# From RDF to SNG

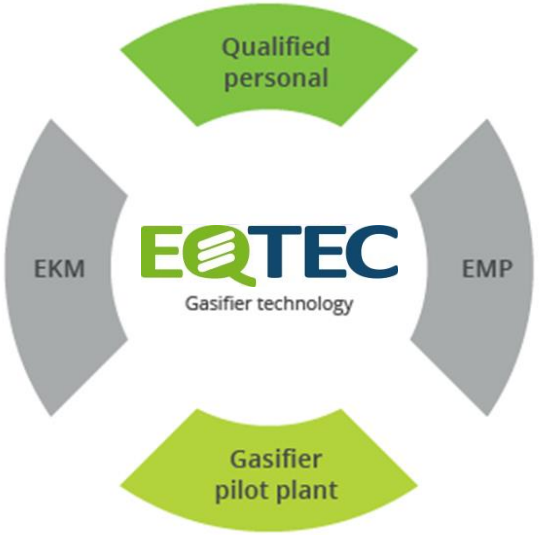
## Previous experiences to overcome gasification challenges

IEA Bioenergy Task 33. Workshop on Waste Gasification

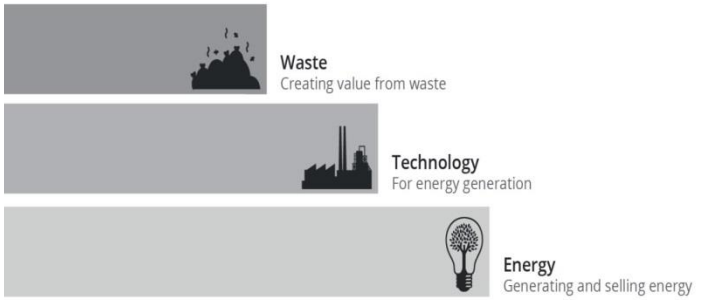
8th May 2018

# Company – Introduction

EQTEC is an engineering and technology Company with the know-how to efficiently convert waste and biomass into energy

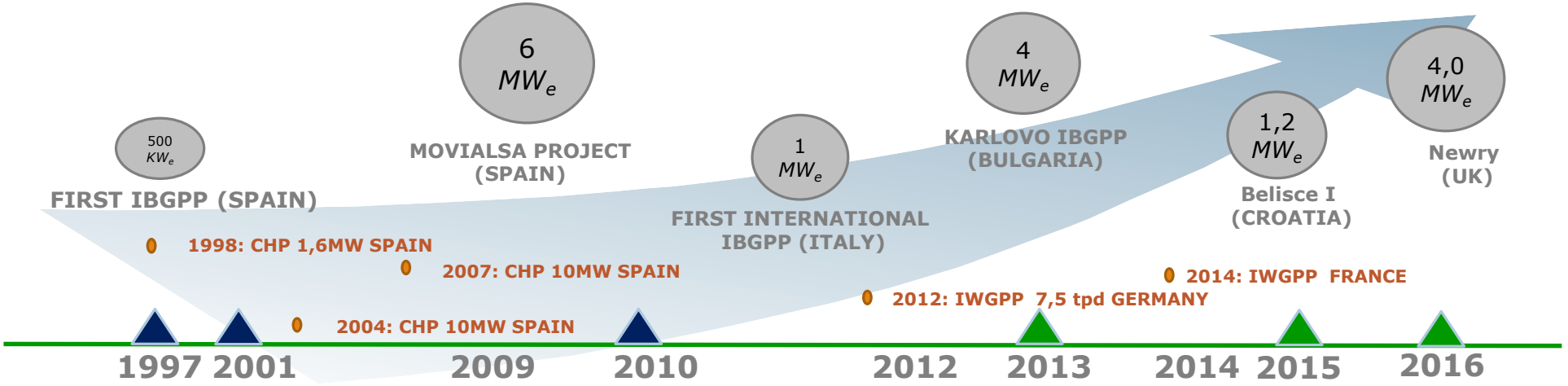


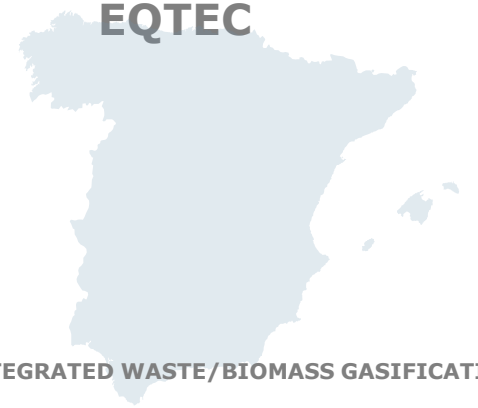

EBIOSS Energy is a holding Company with international presence in the waste and energy business



# Company – Evolution

EQTEC has designed and built more than 400MWt in more than 70 different projects worldwide…



INTEGRATED WASTE/BIOMASS GASIFICATION POWER PLANTS

RELEVANT CHP PROJECTS

# PARTNERS & CUSTOMERS

### ÉLECTRICITÉ DE FRANCE (EDF)

- ✓ Biggest electrical company in the world
- ✓ First European Renewable Energy producer, 2,2 GW under construction
- ❑ Consortium GAMECO, 5 M€ Investment

