REPORT OF THE THREE EXPLOITATION WORKSHOPS

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OTHER		
ETHICS	Ethics requirements	
ORDP	Open Research Data Pilot	

Dissemination Level		
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Contents

List of Figures

List of Tables

Glossary, abbreviations and acronyms

CCUS	Carbon Capture Usage and Storage
CNG	Compressed Natural Gas
EC	European Commission
KER	Key Exploitable Result
LNG	Liquified Natural Gas
PV	Pressure Vessels
R&D	Research & Development
RES	Renewable Energy Source

1. Introduction

Key to securing Europe's energy supply is diversifying supply routes. This includes identifying and building new routes that unlock resources and decrease Europe's dependence on a single supplier of natural gas and other energy resources. The GASVESSEL project **opens new possibilities to exploit stranded, associated and flared gas where this is currently economically unviable and creates new cost-efficient gas-transport solutions.** This will be achieved with a novel offshore and onshore compressed natural gas (CNG) transportation system.

New in the CNG transportation concept is the innovative, patented solution for the manufacturing of Pressure Vessels that are 70% lighter than current state-of-the-art alternatives. This enables new ship designs with much higher payloads and consequently dramatically lower transportation costs per cubic metre of gas.

The GASVESSEL project fills a market niche in transporting smaller gas volumes, where it is not justified to use LNG concepts or pipelines. For CNG no expensive liquefying and re-gasification plants are necessary, which drive up the costs of LNG. CNG is much more flexible than point-to-point pipelines and is also not associated with environmental and political difficulties during construction. These reasons make CNG the most efficient transport method for natural gas up to 2500 km.

1.1 Executive Summary

The main objective of the exploitation workshops is to prove the techno-economic feasibility of the new CNG transportation concept. Three geo-logistic gas exploitation scenarios will be analysed to establish where and how the GASVESSEL concept provides added value. Research and development efforts will concern the functional design of the Pressure Vessel, the prototype facilities and the ship design including gas-compression and decompression systems. This new concept will finally be validated with a cost-benefit analysis and a class design review and safety assessment.

The GASVESSEL concept contributes to ensuring secure and affordable supplies of energy to Europe by diversifying supply routes. It allows identifying and building new routes that decrease the dependency of EU countries on a single supplier of natural gas and other energy sources. More efficient and economically viable offshore CNG transport make waterborne supply of currently unexploited gas resources that dramatically exceed current annual gas consumption in Europe, commercially interesting.

On top of that, the GASVESSEL concept is expected to open important additional business opportunities for European industries from shipbuilding, shipping, Pressure Vessel manufacturers, epoxy resin and carbon fibre manufacturers to oil and gas and energy production companies.

The three exploitation workshops were organised around specific themes. The first workshop focussed on the decision support tool and the design optimisation platform. The two innovative tools that have been deployed in the Gasvessel project, modeFRONTIER and VOLTA were presented giving Gasvessel partner ESTECO useful feedback for further development and validation of the tools and allowing them to fine tune and optimise the tools and enhancing further market uptake of the support tools.

The second workshop was organised with the objective to arrest the Key Exploitable Results (KER's) of the Gasvessel project:

- Platform for collaborative optimisation of CNG scenarios
- Platform for collaborative optimisation of CNG vessels

- Industrial Grade CF for large scale compressed gas vessels
- Construction and industrialization of prototype plants and equipment
- High-pressure steel cylinder wrapped in carbon fibres
- Simulation Model for the Design of a Loading/Unloading System for Pressure Vessels
- Prove the techno-economic feasibility of a new waterborne CNG transport concept

For each result, a more detailed exploitation route has been identified, using the Innovation Canvas as a tool to develop the business models. These will serve as a guideline during the rest of the project to ensure maximum development and bringing the results closer to market potential.

The third exploitation workshop looked into the business cases which will open energy routes in Europe to three different oil and gas fields:

- **East Mediterranean gas fields** – the CNG concept will enable supply of remote areas such as the Greek and Italian islands and Cyprus.
- **Black Sea region** – CNG transport offers a flexible solution for early start-up of gas exploitation, before the planned pipeline will be finished.
- **Barents Sea offshore oil field** – the CNG concept will exploit gas associated to oil winning, which is currently reinjected in the oil fields.

For each business case potential clients were identified. The value proposition and reasons to invest in the Gasvessel technology were further detailed and the required investments for further roll out have been identified. During the general assembly following the third exploitation workshop it has been decided to further develop the specific business cases in a specific exploitation event involving external stakeholders. This event will be organised later in the project when technology has been further developed and tested. Also, different exploitation routes of the KER's will be investigated. Hampered by the travel related to the COVD-19 outbreak, a date has not been set and will be decided upon later.

2. Methodology and Procedures

The Exploitation strategy of the GASVESSEL project is the result of a brainstorming exercise to characterise the most important exploitable results, the KEY EXPLOITABLE RESULTS – KERs, discuss key features, risks and obstacles for their application in specific sectors. For this reason, the partners have been working together (see first draft of the Plan for the Exploitation and Dissemination of Project Results) to identify:

- KERs – Key Exploitable Project Results;
- Intentions of each partner with regard to the dissemination and exploitation of the results;
- Further pathways (funding/financing schemes, partnerships, research activities) to continue investing time and efforts in each result.

In order to boost the Exploitation Strategy, the WP 9 Exploitation and Dissemination, namely task 9.4. Exploitation Workshops and final conference with policy makers, includes the organisation by PNO of three workshops where all the consortium partners will interact and exchange ideas with relevant stakeholders on the following three core themes:

1. The development, implementation and validation of the tools Decision Support tool and the design Optimisation Platform;

2. IPR management its commercial/industrial potential;

3. Thoughts on benchmarking and roadmaps towards exploitation.

After each workshop, PNO team will prepare a report describing the organisation of the workshop and summarising the outcomes for the project partners and the European Commission; the report will also provide considerations on the work done so far and recommendations for the future.

3. FIRST THEMED WORKSHOP – Decision support tool & Design Optimisation platform

3.1 The Topic

The first themed workshop organised in the framework of Task 9.4 has focused on the development, implementation and validation of the tools developed by ESTECO: the Decision Support tool VOLTA and the Design Optimisation Platform **modeFRONTIER**. The GASVESSEL partners have been largely using modeFRONTIER as a comprehensive solution for automation and optimisation engineering design process and VOLTA as a multidisciplinary business process optimisation and simulation data management platform to optimise this novel CNG transportation concept.

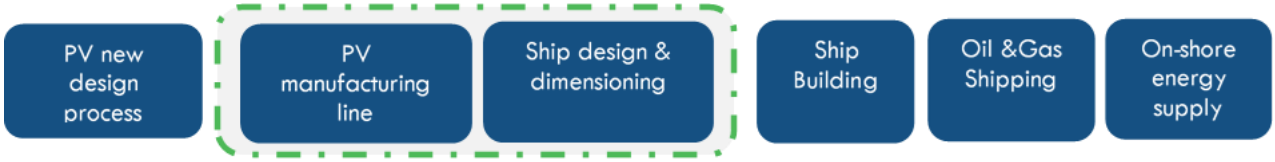


Figure 1: ESTECO positioning in the GASVESSEL value chain.

3.1.1 ModeFRONTIER

The optimal design of the pressure cylinders used in the GASVESSEL depends on different transportation scenarios, which were characterized in an earlier stage of the project. Since the beginning of the project GASVESSEL partner ESTECO has been working on the realisation of an optimisation platform, through the software modeFRONTIER, to enable the efficient design of the pressure cylinders. Simulations will be automatically running, considering the following factors:

- Geometrical parameters of the liner (diameter, length, steel thickness, etc.);
- Operational parameters (autofrettage pressure);
- Material properties of the composite layers (percentage of fibers, orientation of plies…)

Different models have been prepared to simulate the stress and reserve factor of the cylinder including FEM – Finite Elements Methods, structural models and analytical models respectively prepared by Esteco and CNG-V on the basis of semi-empirical considerations.

These models have been integrated into an optimisation workflow through the modeFRONTIER software by ESTECO. Simulations can be run automatically, updating the values of the design parameters through available optimisation algorithms, until the specified objectives are optimized.

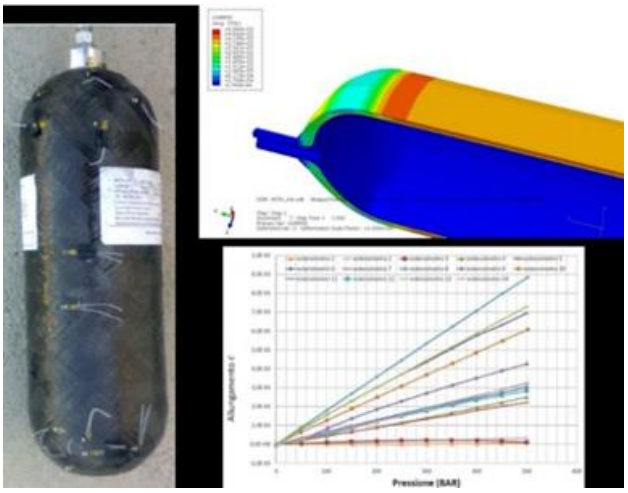


Figure 2: FEM analysis on a candidate solution for the CNG pressure vessel.

In the framework of GASVESSEL project ESTECO modeFRONTIER has supported CNG-V to select the final configuration of the vessel, confirming the structural performance and identifying the optimal winding parameters (i.e. the layers of the fibre-reinforced composite material wrapped around the metal liner).

3.1.2 VOLTA

One of the steps toward successful adaptation of the GASVESSEL concept is the optimisation of the gas delivery from the identified source locations to the identified markets for different scenarios and geographical areas. This will provide indications on the optimal ship size, speed and fleet size in order to reach the lowest gas transport cost. This optimisation process will be managed by VOLTA, a web-based platform that orchestrates simulated data and multi-disciplinary business process to enable conscious decision making and innovative product development.

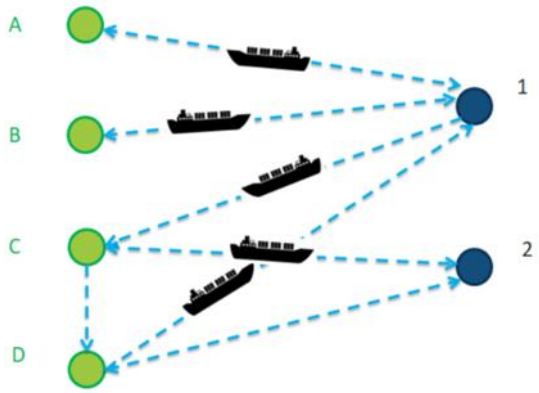


Figure 3: Example of CNG transportation scenario

The **first themed exploitation workshop**, gave to the public the possibility to meet in person the partners of the project and to learn directly from the experts how VOLTA software enabled the project partners to optimise the cost of CNG transport, providing ship designers with indications on the optimal speed, vessel and fleet size. ESTECO engineers performed a live demo of how VOLTA is used by GASVESSEL decision makers to share data, execute optimisation and analyse outcomes.

3.2 The context: the 34th international CAE Conference

Figure 4: Logo of the CAE Conference

The International CAE **(Computer-Aided Engineering)** Conference is one of the principal annual events in Simulation Based Engineering and Sciences and it gathers all the most relevant international stakeholders from all sectors in academia, industry to research and software vendors.

The two-day conference is driven by industrial peers' and pioneers which elaborate and brainstorm on traditional methods and approaches in engineering; opening an engineering network source of new and adopted ideas. The event delivers a powerful platform to exchange exciting developments and achievements as well as, opportunities to explore emerging technologies and techniques accelerating leading organizations.

This year the 34th CAE Conference (8th-9th October 2018, VICENZA) has focused on the topic **"Evolving Engineering Simulation: the age of the digital twin"** to deeply explore how Engineering Simulation is evolving to embrace and even progress the different technologies that are contributing to the development of Industry 4.0. A key advantage of Engineering Simulation is its ability to reveal the unseen and unexpected potentialities of product engineering and of the product manufacturing process. These potentials can then be developed and exploited to lower costs, improve productivity, optimise resources, to enhance existing products and services, and to identify possible new products, services and even markets.

Table 1: The numbers of CAE

The numbers of CAE
1,200 + attendees
150 speakers
60+ exhibitors
15+ thematic sessions
300+ posters

During the two-day conference, the exhibition area of the location (Fiera di Vicenza) has represented the pinnacle for business opportunities as delegates were primarily managers and decision-makers from a variety of industries from across the globe, as well as pre-qualified high-level experts. ESTECO has been one of the Platinum sponsors of the CAE conference, achieving high level of branding and promotion for clients and business partners. The workshop has been organised in the booth dedicated to ESTECO; the GASVESSEL partners organisers of the event, PNO and ESTECO have considered that the CAE conference could represent an excellent way to ensure maximum exposure to the event and to further explore exploitation pathways for the tools developed during the project.

3.3 The agenda

The workshop has been organised during the second day of the event, the 9th of October at 13h00 in the ESTECO booth. The workshop followed the agenda below:

Topic	Speaker
Introduction to the project and how it affects the whole gas industry value chain	Alessia Di Loreto , PNO
modeFrontier and VOLTA and their application within the project	Alberto Clarich, ESTECO
Live demonstration of how VOLTA has been used by GASVESSEL partners	Luca Battaglia, ESTECO

3.4 Promotion of the workshop

The workshop has been advertised through the channels available to perform the communication activities foreseen in the project, namely:

- LinkedIn;
- Twitter;
- Project website (www.gasvessel.eu);
- Partners' personal websites and media;

Moreover, two flyers have been realised and distributed (together with the GASVESSEL project official brochure) during the first day of the conference to catch the attention of the other attendees to the event.

Figure 5: Flyer 1 of the workshop made by ESTECO (front)

Figure 6: Flyer 1 of the workshop made by ESTECO (verso)

Figure 7: Flyer 2 of the Workshop (made by PNO)

Figure 8: GASVESSEL official brochure (front, verso)

3.5 The Partners involved

The workshop has been organised by PNO Innovation and ESTECO.

