Fuel cells and Hydrogen Joint Undertaking (FCH JU) - Knowledge management data collection

Contents

1. Introduction

The FCH JU finances research and innovation projects aiming at bringing fuel cells and hydrogen technologies to market readiness. To this end, it publishes calls for proposals, manages proposal evaluations and ultimately follows project implementation.

In order to assess the effectiveness of its research programme and the needs for further technological developments (to be translated into new calls for proposals), the FCH JU has been mandated to collect data on relevant technologies in a systematic and uniform way.

This need was identified early after the set-up of the FCH JU and follows the explicit request of the FCH JU governing board, reflecting the will of all 3 members of the FCH JU: the European Commission, Hydrogen Europe, representing the industrial stakeholders and N.ERGHY, representing the research community.

The FCH JU has built a Knowledge Management system (TEMONAS) to securely collect and store the data that it collects. The system is intended to yield comparable data from the projects funded by the FCH JU by clearly setting the relevant:

- parameters
- units
- reference period/ date (annual granularity)

FCH JU-supported projects have a contractual obligation to comply with the submission of these data points according to article II.10 of FP7 grant agreements (selected under calls 2008 to 2013) and to dedicated project deliverables in Horizon 2020 projects (selected under calls 2014 onwards).

The outcome as a coherent and comprehensive vision of the fuel cells and hydrogen sector is critical for its further development and visibility, and for fostering political and financial support

2. Data collection

Data is to be collected through a series of template questionnaires tailored to the various technologies and their readiness level, to be answered annually by the funded projects: each project is to be divided into one or more “research object” defining a specific reporting item within the project scope. Each of these research objects will be associated to a specific template questionnaire.

The existing template questionnaires are listed below:

- Car demonstration
- Bus demonstration
- Material handling vehicle demonstration
- Auxiliary power unit demonstration
- Hydrogen refueling station demonstration
- Hydrogen refueling station research
- Electrolyser demonstration
- Electrolyser – research at system level
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- Hydrogen storage
- Stationary fuel cell system demonstration
- Fuel cells – research at system level
- Fuel cells – research at stack level or lower
- Diagnostic systems
- Pre-normative research

The template questionnaire within each research object is divided into descriptive and variable parameters, and for each parameter, the intended meaning / calculation method is specified.

Descriptive parameters define the item addressed in the questionnaire and set the scene for the variable parameters which will report the project progress/results. In principle, descriptive parameters do not change during the project lifetime. On the other hand, variable parameters evolve

and will be different from one data collection exercise to the next according to progress achieved during the reference period.

The parameters have been defined in view of allowing a comprehensive overview of the technology status and contain the Key Performance Indicators (KPIs) defined in the FCH JU Multi-Annual Work Plan (MAWP). For transport applications, they are also in line with the handbooks produced under project "Hylights" funded under FP6 (http://www.fch.europa.eu/projects/knowledge-management).

The parameters requested in each template are listed in Annex 1 – parameter templates.

Each project is expected to provide, to the best of its capabilities, a value for *every* parameter requested. For each parameter, there is also the possibility (optional) to add a comment if it is relevant to give additional information.

The filled questionnaire can only be submitted if, for every single parameter, a value or a comment is provided. This offers the possibility of leaving a parameter unanswered in the case that there is an impossibility to provide a value, for instance because the parameter is not relevant to the project or has not yet been obtained. In such cases, the reason should be given in the comment field.

In general, it will not be acceptable that parameters that are either MAWP KPIs or specified in the "expected impact" section of the call for proposals to which the project has successfully applied are marked as irrelevant to the project itself.

Data provider

For each project, the coordinator, or another person specifically assigned by the coordinator, will be given access to the TEMONAS interface for reporting and is hereby referred to as "data provider".

If needed, several data providers can be assigned to a same research object and different data providers can be assigned to different research objects of the same project.

Input method

The data will be collected online, through a secured connection, in TEMONAS. This program was developed through a project financed by the FCH JU itself, according to the needs defined by the FCH JU Governing Board.

For each research object, the data provider has the possibility (optional) to enter a generic comment, e.g. specifying information relevant to the whole set of data concerned, in addition to the values and comments for the individual parameter.

Confidentiality

Each single parameter in the template questionnaires can be defined by the data provider as either public or confidential.

Public data will be treated as such and the FCH JU will consider that it can disclose them accordingly. This should be the case for data already public on the internet (e.g. certain product specifications or general information, such as hydrogen refueling station or electrolyser locations etc.).

Confidential data will be treated with extreme care and information will not be made public in any form that could lead to the identification of its origin. Confidential data will be visible exclusively by the FCH JU Programme Office staff and will not be made available to either the FCH JU members or its governing bodies.

More information on data treatment is given in section 3.

Data aggregation

Research objects in TEMONAS refer either to single items or a group of equivalent items. This is defined individually for each project according to its nature, its description of work and the type of questionnaire concerned. For instance, reporting is expected individually for single hydrogen refueling stations, electrolysers or industrial-scale CHP units, while aggregated data would be sufficient for a fleet of the same vehicles in a given region or small CHP units deployed in a given region. An intended "rule of thumb" on aggregation levels expected according to the template questionnaires is provided in Annex 2 – data aggregatio.

