4th IPHE Workshop Report
Stationary Fuel Cells

1st March 2011

TOKYO INTERNATIONAL FORUM
Tokyo, Japan

International Partnership for Hydrogen and Fuel Cells in the Economy

Organized by
Ministry of Economy Trade and Industry (METI), Japan
International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE)
New Energy and Industrial Technology Development Organization (NEDO)
Technova

OBJECTIVES

"4th IPHE Workshop on Stationary Fuel Cells" aimed:

- to provide unique interesting opportunities for government agencies, private companies and research organizations from key countries to discuss government policy and industrial activity in the area of stationary FC,
- to help individual countries to learn from programs and activities in other countries, promote commercialization of stationary FC in the future, and
- to support policy making and business strategy development toward the commercialization of stationary FC.

ACKNOWLEDGEMENTS

The International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE) would like to thank the co-organizers of the workshop, Ministry of Economy Trade and Industry (METI), New Energy and Industrial Technology Development Organization (NEDO), and Technova, Japan.

PROGRAM

Opening Session 9:40 – 10:00	
	Moderator: Haruhisa Koguchi, METI
9:40 – 9:50	Opening Remarks by METI
	Kenta Iida, Director, Hydrogen and Fuel Cell Promotion Office
9:50 – 10:00	IPHE Remarks
	Kai Klinder, Managing Director, NOW GmbH
10:00 – 10:05	**Break**

Government Session 10:05 – 12:00	
The session focused on governmental programs and their main stationary technologies / application areas. The speakers provided a short overview of current status, funding schemes (R&D and subsidies), projects and market perspectives, as well as international collaboration activities.	
	Moderator: Haruhisa Koguchi, METI
10:05 – 10:30	Japan-NEDO
	Activities of NEDO for practical use of stationary fuel cell systems **Atsuo Okawara,** Chief Officer, Fuel Cell and Hydrogen Technology Development Dept.
10:30 – 10:55	USA-DOE
	An Overview of the Status and Plans for Stationary Fuel Cells within the Fuel Cell Technologies Program **Rick Farmer,** Deputy Program Manager and Chief Engineer for the U.S. FC Technology Program
10:55 – 11:10	**Break**
11:10 – 11:35	EU-Fuel Cells & Hydrogen Joint Undertaking
	FCH – JU European public/private joint support for fuel cells and hydrogen activities **Mirela Atanasiu**, Project Manager Stationary Applications
11:35 – 12:00	Germany-NOW GmbH
	Cooperation as Success Factor for the German National Innovation Program **Kai Klinder,** Managing Director, Program Management Stationary Fuel Cells
12:00 – 13:10	**Lunch Break**

Parallel Sessions 13:10 – 15:45	
In the parallel sessions, speakers discussed specific technologies as well as the challenges that industries are facing. The sessions also focused on opportunities for cooperation, solutions for commercialization and best practices in overcoming hurdles.	
Parallel Session 1 Residential & Micro CHP Application	
	Chair: Osaka Gas Takahiro Kasuh, Associate director, General Manager
13:10 – 13:30	Japan, Toshiba Fuel Cell Power Systems Corporation ***Challenge to expand the commercialization opportunity with residential PEM, ENEFARM*** **Yuji Nagata,** Technology Executive
13:30 – 13:50	Europe, E.ON Ruhrgas AG ***Callux - The German Lighthouse Project for Market Introduction for Domestic Fuel Cell CHP Systems*** **Dr. Stephan Ramesohl,** Vice President Research and Development
13:50 – 14:10	Europe, Baxi INNOTECH ***Baxi Innotech - Gamma 1.0 - Large scale demonstration of residential PEFC systems in Germany - Status and outlook*** **Philipp Klose,** Devision Manager R&D
14:25 – 14:45	Japan,AISIN ***Challenge the commercialization of the residential SOFC CHP*** **Koji Kiryu,** L&E Development Dept.
14:45 – 15:05	Australia, Ceramic Fuel Cells Ltd. ***Challenges in Commercialising an Ultraefficient SOFC Residential Generator*** **Dr. Karl Foeger,** Chief Technology Officer
15:05 – 15:25	U.S., Clear Edge Power ***Commercialization of ClearEdge5 --a 5 kW Fuel Cell System in the USA*** **Zakiul Kabir,** CTO & Senior Vice President of Engineering
15:25 – 15:45	Korea, KOGAS ***Initial Stage of Commercialization of Residential Fuel Cells in Korea*** **Dr. Dal-Ryung Park,** Principal Researcher, New Energy and Environmental Team, R&D Division
Parallel Session 2 Industrial Application 13:10 – 15:45	
	Chair: Toho Gas Dr. Yasunobu Mizutani, Executive Researcher
13:10 – 13:30	Japan, Fuji Electric Systems Co,. Ltd. ***Present and Future of PAFC at Fuji Electric*** **Kenichi Kuroda,** Fuel Cell Equipment Dept. Chiba Factory Industrial Solutions Group Environmental Solutions Business Headquarters
13:30 – 13:50	U.S., UTC ***PureCell® Combined Heat and Power Fuel Cell Solutions*** **Andrew Dasinger,** Sustainable Strategies Leader
13:50 – 14:10	Korea, POSCO Power ***Energy Forever: Fuel Cell Power Business Intro*** **Taehyoung Kim,** Group Leader, Business Strategy & Marketing Group, Fuel Cell Devision
14:35 – 14:55	Japan, Mitsubishi Heavy Industries, LTD ***Current Status and Future Prospects for SOFC Triple Combined Cycle System*** **Yoshinori Kobayashi,** Deputy General Manager, New energy systems department Power systems headquarters
14:55 – 15:15	Canada, Ballard Power Systems Inc. ***PEM Fuel Cell Systems for Distributed Power Generation*** **Jesper Themsen,** CTO, Dantherm Power A/S
15:15 – 15:35	Europe, Wärtsilä Finland Oy ***Status of the Solid Oxide Fuel Cell System Development at Wärtsilä*** **Kim Åström,** Senior Expert, System Development Product Centre Ecotech

Panel discussion: Technology and Market 15:55 – 17:15	
Vision: Think global, act local! Create a global market entry programme. **The discussion focused on challenges and solutions for overcoming hurdles to commercialization and ways to promote cooperation.**	
	Moderator: UK Energy Research Centre, John Loughhead
15:55 – 16:15	Summary sessions, **John Loughhead,** Executive Director, UK Energy Research Centre
16:15 – 17:15	Discussion
Closing 17:15 – 17:25	
17:15 – 17:25	**Closing Remarks** **IPHE, Kai Klinder,** Managing Director, NOW GmbH

Opening Session

Opening Remarks by METI
***Kenta Iida**, Director, Hydrogen and Fuel Cell Promotion Office*

- Japan is the founding member of IPHE, and we support its activities since its founding in 2003. It is our honor that Japan hosts 4th IPHE Workshop Report Stationary Fuel Cells in Tokyo.
- To achieve 3Es (Energy security, Environment protection, and Economic efficiency) simultaneously, METI has been promoting "Green Innovation" technologies, and hydrogen and fuel cell technology is an important part of the green innovation.
- Japan is the world first country to commercialize residential fuel cells. Since 2009, Japanese manufactures have been selling ENE-FARM (1 kW PEMC systems). As of end of this February, nearly 10,000 unites have been sold in Japan. The top-runner units can reduce more that 100 kg-CO_2 /month, 38% reduction if compared with thermal power plant.