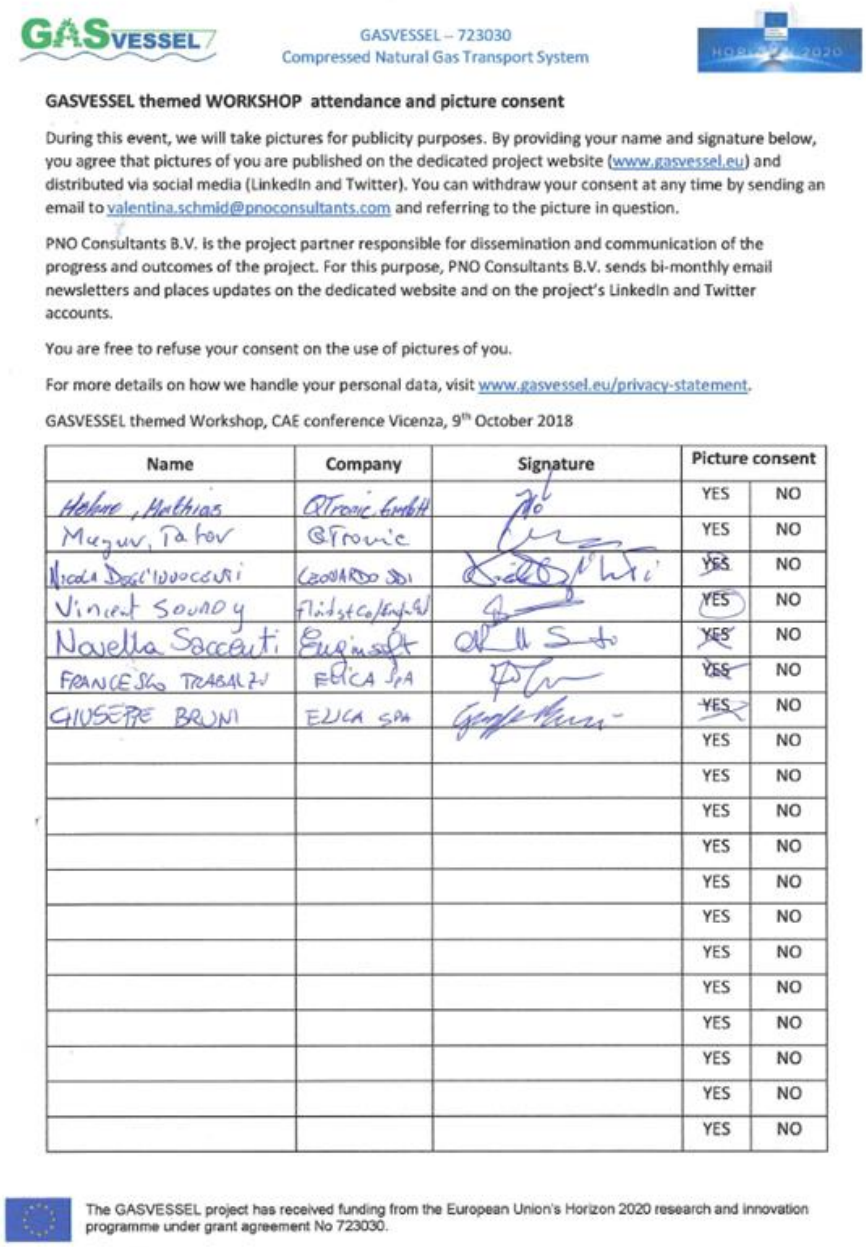
3.5.1 PNO Innovation

PNO Innovation, part of the PNO Group (www.pnoconsultants.com), is specialised in Innovation Management and funding, providing support services to private and public organizations in Innovation processes, Technology Transfer, IT solutions and funding for research, development and innovation. In the GASVESSEL project, PNO has brought its international consulting experience into the consortium including extensive project and innovation management, exploitation and business planning expertise. Within the project, PNO has given a particular attention to value chain stakeholders analysis, communication, exploitation and dissemination (CED) strategies and part of their execution.

3.5.2 ESTECO

ESTECO (www.esteco.com) is a supplier of integration, simulation, optimisation technology and consulting services for the automotive, aerospace, manufacturing, pharmaceutical, petrochemical and life science industry. The company was created in 1999 to exploit the knowledge acquired from a European Union sponsored project on design optimisation (FRONTIER), which was then converted into a successful commercial product. Within the GASVESSEL project, ESTECO is in charge of the development of a design optimisation tool of the pressure vessel and development of a platform for scenario cost analysis and safety analysis.

3.6 List of participants



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GASVESSEL themed Workshop, CAE conference Vicenza, 9th October 2018

Name	Company	Signature	Picture consent	
Helene, Matthias	RTronic GmbH		YES	NO
Muguv, Tahir	RTronic		YES	NO
Nicola Degl'Innocenti	Leonardo SDI		~~YES~~	NO
Vincent Soundy	Flightcell Int. Ltd		YES	NO
Novella Saccenti	Eurosoft		~~YES~~	NO
FRANCESCO TRABALZI	ERICA SpA		~~YES~~	NO
GIUSEPPE BRUNI	ERICA SPA		~~YES~~	NO
			YES	NO
			YES	NO
			YES	NO
			YES	NO
			YES	NO
			YES	NO
			YES	NO
			YES	NO
			YES	NO
			YES	NO
			YES	NO
			YES	NO

The GASVESSEL project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723030.

Figure 9: Attendance to the first workshop and picture consent.

3.7 The speakers, the presentations and the live demonstration of VOLTA

Figure 10: Promotion material for the workshop

3.7.1 Introduction to the GASVESSEL concept

Alessia Di Loreto, Junior Grants & Innovation Consultant at PNO, has been the first speaker in the workshop. On behalf of the consortium she has introduced the project concept and the relevant role it plays in the gas industry value chain.

The Gas industry encompasses a wide range of different activities and processes, which jointly contribute to the transformation of the new resource into useable end-products valued by industrial and private customers. These different activities are linked with each other and these linkages might occur across many different individual firms and can go through national boundaries. In this framework, the development of an alternative transport system of CNG will dramatically affect all the steps of the gas industry value chain. Firstly, GASVESSEL will completely revolutionise the midstream phase (transportation and storage modes); moreover, the innovations introduced will have an impact both on the upstream (new exploitable resources available) and downstream phase (reduction of operational costs).

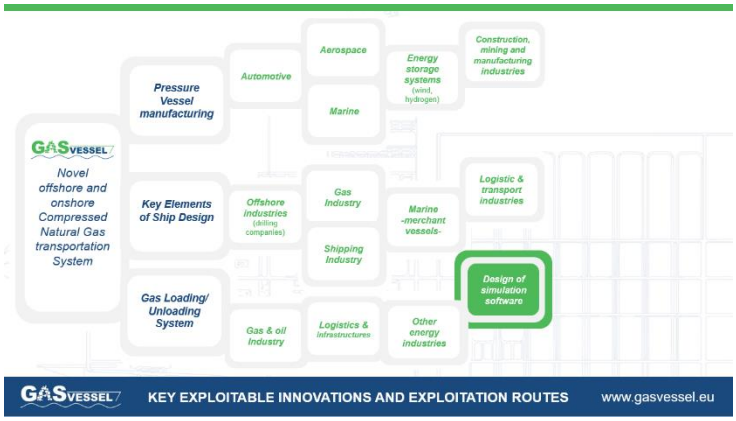


Figure 11: KERs and Exploitation Routes

All the innovations introduced in the project are developed by partners from different background and core businesses. Thus, the exploitation interests of each partner are different and complementary (see Figure 11: KERs and Exploitation Routes). Among all the sectors where the project will stimulate innovation processes there is the simulation and optimisation technology. Gasvessel partner ESTECO since the beginning of the project has been working on the design of modeFRONTIER and VOLTA, in order to support the other consortium members in achieving the best results in the manufacturing of the pressure vessels and in the ship design. Besides their application in GASVESSEL, modeFRONTIER and VOLTA can find a wide range of applications in many other sectors of industry and society (see Figure 12). For this reason, the live demonstration of VOLTA in the framework of the CAE conference, which gathers all the most relevant stakeholders of the sectors where CAE is emerging, has been extremely meaningful.

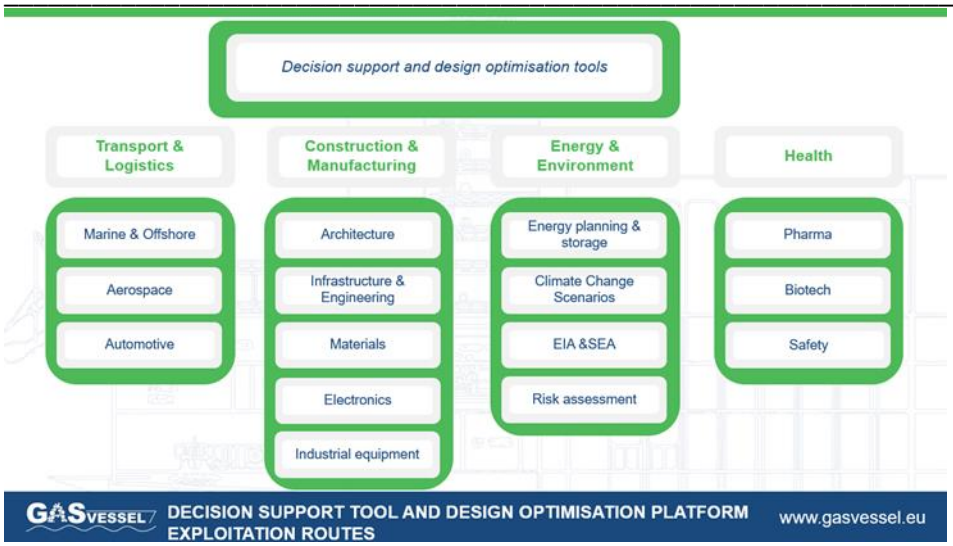


Figure 12: Decision support tool and optimisation platform exploitation routes.

3.7.2 The live demonstration of VOLTA

Once the main concepts have been introduced, Eng. Alberto Clarich, Head of Engineering at ESTECO, has presented how the software have been used from the GASVESSEL partners to set up a process integration/optimization workflow and share via web data and process results. These actions will bring the project directly to the next steps, where ships and vessels will be designed and produced by the partners accordingly to results achieved

Figure 13: A, B, C & D pictures of the workshop and audience

Finally, Eng. Luca Battaglia, Service and Support engineer at ESTECO, has performed the live demonstration of how VOLTA has been used by GASVESSEL partners.

3.7.2 Q&A session

After the live demonstration, ESTECO engineers were available to answer questions and clarify doubts that the audience showed. The questions asked during the session focused mainly on the following topics:

Figure 14: Eng. Luca Battaglia explaining details in the Q&A session.

- **Data storage:** information about how the system stores data and how to upload input files to run the simulation.
- **Report:** how can the user visualise the report, which represents the output file of the process.
- **Web-based service:** VOLTA represents a web-based service relying on the users' servers. Data can be stored in any platform and the users can access to the information stored from everywhere.
- **Results:** the user can save the results obtained from the process and share the results with other users of the software. This is the reason why VOLTA has represented a perfect example to demonstrate and validate its effectiveness: each partner had the chance to share the results with the other partners involved in the Work Packages or tasks.

3.8 Outcomes and next steps

This first themed workshop led by PNO and ESTECO has been an opportunity for the whole GASVESSEL project to receive feedbacks on the Decision support tool & Design Optimisation platform, two innovative tools that are supporting the consortium partners in the development of the project. Among many other events where ESTECO had the chance to be presented as a partner in the project, this workshop will support the company in building a more suitable business model and marketing strategy based on feedback of customers and partners coming from different sectors of industry and with different motivation and ambitions.

Based on outcomes of the GASVESSEL project, ESTECO will continue involving innovators and potential adopters to further develop, test and validate modeFRONTIER and VOLTA in new unexplored sectors. This will be important for ESTECO and enable them to fine-tune and optimise the product when deploying its solutions to the market. In this framework, the participation to this first themed workshop, will ensure the correspondence with customers' needs and expectations and thus wide take-up on the market.

This workshop has outlined to PNO the relationship between GASVESSEL and the other industrial areas, an important element that will facilitate exploitation in the final period of the project. The next steps start with involving all partners in the joint effort of developing the final exploitation strategy to ensure successful exploitation of the results of the project. In terms of concrete actions, two other exploitation workshops will be organised and will create the opportunity for partners to reflect on their earlier input and that of the other partners, to discuss and analyse their approaches and to develop more mature and in-depth approaches to all aspects related to exploitation. Partners will be supported in the exercise where

the aim is to facilitate the development of a better understanding of the players in the field and the marketplace. PNO will encourage the partners to start thinking about exploitation in a strategic way to be able to formulate their answers to key questions related to exploitation. These include questions about possible competitors, expected added value, possible market barriers, the timeline for exploitation, impact on the portfolio and IPR measures.

4. SECOND THEMED WORKSHOP – IPR management and its commercial/industrial potentials

4.1 The aim of the workshop

The second workshop organised in the framework of WP9 has focused on the following main points:

- Brainstorming session together with the consortium members to understand what the actual outcomes of the project are (Key Exploitable Results -KERs) and what is the TRL they target at the end of the project;
- Identify potential partnerships and strategic actions to bring the KERs closer to the market;
- Update the Exploitation plan (to be updated by the end of the project) and consequently set-up a more tailored Exploitation Strategy based on the actual KERs achieved during the project.

4.2 The agenda

The workshop has been held in the morning of 12th April 2019 in Trieste and it has been coupled with the 4th consortium general assembly (held the day before).

2nd day	12th of April 2019
09.00 – 13.00	Workshop on IPR Management and its commercial/industrial potentials (organization by PNO – attendance of all Partners)
13.00	Closure of workshop

PNO has organised the workshop based on the following outline:

- *Retrospective session.* Overview of the Key Exploitable Results-KERs achieved so far. Identification of the major challenges (but also bottlenecks) faced by the partners and the most relevant trends that have characterised the project implementation
- *Perspective session.* Discussion and brainstorming session on potential collaborative partnerships/ negotiations and how to overcome all the barriers emerged.

