INTERIM RESULTS OF THE GROOF PROJECT

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INTRODUCTION

The potentials of synergies between buildings and integrated rooftop greenhouses are described in previous reports and articles. This article provides an overview of the interim results of Greenhouse Gas Emissions (GHG) of the GROOF pilots. For this topic, the research institutes HS Trier / IfaS and CSTB have developed a method as well as reference scenarios to compare the GROOF pilots with a commercial greenhouse vegetable production.

The main challenge in this research field is the diversity of the horticulture sector in terms of production system and greenhouse types. For this reason, four reference scenarios were developed, which are described in previous reports.

In the GROOF pilots exist the same situation, every pilot has its individual greenhouse construction and production system. Therefore, several studies were analysed to obtain average values in the areas of greenhouse construction/design, crop production, organic waste etc. and each pilot was assigned its own reference scenarios. The basis of GHG abatement from the pilots is their individual monitoring system. Therefore HS Trier/IfaS in collaboration with the pilots developed individual monitoring concepts to measure the necessary energy and material flows. In spite of a constant exchange with pilots and relevant stakeholders, challenges in terms of the implementation of the monitoring tools came up. In addition, the crop production started late in some cases.

As a consequence, data gaps or implausible data are present for this monitoring period. For this reason, the energy team in collaboration with the pilots analysed the opportunities (based on the correct monitored data) for a modelling method to close the data gaps of the affected pilots. The GROOF energy team developed solutions and, thanks to continuous exchanges with the pilots, beneficial data for the modelling method could be analysed.

The following article describes the interim results of the potential of GHG emission savings. The monitoring of the pilots is ongoing and the final results will soon be available.

EBF pilot

The EBF unique Chinese lean-to greenhouse is an energy saving greenhouse. The greenhouse used hempcrete and wooden structure on the east, north and west wall as well as ETFE film as double layer on the south side. Using a greenhouse as solar collector is key for the GHG emission savings in this case.

The EBF greenhouse uses synergies between crop and energy production such as integrated PV panels that produce electricity and offer shading to the plants. demand left in the support building.

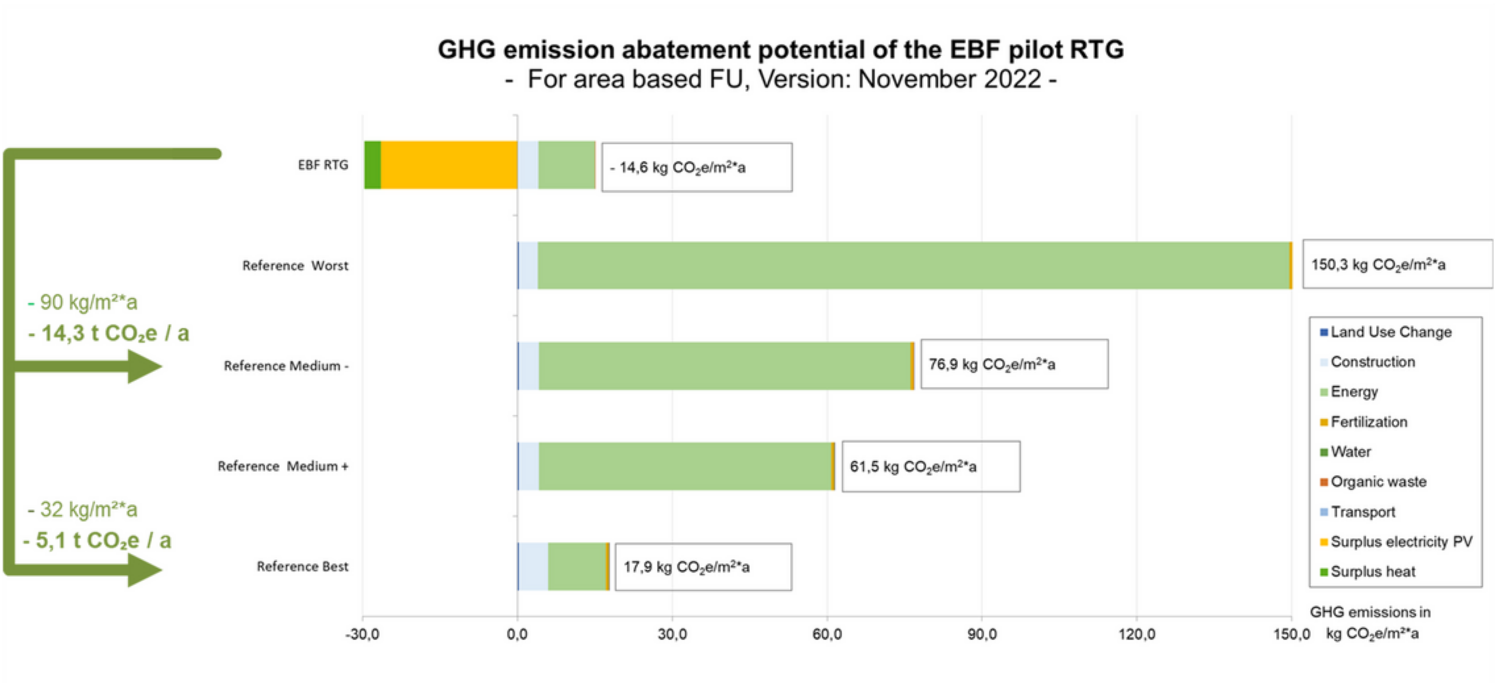
Furthermore, the greenhouse has exceeding heat energy, which can be used in the support building.

