

Pathway to a Competitive European  
Fuel Cell micro-CHP Market

# Andreas Frömmel

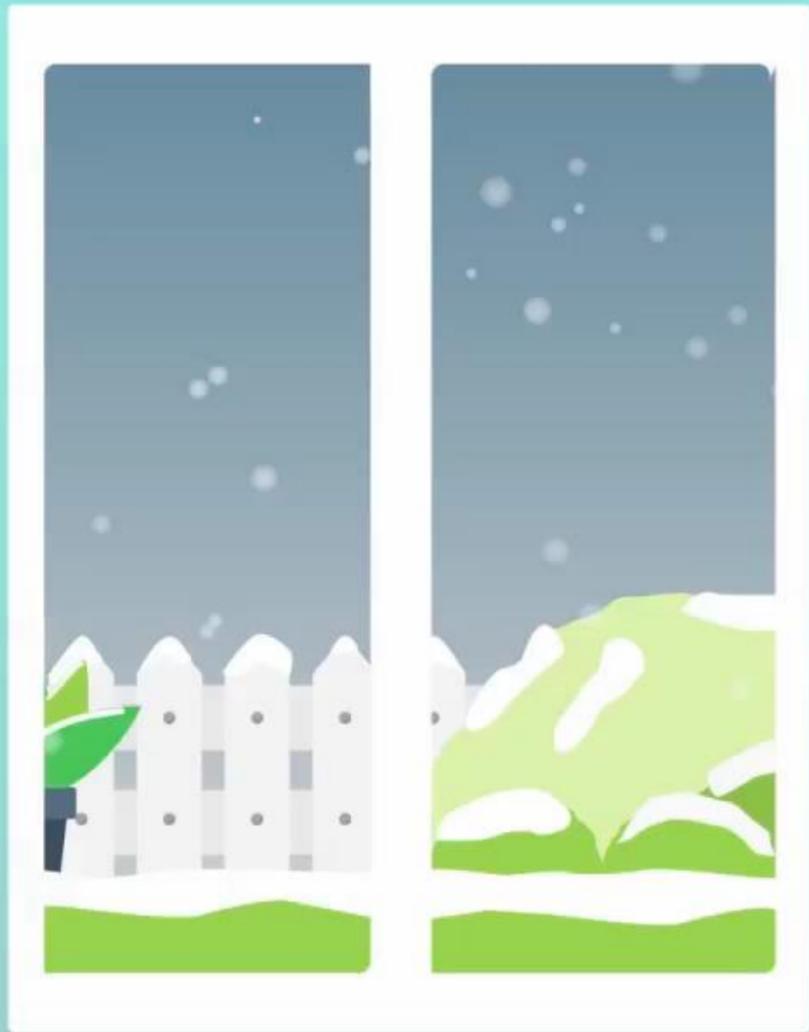
## Sunfire

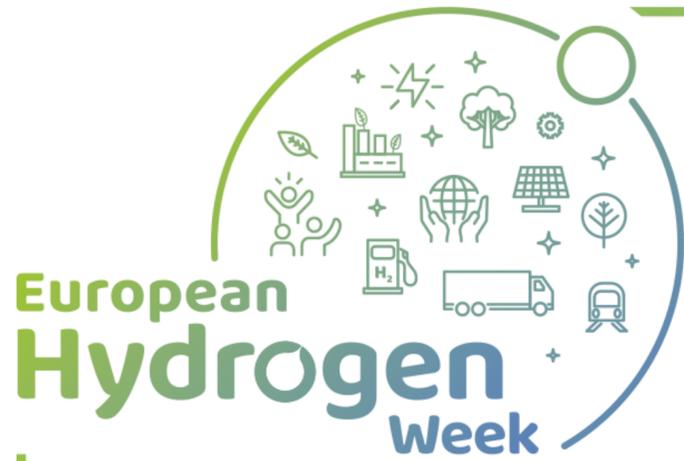
[www.pace-energy.eu](http://www.pace-energy.eu)

[info@pace-energy.eu](mailto:info@pace-energy.eu)

