New μ-CHP network technologies
for energy efficient and sustainable districts

Project co-funded by EC. Grant no 260105.

D10.6.2

Plan for Use and Exploitation of Knowledge generated

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Document history

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Abbreviations

EC - European Commissioner
ESS - Exploitation Strategy Seminar
ETICS - Efficient external thermal insulation system
IPR - Intellectual Property Rights
PUEK - Plan for Use and Exploitation of Knowledge generated
SOFC - Solid Oxide Fuel Cell

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Executive Summary

The overall objective of the FC-DISTRICT project is to optimize and implement an innovative energy production and distribution concept for sustainable and energy efficient refurbished and/or new “energy autonomous” districts exploiting decentralized co-generation coupled with optimized building and district heat storage and distribution network. The goal of the project was achieved and demonstration plant was built in Warsaw, Poland.
Results of the project were specified within this report, each component was described as an independent product as well as a component of the working system. Further exploitation plan was described by the Partners. Market analysis was done in order to introduce developed products to the market.

1. Introduction

This document is the second version of the plan necessary to define use and exploitation of the knowledge generated within the FC-DISTRICT Project (GA 260105), and is relevant for WP 10 (Decision Support – Certification procedures – Business Models – Exploitation Road Map).

Within this report, in order to improve the results in exploitation the players involved in every stage of the generation of the knowledge are defined to clarify their positions and to assign duties and responsibilities for the following exploitation process.
This document contains therefore a brief analysis of the IPR issuing, supporting the definition of each partner competences and duties, providing a short description of benefits expected.
This document basis on agreed with the project coordinator, first version of the PUEK that has been delivered after the ESS held in Genoa at D'Appolonia premises on the 26th of September 2012, in order to provide EC a more complete document integrated also with ESS main results.

1.1. Project description

The concept of the project is based on dynamic heat exchange between the building(s) (fitted with Solid Oxide Fuel Cells – SOFCs, for energy production collaborating with improved thermal storage and insulation building systems), the distribution system (optimized piping and district heating with or without a heat buffer) and the consumer (new business and service models), aiming to achieve energy balance at district level. Advanced insulation materials were developed and implemented for the improvement of building and pipe thermal response. The energy reduction originated from improved efficiency and cost effective high temperature SOFCs, acting as micro heat and power cogeneration (μ-CHP) systems providing demand-flexible electricity and heat to buildings and districts, coupled with optimised energy and power distribution networks that optimally controls heat storage at building and/or district level. Biomass energy generation, implemented through a flexible and distributed system of collection and densification of food wastes, was demonstrated at small scale in order to assess the full scale upgrading into the gas distribution grid.

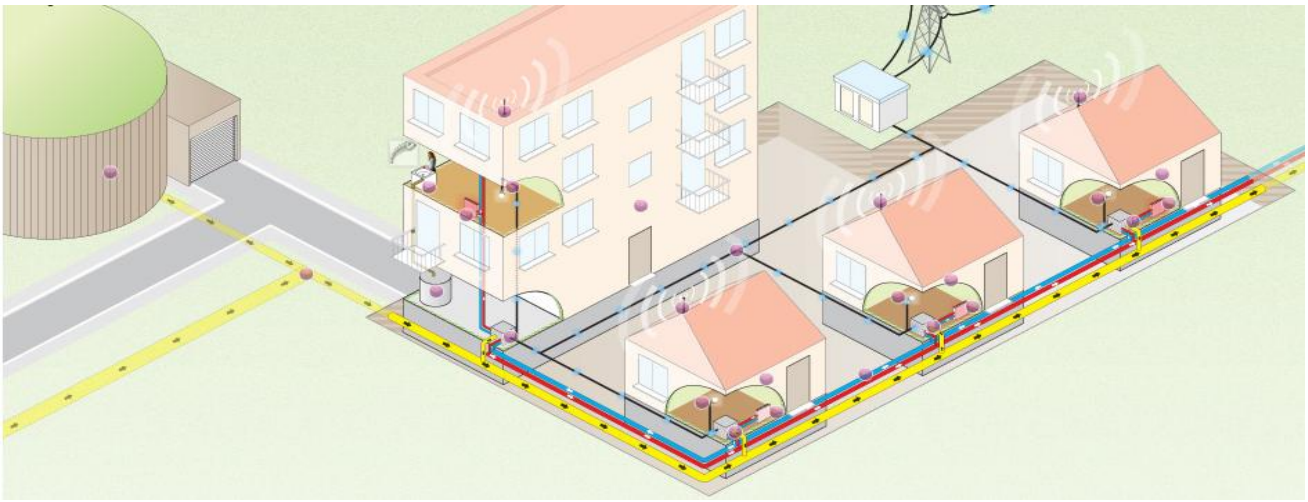

Figure 1 The FC-DISTRICT integration concept

1.2. Consortium description

The consortium is composed by 22 partners from 11 EU-countries: Poland, Germany, Spain, Greece, Italy, Netherlands, Sweden, Portugal, United Kingdom, Belgium and Romania. Seven European industries (Mostostal Warszawa S.A., Acciona Infraestructuras S.A., Knauf Gips KG, Knauf Gypsopiia ABEE, Fagor Electrodomesticos S.Coop.Ltda., D' Appolonia SPA and Powerpipe Systems AB) and four high-tech SMEs (EBZ Entwicklungs- und Vertriebsgesellschaft Brennstoffzelle mbH, RINICOM, Solintel M&P SL, Ecofast Italia Srl) form 60% of the consortium. The integration of energy, heat, nano-manufacturing, materials and building engineering research is achieved via the participation of four of Europe's leading Universities (National Technical University of Athens, TU Bergakademie Freiberg, Chalmers University of Technology, Instituto Superior Tecnico) and six prominent Research Institutions (Institute of Power Engineering, Energy Research Centre of Netherlands, Ikerlan S. Coop., Institute Oskar von Miller SC OVM ICCPET S.A., Sveriges Tekniska Forskningsinstitut AB, Vlaamse Instelling voor Technologisch Onderzoek). Finally, one of the largest European banks (IntesaSanpaolo Eurodesk S.p.r.l.) participates as a partner to develop, examine and verify the viability of business models for exploitation of the FC-DISTRICT concept.

1.3. Funding

FC-DISTRICT project proposal has been prepared for a call opened within Seventh Framework Programme, topic EeB.NMP.2010-2 New technologies for energy efficiency at district level.
Afterwards the proposal has been favourably evaluated by the Commission services with the help of independent experts.
Realization of FC-DISTRICT is co-financed based on grant agreement no. 260105, signed between the project consortium and European Commission.

2. Exploitation Plan

In order to define IPR issues related to the project development, a list of main Items of Innovation (called Exploitable Results), that were developed during the course of the Project, has been arranged. Market analysis was done regarding Product and Service Market Size, Market Trends and Public Acceptance as well as Product and Service Positioning.
The following chart presents a summary overview of the exploitable results. Results one to six are new products while the last result is demonstration plant built within the project duration.

Table 1-1: FC-DISTRICT Exploitable results list.

Exploitable Result	
1	Solid Oxide Fuel Cell μ-CHP unit (SOFC Unit)
2	District heating pipe with improved insulation
3	Food waste collection tank
4	Wireless/hybrid communication network
5	Efficient external thermal insulation system
6	System as a whole
7	System demonstration plant in Warsaw

For each product the following information are presented:

1. Table collecting information regarding the relevant WP, the Exploitation Leader, the date of achievement, and the percentage of achievement of the result;
2. Product description covering:
   - Exploitable foreground description;
   - Relevant Deliverables;
   - Partners involved in the Innovation item development;
   - Owner of the results;
   - Licensors expected.
3. Exploitable Result table giving information about:
   - Innovativeness introduced compared to already existing Products/Services
   - Unique Selling Point (competitive advantages)
   - Product/Service Market Size
   - Market Trends/Public Acceptance
   - Product/Service Positioning
   - Legal or normative or ethical requirements (need for authorisations, compliance to standards, norms, etc.)
   - Competitors
   - Prospects/Customers

- Cost of Implementation (before Exploitation)
- Time to market
- Foreseen Product/Service Price
- Adequateness of internal staff
- Status of IPR: Background (type and partner owner)
- Status of IPR: Foreground (type and partner owner)
- Status of IPR: Exploitation Forms (type and partner owner) e.g. direct industrial use, patenting, technology transfer, license agreement, publications, standards, etc.
- Partner/s involved expectations
- Sources of financing foreseen after the end of the project (venture capital, loans, other grants, etc.)

2.1. SOFC Unit

2.1.1. Product presentation

The result herein presented consists in the development of a SOFC stack integrated within the μ-CHP system.

The realization of the SOFC based μ-CHP units provided demand–flexible electricity and heat at the demonstration sites with the following specifications:

- max. electrical output 1.5 kWel
- max. thermal output 2.75 kWth
- CPOX reforming of Natural Gas
- Electrical connection: 230V, 50Hz
- Inter-connection with a district heat distribution system and an electrical micro-grid potential for tri-generative use (power/heating/cooling) at building level.

Status of advancement of the SOF Unit is presented in the following table.

Table 2-1. FC-DISTRICT Exploitable Result No.1 – status of advancement.

ID No.	Innovation ID	Related WP	Exploitation leader	Date of achievement	Percentage of achievement
1	Solid Oxide Fuel Cell μ-CHP unit (SOFC unit)	WP3	TU-BAF	M30	100%

Table 2-2: Innovation item: SOFC Unit - summary.

