SEMPRE-BIO

D6.1 Draft Plan for Dissemination, Communication and Exploitation

inveniam

SEcuring doMestic PRoduction of cost-Effective BIOmethane

Funded by the European Union

PROJECT INFORMATION

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DISCLAMER

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Acronym Glossary

EBIEs: European Biomethane Innovation Ecosystems	**PEM**: Proton exchange membrane
KER: Key Exploitable Result	**BCE**: Biorefine Cluster Europe
TRL: Technology Readiness Levels	**C&D&E**: Communication, Dissemination, and Exploitation

Consortium partners

	Participant organisation name	Acronym
1	CETAQUA	CET
2	AIGUES DE BARCELONA	AB
3	CRYO INOX	CRYO
4	DEUTSCHES BIOMASSEFORSCHUNGSZENTRUM GEMEINNÜTZIGE	DBFZ
5	DANMARKS TEKNISKE UNIVERSITET	DTU
6	INVENIAM GROUP	INV
7	PROPULS	PROPULS
8	SINTEF AS	SINTEF
9	TERRAWATT	TERRA
10	TRANSPORTS METROPOLITANS DE BARCELONA	TMB
11	UNIVERSITEIT GENT	UGE
12	UNIVERSITAT DE VIC	UVIC
13	BIOGAS-E	BIOGAS-E
14	INNOLAB	INNOLAB
15	NATURGY	NAT
16	NV De Zwanebloem	MASS

Executive Summary

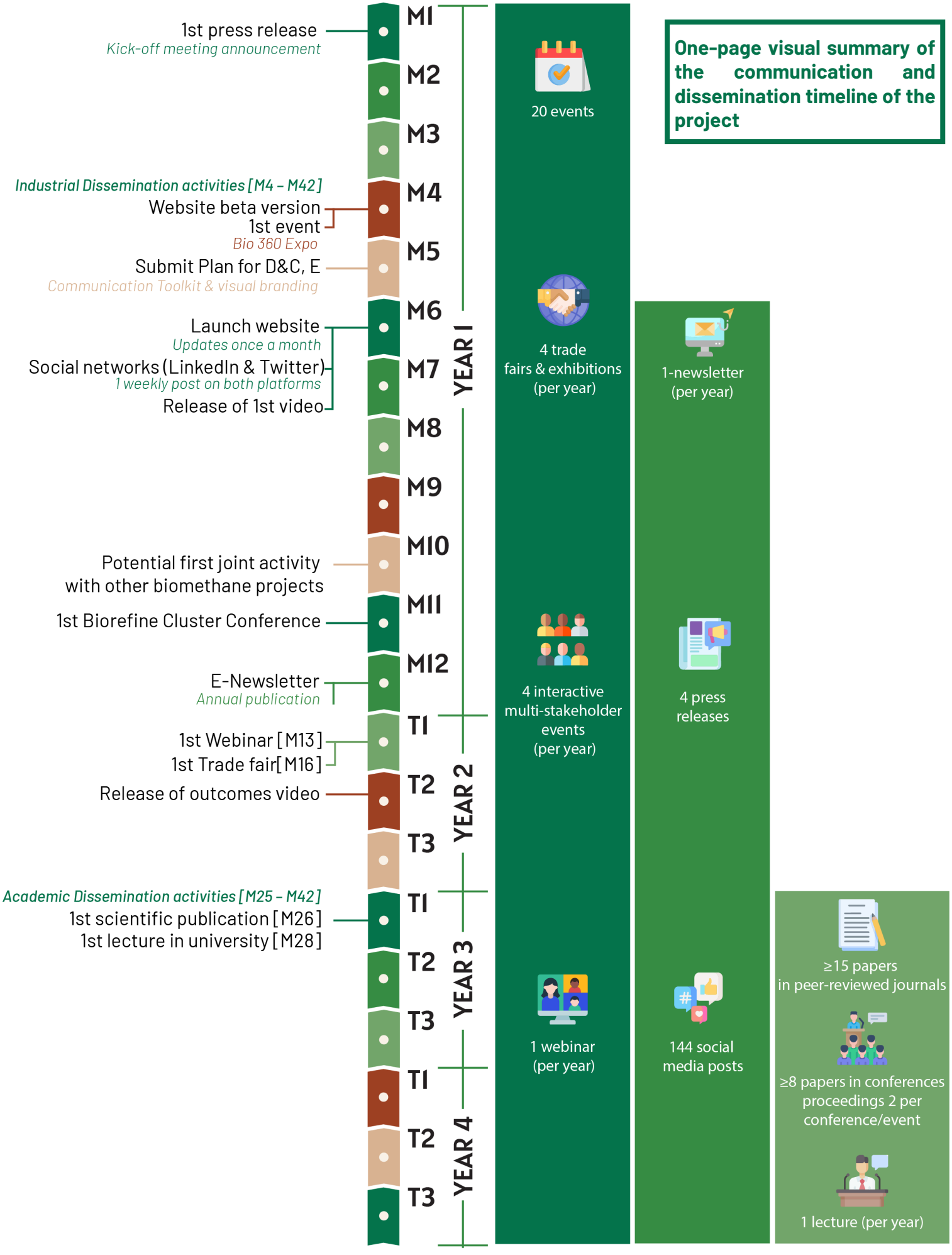
SEMPRE-BIO (SEcuring doMestic PRoduction of cost-Effective BIOmethane) is a €9.9M project financed under the Horizon Europe Cluster 5 programme running from November 2022 to April 2026. SEMPRE-BIO aims to demonstrate novel and cost-effective biomethane production solutions and pathways, deemed essential to achieve the European Green Deal and climate and energy targets for 2030 and the net zero greenhouse gas emissions by 2050, and to increase the market up-take of biomethane-related technologies.

With sites in Baix Llobregat (ES), Bourges (FR), and Adinkerke (BE), SEMPRE-BIO will establish three European Biomethane Innovation Ecosystems (EBIEs), which will be indicative of the various baseline settings for biomethane production throughout Europe. The challenge is to lower investment and operating costs, optimize feedstock supply and use, identify alternative feedstock, and reduce their costs, improve plant efficiency and operations, account for carbon savings, and increase and monetize co-benefits, such as from the commercialization of the digestate or the valorisation of residual gas streams.

A C&D&E plan has been drafted to reach SEMPRE-BIO's stakeholders. This draft plan is a key deliverable within WP6, which is led by the Inveniam Group. Prior to starting the project, the SEMPRE-BIO consortium developed a draft dissemination, communication, and exploitation plan. This plan will be updated during the project, revising the key target groups, messages, and specific concrete activities to be implemented. The plan will function as a living document to guide and monitor dissemination, communications, and exploitation activities, and report on these aspects. The plan will outline key activities, provide implementation timelines, allocate tasks, and provide evaluation parameters. The dissemination, communication, and exploitation strategies for the project aim to raise awareness, increase project impact, as well as end user and stakeholder engagement. Dissemination activities should feed into exploitation of project results, particularly with industrial take-up and, also, potentially through public policy making.

A mapping will be performed to identify, approach, and engage stakeholders, and then define the roadmap to ensure broad visibility of the project results through different mediums. These include periodic updates in a monthly newsletter, the project's social media accounts, the project website, and a final conference to disseminate project results.

One-page visual summary of the communication and dissemination timeline of the project



1 Communication highlights

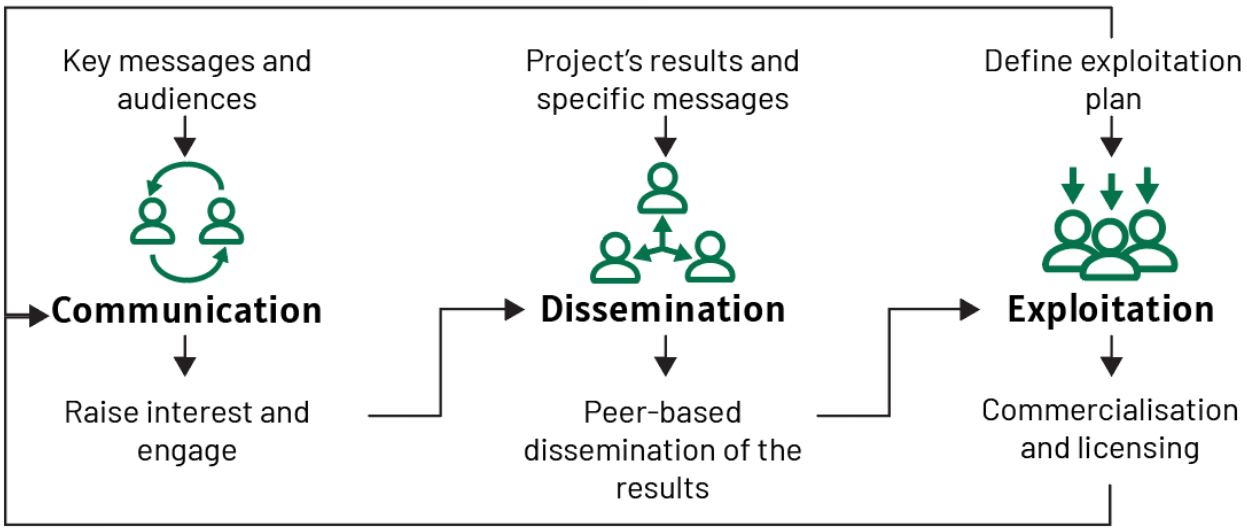


Figure 1. Communication, Dissemination and Exploitation plan schematics.

The following plan is built on an analysis carried out by the consortium during the project to identify the key stakeholders, messages and media that will ensure the project meets its dissemination, communication, and exploitation objectives. Led by INV, Work Package 6 (hereafter WP6) is focused on maximising the future use and impact of the results developed in the project. It will do this through:

- Communication of the project's results throughout its lifespan with the aim to promote, inform, raise interest, and engage with multiple audiences.
- Dissemination of the knowledge generated in the project to key industrial and academic targets and contribution to common information activities to increase the visibility of Horizon Europe supported actions.
- Exploitation of the project's results that focuses on making concrete use of research results for commercialisation and licensing.

It is essential to build systems that allow a two-way communication and sharing of knowledge in order to make sure that the work that is being done within the SEMPRE-BIO consortium is reaching all of the important stakeholders. The overall objectives of the communication plan of SEMPRE-BIO are:

1. Outline key activities, provide implementation timelines, allocate tasks, and provide evaluation parameters.
2. Mapping to identify, approach and engage stakeholders.
3. Define roadmap to ensure broad visibility.
4. Update social media, website, and newsletters.
5. Conference, events, and publications to disseminate results.

2 Aims of the Dissemination Plan

This Dissemination Plan describes the project's communication activities and how they will address the interests of its target groups; specifies the project's various communication channels; and sets out guidelines for the dissemination of research. It will be elaborated at the beginning of the project, outlining the key elements of the overall strategy, including the dissemination and communication channels and tools to be implemented (HOW), the target audiences to be reached (WHO), the key messages to be conveyed to those targets (WHAT), the timing (WHEN) and location (WHERE) of the planned activities, as well as their expected costs. INV will oversee the communication and disseminations activities and the organization of a calendar of activities, with the support of all the partners. INV together with the rest of the consortium will update the draft C&D&E plan to introduce the latest advancements on the project.

Table 1. Communication table: target audience, communication channel, information.

How	Who	What	When	Where
Participation in conferences	Academic / Researchers / Industry experts.	Several conferences to attend during the project lifespan to communicate and disseminate results.	During all the project	Europe
Scientific publications	Academic / Researchers / Industry experts.	High-level peer-reviewed international open journals publications.	Dependent on the evolution of the results.	Open access and peer review journals.
Project Website	Waste management companies. Primary sector SMEs and associations (farming and forestry) Biogas associations and clusters investors.	Resources and information on SEMPRE-BIO's innovative solutions in the energy sector.	Beta version M3, active version M6 and up to 3 years after the end of the project.	Links on the websites of project partners
Video	All SEMPRE-BIO target groups.	Challenges, the objectives, proposed solutions and expected results.	M19	Website & YouTube
Social networks	General public, waste management companies and primary sector associations (farming, forestry, biomethane associations and clusters.	Project's outcomes and maintain the information biomethane-related projects and its audience.	Weekly	LinkedIn, Facebook and Twitter of the project and the partners
e-newsletter	Engineers and technology developers in the energy sector and society.	Report on the implementation of the first analysis and research workshops.	1 per year	LinkedIn, Twitter and Website
Poster and roll-up	Waste management companies, primary sector associations	Key facts and outputs.	M6	Events and workshops

	(farming and forestry), biomethane producers and society.			
Brochures	Waste management companies. Primary sector associations. Biomethane and Biogas associations and clusters.	A general brochure. A more technological-orientated on the tangible results and experiences from case studies.	M6 and M36	Social media
Bus panelling	Society	TMB buses will be panelled to indicate to the public that they are fuelled by biomethane (with a reference to SEMPRE-BIO).	M18	Buses in Barcelona metropolitan area

3 Key target groups and dissemination actors

SEMPRE-BIO will ensure the dissemination of the project results towards the key target groups including policy makers and governmental bodies. This Plan, therefore, identifies and analyses a set of target communities, and classifies them into several groups according to the influence and mutual dependence that exist between these communities and SEMPRE-BIO. We present here, in Table 2 and Table 3, key target groups, their needs and the value proposition of SEMPRE-BIO.

Table 2. Biomethane key target groups, their needs, and the value proposition for SEMPRE-BIO.

