



**FUEL CELLS AND HYDROGEN**  
JOINT UNDERTAKING

## **E-HRS-AS**

**European HRS  
availability system**



**Nadine Hoelzinger**

**Spilett n/t GmbH**

**[h2-map.eu](http://h2-map.eu)**

**[nadine.hoelzinger@spilett.com](mailto:nadine.hoelzinger@spilett.com)**

**Programme Review Days 2019**

Brussels, 19-20 November 2019



# Motivation and objectives



**There is a growing network of HRS in Europe:** > 140 now in operation, expected to grow to 230+ by the early 2020s.

However, even with this additional infrastructure, the network will remain relatively sparse for several years.

**Providing information on the status of HRS in real time** is an important part of ensuring that the user experience of early adopters of FCEVs is positive.



Source: [cleanenergypartnership.de](https://cleanenergypartnership.de)

**The main aim of this initiative** is to connect all operating publicly accessible HRS in Europe to the HRS availability system in 2019.

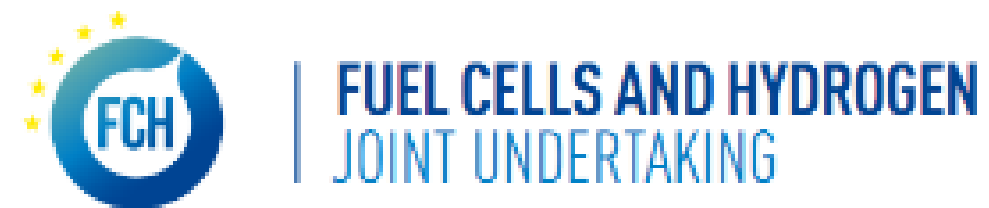
**A second objective** is to continue operation of the system into the 2020s.



# The project team



## ORGANIZATION



## MAIN CONTACT

Enrique Giron

Nadine Hoelzinger  
Marcus Merkel

Tomas Bayer  
Matthias Luettgert

Michael Dolman  
William Nock

## ROLE IN THE PROJECT

- *Study sponsor*
- *Strategic oversight*
- Project lead
- System roll-out support
- Collate lessons learned
- System roll-out (technical lead)
- Create & manage HRS AS platform
- Stakeholder engagement
- Business case development



# Project timeline



- The FCH JU supported the proof of concept of the HRS Availability System (2017/18) and the funding the deployment of the system across Europe (2018/19).
- The FCH JU and the wider project team have an ambition to see continued operation and expansion of the system (connection of new stations) into 2020 and beyond.

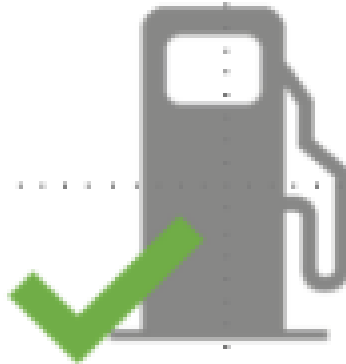
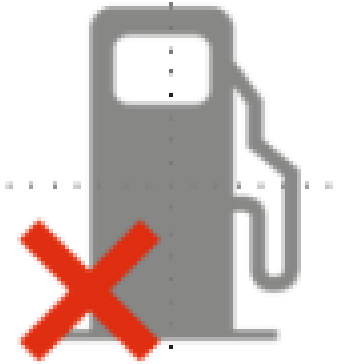

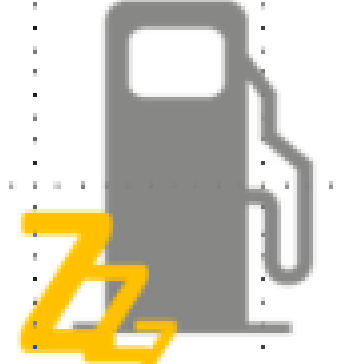
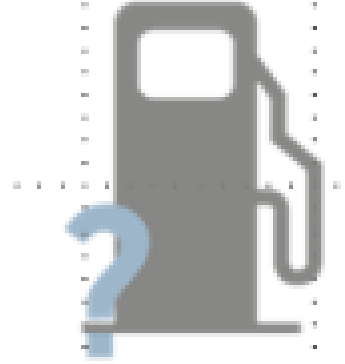




