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

Contents

1. Introduction

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

In view of assessing 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 the concerned 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 data collection is intended to yield comparable data from various projects by unambiguously setting the relevant

- parameters
- units
- validity date (annual granularity)

Data collection is to be performed, as from 2017, through the TRUST (Technology Reporting Using Structured Templates) collection platform.

Projects have a contractual obligation to comply with the submission of the requested data according to article II.10 of FP7 grant agreements (from calls 2008 to 2013) and to dedicated project deliverables[1] for Horizon 2020 projects (from call 2014 onwards).

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

[1] Typically labelled "Annual data reporting" deliverables

2. Data collection

Data collection input period

The data collection system is intended to be open for data input by the projects for at least 1 months each year, typically in the March-June period. For 2018, the foreseen input timeframe should be from May to mid-June.

Reference period

Data collection should concern project data referring to the calendar year (reference year) preceding the collection exercise, i.e. for the 2019 data collection exercise, data should be reported concerning the period from 01/01/2018 to 31/12/2018 (the reference year is 2018).

For projects (a) started or (b) ended in the year preceding the data collection exercise, the reference period for which data are expected is:

a) Project start date to 31/12 of the previous year
b) 01/01 of the previous year to project end date

Templates

Data are to be collected through 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:

- Electrolyser – research at stack level or lower
- Electrolyser – research at system level
- Electrolyser demonstration
- Co-electrolysis research at stack or lower
- Hydrogen production research
- Hydrogen production demonstration
- Hydrogen refuelling station research
- Hydrogen refuelling station demonstration
- Fuel cells – research at stack level or lower
- Fuel cells – research at system level
- Fuel cell car demonstration
- Fuel cell /plug-in car demonstration
- Fuel cell bus demonstration
- Fuel cell material handling vehicle demonstration
- Auxiliary power unit demonstration
- On-board storage for compressed gaseous hydrogen
- Stationary, µ-CHP
- Stationary, non µ-CHP
- Fuel cell stack manufacturing
- Diagnostics – electrolysis
- Diagnostics - fuel cells
- Pre-Normative Research
- Education

The template questionnaire within the research object is divided into descriptive and operational parameters.

Descriptive parameters define the item addressed in the questionnaire and allow to set the scene for which actual results are reported as **operational** parameters. In principle, descriptive parameters do not change during the project lifetime, while operational parameters evolve and will be different from one annual data collection exercise to the next according to progress in the reference period.

The parameters have been defined in view of allowing a comprehensive overview of the technology status and include the Key Performance Indicators (KPIs) defined in the FCH JU Multi-Annual Work Plan (MAWP) addendum.

The parameters requested in each template are listed in Annex 2.

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 providers

The person with access to the online system is hereby referred to as "data provider".

If needed, several data providers can be assigned to a same research object .

Please note that the data providers are assigned specifically for each research object, so different research objects from the same project may have different data providers.

As default, the project coordinator will be assigned as data provider. Changes or additions in data provider can be requested to fchju_trust@fch.europa.eu

Input method

The data will be collected online, through a secured connection, in a programme called TRUST.

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 individual 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.

Confidential data will be treated with extreme care, avoiding that any related information is 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.

From 2018, parameters labeled with the prefix 'KPI' (Key Performance Indicator) will be considered by default **public** unless justification is provided by the data-provider for the necessity to keep the data confidential. These data will be used by the FCH JU only for the purpose of the Annual Programme Review.

More information on data treatment is provided in the section 3.

Data aggregation

Research objects in TRUST 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 refuelling stations, electrolysers or large-scale CHP units, while aggregated data would be sufficient for a fleet of same vehicles 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 1.

3. Data utilisation

As already mentioned above, data provided in TRUST 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".

Data validation (authorisation)

In a first phase after data submission, the data will be validated by the relevant Project Officers which will authorise or reject the entire form. 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. The Project Officer will also verify (and accept/reject) the justifications given for not providing certain parameters.

Data rejection

In the case that a research object form 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 and resubmit the form.

Cost claims related to tasks that would lead to forms 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 to form a view on technology status.

In comparison with public values obtained through continued technology watch and international state of the art values, it also aims at assessing 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 custom already with deliverables and reports, only public data will be disclosed in this context, unless aggregation of several comparable data is possible to provide anonymised and unrecognisable output.

Annex 1: Aggregation level for the items concerned by the various parameter templates