### ENGIE (GDF SUEZ)

- ✓ +160.000 employees
- ✓ 1st world supplier of energy efficient services, 230 DHC sites in the world
- ❑ JV SPL Lyon Confluence DH Project. 25 M€ Budget

### ENDESA (ENEL GROUP)

- ✓ 115.000 GWh/y
- ✓ 7,2 GW RE Capacity
- ❑ Several CHP projects completed

### CHINA ENERGY

- ✓ Company ranked #15 in top 250 Global Contractors
- ✓ 140.000 worldwide employees
- ✓ 28.177 millions € in revenues in 2015
- ❑ Strategic partnership for co-investing and EPC wrap schemes

# PARTNERS & SUPPLIERS

### GENERAL ELECTRIC

- ✓ Multi billion US$ Corporation
- ✓ Supplier of Gensets, tailor made for our EQTEC Gasifier Technology
- ✓ GE Capital to co-invest with EBIOSS in power plants (**First case in Croatia**)


### MOTT CORPORATION

- ✓ World's premier manufacturer of diverse porous metal products
- ✓ Supplier of porous metal filter elements.

SIEMENS

### SIEMENS

- ✓ 348,000 employees
- ✓ Supplier of control systems; PLCs, HMI; DCS, HW & SW.

### HONEYWELL COMBUSTION

- ✓ Fortune 500 Company, +100.000 employees
- ✓ Supplier of Combustion units for thermal oxidizer

Honeywell

## RESEARCH&DEVELOPMENT ACTIVITIES

- Karlsruhe Institute of Technology
- University of Stuttgart
- Royal Institute of Technology of University of Stockholm
- University of Lorraine
- University of Badajoz
- Rafako S.A
- CEA (Comm. à l'énergie atomique et aux énergies alternatives)

## EQTEC GASIFIER TECHNOLOGY partner technology

### Partners Consortium & their Specialization

RAFAKO GRUPA PBG — The largest boiler manufacturer in Europe offering the design and delivery of whole power generation units. **LEADER**

ATMOSTAT ALCEN — Critical products manufacturer for chemical, power and military sectors.

cea — The World's Most Innovative Research Institution in 2015 for its research into areas including renewable power.

EQTEC — Engineering company working on biomass and waste gasification confirmed by market references.

EXERGON — R&D company operating within the power, chemical and related industries.

ICHPW — Research organization which focuses on fossil fuels, biomass and waste conversion into valuable products and energy carriers

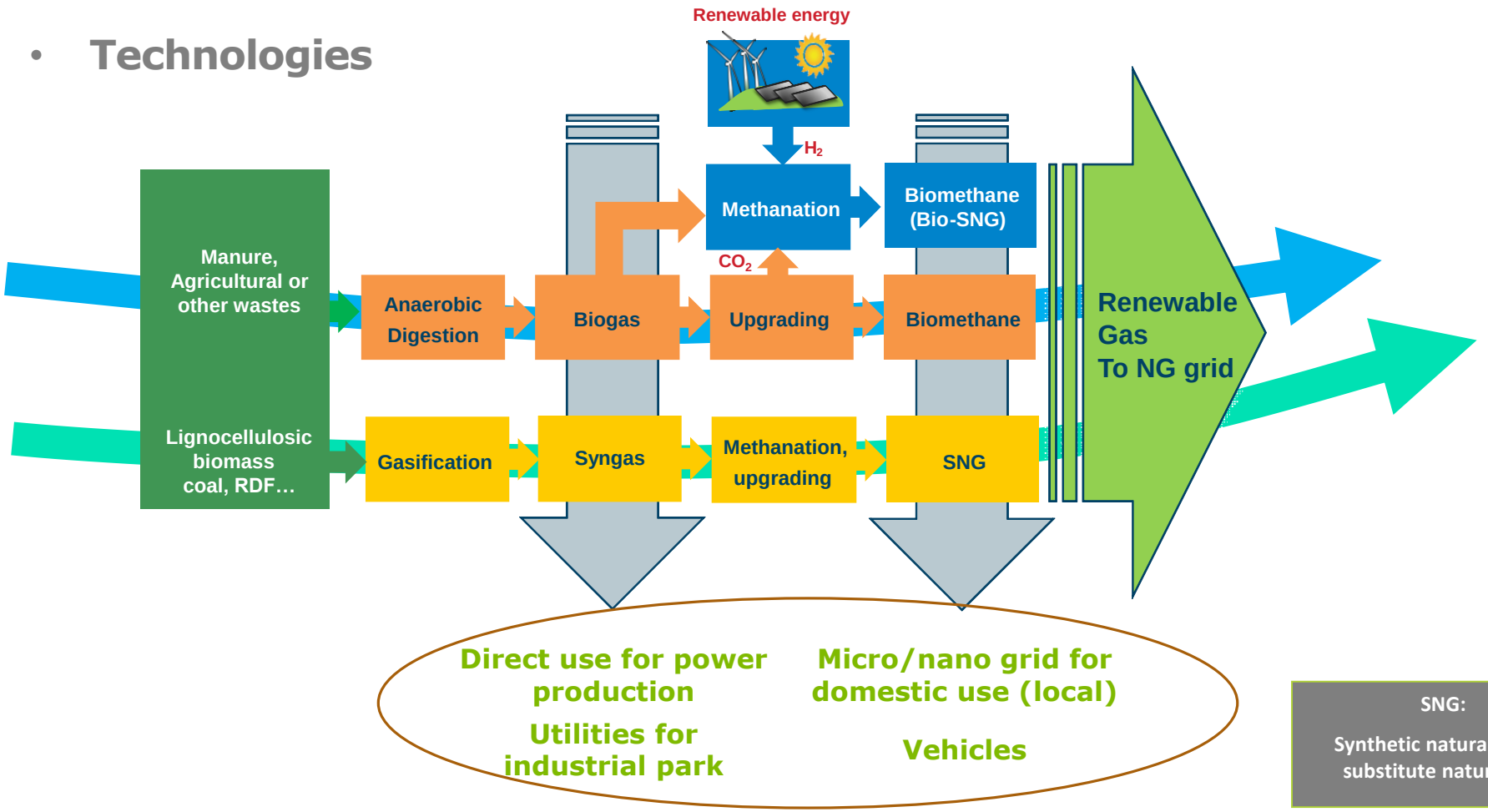
TAURON WYTWARZANIE — One of the largest energy sector companies in Poland dedicated basically for electricity production. **LAUNCHING CUSTOMER**


