Research and Innovation Action

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D8.1
- Project Management Plan
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WP8

Date M48

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31 March 2024	N°3	Tero Joronen	Minna Luhtanen Jukka Konttinen	Extension

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Abbreviations and acronyms

Acronym	Description
APR	Aqueous Phase Reforming
BL	Black Liquor
BL2F	Black Liquor to Fuel by Efficient HydroThermal Application integrated to Pulp Mill, EU project
BUL	Brunel University London
CA	Consortium Agreement
DESCA 2020	Development of a Simplified Consortium Agreement from year 2020
EC	European Commission
EU	European Union
GA	General Assembly
GHG	Greenhouse gas
HTL	HydroThermal Liquefaction
IAB	Industrial Advisory Board
IHDO	Integrated Hydrodeoxygenation
IHTL	Integrated Hydrothermal Liquefaction (with salt separation)
IM	Innovation Manager
KIT	Karlsruhe Institute of Technology
LGI	LGI Consulting, project partner
MB	Management Board
MP	Management Plan
NVG	The Navigator Company
PC	Project Coordinator
SINTEF	SINTEF AS is an independent, non-profit organisation from Norway, part of the SINTEF group

PSI	Paul Scherrer Institute
QM	Quality Manager
SINTEF-ER	SINTEF Energy Research is an independent, non-profit organisation from Norway, part of the SINTEF group
TAU	Tampere University
TL	Task Leader
VTT	Technical Research Centre of Finland Ltd
WBS	Work Breakdown Structure
WP	Work Package
WPLs	Work Package Leaders

Keywords

Black liquor, Fuel, HydroThermal Liquefaction, Project Management

1 Introduction

The European Union (EU) is a global leader in the transition towards a net-zero-greenhouse gas emissions (GHG) economy. In 2009, the EU set its objective to reduce emissions by 80-95% in 2050 and the EU is committed to achieving the transition by 2050 in a socially-fair and cost-efficient manner. In EU, transport is the only major sector where GHG emissions are still rising. Decarbonisation of shipping and aviation is most challenging due to the projected growth of air transport (100% more by 2050), the attractive pricing of fossil fuels, the low energy density of current batteries as barrier for direct electrification, and the long replacement time for aircraft and vessel fleets. The European Commission expects decarbonisation in shipping and aviation to take off by 2030 and we propose a biofuel production technology allowing the first commercial plant to be operational before that. Our aim is to produce drop-in advanced biofuel for shipping and aviation at price range of 0.5-0.90 €/l.

Project BL2F - Black Liquor to Fuel by Efficient HydroThermal Application integrated to Pulp Mill (contract #884111) aims to create full value chain from Black Liquor (BL) feedstock (side stream from chemical pulping) to fuel intermediate and drop-in jet fuels. The selected technology is HydroThermal Liquefaction (HTL). It is, according to several studies, most efficient biofuel production technology. It is especially suitable for converting fluid feedstock, such as BL to fuel intermediate.

The value chain is illustrated in Figure 1. First the technology is integrated to several Pulp Mills to produce the fuel intermediate. Secondly, the fuel intermediate is further refined for shipping fuel and conditioned for aviation fuel. The industrial partner on the Pulp Mill is The Navigator Company from Portugal. Valmet from Finland acts as a technology provider together with the catalyst produced Ranido from Czech Republic. World leading biofuel produced Neste produces the shipping and aviation fuels on its refinery. Avinor and Rolls Royce as the end customer (Industrial Advisory Board (IAB) members) contribute to the distribution and the engine application.

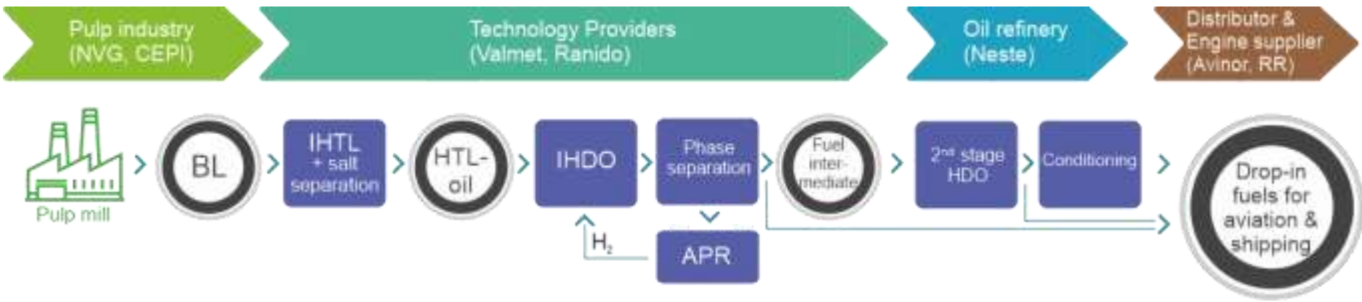

Figure 1. BL2F value chain and process for producing advanced drop-in biofuel for aviation and shipping.

The BL2F (Black Liquor to Fuel) project aims to develop and pilot a first-of-a-kind Integrated HydroThermal Liquefaction (IHTL) process at a pulp mill to produce fuel intermediate for further upgrading in oil refinery. Black liquor is a very promising and currently underutilized abundant non-food feedstock, it is available in huge amounts, globally 170 million tons per annum. The process includes a conversion of biomass to low oxygen content HTL-oil in elevated temperature and pressure (up to 300 bar, 400 C) and in reductive conditions. The HTL-oil is converted to further upgradable fuel intermediate (containing less than 5 mass percentage by mass of oxygen) by Hydrothermal Hydrodeoxygenation (HDO) process integrated to IHTL (IHDO) with an expected mass yield over 45 % and energy content of 85% from black liquor to fuel intermediate. Relatively hard process conditions enable a short residence time of 5 - 7 min. This keeps the required reactor volume and capital costs low. Furthermore, the integration of IHTL to pulp mills offers significant cost reduction. The fuel intermediate will be further upgraded to aviation and marine fuels utilizing existing process units at oil refineries and renewable fuel plants or the intermediate is used as marine fuel as such. At pulp mills, the primary invention is to combine the separation of solids from black liquor during conversion to HTL-oil. Due to the complex chemical composition of HTL-oil, efficient and stable supported metal catalysts are required for IHDO and further upgrading processes, and these are developed in the project. Hydrogen consumed in IHDO is generated by Aqueous Phase Reforming (APR) the aqueous phase of the HTL products. The BL2F project will combine the innovative HTL technology to fundamental chemistry, modelling, process and concept optimization, and sustainability assessment.

Our overall objective is to develop a feasible, efficient and sustainable process converting black liquor (by-product of pulp production) to drop-in biofuels for aviation and shipping. For this, we aim to

Table 1. The overall objectives of BL2F project

Develop an innovative integrated hydrothermal liquefaction (IHTL) and salt separation process
Develop efficient upgrading process by hydrothermal Integrated HydroDeOxygenation (IHDO) to HTL process and to a pulp mill
Improve the sustainability of our concept by internally produced green hydrogen from aqueous phase
Develop HDO catalysts with improved performance and lifetime
Demonstrate cost-competitive further upgrading of fuel intermediate to drop-in fuels
Evaluate market potential, scale-up and demonstration at pulp mills
Assess environmental, economic and societal impact of the whole value chain

2 Project concept

The existing HydroThermal Liquefaction (HTL) process is the most promising production pathway for the next generation biofuels, according to a scientific analysis. In the HTL, biomass is converted under elevated temperature and pressure (up to 300 bar, 400 C) to suitable intermediate for upgrading to drop-in biofuels. Although black liquor is a mass side-stream of forest industry, due to knowledge gaps, investment decisions for full-scale HTL plants in the forest industry have been hindered so far.

