Technology focus: Natural Gas & Biomethane

Webinar Series 6

8th September 2022, 11.00-12.00 CEST

Jean-Marc Boucheret

Public Transport Sustainable Mobility Manager at IVECO

CLEAN BUS EUROPE PLATFORM

UITP

The Clean Bus Europe Platform is financed by the European Union.

Jean-Marc Boucheret
Public Transport Sustainable Mobility Manager, IVECO

- Graduate Engineer Art & Métiers
- 20 years Public Transport

- Product Manager Bus Euro V / VI / Electromobility
- New powertrains & energies

- UITP : Member VEI Com., Trainer ebus
- TEDx speaker

Programme

Technology focus: Battery buses		
11.00 – 11.05	Welcome & Introduction	Aida Abdulah, UITP

11.05 – 11.40	• Introduction to natural gas technology
	  • Different fuels: CNG, LNG, LPG
	  • Units & conversions
	• Natural Gas & Biomethane
	• CO2 emissions : TTW / LCA
	• Vehicle and components
	• Refueling infrastructure
	• Safety aspects
		Jean-Marc Boucheret, IVECO

11.40 – 12.00	Questions & Answers	

Today's goal

- Clear and complete overview of natural gas technology and its fuels
- Brief look into natural gas and biomethane
- What are the main features and main challenges of this technology?
- Which aspects should I consider upfront when considering this technology?
- Insights on safety aspects
- Which sources of information can I refer to, to further learn on a specific technology?

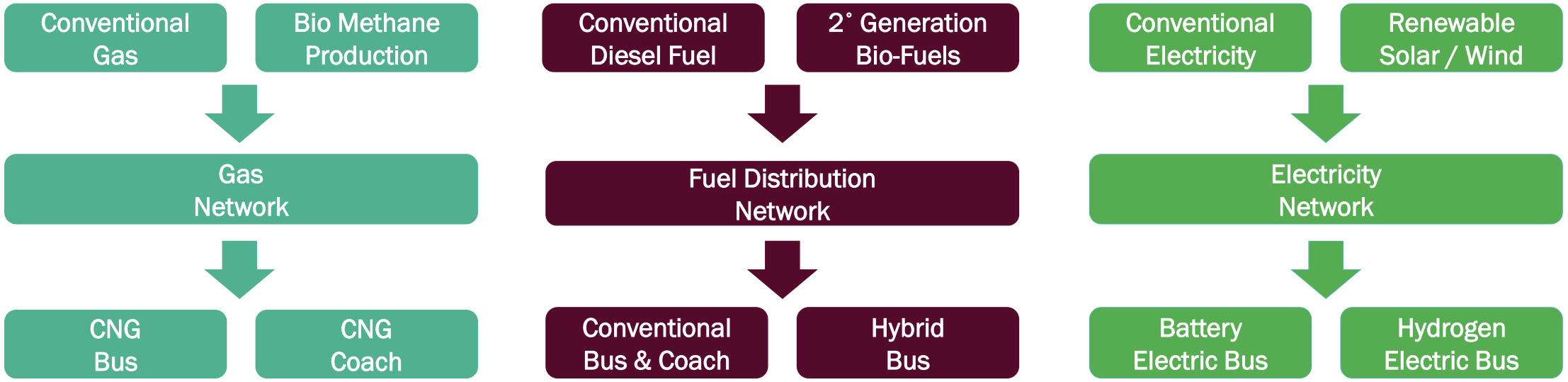
Etiquette for joint discussion

- Participants please mute yourself per default
- You can use the Chat to place your questions, share interesting info or make us aware of any technical issue
- Raise your hand and switch on your camera to ask to have the word
- The session will be recorded.

We count on your valuable contribution for a successful workshop. Thank You!

How to achieve Energetic Transition and Sustainable Mobility

- Concepts :
  - From Fossile to Renewable energy
  - Combine Vehicle + Energy + Renewable
  - Zero-Emission Local / Global
  - Green House Gases emission compensation



Clean Vehicle Directive – 1161/2019

- Applicable to **M3 Class I** = Buses Low Floor & Low Entry, and **M3 Class A**

- Procurement Targets for countries:

Dates / Min.Targets of Clean Vehicles	from 2022 till 2025	from 2026 till 2030
Fr, It, Es, Ge, Au, Dk, Be, NL, Lu, Li, Sw, Fi, CZ, UK, Ma, Cy	**41 to 45%**	**60 to 65%**
Other E.U. Countries	**24 to 37%**	**33 to 53%**

- Clean Vehicle definition is following the Directive of Alternative Fuel Infrastructure 2014/94 :

Minimum

50% Zero-Emission :

- Electric
- Trolleybuses
- H2 Fuel Cell
- H2 ICE

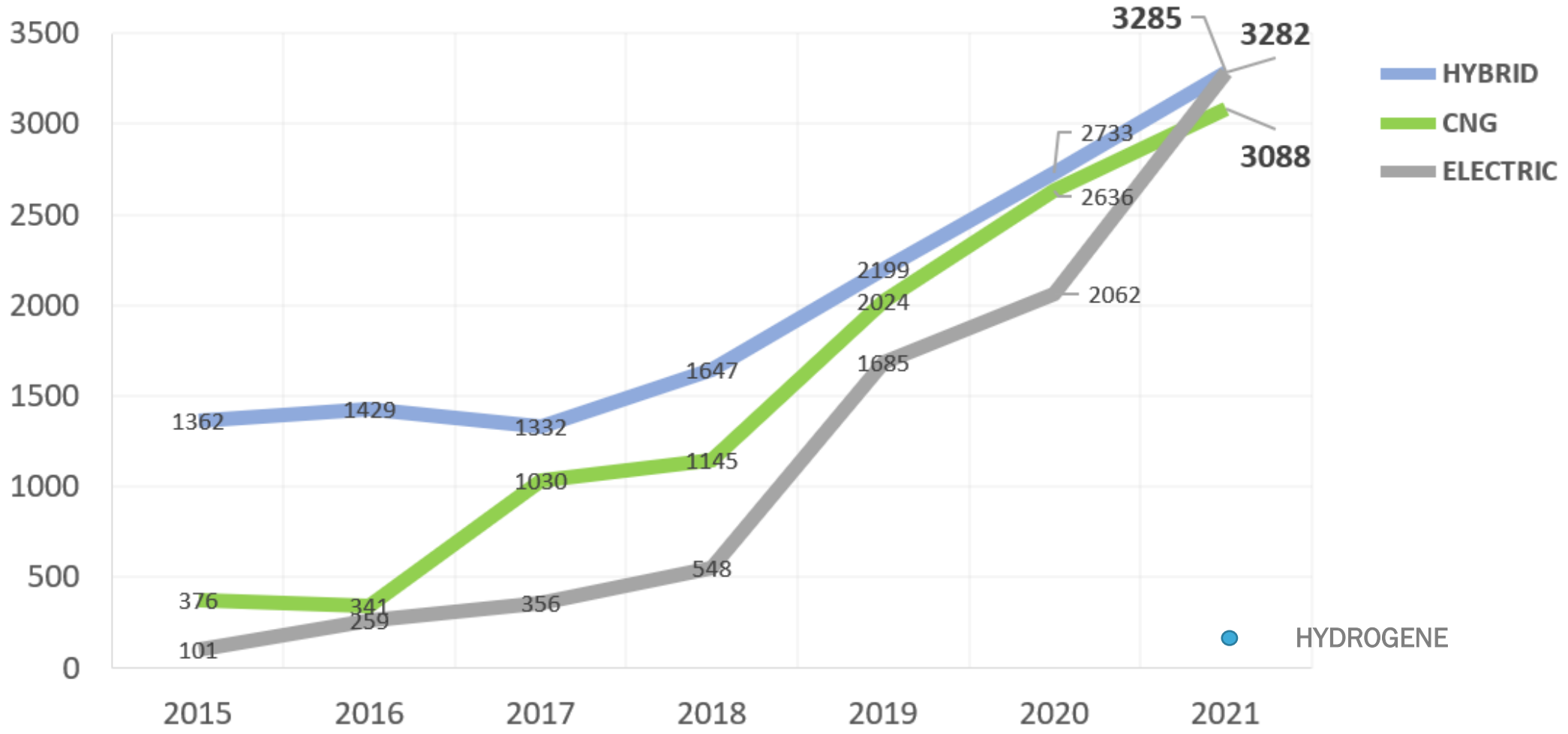
50% Low-Emission :

- Gas (Natural Gas / Biomethane)
- Alternative fuels :
  - Biofuels (B100), synthetic & paraffinic Fuels → HVO, GTL
  - but shall not be blended with fossil diesel (= no B30)

Rest :

- Diesel B7, incl. Hybrid
- Other non eligible

Evolution of bus technology in EU



Source :
ACEA

Example Portfolio compliant CVD

Zero-Emission

Electric BEV

CROSSWAY
LOW ENTRY
ELECTRIC

Low-Emission

Gas

Liquid Alternative Fuels

Vocabulary

METHANE (CH4)

- CNG : Compressed Natural Gas → dominant bus, garbage collection, urban delivery
  - Transport at medium pressure pipes
  - Vehicle storage gaseous at 200 bars

- LNG : Liquified Natural Gas → dominant Long Haul
  - transport & storage in liquid cryogenic -163°C

- LPG : Liquified Petroleum Gas → dominant passenger cars (no more trucks & bus EU)
  - propane (C3H8) + butane (C4H10
  - Transport & storage at low pressure

Units & Conversion

1 Nm3 or Standard Cubic Meter (SCM) :

- unit corresponding to volume of 1 m3 at 0°C and 1,01325 bar
- 1 Nm3 = 0,948 Nm3 at 15°C

1 m3 CNG

- 0,75 to 0,83 kg CNG = 0,79 kg average

Lower Heating Value : depends on the gas composition

- 46 MJ / kg
- 12,8 kWh / kg (1MWh = 3,6 MJ)
- 1 MWh = 78 kg

Volume in tank at 200 bars

- 160 l tank = 32 kg CNG

Density : 0,6

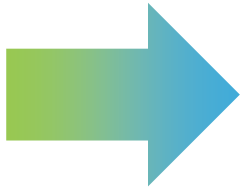
Source :
Circulaire Douanes GNC 2019, JEC CONCAWE 2018, INERIS 2011

Vocabulary

Natural gas

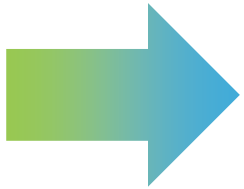
Erdgas

Gaz naturel

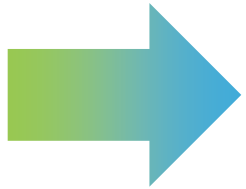


Fossile origine (gas)

