BIKE

BIOFUELS PRODUCTION
AT LOW - ILUC RISK
FOR EUROPEAN SUSTAINABLE
BIOECONOMY

D7.6

Final project Publication

Dissemination level: PU

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Authors	David Chiaramonti (RE-CORD / Polito), Andrea Salimbeni (RE-CORD)
Contributors	All project partners
Reviewer(s)	Andrea Salimbeni (RE-CORD)
Editors	ETA-Florence Renewable Energies
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Executive summary

Sustainable production of biofuels requires well-designed value chains and detailed monitoring to avoid negative impacts, including Indirect Land Use Change (ILUC). The low ILUC-risk concept was introduced in the EU directive (EU) 2015/1513 in 2015, amending the Renewable Energy Directive 2009/28/EC; however, no further operational details, necessary for implementing a legislation, were introduced at that time. In the 2018 recast of the EU RED, low ILUC-risk fuels were for the first time better defined, providing an exemption from the cap on high ILUC-risk feedstock. Within the year 2030, the REDII mandates fuel suppliers to ensure that at least 14% of their supply, import or commercialisation of fuels comes from renewable sources. The overarching goal of the BIKE project is to facilitate the market uptake of European low ILUC-risk feedstocks for the production of sustainable biofuels and bioliquids. The BIKE project follows a **value chain approach** that covers land use, feedstock provisioning, conversion processes, and end-product outputs. This approach combines top-down modelling estimates, based on statistical data and recent research, with bottom-up analysis of actual case studies, with profiles matching the current definition of low ILUC-risk biofuels, bioliquids and biomass fuels.

The activities of BIKE are organized around two low ILUC-risk pathways: 1) Cultivation in unused, abandoned or severely degraded lands and 2) Productivity increases from improved agricultural practices. The first value chain involves biomass feedstocks that can be cultivated on unused, abandoned or severely degraded lands. The second value chain includes biomass feedstocks that can be grown with sequential cropping methods[1], together with other sustainable agronomic practices, such as use of biochar and compost.

The BIKE project identified **two case studies per each value chain**, i.e. four in total, where low ILUC-risk biomass feedstocks are used for the production of three types of biofuels: cellulosic ethanol, renewable diesel (HVO), and biomethane. The two case studies referred to cultivation in **unused lands** are: i) perennial grasses to advanced (lignocellulosic) ethanol, and ii) castor beans to produce HVO renewable diesel. The two case studies identified as **sequential cropping** systems are instead: iii) brassica carinata for renewable diesel production and iv) the Biogas Done Right model (BDR) for biomethane-to-liquid fuels.

BIKE analysis focused on evaluating the sustainability of these chains and identifying strategies to promote the market uptake of these four case studies. Parallel to this assessment study, distributed over 7 work packages, an add-on module was elaborated by ISCC for **certifying low ILUC-risk biofuels production**, which was tested on actual case studies in view of future adoption at commercial scale. Replicability potential of the identified low ILUC-risk biofuels case studies in the EU territory was also examined. Moreover, an environmental, social, and economic sustainability assessment of low ILUC advanced biofuels production routes was performed for each case study.

An evaluation of both the European and national **policy framework** was conducted to identify the existing barriers and opportunities, in order to support the implementation of the low ILUC regulation. Within the assessment, critical aspects have been identified, including some weaknesses on the methodology for classifying severely degraded lands as having low ILUC-risk or other critical

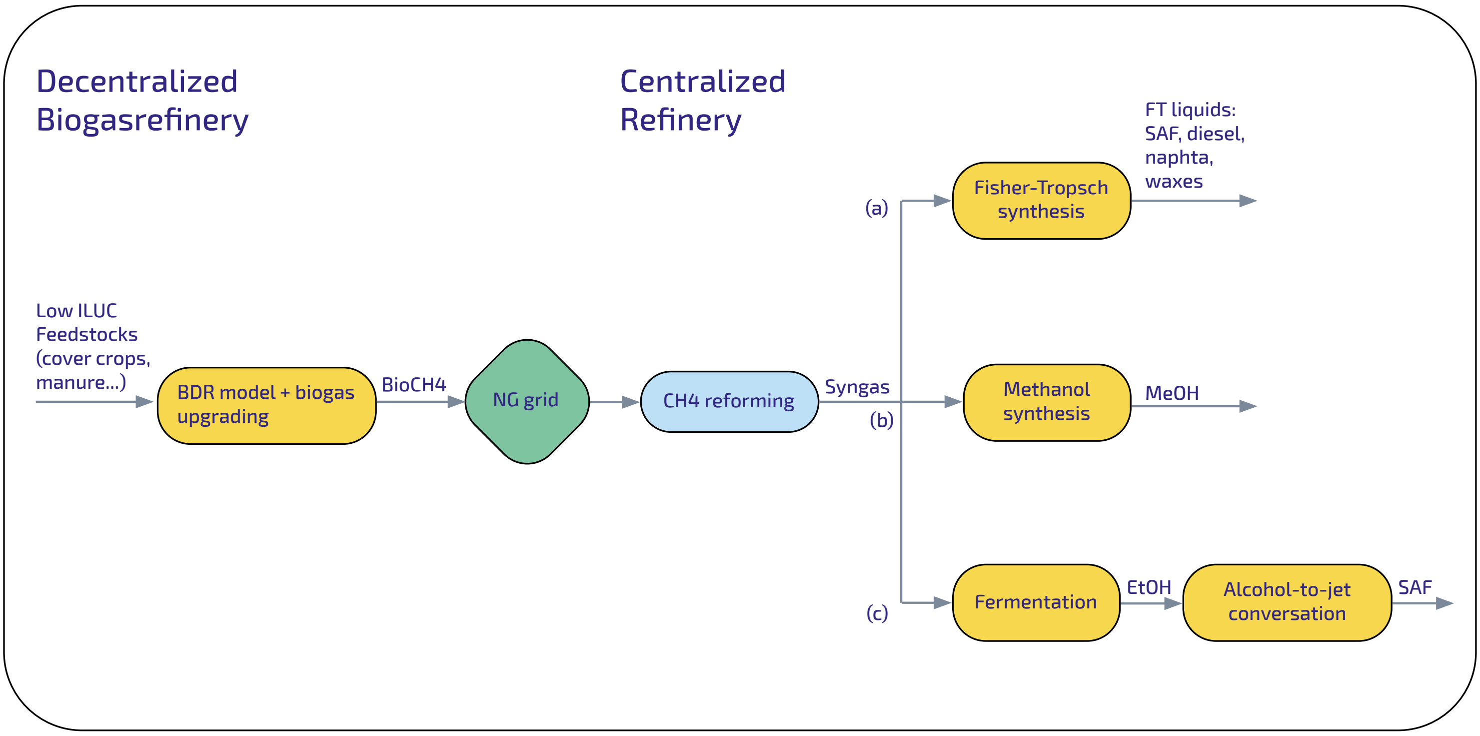
[1] Sequential cropping (also referred to as multi-cropping, double cropping or growing a "harvestable cover crop") is the cultivation of a second crop before or after the harvest of the main food or feed crop on the same agricultural land during an otherwise fallow period.

