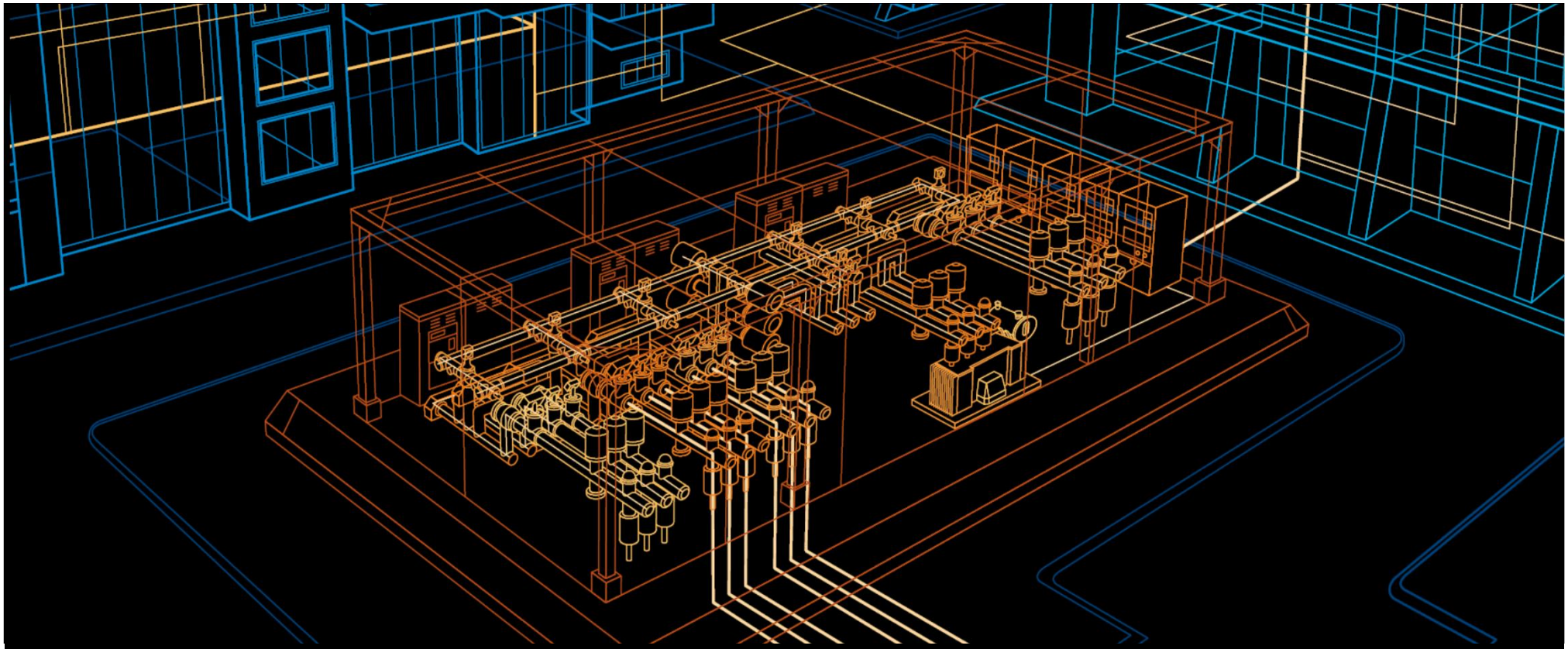
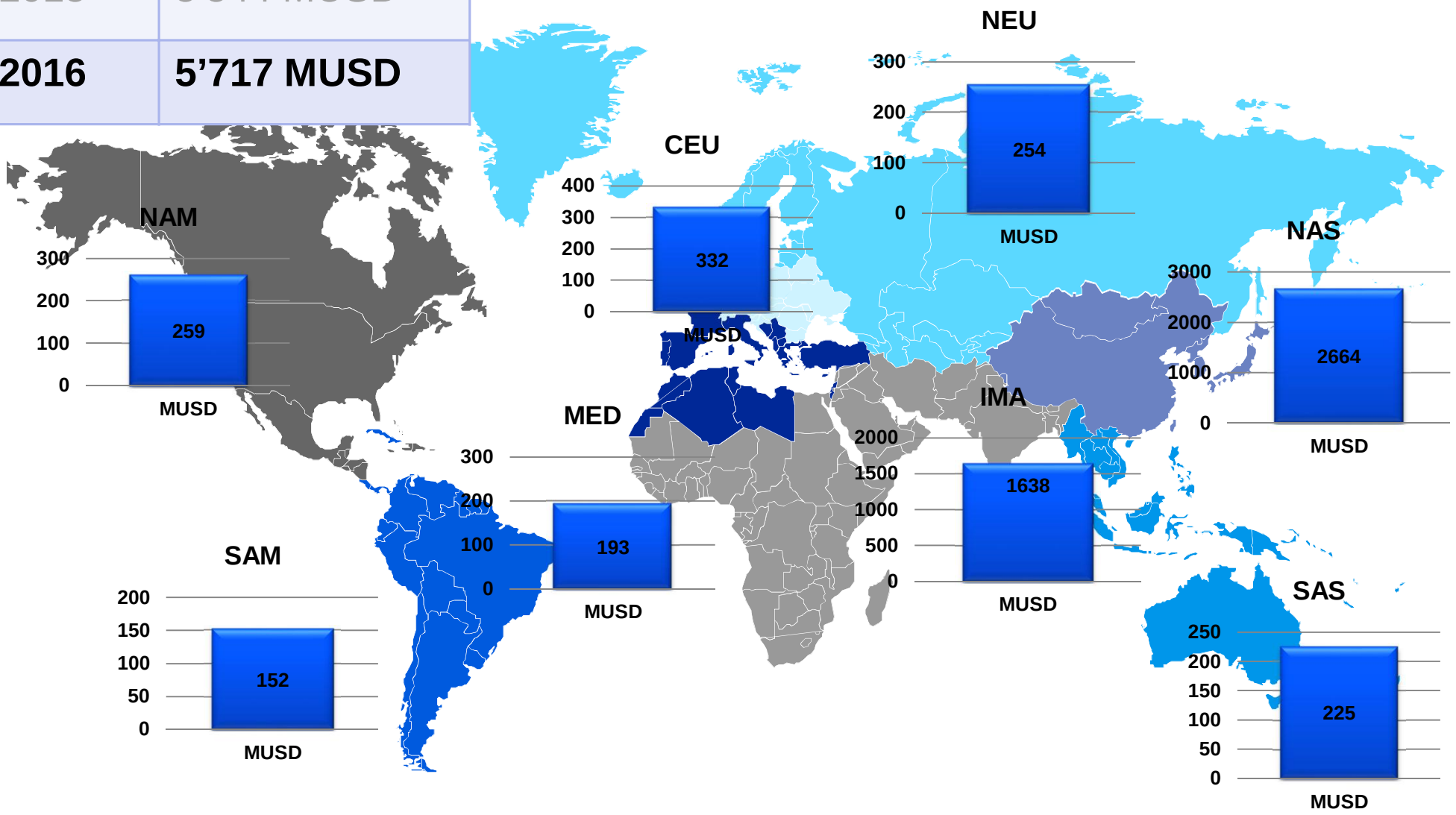


Bekim Tahiri, PG TMM GCB & GIS, 14/10/2016

Gas Insulated Switchgear (GIS)
General Presentation

Estimated Total Market Size 2016

2013	3’465 MUSD
2014	3’623 MUSD
2015	5’544 MUSD
2016	**5’717 MUSD**



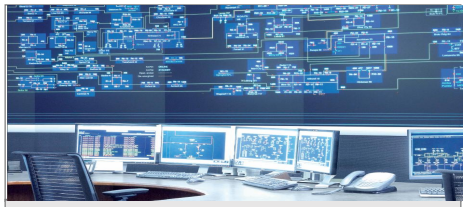
Gas-insulated switchgear
Content

§50 years of innovation

§Benefits

§Portfolio

§Applications



§Digital substation

§Integrated GIS

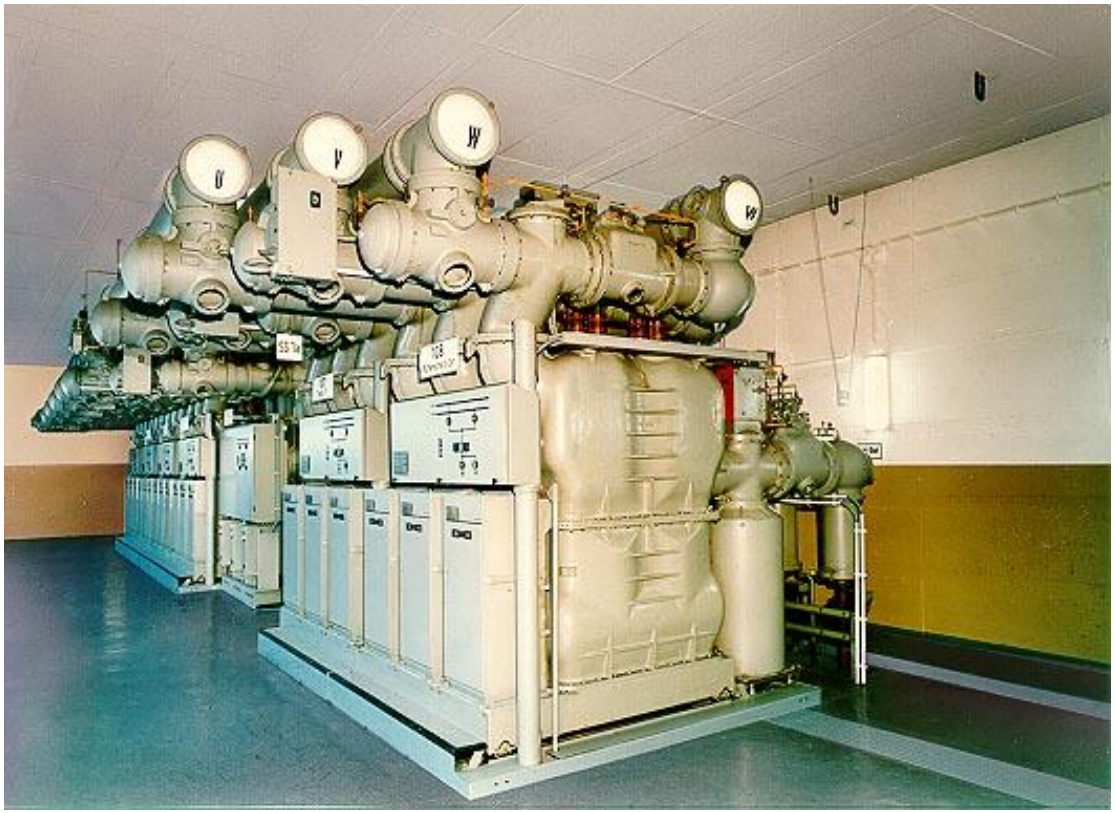
50 years of innovation

ABB GIS – Ways to the future
Technology changes need to be done

- …and they can communicate – even today**!**

ABB GIS – Ways to the future
How do we get there ?

ABB GIS Substations Type ELK
The first 110 kV GIS in the world



- **In operation from 1965 until 2013**
- **48 years of reliable operation !**

Customer: RWE – Indoor Substation Recklinhausen

Gas-insulated switchgear
Many firsts in GIS

170 kV GIS

1967

1976

550 kV GIS

1987

800 kV GIS

145 kV GIS in prefabricated housing

1992

1997

Most compact 123 kV GIS

Ultra high-voltage 1100 kV GIS substation

2008

2009

Largest urban substation

Ultra high-voltage 1200 kV GIS substation

2012

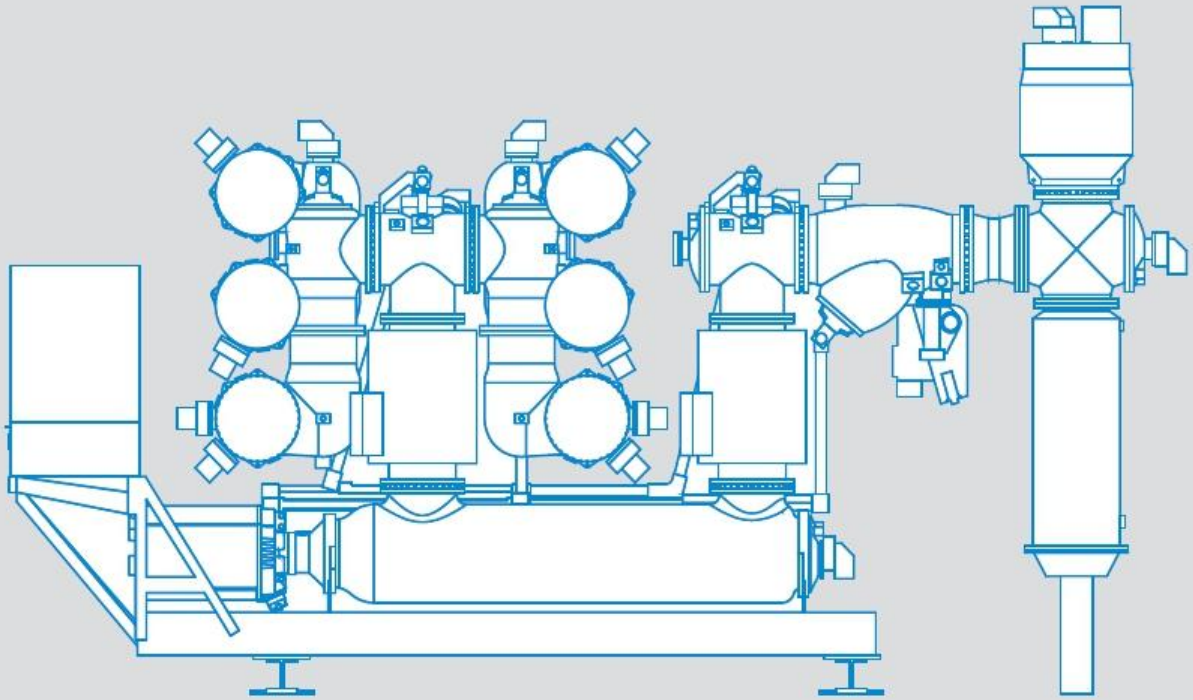
2013

Compact 420 kV substation

Eco-GIS substation

2015

Gas-insulated switchgear
Pioneer and technology leader

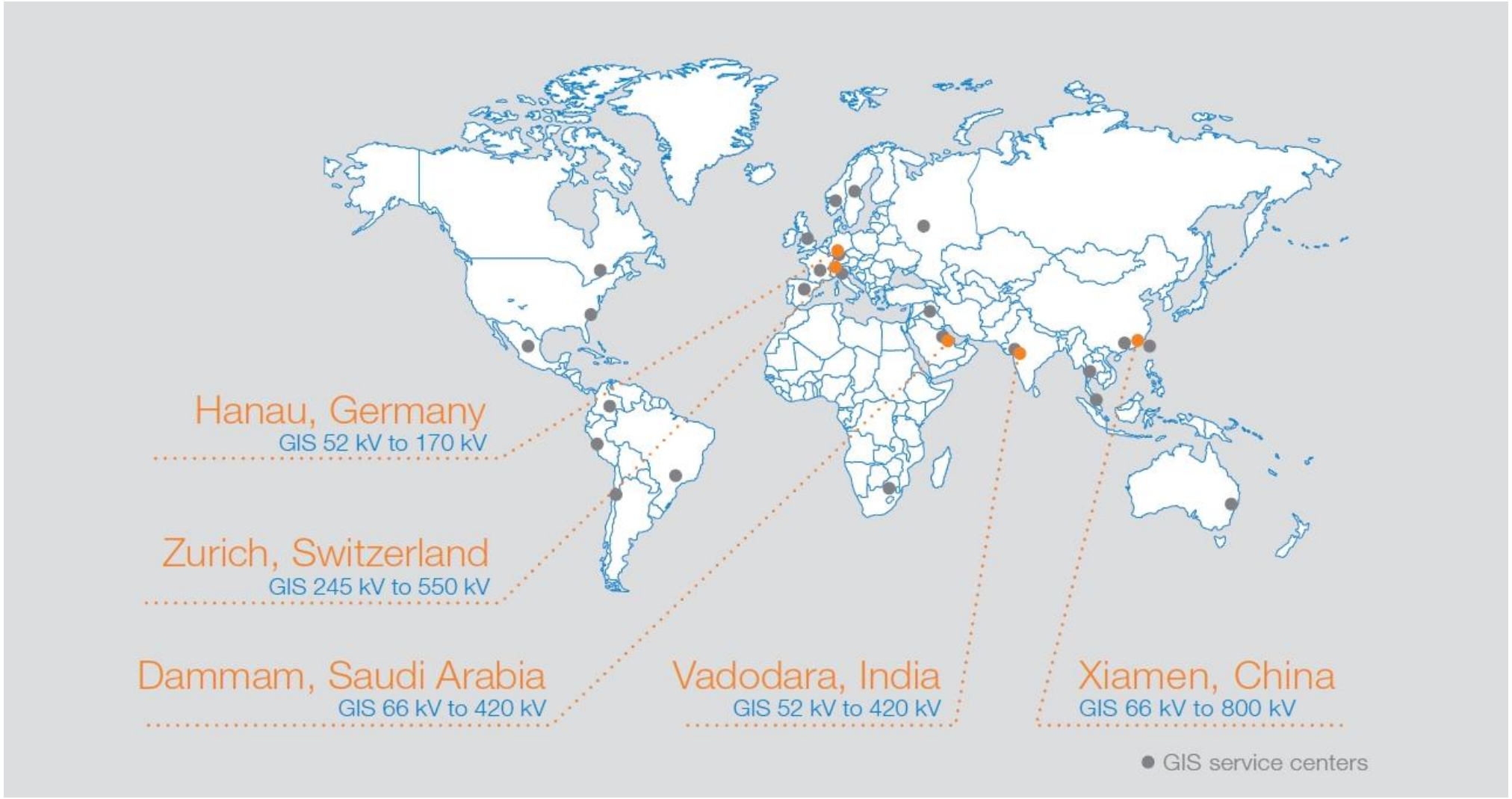


Market leader with more than
25,000 bays
installed worldwide

Driving technology and innovation
since 1965

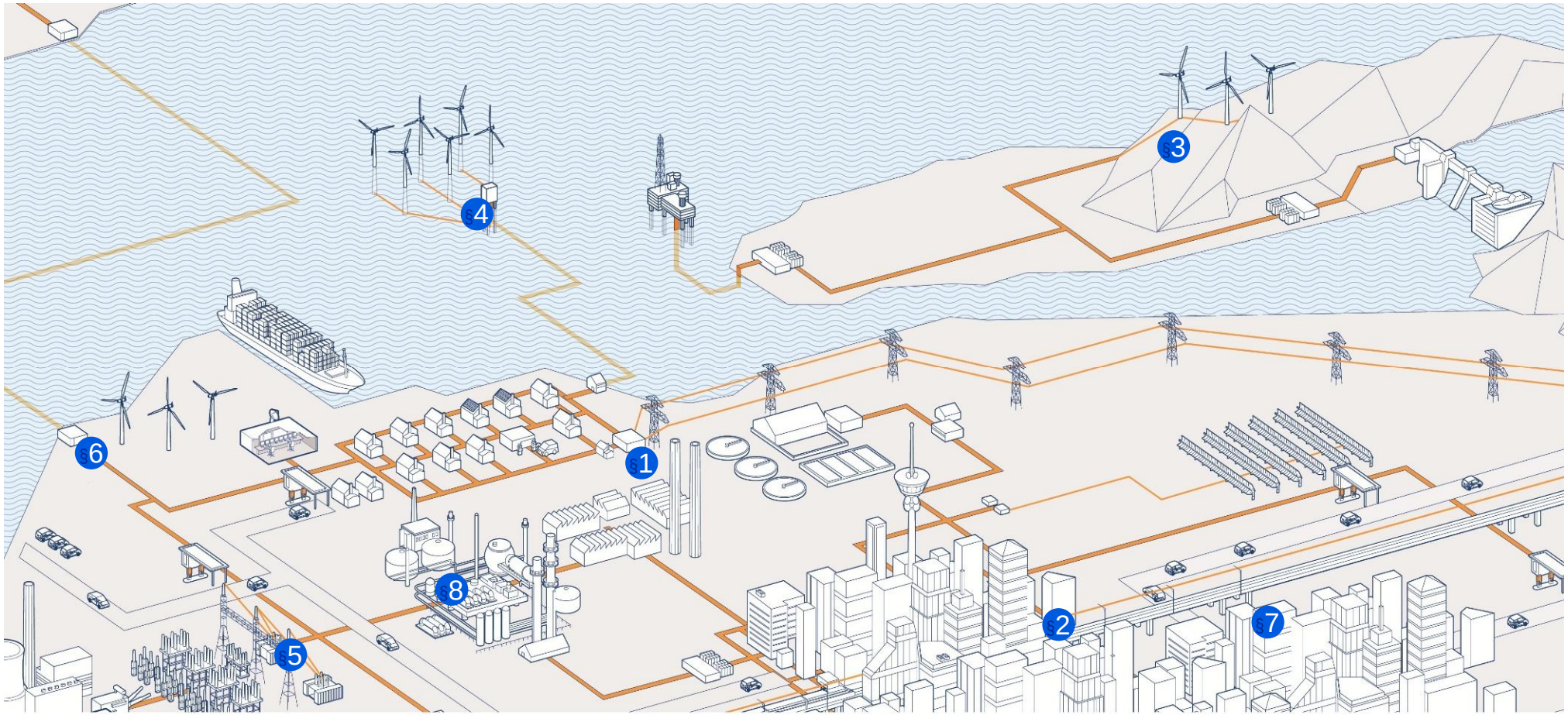
Complete range of GIS
52 kV to 1200 kV

Gas-insulated switchgear
Global manufacturing network



Benefits

Gas-insulated switchgear
Benefits



ECA Financing through SERV

- Interest Rate + Margin: Range from approximately 1.60% to 2.05% per annum (depending on the currency, i.e. either EUR or CHF)
- Front fees: approximately 0.75% flat
- Commitment/Management and other fees: not included in this Letter of Interest
- Tenor: up to 10 years from project start to end of repayment period

Project Scope	100%
min CH content	30%
max local	23%
foreign	47%

Gas Insulated Switchgear
Overall description

Price

LTB
- Circuit Breaker

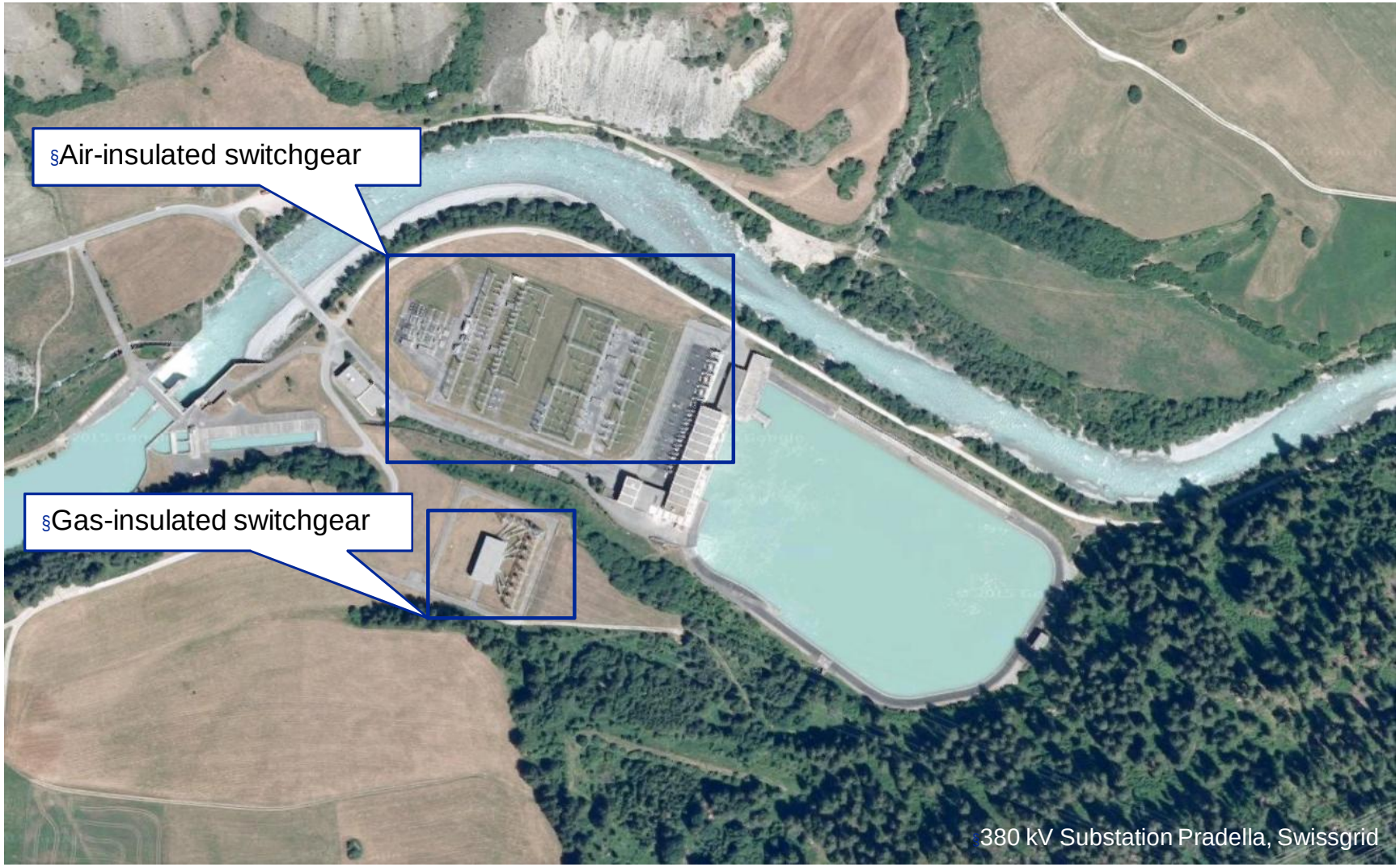
DTB
- Circuit Breaker
- Current Transformer

Hybrid Modules
- Circuit Breaker
- Current Transformer
- Voltage Transformer
- Disconnector
- Earthing Switch

GIS
- Circuit Breaker
- Current Transformer
- Voltage Transformer
- Disconnector
- Earthing Switch
- Busbar / Busducts

Functional Integration

Gas-insulated switchgear
Low space requirement



High Voltage SF6 Insulated Substations
Indoor and Outdoor installation

- Canopies – equipment almost **independent from environment**
- **Building of all types** – Prefab metal to Underground
- Increased **Reliability**
- Use under **difficult climatic conditions**
- **Easy planning** of outages for Service and Maintenance

ABB GIS Substations Type ELK
Inspection

Device	Inspection after	Maintenance after			
	8 years	2 000 operating cycles	5 000 operating cycles	20 fault clearings or 5 000 operating cycles	2 closing operations onto short circuit
Overall Installation	●				
Circuit Breaker	●			●	
Disconnector/Earthing Switch	●		●		
Fast Acting Earthing Switch	●	●			●

Recommended Inspection:

- Visual inspection every 8 years
- No gas compartment opening required!

Recommended Inspection:

- Maintenance for some parts e.g. main contacts is relating on operation cycle / switching cycle. In this case opening of related gas compartment is necessary.

Gas-insulated switchgear
Reduced installation and commissioning time

- Factory assembled, fully tested and shipped as one bay
- Less civil and on-site construction works

Gas-insulated switchgear
Substation security and aesthetics

- Indoor application secures equipment and prevents vandalism
- Enables substation to be hidden in buildings or underground to preserve the aesthetics of the surroundings

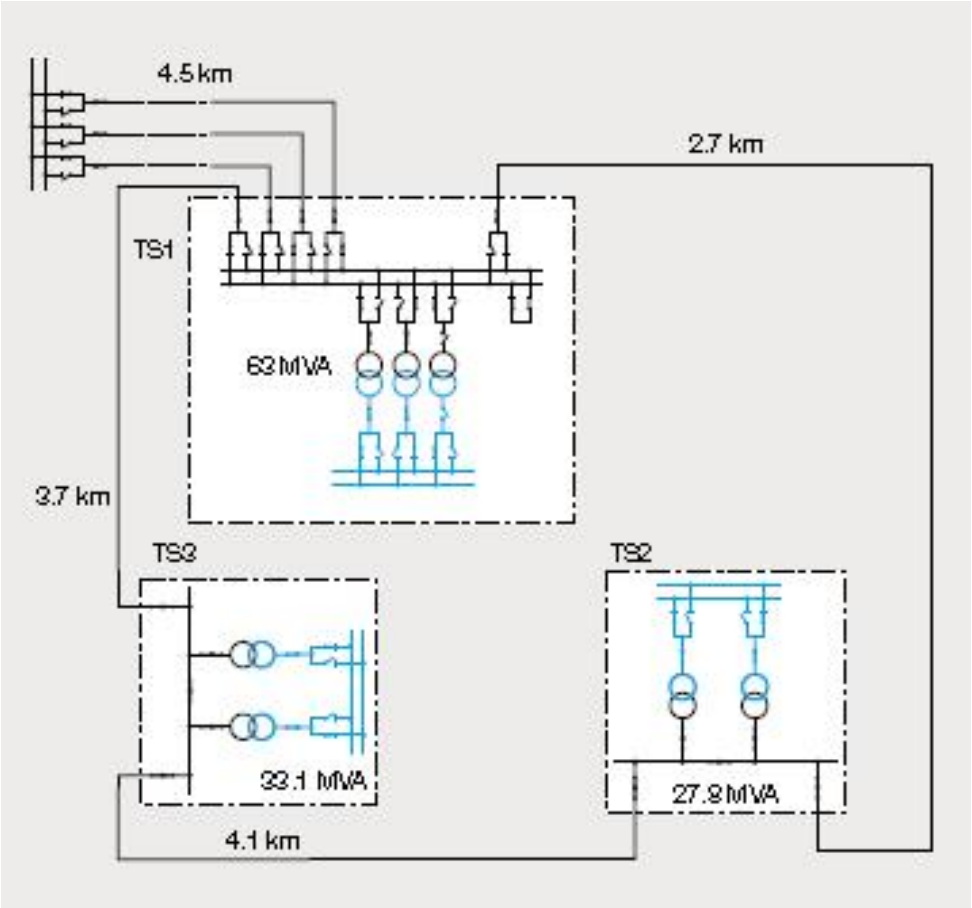
Gas-insulated switchgear
Advanced features for digital substations

- Incorporation of IEC 61850 standards
- One multi-purpose electronic current transformer (ECT) and electronic voltage transformer (EVT) for all applications
- Remote monitoring
- Digital monitoring, measurement, control and protection based on IEC 61850 are integrated into the local control cubicle within the bay for C-product lines

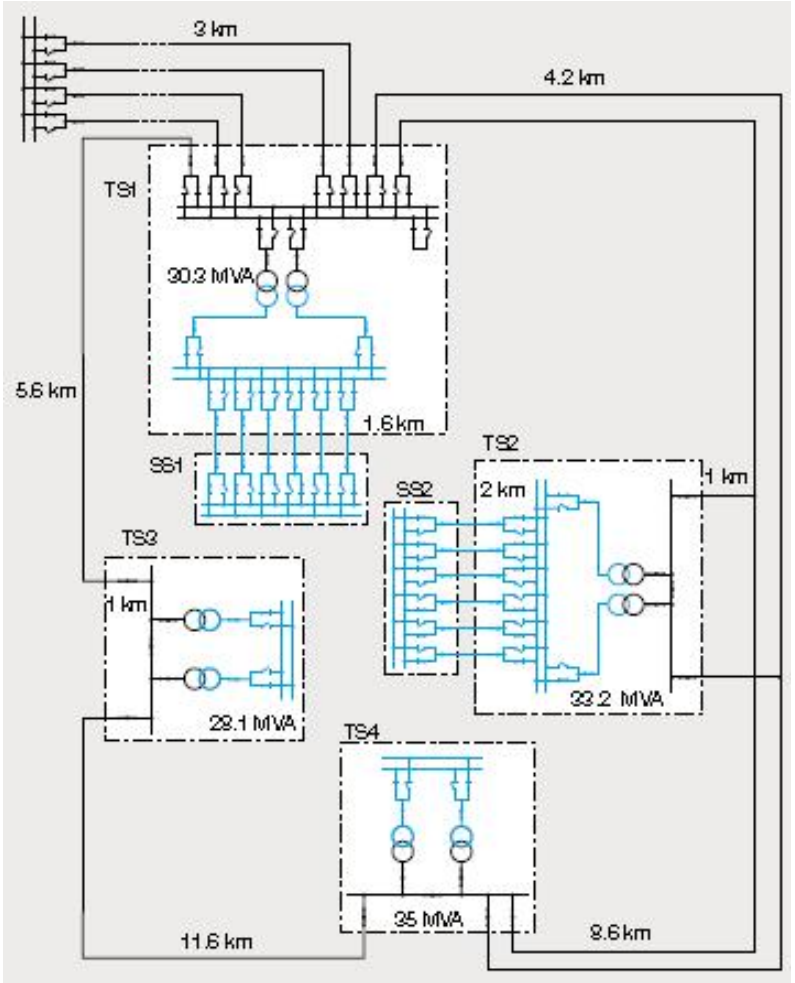
Benefits of Gas Insulated Switchgear

Comparison of GIS and AIS systems for urban supply networks

- GIS HV/MV & Insulated cables



- AIS HV/MV & Air Insulated cables



ONS

Operador Nacional do Sistema Elétrico

Procedimentos de Rede

Assunto	Submódulo	Revisão	Data de Vigência
REQUISITOS MÍNIMOS PARA TRANSFORMADORES E PARA SUBESTAÇÕES E SEUS EQUIPAMENTOS	**2.3**	**1.1**	**16/09/2010**

5.2 Esse atendimento compreende projeto, fabricação, manutenção e operação das instalações referidas no item 1.7 deste submódulo.

