Data Requirements for Work Package 6

Deliverable 6.1.1

Version	Comment	Date
1.0	Issued for comment	January 2012
1.1 and 1.2	Revised following comment from AP	9 February 2012
1.3	Revised and updated following comments from AP and H2Logic	24 April 2012
1.4	Comments removed and uploaded onto portal.	2 September 2013

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1 Purpose

This document provides the proposed data protocols for Work Package 6 (WP6) of the HyTEC project. It provides a template for discussion with vehicle/infrastructure manufacturers on the data to be provided for analysis during the HyTEC project.

The document is 'live' and may be updated throughout the project as new vehicles and refuelling infrastructure are deployed which may have different data acquisition capabilities.

The data protocols are based on those employed in other vehicle monitoring projects, such as the Cenex SmartMove electric vehicle trials and those recommended for hydrogen vehicle projects in the HyLights Monitoring and Assessment Framework (http://www.hylights.org/publications/reports/D3_3_MAF_Handbook-I_FINAL_23October2008.pdf).

2 WP6 roles and responsibilities

Cenex. WP6 leader. Responsible for: collecting, checking and storing all project data; technical analysis of vehicle and station in-use data; driver societal impact assessment; lead on project reporting.

Element Energy. Responsible for: Life Cycle Cost (LCC) assessment of vehicles used in the project; decision-maker societal impact assessment.

Fraunhofer. Responsible for Life Cycle Analysis (LCA) of vehicles used in the project.

Matgas. Responsible for Life Cycle Analysis (LCA) of infrastructure used in the project.

3 Prerequisites

HyTEC Task 4.3 requires that:

a. 'One-off' vehicle data (e.g., coefficient of drag) are collected from the vehicle manufacturers.

b. Sensors are fitted by vehicle manufacturers to collect data for WP6.

c. Data must be gathered for identical vehicle classes with standard diesel/gasoline/hybrid drive trains and battery electric where available.

d. Data is regularly uploaded by the vehicle operators to a data portal.

e. Other data, such as vehicle down time and driver experience, is collected and regularly uploaded by operators to a data portal.

HyTEC Task 4.6 requires that:

a. 'One-off' station and infrastructure specification data are collected from the hydrogen infrastructure builders/operators.

b. Station and infrastructure performance data is regularly uploaded by the station operators to a data portal.

c. Other data, such as system down time, is collected and regularly uploaded by the station operators to a data portal.

4 Report deliverables and confidentiality

Deliverables and levels of confidentiality associated with WP6 are detailed in the table below (taken from the HyTEC Description of Work, page 40):

6.1.1	6.1	Production of data protocols handbook	6	R	PU	Month 3
6.1.2	6.2	Web portal for data exchange	6	O	CO	Month 4
6.1.3	6.3	Workshop to agree assessment frameworks	6	O	CO	Month 6
6.2.1	6.4	Technical summary statistics published to project intranet	6	R	CO	Bi-monthly from month 8
6.2.2	6.5	First year technical report	6	R	RE	Month 24
6.2.3	6.6	Final technical report	6	R	PU	Month 40
6.3.1	6.7	Interim environmental impact assessment report	6	R	RE	Month 24
6.3.2	6.8	Final environmental impact assessment report	6	R	PU	Month 40
6.4	6.9	Techno-economic assessment report	6	R	PU	Month 24
6.5.1	6.10	Analysis of societal attitudes in 'before' survey report	6	R	PU	Month 12
6.5.2	6.11	Final societal attitudes report	6	R	PU	Month 40
6.6	6.12	Final overall technical report	6	R	PU	Month 40

Key:

[2] **R** = Report, **D** = Demonstration, **O** = Other
[3] **PU** = Public, **RE** = Restricted group specified by the consortium (including the FCH JU office), **CO** = Confidential, only for member of the consortium and the FCH JU
[4] Measured in months from the project start date (Month 0)

The WP6 participants recognise the potentially sensitive commercial nature of some of the data requested and will work with manufacturers and data providers to ensure that agreed levels of confidentiality is maintained, whilst ensuring that the analysis agreed in the Description of Work is still possible.

Each deliverable is defined by its level of dissemination (public, restricted or confidential) and this will allow maximum flexibility in ensuring that commercially sensitive data is protected. The final level of dissemination of data (PU, RE, CO) remains to be agreed by the project consortium.