The current knowledge gaps are:

- **Process chemistry:** kinetics of hydrothermal black liquor degradation, characterisation of oligomeric reaction products, char formation and interaction with salts, stable catalysts for HTL-oil upgrading, HTL-oil stability
- **Process technology**: high pressure pumping, corrosion resistant pressure part materials, salt separation, bio oil upgrading to drop-in fuels, overall integrated process concept
- **Modelling**: reaction pathways, mechanisms and kinetics and, overall process model, flow fields inside the HTL reactor
- **Environmental and social sustainability**: comprehensive understanding of life cycle contribution, energy efficiency and societal impact
- **Economics**: cost competitive process design, suitable and affordable corrosion resistant materials, durable catalysts, refining concept

The concept of BL2F integrated to a pulp mill is described in Figure 2. The process is called integrated for three reasons 1) the process is integrated to a pulp mill, making, for instance, treatment of gaseous and aqueous residues and energy integration easier. 2) Salt separation is integrated to supercritical water liquefaction (SCWL). 3) First stage of HDO is integrated to HTL and conducted at supercritical conditions. Feedstock black liquor is fed into the HTL reactor where it converts into HTL-oil. The HTL reactor has an integrated supercritical salt removal. The brine, containing the used cooking chemical and most of the solids is returned to the chemical recovery. HTL-oil is composed of two liquid phases: oil and aqueous phases. The gaseous phase from IHTL is directed to odorous gas treatment of pulp mill. The liquid phases are upgraded by the Hydrothermal HydroDeOxygenation integrated to IHTL (IHDO) producing fuel intermediate or even drop-in fuel component suitable for marine fuels. Phase separation of oil and aqueous phases is performed after IHDO. The aqueous phase in fed to Aqueous Phase Reforming (APR) - producing H_2 rich gas for the IHDO. This improves the sustainability of the solution, as normally applied fossil hydrogen is substituted. The fuel intermediate is transported to an oil refinery or a renewable fuel plant for further upgrading by second-stage HDO and subsequent conditioning to jet fuel e.g. by hydroisomerization.

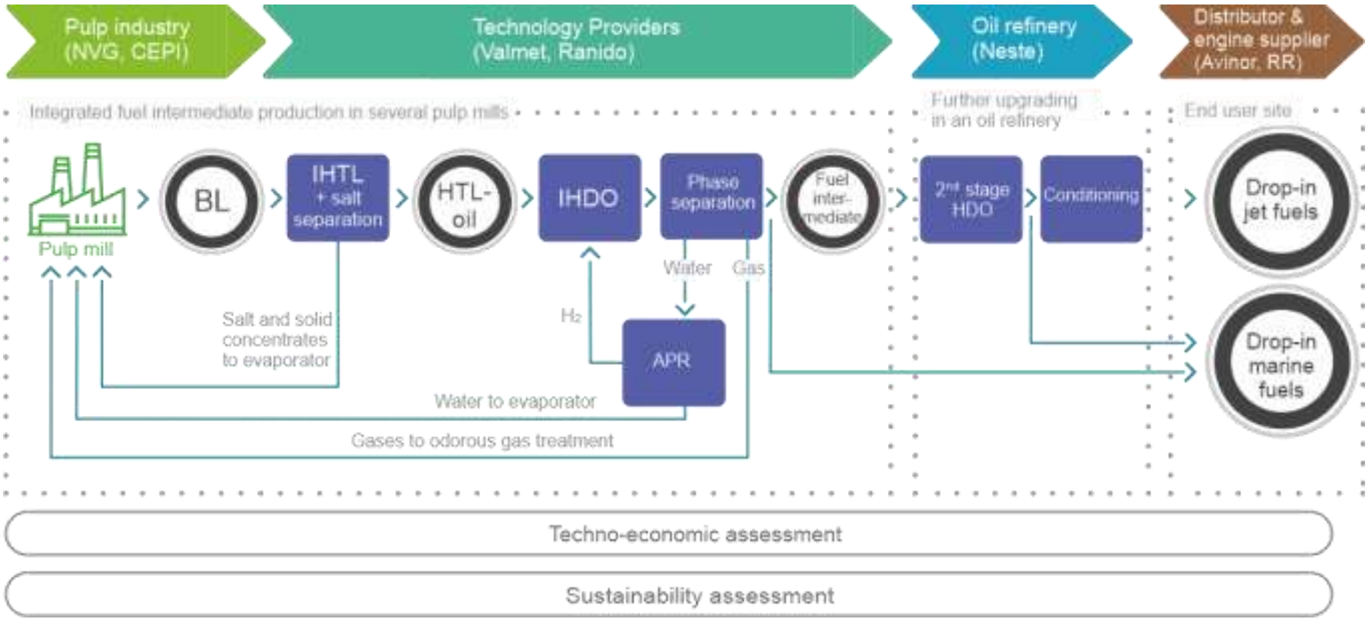

Figure 2. The BL2F concept as a whole

Techno-Economic Assessment aims to form a detailed scale-up analysis to evaluate the economic and environmental performance of the integration of the HTL system into an existing commercial pulp mill of NVG will be calculated under representative industrial conditions. The general methodology is to use parametric models for evaluating the mass and energy flows as well as the capital and operating costs as a function of plant capacity, feedstock composition and process design parameters for the technologies involved.

Sustainability assessment will establish the sustainability indicators will provide quantitative measures of the BL2F scheme sustainability performance within the economic, environmental and social dimensions. The analysis will reveal the key intersections of the different interrelated supply chains, assess their linearity, and identify ways to minimise the waste flows and retain the energy value and materials within the system.

2.1 Development timeline

BL2F technology aims to the market before 2030. The technology readiness level of the novel BL2F process is currently at TRL 3 and will advance to TRL 5 by the end of the project.

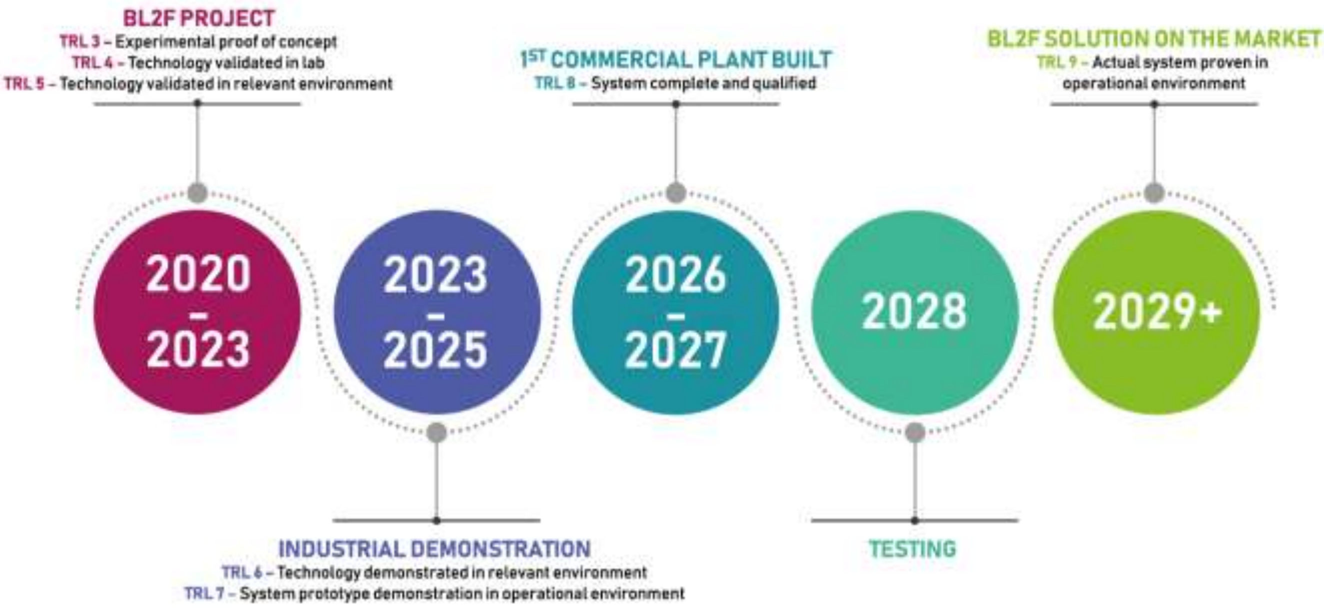

Figure 3. The development timeline of the BL2F technology

Like potentially suitable alternative processes currently under development, extensive R&D time is required since material and process design issues are very complex and need to be carefully studied and tested to achieve industrially relevant levels of availability and performance. First, the proposed research project will take three years (2020-2023). An industrial demonstration is required for mitigating the technical and economic risks and maturing the technology to industrial readiness (2023-2025, reaching TRL 7). The first commercial plant is built within two years (2026-2027, TRL 8) and tested for a year (2028). Thus, the full commercialization (TRL 9) is reached 2029, after 10 years of intensive R&I (Figure 3). The proposed technology is well in line with the desired timeline of EC.

