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BIM:
The Future of Substation Design

Ajmal Saudagar & Kosta Snajderov

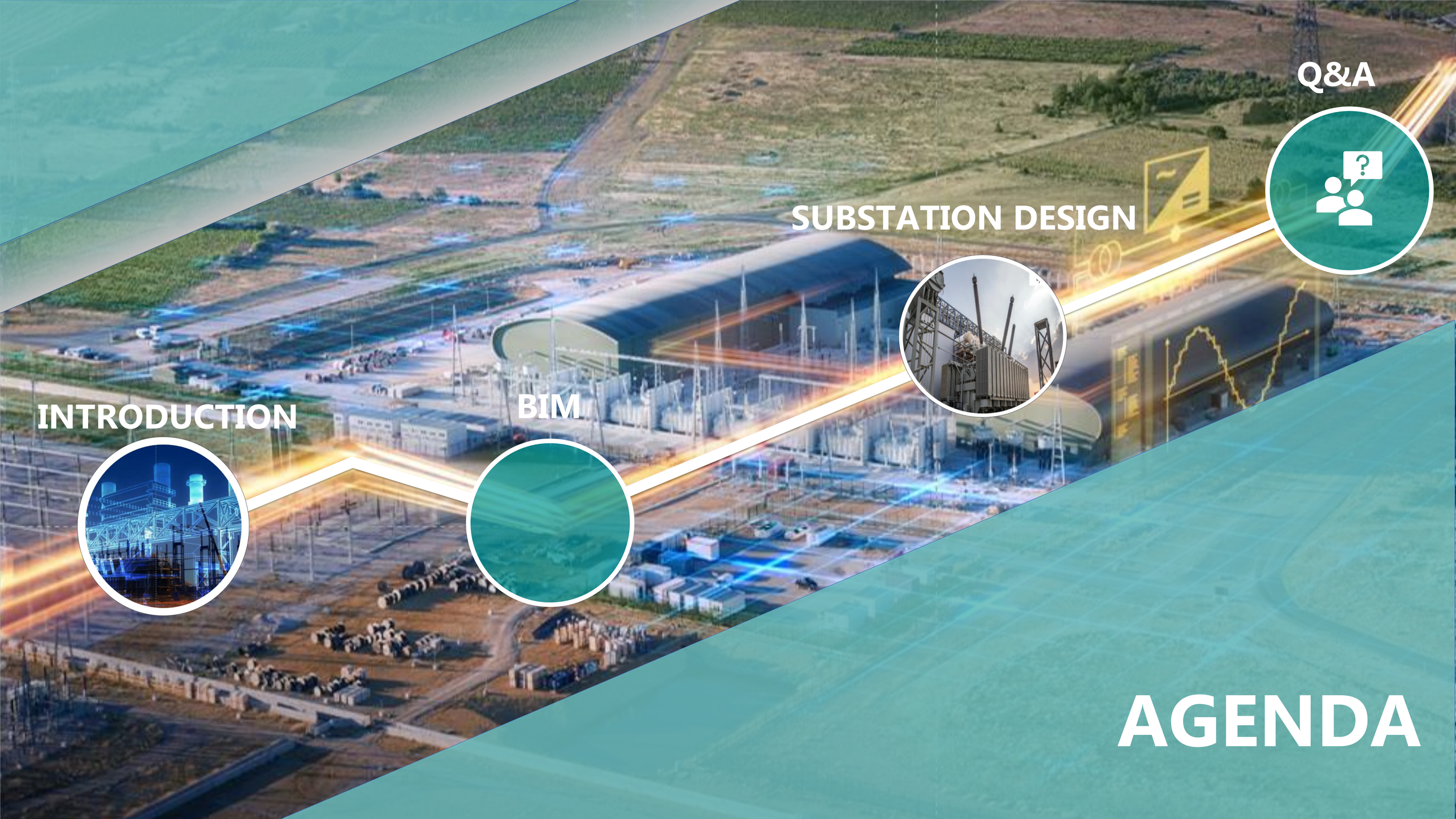
Engineer

Electrical Engineer

LEADERSHIP FORUM

AUTODESK. UNIVERSITY

BIM : THE FUTURE OF SUBSTATION DESIGN



AGENDA

INTRODUCTION

Speakers

Who we are

What we do

About the speakers

Ajmal Saudagar

Ajmal Hussein Saudagar is a BIM Engineer at Siemens GP EPC TS in Dubai, UAE. With a background combining Project Management and BIM Modelling, he is currently working on implementing Building Information Modelling within Siemens for substation design.

Kosta Snajderov

Kosta Snajderov is Senior Electrical Engineer at Engineering Department in Siemens for last 5 years. He is responsible for implementing BIM processes and standards in engineering workflows while up-scaling the primary electrical design with usage of Autodesk tools Revit and Navisworks. He has a strong interest in the substation industry trends that are enhancing digital design processes.

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SIEMENS OPERATING COMPANIES

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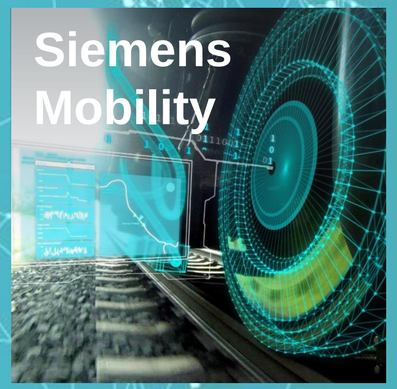

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Gas and Power – Business Units

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Gas and Power – Business Units

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EPC PROJECTS

EPC PROJECTS

Transmission Solutions in Middle East

Our Transmission Solutions Portfolio at a Glance

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HVDC

Grid Access

FACTS

PTL

Turnkey Substation

Service

Our Transmission Solutions Portfolio at a Glance

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HVDC

Grid Access

FACTS

PTL

Turnkey Substation

Service

>10,000
High-Voltage Switchgear Bays in the Region

40%
of Energy Transmission in UAE is from Siemens

>105,000 MVA
Total Installed Power Transformers in the Middle East

> 46,000
GIS Medium-Voltage Switchgears Installed in the Middle East

> 100,000
Numerical Devices Protecting the Electrical Grid in the Middle East

Our contribution to the region

Transmission Solutions

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100+

Substation projects executed in the UAE

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Substation projects executed in Kuwait

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Substation projects executed in Kuwait

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40+

Substation projects executed in Saudi Arabia

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Substation projects executed in the UAE

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Substation projects executed in Kuwait

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Substation projects executed in Pakistan

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100+
Substation projects executed in the UAE

100+
Substation projects executed in Kuwait

40+
Substation projects executed in Saudi Arabia

100+
Substation projects executed in Pakistan

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45+
Substation projects executed in Egypt

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Our contribution to the region

Transmission Solutions

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100+
Substation projects executed in the UAE

100+
Substation projects executed in Kuwait

40+
Substation projects executed in Saudi Arabia

100+
Substation projects executed in Pakistan

45+
Substation projects executed in Egypt

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Our contribution to the region

Transmission Solutions

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100+
Substation projects executed in the UAE

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Substation projects executed in Kuwait

40+
Substation projects executed in Saudi Arabia

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Substation projects executed in Pakistan

45+
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Major Regional Customers

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BIM - Building Information Modelling

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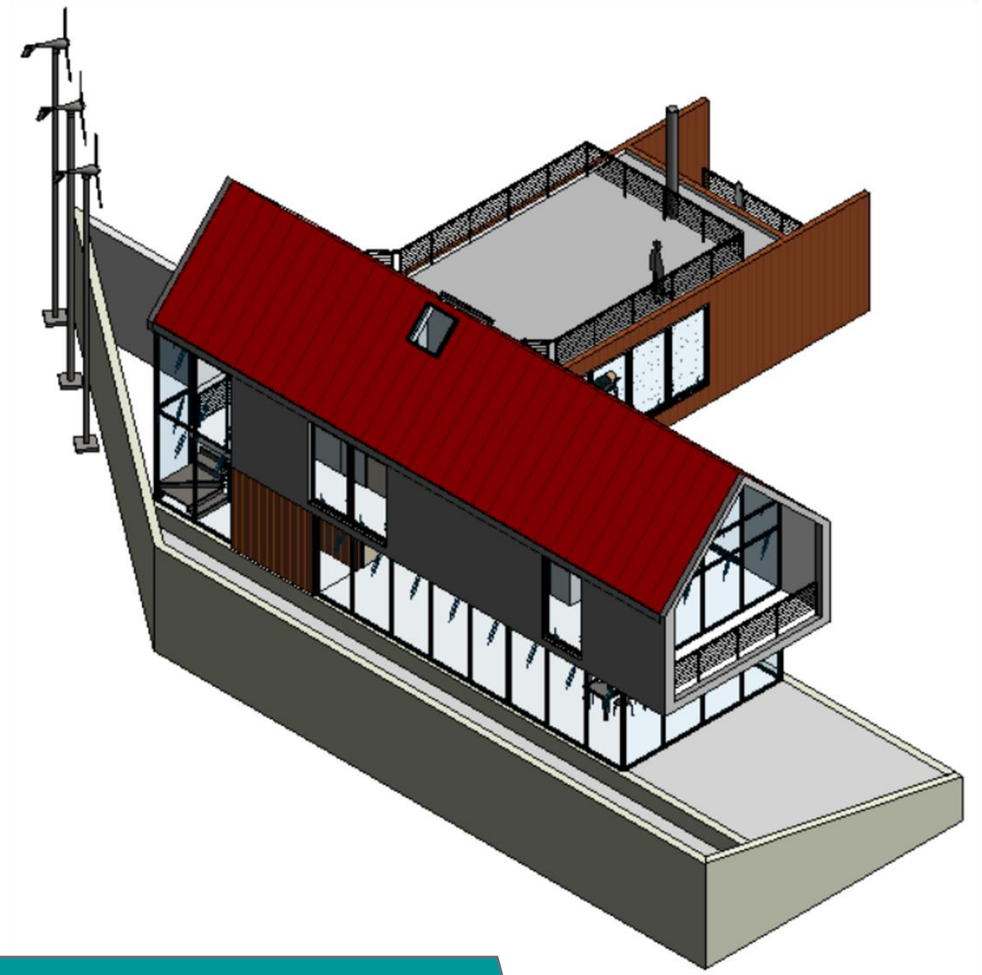
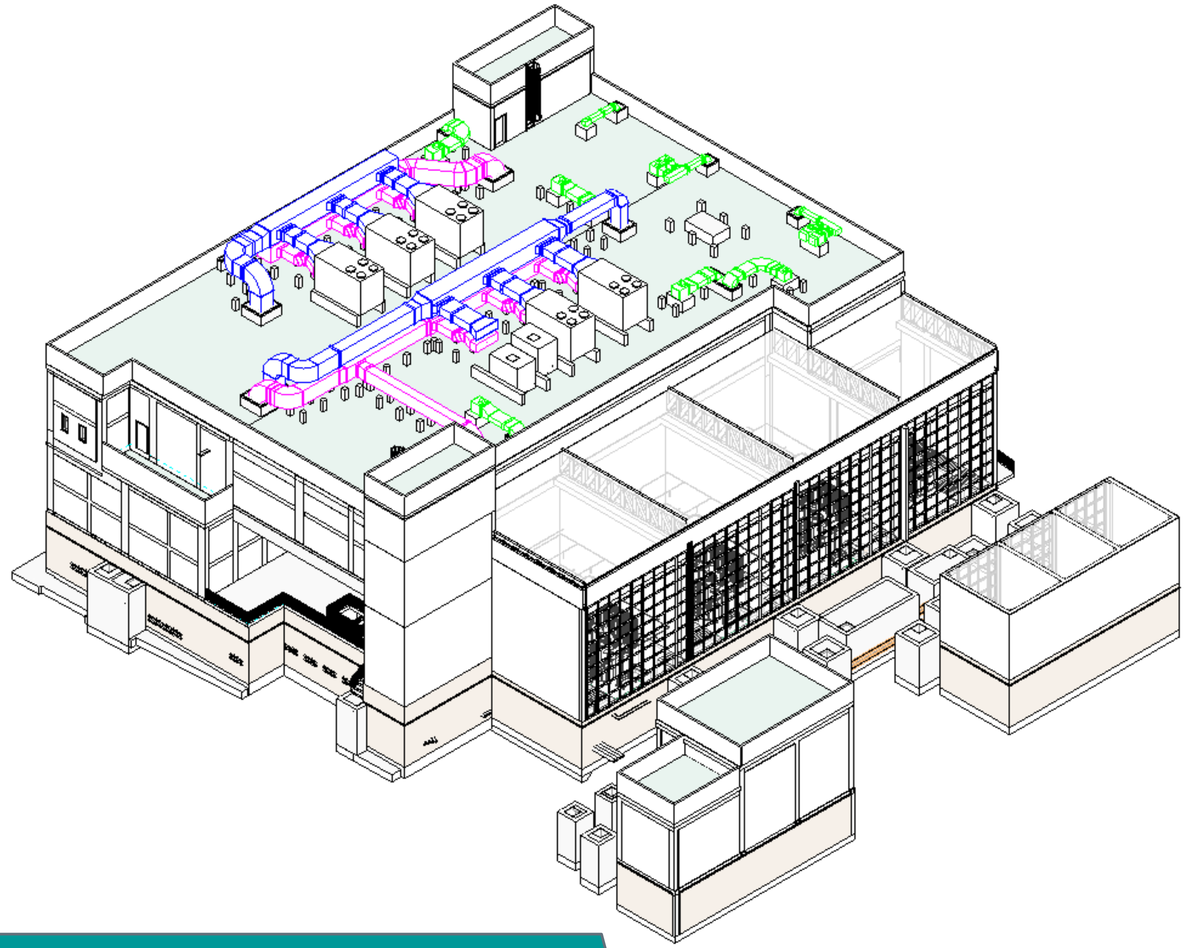


Building



Substation

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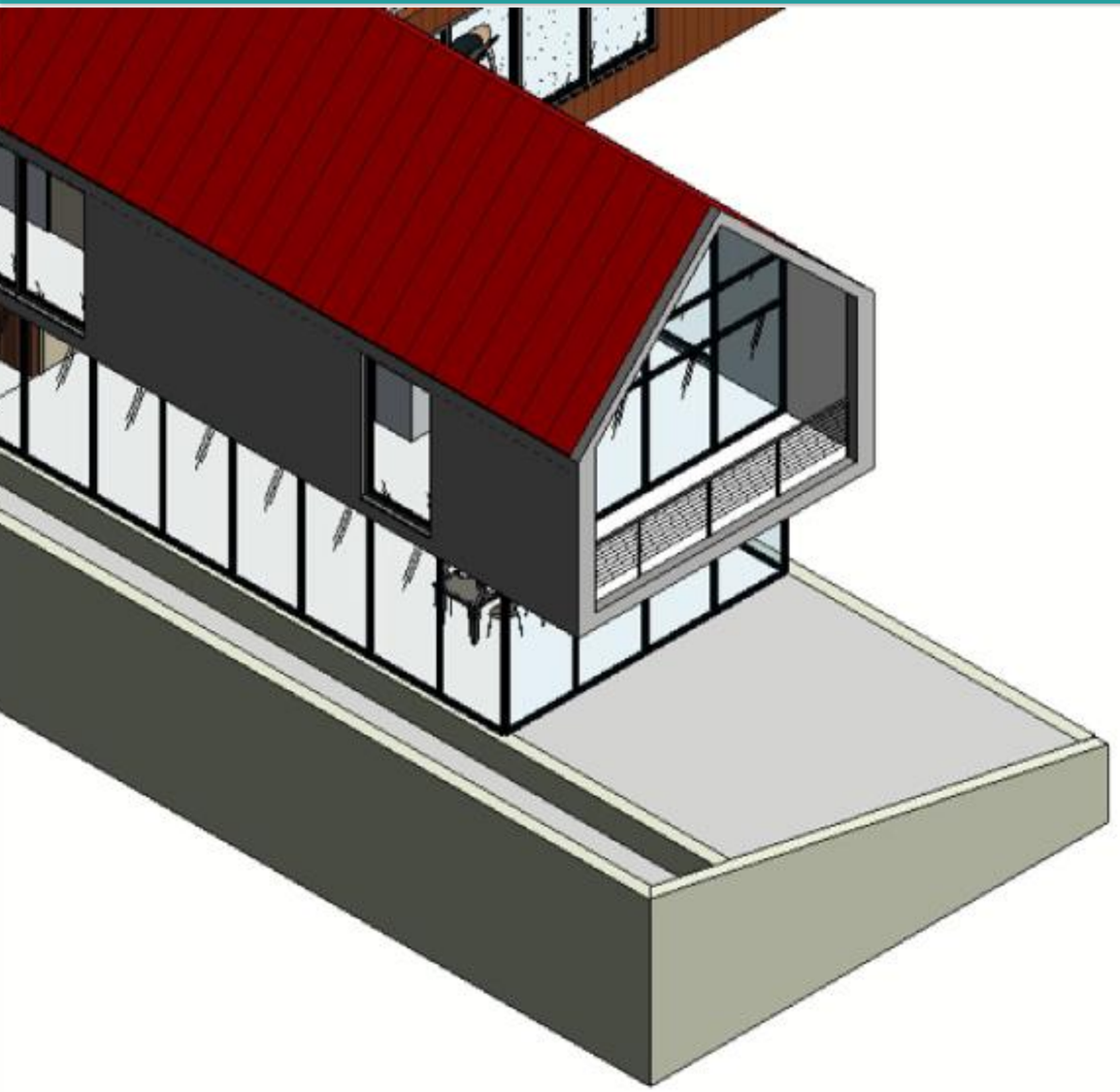

BIM optimizes collaboration by connecting people, information and processes

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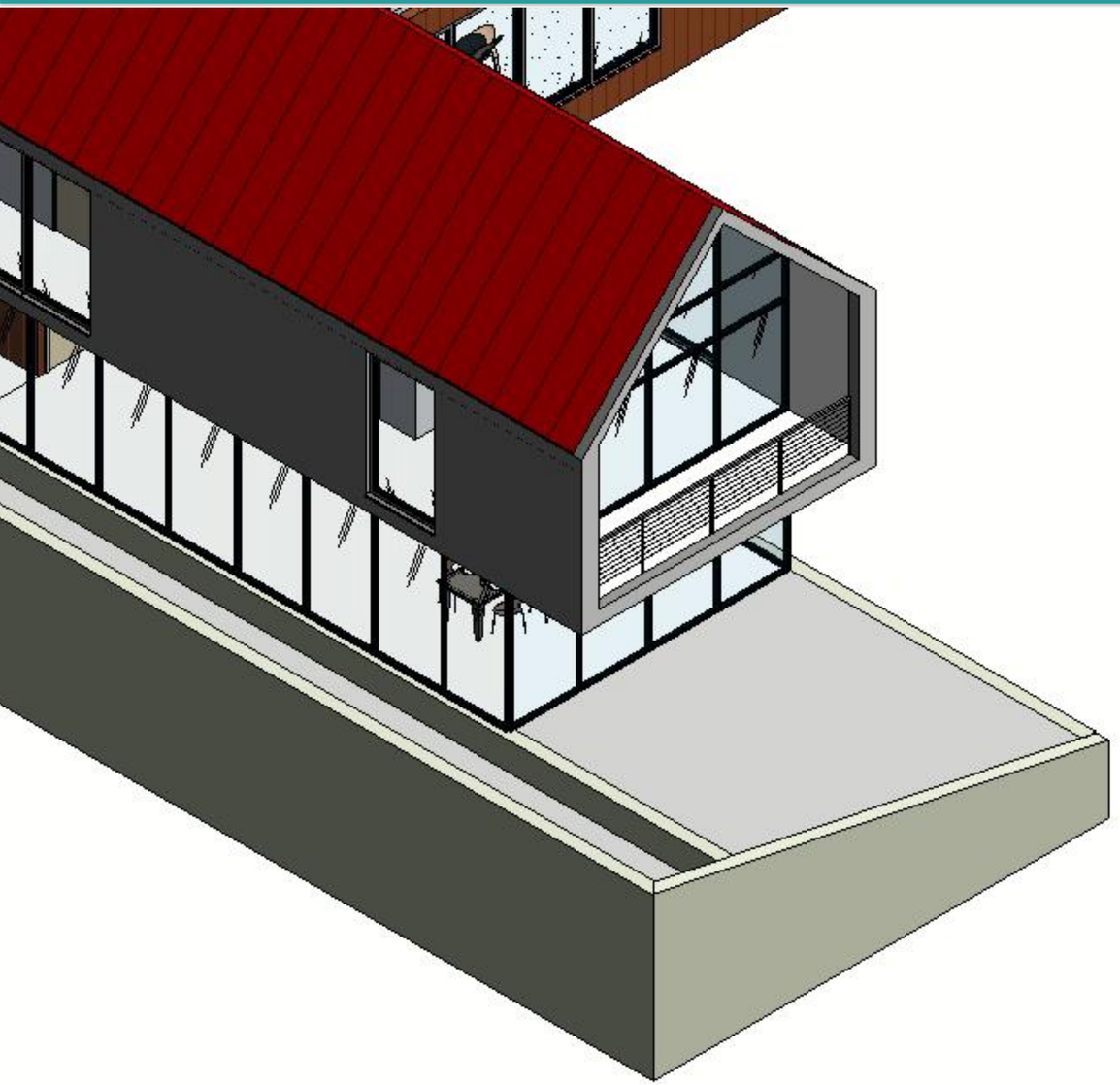

