TRACTION
POWER
SYSTEMS

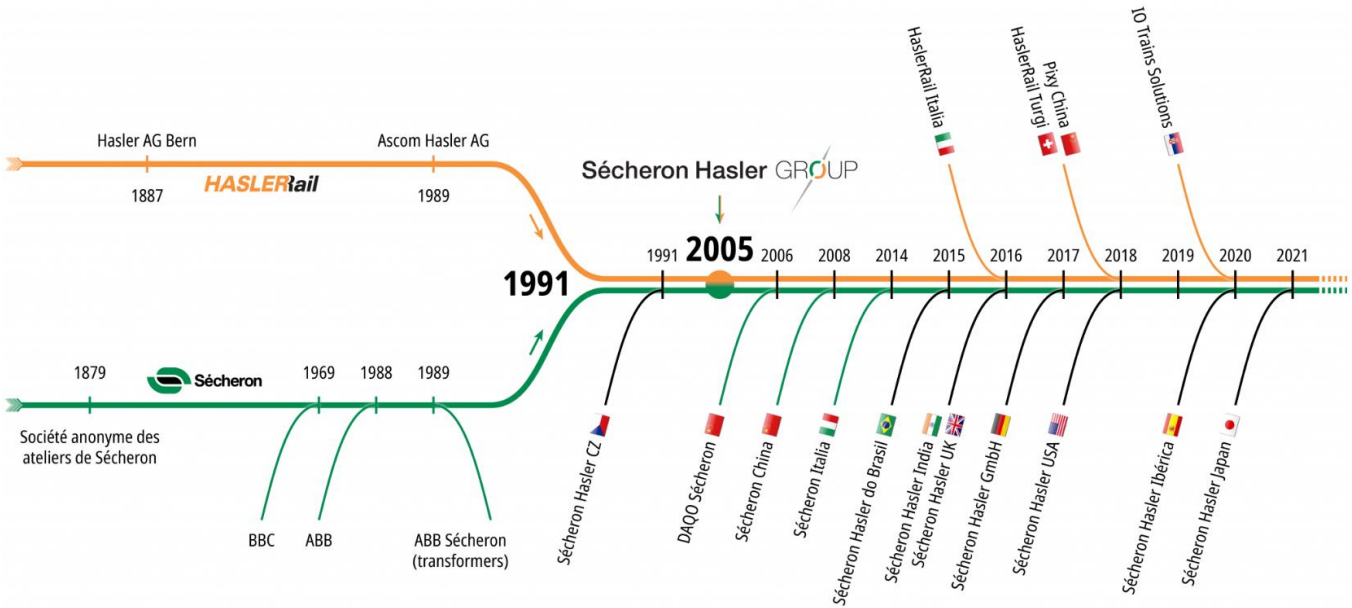
Sécheron

TECHNICAL PRESENTATION VTS

Traction Power Systems

Sécheron Hasler GROUP

HISTORY



More than
140 years
of history

KEY FIGURES

- **Private ownership**

- Sécheron Hasler Group delivers its **products and services** to all major rolling stock manufacturers, railway & mass transit operators, general contractors for fixed installations, and service partners **worldwide**.

2022

1353
FULL TIME
EMPLOYEES

SALES

254 M CHF
= 235 M € *
= 282 M US$ *

*** Exchange rates**
1 € = 0.9833 CHF
1 US$ = 0.9999 CHF

COMPANY MISSION

- Provide Highly Reliable Systems and Components to serve the Rail Transit Industry
- Worldwide Presence
- Comply with IEEE and IEC
- Dual focus at component level and systems level
- Partner with major systems integrators for Rolling Stock and Wayside R&D applications.
- Significant R&D and Quality Assurance
- TPS Systems Group provides DC Engineered Solutions to Owners, Integrators, Packagers, and Integrating Contractors.

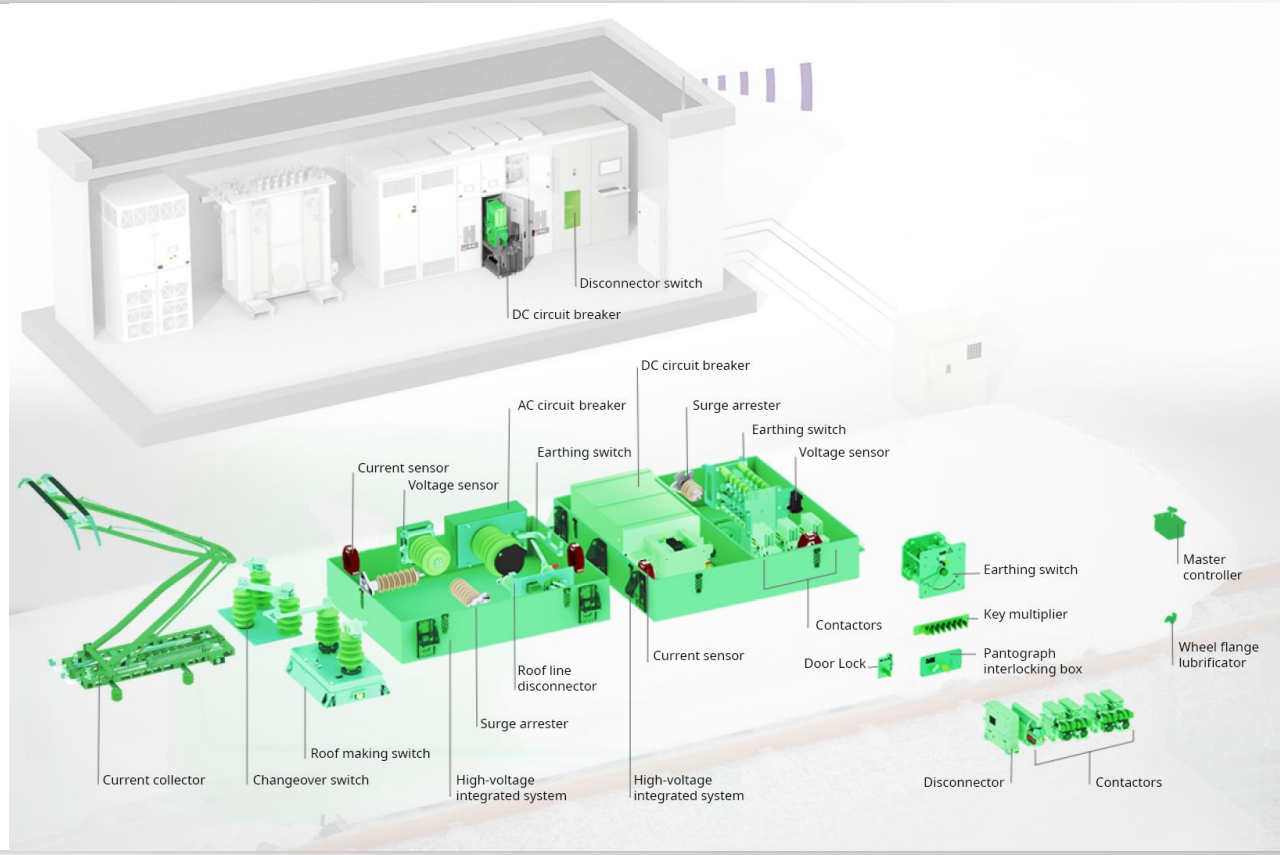
ELECTRICAL SAFETY SOLUTIONS

- DC circuit breakers
- AC circuit breakers
- AC & DC high-voltage integrated systems
- Contactors
- Disconnectors for rolling stock
- Disconnectors for fixed installation
- Earthing switches
- Traction measurement systems
- Current collectors
- Master controllers
- Wheel flange lubricators
- Engineering services