# Retrospective: Phase 1 of the study






## During the first phase of this study we:

- Assembled a group of stakeholders and developed a common definition of HRS availability
- Developed a technical solution to allow the real-time availability of HRS to be communicated publicly
- Demonstrated the system via a proof-of-concept trial
- Collated a register of HRS in Europe (existing / planned)
- Assessed the costs of implementing the system across all stations, and explored potential business models for on-going operation of the system

available	unavailable	restricted available	outside opening hours	no information
				



**Availability states:** “What will the customer experience when standing in front of the dispenser?”

<b>Available</b> 	<b>Limited availability</b> 	<b>Unavailable</b> 	<b>No live status</b> 
The HRS is open and the selected fuel type is available for refuelling.	Refuelling is possible but may be subject to delays or restrictions. Assistance from a technician on site may be needed.	<p>The HRS is open but refuelling is currently impossible.</p> <p><b>Outside opening hours</b> </p> <p>Refuelling is currently impossible because the HRS is outside its opening hours.</p>	The HRS is currently open but the E-HRS-AS does not have sufficiently recent information about hydrogen availability at this station.

**Type A HRS:** A station using a transmitter hardware on site to send updates on signals every minute.

**Type B HRS:** A station transmitting its availability state from the monitoring system via software interface at a defined update interval (< 60 min) and / or on signal change.

**Real-time availability:** Update frequency of 1/min (type A HRS) and <1/hour (type B HRS)

*Manual signal change is only possible as follows: “available -> limited / not available” (not vice*



# Visualization of the data: Real-time availability information

h2-map.eu



## HRS Availability Map

with availability data from the E-HRS-AS

### Choose H<sub>2</sub> fuelling option

700 bar

700 bar

350 bar

350 bar

### HRS statistics













#### Number of HRS

Σ total	137
700 bar	120
350 bar	41
350 bar	16

FCH JU - European Commission

### Map legend

#### HRS status

-  Available 
-  Limited availability 
-  Unavailable 
-  No live status 
-  Outside opening hours 
-  700 bar H<sub>2</sub> for cars not provided 

Availability refers to the selected fuelling option only.



# Visualization of the data: HRS site information

h2-map.eu



## Münster

✓ AVAILABLE

700 BAR

Last update: 3.11.2019, 07:12:59

HRS Site

OEM approved

Westfalen AG


Kopenhagener Straße 19

48163 Münster

Germany

Mo-Su 00:00-24:00

Services & Amenities




HRS-ID: FNBWK

Upcoming Events

Refuelling requirements

Operational Data



## Upcoming Events

upcoming restriction

All date and times below are displayed in the time local to the HRS.

starts 4.11.2019, 12:00:00

ends 7.11.2019, 12:00:00

### Jahreswartung der H2 Anlage

Betankungen sind während der Jahreswartung nicht möglich!

Refuelling will be not possible for the duration of this event.

## Refuelling requirements

Access restriction	open to the public
Authorization	H2.LIVE/CARD
Payment	Invoice via H2.LIVE/CARD

