



Pre-normative REsearch for Safe use of Liquid Hydrogen (PRESLHY)

Project Deliverable

Plan for the Dissemination, Communication and Exploitation - 1st Update

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Approvals			
	Names	Organisation	Date
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Acknowledgments

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Publishable summary

The present deliverable is an update of the dissemination, communication and exploitation plan prepared in after the first 6 months of the project. It presents the strategy for dissemination, communication and exploitation of the knowledge, data and results developed during PRESLHY project. The plan identifies the activities and channels deemed to be the most effective for a profuse dissemination of the project key outputs to the relevant target groups. The timing of the various activities is established. The update aims at monitoring the dissemination activities progress and achievements, and to include new dissemination actions when established. The plan will be updated again at the end of the project in month 36, December 2020.

Keywords

Liquid hydrogen, dissemination, exploitation, dissemination channels, target groups, workshops, events, conferences, website.

Abbreviations

BRHS	Biennial Report Hydrogen Safety
CFD	Computational Fluid Dynamics
FAIR	Findable Accessible Interoperable and Reusable
FCH	Fuel Cells and Hydrogen
GH2	Gaseous Hydrogen
LH2	Liquefied Hydrogen
ORDP	Open Research Data Pilot
PDCE	Plan for the Dissemination, Communication and Exploitation
PIRT	Phenomena Identification and Ranking Table
PNR	Pre-Normative Research
RCS	Regulation, Codes and Standards
SCG	Strategy Coordination Group
SDO	Standard Development Organisation

Definitions

Dissemination: process of spreading and making available the results and deliverables of the project to stakeholders and public.

Exploitation: process of making use and benefiting from the produced resources.

White paper: authoritative guide or report explaining the theory and benefits of a technology, product or policy.

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1. Introduction and Scope

The plan for dissemination, communication and exploitation clarifies how the project results will be shared with stakeholders and how they will be employed. The present deliverable is the 1st update of the plan prepared in month 6, June 2018 (D6.6). Report D6.6 was extended to include a description of the dissemination activities actuated up to month 18 (M18) and a refinement of the plan for the future activities. A brief history of the amendments done to D6.6 is given in paragraph 1.3.

1.1 Project overview

PRESLHY is an EU FCH 2 JU funded research and innovation activity (Project ID 779613). The action addresses pre-normative work for the safe use of liquid (cryogenic) hydrogen (LH2) as an energy carrier.

The project started from the identification of the safety critical areas where knowledge gaps are present and specific standards are needed. The mission is to close the identified knowledge gaps and technological bottlenecks through the development and validation of models and engineering correlations aimed to underpin the design of efficient prevention and mitigation concepts, remove the over-conservative requirements for innovative solutions and provide reliable and consistent hazard distance and zones rules for LH2 based technologies, achieving a cost-efficient and inherently safer design.

The derived models and correlations shall be either directly implemented or at least referred to existing or new international performance-based Regulations, Codes and Standards (RCS).

1.2 Deliverable objectives

The developed dissemination, communication and exploitation plan addresses the following aspects:

- Identification of the area of expected impact.
- Description of the project products that will be generated and disseminated.
- Identification of the target groups of stakeholders that will make use of and benefit from the project results and products.
- Description of the dissemination methods, tools and channels that will be used to make available the project outputs and maximise the stakeholder engagement.
- Outline of the plan timing.
- Definition of a communication strategy to contact the potential users.
- Management of project outputs after the formal completion of the project.

1.3 History of the updates to D6.6

The “Plan for the Dissemination, Communication and Exploitation” reported in D6.6 was herein updated and extended. A list of the sections and associated activities mainly involved by the modifications is given below:

- 2.1 Dissemination key products: the descriptions of the products were modified to include the progress in the development of the project outputs, such as preparation of the table of contents, distribution of relevant templates, etc.
- 2.3 Dissemination channels: a scheme summarising the dissemination channels employed to convey PRESLHY outcomes to the different audiences was introduced in Table 1.

- 2.3.1 Website: a list of the reports developed in PRESLHY and currently available to the public was added to the description of the website.
- 2.3.2 Flyer: the project flyer anticipated in D6.6 plan is herein described.
- 2.3.3 Newsletter: D6.6 anticipated the distribution of the project newsletter. D6.7 describes the newsletter, the plan for its release and presents the 1st issue.
- 2.3.5 Workshops: this section was updated to include the description of the completed workshops, including activities not initially planned in D6.6, such as the PRESLHY-SH2IFT LH₂ safety workshop.
- 2.3.6 Conferences: this section was updated to include the conferences where the consortium members presented the results achieved with PRESLHY research either under the form of oral presentations, conference papers or posters. The plan for future conferences, such as ICHS 2019, was refined and detailed.
- 2.3.7 International meetings and events: this section was expanded to include description of the meetings and events where PRESLHY was represented and/or presented, and it reports a more detailed plan on the participation to future meetings.
- 2.3.8 Scientific publications: this section was expanded to list the scientific publications associated to PRESLHY project.
- 2.4 Time plan and responsibility: Table 5 was updated to indicate the completed activities.
- 3 Communication activities: this chapter was updated to include an update on the past project virtual and face to face meeting as part of the internal communication.

2 Dissemination and exploitation

The main impact of the project will be achieved by the implementation and exploitation of the pre-normative research outcomes, i.e. advancement of knowledge beyond the state-of-the-art, into performance-based standards. The latter in turn will be the main reference for legislative regulations, as suggested by the “modern approach” shown in Figure 1. Therefore, the core of the dissemination and exploitation activities will consist of the extraction and translation of the project scientific findings into suitable information and tools for international SDOs, regulatory bodies and industry, who represent a large part of the targeted audience. To assure a strong interaction, complementarities and synergies between the project outcomes and SDOs and industry needs, a number of key representatives of these two categories are members of the project Advisory Board.

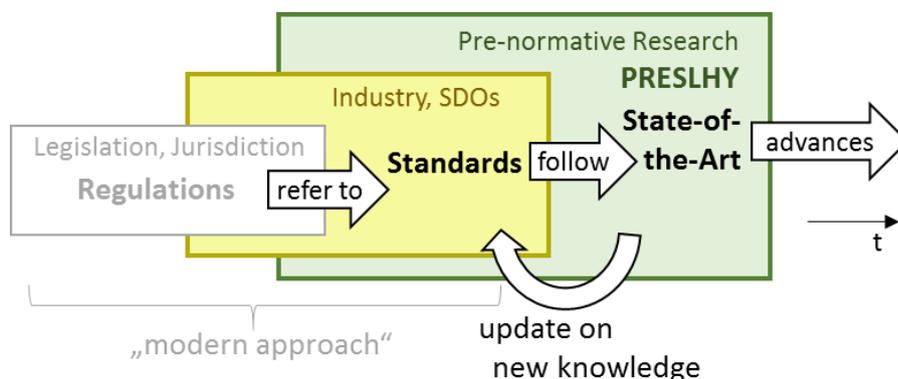


Figure 1. Impact areas and connections among PRESLHY pre-normative research, standardisation and regulation (impact areas of PRESLHY in green and yellow).

2.1 Dissemination key products

In this section, the main outputs produced by the project are presented and discussed. Along with the description of each key product, attention is paid to the development process, the potential user and the employed dissemination channel. The present plan includes timing and frequency of the identified activities. Figure 2 shows a concise scheme of the PRESLHY dissemination and exploitation activities here described.