elements associated to low ILUC-risk definition of feedstocks. BIKE, by addressing these elements, aims at helping farmers and biofuel producers in the development of long-term business plans.

The case studies showed different profitability and uncertainty factors. Sequential cropping with **Biogas Done Right** model demonstrated the possibility to produce biomethane and enough digestate to meet cropland requirements, avoiding the use of chemical fertiliser derived from fossil fuels. Moreover, the large number of Anaerobic Digestion facilities already existing in several EU countries, and the high TRL level of **biomethane-to-liquid technologies**, make this case study extremely interesting, combining:

- a decentralised **biogasrefinery** approach,
- the injection of methane in the **gas grid** (or transport in liquefied or compressed form), and
- a final **centralized conversion in existing/new refineries** to SAF, maritime and heavy-duty fuels.

This approach could quickly deploy the EU biomethane potential by smart integration and full valorization of existing infrastructures (i.e., EU gas network and refineries).



The case studies involving renewable diesel (HVO) production under low ILUC conditions demonstrated a further interesting value chain.
Introducing **brassica as winter crop** is a possible practice, which can increase biomass production without affecting the yield of summer crops.
Similarly, low ILUC **castor oil production to HVO** could provide additional income to both local farmers and industrial stakeholders. Enhancements in this process could involve strategies that minimise transportation costs between cultivation areas, HVO departing ports and biorefineries.
Moreover, by integrating the use of biochar in soil as Low-ILUC agricultural practice, the GHG performance of the value chain can be further improved, enabling the production of carbon negative Low ILUC risk biofuels, as also demonstrated in a parallel EU supported project (BIO4A).[2]

The strength of all these case studies lies in the high TRL of all the considered technologies, and in the possibility to use existing infrastructure.
Compared to the other case studies, the cultivation of perennial grasses on unused farmland showed more criticalities. To ensure sustainability, reduced transportation distance is needed. In the UK case study, transporting Miscanthus within 100 km to an existing biorefinery could only meet 5% of the capacity of a full size 2G plant. Moreover, since dedicated new refineries are necessary for 2G bioethanol production, this low ILUC-risk solution necessitates larger investments and more time for market penetration.

BIKE conducted an assessment to determine the potential for replicating low ILUC-risk case studies across Europe through a **modelling and mapping study**. An additional work has been carried out to estimate the potential impact of **BIKE selected case studies** on the EU transport sector, namely the potential contribution to the production of low ILUC-risk SAF. Findings suggest that a potential exists to produce about **1.1 – 1.5 billion liters of Sustainable Aviation Fuel (SAF) by 2030.** With aviation's fuel demand projected to reach 54.9 billion liters by 2030, achieving the 5.3% SAF share from advanced biofuels, as mandated by the ReFuelEU Aviation proposal[3], would require approximately 2.9 billion liters of SAF. The replication of BIKE low ILUC-risk case studies **could contribute to up to 54% of the SAF required to meet the proposed mandate by 2030.**

The BIKE project has shown that low ILUC-risk biofuel value chains represent a credible additional route to sustainable alternative fuels for transports, which could improve both the sustainability of the value chain and the economic returns for farmers. Moreover, the identified cultivation practices represent an opportunity to restore the European unused or degraded lands, increasing soil organic carbon and reducing the use of inorganic fossil-based fertilisers.

These environmental and agronomic benefits, along with the high TRL level of these technologies, could accelerate the deployment of BIKE value chains. Based on project achievements and stakeholders' feedback, the project also proposed a Follow Up strategy, with the aim of connecting target groups and providing an additional element for low ILUC-risk biofuels market uptake.