**POLYGEN: municipal polygeneration system with biomass and waste**

# What is SNG?

- ✓ Mainly methane (94-98 %) produced from the methanation of syngas (from different sources, coal, biomass, RDF).

- **Technologies**




**SNG:**

Synthetic natural gas or substitute natural gas

- **Motivations for SNG production**

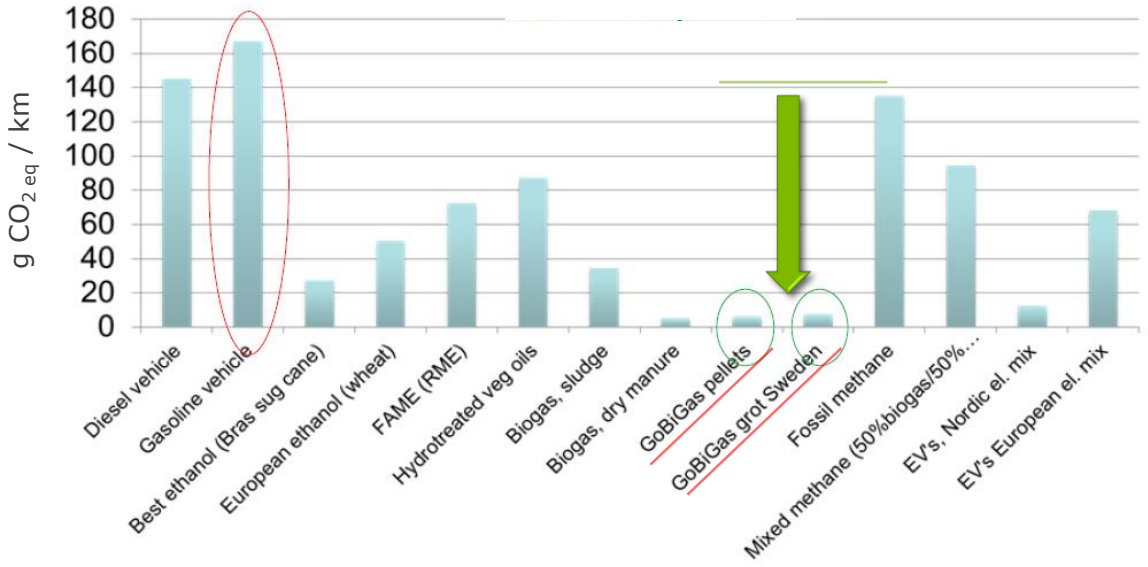
✓ In can be mixed or used as natural gas.

✓ It can be transported or storage as N.G.

