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Bioenergy Retrofits for Europe's Industry

The BIOFIT Project – Retrofitting of the bioethanol industry

BIOFIT Final Policy Conference

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GOBIERNO DE ESPAÑA MINISTERIO DE CIENCIA E INNOVACIÓN

Ciemat Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas

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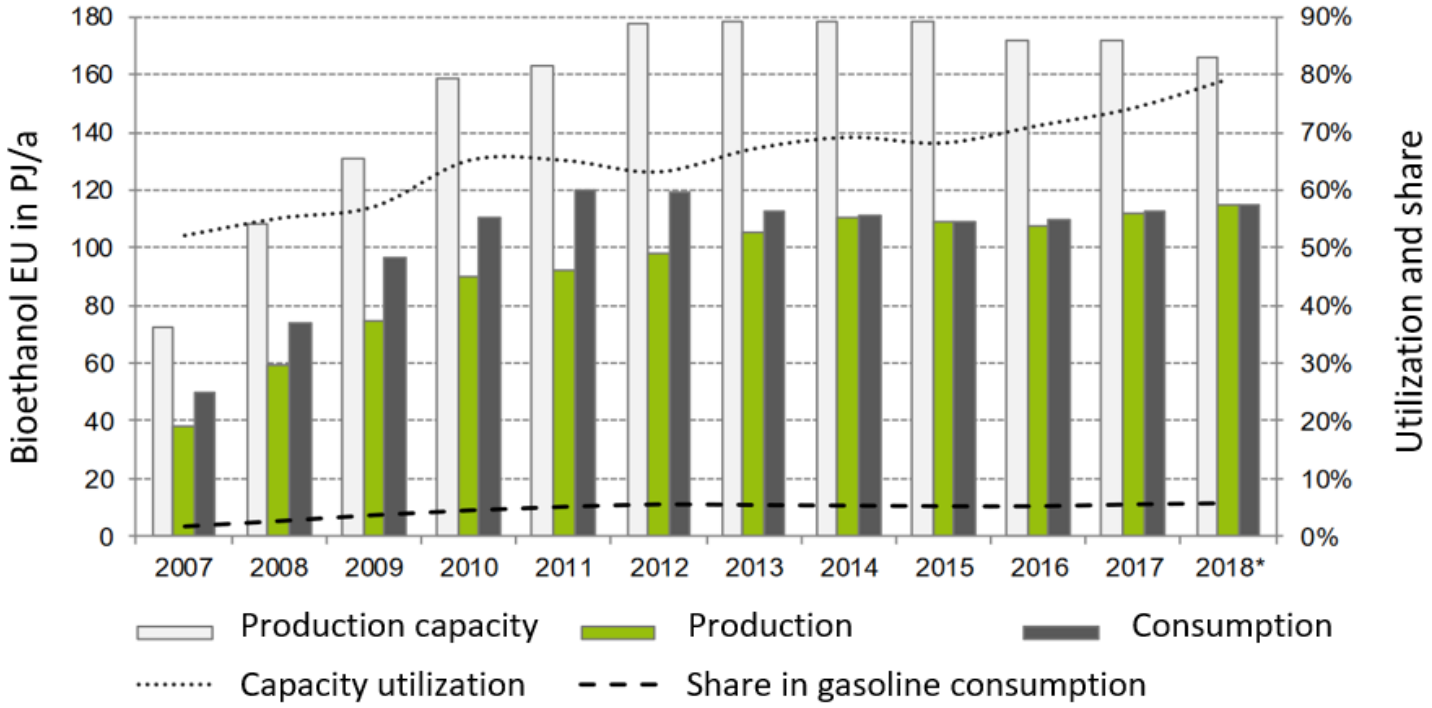
BIOETHANOL MARKET OVERVIEW IN EU



Datenbasis: EC, Eurostat, Global Trade Atlas, ePURE, EU FAS Posts, * Prognose
Kapazität und Auslastung inklusive non-fuel Ethanol

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During the last years:

- ✓ Share of bioethanol in petrol≃ 5%
- ✓ Bioethanol production and consumption increase slightly.
- ✓ Between 2018 and 2019, bioethanol consumption dedicated to transport increased by 6.4%.