2.2 Partners - definition of roles and responsibilities

The BL2F consortium researches and demonstrates the potential of integrated HTL to produce competitive drop-in biofuels for aviation and marine from underutilized non-food feedstock. This task is challenging and requires experts from different fields. The partners are listed in Table 2 below.

Table 2. BL2F project partners

Participant no.	Participant organisation name	Country	Type
1	Tampere University (TAU)	Finland	University
2	Brunel University London (BUL)	UK	University
3	Karlsruhe Institute of Technology (KIT)	Germany	University
4	SINTEF (SINTEF)	Norway	Research Organisation

5	SINTEF Energy Research (SINTEF-ER)	Norway	Research Organisation
6	Paul Scherrer Institute (PSI)	Switzerland	Research Organisation
7	Technical Research Centre of Finland Ltd (VTT)	Finland	Research Organisation
8	The Navigator Company (NVG)	Portugal	Industry
9	Valmet Technologies Oyj (VALMET)	Finland	Industry
10	Neste Oyj (NESTE)	Finland	Industry
11	Ranido Ltd (RANIDO)	Czech Republic	SME
12	LGI Consulting (LGI)	France	SME

The project is an industrially driven research consortium. It consists of 12 partners from eight European countries: Czech Republic, Finland, France, Germany, Norway, Portugal, Switzerland, and UK. Since the post-project uptake of its results requires substantial investments and a reliable value chain, the consortium contains the process supplier Valmet and biofuel refinery Neste. The Navigator Company will provide the feedstock and plant specific data required for the case study, will work actively develop the industrial solution.

The roles of the partners are well balanced both in workload and the field of expertise. The main roles of the partners are as follows. TAU concentrates to the conceptual design of the technology and the piloting. BUL concentrates on the sustainability analysis, and KIT in the reaction kinetics and analytics. SINTEF will do the corrosion analysis and the SINTEF-ER the plant design and techno-economic study. PSI develops the salt separation, VTT develops the APR and leads upgrading. The NVG provides the BL feedstock and Mill information for the case study. Valmet studies the HTL integration into the Pulp Mill. Neste upgrades the fuel intermediate to shipping and aviation fuel. Ranido develops the required catalyst, and LGI coordinates the communication and the exploitation. The more detailed roles of each partner are presented in **Error! Reference source not found.**.

Table 3 The detailed roles of the partners of BL2F

Partner	Roles in the consortium	Resources to be committed
TAU	Coordination, experiments with pilot HTL, HTL process modelling, conceptual design modelling	Pilot HTL equipment (mainly financed from other sources). Software modelling tools.

BUL	Development of Sustainability Assessment	Software modelling tools
KIT	Batch tests, analytics, chemical kinetics	Laboratory and reaction kinetics
SINTEF	Corrosion tests and material selection in collaboration with SINTEF ER	Material selection expertise and corrosion tests
SINTEF ER	Corrosion tests in collaboration with SINTEF Conceptual design and economic analysis of the integrated concept	Continuous HTL reactor for corrosion experiments, software modelling tools
PSI	Salt separation (thermodynamics & process), hydrothermal HDO, analytics of non-volatile biocrude/upgraded biocrude and catalysts	Continuous salt separation test rig, Continuous-flow catalyst test rigs (CSTR, FBR), catalyst & analytical specialists, expert technician team, analytical equipment and laboratory work (catalyst and biocrude)
VTT	Upgrading of HTL product by HDO Simulation of slat separation and effect on pulp mill	Continuous reactor for upgrading and aqueous phase reforming of water phase, analytic lab, simulation tool to calculate salt separator (CHEMSHEET) and effect on pulp mill (HR-MS QToF and Orbitrap, HP-DSC, ...)
NVG	Providing feedstock, special plant data, site for the industrial piloting, exploitation and marketing insight	BL and delivery, R&D management and personnel, site management and operations, business development experts
VALMET	Feedstock know-how, technology evaluation, process design and exploitation	Material specialist, process design specialists, new technology monitoring, feasibility study, and business development
NESTE	Upgrading of bio-oil to advanced biofuel and QA	Refining tests, feasibility study, and business development
RANIDO	Catalyst development & scale-up	Preparation and optimization of HDO catalyst

3 Guidelines

This part of the project management plan explains the main guidelines of the project. The core of the management happens on the collaborative platform Eduuni.

Collaborative platform

The day to day project management is done on an Eduuni platform (

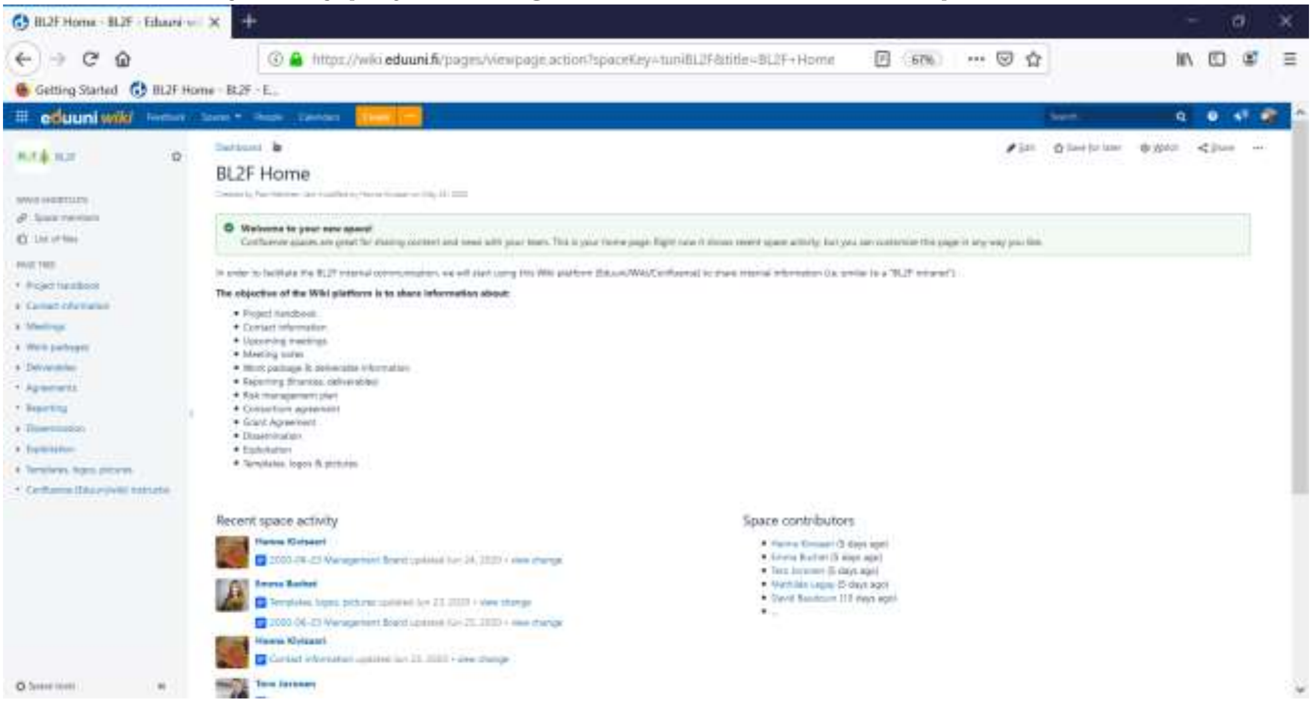

Figure 4). Eduuni is a collaboration service environment for flexible and secure collaboration across organisation and ecosystem boundaries (info.Eduuni.fi). The platforms requires login, that can be made via different platforms (LinkedIn being one of them), so that members would not have to remember an extra password. The platform enables collaborative editing of documents. For instance, the meeting agendas and minutes are directly made at the platform, with the possible direct contribution of anyone. In addition, the deliverables are produced at it in addition. Attachments are linked to the documents are hyperlinks.

