PRESLHY- Annex
Draft 'plan for the dissemination and exploitation of the project's results'

a) Dissemination and exploitation of results

The main impact of this pre-normative research project will be achieved through effective implementation of the pre-normative research outcomes, i.e. the advanced state-of-the-art, into Regulations, Codes and Standards (RCS). According to the "modern approach" the legally binding regulations - which are in fact quite static – actually refer to the more dynamic, performance-based standards, which follow the steadily advancing state-of-the-art in the field. For European regulations these standards have to be real international standards. Therefore, the main target groups for the exploitation of the projects results and the respective dissemination are the international standards developing organisations (SDOs) and the standards user communities, in particular industry.

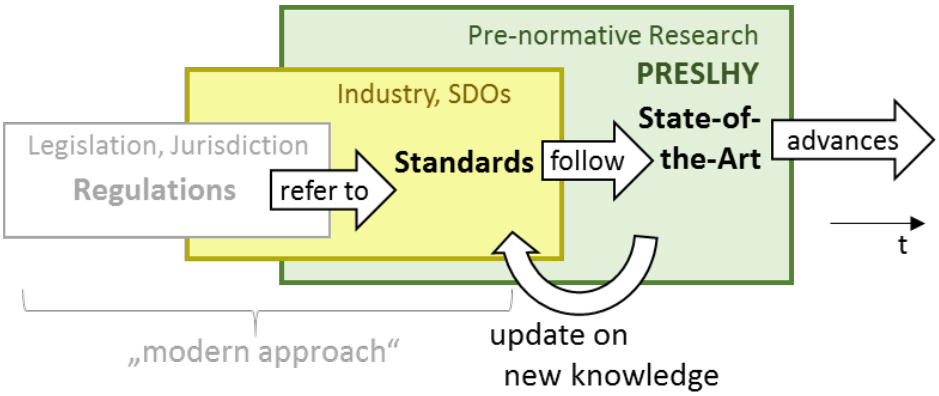

Fig. A1: Impact areas and relationship of pre-normative research, standardization and regulation, highlighting the impact areas of PRESLHY

The dissemination and exploitation activities in PRESLHY are therefore focused on extracting and transforming the new scientific findings into suitable information for SDOs such as ISO/IEC and CEN/CENELEC. In particular, ISO TC197 "Hydrogen Technologies" and CEN/CLC/TC6 "Hydrogen in Energy Systems" will be strongly engaged with the PRESLHY consortium to formulate gaps and bottlenecks, to re-shape the experimental pre-normative research program to the actual needs, and to exploit the results of research activities most appropriately. To this end, key representatives of those organisations and from industry have been identified and invited (and have accepted, see letters of intent) to become members of the PRESLHY Advisory Board. PRESLHY partners will continuously report to the SDOs and other stakeholders on closed knowledge gaps and resolved technological bottlenecks. Intensive communication will be achieved in project meetings, workshops, like the Dissemination Conference, and through direct involvement of several project partners (at least from AL, HSL, IA HYSAFE, INERIS, UU, UWAR) and Advisory Board members in the activities of respective SDOs, at least via the national mirror committees.

The impact of PRESLHY will be further increased considering - besides land transport infrastructure and energy storage – also other fields of application with their own special standardisation needs. In particular aviation, ship and railway transport are potential candidates, as there are recently suggested business cases

with strong demand for scaled-up and safe hydrogen infrastructures. The research results are universal and flexible enough to serve also for these standards as a solid harmonised basis.
In the following the key products for dissemination of PRESLHY results will be described. In fact, they are defining the work program of WP6, dedicated to "Implementation – Exploitation and Dissemination". The description comprises for each case the communication channel, which is deemed most efficient for the respective impact, and the interaction with industry, SDOs and other stakeholders, which include politicians, decision makers, education and training institutions, research organisations, etc. The actual sequence in the presentation follows a shift of the focus related to these target groups, from research (e.g. via scientific publications) to industry and SDOs (e.g. via recommendations), and finally to policy makers and general public via the White Paper.