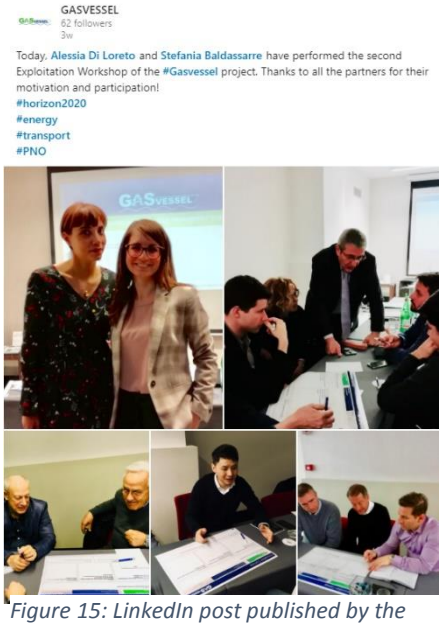


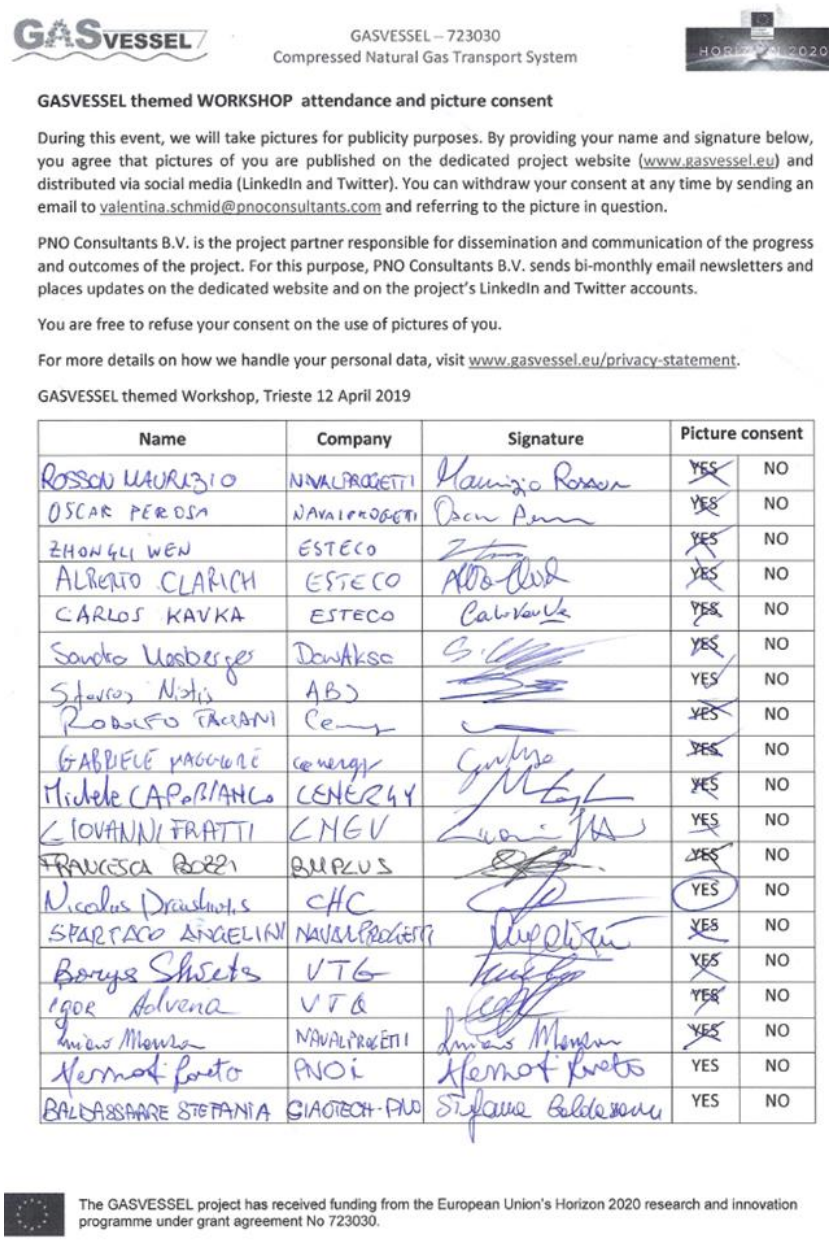
Figure 15: LinkedIn post published by the official Gasvessel account.

4.3 The promotion of the workshop

The workshop has been dedicated exclusively to the GASVESSEL consortium partners and consequently, the communication related to the event has been shared through the channels available to perform the internal communication between the partners, mainly email exchange. Nevertheless, the communication team has advertised on LinkedIn a post dedicated to the Workshop, published on the official LinkedIn account of the project

4.4 The participants

The 2nd Exploitation Workshop has been organised by PNO for the exclusive benefit of the GASVESSEL consortium members. The event has been attended by the representatives of the partner organisations of the project. The Figure 16 below indicates the attendance of the consortium members to the workshop.



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GASVESSEL themed Workshop, Trieste 12 April 2019

Name	Company	Signature	Picture consent	
ROSSO MAURIZIO	NAVALPROGETTI		~~YES~~	NO
OSCAR PEROSA	NAVALPROGETTI		~~YES~~	NO
ZHONGLI WEN	ESTECO		~~YES~~	NO
ALBERTO CLARICH	ESTECO		~~YES~~	NO
CARLOS KAVKA	ESTECO		~~YES~~	NO
Sondre Ueberger	DanAkso		~~YES~~	NO
Stavros Nikis	ABS		YES	NO
RODOLFO TACCANI	Cetena		~~YES~~	NO
GABRIELE MAGGIORE	Cetenergy		~~YES~~	NO
Michele CAPOBIANCO	CENER24		~~YES~~	NO
GIOVANNI FRATTI	CNEV		YES	NO
FRANCESCA BOZZI	BUREAU		~~YES~~	NO
Nicolas Drouillas	CHC		YES	NO
SPARTACO ANGELINI	NAVALPROGETTI		~~YES~~	NO
Borys Shvets	VTG		~~YES~~	NO
IGOR Advena	VTG		~~YES~~	NO
Enrico Morgan	NAVALPROGETTI		~~YES~~	NO
Hermot Pineto	PNO		YES	NO
BALDASSARRE STEFANIA	GIACTECH-PNO		YES	NO

The GASVESSEL project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723030.

Figure 16: Attendance to the second workshop and picture consent.

4.5 The preparation Phase

4.5.1 The preparation of the Questionnaires

Before performing the Workshop, an Exploitation Questionnaire has been prepared by PNO and distributed among the consortium partners. The questionnaire has been organised in four sections:

A. **Admin DATA**, containing general information about the partner (country, legal status and role in the project);
B. **General description of the innovation**, concerning the Key Exploitable Results. The partners have been demanded to provide more detailed information about the innovation they have generated in the project such as Work Package and other partners involved, target TRL, advantages compared to the state of the art, position in the value chain, etc.

C. **Commercial and Industrial Exploitation**. This section focuses on the market (segments for deployment and segments for replication in other sectors, potential users, competitors), the risk assessment and it also asks to the partners which additional R&D activities they need for TRL advancement;
D. **Exploitation Strategy and IPR Management**. Part D requests information on IPR background and foreground (planned patents) and highlighting possible needs of negotiations among the partners, support for exploitation activities and further strategic partnership that could help to bring the KERs closer to the market.

The complete Questionnaire has been attached to this report as an annex (see ANNEX I).

The Exploitation Questionnaire has been distributed to the partners via email, who have been invited to provide more than one questionnaire if they had the chance to obtain more than one KER from the project.

4.5.2 The Preparation of the Innovation Canvas

In order to provide the partners a tool to perform their brainstorming session, PNO team has developed an Innovation Canvas in order to understand the existing relationship between the partners, what are the goals and the resources deployed to achieve the expected results within the project, the activities performed together the current and the future barriers.

The Innovation canvas has been attached to this report as an annex (see ANNEX II).

4.6 The retrospective session

In the retrospective session, Alessia Di Loreto (PNO Innovation) has presented the results collected via the Questionnaires, also providing a preliminary analysis of the outcomes.

Overall, the partners have contributed to the Exploitation Workshop by providing 7 Questionnaires, as shown in the table below.

Table 2: List of Questionnaires received.

No.	Contributor(s)	WP	Group of KER	Title of the KER
1	ESTECO	WP2	Software tools	Platform for collaborative optimisation of CNG scenarios
2		WP3		Platform for collaborative optimisation of CNG vessels
3	DOWAKSA	WP4	Pressure vessels manufacturing	Industrial Grade CF for large scale compressed gas vessels
4	bm plus s.r.l.			Construction and industrialization of prototype plants and equipment
5	CNG-V			High-pressure steel cylinder wrapped in carbon fibres
6	cEnergy	WP6	Off-shore and on-shore gas loading/unloading system	Simulation Model for the Design of a Loading/Unloading System for Pressure Vessels

7		WP7/8	Ship design (Gas loading/unloading PV manufacturing)	Prove the techno-economic feasibility of a new waterborne CNG transport concept

4.6.1 Platform for collaborative optimisation for CNGV scenarios.

Innovation	
Contributor	ESTECO
Country	Italy
Expected TRL	TRL3 – Applied research. First laboratory tests completed; proof of concept.
In collaboration with	CHC, NP, SINTEF, VTG
Description of the KER	modeFRONTIER software is used to define a process workflow that allows to automate the simulation of different transport scenarios, allowing the end user by the web-based software VOLTA of ESTECO to select the optimal parameters (ship size, velocity, depart and destination ports) to achieve the minimum gas costs, accordingly to the demands in each scenario
Advantages vs SOTA	• SOTA: parameters involved in the decision process are changed manually; • Advantages in terms of design of at least 10 times with respect to traditional approach; • Reduction of costs of at least 30-50%.
Replicability	Any industrial field

Value chain

Exploitation	
Competitors	Other optimization and process automation software are already our competitors. As for our knowledge, none have realized an application to CNG scenarios as the one developed in this project.
Risk assessment	The main risk overseen for the application of this technology in naval and oil & gas field in our opinion is still the lack of maturity of CAE process.

4.6.2 Platform for collaborative optimisation for CNG vessels.

Innovation	
Contributor	ESTECO
Country	Italy
Expected TRL	TRL3 – Applied research. First laboratory tests completed; proof of concept.
In collaboration with	NP, CNG-V
Description of the KER	modeFRONTIER software is used to define a process workflow that allows to automate the simulation of different transport scenarios, allowing the end user by the web-based software VOLTA of ESTECO to select the optimal parameters (ship size, velocity, depart and destination ports) to achieve the minimum gas costs, accordingly to the demands in each scenario
Advantages vs SOTA	• SOTA: parameters involved in the decision process are changed manually; • Advantages in terms of design of at least 10 times with respect to traditional approach; • Reduction of costs of at least 30-50%.
Replicability	Any industrial field

Value chain

Exploitation	
Competitors	Other optimization and process automation software are already our competitors. As for our knowledge, none have realized an application to pressure vessels reinforced by composite overwrap as the one developed in this project.
Risk assessment	The main risk overseen for the application of this technology in naval and oil & gas field in our opinion is still the lack of maturity of CAE process.

4.6.3 Design of high-pressure steel cylinder wrapped in carbon fibres

Innovation	
Contributor	CNG-V
Country	Italy
Expected TRL	TRL 7- Demonstration system operating in operational environment at pre-commercial scale
In collaboration with	NP, BMP, ABS, DOW
Description of the KER	Carbon Fiber delivery out of DowAksa Portfolio to the project
Advantages vs SOTA	Currently no such technology exists - no one is producing cylinders of such dimensions and with these specifications. Having them would mean to be able to collect all flared and reinjected gas around the world - big environmental impact.
Replicability	hydrogen or other kind of gas transportation via railway, road or other means.

Value chain

Exploitation	
Users	Potential customers are companies operating in the Oil & Gas Industry.
IPR results	co-owned with other partners

4.6.4 Carbon-fibre manufacturing /downstream application

Innovation	
Competitors	not known competition for the target size and application of this type III PV
Risk assessment	potential risk of CF full cost being too high to meet economic (tariff) targets; Risk in implementing the solution in the market, associated to the large investment, taken by the end-user (ship builder);
Contributor	DowAksa
Country	Turkey
Expected TRL	TRL 5 – Large scale prototype tested in intended environment
In collaboration with	BMP, CNG-V, DOW
Description of the KER	Carbon Fiber delivery out of DowAksa Portfolio to the project
Advantages vs SOTA	innovation of this project is not necessarily related to the CF product this is state of the art
Replicability	Energy storage, transportation, etc.

Value chain

Discussion

Sandro Mosberger (from DowAksa) participated to the presentation, providing some details on the innovation in this production line. The mechanical characteristics developed to produce the carbon-fibre for the PVs can be applied in many other fields and this of course represent an important exploitation potential for future scenarios.

Some consideration have been made upon the market uptake of the PV: the amount of carbon fibres currently produced at DOW corresponds to 3.8 KT (thousands of filaments in one ton), which is the outcome of two production lines running in parallel. At the moment, only one production is dedicated to the Gasvessel project. In order to achieve the commercial scale, indeed DOW should increase the production yield: theoretically to obtain one GASVESSEL ship, at least 5KT of CF are necessary. In this framework, for the future market uptake, the current production line should be upscaled. This upscale, depends on the market: are there enough end-users of GASVESSEL? Are there investors that believe in this project and want to invest on the construction of the ships?

Besides the ship building, there are many possible exploitation routes for the carbon-fibre developed within the GASVESSEL project, i.e. other systems for energy storage and also in the construction and infrastructure sector.

4.6.5 Construction and industrialisation of prototype plants and equipment

Innovation

Contributor	BMP
Country	Italy
Expected TRL	TRL 3: Applied research. First laboratory tests completed; proof of concept.
In collaboration with	NP, CNG-V
Description of the KER	Transportation of high compressed natural gas in large and very light containers not available on the market right now
Advantages vs SOTA	it will be possible supply gas to places that currently are not supplied
Replicability	hydrogen or other kind of gas transportation via railway, road or other means.

Value chain

Exploitation

Support from partners	Support in business strategy and plan for use of the results within the organization

Discussion

In order to produce the prototype of the PV as designed by CNG-V, BMP has developed new equipment. Manufacturing processes and machines were already known but for this is the first time they are implemented at this scale.

4.6.6 Simulation Model for the design of a Loading/Unloading system for Pressure Vessels

Innovation	
Contributor	C-Energy
Country	Italy
Expected TRL	TRL 4: Small scale prototype built in a laboratory environment (“ugly” prototype).
In collaboration with	NP, VTG
Description of the KER	"The simulation model has been designed to deal with multiple pressure vessels to be loaded and unloaded with compressed natural gas with variable composition."
Advantages vs SOTA	The simulation model has been implemented in such a way to help designing the critical components of the loading/unloading system (compressors, heat exchangers, distribution piping), and to help investigating a variety of operational scenarios for multiple pressure vessels (e.g.: complete loading/complete unloading; partial loading/partial unloading; normal unloading/emergency unloading).Once the simulation model is configured with a proper user interface can help speed up both the assessment of design alternatives and the assessment of operational conditions."
Replicability	The simulation model can serve as a support tool for other size and configurations of CNG transport ships based on the GASVESSEL PVs. More in general, can be applied to assist designers and users of PVs in applications other than ship based CNG transport.

Value chain

Exploitation

Competitors	The advantage of the proposed solution with respect to other solutions/tools is to be tailored on the specific needs of the CNG storage and transport.
Risk assessment	Risks are not related with the simulation model itself but rather to matching measures and the use of the model. In particular, putting simulation models to market requires a set of measures, including training, bug fixing, maintenance and upgrade of the software. Moreover, it is necessary to limit responsibility of the software developer in relation with the use and the possible misuse of the software.
TRL advancement	Lab tests and verifications are required to calibrate the model and advance in TRL. Experience is needed in particular to adapt model parameters to changing NG composition and to heat exchange scenarios.

4.6.7 Prove the techno-economic feasibility of a new waterborne CNG transport concept

Innovation	
Contributor	NP
Country	Italy
Expected TRL	TRL 9: Full commercial application, technology available for consumers.
Description of the KER	The new Pressure Cylinders design and prototyping technologies and a new conceptual ship design will make possible to supply natural gas to places where natural gas is not yet a part of the energy supply and start using and monetizing the huge amount of natural gas currently not used (flared, associated, stranded).
Advantages vs SOTA	CNG waterborne transportation covers a segment presently ignored by the traditional gas trade. Pipelines are used for large quantities on short distances. LNG carriers are mainly used on long (oceanic) distances requiring supply of large quantities of gas. CNG transportation will be used on small/medium distances (max abt. 2000-2500 nautical miles) and small/medium quantities of gas. Based on the above it is less important the confrontation between the mentioned means of transportation, but the main target of the Project is to provide the energy supply without affecting the tariffs that final users are currently used to pay in the relevant countries.
Replicability	Railway, road and inland waterway transportation of gas in the gaseous state up to a pressure of 300 bar (natural gas, pure methane, hydrogen, etc.)