6 INSTALAÇÕES DA SUBESTAÇÃO

6.1 Arranjo de barramento

6.1.1 Condições básicas

6.1.1.1 Os arranjos de barramentos para subestações com isolamento a ar da rede básica são estabelecidos nos grupos abaixo, diferenciados por classe de tensão:

(a) Barramentos de tensão igual ou superior a 345 kV: barra dupla com disjuntor e meio; e

(b) Barramentos de 230 kV: barra dupla com disjuntor simples a quatro chaves.

6.1.2 Condições especiais

6.1.2.1 Arranjos de barramento alternativos podem ser utilizados, inclusive os de tecnologia com isolamento em SF-6, desde que apresentem desempenho igual ou superior ao dos arranjos estabelecidos no item 6.1.1.1 deste submódulo, o que deve ser comprovado pelo agente por meio de estudos de confiabilidade e disponibilidade (saída forçada e programada). Além disso, esses arranjos devem atender ao que estabelece o item 4.1 deste submódulo.

6.1.2.2 Os arranjos de barramento alternativos referidos no item 6.1.2.1 deste submódulo devem

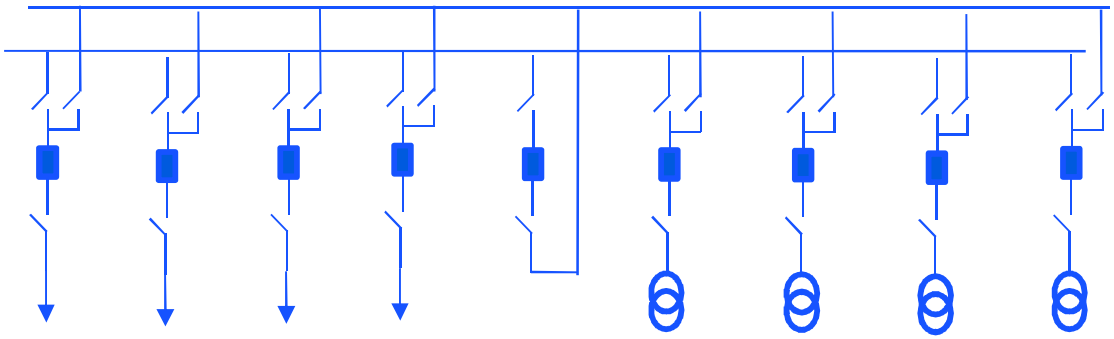
CIGRÉ
SUMMARY OF RESULTS OF THE 2004 - 2007

SUMMARY

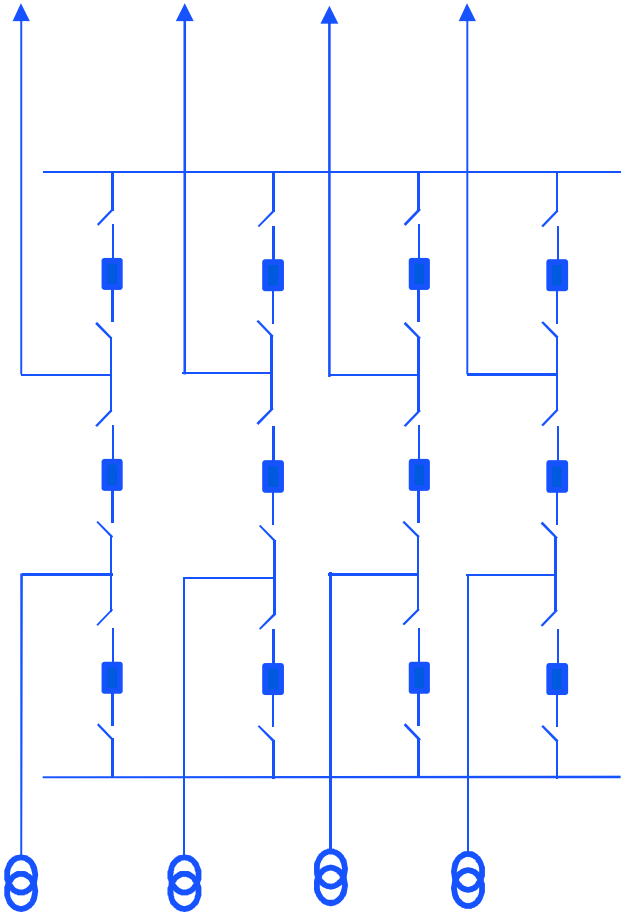
CIGRÉ WG A3.06 has completed a survey of reliability and failures of in-service high voltage equipment. The equipment types considered are SF_6 circuit breakers, disconnectors, earthing switches, instrument transformers and gas insulated switchgear (GIS). 90 utilities from 30 countries have contributed failure and population data, making this the most comprehensive reliability survey for high voltage apparatus ever carried out. The overall major failure frequency for circuit breakers is found to be 0.30 major failures per 100 circuit breaker years of service, which is lower than in a previous survey. Shunt reactor switching is associated with substantial higher failure frequencies than other switching duties. For disconnectors and earthing switches the overall major failure frequency is determined to be 0.21 failures per 100 equipment years of service. A 3:1 ratio between the number of failures caused by the operating mechanisms and failures caused by the primary components of the disconnectors and earthing switches is observed. Instrument transformers show an overall failure frequency of about 0.053 major failures per 100 single phase instruments transformer years of service. In general, individual equipment installed in GIS appears to have lower failure frequencies than equipment in air insulated substations. The overall major failure frequency for GIS bays is about 0.37 major failures per 100 GIS circuit breaker bay years of service. (A GIS circuit breaker bay includes one circuit breaker and all associated disconnectors, instrument transformers, interconnecting busducts and/or parts of busbars and associated terminals.) Six very comprehensive CIGRÉ Technical Brochures containing all results with commentaries, information concerning how the survey was conducted, methods used for statistical analyses, recommendations for utilities and manufacturers, etc. are to be published shortly.

Comparação GIS AIS
Arranjo BD3 vs 1 ½ DJ

GIS

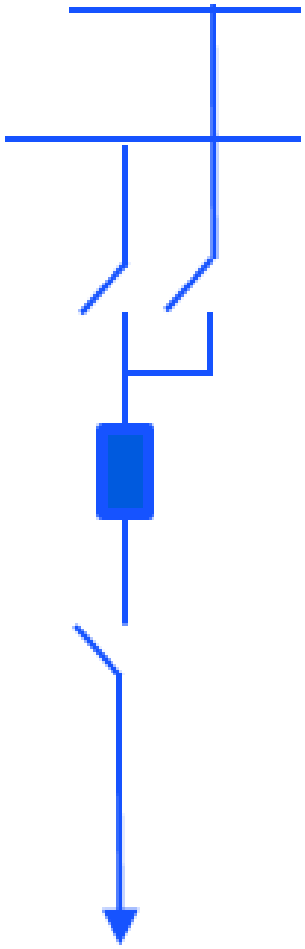


AIS

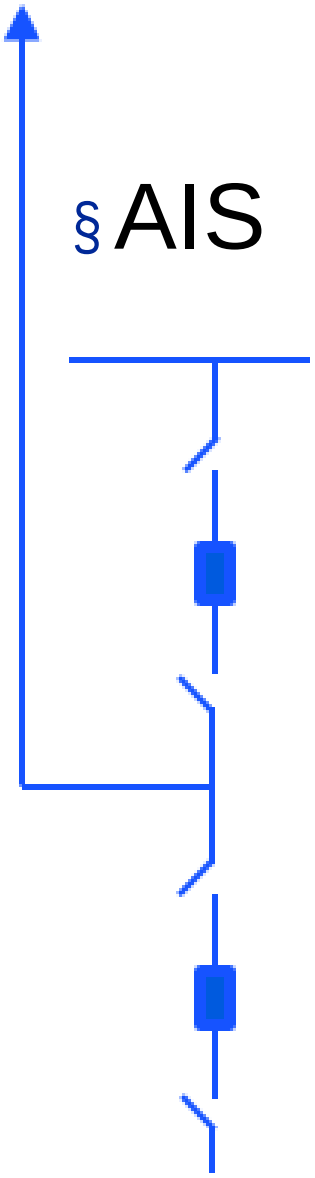


Comparação GIS AIS
Arranjo BD3 vs 1 ½ DJ

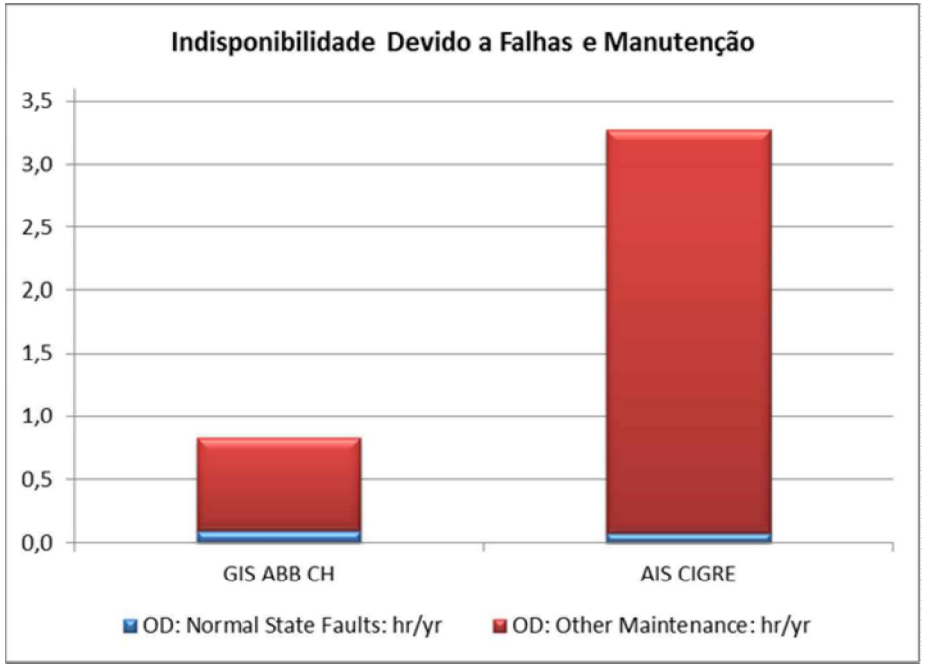
§ GIS

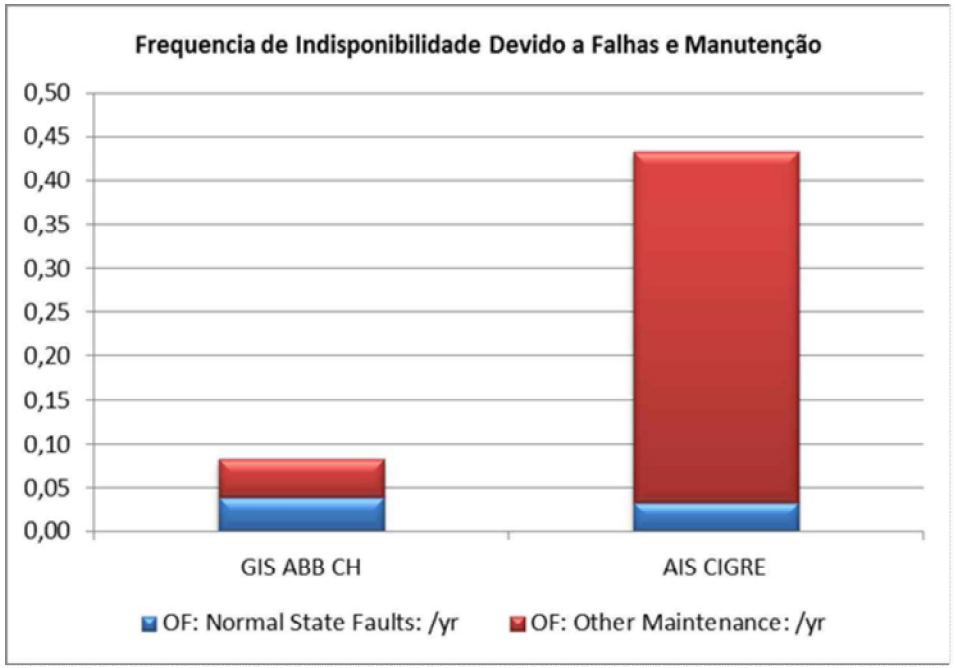


§ AIS



Comparação GIS AIS
Arranjo BD3 vs 1 ½ DJ





Gas-insulated switchgear
Power transmission and distribution

- Environmental challenging areas
- Very low or high temperatures
- Seismic active areas
- Flood areas, wetlands, challenging soil conditions
- Special air conditions (salty, dusty, polluted air)
- Areas with increased concern about visibility
- Security concerns
- Aesthetic concerns
- Project with limited labor resources
- Remote areas
- Mining, oil and gas electrical supply
- AIS extensions or replacements projects because of age or reliability

Gas-insulated switchgear
Integration of renewable energy into the grid

Access to electricity and water

- For all, including in remote locations
- At an economically viable cost
- For an increasing global population

Reduce cost of energy

- Increase renewables contribution
- Hedge against fuel price volatility
- Reduce dependence on imported fuel

Climate change and protection

- CO_2 reduction goals
- Sustainable power generation
- Energy efficiency

Gas-insulated switchgear
Offshore and onshore wind power connections

Applications

- Wind parks
- Oil platforms

Features

- Long maintenance intervals
- Reliable, gas-insulated equipment
- Most compact switchgear

Benefits

- No outages at off-shore substations
- Cost savings by reduced space

Gas-insulated switchgear
Industrial applications

Applications

- Turbines
- Cement industries
- Power distribution
- Mining

Features

- Project management and engineering for complete electrical system integration
- AC motors and complete AC drives system
- Variable speed drivers for high pressure grinding rolls applications
- Site management, installation supervision and commissioning services
- Training

Portfolio

ELK- C è 145, 245 & 420 kV
Modular and reliable

ELK-04 up to 170 kV
Modular solution for reliable energy supply

Rated voltage [kV]	145	170
Rated frequency [Hz]	50/60	50/60
Rated normal current – busbar / feeder [A]	3150	4000
Rated short-time withstand current (up to 3 s) [kA]	40	63
Bay width [mm]	1000	1200
Ambient temperature range [°C]		-30…+40

- Economic and compact layouts for high ratings 170 kV, 63 kA, 4000 A
- Space saving based on few building blocks with standardized dimensions
- Single pole operated circuit-breaker
- Low environmental impact with reduced SF_6-gas
- Resistance against earthquakes with high performance level of 1g
- Digital options for IEC 61850 compatible control and monitoring

ELK-14, 300 - 362 kV
The modular GIS solution

Rated voltage [kV]	300/362
Rated frequency [Hz]	50/60
Rated normal current – busbar / feeder [A]	4000
Rated short-time withstand current (up to 3 s) [kA]	63/80
Bay width [mm]	1680
Ambient temperature range [°C]	-30… +40

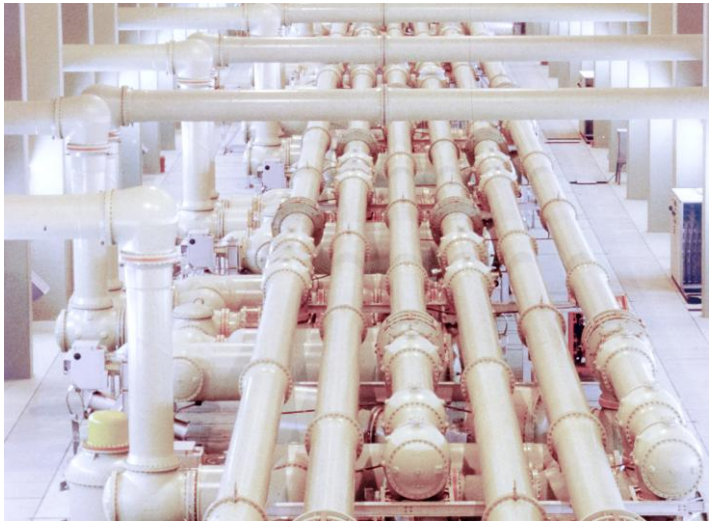
- High performance ratings
- Space saving combined disconnector / earthing switches
- Sophisticated partitioning design ensures highest service continuity during maintenance and repair work
- IEC 61850 compatible control and monitoring

ELK-3 up to 550 kV
High performance ratings in a compact design

Rated voltage [kV]	420	550
Rated frequency [Hz]	50/60	50/60
Rated normal current [A]	5000	6300/5000
Rated short-time withstand current (up to 3 s) [kA]	63	63/80
Bay width [mm]	2160/2700	3120
Ambient temperature range [°C]		-30 … +55

- High performance ratings up to 6300 A and 80 kA
- Less space required than comparable GIS systems
- Fully factory tested for short delivery and installation time
- Modular architecture permits flexibility and adaptation to changing needs
- IEC 61850 compatible control and monitoring

ELK-4, 800 kV
Extra high-voltage GIS



Rated voltage [kV]	800
Rated frequency [Hz]	50
Rated normal current – busbar / feeder [A]	6300/5000
Rated short-time withstand current (up to 3 s) [kA]	63
Bay width [mm]	9420
Ambient temperature range [°C]	-30 … +40

- High performance ratings in a compact design 800 kV, 6300 A, 63 kA
- Reliable, well proven technology based on five decades of GIS experience
- Reduction amount of SF_6-gas up to 20 percent compared to previous designs
- Modular components enable maximum flexibility and customization in layout configuration
- Convenient operation and serviceability

ELK-5, 1200 kV
Ultra-high voltage applications

Rated voltage [kV]	1200
Rated frequency [Hz]	50
Rated normal current – busbar / feeder [A]	8000/5000
Rated short-time withstand current (up to 3 s) [kA]	63
Bay width [mm]	n/a
Ambient temperature range [°C]	-30 … +40

- High performance ratings in a compact design 1200 kV, 8000 A, 63 kA
- Reliable, well proven technology based on five decades of GIS experience
- Very large power plants
- Long range power transmission
- Convenient operation and serviceability
- Comprehensive experience and excellent performance in extra high voltage and UHV GIS technology
- Excellent design, test and service capabilities

Gas-insulated switchgear
Technical data

	Sub-transmission 72.5 - 170 kV		Transmission 245 - 1200 kV			
Product	**ENK**	**ELK-04 C / ELK-04**	**ELK-14 C / ELK-14**	**ELK-3 C / ELK-3**	**ELK-4**	**ELK-5**
Enclosure	Three-phase	Three-, single-phase	Three-, single-phase	Single-phase	Single-phase	Single-phase
Rated voltage [kV]	72.5	145 / 170	245 / 253 / 300	420 / 550	800	1200
Rated power frequency withstand voltage [kV]	140	275 / 325	460	650 / 740	960	1100
Rated lightning impulse withstand voltage [kV]	325	650 / 750	1050	1425 / 1675	2100	2400
Rated normal current [A]	2500	3150 / 4000	3150 / 4000	5000 / 6300	5000 / 6300	5000 / 8000
Rated short circuit breaking current, 3s [kA]	40	40 / 50 / 63	50 / 63 / 80	63 / 80	63	63

Integrated GIS
Modular GIS in prefabricated housing

Rated voltage [kV]	145	170	300	420
Rated frequency [Hz]				50/60
Rated lightning impulse withstand voltage (1.2/50 µs) [kV]	650	750	1050	1425
Rated normal current - busbar/feeder [A]	3150	4000	4000	5000

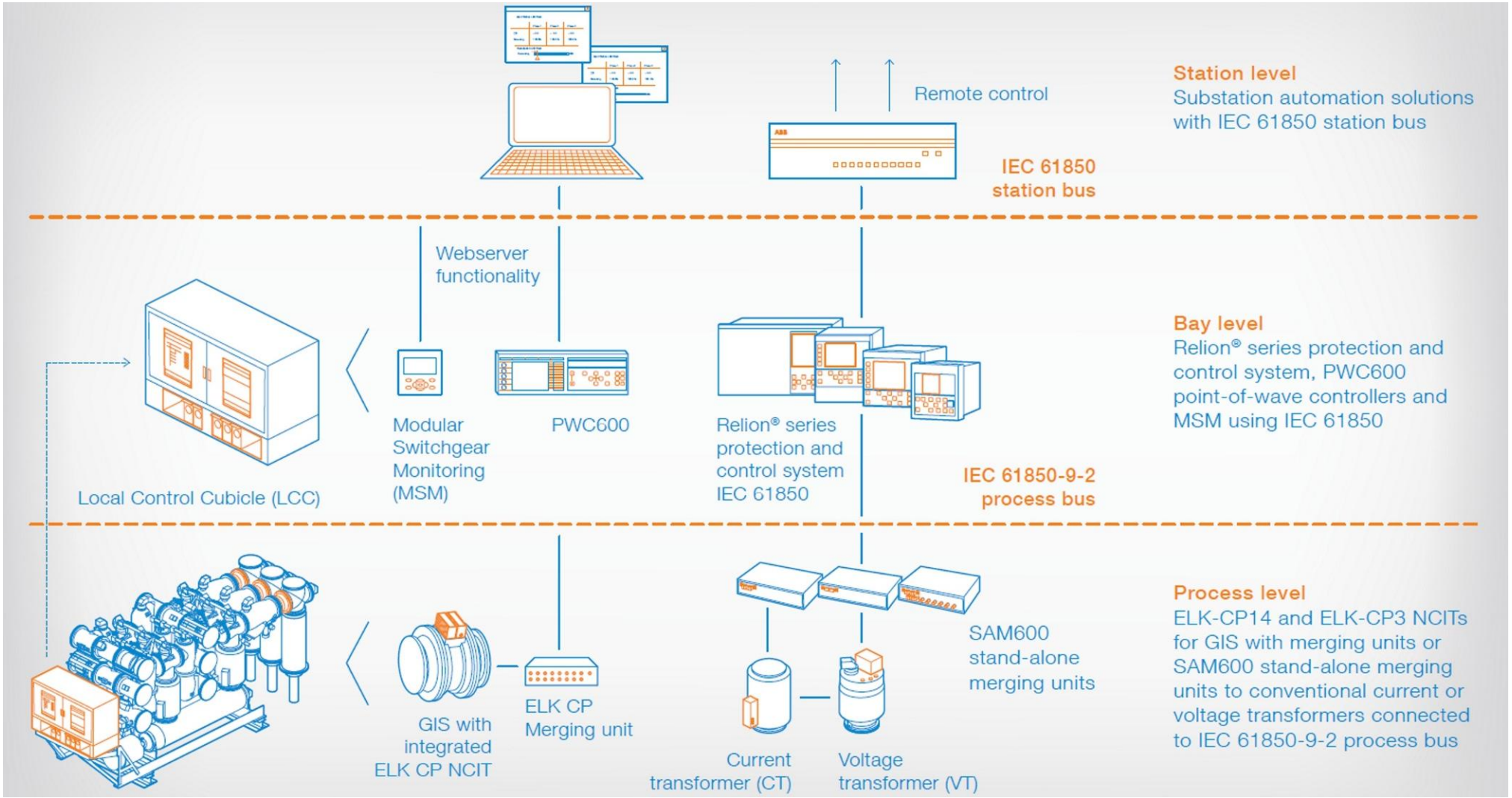
- Quick delivery and installation time for fast substation energization
- Reduced total system cost, project cost savings and on-site work
- Wide range of common circuit configurations
- Reduced project interfaces resulting in lower risks of delay
- Substantial space savings compared to conventionally built AIS substation
- Extended temperature range from -55 °C to +55 °C

Hybrid switchgear
With proven technology

Rated voltage [kV]	145	420	550
Rated frequency [Hz]			50/60
Rated normal current – busbar / feeder [A]	2500	5000	5000/6300
Rated short-time withstand current (up to 3 s) [kA]	40	63	63/80
Ambient temperature range [°C]			-30 … +40

- Up to 70 percent space reduction compared to conventional AIS
- Reduced investment costs including transportation and civil works
- Full substation design flexibility
- Short delivery and installation time
- Customizable modules

Gas-insulated switchgear
Advanced features for digital substations



Eco-GIS
World‘s first eco-efficient GIS installation, Switzerland

- The 170/24 kV substation deploys the first breakthrough GIS with eco-efficient gas mixture with a global warming potential (GWP)* of less than 1 as an alternative to SF_6-gas
- The fluoroketone-based SF_6 alternative gas mixture is a chemical compound developed for switchgear applications in collaboration with 3M
- Potential to lower carbon dioxide (CO_2) equivalent emissions by up to 50 percent through the life-cycle of the equipment

* GWP specifies the extent to which a greenhouse gas contributes to the warming of the atmosphere

Eco-GIS
The new gas mixture

- Eco-efficient gas mixture, consisting of the three components:
  - Perfluoroketones (C5 PFK)
  - CO_2 or N_2
  - O_2
- The gas mixture has a very low green-house warming potential (GWP <1)
- Compared to SF_6-gas the CO_2 equivalent emissions of the new gas mixture is lower by 99.995%
- The new technology is deployed for the first time at a substation located in Oerlikon, Zurich, using a 170 kV GIS as a pilot installation for the leading Swiss utility, ewz

§GIS References
Leblon, 138/13.8 kV Substation, Brazil

Business case

- § Old AIS at ist end of life
- § High maintenance costs
- § Reduced reliability
- § Situated amidst residential district
  - Negative incidents with the population:
    - § - high noise level of transformers
    - § - visual impact of the substation

ABB solution

- § 138/13.8 kV turnkey GIS substation with 5 HV GIS bays and 26 MV GIS bays for replace

Customer benefits

- § Increased grid reliability
- § Sales revenues of the additional property area cover the costs
- § No complains due to noise
- § No vandalism

§GIS References
Barbaña 145 kV Substation, Spain

Business case

- Strong constraints for
  - Noise level
  - Power consumption (air condition, cooling)
  - Ecology (visual impression of substation)

ABB response

- 145kV Turn-Key substation
- Water cooling of transformers
- Optimized utilization between ecology and technology by the water-cooling of the transformers
  - Noise reduction by water-fall
  - Ecological appreciation of the park Customer benefit

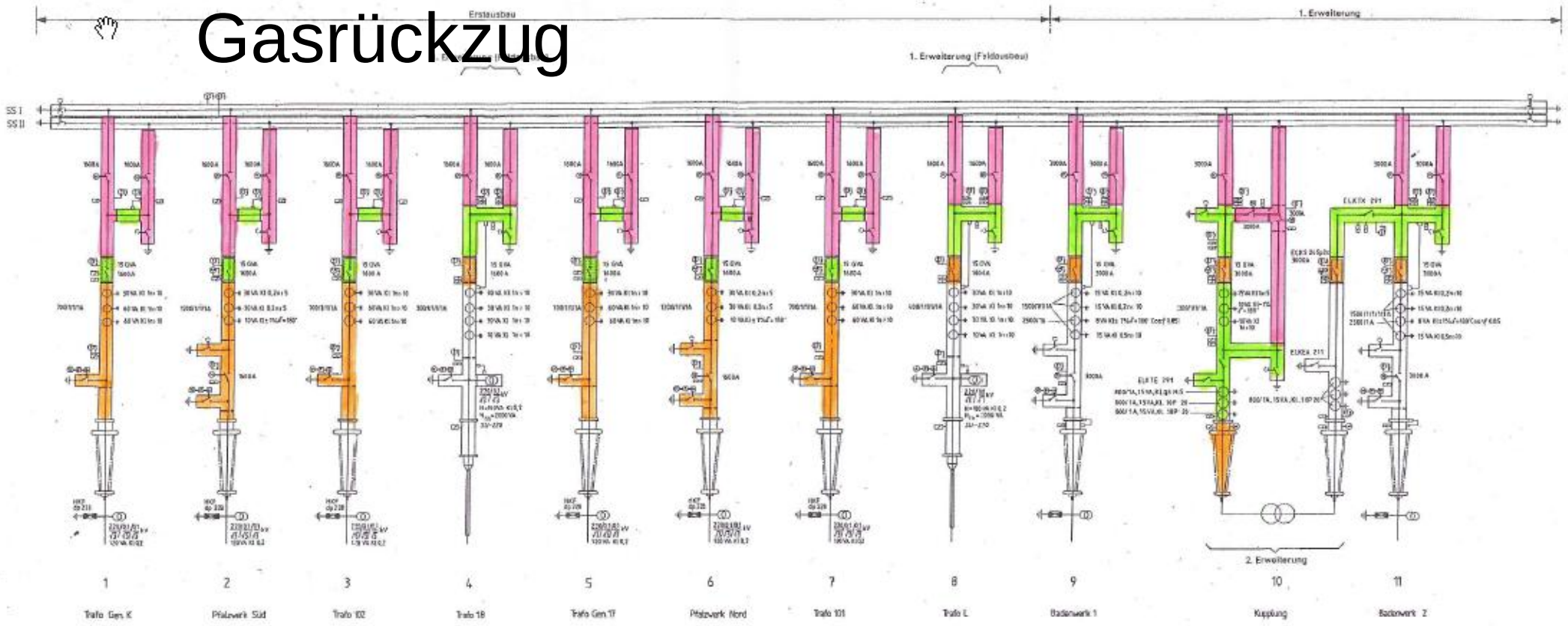
Customer benefits

- Increased grid reliability
- Ecological solution

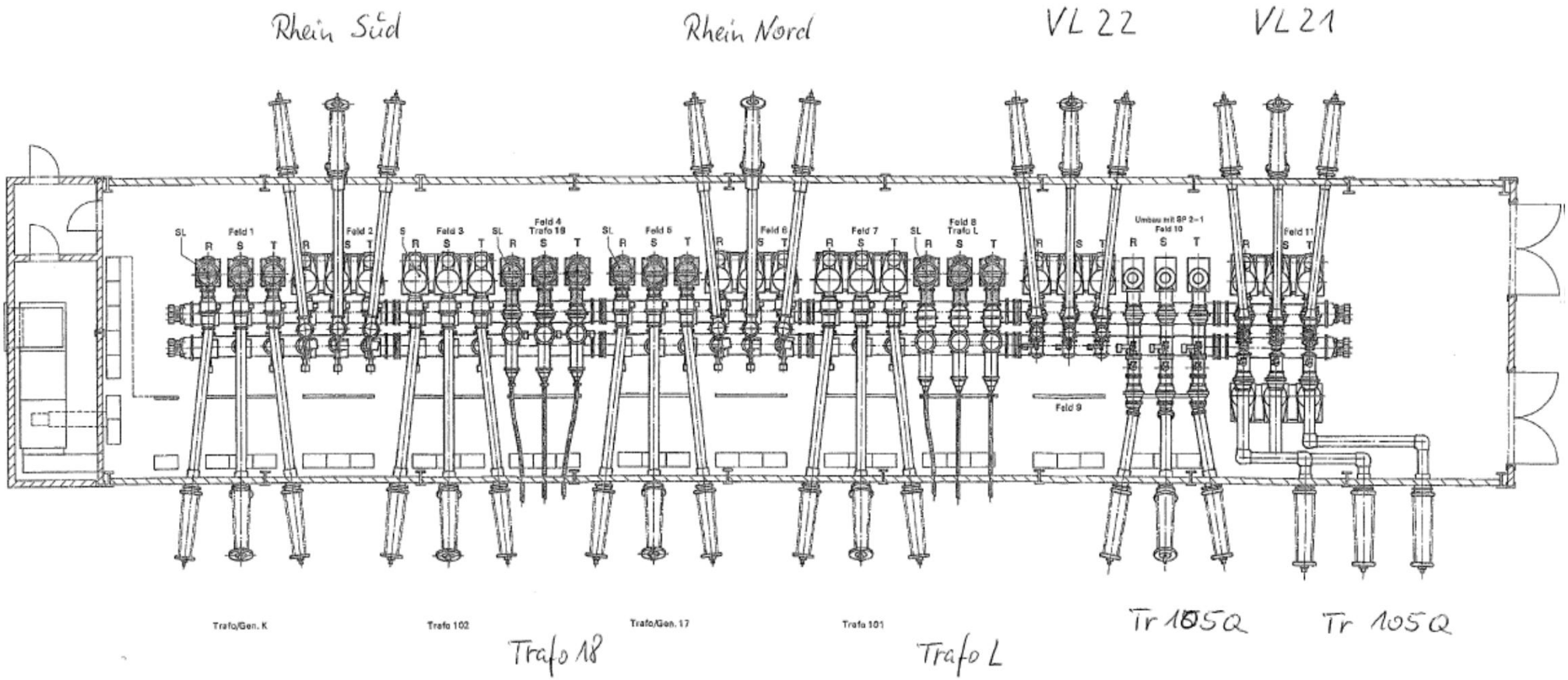
Applications

Unifilar Antigo

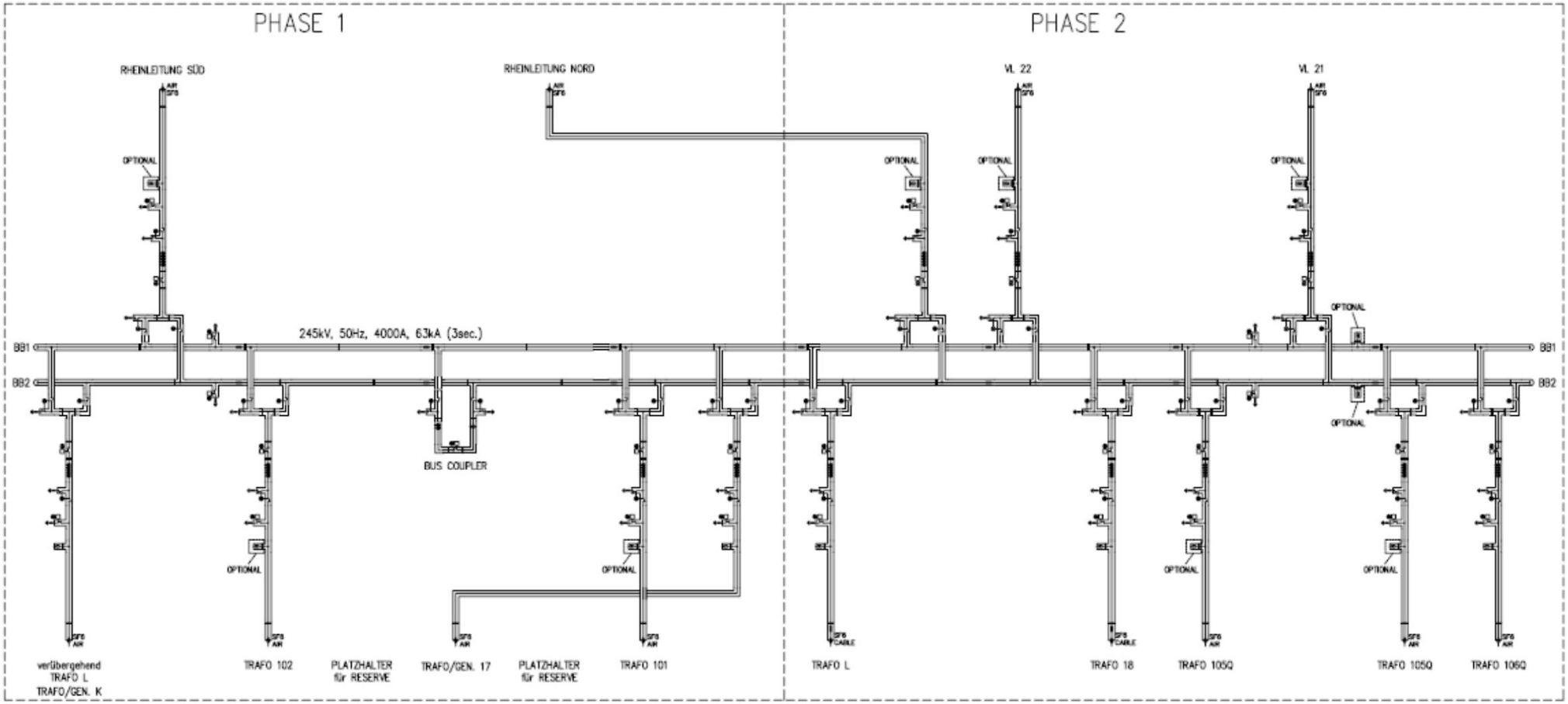
- Existierende Anlage – erheblicher Gasrückzug



