



**FUEL CELLS AND HYDROGEN**  
JOINT UNDERTAKING

***Technology  
validation in  
stationary  
applications: CHP,  
back-up power***

**Antonio  
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**PRD 2017**  
24 November 2017



# Agenda



PROGRAMME REVIEW DAYS 2017  
FUEL CELLS AND HYDROGEN: FROM TECHNOLOGY TO MARKET  
23-24 NOVEMBER, BRUSSELS

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FUEL CELLS AND HYDROGEN: FROM TECHNOLOGY TO MARKET  
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## PANEL 3

### TECHNOLOGY VALIDATION IN STATIONARY APPLICATIONS: CHP, back-up power

- |               |  |
|---------------|--|
| 14:30 - 14:50 | Portfolio overview by <b>Aguilo Rullan Antonio</b> , FCH JU  |
| 14:50 - 15:10 | ENE.FIELD: European-wide field trials for residential fuel cell micro-CHP & PACE: Pathway to a Competitive European FC mCHP market |
| 15:10 - 15:30 | Business models and financing arrangements for the commercialisation of stationary applications of fuel cells                      |
| 15:30 - 15:50 | STAGE-SOFC: Innovative SOFC system layout for stationary power and CHP applications  |
| 15:50 - 16:10 | DEMOSOFC: Demonstration of large SOFC system fed with biogas from WWTP   |
| 16:10 - 16:30 | POWER-UP: Demonstration of 500 kWe alkaline fuel cell system with heat capture   |



# STATIONARY APPLICATIONS

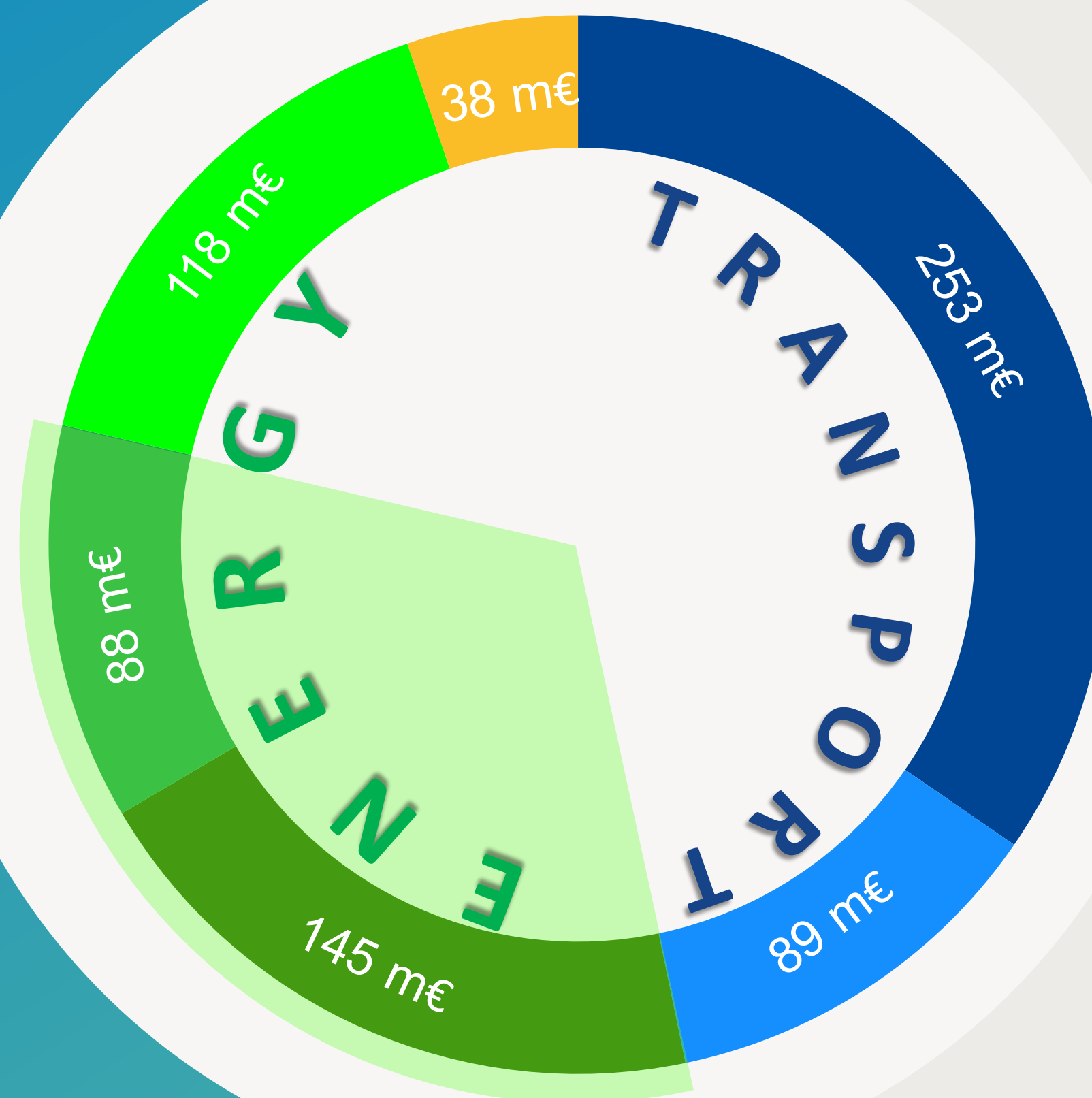
Sustainable heat and power with fuel cells



