

# D5.3 - Bi-mode FCH Multiple Unit TRL7 Service

## WP5 – Demonstrator Integration, Testing and Homologation

### Task 5.3 – Service Experience and Data Collection

|                      |  |
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| Partner | Contribution                     |
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| DLR     | Review of the deliverable        |
| TME     | Review of the deliverable        |
| RENFE   | Review of the deliverable        |
| ADIF    | Review of the deliverable and QC |
| CNH2    | Review of the deliverable        |
| IP      | Review of the deliverable        |

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## Executive Summary

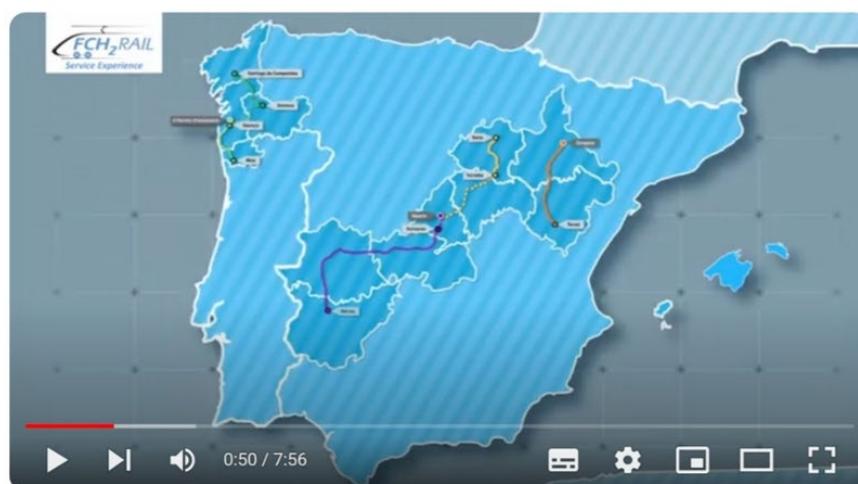
The project 'Fuel Cell Hybrid Power Pack for Rail Applications' was an innovation action in Horizon 2020, the most significant research program in the European Union. Aimed at reducing the production costs of fuel cell systems in transport applications while increasing their lifetime to levels that can compete with conventional technologies, the program developed the project entitled FCH2RAIL, under Grant Agreement No. 101006633 [1].

The main objective of the FCH2RAIL project is to develop, build, test, demonstrate and homologate a scalable, modular, and multi-purpose Fuel Cell Hybrid PowerPack (FCHPP) applicable for different rail applications, and suitable for retrofitting existing electric and diesel trains, to reach TRL7.

The goal of the task 5.3 is to continue with the dynamic testing of task 5.2 that ended with the demonstrator train completing the tests in the Zaragoza-Canfranc Line in June 2023. After this relevant milestone, the task 5.3 aims to evaluate the operation of the train demonstrator in 6 additional lines that were identified as representative by the project partners. During 10 months the train demonstrator has simulated the commercial service in these lines in different operating conditions. That is why this testing campaign is also called **Service Experience**.

During this testing campaign the project has fulfilled additional important milestones: in the Spanish infrastructure the train obtained a new authorization to run in tests among the commercial traffic of the line; in the Portuguese infrastructure the train demonstrator obtained the authorization to run in tests, and it became the first Hydrogen train running for testing also in Portugal.

The Service Experience of the train is captured in a video: <https://www.youtube.com/watch?v=fFuYwuVSyll> showing the Demonstrator on Spanish and Portuguese tracks, and collecting the experiences of some of the partners. The video is the deliverable of the task.



## CAF-FCH2RAIL: First hydrogen train simulating commercial service on Spanish and Portuguese lines

Figure 1 Train demonstrator service experience video on YouTube



In this document a brief complementary photographic report of the train demonstrator during the service experience campaign is included, together with some characteristic aspects of the tests in every line. Refer to the video for the complete information.

