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For the Micro Combined Heat and Power System for Households H-CHP

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1. Introduction

The aim of the H-CHP project is to create sustainable small-scale combined heat and power (CHP) solutions for households in the northern periphery. The aim is also to raise awareness of renewable energy solutions and their use in remote and sparsely populated areas. The task of the Department of Energy Technology at Oulu University of Applied Sciences (Oamk) is to evaluate the results of the project comprehensively and to provide technical expert support for the construction of CHP equipment. The project, which started in 2017, aims to promote the introduction of combined heat and power (CHP) systems in households in the northern periphery. The project involved partners from Finland, Sweden, Iceland, Scotland, and Ireland. [1]

2. The H-CHP project webinar

An international webinar for the Micro Combined Heat and Power System for Households (H-CHP) project, funded by the Interreg Northern Periphery and Arctic Program [2], summarized the results of the partners involved in the project. The webinar in early November 2020 presented the results of the project from five perspectives: 1. an overview of the current situation, 2. construction of a suitable CHP plant, 3. piloting, 4. evaluation and 5. information. All presentations and related reports will be available for download on the project website for anyone interested. [1]

3. Mapping of the current situation

Lews Castle College at the University of the Highlands and Islands, on the island of north-west Scotland, highlighted the general policy of CHP facilities and the benefits to households in a webinar. The use of technology is influenced by local conditions, such as energy use patterns and quantities, weather conditions, fuel availability and storage, and legislation and forms of support, which vary widely even within the project area. Important variables for households are the size of the property, the insulation, the type of heating and the number of inhabitants. Of these, Lews Castle Collage has compiled a large number of records from the project area. The data will be used, among other things, in a calculation model created by them, which can be used to assess the suitability of technically and economically different household energy production methods and their combinations for different applications.

Commercially available small (<20 kW) CHP plants for households have been mapped at Luleå University of Technology. There are only a few companies providing installations and they manufacture facilities as individual production or offer installations as part of their product family. Most of the plants on offer are based on Stirling engines, but one company even offers ORC technology (45 kW). [3] Biogas, wood pellets, wood chips and logs can be used as fuels. The conclusion of the project is that all these installations have in common an unfavorable size class, price and electricity and heat production ratio for households. The plant cost per kilowatt of a small-scale CHP plant (<50 kW) is significantly higher than that of a larger plant (> 1 MW). In a scale suitable for households, the cost of purchasing a CHP plant is up to ten times that of a traditional boiler. Thus, CHP plants are not cost-effective for household energy production, at least not yet.

The profitability of small-scale CHP plants is also reduced by the small share of electricity generation in energy production. The plants produce tens of kilowatts of heat, of which at best 10 % can be converted into electricity, with the remainder being recoverable or waste heat. Very few households have a constant need for such large heat production. Even within a day, electricity demand varies so much that profitable operation of plants is not possible without large-scale heat and electricity storage systems.

4. Construction of an H-CHP plant

The project built one and investigated two different CHP plants. The aim of the FMT research group [4] of the University of Oulu, which is leading the project, was to build a CHP plant based on a steam boiler and machine, using wood pellets as fuel, and the subassemblies of which were dimensioned by Oamk. The steam boiler and machine were made to operate individually during the project, but technical challenges became an obstacle in the implementation of the property's heat and power generation unit. This is a pity, as the other components related to the plant, such as power electronics and the control and user interface, are technically ready. (Figure 1.)

