

GAYA: PRODUCTION OF SNG FROM DRY BIOMASS AND WASTE PYROGASIFICATION IN FRANCE

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IEA Bioenergy workshop:
*Technology advances in liquid biofuels
and renewable gas*



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GAYA Project key facts

Project co-funded by ADEME within the framework of the Call for Expression of Interest (AMI) and the "Second-generation biofuels" Demonstrator Fund



Objective of the project

Demonstrate the technical, economic and environmental viability of bio-SNG production from gasification

gaya

A 10-year R&D program

11 partners



St Fons/Lyon – France – 500 kW SNG

A unique R&D demonstration platform at semi-industrial scale covering all the process chain

With the support of:

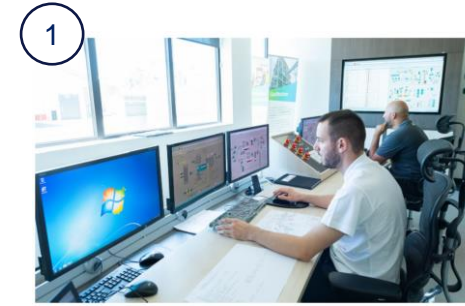
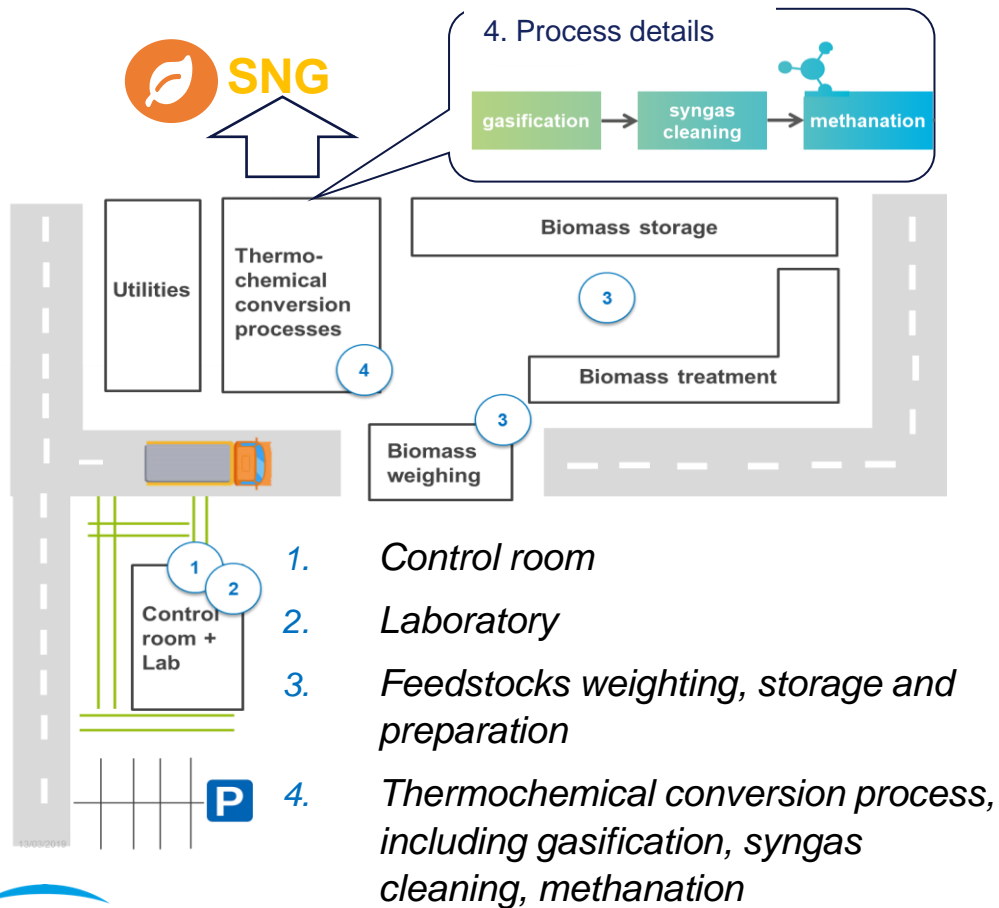


bio-SNG: bio-Substitute of Natural Gas (biomethane)

