IEEE POWER ELECTRONICS SOCIETY

Powering a Sustainable Future

ARC-RESISTANT MEDIUM VOLTAGE DRIVES:

DESIGN and COMPLIANCE

JOABLE ANDRADE ALVES

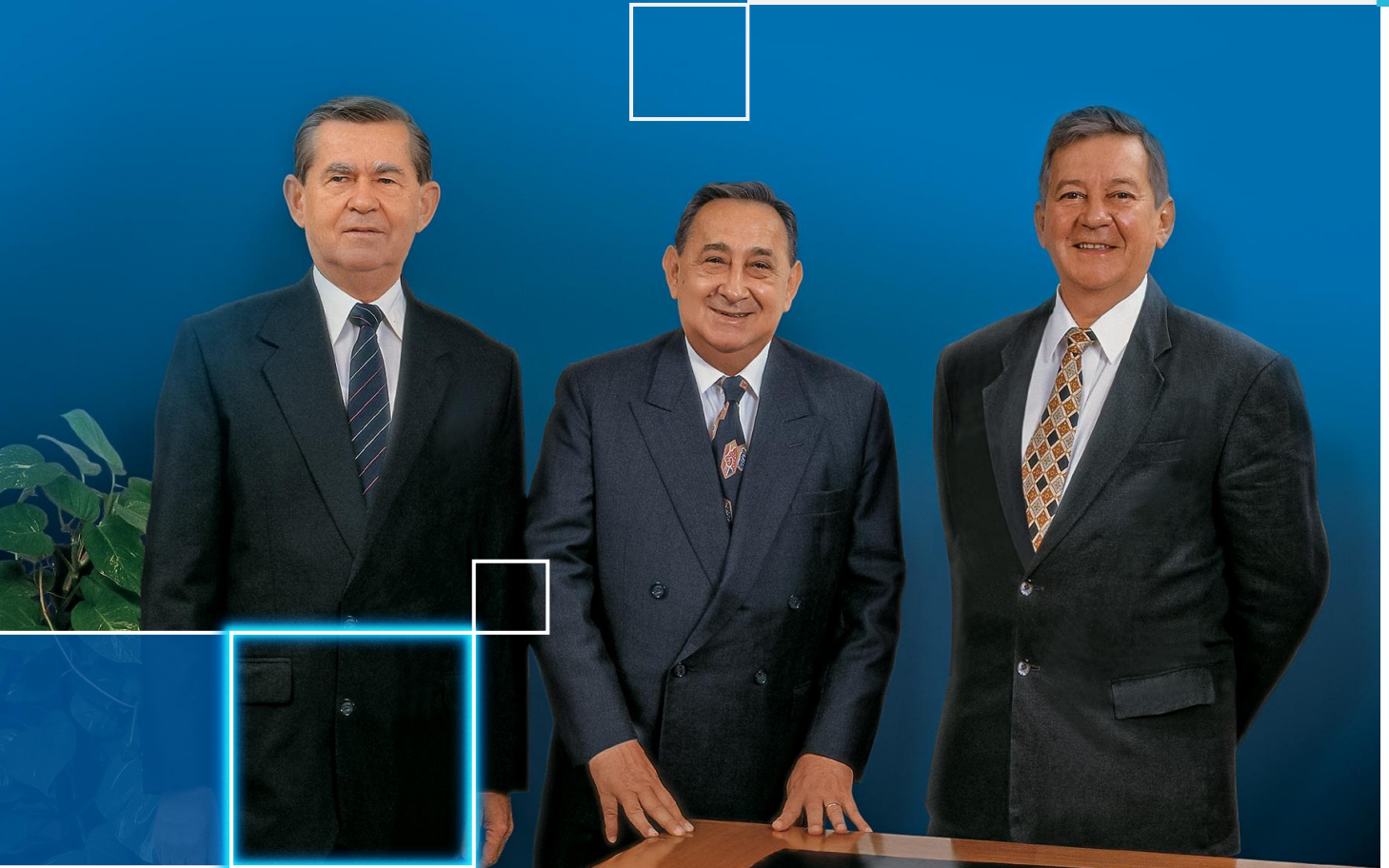
Engineering Board

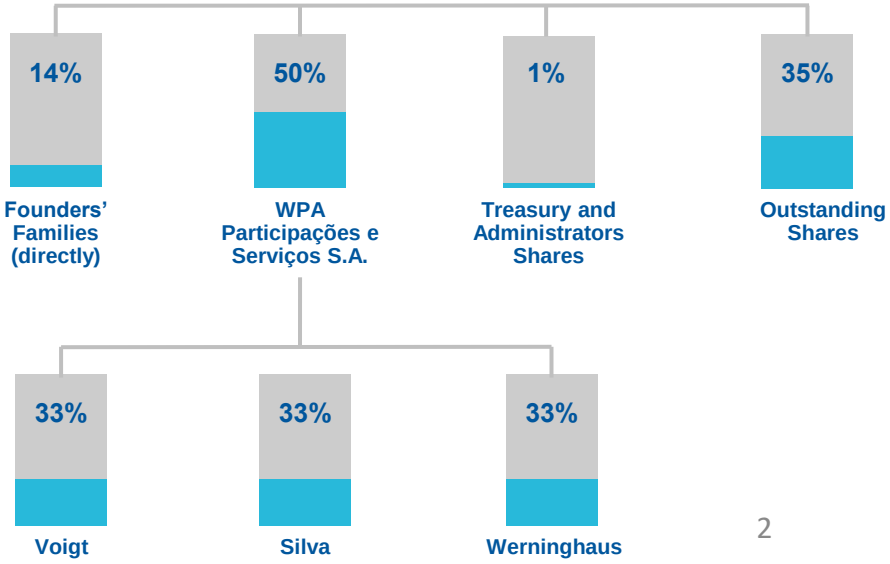
WEG DRIVES & CONTROLS

Driving efficiency and sustainability

The tomorrow that **WEG develops today** was driven by the courage and boldness of those who saw the future and believed that work and unity transform.

In 1961, each of the founders invested the equivalent of a VW car at the time. **Since then, WEG has not stopped and continues to go further**, growing in all directions.





WEG in numbers

67 Manufacturing sites

18 Countries

5 Continents

Distributors in + **than 120 countries**

Net revenues in 2025 **R$ 40.8 billion**

Market Value (Dec/2025) **R$ 204 billion**

[B]³ WEGE3

OTC Pink WEGZY

IBOVESPA B3

ISE B3

The **world's largest manufacturer** of low voltage electric industrial motors

The largest industrial plant for low voltage motors in the world, **with over 1 million m².**

Over **49.300** Employees worldwide

Over **5.500** engineers

WEG in numbers

Over **19 million** motors produced per year

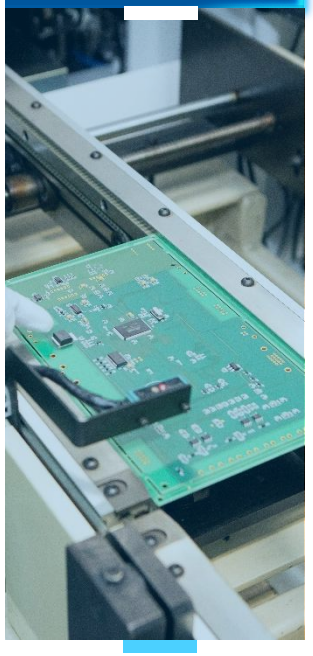
Over **76 thousand MVA** in transformers produced per year

24 million liters of liquid paints and **30,000 T** of powder coatings produced per year

Over **291 thousand MVA** in generators

12,100 hectares of reforestation, 55% of which is made up of renewable resources and 45% of untouched native forest