§ 11 bays

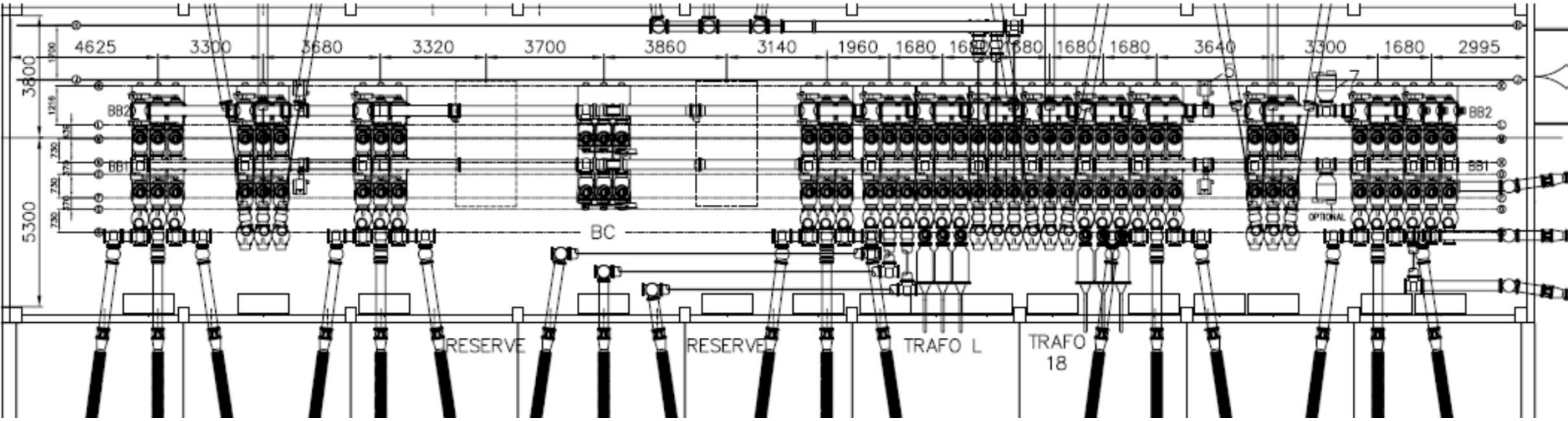

Rhein Süd
Rhein Nord
VL 22
VL 21
SL
Feld 1
Feld 2
Feld 3
Feld 4
Trafo 18
SL
Feld 5
Feld 6
Feld 7
SL
Feld 8
Trafo L
Umbau mit BP 2-1
Feld 10
Feld 11
Feld 9
R S T
Trafo/Gen. K
Trafo 102
Trafo/Gen. 17
Trafo 101
Trafo 18
Trafo L
Tr 105Q
Tr 105Q

Unifilar Novo

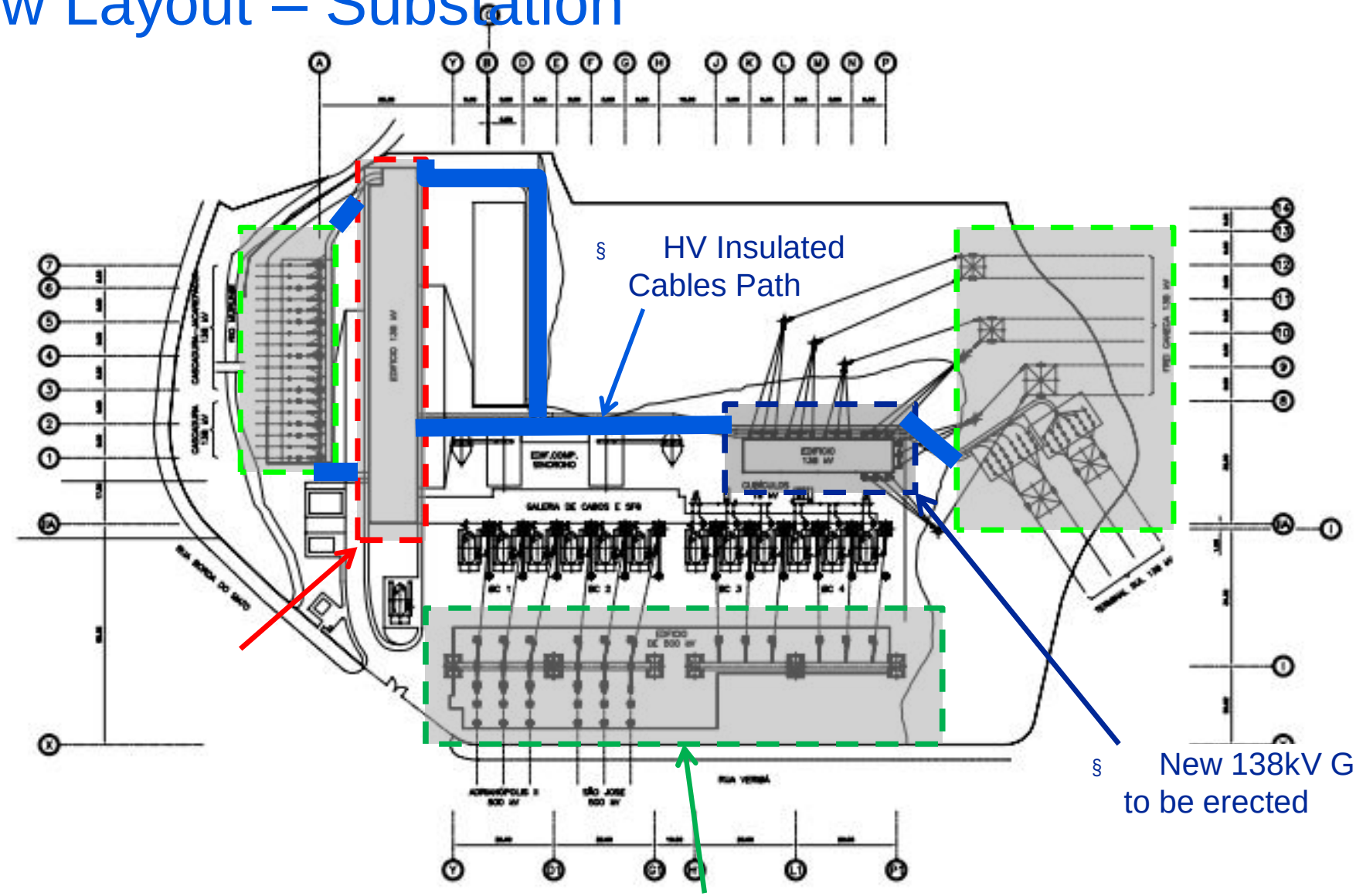


Layout novo

- 14 bays



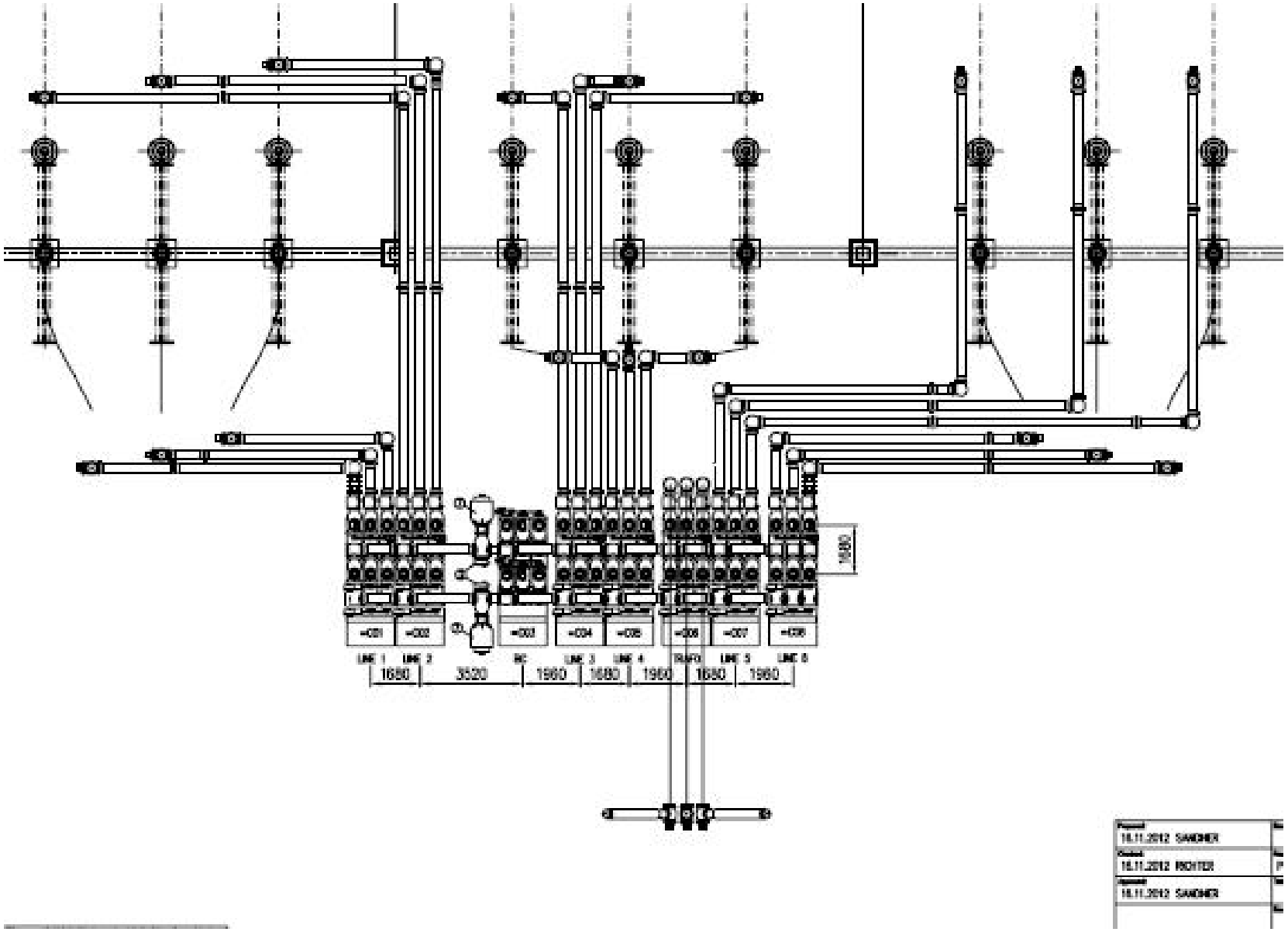
New Layout – Substation



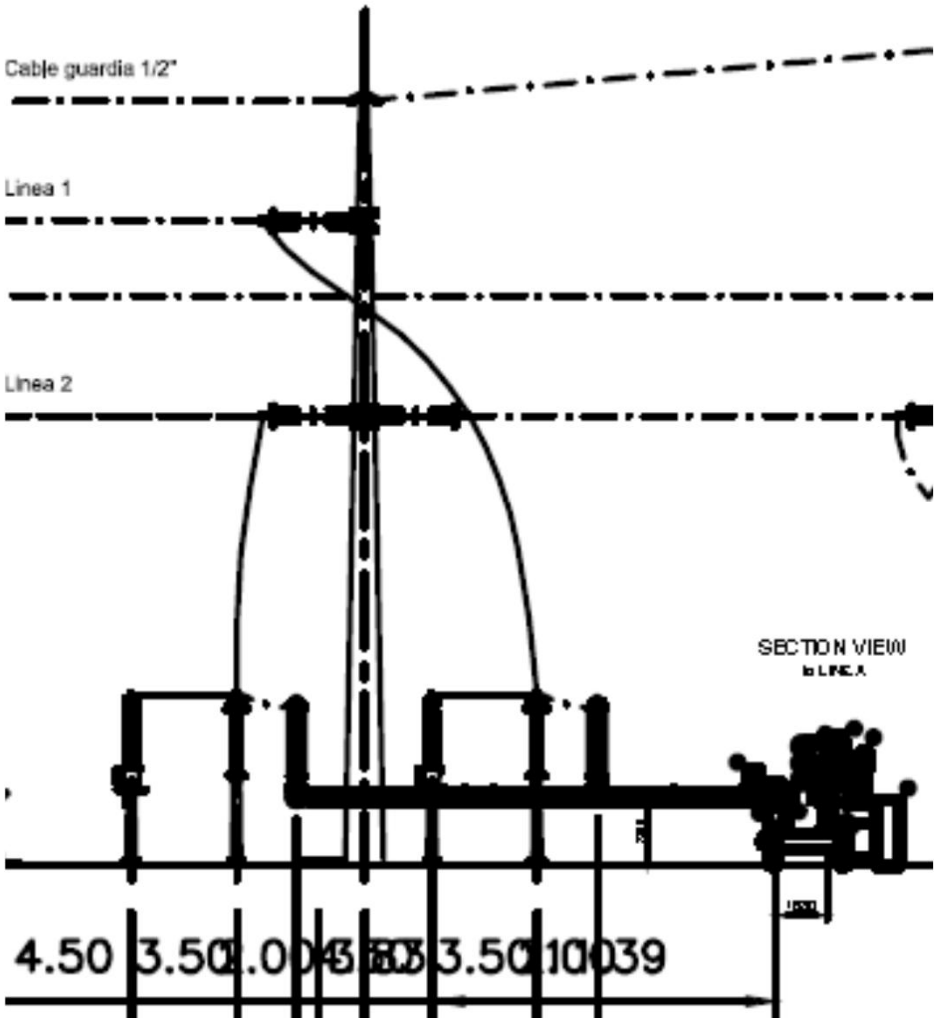
§ Existing 500kV GIS remains in the same position,

§ only the Control System will be updated.

