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# Integrated GIS - Grid Connections

## Modular & Prefabricated Grid Connections

Product Solution and Capability

2024-10-30



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# Agenda

- **Introduction**
- Solution
- Q&A

# Market drivers
## Underlying market drivers

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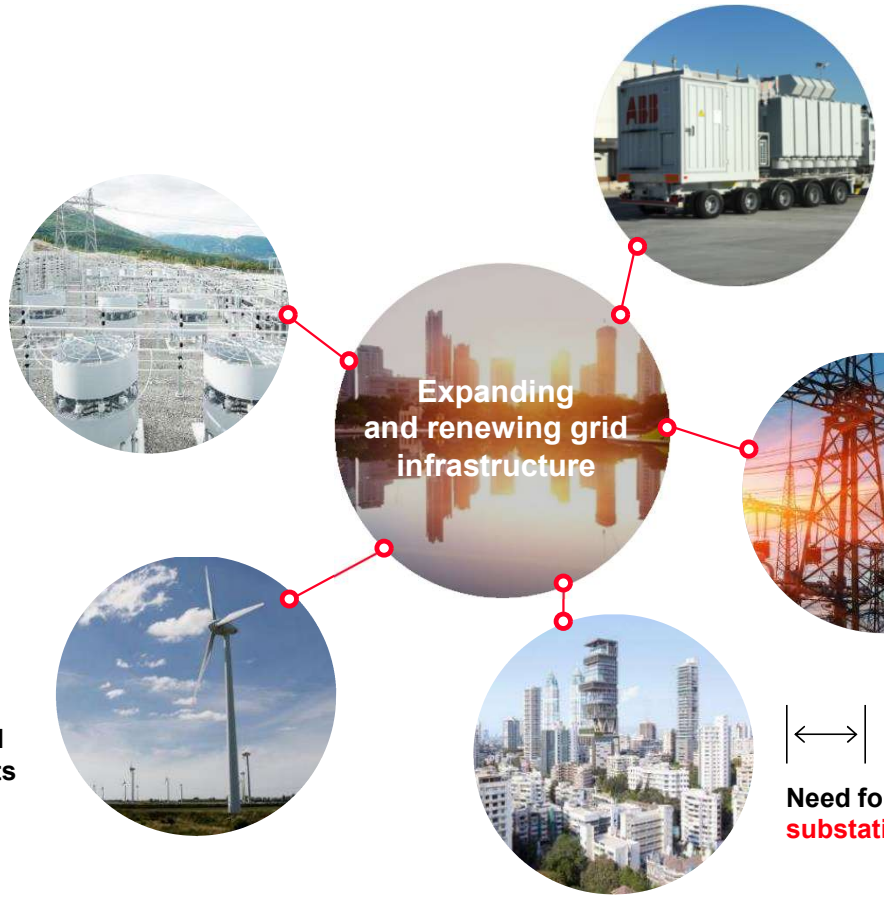


Need for **seamless** upgrades or expansion of existing grids, with **minimum interruption**

Need for **safety back-ups** or temporary grid connections

Need for **standardization** of large asset base

Need for **reduced substation footprint**

Need for **shorter project lead-times** and lower installation costs



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# Prefabricated and containerized grid connection solutions

Hitachi Energy's smart and flexible solutions for a smarter, greener and stronger grid

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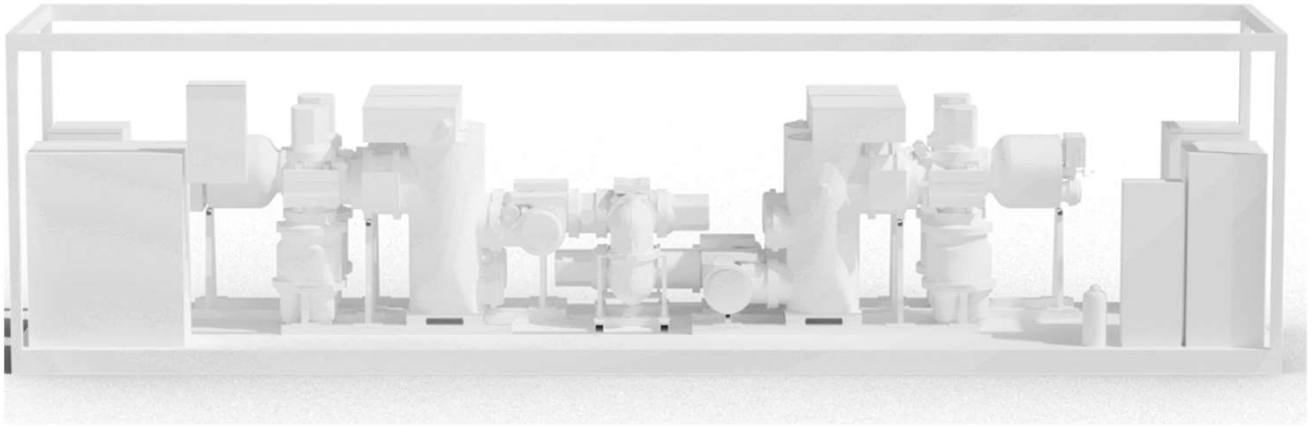
Grid-eXpand™ Connect

**We offer**

- Solutions realized by means of modularized content

**Suitable for many applications**

- Utility
- Process Industries
- Data Centers
- Solar- and Wind Power
- Rail Power Supply



**Smart and flexible solutions, built on Hitachi Energy's well-proven product heritage**

# Grid-eXpand™ | Customer benefits

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**Cast-in-place and site-built solutions**

From here →

## Characteristics

- Bespoke design – usually **different**
- **Many** project interfaces to coordinate
- **Extensive** civil – and site preparation works
- Installation work mainly done **on site**

vs.

**Modularized and prefabricated Grid-eXpand™ solutions**

To there

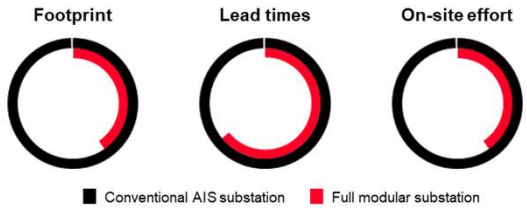
- **Modularized** design with a common core
- **Few** project interfaces to coordinate
- **Drop-in-place** pre-tested modules
- Installation work mainly done **in factories**

## Value Drivers

- Design standardization
- Risk mitigation
- Short installation time
- Repeatable assembly in a controlled environment with quality assurance

## Benefits of Grid-eXpand™ Solutions

- Reliability through well-proven products
- Factory assembled and pre-tested
- Reduced on-site work and time




**Evolving the status quo in design and construction of grid connections**

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# Agenda

- Introduction
- Solution
  - Grid expand solution
  - Mobile substation
- Q&A

# Grid-eXpand™ solutions

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pre-engineering | modularization | pre-fabrication

## Grid-eXpand™ solutions

| | | fast-track construction | asset base harmonization | resilience | asset re-deployment | high mobility |
|---|---|---|---|---|---|---|
| generic | Grid-eXpand™ Connect | Integrated GIS<br>GIS Grid Connection Kit | Skid-mounted Substations<br>Transformation Substations (IEEE)<br>E-house Modules | Grid-eXpand™ Mobile | Mobile Compact Substations | |
| renewables | PV – Grid-eXpand™ Solar | PV Power Collection Package | | | | |
| renewables | wind – Grid-eXpand™ Offshore | | Offshore Grid Solution - Wind | | Mobile Modular Substations | |

Financing advisory and solutions



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# Main benefits of prefabricated and modular substations

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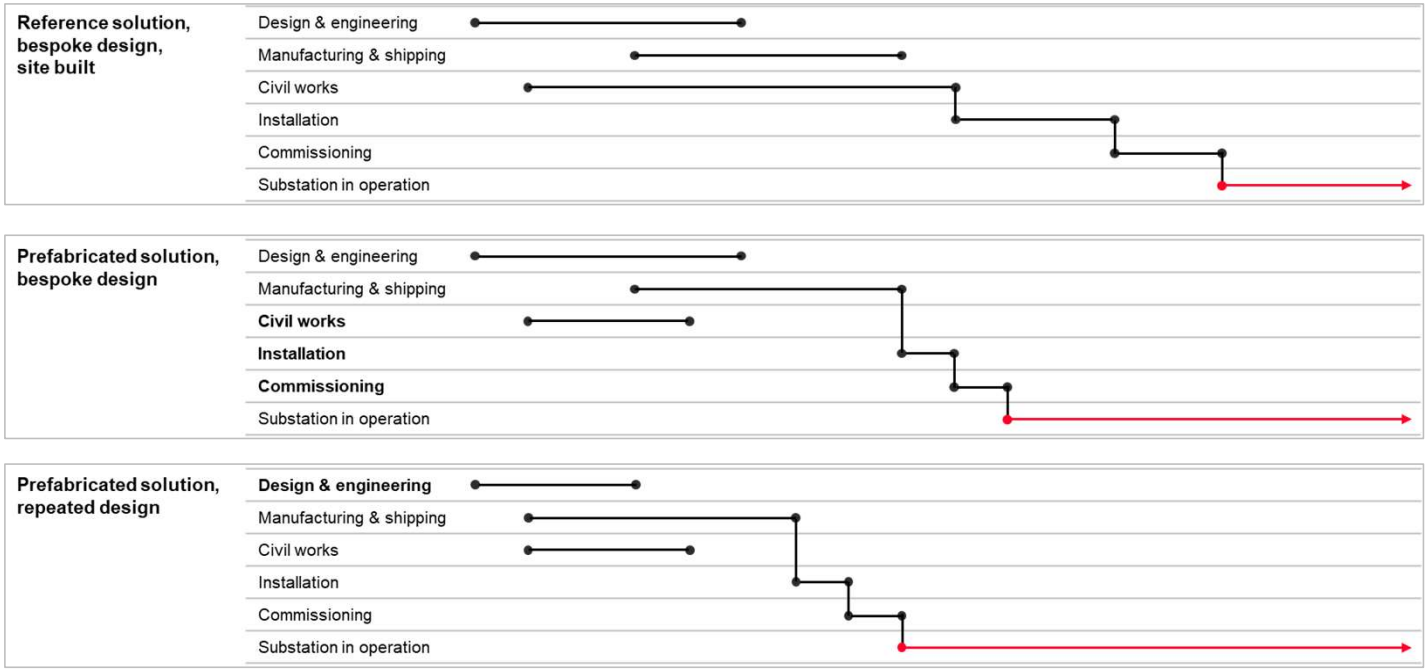
## Reduced time for design, installation and energization

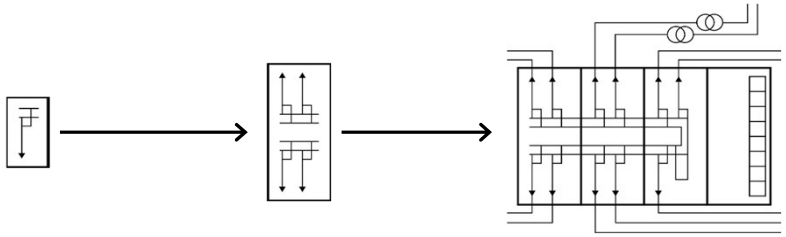
- Drastically reduced amount of and dependencies of civil works
- Shorter installation period and earlier energization compared to conventional switchgear
- Reduced number of interfaces during project execution
- Repeatable system designs and configurations, shortens base and detailed design time



