



Deliverable D6.5

Fully organized, conducted and reported workshops -
Dissemination and discussion of preliminary results from the project

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R E P O R T

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ACRONYMS AND ABBREVIATIONS

AFIR	Alternative Fuel Infrastructure Regulation
IHCS	International Conference of Hydrogen Safety
WP	Work Package
WS	Workshop



1 INTRODUCTION

This document captures the efforts in the mid and late stages of the PRHYDE project to enable the project consortium to seek input from outside of the project, and enable external stakeholders to give feedback to be considered, by conducting a series of small surveys at the start of the project.

Additionally, in order to broaden the awareness of the project with external stakeholders, disseminate the anticipated activities to be carried out within the project and enable external stakeholders to give feedback to be considered, workshops / webinars were conducted.

2 ENGAGEMENT THROUGH PRHYDE WORKSHOPS / WEBINARS

Several workshops have been planned for the course of the PRHYDE project.

The workshops were originally planned as in-person meeting with WebEx access to capture the widest possible range of stakeholders. Following the emergence of the COVID-19 coronavirus crisis, it was unfortunately not possible to hold the workshops in 2020 and 2021 as in person workshops, however they were held as webinars to communicate to interested stakeholders an indication of the plans of the project, and the findings of the “State of the Art” research activity.

The workshops have (/had) the following aims:

The **first workshop/webinar** planned at the start of the project, in month 3 (24th March 2020), was to ensure the widest input possible into identification of the State of the Art and to help ensure the specification of the fuelling protocols to be developed within the project will be of the most relevance to industry.

The findings from this workshop and survey contribute to the tasks of WP2 (and subsequently WPs 3-5), whilst also being a precursor for the subsequent workshops held to address Objective 2 (see Task 6.4).

The **second workshop/webinar**, held in month 4 (23rd April 2020), was an opportunity to further disseminate findings up to that time on State of the Art, and to try to get further feedback on the plans for the project.

Results of both workshops have been summarized and processed to be included in the protocol development as public deliverables D6.3¹ (workshop 1) and D6.4² (workshop 2) and as annex of the respective state of the art documents in WP2 (D2.3 and D2.4).

The consortium also took the opportunity to seek feedback on the planned approach for protocol development by holding a **third workshop/webinar**, held in month 12 (1st December 2020), in addition to those originally planned.

Additional stakeholder workshops took place in order to develop an understanding of what future fuelling protocols should take into consideration, and where limitations may be encountered by the current approaches / technologies on the market. The workshops were held on 2nd and 3rd December 2020 (immediately after the third workshop which took place on 1st December 2020).

Topics discussed and positions developed included:

1. What systems are anticipated in future gaseous hydrogen HD vehicles, and what could the boundary conditions be reasonably anticipated to be that the fuelling protocols of the future would need to adhere to?

¹ Deliverable D6.3 “Report on the external stakeholder engagements conducted at the start of the PRHYDE project – Surveys and Workshop 1” is available on the PRHYDE website at <https://prhyde.eu/progress/>.

² Deliverable D6.4 “Report on the external stakeholder engagements conducted at the start of the PRHYDE project – Workshop 2” is available on the PRHYDE website at <https://prhyde.eu/progress/>.

2. What systems are currently in use on existing non-gaseous (i.e. liquid, cryo-compressed, etc) hydrogen HD vehicles, and what are the boundary conditions that fuelling protocols would need to adhere to?
3. What systems are anticipated in future non-gaseous hydrogen HD vehicles, and what could the boundary conditions be reasonably anticipated to be that the fuelling protocols of the future would need to adhere to?
4. What other constraints are anticipated for ideal future protocols (e.g. filling a train or boat in X minutes)?
5. What other considerations can be reasonably accounted for within future protocols (e.g. multiple systems being filled at the same time on the same vehicle in parallel)?
6. What capabilities of existing components on the market could influence future fuelling protocols, including those required for interoperability (for instance, is there a mechanical interlock on any existing H50 nozzle/receptacle)?
7. Where can component developments that can be reasonably anticipated to address any limitations, and where are there gaps?
8. What capabilities of other factors could influence future fuelling protocols (for instance, infrastructure to application communications)?
9. Where can developments within such other factors be reasonably anticipated to address any limitations, and where are there gaps?

