RENEWABLE ENERGIES

BIOMETHANE PRODUCTION CASE STUDIES

IGNASI MALLOL SANGRA
PROYECTO BIOMETANO

Originis and history

1843

First gas company founded in Spain.

2000

First electricity sales in the liberalised Spanish market.

1969

Pioneer in distribution of natural gas in the Iberian Peninsula.

2009

Acquisition of Unión Fenosa concluded.

1991

Creation of Gas Natural SDG and integration of the gas distribution sector in Spain (merger of Catalana de Gas, Gas Madrid and Repsol Butano's gas pipeline assets).

2010

Launch of Gas Natural Fenosa brand.

1992

Start of international expansion in Latin America, entering Argentine market.

2018

Launch of Naturgy brand.

Who we are

The largest integrated gas and electricity company in Spain and Latin America

1. Figures at 31/12/20.

A. BIOGAS: Where does it come from?

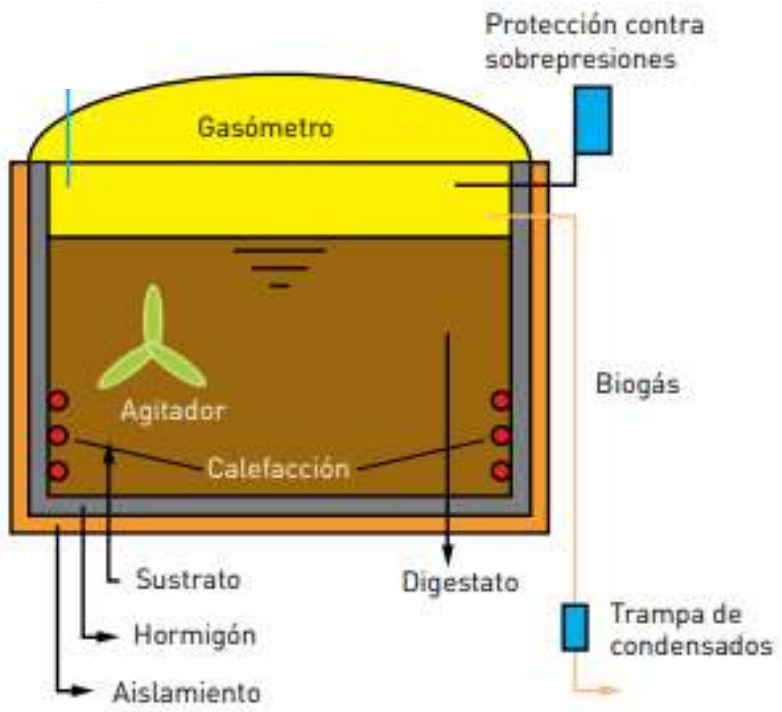
Biogas (BG) is produced in an anaerobic digester (AD) by means of bacteria, in two phases:

1. Digestate (Organic matter) Acidification
2. Transforming the OM in CH_4 with bacteria

The AD are hermetic without any emission to the atmosphere:

- N2
- CH4
- Smell
- Flies, etc.

The process lasts 30 days



B. BIOMETHANE: What is it?

It is a gas with renewable origin, neutral CO2 emissions and totally exchangeable with fossil natural gas (NG).

Renewable gas characteristics

Origin	**Renewable: BIOGAS**
CO_2 Emission	**Neutral emissions of CO_2**
USES	**Same as Natural Gas (NG)**

3 production options

		Market maturity
A 	BIOGAS (AD) + UPGRADING	HIGH
B 	BIOMASS GASIFICATION (THERMAL)	MEDIUM
C 	POWER TO METHANE & POWER TO HYDROGEN	LOW

C. HOW CAN BIOMETHANE BE PRODUCED?

Anaerobic digestion

Biogas (BG)

CO_2

UPGRADING

Biomethane (BM)

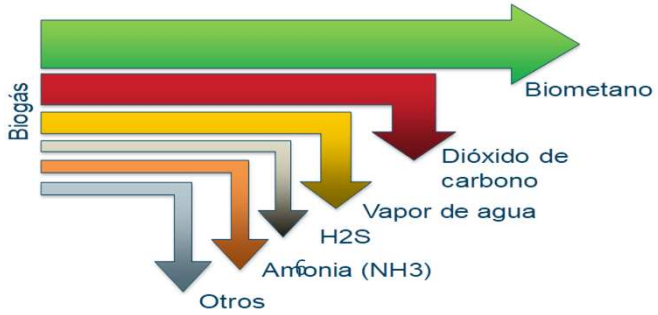
Injection into the Natural Gas GRID

- CH_4 50-70 %
- **CO_2: 30-50%**
- H_2S: up to 2000 ppm
- Siloxanes 0-20 mg/m^3
- Others: ammonia, etc.

TECHNOLOGIES

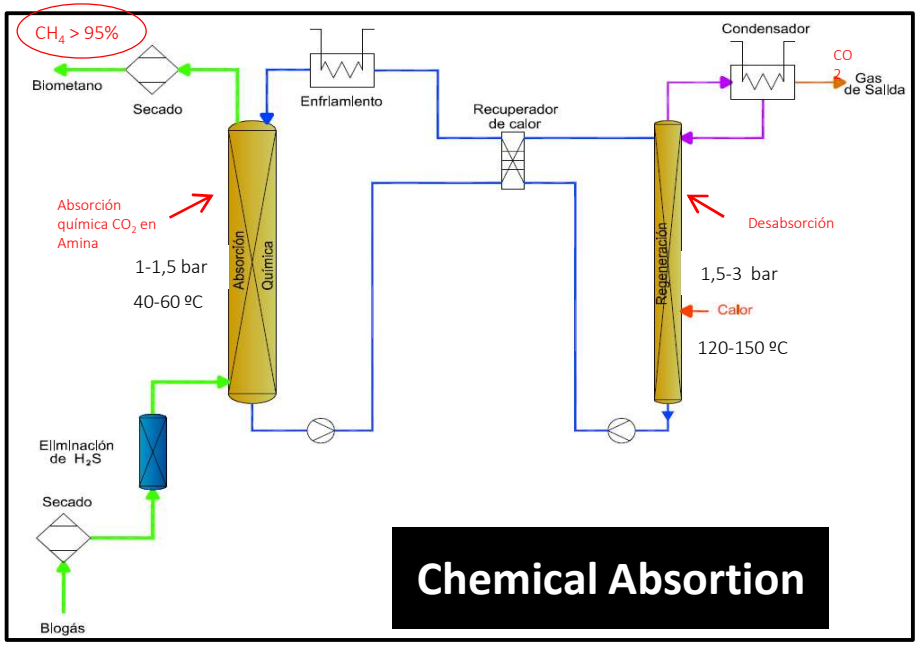
- ✓ PHYSICAL ABSORPTION
- ✓ CHEMICAL ABSORPTION
- ✓ PRESSURIZED WATER SCRUBBER (PWS)
- ✓ MEMBRANES
- ✓ PRESSURE SWING ADSORPTION (PSA)
- ✓ CRIOGENYC

- **$CH_4 \geq 95\%$**
- **$CO_2 \leq 2$ %**
- **H_2S + COS ≤ 15 mg/m3**
- **Siloxanes ≤ 10 mg/m3**
- All other parameters according to regulations



Upgrading: Elimination process of CO_2 and contaminants (H_2S, siloxanes…) present in the biogas

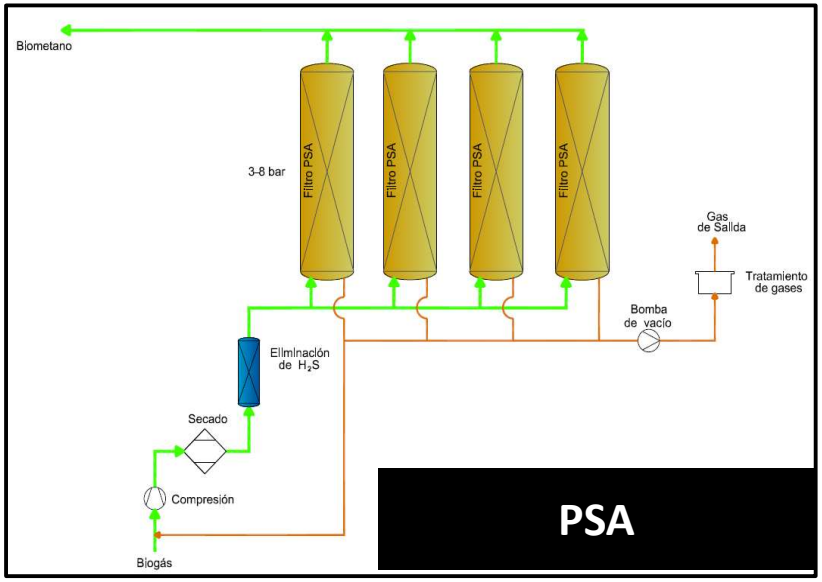
D. UPGRADING TECHNOLOGIES

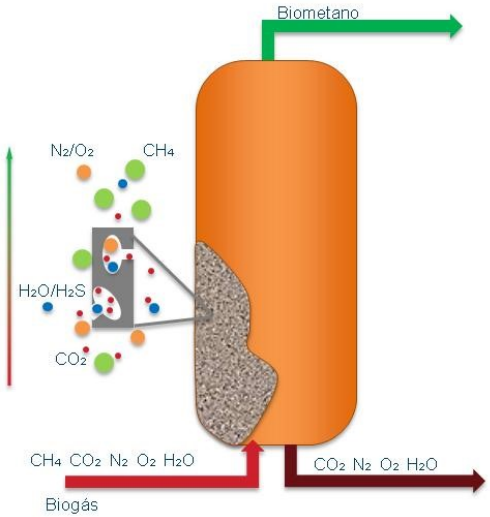


$$\text{Amina} \cdot H_2O + CO_2 \rightleftharpoons \text{Amina-}H^+ + HCO_3^- + \text{heat}$$

- Principle of separation: Chemical absortion of CO2 in an amine solution (MEA, MDEA, DEA..)
- O_2 and N_2 keep going in the BG current
- Higher termal consumption required from the amine regeneration
- Possibility to use the heat excess in other industrial uses

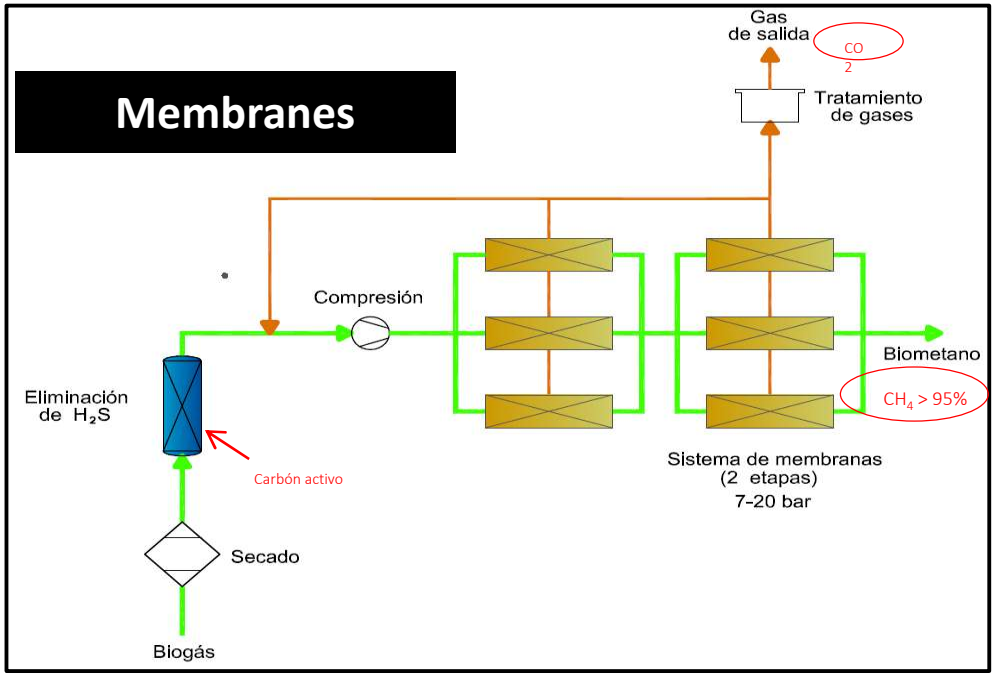
D. UPGRADING TECHNOLOGIES

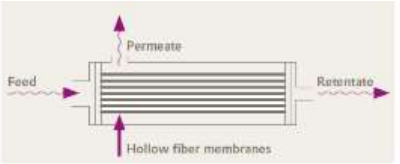


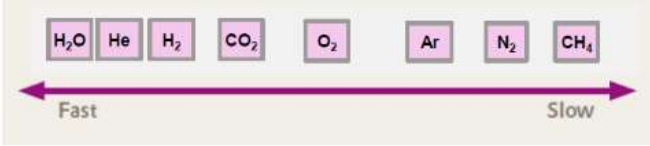


- Principle of separation: flowing presurized Biogas through carbon molecular filters where CO2 is absorbed.
- O_2 and N_2 are absorbed partially
- Once the carbon molecular is saturated , it is regenarated (depressurized and desorb the CO2) . The process takes around 1-2 min.
- Higher electrical consumption

