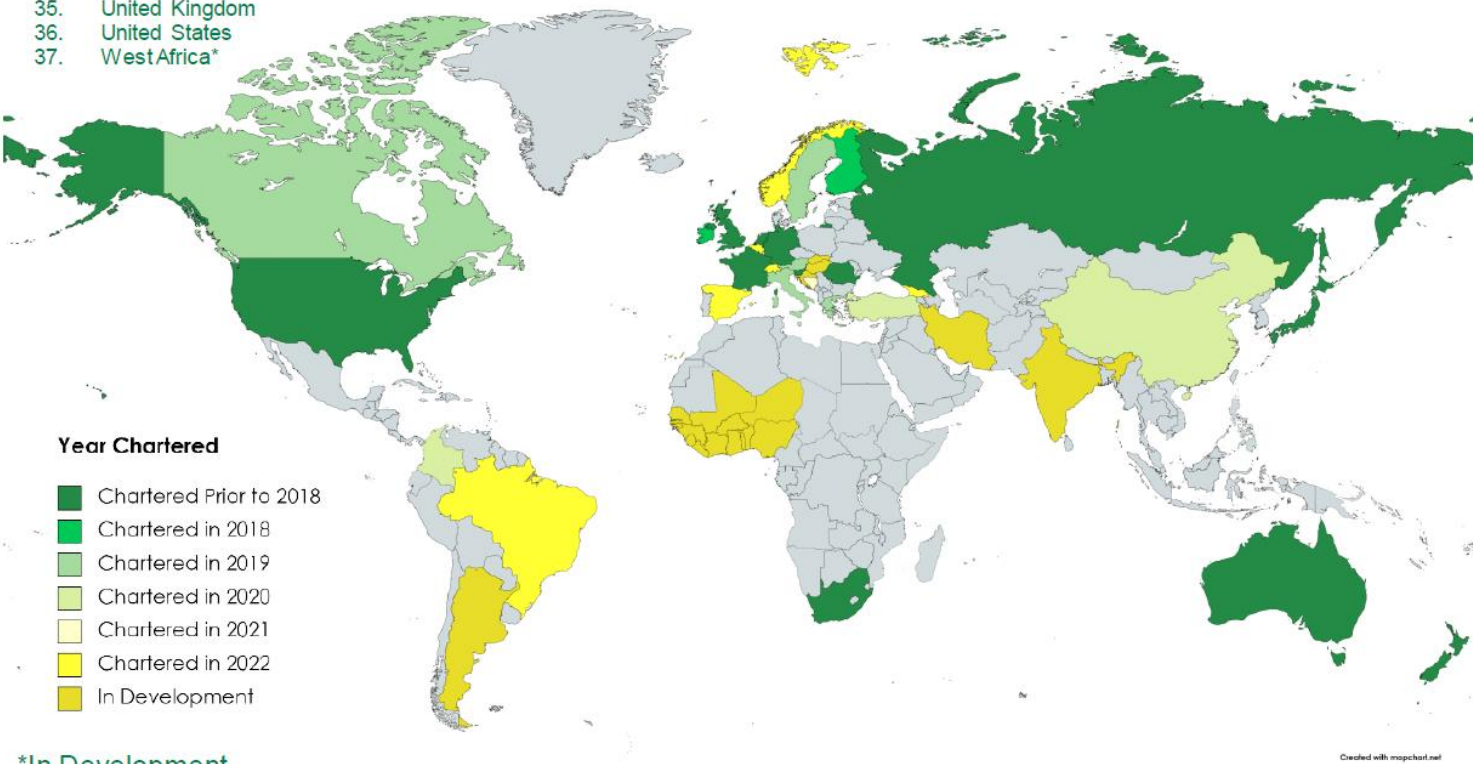
## Next Generation Network



### Current NGN Groups:

1. Argentina\*
2. Australia
3. Austria
4. Belgium
5. Bosnia & Herzegovina
6. Brazil
7. Canada
8. China
9. Colombia
10. Croatia\*
11. Denmark
12. Finland
13. France
14. Georgia
15. Germany
16. Greece
17. Hungary\*
18. India\*
19. Iran\*
20. Ireland
21. Italy
22. Japan
23. Netherlands
24. New Zealand
25. Norway
26. Romania
27. Russia
28. Slovakia\*
29. Slovenia
30. South Africa
31. Spain
32. Sweden
33. Switzerland

34. Turkey
35. United Kingdom
36. United States
37. West Africa\*



- Year Chartered**
- Chartered Prior to 2018
  - Chartered in 2018
  - Chartered in 2019
  - Chartered in 2020
  - Chartered in 2021
  - Chartered in 2022
  - In Development

\*In Development



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## Incoming NGN Chair & Vice Chair: Paris 2022 - 2024

Congratulations to Phil and Anthony for being elected into the positions of Chair and Vice Chair!  
We wish you all the best in your new roles 😊

CHAIR



Phil Coughlan (AU)

VICE-CHAIR



Anthony Giacomoni (US)



# Focus attività

Next Generation Network



ITALIA



## Board

| Ruolo                           | Nominativo         | Azienda                          |
|---------------------------------|--------------------|----------------------------------|
| Chairperson                     | Marco Forteleoni   | TERNA                            |
| Representative IEC NGN Board    | Anna Satta         | TERNA                            |
| Women in CIGRÉ Liaison Lead     | Arianna Guarneri   | TERNA                            |
| Technical Lead                  | Luigi Calcara      | Università La Sapienza           |
| Academic Liaison Lead           | Francesco Sannitti | Università degli Studi di Padova |
| Communications & Marketing Lead | Arman Derviskadic  | HITACHI                          |
| Event Lead                      | Andrea Mazza       | Politecnico di Torino            |



90 membri under 35  
(circa 1/3 da Università)



2 incontri di Comitato  
Direttivo all'anno



Con i suoi ~350 membri, il Comitato Nazionale Italiano (NC IT) è tra i più grandi in Europa e i più attivi al mondo.



Forum allargato che riunisce i principali stakeholder del settore elettrico: università, centri di ricerca, gestori di rete, produttori, costruttori, operatori di mercato, policy maker.



Fanno parte del Comitato tutti coloro, persone fisiche e giuridiche, che sono iscritte al CIGRE. Sono previste cinque categorie di membri: individuali, giovani, studenti, collettivi e università.



Tra le imprese e le associazioni figurano: CESI, Rse, CEI, Prysmian, IMQ, Ansaldo, Edison, Enel, e-distribuzione, Enel Green Power, Siemens, Terna, Med-TSO.



Tra le università: consorzio EnSiEL, Politecnico di Torino, Politecnico di Milano, La Sapienza, Uni Bologna, Cagliari, Genova, Padova, Pisa.

## Workshop Palau 2022



### Study Committee NGN IEC Leads



Branislav Pilát



| Study Committee | Country                       | Contact Name                         | Email Address                                                                                                                                            |
|-----------------|-------------------------------|--------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| A1              | Romania                       | Ciprian BORASCU                      | <a href="mailto:Ciprian.Borascu@transelectrica.ro">Ciprian.Borascu@transelectrica.ro</a>                                                                 |
| A2              | South Africa                  | Mashilo MOABELO                      | <a href="mailto:moabelmm@eskom.co.za">moabelmm@eskom.co.za</a>                                                                                           |
| A3              | Slovakia                      | Branislav PILAT                      | <a href="mailto:Branislav.Pilat@sepsas.sk">Branislav.Pilat@sepsas.sk</a>                                                                                 |
| B1              | United Kingdom<br>Netherlands | Jingyi WAN<br>Sanjay GANESHAN        | <a href="mailto:jingyi.wan@hotmail.com">jingyi.wan@hotmail.com</a><br><a href="mailto:Ganeshan.Sanjay@deme-group.com">Ganeshan.Sanjay@deme-group.com</a> |
| B2              | Slovenia<br>Austria           | Ana LOVRENCIC<br>Kerstin WEINDL      | <a href="mailto:ancka.lovrencic@gmail.com">ancka.lovrencic@gmail.com</a><br><a href="mailto:kerstin.weindl@apg.at">kerstin.weindl@apg.at</a>             |
| B3              | Australia                     | Daniel STAFFORD                      | <a href="mailto:daniel.stafford@jacobs.com">daniel.stafford@jacobs.com</a>                                                                               |
| B4              | China                         | Yuebin ZHOU                          | <a href="mailto:zhouyb@csg.cn">zhouyb@csg.cn</a>                                                                                                         |
| B5              | United Kingdom                | Qiteng HONG                          | <a href="mailto:q.hong@strath.ac.uk">q.hong@strath.ac.uk</a>                                                                                             |
| C1              | China                         | Shang NAN                            | <a href="mailto:cspg_sn@163.com">cspg_sn@163.com</a>                                                                                                     |
| C2              | Germany                       | Andreas LUKASCHIK                    | <a href="mailto:andreas.lukaschik@tennet.eu">andreas.lukaschik@tennet.eu</a>                                                                             |
| C3              | China                         | Han MINGYU                           | <a href="mailto:connorhmy@outlook.com">connorhmy@outlook.com</a>                                                                                         |
| C4              | Spain<br>China                | Alexander GALLARRETA<br>Tian PENGFEI | <a href="mailto:alexander.gallarreta@ehu.eus">alexander.gallarreta@ehu.eus</a><br><a href="mailto:tianpengfei517@126.com">tianpengfei517@126.com</a>     |
| C5              | United States                 | Anthony GIACOMONI                    | <a href="mailto:giaco013@umn.edu">giaco013@umn.edu</a>                                                                                                   |
| C6              | Germany<br>United Kingdom     | Stefie CRAY<br>Harry EVANS           | <a href="mailto:stefanie.cray@ps.rolls-royce.com">stefanie.cray@ps.rolls-royce.com</a><br><a href="mailto:Harry.Evans@ghd.com">Harry.Evans@ghd.com</a>   |
| D1              | Argentina                     | Pablo BOGGETTI                       | <a href="mailto:pablo.boggetti@transener.com.ar">pablo.boggetti@transener.com.ar</a>                                                                     |
| D2              | United Kingdom                | Siva Kaviya TRICHY SIVA<br>RAMAN     | <a href="mailto:sivakaviya@gmail.com">sivakaviya@gmail.com</a>                                                                                           |

Possibilità di costituire vari WG internazionali o aderire ad alcuni già presenti, anche su temi trasversali

## Eventi

|                                                                                  | MAY 2023 |    |    |    |    |    |    |
|----------------------------------------------------------------------------------|----------|----|----|----|----|----|----|
|                                                                                  | S        | M  | T  | W  | T  | F  | S  |
|                                                                                  |          | 1  | 2  | 3  | 4  | 5  | 6  |
|                                                                                  | 7        | 8  | 9  | 10 | 11 | 12 | 13 |
| B3 & A3 Colloquium - Call for papers in Birmingham (GB)                          | 14       | 15 | 16 | 17 | 18 | 19 | 20 |
|                                                                                  | 21       | 22 | 23 | 24 | 25 | 26 | 27 |
| The XIX ERIAC - Encuentro Regional Iberoamericano de CIGRE in Foz do Iguaçu (BR) | 28       | 29 | 30 | 31 |    |    |    |



*Nasce nel 2015 sotto proposta di NGN Regno Unito e approvato dal CIGRE Central Office in occasione della sessione di Parigi del 2016.*

Si tratta di un **momento di presentazione** nella quale i giovani professionisti hanno l'opportunità di:

- Mostrare il loro lavoro ad un pubblico internazionale
- Attivare canali di networking.
- Migliorare la collaborazione tra i gruppi internazionali NGN

I candidati selezionati ricevono, in occasione della **Paris Session 2024**:

- Biglietto gratuito
- Spazio di 10 minuti alla sessione di discussione, per il rispettivo comitato di studio
- Spazio alla Poster session, per il rispettivo comitato di studio
- Invito a partecipare alla competizione di presentazione NGN (sessione generale)
- Articolo incluso nella raccolta generale di conclusione



### Regole di partecipazione:

- Ogni paese/comitato nazionale può presentare fino a 4 candidature, max 1 per Comitato di Studio
- Ogni candidato deve essere membro CIGRE
- Le presentazioni devono avere come tema uno dei Preferential Subject della sessione
- Le presentazioni non devono essere basate su un documento già presentato/accettato per la Paris Session
- Ogni presidente di Comitato può accettare fino a 2 presentazioni

### Ogni nomina deve includere:

1. Full paper preparato dal candidato
2. Bozza di presentazione
3. One pager informativo



### Timeline

- **6 febbraio 2024 (scadenza in comune con i regular paper)**  
Candidatura, per ogni NC, di 4 nominativi complete della documentazione necessaria
- **6 Maggio 2024**  
Selezione da parte dei presidenti di SC (2 presentazioni)
- **7 Maggio 2024**  
Notifica ai candidati
- **Agosto 2024**  
Paris Session

Per informazioni:  
[marco.forteleoni@terna.it](mailto:marco.forteleoni@terna.it)  
[anna.satta@terna.it](mailto:anna.satta@terna.it)

### *Esempio – Working group NGN*



#### CIGRE NGN Taskforce - Speed Up the Energy Transition

##### A INTRODUCTION

It cannot be overlooked that **speeding up the energy transition** is not only sensible but critical in order to achieve timely protection for humans, animals and the environment. In this context, this task force will deliver a paper discussing new perspectives on how the energy transition can be accelerated, with a focus on the **synergies between young engineers, companies and the extensive global network of CIGRE.**

The aim is to extract the **dimensions of actions** that can be undertaken in order to give recommendations specifically for **young engineers and decision-makers** in the environment of CIGRE. In addition to the status quo in the fields of technology, society, politics and environment, the paper will also consider and identify obstacles for slowing down the energy transition. With the investigation of CIGRE's options of operation and **the call to young engineers to take responsibility for shaping their future**, there are new opportunities to speed up the energy transition.

Work in progress  
DRAFT!

- Tematica trasversale
- Group Leader: Harry Evans
- Referenti Italiani: Anna Satta
- Sviluppato tramite piattaforma KMS

Per informazioni:  
[anna.satta@terna.it](mailto:anna.satta@terna.it)

### ELECTRA CIGRE's digital magazine

ELECTRA brings you the latest news, expertise and work from the world of CIGRE, the foremost global community for the development of end to end (E2E) power system expertise.



### Requisiti per gli articoli

- Ipotesi di topic: recente evento NGN di successo
- Ipotesi di contenuti: testimonianza di un membro NGN sul valore aggiunto
- Max 1200 parole

# Focus attività

## Eventi



### Distribuzione dei 25 contributi italiani approvati per la sessione

| Area                 | Comitato Studio                                                | Contributi previsti |
|----------------------|----------------------------------------------------------------|---------------------|
| Equipment            | A1 (Rotating Electrical Machines)                              | 1                   |
|                      | A2 (Power Transformers and reactors)                           | 2                   |
|                      | A3 (Transmission and Distribution Equipment)                   | 2                   |
| Technologies         | B1 (Insulated Cables)                                          | 2                   |
|                      | B2 (Overhead Lines)                                            | 2                   |
|                      | B3 (Substations and Electrical Installations)                  | 3                   |
|                      | B4 (DC Systems and Power Electronic)                           | 3                   |
|                      | B5 (Protection and Automation)                                 | 1                   |
| Systems              | C1 (Power System Development and Economics)                    | 5                   |
|                      | C2 (Power System Operation and Control)                        | 2                   |
|                      | C3 (Power System Environment Performance)                      | -                   |
|                      | C4 (Power System Technical Performance)                        | 1                   |
|                      | C5 (Electricity Markets and Regulation)                        | -                   |
|                      | C6 (Active Distribution System and Dispersed Energy Resources) | -                   |
| New materials and IT | D1 (Materials and Emerging Test Techniques)                    | -                   |
|                      | D2 (Information Systems and Telecommunication)                 | 1                   |

Il congresso si è svolto dal 28 Agosto al 2 settembre e ha ospitato specifici incontri dei comitati di studio, insieme ad una serie di altri eventi e opportunità di networking globale, tra i quali:

- Poster session che presenta più di 950 nuovi articoli
- 6 workshop di settore
- 16 tutorial
- Technical Exhibition
- Incontri Next Generation Network (es. [NGN Presentation Showcase](#))
- Incontri Woman in Energy (es. [Next steps for women in energy transition](#))





# Women in Energy - Cigre

Ing. Arianna Guarneri (TERNA S.p.A.)

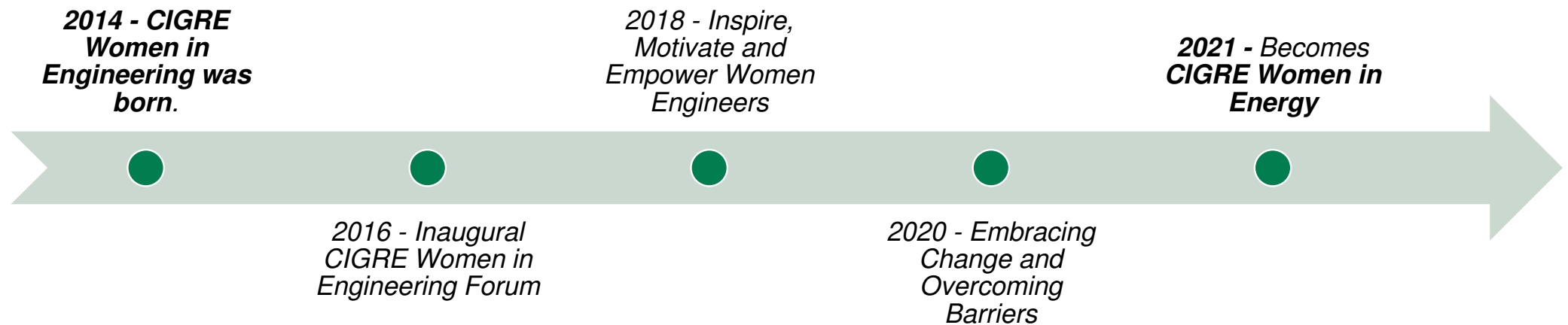


**cigre**

For power system expertise

April 2023

# Women in Energy Cigre



## Vision

CIGRE WiE is a forum for women “engineers” to interact, develop their careers, increase their self-confidence, improve their professional skills, and accomplish their dreams.

## Mission

CIGRE WiE inspires, motivates women engineers by helping to provide links to global thought leaders and role models, as well as to demonstrate the influence and functions of female professional communities.

## Expectations

- Identify winning strategies that drive career success for women in the power & energy industry.
- Understand the knowledge, skills and experience you need to reach your goals.
- Design action plans to grow women’s professional career.

- Women in Energy 2022-26

Chair: Dr. Solange David – Brazil



Vice-Chair: Dr. Biljana Stojkovska - UK



# Women in Energy Cigre



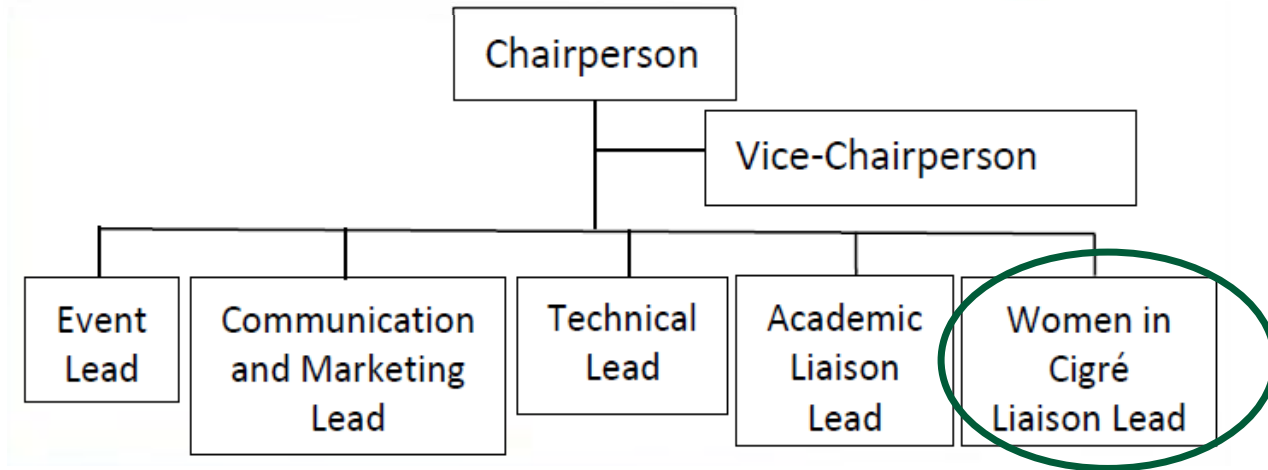
## Update to 2022

| NATIONAL COMMITTEE     | NAME OF WiE CHAIR       |
|------------------------|-------------------------|
| Australia              | Tara-lee MacARTHUR      |
| Brazil                 | Carla Damasceno PEIXOTO |
| Bosnia and Herzegovina | Maja MUFTIC DEDOVIC     |
| Canada                 | Robyn KOROPATNICK       |
| China                  | Bi TIANSHU              |
| Colombia               | Maria GOMEZ             |
| Croatia                | Minea SKOK              |
| France                 | Laurie Anne             |
| GCC                    | Alaa ALKIYUMI           |
| Germany                | Olga OBERLÄNDER         |
| India                  | Seema GUPTA             |
| Iran                   | CIGRE Iran              |
| Israel                 | Tal KATZ                |

| NATIONAL COMMITTEE       | NAME OF WiE CHAIR           |
|--------------------------|-----------------------------|
| Kosovo                   | Pranvera DOBRUNA KRYEZIU    |
| Netherlands              | Luis HURTADO                |
| New Zealand              | Rebecca MARX                |
| Romania                  | Mihai MARCOLT               |
| Russia                   | Yulia ZHILKINA              |
| Slovenia                 | Ana LOVRENCIC               |
| South Africa             | Neo MAPAPANYANE             |
| Spain                    | Ana Simarro GARCIA          |
| Sweden                   | Susanne OLAUSSON            |
| Turkey                   | Hayriye GÜRBÜZ / Dilek KOCA |
| United Kingdom           | Dr. Biljana STOJKOVSKA      |
| United States of America | Amanda OLSON                |
| Italy (NGN liason lead)  | Arianna GUARNERI            |
| Japan                    | CIGRE Japan                 |
| Ukraine                  | CIGRE Ukraine               |
| Egypt                    |                             |

# Women in Energy Cigre

## Activities 2020-2021 CIGRE Italia



### ✓ Establishment of CIGRE NGN Italia (2021)

with the introduction of the figure of *Women in CIGRÉ Liaison Lead*

- It promotes female participation and membership within NGN Italia;
- It supports female participation in CIGRE' activities and initiatives;
- It promotes initiatives in coordination with international CIGRE' Women groups.