Target group and segments	Needs	Value Proposition
Waste producers		
• Waste management companies (e.g., Veolia, owner of project coordinator CET) and landfill operators. • Waste-water treatment companies (e.g., Veolia, owner of project coordinator CET). • Primary sector: Farming and forestry/Agricultural sector (e.g., Bourges (location of case study 2), Belgium dairy farm (location of case study 3)). • Secondary sector: Food & Beverage industry. • Municipal facilities and communities.	• Find affordable solutions to dispose waste to meet EU 2030 target of 10% landfill. • Reduce price risk of waste disposal though long-term contracting. • Improve public perception of waste management companies though reduced pollution and waste exports from Europe to developing countries.	• Long-term competitive contracts for waste disposal. • Alternative to CHP for farms/industries that have low heat needs. • Clean processes without toxic emissions, odour, or solid/liquid waste. • Scalable solutions that can be integrated with industrial waste-producers and/or methane users.
Renewable Gas Promoters & AD and PyroGasification Projects		
• AD installations with idle capacity (e.g., project partner AB) or facing decommissioning due to reduced subsidies and volatile feedstock prices. • Biomethane and gas producers (e.g., Naturgy, project partner). • Pyrogasification installations and companies producing syngas (Examples in Denmark: Stiesdal, Dall Energy and Frichs Pyrolysis). • Biochar networks.	• Maintain commercial viability. • Reduce downtime and maximise production. • Simplify plant operation by reducing waste-disposal, CHP maintenance etc.	• Enable transition to more economically viable business by permitting different types of feedstock and producing a higher value energy product (i.e., biomethane). • Solutions that can be retrofitted easily without significant modification or downtime. • Small footprint solutions that enable integration into existing sites. • Increasing total generation potential of biomethane. • Minimizing methane leaks/vents (GHG emissions).
End users		
• Biomethane suppliers and large direct consumers.	• Secure long-term viability of gas infrastructure in the face	• Competitive biomethane price of 55-75€/MWh (with no subsidy required) but considering

• Gas Suppliers (e.g., NAT, project partner). • Gas Distribution companies • Waste treatment biogas plants (Examples in Denmark: Lemvig, Måbjerg, Vegger, Snertinge, Hashøj) • Transport service companies (e.g., TMB, project partner). • Logistic operators.	of decarbonisation and electrification. • Improve public perception of traditional fossil fuel companies.	potential CO_2 valorisation income and CO_2 tax savings. • Increase biomethane available offer. • Enabling full transition to renewable gas and securing long-term viability of gas infrastructure.
Institutions and Public Administrations		
• Academic Institutions (Universities, Technology Centres, etc.). • Public Administrations.	• Up-to-date with the new findings and developments in the RNG industry. • To know the possible pathways towards meeting national and EU targets for renewable gas by 2030, as well as to set the targets for advanced biofuel quotas.	• Promote the future activities. • Increase security of supply and energy independence. Reduce the dependence on imports of gas.

Additionally, together with the biomethane produced, there will be other outputs that can be considered for the following target groups.

Table 3. Key target groups for conversion of CO_2 value added products, their needs, and the value proposition for SEMPRE-BIO.

Target group and segments	Needs	Value Proposition
Waste producers		
• Farmers, farmer associations, land managers	• Find sustainable and affordable fertilisers. • Meet "Farm to Fork" strategy. • Reduce the need for protein imports.	• Sustainable and cost-effective production of N-, P- and K-based fertilisers from digestate • Microalgae production from digestate and liqCO2 as an alternative protein source for animal feed

Open dissemination strategies have been chosen to optimize the uptake of the SEMPRE-BIO results in all addressed communities. The consortium will choose Open Access self-archiving (Green Access) or Open Access publishing (Gold open access) for their scientific publications.

To communicate efficiently to the identified target groups, both traditional and customized dissemination tools will be utilized.

- Contact decision-makers and politicians at the regional, national and EU-level, such as the European Commission's services (DG ENER, DG MOVE, DG CLIMA, DG AGRI).
- Relevant Members of the European Parliament, national energy officials in Brussels and national capitals, local authorities and relevant members of national parliaments.

- Relevant ministries (environment, agriculture, transport, commerce, health) and chambers for commerce, agriculture and gas & heat in their countries and reach out to the decision makers on regional and national level.
- Relevant think tanks and industrial bodies.

Further target groups for SEMPRE-BIO are:

- **Scientific community**: SEMPRE-BIO will generate a comprehensive database (Work Package 5) with core parameters of innovative biomethane production of investigated technologies and processes. It will serve as basis for ongoing evaluations and development of business models to support the optimization of investigated processes and developed technologies for market uptake. It will generate public and transparent data for further scientific work and network in the field of methanation.
- **Policymakers**: Recommendations to improving policies and decision making for efficient biomethane production technologies for industrial stakeholders (WP5).
- **EU industry**: SEMPRE-BIO will contribute to a more competitive European industry, increasing the number of stakeholders networking (WP1 and WP6) on innovative methane production increased (e.g., plant operators, manufacturers, scientist, associations).
- **Society (and environment)**: The substitution of fossil fuels with cost-efficient biomethane contributes to EU citizens benefitting from a more affordable, clean, carbon-neutral, and secure energy supply. SEMPRE-BIO will contribute to the identification of best efficient combinations of investigated technologies to provide highly efficient and environmentally-friendly biomethane production and utilization of all by-products (WP5). The technologies develop will contribute to reduce GHG emissions (GWP, CO_2-equivalents, emissions of N_2O, CH_4 and CO_2) by using innovative processes for biomethane production in comparison to the current methane production.
- **Existing and potential feedstock suppliers**: this group, being the starting point of the biomethane supply chain, comprises farmers, sewage, wastewater, and municipal waste companies/authorities, etc. There will be a focus on suppliers providing alternative feedstock from undisputed resources rather than a competing food supply, sustaining natural cycles, reliable logistics and low conversion losses, and feedstock that can also be provided in winter.
- **Biogas/Biomethane plant investors and producers**: these can be private and public companies and authorities, as well as groups of citizens, when it comes to financing models of biogas plants. These shall ensure viable approaches for the setting up and running of biomethane plants as well as ensuring a location with possibilities for economic grid-injection and/or customer supply.
- **Energy distribution companies:** key actors in this field are owners/operators of gas grids for grid injection as well as public/private filling operators for direct use in transport.

3.1 Biorefine Cluster Europe

In order to facilitate the inter-project knowledge exchange and maximise the outreach and the effectiveness of the dissemination and networking of the project, SEMPRE-BIO has joined the **Biorefine Cluster Europe (BCE)**, a platform designed to unite European projects in the broad application domain of "bioresource recovery," to ease information sharing and maximize the breadth and efficacy of the dissemination and communication. The direct participation of the Biorefine Cluster Europe will favour connections with initiatives using renewable energy. To enable a successful information exchange across projects and to discuss project outcomes, collaborative webinars and workshops will be organized. This is the link for the SEMPRE-BIO project on the BCE site.

The BCE interconnects projects and people within the domain of bio-based resource recovery, striving to contribute to a more sustainable resource management. The competence focus of the BCE lies within the biorefinery sector the refinement of chemicals, materials, energy, and products from bio-based was streams. It is an initiative of Ghent University with the following goals:

- Ensure the life span of project SEMPRE-BIO deliverables after the project end.

- Stimulate interaction between the projects involved.
- Foster dissemination and stakeholder outreach.
- Promote business development of bio-based resource recovery industries.
- Support the development of circular economy policies.

Joint webinars and workshops will be organised to ensure an effective knowledge exchange between projects and to share project findings. The BCE will allow SEMPRE-BIO to constantly promote its results in the 'e-library', ensuring the effective sustainable continuation of the project activities and the exploitation of its outcomes after its completion. Thanks to the Biorefine network, SEMPRE-BIO will be able to set up a two-ways dialogue with a variety of key stakeholders, such as research centres, companies, and engage them more effectively.

3.2 Professional Energy Associations

Part of the dissemination plan will be also the interaction with Professional Energy Associations (PEAs). They include non-profit organisations and associations that promote the use of Biomethane with a major impact in the gas industry thanks to their publications and communication platforms. Connections with PEAs can have several benefits for the SEMPRE-BIO communication and dissemination campaign.

Table 4 shows a list of Organizations and PEAs relevant for the Dissemination of SEMPRE-BIO.

Table 4. PEAs and their relevance for SEMPRE-BIO.

Organizations or PEAs	Description	Relevance for SEMPRE-BIO
European Forum for Renewable Energy Sources (EUFORES)	An independent non-profit organisation aiming at promoting renewable energy sources and energy efficiency in the European Union.	Institutional network at EU and national level. Communication platform for exchanging information and expertise.
European Renewable Energies Federation (EREF)	The federation of national renewable energy associations from EU Member States	Defend the use of biomethane and promote the non-discriminatory access to the energy market.
European Compost Network (ECN)	A Non-profit membership organisation promoting sustainable recycling practices in composting, anaerobic digestion, and other biological treatment processes of organic resources.	Access to practitioners, researchers, technicians and policy makers to deliver integrated organic waste recycling solutions.
EUROGAS	An association representing the European gas wholesale, retail and distribution sectors towards the EU institutions.	Reaching 67 gas companies and promote benefits of Biomethane / access to studies in legal, economic and technical fields.
Marcogaz	A non-profit international association founded in 1968 and represents the European gas industry on all technical aspects of the gas system's full value chain.	Publications, presentations.
Natural Gas Vehicle Association (NGVA)	An association that promotes the use of natural and renewable gas as a transport fuel.	Mobility sector.

Copa-Cogeca	European Association of farmers and agri-cooperatives.	Agriculture.
European Biogas Association (EBA)	Renewable gas association in Europe committed to the expansion of sustainable biogas and biomethane.	Promote the use of biogas and biomethane in Europe.
Gas Infrastructure Europe (GIE)	An association representing gas infrastructure operators in Europe.	Solutions and advice to store and transport biogas over long distances.

3.3 Communication channels and tools

The Communication Toolkit will facilitate a proper, assertive, and uniform communication between consortium members in all the materials that will be released during and after the project timeline. This Communication Toolkit contains:

- A guide on how to install the Templates for the Microsoft suite.
- Visual style guide and project logo.
- Producing guidelines.
- Social media banners.
- Template for PowerPoint presentations.
- Template for deliverables from the Work Packages.
- Template for minutes from workshops and reports.
- Promotional material (poster, banners, roll-ups, leaflet, etc.).
- Template for press releases.
- Logos from SEMPRE-BIO.
- Logos from the EU commission.
- Logos from the partners.

The Communication Toolkit could be found in the following link. Additionally, in Section 6, we have included a screen capture of the content regarding the production of photos, videos and blogs.

3.3.1 Corporate Identity Manual (internal resource for the consortium)

A corporate image manual has also been created. This document contains the guidelines for the correct use of the SEMPRE-BIO brand to achieve a coherent and easily recognisable image for stakeholders and the general public in any communication and dissemination material. It contains the official name of the project (SEMPRE-BIO, in capital letters and with a hyphen), the description of the use of the logo (dimensions, colours…), the fonts, font sizes, colours to be used in any written reference to the project, either online or offline. The aim is to standardize the graphic parameters to be used uniformly by all the consortium members.

It is fundamental that all consortium members adhere to these guidelines to accurately implement the visual identity of the SEMPRE-BIO image. This document is available to all members through the repository created for the development of the SEMPRE-BIO project as a part of the Communication Toolkit.

3.3.2 Logo

A logotype is a point of identification and differentiation, the image/symbol that will make the project recognizable by the audience. This logo needs to be able to tell the story of the project and convey the brand message. For new projects the best kind of logo would be a combination mark, this kind of logotype combines the project's name and a symbol or icon. This gives the brand the flexibility to be mixed in multiple designs, it also projects a clear and complete description of the project's attributes.

Once the brand is established, this kind of logotypes are easy to edit and simplify. That is why INV has decided that a combination mark is the best option for the SEMPRE-BIO project.

The SEMPRE-BIO logo has the name of the project in the "Alatsi Regular" font. It is a semi condensed geometric sans design that carries this calm and trustable feeling. As for the symbol of the logo, right in the center and front of it, as if it was its heart, there is a flame. This flame is not destroying the shape in the background, it merges with it as it was a part of it. In the background there are 3 shapes that are merged into the shape of a tree a leaf or maybe another kind of flame, a green one. Just as biogas, a mix of raw materials that come together to create a new kind of energy.

The SEMPRE-BIO logo is available in different formats in the Communication Toolkit and the proper way to use it has been indicated in the Corporate Image Manual.

Figure 2. SEMPRE-BIO logo.

3.3.3 Colours

As part of the brand design, the SEMPRE-BIO project has a 5-colour palette. These colours have been selected specifically to embrace the values of the project. Only these colours should be used to represent the SEMPRE-BIO project in all their communication and dissemination applications.

The first 3 colours are a green gamma, the green colour is strongly associated with nature, therefore deeply associated with all the products or projects whose aim is to offer solutions to protect the planet, which is the ultimate aim of SEMPRE-BIO.

Figure 3. SEMPRE-BIO colour palette.

3.4 Communication activities and channels

3.4.1 Publications

All academic partners have endorsed Open Access and they will publish relevant research outputs on the Open Research Europe (ORE) platform to guarantee early and wide dissemination. Articles will be submitted via the single-page submission system provided by ORE. Prepublication checks will be scanned to ensure that all policies and ethical guidelines are adhered to. Once the article has passed the prepublication checks, the preprint version will be published, enabling immediate viewing and citation. All versions of each article will be linked and independently citable. Articles that pass peer review are sent to major indexing databases and repositories and made available in the project website.

ORE articles will be published under a Creative Commons "BY" licenses, with unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited, and leaves the copyright of the article with the current copyright holder. In SEMPRE-BIO, data associated with ORE articles will be available under the terms of a Creative Commons Public Domain Dedication for the sake of replicability. Thus, data reuse will be facilitated and problems of attribution stacking when combining multiple datasets each authored by multiple authors avoided. Finally, all relevant knowledge actors, including stakeholders and citizens, will be involved from the beginning, sharing them research results and outcomes.

The research partners will all look to disseminate their project results to relevant academic and research stakeholders in their respective fields. This will include publication of technical papers and specialised articles, presentations at scientific conferences, and in academic and international scientific journals following the principle of open access. A total of 15 peer-review journals needs to be published during the project lifespan.

Table 5. Options of peer-review journals for SEMPRE-BIO.

