

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



Small-scale gasification for CHP



Rolf Ljunggren, CEO



Forest Energy

Shingo Numa, CEO

CONTENT

1	Cortus Energy x Forest Energy
2	2MWel biomass business in Japan
3	The WoodRoll® technology
4	Business projects
5	Next steps

Cortus Energy x Forest Energy

- 2016年5月にフォレストエナジーとコルタスエナジーは戦略的事業提携

A strategic joint agreement was made between Forest Energy and Cortus Energy in May 2016

- 目的はバイオマスのガス化による1.9MWの熱電併給設備を日本で展開すること

Partnership to develop, build and operate 1.9MWel gasification biomass power plant in Japan

- 日本向けの使用は2016年12月に完成

Basic engineering for Japan model of WoodRoll completed in december 2016



- Gasification technology
- Engineering
- Investment



- Development
- Project finance & Investment
- Operation



2. 2MWel biomass business in Japan



フォレストエナジーの事業概要

Forest Energy

- 木質バイオマス発電所の開発・資金調達・運営を一気通貫で手掛ける

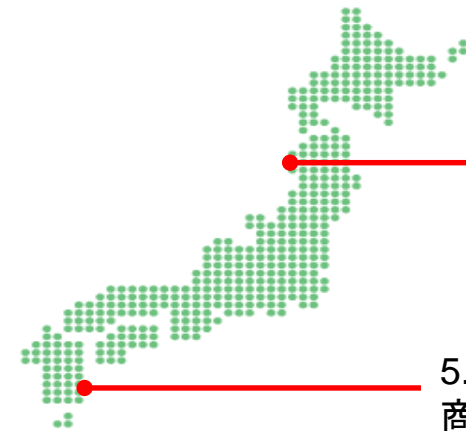
We develop, project finance, own and operate wood fired biomass power plants

5MW +

国内木材を主燃料とする

BTG型の発電所を全国展開

BTG power plant using local wood
as fuel



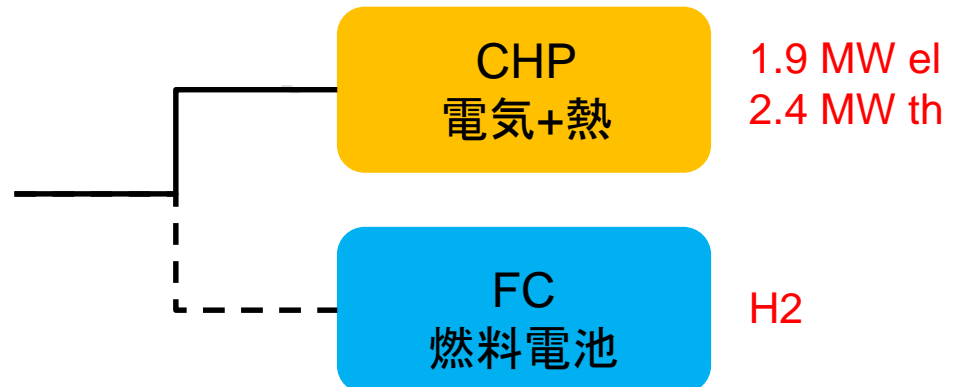
20.5MW、秋田県 Akita
商業運転 Operation 2016 -

5.75MW、宮崎県 Miyazaki
商業運転 Operation 2015 -

2MW

Cortus Energyのガス化技術を使っ
たシステムを日本で独占的に展開

Cortus Energy's WoodRoll
gasification technology



燃料調達の実現

Lessons learnt – Fuel collection

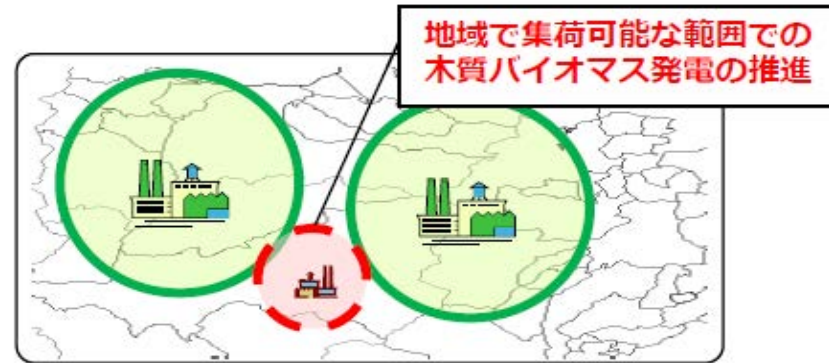
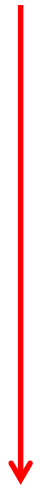
1. 持ち込まれる木材の含水率は45%~60%のレンジでばらつきも大きい
Moisture content of wood delivered is 45 to 60%, with wide variance
2. 異物混入（ワイヤ、鉄片、小石等々）
Wires, stakes and stones found in wood
3. 燃料は買取価格が高いところに行き、運搬圏内は100km~200km
Fuel goes to highest buyer and will travel 100 – 200 km away from power plant
4. 木の伐採・搬出コストは地域・地形によって差が大きい
Large variance in cost to cut down trees, depending on area, steepness and accessibility
5. ペレットは割高かつ品質にバラつきがある
Pellet is still small business, and price is high, quality is variable

小規模バイオマス発電の事業設計

Implication to business and design

現実： 燃料は買取価格が高いところに行き、100km～200kmも集材圏内

Reality: Fuel goes to highest buyer, and will travel 100 – 200 km away from power plant



(農林水産省、調達価格算定委員会資料)

意味合い： 発電所間の棲み分けは曖昧で価格競争に晒される。また、地域によって値段差がある。
燃料種類の柔軟性と高い発電効率を背景に地域ごとに調整する

Implication: Need flexibility in fuel type and high power generation efficiency to have control over fuel price competition. Each area will have its unique characteristics

