FCHO Final Implementation Report

FUEL CELLS AND HYDROGEN OBSERVATORY

Co-funded by the European Union

Clean Hydrogen Partnership

TABLE OF CONTENTS

1. Introduction 2
2. Updates to the portal 3
3. Portal development and status 3
4. FCHO Chapters 4
   4.1. Technology and market 4
      4.1.1. Size of FC market 4
      4.1.2. Hydrogen Supply 5
      4.1.3. Hydrogen Demand 6
      4.1.4. Levelized Cost of Hydrogen 6
      4.1.5. Hydrogen pipelines 7
      4.1.6. Hydrogen refuelling stations 8
      4.1.7. Registered FCEVs 8
      4.1.8. Company directory 8
   4.2. Patents 9
   4.3. Publications 9
   4.4. Education and training 9
   4.5. Policy and RCS 10
      4.5.1. Policy 10
      4.5.2. Standards 10
   4.6. Funding and finance 10
   4.7. Market Data Platform 10
5. Annual reports 12
6. Outline handover plan 12
7. Summary 13

Appendix 14

1. Introduction

The vision for the Fuel Cell and Hydrogen Observatory is to become the go-to, single point of reference for all stakeholders interested in sourcing up to date and relevant information on the hydrogen and fuel cell sector. The ambition is to encompass such information and data of interest to national and international policymakers, industry players, investors, as well as to the education sector and more broadly the general public. The FCHO has been designed to achieve the objective of a dynamic, interesting portal which is intuitive to the user, an iterative process of user testing was undertaken involving Clean Hydrogen JU and test users and feedback on the design and presentation was included. The resulting front end is visually appealing and designed for ease of extraction of data and information. Initial user feedback coming from the Advisory Group and selected industry stakeholders, has been overwhelmingly positive.

This final implementation report documents the changes and updates on the FCHO since the launch of the FCHO in September 2020. This report covers the period of October 2020 – April 2022 and details the developments during this period, the data collected, and any issues or lessons learned arising.

The FCHO had its public launch in September 2020[1], during which the following datastreams went live:

- Technology and Market
- Hydrogen Supply and Demand
- Policies
- Standards
- Patents
- Education and training

The recording of the public launch, the presentations and a document with Q&A are available on the FCHO portal.[2]

In November 2020, a further 'mini' launch took place at Hydrogen Week to launch the Education & Training chapter of the portal.[3]

In March 2022 there have been updates to the data on the portal along with the publication of a new set up updated reports covering the progress in the sector during 2021.

[1] See Appendix for Launch event summary
[2] https://www.fchobservatory.eu/news-events/fuel-cells-hydrogen-observatory-launch-webinar
[3] https://www.fchobservatory.eu/news-events/fch-observatory-education-and-training-chapter-portal-now-live

2. Updates to the portal

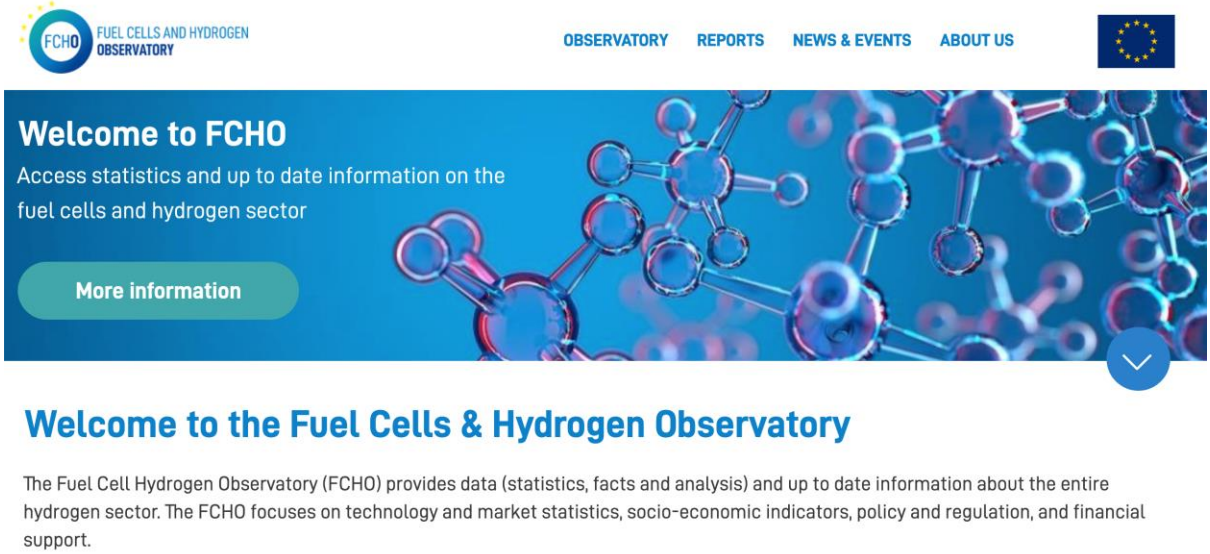
The updates listed below have been completed since the 2020 interim report and the launching of the FCHO portal. Further detail is provided in the respective sections of this report:

- Technology & Market chapter
  - Fuel cell shipment data: Data and visualisations updated.
  - Hydrogen supply capacity: Data updated. Plant locations added to map.
  - Hydrogen demand: Data and visualisations updated.
  - LCOH: A new section on the levelized cost of hydrogen for both grid-connected electrolysers and electrolysers directly connected to renewables has been added.
  - Hydrogen pipelines: A map showing existing hydrogen pipelines was added.
  - Hydrogen refuelling stations: A section on the historical deployment of HRSs was added.
  - Registered FCEVs: Data and visualisations were updated. Data was reviewed and some prior inconsistencies addressed.
- Patents: Patent registration data and visualisations were updated. Analysis of patent filing and granting statistics was also carried and included in a separate report appendix.
- Publications: Data updated.
- Policy and RCS:
  - Policy: Data and visualisations were updated.
  - Standards: Data and visualisations were updated.
- Education and Training chapter:
  - Education Materials: Data updated.
  - Training: Data updated.

3. Portal development and status

The site map underwent a number of iterations during the development phase to ensure that the site was dynamic and interesting to the user. The homepage is depicted below:

Figure 1: The homepage of the FCHO



The site map has been updated from the Inception phase such that the user has a number of ways of accessing the Observatory (charts and data) from the homepage. Sections on Reports, News & Events

and About Us were added alongside the FCHO Twitter feed. Ancillary information such as Glossary, Data Protection and Legal Notice were also populated.

The portal is fully operational, with users of the portal able to access reliable data on a number of aspects of the hydrogen sector. As the portal is functional, the changes to it were updates to the contents rather than any specific changes to the layout or way in which data is displayed.

The only change visible to someone accessing the portal will be the update of the Financial Support section. This section will now provide a link to the European Commission's "Hydrogen Public Funding Compass" due to the contract with the Innovation Loop ending, removing access their database.

Should Clean Hydrogen JU want to extend the operation of the portal, this is one area for future improvement.

4. FCHO Chapters

4.1. Technology and market

The Technology & Market chapter contains the following sections:

4.1.1. Size of FC market

Fuel cell shipment data in this initial version of the portal is sourced from E4tech's Fuel Cell Industry Review 2019 (FCIR1). This is comprised of information collated from more than 100 actors in the fuel cell space. Future updates to this section of the portal will be conducted via an annual data collection cycle and using the Market Data Platform, see section 3.1.2. The data is consolidated to provide the necessary confidentiality required by industry.

The following charts are available to the user:

- Shipments by Fuel Cell type
- Shipments by Region of Integration: Region where the final manufacturer – usually the system
- integrator – integrates the FC into the final product. This is a **new** analysis for the FCHO.
- Shipments by Region of Deployment

The capability to download data and charts is available to the user here as well as throughout other relevant parts of the Observatory. Future data collection cycles will also attempt to collect historic and current shipment data on electrolysers as well as system components.

It is worth restating that E4tech secures this information having built considerable trust with industry players over many years. Clear positioning will be required in the communication around the market data platform to provide the assurances that will be required to secure ongoing industry participation for the data collection cycle.

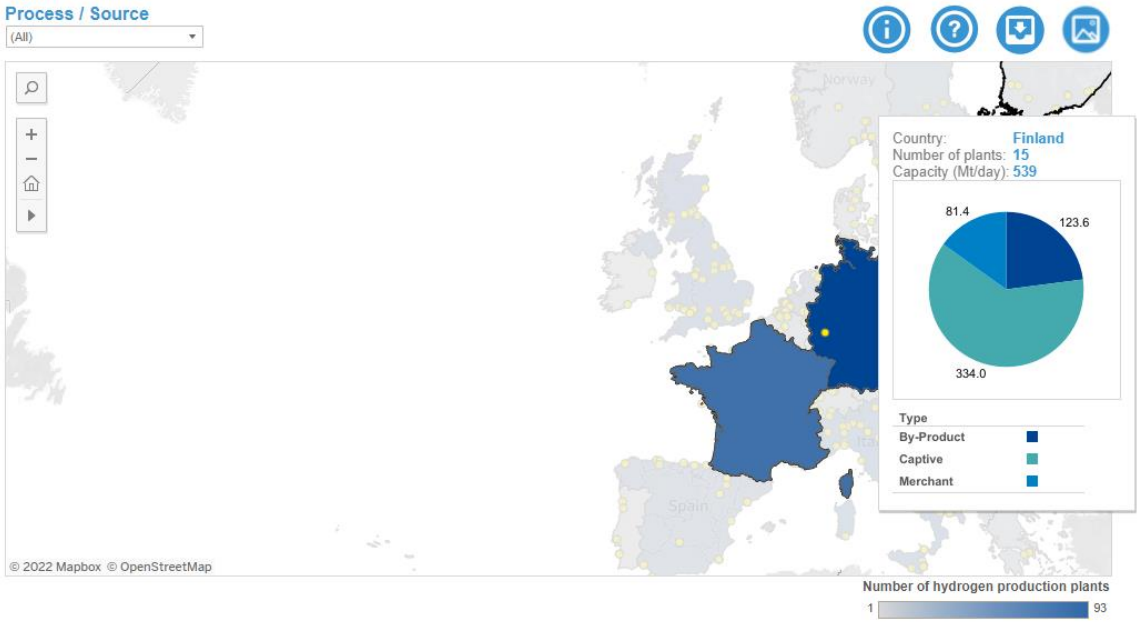
Data collection for both 2020 and 2021 shipment data, managed by E4tech, progressed smoothly. The data collection was undertaken from the last quarter of 2020 to the first few months of 2021, and in the same period from 2021 to 2022. This data has been uploaded to the portal in April and the visualisations have been updated to display this latest information. Hydrogen supply capacity and hydrogen demand