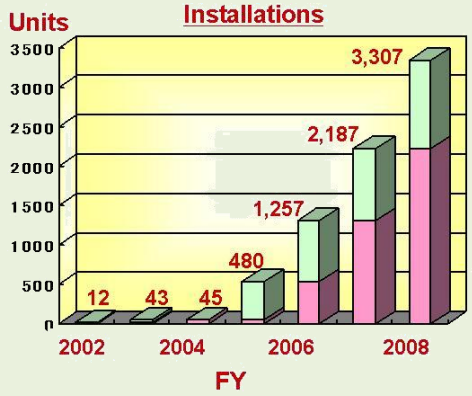
IPHE Remarks
***Kai Klinder**, Managing Director, NOW GmbH*

- In the fields of fuel cell and hydrogen, we need co-operations, because no one can promote the technology, alone. That is why we have established IPHE in 2003.
- NOW is also willing to promote bilateral cooperation, with Japan (NEDO), USA (USA), and Korea.
- FC technology in stationary / CHP application is competing with existing technologies. The cost is still high. FC's durability and performances are becoming acceptable but needed to be improved.
- "Think Global, Act Local" is the keyword for us all. This workshop will provide very good opportunity to learn the best practices.

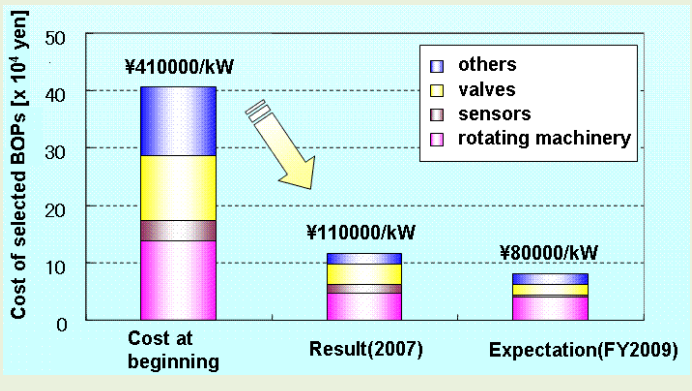
Government Session

Activities of NEDO for practical use of stationary fuel cell systems
Atsuo Okawara, Chief Officer, Fuel Cell and Hydrogen Technology Development Dept, NEDO

- Japan has selected 21 key technologies for "Cool Earth Program", and residential fuel cell technology is listed as a core technology as well as FCVs and technologies for hydrogen production, storage and transport.
- Japanese companies started selling residential fuel cell system in 2009, under the common brand name "ENE-FARM". The Ministry of Economy, Trade and Industry (METI) has designed support program to increase demand of ENE-FARM and to reduce the unit cost further. By the end of FY 2008, more than 3000 units were installed. With the new subsidy program, nearly 10,000 units were offered for FY 2009-2010. For FY 2011, we expect about 8,000 units will be installed.
- With mutual cooperation among PEMFC manufacturers, BOP components were harmonized, resulting in the performance improvements and the cost reduction. As the results of this program (2006-2009), BOP system cost has been reduced from 410,000 yen/kw to 80,000 yen/kw.
- Under the SOFC program, 36 stationary SOFCs are demonstrated in Japan (plan: 2008-2012). Some units have achieved the durability if 8,000 hours.



ENE-FARM installation (2002-2008)

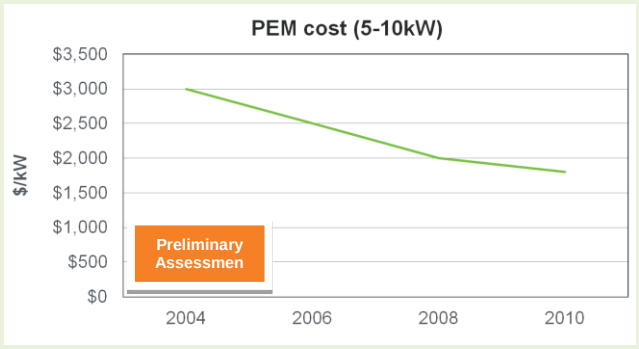


BOP cost reduction program)

An Overview of the Status and Plans for Stationary Fuel Cells within the Fuel Cell Technologies Program

Rick Farmer, Deputy Program Manager and Chief Engineer for the FC Technology Program, US DOE

- DOE's targets for stationary FCs are the durability of 40,000 hours and system cost of 750$/kW. The system cost is the one of the largest barriers for commercialization, so the DOE is promoting Market transformation program to support the market introduction.
- For stationary FCs, DOE is primarily focusing on PEMFC techology, but also promoting SOFC technology, too.
- With DOE's R&D program, 33% electrical efficiency and 61% CHP efficiency have demonstrated by LT-PEM. Over 7,000 hours durability with load cycling has been demonstrated in 20-cell stack. PEM cost is also 40% reduced from 2004 to 2010.
- DOE's targets for micro CHP (1-10 kW) on natural gas are the electrical efficiency of 42.5%, CHP efficiency of 87.5%, cost of $700/kW, and the durability of 40,000 hours.
- With DOE's market transformation program, industry scale FCs (up to 1 MW) are already installed at supermarkets and factories.