# Grid-eXpand™ | Solution characteristics

### Pre-Engineering
- Base solution driven design
- Versatile layouts
- Adaptable system engineering
- International standard conformity (IEC, ANSI)
- Native BIM enabled models (3D,4D,5D…)

### Modularization
- Leveraging modular products
- Simplified interface engineering
- Reduced variance
- Efficient maintenance and service concepts



### Pre-Fabrication
- Improved quality – assembly in controlled environments
- Reduced site installation efforts, reduced risk of delay
- Qualified partners for 3rd party scope for enclosures & auxiliaries

# Fast energization
## Easy handling and transport

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- Standardized housing dimensions
- Relocation within days or even hours
- Fast power deployment
- Easy handling on-site, thanks to standardized lifting interfaces

# Reliable power supply
## Proven technology

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- Safe operation with gas-insulated switchgear
- Long lifetime of products (25-40 years) and long experience in field operation
- Low maintenance effort and costs due to long maintenance cycles and few parts to revise
- Independent of environmental conditions
- Outdoor applications possible
- Secondary control system: pre-cabled and pre-tested in the factory
- Possible integration of power voltage transformer and non-conventional instrument transformer (NCIT)

# Reliable power supply
## Protection from environment

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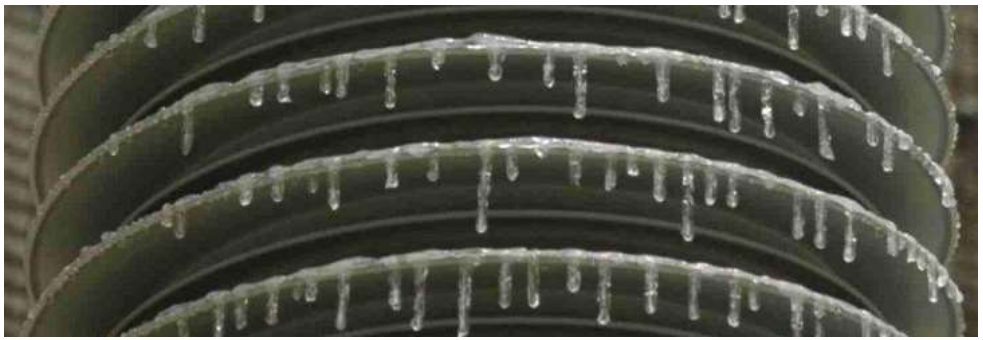
### Extreme or hazardous site conditions

- Jungle or desert
- Remote islands and regions
- Storm, flood, and seismic active areas
- Substation security concerns: sabotage and attacks
- Offshore installations
- Oil and gas industries

### Temperature applications

- Standard -30 °C to +40 °C
- Extreme -55 °C to +55 °C (with air-conditioned housing)



# Transportable, modular, and flexible prefabricated solutions

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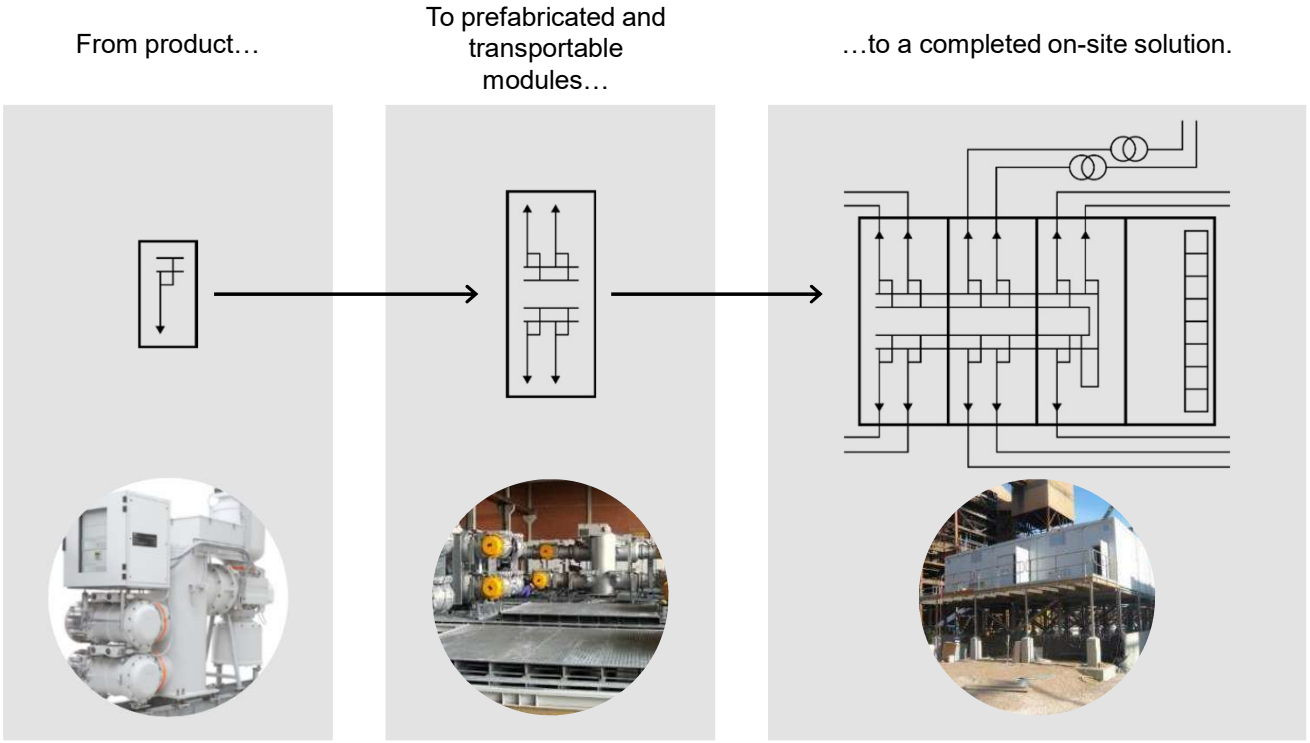
## Benefits

Standard and modular design of products and related interfaces allow combinations for flexible substation solutions to fulfil any customer needs whilst maintaining the advantages of each included product:

- Reliability of systems built on well-proven product technologies
- Fast-track production, based on standardized processes
- Factory pre-testing of singular products and the complete system
- Reduced on-site work and time for site installation and energization



# Modular and Prefabricated Grid Connection: integration concept

Example: HV GIS, SAS and AUX modules

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## Modular Assembly – concept description

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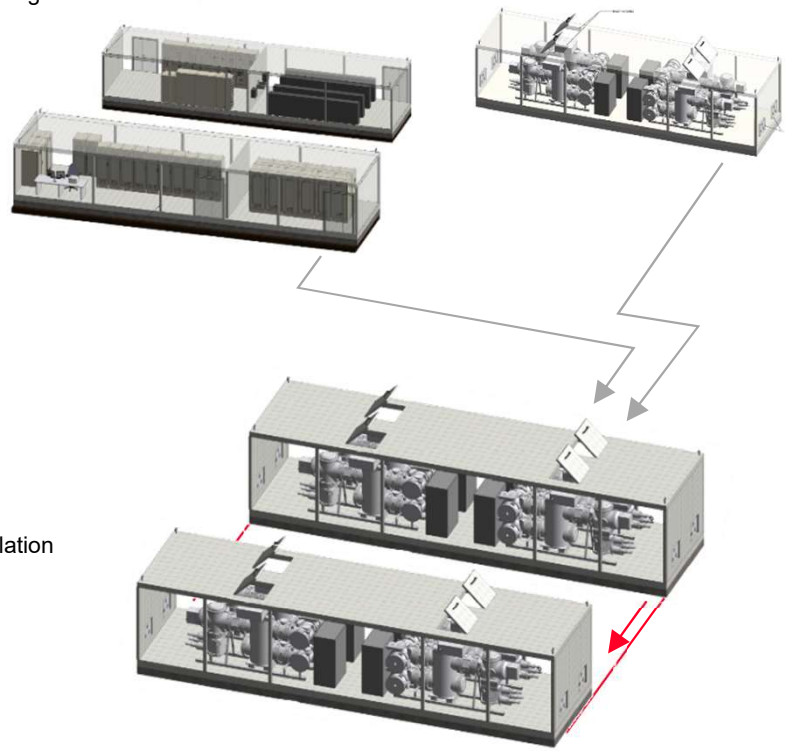
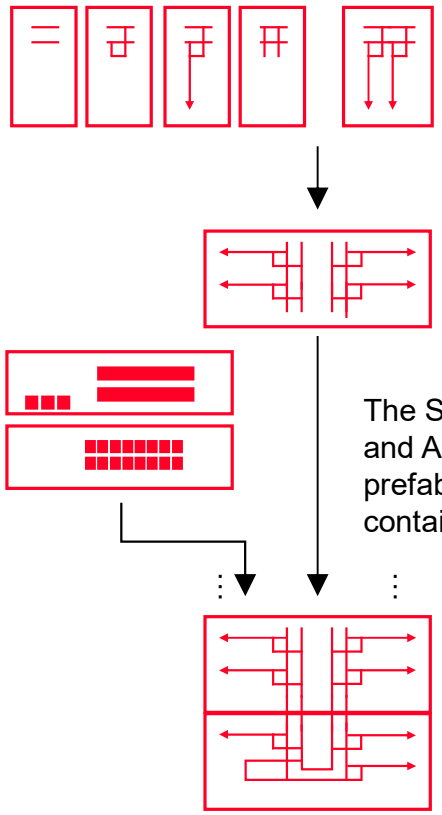


Site installation



Bays are assembled and HV tested **individually in factory and shipped separately or in pairs.**

The GIS **bays** are pre-assembled, wired and tested before leaving the factory

The **GIS** bays are mechanically installed and integrated in container modules at **an integration yard or in an H.E factory (pre-commissioning / functional testing)**

The Substation Automation System (**SAS**) and Auxiliary Systems (**AUX**) are prefabricated with all equipment installed in container modules and shipped to site.

**All Containerized Modules** are transported to site and spliced into a complete substation. Final commissioning, gas-filling and HV-testing of connected busbars is done at site.

