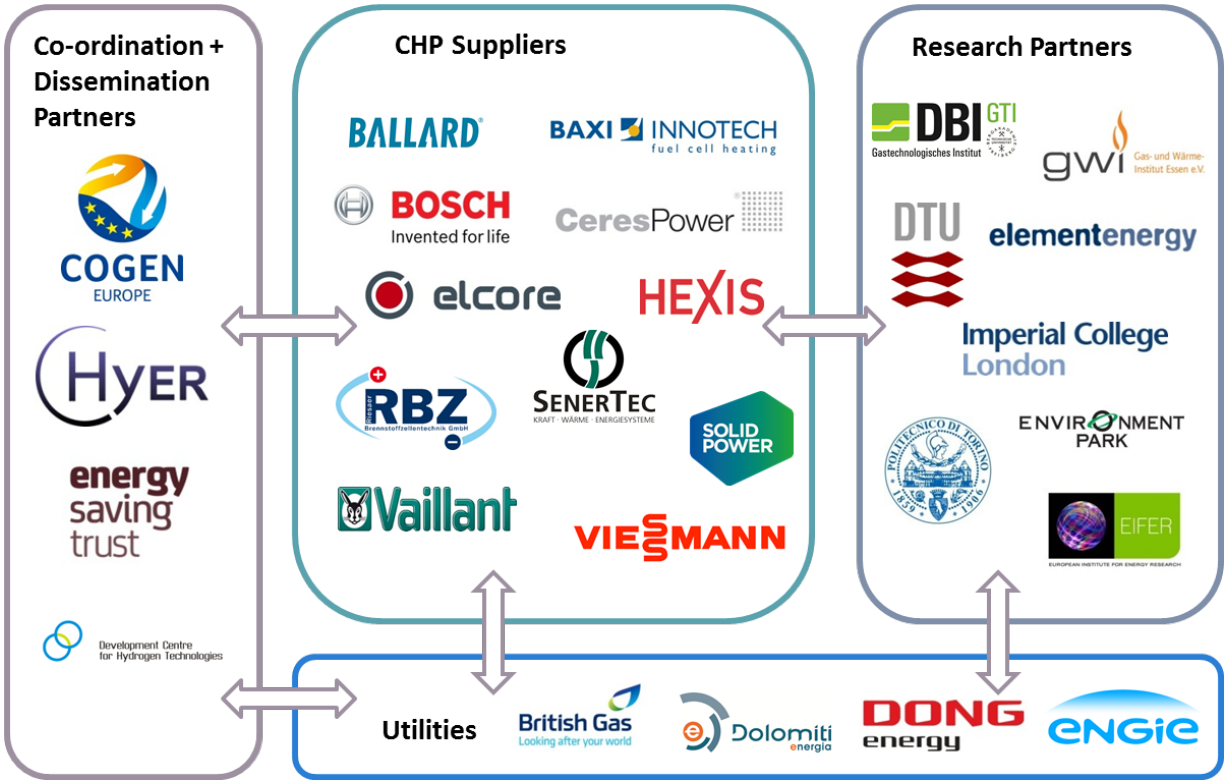
European-wide field trials for residential fuel cell micro-CHP

ene.field results and PACE project introduction

30 March, 2017

The research leading to these results has received funding from the European Union´s 7th Framework Programme (FP7/2007-2013) for the Fuel Cells and Hydrogen Joint Undertaking Technology Initiative under Grant Agreement Number 303462

ene.field is a European platform for FC micro-CHP



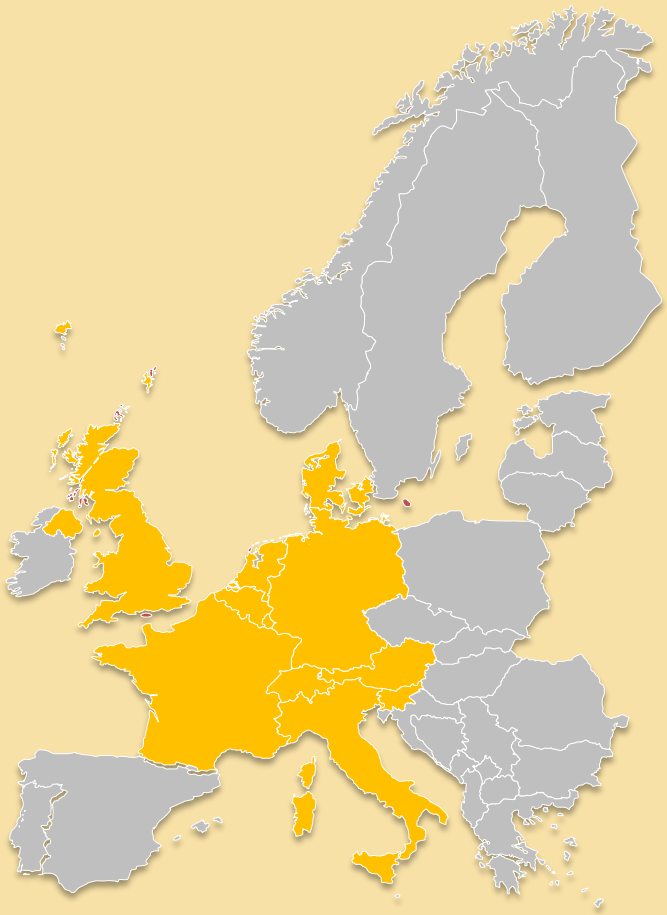
The consortium brings together 27 partners including:

- the leading European FC micro-CHP developers,
- leading European utilities,
- leading research institutes,
- partners in charge of dissemination and coordination of the project.

