PACE

Pathway to a Competitive European Fuel Cell micro-CHP Market

Pathway to a Competitive European Fuel Cell micro-CHP Market

Programme Review Days 2019

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What and why fuel cell micro-Cogeneration?

Heating and Powering your home

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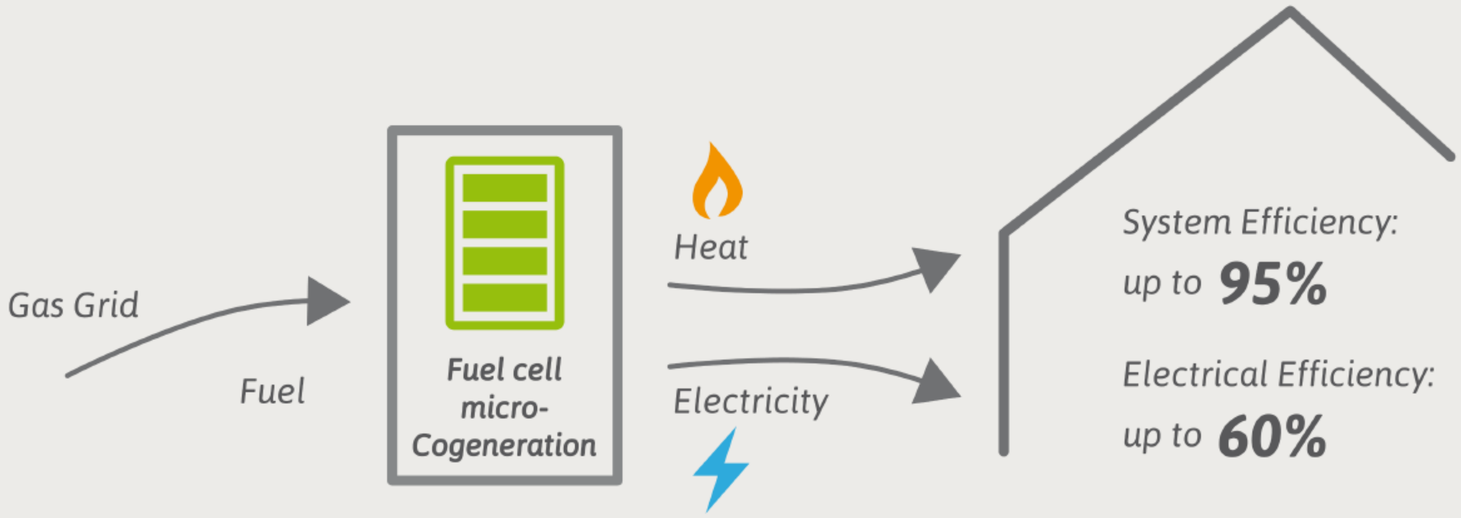
FCH
FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

Fuel Cell micro Cogeneration is a highly efficient home energy system that simultaneously produces heat and electricity and supports the European energy transition by:



- Reducing CO_2 emissions
- Saving primary energy
- Operating with NG and pure H2
- Producing and delivering energy on-site
- Covering higher demand of electricity

What and why fuel cell micro-Cogeneration?

Heating and Powering your home

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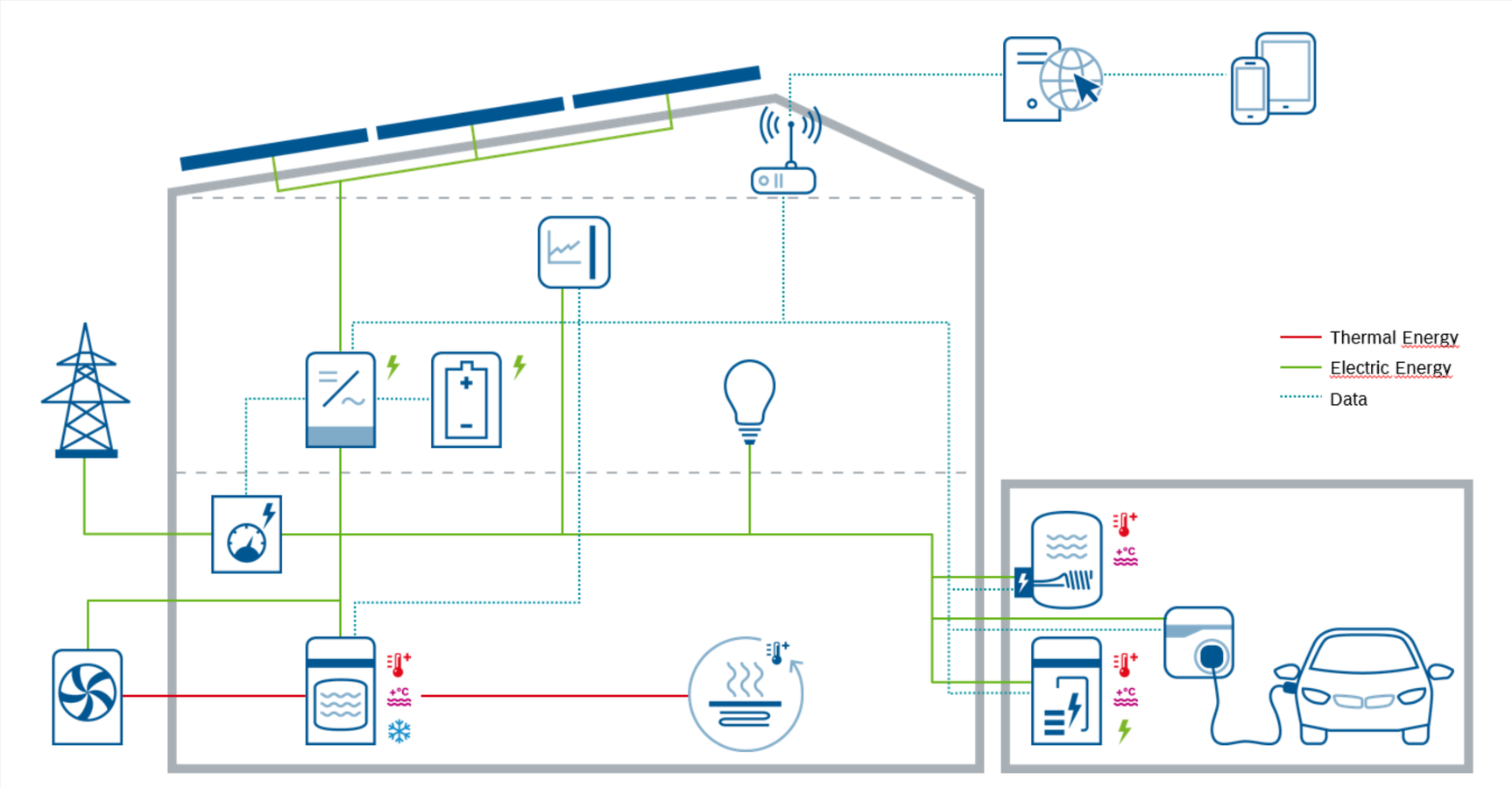
- Empowers consumers
- Supports the European energy transition
- Provides greater flexibility for the energy system
- Fosters innovation and high-value jobs



We offer CO2 savings TODAY!