SOFC Stack system	
Exploitable foreground	An SOFC based μ-CHO unit for supplying electricity and heat in domestic environment has been developed. The unit operates with natural gas and electricity is generated by the integrated SOFC.
Relevant Deliverables	D3.1.6, D3.1.7
Partners involved / Role	TU-BAF: the major components system provider. Design, construction and experimentally characterization of the CPOX reformer. SUNFIRE: the stack provider IST: parametric simulations of the off-gas burner. ECN: responsibility for the design and optimization of the overall process system, equipment list, preparation of material of construction and size EBZ: responsibility for the manufacturing procedure of the system IKERLAN: development of the control interface FAGOR: responsibility for embedding the micro-CHO in a standardized platform NTUA: contribution to the parametrical studies of the system
Owner of the results	SUNFIRE (to be confirmed)
Licensors expected	-

Figure 2-1: The SOFC based µ-CHP unit

2.1.2. Exploitable Result for SOFC Unit

Innovativeness introduced compared to already existing Products/Services	The FC-DISTRICT system is innovative with its fuel processing and low-cost afterburner design. Combined with the Sunfire stack technology, a competitive µ-CHP prototype is available.
Unique Selling Point (competitive advantages)	SOFC based µCHP systems provide high electrical efficiencies down to electrical powers and are therefore ideal for distributed generation. Low emissions in CO_2, NO_x and other pollutants as well as low noise emissions are smooth selling factors. The unit has an innovative design with its fuel processing and low-cost afterburner.
Product/Service Market Size	A competitive SOFC based power generator for off-grid and µ-CHP applications will allow Sunfire to increase its yearly sales from today 3 Mio. € to 100 Mio € in the years 2018-2020. Two-thirds are planned to be in the area of µCHP and one-third for off-grid power systems.
Market Trends/Public Acceptance	SOFC-based µ-CHP applications are in a field-test phase now. Successful field-tests will be the basis for a further product development. Here, the decrease of costs is currently the critical issue. Therefore, manufactures and component suppliers are working together for industry-wide solutions. A high interest in SOFC technology comes currently from Asian markets like Korea, India, Japan and

	China. Here, distributed power is needed to achieve targets in the decrease of GHG emissions and delivers solutions for unstable electrical grids.
Product/Service Positioning	Sunfire provides SOFC stacks and complete Hotboxes for world-wide customers in different applications like µ-CHP and off-grid. The developed inverter is going to br used in future in projects that will require similar compoenets foe power adoption.
Legal or normative or ethical requirements (need for authorisations, compliance to standards, norms, etc.)	The systems have to meet the applicable standards for fuel cells and in the gas industry.
Competitors	The main competitors are currently Japanese companies with its long-term background in fuel cell systems, CFCL from Australia, the Italian company SOFC-Power and ToSPoe Fuel Cell in Denmark. Since none of these companies has a competitive product for final customers in the market, competition is still low. It is expected that a successful product launch will also positively affect other companies in the same sector.
Prospects/Customers	Sunfire is developing different sales channels: (1) providing stacks and stack modules to system developers. (2) Completing SOFC hotboxes (including stack and process gas modules) are provided to system integrators that complete the unit with ColdBoP equipment and control systems.
Cost of Implementation (before Exploitation)	Off-grid solutions will require investment in R&D as well as machinery in the range of 3-5 Mio. €. For mass-markets like µCHP applications an investment in the range of 15-20 Mio. € will be required to bring down costs of production to competitive prices.
Time to market	A commercialisation of off-grid products is planned to be started in 2014. Here, field tests will show whether the products are robust and durable enough for early markets. The experiences and the higher production volume of these applications will allow entering mass-markets that have higher technical and economic risks. Here, extensive long-term field tests will be therefore required before a product launch can start.
Foreseen Product/Service Price	The market price for off-grid technologies is strongly depending on the application and competing products. It ranges from 10,000 €/kW_{el} down to about 3,000 €/kW_{el}. Stack solutions for µCHP applications require to bring down the costs to 500 … 800 €/kW_{el}. These cost targets are only

	achievable if the complete supply chain, starting from the raw materials, will profit from higher production volumes.
Adequateness of internal staff	SOFC technology requires experienced staff in different fields like material sciences, process engineering, construction, electronics and controls. It is very difficult to find adequate staff in the market. Sunfire is therefore reliant on internal development of young engineers, scientists and technicians.
External Partners to be involved	Sunfire works together with different partners world-wide. The main partner and customer is currently Vaillant, one of the market leaders in the heating sector in Europe.
Status of IPR: Background (type and partner owner)	
Status of IPR: Foreground (type and partner owner)	
Status of IPR: Exploitation Forms (type and partner owner) e.g. direct industrial use, patenting, technology transfer, license agreement, publications, standards, etc.	The TUBAF has already filed a patent for the developed Offgas burner.
Which partner contributes to what (main contributions in terms of knowhow, patents, etc.)	-
Partner/s involved expectations	-
Sources of financing foreseen after the end of the project (venture capital, loans, other grants, etc.)	After the end of the project, Sunfire will work mainly with capital from Venture investments, turnover from commercial products and public funding for its R&D expenditure.

2.1.3. Market analysis

Many market potential studies have been produced in the past, both for generic μ-CHP system and for the particular case of Fuel Cell based μ-CHP systems. The discrepancies between them are remarkable and some of them are included as reference. Figure 1.1 shows a comparison between different forecasts for future cumulative fuel cell capacity in Europe and Germany according to estimations made by United Nations Energy Programme (UNEP), Frost & Sullivan consulting firm, and German companies Vaillant, RWE and E.On.

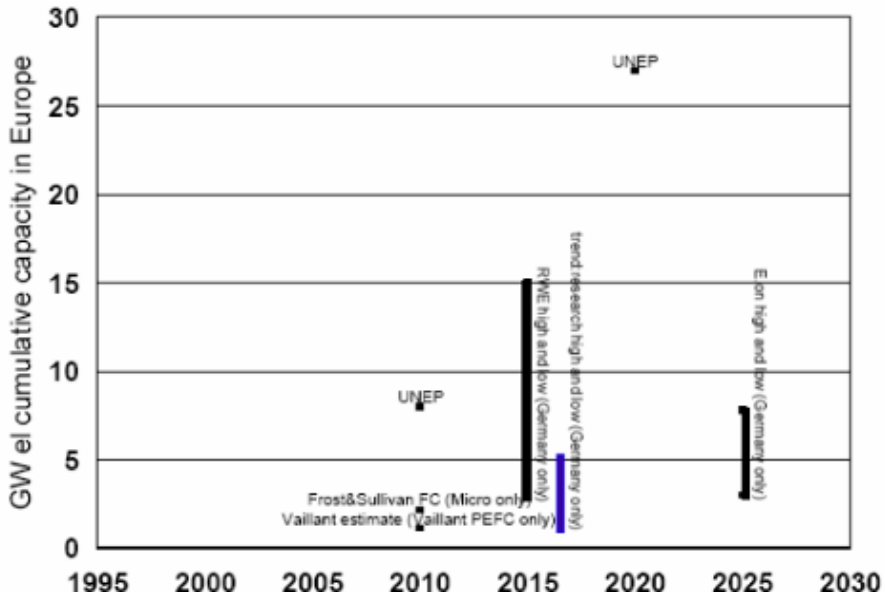

Figure 1.1 Forecasts for future cumulative fuel cell capacity in Europe and Germany according to some estimates

Technical potential market and payback period estimations

The following results are included in the 2011 report "Opportunities for Solid Oxide Fuel Cell Applications" made by Delta Energy & Environment Ltd.

UK and Germany were chosen for this study because (also with Netherlands) they were identified as the key markets through to 2015, considering Belgium, Spain, Italy and possibly France following.

		European Union	Netherlands	Germany	United Kingdom
Boiler market (units / yr)		6-8 million	0.4 million	0.6 million	1.6 million
Key constraints / barriers		Low thermal demand in southern Europe. District heating in Scandinavia / Eastern Europe. Elec. heating / renewable heating	Cheap boilers, mainly combi, installed in attic	Combi has significant market share	Combis, boilers in living space, low quality installers
Policy	Current policy & regulation	Current Directives (CHP Directive, Energy Services Directive, Energy in Buildings Directive) put micro-CHP on the agenda, remove some barriers, but do very little to oblige Member States to drive the market.	€4,000 subsidy was agreed until Nov'11. However, only €4 million of the €10 million originally granted may now be released. Net metering still available.	Exemption on Ecotax on fuel, bonus price on all CHP electricity (5.11c), Renewable Heat Law, Callux Programme. Installation subsidy was ended in 2010 and still unknown if could be re-introduced this year.	Micro-CHP exempt from VAT, bonus price of 10p (12c). Bonus price part of wider FiT (feed-in tariff) package, m-CHP very nearly left out of FiTs.
Delta View	Forward view	Energy efficiency is high on the EU agenda – new Energy Efficiency Directive proposal. 'Hard' 2020 energy efficiency targets are a possibility in 2013. If so, they will drive the wider energy efficiency sector, in which micro-CHP competes.	Uncertainty over future of subsidy post 2011. Government has less aggressive low carbon energy policy, new nuclear, 'belief' in micro-CHP not strong.	Strong 25% cogen target (for all electricity produced). End of 2010, energy policy was looking weak on fossil fuel. Recent announcements on nuclear may bring focus back on cogeneration again.	Government talks a good decentralised energy game, but confidence in micro-CHP is weak / fragile, FiT only for 30,000 units or until 2013. A new focus on cost effective carbon savings for FiT is an encouraging sign.
	Today	★★★☆☆	★★★★☆	★★★☆☆	★★★☆☆
	2013-2015	★★★★☆	★★★☆☆	★★★★☆	★★★☆☆

★ = Very Poor Outlook ★★ = Poor Outlook ★★★ = Moderate Outlook ★★★★ = Good Outlook ★★★★★ = Excellent Outlook

Figure 3.1 Market barriers and policies in key EU market

Fuel cell value chain breakdown

The numbers provided are Delta's best view on the 'typical' or average prices and costs for each element of the value chain, and they were used in the modelling. These were collected from conversations with suppliers and industry experts. Delta believes that these figures were conservative as confirmed by its sources.