小規模バイオマス事業の戦略

Forest Energy approach to small biomass energy in Japan

1. 燃料種類に対してフレキシブルなシステム
Fuel flexibility. No single fuel solution
2. ウッドチップを主燃料とするシステム
Woodchip as main fuel source. Not pellets
3. ウッドチップ含水率の上限が高く、ばらつきを許容できるシステム
Tolerance to high moisture rate and variance in moisture rate
4. 発電効率 ≒ 30%
Power generation efficiency ≒ 30%
5. 熱電併給ができる設備
CHP capability a must
6. 電力事業のみで成立する全体の経済性。熱利業は時間をかけて取り組む
Project economics need to be good just on electricity. Heat usage need time to develop



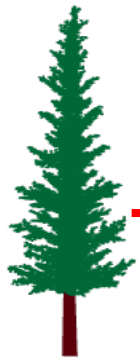
小規模バイオマス・エネルギーシステム

2MW el biomass system

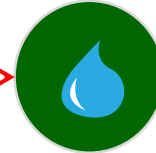
地元木材を
地産地消
Fuel = local biomass

ガス化設備で
木からガスを生成
Gasification

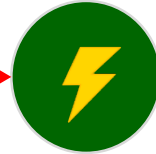
3つの用途
3 applications



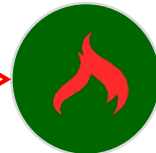
Cortus Enegy "WoodRoll"



燃料電池 (FC)



発電 1.9MWeI



熱供給 2.4MWth

21年目以降
Post FIT

SOFC
固定酸化物型燃料電池
+
MGT
マイクロガスタービン

- ウッドチップ、バーク、竹チップ、籾殻
Woodchips, barks, bamboo chips, rice hulls
- 含水率 moisture rate: ~60%
- 含水率50%のチップを75 ton/日(day)

- 売電で成立する事業モデル
Power (electricity) based business model
- 熱供給は売電後、時間をかけて地域
Take time to coordinate heat usage




3. The WoodRoll® technology

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)**

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.



Fuel flexibility

Waste from industry such as fiber sludge and construction waste.



Agricultural waste such as animal manure and crop residues.

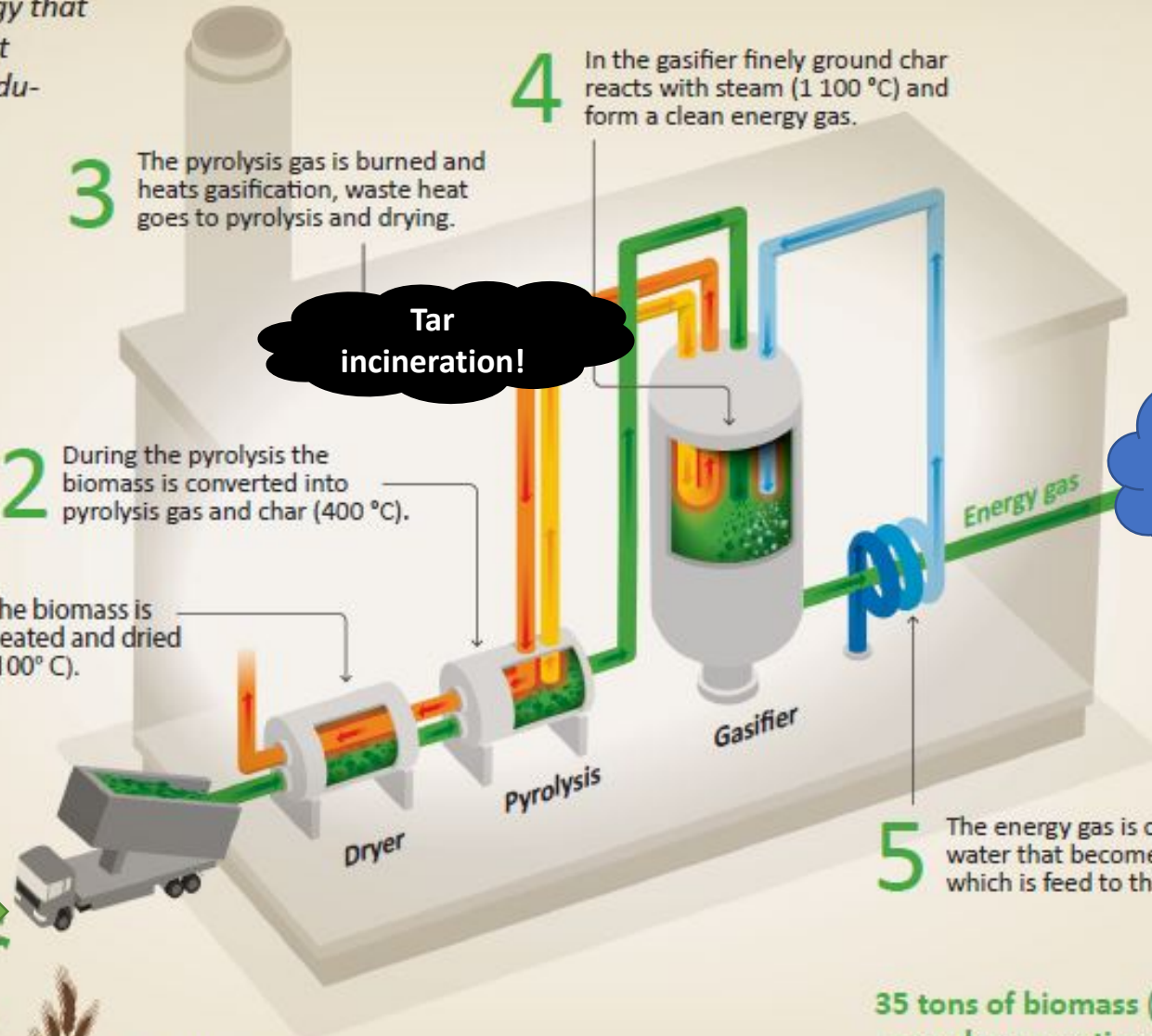
1 The biomass is heated and dried (100° C).

