IDOM

Consulting, Engineering, Architecture

MODULAR SOLUTIONS

A Practical and Economical Construction Technique

Modularization

Provides an Opportunity to Improve Constructability overcoming obstacles of site conditions and realizing advantages of manufacturing conditions.

Is a response to

- Site constraints
- Labor constraints (high labor cost / strong local unions)
- Environmental constraints
- Project constraints
- Tight schedule projects
  - Remote locations
  - Inhospitable work conditions (Health and Safety)
  - Repetitive constructions (repeatability → reduced cost)
  - Height constructions (stackable structures)
  - Need for speed and ease of erection

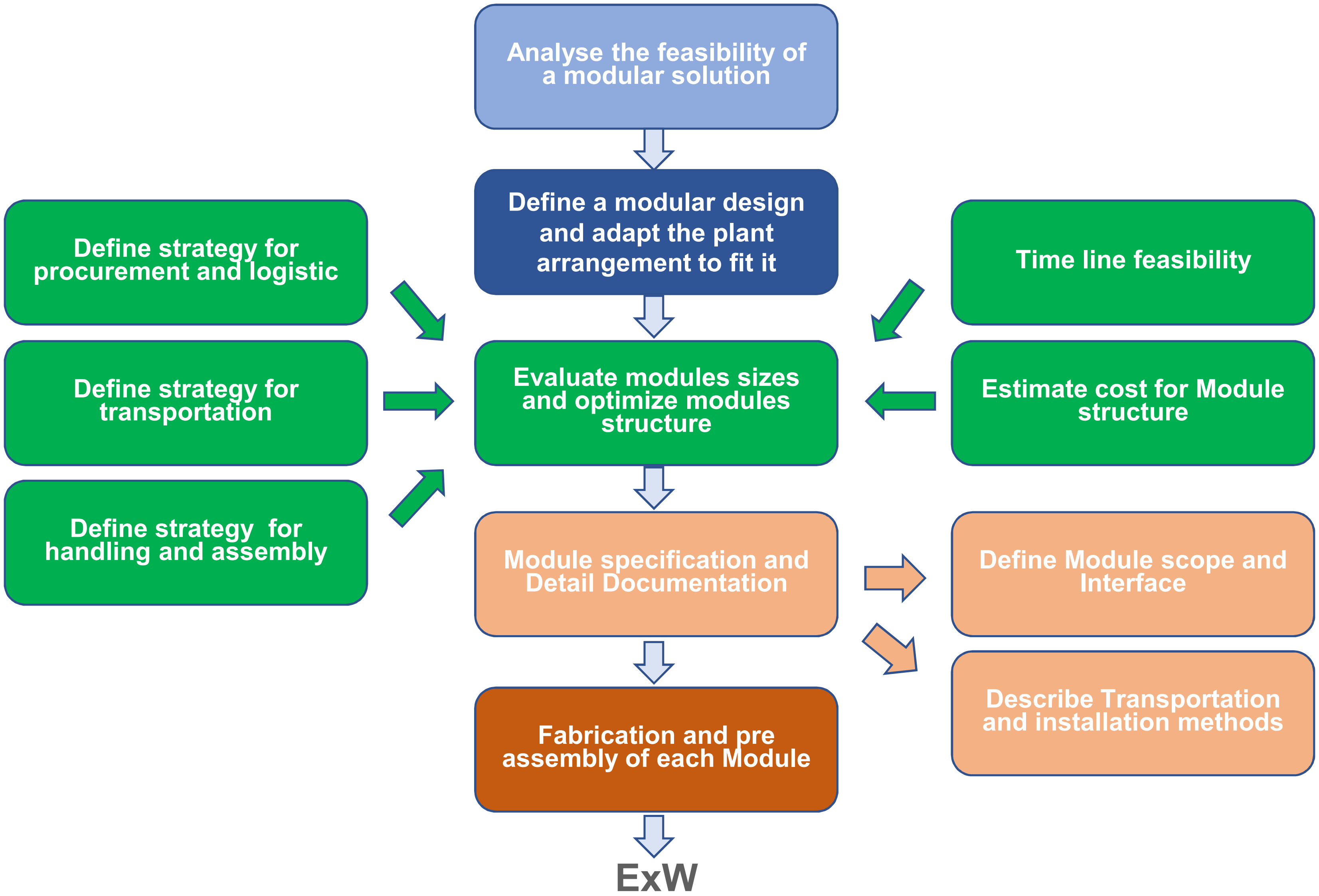
Main advantages

- Modules definition (horizontal, vertical, single level or multi-level depending on the space, equipment, and required piping configuration)
- Manufacturing conditions (controlled environment, higher productivity and improved quality control)
- Reduced plant construction time → Overall cost reduction

Challenges

- More sophisticated engineering and design requirements (needs to take early decisions)
- Purchasing and logistic for equipment/material for modules (more complex requirements)
- Sizes and weights
- Increased risks of transporting and handling assemblies
- On site assembly (changes the nature of design and construction)
  - Higher standard of control and organization
  - Heavy lifting → big cranes during module setting at Site

Modularization roadmap



Modules definition

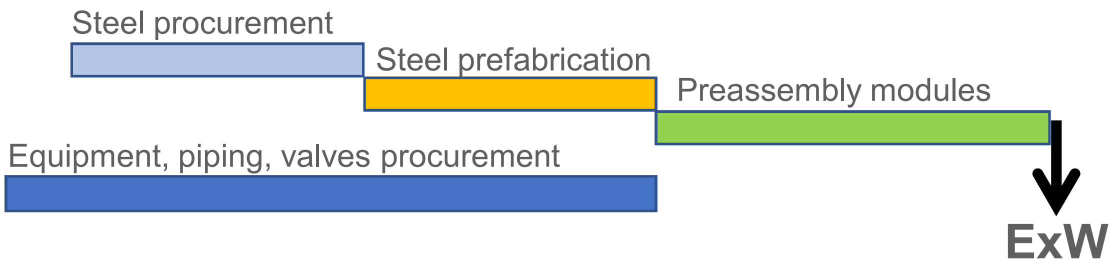
1. Detailed engineering sophistication

a. Equipment selection. There are equipment which accommodates better themselves to a modular construction than others.
b. Equipment layout & piping study. This is the most critical phase of the design, as it leads the number and location of each module.
c. Transportation and assembly requirements must be considered to size the modules
d. Shortened engineering phase and design freezing is compulsory

2. Modularization strategy for procurement and logistic

Prefabrication and Preassembly of modules including wiring and electrical junction boxes installation require the Supply of material in advance.

a. Steel structure including platforms and floors
b. Components
c. Valves
d. Supports
e. Cable trays
f. Cables
g. Piping
h. Instrumentation and junction boxes
i. Other (Cladding, container, etc)

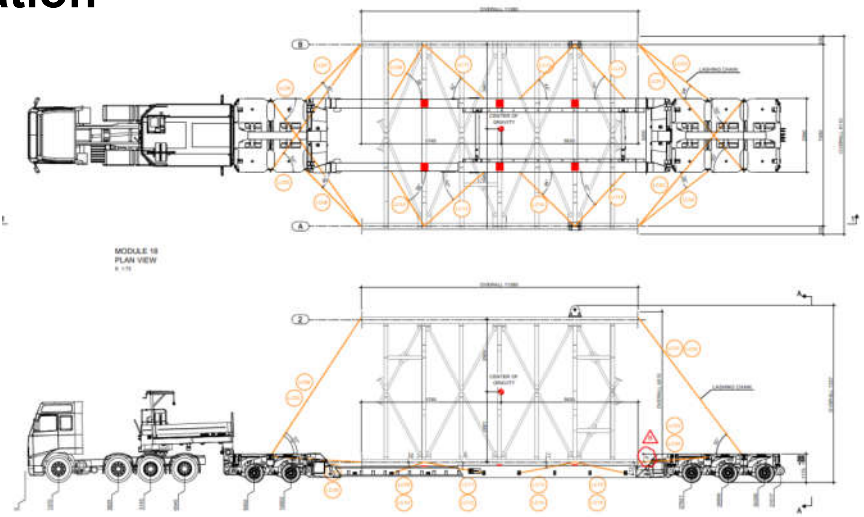


Modules definition

3. Modularization strategy for transportation

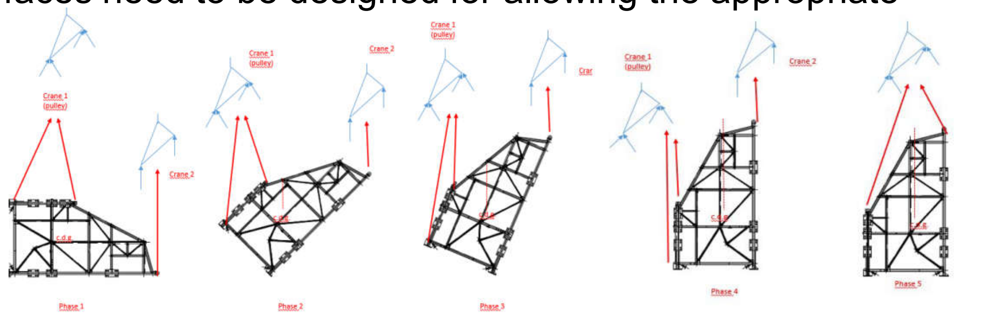
a. Modules transportation needs to be carefully planned and calculated
b. Calculation needs to be performed considering the actual features of transport platforms and the accelerations expected for the real route to be followed from the workshop to the site.
c. High accuracy in the estimate of the center of gravity is required.
d. All ancillary beams, slings and anchorages needs to be carefully selected and checked.