Biogas



Biomass origine purified

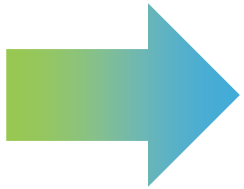


Biomethane

CBG : compressed biogas

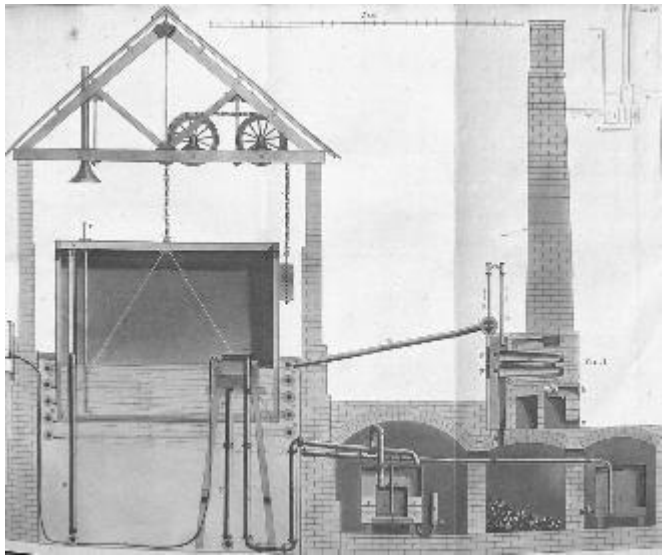
Towngas

Gaz de ville

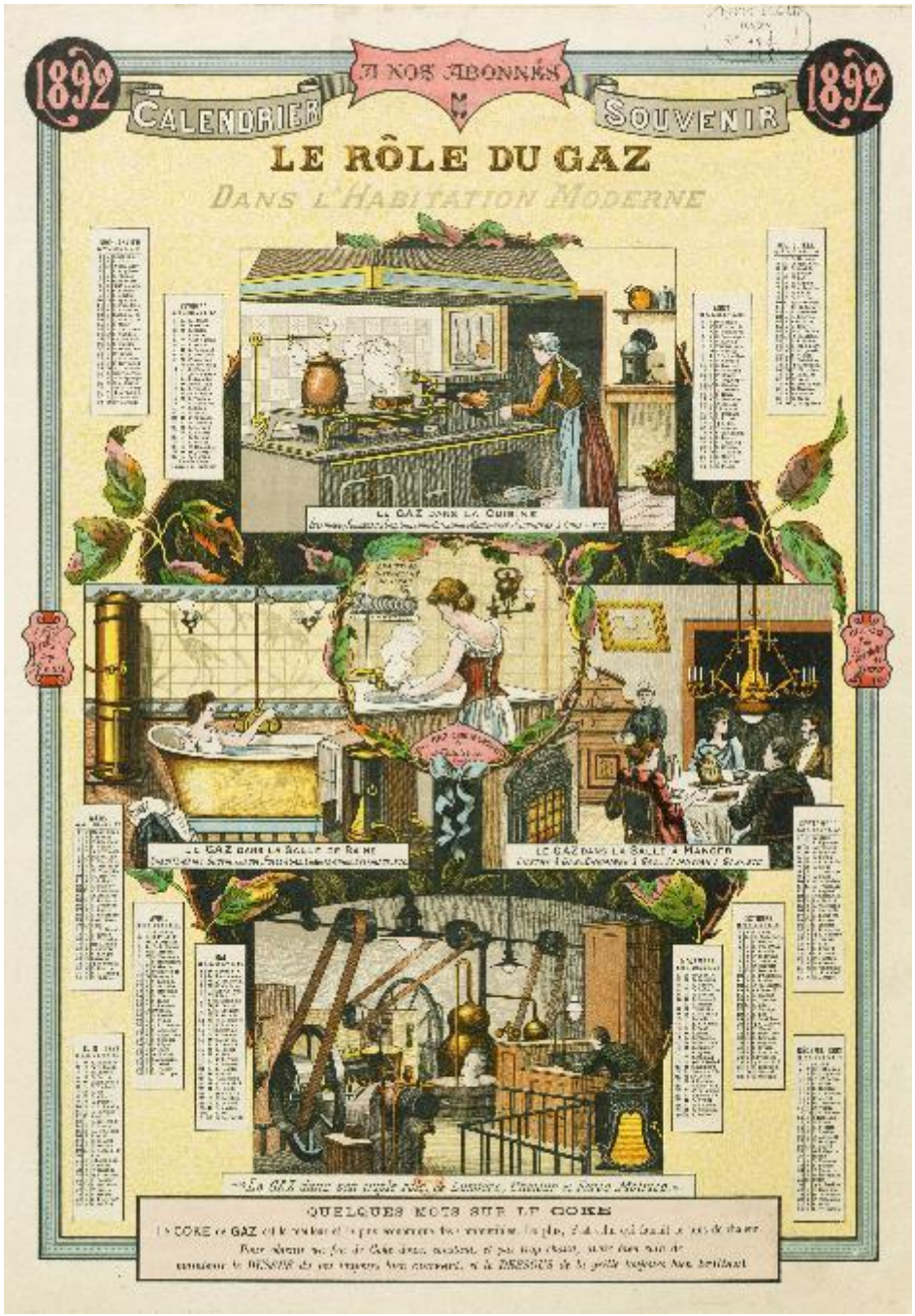


Fossile origine (coal)