# NGN IEC Lead Positions for activities and initiatives

| <div> <div>Organisation:</div> <div>Chair: Stefie Cray</div> <div>Vice Chair: Stanislav Eroshenko</div> <div>Secretary: Anthony Giacomoni</div> </div> |                                                                                           |                                                          |                                                                                           |                                                                                         |                                                                                            |                                                                                             |                                                                                             |         |                                                                                                                                                                                            |                                                                                           |                                                                                             |                                                                                           |
|--------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|----------------------------------------------------------|-------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| Technical & Organisational                                                                                                                             |                                                                                           |                                                          |                                                                                           | Paris Session                                                                           |                                                                                            |                                                                                             | Marketing & Comms (MarCom)                                                                  |         |                                                                                                                                                                                            |                                                                                           |                                                                                             |                                                                                           |
| NGN Showcase                                                                                                                                           | Study Committee Collaboration                                                             | Task Force: „How can we speed up the Energy Transition?“ | NGN Group Constitution (as template for new groups)                                       | Overall Paris Coordination                                                              | NGN Forum                                                                                  | NGN Booth                                                                                   | Overall MarCom Lead                                                                         | Website | Webinar Programme                                                                                                                                                                          | Social Media (Linked In, Instagram)                                                       | Women's Network Rep                                                                         |                                                                                           |
| Lead*                                                                                                                                                  | US**<br> | 1 lead per SC (Anthony co-ordinating)                    | DE<br>   | IE<br> | RU**<br> | RU**<br> | DE**<br> |         | RU<br>                                                                                                  | UK<br> | IR<br>   | IT<br> |
| Support*                                                                                                                                               | CN<br> |                                                          | SE<br> |                                                                                         |                                                                                            |                                                                                             |                                                                                             |         | DE<br><br>JP<br> |                                                                                           | JP<br> |                                                                                           |

\*Lead and Support roles currently allocated per country and refer to the two official representatives of this country's NGN group, as listed on the KMS.

\*\*Legacy roles for 2020 session to be continued at least until 2021 Centennial Session. All other roles to be planned from now to Paris 2022.

# Women in Energy Cigre



## Activities 2020-2021 CIGRE Italia

✓ **2021:** Constitution of the first CIGRE' Women Group in Terna – Teams - to share :

- Events of interest
- Activities of WGs
- Open positions



- ✓ **August 2021:** First involvement of Italy in Cigre Centennial Session WiE Forum
- ✓ **October 2021:** 1° Webinar Women IT – UK
- ✓ **2022:** Coordination with International WiE Groups and Networking
- ✓ **2023:** **GOAL** Constitution of CIGRE Italia WiE Network



### 2021

#### CIGRE NGN Women In Energy (WiE) Roundtable Discussion

Join our Visual Roundtable Discussion on topics related to gender equality, work life balance, STEM participation, female leaderships and innovative projects.

**26 OCT**  
1pm - 2:30pm BST  
2pm - 3:30pm CEST

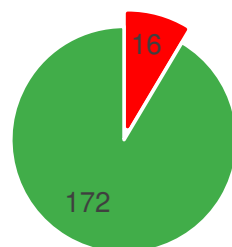
**LIVE**  
@cigre ngn

|                                                                                                                                      |                                                                                                                                     |                                                                                                                                     |
|--------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| <br>Jingyi Wan<br>SENIOR ENGINEER                 | <br>Arianna Guarneri<br>ENVIRONMENTAL ENGINEER   | <br>Angeliki Loukatou<br>RESEARCH ENGINEER       |
| <br>Siva Raviya Trichy<br>SOFTWARE ENGINEER      | <br>Qinghua Han<br>PHD STUDENT                  | <br>Daniela Pagnani<br>PHD RESEARCHER           |
| <br>Giulia Gemma Pancaro<br>ELECTRICAL ENGINEER | <br>Patrizia Fabozzi<br>ENVIRONMENTAL ENGINEER | <br>Beatrice Giachi<br>SENIOR PROJECT ENGINEER |

For more information  
[www.cigre.org/GB/events/next-events](http://www.cigre.org/GB/events/next-events)  
[www.cigre.org.uk/ngn-events](http://www.cigre.org.uk/ngn-events)

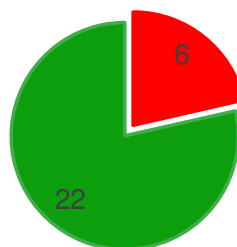
## ..Why Cigré Italia WiE

Women Individual Members – **8%**  
(figures in CIGRE Italia update to Dec.22)



■ Women ■ Men

NGN Italy (< 35 years)  
Women Individual Members – **21%**  
(figures in CIGRE Italia update to Dec.22)



■ Women ■ Men

IT IS FUNDAMENTAL TO UNDERSTAND  
**WHICH ARE REAL OBSTACLES TO  
FEMALE PARTICIPATION TO CIGRE**

1. **Lack of knowledge of Cigre and related opportunities**
2. **Less female presence in Energy Sector**  
  
→ Share of female graduates in STEM still low
3. **Little participation of Women working for Companies which are Collective Members**

**TO UNDERSTAND WHICH ACTIONS ARE  
NECESSARY**

# Cigre Italia WiE



## Specific Objectives of the CIGRE Italia Women in Energy (WiE) Network

- ✓ Promote initiatives to better make known CIGRE and convey within schools, universities, companies and all the organizations registered as collective members in CIGRE Italy CIGRE initiatives, encouraging participation and inclusion in activities and WGs of all interested parties, beyond any distinction of age, gender, profession or other nature, **making leading positions understand importance and opportunity of being part of CIGRE**;
- ✓ Promote/strengthen/support at all levels (school, university, company) the participation of women in CIGRE and CIGRE Italia initiatives, encouraging participation and assumption of roles in activities and WGs;
- ✓ Organize appropriate networking events within CIGRE Italia WiE, promoting synergy with other WiE groups in the world and with other national and international Women in STEM organizations by conveying initiatives organized by them;
- ✓ Report / represent within the national committees CIGRE Italy and CIGRE Italy NGN the activities of CIGRE WiE conveying initiatives of interest promoted by the International Network Women;
- ✓ Bring within CIGRE NGN initiatives of interest promoted by CIGRE Women in Energy and vice versa (role of '*Women in CIGRE Liaison Lead*').

# Women in Energy Cigre



## Link and contacts:

### **CIGRE**

CIGRE Women in Energy <https://www.cigre.org/GB/community/women-in-energy>

Contacting the WIE in different countries: <https://www.cigre.org/GB/community/our-global-presence>

### **CIGRE Italia**

CIGRE Italia WiE <https://www.cigre-italy.org/woman-in-energy/>

Linkedin CIGRE Italia <https://www.linkedin.com/company/76238151/>

### **If interested to Cigre Italia WiE Network**

**please contact** Arianna Guarneri [arianna.guarneri@terna.it](mailto:arianna.guarneri@terna.it)  
Erika Breda [erika.breda@terna.it](mailto:erika.breda@terna.it)



**Women don't have time**

**..but they have temper and  
..above all..**

**TALENT**

**GRAZIE !**



Women in CIGRÉ Liaison Lead CIGRE Italia NGN '21-'22  
Arianna Guarneri [arianna.guarneri@terna.it](mailto:arianna.guarneri@terna.it)



## **Status of superconductivity power applications in RSE**

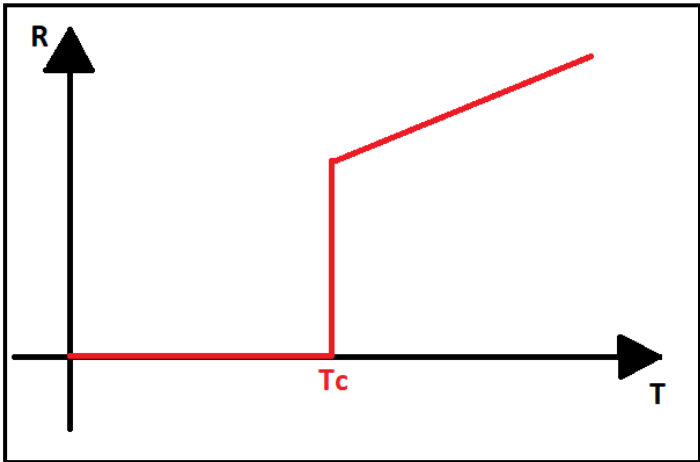
*G. Angeli, M. Ascade, M. Bocchi, G. Fornasier, A. Musso, A. Olchini, V. Rossi*

**CIGRE SC A3 - Transmission and Distribution Equipment**

**Milano, April 18th 2023**

# What does «superconductivity» mean...?

Superconductivity is a natural phenomenon that consists in the loss of resistivity performed by some materials below the **critical temperature ( $T_c$ )** threshold.



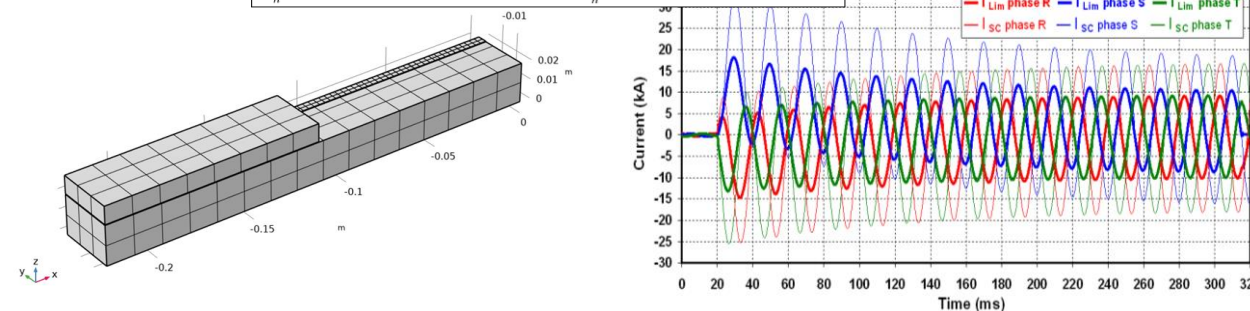
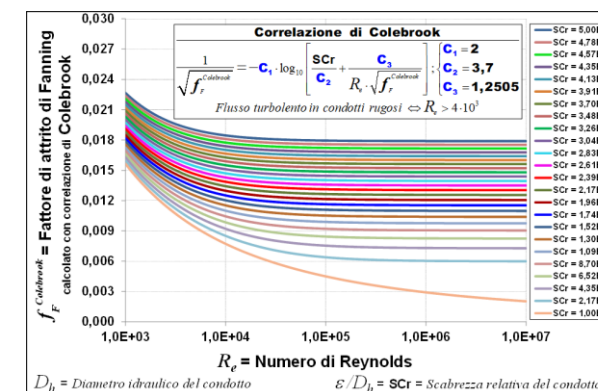
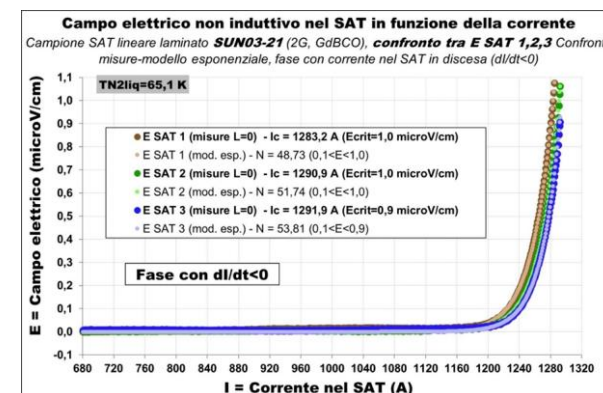
Low Temperature  
Superconductors (LTS)

High Temperature  
Superconductors (HTS)

| Material                  | Discovered in... | $T_c$       | Cryogenic fluid          |
|---------------------------|------------------|-------------|--------------------------|
| Hg                        | 1911             | around 4 K  | Liquid Helium            |
| NbTi e Nb <sub>3</sub> Sn | 1940-1950        | around 20 K | Liquid Helium            |
| YBCO                      | 1986             | 92 K        | Liquid Nitrogen          |
| BSCCO                     | 1988             | 110 K       | Liquid Nitrogen          |
| MgB <sub>2</sub>          | 2001             | 39 K        | Neon and Liquid Hydrogen |

# RSE R/D on HTS Power Applications

- **SFCL Device Design and Modeling**
- **HTS Cables Design and Modeling**
- **HTS Tapes Modeling and Characterization**
- **Techno-Economic Optimization of HTS Co-axial Cables in Different Work Conditions**
- **SFCL Techno-Economic Analysis**
- **Modelling and Measurement of Mechanical Stress on HTS Tapes**
- **Cryogenic Fluids modeling**
- **SFCL Device Assembly and Testing**





# RSE expertise: HTS for power applications

- ❖ SFCL device: design and modeling
- ❖ SFCL techno-economic analysis
- ❖ SFCL device assembly and testing



EU projects



2014- 2018



2022- ongoing



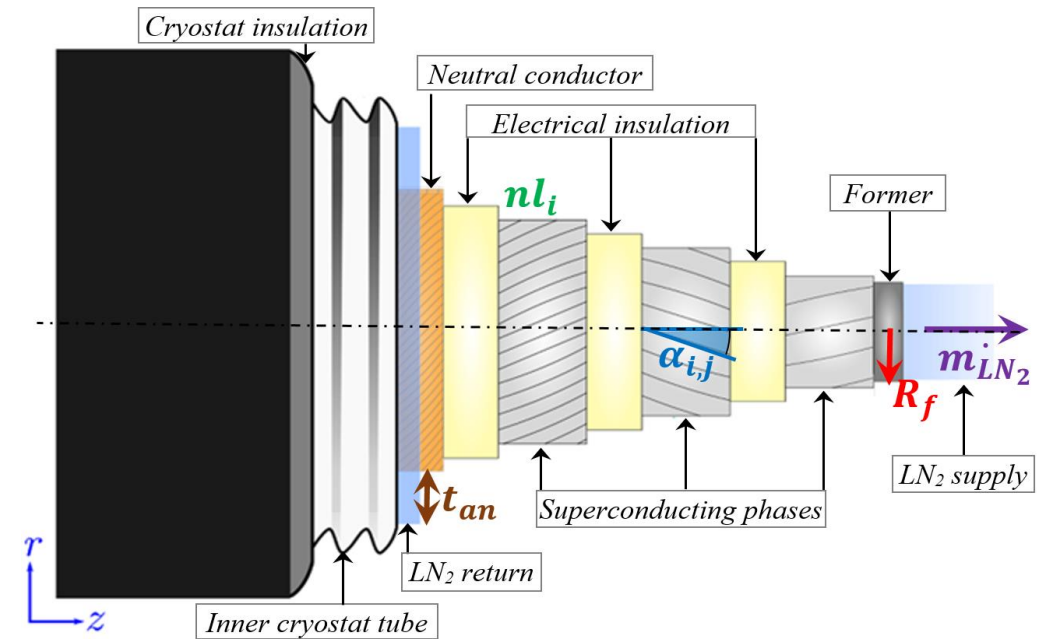
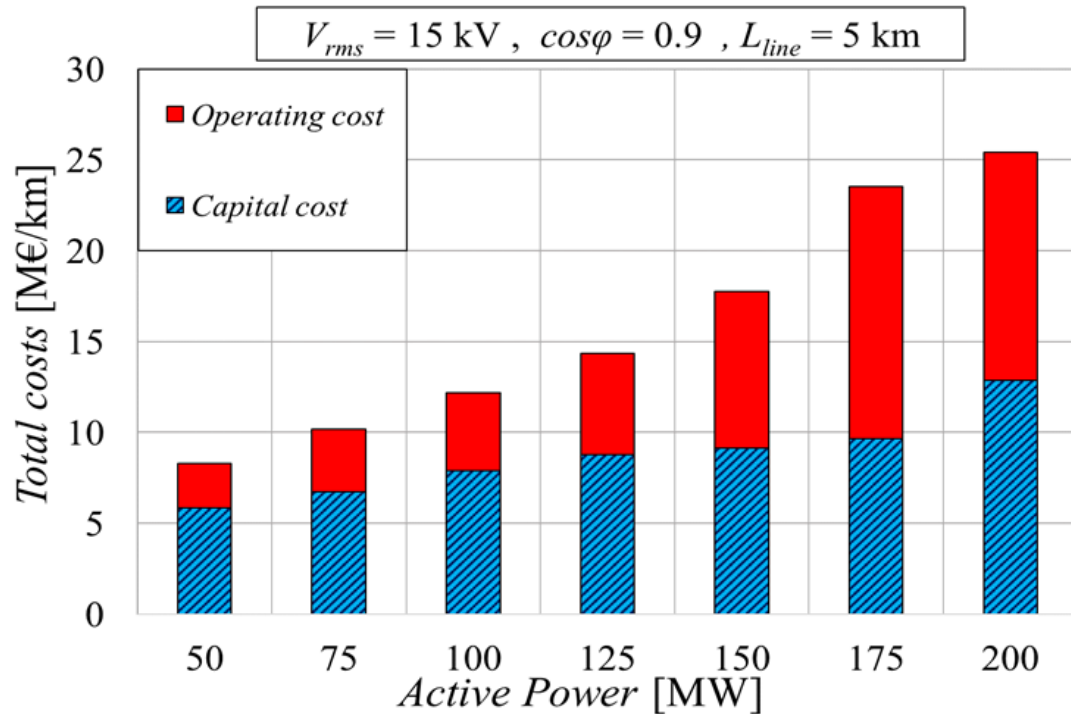
**Full-size  
9kV/3.4MVA  
SFCL prototype  
installed in  
Milan  
distribution grid  
(2012-2014)**



Characterization  
of pancake  
module 5 kV/1kA  
for **FASTGRID  
Project** (2020)

# RSE expertise: HTS for power applications

- ❖ Techno-economic optimization of HTS Coaxial cables in different work conditions