Value chain

Exploitation

Competitors	The only competitor operative with success on the market is US Company Lincoln Hexagon mainly engaged in onshore trade. They use type 4 cylinders in 40' containers with lower pressure and capacity compared with the expected results of the Project.
Risk assessment	More skilled and consequently more expensive crew is required for CNG ships; Finding investors to build the ships; Finding investors to establish PV factory; Finding investors to provide loading/unloading facilities; Get in touch with local authorities to understand rules and regulations in force locally and obtain necessary authorizations

4.6.8 ABS contribution to definition of the Exploitation

In addition to the Exploitation Questionnaires received in the preparation phase, PNO has also collected the contribution of ABS, which expects from the its participation to the GASVESSEL project the exploitation of the following items:

- **Support in improving regulatory framework**. CNG transportation by sea is not covered by only International Regulation or Standard (i.e. by International Maritime Organisation- IMO); for this reason, ABS has developed Guidance providing Rules and Requirements for the design and construction of CNG cylinders and ship, based on past experience and involvement with other concept designs. ABS involvement in the GASVESSEL project will help assessing and improve our rules and requirements.
- **Generation of specific knowledge and expertise in Europe**. Thanks to the GASVESSEL project, the dedicated team will be able to develop skills and expertise on CNG design within the ABS Europe Division and especially within ABS Hellenic. The involvement of ABS Hellenic engineers during the design development and on reviewing the certification for this will help in improving the expertise and the skills of the European team in this type of ships (CNG carriers), which currently is something limited to other areas of ABS global business (mainly US and China)

4.6.9 Analysis of the outcome

The profiles of the partners participating to the survey have been the following:

- Project coordinator
- 1 Feedstock/materials provider;
- 2 Technology providers/developers;
- 2 Prototype developers;

TRL target

During the presentation of the Questionnaires, some inconsistencies have arisen in relation to the TRL of the project. The inconsistencies are highlighted in Figure 17. According to the replies provided in the questionnaires, the major incoherence is related to the pressure vessels: the partners in charge of providing the raw materials (DowAksa) and actually producing the vessel prototype (BMP) have declared a lower TRL (TRL 5 and 3 respectively), while CNG-V reported on its questionnaire a TRL 7. On the other hand, the coordinator (NP) claims to reach TRL 9 when the project ends.

Same inconsistency has been reported for ESTECO, whose software is already commercialised in other sectors; although the tools are still under development in this specific sector, indeed there was a mistake in indicating the TRL level in the Questionnaire.

For this reason, after having shown to the partners the TRL definition according to H2020 guidelines, the TRL targets have been modified as

Table 3: Overview of KER's

KERs	Organisation	Correct TRL
Platform for collaborative optimisation of CNG PVs and scenarios	ESTECO	TRL 8
High-pressure steel cylinders in carbon-fibres	CNG-V	TRL 7-8
Carbon Fibre Manufacturing/ downstream application	DowAksa	TRL 7-8

Construction and industrialisation of prototype plant and equipment	BMP	TRL 7
New waterborne CNG transport concept	NP	TRL 7-8

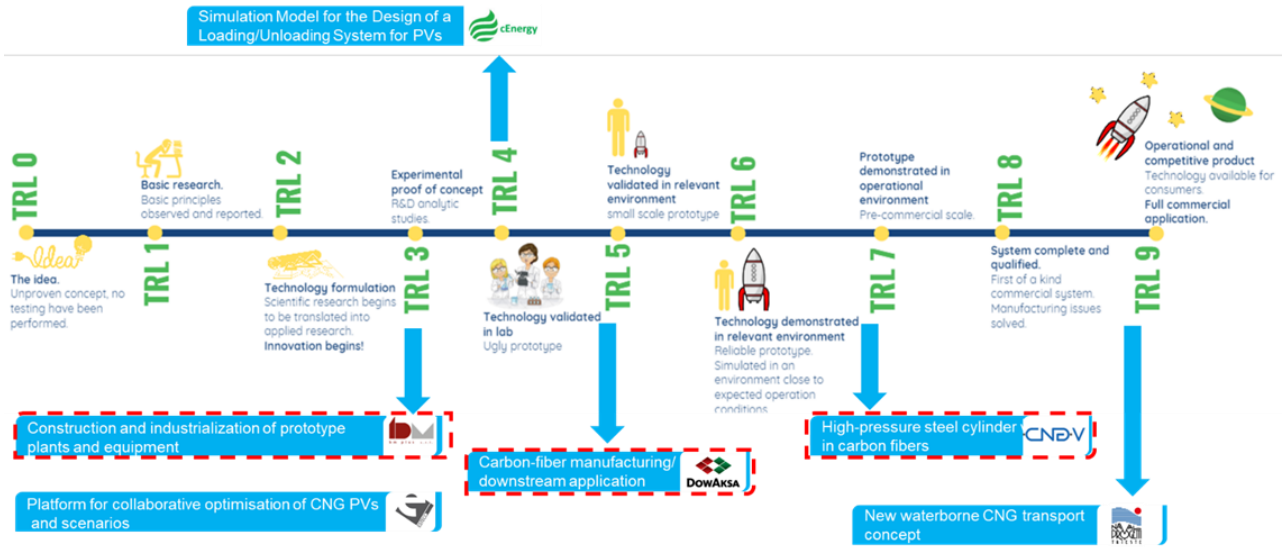


Figure 17: KERs positioning on the TRL line and related inconsistencies.

The market outlook and project's replicability

The partners have also provided some information about the market, identifying the potential users and customers of the GASVESSEL solution such as: customers in the naval fields and in oil & gas industry and companies operating in the gas transport systems.

Moreover, some partners have also provided information about the markets for replicability:

- The PVs can be applied in railway, road and inland waterway transportation of gas in the gaseous state up to a pressure of 300 bar (natural gas, pure methane, hydrogen, etc…);
- The carbon-fibre developed within the project, could be applied in other applications used for energy storage and transportation;
- Software/tools based on collaborative optimisation and process automation can be applied to any industrial field;
- The simulation model for the design of loading/unloading system can be applied to assist designers and users of PVs in other applications beyond the ship based CNG transport.

Desired technology development

Generally, the partners have declared that, in order to bring the technologies closer to the market stage, the following R&D advancements must be pursued:

- Laboratory tests and verifications to calibrate the models and advance the TRL;
- More experience is needed in particular to adapt model parameters to changing natural gas composition and to heat exchange scenarios;

- Support to customers to run the software in their design process;

Risk assessment

In this section, the partners have been demanded to provide their outlook on the risks that have been and will be encountered when bringing the innovation closer to the market. The foreseen risk assessment is summarised as follows in the table below:

Table 4: Risk assessment

Politics
Get in touch with local authorities to understand rules and regulations in force locally and to obtain the necessary authorisations.
Technology
More skilled and consequently more expensive crew required for CNG ships
Lack of maturity of CAE process in naval and oil & gas field
Need for a set of accompanying measures, including training, bug fixing, maintenance and upgrade of the software when putting simulation models to market
Need to limit the responsibility of the software developer in relation with the use and the possible measure of the software
Market
Potential risk of Carbon Fibre (CF) full cost being too high to meet economic (tariff) targets
Risk in implementing the CF solution in the market, associated to the large investment, taken by the end-user (ship builder)
Finding investors to build the ships
Finding investors to establish PV factory
Finding investors to provide loading/unloading facilities

General Considerations about the Questionnaires

After having analysed the responses provided to the queries posed in the Exploitation Questionnaires, the following considerations have been made:

After having analysed the responses provided to the queries posed in the Exploitation Questionnaires, the following considerations have been made:

- Average TRL expected at the end of the project: TRL 7-8;
- Next steeps needed in terms of R&D: more testing activities and experimental verifications;
- In order to achieve the above, the consortium members need a detailed and up-to-date business and strategy plan, in order to exploit the results internally and also to find business partners to further develop the innovations generated within the project;
- The major interest of the partners in terms of exploitation is ***to further perform research activities*** (in the framework of collaborative projects such as H2020, creating a spin-off or a joint venture).

4.7 The Perspective session

After the presentation of the Results of the Questionnaires and related considerations, the consortium partners present at the Workshop have been invited to participate to the perspective session.

The partners have been clustered in groups, following the structure outlined in Figure 18: Organisation of Brainstorming groups

- Partners developing ***analysis and support tools***;
- Partners working on the ***manufacturing line of pressure vessels***;
- Partners involved in the ***downstream activities (end-users)***.

Figure 18: Organisation of Brainstorming groups

The groups had the chance to brainstorm over the project results and consequently also over their partnerships (the ones already in place and the new partners to involve for the future market uptake), the resources available and the resources needed in the future and the expected bottlenecks. The Perspective session has been based on the completion of the Innovation Canvas. Each group of partners has filled in an Innovation Canvas for each KER achieved in the course of the project.

Figure 19: The brainstorming during the Perspective session.

4.7.1 The innovation canvas

The perspective session has produced 4 innovation canvas that can be grouped as follows:

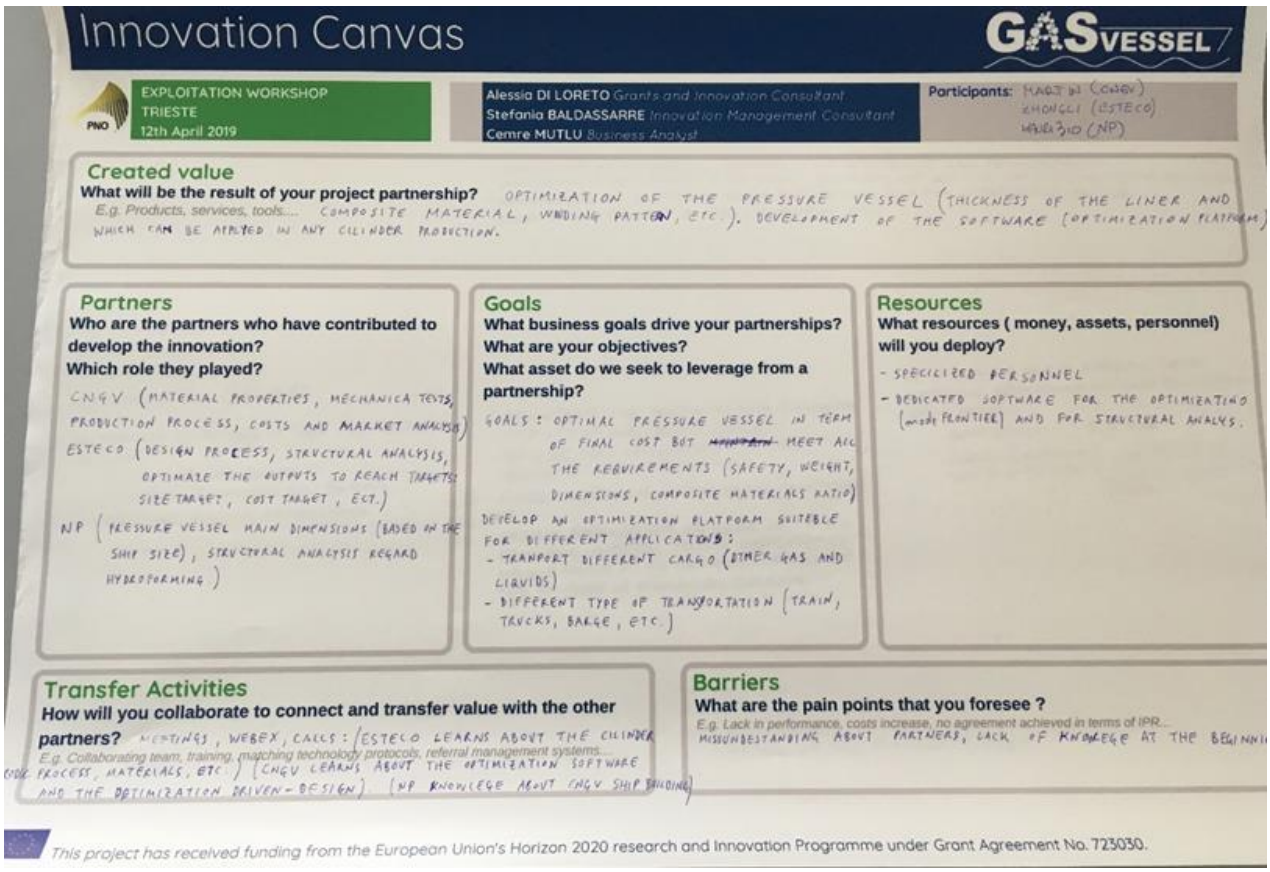
The content of each Canvas will be described in the following pages. It has been designed to highlight:

- Created Value;
- Partners involved;
- Goals;
- Resources;
- Transfer Activities (possible or ongoing);
- Barriers (possible or imaginable).

The answers provided by each canvas, along the data in the questionnaires will represent the ground for the following update of the exploitation strategy

1. Analysis and support tools

Pressure vessels optimisation



Participants

Martin Meze (CNGV), Zhongli Wen (ESTECO), Maurizio Rosson (NP).

Created Value

Development of the software (optimisation platform for parameters such as thickness of the liner, composite materials, winding pattern, etc…) that can be applied to PVs and any cylinder production.

Goals

- Optimal pressure vessel in terms of final costs and performance (meeting all the requirements in terms of safety, weight, dimension and composite material ratio);
- Development of an optimisation platform (software) suitable for different applications, such as transport systems of different fuels (other gases and liquids) and consequently, different transportation modes (via train, trucks, barge…).

Resources

In order to achieve the above-mentioned goals, in the framework of the project the partners have allocated high-specialised personnel and a dedicated software (modeFRONTIER) for PVs optimisation and related structural analyses.