} No new infrastructure needed

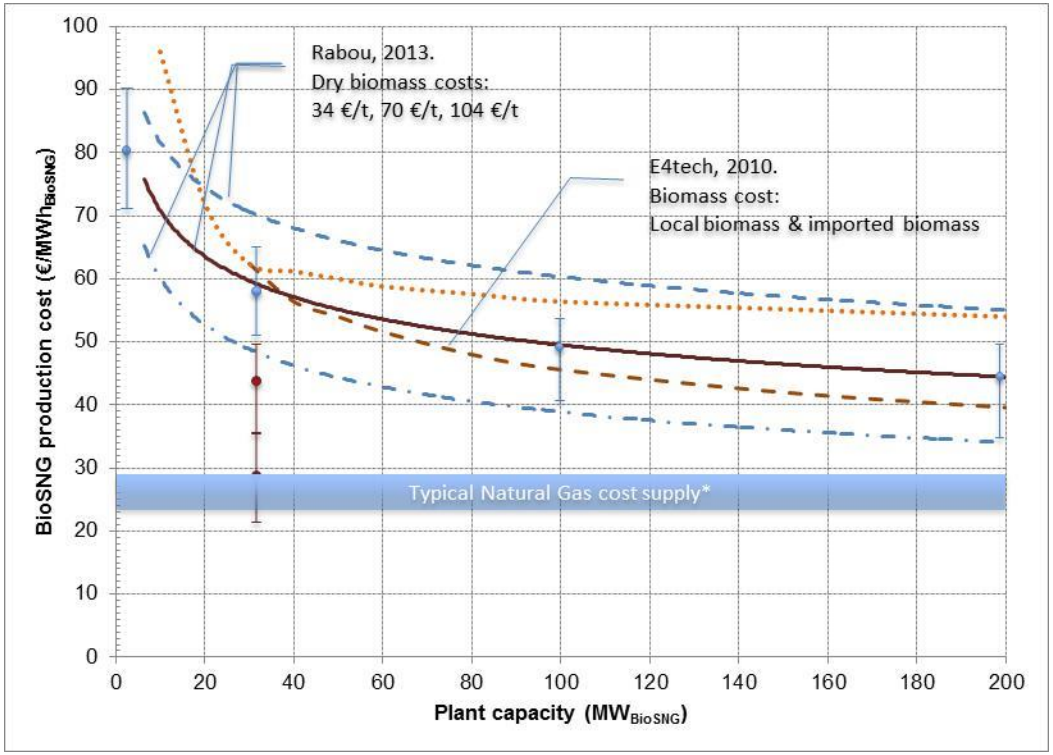
✓ $CO_2$ balance: Lower level of $CO_2$ emissions (depending on the level of biogenic carbon of the feedstock).

✓ Fuel diversification and security of supply.



# Why SNG from RDF?

- ✓ "Opportunity" resources: non-recyclable fractions of urban and commercial refuse.
- ✓ The EU 2008/98/CE directive mandates minimum 50% recycling by 2020.
- ✓ Imposes recovery (including energy) and bans direct landfilling.
- ✓ Economic feasibility.




E4tech (2010) "The potential of bioSNG production in the UK" NNFCC project 10/008.
Rabou, L.P.L.M., Biomass gasification and upgrading to biomethane. EDGaR-DVGW Joint Conference, The Netherlands, 2013.
Zwart, R., Synthetic Natural Gas (SNG): Large-scale introduction of green natural gas in existing grids. ECN, 2007.

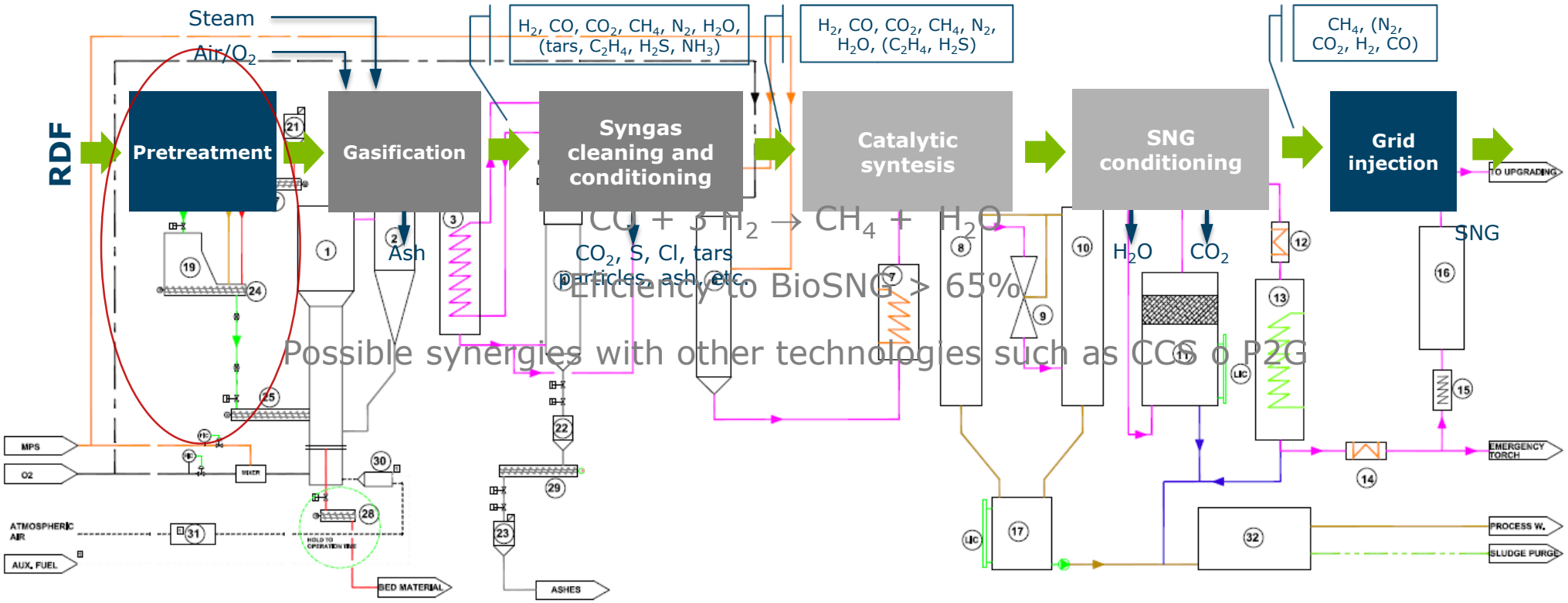
# Why SNG from RDF? Production cost (comparative)

