BIOFIT

Bioenergy Retrofits for Europe's Industry

CERTH CENTRE FOR RESEARCH & TECHNOLOGY HELLAS

HELLENIC PETROLEUM

Final conference

HELPE Case Study

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CONTENTS

Energy Transition Challenges

- Legislative & Regulatory framework uncertainty
- Technological maturity of candidate solutions
- Investment Risk / Funding
- Sustainable raw materials availability
- Time pressure

The Refining of the Future

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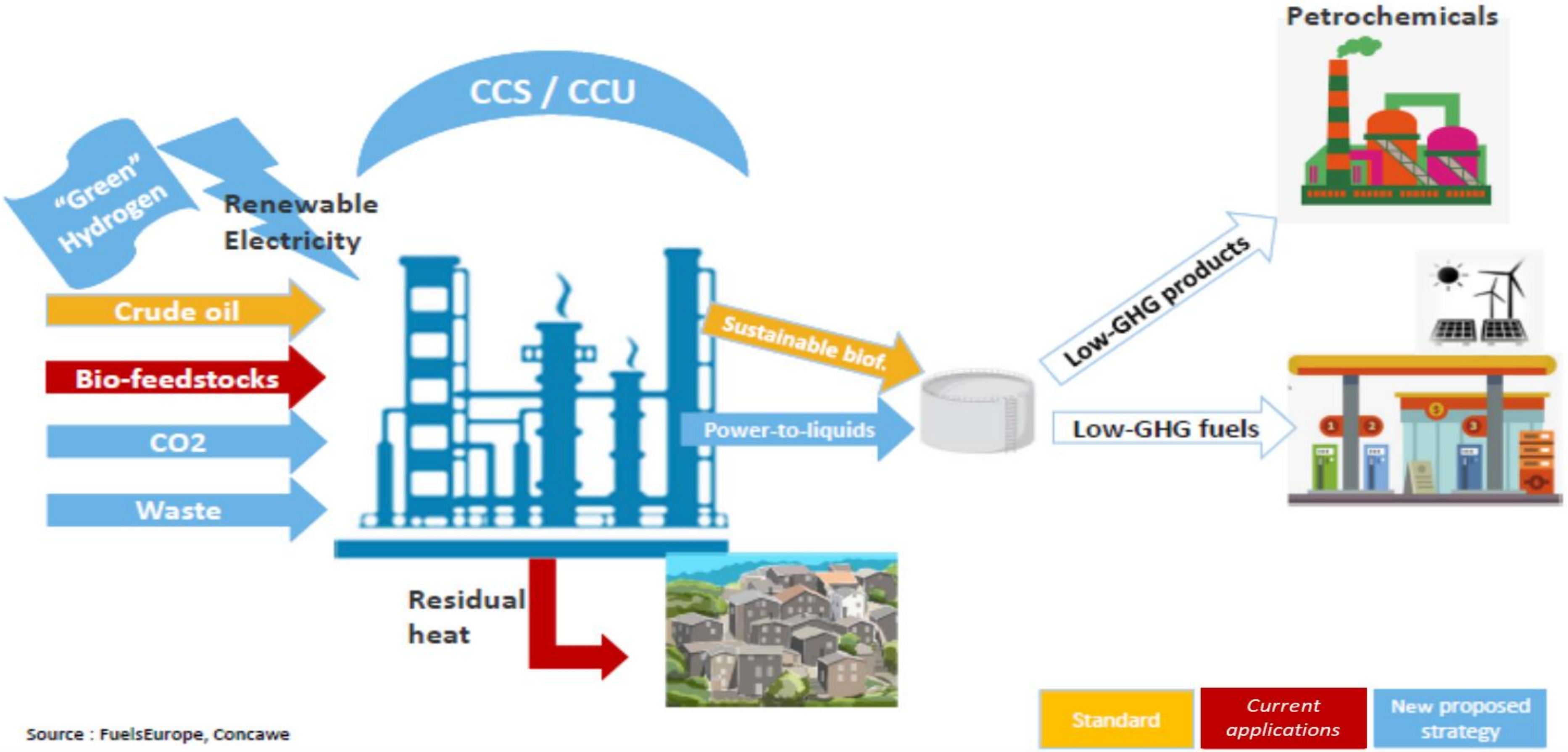
Strategic goal:

- Become a provider of low carbon energy solutions
- Reduce the carbon footprint by 50% until 2030

Addressing the issue of climate change and strive towards energy transformation.