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

- **Electrolyser – research at stack level or lower**: one research object per project
- **Electrolyser – research at system level**: one research object per system
- **Electrolyser demonstration**: one research object per unit
- **Co-electrolysis:** one research object per project
- **Hydrogen production research**: one research object per project
- **Hydrogen production demonstration:** one research object per unit
- **Co-electrolyser stack or lower**: one research object per project
- **Hydrogen refuelling station research**: one research object per project
- **Hydrogen refuelling station demonstration**: one research object per station
- **Fuel cells – research at stack level or lower**: one research object per project or per stack technology
- **Fuel cells – research at system level**: one research object per system or per system technology
- **Fuel cell car demonstration**: one research objects for aggregated data per vehicle model/location (typically this involves several vehicles within a single research object)
- **Fuel cell /plug-in car demonstration**: one research objects for aggregated data per vehicle model/location (typically this involves several vehicles within a single research object)
- **Fuel cell bus demonstration**: one research objects for aggregated data per vehicle model/location (typically this involves several vehicles within a single research object)
- **Fuel cell material handling vehicle demonstration**: one research objects for aggregated data per vehicle model/location (typically this involves several vehicles within a single research object)
- **Auxiliary power unit demonstration**: one research object per unit
- **Onboard storage for compressed gaseous hydrogen**: one research object per unit
- **Stationary, µ-CHP**: one research objects for aggregated data per CHP unit model/location
- **Stationary, non µ-CHP**: one research object per unit
- **Fuel cell stack manufacturing**: one research object per project
- **Diagnostics – electrolysis**: one research object per project
- **Diagnostics - fuel cells**: one research object per project
- **Pre-Normative Research**: one research object per project
- **Education**: one research object per training course
- **HDVs (trucks)** – Under development
- **H2 Carriers – Energy Storage** – Under development

Annex 2: Parameter templates

The exact parameters, as well as to their exact name and order may vary.

Electrolyser – research at stack level or lower

Descriptive

- Technology
- Active cell area
- Operating temperature
- Rated stack durability
- Operating pressure
- Hydrogen purity
- Nominal hydrogen weight capacity
- Input voltage
- Stack nominal capacity
- Rated stack electrical efficiency (HHV, DC current)
- Number of cells in each stack
- KPI - Catalyst at the cathode
- KPI - Catalyst at the anode
- KPI - Stack CAPEX (per kW)
- KPI - Est. stack CAPEX (per kW) @ 100MW annual production
- KPI - Reversible capacity of the Electolyser (Specific System)
- ASR - Active Specific Resistance

Operational

- Start date for reporting
- End date for reporting
- Hours of operation
- Hours of operation - cumulative
- Quantity of hydrogen produced
- Electricity consumed
- KPI - Stack electricity consumption for H2 production
- Stack Thermal Energy Consumption
- Power density
- KPI - Current density
- Stack availability
- Operating time per day
- KPI - Cold start ramp time
- KPI - Hot idle ramp time
- Cell voltage
- Transient response time
- Stack electrical efficiency (HHV, DC current)
- KPI - Production loss rate for HT Electolyser
- Voltage degradation rate in %/kh
- KPI - Efficiency degradation per 1000 h for LT Electrolyser
- KPI- Cathode catalyst loading per W
- Cathode catalyst loading per H2 capacity
- Anode catalyst loading per H2 capacity
- KPI - Anode catalyst loading per W
- KPI - Reversible efficiency of the Electrolyser (Specific System)
- Degradation - ASR

Electrolyser – research at system level

Descriptive

- Technology
- System nominal capacity
- Stack nominal capacity
- System manufacturer
- Stack manufacturer
- Stack Thermal Energy Consumption
- Rated system lifetime
- Rated system electrical efficiency (HHV, AC current)
- Rated stack durability
- Rated stack electrical efficiency (HHV, DC current)
- Power usage of auxiliary equipment at nominal capacity
- Power usage of auxiliary equipment - in standby
- Power converter
- Operating temperature
- Operating pressure
- Number of stacks in each stack array
- Number of stack arrays
- Number of cells in each stack
- Nominal hydrogen weight capacity
- Nominal hydrogen volume capacity
- Maximum overload capacity
- Input voltage
- Hydrogen purity
- System minimum power
- Active cell area
- KPI - System CAPEX
- BoP CAPEX
- KPI- Estimated CAPEX of electrolyser @ 100MW annual production scale
- KPI - Catalyst at the cathode
- KPI - Catalyst at the anode
- KPI - Reversible capacity of the Electolyser (Specific System)
- System CAPEX per kW

Operational

- Start date for reporting
- End date for reporting
- Days of operation
- Hours of operation
- Stack electrical efficiency (HHV, DC current)
- System electrical efficiency (HHV, AC current)
- KPI - Stack electricity consumption
- Maximum overload operation
- System energy consumption for H2 compression
- Cell voltage
- KPI - Current density
- System availability
- Hours of operation - cumulative
- Electricity consumed
- KPI - Hot idle ramp time
- KPI - Cold start ramp time
- Transient response time
- Operating profile
- Minimum part-load operation observed
- Quantity of hydrogen produced
- KPI - Production loss rate for HT Electolyser
- KPI - Efficiency degradation per 1000 h for LT Electrolyser
- KPI - Reversible efficiency of the Electrolyser (Specific System)
- Stack availability
- KPI - Cathode catalyst loading per W
- Cathode catalyst loading per H2 capacity
- KPI-Anode catalyst loading per W
- Anode catalyst loading per H2 capacity
- Power density
- Time from standby to nominal capacity
- Voltage degradation rate in µV/h/cell
- KPI- OPEX (Operational & Maintenance Costs) @ 10 years
- KPI - Use of critical raw materials as catalysts
- KPI- OPEX (Operational & Maintenance Costs)
- System energy consumption for H2 compression
- Time for cold start to nominal capacity