Sécheron

ELECTRICAL
SAFETY
SOLUTIONS

for Rail Vehicles &
DC Traction Power
Substations



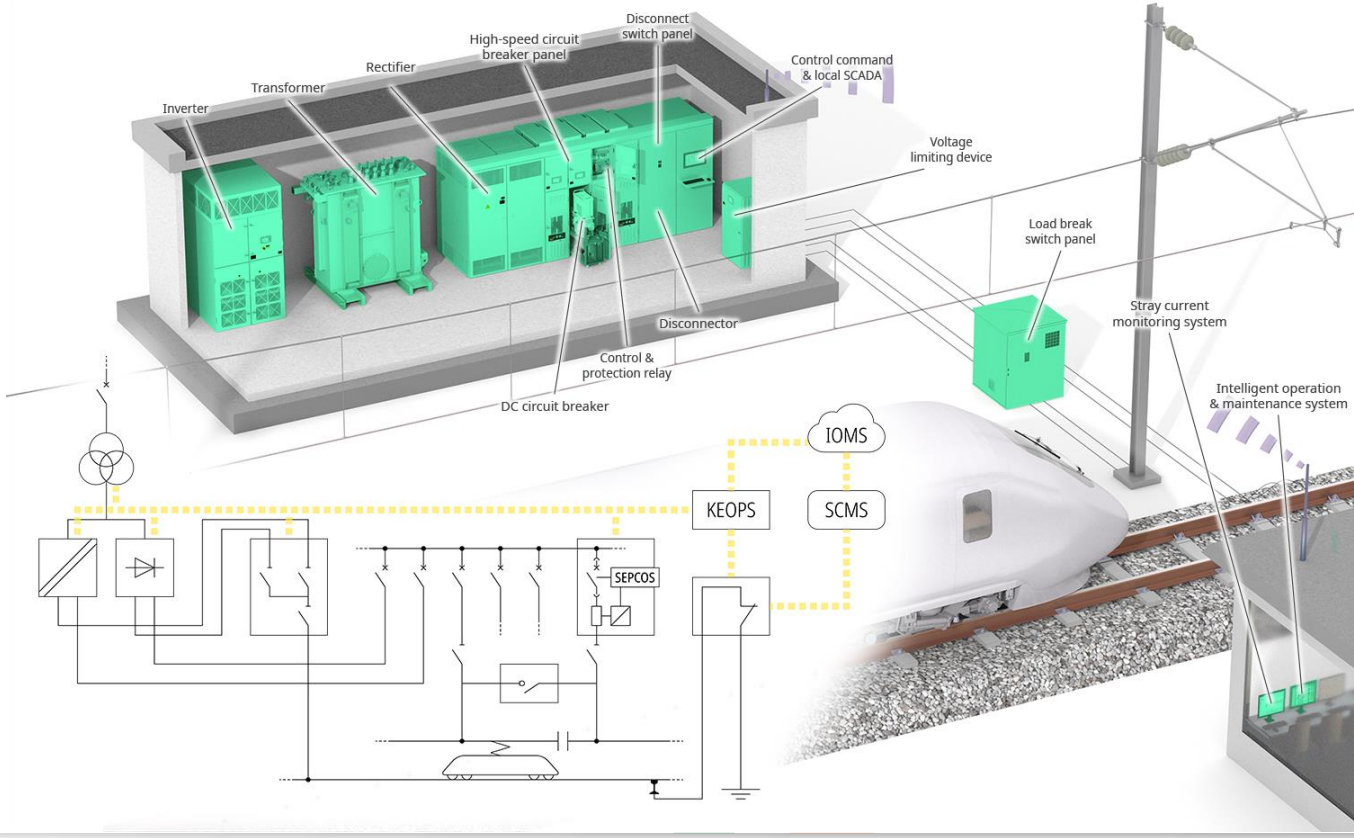
TRACTION POWER SYSTEMS

- Rectifiers
- Inverters
- Reversible controlled converters
- High-speed circuit breaker panels
- Disconnect switch panels
- Load break switch panels
- Voltage limiting devices
- Current & voltage measurement
- Outdoor railway switches
- Control & protection relays
- Control command & local SCADA
- Stray current monitoring systems
- Intelligent operation & maintenance systems
- Engineering services

Sécheron

TRACTION
POWER
SYSTEMS

for Rail Transportation – Electrification



WORLDWIDE PRESENCE

Close to you
in more than
40 countries worldwide

TRACTION POWER SYSTEMS

TRACTION POWER SYSTEMS

PROJECTS OVERVIEW WITH TECHNOLOGY HIGHLIGHTS

SINGAPORE: REVERSIBLE CONTROLLED CONVERTER

- Technical Objective: DC Voltage controlled over complete line
- Technology: Double or reversible converter composed by a thyristor rectifier and an IGBT inverter
- Standard: IEC 62497, IEC 60146-1, IEC 60146-1, IEC 62590
- Approach: Completely independent inversion and rectification functions.
- Quantity: 14 Units
- Supplier Challenge: Client provided high standard of performance and very specific design requirements.
- Designer of Record: Specified by LTA, Designed & Manufactured by Sécheron

DOHA, QUATAR: THYRISTOR BASED INVERTER

- Technical Objective: Heat avoidance in tunnel application with no breaking resistors.
- Technology: High power high overload thyristor inverter (2 MW with 500 % overload @ 750 V)
- Standard: IEC 62497, IEC 60146-1 , IEC 62590
- Approach: Transfer breaking energy into the systems to avert breaking heating load in tunnel.
- Quantity: 54 Units
- Supplier Challenge: High power design with natural air cooling as per customer specification.
- Designer of Record: Specified by MHI, Designed & Manufactured by Sécheron

CADIZ, SPAIN: IGBT BASED INVERTER

- Technical Objective: Optimize energy recovery on existing tram line
- Technology: IGBT inverter
- Standard: IEC 62497, IEC 60146-2 , IEC 62590
- Approach: Prioritize efficient energy recovery with good power quality and unity power factor

- Quantity:2
- Supplier Challenge: Limited space in traction substation, optimization of size and re-use of existing rectifier MV-CB, Installation and commissioning done in an existing line in service
- Designer of Record: Specified by Local Authority (Junta de Andalucía), Designed & Manufactured by Sécheron

PHOENIX, USA: THYRISTOR CONTROLLED RECTIFIER

- Technical Objective: Control of voltage in the DC contact line under heavy overload conditions
- Technology: Thyristor rectifier
- Standard: IEEE 1653.2, IEEE 519
- Approach: Prioritize overload capacity and system reliability

- Quantity:7
- Supplier Challenge: Complex specification with high overload, stringent reactive power requirements, 6 pulse operation, high short circuit withstand

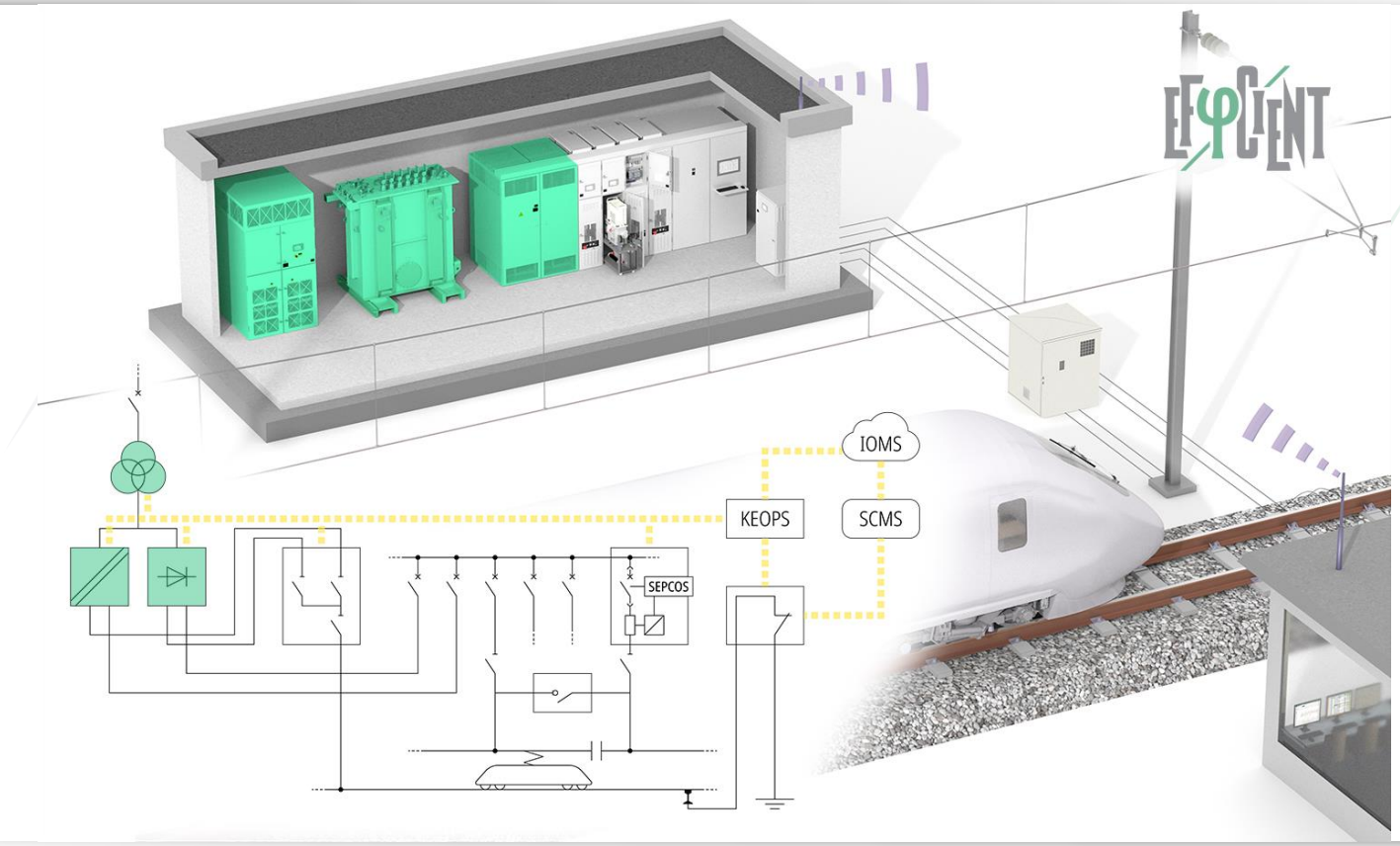
- Designer of Record: Specified by VMR, Designed & Manufactured by Sécheron

BANGALORE, INDIA: IOMS
(INTELLIGENT OPERATION & MAINTENANCE SYSTEMS)

- Secheron delivered equipment for 2 metro lines, 1 more line will be delivered in 2024 for a total of 62 substations
- Secheron responsible for the maintenance of delivered equipment:
  - In January 2022, 5-year contract sign for 29 TPSS
  - Q2 2024, 33 TPSS will be added to the contract (Phase 2)
  - Contract between Secheron Hasler India (SHIN) and Metro of Bangalore (BMRCL) directly
- Sécheron's scope is Design, Build and Maintain including deployment of IOMS
- IOMS provided services, functions:
  - Asset and Maintenance Management System
  - Execute Operations to a reliability and up time performance metric
  - Manage daily operations, scheduling , ordering, etc.
  - Mobile app available (and used in India by owner's operators and Secheron team)
- Bangalore is the main reference of Indian heavy metro systems. IOMS was successfully implemented.

