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EXECUTIVE SUMMARY

This document introduces the material produced to support the data collection of the two questionnaires that address the quantitative part of the study.

As FCH technologies are not commonly known by the general public, and to focus the target of the stakeholders' part, some information about these technologies and its applications are going to be shown in the questionnaires. This will allow establishing the same base information for the interviewees.

This material will appear in the on-line tools developed and will give a neutral view about FCH technologies and their applications. Therefore the information, in a comprehensive way, has been prepared by the experts in social research of the project and its technology coherence has been checked by the partners working in the FCH sector.

The main information has been developed in English and then traduced into all the languages in which the studies are going to be made. That is, for the public study it will be translated into German, French, Flemish, Spanish, Norwegian and Slovenian. The stakeholders' part will also be translated into German, French, Spanish and Slovenian.

ABBREVIATIONS

CA	Consortium Agreement
CSA	Coordination and Support Action
CMO	Central Management Office
EC	European Commission
DX.Y	Deliverable X.Y
FCH	Fuel cell and hydrogen
FCH-JU	Fuel Cell and Hydrogen – Joint Undertaking
GA	Grant Agreement
IPR	Intellectual Property Rights
KET	Key Enabling Technologies
MI	Month I
MSI	Milestone I
PC	Project Coordinator
PO	Project Officer
RC	Regional Committee
SAMT	Social Acceptance Management Toolbox
SMC	Steering Management Committee
SMEs	Small and Medium Enterprises
TC	Technical Committee
WP	Work Package
WPL	Work Package Leader

1. INTRODUCTION

This document introduces the material produced to support the data collection of the two questionnaires that address the quantitative part of the study.

There is a need to explain, in clear, neutral and comprehensive way FCH technologies, the main applications addressed in the study, and also evaluation of consequences of using these technologies.

The main focus of the background material is the general public, as the information and experience they could have is expected to be limited.

As for the stakeholders, to focus the interview and the questionnaire, a small introduction has been developed.

The information has been included in the questionnaires (general public and stakeholder) that are implemented to be carried out online as an introduction to specific parts of the questionnaires. Therefore, the content of this deliverable is divided in the same way:

- Questionnaire for the general public
- Questionnaires for stakeholders

2. BACKGROUND MATERIAL

2.1.Questionnaire for the general public

To explain some parts of the general public questionnaire, the following material has been developed. It will appear in several sections of the on-line survey to explain, in clear, neutral and comprehensive way basic information to help interviewees to give their opinion about the asked questions.

A master questionnaire including the background information has been developed first in English and then checked by partners of the project to review the technical coherence. Once approved it has been translated, as well as the whole questionnaire, into German, French, Flemish, Spanish, Norwegian and Slovenian.

The report presents four types of information in different questionnaires.

- Information on the study; an introduction of the study and FCH technologies.
- Information on hydrogen; a brief explanation of hydrogen and fuel cells is given and its link with energy.
- Information on stationary applications, divided in two sections: home devices and power plants.

- Information on transport applications, divided also in two sections: vehicles (cars and buses and hydrogen refilling stations.
- An annex for the evaluation of consequences with two sections, stationary applications for residential use and hydrogen fuel cell vehicles.

2.1.1. Information on the study

Why this study?

The search for alternative methods of energy supply and use has lead governments and companies to develop a portfolio of energy technologies (such as solar, wind, and geothermal energy) and energy solutions for transportation, like next generation biofuels, advanced batteries for electric vehicles, and hydrogen fuel cell technologies.

Among these potential solutions to future energy challenges, here we are focusing on hydrogen fuel cell technologies. These have various possible end-uses, such as for electricity and heat generation; automobiles, buses and other vehicles; and portable electronics.

It is possible that you may not know much about hydrogen fuel cell technologies at the moment, but it is important that we get to know public opinion at an early stage, so this can be taken into account in the design of future products and infrastructures.

2.1.2. Information on hydrogen

Background information on hydrogen

Over the last decades, **hydrogen (H2)** has gained increasing attention as a fuel and for energy storage. Governments and companies across Europe are devoting efforts to the development and implementation of fuel cells for power generation and residential heating and fuel cell vehicles (FCVs). The main reasons for this include the need to reduce air pollution in towns and cities and to reduce reliance on fossil fuels.

Photo 1: H2, the chemical formula for hydrogen gas

A hydrogen fuel cell is an electrochemical device (like a battery) that combines hydrogen and oxygen to produce electricity. Fuel cells and batteries are similar because they use a chemical reaction to provide electricity. However, fuel cells differ from batteries in that they produce electricity whilst batteries only store electricity. Small fuel cells can power devices such as phones or laptops, while larger fuel cells can provide energy for homes, buildings, industry as well as to power vehicles.