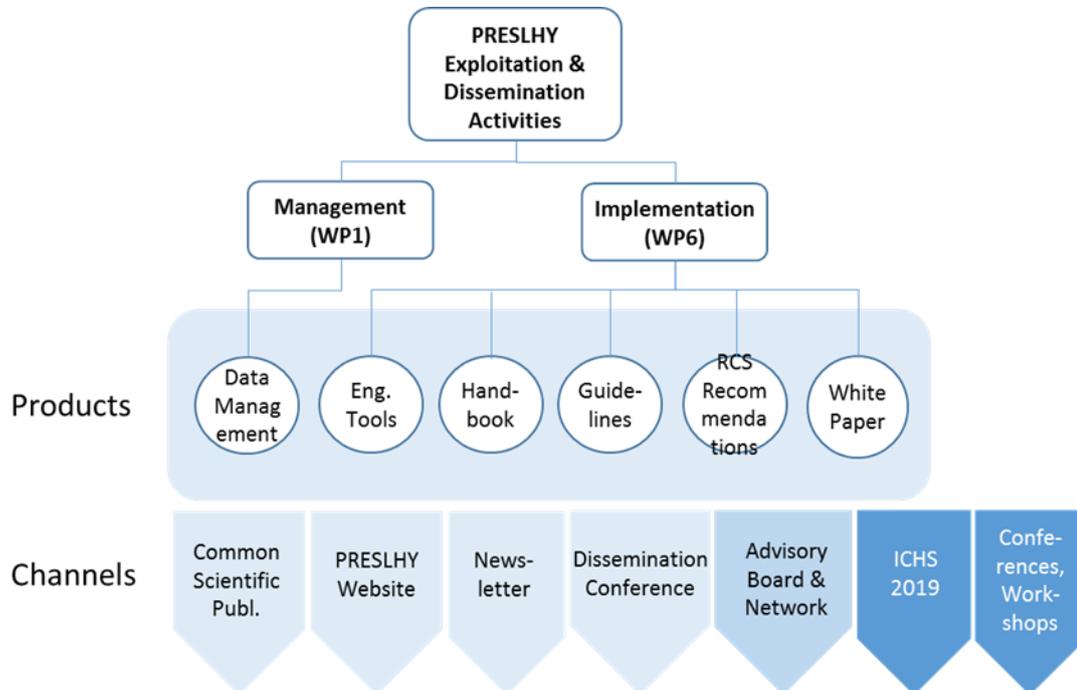


Figure 2. PRESLHY's dissemination products and channels.

2.1.1 Data Management and Common Scientific Publications (leader KIT)

The project will generate new unique experimental data, which will need to be preserved. It is important to assure the data storage in digital format and open access to the research community or any interested party for review, verification and validation of analytical and numerical models, etc. PRESLHY participates in the Pilot on Open Research Data in Horizon 2020. Data will fulfil the Horizon 2020 requirements of being findable, accessible, interoperable and reusable (FAIR). All the details and strategies to achieve these goals are given in the Data Management Plan (see WP1, deliverable D1.3 “Data Management Plan 1st Version”). Requirements, recommendations and further general aspects of the Data Management Plan were discussed during the project kick-off meeting (20th April 2018, Karlsruhe). The template for the metafile data storage was developed by KIT and presented at PRESLHY 2nd project meeting (16th October 2018, Paris-Saclay). It is anticipated that the following dissemination channels may be employed:

- SUSANA project database is currently under consideration for storage and data open access for verification and validation strategies for CFD in hydrogen and risk assessment.
- RADAR project infrastructure and services will be used for the long term and more concise data storage (<https://www.radar-service.eu/>).
- Publication of the research results in peer reviewed journals, such as the International Journal of Hydrogen Energy, key international conferences, such as

the International Conference on Hydrogen Safety, presentations at workshops, exhibitions, schools, etc.

2.1.2 Engineering correlations and tools (leader UU)

The experimental data generated throughout the project duration will be employed for development and validation of analytical models, and to generate engineering correlations for calculation of hazard distances and parameters.

The project partners will describe in detail the developed correlations and tools according to a unified template on quarterly basis as a tool is available. The template was developed by UU and distributed in month 11 (M11). A list of the engineering correlations and tools to be developed was prepared and regularly updated. The current list includes 21 tools. A 1st version of detailed description of novel safety engineering tools for LH2 will be prepared in month 24 (M24), whereas the final version will be ready in month 35 (M35).

The main dissemination channels that will be employed within the project are:

- Implementation into existing and/or emerging integrated platforms for hazards and risks assessment, e.g. European e-Laboratory (NET-Tools project), HyRAM tool (Sandia National Laboratory, USA) and similar Canadian tool (UTRQ), etc. The tools will be freely accessible online to any stakeholders performing safety engineering design, education and training.
- Project dissemination conference: the novel engineering tools for LH2 will be introduced to stakeholders at the dissemination conference envisaged in month M36, i.e. at the end of the project.
- Transfer to higher education courses, e.g. PgCert in Professional Development (Hydrogen Safety) at Ulster University, etc.
- Transfer to SDOs the recommendations for RCS, including engineering correlations.
- Transfer to stakeholders the guidelines through publishing them on the project website, including engineering correlations.

2.1.3 Handbook of Hydrogen Safety: chapter on LH2 safety (leader HySafe)

The knowledge gathered and generated during PRESLHY will be organised and disseminated in the form of a chapter on safety of liquid and cryo-compressed hydrogen, which will be integrated into the Handbook of Hydrogen Safety. The Handbook, known as well as Biennial Report on Hydrogen Safety (BRHS), was one of the leading outputs of the European Network of Excellence (NoE HySafe) “Safety of hydrogen as an energy carrier” (2004-2009). The aim of the Handbook is to provide technical insights into the state-of-the-art knowledge on hydrogen safety, ranging from the phenomena relevant to accidents up to practical information, such as hazard and risk control measures or emergency response plans. The Handbook has been developed and maintained by the International Association for Hydrogen Safety (IA HySafe), partner of the consortium indicated as leader of the chapter development.

The goal of the chapter is “to provide up-to-date knowledge and thus to underpin the stakeholders’ understanding of LH2 safety, including prevention and mitigation techniques” (Grant Agreement). The chapter will include the review of the state-of-the-art, strategies and regulations conducted in WP2 (see D2.1, D2.2, D2.3). The new knowledge generated in work packages WP3, WP4 and WP5 will be the core of the chapter and will include description of hazards, key experimental results, description of the developed

models and engineering correlations related to LH₂ releases and dispersion, ignition, jet fires, explosions, etc.

The table of contents was prepared and agreed in month M12 (Milestone MS6.1). The preparation involved experts on LH₂ safety from HySafe network. It should be noted also here, that the currently agreed structure of the handbook does fit to the idea of having a specific, singular chapter on LH₂. Instead the actual content of the liquid hydrogen chapter will be distributed in the main chapters of the handbook. Therefore, the “Chapter of LH₂ Safety” will be realised rather as a virtual chapter with providing links to the actual content.

The project meetings will comprise the progress of the chapter development as part of standing agenda. Deliverable D6.1 “Handbook of hydrogen safety: chapter on LH₂ safety” will be completed in month M34. The chapter will be disseminated through different channels to various potential users, including but being not limited to:

- Project dissemination conference: the chapter will be introduced to stakeholders at the dissemination conference envisaged in M36.
- Online websites: deliverable D6.1 will be available as public report on the project website (www.preslhy.eu). The contents of the handbook can be implemented as a public Wiki on the BRHS website (<http://www.hysafe.net/wiki/BRHS/BRHS>). The advantages of this channel are multiple. Firstly, it provides an open and user-friendly resource, which can be widely distributed and used as a reference document by practicing engineers and as a compact handbook by new comers in hydrogen safety research and education. Furthermore, the implementation as a public Wiki makes the handbook a dynamic resource, meaning that it can be opened to new contributors, further developments and updates even beyond the project formal duration.
- Educational and training activities, such as higher education in academia, industry short courses, schools, etc.
- Activities of IA HySafe, European Hydrogen Safety Panel, RCS Strategy Coordination Group, ISO TC197, CEN/CLC/TC6, UN GTR#13 IWG SGS, etc. They might use the Handbook in their reviews of safety plans, SDO activities planning, etc.