PRODUCTS & SOLUTIONS

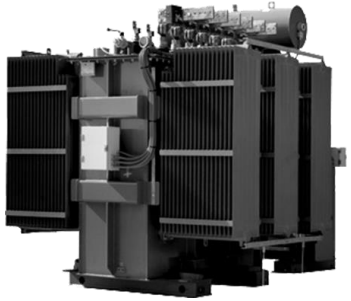
POWER CONVERSION



- **Harmonization** with **traction-rectifier performance**
- Complete **transformer-rectifier groups** on request

- **Cast resin dry** type transformers

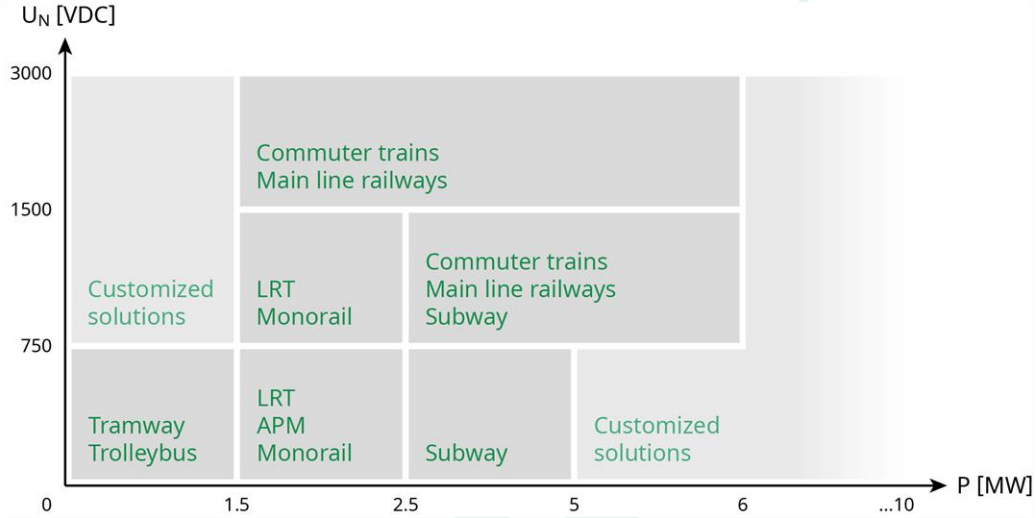
- **Oil immersed** type transformers



- **In-line tests in laboratory**
  - Open-circuit tests
  - Load test
    - Current sharing
    - Voltage and load regulation
    - Temperature rise
  - Measurement of harmonics
  - Measurement of losses and calculation of efficiency factor
  - Short-circuit test

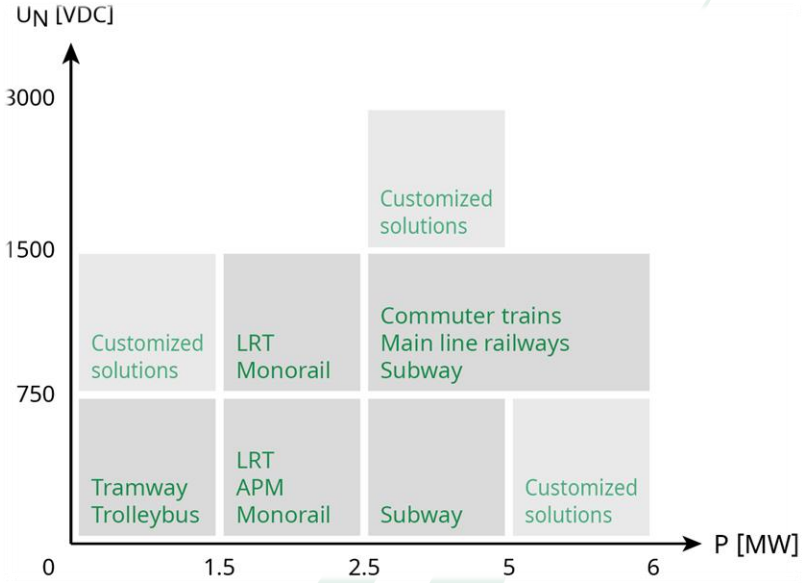
REC-D DIODE RECTIFIERS

- **Ideally sized** and **proven semi-conductors** offering **high performances** and **reliability**
- **Components** are **fully interchangeable**



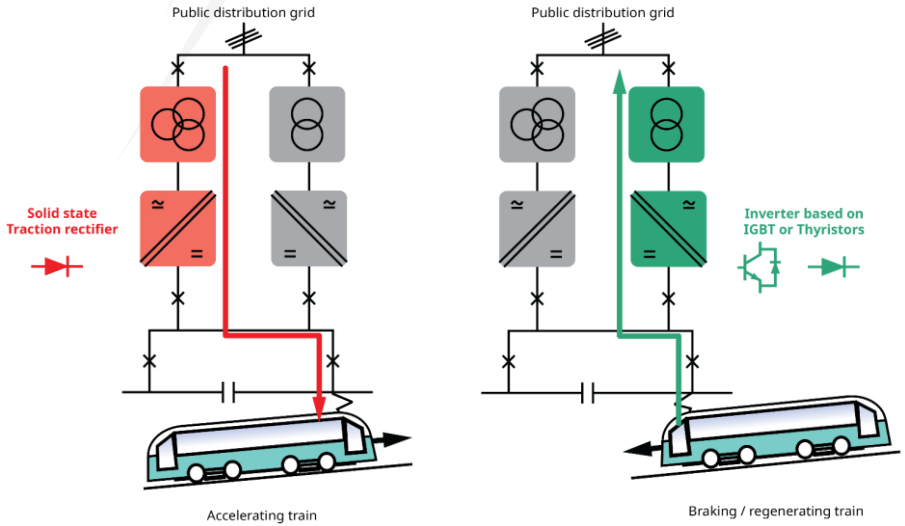
REC-T THYRISTOR CONTROLLED RECTIFIERS

- **Regulation** of the **voltage** of the line in order to compensate voltage drops
- **Optimization** of the operation in case of **double converter**



INV ENERGY RECOVERY SYSTEMS

- Inverter is designed to regenerate the braking energy to the distribution network. Saving up to 20% of the traction energy consumption.
- All voltages, up to 6MW

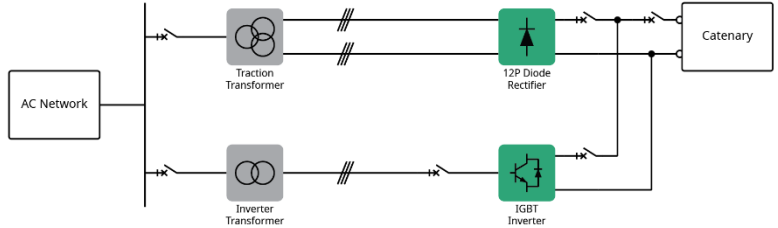


- Green energy for environmental care
- Renewable energy = savings

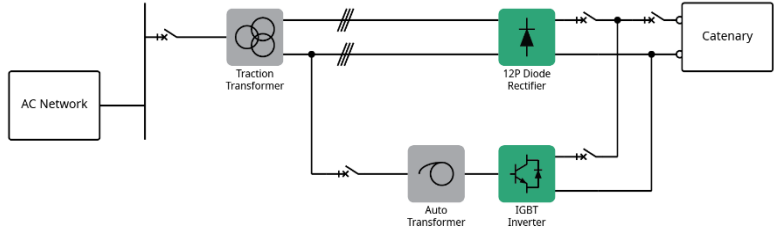
INV-I IGBT INVERTERS

- Designed to **regenerate** the braking energy to the distribution network
- Saving up to **20%** of the **traction energy consumption**

- With dedicated transformer



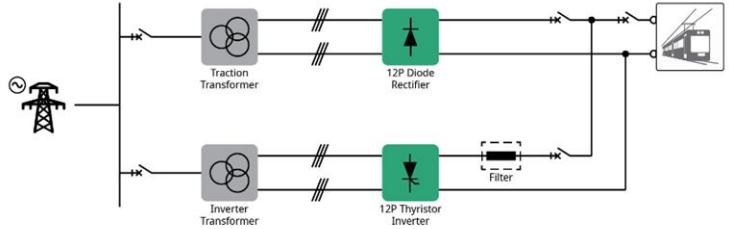
- With autotransformer



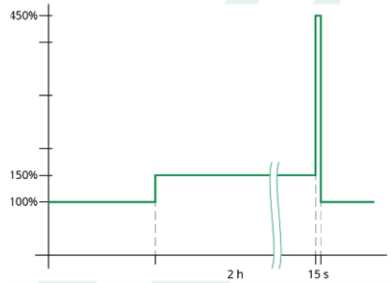
INV-T THYRISTOR INVERTERS

- **Compact** and **robust design** with long MTBF using **presspack thyristor**
- **Cost efficient** at **high power**