Over **1,1 billion** of automation products already manufactured



Global presence

SPAIN
- 1 manufacturing site

NETHERLANDS
- 1 manufacturing site

GERMANY
- **3** manufacturing sites

AUSTRIA
- 1 manufacturing site

ITALY
- **2** manufacturing sites

CANADA
- 1 manufacturing site

USA
- 9 manufacturing sites

MEXICO
- 4 manufacturing sites

COLOMBIA
- 2 manufacturing sites

ARGENTINA
- 3 manufacturing sites

PORTUGAL
- **1** manufacturing site

BRAZIL
- 18 manufacturing sites

SOUTH AFRICA
- 6 manufacturing sites

TÜRKIYE
- **2** manufacturing site

ALGERIA
- 1 manufacturing site

CHINA
- **6** manufacturing sites

INDIA
- **5** manufacturing sites

AUSTRALIA
- 1 manufacturing site

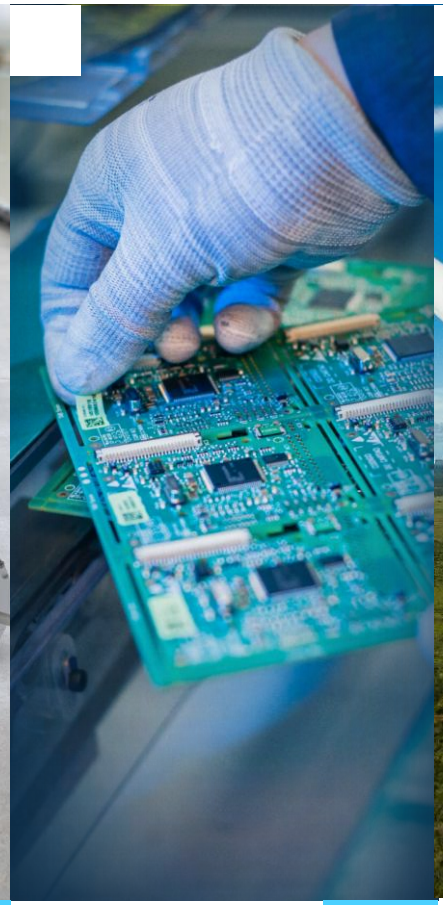
67 manufacturing sites in **18 countries** with commercial operations and technical support in **44 countries** and distributors in more than **120 countries**.

Business Units

Industrial Motors and Gearboxes

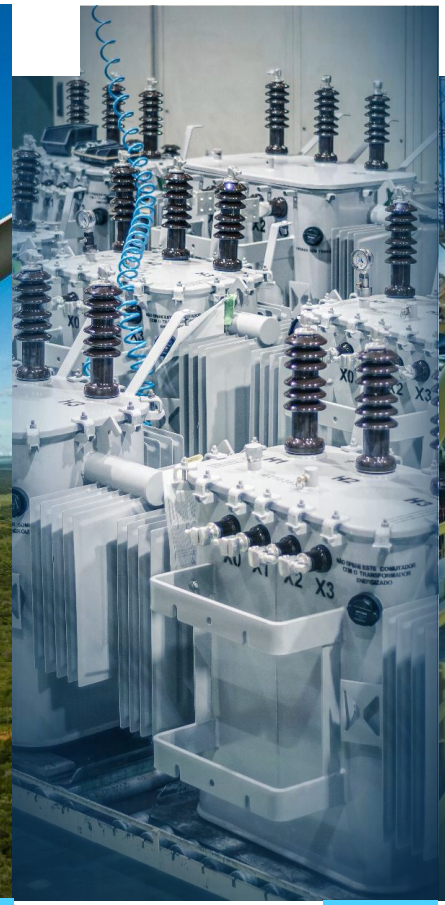
Commercial and Appliance Motors

Automation & Systems



Energy

Transmission and Distribution



Industrial Coatings and Varnishes

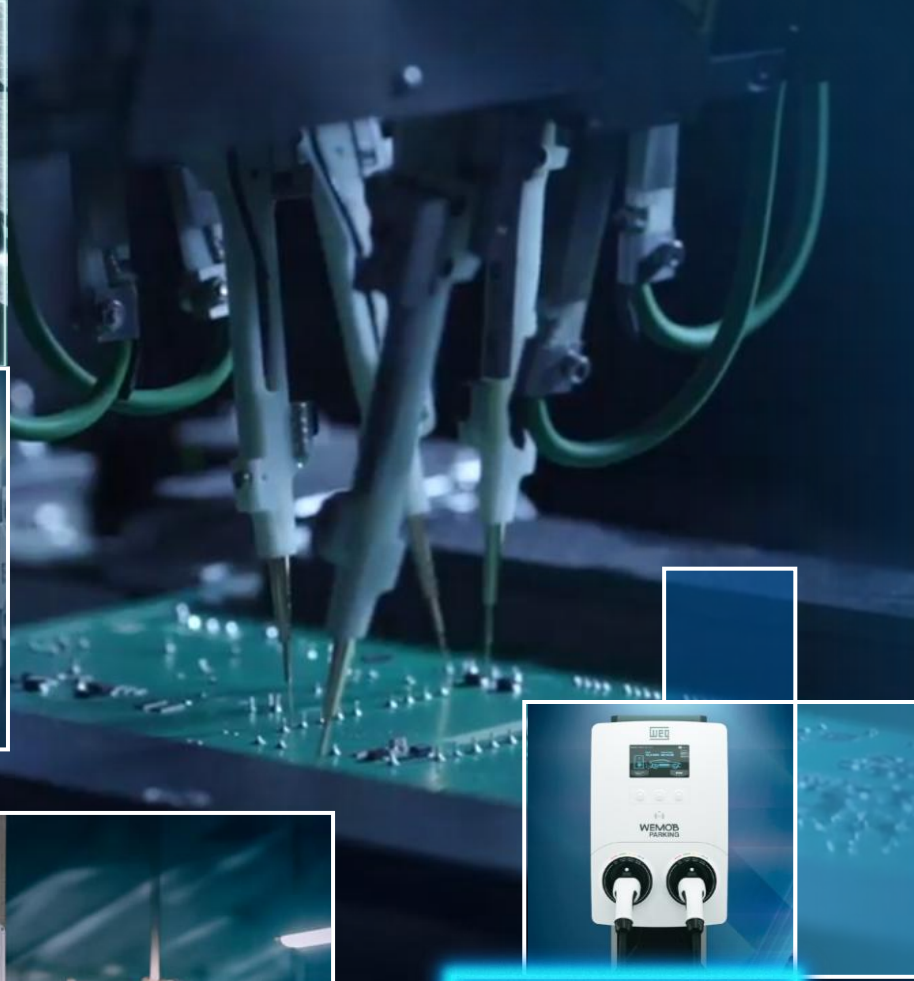
Automation & Systems

- Integration of automation, energy systems, and digitalization;
- Efficient energy utilization across multiple applications;
- Low- and medium-voltage drives and control systems;
- BESS and e-mobility solutions;
- Digital platforms for integrated energy systems;





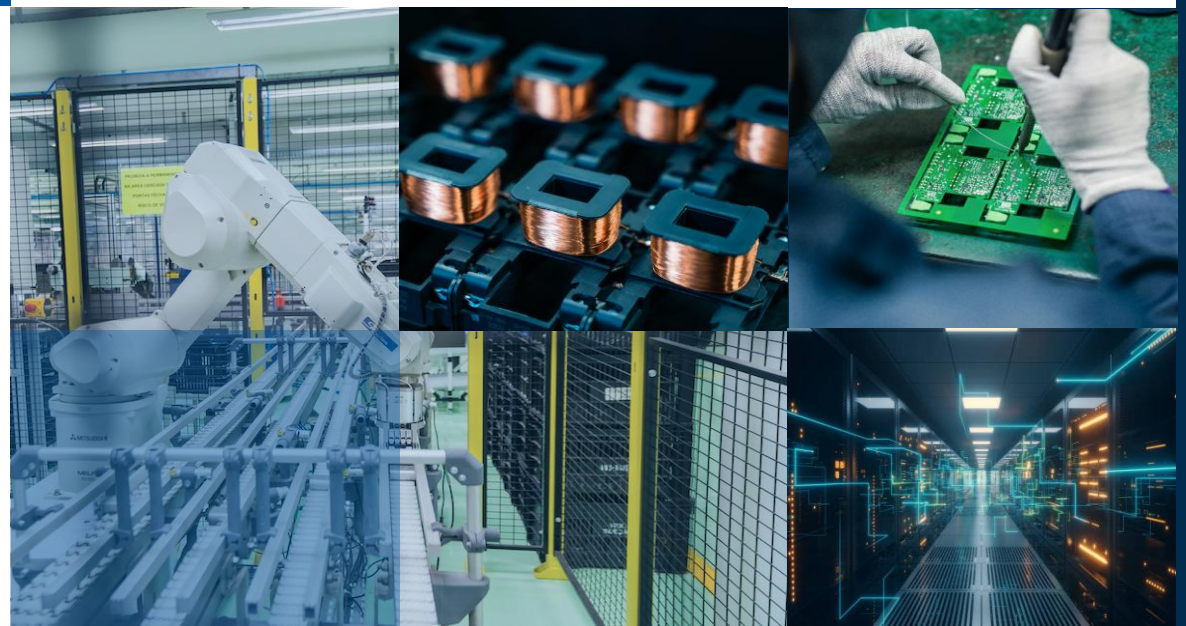




Innovation

Results confirmed in numbers

55,1% of 2024 revenues came from **products that were launched** in the last 5 years.