Source : FuelsEurope, Concawe

Strategic Research & Innovation

- Started as participants in proposed research projects related to energy issues.
- Continue in targeted participation in projects relevant to the Group's activities, enhancing collaborations with the academic community in Greece and abroad.
- Evolve into a team that defines and proposes research projects according to the strategic visions of HELPE.

Areas of Interest

✓ Reduction of CO_2 emissions

✓ Digitalization in refining

✓ Low GHG fuels

✓ Energy storage

✓ Renewable energy sources

✓ E-Mobility

HELPE R&D Overview

Biofuels (Total budget: 10M€, HELPE budget: 1.1M€)

LIFE Biomass C+ *(123.210€, 60%)**

CIRCforBIO *(264.620 €, 70%)*

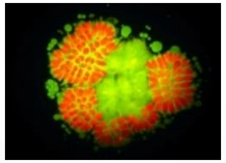
HyCon *(190.875 €, 60 %)*

ALGAFUELS *(168.700€, 65%)*

Beet2Bioref *(118.400€, 65%)*

BREW2BIO (118.000€, 65%)

SUSTAIN Diesel (160.000€, 50%)



ALGEA Biofuels (105.000€, 50%)

Refineries (Total budget: 9M€, HELPE budget: 0,65M€)

ZEOCAT-3D *(HELPE: 98.187,50 €, HELPE RES: 58.062,50 €, 100%)*

ProMethEUs (Protons for Methanol and EU Sustainability) *(HELPE RES: 58.240 €, 65%)*

PROOFF (257.000€, 65%)

deSulfur *(180.000 €, 65%)*

Energy efficiency & Digitalization (Total budget: 6,5M€, HELPE budget: 0,4M€)

Esthisis *(148.990 €, 65%)*

4.0 ARIS *(51.400€, 65%)*

RE cognition *(180.000 €, 100%)*

Green H2 (Total budget: 0,6M€, HELPE budget: 0,14M€)

HYDRO SOL PLANT

HYDROSOL (135.600 €, 46%)

- *Bio-refineries (Total budget: 2,6M€, HELPE budget: 0,1M€)*

BIOFIT Bioenergy Retrofits for Europe's Industry *(83.750 €, 100%)*

Training & Education (Total budget: 1M€, HELPE budget: 0,05M€)

phdhub

White Dragon

- HELPE participates to the Greek plan for the production of environmentally friendly hydrogen as fuel –as an Important Project of Common European Interest (IPCEI) in the context of the Hydrogen Europe program, which encourages regional corporate alliances for large-scale projects using hydrogen technology.
- The Regional Authority of Western Macedonia is coordinating the project and its members are Public Gas Corporation (DEPA), gas grid operator DESFA, Hellenic Petroleum, Motor Oil, Mytilineos, Terna, Polish company Solaris the Demokritos National Center for Scientific Research and the Center for Research and Technology Hellas (CERTH).
- The hydrogen produced will be used for district heating, fuel to be exported via the Trans Adriatic Pipeline, and as fuel for large vehicles such as lorries, buses, etc.