#PRD2020  
#CleanHydrogen

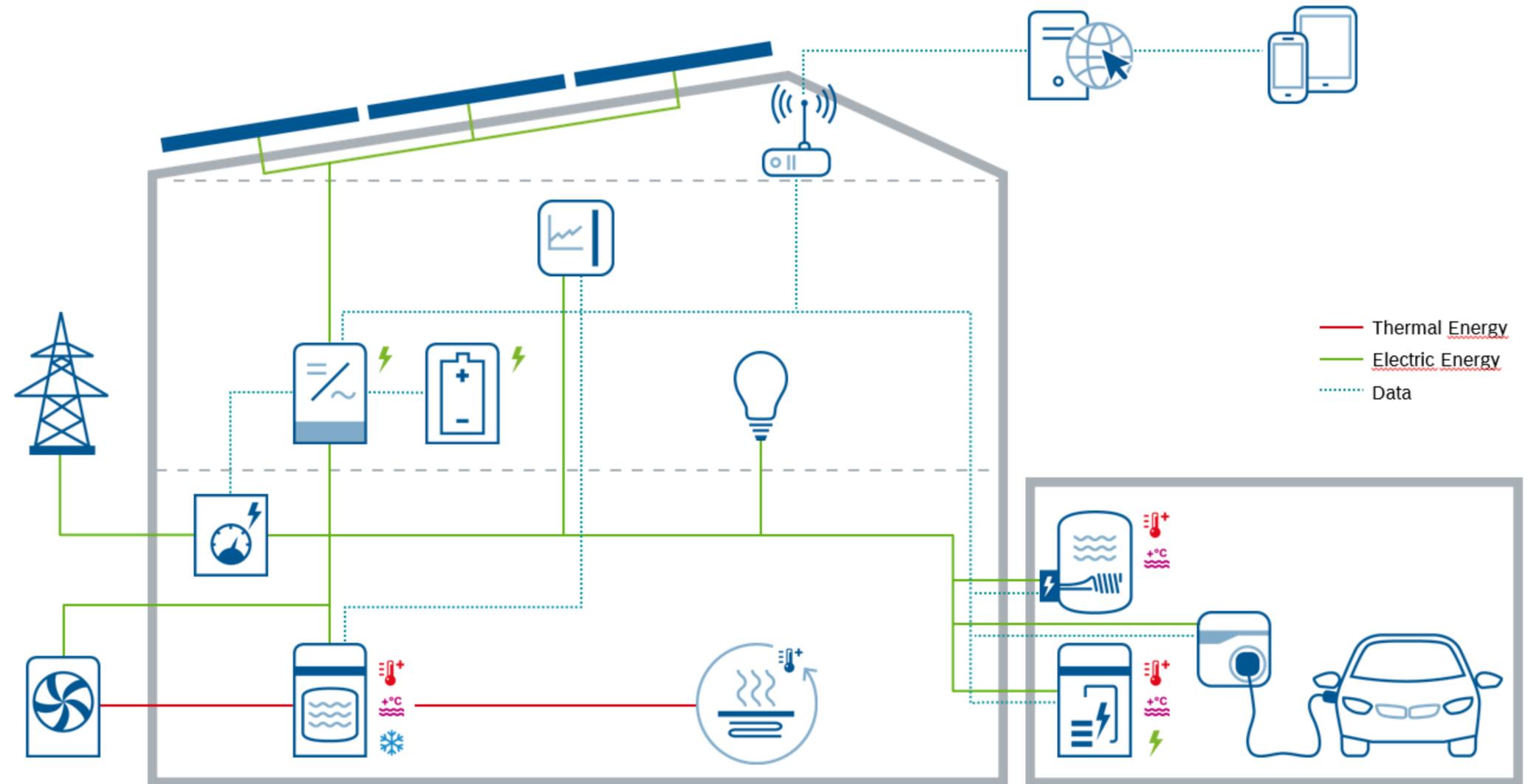






# What and why fuel cell micro-cogeneration?

## Heating and Powering your home



Empowers consumers



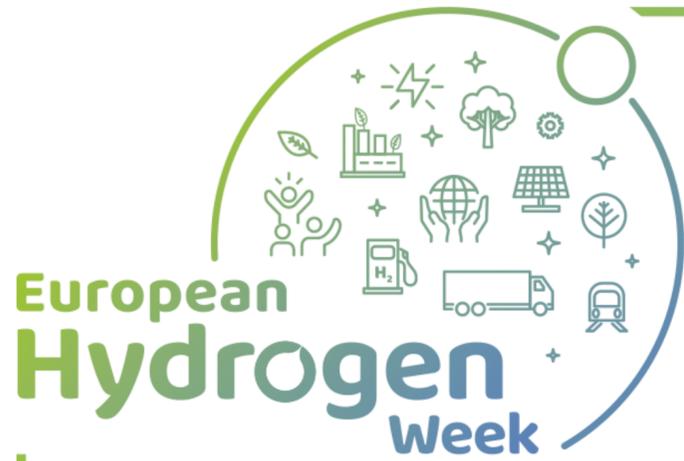
Supports the European energy transition



Provides greater flexibility for the energy system

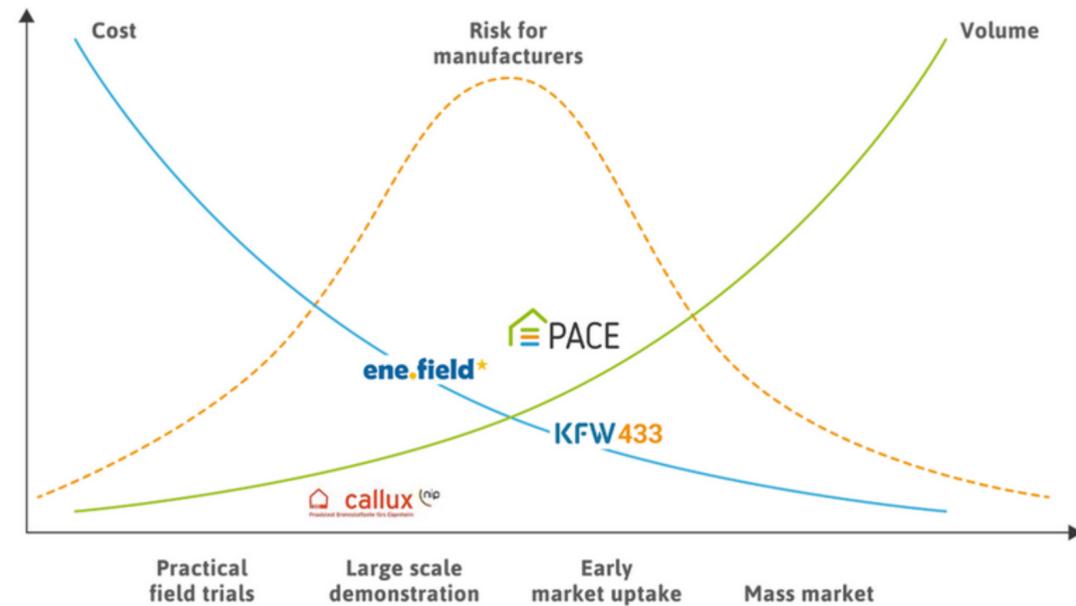


Fosters innovation and high-value jobs



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

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



Reduce costs and improve competitiveness

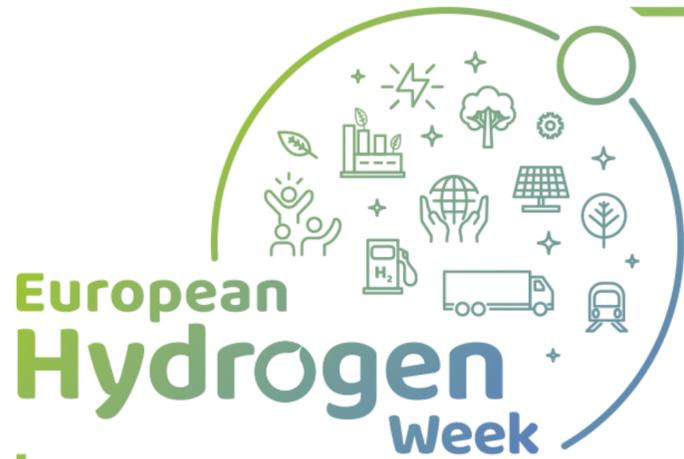
Improve products' performance

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

<p><b>Callux</b></p> <ul style="list-style-type: none"> <li>• Period: 2008 – 2015</li> <li>• Total budget: €75 million</li> <li>• German NIP co-financing: 50%</li> <li>• 500 systems installed in Germany</li> <li>• &gt; 5 million operating hours</li> <li>• CO<sub>2</sub> reduction by 30% on average per year</li> </ul>	<p><b>ene.field</b></p> <ul style="list-style-type: none"> <li>• Period: 2012 – 2017</li> <li>• Total budget: €52 million</li> <li>• EU co-financing (FCH JU/FP7): 50%</li> <li>• &gt; 1,000 systems installed in 11 European countries</li> <li>• &gt; 3 million operating hours so far</li> </ul>	<p><b>PACE</b></p> <ul style="list-style-type: none"> <li>• Period: 2016 – 2021</li> <li>• Total budget: €90 million</li> <li>• EU co-financing (FCH JU/Horizon 2020): 37%</li> <li>• &gt; 2,500 systems to be installed</li> <li>• in 11 European countries</li> <li>• 500 units/manufacture</li> </ul>	<p><b>KFW433</b></p> <ul style="list-style-type: none"> <li>• Period: started in 2016</li> <li>• German NOW NIP grant scheme administered by KfW bank</li> <li>• Beneficiaries: End customers</li> <li>• Eligible size: 0.25 kWe – 5 kWe</li> <li>• Grant value per system: €5,700 – €28,000</li> </ul>
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## PROJECT OVERVIEW

- Call year: 2016
- Call topic: Large scale demonstration of  $\mu$ CHP fuel cells
- Project dates: 01/06/2016 – 31/08/2021
- % stage of implementation 01/11/2017: 78% as of 01/10/2020
- 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



# New systems in PACE

## Summary report on generation 2 systems

- PACE Deliverable 1.7 provides information on the next generation ('Generation Y' or 'Generation 2' FC mCHP systems being deployed by the unit manufacturers in PACE. Information in the report includes:
  - Technical specifications of the new units;
  - Improvements made from the previous unit generation;
  - Feedback from customers;
  - Market material for all manufacturers and methods for meeting and contacting manufacturers.