Since the consortium is in the fortunate position to consist of a large cross section of stakeholders of the HD hydrogen vehicle industry, questions could be targeted towards each audience:

1. HD vehicle manufacturers / operators: road vehicles, trains, boats, off-road vehicles (e.g. mining), etc – to establish:
 - a. What realistic CHSS capacities might need to be?
 - b. Refuelling time constraints in the future (i.e. equivalent to the US DOE 3-5 min fill for light duty)
 - c. What state (liquid/cryo-compressed / gaseous) options there are for different applications?
 - d. Other considerations that affect fuelling
2. Component manufacturers – to establish:
 - a. What temperature ratings are realistic for onboard storage tanks for the future?
 - b. What flow capabilities are realistic for the future?
 - c. How can mechanical interlocks be developed, if necessary?
 - d. Other considerations that affect fuelling

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3. Vehicle and HRS OEMs – to establish (in addition to above):
 - a. What information needs to be transferred between the vehicle and station, and what reliability is necessary?
 - b. Can simplifications be made to the calculation model that would allow for easier and more reliable data processing?

Again, many of these questions were included in the survey sent out to relevant stakeholders. Unfortunately, however, it was difficult to get as wide a variety of responses as would have been expected had face-to-face meetings been possible.

To continue with dissemination activities, a **fourth workshop/webinar** was held on 20th September 2021, directly prior to the International Conference of Hydrogen Safety (ICHS). The purpose of this workshop was to review modelling and testing performed to date, and discuss how to work with results achieved so far, in order to ensure the results generated are useful and of industrial relevance

Due to the extension of the project by nine months, the final workshops will be conducted in 2022.

The **fifth workshop** (originally focus: objective 1) was conducted on 21st April 2022. Its aim was to disseminate and discuss the preliminary results from the project with external stakeholders

Note: Due to the increased ambition of the project, Objective 1 and parts of 2 have essentially been merged together, to develop a protocol that is forward looking beyond the currently available hardware / communications concepts. This workshop will, in line with the original intention, be dissemination of the current status within the project, but without being limited to what was originally described as “Objective 1” when the project was initially defined.

A final workshop (the **sixth workshop/webinar**) is planned for 22nd September 2022 with the aim to disseminate the final results of the project, Additionally, this workshop will cover the proposed next steps for protocol development and deployment, in line with the original intent of Objective 2, where not covered in the project.

3 THIRD WORKSHOP / WEBINAR (1ST DECEMBER 2020)

The third event was a webinar held on the 1st December 2020, giving external stakeholders an update on progress within the PRHYDE project, particularly within the Work Packages 3.

Additional stakeholder workshops took place in order to develop an understanding of what future fuelling protocols should take into consideration, and where limitations may be encountered by the current approaches / technologies on the market. The workshops were held on 2nd and 3rd December 2020 (immediately after the third workshop) in small groups with selected stakeholders.

3.1 Agenda (1st December 2022)

The agenda is included below:

Timing	Subject	Presenter
13:45	Join webinar	
14:00 (15:00 CET)	Introduction <ul style="list-style-type: none"> ▪ Format of webinar ▪ Subsequent workshops ▪ State of the Art (WP2) public deliverables available to date: see https://prhyde.eu/progress/ 	Martin Zerta (LBST)
14:15	Goal with PRHYDE (State of the Art -> WP3 Effort)	Claus Due Sinding (NEL)
14:30	Considerations and decisions to be made	Spencer Quong (on behalf of Toyota North America)
14:50	Two viable paths <ul style="list-style-type: none"> ▪ Performance-based Approach ▪ Formula-based Approach 	Spencer Quong, Steve Mathison (NREL)
15:50	Closing remarks	Martin Zerta (LBST)
16:00	End	

3.2 Agenda follow-up workshop 1 (2nd December 2022)

There was no agenda as such - this workshop followed on from the previous day's webinar (the third PRHYDE webinar). It was planned as Q & A session that would otherwise have followed the webinar presentations had it been feasible to have a longer session the day before.