*Συντονιστής Έργου

WD JV

WD DESFA

WD TAP

Indirect partner

Supporters

Indirect Partners from other IPCEIs

HELPE Case Study in brief

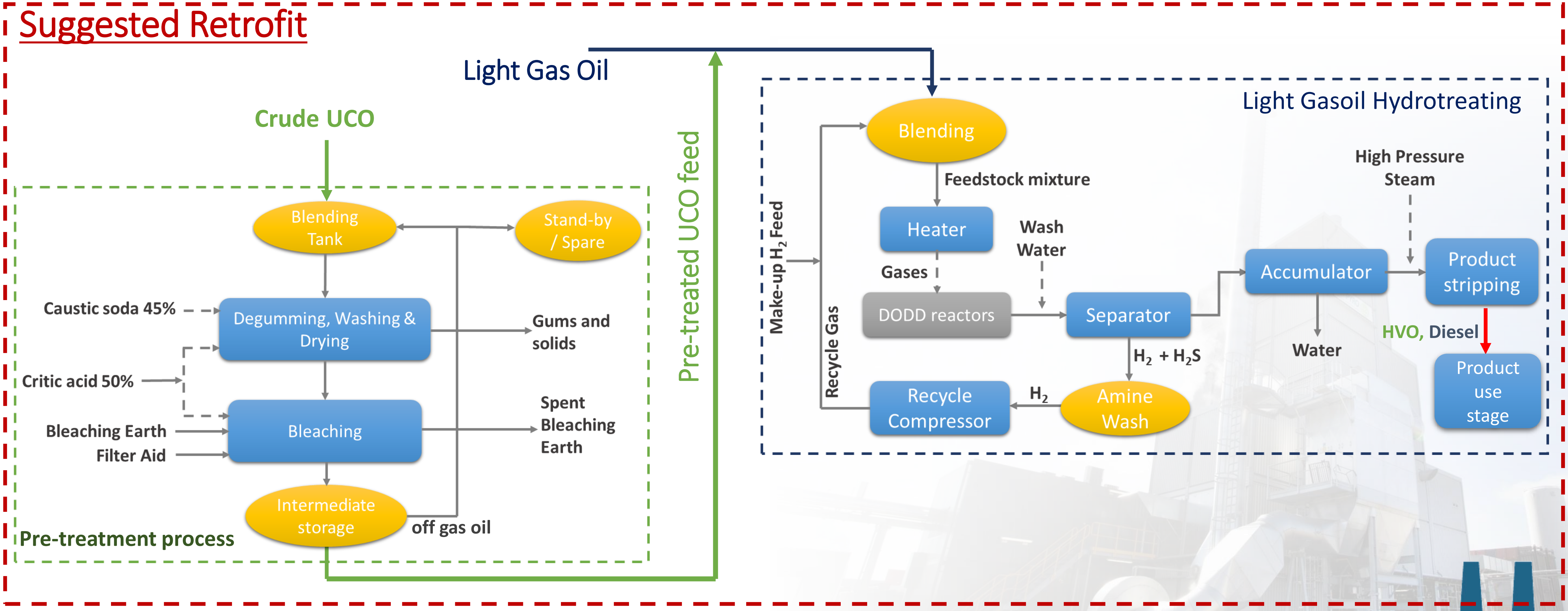
BIOFIT Case Study: **Integration of HVO production in the Thessaloniki refinery of Hellenic Petroleum in Greece**

Project partners investigated the technical challenges associated with co-processing of **UCO** (Used Cooking Oil) along with conventional straight run **LGO** (Light Gas Oil) into an existing Diesel Hydrotreater Unit at HELPE's Thessaloniki refinery in Northern Greece.

The unit is currently used to desulfurize the LGO stream coming from the CDU (Crude Distillation Unit) stripper column. UCO will consist of **5% volume** of the processing mixture. As a result, an annual production of **22,000 tonnes HVO** (Hydrotreated Vegetable Oil) is expected. HVO is characterized as a premium "drop-in fuel" that can replace diesel without modifications to existing refueling systems and/or vehicles.

Technical Description

Suggested Retrofit



Methodological Approach (1/2)

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Technical Description

- Overview - through mass & energy balances – of the current situation in the Light Gasoil HDS Unit;
- Identification of requirements of the suggested retrofit for co-feeding Used Cooking Oil (UCO) to a hydrotreatment unit:
  - *Discussion of modifications to the existing equipment and/or installations of new items to ensure reliable operation.*

Supply Chain Assessment & Market Analysis

- Description of UCO, with particular emphasis on UCO quality & UCO prices;
- Overview on the EU UCO market and the related legal framework – Emphasis on Greece:
  - *Collection & Supply potential of UCO in both the professional sector (e.g., restaurants) and the domestic sector (households);*
  - *Biofuels – UCOME & HVO – production capacities in EU countries, including Greece ;*
  - *UCO trade / UCO imports to EU countries, including Greece;*
  - *Current rules & regulations.*

Methodological Approach (2/2)

Economic Assessment

- Cash flow analysis for the retrofitting scheme;
- Employment of economic KPIs - Net Present Value (NPV), Internal Rate of Return (IRR) & Payback period to assess the financial viability of the suggested retrofit.

