***WoodRoll® - breakthrough technology for cleanest energy gas from biomass!***


CORTUS ENERGY

# Nordic Baltic Bioenergy
# Helsinki, March 2017
# Rolf Ljunggren

# CONTENT



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# 1. Cortus Energy

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# 1.1 Cortus Energy

- Founded in 2006 to develop and commercialize the patented gasification process WoodRoll®.
- WoodRoll® is a gasification process for biomass, producing clean energy gas with a high energy value.
- The purity and high energy value of the energy gas makes it suitable for replacing fossil fuels.
- Listed on Nasdaq OMX First North since february 2013.
- The company has 12 employees and 10 consultants.


- **WWF climate solver (2009)**
- **Top 25 Nordic Cleantech Open (2010)**
- **Top 25 Cleantech summit Geneva (2011)**
- **Classified as ”Beyond state of the art” by German consulting company (2010) and Chicago Gas Technology Institute (2011)**
- **Stockholm Cleantech hotlist (2013-)**
- **Seal of excellence, EU (2016)**

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# 1.2 WoodRoll® test plant in Köping


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# 1.3 Modular 6 MW WoodRoll® plant is marketed now!


# 2. The WoodRoll® technology

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2.1

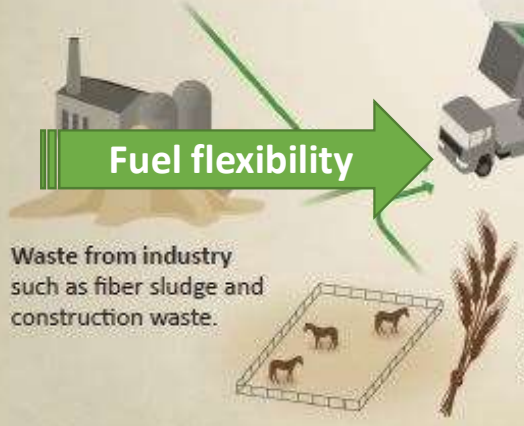
# WoodRoll®– Versatile green Energy gas

*WoodRoll® is a unique technology that replaces fossil energy by efficient gasification of biomass that produces green energy for vehicles, industry and power generation.*

## Feedstock

**Forest-based feedstock** such as forest residues and energy crops.

**Waste from industry** such as fiber sludge and construction waste.



**Agricultural waste** such as animal manure and crop residues.

**Fuel flexibility**

1 The biomass is heated and dried (100° C).

2 During the pyrolysis the biomass is converted into pyrolysis gas and char (400 °C).

3 The pyrolysis gas is burned and heats gasification, waste heat goes to pyrolysis and drying.

**Tar incineration!**

4 In the gasifier finely ground char reacts with steam (1 100 °C) and form a clean energy gas.

5 The energy gas is cooled with water that becomes steam, which is feed to the gasifier.

Dryer

Pyrolysis

Gasifier

Energy gas

## Applications

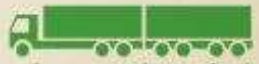
Biogas

Renewable power

Hydrogen

**Ultra clean syngas**

Industry



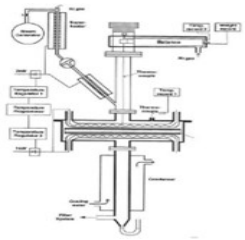
**35 tons of biomass** (equivalent to a lorry with trailer)

**one-day operationof a WoodRoll® = 100 oil barrels**

# 2.2 WoodRoll® – development until today!

**2007**

Collaboration with KTH for bio fuels - Thermo Gravimetric Analysis (TGA)



**2008**

**2009**

150 kW gas pilot tests

**2010**

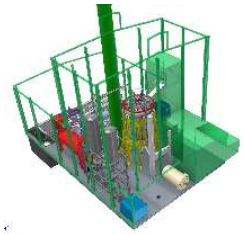
**2011**

500 $kW_{thermal}$ Test gasifyer

New TGA - Close to 300 samples of biofuels made (Mar. -2017).

**2012**

Engineering of 5 MW WoodRoll®



**2013**

500 $kW_{thermal}$ Installation integrated WoodRoll® in Köping

DemoSNG Methanation tested in Köping

**2014**

**2015**

WoodRoll® Test plant

New 6 $MW_{th}$ modular WoodRoll® plant

**2016**

Tests of:

- Fuels
- Gascleaning
- Crackning

**2017-**

**Projects**

6 $MW_{th}$ modular WoodRoll® plant

Höganäs

FOREST ENERGY

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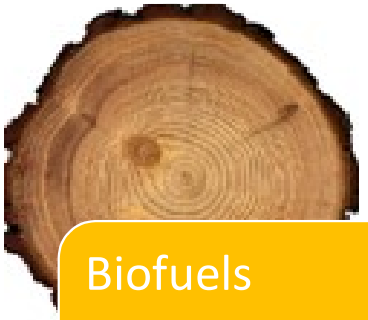
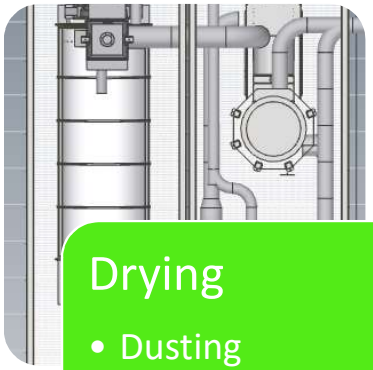
# 2.3 WoodRoll® – Fundamentals



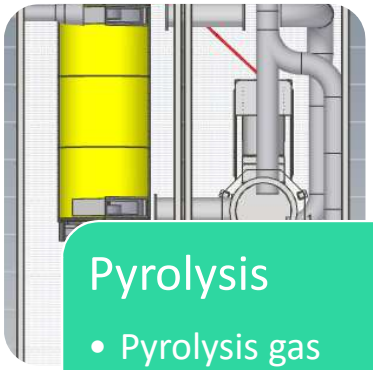
## Biofuels

- Reactivity
- Ashes



## Drying

- Dusting
- Condensation
- Single percentage humidity



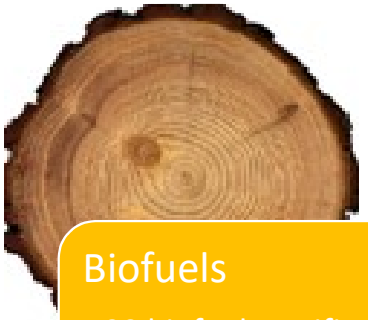
## Pyrolysis

- Pyrolysis gas
- Combustion of pyrolysis gas
- Char yield

## Gasification

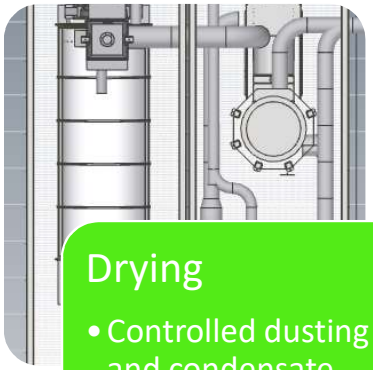
- Conversion rate
- Ash control

# 2.4 WoodRoll® – Acheivements



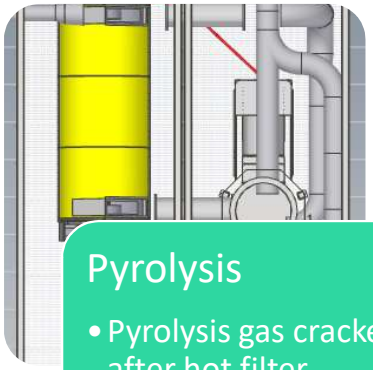
## Biofuels

- 20 biofuels verified



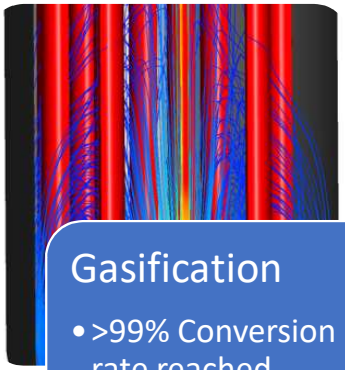
## Drying

- Controlled dusting and condensate
- Single percentage humidity in operation



## Pyrolysis

- Pyrolysis gas cracked after hot filter
- Combustion stable
- Char yield [T, $X_i$] 35% +/-10%



## Gasification

- >99% Conversion rate reached
- Ash melting only for chemical sludge
- Ultra clean syngas


# 3. Operations in Köping

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# 3.1 Operations

## 2016

- Syngas cleaning for catalytic process:
  - Green gas fuel station
  - Biogas Expose
- Bränsletester:
  - Probiostål - Höganäs
  - Cheap biofuels - Biogas Expose
- Catalytic crackning
- Availability/Capacity/Yield

## 2017 and forward

- Methanation
  - Biogas Expose
- Hydrogen
  - Fuel cells for heat and power
- Fuel tests:
  - Biofuels from Japan
  - Cheap biofuels - Biogas Expose
- Availability/Capacity/Yield

