FLAGSHIPS

Clean waterborne transport in Europe

Deliverable D1.3 – Plan for project risk management and quality assurance

Riikka Ikonen, Antti Pohjoranta, Jyrki Mikkola; VTT

FLAGSHIPS - An FCH2 Innovation action funded under H2020-JTI-FCH-2018-1, grant n:o 826215
Start date: 2019-01-01
Duration: 48 months
Project coordinator: VTT Technical Research Centre of Finland Ltd.
Coordinator contact: Jyrki Mikkola, jyrki.mikkola@vtt.fi, tel. +358-40-1701744, Finland

Document information

Title	Plan for project risk management and quality assurance
Deliverable #	D1.3
Draft delivery data	2019-06-19 - date for submission of draft version
Delivery of updated version	2020-12-03 – date for submission of updated version
Validation date	
Dissemination level	Public
Deliverable type	Report
Authors	Riikka Ikonen, Antti Pohjoranta, Jyrki Mikkola

Document validation mark-up

Partner representative add name + date when approving deliverable

VTT	
BPSE	
ABB	
PE	
NOR	
MCT	
CFT	
LMN	
LMF	

Abstract

Deliverable abstract	
The objective of the FLAGSHIPS risks management and quality assurance plan is to assure a sound and continuous risk and quality management throughout the project duration. The document includes a description of risk management and quality assurance procedures utilized in the project as well as a periodically updated listing of critical project risks, their status of realization and possible mitigation means. Therefore, the this plan is a living document and it will be updated as needed.	

Acronyms

CA	Consortium Agreement
DMP	Data Management Plan
DoA	Description of Action, project plan
EB	Executive Board
EC	European Commission
FCH 2 JU	Fuel Cells and Hydrogen Joint Undertaking second phase, under the H2020 Framework
FC	Fuel Cell
GA	Grant Agreement
PC	Project Coordinator
PMC	Project Management Committee
PO	Project Officer at European Commission
PM	Project Manager
TC	Technical Committee
TL	Task Leader
WP	Work package
WPL	Work package Leader

Contents

1 Introduction

The objective of the FLAGSHIPS risks management and quality assurance plan is to assure a sound and continuous risk and quality management throughout the project duration. The document includes proposed risk management and quality assurance procedures and is partly based on, and refers to, the following documents (which it will not replace nor overrule):

- Grant Agreement (GA)
- GA Annex 1 (Description of Action, DoA Part A and Part B) and
- Consortium Agreement (CA)

The plan is a living document and it will be updated as needed. The latest version of the document is always available at the FLAGSHIPS workspace.

2 General project information

Project name:	FLAGSHIPS - Clean waterborne transport in Europe
Short name:	FLAGSHIPS
Call & topic:	An FCH2 Innovation action funded under H2020-JTI-FCH-2018-1
Grant agreement number:	826215
Schedule:	1.1.2019 - 31.12.2022
Overall budget:	6790 562,50 EUR
EU contribution:	4 999 978,75 EUR,
Project coordinator:	VTT Technical Research Centre of Finland Ltd.
Contact:	Jyrki Mikkola, jyrki.mikkola@vtt.fi, tel. +358-40-1701744, Finland

Project key persons per WP
WP1: VTT, Antti Pohjoranta
WP2: BPSE, Maria Luisa Angrisani
WP3: NOR, Hilde-Kristin Saeter
WP4: CFT, Victor Laravoire
WP5: PE, Laurence Grand-Clement
WP6: WPA, Pål Gunnar Eide
WP7: MCT, Marie Launes

List of participants

N:r	Name	Abbr.	Country	Type
1	VTT Technical Research Centre of Finland Ltd.	VTT	FI	RES

2	Ballard Power Systems Europe AS	BPSE	DK	IND
3	ABB Oy	ABB	FI	IND
~~4~~	~~Kongsberg Maritime AS~~ [no longer active member]	~~KM~~	~~NO~~	~~IND~~
5	Pers-EE	PE	FR	SME
6	NORLED AS	NOR	NO	IND
7	NCE Maritime CleanTech	MCT	NO	IND
8	Compagnie Fluviale de Transport	CFT	FR	IND
9	LMG Marin AS	LMN	NO	IND
10	LMG Marin France	LMF	FR	IND
11	Westcon Power & Automation AS	WPA	NO	IND

3 Risk management

3.1 Risk assesment

Risk management of the FLAGSHIPS project will be a continuous task performed during the whole project runtime. This incorporates assessment of the risks and measures as well as definition and execution of risk recovery actions.

The coordinator (VTT) is responsible and carries out continuous project risk management and quality monitoring of project output. This includes:

- Monitoring project progress, adjusting project plan as considered necessary by the consortium for proper project management and ensuring timely delivery of project reports, deliverables and task output.
- Identifying and actively taking part in trouble-shooting of technical and organizational problems.

3.2 Risk mitigation

Risk mitigation of the FLAGSHIPS project aims to foresee and tackle critical risks for implementation. The most important critical risks were recognized and their proposed mitigations were listed during the preparation phase (see Table 1). Based on the critical risk listing, the FLAGSHIPS project should in many ways be considered quite risky, although when successful, also the potential impact of the project is very high.

The Risk Management Plan and the Table 1 (Critical risks for project success) will be updated at least in the annual progress reports.

Table 1 - Critical risks for the FLAGSHIPS project success as considered in the initial project plan.