Fuel cell (1kWe, 1.5 kWth FC + balance of plant + inverter) value chain breakdown for the **UK**:

	2011 - 2013	2014 – 2016	2017 – 2020
Fuel cell module manufacturer selling price (€)	15,000	13,000	9,000
Distributor selling price for fuel cell module (€)	17,250	15,000	10,350
Customer price for fuel cell module (€)	18,100	15,750	10,850
Customer price for the boiler 20 kWth (€)	1,090	1,090	1,090
Customer price for hot water storage tank(€)	1,600	1,380	1,150
Installation cost (€)	3,000	2,000	1,500
Fully installed price (€)	23,790	20,220	14,590

Fuel cell (1kWe, 1.5 kWth FC + balance of plant + inverter) value chain breakdown for **Germany**:

	2011 - 2013	2014 - 2016	2017 – 2020
Fuel cell module manufacturer selling price (€)	17,000	14,500	10,000
Distributor selling price for fuel cell module (€)	20,400	17,400	12,000
Customer price for fuel cell module (€)	24,500	20,900	14,500
Customer price for boiler 20 kWth (€)	2,600	2,600	2,600
Customer price for hot water storage tank (€)	2,000	1,750	1,500
Installation cost (€)	5,000	4,000	3,000
Fully installed price (€)	34,100	29,250	21,600

Source: Delta, 2011

Figure 3.2 Fuel cell value chain breakdown for UK and Germany

UK market - Payback period

Delta used the calculated technology payback periods of fuel cell μ-CHP to inform its view on the anticipated market penetration of fuel cells in UK.

They generated these payback curves by:

- Using its experience of UK heating market evolution in the last 10 years, particularly of condensing boiler introduction in the UK
- Analysis of heat pump uptake in the UK
- Testing these curves with heating industry experts in the UK

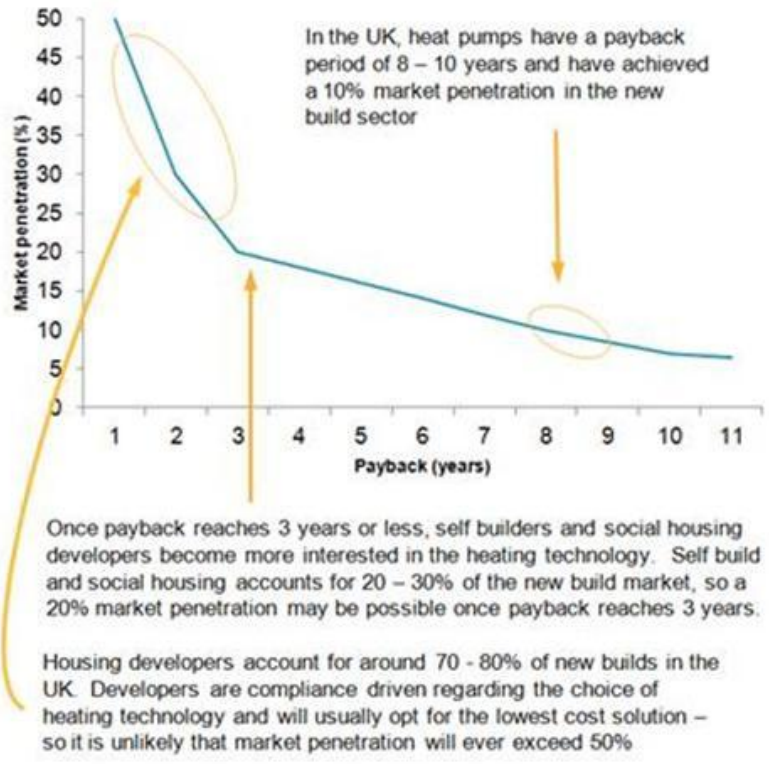

Figure 3.3 Anticipated market penetration of fuel cells versus payback curve for the new build market in the UK

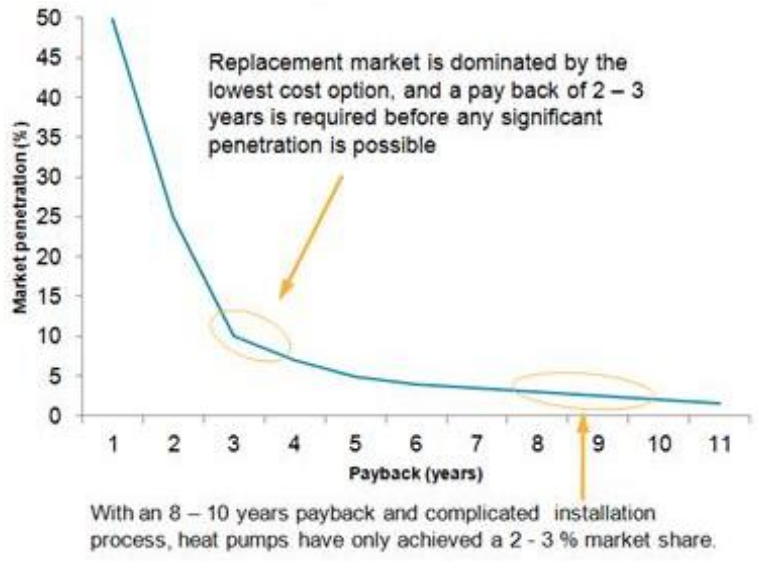

Figure 3.4 Anticipated market penetration of fuel cells versus payback curve for the replacement market in the UK

UK market -New build market

UK represents a potential addressable market in the new build sector.

Suitable homes were considered those with:

- Hot water storage tanks (around 50 – 60% of all new build installations are with a hot water tank)
- A natural gas supply (85 – 90 % of all new builds)
- Sufficient space for a fuel cell unit (30 – 40% of all homes in the UK)
- Maximum addressable market = 30,000 – 40,000 installations per year

Heating system	Installations/yr
Wall hung gas (WHG) boiler (combi)	50,000
WHG boiler (non combi)	48,500
WHG boiler (non combi) with solar thermal	4,000
Floor standing gas boiler	5,000
Heat pump (on gas)	1,400
Heat pump (off gas)	11,500
Oil boiler	1,000
Other (solid, LPG)	5,000
Total	126,400

	2011 - 2013	2014 - 2016	2017 - 2020
Baseline technology	Gas boiler	Gas boiler	Gas boiler plus solar PV
Fully installed price of baseline technology (£)	3,023	3,023	8,423
Fully installed price for fuel cell system (£)	20,687	17,583	12,687
VAT benefit on fuel cell price (15% saving)	3,103	2,637	1,903
Marginal price for fuel cell, with VAT benefit	14,561	11,923	2,361
Net benefit from fuel cell (£ / yr)[1]	628	647	267
Payback (years)	25	20.2	13.2
Market penetration (%)	< 1	< 1	5 – 10
Anticipated sales of fuel cell mCHP per year	Few 10s	Few 100	Few 1,000

1) Net benefit per year = (electricity savings due to fuel cell + financial incentives for fuel cell mCHP) – (marginal running cost + marginal maintenance cost + financial incentives for solar PV).

Figure 3.5 Anticipated market potential for the new build segment in the UK

UK market- Replacement market

UK also represents a potential addressable market in the replacement sector.
Suitable homes are considered those with:

- Hot water storage tanks (around 20 – 30% of replacement market installations are with a hot water tank)
- A natural gas supply (90 – 95% of replacement market)
- Sufficient space for a fuel cell unit (30 – 40% of all homes in the UK)
- Maximum addressable market = 200,000 – 300,000 installations per year

Heating system	Installations/yr
WHG boiler (combi)	1,000,000
WHG boiler (non combi)	333,500
WHG boiler (non combi) with solar thermal	4,000
Floor standing gas boiler	45,000
Heat pump (on gas)	200
Heat pump (off gas)	2,900
Oil boiler	64,000
Other (solid, LPG)	44,000
Total	1,493,600

	2011 – 2013	2014 - 2016	2017 - 2020
Baseline technology	Gas boiler	Gas boiler	Gas boiler
Fully installed price of baseline technology (£)	1,850	1,850	1,850
Fully installed price for fuel cell system (£)	20,687	17,583	12,687
VAT benefit on fuel cell price (15% saving)	3,103	2,637	1,903
Marginal price for fuel cell, with VAT benefit	15,734	13,096	8,934
Net benefit from fuel cell (£ / yr)[1]	628	647	679
Payback (years)	25	20.2	13.1
Market penetration (%)	< 1	< 1	~1
Anticipated sales of fuel cell mCHP per year	Few 10s	Few 100	Few 1,000

1) Net benefit per year = (electricity savings due to fuel cell + financial incentives for fuel cell mCHP) – (marginal running cost + marginal maintenance cost).

Figure 3.6 Anticipated market potential for the replacement segment in the UK

UK market -Forecasted Market Size for Fuel Cell µ-CHP in the UK

	2011 - 2013	2014 – 2016	2017 – 2020
Sales per year in new build market	Few 10s	Few 100	Few 1,000
Sales per year in the replacement market	Few 10s	Few 100	Few 1,000 +
Total sales per year	Several 10s	Several 100	~6,000 – 8,000

Key for the table	
~	approximately
Few	3 – 4
Several	5 - 10

+ Upside potential to low 10,000s per year due to the UK Green Deal financing fuel cell micro-CHP in return for annual payments from the customer, and if energy companies lease fuel cell systems to residential customers.

Figure 3.7 UK market forecast for fuel cell µ-CHP

German market- Payback period

Delta used the calculated technology payback periods of fuel cell µ-CHP to inform its view on the anticipated market penetration of fuel cells in Germany.

