### PACE = Pathway to a Competitive European Fuel Cell micro-Cogeneration Market



Fuel Cell micro-CHP Market

Hans Korteweg

Managing Director, COGEN Europe

https://pace-energy.eu

info@pace-energy.eu



**European** 

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P EUROPEAN PARTNERSHIP

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# **Project Overview**

- Call year: 2016
- Call topic: Large scale demonstration of µCHP fuel cells
- Project dates: 1 June 2016 30 April 2023
- % stage of implementation 27/10/2022: 85%
- Total project budget: € 90 307 094.50
- Clean Hydrogen Partnership max. contribution: € 33 932 752.75
- Other financial contribution: € 56 374 341.75
- Partners: COGEN Europe, BDR Thermea Group, BOSCH, HEXIS, SolydEra, SUNFIRE, VIESSMANN, DTU (Technical University of Denmark), Element Energy (ERM), HSLU (Lucerne University of Applied Sciences)







Pathway to a Competitive European Fuel Cell micro-CHP Market



### PACE at a Glance

Pathway to a Competitive European Fuel Cell micro-CHP Market

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

	10	> 2,800	>500	10	4	€90m
	Partners	Fuel Cell micro- Cogeneration units	Systems per manufacturer	Countries	Countries	Total budget
	Representing manufacturers, utilities & researc community	To be deployed across Europe h between 2016- 2023	Established production capacity per manufacturer	Where the units will be installed	Selected for policy & market development (Belgium, Italy, Netherlands and	Including €33.9m Horizon 2020 funding via FCH JU
	Coordination & Dissemination Partner	Manufacturers VIESMANN BDR TH BOSCH Invented for life	HERMEA GROUP SolydEra		ик) X >10,	000
Field trial + installer training + targeted market & policy development activities Field trial + local installer training		Research Partners elementenergy an ERM Group company	Applied Sciences and Arts HOCHSCHULE LUZERN Engineering and Architecture		FC m cogene units/year	iicro- eration post 2020



### Overview of FC mirco-CHP System in PACE





# Project Progress & Performance of Units Installed

Number of Units	Total Operating	Total kWh	Efficiency**	Availability**
Commissioned*	Hours**	Produced**	(gas to power utilisation)	
2,356 (85% of overall objective)	23,390,524	23,991,535	35-57%	94.8 -100%



Source: **PACE D2.9.** – 3<sup>rd</sup> **Report on Performance Validation of Units Installed** \*as of September 2022. \*\* as of end March 2022.





### 2016-Dec

### PACE Units Installed Across Europe (2016-2022)



# **E**PACE Risks, Challenges & Lessons Learned

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- Supply-chain issues due to COVID-19 crisis, slowing down installation rates;
- Complex policy and political context, prioritising electrification and district heating for building decarbonisation;
- National policies banning gas-based heating in new buildings and even renovations; and
- Energy price crisis makes it difficult to assess customer case, despite important efficiency benefits.





# Buildings are "Hard to Decarbonise"

### Challenges

- 40% of energy consumption & 36% of GHG emissions;
- 80% of buildings demand comes from heating and hot water & 75% of heat demand is based on inefficient natural gas and oil boilers;
- Electrifying heat could increase peak demand by 200-300%; and
- PV and Wind are intermittent and insufficient to cover demand at all times cost-effectively.

- Opportunities
- Improve efficiency of buildings where cost-effective;
- PV & wind seasonal storage as RES H2;
- Smartly electrify by requiring **heat pumps** to consume electricity off peak and in high-RES periods; and
- Enable **efficient & flexible micro-CHP** to produce heat and electricity during peak demand, simultaneously reducing peak demand and balancing the grids.



# Why Fuel Cell micro-Cogeneration?

Heating and Powering your home

### **Supports the European Energy Transition**

With total efficiencies of more than 90%, including electrical efficiencies of up to 60%, this technology can achieve significant energy savings and  $CO_2$  emission reductions. On average in Europe it would save around 1 tonne of  $CO_2/kW$  every year, thus delivering more than 32 million tonnes of  $CO_2$  emission reductions across Europe in 2030.

This "fuel flexible" technology will be progressively fuelled by renewable energy sources, such as hydrogen and renewable gas.





## Why Fuel Cell micro-Cogeneration?

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### **Empower Consumers**

It transforms Europeans into active energy 'prosumers' (producer-consumers), creating a decentralised energy system with a reduced carbon footprint and lower energy bills. Surveys show that more than 90% of end users are pleased with the environmental performance, the comfort and warmth, reliability and running costs of their fuel cell micro-cogeneration unit



"With the fuel cell micro-CHP system, I was able to cover 72% of my electricity use by producing power myself. Compared to before, I save around €1,000 a year", Mr. Boel, Hamburg



### Trial Participants Survey 1/4

Overall how would you describe your experience with your mCHP?