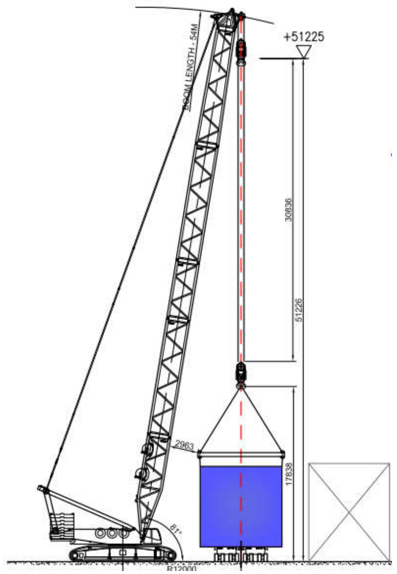
(*) Site close to harbor facilities or workshop → larger modules



4. Modularization strategy for Handling and On-Site Assembly

a. All the modules need to be checked for every possible temporary state, including the handling.
b. The handling sequences need to be assessed and finally defined for each module dedicatedly.
c. All maneuvers need to be designed
d. All the interfaces need to be designed for allowing the appropriate tolerances





Some References

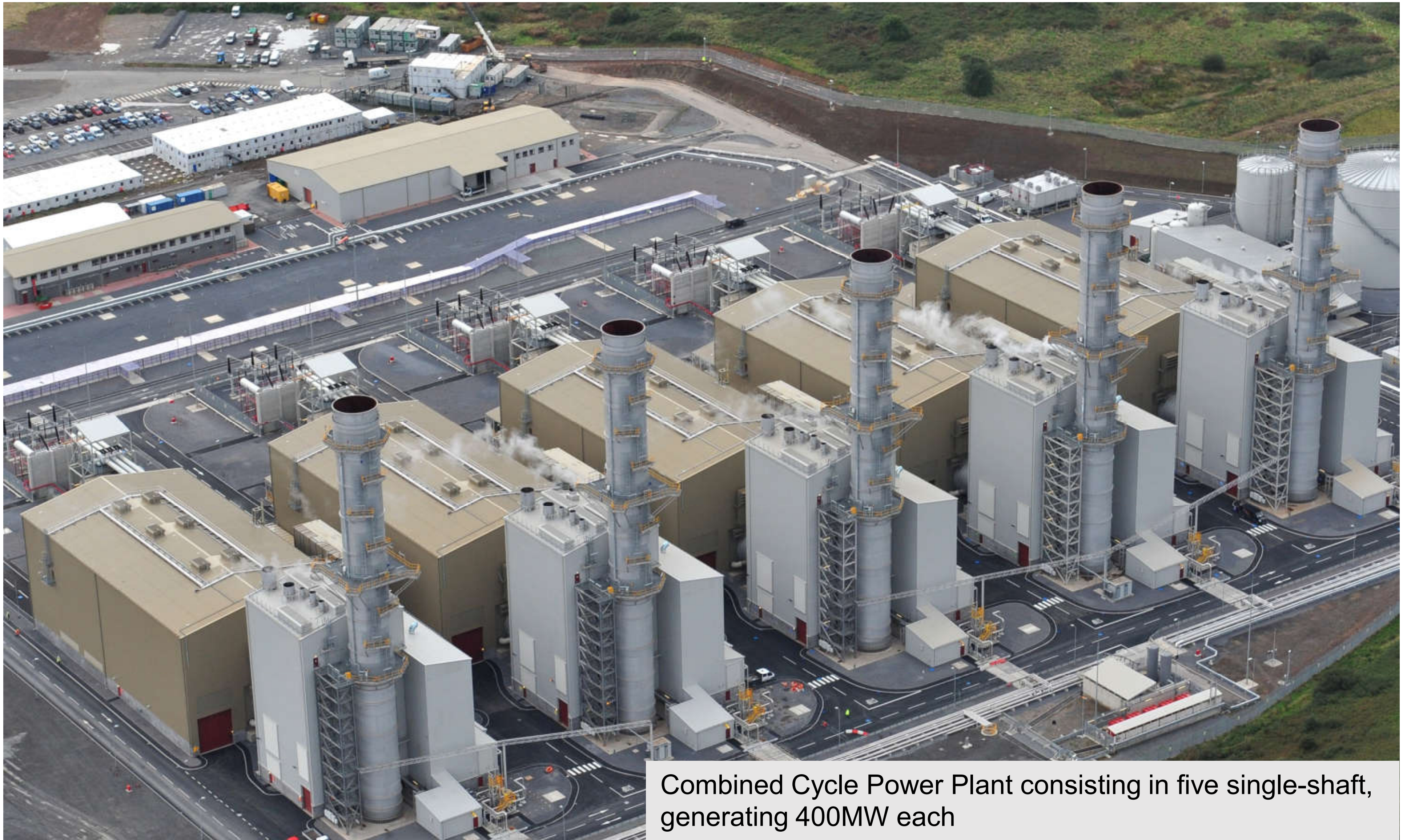
IDOM has been selected by several companies to develop the basic and detailed design of the **modules** in power & process plants to solve site problems due to project limitations.

- **PEMBROKE** (UK. Wales 2009-2012). A 2000 megawatts CCPP. Feed Water Tower (4 sub-modules), Atmospheric Drain Vessel and Closed Cooling Water modules
- **ALBA** (Bahrain 2016-2019) A 1800 megawatts CCPP. Main steam rack in modules
- **MEGALIM.** (Israel 2015-2016) A 121 megawatts CSP plant. Vertical pipe rack in modules
- **POLINTER** (Venezuela). Buthene Unit Process plant. Complete plant in modules
- **KWINANA** (Australia). Waste to Energy Plant - 2x600 ton/day Boiler Lines. All the electrical part in modules

ALSTOM / RWE

Feed Water Tower, Atmospheric Drain Vessel and Closed Cooling Water. Modules design

2000 MW PEMBROKE CCPP



Combined Cycle Power Plant consisting in five single-shaft, generating 400MW each

Reasons to develop a modular solution

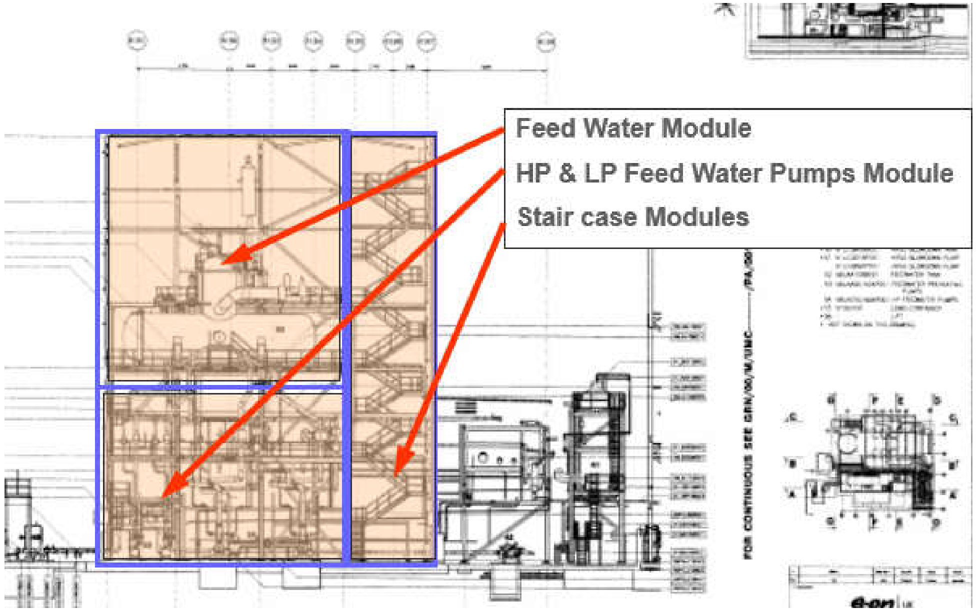
- Tight area
- High labor cost in UK / Unions problems
- Site close to harbor facilities; large modules potential
- 5 units (reduced cost through repeatability)