They generated these payback curves by:

- Using its experience, and Frey & Scholer's experience of German heating market evolution in the last 10 years
- Analysis of heat pump uptake and of the transition from non-condensing to condensing boilers in Germany
- Testing these curves with heating industry experts in Germany

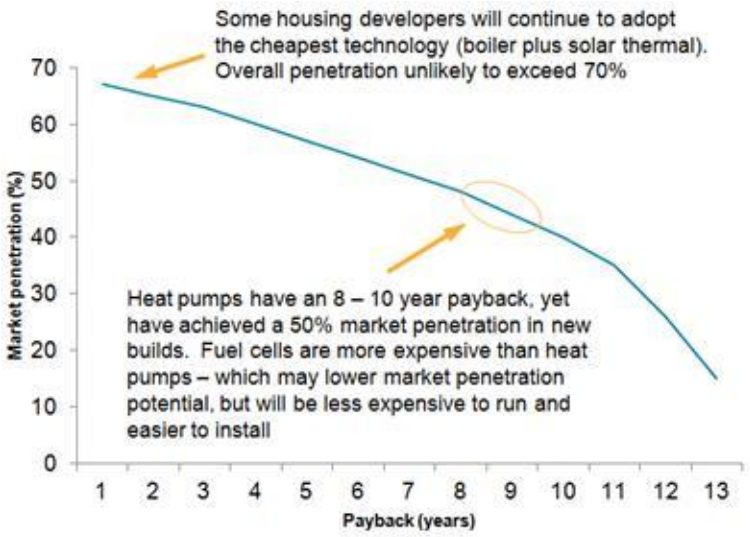

Figure 3.8 Anticipated market penetration of fuel cells versus payback curve for the new build market in Germany

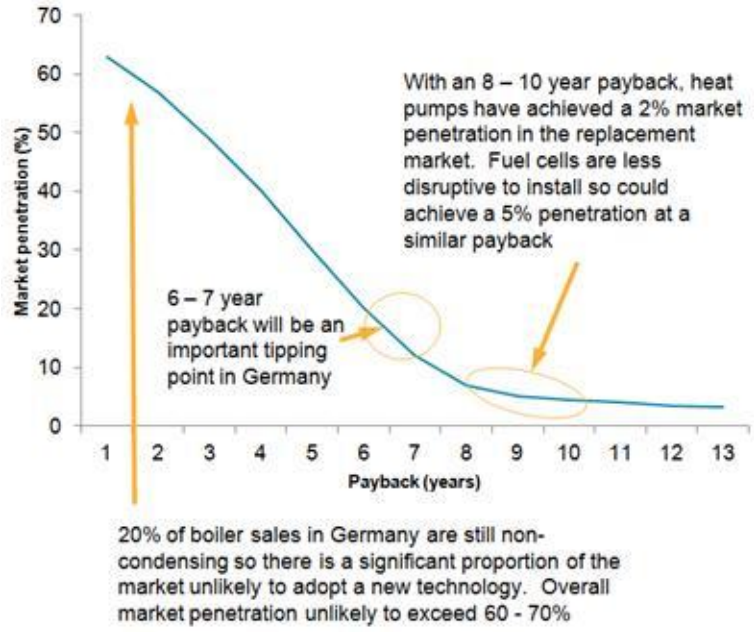

Figure 3.9 Anticipated market penetration of fuel cells versus payback curve for the replacement market in Germany

German market- New build market

Germany represents a potential addressable market in the new build sector.

Suitable homes are considered those with:

- Hot water storage tanks (90 – 100% of all new builds)
- A natural gas supply (40 – 50% of all new builds)
- Sufficient space (basement / utility room) and heat demand for a fuel cell unit (60 – 70% of domestic buildings)
- Maximum addressable market = 30,000 – 50,000 installations per year

Heating system	Inst / yr
WHG boiler (combi, condensing)	0
WHG boiler (non combi, condensing)	0
WHG boiler (non combi, non condensing)	0
WHG boiler (non combi, condensing) with solar thermal	40,000
Floor standing gas boiler	0
Heat pump	20,000
Heat pump with solar thermal	30,000
Other (solid, LPG)	10,000
Micro CHP	500
Total	100,500

	2011 - 2013	2014 - 2016	2017 - 2020
Baseline technology	Gas boiler with solar th.	Gas boiler with solar th.	Gas boiler with solar th.
Fully installed price of baseline technology (€)	8,500	10,000	11,500
Fully installed price for fuel cell system (€)	34,100	29,250	21,600
Upfront subsidy available (€)	0	5,000	3,000
Marginal price for installed fuel cell system (€)	25,600	14,250	7,100
Net benefit from fuel cell (€ / yr)[1]	596	565	491
Payback (years)	42.9	25.2	14.5
Market penetration (%)	< 1	Few %	10 – 20
Anticipated sales of fuel cell mCHP per year	~100	~1,000	Several 000s

1) Net benefit per year = (electricity savings due to fuel cell + financial incentives for fuel cell mCHP + ecotax saving) – (marginal running cost + marginal maintenance cost).

Figure 3.10 Anticipated market potential for the new build segment in Germany

German market- Replacement market

Germany also can be considered a potential addressable market in the replacement sector. Suitable homes are considered those with:

- Hot water storage tanks (70 – 80% of replacement market)
- A natural gas supply (70 – 80% of replacement market)
- Sufficient space (basement / utility room) and heat demand for a fuel cell unit - 60 – 70% of domestic buildings
- Maximum addressable market = 200,000 – 300,000 installations per year

Heating system	Inst / yr
WHG boiler (combi, condensing)	35,000
WHG boiler (non combi, condensing)	200,000
WHG boiler (non combi, non condensing)	100,000
WHG boiler (non combi, condensing) with solar thermal	25,000
Floor standing gas boiler	35,000
Heat pump	10,000
Oil boiler	100,000
Other (solid, LPG)	20,000
Micro CHP	2,500
Total	527,500

	2011 - 2013	2014 - 2016	2017 - 2020
Baseline technology	Gas boiler	Gas boiler	Gas boiler with solar th
Fully installed price of baseline technology (€)	4,400	4,400	8,500
Fully installed price for fuel cell system (€)	34,100	29,250	21,600
Upfront subsidy for micro CHP(€)	0	5,000	3,000
Upfront subsidy for solar thermal in replacement market (€)	0	0	720
Marginal price for installed fuel cell system (€)	29,700	19,850	10,820
Net benefit from fuel cell (€ / yr) [1]	736	895	559
Payback (years)	40.3	22.2	19.3
Market penetration (%)	< 1	~ 1	Few %
Anticipated sales of fuel cell mCHP per year	Several 100	Few 000s	~10,000

1) Net benefit per year = (electricity savings due to fuel cell + financial incentives for fuel cell mCHP + ecotax saving) – (marginal running cost + marginal maintenance cost).

Figure 3.11 Anticipated market potential for the replacement segment in Germany

Forecasted Market Size for Fuel Cell µ-CHP in Germany

	2011 - 2013	2014 – 2016	2017 – 2020
Sales per year in new build market	~100	~1,000	Several 1,000s ++
Sales per year in the replacement market	Several 100	Few 1,000	~10,000 +++
Total sales per year	500 – 1,000	~5,000	10,000 – 20,000

Key for the table	
~	approximately
Low	1 – 2
Few	3 – 4
Several	5 – 10

++ This assumes strong policy is in place for low carbon heating in general and fuel cell micro-CHP in particular – realistic in our view but not certain.
+++ This assumes strong policy is in place for low carbon heating in general and fuel cell micro-CHP in particular – realistic in our view but not certain. Upside potential to several 10,000s due to ease of retrofitting compared to solar thermal.

Figure 3.12 German market forecast for fuel cell µ-CHP

2.2. District heating pipe with improved insulation

2.2.1. Product presentation

The result presented here consists of the development of The Innovative Pipes.

The New Innovative Pipes are based on the combination of either vacuum insulation panels or blankets with aerogels and polyurethane. Preliminary studies showed good performances of the novel products both from the mechanical point of view (adhesion, compressive strength) and from the thermal point of view (the thermal conductivity of the panel is 0.008-0.011 W/m K (depending on dimensions) and the blanket is around 0.017 W/m K). In the market exploitation a payback period of less than 10 years for customers with high energy prices is considered.

The use of twin pipe assemblies instead of single pipes reduces the heat losses with 35-40%. The use of panels on the flow pipe reduces the losses further by about 25%.The insulation capability of the district heating pipes with the twin pipe assembly has been improved. The loss from the flow pipe is reduced by about 40%, when vacuum insulation panels are introduced around the flow pipe in twin pipes of Series 1 for services pipe dimensions less than DN80. The total loss from the flow and return pipes is reduced by about 25%.

Status of advancement of the district heating pipes is presented in the following tables.

Table 2-3. FC-DISTRICT Exploitable Result No.2 - status of advancement.

ID No.	Innovation ID	Related WP	Exploitation leader	Date of achievement	Percentage of achievement
2	District heating pipe with improved insulation	WP6	PS	M42	100%

Table 2-4: Innovation item: District heating pipe with improved insulation - summary.

Innovative Pipes	
Exploitable foreground	New product using vacuum insulation panels in district heating systems where the service temperature is maximum 90˚C. New product using nanoporous blanket in district heating systems where the service temperature is maximum 140˚C. For other industrial purposes the blanket can be used up to 200°C.
Relevant Deliverables	D6.1.1, D6.1.2, D6.1.3, D6.1.4, D6.2.1, D6.2.2, D6.3, D6.5
Partners / Role	PS developed the new pipe concept and the production process and also did some testing CUT has carried out inventory material analyses, and will provide performance evaluations and carry out thermal testing SP defined requirements and test methods, and also carried out mechanical testing DAPP has carried out inventory material analyses
Owner of the results	PS
Licensors expected	No one so far

Figure 2-2: Picture showing a finalized pre-insulated pipe with vacuum insulation panels.