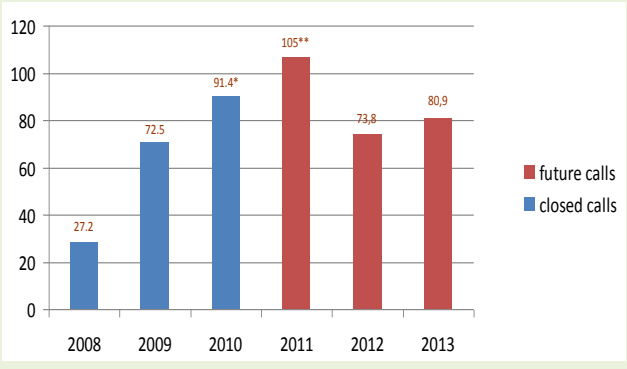
PEM cost reduction (2004-2010)

Seven UTC 200 kW PAFC installed at Verizon

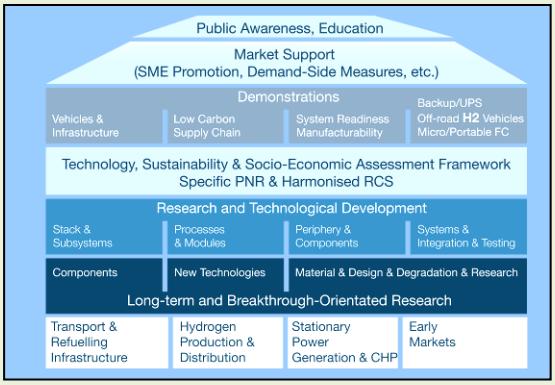
FCH – JU European public/private joint support for fuel cells and hydrogen activities

Mirela Atanasiu, Project Manager Stationary Applications, Fuel Cells & Hydrogen Joint Undertaking

- 3 pillars of the EU Energy Policy are "sustainable development", "security of supply" and "competitiveness". In this respect, fuel cell and hydrogen technologies are key towards Europe's 20-20-20 targets (by 2020, 20% increase in renewable, 20% decrease in emissions, and 20% increase in efficiency).
- The objectives of FCH JU are (i) to bring resources together under a cohesive, long-term strategy (public private partnership), (ii) to ensure commercial focus by matching RTD activities to industry's needs and expectations, and (iii) to scale-up and intensify links between Industry and the Research Community.
- By today, three calls have been launched. The 2011 call will be the biggest call. 34-37% of FCH JU budget will be allocated for stationary power generation and CHP area.
- FCH JU's stationary application targets are (i) installation: 3 - 7 MW electrical capacity by 2010 and 100 MW electrical capacity by 2015, (ii) cost: 5 000 - 6 000 €/kW for micro CHP units and 1,500 - 2,500€/kW for commercial/industrial units.



FCH JU Operational budget (2008 - 2013)

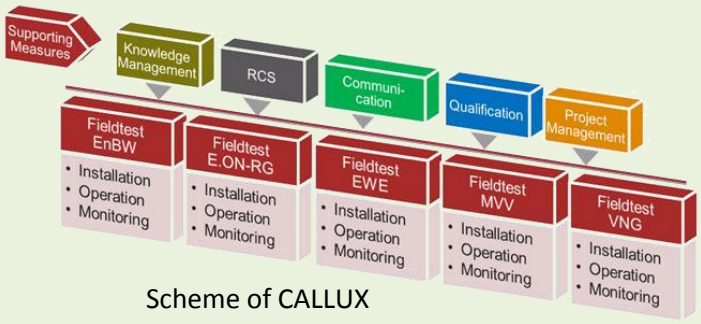


FCH JU Multi-Annual Implementation Plan

Cooperation as Success Factor for the German National Innovation Program
Kai Klinder, Managing Director, Program Management Stationary Fuel Cells, NOW GmbH

- In Sept 2010, German Government has announced "Climate Protection Plan 2050", which aims to reduce the primary energy consumption by 80% until 2050, and to reduce GHG emission by 80% - 95% until 2050. For that purpose, Germany will invest 20 billion € per year. High efficient fuel cells, FC CHPs and FCs with bio-energy will directly support the major climate protection targets.
- Germany has launched National Platform for Hydrogen and Fuel Cell Technologies (NIP) to invest totally 1,400 M€ into FC/H2 applications in 2007-2016. 200 M€ is funded by Fed. Ministry of Economics, focusing on R&D. 500 M€ is funded by Federal Ministry of Transport, Building & Urban Affairs, focusing on demonstration with R&D.
- NIP plans to allocate 36% of the budget to the stationary applications (FC CHP for residential and small business applications, and marine application).
- Lighthouse CALLUX (High-efficient co-generation for residential houses) program has started in Sept 2008. With the budget of 80 M €, 800 units will be installed by 2015.
- Other than CALLUX, 7 development projects with SOFC, LT-PEM and HT-PEM, and 1 research project "Desulphurisation Standard" are ongoing.
- In a global market, a synchronized global R&D and market preparation schedule is required.

Units under investigation at CALLUX

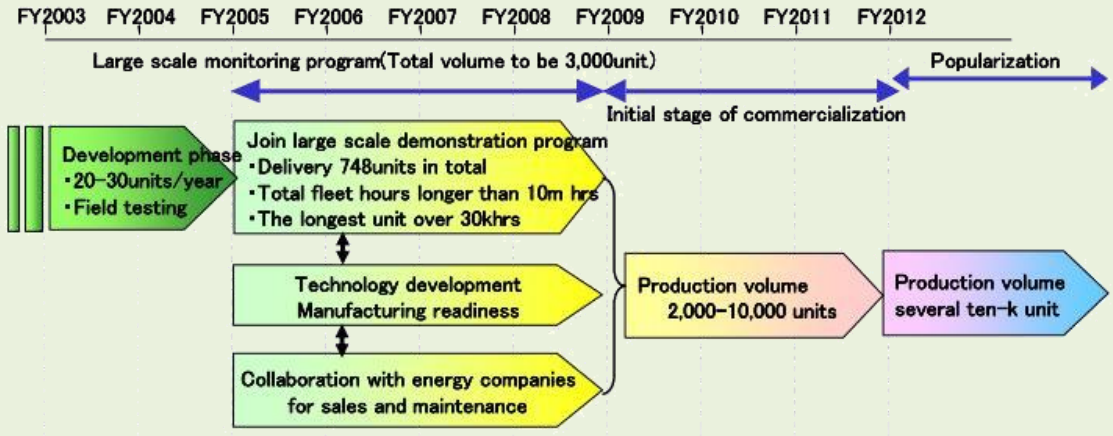


Scheme of CALLUX

<u>Parallel Session 1 Residential & Micro CHP Application</u>
Chair: Takahiro Kasuh, Associate director, General Manager, Osaka Gas

Challenge to expand the commercialization opportunity with residential PEM, ENEFARM
Yuji Nagata, Technology Executive, Toshiba Fuel Cell Power Systems Corporation

- Through the verification and introduction phase, Japan started the commercialization of small residential PEM with standard name, "ENEFARM" in January 2009. The key factors for the success are (i) governmental leadership, (ii) collaborative development under NEDO Project, (iii) technology potential of manufacturers with long history, (iv) collaboration among Japanese companies FCCJ, and (v) partnership with energy companies and manufacturers.
- Toshiba has started the delivery of the initial commercial unit in 2009 with around 2,000 units per year, and 10,000 Toshiba units will be installed by 2012.