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.

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.



Applications

Biogas



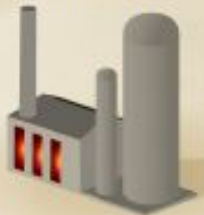
Renewable power

Hydrogen



Ultra clean syngas

Industry



**35 tons of biomass (equivalent to a lorry with trailer)
one-day operation of a WoodRoll® = 100 oil barrels**



WoodRoll® – development until today!

500 kW_{thermal}
Test gasifier



Engineering of
5 MW WoodRoll®



500 kW_{thermal}
Installation integrated
WoodRoll® in Köping



WoodRoll®
Test plant



Tests of:

- Fuels
- Gascleaning
- Crackning



2007

2008

2009

2010

2011

2012

2013

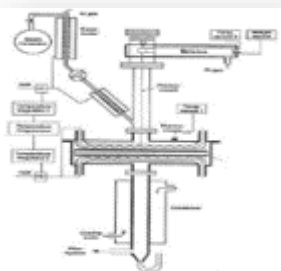
2014

2015

2016

2017-

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



150 kW gas
pilot tests



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



DemoSNG
Methanation tested
in Köping



New 6 MW_{th} modular
WoodRoll® plant

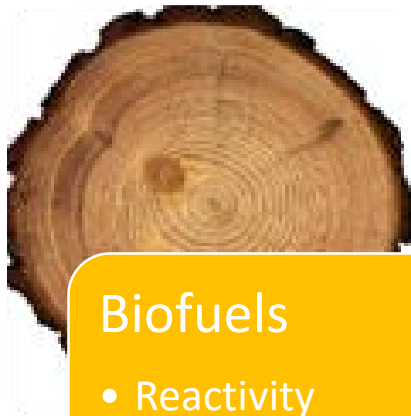


Projects
6 MW_{th} modular
WoodRoll® plant

Höganäs 

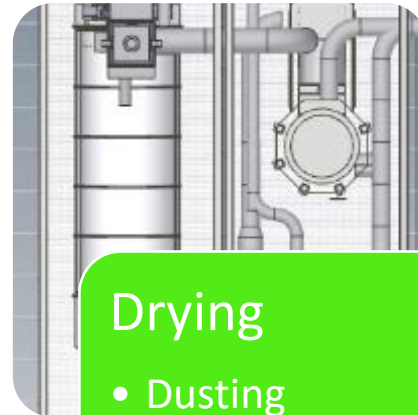


WoodRoll® – Fundamentals



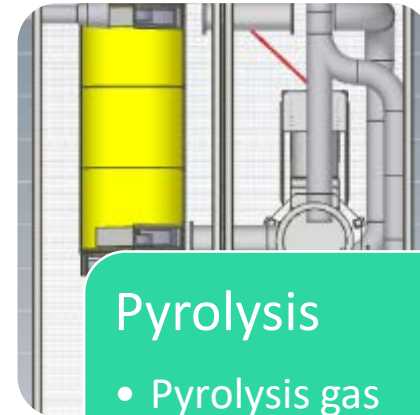
Biofuels

- Reactivity
- Ashes



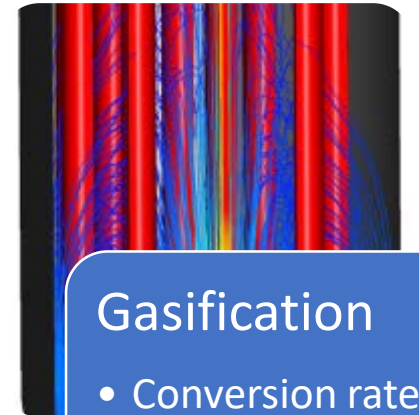
Drying

- Dusting
- Condensation
- Single percentage humidity



Pyrolysis

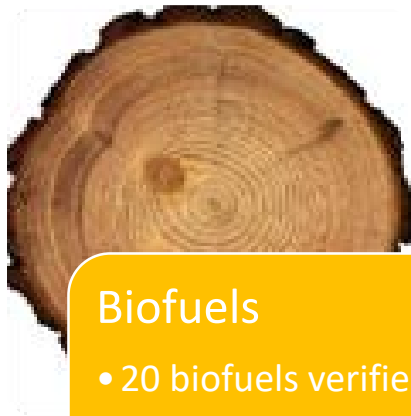
- Pyrolysis gas
- Combustion of pyrolysis gas
- Char yield