Citygas

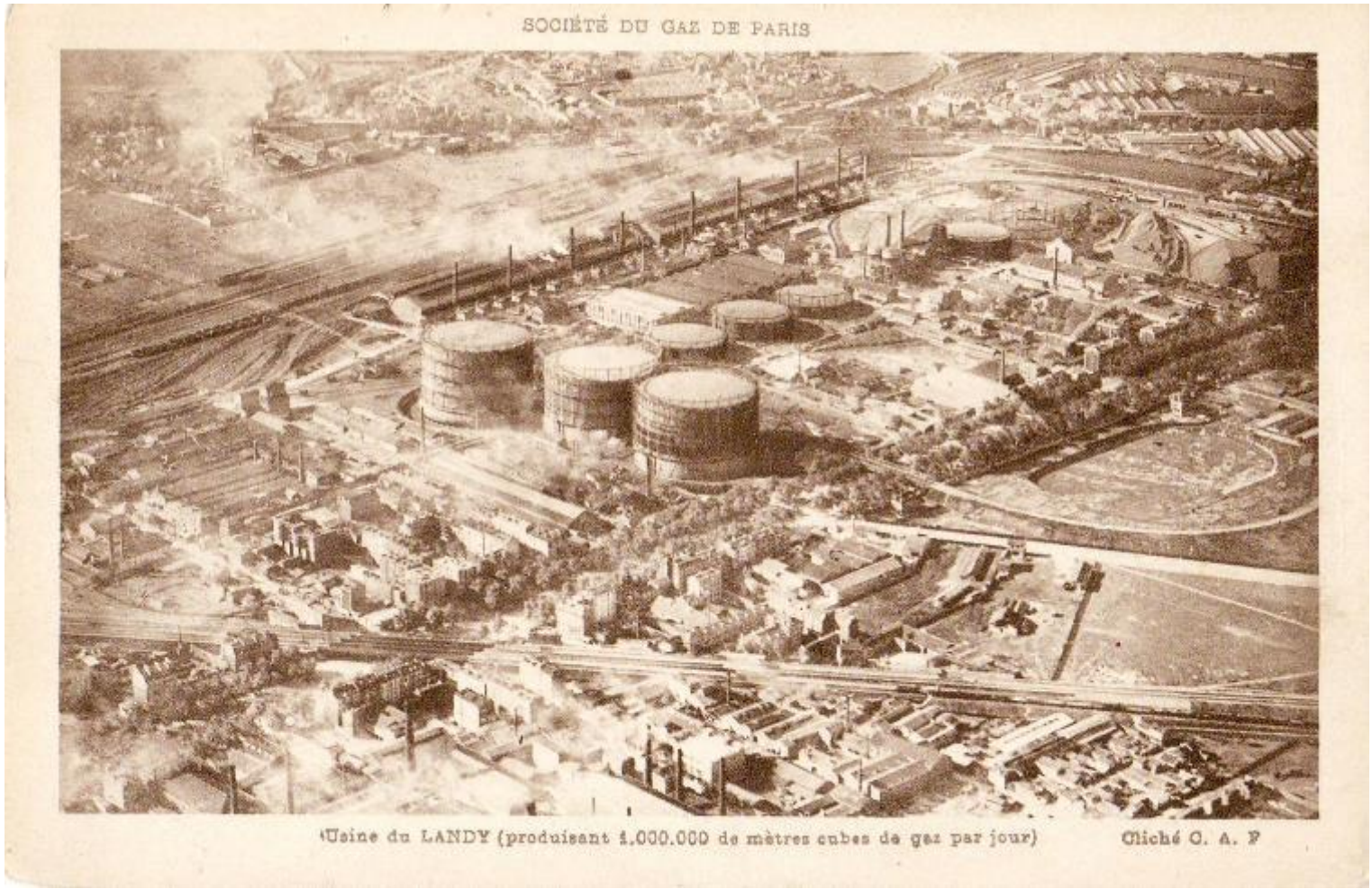


Transformation coal → gas
Distillation
ca. 1810



Source :
Wikipedia, BnF

Citygas

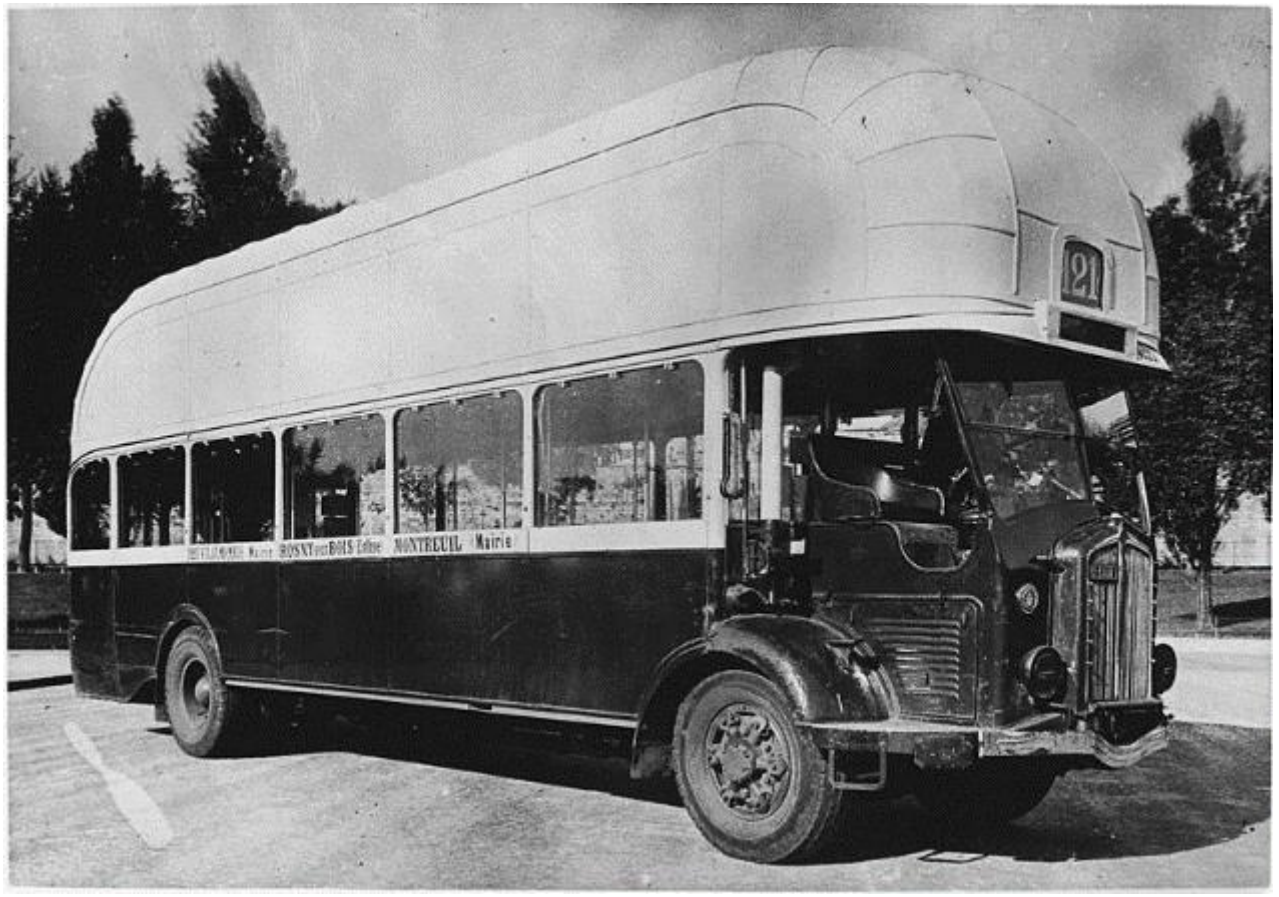


Distillation Coal	volume	weight
H_2	50 %	8 %
CH_4	32 %	42 %
CO	8 %	19 %

Source :
Wikipedia, BnF

Paris / Saint-Denis (football stadium)
ca. 1920

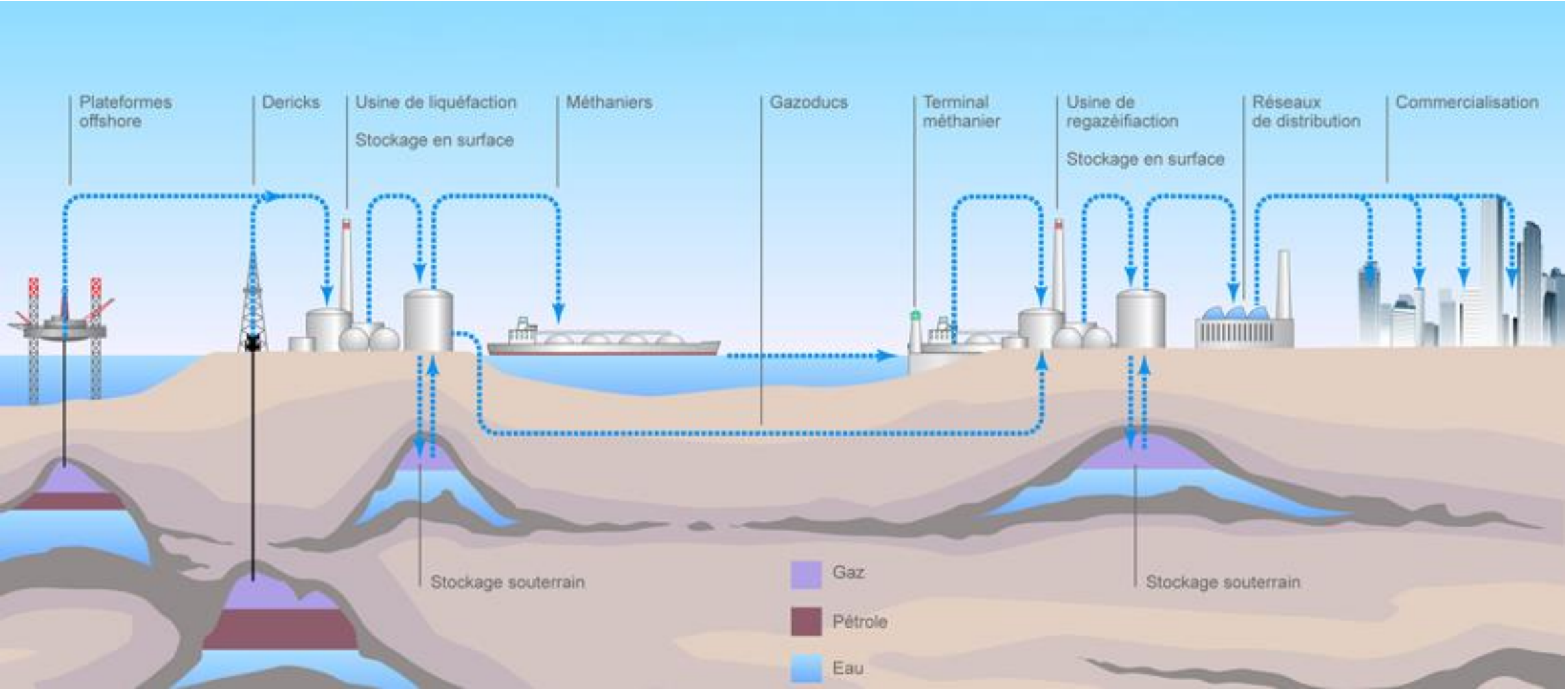
Citygas



- Paris citybus in WWII
- Fueled with citygas, low pressure in rubber membrane
- Operation « opportunity charge » : refueling at both terminus

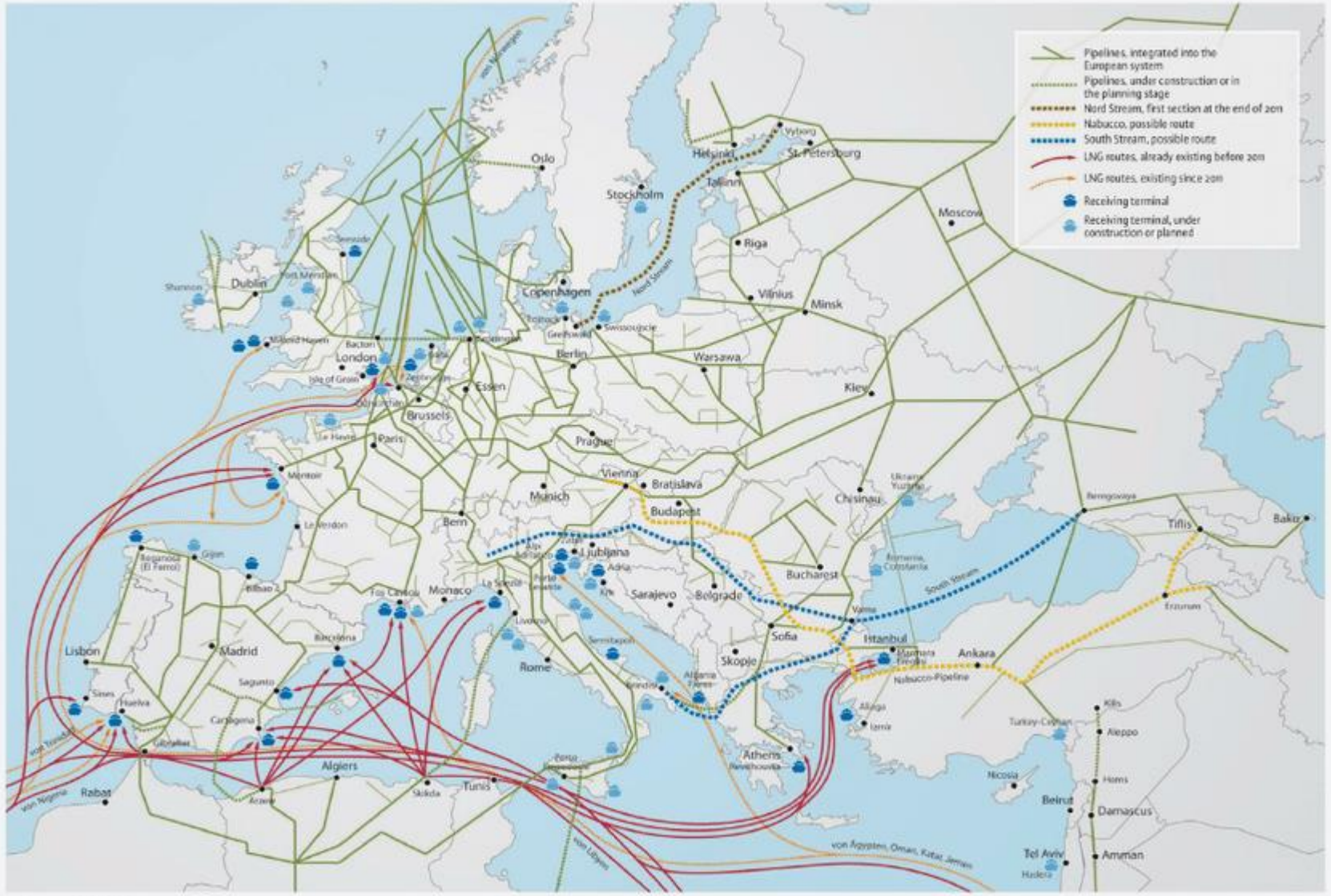
Source :
Franklin D. Roosevelt Library Public Domain Photographs, compiled 1882 - 1962

Natural Gas transport assets



Natural Gas transport assets

Natural gas pipelines and LNG terminals in Europe



Sources: BDEW, Eurogas

Future Gases transport assets

Injecting biomethane

H2 pipes

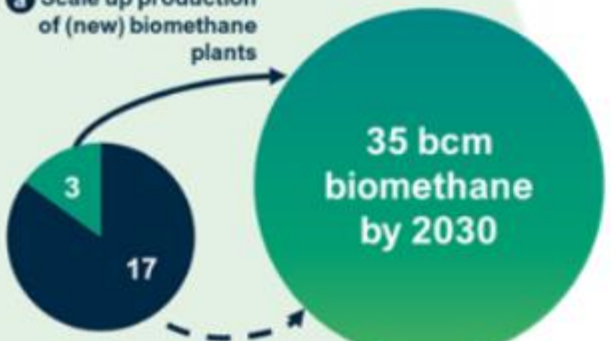
RePower EU : REPowerEU: affordable, secure and sustainable energy for Europe

18/05/2022

What it takes to produce 35 bcm biomethane by 2030

From **3 bcm** biomethane and **17 bcm** biogas production today to **35 bcm biomethane**

a Scale up production of (new) biomethane plants



b Upgrade (part of) existing local biogas plants to biomethane

1 Mobilising sustainable biomass

2 Increase biomethane production capacity

(a) Capital investment of €83 billion in new production capacity

4000 smaller anaerobic digestion based biomethane units

4 mln m³/year and €12 million CAPEX per installation, producing at €80/MWh

1000 large-scale anaerobic digestion based biomethane plants

16 mln m³/year and €35 million CAPEX per installation, producing at €55/MWh

(b) Option to upgrade biogas plants and invest in gasification

Upgrading existing biogas plants to biomethane plants can unlock up to 17 bcm biomethane in 2030, potentially delivering a large part of the 35 bcm target.