[2] https://www.bio4a.eu/wp-content/uploads/2023/08/BIO4AFinal-Publication.pdf
[3] ReFuelEU Aviation proposal, Provisional Agreement Resulting from Interinstitutional Negotiations, Annex I (Volume Shares), 16.6.2023.

BIKE

The project at glance

The BIKE project "Biofuels production at low ILUC risk for European sustainable bioeconomy", is a Horizon 2020 project that run from September 2020 until August 2023. It supported the implementation of the Renewable Energy Directive II (RED II) of the European Commission by aiming towards the following objectives:

- Facilitating the market uptake of EU low ILUC risk biofuels
- Informing the bioenergy and biofuels stakeholders
- Providing policy and market stakeholders with new knowledge
- Helping the removal of the most prominent barriers against the market uptake of low ILUC risk biofuels
- Supporting the sustainable conversion of the biochemical and biofuels industry

What is ILUC and low-ILUC risk?

The entirety of BIKE activities revolved around the concept of low-ILUC risk biofuels (and feedstock). ILUC stands for Indirect Land Use Change, which can occur when pasture or agricultural land previously destined for food and feed markets is diverted to biofuel production. In this case, food and feed demand still needs to be satisfied, which may lead to the extension of agriculture land into areas with high carbon stock such as forests, wetlands and peatlands.

To limit the ILUC phenomenon, European legislation has progressively limited the use of biofuels (those recognized as 1st generation biofuels) derived from crops grown on agricultural land. The exception made in RED II where the so called low-ILUC risk biofuels. These are labelled as "fuels produced in a way that mitigates ILUC emissions, either because they are the result of productivity increases or because they come from crops grown on abandoned or severely degraded land".

The Delegated Act published in 2019 supplementing the RED II, set out both the criteria for determining high ILUC-risk feedstock for biofuels and the criteria for certifying low indirect land-use change (ILUC)–risk biofuels, bioliquids and biomass fuels. The criteria to be fulfilled were essentially:

- Respecting the greenhouse gas emissions saving listed by Article 29 of RED II
- Use of additional feedstock resulting either from measures increasing crop productivity or, or from cultivating crops on areas which were previously not used for cultivation (unused lands), e, or land that was abandoned or severally degraded.

The BIKE concept

Having set the legal context, the BIKE project focussed on a series of case studies where sustainable practices supporting biomass additionality production, carbon storage, and soil quality were implemented, namely:

- Cover Cropping - reduce soil penetration resistance, improve wet aggregate and cumulative infiltration but have insignificant impacts on bulk density, dry aggregate stability, saturated hydraulic conductivity, unsaturated hydraulic conductivity, and plant available water.
- Crop rotation - practice of growing a series of different types of crops in the same area in sequential seasons. Crop rotation gives various nutrients to the soil and replenishes nitrogen, for example, through the use of legumes, or cover crops in sequence with cereals and other crops.
- Cultivation un unused, abandoned or severely degraded land - Produce biomass feedstock for biofuels production in soils which have been abandoned, or not used for several years. Cultivate biomass crops for biofuels production in soils considered as severely degraded, with low Soil Organic Carbon and soil organic matter.

These sustainable practices were implemented in four Case Studies (CS), led by different Project partners.

- CS1: Castor oil for HVO in three sites (unused, abandoned or severely degraded lands) located in Italy, Kenya and Greece.
- CS2: Perennial lignocellulosic crops for advanced biofuels in three sites (unused, abandoned or severely degraded lands) located in Italy, Greece and UK.
- CS3: Brassica carinata for HVO in three sites (as cover crop, in rotation systems with conventional crops) located in Italy, Greece and Uruguay.
- CS4: BiogasDoneRight model for liquid biofuels for road, aviation and maritime from decentralised and distributed biomethane production through centralised FT or synthesis in three sites (in rotation systems with conventional crops) located in Italy, Greece and UK.

To complement this, BIKE partner ISCC developed and tested a Certification scheme dedicated to low-ILUC risk cultivations. This was included as an add-on to the existing ISCC Plus Certification scheme, with audits performed in the BIKE CS sites.

Certification scheme

One of the main objectives of BIKE was to provide a certification concept for low ILUC risk biofuels, bioliquids and biomass fuels. This was to be implemented in the ISCC system, as an add-on for the certification of low ILUC risk feedstocks and biofuels.

ISCC identified relevant criteria and indicators for low ILUC risk biofuels, bioliquids and biomass fuels and describe a methodology to verify those via on-site auditing.
Based on these findings, ISCC developed a handbook, which includes all relevant documents to support auditors and auditees with the verification process.