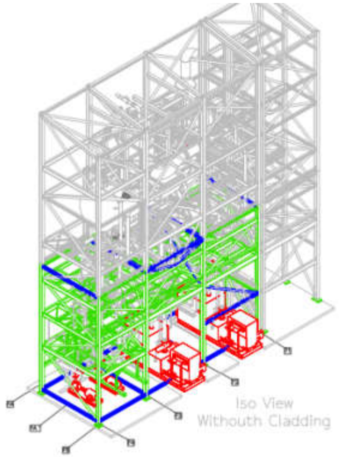
Performed work

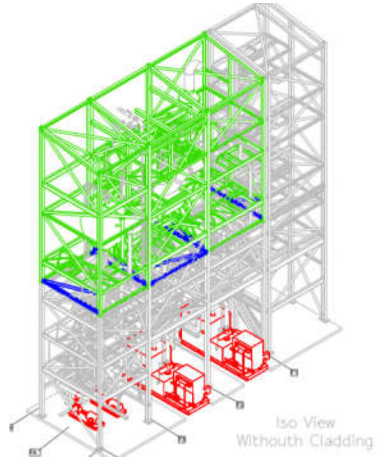
Idom has developed next services related to the following modules (Feed Water Tower (4 sub-modules), Atmospheric Drain Vessel and Closed Cooling Water):

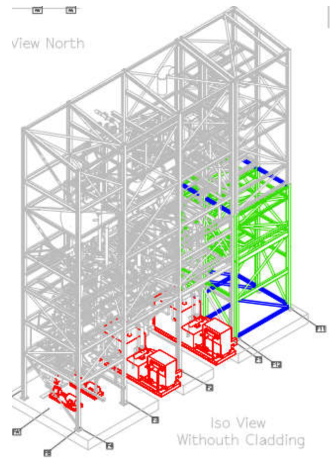
- Consultancy services related to modules handling and transportation
- Technical support for the selection of the final modules fabrication workshop
- Calculations and detailed engineering associated to all disciplines involved (steel works, piping, electricity and I&C)
- 3D modelling of all elements in a PDMS

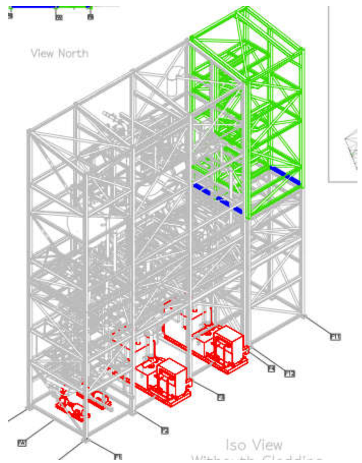
Feed Water Tower (4 sub-modules)



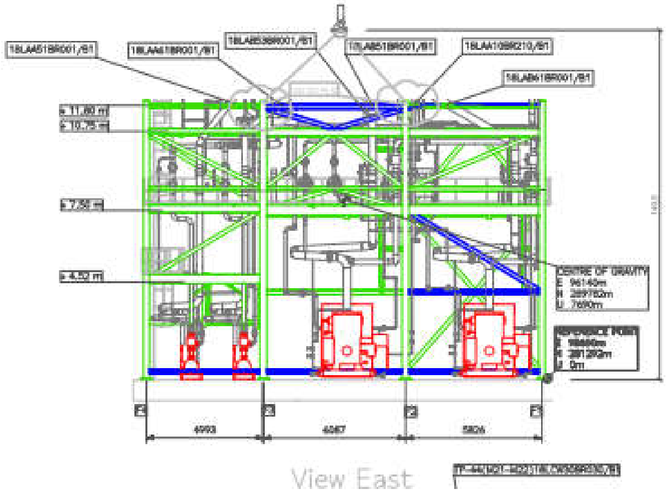






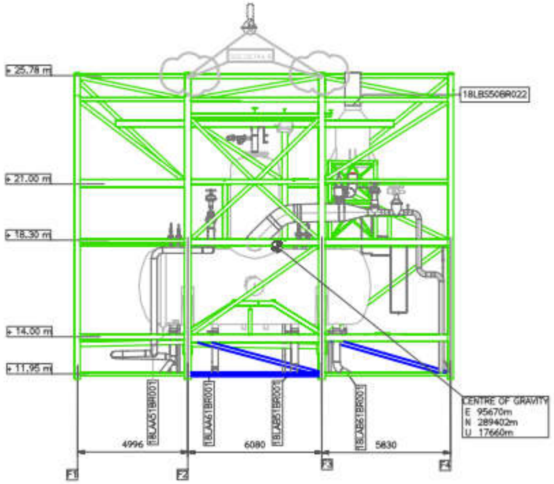


Feed Water Tower (sub-module 1)



Feed Water Tower (sub-modules 3 & 4)

Feed Water Tower (sub-module 2)

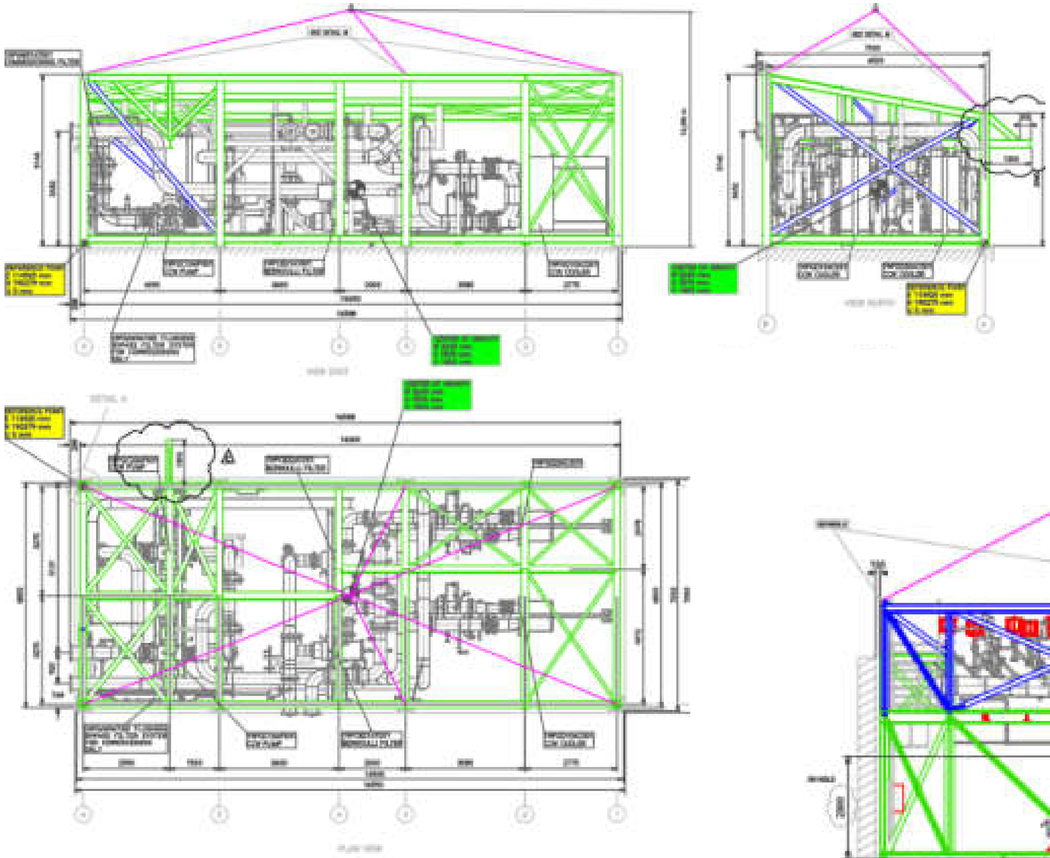


ALSTOM / RWE

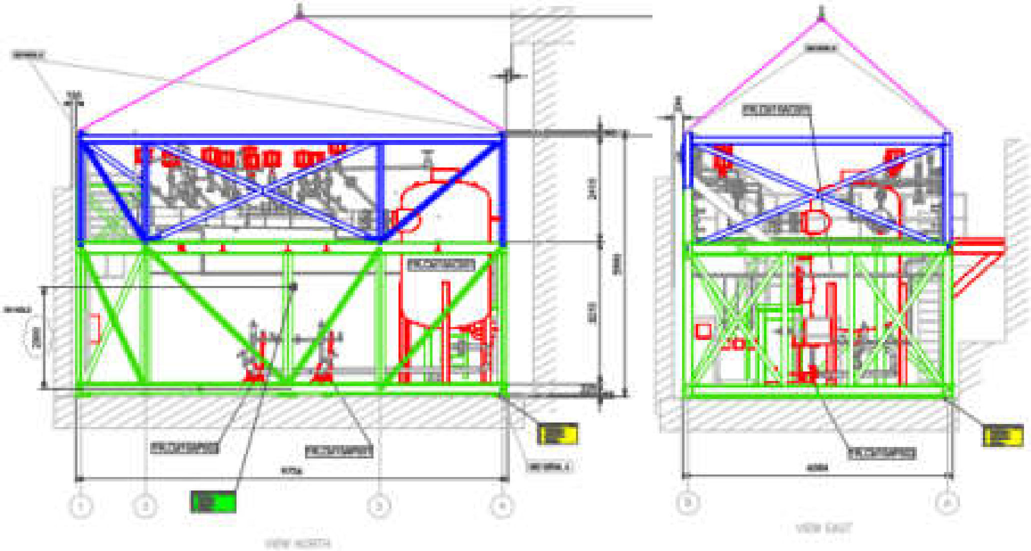
Feed Water Tower, Atmospheric Drain Vessel and Closed Cooling Water. Modules design