Fuel Cell CHP vs. alternative solutions*

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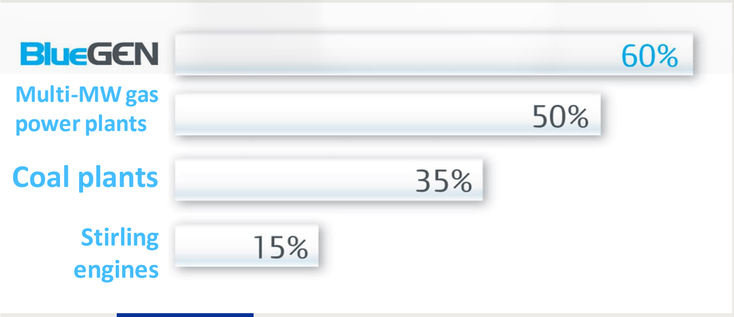
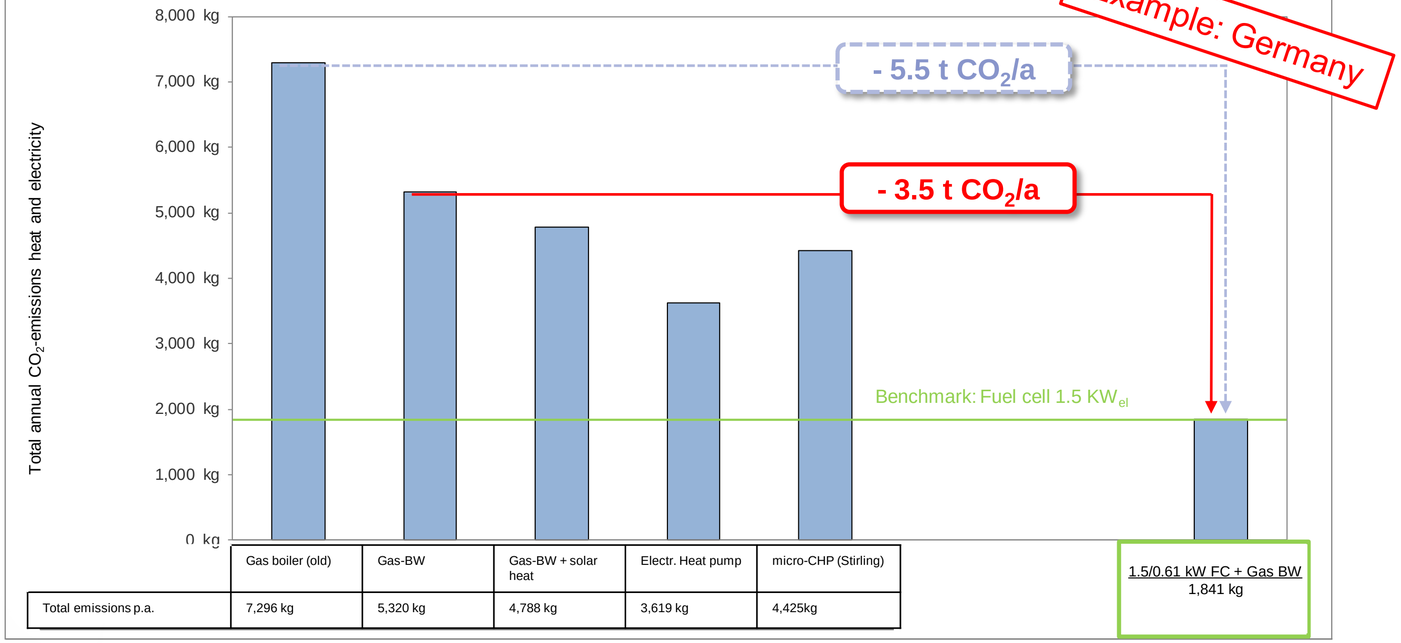


***Calculation (example)*:** single family house, annual heat demand 22,500 kWh_{th}

Example: Germany



	Gas boiler (old)	Gas-BW	Gas-BW + solar heat	Electr. Heat pump	micro-CHP (Stirling)	1.5/0.61 kW FC + Gas BW
Total emissions p.a.	7,296 kg	5,320 kg	4,788 kg	3,619 kg	4,425kg	1,841 kg

Emission factors: Oil: 337 gCO_2/kWh; Natural gas: 227 gCO_2/kWh; Electricity: 563 gCO_2/kWh_{el}; **Technical specifications: Gas fired boiler (old):** therm. efficiency: 70 %; **Gas-condensing boiler (Gas BW):** therm. efficiency: 96 % (if applicable: 10 % fuel savings by solar water heating); **Electric heat pump:** COP: 3,5; **micro-CHP (Stirling):** elect. output: 1 kW_{el}; elect efficiency.: 11 %; therm. output: 8 kW_{th}; therm efficency.: 85 %; annual operating hours: 2,813; **Fuel cell:** elect. output: 1,5 kW_{el}; electr. efficency: 60 %; therm. output: 0,61 kW_{th}; therm. efficiency.: 25 %; annual operating hours: 8,000; additional heat generator: Gas-Condensing boiler: efficiency of 96 %.

→ Compared to **conventional heating technologies**, a great amount of **CO_2 can be saved** through the **application of fuel cells**

Driving the Fuel Cell micro-Cogeneration sector closer to mass market uptake

How to overcome the point of greatest risk in new product commercialisation?

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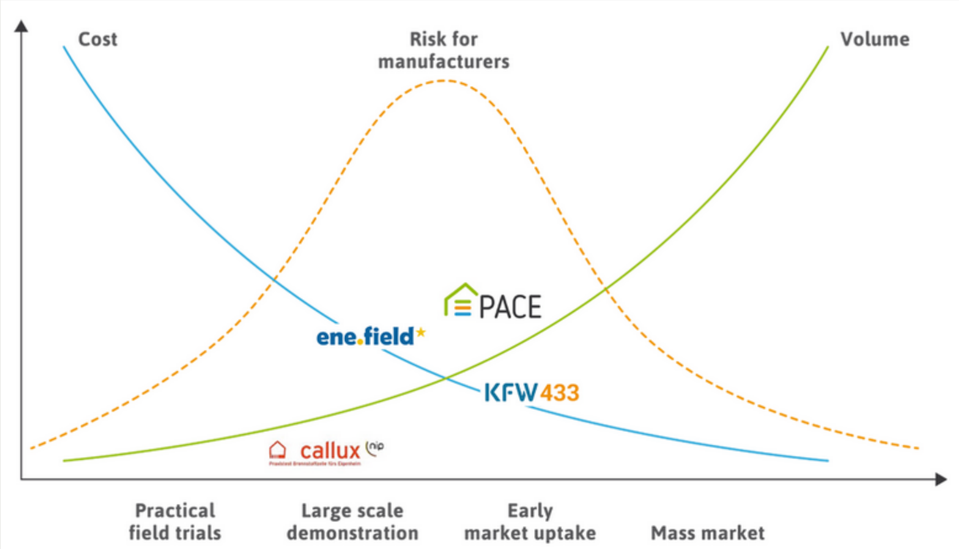

callux

Callux

- Period: **2008 – 2015**
- Total budget: **€75 million**
- German NIP co-financing: 50%
- **500 systems installed in Germany**
- > 5 million operating hours
- **CO_2 reduction by 30% on average per year**

ene.field

ene.field

- Period: **2012 – 2017**
- Total budget: **€52 million**
- EU co-financing (FCH JU/FP7): 50%
- **> 1,000 systems** installed in **11 European countries**
- > 3 million operating hours so far

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- Period: **2016 – 2021**
- Total budget: **€90 million**
- EU co-financing (FCH JU/Horizon 2020): 37%
- **> 2,500 systems** to be installed in **11 European countries**
- **500 units/manufacturer**