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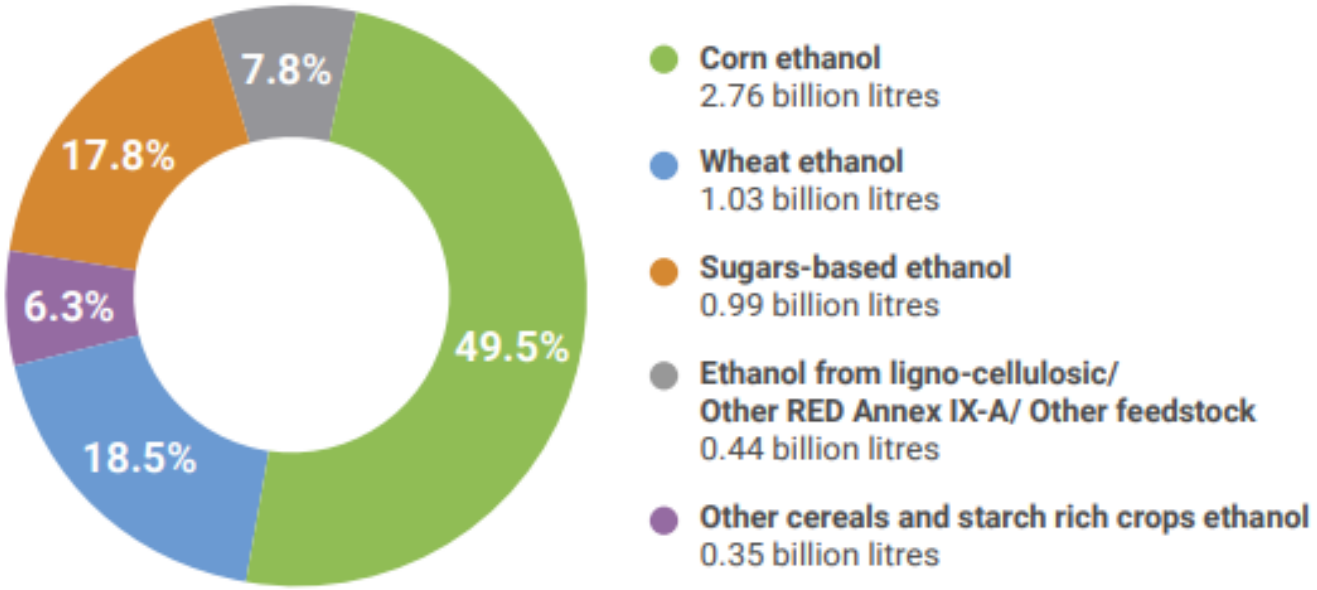
BIOETHANOL MARKET OVERVIEW



Source: Aggregated and audited data of ePURE members. Ethanol volumes in pure alcohol

- In 2020, 49.5 % of bioethanol was produced from corn, followed by wheat and sugar -->**1G BIOETHANOL**
- **Concerns** over the long-term **sustainability of 1G bioethanol:**
  - ✓ Competition for food and feed production
  - ✓ Impacts on land use
  - ✓ Water resource