R$ 1.082 billion
Invested in R&D in 2024

+ 800 thousand
virtual prototypes / year through computer simulation

144 innovation
laboratories worldwide

WEG Stage Gates Methodology

From Idea to Market

Gate 0: Idea Input

Rank ideas in a central bank to select those with high commercial potential.

Gate 1: Business Case

Analyze techno-logical feasibility, competitor solutions, and projected Return on Investment (ROI).

Gate 2: Conceptual Design

Define product specifications, viable design alternatives, and the overall project plan.

Gate 3: Preliminary Design

Build prototypes for performance evaluation and conduct FMEA/tolerances analysis.

Gate 4: Detailed Project

Finalize standard product designs, certification processes, and approve factory capacity.

Gate 5: Manufactu-ring

Complete tooling production, manufacturing standards, and settle the engineering database.

Gate 6: Product Launch

Execute marke-ting plans, commercial files, and official market entry roadshows.

WEG DRIVES & CONTROLS

Topics

What is a **Medium Voltage Variable** Frequency Drive?

Medium Voltage Drives Portfolio.

Medium Voltage Drives Portfolio.

MVW01 **Cooling Methods.**

History of Power Arms Developed for Medium Voltage Drives.

Working Physical Principles for Evaporative Heatsink.

MVW01 Cooling Methods.

Numerical Simulations

New Louvers - Innovative Technical Solution Developed for Arc Resistance Panel.

MVW01 EV AR General Technical Characteristics.

Introduction

What is a Medium Voltage Variable Frequency Drive?

Electronic device that controls the speed and torque of medium voltage AC motors (2.3 kV to 13.8 kV) by adjusting frequency and voltage

- ✔ **Energy savings**

- ✔ **Enhanced** process control

- ✔ **Enhanced** process control
- ✔ **Reduced** mechanical wear

Main Applications

Fans Pumps Compressors Conveyors

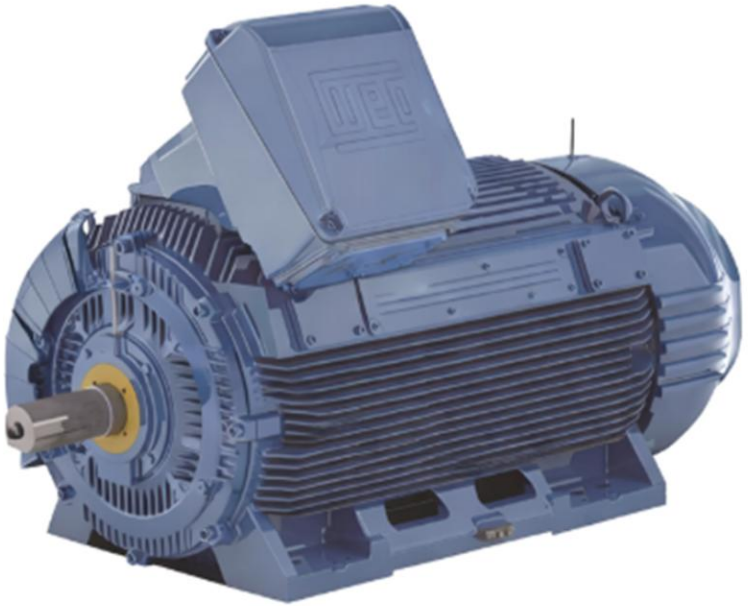
Business Segments

- Water & Wastewater • Oil & Gas
- Mining
- Agribusiness, Sugar & Ethanol
- Steel, Food & Beverage
- Marine, Cellulose & Paper

Size

How big is a medium voltage drive?

(And what does that imply for design, cooling, and safety?)

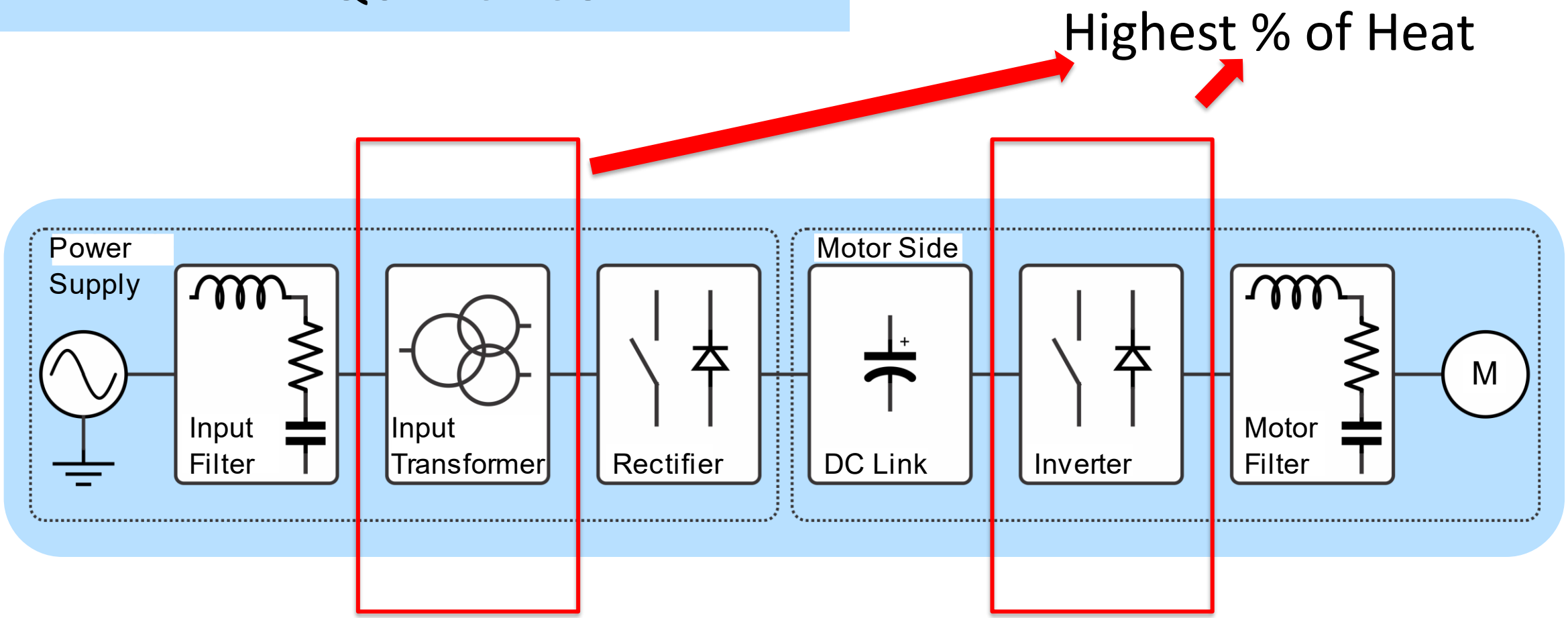


Human scale reference

Size!!!!