- Circuit in parallel

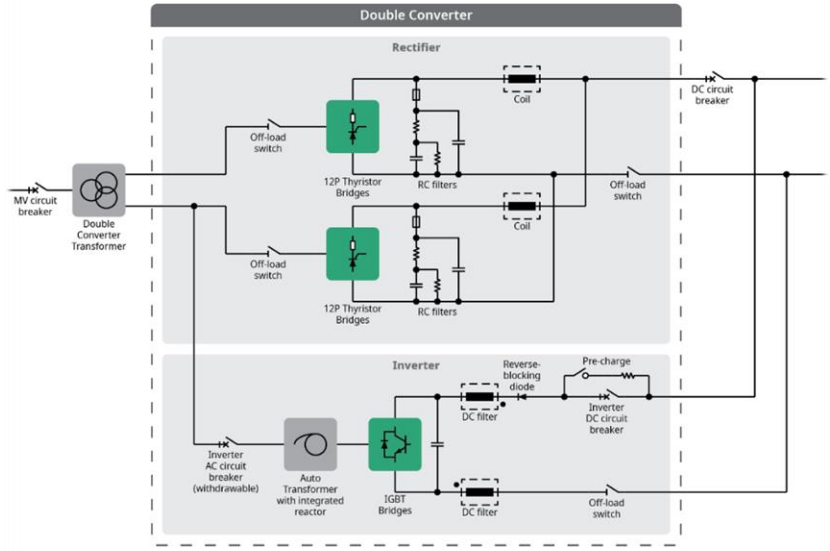


- Up to overload cycle class VII



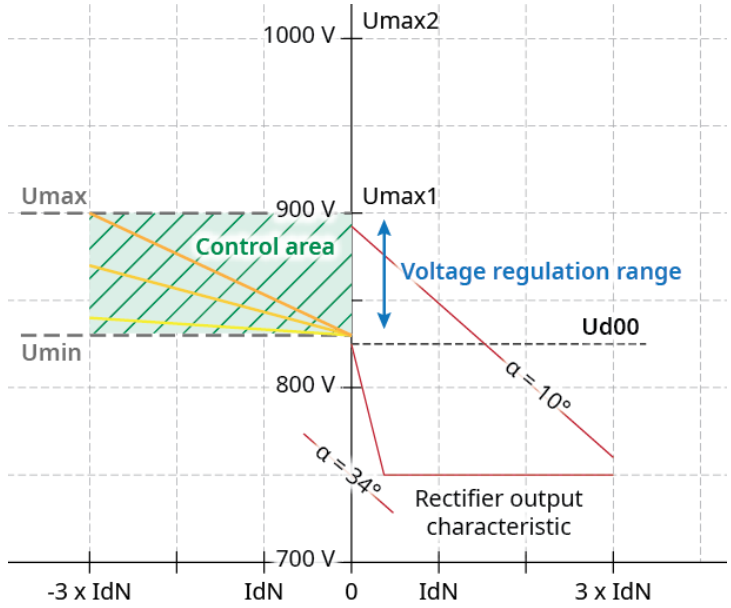
REV REVERSIBLE CONTROLLED CONVERTERS

- **System design** and **protection coordination** with **Sécheron switchgear** to enhance reliability
- **Modular design**, designed for **easy maintenance**



REV CHARACTERISTICS

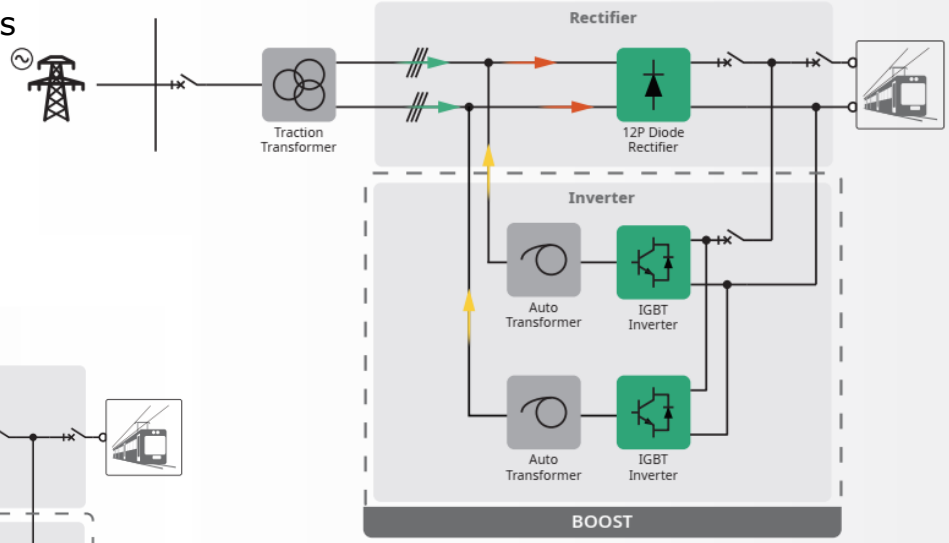
- General characteristics of Reversible Controller Converter Unit



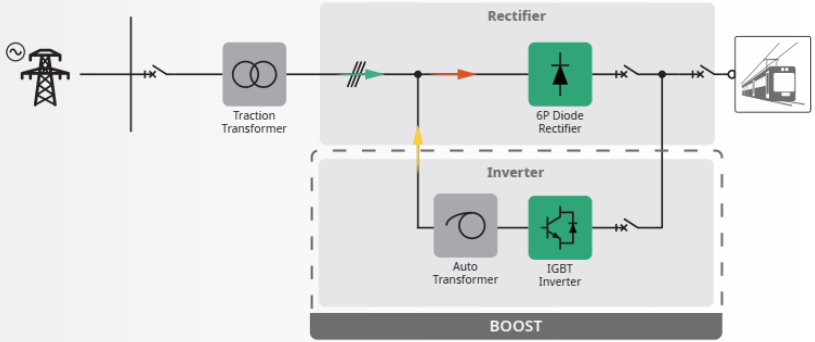
BOOST DIODE RECTIFIER AND IGBT INVERTER

- Sécheron BOOST solution is a reversible system combining reliable diode rectifiers and IGBT inverter
- Complete control over the traction power substations
- Enhanced power factor
- Decreased harmonics
- Reduced transformer power

12-pulse

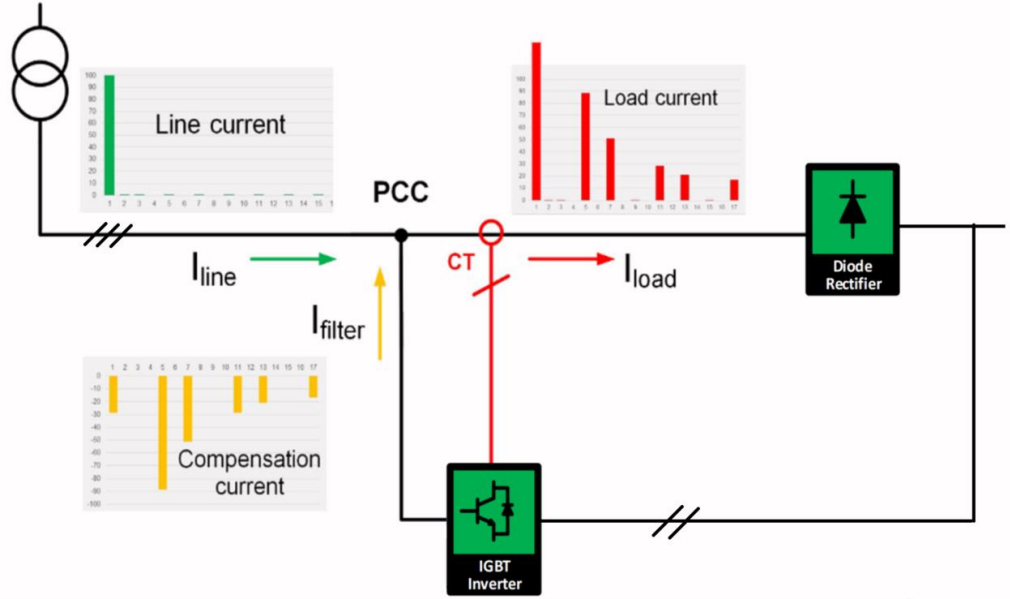


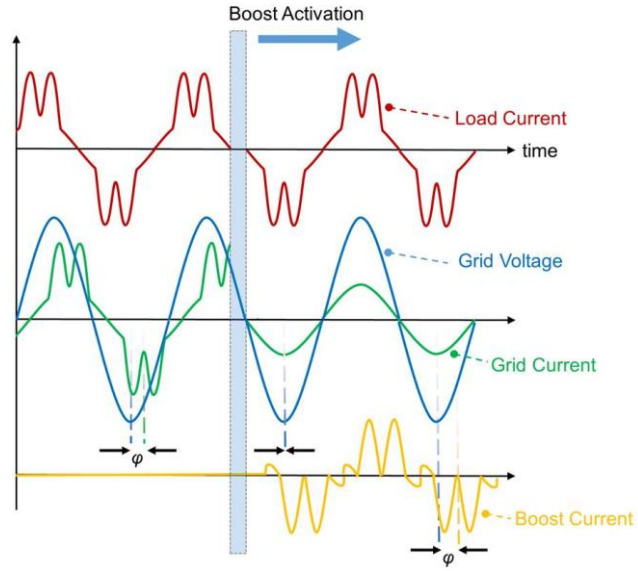
6-pulse



BOOST DIODE RECTIFIER AND IGBT INVERTER

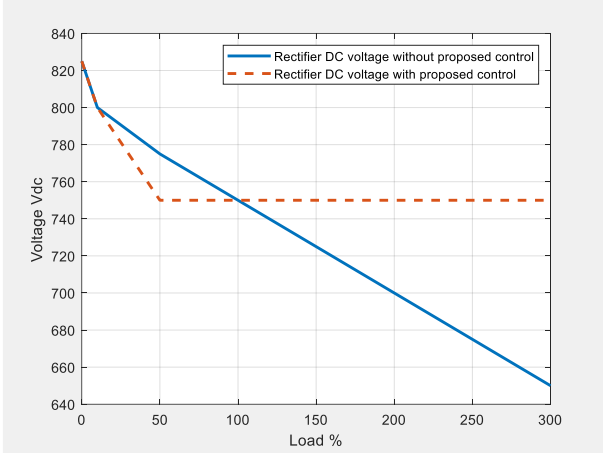
- The BOOST converter injects reactive power to compensate the reactive power naturally absorbed by the diode rectifier-transformer group, thereby reducing the line current.





