

Industry

NAVIGATOR

SUSTAINABLE DEVELOPMENT
STRATEGIES FOR T&D

CONFERENCE 2025

LAST TRENDS & TECHNOLOGIES IN T&D

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Sales & Marketing Director KEMA Labs

9 April 2025, Dubai

KEMA Labs

CESI Group

Journey

- 1 **CESI Group**
- 2 Innovation Trends
- 3 TIC Industry Role

CESI Group Business Units

CESI

KEMA Labs
CESI Group

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

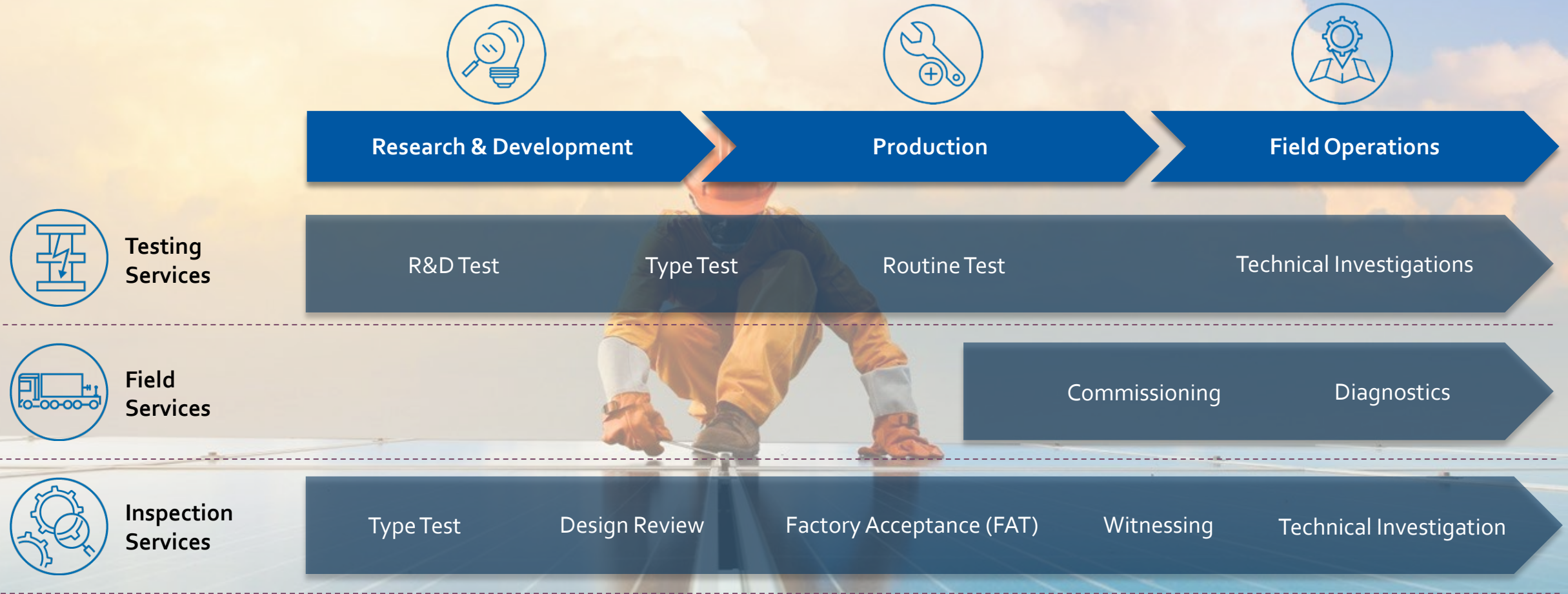
 **CESI** Space
Inspired with innovation

Production of Advanced
Multi-junction Solar Cells for
Space Applications

CESI Consulting
Inspired with innovation

Expertise in The Energy
Industry for Transmission,
Distribution and
Environmental Engineering