2.1.4 Guidelines for safe design and operation of LH₂ infrastructure (leader AL)

The guidelines underpin the inherently safer design and operation of LH₂ systems and infrastructure, addressing the areas where specific RCS have not been established yet or where they are not suitable for use in public space. The innovative strategies and engineering solutions developed during the project will be included in the guidelines following a structure and format resembling established standards, such as the ISO/TR 15916:2015 “Basic considerations for the safety of hydrogen systems”, etc. The preparation and development of guidelines is led by AL. Active contribution of relevant SDOs is expected either through its members in the PRESLHY consortium or through Advisory Board members. The table of content was prepared by AL and UU, and it was agreed in M14 (milestone MS6.2). The project meetings will include the progress of the guidelines in the standing agenda. Completion of guidelines is planned in M35. Several dissemination channels will be employed, among them:

- PRESLHY website: the deliverable D6.2 “Guidelines for safe design and operation of LH₂ infrastructure” will be available on the project website as public report.

- Project dissemination conference: the guidelines will be presented to stakeholders at the dissemination conference envisaged in M36.
- Annual joint meetings of the consortium with SDOs and the Advisory Board.

The stakeholders benefiting by the guidelines development will be primarily engineers from hydrogen industry involved in design, construction, operation and maintenance of LH2 systems and infrastructure. However, the guidelines will be publicly available on the project website, extending the range of possible users.

2.1.5 Recommendations for RCS (leader AL)

The relevant part of guidelines developed at the previous point, including the engineering correlations, will be extracted and expressed in concise language for use by SDOs (recommendations to relevant RCS). The preparation of recommendations for RCS is led by AL. The content will be shaped by the partners participating in the work of regulators and SDOs and in consultation with the Advisory Board. The draft of recommendations will be prepared in M28, whereas the Deliverable D6.3 “Recommendations for RCS” will be completed in M35. The dissemination channels will include:

- Project dissemination conference: the recommendation for RCS will be presented to stakeholders at the dissemination conference envisaged in M36.
- PRESLHY website: the deliverable D6.3 “Recommendations for RCS” will be available on the project website as public report.
- Meetings with SDOs: the recommendations will be presented and promoted at the meetings of relevant SDOs, such as CEN/CLC Technical Committee 6 “Hydrogen in energy systems”, ISO Technical Committee 197 “Hydrogen technologies”, etc.

2.1.6 White Paper on the use of LH2 (leader KIT)

The White Paper has the aim to analyse and report the role and potential benefits of LH2 systems and infrastructure deployment in the fuel cell and hydrogen sector, particularly with regards to the mobility sector. The report will address some aspects of general economics and safety of LH2, paying attention to comparisons with CGH2 systems to highlight LH2 advantages where relevant. The White Paper is considered as one of the major dissemination tools to impact policy making process and influence the development and spread of FCH technology employing liquid or cryo-compressed hydrogen. The table of content of the White Paper was prepared by UU and KIT in M18 (milestone MS6.3). The development process of the White Paper will be led by KIT and the corresponding deliverable (D6.4) will be ready in M35. The target groups of the White Paper are multiple and varied, as well as the dissemination channels:

- Project dissemination conference: the White Paper will be presented to stakeholders at the dissemination conference envisaged in M36.
- PRESLHY website: the deliverable D6.4 “White Paper” will be available on the project website as public report.
- Printed and electronic report: paper and electronic copies of the White Paper will be distributed to a wide range of stakeholders, including decision makers and politicians, e.g. through conferences, exhibitions, etc.

2.2 Target groups

Dissemination and exploitation of the project outcomes will address multiple audiences, including governmental institutions, Hydrogen Europe (HE) and Hydrogen Europe Research (HER) members, relevant academia and research organisations, the public, etc. The description of the potential users includes the communication and dissemination channels deemed most efficient for the respective impact and interaction. The targeted audience includes but is not limited to:

- Project partners: a continuous and intense internal communication will be maintained about the project progress and activities to assure that each partner is updated on the project status and details of findings. The primary channels will be email communications, project meetings and teleconferences, project website, etc.
- The project Advisory Board is constantly updated on the project progress and results. Continuous consultation with the Advisory Board assures the alignment of the project aims to industry and SDOs views and needs, along with the achievement of the maximum impact on research community. Members of the advisory board are invited to project meetings and stakeholder's workshops to exchange knowledge and expertise.
- Academia: PRESLHY project will significantly contribute to the production of unique experimental data, analytical and numerical models, etc. Dissemination of the generated knowledge to the scientific community is planned through publications in peer-reviewed journals, publications in the proceedings and presentations at international conferences such as International Conference on Hydrogen Energy (ICHS), International Seminar on Fire and Explosion Hazards (ISFEH), International Symposium on Hazards, Prevention and Mitigation of Industrial Explosions (ISHPMIE) etc., workshops, poster displays at seminars and exhibitions, etc.
- European institutions, FCH JU, public authorities at a national and local level which include politicians, decision makers, etc. Main dissemination channels for this audience will be the project website and produced deliverables, the White Paper, etc.
- Relevant SDOs and industry will be the primary user of the guidelines and recommendations for RCS developed in WP6. The advisory board includes members of SDOs and industry, assuring a continuous interaction between the two bodies and the project partners.
- Education and training institutions.
- Public engagement is crucial to promote the public acceptance of LH2 and/or cryo-compressed FCH technologies. This audience does not generally need a detailed knowledge of the state-of-the-art, project progression and outputs. Public will be mainly addressed through the project website, distribution of flyers and newsletters, open access to project publications, chapter on LH2 safety for the Handbook, etc.
-

2.3 Dissemination channels

Several methods and channels are used to disseminate the project outputs, according to the targeted audience. First, the project visual identity was defined through the project logo shown in Figure 3.



Figure 3. Project logo.

As a part of the project visual identity definition, a template for power point presentations and deliverables was developed, to assure a uniform and recognizable reporting of the project outputs (see Figure 4).



Figure 4. Presentation template.

Table 1 gathers the dissemination tools that will be employed throughout the project duration and the audience engaged through each of the dissemination tools. All the dissemination channels are described in detail in the present section.

Table 1. Target audiences and dissemination channels.

Dissemination channel	Advisory Board	Academia	European institutions	SDOs & industry	Education & training institutions	Wider public
Website	X	X	X	X	X	X
Flyer	X	X	X	X	X	X
Newsletter	X	X	X	X	X	X
Workshops	X	X		X	X	
Conferences		X			X	
Final project conference	X	X	X	X		
International schools		X			X	X
IEA Hydrogen Task 37 meetings		X		X	X	
ISO/TC 197 meetings				X		
RCS SCG meeting		X	X	X		
European Hydrogen Safety Panel		X	X			
Scientific publications		X			X	
White paper	X		X	X		X

2.3.1 Project website

The project website is the main platform for public dissemination of the project’s progress, deliverables, events, etc. The website is used as well as a tool for the project management and reporting among the partners of the consortium. The set-up of the website included the “*development of the structure and design of document repositories, database repositories and upload areas, coding and testing of the prototypes and of the core components, including emailing, user management etc. Setup of internally accessible prototypical website composed of internal and external domain, testing and finally going public*” (Grant Agreement). The promotional material developed during the project, like a project flyer and a newsletter, will be made available through the website too. The website was developed and established by KIT in M3. The website follows a structure as below:

“**Home(page)**” provides an overview of the project, including its framework and mission. The homepage is shown in Figure 5 and it gives access to the other sections of the website via the menu in the header.

The right column serves as “**News**” section, where the updates and information about the project work and achievements, events and meetings involving the project, etc. are regularly published.

“**Home/Project overview**” addresses a more detailed description of the project aim and objectives.

“**Home/Management structure**” shows the structure of the project assembly, presenting the main interactions among the coordination committee, work packages and their leaders, and the advisory board.

“**Consortium**” presents the list of partners forming the project consortium and “**Consortium/Advisory Board**” lists all members of the Advisory Board.

“**Work packages**” introduces the six work packages and corresponding objectives.

