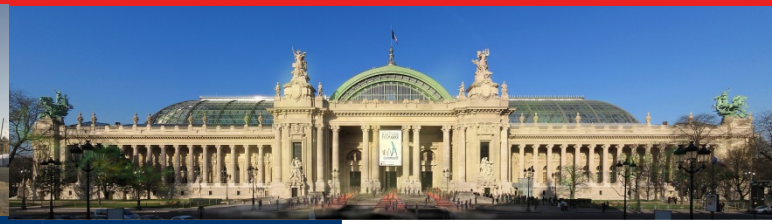
26th World Gas Conference

1 – 5 June 2015, Paris, France



The GAYA Project : Towards industrialization of an innovative 2G Biomethane pathway

Thematic Workshop WOC 5.4/TT1 Renewables

Dr. Ing. Olivier Guerrini
ENGIE – Research and Technology Division - CRIGEN

WGCPARIS2015
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How to produce Biomethane from Biomass ?

1 2 3 4 5 6 7 **8** **9** — ***TRL status*** — 1 2 3 4 5 **6** **7** **8** 9

Wet biomass
preferably without lignin
Organic wastes, manure, WWT sludge, agri residues

Organic matter degradation by microorganisms **without air**

Biological conversion
ANAEROBIC DIGESTION
Low temperatures (15 – 55°C)

η ≈ 15 - 60%

CH_4 CO_2, traces H_2S…

BIOGAS

Water removal
Sulphur removal
Dust removal

GAS TREATMENT

UPGRADING

Technical challenges

BIOMETHANE

2G

Dry – wet biomass
Lignocellulosics
Wood, straw

η ≈ 60 %

Thermal conversion
GASIFICATION
High temperatures
(700 up to > 1500°C)

Process close to combustion with oxygen shortage where solid biomass is volatized into a gaseous fuel.