Electrolyser demonstration

Descriptive

- Country
- Town
- Postcode
- Deployment date
- Technology
- Electricity origin
- Electrolyser manufacturer
- Stack manufacturer
- KPI - Electrolyser Footprint
- Electrolyser price
- System minimum power
- Stack nominal capacity
- Number of stacks
- Electrolyser Volume
- Input voltage
- Maximum overload capacity
- Nominal hydrogen weight capacity
- Nominal power
- Operating pressure
- Operating temperature
- Power converter
- Power usage of auxiliary equipment at nominal capacity
- Power usage of auxiliary equipment - in standby
- Rated stack electrical efficiency (HHV, DC current)
- Rated stack durability
- Rated system lifetime
- Rated system electrical efficiency (HHV, AC current)
- Hydrogen purity
- KPI- Estimated CAPEX of electrolyser @ 100MW annual production scale
- KPI - CAPEX electrolyser
- KPI - OPEX @ 10 years
- KPI - Catalyst at the cathode
- KPI - Catalyst at the anode
- KPI - Reversible capacity of the Electolyser (Specific System)

Operational

- Days of operation
- Start date for reporting
- End date for reporting
- Days of operation - cumulative
- Cost of the hydrogen produced
- Voltage degradation rate in %/kh
- Price/cost of electricity
- KPI - Availability
- Duration of planned maintenance
- KPI-Efficiency degradation per 1000 h for LT electrolysers
- KPI-Estimated Efficiency degradation per 1000 h @ 10 year lifespan for LT electolysers
- Energy consumption for H2 compression
- KPI- Electricity consumption @ nominal capacity
- Electricity consumed
- Fraction of renewable energy input
- Hours of operation
- Hours of operation - cumulative
- Maximum overload operation
- Maximum % power for 98% efficiency
- Number of safety incidents
- Minimum part-load operation
- Stack electrical efficiency (HHV, DC current)
- System electrical efficiency (HHV, AC current)
- KPI- OPEX
- Thermal Energy Consumption @ nominal capacity
- Transient response time
- Quantity of hydrogen produced
- KPI - Hot idle ramp time
- KPI - Cold start ramp time
- KPI - Production loss rate for HT Electolyser
- KPI - Current Density
- KPI-Cathode catalyst loading per W
- KPI - Anode catalyst loading per W
- KPI - Reversible efficiency of the Electrolyser (Specific System)
- KPI - Production loss rate for HT Electolyser @ 10 year lifespan

Co-electrolysis Research at stack level or lower

Descriptive

- Technology for co-electrolysis
- Number of cells in each stack
- Stack nominal power capacity
- Stack lifetime, rated
- Input Voltage
- KPI - Stack electrical efficiency (rated - HHV - DC current) - H2
- KPI - Stack electrical efficiency (rated - HHV - DC current) - Syngas
- Active Cell Area
- KPI - Material at the cathode
- KPI - Material at the anode
- KPI - co-Electrolysis: Operating pressure
- KPI - Capital cost of the stack (per kW)
- Estimated capital cost of the stack (per kW) @ 100MW production
- Operating temperature
- Methanation process
- Methanation catalyst
- Design pressure for the methanation step
- Design overall process efficiency
- Design temperature for the methanation step

Operational

- Start date for reporting
- End date for reporting
- CO2 source
- co-Electrolysis: Hours of operation
- co-Electrolysis: Hours of operation - cumulative
- KPI - co-Electrolysis: Quantity of hydrogen produced
- KPI - co-Electrolysis: Quantity of syngas produced
- Stack availability
- co-Electrolysis: Electricity consumed
- KPI - Stack electrical efficiency (observed - HHV - DC current)
- KPI - Stack: current density
- Stack: power density
- Stack: initial cell voltage
- KPI - Area Specific Resistance
- KPI - Degradation - ASR
- KPI - Stack: electrical efficiency degradation per 1000 h
- Capital cost of the stack (per kW) @ 100 MW
- Methanation yield
- Methanation temperature, experimental
- Methanation pressure, experimental
- Amount of methane produced
- KPI - Overall efficiency

Hydrogen production research

Descriptive

- Hydrogen production method
- Process description
- Hydrogen feedstock
- Main energy source
- Secondary energy input/parasitic losses
- Catalyst(s)
- Hydrogen purification method
- Nominal hydrogen weight capacity
- Nominal hydrogen volume capacity
- KPI - System carbon yield
- KPI - Rated system lifetime
- KPI - Est. System CAPEX per kg/day @ mass production

Operational

- Start date for reporting
- End date for reporting
- TRL @ start of timeframe
- TRL @ end of timeframe
- Hours of operation
- Hours of operation - cumulative
- Catalyst durability, observed
- Hot idle ramp time
- Cold start ramp time
- Operating pressure
- Operating temperature
- Min. part-load operation, observed
- Quantity of hydrogen produced
- Conversion efficiency @ start of timeframe
- KPI - Efficiency degradation rate
- Number of catalyst replacements
- H2 purity before purification
- Purity of the produced hydrogen after purification
- Number of safety incidents
- Est. cost of the hydrogen produced
- KPI - System energy use for H2 production
- KPI - Reactor Scale
- KPI - Reactor production rate