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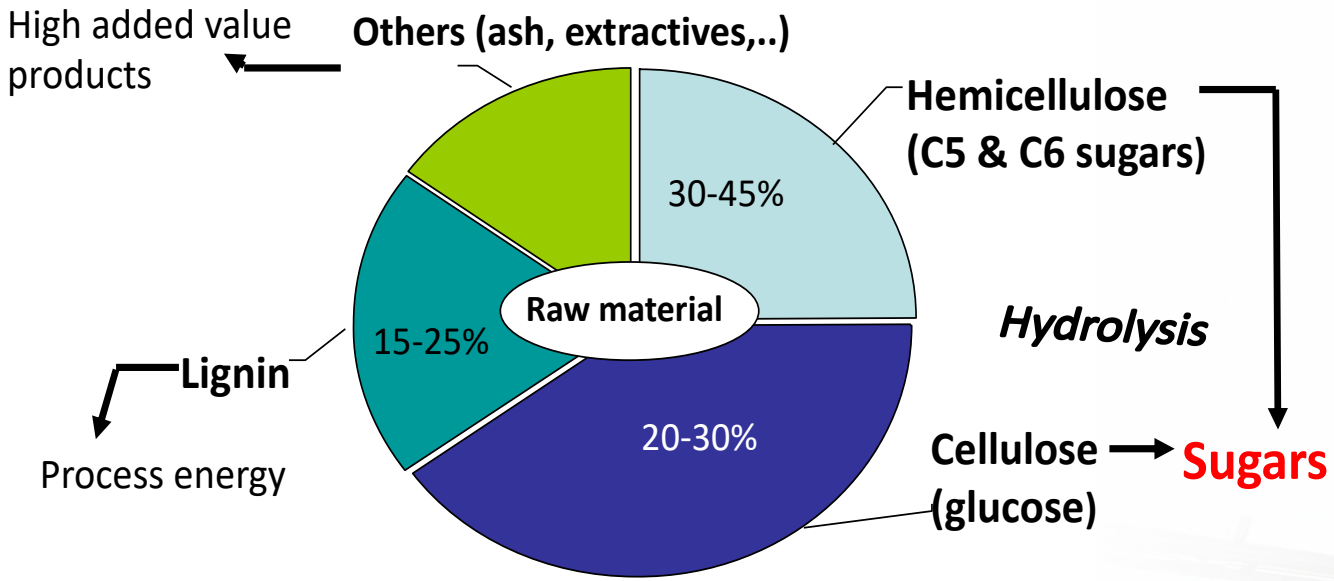
ADVANCED BIOETHANOL

WHY BIOETHANOL FROM LIGNOCELLULOSIC BIOMASS?



- Lignocellulosic biomass is one of the most abundant renewable sources
- **Feedstocks not linked to the food market**, many of them residues (agricultural and forest residues, residues from agroindustries (pulp and paper, food…), organic fraction of municipal solid wastes (MSW), or energy crops
- Lower lifecycle CO_2 emissions →sustainability criteria
- Possibility to obtain high-added value products

RENEWABLE ENERGY DIRECTIVE II (RED II)

- **Promote the transition** from **crop/food-based** biofuels to biofuels from **non-food feedstock:**
  - Within **14% renewable energy target** in **transport sector**, minimum shares **for advanced biofuels** has been stablished: 0.2% (2022), 1% (2025) and 3.5% (**2030).**
  - **Limitation for food-based biofuel** up to a maximum of 7%.

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OPPORTUNITIES FOR RETROFITTING

- ✓ **Policies** are the **main driver** to promote the transition from 1G to adavanced biofuels.
- ✓ **Advanced bioethanol** production still presents **uncertainities** regarding its **economic viability**.
- ✓ The **integration of 2G technology into an existing 1G facility** could be an excellent strategy to ease the transition from 1G generation to advanced biofuels.
- ✓ Integration of 1G and 2G technologies could result in **synergies and cost saving**:
    - Taking adavantage of the existing product distribution and feedstock supply and storage systems.
    - Using the lignocellulosic parts of the sugar and starch crops.
    - Sharing the purification areas.
    - Adapting the sugar content of the fermentation by mixing the mash.
    - Sharing the general infraestructure.
    - Using the lignin as a renewable fuel or for high-added value compounds production.

BIOETHANOL CASE STUDY - METHODOLOGY

Main objective

- To develop a concrete case study for the **retrofitting of a 1G bioethanol facility.**

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BIOETHANOL CASE STUDY - METHODOLOGY

- PROJECT DESCRIPTION
- MARKET ASSESSMENT
- TECHNO-ECONOMIC ASSESSMENT
- SUSTAINABILITY ASSESSMENT
- RISKS ANALYSIS

➢ **Data acquisition:**

- ✓ **1G bioethanol production:** real data from **Vertex Bioenergy.**
- ✓ **Advanced bioethanol production**: modelling of the retrofitting case through process simulation tools →**Aspen Plus V11** (Aspen Technology, Inc,USA):
  - ✓ Generation the mass and energy balance for calculating the raw materials, consumables, utilities and energy requirements.