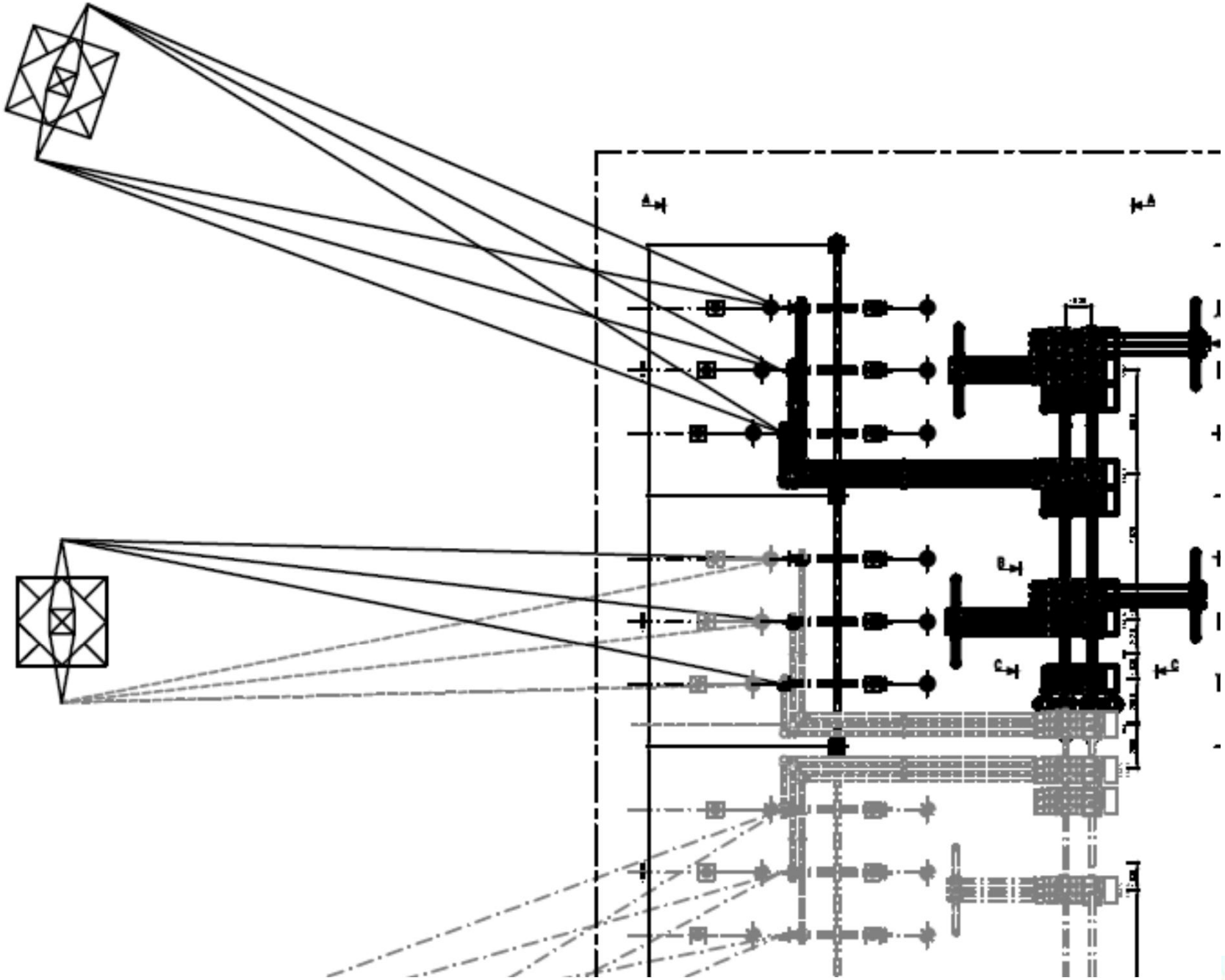
Small footprint 245 kV



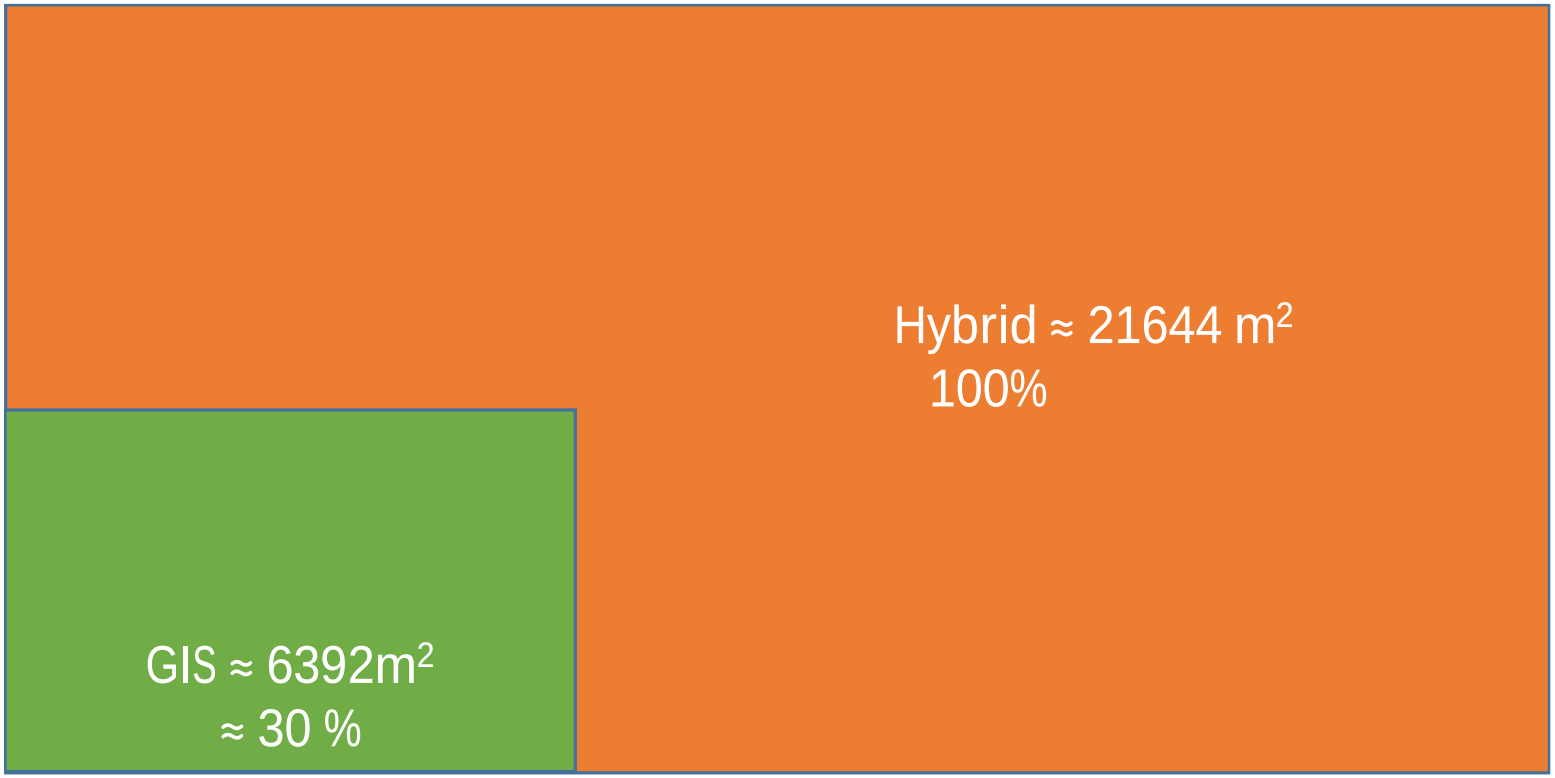
Small footprint 245 kV



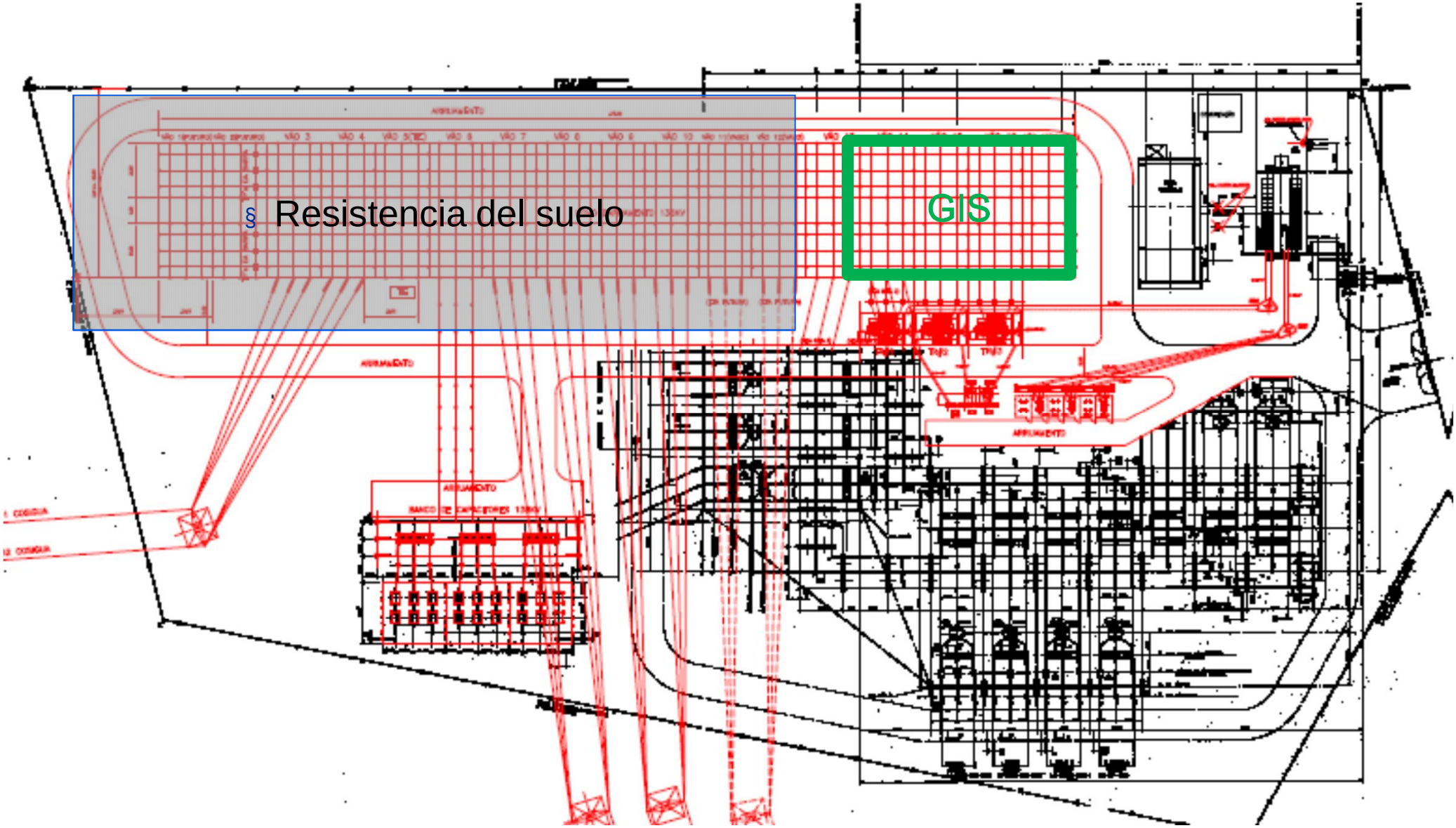
Small footprint 245 kV



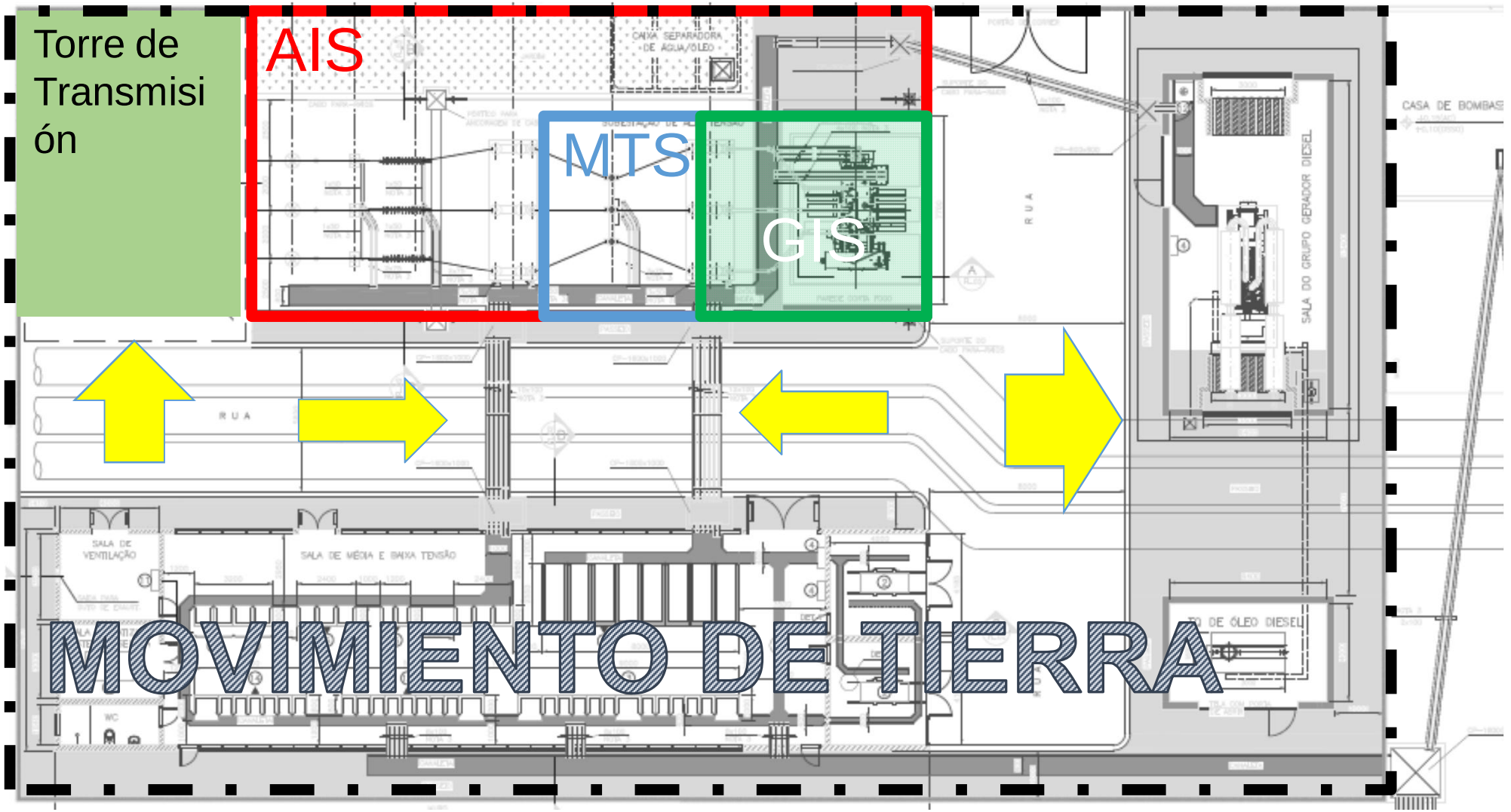
Small footprint



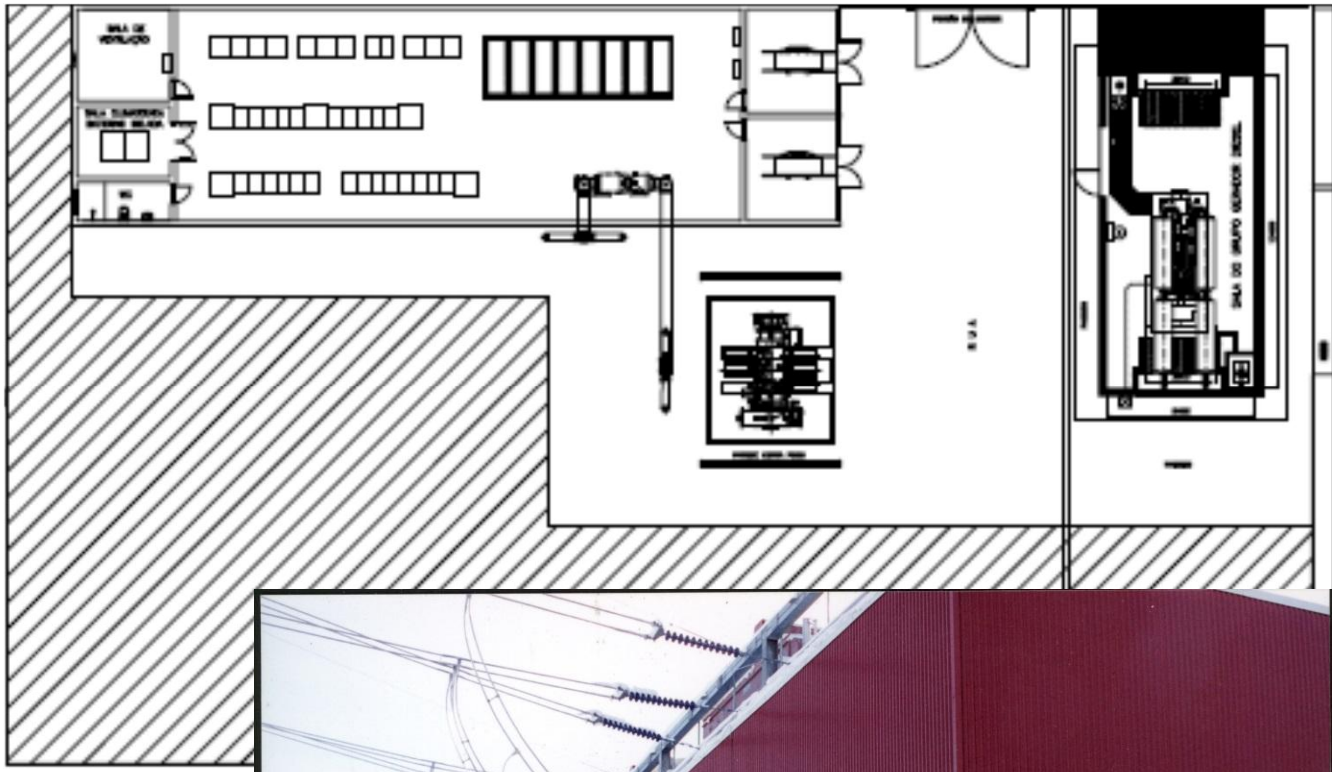
GIS – Distribution

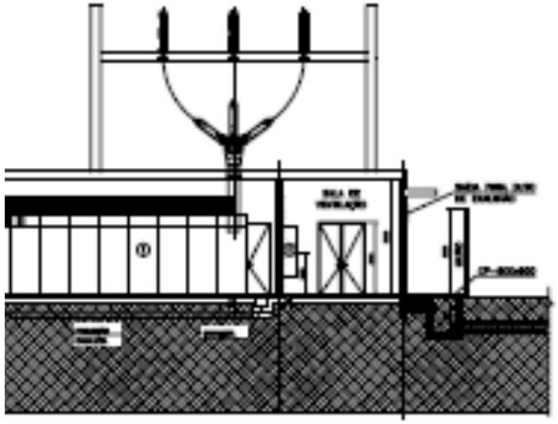


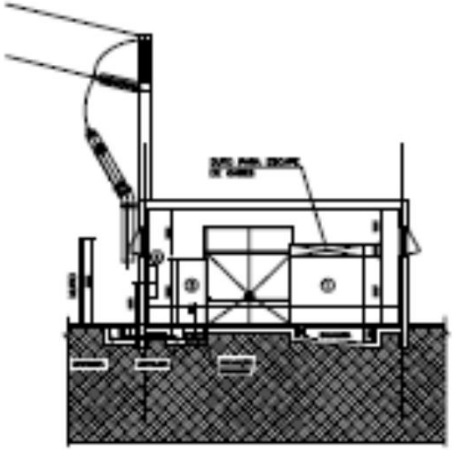
GIS –PCH e ou Industria



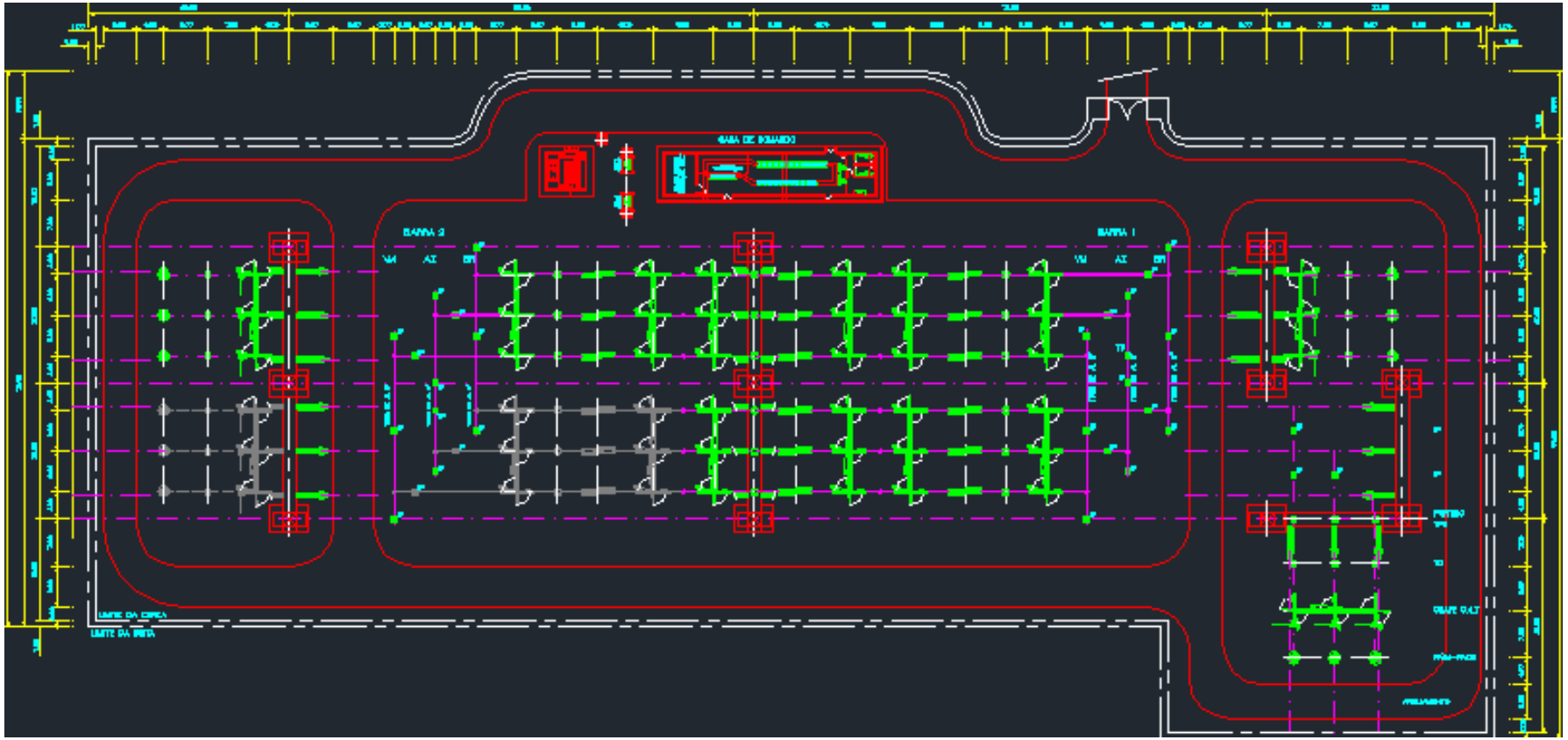
GIS –PCH e ou Industria

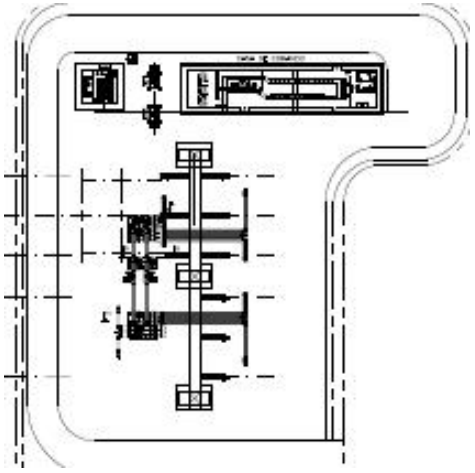




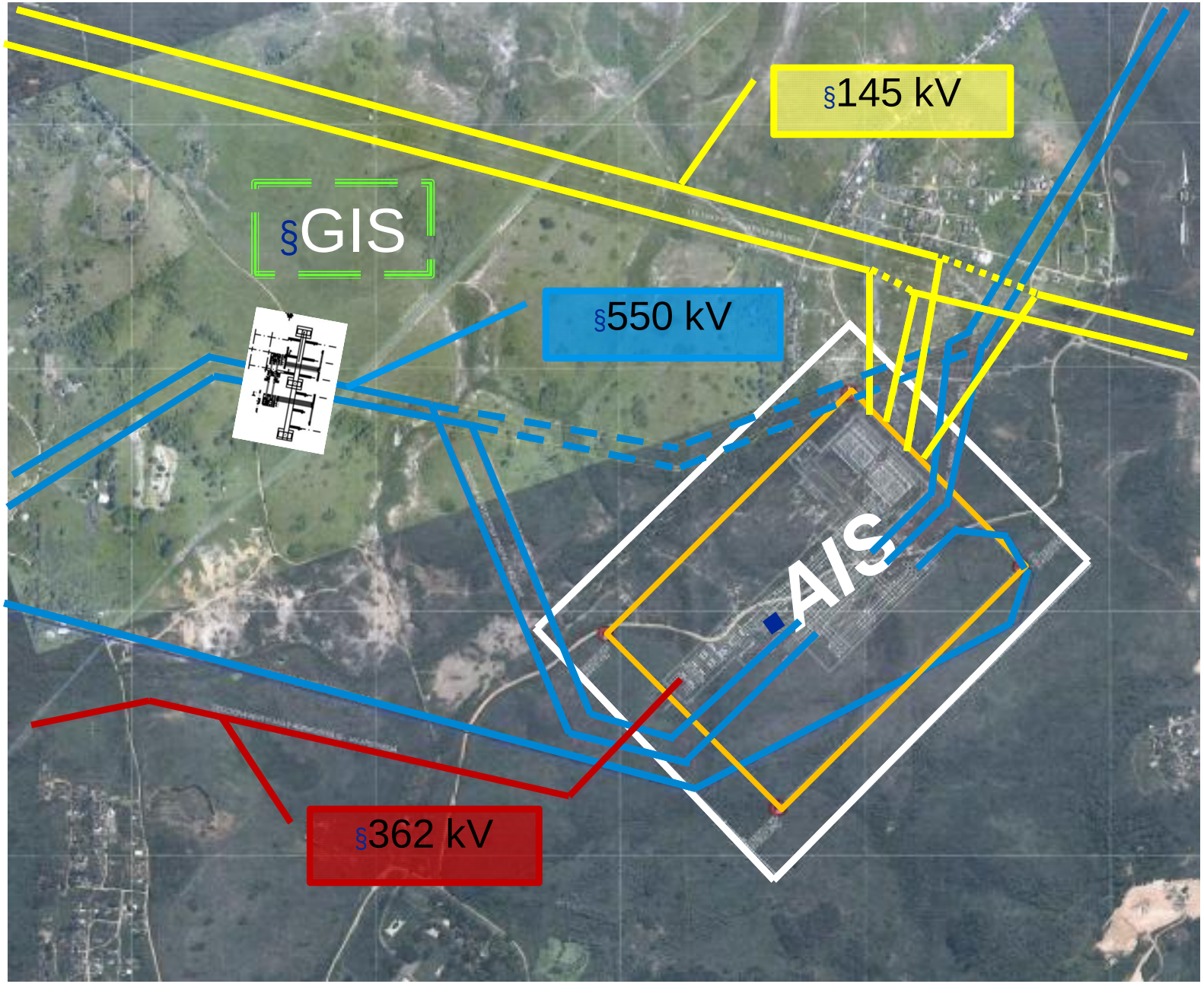


Small footprint 362 kV

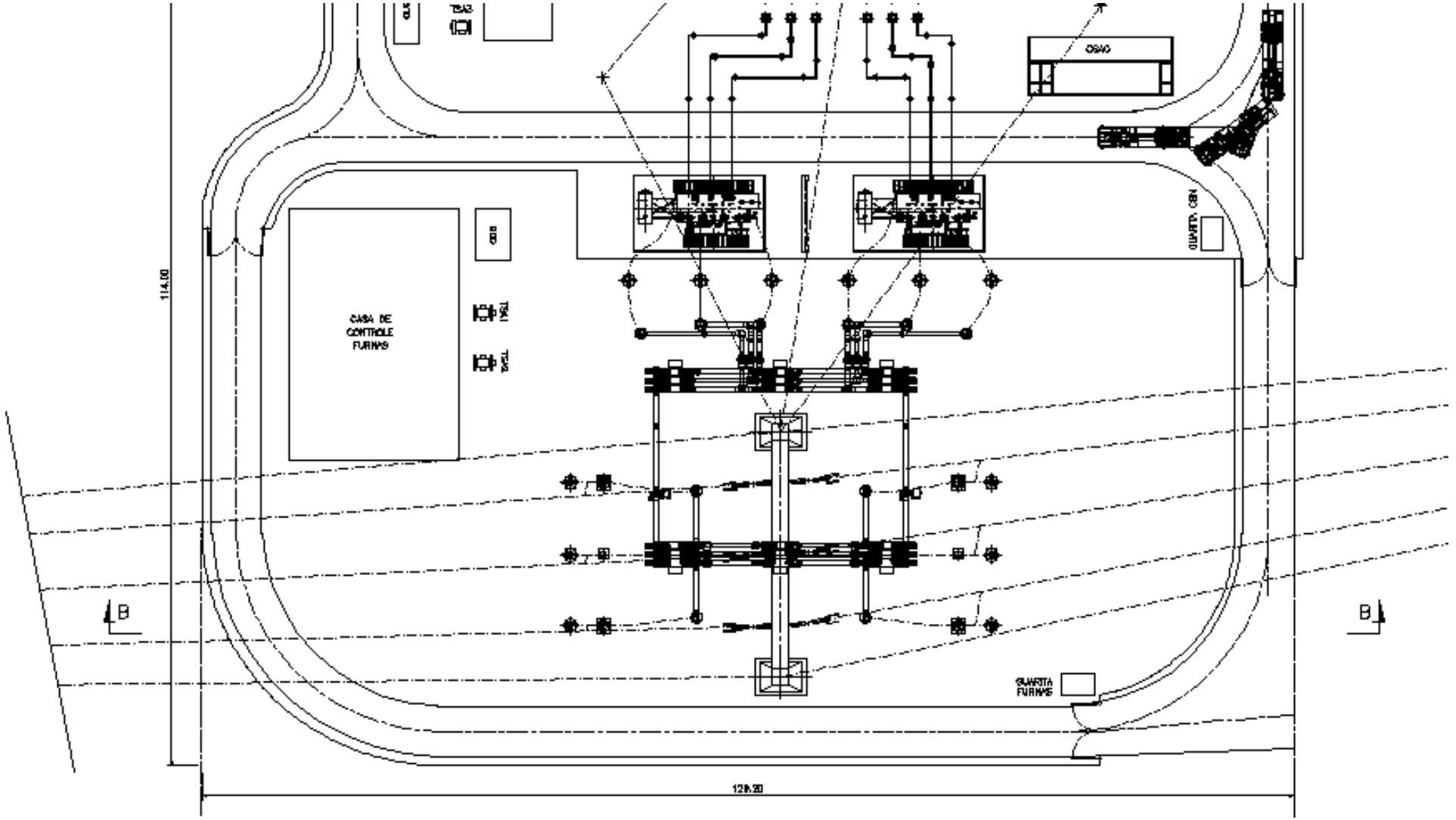




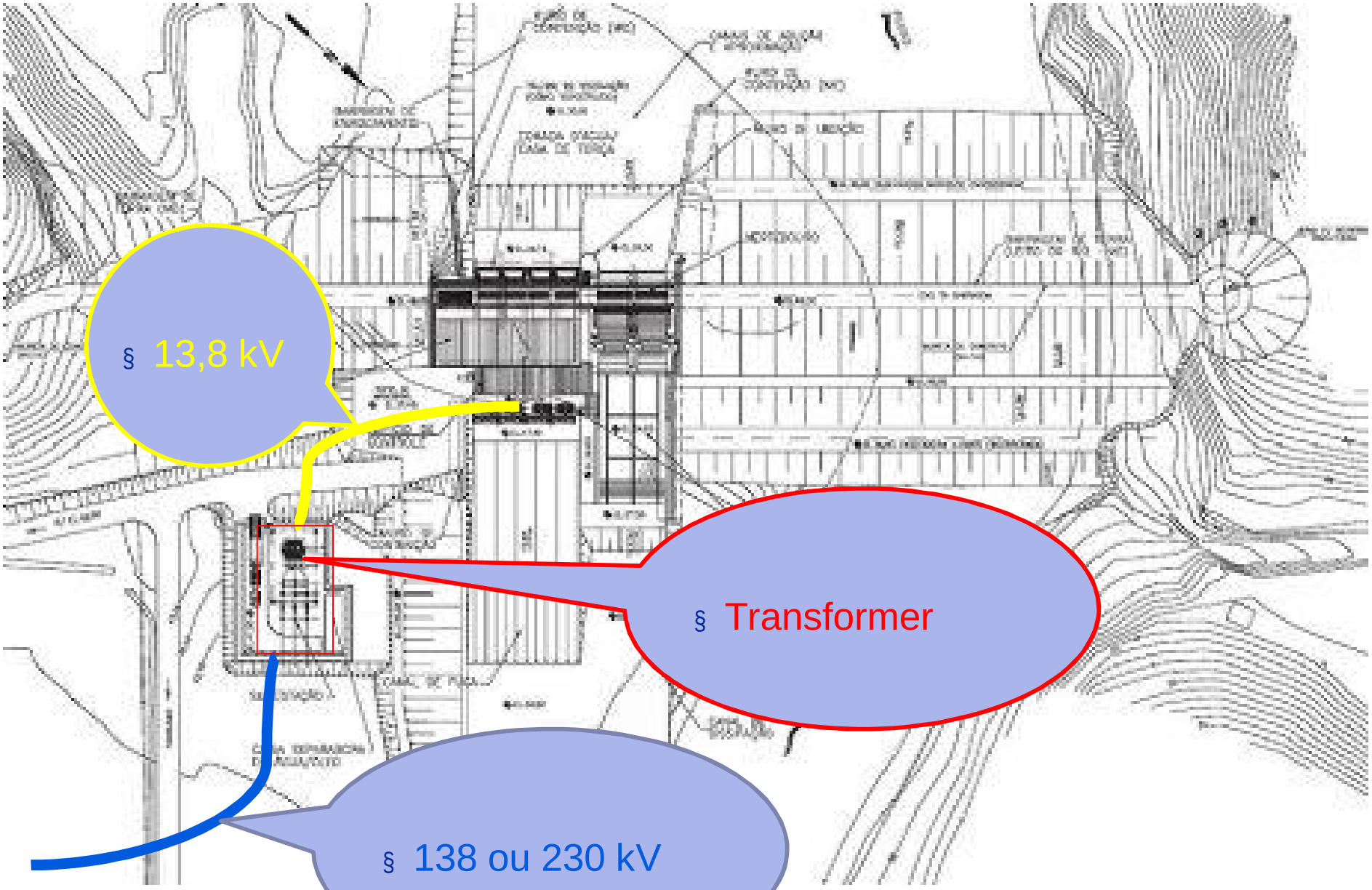
GIS – Transmission



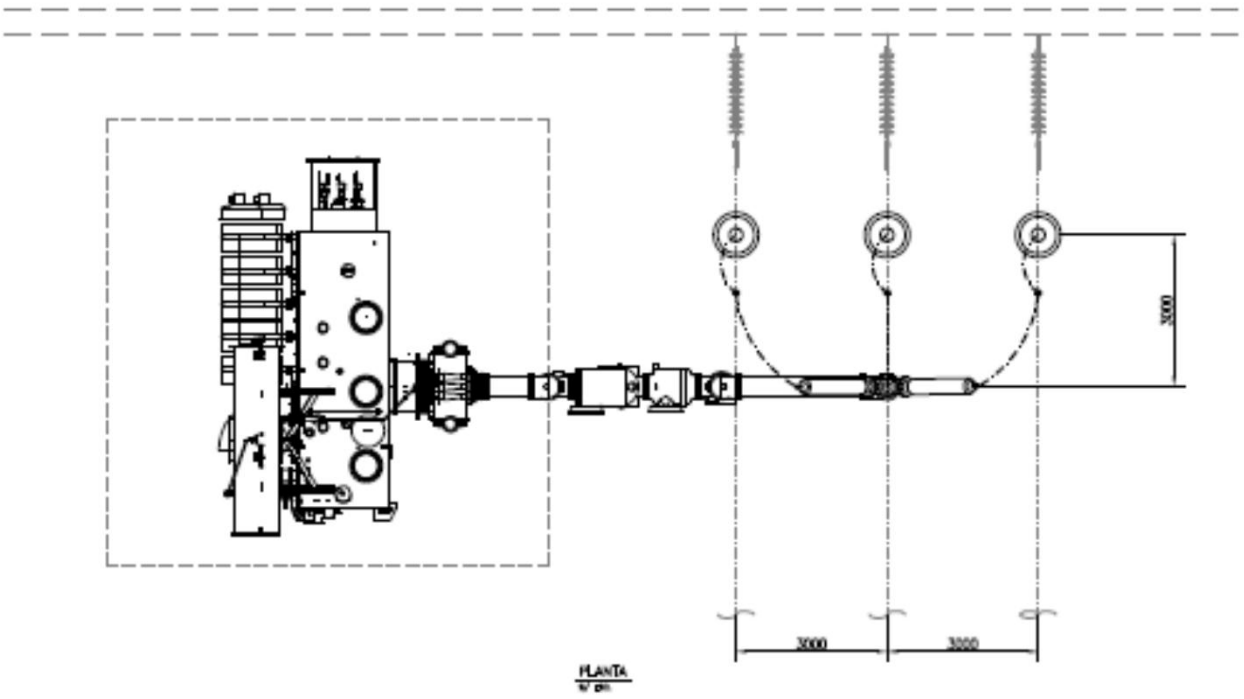
Small footprint 550 kV

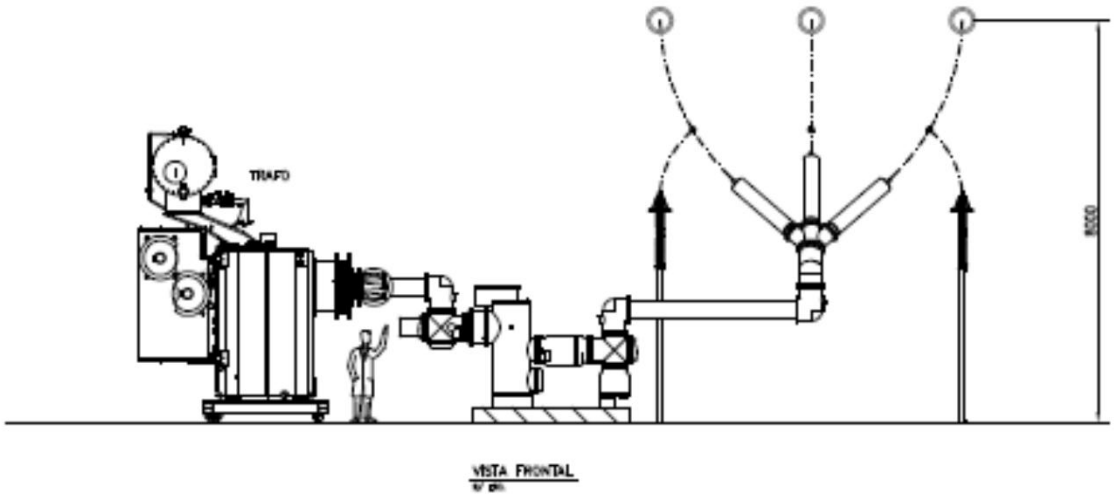


GIS –PCH e ou Industria

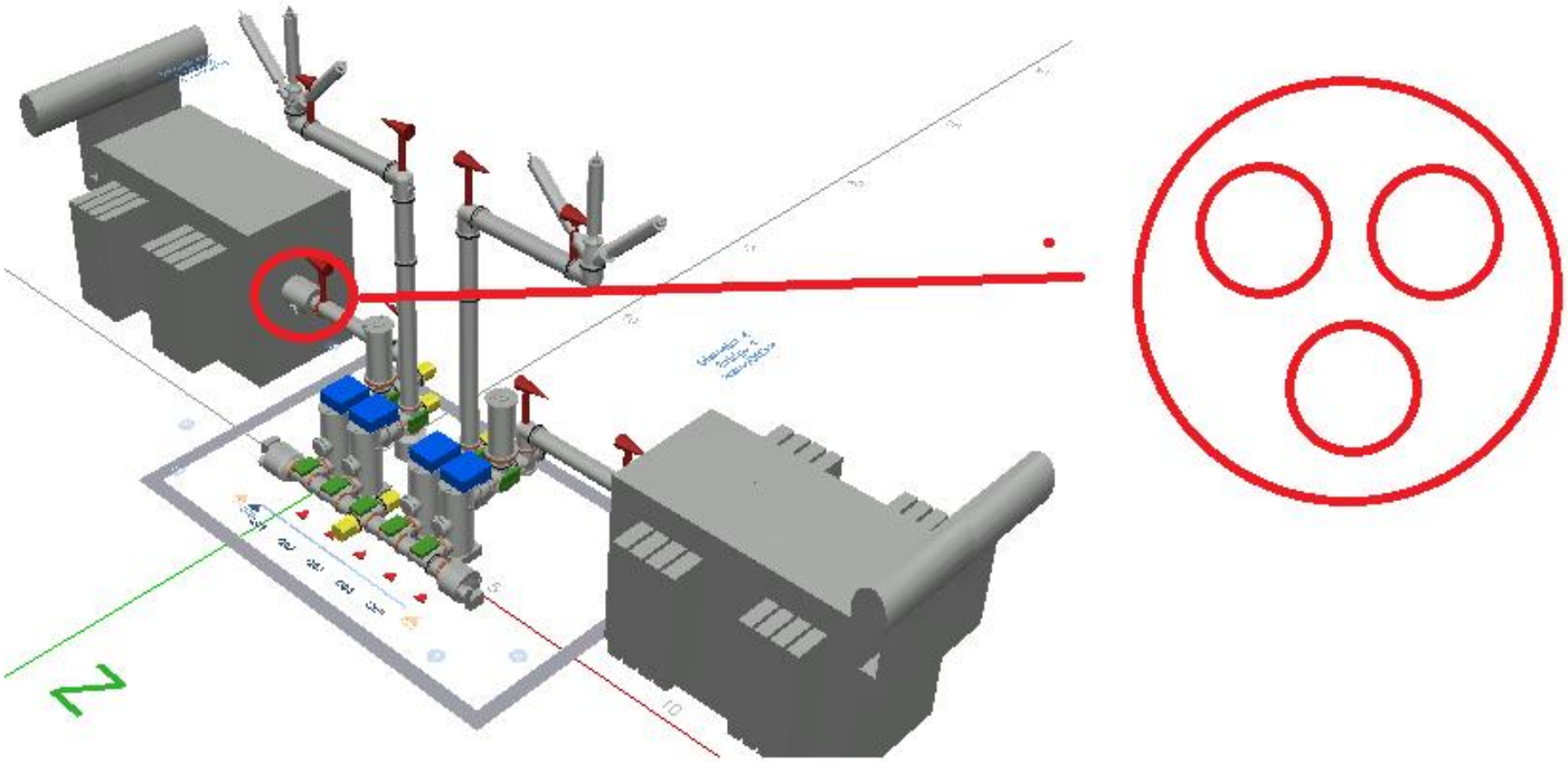


GIS – PCH

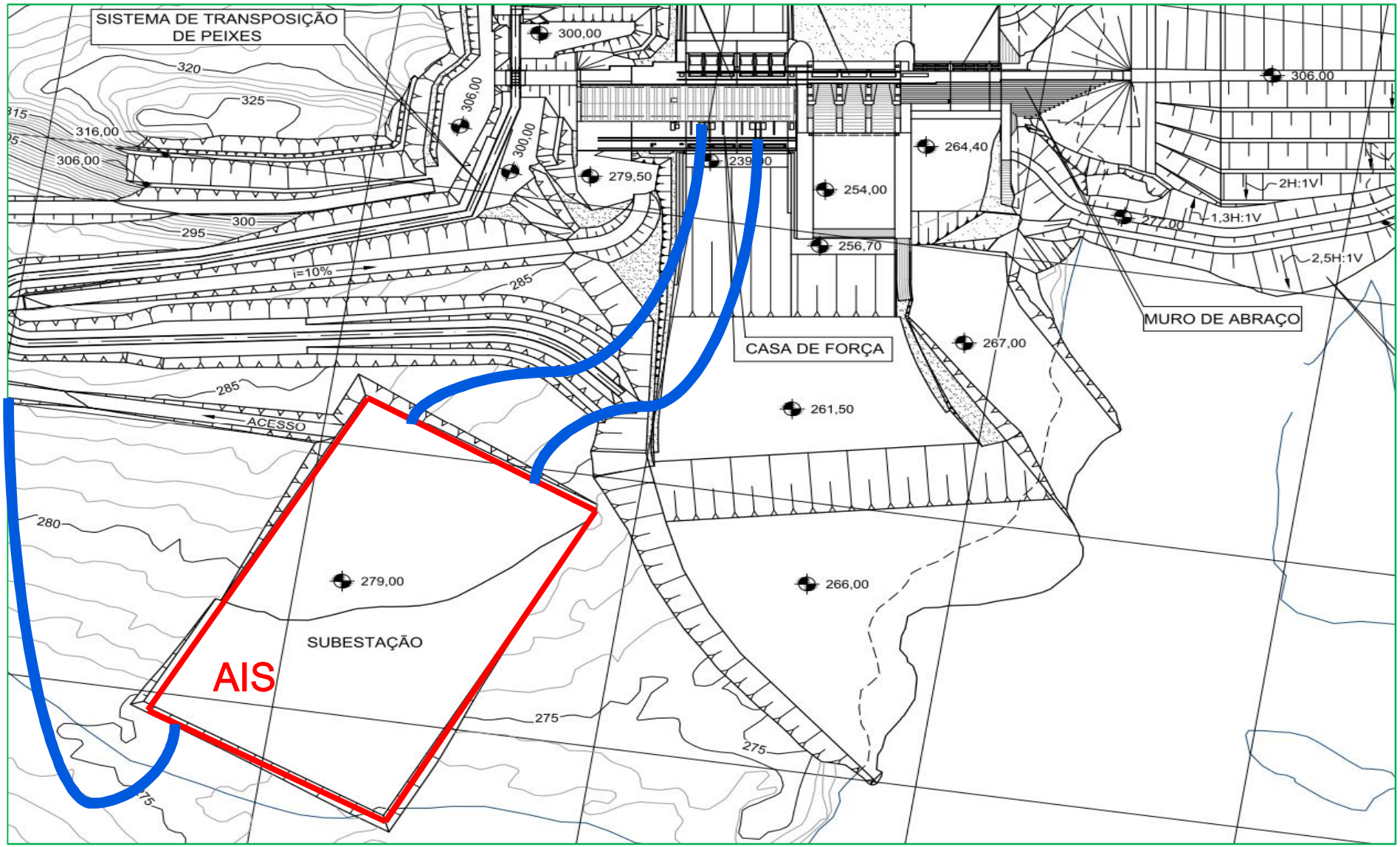




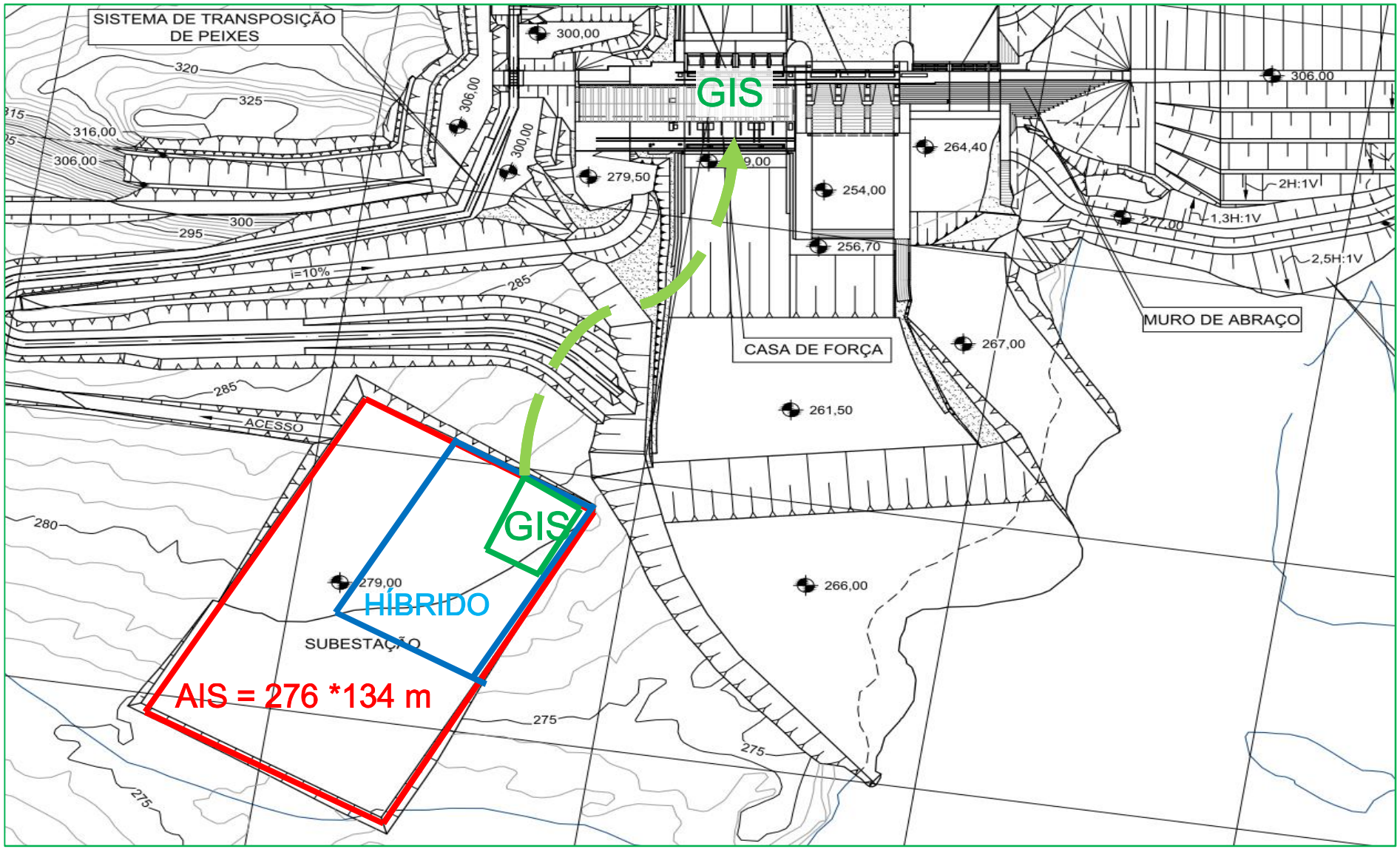