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# Prefabricated and mobile substation solutions

## Hitachi Energy's System Scope

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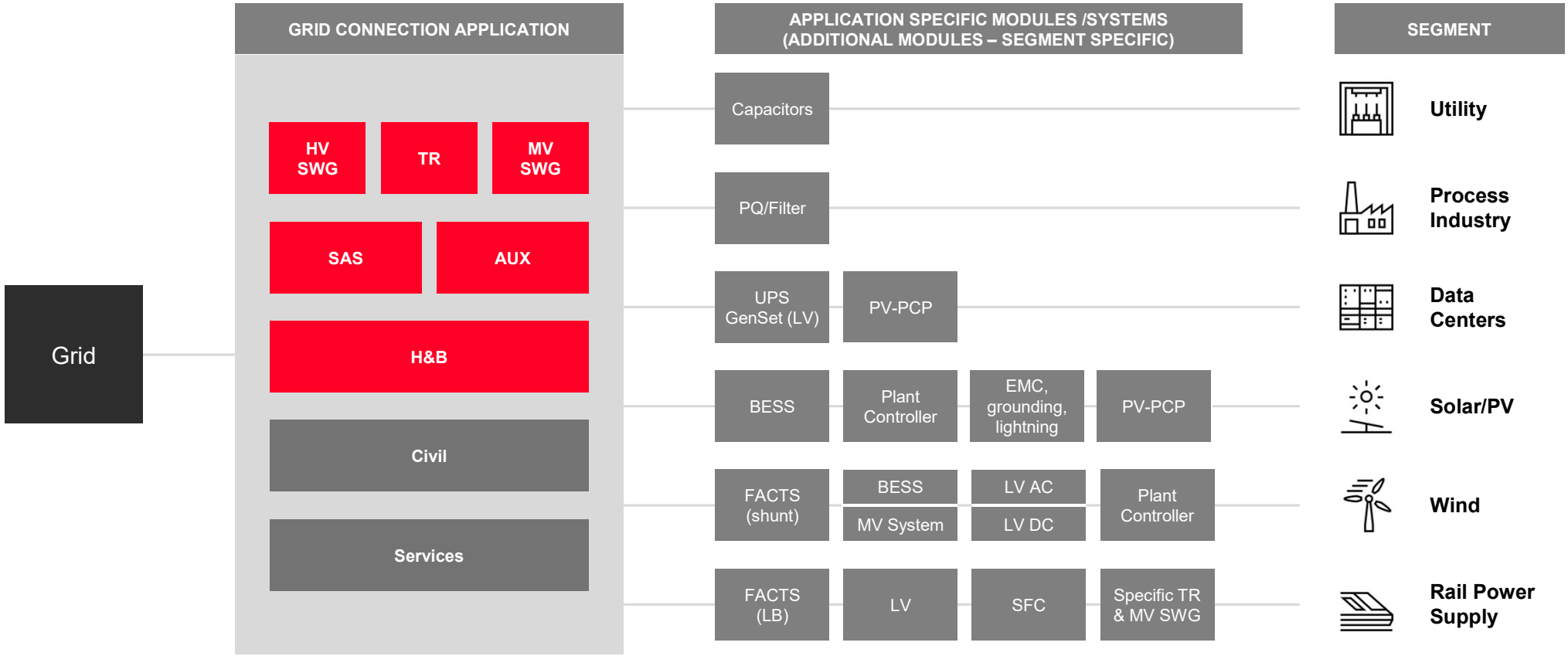





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# Grid Expand Solution (Taiwan Project)

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# Grid-eXpand™ | Prefabricated Modules & Components

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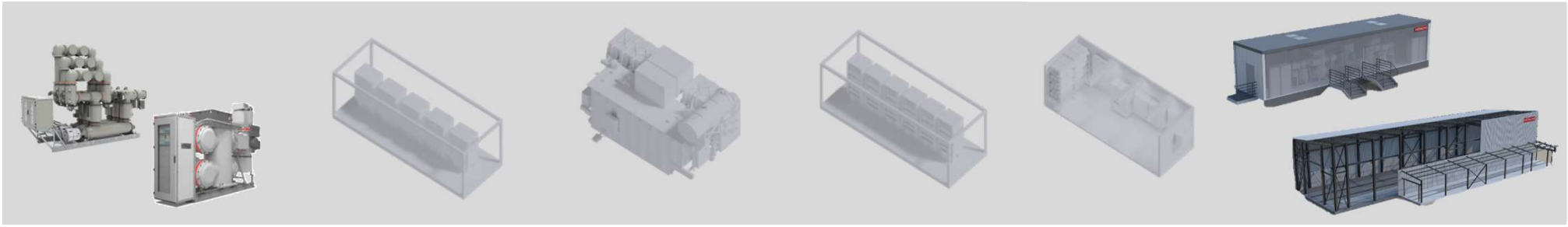
## Core modules



| HV SWG | MV SWG | TR | SAS | AUX | H&B |
|---|---|---|---|---|---|
| **High Voltage Switchgear 72.5 – 420 kV** | **Medium Voltage Switchgear 12 – 42 kV** | **Transformers** | **Substation Automation System (SAS)** | **Auxiliary Systems (AUX)** | **Housing & Base** |
| • Gas Insulated Switchgear (GIS)<br>• Air Insulated Switchgear (AIS)<br>• Hybrid Switchgear (PASS) | • Gas Insulated Switchgear (GIS)<br>• Air Insulated Switchgear (AIS) | • Oil-filled Transformer<br>• Dry Transformer | • Substation Protection, Automation, Control and Communication<br>• Conventional (station bus)<br>• Digital (station- + process bus) | • Auxiliary power<br>• Heating-Ventilation-Air Conditioning<br>• Fire-protection<br>• Lighting & LV-power | • Pre-fab Modular Building<br>• Skids<br>• Trailer<br>• Superstructure |

# High Voltage Gas-insulated Switchgear

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| High Voltage Switchgear 72.5-420 kV | Medium Voltage Switchgear 12-42 kV | Transformers | Substation Automation System (SAS) | Auxiliary Systems (AUX) | Housing & Base |
|---|---|---|---|---|---|

ELK04 up to 145 kV
&
EconiQ™

ELK04 up to 170 kV

ELK-14 up to 300 kV

ELK-3 up to 420 kV
&
EconiQ™

+ Available SF6-free options with EconiQ™



https://www.hitachienergy.com/offering/product-and-system/high-voltage-switchgear-and-breakers/econiq-eco-efficient-hv-portfolio

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# Transformers

72.5-420 kV/12-42kV, 10-200 MVA[1])

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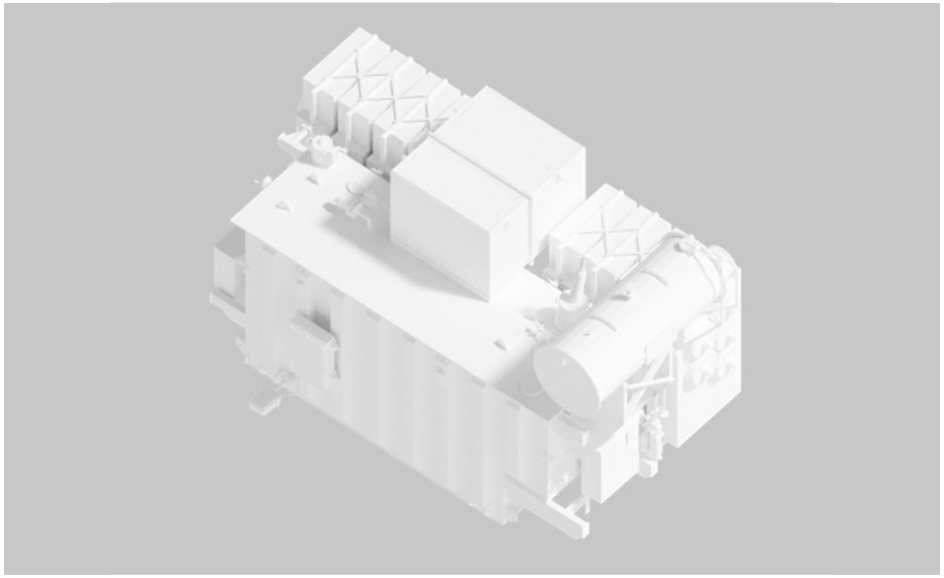
|---|---|---|---|---|---|



## Transformers

- Compact, low-weight, and safe design for integration in modular, mobile, and transportable solutions
- Maximum reliability for continuous operation and/or extreme overload working conditions
- Advanced digital control and management, through integrated sensing and monitoring, digital controls, “digital twin” models, data storing, and analytics
- Broad power and voltage range for classical step-down or step-up transformers
- Complete offering of transformers for specific applications (railway, industrial processes with variable Speed Drives or furnaces, renewable, marine, and off-shore…)

# Substation Automation System (SAS)

Integration of Protection, Automation, and Control Equipment into modules

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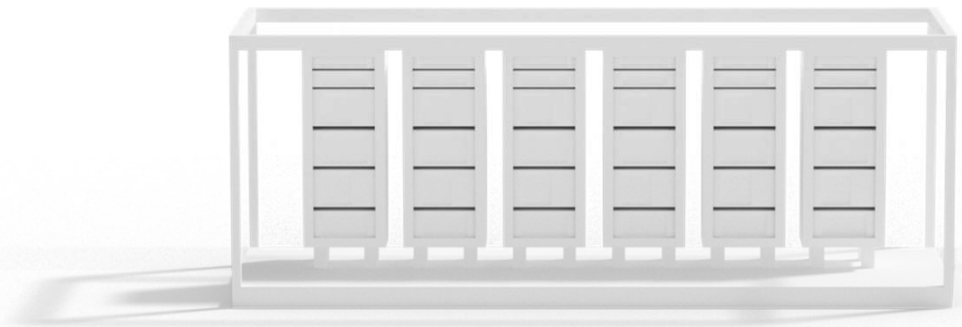
| High Voltage Switchgear 72.5-420 kV | Medium Voltage Switchgear 12-42 kV | Transformers | Substation Automation System (SAS) | Auxiliary Systems (AUX) | Housing & Base |
|---|---|---|---|---|---|



IEC61850 Station Bus + Hardwired Point-to-point or IEC61850 Process Bus

## Control Features

- Bay Control Operations Guided local control of all motorized switching objects
- Secure two-step operation (select-before-operate)
- Hardwired/software (IEC61850) bay interlocking
- Primary and secondary system status supervision and alarm visualization
- Circuit breaker control and supervision

Prefabrication & Modularization work synergistically with a digital substation bus architecture (IEC61850)