Related FCH JU objectives



Increase the efficiency and the durability of fuel cells for power production, while reducing costs



## Stationary

32 %



233 Mill Euros

70 Projects

## Technology validation

20 %



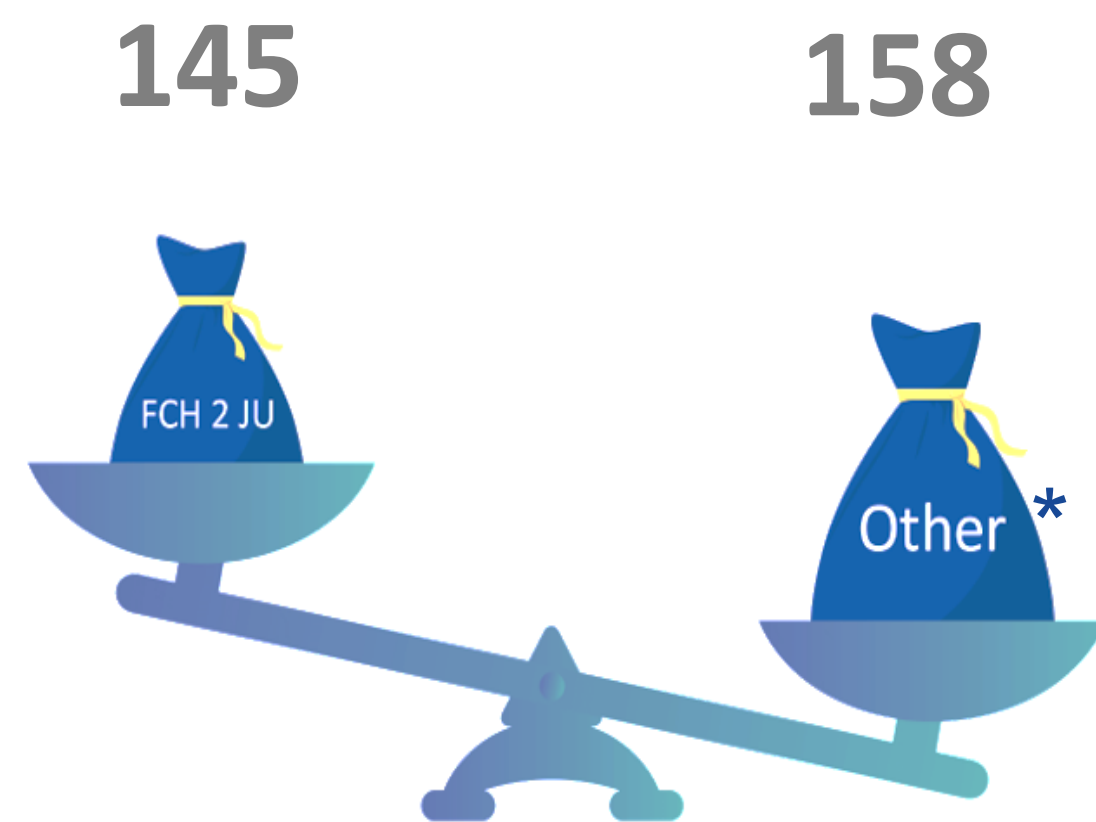
145 M€

28 Projects

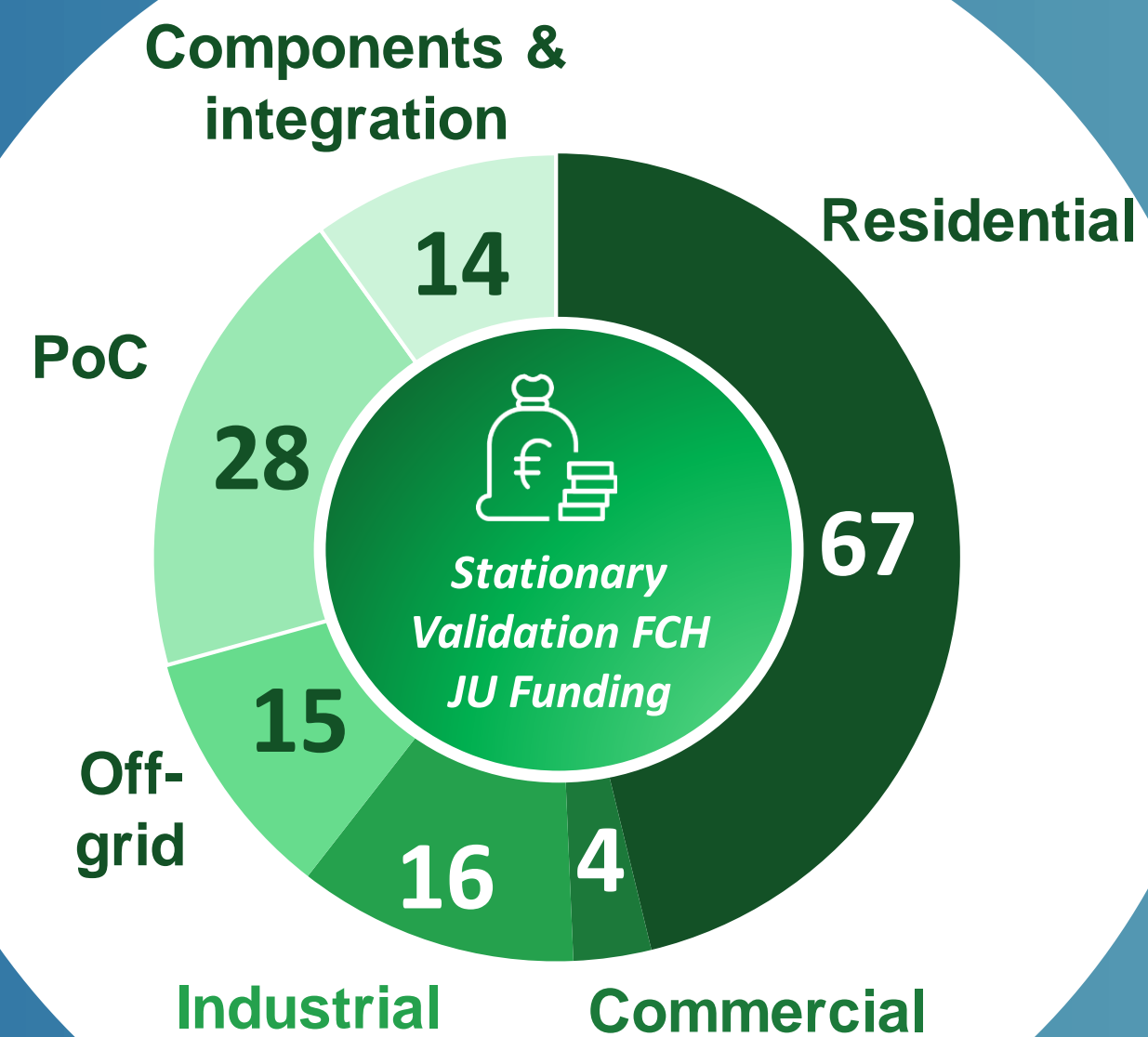


# Demonstrating low carbon and clean heat & power solutions

28 projects – 303 M€



M€



M€



Domestic solutions:  
from hundreds to  