GIS – PCH



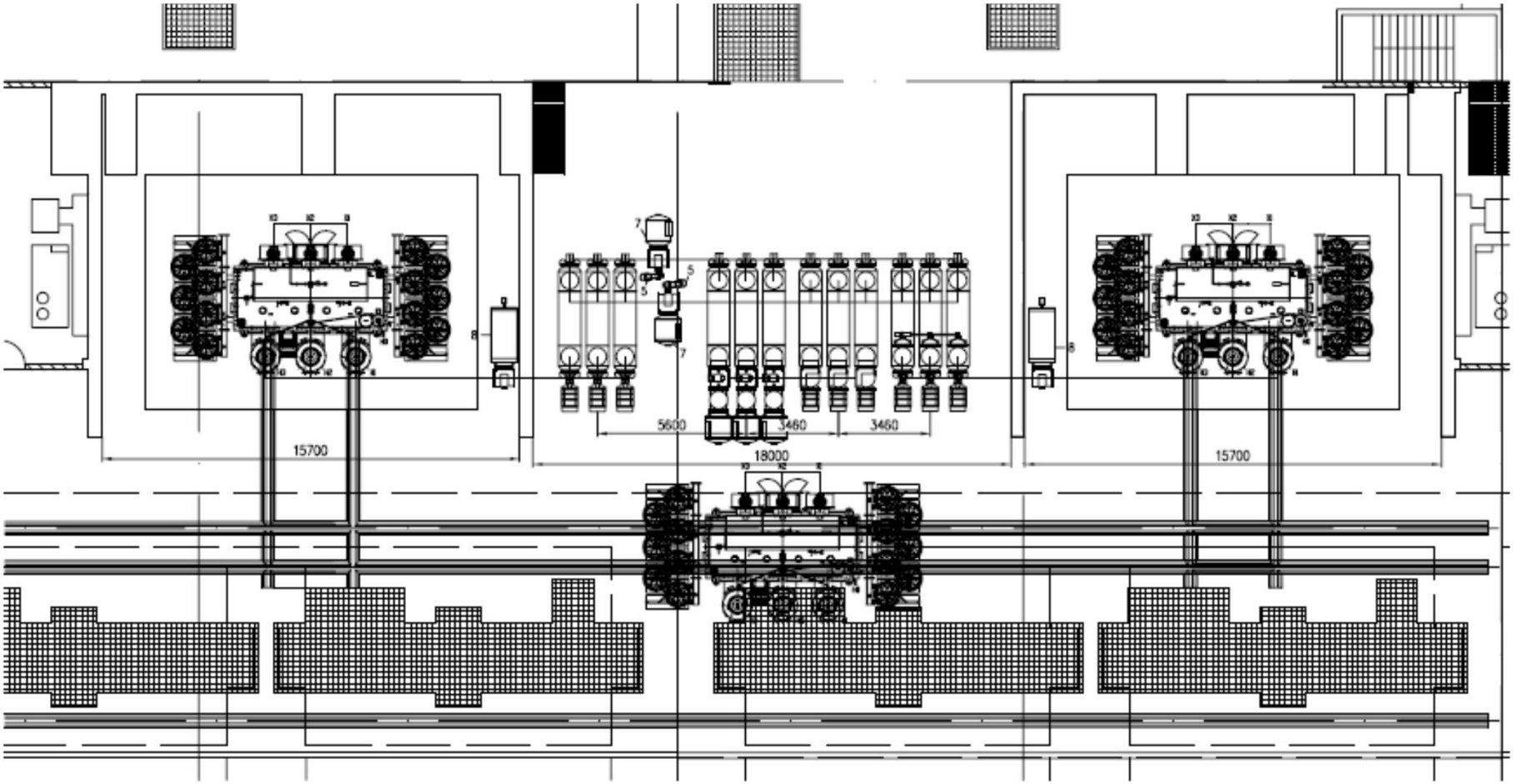
GIS – UHE e ou Industria



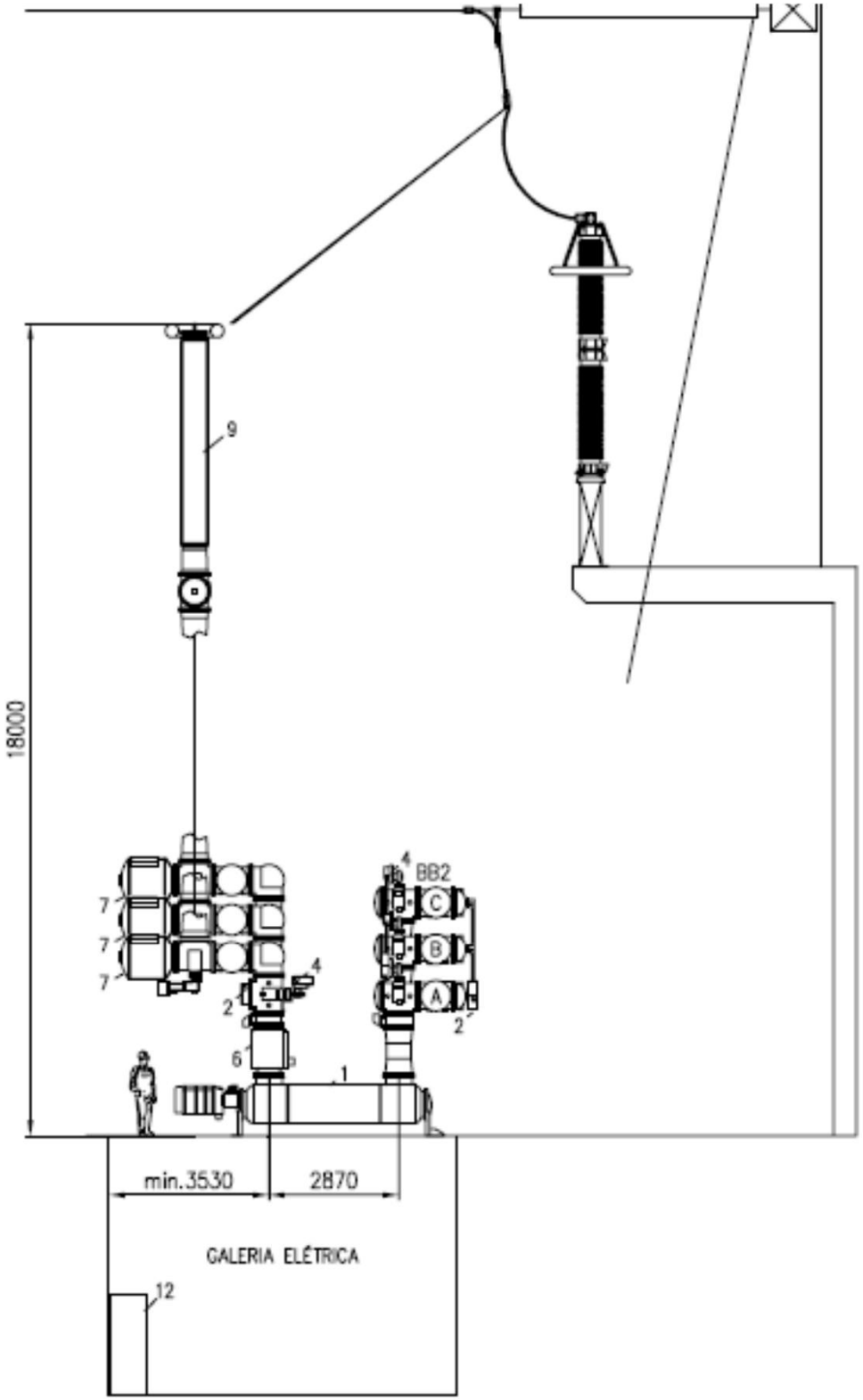
GIS – Usina / Transmissao / Industria



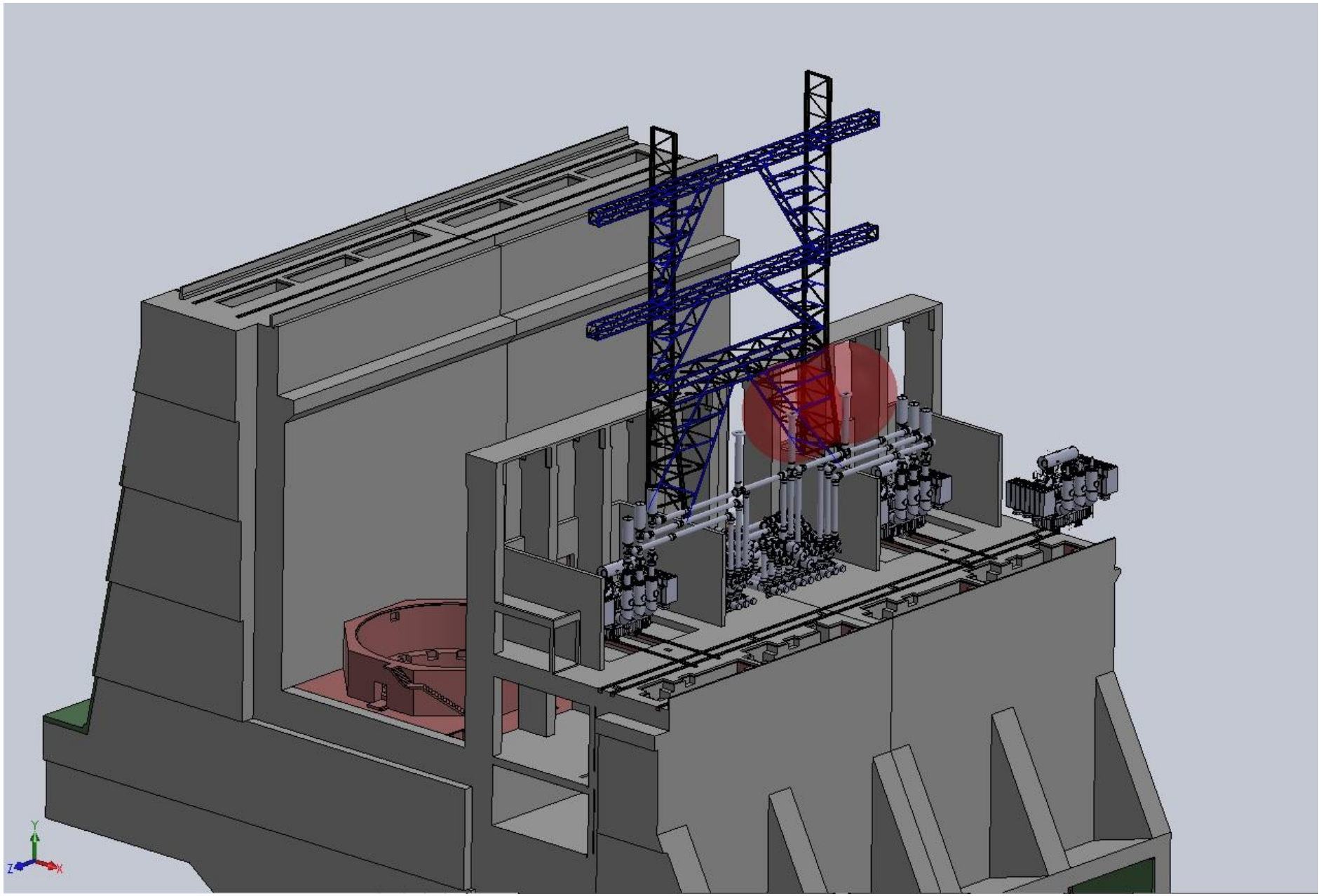
GIS – UHE



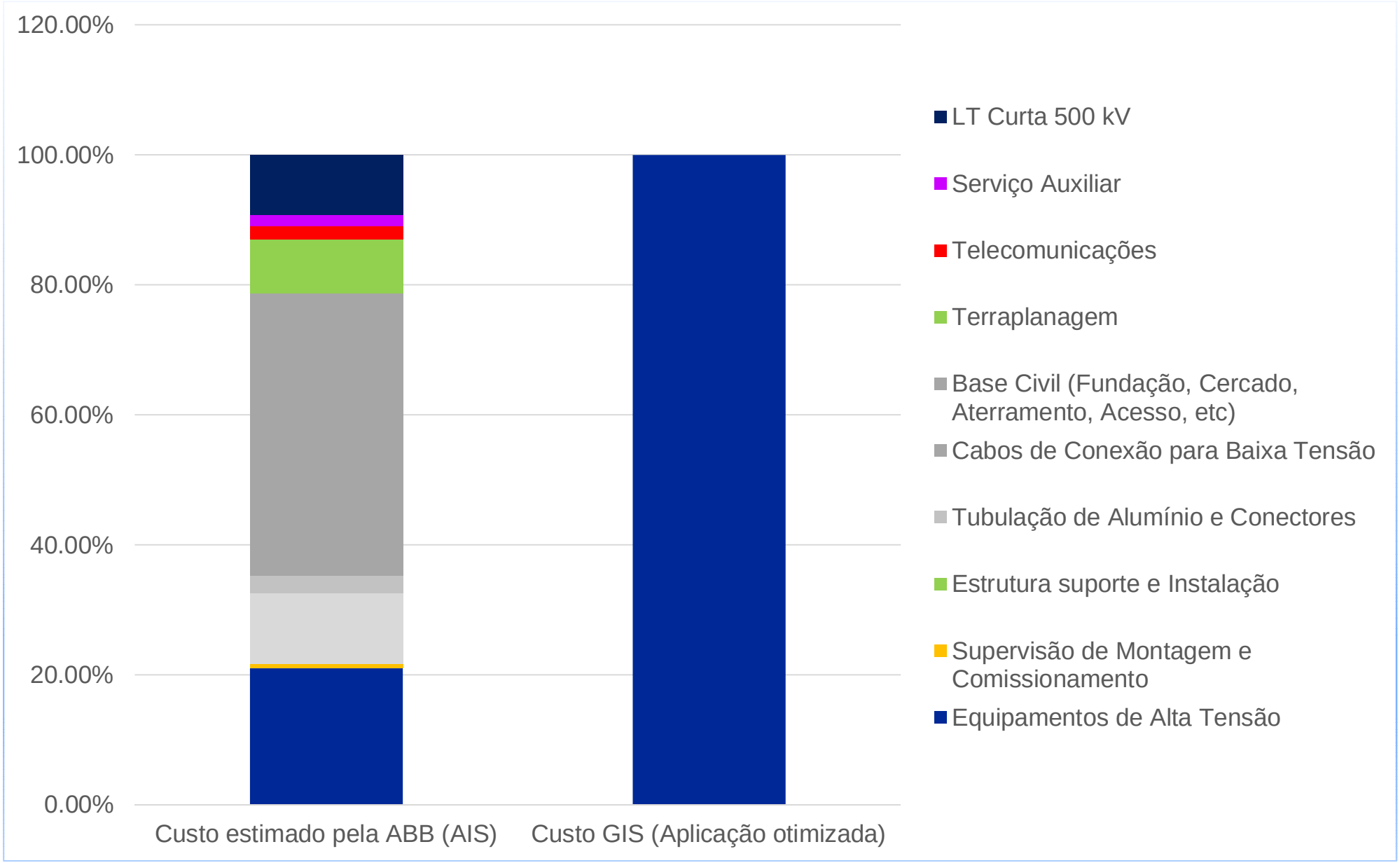
GIS – UHE



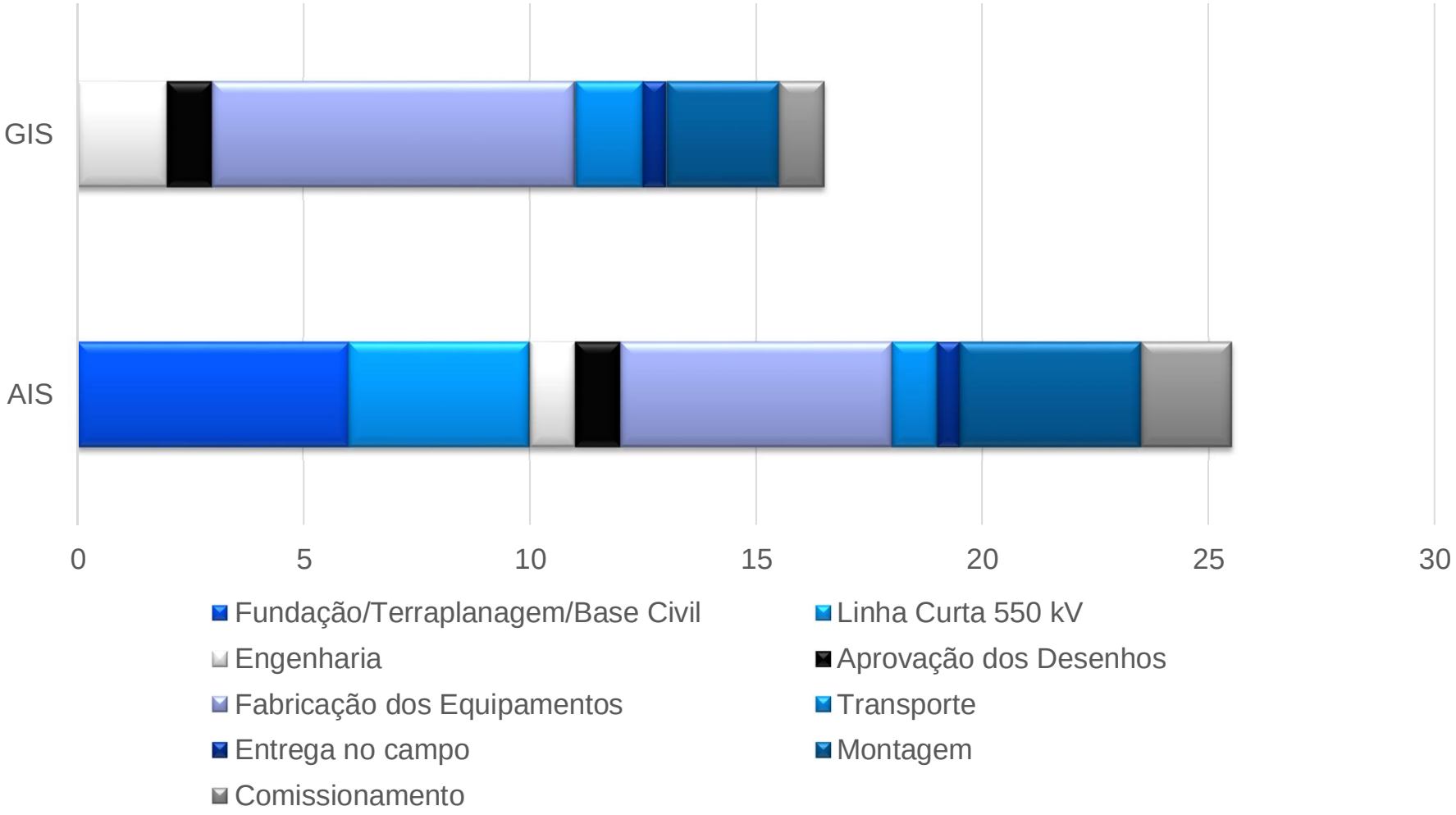
GIS – UHE



UHE – COMPARATIVO – AIS vs GIS

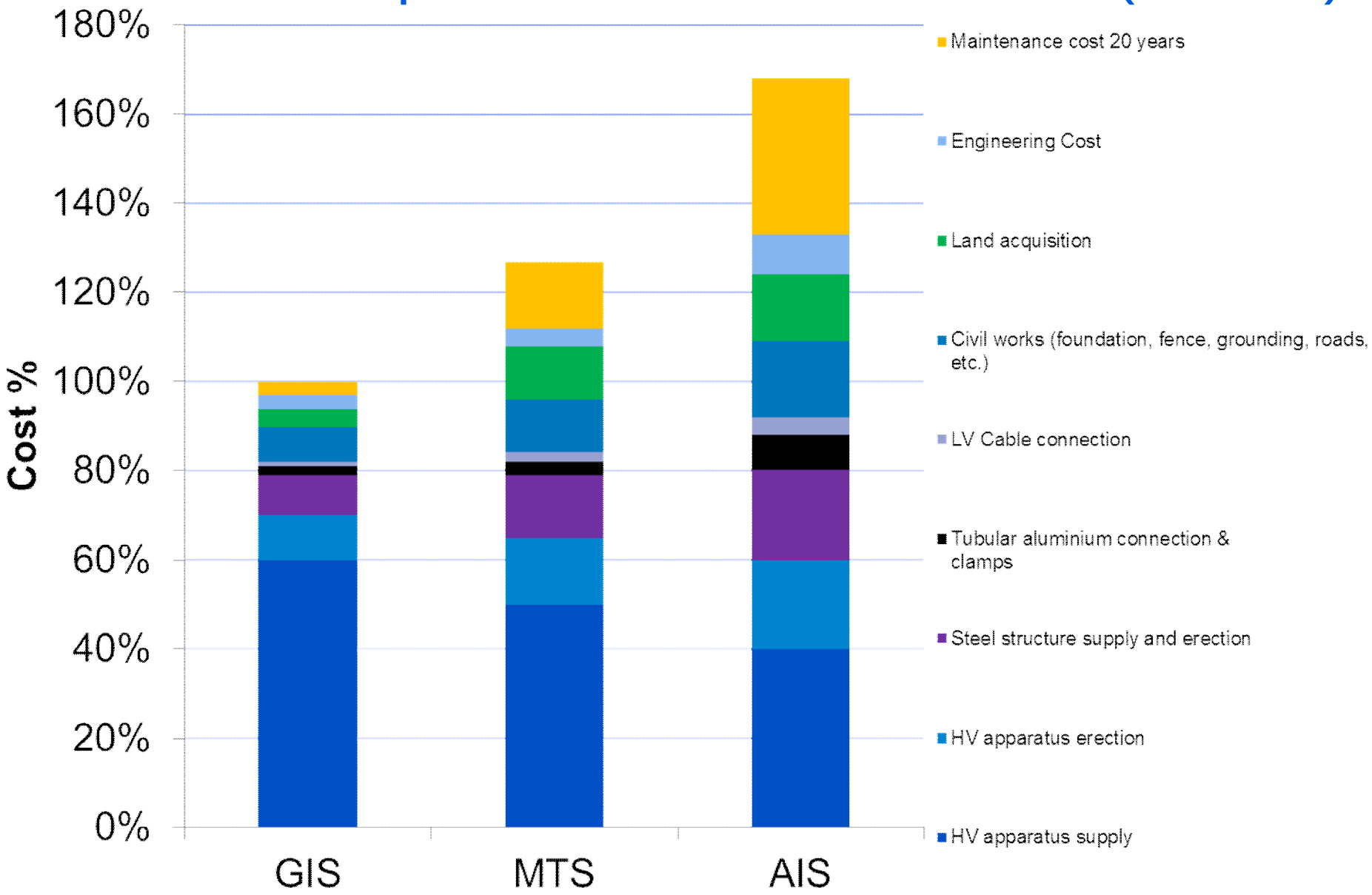


UHE – GIS – Tempo de Execução

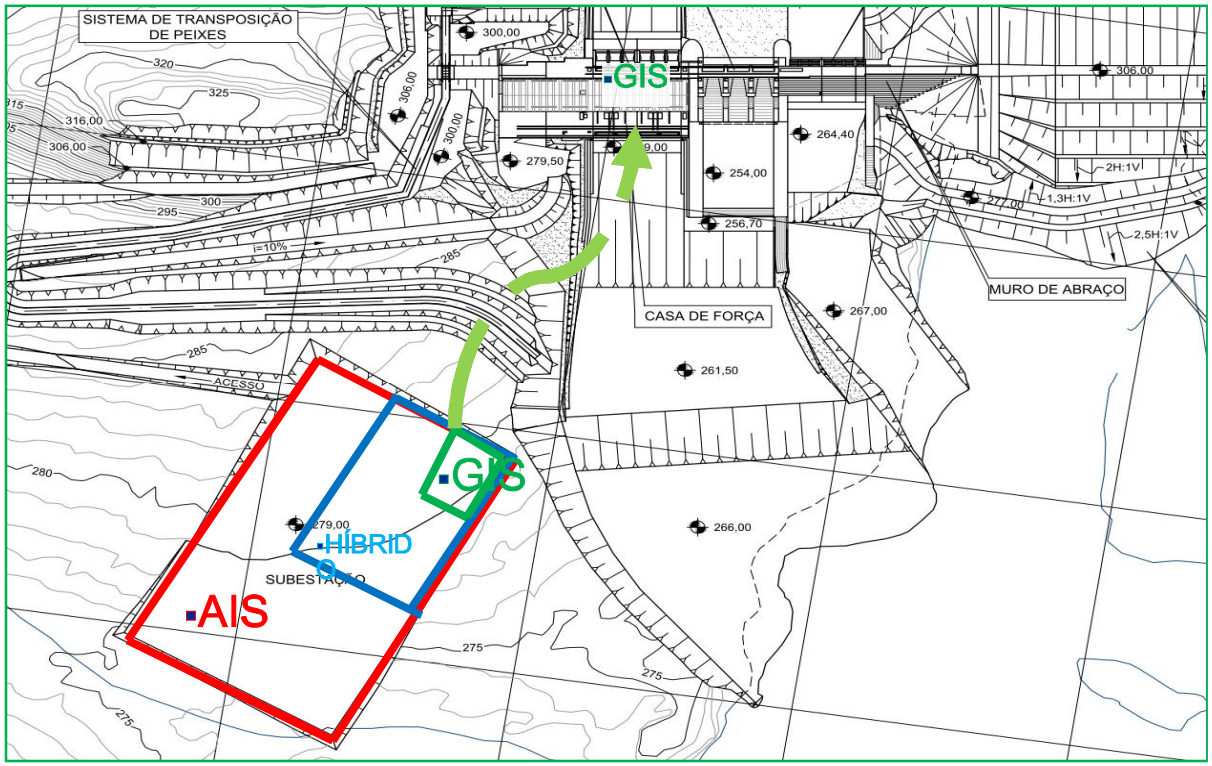


Trends

Economical Comparison GIS – MTS – AIS (500 kV)



GIS – Application

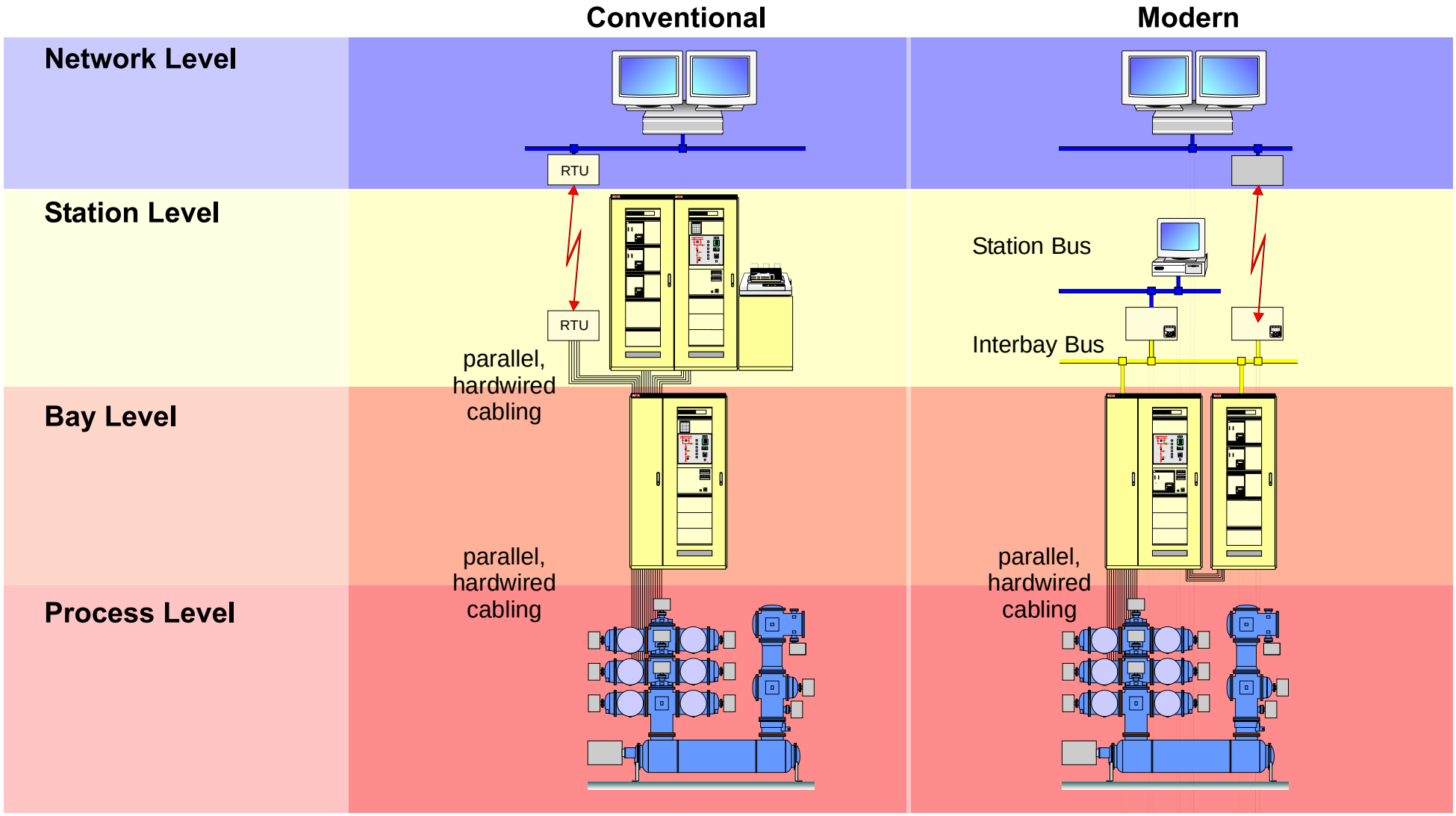


- ***100 %*** eliminación de la SE AIS è flexibilidad de la área a aplicar
- Cortando y optimizando líneas

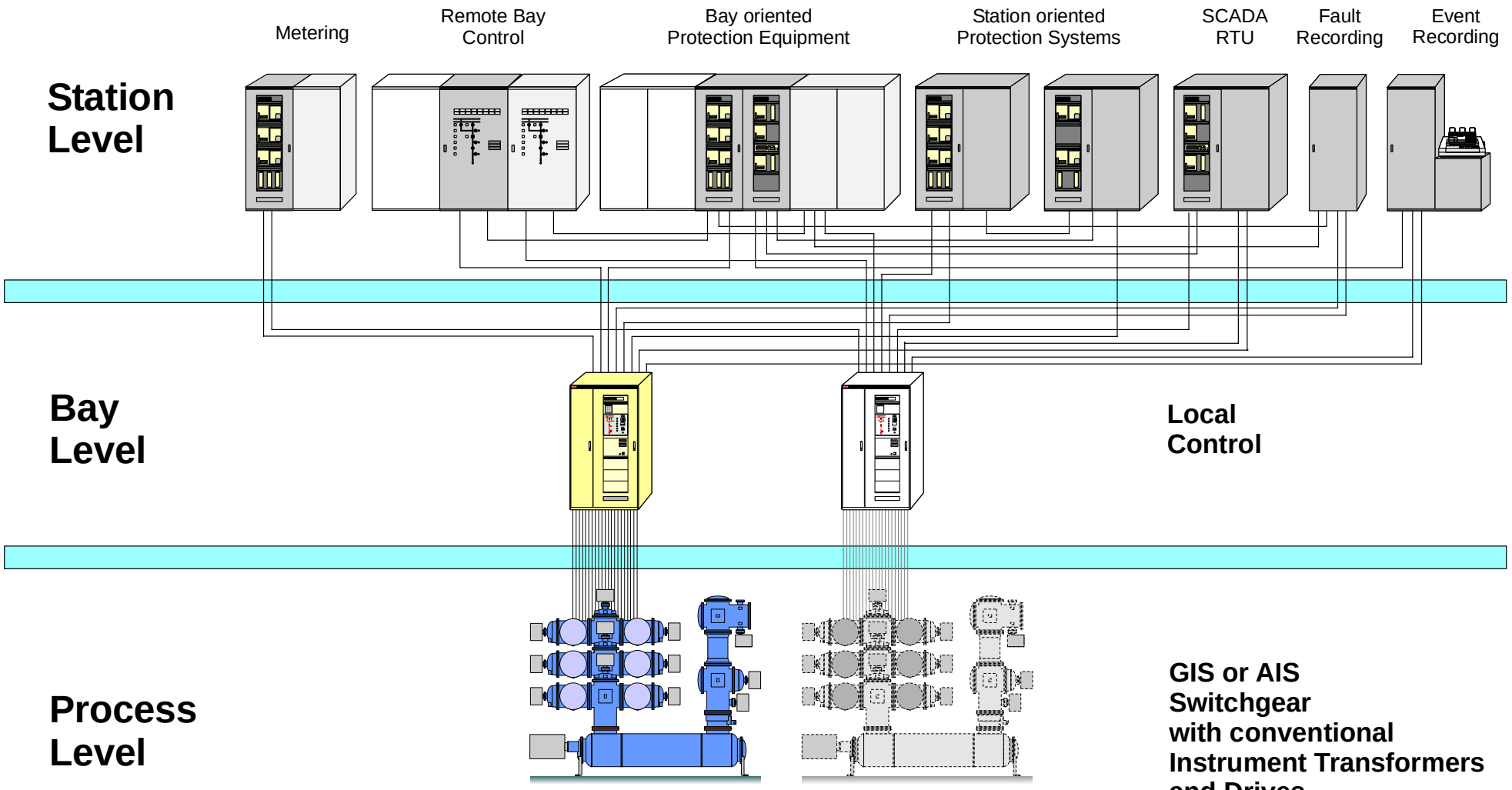
GIS – Industria e ou Shopping

Bay Control Solutions for GIS
Integrated GIS

Technologies Overview



Conventional SA Technology



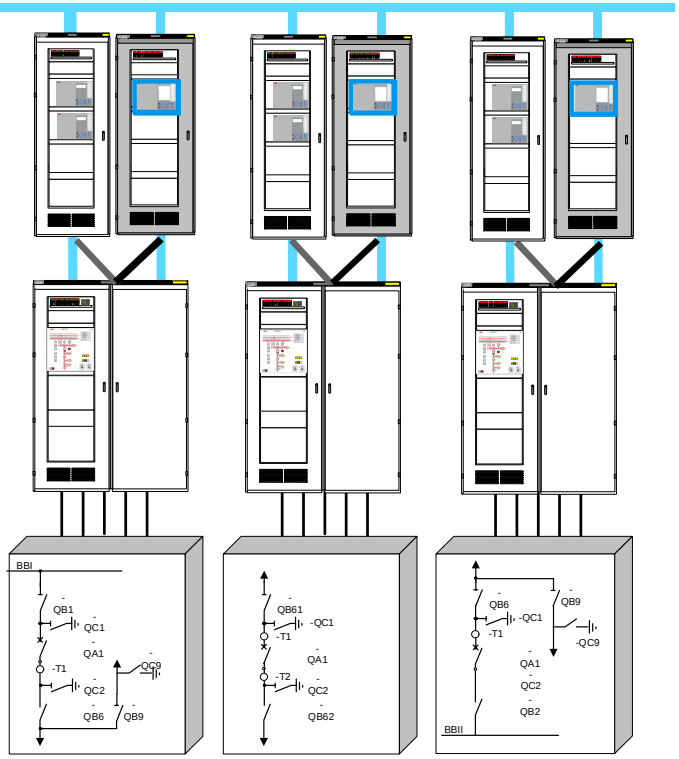
Enhanced integration
From conventional to modern control