KEMA Labs: Your Value Chain, our Value Driver



Journey

- 1 CESI Group
- 2 **Innovation Trends**
- 3 TIC Industry Role

A world of opportunities and challenges for T&D

MACRO-TRENDS

 Manufacturing Re-shoring

 Climate Change Impact

 Renewables & Sustainability Policy

CHALLENGES FOR OEMs DUE TO GLOBAL TRENDS

Ensuring **robust supply chains** to maintain **quality** and meet **delivery timelines**

Ensuring **high standards** in parallel with **rapid production scaling**

Ambitious **targets** for **carbon neutrality** set by most of the countries

Increased **massive climatic events** demanding **short time delivery** for network infrastructures **repair**

Renewable Energy Goals with aim to increase energy share from **renewables**

Green Alternatives transitioning to **green-house gas replacements** and **carbon-neutral materials** with **increase in trade cost** due to **sustainability policies**

IMPACTED
OEMs KPI

LEAD TIME

OPERATIONAL
COST PER UNIT

CARBON
FOOTPRINT

DEFECT RATE

Major trends and innovations transforming grid and challenging traditional network paradigm



Green Insulation Technologies

- More stringent regulations on **SF6 insulated equipment**
- **Adoption of new gas mixtures**, more environmental friendly
- Replacement of mineral oil with natural esters in power transformers

Digital Substations

- **IEC 61850 adoption as protocol communication in all substation layers**
- **Cybersecurity measures** and adoptions to **avoid vulnerable network operations**

Electrical Mobility

- **AC and DC charging infrastructure installation growth** in urban areas
- New network setup to facilitate **fast charging**, load balance of electrical mobility

Smart Grid & Renewable integration

- Introduction of **DC Smart Metering infrastructures** (related also to DC Fast Chargers)
- **Grid Modernization** and **AI** as support to control **Energy Management**

Phasing out SF6 is already happening in several markets

Innovation in Switching is crucial to consolidate or scale market leadership

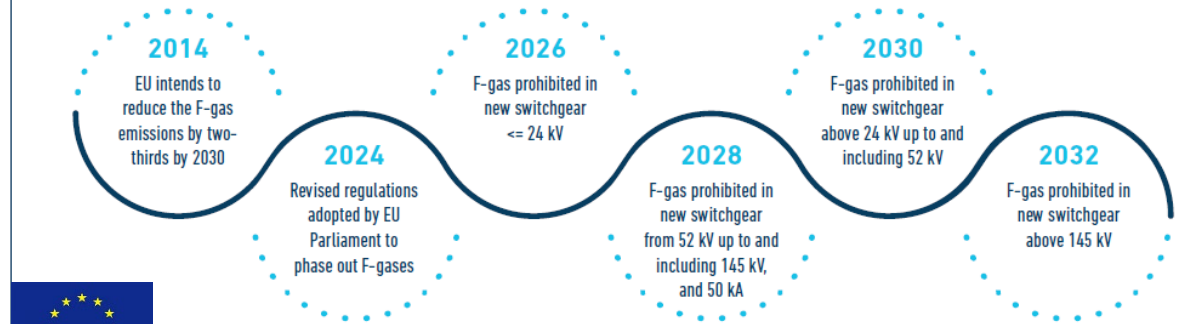


SF6 HIGH GLOBAL WARMING POTENTIAL (GWP)



- Resides in the atmosphere **3,200 years**
- 1 kg SF6 equals 5 times around the world with a gasoline car
- Around 50,000 tons of SF6 in use in the world

EUROPEAN MARKET MILESTONE FOR F-GAS PHASE OUT



FIRST MOVES IN CALIFORNIA TO START PHASE OUT



- **California:** phase-out towards GWP ≤ 1 , otherwise reporting required
- **EPA (Envir. Protection Agency):** Sets reporting requirements above 8.1 ton of SF₆ / PFC