Updated supply and demand data had been compiled through extensive desk research and stakeholder dialogue in 2020 and 2021. The capacity of each European nation is presented and broken down by process/source and a plant location map shows the location of hydrogen sources. The demand of each country is presented by end use application and quantity.

4.1.2. Hydrogen Supply

In this section of the portal, the data is presented in map form, depicting the hydrogen supply landscape in Europe. This encompasses all gaseous hydrogen plants or hydrogen sources and is consolidated to total volume per country. Users can view search results by Merchant, Captive and By-product categories and to filter by production process/feedstock. The source data was compiled by Hydrogen Europe using desk research, by consultation with Industry and validation with Hydrogen Europe membership. This work built on previous work undertaken within the Roads2Hy project and the Hydrogen Analysis Resource Centre, as well as the power-to-H2 projects that were compiled in collaboration with the IEA. Validation of data was a challenge due to commercial confidentialities, however this was overcome by keeping individual plant level data confidential.

Figure 2: The interactive Hydrogen Supply map



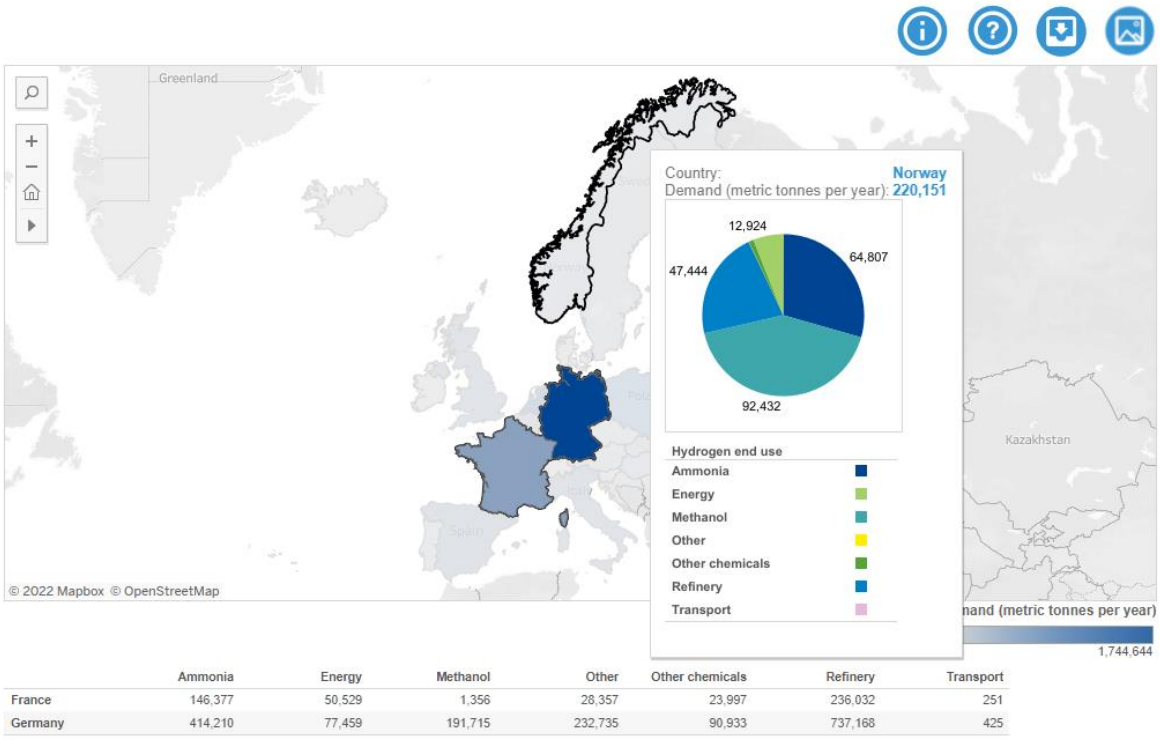
		By-Product	Captive	Merchant
France	Metric tonnes per day	448	1,664	312
	Number of plants	20	11	36
Germany	Metric tonnes per day	994	4,244	1,085
	Number of plants	27	23	63

Locations have been added to the database of hydrogen plants identifying the individual location of each plant, which involved detailed geocoordinates being allocated to each data point. This is presented to the users in a map format in alignment with other parts of the FCHO and replaces the previous hydrogen supply capacity map. Although individual plant capacities cannot be shared due the commercially sensitive nature of the data collected from respondents, the plant location map is a nice addition for users to be able to better understand dynamics of regional hydrogen supply. Electrolyser deployments are also to be captured within this section.