### sunfire Sunfire-Home 750

- Operation with liquid gas (propane/butane) and therefore a clean alternative to fuel oil.
- Heat extraction also possible at high return temperatures (up to max. 65 °C). Ideal for existing buildings.
- Continuous operation possible, as no regeneration times are required.
- "Made in Germany" - from development to the finished product

### Sunfire-Home in Action



### Product Highlights



### Fair event and training with installers' feed back



Installers' feedback to newest model: High quality and very flexible



### Fuel Cell Success Story

House Type: Private  
Installation Year: 2019  
> Renovation of an old listed building



### Two BlueGEN for a villa

Here, two BlueGEN BG-15s supply a historic villa with highly efficient energy. Despite the exterior of the house dating from a different time, modern technology in the form of the BlueGEN units ensures a highly efficient energy supply

"I have a green heart, and so I want to use clean energy for our house."

### Customer's wish

- A sustainable overall energy concept for the new heat and power supply
- A reduction in electricity costs

### Technical requirements

- Challenge: Monument protection
- Installations: wall heating, brine water heat pump, sauna & oven with 9 kW electr. Power and an electric car

### The efficient villa of the Wintzen family

Since 2012 Patricia and Bernd Wintzen have lived in the Villa Högges in Viersen. The red brick and the white frames of the windows immediately catch the eye. But although the villa is more than 100 years old, it is by no means from another time. On the contrary: two innovative BlueGEN BG-15 fuel cells provide the Wintzen family with clean, efficient and low-cost electricity.



Built in 1908, the villa with 350 square metres of residential space has been a listed building since 1989. And this was a particular challenge in the refurbishment, not least because insulation of the exterior facade is only possible on the back of the house due to the monument protection and was implemented in 2017. Due to the lack of insulation and the single glazing, the entire house requires heating throughout the winter months in order to avoid cooling, even individual rooms. From the central stairwell, the heat is redistributed into the adjoining rooms, even when the landlords are travelling.



# Overview of systems in PACE

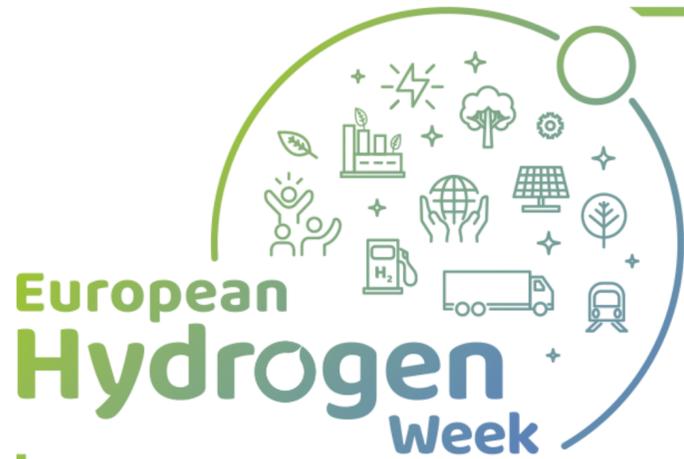
Buderus: Logapower FC10.2	Buderus: System Logaplus	BlueGEN	BlueGEN BG15	Dachs 0.8	eLecta	Vitovvalor 300- P, PA2 and SA2	Sunfire-Home 750
100	200	750		200	300	>750	500
SOFC	SOFC	SOFC	SOFC	PEM	PEM	PEM & SOFC	SOFC
0.7kW	1.5kW	1.5kW	1.5kW	0.75kW	0.75kW	0.75kW	0.75kW
1-2 family homes (up to end 2018)	1-2 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)



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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**
- **1339 PACE units installed before August 2020**