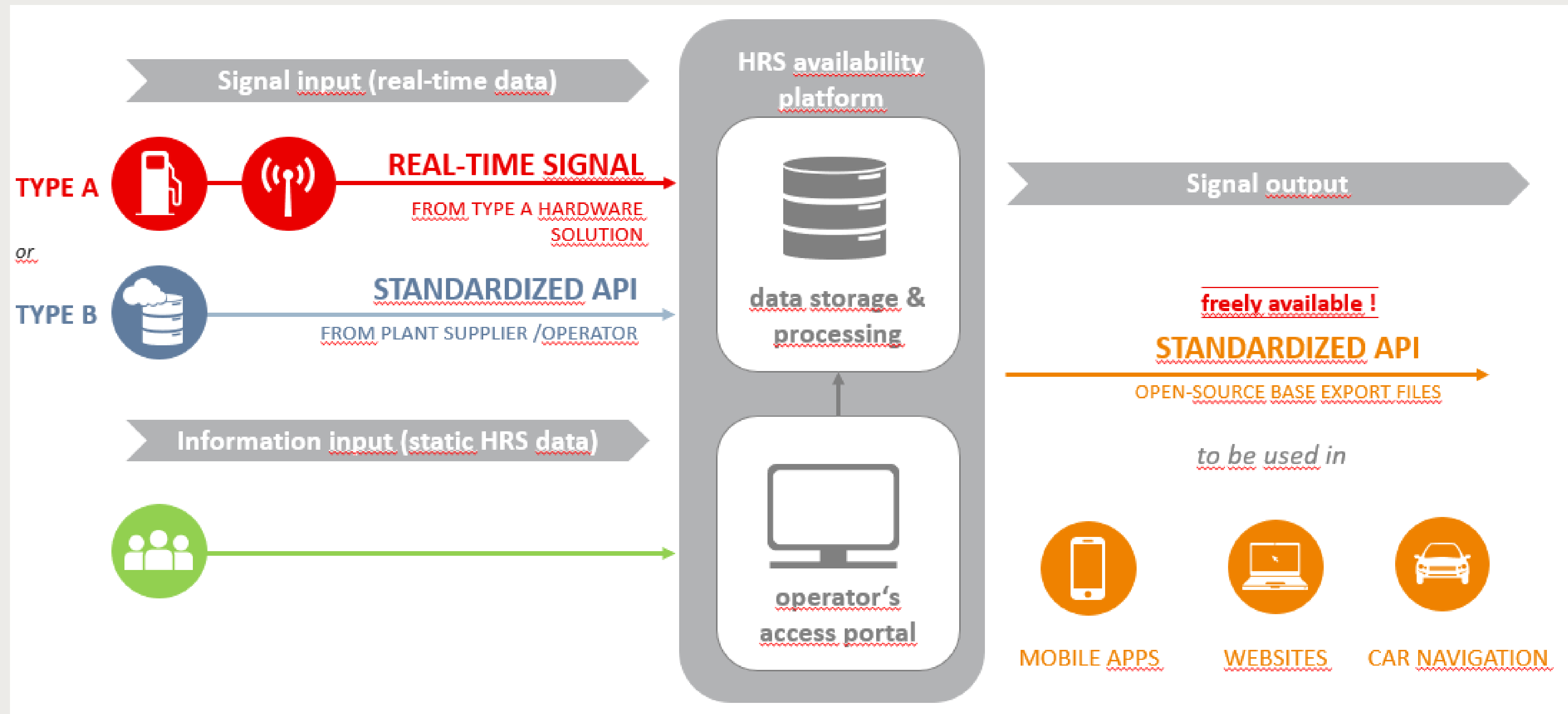
## Operational Data

Station operator	Westfalen AG
Technology supplier	Linde AG
Fuelling options	700 bar <input checked="" type="checkbox"/> OEM approved
	350 bar provided
	350 bar provided
Green hydrogen	(unknown)
Capacity	(unknown)
Station funded by	BMVI