Hydrogen production demonstration

Descriptive

- Country
- Town
- Postcode
- Hydrogen production method
- Description of the production unit
- Manufacturer
- Target application
- Hydrogen feedstock
- Main energy source
- Secondary energy input/parasitic losses
- Operating pressure
- Operating temperature
- Deployment date
- Catalyst(s)
- Hydrogen purification method
- Footprint
- Volume
- Nominal hydrogen weight capacity
- Nominal hydrogen volume capacity
- KPI - Rated system lifetime
- Hydrogen purity
- Conversion efficiency @ start of operations
- TRL @start of operations
- KPI - System CAPEX per kg/day
- KPI - Est. System CAPEX per kg/day @ mass production
- KPI - System carbon yield

Operational

- Start date for reporting
- End date for reporting
- Hours of operation
- Hours of operation - cumulative
- Days of operation
- Days of operation - cumulative
- Operating time per day
- Hot idle ramp time
- Cold start ramp time
- Min. part-load operation, observed
- Quantity of hydrogen produced
- KPI - Availability
- Conversion efficiency @ start of timeframe
- Conversion efficiency @ end of timeframe
- KPI - Efficiency degradation rate
- H2 purity before purification
- H2 purity after purification
- KPI - System energy use for H2 production
- System energy use for H2 compression
- Number of safety incidents
- TRL @ end of timeframe
- Cost of the hydrogen produced
- KPI - OPEX
- KPI - Reactor production rate
- KPI - Reactor Scale

Descriptive

- Hourly capacity
- Daily capacity
- Number of cars per hour
- Number of cars per day
- Number of buses per hour
- Number of buses per day
- Component(s) addressed
- Refuelling protocol
- Hydrogen supply logistics
- On-site H2 production method
- Onsite H2 production rate
- Renewable feed
- Fraction of renewable feed
- Storage capacity
- State of H2 in storage tank
- Nominal pressure of the on-site storage tank
- Noise - compressor
- State of the hydrogen at dispensing
- Dispensing pressure
- CAPEX for the component(s)
- CAPEX for the component(s), est. @ mass prod.
- KPI - CAPEX for the HRS
- KPI - Est. HRS CAPEX @ mass production
- KPI - Lifetime
- KPI - Durability

Operational

- Start date for reporting
- End date for reporting
- Station TRL
- Vehicles refuelled
- Days of operation
- Hours of operation
- Hours of operation - cumulative
- Amount of hydrogen dispensed
- Number of H2 refuellings
- KPI - Availability - in period
- KPI - Mean time between failures (MTBF)
- Metering accuracy
- System energy consumption for H2 compression
- TRL - components
- KPI - Cost of hydrogen
- Number of safety incidents
- KPI -System Energy consumption

Hydrogen refuelling station demonstration

Descriptive

- Country
- Town
- Postcode
- Location type
- Station setting
- Type of access
- HRS manufacturer
- Operator
- Deployment date
- Number of dispensers
- Number of nozzles
- Storage capacity
- Dispensing pressure
- Hourly capacity
- Daily capacity
- Refuelling protocol
- Number of cars per hour
- Number of cars per day
- Number of buses per hour
- Number of buses per day
- Hydrogen supply logistics
- On-site H2 production method
- On-site H2 production rate
- Renewable feed
- Fraction of renewable feed
- KPI - CAPEX for the HRS
- Price of the HRS
- KPI - Lifetime
- KPI - Durability

Operational

- Start date for reporting
- End date for reporting
- Vehicles refuelled
- Days of operation
- Hours of operation
- Distance from the H2 production
- KPI - Amount of H2 dispensed
- KPI - Number of H2 refuellings
- Metering accuracy
- KPI Availability, in period
- KPI - Availability, since start
- KPI - Mean time between failures (MTBF)
- Downtime, overall
- Downtime for scheduled maintenance/upgrades
- Downtime due to the compressor/pump
- Downtime due to the hydrogen storage facility
- Downtime due to the refuelling dispensers
- Downtime due to electrical components
- Downtime due to software issues
- Downtime due to the hydrogen supply
- Downtime due to other reasons
- Number of safety incidents
- KPI - Annual maintenance cost
- KPI - Cost of renewable hydrogen
- Price of hydrogen
- KPI - Energy consumption
- KPI - Labour
- KPI - Cost of hydrogen
- KPI - Labour costs

Fuel cells – research at stack level or lower

Descriptive

- Stack manufacturer
- Fuel cell technology
- Fuel
- Number of cells per stack
- Capacity of the stack - rated
- KPI - Stack durability rated
- Purity required for the fuel
- Catalyst at the cathode
- Catalyst at the anode
- Active cell area
- KPI - Rated stack electrical efficiency (LHV)
- KPI - Rated stack total efficiency (LHV)
- KPI - Stack CAPEX (per kW)
- KPI - Est. stack CAPEX (per kW) @ mass production