D. UPGRADING TECHNOLOGIES







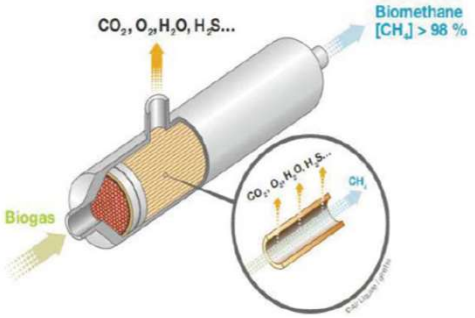
- Principle of separation: Flowing presurized BG through the membranas. These membranes are more permeable to CO2 than to CH4.
- Severeal stages: 2 or 3
- N_2 keeps in the BG current while O_2 reduces partially
- Higher electrical consumption

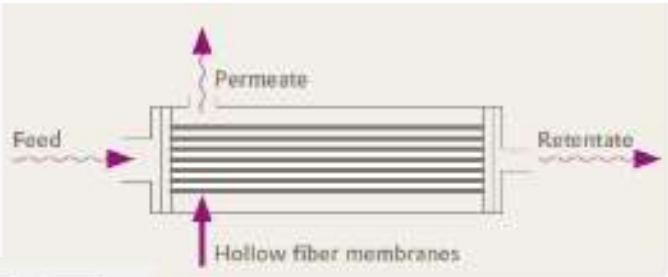
D. UPGRADING TECHNOLOGIES

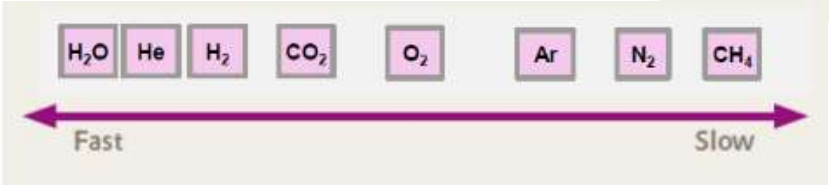
Membranes

Mebrane Tecnology Advantages:

- Modular. Quick installation and commissioning (plug&play)
- Easy operation
- High CH_4 recovery
- Flow and CH_4 concentration could vary
- High CH_4 concentration in BM (>96%)
- Partial reduction of O2
- Smaller installation costs



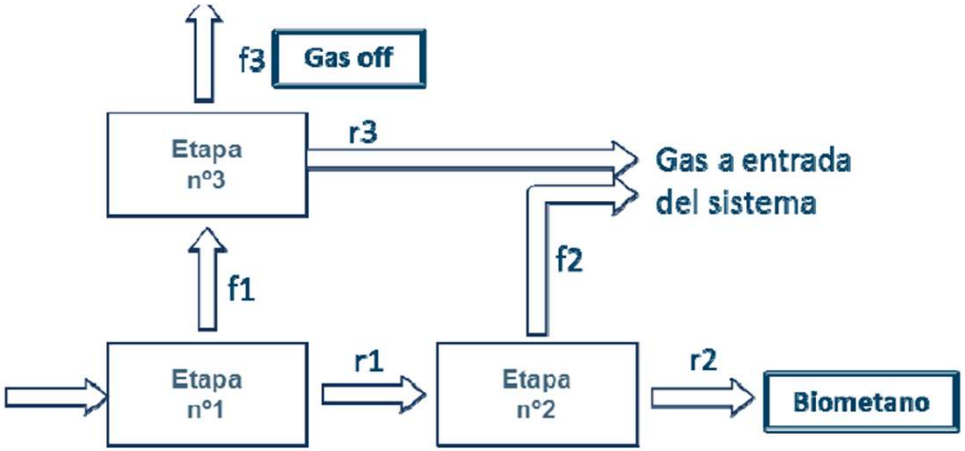




D. UPGRADING TECHNOLOGIES

Membranes

Membrane system with 3 stages to get a Higher CH4 recovery >99%, patented by EVONIK.

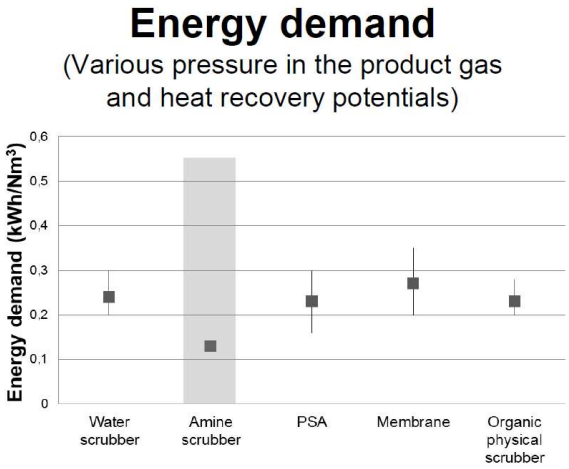


- With 3 stages CH4 Recovery >99%
- With 2 stages CH4 Recovery around 85%

D. UPGRADING TECHNOLOGIES

Overall comparison of technologies

	PSA (adsortion)	Pressurized Water Scrubber (PWS)	Chemical absorption (amines)	Membrane (2-3 stages)
Electricity demand (kWh/Nm³BG)	0,16-0,3	0,2-0,3	0,06-0,17	0,3-0,45
Heat demand(kWh/Nm³BG)	No	No	0,4-0,8	No
Losses of CH_4 %	1-2	~1	~0,1	0,5-1
Operating pressure, bar	1-10	4-10	0,05-4	7-20
Operation temperature, ºC	-	-	106-160	-
Separation of N_2 and O_2	Partially	No	No	Partially (O_2)
Requirement of H_20	No	Yes	Yes	No
Separation of H_2S	External	Yes	External	External

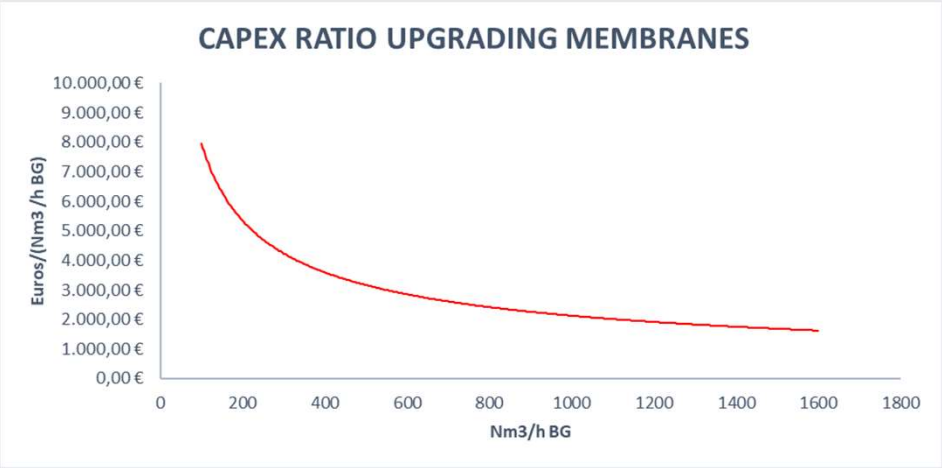


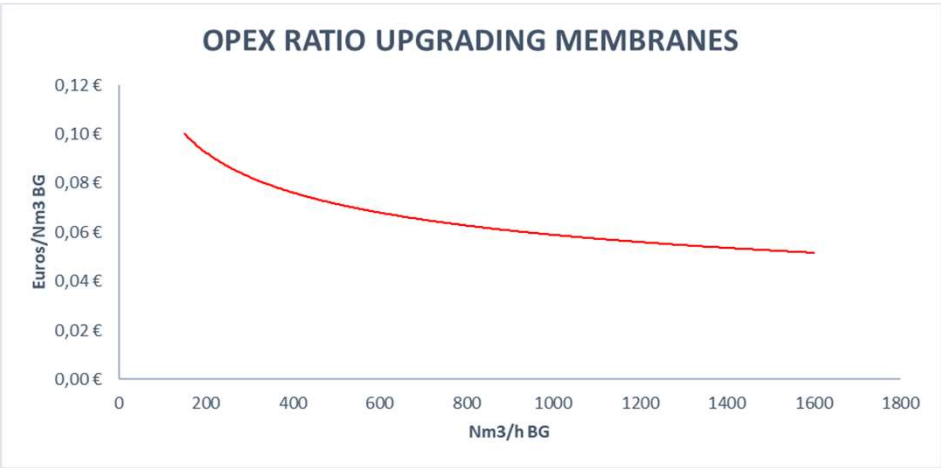
Sources SGC; AIE, Fraunhofer IWES,Otros

The availability of all the technologies is 95%
They reach CH_4 concentrations in the outlet gas over 95%

D. UPGRADING TECHNOLOGIES

Membranes





- CAPEX
  - ✓ Pretreatment including active carbon filters
  - ✓ Upgrading

- OPEX:
  - ✓ Electrical consumption: 0,3-0,45 KWh/Nm3 BG
  - ✓ Active carbon: 1,5-2 g Active Carbon/Nm3 BG considering 300 ppmv H2S
  - ✓ Supervision and operation
  - ✓ Maintenance cost

E. CASES STUDIES

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WWTP BENS

- Upgrading : 100 m^3/h BG from the sludge of a WWTP in Galicia .
- Technology: membranes
- Used in mobility
- Injecting into the grid in Dec 2020.
- CAPEX: 1,1M€
- BM production: 5,5 GWh/year

ELENA MSW LANDFILL

- Upgrading: 350 m^3/h BG from MSW
- Refuse from a MSW treatment plant
- Technology: membranes
- Future grid injection and present use in mobility
- CAPEX: 2,2M€
- BM production: 12 GWh/year

METHAMORPHOSIS

- Upgrading: 214 m^3/h BG from pigs slurries and other organic rests from Catalunya, located in a farm.
- Technology: membranes
- Future grid injection and present use in mobility
- CAPEX: 1,2 M€
- BM production: 9,4 GWh/year

WWTP BUTARQUE

- Upgrading : 100 m^3/h BG from the sludge of a WWTP in Madrid
- Technology: Chemical Adsortion with Amine
- Injecting into the NG grid since October 2019. Also used in mobility.
- CAPEX: 0,8 M€
- BM production: 5 GWh/year

E. CASES STUDIES: BENS Project

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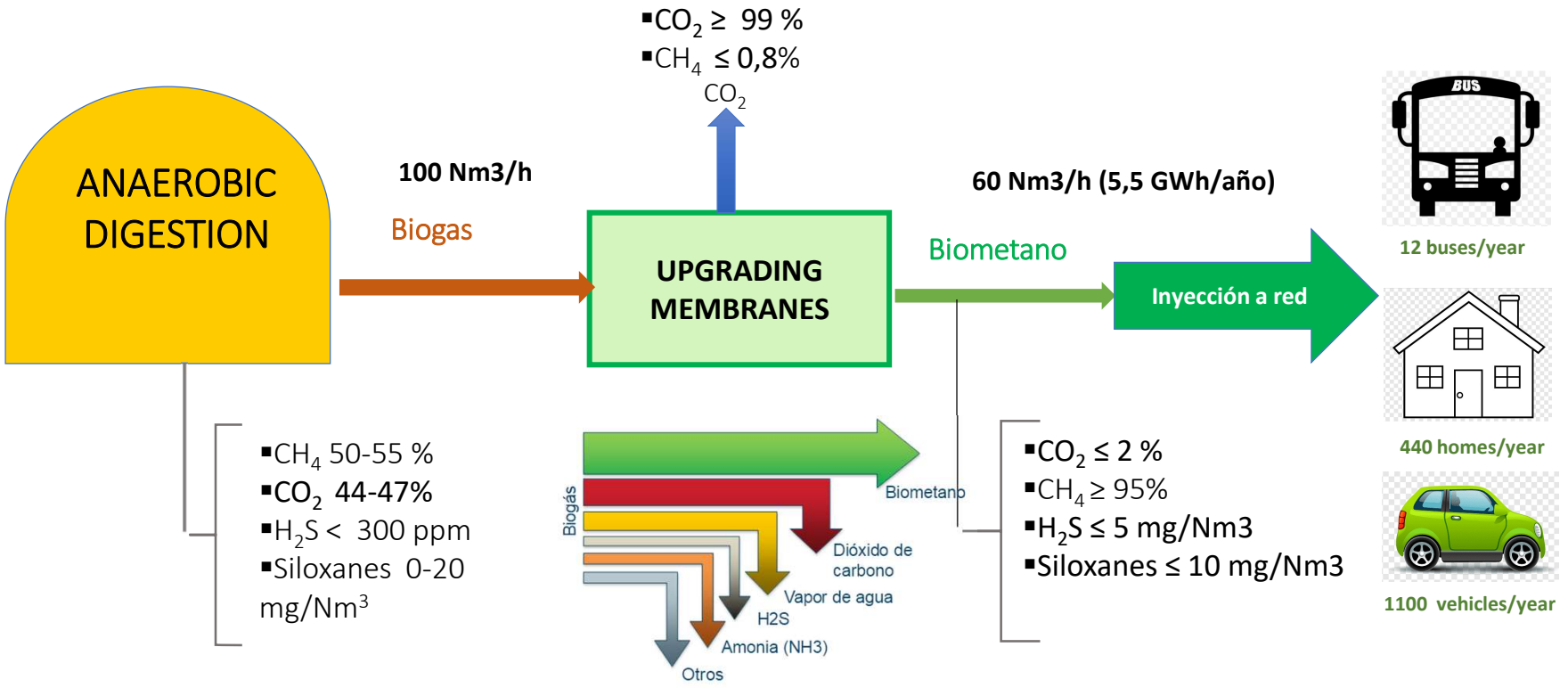

