Call: HORIZON-JTI-CLEANH2-2022-2

(HORIZON-JTI-CLEANH2-2022)

Topic: HORIZON-JTI-CLEANH2-2022-05-03

Type of Action: HORIZON-JU-RIA

Proposal number: 101111888

Proposal acronym: SHIMMER

Type of Model Grant Agreement: HORIZON Action Grant Budget-Based

Table of contents

Proposal ID **101111888**

Acronym **SHIMMER**

1 - General information

Fields marked * are mandatory to fill.

Topic	HORIZON-JTI-CLEANH2-2022-05-03	Type of Action	HORIZON-JU-RIA
Call	HORIZON-JTI-CLEANH2-2022-2	Type of Model Grant Agreement	HORIZON-AG

Acronym: SHIMMER

Proposal title: Safe Hydrogen Injection Modelling and Management for European gas network Resilience

Note that for technical reasons, the following characters are not accepted in the Proposal Title and will be removed: < > " &

Duration in months: 36

Fixed keyword 1: Chemical engineering

Fixed keyword 2: Materials engineering

Free keywords: *Hydrogen, natural gas, gas networks, low-carbon economy, flow modelling, material technology, infrastructure retrofitting and repurposing*

Abstract *

To accelerate the transition to a low-carbon economy while exploiting existing infrastructure, hydrogen can be injected to the natural gas network. However, the there are many technical and regulatory gaps that should be closed and adaptations and investments to be made to assure that multi-gas networks across Europe will be able to operate in a reliable and safe way while providing a highly controllable gas quality and required energy demand. Recently, the European Committee for Standardization concluded the impossibility of setting a common limiting value for hydrogen into the European gas infrastructure recommending a case-by-case analysis. In addition to this, there are still uncertainties related to material integrity on pipelines and networks components with regards to a reduced lifetime in presence of hydrogen. Existent results from previous and ongoing projects on the hydrogen readiness of grid components should be summarized in a systematic manner together with the assessment of the existent T&D infrastructure components at European level to provide stakeholders with decision support and risk reduction information to drive future investments and the development of regulations and standards. The SHIMMER project aims to enable a higher integration and safer hydrogen injection management in multi-gas networks by contributing to the knowledge and better understanding of hydrogen projects, their risks, and opportunities.
- To map and address European gas T&D infrastructure in relation to materials, components, technology, and their readiness for hydrogen blends
- To define methods, tools and technologies for multi-gas network management and quality tracking, including simulation, prediction, and safe management of transients, in view of widespread hydrogen injection in a context of European-wide context
-To propose best practice guidelines for handling the safety of hydrogen in the natural gas infrastructure, managing the risks

Remaining characters 31

Has this proposal (or a very similar one) been submitted in the past 2 years in response to a call for proposals under any EU programme, including the current call? ○ Yes ◉ No

Please give the proposal reference or contract number.

Administrative forms

Proposal ID **101111888**

Acronym **SHIMMER**

Declarations

Field(s) marked * are mandatory to fill.

1) We declare to have the explicit consent of all applicants on their participation and on the content of this proposal. * ☒

2) We confirm that the information contained in this proposal is correct and complete and that none of the project activities have started before the proposal was submitted (unless explicitly authorised in the call conditions). * ☒

3) We declare:
- to be fully compliant with the eligibility criteria set out in the call
- not to be subject to any exclusion grounds under the EU Financial Regulation 2018/1046
- to have the financial and operational capacity to carry out the proposed project. * ☒

4) We acknowledge that all communication will be made through the Funding & Tenders Portal electronic exchange system and that access and use of this system is subject to the Funding & Tenders Portal Terms and Conditions. * ☒

5) We have read, understood and accepted the Funding & Tenders Portal Terms & Conditions and Privacy Statement that set out the conditions of use of the Portal and the scope, purposes, retention periods, etc. for the processing of personal data of all data subjects whose data we communicate for the purpose of the application, evaluation, award and subsequent management of our grant, prizes and contracts (including financial transactions and audits). * ☒

6) We declare that the proposal complies with ethical principles (including the highest standards of research integrity as set out in the ALLEA European Code of Conduct for Research Integrity, as well as applicable international and national law, including the Charter of Fundamental Rights of the European Union and the European Convention on Human Rights and its Supplementary Protocols. Appropriate procedures, policies and structures are in place to foster responsible research practices, to prevent questionable research practices and research misconduct, and to handle allegations of breaches of the principles and standards in the Code of Conduct. * ☒

7) We declare that the proposal has an exclusive focus on civil applications (activities intended to be used in military application or aiming to serve military purposes cannot be funded). If the project involves dual-use items in the sense of Regulation 2021/821, or other items for which authorisation is required, we confirm that we will comply with the applicable regulatory framework (e.g. obtain export/import licences before these items are used). * ☒

8) We confirm that the activities proposed do not
- aim at human cloning for reproductive purposes;
- intend to modify the genetic heritage of human beings which could make such changes heritable (with the exception of research relating to cancer treatment of the gonads, which may be financed), or
- intend to create human embryos solely for the purpose of research or for the purpose of stem cell procurement, including by means of somatic cell nuclear transfer.
- lead to the destruction of human embryos (for example, for obtaining stem cells)

These activities are excluded from funding. * ☒

9) We confirm that for activities carried out outside the Union, the same activities would have been allowed in at least one EU Member State. * ☒

The coordinator is only responsible for the information relating to their own organisation. Each applicant remains responsible for the information declared for their organisation. If the proposal is retained for EU funding, they will all be required to sign a declaration of honour.

False statements or incorrect information may lead to administrative sanctions under the EU Financial Regulation.

2 - Participants

List of participating organisations

#	Participating Organisation Legal Name	Country	Role	Action
1	SINTEF AS	Norway	Coordinator	
2	FUNDACION TECNALIA RESEARCH & INNOVATION	ES	Partner	
3	SNAM S.P.A.	IT	Partner	
4	POLITECNICO DI TORINO	IT	Partner	
5	INSTYTUT NAFTY I GAZU - PANSTWOWY INSTYTUT BADAW	PL	Partner	
6	NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUUR	NL	Partner	
7	BUNDESANSTALT FUER MATERIALFORSCHUNG UND -PRU	DE	Partner	
8	OPERATOR GAZOCIAGOW PRZESYLOWYCH GAZ-SYSTEM	PL	Partner	
9	GERG LE GROUPE EUROPEEN DE RECHERCHES GAZIERES	BE	Partner	
10	GASSCO AS	NO	Partner	
11	REDEXIS SA	ES	Partner	
12	REDEXIS GAS SERVICIOS SL	ES	Affiliated	
13	INRETE Distribuzione Energia S.p.A.	Italy	Partner	
14	ENAGAS TRANSPORTE SA	ES	Partner	

Organisation data

PIC	Legal name
910945140	*SINTEF AS*

Short name: SINTEF

Address

Street	STRINDVEGEN 4
Town	TRONDHEIM
Postcode	7034
Country	Norway
Webpage	www.sintef.no

Specific Legal Statuses

Legal person	yes
Public body	no
Non-profit	yes
International organisation	no
Secondary or Higher education establishment	no
Research organisation	yes

SME Data

Based on the below details from the Participant Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

SME self-declared status	14/01/2022 - no
SME self-assessment	unknown
SME validation	unknown

Departments carrying out the proposed work

Department 1

Department name	SINTEF Industry	☐ not applicable
	☒ Same as proposing organisation's address	
Street	STRINDVEGEN 4	
Town	TRONDHEIM	
Postcode	7034	
Country	Norway	

Main contact person

This will be the person the EU services will contact concerning this proposal (e.g. for additional information, invitation to hearings, sending of evaluation results, convocation to start grant preparation). The data in blue is read-only. Details (name, first name and e-mail) of Main Contact persons should be edited in the step "Participants" of the submission wizard.

Title Dr

Gender ◉ Woman ○ Man ○ Non Binary

First name* **Andrea**

Last name* **Shmueli Alvarado**

E-Mail* **andrea.shmueli@sintef.no**

Position in org. Research Manager

Department SINTEF Institute, process technology

☐ Same as organisation name

☐ Same as proposing organisation's address

Street Tillerbruvegen 200

Town Tiller

Post code 7092

Country Norway

Website https://www.sintef.no

Phone +4745196395

Phone 2 *+xxx xxxxxxxxx*

Other contact persons

First Name	Last Name	E-mail	Phone
Heiner	Schümann	heiner.schumann@sintef.no	+xxx xxxxxxxxx
Grethe	Tangen	grethe.tangen@sintef.no	+xxx xxxxxxxxx

Researchers involved in the proposal

Title	First Name	Last Name	Gender	Nationality	E-mail	Career Stage	Role of researcher (in the project)	Reference Identifier	Type of identifier
Dr	Jan Erik	Olsen	Man	Norway	jan.e.olsen@sintef.no	Category A Top grade re	Team member		Orcid ID
Dr	Lars	Hellemo	Man	Norway	lars.hellemo@sintef.no	Category B Senior resea	Team member		
Dr	Grethe	Tangen	Woman	Norway	grethe.tangen@sintef.no	Category B Senior resea	Team member		
Dr	Paul Roger	Leinan	Man	Norway	paul.roger.leinan@sintef.no	Category B Senior resea	Team member		
Dr	Andrea	Shmueli	Woman	Norway	andrea.shmueli@sintef.no	Category A Top grade re	Leading		
Dr	Heiner	Schümann	Man	Germany	heiner.schumann@sintef.no	Category C Recognised	Team member		
Dr	Martin	Fossen	Man	Norway	martin.fossen@sintef.no	Category B Senior resea	Team member		

Administrative forms

Role of participating organisation in the project

Project management	☒
Communication, dissemination and engagement	☒
Provision of research and technology infrastructure	☒
Co-definition of research and market needs	☐
Civil society representative	☐
Policy maker or regulator, incl. standardisation body	☐
Research performer	☒
Technology developer	☐
Testing/validation of approaches and ideas	☒
Prototyping and demonstration	☐
IPR management incl. technology transfer	☐
Public procurer of results	☐
Private buyer of results	☐
Finance provider (public or private)	☐
Education and training	☐
Contributions from the social sciences or/and the humanities	☐
Other If yes, please specify: (Maximum number of characters allowed: 50)	☐

List of up to 5 publications, widely-used datasets, software, goods, services, or any other achievements relevant to the call content.

Type of achievement	Short description (Max 500 characters)
Publication	*Jan Erik Olsen, Paal Skjetne, "Summarizing an Eulerian–Lagrangian model for subsea gas release and comparing release of CO2 with CH4" Applied Mathematical Modelling, Vol 79, 2020. A mathematical modelling concept for subsea gas releases has been derived. Validation against 4 different experiments is shown.The model is applied to study the difference between release of CO2 and CH4.*
Publication	*Lars Hellemo, et al."Natural Gas Infrastructure Design with an Operational Perspective" Energy Procedia,Vol26,2012, An investment analysis tool for NG infrastructure development. The model takes a system perspective and considers all existing infrastructure as well as the potential expansions. https://doi.org/10.1016/j.egypro.2012.06.011.*
Publication	*Vibeke Stærkebye Nørstebø, Frode Rømo, Lars Hellemo, "Using operations research to optimise operation of the Norwegian natural gas system" Journal of Natural Gas Science and Engineering, Vol2-4,2010,decisions regarding natural gas production, processing and transportation depend on each other, and knowledge about how partial changes in a gas transmission network influence the network capacity and flexibility is crucial in ensuring efficient system operation.*
Software	*GassOpt- The tool is used to evaluate the current network as well as possible network extensions. Our approach ensures optimal operation of the network by considering the complete system and provides valuable insights in the dependencies between the different parts of the system*
Software	*LedaFlow - The advanced multiphase flow pipe simulator*

List of up to 5 most relevant previous projects or activities, connected to the subject of this proposal.

Name of Project or Activity	Short description (Max 500 characters)
CleanExport	*is a Research Council of Norway-funded project for investments and planning of production and transmission/export of energy resources from Norway. The project is developing an open-source modular optimization based on multi-energy-carrier modelling framework. https://www.sintef.no/en/projects/2020/cleanexport/*
Optimization models for NG transport	*SINTEF has developed several models for natural gas transport planning in cooperation with GASSCO for more than 20 years. The expertise developed during this time can be applied in the modelling work for the transmission planning. https://www.sintef.no/en/publications/publication/?pubid=356408*
HyLINE	*Address the pipeline material challenges related to transporting clean H2 gas in the existing subsea pipeline infrastructure for natural gas transport as well as new pipeline infrastructure. https://www.sintef.no/en/projects/2019/hyline-safe-pipelines-for-hydrogen-transport/*
SURE	*Advanced modelling tool for Subsea Gas Release- With support from industry actors, the SINTEF has established a research project to learn more about the effects and hazards of underwater gas blowouts and gas leaks. https://www.sintef.no/en/projects/2013/-sure-advanced-modelling-tool-for-subsea-gas-relea/*

Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work.

Name of infrastructure of equipment	Short description (Max 300 characters)
High pressure PVT cell	*This test facility at the multiphase flow laboratory consists of an autoclave made with titan grade 2 and a sapphire cell. The cell has an inside cell volume of 200 ml. Pressure up to 250 bar, temp between -10C to 150C*

Gender Equality Plan

Does the organization have a Gender Equality Plan (GEP) covering the elements listed below? (•) Yes ( ) No

Minimum process-related requirements (building blocks) for a GEP

- **Publication:** formal document published on the institution's website and signed by the top management
- **Dedicated resources:** commitment of human resources and gender expertise to implement it.
- **Data collection and monitoring:** sex/gender disaggregated data on personnel (and students for establishments concerned) and annual reporting based on indicators.
- **Training:** Awareness raising/trainings on gender equality and unconscious gender biases for staff and decision-makers.
- **Content-wise, recommended areas** to be **covered** and addressed via concrete measures and targets are:
    - work-life balance and organisational culture;
    - gender balance in leadership and decision-making;
    - gender equality in recruitment and career progression;
    - integration of the gender dimension into research and teaching content;
    - measures against gender-based violence including sexual harassment.

PIC	Legal name
999604110	*FUNDACION TECNALIA RESEARCH & INNOVATION*

Short name: TECNALIA

Address

Street	PARQUE CIENTIFICO Y TECNOLOGICO DE BIZKAI
Town	DERIO (BIZKAIA)
Postcode	48160
Country	Spain
Webpage	www.tecnalia.com

Specific Legal Statuses

Legal person	yes
Public body	no
Non-profit	yes
International organisation	no
Secondary or Higher education establishment	no
Research organisation	yes

SME Data

Based on the below details from the Participant Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

SME self-declared status	18/11/2021 - no
SME self-assessment	unknown
SME validation	09/10/2008 - no

Departments carrying out the proposed work

Department 1

Department name	Materials for Extreme Conditions	☐ not applicable
	☐ Same as proposing organisation's address	
Street	Mikeletegi Pasalekua 2	
Town	Donostia – San Sebastián (Gipuzkoa)	
Postcode	20009	
Country	Spain	

Main contact person

This will be the person the EU services will contact concerning this proposal (e.g. for additional information, invitation to hearings, sending of evaluation results, convocation to start grant preparation). The data in blue is read-only. Details (name, first name and e-mail) of Main Contact persons should be edited in the step "Participants" of the submission wizard.

Title: Mr

Gender: ○ Woman ◉ Man ○ Non Binary

First name*: **Pablo**

Last name*: **Benguria**

E-Mail*: **pablo.benguria@tecnalia.com**

Position in org.: Project Manager

Department: Materials for Extreme Conditions

☐ Same as organisation name

☐ Same as proposing organisation's address

Street: Parque Científico y Tecnológico de Bizkaia,Astondo Bidea, Edif700

Town: DErio (Bizkaia)

Post code: E-48160

Country: Spain

Website: www.tecnalia.com

Phone: +34 946 430 850

Phone 2: *+xxx xxxxxxxxx*

Researchers involved in the proposal

Title	First Name	Last Name	Gender	Nationality	E-mail	Career Stage	Role of researcher (in the project)	Reference Identifier	Type of identifier
Dr	Nevena	MArinova	Woman	Bulgaria	Nevena.marinova@tecnalia.com	Category B Senior resea	Leading		
Dr	Jean Baptiste	Jorcin	Man	France	Jbaptiste.jorcin@tecnalia.com	Category B Senior resea	Team member		
Mr	Pablo	Benguria	Man	Spain	Pablo.benguria@tecnalia.com	Category B Senior resea	Team member		
Dr	DAvid	Andres	Man	Spain	David.andres@tecnalia.com	Category B Senior resea	Team member		

Role of participating organisation in the project

Project management	☐
Communication, dissemination and engagement	☐
Provision of research and technology infrastructure	☐
Co-definition of research and market needs	☐
Civil society representative	☐
Policy maker or regulator, incl. standardisation body	☐
Research performer	☒
Technology developer	☐
Testing/validation of approaches and ideas	☒
Prototyping and demonstration	☐
IPR management incl. technology transfer	☐
Public procurer of results	☐
Private buyer of results	☐
Finance provider (public or private)	☐
Education and training	☐
Contributions from the social sciences or/and the humanities	☐
Other If yes, please specify: (Maximum number of characters allowed: 50)	☐

List of up to 5 publications, widely-used datasets, software, goods, services, or any other achievements relevant to the call content.

Type of achievement	Short description (Max 500 characters)
Publication	*Problems Related to Slow Strain Rate Test Performance and Specimen Characterization in Austenitic Corrosion Resistant Alloy Tubes. P. Esteban, R. Caracena, J.-B. Jorcin, A. Iza-Mendia, B. Calleja, A. Lopez. Corrosion NACE (2017).*
Publication	*Compatibility of materials with hydrogen. Particular case: Hydrogen embrittlement of titanium alloys. I. Azkarate, E. Ezponda and V. Madina. International Journal of Hydrogen Energy, Vol. 34, (July 2009), pp. 5976-5980. DOI:10.1016/j.ijhydene.2009.01.058*
Other achievement	*Tecnalia is an active member of the steering committee on Hydrogen Europe (Ekain Fernández) and on International Association for Hydrogen Safety HySafe (Pablo Benguria)*

List of up to 5 most relevant previous projects or activities, connected to the subject of this proposal.

Name of Project or Activity	Short description (Max 500 characters)
HIGGS	*Hydrogen in gas grids: a systematic validation approach at various admixture levels into high pressure grids (H2020-JTI-FCH2 GA#875091, 2020-23)*
H2SAREA	*Development of advanced solutions for a safe hydrogen distribution in natural gas network. Evaluation of materials to hydrogen embrittlement (Basque Government. Hazitek ZE-2021/00001, 2021-22)*
H2FC	*Integrating European Infrastructure to support science and development of Hydrogen- and Fuel Cell Technologies towards European Strategy for Sustainable, Competitive and Secure Energy (FP7-Infrastructure GA#284522; 2011-15)*
ICME- ELKARTEK	*CME- A multi-scale process-microstructure-properties-performance modelling methodology to accelerate the design of materials, processes and acceleration of the design of materials, processes and metallic components. TECNALIA works in one of the use cases related to the study of hydrogen embrittlement in steels, for H2 distribution and storage applications. (Basque Government. Elkartek KK-2021/00022, 2021-22)*

Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work.

Name of infrastructure of equipment	Short description (Max 300 characters)
Hydrogen embrittlement evaluation tests	*Slow strain rate test (SSRT), Hydrogen induced cracking (HIC) test, Stress orientated hydrogen induced cracking (SOHIC) test, C-Ring (CR) test, Four-point bend (4PB) tests, Threshold stress-intensity factor, hydrogen permeation (Devanathan cell), Measurement of the H2 flow through the material.*
High Pressure high temperature autoclaves	*For the high pressures and highly corrosive and toxic chemicals, Tecnalia has a variety of autoclaves, able to work at temperatures up to 400 ºC and 350 bar*
Material characterization lab	*Measurement of H2 flow through the material and evaluation of the H2 trapped in the material (electrochemical permeation test), mechanical tests (tensile, hardness, toughness), study of microstructure and cracks (optical microscopy, SEM–EDX, XRD), measurement of H2 in the material (LECO TCH600)*

Gender Equality Plan

Does the organization have a Gender Equality Plan (GEP) covering the elements listed below? (•) Yes ( ) No

Minimum process-related requirements (building blocks) for a GEP

- **Publication:** formal document published on the institution's website and signed by the top management
- **Dedicated resources:** commitment of human resources and gender expertise to implement it.
- **Data collection and monitoring:** sex/gender disaggregated data on personnel (and students for establishments concerned) and annual reporting based on indicators.
- **Training:** Awareness raising/trainings on gender equality and unconscious gender biases for staff and decision-makers.
- **Content-wise, recommended areas** to be **covered** and addressed via concrete measures and targets are:
    - work-life balance and organisational culture;
    - gender balance in leadership and decision-making;
    - gender equality in recruitment and career progression;
    - integration of the gender dimension into research and teaching content;
    - measures against gender-based violence including sexual harassment.

PIC	Legal name
905331265	*SNAM S.P.A.*

Short name: SNAM

Address

Street	PIAZZA SANTA BARBARA 7
Town	SAN DONATO MILANESE
Postcode	20097
Country	Italy
Webpage	www.snam.it

Specific Legal Statuses

Legal person	yes
Public body	no
Non-profit	no
International organisation	no
Secondary or Higher education establishment	no
Research organisation	no

SME Data

Based on the below details from the Participant Registry the organisation is unknown (small- and medium-sized enterprise) for the call.

SME self-declared status	unknown
SME self-assessment	unknown
SME validation	unknown

Departments carrying out the proposed work

Department 1

Department name	Decarbonization Project	☐ not applicable
	☐ Same as proposing organisation's address	
Street	Piazza Santa Barbara 7	
Town	San Donato Milanese	
Postcode	20097	
Country	Italy	

Main contact person

This will be the person the EU services will contact concerning this proposal (e.g. for additional information, invitation to hearings, sending of evaluation results, convocation to start grant preparation). The data in blue is read-only. Details (name, first name and e-mail) of Main Contact persons should be edited in the step "Participants" of the submission wizard.

Title Mr

Gender ◯ Woman ◉ Man ◯ Non Binary

First name* **Matteo**

Last name* **Robino**

E-Mail* **matteo.robino@snam.it**

Position in org. Hydrogen Expert

Department Decarbonization Projects

☐ Same as organisation name

☒ Same as proposing organisation's address

Street PIAZZA SANTA BARBARA 7

Town SAN DONATO MILANESE

Post code 20097

Country Italy

Website *Please enter website*

Phone + 39 342 1411675

Phone 2 *+xxx xxxxxxxxx*

Researchers involved in the proposal

Title	First Name	Last Name	Gender	Nationality	E-mail	Career Stage	Role of researcher (in the project)	Reference Identifier	Type of identifier
Mr	Alessandro	Clavenna	Man		Alessandro.Clavenna@snam.it		Team member		
Mr	Marino	Crespi	Man		Marino.Crespi@snam.it		Team member		
	Alessia	Borroni	Woman		Alessia.Borroni@snam.it		Team member		

Role of participating organisation in the project

Project management	☐
Communication, dissemination and engagement	☐
Provision of research and technology infrastructure	☐
Co-definition of research and market needs	☒
Civil society representative	☐
Policy maker or regulator, incl. standardisation body	☒
Research performer	☐
Technology developer	☐
Testing/validation of approaches and ideas	☒
Prototyping and demonstration	☐
IPR management incl. technology transfer	☐
Public procurer of results	☐
Private buyer of results	☐
Finance provider (public or private)	☐
Education and training	☐
Contributions from the social sciences or/and the humanities	☐
Other If yes, please specify: (Maximum number of characters allowed: 50)	☐

List of up to 5 publications, widely-used datasets, software, goods, services, or any other achievements relevant to the call content.

Type of achievement	Short description (Max 500 characters)

List of up to 5 most relevant previous projects or activities, connected to the subject of this proposal.

Name of Project or Activity	Short description (Max 500 characters)
Injection of H2NG blends in the gas transport grid	*Own funded pilot project for the injection of H2NG mixtures into Snam network has been carried out to serve industrial end customers with not critical production processes (i.e. a pasta factory and a water bottling plant). In a first phase Snam studied the compatibility of current infrastructure to transport H2NG mixtures with a content of up to 5% H2 in volume, and in a second phase increased the hydrogen content up to 10%.*
PROMETEO	*FCH JU2, ID: 101007194) Design a prototype of a SOE integrated system with high temperature heat sources from renewable energy, in order to optimize electricity consumption, efficiency and sustainability*
E2P2	*(FCH JU2, ID: 101007219) The project aims at demonstrating the feasibility of a reliable energy supply for data centers in urban areas, using fuel cells (powered by CH4 and / or H2).*
OLGA	*(H2020 Green Deal, ID: 101036871) The OLGA (Olympics & Green Airports) project aims at demonstrating the decarbonization of airports through renewable energy sources and green hydrogen. The project, located at Malpensa airport (Italy), intends to design, install and operate a system composed by a 700 kW PEM-electrolyser, an hydrogen storage of 300-400 Nm3 and compression/dispenser unit at 200-250 bar for airport vehicles purposes, such as APUs and local transport connecting the airport with 2026*
MULTHYFUEL	*(FCH JU2, ID: 101006794) MultHyFuel aims at contribute to the effective deployment of hydrogen by developing a common strategy for implementing hydrogen refuelling stations (HRS) in multi-fuel contexts. It will contribute to harmonisation of existing laws through practical, theoretical and experimental data and active and continuous engagement of stakeholders.*

Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work.

Name of infrastructure of equipment	Short description (Max 300 characters)

Gender Equality Plan

Does the organization have a Gender Equality Plan (GEP) covering the elements listed below? (●) Yes ( ) No

Minimum process-related requirements (building blocks) for a GEP

- **Publication:** formal document published on the institution's website and signed by the top management
- **Dedicated resources:** commitment of human resources and gender expertise to implement it.
- **Data collection and monitoring:** sex/gender disaggregated data on personnel (and students for establishments concerned) and annual reporting based on indicators.
- **Training:** Awareness raising/trainings on gender equality and unconscious gender biases for staff and decision-makers.
- **Content-wise, recommended areas** to be **covered** and addressed via concrete measures and targets are:
    - work-life balance and organisational culture;
    - gender balance in leadership and decision-making;
    - gender equality in recruitment and career progression;
    - integration of the gender dimension into research and teaching content;
    - measures against gender-based violence including sexual harassment.

PIC	Legal name
999977754	*POLITECNICO DI TORINO*

Short name: POLITO

Address

Street	CORSO DUCA DEGLI ABRUZZI 24
Town	TORINO
Postcode	10129
Country	Italy
Webpage	www.polito.it

Specific Legal Statuses

Legal person	yes
Public body	yes
Non-profit	yes
International organisation	no
Secondary or Higher education establishment	yes
Research organisation	yes

SME Data

Based on the below details from the Participant Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

SME self-declared status	23/12/2021 - no
SME self-assessment	unknown
SME validation	unknown

Departments carrying out the proposed work

Department 1

Department name: Department of Energy ☐ not applicable

☒ Same as proposing organisation's address

Street: CORSO DUCA DEGLI ABRUZZI 24

Town: TORINO

Postcode: 10129

Country: Italy

Department 2

Department name: Department of Electronics and Telecommunications ☐ not applicable

☒ Same as proposing organisation's address

Street: CORSO DUCA DEGLI ABRUZZI 24

Town: TORINO

Postcode: 10129

Country: Italy

Department 3

Department name: Department of Mathematical Sciences ☐ not applicable

☒ Same as proposing organisation's address

Street: CORSO DUCA DEGLI ABRUZZI 24

Town: TORINO

Postcode: 10129

Country: Italy

Main contact person

This will be the person the EU services will contact concerning this proposal (e.g. for additional information, invitation to hearings, sending of evaluation results, convocation to start grant preparation). The data in blue is read-only. Details (name, first name and e-mail) of Main Contact persons should be edited in the step "Participants" of the submission wizard.

Title Prof.

Gender ◯ Woman ◉ Man ◯ Non Binary

First name* **Pierluigi**

Last name* **Leone**

E-Mail* **pierluigi.leone@polito.it**

Position in org. Professor

Department Department of Energy

☐ Same as organisation name

☒ Same as proposing organisation's address

Street CORSO DUCA DEGLI ABRUZZI 24

Town TORINO

Post code 10129

Country Italy

Website https://www.denerg.polito.it/en/personale/elenco

Phone +390110904422

Phone 2 +393386168872

Other contact persons

First Name	Last Name	E-mail	Phone
Massimiliano	Rapetti	denerg.progetti@polito.it	+39 0110904527
Claudia	Sibilla	claudia.sibilla@polito.it	+39 0110904531

Researchers involved in the proposal

Title	First Name	Last Name	Gender	Nationality	E-mail	Career Stage	Role of researcher (in the project)	Reference Identifier	Type of identifier
Prof	Pierluigi	Leone	Man	Italy	pierluigi.leone@polito.it	Category A Top grade re	Leading	0000-0001-6609-5522	Orcid ID
Prof	Igor	Stievano	Man	Italy	igor.stievano@polito.it	Category A Top grade re	Team member	0000-0001-7287-7360	Orcid ID
Dr	Marco	Cavana	Man	Italy	marco.cavana@polito.it	Category C Recognised	Team member	0000-0002-9754-3583	Orcid ID
Prof	Stefano	Berrone	Man	Italy	stefano.berrone@polito.it	Category A Top grade re	Team member	0000-0001-8642-4258	Orcid ID
Prof	Paolo	Manfredi	Man	Italy	paolo.manfredi@polito.it	Category B Senior resea	Team member	0000-0002-0574-8945	Orcid ID
Prof	Riccardo	Trinchero	Man	Italy	riccardo.trinchero@polito.it	Category B Senior resea	Team member	0000-0002-1838-2591	Orcid ID

Role of participating organisation in the project

Project management	☐
Communication, dissemination and engagement	☐
Provision of research and technology infrastructure	☐
Co-definition of research and market needs	☐
Civil society representative	☐
Policy maker or regulator, incl. standardisation body	☐
Research performer	☒
Technology developer	☐
Testing/validation of approaches and ideas	☐
Prototyping and demonstration	☒
IPR management incl. technology transfer	☐
Public procurer of results	☐
Private buyer of results	☐
Finance provider (public or private)	☐
Education and training	☒
Contributions from the social sciences or/and the humanities	☐
Other If yes, please specify: (Maximum number of characters allowed: 50)	☐

List of up to 5 publications, widely-used datasets, software, goods, services, or any other achievements relevant to the call content.

Type of achievement	Short description (Max 500 characters)
Publication	*S. Pellegrino, A. Lanzini, P. Leone, "Greening the gas network – The need for modelling the distributed injection of alternative fuels", Renewable and Sustainable Energy Reviews, Volume 70, April 2017, Pages 266-286.*
Publication	*M. Cavana, A. Mazza, G. Chicco, P. Leone, "Electrical and gas networks coupling through hydrogen blending under increasing distributed photovoltaic generation", Applied Energy 290, 116764, 2021.*
Publication	*M. Cavana and P. Leone, "Solar hydrogen from North Africa to Europe through greenstream: A simulation-based analysis of blending scenarios and production plant sizing," Int. J. Hydrogen Energy, vol. 46, no. 43, pp. 22618–22637, 2021.*
Publication	*E. Vaccariello, R. Trinchero, P. Leone, and I. S. Stievano, "Synthetic gas networks for the statistical assessment of low-carbon distribution systems," Sustain. Energy, Grids Networks, vol. 31, p. 100765, 2022.*
Publication	*E. Vaccariello, R. Trinchero, I. S. Stievano, and P. Leone, "A Statistical Assessment of Blending Hydrogen into Gas Networks," Energies 14 (16), 5055, 2021.*

List of up to 5 most relevant previous projects or activities, connected to the subject of this proposal.

Name of Project or Activity	Short description (Max 500 characters)
Sardinia Green Hydrogen Project	*Scientific coordination for a demonstration project led by the largest Italian gas DSO of a green hydrogen production unit with multple end-uses including blending for residential users, medium-temperature heat production in a dairy industry, heavy duty transport.*
Contursi hydrogen field trial	*Data analysis of hydrogen leakages in a field trial of hydrogen blending in the transmission gas network in Italy led by the Italian TSO.*
Hydrogen and Synthetic Natural Gas Production	*Scientific coordination for a feasibility project led by the largest Italian gas DSO and a large cement company for green hydrogen and synthetic natural gas production unit with uses in heavy duty transport.*
European Research Projects	*Partecipation in SOFCOM project and Biocellus project about use of fuel cell systems with biogas and biomass syngas (FCH-JU SP1-JTI-FCH.2010.3.4 and FP6-SUSTDEV 502759).*
Other Industrial Research Projects	*Partecipation to feasibility studies about hydrogen valleys in Italy with focus on use of hydrogen for the decarbonization of industrial clusters. Partecipation to the installation and early field demonstration of a SOFC-based trigeneration system (100 kWe) at Siemens Facilities in Torino (2004).*

Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work.

Name of infrastructure of equipment	Short description (Max 300 characters)

Gender Equality Plan

Does the organization have a Gender Equality Plan (GEP) covering the elements listed below? (•) Yes ( ) No

Minimum process-related requirements (building blocks) for a GEP

- **Publication:** formal document published on the institution's website and signed by the top management
- **Dedicated resources:** commitment of human resources and gender expertise to implement it.
- **Data collection and monitoring:** sex/gender disaggregated data on personnel (and students for establishments concerned) and annual reporting based on indicators.
- **Training:** Awareness raising/trainings on gender equality and unconscious gender biases for staff and decision-makers.
- **Content-wise, recommended areas** to be **covered** and addressed via concrete measures and targets are:
    - work-life balance and organisational culture;
    - gender balance in leadership and decision-making;
    - gender equality in recruitment and career progression;
    - integration of the gender dimension into research and teaching content;
    - measures against gender-based violence including sexual harassment.

PIC	Legal name
993695937	*INSTYTUT NAFTY I GAZU - PANSTWOWY INSTYTUT BADAWCZY*

Short name: INIG

Address

Street	UL. LUBICZ 25A
Town	KRAKOW
Postcode	31 503
Country	Poland
Webpage	www.inig.pl

Specific Legal Statuses

Legal person	yes
Public body	yes
Non-profit	yes
International organisation	no
Secondary or Higher education establishment	no
Research organisation	yes

SME Data

Based on the below details from the Participant Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

SME self-declared status	31/12/2020	- no
SME self-assessment	31/12/2020	- no
SME validation	unknown	

Departments carrying out the proposed work

Department 1

Department name: Department of Environmental Protection ☐ not applicable

☐ Same as proposing organisation's address

Street: Bagrowa 1 Str.

Town: Kraków

Postcode: 30-733

Country: Poland

Department 2

Department name: Department of Gas Transmission and Distribution ☐ not applicable

☐ Same as proposing organisation's address

Street: Bagrowa 1 Str.

Town: Kraków

Postcode: 30-733

Country: Poland

Department 3

Department name: Department of Fuel Usage ☐ not applicable

☐ Same as proposing organisation's address

Street: Bagrowa 1 Str.

Town: Kraków

Postcode: 30-733

Country: Poland

Main contact person

This will be the person the EU services will contact concerning this proposal (e.g. for additional information, invitation to hearings, sending of evaluation results, convocation to start grant preparation). The data in blue is read-only. Details (name, first name and e-mail) of Main Contact persons should be edited in the step "Participants" of the submission wizard.

