



**AVEVAWORLD**  
PARIS

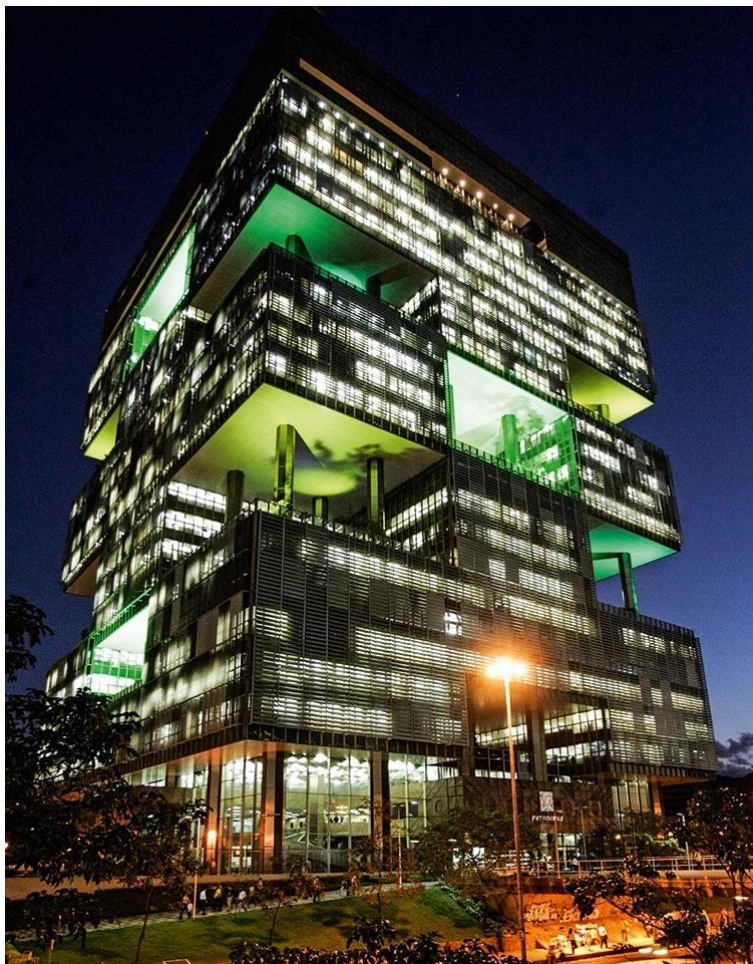
# Petrobras - Connecting design stages through the 3D Model - from Basic to Execution with AVEVA™ E3D Design



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Daniel Möller**

Data: 15/10/2024

# Petrobras



\*2Q24 Results

**Largest oil and gas producer in Brazil**

HD:  
**Rio de Janeiro, Brazil**

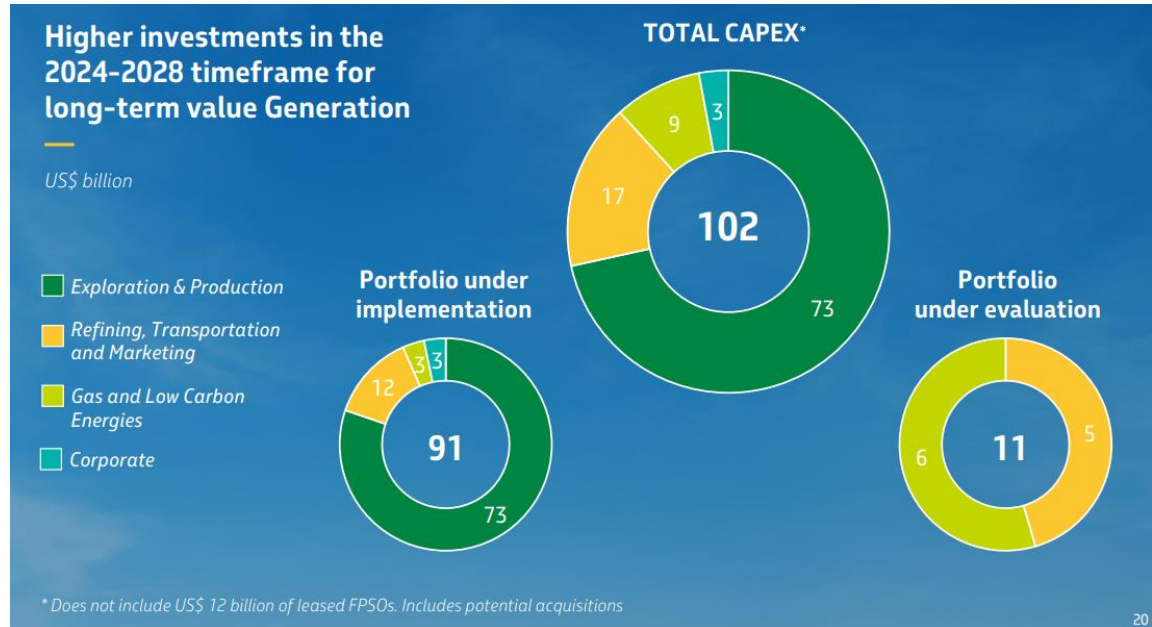
Year of establishment  
**1953**

Annual Revenue:  
US\$  
**99.89bi**

Daily Production:  
**2.78**  
mboed

Daily Refining :  
**1,744**  
bpd

Employees :  
**40,400**



# Organization Chart

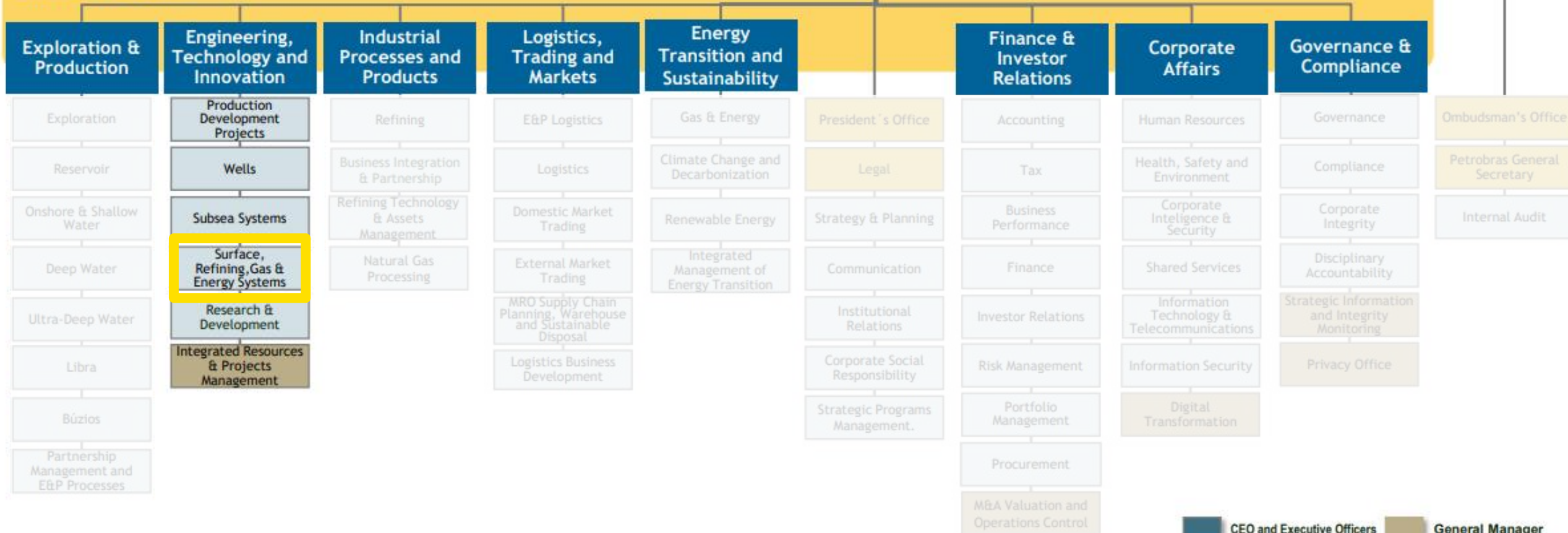
General Shareholders' Meeting

Fiscal Council

Board of Directors

President

Executive Board



CEO and Executive Officers
  General Manager
  Executive Manager
  Specific Functions

# Investing in the expansion and upgrading of the industrial complex with a focus on high-value, low carbon products



## MAIN PROJECTS

 **Increase in Processing Capacity** **225 kbpd**



- *RNEST: Revamp Train 1 and implementation of Train 2*
- *Revamps of current facilities*

 **Increase in S-10 diesel production capacity** **> 290 kbpd<sup>\*\*\*</sup>**



- *New units HDT/HCC GASLUB<sup>\*\*</sup>*
- *REPLAN new HDT*
- *Implementation of RNEST Train 2*
- *Revamps of current facilities*

 **BioRefining<sup>\*</sup>** **34 kbpd**



- *Dedicated plant in RPBC (SAF / Diesel R100)<sup>\*\*</sup>*
- *Dedicated plant GASLUB<sup>\*\*</sup>*