Data Management and Common Scientific Publication
For providing sustainability and thereby maximising the project's impact, it is important to preserve the basic data generated with the quite costly pre-normative research in a convenient way for open access by all stakeholders. PRESLHY will participate in the Pilot on Open Research Data in Horizon 2020. Work package WP1 will develop a detailed **Data Management** Plan for making all data findable, accessible, interoperable and reusable (FAIR). This plan will be presented at the introductory workshop and continuously developed further afterwards. The stored data will be highly valuable for verification and validation of models and simulations, i.e. mainly for the research community, not only within the PRESLHY project but also beyond. KIT will provide excellent data management capabilities to the project. As former coordinator of the FCH JU project SUSANA for verification and validation strategies for CFD in hydrogen risk assessment (www.support-cfd.eu), KIT is operating the associated public database, which could be used for an intermediate solutions at least. For the long term and more concise data storage strategies the infrastructures and services provided by the KIT/FIZ project RADAR (https://www.radar-service.eu/) will be used.
Of course, the consortium intends to publish extensively all developments and results based on these data. Commonly edited **scientific papers published** in peer reviewed journals, like the International Journal for Hydrogen Energy, or submitted to the key event of the community, the International Conference for Hydrogen Safety, are the prototypical pathways to communicate research results and to advance the state-of-the-art.

Engineering correlations and tools
As described before, PRESLHY will generate unique experimental data, which will be used twofold: to validate analytical and numerical models, and to generate empirical and semi-empirical **engineering correlations**. These engineering correlations shall be useful and easily applied for evaluation of innovative risk mitigation concepts and techniques, and for calculation of hazard parameters, like hazard/safety distances. They will be brought into the unified format suitable for consequent programming and implementation into any existing and/or future integrated platforms for hazards and risks assessment, e.g. European e-Laboratory (ongoing FCH JU NET-Tools project), HyRAM tool in USA, similar Canadian tool (UTRQ), etc. The deliverable "Detailed description of novel engineering correlations for LH2 safety" comprises all these new engineering correlations and will be presented, along with other results, at the Dissemination Conference at the end of the project.
These **engineering tools** will be used by partners for scientific and engineering purposes and will be available to a wider range of stakeholders for performing safety engineering design, education and training at beyond the-state-of-the-art level. For example, partner UU will include the developed tools into online module for higher education in hydrogen safety at Ulster University (distance learning). The key impact however, will be through the implementation of the developed tools into quantitative **risk assessment toolkits**, e.g. those listed above. The validated tools will be included into recommendations for RCS to be referred in forthcoming standards. The ISO TC197, for instance, builds its standards on the performance-based approach, which requires correlations rather than simple restricting tables. To this end, the developers of LH2 systems and infrastructures should be provided by validated engineering correlations

for hydrogen safety engineering design. So, even without directly changing or developing new standards, the generated knowledge translated into these novel engineering tools will be of great assistance to engineer inherently safer LH2 and cryo-compressed hydrogen systems.

LH2 specific update of the Handbook of Hydrogen Safety

The revision and extension of the chapter on LH2 safety in the Handbook of Hydrogen Safety (http://www.hysafe.net/wiki/BRHS/BRHS) will provide a written reference of the updated state-of-the-art in LH2 safety. It will include key experimental results, description of models and engineering correlations, etc. This handbook chapter can be implemented as a public Wiki and thus will be open for different contributors in its further development after the project formal closure. The chapter on LH2 safety may serve not only as the reference document for practicing engineers but also as a compact resource for new comers in hydrogen safety research and education.

The Handbook of Hydrogen Safety has been initiated and developed by the NoE HySafe and is, therefore, owned by its legal successor, the International Association for Hydrogen Safety (IA HySafe), which is the PRESLHY consortium partner HYSAFE. HYSAFE will be mandated to develop the chapter during the project and maintain the chapter as an integral part of the Handbook afterwards. It will be used in different educational and training activities of IA HySafe, such as industry short courses, etc. Partner UU is not only coordinating the PRESLHY exploitation and dissemination work package WP6 but also chairs the Education Committee of IA HySafe. The dissemination channels for the Handbook therefore include, but are not limited to, the internet with its high potential for a wide distribution and use of an open and free resource like the Handbook (e.g. by the NET-Tools project), and various IA HySafe activities, potentially including the European Hydrogen Safety Panel, which is expected to be approved shortly (see same FCH JU call as for PRESLHY). The Panel might use the Handbook in their reviews of safety plans and other activities.