This document presents an ideal list of the data which would be collected from the vehicle and infrastructure partners, although it is recognised that not every data point will be available from all partners.

5 Data inputs and outputs

The WP6 description in the Description of Work (DoW) details a number of 'one-off' and on-going data points to be collected, as reproduced below. These high-level data points are expanded on in the sections below, following detailed discussions with the data analysis partners

Vehicle data collection	
Inputs	**Outputs**
Vehicle speed	Journey statistics (average speed, journey lengths, operating durations etc.)
Vehicle position	Fuel consumption
Status of ancillary vehicle equipment	Vehicle energy transfer efficiencies
Power flows across vehicle systems and energy storage devices	Range between refills
Hydrogen pressures and flow	Effects of temperature on performance
Vehicle payload/passenger capacity	Typical drive cycles for vehicles
Vehicle pedal position	Characterisation of system behaviour
	Analysis of vehicle performance characteristics and driving styles

Hydrogen infrastructure data collection	
Inputs	**Outputs**
Fuel delivered	Number of fill events by vehicle
Vehicle identification	Average fill quantities
Refuelling start and end pressures	Fill frequency and duration
Fault codes	Energy consumption
Station energy consumption	Carbon foot-printing

The data collected from the vehicles and station will be analysed in conjunction with technical data supplied from system manufacturers, such as:

- Vehicle specifications (weight, drag and rolling characteristics, tires, component specifications, energy management strategy)
- Fuel cell, battery and electrical motor operating characteristics
- Vehicle storage of hydrogen (pressure, volume)
- Hydrogen origin and transportation route to the filling station data
- Compressor characteristics and electricity origin for the regions of the filling stations
- Hydrogen purity (monitored online for indicator impurities which can be stated on a Certificate of Conformity upon request)

In addition, data will be required from vehicle end users, such as:

- Fault logs
- Safety incident reports
- Driver perception surveys
- Maintenance complications
- Planned and unplanned maintenance intervals (fuelling infrastructure and vehicles)

6 Data requirements for vehicles

Detailed discussions have been held amongst the main data analysis partners for WP6 (Cenex, Matgas, Fraunhofer and Element Energy), in order to understand the data required to produce the deliverables detailed in the DoW. This section details the list of data requested by the data analysis partners, to carry out the full operational and life cycle analyses of the vehicles and infrastructure and the LCC analysis of the vehicles. This list will be used in discussions with infrastructure and vehicle partners to agree on the final data protocols for WP6.

6.1 Production phase

6.1.1 General vehicle data

Data to be provided as one electronic file per vehicle containing the following fields at the start of the vehicle deployment. The mechanism of data upload is to be agreed, but is likely to be via secure FTP or email. Data fields are described below (table structure is based on HyLights MAF handbook v1.1):

Data	Unit	Additional information (if needed)
Completed by	Text	Name of person submitting data
Contact details	Text	Contact details (email, telephone) of person submitting data
Date	Alphanumeric	Date submitted
General		
Vehicle operator	Alphanumeric	Unique identifier for vehicle telemetry which also relates to hydrogen refuelling data
Vehicle identification number (vehicle_id)	Alphanumeric	Unique identifier for vehicle which also relates to telemetry and hydrogen refuelling data
Vehicle type	Alphanumeric	Segment of vehicle. Allowed values: A,B,C,D,E,F
Vehicle manufacturer	Alphanumeric	
Model and variant name	Alphanumeric	
Model year	Integer	
First time on the road as certified vehicle	Alphanumeric	
Odometer reading at project beginning	km	
Vehicle operating hours at project beginning	Integer	
Propulsion system	Text	For example, FC, FC hybrid
Propulsion system manufacturer	Text	
Fuel		
Fuel	Text	For example, hydrogen
Fuel standard	Text	Needed to calculate fuel consumption and efficiency
Fuel purity requirements	Text	
Vehicle dimensions		
Length	m	
Width	m	
Height	m	
Wheel base	m	
Number of seats	Integer	
Unladen weight	kg	
Gross vehicle weight	kg	
Coefficient of drag		

6.1.2 *Vehicle technical specification*

Data to be provided as one electronic file per vehicle containing the following fields at the start of the vehicle deployment. The mechanism of data upload is to be agreed, but is likely to be via secure FTP or email. Data fields are described below (table structure based on HyLights MAF handbook v1.1):