BIM - Building Information Modelling

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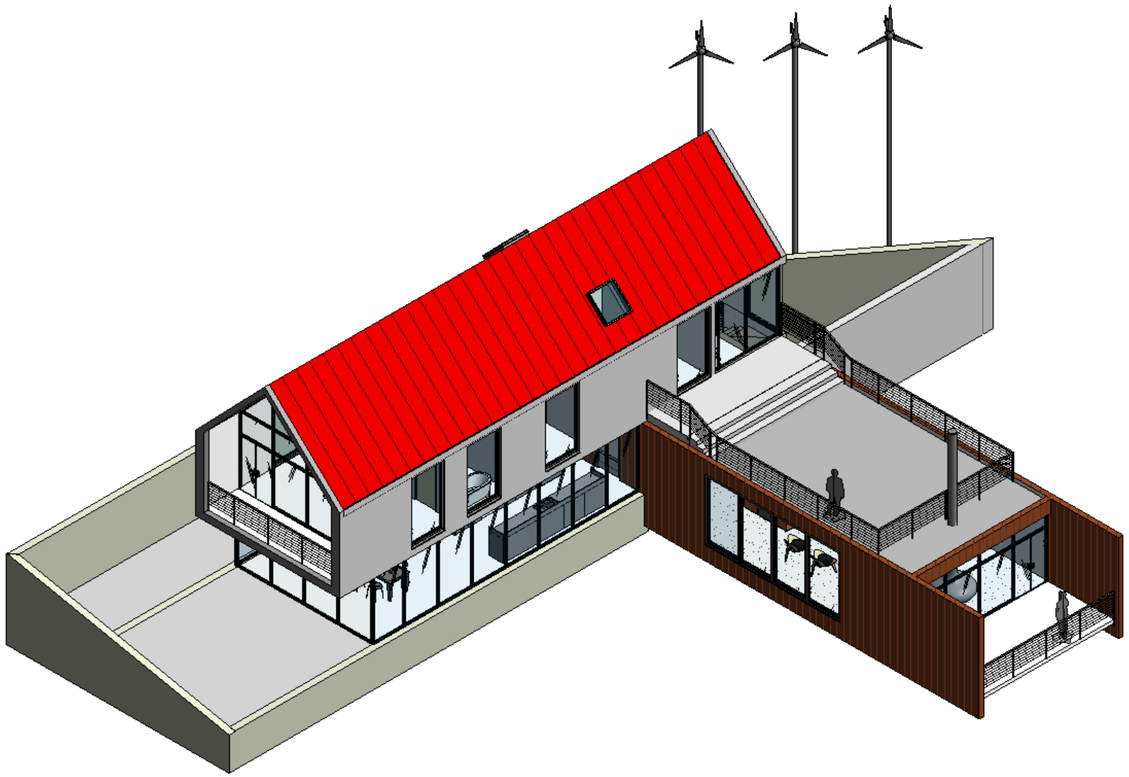

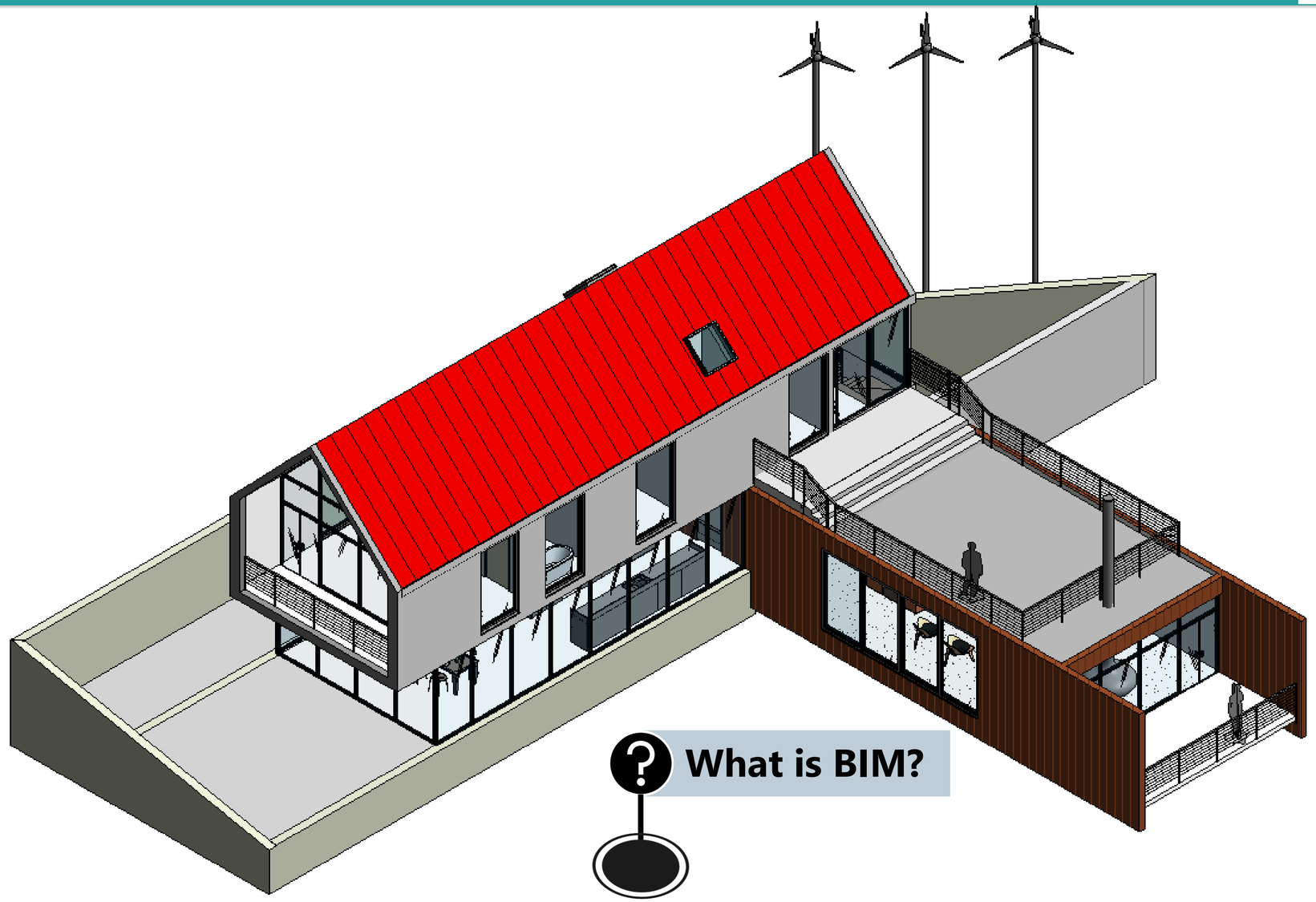

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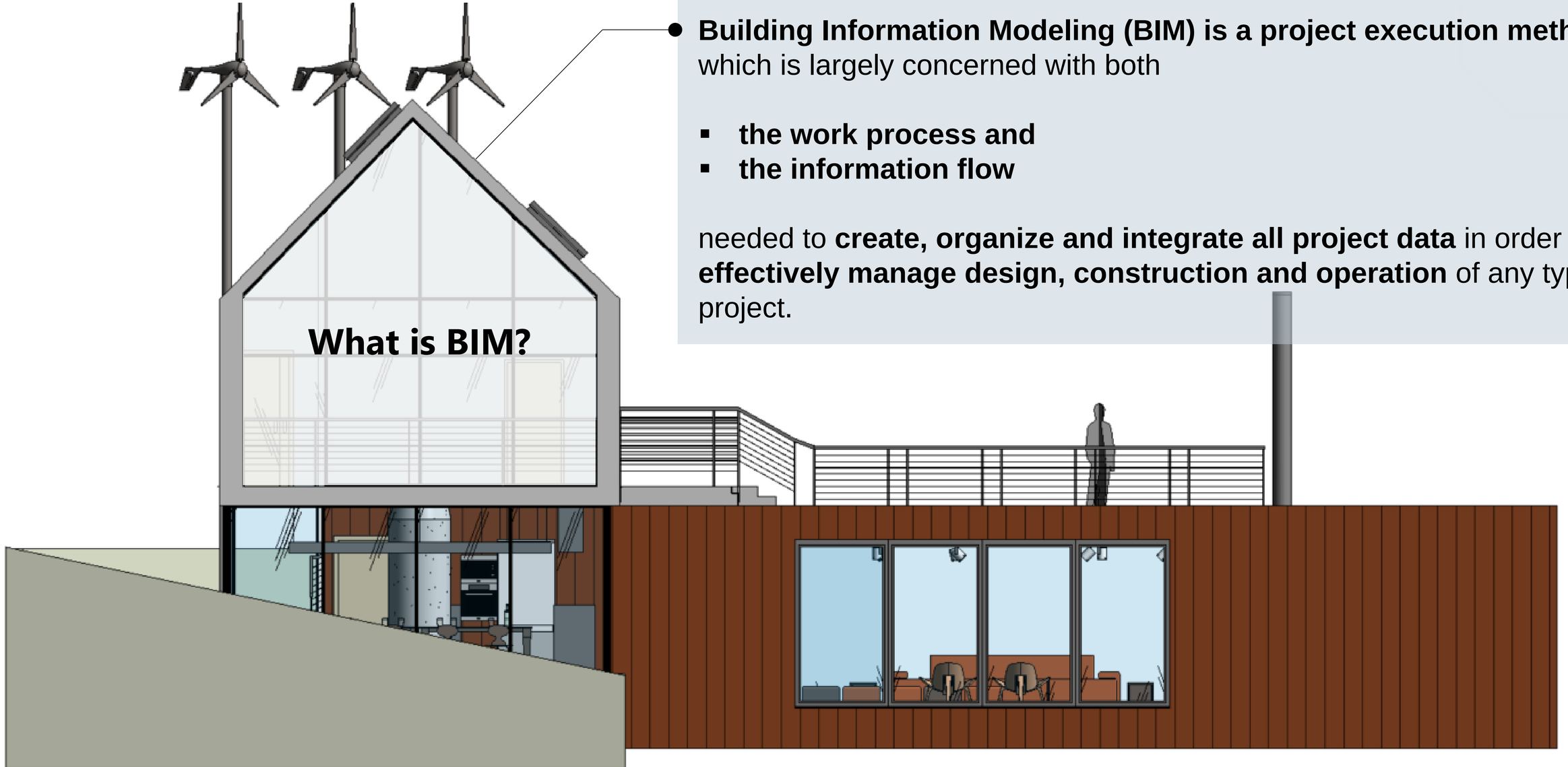
What is BIM?

Building Information Modeling (BIM) is a project execution method which is largely concerned with both

- **the work process and**
- **the information flow**

needed to **create, organize and integrate all project data** in order to **effectively manage design, construction and operation** of any type of project.



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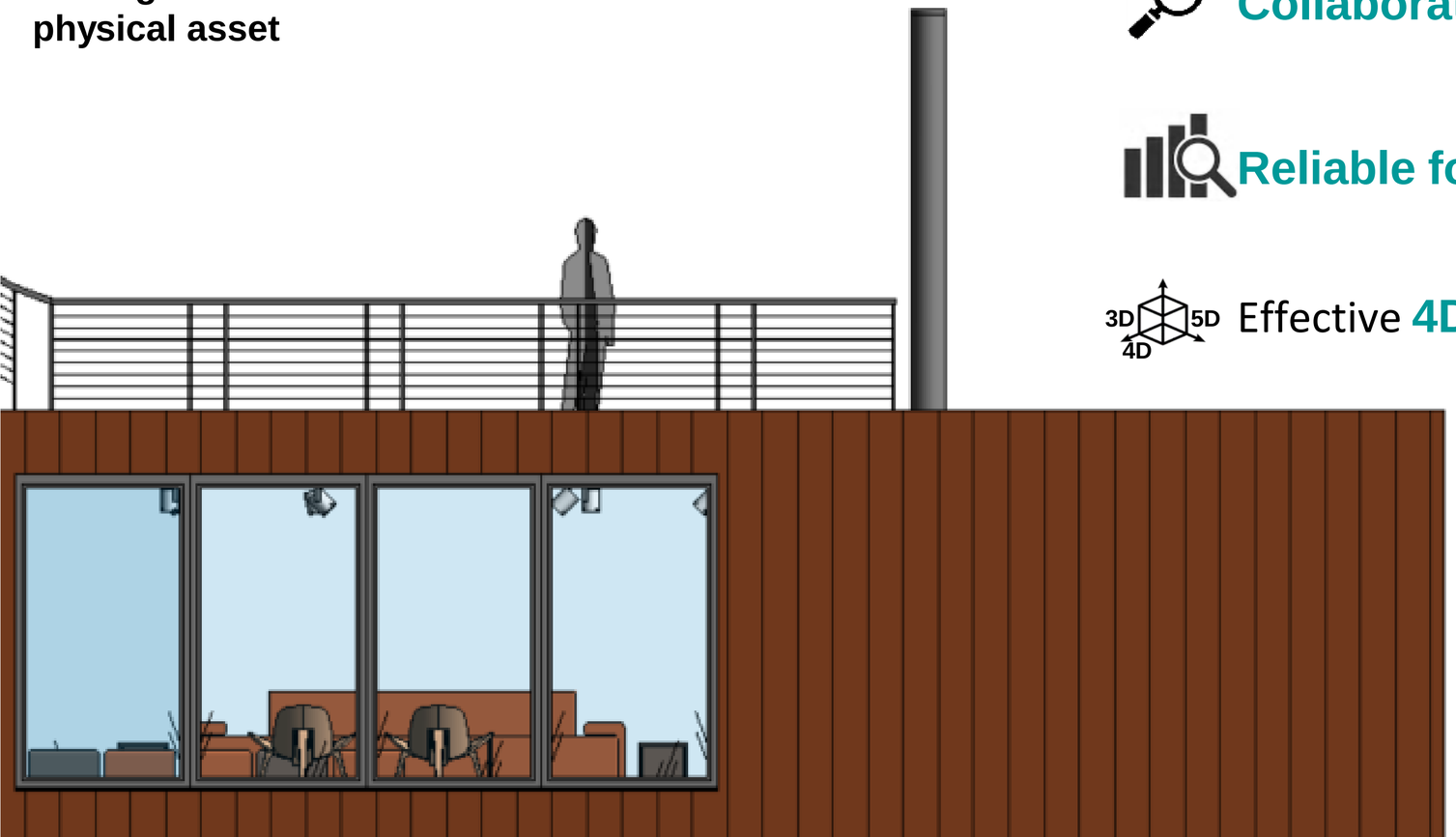
Customer Expectations

Get digital information in addition to the built physical asset



Easy access to and exchange of **coordinated information**

Collaborative design monitoring and reviews in 3D

Reliable forecast on effects of design changes and quantities

Effective **4D** (time) and **5D** (cost) **construction simulations**

Steadily construction **progress monitoring**

Integrated **3D as-built documentation**

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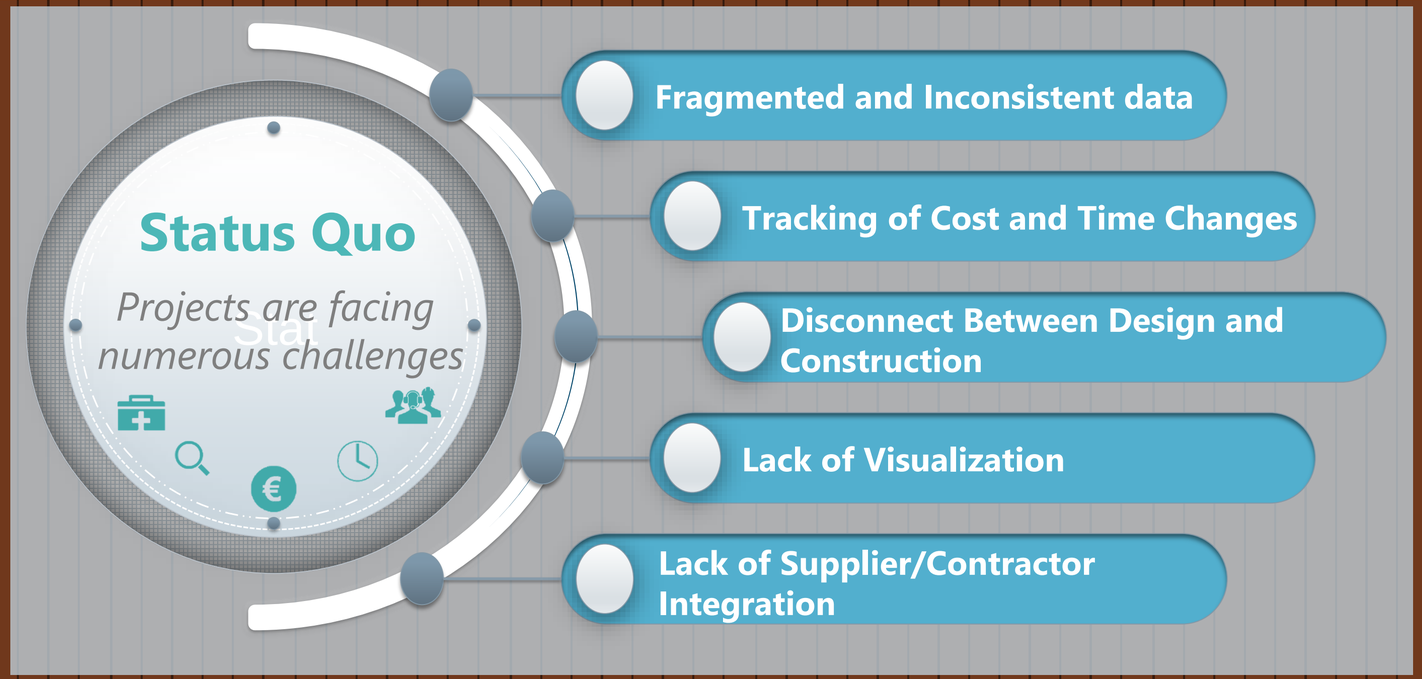