Date perimeter

The questionnaires are to be entered every year through the online TEMONAS interface with results and data relevant to the previous calendar year (e.g. the 2016 data collection concerns data from Jan. 1, 2015 to Dec. 31, 2015). This is required until the full project duration has been covered with data in TEMONAS, i.e. until the year after end date.

3. Data utilisation

Data provided in TEMONAS by the projects will be collected and treated by the FCH JU Programme Office only.

No raw data will be disclosed publicly unless they are provided as "public" in TEMONAS.

Data validation (authorization)

In a first phase, the data will be validated by the relevant Project Managers which will authorise or reject the entire form or the single values provided for the parameters. In this step, the values will be verified in terms of whether they are realistic, whether there is no clerical mistake (order of magnitude, units,….) and whether the "confidential" label (if applicable) is justified (e.g. a vehicle specification available online is expected to be labeled as public in TEMONAS). The Project Manager will also authorise or reject, as appropriate, the reasons put forward for failed delivery of any parameter.

Data rejection

In the case that a parameter is rejected, the data provider will be informed (through an email notification) with an explanation of the reasons for rejection. The data provider will be thus asked to revise the value / comment.

Cost claims related to tasks that would lead to parameters that have been rejected may be suspended until an agreement is found between the FCH JU and the project consortium.

Data exploitation

The FCH JU Programme Office will analyse the data obtained and will form a view on technology status.

In comparison with public values obtained through continued technology watch and state of the art values, it will also be able to assess the positioning of FCH JU projects in the global picture.

In time, through comparison of data obtained for different periods, the achievements of the FCH JU will also be traced in terms of technology progress yielded through the projects financed.

Data disclosure

The FCH JU Programme Office is often assisting its members in defining the state of the art or providing information on project progress.

As is customary with deliverables and reports, only public data will be disclosed in this context, unless aggregation of several comparable data is possible to provide anonymized and unrecognisable output.

Annex 1 – parameter templates

The parameters request in the various template questionnaires (see list below) are detailed in this annex.

Car demonstration

Descriptive parameters

1 System location - country/cluster
2 System location - city
3 Start date(s) of operation
4 Manufacturer/supplier of the vehicle(s)
5 Model of the vehicle(s)
6 Type of vehicle
7 Date of production (year)
8 Power - drivetrain
9 Power density - drivetrain
10 Driving range
11 Speed - Maximum
12 Acceleration time 0-50 km/h
13 Acceleration time 0-100 km/h
14 Weight
15 Height
16 Length
17 Width
18 Capacity- number of seated passengers
19 Hydrogen storage capacity (on-board)
20 Pressure of the on-board hydrogen tank - rated
21 Efficiency - tank-to-wheel - rated
22 Efficiency of the fuel cell - rated
23 Durability / lifetime of the fuel cell vehicle - rated
24 Durability / lifetime of the fuel cell system - rated
25 Ambient temperature - Minimum
26 Ambient temperature - Maximum
27 Cost - specific cost/price of the fuel cell system - actual
28 Cost - specific cost of the fuel cell system @ mass production (estimate)
29 Cost/price of the vehicle
30 Cost of the vehicle @ mass production (estimate)
31 Cost - total cost of ownership (TCO)

Variable parameters

1 Start date for data entries in the reference year
2 End date for data entries in the reference year
3 Number of vehicles deployed - in service
4 Number of vehicles deployed - total
5 Hours of operation - total
6 Hours of operation - cumulative
7 Distance driven
8 Distance driven - cumulative in the project
9 Distance driven - cumulative overall
10 Distance driven - between refuellings/rechargings - average
11 Number of hydrogen refuellings
12 Quantity of hydrogen per refuelling
13 Quantity of hydrogen consumed
14 Quantity of hydrogen consumed - cumulative in the project
15 Rate of hydrogen refuelling - average
16 Consumption - hydrogen
17 Number of electric recharges
18 Quantity of electricity per recharge
19 Quantity of electricity fed
20 Quantity of electricity fed - cumulative in the project
21 Consumption - electricity from recharges
22 Availability of the vehicle(s) - average
23 Distance between failures - mean (MDBF) - average
24 Downtime - overall
25 Downtime due to scheduled maintenance/upgrades
26 Downtime of vehicles due to stack issues
27 Downtime of vehicles due to peripheric mechanical components
28 Downtime of vehicles due to electrical components
29 Downtime of vehicles due to the on-board hydrogen storage tank
30 Downtime of vehicles due to the high voltage battery
31 Number of safety incidents - total
32 Number of events - type 1
33 Number of events - type 2
34 Number of events - type 3
35 Number of events - type 4
36 Number of events - type 5
37 Cost - operational and maintenance costs

Bus demonstration

Descriptive parameters

1 System location - country/cluster
2 System location - city
3 Start date(s) of operation
4 Manufacturer/supplier of the vehicle(s)
5 Model of the vehicle(s)
6 Date of production (year)
7 Operator of the bus(es)
8 Power - drivetrain
9 Power density - drivetrain
10 Speed - Maximum
11 Acceleration time 0-50 km/h
12 Driving range
13 Weight
14 Height
15 Length
16 Width
17 Capacity- number of seated passengers
18 Capacity - number of standing passengers
19 Hydrogen storage capacity (on-board)
20 Pressure of the on-board hydrogen tank - rated
21 Efficiency - tank-to-wheel - rated
22 Efficiency of the fuel cell - rated
23 Durability / lifetime of the fuel cell vehicle - rated
24 Durability / lifetime of the fuel cell system - rated
25 Ambient temperature - Minimum
26 Ambient temperature - Maximum
27 Cost/price of the vehicle
28 Cost of the vehicle @ mass production (estimate)
29 Cost - specific cost/price of the fuel cell system - actual
30 Cost - specific cost of the fuel cell system @ mass production (estimate)
31 Cost - total cost of ownership (TCO)

