BIOFIT

Bioenergy Retrofits for Europe's Industry

Policy Breakfast "Retrofit-for-55"

Results from the BIOFIT H2020 Project

20 January 2022, online

Dina Bacovsky (BEST) and Rainer Janssen (WIP)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 817999.

BIOFIT overall objective

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Bioenergy retrofitting

Bioenergy retrofitting can be used to replace fossil fuels or upgrade outdated renewable technologies

Retrofitting often means lower capital expenditure, shorter lead times, faster implementation, less production time losses and lower risks

Overall objective BIOFIT

"to facilitate the introduction of bioenergy retrofitting in five exemplary industries, namely **first-generation biofuels**, **pulp and paper**, **fossil refineries**, **fossil firing power** and **Combined Heat and Power (CHP) plants**, leading to an increase in the share of renewable energy in the final EU energy consumption."

Project characteristics and partners

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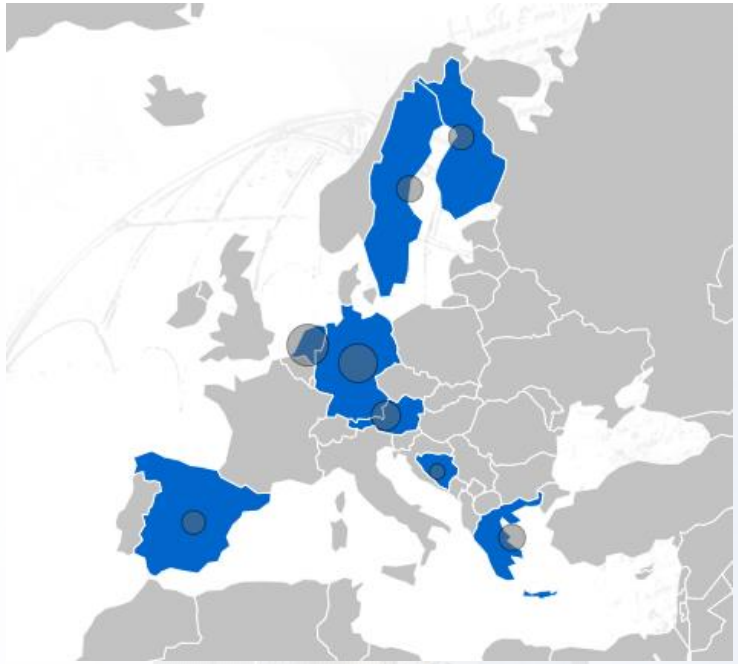
Project characteristics

- Duration; 1 October 2018 – 31 March 2022
- Budget: 2,6 MEuro
- Partners: 14 partners from 8 countries



btg biomass technology group

energikontor sydost

BIOCARBURANTES DE CASTILLA Y LEON SA

HELLENIC PETROLEUM

DBFZ

BEST Bioenergy and Sustainable Technologies

WAGENINGEN UNIVERSITY & RESEARCH

WIP RENEWABLE ENERGIES

VTT

Ciemat

Swedish BioFuels

TechnipFMC

CERTH CENTRE FOR RESEARCH & TECHNOLOGY HELLAS

JP ELEKTROPRIVREDA BiH d.d. - Sarajevo

BIOFIT Case studies

Biofit has developed 10 Concrete proposals – 2 per industry sector – in cooperation with industrial market players with actual retrofitting plans

1G biofuels: Biocarburantes de Castilla y Leon and Swedish Biofuels

Pulp and Paper: AustroCell Hallein and C-Green

Fossil refineries: Total and Hellenic Petroleum

Fossil fired power: Elektroprivreda BiH and EP Produzione

Combined heat and Power: Elektroprivreda BiH and Solvesborgs Energi

Main conclusions:

- There are many new technological options for bioenergy retrofitting
- Nearly all case studies result in an economically feasible project.
- Retrofitting will often result in a significant CAPEX reduction of around 50%, or in some cases over 85%.