thousands



Preparing the  
grounds for  
commercial  
buildings



Exporting  
industrial CHP

## DEPLOYING:

**3,650**  $\mu$ -CHP units  
**160** kW<sub>e</sub> commercial  
**3** MW<sub>e</sub> industrial  
**15** off-grid units



\* Other resources including private and national/regional funding



# Demonstration portfolio

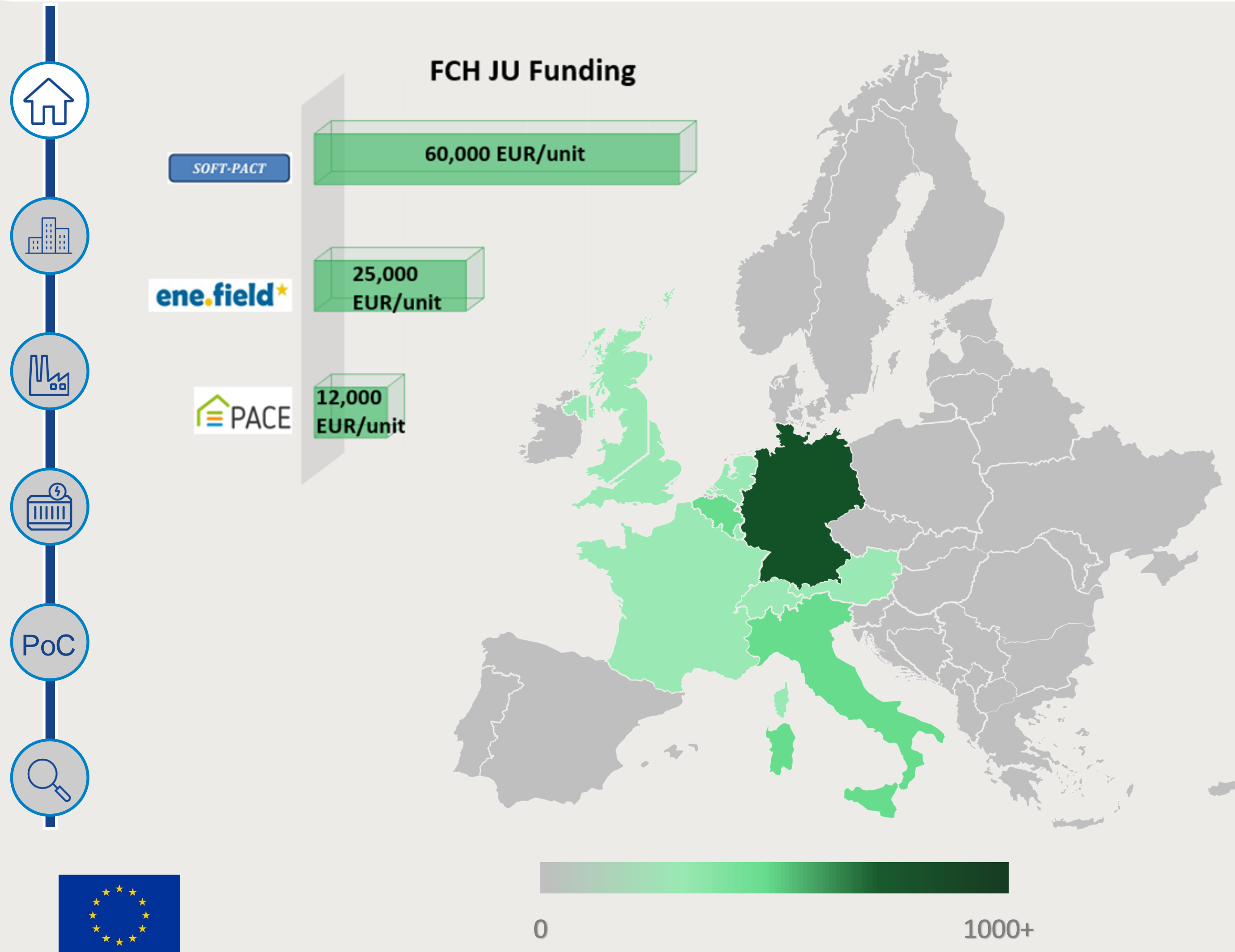
~ 25% of the energy in the EU is consumed in the household sector