SYNGAS

H_2, CO, CO_2, CH_4

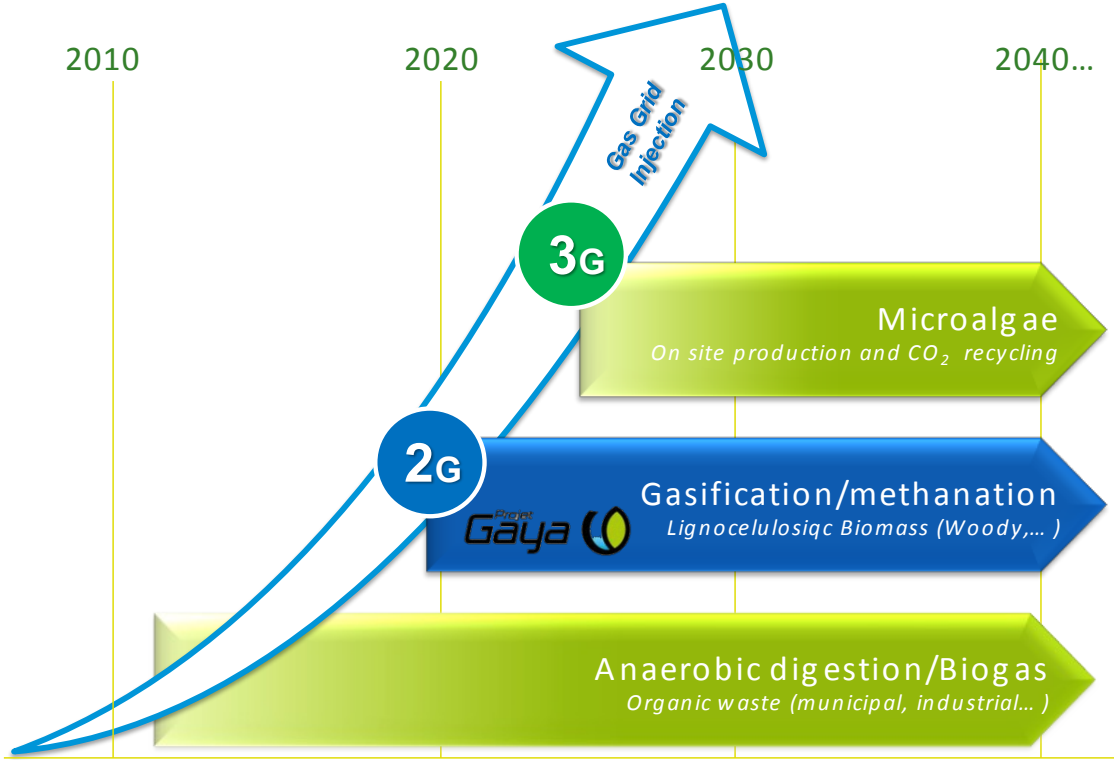
GAS TREATMENT

Tar removal

METHANATION

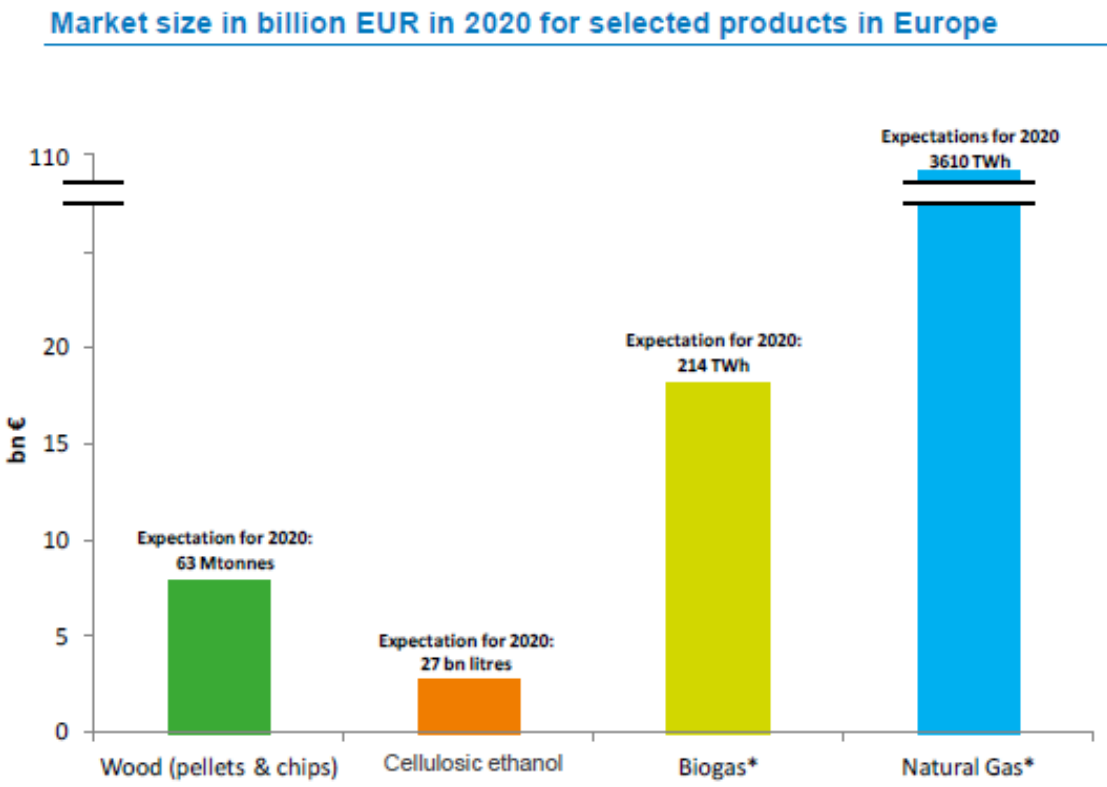
C_2H_4 … → H_2 + CO
$3H_2$ + CO → CH_4 + H_2O

Technology RoadMap and potential assessment



R&D needs	Technical maximum potential 2050 France	Technical maximum potential 2050 Europe
+ + + Concept proof	23 TWh	
+ + Pilot scale	257 TWh ~ 1000 plants	> 560 TWh
+ Available	185 TWh ~ 20 000 plants	> 500 TWh