Title _____ Gender (•) Woman ( ) Man ( ) Non Binary

First name* **Monika** Last name* **Gajec**

E-Mail* **gajec@inig.pl**

Position in org. Environmental Protection Department Manager

Department Department of Environmental Protection ☐ Same as organisation name

☐ Same as proposing organisation's address

Street Bagrowa 1 Str.

Town Kraków Post code 30-733

Country Poland

Website https://www.inig.pl/en/

Phone +48126177414 *Phone 2* *+xxx xxxxxxxxx*

Researchers involved in the proposal

Title	First Name	Last Name	Gender	Nationality	E-mail	Career Stage	Role of researcher (in the project)	Reference Identifier	Type of identifier
Dr	Ewa	Kukulska-Zając	Woman	Poland	kukulska-zajac@inig.pl	Category A Top grade re	Team member		
Mrs	Jadwiga	Holewa-Rataj	Woman	Poland	holewa-rataj@inig.pl	Category B Senior resea	Leading		
Dr	Jacek	Jaworski	Man	Poland	jaworski@inig.pl	Category A Top grade re	Team member		
Mrs	Monika	Gajec	Woman	Poland	gajec@inig.pl	Category C Recognised	Leading		
Dr	Anna	Król	Woman	Poland	krola@inig.pl	Category B Senior resea	Team member		
Mr	Grzegorz	Kołodziejak	Man	Poland	kolodziejak@inig.pl	Category C Recognised	Team member		
Mr	Poitr	Szewczyk	Man	Poland	szewczyk@inig.pl	Category C Recognised	Team member		
Mrs	Anna	Wróblewska	Woman	Poland	wroblewska@inig.pl	Category C Recognised	Team member		
Mr	Ireneusz	Hajdas	Man	Poland	hajdas@inig.pl	Category D First stage r	Team member		
Mr	Robert	Wojtowicz	Man	Poland	wojtowicz@inig.pl	Category C Recognised	Team member		
Mr	Mateusz	Rataj	Man	Poland	rataj@inig.pl	Category C Recognised	Team member		
Mr	Maciej	Basiura	Man	Poland	basiura@inig.pl	Category C Recognised	Team member		

Role of participating organisation in the project

Project management	☐
Communication, dissemination and engagement	☐
Provision of research and technology infrastructure	☐
Co-definition of research and market needs	☒
Civil society representative	☐
Policy maker or regulator, incl. standardisation body	☐
Research performer	☒
Technology developer	☒
Testing/validation of approaches and ideas	☒
Prototyping and demonstration	☐
IPR management incl. technology transfer	☐
Public procurer of results	☐
Private buyer of results	☐
Finance provider (public or private)	☐
Education and training	☐
Contributions from the social sciences or/and the humanities	☐
Other If yes, please specify: (Maximum number of characters allowed: 50)	☐

List of up to 5 publications, widely-used datasets, software, goods, services, or any other achievements relevant to the call content.

Type of achievement	Short description (Max 500 characters)
Publication	*Marco Dell'Isola, Giorgio Ficco, Linda Moretti, Jacek Jaworski, Paweł Kułaga, Ewa Kukulska–Zając, 2021, Impact of Hydrogen Injection on Natural Gas Measurement, https:// doi.org/10.3390/en14248461*
Publication	*Jacek Jaworski, Paweł Kułaga, Giorgio Ficco, Marco Dell'Isola, 2021, Domestic Gas Meter Durability in Hydrogen and Natural Gas Mixtures, https://doi.org/10.3390/en14227555*
Publication	*Anna Huszał, Jacek Jaworski, 2022, Studies on the Impact of Hydrogen on the Results of THT Measurement Devices, https://doi.org/10.3390/en15010221*
Publication	*Huszał A., Jaworski J. Studies of the Impact of Hydrogen on the Stability of Gaseous Mixtures of THT, Energies 2020, 13(23), 6441; DOI: 10.3390/en13236441*
Publication	*Piotr Szewczyk, Jacek Jaworski, 2020, Analysis of the effect of adding hydrogen to natural gas on the tightness of mechanical connections of selected elements of networks and gas installations; DOI: 10.18668/PN2020.231*

List of up to 5 most relevant previous projects or activities, connected to the subject of this proposal.

Name of Project or Activity	Short description (Max 500 characters)
Establishment of the Hydrogen High-pressure Test S	*The aim of the project is to ensure effective access to research infrastructure and reduce the infrastructure gap in the development of RES, including hydrogen energy. The stand will allow the implementation of research works, giving the opportunity to develop innovative technological solutions, new measurement and interpretation methods, and will enable the implementation of research in the areas of:* *metrological tests of gas meters and measuring instruments,* *tests of pipes and fittings,*

Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work.

Name of infrastructure of equipment	Short description (Max 300 characters)
Laboratory gas chromatograph (GC-TCD/TCD/FID	*Gas chromatograph designed for the analysis of gaseous mixtures containing hydrogen. Gas chromatograph enables determination of hydrogen, helium, oxygen, nitrogen, carbon monoxide, carbon dioxide and C1-C5 hydrocarbons in the gas mixture.*
Gas chromatograph test station	*In 2022, it is planned to commission a station that will enable testing on-line gas chromatographs in terms of the correctness of indications and measurement uncertainty, including the uncertainty of determining the energy parameters of gas mixtures containing hydrogen.*
Gas meters flow test stand SG25-G	*Stand for testing gas meters errors in the range of 0,015 to 25 m3/h at low pressure (max. 0,1 barg) with mix. of natural gas with hydrogen up to 30%, and other non-toxic gases. The stand is equipped with a drum reference gas meter (0,015-0,4 m3/h) and a rotary gas meter (0,3-25 m3/h).*
Gas meter test stand	*Stand for testing gas meters errors in the range of 0,015 to 16 m3/h at low pressure (max. 0,1 barg) with mix. of natural gas with hydrogen up to 100% hydrogen, and other non-toxic gases. The stand is equipped with reference drum meters. Measurement uncertainty 0,4%.*
Hydrogen leakage test stand	*Checking the tightness of fittings, gas meters, measuring devices with the use of hydrogen with observation of leakage in water and observation of pressure drop.*

Gender Equality Plan

Does the organization have a Gender Equality Plan (GEP) covering the elements listed below? (•) Yes ( ) No

Minimum process-related requirements (building blocks) for a GEP

- **Publication:** formal document published on the institution's website and signed by the top management
- **Dedicated resources:** commitment of human resources and gender expertise to implement it.
- **Data collection and monitoring:** sex/gender disaggregated data on personnel (and students for establishments concerned) and annual reporting based on indicators.
- **Training:** Awareness raising/trainings on gender equality and unconscious gender biases for staff and decision-makers.
- **Content-wise, recommended areas** to be **covered** and addressed via concrete measures and targets are:
    - work-life balance and organisational culture;
    - gender balance in leadership and decision-making;
    - gender equality in recruitment and career progression;
    - integration of the gender dimension into research and teaching content;
    - measures against gender-based violence including sexual harassment.

PIC	Legal name
999988909	*NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK TNO*

Short name: TNO

Address

Street	ANNA VAN BUERENPLEIN 1
Town	DEN HAAG
Postcode	2595 DA
Country	Netherlands
Webpage	www.tno.nl

Specific Legal Statuses

Legal person	yes
Public body	yes
Non-profit	yes
International organisation	no
Secondary or Higher education establishment	no
Research organisation	yes

SME Data

Based on the below details from the Participant Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

SME self-declared status	30/09/2008	- no
SME self-assessment	unknown	
SME validation	30/09/2008	- no

Departments carrying out the proposed work

Department 1

Department name	Heat Transfer and Fluid Dynamics	☐ not applicable
	☐ Same as proposing organisation's address	
Street	Molengraaffsingel 8	
Town	DELFT	
Postcode	2629 JD	
Country	Netherlands	

Main contact person

This will be the person the EU services will contact concerning this proposal (e.g. for additional information, invitation to hearings, sending of evaluation results, convocation to start grant preparation). The data in blue is read-only. Details (name, first name and e-mail) of Main Contact persons should be edited in the step "Participants" of the submission wizard.

Title: Mr

Gender: ○ Woman ◉ Man ○ Non Binary

First name*: **Huib**

Last name*: **Blokland**

E-Mail*: **huib.blokland@tno.nl**

Position in org.: Senior Project Manager

Department: Heat Transfer and Fluid Dynamics

☐ Same as organisation name

☒ Same as proposing organisation's address

Street: ANNA VAN BUERENPLEIN 1

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Phone 2: +31888666338

Researchers involved in the proposal

Title	First Name	Last Name	Gender	Nationality	E-mail	Career Stage	Role of researcher (in the project)	Reference Identifier	Type of identifier
Dr	Ruud	Van der Linden	Man	Netherlands	ruud.vanderlinden@tno.nl	Category B Senior resea	Team member		
Mr	Huib	Blokland	Man	Netherlands	huib.blokland@tno.nl	Category B Senior resea	Leading		
Mr	Ryvo	Octaviano	Man	Netherlands	ryvo.octaviano@tno.nl	Category C Recognised	Team member		

Role of participating organisation in the project

Project management	☐
Communication, dissemination and engagement	☒
Provision of research and technology infrastructure	☐
Co-definition of research and market needs	☒
Civil society representative	☐
Policy maker or regulator, incl. standardisation body	☐
Research performer	☒
Technology developer	☒
Testing/validation of approaches and ideas	☒
Prototyping and demonstration	☒
IPR management incl. technology transfer	☐
Public procurer of results	☐
Private buyer of results	☐
Finance provider (public or private)	☐
Education and training	☐
Contributions from the social sciences or/and the humanities	☐
Other If yes, please specify: (Maximum number of characters allowed: 50)	☐

List of up to 5 publications, widely-used datasets, software, goods, services, or any other achievements relevant to the call content.

Type of achievement	Short description (Max 500 characters)
Publication	*van der Linden, R.; Octaviano, R.; Blokland, H.; Busking, T. Security of Supply in Gas and Hybrid Energy Networks. Energies 2021, 14, 792. https://doi.org/10.3390/en14040792*
Other achievement	*Research on technologies for measuring the gas composition of natural gas, blended with Hydrogen. Involved in field tests in the Dutch gas grid and in HyDeploy program. Main publications* *- https://www.sciencedirect.com/science/article/pii/S036031992102509X?via%3Dihub* *-https://www.mdpi.com/2072-666X/11/2/116* *-Sensors-Capacitive and Infrared Gas Sensors for the Assessment of the Methane Number of LNG Fuels.pdf*
Software	*Aurora and the MC tool*

List of up to 5 most relevant previous projects or activities, connected to the subject of this proposal.

Name of Project or Activity	Short description (Max 500 characters)
PosHYdon	*World's first offshore green hydrogen production: Poshydon | Green Hydrogen Energy. In this project TNO is involved in designing the offshore electrolyzer and a research program on the admixing of the produced hydrogen in the available gas productions streams. Monitoring and admixing stratiegies are investigated and tested.*
CEN/GERG H2NG	*Review the current scientific and technical framework concerning the use of hydrogen, and drawing from this review a gap analysis. Hydrogen - Gerg. TNO was involved in the WP's about Storage, Power generation, Industrial use and Gas Quality.*
HyDeploy	*TNO was involved in phase 1 (admixing of hydrogen on the university campus of Keele) and phase 2 (admixing in the public grid at Winlaton). Up to 20% of hydrogen has been admixed. Monitoring technologies were evaluated and field tested.*

Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work.

Name of infrastructure of equipment	Short description (Max 300 characters)

Gender Equality Plan

Does the organization have a Gender Equality Plan (GEP) covering the elements listed below? (•) Yes ( ) No

Minimum process-related requirements (building blocks) for a GEP

- **Publication:** formal document published on the institution's website and signed by the top management
- **Dedicated resources:** commitment of human resources and gender expertise to implement it.
- **Data collection and monitoring:** sex/gender disaggregated data on personnel (and students for establishments concerned) and annual reporting based on indicators.
- **Training:** Awareness raising/trainings on gender equality and unconscious gender biases for staff and decision-makers.
- **Content-wise, recommended areas** to be **covered** and addressed via concrete measures and targets are:
    - work-life balance and organisational culture;
    - gender balance in leadership and decision-making;
    - gender equality in recruitment and career progression;
    - integration of the gender dimension into research and teaching content;
    - measures against gender-based violence including sexual harassment.

PIC	Legal name
999507692	*BUNDESANSTALT FUER MATERIALFORSCHUNG UND -PRUEFUNG*

Short name: BAM

Address

Street	Unter den Eichen 87
Town	BERLIN
Postcode	12205
Country	Germany
Webpage	www.bam.de

Specific Legal Statuses

Legal person	yes
Public body	yes
Non-profit	yes
International organisation	no
Secondary or Higher education establishment	no
Research organisation	yes

SME Data

Based on the below details from the Participant Registry the organisation is unknown (small- and medium-sized enterprise) for the call.

SME self-declared status	unknown
SME self-assessment	unknown
SME validation	unknown

Departments carrying out the proposed work

Department 1

Department name	Department 9 – Component Safety	☐ not applicable
	☐ Same as proposing organisation's address	
Street	Unter den Eichen 87	
Town	Berlin	
Postcode	12205	
Country	Germany	

Main contact person

This will be the person the EU services will contact concerning this proposal (e.g. for additional information, invitation to hearings, sending of evaluation results, convocation to start grant preparation). The data in blue is read-only. Details (name, first name and e-mail) of Main Contact persons should be edited in the step "Participants" of the submission wizard.

Title: Dr

Gender: ○ Woman ◉ Man ○ Non Binary

First name*: **Oded**

Last name*: **Sobol**

E-Mail*: **oded.sobol@bam.de**

Position in org.: Project Manager

Department: Department 9 – Component Safety

☐ Same as organisation name

☒ Same as proposing organisation's address

Street: Unter den Eichen 87

Town: BERLIN

Post code: 12205

Country: Germany

Website: www.bam.dehttps://www.bam.de/Navigation/EN/Topics/Energy/Hydrog

Phone: +49 30 81044573

Phone 2: *+xxx xxxxxxxxx*

Researchers involved in the proposal

Title	First Name	Last Name	Gender	Nationality	E-mail	Career Stage	Role of researcher (in the project)	Reference Identifier	Type of identifier
Mr	Florian	Konert	Man	Germany	florian.konert@bam.de	Category D First stage r	Team member		
Mr	Jonathan	Nietzke	Man	Germany	jonathan.nietzke@bam.de	Category D First stage r	Team member		

Role of participating organisation in the project

Project management	☒
Communication, dissemination and engagement	☐
Provision of research and technology infrastructure	☐
Co-definition of research and market needs	☐
Civil society representative	☐
Policy maker or regulator, incl. standardisation body	☐
Research performer	☒
Technology developer	☐
Testing/validation of approaches and ideas	☒
Prototyping and demonstration	☐
IPR management incl. technology transfer	☐
Public procurer of results	☐
Private buyer of results	☐
Finance provider (public or private)	☐
Education and training	☐
Contributions from the social sciences or/and the humanities	☐
Other If yes, please specify: (Maximum number of characters allowed: 50)	☐

List of up to 5 publications, widely-used datasets, software, goods, services, or any other achievements relevant to the call content.

Type of achievement	Short description (Max 500 characters)
Publication	*Muenster, C., Mente, T., Rhode, M. & Boellinghaus, T. in Mathematical Modelling of Weld Phenomena 11. (eds C. Sommitsch, N. Enzinger, & P. Mayr) 435-457 (2016).*
Publication	*Rhode, M., Steger, J., Steppan, E. & Kannengiesser, T. Effect of hydrogen on mechanical properties of heat affected zone of a reactor pressure vessel steel grade. Weld. World 60, 623-638, (2016).*
Publication	*Boellinghaus, Th, H. Hoffmeister, and L. Reuter. "Material properties of as delivered and quenched modified martensitic stainless steels dependent on hydrogen concentration." Belgian Welding Institute, Supermartensitic Stainless Steels'99(Belgium), 264-271 (1999).*
Publication	*Boellinghaus, T., Steppan, E., Mente, T. (2016). Hydrogen Assisted Cracking of a Subsea-Flowline. In: Boellinghaus, T., Lippold, J., Cross, C. (eds) Cracking Phenomena in Welds IV. Springer, Cham (2016).*
Other achievement	*BAM is participating in the ISO technical committee 164 / working group 9 for the standardization of a new testing method*

List of up to 5 most relevant previous projects or activities, connected to the subject of this proposal.

Name of Project or Activity	Short description (Max 500 characters)
TransHyDE flagship project (National)	*WP5, aiming in the project to allocate the gaps and develop new standards, norms, and certifications, needed for accelerating hydrogen transport technologies*
H2SuD (financed by DVGW)	*Study of in-situ repair welding processes of pipelines under pressurized hydrogen*

Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work.

Name of infrastructure of equipment	Short description (Max 300 characters)
Hydrogen embrittlement evaluation tests	*Slow strain rate test (SSRT) using wet cell (electrochemical charging) and using hollow-specimen technique, with samples filled with gaseous hydrogen up 800 bar. Hydrogen permeation (Devanathan cell), Measurement of the H2 concentration in metallic materials.*
High Pressure high temperature autoclaves	*Hydrogen uptake at high pressures up to 1000 bar at temperatures up to 150 ºC*
Hydrogen quantification methods	*Carrier gas hot extraction (CGHE) technique for rapid determination of hydrogen concentration in metals with nitrogen as carrier gas and accuracy of 10 ppb*
Material characterization lab	*Metallography preparation lab, optical and electron microscopy for the study of microstructure and cracks (fractography)*

Gender Equality Plan

Does the organization have a Gender Equality Plan (GEP) covering the elements listed below? (•) Yes ( ) No

Minimum process-related requirements (building blocks) for a GEP

- **Publication:** formal document published on the institution's website and signed by the top management
- **Dedicated resources:** commitment of human resources and gender expertise to implement it.
- **Data collection and monitoring:** sex/gender disaggregated data on personnel (and students for establishments concerned) and annual reporting based on indicators.
- **Training:** Awareness raising/trainings on gender equality and unconscious gender biases for staff and decision-makers.
- **Content-wise, recommended areas** to be **covered** and addressed via concrete measures and targets are:
    - work-life balance and organisational culture;
    - gender balance in leadership and decision-making;
    - gender equality in recruitment and career progression;
    - integration of the gender dimension into research and teaching content;
    - measures against gender-based violence including sexual harassment.

PIC	Legal name
936427525	*OPERATOR GAZOCIAGOW PRZESYLOWYCH GAZ-SYSTEM SPOLKA AKCYJNA*

Short name: GSYS

Address

Street	UL. MSZCZONOWSKA 4
Town	WARSZAWA
Postcode	02 337
Country	Poland
Webpage	www.gaz-system.pl

Specific Legal Statuses

Legal person	yes
Public body	no
Non-profit	no
International organisation	no
Secondary or Higher education establishment	no
Research organisation	no

SME Data

Based on the below details from the Participant Registry the organisation is unknown (small- and medium-sized enterprise) for the call.

SME self-declared status	unknown
SME self-assessment	unknown
SME validation	unknown

Departments carrying out the proposed work

Department 1

Department name	New Technologies Department, R&D Division	☐ not applicable
	☐ Same as proposing organisation's address	
Street	Mszczonowska 4	
Town	Warszawa	
Postcode	02-337	
Country	Poland	

Main contact person

This will be the person the EU services will contact concerning this proposal (e.g. for additional information, invitation to hearings, sending of evaluation results, convocation to start grant preparation). The data in blue is read-only. Details (name, first name and e-mail) of Main Contact persons should be edited in the step "Participants" of the submission wizard.

Title: Dr

Gender: (•) Woman ( ) Man ( ) Non Binary

First name*: **Dorota**

Last name*: **Polak**

E-Mail*: **dorota.polak@gaz-system.pl**

Position in org.: Expert

Department: New Technologies Department

☐ Same as organisation name

☒ Same as proposing organisation's address

Street: UL. MSZCZONOWSKA 4

Town: WARSZAWA

Post code: 02 337

Country: Poland

Website: https://www.gaz-system.pl

Phone: +48 22 220 18 00

Phone 2: *+xxx xxxxxxxxx*

Researchers involved in the proposal

Title	First Name	Last Name	Gender	Nationality	E-mail	Career Stage	Role of researcher (in the project)	Reference Identifier	Type of identifier
Dr	Dorota	Polak	Woman	Poland	dorota.polak@gaz-system.pl	Category C Recognised	Leading		
Mr	Piotr	Paszylk	Man	Poland	piotr.paszylk@gaz-system.pl	Category D First stage r	Team member		
Mr	Łukasz	Piwoda	Man	Poland	lukasz.piwoda@gaz-system.pl	Category D First stage r	Team member		

Role of participating organisation in the project

Project management	☐
Communication, dissemination and engagement	☐
Provision of research and technology infrastructure	☐
Co-definition of research and market needs	☐
Civil society representative	☐
Policy maker or regulator, incl. standardisation body	☐
Research performer	☐
Technology developer	☐
Testing/validation of approaches and ideas	☐
Prototyping and demonstration	☐
IPR management incl. technology transfer	☐
Public procurer of results	☐
Private buyer of results	☐
Finance provider (public or private)	☐
Education and training	☐
Contributions from the social sciences or/and the humanities	☐
Other If yes, please specify: (Maximum number of characters allowed: 50)	☒

Practical knowledge in operation of gas networks

List of up to 5 publications, widely-used datasets, software, goods, services, or any other achievements relevant to the call content.

Type of achievement	Short description (Max 500 characters)
Publication	*Korda-Burza, Aneta , Kałdonek, Monika , Polak, Dorota Selected technical aspects related to the transport of hydrogen admixtures via natural gas network, Przemysł Chemiczny, T.100, nr 5, 2021* *The specifications of the Polish natural gas transmission system was presented, including its components, steel grades and fittings. The impact of H2 blends up to 20% on the phys. chem. properties of the transmitted gas, its energy values, and on the materials of the transmission system was discussed.*

List of up to 5 most relevant previous projects or activities, connected to the subject of this proposal.

Name of Project or Activity	Short description (Max 500 characters)
Analysis of hydrogen impacts on natural gas transm	*The aim of Stage 1 of the project was to determine, based on the literature information, the parameters of transmission gas pipelines, which could be used to transport an addition of up to 10% hydrogen to natural gas. The result of Stage 2 of the project was the acquisition of information from selected industrial end users of gaseous fuel on the possibility of cooperation between their industrial installations and natural gas containing hydrogen.*
HIGGS - Hydrogen in Gas Grids (Advisory Board)	*The aim of the project is to identify to which extent the existing transmission networks can be used for the transport of H2 admixtures by examining selected elements of the gas infrastructure and testing the hydrogen separation system in the case of sensitive installations.*
Joint Industry Projects : "Get prepared for hydrog	*The aim of the project is to gather knowledge on the preparation of individual elements of the gas network for hydrogen transport on the basis of literature data. The study containing the progress of the work of subsequent working groups is being developed as an electronic HYVIKI database.*
DOMHYDRO	*The main assumption of the project was to test gas appliances (heating boiler, gas cooker, water heater, space heater, etc.) for operation, pollutant emissions and efficiency using various hydrogen and natural gas mixtures up to 10% H2. 33 different household appliances were tested in the project. CO and CH4 emissions were measured and the devices' efficiency was checked.*
CEN Hydrogen - H2NG Initiative	*The aim of the project was to review the available knowledge of the possibilities of transporting a hydrogen and natural gas mixture, identify gaps / knowledge gaps, develop recommendations for the removal of barriers in the transport of hydrogen and natural gas mixtures, together with the determination of the costs of removing the barriers. The project was implemented by members of the GERG.*

Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work.

Name of infrastructure of equipment	Short description (Max 300 characters)
Gas Meter Calibration Laboratory	*Gas Meter Calibration Laboratory is the first laboratory in Poland and in this part of Europe to calibrate gas meters with natural gas under operating pressure.*
Gas Quality Measurement Laboratory	*is accredited by the Polish Centre for Accreditation for compliance with standards PN-EN ISO/ IEC 17025:2005 as a testing Laboratory (No. AB 1228). The main measurement services are: basic and extended NG composition, sulfur content (including THT); water and hydrocarbon dew point temperature measur*
Natural gas transmission infrastructure	*GAZ – SYSTEM manages the following infrastructure: over 11 000 km of transmission network, 864 gas stations, and 15 compressor stations.*

Gender Equality Plan

Does the organization have a Gender Equality Plan (GEP) covering the elements listed below? (•) Yes ( ) No

Minimum process-related requirements (building blocks) for a GEP

- **Publication:** formal document published on the institution's website and signed by the top management
- **Dedicated resources:** commitment of human resources and gender expertise to implement it.
- **Data collection and monitoring:** sex/gender disaggregated data on personnel (and students for establishments concerned) and annual reporting based on indicators.
- **Training:** Awareness raising/trainings on gender equality and unconscious gender biases for staff and decision-makers.
- **Content-wise, recommended areas** to be **covered** and addressed via concrete measures and targets are:
    - work-life balance and organisational culture;
    - gender balance in leadership and decision-making;
    - gender equality in recruitment and career progression;
    - integration of the gender dimension into research and teaching content;
    - measures against gender-based violence including sexual harassment.

PIC	Legal name
935111235	*GERG LE GROUPE EUROPEEN DE RECHERCHES GAZIERES*

Short name: GERG

Address

Street	AVENUE PALMERSTON 4
Town	BRUXELLES
Postcode	1000
Country	Belgium
Webpage	www.gerg.eu

Specific Legal Statuses

Legal person	yes
Public body	no
Non-profit	yes
International organisation	no
Secondary or Higher education establishment	no
Research organisation	yes

SME Data

Based on the below details from the Participant Registry the organisation is unknown (small- and medium-sized enterprise) for the call.

SME self-declared status	unknown
SME self-assessment	unknown
SME validation	unknown

Departments carrying out the proposed work

Department 1

Department name	GERG Secretariat	☐ not applicable
	☐ Same as proposing organisation's address	
Street	Av. Palmerston 4	
Town	Brussels	
Postcode	1000	
Country	Belgium	

Main contact person

This will be the person the EU services will contact concerning this proposal (e.g. for additional information, invitation to hearings, sending of evaluation results, convocation to start grant preparation). The data in blue is read-only. Details (name, first name and e-mail) of Main Contact persons should be edited in the step "Participants" of the submission wizard.

Title: Dr

Gender: ○ Woman ◉ Man ○ Non Binary

First name*: **Robert**

Last name*: **Judd**

E-Mail*: **robertjudd@gerg.eu**

Position in org.: Secretary General

Department: GERG Secretariat

☐ Same as organisation name

☒ Same as proposing organisation's address

Street: AVENUE PALMERSTON 4

Town: BRUXELLES

Post code: 1000

Country: Belgium

Website: *Please enter website*

Phone: *+xxx xxxxxxxxx*

Phone 2: *+xxx xxxxxxxxx*

Researchers involved in the proposal

Title	First Name	Last Name	Gender	Nationality	E-mail	Career Stage	Role of researcher (in the project)	Reference Identifier	Type of identifier
Dr	Robert	Judd	Man	United Kingdom	robertjudd@gerg.eu	Category A Top grade re	Leading		
Ms	Alexandra	Kostereva	Woman	France	alexandra.kostereva@gerg.eu	Category D First stage r	Team member		
Mr	Miguel	BAllesteros	Man		miguel.ballesteros@gerg.eu	Category D First stage r	Team member		

Role of participating organisation in the project

Project management	☒
Communication, dissemination and engagement	☒
Provision of research and technology infrastructure	☐
Co-definition of research and market needs	☒
Civil society representative	☐
Policy maker or regulator, incl. standardisation body	☐
Research performer	☐
Technology developer	☐
Testing/validation of approaches and ideas	☐
Prototyping and demonstration	☐
IPR management incl. technology transfer	☐
Public procurer of results	☐
Private buyer of results	☐
Finance provider (public or private)	☐
Education and training	☐
Contributions from the social sciences or/and the humanities	☐
Other If yes, please specify: (Maximum number of characters allowed: 50)	☐

List of up to 5 publications, widely-used datasets, software, goods, services, or any other achievements relevant to the call content.

Type of achievement	Short description (Max 500 characters)
Publication	*GERG's Hydrogen Research Roadmap, 2021. In order to understand how hydrogen could be safely and efficiently included in the current gas grids without harming assets and equipment, while ensuring gas quality compliance, GERG and its experts from the GERG membership and wider stakeholder community have identified and prioritised research gaps in strategic areas of the hydrogen supply chain, highlighting critical aspects to tackle in areas such as safety, gas quality, asset materials, among others*
Other achievement	*HIPS-NET Information network Quarterly Newsletter. It is a network of about 40 partners, bringing together hydrogen experts to contribute to a common European understanding on the H2 tolerance of the existing natural gas grid. Annual workshops are also part of the initiative.*

List of up to 5 most relevant previous projects or activities, connected to the subject of this proposal.

Name of Project or Activity	Short description (Max 500 characters)
THyGA: Testing Hydrogen Admixture for Gas Applicat	*Its main goal is to enable the wide adoption of H2NG (hydrogen in natural gas) blends by closing knowledge gaps regarding technical impacts on residential and commercial gas appliances. The project consortium will identify and recommend appropriate codes and standards that should be adapted to answer the needs and develop a strategy for addressing the challenges for new and existing appliances. Many deliverables already available in the website: https://thyga-project.eu/*
CEN H2 PNR	*Removing the technical barriers to use of hydrogen in natural gas networks and for NG end users. GERG delivered this project on behalf of CEN with funding from the European Commission. The objective was to review the current scientific and technical framework concerning the use of H2, and drawing from this review a gap analysis to be translated into a set of pre-normative research (PNR) requirements. This work will then contribute to the process of standardisation for the introduction of H2*
HyReady	*The objective is to prepare guidelines for TSOs and DSOs to support the preparation of natural gas networks and operations for the injection of H2 (pure and as a gas component) with acceptable consequences. They should lay down sound engineering practice and guidance on mitigation measures to ensure that the considered hydrogen injection in the natural gas system can be done with acceptable consequences.*
GERG HIPS (Hydrogen in Pipeline Systems)	*GERG HIPS (Hydrogen in Pipeline Systems), 2012. Through this GERG project, over 30 partners worked on a benchmark study to understand the impact of hydrogen blending in gas networks up to 10% v/v. The HIPS project was also the precursor of the HIPS-NET network, which is still running.*
NaturalHy	*In 2002, this project started to be shaped to examinate the barriers that existed to, and the advantages that would accrue from the addition of hydrogen to the natural gas transmission and distribution system. GERG is one of the pioneering institutions in the hydrogen economy. The effects of injecting hydrogen on the durability and integrity of the existing natural gas infrastructure have been evaluated.*

Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work.

Name of infrastructure of equipment	Short description (Max 300 characters)

Gender Equality Plan

Does the organization have a Gender Equality Plan (GEP) covering the elements listed below? ○ Yes ◉ No

Minimum process-related requirements (building blocks) for a GEP

- **Publication:** formal document published on the institution's website and signed by the top management
- **Dedicated resources:** commitment of human resources and gender expertise to implement it.
- **Data collection and monitoring:** sex/gender disaggregated data on personnel (and students for establishments concerned) and annual reporting based on indicators.
- **Training:** Awareness raising/trainings on gender equality and unconscious gender biases for staff and decision-makers.
- **Content-wise, recommended areas** to be **covered** and addressed via concrete measures and targets are:
    - work-life balance and organisational culture;
    - gender balance in leadership and decision-making;
    - gender equality in recruitment and career progression;
    - integration of the gender dimension into research and teaching content;
    - measures against gender-based violence including sexual harassment.

PIC	Legal name
997997887	*GASSCO AS*

Short name: GASSCO

Address

Street	BYGNES 75
Town	KOPERVIK
Postcode	4250
Country	Norway
Webpage	www.gassco.no

Specific Legal Statuses

Legal person	yes
Public body	no
Non-profit	yes
International organisation	unknown
Secondary or Higher education establishment	unknown
Research organisation	unknown

SME Data

Based on the below details from the Participant Registry the organisation is unknown (small- and medium-sized enterprise) for the call.

SME self-declared status	unknown
SME self-assessment	unknown
SME validation	unknown

Departments carrying out the proposed work

Department 1

Department name	Research & Development	☐ not applicable
	☒ Same as proposing organisation's address	
Street	BYGNES 75	
Town	KOPERVIK	
Postcode	4250	
Country	Norway	

Main contact person

This will be the person the EU services will contact concerning this proposal (e.g. for additional information, invitation to hearings, sending of evaluation results, convocation to start grant preparation). The data in blue is read-only. Details (name, first name and e-mail) of Main Contact persons should be edited in the step "Participants" of the submission wizard.

Title Mr

Gender ◯ Woman ◉ Man ◯ Non Binary

First name* **Richard**

Last name* **Markeson**

E-Mail* **rima@gassco.no**

Position in org. Program Manager Research & Development

Department Research and Development

☐ Same as organisation name

☒ Same as proposing organisation's address

Street BYGNES 75

Town KOPERVIK

Post code 4250

Country Norway

Website www.gassco.no

Phone +47 52 81 25 00

Phone 2 + 47 99 15 15 57

Researchers involved in the proposal

Title	First Name	Last Name	Gender	Nationality	E-mail	Career Stage	Role of researcher (in the project)	Reference Identifier	Type of identifier
Mr	Leif Idar	Langelandsvik	Man	Norway	lil@gassco.no	Category B Senior resea	Team member		

Role of participating organisation in the project

Project management	☐
Communication, dissemination and engagement	☐
Provision of research and technology infrastructure	☐
Co-definition of research and market needs	☒
Civil society representative	☐
Policy maker or regulator, incl. standardisation body	☐
Research performer	☐
Technology developer	☐
Testing/validation of approaches and ideas	☒
Prototyping and demonstration	☐
IPR management incl. technology transfer	☐
Public procurer of results	☐
Private buyer of results	☐
Finance provider (public or private)	☒
Education and training	☐
Contributions from the social sciences or/and the humanities	☐
Other If yes, please specify: (Maximum number of characters allowed: 50)	☐

List of up to 5 publications, widely-used datasets, software, goods, services, or any other achievements relevant to the call content.

Type of achievement	Short description (Max 500 characters)

List of up to 5 most relevant previous projects or activities, connected to the subject of this proposal.

Name of Project or Activity	Short description (Max 500 characters)
H2Pipe	*Transportation of hydrogen gas in offshore pipeline. A Joint Industry Project to develop the world's first guideline for transport of hydrogen gas in existing and new offshore pipelines.*
GassOpt	*Optimising the Norwegian Natural Gas Production and Transport GassOpt is an optimisation based decision support tool the Norwegian natural gas export network. It has been developed by SINTEF since 1998 and has contributed to substantial value creation in Gassco.*
HyLINE	*Safe Pipelines for Hydrogen Transport A safe and efficient use of Norway's 8800 km subsea pipeline network for transporting hydrogen to the market will be a strong driving force for this transition to happen. However, atomic hydrogen can be absorbed in metallic materials and cause material degradation in the form of hydrogen embrittlement. HyLINE addresses the pipeline material challenges related to transporting clean hydrogen gas in the existing and new subsea pipeline infrastructure*

Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work.