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CASE STUDY

Biocarburantes de Castilla Y Leon (BCyL) facility, Salamanca (Spain)

CURRENT STATE

Feedstock:

- Corn grain: 562,800 t /year

Products:

- **Ethanol : 241,670 m^3/year**
- DDGS : 142,800 t/year
- Electricity : 207,900 MWh
- CO_2 : 40,000 t/year

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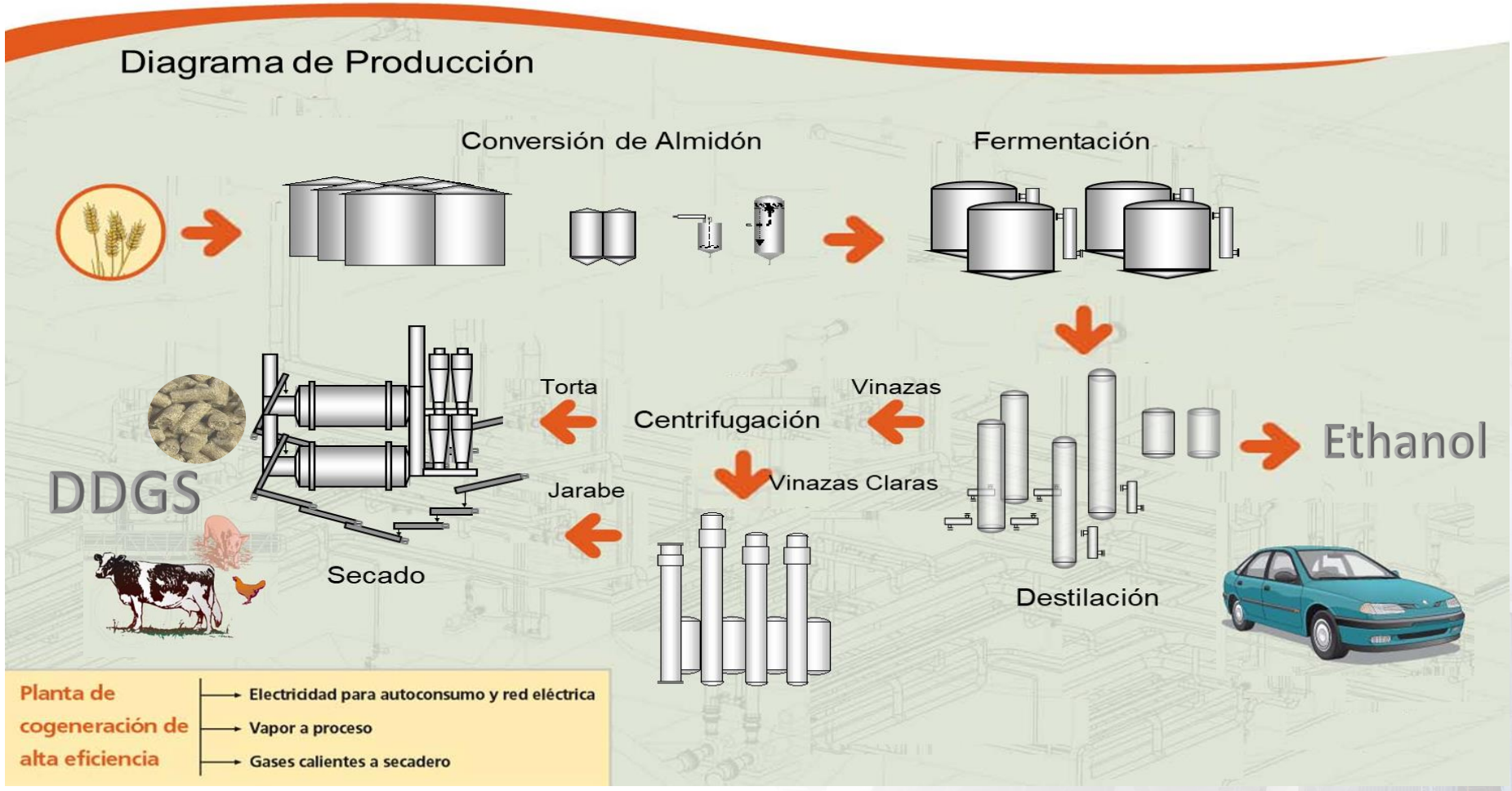
BCyL FACILITY



