



VESTA Methanation Applications for Small Scale, Multipurpose, Green SNG Production

Presenter: Guido Collodi

Amec Foster Wheeler Italiana (a Wood Company)

Convegno ATI ANIMP - Dalla SEN alla de-carbonizzazione possibile con l'obiettivo della crescita economica

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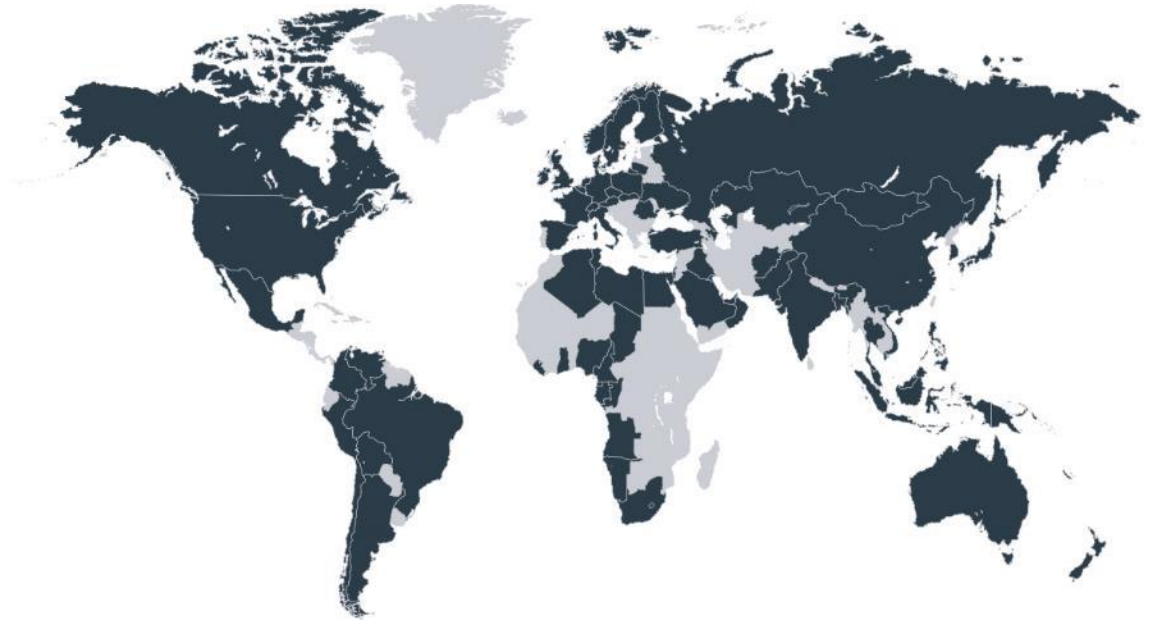
Over 160 years
experience



Wood in short

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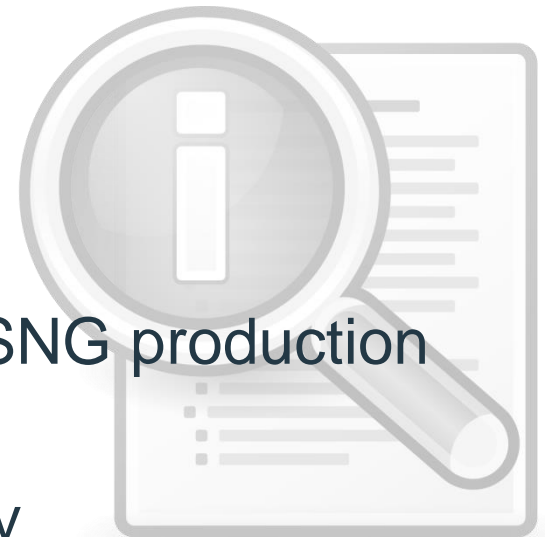
- We have an unmatched global footprint
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- Unlocking our technology across an incredible sector spread



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- ▶ Introduction to Bio-SNG production
- ▶ Decree on Biomethane
- ▶ Alternative process schemes of Bio-SNG production
- ▶ Methanation brick: VESTA technology
- ▶ Techno-economic assessment of the alternative process schemes
- ▶ Conclusions



Background to Bio-SNG production

► What does “SNG” mean?