The Fuel Cells and Hydrogen Joint Undertaking (FCH JU) is committing c. €26 million to ene.field under the EU's 7th Framework Programme for funding research and development

Introduction to ene.field project

- ene.field is the **largest European demonstration** of fuel cell micro-CHP to date
- It aims to deploy up to **1,000 Fuel Cell heating systems** in 11 key European member states
- Project duration of **5 years.** Systems will be demonstrated for 2 to 3 years
- Monitoring for all units (incl. 10% of units with detailed monitoring)
- Outputs of the project include:
  - Detailed performance data
  - LCC & LCA assessments
  - Market analysis & commercialisation strategy
  - Policy recommendations

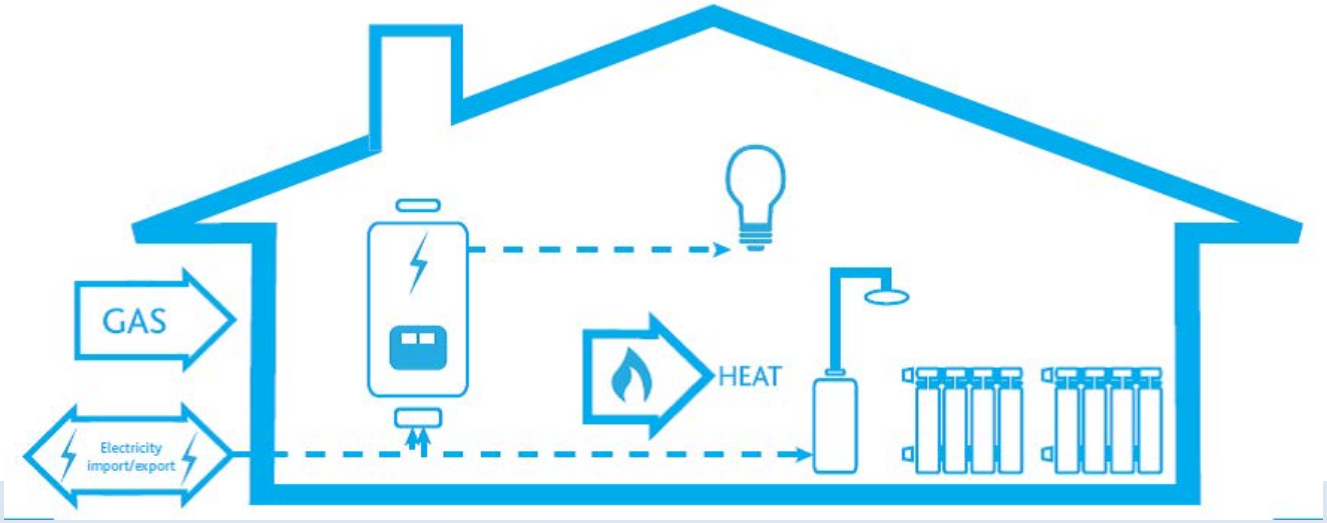


Countries where units are currently expected to be installed

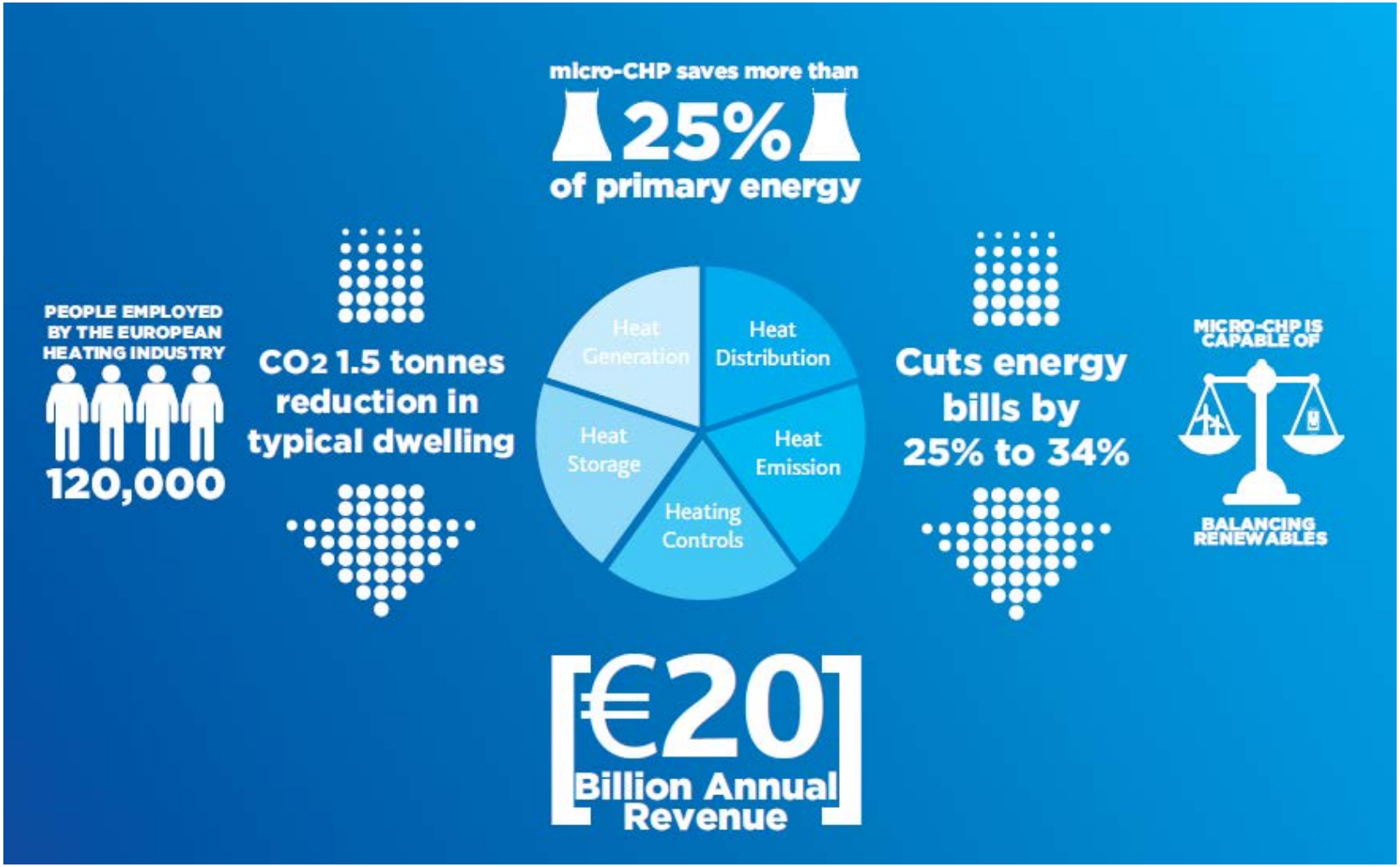
Source: ene.field project

What is micro-CHP

- Micro-CHP…
  - …is a highly efficient distributed energy solution, simultaneously producing heat and electricity near the point of consumption
  - …meets demand for heating, hot water and/or cooling in buildings while generating electricity to replace or complement the grid supply