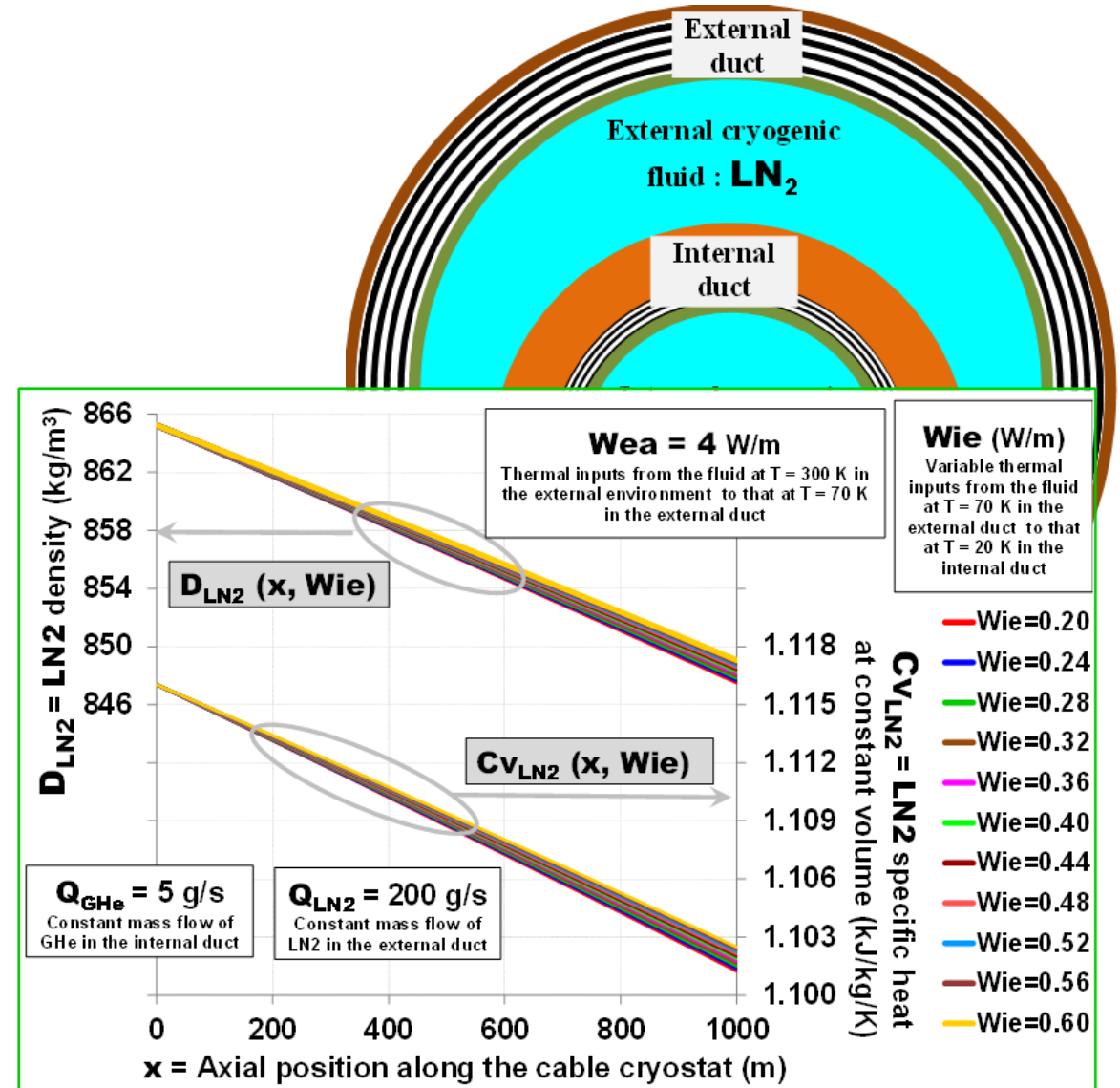
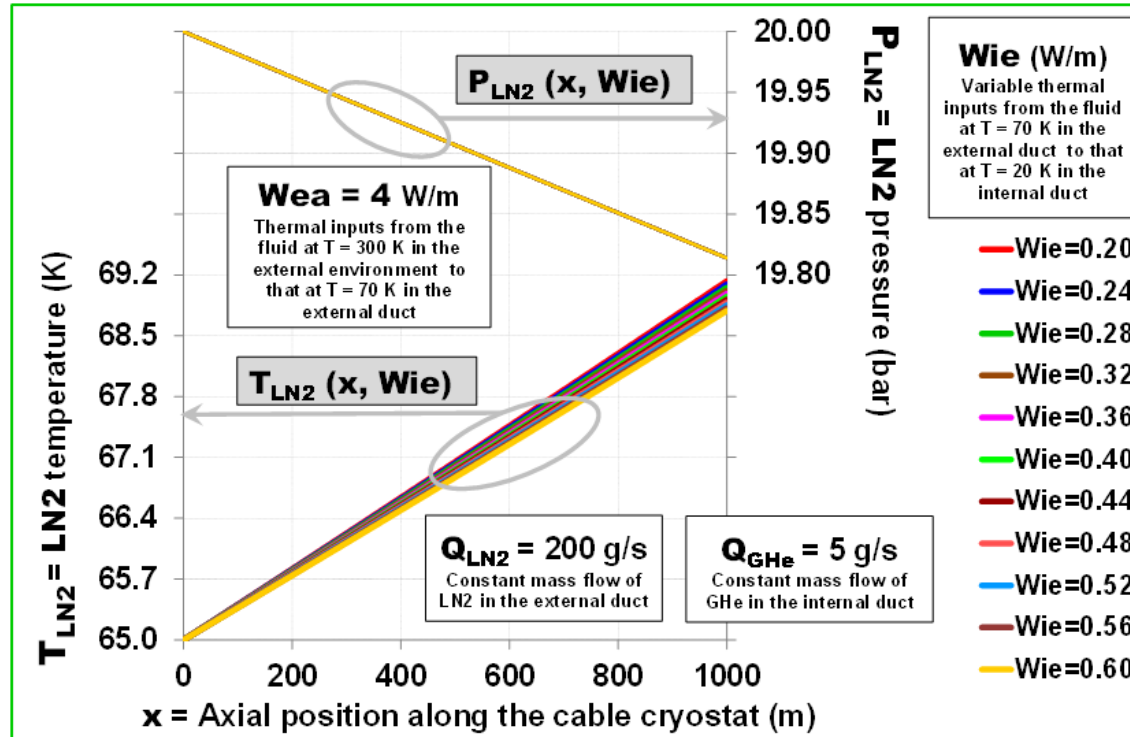
***OSCaR: a tool for techno-economic assessment of HTS power cables***

***A. Musso et al., IEEE Trans. On Appl. Supercond., vol. 32, no. 9, 2022.***



# RSE expertise: HTS for power applications

## ❖ Cryogenic fluids modeling for HTS cables



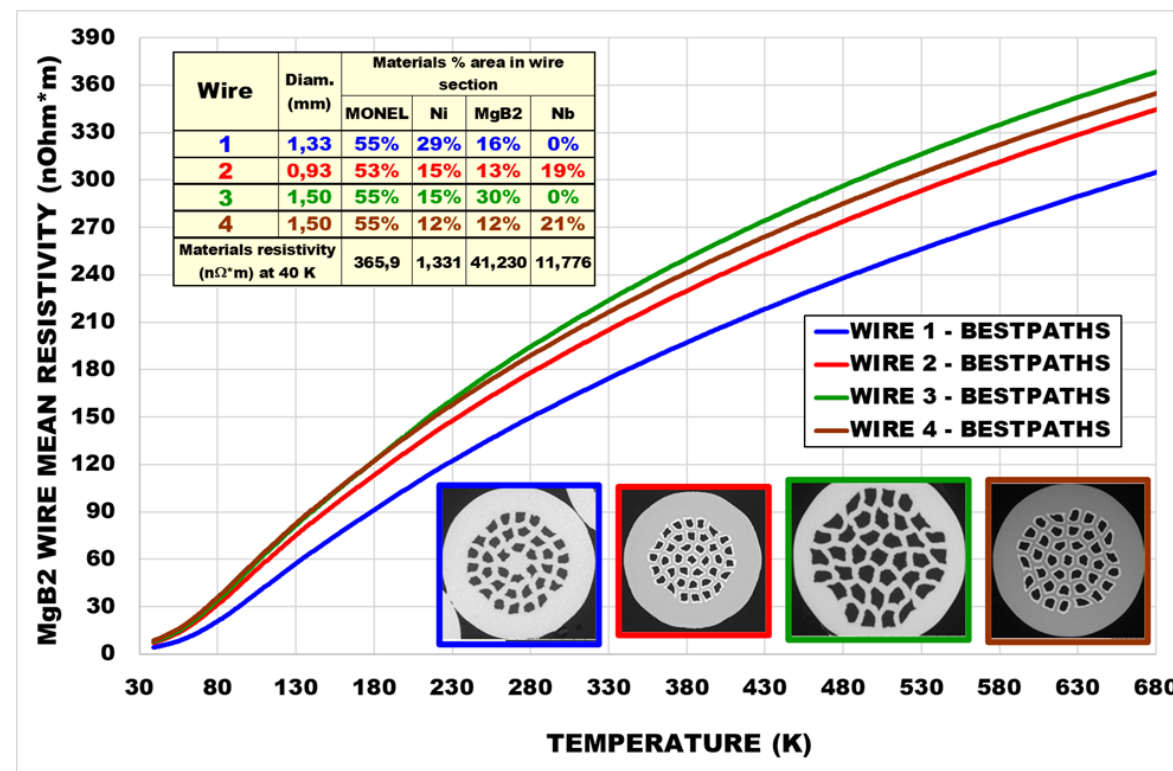
## Temperature and density distribution analysis for a two-flows DC MgB2 cable

# Materials database

- **More than 50 materials** included (they can be freely added/updated).
- For each material, the following temperature-dependent properties are available:
  - ❖ **Electrical resistivity ( $\rho$ );**
  - ❖ **Thermal conductivity ( $\kappa$ );**
  - ❖ **Specific heat capacity ( $C_p$ ).**
- The properties are taken from commercial softwares (METALPAK, CRYOCOMP and MPDB - Material Properties DataBase), literature and experimental tests. Specific materials can have more than one reference (the user can select which one to adopt).

# Materials database

- For each property and material, an **automatic fitting procedure** with the numeric database returns the fitting polynomials (in this work, up to 15<sup>th</sup> order) eventually definable in different temperature ranges.
- The user can freely select/adapt the fitting functions.
- Thus, the referenced numeric database is converted in a list of **coefficients of the best-fitting polynomials functions with temperature.**

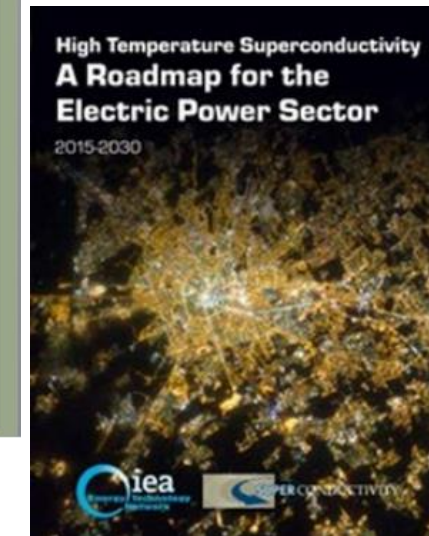
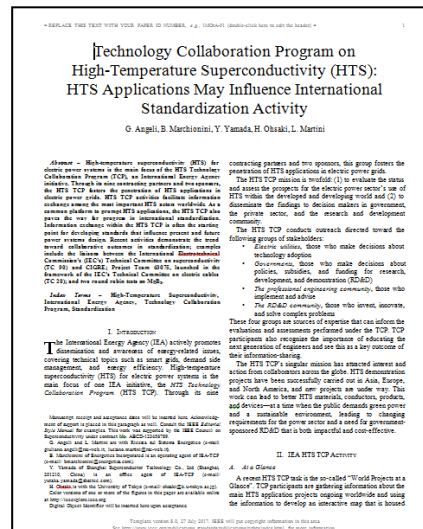


# RSE expertise: HTS for power applications

## International Energy Agency High Temperature Superconductivity Technology Collaboration Programme

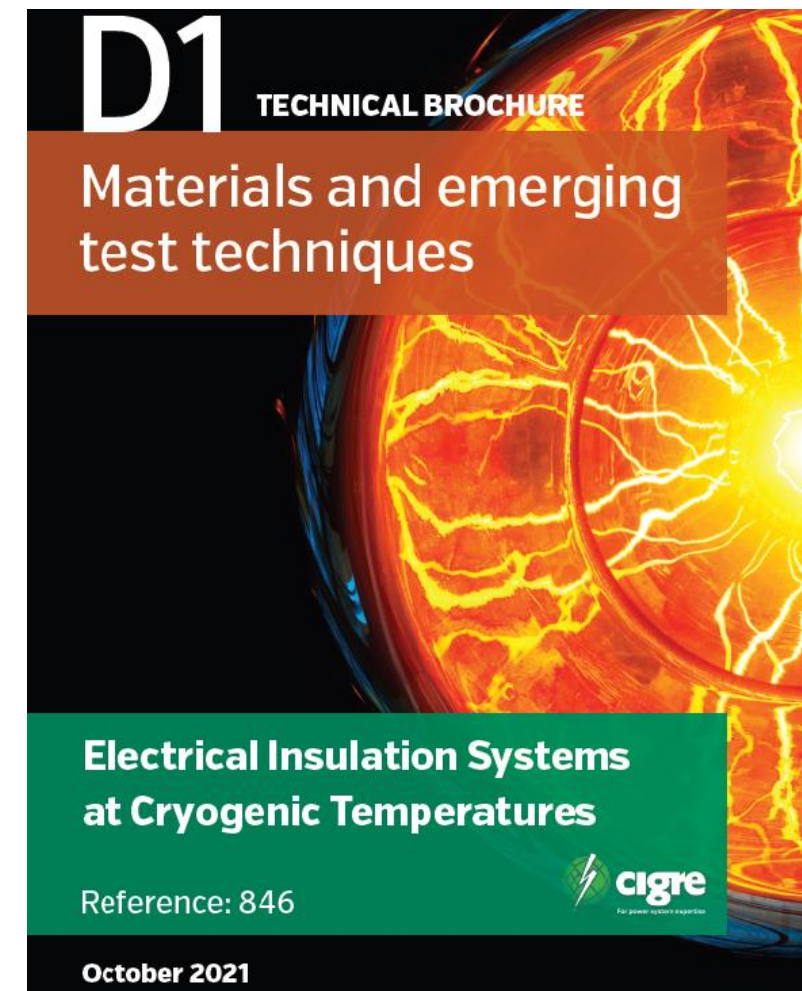
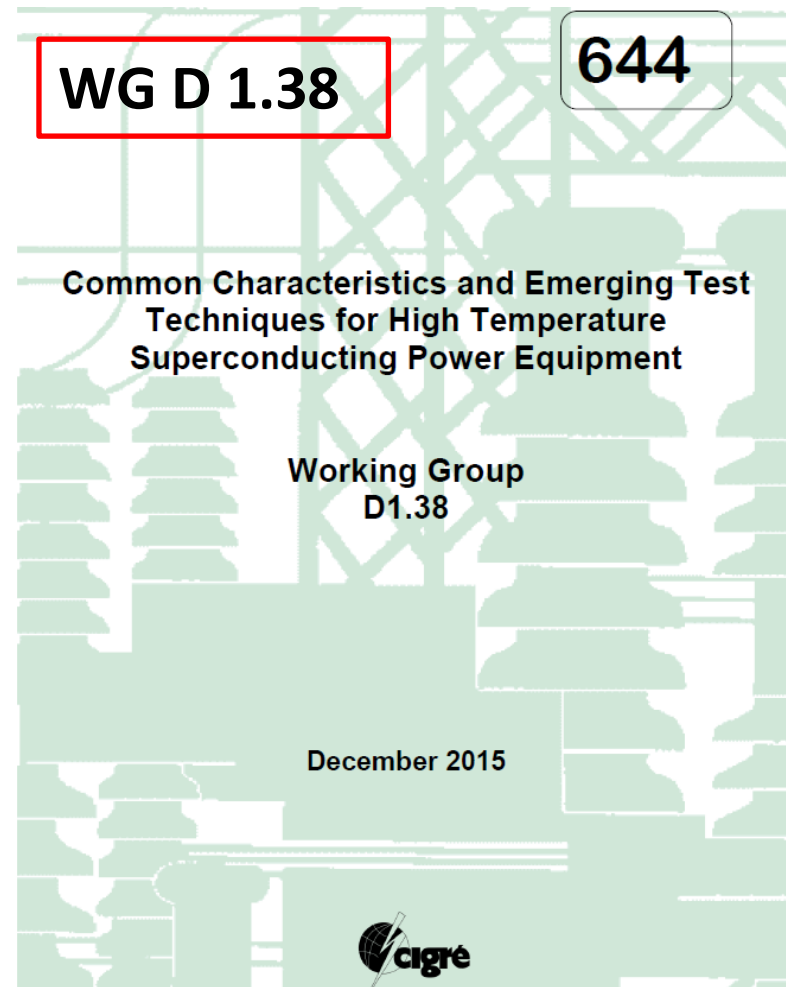
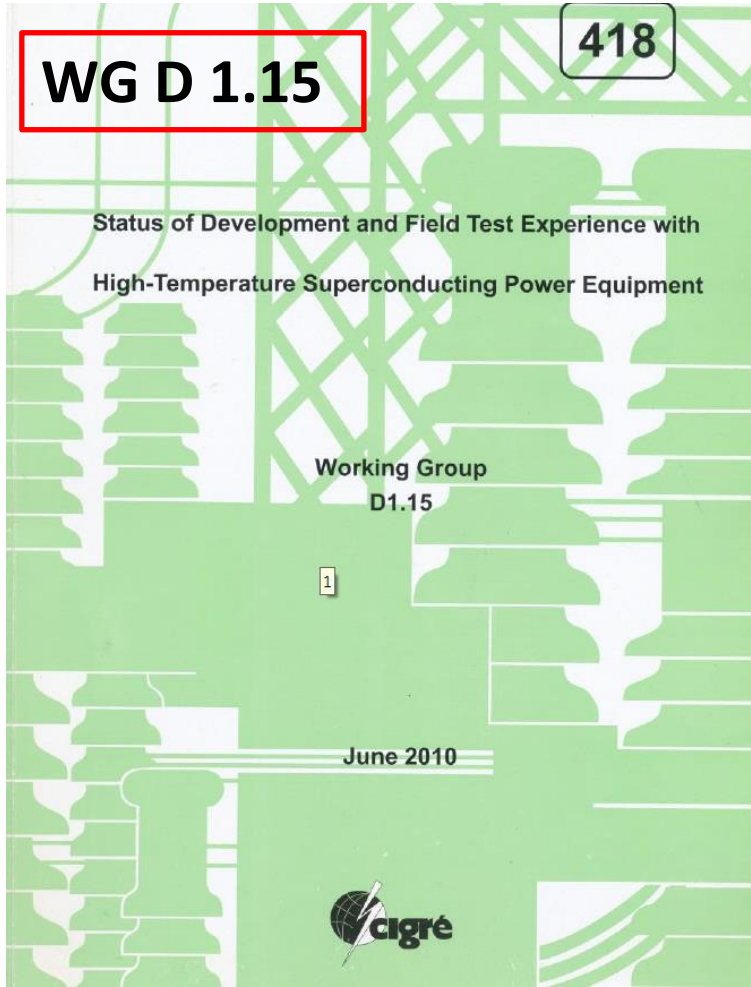


[www.ieahts.org](http://www.ieahts.org)





# RSE expertise: HTS for power applications





# RSE's superconductivity lab: Equipment and test possibilities

## DC tests

- ❖ critical current measurements in LN (from 64 K until 77 K)
- ❖ thermo – electrical stability analysis
- ❖ contact resistance measurement
- ❖ electrical resistance measurement
- ❖ overcurrent tests