BIOFIT Policy Recommendations

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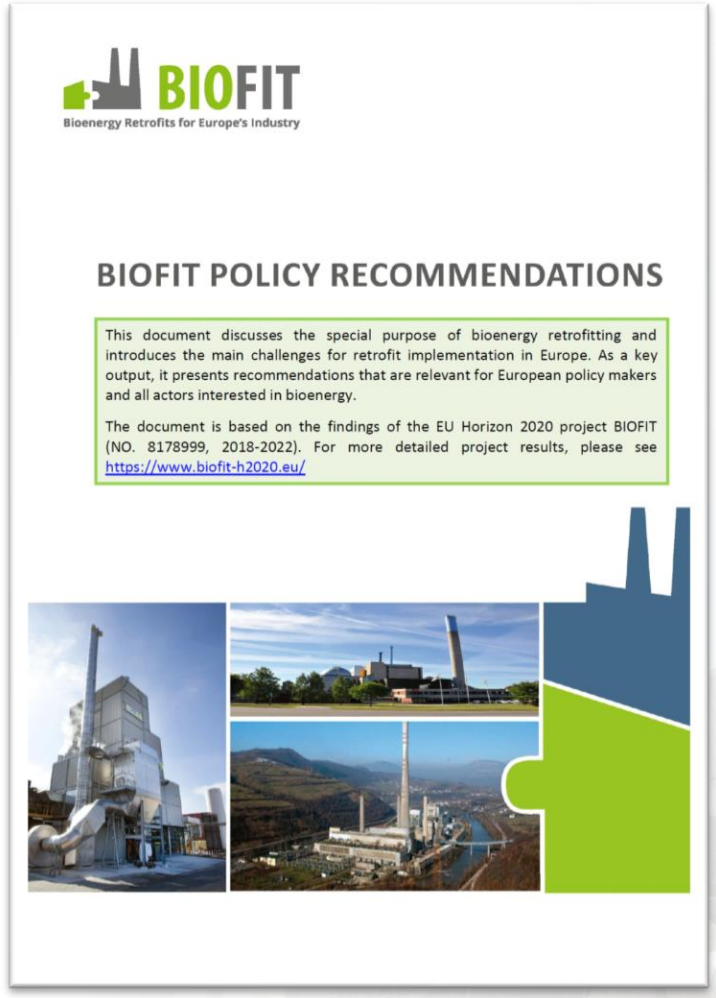
Published in January 2022

Download at:

www.biofit-h2020.eu/
publications-reports/



Fit for 55 Package

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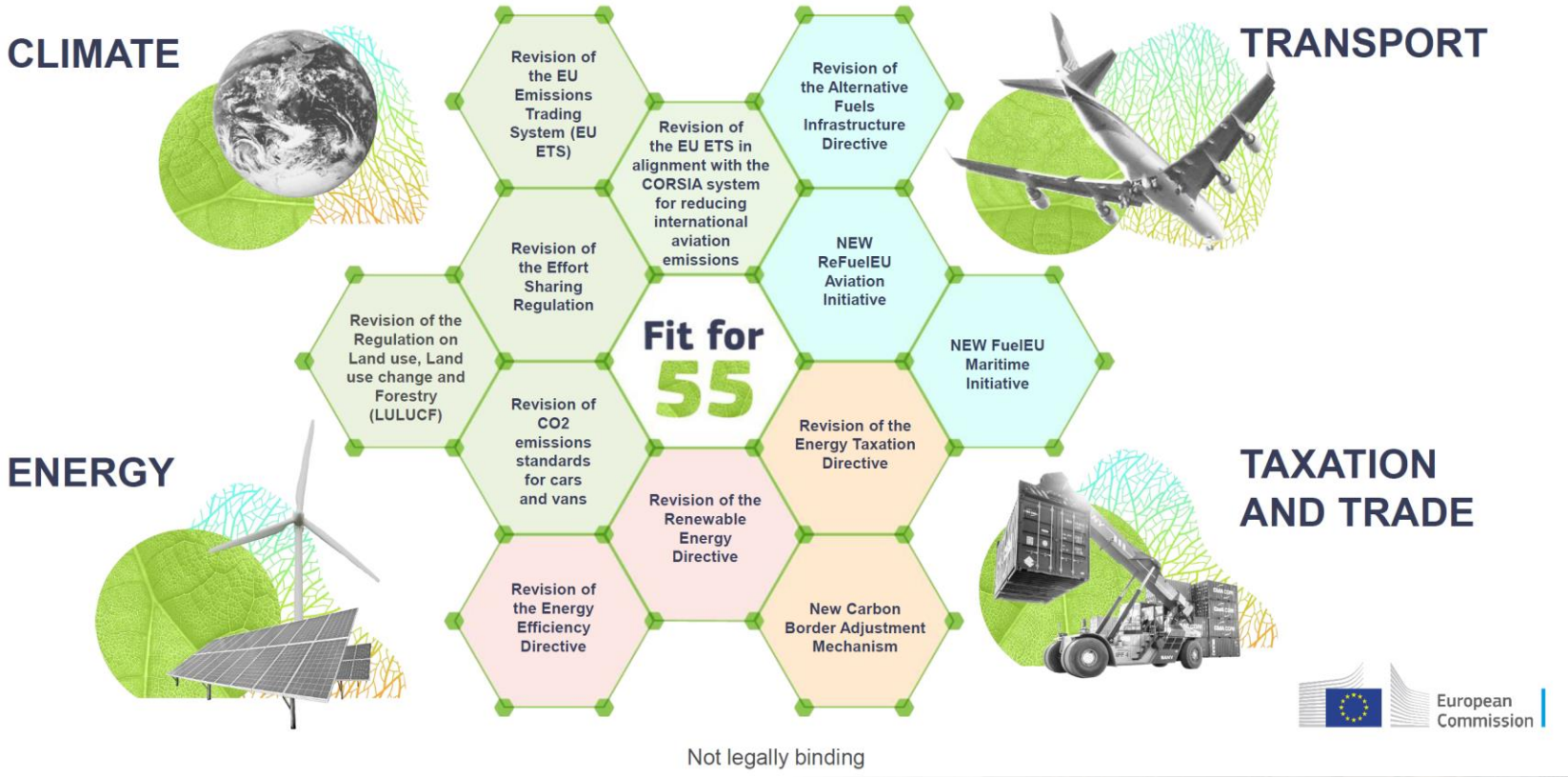
Delivering on the "Fit for 55" commitment