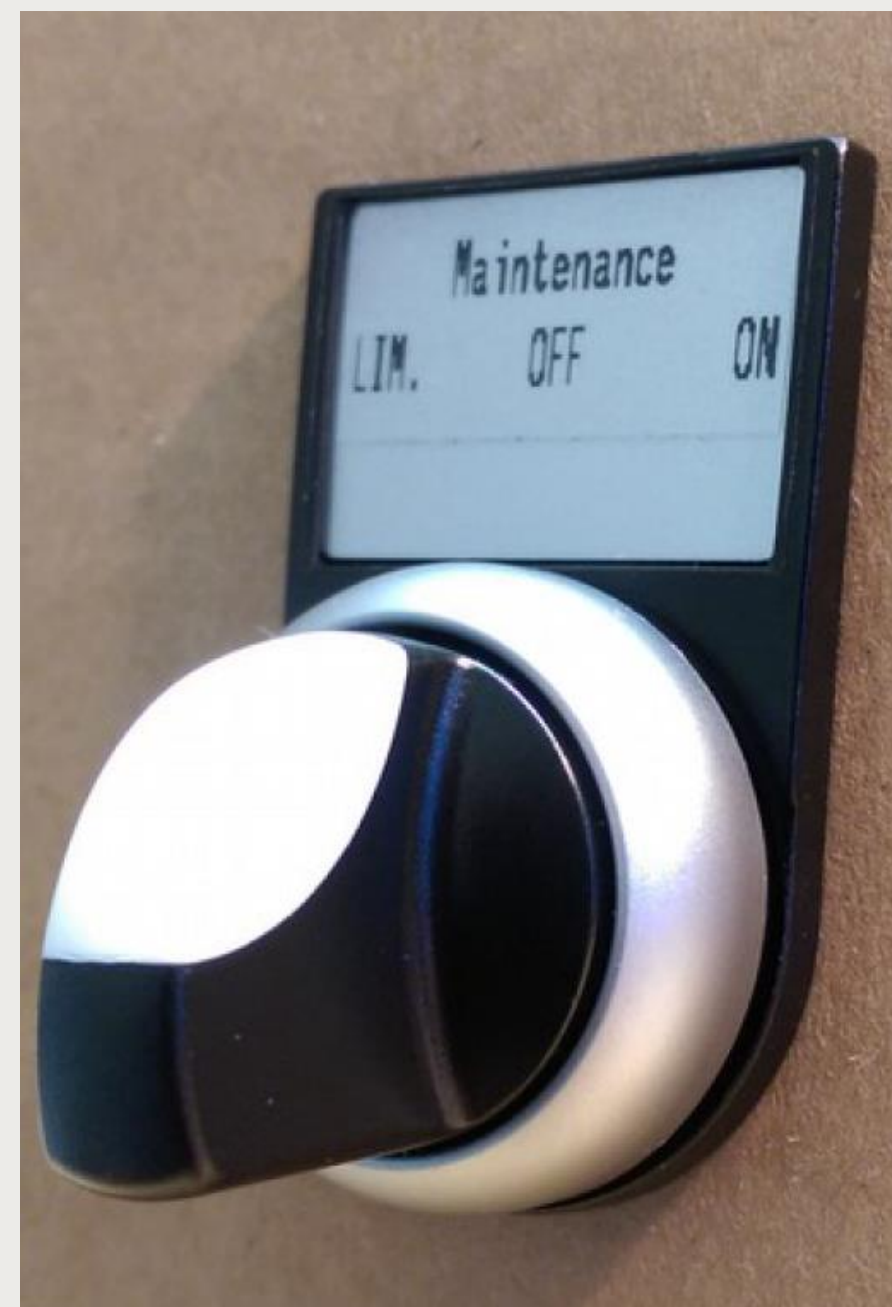
# Behind the scenes - the technical approach of the E-HRS-AS