Open access & Peer-Reviewed Journals	Themes
Nature	All
Biofuel Journal	Biofuels / Renewable gases
Renewable Energy	All
Bioresource Technology	Bioresources
Waste Management	Waste management
Journal of Cleaner Production	All
Energy Conversion and Management	Energy
International Journal of Hydrogen Energy	Hydrogen
Biofuels, Bioproducts and Biorefining	Biogas and biomethane
Biomass and Bioenergy	Biomass and bioenergy
Renewable and sustainable energy reviews	Applied Energy
Publication Platforms	
ResearchGate	ScienceDirect
Scopus	Web of knowledge

3.4.2 E-Newsletter

As a part of the Communication and Dissemination campaign of this project, a periodic e-newsletter (once a year) will be sent starting in M12 after a year of running operations. The objective of the e-newsletter is to present information about the project (activities, progress, outcomes) and inform subscribers on specific issues:

- Updates on the project
- Updates on publications
- Updates on past events: make a report after each event attended with a detailed description
- Updates on future events
- Updates on partners
- Benefits of Biomethane (feasibility and viability)
- Recent and relevant news on biomethane markets.

This information will be provided in summarised format with hyperlinks or a "Read more" button to access that information in full version in the SEMPRE-BIO webpage. This will push the viewer to go to

the website and continue their research thus increasing website traffic and project awareness. The e-newsletter will be sent to the free online subscribers via email in English. To facilitate the dissemination of the e-newsletter, we will use Mailchimp, a marketing automation platform and email marketing service designed and developed for businesses using email to reach out to their target markets.

The targets for the yearly e-newsletter are:

- General public
- Waste management and waste producers' companies
- Primary sector associations (farming, forestry)
- Industry (F&B)
- AD producers, pyrogasification companies and renewable gas promoters
- Institutions and public administrations
- Biogas & Biomethane associations and clusters

3.4.3 Events & Workshops

We have carried out an initial assessment of the most immediate relevant events and workshops for SEMPRE-BIO, see Table 6 and Table 7. Throughout the duration of the project, we will continue scouting for any publication regarding fairs, conferences, exhibitions, and workshops that might be of interest for SEMPRE-BIO.

Table 6. List of conferences of interest for the dissemination of SEMPRE-BIO scientific result.

Event name	Mm/dd/yy	Place
REGATEC 2023	15/05/2023	Berlin, DE
EXPOBIOGAZ	07/06/2023	Strasbourg, FR
European Biomass Conference & Exhibition (EUBCE)	05-08/06/2023	Bologna, IT
International Conference on Biogas Engineering and Production Technologies (ICBEPT)	24-25/06/2023	Paris, FR
Low Temperature Fuel Cell, Electrolyser & H2 Processing (EFCF)	04-07/07/2023	Lucerne, CH
International conference on Biogas Technology ICBT	08-09/07/2023	Prague, CZ
Hy-cell 2023	13-14/09/2023	Stuttgart, DE
Biorefine Conference	09/2023	Gent, BE
European Biogas Conference	24-26/10/2023	Brussels, BE
Bio360 Conference	02/2024	Nantes, FR
European Hydrogen Energy Conference (EHEC)	TBA in 2024	Bilbao, ES
18. International Conference on Biogas Science and Technologies (ICBST)	21-22/10/2024	Athens, GR
International conference on Biogas Technology ICBT	2024, 2025	Prague, PL

Table 7. List of most immediate relevant workshops for SEMPRE-BIO.

Workshop name	Participant	DATE	Place
Workshop on Data Reconciliation	SINTEF, TERRA, DBFZ	6-7/03/2023	Paris, FR
IEA biofuels policy regulation REPorwerEU	DBFZ, INV	22/02/2023	Online
Workshop on Microalgae Cultivation at Pilot-Scale	INNOLAB, UGE, UVIC	TBD	Oostkamp, BE

3.4.4 Project Website

The SEMPRE-BIO project will make use of the website (https://sempre-bio.com/) available in beta version by the time this deliverable is published) for broad communication and, also, targeted dissemination activities. Based on the needs of the SEMPRE-BIO project, the website, the portal and other dissemination materials will be designed, developed, managed, updated, and maintained. The project Website will be the official portal for publishing public deliverables and providing information on SEMPRE-BIO events (such as project meetings and workshops), publications and other exploitable results, as well as regular updates on Twitter, Facebook and LinkedIn, and other selected social media.

A media toolkit has been developed for the project, with some parts accessible through the website, and all elements are available for the partners to distribute in their networks. Two videos will be produced and distributed: a promotional video early in the project and an outcomes video. This task also includes the creating, management and updating of the project website, newsletters, and social media accounts. The website will show project's objectives, public deliverables, news and events, scientific papers and presentations, the project media toolkit, and links to the social media accounts (and vice versa).

The SEMPRE-BIO website will be created at the beginning of the project. It is designed in an attractive and user-friendly way and serves the needs of all user groups. It will be updated on a regular basis, and will feature:

- a general description of the project,
- a section with links and contact information for the partners,
- a section featuring all public project deliverables,
- a section for news and events, a section with links to other biogas projects,
- a section featuring the various country networks, with separate subsections for each country.

In addition, as results become available, articles and other pages may be published that highlight the project's progress and results. The project website will feature responsive design enabling a seamless browsing experience from various portable devices, which are increasingly important for online communication. The website will also feature an online repository that will be populated with original inputs and existing material provided by the partners: it will be the main instrument to ensure the proper use of the project's results during and after its duration, by collecting, distilling, organising, and categorizing previously existing knowledge alongside the knowledge produced by the project. The online repository will be divided into two main sections: "Downloads and deliverables" and "Regulatory frameworks". The "Downloads and deliverables" section will contain the agenda, summary and presentations from the project's workshops and deliverables from each work package.

The "Regulatory frameworks" section will feature subsections for each one of the project's countries as well as for the EU. Within these subsections will be searchable tables containing links to individual legislative acts as well as a link to a PDF for each act that will provide other relevant information, such as the legislation's purpose, relevance, scope, targets, and sustainability criteria.

The SEMPRE-BIO website will be designed to meet the requirements of the European Commission's Information Providers Guide and the W3C Content Accessibility Guidelines 2.0 (which promote equal access to disabled or ageing users as well as users with older hardware). All the information on the website will be accessible to all users (except for the internal section) and will be provided in English.

In addition, the website will link all important projects and networks dealing with biogas and biomethane and, if possible, vice versa, and will be maintained for at least one year after the end of the project.

The suggested development of the web will go in the next order:

- Home
    - SEMPRE-BIO - This page describes the main goals of the project.
    - Promoted news – highlights slider.

- About
  - Consortium - this page describes what entities make up the consortium and the people involved.
  - Map – With the location of the plants.
- Research and background
  - Resources/outputs.
  - Milestones – Small pitch of what the company will be and the financial milestones to get there.
- News & Events
  - News - general news related to the project and the consortium.
  - Event Schedule - Schedule for planned conferences, events, workshops, and seminars (regional, national, EU, and international level).
  - Newsletter – Space for subscription to the newsletter and all downloadable newsletters

3.4.5 Social media

Social media is a useful way to mainstream the SEMPRE-BIO project and provide the most direct online impact on potential and targeted audience. Specific social media accounts on Twitter, LinkedIn and Facebook will be used to share, experience, and participate in project-related issues and disseminate project results and outputs. In addition, the project will count with support of the social media networks of the different partners to further disseminate and communicate the project.

LinkedIn will allow to drive traffic to the SEMPRE-BIO website, identify quality leads, share expertise through content, and grow network.

Twitter is an excellent platform for increasing audience involvement and obtaining more Retweets, likes, and answers from a specific market. Based on our communication and dissemination objectives, the campaign allows SEMPRE-BIO to extend the reach of material to a relevant Twitter audience.

Facebook is a great way to engage with the audience. There are over a two billion people using Facebook. It allows to target audiences quantitively.

To facilitate the monitoring of these social media platforms SEMPRE-BIO will be using Bufferapp, a multi-purpose social media marketing software tool. Bufferapp's core feature is the ability to draft and schedule posts for sharing across multiple social networks.

Communication through social media heavily relies on tags and/or hashtags to reach specific target groups but also to reach a broader audience to increase project awareness and project impact. The table below shows some examples of possible relevant tags and hashtags to use by the consortium:

Table 8. Examples of tags and/or hashtags associated to the project to increase impact and project awareness.

Tags	Hashtags	
@cinea_eu	**#SEMPRE-BIO**	#biogas
	#biomethane	#syngas
	#electrolysis	#biomethanation
	#valorisationCO2	#wastewater
	#cryogenic	#biogasupgrading
	#BioLNG.	#pyrolysis

The #SEMPRE-BIO must be used in all posts to identify the project and create brand awareness.

In addition, each partner will be using their own resources for dissemination activities. This is so that the data and information generated will be widely disseminating, thus reaching a broader audience. Each partner will be expected to be responsible for the creation of the post by ensuring that the following points are followed:

- Always mention or tag the financing programme (CINEA, EC).
- When possible, always tag the project partners.
- The information shared can only come from project's public content (i.e., public deliverables).

Table 9. Communication channels of each of the SEMPRE-BIO partners.

Partner	Website	Social Media
CET	www.cetaqua.com	**Twitter**: @CETAQUA **LinkedIn**: https://www.linkedin.com/company/cetaqua/ **Youtube**: https://www.youtube.com/channel/UCxgY2orROeG1Q_8rHSkCXUw
AB	https://www.aiguesdebarcelona.cat/ca/web/guest/	**Twitter**: @aiguesbcnclient **LinkedIn**: https://www.linkedin.com/company/aig%C3%BCes-de-barcelona/
CRYO	www.cryoinox.com	**LinkedIn**: https://www.linkedin.com/company/cryoinox/ https://www.linkedin.com/company/add-synergy/ - Cryoinox's Brand
DBFZ	https://www.dbfz.de/en/	**Twitter**: @DBFZ_de **LinkedIn**: https://www.linkedin.com/company/dbfz/
DTU	https://www.dtu.dk/	**Twitter**: @DTUTweet **LinkedIn**: https://www.linkedin.com/school/technical-university-of-denmark/
INV	https://www.inveniam-group.com/	**Twitter**: @InveniamGroup **LinkedIn**: https://www.linkedin.com/company/inveniam-group/mycompany/
PROPULS	https://www.propuls.de/	**LinkedIn**: https://www.linkedin.com/company/propuls-gmbh/
SINTEF	https://www.sintef.no/en/	**Twitter**: @SINTEF **LinkedIn**: https://www.linkedin.com/company/sintef/
TERRA	https://terrawatt.fr/	**LinkedIn**: https://www.linkedin.com/company/terrawatteu/
TMB	https://www.tmb.cat/es/home	**Twitter**: @ATMbcn **LinkedIn**:

		https://www.linkedin.com/company/transports-metropolitans-barcelona-tmb/
UGE	https://www.ugent.be/	**Twitter**: @D_en_I_UGent **LinkedIn**: https://www.linkedin.com/school/ghent-university/
UVIC	https://betatechcenter.com/	**Twitter**: @BETA_TechCenter **LinkedIn**: https://www.linkedin.com/company/betatc/
BIOGAS-E	https://www.biogas-e.be/	**Twitter**: @BiogasEvzw **LinkedIn**: https://www.linkedin.com/company/biogas-e/
INNOLAB	http://www.innolab.be/	**Twitter**: @The_InnoLab **LinkedIn**: https://www.linkedin.com/company/theinnolab/about/
NAT	https://www.naturgy.es/hogar	**Twitter**: @Naturgy **LinkedIn**: https://www.linkedin.com/company/naturgy/
MASS	https://www.genhotel.nl/fokbedrijf/zwanebloem	**LinkedIn:** https://www.linkedin.com/in/wannes-masscheleyn-642368259 **Instagram:** https://www.instagram.com/dezwanebloemnv/ **Facebook:** https://www.facebook.com/people/De-Zwanebloem-NV/100017352426989/

3.4.6 Joint Communication with on-going EU biomethane projects

SEMPRE-BIO will contribute to common communication and dissemination activities to increase the visibility and synergies between Horizon Europe supported actions (in particular, projects funded under the same topic HORIZON-CL5-2021-D3-03-16, i.e., METHAREN, HYFUELUP, and BIOMETHAVERSE, see Table 10.

Table 10. Other funded biomethane projects under the HORIZON-CL5-2021-D3-03-16 call.

Projects	Brief description
BIOMETHAVERSE	Aims to diversify the technology basis for biomethane production in Europe, to increase its cost-effectiveness, and to contribute both to the uptake of biomethane technologies. To achieve this goal five innovative biomethane production pathways will be demonstrated in five European countries: France, Greece, Italy, Sweden, and Ukraine.
HYFUELUP	The goal of this project is to demonstrate a flexible and hybrid pathway for the efficient and cost-effective production of biomethane using thermochemical technologies and renewable hydrogen. A complete deployment value chain, including biomethane offtake and distribution, will also be demonstrated to contribute to the market penetration of biomethane in key sectors.

METHAREN	Aims to demonstrate a cost-effective, innovative, more sustainable and circular biomethane production system enabling renewable energy sources intermittency management. To do so, METHAREN is providing improvements beyond the state-of-the art along four main axes related to: i) the biogas plant efficiency; ii) flexibility and energy management for RES integration; iii) the circularity approach for sustainable production and iv) innovative business models and adapted policies.

On the 1st February 2023, a first meeting between the different projects was held. It was decided to create a living document to be shared among the project coordinators and communication leaders to share ideas of potential synergies, such as joint events, mutual participation to each other's events, bilateral promotion of events and news via respective websites and social networks, e-newsletters and social media; project logo display on relevant project communication materials. It was agreed to try and have a first joint event during the first year of the projects, after summer in 2023.

3.5 Communication procedures

Prior to the release of any communication, an internal protocol has been established to protect the privacy of any sensible project or partner's information. The following are intended to be avoided by this process:

- Communication of sensitive information
- IP infringement
- Publication of materials that are not aligned with the partner specific communication.

Table 11. Communication procedure for SEMPRE-BIO related publications.

