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Waste to Energy

December 2019

WTE Portfolio

Together with our partner TegCO:

International Engineering and Technology Company focused on tailor-made solutions for the production of energy from industrial and household waste.

Competence Centre for innovative project solutions in the field of decentralized energy production.

Engineering, EPC and system integrated solutions for Combined Heat and Power (CHP) and Waste Incineration Plants (WtE).

Technical Basis: Patented Combustion Technologies (SFA)

individual planning - financing concept - manufacturing for industrial and public customers

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MEGATREND TOWARDS SMALLER PLANTS.

Decentralized energy supply and related plant size as the success factor.

FOCUS: Customer requirements in terms of plant size and type of fuel.

FINANCING: Development of valid financing concepts in co-operation with long-term investment partners.

IMPLEMENTATION: Expertise and Experience in professional project planning and management, use of patented technology solutions and one-stop construction of plants .

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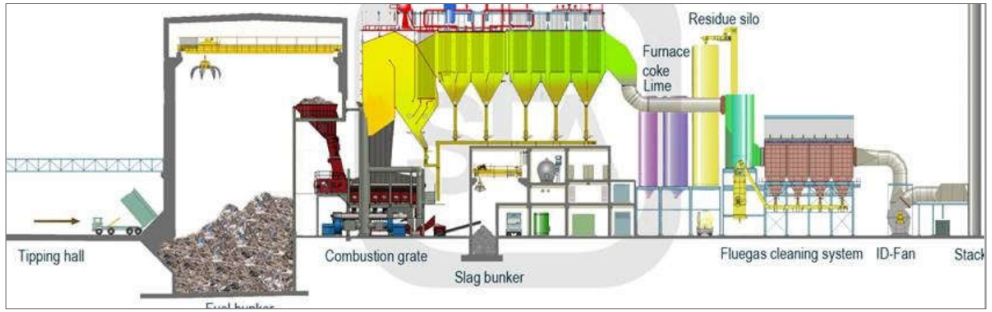
PROJECT DEVELOPMENT

- PERMITS
- CONTRACTS
- PRE-ENGINEERING
- PROJECT FINANCE

PROJECT EXECUTION



- BASIC ENGINEERING
  - FIRING/BOILER
  - BALANCE OF PLANT
- DETAILLED ENGINEERING
  - FIRING/BOILER
  - BALANCE OF PLANT
- MANUFACTURING
- PROCUREMENT
- ERECTION & INSTALLATION

PLANT OPERATION

- TRIAL OPERATION OPERATION /
- MONITORING
- SERVICE &
- MAINTENANCE

ONE-STOP PROJECT REALISATION

FINANCIAL CLOSE

COMMISSIONING/HAND OVER

2 YEARS WARRANTY

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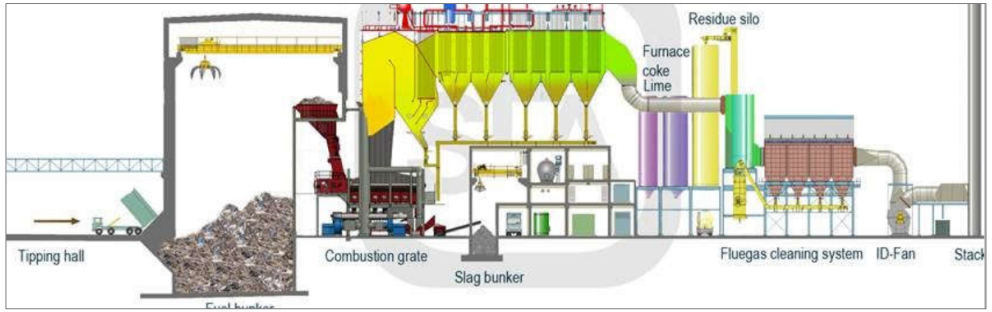

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PLANT OPERATION

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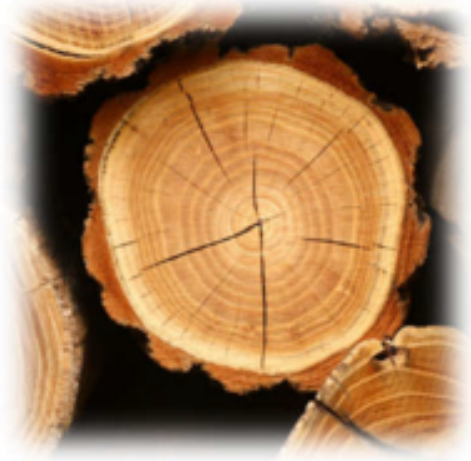
PERFORMANCE RANGE - Type of Fuel



BIOMASS (CONTAMINATED)
Waste wood (contaminated)
A III / A IV

SLUDGE
Municipal sewage sludge
Paper + de-inking sludge

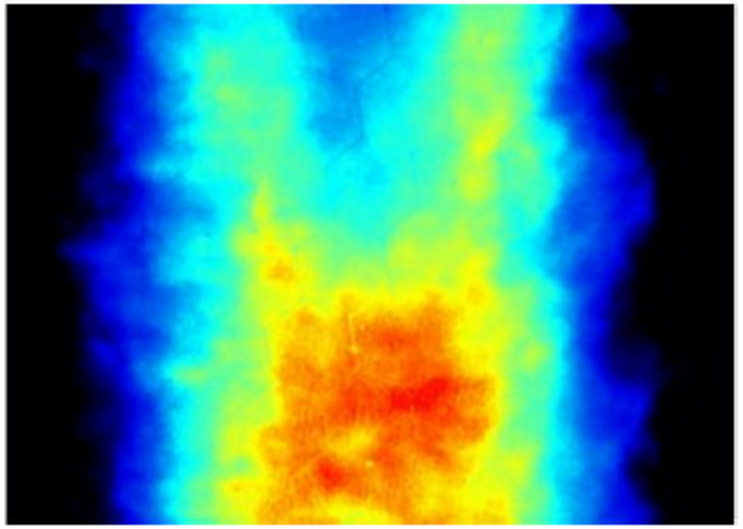
WASTE, RDF, SRF
Rejects
Foils and plastics
Fibre and particle board waste
Municipal waste
Commercial & Industrial waste