Market Size analysis

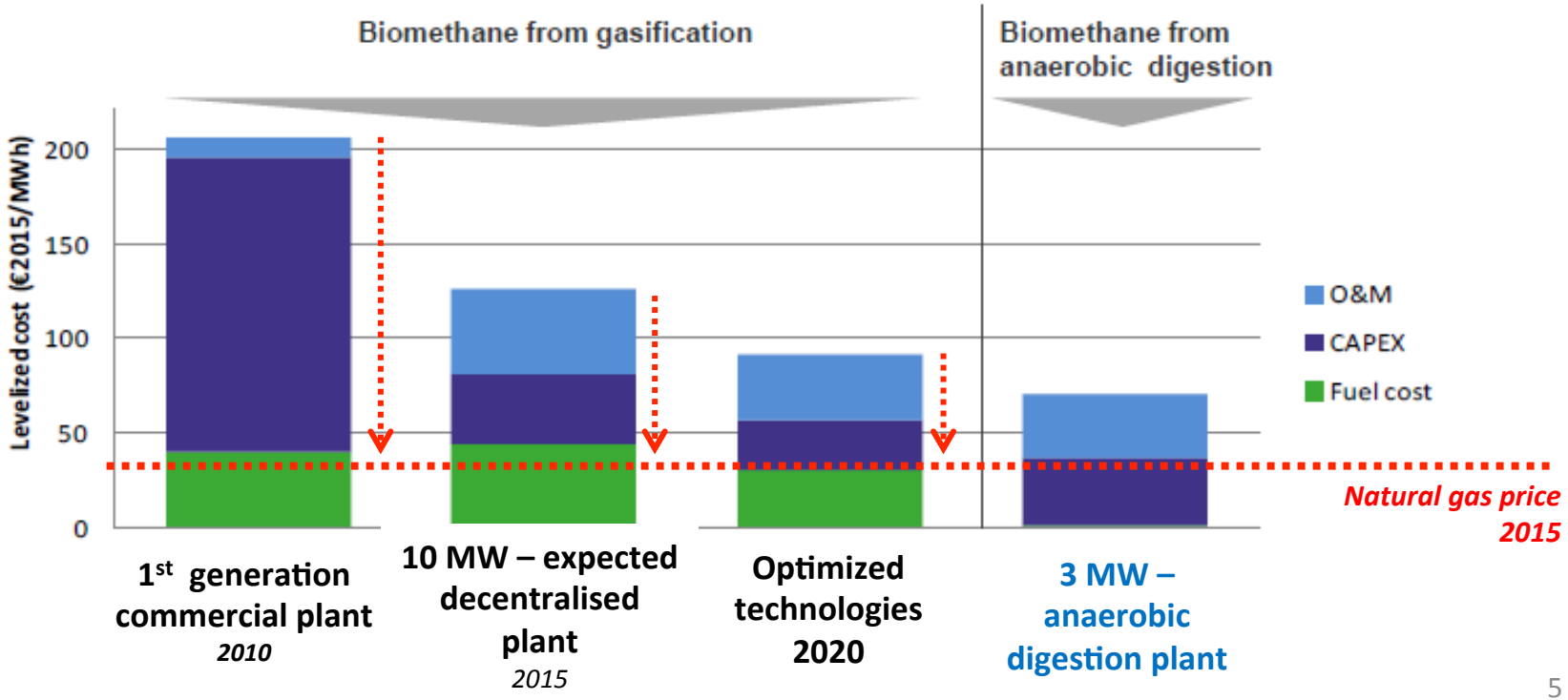


* 11 selected European countries: France, Italy, Belgium, Austria, Switzerland, Germany, Spain, UK, Netherlands, Poland, Finland