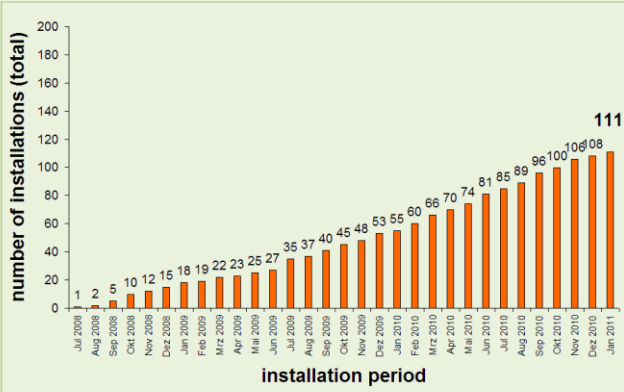


Toshiba's Commercialization plan in Toshiba FCP

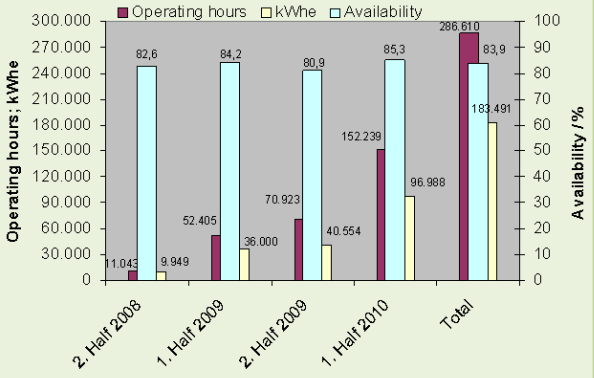
Callux - The German Lighthouse Project for Market Introduction for Domestic Fuel Cell CHP Systems

Dr. Stephan Ramesohl, Vice President Research and Development, E.ON Ruhrgas AG

- CALLUX has started in September 2008. CALLUX target is to prepare the market launch of gas-driven fuel cell heating appliances by demonstrating technical maturity, developing supply chains, enhancing product profile on the market, and validating requirements against customers and the market.
- Approx. 800 fuel cell heating appliances are to be installed under the CALLUX field test by 2012 and to be operated in some cases until 2015. Today 111 fuel cell heating appliances are in operation.
- CALLUX has a total investment volume of more than €80 million, of which 52% are contributed by the project partners.



Planned numbers of appliances at CALLUX

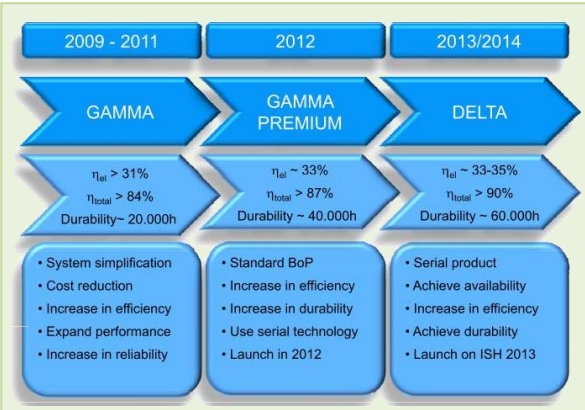


Public Fleet Report (07/2008 - 06/2010)

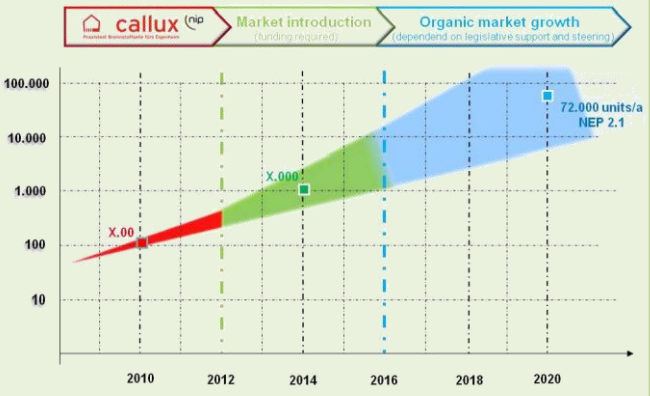
Baxi Innotech -Gamma 1.0 - Large scale demonstration of residential PEFC systems in Germany - Status and outlook

Philipp Klose, Devision Manager R&D, Baxi Innotech

- Baxi has developed pre-series "GAMMA 1.0" with 1.0 kW_{el}, 1.7 kW_{th}. Electrical efficiency is 32%.
- By replacing conventional boiler at an ordinal house, GAMMA 1.0 offers the reduction of heating cost by 900€ a year.
- Baxi will launch GAMMA PREMIUM in 2012, and DELTA in 2013/2014.
- In Germany, micro CHP market will grow to 72,000 units a year by 2020.



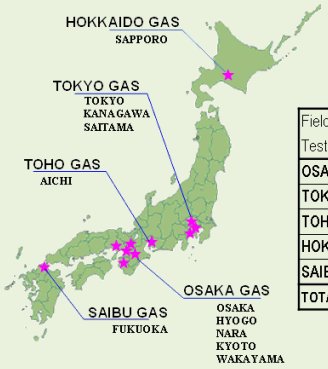
Baxi's product development roadmap



Volume scenario fir micro CHP in Germany

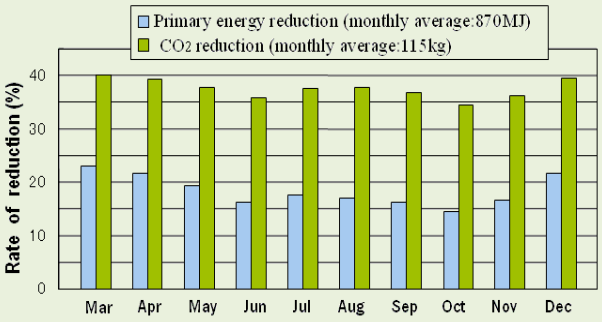
Challenge the commercialization of the residential SOFC CHP
Koji Kiryu, L&E Development Dept. AISIN

- AISIN has working on co-development of SOFC CHP with Toyota, Kyocera and Osaka Gas since March 2009, and AISIN has joined the national project since 2009.
- In 2009 and 2010, AISIN has provided five GAS companies with 88 CHP units in total.
- We have obtained high environmental benefits such as CO_2 reduction and primary energy saving in a standard house.
- For the next step and the future possibilities, the important things are; (i) demonstration to establish reliability as a quality of products, (ii) promoting durability test in demonstration and lab tests to ensure a 10-year life time, and (iii) cost reduction.



