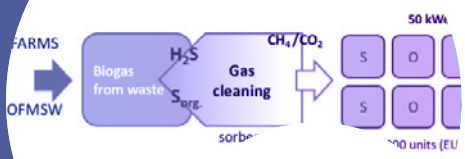
WASTE2WATTS

UNLOCKINGUNUSEDBIO-WASTERESOURCESWITH LOWCOSTCLEANINGANDTHERMALINTEGRATION WITH SOLID OXIDE FUEL CELLS



Project ID:	**826234**
PRD 2023:	**Panel 4 – H2 end uses – stationary applications**
Call topic:	**FCH-02-7-2018: Efficient and cost-optimised biogas-based cogeneration by high temperature fuel cells**
Project total costs:	**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, EREP SA, Etudes et Applications d'Energies Renouvelables et d'Epuration, Paul Scherrer Institut, Politecnico di Torino, SolydEra SA, SolydEra SpA, Sunfire GmbH

https://waste2watts-project.net/

PROJECT AND OBJECTIVES

Waste2Watts is developing cleaning technologies for biogas to make the gas compatible with solid oxide fuel cells (SOFCs). It determines what needs to be cleaned from the gas and to what purity level to clean the gas. It also defines the appropriate 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 6 kWe SOFC on agro-biogas has been prepared, and novel cryogenic cleaning of biogas at a scale of 100 m^3/h has been carried out.

NON-QUANTITATIVE OBJECTIVES

- Test runs with six or seven sorbents each at three different laboratories were conducted, under dry and wet conditions, with different contaminants. The best sorbent (among those tested) was tested in humid conditions with a multi-contaminant gas matrix. Retention capacity was 0.16 g COS, 3 g DMS, 19 g CH_4S and 223 g H_2S per kg of sorbent, which allows the sorbent volume to be calculated for a given biogas flow and contaminant content. However, it was also established that sorption capacity for non-H_2S compounds is much improved for dry biogas. For example, sorption of COS, the most critical compound in terms of removal difficulty, increased fivefold (to 0.8 g/kg sorbent). This guided the design of the cleaning in two steps: wet for H_2S, dry for the other contaminants, with a chiller in between.
- New reforming catalysts were fully tested with dry and mixed reformed biogas and H_2S and DMS contaminants.
- Cells tested with COS (1, 2, 5 ppm) show a 1–2 % performance drop. COS blocks the water–gas shift reaction. It reacts with steam to H_2S and with electrochemical oxygen to SO_2. Performance is partially recovered within 100 hours. It is likely to recover entirely over a longer period. It is clear that mixed reformed biogas behaves better than dry reformed biogas (i.e. 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. This point has been analysed by the Innovation Radar as an innovative solution.
- Reformer catalysts, cells and stacks characterised with specific sulphur compounds show resilience of up to 5 ppm of trace content.
- System cost analysis shows that biogas SOFC can achieve a levelised cost of electricity of < 0.15 ct€/kWhe, even at 20 kWe, for a 4-year stack life (stack cost €1 000/kWe).

FUTURE STEPS AND PLANS

- A cryogenic cleaning chain for biogas flow of 100 m^3/g has been mounted at Biokomp premises and has been prepared for shipping to the biogas site in Vilnius.
- The project is testing the 1.5 kWe SOFC at the agro-biogas site, with adapted biogas cleaning based on project sorbent results. This will involve looking for co-financing, preparing analysis of the biogas site and setting up a site visit to establish project connections.
- Long-term testing of cells and stacks will be performed with 3–5 ppm of sulphur. All set-ups, gas analytics and detailed electrochemical characterisation methods have been established. Stacks and cells are being tested for longer durations than they were previously (> 1 000 hours).
- The final cleaning cost will be updated from Biokomp and Arol after delivery and installation, for integration into the established system model.

QUANTITATIVE TARGETS AND STATUS

Target source	Parameter	Unit	Target	Achieved to date by the project	Target achieved?
MAWP addendum (2018–2020)	SOFC CAPEX	€/kWe	3 500–6 500 (2024)	2 000–4 000	✓
Project's own objectives	Pollutant tolerance	ppm	5	3	⚙
	Pollutant nature and mix	Sulphur compounds	Identification	Critical compounds identified	✓
	Biogas cleaning	€/kWe	< 1 000	< 1 000	
	Levelised cost of energy	€/kWhe	< 15	0.09	
	Voltage loss under constant current (SOFC degradation on biogas reformate)	%/kh	0.4	0.7	⚙

Clean Hydrogen Partnership
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