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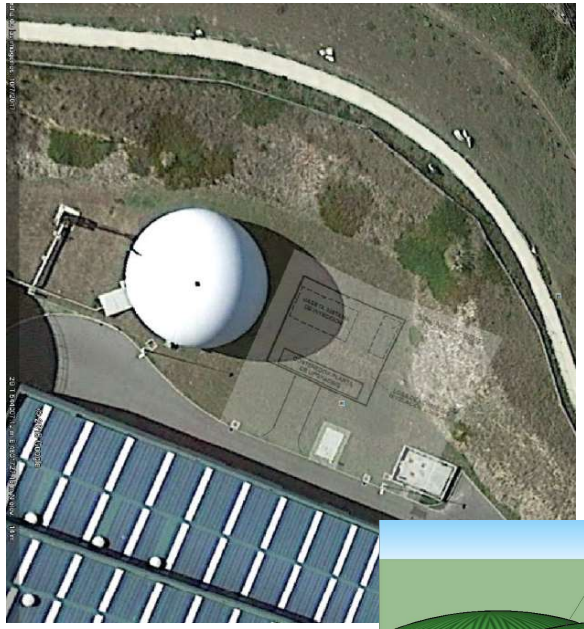
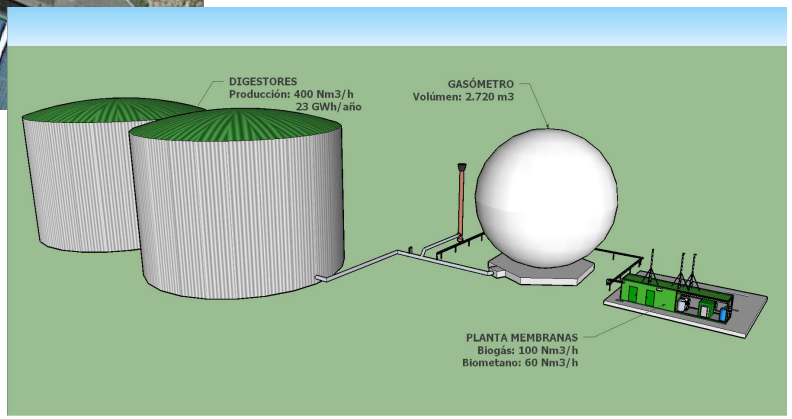
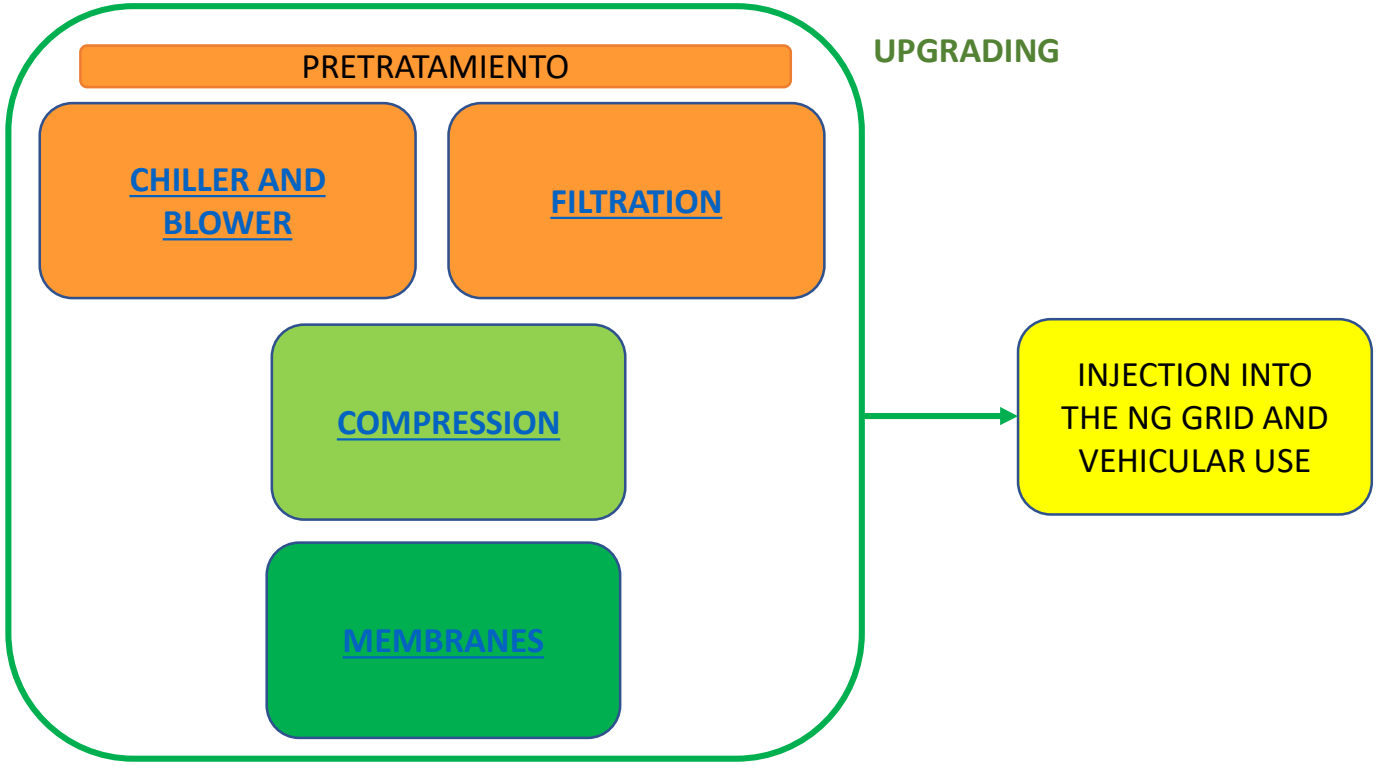


Layout



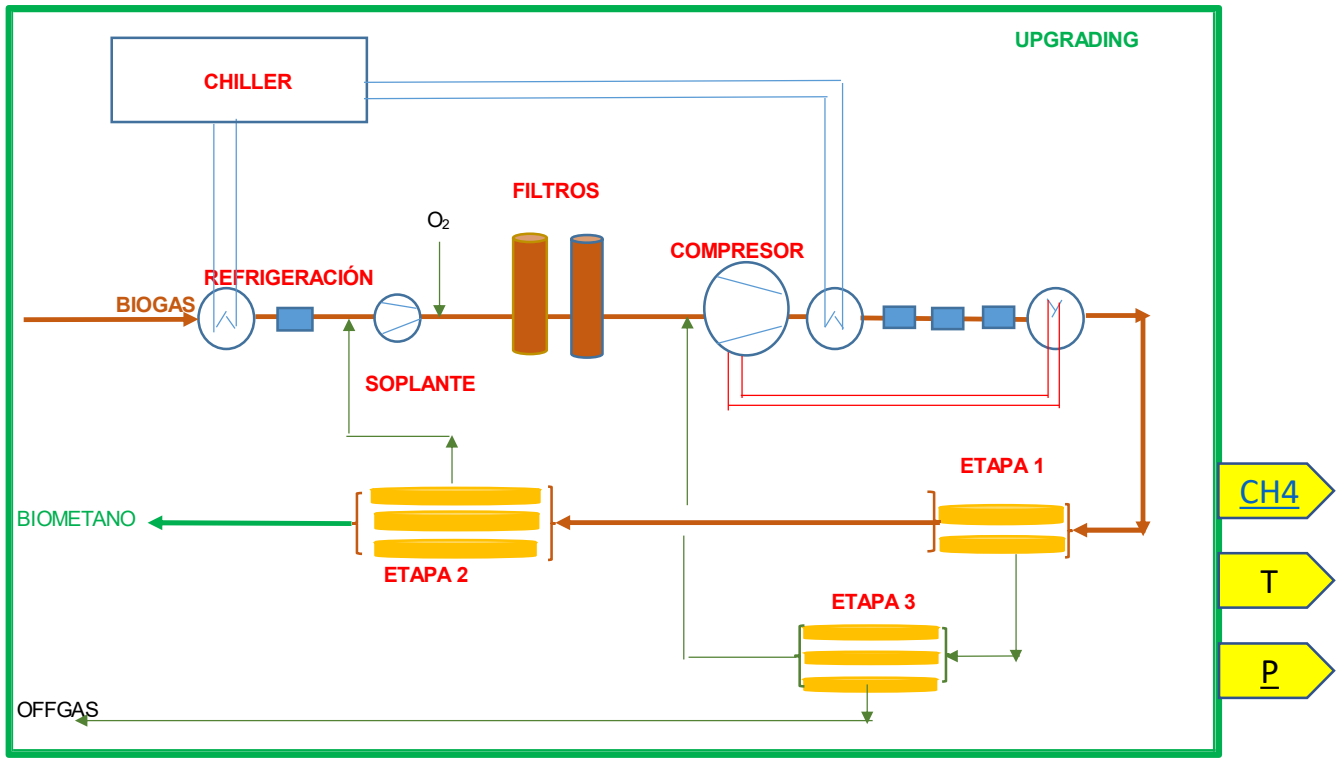
E. CASES STUDIES. BENS Project

Main system parts



E. CASES STUDIES: BENS Project

Process



E. CASES STUDIES. BENS Project

Installed Power and electrical consumption

- Main consumers
  - BG Compressor: 40 kW (PI)
  - Chiller: 4,2 kW (PI)
  - Blower: 3,2 kW (PI)
  - Instrument air compressor: 2,5 kW (PI)
  - Air conditioning: 1 kW (PI)

Installed power	59	kW
Power consumed	26.4	kW
Maximum Power consumed at nominal biogas condition	31 *	kW
Maximum Power consumed at nominal biogas condition	0.33 *	kWh/Nm^3

E. CASES STUDIES. BENS Project

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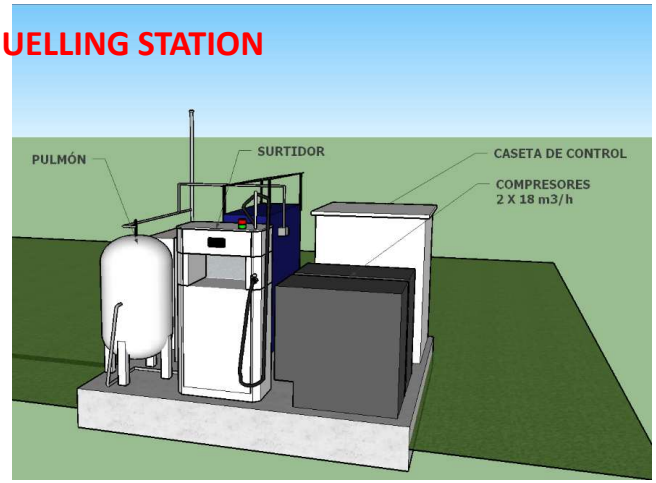
REFUELLING STATION