Field Installation and Test operators	number	FY2009	FY2010
OSAKA GAS	64	23	41
TOKYO GAS	15	4	11
TOHO GAS	3	1	2
HOKKAIDO GAS	3	1	2
SAIBU GAS	3	1	2
TOTAL	88	30	58

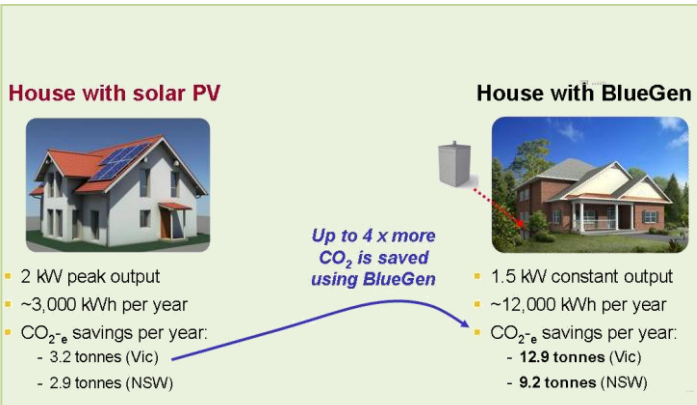
AISIN's SOFC CHP Demonstration in Japan



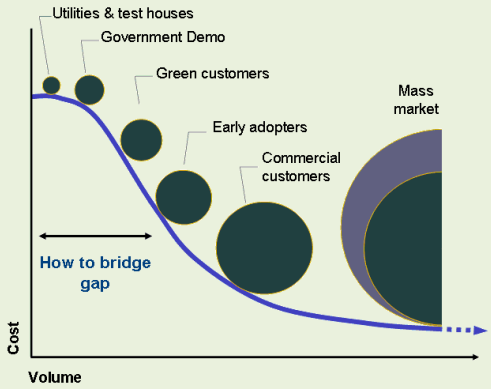
Environmental merit in a standard house

Challenges in Commercialising an Ultraefficient SOFC Residential Generator
Dr. Karl Foeger, Chief Technology Officer, Ceramic Fuel Cells Ltd.

- CFCL is developing highly efficient electricity generators (micro-CHP) for the residential market based on SOFC technology, with about 300,000 hours of field testing experience in 9 countries Since 2006.
- BlueGen system has the electrical efficiency of up to 60% at user site. The generator produces small amounts of heat (heat to power <0.5), but with heat recovery >80% total efficiency.
- Compared with 2kW Solar PV system for home, BlueGen has higher carbon dioxide savings due to constant operation and high electrical efficiency, even when using natural gas as a fuel source.
- To bridge the initial cost (volume gap "valley of death"), government sponsored large field test programs (e.g. Japan's Residential fuel cell demo, Germany's Callux) with ambitious targets are needed. Also market introduction programs (e.g. feed-in tariffs) and capital subsidies are needed.



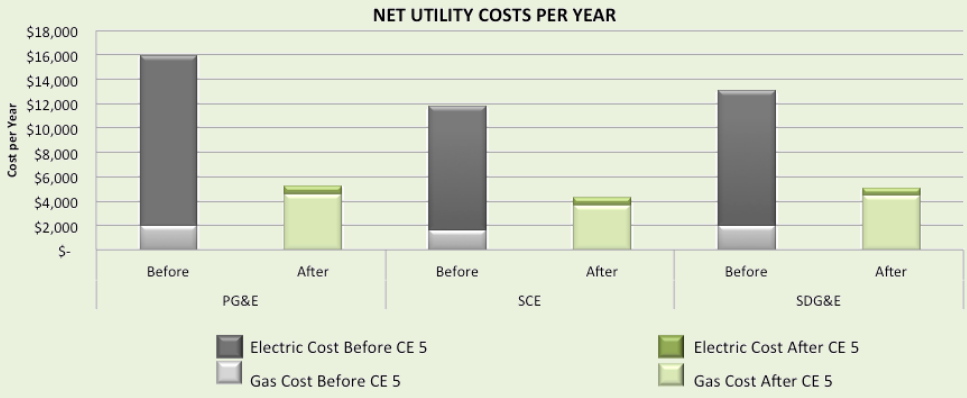
CO2 Savings – BlueGen vs. 2kW Solar PV



Identifying Early Customers

Commercialization of ClearEdge5 --a 5 kW Fuel Cell System in the USA
Zakiul Kabir, CTO & Senior Vice President of Engineering, Clear Edge Power

- Clear Edge Power, established in 2003, offers ClearEdge5 system based on high temperature PEMFC technology. ClearEdge5 has up to 90% CHP energy efficiency and designed for 40% electrical efficiency. It provides >35% reduction in fuel and >35% reduction in CO_2.
- The main market is California, which has several incentives for fuel cells, such as Self-Generation Incentive Program (SGIP) and ITC (Federal Investment Tax Credit).
- The use of a ClearEdge5 system in luxury homes with high electricity tier rates can achieve significant cost savings, and allow a rapid payback period (5-6 years).



Potential cost savings for residential customers in California

Initial Stage of Commercialization of Residential Fuel Cells in Korea
Dr. Dal-Ryung Park, Principal Researcher, New Energy and Environmental Team, R&D Division, KOGAS

- KOGAS had finished installing 210 stationary FC units until last year. Most of the units are fuelled by natural gas.
- In Korea, small stationary program focuses on PEMFC technology and SOFC technology, and large stationary program for distributed power mainly focuses on MCFC technology, with 300 kWe - MW-scale plants.
- KOGAS plans to install 1 kWe mCHP units of 200 units in 2010, 300 units in 2011, and 500 units in 2012.
- As part of Korea's 'Green Home Project', the government has a target of 100,000 residential fuel cell units by 2020.