Guidelines for safe design and operation of LH2 infrastructure

The Guidelines will be focused on areas where LH2 specific standards do not exist or where they are not suitable for use in public areas. They will facilitate inherently safer design and operation of LH2 systems and infrastructure in Europe, even before specific standards or regulation have been established. While the Handbook is focused on underpinning LH2 safety science, the guidelines' focus is more on practical aspects of safer design and operation of LH2 systems and infrastructure.

The guidelines will include innovative safety strategies and engineering solutions developed during the project. Their structure and format will be oriented at established standards, e.g. ISO/TR 15916:2015 "Basic considerations for the safety of hydrogen systems". Thus the PRESLHY guidelines might be considered as a precursor of the LH2 specific part in a next revision of this standard.

The main users of the guidelines are engineers from industry and they expect that the relevant SDOs should provide them by valuable information through their standards. The guidelines allow engineers to follow the state-of-the-art even before it is implemented in a standard (the minimum term to produce a standard is 3 years). The relevant SDOs will contribute to the guidelines actively through its consortium or Advisory Board members. They will have the guidelines as soon as they are available, and will be encouraged to use them in the next update of the relevant standards, guidelines respectively. The dissemination channel include the PRESLHY website and at least the annual joint meetings of the consortium with SDOs, which will be arranged in combination with the scheduled project meetings. The motivation for the guidelines, the validation basis and how these guidelines might be implemented in standards will be the focus of Recommendations for RCS.

Recommendations for RCS

The recommendations for RCS suggest a larger framework for the above Guidelines. They will be formulated in a concise language used by the SDOs. Similarly to the guidelines, the recommendations will be iterated and shaped in the project meetings, where representatives of the SDOs will participate. The recommendations will be published at the PRESLHY website. The consortium or representatives will

present and motivate these recommendations at the meetings of relevant SDOs, including mentioned above ISO and CEN/CENELEC committees.

White Paper on the use of LH2

The White Paper will be commissioned by the PRESLHY consortium to examine the roles and potential benefits of LH2 within the hydrogen and fuel cell sector, especially transport. LH2 is the most effective option for refuelling stations to satisfy growing demand as compared to demonstration projects with gaseous hydrogen storage. The White Paper will include discussion on general economics and safety of LH2. It will include to some extent the comparison of hazards and risks of LH2 systems against gaseous hydrogen systems and highlight its advantages.

The White Paper will be presented at the Dissemination Conference. Printed copies of the White Paper will be distributed to a wide range of stakeholders, including decision makers and politicians. It will be available to all stakeholders through the project website.