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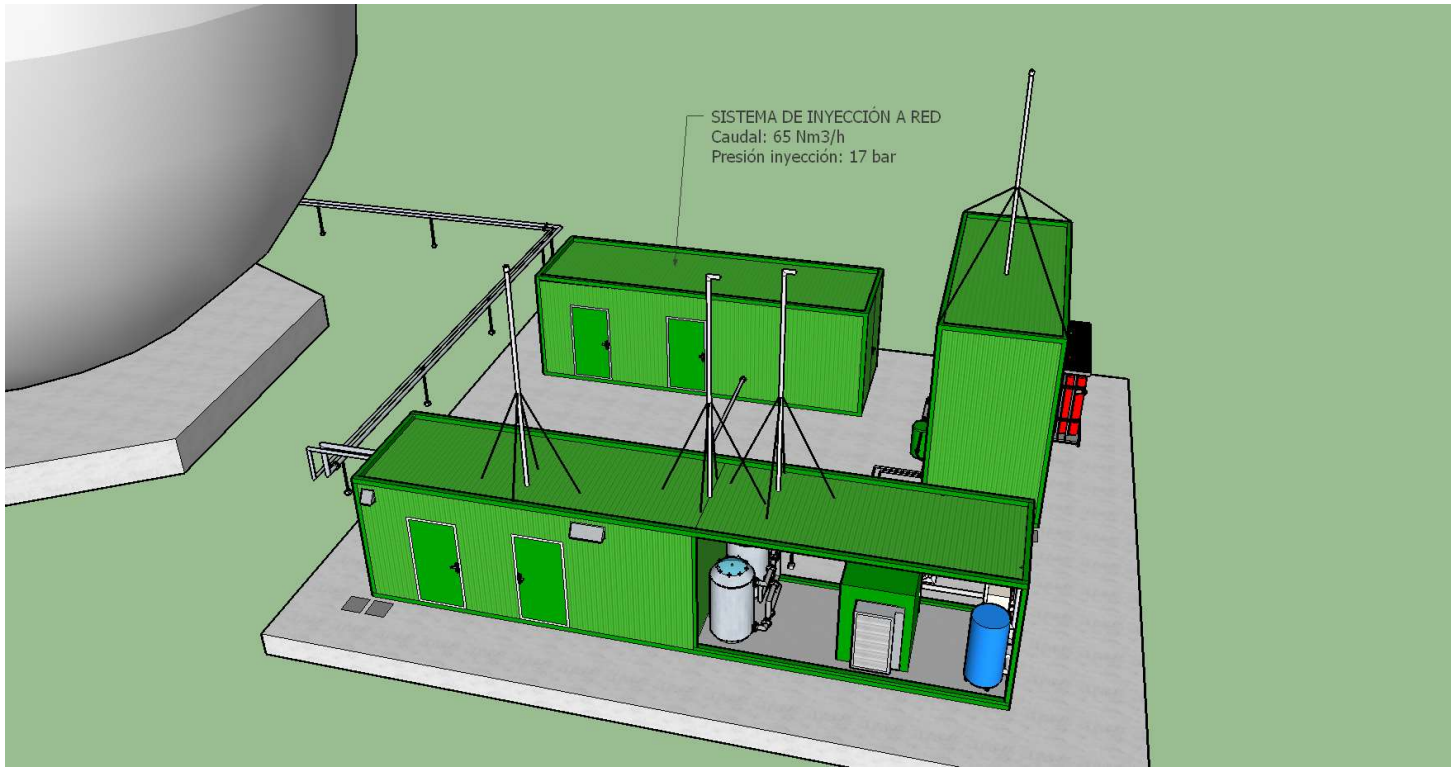
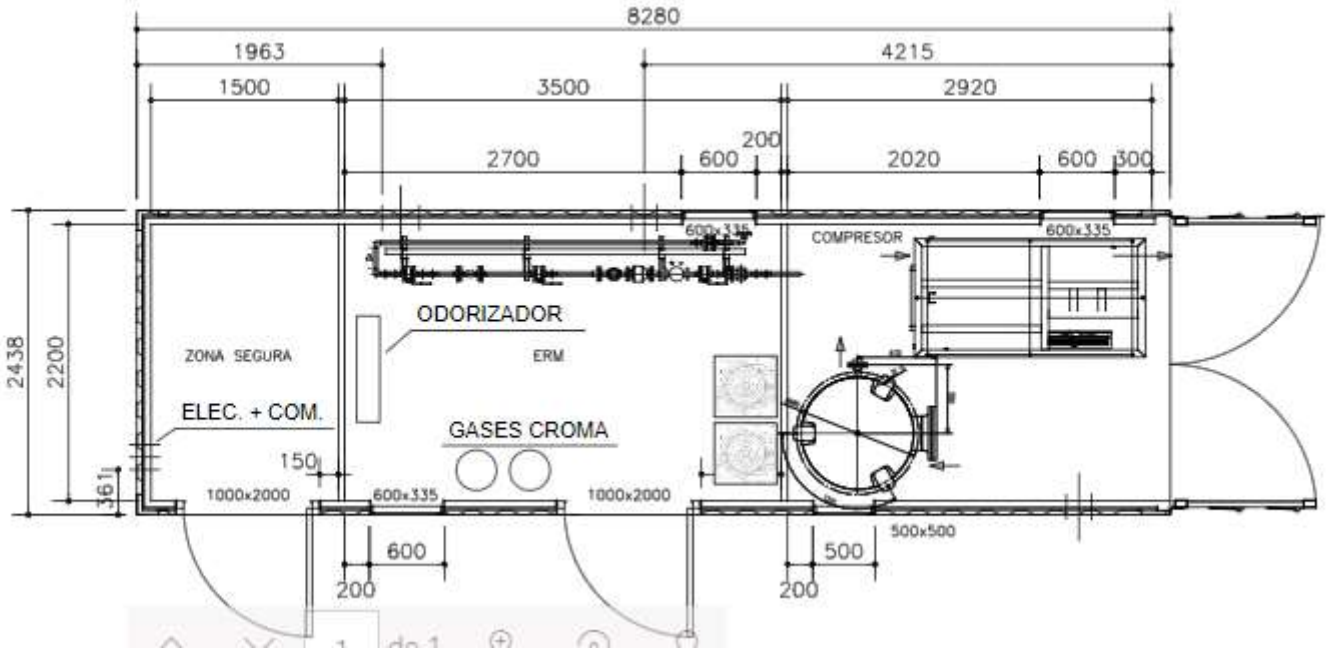


E. CASES STUDIES: BENS Project

GAS ENTRY UNIT : INJECTION SYSTEM INTO THE NG GRID

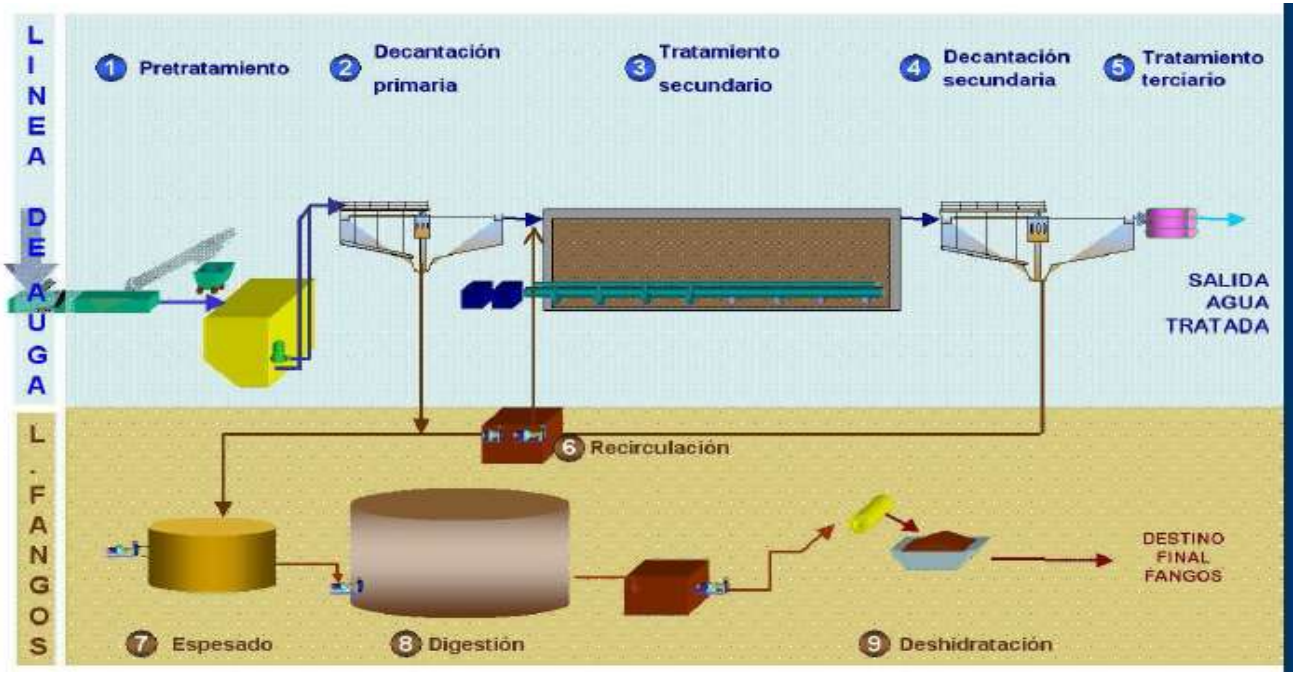


E. CASES STUDIES: BUTARQUE PROJECT

- Biomethane injected into natural gas distribution network
- Development of the Guarantees of Origin for renewable gas in Spain
- Demonstration of the eco-efficiency of renewable gas for mobility

E. CASES STUDIES: BUTARQUE PROJECT

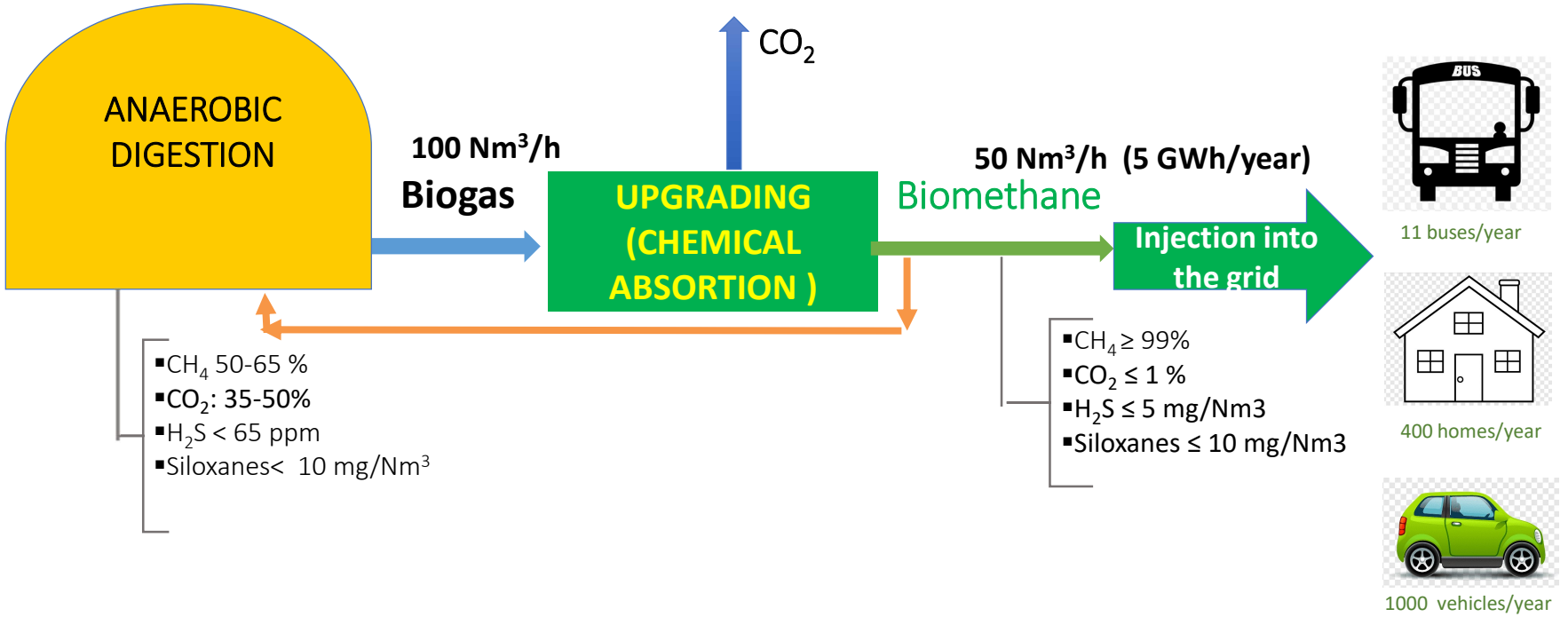
Wastewater Purification Station (WPS) scheme