Variable parameters

1 Start date for data entries in the reference year
2 End date for data entries in the reference year
3 Number of vehicles deployed - in service
4 Number of vehicles deployed - total
5 Hours of operation - total
6 Hours of operation - cumulative
7 Distance driven
8 Distance driven - cumulative in the project
9 Distance driven - cumulative overall
10 Distance driven - between refuellings - average
11 Distance between failures - mean (MDBF) - average
12 Durability / lifetime of the fuel cell system - observed
13 How many fuel cell stack(s) has (have) been replaced on the vehicle(s)?
14 Durability / total distance driven with the fuel cell system - observed
15 Consumption - hydrogen
16 Quantity of hydrogen consumed
17 Quantity of hydrogen consumed - cumulative in the project
18 Quantity of hydrogen per refuelling
19 Rate of hydrogen refuelling - average
20 Number of hydrogen refuellings
21 Availability of the vehicle(s) - average
22 Cost - operational and maintenance costs
23 Downtime - overall
24 Downtime due to scheduled maintenance/upgrades
25 Downtime of vehicles due to stack issues
26 Downtime of vehicles due to peripheric mechanical components
27 Downtime of vehicles due to electrical components
28 Downtime of vehicles due to the on-board hydrogen storage tank
29 Downtime of vehicles due to the high voltage battery
30 Number of safety incidents - total
31 Number of events - type 1
32 Number of events - type 2
33 Number of events - type 3
34 Number of events - type 4
35 Number of events - type 5

Material handling vehicle demonstration

Descriptive parameters

1 System location - country
2 System location - city
3 Start date(s) of operation
4 Manufacturer/supplier of the vehicle(s)
5 Date of production (year)
6 Model of the vehicle(s)
7 Type of material handling vehicle
8 Class of material handling vehicle
9 Load capacity
10 Power - drivetrain
11 Power density - drivetrain
12 Weight
13 Height
14 Length
15 Width
16 Hydrogen storage capacity (on-board)
17 Pressure of the on-board hydrogen tank - rated
18 State of the hydrogen in the storage tank
19 Efficiency of the fuel cell - rated
20 Durability / lifetime of the fuel cell vehicle - rated
21 Durability / lifetime of the fuel cell system - rated
22 Ambient temperature - Minimum
23 Ambient temperature - Maximum
24 Cost/price of the vehicle
25 Cost of the vehicle @ mass production (estimate)
26 Cost - specific cost/price of the fuel cell system - actual
27 Cost - specific cost of the fuel cell system @ mass production (estimate)
28 Cost - hydrogen storage system cost
29 Cost - total cost of ownership (TCO) - MHV

Variable parameters

1 Start date for data entries in the reference year
2 End date for data entries in the reference year
3 Number of vehicles deployed - in service
4 Number of vehicles deployed - total
5 Hours of operation - total
6 Hours of operation - cumulative
7 Hours of operation between refuellings
8 Consumption - hydrogen (hourly)
9 Quantity of hydrogen consumed
10 Quantity of hydrogen consumed - cumulative in the project
11 Rate of hydrogen refuelling - average
12 Number of hydrogen refuellings
13 Availability of the vehicle(s) - average
14 Mean time between failures (MTBF)
15 Downtime - overall
16 Downtime due to scheduled maintenance/upgrades
17 Downtime of vehicles due to electrical components
18 Downtime of vehicles due to the high voltage battery
19 Downtime of vehicles due to the on-board hydrogen storage tank
20 Downtime of vehicles due to peripheric mechanical components
21 Downtime of vehicles due to stack issues
22 Number of events - type 1
23 Number of events - type 2
24 Number of events - type 3
25 Number of events - type 4
26 Number of events - type 5
27 Cost - operational expenditure (OPEX) - MHV

Auxiliary power unit demonstration

Descriptive parameters

1 System location - country
2 Vehicle for the APU
3 Start date of operation
4 Manufacturer/supplier of the APU
5 Manufacturer/supplier of the stack(s)
6 Technology of the fuel cell
7 Type of fuel
8 Capacity of the system - rated
9 Capacity of the stack - rated
10 Weight (APU)
11 Volume
12 Noise
13 Operating pressure
14 Operating temperature
15 Ambient temperature - Minimum
16 Ambient temperature - Maximum
17 Durability / lifetime of the fuel cell system - rated
18 Durability / lifetime of the stack(s) - rated
19 Electrical efficiency of the stack(s) (rated - LHV)
20 Total Efficiency of the system - (rated - LHV)
21 Cost - capital cost of the system (per kW)
22 Cost - capital cost of the system (per kW) @ mass production (estimate)
23 Time for break-even