History of RPG Development

	'06. 8 - '09.7	'07.12 - '10.11	'08.12 - '11.11	Total
Subsidy(Billion Won)	5.5	7.0	8.0	20.5
Units (E.A.)	40	70	100	210
Price (Million Won)	130	100	80	-
Operator	City Gas	Local Government	Energy related Company Private person	-
Tactic	Training and installation start to the natural gas supplier	Driving forward connected to the governmental population project of New and Recycled energy to the locality	Securing the optimal operation method for needs of user	-

※ Main Contractor : Korea Gas Company

Monitoring project for residential fuel cell

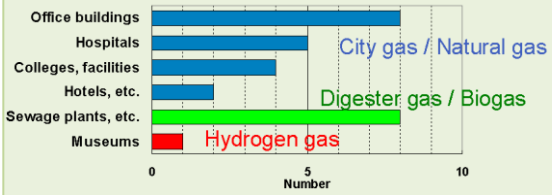
Parallel Session 2 Industrial Application

Chair: Dr. Yasunobu Mizutani, Executive Researcher, Toho Gas

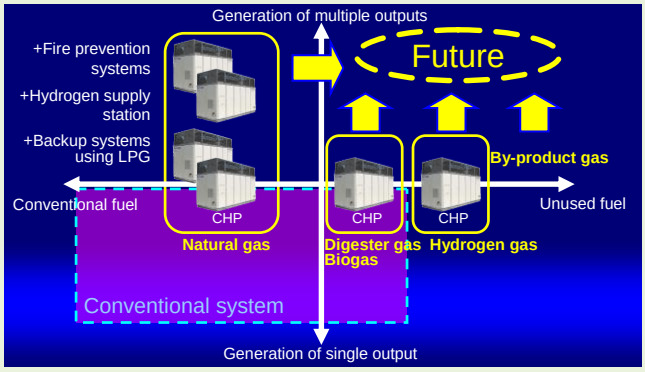
Present and Future of PAFC at Fuji Electric

Kenichi Kuroda, Fuel Cell Equipment Dept. Chiba Factory Industrial Solutions Group, Environmental Solutions Business Headquarters, Fuji Electric Systems Co,. Ltd.

- Fuji Electric has shipped 28 PAFC plants since 1998, and began to ship a new 100kW plant "FP-100i" in 2010. FP-100i can be fueled with natural gas, digester gas and pure hydrogen gas. The electrical efficiency of the pure hydrogen gas-fed plant is 48%, and the total efficiency of 99%.
- Fuji Electric is the first manufacturer in the world to supply a fuel-cell plant for fire prevention purposes. A PAFC package generates low-concentration-oxygen air, so that such air can make data center rooms and warehouses fire-free.
- Fuji Electric plans to emphasize sales in the EU as well as in Japan. The first package began to operate in Germany in July 2010.



Fuji Electric's shipment of PAFC plants

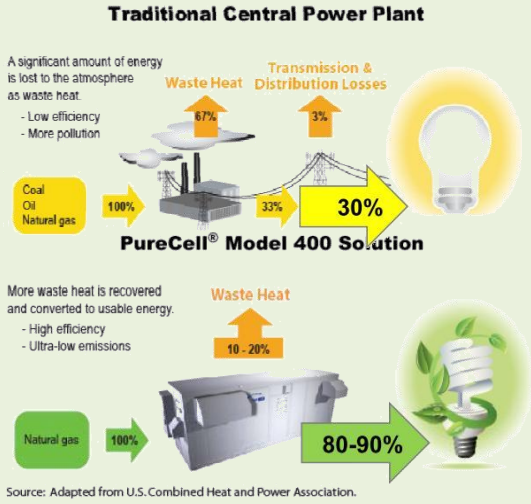


Target market of PAFC plants

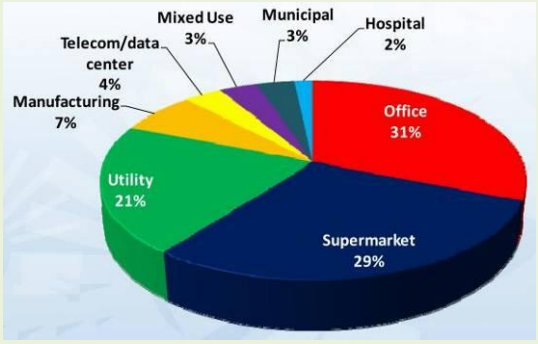
PureCell® Combined Heat and Power Fuel Cell Solutions

Andrew Dasinger, Sustainable Strategies Leader, UTC

- UTC's PureCell Model 400 has the electric Output of 42%, and the overall system efficiency of up to 90%, which is significantly higher than the traditional central power plants.
- Key challenges and barriers are (i) product cost, (ii) thermal utilization and integration, (iii) fluctuating incentives, (iv) other clean energy alternatives , (v) sub-metering restrictions, (vi) existing building retrofit schedules, and (vii) changing economy & operators building philosophy.
- For the cost reduction, UTC has the targets; 45% product cost reduction 2009 to 2011 (target); 30% installation cost reduction 2010 to 2011 (target); 53% reduction in test time over 2010; and significant manufacturing plant upgrade in 2010.



PureCell®- CHP Versus the Grid

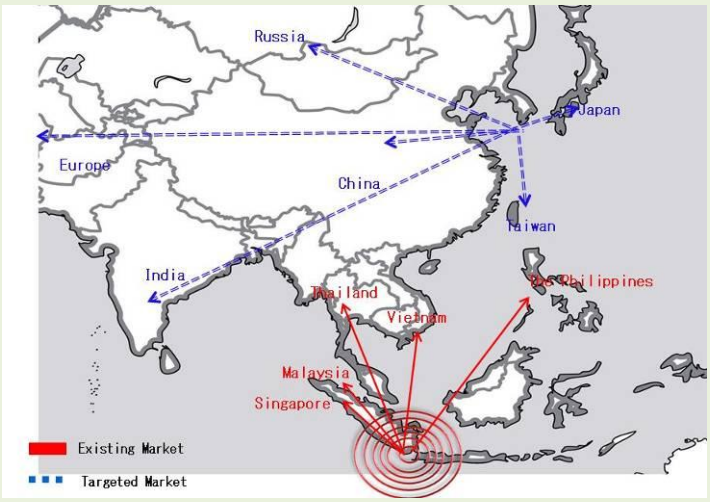


PureCell® Model400 - Market segments

Energy Forever: Fuel Cell Power Business Intro
Taehyoung Kim, Group Leader, Business Strategy & Marketing Group, Fuel Cell Division, POSCO Power

- For domestic market, Korean Government's Feed-In-Tariff helped the installation of stationary FC units to 40MW in total.
- For overseas market, localization, establishment of service network, and cost reduction are the key. POSCO is expanding the FC business to the Southeast-Asia, and the Middle East, and then the world. Indonesia is the key region with Jakarta 300kW Project.