Topology

VARIABLE FREQUENCY CONVERTER

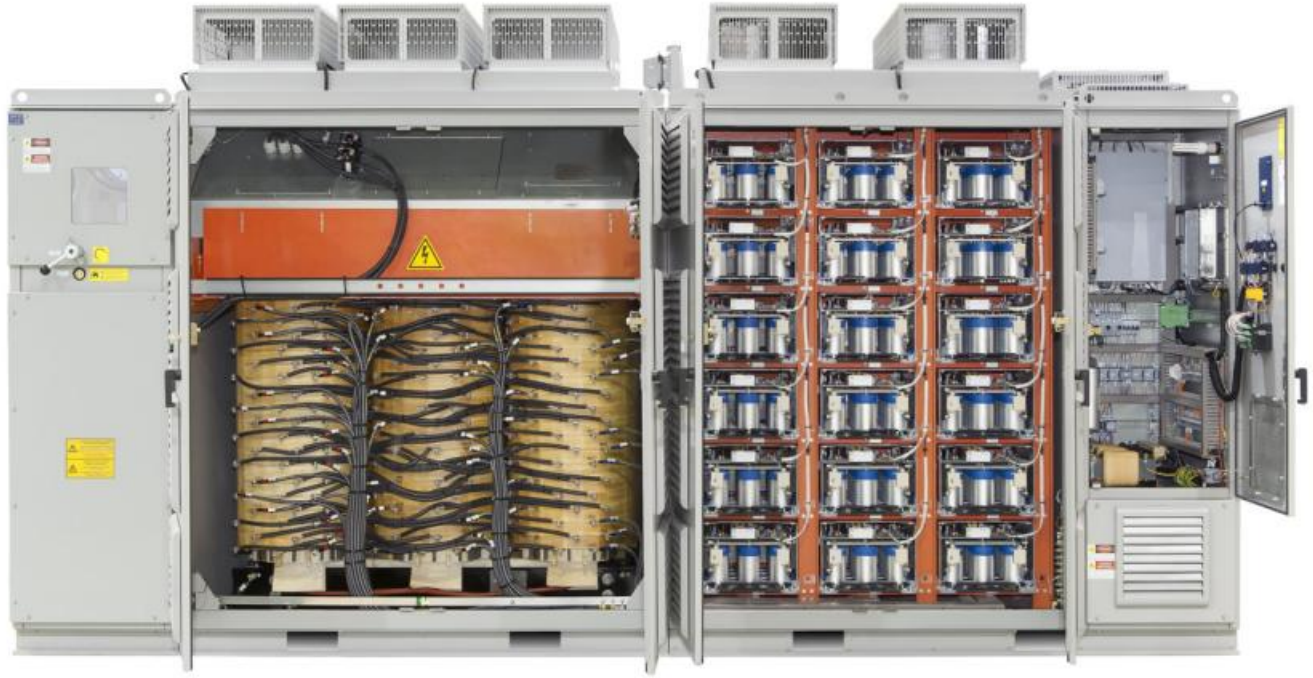


WEG MV Drives

MV Drives Portfolio

MVW01

Topology: Neutral Point Clamp (NPC)
Output Voltage : 3.3kV – 6.9kV
Output Current: Up to 5700A



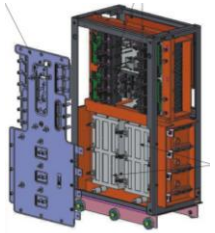
MVW3000

Topology: Cascaded H-Bridge (CHB)
Output Voltage : 2.3kV – 13.8kV
Output Current: Up to 1140A

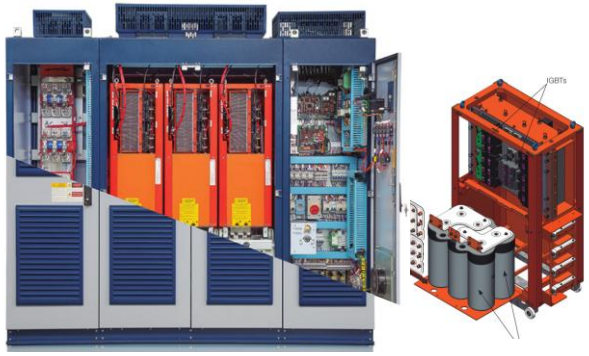
History

Timeline for MV Power Arm Development

2004
MVW01
Air Cooled

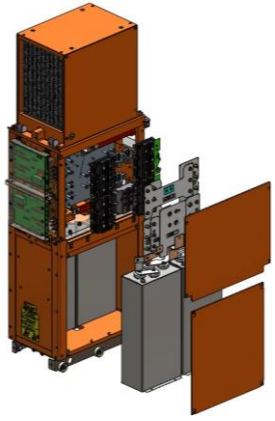


2012
MVW01 G2
Air Cooled



2016
MVW3000
Air Cooled

2024 / 2025
MVW01 EV AR / WC
Evaporative Cooled
Arc Resistant



2006
MVW01
Compact
Air Cooled

2014
MVW01
Water Cooled

2017
MVW01 G3
Air Cooled

MVW01 Cooling

Cooling Methods Comparison Used in the MVW01

AIR COOLED

- Low Components Count
- Fast Maintenance
- With Hot Spots → Standard IGBT Utilization
- Standard Heatsink Footprint
- Standard Power Density

WATER COOLED

- Standard Number of Components
- Need More Maintenance
- No Hot Spots → Better IGBT Utilization
- Better Heatsink Footprint
- Higher Power Density

EVAPORATIVE COOLED

- Lowest Number of Components
- Fast Maintenance
- No Hot Spots → Best IGBT Utilization
- Best Heatsink Footprint
- Highest Power Density

Evaporative Heatsink

Working Physical Principles for Evaporative Heatsink

A **thermosyphon** operates by transferring heat from one point to another using a sealed vessel in a vacuum.

Advantages:

- ✓ High thermal conductivity.
- ✓ Lightweight.
- ✓ Flexibility in design.
- ✓ Simple, passive operation.
- ✓ Cost-effective solution.

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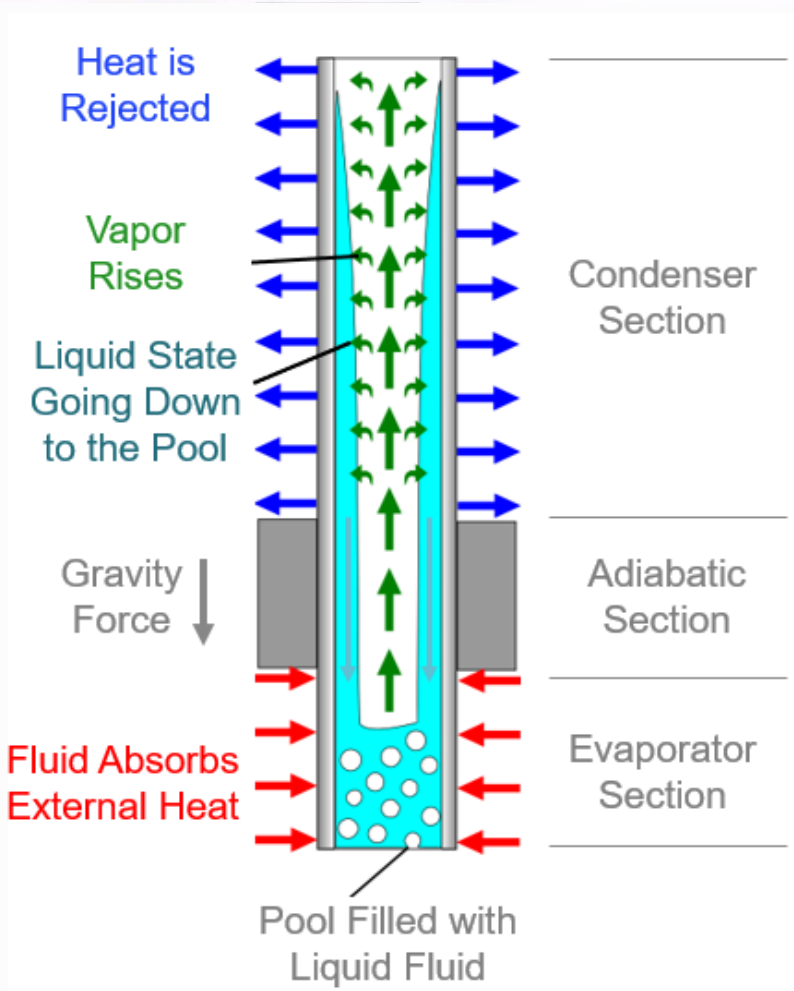
- High thermal conductivity.
- Lightweight.
- Flexibility in design.
- Simple, passive operation.