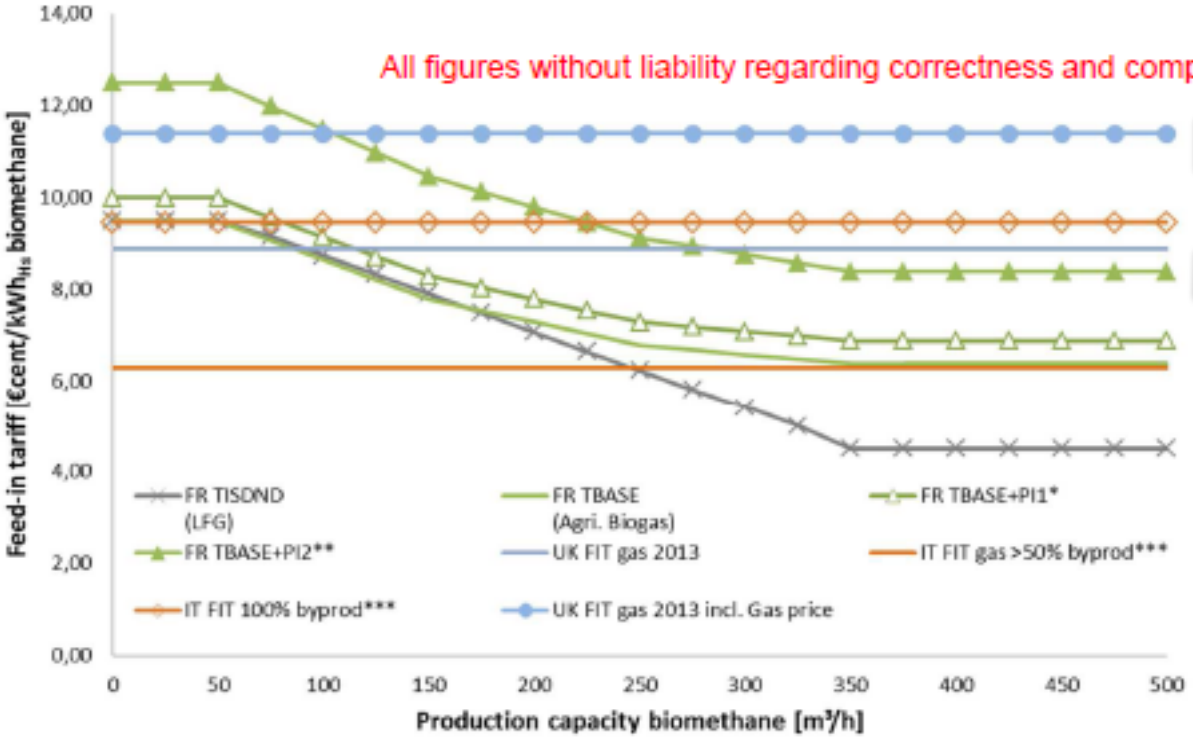
- Biomethane market estimated in 2020 with a price of 85€/MWh compared with natural gas with a price of 30 €/MWh

2G : Cost reduction and technology improvement

Comparison of levelized cost of biomethane for different projects (€/MWh)



Regulation and incentive on the Road for 2G



11,8 €/kWh

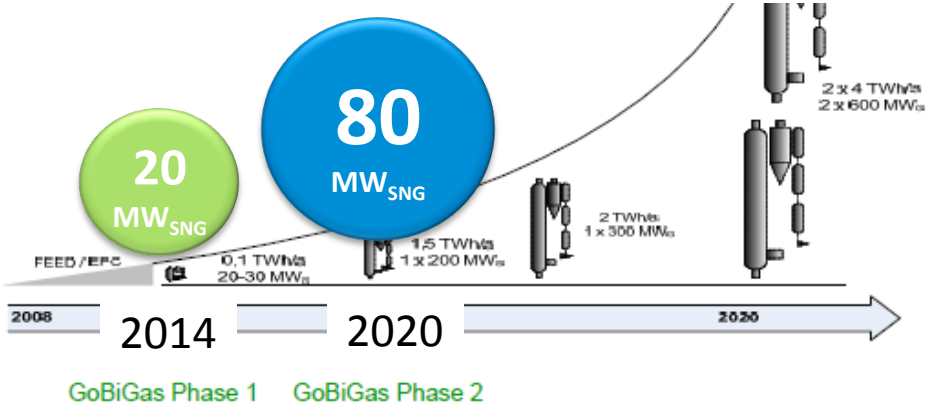
6 - 12 €/kWh

6 – 9 €/kWh

*PI1 - Premium for municipal waste **PI2 - Premium for agroindustry waste
*** new built plants that sell to GSE, gas injection only