WPS of Butarque

- Treatment capacity ≈ 1.700.000 population
- The 5th largest in Spain

E. CASES STUDIES: BUTARQUE PROJECT



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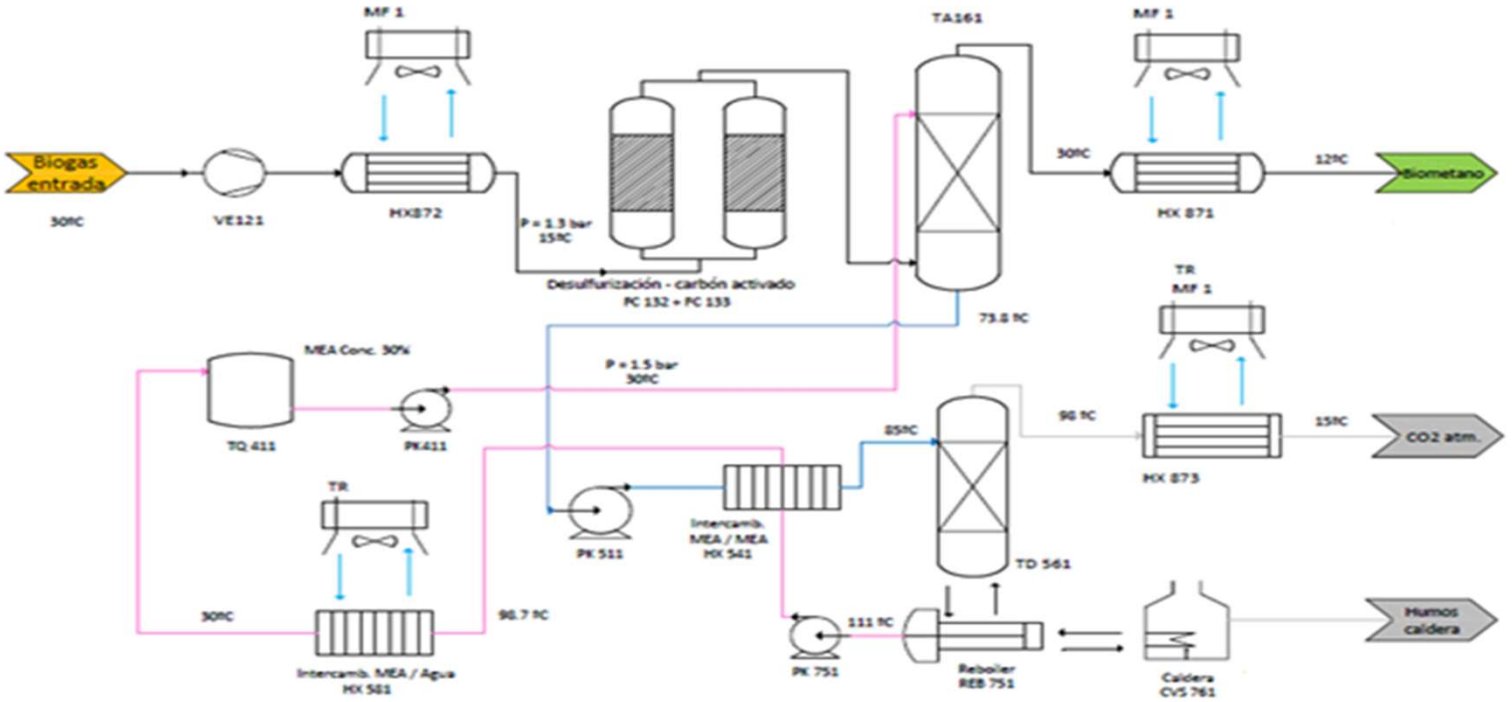

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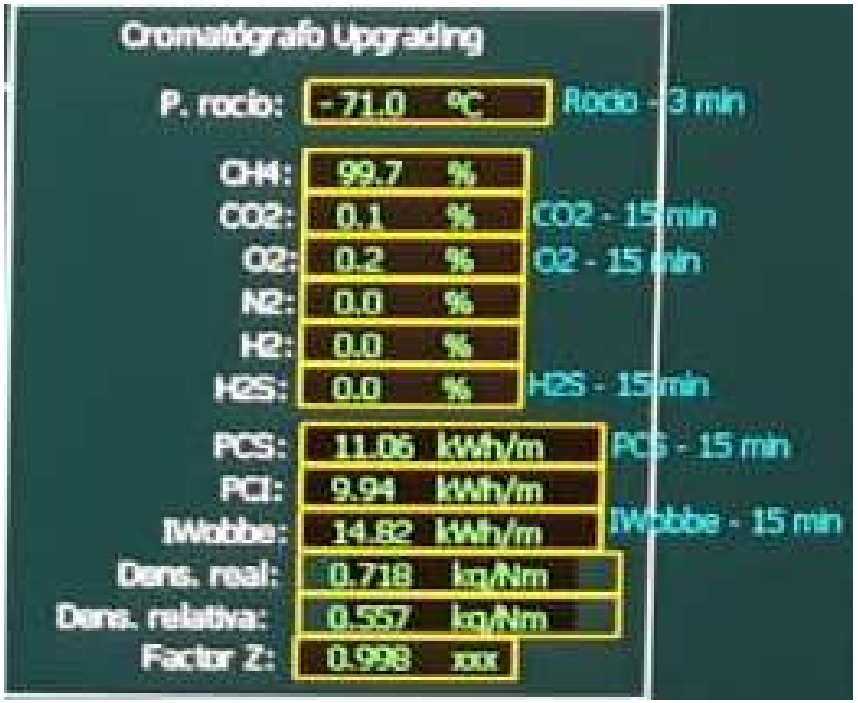

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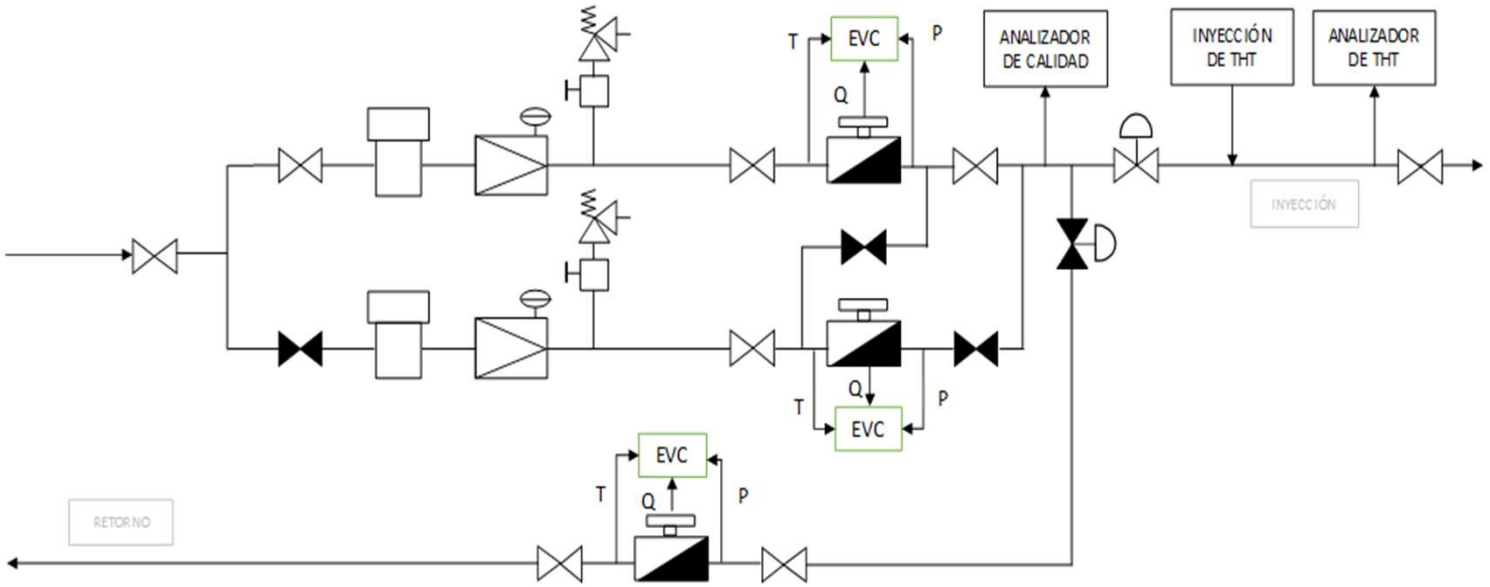

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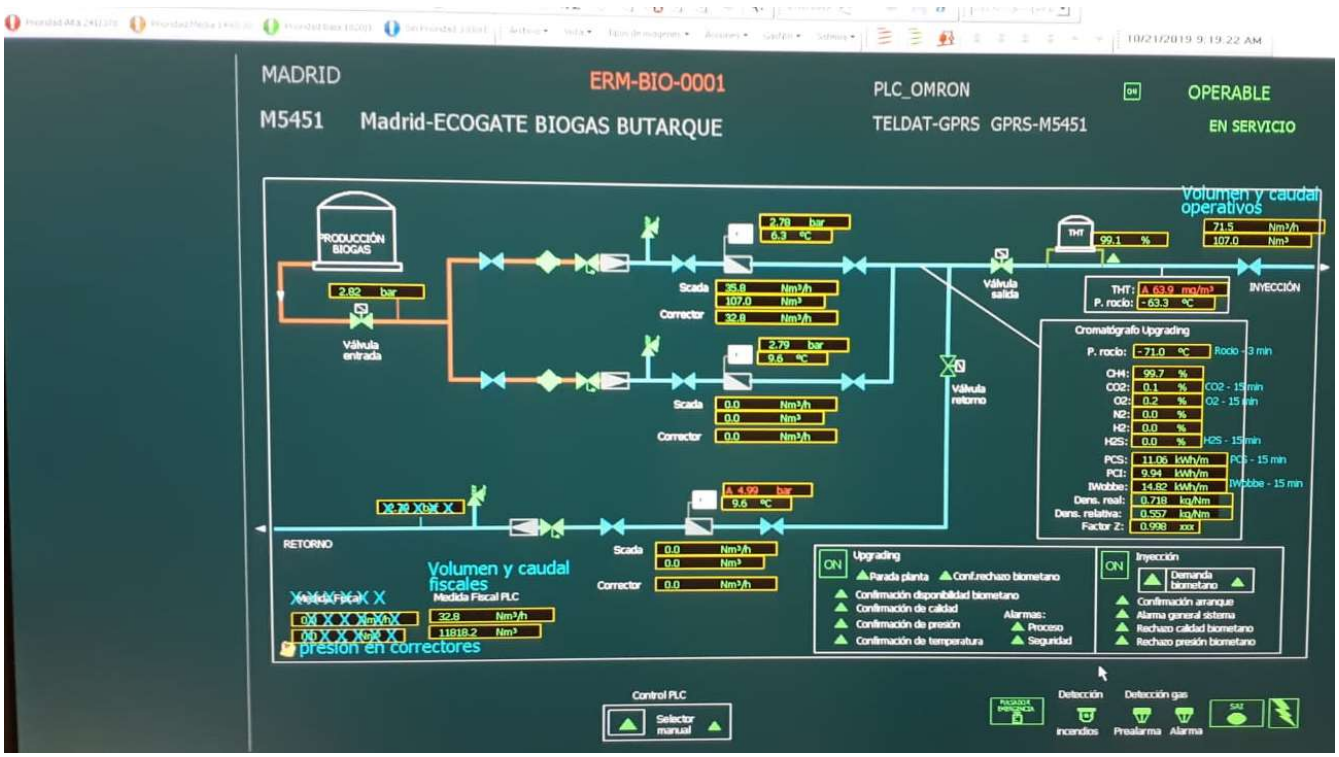

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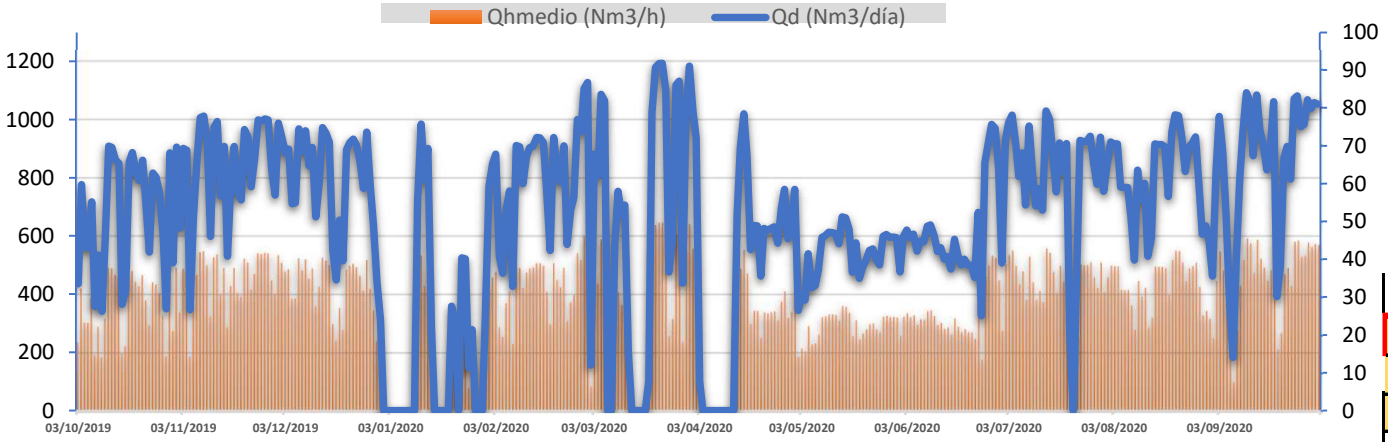