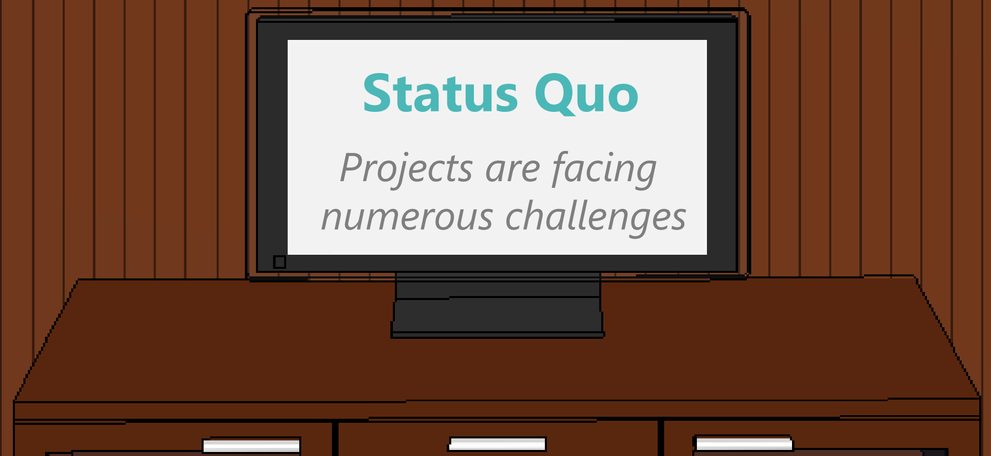

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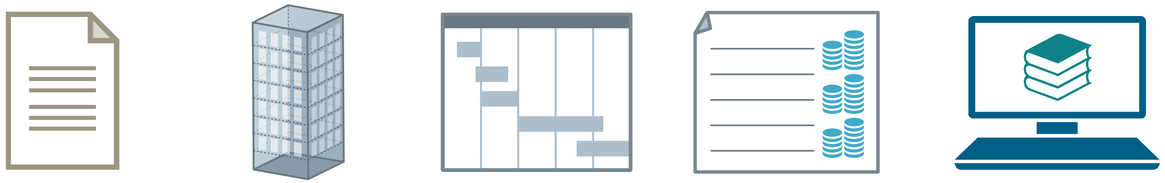
BIM offers different dimensions that help us to plan and operate buildings

2D → 3D → 4D → 5D → 6D → XD



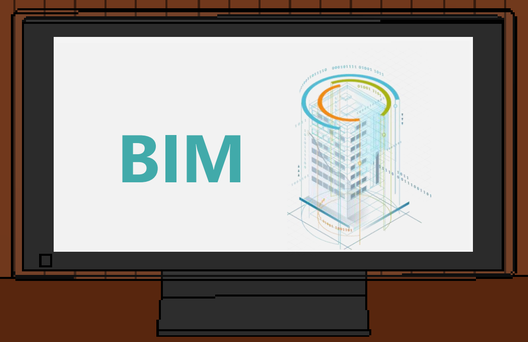
2D Drawings

3D model

Schedule

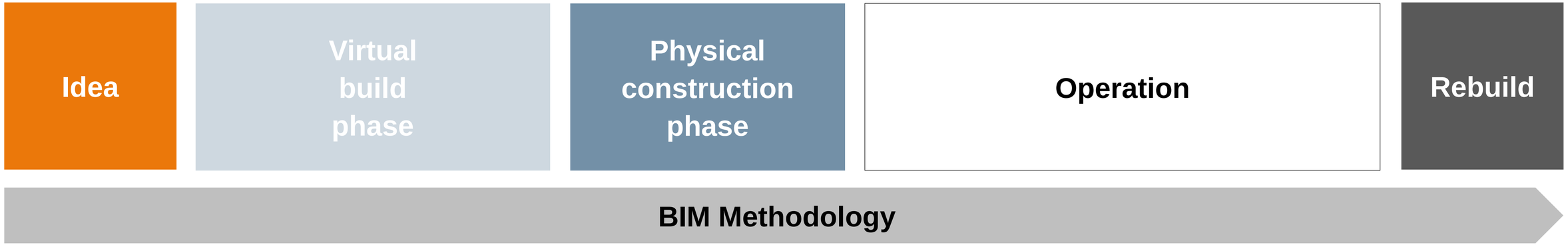
Costs

Building Lifecycle Information (eLibrary)



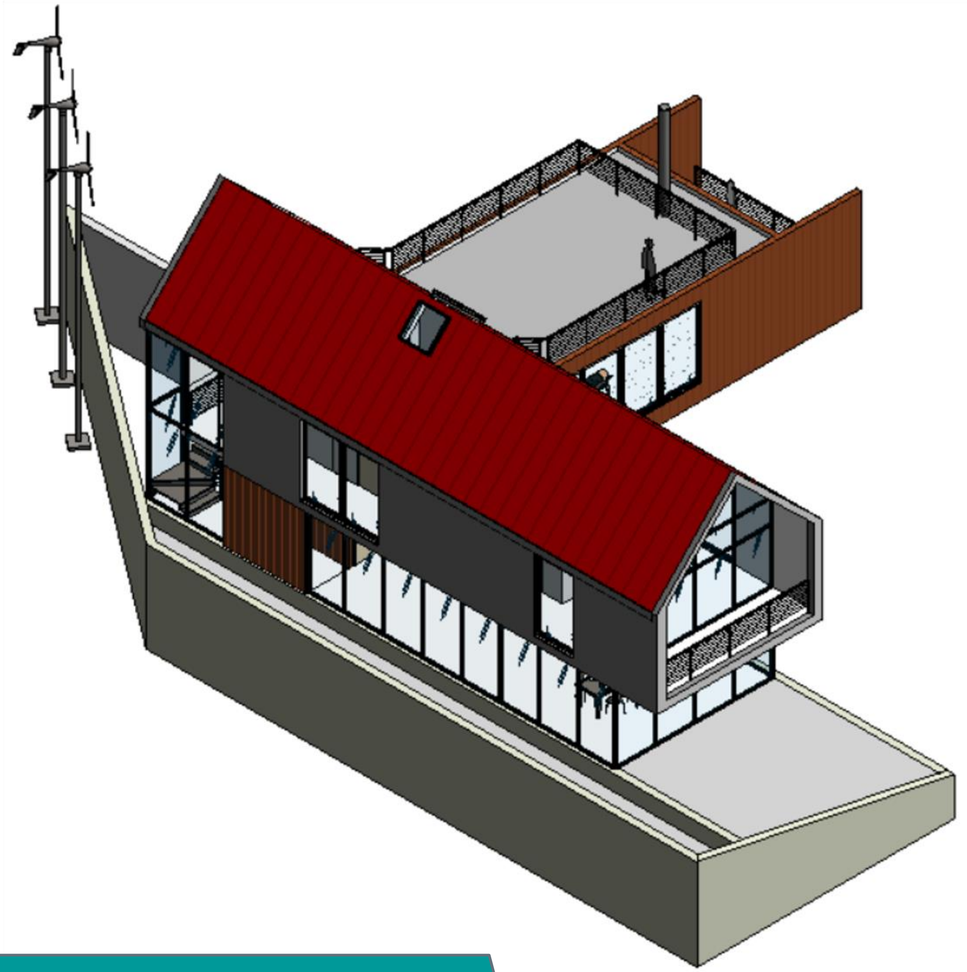
Today w/o the BIM methodology

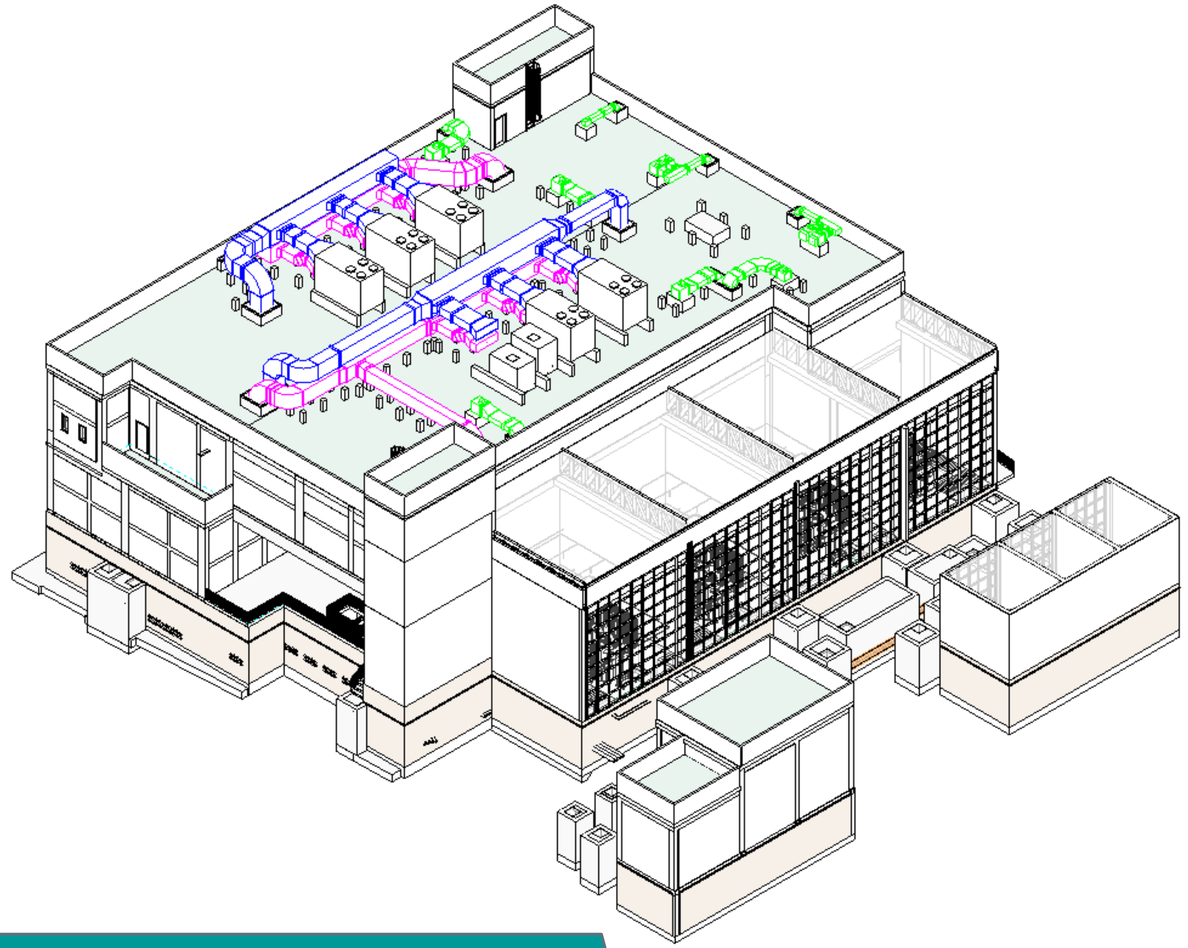
Tomorrow with the BIM methodology



Source: Siemens Switzerland Ltd, Building Technologies Division, BIM “Understanding the language of buildings” March 2017

BIM influences the collaboration btw. the different disciplines as well as the duration of the different phases





BUILDINGS

SUBSTATIONS

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BIM FOR SUBSTATIONS

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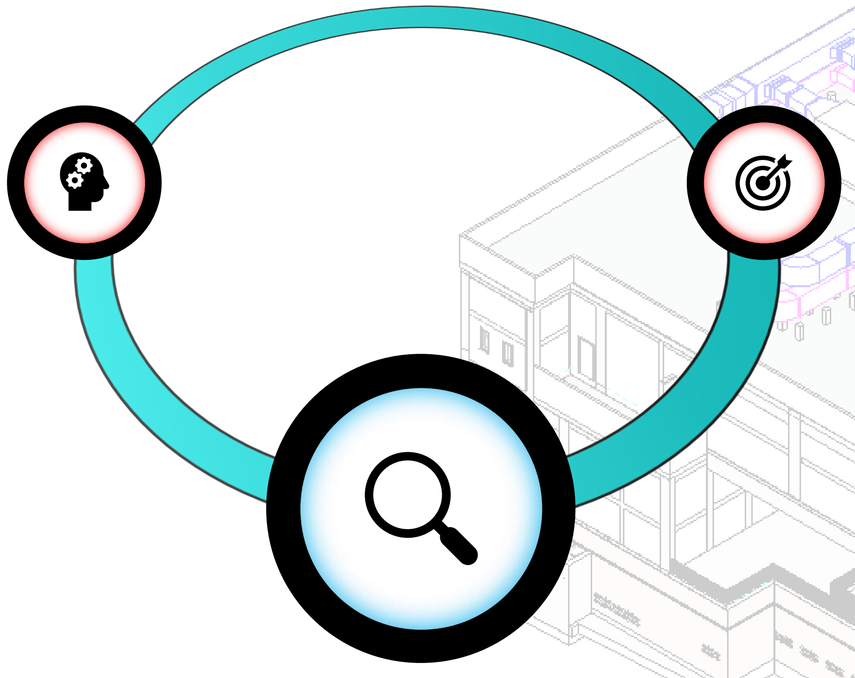

MAJOR CHALLENGES

Internal	❖ How do we transition from a 2D engineering to a full 3D engineering workflow?
External	❖ Suppliers cannot provide usable 3D models ❖ Suppliers are not BIM mature
	❖ BIM maturity level of the substation industry in the region ❖ Customer approval workflows to incorporate 3D design

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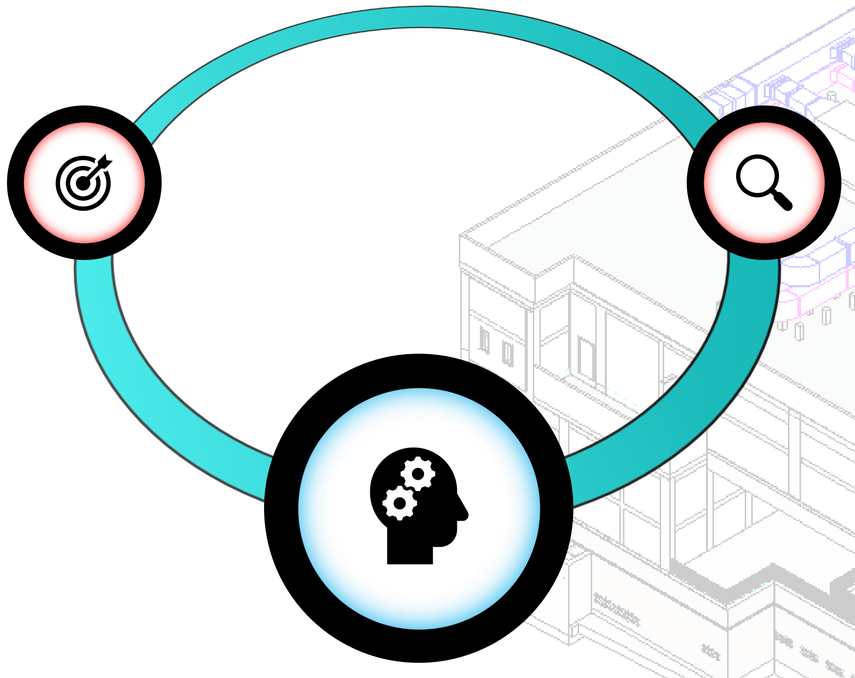

SOLUTION INVESTIGATION

“Single Source of Truth”

One Centralized 3D Substation Building Model

Drawings Generation

2D drawings for construction & installation extracted from 3D model

Supplier Collaboration

Work with suppliers to establish interfaces with suppliers for a new BIM workflow

Customer Collaboration

Align with customers to define a BIM implementation strategy

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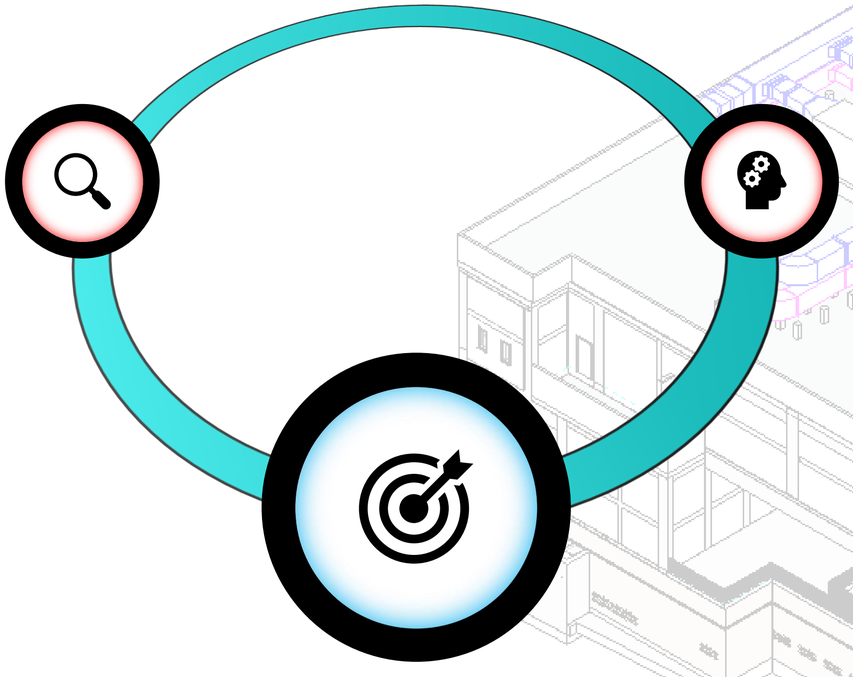

PROJECT OBJECTIVES

1. Substation design in 3D
2. Define and upgrade to 3D engineering workflow
3. Explore a collaborated workflow with internal/external stakeholders
4. Define supplier specifications and supplier coordination roadmap
5. Preparation of GAP List; assessment of current capabilities vs. future state to be achieved.

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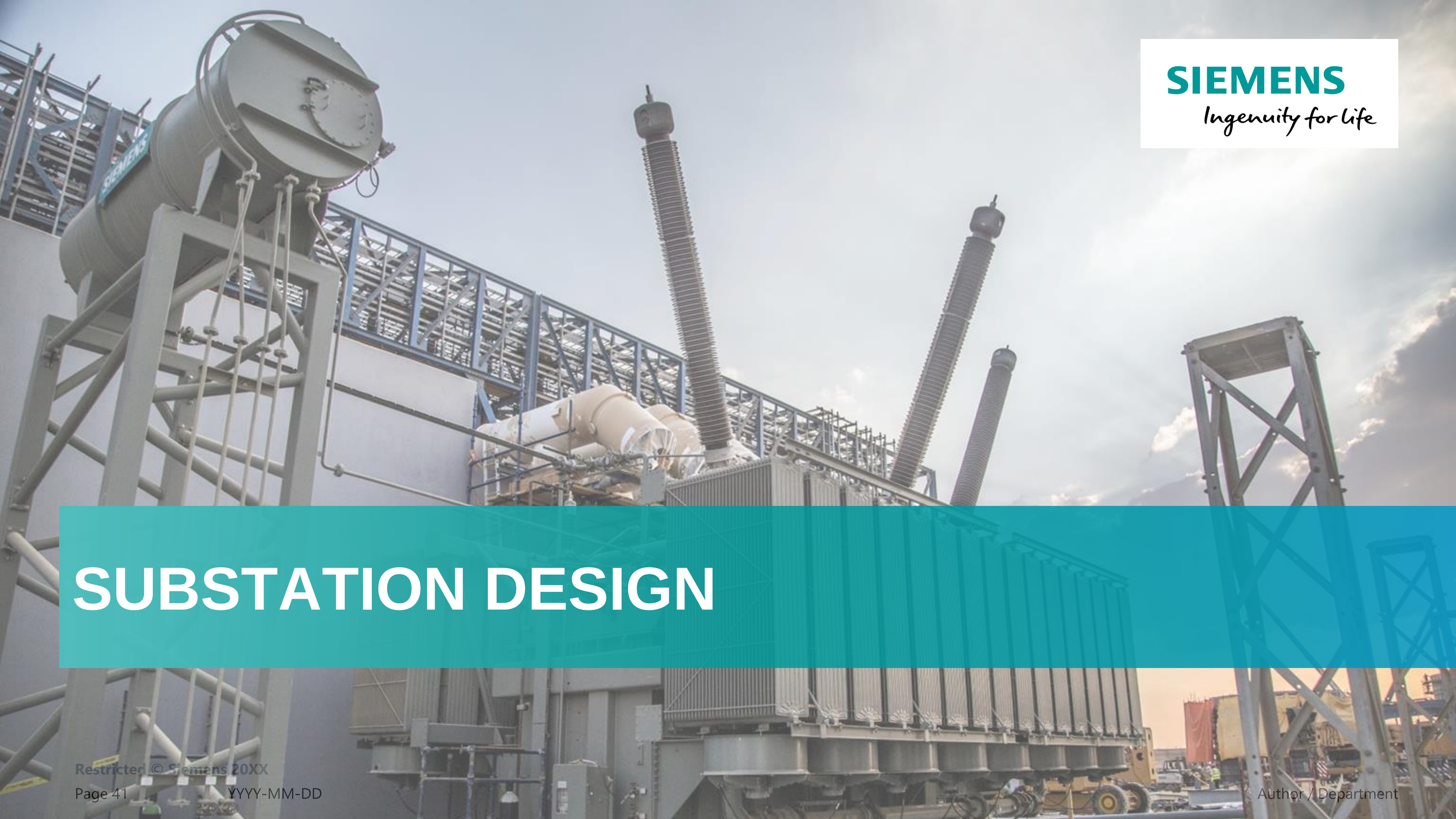

SUBSTATION DESIGN

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What is A Substation?