- ✓ Gasoline: 574 $/T: 55 €/MWh
- ✓ Diesel: 858 $/T: 69 €/MWh
- ✓ Bioethanol: 713 $/T: 85 €/MWh
- ✓ Biodiesel: 945 $/T: 83 €/MWh

- ✓ Bio SNG:
  - ~ 40-65 €/MWh → Plant capacity > 50 MWt
  - ~ 60-120 €/MWh → Plant capacity < 5 MWt
- ✓ SNG from RDF: ~ 25-40 €/MWh

- ✓ Reduction of emissions
- ✓ $CO_{2eq}$ much lower
- ✓ Waste valorization & other social benefits

# Process and Technology




$CO + 3\,H_2 \rightarrow CH_4 + H_2O$

Efficiency to BioSNG > 65%

Possible synergies with other technologies such as CCS o P2G

# Process Challenges: Feedstock

- **Size and moisture requirements**

✓ Level fines causes lower conversion and process efficiency.

✓ Moisture level ~ 15 % → Usually drying packaged needed.

- **Feedstock composition**

✓ Highly heterogeneous feedstock (seasonal changes and along the time).

  ✓ Stream blending (from different silos) system to improve homogeneity at gasifier inlet.

✓ Presence of contaminants (S, N, Cl).

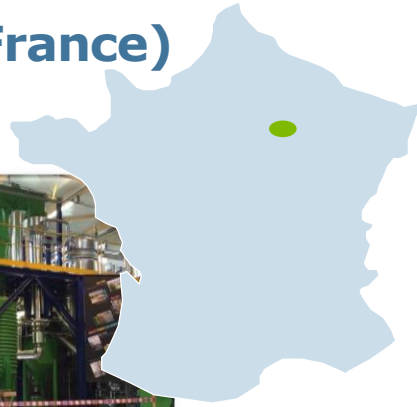
  ✓ To consider in the syngas cleaning system.

- **Integrated RDF & Biomass gasification plant (Lorrain France)**

✓ 1,20 TPD RDF (Thermal uses).

✓ Handling and feeding of RDF.

✓ Establish RDF specifications.



# Process Challenges: Feedstock

- **Feedstock composition**

✓ High ash level.

  ✓ Design of a HT filtering/ash extraction system able to cope with this level of ashes (15-25 %).

✓ Ash fusibility.

  ✓ Determine ash composition to prevent ash softening and bed agglomeration.

  ✓ Reduce gasification temperature.

✓ Presence of alkalis and heavy metals.

  ✓ Optimized filtering temperature to enhance metals/alkalis retention avoiding tar deposition.

- **Integrated RDF & Biomass gasification plant 1MW$_e$ (Gallina, Italy)**

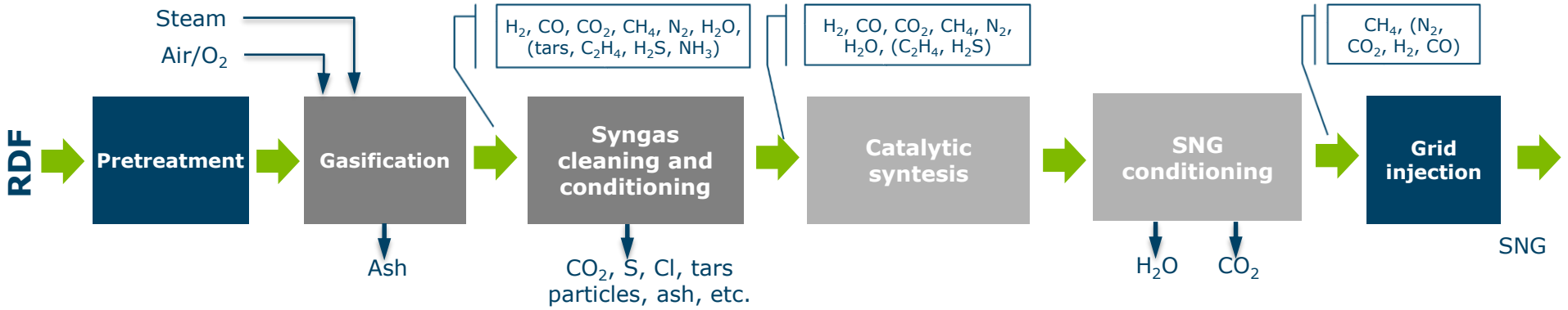
✓ Feedstock (900 kg/h) of straw pellets.