Communication Mean	Procedure
Project's press releases and pictures	1. The communication's partner author will write the press release. 2. The coordinator will oversee content to be published. 3. The remaining partners should evaluate it and give their opinion within 48 hours. 4. INV will review the formatting and graphic image ensuring the correct use of the SEMPRE-BIO brand image. 5. Post the content on the SEMPRE-BIO website, to which the relevant journalists will be given a link. 6. Content can be added to the websites of the corresponding partners once it has been published on the SEMPRE-BIO website.
Partner's press releases and pictures	It must be shared with and reviewed by the coordinator at least 48h before its publication.
Social Media Content	1. Identify or always mention the financial programme (Horizon-IA programme). 2. Always tag the project partners when possible. 3. The shared information can only come from public content from the project (i.e., public deliverables).
Newsletter	1. The communication partner (INV) will write the newsletter. 2. The coordinator will oversee content in the beginning. 3. The partners should evaluate it and give their opinion within 48 hrs. 4. INV will review formatting and graphic image. 5. INV will assemble the design of the newsletter and send it to the people subscribed. 6. Once the project is sent, no changes or modifications will be accepted.

4 KPIs of Dissemination and Communication Activities

Ensuring the widest possible audience for SEMPRE-BIO results, the consortium will work to release the information through various website, social media channels, newsletter and mailing and marketing materials (Table 12). This table will be updated with the progress and achievement of the level of engagement.

Table 12. Summary of Dissemination and Communication activities for SEMPRE-BIO project.

Communication or dissemination method	KPI	Level of engagement
Website	Number of updates	≥ 1 per month
	Visits	≥ 2.000 per year
Project material	Project brochures	150 per event
	Newsletter	4 during project
	Press release	4 during project
	Webinar	1 webinar per year (25 participants for each webinar)
	Videos	2 project videos
Social media (using #SEMPRE-BIO among others)	Twitter posts	1 post/week
	LinkedIn posts	1 post/week
	Facebook	1 post/week
Scientific publications	Publications in peer-review journals	≥ 15 during project
	Publications accepted and published in international reference journals	≥ 15 during project
	Publications in proceedings of conferences	≥ 8 papers in conference proceedings 2 per conference/event
Conferences, exhibitions, and trade fairs	Attending and/or presenting at conferences	20 events to be selected in accordance with D6.1
	Trade fairs and exhibitions	4 events per year
	Interactive multi stockholder event	4 events per year
Lectures in educational contexts	Organized by academic partners	1 per year with around 50-80 participants for each
TMB Buses in Barcelona	Buses	2 buses with a reach of 300 000 people in total

5 SEMPRE-BIO Exploitation Plan

The overall objective of SEMPRE-BIO project is to make a meaningful change in the biomethane sector by designing, building, testing, and validating various biomethane technologies in the European Biomethane Innovation Ecosystems.

The exploitation plan of SEMPRE-BIO is an important part of the whole project, as it fosters the identification of market opportunities and contributes to the assessment of future strategies to commercialize each outcome. It has therefore been divided into two pathways: consortium and individual exploitation.

Joint exploitation of SEMPRE-BIO

The consortium is composed by a multidisciplinary set of companies, including manufacturers, engineering companies and public institutes. This provides the project with complementary sets of skills that increase the joint competence of the consortium.

The following section provides an overview on how each of the consortium partners envisage their role in the future exploitation of the results of SEMPRE-BIO project. Depending on the core areas and expertise of each company, each partner foresees clear future benefits for their business because of the successful completion of the SEMPRE-BIO project.

The main objective of this pathway is to define how the SEMPRE-BIO's **European Biomethane Innovation Ecosystems** in **Baix Llobregat** (ES), **Bourges** (FR) and **Adinkerke** (BE) will continue operating beyond the project and how the SEMPRE-BIO technologies can achieve commercial sustainability beyond the HE funding period. To do so, it must be defined the contents and boundaries of the SEMPRE-BIO biomethane production technologies and the roles and responsibilities of the consortium partners for joint exploitation.

This pathway will focus on developing preliminary business plans for biomethane technologies and defining the roles of project partners (and other stakeholders) in the implementation of these plans. A full business plan development will take place at a later stage and will be described in deliverable D6.5 (M42). The main objective of SEMPRE-BIO is to create a portfolio of all biomethane technologies that have been tested during the project. For this, it is important that technology developers have a defined IP strategy.

At this stage, the **main activities** of the biomethane solutions (including the products and services it offers) are described below considering the **value proposition** and **end users** for the project (described in the Table 2)**.** Different partners may have more than one vision of how SEMPRE-BIO looks and functions beyond the project. This will also be discussed in this section and will feed into future discussions on roles and business models.

Individual exploitation

On the other hand, it has been defined how partners and other stakeholders can individually exploit the project Key Exploitable Results (KERs) to their own ends. This path will deal with identifying the KERs, resolving Intellectually Property Rights issues between partners, developing common exploitation strategies for each KER and assess how individual partners can use the KERs.

In order to collect information for the **exploitation results,** each partner was asked to fill in an exploitation form for the purpose of:

- Confirmation with each partner the KER's they will be involved with and clarifying roles (Section 5.1).
- Providing for a more detailed definition of each KER for the involved partners (Section 5.1).
- Agreeing on ownership of each KER and division in sub-KER's if applicable (Section 5.1.1).
- Obtain contact details of the Tech Transfer Offices of the academic partners to learn about their institution policies regarding result ownership, IP licensing practices and participation/shareholding in joint ventures/spin-off companies (Annex 6.7).

5.1 Identifying KERs

This section provides insight on how each of the consortium partners envisages their role in the future exploitation of the results of SEMPRE-BIO project, depending on the **7 KERs** identified hereunder. To do so, **contributors**, **leaders**, and **joint ownership** are defined.

Table 13. Main characteristics of SEMPRE-BIO KERs

KER	Description	Results owner
KER1. Biomethanation of biogas from WWTP sludge anaerobic digestion **Leader**: CET **Other contributors:** DTU	CET already has laboratory work on bio-methanation, as well as a bio-methanation pilot plant under construction (LIFE NIMBUS). SEMPRE-BIO will be taking bio-methanation from the current TRL of 4 to 7, meaning that it will be ready for the subsequent final scale-up to commercially viable scales if results from WP5 show potential.	Joint ownership, already discussed before the start of the project. In case of exploitation/patenting/ licensing of the reactor configuration and project results by CET, DTU will have to be compensated for the manhours dedicated to WP1 (design of reactor)/ WP2 (data analysis). DTU is not interested in exploiting/ patenting/licensing, only in research.
KER2. Proton exchange membrane (PEM) Electrolysis with hydraulic compression **Leader**: PROPULS **Other contributors: None**	PROPULS obtained a license for the novel stack technology based on hydraulic compression, which was earlier worked out by Westfälische Hochschule and validated in several projects on laboratory scale (TRL 3-4). Since 2020, PROPULS is part of two ongoing actions (PROMET-H_2 and HYDRA-15) with the aim to achieve a further step towards commercialisation of this technology and to realize novel PEM electrolyser stacks with 25 kW and 75 kW, respectively (assuming a TRL 5 by the end of 2022).	ProPuls
KER3. Pyrolysis and cleaning to produce syngas from woody biomass **Leader**: TERRA **Other contributors:** None	Using the know-how of pyrolysis expert Dr Tagutchou, TERRA's CTO, TERRA is developing an ad hoc small-scale pyrolyser based on the previous models constructed at INSA Lyon. TERRA's current TRL is 5, and we expect to achieve TRL 7 in year 3 of the project. Construction of the pyrolyser will be conducted by pyro-gasification expert engineering company Waste to Energy Advanced Solutions SL.	TERRA

KER4. Biomethanation of syngas **Leader**: TERRA **Other contributors:** DTU	TERRA developed its methanation technology (TRL from 3 to 5) during the Biosyp project, financed by French national agency ADEME. After its positive results, TERRA moved to a relevant environment at the Leroux et Lotz factory in Nantes, FR, where is operating a small-scale bio-methanation pilot plant, the TITAN V project (TRL 6). This project is effectively converting pure CO into CH_4 using trickle-bed bioreactors. In SEMPRE-BIO we will build a demo plant with production capacity x5 times larger than Titan's pilot, we will improve the liquid-gas transfer with an innovative patent-pending bio-reactor technology, and we will convert clean syngas from the site pyrolyser (KER3) to biogas. After the operating and the optimization of the plant, we will reach a final TRL 7.	Joint ownership TERRA/DTU and agreements
KER5. Cryogenic cleaning & separation of biogas into liquified biomethane and liquified CO_2 **Leader**: CRYO **Other contributors:** UGE, INNO, small contribution by Biogas-E	CRYO is an Engineering and Production company that designs and builds micro-liquefaction solutions. The CRYOPOLISH and CRYOUPGRADING solutions are in commercial stage with two projects in construction. The Cryogenic cleaning, CRYOCLEANING is in TRL3 – TRL 4 and the project will let us to define the technological limits to reach TRL9.	CRYOINOX ownership. UGE and Biogas-E have no commercial interests, however, their involvement should be outlined.
KER6. Cost-efficient conversion of CO_2 value added products **Leader**: UVIC **Other contributors:** UGE, DTU, INNO	UVIC and DTU have a wide experience on the production of biopolymers and organic acids, respectively, from CO2 and H2 at lab scale fermenters. UGENT and INNOLAB also have experience on the production of microalgae in conventional tubular photobioreactors at pilot scale. SEMPRE-BIO will aim to rise the TRL of all innovative technologies tested in WP4 from 4 to 7 since both the hybrid fermenter and the solar photobioreactor will start from a validation at pilot scale, valorising real effluents (liquified CO2 from biogas and nutrients from digestate), to a prototype	Discussion in progress. UGE has no commercial interests, however, its involvement should be outlined.

	demonstration in operational environment.	
KER7. Proving lower associated costs of production of biomethane by benchmarking **Leader**: DBFZ **Other contributors:** All SEMPRE-BIO partners	DBFZ and SINTEF as research institutes focus on theoretical and practical research in the field of energetic and material use of biomass to develop new processes, methods, and concepts. Researchers bring holistic knowledge and many years of expertise into the research fields of process design and technical economic evaluation into the project particularly in the area of biogas and biomethane and their evaluations. Within the techno-economic analysis innovative technologies are evaluated to identify cost-effective biomethane production with low negative environmental effects and cost reduction potential.	Joint ownership by all contributors.
Other exploitation sub-results		
KER1.2. Production of electrolyser-level high purity demineralized water from regenerated water **Leader**: CET **Other contributors:** CET	Non disclosable information	CET ownership

5.1.1 Exploitation Strategies

In this section, **common exploitation strategies** for KERs can be used by project partners, other **stakeholders,** and **society** at large. To this end, end-users should be defined, whether the KERs will be open/free to access, or whether they will be required to be purchased and how to charge for them, i.e., annual fee, one-off payment, consultancy fee as part of the service/product, license agreement, percentage royalty payment, etc.

Table 14. KER Exploitation Plans and stakeholders.

KERs	Exploitation Activities	Target groups	Stakeholders
KER1	**Technology licensing** can be exclusive in Spain/Europe + AGBAR/Veolia markets, and then it can be licensed to: 1) other entities in the wastewater treatment sector and 2) the potential spin-off of KER6	Wastewater treatment plants, landfill sites with biogas recovery, large new and existing biogas facilities. This technology could eventually also be applied to CO_2 sequestration facilities, such as cement plants or the petrochemical industry.	AB, TMB, City of Barcelona, Citizens.

KER2	In collaboration with industrial partners, PEM electrolysis with hydraulic compression will be **commercialized** by PROPULS to be incorporated in turn-key P2G plants. First phase: offer modular stacks up to about 150 kW. Second phase: upscaling to multi-MW solutions	Energy storage, Power-2-Gas, H_2 refuelling stations, chemical industry, waste-water treatment, biomethane production	
KER3	To include pyrolysers in waste-to-biogas projects developed by TERRA. **Incorporation of the technology in current and future managed plants**.	Waste management and landfill sites to process any organic waste.	Groupe Bergougnan (site owner and operator of AD plant), Veolia (waste manager collecting green waste in the city of Bourges), City of Bourges (biomass source), GRDF (gas grid owner and operator).
KER4	Development and operation of plants financed by green infrastructure funds, development, and **sale of plants to utilities**.	Waste management and landfill sites to process any organic waste, existing and new biogas facilities, local municipal utilities.	
KER5	**Sell integrated equipment** to produce BioLNG and Liquid CO_2 from raw biogas in small flow around 50 Nm^3/h or to receive HPRBC from several location. The value proposition will be based on the revenues from the sale of BioLNG, LCO_2 with very low carbon footprint and from the payment of untreated methane from the farmers.	Small wastewater treatment plants, small new and existing biogas facilities. Combined with High Pressure Raw Biogas Compression (HPRBC) to promote the capture and CH_4 reduction for very small production focus.	Farmers and agro-related businesses in rural areas (e.g., food processing sector).
KER6	Upscaled technology patenting and potential exploitation through **licensing to third parties** or the creation of a **spin-off** to offer technological solutions for CO_2 segregation systems and value-added. bioproducts from CO_2.	Anaerobic digestion plants with co-generation engines, CO_2 segregation systems from biogas upgrading facilities, combustion processes and, in general, industrial facilities generating concentrated effluents of CO_2**.** Also, biotechnological industry manufacturing value-added bioproducts from CO_2.	
KER7	Results of overall evaluation of investigated demonstration plants /processes and their impacts shared with stakeholders (**one-click report**). KER7 will support scale up of demonstration plants and more lucrative business models.	Biogas /biomethane plant operators, gas supplier, industrial investors, political decision makers, science	Biogas /Biomethane plant operators; Gas suppliers; Investors; Policymakers and Scientific community.

5.1.2 Definition of KERs protection and access rights between partners

The second step is to define which partner(s) will own the IPR associated with each KER (normally the lead contributor) and which partners will have the right to continue accessing/using the IPR/KERs after the project ends. Each of the KER's was undertaken by different Consortium Member, therefore the Ownership includes several parties. For multi-ownership cases it is recommended to sign Joint Ownership Agreement, which will indicate contribution of each partner and their equivalent share in cases of patenting, trademarks and design protocols.