Data	**Unit**	**Additional information (if needed)**
Completed by	Text	Name of person submitting data
Contact details	Text	Contact details (email, telephone) of person submitting data
Date	Alphanumeric	Date submitted
Vehicle		
Vehicle_id	Alphanumeric	Unique identifier for vehicle which also relates to telemetry and hydrogen refuelling data
Maximum constant speed	km/h, decimal, 2 decimal places	
Acceleration (0-50km/h)	s, decimal, 2 decimal places	
Acceleration (0-100km/h)	s, decimal, 2 decimal places	
Elasticity (80-120km/h)	s, decimal, 2 decimal places	
Range	km, integer	
Drivetrain		
Volumetric power density	l/kW, decimal, 2 decimal places	
Gravimetric power density	kg/kW, decimal, 2 decimal places	
Ambient temperature limits for vehicle operation	min (°C), max (°C), integer	
Hydrogen storage		
Hydrogen storage capacity of vehicle	kg of H_2, decimal, 2 decimal places	
Energy density of hydrogen storage system	w% and kg/l, decimal, 2 decimal places	
Fuel purity requirements	Text	

6.1.3 Vehicle materials mix for vehicle Life Cycle Analysis

All materials which are needed during the vehicle production should be quantified to guarantee a high-quality LCA. This material data should be based on the bill of materials of the vehicles. The focus of the assessment of the vehicle production phase will be on the comparison of drive trains. Therefore it is important to have a detailed database of fuel cell drive trains used in HyTEC and the alternative standard ICE drive trains. Data will be treated with strict confidentiality and should be provided as one electronic file per vehicle type containing the following fields at the start of the vehicle deployment. The mechanism of data upload is to be agreed, but is likely to be via secure FTP or email. Data fields are described below:

Data	Unit	Additional information (if needed)
Simplified bill of materials of vehicle production according to function groups	kg	Platform, tyres, power train, interior, body, etc.
Material mix of the different function groups		Separate into steel, aluminium, PA, PP, PE, PU etc.
Assembly and production processes		Statement on relevant production processes

6.1.4 Vehicle emissions of ICE drive trains for vehicle Life Cycle Analysis

Emission profiles (of the conventional drive trains) are necessary for the comparison of the environmental impacts of fuel cell drive trains with standard diesel/gasoline/hybrid drive trains. All emission profiles must be based on representative drive cycles or drive patterns (e.g. NEDC), which can be compared with drive patterns of the fuel cell vehicles in HyTEC. Data should be provided as one electronic file per vehicle type containing the following fields at the start of the vehicle deployment. The mechanism of data upload is to be agreed, but is likely to be via secure FTP or email. Data fields are described below:

Data	Unit	Additional information (if needed)
Gasoline/diesel	l/km	Fuel consumption over the representative drive cycle
CO	g/km	Based on representative drive cycle/pattern
HC (CH4, NMHC, benzene, toluene, xylene)	g/km	Based on representative drive cycle/pattern
CO2	g/km	Based on representative drive cycle/pattern
NH3	g/km	Based on representative drive cycle/pattern
N2O	g/km	Based on representative drive cycle/pattern
NO	g/km	Based on representative drive cycle/pattern
NO2	g/km	Based on representative drive cycle/pattern
PN	g/km	Based on representative drive cycle/pattern
PM	g/km	Based on representative drive cycle/pattern

6.1.5 *Vehicle lifetime and cost data for Life Cycle Cost analysis*

Task 6.4 of the HyTEC project will produce a life cycle cost analysis of the vehicles deployed in the project, as well looking at the cost trajectory for these vehicles as they move towards commercialisation.

As part of this, it is important that we understand the capital and operating costs of the vehicles through time. An ideal cost breakdown for the vehicles is illustrated below. However, we recognise the sensitive commercial nature of some of the cost data requested and will work with manufacturers to ensure that confidentiality is maintained, whilst ensuring that the analysis is still possible.