Gasification

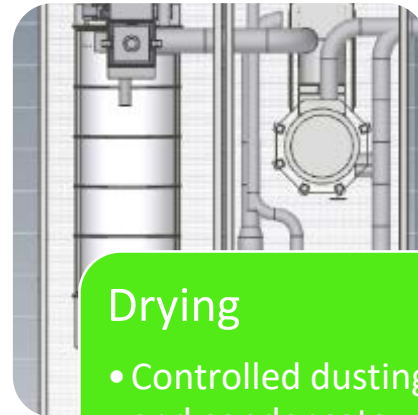
- Conversion rate
- Ash control

WoodRoll® – Achievements



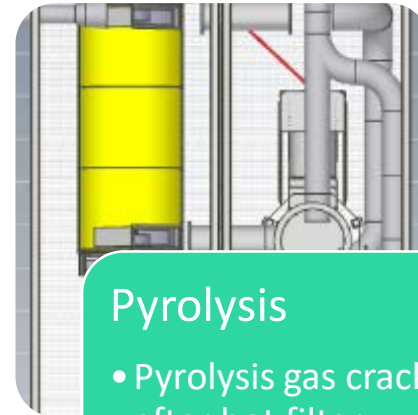
Biofuels

- 20 biofuels verified



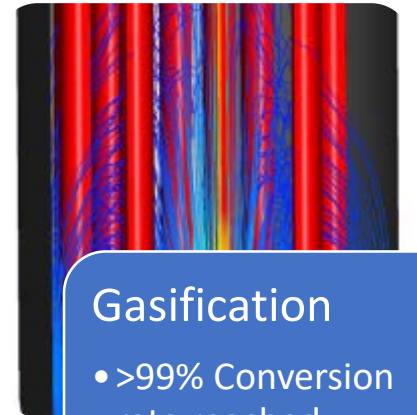
Drying

- Controlled dusting and condensate
- Single percentage humidity in operation



Pyrolysis

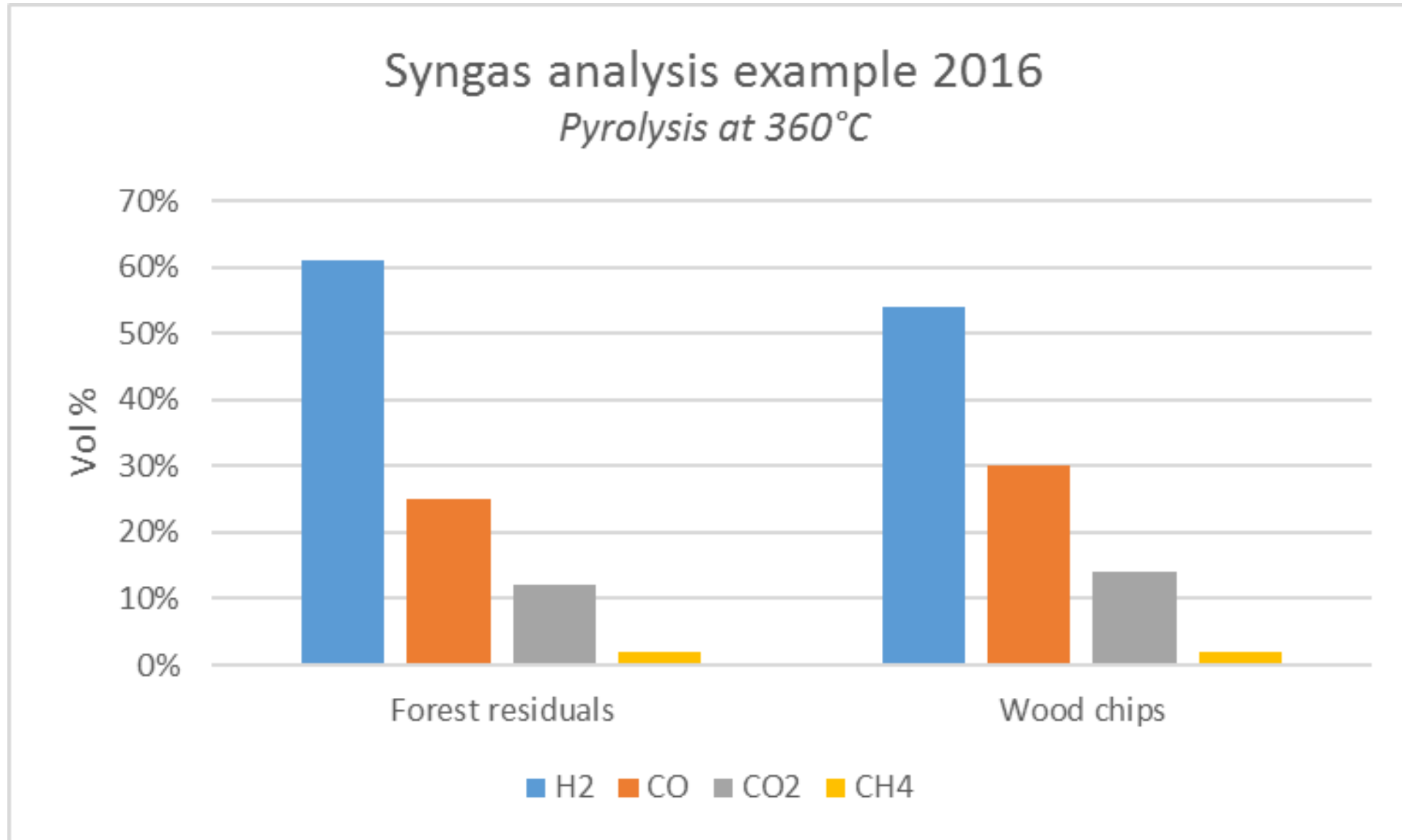
- Pyrolysis gas cracked after hot filter
- Combustion stable
- Char yield [T, X_i] 35% +/-10%



Gasification

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

WoodRoll® – gas composition



4. Business projects

1 Höganäs AB

2 Forest Energy

3 Mariposa



4.1 Probiostål project

Höganäs AB

4.1.1 WoodRoll® in Höganäs

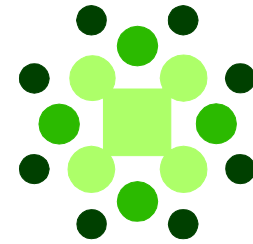
Höganäs AB and Cortus AB collaborate for renewable energy under a 20 years renewable energy supply contract

- 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).