Variable parameters

1 Start date for data entries in the reference year
2 End date for data entries in the reference year
3 Hours of operation - total
4 Hours of operation - cumulative
5 Operating time per day
6 Time for cold start to rated power (from -20°C)
7 Time for cold start to rated power (from +20°C)
8 Amount of fuel consumed
9 Electrical efficiency of the stack(s) (observed - LHV)
10 Total Efficiency of the system - (observed - LHV)
11 Electricity produced - total
12 Useful heat output
13 Availability of the system(s)
14 Mean time between failures (MTBF)
15 Emissions - CO2 emissions per electricity output
16 Emissions - SOx emissions per electricity output
17 Emissions - NOx emissions per electricity output
18 Number of safety incidents - total
19 Cost - operational expenditure (OPEX)

Hydrogen refueling station demonstration

Descriptive parameters

1 System location - country
2 System location - city
3 System location - post code
4 System location - surroundings
5 Start date of operation
6 Operator of the hydrogen refuelling station (HRS)
7 Hydrogen refuelling station access
8 Type of refuelling operation
9 Footprint - station
10 Number of hydrogen dispensers
11 Number of nozzles
12 Hydrogen storage capacity (on-site)
13 Pressure of the on-site storage tank - rated
14 Pressure of the hydrogen dispensed
15 Nominal dispensing capacity of the station - hourly
16 Nominal dispensing capacity of the station - daily
17 Refuelling protocol
18 Number of cars per hour
19 Number of cars per day
20 Number of buses per hour
21 Number of buses per day
22 Hydrogen supply logistics
23 Technology of the onsite hydrogen production
24 Fraction of renewable energy input
25 Source of renewable energy input
26 Production rate of hydrogen - on-site
27 Cost - capital expenditure (CAPEX)

Variable parameters

1 Start date for data entries in the reference year
2 End date for data entries in the reference year
3 Vehicles refuelled
4 Operating time per day
5 Days of operation - total
6 Hours of operation - cumulative (HRS)
7 Quantity of hydrogen produced (HRS)
8 Quantity of hydrogen delivered to the hydrogen refuelling station
9 Distance from the hydrogen production site
10 Quantity of hydrogen dispensed daily - average
11 Quantity of hydrogen dispensed
12 Number of hydrogen refuelling operations
13 Number of daily refuellings - average
14 Refuelling time @200 bar - average
15 Refuelling time @350 bar - average
16 Refuelling time @700 bar - average
17 Utilisation rate of the hydrogen refuelling station
18 Availability of the hydrogen refuelling station - Average
19 Downtime - overall (HRS)
20 Downtime due to scheduled maintenace/upgrades (HRS)
21 Downtime of the hydrogen refuelling station due to the compressor/pump
22 Downtime of the hydrogen refuelling station due to the hydrogen storage facility
23 Downtime of the hydrogen refuelling station due to the refuelling dispensers
24 Downtime of the hydrogen refuelling station due to electrical components
25 Downtime of the hydrogen refuelling station due to software issues
26 Downtime of the hydrogen refuelling station due to the onsite hydrogen production unit
27 Mean time between failures (MTBF)
28 Number of safety incidents - total
29 Nr of safety incidents of level 1 - catastrophic
30 Nr of safety incidents of level 2 - severe loss
31 Nr of safety incidents of level 3 - major damage
32 Nr of safety incidents of level 4 - damage
33 Nr of safety incidents of level 5 - minor damage
34 Utilisation rate of the onsite hydrogen production unit
35 Availability of the onsite hydrogen production unit - Average
36 Cost - operational expenditure (OPEX)
37 Cost of hydrogen

Hydrogen refueling station research

Descriptive parameters

1 Nominal dispensing capacity of the station - hourly
2 Nominal dispensing capacity of the station - daily
3 Number of cars per hour
4 Number of cars per day
5 Number of buses per hour
6 Number of buses per day
7 Component addressed within the project
8 Footprint - station
9 Protocols and standards
10 Scalability & modularity
11 Hydrogen supply logistics
12 Technology of the onsite hydrogen production
13 Source of renewable energy input
14 Fraction of renewable energy input
15 Production rate of hydrogen - on-site
16 Volume - production unit
17 Hydrogen storage capacity (on-site)
18 State of the hydrogen in the storage tank
19 Pressure of the on-site storage tank - rated
20 Noise - compressor
21 State of the hydrogen at dispensing
22 Pressure of the hydrogen dispensed
23 Cost - capital expenditure (CAPEX) - estimated
24 Cost - capital expenditure (CAPEX) (estimate) - components
25 Cost - capital expenditure (CAPEX) (estimate) - components @ mass production

Variable parameters

1 Start date for data entries in the reference year
2 End date for data entries in the reference year
3 Technology readiness level (TRL) - station
4 Vehicles refuelled
5 Days of operation - total
6 Hours of operation - cumulative (HRS)
7 Number of daily refuellings - average
8 Number of hydrogen refuelling operations
9 Refuelling time @200 bar - average
10 Refuelling time @350 bar - average
11 Refuelling time @700 bar - average
12 Utilisation rate of the hydrogen refuelling station
13 Availability of the hydrogen refuelling station - Average
14 Quantity of hydrogen delivered to the hydrogen refuelling station
15 Quantity of hydrogen produced (HRS)
16 Quantity of hydrogen dispensed
17 Quantity of hydrogen dispensed daily - average
18 Metering accuracy
19 System energy consumption for hydrogen compression
20 Technology readiness level (TRL) - components
21 Cost of hydrogen
22 Cost - operational expenditure (OPEX) - estimate