Risk n:o	Risk description	Measures undertaken for risk-mitigation	Likelihood	Impact
R1	Current, partly unclear, partly inapplicable and partly non-existing rule base for the safety approval of hydrogen vessels creates a severe and complex risk for project delay or even non-completion.	- Early involvement of approval authorities (class, national and regional bodies) to project - Early selection of and work orientation according to the so-called *alternative design* approval approach	Medium	High, affects all WPs

		- Two different demo vessel types at two different regions with different approval authorities creates flexibility and redundancy in case of dead-end at either demo site - Including dedicated efforts to safety assessment overview and rule determination - Leveraging on experience from past marine FC+H2 projects, especially MARANDA		
R2	Using for on-land applications in marine PEMFC and H2 system technology, which is primarily developed conditions creates a technology risk, possibly leading to suboptimal or even defunct final system. This holds in particular for LH2 applications, where H2 storage pressure is significantly lower than in compressed gas systems and H2 supply pressure must therefore be made by e.g. compressor.	- Utilize equipment intended for marine purposes to the highest extent possible - Including marine OEM and significant marine technology expertise in project - NOR holds prior experience in LH2 vessel design through their hydrogen car ferry project, which helps preparing to the risk - Acknowledge risk and mitigate risk by proper system design - Dedicate testing periods before demo vessel deployment and subsystem delivery	Medium	Medium, affects all WPs
R3	Missing established supply chain and markets for hydrogen intended for marine fuel use presents both a technology risk and a financial risk to the project. Final hydrogen fuel price is difficult to predict and the availability of hydrogen bunkering equipment (esp. LH2) is uncertain.	- Involve and commit potential H2 suppliers already during project preparation phase - Leverage regional incentives for fostering H2 supply chain; both Stavanger and Lyon have programmes to promote zero-emission transport which supports the build of local H2 supply and market; to this end, involve regional policy bodies early on during the project and its preparation - Mitigate financial risk related to H2 fuel by agreeing in advance with potential H2 suppliers on the price (over the full period of the project)	Medium	Medium, affects all WPs, esp. WP3
R4	The lower gravimetric power density of a PEMFC + H2 hybrid electric propulsion powertrain compared to diesel-mechanical propulsion presents a technical risk, especially for the Stavanger demo where a high-speed ferry is operated. If the power system becomes too heavy, it could make operating the vessel unsustainable either due to excessive fuel costs or due to too long travel time / too low sailing speed.	- Optimization of powertrain w.r.t. weight possibly with some compromise on manoeuvrability; allowing for lower response speed will allow less installed battery capacity - Extending the vessel hull enables more buoyancy, making carrying heavier power system possible, although incurring at the same time more costs; this will shift	Medium	High, affects mainly WP3

		consideration towards new build instead of retrofit		
R5	The high cost of the Stavanger demo power system compared to the maximum allowable grant sum for the project presents a financial risk. Additional funding sources shall be found for the Stavanger demo, which may lead to a conditional approval of project thus a risk to the project as a whole.	- Norway has several national funding mechanisms (e.g. NOx fund, ENOVA) for the development of zero-emission mobility technologies; these shall be utilized to alleviate the costs of the Stavanger demo to the project - Cost allocation mechanisms are used to distribute the costs of the Stavanger demo over time in such a manner that splitting them over to multiple funding sources, including the EU, national funding sources as well as the ship owner becomes possible.	Medium	High, affects mainly WP3
R6	The danger associated with hydrogen in the mind of the public raises fears and thus presents a general risk for public acceptance of the project demonstration operations. There is a chance that a negative sentiment towards hydrogen demonstration activities could lead to delays or even non-completion of the project through public complaints or protests.	- Involve the Lyon and Stavanger municipalities already in project preparation; the government of these regions are known to have favourable opinion towards new, zero-emission technologies - Dedicate efforts to gaining public acceptance through open dissemination and communication of the project and in particular the measures taken to guarantee safety of the demonstration vessels	Low	High, affects all WPs
R7	The project is not self-sufficient in financing based on only the H2020 grant and the companies' standard own investment share (30%). Therefore external co-funding or additional self-investment from the partner companies (in particular CFT, NOR) must be obtained. This creates a financial risk to project implementation - if the necessary additional funding is not obtained, or it is withdrawn during project, the project may not reach its aims in full (due to building of demos not being possible) or partly (acquiring hydrogen fuel for the whole duration of the demo period).	- Secure ship owner commitment to project completion by acquiring statements from NOR and CFT executive officers and/or company board - Resolve external co-financing options before initiating project and seek for preliminary agreements to this end - Minimize project costs by negotiating cost effective hydrogen supply contracts and by cost-efficient design of the demo cases	Medium	High, affects all project, esp. WP3 and WP4

3.2.1 Unforeseen Risks

Some risks have been identified during the project runtime that were not foreseen at the beginning of the project.

Unforeseen Risk	**Risk description**	**Measures undertaken for risk-mitigation**	**Likelihood**	**Impact**

n:o				
U1	Global COVID-19 pandemic might cause delays for the project as companies (both project partners and other companies/entities linked to the project) have to work in part time and all the work has to be done remotely during the lockdown. Such a situation might also cause an extra financial risk for the project as wide pandemic situation and lockdown/curfew might cause serious decrease in revenues for the companies.	- Rearranging some of the work and prioritizing the most urgent actions in order to secure that the project will progress even during the pandemic situation - Changing all the project and technical meetings to remote meetings utilizing the project workspace in Microsoft Teams platform - Applying the extra funding from the national instruments to support the companies and the project if financial risks materialize	Medium	Medium, affects all WPs
U2	Drastic changes in market situation which negate the economic viability of the project	- Evaluation of cost reduction possibility (capex / opex) to make the model viable - Identify alternate that can allow to pursue the FLAGSHIPS project in another way than initially expected	Medium	High

4 Quality assurance

4.1 Quality planning

The project participants adhere to the European Code of Conduct for Research Integrity. The quality assurance approach of the FLAGSHIPS project builds on nominating quality-responsible people for each partner and work package, as applicable. These people will be in charge of maintaining traceability of project decision making at partner sites. The coordinator will conduct regular review of participants' activities by visiting the demonstration sites and relevant supply facilities when project tasks are active.