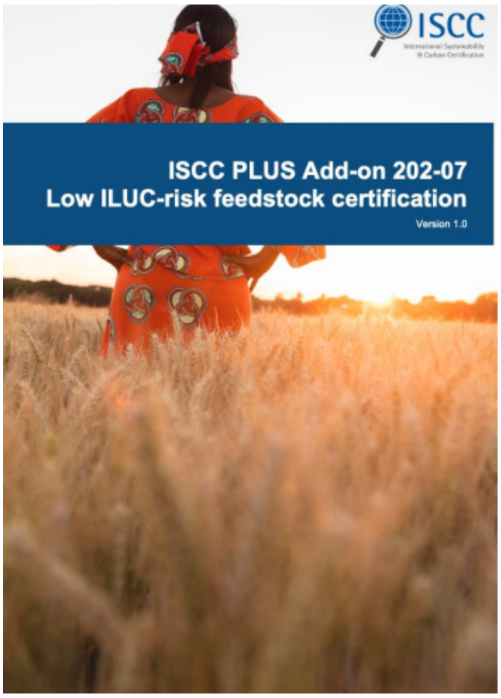
In order to test and verify the identified criteria, ISCC conducted audits in four sites where the BIKE Case Studies are implemented, all conducted by an independent auditor.

Project partner:
Lower Marsh Farm
Crop:
Miscanthus
Low ILUC-risk approach:
Improved management practices

Project partner:
UPM
Crop:
Brassica
Low ILUC-risk approach: sequential croppingLow ILUC-risk approach:
Cultivation on abandoned land

Project partner:
Fattoria Della Piana/Biogas Done Right
Crops:
Corn, sorghum, wheat, grass, alpha alpha, olive
Low ILUC-risk approach:
Cultivation on abandoned land

Project partner:
ENI
Crops:
Castor
Low ILUC-risk approach:
Cultivation on degraded and abandoned land; additional yield



Project findings included in draft ISCC PLUS system document

Public consultation to receive feedback from ISCC stakeholders

Feedback included in adjusted system document

System document implemented in the ISCC PLUS standard

Description of the case studies

BIKE partners collected and analysed data and experiences arising from the field trials in the locations considered. The case studies considered have been grouped in two distinct Value chains, some of the case studies were tested in multiple locations:

Value Chain #1:cultivation in unused, abandoned or severely degraded land

- Castol oil for HVO in Italy, Kenya and Greece led by ENI
- Perennial lignocellulosic crops for advanced biofuels in Italy, Greece and UK led by REC

Value Chain #2: productivity increases from improved agricultural practices

- Brassica carinata for HVO in Italy, Tunisia and Greece and Uruguay as cover crop in rotation systems with conventional crops led by UPM
- BDR model for lroad, aviation and maritime from decentralized and distributed biomethane production through centralised FT or synthesis in Italy Greece and UK led by CIB

Castor bean – Value chain #1

Case Study	Castor bean on abandoned, unused agricultural areas (CRES)
Where and how	Velestino (central Greece); 2021, 2022, 2023 Xanthi (northern Greece); 2021
Agricultural practices	Soil preparation; No tillage in Velestino (abandoned area) and conventional in Xanthi (degraded). No weed control in Velestino on no-till. C1012 hybrid from KAIIMA was sown. Basic and top fertilization was applied. No insects/diseases detected. In both sites the trials irrigated (either by drip or springer).
Harvesting	Harvesting: a) using sunflower header and/or combine machine for cereals (sunflower header was better). The plants, 10 days before harvesting, sprayed with a herbicide to schedule the final harvest
Yields	Mean seed yields: 1.5 to 2.5 t/ha Oil content: 40-45%

Case Study	Castor bean on degraded land (ENI)
Where and how	Makueni **(Kenya)**, 3000 ha distributed in 44 villages Marrubiu **(Italy)**, 15 ha divided in 29 fields
Agricultural practices	**(Kenya)** Soil preparation for castor bean include mechanized ploughing or ripping in a single pass, animal-drawn ploughing, or manual hoeing. Castor bean can be sown at the beginning of the rainy seasons: in October-November (short rain season) and March-April (long rain season), manually, with a density between 1600 to 4000 plants/ha **(Italy)** Reduced tillage was applied (minimum tillage and rotary harrow). Two sowing techniques were applied: a) transplanting and b0 direct sowing at the depth of 3 cm, comparing different plant density
Harvesting	**(Kenya)** Manual and/or mechanical harvesting **(Italy)** Harvesting using combine machine
Yields	**(Kenya)** Seed yields 1.5 to 2.5 t/ha with oil content 45-50%. **(Italy)** Seed yields of 2.6 t/ha with density >1 plant/m2 in 2021

Perennial crops – Value chain #1

Case Study	Switchgrass in unused/abandoned/degraded lands (CRES)
Where and how	Aliartos (central Greece); The fields established from 1998 to 2001. The total area was 1 ha
Agricultural practices	Soil preparation (harrowing, and plowing). A fine seedbed was necessary due to small seed. A chemical weed control was done before sowing. Distances between the rows from 15 to 70 cm. 300 kg basic fertilizer (11-15-15) before sowing and then every 5 years before regrowth. Top nitrogen fertilization of 60 kg N/ha every spring (30-40 days from regrowth). Tested irrigation & fertilization rates, varieties. No insects/diseases detected. A piping system was used for irrigation.
Harvesting	In winter after a killing frost.
Yields	Mean dry biomass yields 12 t/ha (of 20 years); top yields were recorded in years 2 & 3; the dry biomass had 40% leaves; the ash content of the harvested material was 4-5%. The calorific value was 4560 kcal/kg (NCV) 4260 kcal/kg (GCV).