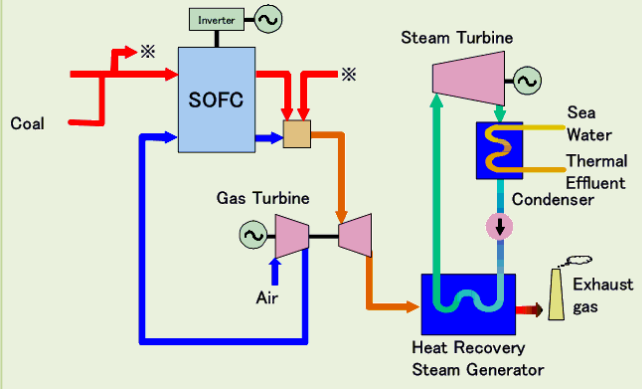
Domestic market



Oversea market

Current Status and Future Prospects for SOFC Triple Combined Cycle System
Yoshinori Kobayashi, Deputy General Manager, New energy systems department power systems headquarters, Mitsubishi Heavy Industries, LTD

- Mitsubishi Heavy Industries (MHI) has been developing highly efficient power generation of combined gas-turbine and steam-turbine (triple combined cycle system), which is the combination of SOFC and GTCC.
- MHI has working on the pressurized SOFC system, which offers high efficiency.
- Aiming at practical use of triple combined cycle system, MHI has been considering a middle-capacity SOFC-MGT combined cycle system (several hundred kW thru several MW) fueled by natural gas.
- Target of MHI is >800MW level triple combined cycle system fueled by natural gas, which has the efficiency of >70% (LHV Net). It will even be possible to achieve net power generation efficiency of >60% (LHV) with a several-hundred-MW-class coal gasifier (IGCC) + SOFC + gas turbine + steam turbine combined cycle system.

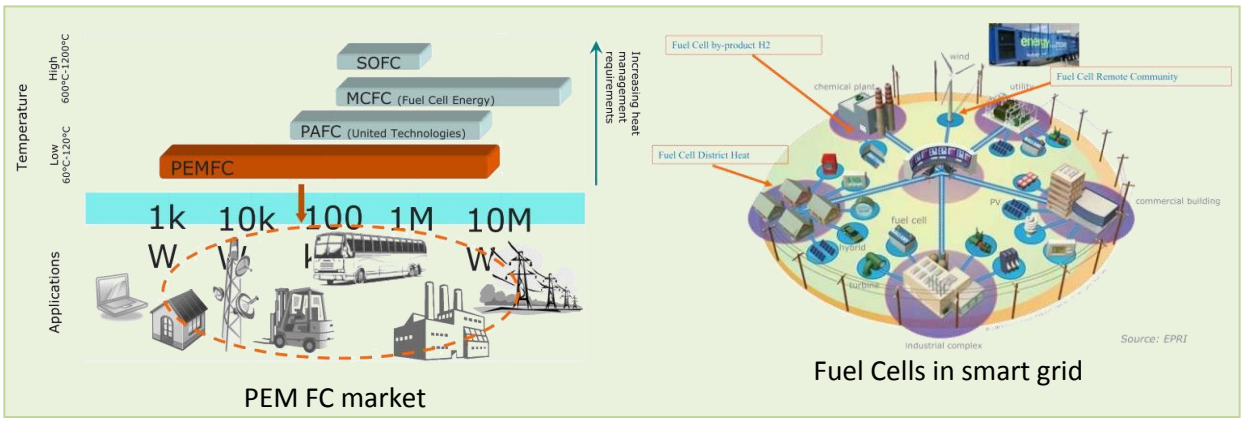


Structure of triple combined cycle

Triple combined cycle system fueled by natural gas

PEM Fuel Cell Systems for Distributed Power Generation
Jesper Themsen, CTO, Dantherm Power A/S (on behalf of Ballard Power Systems Inc.)

- Ballard leadership in PEM fuel cells is based on portfolio of proven commercial solutions (fuel cell stacks, power modules and systems) and strong delivery capabilities (access to over 2,000 patents and licenses, and high volume manufacturing facility). By today, more than 100MW of fuel cell products were shipped.
- Fuel cells have unique ability to provide base load power, storage, or load cycle to meet the demands of distributed generation; (i) by-product hydrogen generation (fuel cell system to offset power requirements at K2 Pure's bleach plant); (ii) remote community electrification (renewable power for remote, off-grid communities to displace diesel generators); and (iii) hydrogen pipeline (fuel cell system to offset peak power requirements at facility).
- As fuel cell product costs continue to decline, fuel cells will play an increasingly prominent role in the clean energy space.

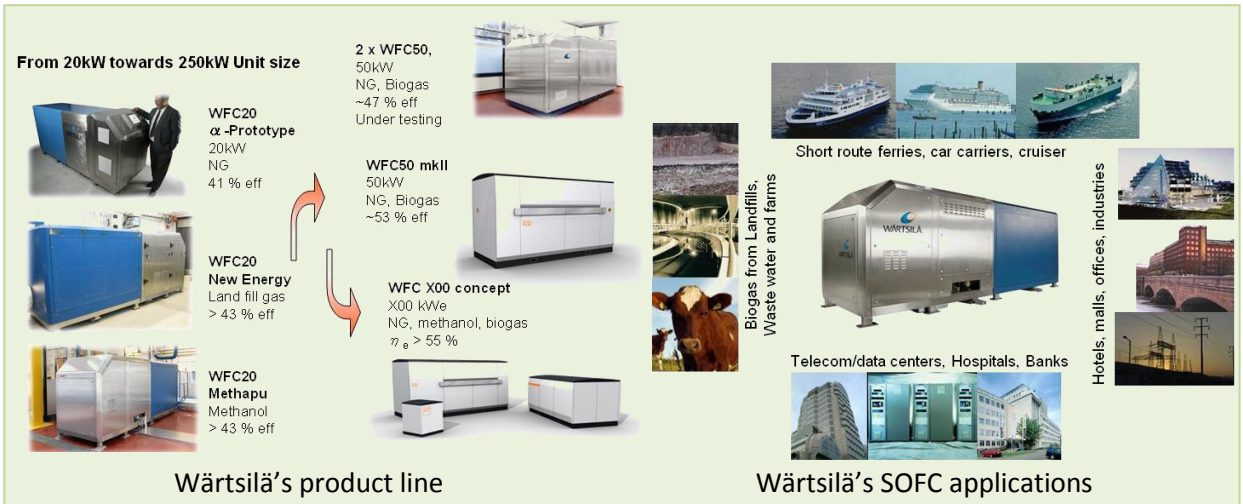


PEM FC market

Fuel Cells in smart grid

Status of the Solid Oxide Fuel Cell System Development at Wärtsilä
Kim Åström, Senior Expert, System Development Product Centre Ecotech, Europe, Wärtsilä Finland Oy

