BIM:
The Future of Substation Design

Ajmal Saudagar & Kosta Snajderov
Engineer & Electrical Engineer
BIM: THE FUTURE OF 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.

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.
Gas and Power – Business Units
Gas and Power – Business Units

Power Generation

Oil-and Gas

EPC Projects
Transmission Solutions in Middle East
Our Transmission Solutions Portfolio at a Glance

- HVDC
- Grid Access
- FACTS
- PTL
- Turnkey Substation
- Service
Our Transmission Solutions Portfolio at a Glance

- **HVDC**
- **Grid Access**
- **FACTS**
- **PTL**
- **Turnkey Substation**
- **Service**

- >10,000 High-Voltage Switchgear Bays in the Region
- >105,000 MVA Total Installed Power Transformers in the Middle East
- >46,000 GIS Medium-Voltage Switchgears Installed in the Middle East
- >40% of Energy Transmission in UAE is from Siemens
- >100,000 Numerical Devices Protecting the Electrical Grid in the Middle East
Our contribution to the region

Transmission Solutions
Our contribution to the region

Transmission Solutions

100+
Substation projects executed in the UAE
Our contribution to the region
Transmission Solutions

100+
Substation projects executed in the UAE

100+
Substation projects executed in Kuwait
Our contribution to the region
Transmission Solutions

100+
Substation projects executed in the UAE

100+
Substation projects executed in Kuwait

40+
Substation projects executed in Saudi Arabia
Our contribution to the region
Transmission Solutions

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
Our contribution to the region

Transmission Solutions

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
Our contribution to the region
Transmission Solutions

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
Our contribution to the region

Transmission Solutions

<table>
<thead>
<tr>
<th>Voltage (kV)</th>
<th>Number of Projects</th>
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</thead>
<tbody>
<tr>
<td>500</td>
<td>100+</td>
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<tr>
<td>245</td>
<td>40+</td>
</tr>
<tr>
<td>145</td>
<td>45+</td>
</tr>
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</table>

- Substation projects executed in Egypt
- Substation projects executed in Pakistan
- Substation projects executed in Saudi Arabia
- Substation projects executed in Kuwait
- Substation projects executed in the UAE
Major Regional Customers
BIM optimizes collaboration by connecting people, information and processes
BIM optimizes collaboration by connecting people, information, and processes.
BIM - Building Information Modelling
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.
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
Projects are facing numerous challenges:

- Fragmented and Inconsistent data
- Tracking of Cost and Time Changes
- Disconnect Between Design and Construction
- Lack of Visualization
- Lack of Supplier/Contractor Integration
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)
BIM influences the collaboration btw. the different disciplines as well as the duration of the different phases

Source: Siemens Switzerland Ltd, Building Technologies Division, BIM "Understanding the language of buildings" March 2017
BIM FOR SUBSTATIONS
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
**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
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.
SUBSTATION DESIGN
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
Where is A Substation used?

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
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.

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.

3. Power distribution

- **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**: Low-voltage (LV)
- **Industrial consumers**: Medium-voltage (MV)
- **Underground distribution lines**
Substations in Middle East

Typical substation layout:
- GIS
- AIS

Gas Insulated Switchgear (GIS) Substation
- Indoor substation
- Main electrical equipment is located inside substation buildings
Substations in Middle East

Typical substation layout:

- GIS
- AIS
SUBSTATION PARTS by DESIGN DISCIPLINE

CIVIL PART

ELECTRICAL PART

MEP PART

2D Design
2D Design

AUTOCAD and other specialized drafting software

CHALLENGES:

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

3D Design
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
ELECTRICAL DESIGN of TYPICAL SUBSTATION

Layout Development

Equipment Design

HV Cables and Cable Accessories Design

Earthing and Lightning System Design
Inside View of the GIS Room
**Example of Cable Ladder Supports developed in Revit with reflected BoQ**

<table>
<thead>
<tr>
<th>Count</th>
<th>Type</th>
<th>Model</th>
<th>Description</th>
<th>Channel End Bracket</th>
<th>Channel Nut No</th>
<th>Channel Nut Size</th>
<th>Soft Plate Bolt Size</th>
<th>Soft Plate No</th>
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<td>1 Tier - 500mm Trapeze Support</td>
<td>1 Tier - 500mm Trapeze Support</td>
<td>1 Tier - 500mm Trapeze Support</td>
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**CABLE HANGERS**
OVERALL MODEL - REVIT

3D Building Model View in Revit
<table>
<thead>
<tr>
<th>LOD</th>
<th>Definition</th>
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<tbody>
<tr>
<td>100</td>
<td>Diagrammatic or schematic model elements: conceptual and/or schematic layout;</td>
</tr>
<tr>
<td>200</td>
<td>Schematic layout with approximate size, shape, and location of equipment;</td>
</tr>
<tr>
<td>300</td>
<td>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.</td>
</tr>
<tr>
<td>350</td>
<td>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.</td>
</tr>
<tr>
<td>400</td>
<td>Supplementary components added to the model required for fabrication and field installation.</td>
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## SUPPLIER SPECIFICATION

### 132kV Switchgear Example

#### Family Types

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Equipment Name</td>
<td>SIEMENS 132kV GIS</td>
</tr>
<tr>
<td>Equipment Type</td>
<td>8DN8 Enhanced</td>
</tr>
<tr>
<td>Heater Voltage</td>
<td>400/230 V AC</td>
</tr>
<tr>
<td>Motor Voltage Circuit Breaker</td>
<td>110 V DC</td>
</tr>
<tr>
<td>Motor Voltage Isolator/Earthschl</td>
<td>110 V DC</td>
</tr>
<tr>
<td>Number of Bays</td>
<td>8</td>
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<tr>
<td>Rated Ambient Temperature</td>
<td>50 (°C)</td>
</tr>
<tr>
<td>Rated Current Bus Coupler</td>
<td>2000 A</td>
</tr>
<tr>
<td>Rated Current Busbar</td>
<td>2000 A</td>
</tr>
<tr>
<td>Rated Current Cable Feeder</td>
<td>1500 A</td>
</tr>
<tr>
<td>Rated Current IDT Feeder</td>
<td>1500 A</td>
</tr>
<tr>
<td>Rated Frequency</td>
<td>50 Hz</td>
</tr>
<tr>
<td>Rated Voltage</td>
<td>145 kV</td>
</tr>
<tr>
<td>Rated Voltage for Control Cir</td>
<td>110 V DC</td>
</tr>
</tbody>
</table>

#### Structural

| Civil Design Specification (ES) |                   |

**How do I manage family types?**

**OK**  **Cancel**  **Apply**
GIS Substation Overview
Substation Full view
Plinth Level
Ground Floor
Transformer Roof Level
Roof Level
Electrical
Equipment
Gas Insulation Station
Gas Insulation Station
Gas Insulation Station
How we’re shaping the future
Thank you