Data to be provided as one electronic file per vehicle type containing the following fields at the start of the vehicle deployment. The mechanism of data upload is to be agreed, but is likely to be via secure FTP or email. Data fields are described below:

Data	Unit	Additional information (if needed)
General		
Completed by	Text	Name of person submitting data
Contact details	Text	Contact details (email, telephone) of person submitting data
Date	Alphanumeric	Date submitted
Vehicle type	Alphanumeric	Type of vehicle within the HyTEC project
Vehicle hydrogen capacity	Kg	
Range of vehicle	Km	Range on standard drive cycle
Fuel consumption	gH_2/km	
CO_2 emissions	g/km	For societal impact costs
Capital cost data for hydrogen vehicles		
Cost of chassis, body and standard interior components	Euros of capital cost	Values provided for 2012-2014, 2015-2017, 2018-2020, 2021-2023, 2024-2026, 2027-2029
Fuel cell system costs (including cooling system)	Euros of capital cost	Values provided for 2012-2014, 2015-2017, 2018-2020, 2021-2023, 2024-2026, 2027-2029 Size of fuel cell in kW required, cost per kW where possible
Stack warranty cost	Euros of capital cost	Values provided for 2012-2014, 2015-2017, 2018-2020, 2021-2023, 2024-2026, 2027-2029
Stack replacement cost	% of fuel cell system costs	Values provided for 2012-2014, 2015-2017, 2018-2020, 2021-2023, 2024-2026, 2027-2029
Energy storage system cost	Euros of capital cost	Values provided for 2012-2014, 2015-2017, 2018-2020, 2021-2023, 2024-2026, 2027-2029 Size of energy storage system in kWh required, cost per kWh where possible
Hydrogen storage system cost	Euros of capital cost	Values provided for 2012-2014, 2015-2017, 2018-2020, 2021-2023, 2024-2026, 2027-2029
Power electronics and electric motor costs	Euros of capital cost	Values provided for 2012-2014, 2015-2017, 2018-2020, 2021-2023, 2024-2026, 2027-2029
Cost of labour for drivetrain integration	Euros of labour cost per vehicle over and above standard drivetrain costs	Values provided for 2012-2014, 2015-2017, 2018-2020, 2021-2023, 2024-2026, 2027-2029
NRE costs	Euros of capital cost	Cost of developing commercial-ready version of vehicles
Capital cost data for conventional fuel incumbents		
Cost of chassis, body and standard interior components	Euros of capital cost	Values provided for 2012-2014, 2015-2017, 2018-2020, 2021-2023, 2024-2026, 2027-2029

Data	Unit	Additional information (if needed)
Standard drivetrain costs	Euros of capital cost	Values provided for 2012-2014, 2015-2017, 2018-2020, 2021-2023, 2024-2026, 2027-2029
Lifetime data		
Standard vehicle lifetime	Thousands of hours operation	Values provided for 2012-2014, 2015-2017, 2018-2020, 2021-2023, 2024-2026, 2027-2029
Stack lifetime	Thousands of hours operation	Values provided for 2012-2014, 2015-2017, 2018-2020, 2021-2023, 2024-2026, 2027-2029
Fuel cell system lifetime	Thousands of hours operation	Values provided for 2012-2014, 2015-2017, 2018-2020, 2021-2023, 2024-2026, 2027-2029

6.2 Trial monitoring phase

6.2.1 Vehicle telemetry data

Data to be provided as Excel or CSV (comma-separated value) file with one row of data per second containing the following fields. Data will be treated with strict confidentiality. In the case of positional (latititude/longitude/height) information which is important to fully characterise vehicle duty cycles data will only be recorded and analysed with the vehicle operator's consent. Data to be uploaded at least monthly. The mechanism of data upload is to be agreed, but is likely to be via secure FTP. Data fields are described below:

Data	Unit	Additional information (if needed)
Vehicle_id	Alphanumeric	Unique identifier for vehicle telemetry which also relates to hydrogen refueling data
Trip_id	Integer	Unique identifier for a trip (reset at each key on/key off event)
Time	DD/MM/YY HH:Mi:SS	One row of data per second. Date and time needed to characterize journeys by day and to assess effect of changes in temperature etc. on efficiency
Vehicle_speed	Km/h (decimal, 2 decimal place)	
Latitude	Decimal	Needed for drive cycle assessment
Longitude	Decimal	Needed for drive cycle assessment
Vehicle_height	Metres	Needed for drive cycle assessment
Accelerator_pedal_position	Decimal	Needed for drive cycle assessment
Fuel cell voltage	Volts	Needed to calculate energy consumption and efficiency
Fuel cell current	Amps	Needed to calculate energy consumption and efficiency
Battery_voltage	Volts	Needed to calculate energy consumption and efficiency
Battery_current	Amps	Needed to calculate energy consumption and efficiency
Depth_of_discharge	% (0-100)	Needed to calculate energy consumption and efficiency
Hydrogen_flow	Grammes/second (decimal)	Needed to calculate fuel consumption and efficiency
Hydrogen_temperature	K	Needed to calculate fuel consumption and efficiency
Hydrogen_pressure	Bar	Needed to calculate fuel consumption and efficiency

