



Deliverable D7.8

6th Project Meeting and Status Report

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R E P O R T

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ACRONYMS AND ABBREVIATIONS

| | |
|------|----------------------------|
| CHJU | Clean Hydrogen Partnership |
| D | Deliverable |
| FC | Fuel Cell |
| HD | Heavy Duty (Vehicle) |
| MoM | Minutes of Meeting |
| WP | Work Package |

EXECUTIVE SUMMARY

Due to the Covid-19 pandemic, the 6th project meeting was held as a hybrid meeting. Part of the PRHYDE team and some external experts had gathered at Nel's H₂ Station Factory, Herning/Denmark on 11th and 12th July 2022. In addition, further participants joined the meeting via web conference.

Enclosed is a summary of the meeting including the list of participants, the agenda and excerpts of the Minutes of Meeting (MoM), adapted for publication. This document provides a brief status update of the different work packages (WP).



Figure 1: Participants during the internal PRHYDE workshop on 11th July 2022, taking place at a hybrid event in Herning, Denmark and online.

1 GENERAL

6th Project Meeting

Project PRHYDE – Protocol for heavy duty hydrogen refueling
 Subject 6th General Assembly, 11th /12th July 2022
 Place Hybrid event: Nel H₂ Station Factory, Herning/Denmark and web conference
 Date 11th July 2022, 1:00-5:30 pm CEST and 12th July 2022, 8:00-12:00 am CEST

1.1 Agenda

The agenda of both days is presented below.

| Time (CET) | Topic | Responsible |
|---------------|--|--|
| Until 11:30 | Arrival at Nel H ₂ Station Factory in Herning (Denmark) (see travel information) | |
| 11:45 – 12:00 | Safety introduction | |
| 12:00 – 13:00 | Lunch | |
| 13:00 – 13:20 | Welcome of coordinator and introductory words | Martin Zerta (LBST) & Claus Due Sinding (Nel) |
| 13:20 – 14:00 | Progress report WP3 (Protocol Development) and WP6 (Dissemination) Basis for discussion in PRHYDE working session | Claus Due Sinding (Nel) & Nick Hart (ITM Power) |
| 14:00 – 14:30 | Comments on proposed document structure for HD refuelling standards in SAE and ISO, covering the potential role of PRHYDE output | Steven Mathison (First Element Fuel, external expert) |
| 14:30 – 17:30 | PRHYDE working session (all) Aim: internal workshop on final project results & recommendations and their dissemination (with participation of selected external experts) | Claus Due Sinding (Nel), Nick Hart (ITM Power), Fouad Ammouri (Air Liquide), Antonio Ruiz (Nikola) |
| 17:30 | Factory tour | |
| Evening event | Visit of local brewery | |

Figure 2: Agenda 11th July 2022, internal PRHYDE workshop

| Time (CET) | Topic | Responsible |
|---------------|---|---|
| 8:00 – 8:30 | Arrival at Nel H ₂ Station Factory in Herning (Denmark) | |
| 8:30 – 8:45 | Welcome of coordinator and project officer | Coordinator (LBST) & Project officer CHJU |
| 8:45 – 09:45 | Summary of the project status & discussion of outstanding work WP3, 4, 5 and 6, each 10 min. PPT + discussion | WP leaders & Project officer CHJU |
| 9:45 – 10:00 | Final project reporting | Coordinator (LBST) |
| 10:00 – 10:10 | Break | |
| 10:10 – 10:40 | Outlook WP3 Summary of working session on 11 th July and working plan for final project months | Claus Due Sinding (Nel) |
| 10:40 – 11:10 | Outlook WP6 Discussion of final project dissemination + planning of final dissemination workshop | Nick Hart (ITM Power) |
| 11:10 – 11:30 | Discussion and closing remarks | Coordinator (LBST) |
| 12:00 – 13:00 | Lunch | |

Figure 3: Agenda 12th July 2022, 6th PRHYDE project meeting

1.2 List of participants

In total, 30 participants were present (in person and online) during the first day and 20 participants during the second day.

Table 1: List of participants (PRHYDE consortium and selected external experts)