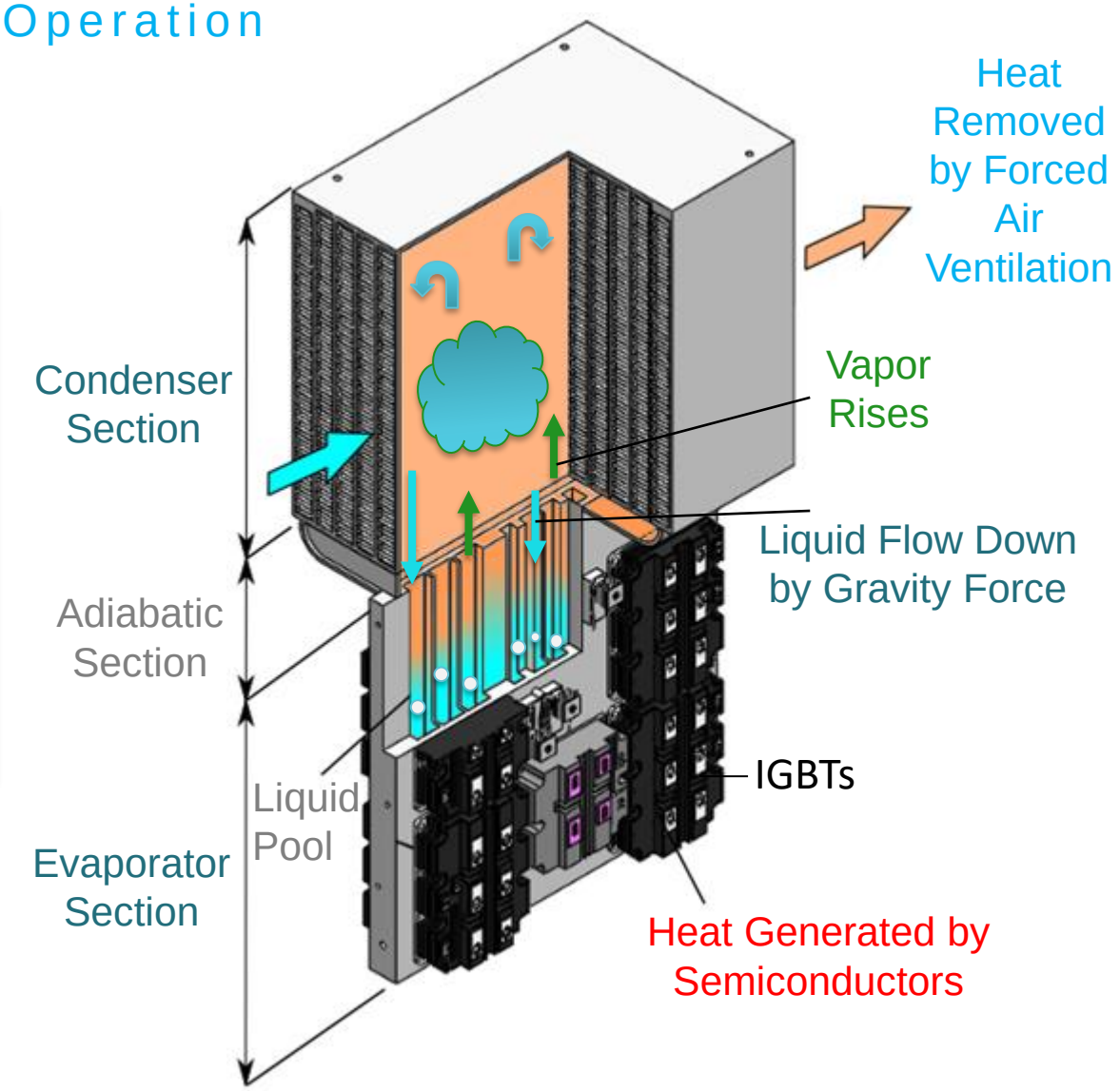
Evaporative Heatsink

Physical Principle of Evaporative Heatsink Operation

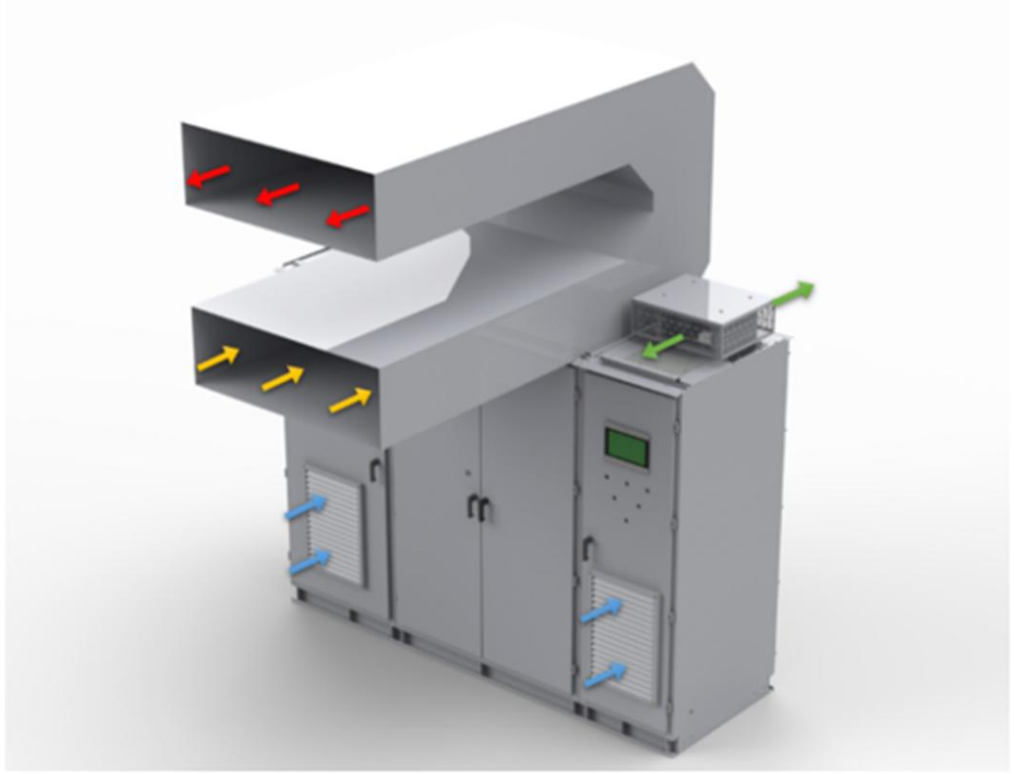
Key Advantages of New Evaporative Heatsink

Utilizes thermosyphon principle and an air heat exchanger with brazed plate fins cooled by forced air ventilation.

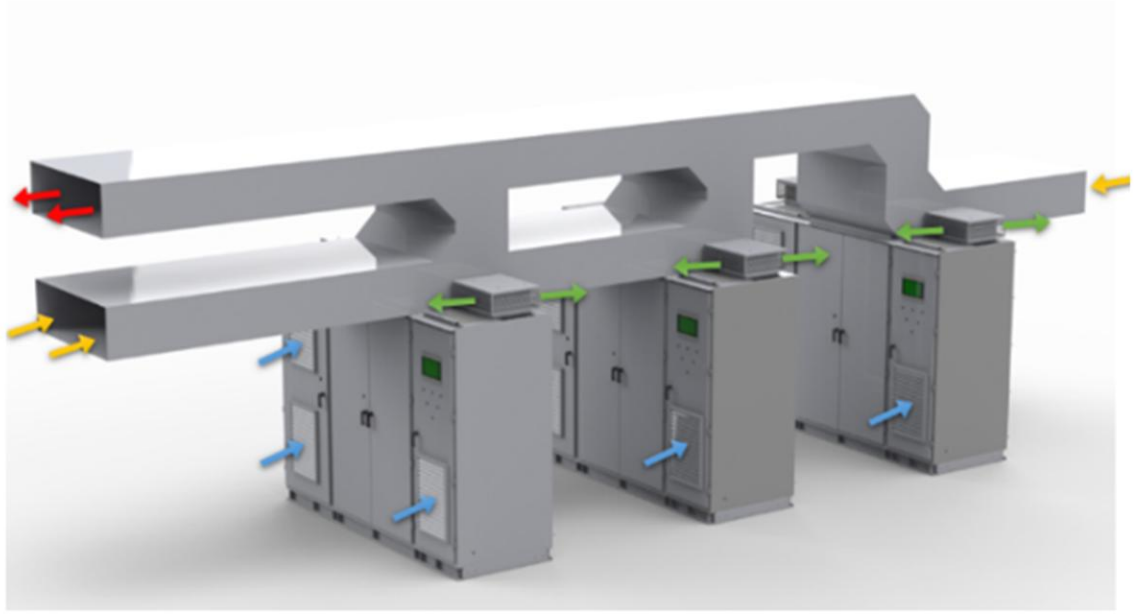
- Higher power density - Allow assembly IGBTs on both sides.
- Low maintenance.
- Power electronics section clean and sealed.
- No hotspots → Best IGBT Utilization



Applications



Applications



Applications

MVW01 EV Arc-Resistant Development

Arc-Resistant Panel Design

Louvers - Innovative Technical Solution

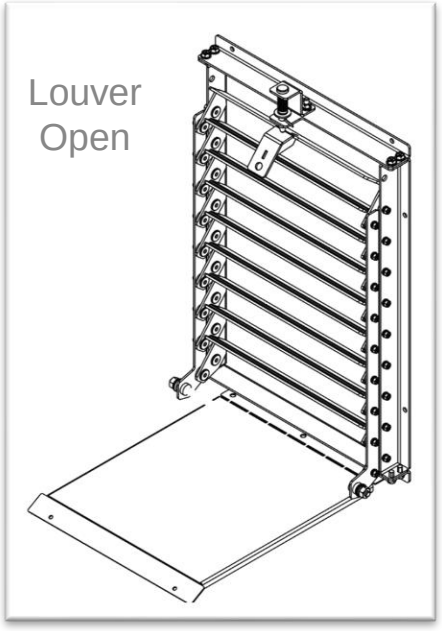
Arc-Resistant Louvers Assembly Applied to a Ventilation System of an Electrical Enclosure

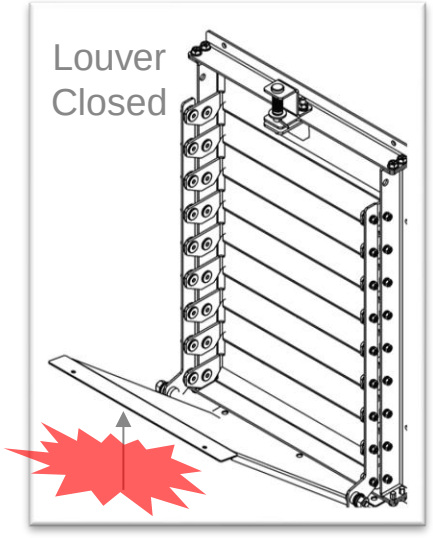
Project Requirements for MVW01 EV AR

- Use of Forced Air Ventilation.
- Use of Louvers on Inverter Doors.
- Develop a Safety Mechanical Solution to Close the Louvers in Case of an Explosion (Arc Fault).