Name of infrastructure of equipment	Short description (Max 300 characters)

Gender Equality Plan

Does the organization have a Gender Equality Plan (GEP) covering the elements listed below? (•) Yes ( ) No

Minimum process-related requirements (building blocks) for a GEP

- **Publication:** formal document published on the institution's website and signed by the top management
- **Dedicated resources:** commitment of human resources and gender expertise to implement it.
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    - work-life balance and organisational culture;
    - gender balance in leadership and decision-making;
    - gender equality in recruitment and career progression;
    - integration of the gender dimension into research and teaching content;
    - measures against gender-based violence including sexual harassment.

PIC	Legal name
905112918	*REDEXIS SA*

Short name: REDEXIS

Address

Street	C MAHONIA 2 EDIFICIO PORTICO PLANTA JARDIN
Town	MADRID
Postcode	28043
Country	Spain
Webpage	http://www.redexis.es/

Specific Legal Statuses

Legal person	yes
Public body	no
Non-profit	no
International organisation	no
Secondary or Higher education establishment	no
Research organisation	no

SME Data

Based on the below details from the Participant Registry the organisation is unknown (small- and medium-sized enterprise) for the call.

SME self-declared status	unknown
SME self-assessment	unknown
SME validation	unknown

Departments carrying out the proposed work

Department 1

Department name	Operations Department	☐ not applicable
	☒ Same as proposing organisation's address	
Street	C MAHONIA 2 EDIFICIO PORTICO PLANTA JARD	
Town	MADRID	
Postcode	28043	
Country	Spain	

Main contact person

This will be the person the EU services will contact concerning this proposal (e.g. for additional information, invitation to hearings, sending of evaluation results, convocation to start grant preparation). The data in blue is read-only. Details (name, first name and e-mail) of Main Contact persons should be edited in the step "Participants" of the submission wizard.

Title Dr

Gender ◉ Woman ○ Man ○ Non Binary

First name* **Maria Dolores**

Last name* **Storch de Gracia**

E-Mail* **lola.storch@redexis.es**

Position in org. Head of Innovation

Department Operations Department

☐ Same as organisation name

☒ Same as proposing organisation's address

Street C MAHONIA 2 EDIFICIO PORTICO PLANTA JARDIN

Town MADRID

Post code 28043

Country Spain

Website https://www.redexis.es/

Phone +34 627 923 114

Phone 2 *+xxx xxxxxxxxx*

Other contact persons

First Name	Last Name	E-mail	Phone
Cristina	Rodríguez	cristina.rodriguez@redexis.es	+34 678 69 45 33
Pablo	Martínez	pablo.martinez@redexis.es	+34 677 91 40 71

Researchers involved in the proposal

Title	First Name	Last Name	Gender	Nationality	E-mail	Career Stage	Role of researcher (in the project)	Reference Identifier	Type of identifier
Mr	Alberto	Cerezo	Man	Spain	alberto.cerezo@redexis.es	Category C Recognised	Team member	0000-0001-7862-986X	Orcid ID
Mr	Pablo	Martinez	Man	Spain	pablo.martinez@redexis.es	Category D First stage r	Team member		
Ms	Cristina	Rodriguez	Woman	Spain	cristina.rodriguez@redexis.es	Category D First stage r	Team member		

Role of participating organisation in the project

Project management	☐
Communication, dissemination and engagement	☒
Provision of research and technology infrastructure	☒
Co-definition of research and market needs	☒
Civil society representative	☐
Policy maker or regulator, incl. standardisation body	☐
Research performer	☐
Technology developer	☐
Testing/validation of approaches and ideas	☒
Prototyping and demonstration	☐
IPR management incl. technology transfer	☐
Public procurer of results	☐
Private buyer of results	☐
Finance provider (public or private)	☐
Education and training	☐
Contributions from the social sciences or/and the humanities	☐
Other If yes, please specify: (Maximum number of characters allowed: 50)	☐

List of up to 5 publications, widely-used datasets, software, goods, services, or any other achievements relevant to the call content.

Type of achievement	Short description (Max 500 characters)
Publication	*Javier Sánchez-Lainez, Dr. Teresa Villuendas, Carlos Montañés, Antonio Gómez, Alberto Cerezo, M. Dolores Storch de Gracia. ADVANCING IN THE DECARBONIZED FUTURE OF NATURAL GAS TRANSMISSION NETWORKS THROUGH A CFD STUDY. International Journal of Hydrogen Energy (April 2022) (https://doi.org/10.1016/j.ijhydene.2022.03.055)*
Other achievement	*2022 European Hydrogen Energy conference (EHEC) Oral Communication "Design of transport, systems ashore, storage in port and supply of hydrogen, in the framework of the OCEANH2 project". Eduardo García-Rosales, Beatriz Nieto, M. Dolores Storch de Gracia, Roberto Morales Burgos, Enrique Saborit, Pablo Martínez Fondón and Alberto Abánades.*
Other achievement	*2022 European Hydrogen Energy Conference (EHEC) Oral Communication "Enabling the injection of hydrogen in high-pressure gas grids: investigation of the impact on materials and equipment, legal, regulatory and technical aspects". Javier Sánchez-Lainez, Vanesa Gil, Alberto Cerezo, M. Dolores Storch de Gracia, Agustín Pascual, Michael Walter, Virginia Madina.*
Service	*Virtual simulator of gas plants and facilities for advanced modeling through the use of BIM technology tools.* *Experimental development of a new sustainable reheating system for liquefied natural gas using the Ranque-Hilsch phenomenon.*

List of up to 5 most relevant previous projects or activities, connected to the subject of this proposal.

Name of Project or Activity	Short description (Max 500 characters)
HIGGS-H2020-875091	*Hydrogen In Gas GridS: a systematic validation approach at various admixture levels into high pressure grids* *Funded by EU under GA nº 875091, FCH JU. Call 2019 TOPIC FCH-02-5-2019 (Energy).* *The objective is to cover the knowledge gaps of the impact that different levels of hydrogen could have on the gas infrastructure, its components and its management. It includes the mapping of technical, legal and regulatory barriers, tests and validation of certain equipment and techno-economic modelling.*
GREEN HYSLAND - H2020-101007201	*Deployment of a H2 Ecosystem on the Island of Mallorca.* *Funded by EU under GA nº 101007201 FCH JU. Call 2020 TOPIC FCH-03-2-2020 (Islands)* *Redexis designs and builds the renewable hydrogen injection point in the gas pipeline network of Mallorca; executes a hydro pipeline and also leads the final use of hydrogen in mobility in Rent a car vehicles and in a fuel cell cogeneration (CHP FC) in an hotel and the Operation for 2 years of the infrastructures associates with the hydroduct.*
COMPUTAMEH-AEI-010500-2020-237	*Dynamic Computational Modeling of Methane-Hydrogen Mixtures in natural gas transport networks.* *Funded by Ministry of Industry, Trade and Tourinsm (Spain) under GA AEI-010500-2020-237 Call AEI 2020 (Innovative Business Groups).* *The scope of this project is the design of an experimental testing circuit capable of testing different mixtures of natural gas with hydrogen and other minor components that could make up the mixture in natural gas transportation networks.*
ZEPPELIN-MISIONES-20211076	*Research into Innovative and Efficient Technologies for the Production and Storage of Green Hydrogen based on the Circular Economy.* *Funded by CDTI (Centre for the Development of Industrial Technology) under GA MIG-20211076. Call MISIONES 2021.* *The objective of the project is investigating a flexible suite of green hydrogen production and storage technologies. Redexis will study the different hydrogen storage technologies*

OCEANH2-MISIONES-20201001	*Generation, storage and distribution of offshore green hydrogen.* *Funded by CDTI (Centre for the Development of Industrial Technology) under GA MIG-20201001. Call MISIONES 2019* *In this project, Redexis participates in the design of hydrogen transport, storage and supply systems.*

Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work.

Name of infrastructure of equipment	**Short description (Max 300 characters)**

Gender Equality Plan

Does the organization have a Gender Equality Plan (GEP) covering the elements listed below? (•) Yes ( ) No

Minimum process-related requirements (building blocks) for a GEP

- **Publication:** formal document published on the institution's website and signed by the top management
- **Dedicated resources:** commitment of human resources and gender expertise to implement it.
- **Data collection and monitoring:** sex/gender disaggregated data on personnel (and students for establishments concerned) and annual reporting based on indicators.
- **Training:** Awareness raising/trainings on gender equality and unconscious gender biases for staff and decision-makers.
- **Content-wise, recommended areas** to be **covered** and addressed via concrete measures and targets are:
    - work-life balance and organisational culture;
    - gender balance in leadership and decision-making;
    - gender equality in recruitment and career progression;
    - integration of the gender dimension into research and teaching content;
    - measures against gender-based violence including sexual harassment.

PIC	Legal name
892728831	*REDEXIS GAS SERVICIOS SL*

Short name: REDEXIS GS

Address

Street	CALLE MAHONIA 22 EDIFICIO PORTICO
Town	MADRID
Postcode	28043
Country	Spain
Webpage	

Specific Legal Statuses

Legal person	yes
Public body	no
Non-profit	no
International organisation	no
Secondary or Higher education establishment	no
Research organisation	no

SME Data

Based on the below details from the Participant Registry the organisation is unknown (small- and medium-sized enterprise) for the call.

SME self-declared status	unknown
SME self-assessment	unknown
SME validation	unknown

Departments carrying out the proposed work

Department 1

Department name	Operations Department	☐ not applicable
	☐ Same as proposing organisation's address	
Street	C/Mahonia 2 (Edificio Pórtico)	
Town	Madrid	
Postcode	28043	
Country	Spain	

Main contact person

This will be the person the EU services will contact concerning this proposal (e.g. for additional information, invitation to hearings, sending of evaluation results, convocation to start grant preparation). The data in blue is read-only. Details (name, first name and e-mail) of Main Contact persons should be edited in the step "Participants" of the submission wizard.

Title _____ Gender ◯ Woman ◯ Man ◯ Non Binary

First name* Last name*

E-Mail*

Position in org. Please indicate the position of the person.

Department *Name of the department/institute carrying out the work.* ☐ Same as organisation name

☐ Same as proposing organisation's address

Street *Please enter street name and number.*

Town *Please enter the name of the town.* Post code *Area code.*

Country *Please select a country*

Website *Please enter website*

Phone *+xxx xxxxxxxxx* *Phone 2* *+xxx xxxxxxxxx*

Researchers involved in the proposal

Title	First Name	Last Name	Gender	Nationality	E-mail	Career Stage	Role of researcher (in the project)	Reference Identifier	Type of identifier
Dr	María Dolores	Storch	Woman	Spain	lola.storch@redexis.es	Category B Senior resea	Leading	0000-0003-1962-5919	Orcid ID

Role of participating organisation in the project

Project management	☐
Communication, dissemination and engagement	☒
Provision of research and technology infrastructure	☒
Co-definition of research and market needs	☐
Civil society representative	☐
Policy maker or regulator, incl. standardisation body	☐
Research performer	☐
Technology developer	☐
Testing/validation of approaches and ideas	☒
Prototyping and demonstration	☒
IPR management incl. technology transfer	☐
Public procurer of results	☐
Private buyer of results	☐
Finance provider (public or private)	☐
Education and training	☐
Contributions from the social sciences or/and the humanities	☐
Other If yes, please specify: (Maximum number of characters allowed: 50)	☐

List of up to 5 publications, widely-used datasets, software, goods, services, or any other achievements relevant to the call content.

Type of achievement	Short description (Max 500 characters)

List of up to 5 most relevant previous projects or activities, connected to the subject of this proposal.

Name of Project or Activity	Short description (Max 500 characters)

Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work.

Name of infrastructure of equipment	Short description (Max 300 characters)

Gender Equality Plan

Does the organization have a Gender Equality Plan (GEP) covering the elements listed below? (•) Yes ( ) No

Minimum process-related requirements (building blocks) for a GEP

- **Publication:** formal document published on the institution's website and signed by the top management
- **Dedicated resources:** commitment of human resources and gender expertise to implement it.
- **Data collection and monitoring:** sex/gender disaggregated data on personnel (and students for establishments concerned) and annual reporting based on indicators.
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    - work-life balance and organisational culture;
    - gender balance in leadership and decision-making;
    - gender equality in recruitment and career progression;
    - integration of the gender dimension into research and teaching content;
    - measures against gender-based violence including sexual harassment.

PIC	Legal name
889540441	*INRETE Distribuzione Energia S.p.A.*

Short name: INRETE

Address

Street	Viale Carlo Berti Pichat 2/4
Town	Bologna
Postcode	40127
Country	Italy
Webpage	https://www.inretedistribuzione.it/

Specific Legal Statuses

Legal person	yes
Public body	no
Non-profit	no
International organisation	no
Secondary or Higher education establishment	no
Research organisation	no

SME Data

Based on the below details from the Participant Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

SME self-declared status	01/09/2021 - no
SME self-assessment	unknown
SME validation	unknown

Departments carrying out the proposed work

Department 1

Department name	INRETE Distribuzione Energia S.p.A.	☐ not applicable
	☒ Same as proposing organisation's address	
Street	Viale Carlo Berti Pichat 2/4	
Town	Bologna	
Postcode	40127	
Country	Italy	

Main contact person

This will be the person the EU services will contact concerning this proposal (e.g. for additional information, invitation to hearings, sending of evaluation results, convocation to start grant preparation). The data in blue is read-only. Details (name, first name and e-mail) of Main Contact persons should be edited in the step "Participants" of the submission wizard.

Title: Dr

Gender: ○ Woman ◉ Man ○ Non Binary

First name*: **Marcello**

Last name*: **Bondensan**

E-Mail*: **marcello.bondesan@inretedistribuzione.it**

Position in org.: Responsabile Sviluppo Distribuzione Energia e Misure

Department: INRETE Distribuzione Energia S.p.A.

☐ Same as organisation name

☒ Same as proposing organisation's address

Street: Viale Carlo Berti Pichat 2/4

Town: Bologna

Post code: 40127

Country: Italy

Website: https://www.linkedin.com/in/bondesan/?locale=it_IT

Phone: +393484950053

Phone 2: *+xxx xxxxxxxxx*

Researchers involved in the proposal

Title	First Name	Last Name	Gender	Nationality	E-mail	Career Stage	Role of researcher (in the project)	Reference Identifier	Type of identifier
Dr	Marcello	Bondesan	Man	Italy	Marcello.Bondesan@inretedistribuzione.it				
Dr	Alessandro	Morgagni	Man	Italy	Alessandro.Morgagni@inretedistribuzione.it				

Role of participating organisation in the project

Project management	☐
Communication, dissemination and engagement	☒
Provision of research and technology infrastructure	☐
Co-definition of research and market needs	☒
Civil society representative	☐
Policy maker or regulator, incl. standardisation body	☐
Research performer	☐
Technology developer	☐
Testing/validation of approaches and ideas	☒
Prototyping and demonstration	☐
IPR management incl. technology transfer	☐
Public procurer of results	☐
Private buyer of results	☐
Finance provider (public or private)	☐
Education and training	☐
Contributions from the social sciences or/and the humanities	☐
Other If yes, please specify: (Maximum number of characters allowed: 50)	☐

List of up to 5 publications, widely-used datasets, software, goods, services, or any other achievements relevant to the call content.

Type of achievement	Short description (Max 500 characters)

List of up to 5 most relevant previous projects or activities, connected to the subject of this proposal.

Name of Project or Activity	Short description (Max 500 characters)
GreenGasCastelfranco	*In this project a section of the gas network was identified that is technically suitable for carrying out the injections of H2GN mixtures located in the Municipality of Castelfranco Emilia, Italy. The first release is expected to be 2% H2 vol. The others, where possible, will be with increasing% H2, compatibly with the limits and requirements of the law, in the hypothesis 5% then 10%.*

Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work.

Name of infrastructure of equipment	Short description (Max 300 characters)

Gender Equality Plan

Does the organization have a Gender Equality Plan (GEP) covering the elements listed below? ○ Yes ◉ No

Minimum process-related requirements (building blocks) for a GEP

- **Publication:** formal document published on the institution's website and signed by the top management
- **Dedicated resources:** commitment of human resources and gender expertise to implement it.
- **Data collection and monitoring:** sex/gender disaggregated data on personnel (and students for establishments concerned) and annual reporting based on indicators.
- **Training:** Awareness raising/trainings on gender equality and unconscious gender biases for staff and decision-makers.
- **Content-wise, recommended areas** to be **covered** and addressed via concrete measures and targets are:
    - work-life balance and organisational culture;
    - gender balance in leadership and decision-making;
    - gender equality in recruitment and career progression;
    - integration of the gender dimension into research and teaching content;
    - measures against gender-based violence including sexual harassment.

PIC	Legal name
915339143	*ENAGAS TRANSPORTE SA*

Short name: ENAGAS TRANSPORTE SA

Address

Street	PASEO DE LOS OLMOS 19
Town	MADRID
Postcode	28005
Country	Spain
Webpage	www.enagas.es

Specific Legal Statuses

Legal person	yes
Public body	no
Non-profit	no
International organisation	no
Secondary or Higher education establishment	no
Research organisation	no

SME Data

Based on the below details from the Participant Registry the organisation is unknown (small- and medium-sized enterprise) for the call.

SME self-declared status	unknown
SME self-assessment	unknown
SME validation	unknown

Departments carrying out the proposed work

Department 1

Department name	Dirección de Servicios Técnicos	☐ not applicable
	☐ Same as proposing organisation's address	
Street	Paseo de los Olmos, 19	
Town	Madrid	
Postcode	28005	
Country	Spain	

Main contact person

This will be the person the EU services will contact concerning this proposal (e.g. for additional information, invitation to hearings, sending of evaluation results, convocation to start grant preparation). The data in blue is read-only. Details (name, first name and e-mail) of Main Contact persons should be edited in the step "Participants" of the submission wizard.

Title: Mr

Gender: ○ Woman ◉ Man ○ Non Binary

First name*: **Antonio**

Last name*: **Gómez Bruque**

E-Mail*: **agomez@enagas.es**

Position in org.: Head of Innovation

Department: Dirección de Servicios Técnicos

☐ Same as organisation name

☒ Same as proposing organisation's address

Street: PASEO DE LOS OLMOS 19

Town: MADRID

Post code: 28005

Country: Spain

Website: www.enagas.es

Phone: +34 689 230 852

Phone 2: *+xxx xxxxxxxxx*

Researchers involved in the proposal

Title	First Name	Last Name	Gender	Nationality	E-mail	Career Stage	Role of researcher (in the project)	Reference Identifier	Type of identifier
Mr	Jose Alfredo	Lana Calvo	Man	Spain	jalana@enagas.es				
Mr	Jorge	Modrego Neila	Man	Spain	jmodrego@enagas.es				
Mr	Ivan	Montero	Man	Spain	imontero@enagas.es				
Mr	Luis Carlos	Gutiérrez Pérez	Man	Spain	lcgutierrez@enagas.es				
Mr	Nelson Andrés	Betancourt	Man	Spain	nabetancourt@enagas.es				

Role of participating organisation in the project

Project management	☐
Communication, dissemination and engagement	☐
Provision of research and technology infrastructure	☐
Co-definition of research and market needs	☒
Civil society representative	☐
Policy maker or regulator, incl. standardisation body	☐
Research performer	☐
Technology developer	☐
Testing/validation of approaches and ideas	☒
Prototyping and demonstration	☐
IPR management incl. technology transfer	☐
Public procurer of results	☐
Private buyer of results	☐
Finance provider (public or private)	☐
Education and training	☐
Contributions from the social sciences or/and the humanities	☐
Other If yes, please specify: (Maximum number of characters allowed: 50)	☐

List of up to 5 publications, widely-used datasets, software, goods, services, or any other achievements relevant to the call content.

Type of achievement	Short description (Max 500 characters)

List of up to 5 most relevant previous projects or activities, connected to the subject of this proposal.

Name of Project or Activity	Short description (Max 500 characters)
CEN H2 PNR	*"Removing the technical barriers to use of hydrogen in natural gas networks and for (natural) gas end users". The objective of this project is to review the current scientific and technical framework concerning the use of hydrogen, and drawing from this review a gap analysis which can then be translated into a set of pre-normative research (PNR) requirements. This work will then contribute to the process of standardisation for the introduction of hydrogen into the gas networks and for endusers.*
Decarb Project	*'Metrology for decarbonising the gas grid' This project will be the first large scale project of its kind that will tackle four measurement challenges that the gas industry need to solve before they can decarbonise the gas grid through introduction of biomethane, hydrogen-enriched natural gas, 100 % hydrogen, and carbon capture and storage (CCS). The project will cover the priority challenges within flow metering, gas composition, physical properties and safety (including monitoring of gas leaks*
GREENH2PIPES project	*GREENH2PIPES aims to advance the research and technological development necessary to promote the production of hydrogen, its transport through the gas grid and its storage using liquid organic carriers.*
NewGasMet Project'Flow metering of renewable gase'	*The overall objective of the project is to increase knowledge about the accuracy and durability of commercially available gas meters after exposure to renewable gases. This should lead to the improvement of existing meter designs and flow calibration standards. https://newgasmet.eu/*
Green Hysland Project	*'Deployment of a H2 Ecosystem on the Island of Mallorca' Green Hysland aims to deploy a fully-functioning Hydrogen (H2) ecosystem in the island of Mallorca, Spain, turning the island into Europe's first H2 hub in Southern Europe. This will be achieved by producing green hydrogen from solar energy and delivering it to the end users, such as the island's tourism, transport, industry and energy sectors, including gas grid injection for green heat and power local end-use.*

Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work.

Name of infrastructure of equipment	Short description (Max 300 characters)
Spanish Gas Infrastructure	*11,000 km of gas pipelines, three underground storage facilities and four regasification plants in Barcelona, Huelva, Cartagena and Gijón. It also owns 50% of the BBG regasification plant in Bilbao and 72.5% of the Sagunto plant*
Enagás Metrological and Innovation Centre (Zaragoz	*The Centre provides technological support and include the Central Laboratory, which is a reference providing measuring services, with laboratories to carry out flow meter calibration at high pressure (up to 50 bar, 24" and 10,000 m3/h actual) and atmospheric, gas analysis and instrument trials.*
Enagás Metrological and Innovation Centre	*Under development. Test bench under development for the evaluation of the impact of natural gas and hydrogen admixtures in components and materials of the gas grid.*

Gender Equality Plan

Does the organization have a Gender Equality Plan (GEP) covering the elements listed below? (•) Yes ( ) No

Minimum process-related requirements (building blocks) for a GEP

- **Publication:** formal document published on the institution's website and signed by the top management
- **Dedicated resources:** commitment of human resources and gender expertise to implement it.
- **Data collection and monitoring:** sex/gender disaggregated data on personnel (and students for establishments concerned) and annual reporting based on indicators.
- **Training:** Awareness raising/trainings on gender equality and unconscious gender biases for staff and decision-makers.
- **Content-wise, recommended areas** to be **covered** and addressed via concrete measures and targets are:
    - work-life balance and organisational culture;
    - gender balance in leadership and decision-making;
    - gender equality in recruitment and career progression;
    - integration of the gender dimension into research and teaching content;
    - measures against gender-based violence including sexual harassment.

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3 - Budget

No.	Name of beneficiary	Country	Role	Personnel costs/€	Subcontracting costs/€	Purchase costs - Travel and substistence /€	Purchase costs - Equipment/€	Purchase costs - Other goods, works and services/€	Internally invoiced goods and services/€ (Unit costs-usual accounting practices)	Indirect costs/€	Total eligible costs	Funding rate	Maximum EU contribution to eligible costs	Requested EU contribution to eligible costs/€	Max grant amount	Income generated by the action	Financial contributions	Other sources of funding - IKOP	Own resources	Total estimated income	IKAA
1	Sintef As	NO	Coordinator	534 530	0	36 000	0	8 500	0	144 757.50	723 787.50	100	723 787.50	723 787.50	723 787.50	0.00	0.00	0.00	0.00	723 787.50	0.00
2	Fundacion Tecnalia Research & Innovation	ES	Partner	299 250	0	16 200	0	8 000	0	80 862.50	404 312.50	100	404 312.50	404 312.50	404 312.50	0.00	0.00	0.00	0.00	404 312.50	0.00
3	Snam S.p.a.	IT	Partner	65 200	0	10 000	0	0	0	18 800.00	94 000.00	100	94 000.00	94 000.00	94 000.00	0.00	0.00	0.00	0.00	94 000.00	0.00
4	Politecnico Di Torino	IT	Partner	238 500	0	24 000	0	0	0	65 625.00	328 125.00	100	328 125.00	328 125.00	328 125.00	0.00	0.00	0.00	0.00	328 125.00	0.00
5	Instytut Nafty I Gazu - Panstwowy Instytut Badawczy	PL	Partner	147 678	0	17 000	16 700	9 500	0	47 719.50	238 597.50	100	238 597.50	238 597.50	238 597.50	0.00	0.00	0.00	0.00	238 597.50	0.00
6	Nederlandse Organisatie Voor Toegepast Natuurwetenschappelijk Onderzoek Tno	NL	Partner	207 400	0	20 000	0	0	0	56 850.00	284 250.00	100	284 250.00	284 250.00	284 250.00	0.00	0.00	0.00	0.00	284 250.00	0.00
7	Bundesanstalt Fuer Materialforsch	DE	Partner	159 300	0	8 000	2 500	4 000	0	43 450.00	217 250.00	100	217 250.00	217 250.00	217 250.00	0.00	0.00	0.00	0.00	217 250.00	0.00

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	ung Und - Pruefung																			
8	Operator Gazociagow Przesylowych Gaz-system Spolka Akcyjna	PL	Partner	61 500	40 000	11 000	0	0	0	18 125.00	130 625.00	100	130 625.00	130 625.00	130 625.00	0.00	0.00	0.00	0.00	130 625.00	0.00
9	Gerg Le Groupe Europeen De Recherches Gazieres	BE	Partner	84 567	0	12 000	0	8 000	0	26 141.75	130 708.75	100	130 708.75	130 708.75	130 708.75	0.00	0.00	0.00	0.00	130 708.75	0.00
10	Gassco As	NO	Partner	22 487	0	8 000	0	0	0	7 621.75	38 108.75	100	38 108.75	0.00	0.00	0.00	0.00	0.00	38 108.75	38 108.75	0.00
11	Redexis Sa	ES	Partner	84 000	0	7 000	0	0	0	22 750.00	113 750.00	100	113 750.00	113 750.00	113 750.00	0.00	0.00	0.00	0.00	113 750.00	0.00
12	Redexis Gas Servicios Sl	ES	Affiliated	27 000	0	7 000	0	0	0	8 500.00	42 500.00	100	42 500.00	42 500.00	42 500.00	0.00	0.00	0.00	0.00	42 500.00	0.00
13	Inrete Distribuzione Energia S.p.a.	IT	Partner	130 000	0	24 000	0	5 000	0	39 750.00	198 750.00	100	198 750.00	198 750.00	198 750.00	0.00	0.00	0.00	0.00	198 750.00	0.00
14	Enagas Transporte Sa	ES	Partner	65 000	0	9 000	0	0	0	18 500.00	92 500.00	100	92 500.00	92 500.00	92 500.00	0.00	0.00	0.00	0.00	92 500.00	0.00
			TOTAL	2 126 412	40 000	209 200	19 200	43 000	0	599 453.00	3 037 265.00		3 037 265.00	2 999 156.25	2 999 156.25	0.00	0.00	0.00	38 108.75	3 037 265.00	0.00

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Acronym **SHIMMER**

4 - Ethics & security

Ethics Issues Table

1. Human Embryonic Stem Cells and Human Embryos			Page
Does this activity involve Human Embryonic Stem Cells (hESCs)?	○ Yes	◉ No	
Does this activity involve the use of human embryos?	○ Yes	◉ No	
2. Humans			**Page**
Does this activity involve human participants?	○ Yes	◉ No	
Does this activity involve interventions (physical also including imaging technology, behavioural treatments, etc.) on the study participants?	○ Yes	◉ No	
Does this activity involve conducting a clinical study as defined by the Clinical Trial Regulation (EU 536/2014)? (using pharmaceuticals, biologicals, radiopharmaceuticals, or advanced therapy medicinal products)	○ Yes	◉ No	
3. Human Cells / Tissues (not covered by section 1)			**Page**
Does this activity involve the use of human cells or tissues?	○ Yes	◉ No	
4. Personal Data			**Page**
Does this activity involve processing of personal data?	○ Yes	◉ No	
Does this activity involve further processing of previously collected personal data (including use of preexisting data sets or sources, merging existing data sets)?	○ Yes	◉ No	
Is it planned to export personal data from the EU to non-EU countries? Specify the type of personal data and countries involved	○ Yes	◉ No	
Is it planned to import personal data from non-EU countries into the EU or from a non-EU country to another non-EU country? Specify the type of personal data and countries involved	○ Yes	◉ No	
Does this activity involve the processing of personal data related to criminal convictions or offences?	○ Yes	◉ No	
5. Animals			**Page**
Does this activity involve animals?	○ Yes	◉ No	
6. Non-EU Countries			**Page**
Will some of the activities be carried out in non-EU countries?	○ Yes	◉ No	
In case non-EU countries are involved, do the activities undertaken in these countries raise potential ethics issues?	○ Yes	◉ No	
It is planned to use local resources (e.g. animal and/or human tissue samples, genetic material, live animals, human remains, materials of historical value, endangered fauna or flora samples, etc.)?	○ Yes	◉ No	
Is it planned to import any material (other than data) from non-EU countries into the EU or from a non-EU country to another non-EU country? For data imports, see section 4.	○ Yes	◉ No	
Is it planned to export any material (other than data) from the EU to non-EU countries? For data exports, see section 4.	○ Yes	◉ No	
Does this activity involve low and/or lower middle income countries, (if yes, detail the benefit-sharing actions planned in the self-assessment)	○ Yes	◉ No	
Could the situation in the country put the individuals taking part in the activity at risk?	○ Yes	◉ No	
7. Environment, Health and Safety			**Page**

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Does this activity involve the use of substances or processes that may cause harm to the environment, to animals or plants.(during the implementation of the activity or further to the use of the results, as a possible impact) ?	○ Yes	◉ No	
Does this activity deal with endangered fauna and/or flora / protected areas?	○ Yes	◉ No	
Does this activity involve the use of substances or processes that may cause harm to humans, including those performing the activity.(during the implementation of the activity or further to the use of the results, as a possible impact) ?	○ Yes	◉ No	

8. Artificial Intelligence			Page
Does this activity involve the development, deployment and/or use of Artificial Intelligence? (if yes, detail in the self-assessment whether that could raise ethical concerns related to human rights and values and detail how this will be addressed).	○ Yes	◉ No	

9. Other Ethics Issues			Page
Are there any other ethics issues that should be taken into consideration?	○ Yes	◉ No	

I confirm that I have taken into account all ethics issues above and that, if any ethics issues apply, I will complete the ethics self-assessment as described in the guidelines How to Complete your Ethics Self-Assessment ☒

Administrative forms

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Ethics Self-Assessment

Ethical dimension of the objectives, methodology and likely impact

The SHIMMER consortium is aware of international conventions and declarations and will properly address any other currently unforeseen ethical and safety issues that may be raised by the proposed activities. The consortium will conduct the project in adherence to the applicable fundamental ethical principles:
• The principle of respect of human dignity and the principles of non-exploitation non-discrimination and non-instrumentalization;
• The principle of individual autonomy and telling the giving of free and informed consent in respect for privacy and confidentiality of personal data;
• The principle of justice the equitable distribution of burdens and benefits of research;
• The principle of beneficence and non-maleficence namely regarding the improvement and protection of health;
• The principle of proportionality (including that research methods are necessary to the aims pursued and that no alternative more acceptable methods are available).
The ethical standards and guidelines of Horizon Europe will be rigorously applied regardless of the country in which the research is carried out several specific ethics issues have been identified in relation to the activities proposed in SHIMMER and will be managed to respect the legal framework and to guarantee the quality of the research, as justified below:

NON-EU COUNTRIES
2 partners from SHIMMER consortium are from a non-EU countries: Norway (SINTEF AS, Gassco). The involvement of the 2 partners is described in more detail in the section- Capacity of participants and consortium as a whole. Briefly, SINTEF AS (Norway), will act as the Coordinator of the project and manage different tasks. Gassco will be involved as a TSO

PERSONAL DATA
Personal data might be involved in WP5 Dissemination, communication and exploitation activities. In this case anonymised participation questionnaires will be used to collect information to assess the effectiveness of the different dissemination and communication activities and feed feedback for improvement.

LAB SAFETY
All necessary safety assessments will be made, and existing national and lab safety rules will be strictly adhered to by all project partners involved.

ENVIRONMENTAL DAMAGE
No potential chemical risk to the environment are envisaged for the chemicals that will be used in the project.

Remaining characters 2679

Compliance with ethical principles and relevant legislations

For SHIMMER, all ethical standards and guidelines of Horizon Europe will be rigorously applied regardless of the country where the research is carried out appropriate health safety and environmental (HSE) procedures conforming to local national guidelines legislation as well as the protection of personal data and GDPR will be followed for the staff involved in SHIMMER.

PROTECTION OF PERSONAL DATA
The General Data Protection Regulation (GDPR) 2016/679 entered into force on 25th of May 2018. Under the regulation, the data controllers and processors are fully accountable for the data processing operations. Any violation of the data subject rights may lead to sanctions as described in Chapter VII, art. 77-84. Partners will respect the GDPR regulation during its collection of personal data during communication, dissemination end network-building activities. Partners have appointed Data Protection Officers (DPO), the contact details of the DPO of SINTEF will be made available to the Commission and all data subject involved. Partners confirmed that all the data we intend to process are relevant and limited to the purposes of the research project (in accordance with the data minimization principle). The purpose is to ensure the dissemination and broad uptake of the results of the project. The personal data will be limited to name (mandatory), organisation (mandatory), title (mandatory), email address (mandatory) and telephone number (optional).

HSE AND MATERIAL EXCHANGE

Work will be performed in certified laboratories by trained staff only strictly a daring to HSE rules implemented and rigorously enforced at all relevant project partners to prevent harm to human health research infrastructure and environment this will all be consistent who is the following easy directives: 90/394 & 97/42 (carcinogens), 92/69 & 93/21 (labeling and packaging), 89/655 & 95/63 (equipment), 1986 Article 130R(2) (environmental protection). To the best of our knowledge about relevant EU regulations and national laws, none of the materials to be exchanged during the project require specific import export authorizations or certificates between countries involved. For example, none of the materials expected to be exchanged appears in the EC list of Controlled/ Dualuse
items of attachment 1 of EC regulation No 2009/428, latest updated as Regulation (EU) No 2019/2199 on 17th of October 2019. however, to closely monitor potential issues arising during the project. Routines for export due diligence will be implemented in the Consortium in order to ensure this in each individual case.