At this stage, different IPR protection strategies will also be suggested by the partners, such as patent, utility model, industrial design, trademark, copyright, or trade secret etc. It will also be important to establish if any other stakeholders will be able to access the KERs and under what conditions. At this interim stage, four main approaches to IPR protection have been analysed with respect to each KER, as shown in Table 16. Initial IPR Protection Proposals for KERs.

The result of this activity should enable post-project exploitation with a clear order of priority and usage rights for the KERs, which reduces the risk of any conflict between partners. These aspects will normally be formalized through a written Memorandums of Understanding (MoU) between the partners for KERs involving more than one partner. This MoU will include the relevant information for also understanding their joint exploitation strategy.

Table 15. Initial IPR Protection Proposals for KERs.

		Patent	Industrial secret	Copyright/tra demark	Open access
KER1	Biomethanation of biogas from WWTP sludge anaerobic digestion				
KER2	PEM Electrolysis with hydraulic compression				
KER3	Pyrolysis and cleaning to produce syngas from woody biomass				
KER4	Biomethanation of syngas				
KER5	Cryogenic cleaning & separation of biogas into liquified biomethane and liquified CO_2				
KER6	Cost-efficient conversion of CO_2 value added product				
KER7	Proving lower associated costs of production of biomethane by benchmarking				
KER1.2	Production of electrolyzer-level high purity demineralized water from regenerated water.				

5.1.2.1 Spin-off

During the development of the project, we will evaluate Different possibilities for the exploitation of KER6 such as the creation of a spin-off or licensing the technology to a third party. The final outcome

will be based on the results obtained in the different stages of the road map defined: i) Design, construction and operation of the technologies, ii) Patentability study and iii) Market study.

It is important to mention that a spin-off will not be created if the results are not previously protected (e.g., patents) or if the risk is too high. In the hypothetical case that it is created, it would be a separate legal entity created by UVIC and UGent to bring CO_2 subproducts into the market (IP assets). These two partners have already experience working together on various European projects such as Fertimanure, Novafert, NutriBudget, Sea2Land, NutriKnow, Folou.

It is generally an efficient solution for universities and research institutions who may not be fully capable of commercialization of their own IP assets. Since spin-offs operate as a bridge between the research environment and industries, bringing research findings to the commercial market with a marketable product, they are a crucial technology transfer method. Additionally, research organizations can concentrate on their primary work of research through spin-offs rather than marketing, which is the primary task of commercial firms of the spin-off.

In case a spin-off is created for the exploitation of these results, DTU and INNOLAB will discuss their implication later on during the project.

5.1.3 Value Proposition for different scenarios

The different site **scenarios** that could adopt the SEMPRE-BIO results (KER1-KER6) are described below, considering variables such as existing infrastructure, feedstock, volume produced, distance to the grid and distance to consumers. In the case of KER7 it will help technology adoption by evaluating the economic benefit of global technologies.

Further in WP6, Task 6.4 the value proposition and business case for different scenarios for all SEMPRE-BIO technologies will be developed.

- **CASE I (Biogas plant):** Rural biogas plant which produces bioLNG and CO_2 through cryo-separation **(KER5&6)** using fermentable solid waste. It can be a large or small-scale energy producer and it can be located far from the gas grid's injection points. Therefore, it is a cost-efficient bioLNG production route for small-isolated sites.
- **CASE II (Biogas plant):** Rural large and small-scale pyro-biomethanation module to process fermentable solid waste and non-fermentable feedstock to produce biogas and biomethane plant **(KER3&4).** This technology injects directly into the biomethane (natural gas) grid.
- **CASE III (Biogas and biomethane plant):** Urban and rural biological methanation of PEM H_2 and biogas to save in upgrading cost and to increase biomethane volume (**KER2**) through fermentable solid. Transform renewable electricity surplus into green hydrogen and convert to biomethane for grid injection (power-to-gas). The plant produces a large volume of biofuels and should be close to gas grid injection points.
- **CASE IV (Biogas plant):** Cost-efficient bioCNG for municipal transport use as biofuel by urban large-scale biomethanation (**KER1**) using wastewater. It does not need to be close to the gas network.
- **CASE V (Biogas plant):** Cost-efficient biomethane to be injected to grid through large-scale biomethanation plant capable to turn biogas into biomethane (**KER2**).
- **CASE VI (Syngas plant):** Cost-effective second-generation biomethane for grid injection for both urban and rural consumers. It is performed by a biomethanation module of synthesis gas using non-fermentable waste. This scenario can have two possibilities.
  - **Option I:** It could produce small volume of syngas if it is located close to one of the gas grid injection points.
  - **Option II**: Large-scale syngas production plant that could be either far from or close to the gas grid.

5.1.4 KER Exploitation Risks

5.1.4.1 Preliminary list of critical risk

Risks are not only limited to the action plan but must consider its technological, business, and human environment, factors that might be enablers or blockers of project and exploitation success. The SEMPRE-BIO approach on risk definition and management will go hand in hand with the project innovation management. This process entails the identification and prioritization of risks and the application of the necessary resources to mitigate the impact of unfortunate consequences. The consortium has made a first assessment and mitigation of the project's risks for implementation in the Table below.

Table 16. List of critical risk during the project. Note: Each risk is assessed according to its probability of likelihood (L, from 1 to 3) and its severity (S, from 1 to 3).

Risk	Proposed risk-mitigation measures	WP	Category	L	S
DTU's reactor configuration campaign is delayed, delaying in turn reactor design and start-up.	Allocating time contingencies, early identification of bottlenecks, clear alignment of experimentation needs for reactor design between DTU and CET.	1	Implementation	2	2
Methanation reaction conversion is lower than nominal by design.	Oversizing the reactor, operating at lower flow rates.	2	Technological	3	2
Achieved biomethane has not enough purity for use.	Recirculating the biomethane to the biogas header, oversizing scrubbing system(s).	2	Technological	2	1
The PEMEL does not achieve the nominal production capacity of 20 Nm^3/h.	Operating at lower biogas flow rates	2	Technological	2	1
Either the PEMEL or the bio-methanation reactor do not allow for intermittent operation.	De-couple to a certain extent the design of experiments from both pieces of equipment.	2	Technological	1	1
Delay in the development or construction of BoP for the PEM electrolyser.	PEM electrolyser involved partners get in close contact with BoP developer to give necessary specifications and ensure schedule. If the delay is severe, adjust the testing plan after agreement with project coordinator.	1,2	Technological	1	2
The microbial composition is not adapted to the gaseous feedstock and homo-acetogenesis is favoured rather than methanogenesis pathway.	Follow microbial resource management and apply bioaugmentation with pure methanogenic culture to alleviate process inhibition.	2	Technological	1	2
The digestate does not contain all important nutrients for a sufficient	Supplementation with exogenous micro-elements that are scarce in the digestate.	2	Technological	2	1

growth of methanogenic microbiome.					
The water solidification damages the heat exchanger and/or methane slip leads to methane hydrates formation on the heat exchanger.	Introduction of an additional dehydration unit to reduce the effects for mechanical damage and resend condensates to digestor to capture the methane slip.	3	Technological	1	3
Part of the H_2S solidification is mixed with the CO_2 and the CH_4 or it cannot be regenerated by the CO_2.	Reducing the amount of water in the raw biogas with traditional solutions or introducing an additional higher temperature regeneration process to restart the heat exchanger once a week.	3	Technological	2	2
Low productivity of value-added products in the innovative technological systems.	Modification of the operating conditions and the technological configuration to improve the solubility of gases in the liquid phase and the use of other high rate biocatalyzers.	4	Technological	2	2
Increase of the costs of the materials.	Switching of part of the equipment and materials to cheaper ones or constructing a smaller bench unit.	4	Execution	1	1
Delayed delivery of the equipment and materials required to construct the technological systems	Time contingencies accounted for in the construction and operation phases in project planning. Starting early the design of the demonstration plants and having continuous communication with providers and delivery times. Ranking quotations on providers not only on economic terms but also on delivery terms and reliability (past projects experience).	4	Execution	1	2
Limited availability of process and operational data for process design primarily due to competition situation and IP-protection.	Utilization of literature data as fallback will be utilized.	5	Data availability	1	2
Dissemination, exploitation, and communication activities raise little interest.	The DEC plan will be updated according to the project needs. A low interest in the project can be spotted early, and additional, more targeted communication channels be developed.	6	Dissemination	2	2
Lack of internal consortium consensus to IPR issues.	It is planned to prepare internal regulations of IPRs related legal issues and will be analysed in course of the CA preparation. The preliminary IPR related regulations have been established.	6	Exploitation	2	2

Low commitment of the partners to the project plan and deadlines.	Most partners (and all with a leading role) are familiar with this type of projects and have proven their commitment during proposal preparation. Clear responsibilities are allocated for each task.	7	Management	1	2
Permitting of the demonstration plants delays the construction and start-up	Permitting will start early in time by doing an early identification of documentation needs for the three case scenarios. For the Barcelona case a very similar legalization and permitting process has already been obtained by CET, whereas for the French case study the current permit will allow for most of the implementation and operations. The Belgium case study will be the one where these activities will be the most active.	4,3, 2	Execution	2	2

5.1.4.2 Risks post project

The following table provides the main risks identified by the partners detailed in six different categories. In addition, its severity grade scored for each risk (1 = low; 10 = high) and the probability of occurrence is calculated with the same index.

Table 17. Risk matrix post SEMPRE-BIO project.

KER	Description of Risks	Criticality of the risk related to the final achievement of result	Probability of risk happening	Potential intervention	Feasibility/ Success of Intervention
Partnership Risk Factors					
KER1	Publishing of results in scientific journals before filing for a patent	10	2	Clear communication of the patenting process	10
KER1	Both CET and DTU want to exploit results	9	1	Clear establishment of partner interests beforehand	6
KER1	CET seen as competition of Pietro Fiorentini's (shareholder of 60% of CRYO.) MicroPyros, which has licensed propriety biomethanation technology and negative effect on consortium transparency.	3	2	Drafting possible future collaboration	4

KER4	Academic congress presentation of results before being patented cancelling the patenting	9	2	Communication between DTU and TERRA	9
KER6	Partners do not get along	4	4	Clear plan of action	*8*
KER7	Data collection uncompleted, no operational data from case studies	2	3	Own assumption of data for overall evaluation, Experiences of involved partners allow estimations for data base	8
All KERs	Consortium member(s) not contributing sufficiently and in time to their requested duties in the work plan	4	2	Milestones will be discussed at the beginning of the project, involvement of WP leaders to organise the data management	8
Technological Risk Factors					
KER3	Syngas composition different from announced by the supplier	7	3	Controlling syngas output during commissioning	9
KER4	Missing parameters for process scale up	8	2	Lab reporting and visit of facilities	10
KER6	Issues with scaling up	7	5	Clear plan of action	*8*
KER6	Issues with transfer/delivery of materials/feedstock	8	7	Close interactions with suppliers	*8*
KER1-KER7	Demonstration plant: delay in operation means delay in operational data for evaluation	3	4	Own assumption of data for overall evaluation	8
Market Risk Factors					
KER1	Cheap H_2 storage/ transportation technologies develop disruptively, rendering conversion onto biomethane/syntheti	8	3	Showing to the market the relevance of all the attractive features of the methanation process: injection	2

	c natural gas less desirable			into existing infrastructure, etc.	
KER1	Technology far from being able to compete with other biomethanation technologies (ElectroChaea, MicroPyros, Gicon, Microbenergy…)	10	5	Benchmarking from the start, keeping an eye open to the market technologies	3
KER1.2	Technology far from being able to compete with other market solutions	10	5	Benchmarking from the start, keeping an eye open to the market technologies	3
KER6	Uncertain investment climate (e.g., due to changing regulation, issues permit/authorisation)	9	6	Close interaction with government	*4*
KER1-KER5	The biomethane generated does not meet the quality requirements	9	2	Continuing monitoring the project results and comparison with market best practices	10
All KERs	No adequate administrative measures to force the adaption of measures, disinvestment due to bad market conditions for utilisation of waste /residues for biogas production	3	4	Joint policy recommendation in discussion with other EU-Biomethane projects, associations at EU - level	6
IPR/Legal Risk Factors					
KER1	Insufficient research on existing patents on the market and developing already licensed technology	10	3	Exhaustive research of the state of the art and existing patents for different reactor configurations	9
KER1.2	Not enough innovation to file for a patent	8	4	Exploration of alternative protection measures or paths to exploitation of results	6

KER1-KER5	No adequate framework for feed-in conditions or built up innovative biomethane facilities for market uptake	3	4	Joint policy recommendation in discussion with other EU-Biomethane projects, associations at EU level	6
Financial/Management Risk Factors					
KER7	Higher costs of innovative biomethane pathways and demonstration plants (e.g., higher energy costs, investment costs, higher personnel costs, delivery difficulties due to energy crisis)	7	8	Evaluation of cost reduction potential in comparison to the conventional biomethane production technologies; Analysis of influencing factors; consideration of revenue options to compensate for increased costs; Optimization of operation afterwards;	6
Environmental/Regulation/Safety risks					
KER1	Lost-Time-Injury accident at one of the potentials scaled-up commercial future plants (or even at the pilot plant itself) hinders further development of the technology	7	2	Have a process development based on Inherently Safer Design, execute HAZID, HAZOP studies and ATEX area classification, adhere to ATEX standards	6
KER1	Pressure from methane emissions EU regulation puts strain on any plant (commercial or pilot) which directly or indirectly (only in emergencies, for instance) vents/flares methane into the atmosphere	6	2	Adhere at all points to local and EU regulation, stay up to date with the latest regulation movements (see Section 5.2 for current regulations)	6
KER3	Leak of CO and toxic compounds	8	2	Monitoring and venting	10

KER4	Liquide leakage of bioreactors	7	1	Monitoring and drainage system	10
KER5, KER6	Changing regulation	9	6	Close interaction with government or ensure project sustainability independent from public subsidy/incentives	7
KER6	Different regulations in different countries	7	6	Good communication between different countries (e.g., via national associations)	*5*
KER6	Safety issues (e.g., bio-LNG)	8	6	Provide guidelines for safe operation	*8*

5.2 EU's Regulatory Framework related to SEMPRE-BIO

The current EU's regulatory framework for biomethane involves a combination of policies and incentives to promote the production and use of biomethane as a renewable energy source in the EU. In the table below, we have described the ones currently applicable to SEMPRE-BIO.