A significant part of the tasks, which directly influence the FLAGSHIPS projects are outsourced to non-partner parties such as naval architect offices, the shipyard and web-design companies. These 'Tier 2' parties will be chosen based on the project partners' previous experience and when this is not possible, a pre-investigation to the prospect subcontractors' or third-parties' status is made before commitment. The decision making process leading to the chosen 'Tier 2' party network will be documented as part of project quality management.

4.2 Quality responsibilities

A light and dynamic project organization structure, illustrated in Figure 1, is set up for the management and decision making in the FLAGSHIPS project. The project organization also directly relates to the responsibility of partners regarding monitoring of project execution quality.

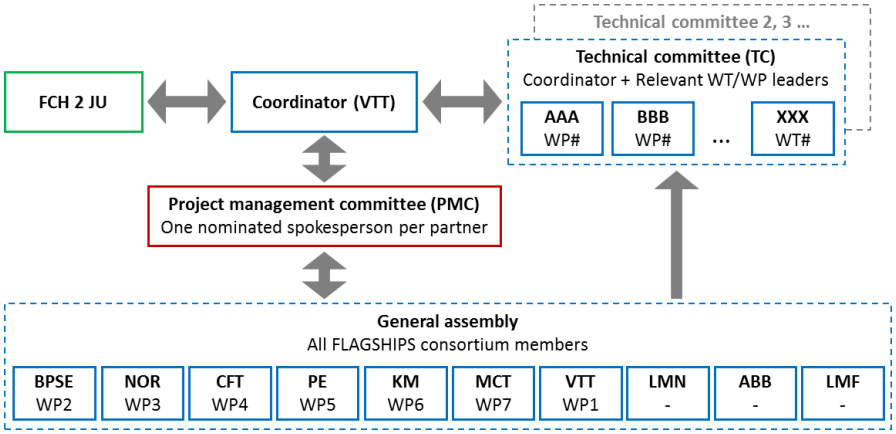

Figure 1 - FLAGSHIPS project organization chart as prepared in the initial project plan.

The project management committee (PMC) is the project-level decision-making body of the FLAGSHIPS project. It calls decisions on all matters not delegated to the project management (coordinator, WP leaders, TCs), but mostly on strategic items.

The PMC is responsible of ensuring that all project work meets its requirements and therefore all decisions, which influence:

- the project scope,
- the budget allocation or
- the project schedule.

In addition, decisions related to consortium membership are subject to approval by the PMC. Also decisions related to IPR and decisions to publish project work and outcomes are made by the PMC. The PMC also receives and acquits the financial and business reports of the consortium members prior to reporting to FCH 2 JU. The PMC settles disputes within the consortium, arising e.g. in case of failure to meet project assignments.

One or more **technical committees (TCs)** are composed of the coordinator and the leaders of case-relevant work packages/tasks to assist in project management and coordinated communication between partners in the FLAGSHIPS project.

The coordinator (VTT) manages the communication between the FLAGSHIPS consortium and the FCH 2 JU. With the help of the management team at VTT, the coordinator manages all day-to-day business of the project, maintains the composition of the TCs, and calls together monthly technical follow-up meetings, PMC meetings as well as the semi-annual meetings of the project general assembly. The coordinator manages the project's administrative, financial and legal activities as well as quality assurance.

The WP leaders (WPLs) and **task leaders (TLs)** within each WP are responsible for operative management of the work within the respective work package. All parties participating directly in a work package must be represented by a task leader or other representative person. The WP leader is responsible for the work package progress and for the related reporting.

4.3 Quality control and methods

The project coordinator (VTT) has quality assurance procedures in place to ensure the quality and integrity of research and the compliance with local, national and EU regulations. In particular, VTT fulfils the **Quality Management System Standard ISO 9001:2000**, valid for research, testing, analysis, consulting services and the development of new technologies.

In addition to financial project management and governance, the project coordinator and the management team support engages in the top-level technical coordination of the project work so to guarantee reaching project goals. To this end, the coordinator shall:

- Coordinate the scientific and technical work between the work package leaders
- Maintain and monitor the work plan, monitor project progress, in particular, the timely initiation of each successive phase and the associated tasks within the project will be controlled through peer-to-peer communication
- Monitor project progress and ensure timely delivery of project reports, deliverables and task output
- Carry out continuous project risk management and quality monitoring of project output, in particular by
    - Identifying and actively taking part in trouble-shooting of technical and organizational problems by arranging technical coordination meetings and by maintaining a plan for risk management, including contingency plan
    - Arranging for periodic visits at demonstration sites, partners' facilities and other sites which are relevant to project outcome quality

4.4 Quality implementation

4.4.1 Communication and meetings

Without neglecting extra-project communication, the internal project organization structure aims to focus communications efforts, where they are most necessary, i.e. where the active work takes place.

Internal communication
The PMC convenes when necessary, but at least in conjunction with the general assembly meetings (at project start, end and every six months in between). The PMC meetings may also take place online and minor decisions (approved by coordinator) where the risk for misunderstanding is non-existent can occur also via e-mail or similar delayed messaging. In case of disagreement, decisions will be made by voting, with each PMC member having one vote.