“**Deliverables**” contains the list of the deliverables and milestones. The reports with a public dissemination level are available in this section. Nine deliverables are currently published and available to the public:

- D1.2 Website including internal communication;
- D2.1 RCS Analysis;
- D2.2 State of the Art report;
- D2.3 LH2 installation description;
- D2.4 LH2 research priorities workshop;
- D2.5 Phenomena identification and ranking table analysis;
- D2.6 Refined work programme;
- D1.3 Data management plan;
- D6.6 Plan for dissemination, communication and exploitation.

“**Events**” section has a twofold function: firstly, it announces the upcoming events, including project meetings, workshops, etc., to both project partners and interested stakeholders. Secondly, it functions as database of the information and resources related to concluded events, such as the material from workshops and project meetings.

“**Resources**” gives access to:

- database of online resources, bibliography and material related to safety of cryo-compressed and liquid hydrogen;
- general project related documents, like proposal application documents, report and presentation templates for dissemination;
- Regulation Codes and Standards of cryo-compressed and liquid hydrogen systems, including both international and national standards, codes and guidelines;
- gallery of interesting video material on liquid hydrogen safety tests and hydrogen technology.

“**Glossary**” presents a list of definitions of the keywords and terms associated to PRESLHY project.

A protected area was created with access granted only to consortium partners. This section is accessible via the “**Login**” menu entry point and allows to share documents and information which are not aimed to a public dissemination or are in preparation, such as for deliverables drafts, etc.

All the website contents are periodically updated as the project progresses. Details on the project website are given in the dedicated deliverable D1.2 “Project website including internal communication tools”.



Figure 5. Homepage of project website www.preslhy.eu.

2.3.2 Flyer

The promotional material includes a project flyer that was developed in November 2018. Figure 6 shows the contents of the flyer, which presents the consortium and stakeholders advisory board, and provides a description of the project motivation, objectives, structure and key outputs of the pre-normative research. Printed copies of the brochure were distributed at several dissemination events, such as the Fuel Cell Hydrogen Joint Undertaking (FCH JU) Review days (16-17 November 2018, Brussels, Belgium), International School Progress on Hydrogen Safety (11-15 March 2019, Belfast, United Kingdom), etc. All project partners have available a set of hard copies and will be involved in their distribution in relevant dissemination events. A version in electronic format was circulated to relevant stakeholders. The digital version of the flyer is available for download on the project website at the link: <https://preslhy.eu/resources/project-related-documents/>.

CONSORTIUM

The PRESLHY network is an international and interdisciplinary group of experts from academic, research and industrial institutions:

- Karlsruhe Institute of Technology, Germany (co-ordinator)
- Air Liquide, France
- Health & Safety Laboratory, UK
- National Center for Scientific Research "Demokritos", Greece
- International Association for Hydrogen Safety, Belgium
- INERIS, France
- Pro-Science GmbH, Germany
- Ulster University, UK
- The University of Warwick, UK

ADVISORY BOARD

The PRESLHY network is consolidated by a wide range of experts and representatives of industry, research and SDOs worldwide:

- **USA:** Air Products, Lawrence Livermore National Laboratory, Sandia National Laboratories
- **Germany:** German Aerospace Centre DLR, ET Energie Technologie, Dresden University, Forschungszentrum Jülich
- **France:** ArianeGroup, CEA
- **Netherlands:** Joint Research Centre JRC
- **Norway:** GexCon, Lloyds
- **Canada:** AVT
- **UK:** Shell
- **Japan:** Kawasaki Heavy Industries

INFORMATION

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To find more information about our research activities, please visit:

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PRESLHY
 PRE-NORMATIVE RESEARCH FOR
SAFE USE OF LIQUID HYDROGEN
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FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING

MOTIVATION

Liquid hydrogen (LH₂) provides larger density and efficiency gains over gaseous storage and transport. The hazards and risks associated with LH₂ are different from the relatively well-known compressed gaseous hydrogen. Moreover, specific and extensive standards and regulations are needed.

The PRESLHY project addresses the pre-normative research for a safe use of cryogenic and liquid hydrogen as an energy carrier.

OBJECTIVES

- Identify the critical safety areas where knowledge gaps are present and specific standards are needed
- Carry out an experimental campaign addressing LH₂ relevant phenomena
- Develop and validate suitable models and engineering correlations
- Underpin a cost-efficient and inherently safer design for LH₂ infrastructure
- Improve techniques for determining hazard zones for LH₂ technologies, where they are currently inconsistent or over-conservative
- Support international Standard Developing Organisations in the update of existing standards and development of new ones

RESEARCH ROADMAP

The research is built around three pillars:

WPI - MANAGEMENT

WP2 - TECHNICAL STRATEGY & EVALUATION

WP3 - RELEASE & MIXING WP4 - IGNITION WP5 - COMBUSTION

WP6 - TECHNICAL IMPLEMENTATION

WP3 - RELEASE & MIXING

- Two-phase flow and dispersion
- Impinging and/or wall attached jets
- LH₂ pool formation and evolution
- Wind effect on large-scale LH₂ releases
- Release in congested/confined spaces

WP4 - IGNITION

- Electrostatic charge in cold jet/plume
- LFL, UFL and MIE for cryogenic H₂
- H₂/condensed O₂ phase mixtures
- LH₂ pool ignition

WP5 - COMBUSTION

- Cryogenic and LH₂ jet fires
- LH₂ pool fires
- Flame propagation and DDT
- BLEVE
- Combustion in congested or confined areas

Each research pillar is analysed through:

- Analytical and theoretical studies
- Numerical modelling
- Experimental campaigns

MAIN OUTPUTS

- Advancement of knowledge beyond the state-of-the-art
- Generation of unique experimental data accessible through RADAR online database and scientific publications
- Compilation of a chapter on LH₂ safety for the Handbook of Hydrogen Safety
- Guidelines for a safe design and operation of LH₂ infrastructure
- Recommendations for Regulations, Codes and Standards (RCS) based on the new knowledge generated
- Validated engineering correlations and tools
- White paper on the safe use of LH₂
- Dissemination conference

PRESLHY RCS VISION

LEGISLATION JURISDICTION INDUSTRY, SDON PRE-NORMATIVE RESEARCH

REGULATIONS STANDARDS STATE-OF-THE-ART

PROPOSING APPROACH FOLLOW UPDATE ON NEW KNOWLEDGE

**PRE-NORMATIVE RESEARCH FOR
SAFE USE OF LIQUID HYDROGEN**

Figure 6. Project flyer.

2.3.3 Newsletter

A periodic newsletter is prepared and released by PRESLHY consortium to raise awareness of the project progress and outcomes among relevant target groups and stakeholders. The newsletter aims at providing insights into the technical implementation and research activities of the project, including the experimental campaign, numerical and analytical studies and at highlighting the achieved results. The contents are concise to facilitate an easy and smooth reading of the edition, and the reader is provided with the proper links for more details. Finally, the newsletter advertises the events related to the projects, both past and upcoming.

The plan for the release of the project newsletter is given in Table 2. The plan includes 4 issues released on a 6 months basis. The table reports the timeline and leaders of each edition, along with a draft of the table of contents and contributors per section, indicated in brackets. All partners are involved in the preparation of the newsletter, according to the activities conducted during the reporting period.

The newsletter is circulated in electronic format. It is distributed to the contacts of HySafe and other partners of the project, widely spreading the project news to several target groups: professionals, hydrogen safety experts, academia, stakeholders, etc. The 1st issue was prepared by UU and released in June 2019. Being the first edition, it included a presentation of the project objectives along with the key results and progresses achieved up to date. The 1st issue is reported in Appendix 1.

Table 2. Newsletter plan.