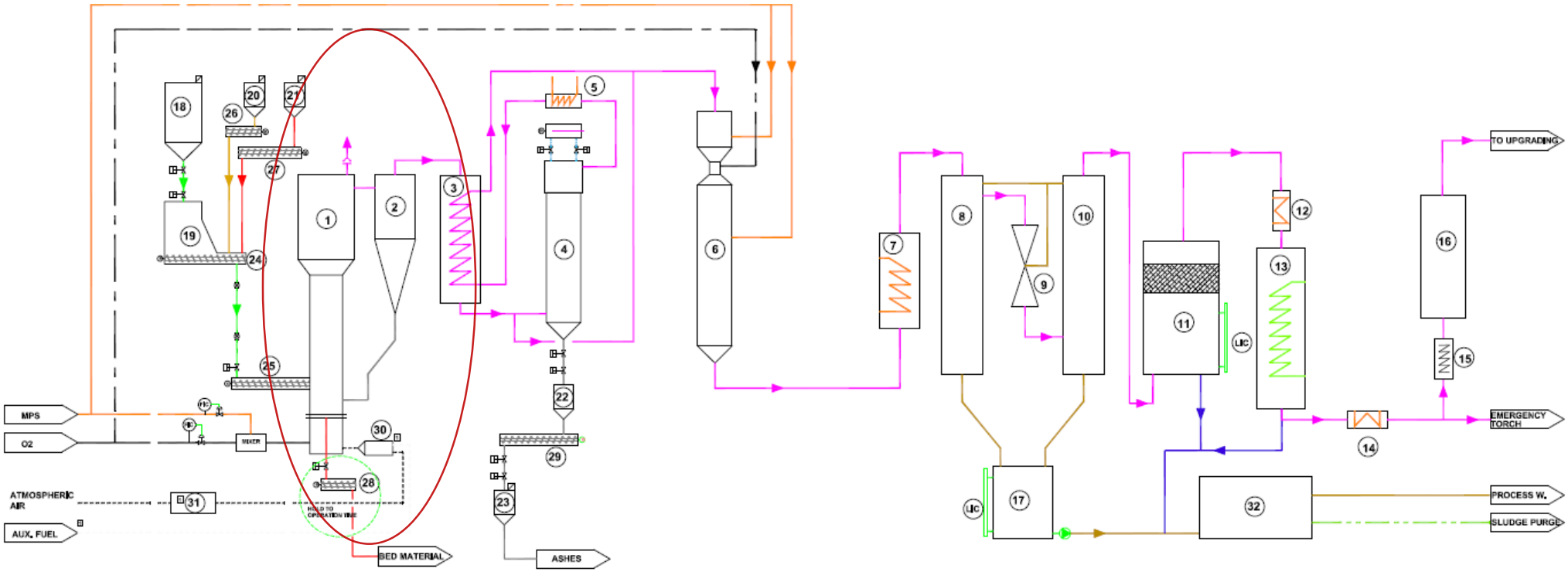
✓ Ash content ~ 17 % wt.

✓ Reduced gasification temperature (700 ºC).

✓ Development of high temperature filter.


# Process Challenges: Gasification Technology



# Process Challenges: Gasification Technology

- **Given the process scale and requeriments:**

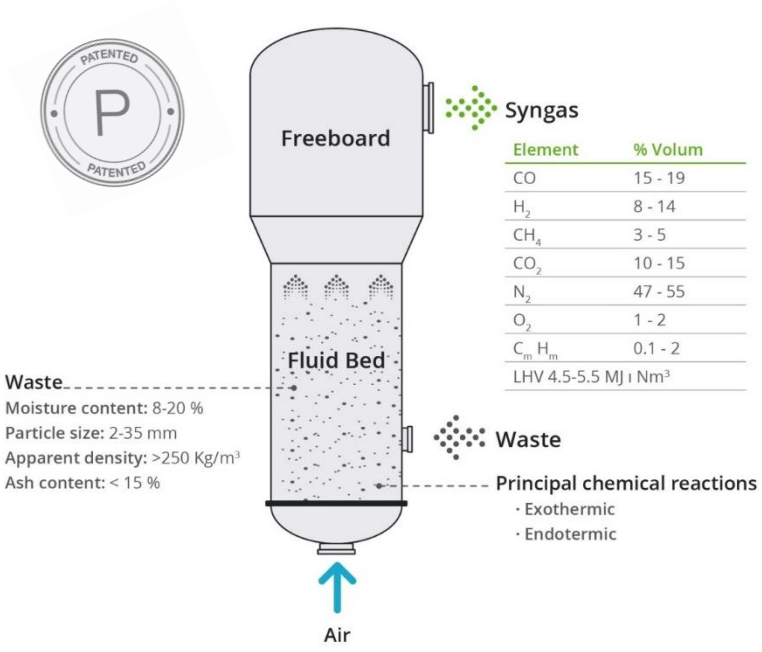
✓ FBG with $O_2$/Steam mixture (atm. or pressurized).

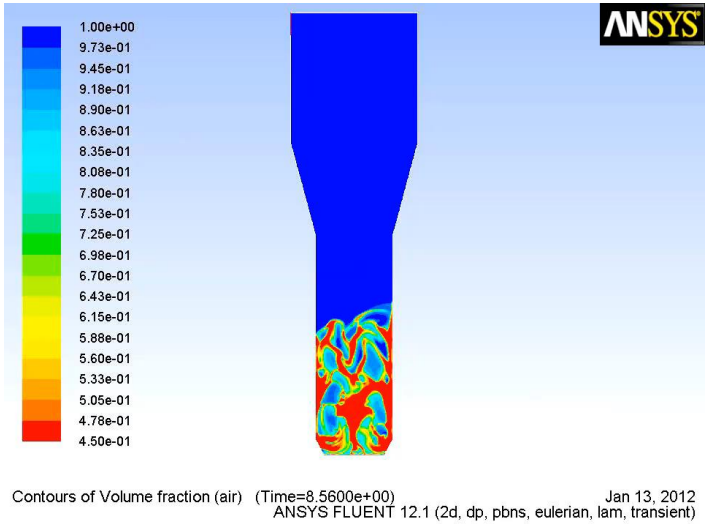
  ✓ $O_2$ separation required.