Partners and transfer activities

The partners who have contributed to the value creation in the framework of analysis and support tools are:

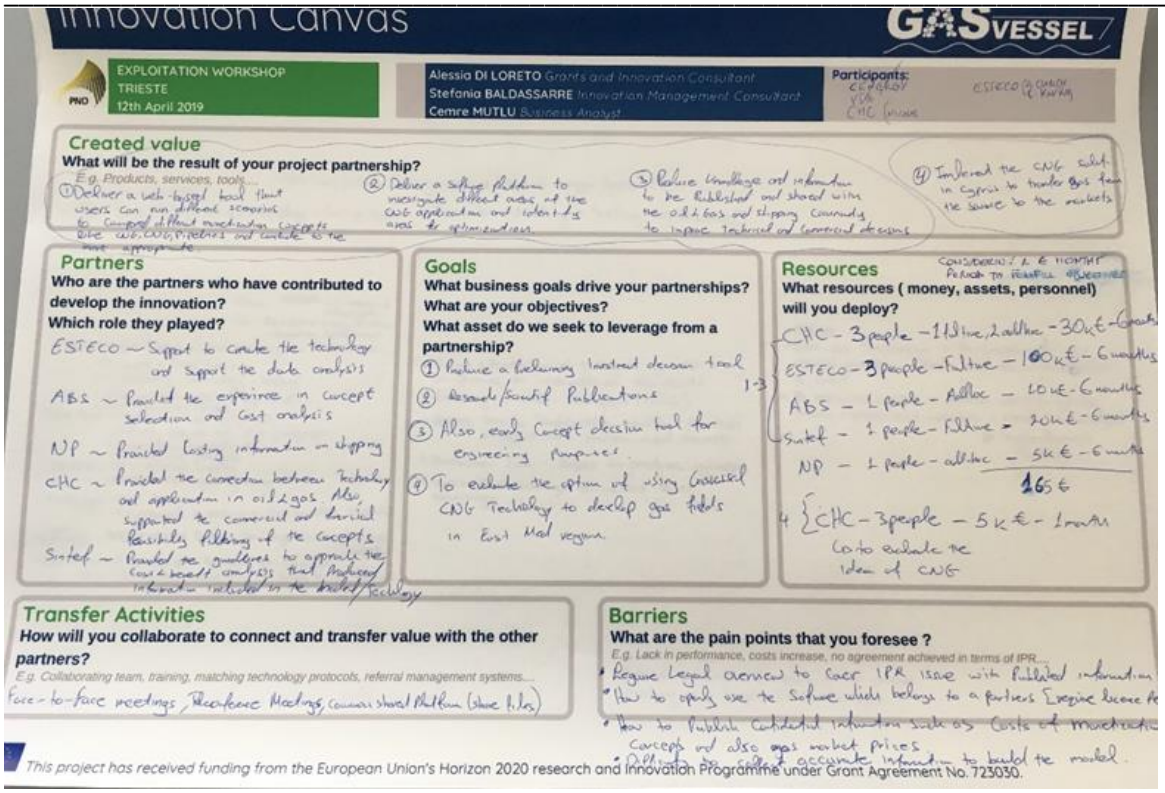
- ESTECO, the partner in charge of the software development for the process design, the structural analyses on the PVs order to optimise the outputs of these analysis to achieve the desired size, the expected cost, etc…
- CNG-V in charge of the analysis of the properties of materials, the mechanical tests, the production processes, costs and market analysis);
- NP has contributed with providing the PVs main dimension (based on the ship size) and also has supported the structural analysis regarding the hydroforming process.

The partners have reached their objectives carrying out the work with different means: meetings (face to face and WebEx) where ESTECO had the chance to learn about the cylinder production process, the materials used and all the necessary technical specifications); at the same time, CNGV has learnt how to use the software and the optimisation-driven design. NP had the chance to investigate the ship building based on PVs.

Barriers

The partners had to face some misunderstanding issues among them owed to the lack of knowledge they owned in the different sectors involved.

Scenario optimisation



Participants

Alberto Clarich and Carlos Kavka (ESTECO), Nicolas Droushotis (CHC)

Created value

- Delivery of a web-based tool where the users have the chance to run different scenarios to compare different monetisation concepts such as CNG, LNG, pipelines in order to choose the most appropriate one;
- Delivery of a software platform to investigate different areas of the CNG application and identify areas for optimisation;
- Produce knowledge to be published and shared with the oil & gas shipping community in order to improve technical and commercial decisions;
- Delivery of a web-based tool where the users have the chance to run different scenarios to compare different monetisation concepts such as CNG, LNG, pipelines in order to choose the most appropriate one;
- Delivery of a software platform to investigate different areas of the CNG application and identify areas for optimisation;
- Produce knowledge to be published and shared with the oil & gas shipping community in order to improve technical and commercial decisions;

- Implement the CNG solution in Cyprus to transfer gas from sources to market.

Goals

- Produce a preliminary investment decision tool;
- Research and scientific publications;

- Have the possibility to evaluate the option of using Gasvessel CNG technology to develop gas fields in East Mediterranean regions.

Resources

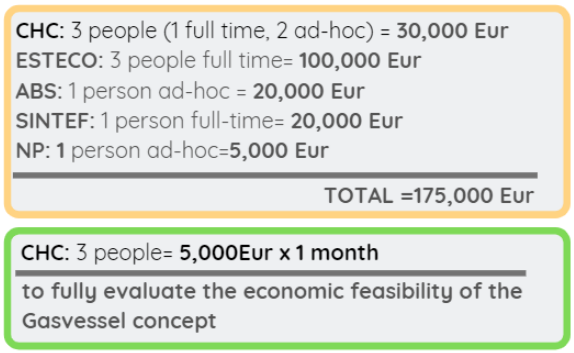


Figure 20: Forecast for resource allocation to create value

In this canvas, the partners have made a detailed forecast of the resources that the consortium will need to meet the objectives. In **Errore. L'origine riferimento non è stata trovata.** (yellow rectangle), the partners have estimated the personnel (and related costs) to develop the web-based platform for scenarios evaluation; the partners have made the forecast, considering a 6 month period, necessary to fulfil the objectives. The green rectangle shows the estimation of resource (cost of personnel) that CHC expects to fully understand the economic feasibility of the Gasvessel CNG solution (in a period of 1 month).

Partners and transfer activities

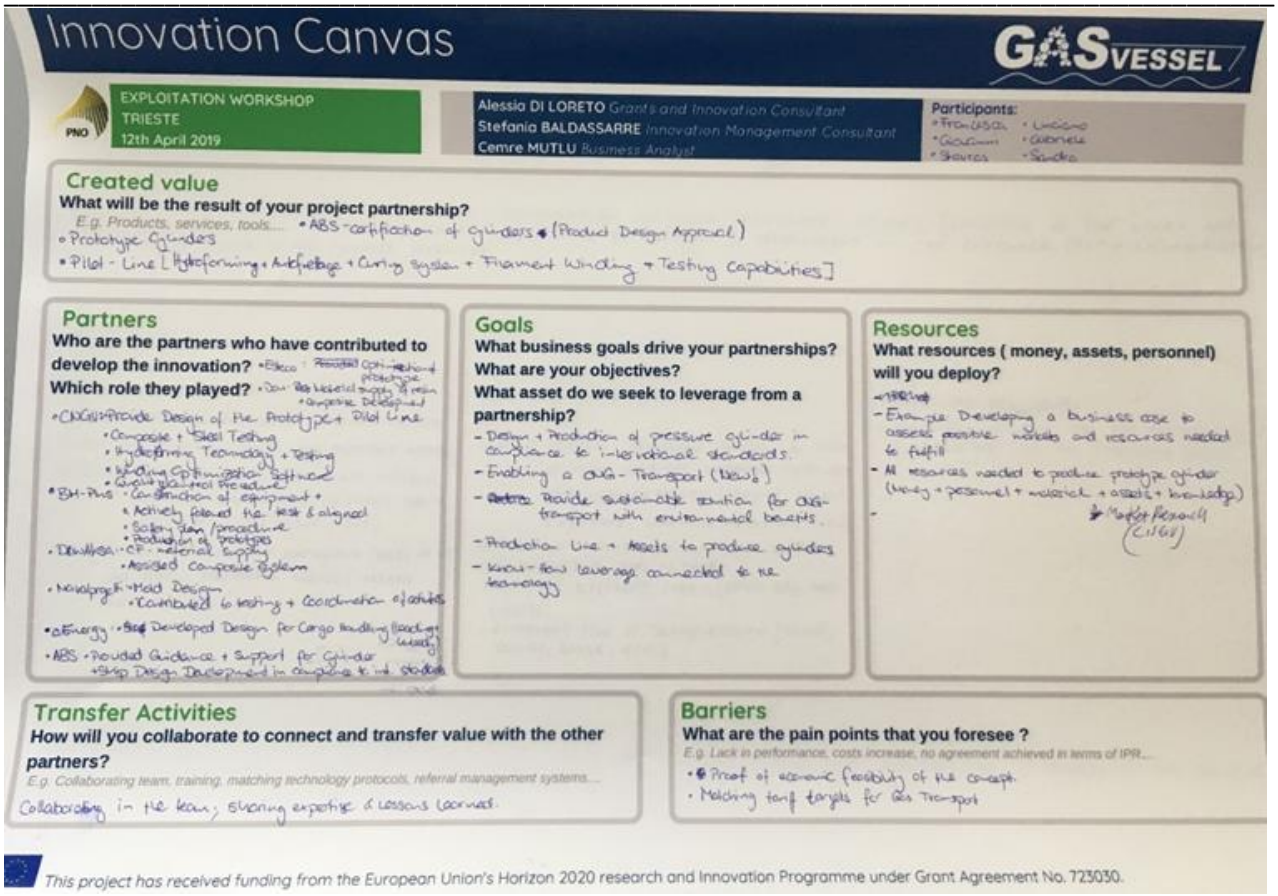
- ESTECO: providing support for data analysis and for technology development;
- ABS: providing costs and information related to shipping gas;
- As end user, CHC represents the connection between the technology development and its application in oil & gas industry. Moreover, the company also supported on the commercial and financial feasibility of the concept;
- SINTEF has provided the guidelines to approach the cost-benefit analysis.

The partners have mainly interacted through means of face-to-face meetings, teleconferences and common shared platform (to share info and documents).

Barriers

- A legal overview is needed, in order to cover IPR issues with published articles;
- IPR issues related to the use of the software developed by one of the partners (licence -fees) and internal agreements;
- Management of information (to make them public)

Manufacturing line of pressure vessels.



Participants

Francesca Bozzi (BMP), Giovanni Fratti (CNG-V), Stavros Niotis (ABS), Gabriele Maggiore (C-Energy), Sandro Masberger (DowAksa), Luciano Manzon (NP).

Created Value

- Prototype of the cylinders;
- Certification of the cylinders (Product Design Approval).
- Pilot-line development (hydroforming, autofrettage, curing system, filament winding, testing activities).

Goals

- Design and production of the pressure cylinders in compliance with international standards;
- Enabling a new CNG transportation mode with clear environmental benefits;
- Kick off of a production line to produce cylinders;
- Generation of knowledge connected to the technology;

Resources

In order to produce the prototype cylinders the partners have deployed all the needed resources: high-specialised personnel, materials, knowledge and economic assets).

For the market uptake, the partners have to invest on a market research and in developing a business case to assess resources available to fulfil the goals and to investigate new markets.

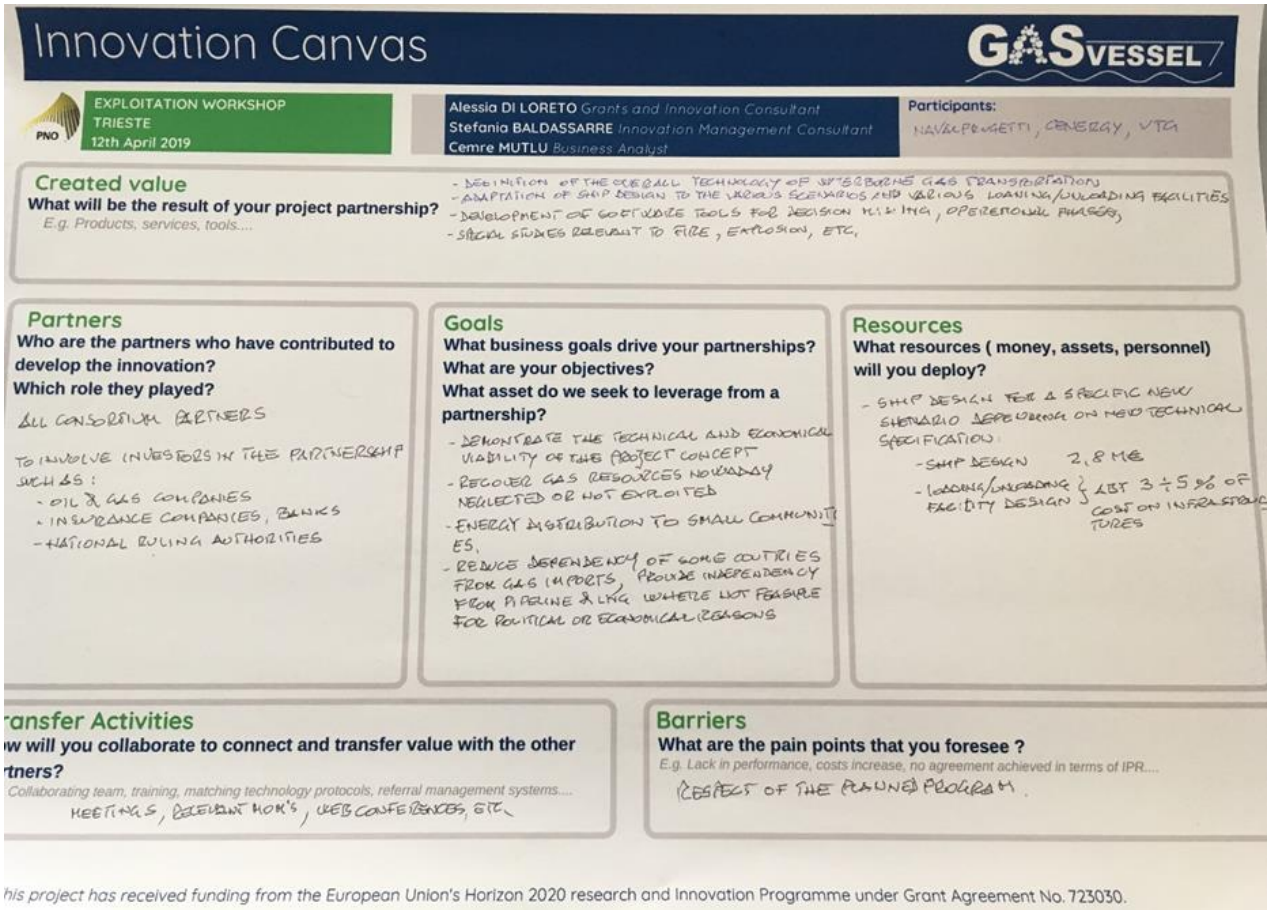
Partners and transfer activities

The partners have established a strong collaboration, sharing their expertise in different fields and lessons learnt.

Barriers

One of the most relevant bottlenecks to overcome to reach the market is the proof of economic feasibility of the concept and to match the proposed solution with the tariff targets for gas transport; partners still need to investigate this issue.

Downstream activities (end-users)



Participants

Navalprogetti, C-Energy, VTG.

Created Value

- Definition of the overall technology of waterborne gas transportation;
- Adaptation of ship design to the various scenarios and various loading/unloading facilities;
- Development of software tools for decision making in operational phases;

Goals

- Demonstrate the technical and economic viability of the project concept;
- Recover gas resources that currently are not exploited/neglected;
- Provide an energy distribution network to small communities;

- Reduce dependency of some countries form gas imports, provide independency from pipelines and LNG where those systems are not feasible for both economic and political reasons.

Resources

The resources will be allocated to realise a ship design for a specific new scenario, depending of new technical specifications. The partners expect the following costs:

- Ship design: €2.8 M
- Loading/unloading facility design will take between 3 and 5% of the total infrastructure cost.

Partners & transfer activities

Indeed, the innovative transport system will be the objective of the whole consortium. Besides the technical role they play within the GASVESSEL consortium, the partners will definitely play a relevant role in the next future (as soon as the technology becomes more and more mature) to involve stakeholders that are willing to invest resources in the technology, such as:

- Oil & gas companies;
- Insurance and bank institutions;
- National authorities and regulatory bodies.