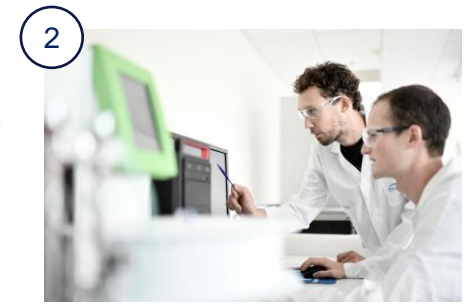


GAYA demonstration plant

A cutting-edge R&D and highly automatized demonstration plant to produce renewables gases from biomass & waste



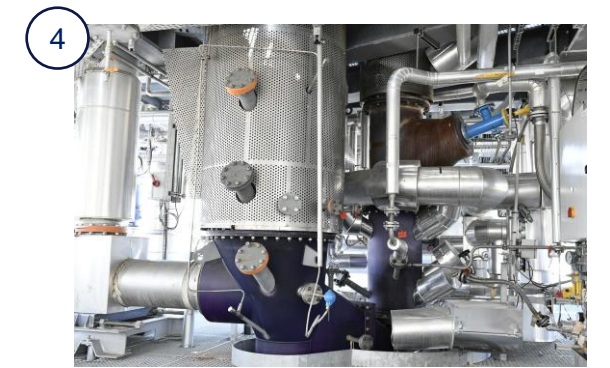
Control room



Analysis laboratory



Feedstock storage & preparation unit



Gasification reactor (dual fluidized bed gasifier (FICFB technology), < Patm., steam)
500-700 kW_{LHV}



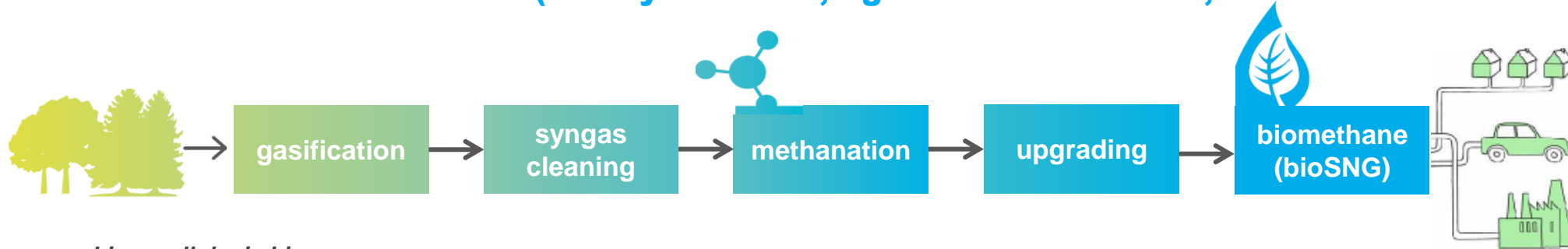
Syngas treatment unit



Reactor installed on the GAYA platform
(~ 400-600 kW_{LHV} SNG)

Sustainable supply and diversification of feedstock

Result# 1: The entire production chain has successfully been operated and proven to be robust and flexible to convert several feedstock (woody residues, agricultural residues, non-hazardous waste...)



Lignocellulosic biomass

Non-hazardous waste

Wood residues
(wood chips / pellets, bark)

Agri residues
(straw, vine stalks..)

Agro-food Industry residues
(olive stones, shells,..)

Energy crops
(miscanthus, eucalyptus..)

Wood waste

Refuse Derived Fuel / Solid Recovered Fuel (RDF/SRF)

Pellets / Fluff

Non recyclable Plastic waste

Sludges (paper sludge, wastewater treatment plant sludge...)