From the frontpage there are several direct links to subpages (left side of

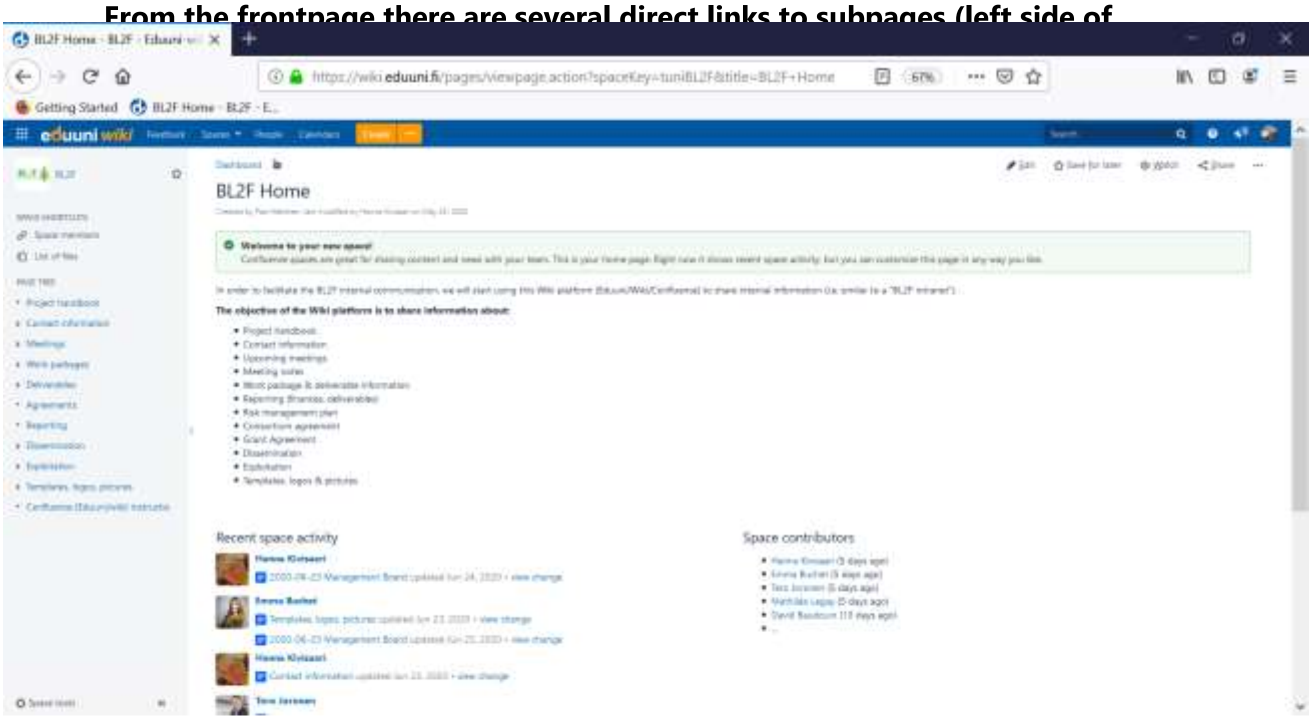

Figure 4); project handbook, contact information, meetings, WPs, Deliverables, Agreements, Reporting, Dissemination, Exploitation, Templates, logos and pictures.

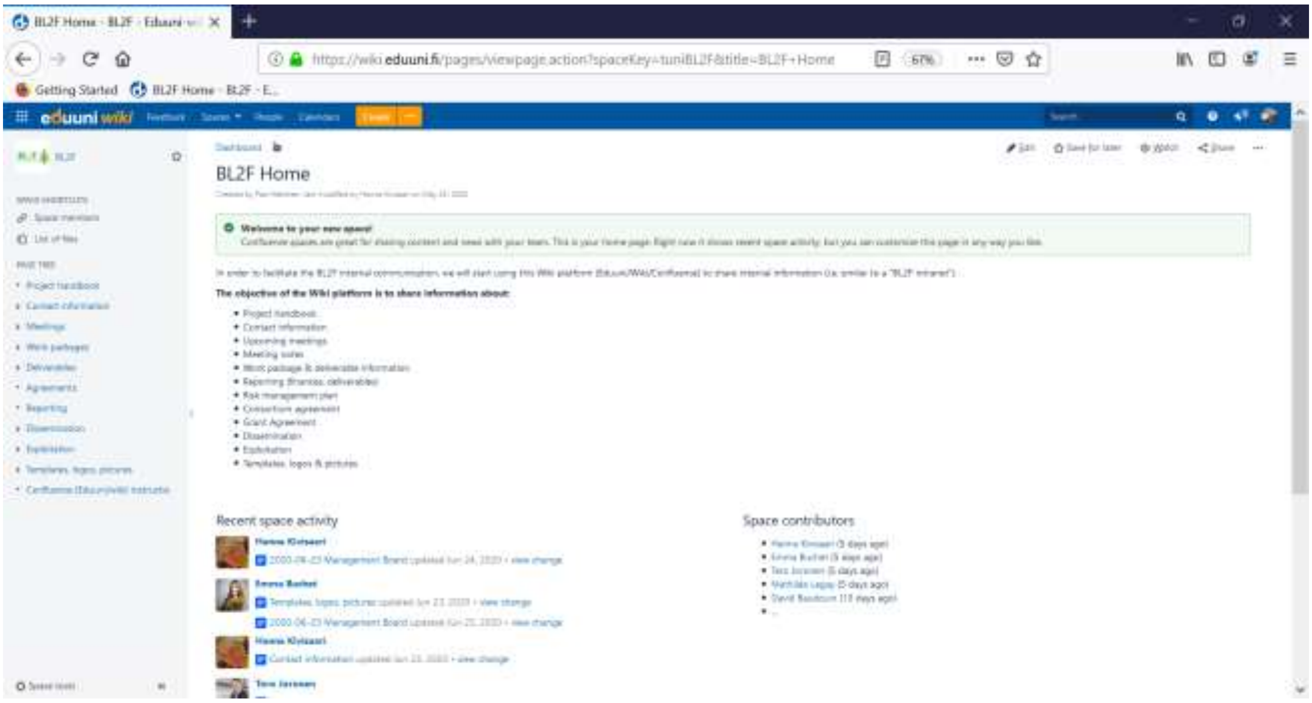

Figure 4. The front page of BL2F Eduuni page.