A sample row of data is shown below:

Vehicle_id,Trip_id,Time,Vehicle_Speed,Latitude,Longitude,Vehicle_height,Accel_pedal_pos,Battery_voltage, Battery_current,DoD,Hydrogen_flow,Hydrogen_pressure

HY_LDN_01,1001,14/03/2010 11:12:23,25.3,50.7470665,3.481121063,25.4,0.25,282,-0.5,80,0.0002,298,200

6.2.2 *Vehicle incident/availability data*

Data to be provided as Excel or CSV (comma-separated value) file with one row of data per vehicle scheduled/unscheduled event, or safety incident. The mechanism of data upload is to be agreed, but is likely to be via secure FTP. Data fields are described below (table structure based on HyLights MAF handbook v1.1):

Data	Unit	Additional information (if needed)
Vehicle_id	Alphanumeric	Unique identifier for vehicle which also relates to telemetry and hydrogen refueling data
Time_out	DD/MM/YY HH:Mi:SS	Time taken out of operation
Odometer_out of operation	Km	Odometer reading when taken out of operation
Time_in	DD/MM/YY HH:Mi:SS	
Odometer_in	Km	Odometer reading when back in operation
Event		
Event_code	Alphanumeric	Allowed values: 0: scheduled maintenance A: stack B: balance of plant C: electrical system D: H_2 storage E: high-voltage battery
Event_comment	Text	Free text comment.
Safety incident		
Safety_code	Decimal	If needed for a safety incident. Allowed values: 0: not a safety incident 1: vehicle incident with injury. H_2 released 2: vehicle incident with injury. No H_2 released 3: vehicle incident without injury. H_2 released 4: vehicle incident without injury. No H_2 released 5: other (see text field below)
Safety_comment	Text	Free text comment if safety incident occurred

6.2.3 *Other vehicle data required for vehicle monitoring*

Payload

In the case of taxis, if automatic monitoring of payload/passenger data is not possible, vehicle loading data must be manually recorded for each vehicle type for a period of two weeks during the trial to allow calculation of the effect of passenger load on vehicle efficiency.

6.2.4 *Vehicle operating cost data for Life Cycle Cost analysis*

Task 6.4 of the HyTEC project will produce a life cycle cost analysis of the vehicles deployed in the project, as well looking at the cost trajectory for these vehicles as they move towards commercialisation.

As part of this, it is important that we understand the operating costs of the vehicles. We recognise the sensitive commercial nature of some of the cost data requested and will work with manufacturers to ensure that confidentiality is maintained, whilst ensuring that the analysis is still possible.

Data should be provided as one electronic file per vehicle type containing the following fields at a frequency to be agreed. The mechanism of data upload is to be agreed, but is likely to be via secure FTP or email. Data fields are described below:

Data	**Unit**	**Additional information (if needed)**
Cost of hydrogen	Euros per Kg	
Maintenance costs	Euros/hour of operation	Additional cost over maintenance of standard vehicle, not including stack replacement costs
Costs of alterations to maintenance facilities	Euros of capital cost	

7 Data requirements for infrastructure

7.1 Production/installation phase

7.1.1 General hydrogen refuelling station data

Data to be provided as one electronic file per station containing the following fields on completion of station commissioning. The mechanism of data upload is to be agreed, but is likely to be via secure FTP or email. Data fields are described below (table structure based on HyLights MAF handbook v1.1):

Data	Unit	Additional information (if needed)
Completed by	Text	Name of person submitting data
Contact details	Text	Contact details (email, telephone) of person submitting data
Date	Alphanumeric	Date submitted
General		
Fuelling station operator	Alphanumeric	
Fuelling station location	Text	
Station_id	Alphanumeric	
Date of first operation	Integer	
Fuelling station details		
Total number of hydrogen dispensing units	Integer	
Total number of hydrogen refueling nozzles	Integer	
Dispensing capacity	kg/day, decimal, 2 decimal places	
Station footprint	m^2	
Type of station (hydrogen only or mixed)	Text	
Accessibility		
Refuelling operation	Alphanumeric	Allowed values: self-service/assisted/operator only
Public access/restricted use	Alphanumeric	Allowed values: public (by appointment)/restricted access
Opening hours	Alphanumeric	Daily/weekly opening hours
Station components		
Hydrogen station supplier	Text	
Hydrogen storage type on site	Text	Allowed values: CH2/LH2/both
Hydrogen manufacture	Text	Allowed values: onsite/offsite
On-site hydrogen storage capacity	kg H2, integer	