RDF/SRF comes from Municipal Solid Waste, Commercial & Industrial waste and Construction & Demolition waste (defined according to European standard NF-EN-15359 (for more details: [LegiFrance](#)))

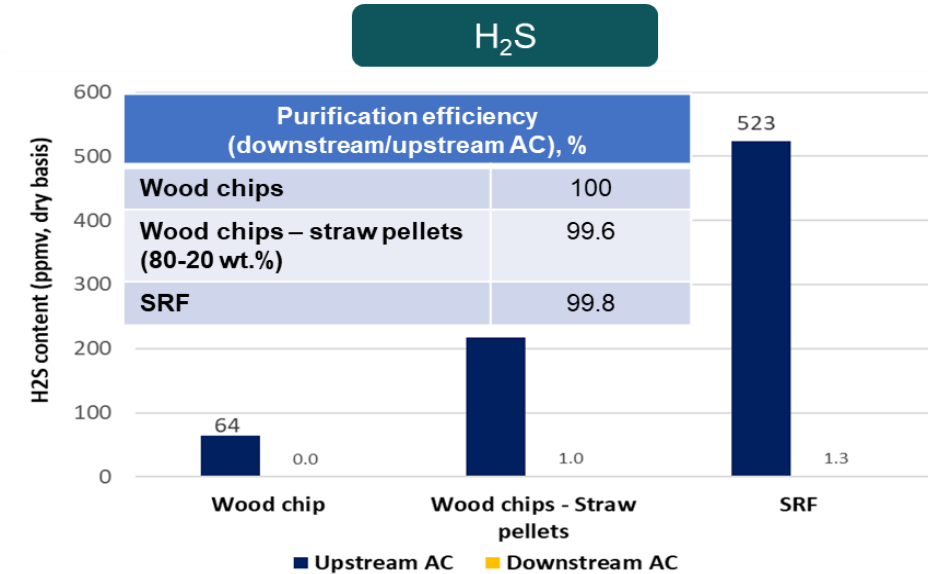
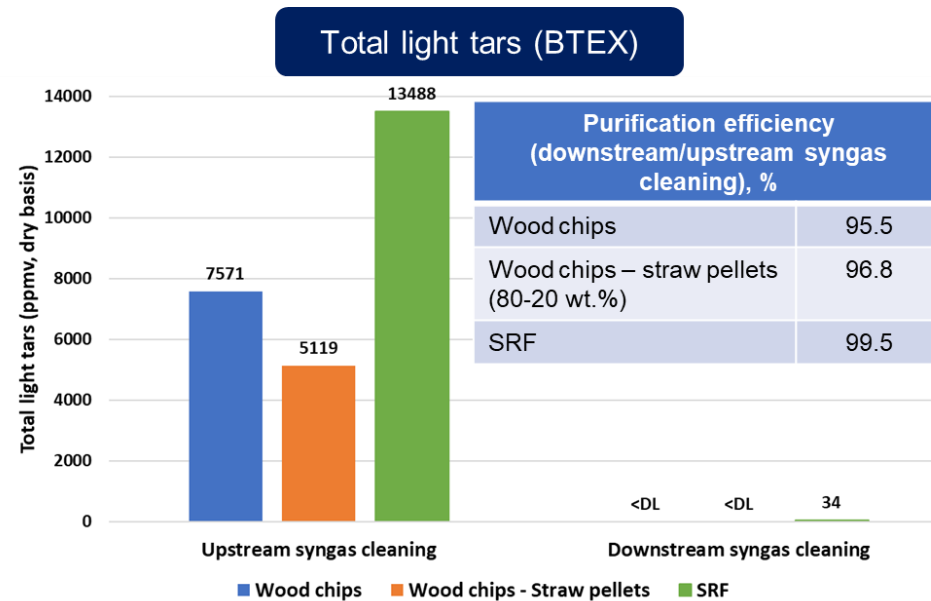


Syngas cleaning

Result #2: the syngas cleaning process chain efficiently removes pollutants (tars, inorganic compounds)

Syngas cleaning process chain:

syngas scrubbing with biodiesel (regenerated), activated carbon beds, Guard bed.