3.3 Agenda follow-up workshop 2 (3rd December 2020)

There was alignment of the content of this workshop with a recent request from the European Commission to CEN/CLC for “interoperability” standards, to be referred to in a future version (or Delegated Regulation) of the AFID.

The workshop was split into two parts:

- 1) what would be needed by non-road transport applications (i.e. off-road, rail, marine, etc) for refuelling with gaseous hydrogen, and, following on from the webinar on the 1st December 2022, whether or not the PRHYDE work is directly applicable
- 2) what would be needed by applications refuelling with non-gaseous hydrogen fuels (i.e. liquid hydrogen, cryo-compressed, etc.)

Note: For those interested, the initial proposal for the content of the future Regulations is available as EU Document 52021PC0559: “Proposal for a Regulation of the European Parliament and of the Council on the deployment of alternative fuels infrastructure, and repealing Directive 2014/94/EU of the European Parliament and of the Council”³

The second part was intended to support the preparation of the PRHYDE deliverable D2.5, “Analysis of existing non-gaseous hydrogen refuelling protocols or applications”.

The main aims in each part were to cover the following:

- The process of refuelling, for instance, including refuelling protocols
- The hardware used for refuelling, for instance, connectors
- The equipment that influences refuelling, for instance, the design of onboard storage.

³ See <https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:52021PC0559>.

UTC Timing (approx.)	Subject	Presenter
14:00 (15:00 CET)	Introduction	Nick Hart & Paul Karzel
14:10	Context – HE perspective (non-road and non-gaseous)	Michael Diderich
14:15	Gaseous hydrogen - Rail <ul style="list-style-type: none"> • CEN TC 256 WG43 • SNCF 	Mick James Charles Foncin & Benoit Laurent
14:30	Gaseous hydrogen - Maritime <ul style="list-style-type: none"> • Maranda project • CMB Tech – Alex Corrigan • HySeas project 	Laurence Grand-Clement (Persee) Alex Corrigan Cedric Dupuis (McPhy)
14:45	Gaseous hydrogen - Off-road <ul style="list-style-type: none"> • Anglo American 	Julian Soles
14:50	Developments in Korea	Dr Chae (MERI)
14:55	Q & A (so far)	
15: 05	Introduction to Deliverable D2.5	Paul Karzel
15:10	Liquid hydrogen (all applications) <ul style="list-style-type: none"> • Air Liquide – Guillaume Petitpas, Florian Pontzen • ZAL - Sebastian Altmann (Aviation) • Standards for refuelling LH2 vehicles – parallels with LNG: <ul style="list-style-type: none"> o Erik Buthker (road) o Jürgen Essler (maritime) 	
15:30	Cryo-compressed hydrogen <ul style="list-style-type: none"> • KEI 	Markus Kampitsch
15:40	Q & A Closing remarks	
16:00	End	

Information presented and discussed during this workshop was fed into the CEN/CLC adhoc working group providing feedback to the European Commission on the proposal for the new Regulation, and PRHYDE Deliverable 2.5 respectively.

3.4 Dissemination

A number of the presentations are available on the PRHYDE website (<https://prhyde.eu/events/>).

The slides presented during the webinar can be previewed and downloaded below:

Workshop 3 – Introduction https://prhyde-cdn.s3-accelerate.amazonaws.com/wp-content/uploads/2021/05/20103009/2020-12-01_PRHYDE-Webinar-3-01-Introduction.pdf
Goal with PRHYDE https://prhyde-cdn.s3-accelerate.amazonaws.com/wp-content/uploads/2021/05/20103011/2020-12-01_PRHYDE-Webinar-3-02-WP3-Presentation-Goal-with-PRHYDE.pdf
Heavy Duty Fueling Protocol Strategic Approach https://prhyde-cdn.s3-accelerate.amazonaws.com/wp-content/uploads/2021/05/20103012/2020-12-01_PRHYDE-Webinar-3-03-Heavy-Duty-Fueling-Protocol-Strategic-Approach.pdf
Performance Based Fueling Protocol https://prhyde-cdn.s3-accelerate.amazonaws.com/wp-content/uploads/2021/05/20103014/2020-12-01_PRHYDE-Webinar-3-04-Performance-Based-Fueling-Protocol.pdf
HD High Flow Fueling Protocol Structures and Options for Consideration https://prhyde-cdn.s3-accelerate.amazonaws.com/wp-content/uploads/2021/05/20103017/2020-12-01_PRHYDE-Webinar-3-05-HD-High-Flow-Fueling-Protocol-Structures-and-Options-for-Consideration.pdf