 **Lubricants Group II** **12 kbpd**



- *New unit HIDW GASLUB<sup>\*\*</sup>*

 **Petrochemicals and Fertilizers**



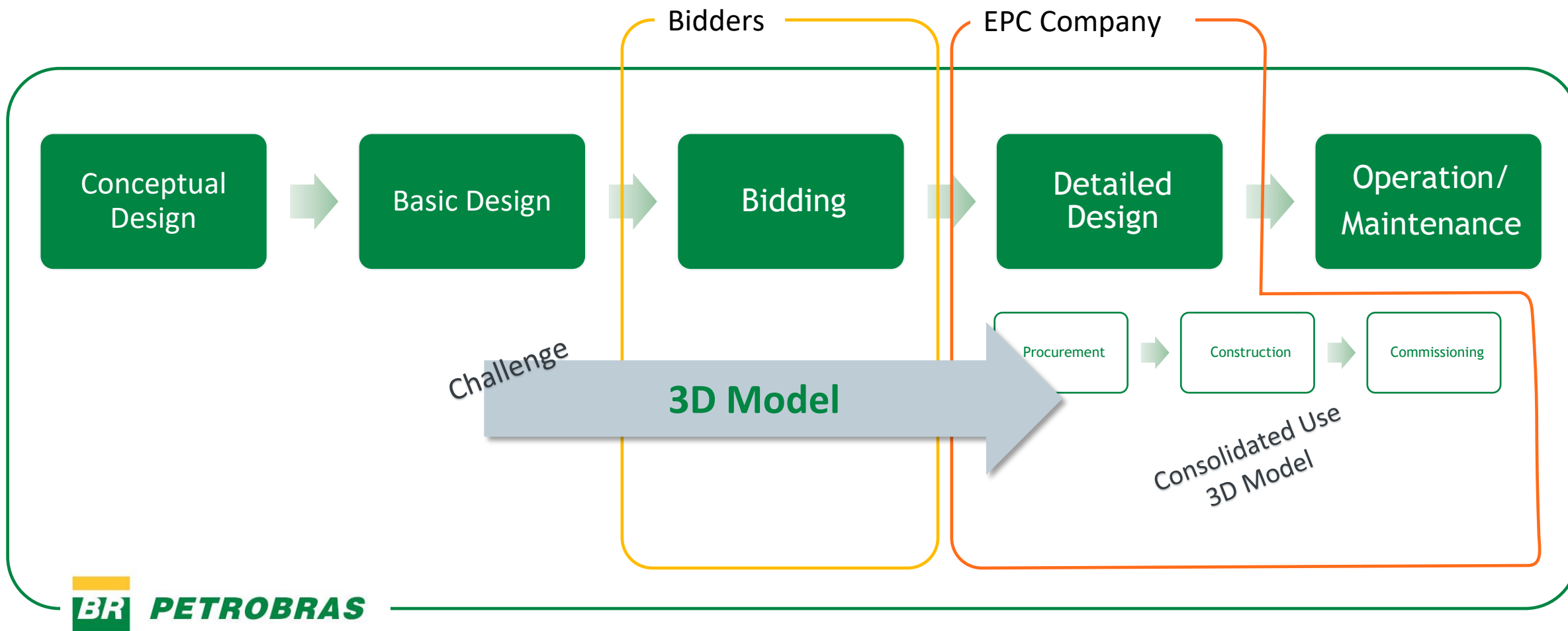
- *Projects under study*

\* 100% Renewable (Diesel R100) | \*\* Projects 2028+ | \*\*\* 80% new capacity / 20% revamps

# Challenge

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# Context

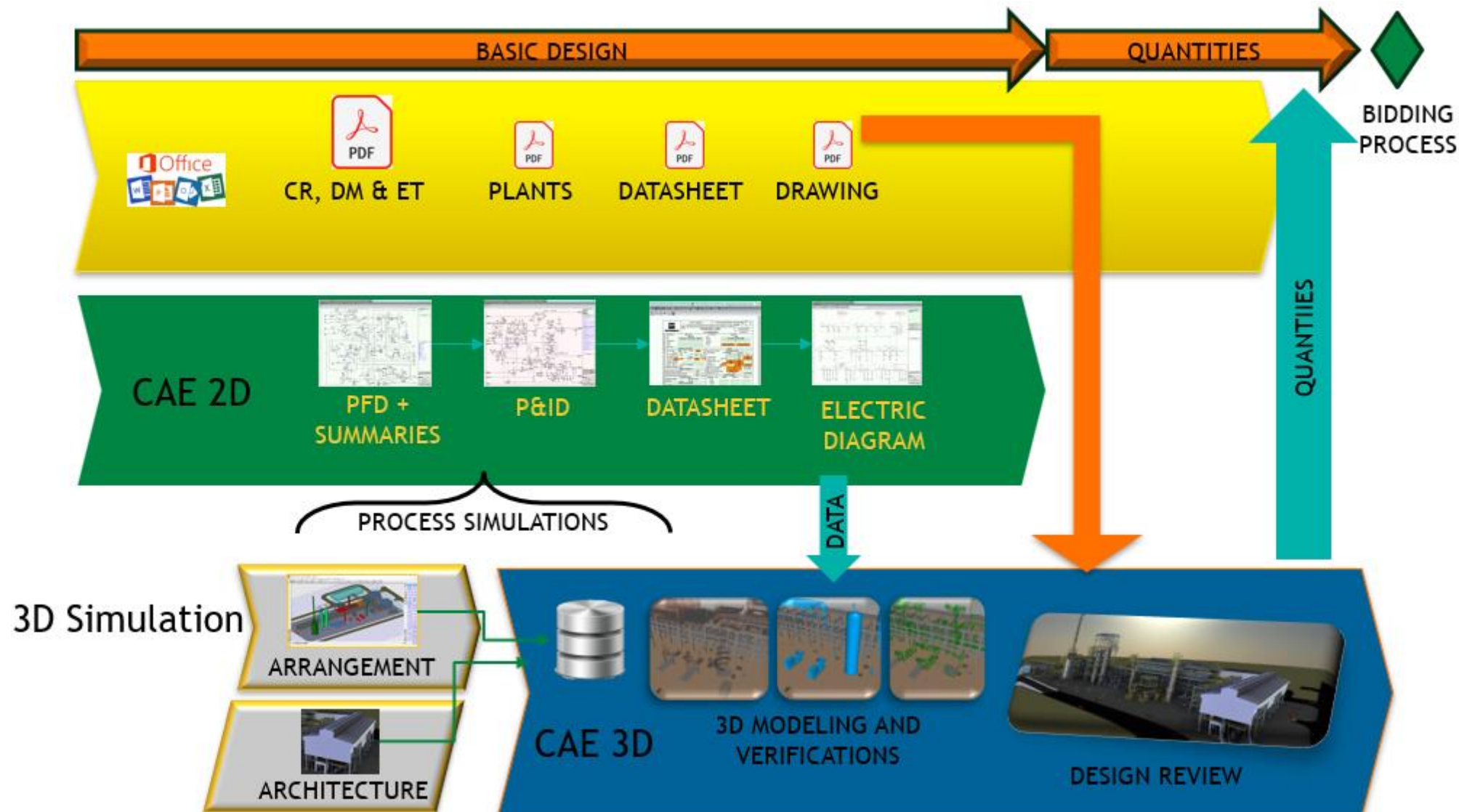


# In the Basic Design Phase

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# Overview



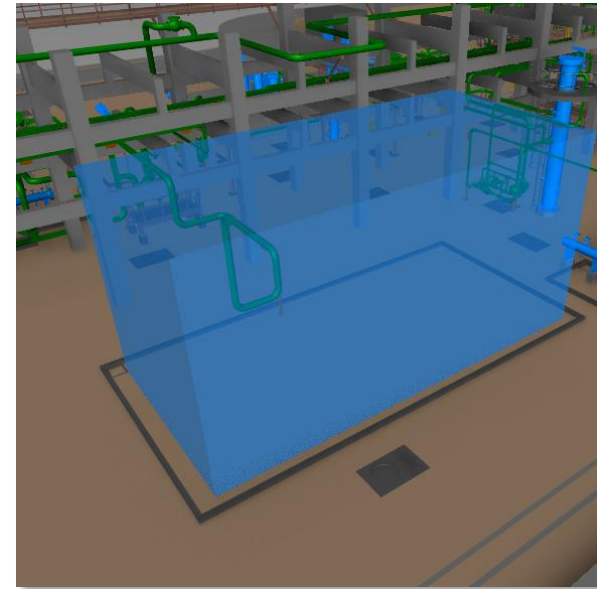
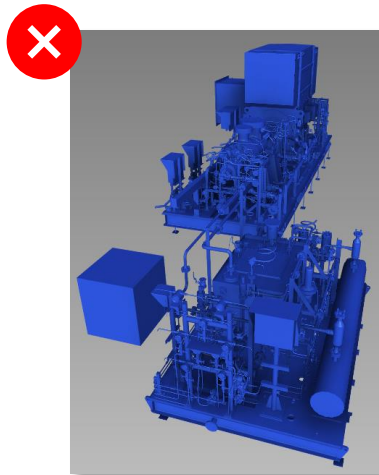
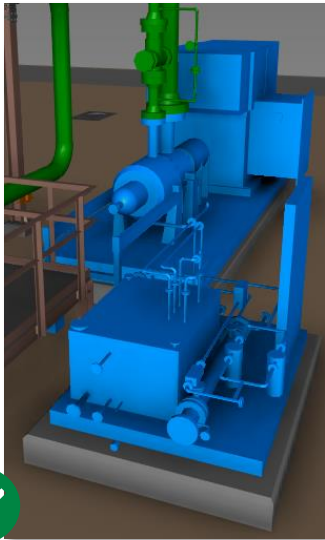
## Using the 3D Model - Challenges:

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- Respect the project maturity level - Basic vs Detailed Design
- Most projects are BrownField
  - Even for new units, there are always interconnections with existing areas
- State of existing documentation: scanned vs 2D vs 3D (PDMS, E3D)
- Multiple scopes: demolition, expansion, adaptations

## Maturity level - Basic vs Detailed Design

In basic design: there are no vendor drawings, there is no detailed package design