N.	Release month, leader and draft of table of contents
1	<p>Release M18, leading partner UU</p> <ol style="list-style-type: none"> 1. Introduction to the project (“Our mission”) 2. Project progress: 1st 2nd, and 3rd project meetings and workshops 3. Launch of DISCHA experimental campaign (KIT, PS) 4. Experimental campaign on ignition of H₂-air mixtures (INERIS) 5. ISO TC 197 accepted “Safe use of LH2 in non-industrial settings” as PWI 6. Joined project meeting and workshop PRESLHY-SH2IFT (March 2019) 7. Forthcoming events: 4th project meeting and workshop, ICHS 2019, FCH JU Review days
2	<p>Release M24, leading partner KIT</p> <ol style="list-style-type: none"> 1. Project progress (KIT) <ol style="list-style-type: none"> 1.1. 4th project meeting and workshop 1.2. Progress on PNR activities (ISO TC 197, etc.) 2. Research findings <ol style="list-style-type: none"> 2.1. Experimental campaign update (general ignition (INERIS), jet fires (KIT), flame acceleration & DDT (KIT, PS), cold plume ignition (HSL), pool fire (KIT)) 2.2. Theoretical and computational studies (All) 3. ICHS 2019: PRESLHY outcomes presented at the event (KIT, UU) 4. Forthcoming events (KIT, UU) <ol style="list-style-type: none"> 4.1. 5th project meeting and workshop 4.2. Announcement of dissemination conference

3	<p>Release M30, leading partner KIT</p> <ol style="list-style-type: none"> 1. Project progress (contributor: KIT) <ol style="list-style-type: none"> 1.1. 5th project meeting and workshop 1.2. Progress on PNR activities (ISO TC 197, etc.) 2. Research findings <ol style="list-style-type: none"> 2.1. Experimental campaign (update on ignition studies (KIT, HSL)) 2.2. Theoretical and computational studies (All) 3. Forthcoming events (KIT, UU): 6th project meeting and workshop, and dissemination conference
4	<p>Release M36, leading partner UU</p> <ol style="list-style-type: none"> 1. Project progress (KIT) <ol style="list-style-type: none"> 1.1. 6th project meeting and workshop 1.2. Progress on PNR activities (ISO TC 197, etc.) 2. Summary of research findings: experimental campaign (KIT, INERIS, HSE, PS), theoretical and computational studies (All) 3. Conclusions from PRESLHY dissemination conference (UU) 4. Update and advertisement of the project products (UU, AL, KIT, HySAFE) <ol style="list-style-type: none"> 4.1. Open Data Repository 4.2 Handbook on hydrogen safety: Chapter on LH2 4.3. Guidelines for safe design and operation of LH2 infrastructure 4.4. Recommendations for RCS 4.5. Engineering correlations and tools 4.6. White Paper on the use of LH2

2.3.4 Posters

Posters will be displayed at dissemination events, such as exhibitions, conferences, etc., to advertise the project. The poster contains information on the motivation and the objectives of the project, the employed approach, experiments and results. The poster can be updated with key outputs throughout the duration of the project.

2.3.5 Workshops

A series of workshops within the consortium and HySafe networks are planned to exchange knowledge and expertise through sessions dedicated to special measurement technologies, experimental or numerical procedures and tools. The workshops are organised by the hosts of each project meeting, with support of all the work package leaders and coordinator. The plan includes 6 workshops aiming to “*information exchange across the work packages WP3 to WP5 boundaries, educate and train involved academic and technical staff, support exchange of tools, knowledge and expertise, and promote deeper cooperation in general, improve the quality of the work and provide added value to all involved parties*” (Grant Agreement).

The workshops are organized in conjunction with the project meetings, to assure partners and advisory board members presence. In addition to the mentioned six fundamentally “technical” workshops, three further events are included in the plan to exchange knowledge in a broader sense and disseminate the project results: research priorities workshop, LH₂ safety workshop and the dissemination conference concluding the project. The complete

list of the workshops, along with the topic and host is given in Table 3. All the presentations and material of the past workshops are available on the project website in the events section, unless specified otherwise.

Table 3. List of meetings and workshops for internal and external information exchange-updated.

Date (Project Month)	Meetings / Venue	Host / Organiser	Workshop Topic	Completed
4	Kick-off Meeting (1st Project Meeting) Karlsruhe, Germany	KIT	<i>Optical Measurement and Electrostatics</i>	✓
9	Initial Workshop Buxton, UK	HSL/ HySafe	<i>Research Priorities Workshop on LH₂</i>	✓
10	2nd Project Meeting Saclay, France	Air Liquide	<i>Cryo-Techniques</i>	✓
15	3rd Project Meeting Bergen, Norway	Gexcon AS/ HySafe	<i>P,T, flow measurement</i>	✓
15	LH₂ Safety Workshop Bergen, Norway	Gexcon AS/ HySafe, PRESLHY, SH2IFT	<i>LH₂ Safety – production, transport and handling</i>	✓
23	4th Project Meeting Buxton, UK	HSL	<i>Two phase measurements</i>	
27	5th Project Meeting Athens, Greece	NCSR	<i>Numerical Tools, CFD and Risk Assessment</i>	
35	Final Project Meeting Belfast, UK	UU	<i>International Standardisation</i>	
36	Dissemination Workshop Brussels, Belgium	HySafe	<i>Dissemination conference</i>	

The first workshop, entitled “**Optical and electrostatic measurement**”, was held on April 19, 2018 in KIT facilities in Karlsruhe, Germany. The session was chaired by Ernie Reinecke (HySafe). The participants to the workshop were members of the consortium and advisory board for a total of approximately 25 attendees. The workshop was dedicated to current optical measurement technologies for cryo and/or liquid hydrogen releases and investigations on electrostatic effects. The agenda of the workshops included the following presentations (speaker indicated as first listed name):

- How to see and quantify hydrogen concentration (and cryogenic hydrogen) using optical diagnostics – Ethan S. Hecht, Bikram Roy Chowdhury, Scott Bisson, Anthony McDaniel (Sandia National Laboratories).
- Development of Background Oriented Schlieren methods for multi-phase objects – Natalie Kotchourko (CoStudyGmbH), Thomas Jordan (KIT).
- Shadowgraphy – Joachim Grune (Pro-Science).
- Electrostatic ignition hazards – Benno Weinberger (INERIS).
- Electrostatic measurements – Philip Hooker (HSL).
- Electrostatic measurements around a cryo-jet – Gottfried Necker (Pro-Science).

The second workshop, entitled “**Cryo-Techniques**”, was held on October 17, 2018 in Air Liquide facilities in Saclay, France. The event was attended by 18 participants. The following topics were treated during the workshop:

- Large scale LNG experimentation at the Spadeadam testing and research centre – Dan Allason (DNV GL).
- Instrumentation at LLNL’s LH₂ facility (California, USA) – Guillaume Petitpas (Air Liquide).
- Spill and release consequences of LNG (sparcling) – Guillaume Leroy (INERIS).
- Cryogenics: low temperature measurement and control technique – Holger Neumann, Thomas Jordan (KIT).

The third workshop, entitled “**Concentration and Flow Measurement Techniques**”, was held on March 7, 2019 in Gexcon AS facilities in Bergen, Norway. The session was chaired by PRESLHY coordinator Thomas Jordan. The event was attended by 21 participants. The programme of the workshop included the following presentations:

- Know good practice for flow measurement at Pro-Science – Andreas Friedrich (PS)
- Experience at HSE – Jonathan Hall (HSE)
- Experience at SNL – Ethan Hecht (Sandia National Laboratories)
- General experience with low T measurement at USN – Knut Vagsaether (University of South-Eastern Norway)
- Flow Measurement at KHI – Kiyotaka Bito (Kawasaki Heavy Industries)

2.3.5.1 PRESLHY research priorities workshop

PRESLHY research priorities workshop was held in Buxton, UK, on the 18th September 2018, as part of the biannual research priorities workshop organized by HySafe. About 40 hydrogen safety experts attended the workshop. The meeting aimed at summarising the state-of-the-art to derive the research priorities for the safer use of liquid hydrogen in non-industrial settings. PRESLHY research work plan was described, focusing on the project strategies to tackle such priorities. A questionnaire for a phenomena identification and ranking exercise (PIRT) was distributed prior to the workshop date. The results were analysed to investigate how PRESLHY aligns with the experts’ views.

