PROJECT FINAL REPORT

Publishable

H2FC-LCA

FCH JU Grant Agreement number: 256850

Funding Scheme:	Coordination and Support Action
Project title:	Fuel Cell and hydrogen Life Cycle Assessment
Period covered:	from 1/10/2010to 30/09/2011
Project coordinator:	Dr. Angelo Moreno
Organisation:	ENEA
Contacts:	Tel: +390630484298
	Fax: +390630483795
	E-mail: angelo.moreno@enea.it
Project website address:	http://www.fc-hyguide.eu

Date of latest version of Annex I against which the assessment will be made: 22/09/2010

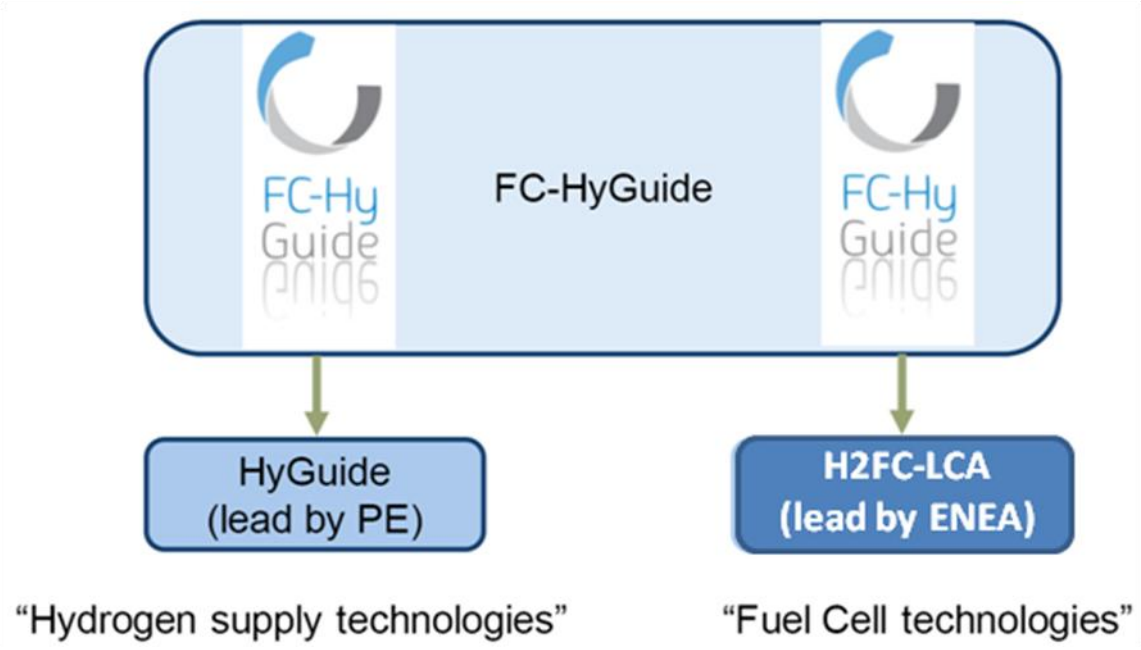
1 Final publishable summary report

Sustainability in the energy filed is becoming more and more a must. The very recent new EU directives like the “20-20-20” by 2020 and the reduction by 2050 of the 80% in CO2 emissions impose a very high attention when proposing new technologies replacing the conventional ones in terms of cost benefit analysis and in terms of their real contribution in lowering CO2 and other greenhouse gases and pollutants: it is mandatory to perform a Life Cycle Assessment.

In particular LCA is mandatory for Fuel cells because they are not yet a commercial technology and a considerable effort in research and development is ongoing to meet not only the efficiency, durability and cost targets but also environmental sustainability. LCA can increase public acceptance, so common rules to carry out such assessments are necessary.

It is well known that ISO standards 14040 and 14044 have been set for LCA, but they leave a high degree of freedom to practitioners: subjectivity linked to some methodological choices (e.g. system boundary definition, allocation, modeling, etc.). To overcome the problem, the ILCD Handbook addressed these topics, providing guidance on the LCA process, from the definition of the decision context to specific requirements for review process. However, the ILCD Handbook is necessarily still generic as it applies to all possible industry sectors, technologies, decision context, etc.. That means a sector specific manual (guidance document) for FC defining rules and the effort of the practitioners and data gathering, data quality, etc. is needed.

H2FC-LCA consortium decided to cooperate with another consortium called HyGuide in order to develop a common LCA methodologies applicable both to FC and to hydrogen technologies. Here in the figures the way the two consortia interacted:



The goal of H2FC-LCA project was to overcome the weak comparability and to reduce complexity by sector specific guidance, developing a simple suitable instrument to be used at program level all over European Union based on common agreed methodologies, with the same approach and with homogenous and harmonized data to ensure that LCA applied by different teams in different contests could immediately be compared and used as they were homogenously calculated on the base of a common harmonized agreed procedures.