A **fuel cell** will produce electricity as long as it has a fuel supply (hydrogen). Although hydrogen is the most common of all elements in the universe, energy has to be used to generate hydrogen. Hydrogen can be produced from any primary energy source. Currently, most hydrogen is produced from natural gas. But also wind power can be used to separate hydrogen from water. The hydrogen then acts as a store of energy that can be transported and used in different ways. In other words, hydrogen is not an energy source but an **energy carrier.**

2.1.3. Stationary applications for residential use

Information on home hydrogen fuel cells

For many years, electricity has mostly been generated in large-scale power stations. However with the increasing use of renewable energy, power is being generated with smaller and more numerous devices. **Stationary fuel cells** are another example of this trend. When located in the home, they allow households to generate part of the electricity and heat they require. As fuel cells are very efficient and can generate electricity from gas, they can reduce the amount of gas that a household needs to buy and eliminate the need to buy electricity.

Photo2: BlueGen fuel cell installed in a home in Sheffield
(Source: CFCL)

With the approximate size of a washing machine and powered by fuel cell technology, these fuel cell applications can be installed in a home utility room. The fuel cell system is connected to the normal gas supply and hot water unit, and then to the homes heating and electricity system. **Hydrogen** is generated from the home's natural gas supply and is fed to the **fuel cell**.

Stationary fuel cells can be also installed in **buildings** such as apartment blocks to provide central heat and electricity to households. So far, large capacity fuel cells are utilized in some countries for schools, hospitals, and other energy-intensive facilities. But multi-family residential buildings represent a new opportunity for fuel cell technology because of their ability to continually provide electricity and heat.

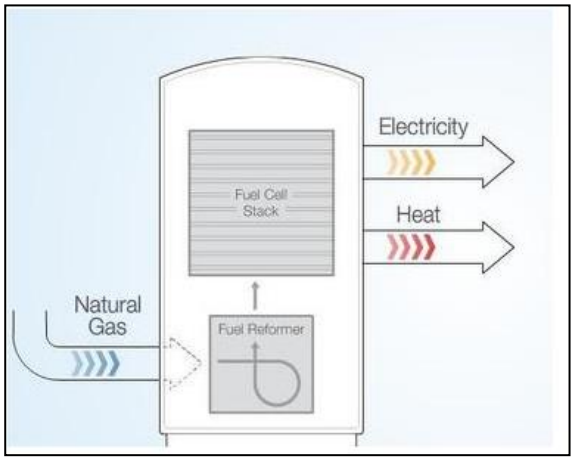

Photo 3: Fuel cell technology in a compact system converts natural gas, propane, and eventually biofuels—into both electricity and heat

Information on fuel cell power plants

A group of fuel cells can act as an integrated fuel **cell power plant** to generate power and heat for homes, business and industries. About the size of a home, a fuel cell power plant is composed of a collection of various box-shaped fuel cell modules. As stated above, these are usually fuelled by natural gas and can be installed close to customers (industrial parks and houses). Hydrogen produced with renewable energy is also possible. A typical fuel cell power plant can have a combined capacity of 15 megawatts: enough to power about 15,000 homes.

Photo 4: Many fuel cells, like these FuelCell Energy units, can run on natural gas or biogas

2.1.4. Hydrogen fuel cell vehicles

Information on fuel-cell hydrogen vehicles

Fuel cell hydrogen vehicles use hydrogen gas to power an electric motor. Unlike conventional vehicles, which run on gasoline or diesel, fuel cell vehicles combine hydrogen and oxygen on a fuel cell to produce electricity, which runs an **electric motor**.

Unlike battery-powered electric vehicles, fuel cell vehicles create electricity in an **onboard fuel cell**, usually using stored hydrogen (from a refuelling hydrogen station) and oxygen from the air.

Photo 5: A hydrogen fuel-cell car leaves a hydrogen fuelling station

Fuel-cell hydrogen cars have to be refilled with hydrogen from a filling station. Refueling a fuel cell vehicle is comparable to refuelling a conventional car. It takes less than 10 minutes to fill current models. Once filled, the driving ranges of a fuel cell vehicle vary, but are expected to be around 450 km.

Although a few automakers currently offer FCEVs, today, every major car manufacturer has some sort of fuel-cell development programme or partnership in the works.

Photo 6: Arrival of First Hydrogen Buses in Aberdeen Project

Information on refuelling stations

Across Europe, plans are being announced to build **hydrogen refueling stations**. A hydrogen station is a storage or filling station for hydrogen. Intended to power hydrogen vehicles, they are usually located along a road or highway. Hydrogen stations have several options. Some stations make their **fuel onsite.** Others have hydrogen delivered as a liquid and others have **hydrogen delivered** as a gas. In both cases, a tanker truck transfers the fuel to the retail site. Each type of station needs equipment for storing, compressing and dispensing hydrogen.