The agenda of the workshops included the following presentations:

- Introduction to PRESLHY – Thomas Jordan (KIT)
- RCS report – Andrei Tchouvelev (HySafe)
- State-of-the-Art dispersion – Alexandros Venetsanos (NCSR)
- State-of-the-Art ignition – Phil Hooker (HSL)
- State-of-the-Art combustion – Simon Jallais (Air Liquide)
- PIRT results – Simon Jallais (Air Liquide)

Details and minutes of the meeting are given in deliverable 2.4 “LH₂ Research Priorities Workshop”.



Figure 7. Group photo taken at the PRESLEY Research Priorities Workshop on 18 September 2018.

2.3.5.2 LH₂ safety workshop

The workshop on “LH₂ Safety - production, transport and handling” was a joint initiative by PRESLEY and SH2IFT (Safe Hydrogen Fuel Handling and Use for Efficient Implementation) projects. The event took place on the 6th March 2019 at Gexcon AS facilities in Bergen, Norway, representing partner HySafe at this event. The workshop aimed at presenting the results and plans of the two LH₂ related projects, the current state-of-the-art of research and industrial applications through the invited talks of experts from organisations external to the project consortiums: Kawasaki HI, MAN Cryo, Sandia National Laboratories, Norled, Moss Maritime. The detailed program is given in Appendix 2. Details and presentations of the workshop are available at the link: <https://www.sintef.no/en/events/hydrogen-safety-liquid-hydrogen-workshop>.

The audience included members from several groups: academia, members of the advisory board, relevant industry representatives, Norwegian Public Authorities, etc. Approximately 70 participants attended the workshop. Given the success, value and large audience of this workshop, PRESLEY consortium is considering the organisation of a second workshop in collaboration with SH2IFT in 2020, to present the results and conclusions of the two projects. The event may be held in conjunction with PRESLEY dissemination conference.

2.3.6 Conferences

The Dissemination Conference will be held either at one of the partners locations or FCH JU facilities in Brussels. Organisation is assigned to UU with assistance from HySafe. The dissemination conference is the culmination event of the project; therefore, it will be organised close to its end, preferably in M36. A duration of 1 or maximum 2 days is considered and attendance of about 100 stakeholders is envisaged. The organisation will aim at including invited speakers from outside the consortium and at participation of collaborators and experts from and beyond Europe. This is thought to increase the impact of the project outputs on the international community working in the field of hydrogen technologies. The possibility to organise the dissemination conference in conjunction with a second workshop on “LH₂ Safety - production, transport and handling” is currently under consideration, given the success and large audience of the first event organised by

PRESLHY, SH2IFT and HySafe in Bergen on the 6th March 2019. As stated in the Grant Agreement, the conference programme will include presentations of the PRESLHY key results, including the Handbook chapter on LH2 safety (D6.1), Guidelines for safe design and operation of LH2 infrastructure (D6.2), Recommendations for RCS (D6.3), Engineering tools (D6.4), etc. The brochure and preliminary programme of the dissemination conference will be prepared in M22 (milestone MS28), so that the conference can be advertised at least 12 months before the event.

Participation to other conferences is used to disseminate the project results, either in form of papers in the conference proceedings and/or presentations. A list of the conducted dissemination activities is given as follow:

- **Hypothesis XIII**, 24-27 July 2018, Singapore:
 - Cirrone D., Makarov D., Molkov V., “Numerical Evaluation of MIE of Hydrogen-Air Mixture” (presentation).
- **International Seminar on Fire and Explosion Hazards**, 21-26 April 2019, Saint-Petersburg, Russia:
 - Cirrone D., Makarov D., Molkov V., “Thermal Dose from Cryogenic Hydrogen Jet Fires” (presentation and paper).
 - Proust C., “Fire and Explosion Safety in Hydrogen Containing Processes: State of the Art and Outstanding Questions” (plenary talk and paper).
 - Vendra C. Madhav Rao, Jennifer X. Wen, “Numerical simulation of flashing liquid hydrogen jet fires” (poster).

The **International Conference on Hydrogen Safety (ICHS)** organised by the International Association for Hydrogen Safety (IA HySafe) provides a relevant platform for presenting and discussing the results and achievement of the project. The ICHS will take place on the 24-26 September 2019 in Adelaide, Australia. Five members of the consortium submitted a total of 6 papers on cryogenic and liquified hydrogen safety associated to PRESLHY project. A further paper dedicated to PRESLHY project description and progress was submitted as well.

Further conferences taken in consideration for dissemination of project findings include but are not limited to:

- European Hydrogen Energy Conference.
- International Symposium on Prevention and Mitigation of Industrial Explosions.
- World Hydrogen Energy Conference.
- World Hydrogen Technologies Convention, etc.

2.3.7 International meetings and events

The extensive dissemination of the project outputs includes also participation to international meetings as the ones organised by relevant SDOs to present and motivate the recommendations for RCS developed during the project, IEA meetings to present the main developments and achievements of the project, etc. In the first 18 months of the project, several of the meetings indicated in the PDCE (D6.6) have been attended to advertise PRESLHY project and disseminate the obtained results.

IEA Hydrogen Task 37 Hydrogen Safety

The purpose of Task 37 is to support the acceleration of a safer implementation of hydrogen infrastructure through coordinated international collaborations and hydrogen safety knowledge dissemination. The participants to the task are experts in hydrogen safety from public authorities, research institutions, academia, industry, etc. Meetings are organised on

a biannual basis to discuss the recent developments and progresses. PRESLHY project was presented by the project coordinator at the meeting held on the 19th October 2018 at Air Liquide facilities in Saclay, France. Attention was paid to the motivation and objectives of the project, the experimental programme and the project expected outcomes. It is envisaged participation to future Task 37 meetings to disseminate the obtained results throughout the project duration.

FCH JU Review Days

The FCH JU Review days took place on the 14-15 November 2018 in Brussels, Belgium. PRESLHY project was listed in the H2FC FCH JU success stories report as a key pre-normative research safety project. During the next review days, to be held on 19-20 September 2019, PRESLHY consortium will present the project progress and results.

ISO/TC 197 Hydrogen Technologies

The PRESLHY project was presented at the plenary meeting of the ISO TC 197 in Vancouver (6-7 December 2018) by the PRESLHY coordinator Dr Thomas Jordan. The project presentation was associated with the proposal for a Preliminary Working Item (PWI) titled “Safe Use of Liquid Hydrogen in Non-industrial Settings”. The PWI proposal received unanimous support by the committee. Dr Thomas Jordan has been nominated as “project manager” of the PWI. PRESLHY shall regularly report on progress of the pre-normative research. Results and conclusions from PRESLHY project with an adequate support by industry may lead to the development of a plan for revising ISO/TR 15916:2015.

International School Progress in Hydrogen Safety and Course in Hydrogen Safety

The International School Progress in Hydrogen Safety (ISPHS) was held between the 11-15 March 2019 at Ulster University in Belfast, UK. The event aimed at presenting the current state-of-the-art and recent developments in hydrogen safety to professionals, researchers and students. PRESLHY project was presented by the project coordinator, Dr Thomas Jordan. The presentation titled “Safety of liquified hydrogen systems and infrastructure” focused on the motivation and objectives of the project, the project expected outcomes, the experimental programme and the preliminary results of the study. A second presentation “Thermal effects of hydrogen jet fires” by Dr Donatella Cirrone included results on numerical studies on cryogenic jet fires obtained within PRESLHY project. Details of the event are given at the link www.ulster.ac.uk/conference/progress-in-hydrogen-safety. A Course in Hydrogen Safety was organised by Ulster University for Airbus SE company. The course involved presentation of the research currently performed within PRESLHY in similar format as for the ISPHS. The event was held on the 17th May 2019 at Ulster University in Belfast, UK. The nine attendees were professionals from Airbus offices in UK, Germany and France.