Barriers

Since the coordinator owns the general overview of the GASVESSEL project workplan, the unrespect of the planned schedule represents the major bottleneck for the project.

4.8 General overview of the Innovation Canvas

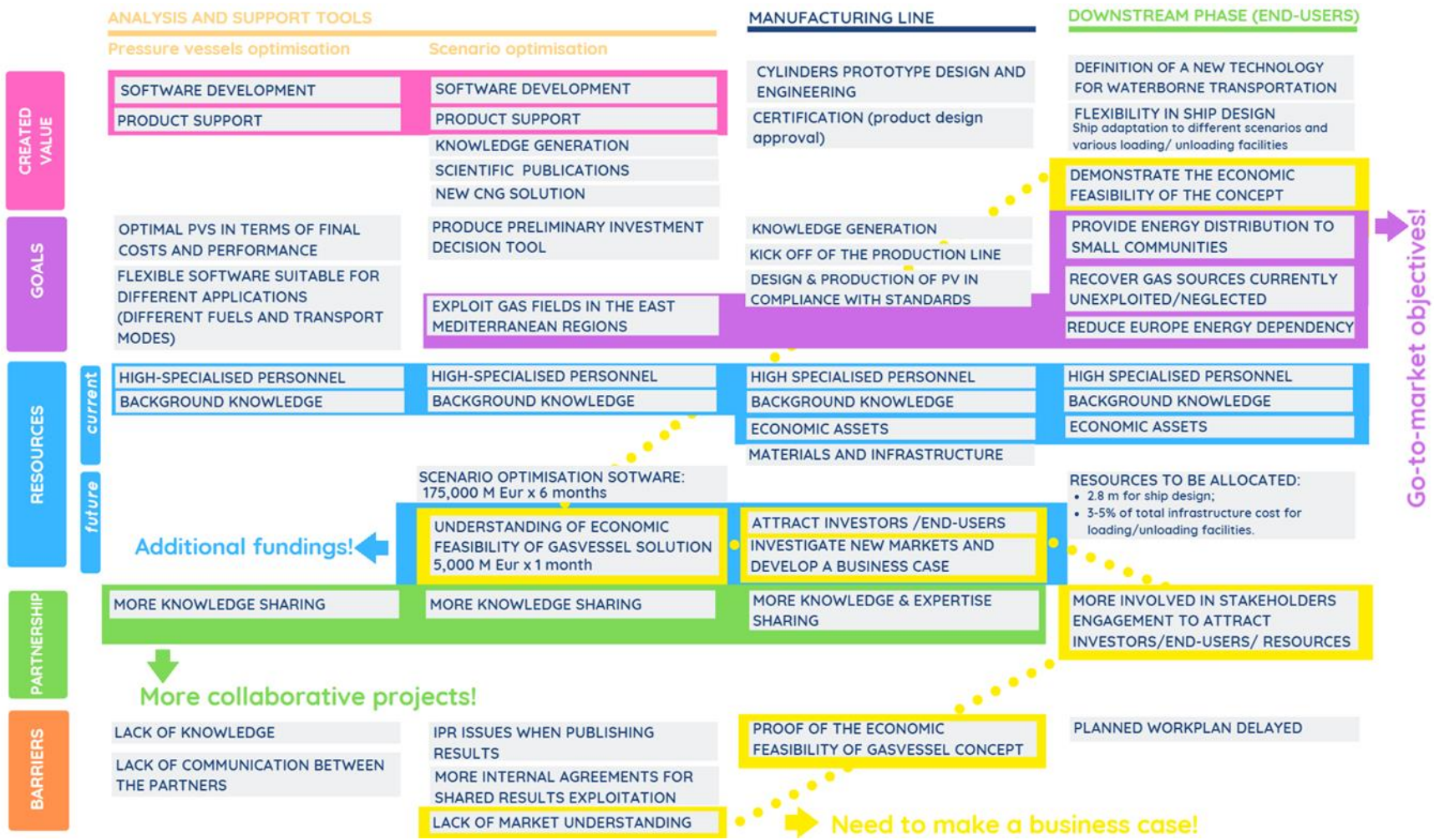


Figure 21: Schematic overview of the innovation canvas

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Figure 21 shows a schematic overview of the most important information obtained thanks to the canvas. Indeed, the main objective of the GASVESSEL project so is the market uptake of gas fields in Europe that are currently unexploited or neglected for economic and political reasons. This objective, which has been expressed by the partners in different ways in the canvas (reduce European energy dependency, provide small communities with a new efficient and cost-effective energy distribution system), clearly defines the **go-to-market target of the GASVESSEL consortium members**.

In terms of technology, the partners have pursued the following:

- **Knowledge generation:** development of skills and expertise in European territory on pressure vessels and CNG carriers (which currently is more developed in China and US).
- **Proof of flexibility of the technology** (flexibility of the cylinders to be adapted to different gases and transport modes, flexibility of the decision support tools that can be suitable to different industry sectors and finally, flexibility in the ship design, to adjust the ship to the various scenarios and to the different loading/unlading facilities.

In terms of Resources, without any doubt the partners have shared the best human resources available and relevant infrastructure to carry out the planned activities; nevertheless, additional funding (from EU/ national authorities or also engaging private investors) are still needed.

As regards the partnership built-up for the GASVESSEL project, the partners have expressed general satisfaction with the current configuration. In addition, the partners have expressed their will to be engaged in more collaborative knowledge in order to increase the knowledge and expertise sharing and to cope with some lack of communication that has been experienced at the beginning of the project (owed to the lack of knowledge in respective sectors) . On the other hand, in some cases, these collaborative activities represent a concern in terms of **IPR management**. Some partners have expressed the need of further internal agreements to share the project results, especially when it comes to make them publicly available.

Moreover, the canvas have shown a recurring statement, that some partners defined as an objective, some as resource, some indicated as a requirement to the partners and some expressed as a concern. In all the cases, the **proof of economic feasibility** of the GASVESSEL concept is of extreme relevance. **The partners are confident in the technology** and strongly believe in its innovative potential; on the other hand, **the market uptake represents their major concern**. For this reason, they have several times expressed the need to develop a solid business case in order to demonstrate the economic feasibility of the GASVESSEL concept to convince end/users (in the oil and gas industry, national authorities) and investors (insurance and bank institutions) of the high potential of the GASVESSEL concept.

4.9 Possible Exploitation Routes

The Exploitation Questionnaires, together with the innovation canvas filed-in by the partners during the workshop, outline three main concept-groups that cluster all the KERs:

- Analysis and support tools;
- Manufacturing line of PVs;
- Downstream activities (end-users).

For each concept-group of KERs, the Innovation canvas helped in identifying possible exploitation routes (Figure 22) that will be further defined and specified during the exploitation strategy for rest of the project.

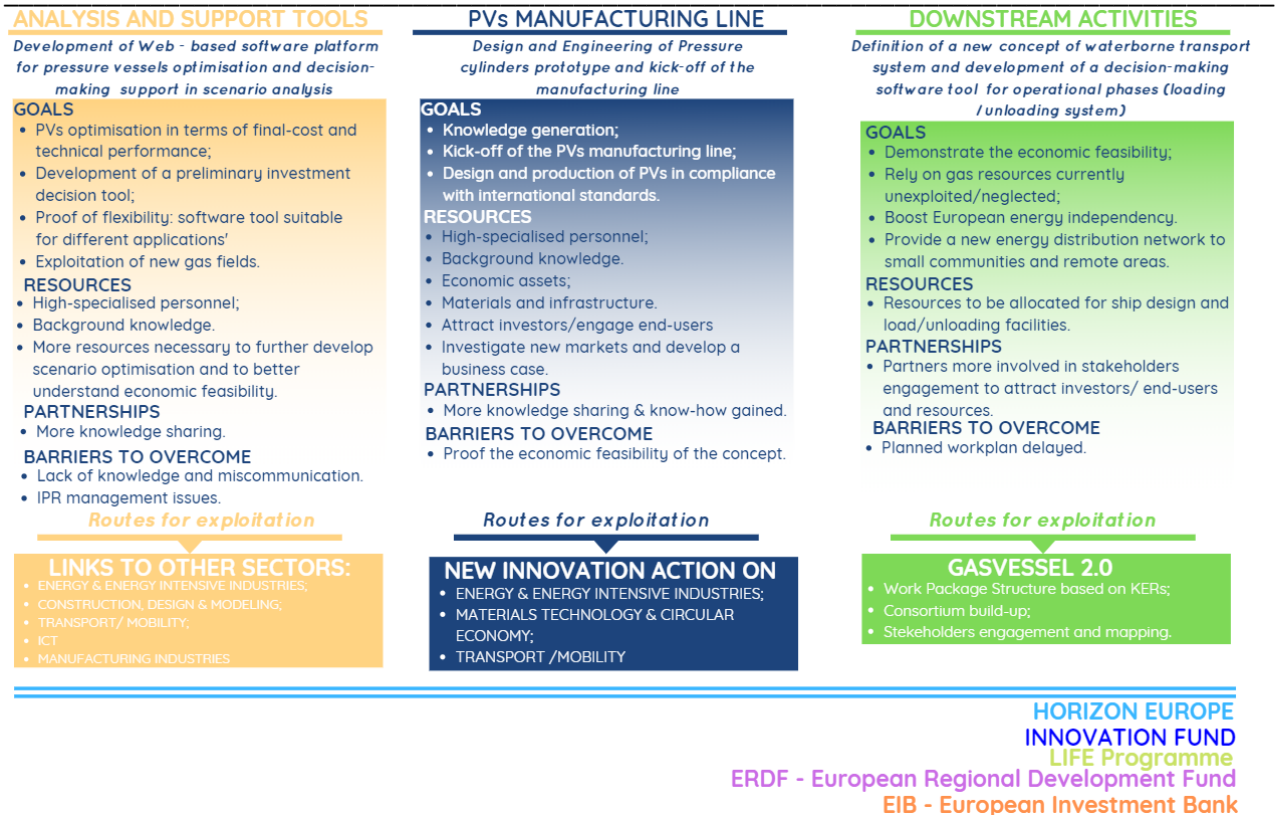


Figure 22: potential Exploitation Routes for each Concept-Group of KERs

Analysis and support tools

As shown in Figure 22, the Exploitation Route of the Analysis and support tools developed within the GASVESSEL project could include a wide range of possibilities. The web-based software platforms could support many other industrial sectors in their own decision- making processes; for this reason, the main exploitation route mentioned in the graphic is based on their potential to be linked to many other sectors and consequently, project topics.

PVs manufacturing line

This concept-group include many different steps of the project value chain (materials supply, design of the cylinders prototype, construction and engineering of the prototype): moreover, the majority of the partners involved in these steps have shown mainly:

- their need to increase the TRL of the innovative solutions (carrying out more R&D activities and participating to more collaborative projects);
- the proof the economic feasibility of the pressure cylinders manufacturing line and the need to investigate further the requirement of the markets and to engage end-users that make worth the kick-off of a production line of cylinders.

For this reason, the main exploitation route suggested is the kick-off of an Innovation Action (or similar) that could support the partners in the increase the TRL and support them in market uptake activities.

Downstream activities

Since this concept-group is centred around the overall innovative waterborne CNG transport system, the main exploitation route mentioned in this case is represented by the possibility of the partners to generate a GASVESSEL 2.0 in order to cope with all the knowledge that the partners need to bring the concept as much as closer to the market and to prove the economic feasibility.

A GASVESSEL 2.0 option, could follow the structure below:

- GASVESSEL 2.0 ***work-package structure will be based on the GASVESSEL KERs*** list and the work that still is needed to e done to advance in TRL;
- *Consortium configuration:* GASVESSEL current consortium assesses together who will move forward and who might abstain;
- ***Stakeholders' analysis to identify key players*** to get involved (as expressed by the partners);
- Possibly, perform a ***funding intelligence*** to identify previously funded project proposals within the field, analysing tendencies (collaboration among some partners) and identifying recurring partnerships.

Further funding opportunities

Figure 23: H2020 grant scanning

Moreover, during the final session of the workshop some other opportunities have been presented. **Errore. L'origine riferimento non è stata trovata.** shows some calls still available under the current Horizon 2020 Work programmes. In addition, the Innovation Fund has also been presented to the consortium members. The innovation Fun is one of the largest funding programmes for demonstration of Innovative ow-carbon Technologies (sectors of RES, CCUS, Energy Intensive Industries, Energy Storage). Grants cover up to 60% of the additional capital and operational costs of innovation. The Innovation Fund (Figure 24) is dedicated to demonstration actions and it can be combined with other sources of funding.

Figure 24: Innovation Fund

The first call of proposals (application process is based on two-stages) will be lunched in the second half of 2020, followed by regular calls until 2030.

In addition to the funding schemes mentioned during the Exploitation Workshop other funding opportunities are indicated below (as also shown in Figure 22**Errore. L'origine riferimento non è stata trovata.**):

Horizon Europe

The Commission has published its proposal for Horizon Europe, an ambitious €100 billion research and innovation programme that will succeed Horizon 2020. The new programme will be implemented through three pillars:

Figure 25: Horizon Europe pillars

The Global Challenges and Industrial Competitiveness pillar (€52.7 billion) directly supports research relating to societal challenges, reinforces technological and industrial capacities, and sets EU-wide missions with ambitious goals tackling some of our biggest problems. It also includes activities pursued by the Joint Research Centre (€2.2 billion) which supports EU and national policymakers with independent scientific evidence and technical support.

LIFE Programme

The LIFE programme is the EU's funding instrument for the environment and climate action. The general objective of LIFE is to contribute to the implementation, updating and development of EU environmental and climate policy and legislation by co-financing projects with European added value.

The LIFE programme has two main sub-programmes:

1- The Environment sub-programme which covers the priority areas Environment and Resource Efficiency, Nature and biodiversity and Environmental Governance and Information. Each of the priority areas covers several thematic priorities.
2- The Climate Action sub-programme which covers climate change mitigation, adaptation and governance and communication priority areas.

For the duration of the second LIFE multiannual work programme for 2018-2020, the maximum EU co-financing rate for "traditional" LIFE projects is 55% of the total eligible project costs. There is no fixed minimum size for project budgets, but the European Commission favours the co-financing of large, ambitious LIFE proposals with a substantial budget. Historically, the average awarded LIFE grant is between 1 and 2 M€.

ERDF- European regional development fund

The ERDF aims to strengthen economic and social cohesion in the European Union by correcting imbalances between its regions. The Key priority areas are:

- Innovation & Research;
- Digital Agenda;
- Support for SMEs;
- Low-Carbon Economy.

The ERDF resources allocated to these priorities will depend on the category of region:

- In more developed regions, at least 80 % of funds must focus on at least two of these priorities;
- In transition regions, this focus is for 60 % of the funds;
- This is 50 % in less developed regions.

EIB- European Investment Bank

The EU bank provides finance instruments to support projects in innovation, SMEs, infrastructure and climate action. Sectors of action: rural development, digital economy, education, ***energy***, health, ***transport***, regional development, urban agenda.

The EIB makes available varied instruments, such as:

- ***Lending:*** Project loans, venture capital, microfinance, etc…
- ***Blending:*** structured finance, guarantees, InnovFin-EU Finance, PF$EE, etc…
- ***Advising:*** support to PPP, sustainable energy-ELENA, etc.

