Fuel cells: a clean and high efficiency solution for the building sector

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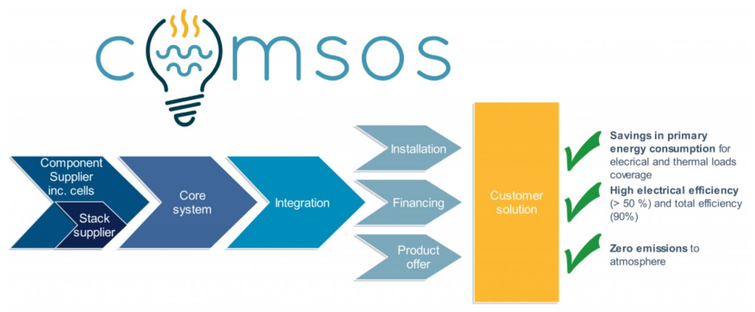
Fuel Cell for the building sector

- Many energy intensive buildings are today still totally grid-dependent. Renewable Energy Sources could play a key role in the decarbonization of the building sector, but they will not be able to ensure a full load coverage without appropriate storage units. Coupling of RES and cogeneration units is an interesting opportunity for different commercial activities.
- In this framework, **fuel cell could play a fundamental role** in supporting the concept of **decentralized energy production**. Electricity and heat could be produced directly where needed, with the **best-in-class electrical efficiency and zero emissions to the atmosphere**.
- Solid Oxide Fuel Cells (SOFC) could be fed by either natural gas from the grid, biogas, biomethane, hydrogen and by mixtures of natural gas and hydrogen (blending). **Fuel flexibility** is another key advantage of the technology.

COMSOS project

COMSOS (Commercial-scale SOFC systems, 2018–2022) project aims to **validate and demonstrate fuel cell based combined heat and power solutions in the mid-sized power range of 10–60 kW**, totaling 450 kW. The project will implement the installation of 25 SOFC technology-based power around the world, to prepare manufacturers for developing capacity for serial manufacturing, sales and marketing of mid FC-CHP products.



Project partners:

https://www.comsos.eu/

The project activities includes:

- **Market analysis** to show the potential dimension of the SOFC end-users in different segments.
- **Business case analysis** to point out the optimal scenarios for the installation of FC-based cogeneration systems.
- Data analysis of the operation of the SOFC units running in different building types to understand their **performance**.
- **Emissions analysis** of the SOFC units to prove the environmental advantage of FC-based cogeneration units.
- Communication of the project activities and dissemination of the results, with the aim of increasing the **awareness towards fuel cell systems** and create possible networks for the 3 SOFC manufacturers.

→ **SOFC producers**

Convion
SOFC 60 kW
Finland

Solidpower
SOFC 12 kW
Italy, Germany

Sunfire
SOFC 25 kW
Germany

→ **COMSOS targets**

- Electrical efficiency > 50%
- Overall efficiency > 90%
- Lifetime > 10 years
- Availability > 90%

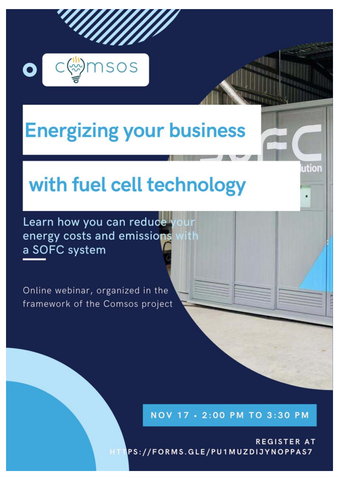
Communication and dissemination

- One important goal of the project is the **communication of the SOFC-CHP concept and its advantages** to different target groups, from possible end-users to the general public and policy makers.
- All **public documentations** developed within the project is available on the project website.
- A **joint declaration** has been signed together with the PACE EU project, focused on FC cogeneration systems for the residential sector.

Joint Declaration on Stationary Fuel Cells for Green Buildings

- A **questionnaire** is available on the Comsos website, to understand the awareness of the public toward fuel cells. Visit our website with the QR code and fill the questionnaire!