Innovative Technical Solution Developed:

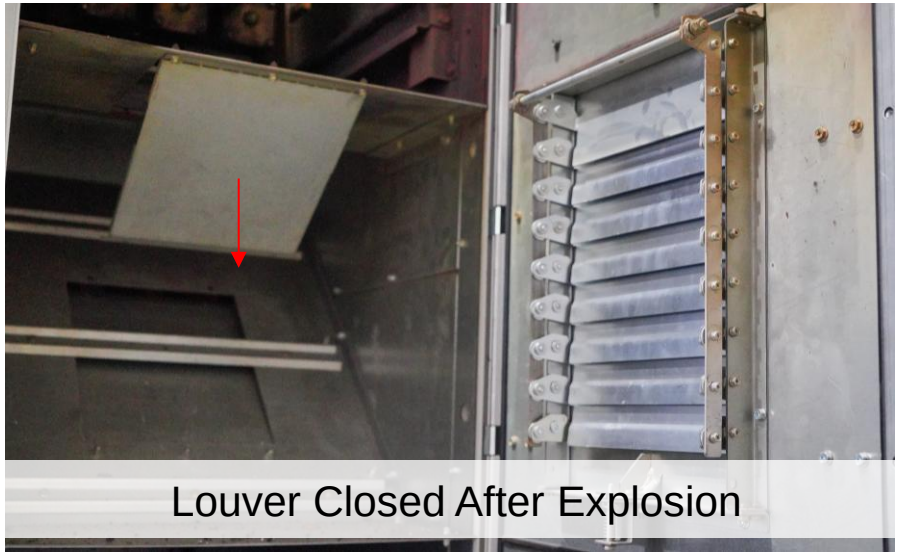
- Arc-Resistant Louvers with Automatic Closing Mechanism.





Shock Wave

Louver Open in Regular Operation



Louver Closed After Explosion

Louvers – Testing of Mockups

Mockup Testing Objectives

- **Normal Operation Validation**
  - ✓ Airflow and ventilation performance
- **Arc Event Response**
  - ✓ Automatic louver closing under shock wave
- **Gas & Particle Management**
  - ✓ Controlled and safe exhaust path

Test Conditions — Up to 20 kA / 0,5 s

- Multiple energy levels (25% → 100%)

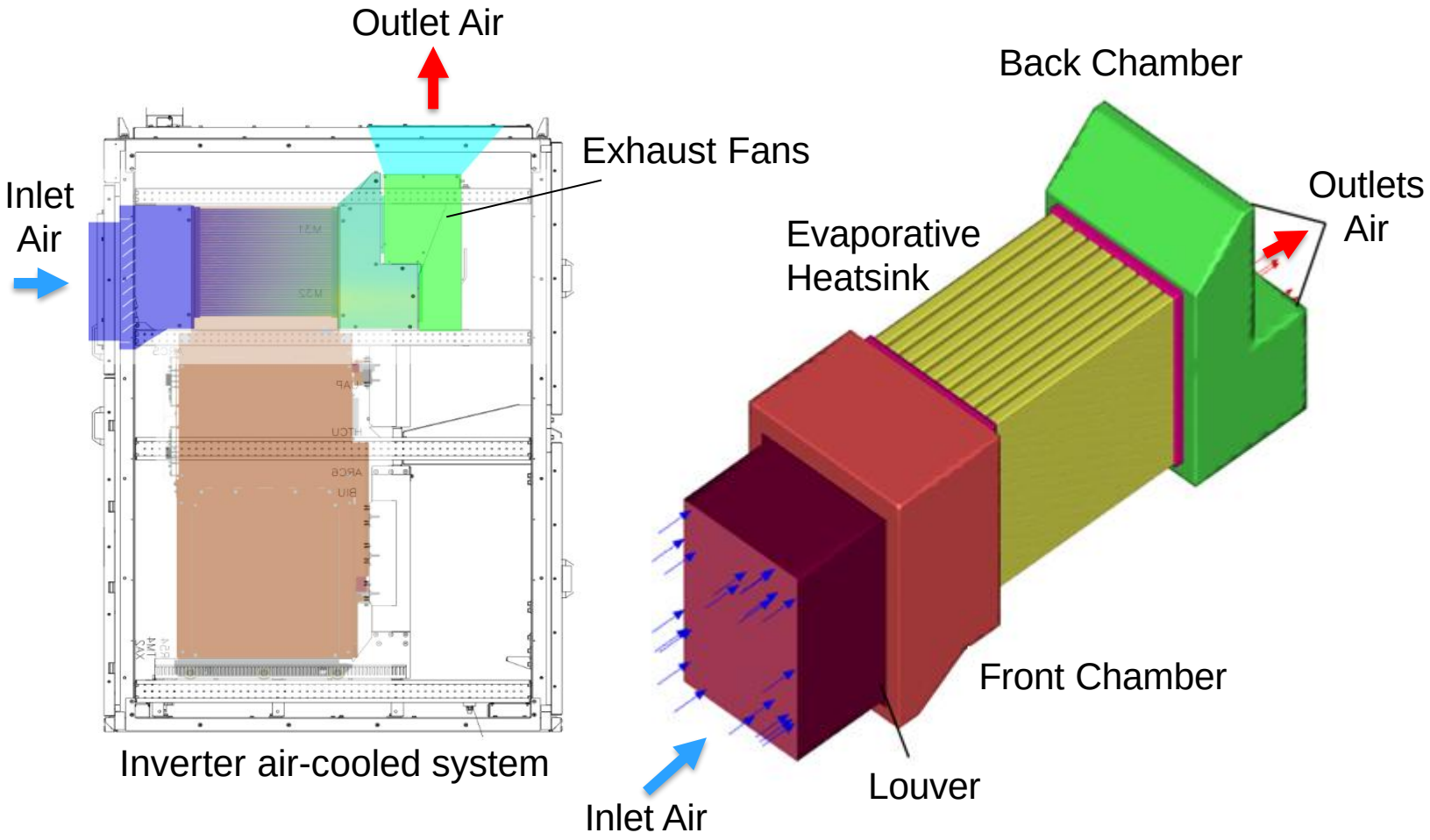
Key Outcomes

- ✓ Structural integrity maintained
- ✓ Fast and reliable louver actuation
- ✓ Safe gas redirection

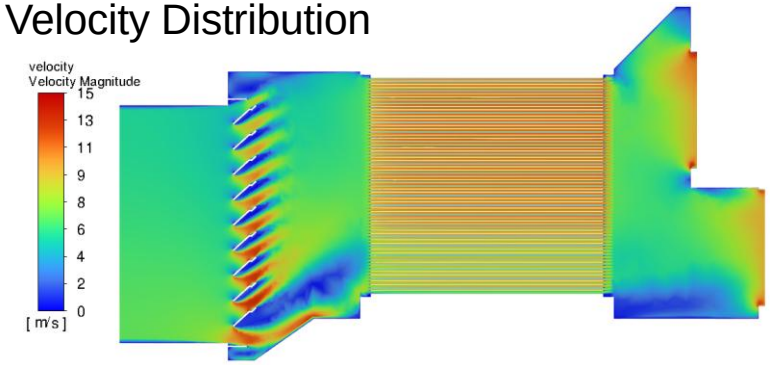
Structured stage-gate development enabled a robust, certified arc-resistant medium voltage drive platform.