4 FOURTH WORKSHOP / WEBINAR (20TH SEPTEMBER 2021)

The fourth dissemination event was a webinar held on the 20th September 2021, in conjunction with the International Conference of Hydrogen Safety (ICHS), giving external stakeholders an update on progress within the PRHYDE project.

4.1 Agenda

The agenda is included below:

UTC Timing (approx.)	Subject	Presenter
12:45	Join webinar	
13:00 (15:00 CET)	Introduction: <ul style="list-style-type: none"> • Introduction to PRHYDE • Public deliverables available to date: see https://prhyde.eu/progress/ 	Martin Zerta Nick Hart
13:05	Presentation: WP3 protocol development update Content: <ul style="list-style-type: none"> • WP3 update on refuelling concepts • Down selection process (performance simulations, risk assessment, etc) • Plan going forward (remaining tasks and expected timeline) 	Claus Sinding / Steve Mathison / Spencer Quong
14:00	Questions	
14:15	Presentation: WP4 and WP5 update on testing Content: WP5: Presentation of practical work carried out to date WP4: Presentation of modelling activity relative to practical work carried out to date	Fouad Ammouri/ Arnaud Charolais/ Alexander Grab / Christian Spitta
14:40	Questions	
14:55	Closing remarks	

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4.2 Dissemination

A number of the presentations are available on the PRHYDE website (<https://prhyde.eu/events/>).

The slides presented during the webinar can be previewed and downloaded below:

Workshop 4 – Introduction

https://prhyde-cdn.s3-accelerate.amazonaws.com/wp-content/uploads/2021/12/14203722/2021-09-20_PRHYDE-Webinar-4-01-Introduction-v2.pdf

WP3 Protocol Development Update

https://prhyde-cdn.s3-accelerate.amazonaws.com/wp-content/uploads/2021/12/14203732/2021-09-20_PRHYDE-Webinar-4-02-WP3-Presentation-Finalrevised.pdf

WP4 Modelling / Simulations + WP5 Testing

https://prhyde-cdn.s3-accelerate.amazonaws.com/wp-content/uploads/2021/12/14203739/2021-09-20_PRHYDE-Webinar-4-03-WP4-WP5-Presentation-FINAL.pdf

5 FIFTH WORKSHOP / WEBINAR (21ST APRIL 2022)

The fifth dissemination event was a webinar held on the 21st April 2022, giving external stakeholders an update on progress within the PRHYDE project, particularly within the Work Package 3.

5.1 Agenda

The agenda is included below:

Timing	Subject	Presenter
14:45	<i>Join webinar</i>	
15:00	Introduction to project (for anyone who couldn't join on the 24 th March)	Martin Zerta
15:10	Summary of first webinar	Nick Hart
15:20	<i>PRHYDE deliverable D2.1:</i> Performance targets for refuelling protocols for heavy duty hydrogen vehicles	Quentin Nouvelot
15:35	<i>PRHYDE deliverable D2.2:</i> Requirements for safe heavy duty gaseous hydrogen vehicle refuelling	Lena Glatz, Nick Hart
15:40	Related topic: Safety Watchdog concept	Fouad Ammouri
15:50	<i>PRHYDE deliverable D2.3:</i> Gap analysis of existing heavy duty gaseous hydrogen vehicle refuelling protocols	Nick Hart
	Related topic: Presentation by Fill'n'Drive	Adrien Zanoto
16:15	<i>PRHYDE deliverable D2.4:</i> Gap analysis of existing hardware used for heavy duty gaseous hydrogen vehicle refuelling	Nick Hart, Quentin Nouvelot
16:30	<i>PRHYDE deliverable D2.5:</i> Analysis of existing non-gaseous hydrogen refuelling protocols or applications	Nick Hart
16:35	<i>PRHYDE deliverable D3.1:</i> Report on the characteristics of the cases to be simulated in the preliminary simulations	Claus Sinding
16:50	Next steps / Plans for smaller web meetings (anticipated in May)	Nick Hart
17:00	<i>End</i>	

5.2 Dissemination

Approximately 125 people attended the workshop.