Remaining characters 2408

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Security issues table

1. EU Classified Information (EUCI)[2]			Page
Does this activity involve information and/or materials requiring protection against unauthorised disclosure (EUCI)?	○ Yes	◉ No	
Does this activity involve non-EU countries which need to have access to EUCI?	○ Yes	◉ No	
2. Misuse			**Page**
Does this activity have the potential for misuse of results?	○ Yes	◉ No	
3. Other Security Issues			**Page**
Does this activity involve information and/or materials subject to national security restrictions? If yes, please specify: (Maximum number of characters allowed: 1000)	○ Yes	◉ No	
Are there any other security issues that should be taken into consideration? If yes, please specify: (Maximum number of characters allowed: 1000)	○ Yes	◉ No	

Security self-assessment

Please specify: (Maximum number of characters allowed: 5000)

Remaining characters 5000

[2]According to the Commission Decision (EU, Euratom) 2015/444 of 13 March 2015 on the security rules for protecting EU classified information, "European Union classified information (EUCI) means any information or material designated by an EU security classification, the unauthorised disclosure of which could cause varying degrees of prejudice to the interests of the European Union or of one or more of the Member States".

[3]Classified background information is information that is already classified by a country and/or international organisation and/or the EU and is going to be used by the project. In this case, the project must have in advance the authorisation from the originator of the classified information, which is the entity (EU institution, EU Member State, third state or international organisation) under whose authority the classified information has been generated.

[4]EU classified foreground information is information (documents/deliverables/materials) planned to be generated by the project and that needs to be protected from unauthorised disclosure. The originator of the EUCI generated by the project is the European Commission.

5 - Other questions

Shimmer
Safe Hydrogen Injection Modelling and Management for European gas network Resilience

Safe Hydrogen Injection Modelling and Management for European gas network Resilience

List of participants

Participant No.	Participant organisation name	Country
1. SINTEF (Coord.)	SINTEF AS	NO
2. TECNALIA	Fundación Tecnalia Research & Innovation	ES
3. SNAM	SNAM S.P.A.	IT
4. POLITO	Politecnico di Torino	IT
5. INIG	Instytut Nafty i Gazu – Państwowy Instytut Badawczy	PO
6. TNO	Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek	NL
7. BAM	Bundesanstalt für Materialforschung und -prüfung	DE
8. GSYS	Operator Gazociagow Przesylowych GAZ-SYSTEM Spolka Akcyjna	PO
9. GERG	GERG LE GROUPE EUROPEEN DE RECHERCHES GAZIERES	BE
10. GASSCO	Gassco AS	NO
11. REDEXIS	Redexis S.A	ES
12. REDEXIS GS*	Redexis Gas Servicios SL	ES
13. INRETE	INRETE Distribuzione Energia S.P.A.	IT
14. ENA	Enagás Transporte S.A.U.	ES

*Affiliated entity

TABLE OF CONTENTS

1Excellence

Europe has an extensive natural gas network infrastructure of more than 200.000 km of transmission pipelines and more than 2.000.000 km of distribution network [1]. Gas consumption represents 21,5% of EU's energy consumption used for heat and power generation to buildings, industry (also used as feedstock), and power sector[1]. The European Green Deal aims to decarbonize the gas sector by 2050 and one measure to achieve the targets is to shift into low-carbon gases whilst reducing its total gas consumption. Hydrogen (H_2) is recognised as a low carbon gas when produced through clean ways and has a leading role in the plans for sector decarbonization. To accelerate the transition to a low-carbon economy while exploiting existing infrastructure, H_2 can be injected into the natural gas network. However, there are many technical and regulatory gaps to be closed as adaptations and investments are required to assure that multi-gas networks across Europe can operate in a reliable and safe way while providing a highly controllable gas quality and meeting the energy demand. Recently, the European Committee for Standardization (CEN) concluded the impossibility of setting a common limiting value for H_2 into the European gas infrastructure[2] due to the lack of harmonization requirements of the national natural gas quality at European level, recommending a case-by-case analysis. In addition, there are still uncertainties related to material integrity of pipelines and networks components, as well as operational strategies of gas infrastructure, with regards to a its hydrogen readiness. Therefore, existent results from previous and ongoing projects on the hydrogen readiness of grid components should be summarized in a systematic manner together with the assessment of the current transmission

1 ACER, 'Gas Factsheet'.

2 CEN, 'EN 16726:2018. Gas Infrastructure - Quality of Gas - Group H'.

and distribution (T&D) infrastructure at European level. This will provide stakeholders with decision support and risk reduction information needed to develop regulations and standards and drive future investments.

The **SHIMMER** project **aims to enable a higher integration of low-carbon gases and safer H_2 injection management in multi-gas networks by strengthening the knowledge base and improving the understanding of risks and opportunities in H_2 projects.** It is expected that the results of SHIMMER will contribute to overcome critical technical and administrative barriers across European gas networks such as:

- for technical standardization bodies, with reference to the knowledge gap to be filled and the pre-regulatory indications necessary for the integration of renewable gases in gas networks.
- for transmission and distribution operators, in the context of strategies for asset management and H_2 injection strategies.
- for regulatory bodies, in the context of initiatives for the harmonization of gas quality, the definition of incentives and the market framework.
- for the gas technology providers, in the context of investments in research and development to align the product offer with the expected evolution of the sector.
- for investors who intend to invest in renewable gas sector in the context of harmonization at EU level ensuring a level playing field (e.g., third party access to H_2 integration in networks).

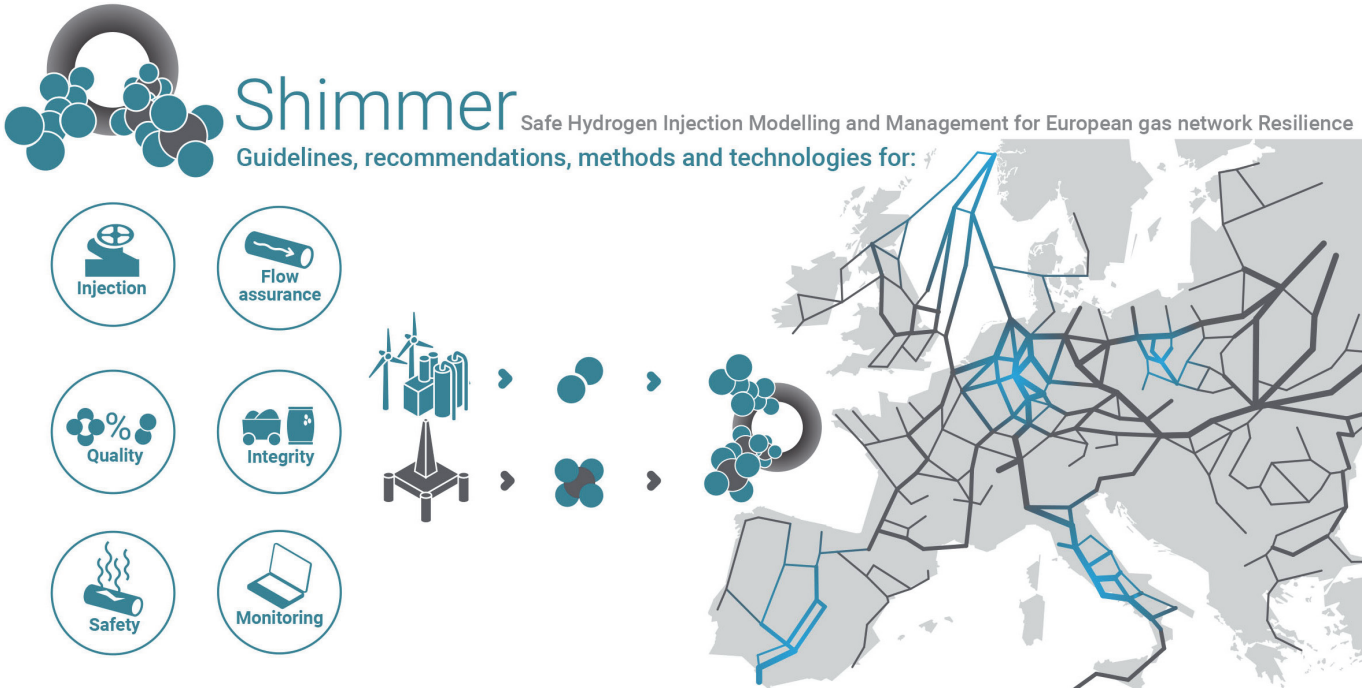


Figure 1. The SHIMMER project

In addition, the activities and results from SHIMMER will respond to all the relevant objectives of the Clean H2 JU SRIA (especially for Pillar 2, H2 Storage and Distribution –Sub Pillar: H_2 in the Natural Gas Grid, and for Cross-cutting issues – Area: Safety, Pre-Normative Research and Regulations, Codes and Standards) as defined in the call HORIZON-JTI-CLEANH2-2022-2. Topic: HORIZON-JTI-CLEANH2-2022-05-03

1.1Objectives and ambition

SHIMMER aims to develop the required tools, methodologies, knowledge, and recommendations to overcome the technological, administrative and regulatory barriers towards a higher integration of low-carbon gases and safer H_2 injection management in multi-gas networks across Europe. A series of key objectives are presented in Table 1.

Table 1. Specific objectives in SHIMMER.

Technical (TO) and non-technical (NTO) objectives
TO1: To map and explore European gas T&D infrastructure in relation to materials, components, technology, and their readiness for H_2. This will be achieved in close interaction with T&D operators in SHIMMER. The geographical diversity of TSOs and DSOs participating in SHIMMER enables addressing different climate, technology and age conditions of network components. In addition, best available technologies and methods for gas leakage monitoring and detection will be assessed in terms of their readiness to be used for H_2-NG blends. An evaluation of the safety risk deviation by using available methods and technologies for leakages

of H_2-NG blends will be performed.

Relation to the work programme: The project will generate a database for materials and components in the existing infrastructure and their readiness for H_2; general understanding of the common challenges of the T&D European gas infrastructure when operating with different blends; it will identify the best available network technologies for integrity management and leakages monitoring and mitigation. SHIMMER aims to establish a cooperation with the project resulting from topics HORIZON-JTI-CLEANH2-2022-02-01 and 2023-02-01 which will be developing parallel testing protocols for non-metallic and metallic materials respectively. These projects will be invited to be part of SHIMMER network group. SHIMMER will recommend priorities for safety requirements, protocols for inspection and risk management, resulting in reduced operational and design fragmentation of the networks across Europe. Development of guidelines, protocols, and recommendations to steer stakeholders towards effective regulation and technical standards.

Verifiable Linked Results (KPI): *Relevant case studies to the European gas network; A robust and user friendly database for materials and components on the existent infrastructure and their readiness for gas blends developed and available for stakeholders; Applicability, availability, and complexity of the existing procedures for components and materials while exposure to H_2 (blends) reviewed and summarized; Recommendations for blending limits due to material and component integrity; Real sample testing for potentially sensitive components and materials in the network with real gas compositions performed; gas leakage monitoring technologies identified; gaps in research and missing information identified; identified risks of energy losses and accidental subsea gas releases* *In cooperation with objective:* TO2, TO3, NTO1. *Relevant deliverables:* D2.1-D3.7

TO2: To define methods, tools and technologies for multi-gas network management and quality tracking, including simulation, prediction, and safe management of transients, in view of widespread H_2 injection in a European-wide context. SHIMMER will develop and validate open-source modelling gas network tools; simulate relevant case studies and develop parametric analysis that allows an out-of-domain, i.e. beyond the scope of the case studies, generalization of results to the European level. In addition, methods and technologies for gas quality tracking and mitigation will be evaluated.

Relation to the work programme: SHIMMER will follow the proposed twofold approach for multi-gas network management using network modelling and identifying technologies for gas quality tracking and mitigation in the network. The project will determine system and engineering constraints that can reduce H_2 acceptability in the network and it will establish optimal operational strategies for high and safe integration of H_2. The constraints imposed by existing applications will be considered. In addition, it will provide general recommendations, protocols and best practices relevant for the handling and control of H_2 in the European gas infrastructure.

Verifiable Linked Results (KPI): *Open-source codes stability and user friendliness (at least as stable as commercial codes); relevant case studies identification and simulations of distribution and transmission networks resulting in enhanced H_2 acceptability; methodology for out-of-domain generalization of results tested: networks archetype vs H_2 admissibility; gas quality technologies identified; gaps in research and missing information identified* *In cooperation with objective:* TOC1, TOC3 ,NTO1. *Relevant deliverables:* D2.5, D4.1-D4.7

TO3: To propose best practice guidelines for handling the safety of H_2 in gas infrastructure and managing the associated risks. SHIMMER will build on the current scientific and technical framework concerning the use of H_2, and on the gap analysis for pre-normative research (PNR) which was previously built by members of the SHIMMER consortium as part of the GERG CEN H2 PNR project[3], the HIGGS project[4] and the THyGA project[5]. The technical approach of SHIMMER combines a review of grid components, technologies, and management strategies readiness for H_2 and will be exploited to generate a comprehensive regulatory approach to develop best practice guidelines and recommendations.

Relation to the work programme: SHIMMER aims to define comprehensive technical information, standard protocols for managing multi-gas networks and give scientific-based evidence to help stakeholders towards the development of effective regulation and technical standards, network repurposing and retrofitting which will also contribute to the relevant objectives of the Clean H2 JU SRIA and support the aims of the H2 and Decarbonised Gas Market Package[6]

Verifiable Linked Results (KPI): *Drafting of a set of guidelines and action plan, based on results from TO1, TO3 and previously mentioned project, serving T&D operators to evaluate H_2 readiness and be aware of the right*

[3] https://www.gerg.eu/projects/H2/removing-the-technical-barriers-to-use-of-H2-in-natural-gas-networks-and-for-natural-gas-end-users/
[4] https://higgsproject.eu/
[5] https://thyga-project.eu/
[6] https://ec.europa.eu/energy/topics/markets-and-consumers/market-legislation/H2-and-decarbonised-gas-market-package_en

measures for implementing H_2 injection according to the information available about their infrastructure. In cooperation with objective: TOC1, TOC3, NTO1. *Relevant deliverables:* D2.5, D3.2-D3.5, D3.7, D4.5-D4.7

NTO1 To maximize the impact of SHIMMER and facilitate the adoption of standards, protocols and guidelines on a European level SHIMMER will perform targeted advertisement and dissemination of results to all relevant stakeholders (T&D operators, technology providers, end-users, project promoters, policy makers and the general public). Study cases and exploitation strategy will be developed having a European perspective. SHIMMER will exploit results and networks from other EU and national programmes and build on existing or develop new standards where relevant.

Relation to the work programme: Include an exploitation strategy. Build on existing standards and contribute to standardisation. Interoperability for data and model sharing will be addressed. Collaborate with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.

Verifiable Linked Results (KPI) Broad dissemination of the project results, including TSO/DSOs outside the consortium, technology suppliers, ongoing projects, policy makers, standardization bodies, academia, and the general public. In cooperation with objective: TO1, TO2, TO3. *Relevant deliverables:* D5.1-D5.2

1.1.1.Ambition state-of-the-art (SoA), progress beyond SoA and maturity level

1.1.1.1. *Mapping and assessing T&D infrastructure components at European level and its readiness level for H2 injection – Start TRL 3 – End TRL 6*

SoA: Even assuming operators have a clear documentation on common components in the system, including their age, origin, service conditions, annual check-ups, repairs and limits based on which protocols, the access to this data is relatively complicated. Besides, there are many more TSOs and DSOs than member states in the EU. In some countries these operators are already participating in projects to validate H_2-readiness of their components. Some of the data is available in EU-projects such as HIGGS[7] project, which has delivered a partial TSO piping material inventory, THyGA[8] which is investigating the H_2 tolerance of commercial and domestic appliances, and HyStorIES[9], which investigates H2 storage conditions in Europe and materials compatibility. Further information can be found in the reports of initiatives, such as those of the European H2 Backbone[10]; national project such as Cadent project[11], which studies the effect of gas quality and impurities on components, HyDeploy, and of course the CEN H2 PNR project.

Considering the impact of H_2 injection into the gas grid, despite general similarity across EU networks, there is no one-stop-shop for H_2 readiness data. The lack of this database hinders H_2 network development planning at EU level. A comprehensive database is a good starting point to ease the evaluation activities across Europe as knowledge can be shared and duplicate work and redundancies can be avoided. This databank can be fed already with the information produced in the above-mentioned projects.

H_2 injection into the existing gas infrastructure has important implications on safety which need to be evaluated for the risk assessment. There are many safety codes and standards that are relevant to H_2 in gas infrastructure. It is particularly important to thoroughly consider the possible changes caused by H_2 in materials. Notably, interaction of H_2 with the materials can result in degradation of the mechanical properties and integrity via permeation through the bulk. The existing codes and standards refer in some cases also to aspects such as purging/venting, gas tightness and leakage detection as well[12]. As they are commonly employed, metallic material and components are covered by several standards which are generally used to assess the compatibility with H_2 (e.g. ASME B31.12, ISO 11114-4 for gas cylinders; ANSI CHMC 1 non-specific for metals in H2 service, ASME BPVC.VIII.·Article KD 10 for pressure vessels etc). Several reviews, technical reports and R&D projects still indicate gaps in these codes and standards when applied to H_2 in existing infrastructure [13,14]. The reason is that many of the codes do not specify a range of natural gas concentrations or constituents and its effect on the pipe material, other codes do not consider the material's in-service-state as part of a component (welded, oxidized, etc.). Instead, generalized indications are applied to guide the use of materials and design methods that are appropriate for the mixtures being transported. Therefore, to ensure

[7] https://cordis.europa.eu/project/id/875091
[9] https://cordis.europa.eu/project/id/101007176
[9] https://cordis.europa.eu/project/id/101007176
[10] van Rossum, R. et al. European H2 Backbone. 1–111 (2020)
[11] https://smarter.energynetworks.org/projects/nia_cad0022
[12] Grant, 'HIGGS Project 2022 Final Document Review on Specific Technical , RCS Barriers , Enablers and Innovations'.
[13] Glover, A. M. & Baird, J. T. M. A. R. Codes and Standards Assessment for H2 Blends into the Natural Gas Infrastructure, NREL. (2021)
[14] Weidner, E., Honselaar, M. & Ortiz Cebolla, R. CEN-CENELEC Sector Forum Energy Management / Working Group H2 Final Report. (2016).

safe operation and adequate qualification procedures for repurposing and retrofitting, harmonization of the existing procedures, indication to and development of new standards and further research are required.

Beyond SoA: SHIMMER will establish a database which includes the data from several projects (such as HIGGS, CEN H_2 PNR, the future project HORIZON-JTI-CLEANH2-2022-02-01, etc.) in addition to actual information from four TSOs and two DSOs in the consortium. The database will be developed within the project and open to all EU-countries allowing to introduce their data at a later stage. Having a broad database will allow to extract information and identify the correlation and variance in the common components in the European systems. As a further step, it will allow to identify the gaps and provide a harmonized picture. SHIMMER will deliver a gap analysis, guidelines and recommendation for standardization which will highlight the key existing procedures which can be directly applied for materials and components qualification for H_2 (blends) and will outline the needs for further research to adapt the qualification procedures. Furthermore, alternative methods, such as sub-sized specimen testing, will be proposed to develop a more straightforward testing protocols for complex geometries which could evolve into new standards. An important insight into how gas quality affects components and materials will be provided after testing of real samples.

1.1.1.2. *Management of multi-gas networks and guidelines to drive investments Start TRL 3 – End TRL 6*

SoA: The readiness of gas infrastructure for the safe injection of H_2 have been largely investigated in terms of deployed materials including pipelines[15,16], non-pipeline elements[17], fittings and junctions [18,19], gaskets, metering devices and chromatography[20]. For gas appliances, technical norms already include reference to H_2 blending limits as in the case of Italy that recently released a technical norm for gas boilers until 20% of H_2 blends [21].

EU projects are investigating the effect on other gas appliances such as the THyGA project[8] . For industrial applications, CEN H_2 PNR project has carried out a systematic review. As for the gas quality, different EU countries have set their own regulations for H_2 concentration in blending as, among others, in the case of Germany [22], Spain [23] and Italy [24].

However, little research has been devoted to operational strategies of gas networks with H_2 blending beyond studies that investigate sector coupling challenges and opportunities with the power sector[25]. For instance, recent studies[26,27,28] investigate quality tracking in distribution networks but these studies did not provide abstraction work to support a widespread, sizeable and safe injection for H_2 blending in gas networks. Besides the literature, at present, operators of local (city-wide) gas networks and to some extent regional gas network operators or TSOs are not much prepared for managing a multi-gas system which would require higher time resolution for consumption data, the deployment of gas quality sensors and advanced gas quality simulation models. These infrastructural lacks are slowing down innovation in this field. However, as the gas infrastructure is a highly interconnected network, a joint research effort is needed to build up common strategies and guidelines helping driving investment in the most efficient way.

Production of H_2 from renewable energy sources (RES) provides opportunities to store surplus RES production with minimal investment. The use of variable blending of H_2 into natural gas is a prospect that needs to be evaluated closer, both in terms of technical feasibility and for the system effects of different levels of injection and different levels of variability. While there has been some research on optimization with transient flows (with homogenous gas mix) and use of line-pack, optimization of transient flows with variations in quality remains an open challenge.

Modelling can help addressing these challenges. In particular, open-source models for energy systems have been gaining more and more interest in recent years as they provide powerful tools for collaborative, transparent and quality studies towards sustainable energy transition. As for energy system modelling and simulation of scenarios, there is a wide availability of models with different features such as LEAP, TEMOA, MUSE. OSeMOSYS, the Open Source Energy Modelling System, was particularly designed for energy access analysis in the framework of the OpTIMUS community initiative. There is also a great availability of open-source models able to describe the power

15 Iskov, 'Using the Natural Gas Network for Transporting Hydrogen – Ten Years Experience'.
16 Iskov, Field Test of Hydrogen in the Natural Gas Grid.
17 Baker Huges, 'Snam and Baker Hughes Test World's First Hydrogen Blend Turbine for Gas Networks'.
18 https://doi.org/10.1016/j.ijhydene.2020.09.061
19 Hermkens, 'Modern PE Pipes Enables the Transport of Hydrogen'.
20 https://doi.org/10.3390/en15103582
21 'UNI/TS 11854:2022. Caldaie Da Riscaldamento Centrale Alimentate Da Combustibili Gassosi'.
22 G 260 Technical Rule 09/2021.
23 Tabella 4 del Protocollo de detalle PD-01 – "Medicion, Calidad y Odorizacion de Gas" de las normas de gestion tecnica del sistema gasista.
24 Ministero della Transizione Ecologica, 'Decreto 3 Giugno 2022 - Aggiornamento al Decreto Del Ministro Dello Sviluppo Economico 18 Maggio 2018, Recante: «Regola Tecnica Sulle Caratteristiche Chimico Fisiche e Sulla Presenza Di Altri Componenti Nel Gas Combustibile».'
25 https://doi.org/10.1016/j.apenergy.2021.116764
26 https://doi.org/10.1016/j.apenergy.2015.05.099
27 Fiebig Hielscher, 'Gas Quality Tracking in Distribution Grids with SmartSim - Application in Complex and Meshed Grids'.
28 P.Schley et al, Gas Quality Tracking Supports Integration of Renewable Gases in the Gas Network - 27th World Gas Conference, 2018

sector with particular attention to the integration of renewable power sources and storage devices such as Calliope, GENx, PyPSA, SciGRID. Some models also incorporate geo-spatial description such as OnSSET, that also belongs to the OpTIMUS community initiative and features planning capability for electrification of non-electrified areas. Conversely, the gas sector does not have encountered all this interest. Notably, only a recent initiative[29] has released a model of the European Gas Transmission Network which mostly focuses on the open sharing of data (technical, topological, operational). Concerning with commercial tools for gas network simulation, some of them has been indicated with the capability of describing H_2 blends such, as examples, SIMONE and SAInt.

Mathematical optimization is frequently used in gas network development[30]. For transmission planning, gas quality planning has mainly focused on specifying safe limits for contaminants (e.g. CO_2 and H_2S) and ranges for energy content (GCV) and in a few countries, H_2 content at entry points to maintain specified quality attributes at point of delivery/exit points. Distribution planning on the other hand has mainly focused on pressure limits (upper and lower) due to homogenous quality. Optimization with quality simulation in network and new business models (blending and extraction) is mathematically challenging due to the non-convexity of the formulations, but general formulations can include tracking of complex, and non-linear quality parameters, including GCV and Wobbe index[31] in addition to volume and pressure constraints. More dynamic operation has also been considered more recently, either to meet variations in demand, efficient use of compressors [32] or to exploit price variations [33].

Beyond SoA: SHIMMER will analyse operational strategies for injection and transport of H_2 blends (WP4) thus providing an assessment of gas infrastructure in terms of bottlenecks of operational capacity and it will provide guidelines for innovative operational strategies of gas networks. This will be achieved by simulating selected test and realistic cases with the capability of describing transient operational conditions or quality tracking in H_2 injection scenarios provided by the T&D stakeholders in SHIMMER. In addition, data and experienced learned from consortium members' field trials such as the projects "GreenGasCastelfranco" (INRETE-Italy), "GREEN HYSLAND"(REDEXIS-Spain), the "Injection of H2NG blends in the gas transport grid" (SNAM-Italy) or projects from members of SHIMMER networking group such as National Grid Future Grid (National Grid- UK) can be used for operational strategies validations. The simulations will be performed using updated gas network models available within the consortium for operation *(TRL 5 to TRL 6)* and planning and design *(TRL3 to TRL5)* that feature the transient and multi-component description of operations. The models will be also benchmarked against commercial simulators. The updated models will be released as open-source tool for operational gas network simulation, they will be licensed for a wide use and will be released in a public repository to be used, updated, and modified by users. As described before, this outcome of the SHIMMER project is unique and will fill up the gap of open-source tools for operational gas networks with quality tracking capability that are not available at the state-of-the-art and can support studies about innovation in the gas sector and more in general studies about energy transition. Finally, a statistical modelling framework on top of the fluid-dynamic model will provide an effort to generalize common challenges for managing and operating multi-gas networks across Europe and the results will be the basis to draft the guidelines and recommendations.

1.1.1.3. *Gas quality measuring technologies – Start TRL 3 – End TRL 5*

TRL is given for gas quality sensors as part of a control system for injection of H_2.

SoA: With multiple injection points of H_2 in the gas grid, quality tracking will be needed to monitor and control. The current grids have quality control at the entry point -and major exit points- by Gas Chromatographs. For quality monitoring and measurement on multiple strategic locations spread over the grid, instruments with lower CAPEX and OPEX are needed. Several technologies are being developed at this moment[34], e.g. based on direct combustion, measuring optical spectra, correlative methods. Some of the technologies have been field tested[35] for application of injection of H_2. Studies have been done on the need and possibility to combine models and quality measuring instruments[36] for monitoring the gas quality with an optimal number of sensors in the grid.

Beyond SoA: SHIMMER will provide an overview of available gas quality measuring technologies. Including an inventory on how the measuring technologies can be part of a control system for mitigation strategies: control the amount of H_2 injection, based on gas quality measurements on strategic locations. The technologies will be evaluated on the ability to be installed in the grid wrt performance, cost indication, maintenance requirements. And the ability

29 https://www.gas.scigrid.de/
30 https://doi.org/10.1007/s11750-022-00635-3
31 https://doi.org/10.1007/s11750-015-0403-y
32 Kazda et al., 'Optimal Utilization of Natural Gas Pipeline Storage Capacity under Future Supply Uncertainty'.
33 Midthun, Optimization Models for Liberalized Natural Gas Markets.
34 Dörr, Koturbash, and Kutcherov, 'Review of Impacts of Gas Qualities with Regard to Quality Determination and Energy Metering of Natural Gas'.
35 Blokland et al., 'Detecting Hydrogen Concentrations during Admixing Hydrogen in Natural Gas Grids'.
36 Guidance Note on Energy Determination when Non-Conventional Gases are injected into the gas network | Marcogaz

to integrate them in a control system for mitigation strategies. Furthermore, SHIMMER will explore the possibility to integrate modelling tools and sensors to enable synergy of combining these technologies.

1.1.1.4. *Technologies inline pipe inspection – Start TRL 3 – End TRL 6*

SoA: A lot of gas pipeline inspection technologies are currently available on the market. Methods for piggable gas pipelines are already well developed and give satisfactory results for detecting inconsistencies in gas pipelines depending on the condition of the specific pipeline section to be inspected and how well the tool matches the requirements set by the inspection objectives. However, methods for non-piggable gas pipelines are at a stage of development and do not give as conclusive results as for piggable ones. The following technologies are currently known: for piggable e.g.: Magnetic Flux Leakage Technology or ultrasounds and for non-piggable pipelines, e.g.: magnetic metal memory method, current magnetometer inspection, ground inspection technology. There are several procedures existing nowadays (e.g. Acoustic emission (AE) testing (AET) commonly used in pipeline inspections) and several protocols such as CFR49 part 192/195 or standards ISO16148, ASTM E1419 and new research at lower TRL's is ongoing on its specific employment for H_2 related problem inspection[37].

Beyond SoA: SHIMMER will provide an overview of the in-line inspections and non-destructive testing tools, both at transmission and distribution level. The identified limitations of currently available technologies will be the basis for identifying challenges in the direction of inspection technology development and their application to gas pipelines transporting H_2 or H_2 blends. The main effects of H_2 on carbon steel pipelines are basically three: decrease in fracture toughness, increased fatigue crack growth rate (FCGR), and decreased ductility. Considering these effects, it will be necessary to assess the ability of current tools to detect these new H_2 related anomalies. Finally, research on new procedures and technologies for non-piggable pipeline components inspection will be carried out and guidelines for its employment provided.

1.1.1.5. *Technologies for monitoring and detection of the leakages – Start TRL 3 – End TRL 6*

SoA: H_2 can make a significant contribution to reducing carbon dioxide emissions as it can be produced from renewable energy sources and emits no CO_2 when consumed. H_2 itself is not a greenhouse gas and does not directly contribute to the rise in global temperatures. However, it can do so indirectly, affecting how much methane and ozone there are in the atmosphere. After carbon dioxide, these two gases are the most important substances contributing to global warming. Therefore, it is extremely important to monitor and assess H_2 emissions from the gas network. Currently, there are devices for measuring methane emissions available on the market based on various measurement methods (thermovision, infrared, ultrasound), but their use is limited by the high limit of quantification (thermovision, infrared), and the impact of atmospheric conditions on the measurement result is difficult to determine (thermovision, infrared) or the inability to conduct measurements in places where there is noise related to gas compression or expansion (ultrasound). The method of measuring gas emissions with air flow does not have such limitations. In this method, the concentration of the gas we are interested in is measured in a steady stream of flowing gas (air) so that all the emitted gas is introduced into the metering device. This method can therefore be implemented, among others, with the use of Hi flow sampler dedicated to measuring methane emissions (INIG has such an apparatus) and with the use of measuring systems described by EPA, which consist of many independent devices, which makes the measurement difficult and requires collecting many data simultaneously. The described methods are dedicated to the measurement of methane emissions but have not been tested for the purposes of assessing the emission of the mixture of natural gas and H_2 into the air. They are also not suitable for testing H_2 emissions because the H_2 molecule is not active for detectors dedicated to methane measurements.

For estimating how much gas enters the atmosphere and how it spreads into the atmosphere from a subsea pipeline, a mathematical modelling framework exist[38]. The framework assumes a pure gas (single component) and has been applied to CH_4 and CO_2. Currently the framework does not have features to study H_2 or gas blends.

Beyond SoA: At present, there are no emission measurement methods allowing for the simultaneous measurement of methane and H_2 emissions from network elements. Therefore, the results obtained during the implementation of the SHIMMER project should provide key information in the field of testing leakages from the gas network of the mixture natural gas and H_2. SHIMMER will cooperate with on-going projects related to 'HORIZON-JTI-CLEANH2-2022 -02-02: H2 and H2NG leak detection for continuous monitoring and safe operation of HRS and future H2/H2NG networks. SHIMMER will also identify risks of energy losses and accidental subsea gas releases as well

[37] Monitoring H2 embrittlement with acoustic emission testing https://www.twi-global.com/what-we-do/research-and-technology/research-programmes/core-research-programme/executive-summaries/34243-monitoring-H2-embrittlement-with-acoustic-emission-testing

[38] https://doi.org/10.1016/j.apm.2019.10.057

as best practices (lessons learned over the past decade about how to minimize natural gas leakage are relevant, despite the differences in the properties of methane and H_2).

In addition, SHIMMER will advance the existing modelling framework on subsea dispersion and atmospheric surfacing of gases from subsea pipelines to include multicomponent gases (gas blends) and H_2.

1.2Methodology

1.2.1.Overall methodology and concept

The integration of H_2 into gas networks poses new challenges and opportunities for gas infrastructure. On the one hand it is key to develop the capacity to ensure a safe supply of gas (i.e., H_2 blended or not with natural gas) being able to monitor, control and dispatch the required flows. On the other hand, beyond the dispatch of energy flows, quality control is an issue, including its time variability, to ensure safe operation of infrastructure (e.g., considering material, components) and end-use applications. The overall methodology of the SHIMMER project is presented in Figure 2.

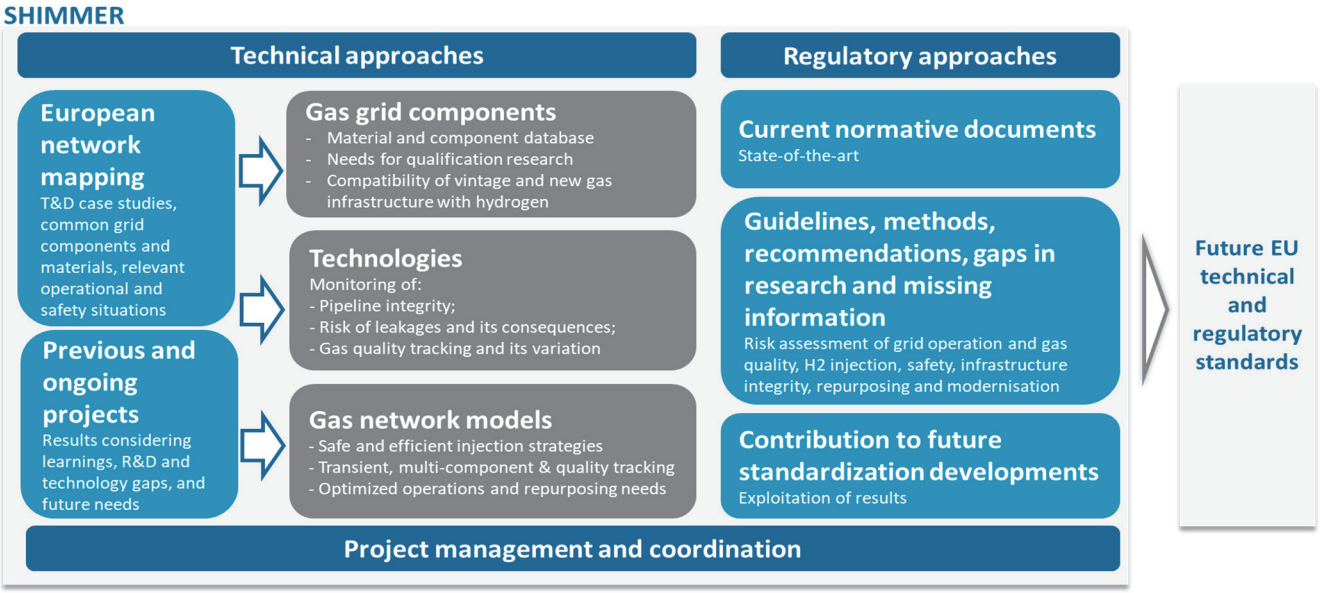


Figure 2. Methodology of SHIMMER

1.2.1.1. *Gas grid components*

A comprehensive databank of in-use components in natural gas infrastructure has a major role on the path to achieve the essential and clear goal of bringing Europe into the zero-emission era. Currently, the approach taken to inject H_2 in gas networks is conducted locally in each country, based on unharmonized protocols for material qualification, physical conditions, concentration thresholds and gas purity. These data are combined usually with information from published literature and results from different tests and used to model and plan the process of injection in a specific country.