Operational

- Start date for reporting
- End date for reporting
- Hours of operation
- Hours of operation - cumulative
- Operating time per day
- Transient response time
- Time for cold start to rated power (from +20Â°C)
- Time for cold start to rated power (from -20Â°C)
- Operating pressure
- Operating temperature
- Minimum ambient temperature
- Maximum ambient temperature
- KPI - Stack availability
- Fuel utilisation rate
- Electricity produced - Total
- KPI - Stack electrical efficiency (LHV) - observed
- KPI - Stack total efficiency (LHV) - observed
- Current density
- KPI - Areal power density
- Cell voltage
- KPI - Degradation rate in %/kh
- KPI - PGM catalyst loading - Anode (in mg/cm2)
- KPI - PGM catalyst loading - Anode (in g/kW)
- KPI - PGM catalyst loading - Cathode (in mg/cm2)
- KPI - PGM catalyst loading - Cathode (in g/kW)
- KPI - Stack Durability
- KPI - Cell Volumetric power density

Fuel cells – research at system level

Descriptive

- System manufacturer
- Stack manufacturer
- Fuel cell technology
- BoP component of interest
- Fuel
- Does the FC system include a reformer?
- Number of stacks per system
- Number of cells per stack
- Rated capacity of the FC system
- KPI - Rated FC system durability
- KPI - Rated stack durability
- Purity required for the fuel
- Catalyst at the cathode
- Catalyst at the anode
- Active cell area
- Rated system electrical efficiency (LHV)
- Rated system total efficiency (LHV)
- Rated stack electrical efficiency (LHV)
- Rated stack total efficiency (LHV)
- KPI - FC system CAPEX
- KPI - Est. FC system CAPEX @ mass production
- KPI - Stack CAPEX (per kW)
- Est. stack CAPEX (per kW) @ mass production
- KPI - BoP CAPEX
- KPI - BoP CAPEX @ mass production

Operational

- Start date for reporting
- End date for reporting
- Fuel utilisation rate
- Electricity produced - Total
- Useful heat output
- System electrical efficiency (LHV) - observed
- System total efficiency (LHV) - observed
- Stack electrical efficiency (LHV) - observed
- Stack total efficiency (LHV) - observed
- Current density
- KPI - Areal power density
- Cell voltage
- KPI - Stack availability
- KPI - Cell Volumetric power density
- Hours of operation
- Hours of operation - cumulative
- Operating time per day
- Operating pressure
- Operating temperature
- Minimum ambient temperature
- Maximum ambient temperature
- KPI - Degradation rate in %/kh
- KPI - System availability
- KPI - Stack durability
- Transient response time
- Time for cold start to rated power (from -20Â°C)
- Time for cold start to rated power (from +20Â°C)
- KPI - PGM catalyst loading - Cathode (in mg/cm2)
- KPI - PGM catalyst loading - Cathode (in g/kW)
- KPI - PGM catalyst loading - Anode (in mg/cm2)
- KPI - PGM catalyst loading - Anode (in g/kW)

Fuel cell car demonstration

Descriptive

- Country
- Town or region
- Deployment date
- Vehicle manufacturer
- Vehicle model
- Vehicle segment
- Production year
- Drivetrain power
- Drivetrain weight
- Range (NEDC)
- Maximum speed
- Weight
- Height
- Length
- Width
- Number of seats
- Hydrogen storage capacity
- Hydrogen tank pressure rating
- KPI - TTW consumption NEDC
- KPI - FC Durability
- Minimum ambient temperature
- Maximum ambient temperature
- KPI - Estimated Fuel cell system cost
- KPI - Vehicle cost
- Vehicle price
- KPI - Fuel cell system cost
- Est. vehicle cost @ mass prod.

Operational

- Start date for reporting
- End date for reporting
- Number of vehicles
- Number of vehicles taken out of service
- Hours of operation
- Hours of operation - cumulative
- KPI - Distance driven
- KPI - Distance driven, cumulative (project)
- KPI - Distance driven, cumulative (overall)
- KPI - Amount of hydrogen fed
- KPI - Availability
- KPI - FC Durability
- Downtime, overall
- Downtime for scheduled maintenance/upgrades
- Downtime due to stack issues
- Downtime due to peripheric mechanical components
- Downtime due to electrical components
- Downtime due to the on-board hydrogen storage tank
- Downtime due to the high voltage battery
- Downtime due to software issues
- KPI - Yearly Maintenance Costs
- MDBF
- Number of safety incidents

Fuel cell /plug-in car demonstration

Descriptive

- Country
- Town or region
- Deployment date
- Manufacturer
- Model
- Vehicle segment
- Production year
- Drivetrain power
- Drivetrain weight
- Range
- Hydrogen range
- Maximum speed
- Weight
- Height
- Length
- Width
- Number of seats
- Hydrogen storage capacity
- Hydrogen tank pressure rating
- Battery capacity
- KPI- FC Durability
- Minimum ambient temperature
- Maximum ambient temperature
- KPI - Fuel cell system cost
- Vehicle cost
- Vehicle price
- KPI - Estimated Fuel cell system cost
- KPI - Est. FC system cost @ mass prod.