PERFORMANCE RANGE - Characteristics of Fuel

CALORIFIC VALUE

6 – 24 MJ/kg

PARTICLE SIZE OF FUEL



max 500 / 800 mm (untreated)
max 1.000 mm (10%)

PERFORMANCE RANGE - Capacity

5 – 100 MWth I 10 – 120 t/h steam I 3 – 35 MWe



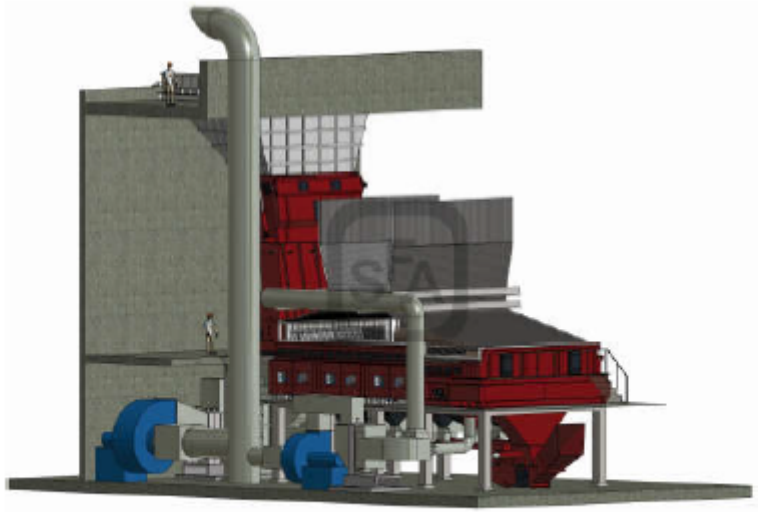






TECHNICAL DETAILS - Combustion system

SFA water-cooled combustion grate



Tailor-made solutions up to 150 MWth
For all fuels with high CV (7-24 MJ/kg)

- municipal and household waste
- RDF, chemical and industrial waste
- low OPEX costs due to high durability of grate
- bars – 32.000hrs (replacement <10%)

SFA air-cooled combustion grate

Tailor-made solutions up to 100 MWth
For all fuels with low CV (6-12 MJ/kg)

- waste-wood, contaminated
- waste with low calorific value
- durability of grate bars – max. 12.000hrs (replacement < 10%)

Modularised design concept of the boilers and grates enables tailor-made solutions and assures the high efficiency and quality of our plants

High grade of standardisation and modularisation:

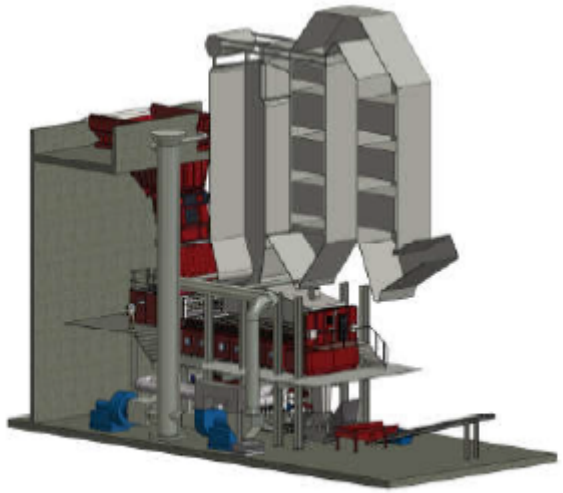
- natural circulation
- fulfilment of IED-Directive for the combustion of waste
- membrane wall evaporator of 3 path design
- economiser / air pre-heater in steel sheet casing
- air- or water-cooled grate
- fuel feed with “pusher”
- start-up and auxiliary burners

TECHNICAL DETAILS - Combustion system

SFA-GRATE TYP	TYPE S	TYPE M	TYPE L
Modularised grate widths*	3,0 m	6,0 m	9,0 m
*) Modular concept, expandable to 30cm each, depending on the type of fuel and steam capacity			
Standardised grate depth	9,3 m	12,3 m *	12,3 m*
*) with burn-out grate			

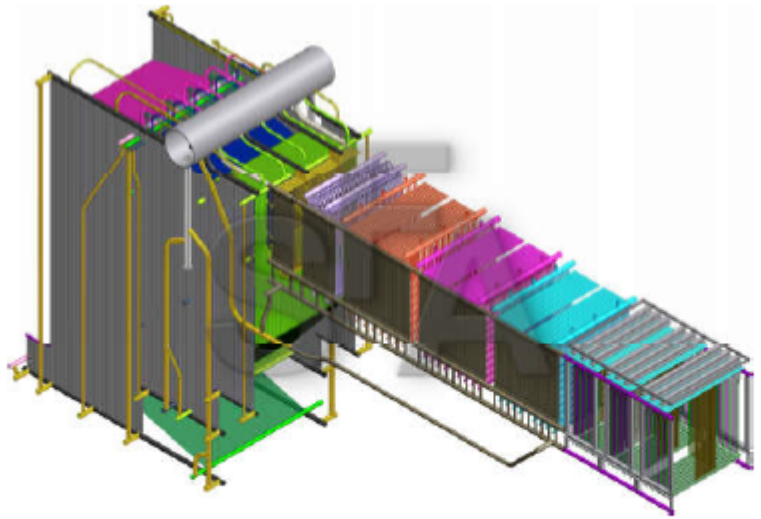
TECHNICAL DETAILS – Steam Boilers

Vertical Boiler Design



- cost-effective, space-saving alternative
- height about 30 m necessary
- stop for boiler-cleaning after 6-8 months
  after 4.000 – 6.000 hrs

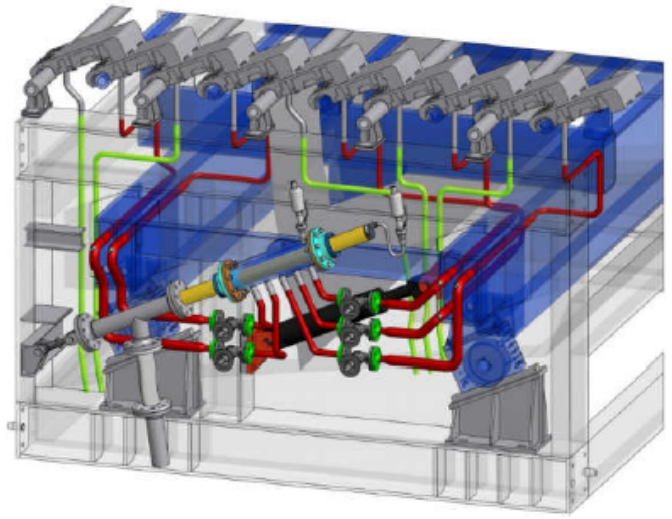
Horizontal Boiler Design



- „Tail-end“ with top-supported horizontal pass
- cleaning of the horizontal pass with rappers
- only 1 yearly maintenance stop for cleaning
  after 8.000 - 8.400 hrs