BIOFIT Policy Breakfast

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THURSDAY, 20th January 2022

Time	*Topic, Presentation*
08:30 (2:00) 5 min pitch, followed by 15 min discussion	**Policy breakfast "Retrofit-for-55" –** *Moderated by Dina Bacovsky (Unit Head Biofuels, BEST) and Rainer Janssen (Managing Director Projects, WIP)* - **Welcome and Introduction** - **Pitch presentations on drivers, barriers and policy recommendations** ○ **General overview** – *Hanna Pihkola (Senior Scientist, VTT)* ○ **Fossil firing power and CHP** – *Manolis Karampinis (Research Associate, CERTH)* ○ **Refineries** – *Patrick Reumerman (Senior Consultant, BTG)* ○ **Pulp & paper** – *Heidi Saastamoinen (Research Scientist, VTT)* ○ **1G biofuels** – *Arne Gröngröft (DBFZ)* - **Wrap-up** – *Dina Bacovsky / Rainer Janssen*
10:30	**End**

General Overview

BIOFIT Policy recommendations document discusses the special purpose of bioenergy retrofitting and introduces the main challenges for retrofit implementation in Europe.

The document aims at providing a concise overview of project outcomes, focusing on topics that are common to all the studied sectors.

It presents general recommendations that are relevant for European policy makers and all actors interested in bioenergy.

[BIOFIT Policy Recommendations]

Special purpose of bioenergy retrofits

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- Bioenergy is an essential form of renewable energy, accounting for almost 60% of the EU's renewable energy production. In the future, bioenergy will remain important.
- The findings from BIOFIT project highlight, how retrofitting could support decarbonisation of the studied five industry sectors.
- Retrofits may provide short-term solutions that could take advantage of existing infrastructure, and support local and regional development.
- Many of the bioenergy retrofits studied in BIOFIT are commercial, mature technologies, even if the need for further R&D activities was also acknowledged.
- They can aid decreasing fossil greenhouse gas emissions, and improving energy and material efficiency of individual mills, and lead to new biobased products, such as biofuels.
- The transport sector in the EU is currently fuelled (95%) by liquid (fossil) fuels. Bioenergy retrofitting can provide solutions needed meeting the demand for renewable fuels.
- For coal regions in transition, the closure of coal mines and power plants results in severe socio-economic pressure. Retrofitting existing plants and establishing local biomass value chains could help to maintain industrial expertise and jobs in these regions.
- In addition to electricity, repowered power plants can create significant amounts of heat for local networks, providing an important local service, even if such plants might not match the efficiency of CHP plants.

Bioenergy retrofits for the fossil power and CHP sectors: coal to biomass conversions

Manolis Karampinis (Research Associate, CERTH)

Coal to biomass conversions

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- Biomass has substituted coal (initially in small shares) in power plants since at least the early '90s
- From around 2005 till 2019, a number of European power utilities have ramped up their biomass consumption by full biomass conversions at large scale coal power plants
- Coal to biomass conversions are primarily concentrated in four countries: UK (~ 3.0 GWe), Denmark (~ 1.2 GWe), Netherlands (~ 1.1 GWe / co-firing) and Belgium (~ 0.3 GWe)
    - Contribution to total electricity production is around 5 % in the UK, 2 – 3 % in BE and NL, and more than 10 % in DK (+ heat for DH)
- Industrial quality wood pellets is the primary biomass fuel used in such conversions for various technical and non-technical reasons
    - In 2019, industrial wood pellet consumption in the EU27+UK amounted to 13.2 Mt / around 3.6 % of the gross inland biomass consumption (on energy basis)
    - Most of the supply is from USA and Canada, but quantities are also sourced from the EU (e.g. Latvia, Portugal) and other countries
    - Other biomass fuels (e.g. straw, agro-industrial residues, etc.) may also be co-fired on a more or less frequent basis
- Biomass conversion projects have also been under consideration in several other EU countries with retiring coal capacities (e.g. France, Italy, Greece, Spain, Portugal) but until now they remain "frozen"
- Note: several coal to biomass conversions have also been implemented in smaller scale plants with a greater feedstock variability

Fossil power & CHP Drivers

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For utilities:

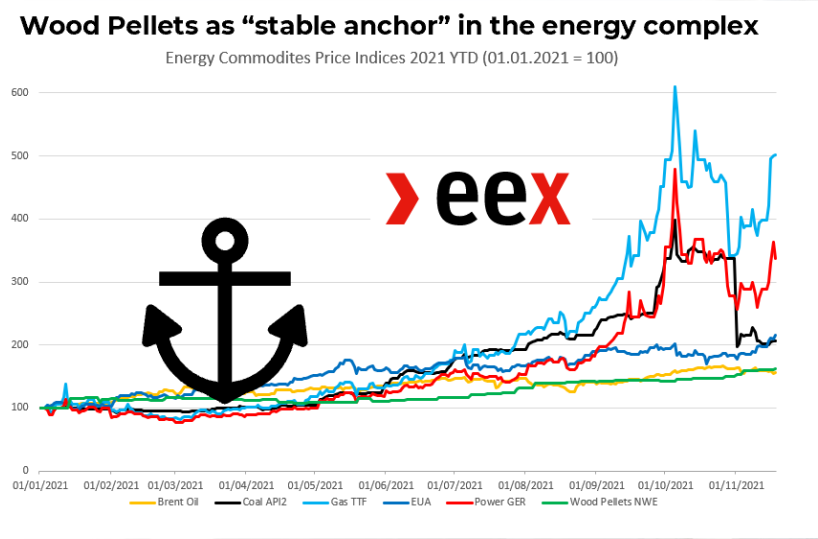
- Utilization of assets (power plants) that would otherwise become stranded
- Generation of renewable electricity
- Financial motivation (feed-in premiums, lower CO_2 cost,…)

For grid operators:

- Dispatchable thermal power generation at large-scale → grid stability

For society:

- Supporting local economies, especially in transition regions → job retention or even creation, continuation of heat deliveries to DH systems
- Stability in energy supply costs



Fossil power & CHP Barriers

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Technical: compatibility of fuel switch with existing equipment

Technical / Regulatory: minimum electrical efficiency or high-efficiency co-generation or BECCS (RED II requirements for fuel input > 100 MW)

Market: access to biomass supply (e.g. distance from ports, undeveloped local markets)

Financial: Lack of financial support mechanisms (e.g. CfDs)

Regulatory: REDIII proposals introduce different requirements & discontinuation of financial support

→ owners will not make decision to convert unless a clear and stable policy framework is in place

Social & political: often negative image of large-scale biopower, opposition from NGOs and certain politicians

→ spill-over effects in regulation

The Fiume Santo BIOFIT case study

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- Owner: EP Produzione (EPH Group)
- Two hard coal fired units: 320 + 320 MWe
- Coal phase-out in Italy by end of 2025
- Sardinia requires at least 600 MWe of baseload capacity according to electrical grid operator
- High local unemployment → increase if power plant closes
- Case study: conversion of Unit 4 from coal to 100 % biomass
  - Investment requirement: 150 MEUR
  - Biomass fuel: primarily wood pellets (imported) + up to 5 % local wood chips
- Prior experience from the biomass conversion at Lynemouth (UK)

Barriers for the Fiume Santo conversion

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Barriers	Fiume Santo	Explanation
Technical		No technical red flags identified for the conversion
Market		Access to global wood pellet market and possibility to tap into local biomass resources
Financial		No dedicated support scheme yet, but possible to adopt one
Regulatory		Discontinuation of support for biopower generation under current REDIII proposal
Social & political		Good support on local / regional level; not so good on central government and Brussels level

Fossil power & CHP Recommendations

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- Acknowledge that coal to biomass conversions is a mature technical solution for the energy transition
- Develop an enabling and stable policy framework under REDIII
  - For Western Balkans, suitable national derogations may be required
- Consider socio-economic factors for project support (e.g. just transition & non-cohesion regions)
- Consider the heat utilization aspects in the appropriate context (multiple customers in Europe served by cogeneration systems that are not "high efficient")
- Incentivize the uptake of alternative & local biomass resources in conversion projects (e.g. agrobiomass)
- Continue promotion and support in innovative technologies (e.g. BECCS)

Bioenergy retrofits for the refinery sector

Patrick Reumerman (Senior Consultant, BTG)




Refineries Drivers

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The existing refinery infrastructure can be used, meaning lower capital costs, quick ramp-up possibilities, and utilization of existing expert knowledge on transportation fuels.

Retrofitting existing refineries can mean avoidance of closure, thereby avoiding costly measures such as soil sanitation. Refineries have also a role in the regional economies, meaning that their continued operation has also an important socio-economic effect.

Renewable fuels offer excellent opportunities to decarbonize 'difficult' sectors like long-range HDVs, aviation and shipping.

Refineries Barriers

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The availability of sufficient amounts of sustainable feedstocks in large quantities at single point locations. This is an issues both with forestry residues, and with waste lipids.

Rapidly changing policy framework – including sustainability criteria – is creating uncertainty and hinder investments

Lack of an EU-wide definition for determining the sustainability of biofuels from co-feeding

Lack of EU wide certification schemes for biofuels blended with fossil fuels, hampering the free transfer of these fuels.

Refineries Recommendations

Cultivation and mobilization of energy crops on marginal lands to increase feedstock availability

Better collection systems for waste lipids, through a combination of stimuli, good logistics, better enforcement and monitoring for disposal practices, and more uniform waste definitions in Member States

Biomass feedstock supply for refineries could be promoted by stimulating technologies related to Intermediate Bioenergy Carries, so that the required volumes become available, and that they can be trade like a commodity. Trade centers could facilitate market uptake.