Substitute Natural Gas (SNG) is the natural gas that can be produced from coal or biomass (Chandel et al., 2009)

- 
- Alternative to expensive natural gas in countries like China where in-house natural gas resources are not present
 - Green natural gas

Background to Bio-SNG production

- ▶ **Bio-SNG:** one of the most flexible approaches to decarbonize end demand
 - ▶ Residential heating (including cooking)
 - ▶ Transportation
 - ▶ Cogeneration
- ▶ A practical pathway to final users
 - ▶ Easy connection of production plants to existing natural gas networks
 - ▶ Technologies (for gas clean-up, drying, methanation, ...) are available and mature for commercial application
- ▶ Three alternative renewable pathways
 - ▶ Biomass gasification
 - ▶ Biogas upgrading
 - ▶ Power to Gas



Decree on biomethane to EU's 2020 goals

Panorama

- ▶ The biogas sector represents **a production potential of renewable gas by 2030 of 10 billion Nm³ of biomethane** (80% from agricultural matrices and 20% from organic wastes, non-biogenic sources, and gasification).
- ▶ The production process of biomethane implicates a **reduction of greenhouse gas emissions**.
- ▶ The previous Legislative Decrees on biomethane (D.M. 5 Dicembre 2013 and D.M. 10 ottobre 2014) have been strongly criticized by the operators of the agro-energy sector due to the lack of success of the provided actions and procedures.

Target

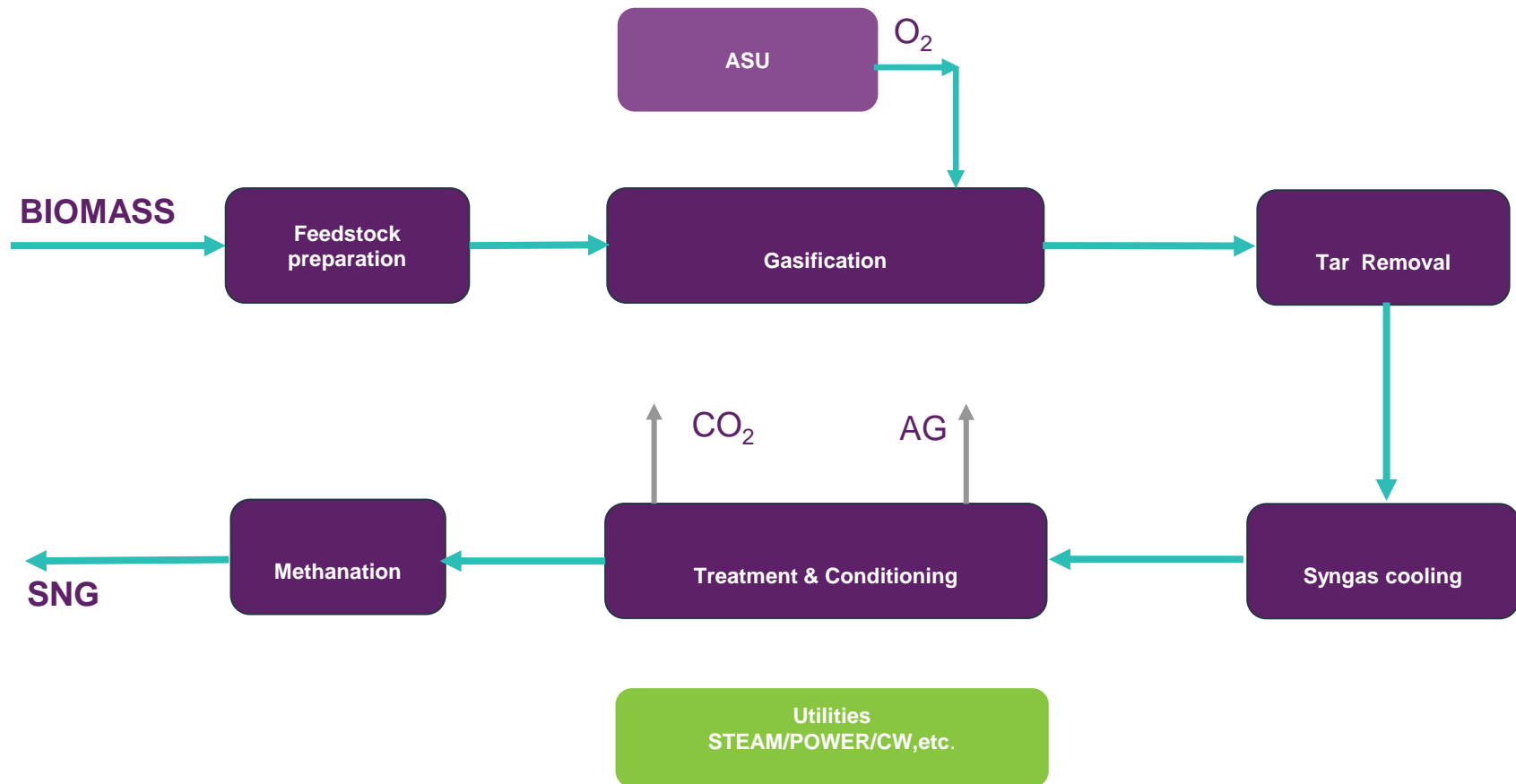
- ▶ Achievement of the amount of renewable energy sources in the sector of transportation according to **2020 standards**.