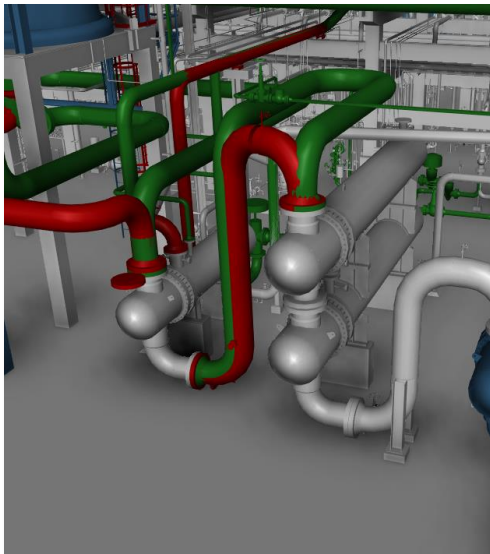


## Brownfield Projects

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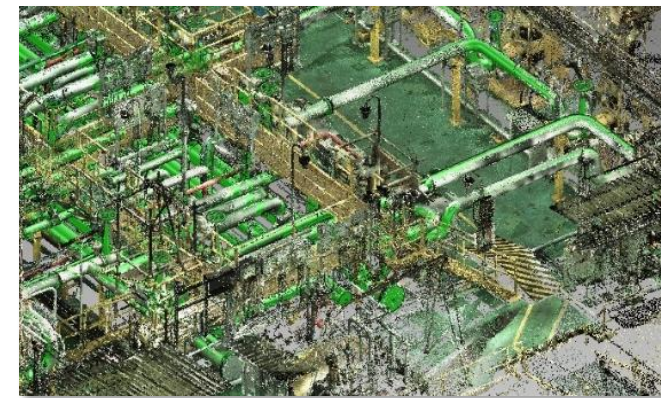
With existing 3D Model:

- Project developed in AVEVA E3D, overlaid on the existing model



Without existing 3D Model / Incomplete 3D Model:

- Project developed in AVEVA E3D, overlaid on point cloud and existing model (if available)
  - Acquisition (Scanner), processing and conversion of point cloud to E3D (AVEVA Point Cloud Manager) - contracted company



# Work Process (Brownfield)

## **TRADITIONAL (WITHOUT USING POINT CLOUD)**

Disciplines experts go to the field and visualize solution alternatives



Office work using photos as reference



Solution is indicated on existing plans and textual and descriptive documents



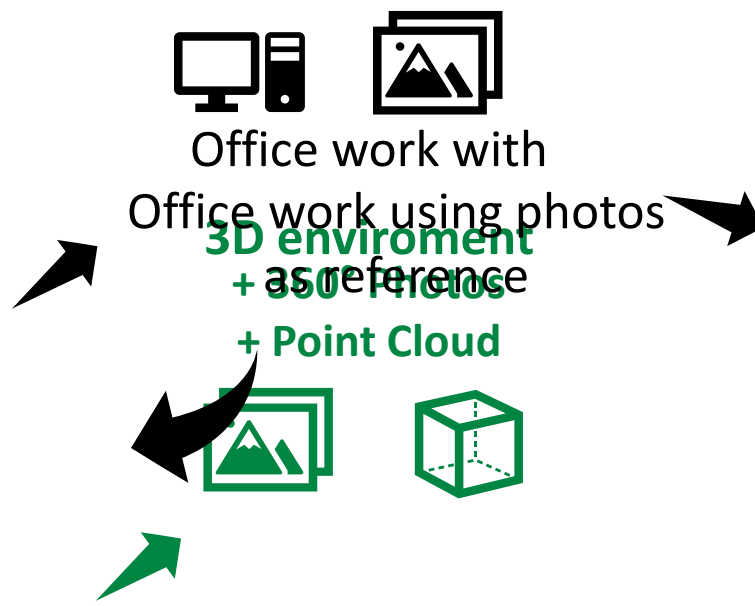
# Work Process (Brownfield)

**TRADITIONAL**  
**+ POINT CLOUDS**

Disciplines experts go to the field and visualize solution alternatives



**Laser Scanning**

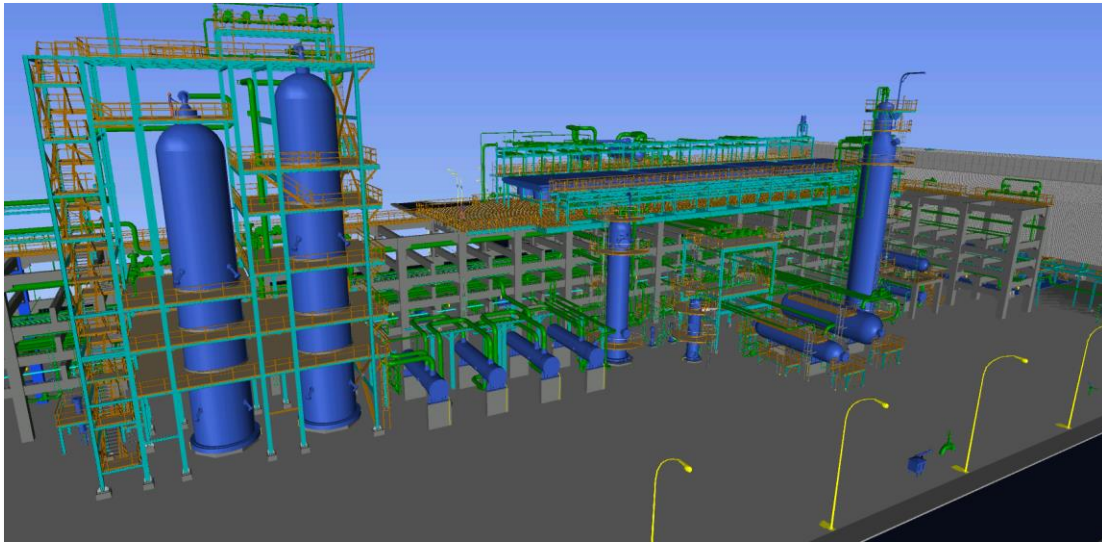


Solution is indicated in  
Solution is indicated on  
**3D Model**  
existing plans and



## Benefits from developing the project in 3D

- Consistency between disciplines



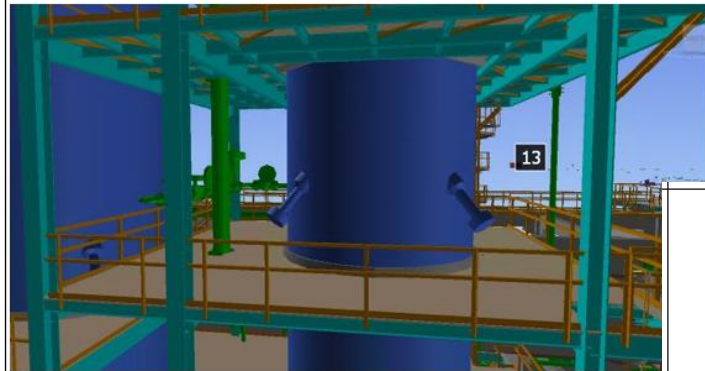
- Interference checking



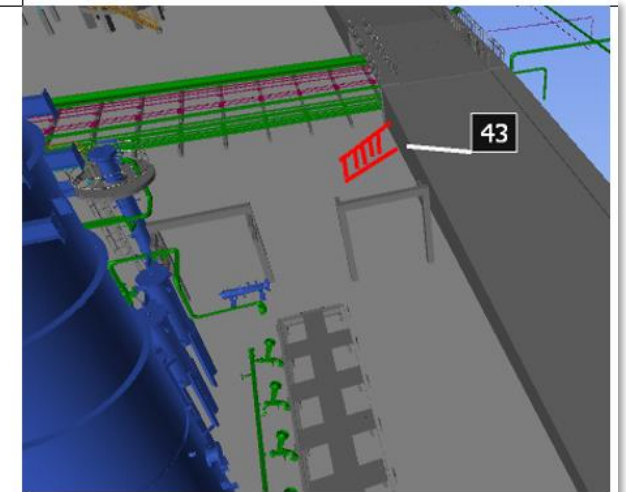
## Benefits from developing the project in 3D

- Design Review with 3D Model
- Early multidisciplinary analysis - comments on ergonomics, operation, maintenance, safety

Incorporate the minimum distance between the platform and the disposal nozzle for connecting the disposal device and the hose, for the upper beds of the reactors. Include the location of the hatch opening for the hose passage.



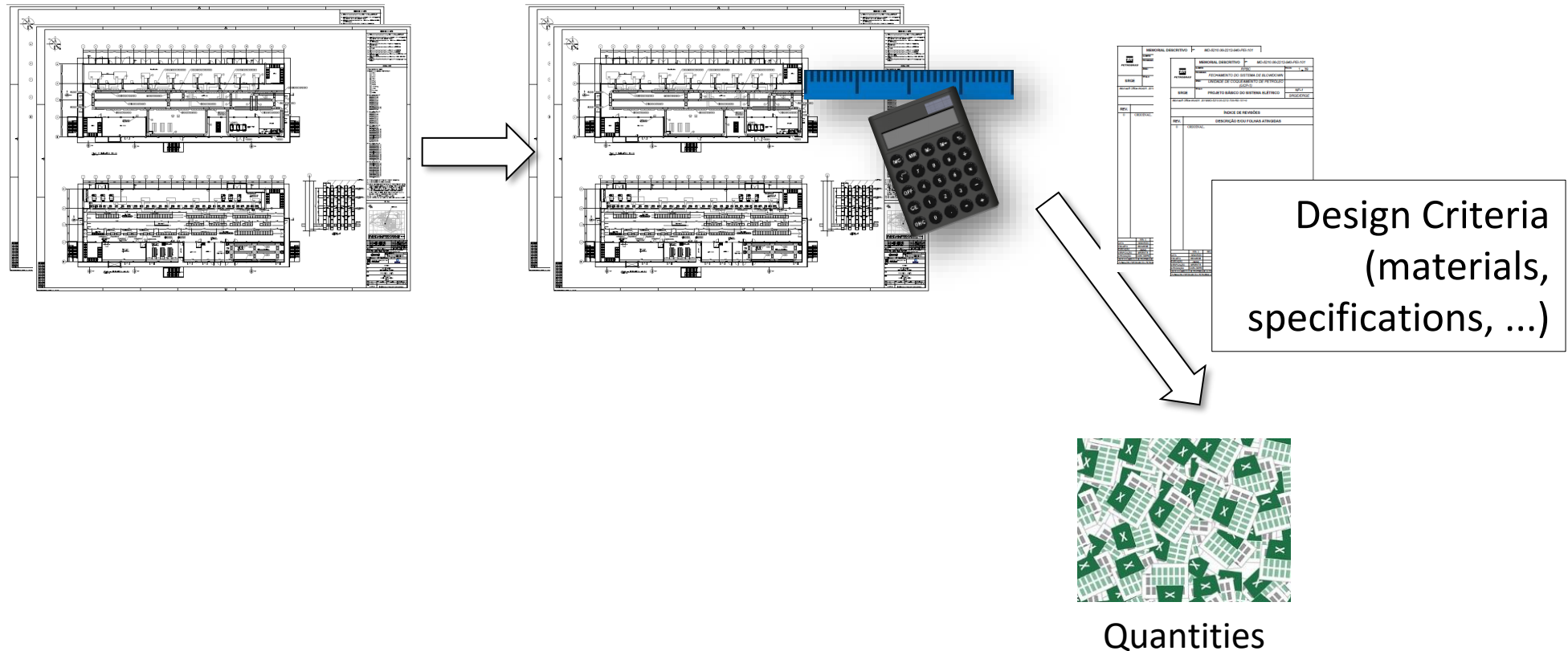
Include a stairway to the street to facilitate an escape route.