Investing in maturing gasification technologies will allow part of the 35bcm to be produced from woody residues.

https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure-and-sustainable-energy-europe_en

Enough biomethane production in EU to meet REPowerEU 2030 target

Jonathan Spencer Jones
26 July 2022

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(Image: 123RF.com)

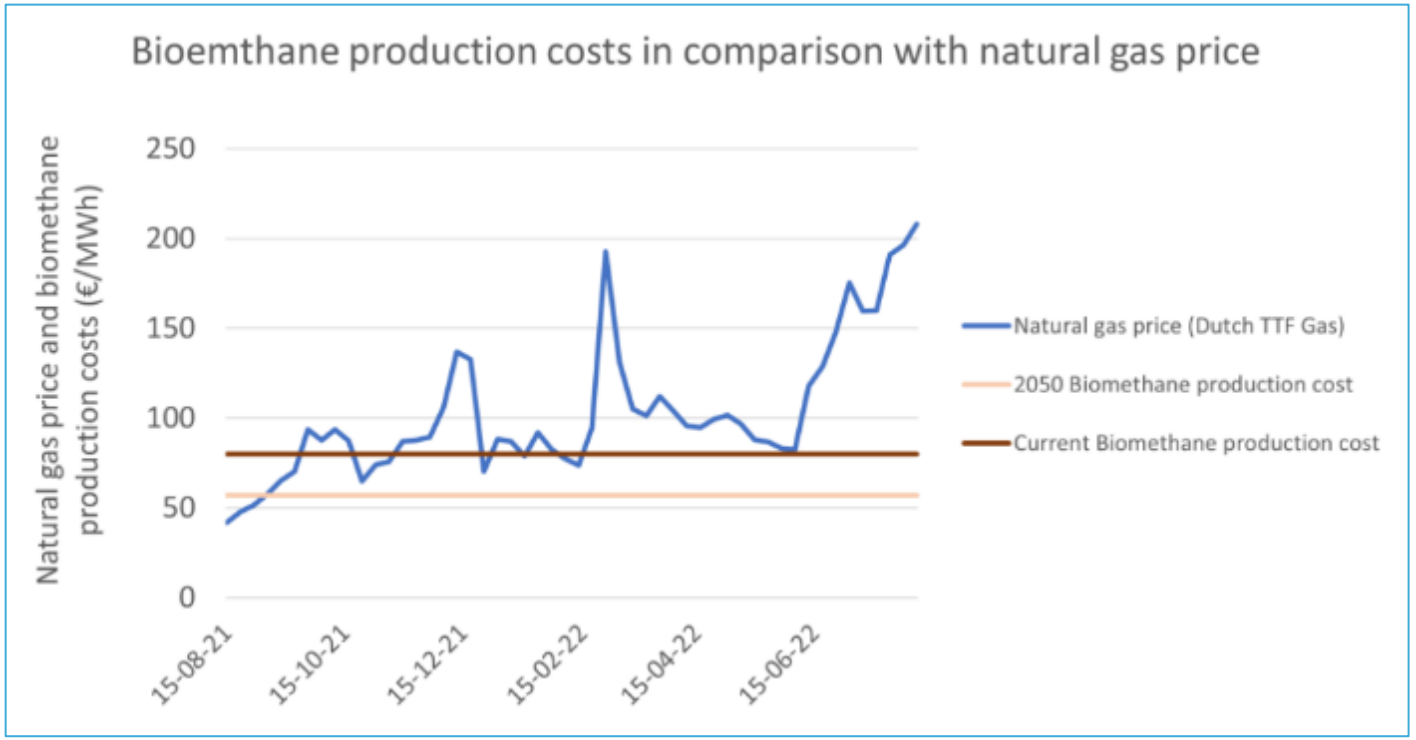
Gas | Biomass | Decarbonisation | Europe & UK | Finance & Investment | Policy & Regulation

A new study from the Gas for Climate consortium estimates that in the EU-27 up to 41 billion m3 (bcm) of biomethane could be available by 2030, exceeding REPowerEU's 35bcm target.

The study, which updates earlier estimates with the EU's ambition to accelerate biomethane production and take advantage of advancements in technology, further finds that up to 151bcm could be available by 2050 – close to the current 155bcm natural gas imports from Russia.

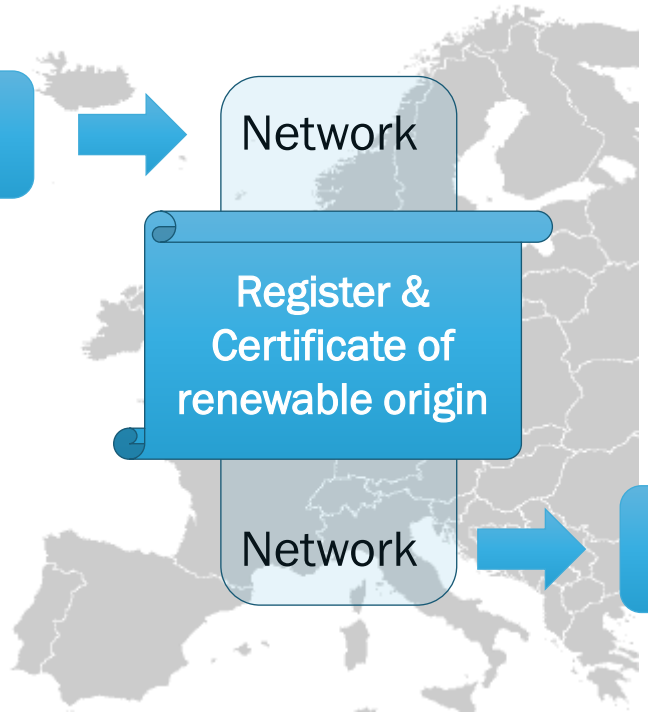
Energy price – impact on TCO - 2022

Fossile vs. Biomethane



Source :
Ouest France, OrangeGas, European Biogas Association, NGVA

Greenhouse Gas Emission Compensation Mechanism



Renewable Energy Producer

Network

Register & Certificate of renewable origin

Network

Energy Supplier

Consumer :

- Recharge batteries
- Fill-up the gas tanks

REGATRACE
Renewable Gas Trade Centre in Europe

Electricity

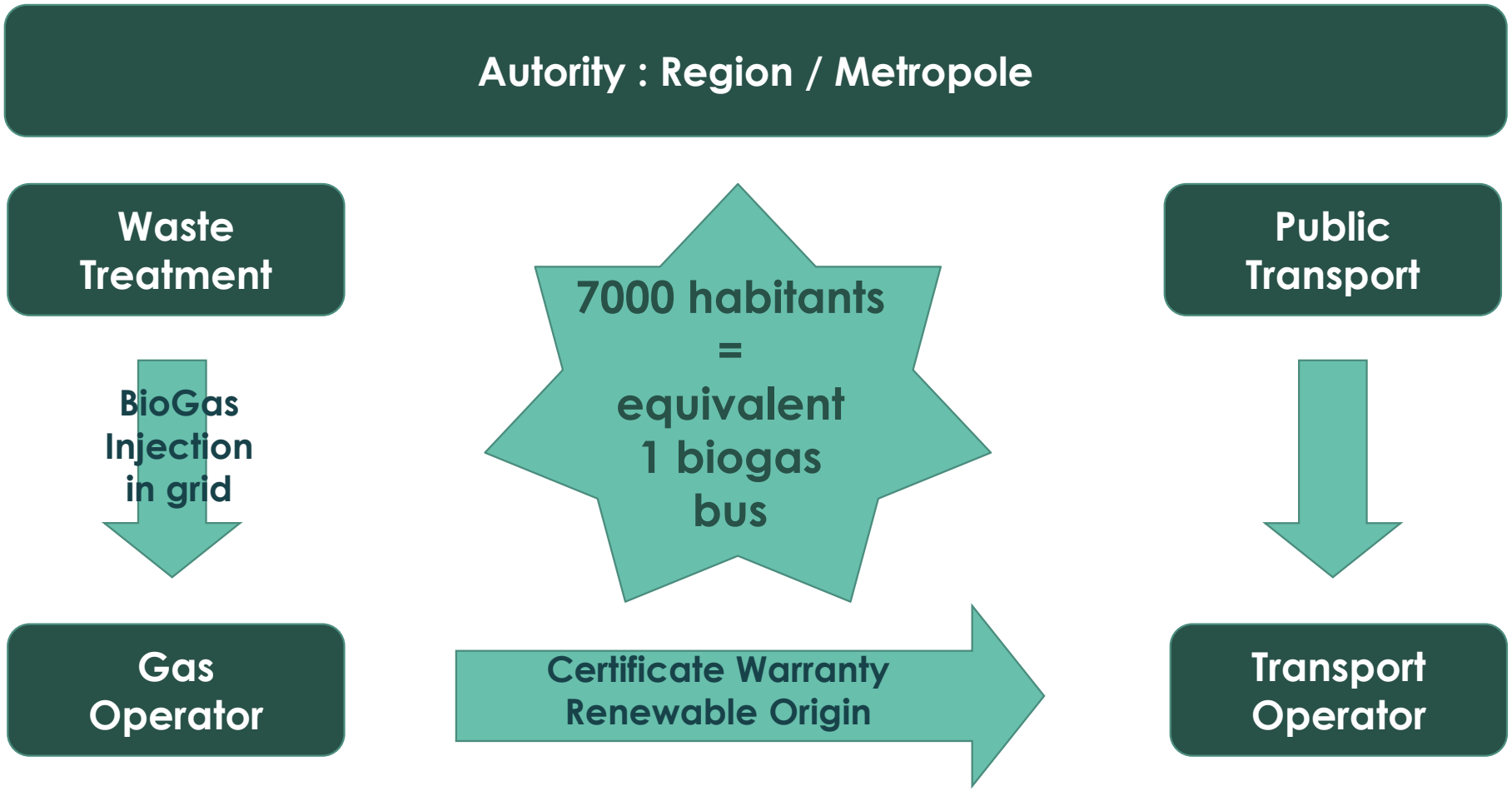
- Hydraulic
- Wind
- Solar

Bio-methane

- Treatment of household wastes
- Agricultural: Intermediate Culture with Energetic Purpose
- Food industry: valorization of by-products

Final goal → Neutralized CO2 Emissions

Path to circular economy



Métropoles investing in methanisation plants

In Nantes, 1 bus out of 2 could run on green gas

03/03/2022

By 2024, public stake holders have to propose recycling solutions for food wastes. Nantes Metropole intends to speed up investments in methanisation plants.

GRDF
GAZ RÉSEAU DISTRIBUTION FRANCE

GRENOBLE ALPES MÉTROPOLE

The waste water treatment plant of Aquapole is injecting biomethane in the GRDF gas grid.
Operational since 2016, it produces 225 Nm3/h biomethane, equivalent to 80 buses.
1/3 of Grenoble buses run on bio-CNG.

Source :
Gas Mobilité, Grenoble Métropole

Grenoble

Thanks to 14 000 t of wastes treated annually, the methanisaytion site will produce 8 000 t of compost and10 GWh of biomethane.
21 M€ : 14 M€ for new building + 7 M€ for upgrade & connect
Investment amortization 12 years

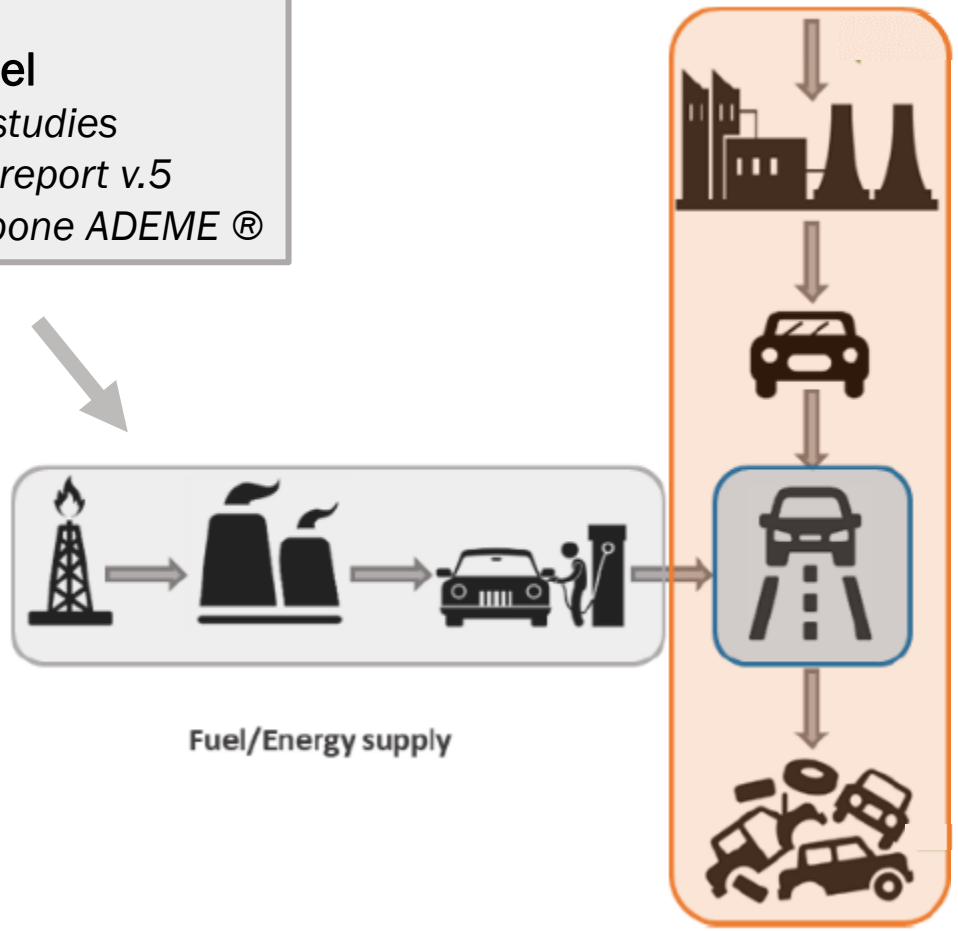
How to assess CO2 emissions of transport vehicles ?