  - …normally installed in residential and public buildings, as well as small businesses



Why micro-CHP?



Source: Delta-ee, Micro-CHP Benefits Study, 2015

FC mCHP has potential to play a key role in decarbonisation of heat in buildings

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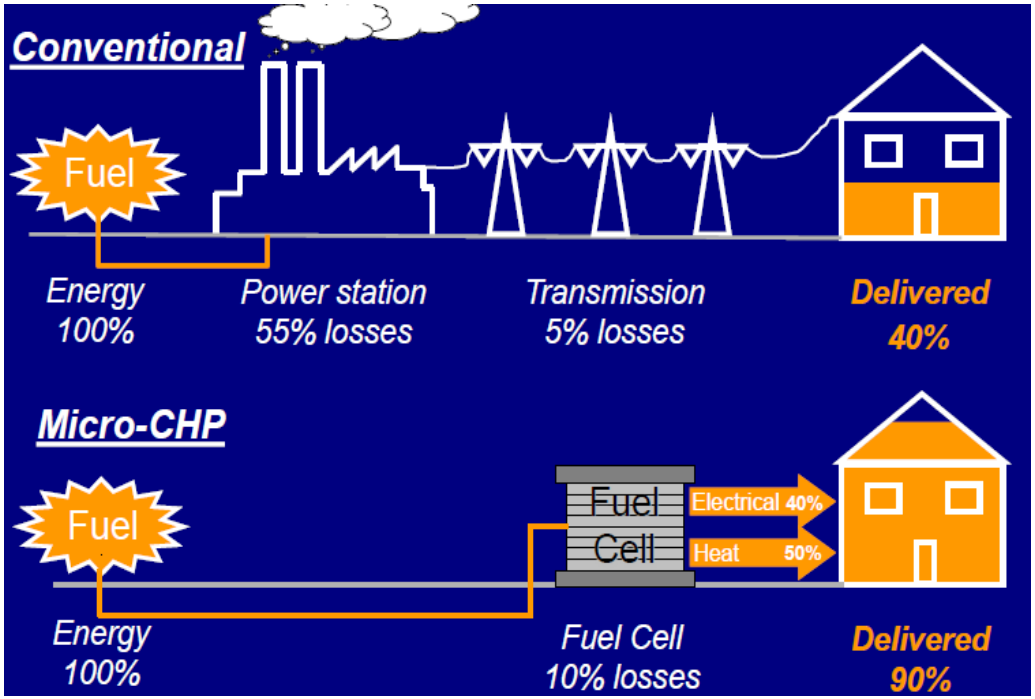
Solution to efficient heat supply in buildings	• High electrical and overall CHP efficiency • Significant primary energy saving and reduction of CO_2 emissions compared to incumbent technologies • Very low local pollutants and noise
Large market potential across Europe	• Replacement for gas boiler market • Suitable for existing buildings and particularly well-matched to modern low heat demand housing • Straightforward integration with existing gas and electrical supplies
Complementary with national energy system transition	• Uses Europe's well-developed, existing natural gas infrastructure • Renewable and zero-carbon with clean gas sources, such as biomethane and hydrogen • Supports increasing renewable generation penetration, e.g. as balancing reserve