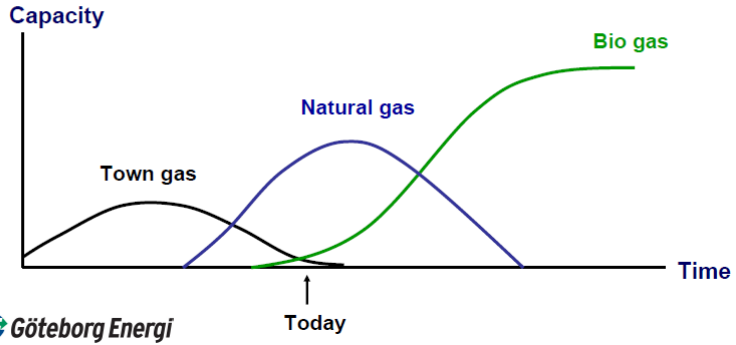
2G Biomethane : an industrial reality in Sweden

- **Project plant GOBIGAS**
- **Owner : City of Goteborg**
- ***Plant operator : Goteborg Energi***
- **Scale :** 20 Mw_{output} / 34 Mw_{input}
- **Technology** : REPOTEC (gasification) + Haldor-Topsoe (methanation)
- **Overall efficiency : 62%**
- **Fuel : Wood**
- **Status : in commissioning**



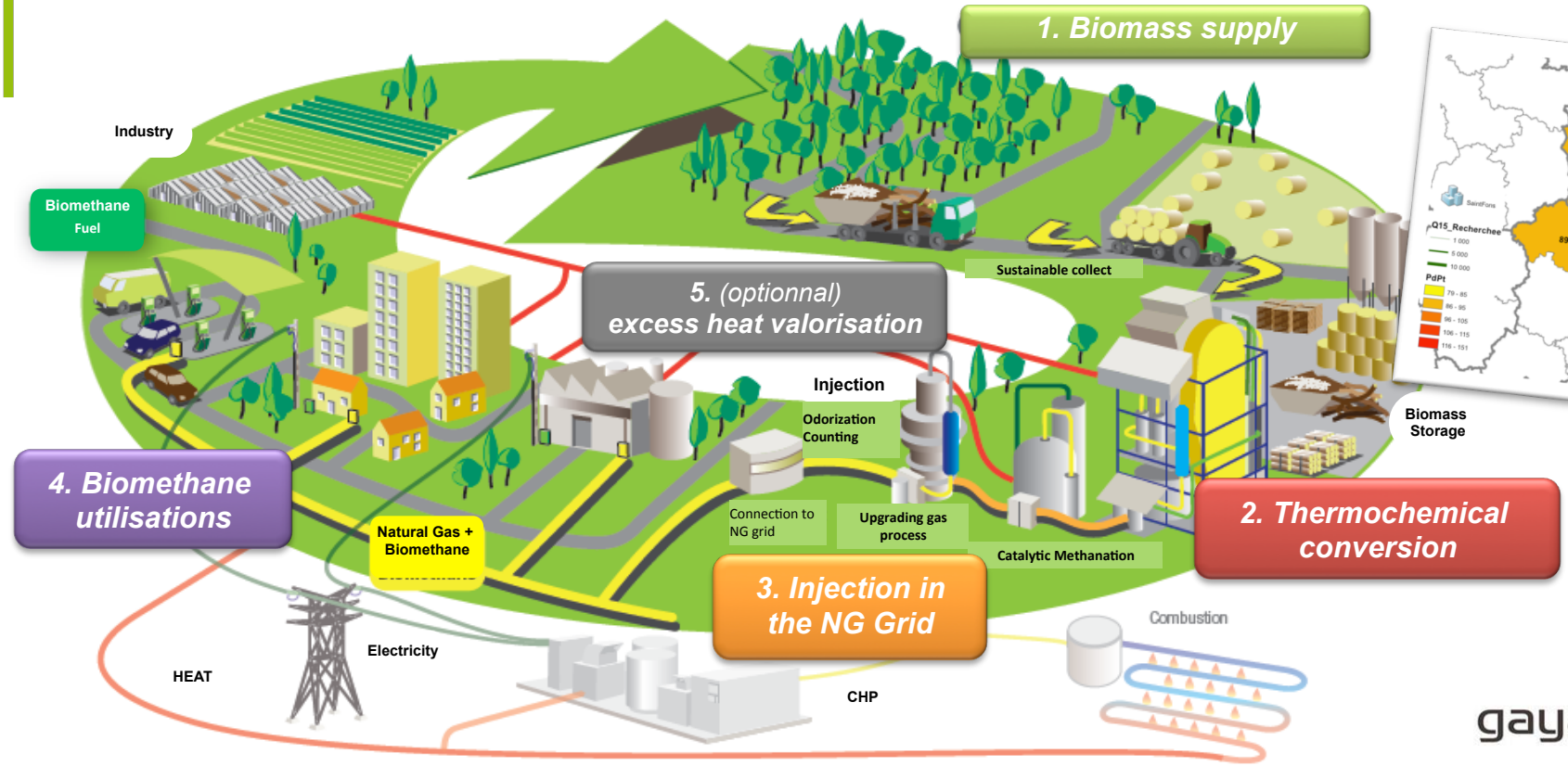
Short term target 2020 > 1 TWh of Bio – SNG