Numerical Simulations

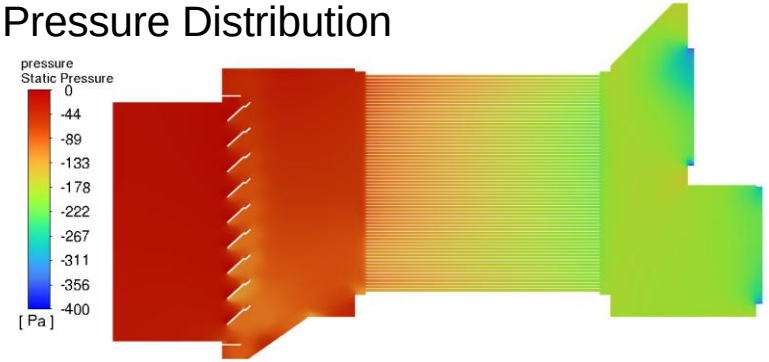
Power Arms Column Air Flow Simulation



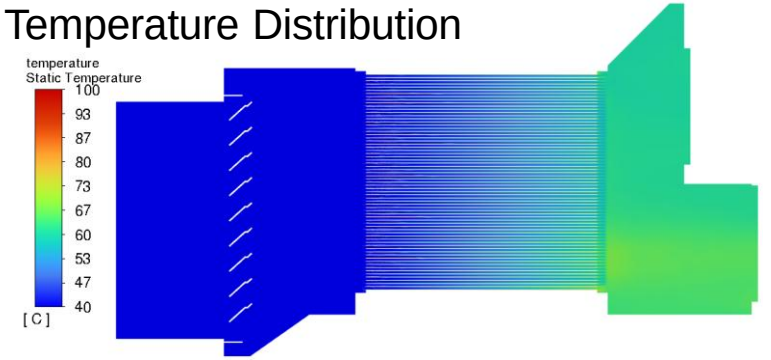
Velocity Distribution



Pressure Distribution

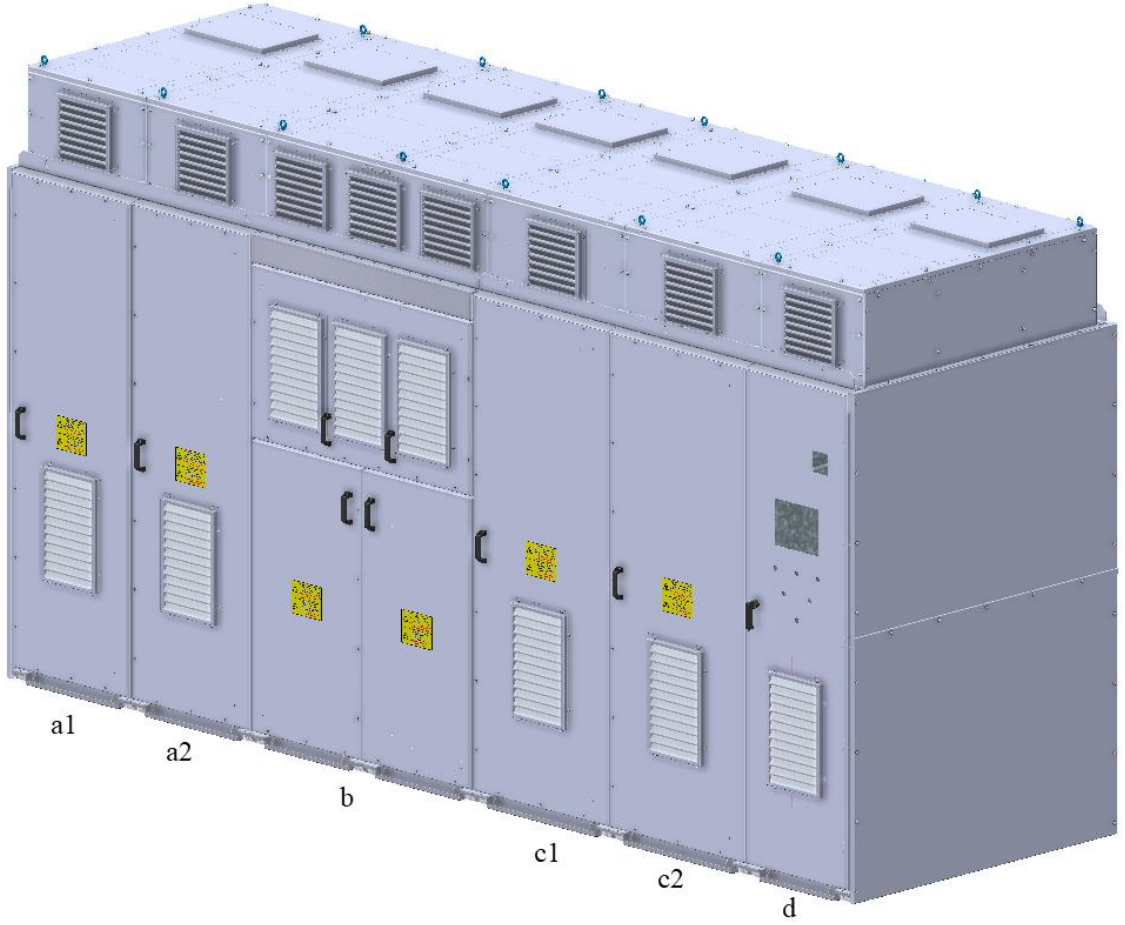


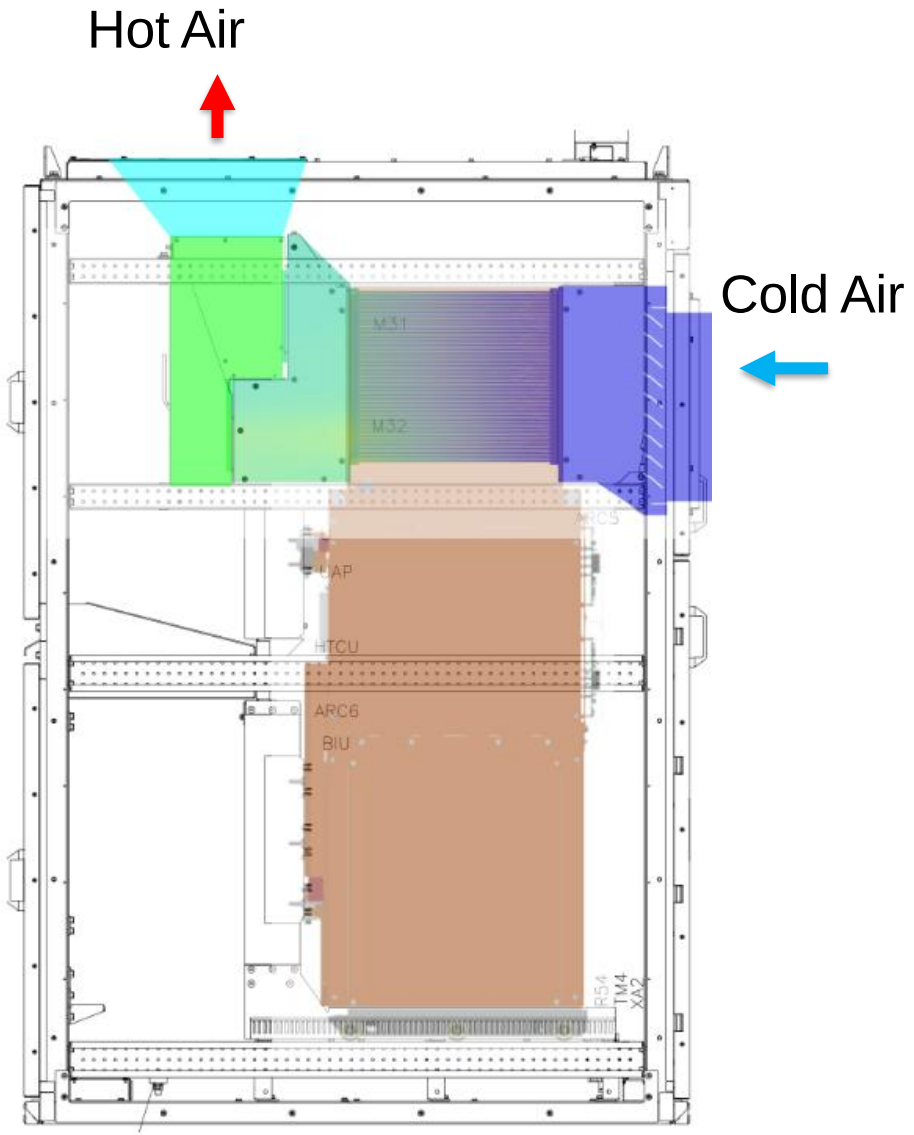
Temperature Distribution



Concept Development

Proposed Cabinet for arc-proof MV-VFD

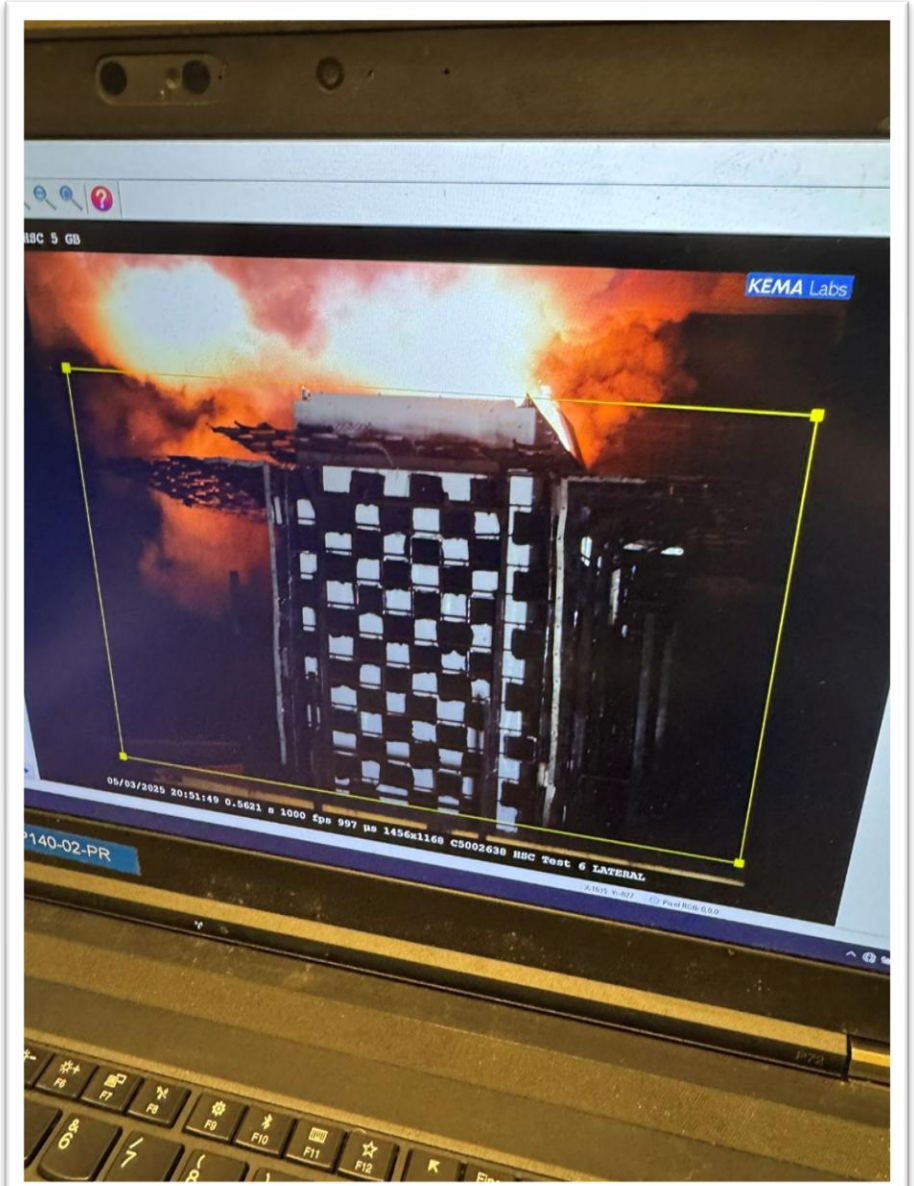




MVW01 Evaporative Arc Resistant

Arc Resistance Test – WEG Laboratory – 20kA 0.5S

Product Certification



KEMA Labs

TEST REPORT

Report No. C5013058
Revision 0

Test Object	AC three-phase metal enclosed switchgear and controlgear fitted with inverter for MV motors.
Designation	MVW01- EV AR **Serial No.** 10013782773
Ratings	6,9 kV 950 A – 20 kA x 0,5 s – 50 / 60Hz
Manufacturer	WEG Drives & Controls - Automação Ltda. Av. Prefeito Waldemar Grubba, 3000 - Vila Lalau, Jaraguá do Sul - Santa Catarina

MVW01 Evaporative Arc Resistant