The coordinator calls **together monthly technical follow-up meetings,** meetings of the PMC and the TCs (when heading them), and meetings of the general assembly. The coordinator takes care of submitting project deliverables to the FCH 2 JU and coordinate project outward communication, including managing the selection of project output made openly available to the public.

When necessary, the WP leaders will call together meetings of task leaders and other representatives of work carried out in the work package. WP leaders compile task-specific progress reports for monthly technical follow-up meetings, for TC meetings and for all project-level communication. In particular, WP leaders report monthly to the project coordinator (in online meetings initiated by VTT) regarding the status, progress and needs for decision making in their WP. The information to the WP leaders is delivered by work task leaders. Task leaders are first-hand responsible for the work in the respective tasks and coordinate the work within the task.

A shared online digital workspace for storing and distributing documents and other digital material is provided by VTT. Microsoft SharePoint is used as workspace software and the workspace is located on a server hosted by VTT. Individual user accounts will be provided for secure access and controlled access management. **All project files are kept in the workspace.**

External communication
The project has a **Plan for the dissemination and exploitation of project results** (D7.2). The plan provides details as to who the project target groups and potential users are, what key message shall be conveyed, what are the key project results, and which communication channels shall be used. Each WP will contribute relevant material for dissemination but generally project communication and dissemination work is led by MCT, leveraging a wide network of co-operators within the industry and among policy makers.

4.4.2 Quality of IPR and data management

To secure due management of project IPR output as well as data collected in the project, a **Plan for management of project IPR and data** (D1.4) is made as part of project management and consortium partners will have last say on what data is collected and shared

FLAGSHIPS is a part of Horizon 2020 programme Open Data Pilot (OPD) and follows the principle *"as open as possible, as closed as necessary"* and focuses on encouraging sound data management as an essential part of research best practice.

Publication principles: Publication of other parties' foreground or background always requires approval, even if "amalgamated" with the publisher's foreground. The publication procedures to be followed are described in detail in section 8.4 of the CA:

- Notice of any planned publication should be given to other Parties at least 30 calendar days before the publication. The planned publication shall be made available on the project management system (project workspace).
- Any objection to the planned publication shall be made in accordance with the Grant Agreement in writing (email) to the Coordinator and to the Party or Parties proposing the dissemination (author) within 21 calendar days after receipt of the notice.
- If no objection is made within the time limit stated above, the publication is permitted.

Knowledge management in FLAGSHIPS is generally directed by the Consortium Agreement (CA).

4.4.3 Milestones and deliverables

Rigorous management of tasks and work packages is necessary as there are several critical paths in the project work structure. Therefore, **milestones are set at critical points to enable progress monitoring** and to support timely decision making in the project. The initially set project milestones are listed in Table 2.

Table 2 - Listing of project milestones as prepared in the initial project plan.

Milestone number (N:o in GA)	Milestone name	Related WP(s)	Est. date	Means of verification
MS2.1 (MS1)	General requirement specification established	WP2	M3	Validation and approval of specification from partners
MS3.1 (MS2)	Ferry retrofit concept and specification complete	WP3	M6	D3.2, D3.4
MS3.2 (MS3)	All subsystem designs complete	WP3	M12	D3.3, D3.5-3.9
MS3.3 (MS4)	LH2 fuel supply agreement signed	WP3	M12	Signed contract
MS3.4 (MS5)	All subsystems delivered to yard	WP3	M18	Receiving of susbsystems
MS3.5 (MS6)	Bunkering system in operation at quayside	WP3	M21	Empirical proof, D3.13
MS3.6 (MS7)	First operating test of ferry carried out	WP3	M25	Empirical proof

MS4.1 (MS8)	Propulsion system top-level design complete	WP4	M6	D4.1
MS4.2 (MS9)	Subsystem detailed designs complete	WP4	M14	D4.5, D4.6, D4.7
MS4.3 (MS10)	Push boat safety approval	WP4	M20	D4.4
MS4.4 (MS11)	H2 swap bunkering in operation at port	WP4	M24	Empirical proof
MS4.5 (MS12)	First operating test of push boat and H2 swap completed	WP4	M27	Empirical proof, video
MS5.1 (MS13)	Conclusion on common safety aspects and RCS policy	WP5	M30	D3.11, D4.4 and D5.1
MS6.1 (MS14	First system data transferred to server from both demo vessels accurately and in correct format	WP6	M26	Correct data available on server in correct format
MS7.1 (MS15)	First response from project external stakeholders	WP7	M18	Communicated stakeholders listed and responses presented in general assembly

Deliverables are contractual obligations of the project. They are identified and responsible partner is denoted for each deliverable. The planned deliverable listing is given in the GA description of action part. When necessary, the deliverable listing and delivery schedule are updated during the project as final execution is refined. **Quality review of deliverables is organized by the coordinator (VTT**). In addition all partners can comment the deliverables.

Deliverable templates are available in the workspace of FLAGSHIPS. Deliverables should be complemented by a written document describing the deliverable using deliverable templates. The coordinator (VTT) is responsible for submitting the deliverables to the EC Participant portal by the deadline.

4.4.4 Logos for documents and presentations

All published papers must (a) display the EU emblem, and (b) include the following text:
"This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 826215". (See GA 29.4-5)

Logos for documents and presentations will be made available in the project workspace.

4.4.5 Reporting periods

Duration of the project: 1.1.2019 – 31.12.2022 (48 months)

Reporting periods to EC:
P1 M1-M16 (April 2020)
P2 M18-M34 (December 2021)
P3 M35-M48 (December 2022)

Project reviews with EC:
RV1 M16
RV2 M34

Periodic reports P1-3 must be submitted to the EC within 60 calendar days from closing of reporting period.