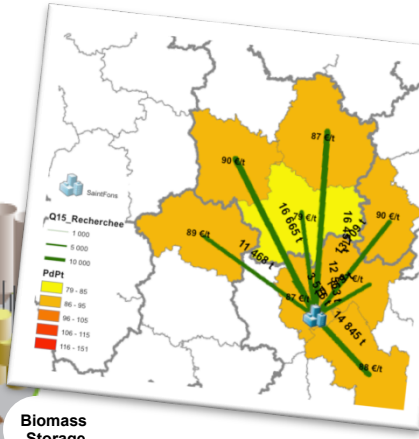
Long term target 2050 – only renewable energy sources



Göteborg Energi

Biomethane form Wood : A decentralised concept





gaya

- Biomethane plant size target : **20 à 80 $MW_{Biomethane}$** - **100 – 300 kT biomass** – Enlarge feedstocks base

The GAYA Project : innovation for competitiveness

2011 — **R&D** Lab Concept

2017 — **R&D Pilot**

2020 — **Industrialization**

gaya

400 kW_{bioSNG}

30 Nm^3/h

20 à 80 MW_{bioSNG}

2 000 - 8 000 Nm^3/h

- Validate at pilot scale **a integrated portfolio of technology solutions** to **support industrial deployment** of 2nd generation Biomethane pathway
- Develop a **profitable industry** by 2020 → **need to reach competitive costs for 2G Biomethane**

The GAYA Project

- Budget of 47 M€ on 9 years with 18,7 M€ of subsidies from ADEME
- 1 R&D demonstration platform with the
- complete chain of conversion process
- 11 Partners
- Team :
  - 16 persons in ENGIE
  - 35 in partners entities

The GAYA Demo Platform

2011 → Kick Off

2012 → 1st eng studies
Location site

2013 → Permitting / 1st stone

2014 → Basic eng

2015 → Detail eng
Civil work / contracting

2016 → 1st blocks deliveries

2017 → Inauguration

2018 R&D / Demo Phase

2019 → End of the project

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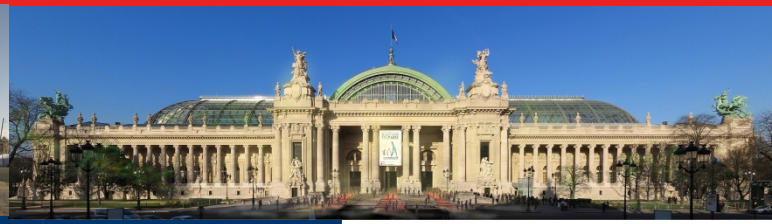