Case Study	Miscanthus in unused/abandoned/degraded lands
Where and how	(United Kingdom) 95 ha of miscanthus cultivated by Miscanthus Nursery Limited, Lower Marsh Farm, established at different time frames; 2006, 2008, 2020, 2022. Two fields' "Beaches" (4.7 ha) and "Tainfield" (4.82 ha) were chosen to evaluate if any potential additionalities do occur (audit for BIKE).
Agricultural practices	In each site the harvesting takes place every spring using direct transport of the material to buyer after the harvest. The harvested material used for renewable fuels and composites.
Harvesting	The harvesting is mainly done with common corn harvesting machinery. The harvested material is pressed and supplied in big bales to the clients
Yields	6.5-9.0 dry tons per hectar

Brassica carinata - Value chain #2

Case Study	Brassica carinata in rotation system (UPM)
Where and how	**(Uruguay)** 50.000 ha since 2015 (variety Avanza64); currently 15.000 ha annually; inserted in local rotation systems (mainly soy as summer crop) as winter crop
Agricultural practices	No tillage (direct seedling machinery), 80 pl/ha Chemical weed control; prior and after emergence No irrigation Basic ferilization: a) basic (50-70 kg/ha P205 & 50-70 kg/ha N20) and top fertilization: a) 50% 30 DAE and 50 % 60 DAE No insects/diseases detected.
Harvesting	Harvesting: early October and swathing in the beginning of June Machinery used was the one used for wheat, barley and soy.
Yields	Mean seed yields: 1500 kg/ha; max of 2700 kg/ha Oil content: 42% of the seeds, high content of erusic acid; used for biodiesel (esterification); certified RSB EU RED Seed meal used for animal feeding The straw remaining in the fields for soil health and grain residues (husks) used for bioenergy.

Case Study	Brassica carinata in rotation system (CRES)
Where and how	1 ha, Nea Gonia **(Greece)**
Agricultural practices	Conventional soil preparation Chemical weed control; prior and after emergence (spring sowing) No irrigation Several insects and diseases detected.
Harvesting	Mechanical harvesting done in June-July 2023. same machinery used for rapeseed
Yields	Mean seed yields was 1.5 t/ha. The oil content of the seeds was 40-42%

Biogas Done Right– Value chain #2

Case Study	Biogas
Where and how	(Greece)
Agricultural practices	Soil preparation (traditional); No weed control Started in December 2020 with durum wheat that harvesting in June 2021. Immediately after, sunn hemp was sown that harvesting in October 2021 and in April 2022 corn will be established that will be harvested in September 2022. Basic and top fertilization was applied for wheat and corn. No insects/diseases detected. A drip irrigation system was established in June 2021 for sunn hemp and it will be used for corn.
Harvesting	Harvesting: Wheat had been harvested with the existing machinery and the same will be done for corn. For sunn hemp the stems had been harvested and stayed in the fields to get dry and they collected a week later.
Yields	Mean seed yields of wheat varied from 5.8 to 6.5 t/ha The dry yields of sunn hemp varied from 16 to 18 t/ha.

Case Study	Brassica carinata as cover crop in rotation system (CRES)
Where and how	**(Italy)** 96.47 ha used to grow low ILUC-risk crops (in the past was abandoned land). The crops that are being rotated are: corn, sorghum and wheat.
Agricultural practices	Reduced tillage (tillage using Vervaet Hydro-trike to distribute with precision bio-digestate) was applied for both corn and grain. Corn was planted at 75,000 plant per hectare in April and is the primary crop and grain was planted at 200kg/ha in October as a secondary crop. Chemical weed control was applied In terms of fertilization 200m3/ha of bio-digestate. Corn had to be irrigated during summer. No insects of diseases detected.
Harvesting	The harvesting was done with New Holland Harvester in September for corn and in March for grain
Yields	The achieved yields were 50 t/ha for corn and , 30 t/ha for grain.

Takeaways from the field tests

Castor bean

The crop performed well, and high yields had been recorded (>1.5 t/ha seeds/ha, yields even > 3 t/ha were measured). There are available high yielding hybrids but the mechanical harvest is under optimisation (the machine collects capsules and additional separation is needed).

Over a land size of 3.000 ha (observed), 4,500 tons of Castor have been produced, yielding 0,54 tons of HVO per hectar (per year).

Perennial lignocellulosic crops

Miscanthus works very well in central and north Europe and there are several fields (with total area higher than 25000 ha) where miscanthus is used for bioenergy and bioproducts.
In the dry area of the Mediterranean region, switchgrass performed quite well (with mean yields of 20 years >10 t/ha) having quite lower irrigation needs.

In the case of Mischantus, over a land size of 858 ha (observed), 7,722 tons of Mischantus have been produced, yielding 2,34 tons of bioethanol per hectar (per year).

Brassica carinata

Carinata performs well in the Mediterranean region and can fit to the existing agricultural systems but is having quite long growing cycle that can hinder the double cropping on annual basis. It suffers also from several diseases and insects that means additional chemical treatments.
Last but not least, it is hard to find high yielding varieties in Europe. One company is controlled the whole breeding.

Over a land size of 110 ha (observed), 382 tons of Brassica have been produced, yielding 0,572-0,678 tons of HVO per hectar (per year).

BiogasDoneRight model

It worked very well in Italy, where implemented by CIB partners. It was tested on abandoned agricultural areas, where corn, cereals and sorghum were rotated. High yields had been recorded and the soil quality had been improved after 9 years activities.
In Greece another rotation had been tested (maize-sunn hemp – wheat & sunn hemp) for biomass production and it was found that higher yields had been recorded compared to the conventional rotation system (wheat-maize that leaving the soil uncovered for around 8 months).