# Over 1000 fuel cell $\mu$ CHP systems installed across EU

Track record of domestic heat and power systems created



**1046 units deployed** under ene.field project  
Over 1 MWe capacity installed  
>5 million operating hours  
**Additional >1,000 units** deployed under German scheme



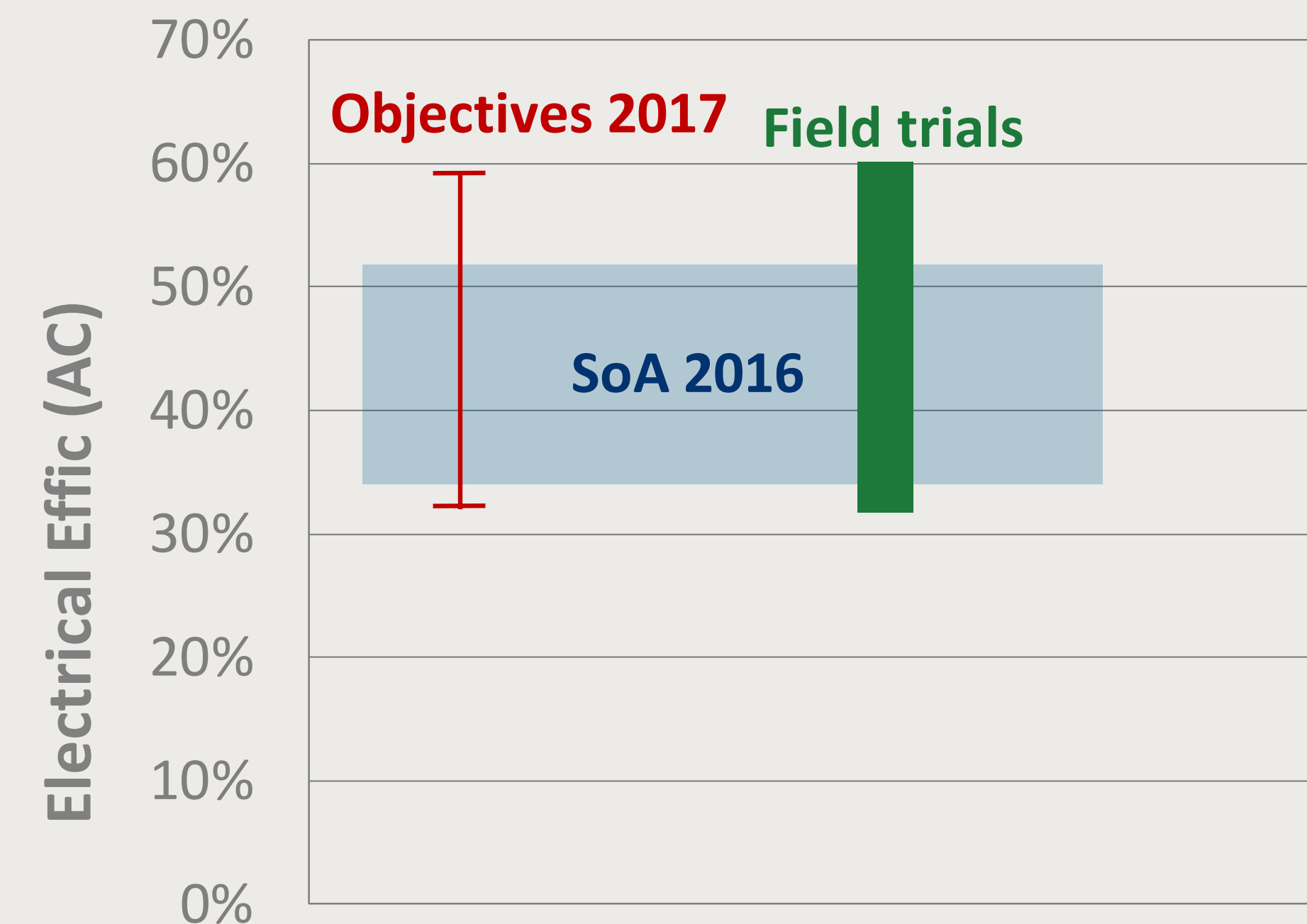
# Electrical efficiencies as high as large combined cycle gas turbines

Results from real life demonstrations



**Efficiency:**  
 $\eta_e$  [33-60%] :  $\eta_{th}$  [25-55%]

- Seasonal electrical AC efficiencies as high as 60% demonstrated
- Overall efficiencies as high as 85-95% demonstrated