A substation is a complex facility within an electrical power grid system.

The main functions of the substation are:

- to switch between lines and to transform voltage from one to another level
- to remotely control power flow in the electrical grid
- to protect stability of the network

A substation can be described by:

- their voltage level / class
- their application within the power system
- the method used to insulate electrical connections
- the style and materials of the structures used

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Where is A Substation used?

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Substation is the integral part of an electrical power grid system. It connects power generation with the end consumers.

The electrical power grid system can be divided in:

1. Power generation
2. Power transmission
3. Power distribution system

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Power generation
Power transmission
Power distribution

Power generation

Power transmission

Power distribution

1. Power generation

Power plant
Generating electricity to meet demand.

Step-up transformer
Stepping up the generated electricity to high voltage (HV) to be able to move long distances.

High-voltage transmission level (HV)

MV/HV

Overhead transmission lines

Gas-insulated transmission lines

2. Power transmission

Gas-insulated switchgear (GIS)
Combination of electrical disconnect switches, and circuit breakers used to control, protect and isolate electrical equipment.

Step-down transformer
Transformation to lower high voltage level.

High-voltage sub-transmission level (HV)

HV/HV

Air-insulated switchgear (AIS)
Combination of electrical disconnect switches, and circuit breakers used to control, protect and isolate electrical equipment.

3. Power distribution

Step-down transformer
Transformation to medium and low-voltage level as it is delivered to end users.

Medium-voltage (MV)

HV / MV

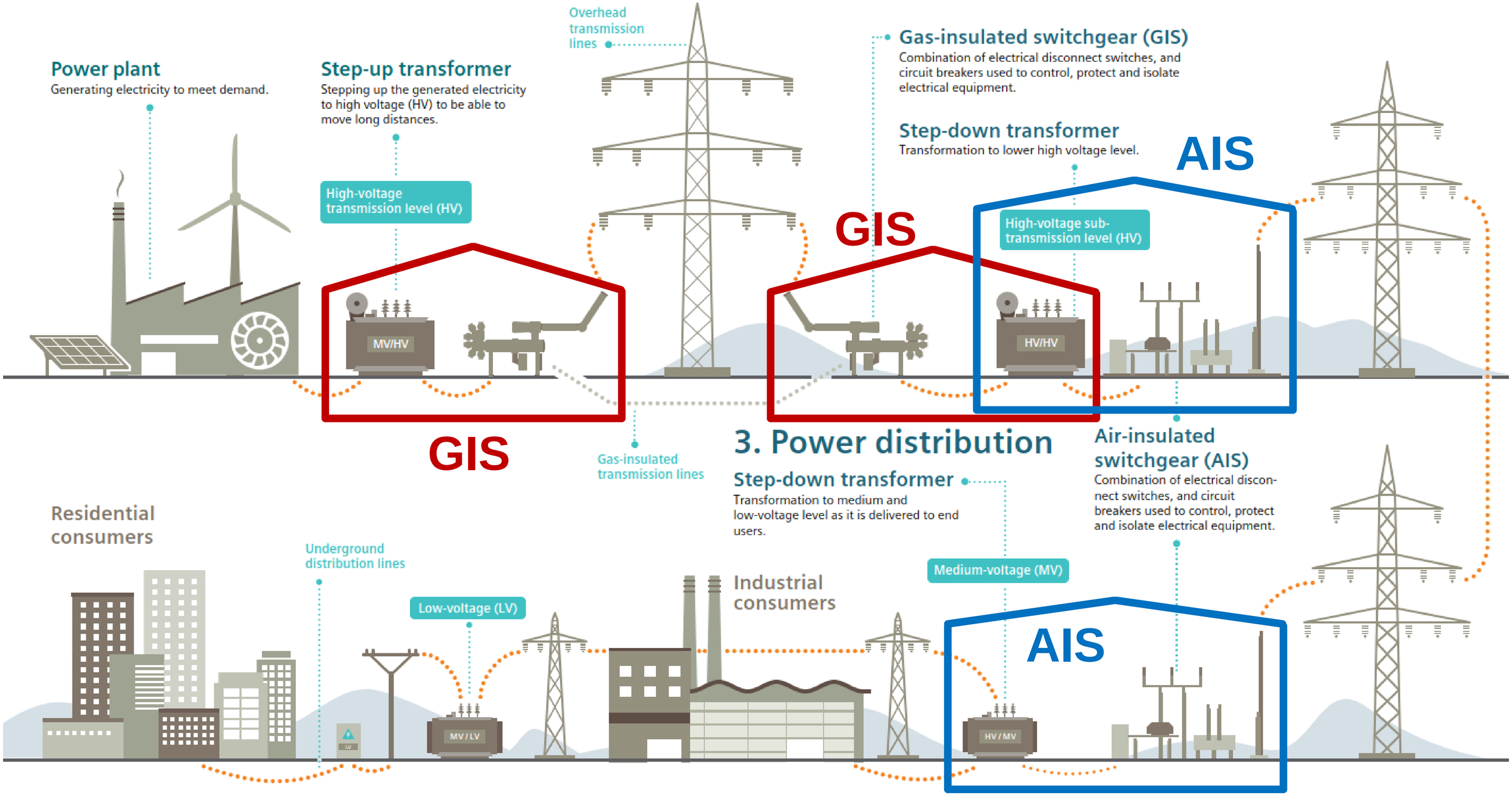
Residential consumers

Underground distribution lines

Low-voltage (LV)

MV / LV

Industrial consumers


1. Power generation
Power plant
Generating electricity to meet demand.
Step-up transformer
Stepping up the generated electricity to high voltage (HV) to be able to move long distances.
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MV/HV
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AIS
GIS
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Step-down transformer
Transformation to medium and low-voltage level as it is delivered to end users.
Air-insulated switchgear (AIS)
Combination of electrical disconnect switches, and circuit breakers used to control, protect and isolate electrical equipment.
Residential consumers
Underground distribution lines
Low-voltage (LV)
MV / LV
Industrial consumers
Medium-voltage (MV)
AIS
HV / MV

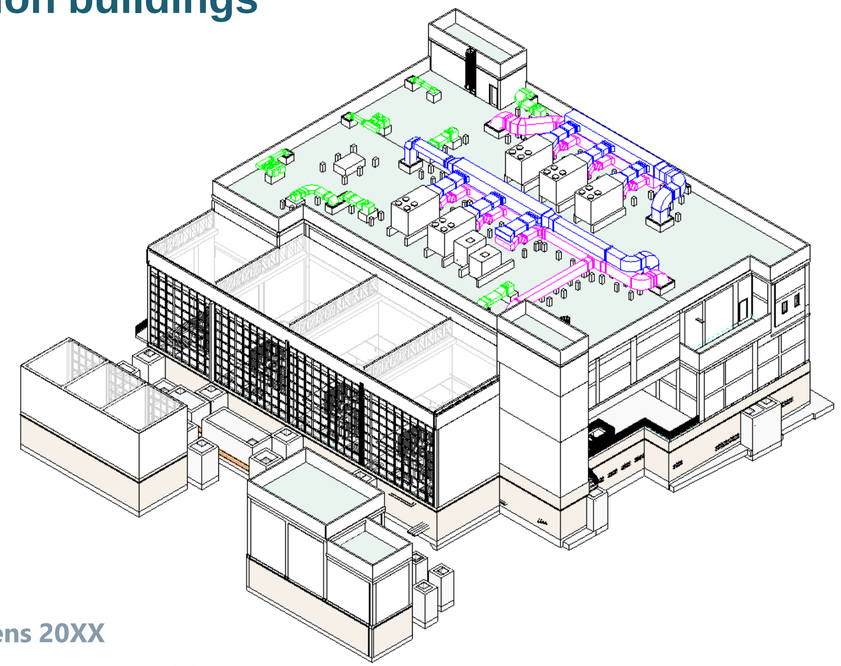
Substations in Middle East

Typical substation layout:

- GIS
- AIS

Gas Insulated Switchgear (GIS) Substation

- Indoor substation
- Main electrical equipment is located inside substation buildings



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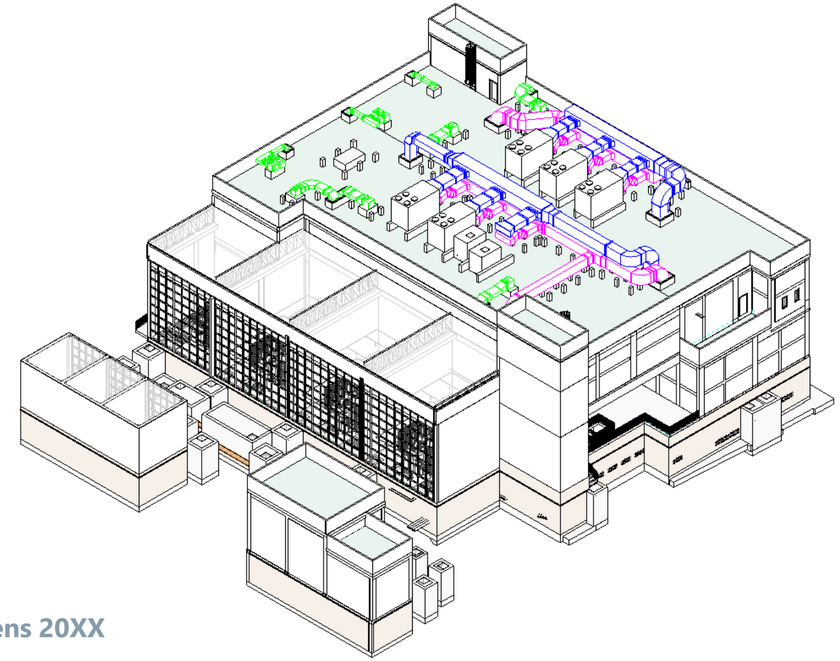
Substations in Middle East

Typical substation layout:

- GIS
- AIS



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SUBSTATION PARTS by DESIGN DISCIPLINE

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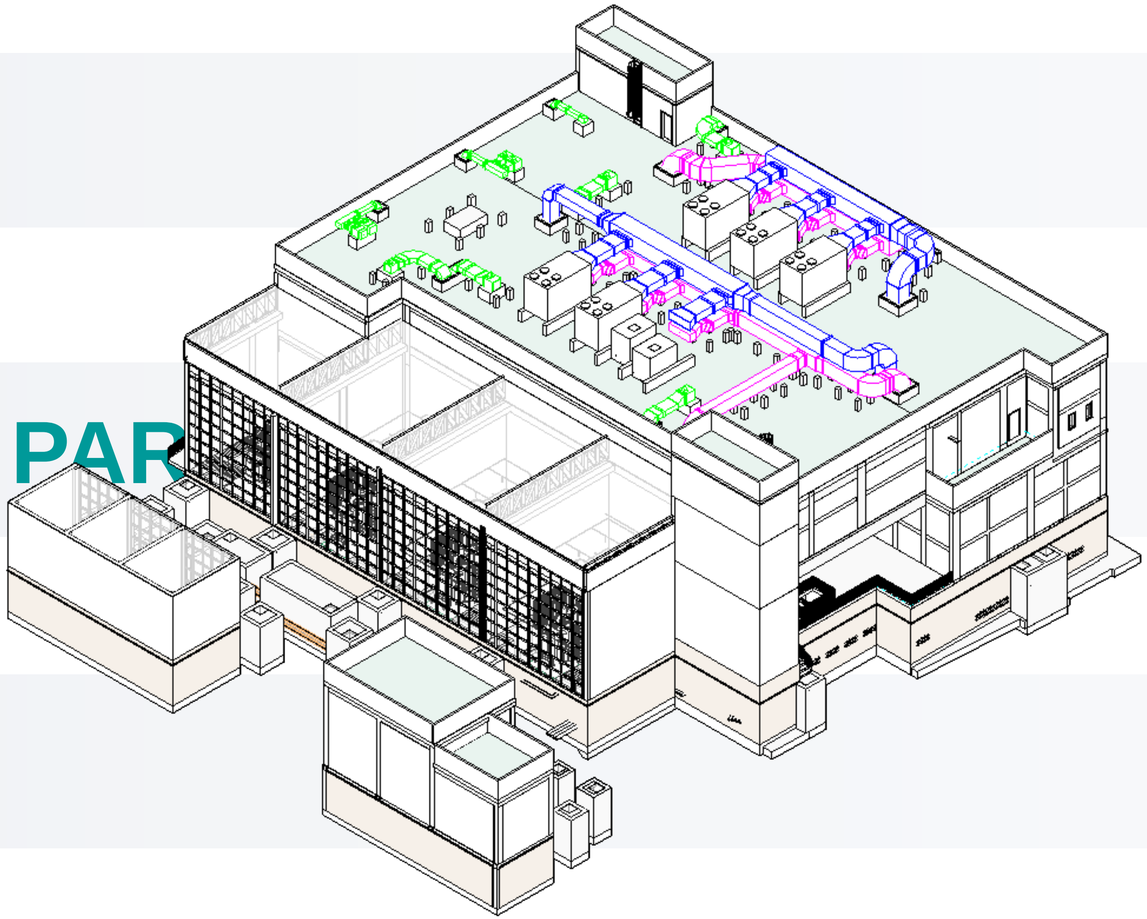
CIVIL PART

ELECTRICAL PAR

MEP PART



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SUBSTATION PARTS by DESIGN DISCIPLINE

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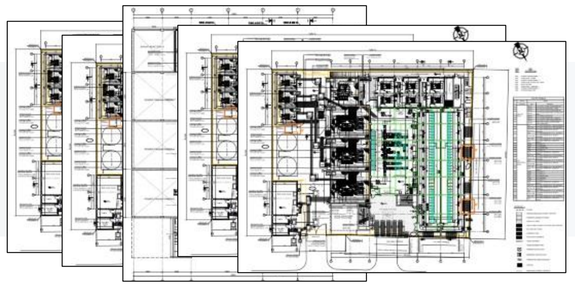
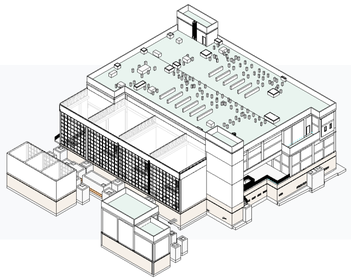
CIVIL PART





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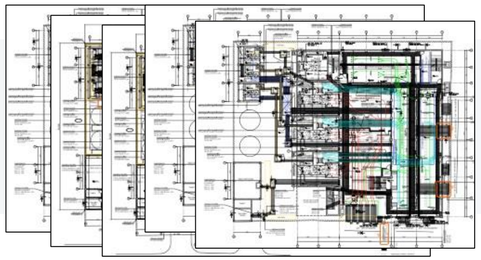

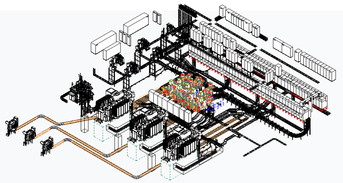

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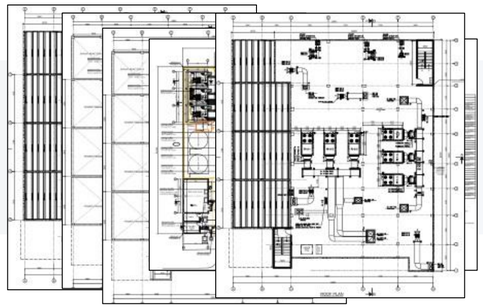

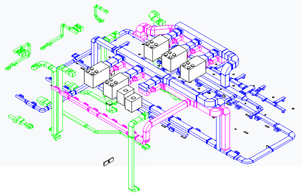

2D Design

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SUBSTATION PARTS by DESIGN DISCIPLINE

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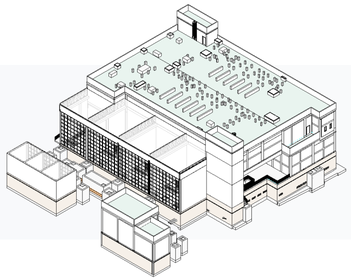
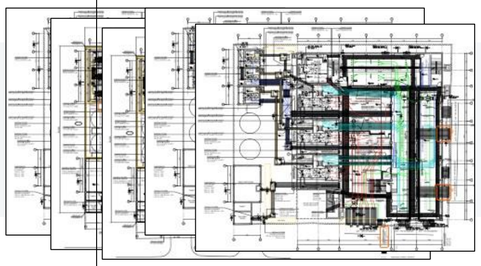
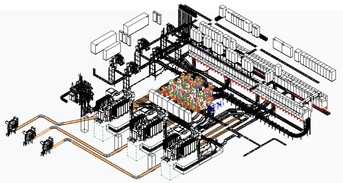
CIVIL PART



ELECTRICAL PART





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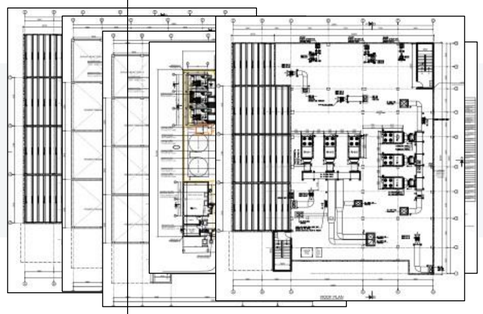

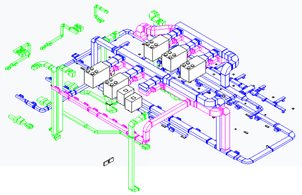

2D Design

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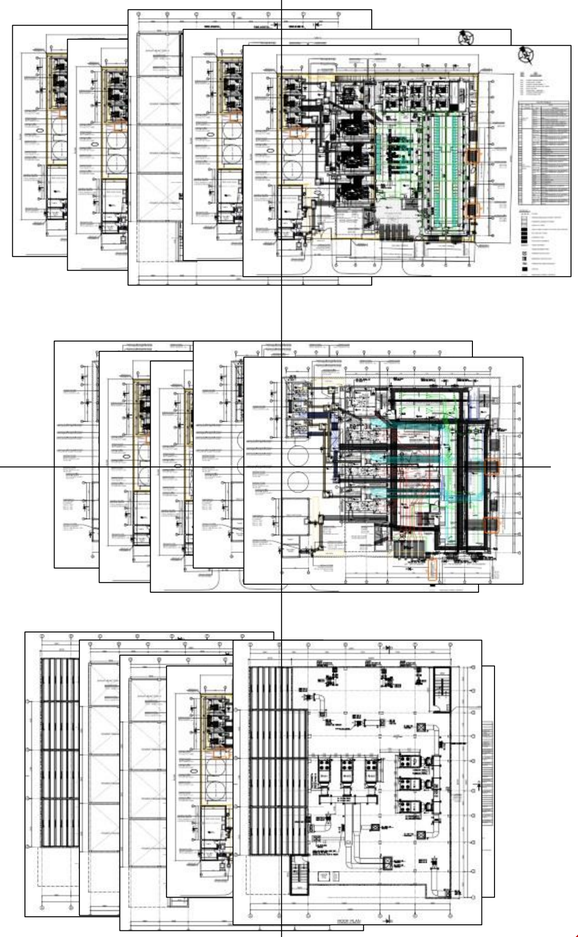
2D Design