# The E-HRS-AS signal transmission

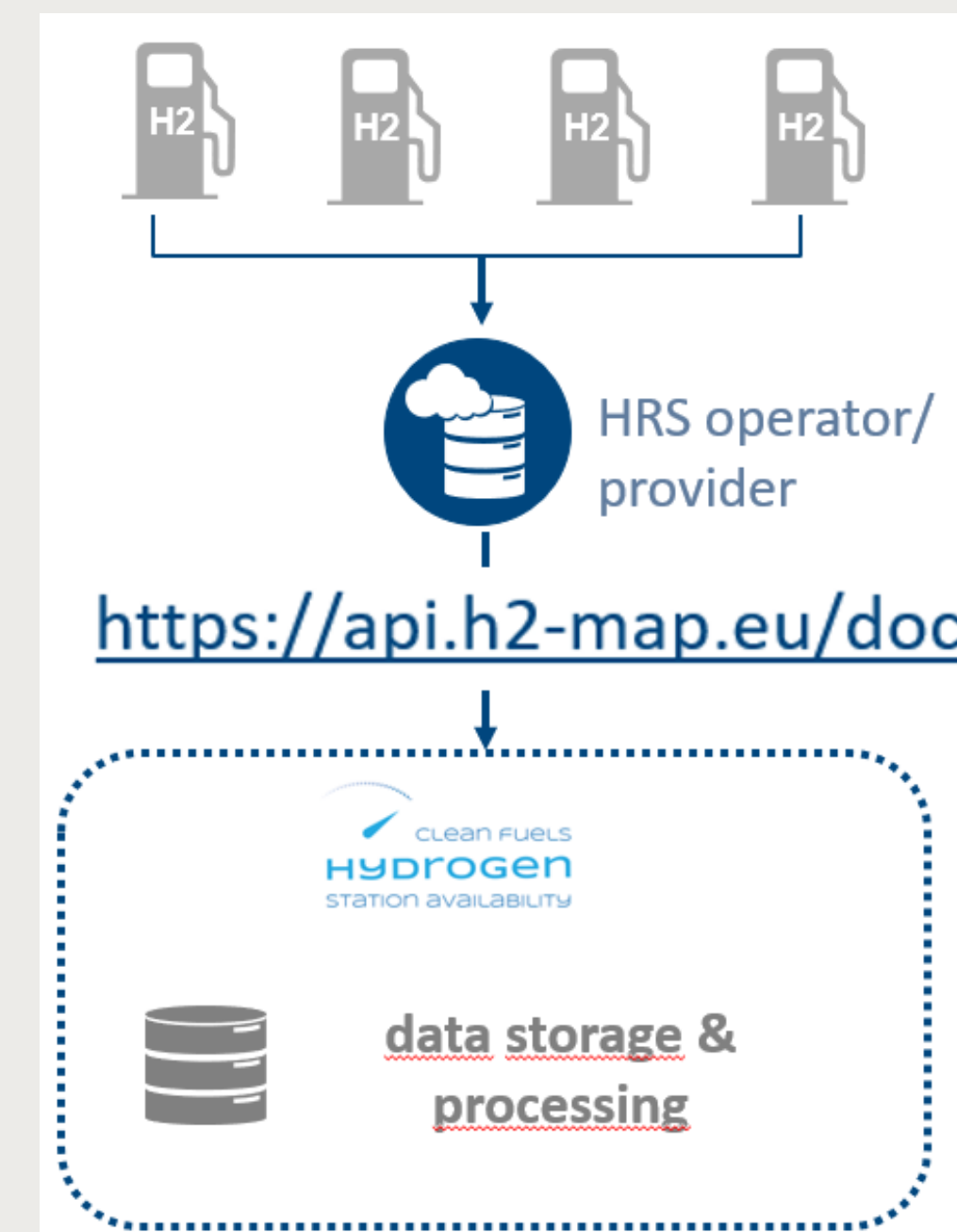
## Hardware solution

(digital I/O, RevPi transmitter & maintenance switch)



## Software solution

(API data import from HRS monitoring systems)





# Comparative evaluation of the signal transmission methods

## Pros & Cons

### Type A HRS



- reliable hardware system, easy to install
- Industry standard technologies
- comparable data sets, guarantee to conform all definitions
- signal update every 60 seconds possible
- easy and transparent trouble-shooting



- only HRS supplier or electrician is allowed to install the hardware
- pre-configuration required,
- organizational efforts for HRS retrofitting may be high

**Implementation may start promptly, depending upon technician capacities**

### Type B HRS



- compatible to plan monitoring systems (via standardized API)
- large amounts of HRS can be connected with one API (economies of scale)
- no extra hardware to be installed on site



- unclear, if signal update every 60 minutes can be realized (from monitoring system)
- quality of signals can not be verified
- risk of high cost for external programming of standardized API
- trouble-shooting in responsibility of HRS operator / supplier

**Implementation requires programming of API per operator / supplier first**

# The E-HRS-AS data export

<https://h2-map.eu/api/v1/doc/>



Individual  
export API to  
allow for  
different  
update  
frequencies  
of data files

## Authentication

- GET** List all HRS
- GET** List real-time availability statuses
- GET** Retrieve HRS
- GET** List events
- GET** Retrieve a real-time availability status
- GET** Retrieve the HRS photo
- GET** List fuel types

Documentation Powered by ReDoc

## E-HRS-AS: HRS Live Availability Status API (1.0)

Download OpenAPI specification: [Download](#)

Tomas Bayer (ENDA GmbH & Co. KG): [h2s@enda.eu](mailto:h2s@enda.eu)

### E-HRS-AS: HRS Live Availability Status API

The European Hydrogen Refuelling Station Availability System (E-HRS-AS) collects real-time availability data reported by HRS all over Europe on a non-proprietary, open-source platform.