KFW433

KFW433

- Period: **started in 2016**
- **German NOW NIP grant scheme** administered by KfW bank
- Beneficiaries: **End customers**
- Eligible size: 0.25 kWe – 5 kWe
- Grant value per system: **€5,700 – €28,000**

Fuel Cell micro-Cogeneration units have demonstrated initial technology readiness in previous European and national demonstration projects

Reduce costs and improve competitiveness

Improve products' performance

Establish Fuel-Cell micro-Cogeneration as a standard technology

Raise awareness on Fuel-Cell micro-Cogeneration

Demonstrate product readiness as a key component in the delivery of EU's energy goals

PROJECT OVERVIEW

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FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

- **Call year:** 2016
- **Call topic:** Large scale demonstration of µCHP fuel cells
- **Project dates:** 01/06/2016 – 31/08/2021
- **% stage of implementation 01/11/2017:** 65% as of 01/11/2019
- **Total project budget:** EUR 90,307,094.50
- **FCH JU max. contribution:** EUR 33,932,752.75
- **Other financial contribution:** EUR 56,374,341.75
- **Partners:** BDR Thermea, Bosch, COGEN Europe, DTU, Element Energy, HSLU, SOLIDpower, Sunfire, Viessmann

PACE at a glance

Promoting a successful transition to the large-scale uptake of Fuel Cell micro-Cogeneration across Europe

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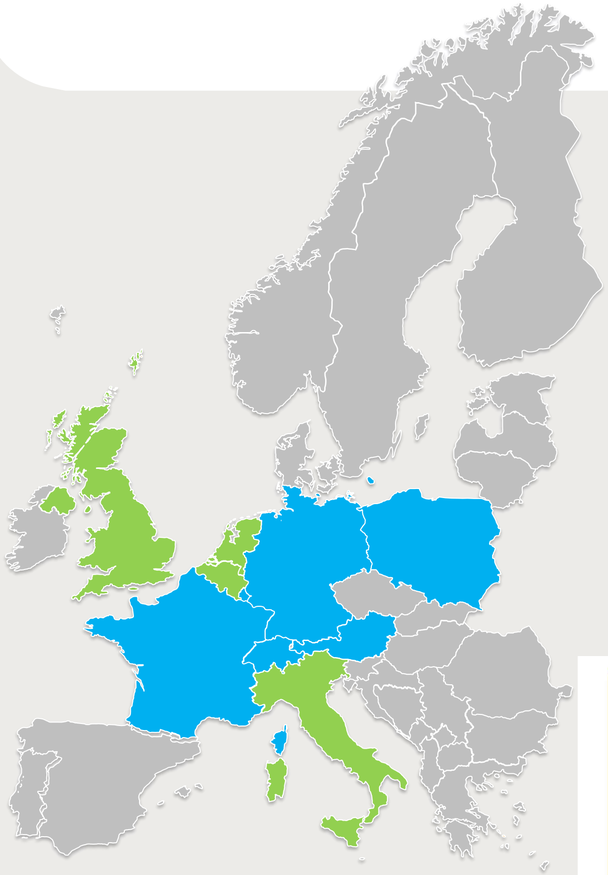
FUEL CELLS AND HYDROGEN JOINT UNDERTAKING



Units deployment + installer training + targeted market & policy development activities

Units deployment + installer training

9
Partners
Representing manufacturers, utilities & research community

> 2,800
Fuel Cell micro-Cogeneration units
To be deployed across Europe between 2016-2021

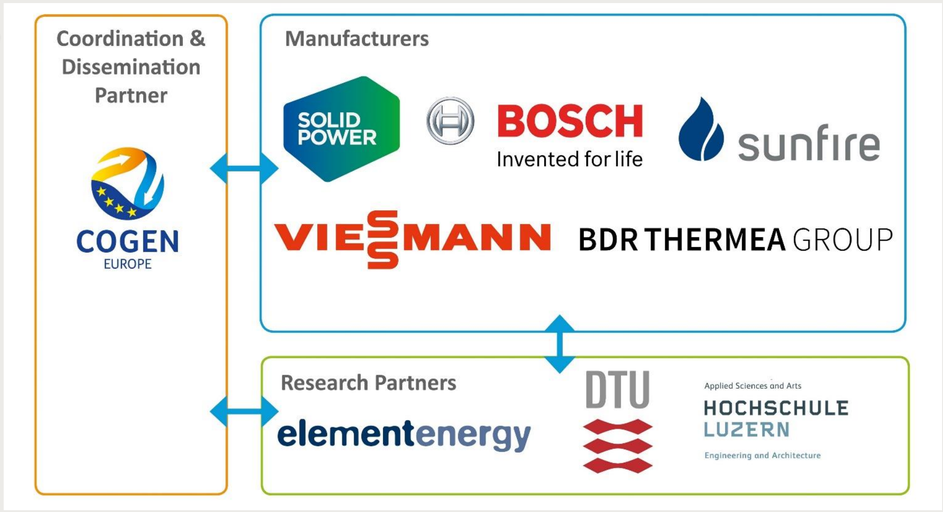
>500
Systems per manufacturer
Established production capacity per manufacturer

10
Countries
Where the units will be installed

4
Countries
Selected for policy & market development (Belgium, Italy, Netherlands and UK)

€90m
Total budget
Including €33.9m Horizon 2020 funding via FCH JU

5
Years
Project duration of 63 months (June 2016 – August 2021)



>10,000
FC micro-cogeneration units/year post 2020

Overview of systems in PACE

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Buderus: Logapower FC10.2	Buderus: System Logaplus	BlueGEN	BlueGEN BG15	Dachs 0.8	eLecta	Vitovalor 300-P, PA2 and SA2	Sunfire-Home 750
							
100	200	750		200	300	>750	500
SOFC	SOFC	SOFC	SOFC	PEM	PEM	PEM & SOFC	SOFC
0.7kW	1.5kW	1.5kW	1.5kW	0.75kW	0.75kW	0.75kW	0.75kW
Buderus JUNKERS	Buderus	SOLID POWER	SOLID POWER	BDR THERMEA GROUP SENERTEC	BDR THERMEA GROUP remeha	VIESMANN	sunfire
1-2 family homes (up to end 2018)	1-2 family homes, residential buildings and SMEs with high electricity demand	SMEs, apartment buildings and multifamily homes		1-2 family houses (for new and existing buildings)		Domestic and small commercial	Residential building (with LPG supply)

Overarching PACE objectives

- **Enhance the state-of-the-art for mCHP performance**
  - Improvements in efficiency and system performance and increased availability to 99%
  - Confirmation of TRL 9 (actual system proven in operational environment) in PACE compared to TRL 7 (system prototype demonstration in operational environment) in Callux and ene.field.
- **Cost reduction through improved design and volume manufacture**
  - Average costs < 10,000 €/FC system by 2020 can be achieved with further investments and support schemes
  - 15 years system lifetime with >50% reduction in stack replacement or no stack replacement during a 10 year service plan
- **Deploy new manufacturing processes for increased capacity**
  - Raising production capacity in the volumes of 1,000 systems/year per OEM by end of 2020
- **Develop efficient routes to market: innovation in sales, marketing and the consumer offer**
- **Identification of potential revenue streams from participation in the power markets and the economic added value from the avoidance of grid expansions**
- **Develop a platform approach to component standardisation for FC mCHP across the EU supply chain**
- **Create the conditions for expansion of the market for FC mCHP across Europe**