3.1 Organisational structure and decision making

The organisational structure of BL2F is shown in Figure 5 below. Two decision–making bodies will formally govern the project: The General Assembly (GA) and the Management Board (MB). The GA will comprise one representative from each participating organisation. It will be chaired by the Project Coordinator (PC) and will act as the ultimate decision-making body. The GA ensures that each partner has a voice and vote in the project management. The MB will include the PC, the work package leaders (WPLs) and the Innovation Manager (IM, Mikko Uusitalo Valmet), Ursel Hornung (KIT), Judit Sandquist (SINTEF), Frederic Vogel (PSI) and its function will be to monitor the day-to-day running of the project. The MB will make proposals and report to the GA. The MB drives the project towards its goals and the impacts to be achieved along the project timelines. The MB ensures that the necessary actions are communicated to all partners and executed to accomplish the planned objectives and impacts as well as ensures that all deliverables are completed in timely manner and with the set quality. The MB is chaired by the PC and the MB is responsible for efficient implementation of the decisions of the GA. The WPLs report to the MB. All the roles are defined, and rules of operation will be proposed in the Consortium Agreement (CA, based on DESCA 2020). The Industry Advisory Board (IAB) (see section 3.2), PC and IM will follow the relevance of the results, and the exploitation of the results. IAB does not have decision-making power, but their recommendation and views are reported to the MB, and the corresponded handled in the GA.

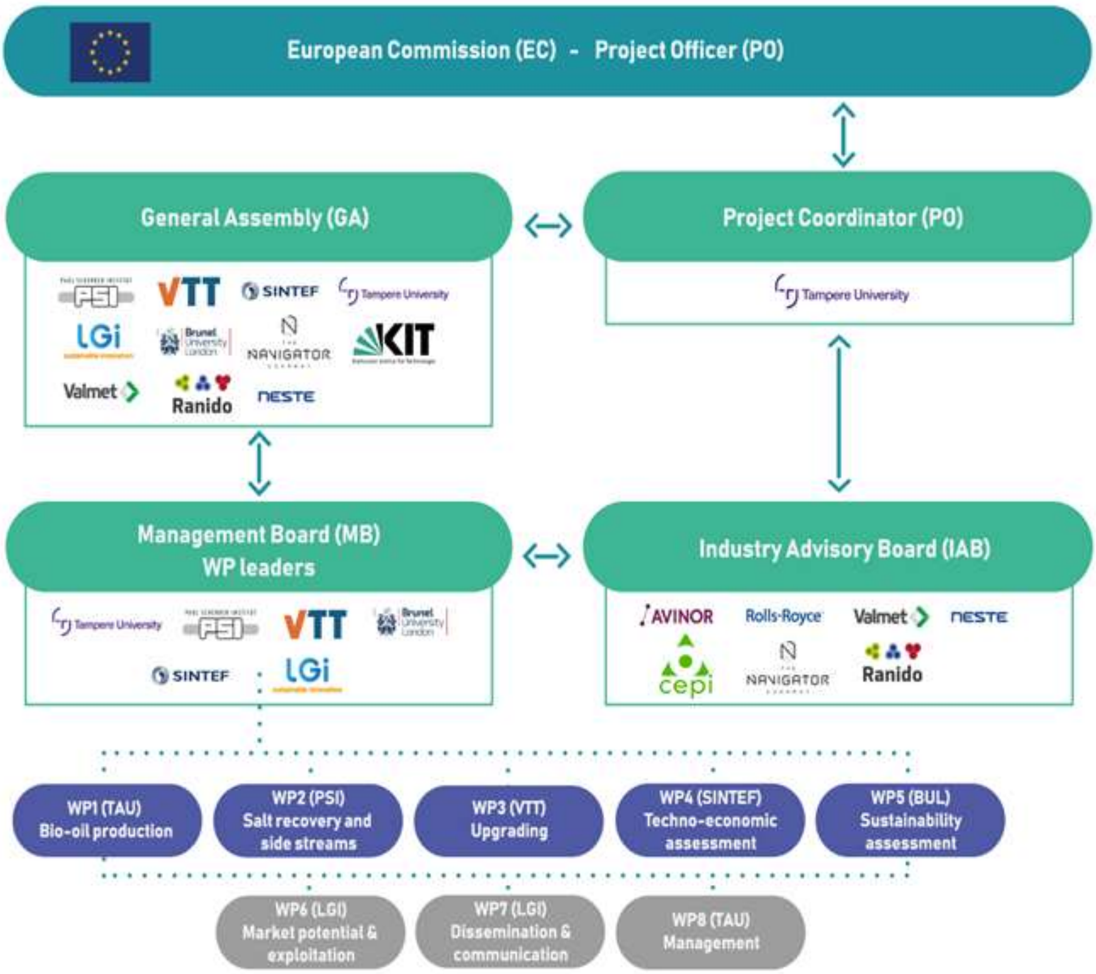

Figure 5. Organizational structure of BL2F project.

The BL2F project is coordinated by TAU, and TAU oversees the administrative, financial, technical/scientific, and organisational management of the project as a whole and is the contact point for the European Commission. The roles and responsibilities of the PC and each partner are defined in the Grant Agreement and the CA. The implementation of the management is described in WP8. The PC is assisted by the Project Support Office a central team of eight Project Management professionals which will second a Project Manager to BL2F.

The project is organised into eight work packages and each WP has been further divided into several specific tasks. The Work Package Leaders (WPLs) are shown in Table 4. The role of each WPL is to lead the work of the WP, and ensure the realisation of the objectives and described in each respective WP. At the same time, links with other work packages are strengthened through effective communication between WPLs and supported by an internal communication (See WBS at chapter 7). The main responsibility of the Task Leader is to ensure execution of their respective task and they report directly to the WPLs.

Table 4. The workpackages and the work package leaders

WP No.	WP title	Leading partner	WPL
WP1	HTL-oil production	TAU	Jukka Konttinen
WP2	Salt recovery and side stream valorization	PSI	David Baudouin
WP3	Upgrading and application testing	VTT	Juha Lehtonen
WP4	Techno-economic assessment	SINTEF-ER	Gonzalo del Alamo
WP5	Sustainability assessment	BUL	Evina Katsou
WP6	Market potential and exploitation	LGI	Mathilde Legay
WP7	Dissemination and communication	LGI	Emma Buchet
WP8	Management	TAU	Tero Joronen/ Hanna Kivisaari

The decision making body GA will function according to the following principles; (a) each member shall have one vote; (b) the responsibilities and authority of the GA shall be set out in the CA, including decisions relating to changes in the technical implementation of the project, the evolution of the Consortium, actions required for non-performing or underperforming Participants, and processes relating to the coordination of IP management and the distribution of EU funding; (c) the GA shall not deliberate and decide validly unless two thirds of the members is present or represented. The detailed decision-making procedures aim to minimise the risk of problems arising during the implementation of the project and provide mechanisms for the amicable resolution of any emerging conflicts.

3.2 Industrial Advisory Board

The Industrial Advisory Board (IAB) is a commentative board that follows especially the significance and exploitation results in collaboration of PC and MB. The IAB consists of members as follows (more detailed descriptions are available in GA).

Table 5. The members of Industrial Advisory Board

Jori Ringman, Director General, CEPI
Arvid Løken, Senior adviser in the Carbon Reduction Programme, and Manager of Nordic Challenges Team, Avinor
Leif-Arne Skarbø, Chief Technology Officer, Bergen Engines AS
Alexandre Gaspar, New Businesses Projects Manager, RAIZ (NVG)
Pavel Kukula, Managing Director, Ranido

Jussi Orhanen, Business Development Manager, Valmet
Juha-Erkki Nieminen, Business Development Manager, Neste

3.3 Innovation management

The project evaluates the main relevant results for exploitation using productive tools to propose new or improved products/services based on (and in order of): customer segments, value proposition, channels, customer relationships, revenue streams, key resources, key activities, key partners and cost structures. The Innovation Manager (Mikko Uusitalo) will coordinate actions together with WP6 related to business intelligence in relation with project results and any other related results. Innovation management finds various solutions to support the justification of investments to the decision-makers and paying customers. Investments include money (e.g. cost for the novel solution) and time (e.g. time spent for training and adapting to the new process).