## AC tests

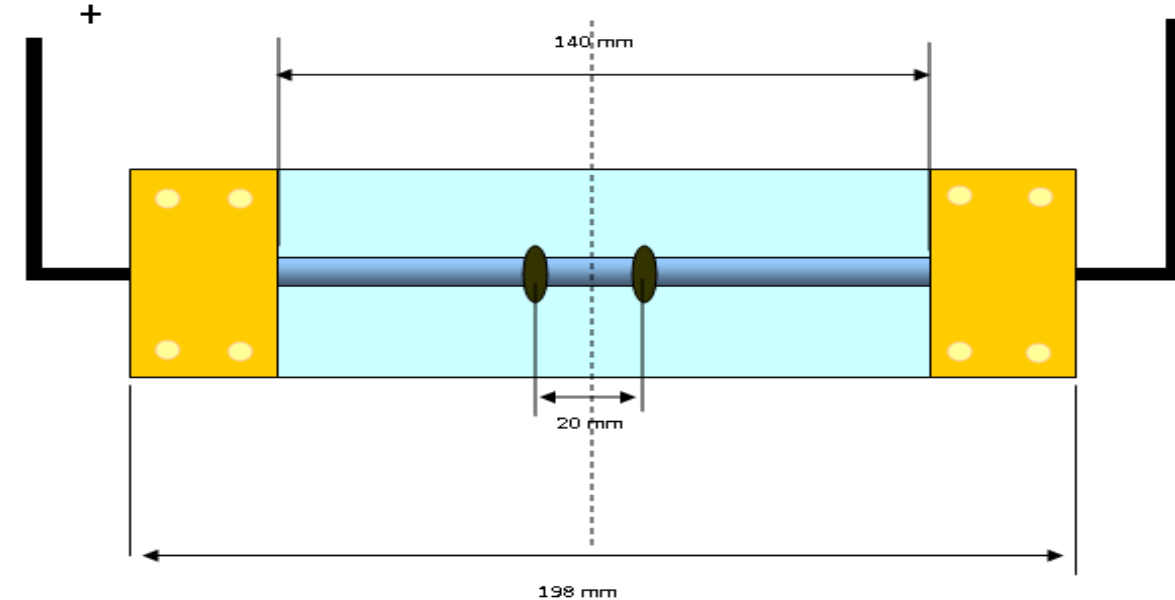
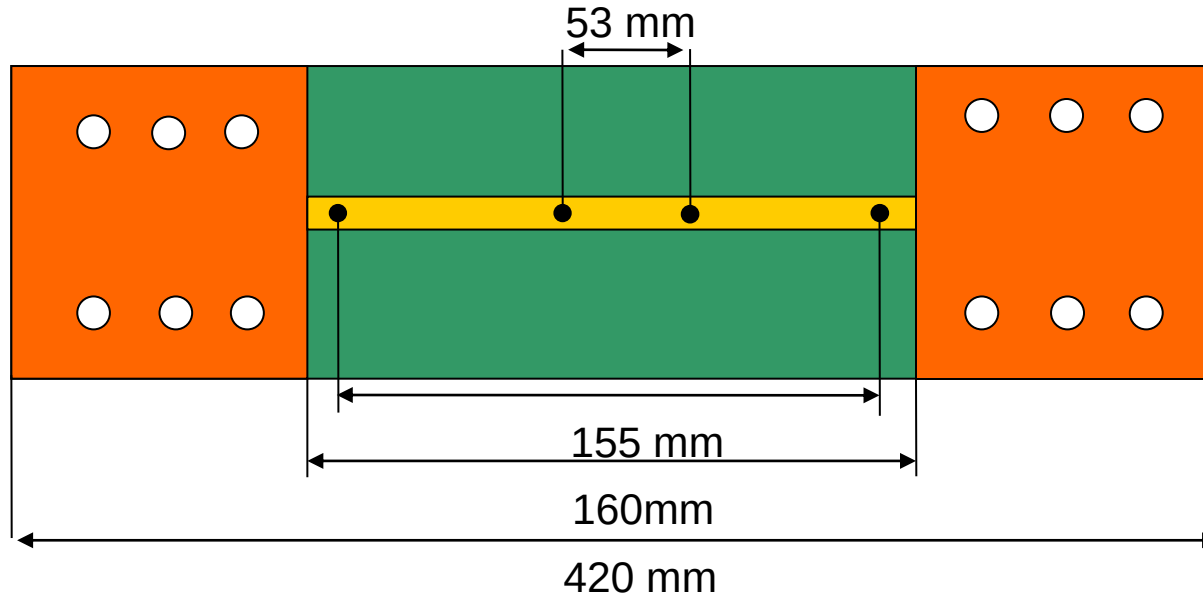
- ❖ losses measurements in tapes & windings
- ❖ quench tests
- ❖ thermo – electrical stability analysis

| Power sources                             |          |                                             |
|-------------------------------------------|----------|---------------------------------------------|
|                                           | Quantity | Rating                                      |
| DC                                        | 4*       | 10 V <sub>DC</sub> - 1.2 kA <sub>DC</sub>   |
|                                           | 2**      | 5 V <sub>DC</sub> - 1.5 kA <sub>DC</sub>    |
| AC                                        | 2**      | 120 V <sub>RMS</sub> - 700 A <sub>RMS</sub> |
| * A new 10V/1.2kA source has been ordered |          |                                             |
| ** Power sources can be parallelized      |          |                                             |



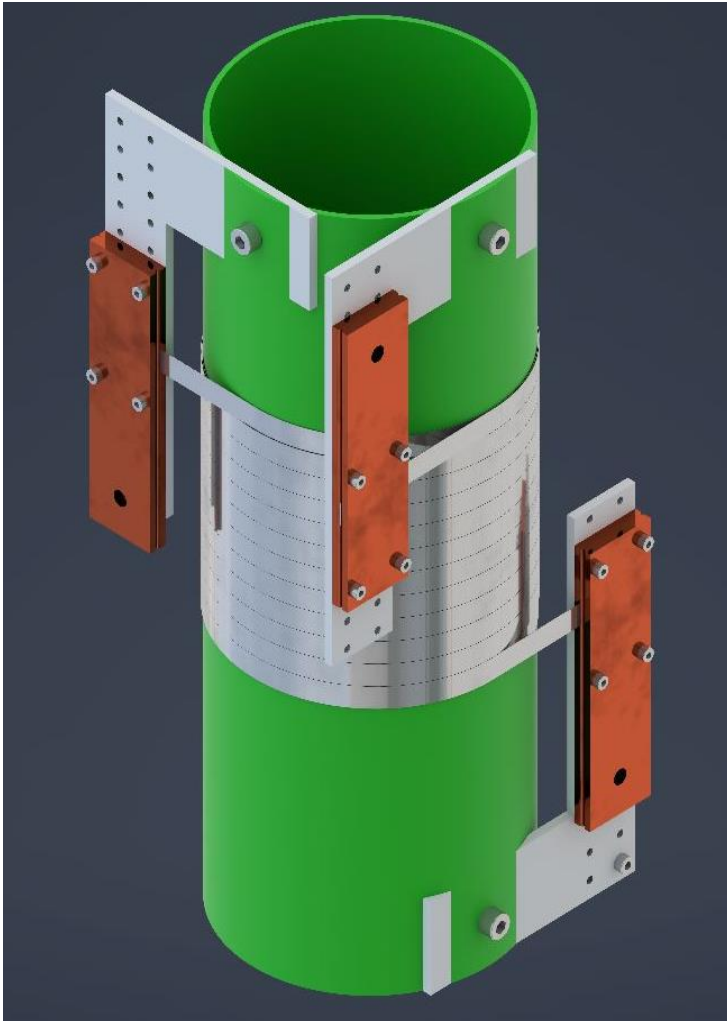
# Critical current tests

## Straight tape holders:



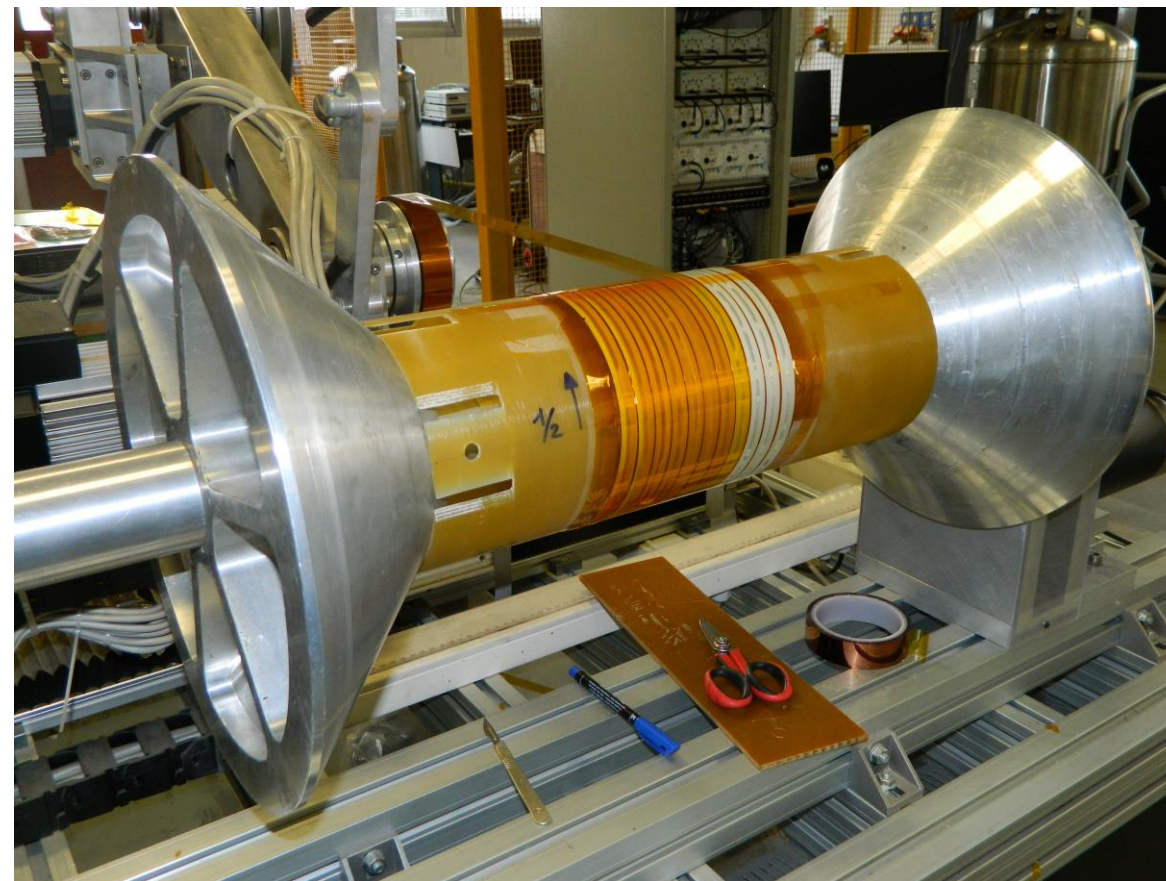
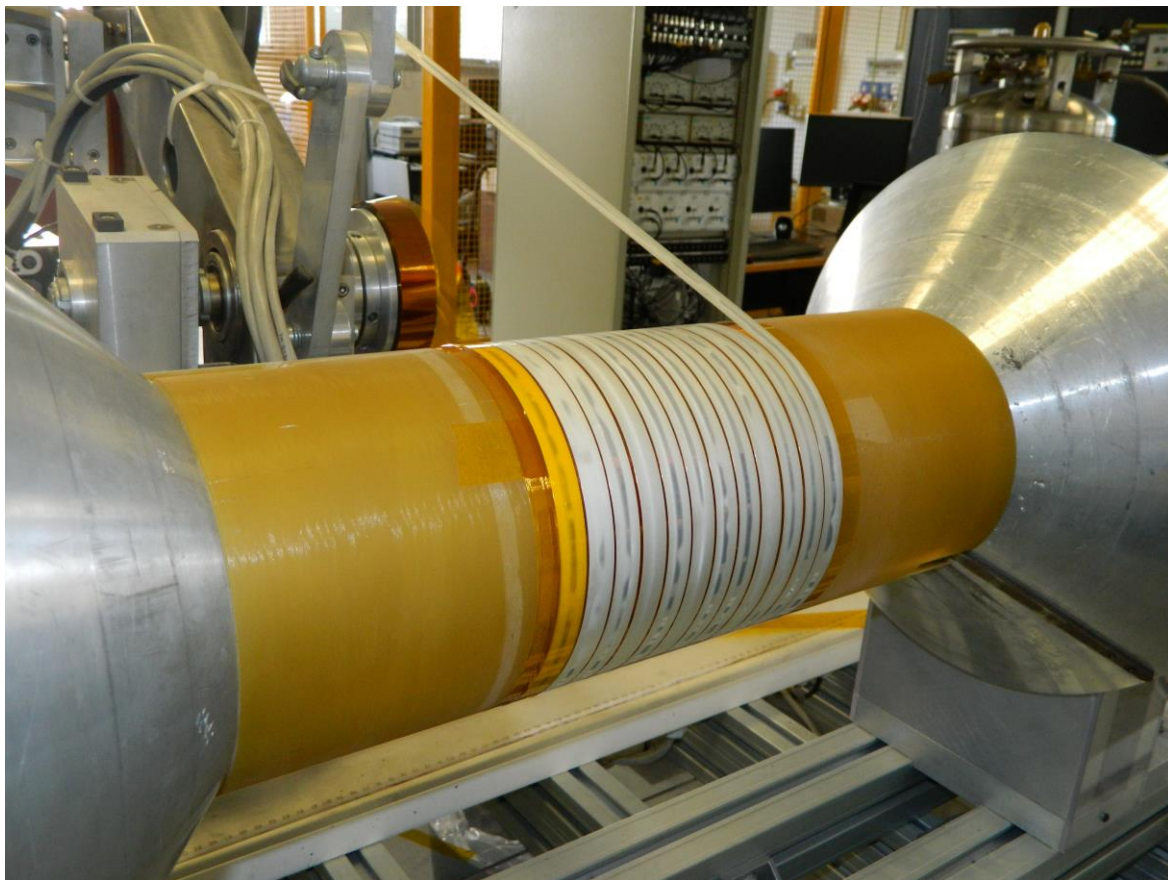
- Available in different geometries (tape length not covered by Cu leads: 15 ÷ 20 cm). Realized to supply single tapes (4÷12 mm wide), multiple stacked tapes, 1 tape and 1 SS heater below (with separate power supplies). Multiple voltage taps can be soldered onto the same tape.
- The same sample holders are used for DC/AC tests.

# 4-layers coil n°1 - SuNAM tape



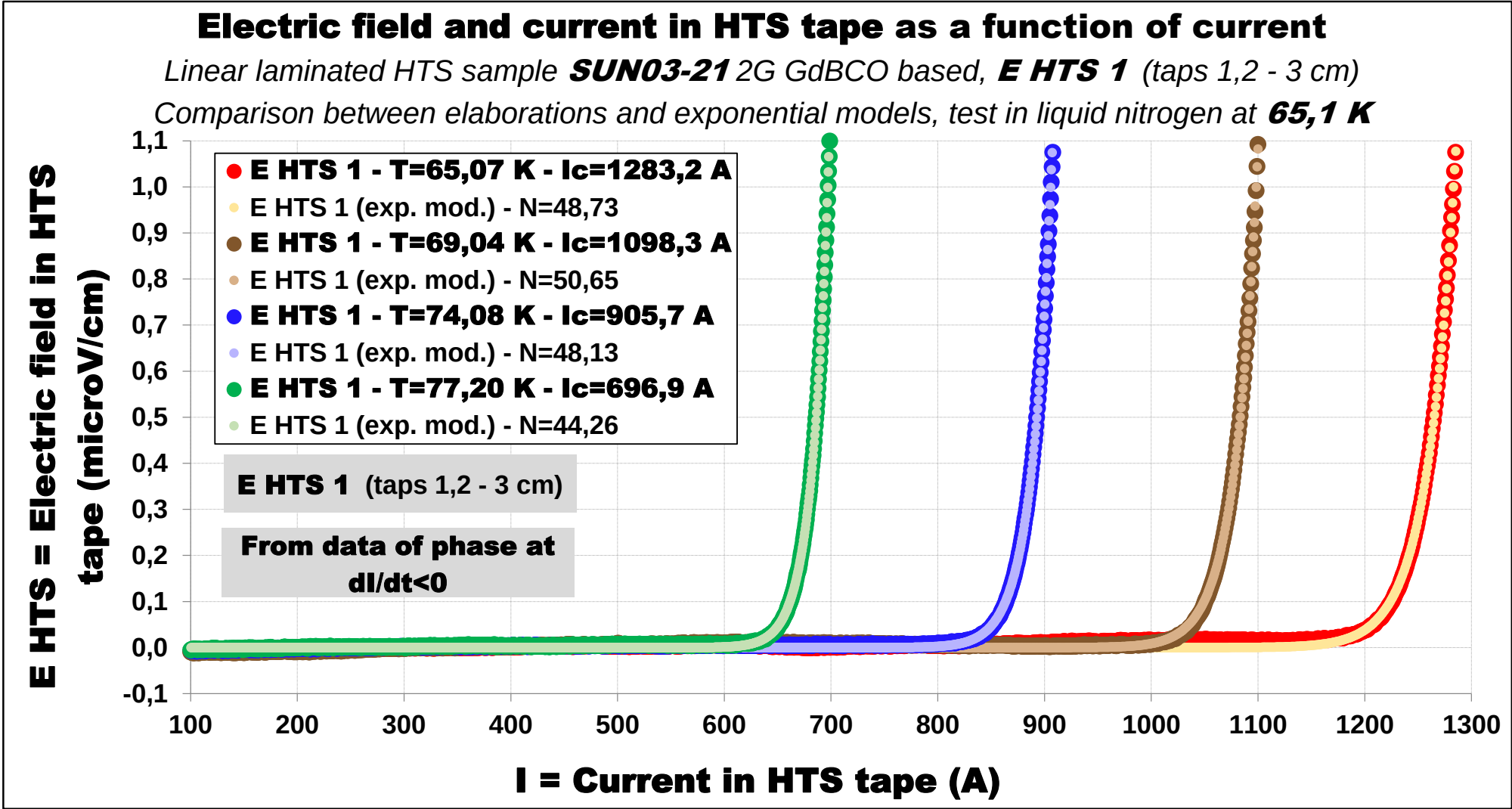


# 4-layers coil n°2 - SuperPower tape



The SuperPower tape as no copper surroundings nor lamination ( $I_c \approx 450$  A compared to 700 A of the SuNAM tape  $\rightarrow$  not relevant for theoretical study).

# Critical current tests on SuNAM SLSS12600 (12 mm) at 65 K

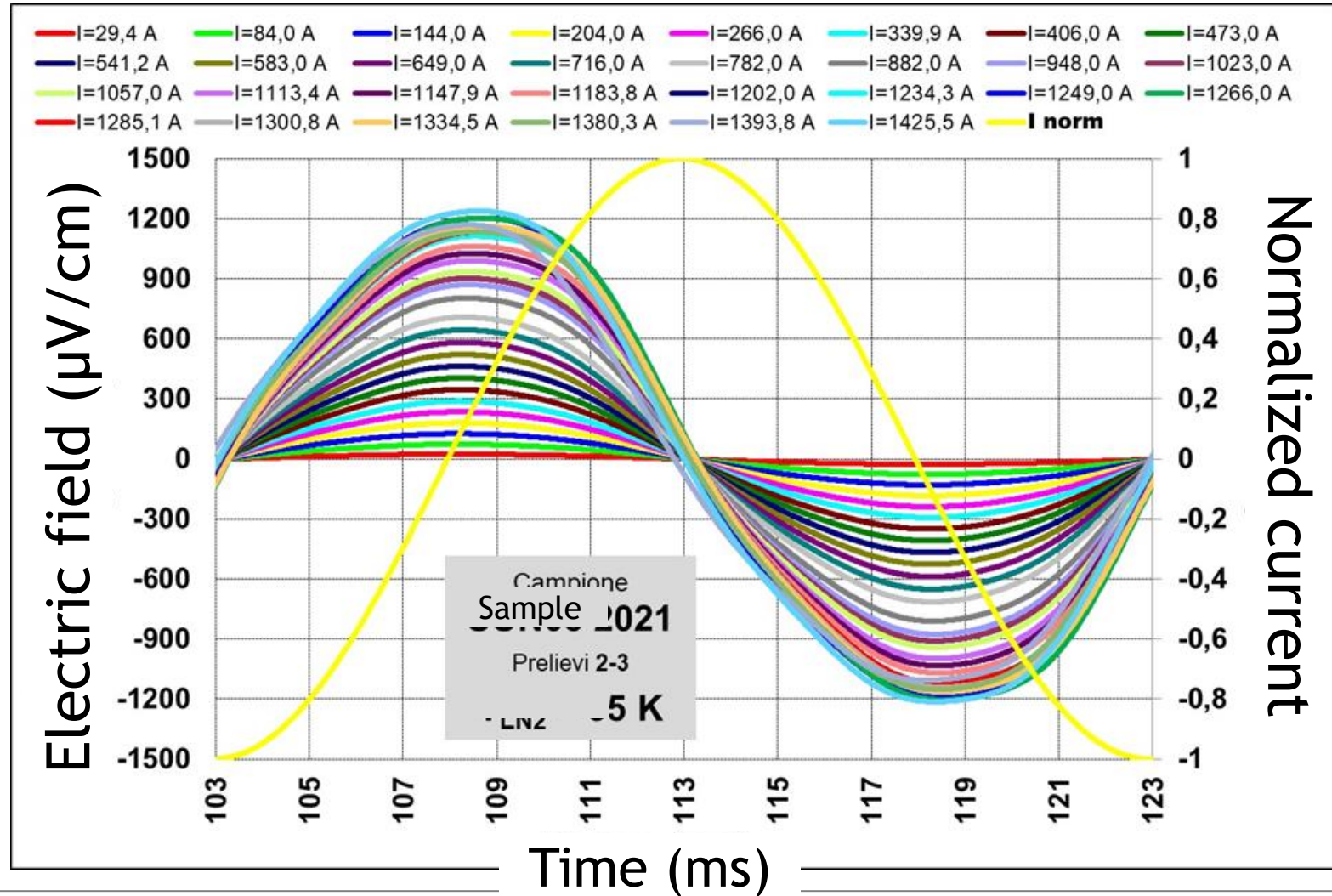
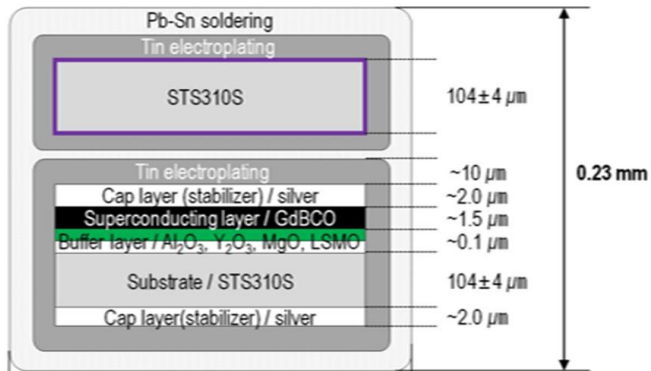