To this aim two projects respectively named “HYGuide” and “H2FC-LCA”, funded by FCH-JU as support action projects, were joined together focussed on delivering a guidance document, training materials and courses as well as case studies and LCI datasets related to fuel cells technologies and on hydrogen production systems.The two consortia agreed to coordinate their projects and to share a common work programme mainly concerning the key overall LCA methodological choices avoiding in such way contradictory results and the delivering of different methodologies.

Grant Agreement n. 256850

The activities under this project were performed taking into account from one side the DoW (annex 1 of the Grant Agreement) and taking into account the main objectives set by the FCH JU:

- Support RTD in member states and associated countries in a coordinated manner;
- Enable market breakthroughs of fuel cell and hydrogen technologies helping Europe in attaining a leadership in these technologies;
- Encourage increased public and private investment in fuel cell and hydrogen technologies;

According to project and FCH-JU goals, the H2FC-LCA project has reached the following objectives:

- Developed, in liaise with the JRC-IES, a Specific Guidance Document for application to fuel cell technologies and related training material with courses for practitioners in industry and research, based on and in line with the International Reference Life Cycle Data System (ILCD) Handbook, coordinated/ co-developed by the EC's JRC-IES. The guidance document has been developed with the following characteristics:
  - ✓ has been reviewed by an external body and accepted by industry
  - ✓ has a modular structure and is applicable for technologies at different stage of maturity (from lab- to commercial-scale) and to different technology-levels (from base technologies up to technology systems). The modular approach will allow each technology developer to assess their own technology without taking into account all the possible combinations in more complex systems, and to make the related information available in the ILCD (International reference Life Cycle Data system) Data Network. The structure of information modules allows the accumulation of knowledge to build up assessments also for more complex systems.
  - ✓ has been developed with the idea of offering step by step guidance for LCA practitioners in industry, as well as for researchers

  The Specific Guidance document consists in to 2 parts and 5 annexes.
- Developed 3 case studies concerning the application of the LCA guidance to PEMFC, SOFC and MCFC systems in order to provide practitioners with real examples how to apply concepts and rules contended in the guidance
- Developed materials for training courses which will be an useful tool to teach researchers, stakeholders from industry and policy makers.
- Implemented, by the two consortia, a website (http://www.fc-hyguide.eu/) as a central information point and as fully integrated component of the ILCD data network, with public and restricted access areas.

To achieve the objectives the project was structured in five work packages (excluding project management) each of them was then structured in different tasks.

WP1 – Development, design, implementation and usage of a website.

A project website was developed in which all project related information and materials can be found, see http://www.fc-hyguide.eu/. The website will support other consortia in accessing the FCH JU specific information on LCA studies, guidance documents and LCA study reporting templates (FC-Guide) and acts as fully integrated platform of the ILCD data network. It has public and restricted access areas (project internal) including up-/down-load ability.

The website. The tasks were:

- TASK 1.1: Development, Design and implementation of a web site

This task was shared between FC-Guide and HyGuide projects. FC-Guide consortium supported HyGuide for the definition of the functional prototype to allow an early view on the basic layout, the navigation structure, and functionality of the web site. It has been reviewed and fined-tuned using feedback to produce the final web site specification.

- TASK 1.2: Content provision for web site

This task comprised the provision of content to the webpage, like a general project description etc.
This content has been continuously updated in the course of the project.
The website has been used both for internal project communications, exchange of information (restricted access areas),as well as for dissemination proposes

WP2 - Development of the Structure and Content of the Guidance Document including key Methodology Aspects

A common meeting (kick off meeting) between the two consortia was organized in order both to identify main methodology aspects and a common approach to address them and to jointly define structure and content of

the guidance documents. Major methodological aspects and table of content of the guidance documents. were agreed as well as the drafts of the LCA study reporting templates.

- **TASK 2.1: Identification of key methodological aspects**

Most crucial steps of the process, i.e. the ones that provide the largest environmental burden, were identified. Based on an extensive literature search the choices related to boundary conditions, the cut-off and allocation criteria, the intermediate and final impact categories identified as relevant, and finally any specific method for data collection, processing and reporting were defined.

- **TASK 2.2: Definition of the structure and content of the guidance document.**

Requirements from ILCD handbook, ISO 14025, Environmental Product Declaration programs and other relevant input, the draft of the guidance document (Manual, PCR) have been defined, together with the LCA study reporting templates. The proposed guidance document consisting of two parts: a Manual, describing in a step by step way how to perform an LCA study in agreement with the standards and ILCD handbook. The second part consisting of PCR-type documents for each product category identified (MCFC, SOFC, PEMFC). it was decided to create an easy to read, and broad accepted document which also provides technical examples (in analogy to the ISO 14040 & 44 standards) to facilitate comprehensiveness, therefore an external professional editor has been sub-contracted. LCA study reporting templates were developed in agreement with the ones provided in the ILCD handbook but tailor-made for hydrogen and fuel cell studies

After the workshop, the draft guidance document was published on the project website, in the restricted area, where the members of the technical expert group (and advisory board / review panel) were able to review it and post their comments. Therefore, the members of the technical expert group had the opportunity to provide their feedback both on the workshop and on the website.