Actions

- ▶ The new decree (March 2018) establishes a **minimum price for the certificates C.I.C.** (Certificati di Immissione in Consumo) derived from the use of advanced biomethane in the **transport sector**.
- ▶ 10-years guaranteed value equal to 375 €/CIC ~ **75 €/Gcal**

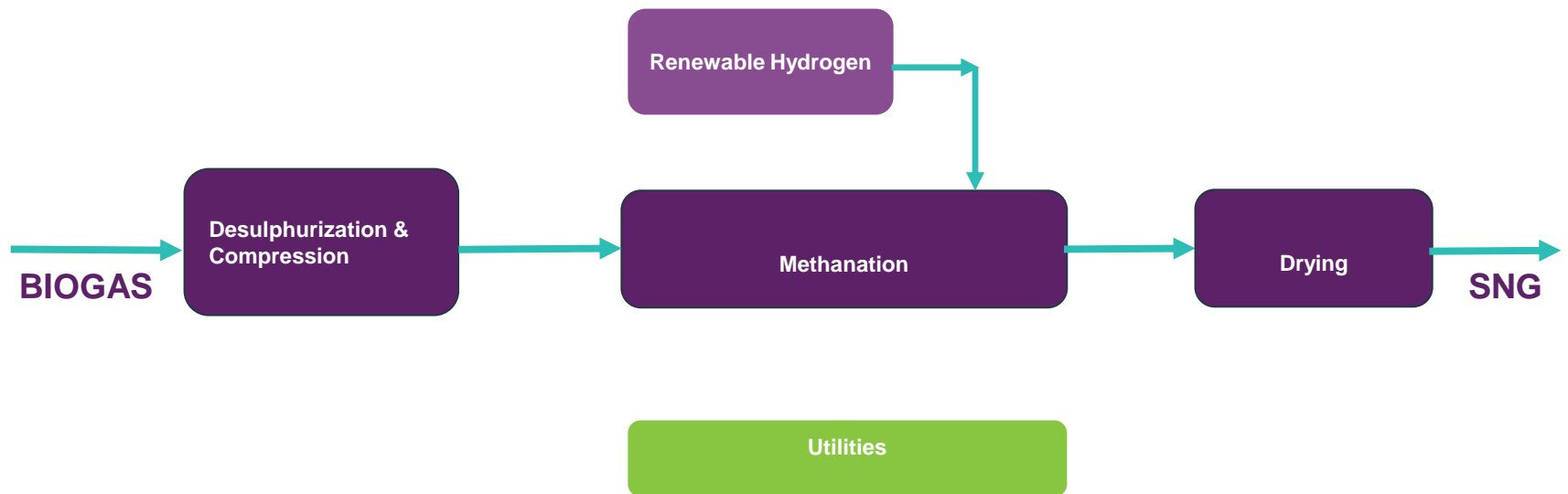
Biomass gasification

Main process blocks: biomass gasification to Bio-SNG



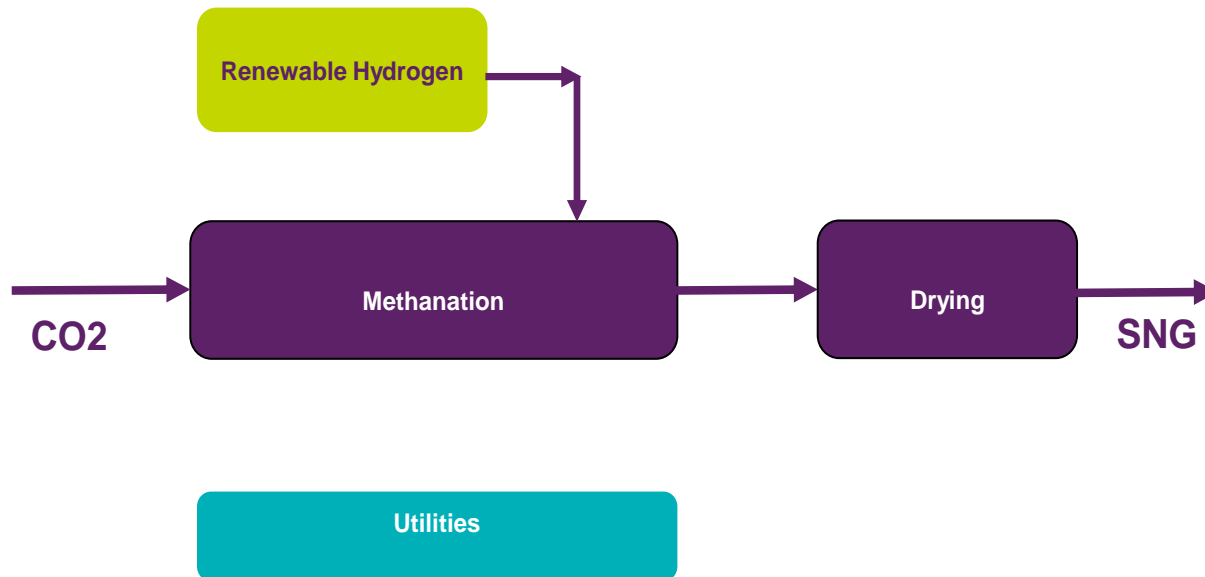
Biogas upgrading

Main process blocks: biogas upgrading to Bio-SNG



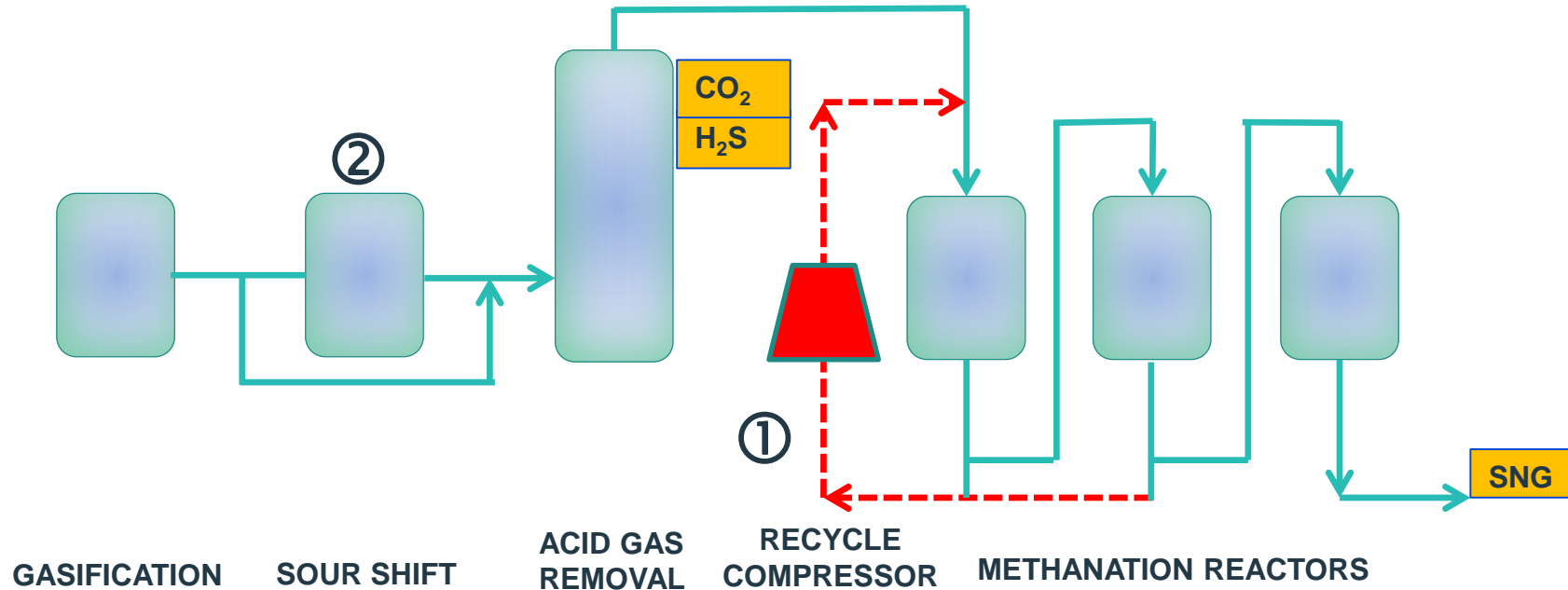
Power to Gas

Main process blocks: integrated Bio-SNG production from Power to Gas application



Technology review - VESTA

► Competing technologies

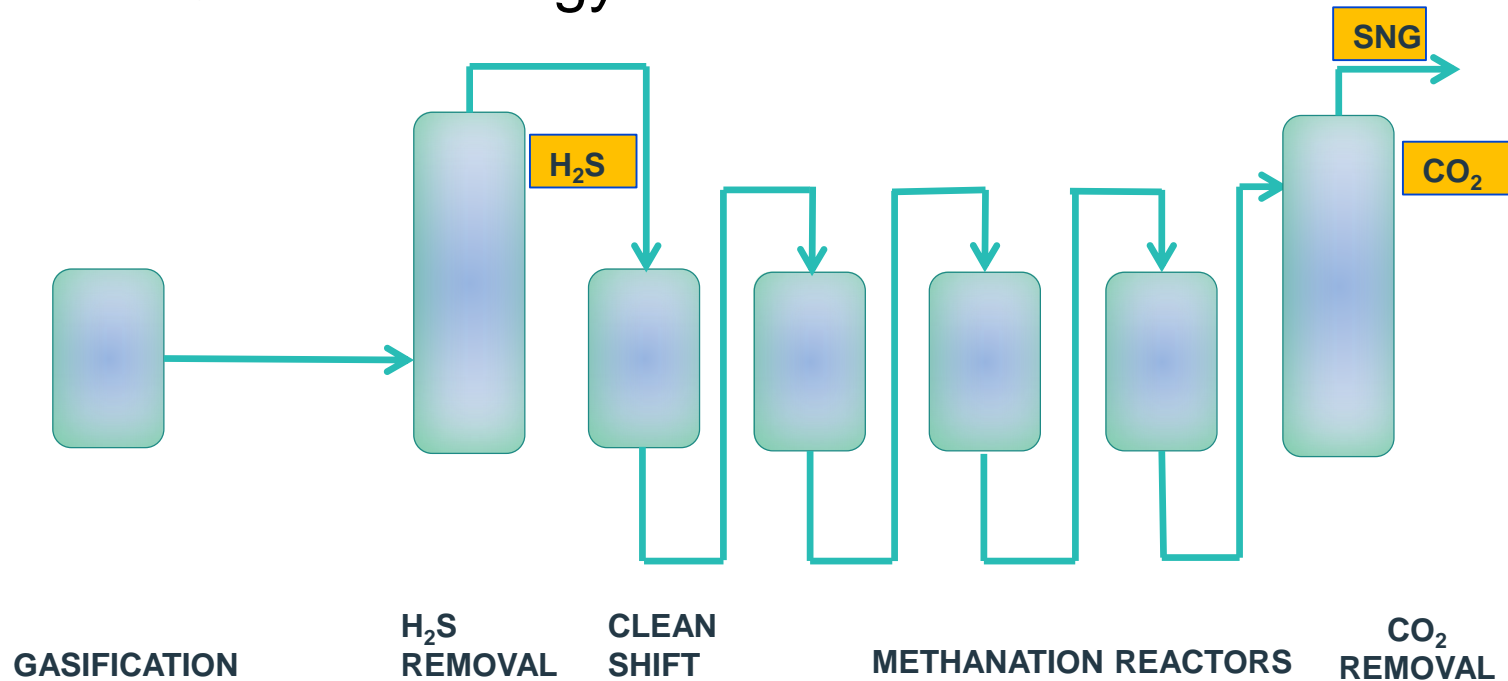


Process characteristics:

- ① Recycle compressor to handle the exothermic reactions (a lot of product gases go through circulation, as a heat transfer medium)