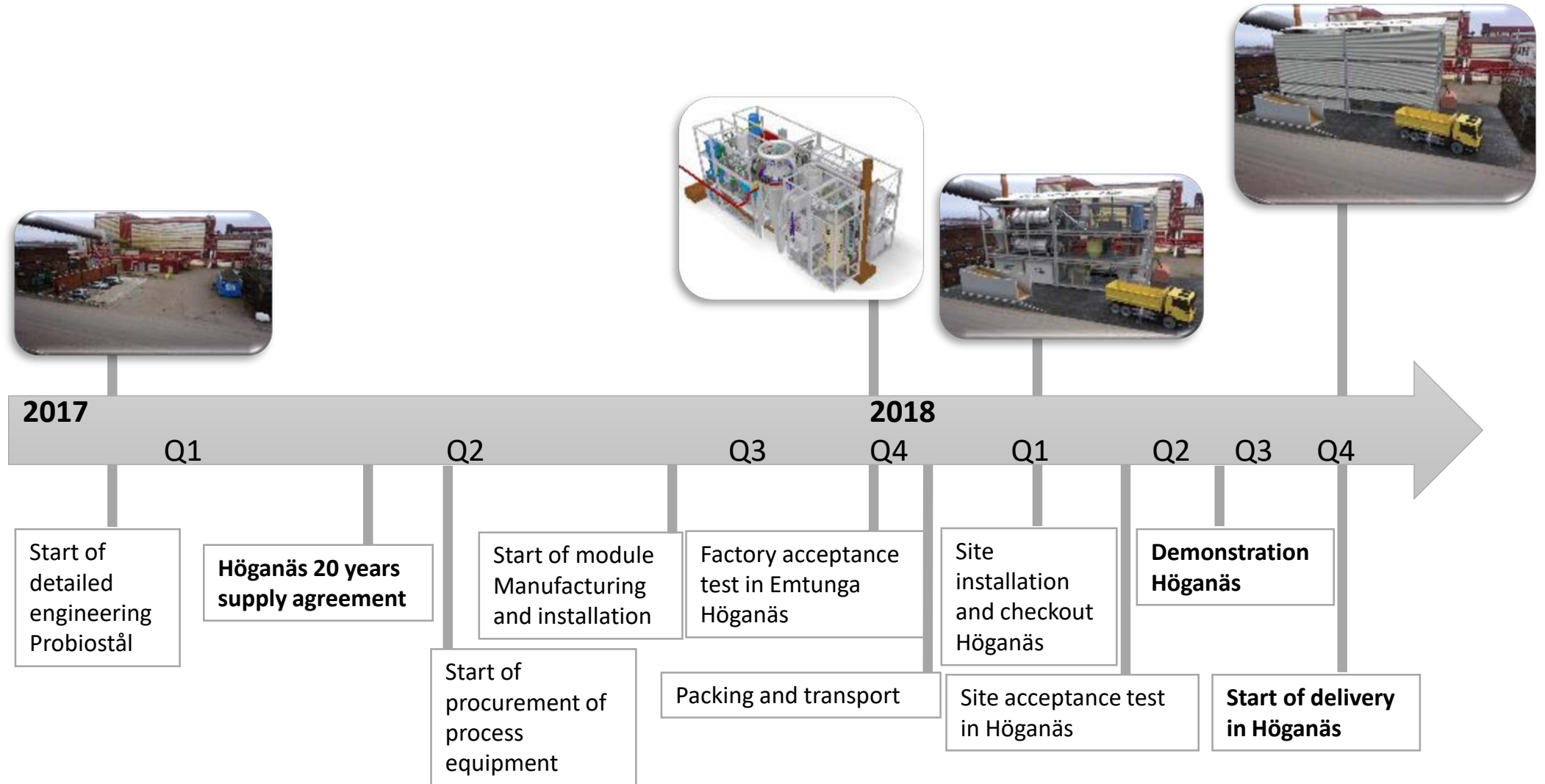
4.1.2 WoodRoll® in Höganäs - background

- 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.

4.1.3 Project partners

The logo for ABB, consisting of the letters 'ABB' in a bold, red, sans-serif font.The logo for Calderys, featuring an orange stylized flame icon to the left of the word 'calderys' in a black, lowercase, sans-serif font.The logo for Höganäs, featuring the word 'Höganäs' in a blue, sans-serif font.The logo for Cortus Energy, featuring the word 'CORTUS' in a large, bold, green, sans-serif font, with the word 'ENERGY' in a smaller, bold, green, sans-serif font below it.The logo for Outokumpu, featuring the words 'OUTO' and 'KUMPU' stacked vertically in a blue, sans-serif font.The logo for SSAB, featuring the letters 'SSAB' in a blue, sans-serif font.The logo for Sveaskog, featuring a green stylized tree icon above the word 'SVEASKOG' in a bold, black, sans-serif font.The logo for Södra, featuring a green stylized tree icon inside a circle to the left of the word 'SÖDRA' in a bold, green, sans-serif font.

