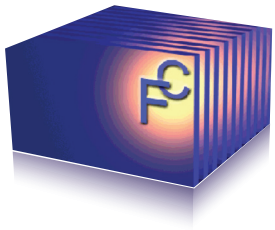

International Energy Agency (IEA) Advanced Fuel Cells

Implementing Agreement

UPDATE OF MEMBER COUNTRIES 2013

September 2014

iea Energy Technology Network

The AFC IA, the Implementing Agreement for a Programme of Research, Development and Demonstration on Advanced Fuel Cells, functions within a framework created by the International Energy Agency (IEA). Views, findings and publications of the AFC IA do not necessarily represent the views or policies of the IEA Secretariat or of all its individual member countries.

This report has been prepared by the National Members and the Secretariat of the Executive Committee, who also acted as Editor.

Copies can be obtained from the programme's web site at **www.ieafuelcell.com** or from:

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Chairman's Foreword

Welcome to the 2013 Update of Member Countries of the Advanced Fuel Cells Implementing Agreement (AFC IA), a technology platform of the International Energy Agency (IEA).

Fuel cells are distinguished by:

- **High efficiencies** – conversion of fuel to electrical energy is generally significantly more efficient than with conventional technologies.
- **Low levels of pollutants** – lower than conventional technologies for power generation and transportation (NO_x, SO_x, fine particulates, etc). In the case of fuel switching to hydrogen for transportation, emissions of pollutants are zero at the point of use.
- **Reduction of CO_2 emissions** – using hydrogen for transportation leads to zero CO_2 emissions at the point of use.

Focusing on the transport sector, fuel cells are the only technology offering an uncompromising transformation of passenger road transportation that can be free of greenhouse gas emissions. Major car companies such as Hyundai and Toyota are promoting fuel cells now over other electric technologies. Longstanding stakeholders including Daimler, Ford and Honda, as well as Hyundai and Toyota, are working towards market introduction between 2015 and 2018. Other world players such as Volkswagen and BMW have stepped up their fuel cell development efforts.

As successful progress towards market-ready fuel cell cars is achieved, the challenge turns towards the fuel infrastructure (for example hydrogen infrastructure including mass storage) and the attention this needs in terms of concepts and programs to achieve implementation in the respective countries. Notable hydrogen infrastructure projects are under way in Japan, Scandinavia, Germany and California in the USA. Regulatory procedures as well as codes and standards will need to be adapted, harmonised and created where necessary. The reliability of the fuelling infrastructure will be subject to enhancement during the initial implementation period.

Any company or institution of a member country is invited to join our Annexes, in which the technical work to develop and understand fuel cells is being done.

Interested companies or institutions from non-member countries are welcome to contact us to consider membership. Moreover, we are happy to welcome companies and organisations to Executive Committee meetings on a sponsorship basis, providing direct access to the most current international technical discussions on fuel cells and the opportunity to expand an international network.

For further information, please see our website **IEA Advanced Fuel Cells** or contact us directly via email at: **Secretariat-AFCIA@ricardo-aea.com**.

Prof Dr Detlef Stolten
Chairman of the Advanced Fuel Cells Implementing Agreement

Detlef Stolten took over as Chairman of AFC IA in 2011 after previously serving as Vice Chairman.

Since 1998, Professor Stolten has been the Director of the Institute for Energy and Climate Research – Electrochemical Process Engineering at Research Centre Jülich, Germany. His research focus is the electrochemistry, chemical engineering and systems analysis for the DMFC, HT-PEFC and SOFC technology, particularly the reforming of middle distillates.

National Updates

Every year, each member of the Advanced Fuel Cells Implementing Agreement (AFC IA) provides a national update that gives details of the country's position with regard to fuel cells, which often relates back to national priorities in the energy arena.

The summaries below outline the national positions and priorities at the end of 2013 and into 2014.