- ② Complex adjustment of the feed gas to achieve on-spec SNG

Technology review - VESTA

► The VESTA technology



Process characteristics:

- No recycle compressor
- CO₂ and H₂O control heat of reaction
- Easy to control

Technology review - VESTA

► Catalyst (high temperature methanation)

- Methanation reactors filled with proprietary Clariant catalyst
- High stability, robust under different conditions
- Suitable for the operating range 230-700 °C (higher than conventional methanation catalysts)
- High CO and CO₂ conversion
- No carbon deposition
- Long operational history and industrial references
- Available as pre-reduced catalyst for simple start-up

► Two Basic Design Packages completed

► First License Sold in Europe

► Based on biomass feedstocks

Technology review - VESTA

- ▶ Wood has signed a cooperation agreement with Clariant International AG (“Clariant”) and Wison Engineering Ltd (“Wison Engineering”) to build a pilot plant to demonstrate the Wood VESTA SNG technology.

Pilot plant:

- ▶ Designed for a production capacity of 100 Nm³/h of SNG and includes all reactors and control system in order to completely demonstrate a real plant in addition to the verification of the chemical reactions
- ▶ Erected in Nanjing, China
- ▶ Two test campaigns have been carried out in 2014 and 2015/2016 to successfully demonstrate a continuous operation at 100% SNG production meeting the Chinese natural gas grid specification, and to test different operating parameters.

Technology review - VESTA

► Methanation: VESTA Pilot Plant



Pilot plant and methanation reactors

Technology review - VESTA

► Methanation: Bio-SNG demonstration plant

The 4.5 MWh Biomass-to-SNG Demonstration Project will establish the commercial feasibility of the Bio-SNG process in the next few months



Advanced Plasma Power Swindon plant

- Funded by the UK's Department for Transport and by National Grid Gas Distribution
- Advanced Plasma Power's Gasplasma® technology to convert biomass to syngas followed by Wood's VESTA SNG technology to convert syngas to substitute natural gas (SNG).
- The Biomass-to-SNG Demonstration scope consist of a Basic Engineering Design (BED) followed by Engineering Procurement & Fabrication (EPF) which includes the following sections:
 - Final gas clean-up (deep desulphurisation, dehalogenation)
 - Clean syngas methanation
 - CO₂ removal system
 - SNG drying
- Wood sections are mechanically completed, while the commissioning of the upstream section are ongoing. Expected start-up date: end of September.