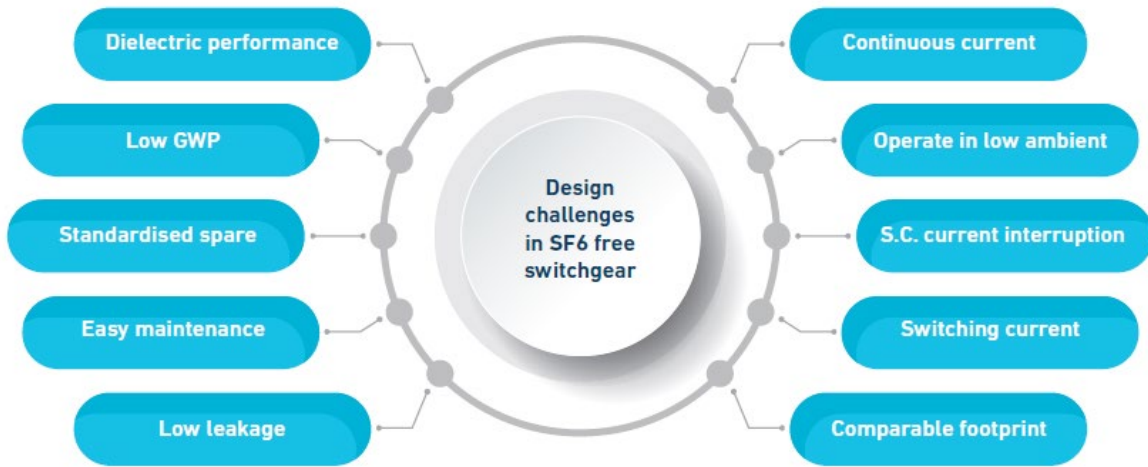
Design challenges of innovative green/blue switchgear

High R&D investments required to fulfil market requirements and reliability of the supply



- Non-SF6 mixtures have **lower breakdown voltage**, requiring **higher pressure** for practical equipment size.
- **Gas tightness** is a challenge due to high pressure, high temperature, and the need for stable materials.
- SF6-free gases have **lower dielectric strength**, impacting continuous current carrying capacity.
- **CO2 in SF6-free gas circuits** may be a challenge due to its low dielectric strength and high thermal conductivity.
- **Reignitions** in vacuum breakers may be a challenge due to the need for arc control and magnetic field generation in long air gaps.
- **Multiple reignitions** in vacuum breakers can be mitigated by external snubber circuitry.

JOIN OUR WORKSHOP TODAY!
 Gizza 1+2 meeting room – 3rd floor
 9th April 2025 2:00 PM – 4:00 PM



Digital Substations and Cybersecurity

A new layer of the substation transmitting data in parallel to the power



Digital Substations



Cybersecurity

- **Optically connected equipment** with unified communication protocols optimizes grid operation
- **Low-power instrument transformers**, monitoring and diagnostics equipment
- **IoT embedded sensors**, digital twins, and **AI** integration
- **Sensors** link the physical and digital worlds
- Multi-vendor **interoperability** with **IEC 61850** adoption

Importance of Cybersecurity in Electrical Substations

- **Protects Critical Infrastructure:** Ensures the reliability and safety of power supply
- **Prevents Unauthorized Access:** Guards against cyber-attacks and data breaches
- **Supports Regulatory Compliance:** Meets industry standards and legal requirements
- **IEC 62351:** Provides specific standards to secure communication protocols in power systems, enhancing overall cybersecurity

Journey

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An exciting year of innovation flowing in our Labs...