2000 MW PEMBROKE CCPP

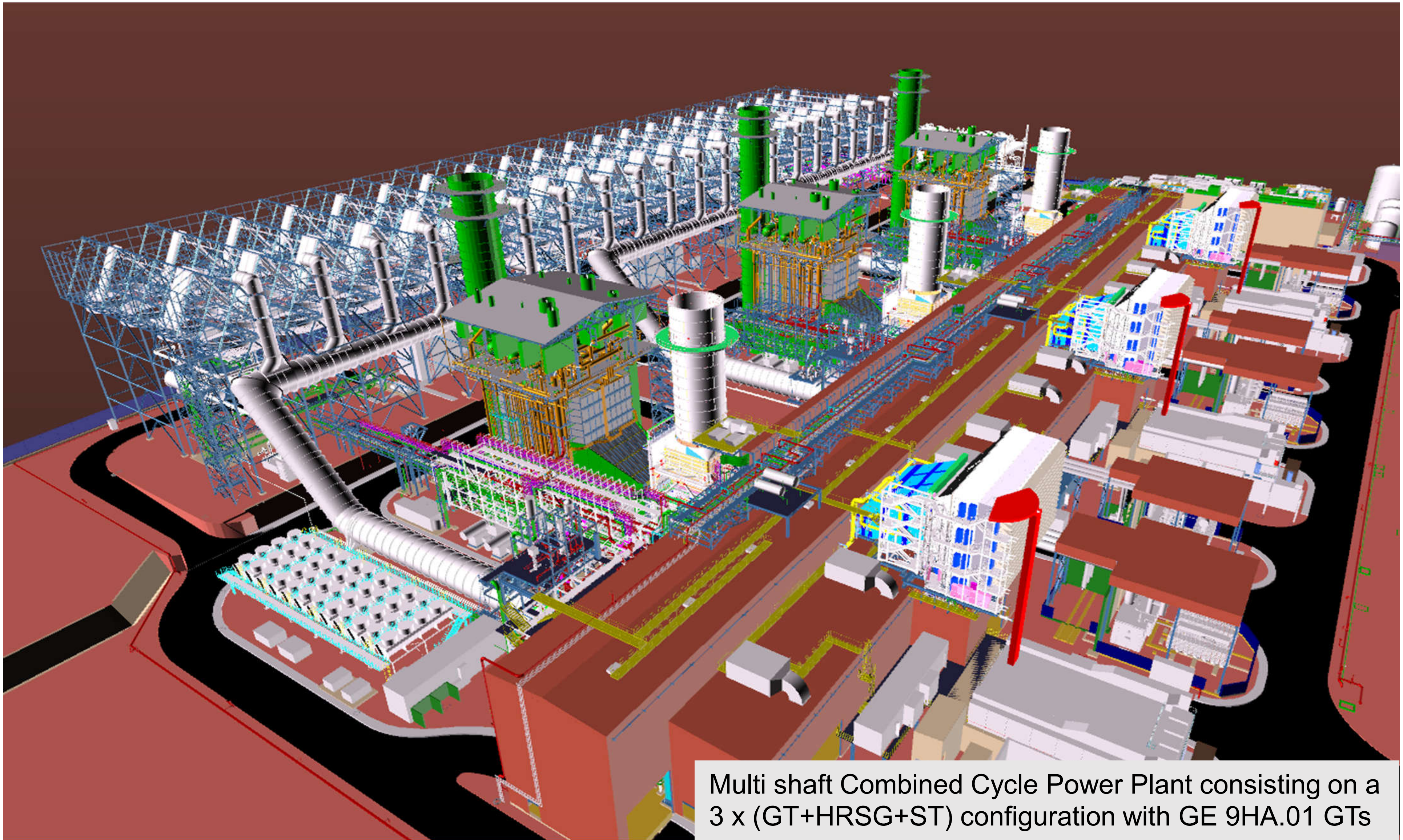
Closed Cooling Water



Atmospheric Drain Vessel



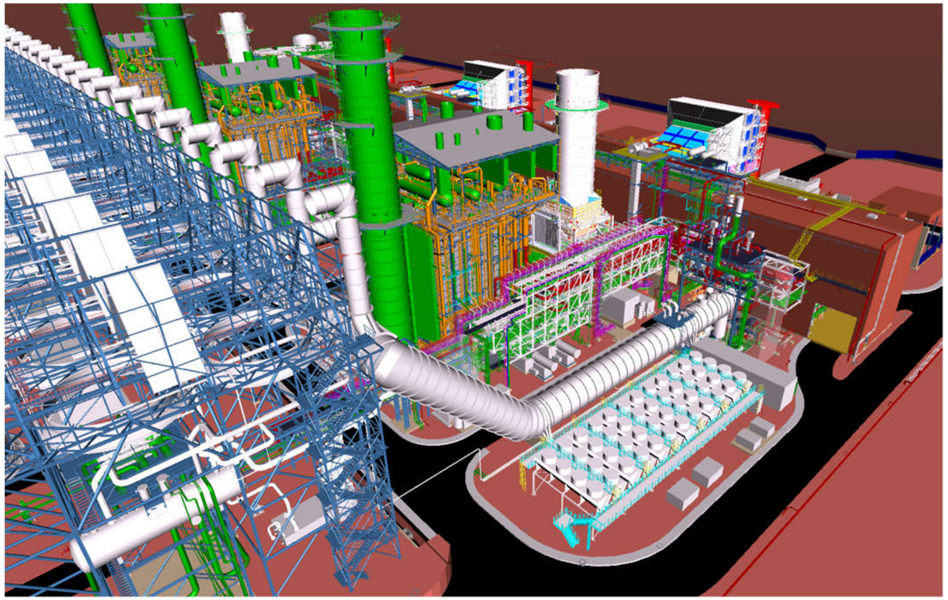
PARTNERSHIP GE-GAMA
Main steam Pipe Rack in modules
1800 MW ALBA POWER STATION 5 - CCPP

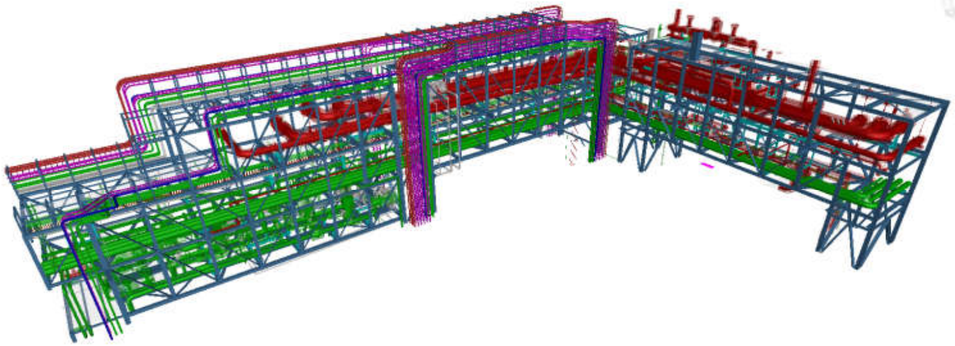


Multi shaft Combined Cycle Power Plant consisting on a 3 x (GT+HRSG+ST) configuration with GE 9HA.01 GTs

Reasons to develop a modular solution

- Tight schedule / customer will insist on «on time COD»
- Tight area
- High labor cost in Bahrein
- Site close to harbor facilities; large modules potential
- 3 units (reduced cost through repeatability)
- Opportunity for future project with same configuration