This API provides public access to both the real-time availability status as well as various static HRS information. Despite being free for everyone to use, the API is secured by a token-based authorization mechanism in order to prevent misuse. If you would like to obtain an API token, please write an email to the contact information above.

We recommend to query status data no more than once per minute. Although there is no rate limiting in place currently, this might change in the future.

An example of how the information provided by this API can be visualised can be seen on <https://h2-map.eu>.

## Authentication

### bearerAuth

An API token issued by the E-HRS-AS is necessary to make any request. The token has to be provided in an Authorization header which should contain precisely the literal string *Bearer*, a single space and the API token in that order. Example: "Bearer 64a3468a15386b0d93c853c3cd2ba043b66a30ec"

Security scheme type:	HTTP
HTTP Authorization Scheme	bearer





# The operator's access portal

## Dashboard (starting page)



E-HRS-AS Portal

Dashboard

HRS Registry

Event scheduler

Reports

Change history

ADMINISTRATION

User administration

Statistics

OTHER APPS

Availability Map

Technician's Setup Assistant

Progress Map

Registry Admin Interface

### Dashboard

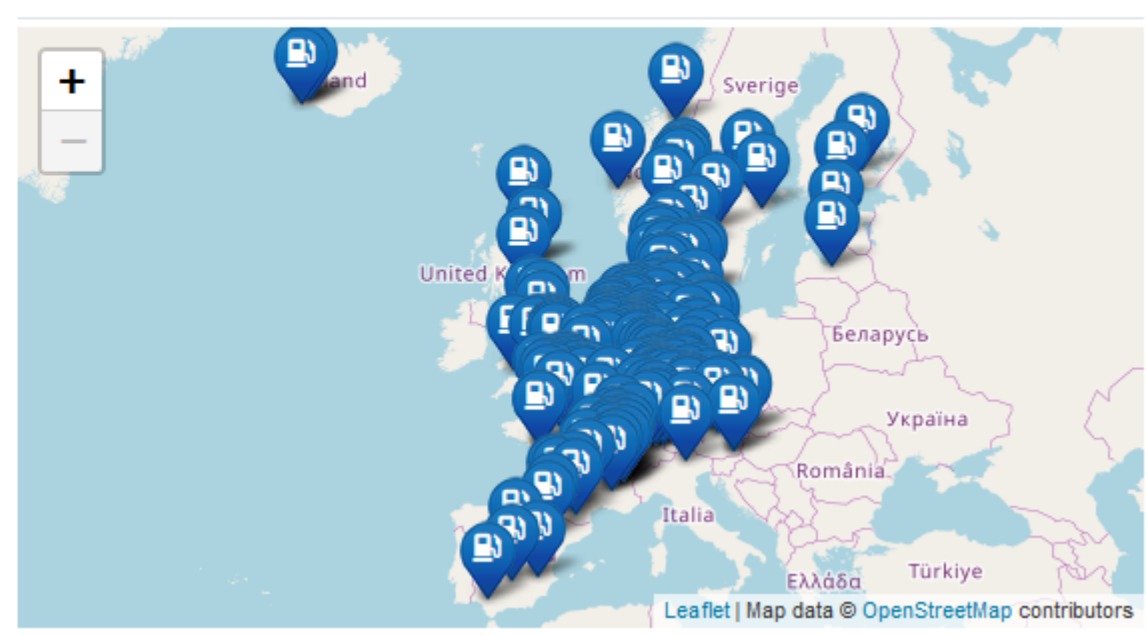
#### CURRENT PROBLEMS

HRS	Availability status	Problem
	✗ failure	700 bar H <sub>2</sub> for cars is unavailable
	✗ failure	700 bar H <sub>2</sub> for cars is unavailable, 350 bar H <sub>2</sub> for buses status could not be retrieved
	? unknown	HRS Availability Transmission System is offline
	✗ failure	700 bar H <sub>2</sub> for cars is unavailable
	✗ failure	700 bar H <sub>2</sub> for cars is unavailable
	✗ failure	350 bar H <sub>2</sub> for buses is unavailable
	✗ failure	700 bar H <sub>2</sub> for cars is unavailable
	✗ failure	700 bar H <sub>2</sub> for cars is unavailable