POWER & DISTRIBUTION TRANSFORMERS



+24 %

*TRANSFORMER TESTING
DEMAND 22'-24'*

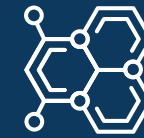


HV & MV SWITCHGEARS



+30 %

*SWITCHGEAR TESTING
DEMAND 23'-24'*



SF6-FREE SOLUTIONS

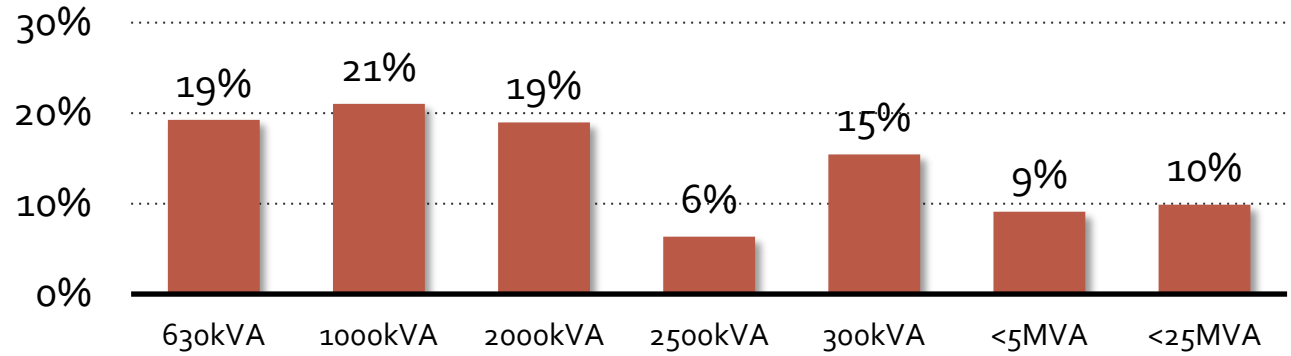


-17 %

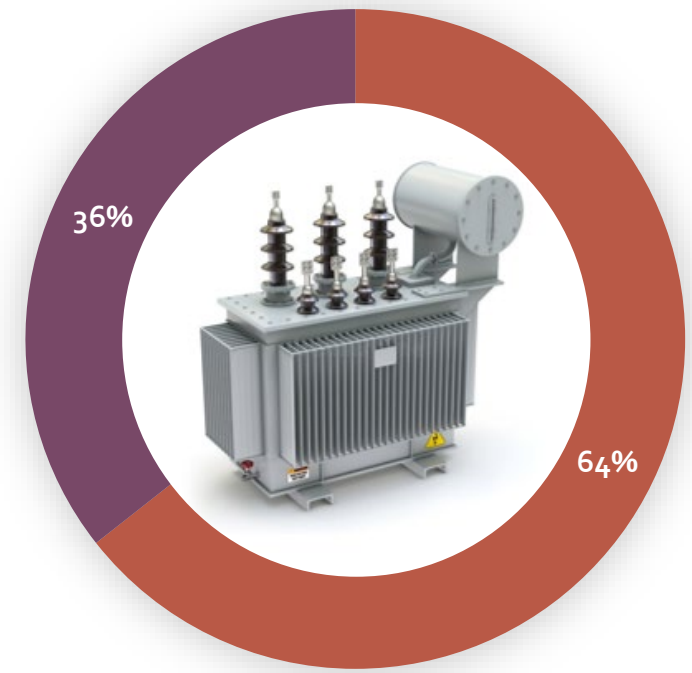
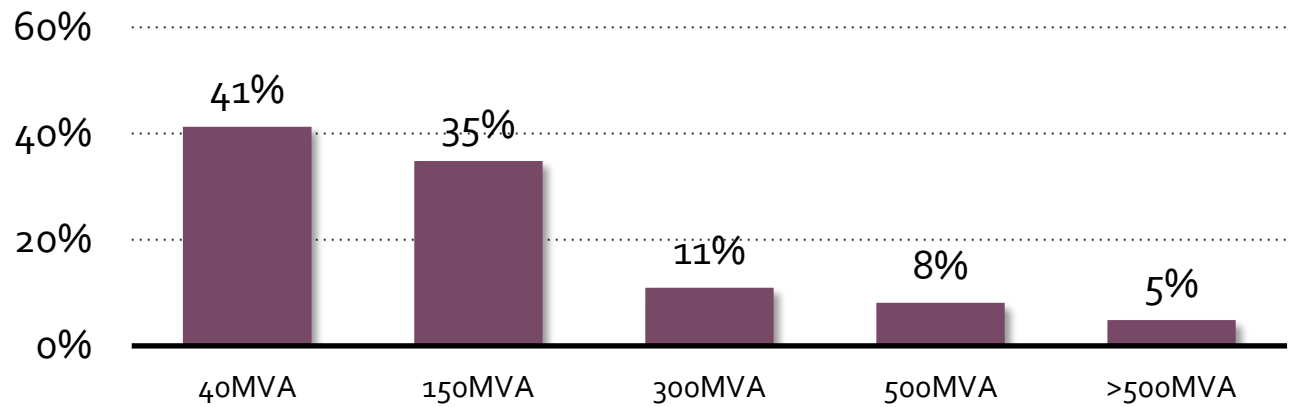
*TESTING DEMAND FOR SF6
BASED SOLUTIONS*