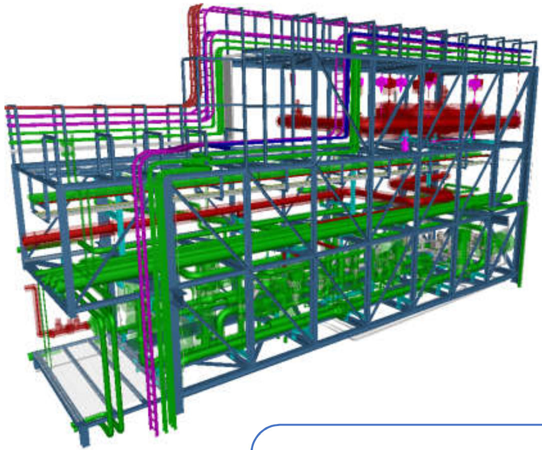
Performed work

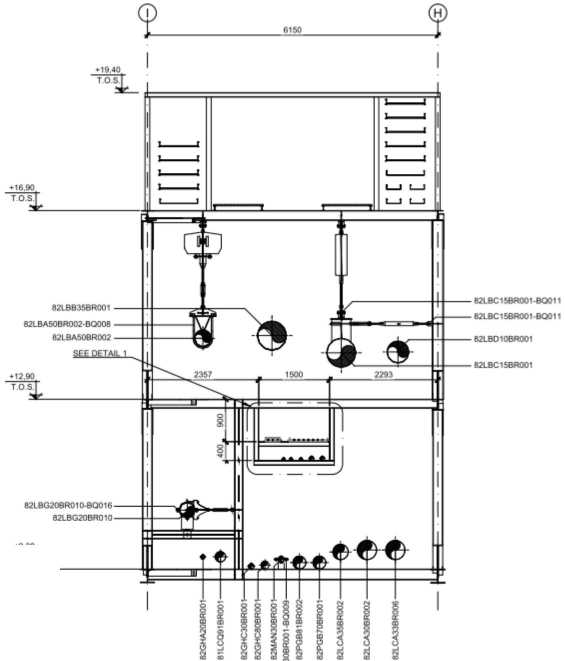
- Main steam Pipe Rack in modules
- Basic and Detailed Design of Steel structure, piping and cable trays
- Detail drawings.
- Integration of all elements inside the modules (equipment, pipelines, cable trays, flooring, railing, etc.)
- Specifications for on-site assembly. (Checking for every possible temporary state, including the handling)
- Calculation and plan of Modules transportation