BOOST DIODE RECTIFIER AND IGBT INVERTER

- By adjusting the reactive power injected on the AC side, it is possible to regulate the rectifier characteristic and thus obtain an ideal "flat" behaviour on the DC side
- This is achieved by compensating not only for the inductive voltage drop of the transformer, but also for the voltage drop caused by the rectifier diodes
- Meanwhile, the energy recovery function is also maintained, the system automatically transitions from recovery mode to BOOST mode without any maneuver or change to the circuit
- The required inverter to rectifier power ratio is approximately of 1 to 3, which is typical for energy recovery systems
- Note that for this to work in a TPSS with multiple rectifiers, the REV-BOOST system must be installed in all the rectifiers so that they maintain load sharing

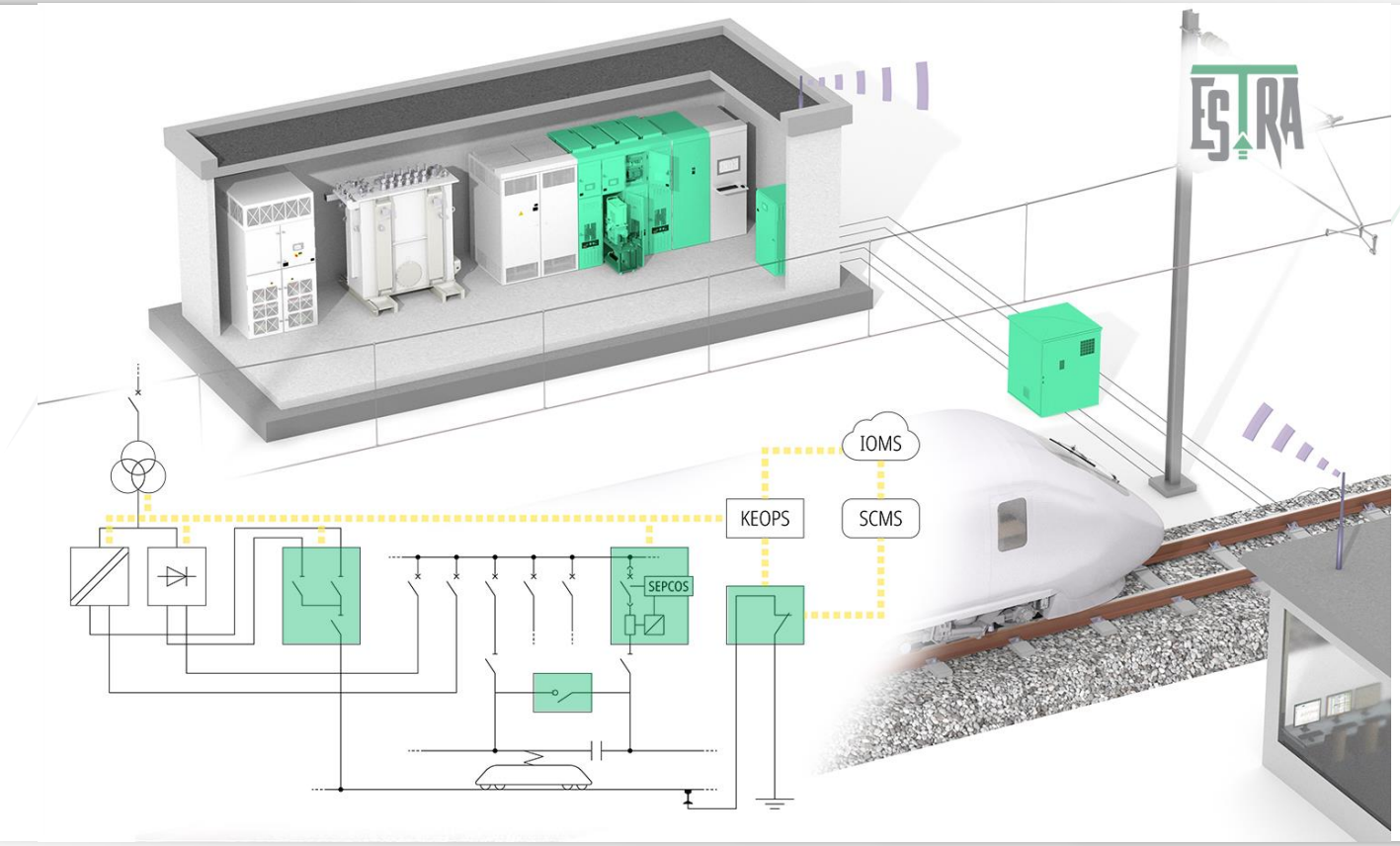


Example for 750 Vdc rectifier sytem

MAIN BENEFITS

- Energy recovery
- Voltage control, loss reduction in the DC line and increased train speed
- Independent rectifier and inverter modes
- Possible installation in existing traction power substations as an upgrade
- Increase of distance between traction power substations
- Improved power factor in medium voltage network
- Reduction of transformer power
- Reduction of no-load voltage in the DC line
- Based on well-known technologies

DC SWITCHGEAR & DISTRIBUTION BOARD

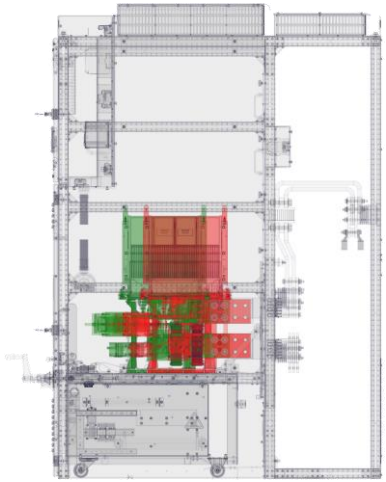


MBS–Heavy Duty

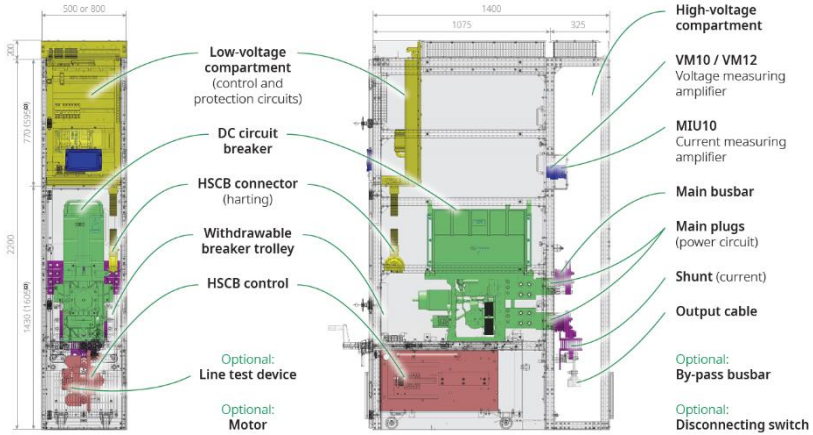
- MBS Panel

- MBS Trolley

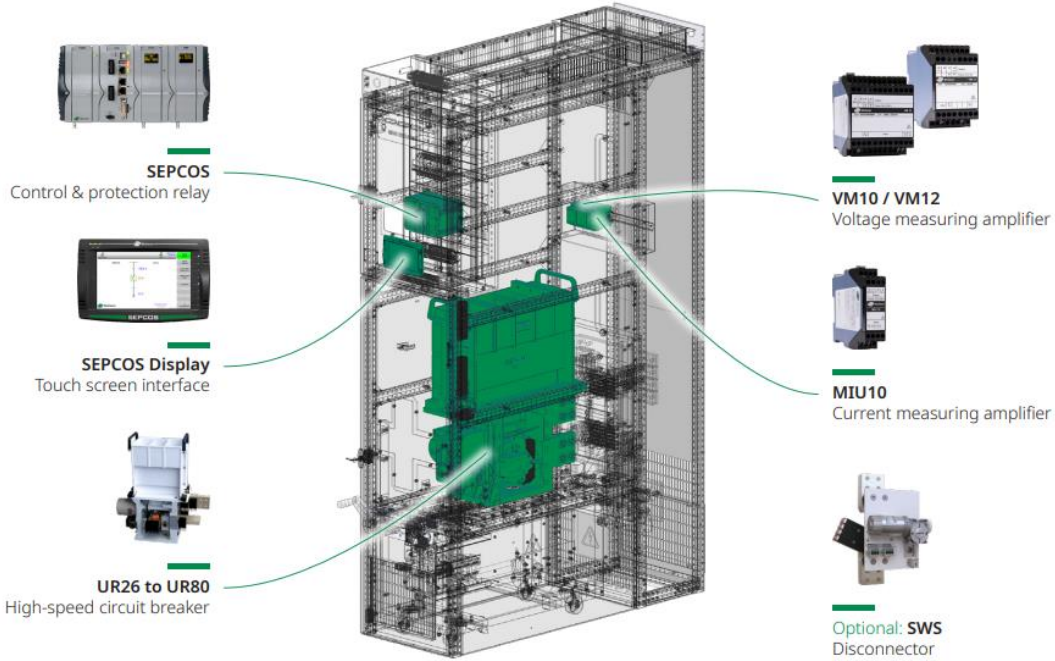
- Service & test positions



- Development based on **Sécheron's experience** of tractions systems and **customer needs**