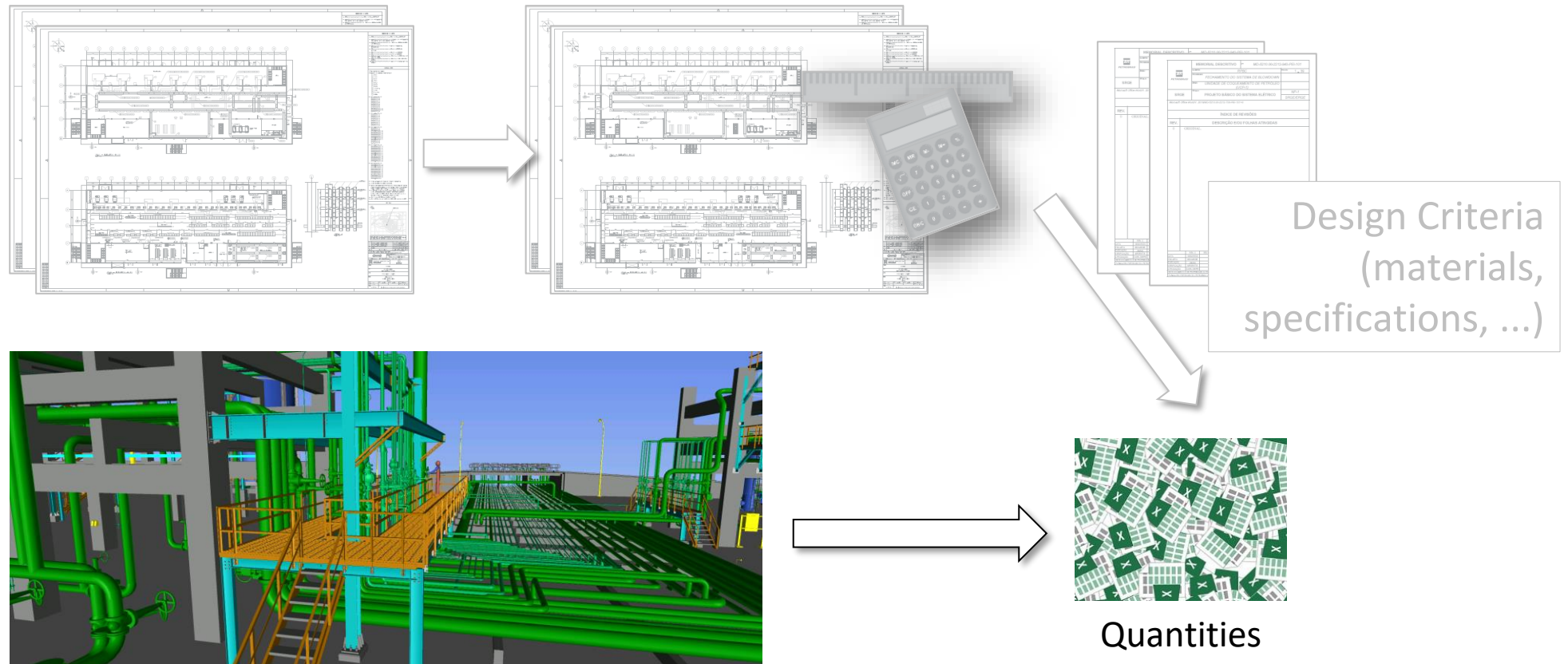
# Benefits from developing the project in 3D

- Automatic extraction of quantities for cost estimation



# Benefits from developing the project in 3D

- Automatic extraction of quantities for cost estimation
- (~ 80% hh reduction)



## Team Engagement

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- Opportunities and Developments in the Internal Startup
- Examples:
  - Configuration of customized reports to meet the cost estimation system (piping, steel structure)
  - Cable tray and electrical/instrumentation cable catalog focused on the estimation system
  - Development of templates and reference projects (substations)
  - Modeling and calculation of excavation volumes



# Modeling and calculation of excavation volumes

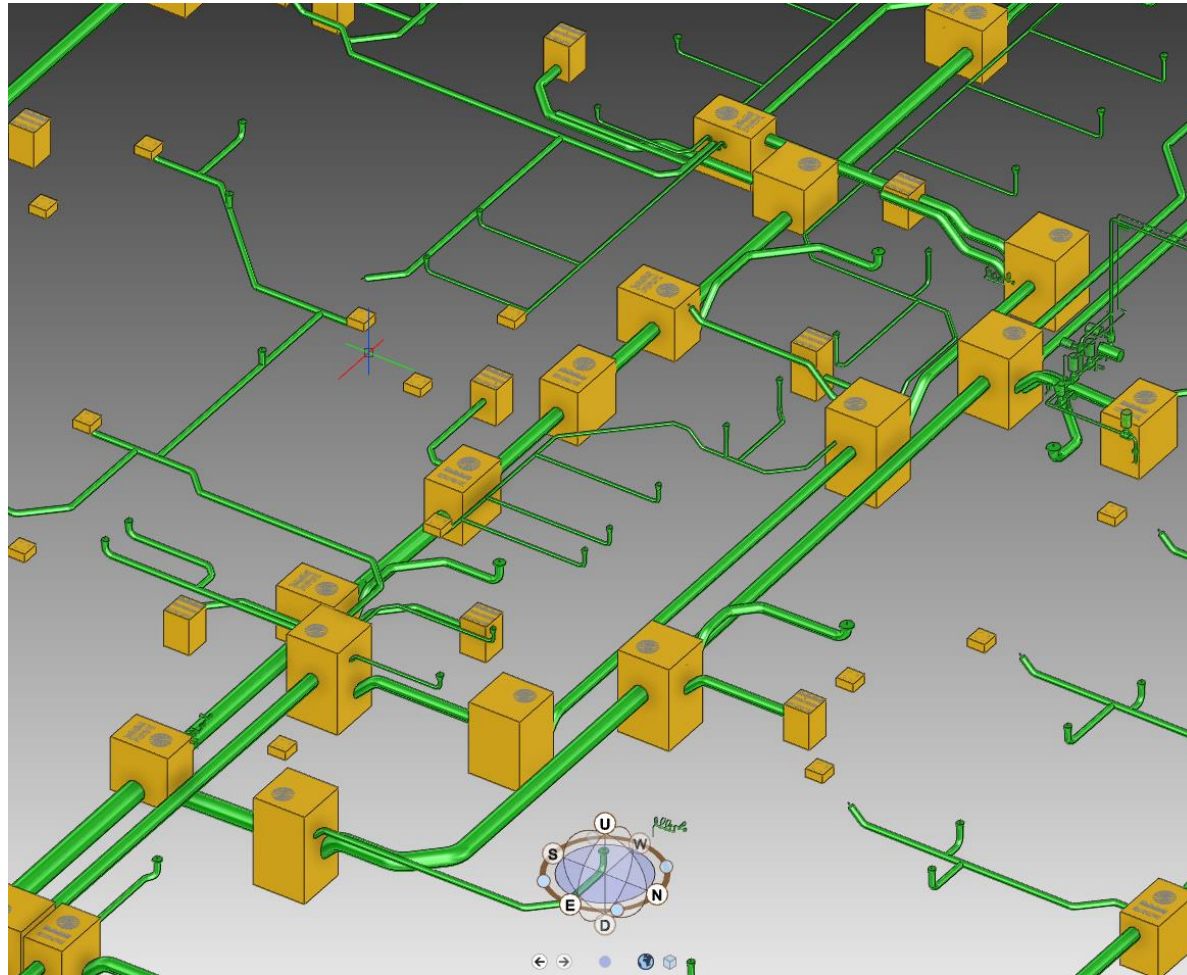
—  
USE CASES - AUTOMATION

## Excavations: foundations, boxes and buried pipelines

- Construction works generate excavations
- There are earthworks involved
- Transportation of volumes
- Disposal and purchase of backfill materials



## Example - Drainage System



### Challenge:

- Large number of elements
- Interlacing and interferences
- Spreadsheet without visuals
- Simplified formulas

# Automatic volume generation - Interactive interfaces

The screenshot displays the AVEVA E3D Design software interface. The main window shows a 3D model of a piping system with yellow rectangular excavation volumes placed around the pipes. A dialog box titled 'Gerar Volumes de Escavação (Bases e Caixas) - vTeste - v2.1' is open, allowing for the configuration of excavation rules and dimensions. The dialog includes sections for 'Regras aplicadas (norma N-1644)', 'Regras de escavação', 'Outras dimensões', and 'Lista de elementos de base'. A table at the bottom of the dialog lists the generated excavation elements with their respective volumes and dimensions.