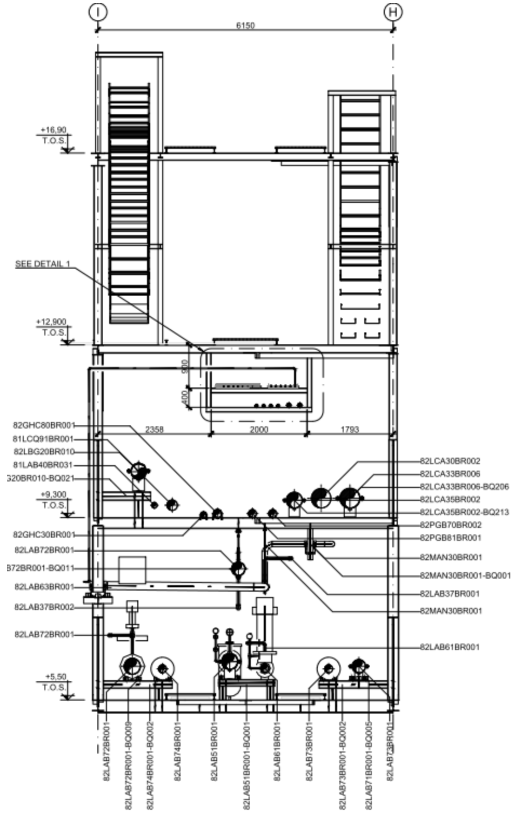
PARTNERSHIP GE-GAMA

Main steam Pipe Rack in modules

1800 MW ALBA POWER STATION 5 - CCPP

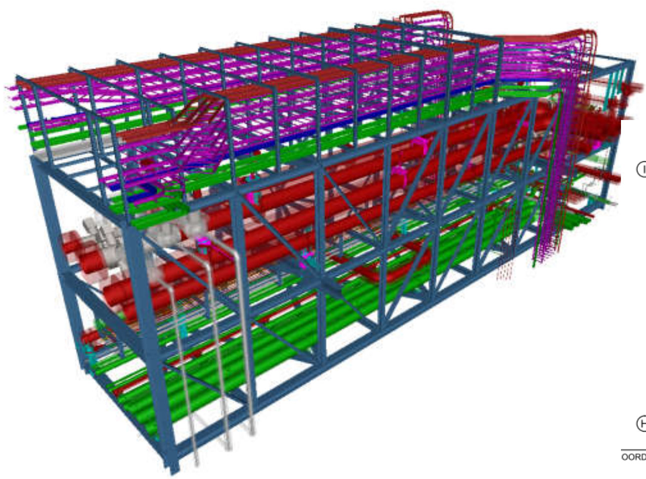


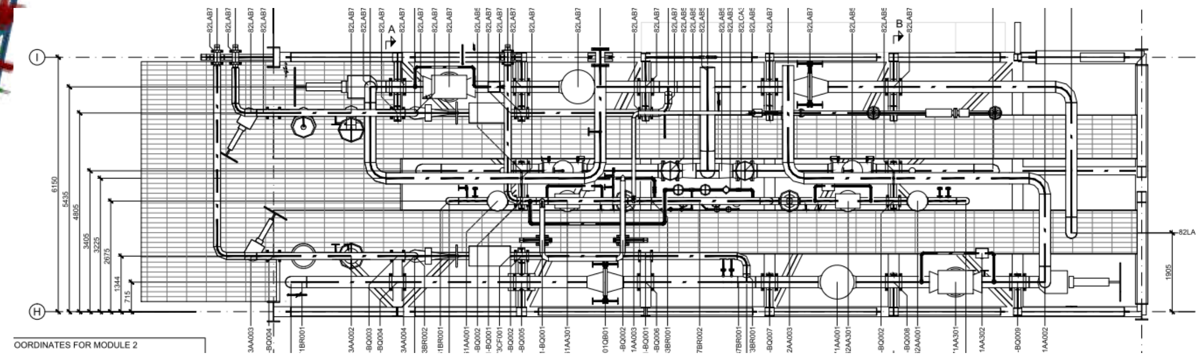




5 modules

85 tn to 190 tn

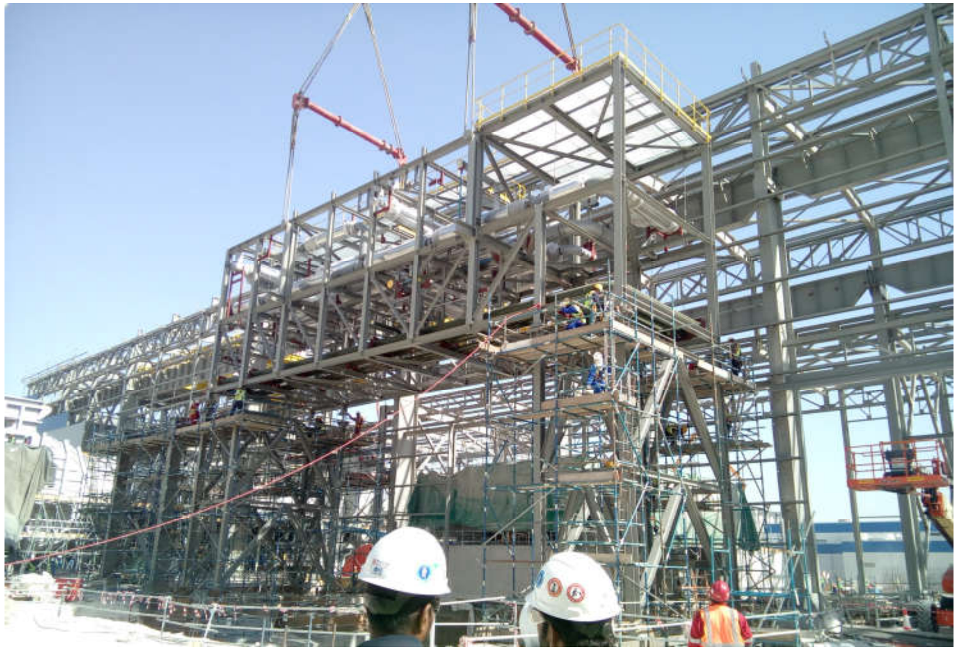




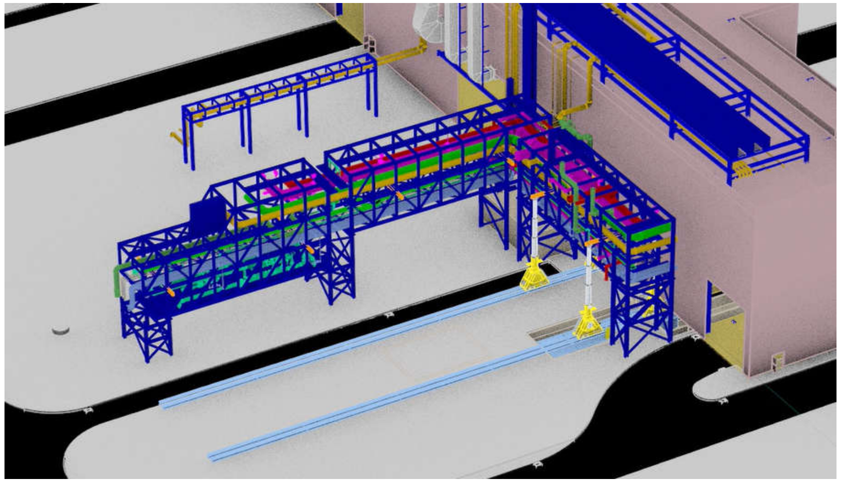
PARTNERSHIP GE-GAMA

Main steam Pipe Rack in modules

1800 MW ALBA POWER STATION 5 - CCPP



On-site assembly. Analysis for pipe rack modules assembly with gantry jacks



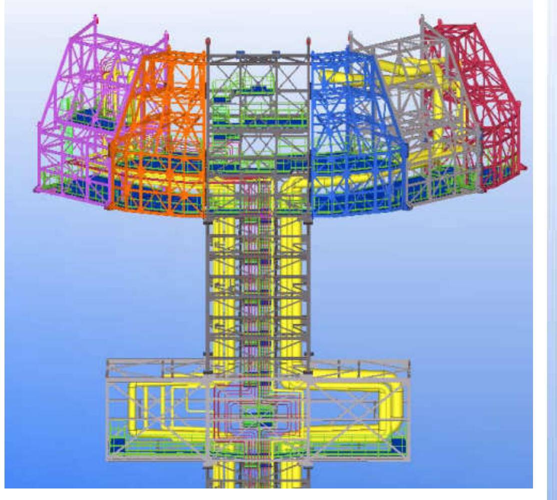
On-site assembly. Pipe rack module assembly with cranes

ALSTOM
Vertical Pipe Rack for Solar Thermal Plant in modules
121 MW CSP Plant

CSP Plant based on central tower technology with direct steam generation of 121 MWe

Reasons to develop a modular solution

- Schedule constrains
- Height construction (Tower + SRSG Height: 240 m)



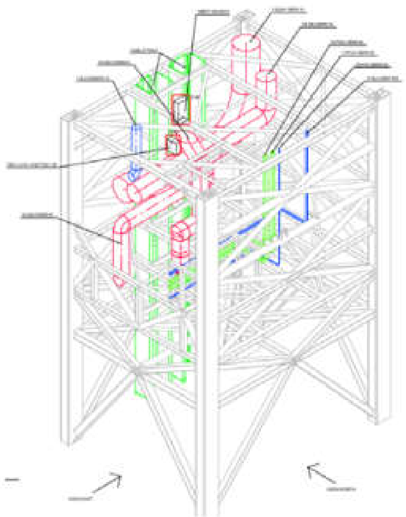
Performed work

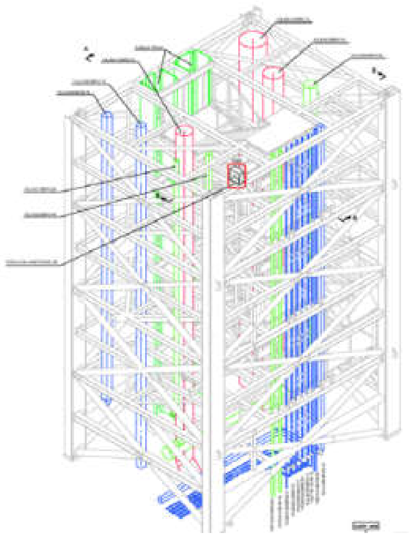
Vertical Pipe Rack for Solar Thermal Plant in modules

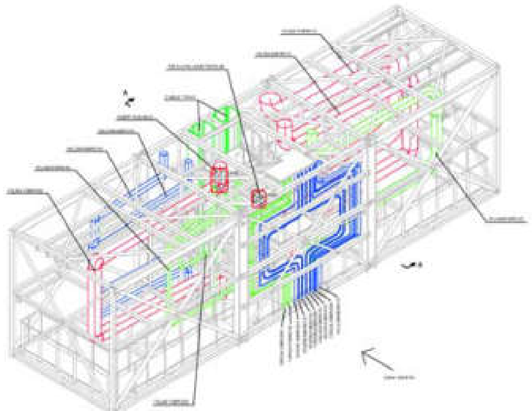
- Comprehensive analysis of Concrete-Steel tower
- Detailed design of Steel structure
- Detailed design of connections between Steel and concrete tower.
- Workshop drawings.
- Specifications and procedures for manufacturing
- Transportation Method Statement
- Specifications and procedures for on-site assembly
- Integration of all elements inside the modules (equipment, pipelines, cable trays, flooring, railing, etc.).
- Quality specifications and Inspection Tests Lists.

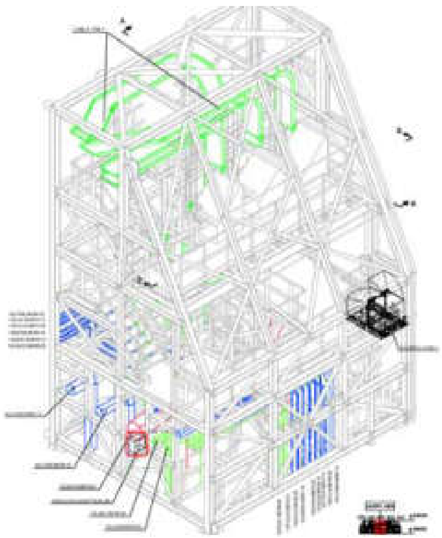
ALSTOM
Vertical Pipe Rack for Solar Thermal Plant in modules
121 MW CSP Plant

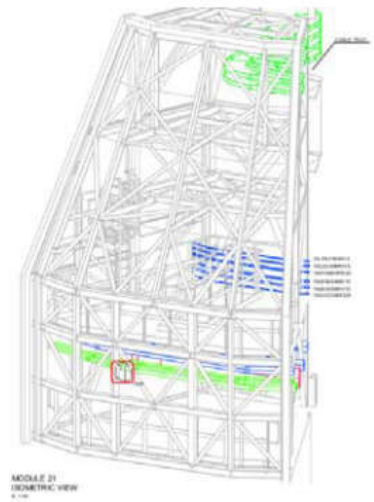
Modularization











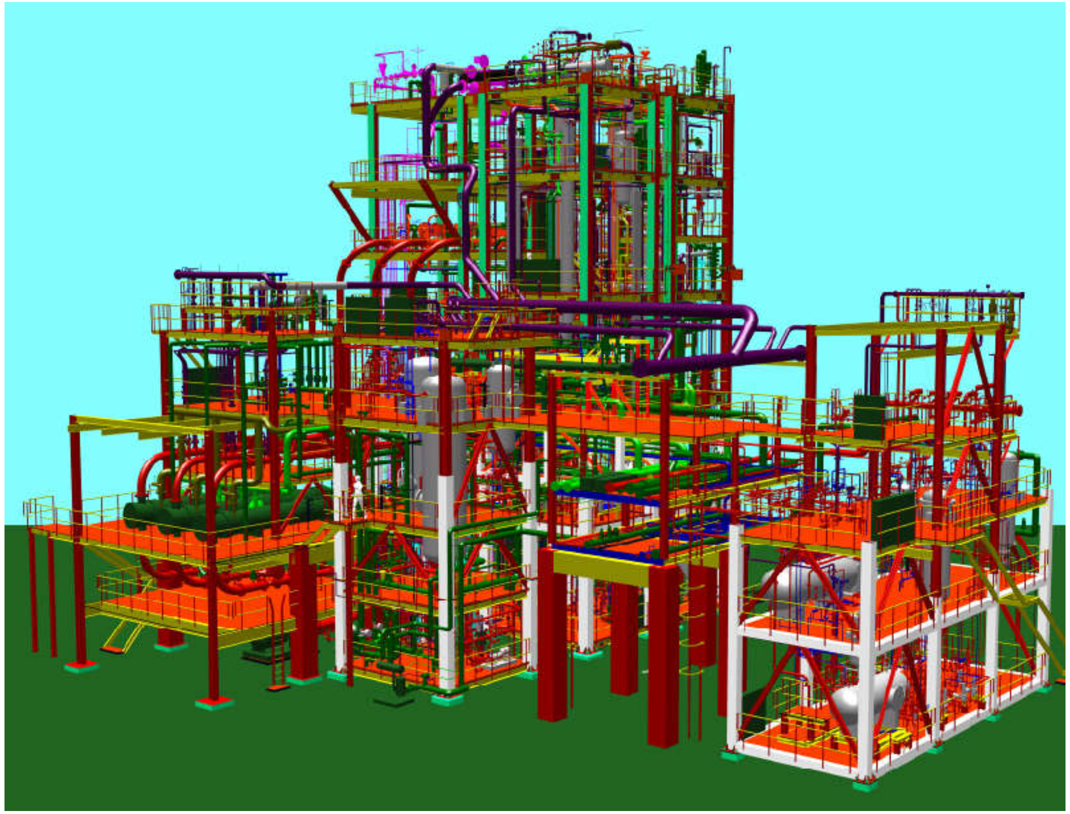
POLINTER

Complete plant in modules

Buthene Unit –15.000 ton/year Unit

Reasons to develop a modular solution

- Lack of adequate materials
- Labor in remote locations
- Advantages of manufacturing conditions



Performed work

Plant in modules:

- Plant Layout design.
- Sets definition and design.
- Modules location and design.
- Maintenance and operation platforms and walkways.
- Equipment layout (reactors, columns, vessels, heat exchangers and pumps).
- Pressure vessels general layout drawings, including nozzles location and supports design according the process requirements.
- Piping design for all the unit systems, including valves and accessories.
- Civil design, modules and main structures detailed design.
- Analysis and design of erection and lifting devices and procedures for the set of modules.
- Trays design for electrical and I&C systems.