# System lifetimes in line with product market entry needs

From lab research to commercial products



 **Durability: 12 years** 

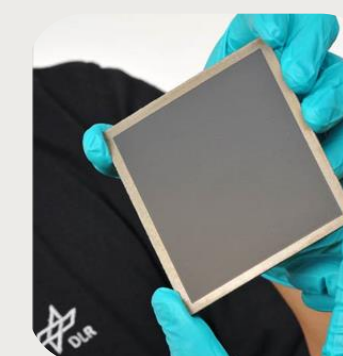
- **80,000 hours (10 years) on the basis of:**
  - Average stack rated durability 45,000 hours
  - Over 5 million hours cumulative operation all units
  - Individual units operating between 1-2 full years



Market required durability achieved



Research at cell and stack levels



From lab research to commercial products



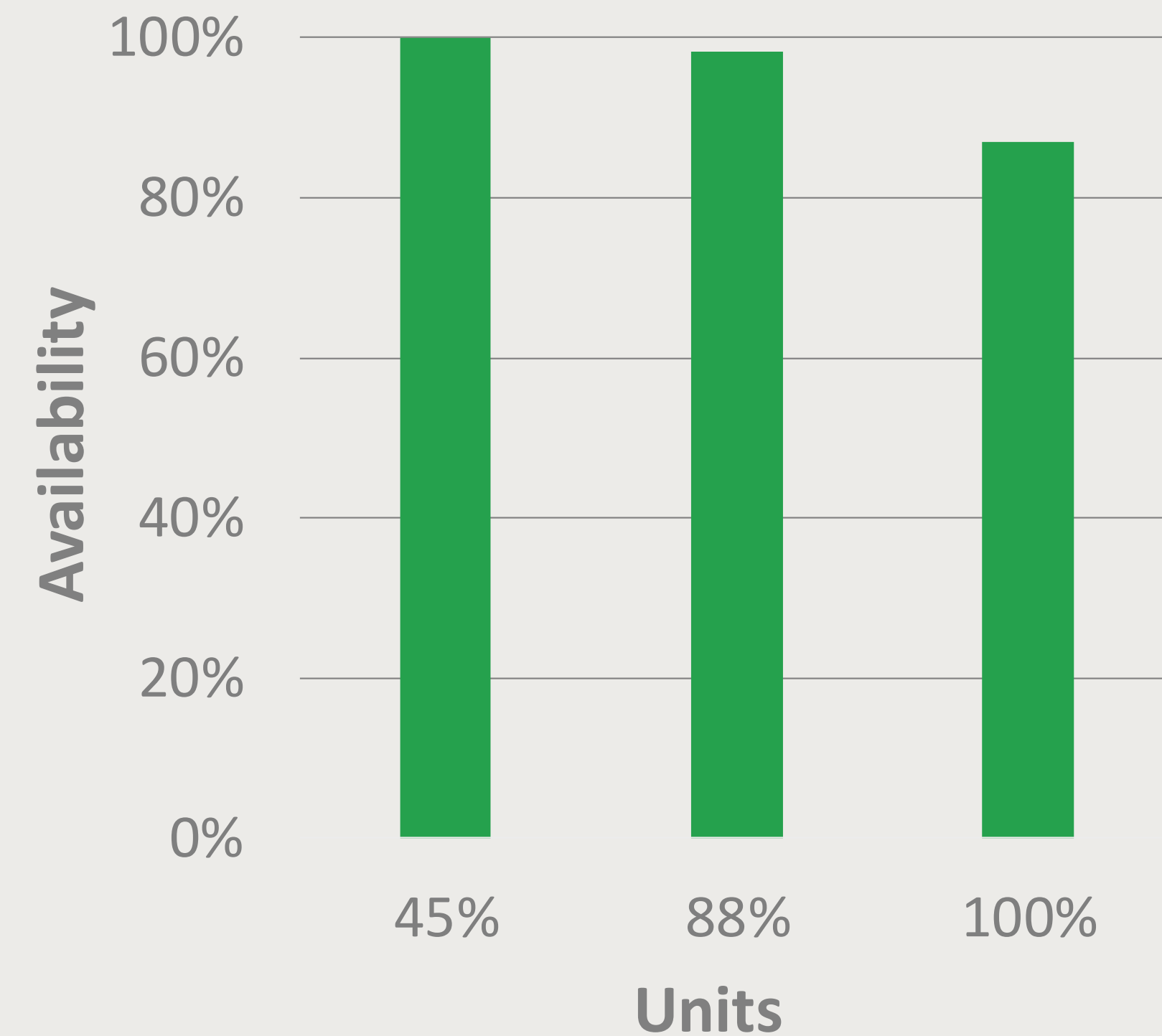
# Availability >99% for units over 1 year of operation

Only 2% issues relate to FC stack



**Availability: 97%**

- Availabilities reported as high as **100%** for 1 year of operation
- 88% of all systems during first year of operation achieved >98.2%
- 14% of issues related to FC appliance
- Only 2% issues relate to FC stack