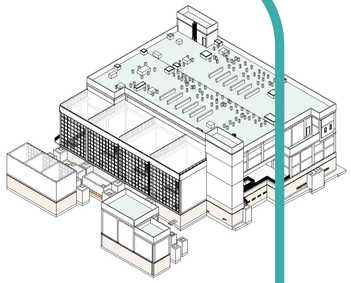


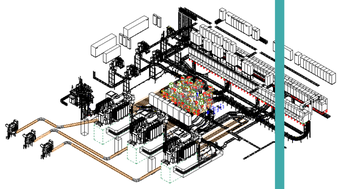
AUTOCAD and other specialized drafting software

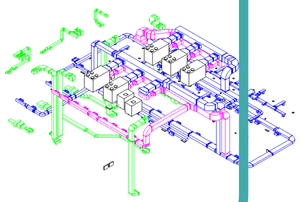
CHALLENGES:

- Non-Coordinated Work and Design
- Data Silos
- Time Delays

3D Design







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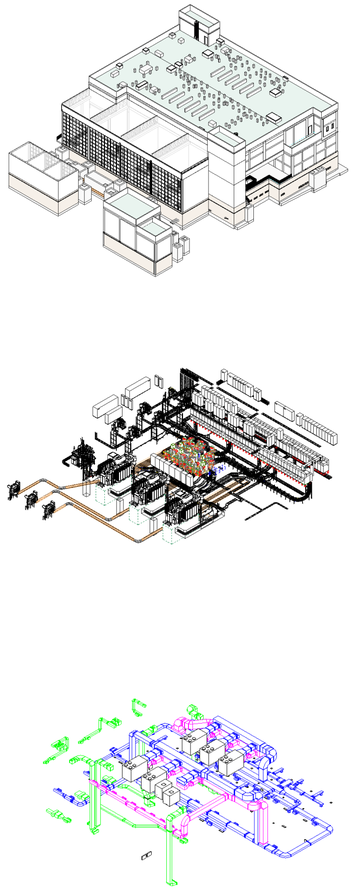
3D Design

REVIT and NAVISWORKS

- One Centralized 3D Substation Building Model
- Coordinated Work and Design
- Drawings and Schedules extracted from 3D Substation Model
- Work Sharing

3D Design



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ELECTRICAL DESIGN of TYPICAL SUBSTATION

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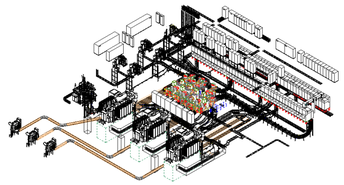

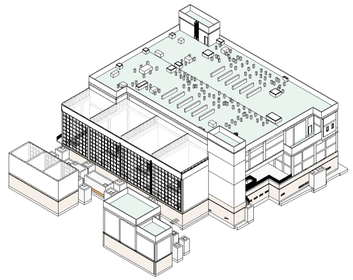

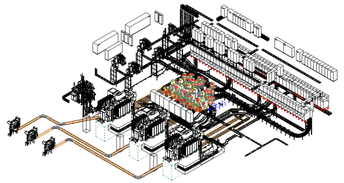

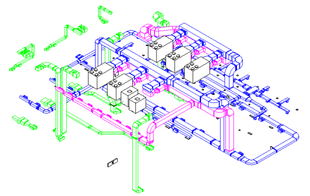

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ELECTRICAL DESIGN of TYPICAL SUBSTATION

SIEMENS
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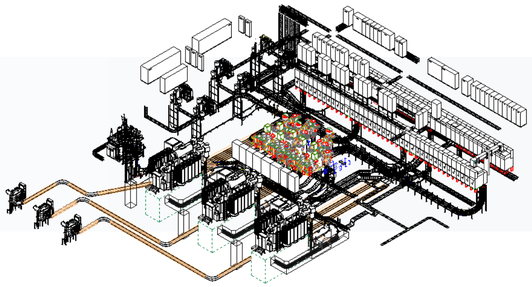

Layout Development

Equipment Design

HV Cables and Cable Accessories Design

Earthing and Lightning System Design

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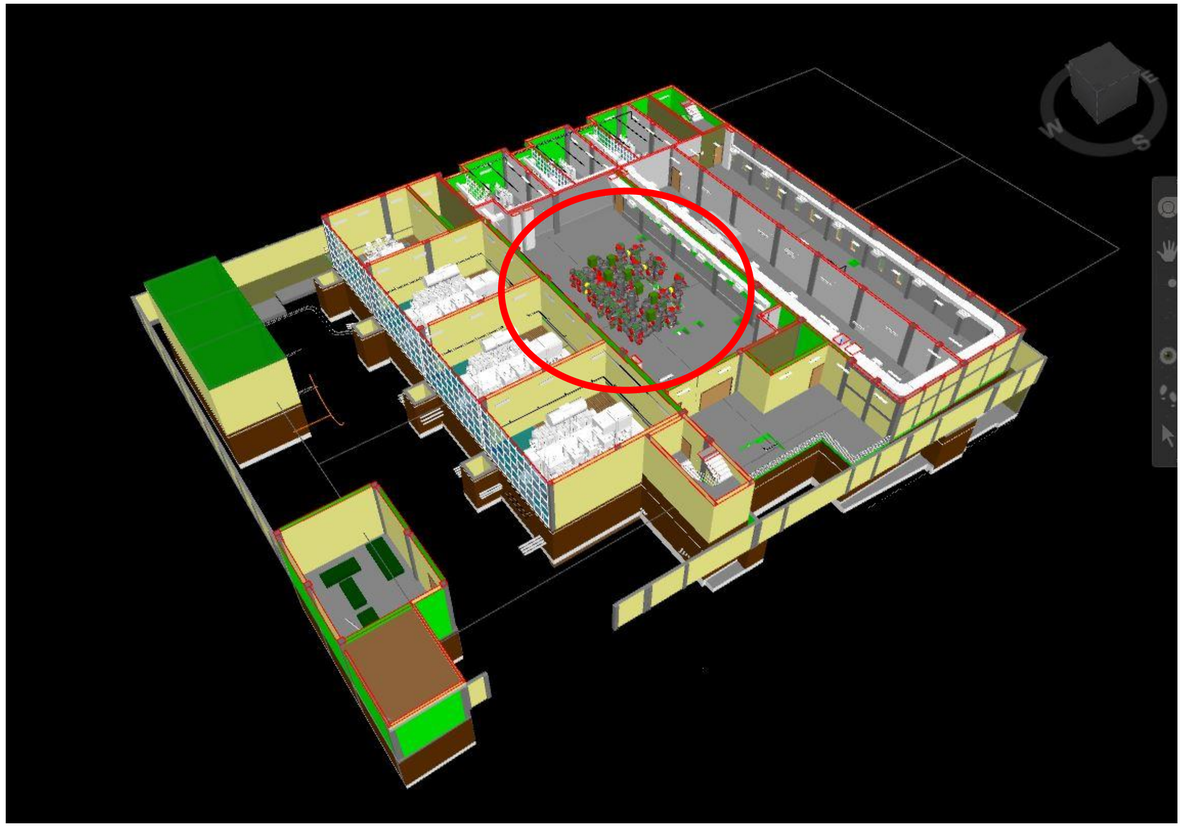

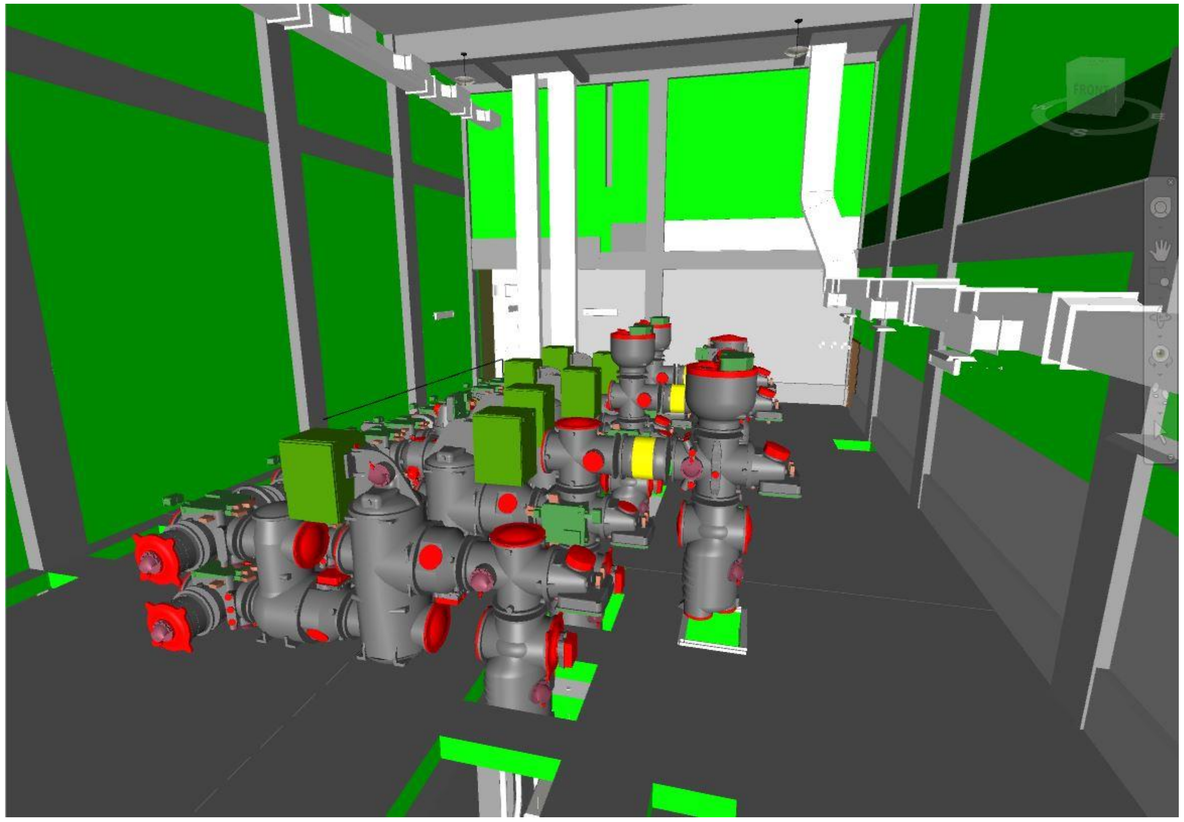

Inside View of the GIS Room

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CABLE HANGERS

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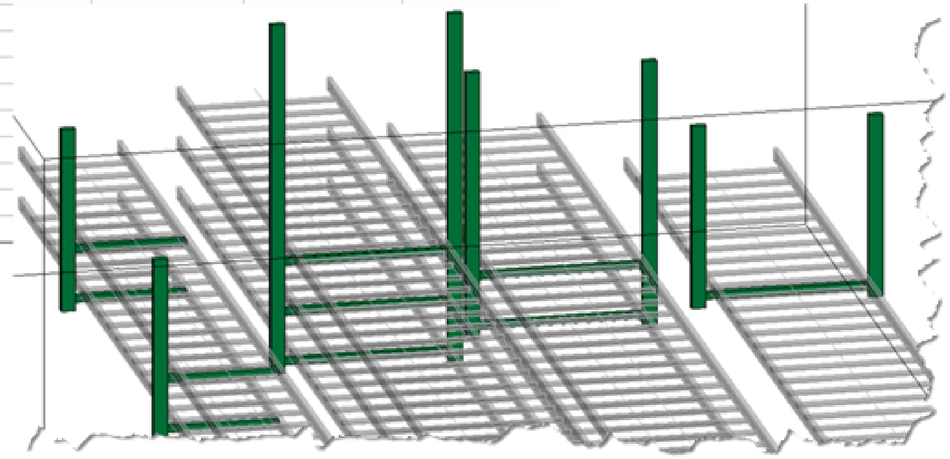
<Cable Hanger Support Schedule>

A	B	C	D	E	F	G	H	I	J	K
					Horizontal Channel			Vertical Channel		
Count	Family	Type	Model	Description	Channel End Bracket	Channel Nut No	Channel Nut Size	Sofit Plate Bolt No	Sofit Plate Bolt Size	Sofit Plate No
1	Cable Support Trapeze Hanger	1 Tier - 900mm		Single Tier - 900mm Trapeze Supp						
1	Cable Support Upright	41x83mm Double Channel	P1001T	41x 83mm Double Channel				2	M10	1
1	Cable Support Upright	41x83mm Double Channel	P1001T	41x 83mm Double Channel				2	M10	1
1	Cable Hanger Support	41x41mm Channel	P1000T	41x41mm Channel	1	3	M8			
1	Cable Support Trapeze Hanger	2 Tier - 900mm		Double Tier - 900mm Trapeze Sup						
1	Cable Support Upright	41x83mm Double Channel	P1001T	41x 83mm Double Channel				2	M10	1
1	Cable Support Upright	41x83mm Double Channel	P1001T	41x 83mm Double Channel				2	M10	1
1	Cable Hanger Support	41x41mm Channel	P1000T	41x41mm Channel	1	3	M8			
1	Cable Hanger Support	41x41mm Channel	P1000T	41x41mm Channel	1	3	M8			
1	Cable Support Trapeze Hanger	3 Tier - 900mm		Triple Tier - 900mm Trapeze Supp						
1	Cable Support Upright	41x83mm Double Channel	P1001T	41x 83mm Double Channel				2	M10	1
1	Cable Support Upright	41x83mm Double Channel	P1001T	41x 83mm Double Channel				2	M10	1
1	Cable Hanger Support	41x41mm Channel	P1000T	41x41mm Channel	1	3	M8			
1	Cable Hanger Support	41x41mm Channel	P1000T	41x41mm Channel	1	3	M8			
1	Cable Hanger Support	41x41mm Channel	P1000T	41x41mm Channel	1	3	M8			
1	Cable Support Cantilever Hanger	2 Tier - 600mm		Double Tier - 900mm Trapeze Sup						
1	Cable Support Upright	41x83mm Double Channel	P1001T	41x 83mm Double Channel						
1	Cable Hanger Support	41x41mm Channel	P1000T	41x41mm Channel	1	3	M8			
1	Cable Hanger Support	41x41mm Channel	P1000T	41x41mm Channel	1	3	M8			
1	Cable Support Cantilever Hanger	2 Tier - 600mm		Double Tier - 900mm Trapeze Sup						
1	Cable Support Upright	41x83mm Double Channel	P1001T	41x 83mm Double Channel						
1	Cable Hanger Support	41x41mm Channel	P1000T	41x41mm Channel	1	3	M8			
1	Cable Hanger Support	41x41mm Channel	P1000T	41x41mm Channel	1	3	M8			



Example of Cable Ladder Supports developed in Revit with reflected BoQ

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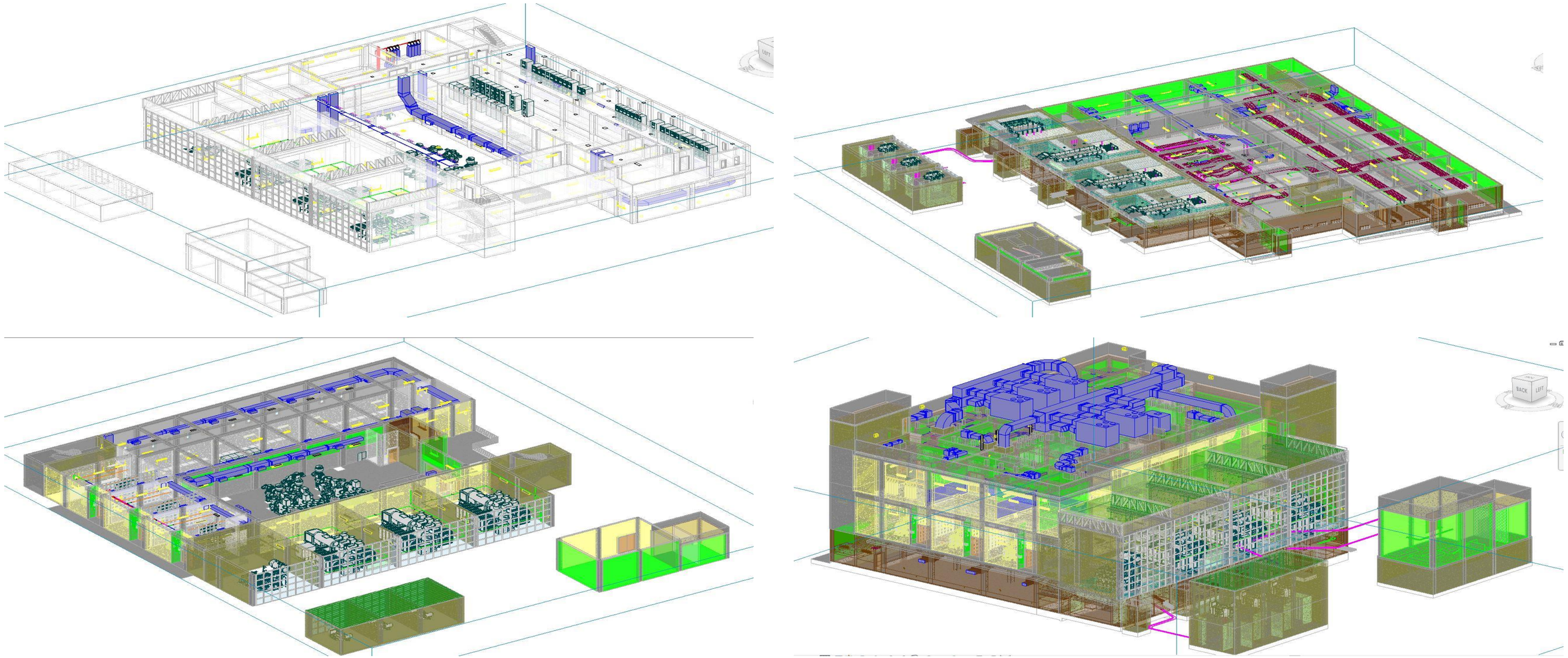
OVERALL MODEL - REVIT



3D Building Model View in Revit

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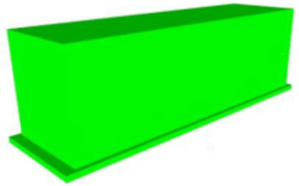
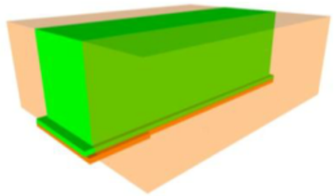
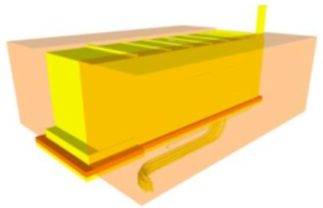
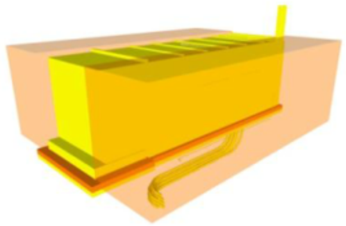
Supplier Specification

SUPPLIER SPECIFICATION

Level of Development

Only Diagrammatic or schematic model elements required. Information can be depicted in 2D. Conceptual and/or schematic layout.	 *180 D5010.10-LOD-200 Packaged Generator Assemblies*
LOD 100	LOD 200
 *181 D5010.10-LOD-300 Packaged Generator Assemblies*	 *182 D5010.10-LOD-350 Packaged Generator Assemblies*
LOD 300	LOD 350
 *183 D5010.10-LOD-400 Packaged Generator Assemblies*	
LOD 400	

LOD	Definition
100	Diagrammatic or schematic model elements: conceptual and/or schematic layout;
200	Schematic layout with approximate size, shape, and location of equipment;
300	Modeled as design-specified size, shape, spacing, and location of equipment and associated components; approximate allowances for spacing and clearances required for all specified supports and seismic control; access/code clearance requirements modeled.
350	Modeled as actual size, shape, spacing, and location of equipment and associated components; actual size, shape, spacing, and location for supports and seismic control; actual size, shape, and location/connections of equipment and support structure/pads. actual access/code clearance requirements modeled.
400	Supplementary components added to the model required for fabrication and field installation.