BM INJECTED INTO THE GRID

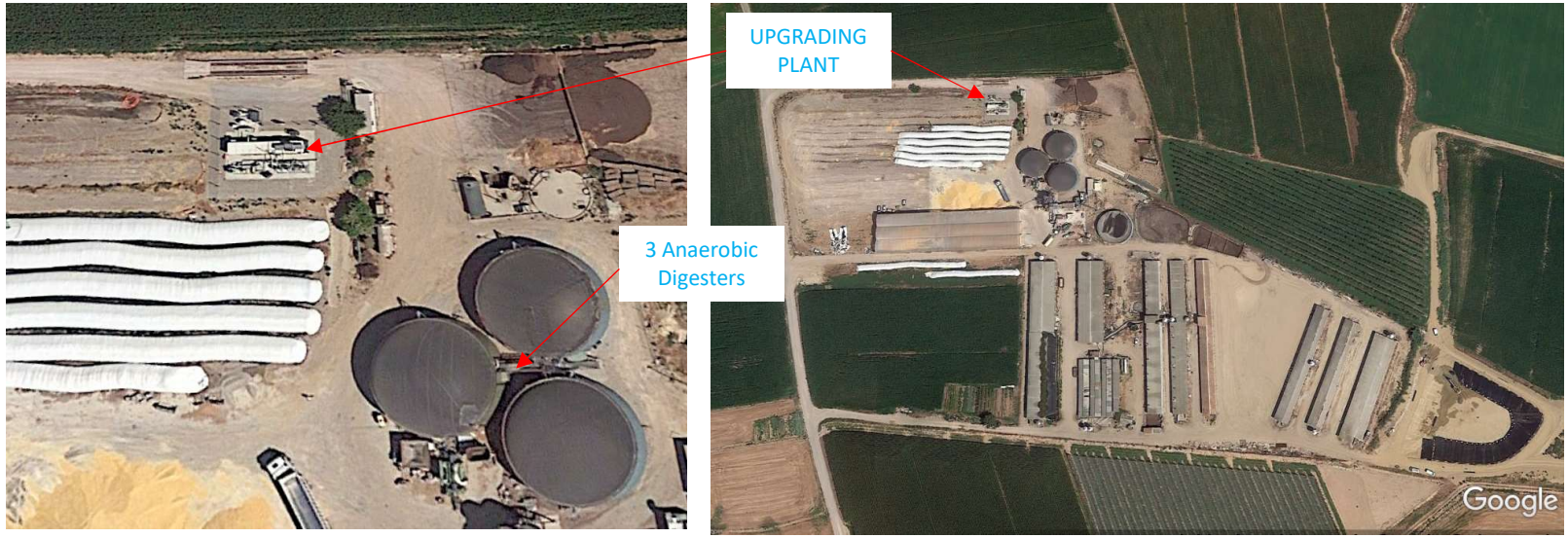
05/10/2020

Valores GR inyectado		
Total GWh	2,553	
Nm3/día	Nm3/hora	MWh/día
666	28	7,0

El GR inyectado hasta ahora equivaldría al consumo anual de:	
511	viviendas
204	vehículos utilitarios
51	taxis
9,1	camiones RSU
5,7	autobuses urbanos

E. CASES STUDIES. Methamorphosis Project

- Catalunya, Spain. Porcaporcs farm. Vila Sana. Lleida
- Biogas (BG) anerobic co-digestión 45T/day of waste products (45% pig slurries + 50% waste from WWTP+ 5% wastes from food industry)
- Farm BG production: 200 Nm^3/h



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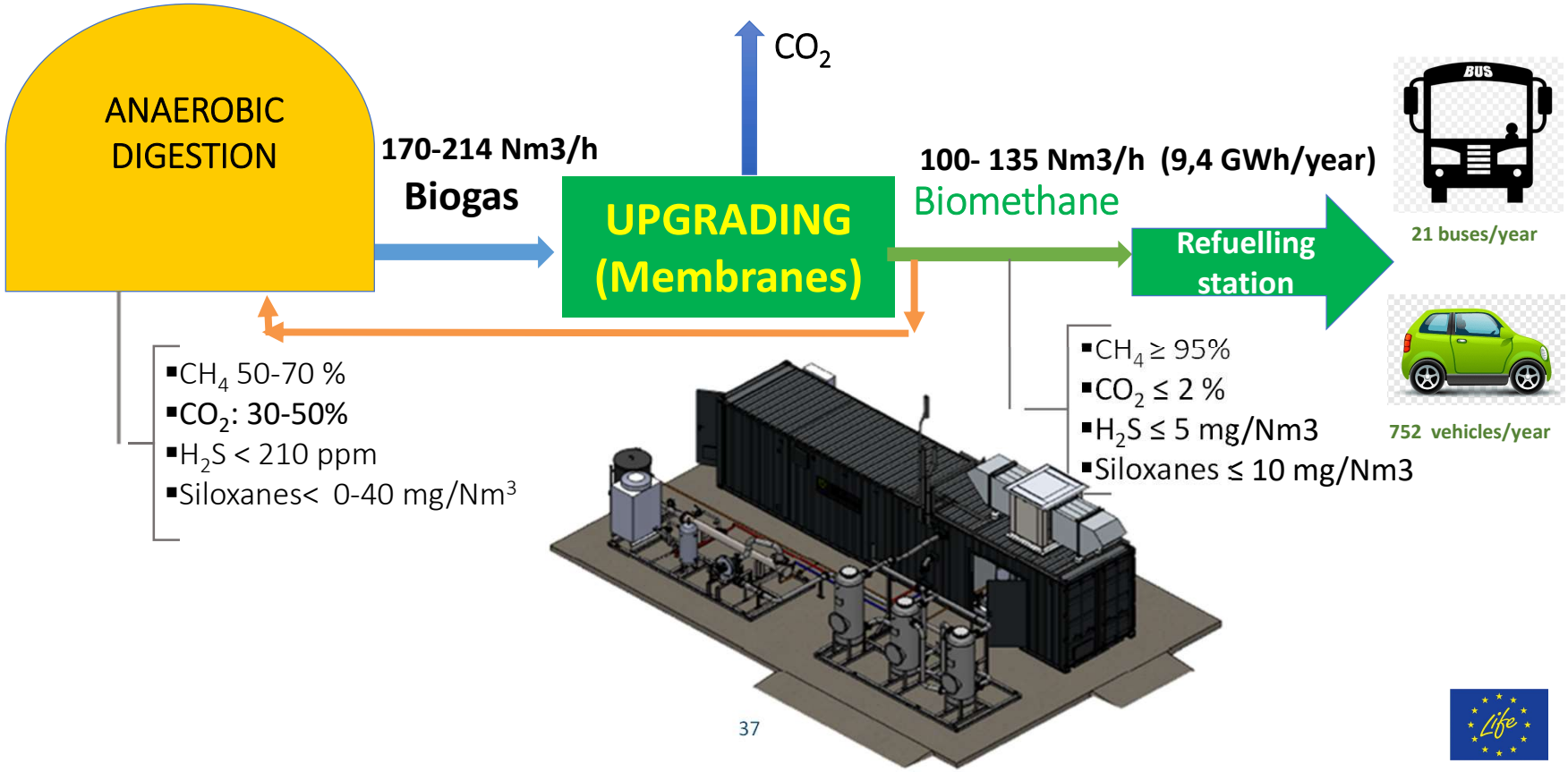

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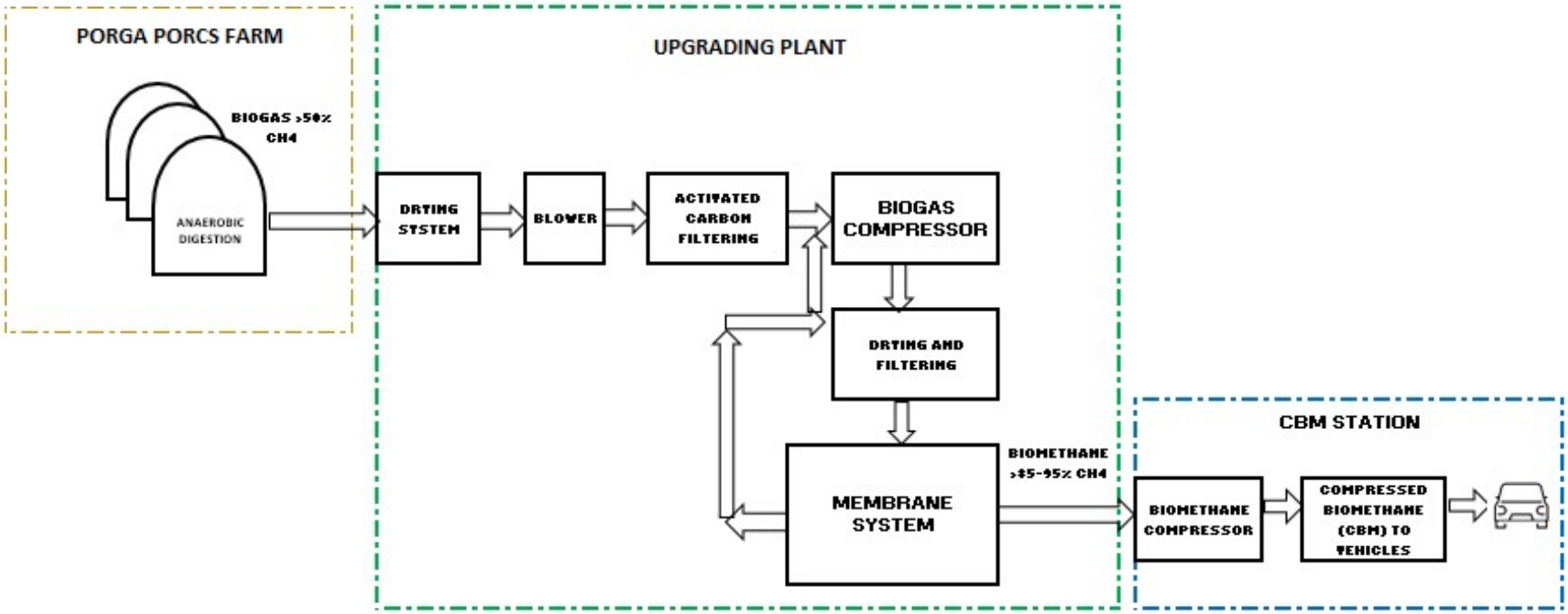
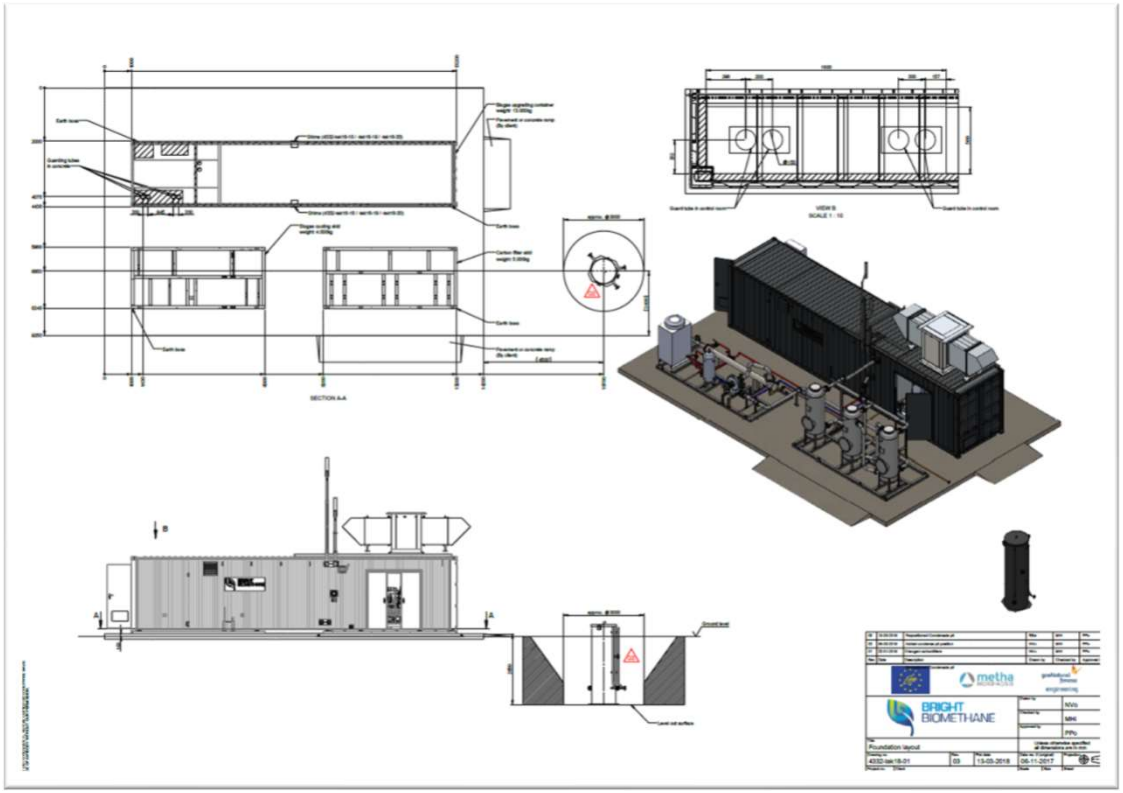