2.2.2. Exploitable Result for District heating pipe with improved insulation

Innovativeness introduced compared to already existing Products/Services	Advanced high performance insulation materials are used in a hybrid district heating pipe. A portion of the traditional insulation material (polyurethane) in a pre-insulated district heating pipe is replaced with advanced high efficient vacuum insulation panels or nanoporous blankets with extremely low thermal conductivity. To meet the requirements of adhesion between the service pipe and the casing pipe it has been chosen to install the panel/blanket in a twin pipe design, where the flow pipe, with the highest temperature is surrounded with high efficient vacuum insulation panels. The new product using vacuum insulation panels can be used in district heating systems where the service temperature is maximum 90˚C. The new product using nanoporous blanket can be used in district heating systems where the service temperature is maximum 140˚C and for industrial purpose up to 200°C
Unique Selling Point (competitive advantages)	The improved insulation decreases the heat losses in the district heating distribution system. The magnitude of improvement in terms of losses from the flow pipe compared to the state of art (with single pipes) is 60-70%. Traditional pipes can meet this improvement by increasing the thickness of the traditional insulation (polyurethane) significantly.
Product/Service Market Size	The economic advantages are higher for small dimensions below DN150. The total length of the installed district heating pipe net in Europe is (excl. Russia) about 100 000 km. The annual installation is estimated to be 5 000 km and at least 20% of that length has small dimensions below DN100.

	This means that the potential market is annually 1 000 km pipe corresponding to the value 10 million Euros. For operating temperatures below 90˚C, a hybrid district heating pipe with vacuum insulation panels can be used, and in the span up to 140˚C the panels can be replaced with nanoporous blankets.
Market Trends/Public Acceptance	The district heating market in central Europe is expected to increase in the coming years. For economic and environmental reasons, it is important to minimize energy losses.
Product/Service Positioning	First, PS will focus on the Danish market (operating temperature below 90˚C and relatively high energy prices), since, beside the economic considerations, there is a public demand to reduce the annual energy consumption with 2%. Second the Swedish and Norwegian markets (for 120˚C systems), where PS is very active today.
Legal or normative or ethical requirements (need for authorisations, compliance to standards, norms, etc.)	There is a European standard for pre-insulated pipes – EN 253 and for twin pipes EN15698-1. All functional requirements in this standard should be fulfilled by the new product in order to convince a conservative market.
Competitors	There are many competitors, local and multinational, producing pre-insulated pipes for the European market, e. g., Logstor A/S, Isoplus AG, Brugg Pipe Systems, and KWH OY.
Prospects/Customers	Public or private energy companies, which are responsible for distribution of the district heating.
Cost of Implementation (before Exploitation)	Investment costs in production lines and other initial costs are estimated to 700 000 – 1 000 000 Euros.
Time to market	The product has been introduced on the Danish market 2014. ~20 Danish potential customers have been informed about the new pipe possibility and the first two commercial orders have been taken of pre-insulated pipes with vacuum insulation panels. If a competitive price of the enhanced hybrid district heating pipes can be set, based on implementation and production costs, which so far remain to be fully investigated, and if the test installations continue to work as expected PS expects also to sell pipes on the Swedish market in the near future.

Foreseen Product/Service Price	The product price for the hybrid insulated pipe is increased in the range 40-75%. The pay-off time for a customer is normally more than 10-years and up to 20 years depending on the price of energy. The argument is that the technical life time is at least more than 70 years and the energy prices will not be lower in the future. The price has to be set for compensating for costs of the high efficient insulation materials and additional production costs for adapting these materials for use in district heating pipes.
Adequateness of internal staff	PS cannot foresee any problems related to this.
External Partners to be involved	Sales partners on new markets for PS can be needed.
Status of IPR: Background (type and partner owner)	No rights have been taken into the project related to the hybrid district heating pipe
Status of IPR: Foreground (type and partner owner)	PS has not so far applied for patents on the final product. PS will rely on confidentially of partners and staff during the development phase. The production process can be easier to protect than the final product.
Status of IPR: Exploitation Forms (type and partner owner) e.g. direct industrial use, patenting, technology transfer, license agreement, publications, standards, etc.	-
Which partner contributes to what (main contributions in terms of knowhow, patents, etc.)	PS has developed the new pipe concept and the production process and also done some testing CUT has carried out inventory material analyses, and has provided performance evaluations and carried out thermal testing SP has defined requirements and test methods and also carried out mechanical testing DAPP has carried out inventory material analyses
Partner/s involved expectations	
Sources of financing foreseen after the end of the project (venture capital, loans, other grants, etc.)	Loans

2.2.3 Market analysis

Temperature limit

Calculations have shown that only hybrid insulated twin pipes with vacuum insulation panels are for the moment possible to give reasonably low pay off times. This depends on that the blanket has about the same price level as the panel but is not as thermally efficient as the panel.

Tests have shown that the panel can be used in system with temperatures up to 114°C but not up to 120(140)°C. So far, we know that only a small change in heat transfer can be noticed after ~10.000 hours with a continuous temperature of 114°C. With a test temperature of 125°C the panels were broken after one week.

Conclusion 1: The pipes can only be used in systems with normal temperature of maximum 100° with short peaks up to 110°C.

Physical properties

The physical properties (as adhesion, compressive strength) of the new product are measured to fulfil the functional demands in EN253:2009.

Conclusion 2: The new pipes are compatible with standard pre-insulated pipes following the functional demands in the standard EN253:2009.

Economical limits

Calculation of pay-off times for different energy prices, see below, shows that the customer have to use relatively high energy prices to get a reasonable pay-off time.
Table 2-5 showing the pay-off time at different energy prices.

	Standard double pipes		Double pipes with panel		Energy savings	Cost increase	Pay off time at different energy prices		
	Heat losses		Heat losses				0,05 Euro/kWh	0,07 Euro/kWh	0,09 Euro/kWh
	W/m	kWh/m*year	W/m	kWh/m*year	kWh/m*year	Euro/m	Years	Years	Years
DN2*25/140	10,3	90,2	8,1	71,0	19,3	23,7	24,6	17,6	13,7
DN2*40/160	17,1	149,8	12,8	112,1	37,7	28,6	15,2	10,8	8,4
DN2*80/250	23,2	203,2	17,3	151,5	51,7	35	13,5	9,7	7,5
DN2*150/450	25,1	219,9	19,7	172,6	47,3	44	18,6	13,3	10,3

The benefit that the supply temperature in remote areas of the heating network can be maintained at an acceptable high level is not included in these calculations.

The pay-off time can be compared to a practical life time of the pipes of 70 years or more. Increasing energy prices have also to be considered. The figures in Table 2-5 will change in the positive direction, when it is possible to decrease the price level of the new product.

Conclusion 3: The pipes are most competitive at energy prices over 0.05 Euro/kWh.

Restrictions during transportation of the pipes and installation

There are no specific restrictions during transportation and installation of the new pipes compared to standard pre-insulated pipes.

Conclusion 4: The costs for installation of the new pipes are the same as for standard pre-insulated pipes.

Market conclusion

The advantage of the new pre-insulated pipes with vacuum insulation panels can be seen for twin pipes, which are used in the outskirts of larger district heating networks or in smaller networks and where the heat demand is lower.

After an examination of different markets in north Europe we have found that the Danish market can accept the limits described above. Furthermore, there is a public demand to reduce the annual energy losses in the distribution networks with 2%.

Marketing in **Denmark** is the first step. About 25 different customers have been approached personally. Two orders have been received so far.

The second step is to attack the **Swedish** and **Norwegian** markets. The product will be shown at the District Heating Exhibition in September/October in Sweden.

2.3 Food waste collection tank

2.3.1 Product presentation

The result herein presented consists in the development of a settling and filtering tank provided with its own monitoring system.
The overall result consists in the achievement of two sub-results, there are in fact, different aspects of novelty in the innovation developed, that involve the tank and its levels monitoring system.
Status of advancement of the food waste collection tank is presented in the following table.

Table 2-5. FC-DISTRICT Exploitable Result No.3 - status of advancement.

ID No.	Innovation ID	Related WP	Exploitation leader	Date of achievement	Percentage of achievement
3	Food waste collection tank	WP4	ECOFAST	M9,M16	100% the tank is ready for the market but still work is needed to optimize the level metering system

Table 2-6: Innovation item: Food waste collection tank- summary.

Tank	
Exploitable foreground	The result herein presented consists in the development of a settling and filtering tank provided with its own monitoring system. The tank is used coupled with installed FWDs for food waste collection. This innovative solution for the waste management has never been applied before. It allows the collection of the highest quality material for biogas production in an easy way, and with no impurities that could affect the anaerobic digestion process efficiency
Relevant Deliverables	D4.2 and D4.3
Partners / Role	DAPP responsibility for conceptual design, material analysis, technology scouting and intelligence analysis, Design of Experiment preparation ECOFAST: responsibility for tank design and prototyping
Owner of the results	ECOFAST (to be confirmed)
Licensors expected	-

Figure 2-3: Tank prototype & level metering system (pictures taken during the Consortium DEMO visit held at Ecofast premises on the 28th September 2012).

2.2.3. Exploitable Result for Food waste collection tank

Innovativeness introduced compared to already existing Products/Services	The result herein presented allows the collection of the highest quality material for biogas production in an easy way, and with no impurities that could affect the anaerobic digestion process efficiency. This solution helps to assist citizens in the separate waste collection, to assist the Waste Management companies in collecting waste with lower frequency and to provide Anaerobic treatment enhancing the biogas production. The result promotes the development of completely novel method for organic kitchen waste collection that has never been implemented before.
Unique Selling Point (competitive advantages)	Citizens could be encouraged in installing this product because it solves the problem of having plastic bins in the kitchen and bins on the roads avoiding therefore any problem of bad odours, and insects proliferation. Citizens can be also more conscious of their role in the reuse of the food waste.