*estimated based on data available today

	PACE (average for project)
Numbers of units (to be) installed	>2800
Overall efficiency	>90-97%
Units manufactured per year as part of project	343* (additional units deployed KfW 433)
Manufacturing capacity/year (company level)	1650*
Time before stack replacement (years)	>6
System lifetime (years)	15-17* (Strongly dependent upon system conditions)
Overall development- TRL	8-9
Availability	98-99%

PACE objectives – on track to be achieved by end of project

Availability 99% / TRL 9 / Costs < 10k€/FC / overall efficiency > 90%

Progress on installations of FC mCHPs

Unit deployment

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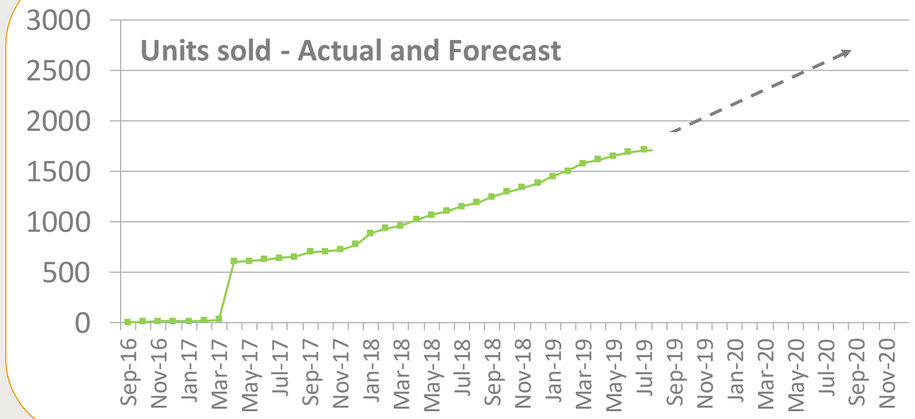
UNIT DEPLOYMENT TO DATE

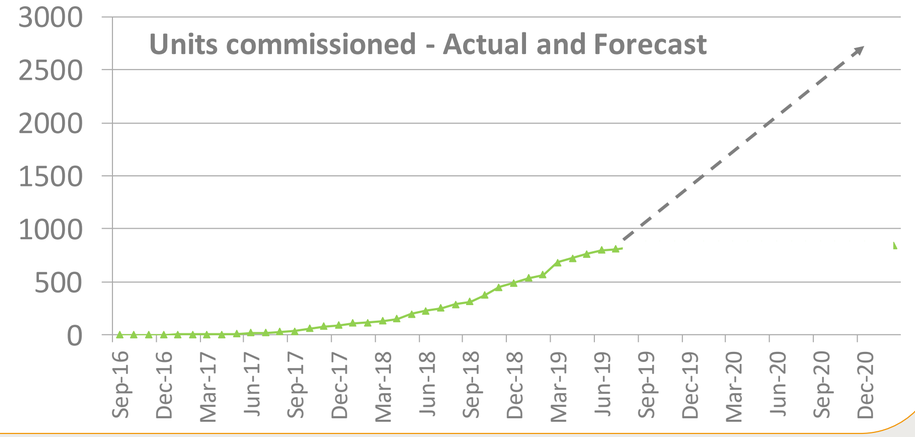
Achievement to-date

FC mCHPs sold
FCmCHPs commissioned

25% 50% 75%

2.800 units





- **29% of units commissioned**
- **60% of units sold**
- **Delay between sold and installed units observed due to various reasons**
- **Some trials about to start**

Units sold are more than forecasted / Units deployed are well on track

% stage of implementation is the % of project *duration* (months) elapsed on 01/11/2019

PACE

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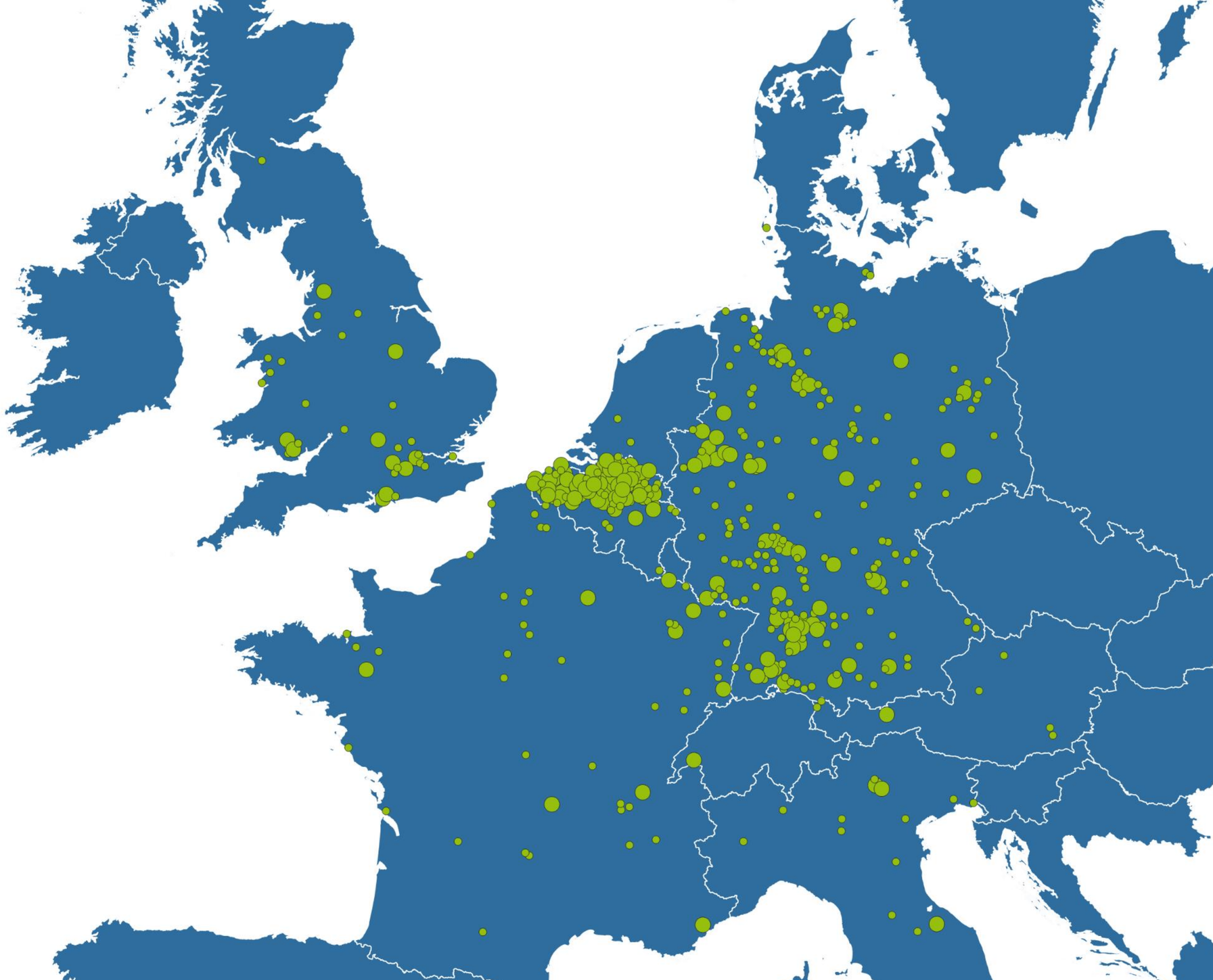
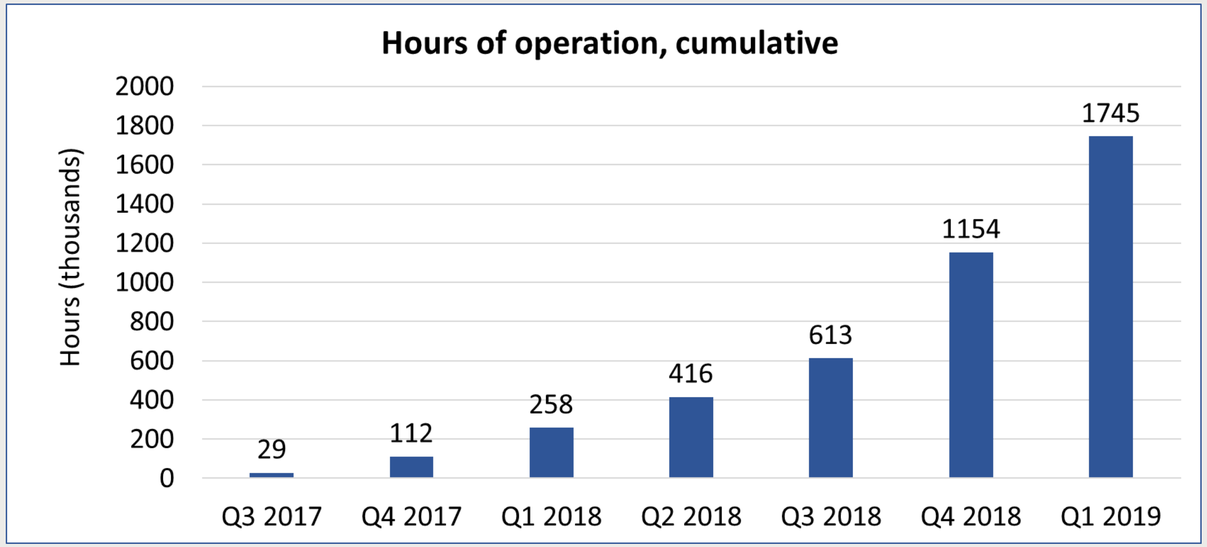
- **108 PACE units installed before April 2018**
- **239 PACE units installed before October 2018**
- **528 PACE units installed before April 2019**
- **857 PACE units installed before October 2019**