# Grid-eXpand™ | Integrated GIS – Examples

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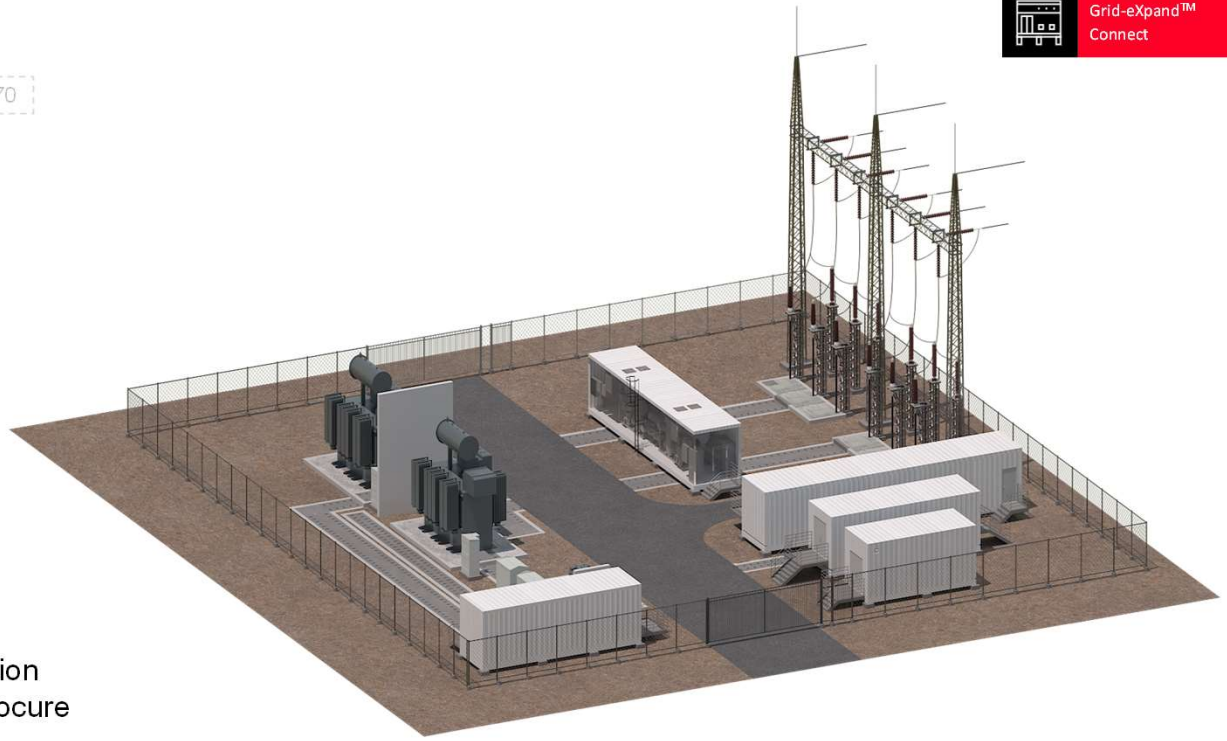
**PFB 1.1.4**

| | | | | | |
|---|---|---|---|---|---|
| Grid Connection Voltage (kV) : | 66 | 115 | **150** | 161 | 170 |
| Secondary Voltage (kV): | 11 | 13.8 | **20** | | |
| High voltage GIS bays : H configs | | | **5** | | |
| Medium voltage feeders: (I/C+O/G+B/S) | | | **2+10+1** | | |
| Power Transformers: (2) MVA | 67 | **120** | 150 | | |
| High Voltage Line Connections: | 1 | **2** | 4 | | |



Electrical standard: IEC

Control and Protection: **Conventional** / Digital

- The base solution contains general and detailed information for all relevant equipment needed to design, engineer, procure and execute a prefabricated GIS substation project.
- All modules are selectable and fully configurable
- Modules can be positioned freely to fit specific site conditions

# Grid-eXpand™ | Grid Connection Kit – Examples

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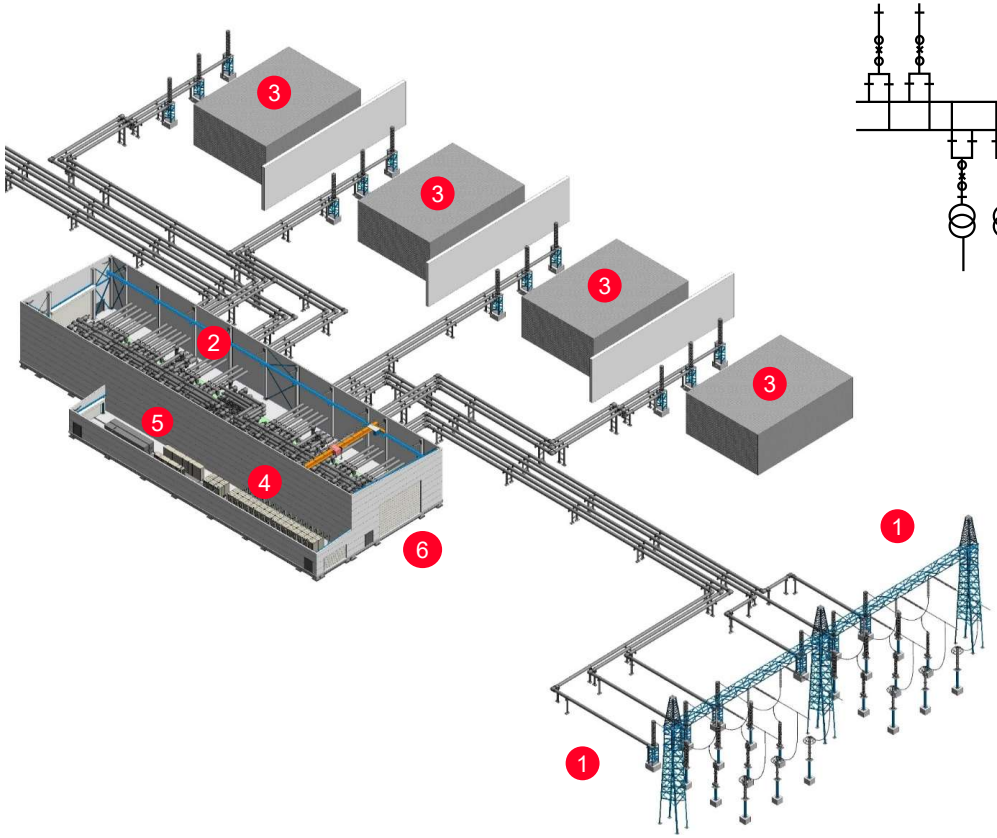
**Grid-eXpand™ - Connect**

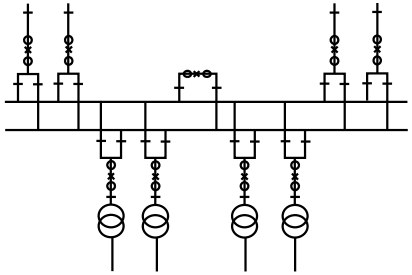
**GIS Grid Connection Kit**

1. From High Voltage Grid
2. Gas Insulated Switchgear unit (GIS)
3. Transformers
4. Protection & Control
5. Auxiliary System (AC, DC)
6. Prefabricated Building

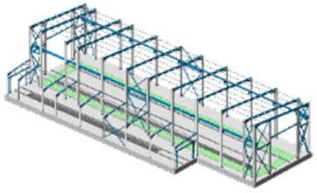
**Typical System Ratings**

| | |
|---|---|
| High Voltage: | 72.5-420 kV |
| Medium Voltage: | 12-36 kV |
| Transformers: | 10-500 MVA |
| HV Feeders: | 3-30 |
| MV Feeders: | 10-30 |



**Skid-mounted GIS**



**Prefabricated Building "PFB"**

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# Grid-eXpand™ | Grid Connection Kit – Example

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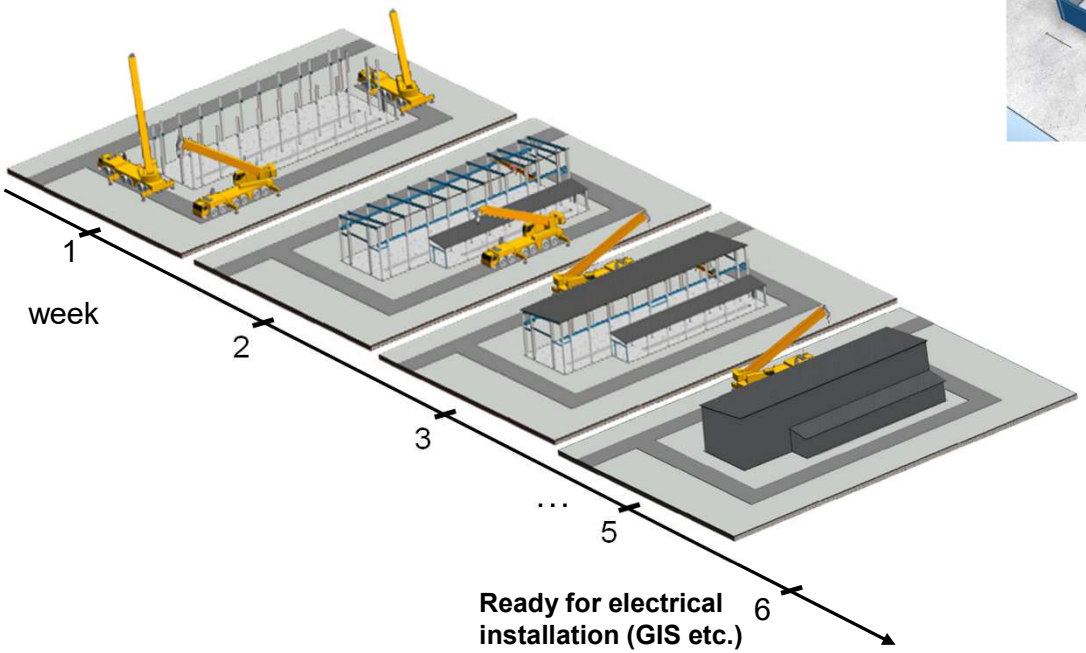
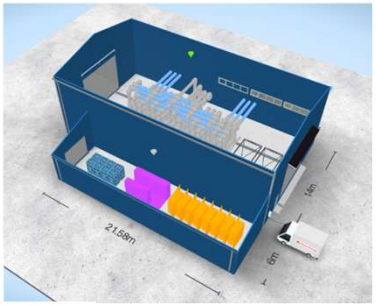
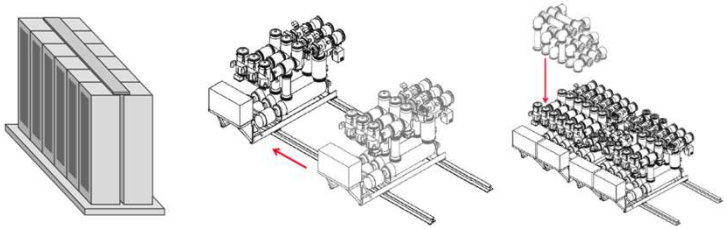
**Assembly of prefabricated steel superstructure**



## Electrical Installation

- Skidding of GIS bay modules on rails
- Connection of passive busbar components
- Skidding of indoor P&C, auxiliary power and battery modules



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# Housing types for containerized modules

Integrated GIS applications

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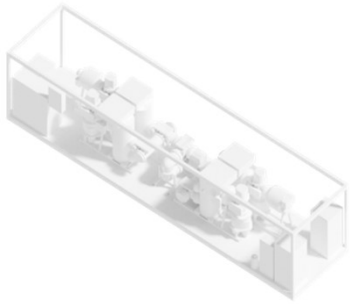
| High Voltage Switchgear 72.5-420 kV | Medium Voltage Switchgear 12-42 kV | Transformers | Substation Automation System (SAS) | Auxiliary Systems (AUX) | Housing & Base |
|---|---|---|---|---|---|

## Standardized layouts for integration of primary equipment



### Single housing unit(SHU)

| Layout | 145 kV | 170 kV | 245kV/300kV | 420kV |
|---|---|---|---|---|
| LILO | Small | Medium | (1-2bays) Large | (1 bay) Large |
| H3 | Large | Large | - | - |
| H4 | Large | Large | - | - |
| H5 | Large | - | - | - |
| xBB | Small | Medium | (1-2 bays) Large | (1 bay) Large |

### Multiple housing unit (MHU)

| Layout | 145 kV | 170 kV | 245kV/300kV |
|---|---|---|---|
| UxBB | Large | Large | (1-2bays) Large |
| 1½CB | Large | Large | (1 bay) Large |
| xBB | Large | Large | (1-bay) Large |
| xRing | Large | Large | (1-bay) Large |