1. AUSTRIA

The major energy policy goals of Austria are to stabilise energy consumption at 1,100PJ by 2020 and to reduce greenhouse gas emissions by 16% (base year: 2005) by 2020. Renewable energy in Austria contributes 26% and by 2020 this figure should be 34%. The R&D programmes strategically cover fuel cell topics to support the development of innovative companies in this field. EUR 2 million to EUR 4 million is spent yearly on national fuel cell and hydrogen projects.

Fuel cell projects in the mobility sector are focused on competitiveness and solutions to modernise and 'green' the transport system. In total, about 500 projects with public funding of EUR 118 million have been supported over the last few years. The new programme, 'Mobility of the Future (2012–2020)', provides an annual budget of EUR 14 to 19 million for R&D in the transport sector.

The option to use fuel cells domestically in Austria fell out of favour, but has recently returned with newly released building codes. By 2014/15 a major demonstration programme including 30 micro combined heat and power (m-CHP) fuel cell systems will take place. It is under negotiation between the Austrian utility companies, manufacturers and ministries.

Table 1 Summary of Austrian Fuel Cell Information

Fuel cell	Infrastructure
Hydrogen filling stations operational	One public station in Vienna, two non-public stations in Graz and Sattledt.

2. DENMARK

The Danish Government's long-term goal for the country's energy policy is to be 100% independent of fossil fuels by the year 2050. According to the Energy Political Agreement of March 2012, the key goals for 2020 are:

- More than 35% renewable energy in final energy consumption.
- Approximately 50% of electricity consumption to be supplied by wind power.
- 7.6% reduction in gross energy consumption in relation to 2010.
- 34% reduction in greenhouse gas emissions in relation to 1990.

Consequently, in the longer term, hydrogen and fuel cell technologies can be part of the solution to convert and store the energy and thereby contribute to the integration of fluctuating renewable energy in the Danish energy system.

Table 2 Summary of Danish Fuel Cell Information

Fuel cells		Details/comments
MW installed and operational	912kW	Danish companies have installed an additional 2,046MW abroad
Number of domestic stationary units	62 units	Danish companies have installed an additional 60 units abroad
Number of other stationary units (large scale)	250 units	Danish companies have installed an additional 652 units abroad
Number of operational fuel cell vehicles	9 vehicles	An additional 12 Danish vehicles are abroad Additionally, Hyundai are operating 17 i35 cars in Denmark
Hydrogen filling stations operational	3 stations in operation	

3. FINLAND

The Finnish Fuel Cell Programme aims to speed the development and application of innovative fuel cell and hydrogen technologies for growing global markets. The specific goals in Finland are to increase the share of renewable energy to 38% by 2020 and to create national pilot and demonstration projects in new energy technologies, including fuel cells. In research and development activities, the target is to put the emphasis on new renewable energy sources such as fuel cells.

Between 2007 and 2013, the Finnish Fuel Cell programme has facilitated more than 70 successful projects, with more than 60 companies involved. Finnish organisations have benefited from having taking part in 17 Fuel Cells and Hydrogen Joint Undertaking (FCH JU) funded projects with a total value of EUR 61 million. Highlights from these projects include:

- The first commercial applications of fuel cell back-up power for telecommunications base stations and portable back-up power.
- Finland's first commercial hydrogen refuelling station.
- Significant advances in CHP based on SOFC. The first 20kW unit was demonstrated for more than 6,000 hours in Vaasa using landfill gas.
- Finnish SOFC research is now recognised as state of the art worldwide.
- Companies from industries such as energy, metals, electronics, chemicals, mechanical engineering and many others have worked together in thematic workshops and helped to form value proposition analyses for fuel cells.

At present, the competiveness of the Finnish industry is in peril. New innovative products are urgently needed to improve the industrial competiveness. Therefore, it would be worthwhile for the Finnish industry to invest in fuel cell and hydrogen applications, where the international industry base is still modest but advancing. The potential in this area is huge because the variety of possible applications is enormous and there is much space for technical advances, areas were the Finnish industry is traditionally strong.