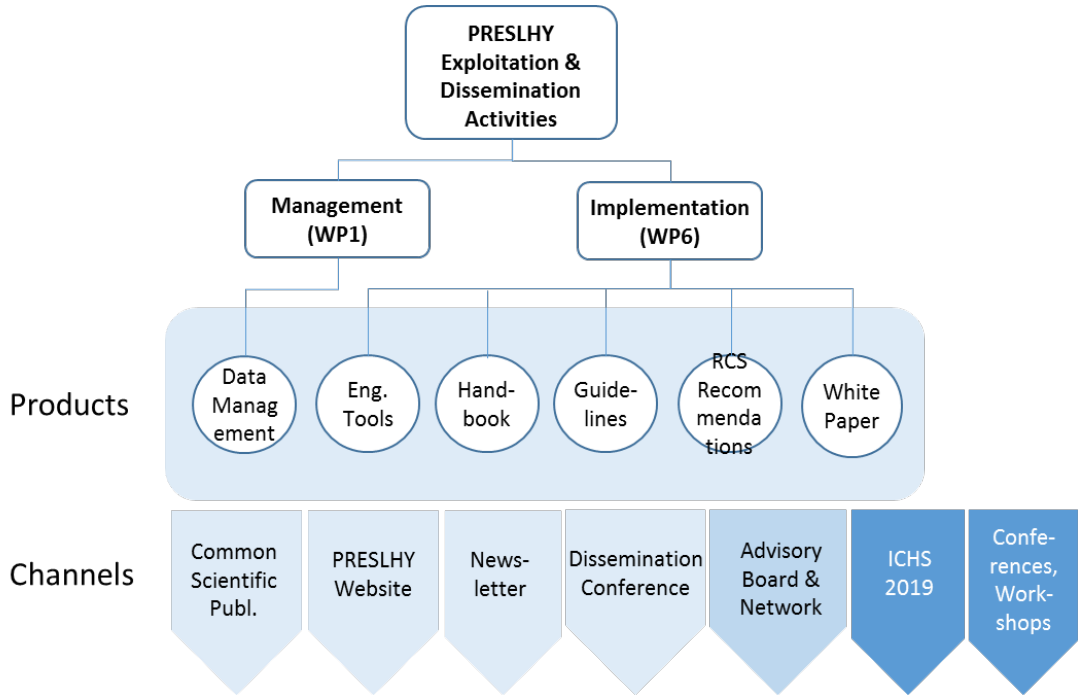

Fig. A2: PRESLHY's dissemination products and communication channels

b) Communication activities

Different national and international events will be used for dissemination of project results. The key events in this regard are the PRESLHY Dissemination Conference, International Conference on Hydrogen Safety ICHS 2019, biannual meetings of International Energy Agency (IEA) Hydrogen Implementation Agreement (HIA) Task 37 Hydrogen Safety, European School on Hydrogen Safety, relevant Continuous Professional Development (CPD) courses, and future IA HySafe Research Priorities Workshops.

However, basic communication and dissemination is already taking place within the PRESLHY network, consisting of the consortium itself and the Advisory Board, which connects the consortium to other stakeholders worldwide. The further links to international research groups and SDOs, mainly established by partner HYSAFE, complement the network on a real international scale. The communication within this broad network is stimulated by regular meetings, where an appropriate balance of scientists, industry

representatives and key persons from SDOs will be ensured by careful planning. All participants are considered messengers of the PRESLHY key results. Equipped with appropriately interpreted and condensed information they will spread the new knowledge widely and help to achieve harmonised and generally accepted progress with regard to the state-of-the-art. Besides this implicit mechanism PRESLHY will establish at least two explicit communication means. The first is the obligatory website, the other is a dedicated event close to the end of the project, the Dissemination Conference.

The **PRESLHY website** will be developed and operated by work package WP1 "Management". It will be developed on the same platform used for the HYSAFE website (see www.hysafe.info) applying the same Content Management System CMS Wordpress. Wordpress provides high quality plugins for setting up and distributing an attractive **newsletter**. Together with the user database of HYSAFE this will seriously increase the reach for spreading the news of the project. An FAQ mechanism, flexible posting mechanisms and commenting features will intensify the interaction with all other, not directly involved interested parties. The chosen formats will ease the later integration of the website in the HYSAFE domain and web services, for maintaining the web presence for a minimum duration of 5 years after the project end.

The **Dissemination Conference** will be organised in Brussels close to the end of the project. It will be a culmination event, where the key project outputs will be presented to all stakeholders. It is expected that about 100 persons will attend the event. Participation of collaborators and experts from USA, Japan, Canada, China and other countries outside Europe is expected, including invited speakers from outside the consortium. This is thought to increase the impact of the project outputs on the international community working in the field of hydrogen technologies.

The International Conference for Hydrogen Safety ICHS (http://www.hysafe.info/activities/ichs/) provides another huge open platform for presenting and discussing new findings. This ICHS is organised by partner HYSAFE biennially since 2005. The conference is endorsed by IPHE, IEA HIA, FCH JU, US DoE, etc. and therefore is worldwide accepted as the unique highly focussed reference event for hydrogen safety issues. The 8th issue of the ICHS organised in September 2019, will provide a perfect opportunity for a very broad communication of the PRESLHY results. All contributions to the ICHS are stored on its repository, mirrored on the Hydrogen Portal (https://h2tools.org/ichs) and are typically published after a latency of about 6 months. Thus, the ICHS might be considered as the living memory of the hydrogen safety community and the new knowledge generated by PRESLHY will be disseminated further and preserved in the long term. The last paragraph will elaborate further on this long-term issue.

c) Sustainability

The consortium will mandate HYSAFE to maintain and, in case, develop further the PRESLHY deliverables on the long term. A reasonable budget will be allocated for maintaining the web content and handbook chapter, and to disseminate further the project results for at least 5 years after the project end. Appropriate arrangements will be made in the Consortium Agreement.
With its vision and mission, with its unique open network, neutral position and relevant activities – including but not limited to the ICHS, Research Priorities Workshops, Educational Events, and Handbook - and with its probable involvement in the European Hydrogen Safety Panel, HYSAFE is best suited for supplying sustainability to the PRESLHY results and for maximising the impact and the outreach of this pre-normative research project in general.