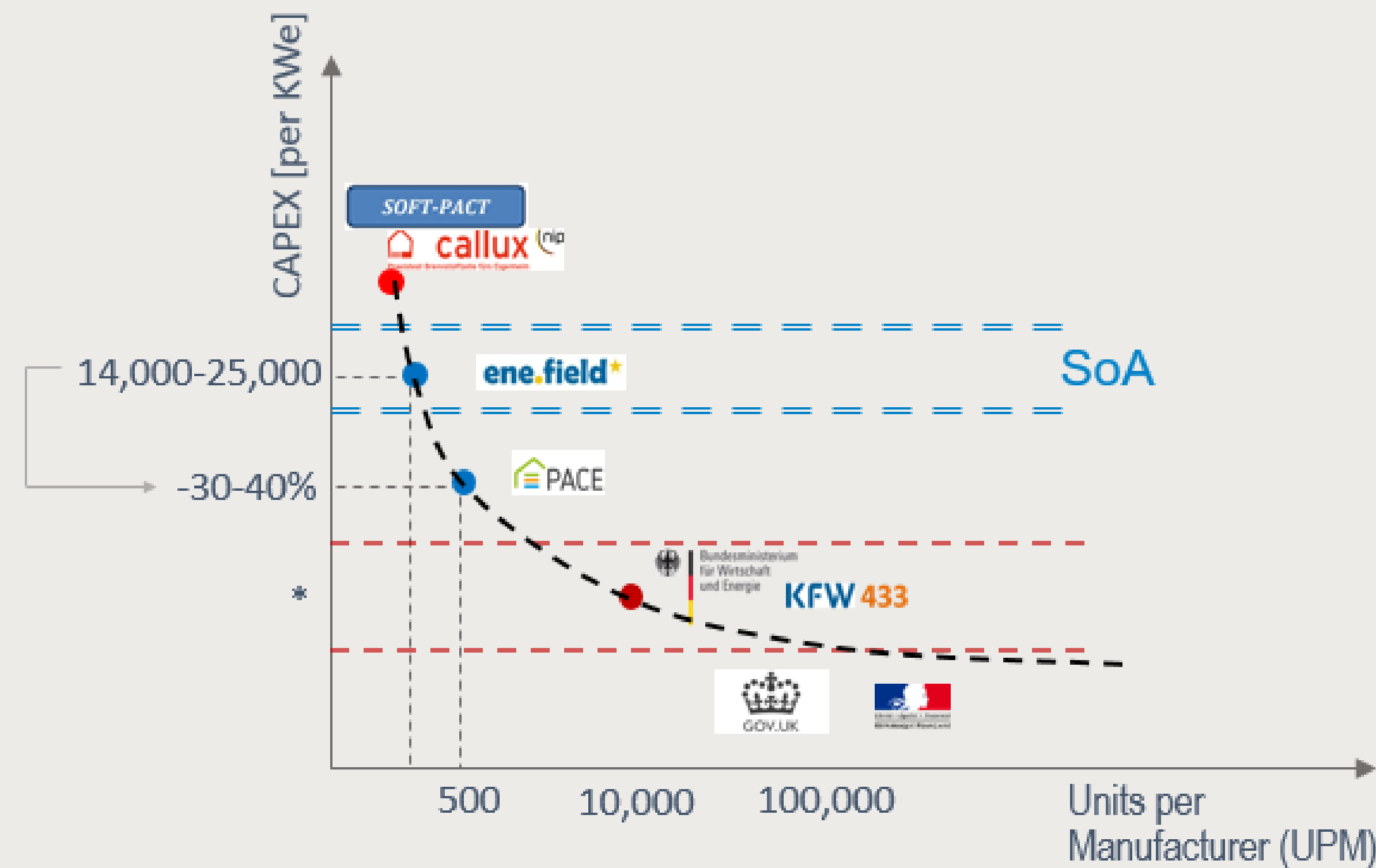
# Meeting cost reduction curves

Further cost reductions via: next generation products + increased volumes



 **CAPEX: 14,000 €/kW<sub>e</sub>** 

- **14,000 - 25,000 EUR/kW<sub>e</sub> prices achieved**
- At 500 units per manufacturer 40% further cost reductions expected
- New business models starting to emerge



\* Positive business cases emerging with no subsidy



# Lowest impact on air quality of all domestic gas appliances

Levelised cost of energy decreasing steadily



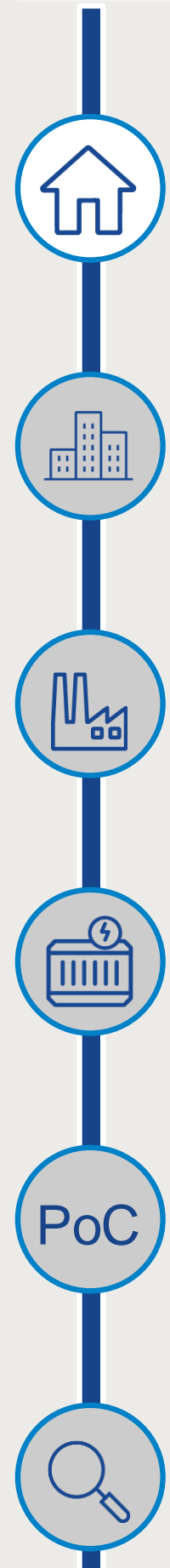
## Emissions NOx/SOx

- Lowest NOx emission of gas appliances at the domestic size
- Confirmed no SOx emission present