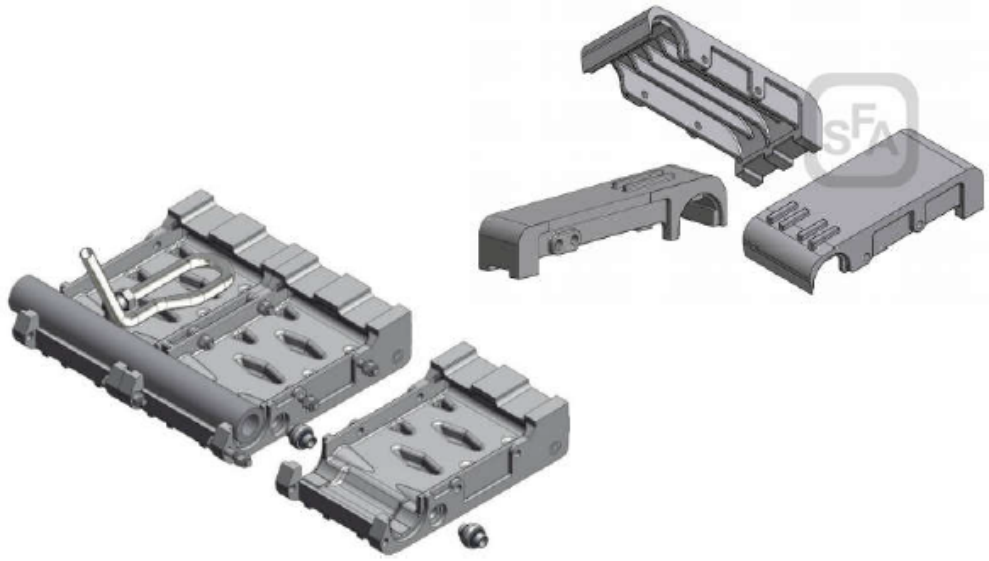
TECHNICAL DETAILS – SFA Patents

Vertical Boiler Design



Patented motion compensator for the cooling water circuit

Horizontal Boiler Design



Patented water-cooled grate plate and patented connection system for the water-cooled grate plates.
Patented air-cooled grate plate with air outlet opening with integrated cleaning scrappers

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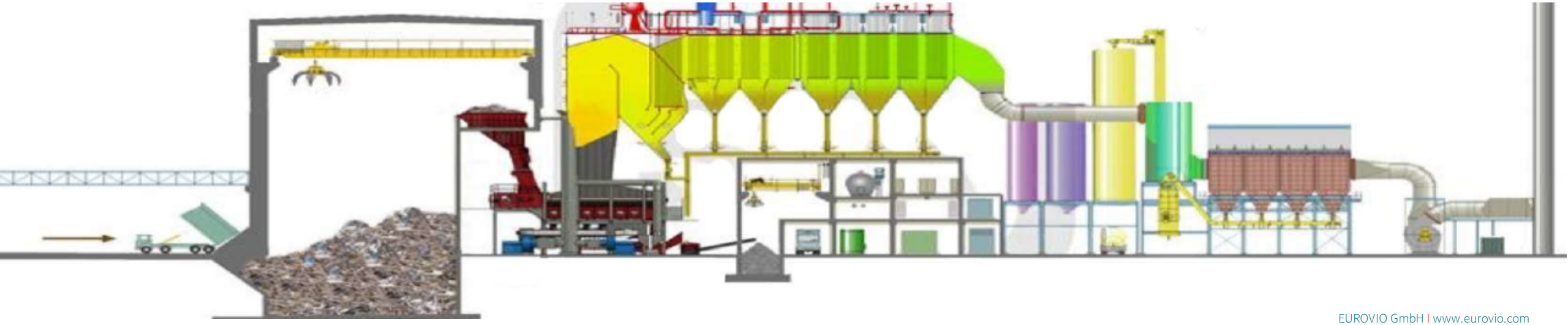
FROM WASTE TO ENERGY

INDIVIDUAL PLANNING - FINANCING CONCEPT - MANUFACTURING FOR INDUSTRIAL AND PUBLIC CUSTOMERS



Main SFA References

Rostock Vattenfall Europe
Plant Output: 87 MWth,
Steam Data: 65/42 bar, 405 degC
Power 20 MWe + Heat 25 M

Fuel: RDF, Municipal and Industrial Waste (rough presorted)
Fuel amount: 180.000 t/a (max.230.000 t/a)
Calorific value (LHV): 11 – 18 MJ/kg
Fuel size: 90%<500 mm, 10%<800 mm
Availability: > 8.000h
Grate Dimension: 9 m x 12,6 m

Main SFA References

BIB for APCON / Thai - 2016
Bangkok Industrial Boiler
45 MWth, (42 bar, 420°C)
grate combustion-system for RDF,
Municipal + Industrial Waste

Mainova Fechenheim / D - 2006
44 MWth (66 bar, 450°C)
waste wood, RDF

Main SFA References

RWE Berlin Neukölln / D - 2006
2 x 53 MWth (60/80 bar, 450°C)
waste wood, RDF

Meidensha / Thailand - 2007
50 MWth (45/66 bar, 420°C)
biomass (palm stalk)
ASME test-procedure

Exemplary Reference Case - Specifications

ROJECT PRESENTATION

2 x 10 MWel CHP READY !