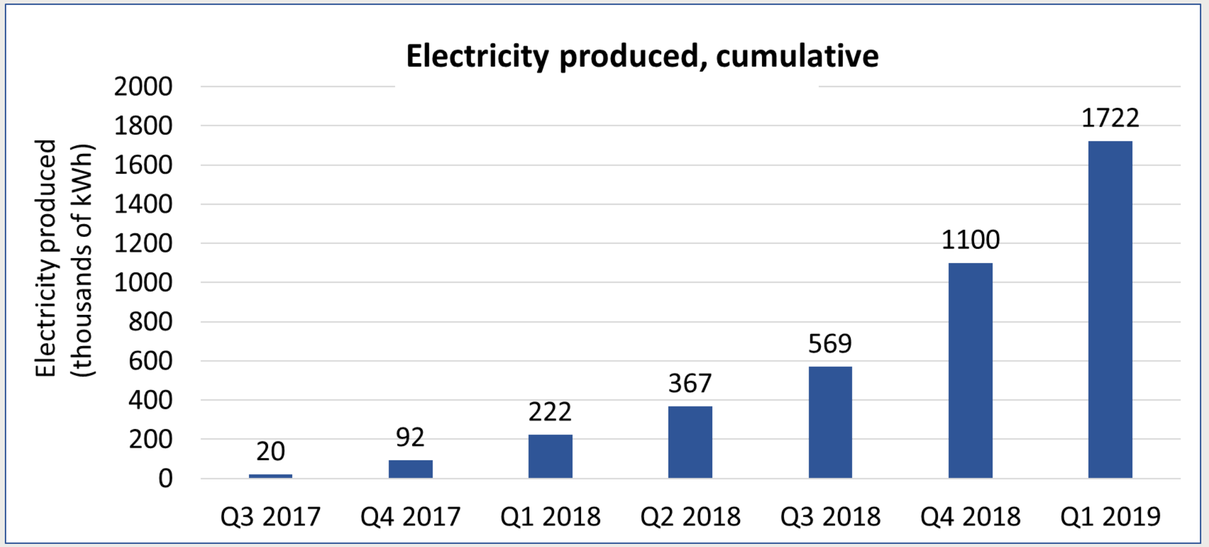


Data collection

Number of units	Total operating hours	Total kWh produced	Efficiency (gas to power utilisation)	Availability
548	1.745.158	1.721.698	35-60%	99%

(as of April 2019)





Source: **PACE D2.1. - 1st annual report on performance validation of units installed**

Customer survey

Overview of customer and building characteristics

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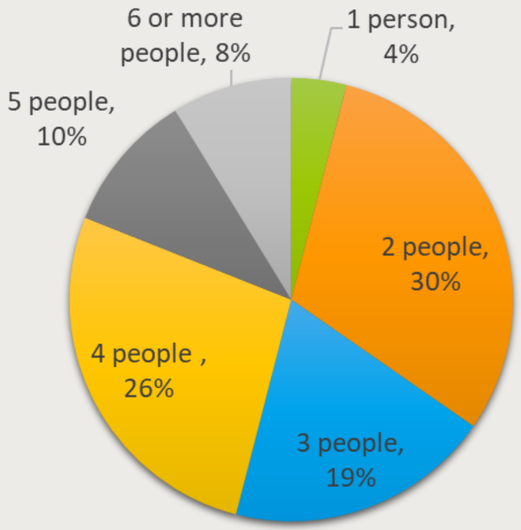
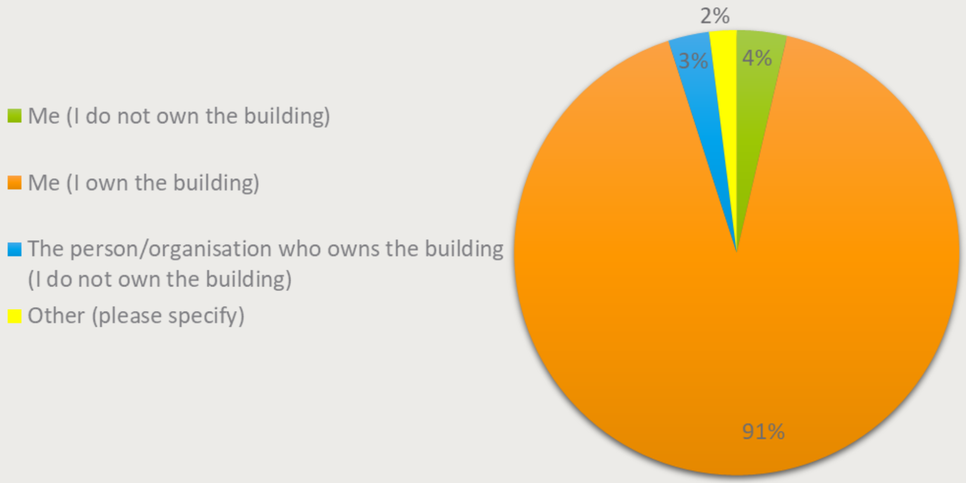
Number of residents