4.1.3. Hydrogen Demand

The Hydrogen Demand section includes information on the hydrogen volumes that make up the industrial demand for hydrogen in Europe. Again, the information is presented in map form and users can interrogate the data by country and by industry to gain an understanding of the total hydrogen consumed in the various industrial sectors. Data was sourced using desk research, in consultation with Hydrogen Europe membership and broad discussions with relevant Industry associations.

Figure 3: The Hydrogen Demand map

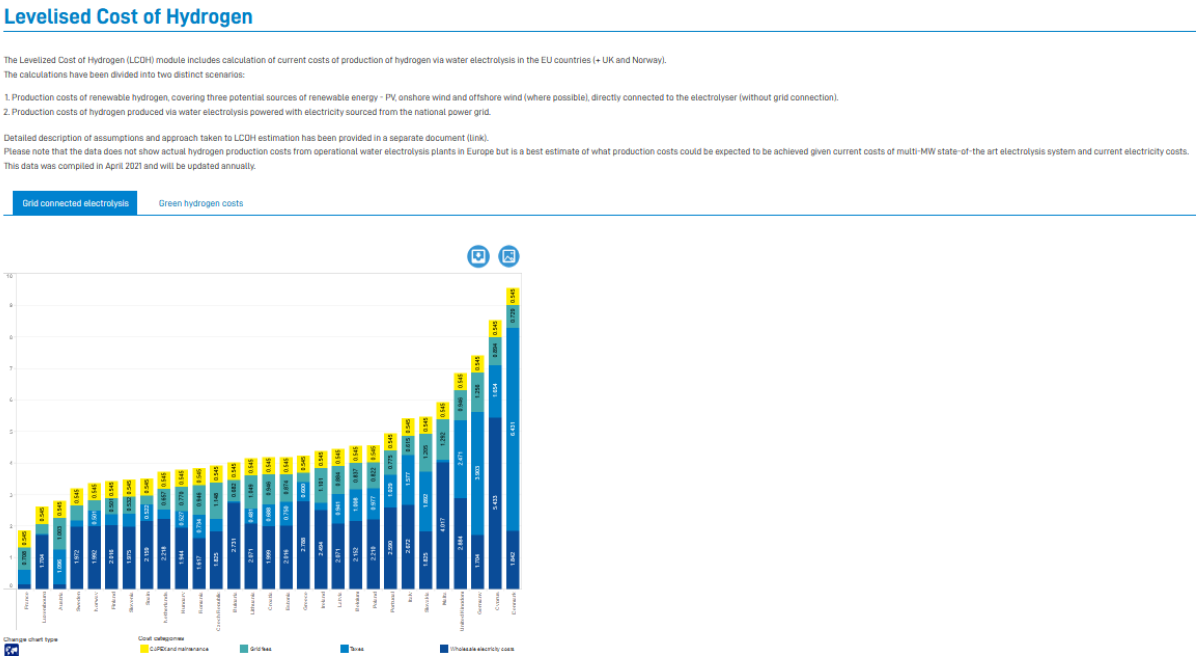


	Ammonia	Energy	Methanol	Other	Other chemicals	Refinery	Transport
France	146,377	50,529	1,356	28,357	23,997	236,032	251
Germany	414,210	77,459	191,715	232,735	90,933	737,168	425

4.1.4. Levelized Cost of Hydrogen

The levelized cost of hydrogen (LCOH) section has been completely updated since the initial data collection was undertaken in February 2020. Visualisations have been created to show LCOH for renewables connected electrolysis as well as grid connected, as shown in figure 4.
In 2022, the assumptions around the fees and costs associated with the LCOH, such as grid fees, tariffs and Capex costs have been updated for each country. The LCOH for directly connected renewable electricity sources have also been updated to reflect recent values.