POLINTER
Complete plant in modules
Buthene Unit –15.000 ton/year Unit

Project Type:

Pertochemical plant

Location of plant:

Venezuela

Design by:

IDOM

Frabrication of modules:

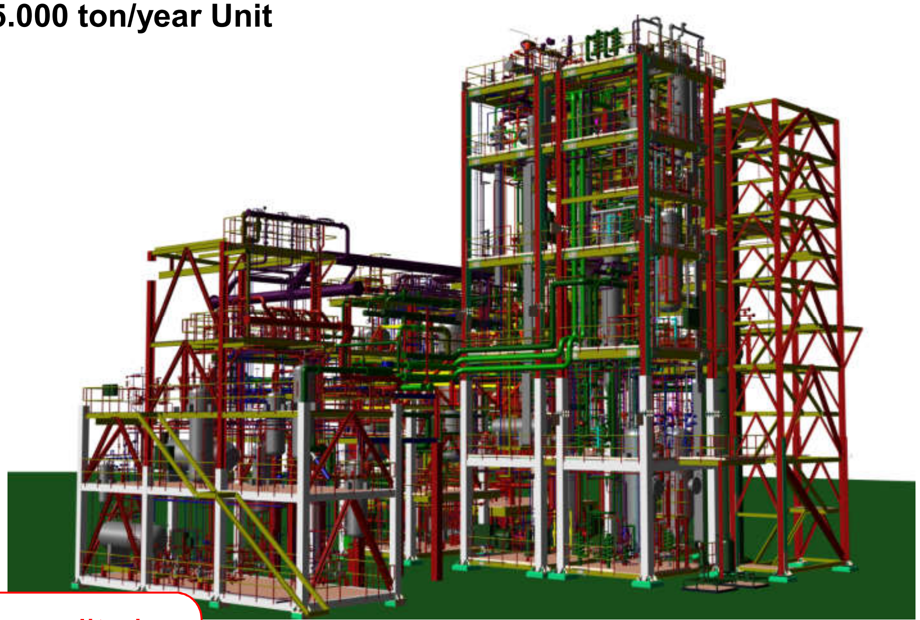
France

Weight of single modules:

~60 to 170 tones

Sample Dimensions of modules:

m long x 5 x 5



From design into reality in
13 modules

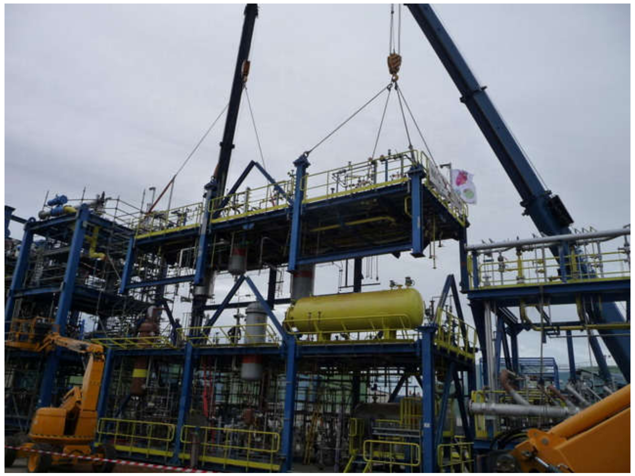
POLINTER

Complete plant in modules

Buthene Unit –15.000 ton/year Unit

Number of Modules: 13 sets (161 – 63 t/each).





Number of Modules: 13 sets (161 – 63 t/each).





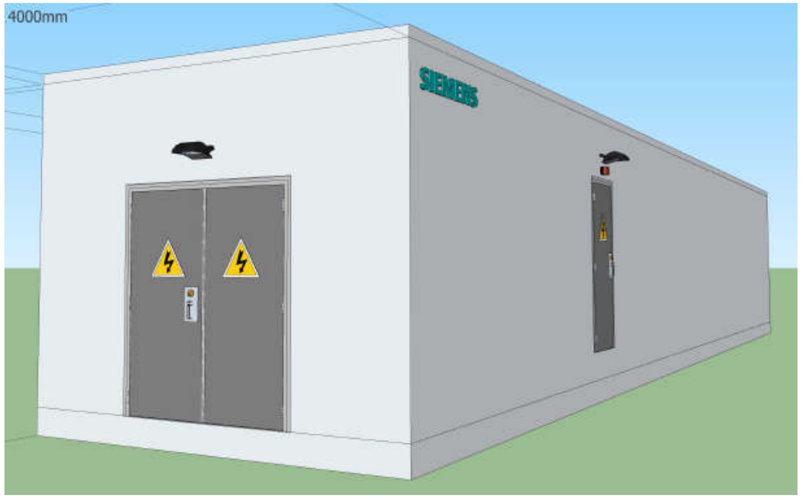

KWINANA

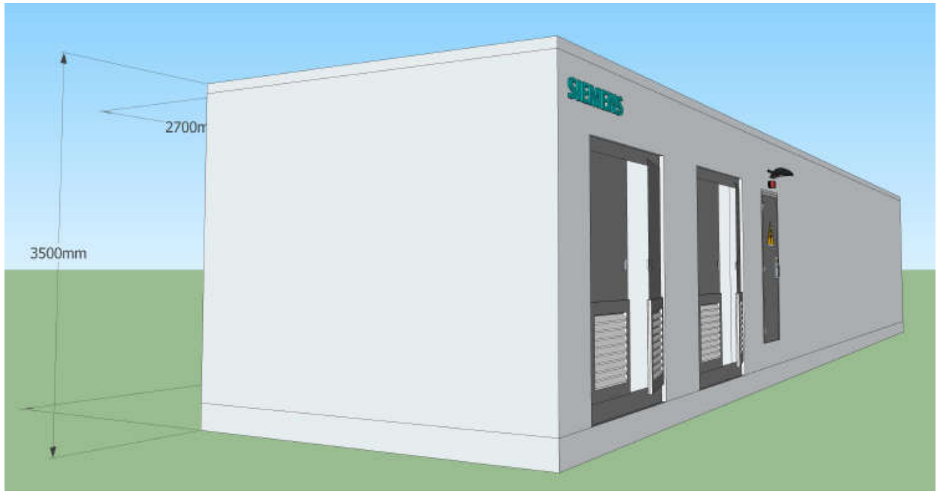
All the electrical part in modules

Waste to Energy Plant –2x600 ton/day Boiler Lines

Reasons to develop a modular solution

- High labor cost in Australia. Labor in remote locations.
- Advantages of manufacturing conditions.
- Everything inside E-houses prewired at workshop, including cables and cable ways.
- Tests and inspection at workshop (FAT).
- Integration by one subcontractor, minor mistake probability.
- Problems solved before commissioning.
- The assembly does not depend on construction schedule.





Performed work

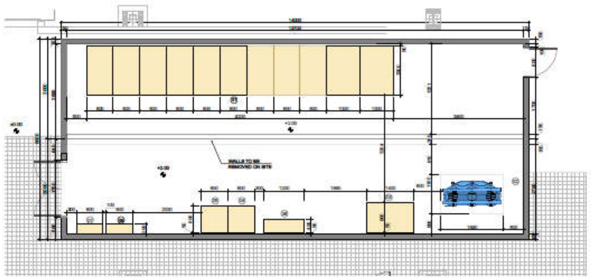
Plant in modules:

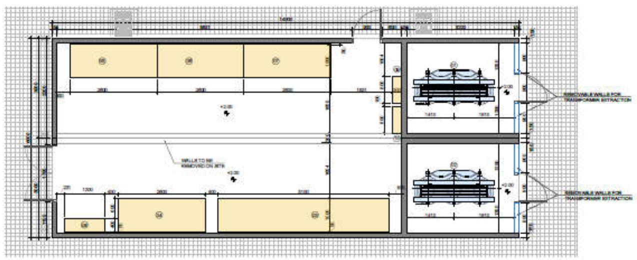
- Plant Layout design.
- E-houses location and design.
- Equipment layout (cabinets, transformers, RIOs, etc.).
- Integration of the E-houses in Plant design.
  - Maintenance and operation platforms and walkways
  - Analysis and design of hoists and maintenance procedures for the set of modules.
  - Civil design, modules and main structures detailed design.