Elem. selecionado	Tipo	Elem. gerado	Vol. de escav. (m³)	Alt. vert. (m)	Alt. incl. (m)	Status
=16604/5290	BOX	/VESC_16604/5290	11,721	1,250	0,460	OK
=16604/5727	BOX	/VESC_16604/5727	36,062	1,250	1,540	A profundidade excede o limite de 1,750 m
=16604/7382	BOX	/VESC_16604/7382	3,726	1,150	0,000	OK
=16604/6882	BOX	/VESC_16604/6882	30,474	1,250	1,355	A profundidade excede o limite de 1,750 m
=16604/6838	BOX	/VESC_16604/6838	21,849	1,250	1,005	A profundidade excede o limite de 1,750 m
=16604/5208	BOX	/VESC_16604/5208	11,492	1,250	0,440	OK
=16604/7320	BOX	/VESC_16604/7320	3,758	1,160	0,000	OK
=16604/5434	BOX	/VESC_16604/5434	31,114	1,250	1,378	A profundidade excede o limite de 1,750 m
=16604/5910	BOX	/VESC_16604/5910	3,920	1,210	0,000	OK
=16604/5085	BOX	/VESC_16604/5085	11,956	1,250	0,480	OK

Conjunto de volumes gerado: Volume total de escavação: 316,647 m³

- Interface integrated with AVEVA E3D Design
- Interactive element selection
- Adjustable configurations and rules

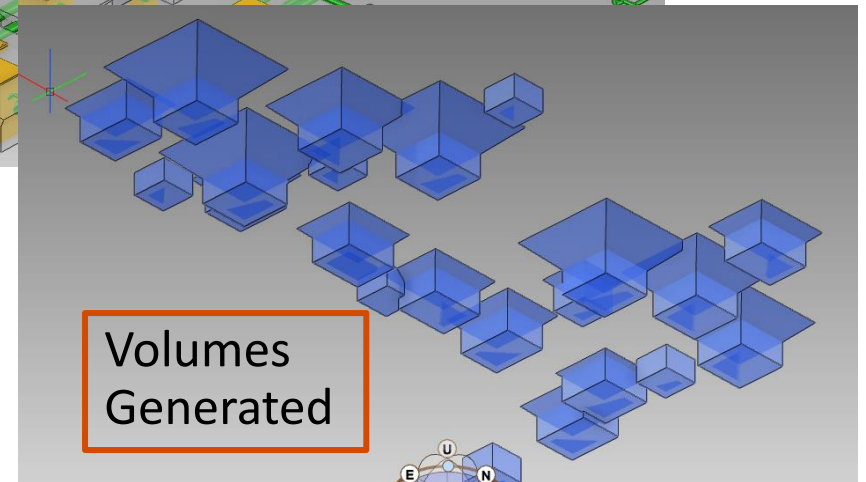
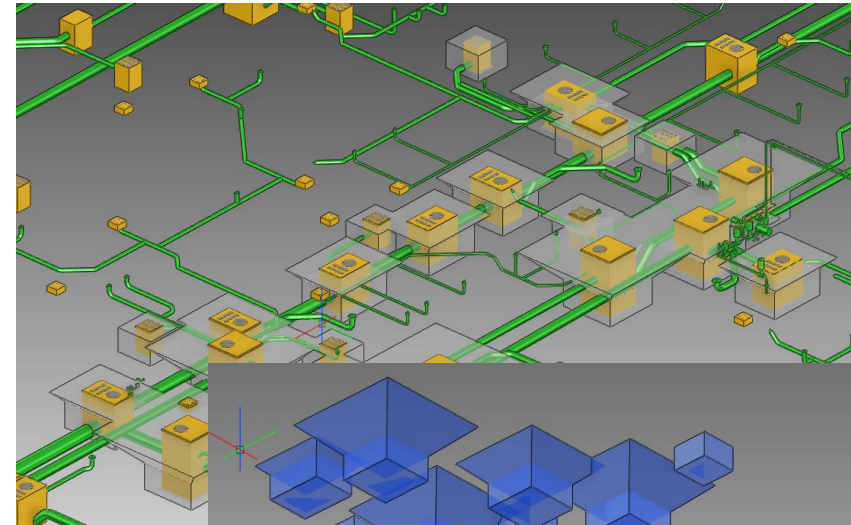
# Automatic volume generation - Drainage Boxes

## Engineering Rules

Elem. selecionado	Tipo	Elem. gerado	Vol. de escav. (m³)	Alt. vert. (m)	Alt. incl. (m)	Status
=16604/5290	BOX	/VESC_16604/5290	11,721	1,250	0,460	OK
=16604/5727	BOX	/VESC_16604/5727	36,062	1,250	1,540	A profundidade excede o limite de 1,750
=16604/7382	BOX	/VESC_16604/7382	3,726	1,150	0,000	OK
=16604/6882	BOX	/VESC_16604/6882	30,474	1,250	1,355	A profundidade excede o limite de 1,750
=16604/6838	BOX	/VESC_16604/6838	21,849	1,250	1,005	A profundidade excede o limite de 1,750
=16604/5208	BOX	/VESC_16604/5208	11,492	1,250	0,440	OK
=16604/7320	BOX	/VESC_16604/7320	3,758	1,160	0,000	OK
=16604/5434	BOX	/VESC_16604/5434	31,114	1,250	1,378	A profundidade excede o limite de 1,750
=16604/5910	BOX	/VESC_16604/5910	3,920	1,210	0,000	OK

Selected elements

Status messages



Volumes Generated



# Automatic volume generation - Piping

## Engineering Rules

Gerar volumes de escavação para tubulações enterradas - vTech 9.2.2

Regras aplicadas (norma N-1601):

Tipo de escavação:

- Solos coesivos sem escora
- Solos coesivos com escora
- Solos não coesivos
- Regras customizadas

Dimensões de escavação:

Parede incl. máx.: 0.50 m

Sobrelarg. máx.: 5.00 m

Âng. parede: 45.0 °

Inclinada:

Sobrelarg. inclin.:

Inclinação dos tubos:

Somente gerar vala para tubos com inclinação  $\alpha$  entre:

0.0 °   $\leq$    $\alpha$    $\leq$  46.0 °

Largura da vala:

D  $\leq$  0.40 m L = 0.80 m

0.40 < D  $\leq$  0.80 m L = D + 0.60 m

D > 0.80 m L = D + 0.40 m

Elemento selecionado: /10-W14-2316-0028-Ec

Gerar volumes dentro do elemento: Usar CE

Elemento de nível do terreno (floor): Usar CE

Nível do terreno em relação ao floor:

- Topo: Z = 0
- Centro: Z = -50
- Fundo: Z = -100
- Outro: Z = -50

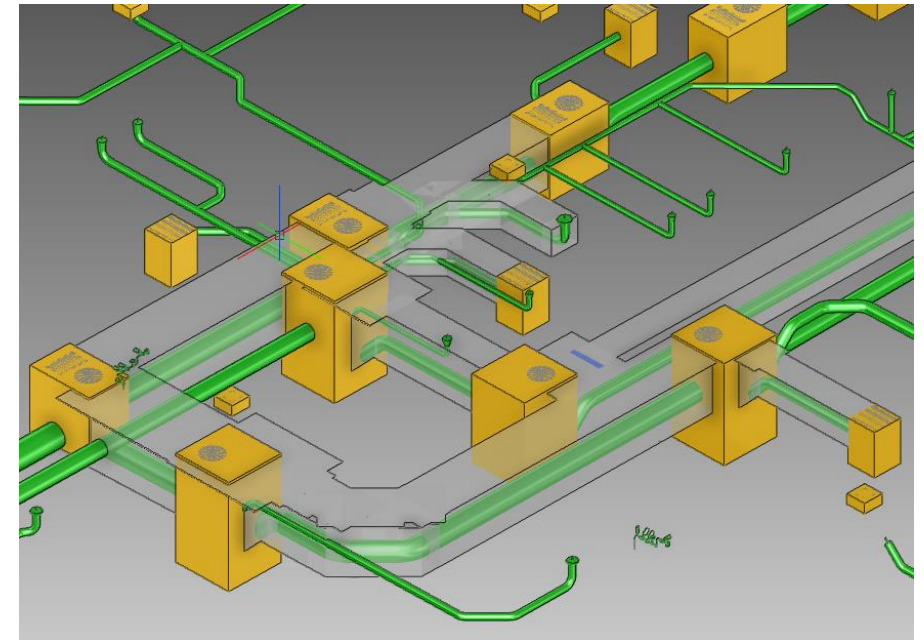
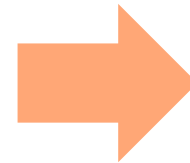
Lista de elementos de tubulação (trechos de tubo reto):

Elem. selec.	Tipo	Pertence a	Diâm.	Compr.	Inclinação	Elem. gerado	Vol. de escav. (m <sup>3</sup> )
ileave tube of = 16604/8030	TUBING	/20-W14-2316-0010-Ec/B1	0,508	8,428	-0,3°	/VESC_TUBI_16604/8030	13,317
= 16604/8031	ELBOW	/20-W14-2316-0010-Ec/B1	0,500	0,635	-0,3°	/VESC_ELBO_16604/8031	1,238
ileave tube of = 16604/8031	TUBING	/20-W14-2316-0010-Ec/B1	0,508	0,971	-0,3°	/VESC_TUBI_16604/8031	1,614
= 16604/8032	ELBOW	/20-W14-2316-0010-Ec/B1	0,500	0,635	-0,3°	/VESC_ELBO_16604/8032	1,252
ileave tube of = 16604/8032	TUBING	/20-W14-2316-0010-Ec/B1	0,508	1,230	-0,3°	/VESC_TUBI_16604/8032	2,053
= 16604/8033	ELBOW	/20-W14-2316-0010-Ec/B1	0,500	0,635	-45,3°	/VESC_ELBO_16604/8033	1,565
ileave tube of = 16604/8033	TUBING	/20-W14-2316-0010-Ec/B1	0,508	1,031	-45,3°	/VESC_TUBI_16604/8033	4,592