Operational

- Start date for reporting
- End date for reporting
- Number of vehicles
- Number of vehicles taken out of service
- Hours of operation
- Hours of operation - cumulative
- KPI - Distance driven
- KPI - Distance driven, cumulative (project)
- KPI - Distance driven, cumulative (overall)
- KPI - Amount of hydrogen fed
- Number of electric recharges
- KPI - Amount of electricity fed
- KPI - Availability
- MDBF
- Downtime, overall
- Downtime for scheduled maintenance/upgrades
- Downtime due to stack issues
- Downtime due to peripheric mechanical components
- Downtime due to electrical components
- Downtime due to the on-board hydrogen storage tank
- Downtime due to the high voltage battery
- Downtime due to software issues
- Number of safety incidents
- KPI - Yearly Maintenance cost
- KPI- FC Durability
- Number of H2 refuellings
- Number of safety incidents

Descriptive

- Country
- Town or region
- Deployment date
- Bus manufacturer
- Bus model
- Production year
- Bus operator
- Drivetrain power
- Number of stacks
- Drivetrain weight
- Maximum speed
- Range (SORT 1)
- Range (SORT 2)
- Weight
- Height
- Length
- Width
- Number of seated passengers
- Number of standing passengers
- Hydrogen storage capacity
- Hydrogen tank pressure rating
- KPI - TTW consumption SORT 1
- KPI - TTW consumption SORT 2
- KPI - Bus durability
- KPI - Fuel cell system durability
- Minimum ambient temperature
- Maximum ambient temperature
- Vehicle price
- KPI - Bus cost
- KPI - Fuel cell system cost
- KPI - Est. FC system cost @ mass prod.
- Est. bus cost @ mass prod.

Operational

- Start date for reporting
- End date for reporting
- Number of buses
- Number of buses taken out of service
- Hours of operation
- Hours of operation - cumulative
- KPI - Distance driven
- KPI - Distance driven, cumulative (project)
- KPI - Distance driven, cumulative (overall)
- MDBF
- Stack durability
- Number of stacks reaching EoL
- Distance driven with same stack until EoL
- Max Distance driven with same stack until EoL
- Min Distance driven with same stack until EoL
- Downtime, overall
- Downtime for scheduled maintenance/upgrades
- Downtime due to stack issues
- Downtime due to electrical components
- Downtime due to the on-board hydrogen storage tank
- Downtime due to the high voltage battery
- Downtime due to peripheric mechanical components
- KPI - Amount of hydrogen fed
- Downtime due to software issues
- KPI - Availability
- Number of safety incidents
- KPI- Yearly maintenance cost

Descriptive

- Country
- Town
- Deployment date
- Manufacturer
- Production year
- Model
- MHV Type
- Forklift Class
- Load capacity
- FC system weight
- Vehicle Power
- Vehicle Weight
- Vehicle height
- Vehicle length
- Vehicle width
- H2 storage capacity
- H2 tank pressure rating
- State of the H2 in tank
- KPI - System Electrical efficiency, rated
- KPI - Vehicle lifetime
- System durability, rated
- Minimum ambient temperature
- Maximum ambient temperature
- Vehicle cost
- Vehicle price
- KPI - Fuel cell system cost
- KPI - Est. FC system cost @ mass prod.
- Fuel cell system price
- CAPEX - storage tank

Operational

- Start date for reporting
- End date for reporting
- Number of vehicles
- Number of vehicles taken out of service
- Hours of operation
- Hours of operation - cumulative
- KPI - Hydrogen consumption
- Number of H2 refuellings
- KPI - Availability
- KPI- MTBF
- Downtime, overall
- Downtime for scheduled maintenance/upgrades
- Downtime due to electrical components
- Downtime due to the high voltage battery
- Downtime due to the on-board hydrogen storage tank
- Downtime due to peripheric mechanical components
- Downtime due to stack issues
- Downtime due to software issues
- KPI - Cost of Spare parts
- KPI - Labour cost
- Number of safety incidents

Auxiliary power unit demonstration

Descriptive

- Country
- APU Vehicle
- APU deployment date
- APU unit manufacturer
- APU stack manufacturer
- Fuel cell technology
- APU fuel
- APU system power
- Stack power
- APU Weight
- APU Volume
- APU Noise
- APU operating pressure
- APU operating temperature
- Minimum ambient temperature
- Maximum ambient temperature
- KPI - Fuel Cell system durability
- Stack durability
- KPI - Rated system electrical efficiency (LHV)
- KPI - Rated system total efficiency (LHV)
- Rated stack electrical efficiency (LHV)
- Rated stack total efficiency (LHV)
- KPI - APU CAPEX
- Time for break-even, current CAPEX
- Time for break-even, projected CAPEX
- Est. APU CAPEX @ mass production

Operational

- Start date for reporting
- End date for reporting
- Hours of operation
- Hours of operation - cumulative
- Average duration of each operation
- Time for cold start (-20°C)
- Time for cold start (+20°C)
- Amount of fuel fed to the APU
- KPI - System electrical efficiency (LHV), observed
- KPI - System total efficiency (LHV), observed
- Stack electrical efficiency (LHV), observed
- Stack total efficiency (LHV), observed
- Total electricity produced
- Useful heat output
- APU availability
- Mean time between failures (MTBF)
- CO2 emissions
- SOx emissions
- NOx emissions
- Number of safety incidents
- OPEX