4. FRANCE

The French National road map on Hydrogen and Fuel Cells is organised into four focus areas, with agreed timescales and budgets:

1. Hydrogen/renewable energy convergence – hydrogen from renewable energy, hydrogen for renewable energy, five to seven years, EUR 150 to 200 million with three R&D projects and three demonstration projects expected.
2. Towards a new generation of electro-mobility – broadening the EV markets, 10 years, EUR 200 million with two R&D projects, three demonstration projects and one industrial pre-deployment expected.
3. H2FC for a sustainable city – H2FC as a component of eco-districts and smart grids, 10 years, EUR 150 to 360 million with one R&D project and six demonstration projects expected.
4. H2FC, driver of national and international growth – exporting tomorrow's energy technologies, five years, EUR 105 to 180 million, with one demonstration project and four industrial pre-deployment projects expected.

Table 3 Summary of French Fuel Cell Information

Fuel cells		Details/ comments/ companies involved
Number of other stationary units (large scale)	1 (360kW): hydrogen and fuel cell system coupled with a PV plant for peak shaving on electric grid	Myrte Project (Corsica) led by AREVA
Operational FC vehicles	H2FC: 5kW range extender system	FAM Automobiles/ Michelin
	HyKangoo: 5kW range extender system	SymbioFCell, Renault, Solvay
	GreenGT H2: 300kW Fuel Cell racing car to be engaged for real in the Le Mans race in June 2013	GreenGT, SymbioFCell
	Fork-lift fleet testing (9 units) on Air Liquide plant	Hypulsion (GV Axane/Plugpower)

5 GERMANY

In Germany, hydrogen and fuel cell technology play an essential role in the anticipated future of mobility and energy supply. In 2006, to guarantee the further development of these technologies, the Government, industry and science began a strategic alliance called the National Innovation Programme for Hydrogen and Fuel Cell Technology (NIP) to speed up the process of market preparation of products. The total budget of NIP, invested over a period of 10 years up to 2016, amounts to EUR 1.4 billion.

The targets established by NIP are:

- Accelerating market development through targeted support and promotion of hydrogen and fuel cell sectors in mobile, stationary and portable areas.
- Strengthening value chains and added value in Germany.
- Securing technological leadership and implementing the technology in Germany.

The focus is large-scale demonstration projects and R&D projects. Specific programme areas within NIP are Transport and Hydrogen Infrastructure, Hydrogen Provision, Stationary Energy Supply and Special Markets.

Table 4 Summary of German Fuel Cell Information

		Details/ comments
MW installed and operational	2.35MW [1]	
Number of domestic stationary units	400 units	Only Callux, as of 12.02.2014: 2,900,000 hours operation, 1,700,000kWh electricity produced [2]
New in 2013	Approximately 100 units	
Number of operational fuel cell vehicles	112 cars and 15 buses	Clean Energy Partnership (CEP) fleet [3]
Portable units	Special markets: 5,400 systems produced in 2013 [1]	
Hydrogen filling stations operational	27 stations in Clean Energy Partnership (CEP) 15 available to the public	

[1] Information from VDMA Fuel Cells Association, Konjunkturspiegel für die Brennstoffzellen-Industrie 2013
[2] Information from the Callux Project: www.callux.net
[3] Information from the CEP: www.cleanenergypartnership.de/

6 ISRAEL

The development of fuel cells and hydrogen technologies in Israel is driven by private companies, academic research and the Government, individually and in collaboration. In 2010, the Government launched a national programme establishing Israel as a centre of knowledge and industry in the field of fuel alternatives for transportation, with fuel cells promoted as a viable option.

There are fuel cell research groups in seven universities, and several highly advanced industrial fuel cell enterprises conducting R&D and demonstration programs. The programs span a broad range of applications including stationary and automotive, based on SOFC and Alkaline Fuel Cell (AFC) technologies and using methanol, hydrogen and other alternatives as the fuel.

R&D programmes support the development of fuel cells and their applications, including the Transportation Electric Power Solutions group (TEPS), begun in 2011 as a unique collaboration between industry, academia and Government, to promote advanced fuel cell technologies and solutions. The Government supports innovative research in this area; invests in and encourages private companies; supports national infrastructure and supports international cooperation and collaboration. In 2012, the total of Governmental support to these programmes was about USD 10 million.