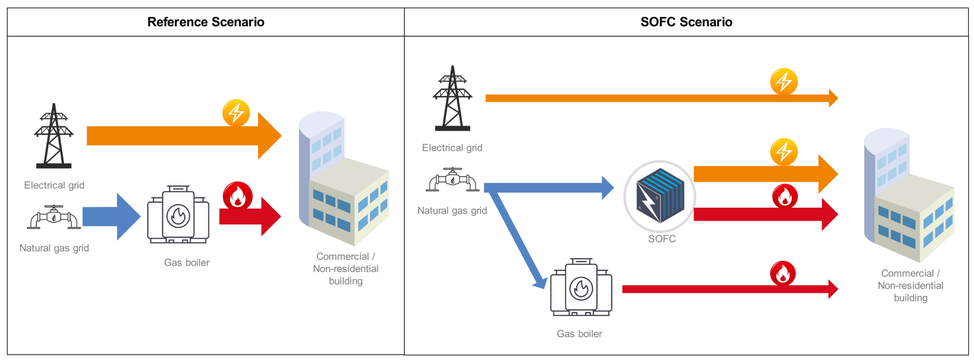
- A **webinar**, aimed to show the potential business cases for SOFC in the commercial sector and the view of the manufactures, will be held **online on November 17, 2021**, between 2 and 3.30 pm. Visit our website to register to the event!



[1] F. Accurso, M. Gandiglio, M. Santarelli, J Buunk, T. Hakala, J. Kiviaho, S. Modena, M. Münch, E. Varkaraki, "*Installation of fuel cell-based cogeneration systems in the commercial and retail sector: Assessment in the framework of the COMSOS project*", Energy Conversion and Management, Volume 239, 2021, https://doi.org/10.1016/j.enconman.2021.114202

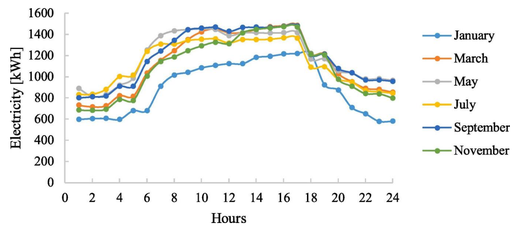
Market analysis and business cases

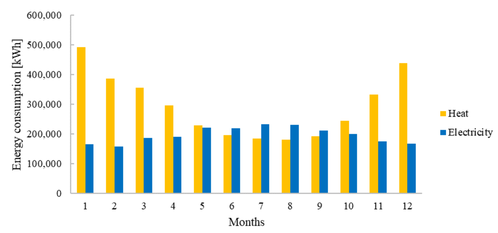
→ The **optimal market segments** for the installation of FC-based cogeneration systems have been identified by means of techno-economic evaluations based on real buildings load profiles (electrical and thermal). The SOFC scenario is always analyzed in comparison with the reference case.



→ Analysis of the electrical and thermal load.

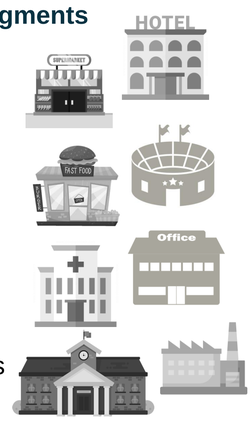
The best building types are the ones where an electrical (and thermal) **base load** is available. In this scenario, the SOFC can run continuously, maximizing its capacity factor and the economic profitability.





→ Optimal market segments

- Supermarkets
- Hotels
- Shopping centers
- Restaurants
- Sport centers
- Hospitals
- Swimming pools
- Small industrial sites
- Office buildings



→ Most suitable geographic locations

- Germany
- UK
- Italy

→ Key drivers for SOFC installation:

- Availability of a base load
- Heat requirement
- Energy prices (spark spread)
- Availability of incentives on cogeneration or building energy efficiency