Electrolyser demonstration

Descriptive parameters

1 System location - country
2 System location - city
3 System location - post code
4 Start date of operation
5 Manufacturer/supplier
6 Manufacturer/supplier of the stack(s)
7 Technology of the electrolyser
8 Production rate of hydrogen - rated - daily weight
9 Production rate of hydrogen - rated - hourly volume
10 Capacity of the system - rated
11 Capacity of the stack - rated
12 Footprint - hydrogen production unit
13 Volume
14 Nature of the electricity source
15 Fraction of renewable energy input
16 Durability / Lifetime of the system - rated
17 Durability / lifetime of the stack(s) - rated
18 Quality required for water
19 Purity of the produced hydrogen - rated
20 Type of power converter
21 Input voltage
22 Power usage of auxiliary equipment - idle
23 Power usage of auxiliary equipment - max production
24 Electrical efficiency of the stack(s) (rated - HHV - DC current)
25 Electrical efficiency of the system (rated - HHV - AC current)
26 Planned maintenance - duration
27 Cost - capital cost of the system (per kW)
28 Cost - capital cost of the system (per ton/day)
29 Cost - capital cost of the system (per ton/day) @ mass production (estimate)

Variable parameters

1 Start date for data entries in the reference year
2 End date for data entries in the reference year
3 Hours of operation - total (system)
4 Hours of operation - cumulative (system)
5 Operating time per day
6 Transient response time
7 Time for hot start to 100% H2 output rate
8 Time for hot start to 100% power
9 Time for cold start to 100% H2 output rate
10 Time for cold start to 100% power
11 Part-load operation - minimum
12 Ramping flexibility - minimum power
13 Ramping flexibility - maximum power
14 Operating pressure
15 Operating temperature
16 Quantity of hydrogen produced
17 Electricity consumed - total (system)
18 Availability of the system(s)
19 Efficiency degradation
20 Degradation rate in µV/h
21 Degradation rate in %/kh
22 Electrical efficiency of the stack(s) (observed - HHV - DC current)
23 Electrical efficiency of the system (observed - HHV - AC current)
24 System energy consumption for hydrogen production
25 System energy consumption for hydrogen compression
26 Operating profile
27 Number of safety incidents - total
28 Price/cost of electricity
29 Cost of electricity consumed - levelised (LCOE)
30 Cost - operational expenditure (OPEX)
31 Cost of the hydrogen produced

Electrolyser – research at system level

Descriptive parameters

1 Manufacturer/supplier
2 Manufacturer/supplier of the stack(s)
3 Technology of the electrolyser
4 Number of units per system
5 Number of stacks per unit
6 Number of cells per stack
7 Production rate of hydrogen - rated - daily weight
8 Production rate of hydrogen - rated - hourly volume
9 Capacity of the system - rated
10 Capacity of the stack - rated
11 Durability / Lifetime of the system - rated
12 Durability / lifetime of the stack(s) - rated
13 Quality required for water
14 Type of power converter
15 Input voltage
16 Power usage of auxiliary equipment - idle
17 Power usage of auxiliary equipment - max production
18 Catalyst at the anode
19 Catalyst at the cathode
20 Cell area - active
21 Purity of the produced hydrogen - rated
22 Electrical efficiency of the system (rated - HHV - AC current)
23 Electrical efficiency of the stack(s) (rated - HHV - DC current)
24 Cost - capital cost of the system (per kW)
25 Cost - capital cost of the system (per ton/day)
26 Cost - capital cost of the system (per ton/day) @ mass production (estimate)
27 Cost - balance of plant (BoP)

Variable parameters

1 Start date for data entries in the reference year
2 End date for data entries in the reference year
3 Hours of operation - total (system)
4 Hours of operation - cumulative (system)
5 Operating time per day
6 Transient response time
7 Time for hot start to 100% H2 output rate
8 Time for hot start to 100% power
9 Time for cold start to 100% H2 output rate
10 Time for cold start to 100% power
11 Part-load operation - minimum
12 Operating pressure
13 Operating temperature
14 Quantity of hydrogen produced
15 Electricity consumed - total (system)
16 Availability of the system(s)
17 Availability of the stack(s)
18 Efficiency degradation
19 Electrical efficiency of the system (observed - HHV - AC current)
20 Electrical efficiency of the stack(s) (observed - HHV - DC current)
21 System energy consumption for hydrogen production
22 System energy consumption for hydrogen compression
23 Stack energy consumption for hydrogen production
24 Operating profile
25 Current density
26 Heat loss density
27 Power density
28 Cell voltage
29 Degradation rate in µV/h
30 Degradation rate in %/kh
31 Catalyst loading - Anode (in mg/cm2)
32 Catalyst loading - Cathode (in mg/cm2)
33 Catalyst loading - Overall (in mg/cm2)
34 Catalyst loading - Anode - in g/(kg H2/day)
35 Catalyst loading - Cathode - in g/(kg H2/day)
36 Catalyst loading - Overall - in g/(kg H2/day)

Electrolyser – research at stack level

Descriptive parameters

1 Technology of the fuel cell
2 Type of fuel
3 Number of stacks per unit
4 Number of cells per stack
5 Capacity of the stack - rated
6 Durability / lifetime of the stack(s) - rated
7 Purity required for the fuel
8 Cell area - active
9 Catalyst at the cathode
10 Catalyst at the anode
11 Cost - capital cost of the stack (per kW)
12 Cost - capital cost of the stack (per kW) @ mass production (estimate)