Composition

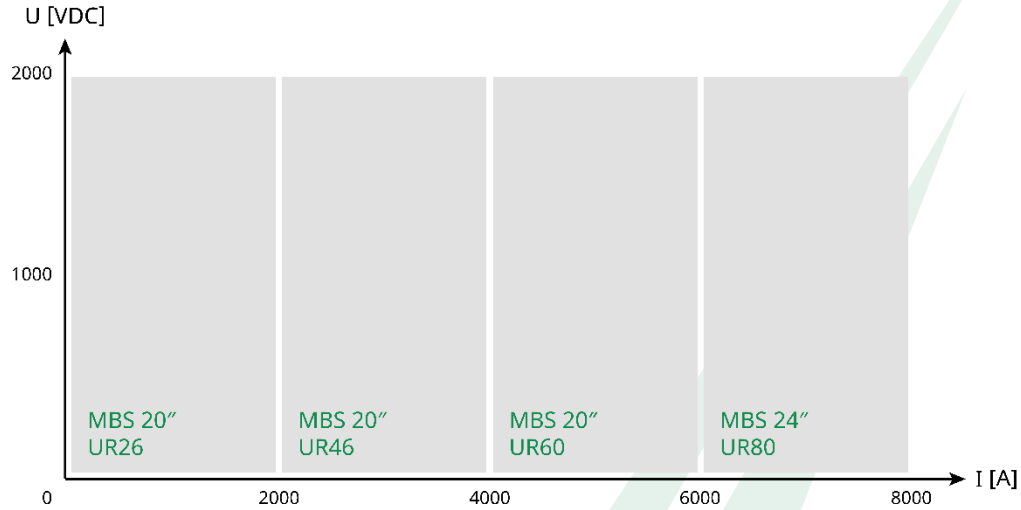


- **Key components** of the switchgear are **Sécheron's own products**

MBS HIGH-SPEED CIRCUIT BREAKER PANELS

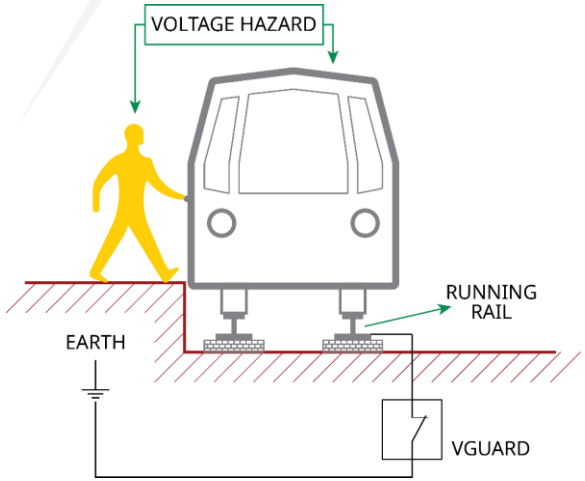
- **MBS–HD**

- **Heavy Duty** performances
- Fully type tested according to **IEEE Std. C37.20.1-2015** and **C37.14-2015**
- Meet all applicable **Buy America Act** requirements



VGUARD VOLTAGE LIMITING DEVICES

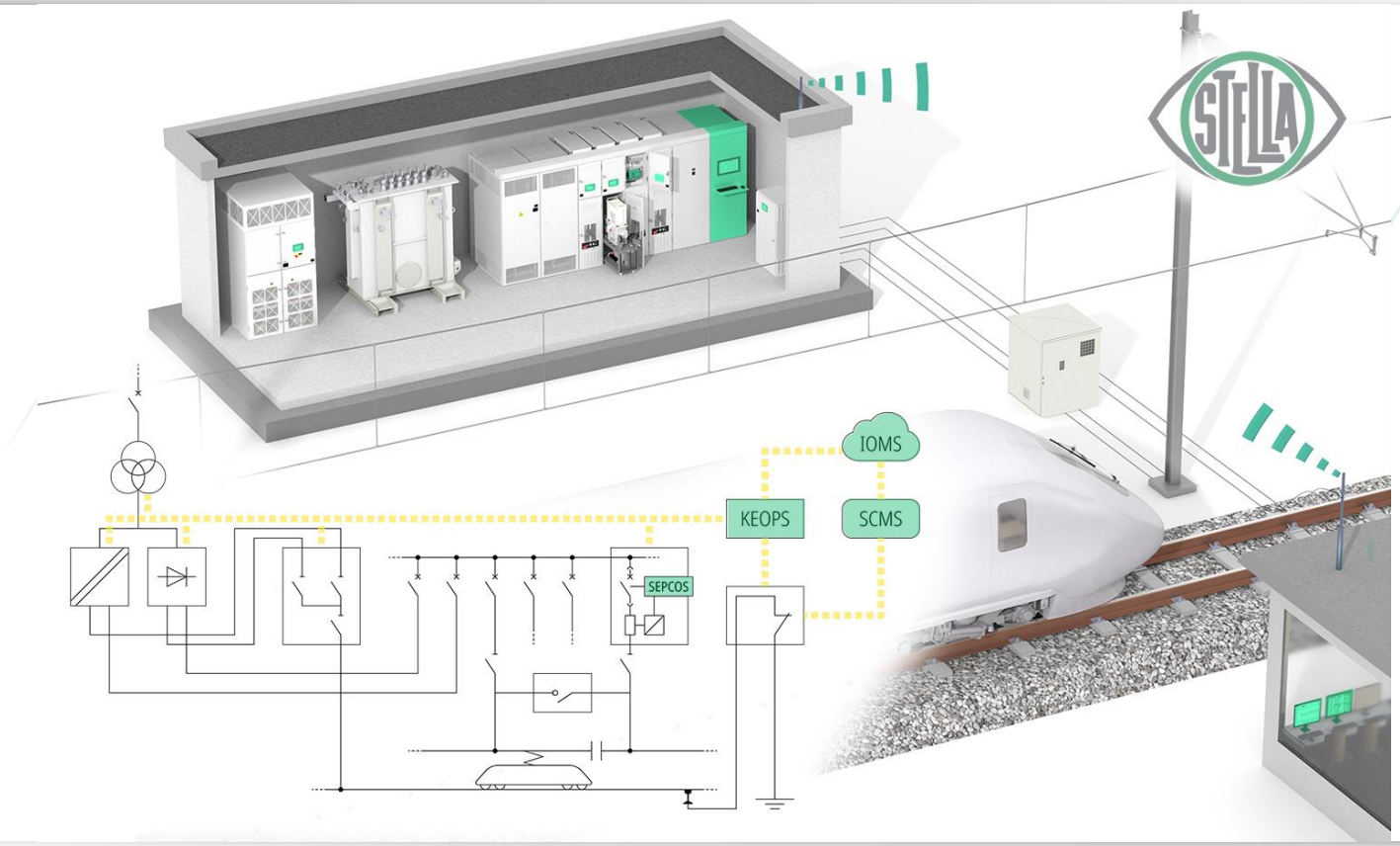
- Ensuring **protection** of person according to **voltage limits** defined in **EN 50122-1**
- **Negative-earth protection** and **monitoring** for systems up to **3.6 kV**



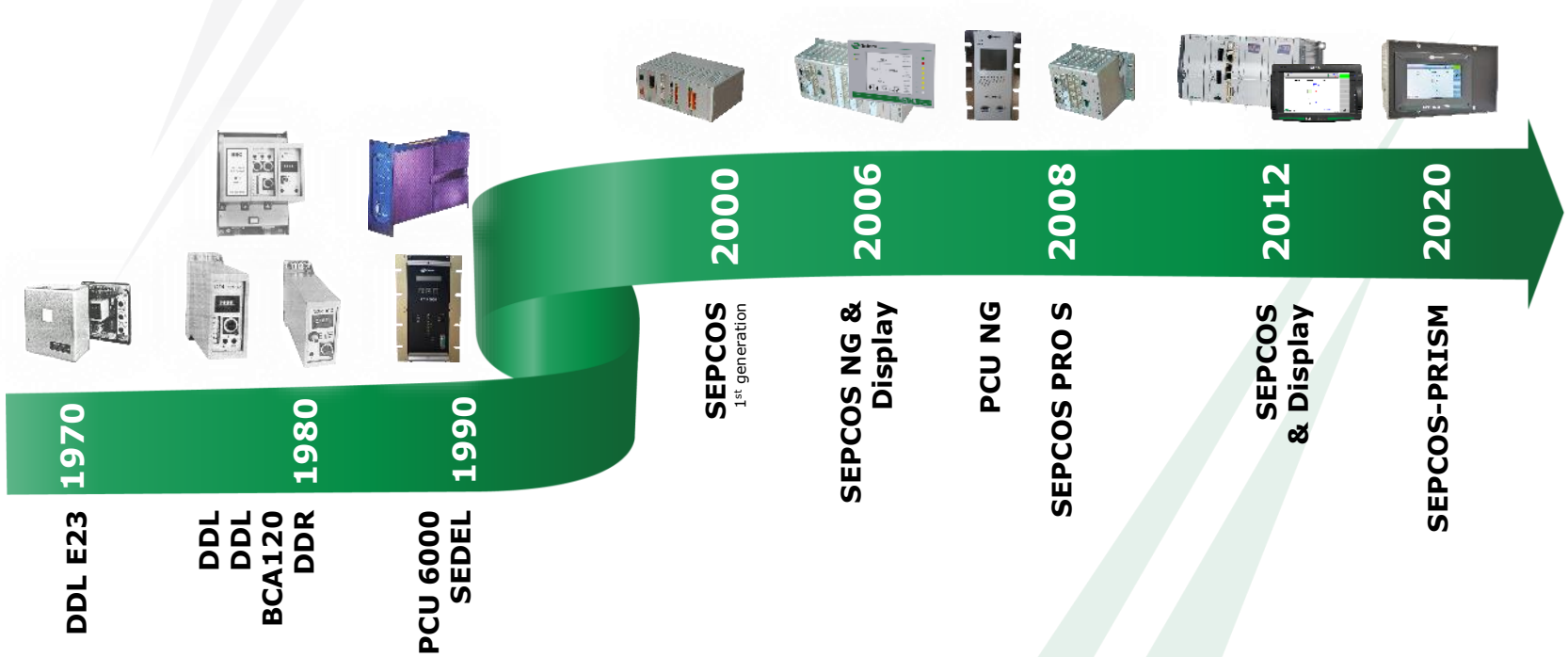
- **IP42 variant**

- **IP55 variant**

PROTECTION & SUPERVISION



50 years of experience in control & protection relays



SEPCOS DC CONTROL & PROTECTION RELAYS

- **High-tech** equipment that satisfies the most demanding **safety requirements** applicable to **DC electrical power systems**
- A **powerful electronic system** based on **several microprocessors**