Syngas reach the quality requirements prior to catalytic methanation:

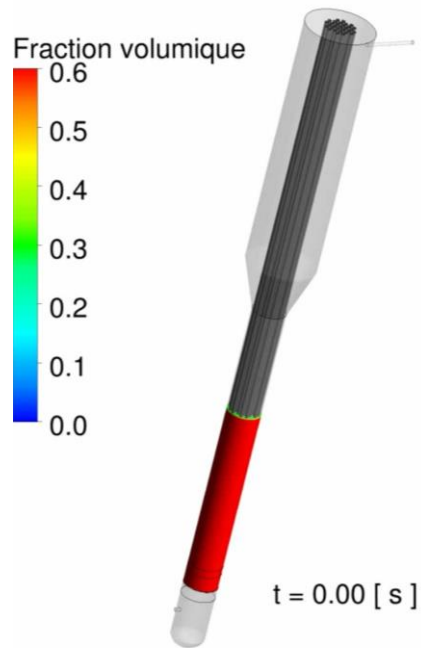
H₂S < 1 ppmv, BTEX < 1 ppmv (independent of the feedstock)

Catalytic methanation

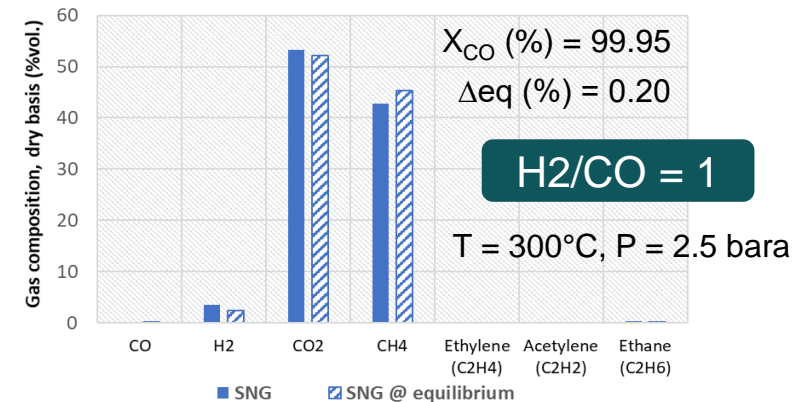
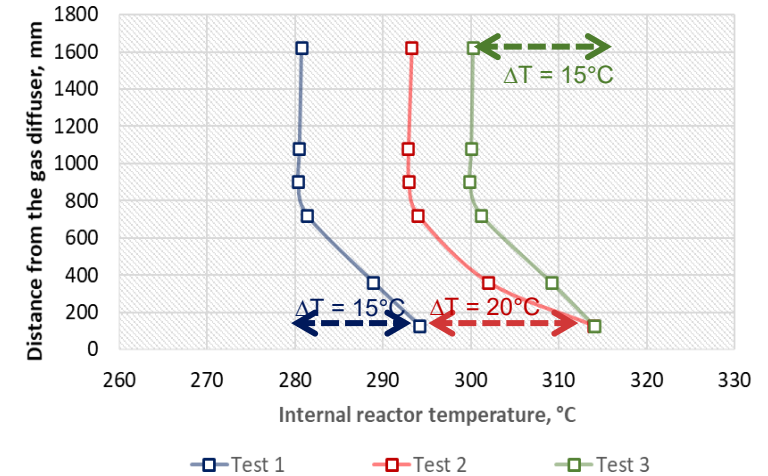
8 ENGIE Patents

Result #3: demonstration at semi-industrial scale (400-600 kW_{LHV} SNG) of an innovative, highly flexible methanation solution to convert syngas into SNG

Isothermal fluidized bed for syngas or CO₂ conversion



- Excellent exothermicity management: ΔT bed < 25°C
- Maximum CO conversion was achieved (< 0.5% deviation from equilibrium) at low pressure (< 5 bara)
- High adaptability of the reactor to operating conditions (stabilization time < 30 minutes)
- Endurable (no attrition) and highly active catalyst ($T > 260^\circ\text{C}$) for CO₂ and syngas methanation