## Glossary of Terms

| Abbreviations | Description                                  |
|---------------|--|
| CA            | Consortium Agreement                         |
| CAF           | Construcciones y Auxiliares de Ferrocarriles |
| CNH2          | Centro Nacional del Hidrogeno                |
| GA            | Grant Agreement                              |
| FCHPP         | Fuel Cell Hybrid PowerPack                   |
| GA            | Grant Agreement                              |
| TME           | Toyota Motor Europe                          |
| TRL           | Technological Readiness Level                |

| Acronyms | Description                                      |
|----------|--|
| FCH2RAIL | Fuel Cell Hybrid PowerPack for Rail Applications |

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## 1. Bi-mode FCH Multiple Unit TRL7 Service

After the tests on the Zaragoza-Canfranc line, the train has continued the dynamic testing phase on 6 additional lines for 10 months.

| LINE                      | TESTS STARTING DATE | TESTS ENDIND DATE |
|---------------------------|---------------------|-------------------|
| MADRID - SORIA            | 10.11.2023          | 20.11.2023        |
| ZARAGOZA - TERUEL         | 29.11.2023          | 12.01.2024        |
| MADRID - TALAVERA         | 14.02.2024          | 16.02.2024        |
| MADRID – CACERES - MERIDA | 22.02.2024          | 02.03.2024        |
| MINHO LINE                | 03.04.2024          | 06.04.2024        |
| OURENSE SANTIAGO          | 09.04.2024          | 18.04.2024        |

Table 1 Test periods for the different lines during Service Experience Campaign

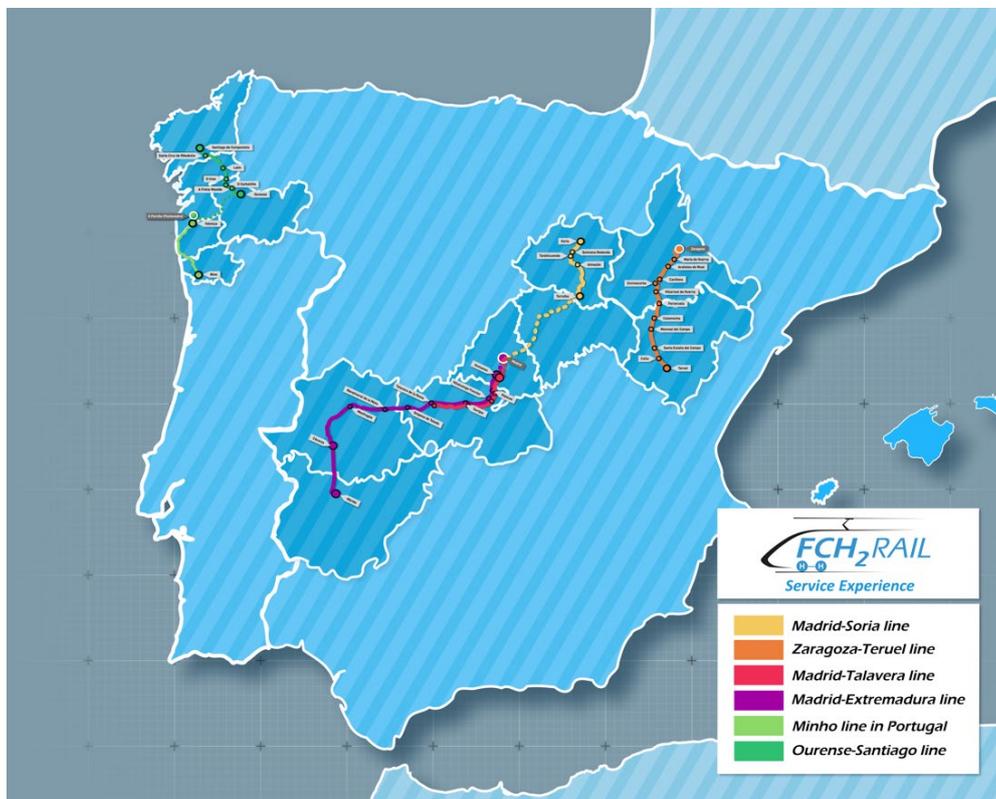


Figure 2 Map of the lines covered during the service experience campaign. Credit: CAF (CC BY-NC-ND 4.0)

### 1.1 Madrid-Soria line

On the Madrid-Soria line the testing was performed on the non-electrified section between Torralba and Soria.

