WASTE2WATTS

UNLOCKING UNUSED BIO-WASTE RESOURCES WITH LOW COST CLEANING AND THERMAL INTEGRATION WITH SOLID OXIDE FUEL CELLS

Project ID	826234
PRR 2024	Pillar 4 – H_2 end uses: stationary application
Call topic	FCH-02-7-2018: Efficient and cost-optimised biogas-based cogeneration by high-temperature fuel cells
Project total cost	EUR 1 681 602.50
Clean H_2 JU max. contribution	EUR 1 681 602.50
Project period	1.1.2019–30.9.2023
Coordinator	École polytechnique fédérale de Lausanne, Switzerland
Beneficiaries	Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile; Arol Energy; Biokomp SRL; Commissariat à l'Énergie Atomique et aux Énergies Alternatives; Etudes et Applications d'Energies Renouvelables et d'Epuration; Paul Scherrer Institut; Politecnico di Torino; SolydEra SA; SolydEra SpA; Sunfire GmbH

https://cordis.europa.eu/project/id/826234

PROJECT AND GENERAL OBJECTIVES

There is a huge amount of biogas available in the agriculture sector in Europe for use by small-scale SOFCs (50 kWe, in theory 0.5 million units or 25 GWe, or 1 500 PJ, equal to 8 % of the EU's natural gas).

WASTE2WATTS aim was to develop cleaning technologies for biogas to make the gas compatible with solid oxide fuel cells (SOFCs). The technology determines what needs to be cleaned from the gas and to what purity level it must be cleaned. It also defines the proper scale for the best application of SOFCs with biogas, and the bioresources available at that scale. It assesses reformer catalysts and cells/stacks with biogas impurities and representative gas mixtures. A system layout proposes operating strategies without external water addition. A 1.5 kWe SOFC running on agro-biogas was prepared, and a novel cryogenic system for cleaning biogas at a scale of 100 m^3/h was installed.

NON-QUANTITATIVE OBJECTIVES

- The project compiled a sorbents database.
- Sorbents' behaviour was analysed in relation to specific contaminants. COS is the most critical contaminant (< 1 g/kg of sorbent).
- If SOFC cells are run with COS, the outlet gases are H_2S and SO_2; the water–gas shift reaction is affected.
- New catalysts for biogas reforming were tested (Ni_4Fe, Ru-doped SmCeCoO). They can cope with poisonings up to 25 ppm for short durations.
- Retention capacity was 0.16 g COS, 3 g DMS, 19 g CH_4S and 223 g H_2S per kilogram of sorbent. Th sorption capacity for non-H_2S compounds was much improved (5 times better) for dry biogas.
- Mixed reformed biogas behaves better than dry reformed biogas; therefore, steam must be added for reforming.

PROGRESS AND MAIN ACHIEVEMENTS

- Sorbents have been characterised specifically for biogas cleaning, allowing for the choice of an adapted cleaning solution (IR).
- Reformer catalysts, cells and stacks characterised with specific sulphur compounds show resilience up to 5 ppm of trace content.
- System cost analysis showed that biogas SOFC can achieve a LCOE of < 15 ct€/kWhe, even at 20 kWe, for a 4-year stack life (stack cost 1 000€/kWe)
- The reformer catalysts can be considered for the Innovation Radar.
- A market evaluation was performed that concluded that >100 000 SOFC units of 50 kWe could be installed in the countries CH, DE, FR, IT unlocking presently unused biogas resource.
- Total testing amounted to >7000h for sorbents, >11 000h for reformer catalysts, 27 000h for cells, >20 000h for stacks, that is,. total on-stream testing of 65 000h mainly by 4 Laboratories during 4 years.
- W2W installed a cryogenic cleaning chain for biogas flow of 100 m^3/g on a real biogas site. It needs further running to test the effectiveness of contaminant removal by this method.
- W2W installed a 1.5 kWe SOFC on an agro-biogas site, which ran for 1 month before being shut down. A new gas-cleaning kit was built and will be deployed on the site, after which the testing will resume for 1–2 years with different sorbents. This will require follow-up financing.
- SolydEra started the production of 10 kWe stacks that can be assembled to offer 50–300 kWe SOFC systems, including to the biogas market. A total of 50 kWe has been identified as a promising market size, in which competition from engines is the lowest.
- The cost calculation for cleaning was refined with results from the field tests.
- Alternative ways of gas cleaning (to form solid sorbents) were investigated.

FUTURE STEPS AND PLANS

The project has finished.

PROJECT TARGETS

Target source	Parameter	Unit	Target	Achieved to date by the project	Target achieved?
Project's own objectives	Pollutant nature and mix	Sulphur compounds	Identification	Critical compounds identified	
	Cost of biogas cleaning	€/kWe	< 1 000	< 1 000	
	LCOE	€/kWh	< 15	0.09	
	SOFC degradation on biogas reformate (voltage loss under constant current)	%/kh	0.4	0.2–0.5	✓
	Pollutant tolerance	ppm	3	3	
MAWP (2014–2020)	SOFC CAPEX	€/kWe	3 500–6 500	2 000–4 000	
	Electrical efficiency	%	35–60	55	

Clean Hydrogen Partnership
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