  ✓ Simpler from an operational point of view.

  ✓ Reduction of equipment size when working at pressure (useful for methanation process).

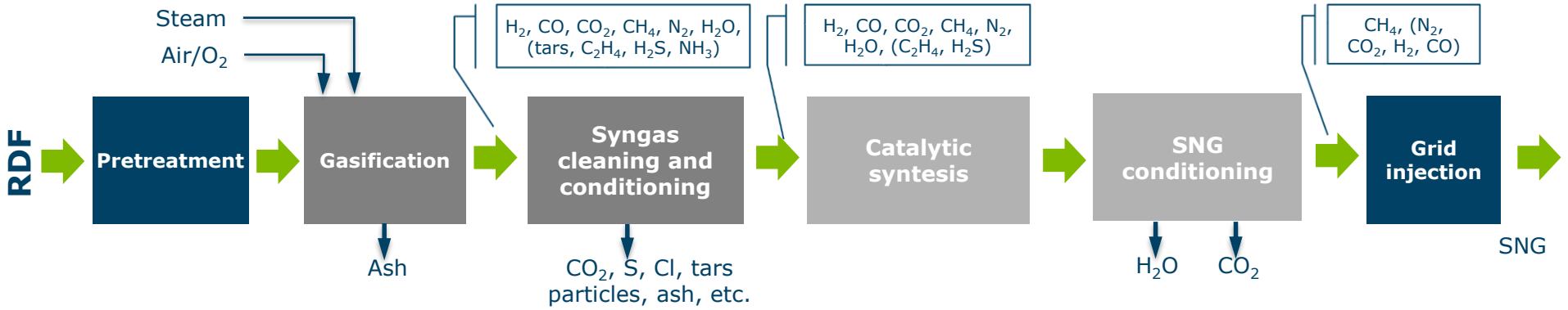
✓ Two stages gasification: steam gasification and air combustion.

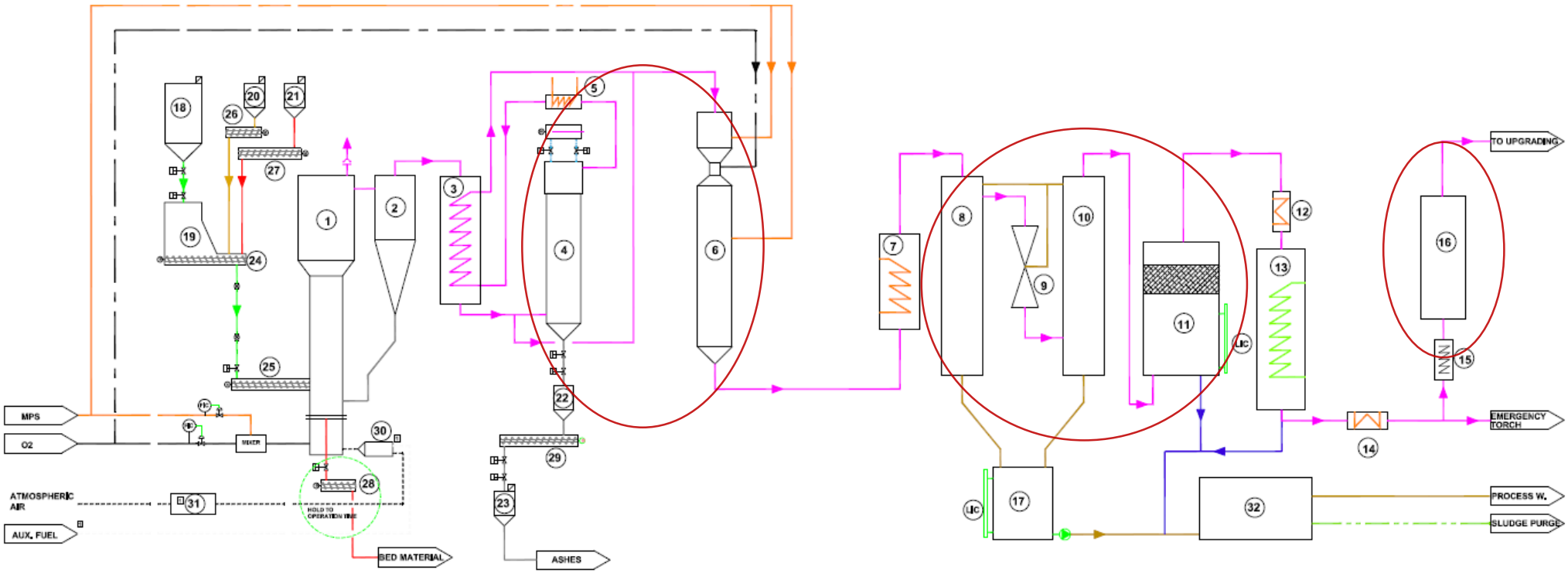



**Our technology is based on a bubbling fluid bed gasifier**

# Process Challenges: Syngas Cleaning and Conditioning



# Process Challenges: Syngas Cleaning and Conditioning

- ✓ High levels of contaminant reduction required.
- ✓ Design of syngas cleaning in several stages.
- ✓ Quality of syngas at gasifier outlet not determining.