Product/Service Market Size	The market potential is huge and it depends on the attitude of the MSW (Municipal Solid Waste) companies and Waste Water Companies in view of their attitude in promoting a technology that interfere with their standard activity. If we look to the North American market the use of disposers/ macerators has a market penetration of 55% with an estimated total number of domestic disposer of 110millions of units. According to the Korean Ecofast distributor "If we could assume that 1/10 of units can be reached in the due time, we can say that 18,000 STT can be sold in the next coming years in the Korean market" that means an increase in Ecofast turnover of several million €.
Market Trends/Public Acceptance	This solution could be exploited in the market of waste management. The tank developed is ready for the market: it could be sold to waste water/ waste management companies. The market is still a niche market but with high potentialities of growing. Market perspectives and opportunities have been presented in Deliverable D10.3.3.
Product/Service Positioning	The product/service can be considered a mass market being a solution for all communities problem.
Legal or normative or ethical requirements (need for authorisations, compliance to standards, norms, etc.)	The tank system represents a solution to overcome existing technical and non technical barriers affecting the use of the waste disposers, mainly related to sewerage system. Each country has its own norms, standards and requires specific authorisation. The tank system has been realized to maximize the reuse of the food waste to biogas; the residual limited mass (mainly rbCOD) doesn't represent a risk of sedimentation nor clockage for the sewage system. Generally speaking the attention paid to the KFW separated collection is growing all around the World since the last 3-4 years The model proposed by STT technology within FC-DISTRICT project is an innovating solution on this scenario and it is targeted to increase the exploitation of the KFW recycling because it collect an higher quantity of organic substrate in comparison with the alternative solution like the dewaterers.
Competitors	The tank system is an innovative solution; competitors can be considered: • Municipal collecting systems separating the food waste with sorting process in a centralised facility • Food waste disposers installed in the sinks of the single kitchen diverting the flow to the sewerage network. The disposers manufactures are large multinational

	companies (ISE a division of Emerson Electric Company, GE and few manufacturers from Far East) • Food waste disposers combined with standard tanks collecting all the flow diverted from the machines. This technology is used in some areas of central-north Europe and it is applied typically for professional kitchens waste collection
Prospects/Customers	Tank system can be purchased by: • The families living in the same multi apartments buildings provided there is an incentive or an obligation set by the local authority • A MSW or Waste Water Company or more generally any entity dealing with the food waste collection and reuse • In a future scenario an Energy Company which is attracted by the possibility to produce renewable energy (biogas) at “zero Km” .This technology, coupled with district anaerobic digesters, allows, in fact, the collection, the processing and biogas production in the same district where the waste is generated.
Cost of Implementation (before Exploitation)	Further investments can be foreseen in terms of system tank installations. The main problem in developing new technologies related to waste treatment is the testing phase due to the limitations in the handling of adequate quantities of material because of legal issues. A real field test is necessary for validating the model.
Time to market	Once an adequate field test will be performed the tank system can be considered ready for the market. A six months period should be enough, so that 1 year time to market can be considered realistic considering possible feedback from the test.
Foreseen Product/Service Price	10.000-15.000€ at this early stage while lower prices are expected if the technology penetrates significantly the market of food waste collection and treatment. According to the scenario study carried out and reported in D4.6 once the tank will be put on the market it is expected that thousands of units will be sold and the price is expected to significantly diminish and the costs for implementing the FC-DISTRICT model will be reduced as well.
Adequateness of internal staff	Complete
External Partners to be involved	None
Status of IPR: Background (type and partner owner)	IND: D’Appolonia SME: ECOFAST
Status of IPR: Foreground (type and partner owner)	SME: ECOFAST
Status of IPR: Exploitation Forms (type and partner owner)	Patent and license agreement are all acceptable forms to exploit the new technology

e.g. direct industrial use, patenting, technology transfer, license agreement, publications, standards, etc.	
Which partner contributes to what (main contributions in terms of knowhow, patents, etc.)	D'Appolonia for design of experiments, testing, results dissemination. Ecofast for the technologies in shredding, filtering and density device control
Partner/s involved expectations	D'Appolonia: consolidate its role as engineering services company in the field of innovative environmental solutions Ecofast: address a new market in the field of environmental technologies
Sources of financing foreseen after the end of the project (venture capital, loans, other grants, etc.)	Venture capital is considered the most appropriate form to support further development of this technology

2.2.4. Market analysis

The amount of food thrown away is a waste of resources. The increasing urbanisation of the world population could lead to a doubling in the volume of Municipal Solid Waste (MSW) created annually by 2025, according to the research conducted by the World Watch Institute[1] (2012) - an independent research organisation dedicated to global environmental concerns. The report has shown that although some of this waste is recycled, the doubling of waste that current projections indicate would bring the volume of MSW to 2.6 billion tonnes per year - challenging environmental and public health management in the world's cities.

MSW tends to be generated in much higher quantities in wealthier regions of the world. Members of the Organisation for Economic Co-operation and Development (OECD), a group of 34 industrialised nations, lead the world in MSW generation, at nearly 1.6 million tonnes per day. By contrast, the report found that sub-Saharan Africa produces less than one eighth as much, some 200,000 tonnes per day.

However, the list of top 10 MSW producing countries includes four developing nations (Brazil, China, India, and Mexico) in part because of the size of their urban populations and in part because their city dwellers are prospering and adopting high-consumption lifestyles.

Unsurprisingly the U.S. leads the world in MSW output at some 621,000 tonnes per day, China is a relatively close second, at some 521,000 tonnes. Even among the top 10, however, there is a wide range of output, with the U.S. generating nearly seven times more urban refuse than France, in tenth position, does.

According to World Watch, urbanisation and income levels also tend to determine the type of waste generated. The share of inorganic materials in the waste stream, including plastics, paper, and aluminium, tends to increase as people grow wealthier and move to cities.

By contrast, the waste flows in rural areas are characterised by a high share of organic matter, ranging from 40% to 85%. **Similarly, organic waste accounts for more than 60% of MSW in low-income countries, and a quarter of the waste stream in high-income countries.**

The growing interest in MSW recovery is being primarily driven by the maturing of both regulations of markets for post-consumer materials. Additional statistics from the UN Environment Programme

[1] http://www.worldwatch.org/global-municipal-solid-waste-continues-grow (2012).

(UNEP) estimate the market for waste management, from collection through recycling, to be some $400 billion worldwide.

However, the UNEP also estimates that to 'green' the waste sector would require, among other things, a 350% increase in the recycling of MSW at the global level, including nearly complete recovery of all organic material through composting or conversion to energy.

Furthermore, the recycling rate is projected to roughly double over the same period and total material sent to landfill will likely decrease to about a fifth of the 1990 level by 2015. Evidences of this growing care towards the Organic Waste recycling, and in particular of the kitchen food waste, is demonstrated also by the Korean legislation, the Malaysian legislation, the USA and European scenarios.

The investigation results, presented in the following, have been obtained both interviewing local exclusive distributor of Ecofast technologies on the Korean and Malaysian market, and analyzing the current legislative attitude in the US and European scenarios.

Korean scenario – market potential

Ecofast Korean local exclusive distributor answered as follow to Ecofast request of information regarding the FC-DISTRICT food waste collection model business potential on the Korean market.

“If FC-DISTRICT will develop successfully , I would tell you that this system could be the best method for the food waste treatment in Korea and for the sustainability management in the future energy market. Also, we all don't know yet how it would impact the market. For example, let's assume the capacity of the system Self Thickening Tank (STT) of FC-DISTRICT like the present Stand Alone module system. If we assume to install one STT every 50 household and considering that presently, 9,000,000 households can use the system in Korea we have a market potential of 180.000 STT. If **we could assume that 1/10 of units can be reached in the due time, we can say that 18,000 STT can be sold in the next coming years in the Korean market**. As far as Korean Government attitudes, we had positive output from them so far. If FC-DISTRICT project can be demonstrated in Korea and recognised as a good solution, we can say that it's impact will be huge” .

Malaysian scenario – market potential

Ecofast Malaysian distributor answered as follows to Ecofast request of information regarding the business potential on the Malaysian market: “ Rewiser Concept (i.e.: the commercial name of the remote system produced by Ecofast, including the FC-DISTRICT tank model) is a totally new idea to be put forward to Solid Waste Management Corporation under our Ministry of Housing and Local Government, and we are working very hard by taking every opportunity created and available to introduce Rewiser Concept.

At present under the Solid Waste Management Act the MSW Corporation has drawn out and finalized 6 Strategies on Food Waste Management (Please Note: Only Food Waste), which are targeted at Source Separation by Waste Generators. And this new guidelines allow us to capitalize on Ecofast System”.

USA scenario – market pespectives

The growth of KFW recycling concerning the situation in U.S. A. is well described by the recently paper posted on BioCycle.net[2], a specialized magazine for biogas and compost business reported in the following.

[2] www.biocycle.net, 2013

WASHINGTON, DC, DECEMBER 20, 2013 – The new "Commercial Organic Waste" policy continues the momentum of similar state-wide policies requiring food waste recycling passed in Vermont and Connecticut and initiatives in cities like San Francisco, Austin, Portland and Seattle. Expected to be signed into law next week, Mayor Michael Bloomberg noted that "[this] initiative is a significant step towards our NYC goal of diverting more waste from landfills" – intended to reduce the City's greenhouse gas emissions from waste disposal, and produce resources such as biogas and soil amendment products from what used to be regarded as wastes.

NYC's extraordinary action will be a shot of adrenaline to the growing biogas and compost industries which are ready, able and willing to manage organic wastes as a resource. This new policy fulfills a fundamental need for biogas and composting project development: a predictable and reliable source of organic feedstocks. With it, compost manufacturing facilities can produce a reliable supply of compost and biogas facilities can continuously produce biogas and digested materials for gardening and agriculture," said Patrick Serfass, Executive Director of the American Biogas Council (ABC). "Project financing also flows more readily with more certainty in feedstock supply, and will create jobs, renewable energy and soil amendment products while reducing greenhouse gases.

"Nationally, this will bring attention to one of the easiest steps cities and states can take to improve the environment and economy: require organics in the waste stream to be recycled just like everyone should recycle glass, metal, paper and plastic."