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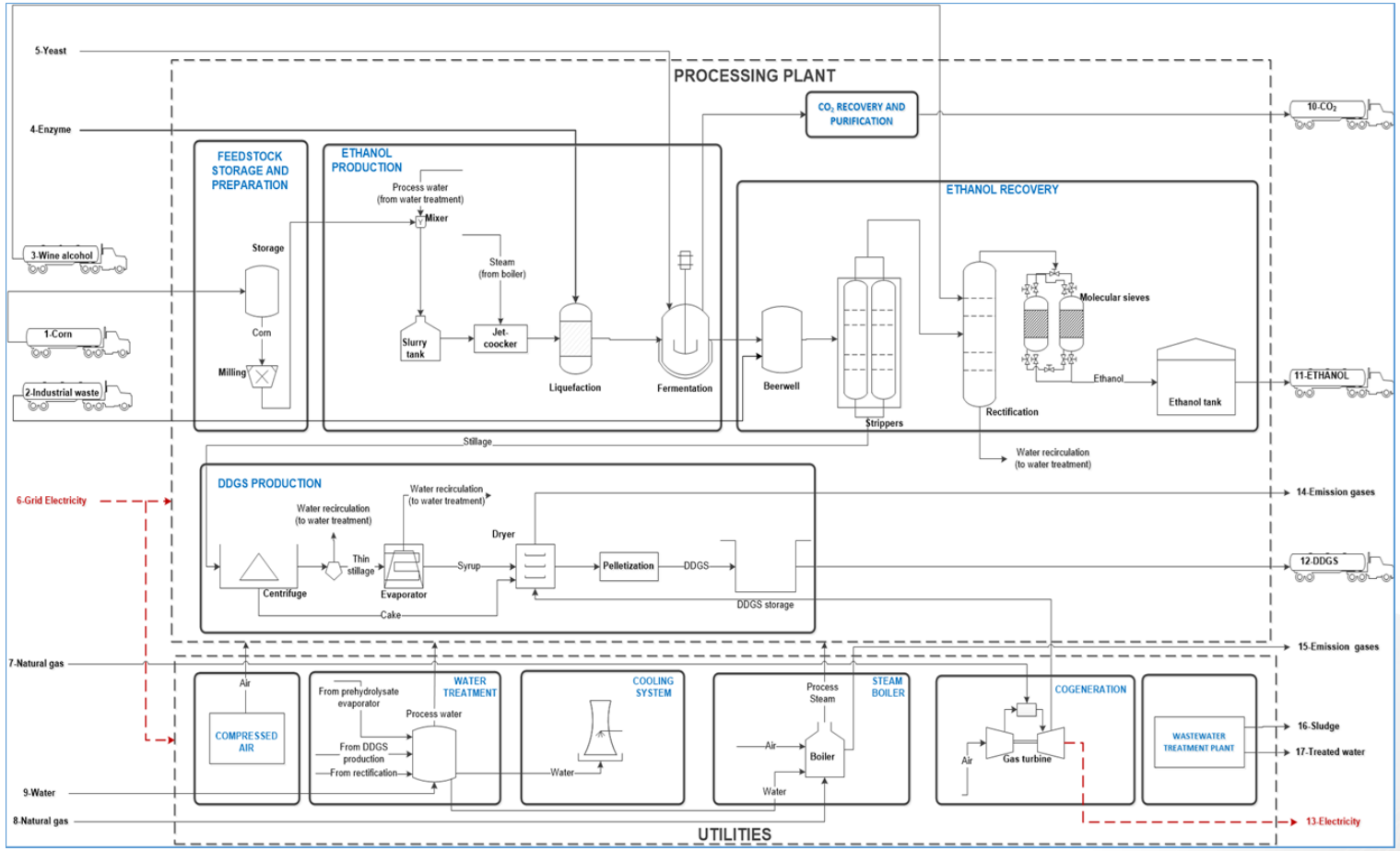
RETROFIT: CASE A