Table 18. EU's Regulatory Framework related to SEMPRE-BIO project.

Legislative act	Full name of Regulatory Act	Date of Publication	Relevance
SWD (2022) 230 final	Implementing the repower EU action plan: investment needs, hydrogen accelerator and achieving the bio-methane targets.	18.05.2022	Biomethane
Directive (EU) 2018/2001	Directive (EU) 2018/2001 of the European parliament and of the council on the promotion of the use of energy from renewable sources.	11.12.2018	Energy sector
DIRECTIVE (EU) 2018/410	DIRECTIVE (EU) 2018/410 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL amending Directive 2003/87/EC to enhance cost-effective emission reductions and low-carbon investments, and Decision (EU) 2015/1814.	14.03.2018	Energy sector
National Energy and Climate Plan (NECP) 2021-2030	The National Energy and Climate Plan is a ten-year integrated document mandated by the European Union to each of its member states for the EU to meet its overall greenhouse gases emissions targets.	31.12.2018	National Plan for biomethane and biogas integration

5.3 SEMPRE-BIO Business Model and Market Analysis

5.3.1 Business model

The objective of this section is to develop a preliminary business plan on how the biomethane solutions, defined in the previous sections, will be commercialized beyond the HE project. The business plan will cover the tech to market transition plan containing: i) Business Model; ii) Financial Forecasts and revenues; and iii) Four analysis on markets encompassed by the project (Biomethane, Biochar, CO_2 valorisation value added products and PEM electrolysers). It will show the best course of action in the short and the mid-term to ensure a successful progression of the technology towards the market.

Different fine-tuned business models for each KER will be defined during WP6 Task 6.4. The preliminary business model is that SEMPRE-BIO's industrial partners (TERRA, CRYO) will develop, build, own and operate bio-methanation (from biogas or syngas) and cryoseparation infrastructure themselves through subsidiary companies. Individual projects will be financed and developed through Special Purpose Vehicles (SPVs) subsidiary of the main companies, together with investor partners. This is a well-established model of developing renewable energy projects, raise project finance and manage risk, and a model in which project partners have had previous success with.

CET's business model will flow through an entirely different path, since it is a non-profit technological centre, and it does not have the instruments for the direct exploitation of its results nor interest in doing so. As part of the Agbar group, which is in part mostly owned by Veolia, it will rely on inner agents to the group for the exploitation of its results, such as Aquatec and existing EPC technologists within Veolia, which will have the capacity to build (and operate) biomethane plants with the results obtained from SEMPRE-BIO. Some of these plants will be built within currently operated facilities by Agbar/Veolia through their own funds while most will be sold as a turnkey solution to external customers. All Intellectual Property will still be owned by CET and will be leased to said engineering firms within Agbar/Veolia. Licensing to third parties is an option which will also be explored.ProPuls is an engineering company (SME) in the field of energy systems with a clearly defined strategy to provide engineering services, e.g., automation units for BIO-gas plants, to commercialize hydrogen technology in general and, especially, to exploit the novel high-pressure electrolyzer that is currently worked out in the framework of several R&D projects such as SEMPRE-BIO. The developments in SEMPRE-BIO will result in the next level of ProPuls' PEM electrolyzer as well as in an increase in system understanding, especially in the field of modern BIO-gas plants in combination with a PEM electrolysis unit. The demo site in Barcelona will be used to validate the worked-out technology on the one hand site, but also to provide insights into potential applications – in the SEMPRE-BIO case the later use of BIO-methan as a fuel for transportation. This will provide the opportunity to directly address business partners and potential clients all over Europe or even worldwide to showcase the demo site. Under license of CETAQUA and on a commercial base, subsequently to SEMPRE-BIO project ProPuls can extend its business by providing engineering services for the worked-out BIO-gas plant technology or by supplying the developed electrolysis unit in industrial-scale for different applications.Each SPV will make revenue on both sides of the operation: energy sales for biomethane (injection or liquified to gas suppliers) and gate fees for waste disposal in the EU countries and feedstock where it applies. Key to achieving this business model are long-term supply agreements with Waste Management Companies and Energy Companies to reduce price risk by guaranteeing stable reoccurring revenues once the project is operational.

The business case for each location has many variables: biogas prices at the production site, biomethane injection/LBG prices, waste fees, incentives and support policies, grid injection rights for small producers, biomethane support tariffs, green certificates, quotas, carbon credits or taxes.

Both SEMPRE-BIO industrial partners and independent investors will have the option to be shareholders in the SPV's, with priority of the companies that first have pushed each technology. During the SEMPRE-BIO project, in WP6 T6.4, INVENIAM will work on identifying potential Investor Partners as the major financial backers of each SPV. The first step will be to sufficiently de-risk project to achieve an attractive investment opportunity that is sufficiently low risk. INV will contact promoter companies as well that

deal with acquisition of permits, authorizations, and permissions, establishing the base for long-term supply agreements and building a network of Project Partners. The target of SEMPRE-BIO initial business model is to offer investors a 15% IRR in a 15-year horizon with a 20% margin on the projects CAPEX.

Table 33 and Figure 4 summarizes the main aspects of our business model. Nevertheless, as mentioned above, this is a preliminary business plan, so it has not gone into in depth. The final study will be presented in "D6.5 Business Plan" in M42 detailing the technology-to-market plan considering scientific achievements and market dynamics: market analysis in depth, competitive analysis, go-to-market strategy, deployment and operation plan, financial plan, company growth strategy, product portfolio objectives, development strategy, and stakeholder analysis. To complete this, T5.3 and T5.4 inputs will be key.

Table 19. SEMPRE-BIO business model.

SEMPRE-BIO KERs	Location	Revenue Stream
Biomethanation of biogas from WWTP sludge anaerobic digestion	Spain	Single Unit Sales. Unit Sale with Service Contract. Long-term biomethane purchase agreements and waste gate fees.
PEM Electrolysis with hydraulic compression	Germany	
Pyrolysis and cleaning to produce syngas from woody biomass	France	Royalties - Single Unit Sales. Long-term biomethane purchase agreements and waste gate fees.
Biomethanation of syngas	France	
Cryogenic cleaning & separation of biogas into liquified biomethane and liquified CO_2	Spain	Royalties – Single Unit sales. Long-term biomethane purchase agreements and waste gate fees.
Cost-efficient conversion of CO_2 value added products	To be defined in the project	To be defined in the project. See section 5.3.2.3 for potential options.
Proving lower associated costs of production of biomethane by benchmarking	To be defined in the project, but it is assumed for Europe	To be defined in the project. Revenue from sale of renewable biomethane, incl. CO_2 use, use of fermentation products as fertilizer, material use by biopolimers.

A several revenue streams are the ones expected to be developed for SEMPRE-BIO's biomethane technologies after the end of the HE project.

In the SEMPRE-BIO Grant Agreement an initial business plan canvas (BPC) (Figure 4) was presented, highlighting the key elements that are likely to be relevant to a biomethane technologies business plan. This canvas will be used as a starting point in the project, and then updated to develop the biomethane solutions and their business plans.

<table>
<tr><th>Key partners</th><th>Key activities</th><th>Value proposition</th><th>Customer relationships</th><th>Customer segments</th></tr>
<tr>
<td>• Farm associations
• Waste & water operators
• Biogas plant developers
• Gas suppliers & distributors
• Vehicle fuel retailers
• Transport companies
• Logistic operators
• Public & private investors
• Policy makers</td>
<td>• Pilot plant installation & operations
• Commercialization & project dissemination

Key resources
• Extensive knowledge in biogas upgrading solutions
• IP protection
• Leverage previous R&D projects & public funding</td>
<td>• Cost-effective biogas & syngas upgrading for small-scale AD sites with idle capacity
• Gives small-scale producers access to the gas pipeline
• Allows the utilisation of unexploited biogas potential and avoids decommissioning of running biogas plants about to become unprofitable due to biogas incentives phasing out</td>
<td>• Participation in consortium activities
• Participation in clusters (e.g., Biorefine Cluster)
• SEMPRE-BIO technological industries client base (CRYO, PROPULS, TERRA)
• BIOGAS-E members

Channels
• Online & offline lead generation and account executives
• Partners sales channel
• Comm. actions
• Participation in trade fairs & exhibitions</td>
<td>• Farming
• Forestry
• F&B, paper industry
• Waste management companies
• Wastewater management companies
• Biogas & syngas producers (AD & pyrogasification plants)
• Biomethane producers with idle capacity</td>
</tr>
<tr><th colspan="3">Cost structure</th><th colspan="2">Revenue streams</th></tr>
<tr>
<td colspan="3">• Fixed costs: personnel, equipment, IPR costs
• Variable costs: electricity (specially in sites using electrolysis for H2 for methanation), subcontracting, commercialization, travel costs, sales force</td>
<td colspan="2">• Long-term biomethane purchase agreements and, in some cases, waste gate fees (depending on type of feedstock and location)
• Single unit sales
• Unit sale with service contract</td>
</tr>
</table>

Figure 4. SEMPRE-BIO Business Canvas.

5.3.2 Market analysis

At this stage, a preliminary market analysis has been carried out, covering all the technologies and subproducts of SEMPRE-BIO project, i.e, biogas and biomethane; biochar; CO_2 valorisation (biopolymers, alternative proteins and biochemicals; and electrolysers).

5.3.2.1 Biogas and biomethane Market

In the current European landscape, biomass production is a booming energy market, as it is a promising green technology for biogas generation or biomethane. These biofuels have the potential to achieve the Paris Agreement that aims to keep global temperature rise well below 2°C or limit it to 1.5°C and tackle global warming, meet the growing energy demand, and achieve a sustainable bioeconomy.

Biomethane is a fast-expanding sector in Europe, with double digit growth over the past 5 years. In 2019, according to the European Biogas Association (EBA), there were already a total of 18,943 biogas plants in Europe, producing 193 TWh of biogas. As for biomethane, 26.7 TWh were produced in 725 plants[1]. Europe has increased the number of biomethane plants by a further 40%, with a total of 1,023 plants in October 2021. Sustainable biomethane can cover up to an estimated production of at least 1,000 TWh in the EU[2].

The biomethane leaders' countries are France and Germany with 306 and 242 respectively in 2021.

[1] https://energia.gob.es/es-es/Novedades/Documents/00HR_Biogas_V6.pdf
[2] https://www.europeanbiogas.eu/record-breaking-year-for-biomethane-production-shows-eba-gie-biomethane-map-2021/#_ftn1

In addition, the gas crisis triggered by Russia's invasion of Ukraine in February 2022 has caused a series of market adjustments. European buyers have strongly increased their LNG procurement, resulting in market tightening and demand destruction in various importing regions. The EU is taking a series of measures to strengthen security of gas supply. Therefore, Europe is investing in biomethane to end its energy dependence on Russia through REPowerEU.

Following this EU goal, SEMPRE-BIO project demonstrates several biomethane production technologies that will be able to start supplying the EU in the years indicated in the table below.

Table 20. KER market entry estimation .

Exploitable Result	Market entry estimation
KER1. Biomethanation of CO_2 from WWTP sludge anaerobic digestion	By 2030, depending on penetration of renewable energy on the power mix could be earlier or later.
KER3. Pyrolysis and cleaning to produce syngas from woody biomass	Expected market penetration by 2026.
KER4. Biomethanation of syngas	Expected market penetration by 2026.
KER5. Cryogenic cleaning & separation of biogas into liquified biomethane and liquified CO_2	By 2024, offer its solution to raw biogas plants below 250 Nm^3/h or with High H_2S concentration
KER7. Proving lower associated costs of production of biomethane by benchmarking	Transferability of innovative biomethane production to other locations (existing and new) by 2030.

The European Biogas Association (EBA) and Gas Infrastructure Europe (GIE) developed the European Biomethane Map in 2020. There are currently 18 countries producing biomethane in Europe. France has the highest proportion of biomethane plants (306), closely followed by Germany (242), following by Belgium (189) and the UK (85). Last is Iceland and Spain.

In the following, we will go into detail in Spain, France, and Belgium, as these are the three countries in which the three EBIEs will be built.

- Spain has the first (and only) biomethane plant injecting into the grid inaugurated in 2009, called P.T Valdemingómez (Madrid) which has the largest production capacity in Europe. However, there are currently 5 in operation (Valdemingomez, Biometagas, Elena, Biogasnalia and EDAR Bens) and around 20 on the way to be constructed.
- The French biomethane sector is very dynamic. France is one of the few countries to have set specific biomethane targets, namely, to produce 1.7 TWh biomethane by 2018 and 8 TWh biomethane by 2023. Since biomethane was granted access to the gas grid in 2011, and the ambitious biomethane targets were set, growth has been considerable, with the number of new biomethane plants going from 7 to 107 between 2015 and September 2019[3].
- Belgium has a well-developed biogas sector, with 189 active installations in 2020 and a total production of 2.7 TWh of biogas. The biogas is mainly produced from agricultural (80%) and industrial waste streams. In contrast to neighbouring countries, the upgrading of biogas to biomethane is a fairly new development. The first Flemish biomethane plant (80 m^3/h injection capacity) started injecting biomethane in the gas grid at the end of 2018[3].

[3] https://www.regatrace.eu/second-participatory-workshop-to-define-a-roadmap-for-biomethane-in-belgium/

5.3.2.2 Biochar Market

As a result of the wood pyrolysis to be carried out in Bourges (France), biochar will be obtained as a valuable by-product. Biochar has already a growing market as soil substrate and fertilizer.