SEPCOS DC CONTROL & PROTECTION RELAYS

- **Modular** product according to each project needs

- **SEPCOS BASIC**

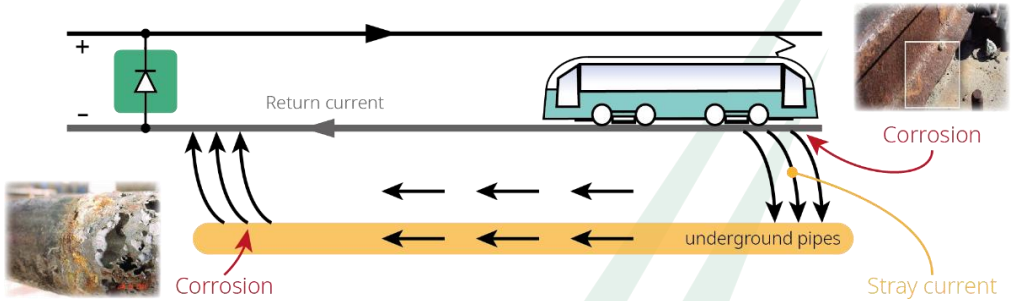
- **SEPCOS COMPACT**

- **SEPCOS PLC**

- **SEPCOS GATEWAY**

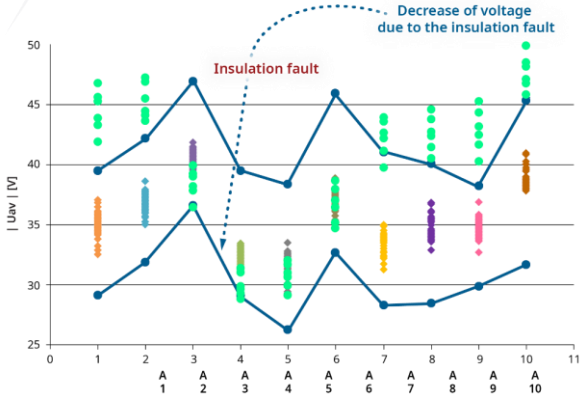
SCMS STRAY CURRENT MONITORING SYSTEMS

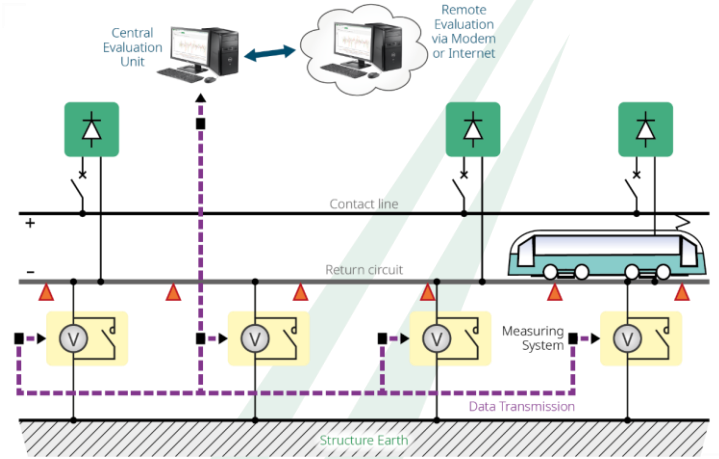
- **Monitoring** of **stray currents** based on **rail potentials measurements**
- Designed to **limit corrosion** of **metallic structure**
- Recommended according to **EN50122-2:2011** standard



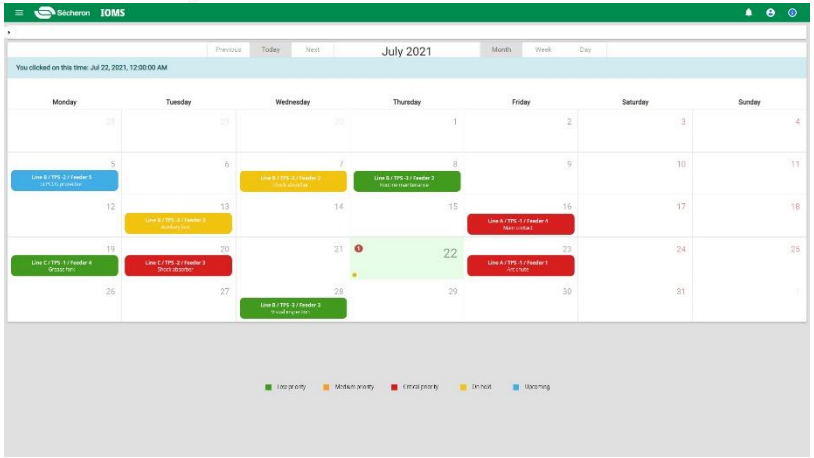
SCMS STRAY CURRENT MONITORING SYSTEMS

- **Collect** of **potential** between return rail and earth via **VLD**'s located all along the track
- **Transmission** of **collected data** from the **SCD** to the **central unit** via communication
- The **central unit archives**, **analyses** and **depicts** the **potential** of the tracks via an executable **HMI** interface





- **Decrease** physical **human service intervention** inside a **traction power substation energized environment**
- **Expand** traction power substation **life time**
- Run on **cloud based server** or in a local PC under the customer premises

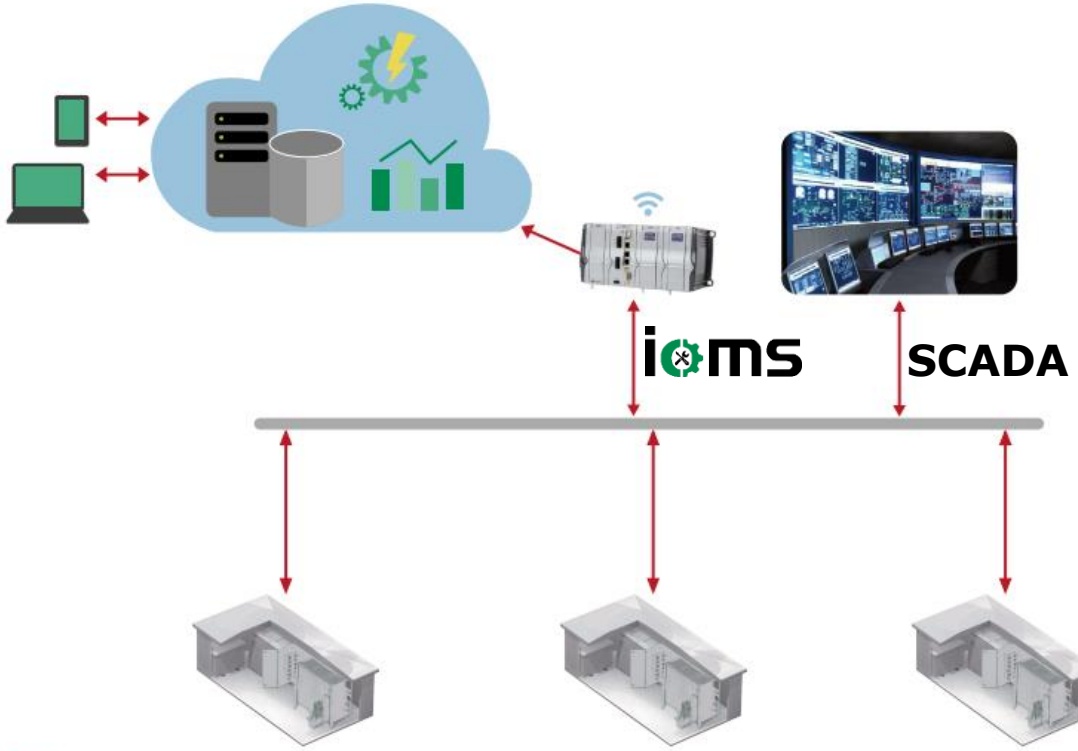


Line	Substation	Cubicle	Equipment	Maintenance action	Status	Foreseen at	Progress
- Geneve-Lausane	Geneve	Feeder3	HSCB	Fork A	15000/25000 cycles	01.01.2022	
	+ Geneve	Feeder3	HSCB	Fork	15000/25000 cycles	01.01.2022	
	- Nyon	Feeder1	HSCB	Main contact wearing	25%	01.01.2022	
		- Feeder1	HSCB	Main contact wearing	25%	01.01.2022	
			- HSCB	Main contact wearing	25%	01.01.2022	
				Main contact wearing	25%	01.01.2022	
				Arc shute wearing	35% C	01.09.2021	
				Fork B	15000/25000 cycles	01.01.2022	
				Spring	15000/50000 cycles	01.01.2022	
				Shock absorber	15000/50000 cycles	01.01.2022	
				Closing device	15000/150000 cycles	01.01.2022	
				Direct over-current instantaneous release	5000/10000 trips	01.01.2022	
				Indirect release	7500/1000 trips	01.01.2022	
				Basic inspection	200/365 days	01.01.2022	
					200/730 days		
				Detailed inspection	15/250 trips	01.01.2022	
					80/500 cycles		
			- DSF (disconnector switch)	Complete inspection	26/1095 days	01.01.2022	
				Routine inspection	26/182 days	01.01.2022	
				Complete inspection	825/1095 days	01.01.2022	
			+ SEPCOS	Visual Inspection	305/1095 days	01.01.2022	
		+ Feeder2	HSCB	Arc shute wearing	60%	01.01.2022	
		- Feeder3	HSCB	Main contact wearing	86%	01.01.2022	
			HSCB	Shock absorber	15000/25000 cycles	01.01.2022	
				Main contact wearing	25%	01.01.2022	
				Arc shute wearing	35%	01.09.2021	
				Fork	15000/25000 cycles	01.01.2022	
				Spring	15000/25000 cycles	01.01.2022	
				Shock absorber	15000/25000 cycles	01.01.2022	
				Closing device	15000/25000 cycles	01.01.2022	
				Direct over-current instantaneous release	5000/10000 trips	01.01.2022	
				Indirect release	7500/1000 trips	01.01.2022	
				Basic inspection	200/365 days	01.01.2022	
					200/730 days		
				Detailed inspection	15/250 trips	01.01.2022	
					80/500 cycles		
+ Berne - Zurich	Bern	Feeder2	HSCB	Fork	15000/25000 cycles	01.01.2022	