Variable parameters

1 Start date for data entries in the reference year
2 End date for data entries in the reference year
3 Hours of operation - total (stack)
4 Hours of operation - cumulative (stack)
5 Operating time per day
6 Transient response time
7 Time for cold start to rated power (from +20°C)
8 Time for cold start to rated power (from -20°C)
9 Operating pressure
10 Operating temperature
11 Ambient temperature - Minimum
12 Ambient temperature - Maximum
13 Availability of the stack(s)
14 Fuel utilisation rate
15 Electricity produced - total
16 Electrical efficiency of the stack(s) (observed - LHV)
17 Total efficiency of the stack - (observed - LHV)
18 Current density
19 Power density
20 Cell voltage
21 Degradation rate in µV/h
22 Degradation rate in %/kh
23 Catalyst loading - Anode (in mg/cm2)
24 Catalyst loading - Cathode (in mg/cm2)
25 Catalyst loading - Overall (in mg/cm2)
26 Catalyst loading - Anode (in g/kW)
27 Catalyst loading - Cathode (in g/kW)
28 Catalyst loading - Overall (in g/kW)

Hydrogen production other than electrolysis - demonstration

Descriptive parameters

1 System location - country
2 System location - city
3 System location - post code
4 Start date of operation
5 Description of the demo object
6 Manufacturer/supplier of the H2 production unit
7 Feedstock
8 Main energy source
9 Secondary energy input/parasitic losses - if applicable
10 Purification of hydrocarbon feed before reactor
11 Purification of water feed before reactor
12 Catalyst(s)
13 Hydrogen purification method
14 Footprint - hydrogen production unit
15 Volume
16 Production rate of hydrogen - rated - daily weight
17 Durability / Lifetime of the system - rated
18 Purity of the produced hydrogen - rated
19 Conversion efficiency @ start of operations
20 Technology readiness level (TRL) @start of operations
21 Cost - capital cost of the system (per ton/day)
22 Cost - capital cost of the system (per ton/day) @ mass production (estimate)

Variable paramaters

1 Start date for data entries in the reference year
2 End date for data entries in the reference year
3 Hours of operation - total (system)
4 Hours of operation - cumulative (system)
5 Operating time per day
6 Time for hot start to 100% H2 output rate
7 Time for cold start to 100% H2 output rate
8 Part-load operation - minimum
9 Operating pressure
10 Operating temperature
11 Quantity of hydrogen produced
12 Availability of the system(s)
13 Conversion efficiency @ start of reporting period
14 Efficiency degradation
15 Number of times the catalyst was replaced
16 Number of times the reactor was replaced
17 Number of times the fermeting/biological agents were replaced
18 Number of times hydrogen purification membrane was replaced
19 Purity of the produced hydrogen before purification
20 Purity of the produced hydrogen after purification
21 System energy consumption for hydrogen production
22 System energy consumption for hydrogen compression
23 Number of safety incidents - total
24 Technology readiness level (TRL) @start of timeframe
25 Cost of the hydrogen produced
26 OPEX

Hydrogen production other than electrolysis - research

Descriptive parameters

1 Feedstock
2 Main energy source
3 Secondary energy input/parasitic losses - if applicable
4 Purification of hydrocarbon feed before reactor
5 Purification of water feed before reactor
6 Catalyst(s)
7 Hydrogen purification method

Variable parameters

1 Start date for data entries in the reference year
2 End date for data entries in the reference year
3 Hours of operation - total (system)
4 Hours of operation - cumulative (system)
5 Time for hot start to 100% H2 output rate
6 Time for cold start to 100% H2 output rate
7 Part-load operation - minimum
8 Operating pressure
9 Operating temperature
10 Quantity of hydrogen produced
11 Conversion efficiency @ start of timeframe
12 Efficiency degradation
13 Number of times the catalyst was replaced
14 Number of times the reactor was replaced
15 Number of times the fermeting/biological agents were replaced
16 Number of times hydrogen purification membrane was replaced
17 Purity of the produced hydrogen
18 Technology readiness level (TRL) @start of timeframe
19 Cost of hydrogen

Hydrogen storage

Descriptive parameters

1 State of the hydrogen in the storage tank
2 Storage application
3 Storage vessel material
4 Internal lining (if applicable)
5 Hydrogen volumetric capacity
6 Hydrogen gravimetric capacity
7 Supporting/carrier substrate: nature
8 Supporting/carrier substrate: cost
9 Supporting/carrier substrate: hydrogen gravimetric capacity
10 Maximum pressure - rated
11 Minimum temperature - rated
12 Maximum temperature - rated
13 Volume
14 Weight
15 Hydrogen storage system cost (CAPEX) per kg of capacity
16 Hydrogen storage system cost (CAPEX) per kg capacity @ mass production (estimate)
17 Additional CAPEX needed

Variable parameters

1 Durability / lifetime of the storage system (observed)
2 Durability / lifetime of the storage system (projected/estimated)
3 Number of charging/discharging cycles achieved
4 Maximum number of charging/discharging cycles (estimate)
5 Energy to load the hydrogen
6 Peak hydrogen charging rate
7 Energy to discharge the hydrogen
8 Peak hydrogen discharging rate
9 Total amount of hydrogen discharged
10 Boil-off
11 Operational cost