Nearly 80% of respondents reported having a positive overall experience with their FC mCHP unit and just 8% described their experience as negative or very negative.







Trial Participants Survey 2/4

Overall how would you describe your experience with your mCHP?

100% 90% 80% 70% 60% 50% 40% 30% 20% 10% 0% Non-residential Austria Belgium Germany France UK

■ Very negative ■ Negative ■ Neutral ■ Positive ■ Very positive

No negative responses were reported by any nonresidential respondents.

100%

90%

80%

70%

60%

50%

40%

30%

20%

10%

0%

Residential

Fuel Cell micro-CHP Market

Austria reported the highest number of "very positive" responses, and only Belgium and Germany were the only two countries to report any "very negative" experiences.

As the two countries with the most installations, it would be expected that Germany and Belgium would have a broader range of responses.



I am the type of person to worry about being 'green'

I am the type of person who likes to try new products

I feel a moral obligation to reduce my emission of greenhouse gases

Trial Participants Survey 3/4



- The general profile of the customer is affluent couples or families living in large detached housing. It appears that these customers are active 'early adopters' who are interested in trialling new technologies in order to reduce carbon emissions.
- Expectations of the FC mCHP units were generally very high, with the majority of customers expecting the system to fully meet their heating and electricity needs while reducing energy consumption and energy costs. These expectations were not always met in the responses to the during operation surveys. It is clear that cost remains a particularly important limiting factor, in addition to installation and maintenance requirements. This could also reflect some difficulties encountered over the last few years related to the COVID-19 pandemic and energy price rises.
- Customers were, on the whole, very satisfied with the performance and features of their FC mCHP unit. The environmental impact, comfort and warmth, design and
  generation of electricity were considered the most liked features, while the cost of repair and maintenance, effort of the installation process and public visibility of FC
  mCHP could all use improvements. These parameters are all common problems related to new and emerging technologies, as OEMs and installers develop the technical
  competencies to install and maintain FC mCHP. As a new technology, FC mCHP has additional requirements for specialised training (e.g. electrician know-how, IT skills),
  and as such only trained and qualified installers can sell and install the technology.
- The responses regarding overall experiences with FC mCHP units have highlighted some concerns, despite the customers being generally supportive of the technology and being 'early adopters'. These concerns could therefore be exacerbated in a wider market where customers may be less accepting of issues with the technology. It is also worth noting, however, that as these respondents are largely 'early adopters' trying out new technologies, this may have led to inflated initial expectations.



In the past year, have you experienced any problems or breakdowns?





# Trial Participants Survey 4/4

- The actual financial benefits of FC mCHP were lower than the expected, particularly regarding gas and oil bills. 81% of respondents anticipated a decrease in their gas and oil bills after the installation of their FC mCHP, whereas only 57% actually experienced a decrease.
- Over 50% of respondents experienced problems or breakdowns in the first two years of their FC mCHP, with electricity loss being the most common problem. The most common length of time between reporting an issue and someone coming to visit was more than 2 days for emergency problems, and more than 1 week for non-emergency issues. The relatively long time taken to repair these issues may reflect the lack of installers who are able to carry out maintenance on this new technology (See D1.2 report for further information). The average consumer for this technology is currently still an early-adopter, and there is therefore a strong need to improve on these areas when scaling up the technology to larger markets.
- With regards to their overall experience with the unit, non-residential respondents were reportedly more neutral. There were no negative experiences reported from non-residential respondents, but there were also fewer positive and very positive responses. Customers are perhaps more inclined to feel strongly about technology being used for their own use in a private, home setting.
- As found in Report 1, financial considerations are still a major part of customer motivations and expectations. This is likely to be exacerbated through wider industry developments in the energy market.



Fuel cell micro-CHP significantly reduced consumer energy bills compared to standard heating solutions & grid electricity in 2020-2021\*.

## Self-consumption Benefits of Fuel Cell micro-CHP



\* The analysis assumes stable energy prices, based on 2020-2021 trends. Between 2021 – 2022 energy price volatility and emergency government interventions make it difficult to predict fuel cell energy bill savings. Since the ratio between electricity and gas prices have remained high in many countries, we expect that field trial participants have experienced lower energy bills than other consumers, due to both higher efficiency and self-generation of power.

Source: PACE project (HSLU), 2021. Economic value of mCHP's participating in power and grid service markets.



## Why Fuel Cell micro-Cogeneration?

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Heating and Powering your home

Fuel Cell micro-Cogeneration is a highly efficient home energy system that simultaneously produces heat and electricity











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