A number of the presentations are available on the PRHYDE website (<https://prhyde.eu/events/>).

The slides presented during the webinar can be previewed and downloaded below:

Workshop 4 – Introduction https://prhyde-cdn.s3-accelerate.amazonaws.com/wp-content/uploads/2022/05/11081856/PRHYDE_5th_Webinar_01_Introduction_2022-04-21.pdf
WP3 Protocol Development Update https://prhyde-cdn.s3-accelerate.amazonaws.com/wp-content/uploads/2022/05/11081858/PRHYDE_5th_Webinar_02_WP3_Protocol_Development_Update_Refuelling_approaches_2022-04-21.pdf
WP3 Risk Assessment https://prhyde-cdn.s3-accelerate.amazonaws.com/wp-content/uploads/2022/05/11081900/PRHYDE_5th_Webinar_03_WP3_Risk_Assessment_2022-04-21.pdf
WP4 Update on numerical simulations https://prhyde-cdn.s3-accelerate.amazonaws.com/wp-content/uploads/2022/05/11081902/PRHYDE_5th_Webinar_04_WP4_Update_on_numerical_simulations_2022-04-21.pdf
WP5 Update on experimental validation https://prhyde-cdn.s3-accelerate.amazonaws.com/wp-content/uploads/2022/05/11081902/PRHYDE_5th_Webinar_04_WP4_Update_on_numerical_simulations_2022-04-21.pdf

6 CONCLUDING REMARKS

The disruption that the Covid-19 coronavirus caused to the planned schedule for interaction with external stakeholders created difficulties in arriving at a situation where the types of conversations that had been hoped for were able to take place. However, from a perspective of dissemination of the project goals and activities, the workshops/webinars were successful, and seemingly positively received.

A final workshop (the **sixth workshop/webinar**) is planned for 22nd September 2022 with the aim to disseminate the final results of the project. Additionally, this workshop will cover the proposed next steps for protocol development and deployment, in line with the original intent of Objective 2, where not covered in the project.



What is PRHYDE?

With funding from the Fuel Cells and Hydrogen 2 Joint Undertaking (FCH 2 JU, now CHJU), the PRHYDE project is aiming to develop recommendations for a non-proprietary heavy duty refuelling protocol used for future standardization activities for trucks and other heavy duty transport systems applying hydrogen technologies.

Based on existing fuelling protocols and current state of the art for compressed (gaseous) hydrogen fuelling, different hydrogen fuelling protocols are to be developed for large tank systems with 35, 50, and 70 MPa nominal working pressures using simulations as well as experimental verification. A broad industry perspective is captured via an intense stakeholder participation process throughout the project.

The work will enable the widespread deployment of hydrogen for heavy duty applications in road, train, and maritime transport. The results will be a valuable guidance for station design but also the prerequisite for the deployment of a standardized, cost-effective hydrogen infrastructure.

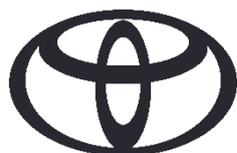
Further information can be found under <https://www.prhyde.eu>. For feedback on the PRHYDE project or the published deliverables, please contact info@prhyde.eu.

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Members of the PRHYDE Consortium:



Further linked third partner to the project are MAN and Toyota North America.

We also thank the following companies and institutions for their contribution to the project (in alphabetical order): Bennet Pump, Daimler, FirstElement Fuel, Hexagon Purus, Honda, LifteH2, Luxfer, National Renewable Energy Laboratory (NREL), National Technology & Engineering Solutions of Sandia, LLC (NESS), Risktec, Savannah River National Laboratory (SRNL) and TÜV SÜD Rail.