Figure 4: Production version of the LOHC bar chart



4.1.5. Hydrogen pipelines

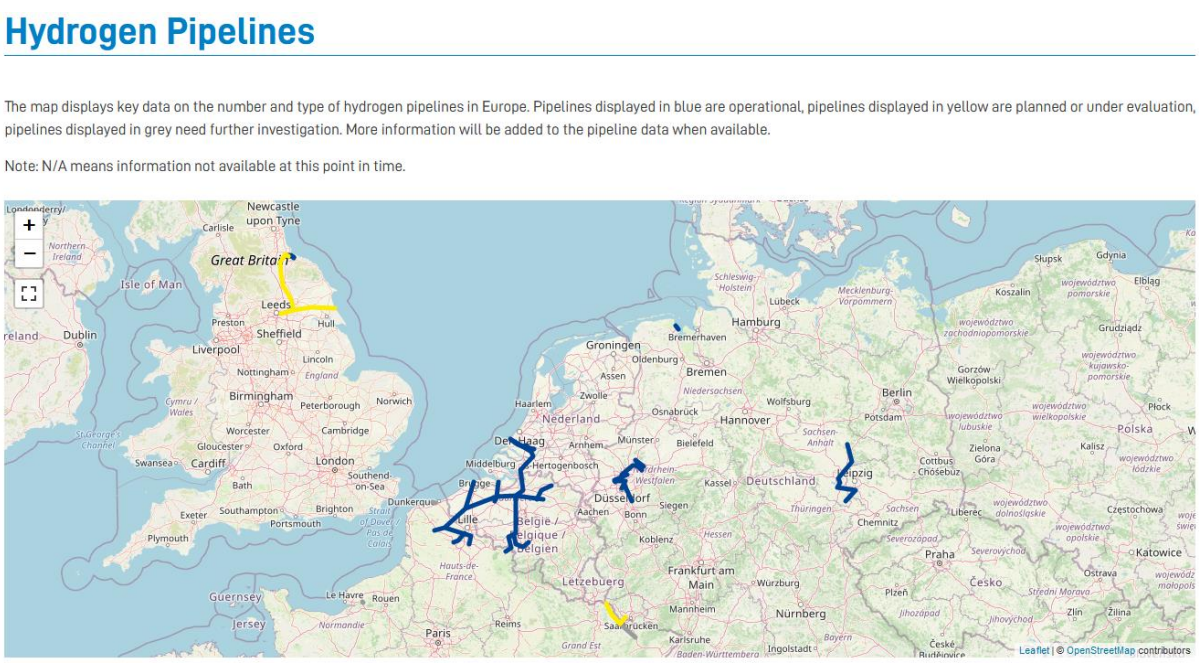
A section covering hydrogen pipelines was added to the portal in November 2020. It was envisaged that this section would depict a map of all the hydrogen pipelines in Europe, along with the high level capacities of each network. The following data elements were collected (when available):

- Status: Existing/planned
- Owner
- End-users
- Typology
- Capacity
- Diameter
- Pressure
- Material

An initial data set was used for the first visualisations, with the data validation between Hydrogen Europe (the datastream owner) and pipeline owners ongoing throughout the project. The current dataset shows all operational pipelines at the time of publishing, but there are some gaps in the data elements due to their potentially commercially sensitive nature.

The production version of the pipeline map is show in Figure 5.

Figure 5: Production version of the hydrogen pipeline map



4.1.6. Hydrogen refuelling stations

While the availability system data on this part of the portal is supplied directly from the European Hydrogen Refuelling Station Availability System (E-HRS-AS), the cumulative data was only represented up to 2020.

The cumulative data has now been updated to show how the number of HRS has changed in 2021.

4.1.7. Registered FCEVs

The source data for fuel cell vehicles displayed on the portal is derived from data collected by Fier for the EAFO portal. The process for data collection on passenger cars was robust, as Fier used national registration databases. However, this was not the case for other vehicles and the data collection process instead relied on media announcements, market information etc. and was therefore more likely to be inaccurate. E4tech undertook extensive validation and correction of the data in order to be confident to upload it to the portal which was a time-consuming process. This issue can be addressed through the closer collaboration between EAFO and FCHO that has been envisaged for future funding rounds of the two observatories.
This section was updated in March 2022 to reflect the registrations of FCEV across Europe in 2021. There have also been some small changes to 2020 values.

4.1.8. Company directory

The company directory database contains more than 300 actors in the fuel cell and hydrogen space. This is an update of previous work undertaken in the FCHJU value chain study. The database is Excel based, supplemented by additional desk research completed by E4tech in Spring 2020. The company information is viewed on a comprehensive interactive map which allows the user to search by free text and/or filter by several categories. The FCHO has an aspiration to broaden the database of supply chain actors in the future.

4.2. Patents

Patent data can be viewed in the portal either via a map or via a chart, displaying the number of registered patents for various classifications by country, by year. This patent data was extracted from the PatBase database on 15-17 February 2020 by project partner, HGF. This data is classified according to an established classification system, the Cooperative Patent Classification (CPC), and the bounds of the analysis are determined by the classifications that are allocated when registering the patent. Therefore, the analysis is reliant upon the most appropriate (and appropriate level/sublevel) of classification.
HGF conducted further data searches in February and March in both 2021 and 2022, and the data obtained was uploaded to the portal to offer an up-to-date view. Following feedback from the FCHJU, new data searches were included in the analysis and this has fed through to the annual report.

4.3. Publications

The number of publications in the hydrogen and fuel cell space can be viewed by country and by year, either in a map or chart form. The source data has come from the JRC TIMS portal and therefore has classifications set by TIM. The first dataset was obtained in January 2019 and was then updated annually.
The data spans several files and is cleaned and consolidated before uploading to the FCHO. As this data contains personal information (names of authors) the background file cannot be downloaded from the FCHO due to data protection considerations.
Duplicates exist in this dataset where a publication may be relevant to more than one sub-category. This is unavoidable and therefore we include an explanation to this effect on the portal.
Publication data for 2021 was received from JRC TIMS[4] and has also been uploaded onto the system in March 2022.

4.4. Education and training

The Education & Training chapter was launched in November 2020 based on the first round of data collection. Working with Hydrogen Europe Research (HER) post the launch, we decided to rework the questionnaire in its entirety, as the original did not provide the detail or clarity that we had hoped. This meant essentially starting the chapter from scratch but within the limitations of the system architecture that had already been created. Subsequent manual work arounds had to be undertaken by HER as the architecture had been written based on the original questionnaire.