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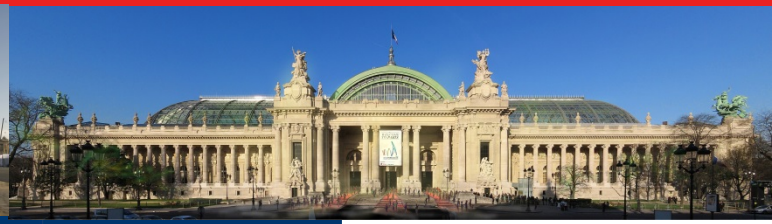

APPENDICES

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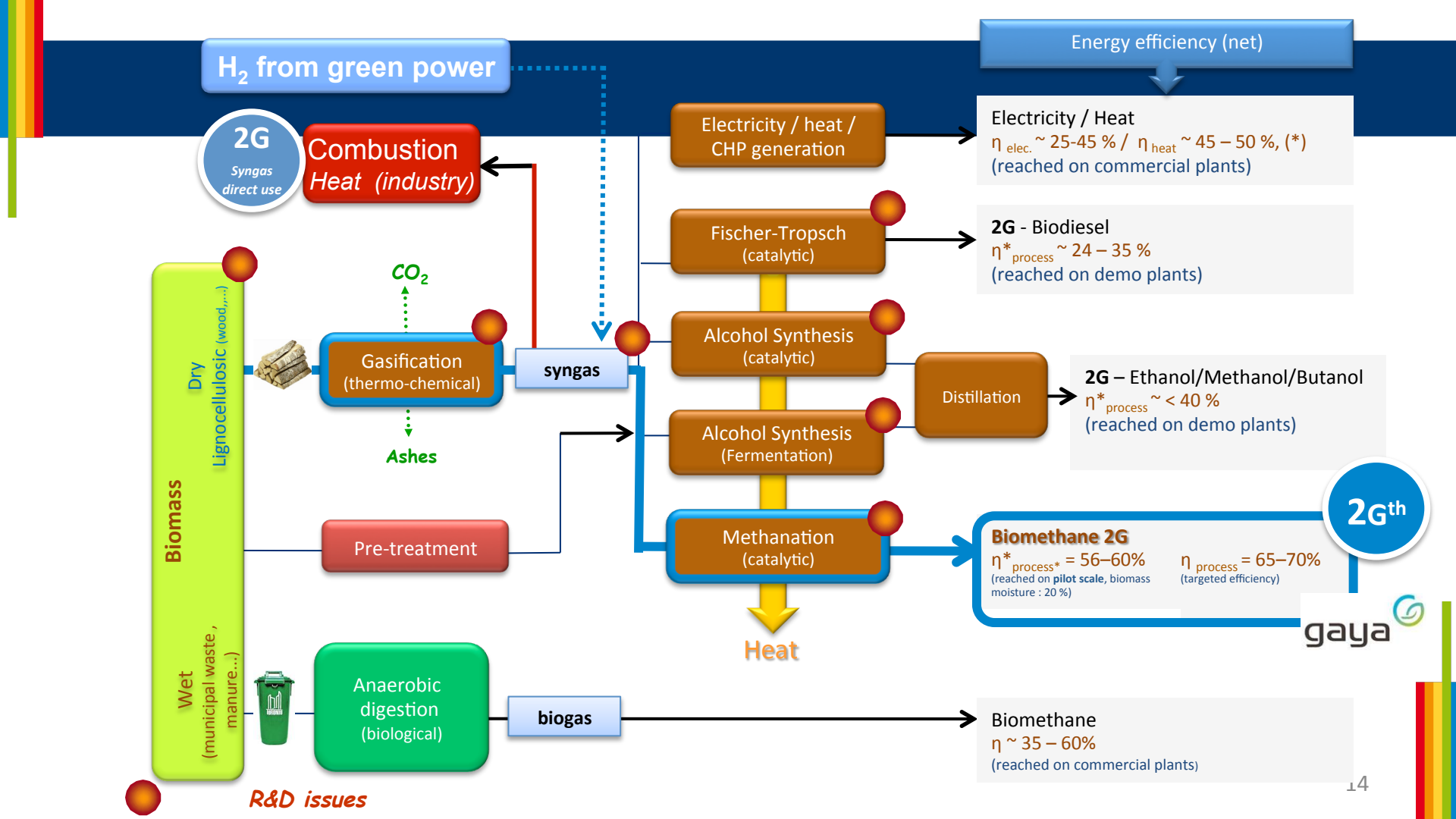
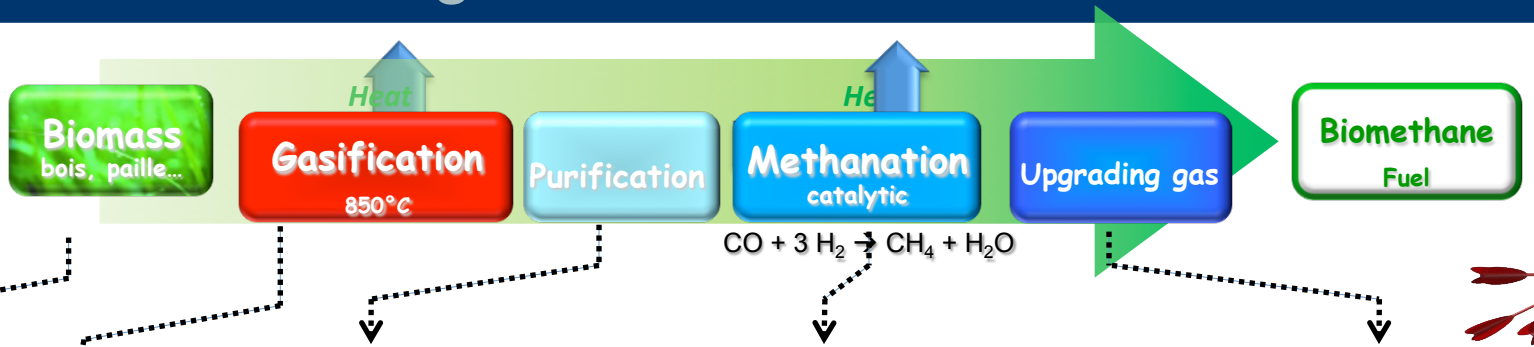