Technical Characteristics MVW01 EV AR

Drive Capability

- Up to **30 MW**
- 3.3 kV – **6.9 kV**
- 0 – 120 Hz
- Protection: **IP42**
- 12–36 pulse configurations
- Air-cooled system

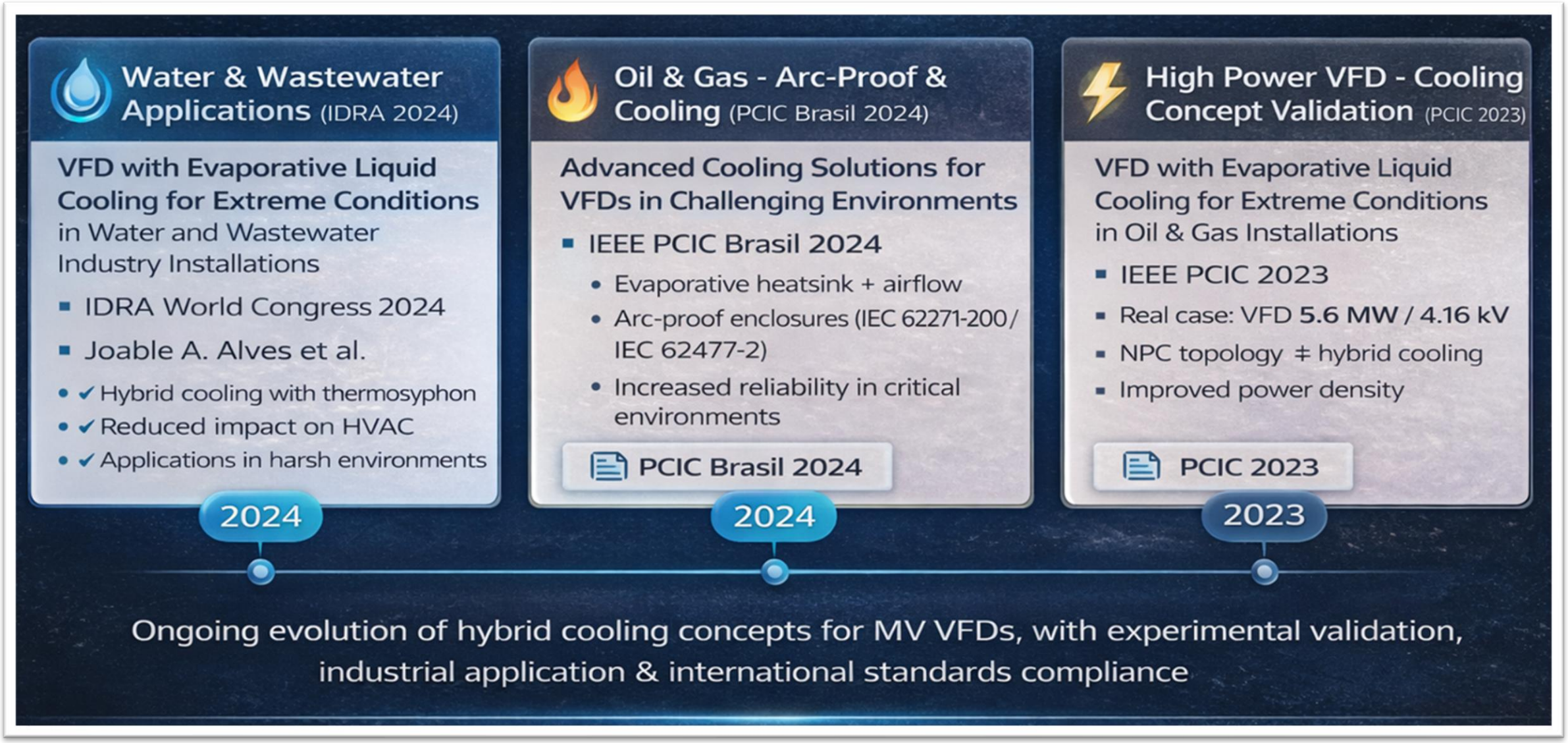
Arc-Resistant Performance

- **20 kA / 0,5 s**

IAC Classification:

- ✓ A FLR IEC 622271-200
- ✓ 2b FLR IEC 62477-2

Technical Publications



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Powering a Sustainable Future

A more INNOVATIVE tomorrow drives us today.

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Driving efficiency and sustainability

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A more INNOVATIVE tomorrow drives us today.

THANK YOU

Prof. Telles Lazzarin
SOBRAEP

Prof. Marco Liserre
PELS VP for Technical Operations

Dr. Rasha Saeed
IEEE-PELS - Technical Committees Webinar Programme

Eng. Thiago Fonseca Rech

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