Working in collaboration with the leader of T6.5, the IM will oversee and coordinate the following activities:

- Appropriateness of the IPR-principles, proposing any required changes of the CA for approval by the GA
- Review, approval and follow-up of the exploitation strategy and plan
- Exploitation activities in agreement with the project's open science policy
- Central contact of the PC and all partners concerning inventions and exploitation options
- Identification of inventions, including those generated during co-creation in the social innovation process, with potential for exploitation and emerging innovations related to the project results
- Identification of new exploitation opportunities, internal and external
- Monitoring of competitors, markets, technologies, innovations, IPR
- Monitoring of stakeholders and lead-users, which could become licensing partners for exploitation
- Monitoring and acting on funding and financing opportunities like the H2020 and EU finance for business plan development, developing the prototypes into products and piloting the system beyond TRL5

3.4 Risk management

This project is technically very demanding. Potential risks will be identified and recorded in a risk register in agreement with the scheduled work plan and tasks. The risk management is led by the Quality Manager (Jukka Konttinen, TAU). The risk management consequently assesses any potential technical and management risks to be able to react fast and to guarantee proper implementation of the project by adjusting tasks, if necessary. Potential risks and mitigation measures have been identified as summarised in the contingency plan. The likelihood and the severity of each risk is assessed as low (L), medium (M), or high (H).

A Risk management plan elaborating on the risks identified at proposal submission stage (Table 6, below) will be developed and updated regularly (D8.2). Especial attention is put on the availability of resources and recovering of potential changes in the consortium.

Table 6 Critical risks for the implementation of the project at the beginning of project

Description of risk	Level of Likelihood /Impact *)	WP(s)	Proposed risk-mitigation measures
Failure of continuous lab-scale HTL unit: Cannot supply Tasks 1.4 and 2.2 with liquefied biomass	M/H	1	The required materials are run by batch in order to have the critical samples available. The error caused by method change is estimated. Possible modifications in the continuous HTL-unit design and configuration
Failure of continuous lab-scale HTL unit for corrosion experiments: Cannot perform long-term continuous tests	M/M	1	The corrosion experiments to be performed in a batch reactor. As consequence, the results will be less realistic.
Only very expensive alloys applicable: Very high CAPEX	M/H	1	Use of overlay weld on top of a cheap construction steel to reduce the use of the expensive alloys
Integrated HTL-Salt separator plugs or fails to desalinate or liquefy biomass: Inability to deliver concentrated brine or desalinated HTL-oil despite process optimization.	M/H	2	Identification and removal of root cause: use of different rigs available at PSI; modification of separator vessel/ used in a series, separator redesign, testing HTL and separator in separate vessels
Aqueous phase reforming (APR) catalyst deactivates or hydrogen production by APR is not satisfactory: The performance in not meeting the requirement	M/H	2	Identification of root cause & act 1) test less sensitive catalyst 2) purify feed (Sulfur, other salts) 3) co-fed another feedstock to APR such as methanol to increase hydrogen production 4) investigate hydrogen production by other methods, such as HTG
Hydrothermal HDO catalyst lacks long term stability: Catalysts fails to efficiently perform hydrothermal treatment	M/H	3	Identification of root cause & act: 1) Adapt feed sulfur content, depending on the catalytic system; 2) Regeneration of catalyst based on procedures developed at PSI

Upgrading of Jet A-1 not able with HDO: E.g. hydroisomerization is required	M/H	3	Early phase detection of the HDO performance on Jet A-1. Analysis of the phenomenon. Re-design the tests to find right approach.
Lack of HTL-oil or Fuel Intermediate: Pilots not able to provide enough material for upgrading tests	M/H	3	Clear and early detection of the problem. Root cause analysis and relevant effort for correcting the cause or revising the plan, but finding substituting course for the HTL-oil or Fuel Intermediate.
Delay or absence on providing experimental data to perform the overall process design and analysis	M/H	4	Quantify at early stage realistic ranges for the key process performance parameters based on literature data and modelling
No-deal Brexit: UK partner BUL will not be financed (not likely 6/20202)	L/H	5	The UK government has committed to guarantee funding for all successful competitive UK bids to Horizon 2020 that are submitted before UK leaves the EU, if there is a no-deal Brexit[1]. However, since this is not a legally binding promise, alternative research groups for dealing with BUL's responsibilities (particularly WP5) have been identified. The Brexit situation does not seem to affect the execution of the project
COVID-19: Extra delay on the activities	H/H	All	COVID-19 pandemia has already at the time of the publishing delayed sample collection and laboratory analytics. Special attention is to be paid to coordination of the tasks and rearrangement of the project work. More frequent MB meeting have been made.
Insufficient interviews for replicability to other sectors: Replicability analysis will be weak	L/L	6	Industry partners are participating in the task and all project partners can help identify a broad list of stakeholders to be consulted.

***) Level of likelihood & impact: L=low; M=medium; H=high**

[1] *https://www.gov.uk/guidance/horizon-2020-funding-after-brexit*

3.5 Quality assurance plan

Next to the risk management, the quality assurance is essential for reaching the project's targets, and the Quality Manager Jukka Konttinen (TAU) will coordinate the work. The main target is to monitor the achievements of the project, i.e. the deliverables and milestones, and to establish adequate processes within the project to get high-quality results. It aims at steering and controlling the project in compliance with contractual regulations. The WPL is in charge of the quality of deliverables. The project management experts within the project office with PC will do the definition, implementation and improvement of processes, methods and tools. Regarding the quality of the technical results, the transfer activities of dissemination will be based on peer reviews. At least two experts (not directly involved at the preparation of the deliverable) will evaluate each deliverable. If needed, the PC or WPL can allocate a third reviewer. The WPLs are responsible for the technical content and the PC acts as the final control point.

Quality assurance ensures good research and project practices and quality of the deliverables, as well as monitors all procedures carried out in the project. The Quality Manager (QM) manages the quality procedures of the project and defines quality control criteria for deliverables in agreement with all the project partners. The Quality Assurance Plan (included in the Project Management Plan) (D8.1) will define principles of good research practice related to BL2F tasks and define how and

by whom the project deliverables will be reviewed prior to submission. It also includes training material on Innovation Management, ethics, good research practice. A peer-review system will be established consisting of representatives.

3.6 Deliverable review guideline

- WP-leader: Start preparing the deliverable with lead beneficiary and check the schedule
- Decide the reviewers (2 from beneficiaries which have not been preparing the deliverable) and inform them (1 month before the DL)
- Ensure the quality and timing (WP-leader and lead beneficiary)
- Reviewers gets the material in 2 weeks
- 2 weeks' time to make corrections

Coordinator (TAU) gets the final deliverable (in deliverable template doc/pdf) latest 2 working days before the deadline.

4 Training material on research ethics

The BL2F project will follow the good research conducting principals. They are listed directly according to the recommendation of Finnish board of research integrity (TENK). They have published Responsible conduct of research (RCR) Responsible conduct of research and procedures for handling allegations of misconduct in Finland. Guidelines of the Finnish Advisory Board on Research Integrity 2012 (pdf) - *in Finnish, Swedish and English, attachment 2)*

The responsible conduct of research (RCR 2012, attachment 2).

In order for research to be ethically acceptable and reliable and for its results to be credible, the research must be conducted according to the responsible conduct of research. Applying the guidelines for the responsible conduct of research within the research community constitutes a form of self-regulation that is bound by legislation. Furthermore, the responsible conduct of research is an integral part of the quality assurance of research organisations. From the point of view of research integrity, the premises for the responsible conduct of research are as follows:

1. The research follows the principles that are endorsed by the research community, that is, integrity, meticulousness, and accuracy in conducting research, and in recording, presenting, and evaluating the research results.