Financial reporting is carried out electronically by each partner independently at the European commission's Participant Portal:
http://ec.europa.eu/research/participants/portal/desktop/en/home.html
http://ec.europa.eu/research/participants/docs/h2020-funding-guide/user-account-and-roles/ecas-login_en.htm

The Coordinator is the intermediary for communication between the EC and the project consortium (i.e. the partners). The Coordinator will provide detailed reporting instructions per each reporting item.

4.4.6 Reference documents

Legal documents, in order of precedence, and available on the project workspace:

Grant Agreement (GA) and annexes

- Agreement between European Commission and project partners
- Always the superseding agreement

Consortium Agreement (CA)

- Agreement between partners

User guides:
AGA – Annotated Model Grant Agreement:
http://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/amga/h2020-amga_en.pdf

This user guide, in the form of an annotated model grant agreement aims to explain to applicants and beneficiaries the functions and practice of the GA. It help the GA users understand and interpret the GA, by avoiding technical vocabulary, legal references and jargon, and seeking to help readers find answers to any practical questions they may have about particular parts of the GAs (explains concepts, gives examples and templates).

Online Manual:
http://ec.europa.eu/research/participants/docs/h2020-funding-guide/index_en.htm

The online manual guides the participants of H2020 project in the practices of all phases of the project.

5 Follow-up of project risk management

5.1 Follow-up at M6

This follow-up includes the GA preparation period and project duration from kick-off to M6.

5.1.1 Re-assessment of financial risks to project during Grant Agreement preparation (i.e. adding R7)

The risk R7 (non-self-sufficient financing) was added (in addition to R5) to the list of project critical risks during the preparation phase of the project Grant Agreement because written ship owner commitment had not been obtained by that time. Furthermore, new information related to ferry costs leading to this modification came to Norled as their other hydrogen ferry projects progressed and the consortium became better aware of the financial requirements of a hydrogen ferry. It became clear that in order to realize the Stavanger vessel, a customer and the entailing revenue flow for the ship had to be secured.

During the early part of the project a customer contract for the Stavanger ferry was accomplished as Norled successfully won a round operation service tenders for a route suitable for the Stavanger hydrogen vessel. Moderate insecurity to the availability of hydrogen fuel at an affordable cost still exists and thus the financial risk considered here is partially bound also to R3 referring directly to supply of hydrogen.

5.1.2 Realization of R4 (technical risk with marine FCs & H2) during Grant Agreement preparation

Given the significant project risks related to the PEMFC technology for marine applications, in particular regarding the Stavanger vessel, a preliminary technology evaluation was put underway by the consortium partners (esp. Norled) before start of project, during GA preparation. As outcome of this evaluation, it was concluded that technology risk R4 will realize itself and as consequence, a high-speed ferry based on PEMFCs and hydrogen was deemed an infeasible approach during the time-span of the envisaged project. To recover from the risk realization, a new plan for project implementation, without sacrificing significant project objectives was devised based on a normal-speed ferry. In retrospect, utilizing a normal-speed ferry instead of the high-speed ferry as case vessel has proven to carry several other benefits than merely lower technical risk, including potentially higher impact as well as better controllability over costs.

5.1.3 Partial realization of risk R3 (missing H2 supply chain, on behalf of LH2) during early project implementation

In the original project plan, the possibility of operating the Stavanger vessel based on liquid hydrogen (LH2) was maintained and considered as the primary fuel storage solution. During the early project execution, and based on Norled's experience with their other hydrogen ferry project (utilizing LH2), it was deemed however that building the Stavanger vessel for LH2 operation is not currently feasible. The main reason is the cost of liquid hydrogen fuel, which is unbearable to this project at the moment. In addition, as no LH2 is available in Norway, utilizing it as fuel entails significant dependence of the ferry operation to just a few fuel suppliers in Europe and this is an unbearable operative risk to the ferry operator (Norled).

5.1.4 Pre-financing arrangement to mitigate financial project risk related to Stavanger vessel

As explained in Section 5.1.1 significant financial risks related to the Stavanger vessel were observed during the early part of the project. Given the early phase of the project, these risks clearly could jeopardize the whole project (and not just the Stavanger vessel). Furthermore, during the preparation of the Grant Agreement, it became clear that Kongsberg Maritime, who was an original partner of the Stavanger vessel group, would leave the consortium. To maintain control over the financial risk related to the project parts influenced by the Stavanger vessel operations, VTT split the distribution of project pre-financing into two parts, the other part being conditional to a functional Stavanger vessel working group and a feasible Stavanger vessel work plan.

At the date of writing this follow-up (2019-06-30) a seemingly well-functioning working group for the Stavanger vessel has been established based on Norled, LMG Marin and Westcon and the financial questions have mostly

been clarified. Documenting of the vessel project plan is underway and should be complete by M9-M10 of the project, thus enabling the normalization of the project status.

5.2 Follow-up at M22

This follow-up includes the first reporting period and the review process until the M22.

5.2.1 Realization of risks R3 (missing H2 supply chain), R5 (unexpectly high cost) and R7 (the project is not self-sufficient in financing) in case of Stavanger demo vessel

Hydrogen fuel supply agreement for Stavanger ferry has not been signed yet, mainly because the intended supplier for the consortium, Norsk H2, went bankrupt in 2019. Because of that, extensive work has been carried out by Norled to find substitutive producer for gaseous hydrogen, which has proven to be extremely hard task. There is no existing hydrogen infrastructure in the area, which means that in any case, a completely new hydrogen producing facility will need to be established for Stavanger ferries needs.