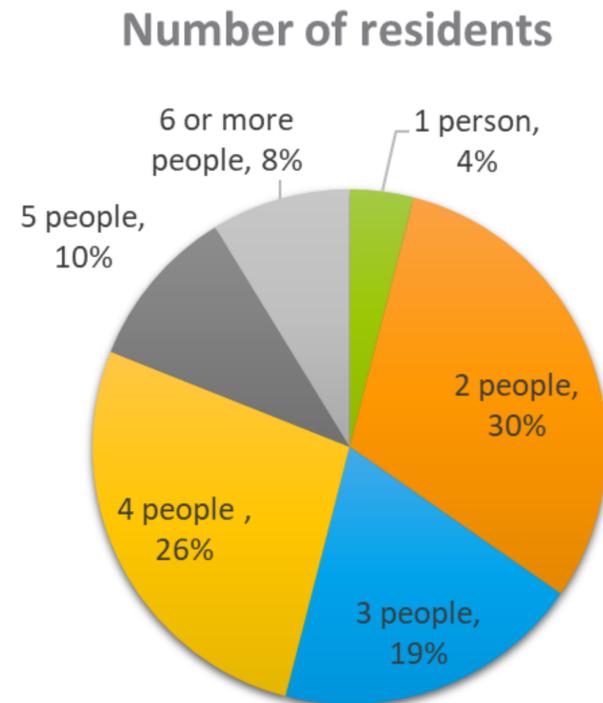




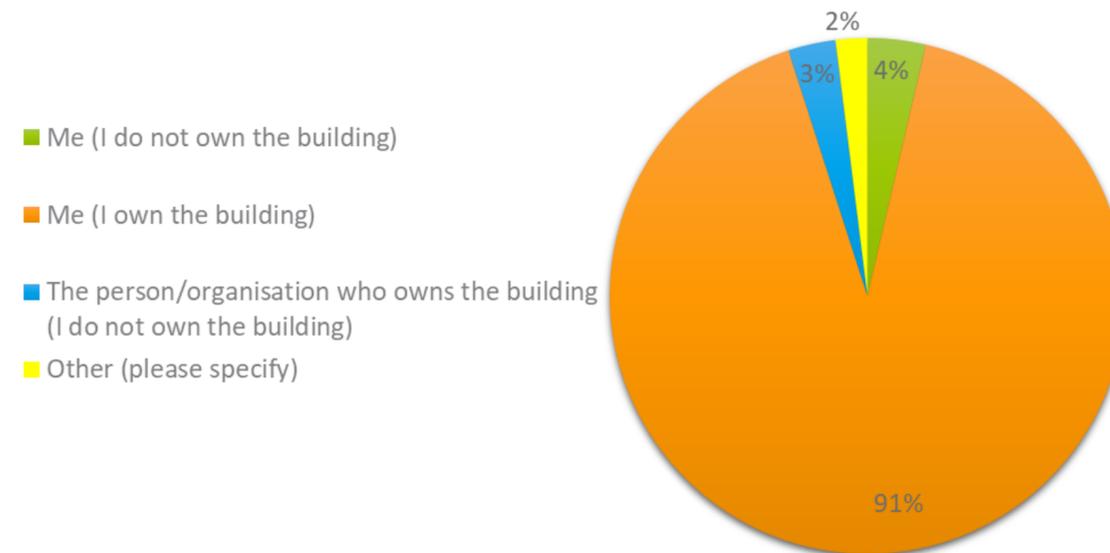
# Customer survey

Overview of customer and building characteristics

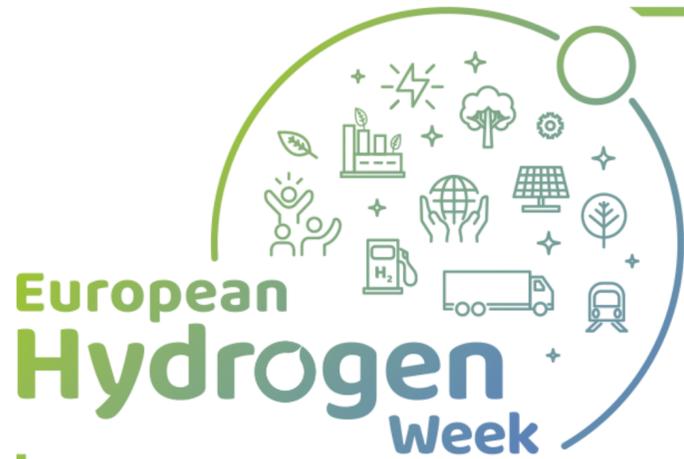
## Number of residents



## Who decided to buy the FC mCHP



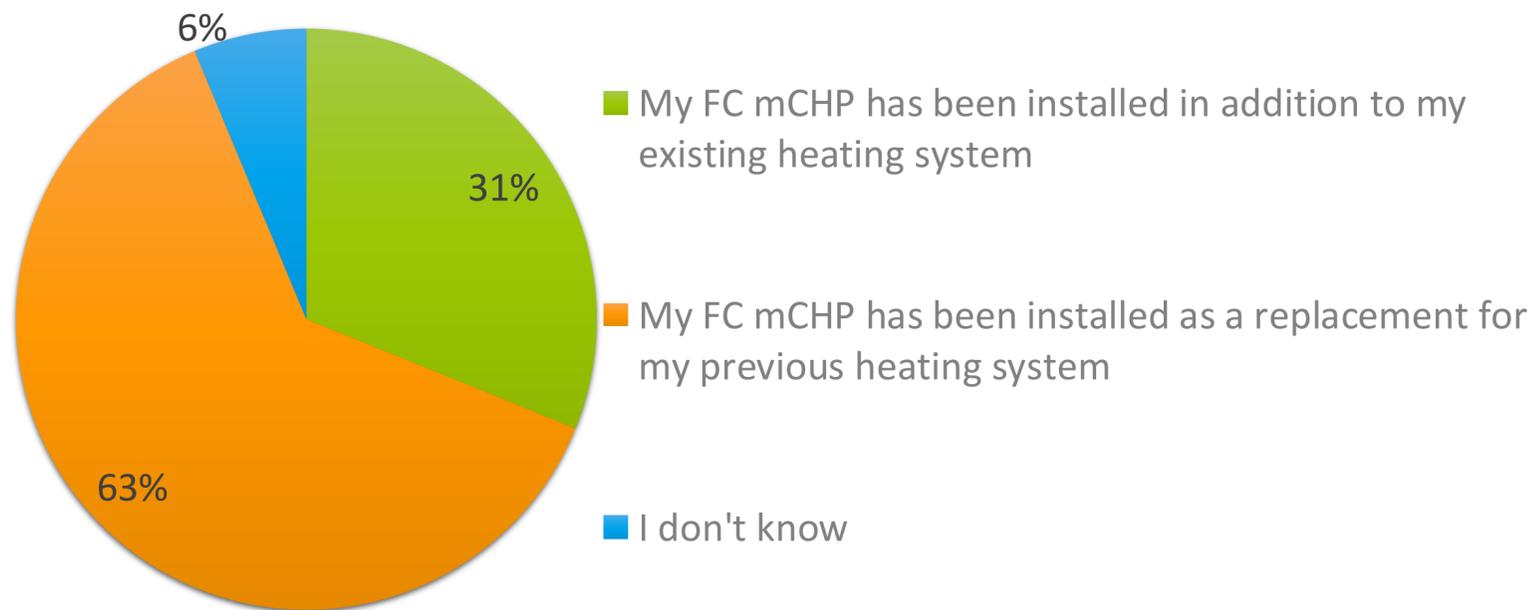
75% of the customers live in a 2-4 person household  
 95% of the respondents chose to purchase the FC mCHP by themselves  
 91% of all customers own the building