# AC losses measurements

## Post-processing example: SuNAM SLSS12600 tape at 65 K

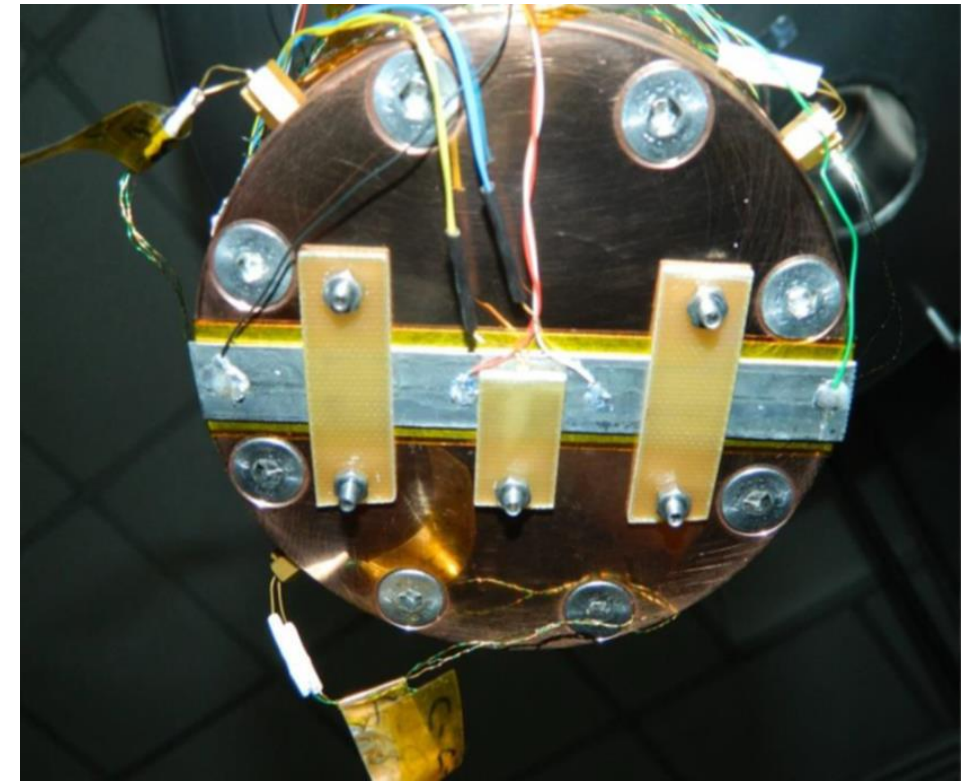
SuNAM SLSS12600  
 $I_c$  @ 65 K = 1280 A



# Measurements of HTS tape resistance

## Test procedure

- 1) The sample is cooled down into a cryostat, with a cryocooler;
- 2) A constant and low current (0.1 A) is supplied;
- 3) The cryocooler is switched off and the temperature is left gradually increase up to room temperature (many hours of testing);
- 4) The voltage signal is continuously acquired during the test.

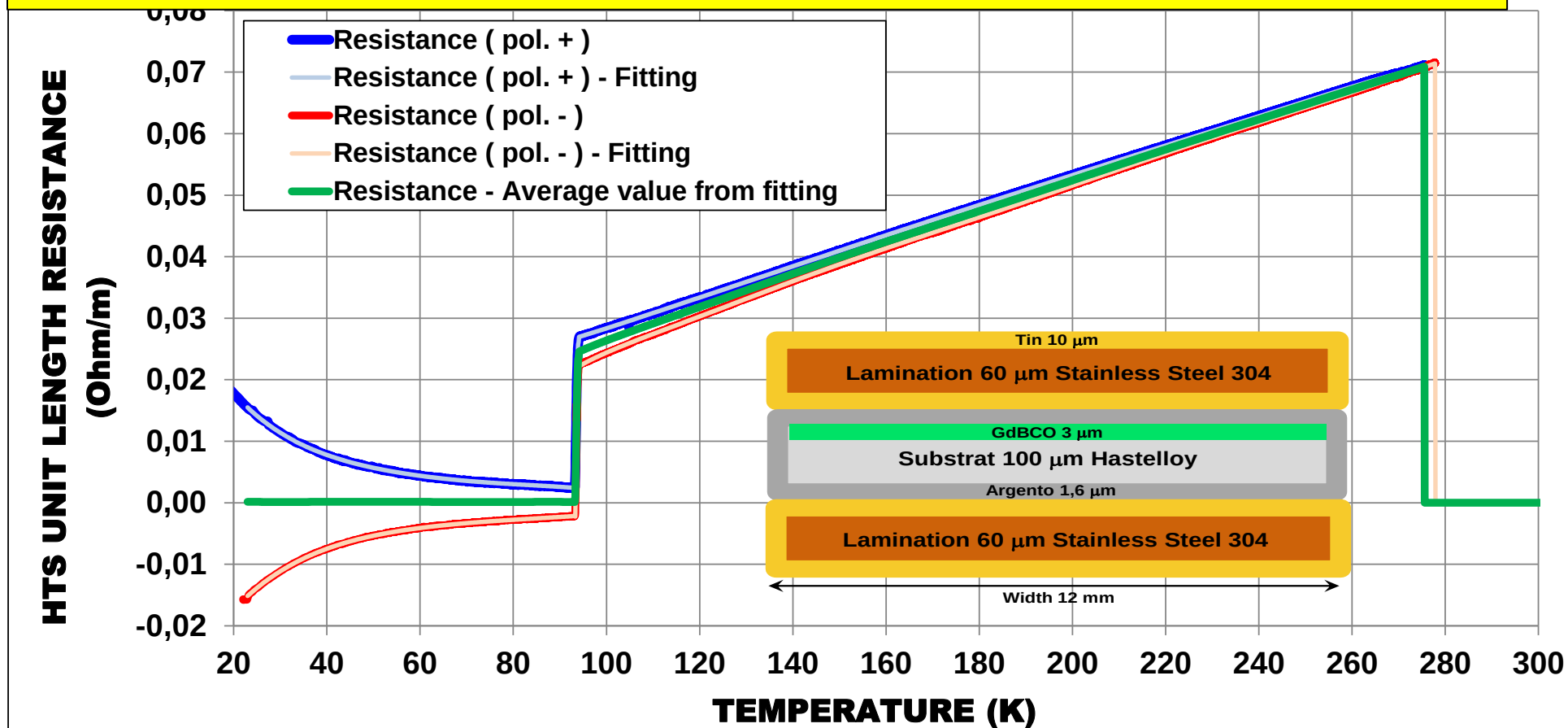


*Straight HTS tape mounted on the cryocooler cold head*

# Measurements of HTS tape resistance

## Example of measurements and post-processing results

The polarity of the current is reversed in subsequent tests. The resulting voltage signals are averaged to eliminate thermo-electric effects.



# Summary of test options at RSE on HTS tapes

Short straight samples

- Critical current
- AC losses
- Overcurrent tests
- R(T) tests

They can be performed in different **cooling conditions**:

- 1) LN<sub>2</sub> bath at room pressure (77 K);
- 2) Subcooled LN<sub>2</sub> bath in a pressure-controlled cryostat (65 K to 77 K);
- 3) Conduction-cooling with a 1-stage crycooler (down to 12 K. Temp left rise gradually in R(T) tests).



If **longer pieces** have to be tested, they can be wound around cylindrical supports in layer-wound coils (a new pancake winding machine is under evaluation) and tested in LN<sub>2</sub> bath.

A new multi-layer sample-holder is described in this presentation.

# Future outlook: superconducting cables cooled-down by hydrogen

- In the framework of “PNRR - Ricerca Idrogeno - Mission M2-C4 Investimento 3.5: Ricerca e sviluppo sull'idrogeno”
- June 2022- December 2025
- Financing: around 100 M€ (RSE 15 M€)
- **Activity: Simulations and techno-economic analysis of systems based on superconducting cables cooled-down by liquid hydrogen for the combined transportation of hydrogen and electric energy**
- **Position inside the project:** WP2 - *Ricerca e sviluppo di soluzioni per il trasporto, distribuzione e usi finali dell'idrogeno nelle reti del gas naturale*
- **Collaborations:** Università di Bologna, Politecnico di Torino





# Acknowledgments

**This work has been financed by the Research Fund for the Italian Electrical System under the Three-Year Research Plan 2022-2024 (DM MITE n. 337, 15.09.2022), in compliance with the Decree of April 16th, 2018”.**

# **Thank you for your attention!**



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andrea.musso@rse-web.it**



## **Viktor, a fully dielectric E-Field sensor**

*Andrea Barbareschi Villa, RSE*

# Viktor

*A vector E-Field sensor*

The on line diagnostic of high voltage insulators, used in overhead lines, has proved a powerful tool to detect and prevent the failure of such components. Among the many diagnostic techniques, E-field sensors have been extensively used to assess the presence of surface or internal defects. Electric field sensors are mostly based on capacitive metallic gauges, which induce a significant electric field distortion and may pose a threat to live line workers who perform the measurement.

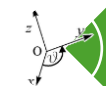
In this work, we introduce a new class of electric field sensors that are fully dielectric. The sensor is capable of measuring the modulus and the direction of the electric field in a plane with a high rejection of the components orthogonal to that plane in a very broad frequency interval.



No metal parts

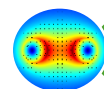
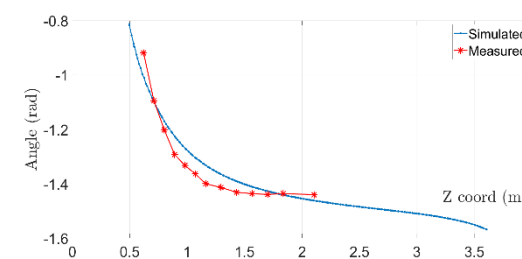
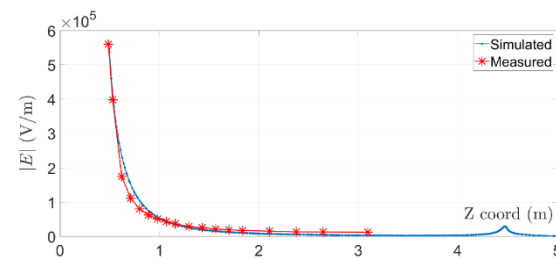


Large bandwidth (20 mHz – 20 MHz)



Measure 2 components

## Test with HV composite insulator (no defects)

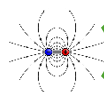


E-field profile along the insulator



E-field strength and orientation validated

## Test with HV composite insulator (with defects)



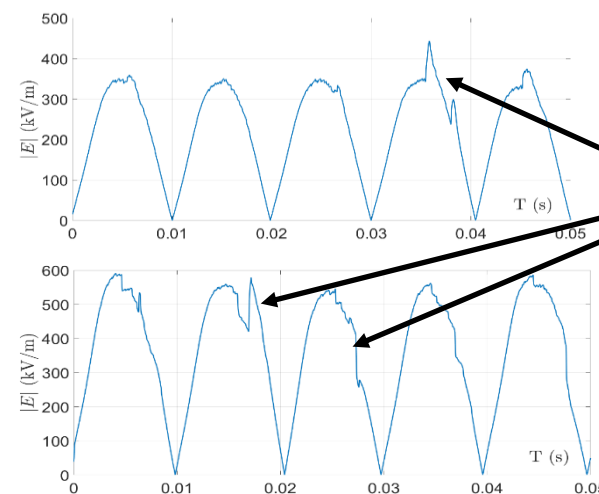
Evolution of the modulus of E



Defect localization



Discharge intensity and frequency characterization



Discharge



# Acknowledgments

**This work has been financed by the Research Fund for the Italian Electrical System under the Three-Year Research Plan 2022-2024 (DM MITE n. 337, 15.09.2022), in compliance with the Decree of April 16th, 2018”.**



GRAZIE PER L'ATTENZIONE

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# G&W Altea Srl - Company overview

Altea Founded in 2008, acquired by G&W in 2019

Specialized in innovative, accurate LPITs for indoor & outdoor applications

2016 Small manufacturing & engineering operation located in Ferrara

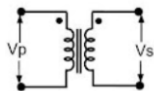
Today 12 employees, 31 blue collars

Elisa Scala, R&D manager

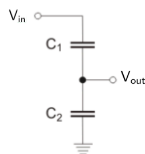
# Technologies in Medium Voltage

## Voltage

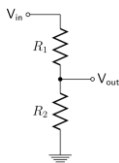
- Conventional Inductive VTs
- **Capacitive Dividers**
- Resistive Dividers
- Optical Sensors



Inductive VT



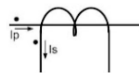
Capacitive Divider



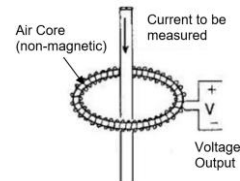
Resistive Divider

## Current

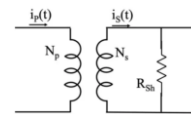
- Conventional Inductive CTs
- **Rogowski Coil**
- Inductive Coil with Shunt Resistor
- Optical Sensors



Inductive CT



Rogowski Coil



Inductive CT with Shunt Resistor

- ✓ Accurate over a wide measurement range
  - ✓ Compact & Lightweight
- ✓ High bandwidth frequency measurement
- ✓ Multipurpose: protection & measurement
- ✓ Galvanic isolation (sensor-primary isolation)
- ✓ No ferro resonance, Does not saturate, No hazardous open secondary voltages

# G&W Altea Sensors – 2022 Product Portfolio

## Outdoor – stand alone

### Voltage Only



VS-38-O VS-27-O

Accusense

Integrate w/ OH switch, IED



### Combination Sensors



CVS-40.5-O CVS-24-O

Integrate w/ OH switch, IED



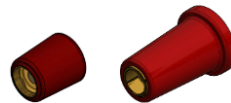
## Indoor

### Voltage Only



VS-24-I

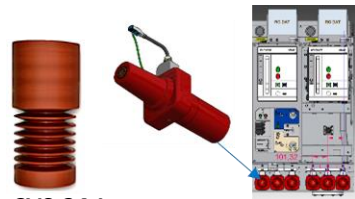
Integrate w/ UG switch, IED



• back plug sensor



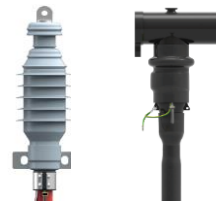
### Combination Sensors



CVS-24-I

CVS-P-24-SB01

Integrate w/ UG switch, IED



24kV Smart Terminations







# **Optical sensors for Medium Voltage equipment**

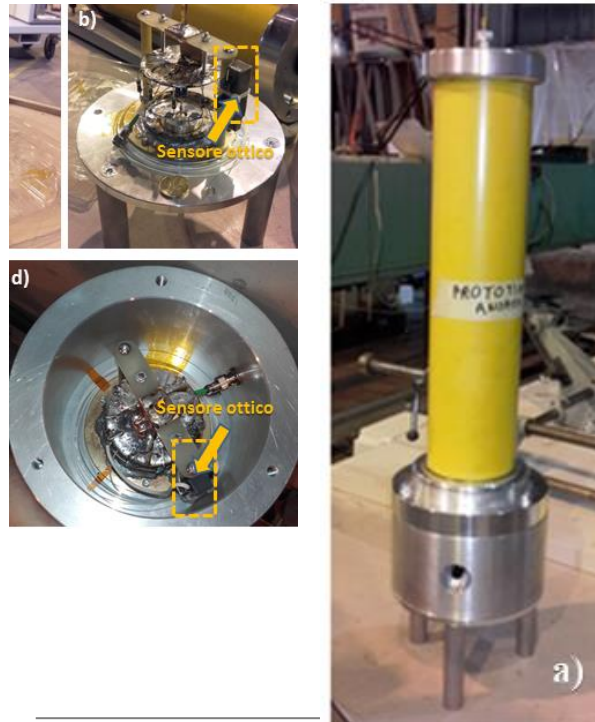
*Letizia De Maria, RSE*

# OPTICAL VOLTAGE SENSOR (OVS) FOR MEDIUM VOLTAGE EQUIPMENT



The OVS developed by RSE has been inserted in an ad hoc developed Medium Voltage (20kV) capacitive divider with known and stable Voltage ratio, ( $k < 0.2\%$ ).

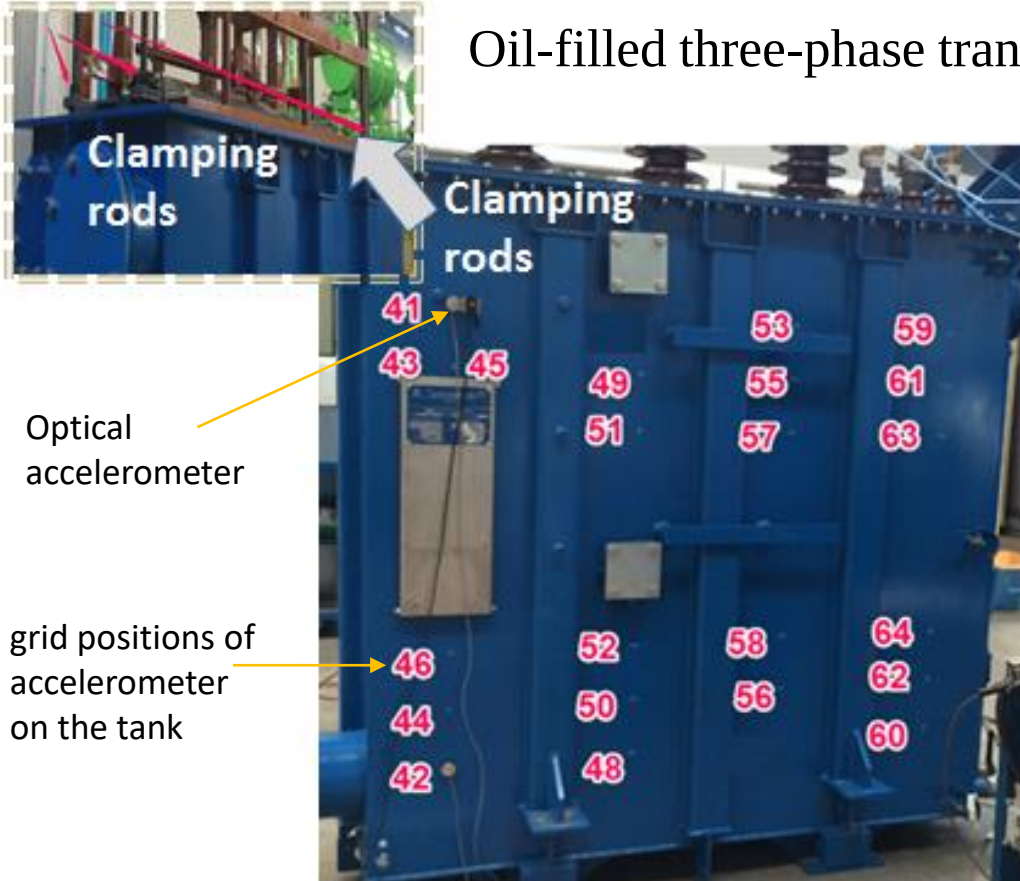
Functional tests have been carried out on the OVT embedded assembly either fast pulses (A) by means of a High Voltage Pulse source and in an experimental circuit which replicates a typical Medium Voltage cable network configuration (B).