Over a land size of 200 ha (observed), 14,569 tons of Maize and Triticale silage have been produced, yielding 6,599 m3 of biogas per hectare (per year), equal to 4,9 tons of biogas per hectar.

Replicability of the BIKE case studies

A key contribution of BIKE has been the analysis of the replicability potential of the project's case studies across Europe. Providing data and insights on where and how low-ILUC risk feedstock production can take place, is an important element for favouring the uptake of sustainable biofuels.

BIKE coordinator RE-CORD has used the methodology depicted in the diagram to realize this kind of analysis.

Data collection

- Position of biorefineries;
- Position and extension of underutilized lands;
- Position and extension of cultivated lands;
- Crop rotation schemes.

Data elaboration

Crop yields modelling;
Calculation of:

- Potential biomass production;
- Potential biofuel production.

Identification of most promising case studies

This work is detailed in DX.X, for the sake of this publication, we are keen to show you the results of such analysis, where promising countries and sites have been identified, for the production of the low-ILUC feedstock considered by BIKE.

Biomass and bioethanol potential production

The study has been performed on the whole EU territory. First, attainable yields of the target crops (switchgrass and miscanthus) have been simulated in the area of underutilized croplands of Europe, which is estimated to be approximately 5.3 million hectares. Secondly, two possible sustainable scenarios for biomass supply have been identified, consisting in supply distances of 70 km and 150 km from existing bioethanol refineries. Finally, the potential biomass and bioethanol production – thus the replicability potential of the case study – has been evaluated.

ROMANIA

498,623
tons dry biomass

68,651
tons bioethanol

1 plant in 70km range

1,131,775
tons dry biomass

155,823
tons bioethanol

1 plant in 150km range

SLOVAKIA

581,773
tons dry biomass

80,099
tons bioethanol

1 plant in 150km range

SPAIN

630,856
tons dry biomass

86,857
tons bioethanol

1 plant in 150km range

POLAND

544,118
tons dry biomass

79,914
tons bioethanol

1 plant in 150km range

Castor Oil and HVO production

The study has been performed considering only mediterranean regions of Europe.
In accordance with the methodology employed for the case study on perennial crops, the castor bean case study involved integrating geospatial data regarding underutilized lands and corresponding target crop attainable yield, subsequently calculating the potential oil production within a certain supply radius from suitable biorefineries.

The supply distances considered for this case study are of 230 km and 500 km from existing HVO and biodiesel refineries (the latter considered only in those areas in which HVO technology is not established).

SPAIN

328,691
tons oil

230,084
tons HVO

3 plants in 230km range

927,695
tons oil

649,387
tons NVO

1 plant in 500km range

336,230
tons oil

319,419
tons biodiesel

1 plant in 230km range

ITALY

63,103
tons oil

44,172
tons NVO

1 plant in 500km range

29,411
tons oil

20,588
tons HVO

1 plant in 230km range

GREECE

990,798
tons oil

941,258
tons biodiesel

1 plant in 500km range

267,168
tons oil

253,810
tons biodiesel

1 plant in 230km range

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Brassica Oil and renewable diesel production

The investigation was conducted in European Mediterranean areas. Since the successful establishment of Brassica Carinata in Mediterranean regions depends on its rotational fit into current cropping system, the methodology adopted for the replicability potential assessment involved the following steps:

- Identification of the most common sequential crop calendars in mediterranean areas and into which brassica carinata could be incorporated;
- Determination of the amount of arable land involved in the selected cultivation schemes;
- Brassica yield modelling on these lands and estimation of the possible annual oil production, considering ranges of 230 km and 500 km from existing HVO and biodiesel refineries (the latter considered only in those areas in which HVO technology is not established)

Brassica carinata can be grown either as a winter cover crop or as a summer cover crop. In this work, both varieties have been considered. Moreover, as a conservative scenario, 25% of identified arable lands was considered as available every year for brassica cultivation.

SPAIN
Brassica summer crop

112,0065
tons oil
78,446
tons HVO
3 HVO plants in 230km range

283,997
tons oil
198,798
tons NVO
2 HVO plants in 500km range

88,444
tons oil
84,022
tons biodiesel
1 biodiesel plant in 230km range

ITALY
Brassica summer crop

103,252
tons oil
72,276
tons ?
2 HVO plants in 230km range

123,733
tons oil
86,613
tons HVO
1 HVO plant in 500km range

75,483
tons oil
71,709
tons HVO
1 biodiesel plant in 230km range

GREECE
Brassica winter crop

69,424
tons oil
65,953
tons HVO
1 biodiesel plant in 500km range

33,630
tons oil
31,949
tons biodiesel
1 biodiesel plant in 230km range

23,493
tons oil
22,318
tons biodiesel
1 biodiesel plant in 230km range

Biogas Done Right model for biomethane-to-liquid production

The BDR model is based on the decentralized production of biomethane from sequential cropping methods, further biomethane injection into the gas grid, final processing in centralized biomethane-to-liquid conversion plants. In order to assess the replicability potential of this case study in Europe, BIKE coordinator RE-CORD first examined EU countries considering:

1. Number of biomethane and biogas plants and corresponding installed capacity;
2. Extension of the natural gas network.

Potentials of biomethane and bioliquids production were then determined for the top countries identified, which are: Italy, France, Germany, and UK. The estimation has been conducted by calculating:

- The potential biomethane production that could be achieved through an upgrading of 90% of the existing biogas plants by 2030;
- The potential liquid production that could be achieved through installation of a centralized Fisher-Tropsch or MeOH plant.