A stable, enabling, technology neutral, policy framework with clear, uniform sustainability criteria, that avoids unfair international competition

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Bioenergy retrofits for the pulp and paper sector

Heidi Saastamoinen (Research Scientist, VTT)

Pulp&Paper

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Bioenergy retrofits relate to both substitution of fossil fuels at sites and production of new renewable products, mainly fuels for the transport sector.

Side streams:

- Bark
- Sawdust sludge
- Black/Brown liquor
- Foul condensates of black liquor
- "Soap"
- Hemicellulose
- Lignin
- Sludge/slurry

Retrofits:

- Biomass CHP integration
- Biomass or biomethane use in lime kiln
- Bark gasification
- Brown liquor ethanol
- Tall oil biodiesel
- Hydrothermal liquefaction of lignin
- Anaerobic digestion of sludge
- Valorisation of pulp and paper slurry
- Black liquor gasification to DME
- Lignin extraction from black liquor
- Methanol from pulp mills

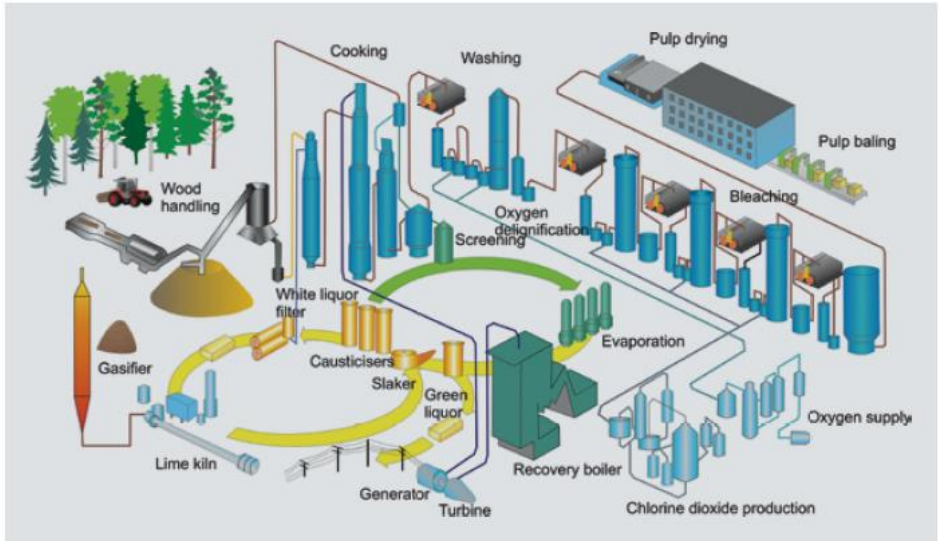
Products:

- Heat
- Electricity
- Biogas
- Biomethane
- Biodiesel
- Ethanol
- Biocrude
- Biomethanol
- DME
- Lignin
- Biochar/HTC biocoal

Currently known P&P retrofits (Figure source: https://www.biofit-h2020.eu/biofit-industry-map/)

More information from: BIOFIT Handbook, BIOFIT Best Practice Factsheets for P&P sector

Pulp & Paper Drivers



A schematic diagram of a typical energy self-sufficient Nordic Pulp Mill
(Source: IRENA (2018), Bioenergy from Finnish forests: Sustainable, efficient and modern use of wood, International Renewable Energy Agency, Abu Dhabi.)

- **Digitalization**
  - Global trend of reducing print paper demand requires pulp mills to find also other valuable products.
  - Bioenergy retrofits provide valuable bio-based products for the energy and transport sectors and allow the P&P companies to widen their product portfolios and to create new businesses.
- **Climate change mitigation**
  - Urgent need for climate change mitigation increases the demand for energy, fuels and products from renewable sources.
  - Bioenergy retrofits support the achievement of the European climate and energy targets.
- **Circular economy and sustainability**
  - The role of forests as carbon sinks is getting more important and may limit the direct use of virgin wood.
  - Use of by-products from industry or harvesting is more sustainable than use of slowly growing forest biomass for fuel or energy production.
- **Energy and material efficiency**
  - Pulp mills that are no longer integrated to paper mills use less energy than before, which opens up opportunities for producing high-value bioenergy products from their side streams.

Pulp&Paper Barriers

Demonstration in the EffiSludge for LIFE project aimed at improving the energy efficiency of the aerobic wastewater treatment processing wastewaters from the pulp mill at the site of Norske Skog's pulp mill. Source of Figure: https://scandinavianbiogas.com/en/project/skogn-en/

- **Feedstock availability and acceptability**
  - Tightening sustainability criteria and concerns related to carbon sinks and biodiversity create uncertainty.
  - The mills are in different positions regarding availability of biomass.
- Bioenergy **retrofit technologies are not directly replicable** from one mill to another - feasibility of retrofits must be assessed case by case
  - their suitability depends on the used pulping technology, local operational environment and markets
  - process during the first retrofit establishment can lead to further retrofitting
  - the volume of available the residues limits potential amount of final products
- The retrofit options have **different technical readiness levels**
  - Challenges in assessing the feasibility of emerging technologies
- **Availability of local networks** is in essential role when retrofits are considered
  - value chain needs to be built up from the production to customers
  - some of the products need further refining before entering the markets
- **Rapidly changing policy and market conditions**
- **International competition**