H_2 from green power
Energy efficiency (net)
2G
Syngas direct use
Combustion
Heat (industry)
Electricity / heat / CHP generation
Electricity / Heat
$\eta_{elec.}$ ~ 25-45 % / η_{heat} ~ 45 – 50 %, (*)
(reached on commercial plants)
Fischer-Tropsch (catalytic)
2G - Biodiesel
$\eta^*_{process}$ ~ 24 – 35 %
(reached on demo plants)
CO_2
Biomass
Dry Lignocellulosic (wood,...)
Gasification (thermo-chemical)
syngas
Alcohol Synthesis (catalytic)
Distillation
2G – Ethanol/Methanol/Butanol
$\eta^*_{process}$ ~ < 40 %
(reached on demo plants)
Ashes
Alcohol Synthesis (Fermentation)
Pre-treatment
Methanation (catalytic)
2Gth
Biomethane 2G
$\eta^*_{process*}$ = 56–60%
(reached on pilot scale, biomass moisture : 20 %)
$\eta_{process}$ = 65–70%
(targeted efficiency)
Heat
gaya
Wet (municipal waste , manure...)
Anaerobic digestion (biological)
biogas
Biomethane
η ~ 35 – 60%
(reached on commercial plants)
R&D issues

Technical Challenges



Flexibility and OPEX reduction

CAPEX reduction and syngas quality improvement

A complex technical barrier

- *Need to improve understanding of the processing units and innovate on combination (reforming, advanced scrubbing,…)*
- *CAPEX reduction, Tars recycling and energy recovery are the key drivers for tech improvements*

Some technical and economical gaps

- *Current commercial processes are not economically suitable to biomass conversion*
- *A promising methanation technologies need to be developed and industrialized*
- *Process integration with the upgrading gas part is one of the key drivers*

Efficient conventionnal technologies but need a tight integration

- *Lowering CAPEX*
- *Decrease electricity consumption*
- *Better integration with methanation and gasification*
- *Reduce methane losses and compression needs are the key drivers*

15