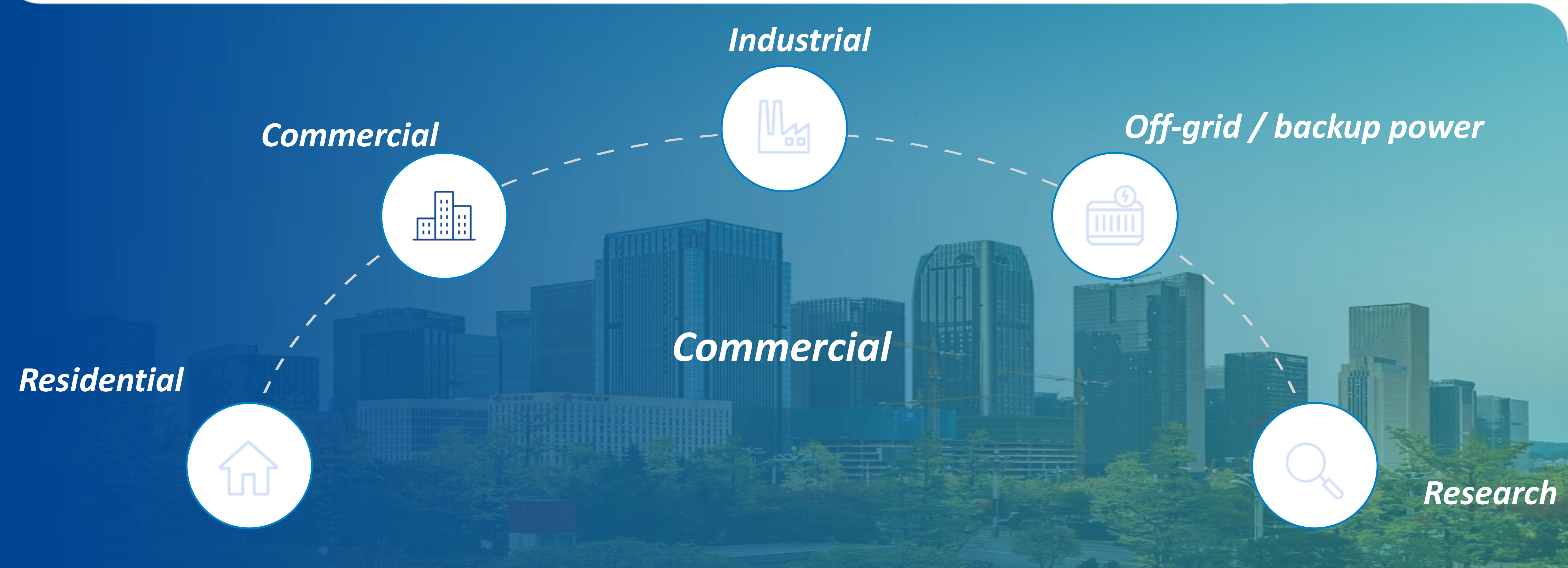
## Levelised cost of energy

- 2.5 grid parity achieved in some markets
- Dependent on national conditions



# Demonstration portfolio

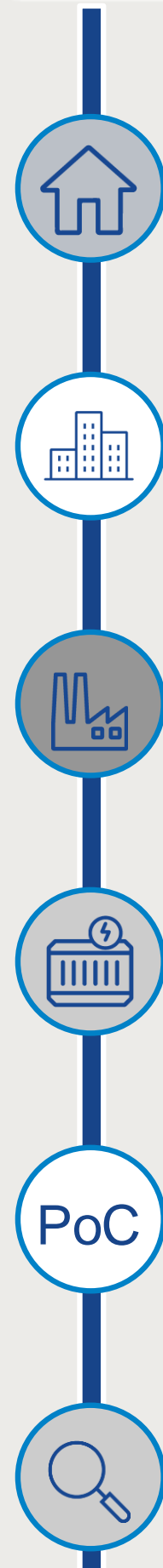
~ 13% of the energy in the EU is consumed in the services sector





# Preparing the grounds for fuel cells in commercial buildings

Demonstrations to follow as from next year



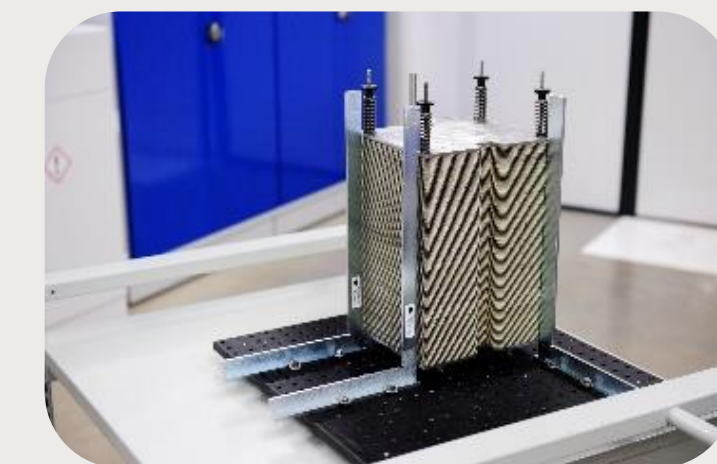
## 50 kW<sub>e</sub> Fuel cell solutions at Proof of Concept



- Automotive EU derivative FC systems
- Targeted electrical efficiencies of 40%



- System electrical efficiencies 53% proven
- Targeted electrical efficiencies of 60%



- Est. system CAPEX (per kW) @ mass production @ < 4,000 €/kW<sub>e</sub>





# Demonstration portfolio

~ 25% of the energy in the EU is consumed in the industry sector





# Exporting EU fuel cell technology for industrial applications

Results of 2,000 hours of operation



**CAPEX : 3500 €/kW<sub>e</sub>**

- CAPEX achieved, but costs remain high
- Potential business models beyond EU emerging

**Efficiency:  $\eta_e$  45%**

- Electrical AC efficiencies as high as 50% demonstrated
- Over limited operational hours