Photo 7: Hydrogen station in Höchst, district of Frankfurt am Main, Germany.

2.1.5. Annex: For the evaluation of consequences

Stationary applications for residential use

They would reduce the need to purchase electricity from a power company

Combining the production of on-site local heat with local electricity generation to meet on-site energy needs for both can save around 25% of the primary energy needed.

They would reduce CO2 emissions

A typical fuel cell micro combined heat and power system, using natural gas as the hydrogen source and comprising a fuel cell unit, peak load boiler and hot water tank, can reduce CO2 emissions by up to 50% compared to the separate generation of heat and power.

High initial capital costs

As of December 2012, Panasonic and Tokyo Gas Co., Ltd. sold Ene-Farm units (full cell units that convert natural gas to heat and electricity) in Japan for a price of around 20,000 € before installation.

House space requirements

Installing a domestic fuel cell micro-CHP system requires around 0.65 m2 (about the size of fridge freezer).

It will reduce the cost of producing energy

Operating costs for home fuel cells can be as low as 10 cents per kWh for electricity. Residential systems are advertised by their manufacturers as reducing household bills by 450-1,000 euros per year.

Similar risks to other fuels

Like any other fuel, hydrogen poses risks if not properly handled. Some of the properties of hydrogen make it potentially less hazardous than natural gas, petrol and diesel, while other characteristics make it more dangerous in particular situations. Specific precautions, such as good venting, need to be in place for hydrogen just as for many other fuels.

Hydrogen fuel cell vehicles

They would reduce the need for petroleum

Fuel cell vehicles use hydrogen gas and oxygen to power an electric motor. As hydrogen can be produced from a variety of domestic resources, hydrogen vehicles would reduce the need for petroleum.

Lower CO2 emissions than conventional cars

When oxygen and hydrogen react, they produce only water and heat, making hydrogen vehicles "zero-emissions" vehicles (like battery-powered electric vehicles). Total CO2 emissions depend on the source of energy used to produce the hydrogen. If solar, wind or other renewable resources generate the electricity, hydrogen could be produced without any carbon emissions at all. If the electricity used to produce hydrogen comes from natural gas, cars and buses cut emissions by over 30 percent when compared with their gasoline-powered counterparts.

Price of fuel cell material

The cost of the vehicles powered by hydrogen is still a key issue. Platinum is one of the most commonly used catalysts for fuel cells, but it is a very expensive and scarce resource. Initial pricing of Toyota Mirai, for instance, has been set at 53,231 € (state incentives in some countries could reduce the price).

Price of hydrogen

Hydrogen fuel cars are, on a simple per km basis, cheaper to run than regular gasoline engines. Right now, state-of-the-art hydrogen extraction from natural gas, pressurized and delivered to the customer, costs before taxes less than 1 euro for a litre of gasoline equivalent.

Infrastructure needed

New infrastructure will be needed for hydrogen refuelling. Very few countries have more than 15 hydrogen filling stations operational and the network is only slowly growing. Interested drivers should ensure they live near hydrogen refuelling stations.

Range

Current hydrogen cars have a range of around 450 km. This is a higher range than the majority of Electric Vehicles in the market and a lower range as compared to the performance of diesel vehicles.

Safety issues

Hydrogen poses risks of the same order of magnitude as other fuels. In a collision in an open space, a hydrogen fuel cell car should have less potential hazard than either natural gas or a gasoline vehicle. A potential risk is a release in an enclosed home garage, where an accumulation of hydrogen could lead to fire or explosion if no hydrogen detection or risk mitigation devices or measures are applied (such as passive or active ventilation).

2.2.Questionnaires for stakeholders (Quantitative and Qualitative)

A short introduction has been developed to introduce the questionnaires for stakeholders. As well as for the general public survey, a master questionnaire including the background information has been developed first in English and then checked by partners of the project to review the technical coherence. Once approved it has been translated, as well as the whole questionnaire, into German, French, Spanish and Slovenian.

2.2.1. Information on stationary applications

Data centres, banks, hospitals, grocery stores, telecom companies and government agencies are adopting small stationary hydrogen fuel cells for various purposes (mainly for prime power solutions, CHP and back-up power). Stationary fuel cells also allow households to generate part of the electricity and heat they require, reducing the electricity and gas purchase from an electric power company.

2.2.2. Information on transport applications

Although only a few automakers currently offer Fuel Cell Electric (FCE) passenger cars today, every major car manufacturer has some sort of fuel-cell development programme or partnership in the works. Fuel cell technology is also being used in buses: fuel cells have been used to power low emissions buses in cities across Europe, the United States and Asia. Currently, more hydrogen fuelling stations are being built to enable travel in FCEVs.