IEC61850

Protection Cubicle

Remote Control Cubicle

Local Control Cubicle



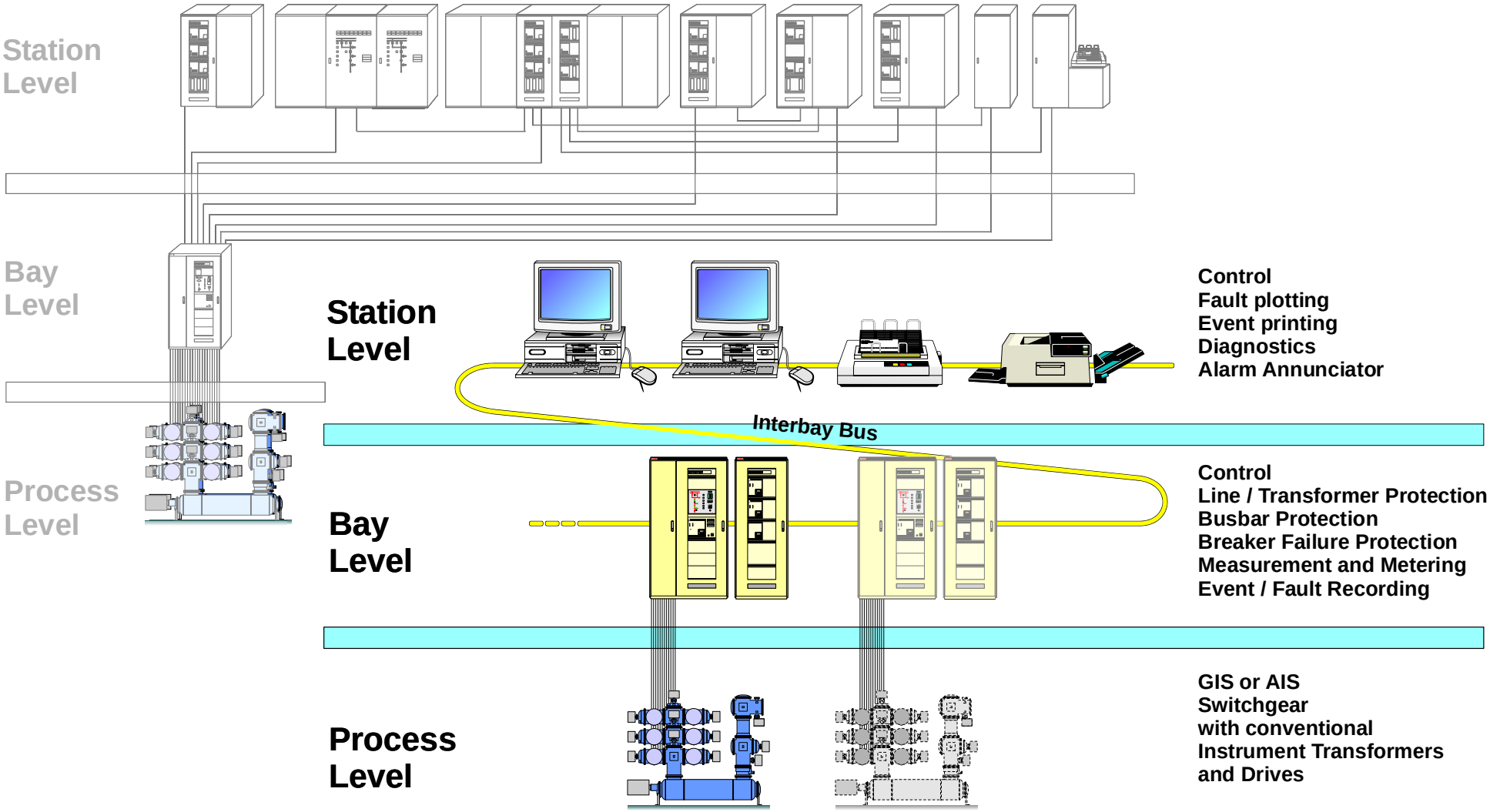
Conventional LCC

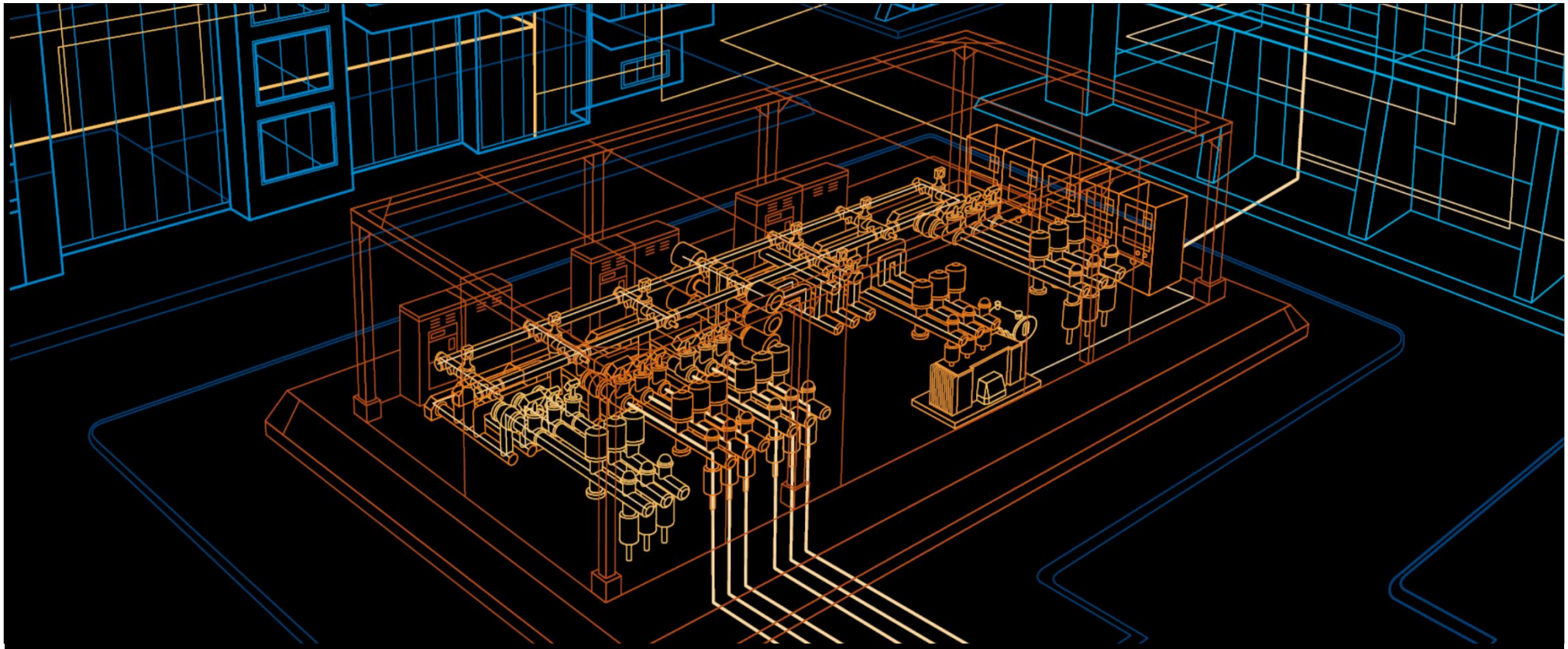
- Normally used if integration into SA system is not in scope of LCC supplier
- The Bay Controller is located in a separate remote control cubicle (RCC)
- **High overall space requirement for LCC and RCC**

Modern LCC (combination of LCC and RCC)

- Direct integration of LCC into station automation system
- Less overall space for panels required
- Fewer inter-panel cabling
- **Lower overall cost**

Modern SA Systems





Integrated GIS technology up to 170 kV

Modular switchgear in prefabricated housing

Power and productivity
for a better world™

Integrated GIS

Three different housing options

- Stand-alone single unit (SHU)
  - base frame only
  - trailer mounted

- Docked double / multiple units (MHU)

- Prefabricated modular building (PFB)
  - building modules are transportable in freight containers

Integrated GIS

Extending the GIS product portfolio

Layouts

LILO	line in-out (single feeder)
H3	3 circuit breakers
H4	4 circuit breakers
H5	5 circuit breakers
x-Ring	Ring with x breakers
SBB	Single Busbar
DBB	Double Busbar

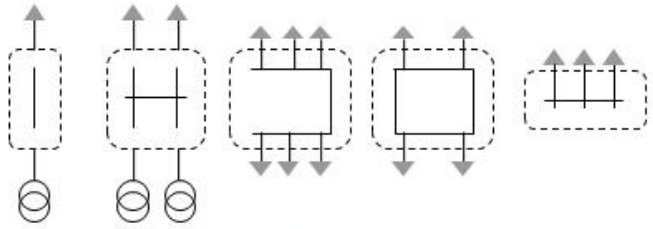
Building types

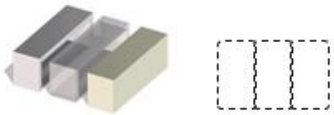
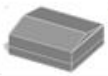
SHU	Single Housing Unit
MHU	Multiple (Docked) Housing Unit
PFB	Pre-fabricated Modular Building

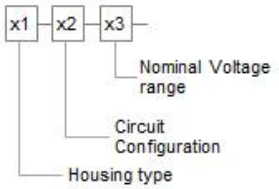
Legend

Integrated GIS	
Conventional GIS	

Busbar configurations

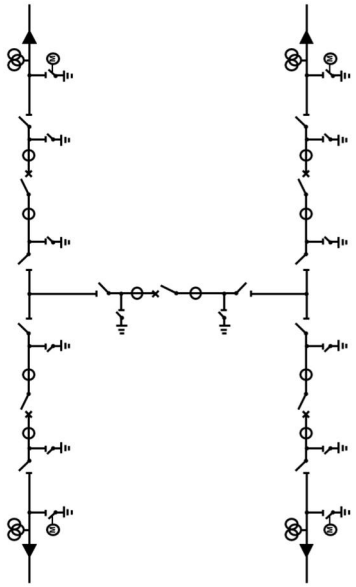


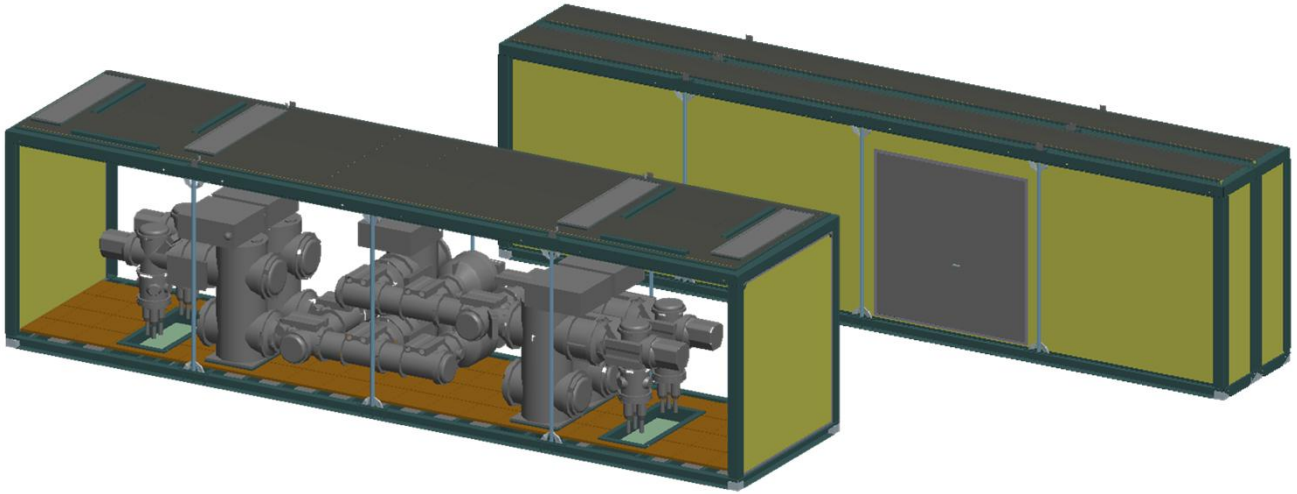
Housing Type	Circuit Configuration	Voltage Range (kV) 72-170	170-245	300	420
Single Housing Unit (SHU)  optional trailer mounts	LILO	■	■	■	■
	H3	■			
	H4	■			
	H5	■			
Multiple Housing Unit (MHU) 	H3		■		
	H4		■		
	H5	■	■		
	4-Ring	■	■		
	SBB U-type	■	■		
	DBB U-type	■	■		
	xBB straight	■	■		■
	1½ Breaker	■			■
Pre-fabricated Building (PFB) 	x-Ring	■	■	■	■
	SBB	■	■	■	■
	DBB	■	■	■	■



x1 SHU, MHU, PFB
x2 LILO, H3, H4, H5, RING, USBB, UDBB, SBB, DBB, 1½CB
x3 72-170, 170-145, 300, 420

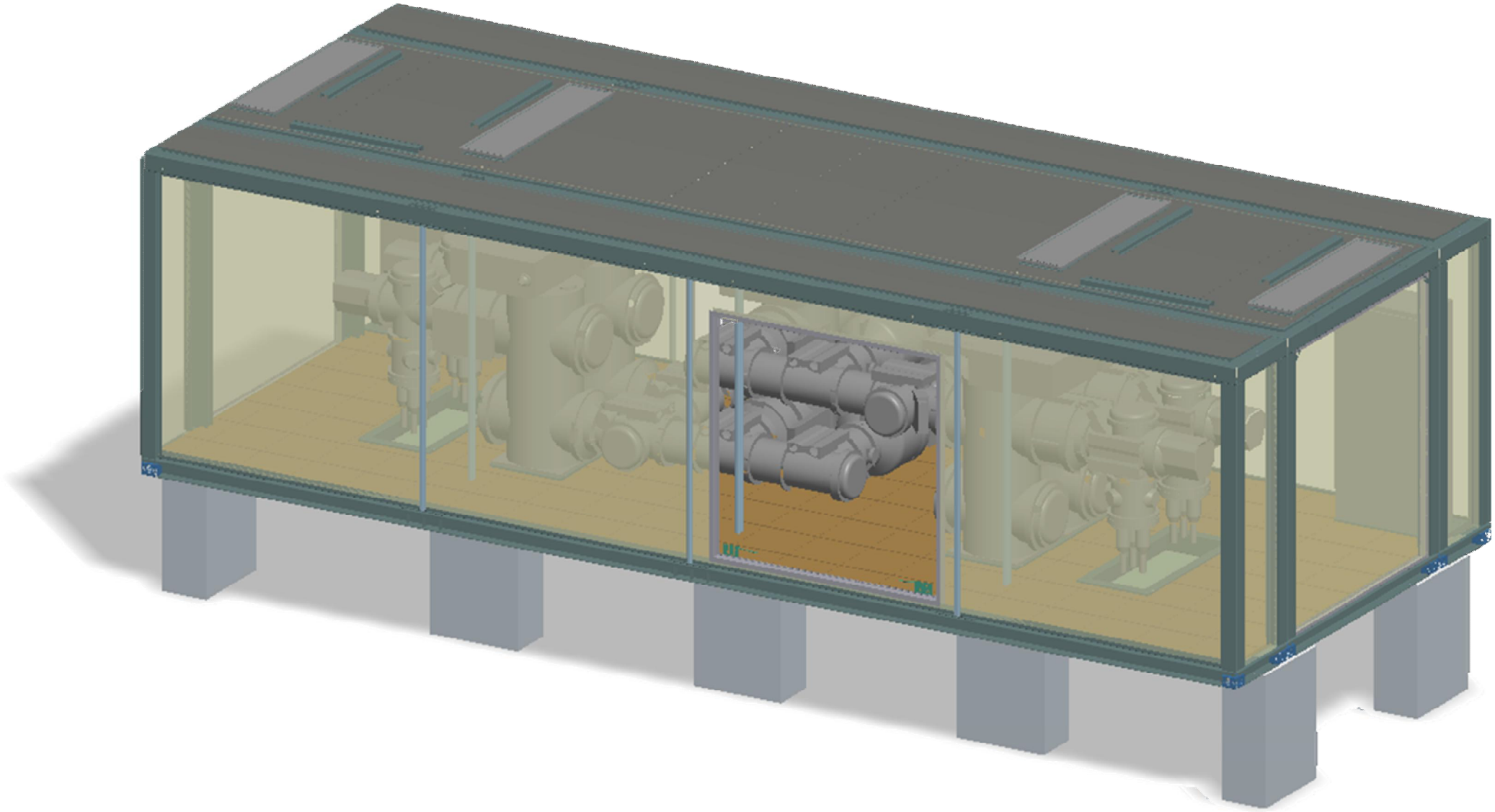
Example – Integrated GIS
H5 145kV, 170kV (ELK04) with cable connections





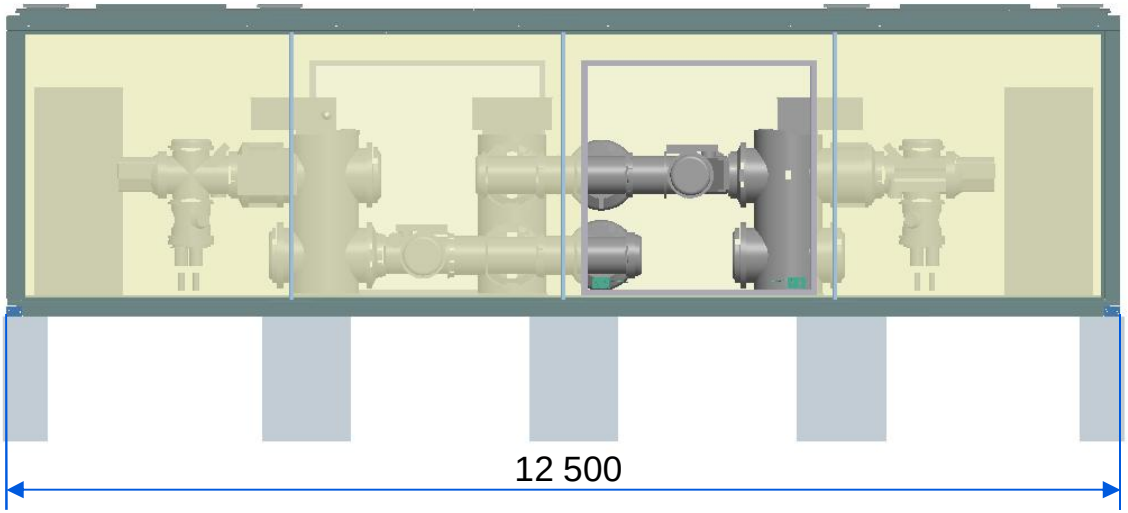
- 2 compact shipping units (LxWxH: 12.5 x 2.5 x 3.5 m)
- Very fast installation on site with pluggable cable connections
- Local control cubicle and substation automation equipment pre-installed

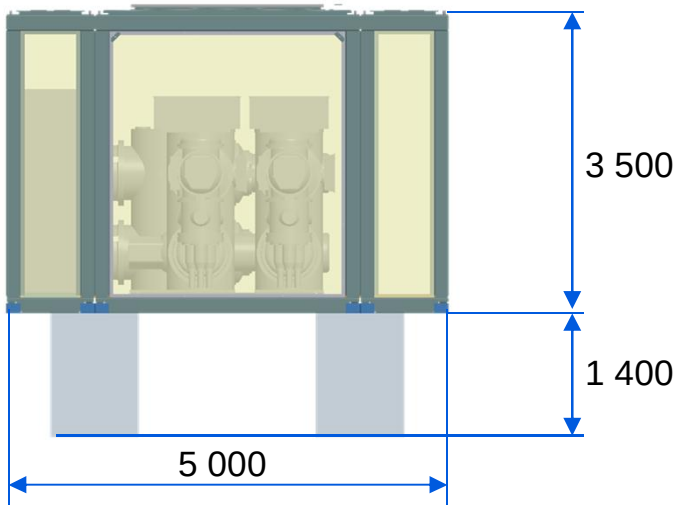
Example – Integrated GIS
H5 145kV, 170kV (ELK04) with cable connections

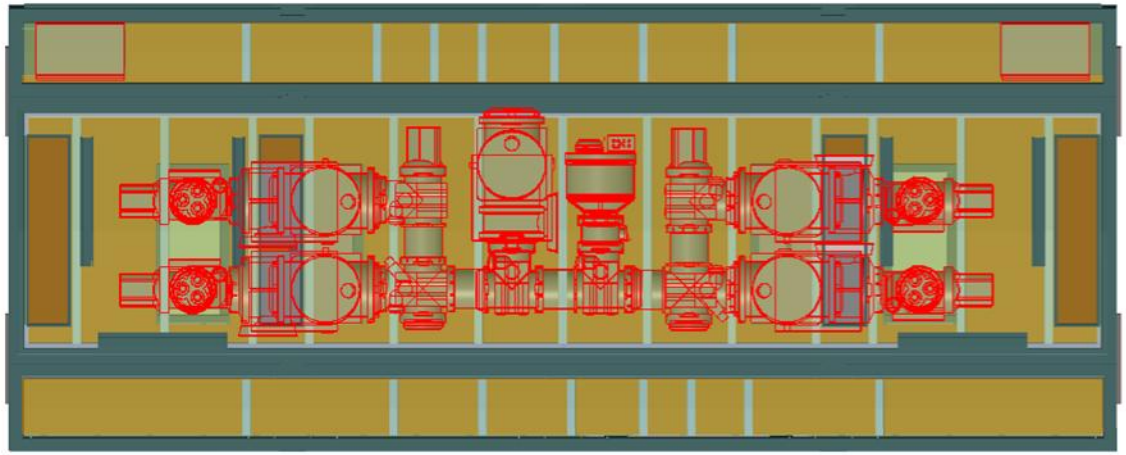


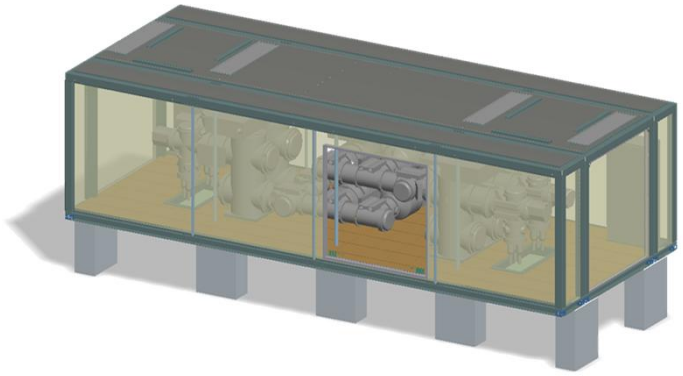
Integrated GIS – ELK04, H5, 145kV / 170kV

(mm)





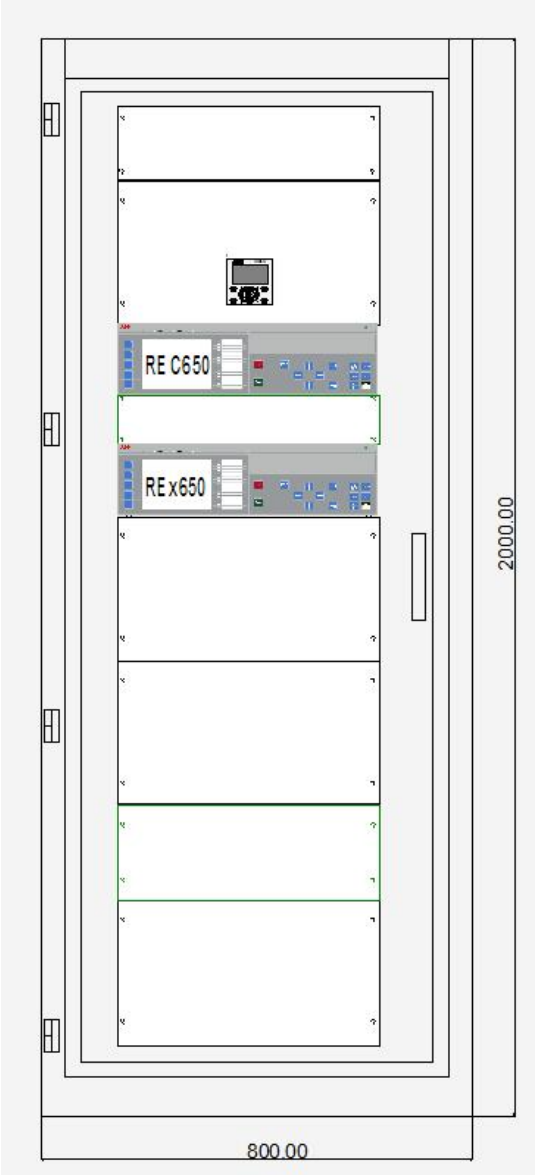




Integrated GIS
Auxilliary Equipment

- HVAC
  - Heating
  - Ventilation & over-pressure
  - Air-conditioning
- LV distribution board
- UPS
- Small power and lighting
- Fire fighting equipment (fixed or portable)
- Fire detectors
- Pressure relief system

Local control cubicle,
Integrated GIS stand-alone version, Smart Grid Enabled



Control Unit – REC 650

Protection Unit – REx 650
(From the Relion 650 family)

Gas Monitoring – MSM

General features

- IEC 61850 compliant

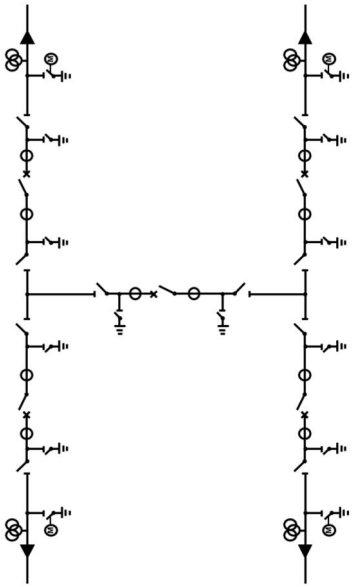
- IEC 61850-8-1 including GOOSE messaging

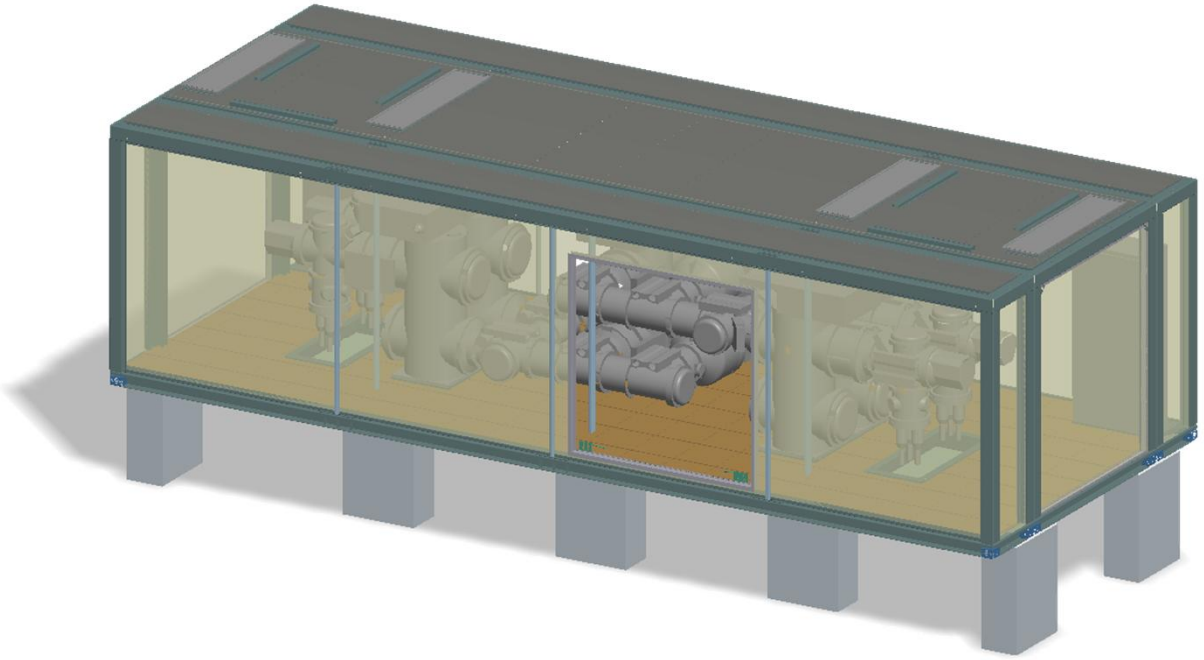
- Monitoring via web interface & IEC 61850

- All IED´s loaded with a standard set of application SW.

- PWC 600 available as option

Integrated GIS
Full Substation Automation Functionality



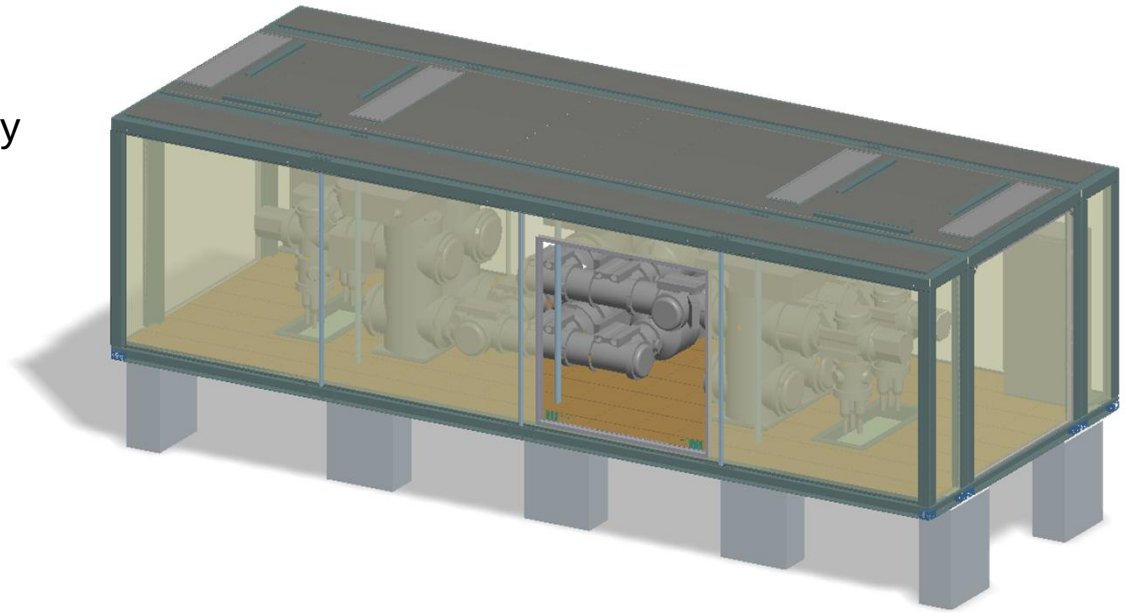


Complete substation automation panel including :

- Assembled and pre-tested panels with control, monitoring and protection IEDs, RTUs/gateways, HMI, local/remote control, including interconnections
- AC/DC distribution panels, batteries, battery chargers, UPS, etc.
- Marshalling cubicles, inter-panel wiring and cable management, etc.
- Environmental management systems for HVAC, station auxiliary systems for alarms (intruder, fire, etc.), CCTV, associated communication systems

Integrated GIS
Full Substation Automation Functionality

- Comprehensive substation automation, protection and control solution for maximum safety, efficiency and reliability
- Fast access to precise information from local and remote to shorten response times

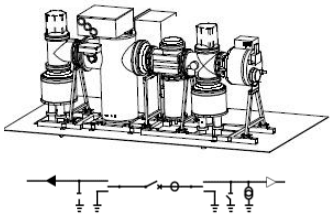


System features	
IEC 61850 compliant	ü
Built-in cyber security	ü
Flexible automation functions	ü

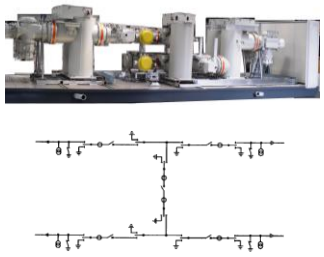
Monitoring and control features	
System supervision, alarms, events, status indications, measurements	ü
Remote control, monitoring and diagnostics	ü
Local control and monitoring	ü
Uploading and storage of disturbance fault records	ü

Aplicación GIS integrada
Subestación completa

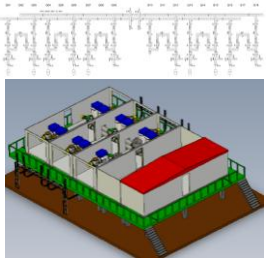
§Bay entrada / saida



§Configuração -H



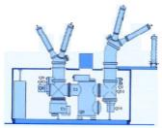
§Multiplos bays (>5)



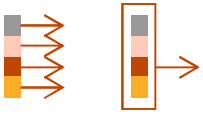
§Entrega rapida

§Flexibilidades no Sistema com modulos configuraveis

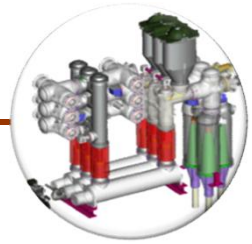
§Facilidade e instalação rápida montagem e commisionamento (pré-testado)



§Subestação com layout compacta



§Numero reduzido de interface de engenharia para integradores de sistema com o aumento do escopo de fornecimento



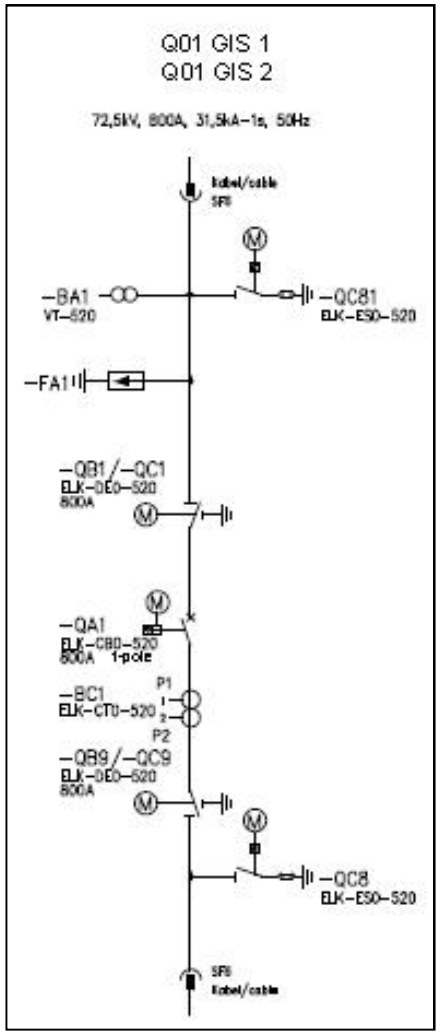
Tecnologia primária & secundária em GIS

Controle & Proteção (C&P)