Although the data collection and formatting of data received was a time-consuming exercise, nevertheless a very good response was received, and a strong dataset now exists on which to build future analysis. This is reflected in the first annual report for the Education & Training chapter.

If a further iteration of the FCHO is to be commissioned, it is recommended that resources be allocated to fine tune this chapter in order to eliminate the manual work that is now included as part of the data collection.

The Education & Training chapter was updated with information collected in January and February 2022 to illustrate what courses and qualifications are available to benefit those who work or wish to work in

[4] https://www.clean-hydrogen.europa.eu/knowledge-management/tools-innovation-monitoring-tim-0_en

the hydrogen sector. Publicly accessible educational materials for people interested in the fuel cell and hydrogen field have also been updated.

4.5. Policy and RCS

4.5.1. Policy

The policy questionnaire is extensive and complex in structure, with a number of dependent variables. In the first iteration, some of the detail in the data could not be fully extracted due to the system architecture deployed. Resources were prioritized to put in place a solution which resolved some the issues (within the budget resources available). These changes facilitated efficient data analysis in 2021 compared to 2020, which was evident in the Policies annual report of 2021 .

Both the EU and National Policy sections of the portal have been updated with data collected in February and March 2022.

The National policy data is accessed through a world map and broken down by incentives and other policies.

4.5.2. Standards

The standards database was entirely updated as part of the data collection cycle for 2020. Some minor changes have been made to the presentation on the portal to improve the presentation i.e. elimination of duplicate pathways when searching.

The standards database was again updated in 2022, as part of the data collection cycle for 2021.

4.6. Funding and finance

The initial scope of works on the finance chapter involved developing an API to extract data from the Innovation Loop portal. Unfortunately, this proved technically challenging due to the nature of how Innovation Loop's portal worked (searching many other websites/portals) and an alternative approach was developed. Inycom implemented a 'window in window' solution, similar to that employed for HRS-AS. This meant that users of the FCHO who were accessing the funding chapter, undertaking searches and seeing results directly from the InnoLoop platform. By incorporating the FCHO branding, this meant that the user had a seamless experience and there was no 'step out' from the FCHO. This approach also meant that any updates were available to the user as soon as they were implemented on the InnoLoop site, meaning there was no time delay updating different portals. Searches were performed on InnoLoop's portal using their AI functionality, broader than a keyword search. This retrieved results which had synergy with the search criteria in addition to the exact results, offering a broader service to the user.

In May 2022, the contract with Innovation Loop expired, and this section of the portal was replaced with a link to the Hydrogen Public Funding Compass. In the expected continuation of the portal, this issue can be addressed with an alternative approach.

4.7. Market Data Platform

The scope of the market data platform was to collect market data in an annual cycle, which would then be used to publish information in charts and maps in different parts of the portal. The MDP is an interactive tool that was developed to collect information to feed the FCHO. It was designed with a built

in QA process based on the experience gained through many years of assembling the Fuel Cell Industry Review. Each company profile on the MDP would be owned by the users from that company that were given access to the profile. Those users would also be able to provide updates to their company profile at any time. The platform was designed to be able to accommodate the existing Excel data tables of historical information from the FCIR alongside E4tech's in-house actor database as well as future data which would be input directly by users into the MDP. The aspirations for the MDP were high; it is an extensive and complex tool, involving many datapoints per record (company) as the more comprehensive the data collection capability, the more valuable the analysis will be to the users.

Testing of the MDP was carried out and a number of issues were identified and addressed. Extensive internal and external testing of the MDP was a priority as it was believed that this will be critical in supporting the acceptance of and engagement with the MDP. As testing of the MDP could not be completed in time to support the 2021 data gathering cycle, the traditional data gathering process was employed, with a roll-out anticipated for the final data gathering cycle. However, testing revealed that further development was required, and deployment was put on hold to focus on updating the other FCHO sections. It was agreed with Clean Hydrogen JU that the MDP would remain with E4tech rather than on the FCHO.

5. Annual reports

The annual reports published on the portal in Spring 2020 and 2021, with the most recent set of annual reports finalized and uploaded to the portal in 2022. The set of published 2022 reports includes the following:

- Chapter 1: Technology and Market
  - Along with the sections from previous years covering Fuel Cell shipments, operational HRS and FCEV registrations in Europe, this year introduces a section on the deployment of electrolysers. This new section features information on the number of electrolyser units deployed in Europe from 2000 up until 2021. The data is further broken down by electrolyser type, application and region of deployment.
- Chapter 2: Hydrogen Supply and Demand
- Chapter 3: Policies
- Chapter 4: Standards
- Chapter 5: Patents report and Appendix
- Chapter 6: Education and Training

6. Outline handover plan

In view of the upcoming end of the contract to maintain the FCHO portal, Inycom have written a handover document to facilitate the transfer of the portal. The handover document covers the following areas:

- Portal management and structure
- Back-end management guide
- IT management guide
- Additional considerations

This document, together with the collaborative support from Inycom will enable the smooth transfer of the technical management of the platform. The handover is expected to take place in June, as soon as the Clean Hydrogen JU signs the contract with the contractor who will take-over the platform.