More information from: Drivers and barriers in retrofitting pulp and paper industry with bioenergy for more efficient production of liquid, solid and gaseous biofuels: A review

Pulp & Paper Recommendations

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- **R&D funding as well as investment support should be targeted to new technologies that allow efficient side-stream utilisation and increase overall energy-efficiency.**
- Long-term political support and consistency in the development of the regulatory framework would be important to **support the investments and the scaling-up of the retrofit technologies** that typically require high upfront investments.
- **Research and funding should be allocated for studying the possibilities for broadening their feedstock base and increasing awareness of related challenges.** Potential means could include support for finding alternative feedstocks, investments in energy efficiency and other new technological solutions that could help in decarbonisation of the sector.
- While **tackling** the greenhouse gas emissions at the EU-level, most industries are exposed to **international competition**. According to The European Green Deal, "The commission will propose a carbon border adjust mechanism, for selected sectors, to reduce the risk of carbon leakage." This is of importance to the pulp and paper industry sector, for example, to avoid problems with intercontinental competition.

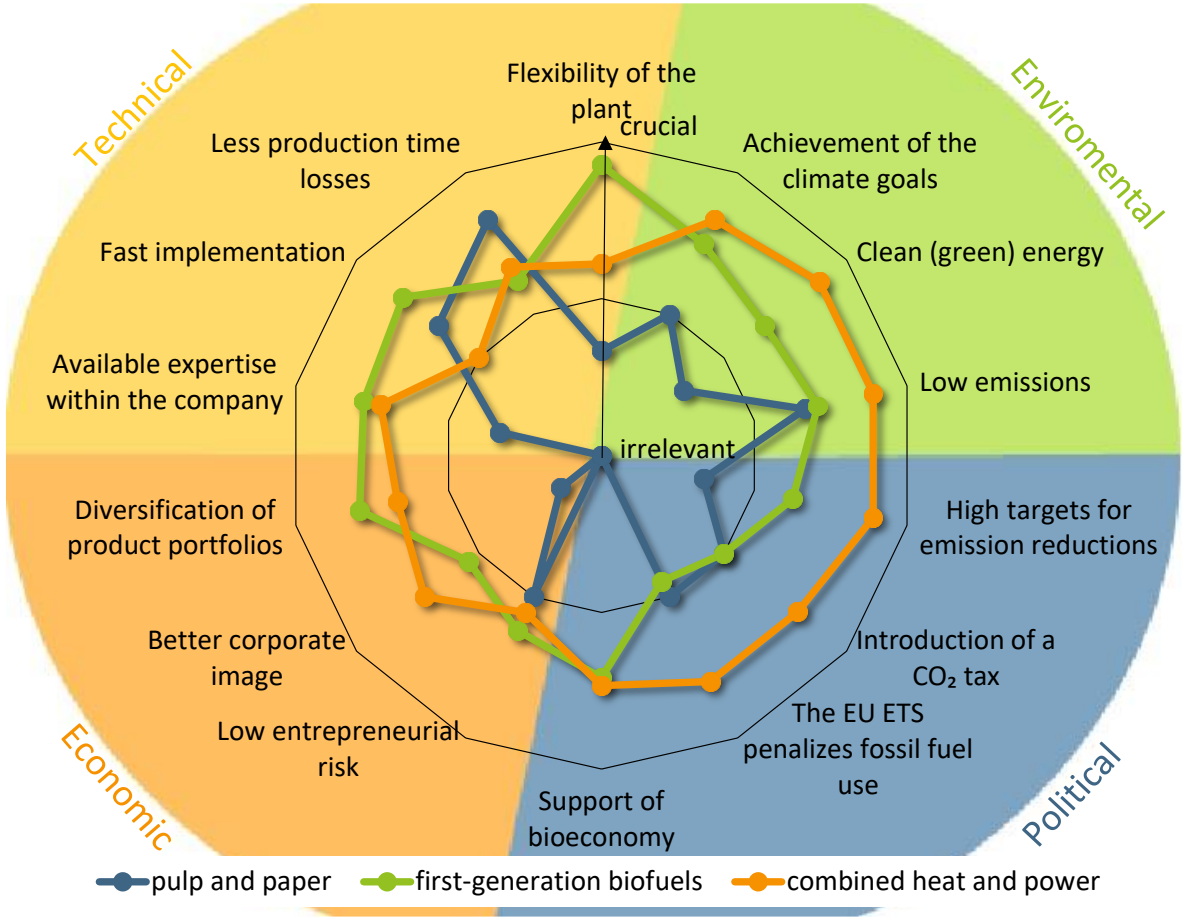
Södra Cell Bioproducts' biomethanol plant at Södra's mill in Mönsterås is one of a kind bioenergy retrofit in pulping industry. Source of figure: Södra's image bank/Södra Skogsägarna