# Housing types for containerized modules

Integrated GIS applications

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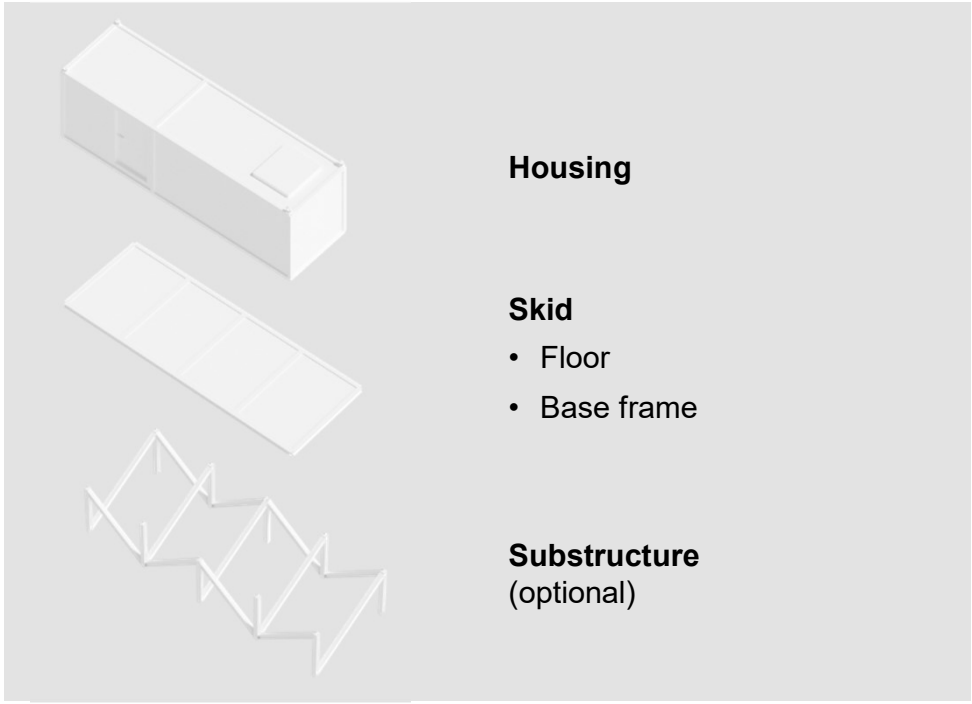

**Housing**

**Skid**

- Floor
- Base frame

**Substructure**
(optional)

## Modular and flexible enclosure system

- Standardized sizes for single housing unit (SHU) or multiple housing units (MHU)
- Housing units dimensions are designed close to ISO container norm measurements for optimized and easy transport
- Modular skid system with base frame, floor, and housing top
- Reduced complexity for cabling with double floor system
- For 72.5-145kV GIS, up to 5 GIS bays and local control cubicles (LCCs) mounted on a single skid
- Optional support structure available
- Designed to withstand rough handling during transport and harsh on-site conditions

# Foundation Options

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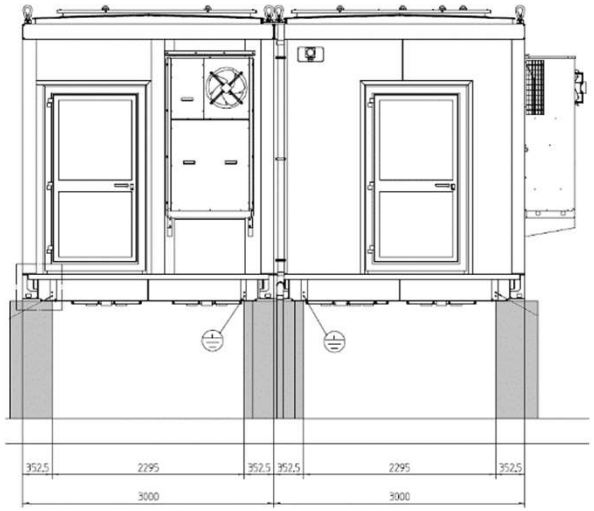


**Extended concrete pillar or Concrete Slab**

+ Cost efficient for permanent installations

**Steel substructure**

+ Less excavation / civil at site

**Extendable support legs**

+ Fast deployment / re-deployment
+ High mobility
+ drive-in & no-crane possible (requires extra space)
+ No need to leave trailer on premise




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# Foundation Options - extendable support legs

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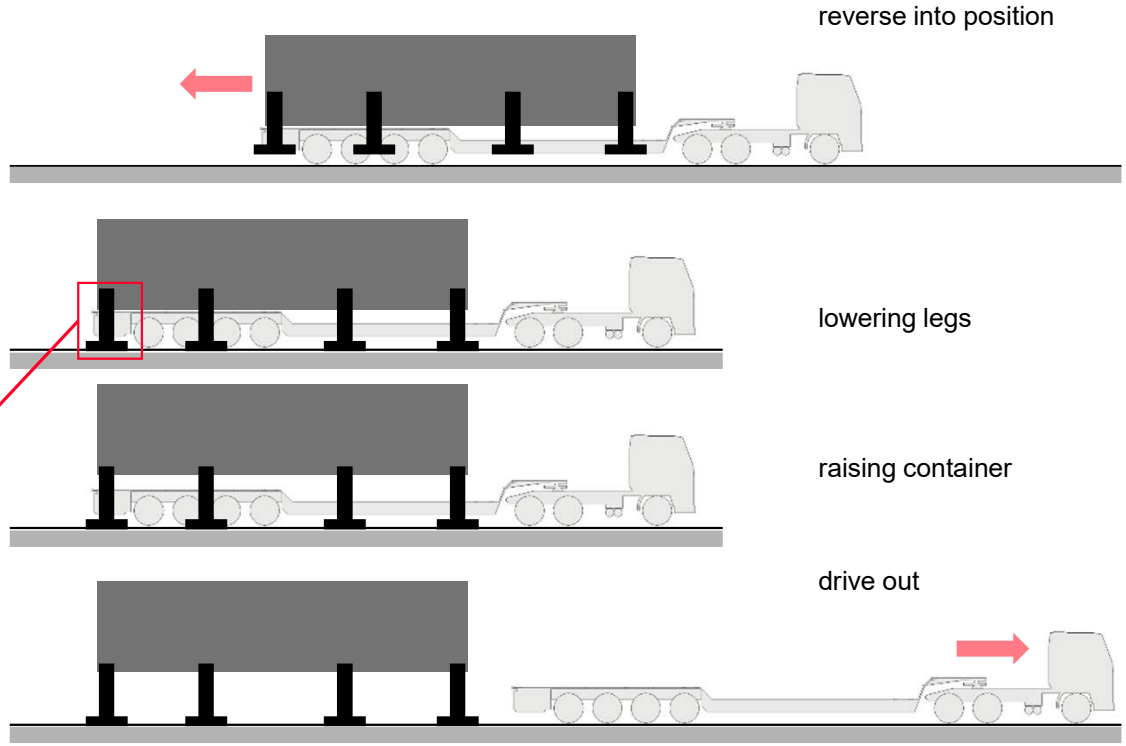
**Option 1**
Container positioning with crane – for small compounds

- Heavy-duty trailer landing gear
- Height compensation and leveling possible at each leg
- Raising/lowering by hand crank
- Lifting capacity up to 28t per leg

**Option 2**
Drive-in-Drop-off – no crane required







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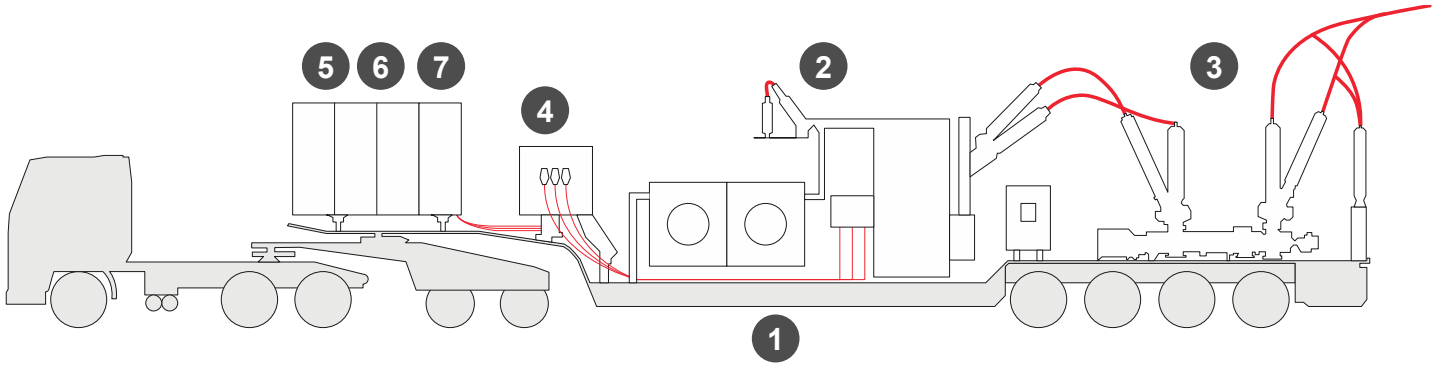
# Grid-eXpand™ | Skid-Mounted Solutions – Example

Grid-eXpand™ Mobile

1. Trailer or skid
2. Power transformer
3. HV equipment
4. Auxiliary transformer
5. Container / MV Switchgear
6. Substation Automation system
7. Other equipment



# Grid-eXpand™ | Mobile Substations - Example

**PFB 1.6.6.1.2**

Grid-eXpand™ Mobile

| | | | | | |
|---|---|---|---|---|---|
| Grid Connection Voltage (kV) : | 66 | 115 | **132** | 150 | 170 |
| Secondary Voltage (kV): | 11 | **13.8** | 33 | | |
| High voltage GIS bays : PASS M0 | | **1** | | | |
| Medium voltage feeders: | (I/C+O/G) | **1+6** | | | |
| Power Transformers: (1) MVA | **67** | 120 | 150 | | |
| High Voltage Line Connections: | **1** | 2 | 4 | | |

Electrical standard: IEC

Control and Protection: **Conventional** / Digital

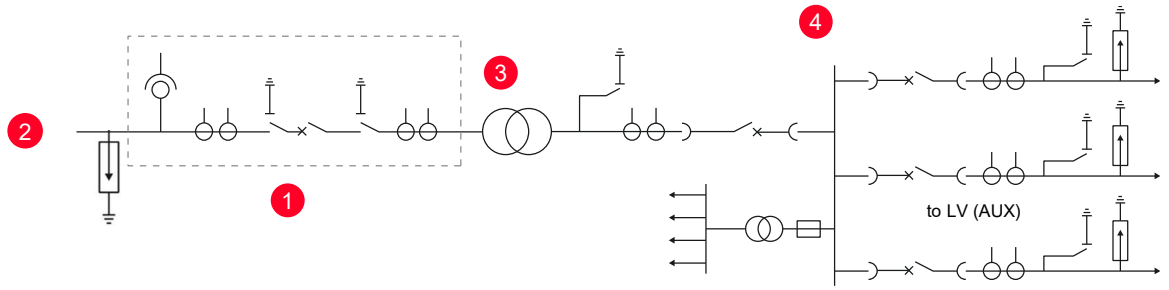
- The base solution contains general and detailed information for all relevant equipment needed to design, engineer, procure and execute a mobile modular substation project.
- All modules are selectable and fully configurable
- Modules can be positioned freely to fit specific site conditions