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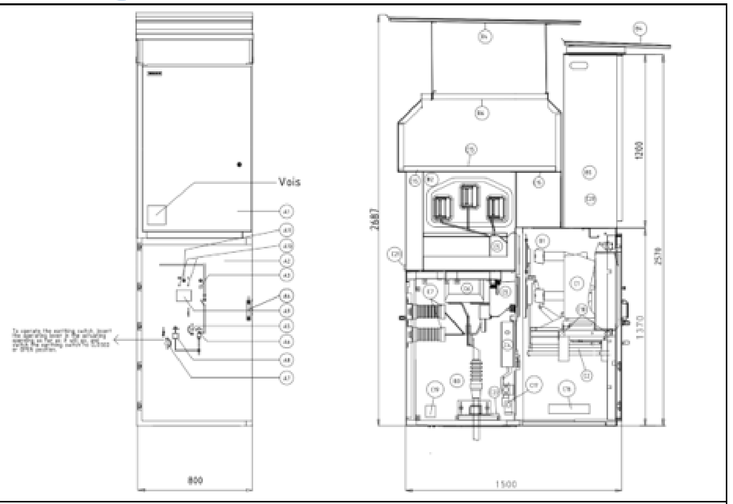
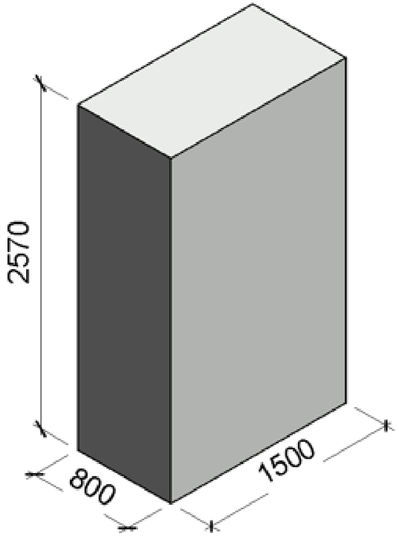
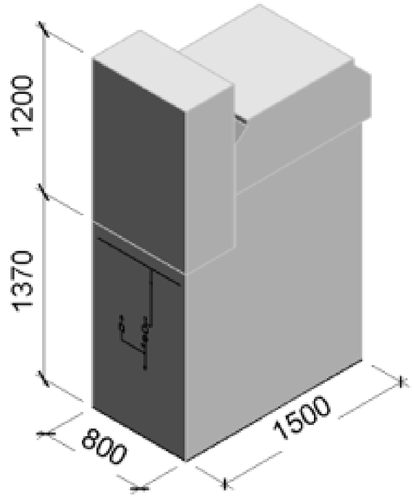
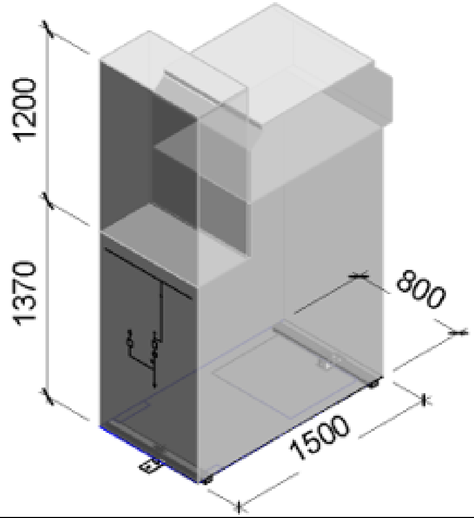
SUPPLIER SPECIFICATION

11kV Switchgear Example

LOD 100	 2D Drawings
LOD 200	 Outline Box
LOD 300	 Exact Panel Geometry
LOD 350	 Panel with Fixing Arrangement

SUPPLIER SPECIFICATION

132kV Switchgear Example

Family Types

Type name: A100-E-SIE-8DN8E

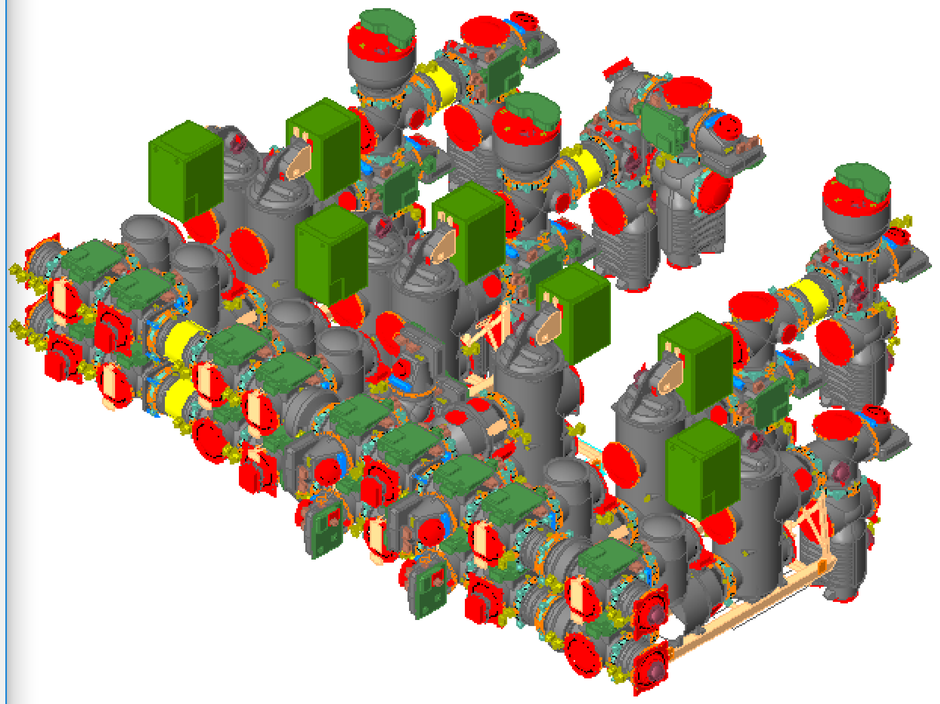
Search parameters

Parameter	Value	Formula	Lock
Electrical			
Equipment Name	SIEMENS 132kV GIS	=	
Equipment Type	8DN8 Enhanced	=	
Heater Voltage	400/230 V AC	=	
Motor Voltage Circuit Breaker	110 V DC	=	
Motor Voltage Isolator/Earthi	110 V DC	=	
Number of Bays	8	=	☐
Rated Ambient Temperature	50 (C)	=	
Rated Current Bus Coupler	2000 A	=	
Rated Current Busbar	2000 A	=	
Rated Current Cable Feeder	1500 A	=	
Rated Current IDT Feeder	1500 A	=	
Rated Frequency	50 Hz	=	
Rated Voltage	145 kV	=	
Rated Voltage for Control Cir	110 V DC	=	
Structural			
Civil Design Specification (E5		=	

Manage Lookup Tables

How do I manage family types?

OK Cancel Apply



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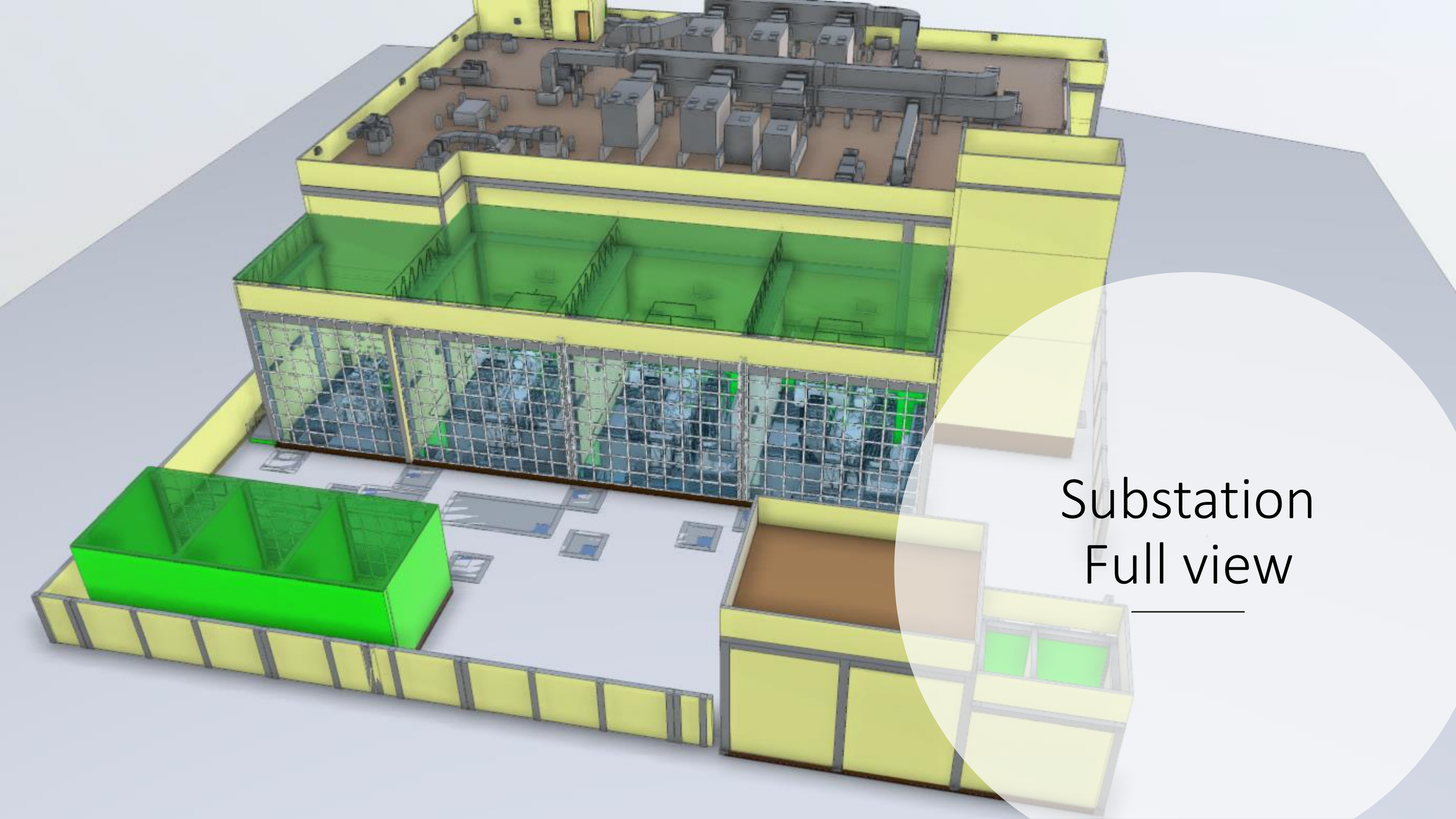
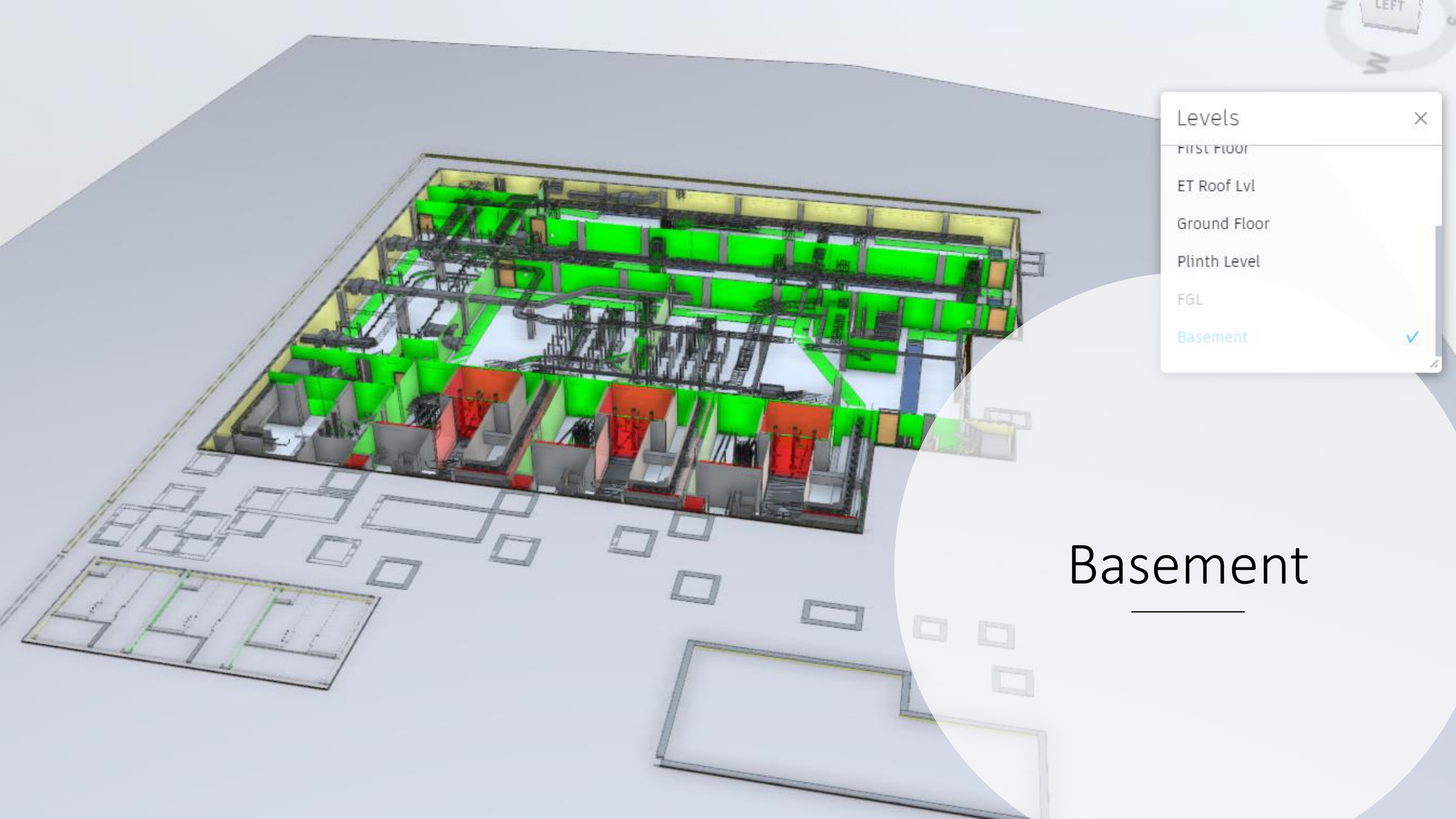
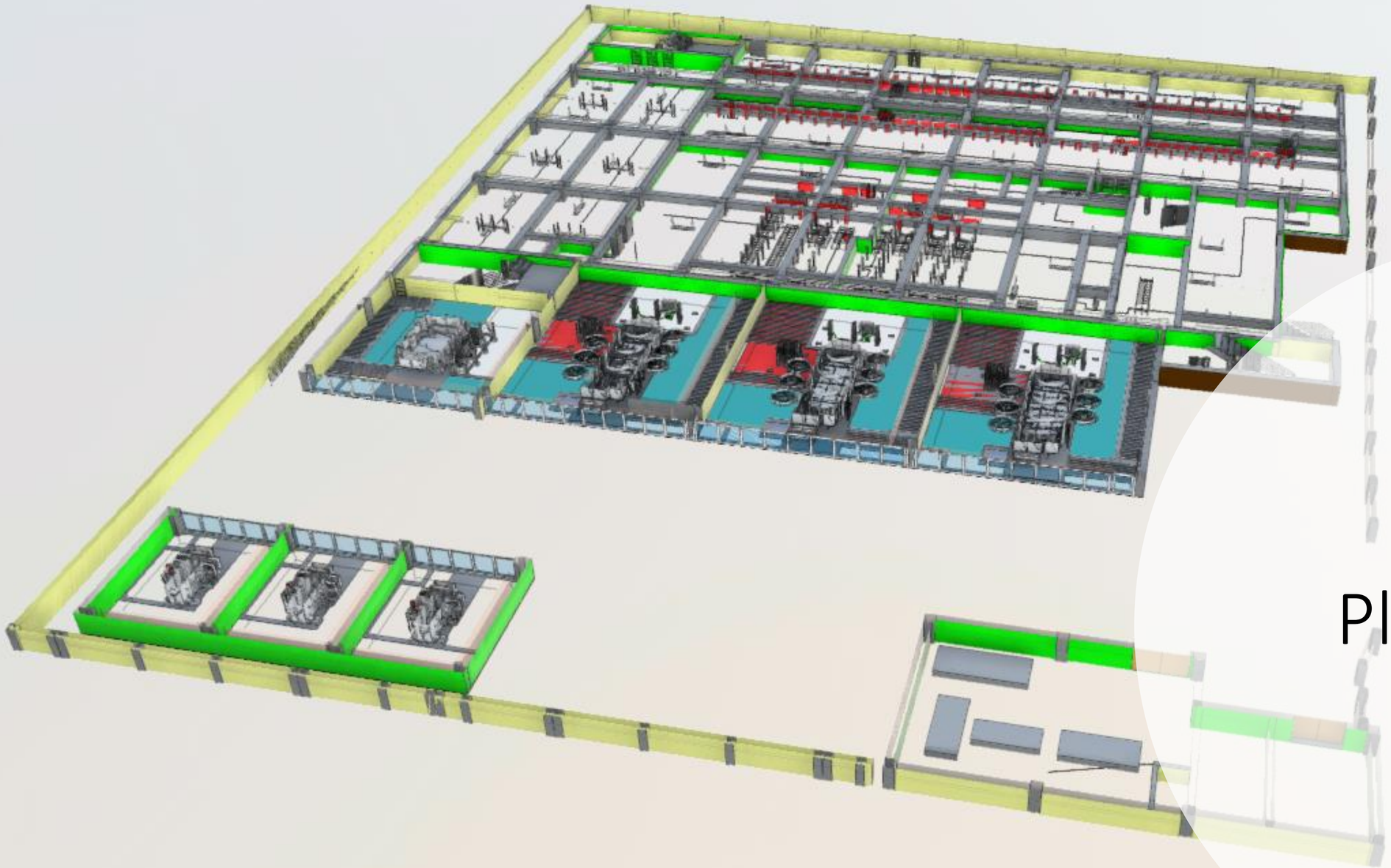
GIS Substation Overview