WASTE-TO-ENERGY POWER PLANT,

Energy from Waste - A Solution for the Future

- Treatment of waste from households and industry is one of the main issues all over the world.
- Even with modern waste collection, re-use and recycling systems, one will end up with a fraction of mixed residual waste, which needs to be treated in a sustainable way.
- The most realistic process from a business perspective in view of the regulatory environment, Waste-to-Energy (WtE) plants are the preferred option.
- These types of Waste-to-Energy plants involve the generation of electricity and the possibility to supply heat or steam (Co-Generation of both electricity and steam)
- Incineration of municipal and industrial solid waste avoids the release of methane. Every ton of waste incinerated, prevents about one ton of carbon dioxide equivalents from being released to the atmosphere.
- Volume of combusted waste is reduced by more than 90%, increasing the lifetime of existing landfills.

CUSTOMER:
SPV – UK

Location:
UK

PROJECT
WtE – CHP-Ready
RDF Power Plant

General concept:

- Plant configuration concept: > 1 + 1 per Unit (1 boilers + 1 turbine)
- Fuel: > RDF (Low-grade), Municipal and Industrial Waste
- Air- water-cooled grate-fired boiler
- Advanced Flue gas cleaning system (BREF BAT fit)
- Steam turbine set
- Air-cooled Condenser
- Compact balance of plant equipment
- Centralized control system

Plant Operation conditions:

- Base load operation for electricity production
- Steam extraction for industrial use will be foreseen

Model of a same-sized WtE-Power Plant 2 x 10 MWe

(Property footprint: 50m x 150m)

PLANNING DETAILS / PERMITS

Land	Doncaster, UK
Permits:	WID / IED compliant design to take RDF as feedstock Planning application process - to clarify whether existing Planning Permission can be used Environmental Operating Permit – to be applied for after Planning Permission is obtained
Emissions:	EU - Directive 2010/75 and also fit for new BREF BAT (2020), secured by a multi-stage Selective Non-Catalytic Reduction (SNCR) for the reduction of NOx and an Advanced Dry Flue-Gas Cleaning with a bag filter
Noise level:	85dB near – 50dB offices
Grid connection:	secured and tied to the site
Fuel:	Low grade RDF to be supplied on a 10 + 5 + 5 -year contract with a “blue-chip” supplier
Operation & Maintenance (O&M):	
	Head of Terms regarding a 10 (20) - year O&M contract agreed, therefore Hand Over from Construction to Operation seamless

Plant Description (all Values per Unit):

- Thermal Output: 44,5 MWth
- Steam data: 50 t/h / 42 bar / 420°C
- Main Fuel: RDF, Waste (Commercial + Industrial)
- Calorific Value 8,4 MJ/kg
- Range of CV 7 - 12 MJ/kg
- Fuel flow rate 159.080 t/a (19,4 t/h)
- Fuel size: 90% < 500mm, 10% < 800mm
- Availability: 8.200 h
- Noise level 85dB near – 50 dB offices
- Emissions EU Directive 2010/75, BREF BAT (2020)
- Output at Gen. Term. 10,0 MWel / 8,5 MWel net
- Annually Output (net) 69.700 MWh
  - ready to supply up to 30,000 homes with electricity
  - Heat extraction at the turbine will be foreseen to be “CHP-Ready”

Combustion Technology:

- air- water- cooled grate from SFA-Handels GmbH (Schenkel) with patented grate plates in order to meet IED requirements regarding TOC and LOI levels in the bottom ash

Patented highlights of the Combustion Grate:

- water-cooled with motion compensator, connection system for grate plates without hoses, air outlet openings with cleaning rappers

Boiler design – Vertical Boiler:

- to ensure the lowest possible height of the boiler house, special compact, vertical, naturally circulated 6-pass, bottom-supported, patented boiler design according to the applicable EN 12953 and PED 2014/68/EU standards, with comprehensive cleaning devices ensuring high efficiency and availability and only one maintenance stop per year

Advanced Gas Cleaning Technology (BREF BAT fit)

- advanced dry sorption plant with pre-separator and re-circulation by using additives (lime, Sodium-Bicarbonate, activated carbon) with a downstream bag-filter for binding of gaseous pollutants and heavy metals in the filter cake

Improved SNCR-System:

- Improved multi-stage Selective Non-Calatytic Reduction System will be integrated into the boiler for NOx-removal using an urea-water-solution or ammonia-water-solution (Sodium-Bicarbonate, Carbamin)

Steam Turbine

- industrial “Multi-Stage” Steam Turbine has been designed; applications for a later steam extraction foreseen for production processes or heating if required

Benefits of Boiler Design

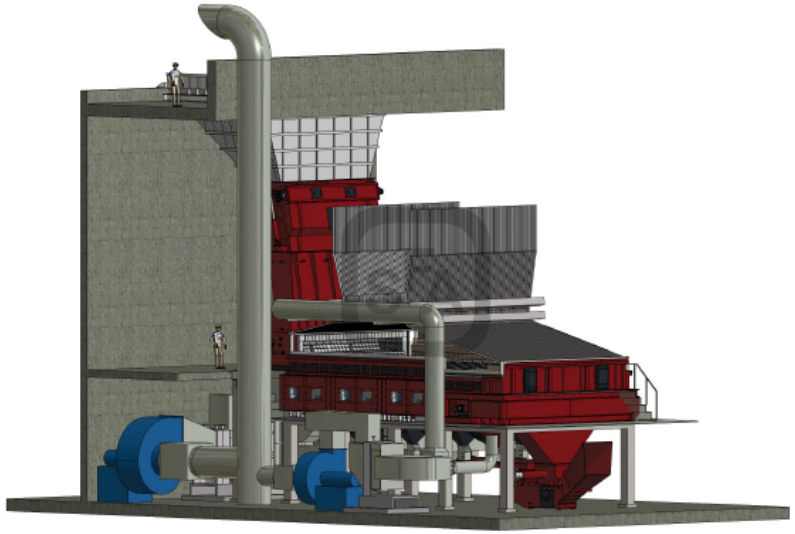
- in line with EU-requirements (WID) residence time 2 sec at 850 °C
- patented special and compact boiler design, which allows a high availability of > 8’000 operating hours
- advanced Gas-Cleaning – **BREF- BAT Fit** - “Dry Flue Gas Cleaning System” using additives and
- adapted to the fuel used to ensure compliance with European limits according to IED and also fit
- for the upcoming stricter BREF BAT limits.
- high availability ensured by intensive cleaning devices

Highlights of the Plant Layout:

- Boiler- House dimensions
  - our standard boiler design is based on a height-saving compact boiler design, a height of boiler house at appr 30m is sufficient.