Norled has been in contact with numerous potential suppliers, but they are all either not mature enough to be able to start up within our given time frame for the ferry tender contract period, or there are physical hinders such as restricted supply of electricity at the desired location for production and it will take years to get guaranteed supplies. This is in contradiction to what was anticipated in 2018 when the project started. Norled expected the marked to move faster than what it has proven to do. We still foresee more use of hydrogen for maritime use, but the pace is still slow.

Norled has been in discussion with company GreenH and they would be willing to start the production in the area. However, so far no other companies in the area would be willing to commit for hydrogen technologies, which means that Norled would be the only customer for GreenH. This in turn would mean that Norled would need to commit for buying hydrogen for 8 years so that the investment would be sensible for Green H. The ferry from Norled would need 500 kg/day in average, and GreenH would need to sell 1000 kg/day just to break even with their plant. They will still be willing to start up at Norled's commitment as they feel confident more clients will sign up in the coming years.

There are other potential initiatives along the west coast and north in Norway, but Norway is a long-stretched country so any initiative outside the Stavanger area will suffer from a substantial added cost due to transport.

Hydrogen technologies (both at vessel and at land side) are still novel and there are several risks included. Thus, committing to buy the hydrogen every day for 8 years would be of high risk for Norled. Norled has been granted funding from the governmental NOx fund, and we are expecting a positive answer from Enova in December, also adding to our budgets. The process towards Enova has been more intricate than expected and Enova has only limited room to support the production facility, though after a long process the application for support to Norled is being evaluated.

Norled has not succeeded in getting other governmental bodies in Norway to support the project financially, expect the NOx fund and Enova as mentioned.

Another financial issue realized relates to the bunkering of the vessel. Original intention was to build the bunkering station at Judaberg, which is the home port of the vessel. However, Judaberg is located in small island outside Stavanger and it turned out that electrical network (power grid) for this island is not sufficient to start the hydrogen production, and it will not be upgraded until earliest 2025. For this reason, the production needs to be located in the mainland side. This means that every night, when not in operation, the vessel needs to sail to bunkering quay and back. For this, Norled would need to hire extra personnel do conduct this work which would again cause an extra cost of 2 million euros, summed up over 8 years. Transport by truck has also

been considered, but this is also not cost effective due to both transport and extra personnel. In addition, after working with safety distances for bunkering, we foresee Judaberg will not be approved as bunkering quay due to its location close to other vessels and households, which again means the vessel must be sailed to a nearby quay to bunker. The same personnel issue occurs for this option.

Because of all these reasons, Norled and FLAGSHIPS consortium has proposed an alternative solution, where the vessel would be operated with hydrogen 1-2 days per week and other times with bio-diesel which is intended back-up power solution of the vessel. Yet, all the same hydrogen and fuel cell installations would be made, and vessel would be powered by 100% H2&FC power on those days when operating on hydrogen. This approach would help Norled to get started with gaseous hydrogen vessel operation and Norled would have an option to increase the hydrogen operation straight away when the hydrogen infrastructure will develop. This plan was rejected by FCH JU and will therefore not be further pursued unless FCH 2 JU opens this option again.

A last-minute offer for hydrogen supply has been received from the company Distry in cooperation with H2V. The benefit of the offer is the length of the commitment period, which is only 18 months, just enough to prove the operation in the required test period by Flagships. This will give Norled the chance to let the market develop and give new supplies better time to establish. It is not known what the outcome will be for the market situation in 2022/2023. The downside of the offer is the price, indicated to 10 EUR/kg H2. In addition, even if the components are known, there are many uncertainties to be seen as the concept is not matured. This increases the risk.

Norled is not seeing the project as doable under the current conditions. The main argument for not conducting the project is the increased operational cost due to extra personnel, which does not give any extra value back to the company. Further, it will be a high level of risk associated with going into a long-term contract for H2 supply, but it is seen as more manageable. The short-term contract still needs more work to be a viable option, but it bears the same problems with bunkering quay and added cost due to extra personnel.

Norled appreciates the value of conducting the project to gain more knowledge about hydrogen technology, even if we see the commercial terms as very difficult. We would like to be sure to have done the correct evaluations by taking the suspension period to validate the conclusion, or to find a viable way to complete the project.

5.2.2 Realization of risk U1 (COVID-19 pandemic)

The unforeseen COVID-19 pandemic has caused a drastic change in our lifw and ways of working. The pandemic has caused delays for the project as some partners have had to work part time and also some suppliers and other linked companies have had to do so. Also, it might be that building of the vessels might be delayed in the yards as this has also affected them. Total delay caused by this is not yet known as the situation is still very much developing. Also, the financial risks and effects are not yet known but will be seen in few months when the situation slowly returns towards the normal.

5.2.3 Realization of risks R7 (financial risk), U1 (COVID-19 pandemic) and U2 (drastic change in market) in regards to Lyon pusher boat and their consequences

First risk to realize was the risk R7 (financial risk) related to the shipbuilding of the Lyon pusher. The budget price defined early 2018 during the proposal phase was 2.3 M€ while the consolidated price from the shipyard was 3.9M€ which gives 1.6M€ unforeseen additional expenses. This cost increase was mainly driven by three factors:

1) While the inland navigation ships are in general diesel direct propulsion, this H2 powered pusher has to be diesel electric, which already bring an unforeseen higher cost.
2) In addition, the hydrogen system is also bringing unforeseen cost in a large extent. The hydrogen piping which is required to be stainless steel double wall inside the ship, together with the related instrument and valves (pressure transmitter, remote controlled valves) is a large contributor to the cost increase.
3) Then, the safety systems induced by the use of hydrogen, including H2 sensors, remote controlled valves with ESD redundancy, redundant sensors and the ESD system in itself, is also a major factor of the unforeseen cost.