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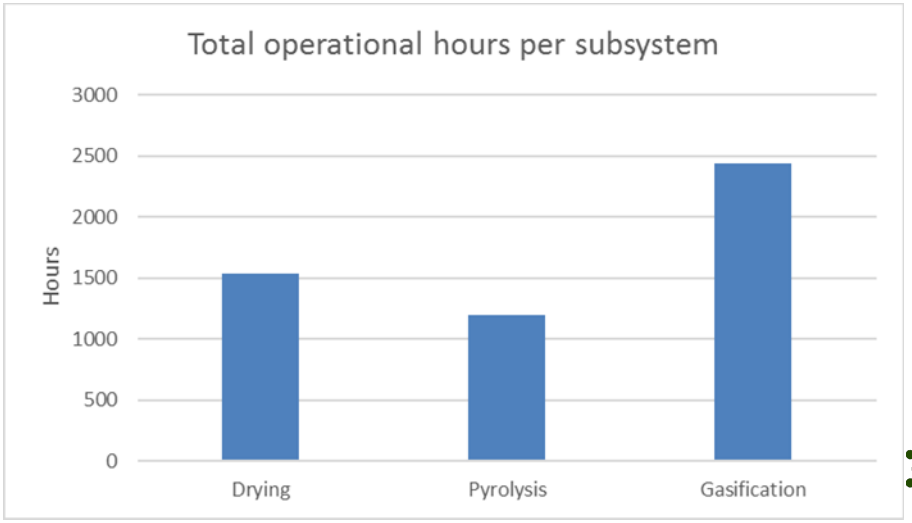
# 3.2 Test plant in Köping


| Process Block | Year installed | | | | | |
|---|---|---|---|---|---|---|
| | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| 01 Biomass handling | | | | | | |
| 02 Drying | | | | | | |
| 03 Pyrolysis | | | | | | |
| 04 Char handling | | | | | | |
| 05 Gasifier and cyclone | | | | | | |
| 06 Steam system | | | | | | |
| 07 Water treatment system | | | | | | |
| 08 Bottom ash handling | | | | | | |
| 09 Burner system | | | | | | |
| 10 Syngas flowtrain | | | | | | |
| 11 Syngas cleaning system | | | | | | |
| 18 Chimney | | | | | | |
| 19 LPG | | | | | | |
| 20 Flare | | | | | | |
| 21 Nitrogen | | | | | | |
| 22. Water | | | | | | |
| 32 Compressed air | | | | | | |
| 33. Cooling water | | | | | | |

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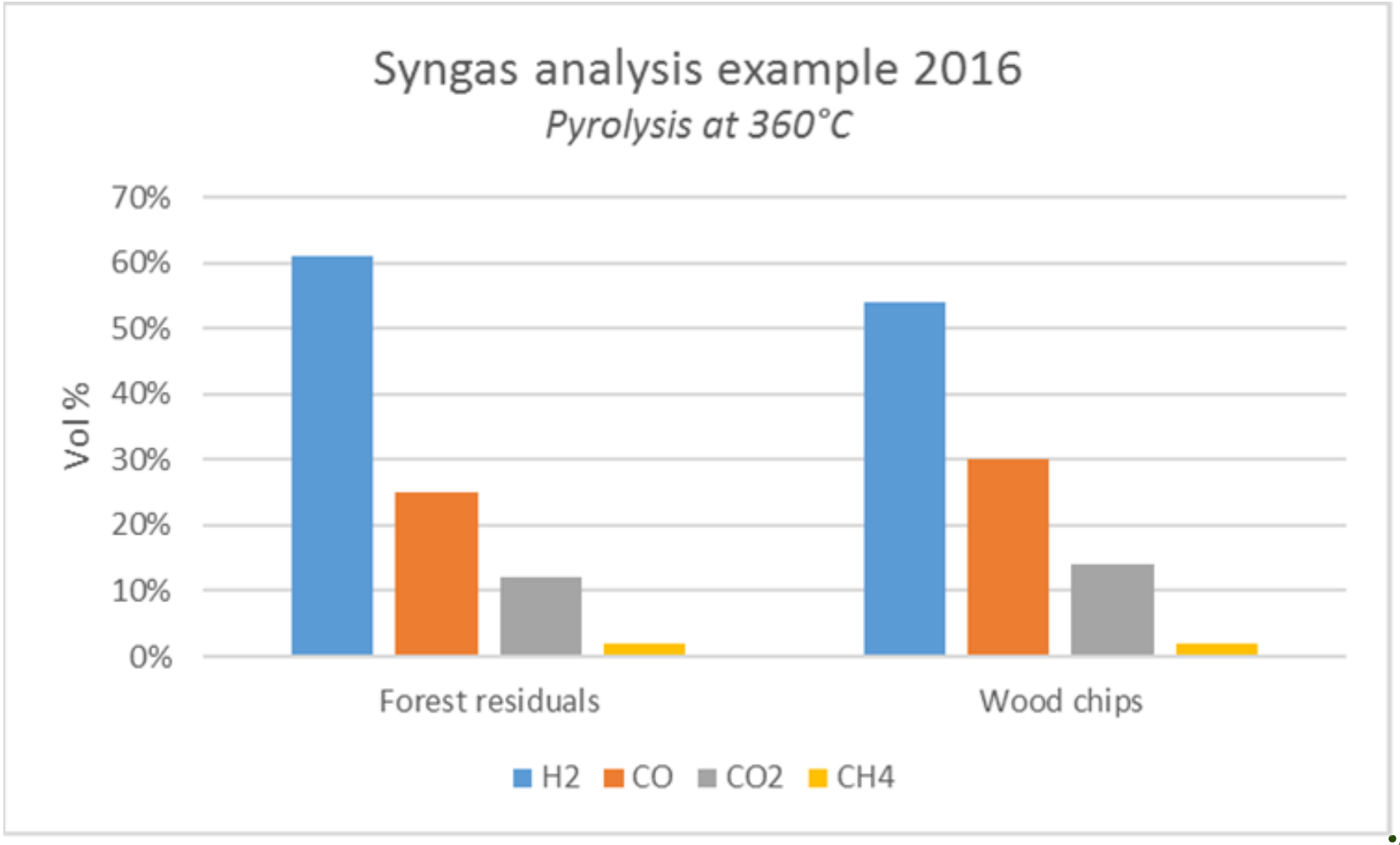
# 3.3 Probiostål syngas