2)

Well-to-Wheel

Stakeholder studies

- *JEC WTW report v.5*
- *Base Carbone ADEME ®*



3)

Life Cycle Analysis

- *Voluntary*
- *Methodology ISO 14040/44*
- *Non harmonised criteria*

1)

Tail-pipe

Consumption → CO2

- SORT + Emission factor
- VECTO (CO2 Directive)

Directive CO2 vehicles

- *Revision in 2022-23*
- *Status renewables tbd*

Which contributions of renewable fuels in EU texts ?

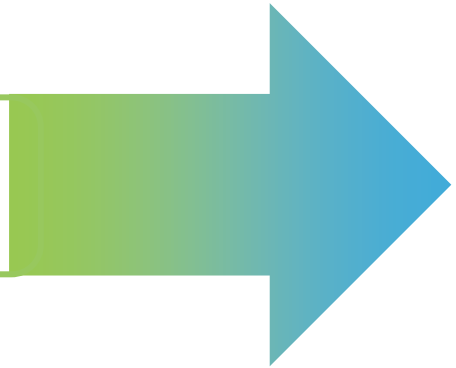
Well-to-Wheel

BioCNG emission Tank-to-Wheel

CBG Municipal wastes : 10,7 gCO2 / MJ
Source : JEC WTW study Version 5 (2018)

Lower Heating Value : 46 MJ / kg
10,7 * 46 = **0,49 kg CO2 / kg**

CNG fossile H-gas : **2,67 kg CO2 / kg**
Source : JEC Concawe (2018)



-82% CO2

Which contributions of renewable fuels in EU texts ?

Tail-pipe : Current CO2 Directives : No contribution

LCA

Clean Vehicle Directive 1161/2019

Recital 31.

By 31 December 2027 [...] the Commission should also assess, inter alia, the possibility of aligning this Directive to any methodology for counting life-cycle CO2 emissions and well-to-wheel CO2 emissions developed in the context of EU vehicle CO2 emission performance standards.

Revision Regulation (UE) 2019/631, Passenger cars & LCV CO2

Council agreement, 30,06,2022

Recital 9a.

Following consultation with stakeholders, the Commission will make a proposal for registering after 2035 vehicles running exclusively on CO2 neutral fuels in conformity with EU law, outside the scope of the fleet standards, and in conformity with the Union's climate neutrality objective.

Regulation (EU) 2019/1242 – CO2 Standards Heavy-Duty vehicles

Recital 42,

It is important to assess the full life-cycle CO2 emissions from heavy-duty vehicles at Union level. To that end, the Commission should evaluate not later than 2023 the possibility of developing a common Union methodology for the assessment and the consistent data reporting of the full life-cycle CO2 emissions of heavy-duty vehicles that are placed on the Union market.

Life Cycle Analysis

- Citybus

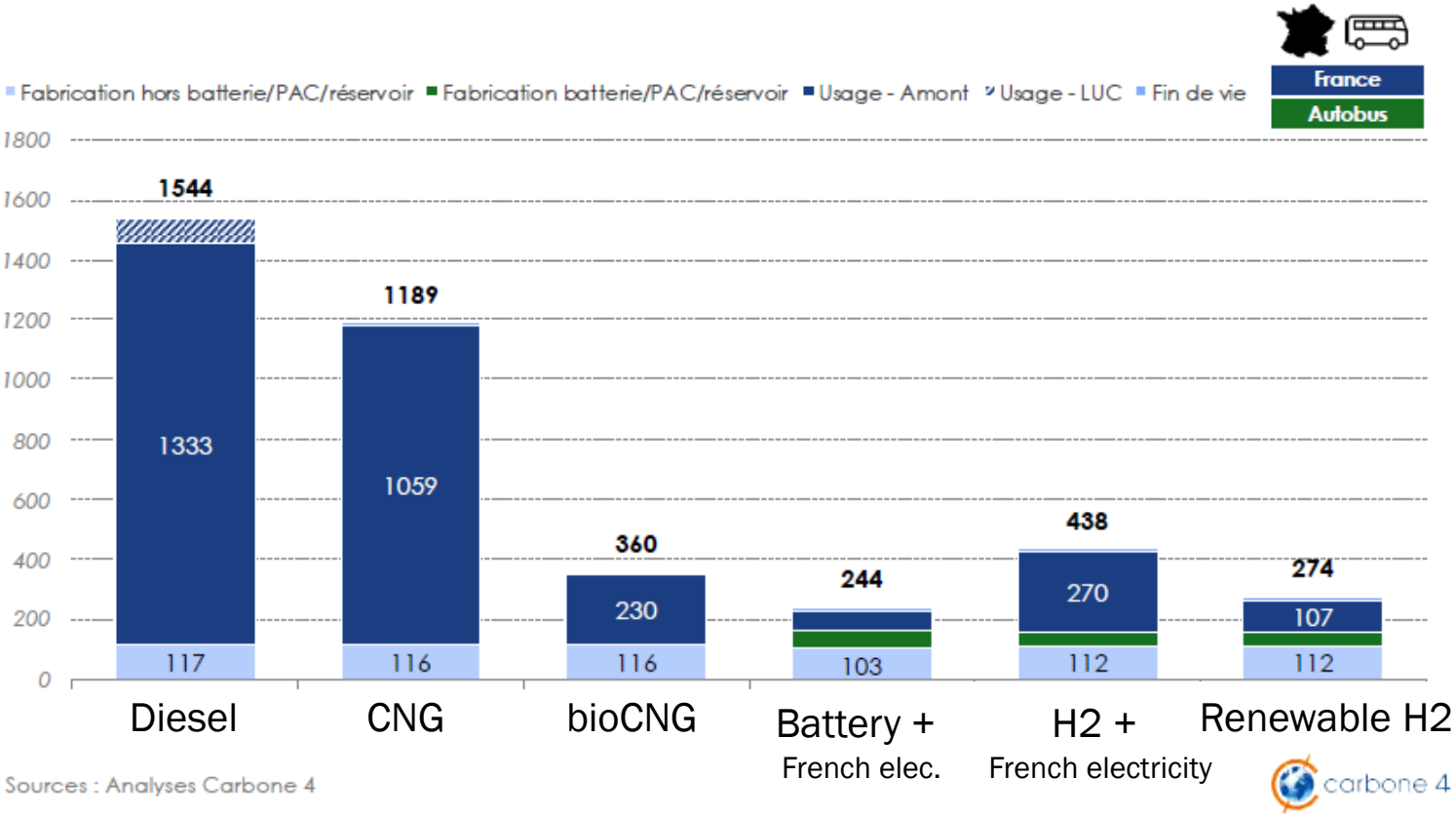


Figure 12 – Average carbon footprint over citybus lifetime - sold in 2020 in France
g CO2e/km

carbone 4

October 2020

Life Cycle Analysis

- Citybus

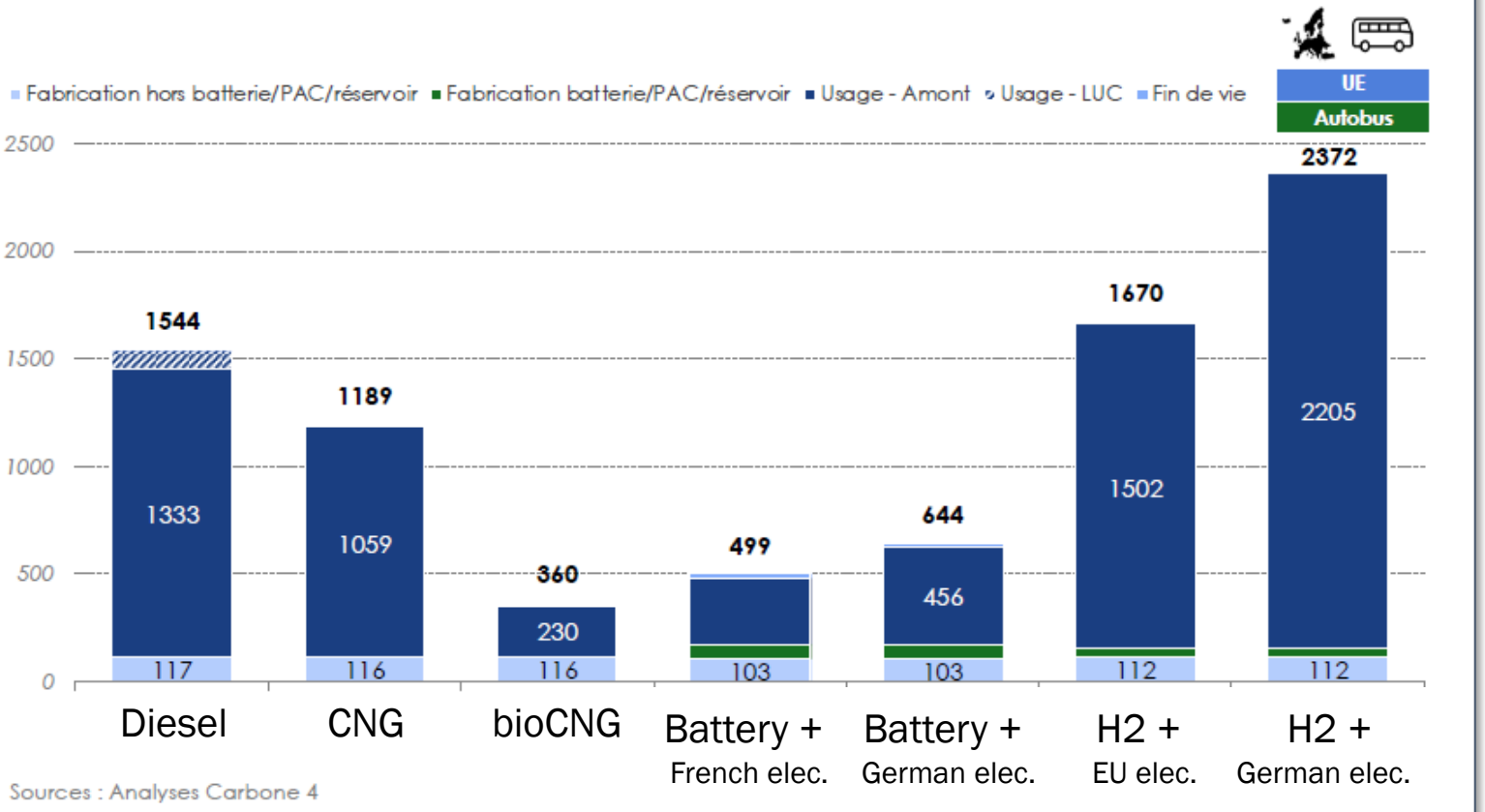
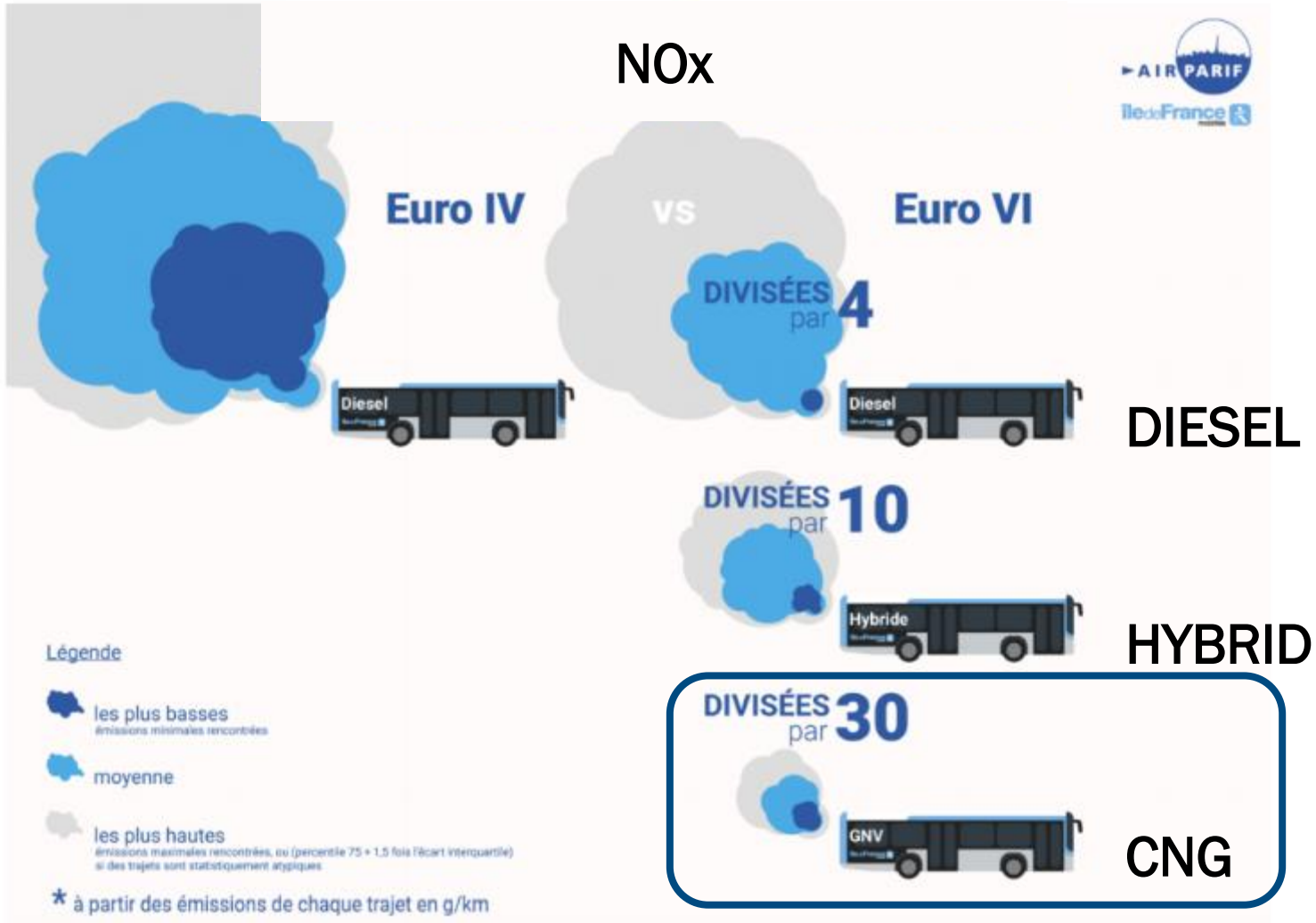