Casa pré-fabricada com estrutura completa

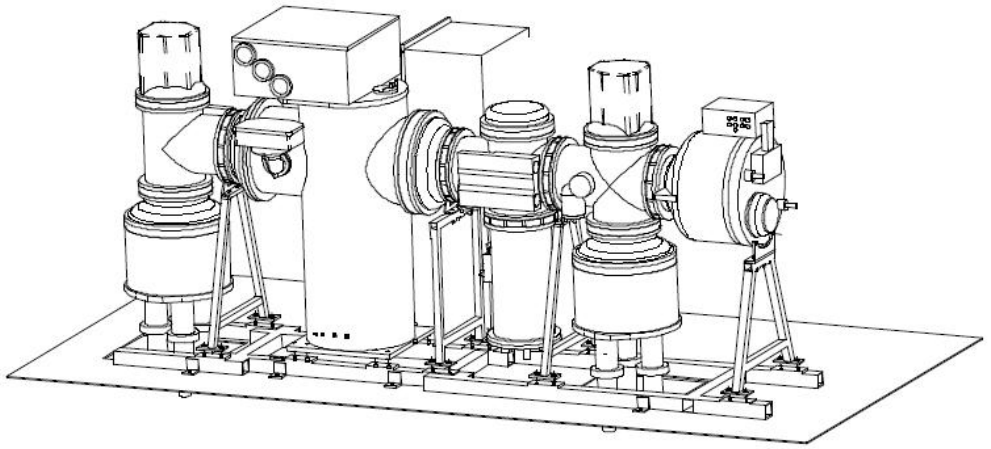
Integrated GIS technology up to 170 kV
Selected References

Project Example - Jernbaneverket Norway (Rail Utility)
Integrated GIS 72.5kV



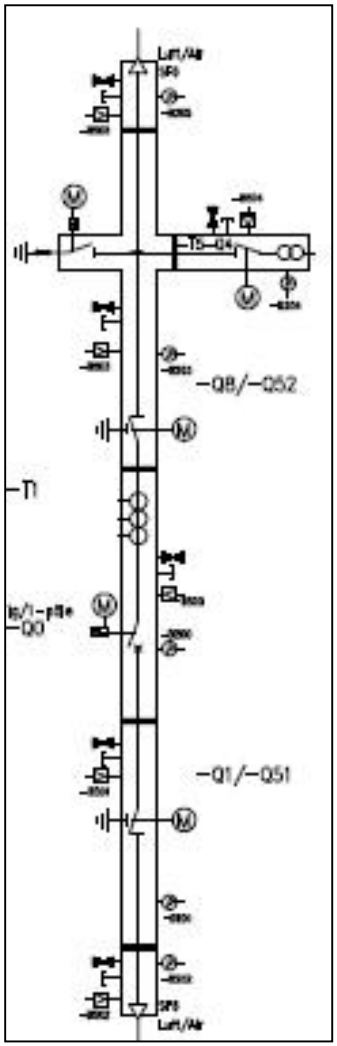
- 2 x units single feeders in housing

- EPC intermediary: Balfour Beatty Rail, Sweden
- Scope DEABB: Integrated ELK04
- Status: Shipping, FAT approved by customer

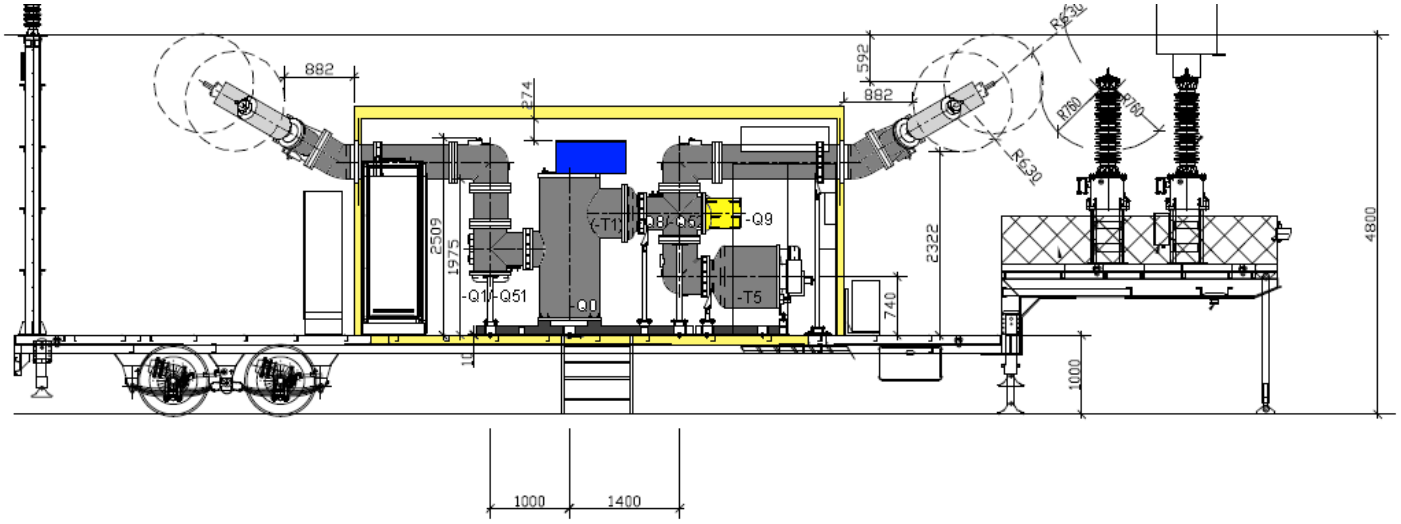


Project Example - Jernbaneverket Norway (Rail Utility)
Integrated GIS 72.5kV

Sonelgaz, Algeria
Cabines Mobiles, 72.5kV

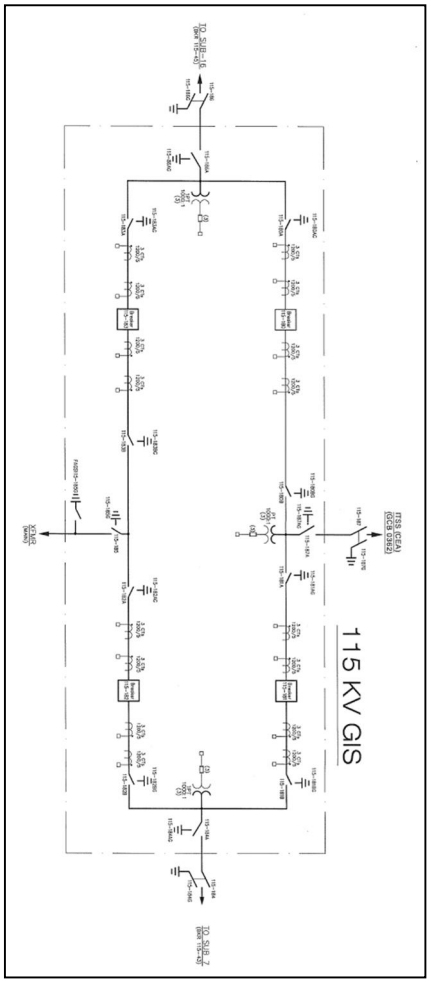


- 18 x units Mobile GIS (trailer mounted) in climatized housing.
- EPC intermediary: MATELEC, Lebanon
- Scope DEABB: GIS (ELK04) + Housing
- Status: Awarded DEABB, P.O. sent to housing supplier (Gföllner, AT).
- Delivery scheme: start in May 2013,
  rate: 4 units per week,
  all units shipped until June 14, 2013.

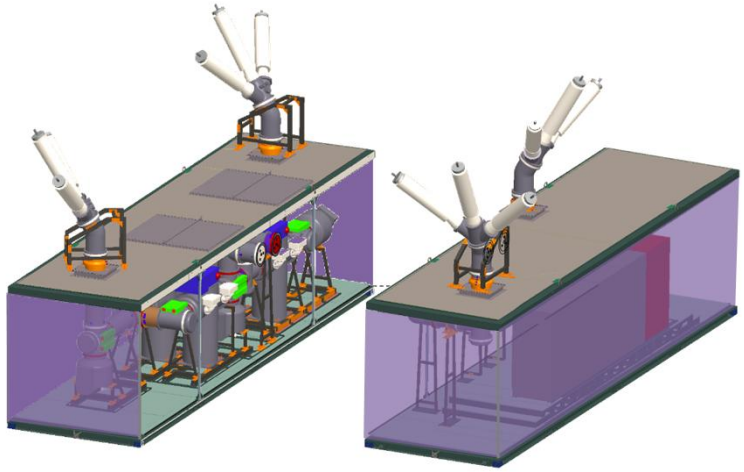


Project Example - Sonelgaz, Algeria
Housing unit with A/C and Bushings

Project Example - Anchorage, Alaska US
MHU ELK04, 145kV

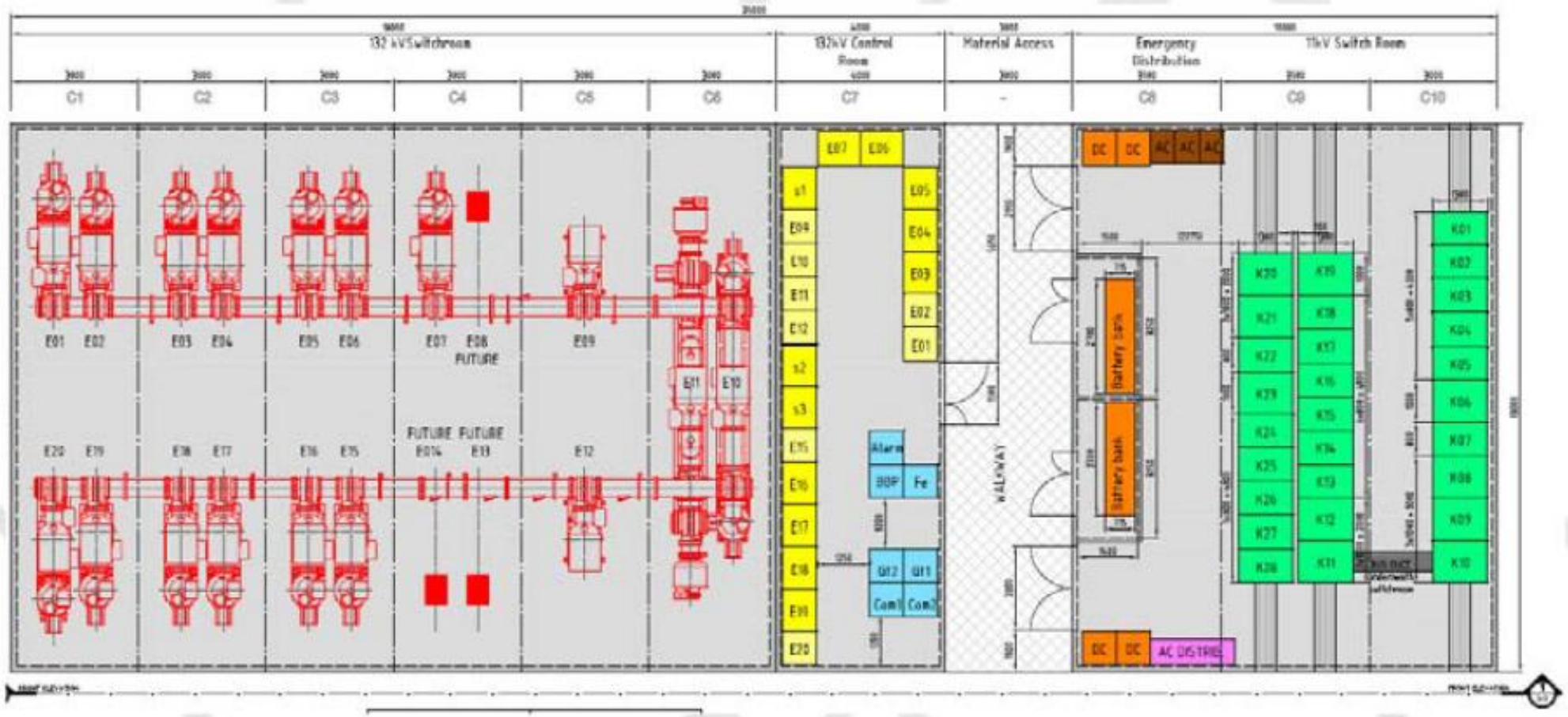


- Integrated GIS in climatized housing.
  - 4 circuit breakers in ring application
  - Roof mounted bushings
  - Footprint with AIS (DTBs): 180ft x 150ft, 27,000 sqft
  - Footprint with Integrated GIS: 40ft x 21ft, 840 sqft



Project Example – Anchorage, Alaska US
Substation completed

Project Example – Constancia, Peru
Mining and Mineral

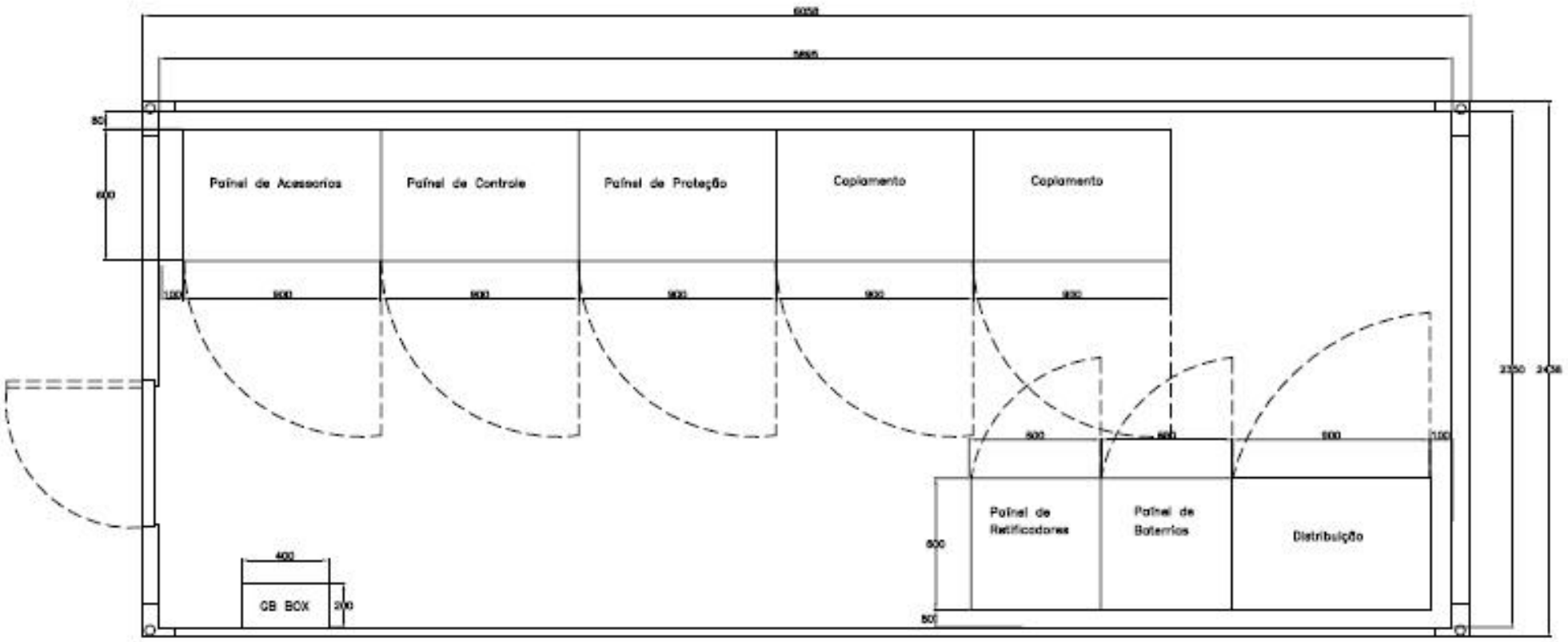


E-House solution for 17 bays Double Bus 132 kV GIS, including 28 Panels 11KV 2500A , 50 KA , complete with Auxiliaries, Protection Control and SCADA system

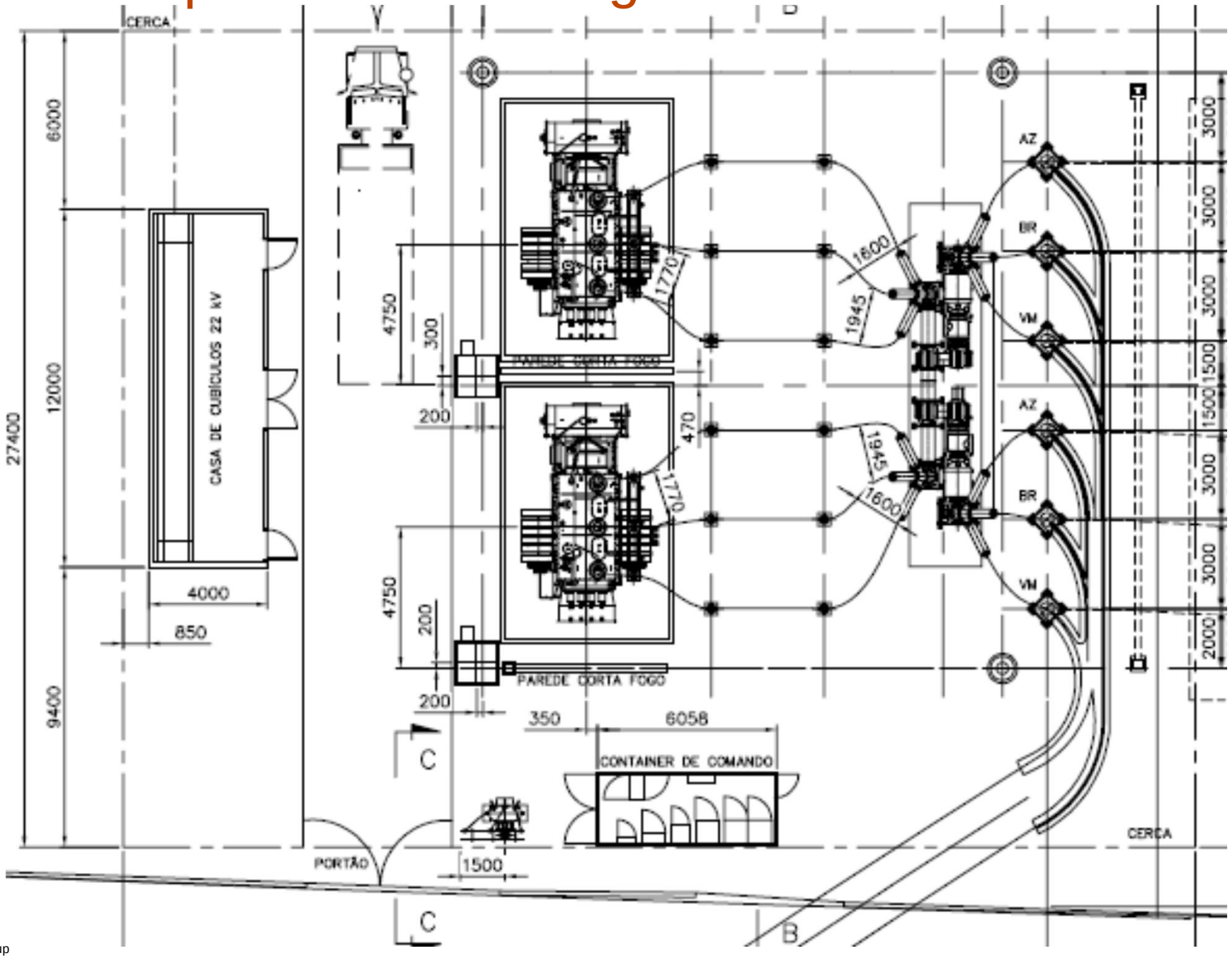
Project Example – Constancia, Peru
Mining and Mineral

Integrated GIS Applications
Mobile solution 10&20‘ Control housing

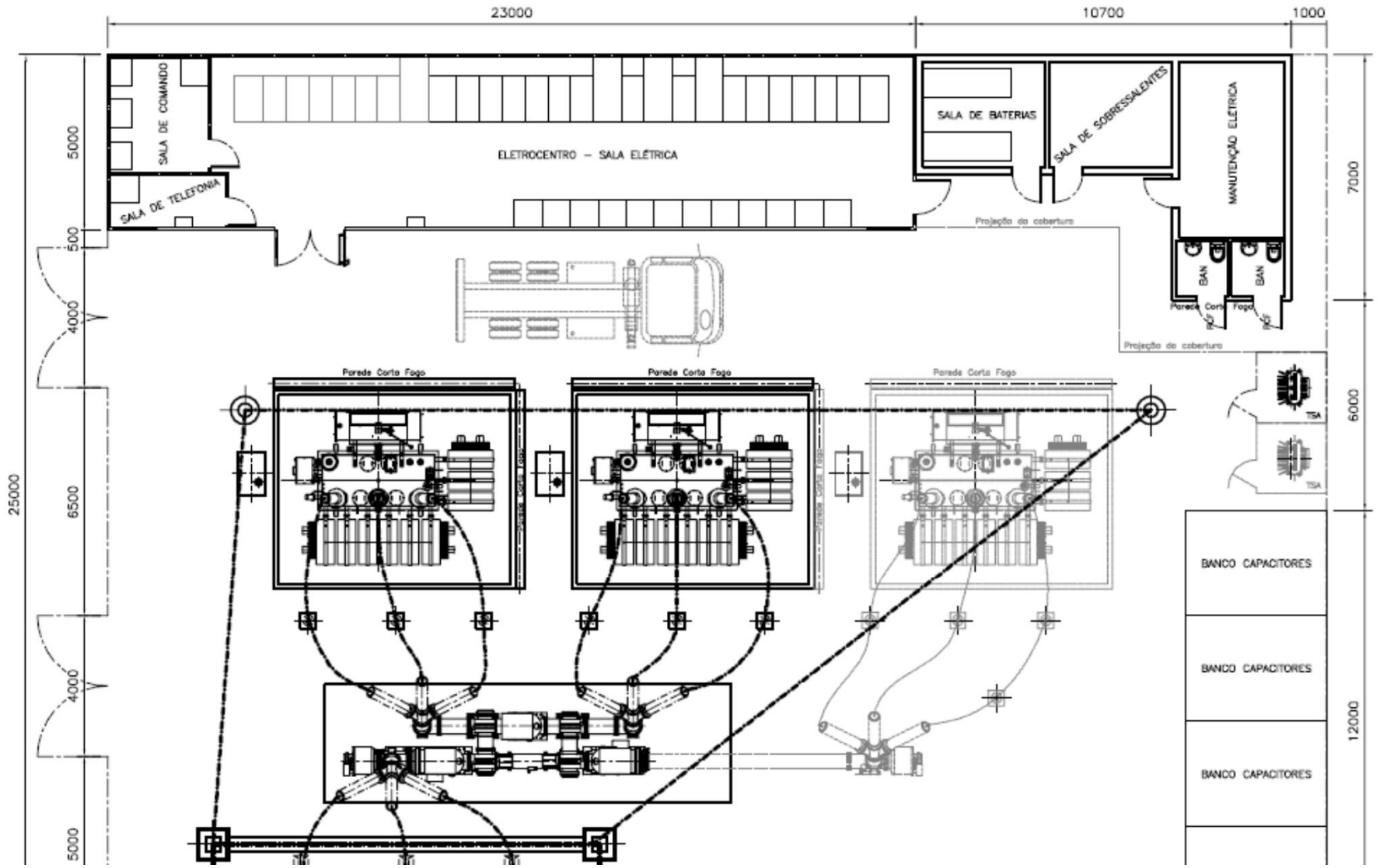
Integrated GIS Applications
Mobile solution 10&20‘ Control housing



Small footprint 145 kV Integrated



Small footprint 145 kV Integrated



GIS Integrada CEMIG

CEMIG
2 or 3 CB

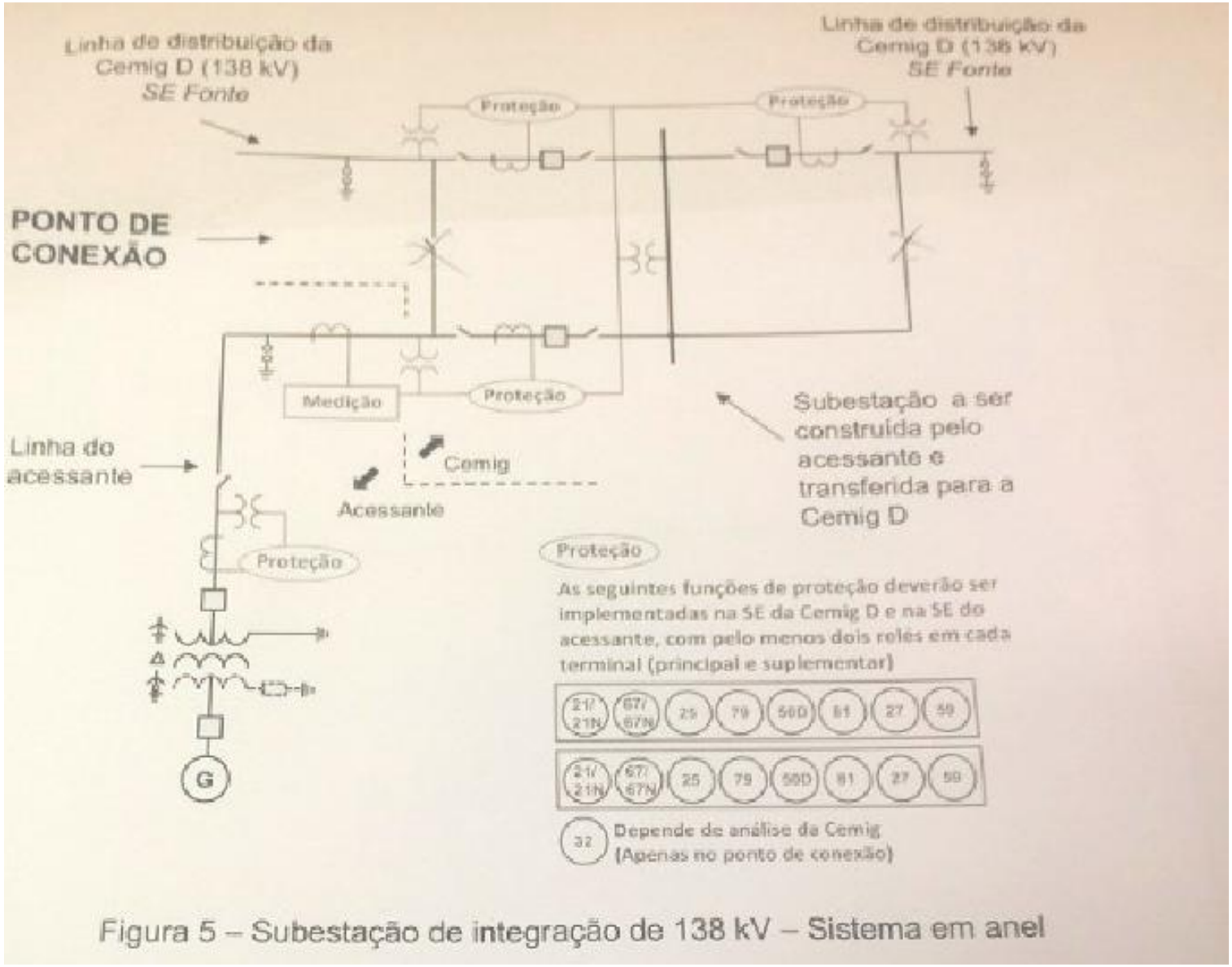
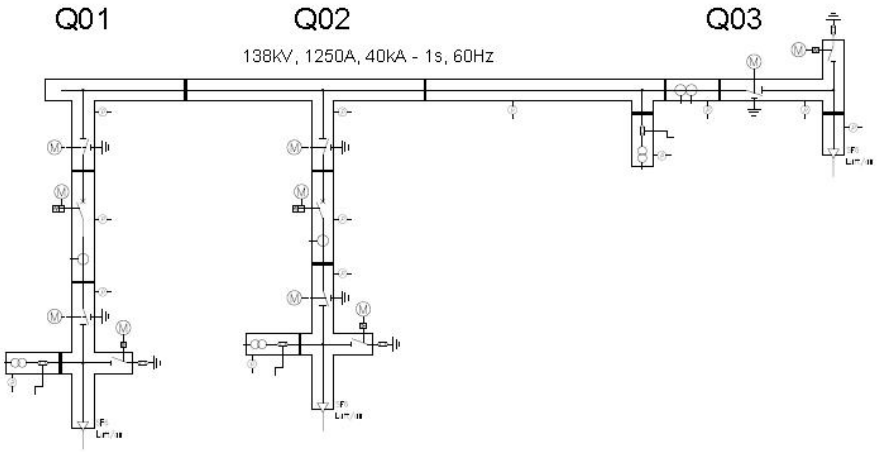
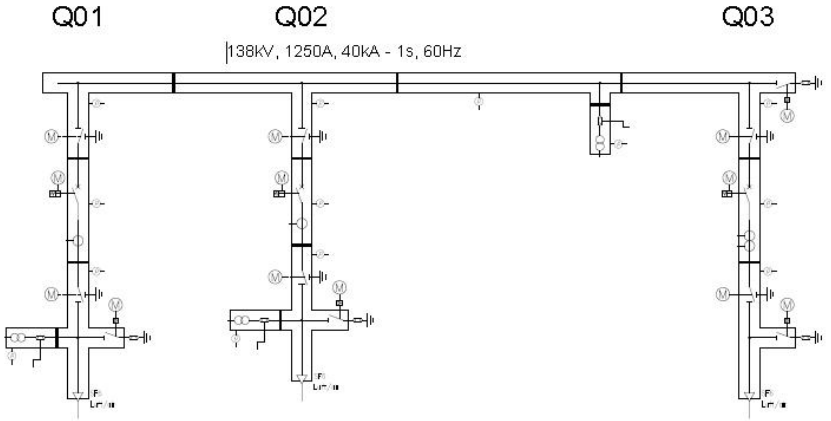


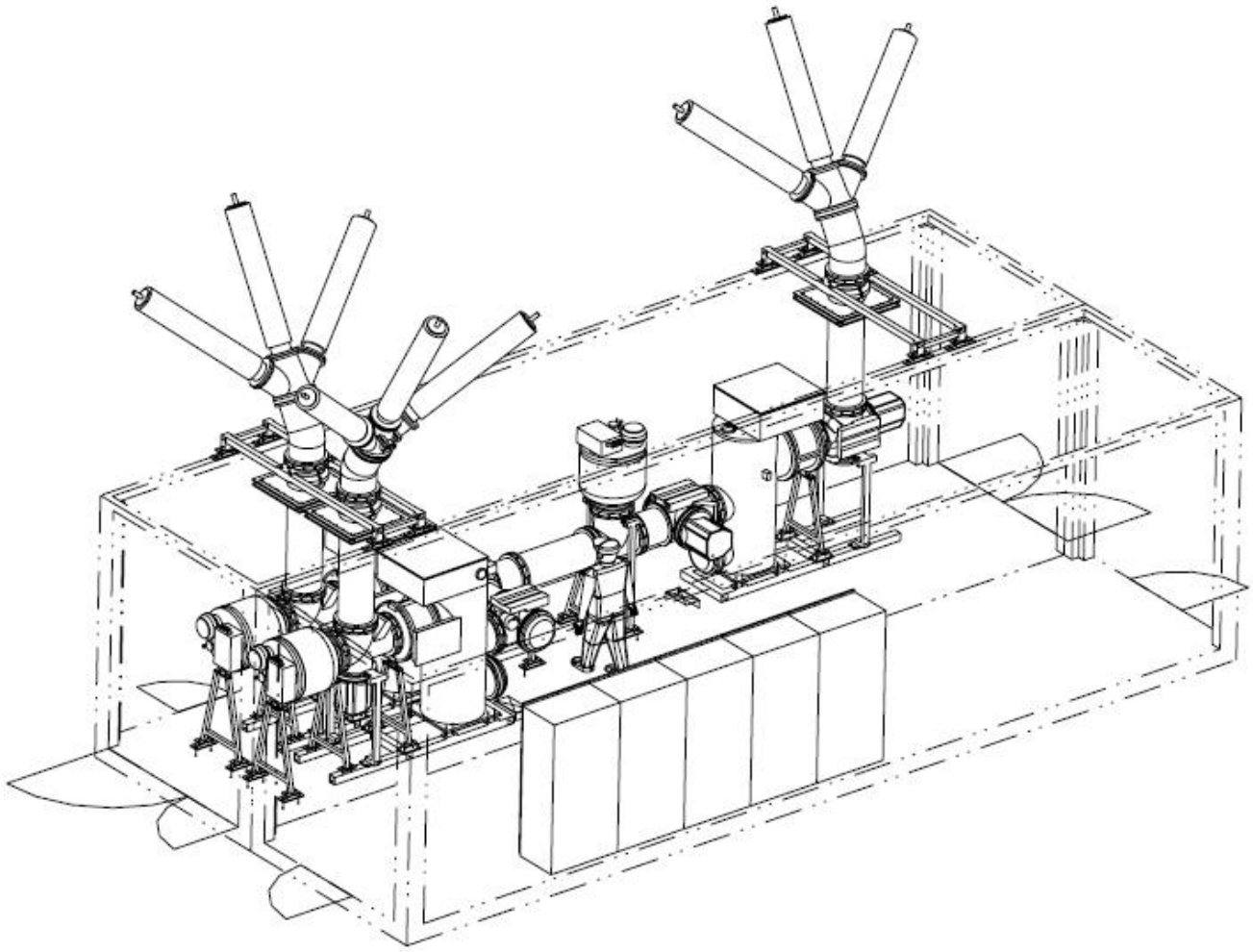
Figura 5 – Subestação de integração de 138 kV – Sistema em anel