# Grid-eXpand™ | Skid-Mounted Solutions – Example

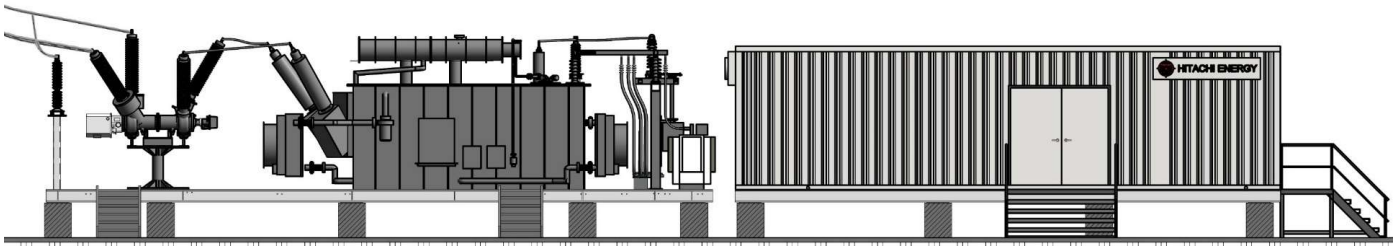


**Grid-eXpand™ - Connect**

**Skid-mounted Solutions**




1. Hybrid Switchgear (PASS)
2. High Voltage Grid connection, including surge arrester
3. Transformer
4. Medium Voltage Distribution




**Typical System Ratings**

| | |
|---|---|
| High Voltage: | 66-145 kV |
| Medium Voltage: | 12-36 kV |
| Transformers: | 5-25 MVA |
| HV Feeders: | 1 |
| MV Feeders: | 1-5 |

# Integrated GIS

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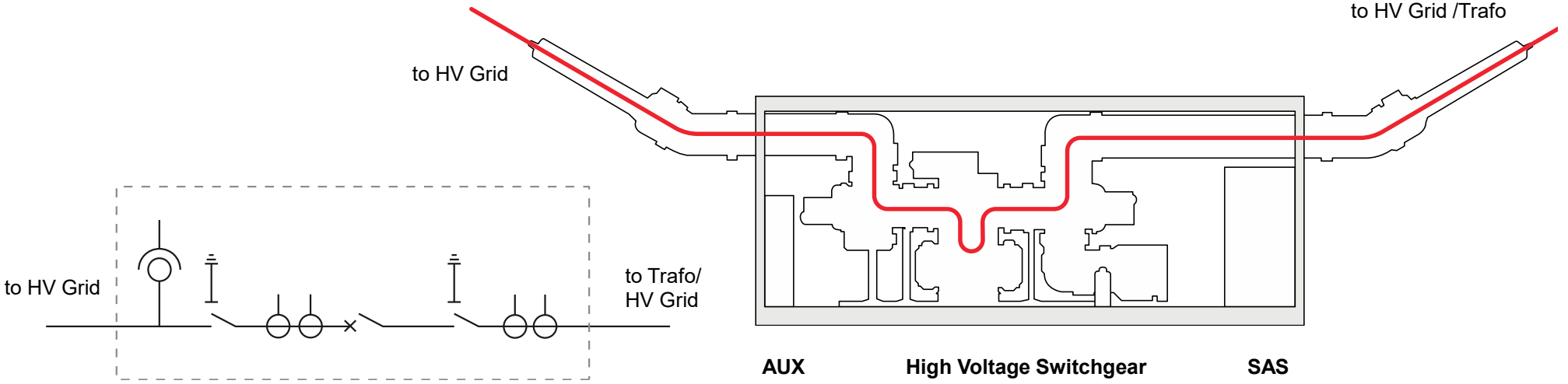
HV SWG | TR | MV SWG
SAS | AUX
H&B

High Voltage: 72.5-170 kV,
Medium Voltage: -
Transformer: -
Skid (LxWxH m): 8 x 3 x 3.5
HV Feeders: 1
MV Feeders: -




Fatkul Maarif



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# Integrated GIS – Module with bushings

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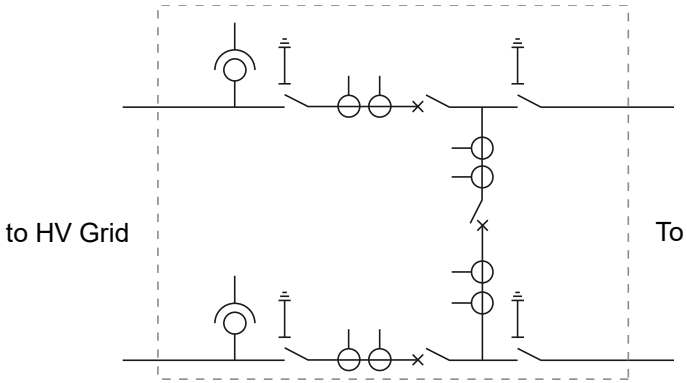
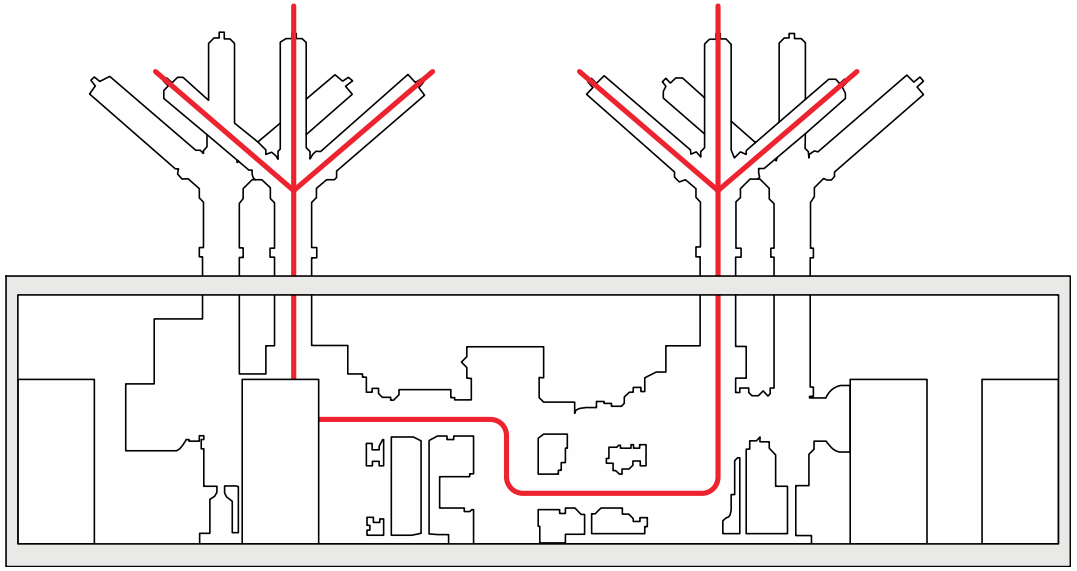
HV SWG | TR | MV SWG

SAS | AUX

H&B

High Voltage: 72.5-145 kV
Medium Voltage: -
Transformer: -
Skid (LxWxH m): 8 x 3 x 3.5
HV Feeders: -
MV Feeders: -



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# Integrated GIS – Examples

From “building blocks” to complete solutions

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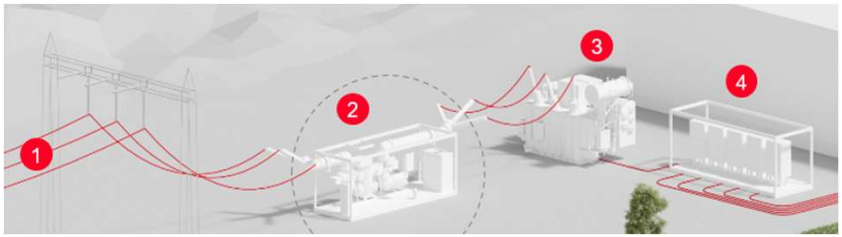
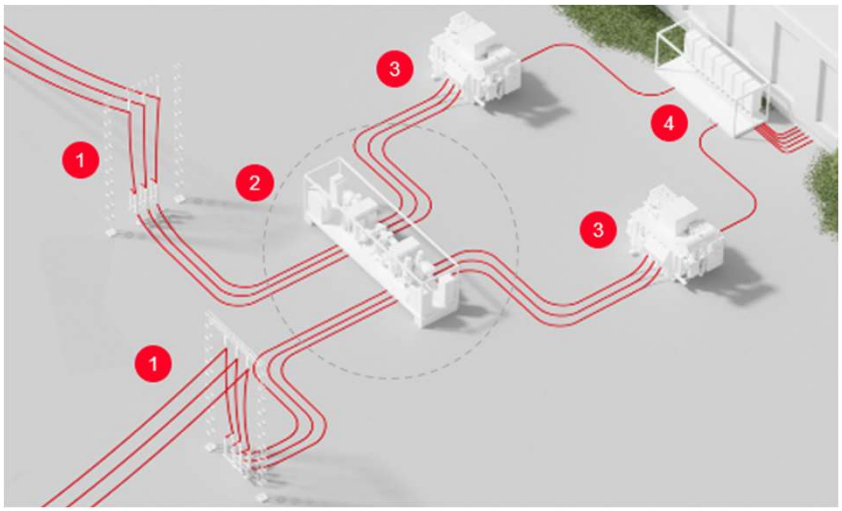
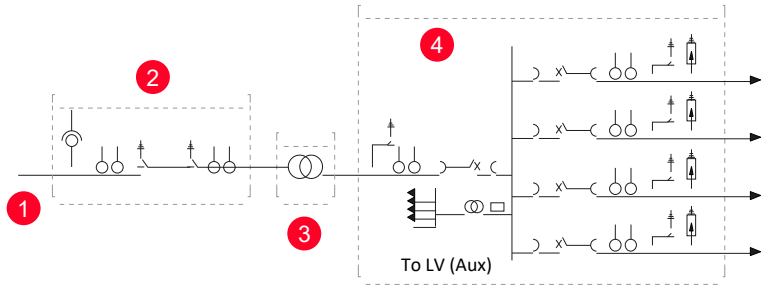
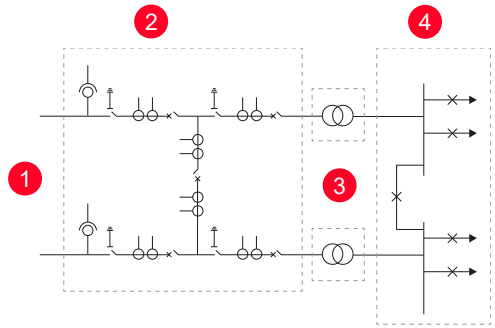
**Containerized Switchgear Solutions**




1. From High Voltage Grid
2. Gas Insulated Switchgear unit (GIS)
3. Transformer
4. Medium Voltage Distribution

**Typical System Ratings**

| | |
|---|---|
| High Voltage: | 72.5-170 kV |
| Medium Voltage: | 12-36 kV |
| Transformers: | 10-60 MVA |
| HV Feeders: | 1-5 |
| MV Feeders: | 10-30 |