The databank developed within SHIMMER as part of WP2 will be a prototype Europe-wide tool (content of the databank based on the input from WP2 and crosscheck as part of WP3 are shown in Figure 3 in blue and grey, respectively). The tool will serve all TSOs and DSOs to gain an overview on the used components (e.g. valves, fittings, filters, meters, etc) and assist policy-makers. In parallel the tool will be used by the project partners to adjust the blending models at a later stage of the project. Overall, the data can be organized geographically using GIS software/online platform such as QGIS, GRASS or SAGA. Confidential data (e.g. exact location of a system) will not be provided, geographic resolution will be limited due to strategic risks. The data will be initially collected in WP2 from the TSOs and DSOs, introduced into the database, restructured by iterations with the TSOs and DSOs and then shared with the partners in WP3. To thoroughly complete the component data bank, SHIMMER will build on the results of other projects, such as HIGGS, ThyGA, HyStorIES, Cadnet project, HyDeploy project etc. as well as other projects and initiatives with public results.

The analysis of the current materials and components qualification procedures for H_2 in WP3 will be based on a thorough revision of standards, codes, research bibliography and results from previous projects which have

performed similar studies (HIGGS, NaturalHY[39], ACER[40], IEA[41]; NREL and SANDIA[13] reports etc.). This will ensure that SHIMMER provides a broader vision when defining gaps and research directions and that the project will advance one step further beyond the scope of current projects. The available information on grid components and review of standards for material testing and qualification generated in WP2 will be used to identify the relevant materials, critical components, and conditions. The interaction between related tasks and WPs is shown in Figure 3.

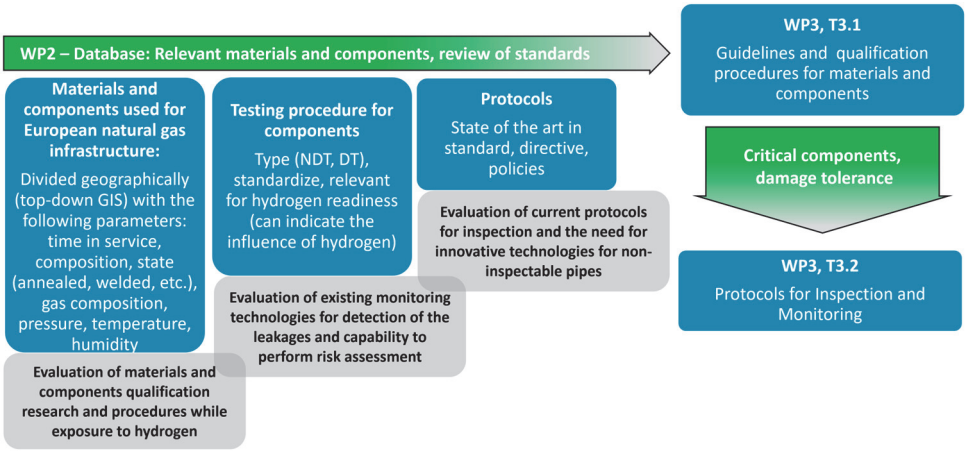


Figure 3.Methodology for gas grid components: Databank structure and guidelines for qualification

The technical analysis carried out will aim to first identify key factors such as critical materials properties, admissible defect size etc relevant to H_2 service. This information will also serve as an important input for the tasks related to Inspection and Monitoring in WP3. Based on the latter and on the Gap Analysis performed, SHIMMER will elaborate guidelines and qualification procedures for materials and components to support future standardization. To ensure the optimal results in the latter task, efficient communication with standardization bodies and technical committees will be established.

Furthermore, the required areas of further development will be identified and new directions, including alternative testing methods with reduced complexity (such as testing subsized specimens) will be proposed and demonstrated. These new methods could significantly facilitate and speed up the qualification procedures in long term, including for components with complexed geometry.

To ensure that the data used and the performed analysis is up-to-date and considers the most current advances in testing and qualification, SHIMMER will establish cooperation with the project under the topic HORIZON-JTI-CLEANH2-2022-02-01 of Distribution non-steel metallic gas grid materials with H_2 which will be developing in parallel testing protocols for non-steel metallic materials (cast iron, brass, aluminium etc) and with the project under the topic HORIZON-JTI-CLEANH2-2022-02-01 of Pre-Normative Research about the compatibility of Transmission gas grid steels with H2 and development of mitigation technique. Conventional and alternative evaluation methods should be included in the SHIMMER project to ensure an up-to-date result of this project.

1.2.1.2. *Technologies*

Technologies inline pipe inspection (WP3): To ensure the transmission and distribution of H_2, it is necessary to have complete information regarding the technical condition of the section of the transmission network in which H_2 will be present. In that sense SHIMMER project will investigate in T3.2 how the current inspection technologies address the challenges pose by H_2 (or blends) transport and will define a set of guidelines for future research requirements to fully cope with these challenges, especially in non-piggable sections.

First, it is necessary to identify the maximum admissible defects as well as the pathologies evolution rate for the existing components of the network to be able to certainly assess the validity of current procedures. In that sense T3.2 will attain this objective through intense interaction with T3.1.2. These new challenges will be merged with already existing ones in current gas distribution and transmission networks to define the requirements for inspection technologies. From this base, T3.2.1 will assess the readiness level of these technologies to deal with the identified challenges. In this framework, the best way to obtain such information is to analyze pipeline inspection reports with

[39] https://cordis.europa.eu/project/id/502661

[40] ACER. Transporting Pure H2 by Repurposing Existing Gas Infrastructure: Overview of existing studies and reflections on the conditions for repurposing. Report 1–23 (2021).

[41] Report, S. Task 41 Special Project Renewable Gases-H2 in the Grid Activity funded by the European Commission, Germany and Sweden with contributions from the Netherlands Synthesis Report. 40, (2022)

Magnetic Flux Leakage Technology, which require piggable pipelines. Based on this method, it is possible to identify potentially dangerous defects that cause local stress concentration and increase the risk of cracking from the point of view of transporting H_2, which may result in a decrease in the strength parameters of steel. However, the biggest challenge is to assess the technical condition of those gas pipelines that are not suitable for pigging, for natural gas transmission pipelines, depending on the country's infrastructure operator, even more than 50% of pipelines are not suitable for pig inspection. The SHIMMER project will identify and analyze innovative methods for assessing the technical condition of non-piggable gas pipelines. Finally, a survey will be carried out on how to deal with the identified existing gaps in current procedures, protocols and methods through the use of new technologies (or new procedures based on existing ones). Special attention will be paid in this work to the challenges posed by non-piggable sections as commented before. This survey will provide guidelines for future research in this domain.

Monitoring technologies for detection of the leakages and capability to perform risk assessment (WP3): H_2 has small molecule size, low molecular weight, high diffusivity, and low viscosity so it can easily leak from infrastructure throughout the value chain. Therefore, it is extremely important to monitor and assess H_2 emissions from the gas network. Currently, there are no methods allowing for the simultaneous measurement of methane and H_2 emissions from network elements. Therefore, the results obtained during the SHIMMER project should provide key information in the field of gas grid leakage testing of a mixture of natural gas and H_2. As part of the WP3 implementation, a methodology will be developed for the estimation of methane and H_2 emissions from gas networks transporting H_2-NG mixtures and H_2 emission from gas networks transporting pure H_2. As part of the task, the optimal method for estimating methane and H_2 emissions from gas networks will be selected from among:

1.The correlation method based on the correlation of the H_2 concentration measured at the leak site to the actual emission amount, like the estimation of the methane emission amount described in the standard EN 15466,

2.The correlation method based on the correlation of the amount of methane emission measured with the air flow method and the ratio of methane: H_2 concentrations in the transported mixture and the amount of H_2 emission,

3.Direct measurement of H_2 emissions by the flowing air method, this is an approved method for measuring methane emissions developed by the EPA.

The methods described in points 1 and 3 can be used to estimate the amount of H_2 emissions from the networks transporting both NG-H mixtures and pure H_2, while the second method will be applicable only to NG-H_2 mixtures.

The research necessary to develop the above-mentioned methods will mostly be carried out on a stand for simulating the volume of gas emissions from renewable energy sources, which will be put into operation in INIG in December 2022. The research in the real system will be supplemented by modelling. Based on the results of the conducted research and analyzes, the optimal methodology for estimating the amount of H_2 or H_2 and methane emissions from gas networks transporting H_2 or its mixtures with NG will be developed and indicated. This will allow to estimate the amount of energy losses related to both the transport of pure H_2 and its mixtures with NG, and to assess the environmental impact of the transport of this type of gases and their mixtures. The developed method should be characterized by low uncertainty, allow for quick results, be easy to apply in areas typical for gas networks and be applicable in explosion hazard zones.

The modelling framework for estimating the dispersion and surfacing of subsea gas release as input to risk assessments in WP3 will be based on an existing framework for CH_4 or CO_2. This framework applies computational fluid dynamics to predict how gas bubbles moves upwards in the water column towards the atmosphere. From these predictions it is possible to extract how much gas enters the atmosphere and poses a threat to life and infrastructure at the surface. The existing framework is built around a commercial third-party software. As a first task in SHIMMER, an evaluation will be made on whether to transition this to an open software or continue the development linked to the commercial software. Thereafter the framework needs to be generalized to account for multicomponent gases and material properties and thermodynamics for H_2 need to be implemented. This is needed to be capable for analysing subsea releases of H_2 blends. When the framework has been updated, two series of simulations will be performed. The first series will focus on model sensitivity to input parameters and model assumptions to highlight the uncertainty of the predictions and identify where future efforts need to be focused. The second series of simulations will analyse various relevant release scenarios to shed light on typical risks. Both simulation series will have an impact on safety protocols.

Gas Quality monitoring technologies (WP4): With multiple injection points of H_2 in the gas grid, quality tracking will be needed to monitor and control. The current grids have quality control at the entry point by gas chromatographs. For quality monitoring on multiple strategic locations spread over the grid, instruments with lower CAPEX and OPEX are needed.

SHIMMER (WP4) will define a set of requirements for gas quality instruments with input of TSO (SNAM, ENA, GASSCO, GSYS) and DSO (RED, INRETE) partners in the project. Based on the requirements, by literature study and interviews with European Associations on overview of available gas quality measuring technologies will be made. Including an inventory on how the measuring technologies can be part of a control system for mitigation strategies: control the amount of H_2 injection, based on gas quality measurements on strategic locations.

In SHIMMER these technologies will be evaluated on the ability to be installed in the grid with respect to performance, cost indication, maintenance requirements, and the ability to integrate them in a control system for mitigation strategies. Furthermore, SHIMMER will explore the possibility to integrate modelling tools and sensors to enable synergy of combining these technologies.

1.2.1.3. *Gas network models and network management*

The overall modelling approach in SHIMMER (WP4) is summarized on Figure 4 . After defining network data model (i.e., test cases that include sample networks with relevant components of pipe and non-pipe elements; e.g., realistic cases that include real networks encompassing archetypes of topologies, operational parameters, etc), the consortium will deploy available models and develop new open-source models to design and simulate operations of different scenarios for H_2 blends within gas networks.

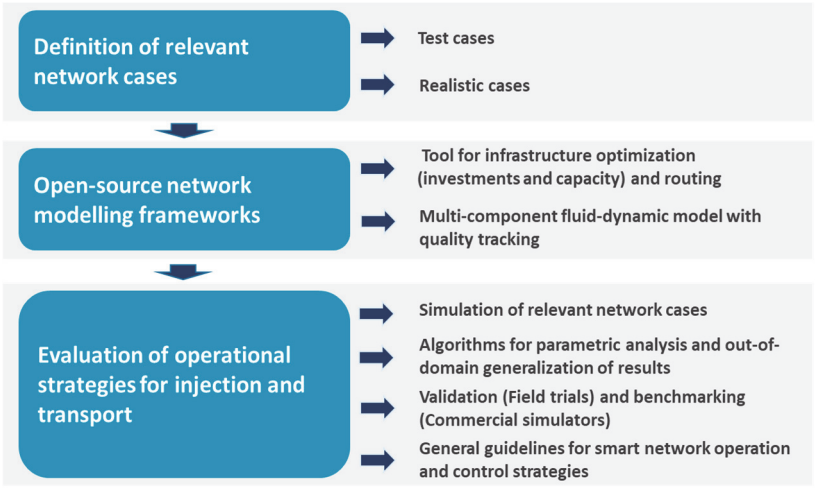


Figure 4. Gas networks modelling methodology methodology

Strategic and operational gas network models will be used to analyse relevant network cases of H_2 injection. The partners SINTEF, POLITO and TNO have developed over time a series of operational and design gas network models. Some of the mentioned models have been previously improved by the partners and tailored to handle the complexity of H_2 injection scenarios. The activities within SHIMMER aim to expand the capabilities of the existent network models available within the consortium and to prepare them for open-source release. Validation and benchmarking of the models will be performed against available data and commercial models. A statistical modelling framework on top of the fluid-dynamic model will provide an effort to generalize common challenges for managing and operating multi-gas networks across Europe and the results will be the basis to draft the guidelines and recommendations. Notably, the following operational strategies can be investigated (not exhaustive list): 1) network monitoring and dynamic pressure modulation; 2) injection facilities, their operation and their coordinated injection strategies; 3) localization of injection points and quality control within the network; 4) line pack management for higher H_2 integration and mitigation of time quality fluctuations. In more detail the methodology for the modelling activities is presented below:

Optimization of network design and needs for modifications: To investigate good infrastructure configurations supporting H_2 injection, tools for infrastructure planning for natural gas and multi-energy-carrier systems will be adapted for analyses of systems with H_2 injection. To support a larger number of capacity expansions (or reductions) and repurposing of existing infrastructure, models based on mixed integer linear programming (MILP) will be used. Existing models available to the consortium cover optimization of investments and operational use of components such as compressors, storages and pipelines. Due to the combinatorial nature of such problems in combination with the non-linearities, to model the gas flows require simplified (usually linearised) representation of the physic for the operational decisions (e.g. routing, volumes to satisfy demand and/or supply constraints). The per time period operations of the flow in a pipeline will be represented as a steady-state system where the flow is bounded above by the pressure drop according to the (approximated) Weymouth equation.

These models can also support quality tracking with different formulations but solving large scale problems can be computationally challenging depending on the network topology (whether different qualities may be blended first and later split to different pipes) and quality constraints.

SHIMMER (WP4) will address challenges in the design of networks for transmission of gas with different levels of H_2 admixing in combination with local injection (within the distribution network), by analysing different demand regimes depending on the distribution network needs and local injection levels, to determine necessary compressor

capacity, storage capacities and potential for flexible routing of natural gas and/or natural gas with different levels of H_2 admixed to account for variations in H_2 production from renewable energy production and investigate levels of centralized injection before or within the transmission network and local injection.

Transient and multi-component fluid dynamic network model with quality tracking The consortium has developed over time a series of operational models of gas networks specifically tailored to handle complexity of H_2 injection scenarios and thus to deliver solutions for the high and safe integration of H_2 in networks. The most advanced models available to the consortium are based on 1) Fergusson equation for the calculation of the pipeline pressure drop; 2) GERG-2008 equation of state for the definition of the natural gas admixture properties; 3) Cheng equation for the determination of friction factor [42]. The model can handle meshed networks (infrastructure with loops in their topology), solved using an iterative procedure between the fluid-dynamic solver and the quality tracking. **Quality tracking** is based on the batch method[43] and extended to a whole network structure. The model has been validated [44] [45] against results from literature (commercial software and real data). The multi-component feature and GERG equation implementation enables simulations with different compositions including the blending of H_2; model also includes the description of elevation differences (important for e.g. offshore transport pipelines). It can be easily expanded to non-pipeline elements such as compressors and reduction stations[15] . The model is flexible to cater for a wide range of topology, extensions, number of injection and withdrawal points etc. For some applications to distribution networks, a specific, simpler, steady state model was developed. The range of flexible models available within the consortium will enable to address each case with the most appropriate tool, performing a trade-off between complexity of the cases, computational effort and accuracy of the results.

Parametric analysis and out-of-domain generalizations of results: Beyond the lack of studies about gas network operational strategies in the perspective of infrastructure readiness to H_2 blending, the few studies available in literature are based on a case-by-case analysis approach. While case-specific studies are very powerful to analyse in details implementation projects and they may provide qualitative general insights, they usually fail in the generalization of results at quantitative level. To fill this gap, SHIMMER proposes to introduce statistical methodologies either for the generation of scenarios, the generation of multiple synthetic networks and analysis of simulation results.

The planned activities in SHIMMER aim to provide companies and energy providers with generalized technical findings based on robust statistical procedure. The aim is twofold: (i) a systematic sensitivity analysis (ii) the design of a robust and efficient statistical procedure. An example of this approach considering blending of H_2 into distribution gas networks is presented in [44]. To alleviate the computational burden of many simulations, techniques leveraging the recent advances of machine learning tools for parametric analysis and uncertainty quantification will be applied. Emphasis is given to the selection of the technique allowing to set design margins e.g. in a worst-case scenario, with the smallest number of simulations yielding reproducible results and statistical significance[46]. Physical consistent synthetic models of gas networks are generated through a well-defined procedure, supporting this task with the experience needed to possibly assess the effect of different network topologies.

The methodology to be used in these tasks will be as follows: (1) Systematic assessment of the effects of network topology (e.g based on the slight modification of a given network). Analysis carried out on a selection of test cases of interest; (2) Statistical analysis and collection of quantitative information about the dominant contributions yielding larger variability; (3) Cross comparison of machine learning techniques supporting the speed up of the above-mentioned statistical assessment; (4) Definition of a ready-to-use validated procedure.

1.2.1.4. *Contribution to future standardization developments*

The interaction between GERG and CEN TC within the recently completed GERG CEN H2 PNR project (overseen by a CEN TC/234 Supervisory Board) will strengthen the link between SHIMMER and the EU standardisation community in prioritisation of research needs for standardisation, aligning project direction and outputs.

This may involve providing information, participating in ongoing works, submitting proposals for the modification of existing standards or promoting the elaboration of new standards like technical specifications (TS). The development of fast-track standards like CEN Workshop Agreements (CWA) is usually the best-suited option in the frame of a Horizon Europe project.

[42] Cheng, 'Formulas for Friction Factor in Transitional Regimes'.
[43] Chaczykowski et al., 'Gas Composition Tracking in Transient Pipeline Flow'.
[44] Cavana, 'Gas Network Modelling for a Multi-Gas System'.
[45] Cavana et al., 'Electrical and Gas Networks Coupling through Hydrogen Blending under Increasing Distributed Photovoltaic Generation'.
[46] Vaccariello et al., 'Synthetic Gas Networks for the Statistical Assessment of Low-Carbon Distribution Systems'.

The possibilities to collaborate with other EU-funded projects (national and international) will be analysed to pursue synergies with SHIMMER, mainly with other projects funded in the same call and others within the umbrella of Made in Europe. In particular, the consortium will reach to call topic HORIZON-JTI-CLEANH2-2022-02-01 beneficiaries, which will be developing parallel testing protocols for metallic materials.

Task 2.2 in WP2 outlines how an initial review of standards is going to be conducted for material testing and qualification for compatibility with H_2, gas leakage monitoring and detection methods. Standards related to network equipment, gas quality and end-use will be reviewed individually in order to provide specific contributions to the corresponding standards and the content of policy directives will also be studied. WP3 will deliver guidelines and procedures for the assessment of component behaviour and structural integrity assessment of the pipeline network in the presence of H_2-NG mixtures; it will be a valuable contribution to future standardization developments, including the proposal of validation methods and characterization techniques. Efficient communication with Technical Committees ISO TC 197 H2 technologies and ISO TC 164 Mechanical testing of metals will be ensured.

Concerning the management of H_2 injection and blending in the network, WP4 will deliver guidelines for the networkwide quality management as a result of the modelling activities, providing T&D system operators with best practices of control implementation (e.g. multiple injection coordination) according to the peculiarities of the network and the customers. Furthermore, it will give methods and recommendations on control strategies for injection and positioning of optimal monitoring points in the network and it will highlight possible need for modifications on gas reduction stations (EN 12186:2014), gas quality monitoring devices (e.g. EN ISO 6974 Part1-3), on gas property monitoring (EN ISO 6976:2016 Gas property calculation) on billing system requirements ('EN ISO 15112:2018 "Energy determination") and on standardization of blending and de-blending units by facing some issues such as redundancy to ensure safe and continuous supply of fuels at the users. Especially, some of the simulation scenarios in WP4 will consider some pending challenges that has been recently indicated by the ACER-CEER[47] , such as the harmonization at EU level of gas blending quality control at injection point or at the whole network level.

Through connection to ongoing initiatives such as the UK IGEM H2 committee and their standards update (IGEM H1, PAS 4444, SR25 etc) the project will also draw from and contribute to relevant initiatives in other jurisdictions which have direct relevance to the global push to develop cross border approaches to H_2 implementation.

1.2.2.National or international research and innovation activities to be linked to the project

The expertise grown by the partners from each of the following projects will greatly benefit project SHIMMER and will allow to gain a deeper understanding of the problems at hand in a faster manner. The relevance to SHIMMER is highlighted in blue below:

- **CleanExport (SINTEF)** is a Research Council of Norway-funded project for investments and planning of production and transmission/export of energy resources from Norway. The project is developing an open-source modular optimization based on multi-energy-carrier modelling framework. *The modelling framework may be used as basis for modelling activities in WP4*
- **Optimization models for NG transport (SINTEF & GASSCO)** SINTEF has developed several models for natural gas transport planning in cooperation with GASSCO for more than 20 years. The expertise developed during this time can be applied in the modelling work for the transmission planning. *Existing models and/or formulations may be adapted from existing tools to support H_2 and be applied in WP4*
- **HyLINE** (SINTEF) Address the pipeline material challenges related to transporting clean H_2 gas in the existing subsea pipeline infrastructure for natural gas transport as well as new pipeline infrastructure. *Knowledge on materials and integrity risks relevant to WP2 and WP3*
- **HyDeploy (TNO)** TNO was involved in phase 1 (admixing of H_2 on the university campus of Keele) and phase 2 (admixing in the public grid at Winlaton). Up to 20% of H2 has been admixed. Monitoring technologies were evaluated and field tested. *Experience with monitoring technologies, risks and management strategies for H2-NG blends relevant to WP4*
- **GERG CEN H2 PNR project (GERG, TNO, GSYS, ENA):** Review the current scientific and technical framework concerning the use of H_2 and drawing from this review a gap analysis. *Gap analysis as a background for SHIMMER relevant to WP2-WP5*
- **HIGGS** (TECNALIA, RED) H2 in gas grids: a systematic validation approach at various admixture levels into high pressure grids (H2020-JTI-FCH2 GA#875091, 2020-23). *Knowledge on testing procedures and applicable standards relevant to WP3; inventory on piping materials relevant to WP2*

[47] https://www.ceer.eu/white-paper-hydrogen

- **H2SAREA (TECNALIA)** Development of advanced solutions for a safe H_2 distribution in natural gas network. Evaluation of materials to H_2 embrittlement (Basque Government. Hazitek ZE-2021/00001, 2021-22). *Knowledge on materials and integrity risks relevant to WP2 and WP3*
- **ICME-ELKARTEK (TECNALIA) ICME-** A multi-scale process-microstructure-properties-performance modelling methodology to accelerate the design of materials, processes and acceleration of the design of materials, processes and metallic components. TECNALIA works in one of the use cases related to the study of H2 embrittlement in steels, for H2 distribution and storage applications. (Basque Government. Elkartek KK-2021/00022, 2021-22). *Knowledge on materials and integrity risks relevant to WP2 and WP3*
- **TransHyDE (BAM)** allocate the gaps and develop new standards, norms, and certifications, needed for accelerating H2 transport technologies. *Background information on standards, norms and certifications relevant to WP2 and WP3 and WP5*
- **THyGA (GERG):** The main goal of the project is to enable the wide adoption of H2NG (H2 in natural gas) blends by closing knowledge gaps regarding technical impacts on residential and commercial gas appliances. *End-user requirements and constrains for the use of H2-NG blends relevant to WP4 and WP5*
- **Injection of H2NG blends in the gas transport grid (SNAM) (2018-2020).** Own funded pilot project for the injection of H2NG mixtures into SNAM network has been carried out to serve industrial end customers with not critical production processes. In a first phase SNAM studied the compatibility of current infrastructure to transport H2NG mixtures with a content of up to 5% H_2 in volume, and in a second phase increased the H_2 content up to 10%. *Field experience and knowledge with risks and management strategies for H2-NG blends relevant to WP4*
- **Analysis of H2 impacts on natural gas transmission network (GSYS)** literature review to determine the parameters of transmission gas pipelines, which could be used to transport an addition of up to 10% H_2 to natural gas and the acquisition of information from selected industrial end users of gaseous fuel on the possibility of cooperation between their industrial installations and natural gas containing H2. *Monitoring and H_2 admixing strategies relevant to WP4 and End-user requirements and constrains for the use of H_2-NG blends relevant to WP4 and WP5*
- **GREEN HYSLAND (RED, ENA):** This project, funded in 2020 by FCHJU, aims to deploy a fully-functioning H2 ecosystem in the island of Mallorca, Spain, turning the island into Europe's first H2 hub in Southern Europe. This will be achieved by producing green H_2 from solar energy and delivering it to the end users, such as the island's tourism, transport, industry and energy sectors, including gas grid injection for green heat and power local end-use. *Field experience and knowledge with risks and management strategies for H_2-NG blends relevant to WP4*
- **GreenGasCastelfranco (INRETE)**: In this project a section of the gas network was identified that is technically suitable for carrying out the injections of H2GN mixtures located in the Municipality of Castelfranco Emilia, Italy. The first release is expected to be 2% H_2 vol. The others, where possible, will be with increasing% H_2, compatibly with the limits and requirements of the law, in the hypothesis 5% then 10%. *Field experience and knowledge with risks and management strategies for H2-NG blends relevant to WP4*
- **GREENH2PIPES (ENA):** Research project. Boosting hydrogen transport through existing infrastructures. *Experience and knowledge about management strategies for H2-NG blends relevant to WP4 and WP5*

To increase the added value, SHIMMER will be built on the outcomes of relevant ongoing projects outside the consortium. By the time of submission SHIMMER has already stablished contact and got support for collaboration with the following projects by participating in SHIMMER networking group: HyDelta (Netherlands), Future grid (National Grid's -UK), HyBlend (NREL – USA), H2020 Decarb (NPL -UK). In addition, SHIMMER to build a cooperation with the project resulting from topics HORIZON-JTI-CLEANH2-2022-02-01(LoS from the CANDHy proposal), HORIZON-JTI-CLEANH2-2022 -02-02 (Leakage detection), HORIZON-JTI-CLEANH2-2022-02-01and HORIZON-JTI-CLEANH2-2022-1 (measuring devices).

1.2.3.Interdisciplinary Considerations

The SHIMMER project requires highly complex activities and interdisciplinary skills covering mechanical and chemical engineering, material science, thermodynamics, fluid dynamics, numerical simulations, process control, data analytics and ICT, automation, energy system analysis, integration and planning, economics, marketing and communication.

The research organizations and academia, BAM, TECNALIA and INIG have expertise in material science, pipeline integrity management and relevant technologies for pipeline and leakage monitoring in the presence of H_2-NG blends required for the tasks in WP2 and WP3. The consequent management of risks for leakages on multi-gas scenario will be performed by SINTEF and GSYS. Partners involved in developing the multi-gas networks modelling tools ana network management strategies each with their own expertise and involvement in WP4 are TNO, SINTEF and POLITO. TNO has expertise on measuring technologies for gas quality and will lead this activity in WP4. All research and academic partners will closely collaborate with the *TSOs and DSOs* in the project ENA, SNAM,

GASSCO, GSYS, REDEXIS and INRETE will significantly contribute with relevant industrial input, experience, future needs, models validation and to define the case studies and scenarios required to improve future operations, modernisation requirements and network management. *GERG* would lead the dissemination and exploitation activities and create bridges between previous and ongoing projects in WP5. Each partner is responsible for contributing to dissemination and exploitation together with GERG. Project management and coordination will be led by SINTEF with support from all the partners. To ensure effective execution, the project is divided into 5 work packages, with WP leaders selected by qualification and responsible for coordinating interdisciplinary work within each WP.

1.2.4.Gender dimension in R&I content

The consortium believes that achieving equal gender representation at all levels in science and innovation will drive the progress towards a prosperous and sustainable EU economy. The project objectives do not have any specific issues associated with gender, as there are no perceived issues in relation to users of the technology.

The SHIMMER partners recognize the importance of- and are committed to- gender equality throughout the project lifetime in all parts of the research, development, communication, and exploitation. The consortium welcomes this requirement from the European Commission and shares the sense of urgency in achieving gender balance in research and innovation activities and will adhere to the Gender European Policy (Articles 2 and 3 of the Treaty on European Union and Article 8 TFEU) and in agreement with “EU Strategy for equality between women and men”. The work will be based on the partners' available Gender Equality Plans (GEPs), GEPs currently under development and equivalent reports and documentations; SINTEF's GEP was finalized by January 1st 2022 and is aligned to the requirements of the eligibility criteria in the Horizon Europe work programme the Norwegian Equality and Anti-discrimination Act AIT's GEP43 IREC's Equality Plan44, JM's Gender Pay Gap Report 202045, VIA's recruitment policy on "Equal opportunities and promotion of diversity". All partners will be engaged to contrast inequality between women and men in all aspects of the project. SHIMMER will have a good share of female participants in central roles, some of which are: Andrea Shmueli (SINTEF) as project coordinator, Nevena Marinova (TECNALIA) as WP3 leader, Dorota Polak (GSYS) as T3.2 leader, Monika Gajec (INIG) as T3.3 leader, Maria Storch as technical point of contact from (REDEXIS) and Alexandra Kostereva (GERG) as WP5 leader.

1.2.5.Open Science practices

Open science accelerates the deployment of higher admixtures of H_2 in the existent natural gas networks which highly contributes to the energy transition and the achievement of long-term sustainability goals. Open science through the generation of linked open research data, open-source software development, and open-access publishing of scientific results will be encouraged. A systematic and open access to the material, components, and operational data and procedures from selected gas networks across Europe are essential to identify the current research gaps to be closed towards the updating the natural gas standards for H_2 blends. Relevant data, provided by the TSOs and DSOs in the SHIMMER consortium, together with open-source flow network models will be used to develop methods, procedures and recommendations that will be openly accessible to the scientific community. Data will be formatted according to the recommendations from the format COLLADA (COLLAborative Design Activity) and supplemented with appropriate metadata. This will allow the data generated in the project to be both semantically rich and optimally machine-readable. The intention in SHIMMER is not only to enable an open database, in which the user will have access to most data (apart from sensitive or confidential defined by the source, e.g. TSO/DSO), but also, to develop open-source codes for network modelling that will be made available to the community under non-restrictive open-source licenses. Open-access publishing of the SHIMMER scientific papers, public reports and deliverables will be performed, after careful IPR considerations and using the open access principles, meaning published without delay and stored in a publicly available repository. Examples of public portals/repository to be used are European Open Science Cloud, OpenAIRE and Zenodo.

1.2.6.Research data management

As the SHIMMER consortium consists of an important portion of industrial partners, the project will aim to exploit the results commercially and industrially and to protect all relevant data as IPR. In this light there is a need to protect competitive advantages gained by the cost- and effort-intensive development of innovative solutions from competitors. However, the consortium intents to publish the scientific results of the project in journals which allow green or golden open accesses. In the budget, SHIMMER partners have reserved financial provisions to cover the additional expenses for open access publications. SHIMMER will monitor how **project results** will be exploited and accessible for verification, reuse or preserved through a Data Management Plan (DMP) that will have its first draft available as Deliverable D1.1 of WP1 at M6. The DMP will outline how information and project data will be managed considering the dissemination and exploitation strategies and plans deployed in SHIMMER. **Data preservation** within SHIMMER will be in line with Horizon Europe open data guidelines that ensure that research data is findable,

accessible, interoperable and reusable (FAIR). All publications will be open access and thus available to all peer-reviewed scientific publications relating to the project's results. SHIMMER partners have set aside funds to publish OA articles. All publications (final articles or manuscripts accepted for publication) will be deposited into the institutional repository of the affiliated institution, on the SHIMMER website or in an appropriate repository. The publication policy will be further described in the Grant Agreement / Consortium Agreement. The open access logic will include all metadata, conference proceedings and other text publications. These will be deposited either in public repositories or on the project website. Datasets will be made available throughout and after the project for scientific and public use and results are published on our website. In case of protected data, we will provide a metadata description that will be publicly available.

2Impact

2.1Project's pathways towards impact

2.1.1.Impacts set out in the work programme

SHIMMER addresses the call HORIZON-JTI-CLEANH2-2022-2. SHIMMER will contribute towards the expected outcomes (EO) listed in the specific call topic in several ways. Specifically, this will lead to the following EOs as outlined in the call:

EO 1: Definition of methods, tools and technologies for multi-gas network management and quality tracking, including simulation, prediction and safe management of transients, in view of widespread H_2 injection in a context of European-wide interoperability and gas market reform

SHIMMER will develop the methods and tools for multi-gas network management and quality tracking in WP4 as a management framework. The results generated from these tools will provide the possibility for optimization at system level and to define effective operational strategies for H_2 injection while assuring the gas supply and respecting quality constraints at end-user locations and other relevant constraints (e.g. contractual, OPEX, control strategies). The simulated cases will be built based on the data and operational conditions provided by the six TSOs and DSOs from 4 different locations in Europe (Spain, Italy, Norway and Poland). Provided data from TSOs will be used to validate the methods and tools. In addition, SHIMMER will assess in WP4 promising gas quality for quality tracking and the ones that are able to subsequently mitigate quality variation in the natural gas network. The released tutorials from the open-source models will provide a catalogue of possible challenges and opportunities to gas stakeholders and to network operators (TSO/DSO) in the context of strategies for the modernization of assets to improve the readiness for safe H_2 injection management. This is expected to contribute to harmonize intersectoral integration and to develop regulations to be used by investors and operators at EU level.

EO 2: Best practice guidelines for handling the safety of H_2 in the natural gas infrastructure, managing the risks (with prevention and mitigation protocols) for guaranteeing the safe interoperability of gas transport at European level; will be developed by SHIMMER based on the results from WP2, WP3 and WP4. These results will contribute to generalize common challenges across Europe and to define guidelines and recommendations in a context of European-wide interoperability and gas reform. If a major emission of H_2 occurs, it is common practice to have pre-approved protocols in place for handling such events. The protocols depend on estimates of dispersion and concentration of H_2, e.g. for specifying safe standoff distances with respect to intervention operations. Such estimates depend on mathematical simulations of release scenarios. SHIMMER will significantly enhance the accuracy in the estimates of releases from the network and thus enhance safety protocols. In addition, SHIMMER will investigate the readiness level of pipe inspection technologies when H_2 will be present.