More information from: Sectoral Recommendation Paper: Pulp and paper

Bioenergy retrofits for the first generation biofuels sector

Arne Gröngröft (Researcher, DBFZ)

1G Biofuels Drivers

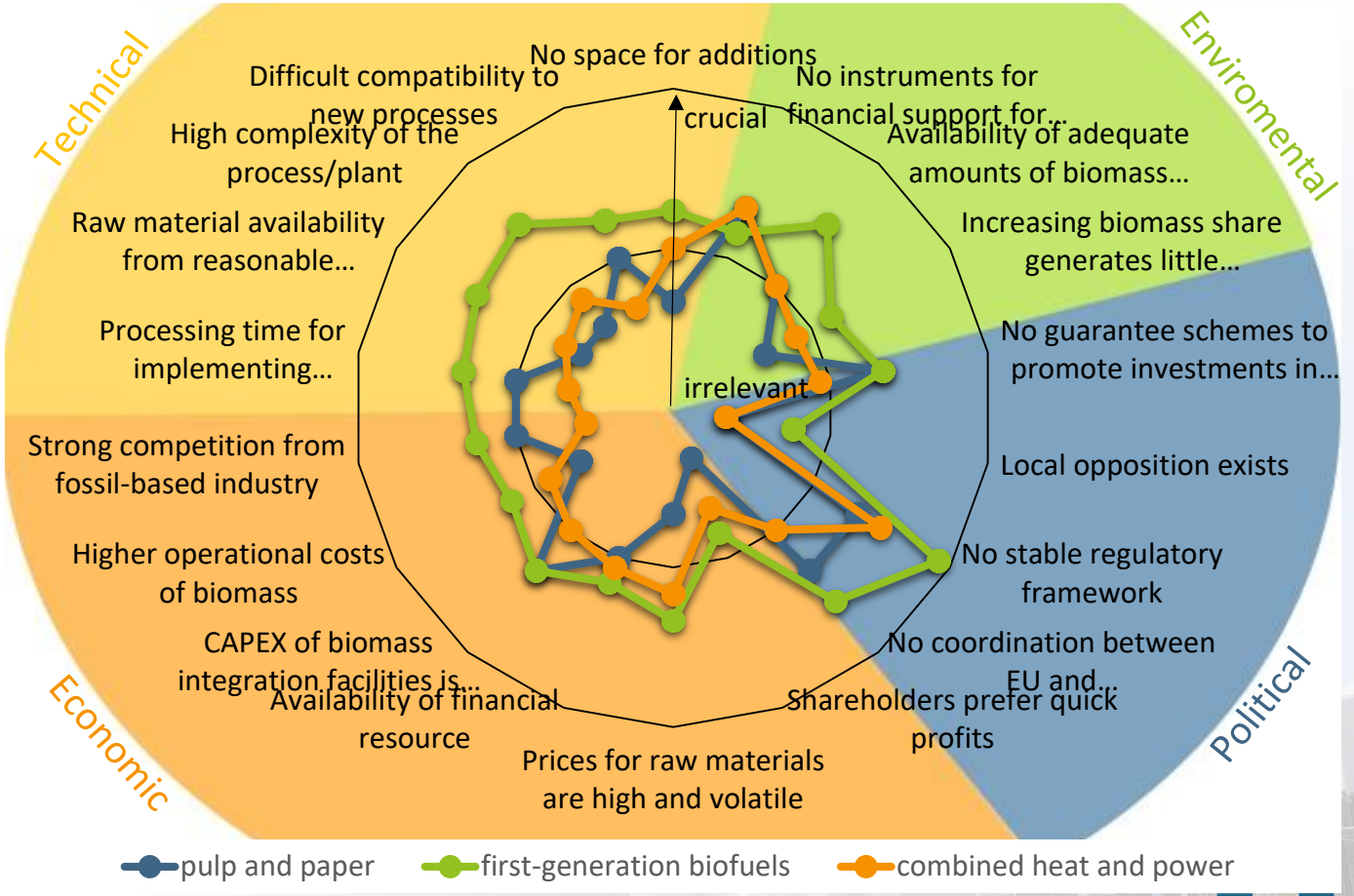


- Increasing (feedstock) flexibility of the plant
- Diversification of product portfolios and quality improvements of products
  - Production of biofuels for different applications, e.g. marine and aviation sector
  - Lowering GHG emissions
  - Revenues from high value by-products
- Feedstock change to residues / 2G (REDII, Annex IX) (benefits on market: e.g. double counting)
- Exploring synergies with renewable electricity generation and CO_2 utilization

1G Biofuels Barriers

Main barriers for retrofitting in the 1G biofuels sector

- **Instable regulatory framework** and **insufficient coordination** between EU and national policies
- Availability of **adequate amounts of biomass**
- **Rapid integration** of retrofits into complex existing plants requires **special expertise** to minimize downtimes
- Severe retrofits like changes from agricultural to waste based feedstock come with a **change in management strategy**