#### ONGOING AND UPCOMING EVENTS

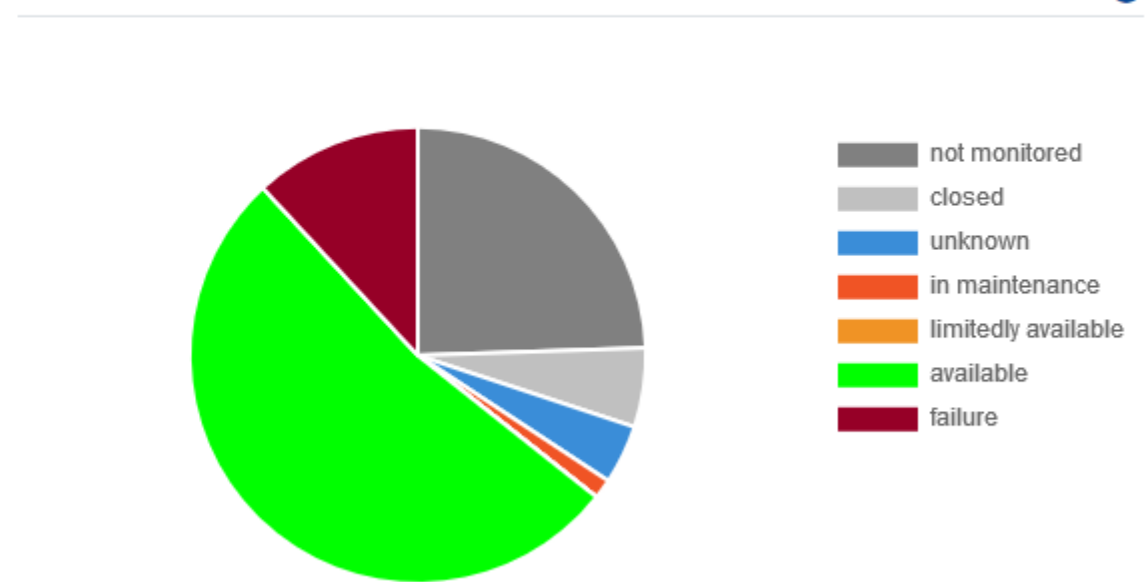
HRS	Subject	Start date	End date	Status
	Maintenance	, 2019, 9 a.m.	, 2019, 2 p.m.	scheduled and announced
	Jahreswartung	, 2019, noon	, 2019, noon	scheduled and announced
	2000h Wartung	, 2019, 8 a.m.	, 2019, 5 p.m.	scheduled
	Hydrogen station must be switched off	, 2019, 3 p.m.	, 2019, 2 p.m.	scheduled and announced

#### MY STATIONS



number of stations: 251

#### REAL-TIME AVAILABILITY





# The operator's access portal

## HRS registry



E-HRS-AS Portal

Dashboard

HRS Registry

Event scheduler

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### HRS Registry



ID	Name	Live availability status	Owner	Operator	Construction state	Country	Actions
AJMFY	Kolding	✓ available	Danish Hydrogen Fuel A/S	Danish Hydrogen Fuel A/S	in operation	Denmark	
AQAIW	Wuppertal	✓ available	H2 Mobility	H2 Mobility	in operation	Germany	





# The operator's access portal

## HRS registry



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Registry Admin Interface

Edit master data

Scheduled events

Schedule event

Change history

Reports

Configure recording

Edit HRS: Münster

FNBWK

Note: It can take up to 15 minutes for your changes to become publicly visible.

ADDRESS

Street address

Kopenhagener Straße 19

Postal code

48163

City

Münster

Country\*

Germany

GEOLOCATION

Latitude\*

51.8926045037109

Longitude\*

7.58397809011574

Entrance latitude\*

51.8921665661097

Entrance longitude\*

7.58420085966603

INVOLVED PARTIES

HRS owner

Westfalen AG

HRS operator

Westfalen AG

HRS received funding from

BMVI

(multiple selections possible)

SITE

Site operator

Westfalen AG

Site amenities

Shop, Toilets

Opening hours

Mo-Su 00:00-24:00

PHOTO

Action: 

keep

Map

Dragging the markers automatically updates the coordinates to the left.