| Contaminant | Typical concentrations in syngas | Engine | Catalytic synthesis |
|---|---|---|---|
| **Tar** | 10000-15000 mg/Nm$^3$ | < 55 mg/Nm$^3$ | 5 mg/Nm$^3$ |
| **Particles** | 10000 mg/Nm$^3$ | < 50 mg/Nm$^3$ | 10 mg/Nm$^3$ |
| **Alkalis (Na+K)** | 1600 mg/Nm$^3$ | - | 1 mg/Nm$^3$ |
| **$NH_3$ (+HCN)** | 3000 ppmv | < 55 mg/Nm$^3$ (N total) | 100 ppmv (Total N) |
| **Sulphur ($H_2S$, COS, $CS_2$)** | 100 ppmv | < 1150 mg/Nm$^3$ (S total) | 0.2 ppmv (Total S) |
| **Halogens (HCl, HF, HBr)** | 25000 ppbv | < 100 mg/Nm$^3$ (Total halogens) | <25 ppbv (Total halogens) |
| **Heavy metals** | < 300 mg/Nm$^3$ | - | <1 mg/Nm$^3$ |

- ✓ Key points in syngas cleaning:
  - ✓ Carbon can cause catalyst deactivation (tar, BTX, light hydrocarbons).
  - ✓ Particles/N, S and Cl compounds: catalyst poisoning.

# Process Challenges: Syngas Cleaning and Conditioning

- **Tar cleaning**

✓ Optimized gasification temperature and residence time to reduce tar content.

✓ Usually higher tar contents than those of biomass.

✓ Presence of waxes from polymer decomposition.

✓ Cl presence hamper hydrocarbon cracking.

- **Integrated Biomass gasification power plant 4 $MW_e$ (Karlovo, Bulgary)**

✓ Feedstock: straw pellets.

✓ Fusibility issues: reduced gasification temperature (700 ºC).

✓ Development of cracker and reforming reactor to reduce level of tars.

✓ Combined with wet scrubbers and condensing stages.

# Process Challenges: Syngas Cleaning and Conditioning

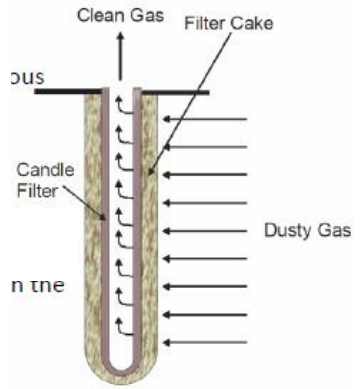
- **Particles and metals removal**

✓ Usually higher particle levels than those of biomass (much higher ash content).

✓ Even higher level if additive is added to remove other contaminants (Cl, S, etc.).

  ✓ Combination of high efficiency cyclones and high temperature filters.

- **Integrated RDF & Biomass gasification plant:**
  **1 $MW_e$ (Gallina, Italy)**
  **4 $MW_e$(Karlovo, Bulgary)**




✓ Feedstock (900 kg/h) of straw pellets.

✓ Reduced gasification temperature.

✓ Development of high temperature filter.

  ✓ Optimization of filtering temperature to retain heavy metals and avoid tar deposition on the filter candles.

  ✓ Filtering media (high temperature). Metallic or ceramic.

# Process Challenges: Syngas Cleaning and Conditioning

- **Other contaminants**

✓ Halogens (HCl) and nitrogen compounds ($NH_3$ and HCN)

- ✓ Use of solid additives to adsorb some of the minor contaminants.
- ✓ Usually wet scrubbing (evaluation of most adequate pH) to remove the different contaminants.

✓ Sulphur compounds ($H_2S$ /COS)

- ✓ Low level of sulphur compounds in for catalytic process requires combination of a catalytic stage (hydration) and ZnO bed for H2S retention (level of ppm).

- **Additional considerations**

✓ Level of purity of $CH_4$ usually > 95%

- ✓ Concentration of inerts ($N_2$, Ar, etc.) before methanation has to be low.
- ✓ High purity $O_2$ required.
- ✓ Use of $CO_2$ or steam instead of $N_2$ or air as auxiliary gases in the process (feeding, filtering, etc.).

✓ Synergy with catalytic synthesis: Heat integration.

✓ ……

# RDF to SNG: Summary

- **Participation in POLYGEN project:**

✓ Additional experience on RDF gasification.

✓ $O_2$/steam gasification.

✓ Know how about the main aspects to consider in the RDF to SNG process.

- **Previous gasification experience**

✓ Feeding complicated feedstocks.

✓ Tar abatement equipment.

✓ High temperature filtering continuous process.

THANK YOU VERY MUCH FOR YOUR ATTENTION

# From RDF to SNG

## Previous experiences to overcome gasification challenges

www.eqtec.com www.ebioss.com