2. The methods applied for data acquisition as well as for research and evaluation, conform to scientific criteria and are ethically sustainable. When publishing the research results, the results are communicated in an open and responsible fashion that is intrinsic to the dissemination of scientific knowledge.

3. The researcher takes due account of the work and achievements of other researchers by respecting their work, citing their publications appropriately, and by giving their achievements the credit and weight they deserve in carrying out the researcher's own research and publishing its results.

4. The researcher complies with the standards set for scientific knowledge in planning and conducting the research, in reporting the research results and in recording the data obtained during the research.

5. The necessary research permits have been acquired and the preliminary ethical review that is required for certain fields of research has been conducted.

6. Before beginning the research or recruiting the researchers, all parties within the research project or team (the employer, the principal investigator, and the team members) agree on the researchers' rights, responsibilities, and obligations, principles concerning authorship, and questions concerning archiving and accessing the data. These agreements may be further specified during the course of the research.

7. Sources of financing, conflicts of interest or other commitments relevant to the conduct of research are announced to all members of the research project and reported when publishing the research results.

8. Researchers refrain from all research-related evaluation and decision-making situations, when there is reason to suspect a conflict of interest.

9. The research organisation adheres to good personnel and financial administration practices and takes into account the data protection legislation.

5 Project procedures

5.1 Meetings

The project management will in practice be largely conducted in meetings. The meetings are listed in Table 7. In addition, meetings will be an important part of BL2F's communication strategy and will facilitate knowledge transfer among the partners. Joint project meetings consisting of GA and MB meetings will be organised as 2-day events. In the MB meetings, project progress will be monitored. The following aspects will be considered: (1) Scientific progress including Deliverables (Listed in the BL2F Eduuni platform**Error! Reference source not found.**) and Milestones (listed in the BL2F Eduuni platform), (2) Dissemination activities; (3) IPR-protection e.g. patent applications and trade secret, (4) exploitation aspects, and (5) detailed implementation plan. If deviations from the work plan become evident, contingency plans will be proposed to the Commission to overcome any difficulties or to modify the direction of research accordingly. During the WP meetings, WPLs will summarize progress (in collaboration with Task Leaders (TL)) in their respective WPs and their plans for the subsequent 6–12 months. Interactions among the WPs will be encouraged by arranging time for small meetings between relevant working parties during project meetings. The progress of WP is followed by WBS illustration (See part 7). Minutes of GA, MB and WP meetings will be compiled and uploaded onto the password-protected area of the BL2F Eduuni workspace. Further ad hoc meetings will be arranged and conducted in person, by telephone, Skype or video conferencing as appropriate. The aim is to organize the halfway (18-month) meeting and final meeting together with the clustering workshops described in WP7.

Table 7 Meeting plan for regular meetings

Meeting	Time	Attendees	Content
Project Kick-off	Project start-up, M01 (face-to-face)	All project partners	Discuss the work plan, structure of the project organisation, flows of information and promote creativity and co-operation.
WP Meetings	At least bimonthly (remote)	WPL and WP participants	Focus the work within a WP; a status report is generated for WPL and distributed to all participants
MB	Quarterly (face-to-face or virtual)	MB members	Coordinate and monitor the work of different WPs, discuss the project work progress and co-ordination, outstand actions, and ad hoc issues. Review of planned Milestones and risks elements. To control the whole project commitment to the final objectives, costs and deadlines. Minutes will be recorded by the

			Project Manager and distributed to all participants.
Industry Advisory Board	At least annually prior to GA	Companies, PC, IM	Coordinate the relevance and exploitation of results
GA	Annually (face-to-face)	All partners	Decision-making on strategic issues of the project. Minutes will be recorded by the Project Manager and distributed to all participants
Project end seminar	M48	All partners and networks	Summaries of the main findings of the project, especially exploitation plans, further research and piloting

6 Gantt chart

The project was extended first after M12 for 6 months due to several issues caused by COVID-19. Especially delays where in the emigration services related to new recruitments and laboratory service due to restrictions to attend the laboratories. The second extension was due to delays in the piloting equipment. The delay was caused by extra complexity of the BL2F modifications, lack of personnel and reliability issues with the EHTA equipment. The total period of time for the project was 4 years (48 months).

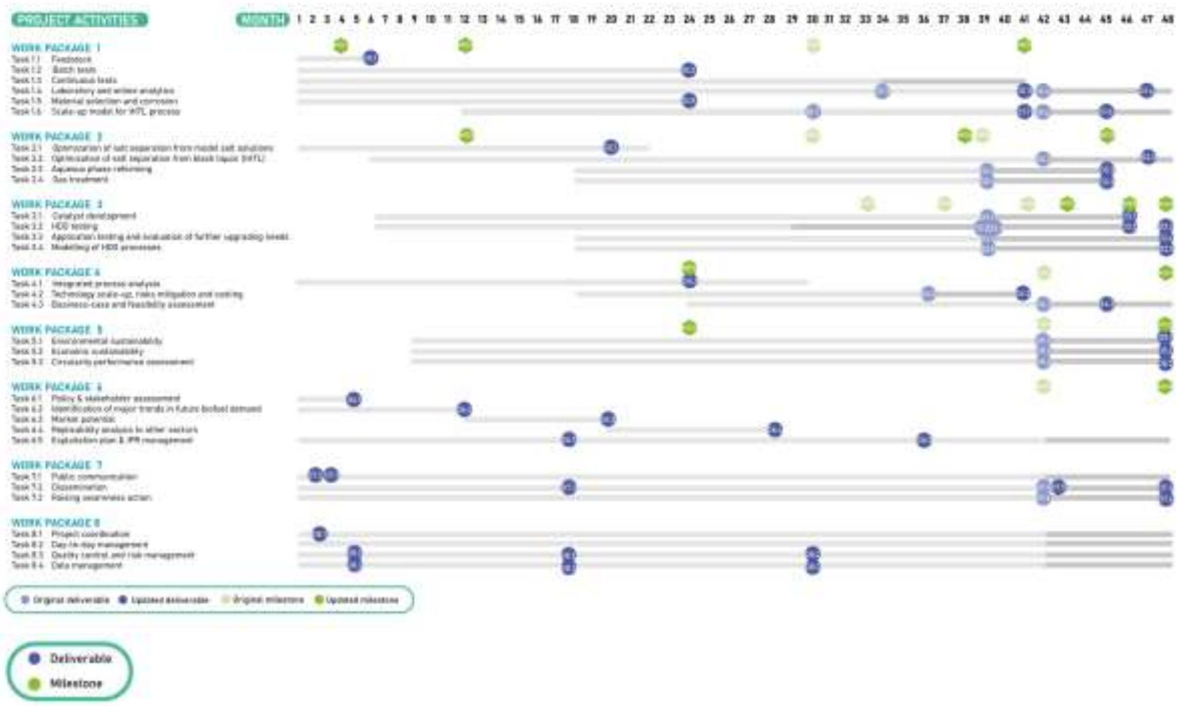

Figure 6 Updated Gantt chart of the BL2F project that will be used for monitoring the progress of the project

7 Work Breakdown Structure

For the efficient work of each WP a work breakdown structure will be made. It links the subtasks and separate parts to a whole WBS defines the synchronization of the parts and sets the preconditions to each part. The graph will be used to visualize and follow-up the progress (Figure 7). It also lists the key targets of each part (subtask) and risks. Especially important is to present the links between different WPs. The WBS also lists the subtask leaders, if they have been nominated.