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# 4. Business projects

1. Höganäs AB
2. Forest Energy
3. Mariposa

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# 4.1 Probiostål project

## Höganäs AB

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# 4.1.1 WoodRoll® in Höganäs

- Höganäs AB and Cortus AB collaborate for renewable energy
  - Höganäs wants to be the first steel manufacturer to replace fossil such as natural gas and coke with renewable energy to stay ahead of the competition
  - Cortus has an excellent first commercial and industrial plant to operate in 2018
  - A cooperation has been running since 2012 within Jernkontoret (Swedish Iron and Steel Society).
- A pre-design (Basic engineering) has been completed for Höganäs in 2015/16 at a cost of 8.5 MSEK, where industry, institutes and academy together have developed a basis for the introduction of renewable energy in the production facilities at Högnäs.
- The pre-design includes:
  - Manufacturing, installation, commissioning of a WoodRoll®- plant (Cortus/Höganäs)
  - Environmental impact study as a life cycle analysis (Swerea)
  - Modeling, simulation and analysis of heating process impact in Höganäs (KTH)
  - Energy optimization of the system – gasification and furnace (KTH)
- The parties are finalizing a 20 year supply contract.

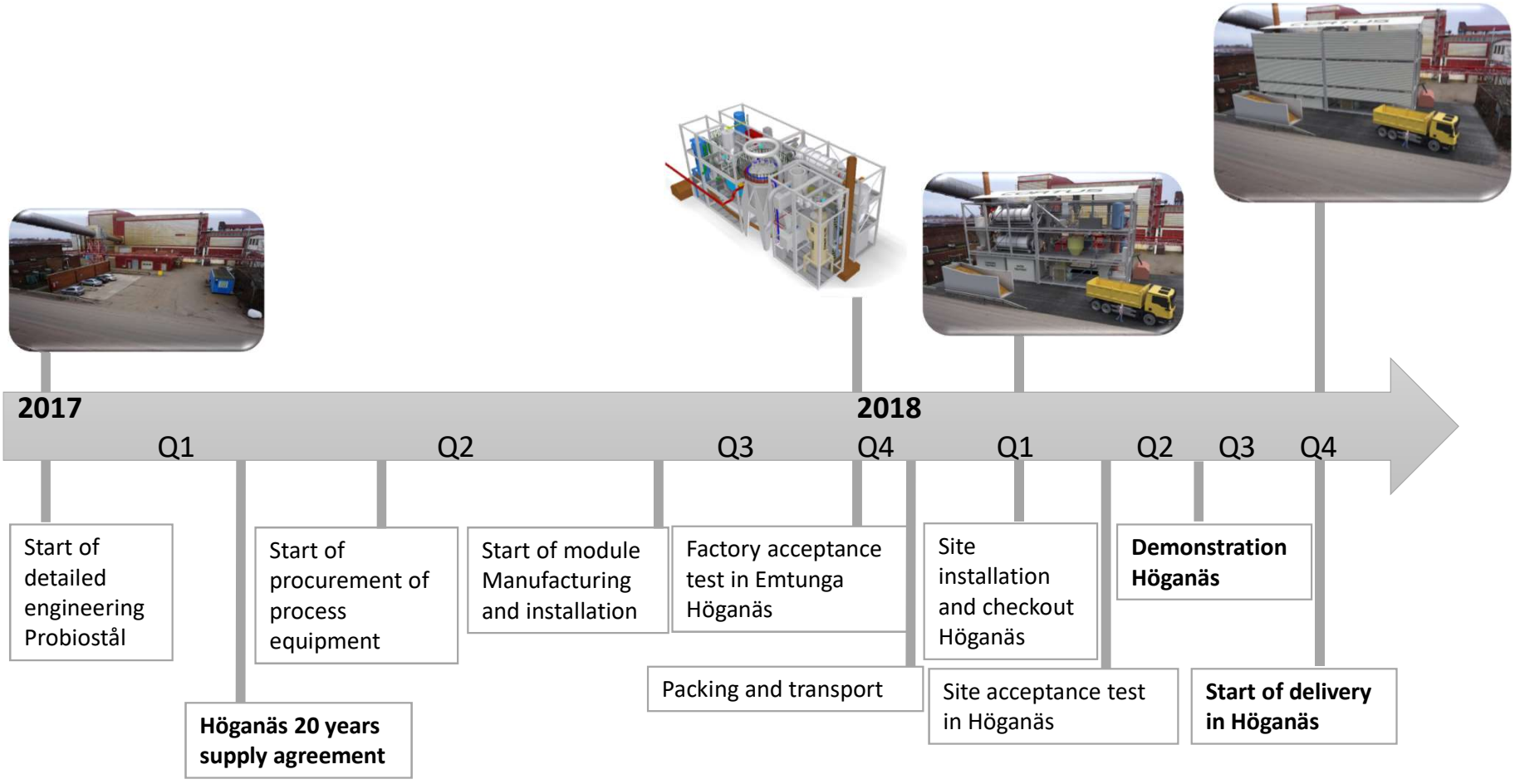
## 4.1.2 Project partners








# 4.1.3 Project plan



# 4.1.4. Modular 6 MW WoodRoll®

**Engineering**

- The plant is sectioned into function blocks
- Cortus is responsible for process engineering
- Design support from ÅF, WSP (AutoCAD Inventor)
- The engineering is based on the pilot plant in Köping
- Process equipment is bought from established suppliers
- The modules are manufactured in Emtunga

**Modules**

- The plant consist of 14 modules
- The basic module size is 4.45 m * 13.35 m * 4.00 m
- Each module will have its own electrical cabinet
- The process modules have integrated electrical and control cabinets
- Power and network connections to the modules

# 4.1.5 Planned structure for modular plant at site 2018


# 4.2 Forest Energy, Japan

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# 4.2.1 Forest Energy

- A strategic joint agreemeent was made between Forest Energy and Cortus Energy in maj 2016, including up to 25 plants whithin 5 years.
- Order on a Basic engineering for the first common project in june 2016. The work was finished in december 2016.
- The aim with the Basic engineering is to have a technical basis and documentation for new heat and power projects in Japan.
- The application for support of the 20 year electricity supply (PPA) for the first project is submitted.
- Applications for further projects will be made during 2017.
- The projects are based on co-ownership and a structured finanzing avaible on the Japanese market.
- Order of the first plant is expected before mid 2017.