- **Production** of **11,000 m3/year** of advanced bioethanol sustainable using **industrial residues** listed in RED II
- **Feedstock:**
  - Industrial waste from yeast production plant (10 % vol Ethanol): **20,000 m3/year**
  - Wine alcohol (93% vol Ethanol): **9,700 m3/year**

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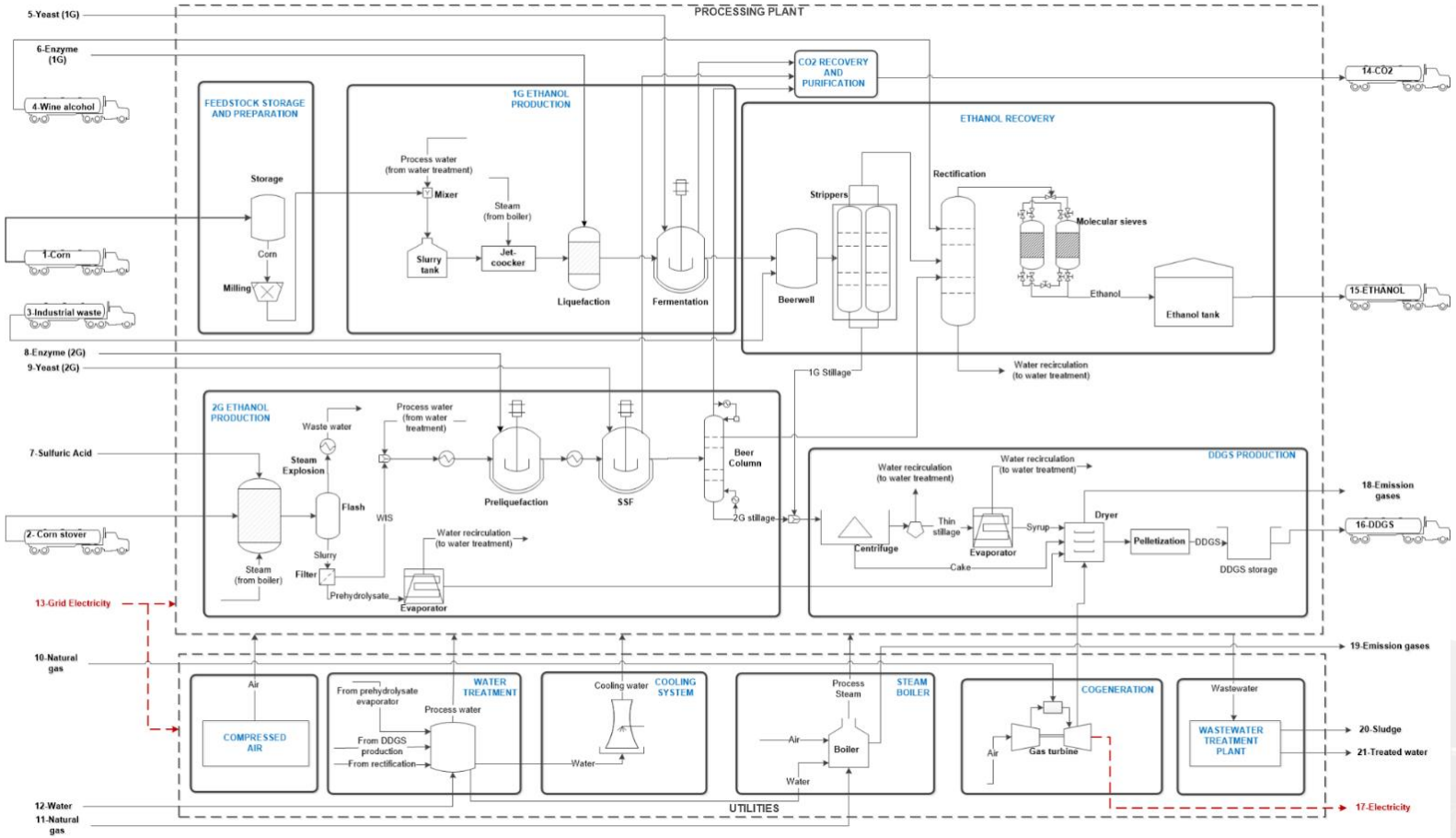
RETROFIT: CASE B