E. CASES STUDIES. Methamorphosis Project

DETAIL ENGINEERING



E. CASES STUDIES. Methamorphosis Project

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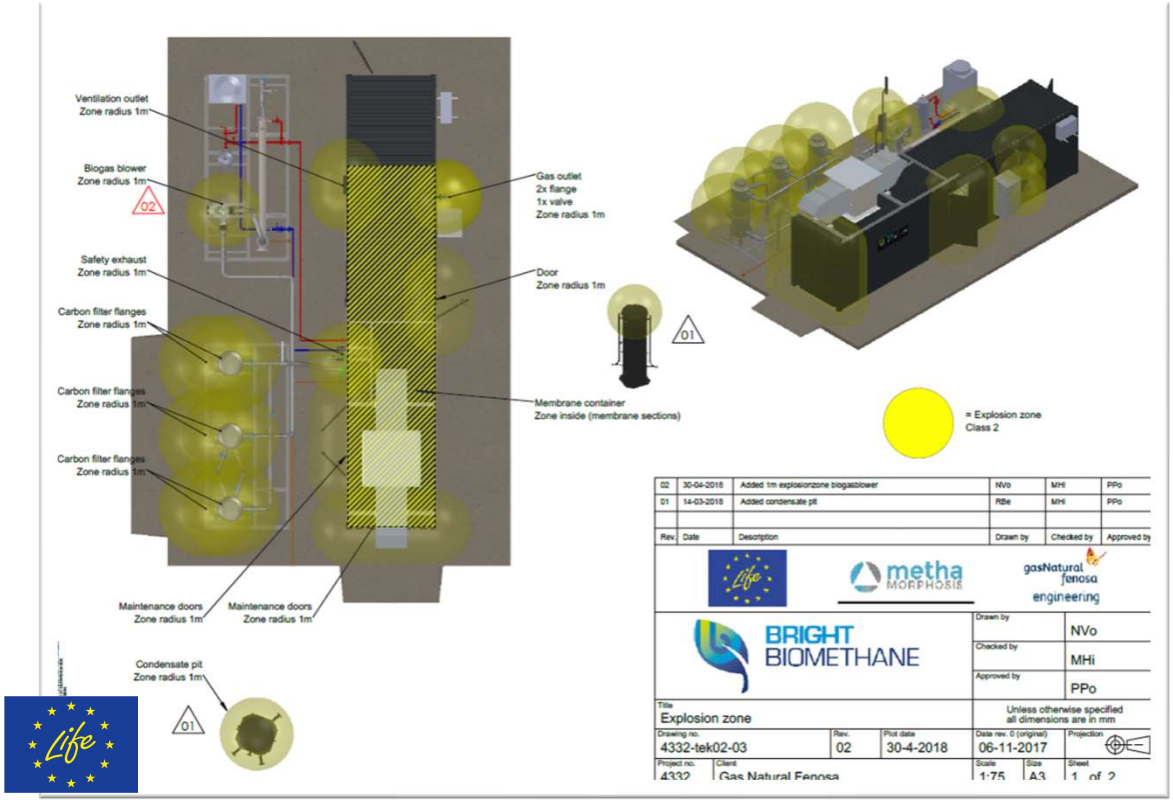


E. CASES STUDIES. Methamorphosis Project

METHAGRO Upgrading Construction and Assembly

E. CASES STUDIES. Methamorphosis Project

Upgrading plant constructed by Bright Biomethane with a capacity of 214 Nm^3/h of BG resulting in a production of 100-135 Nm^3/h BM. Plant includes a pretreatment process (3 carbon filters, drying sistem and the blower) and the Membrane unit with 19 membranes fed by a BG compressor (16 barg) manufactured by ADICOMP.

E. CASES STUDIES. Methamorphosis Project

- *Stage* 1: 5 MEMBRANES
- Stage 2: 8 MEMBRANES
- Stage 3: 6 MEMBRANES

E. CASES STUDIES. Methamorphosis Project

BIOGAS COMPRESSOR

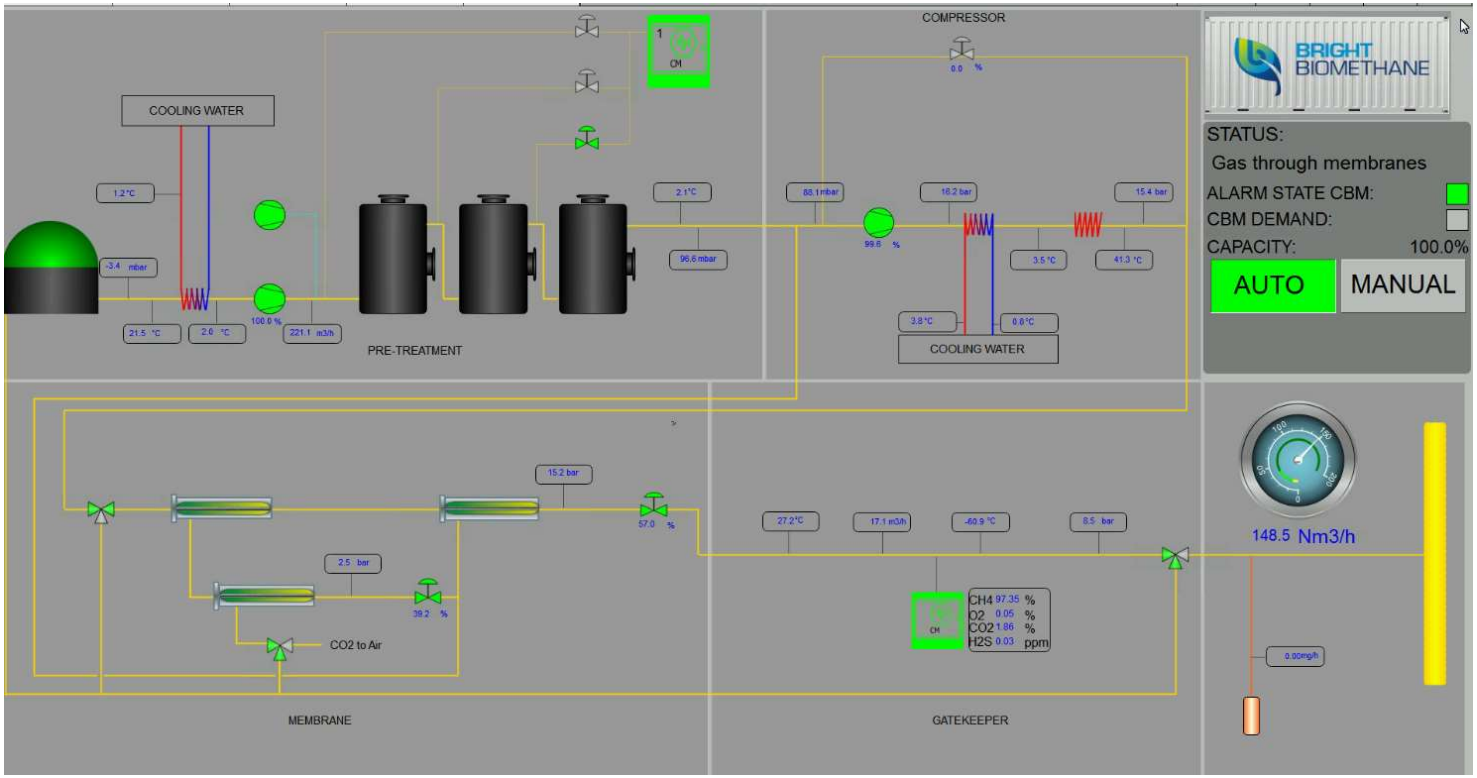
E. CASES STUDIES. Methamorphosis Project

Gas refuelling station supplied by GASECO.

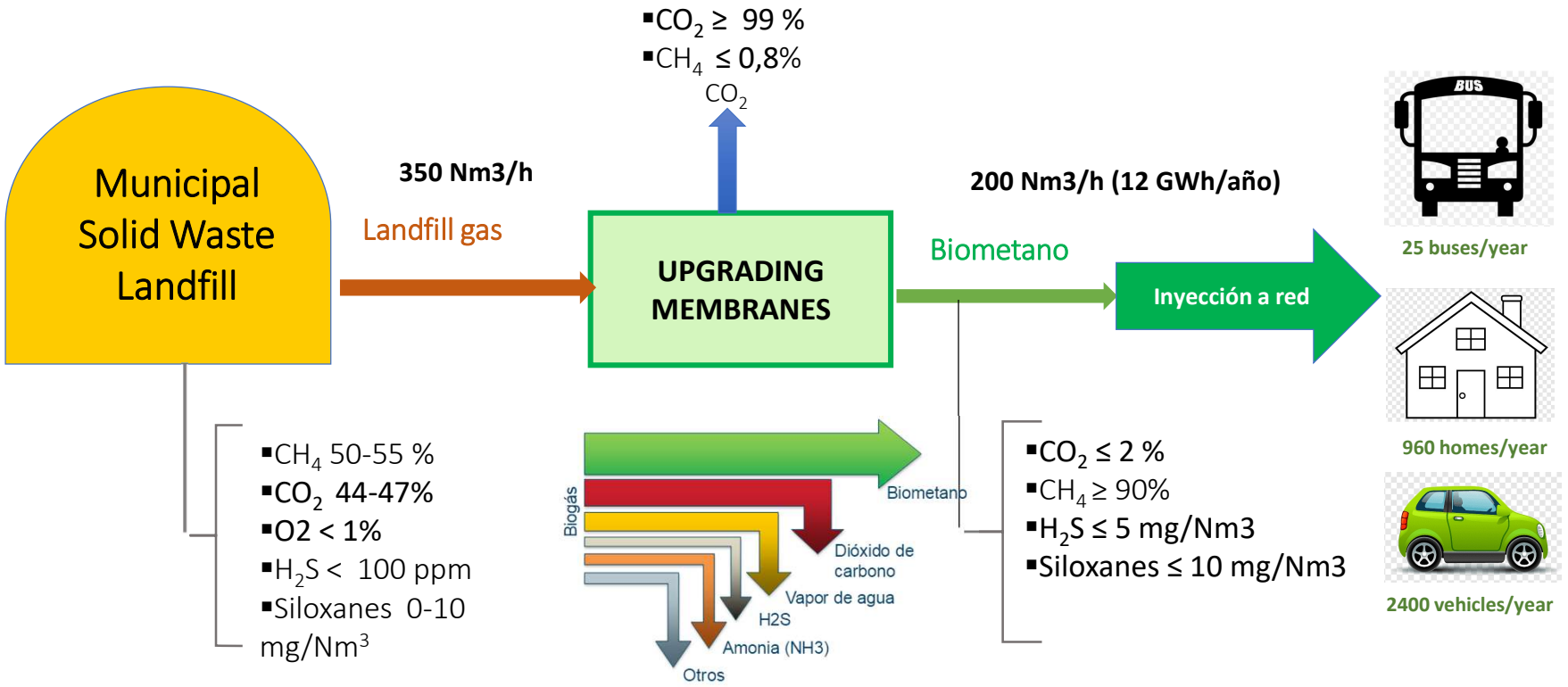
- 14 bottles x 80 l
- Compressor for 18 Nm3/h (SAFE)