1G Biofuels Recommendations

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FEEDSTOCK

- broadening the feedstock base for biofuels production, incl. e.g. biomass from MUC* lands
- establishment of collection and documentation systems for residues and waste streams, incl. e.g. UCO and animal fats

TECHNOLOGY

- technology open research, policy and funding
- technical retrofitting options are depending e.g. on the general process, feedstock availability, intended result and investment volume

INVESTMENT

- facilitated or supported access to credits for retrofitting
- funding schemes to support the study of feedstock potentials and technology development as well as the implementation of retrofits

COORDINATION

- clear, stable and ambitious long-term framework conditions
- coordinated national decisions e.g. in terms of creditability of feedstock according to RED II, Annex IX, Part A

* marginal, underutilized and contaminated

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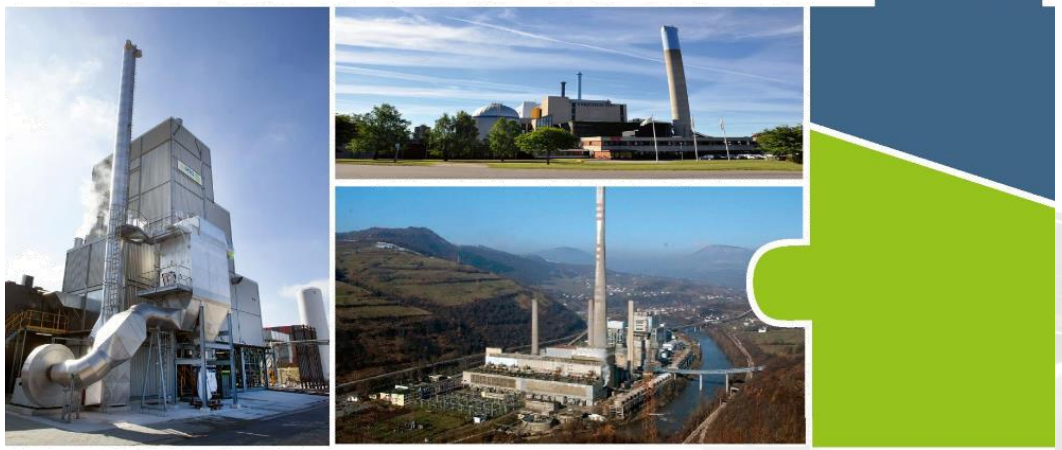
Bioenergy retrofits General Recommendations

Hanna Pihkola (Senior Scientist, VTT)



Identified challenges for retrofitting

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- Rapidly changing policy framework and market conditions
- Complex and interconnected regulation
- The definition of waste materials varies between the Member States
- Sourcing of unexploited feedstocks to secure raw material availability
- Need for technology-neutral legislation
- Fossil fuels are still promoted
- International competition
- Lack of information, cooperation and general awareness

General Recommendations

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- **Research and funding should be allocated for broadening the feedstock base for bioenergy and biofuels** production, including biomass from marginal, underutilised, contaminated (MUC) lands**.**
- Many of the potential residue and waste streams applicable for biofuel production are scattered and difficult to mobilize. **New collection systems for residues and waste should be established**.
- **National and EU legislation should be revised in order to remove obstacles for and/or promote the sustainable collection of agricultural and forestry residues** for the bioeconomy. Retrofitting could be promoted also by removing legal obstacles regarding the co-processing of fossil and biobased feedstocks and developing the related standardisation.
- **Biomass feedstock supply for refineries could be promoted by stimulating technologies related to intermediate bioenergy carriers, IBCs** (pre-treated biomass, such as torrefied pellets and bio-oil) so that they can be traded like a commodity.
- Regulations and governance should set economic incentives and construct a step-by-step supply chain system that will **enhance the collection of used cooking oil (UCO) and animal fats**.
- **Support for further research of alternative pathways towards a cost-effective and sustainable advanced bioethanol production** (such as retrofitting 1st generation biofuel plants with 2nd generation biofuel add-ons) is still needed.
- **Biorefineries allow putting the cascading principle into practice.** However, such investments have **high risk and high capital expenditures that need to be tackled with a stable and long-term policy framework**.
- In order to facilitate the market uptake of emerging technologies for bioenergy retrofitting in the pulping industry, **R&D funding as well as investment support should be targeted at new technologies that allow efficient side-stream utilisation and increase overall energy-efficiency**.
- **Standard calculation formulas should be developed and implemented to quantify the renewable content of all transport fuels**. Current work on a Europe-wide definition should be conducted with diligence, speed and in cooperation with renewable fuel producers.
- Renewable aviation fuels have the potential to deliver a major contribution to achieving increased EU climate targets for 2030. This requires **developing a supportive technology neutral policy environment for the successful deployment of renewable jet fuel technologies**, and internationally consistent sustainability certification procedures that take into account regionally specific contexts.
- **Careful and transparent communication and information to the public is needed** to maintain and strengthen public trust in industrial activities to implement bioenergy technologies.
- **BIOFIT Policy Recommendations**

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https://www.biofit-h2020.eu/