**A. Lightning pulse test**

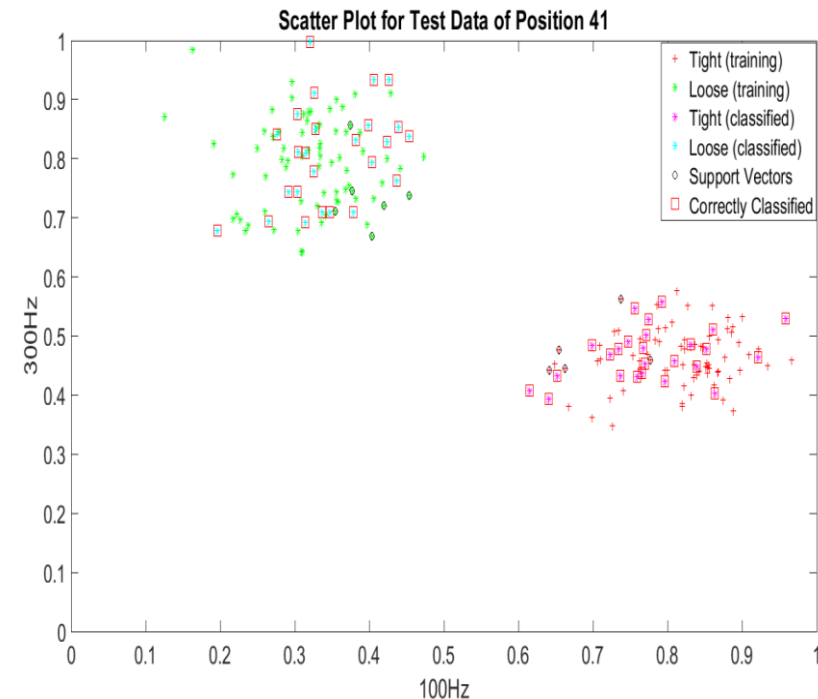


# DEEP LEARNING FOR FAULT DETECTION IN TRANSFORMERS USING VIBRATION DATA



Oil-filled three-phase transformer 750kVA (42kV/580V)

Machine Learning Method applied to vibration data



Results:

- training and testing classifier for each position
- Optimization of sensor number

defect: winding looseness  
Binary case : tight, loose winding

**THANK YOU FOR YOUR ATTENTION !**

Letizia.demaria@rse-web.it

This work has been financed by the Research Fund for the Italian Electrical System in compliance with the Decree of Minister of Economic Development; April 16 2018



GRAZIE PER L'ATTENZIONE



## **SAMU evolute per le misure di corrente e tensione in AT**

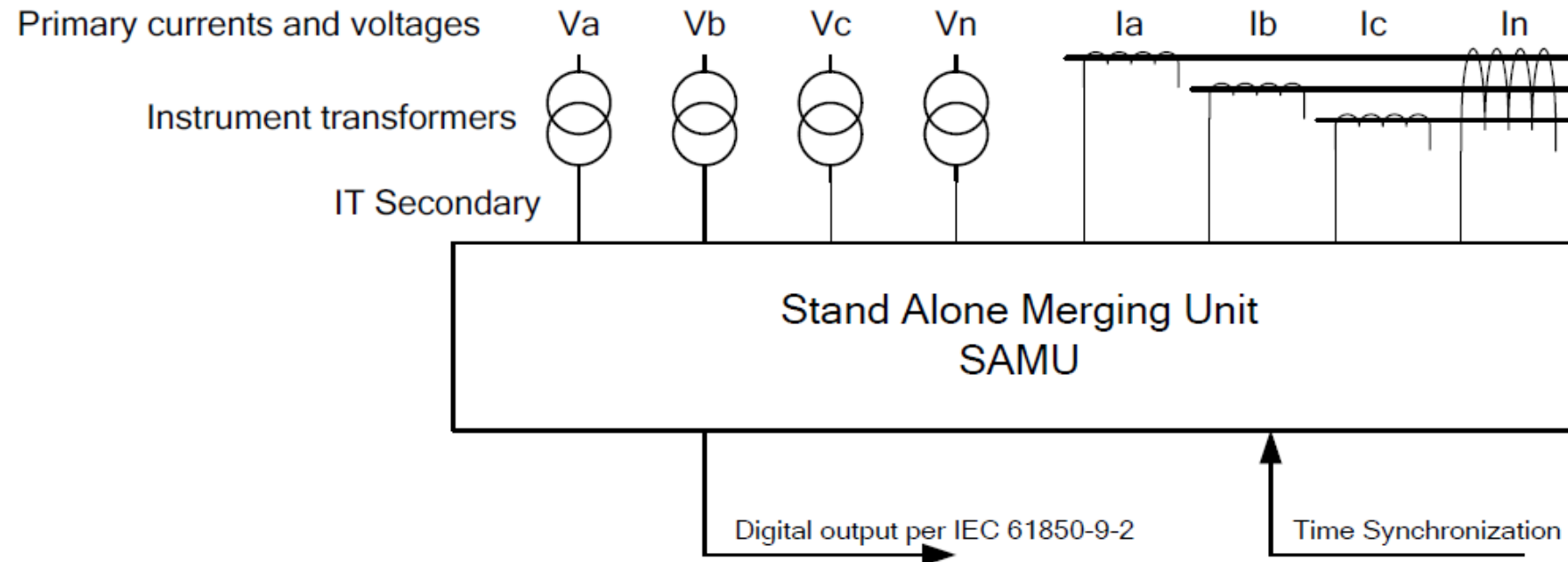
*Luca Barbieri, Giovanni D'Avanzo, Paolo Mazza e Daniele Palladini*

*Ricerca sul Sistema Energetico - RSE*

*Incontro Panel italiano SC A3 CIGRE – T&D Equipment*

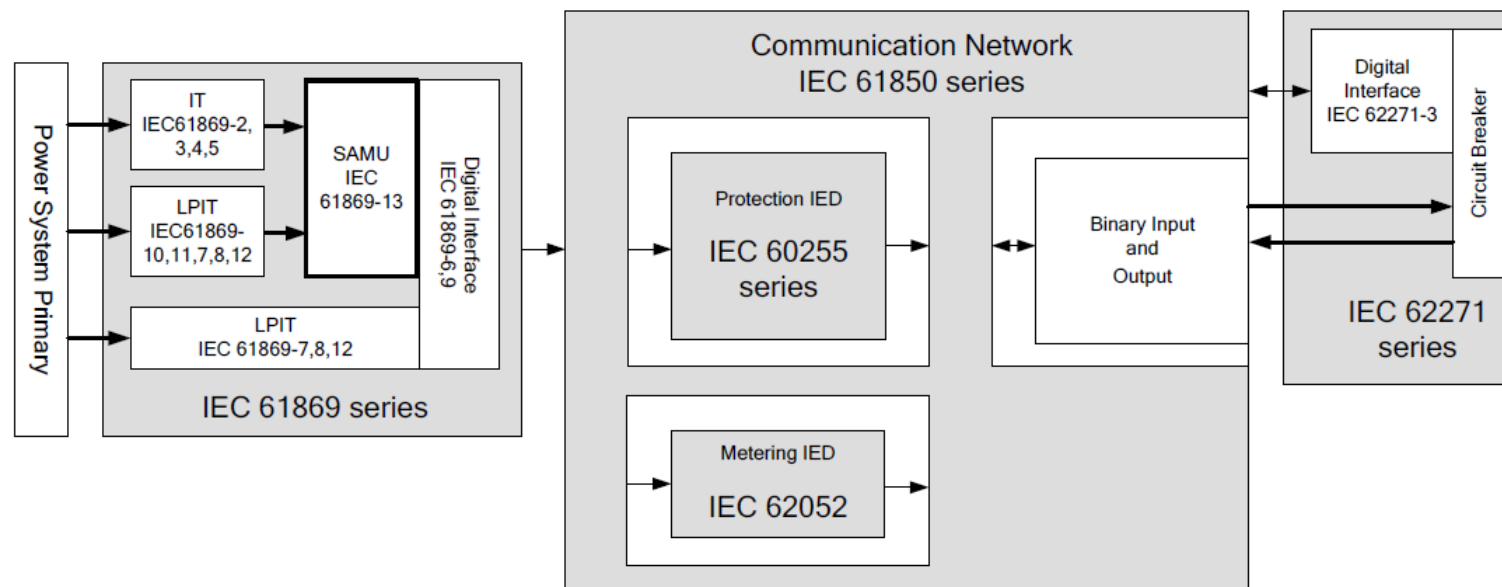
*18 Aprile 2023*

## Schema a blocchi generale di una tipica applicazione di SAMU



...da IEC 61869-13:2021

## Posizione della SAMU in relazione agli altri componenti della catena di protezione e misura



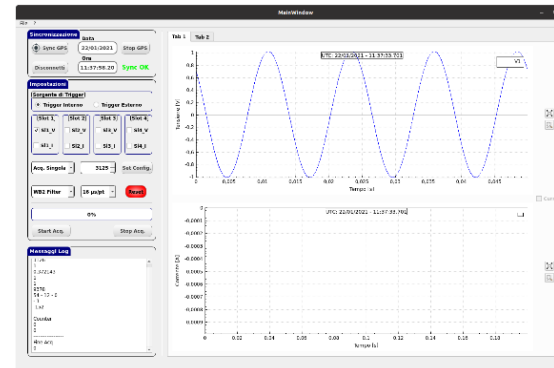
...da IEC 61869-13:2021

# SAMU con funzionalità avanzate per la compensazione di errori e non idealità dei trasformatori di misura



we move

*Primo prototipo di SAMU con funzionalità avanzate* Implementazione e validazione sperimentale di algoritmi di compensazione delle non idealità dei trasformatori di misura in collaborazione con alcune Università e Istituti di Ricerca Italiani



Università degli Studi della Campania Luigi Vanvitelli



POLITECNICO MILANO 1863



- *Nuovo algoritmo di compensazione*, basato sulle serie di Volterra e sui parametri fisici del trasformatore di misura.
- *Nuovo prototipo di SAMU con funzionalità avanzate*, basato su componentistica di nuova generazione per prestazioni metrologiche ancora più spinte.
- *Sperimentazione in campo dei prototipi di SAMU* nella Test Facility MT di RSE



Ricerca sul Sistema Energetico - RSE S.p.A.

Via R. Rubattino 54 - 20134 Milano | [www.rse-web.it](http://www.rse-web.it)

# *Grazie !*

**daniele.palladini@rse-web.it**

## **Ringraziamenti**

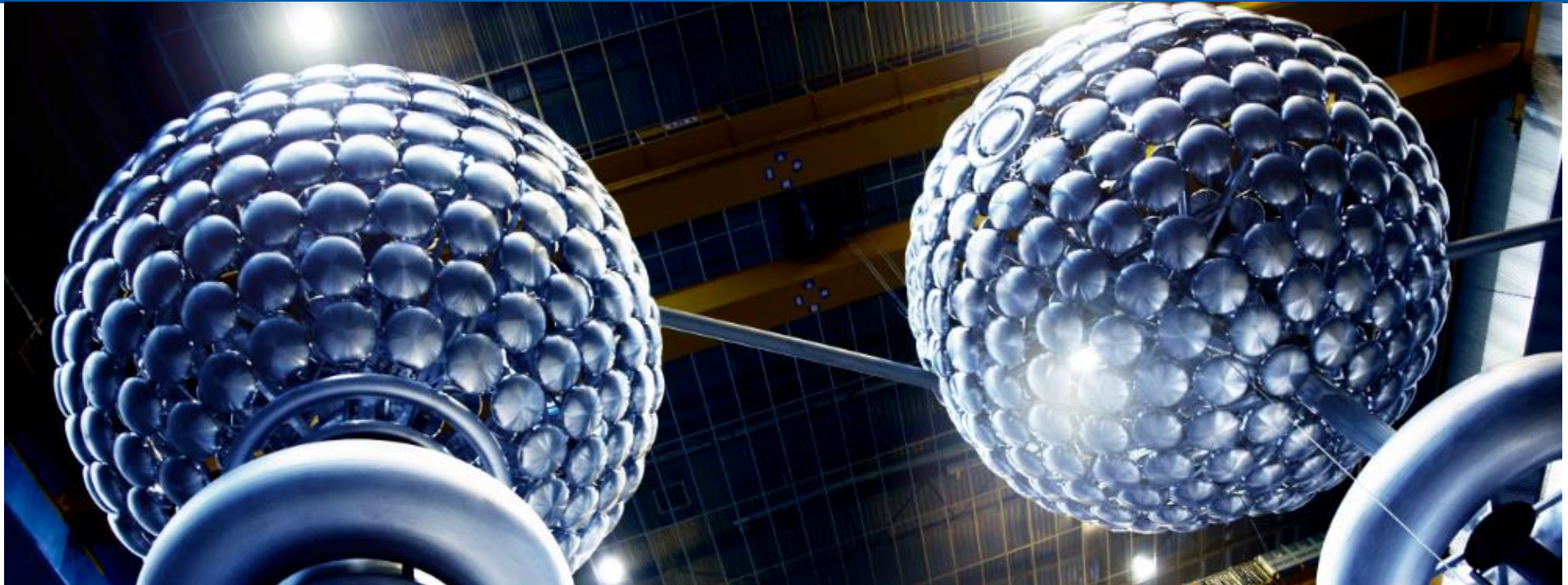
**Questa ricerca è stata finanziata dal Ministero della Transizione Ecologica nell'ambito dell'Accordo di programma Mission Innovation 2021-2024 - progetto "MISSION - Microreti e sistemi smart, multivettore ed integrati per accelerare la transizione energetica"**



# SF<sub>6</sub> alternatives in switchgear

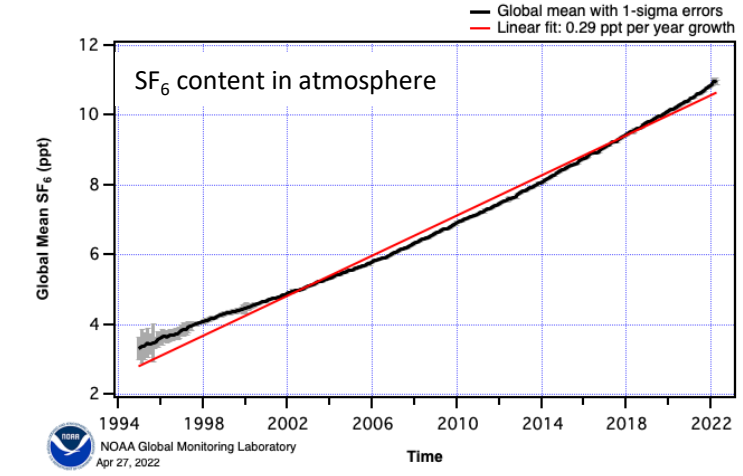
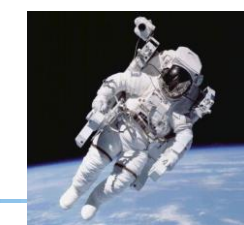
Meeting Italian Panel Cigre SC A3

18<sup>th</sup> April 2023



# SF<sub>6</sub> in the world

- SF<sub>6</sub> is extreme greenhouse gas: GWP 25,200 (IPCC AR6 2022)
  - resides in the atmosphere 3,200 years
  - 1 kg SF<sub>6</sub> equals 5 times around the world with a gasoline car
  - SF<sub>6</sub> emission equivalent to 0.3 - 0.6% of global CO<sub>2</sub> emission
- EU is reviewing F-gas regulation (after voting March 30, 2023)
  - Ban of all F-gases ≤ 145 kV @ 2028  
     > 145 kV @ 2031
  - Exemption (GWP<1000) when: on deadline no solution available  
     2 years after deadline only one bid
- TenneT TSO: 2/3 of all new assets SF<sub>6</sub>-free by 2030
  - Long term: when at least 2 products available GWP < 1, then choose this
- California: phase-out towards GWP ≤ 1, otherwise reporting required
- Japan: Reduced SF<sub>6</sub> leakage -> 0.1%/yr
- Korea: KEPCO supports development SF<sub>6</sub>-free switchgear
- Two tracks: gas based and vacuum + air



California Clean Air Resources Board 2022

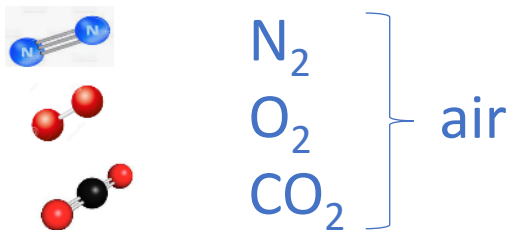
| Voltage (kV) | Short-circuit Current (kA) | CARB Phase out Date |
|--------------|----------------------------|---------------------|
| ≤ 145        | < 63                       | 1/1/2025            |
|              | ≥ 63                       | 1/1/2025            |
| ≤ 245        | All                        | 1/1/2029            |
| > 245        | All                        | 1/1/2031            |

KEPCO 2019



# SF<sub>6</sub> gas alternatives

## natural-origin gases

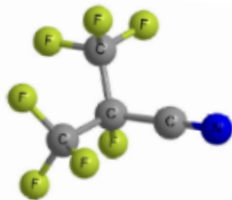


## various mixtures

- GWP < 1
- For insulation (switching in vacuum)



## fluoronitriles



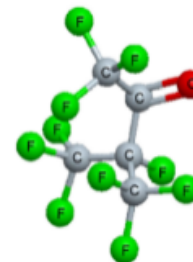
Novec™ 4710  
C4-FN  
g<sup>3</sup> (GE)  
Econiq (Hitachi En.)

5 % in a mixture with CO<sub>2</sub> (85 %) and O<sub>2</sub> (10 %)

- GWP 2750
- In mixture GWP < 1000
- For high voltage
- Insulation and switching



## fluoroketones



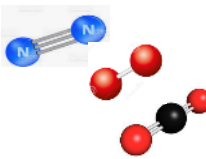
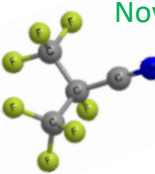
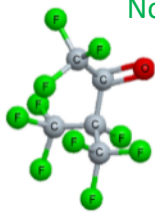
Novec™ 5110  
C5-FK  
AirPlus (ABB)

- GWP < 1
- In mixture GWP < 1
- For medium voltage
- Insulation and switching





# SF<sub>6</sub> – free switchgear

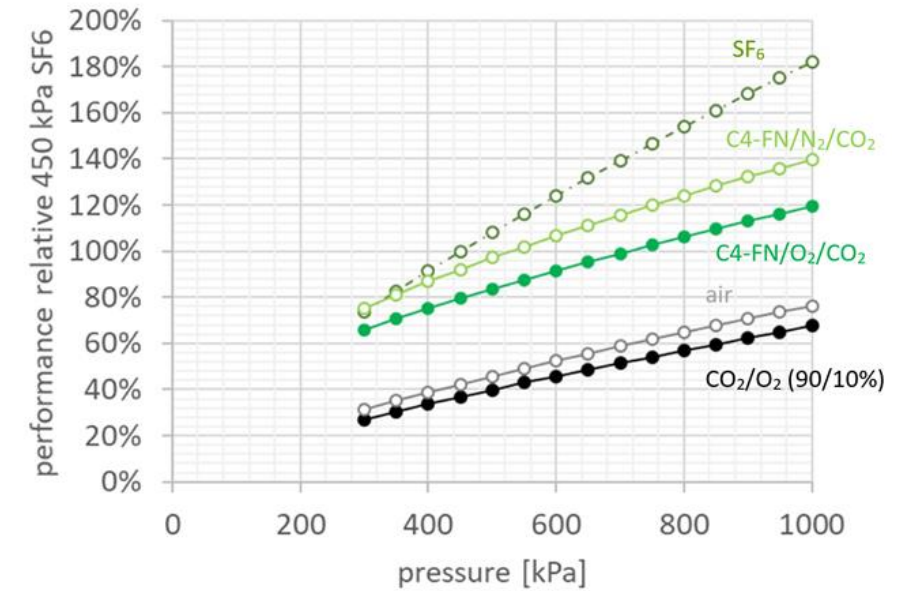
|                                                                                                                                                              | INSULATION                                         | INTERRUPTION                     | GWP           | VOLTAGE       | TECHNOLOGY           |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|----------------------------------|---------------|---------------|----------------------|
|  <b>SF<sub>6</sub></b>                                                      |                                                    | <b>SF<sub>6</sub></b>            | <b>25 200</b> | 24 – 1 200 kV | dist / LT / DT / GIS |
| natural-origin gases<br> N <sub>2</sub><br>O <sub>2</sub><br>CO <sub>2</sub> | AIR, N <sub>2</sub> , solid                        | VACUUM                           | 0             | 10 - 170 kV   | dist / LT / DT / GIS |
|                                                                                                                                                              |                                                    | O <sub>2</sub> / CO <sub>2</sub> | 1             | 72.5 - 145 kV | LT                   |
|                                                                                                                                                              | TECHNICAL AIR                                      |                                  | 0             | 420 kV        | GIB / GIL            |
| fluoronitriles<br> Novec™ 4710<br>C4-FN<br>g <sup>3</sup>                   | C5-FK / AIR                                        | VACUUM<br>C5-FK / AIR            | 1             | 10 - 40.5 kV  | Distr / LBS / GIS    |
|                                                                                                                                                              | C4-FN / AIR                                        | VACUUM<br>C4-FN / AIR            | 300 - 750     |               |                      |
|                                                                                                                                                              | C4-FN / O <sub>2</sub> / CO <sub>2</sub> mixture A |                                  | 300 - 750     |               |                      |
|                                                                                                                                                              | C4-FN / O <sub>2</sub> / CO <sub>2</sub> mixture B |                                  | 300 - 750     | 72.5 - 170 kV | GIS / LT / DT        |
| fluoroketones<br> Novec™ 5110<br>C5-FK<br>AirPlus                         | C4-FN / CO <sub>2</sub>                            |                                  | 300 - 750     |               |                      |
|                                                                                                                                                              | C4-FN / N <sub>2</sub>                             |                                  | > 500         | 1 000 kV      |                      |
|                                                                                                                                                              | C5-FK / O <sub>2</sub> / N <sub>2</sub>            |                                  | 300 - 750     | 420 kV        | GIB / GIL            |
|                                                                                                                                                              |                                                    |                                  | 1             | 420 kV        |                      |