4.1.4 Project plan



4.1.5 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

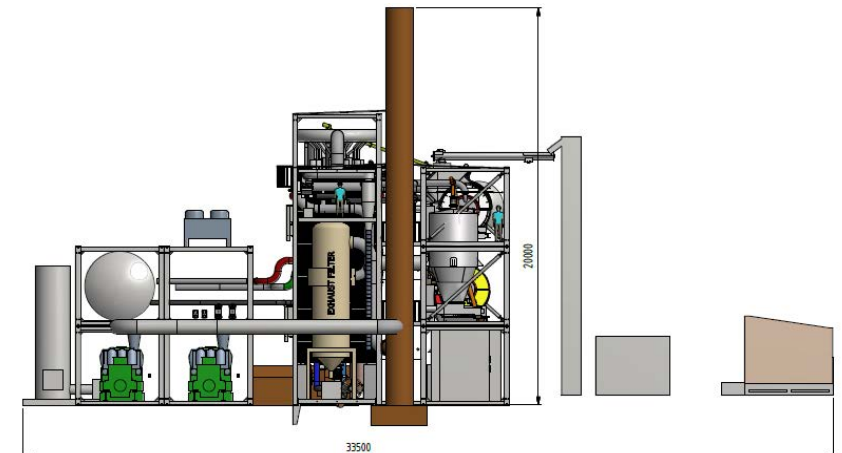
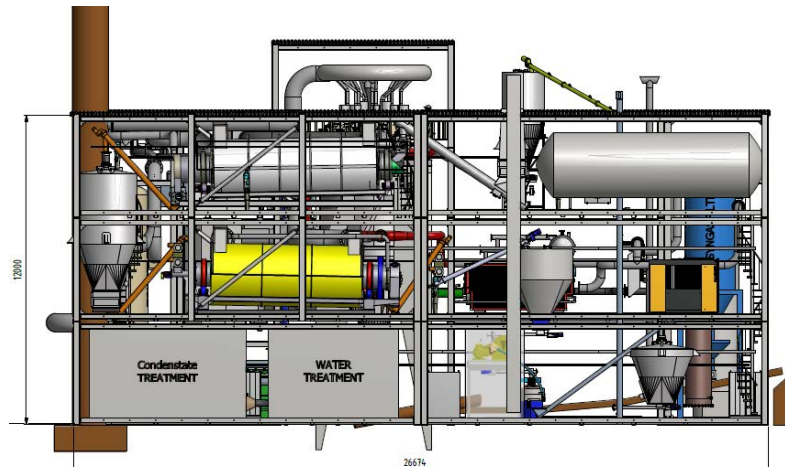
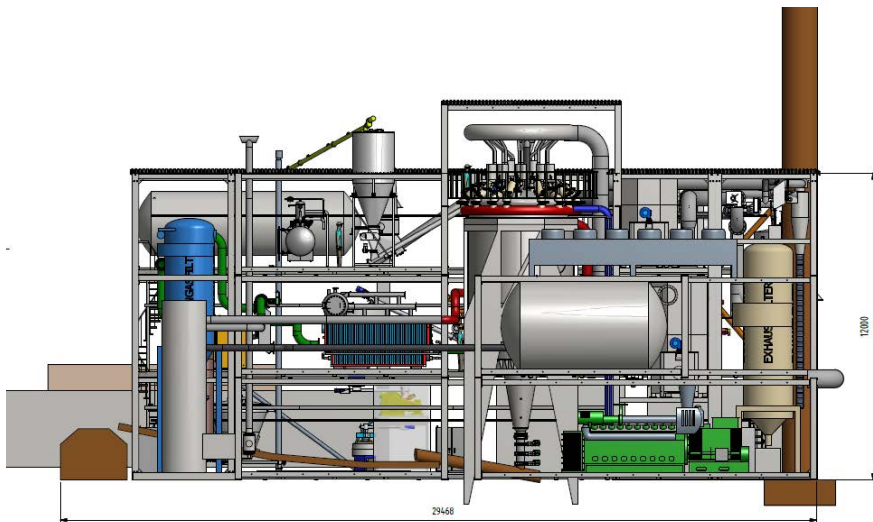