7 ITALY

In 2013, the National Energy Strategy to 2020 for Italy was published with its focus being to reduce the cost [4] and dependence on energy imports [5] for Italy whilst maintaining the environmental targets [6]. These objectives should be achieved through increasing energy efficiency [7] and the use of renewables [8], across seven flagship approaches:

1. Fostering across-the-board energy efficiency.
2. Promoting a competitive gas market (with the aim of turning Italy into a main Southern European hub for natural gas).
3. Strengthened support for Renewables (including storage systems).
4. A domestic electricity market fully integrated with the European market.
5. Restructuring the refining industry.
6. Sustainable raising of domestic hydrocarbon production.
7. Modernising the governance system of the energy sector.

The Energy Strategy requires current technologies to be widely deployed by 2020, including hydrogen and fuel cell technologies. Italian stakeholders are developing a political platform for the definition and implementation of a specific Italian Hydrogen and Fuel Cell Roadmap. There is little focus on fuel cell and hydrogen technologies centrally, but local activities are active at the forefront of European deployment of all scales of fuel cell technologies.

A significant development in 2013 has been the scaling up of SOFCpower's manufacturing facilities, from a few tens of kW per year to 2MW/year of SOFC stack roll-out, increasing the area of its factory by a factor of four. SOFCpower's main focus is the residential-scale CHP market, but their units can also be used with biogas and in waste-to-energy (WTE) applications.

[4] A €14 billion reduction

[5] Reduction from 84% to 67%

[6] Environmental targets are to reduce GHG emissions by 19% compared to 1990

[7] Energy efficiency should lead to a reduction of 24% of primary energy consumption

[8] Renewables will be up to 20% of total energy consumption, becoming the main source for electricity generation with 36–38% (from 23% in 2010) of total make-up of electricity generation

The second major, independent, industrial player in Italy is Electro Power Systems (EPS), which deploys back-up power systems (either fed by hydrogen or incorporating the complete cycle from renewable-assisted water electrolysis back to hydrogen oxidation in the same unit), with over 3,000 units worldwide.

The INGRID project, which aims to provide effective balancing support to the local electricity grid by means of a 39MWh energy storage facility that will combine a 1.2MW electrolyser with a 1 ton hydrogen storage facility, utilising renewable energy from solar and wind farms in the Puglia region, is still continuing. The hydrogen generated will be utilised by fuel cells either for grid energy or for transport purposes.

Italy has one new large-scale combined cooling, heat and power (CCHP) fuel cell installation underway, with funding agreed for a 400kW molten carbonate fuel cell (MCFC) system at ENEA in Portici. The final negotiations are underway. There are several other large scale installations that may progress in the near future [9].

Table 5 Summary of Italian Fuel Cell Information

		Details/ comments
MW installed and operational	More than 1MW, over 500 systems	installation of first large-scale systems (400kW) under negotiation
Number of domestic stationary units New in 2013	35 25	A further 125 are being installed
Number of other stationary units (large scale)	350	Remote systems for telecom repeater stations, EPS
Number of operational FC vehicles	5	Milano and Bolzano
Hydrogen filling stations operational	10 stations, although not all are active	

8 JAPAN

Japan is a leading country in the field of fuel cells, both for residential applications and for passenger cars.

Commercialisation of ENE-FARM micro-CHP residential fuel cell products has been particularly successful. The first of these products were launched in early 2009, and the total number of installed systems was over 57,000 by the end of October 2013. A further subsidy round for ENE-FARM was announced in December 2013 with JPY 20 billion made available for 50,000 units (USD 200 million, EUR 140 million). This funding will provide a subsidy of 0.37M JPY for each PEFC unit (3,700 USD, 2,600 EUR) and JPY 0.43 million for each SOFC unit (USD 4,300, EUR 3,100), respectively.