Early 2020, the high risk of exceeding the budgeted cost of 2.3M€ for shipbuilding had been identified and a revised budget had been produced by CFT with shipbuilding cost provisioned up to 3.3M€, which appeared on July 2020 to be still under the actual ship cost.
Discussion and negotiation with the shipyard had succeeded in decreasing the shipbuilding price from 4.1M€ to 3.9M€ by end of July 2020, but it was still a higher cost than the expected 3.3M€.

Although it could have been considered to revise the budget and accept the cost increase (which would have led to multiply by three the operating cost), the full picture of the situation had to be checked.
The social climate in France has been highly intense since end of 2019. Important strikes and political measures have highly affected the container market (e.g. the yellow jacket strikes and then the strike opposed to the pension reform).
The COVID-19 crisis (risk U1) and the associated lockdown has completely stopped the economy in France and the container business has continued to lower in unprecedented way.
In side of the business activity, the container market is also affected by fuel cost: high fuel costs increase the modal shift for container transport from road haulage to inland navigation transport. On the contrary, low fuel prices reduce its competitiveness. As of now, and as a consequence of the COVID-19 crisis, the fuel cost is at its lowest point since several years.

Again, the competitiveness of the inland navigation container transport and viability is at a very difficult step and has led to realization of risk U2.
The market has not improved yet, and there is no clear estimation of when it can start.

These element demonstrated that CFT's business model for the container market is not viable anymore and that a model change is required.
Beside the business model for the container, it is the whole pusher model (with a fleet of pushers and a fleet of barges) which seems to have reach a point where it is not viable anymore. A shift toward self-propelled unit seems to be the most interesting solution for the future.

All these contributed to the decision to cancel the pusher development and proposing a new concept based on ZULU vessel.

6 Follow-up of project quality assurance

6.1 General follow-up at M6

This follow-up includes the GA preparation period and project duration from kick-off to M6.

A consortium agreement was drafted by VTT and submitted for signatures in early March 2019. By M6 of the project all other partners, except Norled and Westcon have signed the CA, the two being held back by the unclear situation with the Stavanger vessel. At the date of writing this follow-up (2019-06-30) a seemingly well-functioning working group for the Stavanger vessel has been established based on Norled, LMG Marin and Westcon and the financial questions have mostly been clarified. Documenting of the vessel project plan is underway. This plan is then formulated into an amendment of the project GA, allowing accession of Westcon to the consortium and enabling the normalization of the project status. Finalizing the GA amendment as well as CA signatures is due after summer 2019 and should be complete by M9-M10 of the project.

A PMC meeting was held in conjunction to both project general assembly meetings (up to M6) and the PMC decision making process was introduced to and approved by the consortium partners. The PMC meeting memorandums have been made available to the authorized bodies for review.

Up to M6 most deliverables have been submitted in due time. One exceptions was a two-month delay of the website as publication of the project was held back due to the unclear situation of the Stavanger vessel. Another exception is that the first deliverables for the Stavanger vessel are delayed by ca. two months, for the same reason as before, but on the other hand thanks to re-alignment of the project work, some subsequent deliverables are ahead of schedule (cf. M6 meeting memo).

As result of project general assembly at M6 in Hobro, it was concluded that full-project assembly meetings may not be the most appropriate use of project resources. Rather, ship-specific assemblies collecting the teams related to the Lyon vessel and Stavanger vessel, separately, into more focused and thus hopefully better efficient meetings was considered preferred. To this end, two technical committees (TCs), as outlined in the project management procedures, were established in this meeting: one (TC Lyon) for the Lyon vessel and another (TC Stavanger) for the Stavanger vessel. Despite forming of TCs, project-wide meetings will be held when considered necessary and project-level information transaction is also facilitated via remote meetings.

Milestones
Due to the “persistently-live” situation of to the Stavanger vessel, and finally the subsequent changes in project scope as well as the moderate delays in project work, some changes to the project milestones are due. At M6 / June 2019 these may be listed as below.

Challenges:

- MS2.1 (MS1), “General requirement specification complete”, whose completion is monitored by a partner approval and which is due in M3, is considered largely achieved, but still undocumented. Whereas the document pending approval of partners is in a good shape on behalf of the parts based on the Lyon vessel, it is largely lacking the parts depending on input from the Stavanger ferry. It is considered that this milestone is thus fulfilled on behalf of the Lyon vessel. On behalf of the Stavanger vessel, its completion is postponed until M8.
- MS3.1 (MS2), “Ferry retrofit concept and specification complete”, originally due at M6 is postponed by two months to M8 and renamed to “Ferry concept and specification complete”, as the ferry is now a new build (and not a retrofit).
- MS3.3 (MS4), “LH2 fuel supply agreement signed”, due M12, is renamed to “H2 fuel supply agreement signed” as the revised Stavanger ferry is not fuelled by liquid hydrogen but gaseous hydrogen.

Accomplishments:

- MS4.1 (MS8), “Propulsion system top-level design complete” (for Lyon vessel), due M6, is achieved and the related deliverable D4.1 is approved by relevant consortium partners.

- MS2.1 (MS1), “General requirement specification complete”, due in M3, is considered fulfilled on behalf of the Lyon vessel. (See above for further info.)

6.2 General follow-up at M23

This follow-up includes activities during first reporting period and the 1st review process.

During the first reporting period, signing of CA by all parties was finished. Also, first amendment was submitted in M12. This handled following topics: Removal of KM, addition of WPA, changes in Annex 1 and Annex 2, change in reporting periods and change to the action’s estimated eligible costs.