Environmental Assessment

- Life cycle greenhouse gas (GHG) emissions calculation according to RED II Directive (Annex V, Part C)

GHG emissions from the production and use of biofuel are calculated as:

$$E = e_{ec} + e_l + e_p + e_{td} + e_u - e_{sca} - e_{ccs} - e_{ccr} \text{ [gCO}_{2eq}\text{/MJ biofuel]}$$

where

E = total emissions from the use of the biofuel;
e_{ec} = emissions from the extraction or cultivation of raw materials;
e_l = annualized emissions from carbon stock changes caused by land-use change;
e_p = emissions from processing;
e_{td} = emissions from transport and distribution;
e_u = emissions from the liquid in use;
e_{sca} = emission savings from soil carbon accumulation via improved agriculture management;
e_{ccs} = emission savings from carbon capture and geological storage and
e_{ccr} = emission savings from carbon capture and replacement;

The GHG emission savings from biofuel are calculated as (EU 2018):

$$Savings = (E_{F(t)} - E_{B(t)})/E_{F(t)}$$

where

E_B = total emissions from the biofuel in [gCO_{2eq}/MJ];
E_F = total emissions from the fossil fuel comparator in [gCO_{2eq}/MJ]

*According to RED II:
"For biofuels used as transport fuels, the fossil fuel comparator EF(t) shall be 94 $gCO_{2eq.}$/MJ".

Major Findings of BIOFIT Project

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Supply chain Assessment

- Even with a high fresh oil consumption, current UCO collection in Greece is not sufficient for co-processing. **UCO import** from other countries (e.g., from Ukraine) is necessary;
- So far, UCO import from third countries is not limited, but a **certification of origin** is required;
- **Long-term contracts** are a good option to secure supply and price
- Suggested retrofit is within the **1.7% cap of RED II.**

Techno-economic Assessment

- Co-feeding UCO in the existing Thessaloniki Refinery is in general **financially attractive (under certain assumptions),** with:
  - *IRR of 20.5%, NPV of 16.9 M€ (investment of 29,1 M€) & payback period of 4.1 years.*
- Potential **fluctuations** in either the **buying price of UCO** or the **selling price of the green LAGO** product significantly affect the profitability of the suggested retrofit:
  - *Max .UCO buying price: 805 €/ton & Min. green LAGO selling price: 1265 €/ton.*

Environmental Assessment

- Co-feeding UCO and LAGO - in a 5/95 ratio - shows **positive results** towards lowering overall GHG emissions (4.2% emissions avoided from UCO-based HVO);
- The construction of **a newly refining unit** using 100% UCO as feedstock presents significant (about 86%) emissions savings compared to RED II comparator;
- Further investigation with respect to the environmental impacts of **clean fuel production** processes;
- Due to the max cap on UCO usage imposed by RED II legislation, **alternative sources of bio feedstock** will have to be considered.

Barriers & Opportunities

Barriers

- Lack of knowledge on the **location of UCO collection** point and inaccessible central collection points from households;
- Lack of knowledge **on environmental effects** of dumping vs. collecting;
- Uncertain income for collectors, due to **fluctuating UCO selling prices and supply volumes** in the professional sector;
- **Lack of traceability system for collectable UCO**, especially regarding the amounts produced from households;
- **Lack of Infrastructure** & **fuel quality standards**;
- **Undefined political framework** regarding the UCO import and quality standards;
- **Low collection efficiency of UCO** originating from the household due to lack of logistics;
- Lack of **regulations** from the Greek government - lack of provision of **financial incentives**.

Opportunities

- Biofuel's contribution **to energy transition** attempted by the EU;
- **Economic value of UCO** as a resource;
- **Competitive price of HVO** compared to alternative fuels;
- **Higher HVO fuel efficiency** and a chemical structural identical with petroleum diesel;
- **Cost-effective production of HVO**; it does not require expensive technology investment, while other biofuels do.

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Thank you for your attention!

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