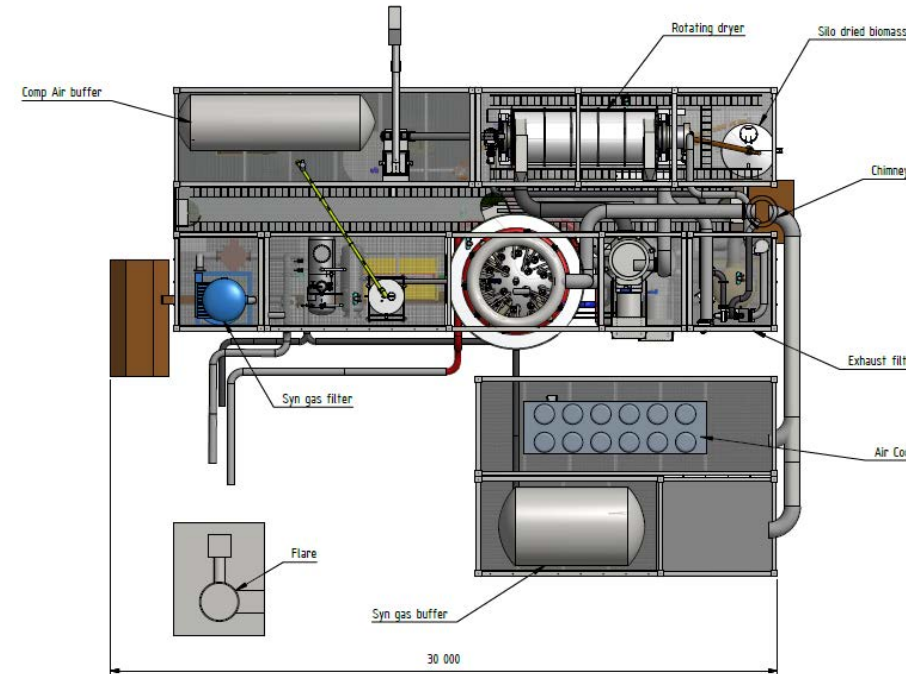
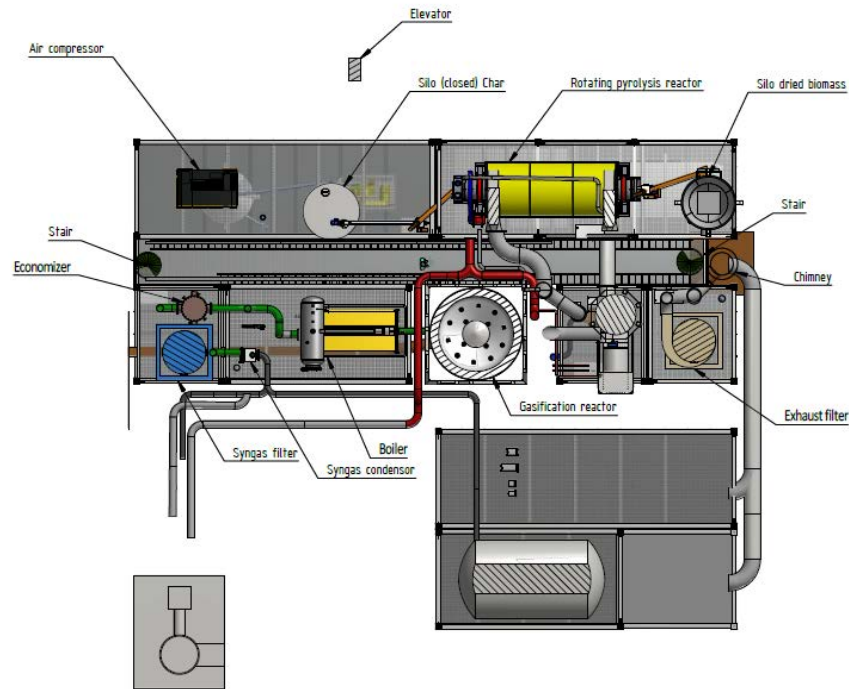
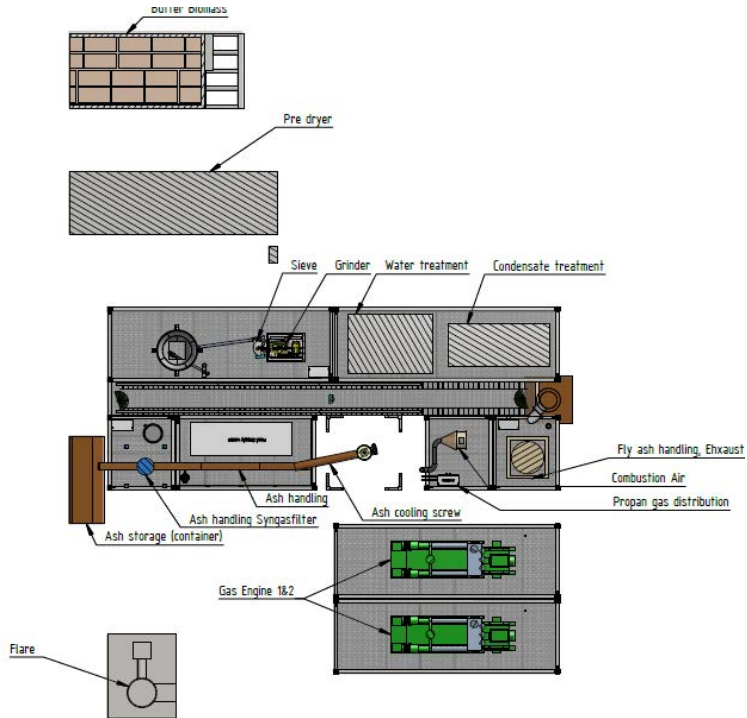
4.1.6 Planned structure for modular plant at site 2018