+24 % testing demand for Distribution and Power Transformers in 22'-24' driven by Renewables and Ecodesign Regulations

DISTRIBUTION TRANSFORMERS BY RATED POWER



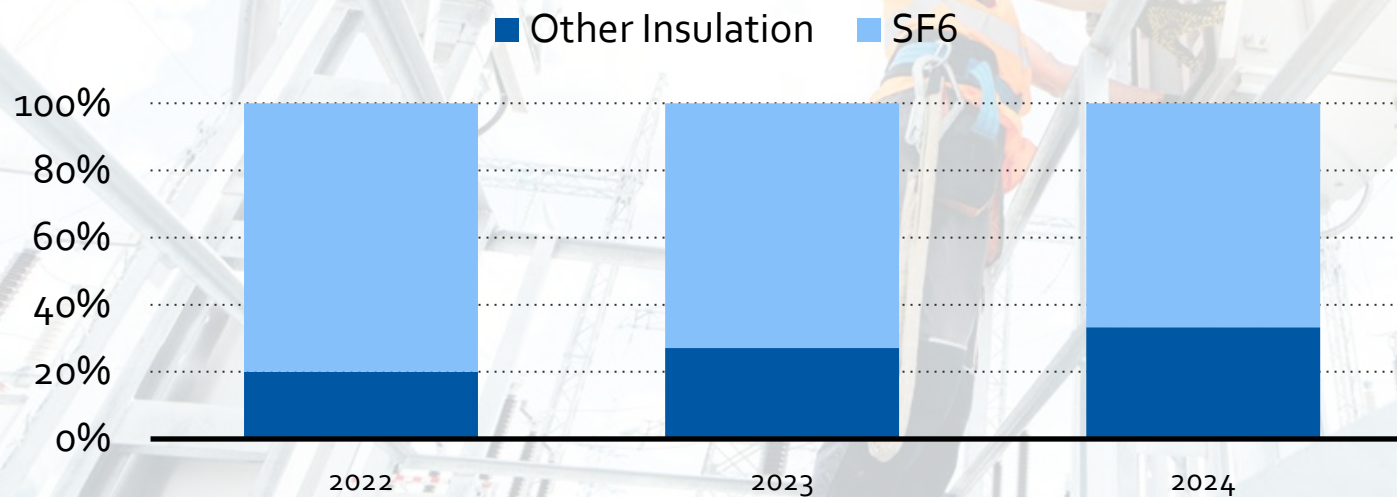
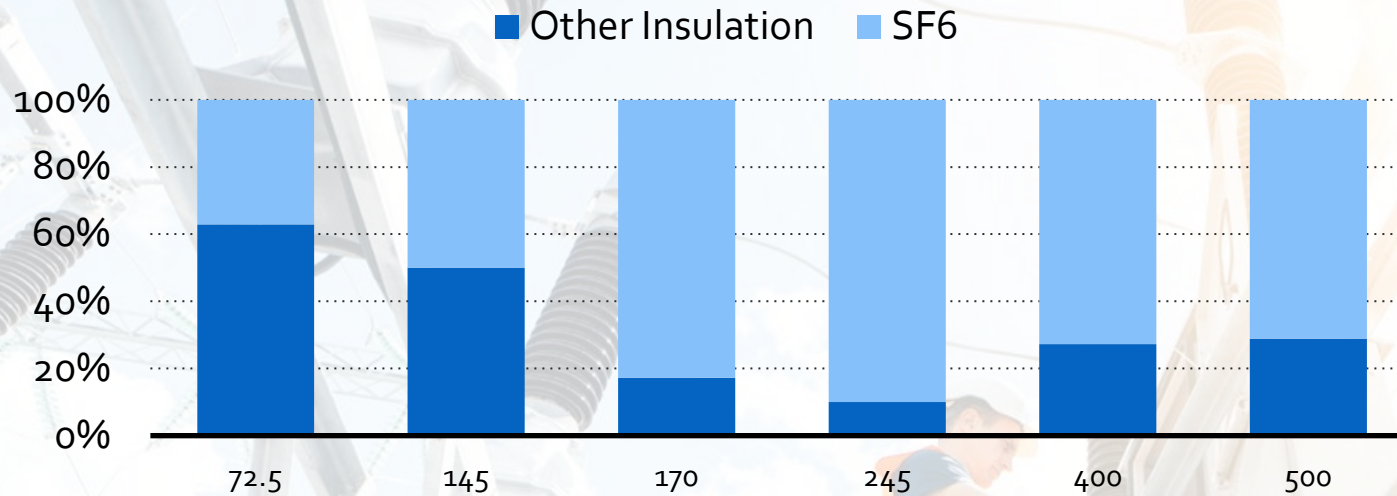
POWER TRANSFORMERS BY RATED POWER