Figure 14 – Average carbon footprint over citybus lifetime - sold in 2020
g CO2e/km

carbone 4

October 2020

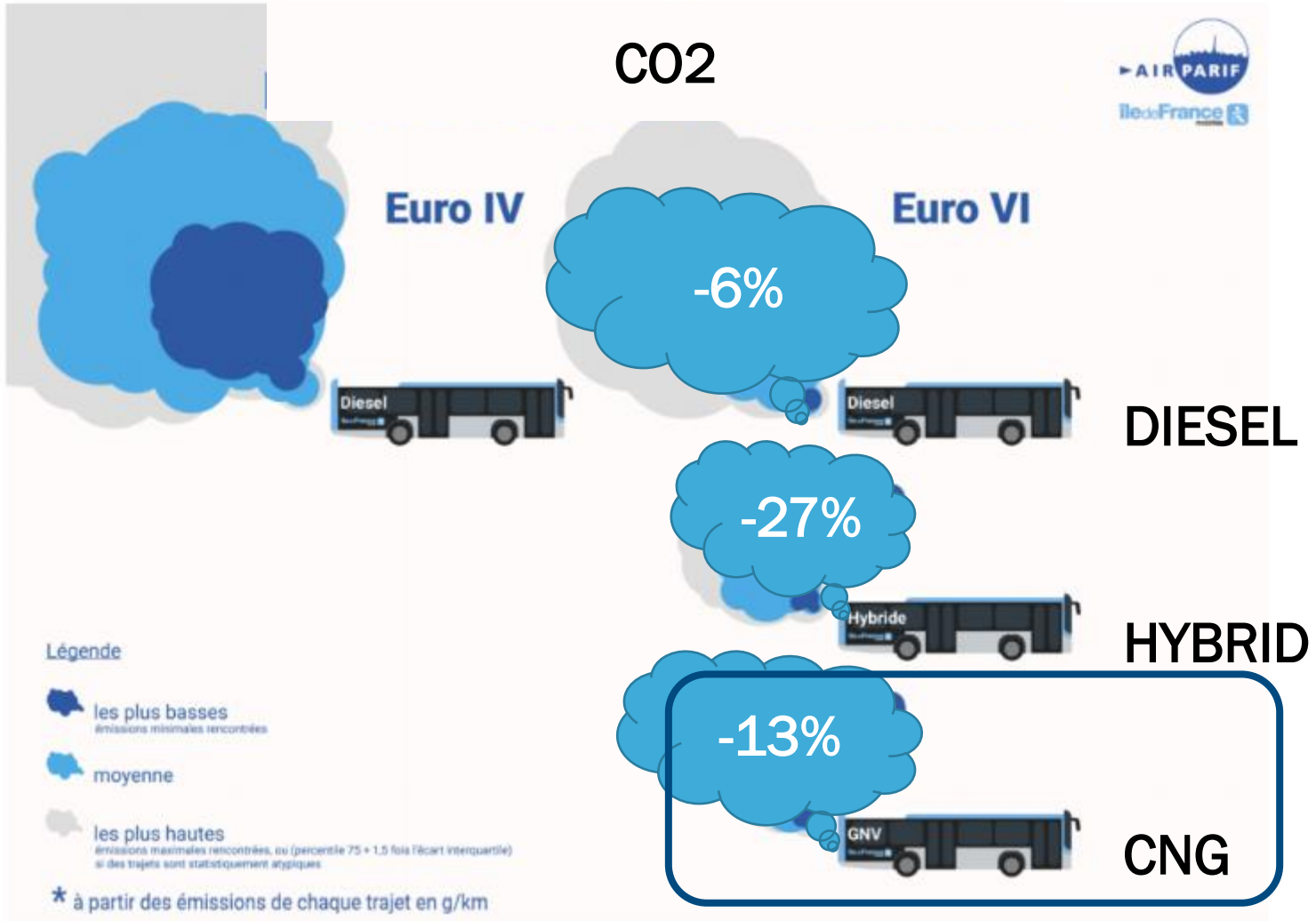
Emissions (1/2)



ÎledeFrance mobilités

January 2021

Emissions (2/2)

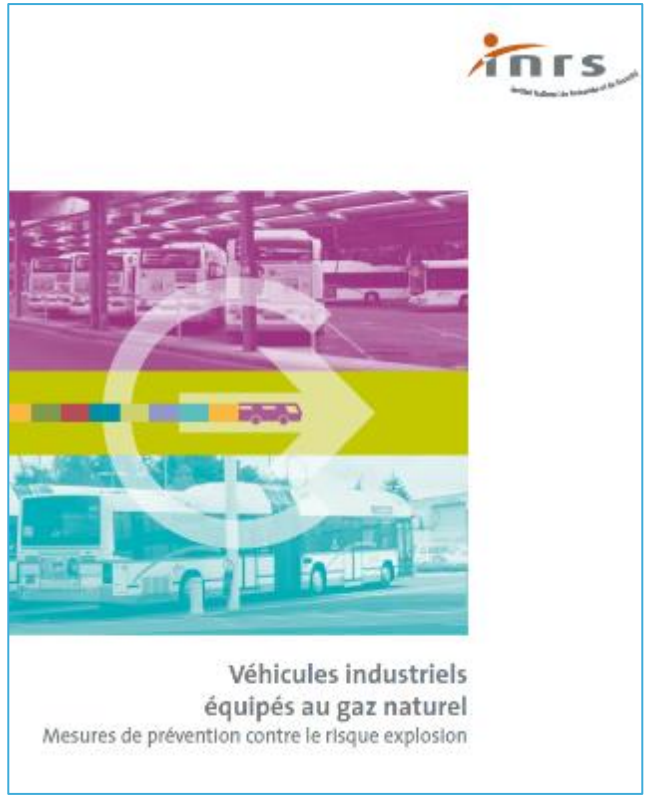


January 2021

Safety – technical training – human organisation

- Identification of risks
- Building installation
- Leak detection
- Organisation
- Training

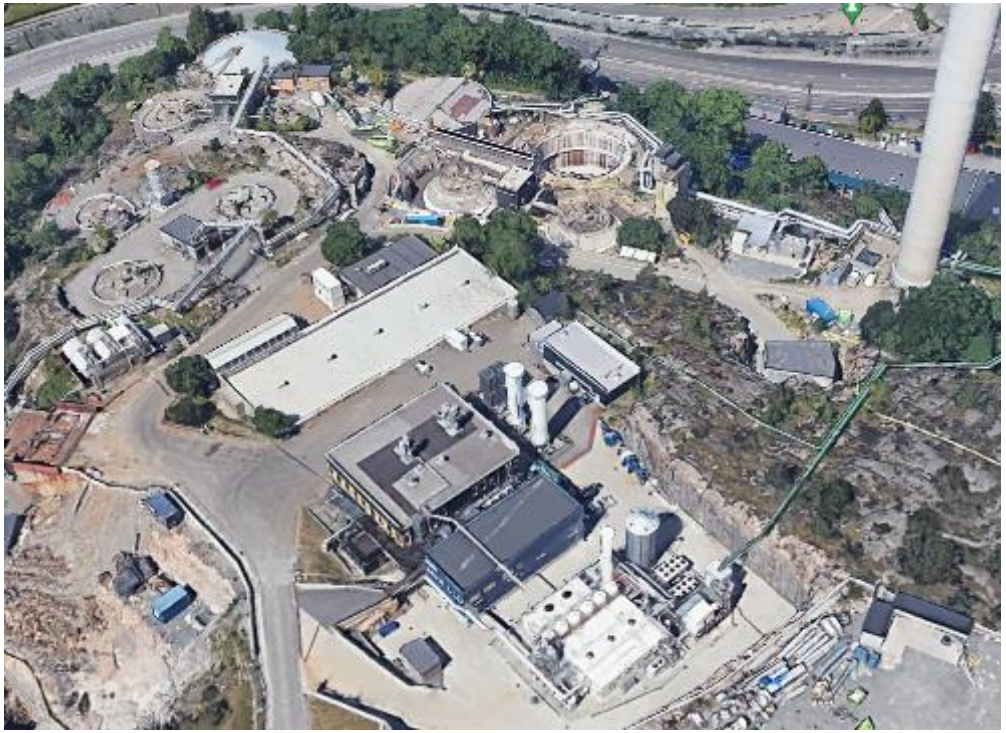
Qualification level	Intervention scope	Training received
1	Low pressure cuicuit	CNG training + OEM
2	High / Low pressure circuit, except electrovalve tank	Specific OEM training
3	all	Expented OEM training & other trainings