[9] Proposed MCFC installations, all to be supplied by Fuel Cell Energy Solutions (Germany):
- 400kW MCFC system at INFN, Frascati. Funding not yet requested.
- Two 400 kW systems fed with biogas from anaerobic digestion of the organic fraction of MSW from Ariccia, south of Rome.
- A private commission for one or two 400kW CHP systems fed with natural gas; negotiations are ongoing.
- The waste management agency of Terni is in its first stages of contact with suppliers for a system fed with biogas.
- Three municipalities near Milan (Rho, Pero and Settimo Milanese) are concluding negotiations with suppliers for a biogas fed system.

The government subsidy for ENE-FARM products will cease in 2015, with the assumption that the price for a domestic fuel cell system will have decreased to around JPY 700,000 – 800,000 by 2016. The target sales price by 2020-2030 is JPY 500,000 – 600,000 in the NEDO (government) scenario. In April 2013 Panasonic released a new ENE-FARM model priced at just less than JPY 2 million (approx. USD 20,000, EUR 14,000). To date the price of ENE-FARM products has dropped in line with expectations.

Japan has a number of car manufacturers that are developing fuel cell systems for transport. Toyota announced they would jointly develop FCEVs with BMW on January 24, 2013. Nissan, together with Daimler and Ford, announced the joint development of FCEV technology on January 28, 2013. Meanwhile, Honda announced the joint development of FCEV technology with GM on July 2, 2013.

Toyota's new-generation sedan-type FCEV (FCV CONCEPT) was unveiled in 2013 at the Tokyo Motor Show, with Honda unveiling their new FCEV concept at the Los Angeles Motor Show in 2013. Both Toyota and Honda announced that sales of sedan-type FCEVs will start around 2015.

In 2011 10 Japanese energy companies and three automakers made a joint statement committing to 100 hydrogen refuelling stations in 2015 based around four main urban areas, to coincide with the market introduction of FCEVs from Toyota, Honda and Nissan. The key issue for FCEVs, to enable full commercialisation in 2025-2030, remains cost reduction of the fuel cell system itself.

A new research focus of triple combined power that uses SOFC systems in conjunction with a gas-turbine and a steam-turbine, was begun in 2012, with the emphasis on elemental technology development. Two new NEDO programmes have begun in 2013; one targets technology development for SOFC for commercialisation and has a budget of JPY 1.24 billion in 2013, and will run to 2017; the second will target technology development for hydrogen utilisation, and with a budget of JPY 2 billion in 2013, and will run to 2017.

Table 6 Summary of Japanese Fuel Cell Information

		Details/ comments
MW installed and operational	Approximately 40MW [10] 1.6MW	Ene-Farm as of Oct 2013 PAFC technology (estimation)
Number of domestic stationary units New in 2013	57,000 units 13,000 units	Ene-Farm From April to October 2013
Number of other stationary units (large scale)	10	PAFC technology, 100kW those shipped in 2012 only
Number of operational fuel cell vehicles	55 cars and buses	
Hydrogen filling stations operational	17 stations	

[10] Assuming each unit is 700W. Some units are 750W.

9 KOREA

The national programme of fuel cells in Korea is driven mainly by the Ministry of Trade, Industry & Energy (MOTIE), which works for the commercial adoption of fuel cell as a strategic technology for future hydrogen infrastructure, and promotes innovative technology that will reduce the price and enhance performance and durability of fuel cells. The budget in 2012 was KRW 46 billion (approximately USD 43 million, Government funding only). Total electricity production from fuel cells in 2012 was 389GWh.

The RPS (Renewable Portfolio Standard) was introduced in 2012 and applies to stationary fuel cells as a renewable energy technology. RPS mandates the portion of renewable electricity to be generated to every power company with a capacity of 500MW or larger. The required portion will increase from 2% in 2012 to 10% in 2022.

In 2010, the 'Dissemination of Green Home Program' began, with the target of constructing one million green homes by 2020. Fuel cells are included in the list of power sources with the Korean Government subsidising 80% of the installation costs of fuel cells in 2012. The subsidy available will be reduced gradually to 30% by 2020.