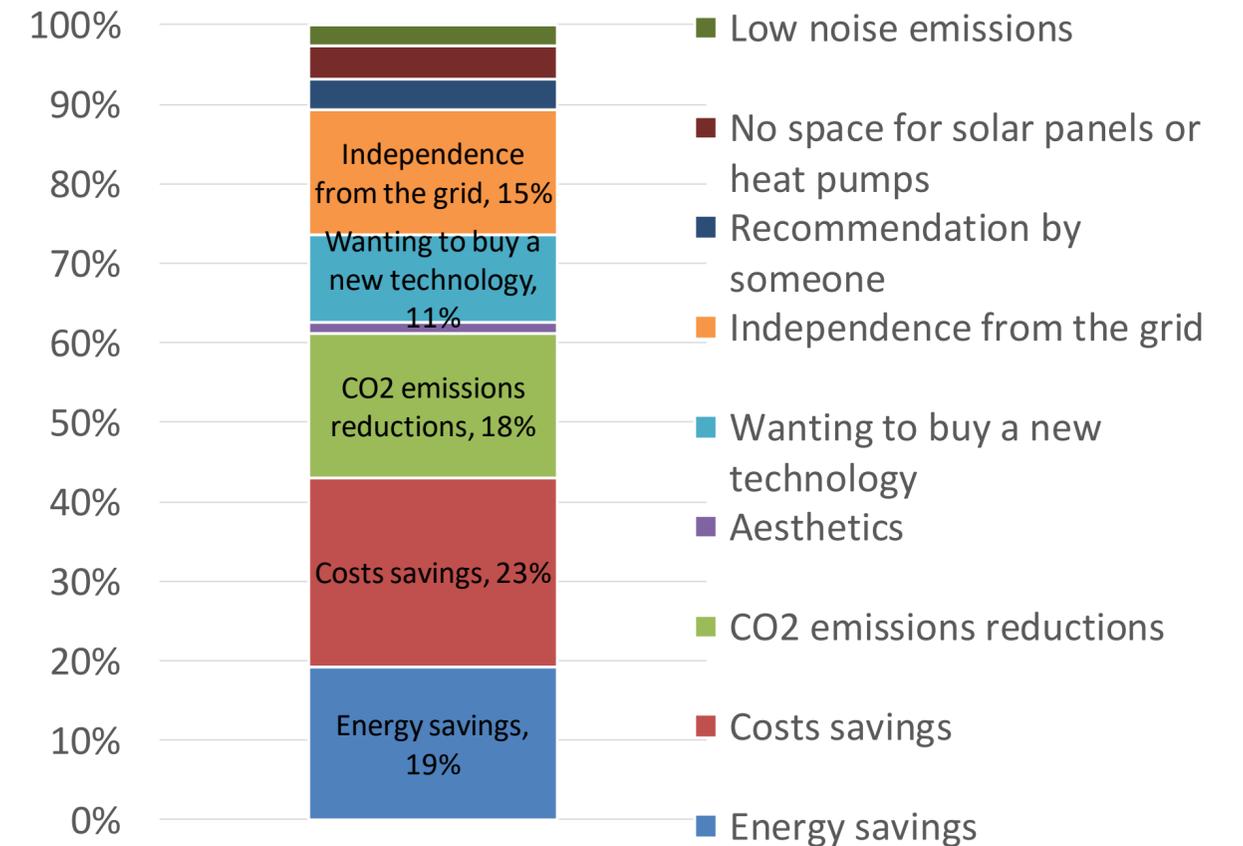
# Customer survey

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

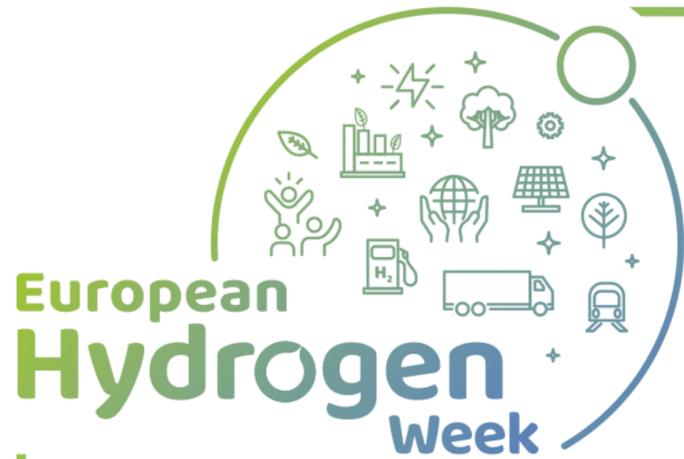
## FC mCHP as a replacement or in addition?



## 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



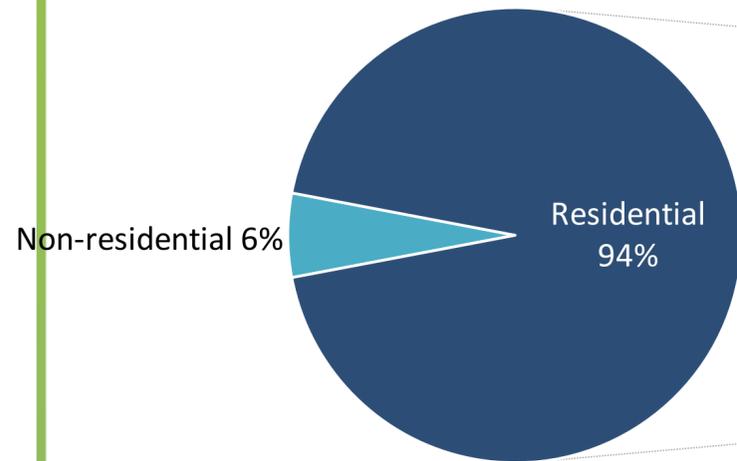
# Customer survey

## Overview of customer and building characteristics

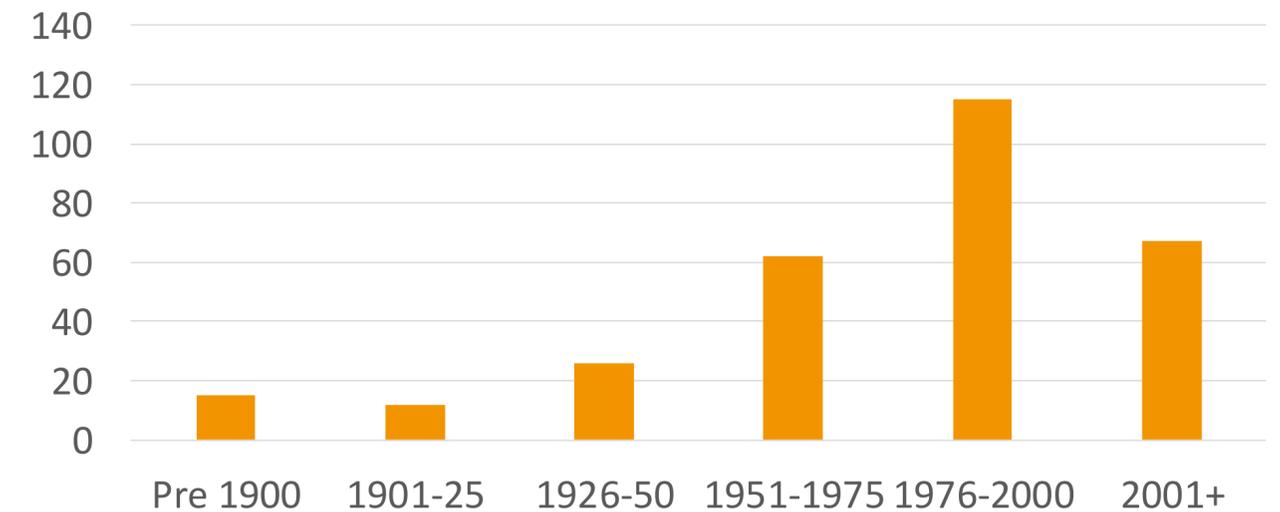
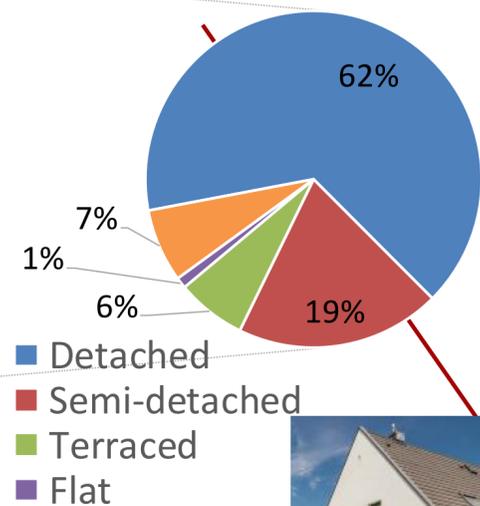
### Building type