Substation Full view


LEFT
Levels
First Floor
ET Roof Lvl
Ground Floor
Plinth Level
FGL
Basement

Basement



Levels

First Floor

ET Roof Lvl

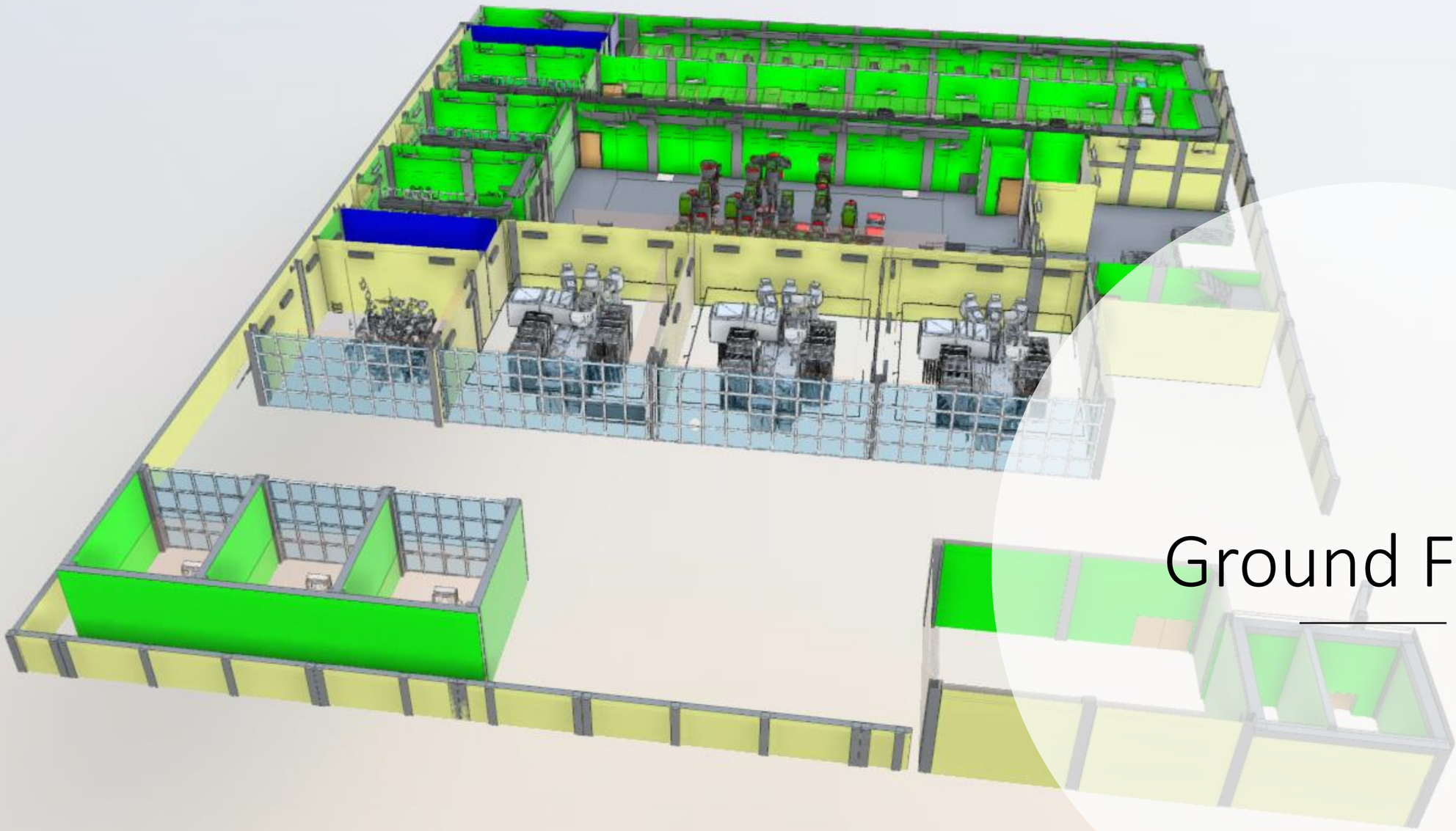
Ground Floor

Plinth Level ✓

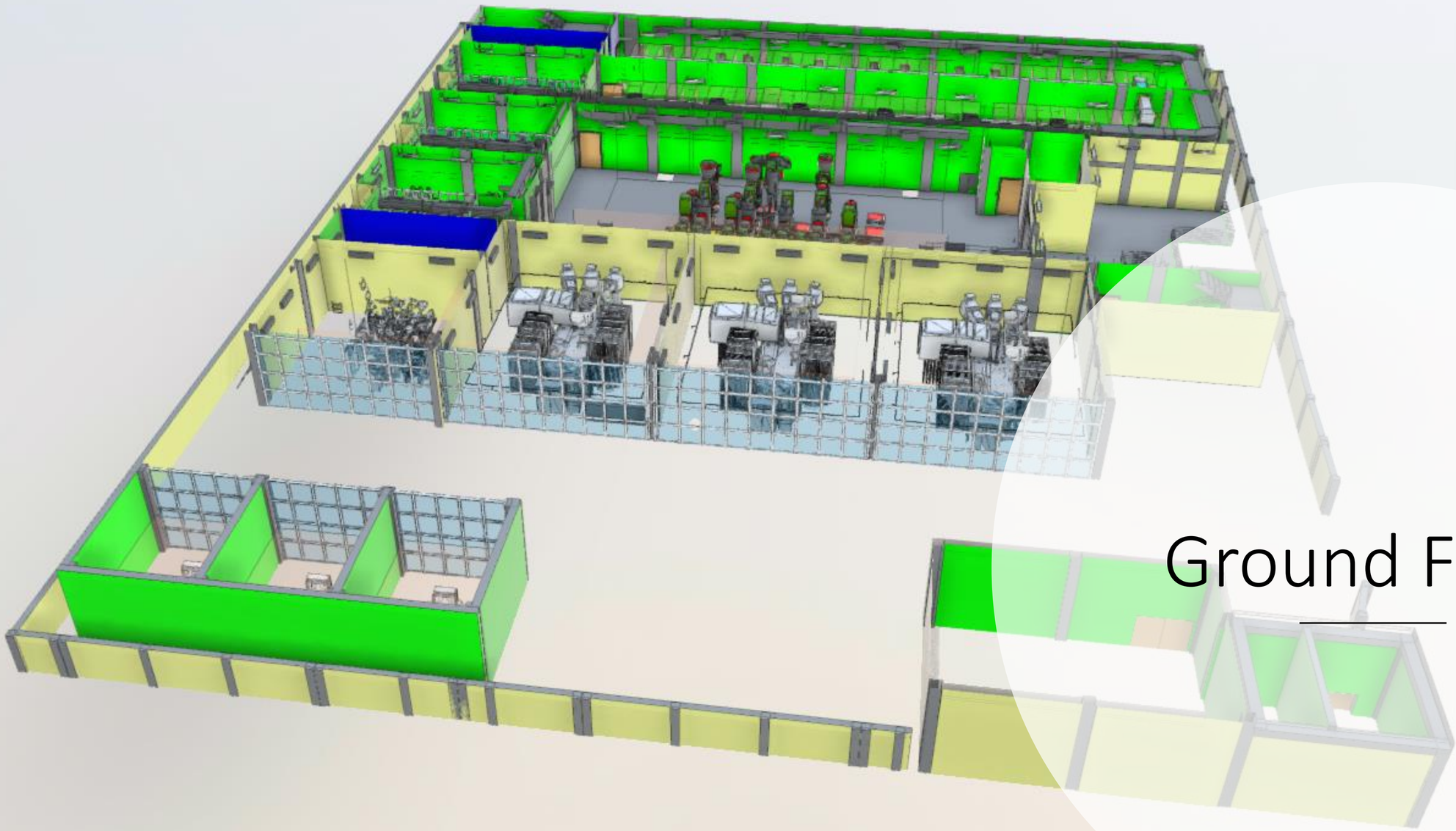
FGL

Basement

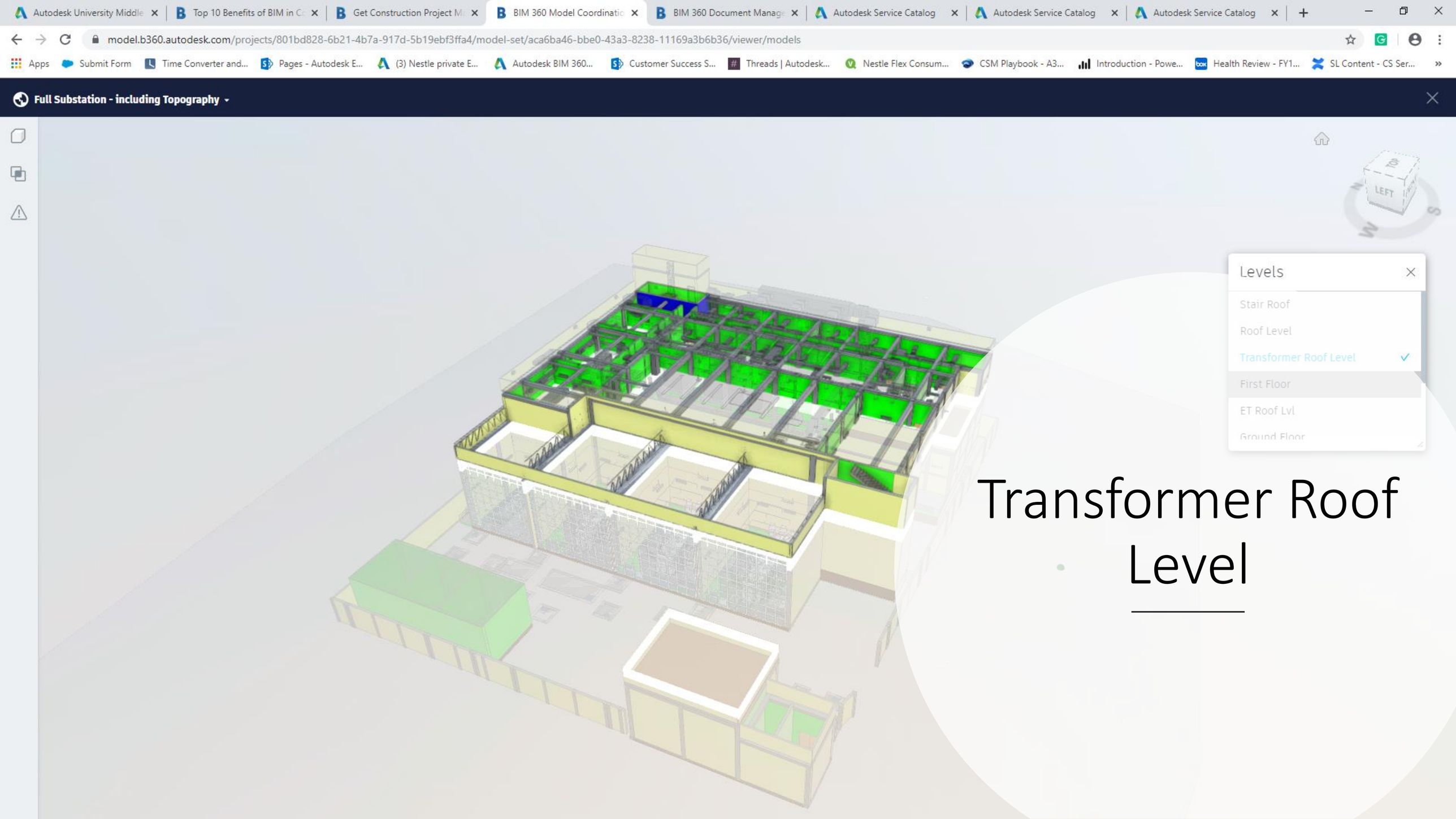
Plinth Level

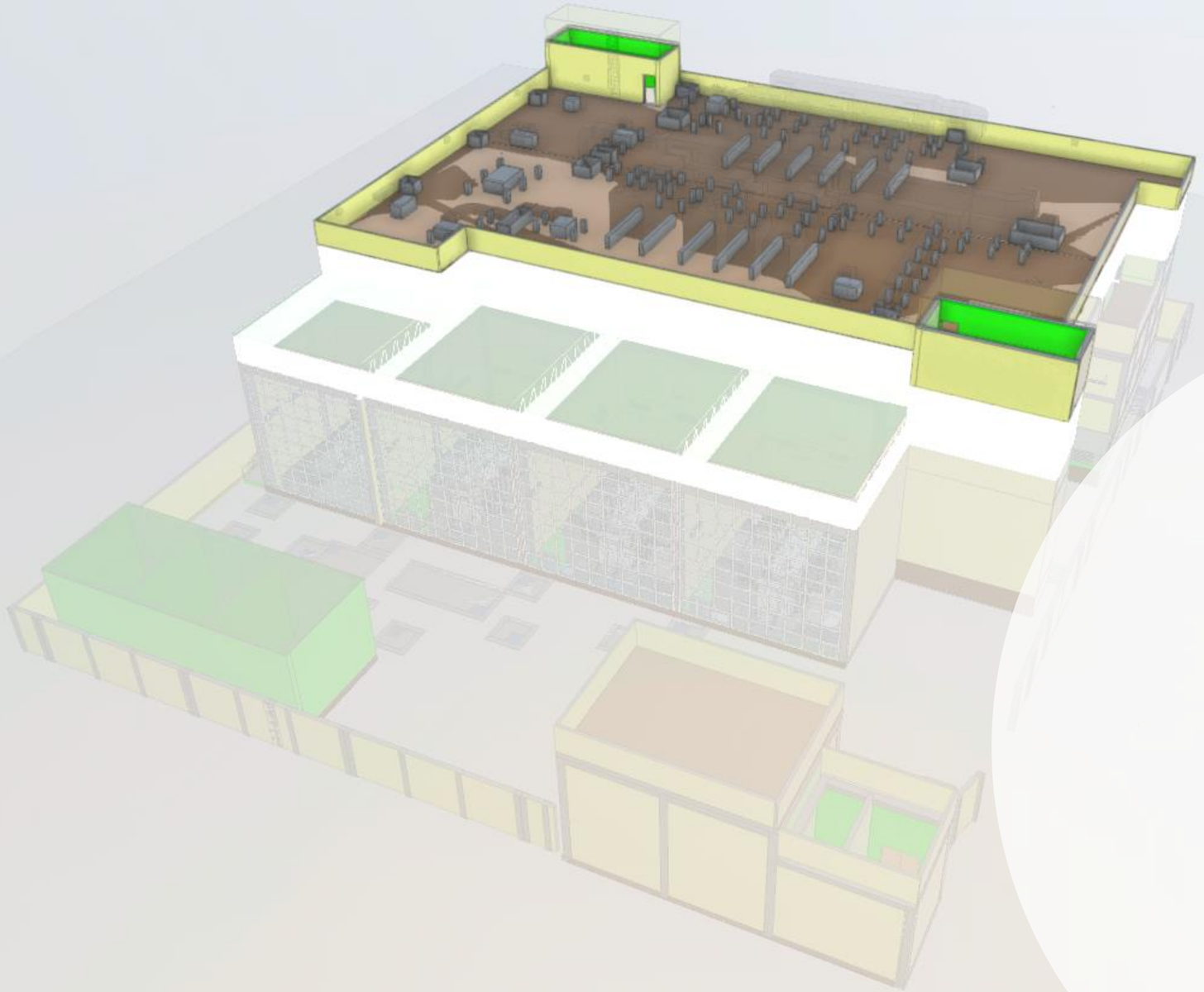


Ground Floor

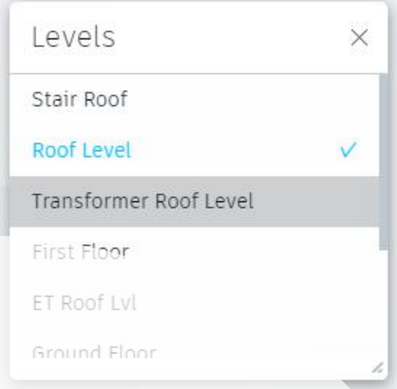


Ground Floor

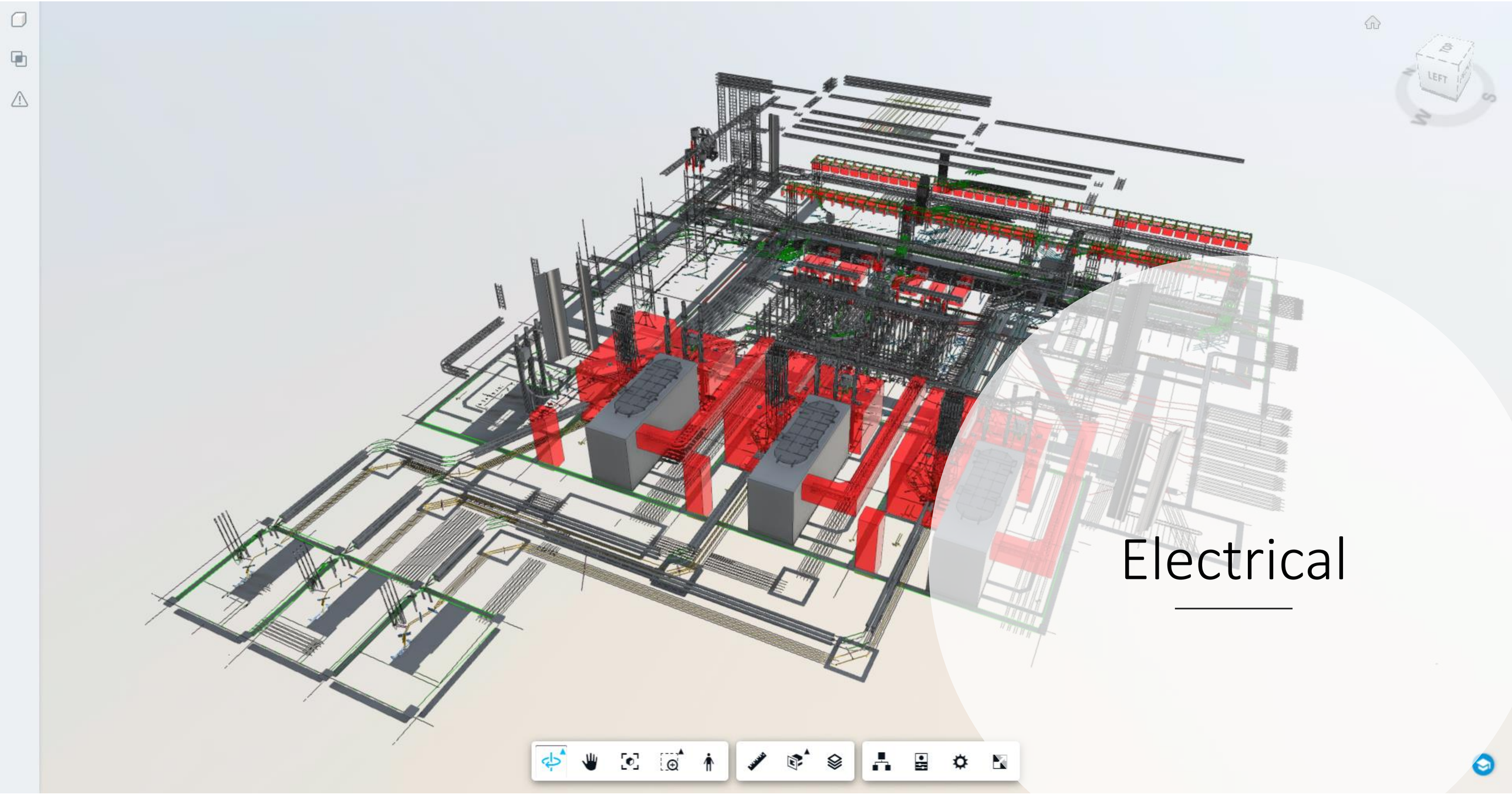

Autodesk University Middle
Top 10 Benefits of BIM in C
Get Construction Project M
BIM 360 Model Coordinatio
BIM 360 Document Manage
Autodesk Service Catalog
Autodesk Service Catalog
Autodesk Service Catalog
model.b360.autodesk.com/projects/801bd828-6b21-4b7a-917d-5b19ebf3ffa4/model-set/aca6ba46-bbe0-43a3-8238-11169a3b6b36/viewer/models
Apps
Submit Form
Time Converter and...
Pages - Autodesk E...
(3) Nestle private E...
Autodesk BIM 360...
Customer Success S...
Threads | Autodesk...
Nestle Flex Consum...
CSM Playbook - A3...
Introduction - Powe...
Health Review - FY1...
SL Content - CS Ser...
Full Substation - including Topography
LEFT
Levels
Stair Roof
Roof Level
Transformer Roof Level
First Floor
ET Roof Lvl
Ground Floor
Transformer Roof Level