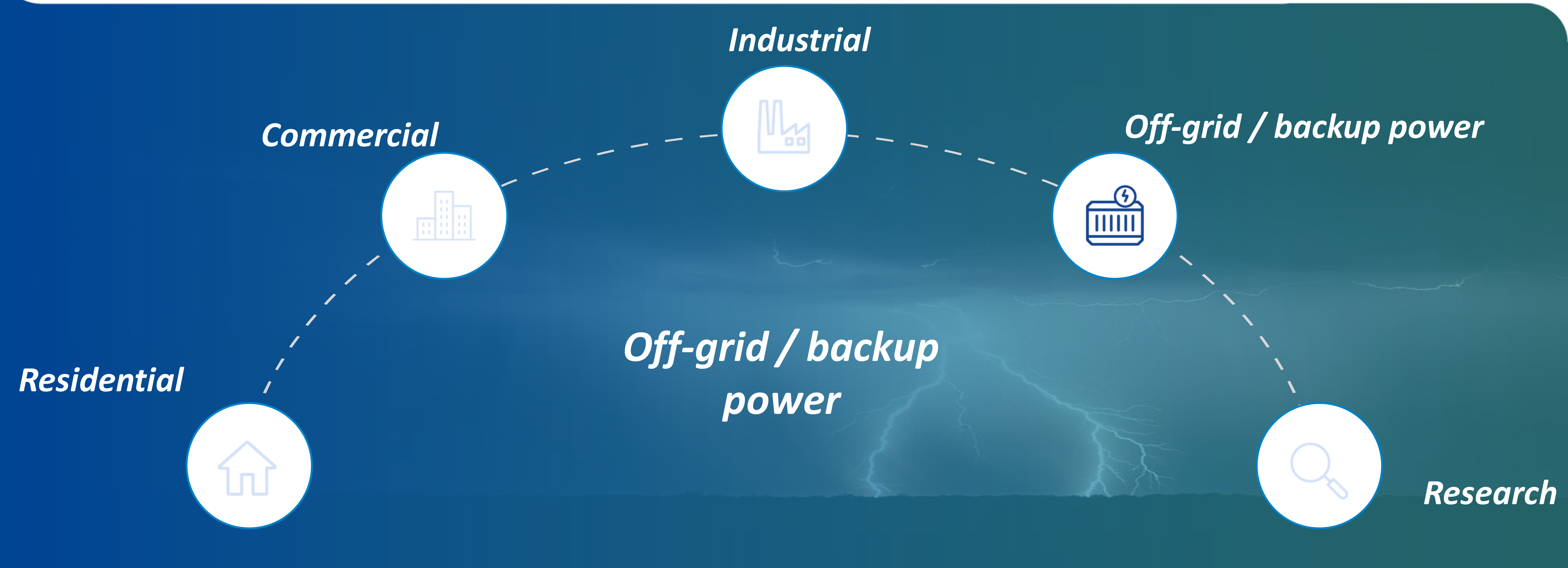


By-product H<sub>2</sub> used in fuel cells for power  
(and heat production)



# Demonstration portfolio

Delivering reliable power supply






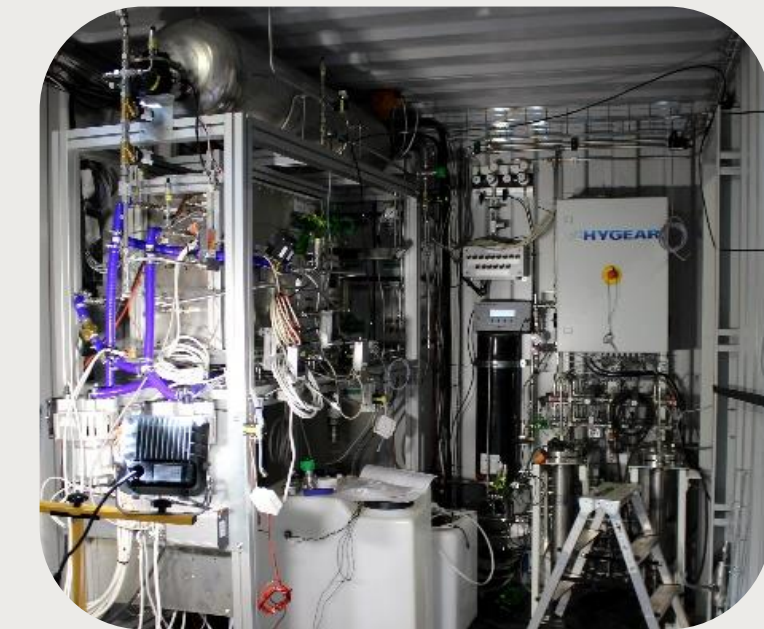
# From early demos to next generation solutions

Demonstrations to follow as from next year



## Application for off-grid/back-up

- Early demos saw circa 15 systems installed
- Improved products being developed
- < 7 kWe off-grid and back-up power
- >45% % electrical efficiencies proven
- Limited operational hours 
- Demonstrations to follow as from next year



SOFC + PEMFC+ AFC  
Multi fuels



# Where are we .... where are we heading

Mainstreaming technology...consolidating EU leadership...reducing emissions...increasing energy efficiency & renewables



Fuel cells for EU households: from hundreds to thousands



Preparing the grounds for fuel cells in commercial buildings



Exporting EU fuel cell technology for industrial applications



Next generation of off grid / back-up systems being developed







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JOINT UNDERTAKING

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