■ Distribution transformers ■ Power transformers

+24 %
 TRANSFORMER TESTING DEMAND 22'-24'

HV Switchgears: Alternative Gas and AIS replacing SF6 solutions in primary voltage segments



Comments

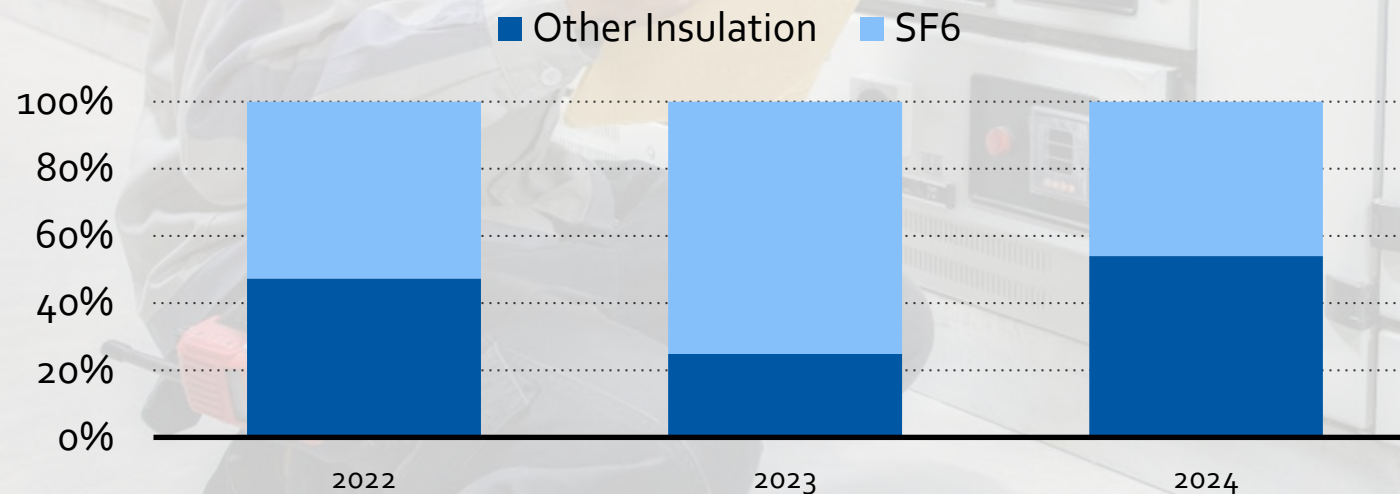
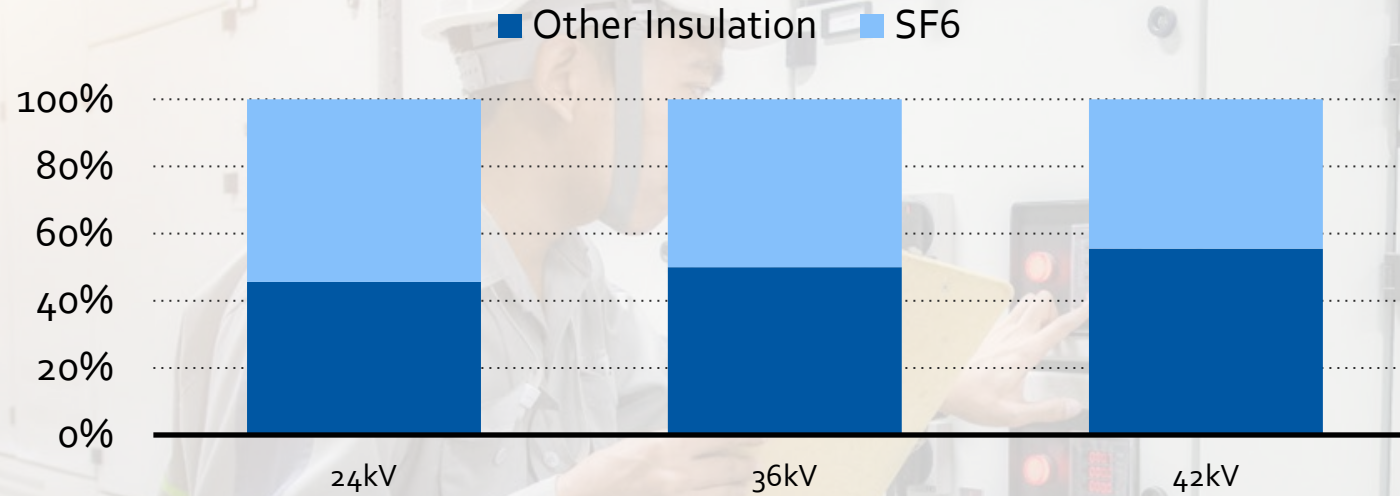
SF6-free alternatives

- Primary High Voltage levels increasing investments to cover and qualify alternative medium to SF6 (Vacuum and Alternative Mix)
- Trend for qualification of SF6 alternatives increasing

+13 %

TESTING DEMAND FOR SF6-FREE SOLUTIONS

MV Switchgears: Road to a low GWP score is going strong



Comments

SF6-free alternatives

- Overall share requests from the market in '24 shows a strong direction on SF6-Alternative solutions (>50 % of requests)
- On all the voltage levels, share of other insulating mediums is strongly replacing SF6