- Wärtsilä's mission is "Wärtsilä will generate new business opportunities and support existing product portfolio by developing and commercializing fuel cell products. Fuel cell products will expand Wärtsilä power solutions offering by providing highly efficient and clean power generation products at lower power range (< 5 MW)."
- With partners, Wärtsilä is promoting planar SOFC technology for applications of (i) short route ferries, car carriers, cruiser, (ii) hotels, malls, offices, industries, (iii) telecom/data centers, hospitals, banks, and (iv) biogas from Landfills, waste water and farms.
- Wärtsilä has established a position among the leading SOFC developers. Wärtsilä has demonstrated the use of methanol and land fill gas for SOFC. WFC20 and WFC50 units will provide extensive experience over SOFC in marine and biogas applications.
- First product WFC50II will be provided with electrical efficiency of 53%.



Wärtsilä's product line

Wärtsilä's SOFC applications

Panel discussion: Technology and Market
Moderator: John Loughhead, Executive Director, UK Energy Research Centre

Summary from Parallel Session 1 Residential & Micro CHP Application
Takahiro Kasuh has summarized Parallel Session 1;
- There are wide range of system specifications and usages for residential and micro CHPs. Still, it is generally recognized that we need technology developments further, and it takes time.
- For the reduction of BOP cost, Japan's R&D on BOP components for residential fuel cell systems will provide the best practice.
- To overcome the valley of death, FCs need incentives, such as tax exemption and subsidy program.

Summary from Parallel Session 2 Industrial Application
Dr. Yasunobu Mizutani has summarized Parallel Session 2;
- For industry application, system specifications and technologies (PEMFC, SOFC, PAFC, MCFC) are so diverse. Though the discussion, participants can share the best practice.
- Technological tasks are cost, durability, and energy efficiency.
- To overcome market barriers, the clarification of added values for customers (high energy efficiency, low emission), and the cost reduction (fuel cost and operation cost) are necessary.

Summary and Thoughts
John Loughhead, has summarized the findings as follows;
- The focuses of presentations were on FC systems, not on sticks, fuel cells or transformers. Thus the technique is now matured and we are not talking about imagined products anymore. This is the big change for the last five years.
- The issue is, now, cost, cost and cost. We need continued governmental support. In many cases each country tried to gain industrial pay out, but there is not enough international collaboration. Also, industries have to clarify the added value.
- What we need is;
  → Harmonization not only for system, but also for components,
  → Level and nature of subsidies to be defined
  → Consistency of policy
- There are different drivers for changing our energy strategy: (1) energy security, (2) grid + network support, (3) carbon emission reduction, (4) energy efficiency.

6 key topics or main hurdles were identified during the discussion.

1. Harmonization
- How can systems be better standardized for: safety, testing (meaning how to calculate the performance to be comparable), design and insulation.
- How should we work with TC 105?
- ***IPHE task → Could become a topic for the RCS Working Group***

2. Support Programs
- The consistency or coherence of policy on support programs is needed.
- Counting in the technology perspective but also an understanding of the energy market is important. How do we manage the variety? Better understanding of the economic drivers and major characteristics of the markets needed.
- UK – free markets, focused on low carbon
- U.S. – utility companies are very traditional. How to serve the customers base → how can fuel cells solve this problem. It's not about competition but about compilation
- Germany – calculated target carbon footprint (government). What is the best motivator for a change – pain and incentives! Suggestion; (i) beneficial program for low footprint, (ii) taxes for high footprint → tax reform controlled by carbon footprint, (iii) global approach on carbon footprint.
- Generally, utilities are conservative and likely to avoid changes. (they see distributed generators are "enemies".) Still, there are possibilities that FCs can help their business and Fs would minimize their investment. Also, we may learn from solar PV experience (introduction of PVs against the utilities).
- ***IPHE task → comparison of scale of incentives***

3. Supply Chain

- Extensive supply chain with different components for different manufactures
- Fuel cell industry has a bad reputation (nobody would like to work with the industry). The cost targets from the industry are not realistic for suppliers (30,000 hour durability is not realistic). Therefore, the industry has to stick to realistic targets.
- Finding ways of getting a supply chain, somehow without governmental money.
- Could an international supply chain work? – (i) Sharing information not easy. (ii) Supplier are stronger than system manufactures. Japanese BOP suppliers may be interested in the business with foreign FC system manufacturers.
- ***IPHE task – take the lead and talk to companies, help building up a common 50 supplier data base, quality must be assured.***

4. Maintenance of operation

- The system maintenance requires skills and capability of engineers and technicians.
- Can we deliver 2 million fuel cells to the customers, and provide maintenance and services? → Yes, but we need to establish the support system and organizations for the services.
- To provide installation and training support skills, we need to develop maintenance technology and skills, together with the market growth. And education and training are needed for the market. The creation of certification for installers is also needed.
- Internet-based control systems and user communication (data monitoring box) can provide the safety and reduce the maintenance burden of local staff.
- We need to summarize and prepare the maintenance manual and materials on the issues and common understandings on the data.

5. Funding

- Funds should be directed to programs and projects, not to each company (units).
- It is needed to prepare risk sharing scheme, with which a company might talk with a bank for R&D loans.

6. Users

- The clarification of added values for consumers is important. The industries can design a system, but still the industry doesn't know how the consumers may use it. And energy consumption patterns really depend on users – the issue of misusing might occur.
- Costs and reliability are the main issues (but different behavior in industrial and residential field.)
- ***IPHE task – spread the message of H2 and FC to users***

Outcome

We are no longer in the stage of research, we have to built up the market. Therefore:

1. Convince government to support technology and market development (tax program)
2. Harmonize RCS
3. Demo programs are welcome
4. IPHE could be a platform to communicate how to get to the customers
5. Reducing costs is up to industry, this could be done via volume
6. IPHE → Convince government to move to more fair energy prices