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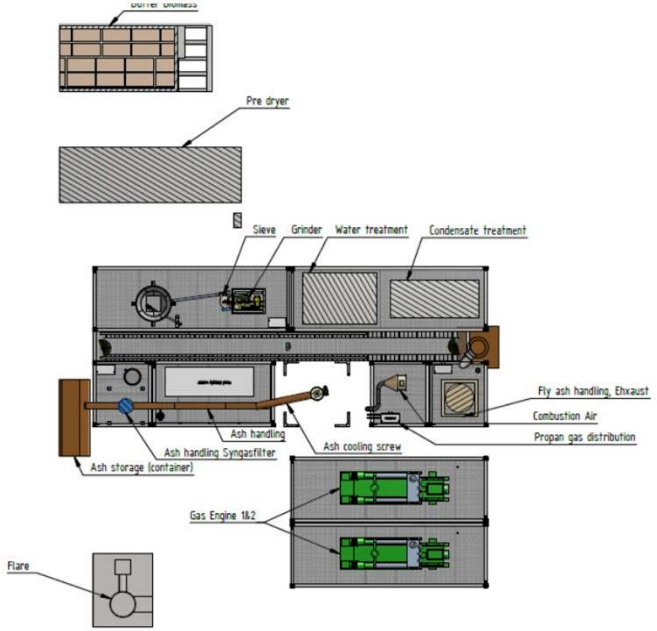
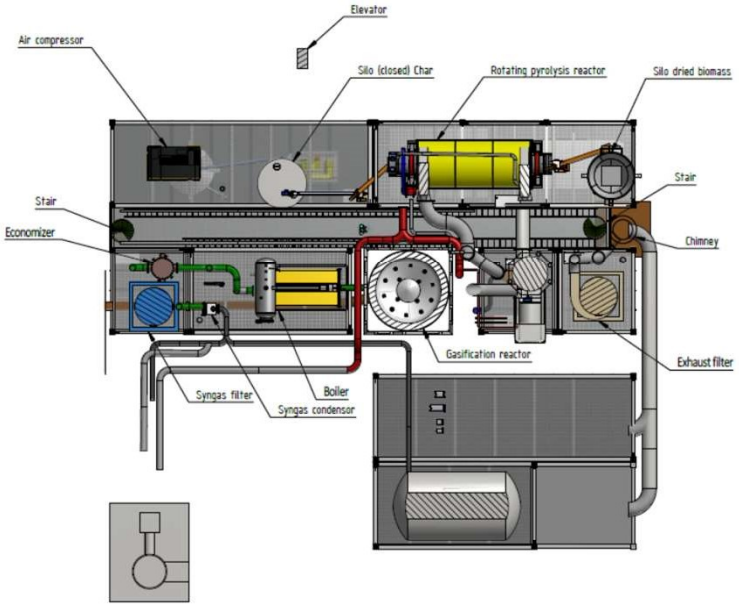