Source: ene.field project | FC mCHP: Fuel Cell micro-CHP (Combined Heat and Power)

An efficient way to produce and deliver energy

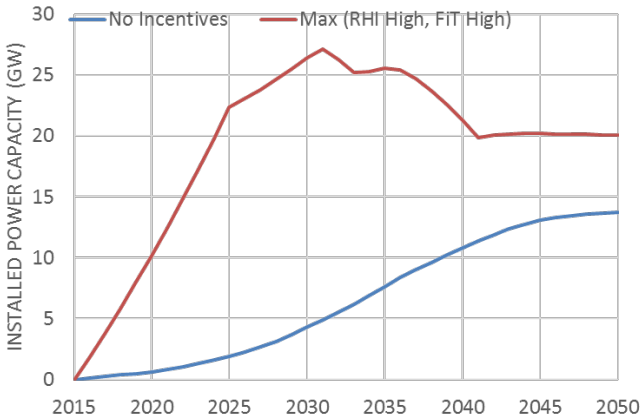
CHP is an efficient way to deliver / produce energy as it is based on simultaneous production of electricity and thermal energy used to meet local needs

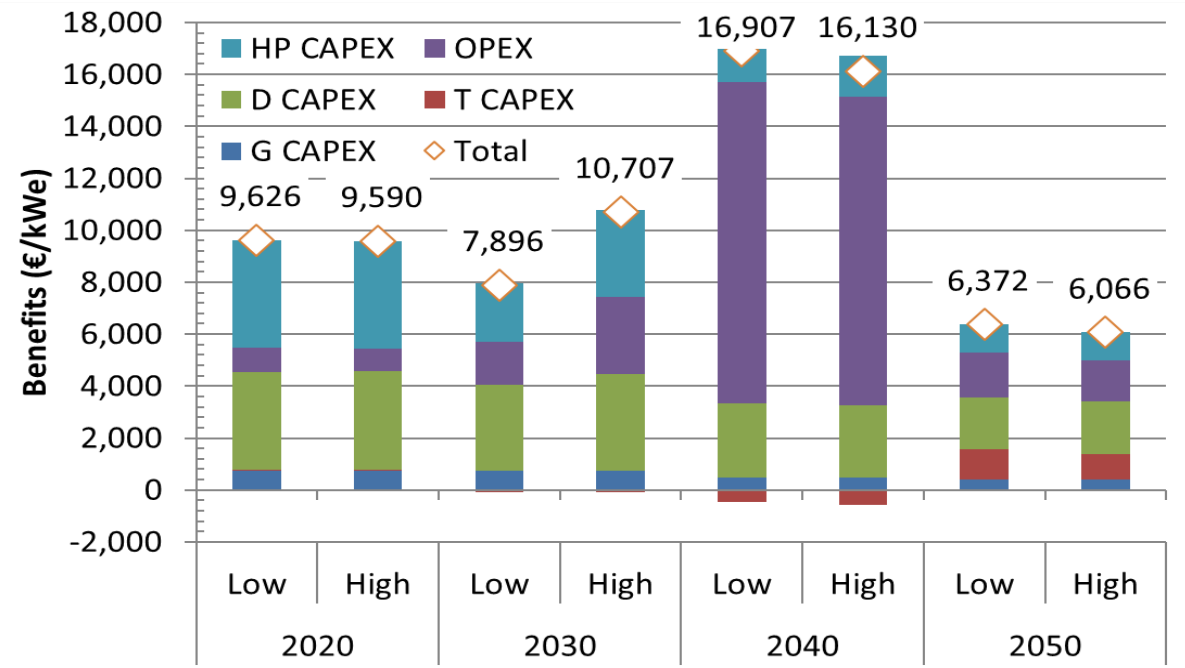
- Micro CHP allows decentralised generation of heat and power at peak time
- High electrical / thermal efficiencies
- Decentralised supply of heat / electricity
- Reduced electricity transmission losses
- Reduce CO_2 associated with energy production at peak time
- Less constraints for grid operation



Source: H2FC SUPERGEN http://www.h2fcsupergen.com/wp-content/uploads/2013/06/Progress-in-Fuel-Cell-mCHP-Prof-Nigel-Brandon-Imperial.pdf

Macroeconomic benefits of µCHP (preliminary)





Capacity factor of µCHP	55%	55%	55%	55%	90%	90%	43%	41%
Operational drivers	Heat led				Heat and electricity led			

Note: electrical efficiency at 35%

Putting citizens at the centre of energy transition

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Energy efficiency, emissions reduction and cost savings are key motivations for customers and installers trialling the technology

FC mCHP can be a flexible solution for customers with high energy demand willing to increase the energy efficiency for their building