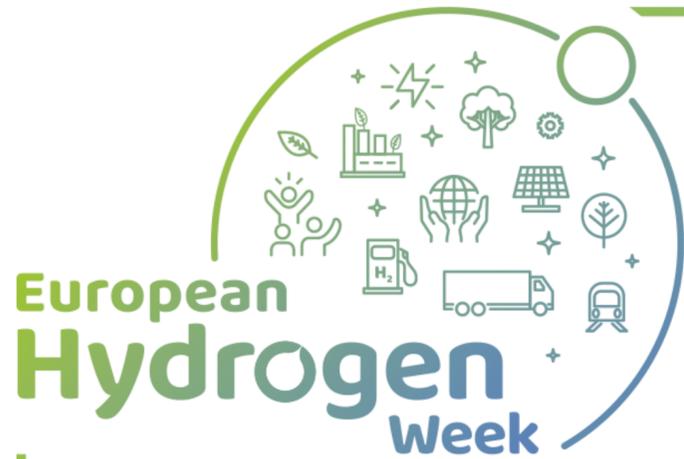
### Year of construction



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

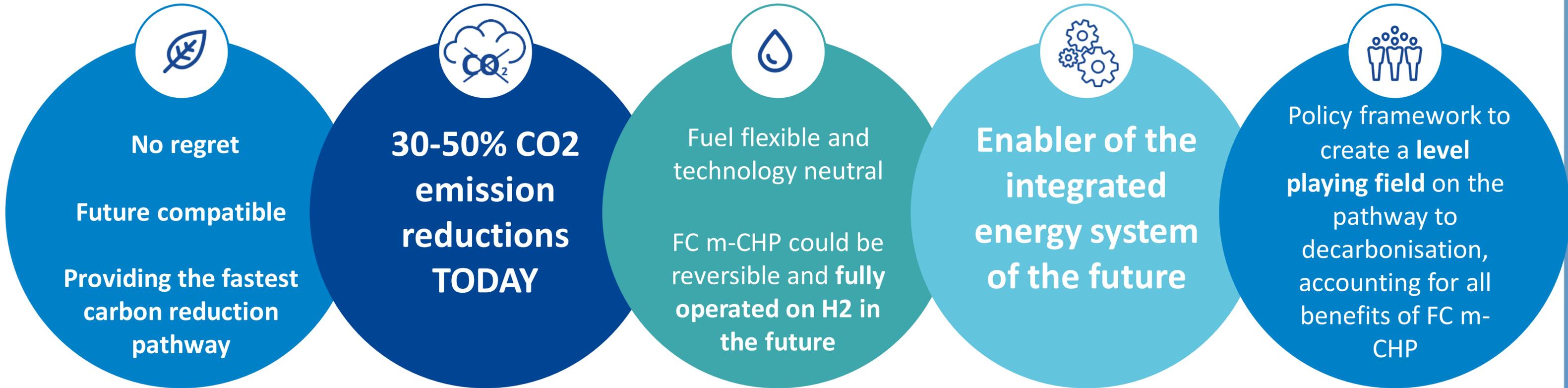


**Building type: 94% Residential; 81% (Semi) – detached**  
**Building age: Most building relatively modern < 50Y**



# Conclusions and recommendations

## Fuel Cell micro-Cogeneration



# PACE at international trade fairs and installers' trainings



# PACE communication and dissemination activities



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!



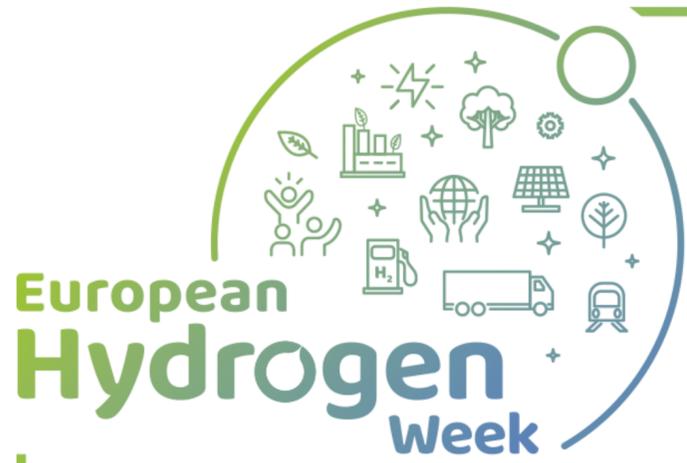
Fuel Cell micro-Cogeneration: Putting empowered European citizens on the road to a low-carbon energy future!

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.

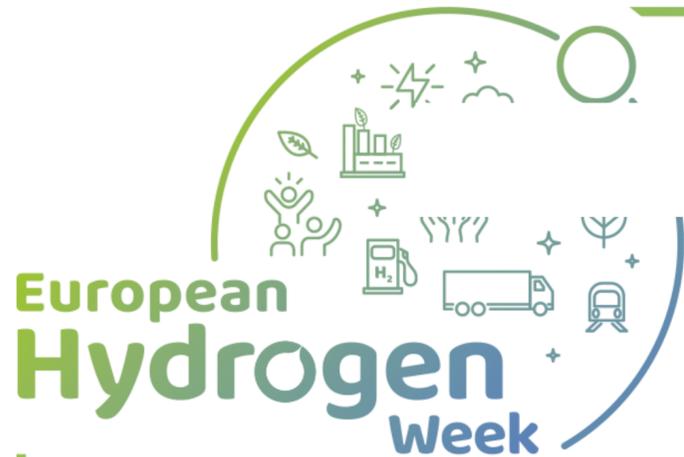




# Back-up slides

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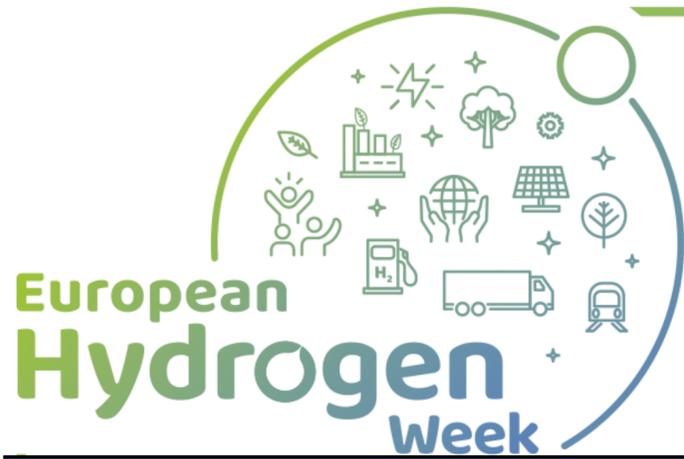
# Overarching PACE objectives

- 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.
- Increased manufacturing volume leading to a reduction in cost over time
  - Increased company level manufacturing capacity to over 1000 units/year for each manufacturer will lead to reductions in unit price for the consumer over time
  - 15 years system lifetime with >50% reduction in stack replacement or no stack replacement during a 10 year service plan
- 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 Availability	8-9 99%

**PACE objectives – on track to be achieved by end of project**  
 Availability 99% / TRL 9 / Costs < 10k€/FC / overall efficiency > 90%