The methanation technology is adaptable to different gasification technology producing syngas with several H₂/CO and H₂/CO₂ ratios

SNG quality

Result #4: A high quality of SNG produced compatible with existing biomethane standards (EN 16723) and French grid specifications to be injected into the gas grids or used as biofuels (bio-NGV)

Main compounds

Compound	Unit	SNG after upgrading ⁽¹⁾		
		Min - Max	French gas grids spec. ⁽²⁾	EN 16723 ⁽³⁾
CO ₂	mol.%	0.7 – 2.4	< 2.5	< 2.5
CO	mol.%	0.06 – 0.08	< 2	< 0.1
H ₂	mol.%	1 – 1.7	< 6	< 2
CH ₄	mol.%	94.5 – 97	/	/
Ethane (C ₂ H ₆)	mol.%	0.9 – 2.1	/	/
HHV	kWh/m ³ (n)	10.8 – 11.1	10.7 – 12.8 (H gas)	10.3 – 14.1 (2H gas group)
Wobbe Index	kWh/m ³ (n)	14.2 – 14.7	13.64 – 15.70	13.4 – 16.0
Density	-	0.560 – 0.585	0.555 – 0.7	/
Methane index	-	93 – 98	/	> 65

Residual pollutants: exhaustive analysis performed on more than 100 compounds

Compound	Unit	Max up to now	French gas grids spec.	EN 16723
O ₂	ppmv	< 100 (**)	100	10,000
Propane (C ₃ H ₈) + propylene (C ₃ H ₆)	ppmv	< 30 (*)	-	-
Ethylene (C ₂ H ₄) + acetylene (C ₂ H ₂)	ppmv	< 10 (*)	-	-
Total S (incl. H ₂ S + COS)	ppmv	< 1.5 (0.6)	30 (5)	30 (5)
Total COVs	ppmv	< 8	/	/
Total Cl	mg/m ³ (n)	< 1	1	/
Total F	mg/m ³ (n)	< 1.5	10	/
NH ₃	mg/m ³ (n)	0.7	3	10
Hg	µg/m ³ (n)	0.2	1	/
Total volatile Si	mg/m ³ (n)	0.01 (*)	/	0.3
...		

(1): Several SNG upgrading scenarios possible

(2) Extract from "Prescriptions techniques applicables aux canalisations de transport de GRTgaz et aux installations de transport, de distribution et de stockage de gaz raccordées au réseau de GRTgaz, Avril 2018

(3) Extract from EN 16723-1 "Natural gas and biomethane for use in transport and biomethane for injection into natural gas networks" - part 1: specifications of biomethane for injection into natural gas networks and EN 16723-2 "Natural gas and biomethane for use in transport and biomethane for injection into natural gas networks" - part 2: fuel specifications for motor vehicles"

Technical, economic and environmental overall results



Technical validation of the process at demo-scale

- > 150 tests performed
- Long duration tests in continuous mode (24h/24h)

The entire production chain has successfully been proven to be robust and flexible to convert several feedstock



Lowering production costs

- Innovations (10 patents)
- Optimization of the process

-30 % of CAPEX and
-10 % to -100%
on feedstocks supply costs compared to the state of the art