Who decided to buy the FC mCHP



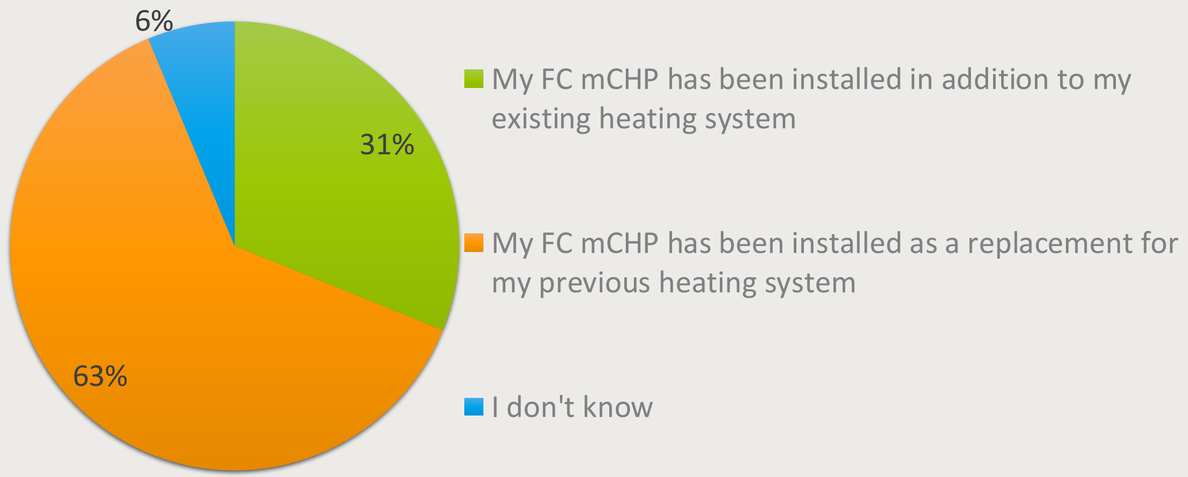
75% of the customers live in a 2-4 person household
95% of the respondents chose to purchase the FC mCHP by themselves
91% of all customers own the building

Source: **PACE Report on customer attitudes to fuel cell micro-CHP**

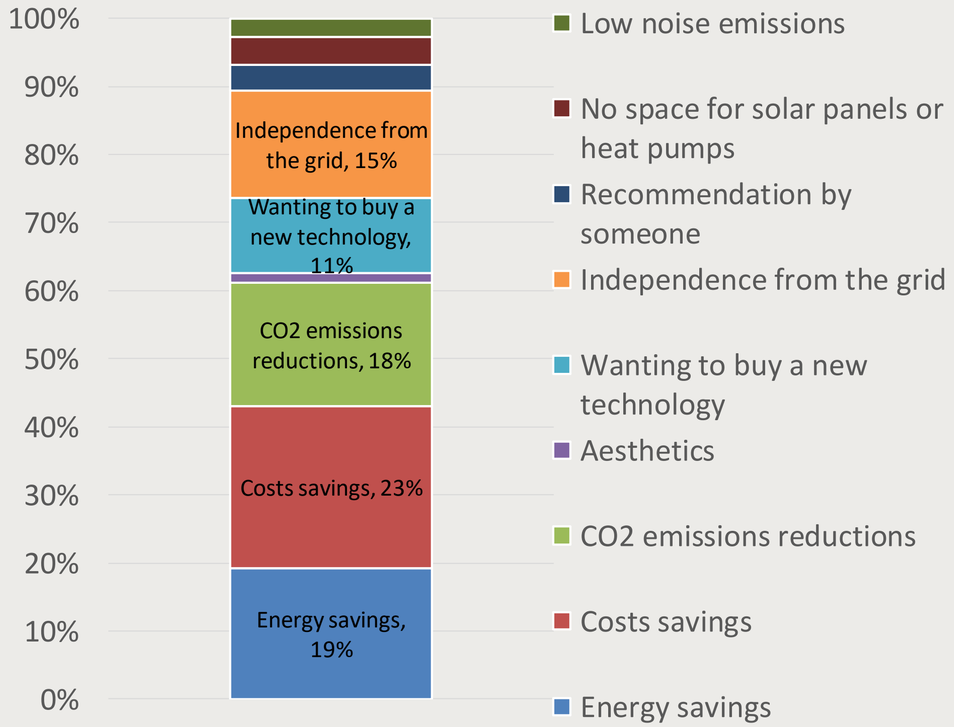
Customer survey

Customers' motivation to purchase a Fuel Cell micro-Cogeneration unit

FC mCHP as a replacement or in addition?



Motivations to purchase FC mCHP?



Motivation to buy: Mostly linked to CO2, energy or costs savings opportunity

Replacement or add on: 63% replaced the existing heating system

31% in addition to existing heating systems

Source: **PACE Report on customer attitudes to fuel cell**

Customer survey

Overview of customer and building characteristics

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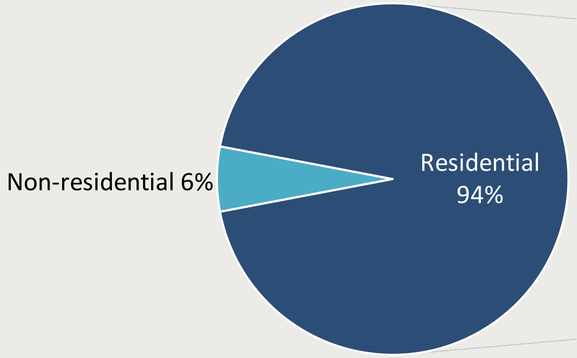
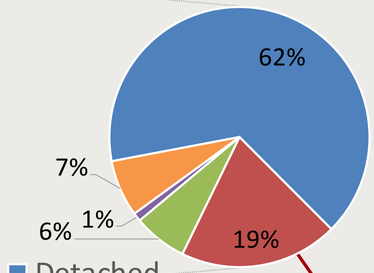
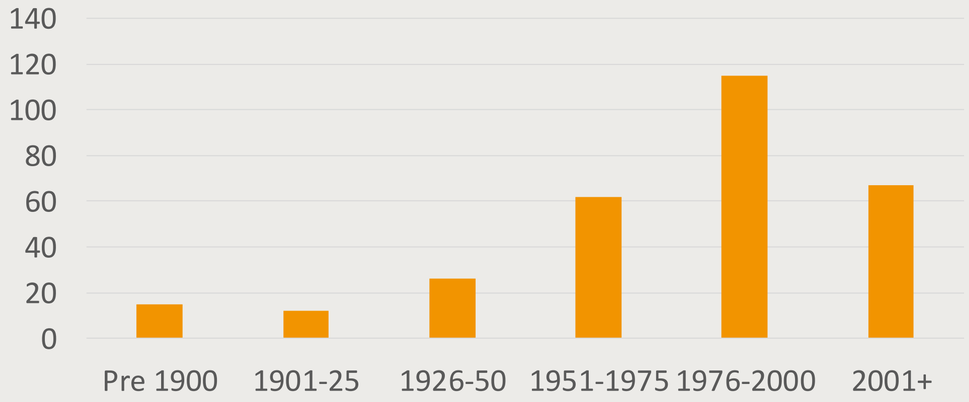
Building type



Non residential: offices, educational building, hotel, restaurant, wholesale and retail trade, others,



Year of construction



Building type: 94% Residential; 81% (Semi) – detached
Building age : Most building relatively modern < 50Y