Grate- and Boiler Design

Water-cooled combustion grate

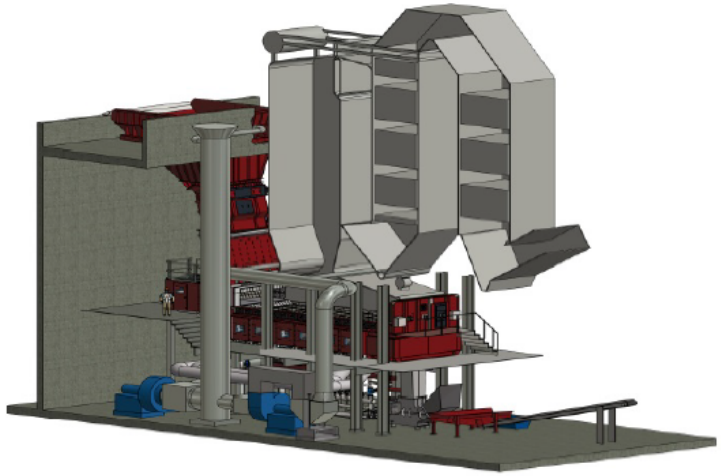


Highlights

- tailor-made solutions up to 100 MWth
- for all fuels with low/high CV (7-24 MJ/kg)
- RDF, municipal-+industrial waste
- Low OPEX costs due to high durability of grate bars – 32.000 hrs (replacement < 10%)

Vertical Boiler Design – Highlights

- classic drum type boiler with natural circulation and negative pressure in the combustion chamber
- vertical, natural circulated 6-pass bottom-supported design
- special patented compact design, which allows a high availability of t 8’000
- operating hours
- only 1 annual maintenance stop for cleaning



Flue-Gas Cleaning Technologies

Different legal regulations, such as IED, BREF BAT and various components of the fuels require the use of state-of-the-art gas cleaning technologies.

Dry flue gas cleaning system – BREF BAT Fit:

- improved multi-stage SNCR system (Selective Non--Cat. Red. System) for reduction of NOx levels to 120 mg
  - Spraying reductive substance (urea/ammonia) into the boiler
- Advanced Dry Flue Gas Cleaning System using additives
  - With pre-separation and sorbent recirculation
  - Additive (lime/sodium bicarbonate) is injected to neutralize SO2 (to 30 mg), HCl (to 6 mg) and HF acids.
  - Also injection of active carbon to reduce heavy metals and dioxins / furans.
- Bag house filter for reduction of particles in flue gases (PM10 below 2,5mg).
  - Ash particles with spent / unspent additives are filtered out and bound in the filter cake.

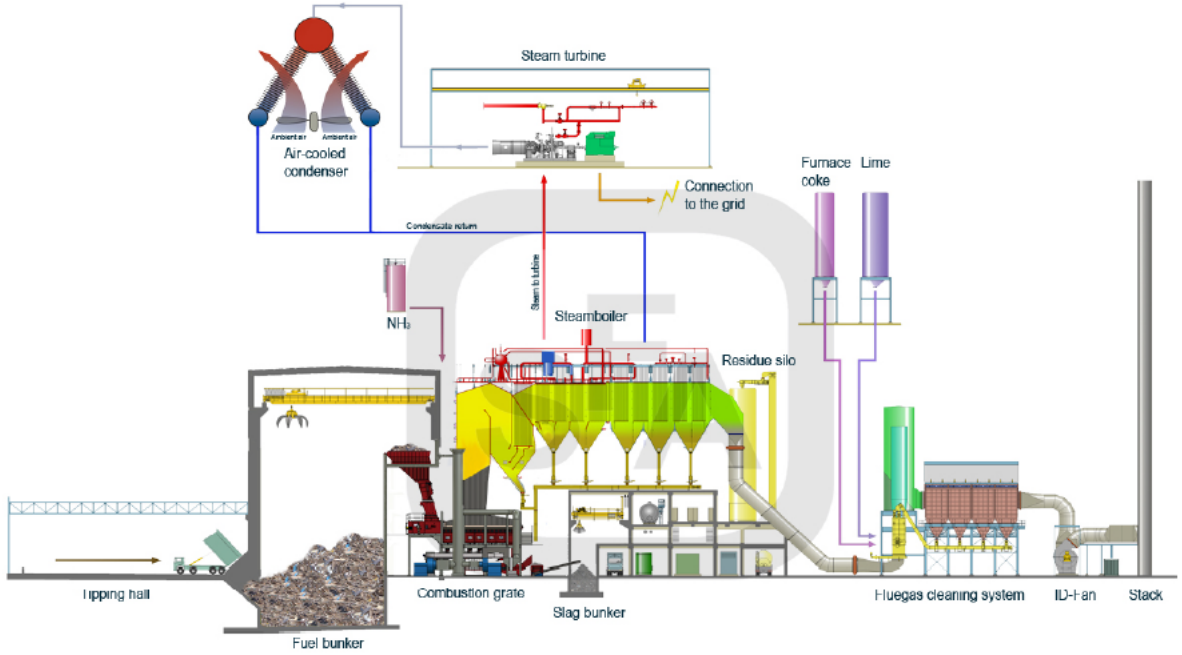
	DRY SYSTEM	WET SYTEM
	Requirements according to WID	More stringent requirements
BIOMASS	BAGHOUSE-FILTER	
WASTE WOOD RESIDUES, REJECTS RDF, SRF MUN. + IND. WASTE	DRY FLUE-GAS SCRUBBING SYSTEM SNCR	Single-Stage or Two-Stage Wet Scrubbing System SCR
NOX	SNCR	SCR

Continuous Emission Monitoring System (CEMS) - required by WID / IED - will be installed in the stack and monitors all main parameters to the control room.

