

Development of a novel highly efficient energy supply system for energy autonomous multi-family buildings based on biomass gasification coupled with an SOFC and a PV system

Micro-Bio-CHP

<https://microbiochp-project.eu>



Project Coordinator:

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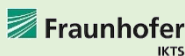


Project Partners:

CATATOR AB (SE)
www.catator.com



Fraunhofer Institute for Ceramic Technologies and Systems IKTS (DE)
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HYSYTECH SRL (IT)
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The project

Micro-Bio-CHP aims at the development of an innovative renewable energy-based system for heat and electricity supply in order to achieve almost energy autonomous multi-family buildings with regard to heating and electricity consumption as well as electro-mobility. This shall be achieved by integrating a novel highly efficient biomass micro-CHP technology based on an updraft gasifier, a novel gas cleaning system and a solid oxide fuel cell (SOFC), a state-of-the-art PV system and appropriate innovative energy storage solutions.

Technological highlights

- Flexible partitioning of the product gas produced in the gasifier for utilisation in the SOFC for electricity production and in a gas burner for heat production
- A novel and compact gas cleaning system
- New highly efficient and durable stack units
- A novel and compact SOFC system with integrated HCl and H₂S removal reactors
- SOFC operation at zero emissions

Based on a 2.5 kW_{el} SOFC with an electric efficiency of 44%, which is flexibly coupled with a 15 kW wood pellet gasifier, overall efficiencies of more than 90% shall be gained. A TRL of 5 shall be achieved at the end of the project.

The R&I methodology applied relies on technology development (based on process simulations, CFD aided design of the single units, test plant construction, performance and evaluation of test runs) and a technology assessment part covering risk, techno-economic, environmental and overall impact assessments as.

Project key data

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Disclaimer of warranties

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Micro-Bio-CHP concept

- Combination of two renewable wintertime systems that perfectly complement each other in terms of heat and electricity production and coverage of heat and electricity needs of a multi-family building throughout the year.
- **Biomass CHP system** consisting of a biomass gasifier, a gas burner, a SOFC system, a heat recovery unit and a heat buffer storage
 - Secures the heat and electricity consumption during wintertime and transition seasons
 - Is not operated during seasons without space heating demand
- **PV system**
 - Supplies base load electricity in the winter and covers the whole electricity demand in summer
 - Takes over domestic hot water supply during summer as well as during parts of the transition seasons (when the biomass CHP system is not in operation) via a power-to-heat device
 - Novel electricity storage by bi-directional charging
 - Excess electricity of the PV system to be utilised for e-mobility

Biomass conversion module

- Small-scale fixed-bed updraft gasifier technology operated with wood pellets
- Novel product gas burner with almost zero CO, OGC and PM emissions directly coupled to the gasifier
- Novel extraction of a part of the product gas to supply the SOFC
- Integrated gas cleaning and tar reforming
- Flexible adjustment of the share of product gas fed to the SOFC and to the product gas burner
- Operation in heat only mode and in CHP mode possible

SOFC system with MK35X stack module

- Integrated dry-sorption-based HCl and H₂S removal in a compact design
- MK35x SOFC stack modules optimized for operation with product gas from biomass updraft gasification
- Integration of all SOFC system components into a compact single unit
- Appropriate process control for operation with product gas from the biomass gasifier
- Almost zero emission operation due to optimised catalytic SOFC off-gas combustion

Micro-Bio-CHP testing plant

- Installed at BIOS BIOENERGYSYSTEME GmbH, Graz, Austria
- Comprises the biomass conversion module and the SOFC module
- Fully operational since October 2024



Performance

- Biomass conversion module: 15 kW fuel power input (related to the NCV) and up to 11 kW heat production
- SOFC system with an electric output of 2.5 kW at full load operation
- Overall efficiency >90% (related to the NCV of the biomass fuel supplied)

Advantages

- Energy autonomy for multi-family buildings
- Almost zero harmful gaseous and dust emissions
- No harmful liquid effluents
- High energy efficiency
- Compact design