EO 3: Mapping and assessing T&D infrastructure components at European level to identify best available technologies, the H_2 readiness of components, network technologies and monitoring protocols to steer stakeholders towards effective regulation and technical standards, network repurposing and modernisation investments. As part of WP2, the project will generate a database for materials and components on the existent infrastructure and their readiness for gas blends. In addition, SHIMMER will generate general understanding of the common challenges of the T&D European gas infrastructure when operating with blend compositions as part of WP2 and WP3; it will identify the best available network technologies for pipe inspection and leakages monitoring and mitigation in WP3. SHIMMER will recommend priorities for safety requirements, protocols for inspection and risk management. Reduced operational and design fragmentation of the networks across Europe. Development of guidelines, protocols, and recommendations to steer stakeholders towards effective regulation and technical standards.

2.1.2.Expected impact and indicators towards destination

Clean H_2 JU	Clean H_2 JU SRIA	Horizon Europe
SHIMMER will address several **KPIs** from the CHJU **monitoring framework,** especially: Supporting climate and neutral actions: **KPI-1a**: share of JU budget supporting H_2 end-use solutions in hard to abate sectors *(i.e. industries that can admit a share of H_2 in their gas processes such as power stations, kilns, furnaces, steel).* Supporting market uptake of clean H_2 applications: **KPI-4**: education and training *(e.g. RTOs will feed research and projects with SHIMMER outcomes, TSOs/DSOs in SHIMMER will transfer the knowledge/guidelines on H_2 injection internally).* Reinforcing EU scientific and industrial ecosystem: **KPI-13**: promoting cross-sectorial solutions *(SHIMMER outcomes will benefit industry and research institutes in and beyond project partners).* Reducing GHG Emissions: **KPI-14**: expected avoided emissions *(e.g. "Fit for 55" package).* Energy transition with renewable H_2: **KPI-15**: market uptake of clean H_2.	SHIMMER will contribute to the following **research actions** from the CHJU SRIA: Early stage: i) Develop testing techniques to precisely *map the influence of H_2* on different pipeline *materials*, ii) Qualify *the effects of H_2* on the different types of *materials* and *component*s, iii) Precisely *model the influence of H_2 including blends* on identified safety and risk areas to update design and operating methods, and ensure safe operation. Development: i) Compact *blending* and mixing units for H_2 *injection*, iii) Qualify the *impact of H_2 on network* compressor stations and its *components*, as well as components regularly found in metering and regulating stations such as filters, heat exchangers, pressure regulators and develop new compatible components, iv) understanding the techno-economic potential for repurposing natural gas pipelines. SHIMMER will also tackle the following **technology KPIs** from the CHJU SRIA: Cross-cutting. *Education and public awareness:* i) trained professionals, ii) universities/institutes offering courses on H_2). *Safety, PNR & RCS:* iii) projects with proactive safety management, iv) impact on standards at scope. H_2 storage and distribution. *H_2 distribution:* i) OPEX pipeline (SHIMMER will support cost reduction studies associated to H_2-NG blending and repurposing the gas network). *H2 transportation*: ii) H_2 leakage (linked to safety, SHIMMER will address materials and components integrity to aim for no leakage).	SHIMMER will have an impact on the three types of **Key Impact Pathways (KIPs)** established in Horizon Europe: Scientific impact: i) creating high quality new knowledge *(H_2 injection is still rather new and SHIMMER will produce key exploitable knowledge for its implementation)*, ii) fostering diffusion of knowledge and open source *(the open-source model for multi-component gas networks in SHIMMER will be used, validated and updated by multiple stakeholders).* Societal impact: i) addressing EU policy priorities and global challenges through R&I *(SHIMMER will help develop regulations for H_2 injection technologies in gas networks)*, ii) strengthening the uptake of R&I in society. Technological/economic impact: i) generating innovation-based growth, ii) leveraging investment in R&I *(SHIMMER relies on the resilience of the gas infrastructure to reduce investments by assessing blending and repurposing to contribute to energy security and decarbonisation).* SHIMMER will also aim to meet the different **common indicators** for all partnerships in Horizon Europe, such as: coordinated and joint activities with other European partnerships (coherence and synergies), international actors involved plus visibility in national, European, international policy/industry (international visibility and positioning), alignment of national/regional/sectorial policies (directionality).

2.1.3. Scale and significance of the project's contribution to the expected outcomes and impact

A huge scale in the context of SHIMMER is expected considering the target groups that will benefit over time. With five TSOs in the consortium (ENA, SNAM, GASSCO, GSYS, REDEXIS) we are making sure that four countries (Spain, Italy, Poland, Norway) with a significant share of the European gas infrastructure are included in this project, facilitating the initial inter-comparability of materials and components with H_2 and to de-risk and optimize future injection strategies and network management. Norway is a critical gas supplier in Europe via pipeline and considering the current market circumstances it is important to leverage its progress in compatibility with H_2. At distribution level, two DSOs in the SHIMMER consortium (REDEXIS; INRETE) strengthen the project with the provision of information on typical materials and components of the distribution network. To better map the European network, gas infrastructure operators in other geographical locations have been invited to the networking group (e.g., Austria, France, Ireland, UK), as well as end users to provide inputs on gas quality variation for the modelling parameters. Considering multiple target groups broadens the scale expected in the whole value chain.

The other pipeline route via North African countries like Algeria and Libya is part of the scale of SHIMMER, especially through the infrastructure in Italy and Spain. POLITO, for example, can disseminate results in this area using its background network of collaborations (e.g. POLITO is coordinating capacity building projects in Tunisia and Libya, i.e., NePRev and Enbrain involving university/industrial associations). In view of combining decarbonization and security goals, and with the need to harmonize the situation in Europe, SHIMMER will have a high impact in Europe and regions overseas in the Mediterranean, considering the gas infrastructure in place connecting countries represented in the consortium like Italy and Spain.

The scientific significance of SHIMMER will be complemented by existing and ongoing research projects, avoiding work duplication. Cooperation with the project resulting from topic HORIZON-JTI-CLEANH2-2022-02-01 and 2023-02-01 will be a priority particularly for the testing protocols for metallic materials that will be needed in SHIMMER. By the time of submission, the SHIMMER consortium has been in coordination with some of the consortiums submitting their proposals to these calls. Ongoing projects and relevant research associations outside Europe have been also invited to the networking group (e.g. USA, Australia) to expand the learnings and increase the impact from SHIMMER across borders.

The project will build on (non-exhaustive list): GERG

CEN H2 PNR project, HIGGS and THyGA; considering that several SHIMMER participants have been directly involved in these projects which facilitates the exchange. For instance, other relevant projects like Future Grid in the UK can provide important lessons and recommendations to SHIMMER, and they will be contacted via the network group. Furthermore, SHIMMER will support the aims of the H_2 and Decarbonised Gas Market Package, which provides the regulatory framework within which future gas networks will operate; as well as energy security objectives (some stated in the REPowerEU plan).

2.1.4.Barriers for future implementation

Table 2.Barriers for future implementation and measures to overcome them. "T": Type; "E": Effect

T	Barrier description	E	Measures to overcome barriers
Technical /Technological	Lack of experience with H_2 injection in general Skilled researchers and engineers to perform the project activities and later exploit the outcomes will be needed for a greater impact.	M	These barriers will be evaluated as constraints for the optimization models developed, preparing the future implementation sufficiently in advance. Transfer of expertise and identification of suitable test methods applicable to similar conditions for qualifying material / equipment readiness for H_2, helping in any retrofitting or new pipeline project. SHIMMER will profit from the presence of research institutes, universities and GERG to spread the results further and prepare motivated young expertise for future employment thus reducing skills mismatch in the gas sector. The advisory board and networking group will play a critical role to reach diverse stakeholders and facilitate implementation.
Regulatory /Standardization	Insufficient standards for H_2 blending levels and injection protocols; conditions differ significantly across European countries which hinders harmonisation.	H	Building on projects studying standards such as the GERG CEN H_2 pre-normative research. SHIMMER will envisage to produce relevant results that can contribute to European standards, avoiding duplication of work and working in conjunction with past/ongoing projects' outcomes. Constant interaction with standardisation committees.
Policy	A lack of policy support for blending could be an obstacle.	H	SHIMMER will create awareness of the techno-economic benefits of blends but also aim to cover dedicated H_2 transport.
Energy Geopolitics	The geopolitical environment linked to energy assets such as gas infrastructure could be a potential barrier.	M	Mitigated by selecting strategic assets ideally not exposed to controversial border or conflict areas.

Data Access	Confidential infrastructure or information on certain countries, as well as unavailable data for example for old assets. The modelling tool to be developed in SHIMMER also depends on the data obtained.	M	The database will be available to several stakeholders, being an opportunity for reducing digital division (e.g., especially for regional contexts, outside Europe, with limited economic resources to access copyrighted modelling tools). The open-source approach enables open collaboration with the possibility to expand future capabilities of the tool, guaranteeing the reproducibility of results and thus transparency of reported findings
Societal /Environmental	The acceptance of H_2 technologies is not all set, meaning injection of H_2 into the pipeline might be hindered by public resistance or environmental impact.	M	The educational opportunity provided by the open access approach will help amplify messages, thus increasing its reputation and leading role in energy and H_2 sector, safety being a must (dedicated WP for integrity management and safety including H_2 leakage evaluation). The CDP and EP will be designed/updated to promote the benefits of H blending.
Cooperation with other projects	It is essential to have information about previous and ongoing projects and perform a European network mapping, otherwise the value and impact will be insufficient or there is a risk of work duplication.	M	For the project to be successful, it will be necessary to be able to collect comprehensive information and create strong synergies with other projects and consortiums, TSOs and DSOs at European level. From an early stage, SHIMMER has invited a significant number of complementary entities/projects for future advise/exchange.

2.2Measures to maximise impact -Dissemination, exploitation and communication

2.2.1.Dissemination, communication and exploitation of results

The draft plan for dissemination and exploitation of the results aims to strengthen and speed up the market uptake and knowledge transfer of successful results of the project. The exploitation strategy is based on transferring the project outcomes by establishing an active communication performed by the key research and academic partners and, industrial partners. A continuous and active dialog and involvement of relevant stakeholders such as technology providers, potential end-users, policy makers, standardization bodies and other ongoing projects will provide early input on possible weaknesses of the concept, standardization requirements for interfacing the technologies across the value chain. The plan for exploitation of results will play a key role for managing the knowledge generated in SHIMMER and IPR protection according to the interest of the partners.

2.2.1.1. *Outlined dissemination and communication strategy*

The communication strategies have been designed to ensure that the project impact is maximized. The communication activities will be outlined in the CA to be signed before project start. Communications will be undertaken throughout the duration of the project. In addition to communicating our knowledge and results to our potential end users, we also intend to share all the publicly communicable deliverables within the scientific and academic communities related to our end-users. A preliminary communication plan including the target audiences and measures of communication to these audiences are shown in Table 3. A detailed analysis of the target groups and the optimal communication methods for each of these groups will be determined as a part of the SHIMMER plan for the dissemination and exploitation of results.

Table 3.Target Audience, communication & dissemination tools

Target Audience	Main objective of Communications	Main communication & dissemination instruments/activites	Measure / indicators
TG1: General public	To disseminate project results and create awareness of their benefits for the society, through open communication actions	Project website	At least 3500 views
		Social media accounts (e.g. LinkedIn)	1000 impressions per year
		Press releases	3 press releases
		Project video	1 video
		Popular Science articles	At least 4 articles
		Project Brochure/poster/logo	Shared on events

TG2: Academic stakeholders (universities and research institutes).	To follow Open Data principles to bring the outcomes of SHIMMER by promoting the creation/update of energy programmes at universities and research work about H2 in natural gas networks.	•Open Access Publications in peer-reviewed journals with high impact factor •Presentations at the conferences •Partners's academic network •Project published at partners websites •Distribution of digital material but also posters or handouts at relevant events.	•Evidence of the integration of SHIMMER results in students' group projects or any knowledge transfer at educational/research level. •At least 1 article and publication per RTO •At least 3 papers will be gold open access.
TG3: Standardization bodies, European and national policy makers	Contribute to the development of guidelines and standards for the adaptation of gas infrastructure for the transportation of H2-NG.	•Dissemination, workshops with regulatory, and governmental agencies (e.g EEA, EASP, CSR Europe, European Commission) •Advisory Board formed by European associations across the gas value chain and with an active participation on policy-making	•At least 2 meetings with standardisation committees (e.g., CEN). •AB meetings
TG4: Other related projects.	To enable an effective information exchange , to align progress and to avoid work duplication.	•Interactions with previous and ongoing relevant projects and initiatives (see section 1.2.2) both inside and outside the consortium.	•At least 1 meeting with 2 relevant EU projects and/or National projects • Networking group meetings
TG5: Scientific community , industrial stakeholders and technology providers	To ensure that further research or commercial applications can use the outcomes of SHIMMER in fields such as gas quality tracking devices, modelling, materials and testing.	•Workshops, trade fairs and webinars to promote results and technologies. •Partners' networks and communication channels. •SHIMMERs open-source models platform	•1 workshop open to participants outside SHIMMER (50 participants) •At least 1 article and publication per technical partner. •At least 1 conference per technical partner •Project promotion in social media account
TG6: End-Users	To consider the requirements of end-users (sensitive to gas quality variations, blending limits, integrity concerns, H2 purity, metering devices compatibility, etc)	•Dissemination to key end-users that can exploit SHIMMER results (e.g. appliance manufacturers, heating industry). They will be invited to the workshops organized.	•Participation in at least 2 conferences/forums targeted to end-users who benefit from SHIMMER outcomes. -steel and materials producers or any type of end-user (e.g., SteelH2, EUROCORR, FABIG). •Project promotion in social media account
TG7: DSOs & TSOs	To share and increase the use of SHIMMER results across operators in Europe, to enable feedback and verification and reproducibility as well as validation of models.	•Invitation to use and populate the the SHIMMER' database and to use open-source model platform •Participation in Scientific and Technical Conferences and relevant forums •Project published at partners websites	•1 presentation at a GERG H_2 Working Group Workshop where TSOs and DSOs typically participate. •Participation in FORGAZ organized by INIG. • Project promotion in social media account
TG8: European and International	To enable a wider impact, across multiple stakeholders from various sectors Target associations would not	•Associations in the advisory board, (e.g., Marcogaz, Euramet, H2IT) are important means of dissemination and potentially source of relevant inputs.	•AB meetings •Networking meetings •Participation in at least 2 collaborative workshops or conferences (e.g., EGATEC

Associations	be limited to Europe only but also overseas.	•Exchange with other international associations that do research on H2 acceptance in gas pipelines will facilitate the spread of results and comparison of SHIMMER outcomes with their activities.	2024 organised by GERG & Marcogaz). •Project promotion in social media account

Target scientific journals and magazines (Examples): Potential scientific journals: Renewable and Sustainable Energy Reviews; International Journal of H_2 Energy; Sustainable Cities and Society; Energies.
Specific target conferences, symposia, and trade shows (Examples): Minimum of 8 external events. International conferences/events targeted include: such as: GAS 2023, GAS 2025, European Gas Conference, World Gas Conference, European Gas Technology Conference (EGATEC), Gas Analysis Symposium, IGU International Gas Research Conference (2024), European Sustainable Energy Week (EUSEW), European H2 Energy Conference, World H2 Energy Conference (WHEC). Further relevant conferences may be identified during the project.

2.3Exploitation strategy

SHIMMER envisages a series of key exploitable results that will have a positive impact on a wide range of stakeholders, mainly gas infrastructure operators, but also end-users, the scientific community, among others. The exploitation strategy relies on the experienced background of the SHIMMER partners, plus the synergies of their network and technical capabilities to produce exploitable benefits, through effective means of exploitation, at company, national, EU and international level. The exploitation strategy follows a multi-purpose approach (e.g., societal, scientific, economics) and to guarantee that results are used as soon as they are exploitable. For that reason, it is closely linked to dissemination to maximise the results' impact. To achieve this objective, the following steps are followed:

Identification of potentially exploitable results: To better understand the potential exploitable results from SHIMMER, it is necessary to identify the current and future needs of the different stakeholders. First, there is a need to map European gas T&D infrastructure and interact with operators to collect information about materials, components, technology and their readiness for H_2 blending; then, operators need to develop knowledge for localisation of H_2 injection, managing fluctuations for H_2-NG blends to understand the implications for repurposing; and finally, there is a need for protocols (prevention and mitigation) for inspection and monitoring. Based on this analysis, a series of key exploitable results are summarised in Table 4. One of the main expected impacts is that SHIMMER will contribute to European or international standards for safe H_2 injection.

Target groups identification: Different needs imply different target groups. In SHIMMER, 8 target groups were identified and they are detailed in Table 3. Project activities will be set up in a way that they suit the target groups as much as possible.

Development of exploitation strategies: Each target group may require different means of exploitation. For example, the scientific community will benefit more from technical papers or SHIMMER presentations in scientific conferences. On the other hand, the general public will prefer more condensed and visually appealing information in the form of flyers, posters or non-technical workshops. Feedback from the Advisory Board and the Networking Group will amplify SHIMMER results, with the possibility of a direct business model from the project to the market. In general, different exploitation strategies aim to transfer the project results to appropriate stakeholders at regional, national and European level. Nevertheless, it is also essential to plan that project members can exploit the results.

Table 4. Key Exploitable Results (KER)

KER	Users	Exploitation Route
KER1: Open-source model of multi-component gas networks with general significance.	TSOs/DSOs, RTOs, engineering and consultant companies	R&D, training and education 2) Increased collaboration across companies and institutions
KER2: Qualitative and quantitative analysis regarding material and component compatibility for H_2 technologies	TSOs/DSOs, RTOs, material producers, regulation and standardization bodies	1) Guidelines, testing protocols and methods towards improved safety and material related standards
KER3: European components & materials database. Readiness for H_2 injection	TSOs/DSOs, RTOs, steel producers, regulation and standardization bodies	1) R&D, training and education 2) Increased collaboration across companies and institutions 3) Guidelines, protocols and methods towards improved safety and material related standards
KER4: Qualification procedures, testing protocols for pipeline inspection technologies	TSOs/DSOs, RTOs, material producers, technology suppliers,	1) Technology improvements and upgrades for blends 2) Input to steer stakeholders towards effective regulation and technical standards.

	regulation and standardization bodies	
KER5: Overview of gas quality measuring technologies and their integration in a control system for H_2 injection based on end-users' needs.	TSOs/DSOs, RTOs, End-users, technology providers, regulation and standardization bodies	1) Technology improvements and upgrades for blends 2) Input to steer stakeholders towards effective regulation and technical standards.
KER6: State of the art of the normative concerning H_2 injection in natural gas grids.	TSOs/DSOs, RTOs, regulation and standardization bodies	Publications 2) Workshops with regulatory and governmental agencies such as standardisation committees 3) Future creation of regulations and standards (and harmonisation) for H_2 injection in natural gas networks at EU level
KER7: Guidelines for the injection of H_2 in NG grids and management of multi-gas networks	TSOs/DSOs, RTOs, technology providers, regulation and standardization bodies	1) Publications 2) Workshops with regulatory and governmental agencies and members of the AB and networking group 3) Future creation of regulations and standards (and harmonisation) for H_2 injection in natural gas networks at EU level 4) Technology improvements and upgrades for blends
KER8: Recommendations existing monitoring technologies for detection of the H_2-NG leakages and capability to perform risk assessment	TSOs/DSOs, RTOs, technology providers, regulation and standardization bodies	1) Technology improvements and upgrades for blends 2) Input to steer stakeholders towards effective regulation and technical standards.

2.3.1.Strategy for knowledge management and protection

Intellectual Property Rights (IPR): IPR handling will be regulated by the Consortium Agreement and will be based on: The Guide on IP in Horizon 2020 (and corresponding updates for Horizon Europe when available), as provided via the IPR Helpdesk; The Consortium Agreement tutorial checklist as provided via the IPR Helpdesk and DESCA and the legitimate interest of the partners. Appropriate measures (e.g. patenting and/or commercial deployment) for handling of the exploitable results of the project will be taken before considering any scientific publications and public dissemination. This includes all technology transferable results where industrial partners have a role, but also institute and university specific results which might require protection before publishing. An appointed IPR manager will assure the development of the **SHIMMER** IP strategy and exploitation plan. The exploitation plan and updates will also contain competitor analyses. According to the procedures provided by the EC a results ownership list will be provided and concluded in the final periodic report of the project. Dissemination of the scientific results will be performed through peer-review papers in high impact scientific journals and presentations at recognized international conferences after the consortiums approval. The support from the European Commission will be acknowledged in all publications and presentations.

Background knowledge: The project will draw on pre-existing knowledge and know-how contributed by partners (Background Intellectual Property – BIP). In general, all of the intellectual property rights and documentation related to the partners' pre-existing knowledge and know-how will need to be declared, will remain the property of the partner who owns them and will only be used for which access rights have been granted. These partners will always be able to continue their business activities without being blocked in their further activities by ideas that may be developed by others in the IP holding Organisation's specific technology field. Moreover, access rights to pre-existing IP will follow the rules set out in the HEU rules for participation. During the execution of the SHIMMER project, all partners shall provide a limited non-exclusive royalty free non-assignable license on their Background IP to another partner if that partner's background is necessary for the completion of his own work during this project. Such license shall not be sub-licensable and shall be for the sole purpose of jointly completing the project. Access rights to background needed for use of own Foreground will be granted on fair and reasonable conditions.

Foreground knowledge: The allocation of property and rights of use of knowledge and know-how jointly developed by the partners during the project (Foreground IP – FIP) will have to be made available to all partners in the project under the conditions outlined in the CA. Potential IP will be identified through the WP Leaders in their half yearly reports. All publications, press releases and other forms of dissemination material will be screened for information that could compromise the IP-protection process and sanction, following legal advice, the withholding of all data that could potentially compromise IP-protection for a defined period of up to four years. The consortium partners will agree on common data access and IPR management rules as set out in the project Consortium Agreement.

2.4Summary: KEY ELEMENTS OF THE IMPACT SECTION

NEEDS &EXPECTED OUTCOMES (EO)	TARGET GROUPS (TG), D&E&C MEASURES	KEY EXPLOITABLE RESULTS (KER) & IMPACTS
Needs: i) mapping European gas T&D infrastructure, managing concentration fluctuations for blends; detailed understanding of the implications of repurposing pipes for H2 **ii)** develop knowledge for localisation of H2 injection, **iii)** protocols for inspection and monitoring, **iv)** standards for H2 injection & gas quality fluctuations. **EO 1:** Definition of methods, tools and technologies for multi-gas network management and quality tracking, including simulation, prediction and safe management of transients, in view of widespread H2 injection in a context of European-wide interoperability and gas market reform. **EO 2:** Best practice guidelines for handling the safety of H2 in the natural gas infrastructure, managing the risks (with prevention and mitigation protocols) for guaranteeing the safe interoperability of gas transport at European level. **EO 3**: Mapping T&D infrastructure components at European level to identify best available technologies, the H2 readiness of components, network technologies & monitoring protocols; to steer stakeholders towards effective regulation, technical standards, network repurposing and modernisation investments.	**TG1**: General Public. **TG2**: Academic stakeholders. **TG3**: Standardization bodies, European and national policy makers. **TG4**: other related projects. **TG5**: Scientific community, industrial stakeholders and technology providers. **TG6**: End-Users. **TG7**: DSOs & TSOs. **TG8**: Associations. **Communication & Dissemination**: Communication and Dissemination Plan (CDP). Tools & materials to use include: SHIMMER website, e-newsletters (2/y), social and professional networking with KPIs, dedicated workshops (M18, M36), participation in conferences/events (2/y), scientific publications (2/y). **Exploitation**: Exploitation Plan (EP). Multipurpose approach exploitation strategy based on 3 steps : i) identification of Key Exploitable Results (KER), ii) identification of Target Groups (TG) and iii) Development of exploitation strategies. **Advisory Board (AB):** to expand the impact towards policy making, standardization and technology uptake. **Network Group (NG)**: for broader result dissemination & exploitation by stakeholders from different target groups.	**KER1**: Open-source model of multi-component gas networks with general significance. *Impact*: Increased collaboration opportunities for model development to handle the complexity of H2 injection scenarios **KER2**: Qualitative/quantitative analysis of material compatibility for H2 technologies. *Impact: Improved safety management strategies for* H2 blends **KER3**: European components & materials database. Readiness for H2 injection. *Impact*: Easy access to information, tool with a general significance that facilitates the impact on various external stakeholders. **KER4**: Qualification procedures, testing protocols for pipeline inspection technologies. *Impact*: Harmonisation of requirements for assessing materials compatibility with H2, structural integrity assessment **KER5**: Overview of gas quality measuring technologies and their integration in a control system for H2 injection based on end-users' needs.. *Impact*: new technologies to be developed and/or tested for gas quality monitoring. **KER6**: State of the art of the normative concerning H2 injection in natural gas grids. *Impact*: Support future standardisation related to qualification of components for H2-NG blends, injection & monitoring, testing and energy determination. **KER7**: Guidelines for the injection of H2 in NG grids and management of multi-gas networks. *Impact*: guide European gas operators, H2 producers, end-users and standardization bodies to integrate the H2 value chain. **KER8**: Recommendations existing monitoring technologies for detection of the H2-NG leakages and capability to perform risk assessment. *Impact*: Reduce risks and costs of H2 leak monitoring technologies, environmental impact.

3Quality and efficiency of the implementation

3.1Work plan and resources

The SHIMMER project is organized in 5 work packages (WP) based on the workflow of the project. The overall planning of **SHIMMER** is shown in Figure 9, including the Management structure in **SHIMMER** and the workflow and main interdependencies between WPs. Gantt chart, where the timing of the different work packages and their components, is provided in Figure 6. A description of each WP and their milestones and deliverables for reaching the project objectives, the identified critical risks for implementation, as well as an overview of the distribution of resources are given in the Table 5 to Table 9 below.

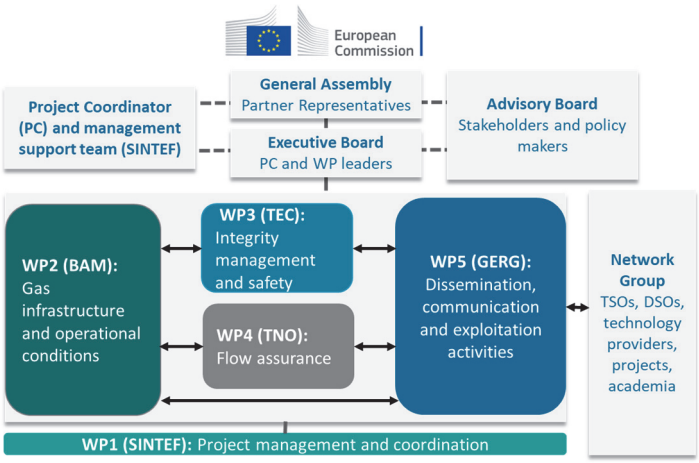


Figure 5. Management structure in SHIMMER and workflow and main interdependencies between WPs methodology

	Year 1				Year 2				Year 3			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
WP1: Project management and coordination												
T1.1: Administrative and financial Project Coordination												
T1.2: Technical project coordination												
T1.3: Data Management												
T1.4: Risk and Quality Management												
Deliverables		D1.1	D1.2		D1.3		D1.2		D1.3		D1.2	D1.4
Milestones	MS1											MS2
WP2: Gas Infrastructure and operational conditions												
T2.1: Materials and components used for European natural gas infrastructure												
T2.2: State of the art of all the normative (standard, directive, policies, etc.) related and/or have impact on the H2 injection into the gas grid												
Deliverables		D2.1, D2.2		D2.3	D2.4			D2.5				
Milestones			MS3		MS4							
WP3: Integrity managemet and safety												
T3.1: Evaluation of materials and components qualification research and procedures to assess their hydrogen readiness												
T3.2: Guide for in-line inspection of pipelines in the presence of natural gas blends with hydrogen												
T3.3: Evaluation of existing monitoring technologies for detection of the leakages and capability to perform risk assessment												
Deliverables					D3.6, D3.7	D3.1			D3.4	D3.3, D3.5	D3.2	
Milestones											MS5	
WP4: Flow assurance												
T4.1: Definition of network models and case studies												
T4.2: Optimization of network design and needs for modifications												
T4.3: Operational strategies for injection and flow transport management												
T4.4: Evaluation of gas quality measuring technologies for effective network management												
Deliverables				D4.1				D4.4		D4.2, D4.6	D4.5, D4.7	D4.3
Milestones				MS6		MS8		MS7, MS9, MS10				
WP5: Dissemination, communication and exploitation activities												
T5.1: Communication and dissemination plan												
T5.2: Communication and dissemination activities												
T5.3: Preparation of the exploitation plan												
T5.4: Implementation of the exploitation strategy												
Deliverables	D5.1, D5.4					D5.2, D5.3						D5.5
Milestones	MS11, MS13	MS12										

Figure 6. Gantt Diagram

Table 5. List of work packages. "PM" Person Month; "SM": start Month, "EM" End Month

WP	Work Package Title	Lead	Lead#	PM	SM	EM
1	Project management and coordination	SINTEF	1	32	1	36
2	Gas infrastructure and operational conditions	BAM	7	54,5	1	24
3	Integrity management and safety	TECNALIA	2	106,8	1	36
4	Flow assurance	TNO	6	82,9	1	36
5	Communication, exploitation and dissemination	GERG	9	24,2	1	36
	Total			**303,3**		

The detailed WP descriptions are given in the following tables; For each task (T), the leader is given in bold and underlined.

Table 6. Work Packages Description

WP number	WP1		**Lead beneficiary**					**SINTEF**						
WP title	**Project Management and Coordination**													
Participant number	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Short name of participant	SINTEF	TECNALIA	SNAM	POLITO	INIG	TNO	BAM	GSYS	GERG	GASSCO	REDEXIS	REDEXIS GS	INRETE	ENA
PM per participant	13	2	0,5	2	2,6	3	2	1	0,6	0,8	1	1	2	0,5
Start month	M1			**End month**					M36					
The targeted objectives: 1. Efficient and transparent coordination and management of the project; **2.** Productive communication within the consortium; **3.** Efficient Grant management (resource optimisation); **4.** Communication with the EC; **5.** Data Management; **6.** Risk Management														
T1.1: Administrative and financial Project Coordination (<u>SINTEF,</u> all partners**) (**M1-M36): This task deals with different aspects of the coordination of the project, such as the financial, administrative and communication management through a management support team (MST). SINTEF will manage and steer the financial and administrative activities to assure optimal implementation of SHIMMER. Specific responsibilities and tasks will be assigned to people involved according to experience and skills of SINTEF's staff. Additionally, SINTEF will prepare cost declarations to ensure that all budgetary actions are performed according to the rules and regulations set by the EC and the CA. SINTEF will be supported by the Work Package Leaders in collecting the information to create reports for the Project Management Board meetings and compile the reports according to the EC's requirements. Furthermore, the Coordinator SINTEF will be responsible for the timely submission of the reports to the EC. **T1.2: Technical project coordination (<u>SINTEF</u>**, all partners**) (**M1-M36): The technical coordination will monitor the technical progress of the project activities with respect to the goals, deliverables and milestones in order to ensure the achievement of the expected technical results, according to the procedures established in the Project Management Plan. The project coordinator will prepare technical reports each six months with the help of the WP leaders. Clear reporting procedures and timetables will be laid out to ensure efficient reporting, deliverables and milestones completion. During the first month of the SHIMMER project implementation, SINTEF will organise a Kick-off Meeting to build and strengthen an effective and efficient work team for the project. SINTEF will organise Project Management Board meetings once per year (at least once face-to-face) to review and manage the project. The monitoring reports arising by the coordinator with the help of the WP leaders will be the basis for discussion of the project progress and decision making during the meetings. The project management will be supported using a set of collaboration and management tools, such as a document repository (e.g. Microsoft SharePoint) and communication tools (e.g. Zoom, Teams). **T1.3 Data Management (<u>SINTEF</u>**, all partners) **(**M01-M36): Within this task a data management plan will be developed to manage the data generated and used during and after the project's completion respecting the standards relevant to the activity. Compliance with the GDPR will be addressed and the deliverable will include ethics and gender issue. For compliance with Findable, Accessible, Interoperable and Reusable (FAIR) data, a DMP will be prepared accordingly section 1.2.6 **T1.4: Risk and Quality Management (SINTEF, all) (M1-M36).** T1.4 will be dedicated to the definition and application of quality methodologies and risk management procedures. SHIMMER involves risks, mainly due to the broad scope and high ambitions of the proposed activities. The main risks have already been identified by the consortium partners and reported in Table 9. These risks will be monitored by the coordinator the MST and the quality and risk manager with the support of all the WP leaders, that will be required to report periodically about the project progress, possible deviations and contingency plans, in order to intervene and mitigate the possible barriers which could prevent the smooth implementation of the project.														

WP number	WP2		Lead beneficiary				BAM						
WP title	Gas infrastructure and operational conditions												
Participant number	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Short name of participant	SINTEF	TECNALIA	SNAM	POLITO	INIG	TNO	BAM	GSYS	GERG	GASSCO	REDEXIS	REDEXIS GS	INRETE	ENA
PM per participant	0	10	3	0	0	0	24	2	4,2	0,3	4	1	3	3
Start month	M1			End month				M24						

The targeted objectives: 1. Identifying relevant natural gas infrastructure as case studies together with TSOs and DSOs 2. Develop a database for materials and components on the existent infrastructure 3. map the relevant operational conditions for the gas infrastructure

T2.1 Materials and components used for European natural gas infrastructure (BAM, GSYS, ENA, SNAM, GASSCO, REDEXIS, REDEXIS GS, INRETE) (M1-M24)

This task focuses on collecting and organizing the existing data in a usable structure. The geographical diversity of TSOs participating in the research enables the option to obtain the climate influence on the components as well as broad production technology spectrum. Therefore, it is assumed that the database will have after this step a proper structure based on the information given by these TSOs.

The expected outcomes are therefore the mapping of typical components installed in representative subsections of the European gas network and, together with the knowledge of the acceptability limits of end-user appliances, a base for defining safety requirements and protocols for the inspection (e.g. leak detection) and consequent management of risks.

Subtask 2.1.1 preparation, delivery and collection of a 'component ID' template from TSOs/DSOs As a starting point BAM will collect from transmission and distribution system operators (TSO and DSO, namely ENA – Spain, SNAM – Italy, GSYS – Poland, GASSCO – Norway, REDEXIS – Spain and INRETE - Italy) relevant information on the typical components used in gas grids (e.g. pipelines valves, fittings, gaskets, sealant, metering, odorisation, reduction stations, etc). To this point an information about the frequency of replacing a component due to safety regulations or failure are from benefit for the next WPs.

Subtask 2.1.2 development of a database and introduction of the data, improvement iterations with stakeholders: Based on the collected data, a structure for the database will be developed and tested by the DSOs/TSOs. The database will be developed based on geographic information system (GIS) with top-down design allowing the user to choose a specific country or region in which the components are in-use. An option of 'zoom-in' to the line level is limited due to security reasons. The database will allow at a later stage a crosscheck of parameters (e.g. similar materials in different countries) and eventually refer the costumers to existing information and tests with regard to hydrogen (i.e. the assessment of the compatibility of an item with ready-for-hydrogen ranking of typical items on the gas networks).