7. Summary

The status of the FCHO update for 2022, for Milestone 5 is shown below

Existing	Data Collection 2020	Presentation on the Portal	Annual Report 2021	Annual Report 2022
Portal Structure & detailed site map	N/A	●	N/A	N/A
Technology & Market	●	●	●	●
Supply & Demand	●	●	●	●
Patents	●	●	●	●
Publications	●	●	●	●
Policy	●	●	●	●
Standards	●	●	●	●
Financial Support	●	●	N/A	N/A
HRS Availability System	●	●	Incl. in Tech & Market	Incl. in Tech & Market
EAFO FCEV deployment data	●	●	Incl. in Tech & Market	Incl. in Tech & Market
Education & Training	●	●	N/A	N/A
Plant Location Map	●	●	N/A	N/A
Pipelines	●	●	N/A	N/A
LCOH	●	●	N/A	N/A
Electrolyser data (included in Supply & Demand report)			●	●
Electrolyser deployment data (included in Technology & Market report)				●

Appendix

Launch event

In the framework of the launch of the portal, a launch event was organised to bring together the stakeholders, inform them about the FCHO and allow them to give a first feedback. The event was take place online on 15.09.2020 at 10:00 to 11:40.

The registration was open on August, 10th. In total, 1603 people registered and 1019 joined the event. The average time of staying on line was 53 minutes.

On 8th August two social media accounts were created: LinkedIn and Twitter.

The FCHO has a Twitter account, @FCHObservatory and LinkedIn account, Fuel Cells & Hydrogen Observatory (FCHO). These accounts shared relevant information and updates on the launch event. In the weeks before the launch the accounts shared mostly information about the event, speaker announcements, agenda updates and urged people to register. A special hashtag, #FCHO, was created for these tweets. The developments were also shared on project/partners social media accounts.

Followers:

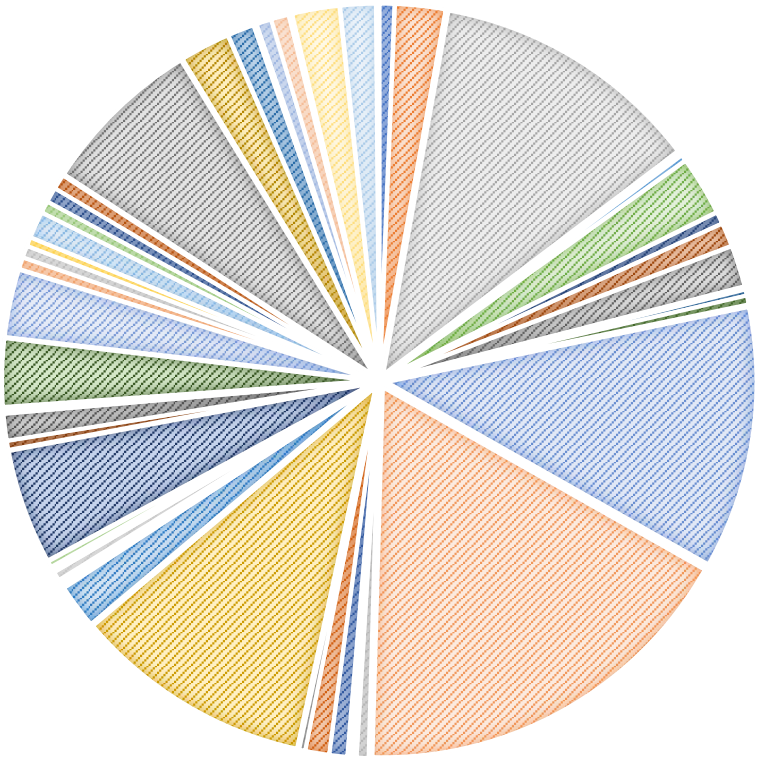
- LinkedIn - 924 followers (as of September 2020).
- Twitter - 298 followers (as of September 2020).

The press release was sent to all registered people who agreed receiving marketing emails from FCHO on 15th September (afternoon). Additionally, the press release was sent out from project partners as a newsletter/email blast. Once the press release was sent, the news was published on the FCHO and other project partners websites.

On 18th September (Friday) the thank you email was sent to all attendees who agreed receiving marketing emails from FCHO. The email contained the link to the recording and post event survey and presentation.

The questions asked during the launch were gathered and answered. The pdf document was shared on the FCHO website alongside Twitter and LinkedIn announcements on 28th September.