# Implications for use of alternatives – gas circuit breakers

## Normal operation:

- Lower critical electrical field
  - Lower breakdown voltage
    - > higher pressure and/or larger size
- High boiling point of fluorinated compounds
  - Limits “very cold” applications
    - > reduce the fraction of F-gas or leave out
- Smaller molecule of CO<sub>2</sub> compared to SF<sub>6</sub>
  - EPDM (Ethylene Propylene Diene Monomer) seals and gaskets have high leakage
    - > butyl rubber
- Different thermal effusivity
  - Lower convective heat transfer (GIS)
    - > higher temperature rise



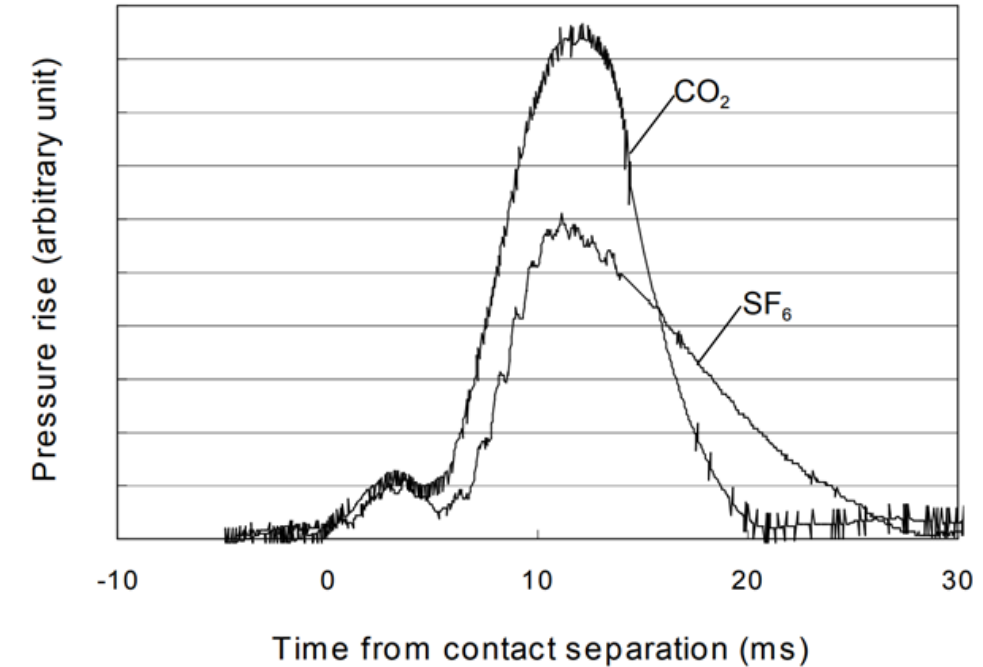
Gatzsche, CIGRE 2022



# Implications for use of alternatives – gas circuit breakers

## Current interruption:

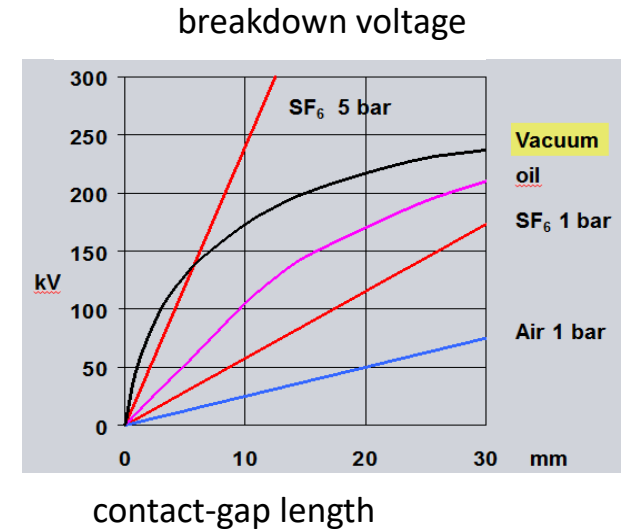
- Decomposition of fluorinated compounds under arcing
  - May impact electrical life
    - > have enough gas on board
- Lower adiabatic index
  - High transient pressure during interruption
    - > re-enforce arcing chamber
- Higher speed of sound
  - Faster flushing of the arcing zone
    - > Larger compression volume, valves re-design
- Lower critical electrical field
  - Affects recovery after interruption
    - > may require higher opening velocity



# Implications for use of alternatives – vacuum circuit breakers

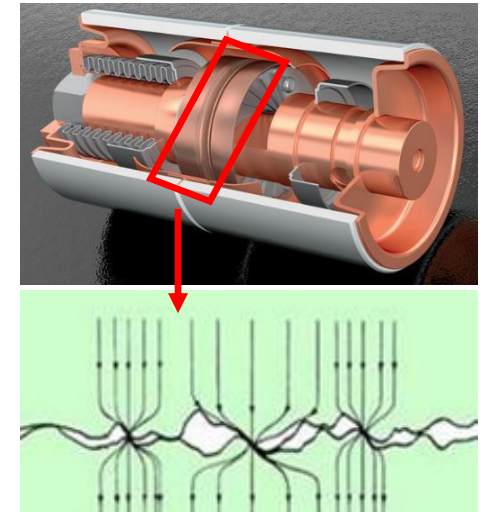
## Steady state:

- Lower critical electrical field of outside insulation
  - Lower breakdown voltage -> higher pressure and/or larger size
- Saturation of breakdown vs gap length characteristic
  - Increase of gap length no longer effective -> more interrupters in series
- One contact must perform all functions
  - Continuous current for transmission too low -> increase contact forces



## Interruption:

- Vacuum gap can breakdown spontaneously after switching
  - Non-sustained disruptive discharge -> awareness
- Switching transients with inductive and capacitive switching
  - Multiple re-ignitions, restrikes -> mitigation by controlled switching, snubbers



# SF<sub>6</sub>-free transmission switchgear 72.5 – 170 kV (examples)

|                       |  |  |  |  |  |  |  |  |  |  |  |  |
|-----------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
|                       |  |  |  |  |  |  |  |  |  |  |  |  |
| Design                | GIS                                                                               | GIS / LT                                                                          | GIS                                                                               | Live tank                                                                         | GIS                                                                                | GIS                                                                                 | GIS / LT                                                                            | Dead tank                                                                           | GIS                                                                                 | Recloser                                                                            | Dead tank                                                                           | GIS                                                                                 |
| Insulation            | C4-FN mix                                                                         | C4-FN mix                                                                         | C5-FK mix<br>-><br>C4-FN mix                                                      | Dry air                                                                           | C4-FN mix<br>O <sub>2</sub> -free                                                  | Dry air                                                                             | Techn. air                                                                          | Techn. air                                                                          | C4-FN/<br>CO <sub>2</sub>                                                           | Solid                                                                               | Dry air                                                                             | Dry Air                                                                             |
| Switching medium      | C4-FN mix                                                                         | C4-FN mix                                                                         | C5-FK mix<br>-><br>C4-FN mix                                                      | O <sub>2</sub> / CO <sub>2</sub>                                                  | C4-FN mix<br>O <sub>2</sub> -free                                                  | Vacuum                                                                              | Vacuum                                                                              | Vacuum                                                                              | Vacuum                                                                              | Vacuum                                                                              | Vacuum                                                                              | Vacuum                                                                              |
| Volt. (kV)            | 170                                                                               | 145                                                                               | 170                                                                               | 145                                                                               | 170                                                                                | 170                                                                                 | 145                                                                                 | 72/84                                                                               | 170                                                                                 | 72.5                                                                                | 145                                                                                 | 72/84                                                                               |
| Current (A)           | 3150                                                                              | 3150                                                                              | 1250                                                                              | 3150                                                                              |                                                                                    | 4000                                                                                | 3150                                                                                | 1200                                                                                | 4000                                                                                | 2000                                                                                | 3150                                                                                |                                                                                     |
| SC curr (kA)          | 50                                                                                | 40                                                                                | 50                                                                                | 40                                                                                | 50                                                                                 | 50                                                                                  | 40                                                                                  | 31.5                                                                                | 50                                                                                  | 31.5                                                                                | 40                                                                                  |                                                                                     |
| Fill. Press. (MPa)abs | 0.8                                                                               | 0.85                                                                              | 0.83                                                                              | 1.2                                                                               | 0.85                                                                               |                                                                                     | 0.8                                                                                 |                                                                                     | 0.75                                                                                | 0.8                                                                                 | 1.0                                                                                 | -                                                                                   |



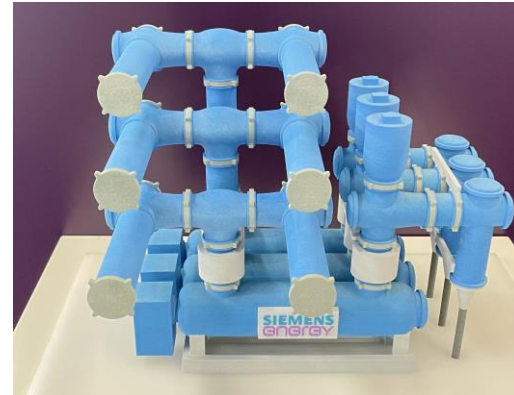
# A look at CIGRE 2022



Workshop on SF6 alternatives



Meidensha 145 kV vacuum + technical air in Alaska



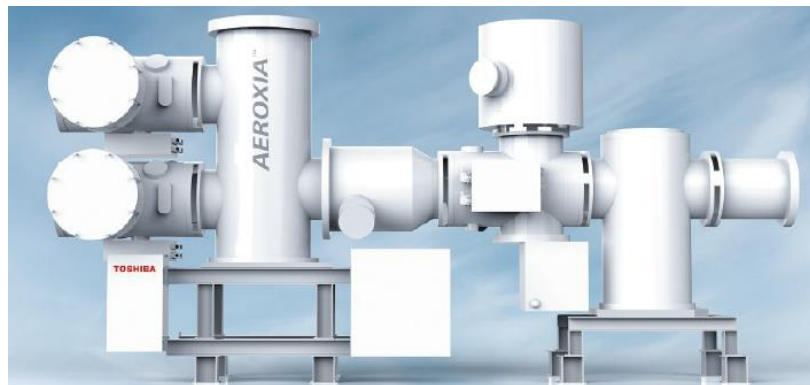
Siemens Energy 420 kV SF<sub>6</sub>-free air insulated GIS 1:25 model



GE 245 kV g<sup>3</sup> dead tank circuit breaker



HiVoDuct 245 kV Pressurised Air Cable



Toshiba 72.5 kV vacuum + technical air



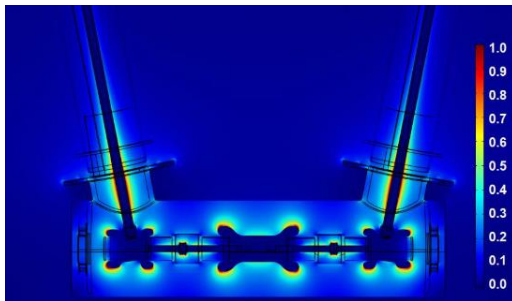
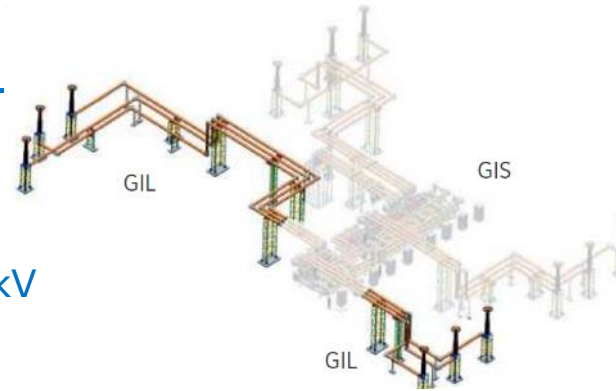
Hitachi Energy 420 kV C4-FN / O<sub>2</sub> / CO<sub>2</sub>



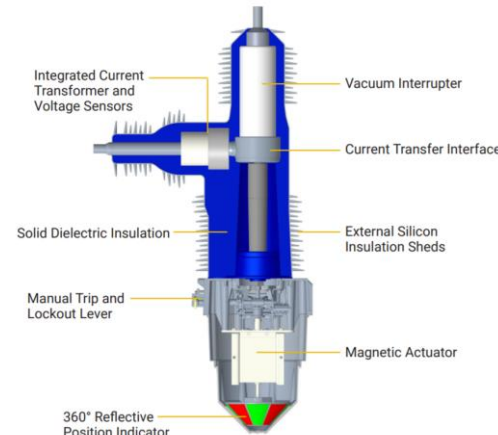
Mitsubishi Electric 145 kV vacuum interrupter

# Outlook

- Insulation
  - GIL / GIB already in operation 420 -> 1000 kV
  - switchgear still SF<sub>6</sub> based
- Interruption
  - up to 170 kV to approach SF<sub>6</sub>
  - (when) can alternatives fully match SF<sub>6</sub>?
  - Limit of single break vacuum?
- Multi-break technology
- Solid insulation?
  - AutoRecloser
  - Switches

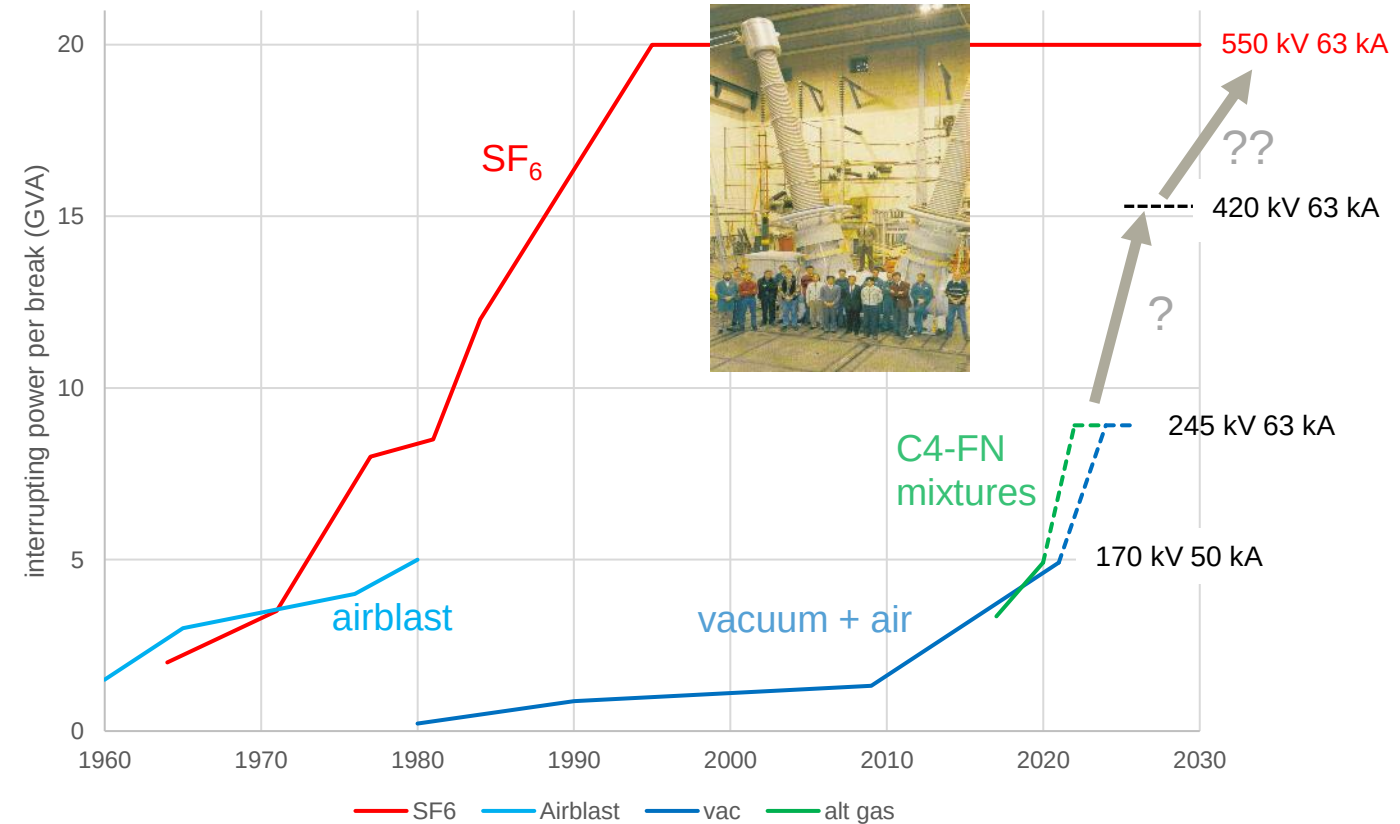


Nikolic CIGRE 2020, 245 kV  
single break study SF<sub>6</sub>-free DT VCB



Vacuum AutoRecloser  
solid-insulated 72.5 kV 31.5 kA

## Interrupting power **per break** (GVA)

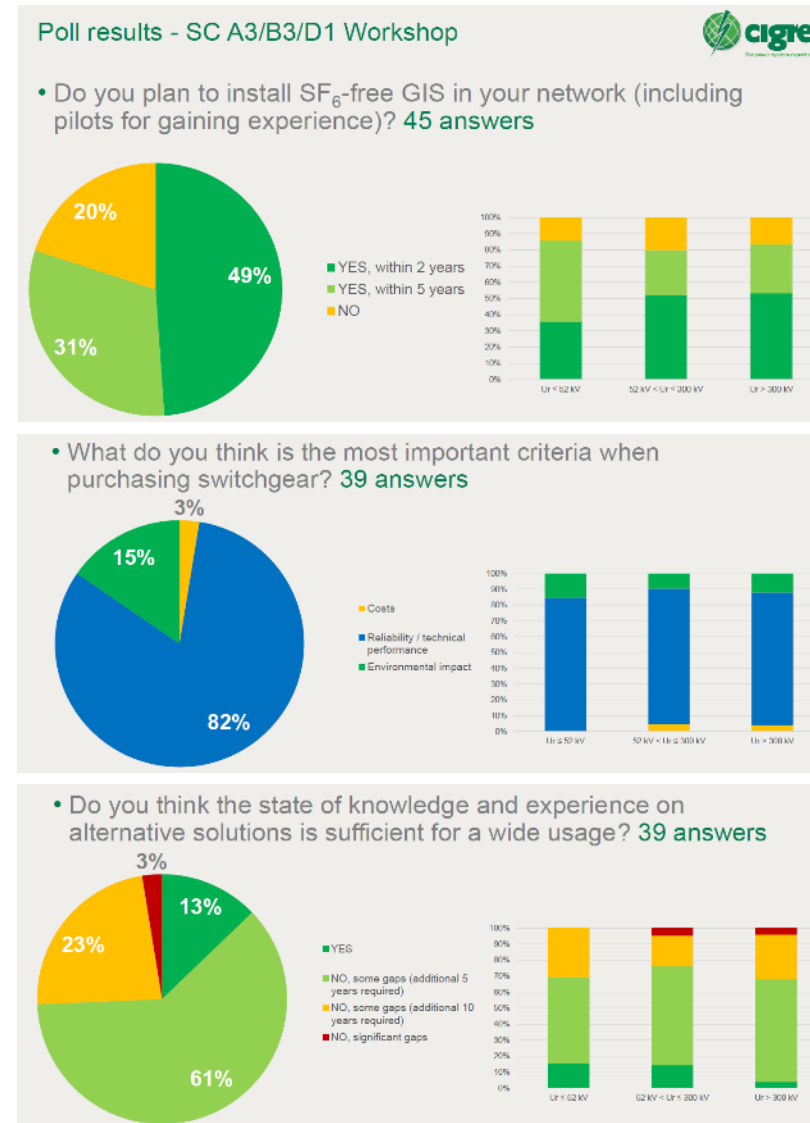




# System operators embraces the change?

Results from poll at CIGRE SF<sub>6</sub>-free switchgear workshop Aug. 2021

- When planning to install SF<sub>6</sub>-free GIS?  
80% says "within 5 years" (49% within 2 years)
- When do you stop buying SF<sub>6</sub> equipment?  
74% says "yes within 10 years" (22% within 5 years)
- Higher price allowed?  
63% says "yes"
- Decided already on a certain technology?  
72% says "not yet"
- State of knowledge and experience enough for wide use?  
87% says "not yet" (13% thinks needs another 10 years)
- Most important criterion to decide on "new" switchgear?  
82% says "reliability" (only 3% says "costs")
- No uncertainty about the willingness to get rid of SF<sub>6</sub>
- Uncertainty about the technology readiness level of the alternatives?