T2.2 State of the art of all the normative (standard, directive, policies, etc.) related and/or have impact on the H_2 injection into the gas grid (GERG, TECNALIA, SNAM, REDEXIS, REDEXIS GS, INRETE) M2-M24)

Standards and regulations for hydrogen injection technologies in natural gas networks will need to be developed at EU level to ensure they are not restricted in their roll-out. The role of PNR activities (e.g. GERG CEN H2 PNR project) is also essential to support policymaking by incorporating existing and planned research activities.

In 2022 GERG, on behalf of CEN, completed an extensive gap analysis of PNR needs for introduction of H_2 into gas networks and for end use. CEN TC/234 (Gas Infrastructure) WG13, set up to supervise this project, incorporates inputs from a broad Stakeholder group of CEN Technical Committees, and interacts closely with the European Commission / Clean Hydrogen Alliance Working Group on H_2 Standardisation. The activities of CEN TC 234 WG13 in prioritising standardisation needs is likely to continue, and GERG, and several of the project partners and the SHIMMER Advisory Group (including Gas Network Operators) will be part of the ongoing process.

Subtask 2.2.1 Revise standards for material testing and qualification for compatibility with hydrogen, gas leakage monitoring and detection methods from gas networks (M2-M24): In this task TECNALIA, in alignment with the outputs of HIGGS and the GERG CEN H2 PNR project, will review the existing standards for qualification and testing of metallic materials in hydrogen gas, such as ISO 11114-4; ASME B31-12, ISO 15589-1, ISO 7539-11, EIGA IGC Doc 121/14, ANSI CHMC 1, SAE J2579 and ASME BPVC.VIII. Since most of the

standards are application-specific, the focus of the analysis will be assessing the applicability of the existing standards for qualification of the existing European gas infrastructure and its components with H_2-NG and H_2-transmission and distribution. Another important task is to identify the work groups in the standardization bodies, related to the compatibility of metallic materials with hydrogen, follow their activity and updates and ensure communication with them.

Subtask 2.2.2 Review of Standards associated with network equipment (M2-M24): In terms of network equipment, based on the components that will be part of the database, related standards will be reviewed such as gas pressure regulators (e.g. EN 334, EN 12186, ISO 23555-2), valves (e.g. EN 331, EN 14141, DIN 3230-5), gas meters (e.g. EN 12480, EN 12261, EN 14236) and compressors (e.g. EN 12583, ISO 10439, ISO 10440). Recommendations will be provided to the responsible CEN TCs 234, 235, 236, 237 and 232 at European level in order to adapt current standards for hydrogen injection in the natural gas network for the different families of components, based on SHIMMER outcomes.

Subtask 2.2.3 Review standards and regulations associated with gas quality control and variation (M2-M24): In the area of flow assurance, SHIMMER plans to assess the applicability and potential adaptation of standards initially regarding the energy content of H_2-NG blends and up to 100% H_2, starting with a detailed review of the standard EN ISO 15112:2018 which defines the requirements for billing to determine the energy content via metering or gas quality simulation. EN ISO 6976 will be a reference for the calculation of properties like Wobbe Index and Calorific Value. To assess gas quality needs linked to injection, a separate review will be performed, especially referring to the European standard 16726 and the international standard ISO 14687. CEN TC/234 WG11 will be an imperative contact for dissemination of recommendations to support gas quality standards.

Subtask 2.2.4 Review Standards Associated with different end user types (domestic commercial and industrial, including power generation) (M2-M24): Considering that SHIMMER will develop a multi-gas network model with quality tracking capabilities, it will also be necessary to review standards relevant to end-user needs. As there are many potential domestic and industrial end-users, emphasis will be placed on those that will in reality be connected to the networks that will be part of the mapping in SHIMMER. Standards to study (not exhaustive) include ISO 12789, ISO 19859, EN 15502, EN 17082, EN 746 in order to cover boilers, heaters, burners, power generation, among other end-uses able to admit H_2-NG and H_2 with different requirements. Particular attention to the technical report CEN/TR 16787 for industrial gas installations is going to be important to facilitate the recommendation of adaptations. Issues relating hazardous area classification in the presence of hydrogen blends will also be addressed on a holistic level (drawing example from the recent update of the UK IGEM SR25 hydrogen supplement and the outcomes of initiatives such as HYSAFE).

Subtask 2.2.5. Review Policy directives including RED II, the Hydrogen and decarbonised gas package, REPowerEU and the impact on innovation needs and drivers associated with the introduction and injection of H_2 in the network (M1-M12): In addition to the update and creation of standards to support H_2 injection in the gas network, policies that help achieve the binomial 'security and decarbonization' through the harmonization of gas quality guidelines in hydrogen blends transport and distribution are essential. SHIMMER will contribute to framing these policies and regulatory environment. The regulatory framework on gas quality harmonization/management, billing, guidelines for hydrogen production/injection in the context of unbundling, incentives and the market framework (e.g., flexibility and sector coupling) will be studied.

The commission proposal for a regulation on the internal markets for renewable and natural gases[48] acknowledges that most stakeholders agree that blending can provide a cost-efficient and fast first step, despite the high technical costs, to energy system decarbonization; along with network planning integration (TYNDP & NDP) and a joint gas-electricity plan. ACER[49] produced a report on EU policy and regulatory framework for H_2 injection in the gas network, listing EU legal acts (e.g. RED II) and national hydrogen strategies in the EU; also the ACER/CEER[50] white paper recommending 6 key issues when regulating hydrogen will be reviewed.

[48] European Commission (2021), Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the internal markets for renewable and natural gases and for hydrogen

[49] ACER (2021), Possible regulation of hydrogen networks

[50] ACER, CEER (2021), When and How to Regulate Hydrogen Networks? "European Green Deal" Regulatory White Paper series

WP number	WP3		Lead beneficiary					TECNALIA						
WP title	Integrity management and safety													
Participant number	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Short name of participant	SINTEF	TECNALIA	SNAM	POLITO	INIG	TNO	BAM	GSYS	GERG	GASSCO	REDEXIS	REDEXIS GS	INRETE	ENA
PM per participant	9,5	43	3	0	25	0	0	15	0	0,3	4	1	3	3
Start month	M1			End month					M36					

The targeted objectives: 1) To stablish the basis for managing integrity and safety on existent networks using blends 2) To map blending limits due to material and component integrity, functionality and safety 3) To define priorities for modernization/repurposing, safety requirements, protocols for inspection, risk management (basis for evaluation of fitness for purpose of components of the gas infra) 4) To provide recommendations on standard gaps for optimal integrity management and safety

T3.1 Evaluation of materials and components qualification research and procedures to assess their hydrogen readiness (TECNALIA, GSYS, ENA, SNAM, INIG, REDEXIS, REDEXIS GS, GASSCO) (M01 – M32)

Subtask 3.1.1 Review of existing knowledge and procedures on qualification, testing and compatibility of the gas infrastructure with hydrogen and hydrogen containing blends (M01-M12): To assess the hydrogen readiness of the current gas infrastructure, TECNALIA will revise the existing knowledge on hydrogen compatibility and qualification of metallic materials.

The subtask will be divided into the following activities:

1.*Revise ongoing and finalized projects*: The goal of this task is to identify as many as possible related research and industrial projects, to gain clear vision of their results and achievements, to build on them for a better understanding and also systemizing the available data and knowledge. Such projects are R&D projects, (eg., CEN H2 PNR and HIGGS project, which has prepared a partial inventory of the materials in the European TSO network and an assessment of their compatibility with hydrogen), Joint Industrial Partnership Projects (JIP) etc. Importantly, SHIMMER will aim to use this knowledge and build upon the existing information to contribute with high quality analysis on the current state of the hydrogen readiness of the EU gas grid.

2.*Revise research bibliography on the testing and evaluation of compatibility of materials and components, identified in Task 2.1.* A critical analysis of the existing bibliography will be carried out to identify suitable test and qualification procedures for elaborating guidelines and recommendations for standardization.

Subtask 3.1.2 Analyse the applicability, availability, and complexity of the existing procedures and identify gaps in research and missing information (M12-M32) The following activities will be performed by TECNALIA:

1. Structural integrity assessment of the networks and components, including an update of the failure tree due to H_2 ingress, to clarify its influence on the failure modes and on the different pathologies.

2.Identification of the critical material and component properties (actual condition in terms of defects).

3.Based on the critical properties: i) Evaluate the existence of key material data (provided by WP2) and their reliability ii) In the case of insufficient data, the required characterization techniques will be assessed, including their fit to H_2-NG mixtures. Gaps in the standards for the validation and qualification of materials/components will be identified, such as ASME BPVC or ASME B31.12, as well as the need for new standards.

4.Propose research areas of development based on the most critical paths, optimizing the resources to contribute to the standardization process for H_2-NG mixtures in the existing grid.

5.Evaluate the application of small-scale testing techniques to characterize components and materials under working conditions, such as the small punch test, and pilot testing. These techniques would enable the obtainment of local properties or the analysis of complex geometries whenever conventional techniques are not available.

6.Effect of gas quality on materials performance (Testing), which can affect the life of the components. Based on Tasks 2.1 and 2.2, potentially sensitive components/materials will be selected and tested varying the gas quality of the NG blended with hydrogen. Some of the tests might include varying Sulphur compounds-quantity, testing in the presence of odorants, or substances that could act as embrittlement inhibitors (e.g. oxygen) etc. The test program will be adapted to the results of the gap analysis described above.

7.Proposal of guidelines and procedures for the assessment of component behavior and structural integrity assessment of the network in the presence of H_2-NG blends, including validation and characterization techniques.

8.Ensure communication with Technical committees, such as ISO TC 197 Hydrogen technologies, ISO TC 164 Mechanical testing of metals or ISO TC 234 Gas infrastructure.

9.Assessment of fitness-for-purpose design and risk assessment procedures based on the current standards and guidelines, which would enable a damage tolerant approach. Identification of gaps or need for new codes. Results will also contribute to subtask 3.2.2 by identifying the key features with higher priority for inspection (most probable location, orientation, propagation rate, maximum allowable size) that will be key to identify the most adequate non-destructive technique (NDT). Designing values, at least rough estimations, will be obtained for the NDT screening. A deliverable D3.1 will be created in M17 for T3.2.2.

T3.2 Guide for in-line inspection of pipelines in the presence of natural gas blends with hydrogen (GSYS, ENA, TEC, SNAM, REDEXIS, REDEXIS GS, GASSCO) (M03-M30)

Subtask 3.2.1 Review of current inspection methods, procedures and protocols for pipeline inspections and challenges in the inspection methods for non-piggable hydrogen pipelines (M3-M15) This task will include a review of the in-line inspections and non-destructive testing tools, both at transmission and distribution level and for piggable e.g.: Magnetic Flux Leakage Technology and for non-piggable pipelines, e.g.: magnetic metal memory method, current magnetometer inspection, ground inspection technology. There are several procedures existing nowadays (e.g. Acoustic emission (AE) testing (AET) commonly used in pipeline inspections) and several protocols such as CFR49 part 192/195 or standards ISO16148, ASTM E1419. The advantages and disadvantages of each method and their limitations will be identified. For example, in-line inspection (ILI) technology has certain probability of detection (POD), so not all defects may be detected. This is a gap in ILI technology. This can be an issue when assessing the current condition of the pipelines prior to hydrogen injection.

Results from Task 3.1. related to Identification of critical material properties and component factors will be used to identify the challenges and define key parameters which might influence the inspection protocols, such as admissible defect. The technology review will assess their capability to detect and measure related anomalies caused by H_2 injection (such as decrease in fracture toughness, increased fatigue crack growth rate (FCGR), and decreased ductility). Recommendations will be created towards a H_2 management protocol for existing pipelines.

Subtask 3.2.2 Evaluation of readiness levels of current and prospective NDT inspection techniques for the identified challenges with blends. Definition of future research and innovation guidelines (M16-M30) An attempt will be made to define limits in terms of the types and magnitude of defects and stresses present in gas pipelines for hydrogen transportation. The limits will be related to the technical capabilities of the available methods, identified and analysed in subtask 3.2.1 The requirements for gas pipelines will be defined, from the point of view of their technical condition, necessary to ensure safe hydrogen transportation.

Additionally, an assessment will be carried out on promising research on new technologies, e.g the use of AET for H_2 embrittlement monitoring, which could deal with the identified limitations for H_2 pipelines inspections, especially for non-piggable sections. Guidelines for future research and innovation activities will be drawn.

T3.3 Evaluation of existing monitoring technologies for detection of the leakages and capability to perform risk assessment (INIG, SINTEF, ENA, SNAM, REDEXIS, REDEXIS GS, INRETE, GASSCO) (Month 01 – Month 36)

Subtask 3.3.1 Review of gas leakage monitoring and detection methods from gas networks and emission measurement methods (M1-12): This subtask will contain the comparison of methods ranging from the most widely used on gas networks to those in implementation research phase. The application of the methods currently used also for H_2-NG mixtures will significantly reduce the costs of adapting the network operation.

Subtask 3.3.2 Evaluation and research on gas leakage monitoring and detection methods from gas networks (M10-26): Analysis of methods to detect both methane and hydrogen leakage (e.g. balance methods, mass balance at the input and output to a network fragment; acoustic methods, methods with thermal sensors), and to detect only methane leaks (e.g. infrared). The sensitivity of these methods will change depending on the H_2-NG mixing ratio. To assess this, a stand for simulating the volume of gas emissions (available in INIG by December 2022) will be employed. The research in this real system will be supported by modelling. The optimal methodology for estimating the amount of hydrogen or hydrogen and methane emissions will be proposed.

Subtask 3.3.3 Risk assessment in terms of energy losses and greenhouse gas emissions during the transport of H_2-NG mixtures depending on the applied methods of monitoring and detection of gas leakages (M20-M30) Analysis of how the change of the detection limit for a leakage can affect gas emissions, and thus energy losses and methane emissions will be carried out. The amount of energy losses related to both the transport of pure hydrogen and blends with NG will be estimated to assess the environmental impact of the transport of this type of

gases/mixtures. The resulting method from task 3.3.2 should be characterized in terms of low uncertainty, allow for quick results, be easy to apply in areas typical for gas networks and be applicable in explosion hazard zones

Subtask 3.3.4 Risk assessment of severe accidental subsea gas releases (M6-M16): Full bore rupture of pipelines will result in severe release of H_2 into the atmosphere or the water column if occurring subsea. The safety risk of such scenarios needs to be assessed e.g. to have intervention plans available. Verified assessment capabilities exist for dispersion of H_2 in the atmosphere, but not in the water column. When released from a pipeline, H_2 will disperse as bubbles upwards to the surface and spread into the atmosphere where it can pose a threat to surface vessels and personnel. Being able to predict how H_2 and/or gas blends disperse in the ocean and passes into the atmosphere is important for such assessments. Existing methods for subsea release of CH_4[51] will be further developed to study H_2 and gas blends by a mathematical model. This requires a new capability to handle gas mixture as the method currently assumes a single gas component. Further, material properties for H_2 need to be implemented. A sensitivity analysis of the mathematical model will be performed to identify future needs for model improvement and a series of potential release scenarios will be simulated to shed light on risk concerns.

WP number	WP4		**Lead beneficiary**			TNO							
WP title	**Flow assurance**												
Participant number	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Short name of participant	SINTEF	TECNALIA	SNAM	POLITO	INIG	TNO	BAM	GSYS	GERG	GASSCO	REDEXIS	REDEXIS GS	INRETE	ENA
PM per participant	22,5	0	3	23,5	0	20	0	2	0	0,5	4	1	3	3
Start month	M1			**End month**				36						

The targeted objectives: 1) To determine system and engineering constraints that can reduce hydrogen acceptability in the networks 2) To study the fluid dynamic impacts on H_2 blending 3) To map how contractual constrains will affect H_2 admissibility 4) To establish general guidelines on how gas quality parameters will impact H_2 admissibility 5) To establish optimal operational strategies and best practice recommendations for handling and control of H_2 in the NG infrastructure

T4.1 Definition of network models and case studies: **(TNO, SINTEF, POLITO, ENA, SNAM, REDEXIS, REDEXIS GS, INRETE) (M1 – M12):** This task will define the general model structure (data model) of a network such that all the network components (pipelines, equipment, storage facilities, processing equipment) are included, specified by parameter sets and stored, forming a database. The data model is used for both network design and for detailed network simulation. Available operational models of gas networks within the consortium will be selected and used for simulation of selected test and realistic cases with the capability of quality tracking and management of multi-gas networks.

Subtask 4.1.1 Test Cases: The development of the software for optimization of network design, dynamic network simulation, operational strategy testing and parametric analysis requires a set of (small) testbed models for testing and validation of software functionality, correctness, performance, and robustness. These test cases (both for T&D archetypes) are defined in this subtask and serve as a testbed throughout the project. Realistic size cases are developed as part of subtask 4.1.2.

Subtask 4.1.2 Realistic Cases: Relevant T&D test cases include networks with the inclusion of compression stations, storage facilities and other non-pipe elements, multiple-city gates for natural gas and blends injection. Two realistic cases will be defined to investigate strategies for H_2 injection. The selected cases consider networks that in size and realizability fits the time scales described in the challenges referred in the following. Realistic cases will be representatives of EU relevant gas infrastructure assets. The final selection of realistic cases is defined in collaboration with stakeholders (gas network operators) in the consortium that provide gas network technical data to perform simulations to test the computational capability of the code (see subtask 4.1.3) and the correctness of the fluid-dynamic results.

At least one realistic case at transmission network level will be investigated to analyse relevant hydrogen injection challenges such as (not exhaustive list): 1) sector coupling of power and gas networks with line-pack management challenge in variable supply/demand profiles; 2) hydrogen blending and transport from EU neighbourhood areas

[51] Olsen and Skjetne, 'Summarizing an Eulerian–Lagrangian Model for Subsea Gas Release and Comparing Release of CO2 with CH4'.

(e.g., North Africa) analysing compression behaviour challenge; 3) multiple industrial users with deblending technologies at final facilities as quality assurance challenge ; 4) EU-interconnection with deblending towards gas quality harmonization challenge ; 5) storage system as dispatch/asset management challenge; 6) multiple gas injection in the network as smart flow/pressure control challenge.

At the distribution network level, at least one realistic scale regional network case will be considered to investigate specific challenges that involve detailed quality tracking and quality control for safety of users. The next design and control strategy challenges are investigated: 1) multiple pressure levels and multiple city-gates; 2) a complex meshed grid with multiple injections points, injection levels and supply profiles; 3) a wide range of end-users (industrial, domestic) with very specific quality demands and time varying demand profiles; 4) limited local storage facilities and limited line-pack; 5) quality sensor positioning.

Subtask 4.1.3 Operational gas network models: Available operational gas network models to define data set and modelling framework. The consortium has developed over time a series of operational models of gas networks specifically tailored to handle complexity of hydrogen injection scenarios. These models feature the transient and multi-component fluid-dynamic description of any kind of gas network, equipped also with quality tracking features. These models will be used in Task 4.3 to determine operational strategies of gas networks with hydrogen blending. In the framework of this task, operational gas network models will be reviewed within the consortium with the aim to identify required data set and format in supporting subtasks 4.1.1 and 4.1.2 as well output to be generated in Task 4.3.

T4.2 Optimization of network design and needs for modifications (SINTEF, TNO, POLITO, ENA, SNAM, GASSCO, REDEXIS, REDEXIS GS) M06—M30: System level models to analyze capacity, investments or routing will be developed to assess trade-offs between expansions across the transport (or distribution) network. Models based on mathematical optimization with necessary approximations to achieve computational tractability will be complemented with more detailed simulation models. The optimization models will build on existing modular and open-source modelling framework developed at SINTEF as an extension module and the simulation model will be based on POLITO's network model. Both models will be released under an open-source license, and the optimized transmission network from T4.2 will be included for simulation in T4.3.

Subtask 4.2.1 System Design and Capacities: Develop extension module for design of systems with capacity of storages, compressors and decide investment times for each upgrade or new investment. Assign pipelines for either pure NG, pure H_2 or a mix, and assign degree of mix in % within a given bound (e.g. in discrete steps from 0% up to 20% H_2). Decide routing of NG, H_2 and mixed gas for each operational period to evaluate cost/profitability, given time profiles for demand, production from RES and availability of NG.

Subtask 4.2.2 Investment recommendations based on injection strategies: Use investment model to evaluate different approaches for injection strategies based on fixed mixture or variations, as well as need for storage and compression capacity. Evaluate different scenarios/sensitivities in terms of H_2 demand, NG demand, RES production and costs of infrastructure upgrades and investments. Suggest most promising strategies based on results from model analyses.

Subtask 4.2.3 Evaluation of Accuracy/Validation and Operational Bounds: Simulate the system with more accurate models (from T4.3) and compare accuracy with simplified models used for optimization in T4.2, and investigate which conditions necessitate optimization with higher quality constraints or transients for satisfactory accuracy. From these constrains develop method to incorporate bounds from simulation models in T4.2.1, in terms of new constraints in the optimization models, e.g., on mixture, maximum flow rates, blend quality. From the above analysis provide an overview of operational bonds including undesirable conditions (e.g., accumulation of blend/mixture differences) in the pipeline networks, processing/booster stations, and during storage in pipelines and reservoirs (depleted fields, aquifer, and salt caverns). An overview of bounds for the fluid and thermodynamical conditions in pipelines, process station and at storages (pressure, pressure drop, velocities and temperature) will be established with models from T4.1 and T4.2, and when appropriate from available tools such as PVTsim and Ansys Fluent, for relevant network and storage scenarios derived in T4.3.

Subtask 4.2.4 Open-source model of multi-component gas networks with quality tracking capability: Available operational models to be adapted for open-source release The open-source model will be able to handle the multi-component description of both high-pressure transmission networks and highly meshed distribution networks including non-pipe elements. The model can deliver relevant output throughout the network such as fluid dynamic data of velocity and pressure, gas composition and quality tracking, operational strategies for hydrogen injection aiming at its high and safe integration into the energy system. The open-source model will be validated against SINTEF and TNO tools and/or commercial tools (e.g., SIMONE, LEDA). The open-source model could be helpful for stakeholders that wish to evaluate hydrogen integration in gas networks.

T4.3 Operational strategies for injection and flow transport management: (TNO, SINTEF, POLITO, ENA, SNAM, GASSCO, REDEXIS, REDEXIS GS, INRETE) (M12-M35): Task 4.3 focuses on how to operate a network, as defined in 4.1 and optimized in 4.2 in a smart way, evaluating and optimizing the security of supply, safe operation, not exceeding composition constraints at end-user locations, and operational expenditure (OPEX). Due to time-varying supply and demand, storage and physical bottlenecks of flow and pressure, the effect of operational control strategies (for equipment, storages, reducing and metering stations) have a large effect on network performance. Key performance indicators (KPIs) are defined to quantify network performance and security of supply, which is distributed in both geographical space as in time.

Subtask 4.3.1 Operational network simulation: In this task several different strategies will be designed and evaluated to develop smart injection strategies and guidelines to operate the networks across Europe based on network and injection challenges obtained from the case studies in T4.1. This task will result on:

- strategies for network monitoring and control towards smart gas network configurations (e.g. dynamic pressure modulation at city gates of injection points).
- guidelines for injection characteristics (e.g. pure or blended hydrogen injection, redundancy in injection stations) and localization in the grid (e.g. in the case of multiple city-gates)
- guidelines for multiple injection location management and coordination;
- guidelines for composition tracking (e.g. location of sensors for monitoring) in the network
- line pack management in transmission networks towards sector coupling (e.g. mitigation of quality fluctuations over time)

Preliminary results about dynamic pressure control towards increasing hydrogen uptake have been already investigated by proponents at the distribution level[52].

Subtask 4.3.2 Parametric analysis and out-of-domain generalization of results In this task the evaluation of the effect on operational strategies on variations in the network design and network parameters will be performed based on parametric analysis and uncertainty quantification of synthetic gas networks.

The consortium has developed methodologies to generate synthetic gas networks based on realistic archetypes with respect to which are consistent in a topological and technical manner. This task will foresee the simulation of operational strategies on synthetic gas networks. Moreover, a robust and efficient statistical procedure is suitably designed accounting for machine learning tools for parametric analysis and uncertainty quantification which may be based on polynomial chaos expansions, support vector machine regressions, Gaussian processes, or others (e.g., selection upon cross comparison of machine learning techniques). Generalized results will help the required abstraction work about the management of multi-gas network as required by the call thus giving guidelines whose general validity is supported by mathematical findings.

T4.4 Evaluation of gas quality measuring technologies for effective network management (TNO, ENA, SNAM, GASSCO, REDEXIS, REDEXIS GS, INRETE) (M12 – M35)

Subtask 4.4.1 Definition of requirements: In this task the requirements related to safety aspects, i.e. response time will be evaluated in discussion with the TSO's and DSO's in the consortium. Special attention for requirements related to safety aspects (i.e. response time) or to number of sensors and location of sensors for different injection strategies and performance (accuracy) of the sensors in relation to performance of the gas quality modelling technologies. In addition, the requirements regarding integrating of the modelling tools with measuring technologies will be evaluated.

Subtask 4.4.2 Survey on possible technologies: This task will consist of performing a survey and a literature search and scan of available measuring technologies based on the requirements from 4.4.1 and on how the measuring technologies can be part of a control system for mitigation strategies: control the amount of H2 injection, based on gas quality measurements on strategic locations. In addition, this task will provide a review on available standards for gas quality measuring technologies in H_2-NG mixtures.

Subtask 4.4.3 Evaluation: This task will conduct an evaluation of the technologies from 4.4.2 with respect to the requirements from 4.4.1, resulting in an overview of available technologies and recommendations for technology development. Possible topics for evaluation are:

1. Technologies for measuring the gas quality; ability to be installed in the grid with respect to performance, cost indication, maintenance requirements.
2. Ability to integrate them in a control system for mitigation strategies.

[52] Cavana, Marco, Vaccariello, Enrico, and Leone, Pierluigi, 'Pressure Management in Smart Gas Networks for Increasing Hydrogen Blending'.

3.Exploring the possibility to integrate modelling tools and sensors to enable synergy of combining these technologies (define number of sensors and sensor locations). Using one of the cases from 4.3
Recommendations on improvements for standards for gas quality measuring technologies in H2-NG mixtures.

WP number	WP5			**Lead beneficiary**				GERG						
WP title	**Dissemination, communication and exploitation activities**													
Participant number	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Short name of participant	SINTEF	TECNALIA	SNAM	POLITO	INIG	TNO	BAM	GSYS	GERG	GASSCO	REDEXIS	REDEXIS GS	INRETE	ENA
PM per participant	3	2	0,5	1	2,6	2	1	0,5	7	0,1	1	1	2	0,5
Start month	M1			**End month**				M36						

The targeted objectives: 1. •Communicate and disseminate the project results to the key stakeholders and general public; **2.** •Lead a stakeholder analysis to map key actors to finetune the business model; **3.** Support the exploitation of the project results among the partners, through the definition of marketable results, the setting up of individual exploitation and business plans and the exploitation agreement

T5.1. Communication and Dissemination Plan (GERG) (M01 – M06): A detailed Communication and Dissemination Plan (CDP) will be developed at the beginning of the project and will be periodically updated and deployed during the project life cycle. The different iterations will include the activities developed in the project according to the previous plan version as well as the foreseen ones for the next period. The CDP will contain, at least, the following elements:

- The identification and classification of the stakeholders to be targeted, establishing a characterisation of their needs and concerns in the design of the most suitable strategy for each of them.
- Communication strategies to the wider public and stakeholders that are not specifically targeted for dissemination (media, trade associations, wider public).
- The dissemination methods and their associated activities and tools to reach the expected impact, like the project website, conferences, workshops, publications.
- Dissemination procedures according to the Grant Agreement (GA) and the Consortium Agreement (CA).
- Schedule and complementarities of the dissemination activities among the partners.

The deliverables of the project will be used as the basis for the CDP and to monitor the progress of dissemination activities. The partner responsible for each deliverable will be asked to establish the dissemination potential of the deliverable prior to its submission. GERG will track the communication and dissemination activities, and present a brief overview at every Steering Committee (SC) meeting.

T5.2. Communication and Dissemination activities (GERG, All partners) (M01 – M36): This task aims to raise awareness about the project through communication actions, liaise with the stakeholder community in order to shape the direction of the project's work programme, and actively disseminate the research outcomes and best practices to the end user and stakeholder communities. The activities of this task will follow the CDP and its updates.

Subtask 5.2.1 Main communication activities and tools:

Project website. The consortium will create a website to showcase the project aims, project general information and public results. The webpage will be regularly updated with information such as project reports, papers published by the partners, project meetings, workshops and other events.

Internal consortium workspace. For communication between partners only, a Sharepoint will be used for the exchange of information and a digital archive throughout the project.

Project identity kit. A visual identity will be designed for the project to ensure the project is recognisable and increase efficiency of communication and dissemination actions.

Project flyer and poster will be prepared addressing all relevant information about the project and the partners in the beginning of the project. The texts will be written for a non-specialist audience with an interest in the energy field. The flyer and poster will be available for download on the website for all partners. The flyer will mainly be used as a handout during project presentations at conferences and will be added to letters and emails for communications with non-project partners. The project poster will be used to present the general outline of the project during minor conferences and meetings.

Social media. GERG together with all partners will communicate with the public concerning interesting findings, attractive and up-to-date contents through social media (e.g. LinkedIn, ResearchGate). All partners will reply to

any enquiries received through these channels. The Twitter and LinkedIn accounts of partners will serve as relay to communicate on SHIMMER events and main results.

Subtask 5.2.2 Main dissemination activities and tools.

Press releases and newsletters. Several press releases will be published by the project, linked to the most important milestones, such as launching of the project, general progress announcements (public information) by Midterm Review meeting, dissemination of the different workshops, final project announcements, general results (public information). A bi-annual newsletter on the project results will be sent to the consortium and interested stakeholders (a call to subscribe to the newsletter will be visible on the website and shared during events).

Publications and journals. Research results will be disseminated through publications in peer-reviewed and trade journals and magazines, as well as submitted to Open Research Europe. The open access publications are expected to be the result of a collaborative effort from partners (from different countries). The authors of the open access peer reviewed papers will clearly acknowledge the financial support provided as required by the European Commission.

Subtask 5.2.1 Networking activities

GERG networks. GERG will disseminate the project output to the network of GERG members, partners and other gas related stakeholders within the broader GERG network, extending expertise or interest in hydrogen: presentation in the GERG Hydrogen Working Group and ad-hoc meetings, mention in the GERG newsletter and social media. The Emerging Fuels network established by GERG between research-based organisations in the USA (PRCI), Australia (Future Fuels CRC and APGA) and Europe will also act as point of information exchange.

National/international events (conferences, fairs, workshops). The partners plan to give **at least 8 presentations** at international conferences.

Dedicated workshops and training. GERG together with all partners will use project outputs to collate and prepare the training materials for the webinars and workshops and advertise these events through the appropriate channels (stakeholder networks, industrial networks related to hydrogen injection, social media). GERG together with all partners will organize at least 2 workshops during the lifetime of the project.

- M18: A General workshop directed to scientific/research/technical community will be organised halfway through the project. Hybrid, or if not possible fully virtual format. This workshop will be open to the Stakeholder Advisory Board, the Networking Group, as well as to additional external stakeholders. Potential to be organised in conjunction with CHP-JU and projects addressing complementary research. The target size of the audience is at least 60 participants.
- M36: A Closing Workshop will be organised at the end of the project and will be directed at all interested stakeholders (Advisory Board, Networking Group, scientific/technical community, regulators, decision-makers). Hybrid format, central location attractive for all stakeholders. The target size of the audience is at least 100 participants. It summarises the achievements of the project, and facilitate dissemination of the results by using the extensive network of contacts of SHIMMER partners.

Advisory board and networking group. The project will create an Advisory Board (AB) composed by the associations (see section 3.2.1) that will help expand the impact towards policy making, standardisation and technology uptake, as well as provide the consortium with valuable feedback on the interim results. Interaction of the AB will be achieved via a central website; ad-hoc meetings will be held yearly either online or at suitable events where the committee are in attendance.

Stakeholders from industry (gas operators such as TSOs and DSOs, technology manufacturers), standardisation bodies, research institutes and laboratories that have an interest in the outputs of the SHIMMER project will be invited to join a Networking Group (NG). This Group will receive dedicated information updates, as well as invitations to workshops and other events organised by the project. Targeted subgroups within the Networking Group may be developed if this improves the efficiency of information exchange (e.g., gas industry, regulators and standards bodies, etc.).

Interactions with Clean Hydrogen Partnership and Clean Hydrogen Mission : In order to contribute towards the activities of Mission Innovation 2.0 - Clean Hydrogen Mission, the results of SHIMMER will be disseminated in Clean Hydrogen Mission member countries, particularly in the US and Australia, to create research or industrial linkages with interested entities and associations for future collaboration. The cooperation with entities from Clean Hydrogen Mission member countries will be essential to jointly support the global hydrogen economy. Acknowledgment of EU funding will be part of all communication and dissemination activities through visuals and a funding statement visibly displayed on communication materials.

T5.3: Preparation of the Exploitation Plan (GERG, All partners) (M01 –12): The aim of this task is to ensure the take-up of the project's outputs by all relevant stakeholders, with a long-term perspective. All project partners will be involved in dissemination and exploitation; this will be critical to foster awareness and transfer outputs of the project.

At the beginning of the project, an exploitation plan (EP) will be created by GERG with input from all partners and updated periodically to capture the needs of the research community. The EP will build on the stakeholder groups and knowledge sharing methods identified in the Communication and Dissemination Plan. It will introduce tasks to ensure various stakeholders make concrete use of the project results.
The EP will target the scientific, technical, and business communities [and specific community for the project]. It will include expected use of project results by the partners of SHIMMER, the Advisory Board, Networking Group, and external stakeholders when identified. Other target audiences will include regulators and decision makers, at EU level and from Member States, to present them the summary of research, recommendations, and guidelines for hydrogen readiness of the European gas T&D networks. Table 4 in the impact section contains the details of SHIMMER key exploitable results, users and exploitation routes.
T5.4 Implementation of the Exploitation Strategy (GERG, All partners) (M01 – M36): Exploitation will be promoted via (non exhaustive):
i)fostering further research activities in academic, industrial and scientific contexts thanks to the open-source modelling framework developed,
ii)using the results to update/produce standards for hydrogen injection and gas quality variation in H2-NG blends,
iii)building on complementary projects to avoid work duplication in future research activities,
iv)enable access to a comprehensive database of European materials and components and H2-NG readiness, to attract more stakeholders and increase its robustness thanks to its general significance nature,
v)sharing the recommended guidelines and practices from SHIMMER with gas infrastructure operators, H_2 producers and end-users for a safe and efficient use of the existing natural gas network.
The tools provided by the European Commission will be used for exploitation purposes: Horizon Dashboard, CORDIS, Innovation Radar, Horizon Results Booster and Platform, others.
Contribution to the ongoing and future standardization developments: As a follow up to the recently completed GERG CEN H2 PNR project, overseen by a CEN TC/234 Supervisory Board, GERG will continue to interact strongly with the CEN TC and international standardisation community in prioritisation research needs for standardisation. This interaction will strengthen the link between CEN, the EU standardisation process and SHIMMER, and ensure alignment between standardisation needs and project direction and outputs.