Techno-economic assessment of Biomass-to-SNG

► Case study #1: Biomass gasification to Bio-SNG production

► Main Input Data

Feedstock: Woody materials

Outlet thermal power (SNG): 200 MWh

(or 21,000 Nm³/h)

► Plant Configuration

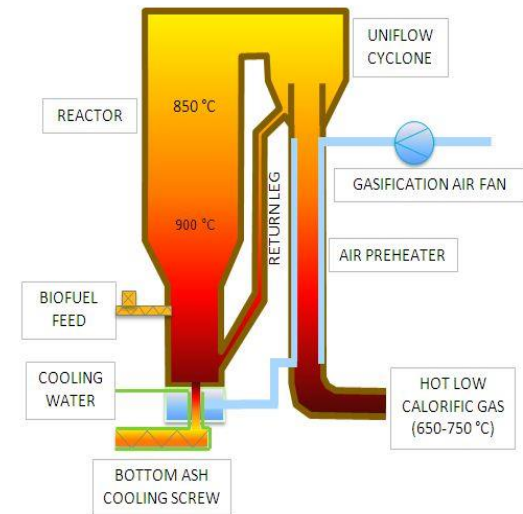
CFB Gasifier pressurized and oxygen blown

Catalytic tar reforming

Physical solvent washing for H₂S removal

VESTA SNG Technology

Chemical solvent washing for CO₂ removal



ITEM	VALUE	UNIT
Inlet thermal power	315-330	MWh
Efficiency (SNG thermal power / Biomass thermal power)	Up to 67	%
SNG production cost (Biomass cost 22 €/ton; Full Equity, I.R.R. 8%)	13.0	\$/MMbtu

Techno-economic assessment of Biogas-to-SNG

► Case study #2: Biogas upgrading to Bio-SNG production

► Main Input Data

Feedstocks: 3 MWh Biogas

550 Nm³/h Renewable Hydrogen

Outlet thermal power (SNG): 4.4 MWh

► Plant Configuration

Electrolyzers for Hydrogen generation

Desulphurization (biological or chemical)

VESTA SNG Technology

ITEM	VALUE	UNIT
Electrical power required for renewable hydrogen production	2.3	MW
Outlet SNG flowrate	455	Nm ³ /h
Electrical power to SNG efficiency	61	%

Techno-economic assessment of Power to Gas-to-SNG

► Case study #3: Power to Gas application to Bio-SNG production

► Main Input Data

Feedstocks: 141 Nm³/h CO₂

550 Nm³/h Renewable Hydrogen

Outlet thermal power (SNG): 4.4 MWh

► Plant Configuration

Electrolyzers for Hydrogen generation

VESTA SNG Technology

ITEM	VALUE	UNIT
Electrical power required for renewable Hydrogen production	2.3	MW
Outlet SNG flowrate	145	Nm ³ /h
Electrical power to SNG efficiency	60	%

Conclusions

- ▶ SNG production via biomass gasification, biogas and Power to Gas applications has been proved to be technically feasible.
- ▶ Considering a middle term forecast for the natural gas price of 8-10 \$/MMBtu the biomass gasification plant can be economically attractive with an incentive in line with what currently applies in Northern Europe, or alternatively considering a monetization for the low level heat integration (e.g., district heating).
- ▶ New Italian decree on biomethane provides a strong potential to biofuel production to meet “2020 goals” by recognizing the value of the C.I.C.
- ▶ Main technologies are available and mature for commercial application.
- ▶ Wood is strongly committed in this field, being technology leader, together with Clariant, of a patented SNG production process (VESTA) that can be applied to shape the future of clean energy.

Thank you

G. Collodi
guido.collodi@woodplc.com

L. Mancuso
luca.mancuso@woodplc.com

F. Ruggeri
fabio.ruggeri@woodplc.com

V. Depetri
valentina.depetri@woodplc.com

**For VESTA enquiries,
please contact
SNG@amecfw.com**

Questions and Answers?!