IOMS SOFTWARE FEATURES

- Predict maintenance time frame
- Geo-localize potential faults
- Produce complete & detailed incident reports
- Statistical fault analysis
- Customizable dashboard (alarms, power consumption…)
- Easy and Automatic scheduling (Calendar, Gantt view)
- Automatically add periodic maintenance actions, sort action per type (breakdown, routine, planned…)
- Job card, power block and team assignment

IOMS HIGH LEVEL ARCHITECTURE



TAILOR MADE SOLUTIONS

TAILOR MADE SOLUTIONS

- RATP: **DVS cubicles**
- Type tested according to IEC Standards and customer specification

TAILOR MADE SOLUTIONS

- Seattle: **Tie breaker cubicles**
- Type tested according to ANSI C37.20.1 Standards

Independent, accredited testing station - Member laboratory of STL and LOVAG

DESIGN TEST REPORT

NO. 00352-14-0011

Sécheron SA Rue du Pré-Bouvier 25 - Zimeysa 1217 Meyrin - Geneva SWITZERLAND	CLIENT
Sécheron SA Production	MANUFACTURER
Metal-enclosed low-voltage power circuit breaker switchgear	TEST OBJECT
Enclosure: Tie Breaker cubicle or NEMA 1 / IP20 Circuit-breaker: UR46M-825	TYPE
Enclosure: SG827910R67432 Circuit-breaker: 400J35675*1.1/02	SERIAL NO.
Rated maximum voltage 1600 V_DC Rated peak current 100 kA Rated short-circuit current 60 kA Rated current 4000 A	RATED CHARACTERISTICS GIVEN BY THE CLIENT
IEEE Std C37.20.1™-2002 with reference to IEEE Std C37.14™-2002 IEEE Std C37.16™-2009	NORMATIVE DOCUMENT
Design test: - Short-circuit current withstand test	RANGE OF TESTS PERFORMED
28 January 2014	DATE OF TEST
The ratings of the test object related to the scope of test have been proved. The design test has been PASSED.	TEST RESULT

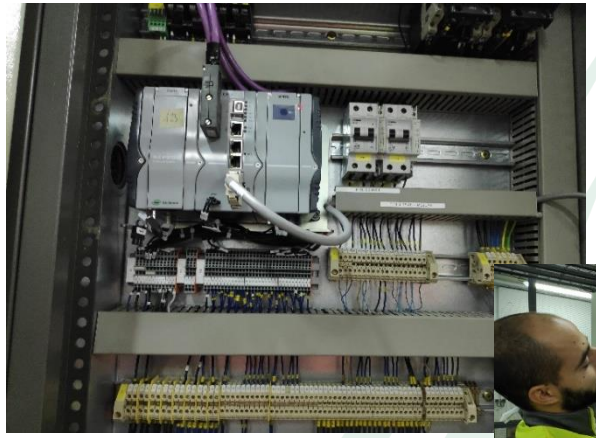
RONALD BORCHERT
Senior engineer
Berlin, 27 February 2014

CHRISTIAN JURASCHEK
Test engineer in charge

TAILOR MADE SOLUTIONS

- **Caen Tramway – France**
- Replacement of 18 x SITRAS protection relays from Siemens + Current & voltage transducers due to obsolescence issue (Control of Sécheron breakers)

Before retrofit



After retrofit

TAILOR MADE SOLUTIONS

- **Yarra Trams Melbourne - Australia**
- Retrofit of 17 feeder breaker cubicles located in 3 TPS – Complete trolley retrofit (Replacement of AEG breaker by UR / Omron protection relays / Additional LTD device)

Before retrofit

After retrofit

TAILOR MADE SOLUTIONS

- **Jakarta Kommuter Train – Indonesia**
- Meiden HSCB trolley replacement (UR36-82s - 3600A / 1500V)

Before retrofit

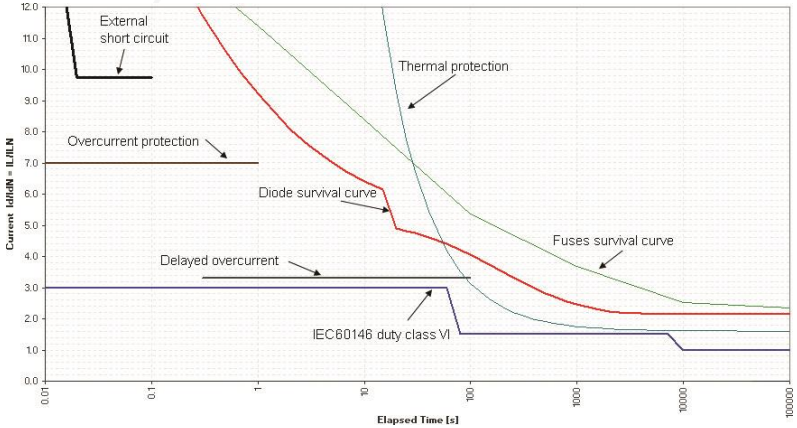
After retrofit

ENGINEERING SERVICES

NETWORK EXPERTISE

- **Dynamic DC network** and **train simulation**
- **Wide range** of **services** from **dynamic network simulation** to **measurement on-site** and **laboratory**

- Protection coordination of a transformer-rectifier unit



- Short-circuit and on-site tests

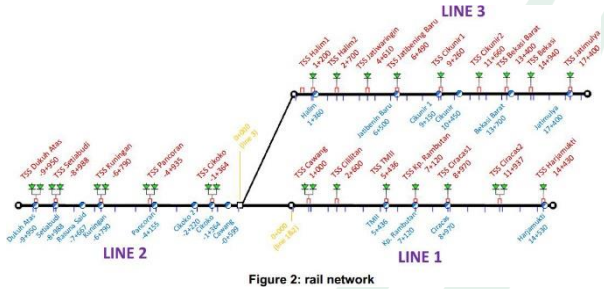


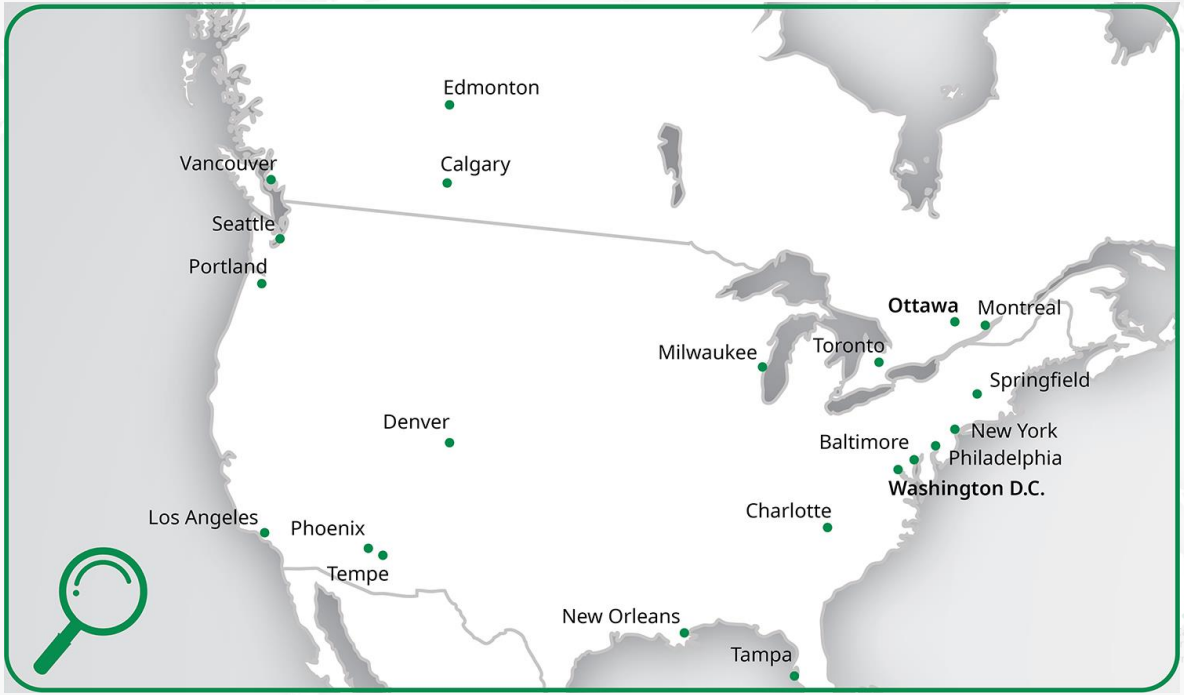
Figure 2: rail network

REFERENCES

REFERENCES

References in
273 cities and
60 countries

REFERENCES – USA & CANADA



WHAT MAKES US **UNIQUE**

Wide range of **top quality products**

System service expertise
(system study, transformer group, SCMS, local SCADA)

World leader in **DC field**

Strong **local support** & local expertise

THANK YOU FOR YOUR ATTENTION

Sécheron

Sécheron Hasler GROUP

Smart. Safe. Swiss.