Among the blending instruments, a special focus is dedicated to the Innov-Energy Fin. This instrument includes loans, loan guarantees or equity type financing typically between € 7.5 M and € 75 M. It provides funds to Projects **in the field of energy system transformation**, including but not limited to renewable energy technologies, smart energy systems, *energy storage*, carbon capture and use.

It is directly deployed by EIB and provides support in bridging the gap from demonstration to commercialisation.

4.10 Conclusions and next steps

The next step to fulfil the Gasvessel Exploitation Strategy will be the organisation of the third themed workshop: thoughts on benchmarking and roadmaps towards exploitation. As leader of Work Package 9, PNO has already outlined a possible structure for the workshop that will focus on how to connect interested stakeholders to the consortium to jointly participate to exploitation activities.

The results of this workshop coupled with the feedbacks from the stakeholders in the third workshop will support PNO team (as WP leader) and the whole consortium in updating the Exploitation strategy (and related Exploitation plan) within the project end.

5. THIRD THEMED WORKSHOP – Thoughts on benchmarking and roadmaps towards exploitation.

The third themed workshop focused on the roadmaps to further exploitation of the Gasvessel results and was organised by PNO in conjunction with the General Assembly in Buttrio (Italy) on 30 October 2019.

5.1 The aim of the workshop

The workshop focused on the preparation of the three identified business cases and ought to be seen as critical input for a larger exploitation workshop involving external stakeholders. Owing to the travel restrictions the organisation of this final exploitation workshop has been delayed until after the submission of this current report. The main aims of the workshop were the following:

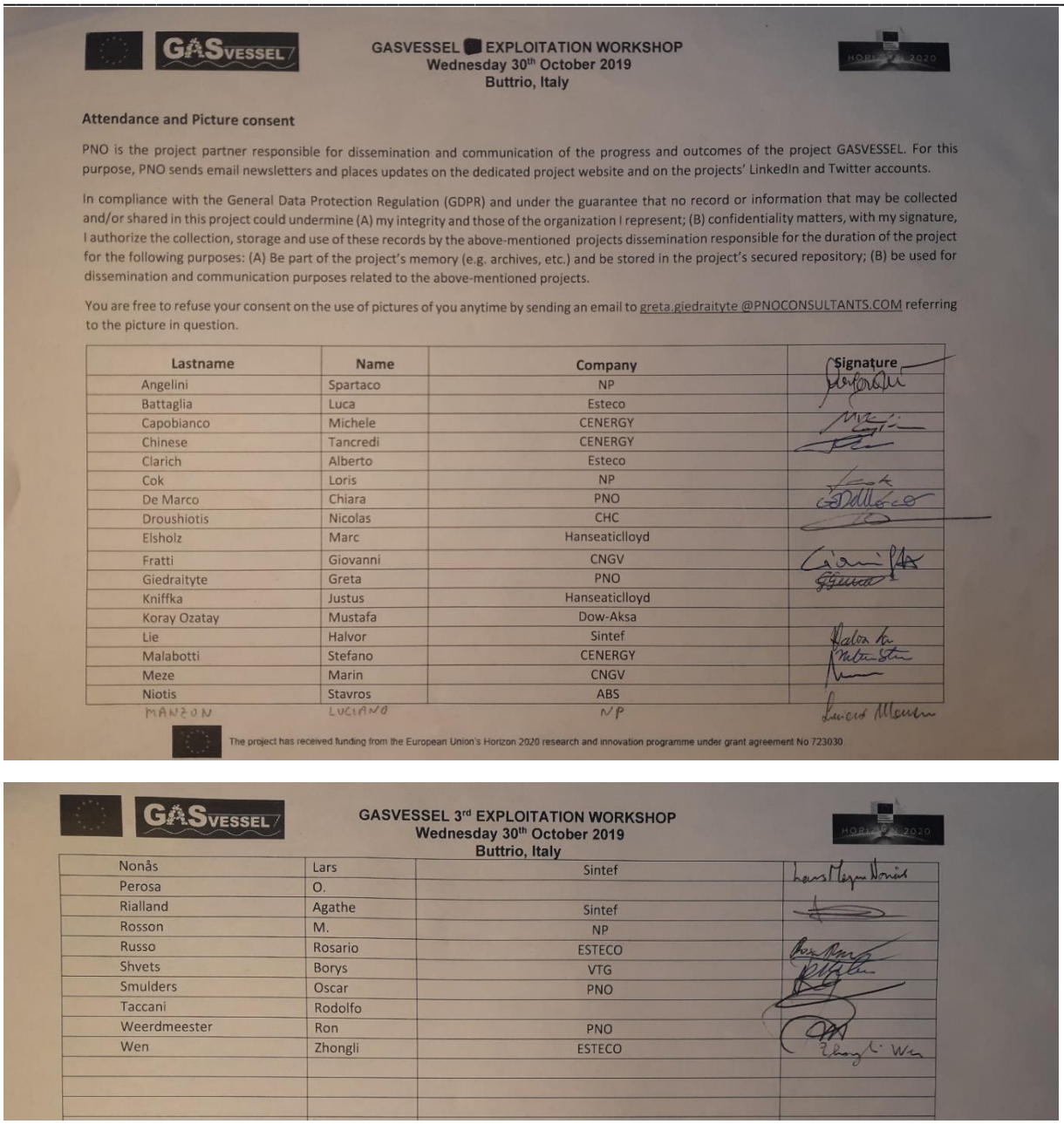
- Further develop the business cases for the Barents Sea, the Mediterranean and the Black Sea.
- Identifying the most relevant clients for each of the business cases
- Identifying the investments necessary for further market development of the business case
- Identifying potential barriers and bottlenecks for further development.
- Describing the value chain elements necessary for developing the Gasvessel solution in each of the business cases

5.2 The agenda

Time	Agenda item	Lead
1145	Introduction, Plenary presentation of the approach and introduction to the three business cases	PNO
1230	Lunch Break	
1300	Subgroups: define and further detail the business cases	All
1430	Plenary feedback of the subgroups	PNO
1530	Conclusions and next steps	PNO

5.3 The participants

The 3rd Exploitation Workshop has been organised by PNO for the exclusive benefit of the GASVESSEL consortium members. The workshop has been attended by the representatives of the partner organisations of the project as shown in Figure 26 below.



GASVESSEL EXPLOITATION WORKSHOP
Wednesday 30th October 2019
Buttrio, Italy

Attendance and Picture consent

PNO is the project partner responsible for dissemination and communication of the progress and outcomes of the project GASVESSEL. For this purpose, PNO sends email newsletters and places updates on the dedicated project website and on the projects' LinkedIn and Twitter accounts.

In compliance with the General Data Protection Regulation (GDPR) and under the guarantee that no record or information that may be collected and/or shared in this project could undermine (A) my integrity and those of the organization I represent; (B) confidentiality matters, with my signature, I authorize the collection, storage and use of these records by the above-mentioned projects dissemination responsible for the duration of the project for the following purposes: (A) Be part of the project's memory (e.g. archives, etc.) and be stored in the project's secured repository; (B) be used for dissemination and communication purposes related to the above-mentioned projects.

You are free to refuse your consent on the use of pictures of you anytime by sending an email to greta.giedraityte @PNOCONSULTANTS.COM referring to the picture in question.

Lastname	Name	Company	Signature
Angelini	Spartaco	NP	
Battaglia	Luca	Esteco	
Capobianco	Michele	CENERGY	
Chinese	Tancredi	CENERGY	
Clarich	Alberto	Esteco	
Cok	Loris	NP	
De Marco	Chiara	PNO	
Droushiotis	Nicolas	CHC	
Elsholz	Marc	Hanseaticlloyd	
Fratti	Giovanni	CNGV	
Giedraityte	Greta	PNO	
Kniffka	Justus	Hanseaticlloyd	
Koray Ozatay	Mustafa	Dow-Aksa	
Lie	Halvor	Sintef	
Malabotti	Stefano	CENERGY	
Meze	Marin	CNGV	
Niotis	Stavros	ABS	
MANZON	LUCIANO	NP	

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723030.

GASVESSEL 3rd EXPLOITATION WORKSHOP
Wednesday 30th October 2019
Buttrio, Italy

Nonås	Lars	Sintef	
Perosa	O.		
Rialland	Agathe	Sintef	
Rosson	M.	NP	
Russo	Rosario	ESTECO	
Shvets	Borys	VTG	
Smulders	Oscar	PNO	
Taccani	Rodolfo		
Weerdmeester	Ron	PNO	
Wen	Zhongli	ESTECO	

Figure 26: Participants to the 3rd explotation workshop

5.4 Preparation of the workshop

After a brief recapitulation of the three business cases by Oscar Smulders of PNO the participants were asked to divide in subgroups that worked on one specific business case. In order to structure the workshop and assure comparable outcomes participants were asked to focus on two main questions of the 'magic business model triangle':

- WHO are the main Value Chain partner(s) / problem or opportunity owners (i.e. the future Gasvessel clients)
- HOW will the solution be delivered through the Business Model to the partners?

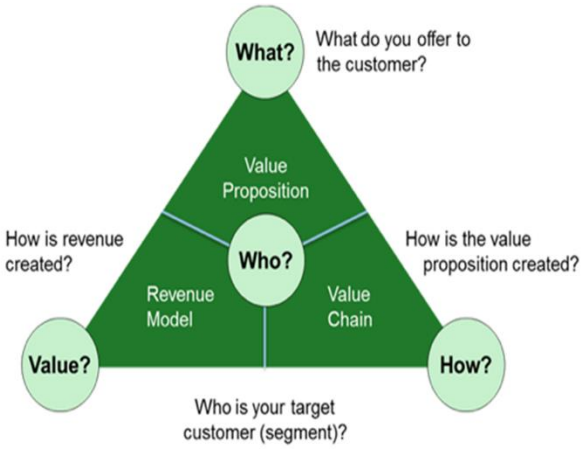


Figure 27: The 'magic triangle' of business model innovation

The particpants were asked to think about the following questions:

- Who are the top 5 clients and why?
- Why would they invest?
- What is the investment needed to roll out?
- Which are the potential bottlenecks / showstoppers?
- Upscaling infra structure, production capacity, ships:
  - Who is going to invest?
  - Who is going to place orders?
- Value Chain elements:
  - Who is the owner of each part?
  - Who is the client?
  - What is the value?

5.5 Results

The following sections will present the results for the subgroups deliberations on each of the business cases:

- Barents Sea business case
- Mediterranean business case
- Black Sea business case

5.5.1 Barents Sea Business Case

In the case of the Barents Sea scenario, an associated gas field, J. Castberg, and a gas field, Alke, were identified as potential gas sources. The selected target market is the United Kingdom due to the existing infrastructure that allows easy access to this well-established gas market. It is expected that the UK market can absorb available gas production from Norway, from which it is already importing considerable amounts

of natural gas. The figure below summarizes the loading of gas from offshore and transporting it using the Gasvessel concept to the gas unloading location.

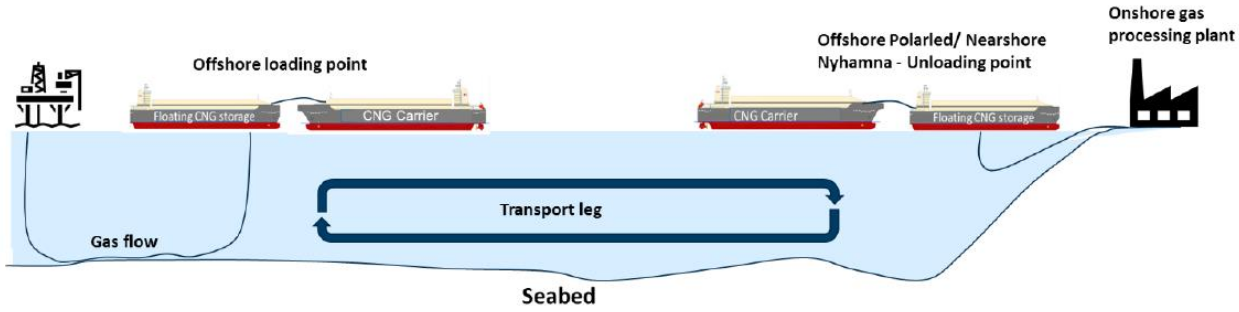


Figure 28: Main value chain aspects of Barents Sea scenarios

The subgroup that focused on the Barents Sea investigated two separate scenarios. A first scenario that is looking to exploit associated gas and a second one that is focusing on small gas fields which are unlikely to be exploited for production by pipeline.

The main client for the Gasvessel solution operating in the Barents Sea would be Equinor, a Norwegian state-owned multinational energy company and the largest operator on the Norwegian continental shelf. Equinor exploits numerous oil- and gas fields and operates several pipelines. Gasvessel's value proposition for Equinor could consist of several aspects:

- Optimising the exploitation of the oil platform;
- Reducing the downstream cost in using the pipeline;
- Maximising the use of existing pipeline system, once the gas fields start reducing in volume;
- Optimising the exploitation of the oil field, by directly bringing the gas to the Nyhamna gas processing plant or by a (polarlid) pipeline that goes to Nyhamna.

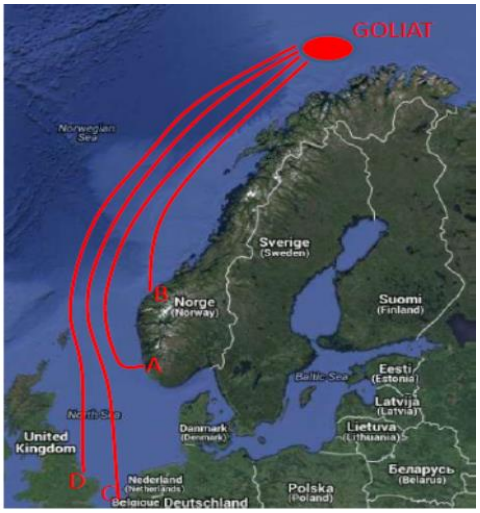


Figure 29: Barents Sea exploitation routes

The required investment for this model would mainly consist of ship(s), storage equipment and an onloading system. With potential end users in the UK, other value chain partners to involve in this setting would be Gassco, the operator for the integrated system for transporting gas from the Norwegian continental shelf to other European countries and managing the pipeline between Norway and UK. The interest for Gassco would be that they could optimize the use of the existing pipeline infrastructure and be able to expand the gas infrastructure with a flexible and scalable solution.

Two important questions raised in this option are whether Equinor would be able to sell additional gas to the UK using existing pipeline infrastructure and whether it would be commercially more interesting than injecting the associated gas (instead of water).

The working group also studied another angle in this business case, where a shipping company or operator (e.g. Teekay). The value proposition in this case would consist of offering dynamic and scalable gas storage

and transport services to multiple clients (small gas fields, associated gas from multiple platforms and operators (e.g. Equinor, ENEL, and even in Russia). The infrastructure investments in this case consist of:

- Loading infrastructure (connection, storage and compression) per field and platform
- Off-loading-system to the pipeline (incl. storage)
- Ship(s)
- Storage facilities (floating or onshore, e.g. simplified ship)
- Production capacity of gas-containers
- Dedicated Carbon fibre production facility for the GASVESSEL service concept

Two separate value chains can be distinguished. The simplest one is offering the storage and transport services to big companies like Equinor or ENEL, who then take care of the rest. The more challenging one would be buying gas from these companies and then selling it to end-users.