Onboard storage tank for compressed gaseous hydrogen

Descriptive

- State of H2 in storage tank
- Tank type
- Storage tank material
- Internal lining material
- Internal tank volume
- External tank volume
- Deployment date
- Minimum working pressure
- Nominal working pressure
- Minimum temperature - rated
- Maximum temperature - rated
- KPI - Tank price
- KPI - CAPEX for Storage tank
- KPI - Estimated storage tank CAPEX @ mass production
- KPI - Volumetric capacity
- KPI - Gravimetric capacity

Operational

- Start date for reporting
- End date for reporting
- Proven durability of the storage tank
- KPI - Est. lifetime of storage tank
- Number of cycles
- Type of cycle applied
- Peak hydrogen charging rate
- Type of cycle applied

Stationary, m-CHP

Descriptive

- Country
- Deployment date
- Manufacturer
- Model
- Stage of development
- Certification
- Stack manufacturer
- Technology
- Fuel cell module (sub)components
- Other sub-systems offered in the m-CHP unit
- Rated electrical capacity of the FC module
- Rated thermal capacity of the FC module
- KPI - Fuel Cell Volume
- Stack operating temperature
- Start-up time
- Transient response time
- Part load operation electrical efficiency - 30%
- Part load operation electrical efficiency - 50%
- KPI - Lifetime of the m-CHP unit
- KPI - stack durability
- Rated electrical efficiency (LHV) of the FC module
- KPI - Reliability
- Rated thermal efficiency (LHV) of the FC module
- Sound power level at rated condition
- KPI - Hydrogen tolerance
- KPI - CAPEX
- Installation costs
- Estimated Cost of spare parts
- Est. CAPEX @ mass production
- Operating profile
- CO emissions at rated conditions
- SOx emissions at rated conditions
- NOx emissions at rated conditions

Operational

- Start date for reporting
- End date for reporting
- Number of m-CHP units deployed
- Fuel
- Hours of operation
- Hours of operation - cumulative
- Days of operation
- Fuel cell module max. cumulative hours of operation
- Operating profile
- Electricity produced
- Useful heat output
- Energy content of natural gas consumed
- KPI - Availability
- Best availability
- Fuel cell module max. cumulative hours of operation
- Number of safety incidents
- KPI - Operational and maintenance costs (OPEX)
- KPI - Number of stack replacements

Stationary General

Descriptive

- Country
- Town or region
- Postcode
- End user
- Deployment date
- Manufacturer
- Model
- Stack manufacturer
- Technology
- Stationary application
- Fuel
- Does the fuel cell system include a fuel reformer?
- Number of stacks
- Electrical power of stacks
- Rated system electrical capacity
- Rated system thermal capacity
- KPI - Rated system electrical efficiency (LHV)
- KPI - Rated system thermal efficiency (LHV)
- Description
- KPI - Lifetime of the fuel cell system
- KPI - Stack durability
- KPI - Reliability
- Start-up time
- Transient response time
- Part load operation electrical efficiency - 30%
- Part load operation electrical efficiency - 50%
- KPI - Hydrogen tolerance
- CO emissions at rated conditions
- NOx emissions at rated conditions
- SOx emissions at rated conditions
- Sound power level at rated condition
- KPI - CAPEX
- Est. system CAPEX (per kW) @ mass production
- System installation costs
- Estimated Cost of spare parts
- KPI - Land use / footprint

Operational

- Start date for reporting
- End date for reporting
- Hours of operation
- Days of operation
- Hours of operation - cumulative
- Energy input from fuel
- Electricity produced
- Useful heat output
- KPI - Availability
- Efficiency degradation rate
- Power degradation rate
- Number of safety incidents
- Fuel
- Fuel price
- KPI - Operational and maintenance c (OPEX)
- KPI - Number of stack replacements

Fuel cell stack manufacturing

Descriptive

- Reference process: description
- Fuel cell technology
- Target application
- Reference process: Stack weight
- Reference process: Stack volume
- Reference process: Stack nominal capacity
- Reference process: Active cell area
- KPI - Reference process: Electrical efficiency
- KPI - Reference process: Durability
- KPI - Reference process: Degradation rate
- KPI - Reference process: prod. rate (stacks/yr)
- Reference process: specifications criteria
- Reference process: Percent in-specification
- Reference process: quality testing duration
- KPI - Reference process: production scrap rate
- KPI - Reference process: Nr staff per stack
- KPI - Reference process: Nr staff per MW
- KPI - Reference process: Cost of Materials per stack
- KPI - Reference process: Cost of materials per MW
- KPI - Reference process: energy per stack
- KPI - Reference process: energy per MW
- KPI - Reference process: OPEX per stack
- KPI - Reference process: CAPEX
- Reference process: footprint