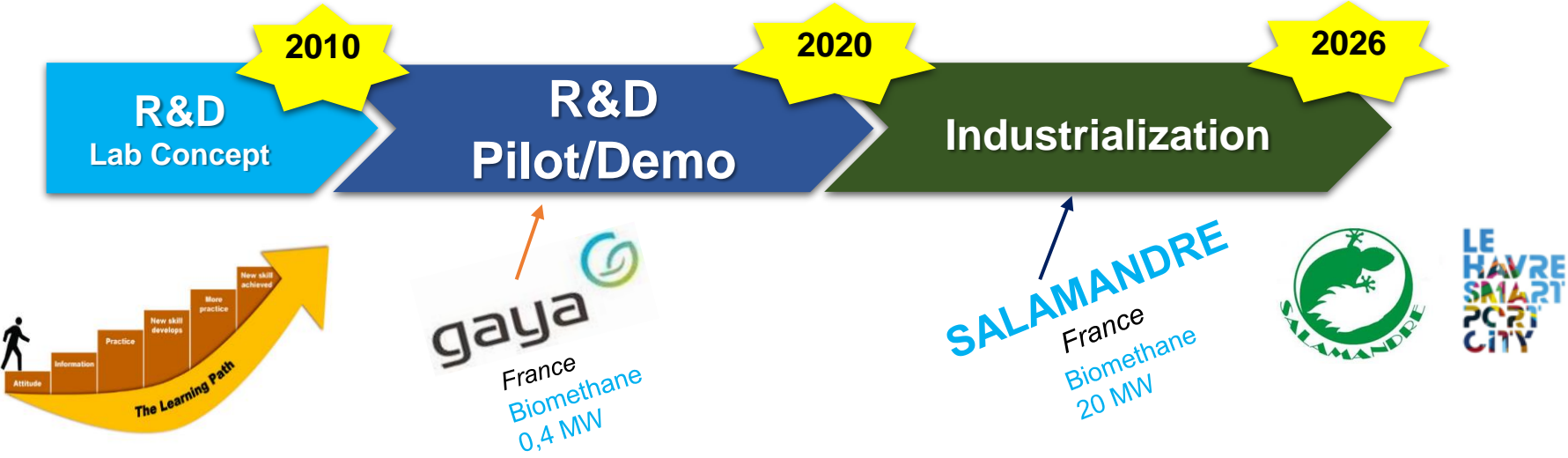


Environmental benefit confirmed

- Life Cycle Analysis performed
- Compliance with thresholds imposed by RED II (for heat or bio-fuels)

-86 % of GHG
reduction using 2G
biomethane compared
to fossil fuels (RED II)

A project and a platform supporting the industrialization of the sector for ENGIE





Salamander project

ENGIE's first commercial project of SNG from gasification to be installed in Le Havre



170 GWh of SNG

For heavy / maritime transport and intensive industries

+ ~40 GWh of renewable heat

For industrialists and urban networks



70 000 t/year of non-recyclable waste recovered

Supplied regionally and otherwise exported, incinerated or landfilled



Partnerships and funding

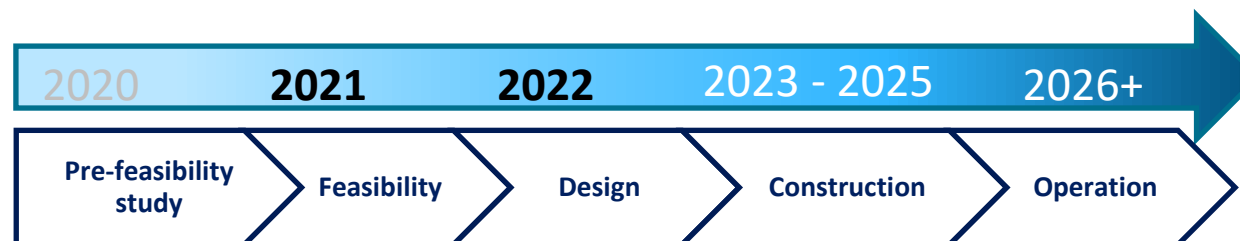
Public-private with the French State

Territorial Pact Le Havre Seine Métropole



Innovation Fund candidate

Eligible for the Just Transition Fund



A R&D platform dedicated to green gases from gasification

A pre-industrial demonstrator (TRL 7 – 8) open to future collaborative research projects

- Diversification of feedstocks for gasification sector
- Diversification of applications downstream of pyrogasification (H₂, etc.)
- A semi-industrial trial environment made available for start-ups to test, de-risk and validate their innovative solutions

Derisk future industrial projects and innovative technological solutions

- Tests on specific feedstocks (biomass, waste)
- Training and expertise center (green gas process and analysis)

Communication / dissemination

- Visits, supply of national (or European) working groups for the development of renewable gas sector from gasification

Willingness to **mutualize the efforts** with other players at European level to promote and facilitate **green gas development**



Thank you for your attention !



Contact

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