Source: **PACE Report on customer attitudes to fuel cell micro-CHP**

Customer survey

Customers' Willingness to pay for a Fuel Cell micro-Cogeneration unit

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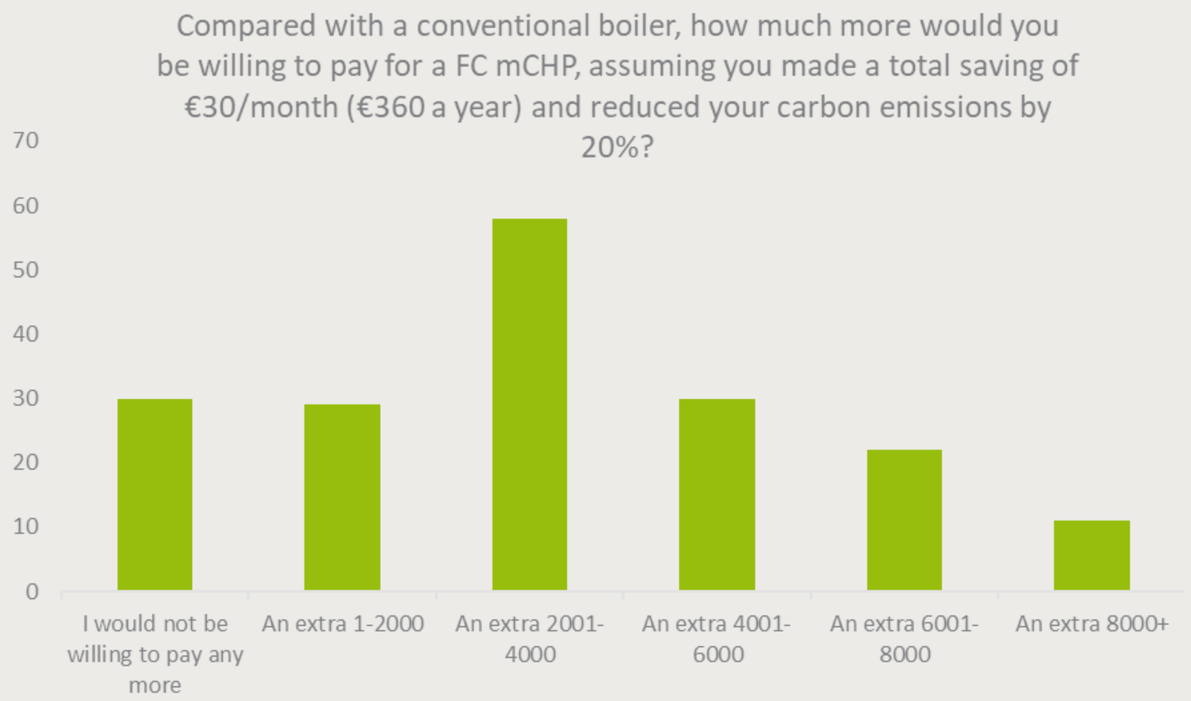
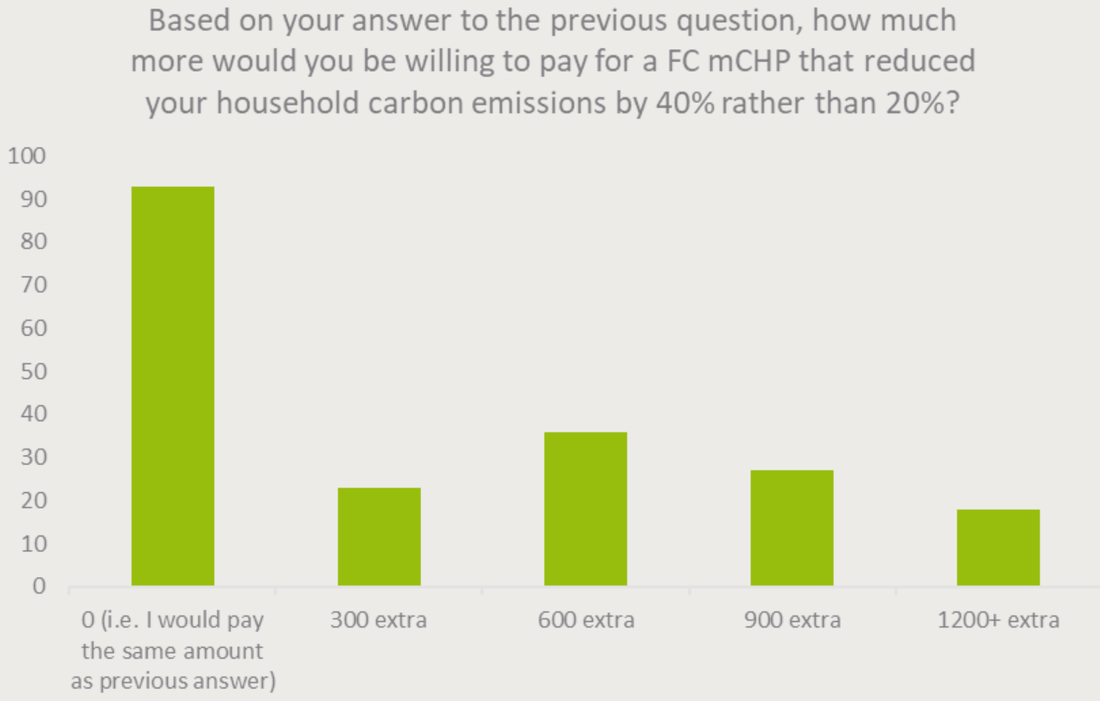
Willingness to pay more for a FC mCHP than for incumbent technology





72% of respondents would to pay more for a FC mCHP as for incumbent technology
>50% would be willing to pay an additional €2,000 or more assuming operational savings (€ 30/month) and reduced carbon emissions (-20%)

Source: **PACE Report on customer attitudes to fuel cell micro-CHP**

Joint Declaration on Stationary Fuel Cells for Green Buildings

Joint Declaration on Stationary Fuel Cells for Green Buildings

We, the signatories of this declaration, acknowledge the global challenge posed by climate change and recognise the potential of Stationary Fuel Cells in the decarbonisation of the buildings sector.

Households and small businesses will play a vital role in the transition towards a decarbonised society. With heating and cooling in buildings responsible for 36% of carbon emissions in Europe, there is enormous potential to reduce our carbon footprint in the buildings sector through efficient, renewable and decentralised smart energy solutions.

Delivering an ambitious and just energy transition means establishing low-carbon technologies as the norm, while maintaining customer choice and ensuring the affordability of energy services. Stationary Fuel Cells have emerged as a key solution to these challenges – a solution that can contribute towards a progressive, consumer-centred pathway to carbon neutral homes and businesses by 2050.

Stationary Fuel Cells reduce energy consumption, carbon emissions and local air pollution. They can be connected to the gas grid or installed off grid, but they use hydrogen to efficiently produce heat and power and will increasingly run on renewable hydrogen or synthetic gases. Their deployment will help transform Europeans from energy consumers to energy 'prosumers' (producer-consumers), putting them at the centre of a future decentralised energy system.

Stationary Fuel Cells will increase the resilience of our increasingly renewable energy system by providing electricity when wind and solar energy output is low.

The signatories of this declaration stress that Stationary Fuel Cells have tremendous potential to contribute to the EU's climate and energy objectives today and in the future, as part of a package of technology and market solutions tailored to residential and commercial buildings. Stationary Fuel Cells are at a critical stage in market adoption. Production and market uptake need to be increased and consumer and supply chain awareness must improve.