Combined with the City's recent adoption of a law establishing organic resource collection pilots from schools and residences, and building on initial efforts by local haulers to begin the process of diverting organics, Intro 1162 extends the City's intention to divert thousands of tons of food scraps from disposal in distant landfills to a range of better, local options – including composting and the production of biogas through anaerobic digestion.

"With the passage of this initiative, NYC is taking a bold and decisive step toward establishing a sustainable environment for its citizens. This move will benefit generations to come," said Lori Scozzafava, Executive Director of the US Composting Council (USCC)."

Ecofast at the present has no operating connection within the US market, nevertheless this document shows the improving potential market for the innovative technology developed within the FC- DISTRICT project.

European scenario – market perspectives

In Europe the situation is changing too and the recent facts in Scotland represent a clear sign of the new framework of the KFW collection.

Zero Waste Scotland[3] is a program managed by Waste & Resources Action Program (WRAP) on behalf of the Scottish Government. Specifically the program states that "If you run a food business which produce over 50 kg of food waste per week, you must present it for the separate collection from 1 January 2014", while " from 1 January 2016, any non-rural business or organization which produces food waste will have a duty to ensure that it is not deposited directly or indirectly into a public drain or sewer".

Food waste disposers such as macerators cannot be used to discharge food waste to a drain or sewer in a non-rural area where a separate food waste collection service is available.

Systems which dewater food waste at source and store the solid material for collection and treatment are an acceptable form of management, but only if the loss of solid matter to sewers is minimal. Systems like enzymatic digesters which do not recover any organic waste prior to it going to sewer are banned under the Regulations as the food waste is all going into the sewer.

[3] http://brrd.zerowastescotland.org.uk/

There is no legal requirement for macerators to be removed however your businesses may choose to remove macerators to prevent staff using them and avoid the risk of a fine. Businesses are also liable to prosecution under Section 46 of the Sewerage (Scotland) Act 1968 which makes it an offence to discharge any substance into the public sewer likely to obstruct its free flow. Disposing of food waste to the drain could also result in flooding within your (and surrounding) business premises.

There is evidence to suggest that fat, oils and grease cause the majority of drain blockages and further legislation is underway to deal with this specific problem."

In this frame work is quite clear that a system using devices like STT has a clear advantages because thanks to its thin filtration the discharge into the public drain of solid or oil and grease is practically excluded.

2.3. Wireless/hybrid communication network

2.3.1. Product presentation

The result herein presented consists in the development of new Dynamic control system for energy storage and hybrid wireless system. Status of advancement of the wireless/hybrid communication network is presented in the following table.

Table 2-7. FC-DISTRICT Exploitable Result No.4 - status of advancement.

ID No.	Innovation ID	Related WP	Exploitation leader	Date of achievement	Percentage of achievement
4	Wireless/hybrid communication network	WP7	FAGOR	M18	100%

Table 2-8: Innovation item: Wireless/hybrid communication network.

Dynamic control system and hybrid wireless system	
Exploitable foreground	A single integrated solution with specialised hardware and software for intelligent building systems management is developed. The data network infrastructure allows to: • Deploy sensors at different remote points of the district and gather data at a central location. • Control of SOFC units and other devices deployed in the district; Provide reliable, dynamic, mesh communication network. Excess bandwidth of the systems can be employed for distribution of internet access or use of adhoc devices/sensors, LAN communication, surveillance system, or virtually any IP communication.
Relevant Deliverable	D7.1.1; D7.1.2; D7.1.3; D7.2.1; D7.2.2; D7.2.3; D7.3.1; D7.3.2.1; D7.3.2.2; D7.3.3
Partners	RINICOM: is responsible for assessing the technical specifications of the communication system for monitoring and control, components selection, testing and implementation IKERLAN: is responsible for control and fault protection functionalities analyses, development and implementation FAGOR: is responsible for defining technical specifications and tests criteria for laboratory tests
Owner of the results	FAGOR/RINICOM/Ikerlan each partner within WP7 owns results as per their individual work performed
Licensors expected	-

2.3.2. Exploitable Result for Wireless/hybrid communication network

Innovativeness introduced compared to already existing Products/Services	A single integrated solution with specialised hardware and software for intelligent building systems management is developed. Excess bandwidth of the systems can be employed for distribution of internet access or use of ad hoc devices/sensors, LAN communication, surveillance system, or virtually any IP communication.
Unique Selling Point (competitive advantages)	• Reduced price compared to projects carried out by individual integrators. • Single management and communication solution for the whole system. • Significantly reduced integration and planning time • Minimized maintenance cost
Product/Service Market Size	Smart home market est. $11 billion by 2015
Market Trends/Public Acceptance	Intelligent building management since foundation has only been going one way (up) and since it allows for better savings, greener approach to building management, etc. it is not likely to ever change. The green/intelligent building trend is rising exceptionally.
Product/Service Positioning	-
Legal or normative or ethical requirements (need for authorisations, compliance to standards, norms, etc.)	Wireless systems that are used have been chosen specifically to avoid any difficulties with regulatory bodies, thus operating in license-exempt bands. Control software might need approvals for security from a competent body
Competitors	Mainly system integrators offering a similar service on a per-project basis
Prospects/Customers	Real estate developers, small/medium independent housing estate owners.
Cost of Implementation (before Exploitation)	€1m approximately
Time to market	Hardware side of the system is ready available upon the completion of FC-District project, software will need interface improvement, language support, etc. in order to be market-ready. Est. time for completion – 1 year.
Foreseen Product/Service Price	Depending on the scale of district/development and systems installed the price could range between €15,000.00 and €35,000.00 per building. Option of charging separately for hardware per building and

	software per license is also being considered.
Adequateness of internal staff	N/A
External Partners to be involved	None
Status of IPR: Background (type and partner owner)	Background IPR entirely owned by the involved partners with no external disclosure
Status of IPR: Foreground (type and partner owner)	Foreground IPR entirely owned by the involved partners with partial external disclosure
Status of IPR: Exploitation Forms (type and partner owner) e.g. direct industrial use, patenting, technology transfer, license agreement, publications, standards, etc.	Still considering options of direct industrial use, license agreement.
Which partner contributes to what (main contributions in terms of knowhow, patents, etc.)	Rinicom – hardware and software solution for communications. Integration know-how. Ikerlan, Fagor – Hardware and software solution for control of SOFC and related equipment.
Partner/s involved expectations	-
Sources of financing foreseen after the end of the project (venture capital, loans, other grants, etc.)	Possible other grant search for bringing the product into the market, but mainly through investment of company's own organic funds.

2.4. Efficient external thermal insulation system (ETICS)

2.4.1. Product presentation

The result herein presented consists in the development of new ETICS.
The New systems proposed by KNAUFKG are based on:

- Adhesive and basecoat mortar for application without reinforcing mesh;
- Vacuum Insulation Panels;
- Accessories: hammer dowel with plastic steel nail, free of thermal bridges.

Status of advancement of the ETICS system is presented in the following table

Table 2-9. FC-DISTRICT Exploitable Result No.4 - status of advancement.

ID No.	Innovation ID	Related WP	Exploitation leader	Date of achievement	Percentage of achievement
5	Efficient external thermal insulation system	WP5 WP9	KNAUFKG	M24	100%

Table 2-10: Innovation item: Efficient external thermal insulation system - summary.

Innovative ETICS	
Exploitable foreground	New ETICS consisting of VIP sandwiched in insulation material with improved thermal performance, applicable to lightweight construction.
Relevant Deliverable	D9.1
Partners	KNAUFKG: Responsible for the development of the new external insulation system (panels, dowels, installation procedure) for retrofitted and new buildings. ACCIONA: will analyze non technical barriers to the market penetration of the thermal storage system coupled to the application in building of novel ETICS NTUA: Has carried out supportive experiments for novel elements development. Has carried out monitoring campaign to prove the performance characteristics of the new ETICS.
External Partners to be involved	VA-Q-TEC (VIP provider)
Owner of the results	KNAUF
Licensors expected	-

Figure 2-4: Completed installation of new sandwich panels with VIP at the mock up at the NTUA Campus.

2.4.2. Exploitable Result for Efficient external thermal insulation system

Innovativeness introduced compared to already existing Products/Services	New ETICS consisting of VIP sandwiched in insulation material with improved thermal performance, applicable to lightweight construction.
Unique Selling Point (competitive advantages)	Advantages for the customer: lower thickness of external insulation system (reduced weight and loss of space), faster application.
Product/Service Market Size	Not known
Market Trends/Public Acceptance	It is a niche market for special requirements (north climates, large buildings, special retrofitting) Target: Low energy consumption in new or renovated lightweight buildings.
Product/Service Positioning	Not known
Legal or normative or ethical requirements (need for authorisations, compliance to standards, norms, etc.)	Not known
Competitors	Other ETICS developers.
Prospects/Customers	The product is detected to: Construction industry Energy Engineers, Architects, Constructors, Developers, Applicators
Cost of Implementation (before Exploitation)	Prototype product has been hand produced in the frame of the project. Further research is needed for developing methods for mass production and fast installation and long term property assessment.
Time to market	The new ETICS could be ready for commercialization ca. 2 years after the end of the project.
Foreseen Product/Service Price	Price not known at the moment.
Adequateness of internal staff	Good
Status of IPR: Background (type and partner owner)	Any IPR belongs to KNAUF
Status of IPR: Foreground (type and partner owner)	N/A
Status of IPR: Exploitation Forms (type and partner owner) e.g. direct industrial use, patenting, technology transfer, license agreement, publications, standards, etc.	Publications (NTUA,KNAUF)
Which partner contributes to what (main contributions in terms of	

knowhow, patents, etc.)	
Partner/s involved expectations	Mid-term product commercialization
Sources of financing foreseen after the end of the project (venture capital, loans, other grants, etc.)	KNAUF will fund further research

System FC-District

2.4.3. Product presentation

The scope of research activates set in FC-DISTRICT project, comprises development of various products e.g.: Micro-CHP System based on Solid Oxide Fuel Cells (SOFC), External Thermal Insulation Component Systems (ETICS), District heating pipe with improved insulation, Wireless/hybrid communication network.