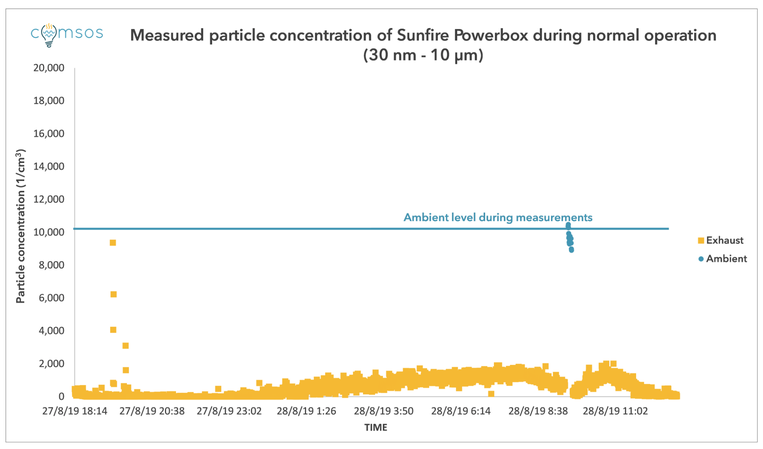
Business case analysis results

Target markets	variation in target group	Average base load use (kW)	Baseload coverage of total	Heat utilization	VoLL	Capacity fit with 30 kW	Capacity fit with multiple units
Hotel	Large	80	50%	High	Medium	Yes, for small scale. (+/- 2.000 m²)	Yes, only for very large scale limited
Supermarket	Medium	60	60%	Low	High	Yes, for small scale. (+/- 500 m²)	Yes, can cover total range.
Office Building	Large	10	25%	Medium	Low	Yes, medium sized office buildings (+100 people)	Limited, only large scale office buildings
Commercial site	Large	100	40%	Medium	Medium	Limited, only covering critical load might be option	Yes, but large variation in capacity needs
Sport centre	Medium	10	25%	Medium	Low	Limited, little base load capacity required	No, little capacity required
Hospital	Limited	200	75%	High	High	No, more capacity required.	Limited, only covering critical load might be option.
Small commercial business	Large	10	50%	High	High	Yes, but large variation in capacity needs	Yes, but large variation in capacity needs
Shopping centre	Medium	10	30%	Medium	Medium	Limited, little base load capacity required	No, little capacity required
NzeB appartment building	Large	10	40%	Medium	Low	Yes, larger buildings. (+ 60 homes)	Limited, too much capacity for most buildings
Data centre with heat delivery	Large	>200	90%	High	High	Limited, covering a single server room might be option	Yes, small scale datacenters
Data centre	Large	>200	90%	Low	High	Limited, covering a single server room might be option	Yes, small scale datacenter

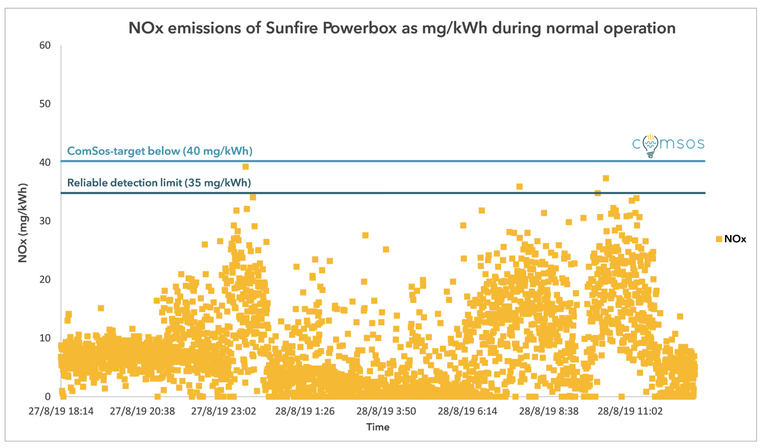
Results from the SOFC modules operation

- The **first Comsos SOFC installation** has been performed in Hsinchu (Taiwan) by Sunfire in 2019.
- The SOFC module has been operating for more than 3'000 hours. Over **38 MWh of electricity** have been produced.
- **Electrical efficiency** in the 50-100% operation range was stable with values **higher than 50%**. Thermal recovery was also performed by the end-users.

- **Emission measurements** to Sunfire Powerbox were carried out by experts from VTT during August 2019 at Dresden.



Sunfire Powerbox reached the ComSos-project target of **NOx emissions less than 40 mg/kWh** during normal operation.



Particle emissions from Sunfire Powerbox are significantly **less than particle concentrations in ambient air** so particle-wise Sunfire Powerbox works as an air cleaner.