The most characteristic feature of these tests is that the highest altitude is reached on this line: 1160m.



Figure 3 Train Demonstrator during testing campaign in Madrid-Soria line. Carlos IV bridge. Credit: CAF (CC BY-NC-ND 4.0)



Figure 4 Train Demonstrator during testing campaign in Madrid-Soria line. Soria Station. Credit: CAF (CC BY-NC-ND 4.0)

## 1.2 Zaragoza-Teruel line

During the testing in this line the temperature decreased down to  $-3^{\circ}\text{C}$ , so the correct operation of the powerpack at low temperature conditions was tested, even with ice and snow.



Figure 5 Train Demonstrator during testing campaign in Zaragoza-Teruel line. Ferreruela station. Credit: CAF (CC BY-NC-ND 4.0)



Figure 6 Train Demonstrator during testing campaign in Zaragoza-Teruel line. Teruel station. Credit: CAF (CC BY-NC-ND 4.0)

### 1.3 Madrid-Talavera line

One of the main characteristics of the tests on this line is that the demonstrator train ran at a high average speed.



Figure 7 Train Demonstrator during testing campaign in Madrid - Talavera line. Talavera Station. Credit: CAF (CC BY-NC-ND 4.0)

### 1.4 Madrid-Caceres – Merida line

In the Madrid-Caceres line the maximum autonomy of the train demonstrator was tested, with 616Km when running from Humanes to Caceres, and increasing it up to 804Km when running from Humanes to Merida.



Figure 8 Train Demonstrator during testing campaign in Humanes-Caceres line. Caceres Station (1/2). Credit: CAF (CC BY-NC-ND 4.0)



Figure 9 Train Demonstrator during testing campaign in Humanes-Caceres line. Caceres Station (2/2). Credit: CAF (CC BY-NC-ND 4.0)

## 1.5 Minho line in Portugal

Without any doubt, the most relevant experience during the tests in this line is being the first hydrogen train to run in Portugal.



Figure 10 Train Demonstrator during testing campaign in Portugal. Viana do Castelo Station. Credit: CAF (CC BY-NC-ND 4.0)



Figure 11 Train Demonstrator during testing campaign in Portugal. Darque Station. Credit: CAF (CC BY-NC-ND 4.0)

## 1.6 Ourense-Santiago line

Last but not least, the testing in the Ourense-Santiago line have offered to the train demonstrator the opportunity to test its performance in steep gradients.



Figure 12 Train Demonstrator during testing campaign in Ourense-Santiago line. Santiago de Compostela Station. Credit: CAF (CC BY-NC-ND 4.0)

## 2. Conclusions

The demonstrator train has successfully completed this stage of testing, after 10,000km in H2 mode, 6000 km in electric mode, and 37 days of dynamic testing. Approximately 2200kg of H2 have been consumed during this testing stage.

The train has overcome limits and boundaries. The project's objective of extending the number of use cases for the hydrogen trains is fully met.

The experience with the demonstration train service has been a great success and the partners are proud of the results achieved.

During this task and intensive collaboration and coordination has been required between the partners. The completion of this task demonstrates the good cooperation between all of them.

The data collected during this Task is the basis for the definition of the KPIs and the analysis of the competitiveness to be developed in the WP6, during the next project stages.

### 3. References

- [1] European Commission, “Grant Agreement Number- 101006633 - FCH2Rail,” 2020.
- [2] Consortium FCH2Rail Project, “Consortium Agreement FCH2Rail,” 2020.

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