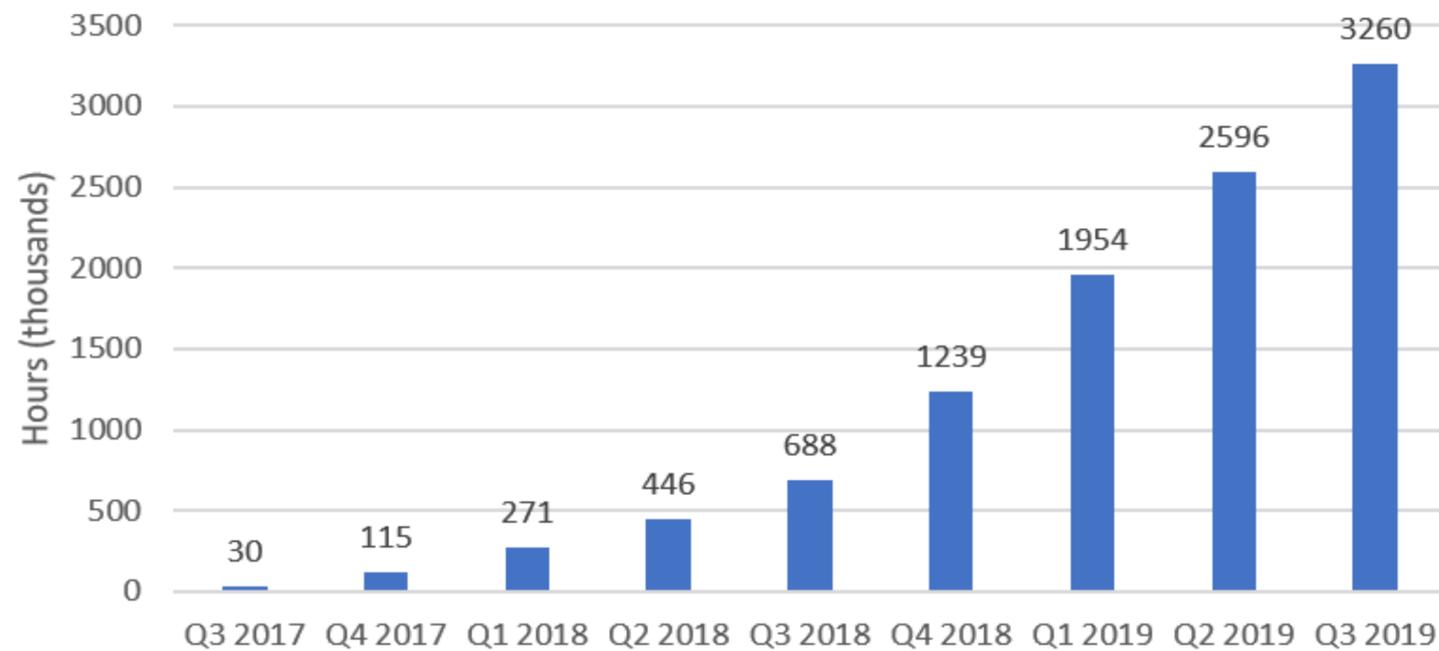


# Data collection

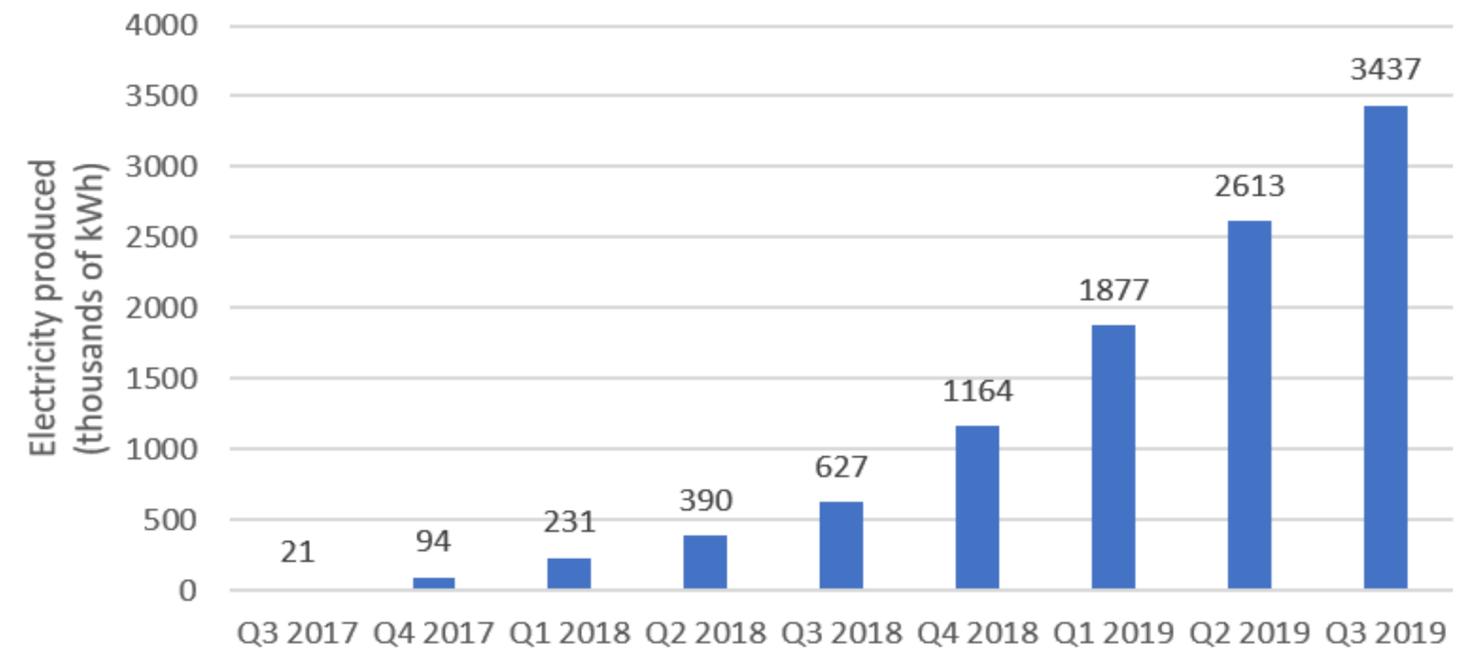
Number of units	Total operating hours	Total kWh produced	Efficiency (gas to power utilisation)	Availability
<b>1.339</b>	<b>3.259.742</b>	<b>3.436.612</b>	<b>35-60%</b>	<b>99%</b>

(as of October 2019)