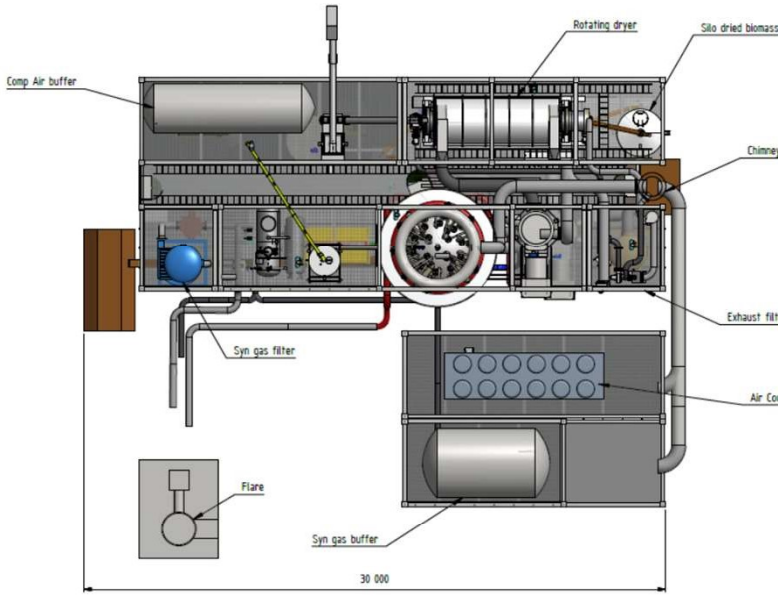
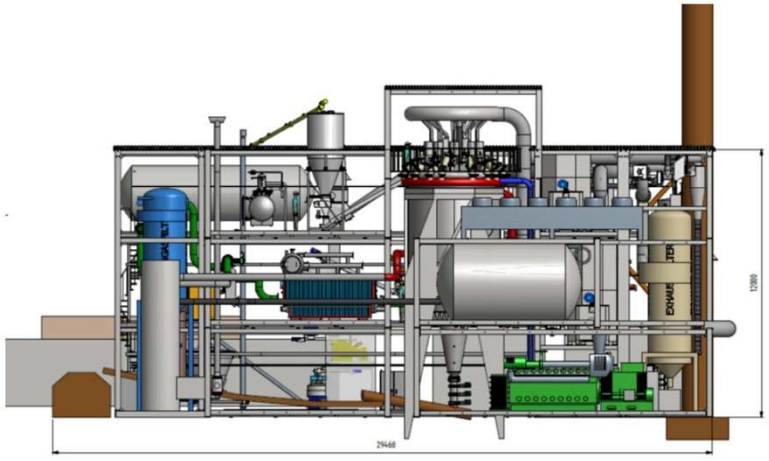
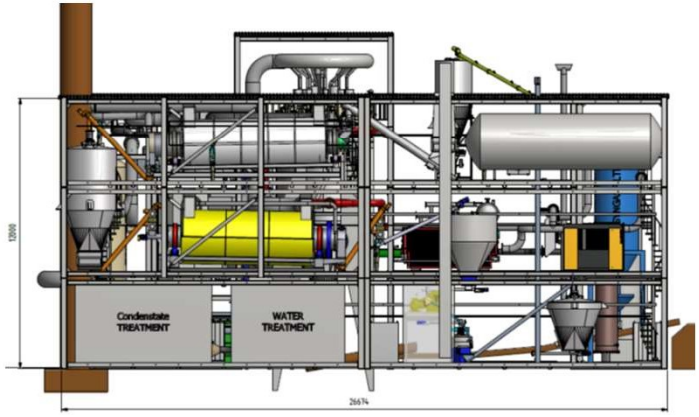
# 4.2.2 First WoodRoll®plant in Japan