Table 2-11. FC-DISTRICT Exploitable Result No.6 - status of advancement.

ID No.	Innovation ID	Related WP	Exploitation leader	Date of achievement	Percentage of achievement
6	FC-District system	WP9	MOST	**M48**	100%

Table 2-12: Innovation item: System FC-District - summary.

Innovative System FC-District	
Exploitable foreground	FC-District system consists of a mix of technologies, connected within one system. It provides both heat and electricity from CHP units which are working in highly flexible . Fluent cooperation of all the system components is ensured by wireless management.
Relevant Deliverable	D9.3
Partners	MOST, NTUA, ACCIONA, IEn, FAGOR, EBZ, CUT, PS, IKERLAN, Rinicom, SOL, KNAUFKG, DAPP,SP, ECOFAST, KNAUFABEE,
Owner of the results	The consortium
Licensors expected	-

2.4.4. Exploitable Result for Efficient external thermal insulation system

Innovativeness introduced compared to already existing Products/Services	System FC-District is innovative itself, heat losses for distribution are minimized. System is centrally controlled what makes it flexible and provide constant heat and electric supply to the serviced buildings.
Unique Selling Point (competitive advantages)	Decreasing the total fossil fuel usage comparing to conventional district heating systems. Reduction of greenhouse gas emission. Flexibility and reliability .
Product/Service Market Size	Newly build or retrofitted districts in urbanized and highly urbanized areas.
Market Trends/Public Acceptance	In Europe, district heating is popular and in many cities heat is delivered by city grid. As new areas are urbanized there is a constant need for infrastructure to meet the growing demand for heat and electricity. Long distance grids are unreliable. Extended piping network also generates higher heat losses. As environmental awareness is constantly growing people are looking for more sustainable and energy efficient solutions.
Product/Service Positioning	-
Legal or normative or ethical requirements (need for authorisations, compliance to standards, norms, etc.)	So far there is no legal, normative or ethical requirements which refers to system as a whole. Many countries, especially in Europe, support CHP systems due to high overall efficiency of energy production.
Competitors	The internal and external combustion engines, district heating system operators, type C boiler producers, local power plants owners
Prospects/Customers	Small businesses and schools, buildings with high heating demands , public and private investors, developers, facility management companies
Cost of Implementation (before Exploitation)	-
Time to market	Product is not ready to be introduced to the market because of lack of the sufficient data from the demonstration plant.
Foreseen Product/Service Price	The product price is not yet possible to estimate. Investment cost depends on the size of the system.
Adequateness of internal staff	-
Status of IPR: Background (type and partner owner)	-
Status of IPR: Foreground (type	-

and partner owner)	
Status of IPR: Exploitation Forms (type and partner owner) e.g. direct industrial use, patenting, technology transfer, license agreement, publications, standards, etc.	-
Which partner contributes to what (main contributions in terms of knowhow, patents, etc.)	-
Partner/s involved expectations	-
Sources of financing foreseen after the end of the project (venture capital, loans, other grants, etc.)	-

2.4.5. Market analysis

Market analysis showed the public owners or developers of housing areas or groups of housing, such as local authorities and private house builders of new estates can be more interested in negotiation with micro CHP supplying consortia for mass installation and maintenance in one area than private owners.

Furthermore, private owners may be reluctant to act early and may require encouragement, incentives and regulations to stimulate.

The installation of an efficient heating and electric improvements have a significant cost that a homeowner bears more easily than a tenant. Whereas it is in the owner's interest to invest in order to reduce energy costs over the long term, tenants have little incentive to improve dwellings that they do not own.

Another possible end-users are small businesses and schools with sufficiently large electricity and heat requirements; schools can also benefit from an educational point of view, by using data from their fuel cell for teaching purposes.

Market capacity

Typical heating consumption levels of the existing stock by age are difficult to make due to the multiple factors affecting heating consumption. It is however clear that the largest energy saving potential is associated with the older building stock. Moreover, although heating needs in Southern countries such as Portugal and Italy are lower due to milder winters, the energy use in these countries is relatively high, which can be an indication of lack of sufficient thermal envelope insulation in their building stocks. For those countries, cooling becomes an important contributor to the overall consumption, where homes are, in many cases, equipped with air-conditioning systems. To recall the Deliverable 2.1.1 within the existing European stock, a large share (more than 40%) is built before 1960s where there were only few or no requirements for energy efficiency and only a small part of these have undergone major energy retrofits, meaning that, these have low insulation levels and their systems are old and inefficient. The oldest part of the building stock contributes greatly to the high energy consumption in the building sector.

Table 2.6.1. Market capacity for micro CHP depending on characteristic of building.

District Typology	Characteristic of buildings	Market capacity for FC DISTRICT system
I - Old town	The old and in the most cases not enough insulated buildings	Very Good
II - Outdated blocks of flats	The high buildings with very poor insulation.	Very Good
III - Modern blocks of flats	Buildings have to met with the existing standards regarding to envelopes thermal quality	Good
IV - Single family houses	The space heating needs higher than in multi-family buildings	Very Good
V - Industrial area	High thermal quality	Average
VI - Multi-functional development	New buildings, high thermal quality	Good

Table 2.6.2. Market capacity for micro CHP depending on competing technologies.

District Typology	Competing technologies	Market capacity for FC DISTRICT system
I - Old town	Condensing and non condensing boilers	Very Good
II - Outdated blocks of flats	District heating networks	Very Good
III - Modern blocks of flats	District heating networks	Very Good
IV - Single family houses	RES	Good
V - Industrial area	RES	Good
VI - Multi-functional development	District heating networks	Very Good

Table 2.6.3. Market capacity for micro CHP depending on financial status of clients.

District Typology	Financial issues	Market capacity for micro CHP
I - Old town	The big disparity of financial status of residents.	Average
II - Outdated blocks of flats	The financial status of residents is different but without as disparities as in old towns.	Average
III - Modern blocks of flats	Middle and Upper-Middle Class with good financial conditions.	Good
IV - Single family houses	Average and Good Financial Status of residents.	Good
V - Industrial area	Districts dominated by big companies, manufacturers and workers	Very Good
VI - Multi-functional development	Very good financial status of residents	Very Good

The best opportunities are recognized for Industrial and multi-functional Districts. In case of District III – modern flat of blocks, also great opportunities exist but financial incentives are necessary. On the other side we conclude that the inhabitants in Old Town Districts seems to be less interested in using the micro CHP systems.

The FC DISTRICT systems may appeal first to a “premium” market segment having the following features:

- Above average size single family homes
- Above average household income
- High annual energy expenditures to justify increased capital costs.
- Regions with favorable differences between the cost of gas and electricity.

3. Demonstration Plant

The pilot plant developed and built within FC-DISTRICT research project, is located in Warsaw at the facilities of Instytut Energetyki at ul. Mory 8, and comprises in particular: one m-CHP based on SOFC technology, two m-CHPs based on Stirling engine, district heating pipelines connecting three buildings, hydraulic assemblies in the three buildings connecting m-CHPs with the district heating and heating systems of the buildings, buffer tank, communication system, control room with computers and software, monitoring equipment, and more.

To set exploitation rules of the pilot plant developed and built within FC-DISTRICT research project, grant agreement no 260105, the Exploitation Agreement is made between the partners of Consortium who decided to continue cooperation after termination of the research project in order to achieve particular exploitation objectives:

1) Mostostal Warszawa S.A. – to include Pilot Plant in the reference portfolio of the company,
2) National Technical University of Athens – to gather monitoring data of Pilot Plant operation,
3) Instytut Energetyki – to operate Pilot Plant within own m-CHP centre,
4) EBZ Entwicklungs- und Vertriebsgesellschaft Brennstoffzelle mbH – to evaluate long term operation of m-CHP unit based on SOFC,
5) Ikerlan S. Coop. – to gather monitoring data of Pilot Plant operation,
6) RINICOM Limited – to evaluate the long term operation of hybrid-mesh communication system,
7) SUNFIRE GMBH – to gather data of long term operation of the fuel cell stack installed in m-CHP.

According Exploitation Agreement the responsibilities of partners are as follows:

1) Mostostal Warszawa S.A. – to fix any faults in the piping or hydraulic fittings of Pilot Plant; to carry on data acquisition of CPC2 building monitoring.
2) National Technical University of Athens – to get access to all measurement data of Pilot Plant gathered by Parties; to provide to Parties results of Pilot Plant operation elaborated basing on the gathered data.
3) Instytut Energetyki – to make possible unlimited access to Pilot Plant by representative of Parties, and in particular make possible visits of guests invited by Parties (e.g. potential clients); to provide all media needed for Pilot Plant operation (natural gas, electricity, water); to get unlimited possibilities of performing tests and measurements, without right of making changes to the system.
4) EBZ Entwicklungs- und Vertriebsgesellschaft Brennstoffzelle mbH – in case of the m-CHP SOFC unit to fix it, in particular to replace any faulty elements with the spare parts,
5) Ikerlan S. Coop. - in case of the m-CHP Stirling unit failure to fix it, in particular to replace any faulty elements with the spare parts,
6) RINICOM Limited – in case of the communication system failure to fix it, in particular to replace any faulty elements with the spare parts,
7) SUNFIRE GMBH – in case of SOFC stack failure to replace it with second one (one spare stack available in total).

The current Special Partnership Agreement does not involve any IPR. In any case, the FC-DISTRICT Consortium Agreement will prevail over the current Exploitation Agreement in relation to IPR issues.

4. List of applications for patents, trademarks, registered designs, etc.

Type of IP Rights: Patents, Trademarks, Utility models, etc.	Application reference(s)	Subject or title of application	Applicant (s) (as on the application)
Patent	PCT/EP2012/063035 International reference number	Off-gas burner	Dimosthenis Trimis, Alexandra Loukou and Isabel Frenzel (TU-BAF)