55 %

SHARE OF TESTING DEMAND FOR SF6-FREE SOLUTIONS IN '24

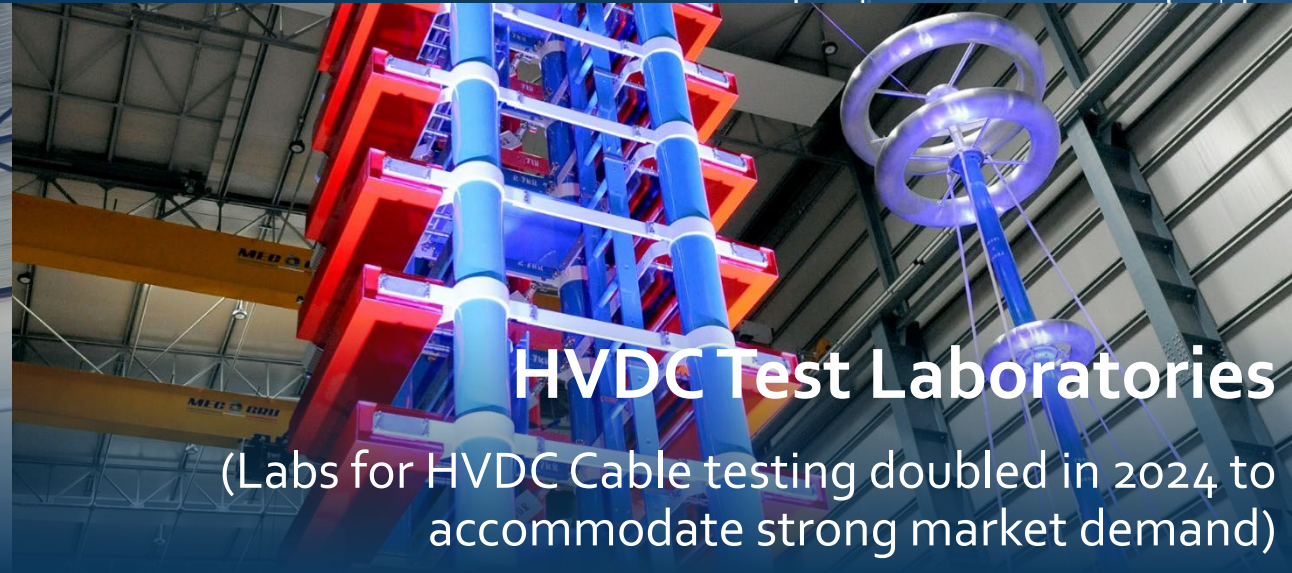
Evolving Labs for evolving markets

Unique ability to develop custom facilities for new market requirements



High Power Laboratories

(Renewed Green Gas Management system for HV and MV Switchgear testing)



HVDC Test Laboratories

(Labs for HVDC Cable testing doubled in 2024 to accommodate strong market demand)



Flex Power Grid Lab

(up to 1.32 MVA hardware-in-the-loop to test complex network requirements)



Battery Lab

(Cells cycling – several channels up to 1,200 A to validate long-term performance of Battery)

Want to know more?

JOIN OUR WORKSHOP TODAY!

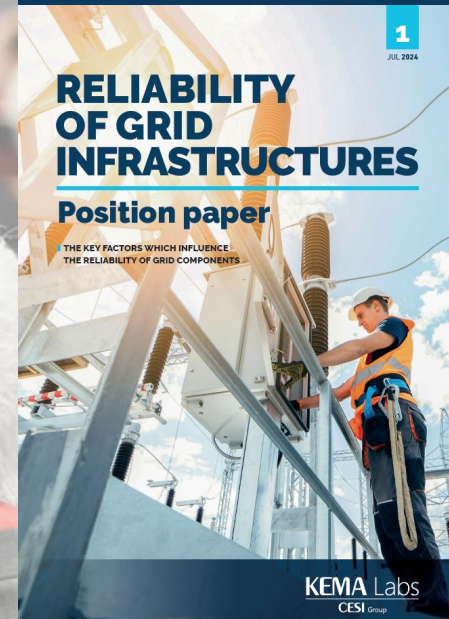
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- **Transformers:** The presentation will focus on the significant stresses on transformers during short-circuits, field failures, laboratory testing, and the latest developments in testing standards.
- **Switchgear:** An overview of innovations in MV and HV switchgear driven by environmental needs and new regulations to replace SF6 gas will be provided. This includes the requirements these technologies must meet and the challenges they face in T&D grids, along with examples of products utilizing these advancements.



Shankar Subramany
*Head of Technology & Innovation Grid
Components*

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KEMA Labs



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