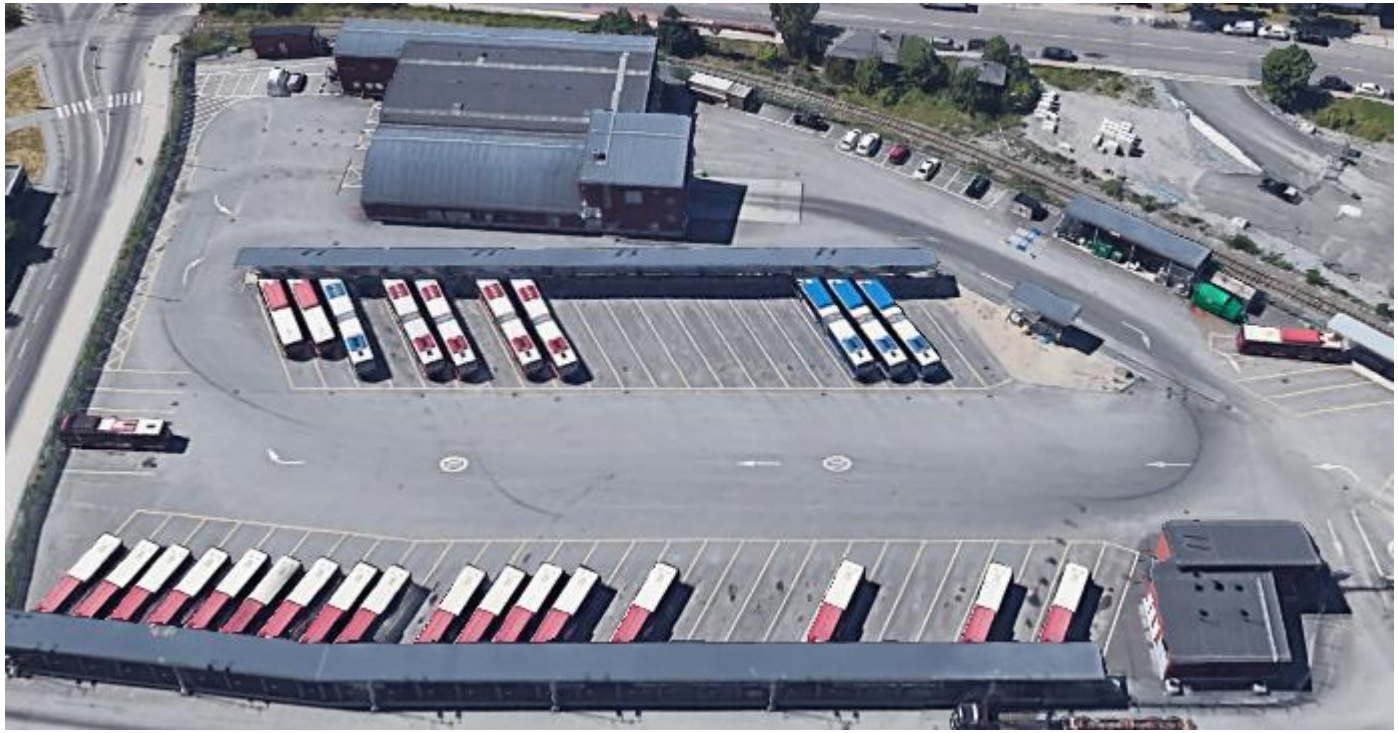


Lille – Sequedin bus depot

Créteil - RATP

Stockholm





Filling-up vehicles

Fast : 10 mn

Accelerated : 30-60 mn

Refueling station

Slow : 7 h

Filling nozzles

Nominal pressure ;
full 200 bars

Pressure gauge

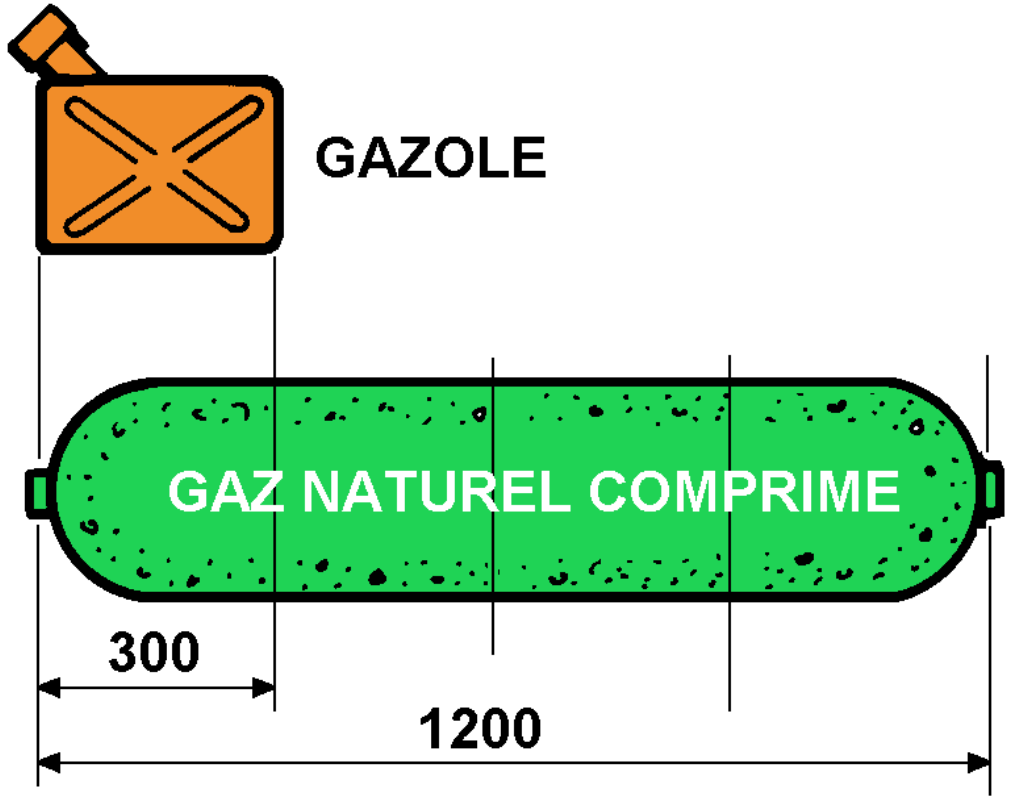
NGV 2

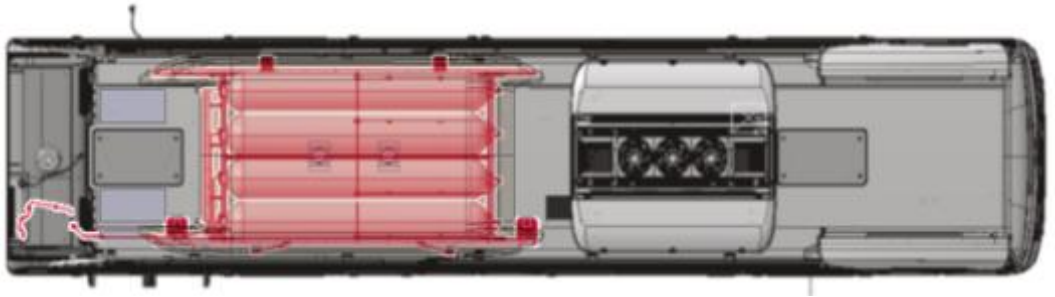
Gas Flow x2

NGV 1

Tanks

At 200 bars, gas stored in the vehicle occupies 4x more volume



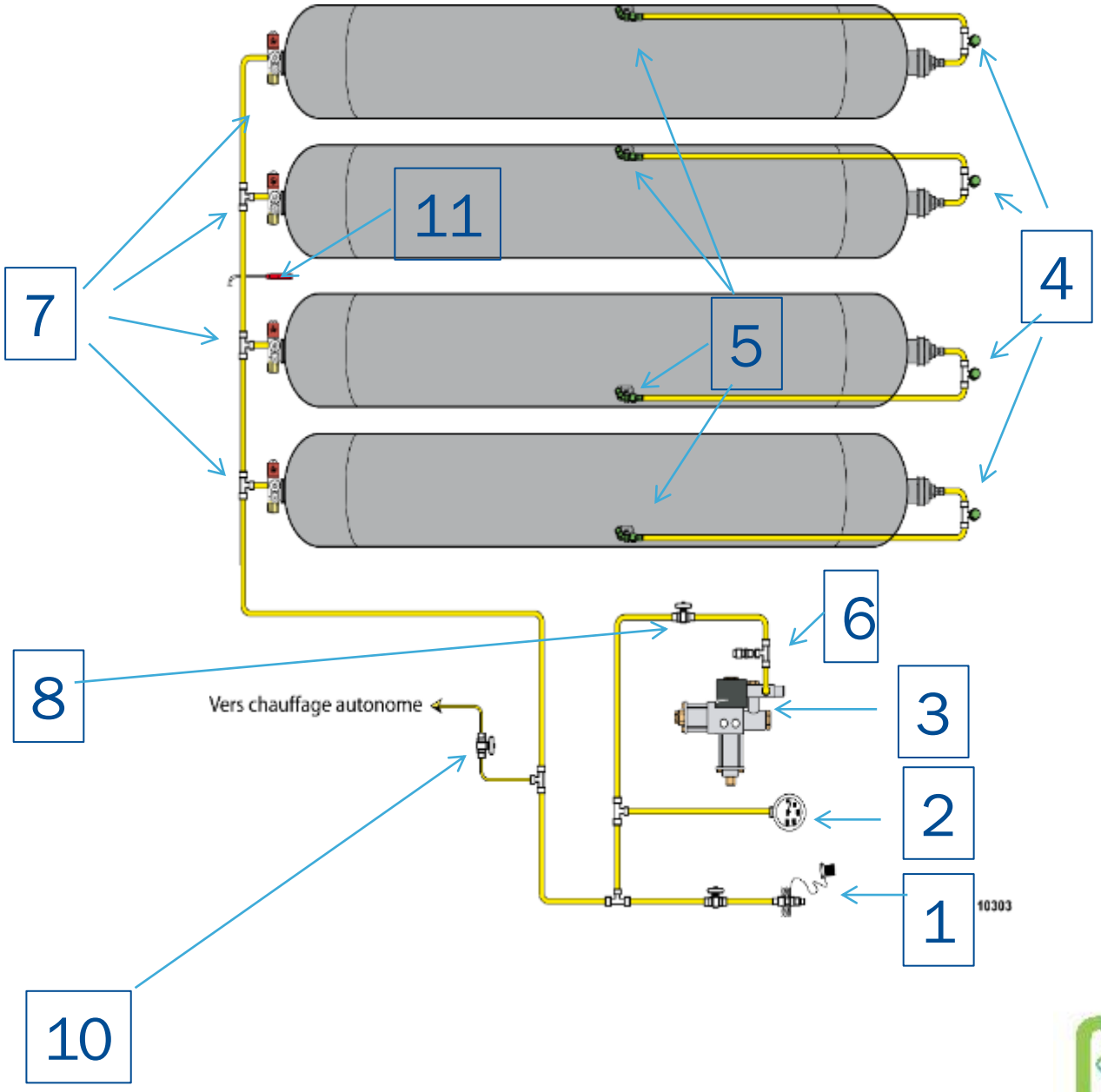


12 m CNG bus
4 tanks on the roof

High pressure CNG circuit

Components

1. Filling nozzle
2. Pression Gauge
3. Expansion module → engine
4. Thermal fuses (neck of tank)
5. Thermal fuses (middle of tank)
6. Cap
7. Multifunctional electro-valve
8. ¼ turn valve engine
9. ¼ turn valve filling
10. ¼ turn valve additional heater
11. Temperature gauge rack



Tanks

Detailed Inspection Control : all high pressure, incl tanks
Visuel check s, gas leak instrument. Every 4 years.