E. CASES STUDIES. Methamorphosis Project

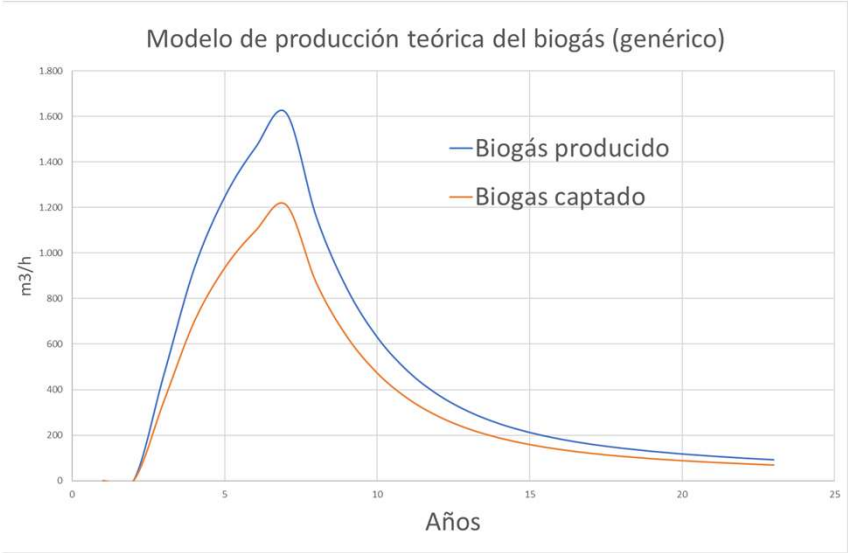
Continuous monitoring: PLC + SCADA



E. CASES STUDIES. Elena landfill



Desgasificación del depósito controlado

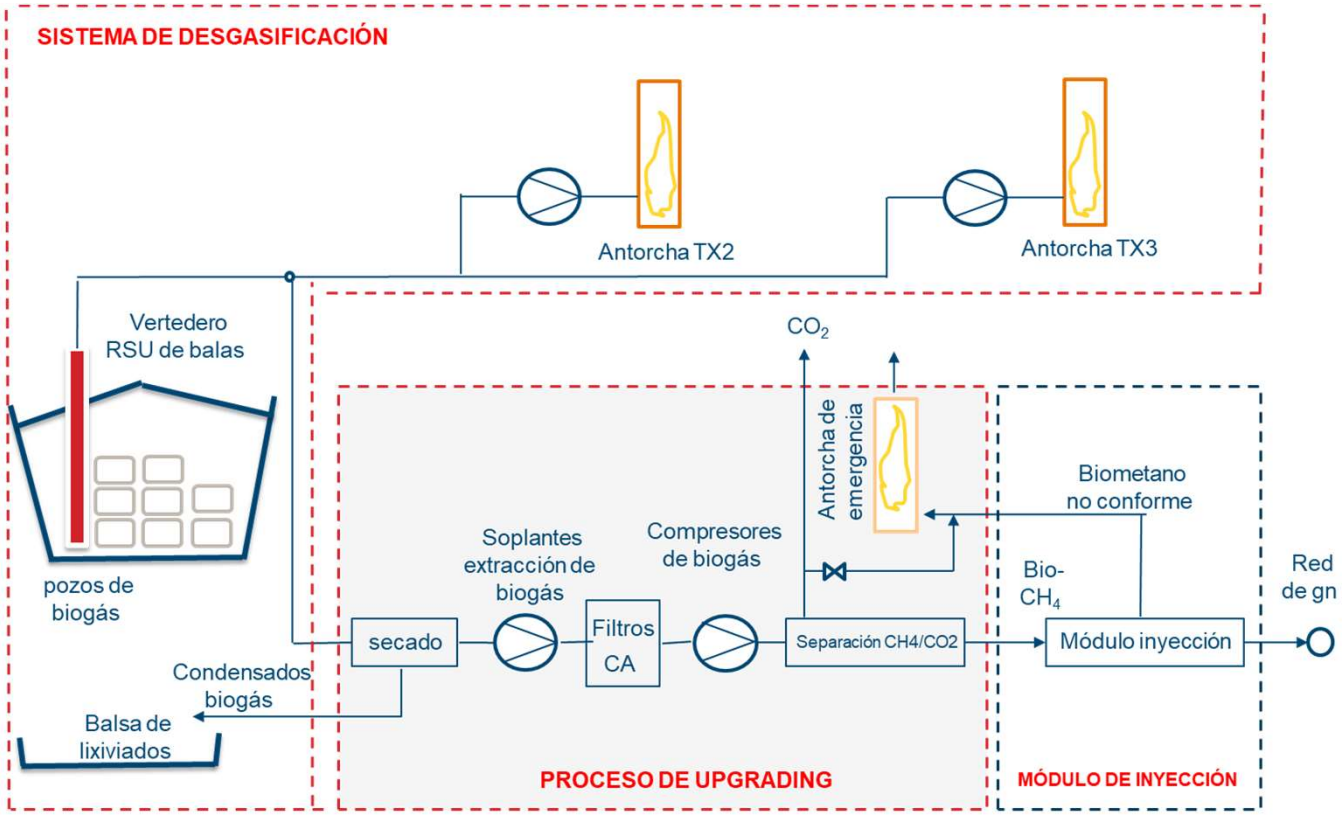


COLECTORES PRINCIPALES

POZOS DE CAPTACIÓN VERTICALES

ANTORCHA

Solución tecnológica



Fotografía general

Acometida de biogás

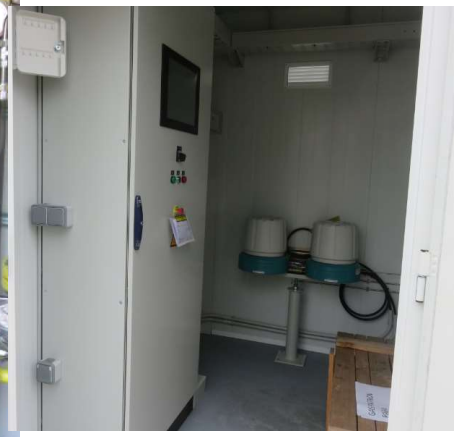
Extracción de biogás y secado

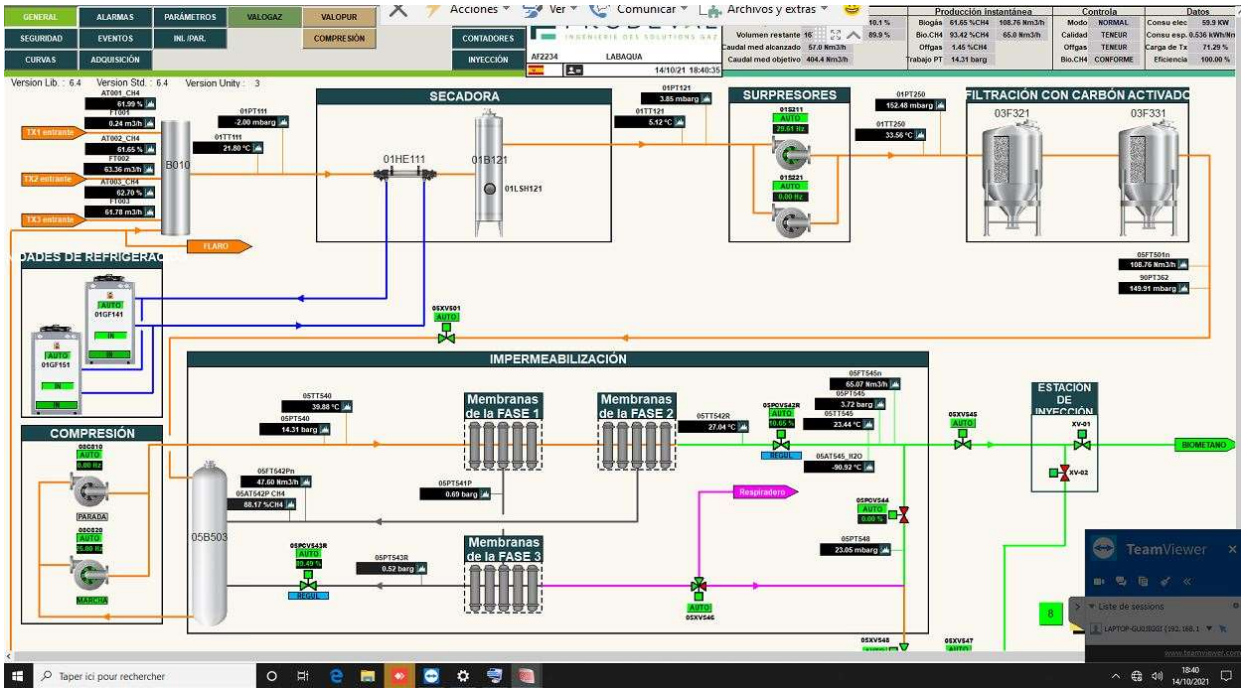
Filtros de carbón activo y compresores

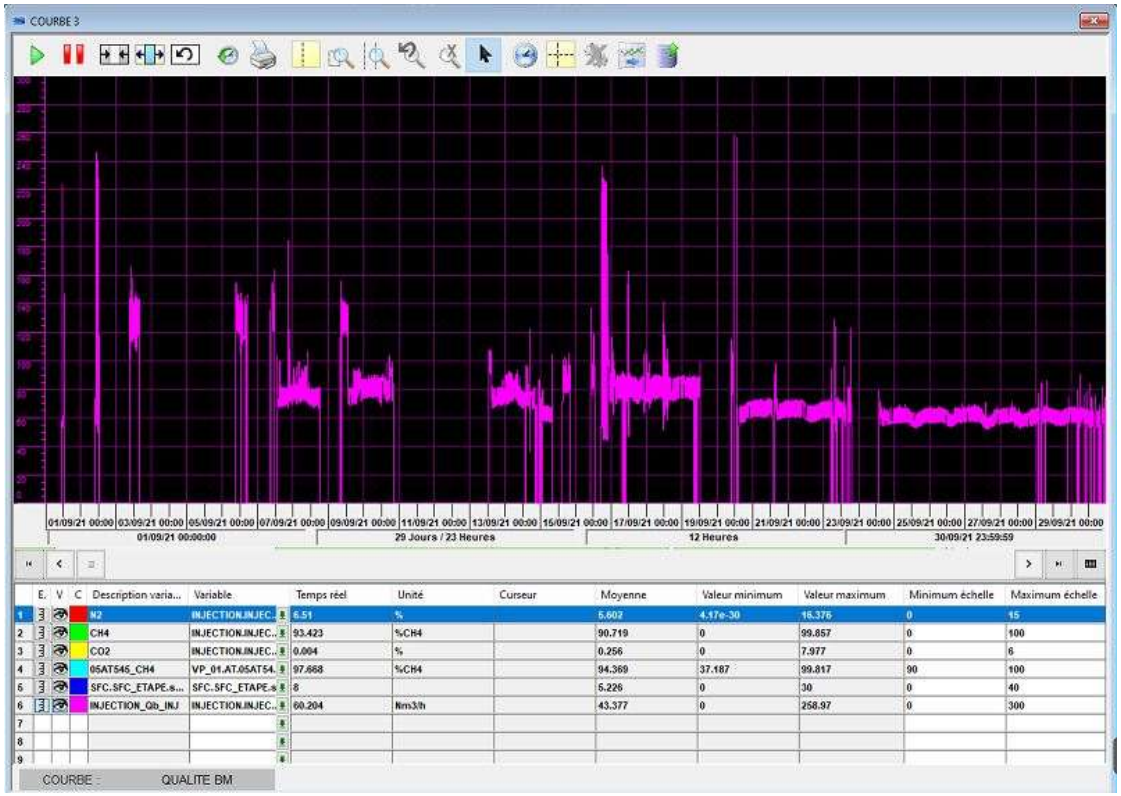
Contenedor de membranas

Módulo de inyección

Módulo de inyección




GENERAL
ALARMAS
PARÁMETROS
VALOGAZ
VALOPUR
SEGURIDAD
EVENTOS
INI. /PAR.
COMPRESIÓN
CURVAS
ADQUISICIÓN
CONTADORES
INYECCIÓN
Acciones
Ver
Comunicar
Archivos y extras
Producción instantánea
Controla
Datos
SECADORA
SURPRESORES
FILTRACIÓN CON CARBÓN ACTIVADO
01HE111
01B121
01LSH121
B010
FLARO
IMPERMEABILIZACIÓN
Membranas de la FASE 1
Membranas de la FASE 2
Membranas de la FASE 3
COMPRESIÓN
05B503
Respiradero
ESTACIÓN DE INYECCIÓN
BIOMETANO
TeamViewer
Taper ici pour rechercher


COURBE 3
01/09/21 00:00 03/09/21 00:00 05/09/21 00:00 07/09/21 00:00 09/09/21 00:00 11/09/21 00:00 13/09/21 00:00 15/09/21 00:00 17/09/21 00:00 19/09/21 00:00 21/09/21 00:00 23/09/21 00:00 25/09/21 00:00 27/09/21 00:00 29/09/21 00:00
01/09/21 00:00:00
29 Jours / 23 Heures
12 Heures
30/09/21 23:59:59
E. V C Description varia... Variable Temps réel Unité Curseur Moyenne Valeur minimum Valeur maximum Minimum échelle Maximum échelle
1 H2 INJECTION.INJEC.. 6.51 % 5.602 4.17e-30 16.376 0 15
2 CH4 INJECTION.INJEC.. 93.423 %CH4 90.719 0 99.857 0 100
3 CO2 INJECTION.INJEC.. 0.004 % 0.256 0 7.977 0 6
4 05AT545_CH4 VP_01.AT.05AT54. 97.668 %CH4 94.369 37.187 99.817 90 100
5 SFC.SFC_ETAPE.s... SFC.SFC_ETAPE.s 8 5.226 0 30 0 40
6 INJECTION_Qb_INJ INJECTION.INJEC.. 60.204 Nm3/h 43.377 0 258.97 0 300
7
8
9
COURBE : QUALITE BM

E. CASES STUDIES

CONCLUSIONS

- Biomethane is a key energy in the decarbonization
- It promotes the use of renewable energies
- It contributes to the security of supply and energy independence
- It improves the environmental management of organic waste
- Generates synergies with the agri-food industry
- Supports rural development, job placement and population in agricultural settings.

Thank you for your kind attention!

Ignasi Mallol

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