In the first reporting period, main work was related to the specification and design of the vessels and subsystems. The work progressed well (with some delays) and the detailed designs of both vessels were finished, pending few minor issues.

Deliverables and Milestones
Summary of deliverables and milestones in first reporting period can be seen in Table 4. All deliverables due were submitted except the deliverable D5.2. For this more information needed to be gathered and thus, it was postponed. This was agreed with the Project Officer beforehand.
Regarding the milestones, all other milestones were reached during the 1st period, except MS4 Hydrogen fuel supply agreement signed. This issue has been decribed more in detail in Chapter 5.2.1 of this document.

Table 3. Deliverables and Milestones in first reporting period

Deliverable / Milestone	Title	Status
D1.1	Kick-off meeting report	Submitted
D1.2	Project internal workspace for sharing data and documents	Submitted
D1.3	Plan for project risk management and quality assurance	Submitted
D1.4	Plan for management of project IPR and data	Submitted
D2.1	Report on general design considerations	Submitted
D2.2	Report on maritime specific fuel cell system design	Submitted
D3.2	Zero-emission ferry concept design, route study, model testing and operational specification	Submitted
D3.3	Ship technical drawings (GA, H2 systems) and technical outline specification	Submitted
D3.4	Electrical load analysis and electrical propulsion system design	Submitted
D3.5	Stability analysis, weight calculations, inclining test or displacement measurements	Submitted
D3.6	Hydrogen system, auxiliary piping, ventilation and Instrumentation diagrams (P&IDs)	Submitted
D3.7	Structural drawings for ferry arrangement	Submitted
D3.8	Fuel cell hybrid power system design and optimization	Submitted
D3.9	Electrical propulsion system design	Submitted
D4.2	Push boat outline specification	Submitted
D4.3	High level specification of the push boat fuel cell electric powertrain	Submitted
D4.5	H2 storage and bunkering process specification	Submitted

D4.6	Detailed fuel cell electric powertrain design	Submitted
D4.7	Summary of pusher detailed drawings	Submitted
D5.1	Common, applicable safety regulations and approaches	Submitted
D5.2	Common safety analysis e-tools	Rescheduled
D7.1	Project website	Submitted
D7.2	Revised version of the 'plan for the dissemination and exploitation of the project's results'	Submitted
D8.1	NEC - Requirement No. 1	Submitted
MS1	General requirement specification established	Submitted
MS2	Ferry concept and specification complete	Submitted
MS3	All subsystem designs complete	Submitted
MS4	Hydrogen fuel supply agreement signed	Delayed
MS8	Propulsion system top-level design complete	Submitted
MS9	Subsystem detailed designs complete	Submitted

Review meeting and issues

The review process after first reporting period raised some issues and risks in project content. The review report highlighted three major uncertainties in the project:

- The H2 supply chain for commercial operation of the passenger ferry in Stavanger is not demonstrated. The proposal to have 1-2 days per week operated on hydrogen and the remaining time on bio-diesel is not acceptable.
- The class notation of the CFT vessel (proposed ZULU) and Norled's passenger ferry is not clearly indicated. It is recalled that the prime objective of FLAGSHIPS is "100% of on board power for auxiliaries and propulsion to be FC or FC battery hybrid". It is understood that, when in harbour, the ships may be plugged into the on-shore power grid or in an emergency use a diesel-power generator. Yet, it derives that class notation FC power must be achieved.
- The replacement plan for an alternative to the barge pusher in Lyon is yet to be confirmed by CFT.

It was recommended by the reviewers that project would be suspended for 4 months in order to solve these issues. However, the project consortium have already worked extensively with these issues and we think that suspensions of the project is not necessary and thus, we will present our answer to these questions in M24.

6.3 Meetings with project-level significance

Table 4 lists those meetings held by the project partners, which are considered to have project-wide relevance, in particular for project quality monitoring. This list will be updated as meetings are held.

Table 4 - A list of meetings considered to have project-wide relevance to FLAGSHIPS

Meeting	Date	Location	Comments
Project kick-off (General assembly & PMC)	M1	Lyon, CFT	
Elektra communication	M5	Berlin, NOW	
BV communication	M5	Paris, BV	
Lyon vessel pre-HAZID workshop	M6	Aalborg, Airport	

General assembly & PMC	M6	Hobro, BPSE	
Lyon vessel HAZID workshop	M11	Toulouse	
General assembly & PMC	M13	Amsterdam	
Stavanger vessel pre-HAZID workshop	M16	Online/Teams	
General assembly & PMC	M16	Online/Teams	
General assembly & PMC	M18	Online/Teams	
General assembly & PMC	M20	Online/Teams	Issues related to realized risks caused a need to held PMC meetings more frequently than planned. Also meetings with FCH 2 JU and relevant partners were organized in order to discuss the issues.
Meeting between VTT, CFT and FCH 2 JU	M20	Online/Teams	
General assembly & PMC	M21	Online/Teams	
Review meetings with EC	M21	Online/Teams	
Meeting between VTT, NOR and FCH 2 JU		Online/Teams	
General assembly & PMC	M22	Online/Teams	
General assembly & PMC	M23	Online/Teams	
General assembly & PMC	M23	Online/Teams	
General assembly & PMC	M24	TBC	Scheduled
General assembly & PMC	M30	TBC	Scheduled
Review meetings with EC + General assembly & PMC	M34	TBC	Scheduled
General assembly/PMC	M42	TBC	Scheduled
General assembly/PMC	M48	TBC	Scheduled
Review meetings with EC	M48	TBC	Scheduled