To maximise the decarbonisation potential of Stationary Fuel Cells we need sound and ambitious policies at European, national and local level to create a level-playing field for all energy solutions. Secondly, we need a commitment by industry to innovate in technology solutions, market deployment and customer empowerment. Finally, targeted funding and financing opportunities will address the industry's needs and bridge the gap between early market uptake and mass commercialisation.

The signatories are committed to fostering opportunities for the fuel cells and hydrogen sector, ensuring it can reach its potential and significantly contribute towards EU's energy, climate and competitiveness objectives as well as the urgent climate action needed at global level.

Political character of this initiative: This document does not create any legal rights or obligations and does not intend to replace or modify any existing legal rights or obligations.

The PACE and ComSos projects have received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking respectively under grant agreement No 700339 and grant agreement No 779481. This Joint Undertaking receives support from the European Union's Horizon 2020 research and innovation programme and Hydrogen Europe and Hydrogen Research.

- **What?** Joint declaration on Stationary Fuel Cells (SFC) launched by the PACE and ComSos project
- **Why?** SFC as key solution to the decarbonisation challenge
- **Calling upon:**
  - Sound and ambitious policies at European, national and local level
  - Commitment by industry to innovate
  - Targeted funding and financing opportunities
- **Who?** The signatories are committed to fostering hydrogen sector

SIGN THE DECLARATION NOW ON
www.pace-energy.eu

Conclusions and recommendations

Fuel Cell micro-Cogeneration

Pathway to a Competitive European Fuel Cell micro-CHP Market

No regret

Future compatible

Providing the fastest carbon reduction pathway

30-50% CO2 emission reductions TODAY

Fuel flexible and technology neutral

FC m-CHP could be reversible and **fully operated on H2 in the future**

Enabler of the integrated energy system of the future

Policy framework to create a **level playing field** on the pathway to decarbonisation, accounting for all benefits of FC m-CHP

Background slides

Fuel Cell micro-Cogeneration empowering consumers towards a low-carbon future

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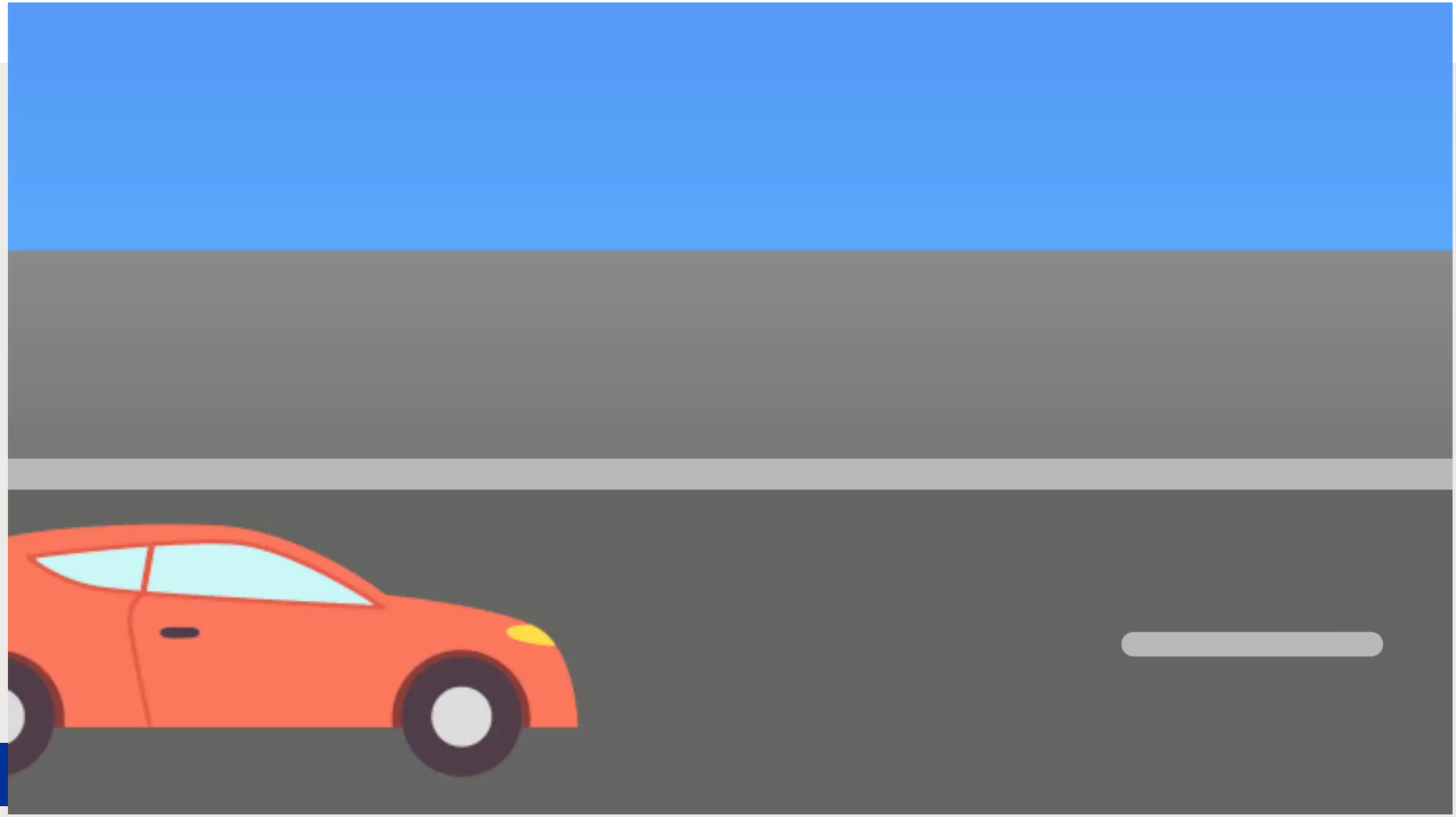

PACE at international trade fairs and installers' trainings

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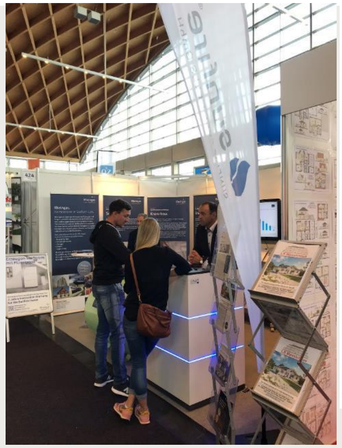

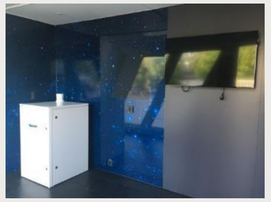

PACE communication and dissemination activities

PACE
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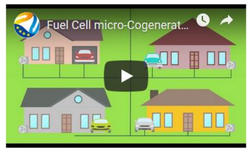
Fuel Cell micro-Cogeneration: Your home unit to a low-carbon energy future!

Generate your own low-carbon electricity and heat with Fuel Cell micro-Cogeneration and save on your energy bill!



Fuel Cell micro-Cogeneration: Putting empowered European citizens on the road to a low-carbon energy future!

Fuel Cell micro-Cogeneration is a very efficient technology to generate your own heat and electricity at home or business using hydrogen and fuel cells.

Fuel Cell micro-Cogeneration: A new business opportunity for the energy sector!

Fuel Cell micro-Cogeneration is a very efficient technology to generate heat and electricity at home or in a small business using hydrogen and fuel cells. This new technology brings many benefits to the entire energy sector.