### Hours of operation, cumulative



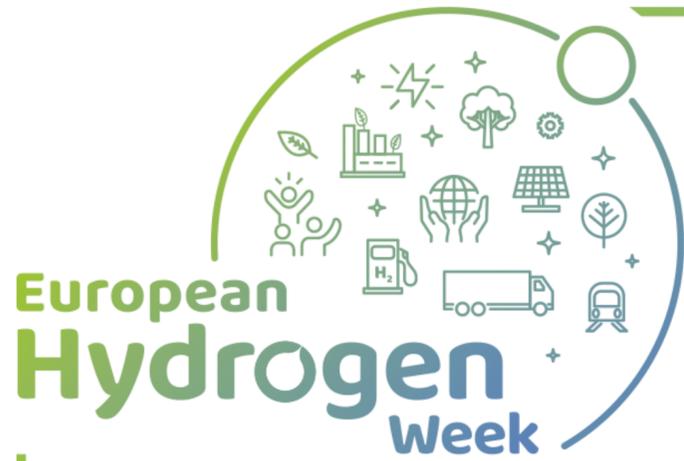
### Electricity produced, cumulative



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



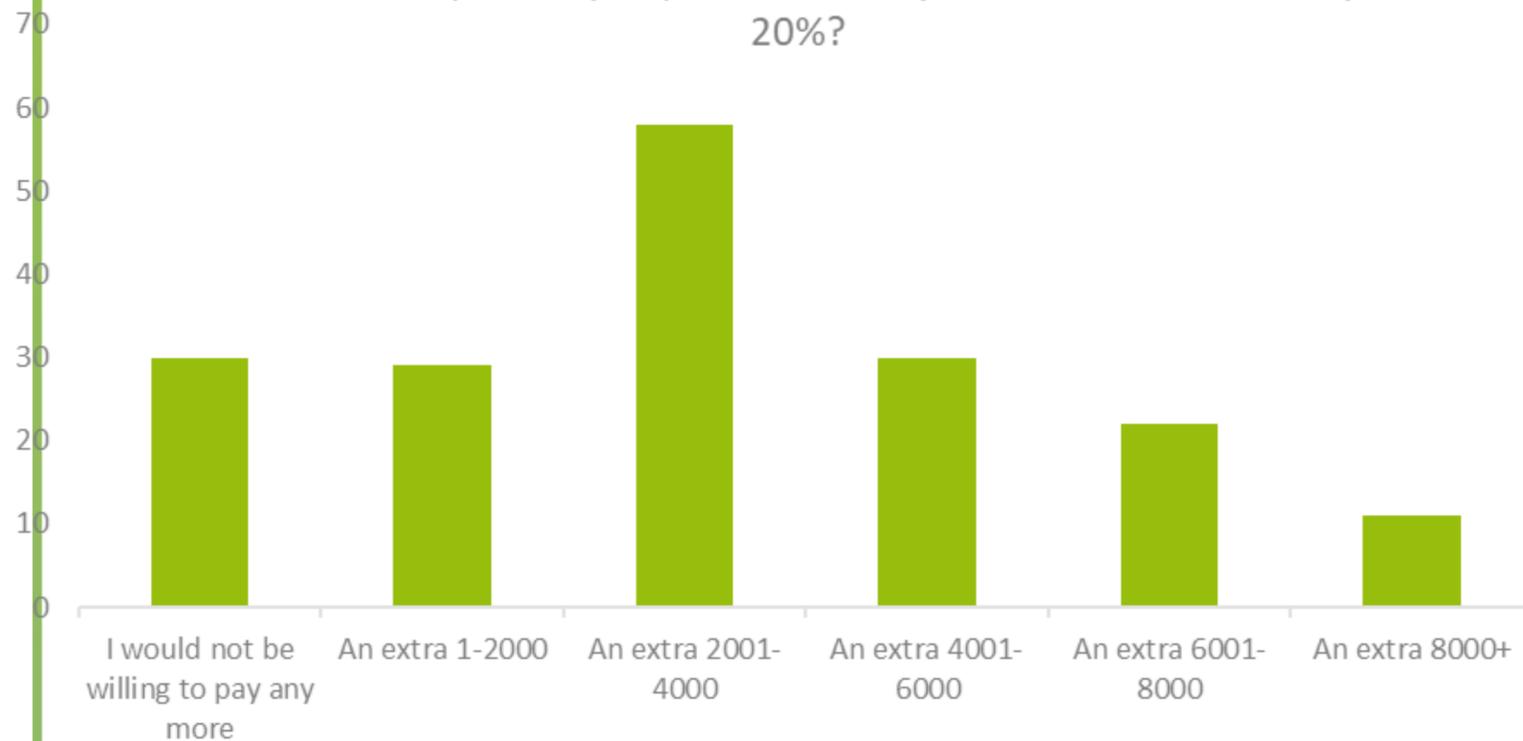


# Customer survey

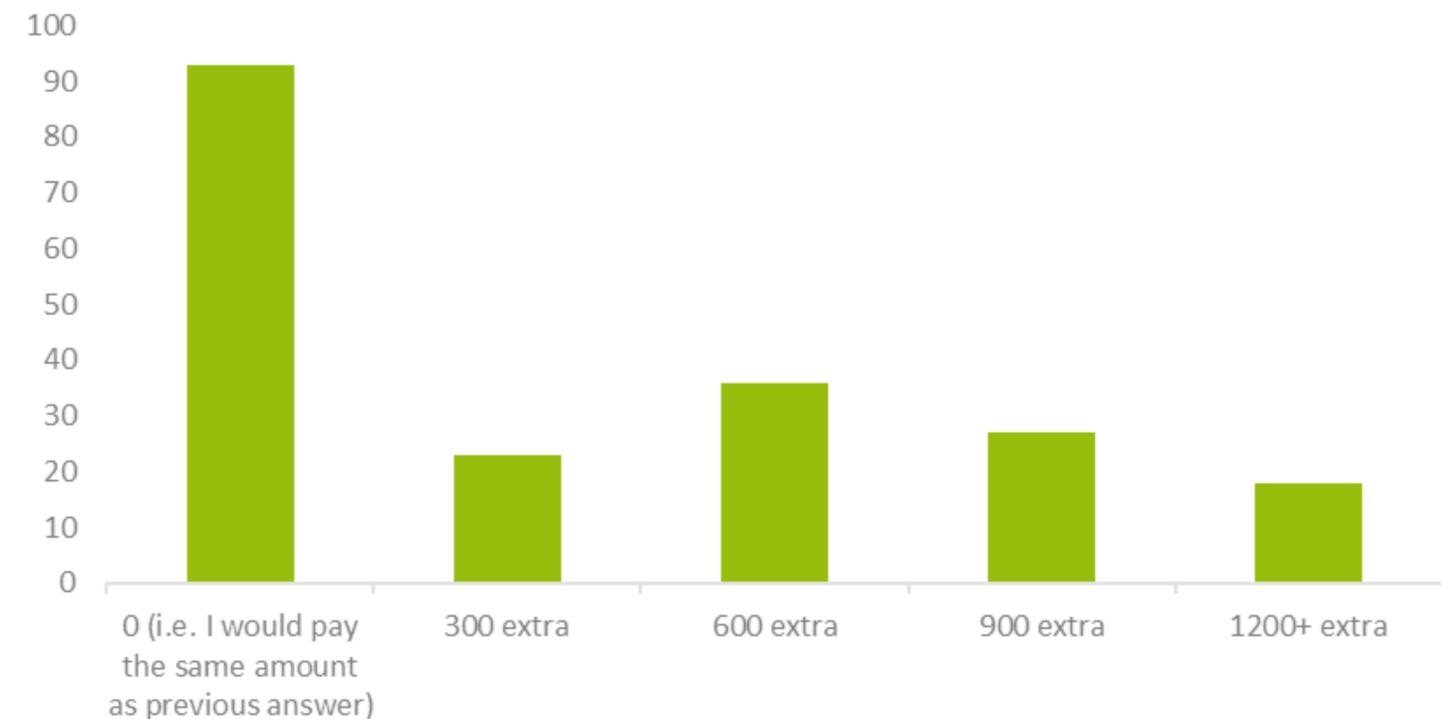
## Customers' Willingness to pay for a Fuel Cell micro-Cogeneration unit

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

Compared with a conventional boiler, how much more would you be willing to pay for a FC mCHP, assuming you made a total saving of €30/month (€360 a year) and reduced your carbon emissions by 20%?



Based on your answer to the previous question, how much more would you be willing to pay for a FC mCHP that reduced your household carbon emissions by 40% rather than 20%?



**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%)**