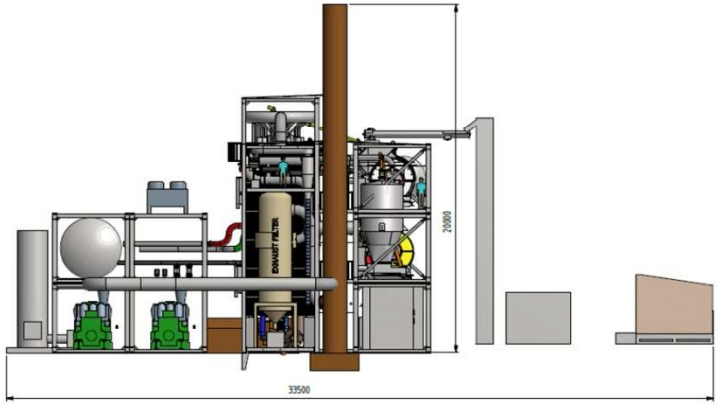


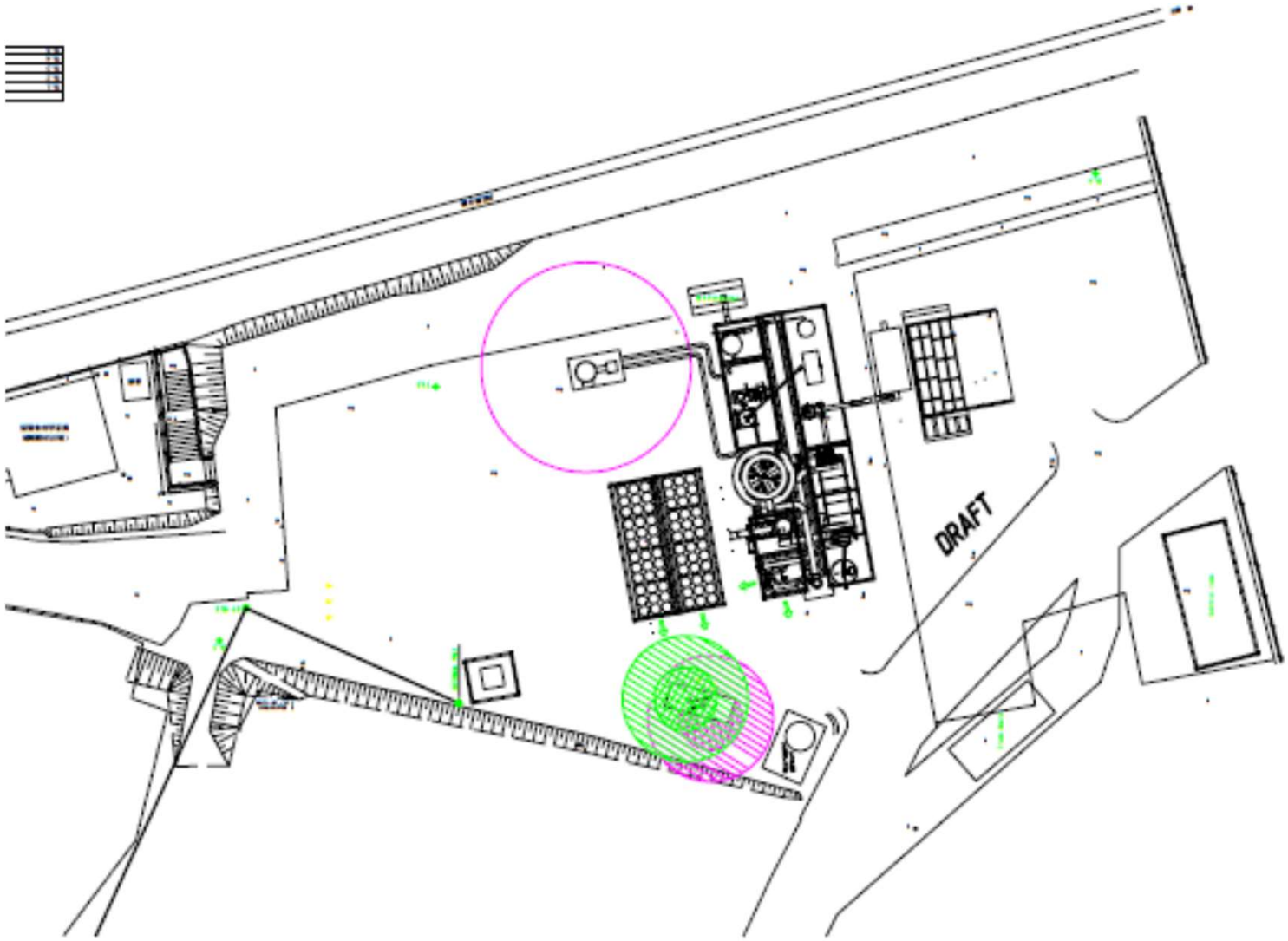



# 4.2.3 First WoodRoll®plant in Japan




# 4.3 Mariposa, California

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# 3.3.1 Mariposa biomass project

- An **EPIC grant of 5 MUSD** has been granted by California Energy Commission on the 24th of March 2017 for this project
- The project group has been working for nearly two years for a joint heat and power project in Mariposa (California) based on a modular 6 MW WoodRoll® with double gas engines and heat recovery
- In 2016 MBP received support from the state for a pre-design study of a biomass heat and power plant based on a modular 6 MW WoodRoll®
- Environmental permit application has been sent in (March 2017)
- For a realization phase of the project, possibilites for further collaborations with other parties in California are necessary and under investigation. This is a prerequisite for implementation of the project.
- Basic engineering will be started in the second half of 2017.
- A plant order is expected early 2018.