FC mCHP can significantly contribute to emission reduction and costs savings for domestic and commercial customers alike

ene.field unit installed at Family Aberl's home

Historical Logherberhaus Hotel equipped with an ene.field fuel cell

Mulhouse Architect's Office reaping the benefits of ene.field 5 kWe unit

More end-user & installer stories at
www.enefield.eu

ene.field & PACE – looking forward

ene.field

PACE
Pathway to a competitive European Fuel Cell micro-CHP Market

- > 2500 units (mostly residential)
- €34 million – EU funding
- Further product innovation, cost reduction and policy & market development

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- Up to 1,000 units (mostly residential)
- 26 partners from industry and research
- €26 million EU funding
- Show potential of market segment and open new market

Mass market

- Fully competitive without any funding

Market uptake

- Favourable EU and national policy frameworks
- Industrial ramp up

- High level recognition under the Energy Union Framework (upcoming EED, EPBD Reviews, Electricity Market Design Initiative)

Large scale demonstration

Practical field trials

KFW 433

- Large scale deployment of FC mCHP in Germany
- Subsidies to max 40% of eligible costs (e.g. € 10.200 for a 1 KWe unit)
- Targetting end-users (initial)

callux nip
Praxistest Brennstoffzelle fürs Eigenheim

- ~500 units installed
- Significant costs reduction achieved
- > 3million operating hours
- System reliability confirmed
- Subsidies unconfirmed

ene.field FC mCHP Field trials partners and products

Vitovalor 300-P
Viessmann

FCmCHP G4
Ballard Power

Galileo 1000 N
Hexis

Cerapower
Bosch

Dachs InnoGen
Baxi Innotech

ENGEN2500
SOLIDpower

G5+
Vaillant

SteelGen
Ceres Power

Elcore 2400
Elcore

BLUEGEN
SOLIDpower

Inhouse 5000+
RBZ

Source: ene.field project | FC mCHP: Fuel Cell microCombined heat and Power

Technical characteristics of systems in ene.field

- The systems deployed in ene.field include **a range of fuel cell technology**, system size and operating strategies
- **10 active suppliers** directly involved in the project and in direct interaction with their customers

Elcore 2400	Dachs InnoGen	Cerapower FC10 Logapower FC10	Vitovalor	SteelGen	Galileo 1000 N	Vaillant G5+	PEMmCHP G5	BLUEGEN	ENGEN 2500	Inhouse 5000+
HT PEM	LT PEM	SOFC	PEM	LT SOFC	SOFC	SOFC	LT PEM	SOFC	SOFC	LT PEM
300W	**700W**	**700W**	**700W**	**700W**	**1kW**	**1kW**	**2kW**	**2kW**	**2.5kW**	**5kW**
Natural Gas	Natural Gas	Natural Gas, Gas	Natural Gas	Natural Gas	Natural gas+ Biogas	Natural Gas	Natural Gas + Biogas	Natural Gas	Natural Gas	Natural gas + Biogas + H2
Wall	Floor	Floor	Floor	Wall	Floor	Wall	Floor	Floor	Floor	Floor
Elcore	**SenerTec**	**Bosch Thermotechnik**	**Viessmann**	**Ceres Power**	**Hexis**	**Vaillant**	**Ballard Power**	**Solid Power**		**RBZ**

Mostly one to two-family houses applications (but not limited to)

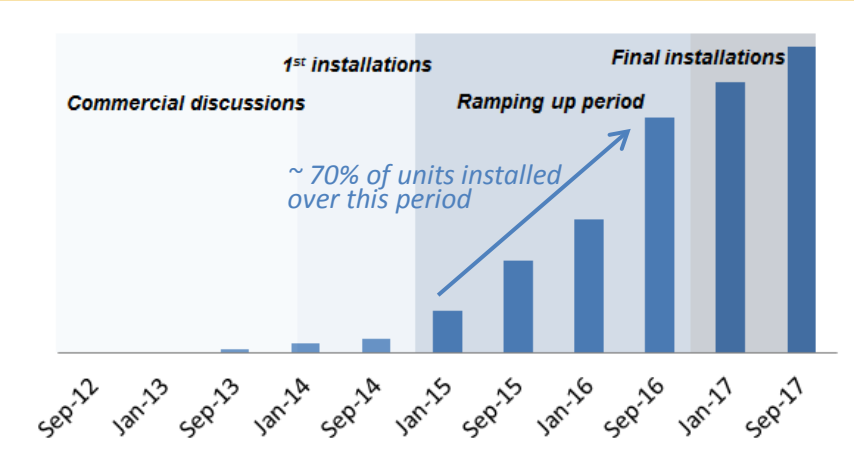
Mostly small and medium commercial buildings, block of flats applications (but not limited to)

Source: ene.field project

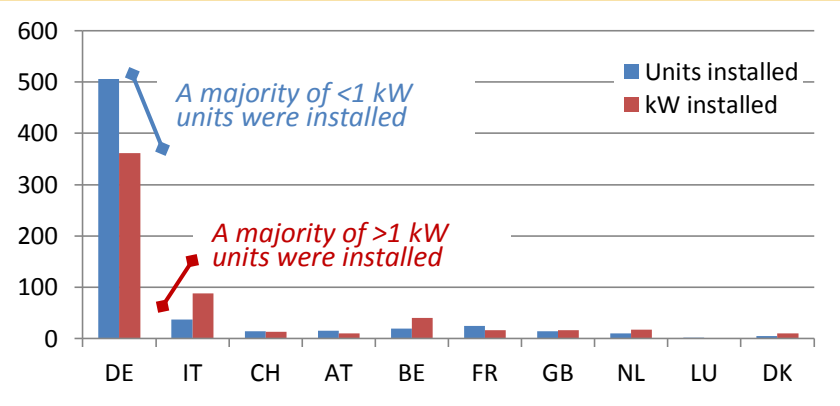
Status of field trial– deployment overview