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# Integrated GIS

A compact and modular Line-in/out GIS unit for connection to a single line

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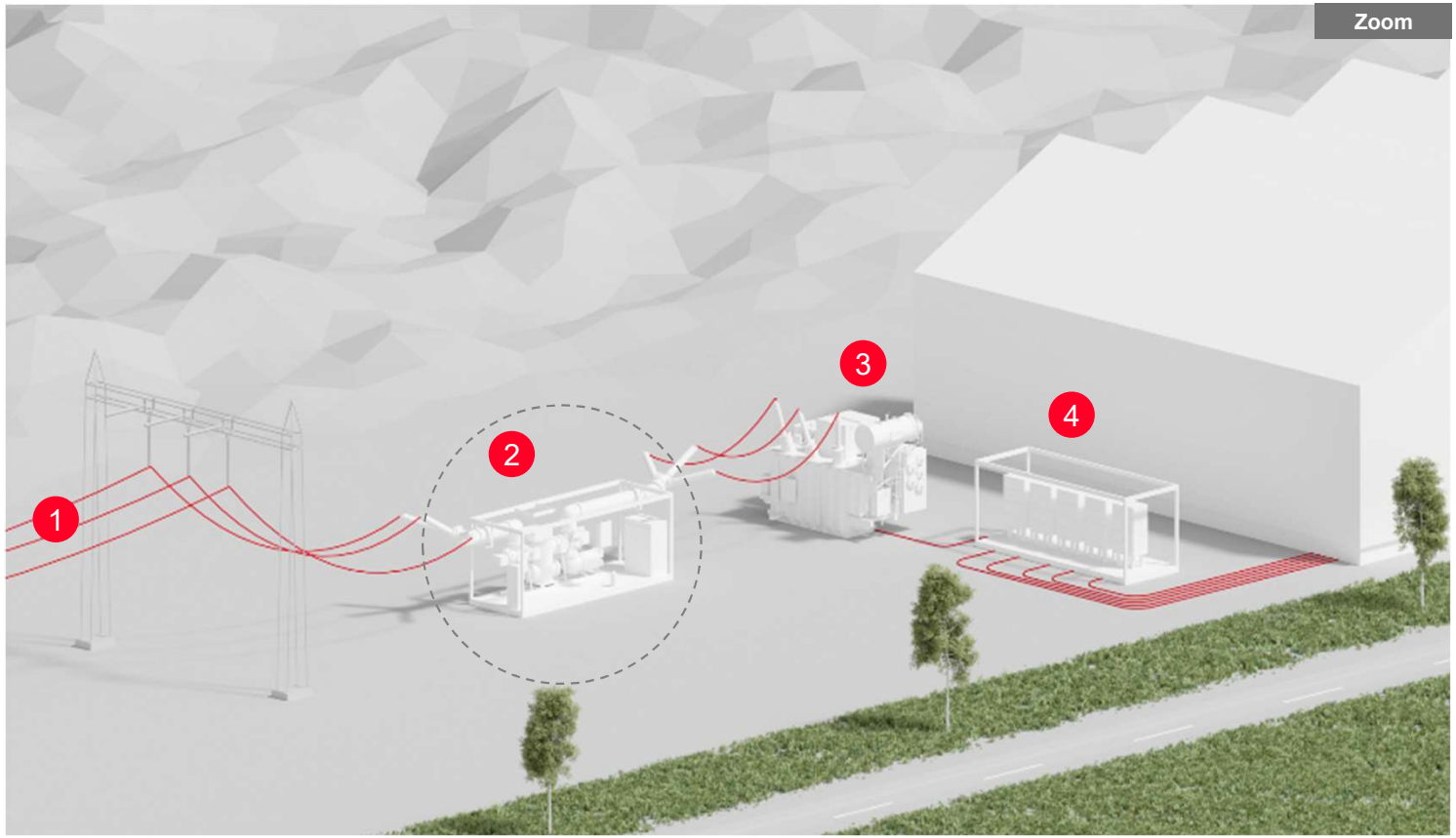
1. From High Voltage Grid
2. LILO Gas Insulated Switchgear unit (GIS)
3. Transformer
4. Medium Voltage Distribution



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# Integrated GIS (H-schemes)

Fully integrated GIS modules in H3, H4 and H5 arrangements

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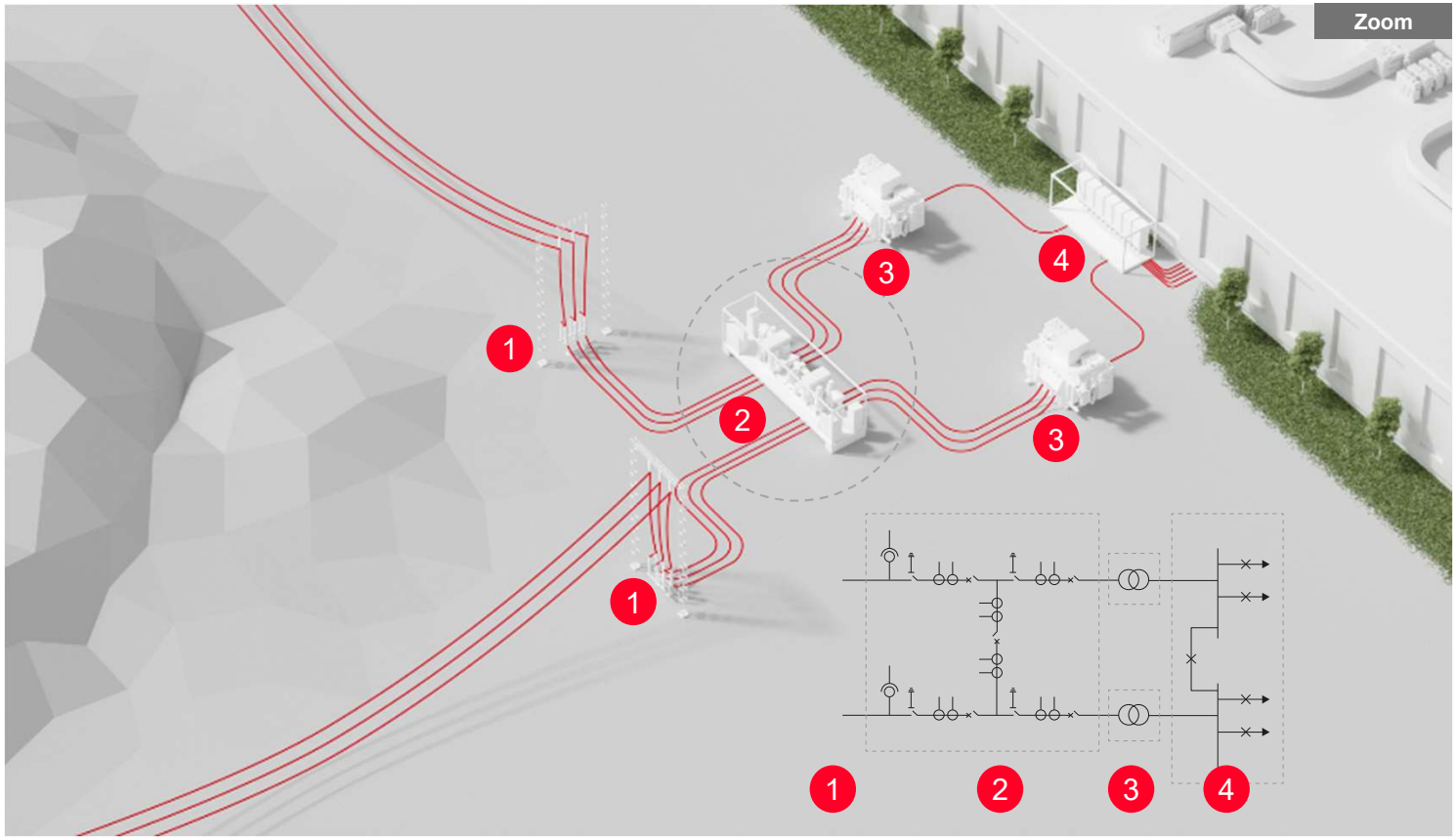
1. From High Voltage Grid
2. Gas Insulated Switchgear (GIS)
3. Transformer
4. Medium Voltage Distribution



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# Integrated GIS

## Integrated GIS with housing up to 420kV

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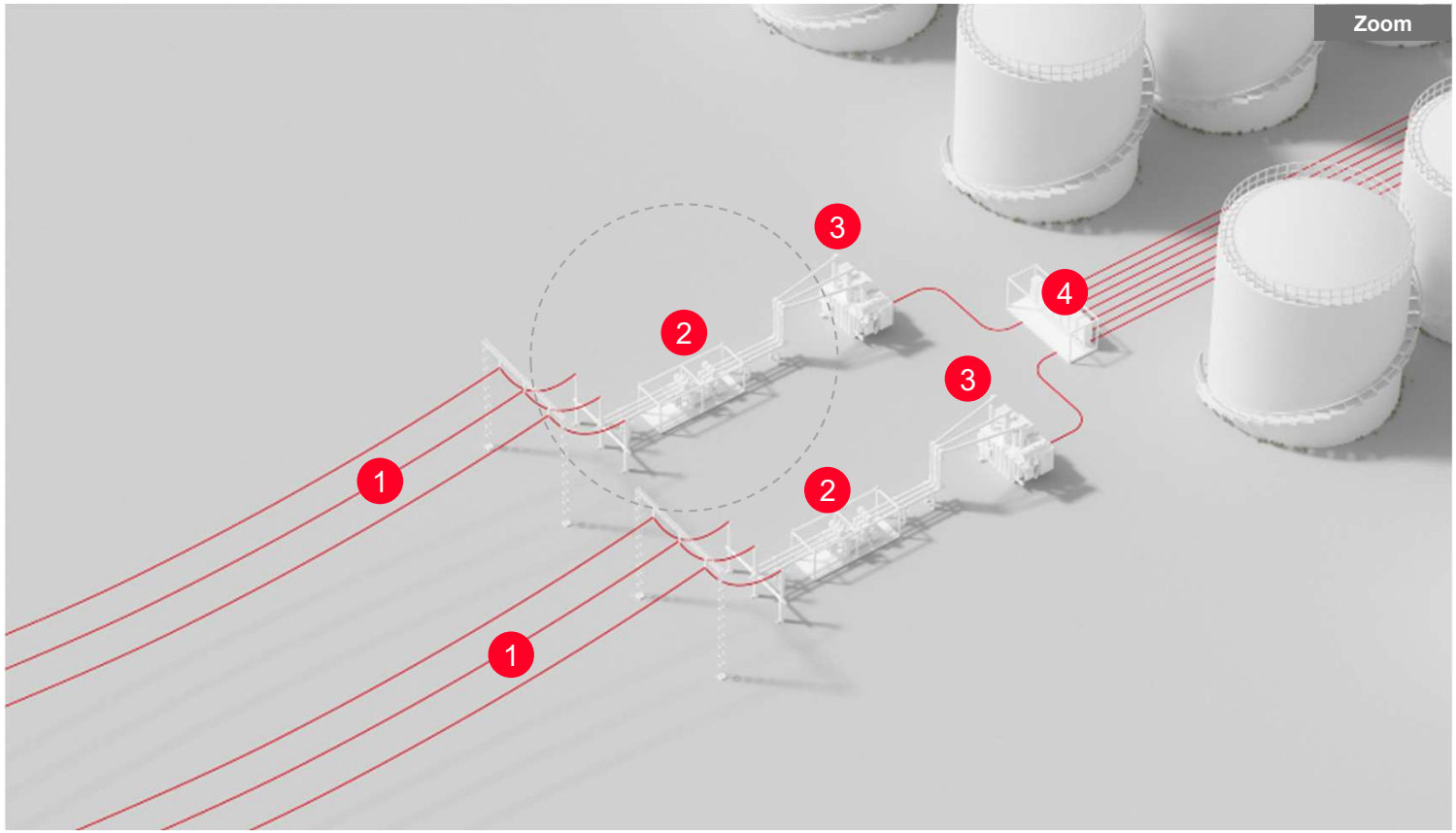
1. From High Voltage Grid
2. High Voltage Switchgear (GIS)
3. Transformer
4. Medium Voltage Distribution