Research Priorities in Hydrogen Safety Workshops

The Research Priorities workshop is organised by IA HySafe on a biannual basis. The most recent edition was held at HSL premises in Buxton, UK, on the 17-20 September 2019. The purpose of this internationally open activity is to provide an update on the State-of-the-Art with respect to hydrogen safety knowledge and to prioritize the research activities to address corresponding gaps in the short and medium term. A session on the 18th September was dedicated to PRESLHY project. Details are given in the dedicated section 2.3.5.1 of the present deliverable.

In addition to the attended events, PRESLHY consortium members envisage to participate to the following meetings or events:

- Meetings of European Hydrogen Safety Panel (EHSP). The international meetings are aimed at discussing the activities and strategies at a programme and project level to assure an adequate management of the hydrogen safety research activities, to promote and disseminate H₂ safety culture within and outside of the FCH 2 JU programme. Next meeting will be held on the 25th June 2019, in Brussels.
- European RCS Strategy Coordination Group (SCG) meetings on the activities for the development and use of harmonised performance-based standards for FCH appliances and systems, their safety in energy and transport applications. Next meeting will be held on the 18th November 2019, in Brussels.
- Meetings of CEN/CLC/TC 6 Hydrogen in Energy Systems.
- Meetings of UN GTR#13 IWG SGS.
- European School on Hydrogen Safety, etc.

Table 4. Current conferences, international meetings and events time plan.

Event	Location	Date	Month	Done
Hypothesis XIII	Singapore	24-27 July 18	M7	✓
IEA HIA Task 37 Hydrogen Safety	Saclay, France	19 October 18	M10	✓
ISO/TC 197 Hydrogen Technologies	Vancouver, Canada	6-7 December 18	M12	✓
International School Progress in Hydrogen Safety	Belfast, UK	11-15 March 19	M15	✓
International Seminar on Fire and Explosion Hazards,	Saint-Petersburg, Russia	21-26 April 19	M16	✓
Course in Hydrogen Safety	Belfast, UK	17 May 19	M17	✓
European Hydrogen Safety Panel	Brussels, Belgium	25 June 19	M18	
European RCS Strategy Coordination Group (SCG) meeting	Brussels, Belgium	26 June 19	M18	
ICH2019	Adelaide, Australia	24-26 September 19	M21	
FCH Review days 2019	Brussels, Belgium	19-20 November 19	M23	
23 rd World Hydrogen Energy Conference	Istanbul, Turkey	5-9 July 20	M30	
Research Priorities Workshop	Buxton, UK	September 20	M33	

2.3.8 Scientific publications

Scientific publication in peer-reviewed journals, such as the International Journal of Hydrogen Energy, is the main channel for disseminating the knowledge generated by the project to the scientific community, along with presentations at the conferences mentioned above. Scientific conference contributions and papers for peer-reviewed journals resulting from the project will report the acknowledgement as stated in the Grant Agreement: “This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking under

the European Union’s Horizon 2020 research and innovation programme under grant agreement No 779613”.

A list of the published papers in peer-reviewed journals is given below:

1. Cirrone D., Makarov D., Molkov V., “Thermal Radiation from Cryogenic Hydrogen Jet Fires”, International Journal of Hydrogen Energy, Volume 44, Issue 17, 2019, Pages 8874-8885.
2. Venetsanos A., “Homogeneous Non-Equilibrium Two-Phase Choked Flow Modelling”, International Journal of Hydrogen Energy, Volume 43, Issue 50, 2018, Pages 22715-22726.

2.4 Time plan and responsibility

The timeline for the dissemination and exploitation activities as reflected in the contract via the corresponding deliverables and milestones is given in Table 5, along with the related sub-task, responsible partner and current status.

Table 5. Dissemination and exploitation time plan and responsibilities.

D/MS	Title	Task	Lead	Due	Done
D1.2	Website including internal communication tools	1.4	KIT	M3	✓
D1.3	Data Management Plan 1st Version	1.2	KIT	M6	✓
MS25	ToC of Handbook of Hydrogen Safety: chapter on LH2 safety	6.1	UU	M12	✓
D6.1	Handbook of Hydrogen Safety: chapter on LH2 safety	6.1	HySafe	M34	
MS26	ToC of Guidelines for safe design and operation of LH2 infrastructure	6.2	UU	M14	✓
D6.2	Guidelines for safe design and operation of LH2 infrastructures	6.2	AL	M35	
MS30	Discussion draft of recommendations for RCS	6.3	UU	M28	
D6.3	Recommendations for RCS	6.3	AL	M35	
MS27	ToC of White paper	6.5	UU	M18	✓
D6.4	White Paper	6.5	KIT	M35	
MS29	Detailed description of novel engineering tools for LH2 Version 1	6.4	UU	M24	
D6.5	Detailed description of novel engineering tools for LH2 safety	6.4	UU	M35	
D6.6	Plan for the dissemination, communication and exploitation	6.6	UU	M6	✓
D6.7	<i>Plan for the dissemination, communication and exploitation-1st update</i>	6.6	UU	M18	✓
MS28	Brochure and preliminary programme of the dissemination conference	6.6	UU	M22	
D6.8	Plan for the dissemination, communication and exploitation-2nd update	6.6	UU	M36	
D6.9	Report on the communication activities carried out to the general public	6.6	UU	M36	

3 Communication activities

The communication activities aim at assuring an efficient interaction between the project partners and effective promotion of the project to the targeted audiences. The plan timing covers the entire project duration.

3.1 Internal communication

Effective communication inside the consortium is fundamental for the success of the project. All partners must be updated continuously on project progress, deliverables status and planning, etc. Typical communication means inside the consortium are emails, the project website protected area with document repositories, collaborative document processing, virtual and real meetings. Two project meetings per year are organised at different partners locations. List of the meetings is given in Table 3. The meetings are used to report the progress of the project deliverables and outputs, discuss project further steps and developments, and exchange knowledge and expertise through concomitant workshops, see section 2.3.5. Up to this moment, 3 project meetings have taken place.

The communication for day-to-day management and administration is supported by regular, typically monthly, telephone conferences or virtual meetings of the Coordination Committee (CC). So far 15 CC meetings were organised and documented. Via Action Lists and check of deliverables and milestones the progress on the project is controlled. The CC meetings provide opportunities for discussing potential problems and preparing dedicated meetings.

3.2 External communication

The free online access to the project outputs through the website and the KITopen research data repository are key elements for spreading the generated knowledge (www.preslhy.eu). Relevant project events and news will be advertised through the project website and the IA HySafe website as well (www.hysafe.org).

PRESLHY dissemination conference represents a crucial activity for communicating the project outputs to the relevant stakeholders (M36, see section 2.3.6 for detailed description).

Further communication and promotion of the project to the multiple audiences identified in section 2.2 will include but not limit to:

- Advisory Board, which is composed by representatives of relevant industry and SDOs, connecting the consortium to the stakeholders worldwide.
- International meetings organised by relevant SDOs and RCS committees for discussion and promotion of Recommendation for RCSs (see section 2.3.7).
- International conferences, such as the International Conference on Hydrogen Safety (2019), etc. (see section 2.3.6).
- Scientific publications in peer-reviewed journals to outreach the research community, implementing an open access policy to engage a wider audience.
- Biannual meetings of International Energy Agency (IEA) Hydrogen Implementation Agreement (HIA) Task 37 Hydrogen Safety meetings to systematically present and discuss the results of the performed research.
- European School on Hydrogen Safety.
- Relevant Continuous Professional Development (CPD) courses.
- IA HySafe Research Priorities Workshop.
- PRESLHY newsletter and press-releases.

4 Sustainability

The plan is arranged to support visibility and availability of the major project outcomes for at least 5 years after the project formal end. The main efforts will be spent on maintaining the handbook chapter and web contents, such as the deliverables produced throughout the project duration. The long-term basis availability of PRESLHY experimental data is envisaged through storage in digital format on provided databases. Details can be found in the “Data Management Plan” (see deliverable D1.3 “Data Management Plan 1st Version”, WP1). HySafe presence among the project partners enhances the sustainability of the PRESLHY results, and maximization of the impact and outreach of this pre-normative research project, thanks to its unique open network, neutral position and involvement in relevant activities –including but not limited to the ICHS, Research Priorities Workshops, educational events and the European Hydrogen Safety Panel.