Stationary fuel cell system demonstration

Descriptive parameters

1 System location - country
2 System location - city
3 System location - post code
4 Start date(s) of operation
5 Manufacturer/supplier
6 Manufacturer/supplier of the stack(s)
7 Technology of the fuel cell
8 Type of fuel
9 Capacity of the system - rated
10 Capacity of the stack - rated
11 Volume
12 Operating pressure
13 Operating temperature
14 Ambient temperature - Minimum
15 Ambient temperature - Maximum
16 Durability / lifetime of the fuel cell system - rated
17 Durability / lifetime of the stack(s) - rated
18 Electrical efficiency of the system (rated - LHV)
19 Total Efficiency of the system - (rated - LHV)
20 Emissions - CO2 emissions per electricity output
21 Emissions - SOx emissions per electricity output
22 Emissions - NOx emissions per electricity output
23 Noise
24 Cost - capital cost of the system (per kW)
25 Cost - capital cost of the system (per kW) @ mass production (estimate)

Variable parameters

1 Start date for data entries in the reference year
2 End date for data entries in the reference year
3 Number of demonstration systems deployed
4 Hours of operation - total
5 Hours of operation - cumulative
6 Operating time per day
7 Durability / lifetime of the fuel cell system - observed
8 How many fuel cell stack(s) has (have) been replaced on the vehicle(s)?
9 Transient response time
10 Time for cold start to rated power (from -20°C)
11 Time for cold start to rated power (from +20°C)
12 Operating profile
13 Electricity produced - total
14 Useful heat output
15 Availability of the system(s)
16 Electrical efficiency of the system (observed - LHV)
17 Total Efficiency of the system - (observed - LHV)
18 Number of safety incidents - total
19 Cost - operational expenditure (OPEX)
20 Cost/price of the hydrogen fuel
21 Cost of other fuel
22 Cost of electricity generated - levelised (LCOE)

Fuel cells – research at system level

Descriptive parameters

1 Manufacturer/supplier
2 Manufacturer/supplier of the stack(s)
3 Technology of the fuel cell
4 BoP component of interest
5 Type of fuel
6 Number of units per system
7 Number of stacks per unit
8 Number of cells per stack
9 Capacity of the system - rated
10 Durability / lifetime of the fuel cell system - rated
11 Durability / lifetime of the stack(s) - rated
12 Purity required for the fuel
13 Catalyst at the cathode
14 Catalyst at the anode
15 Cell area - active
16 Electrical efficiency of the system (rated - LHV)
17 Total Efficiency of the system - (rated - LHV)
18 Electrical efficiency of the stack(s) (rated - LHV)
19 Total efficiency of the stack - (rated - LHV)
20 Cost - capital cost of the system (per kW)
21 Cost - capital cost of the system (per kW) @ mass production (estimate)
22 Cost - balance of plant (BoP)

Variable parameters

1 Start date for data entries in the reference year
2 End date for data entries in the reference year
3 Hours of operation - total (system)
4 Hours of operation - cumulative (system)
5 Operating time per day
6 Transient response time
7 Time for cold start to rated power (from -20°C)
8 Time for cold start to rated power (from +20°C)
9 Operating pressure
10 Operating temperature
11 Ambient temperature - Minimum
12 Ambient temperature - Maximum
13 Fuel utilisation rate
14 Electricity produced - total
15 Useful heat output
16 Electrical efficiency of the system (observed - LHV)
17 Total Efficiency of the system - (observed - LHV)
18 Electrical efficiency of the stack(s) (observed - LHV)
19 Total efficiency of the stack - (observed - LHV)
20 Current density
21 Power density
22 Cell voltage
23 Availability of the system(s)
24 Availability of the stack(s)
25 Degradation rate in %/kh
26 Degradation rate in µV/h
27 Catalyst loading - Anode (in mg/cm2)
28 Catalyst loading - Anode (in g/kW)
29 Catalyst loading - Cathode (in mg/cm2)
30 Catalyst loading - Cathode (in g/kW)
31 Catalyst loading - Overall (in mg/cm2)
32 Catalyst loading - Overall (in g/kW)
33 Cost/price of the hydrogen fuel
34 Cost of other fuel
35 Cost of electricity generated - levelised (LCOE)

Fuel cells – research at stack level or lower

Descriptive parameters

1 Technology of the fuel cell
2 Type of fuel
3 Number of stacks per unit
4 Number of cells per stack
5 Capacity of the stack - rated
6 Durability / lifetime of the stack(s) - rated
7 Purity required for the fuel
8 Cell area - active
9 Catalyst at the cathode
10 Catalyst at the anode
11 Cost - capital cost of the stack (per kW)
12 Cost - capital cost of the stack (per kW) @ mass production (estimate)

Variable parameters

1 Start date for data entries in the reference year
2 End date for data entries in the reference year
3 Hours of operation - total (stack)
4 Hours of operation - cumulative (stack)
5 Operating time per day
6 Transient response time
7 Time for cold start to rated power (from +20°C)
8 Time for cold start to rated power (from -20°C)
9 Operating pressure
10 Operating temperature
11 Ambient temperature - Minimum
12 Ambient temperature - Maximum
13 Availability of the stack(s)
14 Fuel utilisation rate
15 Electricity produced - total
16 Electrical efficiency of the stack(s) (observed - LHV)
17 Total efficiency of the stack - (observed - LHV)
18 Current density
19 Power density
20 Cell voltage
21 Degradation rate in µV/h
22 Degradation rate in %/kh
23 Catalyst loading - Anode (in mg/cm2)
24 Catalyst loading - Cathode (in mg/cm2)
25 Catalyst loading - Overall (in mg/cm2)
26 Catalyst loading - Anode (in g/kW)
27 Catalyst loading - Cathode (in g/kW)
28 Catalyst loading - Overall (in g/kW)