Continuous emission monitoring system (CEMS)

✓ CEMS is required by WID, the following parameters are monitored:

- carbon monoxide content (CO)
- nitrogen oxides content (NO)
- oxygen content (O2)
- sulphur dioxide content (SO2)
- hydrochloric acid content (HCl)
- hydrofluoric acid content (HF)
- organic carbon content TOC
- moisture in flue gas content
- dust content
- temperature of the flue gas
- absolute pressure of the flue gas
- volume flow of dry flue gas



SCOPE OF SUPPLY AND SERVICES

BATTERY LIMITS

- 11kV / 33kV: at generator terminals
- Fuel: at inlet fuel silo
- Water: 1 m outside machine hall
- Fuel gas: 1 m outside boiler structure
- Consumables: at filling flange

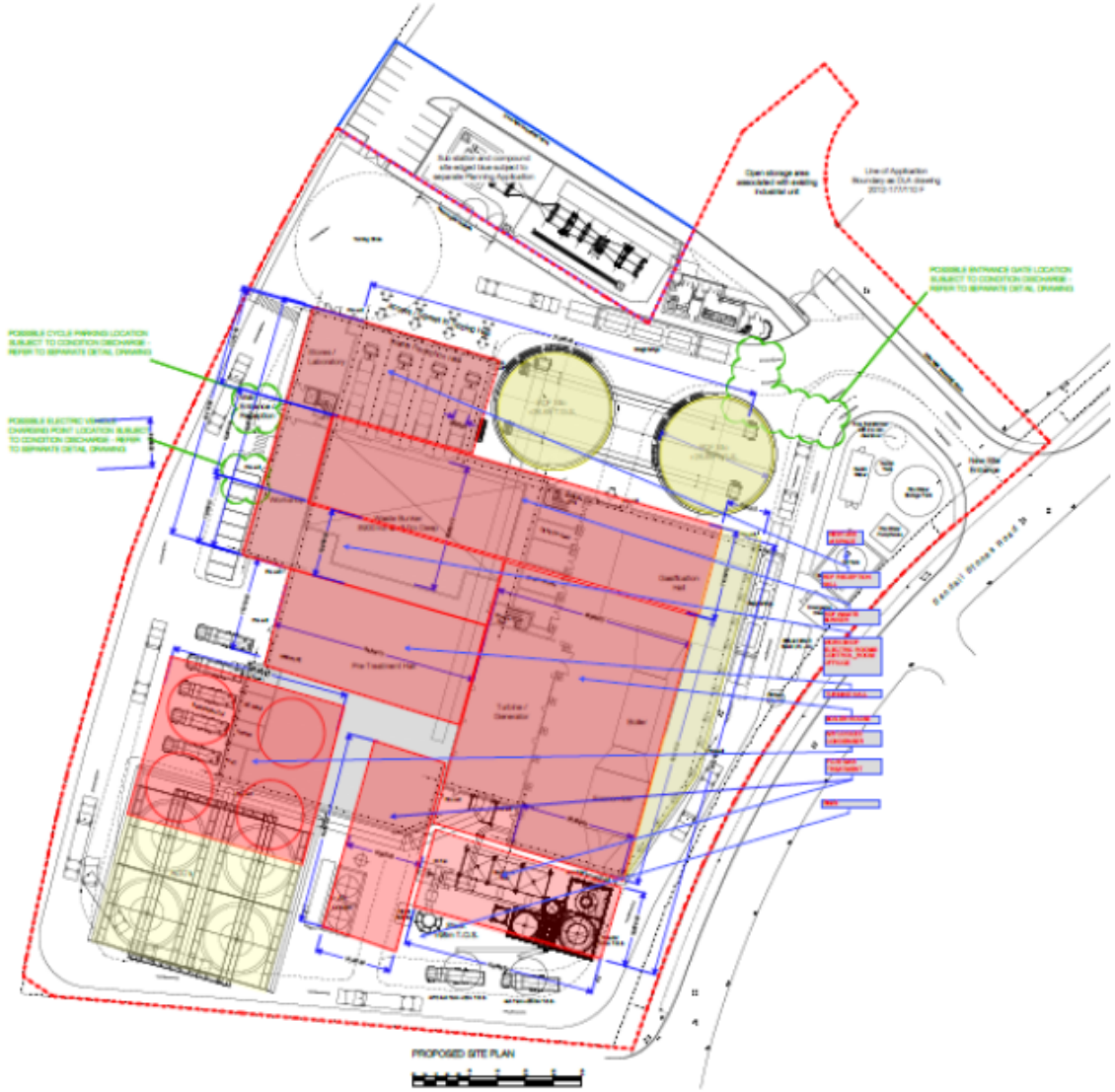
Added scope of Supply

- Civil Engineering and Construction
- Coordination / wrapping of civil part
- Site preparation & infrastructure
- HV grid connection
- Fuel supply and selection
- Boiler and turbine-house steel structure and casing
- Plant operation up to TOC
- Application for amending approvals (if any)
- Permitting
- Spare parts & wear parts