| Company | Name | 11 th July 2022 | | 12 th July 2022 | |
|-------------------|-------------------------|----------------------------|-----------|----------------------------|----------|
| | | In person | Remotely | In person | Remotely |
| Air Liquide | Fouad Ammouri | X | | X | |
| Air Liquide | Vincent Ren | X | | X | |
| Air Liquide | Elena Vyazmina | | X | | X |
| Air Liquide | Guy de Réals | | X | | |
| Air Liquide | Guillaume Lodier | | | | X |
| CEA | Stephane Villalonga | | X | | X |
| Engie | Quentin Nouvelot | X | | X | |
| Engie | Thomas Guewouo | | X | | |
| Engie | Dorine Croulé | | X | | |
| ITM Power | Nick Hart | | X | | X |
| ITM Power | Weronika Boratynska | | X | | X |
| LBST | Martin Zerta | X | | X | |
| LBST | Christopher Kutz | X | | X | |
| LBST | Susanne Goeritz | | X | | X |
| NEL | Claus Due Sinding | X | | X | |
| NEL | Annemarie Purmer | X | | X | |
| NEL | Jannik Hartwig Jakobsen | X | | X | |
| NEL | Bo Rohde Jensen | X | | X | |
| NEL | Bjarne Vig | | X | | X |
| Nikola | Antonio Ruiz | | X | | X |
| Shell | Benoit Poulet | X | | X | |
| Shell | Carlos Damas | | X | | |
| Shell | Todd Comins | | X | | |
| Toyota | Vincent Mattelaer | X | | X | |
| FirstElement Fuel | Steven Mathison | | X | | |
| LIFTEH2 | Paul Karzel | X | | X | |
| NREL | Shaun Onorato | | X | | |
| NREL | Taichi Kuroki | | X | | |
| Bennett Pump | Anne Robb | | X | | |
| Bennett Pump | Chad Paffhausen | | X | | |
| Bennett Pump | Kevin Maddalena | | X | | |
| Total | | 12 | 18 | 12 | 8 |

1.3 General topics of the meeting

The 6th general assembly within the PRHYDE project was divided into two sessions. On the 11th July 2022, an internal workshop with PRHYDE members and selected external experts took place to discuss the final project results and further open issues related to refuelling concept development (see Figure 2). The second session on the 12th July 2022 was organised as an internal project meeting, with brief presentations of each WP leader about the status of their WP and the open actions required until the project end (see Figure 3).

The PRHYDE partners agreed on the further timeline and started with preparations of the final dissemination webinar to take place in September 2022.

2 STATUS REPORT

Based on the discussions during the 6th project meeting, the following chapters provide a brief overview of the current project status for the public.

2.1 Summary: Overview and timeline

After 30 months of the PRHYDE project, WP 1 (Ethics requirements) and WP 2 (State-of-the-Art and specifications) have been completed¹, while all other work packages are in a progressing state.

- As of June 2022 (month 30), 33 deliverables have been finalized and submitted to the CHJU.
- All public deliverables are available on the project website, www.prhyde.eu.
- In total, 10 deliverables are still open, with two deliverables being due in May 2022 (month 29) and one being due in June 2022 (month 30).
- Key public deliverables with final project results will be delivered until September 2022.
- Milestones: Until July 2022, 8 out of 9 milestones are achieved. The final open milestone is milestone 3: Final fuelling protocol specifications. It is connected to deliverable D3.5 and is expected to be achieved until end of July/beginning of August 2022.
- Final presentation of the results and recommendations are planned for 22nd September 2022 in an online web session (1 to 5 pm CET) targeted for all interested stakeholders and (standardization) experts.

The project runs until September 2022 (month 33). Further project reporting will take place after the project's end.

2.2 WP 3 – Protocol development

Within WP 3 (protocol development), the concepts for refuelling protocols of heavy-duty vehicles have been refined based on input from simulations (in WP 4) and experimental validation tests (in WP 5).

- Deliverables D3.3 (draft fuelling protocol specifications, confidential) and D3.4 (Safety and risk assessment of fuelling protocols, confidential) have been finalized. Key elements of both deliverables have been presented during the fifth PRHYDE webinar/workshop on 21st April 2022². Further dissemination took place during the ICHS 2021³ (International Conference of Hydrogen Safety).

¹ See PRHYDE Deliverable D7.5 for a detailed description of WP1 and WP2.

² Slides available here: <https://prhyde.eu/events/>.

³ ID152: Safety and other considerations in the development of a hydrogen fueling protocol for Heavy-Duty Road Vehicles. Claus Due Sinding, Steven Mathison, Spencer Quong, et.al. available here: <https://hysafe.info/ichs2021/conference-papers-and-presentations/>.

- Key efforts are focusing on deliverable D3.5 (Final fuelling protocol specifications), which is planned to be finalized until end of July / beginning of August 2022. The document will serve as the main input for the final project deliverable D6.7, which will include PRHYDE results for public dissemination and targeting standardization experts.
- In addition, two further (internal) documents are prepared: One describing the roadmap on further steps required toward the development of an international standardization protocol based on PRHYDE concepts and one slide deck with a high-level introduction into PRHYDE.

2.3 WP 4 – Modelling and Simulations

Simulations for different tanks to be used in the WP 5 test campaign have been prepared in WP 4.

- Final modelling runs have been conducted using the different models. Preliminary results were documented in D4.4 (Report on comparison between preliminary computations and experimental results for single tanks, confidential), which was finalized in April 2022 (month 28). All further results will be documented in deliverable D4.5 (Report on complementary calculations).
- The results of modelling and simulations will be documented for publication in deliverable D4.8 (Synthesis of WP4 conclusions to be transferred to WP 6), which is the main input of WP4 into the final public project deliverables D6.7 and D6.8.
- Key results of the simulation activities were presented during the ICHS 2021 (International Conference of Hydrogen Safety)⁴ and WHEC 2022 (World Hydrogen Energy Conference)⁵.