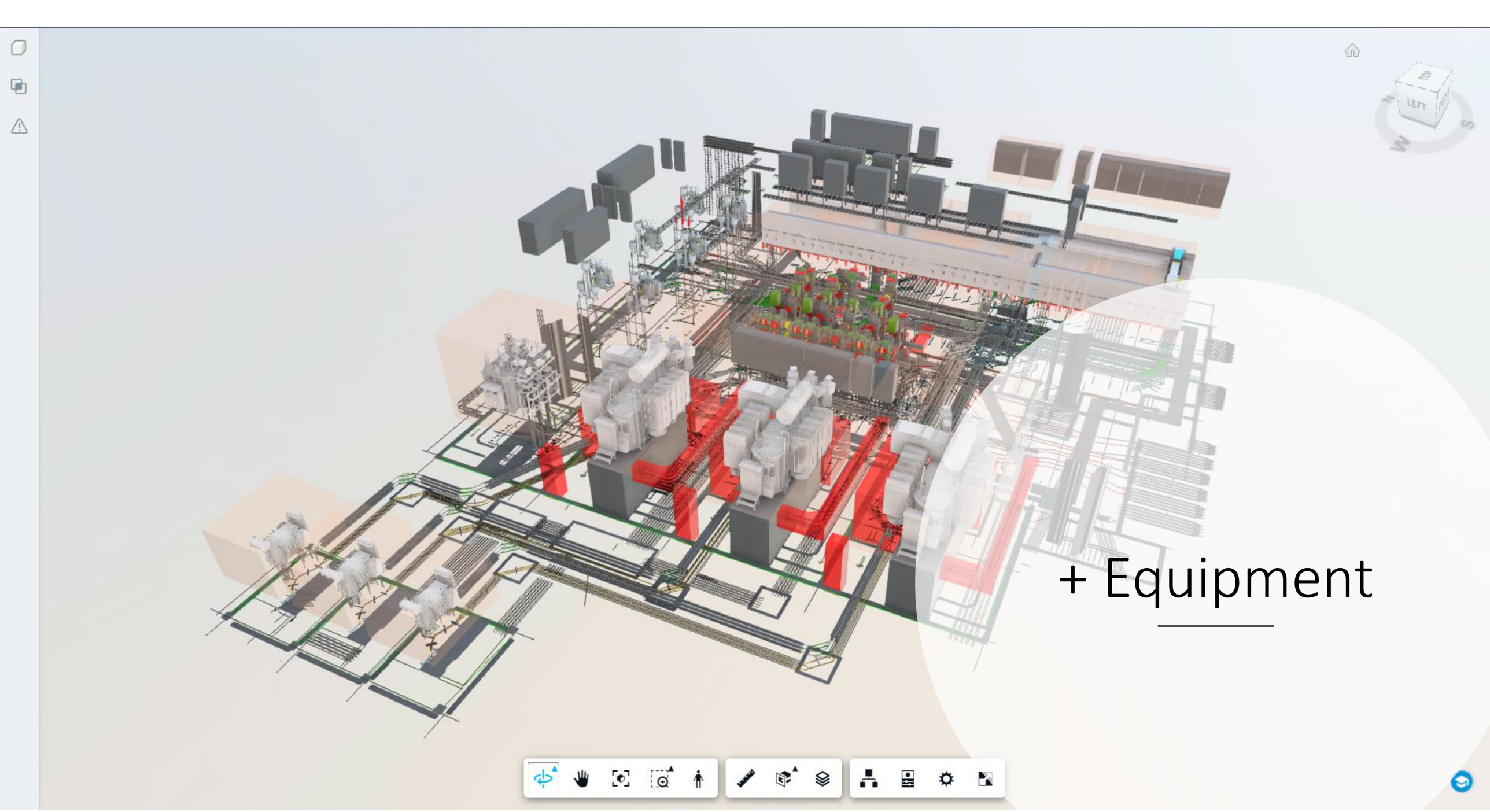
LEFT
N
S
W

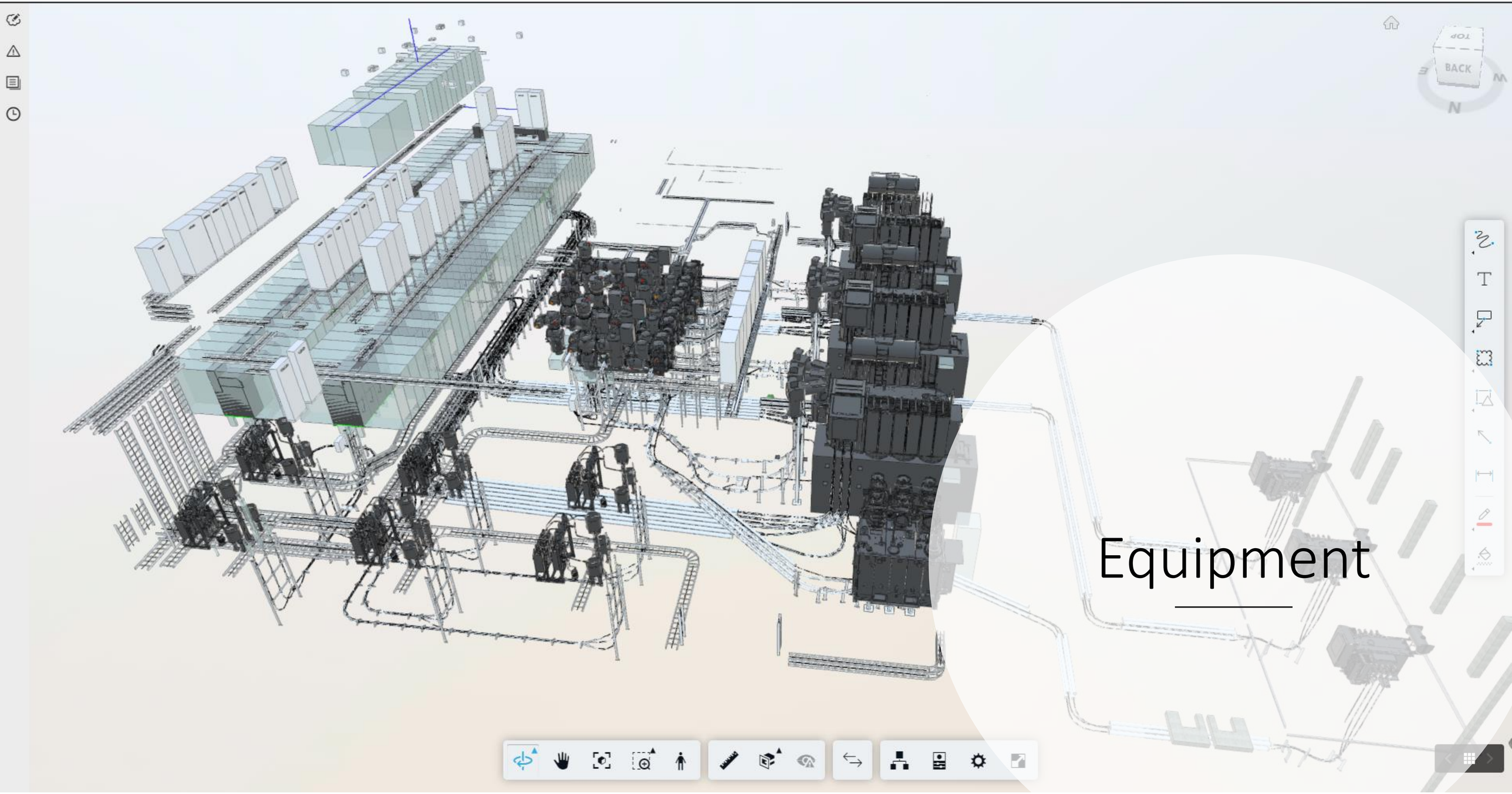

Levels
Stair Roof
Roof Level
Transformer Roof Level
First Floor
ET Roof Lvl
Ground Floor

Roof Level



Electrical

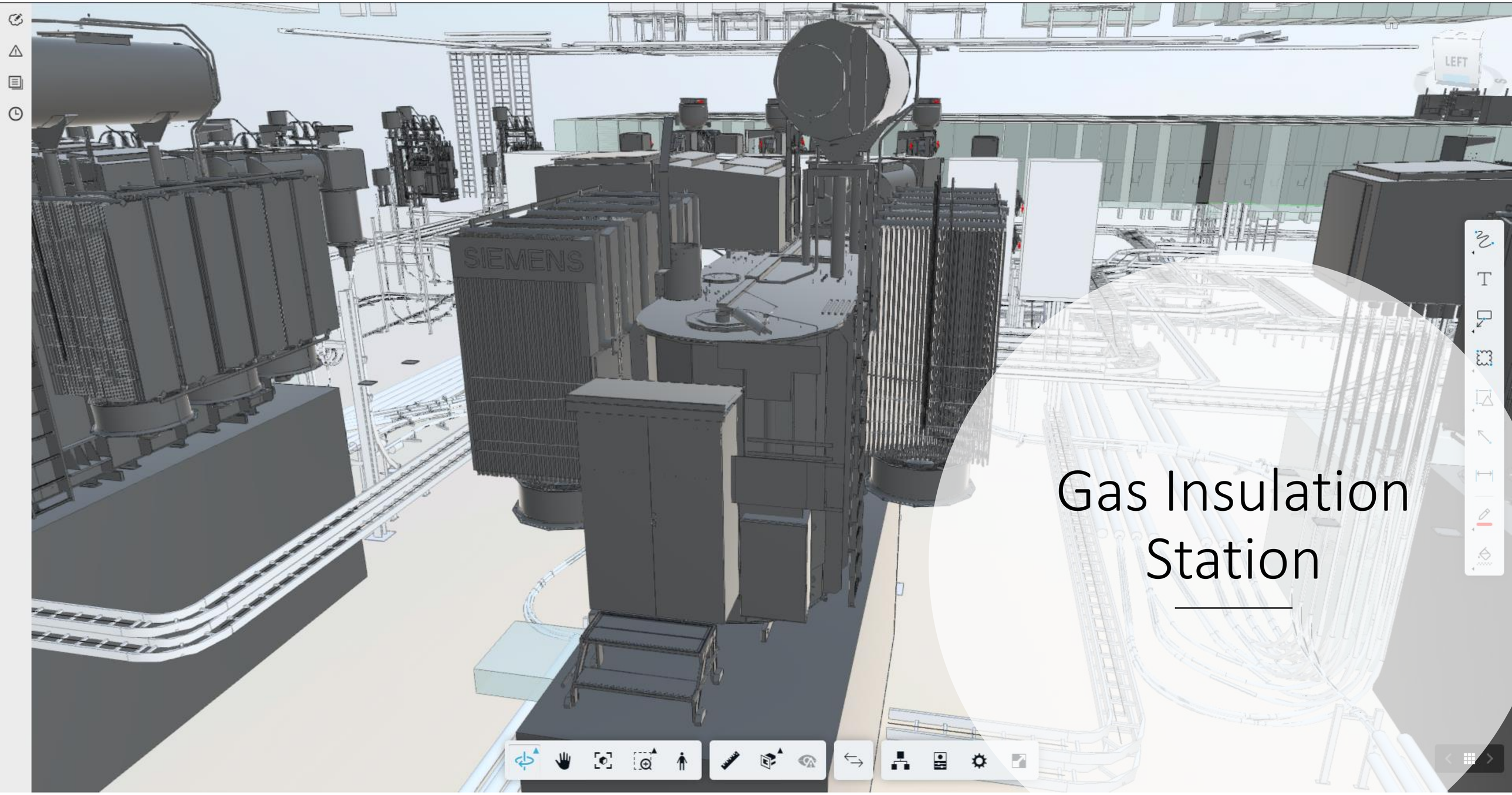

+ Equipment



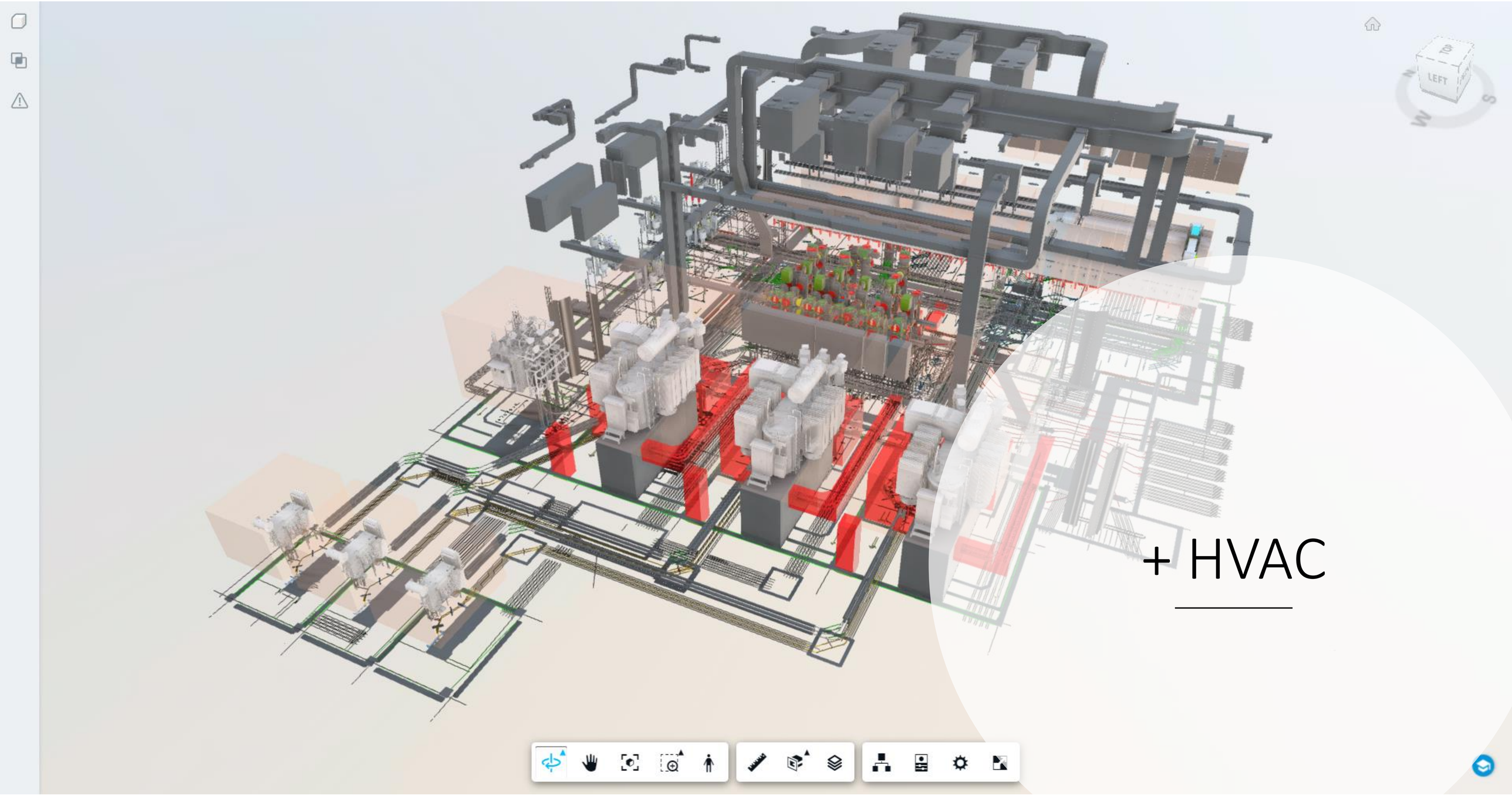
Equipment

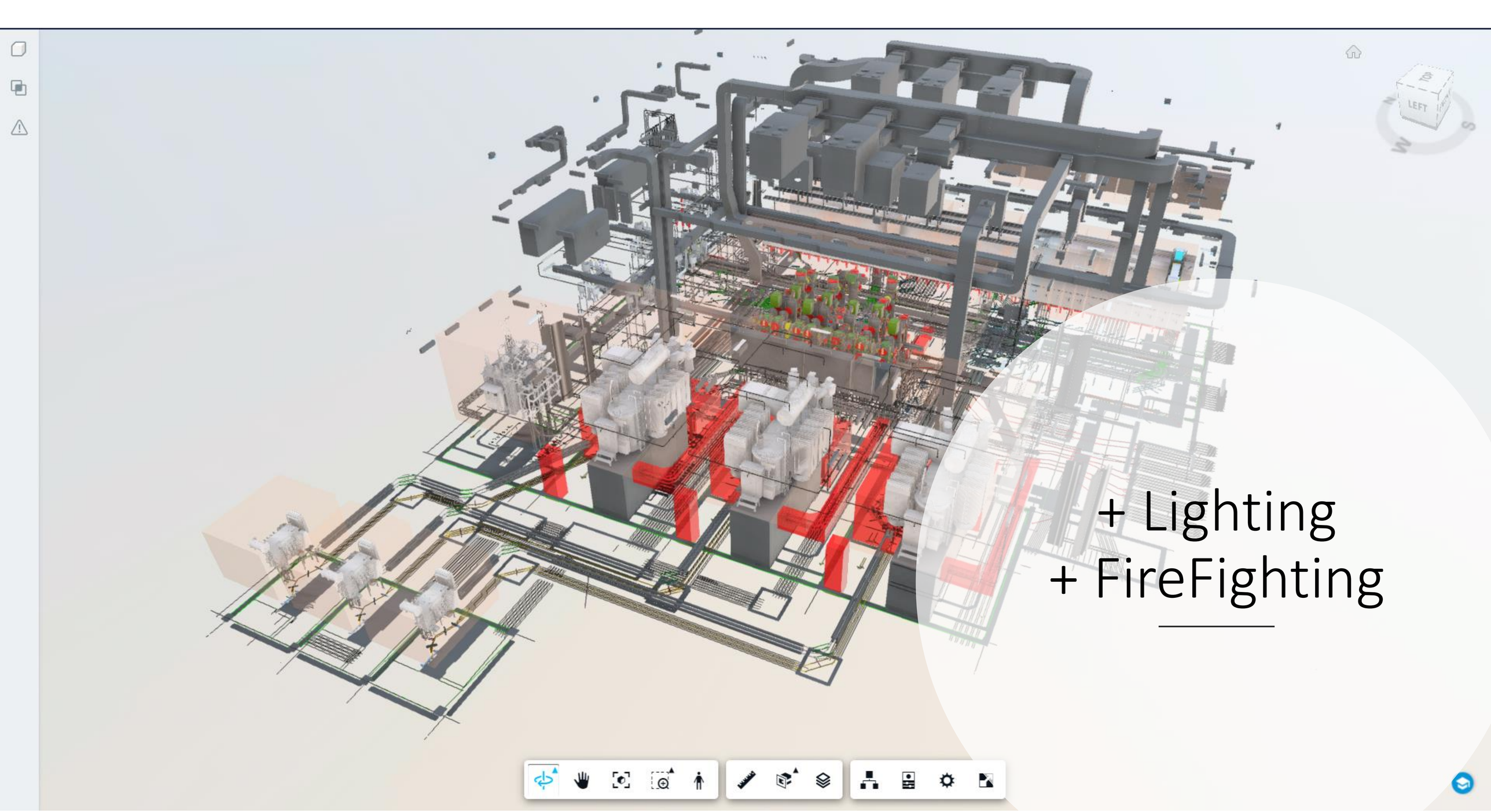
Gas Insulation Station

Gas Insulation Station



Gas Insulation Station


LEFT
+ HVAC


LEFT
+ Lighting
+ FireFighting

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How we're shaping the future

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Q & A

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Thank you

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