Multifunction valve

« Pressure Relief Device » : PRD

Over-pressure
relief valve 280 bars

Tank

Thermal fuse 110°c

Electrovalve

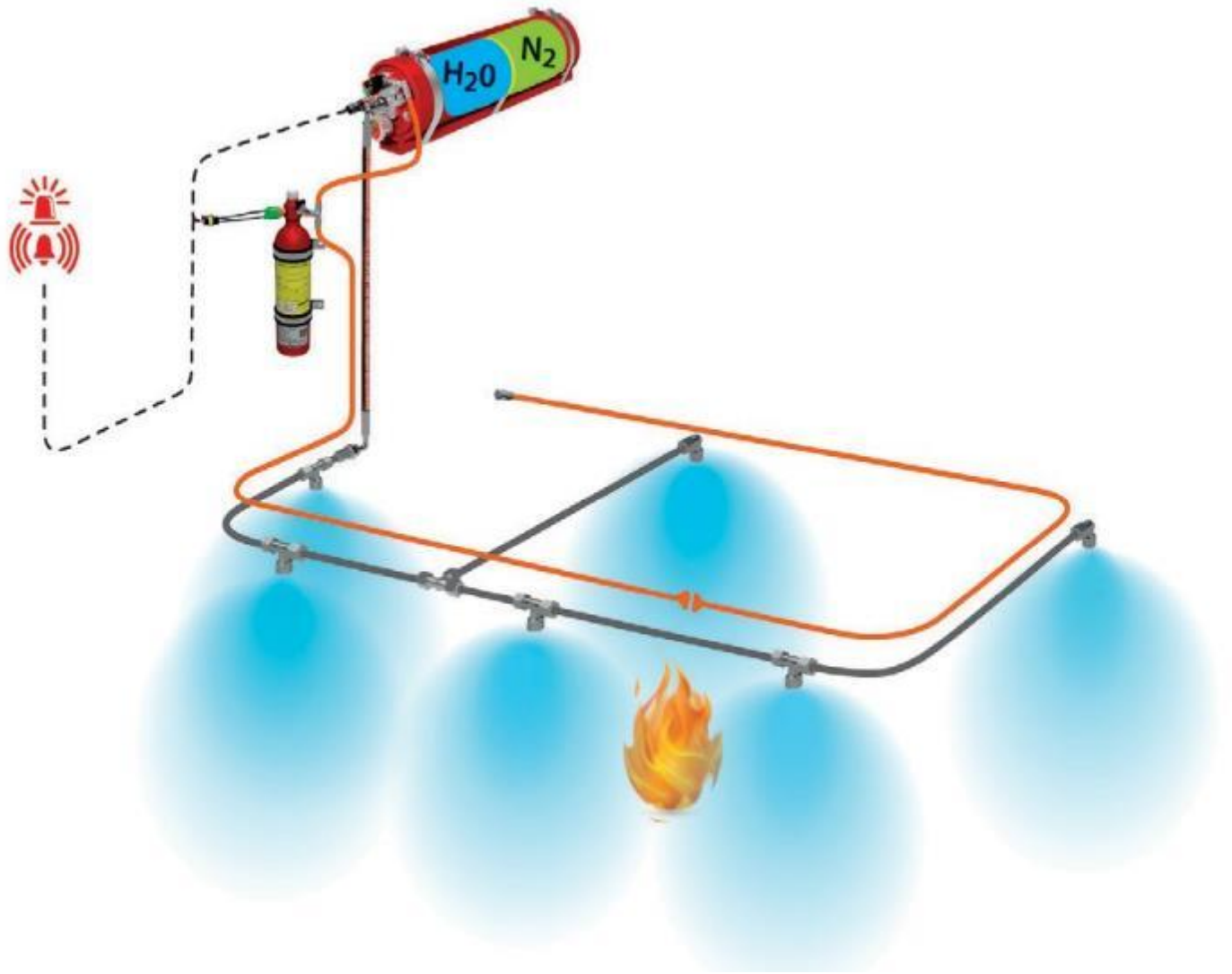
to Vehicle
HP piping

Manual valve

Non-return valve
+ flow limiter

Pressure sensor
For detection P > 250 bars

Fire detection system – water fog spray



Safety vehicle

Leak Detection

Shock Sensor

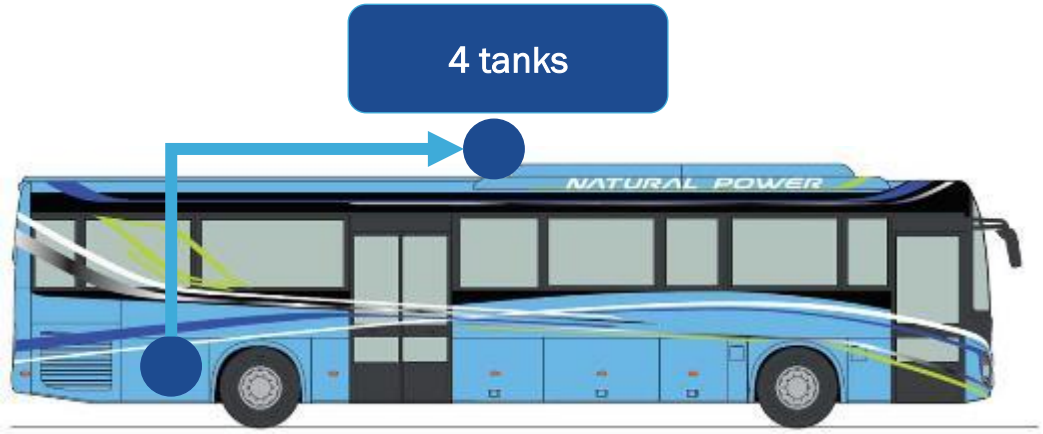
Fire Detection

Fire Extingui.

6 systems in action

Pressure Control

Thermal Fuse



Devices in gas vehicles – R110 and additional

Safety vehicle

Leak Detection

Shock Sensor

Fire Detection

Fire Extingui.

6 systems in action

Pressure Control

Thermal Fuse

Low pressure 200 → 9 bars

electrovalves

Devices in gas vehicles – R110 and additional

Safety vehicle

- Leak Detection
- Shock Sensor
- Fire Detection
- Fire Extingui.

6 systems in action

- Pressure Control
- Thermal Fuse

3 leak detection zones :
- Engine compartment
- Additional heating
- Tanks

Monitor on dashboard
Visual + sound

Devices in gas vehicles – R110 and additional

Safety vehicle

Leak Detection

Shock Sensor

Fire Detection

Fire Extingui.

6 systems in action

Pressure Control

Thermal Fuse

2 zones fire detection:
- Engine compartment
- Additional heating

light on dashboard

Devices in gas vehicles – R110 and additional

Safety vehicle

Leak Detection

Shock Sensor

Fire Detection

Fire Extingui.

6 systems in action

Pressure Control

Thermal Fuse

3 zones for extinguishing:

- 2 Engine compartment
- Additional heater

Fog system

Devices in gas vehicles – R110 and additional

Safety vehicle

Leak Detection

Shock Sensor

Fire Detection

Fire Extingui.

6 systems in action

Pressure Control

Thermal Fuse

Shock sensor :
Position rear left

Closing Electrovalves

Devices in gas vehicles – R110 and additional

Safety vehicle

Leak Detection

Shock Sensor

Fire Detection

Fire Extingui.

6 systems in action

Pressure Control

Thermal Fuse

Each tank :
- Pression sensor
- Overpressure discharge valve 290 bars

Light / buzzer on dashboard

Devices in gas vehicles – R110 and additional

Safety vehicle

Leak Detection

Shock Sensor

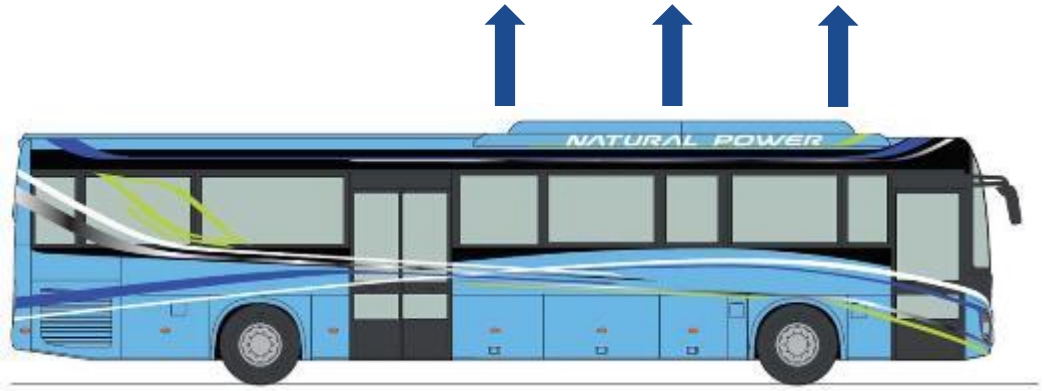
Fire Detection

Fire Extingui.

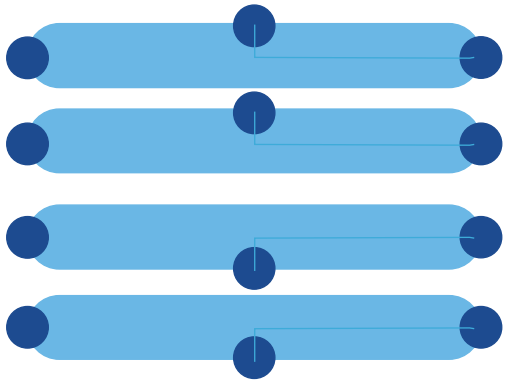
6 systems in action

Pressure Control

Thermal Fuse



12 fuses
to liberate gas
if Temp > 110 °C



Devices in gas vehicles – R110 and additional

Safety vehicle

Leak Detection

Shock Sensor

Fire Detection

Fire Extingui.

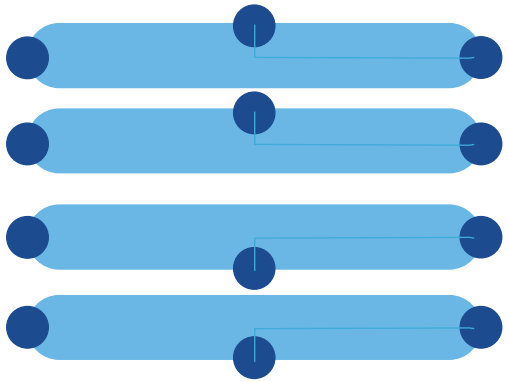
6 systems in action

Pressure Control

Thermal Fuse

Auto-tests

12 fuses
to liberate gas
if Temp > 110 °C



Devices in gas vehicles – R110 and additional

Questions & Answers

Thank You!

The recording will be available soon at

www.cleanbusplatform.eu

High pressure CNG circuit

Components

1. Filling nozzle
2. Pression Gauge
3. Expansion module → engine
4. Thermal fuses (neck of tank)
5. Thermal fuses (middle of tank)
6. Cap
7. Multifunctional electro-valve
8. ¼ turn valve engine
9. ¼ turn valve filling
10. ¼ turn valve additional heater
11. Temperature gauge rack