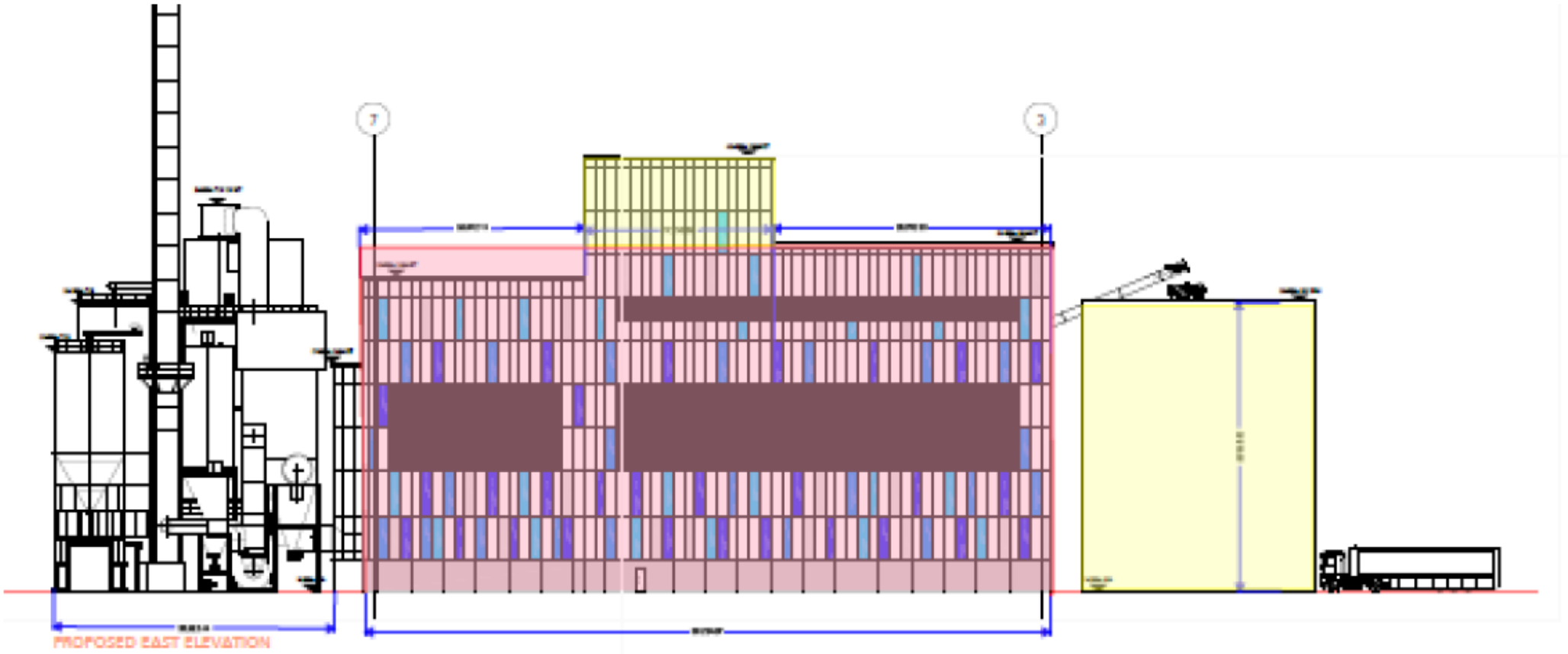
Scope of Supply

- Fuel storage bin, input of fuel
- Water- air- cooled grate integrated into a high pressure steam boiler
- Boiler supporting steel structure, stairs & platforms
- Flue gas cleaning plant
- Ash handling
- Steam turbine / generator set
- Air-cooled condenser
- Water steam cycle
- Condensate system
- Feed water system
- Water treatment plant
- Auxiliary systems
- Electrical system
- Control system
- Engineering, Design, Erection,
- Commissioning & Test Run