ATTENDEES BY COUNTRY

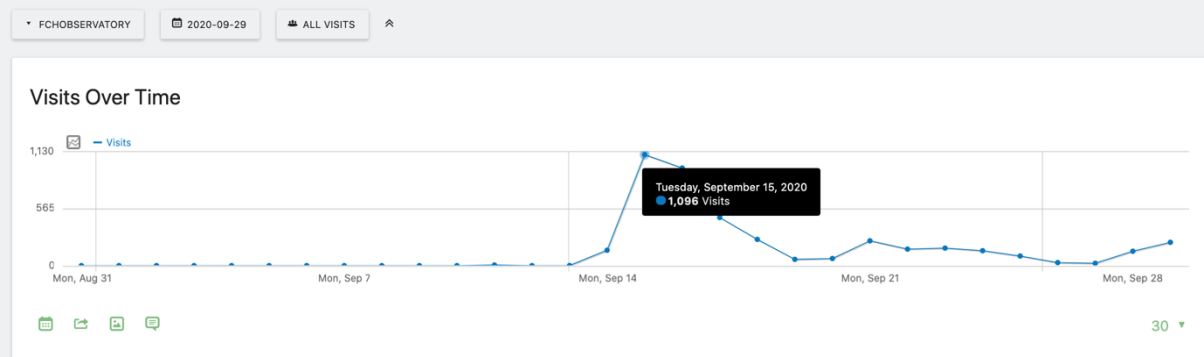


- Australia
- Austria
- Belgium
- Bulgaria
- Canada
- Chile
- Croatia
- Czechia
- Denmark
- El Salvador
- Estonia
- Finland
- France
- Germany
- Greece
- Hong Kong SAR
- Hungary
- Iceland
- India
- Ireland
- Israel
- Italy
- Japan
- Korea, Republic of
- Latvia
- Lithuania
- Luxembourg
- Malta
- Mexico
- Morocco
- Netherlands
- Nigeria
- Norway
- Peru
- Philippines
- Poland
- Portugal
- Romania
- Russian Federation
- Saudi Arabia
- Singapore
- Slovakia
- Slovenia
- South Africa
- Spain
- Sweden
- Switzerland
- Taiwan
- Turkey
- Ukraine
- United Arab Emirates
- United Kingdom
- United States of America
- Zimbabwe

Portal Statistics

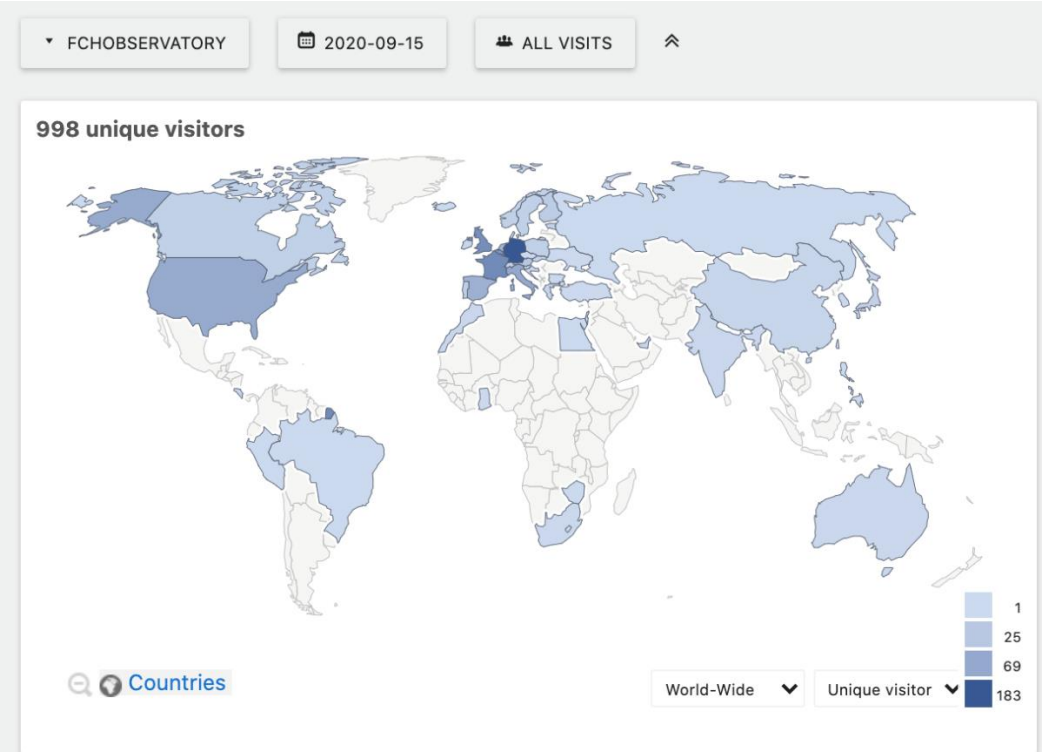
Portal visitors on go live day 15th September

Figure 6. Portal stats post launch



Peak visitors occurred on the launch day and amounted to 1,096 hits to the portal. The number of unique visitors was 998 coming from across the globe as shown in the map below.

Figure 7. Geographical spread of visitors to portal on launch day



Total number of discrete countries from which users accessed the portal on launch day was 51.

Figure 8. Breakdown by continent of users accessing the portal on 15th September

CONTINENT	UNIQUE VISITORS
Europe	857
North America	80
Asia	44
Africa	12
Oceania	5
Central America	2
South America	2
Unknown	2

Launch day visits Overview

1,096 visits, **998** unique visitors

5 min 51s average visit duration

38% visits have bounced (left the website after one page)

5.7 actions (page views, downloads, outlinks and internal site searches) per visit

Summary

The FCHO launch can be considered to be a huge success. The program for ongoing communications to keep the FCHO profile high is in development and will be shared with the FCHJU.