Fuel cell vehicle commercialisation is underway with the second phase of the demonstration programme running from 2010 to 2013. One hundred fuel cell vehicles are in operation providing data on durability, operational cost and the effect on the environment. There are 14 hydrogen fueling stations in operation and the Government target is to increase this number to 48 by 2015 and 500 by 2030. The focus will be on both onsite hydrogen reforming and hydrogen delivery (by truck) for refuelling stations.

Table 7 Summary of Korean Fuel Cell Information

		Details/ comments
MW installed and operational	MCFC : 113MW PAFC : 4.8MW PEFC : 1,97MW	MCFC : 1.2MW/2.4MW POSCO Energy Products PAFC : 400kW UTC Products PEFC : 1kW FCP, GS Fuel Cell Products
Number of domestic stationary units New in 2013	1,970 units 260 1kW units	(2006–2013, 1kw residential use)
Number of other stationary units (large scale) New in 2013	MCFC: 43 units PAFC: 12 units 58.8MW	MCFC
Number of operational FC vehicles	120 passenger cars, 6 buses	SUV equipped with 100kW stack, 70MPa (700 bar) Tank (6kg H_2[11]) Bus equipped with 200kW stack, 70MPa (700 bar) (30kg H_2)
Hydrogen filling stations operational	14 stations (2 under construction)	

[11] H_2 denotes Hydrogen.

10 MEXICO

Mexico enjoys very favourable conditions to adopt fuel cells in such applications as utility transportation and back-up power. Such conditions arise from several positive situations: its favourable geographical location (Ballard has established a manufacturing facility in Mexico near the US border) and Mexico being one of the largest automobile manufacturers in the world with a well-developed related industry and very keen on new technology products. According to a global firm [12], Mexico is, for some industries like electronic goods, the most competitive country in the world in terms of manufacturing costs, stating that these are approximately 25% lower than in the United States and even lower than in the BRIC countries.

In recent months an Energy Reform allowing more private participation in this sector was approved by Congress, which should facilitate the introduction of emerging energy technologies. Scientists have made efforts, together with visionary congressmen, to introduce a hydrogen initiative to enact hydrogen technologies into the newly reformed energy sector vision. Although Mexico has not included fuel cell technologies specifically in its present energy roadmap, the energy reforms introduced by the present Government facilitate the introduction of clean technologies in a more market-driven atmosphere, where final users should be presented with more than fossil-fuelled options for electricity generation.

Table 8 Summary of Mexican Fuel Cell Information

		Details/comments
MW installed and operational	0.28MW [13]	From a recent finance report
Portable units	Approximately 40kW	Several low power (0.5 – 2kW) FC (PEM) are on test in different R&D organisations.

11 SWEDEN

The hydrogen and fuel cell activities in Sweden are driven from the bottom-up, by developing companies, academic research and experts. The aim of the Swedish Government is to observe the market and to support industry and universities with national activities focused on a new research programme on PEFC and SOFC (about EUR 600,000 per year) and participation in IEA and EU activities (about EUR 70,000 per year). Another programme to cover the international business development is under preparation and will begin in 2014. The new programme has a focus on transport applications, but it is still under development.

[12] Alix Partners, cited in the Electronics Trade and Investments Reports by ProMexico

[13] Considering that Ballard units come in 2.5 and 5kW, installed capacity might be larger, as it has been reported that 114 units of Ballard's ElectraGenTM-ME have been installed in Mexico. Other units commercialised by Microm should also add up to this number