- **Close to 850 systems installed** so far **in 10 countries across the field trials**
- **A rapid ramp-up in deployment occurred over 2016** – the majority of the units were installed over 2015 and 2016
- The 1st phase of the project focussed on **developing strategies for field trials and finalising contractual agreements**
- **Monitoring for all units** & 10% of units to undergo detailed technical monitoring

Ramping up of installations during project



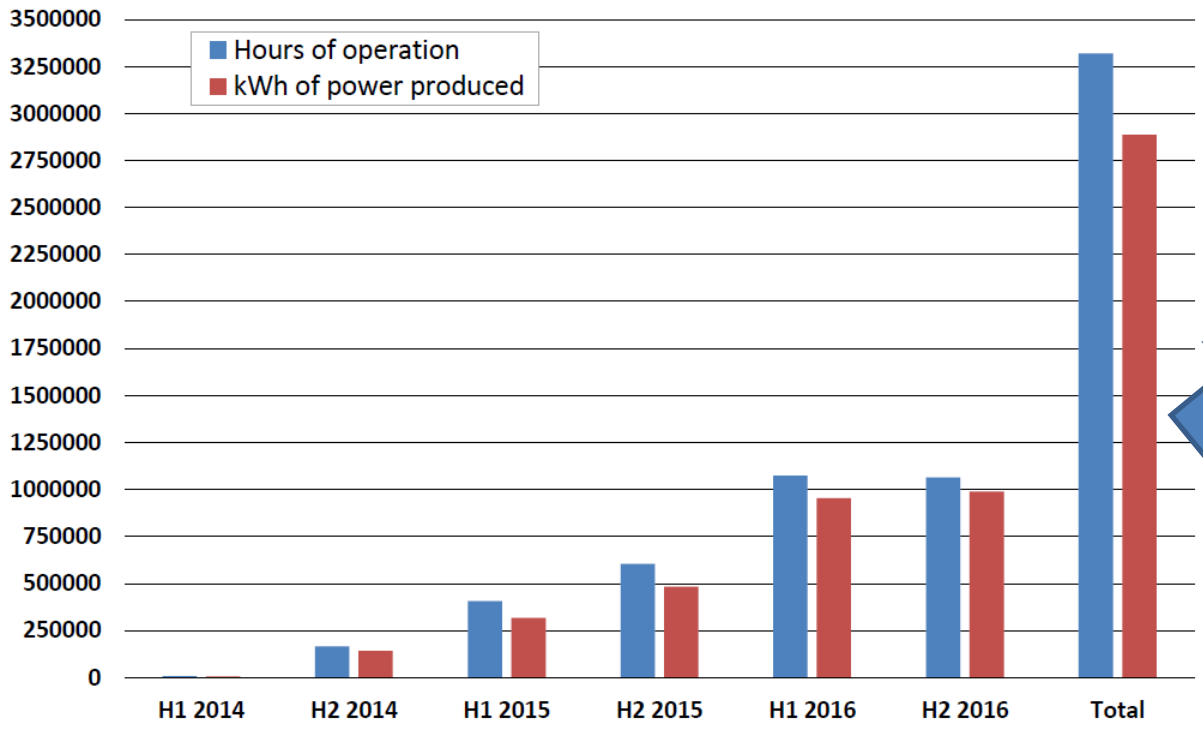
Installations per country and capacity (kW)



Source: ene.field project

Reliable performance has been demonstrated

The ene.field project has demonstrated as of today more than 3 million hours of operation and close to 3 GWh of power produced