Conjunto de volumes gerado: Volume total de escavação: 88,109 m<sup>3</sup>

Gerar Volumes

## Selected elements



## Volumes Generated

# Interference handling - Backfill volume

Selected Volumes

Selected Interferences

Gerar Volumes de Reaterro - vTeste - v2.2

Elemento selecionado: /VOLUMES\_GERADOS

Usar este grupo de volumes de escavação: /VOL\_ESCAV\_VOLUMES\_GERADOS\_04

Gerar volumes dentro do elemento: /VOLUMES\_GERADOS

Grupos de interferências (subtrair volumes):

Elem. selecionado	Tipo	Status
/U(25144)-C9-CAIXA-DRENAGEM-PLUVIAL	ZONE	
/U(25144)-C9-CAIXA-DRENAGEM-OLEOSA	ZONE	
/U(02316)-CCL18-CAIXA-DRENAGEM-OLEOSA	ZONE	
/U(02316)-CCL18-CAIXA-DRENAGEM-PLUVIAL	ZONE	
/U(02316)-CCL18-CAIXA-ESGOTO-SANITARIO	ZONE	
/U(02316)-HDS-CAIXA-DRENAGEM-CONTAMINADA	ZONE	OK - 30 interferências
/U(02316)-HDS-CAIXA-DRENAGEM-OLEOSA	ZONE	OK - 27 interferências
/U(02316)-HDS-CAIXA-DRENAGEM-PLUVIAL	ZONE	
/U(02316)-HDS_NC-LIMPEZA_E-DRENAGEM	ZONE	OK - 99 interferências

Volumes Gerados:

Elem. gerado	Interf.	Escav. (m³)	Reaterro (m³)	Conc. s/ interf. (m³)	Conc. c/ interf. (m³)	Areia s/ interf. (m³)	Areia c/ interf. (m³)
/VREA_16604/5290	6	11,721	7,376	0,140	0,137	0,000	0,000
/VREA_16604/5727	8	36,062	28,598	0,162	0,162	0,000	0,000
/VREA_16604/7382	4	3,726	2,966	0,050	0,050	0,000	0,000
/VREA_16604/6882	30	30,474	20,831	0,162	0,162	0,000	0,000
/VREA_16604/6838	6	21,849	15,956	0,162	0,162	0,000	0,000
/VREA_16604/5208	17	11,492	6,810	0,140	0,139	0,000	0,000
/VREA_16604/7320	5	3,758	2,976	0,050	0,050	0,000	0,000

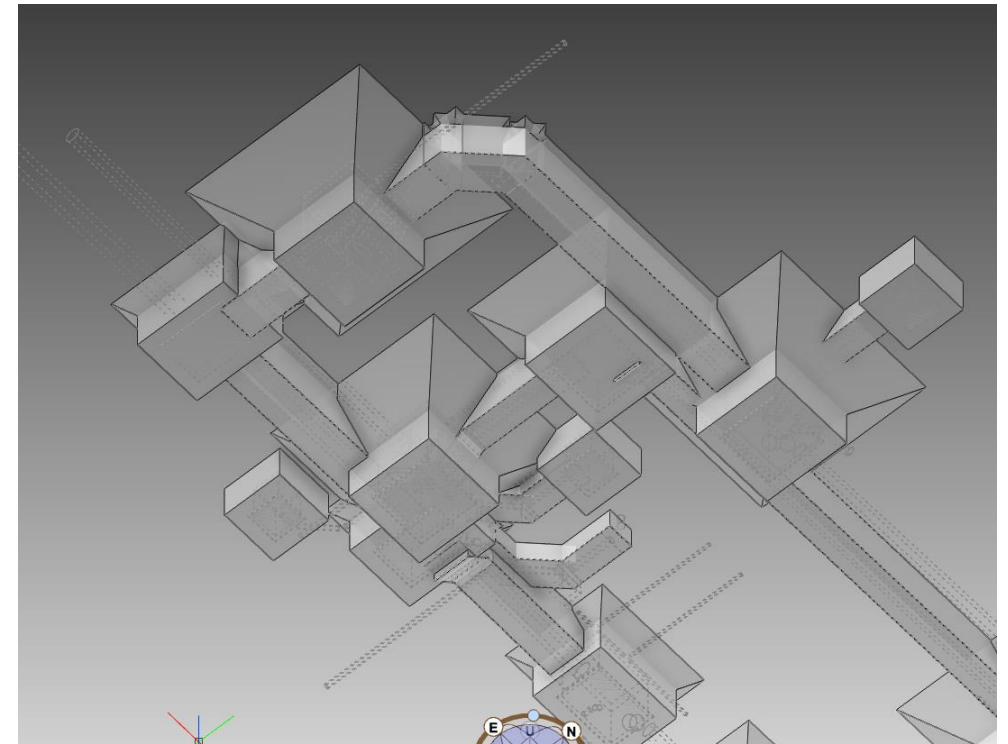
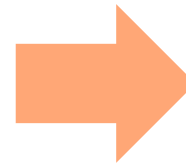
Conjunto de volumes gerado:

Volume total de escavação: 316,65 m³  
Volume total de reaterro: 228,344 m³

Concreto magro sem interf.: 2,626 m³  
Concreto magro com interf.: 2,622 m³  
Volume de areia sem interf.: 0,000 m³  
Volume de areia com interf.: 0,000 m³

Gerar Volumes

Backfill volumes generated



Volumes Generated

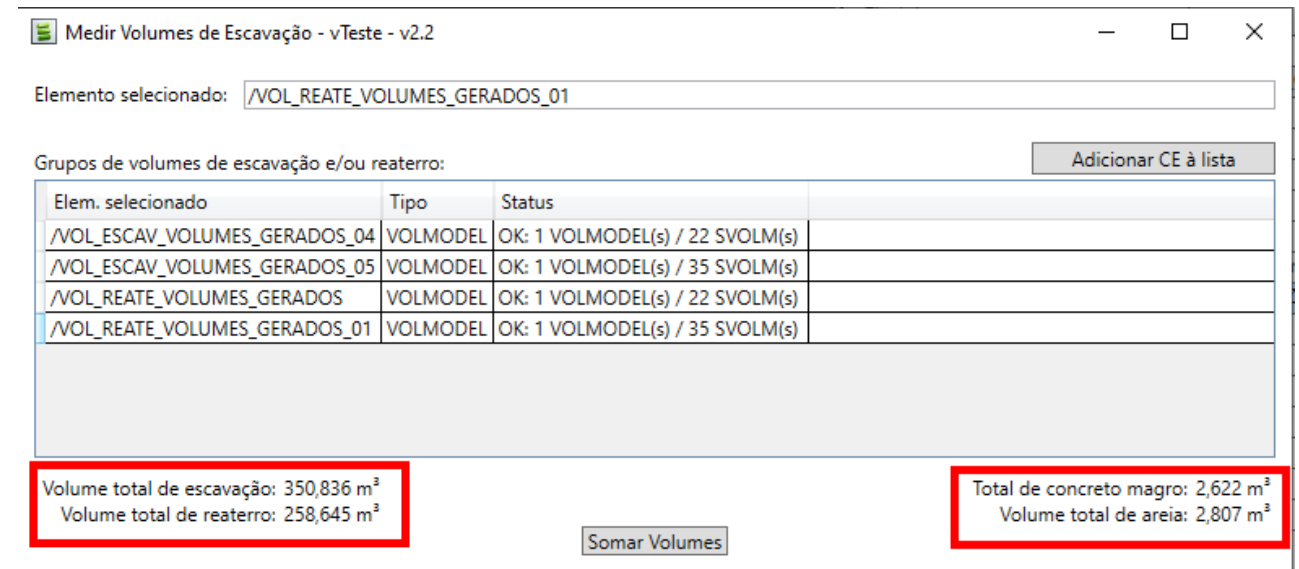
## Total volumes sum

### Various types:

- Excavation volumes
- Backfill
- Sand and concrete

### Advantages:

- Instant calculation
- Handles intersections
- Gain in precision and productivity



Medir Volumes de Escavação - vTeste - v2.2

Elemento selecionado: /VOL\_REATE\_VOLUMES\_GERADOS\_01

Grupos de volumes de escavação e/ou reaterro: Adicionar CE à lista

Elem. selecionado	Tipo	Status
/VOL_ESCAV_VOLUMES_GERADOS_04	VOLMODEL	OK: 1 VOLMODEL(s) / 22 SVOLM(s)
/VOL_ESCAV_VOLUMES_GERADOS_05	VOLMODEL	OK: 1 VOLMODEL(s) / 35 SVOLM(s)
/VOL_REATE_VOLUMES_GERADOS	VOLMODEL	OK: 1 VOLMODEL(s) / 22 SVOLM(s)
/VOL_REATE_VOLUMES_GERADOS_01	VOLMODEL	OK: 1 VOLMODEL(s) / 35 SVOLM(s)

Volume total de escavação: 350,836 m<sup>3</sup>  
Volume total de reaterro: 258,645 m<sup>3</sup>