Fisher-Tropsch and MeOH plants have been selected since they currently represent the most promising types of centralized plants at commercial scale.

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ITALY

2,96 bcm/year	**1,62** mcm/year	**3,53** mcm/year
Biomethane potential production	Liquid potential production (Biodiesel via Fischer Tropsch)	Liquid potential production (Methanol)

FRANCE

0,9 bcm/year	**0,49** mcm/year	**1,08** mcm/year
Biomethane potential production	Liquid potential production (Biodiesel via Fischer Tropsch)	Liquid potential production (Methanol)

UNITED KINGDOM

1,34 bcm/year	**0,73** mcm/year	**1,59** mcm/year
Biomethane potential production	Liquid potential production (Biodiesel via Fischer Tropsch)	Liquid potential production (Methanol)

Technology innovation assessment

BIKE partners performed a Technology Innovation System (TIS) assessment for each single case study. They are identified as single TIS where the analysis considered structural components like **Actors**, **Networks**, **Institutions** and **Technology factors**. Their relations took the form of 7 functions that form the keystone of the TIS assessment. The functions can be defined in the following way:

F1 Entrepreneurial Experimentation and production: this function addresses the supporting conditions such as policies, standards and regulations, which are formed as a result of experimental activities and trials conducted by the actors involved in the system.

F2 Knowledge Development: the scope of this function is to evaluate the available knowledge base of the TIS, its accessibility and its flow to the respective actors.

F3 Knowledge exchange: this system function is aimed to evaluate the type and the amount of professional and stakeholder networks.

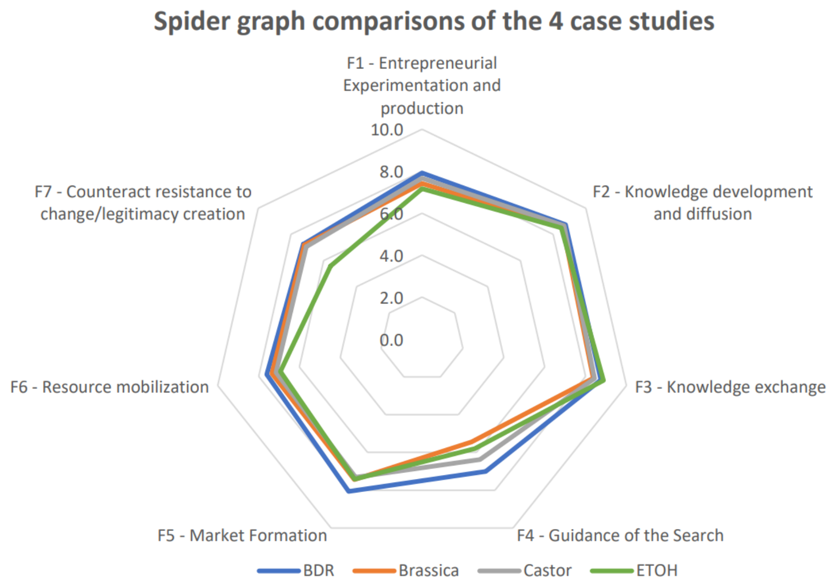
F4 Guidance of the Search: this function relates the motivation of the actors to take part to the growth and propagation of the TIS, considering all the mechanisms involved.

F5 Market Formation: this system function analyses the formation of a marked aroused from the TIS. To this end, it is important to identify the possible demand from the perspective of the end user, and the possible existence of a present or competitive market.

F6 Resource Mobilization: the development of the TIS in focus leads to the mobilization of a set of resources, such as human resources (skilled labor), financial resources (investments, venue capital, subsidies, etc.), and physical resources (infrastructure, material, etc.).

F7 Counteract resistance to change/legitimacy creation: this function assesses the perception of the actors involvement along the value chain. Legitimacy could be either direct (i.e. with regards to compliance with established institutions) or indirect (i.e. with regards to end user acceptance of the TIS). As regards the biofuels production at low ILUC risk, the use of biomass to produce energy has definitively high environmental benefits, but nevertheless there could be resistances that hamper the dispersion of the TIS, e.g. oppositions towards the construction of thermochemical conversion plants.

The results of this analysis, described in high detail in D3.2, are summarized by the following image.



Policy recommendations

During the entire project life, BIKE partners have profoundly dealt with policy and regulation aspects. Part of this work has taken the shape of a series of briefing notes: each one focussing on EU policy provisions relevant to the low ILUC-risk concept.