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# Integrated GIS

## Multi-bay GIS with single and double busbars

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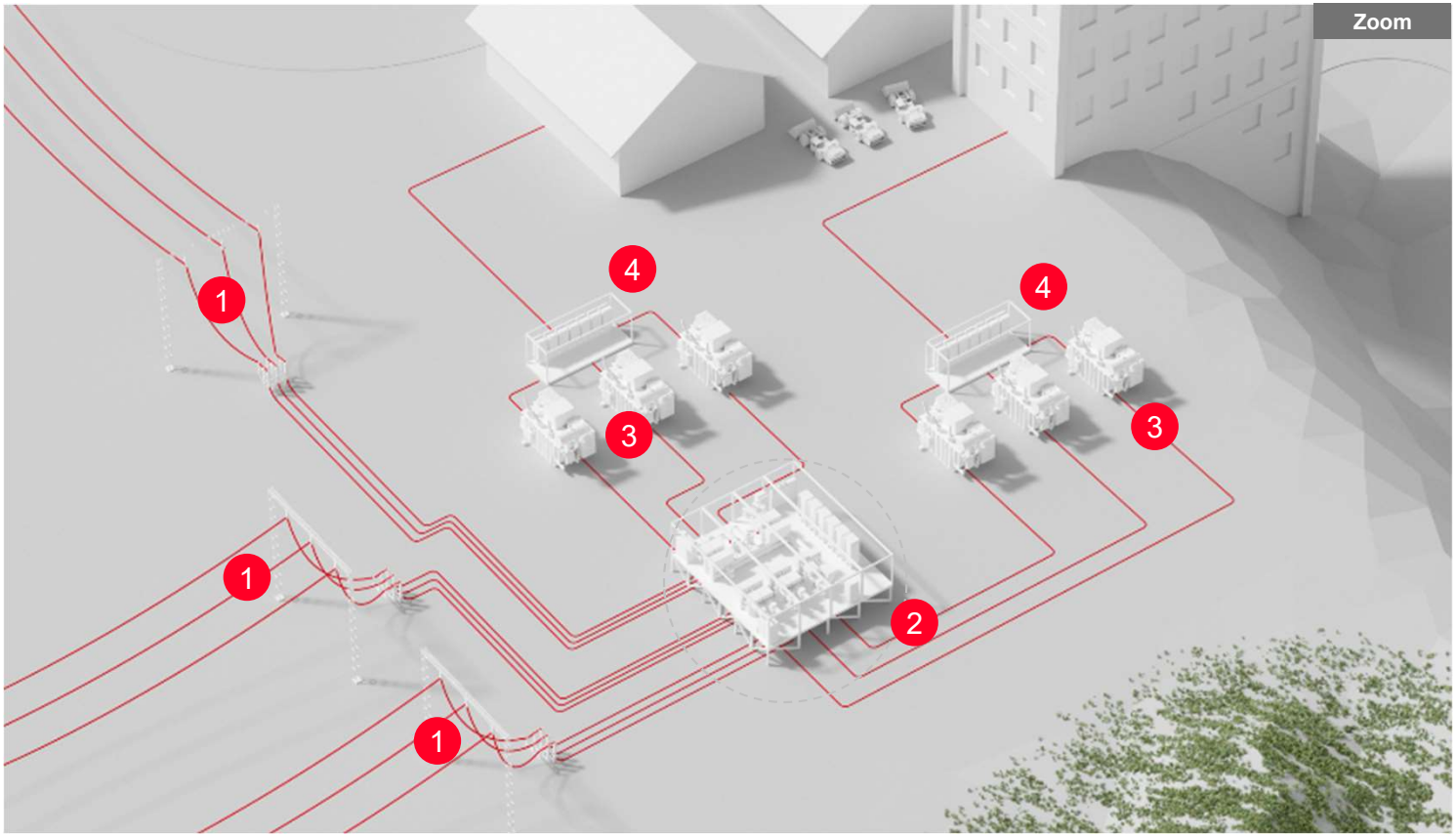
1. From High Voltage Grid
2. High Voltage Switchgear (GIS)
3. Transformer
4. Medium Voltage Distribution



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# Integrated GIS - Solution Example

A compact multi-story arrangement of stackable and scalable modules

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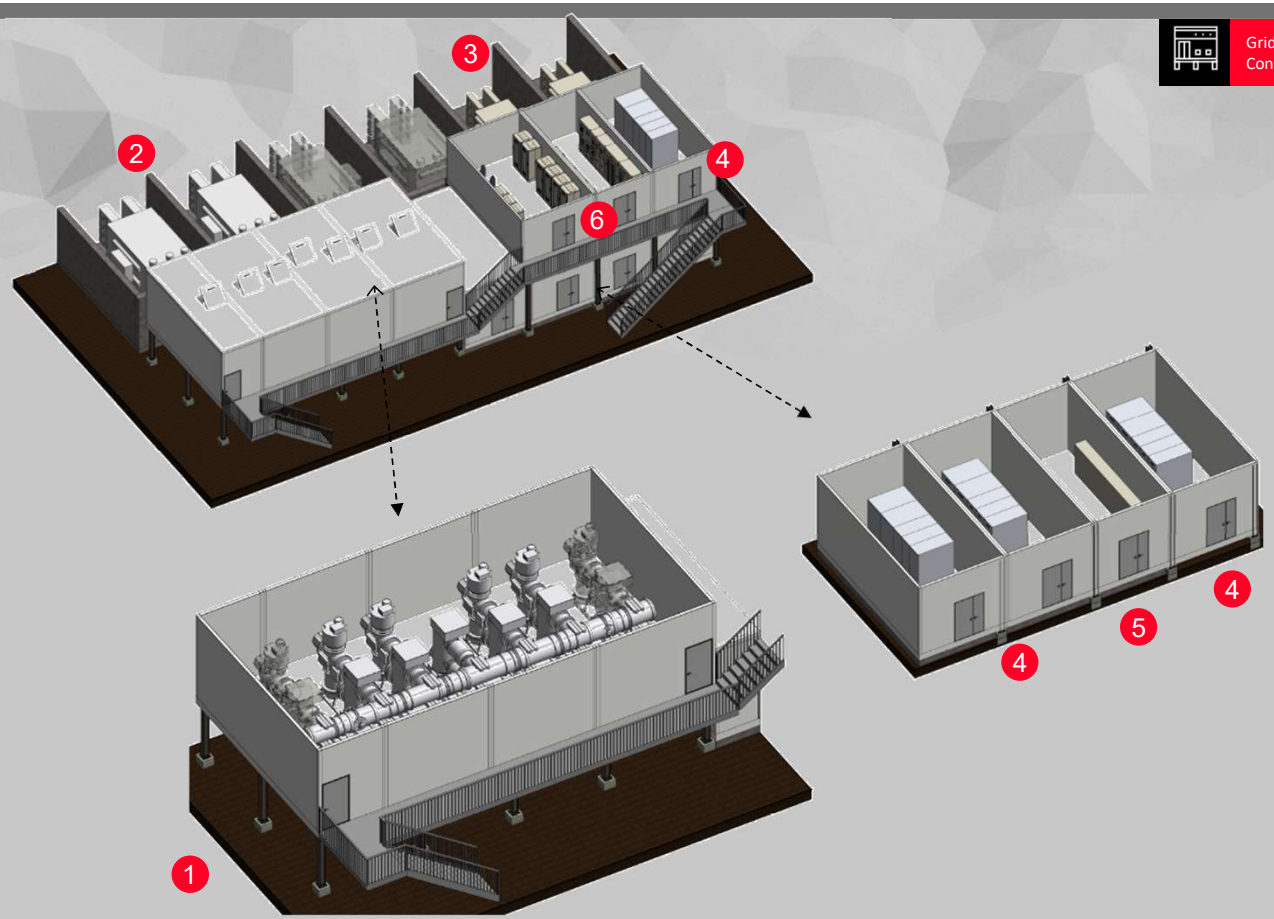
1. High Voltage Switchgear (GIS)
2. Power Transformers
3. Auxiliary Power Transformers/NER
4. Medium Voltage Switchgear
5. Battery and Charging System
6. Control, Protection and SCADA System



# SNAP-1 (SN Aboitiz, 230kV substation with 20MW BESS)

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# Prefabricated gas-insulated switchgear

Rantau Dadap, Geothermal substation, South Sumatera, Indonesia

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## Customer need

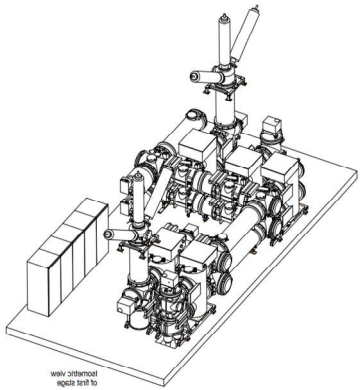
- Provision of a reliable power supply for an expanding geotermal located in South sumatera, Indonesia
- Compact solution for electrical package due to located on remote area.

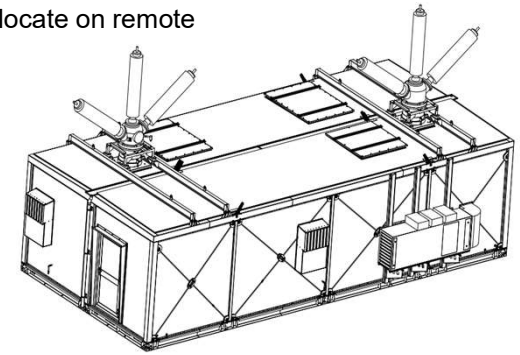
## Our Solution

- 4 bays single busbar at 170 kV
- Design, installation and commissioning of a pre-fabricated integrated gas-insulated switchgear unit
- Extension possibility for a future bay inside switchgear unit

## Customer values

- Less coordination of interfaces required
- The prefabrication of the substation resulted in reduced installation and commissioning time on site. The substation footprint was reduced
- Cost-optimized deployment by reduced installation cost and this locate on remote area.



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# Agenda

- Introduction
- Case Studies
- Q&A


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