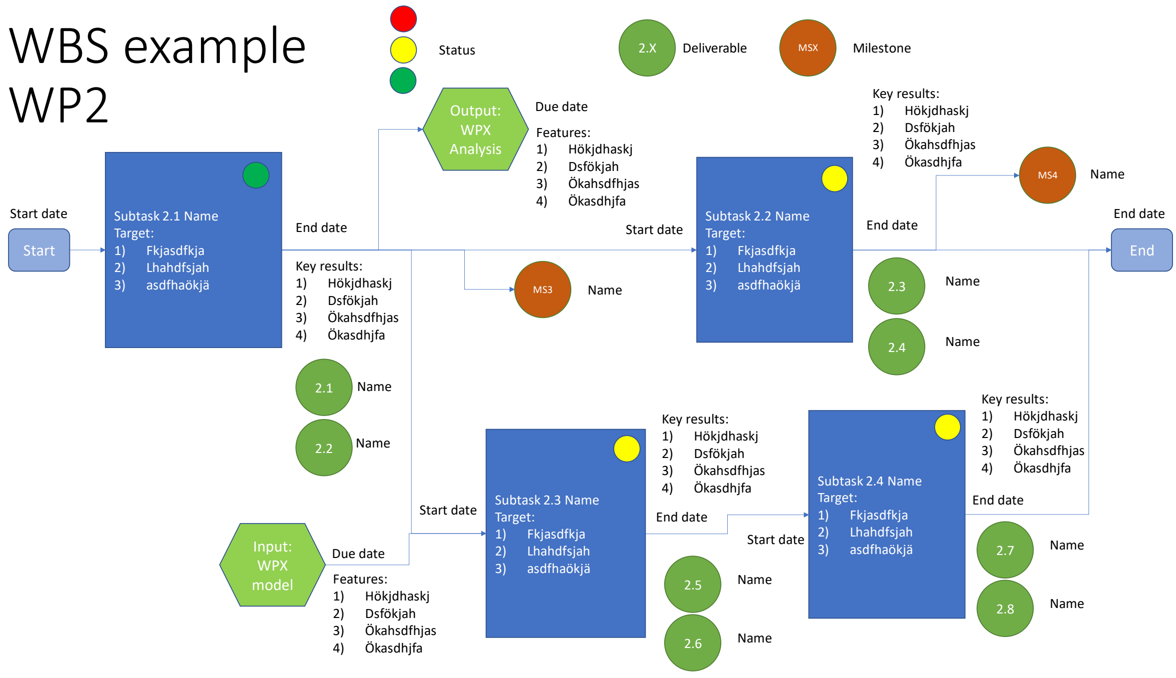

Figure 7. An example of the Work Breakdown structure (WBS)

Work break-down structures are applied in the follow-up of the project in MB meetings. They are updated to each meeting. They are available in the minutes of the MB meetings in the BL2F eduuni page.

8 Mitigation of the delay in the piloting of the continuous process

The piloting of the new technology was in the beginning of the project found one of the main risks (Table 6 Critical risks for the implementation of the project at the beginning of project). This is indicated in the risks in the Table 9 below. The design of the salt separation was delayed due to lack of salt separation data, and complexity of the reactor design. Also, the construction and the start-up of the equipment took longer than expected. The operation of the equipment has been unreliable due to high temperature and pressure. Several modifications of the gaskets have been required. The equipment is shown in right part of Figure 8 below. In the design flushing fluids are added (Figure 8, middle), in addition flushing structures are designed and added inside the reactor (Figure 8, right). The lack of experimental product causes natural issues with down-stream processing research of IHDO and APR, and the related catalyst development. Another implication is the difficulties in the process design due to lack of experimental data (Table 9).

The risk follow up has been made during the project already. Firstly, the experimental set-up has been modified to enhance the reliability and preparation and replacement of the broke equipment have been made. Secondly, In the process related experiments of IHDO and salt separation model components have been formed. Thirdly, first results of BL test were conducted at SINTEF test equipment. Results where received, but the system is not equipped with the integrated salt separation. These have been made able to have first mitigation measures of the piloting delay, but by the deadline of the MP only first salt separation test of type-1 and type-2 salt have been made with the IHTL equipment.

The delay is mostly caused by Task 1.3 continuous tests. Subtask 1.3.2 The continuous tests with salt separation where to made by M25. Neither the equipment has not been available for the test at Pulp Mill (subtask 1.3.3). The most issues of the delay are to the WP3, Task 3.1 Catalyst development, Task 3.2 HDO testing, and Task 3.3 Application testing and evaluation of further upgrading (conditioning) needs. Some preliminary catalyst development has been made by model compounds in 3.1 and 3.2, but the upgrading requires real feedstock. Naturally, the lack of real feedstock affects also WP4 - Techno-Economic Assessment and WP5 - Sustainability assessment as there is not available the data on the products quality of the performance of the process. Naturally, this data would also need to be available for the exploitation part of WP6.

The issues on the IHDO and APR developments in WP3 have become critical. Real feed is needed urgently. The continuous pilot plant has only been able for first test with salts. The estimate for the first BL runs is in December 2022. In the general meeting in October 2022, VTT indicated that they would need to have 6 months extra time for testing the IHDO. Ranido would need to have the same time for catalyst development. The process scale-up and integration analysis require also extra time in WP4.

The way of mitigating the lack of real feedstock are 1) try to renew the equipment for the tests, 2) check out other possible sources of BL HTL-oil, 3) post-pone the affected task by 6 months to make possible to gain the promised results.

Table 8. Critical risks realized in the project

Failure of continuous lab-scale HTL unit: Cannot supply Tasks 1.4 and 2.2 with liquefied biomass	M/H	1	The required materials are run by batch in order to have the critical samples available. The error caused by method change is estimated. Possible modifications in the continuous HTL-unit design and configuration
Lack of HTL-oil or Fuel Intermediate: Pilots not able to provide enough material for upgrading tests	M/H	3	Clear and early detection of the problem. Root cause analysis and relevant effort for correcting the cause or revising the plan, but finding substituting course for the HTL-oil or Fuel Intermediate.
Delay or absence on providing experimental data to perform the overall process design and analysis	M/H	4	Quantify at early-stage realistic ranges for the key process performance parameters based on literature data and modelling

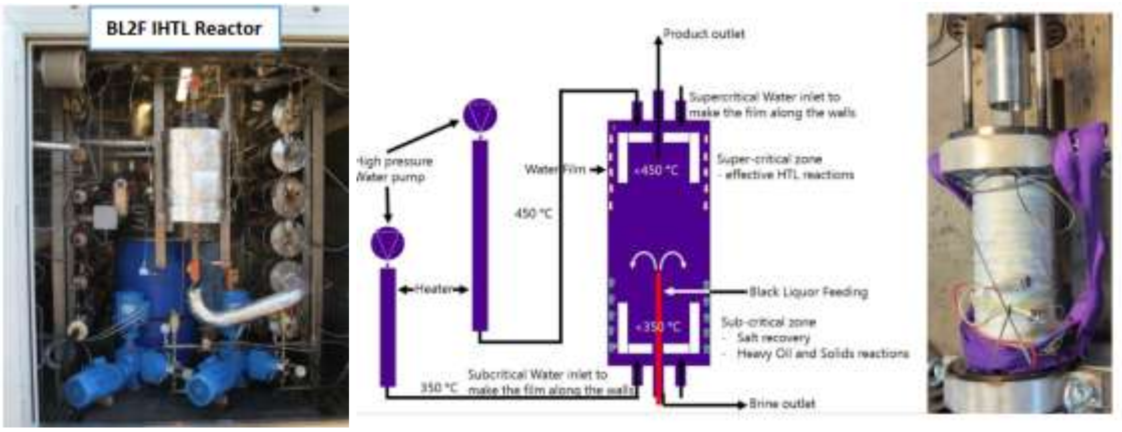

Figure 8. The EHTA pilot with IHTL modification (left, two flushing pumps added, and brine outlet added. New reactor design planned in BL2F (middle). Photo of the reactor (right)

10 Attachments

1. BL2F IPR webinar slides (pdf)
2. The RCR guidelines: Responsible conduct of research and procedures for handling allegations of misconduct in Finland. Guidelines of the Finnish Advisory Board on Research Integrity 2012 (pdf) - *in Finnish, Swedish and English*