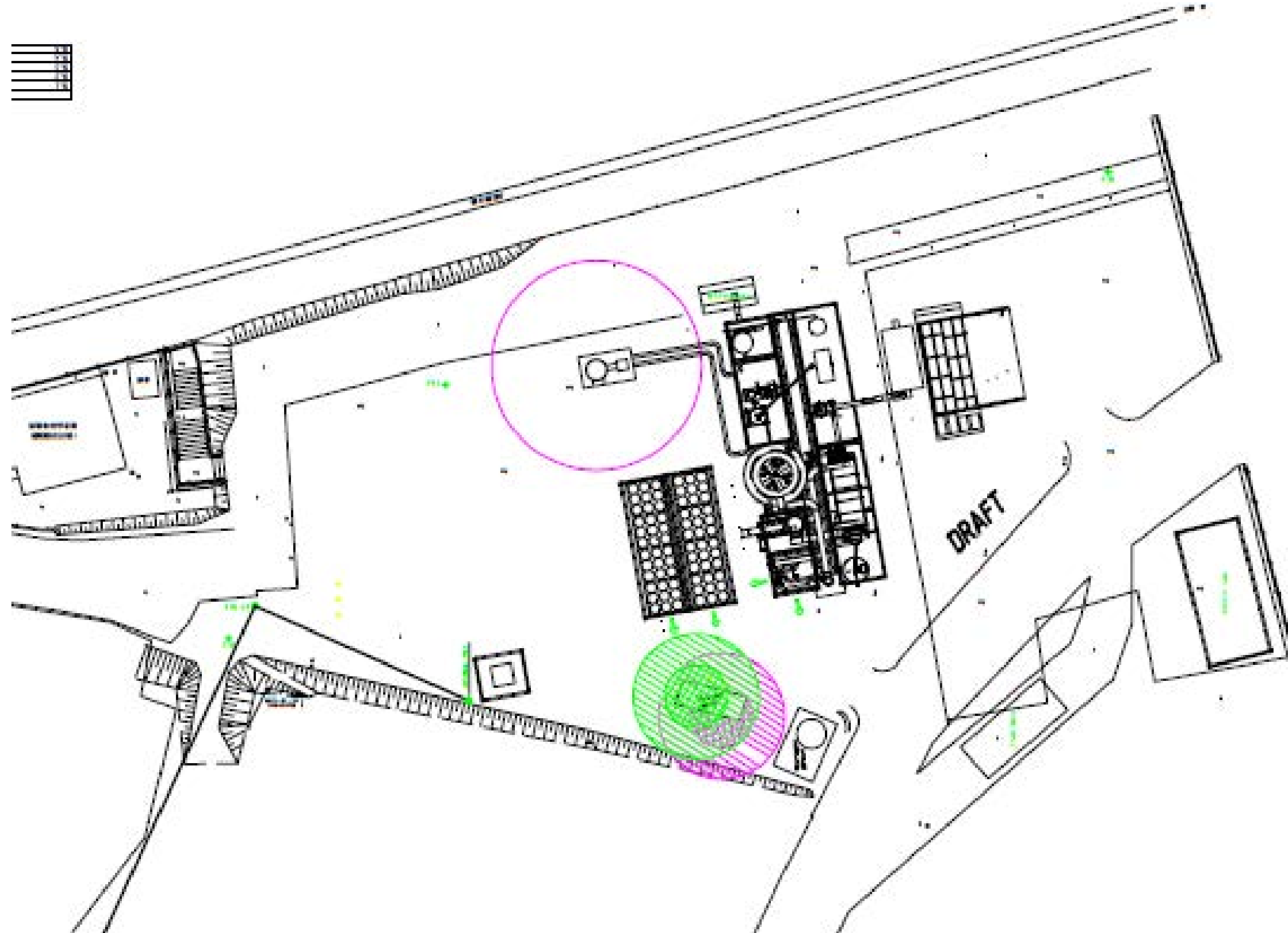


4.2 Forest Energy, Japan

4.2.1 First WoodRoll® plant in Japan



4.2.2 First WoodRoll[®] plant in Japan



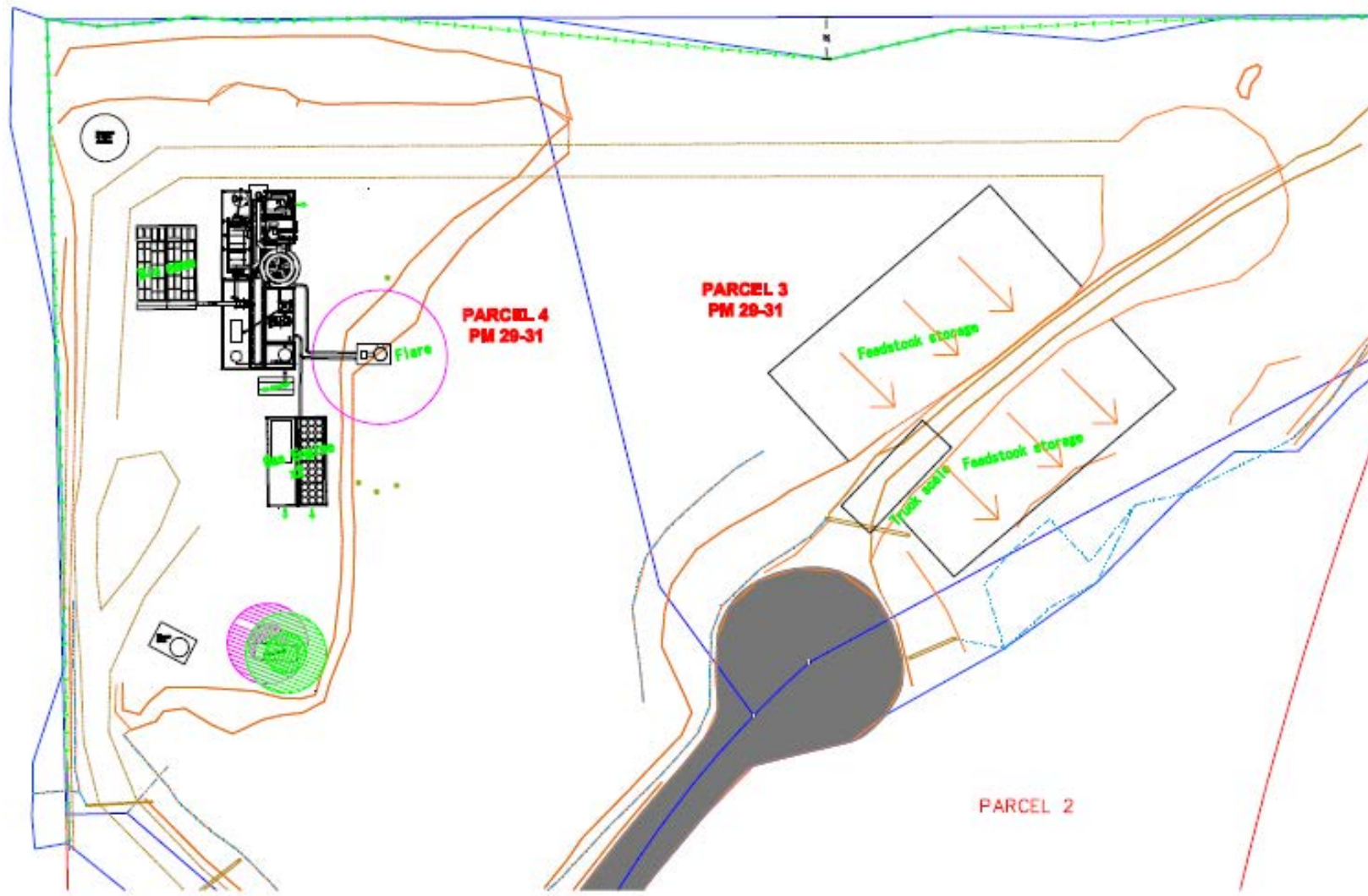


4.3 Mariposa, California

4.3.1 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, possibilities 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.

4.3.2 Mariposa biomass project





5. Next step