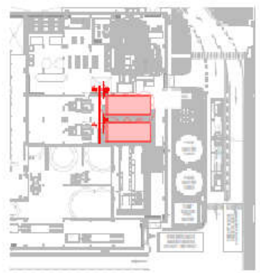
KWINANA

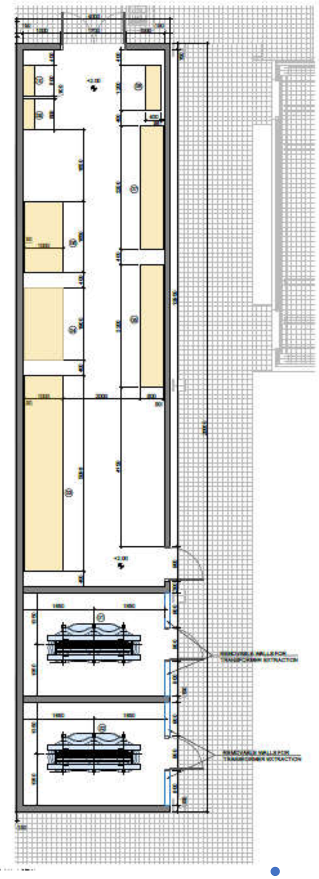
All the electrical part in modules (E-houses)

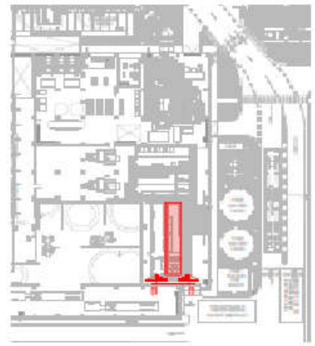
Waste to Energy Plant –2x600 ton/day Boiler Lines

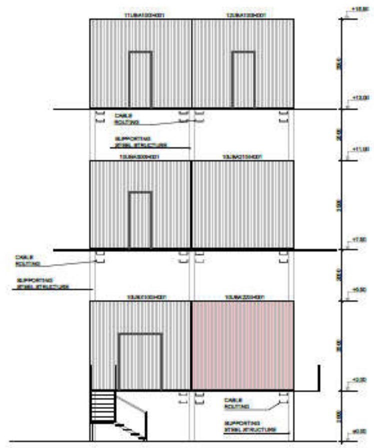










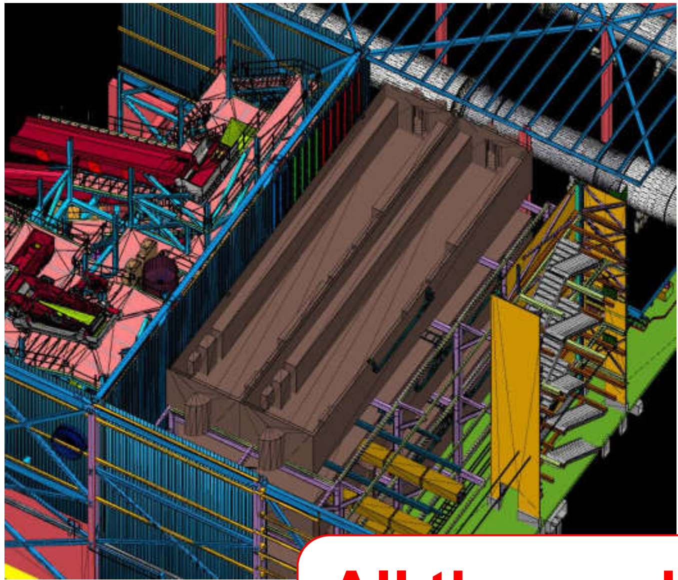
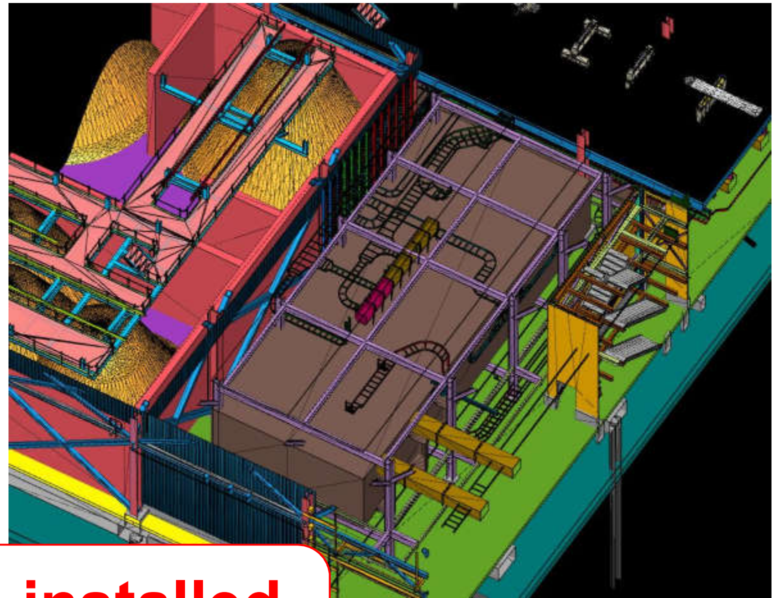


10 Electrical and Control E-houses

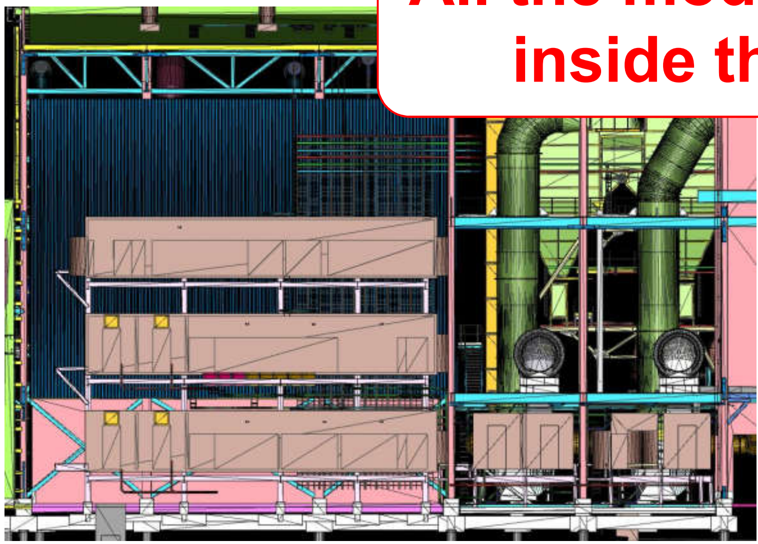
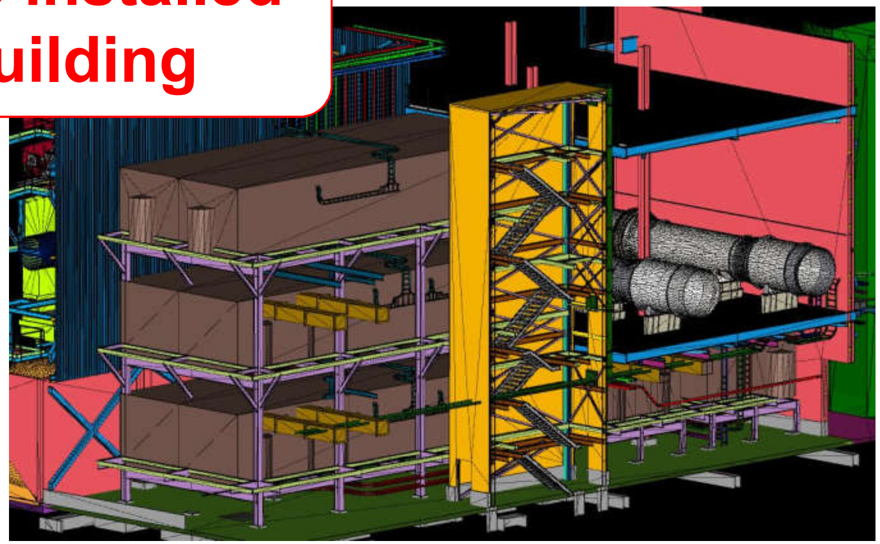
The different modules include:

- MV Switchgear
- Grounding Transformer
- Grounding Resistor (MV)
- GSTU Protection Panelboard
- Metering Panelboard
- 11/0,69 kV Service Transformers
- 415V Switchboard
- VSDs for different devices
- Turbine Control System Cabinets
- Boiler Control System Cabinets
- Motor Control Cabinets (MCC)
- Lighting and Small Loads Transformers
- UPS Panelboard
- DC Panelboard
- Batteries
- VMS Cabinet
- DCS Remote Cabinets
- Firefighting Panelboards

KWINANA
All the electrical part in modules (E-houses)
Waste to Energy Plant –2x600 ton/day Boiler Lines

All the modules installed inside the building

Erection examples

Steel support structures

Steel support structure with stairs, platforms and handrails

Raised floor base frame

Raised floor

Two levels od E-Houses with stairs, platforms and handrails