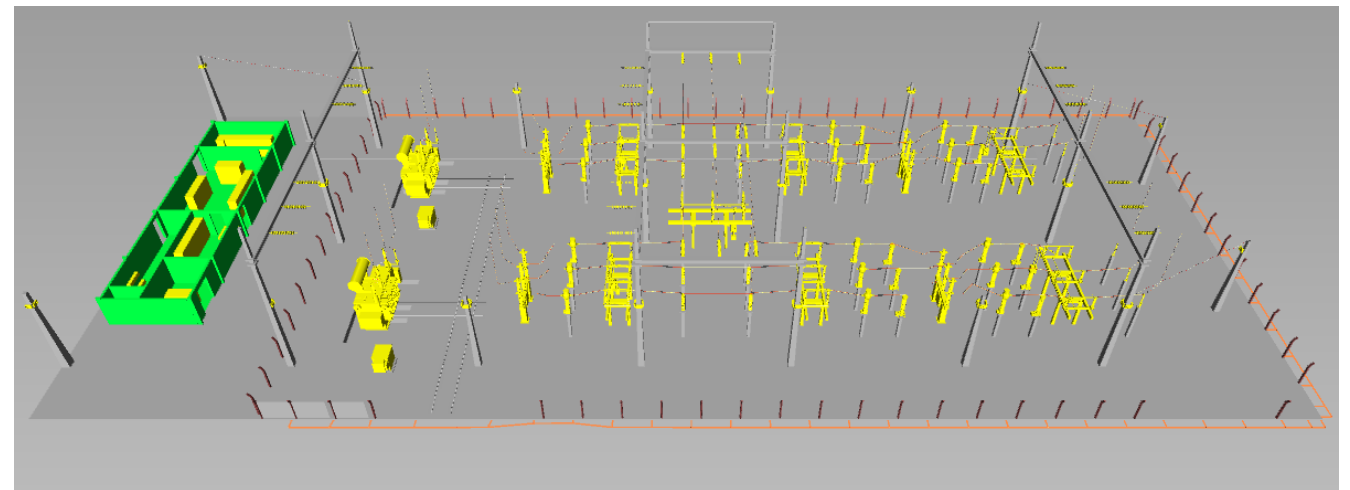
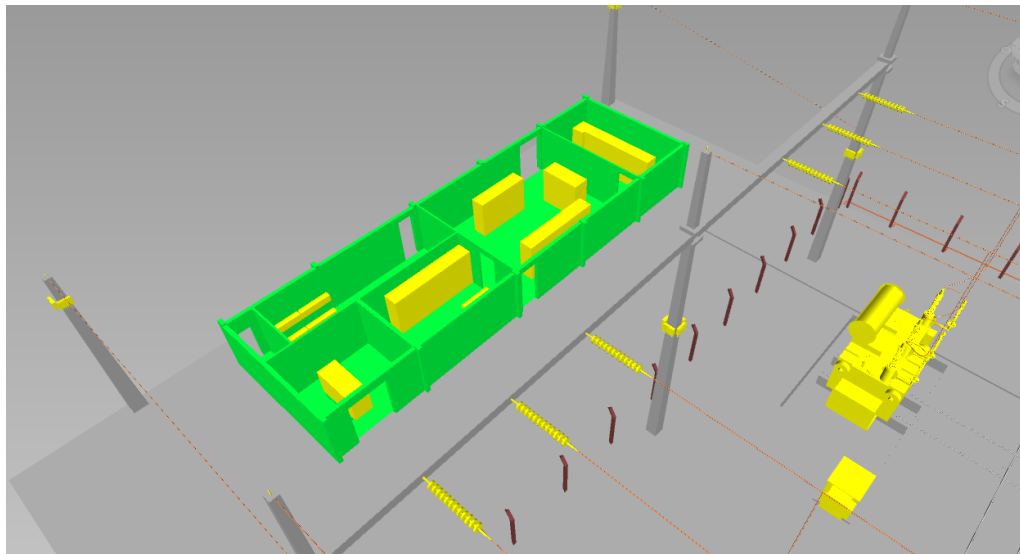
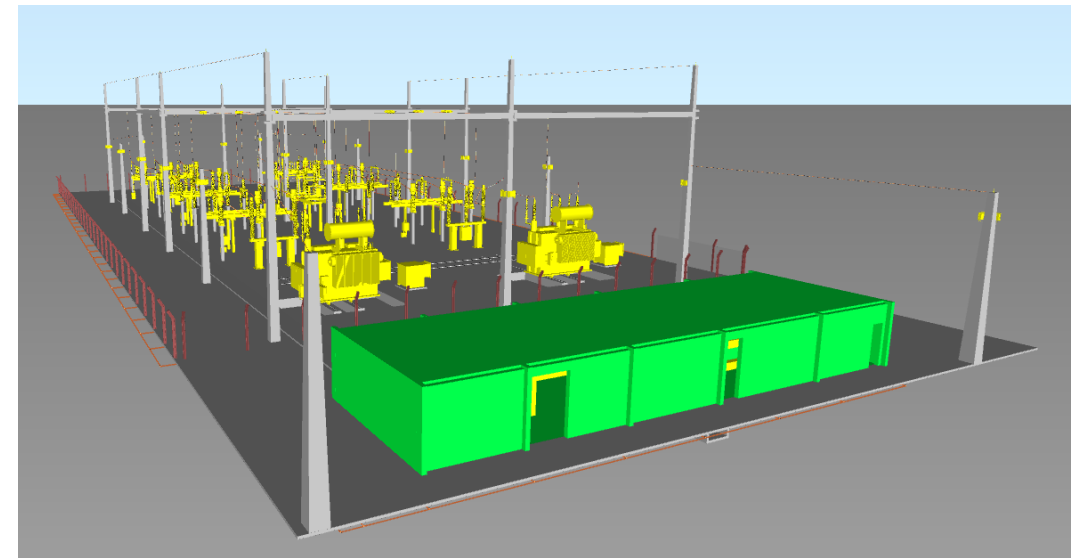
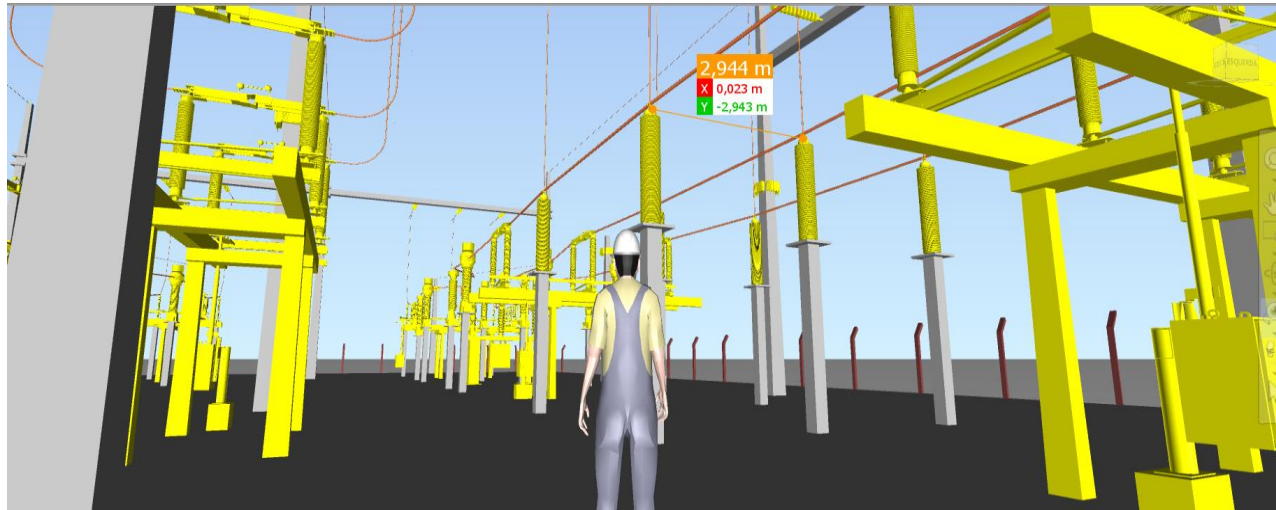
Somar Volumes

Total de concreto magro: 2,622 m<sup>3</sup>  
Volume total de areia: 2,807 m<sup>3</sup>

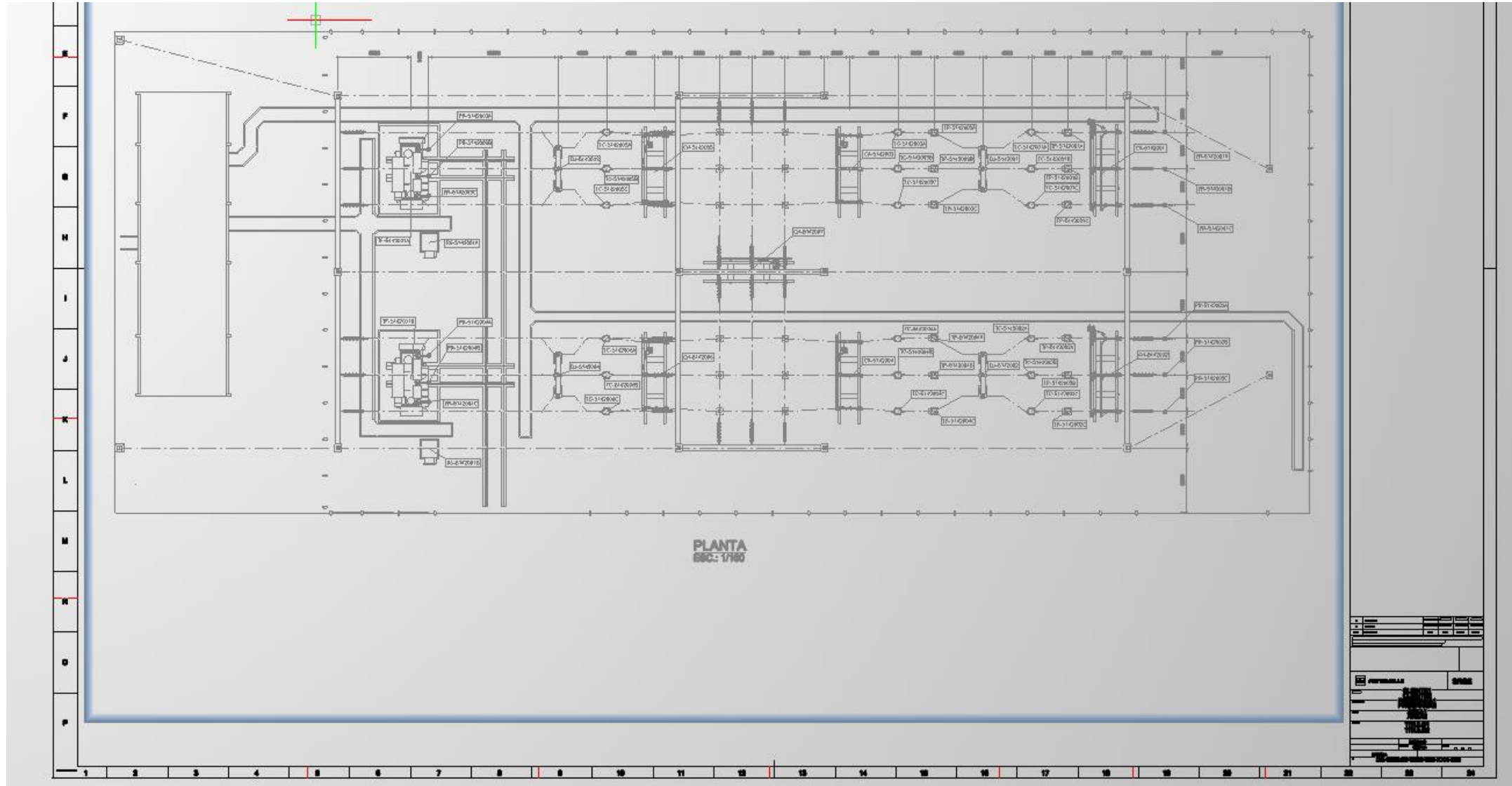
# Development of templates and reference projects (substations)