- **Production** of 11,000 m3/year of advanced bioethanol from industrial residues and **19,000 m3/year** of advanced ethanol from **corn stover.**
- **Feedstock:**
  - ✓ Corn stover: 129,000 t/year
  - ✓ Industrial waste (10 % vol Ethanol): 20,000 m3/year
  - ✓ Wine alcohol (93% vol Ethanol): 9,700 m3/year

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MAIN RESULTS FROM THE STUDY

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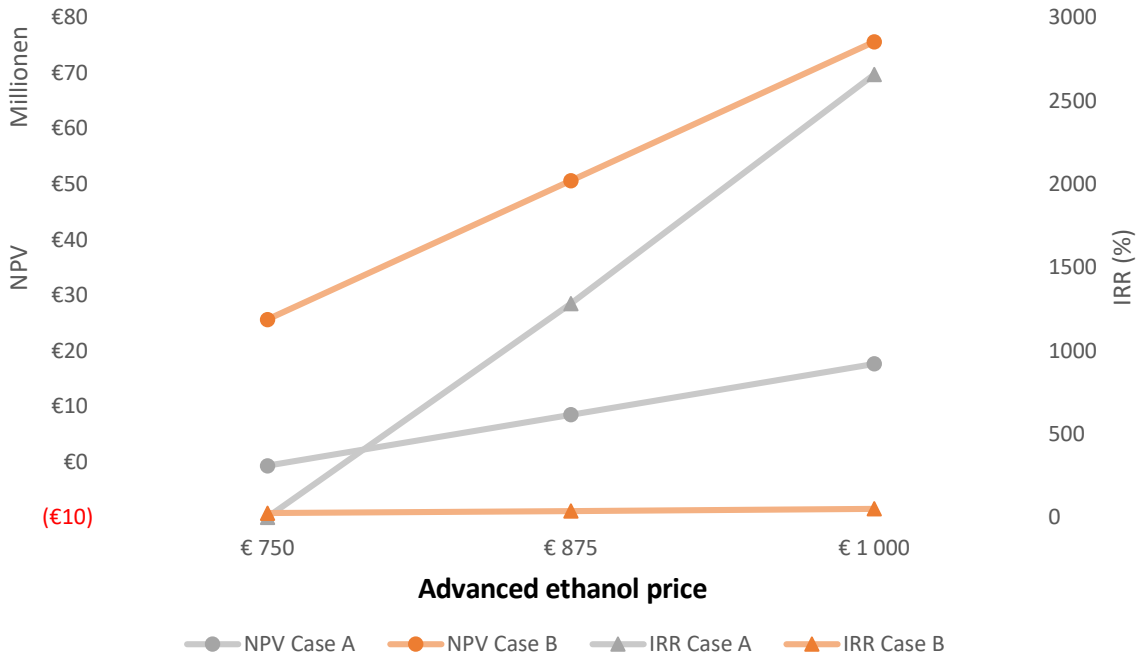
Economic assessment



- **Advanced ethanol price** has a great impact on the economic viability→ In Case A, **price below 750 €/m³** results in a negative NPV.
- **NPV:** better results are obtained for Case B than for Case A, mainly due to the higher production of advanced ethanol in case B.→11.000 m3 (Case A) vs 30.000 m3(Case B).
- The **increase in the IRR** of Case A is much greater than that of Case B → investment required in case A (100.000 €) is much less than in case B (30.450.000)
- The **yield of advanced ethanol** has a great impact on the economic viability.