Enough electricity to cover the yearly consumption of

500 X

600 X Heat Pumps

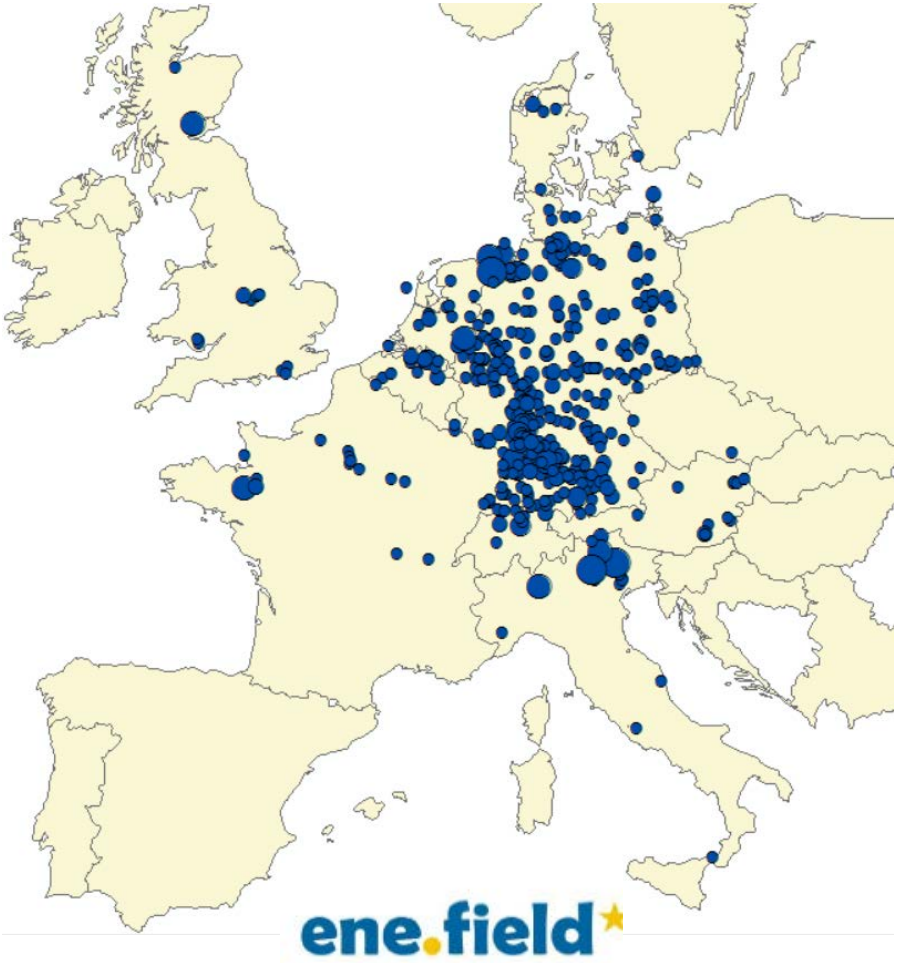
This contributes to the already >4 million hours and 2.5 million kWh of power produced recorded under Callux project in Germany

Source: ene.field project

FC mCHP suppliers are qualifying new routes to market and opening new markets via ene.field

The project is contributing to the development of new markets around Europe while developing further the more advanced German market

callux (nip
Praxistest Brennstoffzelle fürs Eigenheim



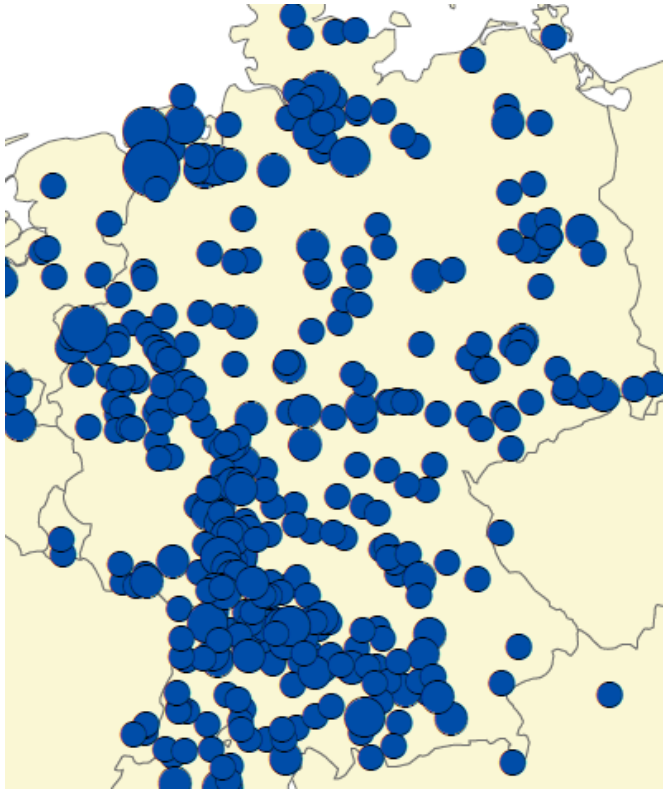
Status as of November 2016, additional systems to be deployed

Source: Callux project / ene.field project | FC mCHP: Fuel Cell microCombined heat and Power

Germany is still the most successful market in Europe in terms of deployment number

The bulk of the units deployed have been installed in Germany thanks to existing support schemes

- **This was mainly a result of the financial support available** (e.g. BAFA, KfW433) which **contributed to decreasing the investment costs** & favoured the ramping up of the installation numbers
- **Overall supportive policy framework** (e.g. building code recognises micro-CHP system benefits – primary energy factor of 2.8)
- It is also due to a **better understanding of the technology** by the end customers, installers and energy services suppliers
- Germany also has a favourable spark spread and **FC mCHPs are also very well suited for the German market**
- For similar uptake in other countries, **Technology Introduction Programmes (TIP) in member states are required to ensure a sustained and successful take-up of the technology**



ene.field installations in Germany

Status as of November 2016, additional systems to be deployed

Lessons learned – Policy readiness!