2.4 WP 5 – Experimental Validation

In WP 5 (Experimental Validation), the work can mainly be divided into three phases:

- Phase 1 Testing: Generation of Experimental Data for Model Verification (completed)
Nikola and ZBT have conducted test campaigns on single tanks to generate data for verification of WP4's 0D and 3D simulations.
- Phase 2 Testing: Implementation Testing of the Protocol Concepts (completed)
Nikola and ZBT have conducted tests on single tanks using the protocol concepts developed in PRHYDE. The objective of these tests was to confirm

⁴ ID167: Protocol for Heavy Duty hydrogen refueling: a modelling benchmark. Arnaud Charolais, Fouad Ammouri, Elena Vyazmina, et.al. and ID118: CFD simulations of the refuelling of long horizontal H₂ tanks. Pierre Carrere, Guillaume Lodier, Elena Vyazmina, et.al. available here: <https://hysafe.info/ichs2021/conference-papers-and-presentations/>.

⁵ See <https://whecistanbul.org/>. Presentation will be uploaded to <https://prhyde.eu/events/>.

the successful implementation of the protocol concepts and confirm the results of the performance simulation campaign conducted by WP 4

- Phase 3 Testing: Full-System Testing (open)

Testing on full systems will not be complete by the close of the project. Instead, it is expected that full-system testing will only be possible during fall or winter 2022. The test will be performed at NREL's and Toyota North America's testing facilities. It is, however, planned to publish key test results as an appendix to final deliverables on the website of the project. Key results and recommendations of the PRHYDE project will not be delayed by the ongoing Phase 3 testing as the protocol concepts developed in WP3 are mainly based on single tank testing in Phase 2: Implementation Testing of the Protocol Concepts.

As PRHYDE will provide protocol concepts for further standard protocol development in standardization committees like ISO TC197 WG24, it is expected that these full system testing in Phase 3 will add further validation and value to this process.

With regard to the testing campaign, the following documents have been prepared:

- Mechanical measurements on single tanks have been performed by CEA at CEA's and ZBT's test facility (see Figure 4 and Figure 6) during 2021 and in May 2022. The test set-up and results have been documented in deliverable D5.2 (Mechanical measurements systems, confidential), D5.3 (Mechanical measurements intermediate test results, confidential) and D5.4: (Mechanical measurements final test report and data analysis, public).⁶
- WP 5 refuelling test phase activities mainly took place at ZBT's test facility in Germany (see Figure 4) (in addition, preliminary tests of the 70 MPa type IV tank test was conducted by Nikola). Single tank testing of different vessels (equipped with thermocouple trees) took place between September Q3 2021 to Q2 2022. Test specifications were summarized in deliverable D5.1 and final results of the experimental test campaign will be collected in deliverable D5.5.
- Further full-system tests have been planned in the project to validate single test results. The test results will, however, only be available after the project end (see above) as an annex to existing documents.

⁶ Deliverables D5.3 D5.4 are available here: <https://prhyde.eu/progress/>.



Figure 4: Commissioning of ZBT hydrogen test field (Source: ZBT)



Figure 5: Hydrogen fuelling at ZBT test field (Source: ZBT)



Figure 6: Mechanical measurements on 244L vessel at ZBT
(Source: CEA)

2.5 WP 6 – Communication and Dissemination

WP 6 (recommendations and dissemination) has successfully organized five webinars/workshops (in form of web conference) until June 2022.

- The fifth workshop (webinar) was conducted on 21st April 2022. Its aim was to disseminate and discuss the preliminary results from the project with external stakeholders.
- A final workshop (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.
- On the webpage (see <https://prhyde.eu/progress/>) public presentations and project deliverables are available for review and comments by stakeholders.
- For stakeholder information the project has initiated newsletters to stakeholders and social media posts. Presentations to standardization organizations were given.
- Further project results have been presented at international conferences, e.g. ICHE 2021 or WHEC 2022 (see WP3 and WP4 description above).

2.6 WP 7 – Project Management

- The PRHYDE coordinator has set up a regular monthly consortium call to discuss all project-related topics between the consortium partners in addition to the individual calls, implemented on work package level.
- In total: 6th project meetings were organized until July 2022: The kick-off meeting took place in Paris on 5th February 2020, the 2nd project meeting was

held via web conference on 25th and 26th June 2020, the 3rd project meeting on 17th December 2020 and the 4th project meeting on 18th June 2020, the 5th project meeting on 16th December and the 6th project meeting on 11th and 12th July 2022 in Herning, Denmark and online. When available, also the project officer of the CHJU participated during the meetings.

- In September 2021, a contract amendment was prepared to extend the project by nine months until September 2022.
- Final project reporting is planned to take place after the project's end during October and November 2022.



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.

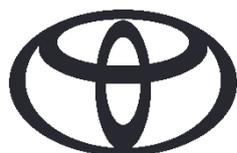
Further information can be found under <https://www.prhyde.eu>. For feedback on the PRHYDE project or the published deliverables, please contact info@prhyde.eu.

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Members of the PRHYDE Consortium:



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

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