Appendix 1 - 1st issue PRESLHY Newsletter



Newsletter

ISSUE 1

MAY 2019

Top stories in this newsletter



Our mission



Experimental campaign progress



ISO TC 197 PWI

Our mission

PRESLHY project addresses the pre-normative research for a safer use of cryogenic and liquid hydrogen (LH₂) as an energy carrier. The project aims at achieving the following objectives:

- ⇒ Identify the critical safety areas with knowledge gaps and need of specific standards;
- ⇒ Carry out an experimental campaign addressing LH₂ relevant phenomena;
- ⇒ Develop and validate suitable models and engineering correlations;
- ⇒ Underpin a cost-efficient and inherently safer design for LH₂ infrastructure;
- ⇒ Improve techniques for determining hazard zones for LH₂ technologies, where they are currently inconsistent or over-conservative;
- ⇒ Support international Standard Developing Organisations (SDO) in the update of existing standards and development of new ones.

Project progress

During the first phase of PRESLHY project, the consortium has met several times during the project meetings and events held in Karlsruhe (Germany), Paris (France), Buxton (UK) and Bergen (Norway).

PRESLHY consortium organized 3 workshops in collaboration with HySafe to exchange knowledge and expertise on special measurement technologies, experimental procedures and tools:

- * Optical and electrostatic measurement
- * Cryo-techniques
- * Concentration and flow measurement techniques

The material associated to the workshops is available at PRESLHY website www.preslhy.eu in the events section.

PRESLHY research priorities workshop was held in Buxton, UK, on the 18th of September 2018, as part of the biannual research priorities workshop organized by HySafe and attended by worldwide hydrogen safety experts. The meeting summarised the state-of-the-art to derive the research priorities for the safer use of liquid hydrogen in non-industrial settings.

Launch of DISCHA experimental campaign

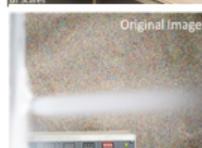


The first tests on releases of LN₂ in the cooled DISCHA facility in KIT were started on 17th of April 2019, to calibrate the experimental facility. Afterwards, hydrogen releases from four nozzle diameters ($d = 0.5, 1, 2, 4$ mm) were investigated at seven initial pressure in the range 5-200 bar. Every experiment was repeated at least two times to ensure reproducibility. Preliminary results for a cold experiment ($T \approx 80$ K) with the 4 mm nozzle and an initial pressure of 200 bar showed a decrease of temperature to 110 K at the thermocouples in proximity of the release point, causing a strong freezing of the ambient humidity at the release nozzle. The near-field to the release point is shown in figure on the left (bottom).

Three thermocouples and a pressure sensor were located inside the vessel to monitor storage parameters and verify whether the cryo-compressed gaseous hydrogen liquefies inside the tank during the blowdown.

The experimental tests on unignited releases were completed. The following set of experiments will involve ignited jets at same release pressure and temperature to investigate the thermal and pressure effects in the surroundings of the jet fire.

Figures: DISCHA experimental set-up (top); Near-field image of release at 80K, 200 bar and $d=4$ mm (bottom)



Experimental campaign on ignition of hydrogen-air mixtures

INERIS performed a series of tests on ignition by hot surfaces of hydrogen-air mixtures with temperature down to 120 K, to investigate the effect of the mixture temperature on standard ignition parameters. Hydrogen concentration in air was varied within the range 4 - 80%. It was observed that the temperature of the hot surface required to ignite the mixture was marginally affected by the temperature and composition of the gas mixture.

INERIS is conducting a second experimental campaign to assess the Minimum Ignition Energy (MIE) of hydrogen - air mixtures at cryogenic temperature. A first set of measurements were performed on mixtures at ambient temperature. Currently, the MIE device is being adapted to the use with cryogenic temperatures.



Figure: experimental set-up for ignition by hot surface

ISO TC 197 accepted "Safe use of LH₂ in non-industrial settings" as PWI



"Safe Use of Liquid Hydrogen in Non-industrial Settings" has been set up as a Preliminary Working Item (PWI) N. 24077 at the plenary meeting of the ISO TC 197 in Vancouver (6-7 December 2018). The PWI proposal received unanimous support by the committee. Dr. Thomas Jordan, the PRESLHY coordinator, has been nominated as "project manager" of the PWI.

LH₂ Safety Workshop - 6th March 2019, Bergen, Norway

PRESLHY and SH2IFT consortiums joint their forces and expertise to organize a workshop on LH₂ Safety - production, transport and handling. The event took place on the 6th March 2019 at Gexcon AS facilities in Bergen, Norway. The workshop aimed at presenting the results and plans of the two LH₂ related projects, supported by an update on the current state-of-the-art, research and industrial applications through the invited talks of experts from Kawasaki HI, MAN Cryo, Sandia National Laboratories, Norled and Moss Maritime. Details and presentations are available at: www.sintef.no/en/events/hydrogen-safety-liquid-hydrogen-workshop/.

Forthcoming events

- ⇒ European Hydrogen Safety Panel meeting & RCS Strategy Coordination Group workshop on RCS and safety, Brussels, Belgium (24-26 June 2019)
- ⇒ International Conference on Hydrogen Safety 2019, Adelaide, Australia (24-26 September 2019)
- ⇒ PRESLHY 4th project meeting and workshop, Buxton, UK (6-8 November 2019)
- ⇒ FCH JU Review Days, Brussels, Belgium (November 2019)



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To find more information about our research activities, please visit: www.preslhy.eu
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Appendix 2 - LH₂ Safety workshop agenda

Wednesday 6 March 2019, Bergen, Norway

PROGRAM:

09:30 – 10:00 Registration and coffee

10:00 – 10:30 **Welcome, HySafe, PRESLHY & SH₂IFT** (Project partners)

10:30 – 11:05 **Production, transport and handling of LH₂: Safety issues and knowledge gaps** (L. Bernard, Air Liquide)

11:05 – 11:25 Refreshments

11:25 – 11:45 **SH₂IFT – Update on planned LH₂ BLEVE and LH₂ RPT experiments** (K. v. Wingerden & M. N. Holme, Gexcon)

11:45 – 12:05 **SH₂IFT – Invitation to blind-prediction benchmark exercise on jet fires** (R. Stølen, RISE Fire Research)

12:05 – 12:25 **Overview of results from PRESLHY** (general, strategy, connected work) – (T. Jordan KIT)

12:25 – 13:00 **Invited talk – Quantitative risk assessment of LH₂ systems: data and model needs** (E. Hecht, SANDIA)

13:00 – 14:00 Lunch

14:00 – 14:15 **PRESLHY – Release and distribution** (A. Venetsanos, NCSRD)

14:15 – 14:30 **PRESLHY – Ignition** (S. Hawksworth or S. Coldrick, HSL - TBC)

14:30 – 14:45 **PRESLHY – Combustion** (M. Kuznetsov, KIT)

14:45 – 15:00 **PRESLHY – Expected impact and dissemination routes of outcomes** (D. Cirrone, UU)

15:00 – 15:20 Refreshments

15:20 – 15:40 **Industry perspective – Large scale LH₂ supply chain project & H₂ gas turbine demonstration** (K. Morimoto, Kawasaki HI)

15:40 – 16:00 **Industry perspective – MAN Cryo marine liquid hydrogen fuel gas system** (K. Lorentsson, MAN Cryo)

16:00 – 16:20 **Industry perspective – World's first hydrogen electric car ferry – driven by LH₂** (I. Østvik, Norled)

16:20 – 16:40 **Industry perspective – Liquid hydrogen bunker vessel** (M. Bøhlerengen, Moss Maritime)

16:40 – 17:00 **Q&A and panel discussion** - Safe introduction of LH₂: Challenges, bottlenecks, regulations and public acceptance

~17:00 End



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