Operational

- Start date for reporting
- End date for reporting
- Project process: description
- Project process: Stack weight
- Project process: Stack volume
- Project process: Stack nominal capacity
- Project process: Active cell area
- KPI - Project process: Electrical efficiency
- KPI - Project process: Durability
- KPI - Project process: Prod. Rate (stacks/yr)
- Project process: specifications criteria
- Project process: Percent in-specification
- Project process: Quality testing duration
- Project process: production scrap rate
- KPI - Project process: nr staff per stack
- KPI - Project process: nr staff per MW
- KPI -Project process: Cost of Materials per stack
- KPI - Project process: Cost of materials per MW
- KPI - Project process: Energy per stack
- KPI - Project process: Energy per MW
- Project process: OPEX per stack
- KPI - Project process: CAPEX
- Project process: footprint

Diagnostics – electrolysis

Descriptive

- Diagnostic/control tool description
- Property measured by the tool
- Information derived
- Does the tool measure the degradation?
- Power usage of the tool
- Association to prognostics for residual lifetime?
- KPI - Tool CAPEX
- Electrolyser (system) manufacturer
- Electrolyser system technology
- H2 production rate, nominal - daily weight
- Electrolyser nominal power
- KPI - System durability - rated
- Stack manufacturer
- Stack capacity - rated
- KPI - Stack durability - rated
- Capital cost of the electrolyser system

Operational

- Start date for reporting
- End date for reporting
- Stack hours of operation
- System hours of operation
- Tool hours of operation
- KPI - System electrical efficiency at start
- KPI - System electrical efficiency at end
- KPI - Est. improvement of degradation rate
- KPI - Improvement of mean time between failures (MTBF)
- KPI - Availability improvement
- KPI - Predicted system durability
- KPI - Predicted stack durability
- Est. improvement of system lifetime
- Est. improvement of stack lifetime
- Number of faults detected
- Number of failures detected
- Detection rate - total
- Detection rate - H2 in O2 stream or vice versa
- Detection rate - breaks/leakages
- Detection rate - delamination
- Detection rate - other issues
- KPI - Diagnosis/monitoring tool availability
- Tool operational costs per kg H2
- Est. electrolyser system OPEX reduction per kWh

Diagnostics - fuel cells

Descriptive

- Diagnostic/control tool description
- Property measured by the tool
- Information derived
- Does the tool measure the degradation?
- Power usage of the tool
- Association to prognostics for residual lifetime?
- KPI - Tool CAPEX
- Fuel cell system manufacturer
- Fuel cell system technology
- Fuel cell application
- Fuel
- Fuel cell system capacity
- Fuel cell system durability - rated
- Stack manufacturer
- Stack capacity - rated
- KPI - Stack durability, rated
- Capital cost of the fuel cell system

Operational

- Start date for reporting
- End date for reporting
- Stack hours of operation
- System hours of operation
- Tool hours of operation
- System electrical efficiency at start
- System electrical efficiency at end
- KPI - Est. improvement of degradation rate
- KPI - MTBF improvement
- KPI - Availability improvement
- KPI - Predicted System durability
- KPI - Predicted Stack durability
- Est. improvement of system lifetime
- Est. improvement of stack lifetime
- Number of faults detected
- Number of failures detected
- Detection rate - total
- Detection rate - fuel starvation
- Detection rate - air starvation
- Detection rate - flooding and dehydration
- Detection rate - changes in fuel composition
- Detection rate - sulphur poisoning
- Detection rate - breaks and/or leakages
- Detection rate - to delamination
- Detection rate - other issues
- KPI - Diagnosis/monitoring tool availability
- Tool -OPEX per kWh
- Est. FC system operational costs reduction per kWh

Pre-Normative Research

Descriptive

- KPI - Gap in knowledge addressed
- Project objective
- FCH JU pillar
- Approach
- Target RCS
- Target organisation
- Target tech/working group
- Other RCS addressing the issue tackled by the project
- Foreseen means
- Collaborations outside EU28

Operational

- Start date for reporting
- End date for reporting
- Newly detected relevant RCS activities
- Progress vs knowledge gap
- Is consortium involved first-hand in standardisation bodies?
- Standard developing organisation(s) contacted
- KPI - Number of meetings with standard developing organisations
- Number of workshops with standard developing organisations
- KPI - Number of reports sent to standard developing organisations
- Regulatory bodies contacted to date
- KPI - Number of meetings with regulatory organisations
- Number of workshops with regulatory organisations
- KPI - Number of reports sent to regulatory organisations
- KPI - Number of peer reviewed publications
- KPI - Number of patents
- KPI - Number of oral presentations @ scientific seminars/conferences
- KPI - Nr of posters at scientific seminars/conferences
- KPI - Have the project results been integrated in any RCSs?
- When (year) do you expect project results to be integrated in any RCS?

Education

Descriptive

- Training course: name & brief description
- Training topic(s)
- Training target group(s)
- Training type
- Training material
- Training lanugage(s)
- Training attendance method
- Training duration
- Is there a passing test/exam?
- Awarding of a diploma/certification
- Training website

Operational

- Start date for reporting
- End date for reporting
- KPI - Number of people trained in reference period
- KPI - Total number of people trained in project
- Training location(s) in reference period
- Training location(s) in the project
- KPI - Trainees per country in the reference period
- KPI - Trainees per country in the project
- KPI - Nr of diplomas/certificates issued in reference period
- KPI - Nr of diplomas/certificates issued in the project

HDVs Trucks & H2 Carriers - Storage

Under development...