Diagnostic systems

Descriptive parameters

1 Targeted sector/application
2 Manufacturer/supplier of the stack(s)
3 Technology of the system
4 Type of fuel
5 Purity required for the fuel
6 Number of units per system
7 Number of stacks per unit
8 Number of cells per stack
9 Capacity of the system - rated
10 Capacity of the stack - rated
11 Power usage of the diagnostic/control tool
12 Diagnostic tool
13 Does your tool measure the degradation?
14 Have you developed prognostics tools for remaining lifetime estimation?
15 Cost - capital cost of the system (per kW)
16 Cost - capital cost of the diagnostic/control system

Variable parameters

1 Start date for data entries in the reference year
2 End date for data entries in the reference year
3 Hours of operation - total (stack)
4 Hours of operation - total (system)
5 Hours of operation - total (diagnostic)
6 Operating pressure
7 Operating temperature
8 Durability / Lifetime of the system - observed/predicted
9 Improvement of the system lifetime - estimate
10 Durability / lifetime of the stack(s) - observed/predicted
11 Improvement of the stack lifetime - estimate
12 Durability / Lifetime of the diagnostic system - observed
13 Degradation rate in %/kh (diagnosis)
14 Degradation rate in µV/h (diagnosis)
15 Improvement of the degradation rate - estimate
16 Electrical efficiency of the system
17 Improvement of the system electrical efficiency
18 Improvement of the mean time between failures (MTBF) - estimate
19 Improvement of the availability - estimate
20 Availability of the diagnosis/monitoring system
21 Number of fuel cell faults detected
22 Number of fuel cell failures detected
23 Performance indicator of the diagnostic tool
24 Performance indicator towards faults/failures detection due to fuel starvation
25 Performance indicator towards faults/failures detection due to air starvation
26 Performance indicator towards faults/failures detection due to flooding and dehydration
27 Performance indicator towards faults/failures detection due to changes in fuel composition
28 Performance indicator towards faults/failures detection due to sulphur poisoning
29 Performance indicator towards faults/failures detection due to breaks and/or leakages
30 Performance indicator towards faults/failures detection due to delamination
31 Performance indicator towards faults/failures detection due to other issues
32 Cost - operational expenditure - diagnosis/control
33 Cost - operational expenditure - system
34 Cost reduction - operational expenditure

Pre-normative research

Descriptive parameters

1 Gap in knowledge addressed
2 Project objective
3 FCH JU pillar
4 Approach
5 Target regulation, code or standard
6 Targeted organisation
7 Targeted technical/working group
8 Other RCS addressing the issue tackled by the project
9 Foreseen means of improvement/revision of standard
10 Collaborations outside EU28

Variable parameters

1 Start date for data entries in the reference year
2 End date for data entries in the reference year
3 Newly detected relevant RCS activities
4 Progress vs knowledge gap
5 Standards: is consortium involved first-hand?
6 Standard developing organisation(s) contacted to date
7 Number of meetings with standard developing organisations
8 Number of workshops with standard developing organisations
9 Number of reports sent to standard developing organisations
10 Regulatory bodies contacted to date
11 Number of meetings with regulatory organisations
12 Number of workshops with regulatory organisations
13 Number of reports sent to regulatory organisations
14 Number of peer reviewed publications
15 Number of patents
16 Number of oral presentations at scientific seminars/conferences
17 Nr of posters at scientific seminars/conferences
18 Have the project results been integrated (to date) in in any regulation, codes or standards?
19 By what year would you expect that the project result become integrated in any regulation, code or standard?

Annex 2 – data aggregation

The information given below is indicative. The aggregation is always done individually according to the exact nature of the project and its description of work

- Car demonstration: one research object for aggregated data per car model/location (typically this involves several cars within a single research object)
- Bus demonstration: one research object for aggregated data per bus model/location (typically this involves a few buses within a single research object)
- Material handling vehicle (MHV) demonstration: one research object for aggregated data per MHV model/location (typically this involves several MHVs within a single research object)
- Auxiliary power unit demonstration: one research object per unit
- Hydrogen refueling station demonstration: one research object per station
- Hydrogen refueling station research: one research object per project
- Electrolyser demonstration - one research object per unit
- Electrolyser – research at system level: one research object per system
- Electrolyser – research at stack level or lower: one research object per project
- Hydrogen production other than electrolysis - demonstration: one research object per unit
- Hydrogen production other than electrolysis - research: one research object per project
- Hydrogen storage - one research object per unit
- Stationary fuel cell system demonstration: one research objects for aggregated data per CHP unit model/location (typically this involves several CHP within a single research object for micro-CHP but may be for dingle units in case of larger systems)
- Fuel cells – research at system level - one research object per system
- Fuel cells – research at stack level or lower - one research object per project
- Diagnostic systems - one research object per system
- PNR: one research object per project