As is evident from the briefing note titles, low ILUC-risk touches on a number of different policy areas, including renewable energy, agriculture and land use, environment, climate, and finance. Recommendations emerging from the briefing notes include (briefing note number in brackets):

- Recognise the potential for the low ILUC-risk concept to be adopted beyond the energy sector [1]
- Amend definitions in the RED to confirm the eligibility for low ILUC-risk certification of intermediate crops [2]
- Broaden the scope of low ILUC-risk to encompass certification of all types of crops [2]
- Clarify the term “severely degraded land” and its overlap with “unused land” [2,6]
- Highlight the flexibility given to EU Member States to incorporate low ILUC-risk into national regulations for RED compliance [3]
- Augment the list of “additionality measures” to recognise further sustainable agricultural practices [4]
- Strengthen safeguards against the spread of invasive alien species by extending the RED sustainability criteria [5]
- Recognise the potential for rehabilitation of abandoned land with low ILUC-risk cropping systems to control the spread of invasive alien species [5]
- Take advantage of existing systems for low ILUC-risk certification in assessing feedstocks against proposed new entries in Annex IX of the RED [6]

- Recognise the overlap between low ILUC-risk production models and carbon farming practices, in order to streamline certification criteria & auditing processes [7,8]
- Ensure additionality tests are mutually coherent between carbon farming and low ILUC-risk regulations, for the benefit of projects which encompass both [8]
- Introduce the language of land use change into CAP sustainability objectives [9]
- Support up-front low ILUC-risk investments with discretionary subsidies, and explore how certification could play into results-based subsidy schemes [9,11]
- Create catalogues / maps for the different land types defined in the RED [10]
- Review the potential (and conduct trials) for agricultural land rehabilitation using low ILUC-risk production methods [10]
- Develop common sets of sustainability indicators for water use, biodiversity, soil disturbance, etc. [11]
- Develop whole-value-chain sustainability indicators which are also capable of monitoring complex multi-year rotations specifically for biofuel production [11]
- Use the FSDN framework for collecting farm-level data pertinent to low ILUC-risk production [11]
- Recognise low ILUC-risk in financing platforms and programmes [1,12]
- Recognise low ILUC-risk certification in the technical screening criteria of the EU Sustainable Finance Taxonomy [12]
- Develop a carbon farming certification scheme which tracks sub-soil carbon [13]
- Provide guidelines for the assessment of on-field heterogeneity in soil sampling [13]
- Allow projects that use biochar to build soil carbon to operate under a simplified monitoring and accounting regime [13]

Complete list of the BIKE Briefing notes, available for download

#1 Policy to support low-ILUC-risk agriculture
#2 Legal definitions in the low ILUC-risk policy framework
#3 Low ILUC-risk in EU Member State policy
#4 Additionality measures for low ILUC-risk projects
#5 Management of invasive alien species in low-ILUC risk production models
#6 Low ILUC risk crops and Annex IX
#7 Soil carbon crediting and the low ILUC-risk system
#8 Sustainability delivering carbon farming and low ILUC-risk
#9 CAP support for sustainable low ILUC-risk feedstock production
#10 Ecologically appropriate crops for restoration of unused and severely degraded lands
#11 Sustainability indicators for food and biofuel production
#12 Low ILUC-risk concept in the EU taxonomy
#13 Soil sampling and soil organic carbon across agricultural landscapes

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Further readings

The present document wanted to provide an essential summary of the BIKE project outcomes, to make it accessible and easily readable. The information provided in the various sections are the results of 3 years of research work and field trials, and more detailed information and analysis can be found in the several project deliverables published. Here below you can find the list of the public ones, and the hyperlink for the download.

D1.1 Report on criteria and indicators for low ILUC-risk certification

D2.1 Productivity increases that can result in additional feedstock for European biomass crop options

D2.2 Options to grow crops on unused, abandoned and/or severely degraded lands

D2.3 Climate positive farming solutions

D3.1 Overview on biofuels production facilities and technologies in Europe

D3.2 Technology Innovation assessment of low ILUC risk system in the EU biofuels sector

D3.3 Replication potential of case studies examined in BIKE

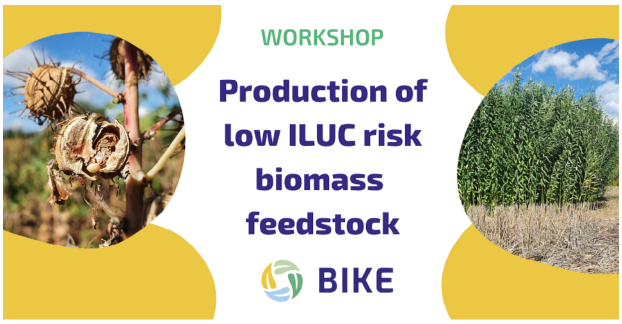
D4.1 Report on the design of sustainability indicators set

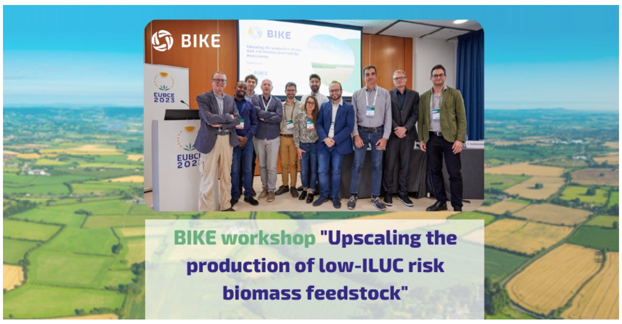
D5.1 Assessment of the Frameworks and Recommendations about Enabling Policies

D6.1 Reports on good practice cases

D6.4 Main findings of the Open labs

Re-watch the BIKE events





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BIOFUELS PRODUCTION AT LOW - ILUC RISK FOR EUROPEAN SUSTAINABLE BIOECONOMY

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