Europe's Soil Conditioners Market was valued in 3.95 billion USD in 2021 and estimated to be growing at a CAGR of 8,31%, to reach USD 4.90 billion by 2026. Soil improvers are included in the category of soil amendments, along with fertilisers and nonorganic materials. Out of the types of conditioners, organic conditioners hold 69% of the market share across Europe. The organic sector in Europe has been rapidly developing because of the growing demand from consumers for healthy food products and increasing awareness about soil enhancement.

Some of **leading companies operating in the biochar market** are Terra Humana Ltd (Poland), Carbonis GmbH & Co. KG (Germany), Beston (China), Ecoera (Sweden), Carbofex (Finland) among others.

The market leaders of **soil conditioners producers** are BASF (12% market share), Evonik Industries (9%), Solvay (7%), and Croda International PLC (5%). Furthermore, European agriculture traditionally relied on organic manure, such as cow dung, as the main source of soil enrichment. Reduced domestication of cattle by the farming community has depleted its availability, opening opportunities for other soil improvers produced from biowaste.

5.3.2.3 CO_2 Valorisation Market

New pathways for using CO_2 in by-product production are generating global interest. According to the IEA up to 2019, almost USD 1 billion has been allocated in the last decade for CO_2 start-ups. The CO_2 market is likely to remain relatively small in the short term, however, it has many opportunities in the long term. Based on the project results obtained in the different stages of the road map, the creation of a spin-off will be studied. If launched, it expects to enter the market in 2030.

The range of potential CO_2 use applications is very large and includes direct use, by which CO_2 is not chemically altered (non-conversion), by transformation (via multiple chemical and biological processes) to fuels and chemicals and building materials (conversion).

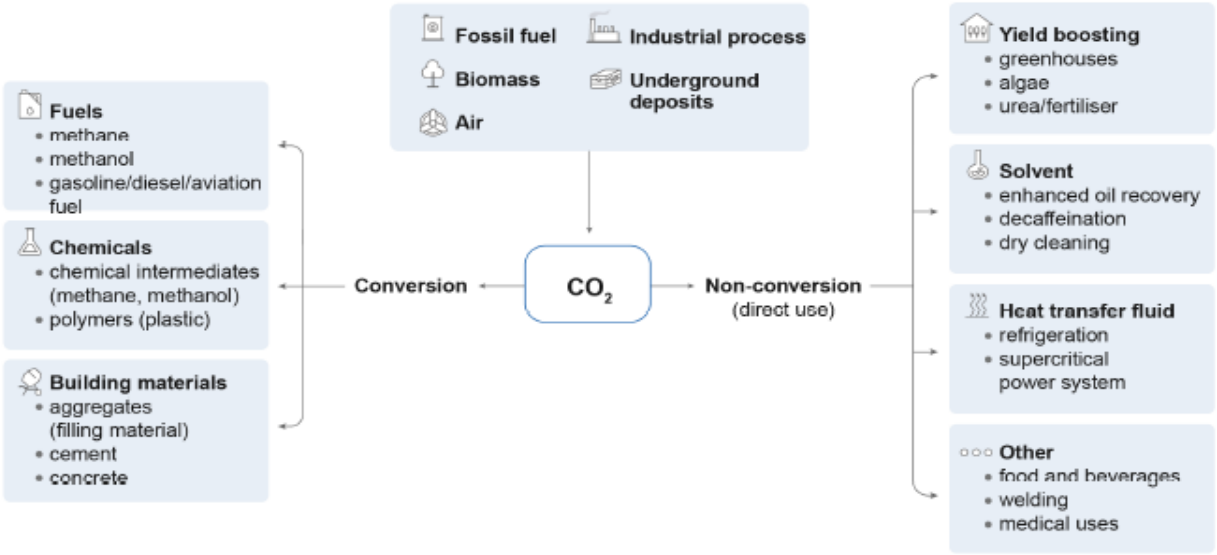


Figure 5. Simple classification of pathways for CO2 use. Source: IEA, 2019.

Although most conversion pathways are highly energy-intensive, they are attracting growing interest and support from governments, industry, and investors. Companies such as CarbonCure and Solidia,

which use CO_2 to manufacture concrete, have recently attracted investment from Breakthrough Energy Ventures and OGCI Climate Investments, respectively. In North America, the NRG COSIA Carbon XPrize is supporting the development of novel CO_2 use opportunities with a USD 20 million global competition XPRIZE, 2019). Governments in Canada, Japan, the United Kingdom and the United States as well as the European Commission are also providing significant RD&D support for CO_2 use[4].

xHowever, the possible spin-off that could be created for the valorisation of CO_2 products in SEMPRE-BIO project will be more focused on **biopolymers**, **alternative protein** to be used as an ingredient for food and animal feed and **biochemicals** such as hydrogen sulphide, caproic acid, organic acids.

Biopolymer processing with CO_2 can be competitive in the market, due to the relatively low energy required for their production and their high market value. Some claim that certain polymers can be made at 15% to 30% lower cost than their fossil counterparts, provided the CO_2 used is cheaper than the fossil fuels-based raw material it replaces.

Alternative protein derived from microalgae and/or purple bacteria is considered a promising pathway to replace some of the main sources of vegetable protein currently used in feed production (e.g., soybean and corn), which are mainly imported from America, entailing high economic costs and environmental footprint. The intrinsic properties of microalgae, mainly associated with their high protein and lipid content, are considered promising for the formulation of feed in which the nutritional content in terms of amino acids and fatty acids is essential for the growth of animals, especially during the first stages of their life.

Biochemicals such as acetic acid, caproic acid or succinic acid are used at industrial level in different applications (e.g., production of food and beverages, feed or pharmaceuticals). The global organic acids market is valued at USD 11.02 billion in 2021 and is projected to attain a value of USD 16.45 billion by 2028 at a CAGR of 5.9% during the forecast period (2022–2028). Based on the current market price for organic acids, the production of caproic acid, succinic acid and valeric acid by alternatives processes based on CO2 valorisation is key to contribute to the future market needs.

5.3.2.4 Electrolysers Market

Hydrogen gas is an important energy carrier and a potential alternative clean energy fuel. In addition, if injected into biomethanation plants, it can improve plant performance as in the **Case Study I** (Baix Llobregat).

Newly commercialized green hydrogen applications, such as water electrolysis, are opening new opportunities in transportation and other energy-related industries, as it is the case of PEM Electrolysis with hydraulic compression (**KER2**). In SEMPRE-BIO the first multi-MW scale PEM electrolysis based on hydraulic compression is expected to be ready by 2027, with full commercialisation from 2030 onwards.

Water electrolysis is an electrochemical process that uses electricity to split water into hydrogen and oxygen (O2). In 2020, this process accounted for approx. 0.03% of hydrogen production for energy and chemical feedstocks. Of installed global electrolyser capacity of 290 MW, more than 40% is based in Europe with the next-largest capacity shares in Canada (9%) and China (8%)[5].

Currently, there are four main electrolyser technologies: alkaline; proton exchange membrane (PEM); solid oxide electrolysis cells (SOECs); and anion exchange membranes (AEMs). Alkaline electrolysers dominate with 61% of installed capacity in 2020, while PEMs have a 31% share (Figure 7).

According to IEA, by 2030, global installed electrolyser capacity could climb to 54 GW, given capacity under construction and planned where Europe is leading with 22 GW. If all projects at the very early planning stages are counted, capacity could even reach 91 GW by 2030.

[4] https://www.iea.org/reports/putting-co2-to-use
[5] https://iea.blob.core.windows.net/assets/e57fd1ee-aac7-494d-a351-f2a4024909b4/GlobalHydrogenReview2021.pdf

The global electrolyser market size was valued at USD 390.4 million in 2021. The market is projected to grow from USD 416M in 2022 to USD 619.6 million by 2029, exhibiting a CAGR of 5.8% during the forecast period (2022-2029).

Some **electrolysers competitors** are Next Hydrogen (Canada), Amalyst (UK), Hysata (Australia), ITM Power (UK), Hymeth (Denmark), Sylfen (France) among others.

As part of the analysis, we collected information on IPR background, exploitable results and competitor's landscape, however these are not included here due to its confidential nature (this deliverable is publishable).

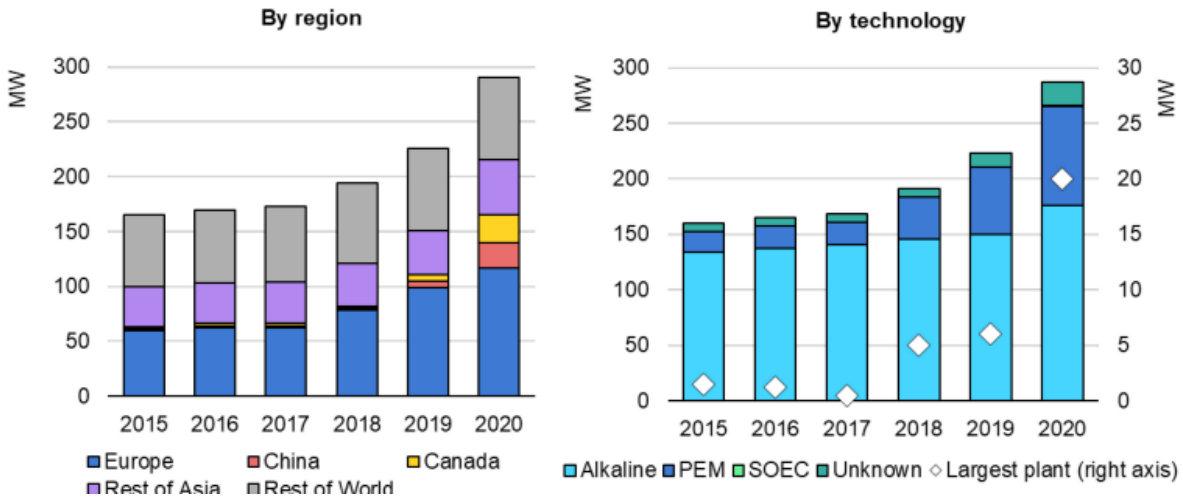


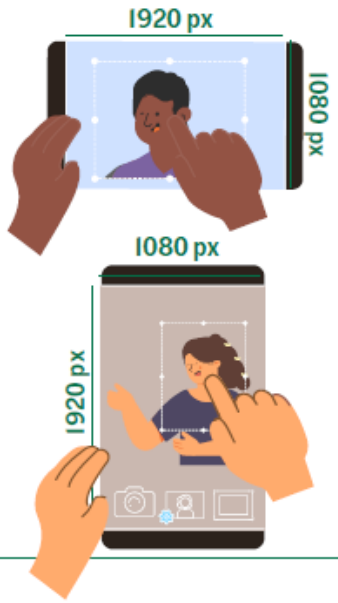
Figure 6. Global installed electrolysis capacity by region and technology 2015-2020. Notes: SOEC = solid oxide electrolysis cell. Source: IEA,2021, Hydrogen Projects Database.

6 Annex

6.1 Photo production guidelines

Photo production

1. Photos can be both horizontal and vertical.
2. Resolution should be HD (1920 x 1080) minimum. You can check this in the settings of your phone camera app.
3. Make sure to make photos with the right lightning. Quality may decrease in dark places.
4. Do not make photos of people with a strongly illuminated background, place the subject or the focus on the areas being illuminated and not the direct source of the light.
5. Before taking the photo make sure that the subject is in focus and with the right light adjustment by clicking on the person face.

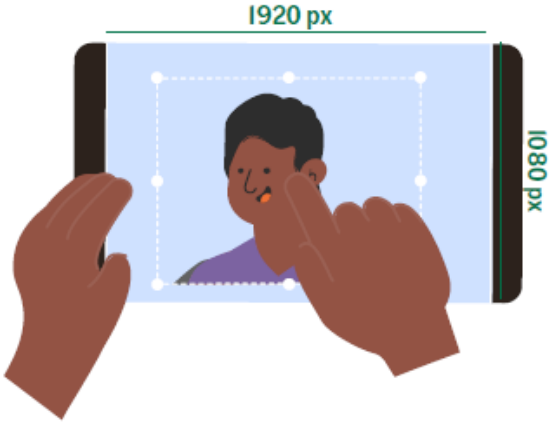


Funded by the European Union

6.2 Video production guidelines

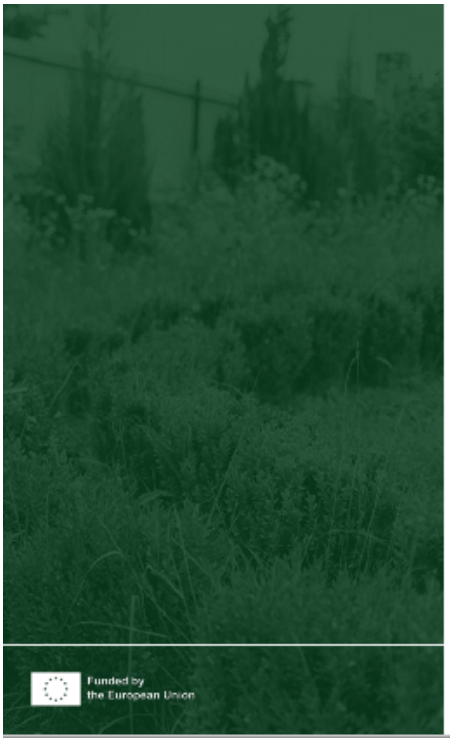
Video production

1. All videos should be horizontal.
2. Resolution should be HD (1920 x 1080) minimum. You can check this in the settings of your phone camera app.
3. Make sure to record in well lit place. Avoid recording in dark rooms.
4. Record only on quiet places and where there are not many people passing by.
5. Choose an appropriate background, nothing distracting. Avoid excessive light on the back.
6. Before start recording make sure that the subject is in focus and with the right light adjustment by clicking on the person face.



Funded by the European Union

6.3 Blogpost author guidelines



Blog Post

Format

- Blogs may have a minimum of 350-500 words.
- Name of the author, roll* and institution*(optional)
- Title, no more than 50 characters. Using keywords that will help promote in social media.
- First paragraph should be a small sum up of the article. (3 or 4 sentences, max 20 words)
- An image or a photo to illustrate. (event, participants, speakers). If it is a stock image it is important to know if the image is free of use.