# Testing in quality assurance / design verification

- Switchgear is newly designed
- A variety of technologies on the market
  - Thermo-electrically complicated
- Independent type test certificate (not from country of origin) gives maximum performance assurance
- Critical test duties
  - New sensitivities of new gases?
  - Extremes of the composition?
- Pre-qualification for lifetime
  - Electrical endurance?
  - Gas consumption?

Test experience @ KEMA High-Power Labs

- Switchgear from 15 different manufacturing sites
- Up to 145/170 kV @ 50 kA three-phase synthetic
- Mostly R&D tests, no type-test certificate issued
- Short-circuit (all duties), capacitive, shunt reactor, bus transfer, MV internal arc





# Factors in asset management

- Regulator restricting GWP? -> new EU F-gas regulation
- Low GWP F-gases only an intermediate solution?
- Life Cycle Assessment?
- Health (toxicity?), safety and environment (PFAS)?
- Size / pressure / costs / temperature?
- TRL? Convergence of technology?
- One gas fits all? Interoperability?
  - Multiple gases in one station?
- Stability of composition? How to measure?
- Retrofit for insulation in existing GIS sections?
- Natural-origin gases for switching and insulation?
- Long term behaviour?
  - Pre-qualification test program mitigates risk
- Scalability? Single break 420 kV?
- Supplier monopoly of synthetic gases?!!!
  - 3M stops supply of NOVEC gases @ 2025



# Sole supplier abandons C4-FN, C5-FK gas in 2025

- 3M decides to stop production of C4-FN, C5-FK gas end of 2025
- Reason is that these gases belong to PFAS substances (Per- and polyFluoroAlkyl Substances)
- These “forever plastics” will be under scrutiny of environmental legislators in US, EU
- Future of this SF<sub>6</sub> alternative “overnight” becomes uncertain



December 20, 2022

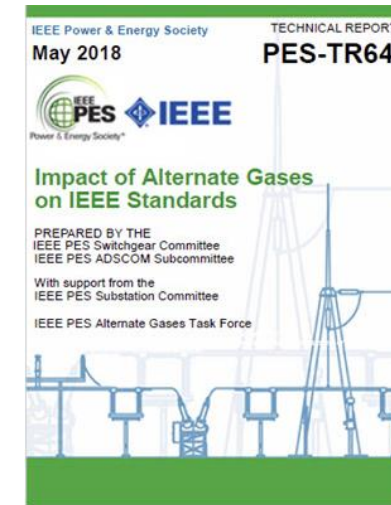
Dear Valued Customer,

3M today announced it plans to exit per- and polyfluoroalkyl substance (PFAS) manufacturing and work to discontinue use of PFAS in its product portfolio by the end of 2025. This portfolio decision is based on careful consideration and a thorough evaluation of the external landscape, including multiple factors such as accelerating regulatory trends focused on reducing or eliminating the presence of PFAS in the environment and changing stakeholder expectations.





- **IEEE PES TR64** “Impact of Alternate Gases on Existing IEEE Standards” 2018 (Uzelac)
- **CIGRE WG B3.45** “Application of non-SF<sub>6</sub> gases or gas mixtures in medium voltage and high voltage gas-insulated switchgear. TB 802, 2020 (Knol)
- **T&D Europe** “Technical report on alternative to SF<sub>6</sub> gas in medium voltage & high voltage electrical equipment” (2020)
- **CIGRE WG D1.67** “Dielectric performance of new non-SF<sub>6</sub> gases and gas mixtures for gas-insulated systems”. TB 849, 2021 (Franck)
- **IEC 62271-4 ED-2** “Handling procedures for gases and gas mixtures for interruption and insulation” -> 2022
- **CIGRE WG A3.41** “Interruption and switching performance with SF<sub>6</sub> free switching equipment”. TB 871, 2022 (Smeets)
- **IEEE C37.100.7** “Guide for the Evaluation of Performance Characteristics of Non-Sulfur Hexafluoride Insulation and Arc Quenching Media for Switchgear Rated above 1000 V” -> 2023 (Schiffbauer)
- **CIGRE WG B3/A3.60** “User guide for non-SF<sub>6</sub> gases and gas mixtures in substations” -> 2024 (Knol)







Milano · Arnhem · Berlino · Mannheim · Prague · Dubai · Dammam · Santiago de Chile · Rio De Janeiro · Knoxville (USA) · Shanghai



**synecom**  
*S.R.L.*



# Electric power and SF<sub>6</sub> installed worldwide

2017: The installed electric power in the world was **P= 7699.8 GW**

The amount of SF<sub>6</sub> required in electrical equipment is **IF = 57.78 ton per GW installed**  
(2010 data)

The estimate of SF<sub>6</sub> installed in electrical equipment in the world is:

$$m_{\text{SF}_6} = P \times \text{IF} = 7699,8 \text{ GW} \times 57,78 \frac{\text{ton}}{\text{GW}} = \underline{\underline{444.894,44 \text{ ton}}}$$

The average useful life of an equipment is about **30 years**

Every year **more than 15.000** tons of gas are disposed by burning or even released into the air: this amount of SF<sub>6</sub> gas covers about **80% of the world's annual need**



Why keep producing new SF<sub>6</sub> and dispose dirty/decomposed SF<sub>6</sub> when we can Regenerate it?



# SF<sub>6</sub>'s emissions in the life cycle of electrical equipment

LIFETIME MOLECULE TOTAL EMISSIONS:

BETTER SCENARIO → **15.68%** EMISSIONS

WORST CASE SCENARIO → **27.30%** EMISSIONS

Gas production  
0,38 – 10 %

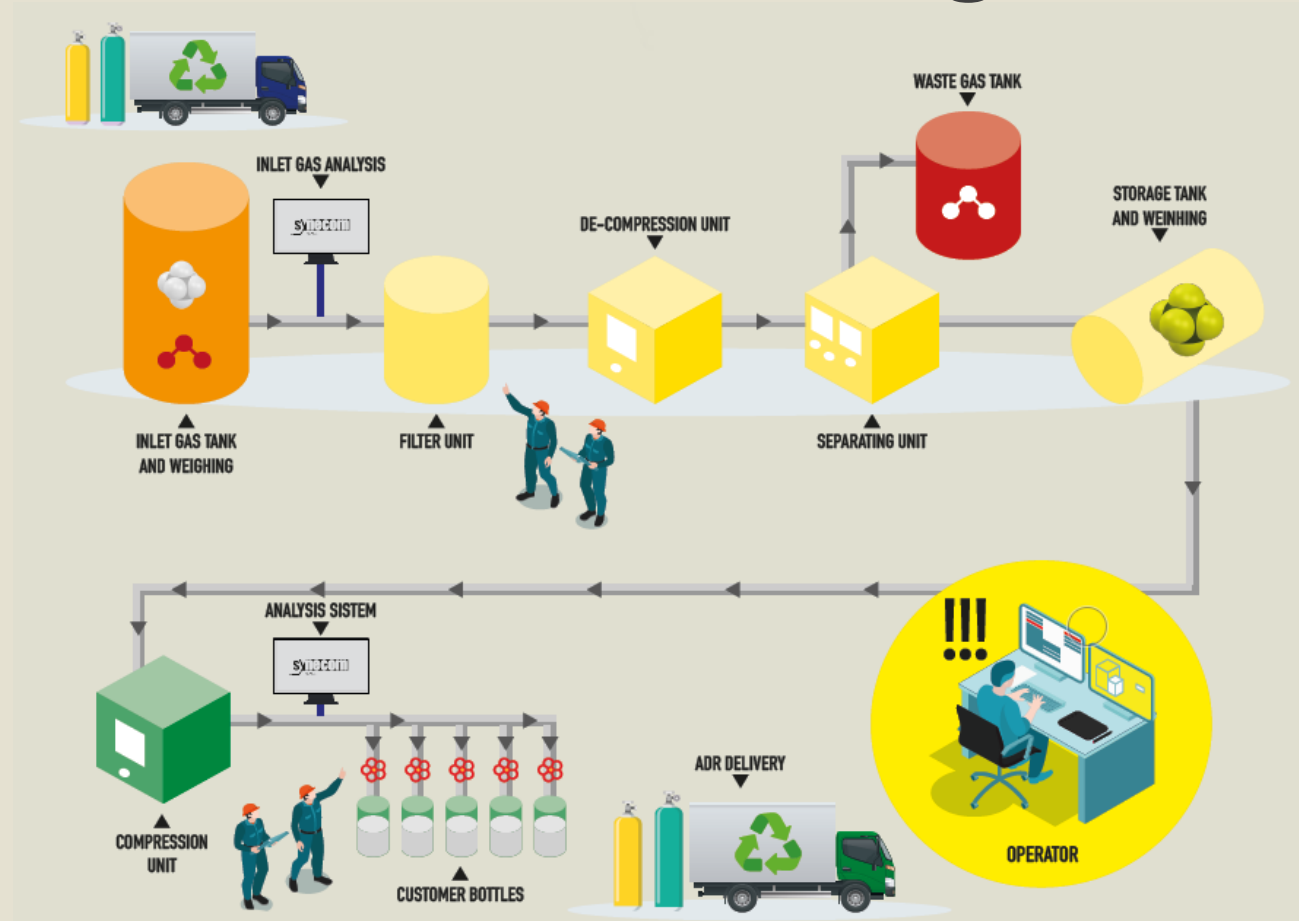
Equipment  
production and  
installation  
8,6%

Equipment life,  
maintenance and  
dismantling  
4,7%

Gas disposal  
2 – 4 %

# Synecom SF<sub>6</sub> Regeneration and its advantages

- ✓ All processes are molecular sealed  
**EMISSION FREE**
- ✓ Regenerated gas is  $> 3.7 \text{ N o } > 4.0$   
**BETTER QUALITY THAN IEC 60376 REQUIREMENT**
- ✓ Avoid SF<sub>6</sub> disposal and  
**FULL RECONDITION YOUR SF<sub>6</sub>**  
**FULLY COMPLIANT WITH GREEN ECONOMY PHILOSOPHY & SUSTAINABILITY<sup>3</sup>**
- ✓ Recycling is not possible when gas is too contaminated  
**REGENERATION STARTS WHEN RECYCLING IS NOT POSSIBLE ANYMORE**
- ✓ ISO 14001 dedicated to Regeneration
- ✓ **CERTIFIED REGENERATION PROCESS**





Thank you for your attention

Any question?

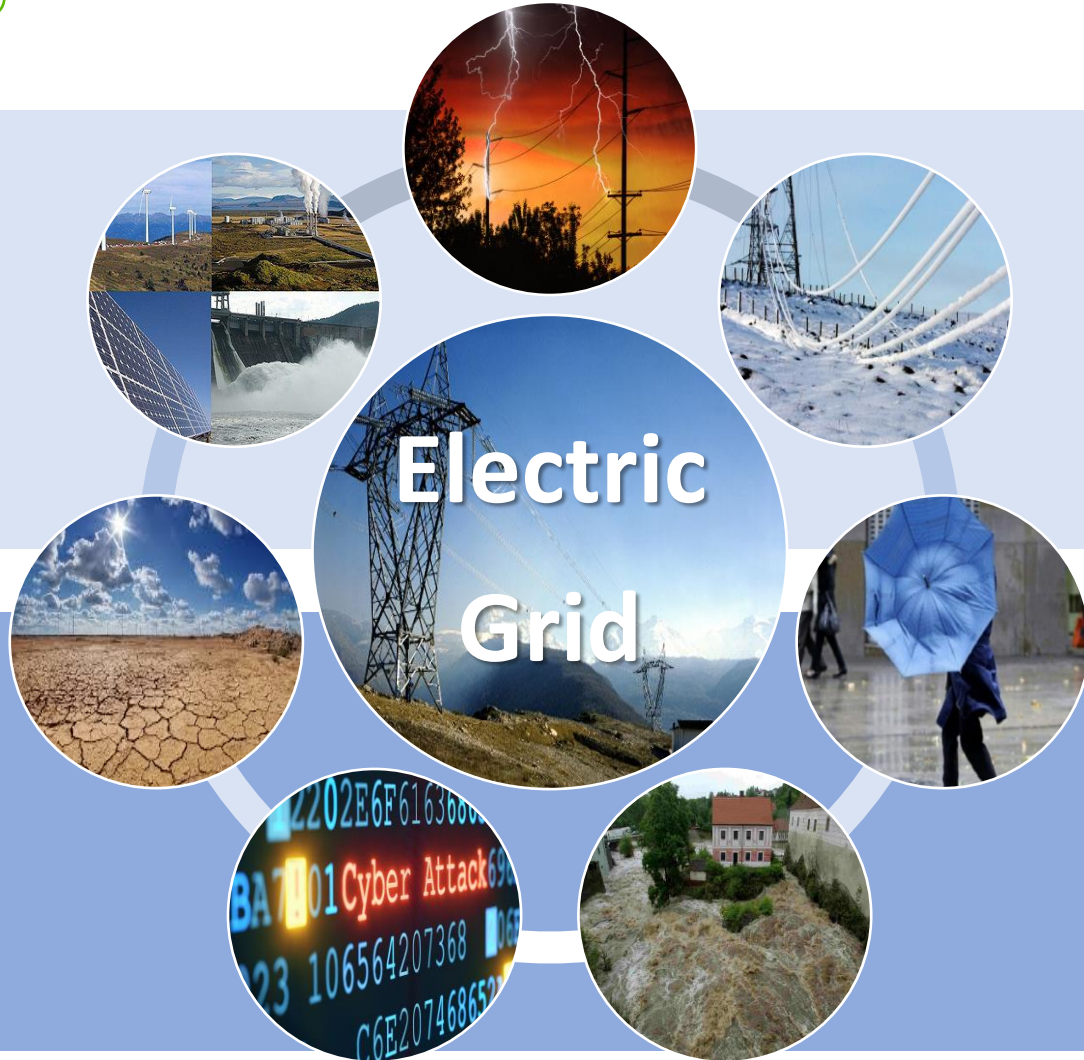
Q&A

April 18<sup>th</sup> 2023  
Italian Panel of SC A3 CIGRE (T&D Equipment)



# An approach to increase the resilience of the electrical grid

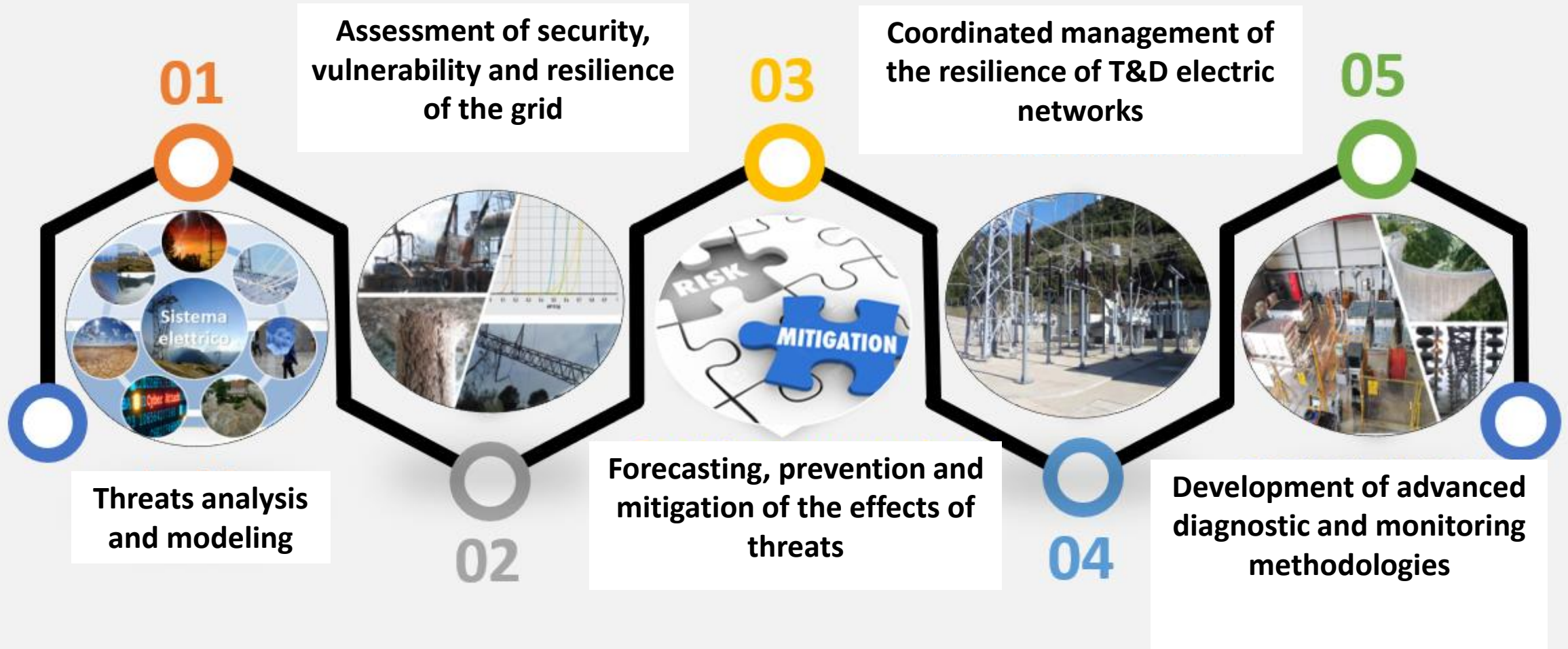
# Reasons of the project



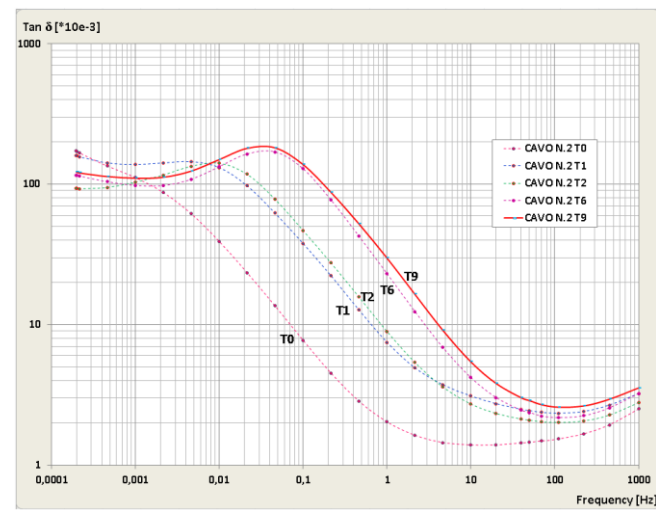
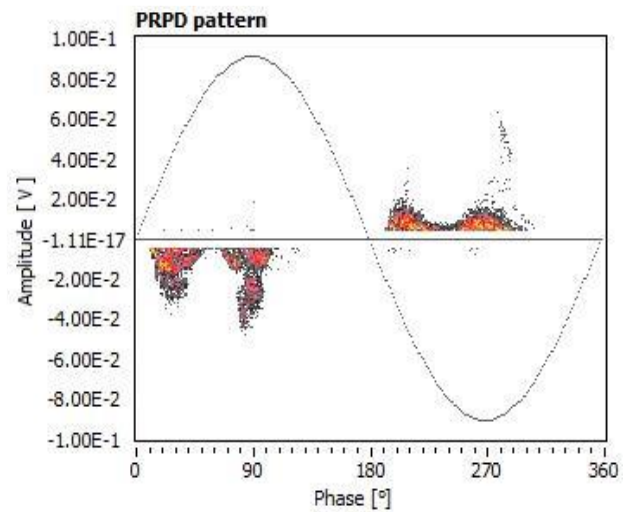
💣 The increase in the **frequency** and **intensity** of **extreme weather events** can cause several **network components** to go **out of service** up to a **blackout**

► There is the need to **increase** the grid **resilience**, that can be defined as «**the ability to limit the extent, severity and duration of system outages following an extreme event**»









# Acknowledgments



**This work has been financed by the Research Fund for the Italian Electrical System under the Three-Year Research Plan 2022-2024 (DM MITE n. 337, 15.09.2022), in compliance with the Decree of April 16th, 2018”.**

Thank you for  
your attention

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