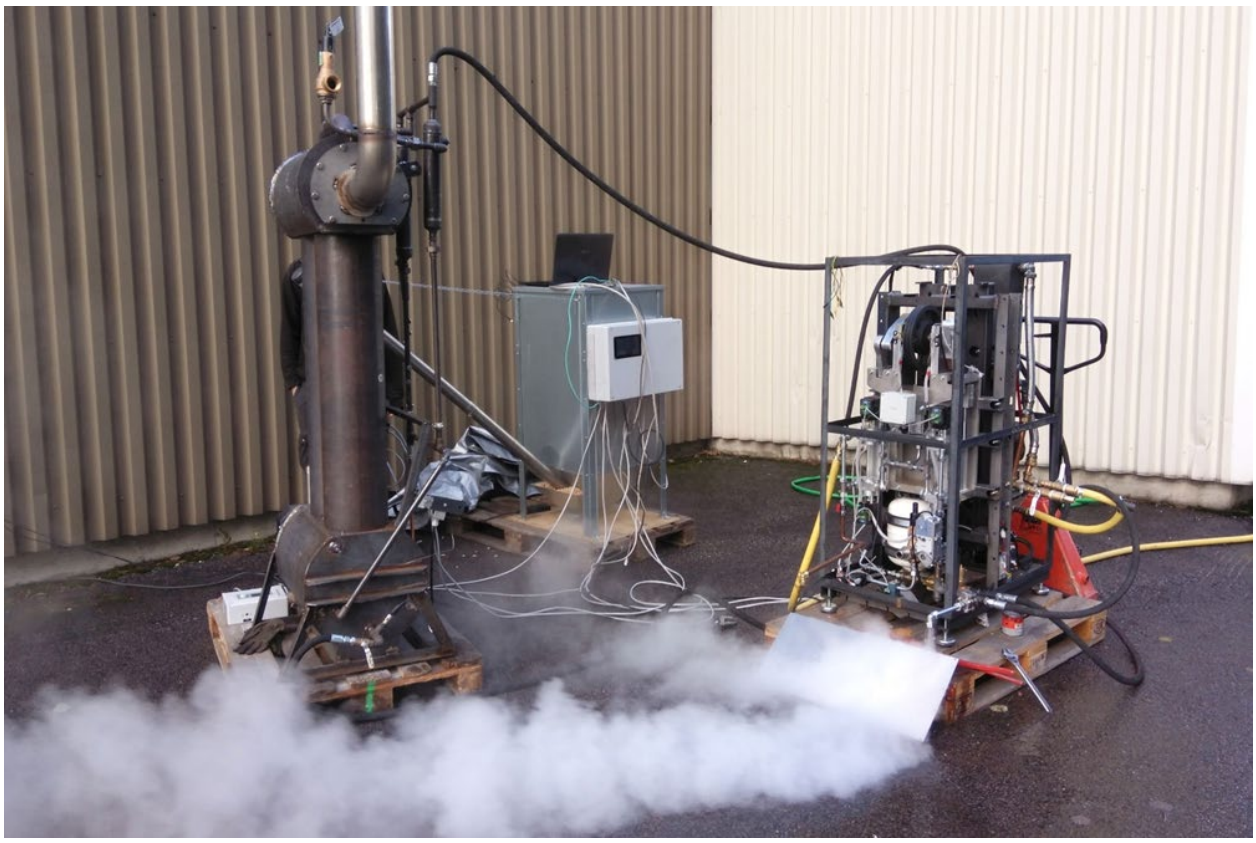

FIGURE 1. Trial operation of a CHP plant based on a steam boiler and machine (photo: Markku Kananen)

The University of Oulu also studied a commercially available Stirling engine-based CHP unit (Biogen Woodlog Gasifier) for households [5]. It is practically a traditional log boiler with a Stirling engine placed in the combustion chamber. The plant generates 22 kW of heat and 1.05 kW of electricity at full power. After successful test runs, the unit was moved to a household in Scotland for practical testing. (Figure 2.)

FIGURE 2. Trial operation of a wood log CHP unit (photo: Markku Kananen)

The Faculty of Production and Mechanical Engineering at the University of Iceland studied a wood gasification-based CHP plant built on top of a car trailer (Figure 3). The plant for research and demonstration use generates 20 kW of both heat and electricity. During the test runs, the plant has been found to be fully functional with dried wood chips and wood pellets can be utilized as additional fuel. The great goal of the University of Iceland is to make the plant also operate with selected household waste, so that in waste-free remote areas, both waste management and energy production would take place at the same time. Achieving this goal, however, requires thorough research and legislative changes before they materialize.

FIGURE 3. University of Iceland's CHP plant (photo: Rúnar Unnþórsson)

5. Piloting

The Stirling generator (Woodlog Gasifier) was installed in a household on the Outer Hebrides archipelago off the west coast of Scotland, chosen by the Scottish Tighean Innse Gall (TIG). The installation work was challenging in the current corona situation when a water-circulating heating system and equipment installation were assembled in the house at the same time. Getting skilled installers on site was not always possible on time. However, the commissioning and adjustment of the plant is now underway and results from operations are expected during the rest of the year. Included within the webinar, TIG also published a user guide for the public on the above-mentioned power plants. The guide is available on the project website. [2]

6. Evaluation

In addition to technical expertise, Oamk's role in the project is to evaluate each part of the project. In addition to the technical aspects, the evaluation examines the project in terms of sustainable development, locality and socio-economic perspectives. The evaluation will be published in connection with the final report of the project on the project website. [1]

7. Information

Information on the most significant events and results of the project can be found on the project website and contact with the Irish partner, Energy Action. The project has been presented in several workshops, seminars and conferences. In connection with the webinar, a community guide prepared by TIG was also published, reviewing the objectives and results of the project. An English language guide is available on the project website. [1]

8. Webinar Summary

The official results of the project, of which the webinar gave some taste, will be published during 2020. There is a need for a functioning, household-oriented and sustainable CHP plant in remote and sparsely populated areas of the project area. However, uniform recommendations for equipment are not possible due to different forms and methods of energy use, building stock, weather conditions, and the availability of fuels. In addition, the legislation of different countries and regions imposes different technical requirements on institutions. Although CHP is very challenging in a size range suitable for individual households, awareness of the different opportunities in the area has increased in line with the project's objectives. We hope that in the future this information will be used extensively when looking at household energy production and use.

9. References

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