WP3 – Preparation and consultation of the guidance documents.

The main aim was to review and validate the guidance documents submitting them to members, to the users (public) and to an advisory board. For these purposes workshops with the technical expert group, public consultation and meetings with the advisory board / review panel were organized: draft guidance documents were discussed, revised and finalized. WP3 was divided into 5 tasks, as following:

- **TASK 3.1: Workshop on developed draft guidance document.**

A workshop was organized for partners, the technical expert group, the advisory body (technical experts from industry and research organizations, coordinated by the European Hydrogen Association). with two main subjects:

- Introduction to the developed draft guidance document to make participant aware off
- Provide the possibility to comment on the draft guidance document

A first draft guidance document was prepared and down loaded in the project website: members, technical expert group and advisory board / review panel were able to review it and post their comments guarantying, in this way, to address a wide range of industry and research organization members.

- **TASK 3.2: Revision of the document**

A revised version of the guidance document has been prepared including feedbacks gained.

- **TASK 3.3: Public consultation on the advanced FC-Guide (available at the web site)**

A second round of consultation was performed publishing the advanced guidance document on the public area of the web site for public consultation for a time frame of 4 weeks. Using the networks of the partners along with the mailing list of the European Commission's LCT-Forum, the public consultation time frame was announced in advance via several media, such as newsletter, conference announcements, etc. Main goal of the consultation round was to validate the advanced guidance document by investigating the appropriateness, completeness and user-friendliness in real world case studies.

- **TASK 3.4: Revision of the advanced document**

The feedbacks gained in this second round of consultation were used to refine the guidance document that formed the basis for the review.

- **TASK 3.5: Review and finalization of the document**

Before the guidance document was finally released, the Consortium submitted it to the Advisory Board / Review Panel (group of experts) for their approval. This approval was conducted in an iterative nature: amendments were possible resulting in a final guidance document (FC-Guide) and a comments & reply document (including the comments of the Review Panel). These two documents have been published and the final approved guidance document has been reviewed in terms of appropriateness, user-friendliness and consistency with regard to the appropriate LCA, PCR and ILCD methodologies.

WP4 – Case studies

Case studies were performed in order to test the applicability of the guidance document on PEMFC, SOFC and MCFC. The results have been made available in ILCD format and have been used as examples of applications of the guidance document to annexed to FC-Guide and used in training courses (WP6).
Another goal of this case studies has been another way of assessing in practice the guidance document against the appropriateness, user-friendliness and consistency with regard to the appropriate LCA, PCR, and ILCD methodologies.

WP5 – Dissemination, external communication, and training courses

The results of the project were promoted and disseminated in conferences, workshops, meetings both at national and international level involving main stakeholders, interested parties and decision makers. Special attention was dedicated to practitioners organizing dedicated training courses (two) having developed training toolkit that can be used for training courses and for easier application of the developed guidance.
To these purposes all outcomes from WP3 and WP4 were used. The training materials were revised and amended by the feedback gained during the two training courses in an iterative procedure to maximize their quality. The training materials are also available at http://www.fc-hyguide.eu/.

In conclusion the two guidance documents on “how to perform Life Cycle Assessment (LCA) in the field of hydrogen production and fuel cell technologies” developed by the two consortia in a peer reviewed process are now available (ready-to-use) for on-going FCH JU projects. The platform, as an integrative part of the ILCD data network, can be used as a hub for LCA data sets in the field of hydrogen and fuel cells.
For further information please visit http://www.fc-hyguide.eu/ or contact the coordinators via email info@fc-hyguide.eu.

List of beneficiaries

Beneficiary name	Contact name	Associated coordinates
AGENZIA NAZIONALE PER LE NUOVE TECNOLOGIE, L'ENERGIA E LO SVILUPPO ECONOMICO SOSTENIBILE	Dr. Angelo Moreno	ENEA
University of Split, Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture	Prof. Frano Barbir	UNISPLIT
UNIVERSITA DEGLI STUDI DI NAPOLI PARTHENOPE	Prof. Sergio Ulgiati	UNIPARTH
TECHNISCHE UNIVERSITAET GRAZ	Prof. Michael Narodoslawsky	TU Graz
NATIONAL TECHNICAL UNIVERSITY OF ATHENS NTUA	Prof. Maria Founti	NTUA
PLANUNGSGRUPPE ENERGIE UND TECHNIK GBR	Dr. Robert Steinberger Wilkens	PLANET

Website: http://www.fc-hyguide.eu/
Contacts: info@fc-hyguide.eu
angelo.moreno@enea.it
paolo.masoni@enea.it
alessandra.zamagni@enea.it