Content

- Articles should be relevant to the SEMPRE-BIO project or relate directly to the project.
- Avoid political jargon and academic theory. If needed , there should be a clear explanation.
- If there are references being used we need to add the bibliography and links

6.4 Exploitation

The tables completed by each partner for the business plan are described below.

- **CET**

Table 21. Detail of results - CET.

DETAIL OF RESULTS – CET (this table applies to KER1)	
Roll in the KER1	Leader
Non-confidential description of results your organization is participating in	Purity obtained of the biomethane, conversion vs. residence time, heating/cooling needs, nutrient consumption, energy consumption, competing reactions and side products, impact of traces of H_2 on bus engine and pressure tanks, inhibition by pH or pollutants in biogas...
Name and position of researchers involved	CET: Oriol Casal – R&D Project Manager DTU: Professor Irini Angelidaki and Postdoc Antonio Grimalt Alemany DTU: PhD candidate: Estelle Goonesekera
Participants/stakeholders from other organization	None
Has result ownership been discussed?	Yes, with DTU's Juridic specialist and legal advisor Freja Kjaer.
Are access rights necessary for other partners?	WP5: Only for SINTEF/DBFZ to carry out their tasks within WP5. Publication of data only after consulting with partners who owns the data.
Have you conducted any preliminary IP protection measures? E.g., background search, freedom-to-operate	No
Background IP	Results on methanation for the LIFE NIMBUS project for a biotrickling filter type of reactor.
Foreground IP	No further action planned
Does the research team have previous experience in patenting processes?	No however we have an expert within the staff of CET.
Do you intend to publish academically the results? Is the team aware of the implications of academic publishing regarding patenting?	No, however DTU will want to publish to a certain extent. That should not be a problem as long as the patent has been filed for as far as we know.

CET has a Technology Transfer Office (TTO); however, it has not had any research projects transferred successfully via licensing/spin-off in areas related to SEMPRE-BIO e.g., renewable gases.

- **DTU**

Table 22. Detail of results - DTU.

DETAIL OF RESULTS – DTU (KER1, KER3 and KER4)	
Roll in KER1, KER3 and KER4	Contributor
Non-confidential description of results your organization is participating in	Determination of optimal Reactor configurations and microbial community analysis for biogas upgrading and syngas biomethanation
Name and position of researchers involved	Professor Irini Angelidaki, Postdoc Antonio Grimalt Alemany and PhD student Estelle Goonesekera
Participants/stakeholders from other organization	None
Has result ownership been discussed?	A meeting TERRA has been organized with CET and to coordinate project activities, discuss planning and KERs.
Are access rights necessary for other partners?	DTU is not the leader
Have you conducted any preliminary IP protection measures? E.g., background search, freedom-to-operate	No
Background IP	None
Foreground IP	No further action planned
Does the research team have previous experience in patenting processes?	YES
Do you intend to publish academically the results? Is the team aware of the implications of academic publishing regarding patenting?	Yes, a part of the experimental results from DTU will be published in scientific journals.

DTU has a Technology Transfer Office however, it has not had any research projects transferred successfully via licensing/spin-off in areas related to SEMPRE-BIO e.g., renewable gases.

- **PROPULS**

Table 23. Detail of results -PROPULS.

DETAIL OF RESULTS – PROPULS (KER2)	
Roll in KER2	Leader
Non-confidential description of results your organization is participating in	PEM Electrolysis Stack based on hydraulic compression
Name and position of researchers involved	Dr Ulrich Rost, Jeffrey Roth, Philipp Neuhaus
Participants/stakeholders from other organization	Exclusively licensed by Westfälische Hochschule Gelsenkirchen
Has result ownership been discussed?	No
Are access rights necessary for other partners?	No
Have you conducted any preliminary IP protection measures? E.g., background search, freedom-to-operate	Yes
Background IP	Already patented
Foreground IP	No further action planned
Does the research team have previous experience in patenting processes?	Yes, already patented several ideas
Do you intend to publish academically the results? Is the team aware of the implications of academic publishing regarding patenting?	Yes

PROPULS, due to their small size, does not have a Technology Transfer Office.

- **TERRA**

Table 24. Detail of results - TERRA.

DETAIL OF RESULTS – TERRA (KER3 and KER4)	
Roll in KER3 and KER4	Leader
Non-confidential description of results your organization is participating in	TERRA aims to transform non-fermentable organic waste (i.e., lignin rich materials that are usually composted, non-fermentable in AD) into biogas. Using a pyrolysis process, woody biomass is gasified into non-condensable gases that can be injected into bioreactors. These bioreactors contain microorganisms (methanogens bacteria, archaea) that will metabolize lean gases under specific conditions (biomethanation). It results a biogas with the same quality as biogas produce by AD. Our work here will be to bring the process from lab scale (data obtained with DTU and our previous project) to industrial pilot scale at Bourges EBIE.
Name and position of researchers involved	Yann Mercier – Senior Researcher / SME Owner Pierre-Yves Mocaer – Senior Researcher / Technical Director Eric Suñol – Financial Director
Participants/stakeholders from other organization	NA
Has result ownership been discussed?	Yes, joint ownership of discoveries with DTU
Are access rights necessary for other partners?	No
Have you conducted any preliminary IP protection measures? E.g., background search, freedom-to-operate	Yes, TERRA process under patent WO2017158024, EU, 2017 WO2018210960, EU, 2018
Background IP	Yes, already patented
Foreground IP	No further action planned
Does the research team have previous experience in patenting processes?	Yes – Yann Mercier
Do you intend to publish academically the results? Is the team aware of the implications of academic publishing regarding patenting?	Yes – Discussed with DTU

TERRA does not have a Technology Transfer Office.

- **CRYO**

Table 25. Detail of results - CRYO.

DETAIL OF RESULTS – CRYO (KER5)	
Roll in KER5	Leader
Non-confidential description of results your organization is participating in	Cryogenic cleaning and separation of biogas into bio-LNG and liquified CO_2)
Name and position of researchers/personnel involved	Ismael Callejón – Owner & Director Sergi Forns – Chief Executive Officer Andrea Munaretto – Project Coordinator
Participants/stakeholders from other organization	UPC (Universitat Politècnica de Catalunya)
Has result ownership been discussed?	Yes
Are access rights necessary for other partners?	Not in principle
Have you conducted any preliminary IP (Intellectual property, that is patents, designs, utility models) protection measures? E.g., background search, freedom-to-operate	No, not necessary
Background Intellectual Property	ZEP Pump patent
Foreground Intellectual Property	3 concepts to be patented
Does the research team have previous experience in patenting processes?	Yes, CRYO has successfully patented other inventions
Do you intend to publish academically the results? Is the team aware of the implications of academic publishing regarding patenting?	No

CRYO does not have a Technology Transfer Office.

- **DBFZ**

Table 26. Detail of results - DBFZ.

DETAIL OF RESULTS – DBFZ (KER7)	
Roll in KER7	Leader
Non-confidential description of results your organization is participating in	Status quo of CO_2 valorisation (WP 4); activities of policy recommendation of EU Biomethane Projects (WP5) and plant concepts (WP5)
Name and position of researchers involved	Jaqueline Daniel-Gromke (working group leader) Velina Denysenko, scientific researcher Janine Müller, scientific researcher Tino Barchmann, scientific researcher Katja Oehmichen, scientific researcher
Participants/stakeholders from other organization	No
Has result ownership been discussed?	Yes
Are access rights necessary for other partners?	No
Have you conducted any preliminary IP protection measures? E.g., background search, freedom-to-operate	No
Background IP	Methodology for economical evaluation of biomethane pathways; cost data of biogas plants and biomethane upgrading technologies; data base biogas plants with technical parameters in Germany.
Foreground IP	No further action planned
Does the research team have previous experience in patenting processes?	No
Do you intend to publish academically the results? Is the team aware of the implications of academic publishing regarding patenting?	Yes, we intend to publish the main results of overall evaluation of biomethane production with involved project partners academically. We are aware of the implication regarding patenting. It is not foreseen to publish technical details of concepts /case studies.

DBFZ have a Technology Transfer Office. The organisation's policy on technology transfer is as follows. Internal guidelines on innovation processes only exist in DE. In short: (sub-) licensing of IP is possible; no general restrictions apply (case-by-case-decision). Overview of spin-offs is provided here. DBFZ currently has no policy regarding investment in spin-offs. Part-time employment for entrepreneurs is possible and entrepreneurship is encouraged. As of 01/2023, some spin-offs have office space on campus.

On the other hand, DBFZ has not had any research projects successfully transferred via licensing/spin-off in areas related to SEMPRE-BIO.

- **AB**

AB does not generate any results; therefore, it does not need any specification.

- **INV**

INV does not generate any results; therefore, it does not need any specification.

- **SINTEF**

Table 27. Detail of results - SINTEF.

DETAIL OF TECHNO-ECONOMIC ASSESSMENT – SINTEF	
Roll in KERs	Participant
Non-confidential description of results your organization is participating in	Providing PEM membanes to ProPuls (WP2) Improved understanding of CO_2 valorisation (Case studies and WP 4); Evaluation of case studies, their technical design, economic performance and social impact (WP5)
Name and position of researchers involved	Bernd Wittgens, Senior Business Developer Olaf Trygve Berglihn, Senior Reseracher Torbjørn Pettersen, Senior Researcher Luis Colmenares-Rausseo, Senior Researcher Kirsten Svenja Wiebe, Senior Researcher
Participants/stakeholders from other organization	No
Has result ownership been discussed?	See Consortium Agreement
Are access rights necessary for other partners?	No
Have you conducted any preliminary IP protection measures? E.g., background search, freedom-to-operate	No
Background IP	Comprehensive knowledge regarding chemical engineering, process design, process modelling, optimization, techno-economic and environmental/social impact assessment for biobased conversion processes.
Foreground IP	No further actions planned
Does the research team have previous experience in patenting processes?	Yes
Do you intend to publish academically the results? Is the team aware of the implications of academic publishing regarding patenting?	YES, however SINTEF will want to publish to a certain extent. Publishing will be performed in strong cooperation with partners, especially in areas where patenting of technologies or applications is planned, publishing is postponed until these are secured.

- **TMB**

TMB does not generate any results; therefore, it does not need any specification.

- **UGE**

Table 28. Detail of results - UGE.

DETAIL OF RESULTS –UGE (KER5 and KER6)	
Roll in KER5 and KER6	Contributor
Non-confidential description of results your organization is participating in	To be discussed with UVIC and BIOGAS-E
Name and position of researchers involved	Prof. Erik Meers (Research group leader) Dr. Çağrı Akyol (postdoctoral researcher) Dr. Marcella Fernandes de Souza (postdoctoral researcher) Shruti Katti (PhD candidate)
Participants/stakeholders from other organization	Tbd
Has result ownership been discussed?	In case
Are access rights necessary for other partners?	Not in principle
Have you conducted any preliminary IP protection measures? E.g., background search, freedom-to-operate	No, not necessary
Background IP	No, not necessary
Foreground IP	No further action planned
Does the research team have previous experience in patenting processes?	Erik Meers (Research group leader) does.
Do you intend to publish academically the results? Is the team aware of the implications of academic publishing regarding patenting?	Yes

- **UVIC**

Table 29. Detail of results - UVIC.

DETAIL OF RESULTS –UVIC (KER6)	
Roll in KER6	Leader
Non-confidential description of results your organization is participating in	Valorisation of CO2 from biomethane streams for production of added-value products
Name and position of researchers involved	Lidia Paredes (Postdoctoral researcher) Laura Foix (Postdoctoral researcher) Pablo Martin Binder (PhD candidate)
Participants/stakeholders from other organization	UGENT, DTU, INNOLAB
Has result ownership been discussed?	Preliminarily
Are access rights necessary for other partners?	Not in principle
Have you conducted any preliminary IP protection measures? E.g., background search, freedom-to-operate	No
Background IP	No
Foreground IP	Depending on future results, technology patentability study and market study
Does the research team have previous experience in patenting processes?	Yes (the organization)
Do you intend to publish academically the results? Is the team aware of the implications of academic publishing regarding patenting?	Yes

- **BIOGAS-E**

Table 30. Detail of results - BIOGAS-E.

DETAIL OF RESULTS – BIOGAS-E (KER6)	
Role in KER5	Contributor
Non-confidential description of results your organization is participating in	To be discussed with CRYO
Name and position of researchers involved	Tine Vergote – Coordinator Céline Wyffels – Project Employee Isabel Vanneste – Administrative Employee
Participants/stakeholders from other organization	Tbd
Has result ownership been discussed?	Has been discussed with UGE.
Are access rights necessary for other partners?	Not in principle
Have you conducted any preliminary IP protection measures? E.g., background search, freedom-to-operate	No, not necessary
Background IP	No, not necessary
Foreground IP	No further action planned
Does the research team have previous experience in patenting processes?	Currently participating in five projects (2 Horizon Europe). No experience in patenting processes.
Do you intend to publish academically the results? Is the team aware of the implications of academic publishing regarding patenting?	Not Biogas-E, probably UGE

- **INNOLAB**

Table 31. Detail of results - INNOLAB.

DETAIL OF RESULTS –INNOLAB (KER5 and KER6)	
Roll in KER5 and KER6	Contributor
Non-confidential description of results your organization is participating in	To be discussed with UVIC and BIOGAS-E
Name and position of researchers involved	Bernard Willems (CEO-Research leader) Jean-Baptiste Joos (Operational manager) Dr. Amr Chamaa (R&D manager)
Participants/stakeholders from other organization	Tbd
Has result ownership been discussed?	Has been discussed with UGE
Are access rights necessary for other partners?	Not in principle
Have you conducted any preliminary IP protection measures? E.g., background search, freedom-to-operate	No, not necessary
Background IP	No, not necessary
Foreground IP	No further action planned
Does the research team have previous experience in patenting processes?	No
Do you intend to publish academically the results? Is the team aware of the implications of academic publishing regarding patenting?	No

- **NAT**

NAT does not generate any results; therefore, it does not need any specification.

- **MASS**

MASS does not generate any results; therefore, it does not need any specification.