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USE CASES - Reference projects

# Final Model

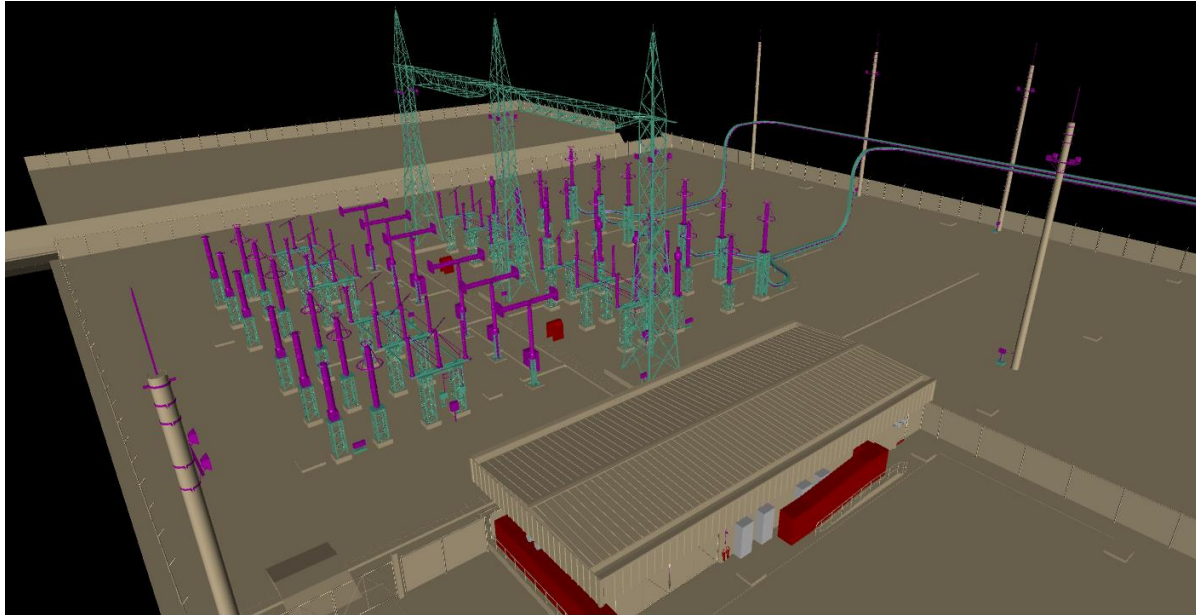


# Plants extracted from the 3D reference models

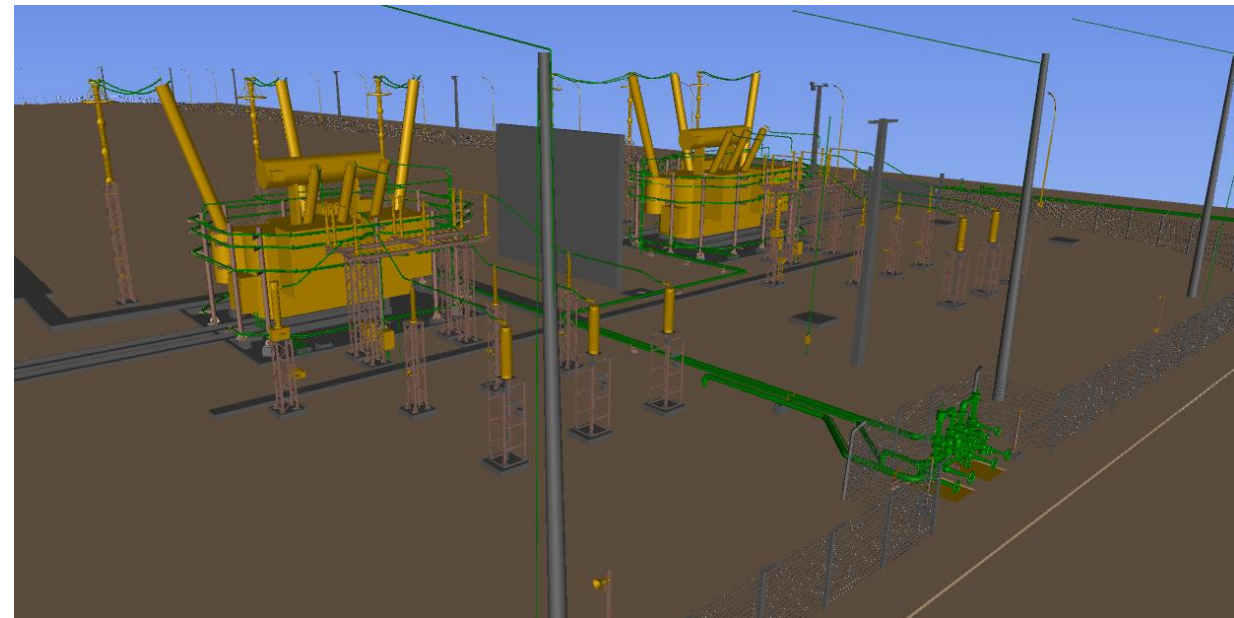


# Other Models

SE 345 kV



SE 440 kV



# Other uses of the 3D model during Basic Design

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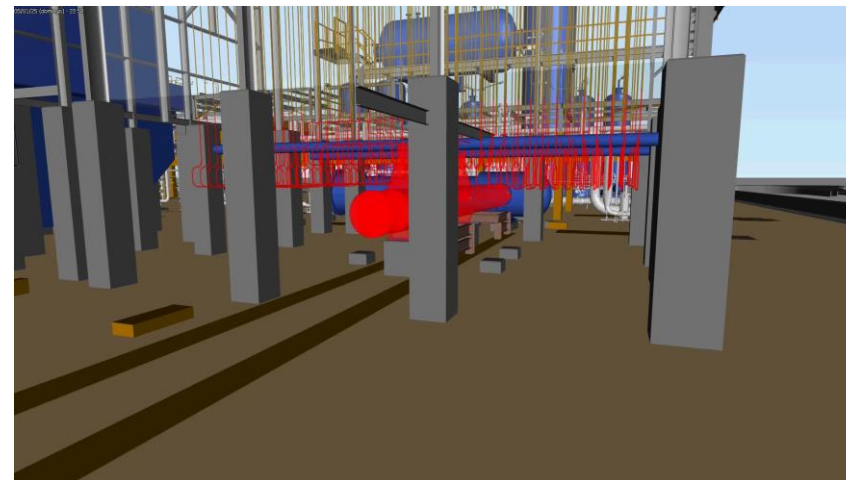


## Other uses of the 3D model during Basic Design

- Validation of preliminary planning - 4D



- Simulation of critical activities - to confirm feasibility





# Bidding Phase

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## What are the expected gains from providing the 3D Model during the bidding process?

- Clarity on the project scope (Contractual documentation set vs 3D Model)
- Reduce time for quantity take-offs - part of the quantities can be extracted from the 3D model

Important to remember: the basic design 3D does not cover the entire scope

- Reduce uncertainties - less price variation and risk of losing the bidding process

INFEASIBILITY

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MAXIMUM PRICE

# Detailed Design Phase

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## Use of Basic Design 3D Model in Detailed Design

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- Part of an initial model is contracted - anticipation of detailed design activities in 3D model
- Simulations are possible from day one
- Supervision team arrives with knowledge and familiarity with the project.
- A lower level of rework is expected - anticipation of various comments in the Basic Design Review

# Results

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# Petrobras: Achieving Efficiency Gains through 3D Modeling from Basic to Execution

## Challenge

- Respect the project maturity level - Basic vs Detailed Design
- Most projects are BrownField, even for new units, there are always interconnections with existing areas
- State of existing documentation: scanned vs 2D vs 3D (PDMS, E3D)
- Multiple scopes: demolition, expansion, adaptations

## Solution

- Develop data-centric projects from the early design phases and consolidate the use of the 3D Model from the Basic Design stage, acting as a discipline integrator and in conjunction with laser scanning and point cloud technology.

## Results

- **Reduced effort for quantity take-offs (~ 80% reduction)**
- **Early analysis (operation, maintenance, planning, constructability)**
- **Greater clarity on project scope during Bidding**
- **Accelerated start of Detailed Design**





# Next Steps

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## Next Steps

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- Develop more integrations between Specialized Tools and Project Databases
  - Testing with AVEVA Engineering
- Expand extraction of documentation and quantities directly from project databases

### In the future...

- Replace 2D basic design documents (plans, sections and views) with the 3D model itself
- Better interoperability for integration between AVEVA E3D and BIM Models



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