As potential drawbacks in this scenario the working group identified the competitiveness of midstream tariffs and the 'chicken and egg' question with respect to the necessary investment. One option allowing to deal with these bottlenecks would be to start with container production facility using standard 45 feet containers for CNG transport (on normal ships, trucks etc.) before investing in dedicated ships and transport equipment.

5.4.2 Mediterranean Business Case

For the Mediterranean business case it is assumed that natural gas will be sourced from a the Cyprus Exclusive Economic Zone (EEZ), targeting markets in Cyprus, Greece (Crete), Lebanon and Egypt.

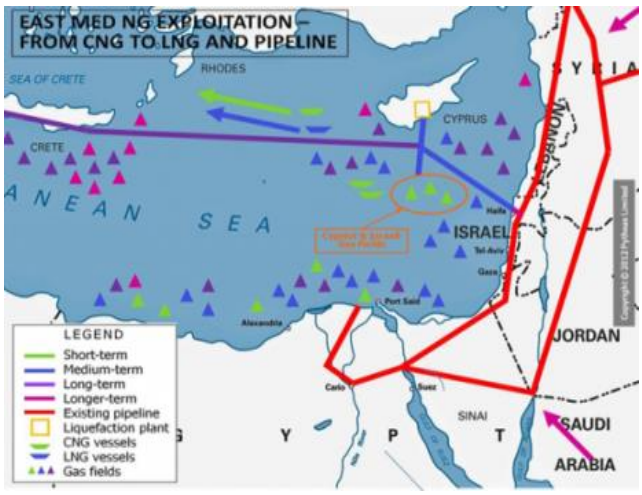


Figure 30: map of East Mediterreanean gasfields exploitation

Potential clients in these markets are

- Power plants owners: These can be semi-governmental plants or smaller full private power plants (liberalisation of the markets).
- Distributors/operators: either private distributors buying gas and distributing companies that distribute gas after buying it (Cyprus, probably Crete and Lebanon) or government ones (Egypt)
- Ship owners
- Oil and Gas companies like ENI, Exxon, Total, Shell, Noble Energy (Research CNG), BP, LukOil, Energian Oil & Gas.

The following **benefits and interests** for the clients were identified:

- Different development concepts for operators
- Green energy for government, lower CO_2 field emissions
- Lower costs for all potential clients
- Complementary solutions to others already in use
- Reach remote areas not reachable with other solutions, more flexibility

- Lowering the prices
- Market and resource flexibility
- Use unexploitable sources, mix of price and unreachable areas, challenging cost and feasibility

- Use the gas, instead of reinjection, to extract oil: associated gas field (not convenient): to unlock associated gas volume
- Reducing environmental impact of transportation (no pipelines anymore)

In order to achieve the identified business case, **important investments** need to be done. Operators need to undertake important capital expenditure investments for the development of the solution, whereby the full value chain needs to be developed. This consists of investment in the whole value chain until the selling point to the market, building on and offshore facilities and buying the gas vessels. The targeted market parties therefore need to commit on gas volumes. It is noted that multiple actors may need to be involved as it is considered unlikely that one sole actor would assume the risk of building the entire value chain

The following **bottlenecks** have been identified:

- Single actor building, managing, and controlling the entire value chain is seen as a potential bottleneck for the development of the business case.
- Technology readiness: if technology is not ready, clients would need to buy and then develop it by themselves.
- Risk assessment.
- Because a storage buffer is needed in any case, authorisations from governments to build the infrastructures are needed. The processes to get the authorisations are time consuming and are seen as an risk factor Also approvals are needed following national and international standards.
- Gas commitment from buyers, nobody wants to commit to gas purchasing over longer periods of time.

Other potential exploitation routes to be further looked in to are:

- A potential step to enhance market uptake might be to use standard sea containers and Gasvessel cylinders. The upfront investment in this case would be significantly lower as there is no need to invest in specific ships. Still the same vessel technology could be used.
- Specifically, the scenario of using 40ft containers to refill gas stations only could help using the cleaner gas and create an important impact on the automotive sector in decreasing gas NOX particles (would be 0 with gas) and reducing CO_2 (25-30% reduction). The use of the containers could help in the upstart, as it is not necessary to build the entire infrastructure, thereby alleviating important investment levels
- Several other potential markets are named:
  - The Spanish market, where there are few L&G applications.
  - Emerging markets: remote areas are great potential scenarios to be explored outside Europe, but in Europe Energy is diffused and energy sources are multiple. In Europe islands are the main targets. In this light it would be of interest to see whether Sardinia can also be a possibility.

5.4.3 Black Sea Business Case

From the potential source of natural gas, the Shah Deniz field in Azerbaijan, gas would be transported through the territory of Azerbaijan, Georgia where a pipeline shall be built to deliver the gas to the coastal region of Georgia, where the gas will be compressed and loaded via the near shore loading onboard the Gasvessel . The shortest routes of the existing gas pipelines from the Shah Deniz field to the Black Sea coast are the Baku-Tbilisi-Erzurum and TANAP gas pipelines in the territory of Georgia. Thus, Georgia is selected as the country where the source terminal is to be located. Ukraine was chosen as the target country where the unloading terminal will be located. Ukraine is one of the Black Sea countries most dependent on Russian natural gas imports. In order to successfully execute the loading and unloading of the Gasvessel, it is essential to create the necessary infrastructure connecting the existing gas transportation systems of Georgia and Ukraine with terminal sites. The subgroup investigating the exploitation of the Black Sea route identified several potential cases.

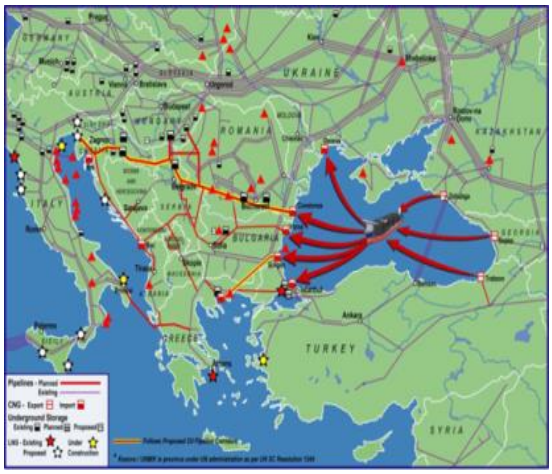


Figure 31: Black Sea exploitation routes

In the first case, the Ukranian government would be the principal client through the state-owned oil and gas company Naftogaz. Ukraine is still heavily dependent on coal for its energy source. In order to meet the domestic industrial demand, Ukraine has set the objective to be autonomous by 2026. In this perspective Ukraine will be an interesting potential client for importing gas from the Azerbaijani fields transported by the Gasvessel solution. Georgia, being a transit country, should also be regarded as a potentially interested client in this case, as the Azerbaijani government as they can increase the sales of their gas fields. To connect to the existing pipeline network, the following infrastructure needs to be built:

- Pipeline Turkish border – Poti (Georgia) of 140km
- Compressor station
- Loading terminal Poti
- Unloading terminal Ukraine
- Gasvessel transport ships (2 or3)

The main bottleneck to be solved in this scenario concerns the absence of underground storage facilities in South Ukraine. Furthermore, there are doubts on the available budget of the Georgian to finance the necessary infrastructural works needed to connect to the existing piping network.

The second case having been discussed, involves small or large utility plants, municipalities or industrial plants who want to be independent and are located along the Black Sea coast (Turkey, Romania, Bulgaria). They are often located in remote mountainous areas, which are difficult to supply. The gas would be transported in Gasvessel cylinders built into standard sea containers. These containers can serve as cheap transport and storage facility. The required investments for this option are limited in the sense that

existing gas networks would be used and that the gas will be transported to the final client destination by loading the standard containers on trucks with capacity to handle the containers. The containers can be

either offloaded on site or fill underground storage facilities. Investment would be needed to build simplified compressor and loading stations. Aspects to consider in further elaborating this case are the number of unloading facilities in the Black Sea, and the perceived higher risk associated with less professional people managing the smaller containers.

6. Conclusions and next steps

During the three exploitation workshops valuable insights have bene generated into the three different themes. In the first themed workshop focussing on the decision support tool and the design optimisation platform, the two innovative tools modeFRONTIER and VOLTA were presented. ESTECO gained insightful feedback allowing further development and validation of the tools allowing them to fine tune and optimise the tools and enhancing further market uptake of the support tools.

The second workshop focused on identifying the Key Exploitable Results (KER's). During this workshop strategic actions have been set out to bring the KER's closer to the market. Based on a thorough preparative questionnaire a number of KER's had been identified. During the workshop the following exploitable results were further discussed:

- Platform for collaborative optimisation of CNG scenarios
- Platform for collaborative optimisation of CNG vessels
- Industrial Grade CF for large scale compressed gas vessels
- Construction and industrialization of prototype plants and equipment
- High-pressure steel cylinder wrapped in carbon fibres
- Simulation Model for the Design of a Loading/Unloading System for Pressure Vessels
- Prove the techno-economic feasibility of a new waterborne CNG transport concept

For each result, a more detailed exploitation route has been identified, using the Innovation Canvas as a tool to develop the business models. These will serve as a guideline during the rest of the project to ensure maximum development and bringing the results closer to market potential.

The third exploitation workshop had a clear focus on the identified business cases for the Gasvessel technology. The three business cases for Mediterranean, Barents Sea and Black Sea were discussed. Key elements of the business cases were further deliberated on, such as identifying potential clients for each business case, the reasons to invest in the Gasvessel technology and the required investments for further roll out. Important investments in infrastructural equipment are needed for the business cases to be realised, which requires active involvement of potential clients. During the general assembly following the third exploitation workshop it has been decided to further develop the specific business cases in a specific exploitation event involving external stakeholders. This event will be organised later in the project, when technology has been further developed and tested. Also, different exploitation routes of the KER's will be looked into. As the COVID-19 pandemic and the resulting travel restrictions and uncertainty, a date for this event has not yet been set and will be decided upon later on in the project.

ANNEX I: Exploitation Questionnaire -template

DOCUMENT MANAGEMENT	
CREATED BY:	Alessia Di Loreto, *PNO Innovation*
DATE	19.03.2019
COMPLETED BY:	*Please,fill in with your name*
DEADLINE FOR COMPLETION:	29.03.2019
OBJECTIVE OF THE QUESTIONNAIRE: Provide a general overview of the KERs generated from the GASVESSEL project so far and better define the exploitation strategy, taking into account all the possible barriers.	

PARTNER ORGANISATION	NAME OF THE ORGANISATION XXXX	NOTES
A. Admin **DATA**		
Country		
Sector of Interest		*Please describe your sector of activities within the context of the proeject*
Legal Status	Please select	
Role in the Project	Please select If *other*, please specify	
B. General description of the **INNOVATION**		
Groups of KERs (Key Exploitable Results)	Please select	
Title of the specific Innovation	….	*Please provide a title for your innovation (ideally not exceeding 10 words)*
TRL at the end of the project	Please select	
Within the frame of:	Please select	*Please define the work package in which you developed your Key Exploitable Result(s)*
In collaboration with:	….	*Please indicate the consortium members you had the chance to collaborate to develop the innovati*
Description of the new concept/innovation	….	*Provide a description of the challenge to be solved and explain how the innovation is expected to solve this challenge (up to 50 words)*
Advantages of the new concept/ innovation Vs State of the art	….	*What are the limiting factors in the state of the art and how the expected innovation could overcome them. Give some qualitative and quantitative indications of benefits for end users (e.g. environmentally friendly, 10 times cheaper, 5 process steps less, 3 times faster processing)*
Replicability	….	*Please specify in which application areas the new concept/ innovation could be applied,* ***beyond the activity of the project.***
Position in the GASVESSEL value chain	Please select	*Please provide a brief description of the value chain in which your results can be exploited: for example what are the raw material/process needed, where is the position of the innovation in the value chain and what are the further process/steps needed to reach the end users.*
Your interest in the exploitable result	Please select If *other,* please specify	
C. Commercial and Industrial **EXPLOITATION**		
Potential users/ customers	….	*Who are the potential users? Do you know their needs and demands?*
Potential market segments	….	*What are the potential market segments you plan to target?*
Market segments for replicability		*What are the potential market segments you plan to replicate the innovation?*
Competive solutions and competitors	….	*Who is the competition and what solutions exist already?*
Risk assessment	….	*Please provide an indication about the foreseen risks that can be encountered when bringing this innovation to market (e.g. risk of emerging technologies that are much cheaper, the innovative technology needs significant investment in current production lines to be implemented, side effects on health is not fully understood, etc.)*
Additional R&D steps required for TRL advancement	….	*What further work will be required (post-project) to take the KER from current TRL into a patent/ product/service*

D. Knowledge **EXPLOITATION**

Dissemination level	Please select	*If the exploitable result happens to be a project deliverable, please indicate the dissemination level that is determined in the GA. If the exploitable result is NOT a project deliverable, you might estimate the dissemination level or leave the cell empty.*
	If *other,* please specify	
Dissemination strategy	**Events:** Conference(s): xxx (Date) , Workshop(s): xxx (Date) , Seminar(s): xxx (Date) , Internal gathering event(s): xxx (Date) , Other	*Please provide the most relevant events and channels where you want to disseminate your innovation after protection.*
	Channels: Journal(s): … , Platform(s): ….. , Other	

E. Exploitation strategy and **IPR MANAGEMENT**

IPR background	….	*Please describe the knowledge (i.e. bakground related patents or other IPR) your organisation has brought to the project.*
Granted patents (ID)	….	*Please describe the patents that were issued from the project work.*
Results Ownership	co-owned with other partners	
Planned patents	YES/NO - x patents	
Negotiations with other project partners needed?	Please select	
	Please specify	
Preferred support by exploitation partners	Please select	
	If other, please specify	
Strategic R&D partnerships that should be involved?	….	*Involvement of e.g. other research partners, distributors, key customers, suppliers needed?*

.]

ANNEX II: Innovation Canvas - template

Innovation Canvas

PNO

Alessia DI LORETO *Grants and Innovation Consultant*
Stefania BALDASSARRE *Innovation Management Consultant*
Cemre MUTLU *Business Analyst*

Participants:

Created value
What will be the result of your project partnership?
E.g. Products, services, tools....

Partners
Who are the partners who have contributed to develop the innovation?
Which role they played?

Goals
What business goals drive your partnerships?
What are your objectives?
What asset do we seek to leverage from a partnership?

Resources
What resources (money, assets, personnel) will you deploy?

Transfer Activities
How will you collaborate to connect and transfer value with the other partners?
E.g. Collaborating team, training, matching technology protocols, referral management systems....

Barriers
What are the pain points that you foresee ?
E.g. Lack in performance, costs increase, no agreement achieved in terms of IPR....

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