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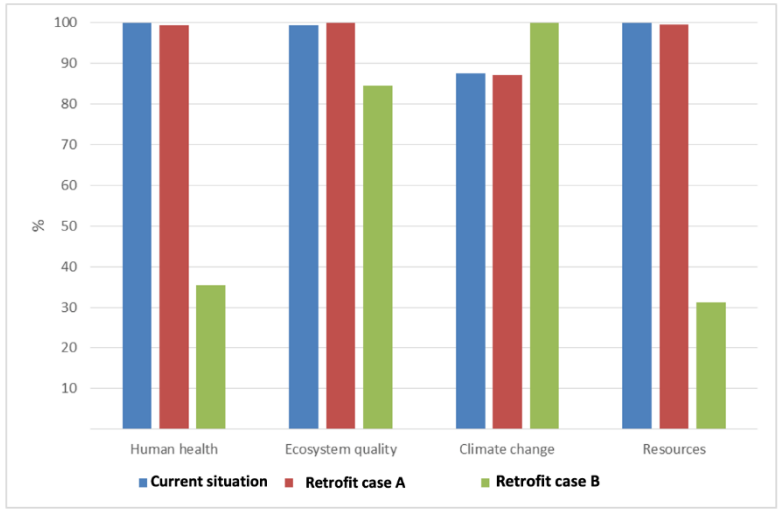
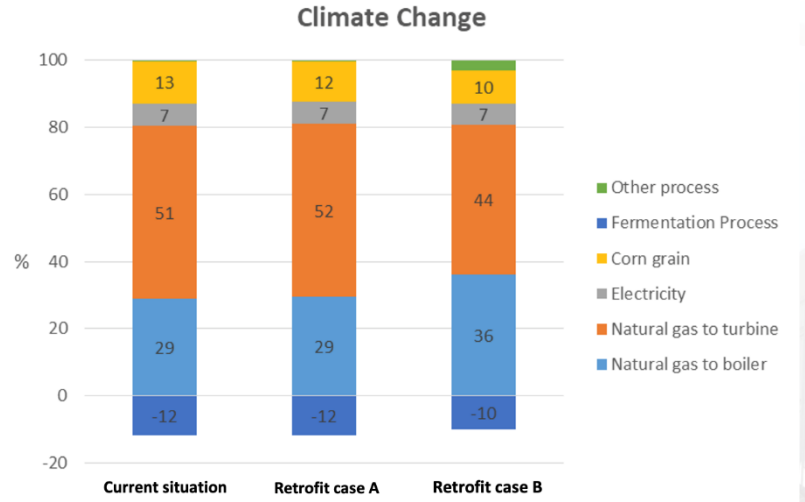
MAIN RESULTS FROM THE STUDY

Environmental assessment





- **Current situation** and **Retrofit Case A** present similar environmental behavior.
- **Retrofit Case B:** highest contribution to the climate change impact category, but the lowest impact in the categories of human health, ecosystem quality and resources.
- **Retrofit Case B:** the environmental benefits from the utilization of waste as feedstock reversed from the increased demand for energy consumption in the process
- **Both retrofit cases and current situation**: Natural gas consumption is responsible for the most significant share of Climate Change.

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MAIN RESULTS FROM THE STUDY

Risk assessment

Risk	Probability (1 – 4)	Consequence (1 – 4)	Total risk* (1 – 16)	Risk mitigation action
Change in regulations concerning the use of biofuels	3	3	9	Diversification in products: bioethanol 1G, bioethanol 2G, industrial alcohol, etc..
Decrease in support for biofuels compared to other renewable resources in the transport sector such as renewable electricity (electric car) or hydrogen	3	2	6	Diversification in other technologies such as hydrogen, jet fuel, bioplastics, etc
Raw material supply	3	2	6	Diversification of raw materials
Variability in the price of raw materials	3	2	6	Diversification of raw materials
Raw material storage / Safety stock to maintain production	2	2	4	Investment in storage
Safety in raw material storage	2	1	2	Investment in storage
Decrease in fuel use caused by a decrease in mobility due to the pandemic.	1	2	2	Diversification in products
Risk in the process. Efficiency issues	1	1	1	Investment in R&D&I

*Total risk =Probality *Consequence

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Thank you!

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