Table 7.List of deliverables (LP=Lead Participant, DL= Dissemination Level; DD= Delivery date- Month)

No.	Deliverable name	WP	LP	Type	DL	DD
D1.1	Data Management Plan	1	SINTEF	R	CO	6
D1.2	Activity reports elaborated and delivered to the Commission	1	SINTEF	R	CO	8,20,32
D1.3	Periodic report elaborated and delivered to the Commission	1	SINTEF	R	CO	14,26
D1.4	Final reporting to the commission incl. publications and financial statements	1	SINTEF	R	CO	36
D2.1	Information fed into the database	2	BAM	DATA	PU	5
D2.2	Database prototype structure developed (Beta version)	2	BAM	DATA	PU	5
D2.3	Developed database (release version)	2	BAM	DATA	PU	10
D2.4	Scope and limitations of standards for testing and qualifications of materials and components for H2 service	2	TECNALIA	R	PU	12
D2.5	Review of all normative	2	GERG	R	PU	24
D3.1	Identification of critical material properties and component factors	3	TECNALIA	R	PU	17
D3.2	Assesing the compatiblity of the existing NG infrastructure with H2-NG blends	3	TECNALIA	R	PU	32
D3.3	Report on recommendation and guidelines for inspection of pipelines for H-NG blends	3	GSYS	R	PU	30
D3.4	List of methods for gas leakage monitoring along with their physicochemical basis and scope of application (distribution and/or transmission network) and popularity	3	INIG	R	PU	26
D3.5	Summary list of recommended methods along with an assessment of the possibility of their application to mixtures of various compositions and impact on the emission volume, as well as an indication of any gaps, both in access to methods and in the field of standardization	3	INIG	R	PU	30

D3.6	Peer-reviewed scientific publication documenting the mathematical model for subsea dispersion of H2 and gas blends	3	SINTEF	R	PU	16
D3.7	Report on the implication of subsea dispersion on overall risk assessment of severe H2 releases and future needs to enhance safety and/or accuracy in risk assessments	3	SINTEF	R	PU	16
D4.1	Report describing the defined simulated test cases, realistic scale testcase(s), and available operational models including required data set and format	4	TNO	R	PU	12
D4.2	Tool for infrastructure optimization (investments and capacity)	4	SINTEF	DATA+ R	PU	30
D4.3	Report documenting recommendations of mixing strategies and infrastructure needs	4	SINTEF	R	PU	35
D4.4	Open-source fluid-dynamic model with gas quality tracking released with handbook and tutorials	4	POLIT O	DATA + R	PU	24
D4.5	Report and guidelines on operational control strategies for injection in networks for the relevant cases and positioning of optimal monitoring points in the network	4	TNO	R	PU	35
D4.6	Report on parametric analysis and out-of-domain generalization of results; analysis and guidelines for smart network operation	4	POLIT O	R	PU	30
D4.7	Report with an overview of available gas quality measurement technologies and an evaluation on the performance, ability to integrate them in a control system and combine them with modelling tools	4	TNO	R	PU	35
D5.1	Communication and Dissemination Plan (CDP)	5	GERG	R	PU	3
D5.2	Exploitation Plan (EP)	5	GERG	R	PU	18
D5.3	General workshop directed to scientific/research/technical community	5	GERG	OTHE R	PU	18
D5.4	SHIMMER **website**	5	GERG	DEC	PU	3
D5.5	Closing public workshop	5	GERG	OTHE R	PU	36

Table 8. Milestones and their verification. DD: Due Date (Month)

#	Milestone name	WP	DD	Means of verification
MS1	Kick-off meeting	1	1	Minutes of meeting
MS2	Final meeting. Exploitation and further collaboration.	1	36	Minutes of meeting
MS3	Initial structure of the database and gaps identified	2	10	Minutes of meeting
MS4	TSO/DSO feedback (gaps and database structure)	2	16	Minutes of meeting
MS5	Identified gaps and barriers in existing qualification procedures and recommendations for future development and standardization	3	32	Report
MS6	Dataset for operational gas network simulation in place	4	12	Report
MS7	1st version H2 blending module (syst. design and capacities)	4	24	Code sharing platform
MS8	Open-source model validated	4	18	Minutes of workshop
MS9	Algorithms for the out-of-domain generalization of results selected	4	24	Presentation
MS10	Requirements - gas quality measuring technologies defined	4	24	List of requirements (validated)
MS11	Communication plan	5	2	Document
MS12	Communication toolkit	5	5	Brochure, poster, etc.
MS13	Press release	5	1	Press release send out by all the partners

As a project of novel technical objectives featuring complex and specialized technologies, SHIMMER includes inherent risks towards delivering the expected results and achieving its goals. Close collaboration and effective communication between the partners will ensure that the project progresses according to the plan. If new, unforeseen risks appear during the project, new contingency plans will be formulated and implemented. Measures to avoid risks

of technical, legal, financial, or administrative nature will be taken, together with a list of potential risks and contingency plans from the start of the project (Table 9).

Table 9.. Critical risks for implementation . Type (T) Work Package (WP), Level of Likelihood (LL): L= low, M = medium, H=high

T	Description	LL	WP	Proposed risk-mitigation measures
Adm	Delay of project deliverables and milestones	L	All	Balancing partner's participation in several WPs, allowing and ensuring that the overall picture is clear.
	Partner desynchronization and understanding of the overall project picture	L	All	Good collaboration and communication between partners during the proposal development. Regular and clear communication of tasks and interfaces.
	Partner withdrawal or underperformance of partners	L		Fast redistribution of tasks due to complementarities of the partners and background. WP leaders will monitor progress and communicate difficulties to Coordinator, who will reorganise the tasks between partners if necessary.
	Potential coronavirus (COVID-19) outbreak	M	All	Establish procedures for reschedule of affected project to have a minimal impact on the deliverables. Use for online meetings.
	Intellectual property conflicts among partners.	L	All	Discussion in the project committees of problems and propose solutions.
	Project overspending in travel or equipment	L	All	Progress meetings and workshops will coincide as much as possible. Funds will be moved from other categories if possible. Spending will be monitored closely. Participants will participate remotely as much as possible to reduce costs
Tech	Missing data for some components as well as data level gaps (e.g. 'steel pipeline from the 50'' in comparison to 'X65 pipeline')	M	WP 2	The database will include the field – gaps in which the missing data should be described or clarified. In addition, it is planned to have a 'traffic light' indicator based on the empty fields for each component, to provide the user with a hint on the data quality
	Confidential data which cannot be shared without confidentiality agreement or outside the TSO / DSO	M	WP 2	The database should indicate the existence of data and refer the user to the company and / or contact person due to confidentiality reasons. The existence of information should not be hidden but access should be controlled, not within the database.
	Information not accessible to the general public	L	WP 3	Results from certain research and industrial projects might not be accessible to the general public. SHIMMER will aim to gain access to all relevant information, e.g., through purchase of key scientific papers, and will aim to gather enough information from publicly available R&D projects, e.g. HIGGS or CEN H2 PNR, to guarantee an extensive review of the state of the art.
	Non-identification of relevant information	L	WP 3	Certain relevant projects and achievements might not be identified during the review of the state of the art. Regular communications with the rest of partners and relevant contributors will be performed to receive feedback and guarantee the relevant available data and knowledge are considered.
	Lack of data to perform an initial fault tree analysis	L	WP 3	Risks may arise from a lack of knowledge of the current state of the network, such as usual defects, and working conditions. The required data will be defined based on research of previous projects, review of the state of the art and consultation with relevant partners and collaborators.
	Equipment non-available/under repair	H	WP 3	Risks may arise from the non-availability of the testing equipment due to maintenance or repair works. Mitigation measures will be put in place to ensure a minimum interruption of the testing campaigns. As last resource, tests will be outsourced if necessary.
	Lack of data to identify relevant testing conditions	L	WP 3	In the case of missing input data to identify relevant testing conditions and key components/materials, these will be defined based on research of previous projects, review of the state of the art and consultation with relevant partners and collaborators.

	Inconclusive results from testing campaign	L	WP 3	Adaptation of the testing campaign based on the results obtained previously within the task to guarantee the relevance and utility of the testing results.
	Failure to implement multicomponent gas release model	L	WP 3	Analyze gas release as pure H2 and pure CH4 and make conservative estimates for gas blends based on weighted averaging.
	Alignment with format for data sharing (technical, operation, topological) for operational gas network modelling	L	WP 4	Input data for gas network models consist of relevant operational parameters,topology and design of the network. To use these data with models, it is needed to align with a required input format. This risk will be mitigated at the beginning of the project (Task 1) where the consortium will agree on input data format to be used in the project (this will be based on a convergence to best practice at industrial level).
	Lack of data for validation of operation models	M	WP 4	Risks may arise from the lack of experimental data that cover all modelled cases especially the ones that include non-pipe elements. Risks also include lack of experimental data of H2 blended operated network. This risk is mitigated by the fact that operational gas network models available in the consortium have been validated by each partner against experimental data or data from other software. These models also use physical equations that are able to handle H2 blends (e.g., equation of state for complex gas mixtures). To For the validation with H2 blends, the consortium include partners with field trial projects on H2 blends and further validation can be done by using these experimental data.
	Management of open-source modelling during project lifetime and end of project	M	WP 4	The open-source multi-component gas network model will be managed until the end of the project. There is the risk that after the end of the project, the model will cease to develop if no supervision is guaranteed thus reducing the overall impact of the project. To reduce this risk, during the project and the dissemination activities, the consortium will promote the open-source platform to establish further collaboration (e.g., with gas association, institutions, etc...) for the management of the platform after the end of the project.
	Need to update and re-align operational network strategies due to the highly transformative arena in the gas sector that is driven by geopolitical, technology and policy changes.	L	WP 4	Gas sector is undertaking a deep transformative change due to the matching of security and decarbonization goals. There is a great wave of technological change with some possible digital breakthrough technology that can penetrate the gas sector. Therefore, there is the risk of obsolescence of operational gas network strategies with H2 blends. This risk is mitigated by a continuous alignment with state-of-the art at technology, normative and policy level thanks also to the variety of stakeholder that belong to the consortium
	Generalization of results for operational strategies of gas networks with H2 blending	L	WP 4	Due to a large variety of possible conditions (e.g., network configuration, operational parameters, etc...), there is the risk the results for operational strategies of gas networks with H2 blending could be case-specific. This risk is mitigated by the fact that the consortium will adopt statistical tools to build scenarios, run simulation and describe results.
Com	Negative social impact	L	All	A participatory approach will be applied as part of WP to involve stakeholders
	Weak communication and dissemination to stakeholders	L	WP 5	All partners are involved in the communication WP which make this risk low. In any case, communication strategy can be restructured and re-evaluated if needed during the project. For example, communication material can be tailor made for both technical and non-technical groups.
	Lower number of visits to the website and access to e-learning material than expected	M	WP 5	Wide dissemination of the URL, good referencing will be planned to avoid this risk. All partners will use different channels to draw visitors to the website: social media, newsletters, company website, etc. The website and communication material will be promoted at all the events partners in the consortium attend. Continuous monitoring of KPIs such as engagement and followers.

Sust	Sustainable benefit of the process not high enough	M	All	Continuous monitoring of societal, environmental and economic performance and optimization the processing methods to comply with standards

3.1.1.Resources to be committed

To meet the ambitious aims of the SHIMMER project, the partners prepared a detailed work and resources plan for the 36 months project. For the project, requested grant is € 2 999 156.25; the total budget for the project would be €3 037 265 (due to own financing from GASSCO) and the personnel resources needed are 300,3 PM. The PM budget distribution is reported in Table 10

Table 10 Summary of staff effort

	WP1	WP2	WP3	WP4	WP5	Total PM
1 / SINTEF	13	0	9,5	22,9	3	**48,4**
2 / TECNALIA	2	10	43	0	2	**57**
3 / SNAM	0,5	3	3	3	0,5	**10**
4 / POLITO	2	0	0	23,5	1	**26,5**
5 / INIG	2,6	0	25	0	2,6	**30,2**
6 / TNO	3	0	0	20	2	**25**
7 / BAM	2	24	0	0	1	**27**
8 / GSYS	1	2	15	2	0,5	**20,5**
9 / GERG	0,6	4,2	0	0	7	**11,8**
10 / GASSCO*	0,8	0,3	0,3	0,5	0,1	**1,9**
11 / REDEXIS	1	4	4	4	1	**14**
12 / REDEXIS GS	1	1	1	1	1	**5**
13 / INRETE	2	3	3	3	2	**13**
14 / ENAGAS	0,5	3	3	3	0,5	**10**
Total PM	**32**	**54,5**	**106,8**	**82,9**	**24,2**	**300,3**

*GASSCO will participate as a "Beneficiary requesting zero funding" and will contribute with "own resources financing" equivalent to **€** 38 108.75 for their participation in the project in the form of personnel costs; travel and subsistence and indirect costs. Their planned effort per WP is shown in Table 10 above. We would like to make this clarification as there was not allowed in the budget table of the EU commission portal to modify the maximum finance rate to 0% and a warning was issued at the time of submission in the portal. Their distribution of costs would be as follows:

GASSCO	Cost (€)	Justification
Personnel costs	22 487	Following GASSCO's PM distribution as shown in Table 10
Travel	8 000	8 two-day trips WP1,2,3,4. 1 person
Indirect costs	7 621.75	25% of personnel costs and purchase costs
Total	**38 108.75**	

Table 11 Subcontracting costs' items

GSYS	Cost (€)	Justification
Subcontracting	40000	Costs associated with the rental of diagnostic equipment or demonstration tests of pipeline inspection technology
Total	**40000**	

Table 12 'Purchase costs' items (travel and subsistence, equipment and other goods, works and services)

GSYS	Cost (€)	Justification
Travel	11 000	Costs for 3 meetings (WP3+kick of), 2 people. 1 Conference, 2 people
Total	**11 000**	
GERG	**Cost (€)**	**Justification**
Travel	12 000	KOM and 6 GA meetings (WP1), 2 nights, 1 person. 3 dissemination meetings (WP4, WP5), 2 nights, 1 person. 2 conferences, 1 participant including fee, travel and cost of stay.

Other goods and services	8 000	Organisation of two general workshops: mid-term and end of project; website costs; communication material creation costs
Total	**20 000**	
INIG	**Cost (€)**	**Justification**
Travel	17 000	KOM and 6 GA meetings, 2 nights, 2 person.1 conference, 1 person
Equipment	16 700	System of visualization and recording of pressure and temperature WP3; methane and hydrogen detectors WP3; test samples (pipes, fittings, valves) WP3
Remaining purchase costs (<15% of pers. Costs)	9500	
Total	**43 200**	
GASSCO	**Cost (€)**	**Justification**
Travel	8 000	8 two day trips for WP 1, WP2, WP3, WP4. 1 person
Total	**8 000**	
SNAM	**Cost (€)**	**Justification**
Travel	10 000	Two days meetings for two persons (4 meetings in total)
Total	**10 000**	
REDEXIS GS	**Cost (€)**	**Justification**
Travel	7000	KOM and 6 GA meetings, 2 nights, 1 person and 1 conference in Europe 1 person
Total	**7000**	
INRETE	**Cost (€)**	**Justification**
Travel	24 000	Two days meetings for 2 persons, including 2 meetings per year. 2 conference, 1 person
Remaining purchase costs (<15% of pers. Costs)	5000	
Total	**29 000**	

3.2Capacity of participants and consortium as a whole

3.2.1.The consortium and its complementarity

The partners have been selected from the leading groups in Europe to have complementary technical capabilities, infrastructure and know-how to reach the ambitious technological goals of the project. In addition, the consortium has the capability to credibly exploit the project results both in short-term and in making plans for long-term exploitation.

The capabilities of the different partners – 1 university, 4 research institutes, 5 large industry partners – are well equilibrated to complement each other in all major activities that ensures that there is no unnecessary overlap of activities as clarified in the WP descriptions. The activities of the SHIMMER project cover the full value chain and for each major part of that chain the activity is supported by a variety of partners ranging from academic to industry participation. The area of expertise and the role of each participant in SHIMMER is summarized below.

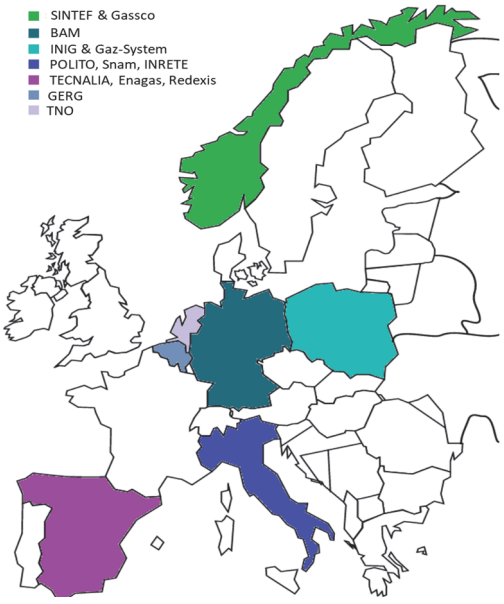


Figure 7. The SHIMMER consortium

SINTEF is a Research and Technology Organization (RTO) composed of several legal entities gathering 2200 employees in Norway, has extensive knowledge within mechanical and chemical engineering, thermodynamics, multiphase flows, mathematics, and flow modelling. They also have experience with prototype testing and the facilities to operate the process in pilot scale and using the results to design and make cost estimates for a full-scale process. SINTEF will be the project coordinator of SHIMMER, will lead WP1 and be task leader in T4.2. In addition, SINTEF will lead the subtask 3.4.4 about risk assessment of severe accidental subsea gas releases and will assist with dissemination activities.

BAM is a senior scientific and technical federal institute for materials research and testing with responsibility to the federal ministry for economic affairs and climate action (BMWK) in Germany. BAM has more than 1600 employees including technicians, engineers, students and senior scientists working in different disciplines. More than 10% of our employees are focusing on H2 related themes such as sensor development, flammability, vessels testing and certification and analysis of materials for H2 technologies. Based on the experience with participation in and the establishment of databanks about materials, BAM will lead WP2. In addition, BAM is willing to assist with the dissemination, as the institute is highly active in the relevant DIN and ISO committees

TECNALIA is the largest centre of applied research and technological development in Spain, a benchmark in Europe and a member of the Basque Research and Technology Alliance. With 1,400 experts from 30 different nationalities, we collaborate with companies and institutions to improve their competitiveness, people's quality of life and achieve sustainable growth. Its main scopes of action are: Smart Manufacturing, Digital Transformation, Energy Transition, Sustainable Mobility, Personalized Health and Urban Ecosystem, and in SHIMMER project will lead WP3 with a special focus on Task 3.1 and will collaborate in WP2 as well.

TNO: Netherlands Organisation for Applied Scientific Research, TNO, is the largest fully independent Research, Development and Consultancy organization in the Netherlands and via its Energy Transition unit, TNO develops new, applicable knowledge for innovations to accelerate the energy transition integrating geo-energy, wind, solar, biofuels and H2. TNO has developed detailed physical gas grid models, which were validated in real gas grids in the Netherlands. TNO has lead technology R&D programs for cost-effective gas quality sensors and was involved in field tests of these sensors, admixing up to 20% of H2 in natural gas. TNO is developing methods for optimizing the use of detailed models and monitoring technologies for applications like smart billing and safe injection of H2. TNO background will be used for generating methods, tools and technologies for multi-gas network management and quality tracking, including simulation, prediction, and safe management of transients, in view of widespread H2 injection in a context of European-wide context.

INIG The Oil and Gas Institute – National Research Institute is a recognized Polish research unit. INIG closely cooperates with the gas industry, including gas network operators, producers of metering devices and producers of renewable fuels, working to increase the country's energy and public security and its sustainable development. For several years, INIG has been carrying out R&D works related to the injection of H2 into the gas networks and the safety of use of the H2-NG mixtures created in this way. INIG is also the creator of its own gas mixing plant, which allows for the creation of dynamic mixtures of 7 components. Moreover, the Institute has several test benches for the calibration and testing of gas meters at low pressure, based on volumetric standards (drum and rotary gas meters) and turbine standards with traceability for air. The laboratory has been carrying out tests according to, among others, EN 12480, EN 12261, EN 1359, EN 14236, EN 12405-1. INIG participates in the development of standardization documents and new test methods. INIG will be involved in realization of Tasks 3.3.1-3.3.3 of the SHIMMER Project.

POLITO was established in 1906 from the roots of the Technical School for Engineers created in 1859. POLITO boasts over 30 years of research experience in the field of technologies and processes for H_2. Founding member in 2007 of the H2 Research Europe - HER and member of the Italian H_2 and Fuel Cells Association - H2IT, POLITO is currently coordinator of about 10 projects in the European Fuel Cells and H_2 Joint Undertaking (FCH-JU) and partner in about 30 projects on the same platform. POLITO is collaborating with several stakeholder in the field of H_2 energy and with gas TSO and DSO in key flagship projects (i.e., POLITO is the scientific advisor of the Sardinia Green H_2 Project that will start in 2023 led by the Italian DSO, Italgas spa). In the framework of the SHIMMER project POLITO, with the involvement of three different departments, will be especially involved in WP4 and tasks 4.1, 4.2 and 4.3 sharing modelling expertise and capability to identify and simulate challenges of H2 blending with natural gas.

ENA is Spain's leading NG transmission company and Technical Manager of the Spanish gas system, with 50 years' experience in the development, operation, and maintenance of gas infrastructures, including gas transmission assets, LNG regasification terminals and underground gas storage facilities. ENA is accredited as an independent TSO by the EU and carries out its activities in 8 countries. ENA is firmly committed to gas grid decarbonisation. through the injection of renewable gases, such as H2 and biomethane, as new solution in the energy transition process and in the promotion of low-carbon economy. As part of its commitment to H2, ENA participates in National and European research and innovation projects such as: GREENH2PIPES, Decarb, NewGasMet, SUN2HY and Green Hysland. Main role: ENA as will contribute with its expertise to WP 2 with relevant data on its network elements' H2 readiness, to WP 3 with its knowledge regarding challenges and technical gaps for integrity management of H2 systems, and to WP4 helping in the definition of relevant test cases and validating simulation results.

SNAM is Europe's leading operator in natural gas transport and storage, with an infrastructure enabling the energy transition. It ranks among the top ten Italian listed companies by market capitalization. SNAM manages a transmission network of approximately 41,000 km, and 13 compression stations between Italy, Austria, France, Greece and the United Kingdom, delivering annually more than 75 billion of Sm3 and holds 3.5% of the world's storage capacity. Through its participated companies, SNAM also operate gas transport infrastructure in Tunisia and Algeria (Transmed SpA) and in the United Arab Emirates (ADNOC). SNAM has more than 80 years of experience in the development and management of networks and plants, ensuring the security of supplies and promotes the energy transition in the areas crossed. SNAM successfully injected up to 10% of hydrogen in its NG network in Italy at Contursi Terme in 2019. To push the R&D hydrogen SNAM actively participate in different EU projects, such as: HyUSPRe, MultHyFuel, PROMETEO, E2P2, OLGA, H2 Valcamonica. SNAM is actively engaged in several European associations like, for example, MARCOGAZ, ENTSOG, H2IT, Hydrogen Europe such as in standardization activities through its involvement in national and European technical committees. During the project SNAM will contribute to the activities included in WP2, WP3 and WP4, providing its experience and the Operator's point of view.

GASSCO is the operator for the integrated system for transporting gas from the Norwegian continental shelf to other European countries. This role confers overall responsibility for running the infrastructure on behalf of the owners. GASSCO will contribute to the activities included in WP2, WP3 and WP4, providing its experience and the Operator's point of view.

GSYS plays a strategic role in the Polish economy. The company is responsible for natural gas transmission, operates major gas pipelines in Poland. As part of the 2015-2025 investment programme, GS is developing over 2000 km of new gas pipelines in western, southern and eastern parts of Poland. Currently, the company is implementing one of the most important infrastructural projects in Poland – the Baltic Pipe, which consists in the construction of a bidirectional offshore gas pipeline connecting Poland and Denmark as well as the expansion of the local transmission network and three gas compressor stations.

GERG aims to ensure that our gas infrastructure remains at the heart of the energy system and integral in our transition to a sustainable energy future, with a strong European network. Participation in previous/ongoing European funded projects (e.g., THyGA, CEN H2 PNR, ELEGANCy), as well as internal projects and other partnerships that bring expertise to the consortium. GERG will lead WP5 for the dissemination and exploitation activities and will lead task 2.3 on the state of the art of all the normative related and/or have impact on the H2 injection into the gas grid

REDEXIS (incl. REDEXIS GS) is an integrated energy infrastructure company that is active in the development and operation of networks for the transmission and distribution of natural gas, the distribution and sale of liquefied petroleum gas and the promotion of new gas-powered mobility infrastructure, renewable gas and H2. RED operates, at transmission level, 51 high pressure pipelines, with 148 measurement and regulation stations, additionally, RED operates more than 10.073 km of pipelines in the distribution gas network; allowing it to provide Spanish homes, businesses, and industries with access to new, more sustainable and efficient energy sources throughout 733.174 connection points. RED will contribute in all the different tasks of the project, assessing as TSO/DSO and specifically with relevant data of networks elements, technical gaps and expert knowledge thanks to its privileged position as partner in other key projects connected such as H2020 HIGGS and H2020 Green Hysland.

INRETE is part of HERA Group, which is one of Italy's largest multi-utility companies, with more than 9000 employees and a rapidly growing business plan in gas, energy and water distribution and in waste treatment. INRETE is a gas and electric Distribution System Operator. INRETE operates mainly in the Emilia-Romagna region (in the north of Italy). INRETE manages gas distribution networks in 138 municipalities and more of 1.1 million of gas customers and more than 14.000 km of pipelines (this length doesn't consider service lines). INRETE will be involved in various activities such as: contributing with its experience (i) to WP 2 with data on the relevant components of its network, including the qualitative results of the preliminary assessment of H2 readiness, (ii) to WP 3 with its knowledge of network technologies, inspection and leak detection, (iii) to WP 4 to help identify case studies and technologies consistent with DSO's management requirement.

3.2.2.Access to critical infrastructure

One of the key infrastructures in this project is a storage platform for the data produced and gathered and more important for the databank establishment and availability (cf. WP2). Within the duration of SHIMMER, it is planned to purchase a 5 TB storage place in a commercial cloud-service (e.g. Amazon web services – AWS, or Microsoft AZURE) to allow free access to the data. This cloud-service should be available for another two years after the project ends. Following this period, the produced data will be stored internally on BAM computers (as BAM is the leader of WP2) for an additional period of 10 years, BAM is obliged as a federal institute to store and backup the data for at least 10 years. Contact info to obtain the data upon request within this period will be provided in the project website.

The total time period is 15 years. The assumption is that after 15 years the relevance of the information has expired thanks to the utilization of the gas infrastructure for H2 (the goal within European Green Deal of zero net emissions by 2050, with an interim target of 55% emission reduction by 2030)

3.2.3.Industrial involvement

The involvement of the industrial partners is crucial for the success of SHIMMER. The geographical diversity of TSOs (ENA, GSYS, GASSCO, SNAM) and DSOs (REDEXIS, REDEXIS GS, INRETE) participating in SHIMMER enables the option to obtain the climate influence on the components, network management and operational strategies and constrains as well as broad production technology spectrum. In addition, the industrial constellation will pursue to generalize common challenges, protocols, technology use and strategies that can be extrapolated to a European level.

The Advisory Board (AB) has committed to act as industrial advisor for the SHIMMER consortium and to expand the impact towards interoperablity, policy making, standardization and technology uptake across Europe. SHIMMER AB includes different European and international associations across the gas value chain and some of them have an active participation on policy-making. The following associations delivered a letter and emails of support to participate as an AB member of SHIMMER:

- **Marcogaz:** is a non-profit international association and represents the European gas industry on all technical aspects of the gas system's full value chain. It represents the interests of national and European gas associations as well as the individual gas companies' members spread across Europe. The association monitors and advises on European technical regulation, standardisation and certification concerning sustainability, safety and integrity aspects [53]of gas systems and energy efficiency.[54]
- **ENTSOG:** The European network of transmission system operators for gas. Its role is " is to facilitate and enhance cooperation between national gas transmission system operators (TSOs) across Europe, to ensure the development of a pan-European transmission system in line with European Union energy and climate goals" [55]
- **Farecogaz**: "European Association of the manufacturers dealing with the gas metering chain, gas pressure regulators with associated safety devices and relevant stations. The association works with the representation towards EU authorities, relevant organisations, standardisation bodies and other stakeholders Cooperation with and development of European working groups on relevant standardisation issues"[56]
- **EURAMET:** European association of National Metrology institutes. Their mission "is to develop and disseminate an integrated, cost effective and internationally competitive measurement infrastructure for Europe". " EURAMET has amongst its responsibilities the provision of support for policy-making particularly where measurement has an important role in setting and/or implementing the policy. In many European Directives

[53] https://ehi.eu/about-ehi/
[54] https://www.marcogaz.org/about/about-us/
[55] https://www.entsog.eu/about-entsog
[56] https://www.farecogaz.eu/

measurements are a basic building block. EURAMET members actively support the implementation of many EC Directives through measurement and monitoring work."[57]

•**EHI:** European Heating Industry will represent the end-user perspective. They bring "together companies that are leaders in the production of efficient heating systems" including for example technology providers for boilers, thermal systems, heat pumps and fuel cells

•**CIG**: *Comitato Italiano Gas* is one of the Italian bodies federated to the Italian national unification body (UNI). This body has the task of drawing up national technical standards in the fuel gas sector which are then published by UNI.[58]

•**H2IT:** The Italian Hydrogen and Fuel cell association " H2IT aims to create the political and regulatory conditions for the development of a hydrogen application market in Italy, as well as to promote its use through public and private participation"[59]

•**GTI** The Gas Technology Institute is an American non-profit research and development organization which develops, demonstrates, and licenses new energy technologies for private and public clients, with a particular focus on the natural gas industry. One of their focus areas is Hydrogen and blending on natural gas infrastructure [60]. GTI would be an AB member providing a view on international R&D

SHIMMER will also develop a **networking group** which will mainly consist of European and international industrial participants representing different stakeholders outside the project consortium such as associations, TSOs, DSOs, end-users, universities and relevant project representatives. This group is expected to be dynamic and to grow during the project period. By the time of the proposal submission, SHIMMER gathered letters and emails of support from the following stakeholders:

- **TSOs:** National Grid (UK), GRTGaz (France), Energinet (Denmark), GNI (Ireland), Gas Connect Austria (Austria), Desfa (Greece).
- **DSOs:** GRDF (France), GRTGaz (France), Nortegas (Spain), Stedin (The Netherlands).
- **Relevant Projects (not including all within the consortium):** H2020 HIGGS, FutureGrid (UK), HyDelta (The Netherlands), HyBlend (USA through NREL), Metrology for decarbonising the gas grid "Decarb", HySafe (UK).
- **Research organizations and Universities:** Fundacion Hidrógeno Aragon (Spain), NREL (USA), Ulster University (UK).
- **Other Stakeholders**: ArcelorMittal (Spain), Kiwa (The Netherlands)

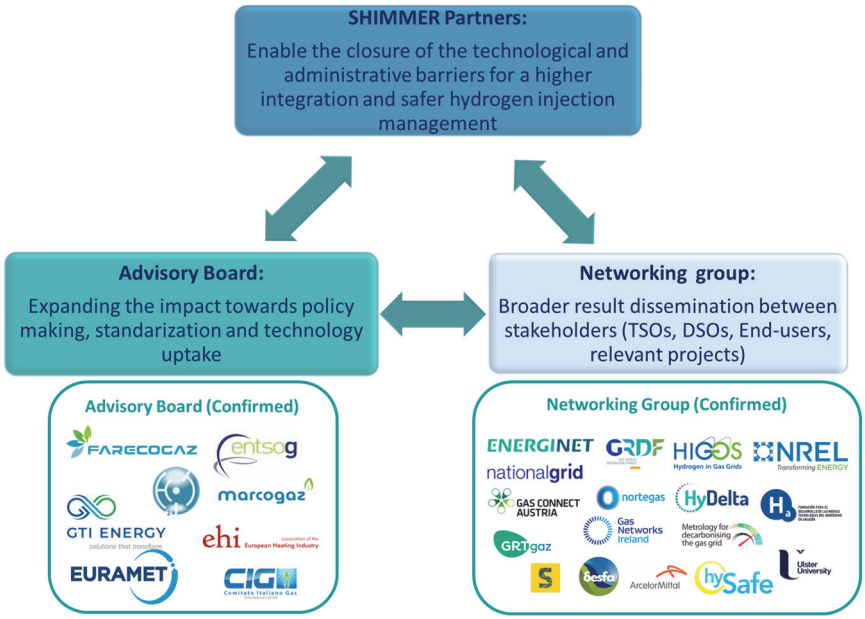
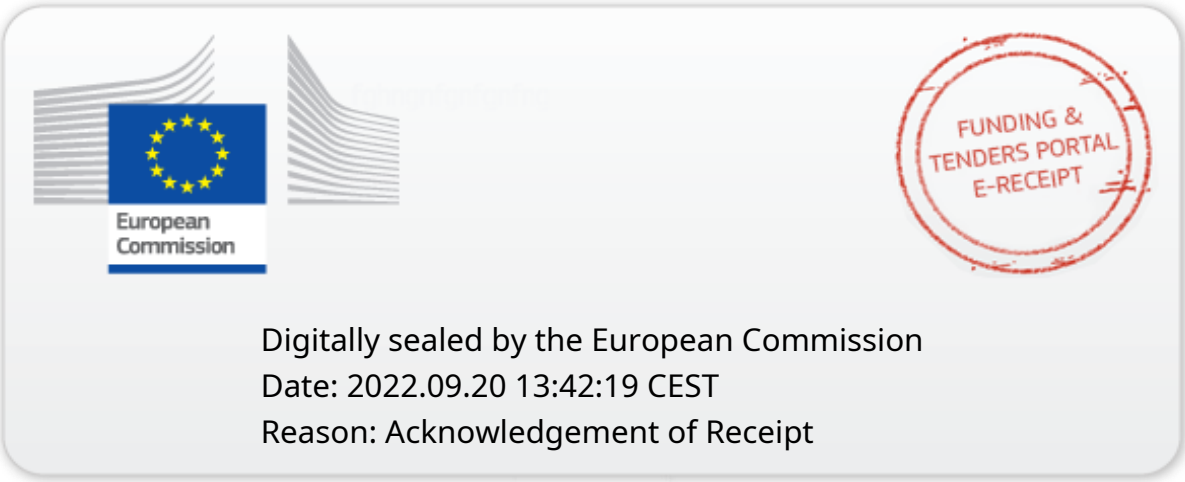


Figure 8. Stakeholders involved in SHIMMER

3.2.4.**Other Countries:** There are no other countries involved in the SHIMMER project.

[57] https://www.euramet.org/about-euramet
[58] https://www.cig.it/
[59] https://www.h2it.it/
[60] https://www.gti.energy/hydrogen-technology-center/



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