Table 9 Summary of Swedish Fuel Cell Information

		Details/comments
MW installed and operational	Less than 1MW	Some back-up power units are installed most for test or demonstrations
Number of domestic stationary units	Less than 10	A few PEFC units running but not really as residential fuel cells
Number of operational fuel cell vehicles	2 Hyundai FCV cars in Malmö as part of an EU-project	The two Hyundai cars as a part of the EU Next Move project. The region, Skåne, is sharing the project with the City of Copenhagen
Portable units	A fast growing number of myFC Powertrekk, with PEM technology. A portable charger for mobile phones, GPS or similar USB connected units	myFC a Swedish company has commercialised the Powertrekk unit. It is now sold at large home electronics stores [14]
Hydrogen filling stations (HRS) operational	One movable HRS in Arjeplog mainly for winter testing. There are two HRS in the city of Malmö, one new 70MPa (700 bar) moveable station that is placed there temporary during the NextMove project. The old HRS from 2003 is mothballed but has been tested with good results. Today it can deliver hydrogen up to 35 MPa (350 bar)	

12 SWITZERLAND

Switzerland is focusing on reducing domestic emissions through targets, through an incentive fee on thermal fossil fuels to encourage energy efficiency and renewable energy renovations, and through emission caps for passenger cars at average CO_2 emissions of 130g of CO_2/km starting in 2015.

Table 10 Summary of Swiss Fuel Cell Information

		Details/comments
MW installed and operational	0.26MW	1 MCFC plant with 240kW, a few domestic SOFC systems (1-3kW), a few 1-2kW systems for UPS (Telecom)
Number of domestic stationary units	Approximately 15	Some are not in the field, but with the developers (Hexis)
Number of other stationary units	Approximately 10	One big MCFC plant, the others are small units for UPS
Number of operational fuel cell vehicles	5 buses and 5 other vehicles	5 buses from Daimler on regular services, a few other pilot and demonstration vehicles (municipal vehicle Hy.muve, a few passenger cars)
Hydrogen filling stations operational	Two, with a further one planned: • First one opened in spring 2012, using alkaline electrolysis producing 130kg H_2/day at 35MPa (350 bar). • Second at Belenos Clean Power Holding AG (not public, for R&D). • Third one in planning at EMPA (research), PV combined with electrolysis.	

[14] For more information on myFC see www.siba.se/product/15329724/powertrekk

13 USA

"As part of an all-of-the-above energy approach, fuel cell technologies are paving the way to competitiveness in the global clean energy market and to new jobs and business creation across the country."
Secretary Moniz, US Department of Energy, December 2013

The US Department of Energy's Fuel Cell Technologies Office aims to enable the widespread commercialisation of a portfolio of hydrogen and fuel cell technologies through applied research, technology development and demonstration, and diverse efforts to overcome institutional and market challenges. The appropriation for FY12 was USD 103,624,000 and USD 95,844,000 for FY13. The key targets that many other countries also reference are:

Fuel cells:

- By 2015, develop a fuel cell system for portable power (less than 250W) with an energy density of 900Wh/litre.
- By 2017, develop a direct-hydrogen fuel cell power system for transportation with a peak efficiency of 60% and 5,000-hour durability, that costs USD 30/kW at high volume.
- By 2020, develop distributed generation and micro-CHP fuel cell systems (5kW) with an electrical efficiency of 45% and 60,000 hour durability that operate on natural gas or LPG and cost USD 1,500/kW.
- By 2020, develop medium-scale CHP fuel cell systems (100kW–3MW) with electrical efficiency of 50%, CHP efficiency of 90% ,and operate for 80,000 hours at a cost of USD 1,500/kW for operation on natural gas and USD 2,100/kW when configured for operation on biogas.
- By 2020, develop a fuel cell system for auxiliary power units (1–10kW) with a specific power of 45W/kg and a power density of 40W/litre at a cost of USD 1,000/kW.

Hydrogen storage:

- By 2017, develop and verify on-board hydrogen storage systems with specific energy of 1.8kWh/kg (5.5 wt%) and energy density of 1.3kWh/litre (0.040kg hydrogen/litre).
- Ultimate full-fleet target of 2.5kWh/kg system (7.5 wt% hydrogen) and 2.3kWh/litre (0.070kg hydrogen/litre).

Table 11 Summary of the USA Fuel Cell Information

		Details/comments
MW installed and operational	249MW (total from 2008–2013)	A total of 13,605 units An additional 27MW (1,558 units) were exported