7.1.2 Distribution of hydrogen to H2 fuelling stations

The upstream and transport processes of the hydrogen distribution for fuelling stations play an important role in assessing the life cycle of fuel cell vehicles. Data to be provided for all potential distribution pathways for the project, as well as possible future scenarios. Data to be provided as one electronic file per station containing the following fields when the station has been commissioned. The mechanism of data upload is to be agreed, but is likely to be via secure FTP or email:

Data	Unit	Additional information (if needed)
Station_id	Alphanumeric	
If off-site central production		
Transport distance	km	Distribution for refuelling stations
Means of transportation	Truck/vessel etc.	
Aggregate state of hydrogen during transportation	Liquid/gas	
Losses of hydrogen during transportation and measurement of hydrogen mass at tranship points	kg	e.g. boil-off and others. Estimates are acceptable as this is not currently metered.
If on-site production		
Type of production unit	Text	Example values: natural gas + reformer, LPG + reformer, electrolysis + electrolyser, etc.

7.1.3 Infrastructure materials mix for environmental impact assessment

For the LCA of the hydrogen infrastructure, the emissions related to the materials of construction must be taken into account, especially if H_2 on-site production by e.g. electrolysis is envisaged. The materials data can be retrieved from the bill of materials for both the hydrogen production unit, in case of on-site production, and the hydrogen filling station. Data will be treated with strict confidentiality and should be provided as one electronic file per station containing the following fields at the start of the station deployment. The mechanism of data upload is to be agreed, but is likely to be via secure FTP or email:

Data	Unit	Additional information (if needed)
Simplified bill of materials of fuelling station production according to function groups.	kg	
Simplified bill of materials of on-site production unit.	kg	
Material mix of the different modules for the filling station.		Separate into steel, aluminum, PA, PP, PE, PU etc.
Material mix of the different modules for the on-site production unit.		Separate into steel, aluminum, PA, PP, PE, PU etc.
Assembly and production processes		Statement on relevant production processes

7.1.4 *Emissions from hydrogen production*

Emission profiles are necessary for the comparison of the environmental impacts of the different hydrogen production pathways. Data to be provided for all potential distribution pathways for the project, as well as possible future scenarios. Information on the production technology and the primary feedstock mix for producing H_2 should be provided as one electronic file per station containing the following fields when the station has been commissioned. The mechanism of data upload is to be agreed, but is likely to be via secure FTP or email (table structure based on HyLights MAF handbook v1.1):

Data	Unit	Additional information (if needed)
Type of hydrogen supply		On-site (natural gas + reformer, LPG + reformer, electrolysis + electrolyser) or off-site (SMR + pipeline SMR + delivery truck), etc.
Natural gas	%	Primary feedstock mix for H2 production (sums to 100%)
Liquid hydrocarbons	%	Primary feedstock mix for H2 production (sums to 100%)
Coal	%	Primary feedstock mix for H2 production (sums to 100%)
Nuclear	%	Primary feedstock mix for H2 production (sums to 100%)
National electricity grid mix (year)	%	Primary feedstock mix for H2 production (sums to 100%)
Biomass	%	Primary feedstock mix for H2 production (sums to 100%)
Hydro	%	Primary feedstock mix for H2 production (sums to 100%)
Wind	%	Primary feedstock mix for H2 production (sums to 100%)
Solar	%	Primary feedstock mix for H2 production (sums to 100%)
Geothermal	%	Primary feedstock mix for H2 production (sums to 100%)
Others	%	Primary feedstock mix for H2 production (sums to 100%)

7.1.5 *Infrastructure operating cost data for Life Cycle Cost analysis*

Task 6.4 of the HyTEC project will produce a life cycle cost analysis of the vehicles and infrastructure deployed in the project, as well looking at the cost trajectory as they move towards commercialisation.

As part of this, it is important that we understand the operating costs of the vehicles-infrastructure combination. We recognise the sensitive commercial nature of some of the cost data requested and will work with manufacturers to ensure that confidentiality is maintained, whilst ensuring that the analysis is still possible.