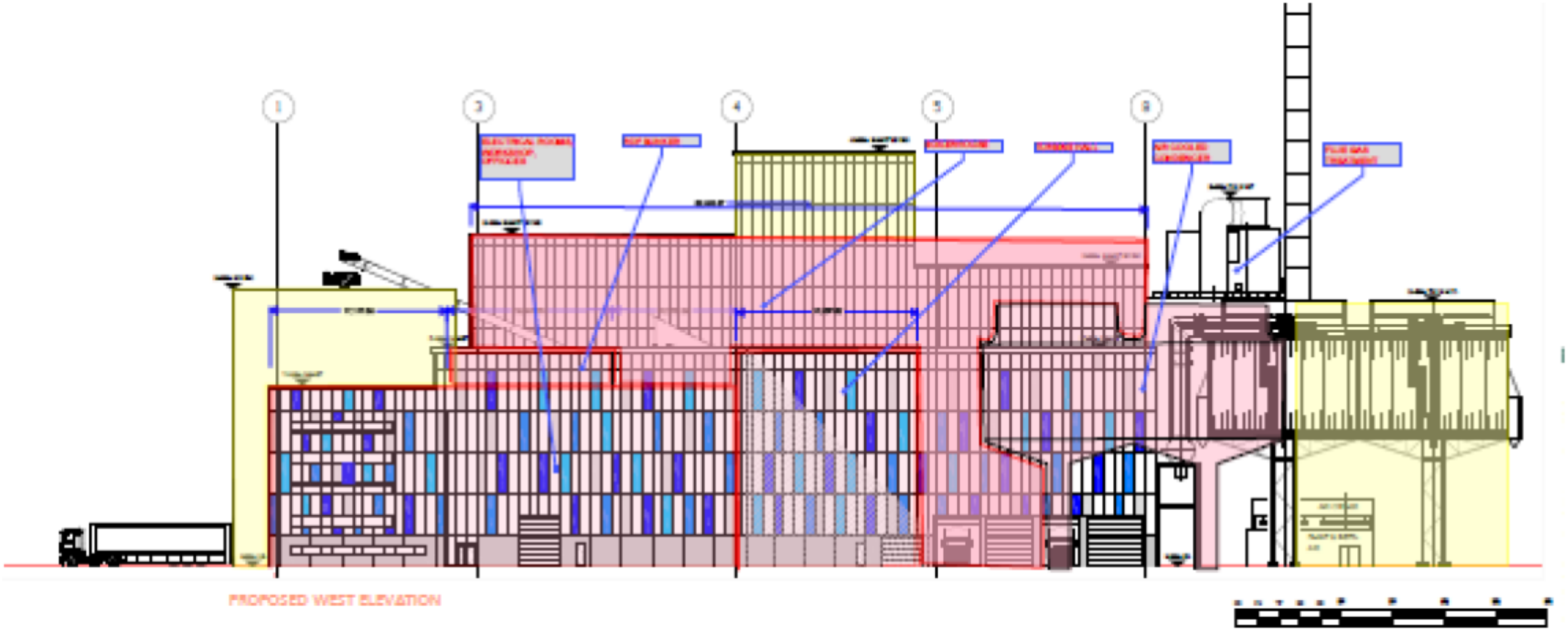
DONCASTER – 2 X 10 MWel GENERAL LAYOUT



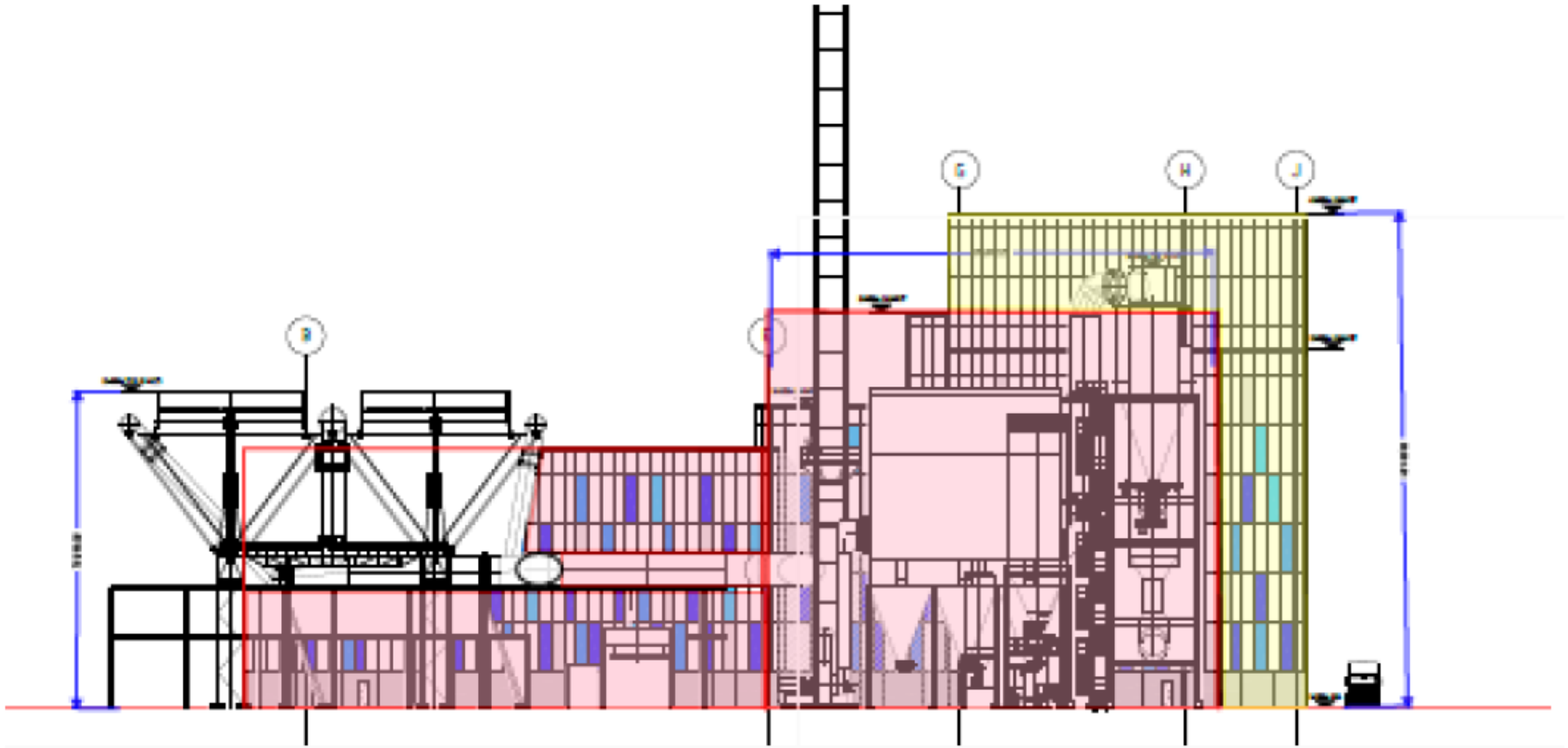
DONCASTER – 2 X 10 MWel ELEVATION VIEW (1/2)



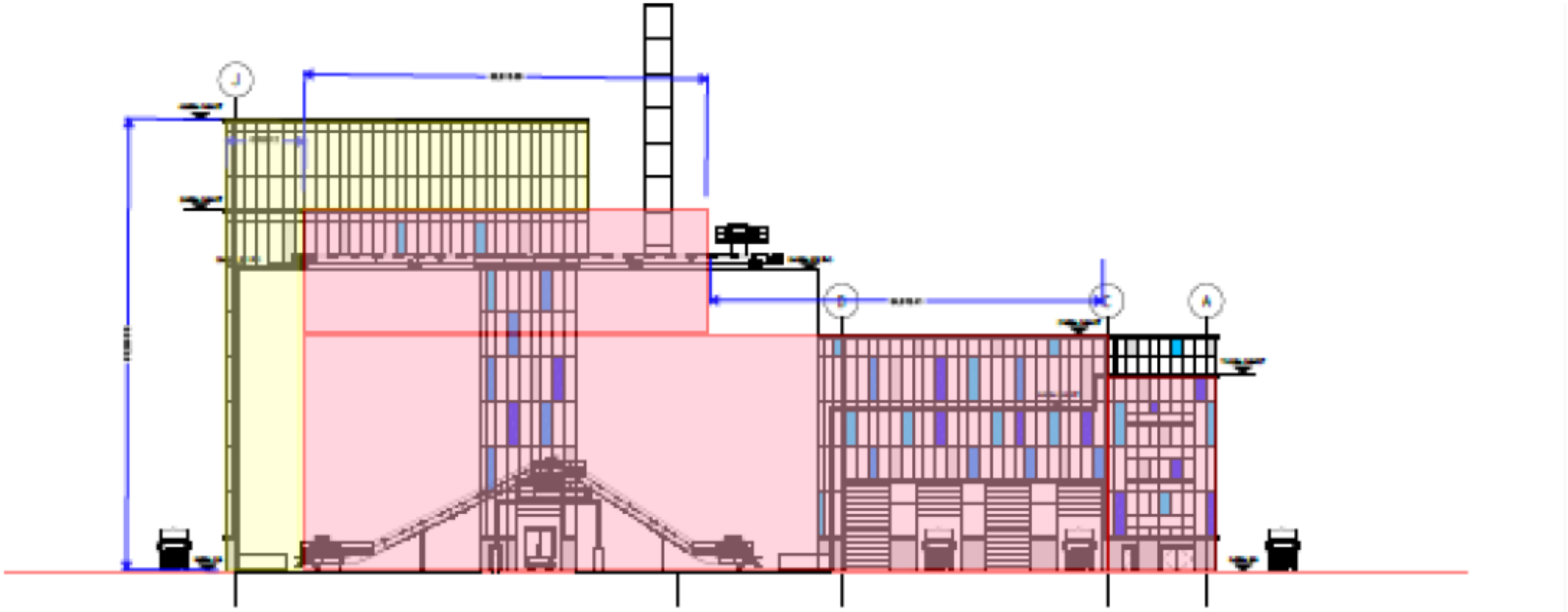
DONCASTER – 2 X 10 MWel ELEVATION VIEW (2/2)



DONCASTER – 2 X 10 MWel END ELEVATION VIEW (1/2)



DONCASTER – 2 X 10 MWel END ELEVATION VIEW (2/2)



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