CEMIG
2 or 3 CB ABB Solution





CEMIG
2 or 3 CB ABB Solution



CEMIG
Control & Protection

System design

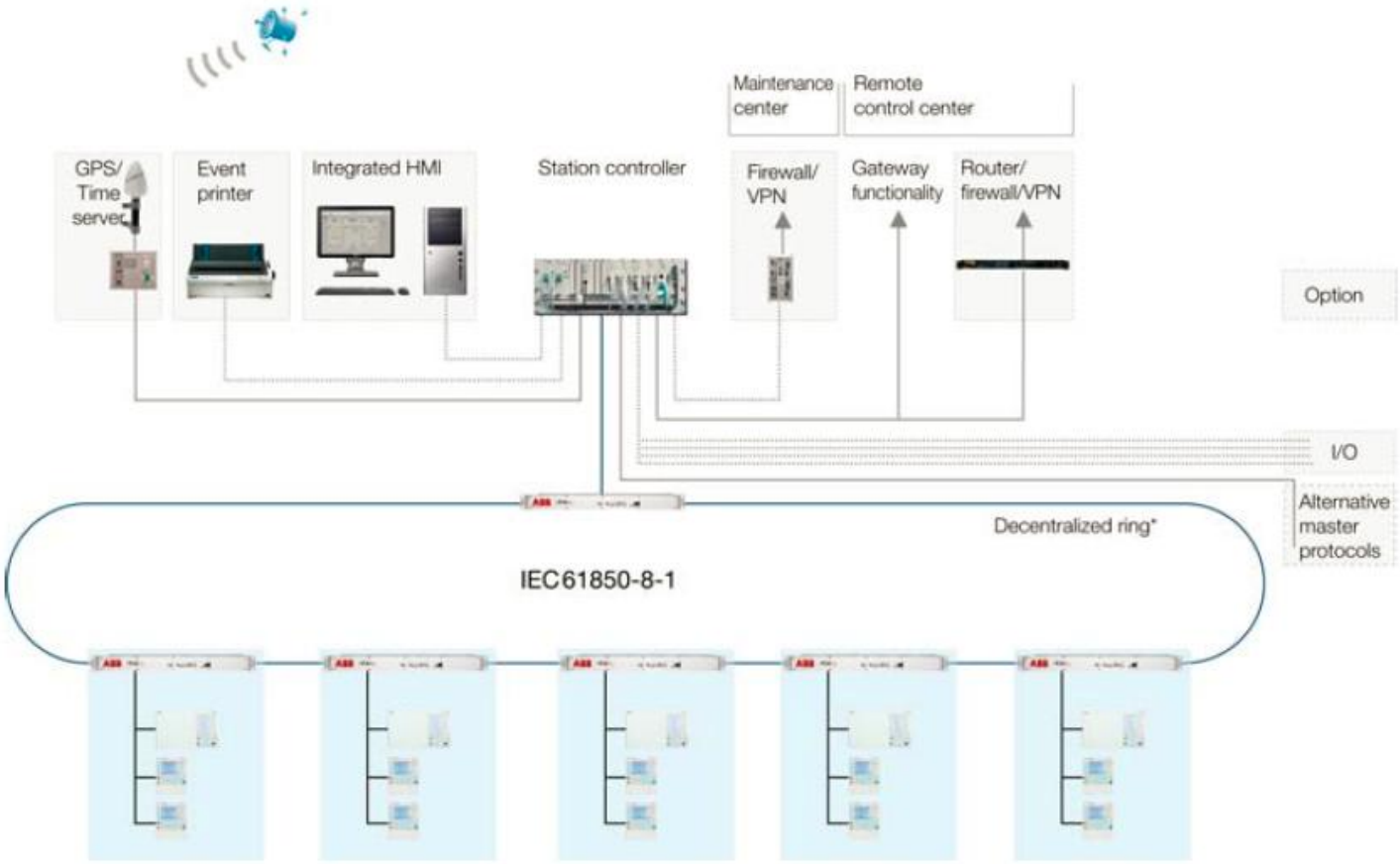
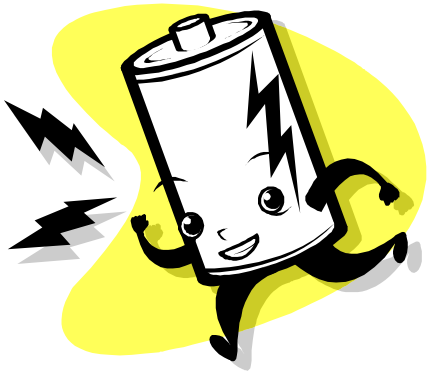
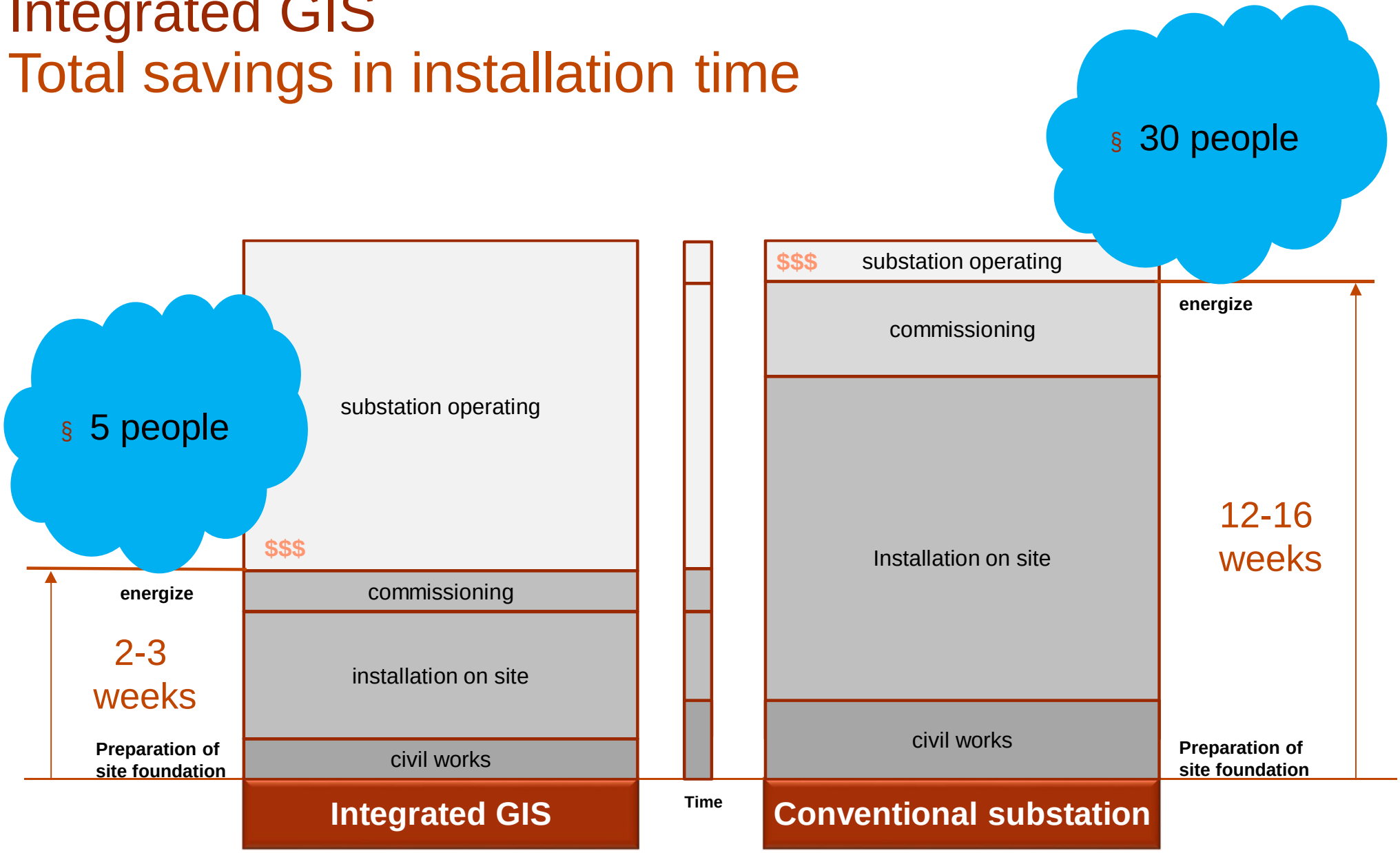


Fig. 1 SAS605 System Overview

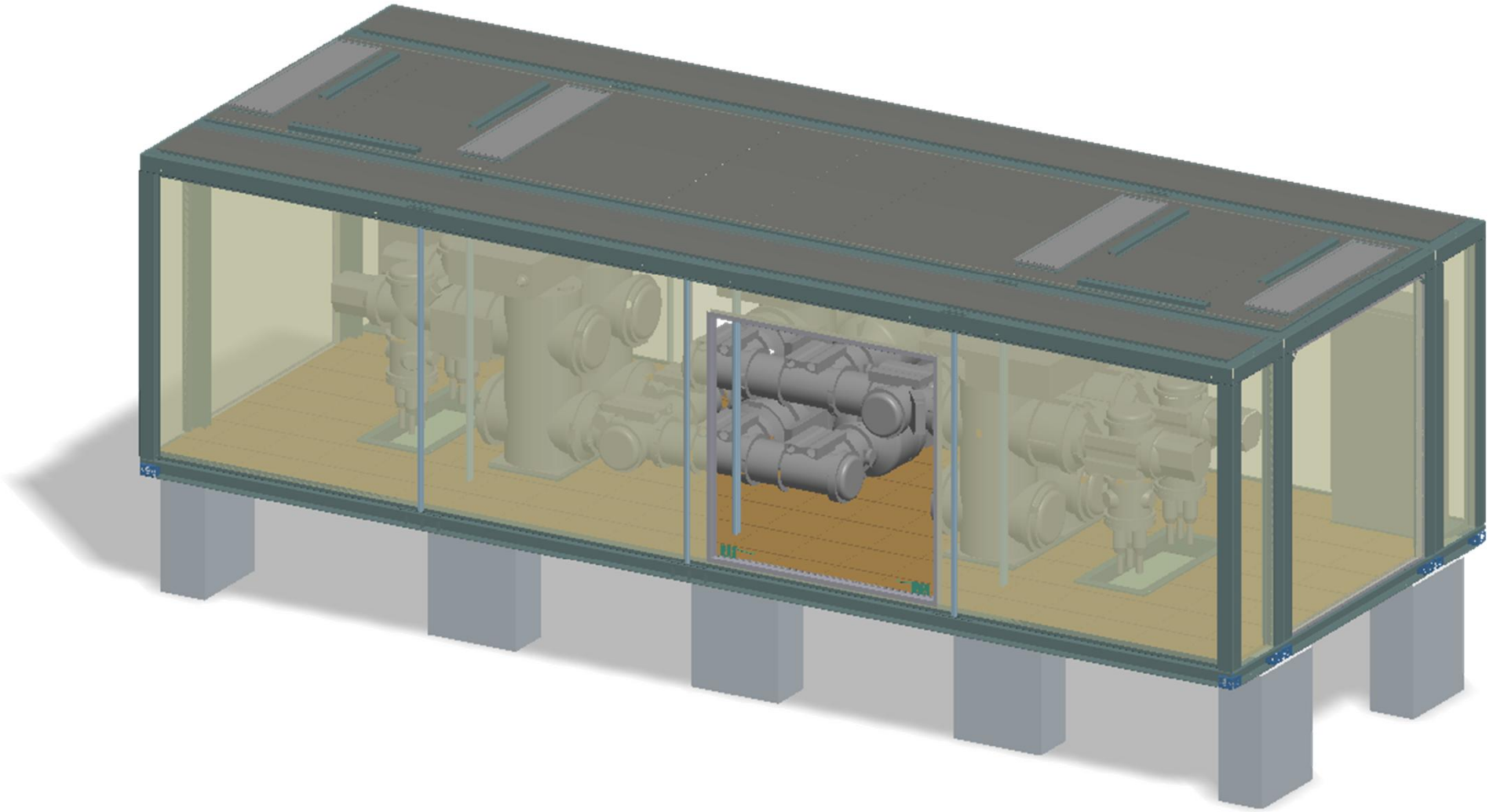
CEMIG
Auxiliaries



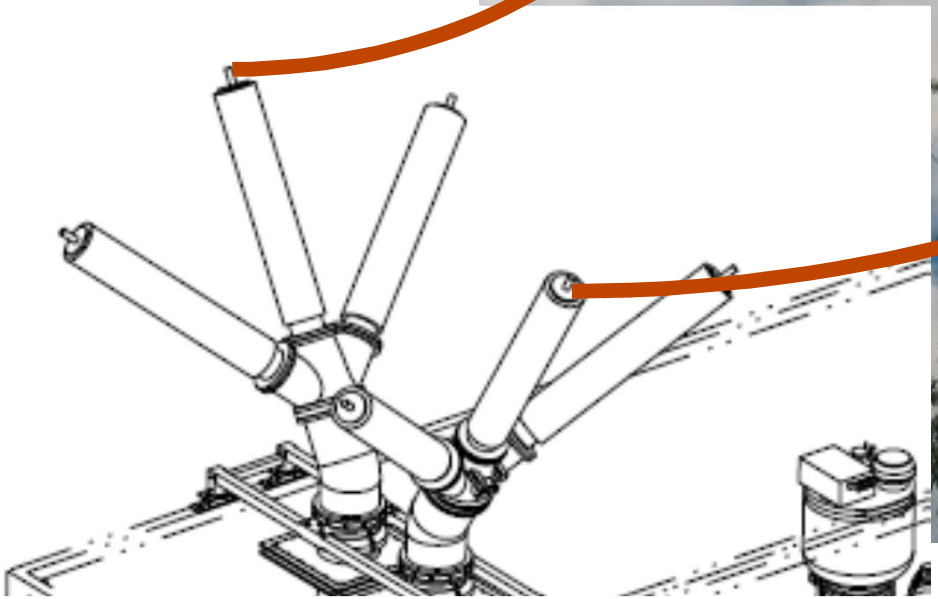
Integrated GIS
Total savings in installation time



Integrated GIS – ELK04, 145kV / 170kV

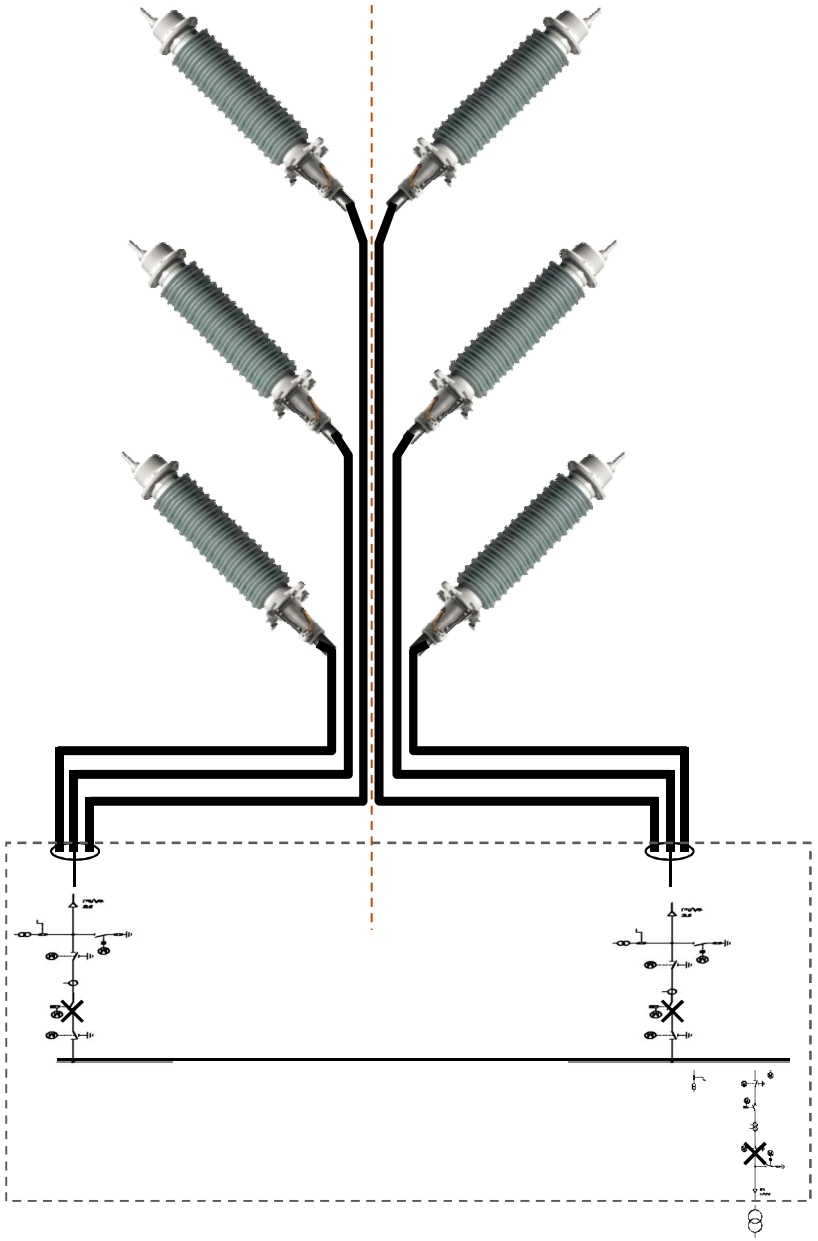


Integrated GIS – ELK04, 145kV / 170kV

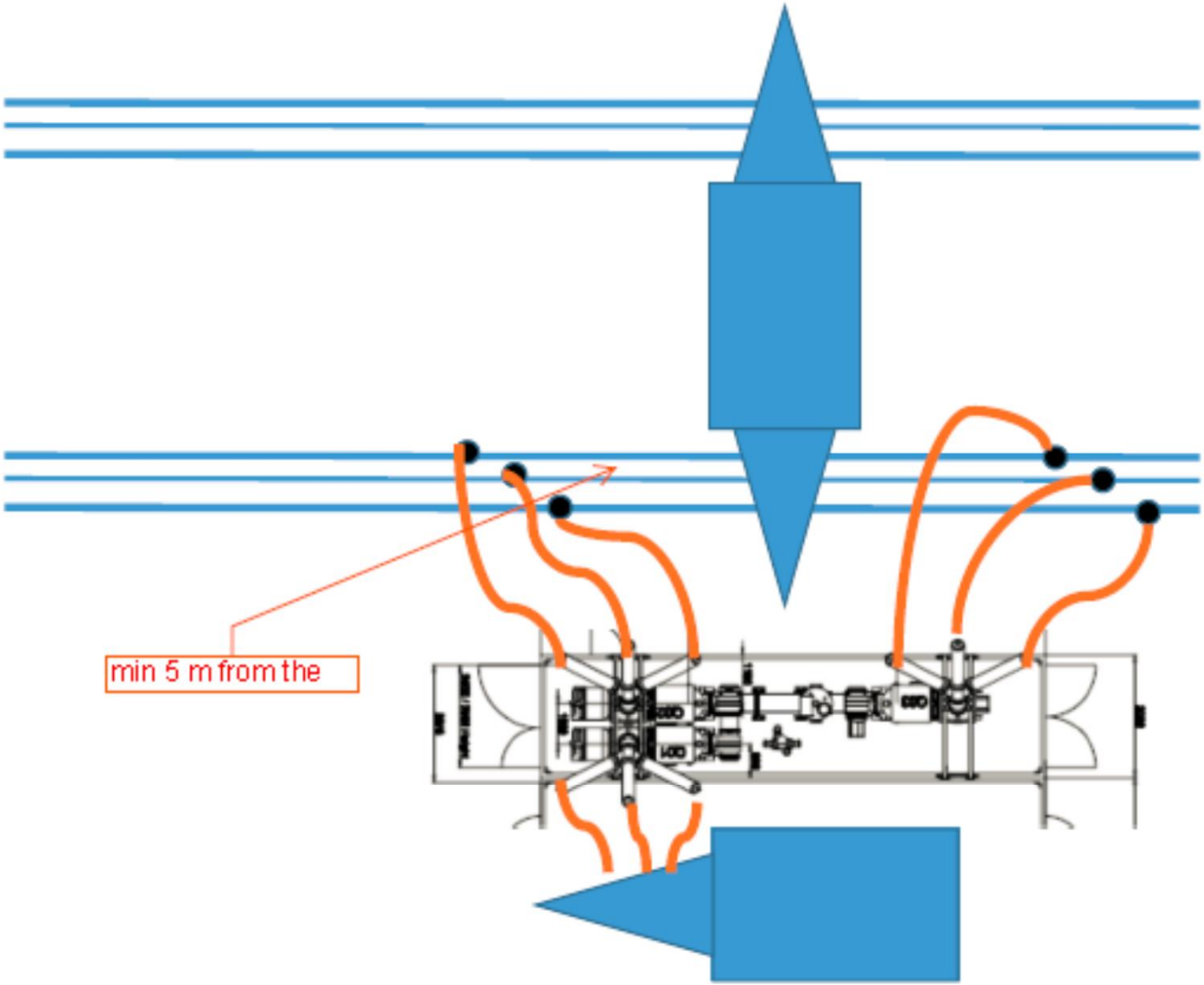


Integrated GIS – ELK04, 145kV / 170kV

Dry pre-assembled dry cable termination, outdoor, TD 145

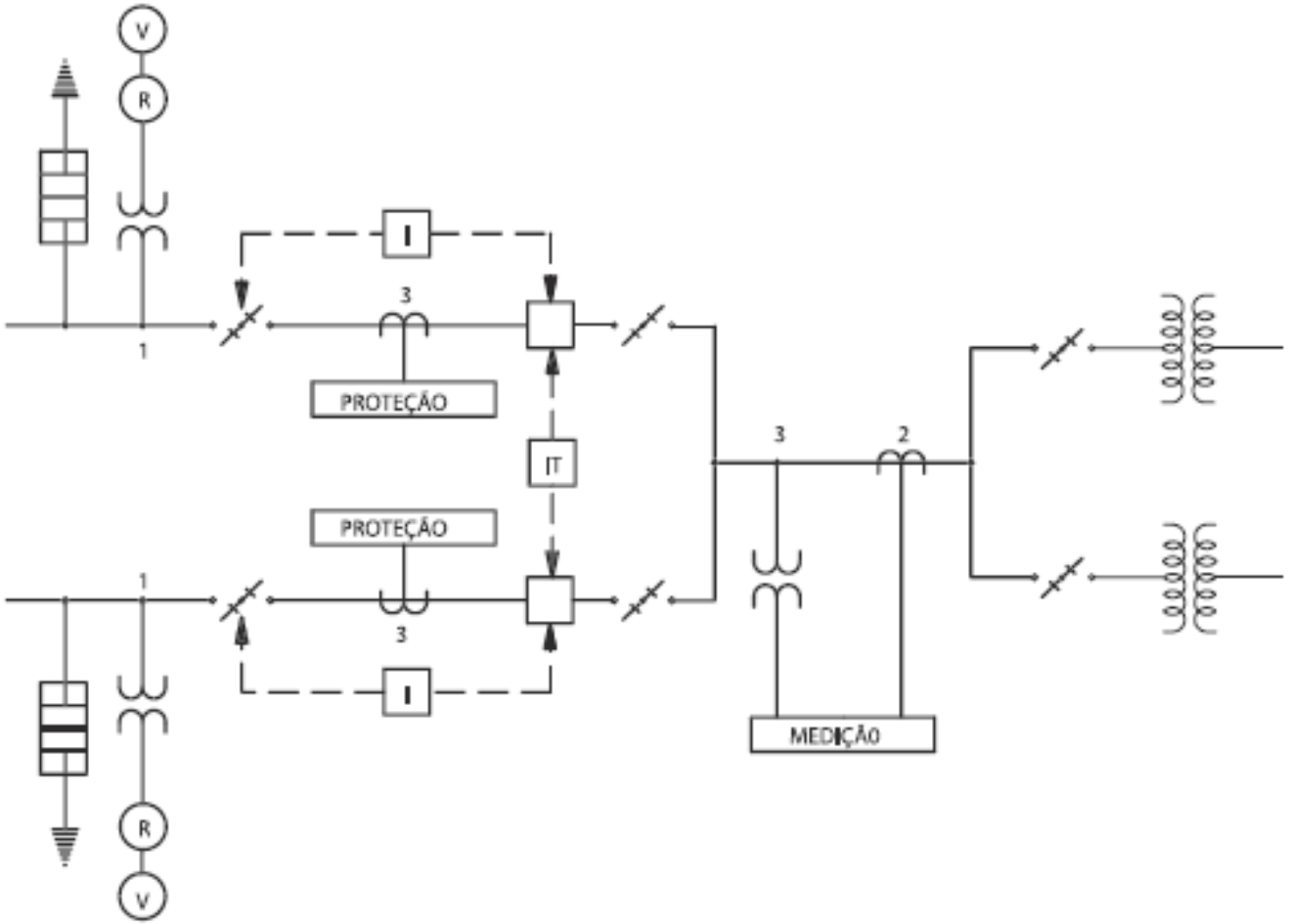


CEMIG

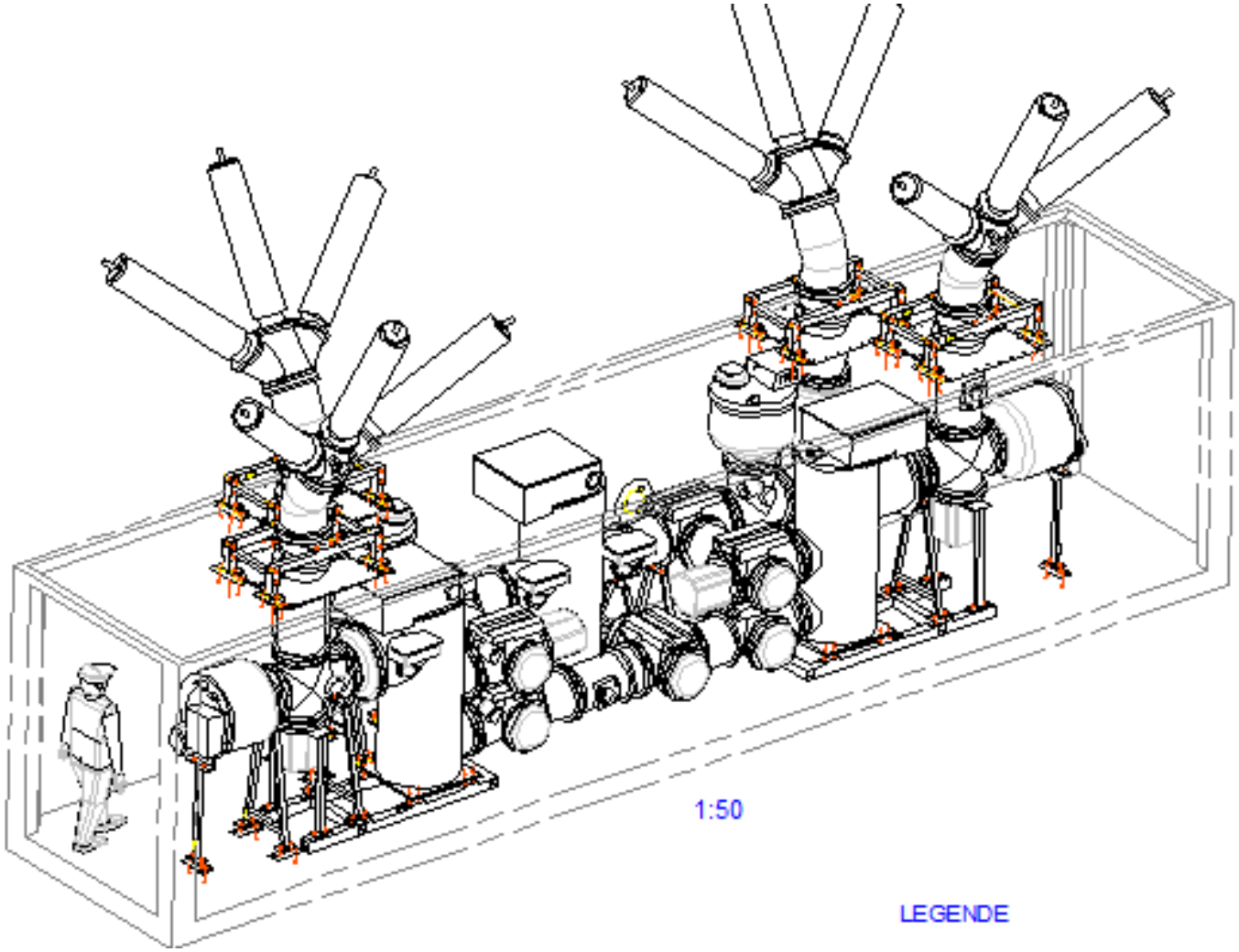


GIS Integrada Eletropaulo

Integrated GIS technology
Eletropaulo



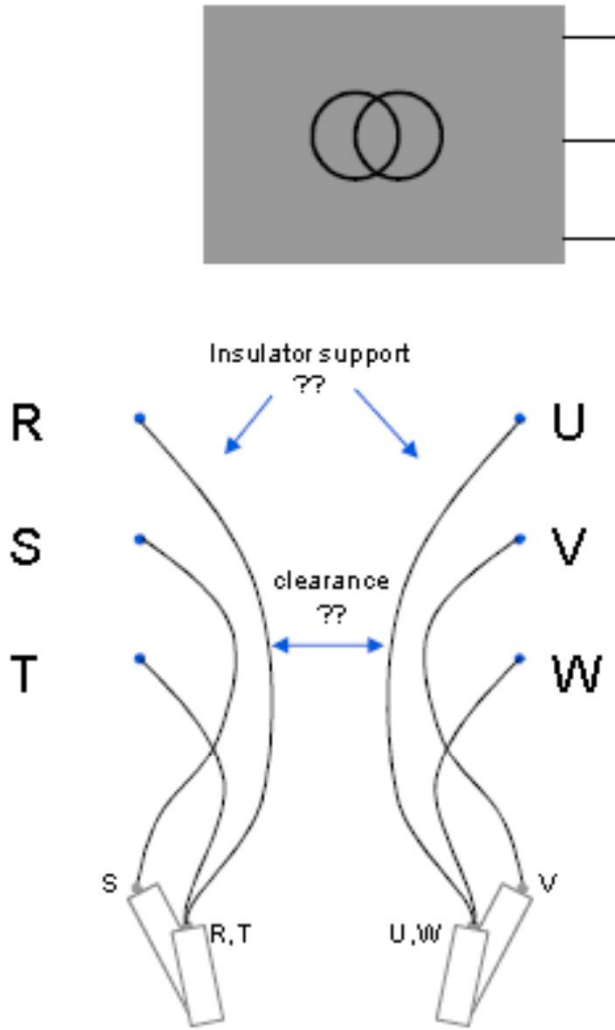
Integrated GIS technology
Eletropaulo

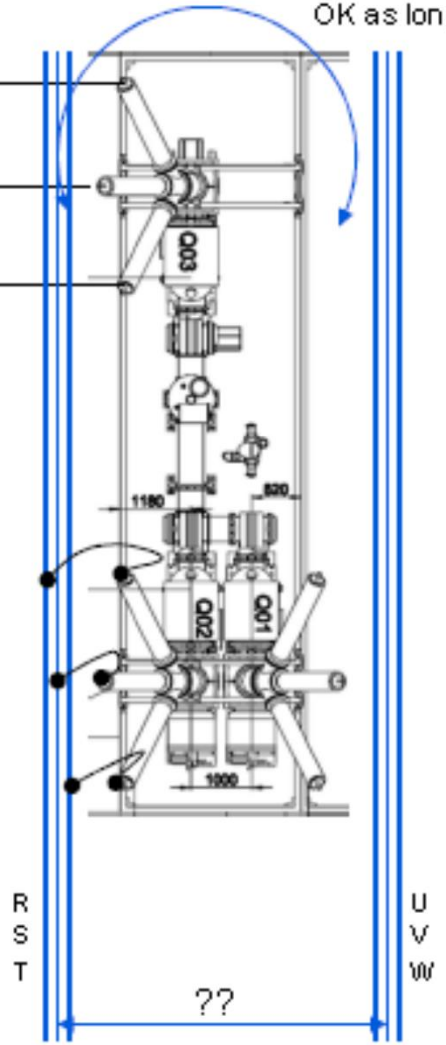


Eletropaulo

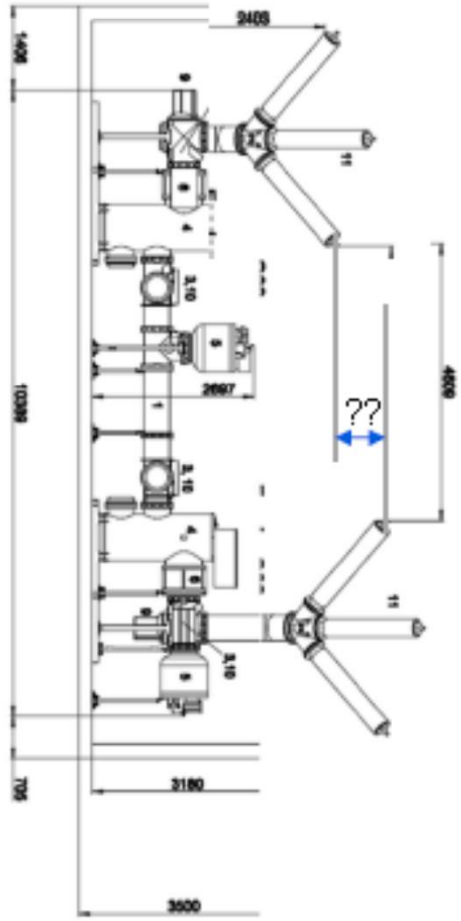
IGA 2 and 3 CB
Underneath double circuit OHL

OK as long as the bushing is clear of the OH-line





distance between
double circuit lines??



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