Data to be provided as one electronic file per infrastructure installation containing the following fields at a frequency to be agreed. The mechanism of data upload is to be agreed, but is likely to be via secure FTP or email. Data fields are described below:

Data	Unit	Additional information (if needed)
Cost of delivery of hydrogen	Euros per Kg	Values provided for 2012-2014, 2015-2017, 2018-2020, 2021-2023, 2024-2026, 2027-2029
Capital costs	Euros of capital cost	Values provided for 2012-2014, 2015-2017, 2018-2020, 2021-2023, 2024-2026, 2027-2029
Maintenance costs	Euros per year of operation	Values provided for 2012-2014, 2015-2017, 2018-2020, 2021-2023, 2024-2026, 2027-2029

7.2 Trial monitoring phase

7.2.1 Hydrogen refuelling facility data

Data to be provided as Excel or CSV (comma-separated value) file with one row of data per vehicle fill or scheduled/unscheduled event as described in the acquisition frequency column below. The mechanism of data upload is to be agreed, but is likely to be via secure FTP. Data fields are described below:

Data	**Unit**	**Acquisition frequency**	**Additional information (if needed)**
Station_id	Alphanumeric		Unique identifier for the hydrogen station unit
Vehicle_id	Alphanumeric		Unique identifier for vehicle. Fuelcardid is acceptable provided a unique fuel card is assigned to each vehicle
Date	DD/MM/YY HH:Mi		Date and time of vehicle fill
Vehicle_pressure_start	Bar	For each filling	Needed for energy efficiency calculations
Vehicle_pressure_end	Bar	For each filling	Needed for energy efficiency calculations
Hydrogen_mass_transferrred	kg	For each filling	Needed for energy efficiency calculations
Filling_duration	HH:MM:SS	For each filling – steps of 15 seconds	
Total_hydrogen_transferred	kg	Daily total	For closing the mass balance
Electricity_consumed	kWh	Daily	Consumption of the station unit only
Downtime_hours	Hours	Daily	
Downtime_reason	Integer		*Station unit downtime category codes. Allowed values are:* 0. Failure – Hydrogen storage 1. Failure - Hydrogen compressors. 2. Failure – Dispensing equipment 3. Failure - Control or electronics. 4. Failure - Alarms, H2 leaks, safety devices 5. Failure – Production Unit 6. Failure – external H2 delivery 7. Safety issues 8. External reasons (e.g. power outage). 9. Other.

7.2.2 *Hydrogen production unit information for refuelling station monitoring*

Data to be provided as Excel or CSV (comma-separated value) file with one row of data per event as described in the acquisition frequency column below. Data should be uploaded at least monthly. The mechanism of data upload remains to be agreed, but is likely to be via secure FTP. Data fields are described below:

Data	Unit	Acquisition frequency	Additional information (if needed)
On-site hydrogen production			
Stationid	Alphanumeric		Unique identifier for the hydrogen station unit
Date	DD/MM/YY HH:Mi		Date and time of data acquisition
Hydrogen_produced	kg	Daily	Amount of hydrogen produced per day on site
Hydrogen_to_station	kg	Daily	Amount of hydrogen delivered to the station unit.
Electricity_consumed	kWh	Daily	Electricity consumed by the production unit only.
NG_consumed	Cubic Meters	Daily	Only for sites with NG reforming
Water_consumed	Cubic meters	Monthly (last calendar day of each month).	
Downtime_hours	Hours	Daily	
Storage type	Text		
Storage capacity	kg		
External hydrogen delivery			
Station_id	Alphanumeric		Unique identifier for the hydrogen station unit
Date	DD/MM/YY HH:Mi:SS		Date and time of data acquisition
Hydrogen_delivered	kg	Monthly	

7.2.3 *Hydrogen facility extra energy and consumables use*

Data to be provided as one electronic file per station containing the following fields on completion of station commissioning. The mechanism of data upload remains to be agreed, but is likely to be via secure FTP or email:

Data	Unit	Acquisition frequency	Additional information (if needed)
Station_id	Alphanumeric		Unique identifier for the Infrastructure
Date	DD/MM/YY HH:Mi		Date and time of vehicle fill
Expected Nitrogen_consumption		Monthly	
Expected Argon_consumption		Annual	
Extra_electricity_consumption	kWh	Daily	Electricity consumption other than station unit and production unit consumption.