European Union flag

# The operator's access portal

## Event scheduler



E-HRS-AS Portal

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Event scheduler

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Event list

+ Create new

HRS	Subject	Start date	End date	Availability status override	Status	Actions
	Wartung Elektrolyseur	, 2019, 8 a.m.	, 2019, 10 a.m.	no status override	expired	
	Maintenance	, 2019, 9 a.m.	, 2019, 5 p.m.	no status override	expired	
	Maintenance	, 2019, 9 a.m.	, 2019, 2 p.m.	no status override	scheduled and announced	
	Jahreswartung der H2 Anlage	, 2019, noon	, 2019, noon	unavailable	scheduled and announced	
	2000h Wartung	, 2019, 8 a.m.	, 2019, 5 p.m.	limitedly available	scheduled	
	Hydrogen station must be switched off	, 2019, 3 p.m.	, 2019, 2 p.m.	no status override	scheduled and announced	

Note: All date and times above are displayed in the time local to the respective HRS.

Create new event

Note: It can take up to 15 minutes for your changes to become publicly visible.

HRS\*

Nothing selected

HRS on which the event takes place.

Override availability status\*

no status override

This overrides the availability status for the duration of the event. It is also used to inform the customers in advance whether they will be able to refuel during this event.

SCHEDULE

Note: The date and times below are to be stated in the local time of the HRS site.

Scheduled start of event\*

Scheduled start of this event. This must lie in the future.

Scheduled end of event

Scheduled end of this event. If this is not set, it is taken to mean that the event is open-ended.

Start of customer notifications

Indicates the point in time from which on this event is visible to customers. If this is not set, the notification will immediately be visible to the public.

MESSAGE

Subject\*

The subject of the notification becomes visible to customers and should be a concise description of the event.

Message

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# The operator's access portal

## Reports



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Create report

Configure report parameters

HRS and Fuel Type

HRS\*

Nothing selected

HRS for which to create the status report.

Fuel type\*

700 bar H<sub>2</sub> for cars

Select any of the fuel types provided on the station.

Observation Period

Single month

Month

Span of months

Single year

Custom period

Create



# The operator's access portal

## Reports (example of a virtual HRS)



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Availability status report for HRS: Porto Airport CSGGK

Create new report

HRS Availability Status Report

SUBJECT

HRS: Porto Airport

Fuel type: 700 bar

Observation period: Sept. 1, 2019, midnight - Oct. 1, 2019, midnight

KEY PERFORMANCE INDICATORS

Indicator	Value
Number of failures	7
Availability	96.9 %
Mean down time	3 hours, 9 minutes
Mean time between failures	4 days, 4 hours
Mean failure rate	0.010028 failures per hour
System reliability	100 %

AVAILABILITY DISTRIBUTION

Total elapsed time per HRS status:

Status	Percentage	Total time
not monitored	0 %	1 minute, 54 seconds
unknown	0 %	0 seconds
limitedly available	0 %	0 seconds
available	96.9 %	29 days, 2 hours
failure	3.1 %	22 hours, 6 minutes
in maintenance	0 %	0 seconds

Download PDF report

Export as Excel file

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# The operator's access portal

## Change history



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»» LAST

HRS	Date	User	Action
	3.11.2019, 11:30:49		Changed owner, hrs_owner_contact and hrs_owner_contact_status.
	3.11.2019, 11:29:59		Changed owner, hrs_owner_contact, hrs_operator_contact, hrs_operator_contact_status and notes.
	1.11.2019, 15:05:09		Changed number_of_350_bar_bus_dispensers.
	1.11.2019, 14:13:06		Changed notes.
	1.11.2019, 14:11:34		Changed oem_approval_700_bar_car.
	29.10.2019, 14:14:12		Changed access_restriction_details.
	29.10.2019, 14:12:35		Changed remarks.
	29.10.2019, 14:00:16		Changed access_restriction_details.



Thank you very much for your attention!



If you are interested in connecting your HRS to the European HRS availability system or get more information, please contact

**[E-HRS-AS@fch.europa.eu](mailto:E-HRS-AS@fch.europa.eu)**