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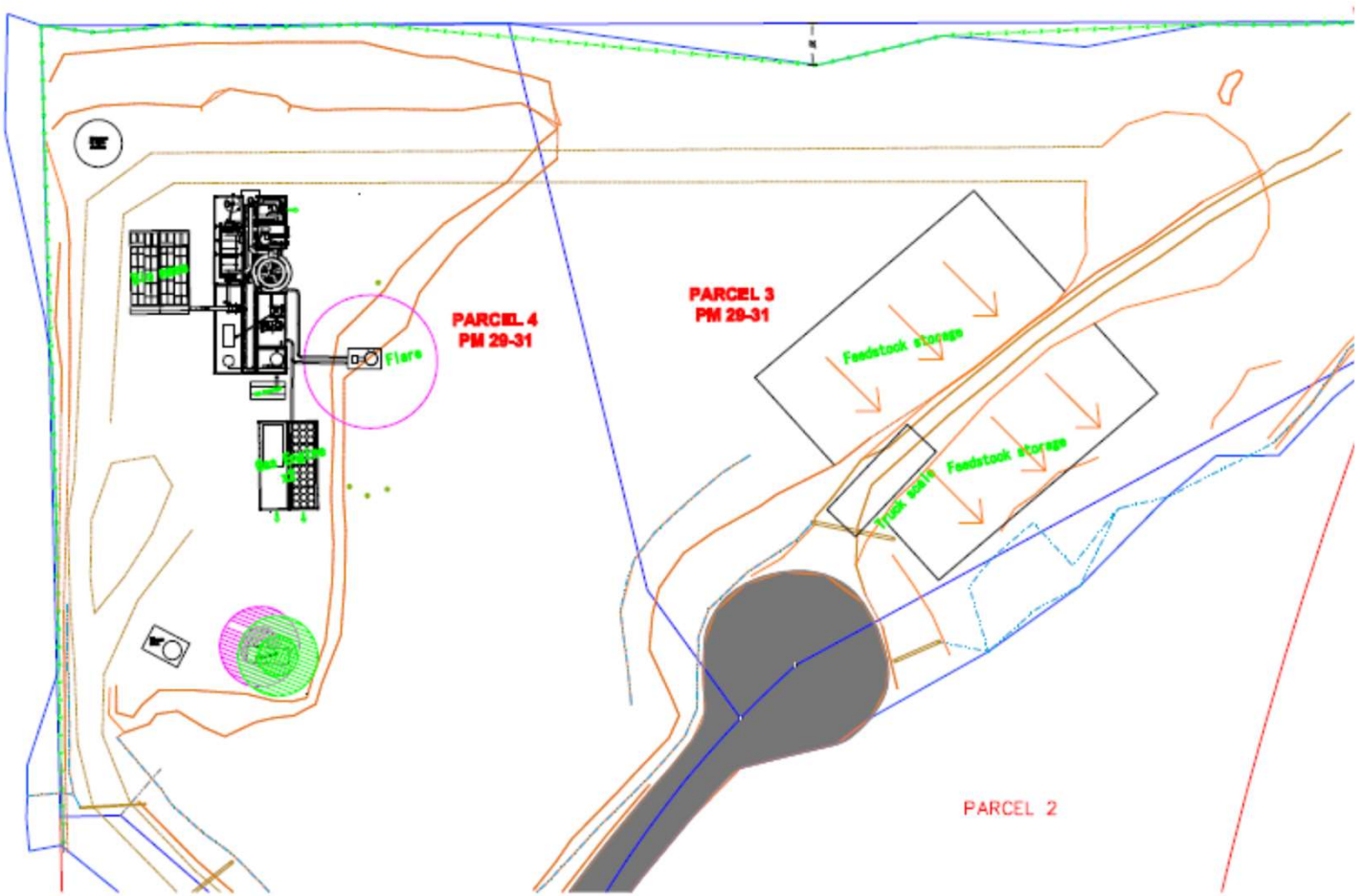
# 3.3.2 Mariposa biomass project

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# 5. Next step

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# 5. Next step

Power

Industry

**WoodRoll MARKET**

Hydrogen

Synthetic fuels and chemicals


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