Policy framework & regulatory issues

- **High level political recognition of FC mCHP benefits** needed at the national level
- **Few dedicated support schemes** that adequately and fairly reward FC mCHP based on an agreed timeline & KPIs (exemplar is KfW 433 (TEP) in Germany)
- **Administrative barriers** preventing access to existing support schemes and funding, as well as for grid connection
- **Lack of harmonisation of standards** across Europe also perceived as a barrier (e.g. gas quality, electrical and thermal size of domestic appliances)
- **Methodologies inadequate/undermining full potential** assessing FC mCHP performance vs other heating technologies (e.g. energy labelling at EU level, buildings codes)

Policy development should closely follow & complement the industry's commitment to FC mCHP cost reduction and performance improvements!!

Source: ene.field project

PACE – Pathway to a Competitive European FC mCHP Market

PACE
Pathway to a competitive European Fuel Cell micro-CHP Market

9 Partners

representing manufacturers, utilities & research community

> 2.500 FC mCHP

to be deployed across Europe between 2016-2021

Installations across 10 countries

5 target countries for policy and market development: Belgium, France, Italy, Netherlands & UK

€90 m total budget

€ 33.9 mil in Horizon2020 funding via FCH JU

BDR THERMEA
BOSCH Invented for life
COGEN EUROPE
DTU
elementenergy
EWE
SOLID POWER
Vaillant
VIESSMANN

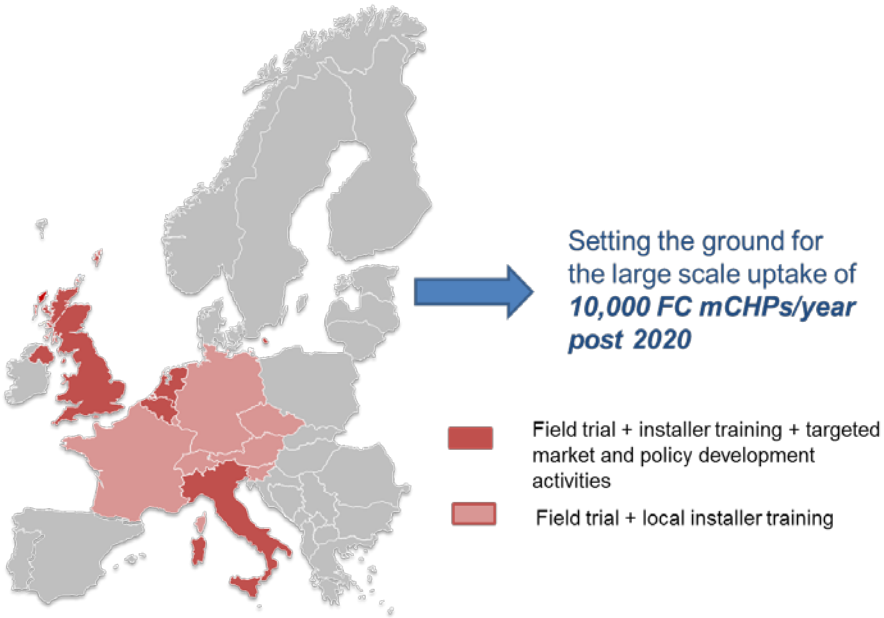
Objectives:

- **Product innovation and cost reduction** – constructing and demonstrating next generation FC mCHP units, designed for cost reduction, increased performance and mass manufacture.
- **Supply chain development** – working to build a more competitive EU component supply chain.
- **Policy collaboration** – working collaboratively with member states to develop policy to enable the transition to wider roll-out.
- **Demonstrating and verifying primary energy savings, and testing grid benefits** – for innovative business model application.

PACE – Pathway to a Competitive European FC mCHP Market

PACE
Pathway to a competitive European Fuel Cell micro-CHP Market

- PACE aims to **install more than 2,500 FC mCHP**, thus enabling several thousand consumers to actively contribute to Europe's energy transition
- PACE will unlock the market for FC mCHP large scale uptake preparing the supply chain and working with policymakers in selected member states to promote a **successful transition to volumes in the order of 10,000 units/year post 2020**.



- PACE will demonstrate that **FC mCHP products are smart grid ready** and that they **can run on renewable fuels**, thus enabling a higher uptake of renewable energy.
- PACE brings innovative **FC mCHP products to the consumer through new business models**.
- PACE will provide **up-skilling opportunities for the domestic heating sector supply chain** (i.e. installers, planners)

Conclusions

- ene.field and now PACE are **the largest European deployment of FC mCHP energy solutions** to date, contributing to **advances in quality of the products** and **opening new markets for further commercialisation activities**

- While **FC mCHP are already competitive with regards to OPEX and GHG emissions compared to other heating technologies**, CAPEX needs to be reduced significantly for the technology to be attractive to a wider group of customers.

- **Collaboration among industry, research institutes and other relevant stakeholders at European and national levels** is expected to contribute to accelerate costs reduction and tackle some key challenges around supply chain development.

- **European industry is investing substantial sums, given its belief in the potential of FC mCHP to deliver environmental and economic benefits**, however commitment needs to be sustained by high level political recognition of these benefits

- The **market uptake of FC micro-CHPs requires a coherent, steady and predictable policy framework** → Analysis conducted in the context of the project showed that these conditions are not in place today

- **Financial support is key during the transitional period to mass commercialisation** as shown by the European experience promoting other emerging technologies (e.g. PV, heat pumps)

ene.field & PACE – looking forward

ene.field

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