Finally, the surrounding roof surfaces of the building are used for an electricity production as well. Based on this design, the greenhouse and the building produce food and generate energy in a synergic manner.

EBF pilot

In terms of energy production, it could be mentioned that the greenhouse produces more energy than it needs. On average, the greenhouse consumed around 6.400 kWh/a heat and 200 kWh/a electricity during the last monitoring period. Compared to this energy demand, the greenhouse generated around 7.100 kWh/a electricity from the PV systems and provide 1.800 kWh/a heat to the support building. Based on this energy production and on the renewable construction material, the EBF greenhouse can reduce the GHG emissions of around -14,3 tCO2e/a compared to Reference Medium Minus scenario. On the basis of the area, a reduction of around -91 kgCO2e/m²*a has been calculated. In comparison with the Reference Best Scenarios, -5,1 tCO2e/a and -31 kgCO2/m²*a could be achieved.

The following illustration shows the comparison with the reference scenarios.



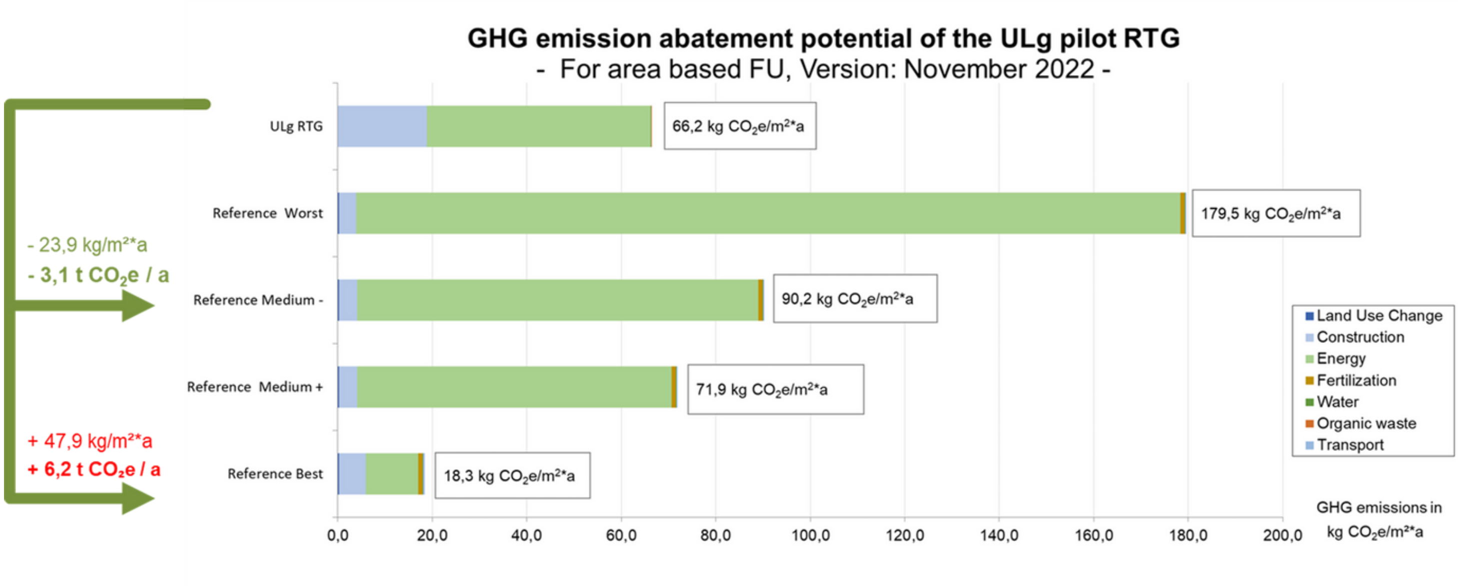
ULg pilot

The ULg RTG will be integrated into the TERRA building complex and will be constructed on top of the technical unit's terrace in between two other buildings. The walls of the surrounding buildings are constructed as ventilated façades which can be negatively affected by the climate conditions inside the greenhouse. To overcome this constraint, the greenhouse will not be physically connected to the building wall but rather have a separate wall with sandwich panels. Moreover, it will be built on a "floating foundation" on the insulation of the existing flat roof. Based on these conditions, a lean-to structure was chosen because of its lighter weight. Furthermore, this RTG typ has a 13% lower energy demand as other possible GH structures. For higher energy efficiency purposes, the north wall (in front of the building) will be constructed with 120 mm sandwich panels. Furthermore, sandwich panels (thickness between 40 and 60 mm) will be used up to a height of 0,9 m on the western, southern and eastern sides of the RTG. This material has a lower U-value (0,35 to 0,55 W/m²*K) than other envelope materials (e.g. glass, foil, etc.). For the transparent envelope material, heat protecting glass (U-value 1,1 W/m²*K, 70% light transmission rate) was chosen. To achieve higher energy efficiency standard, the installation of one thermal screen is also integrated.

This standalone greenhouse construction is beneficial for roofs; however, it poses challenges in terms of physical connection (e.g. ventilated facade) to the building, and it has effects on the construction materials.

ULg pilot

This impact is demonstrated by the GHG emissions for construction. Furthermore, the high energy efficiency standard of the greenhouse construction/design (e.g.: heat protecting glasses etc.) leads to higher GHG emissions in construction material compared to the Reference scenarios. According to this greenhouse design, a reduction of the GHG emissions of around -3,1 tCO2e/a compared to Reference Medium Minus scenario has been calculated. Based on the area, a reduction of around -23,9 kgCO2e/m²*a has been calculated. In comparison with the Reference Best scenarios, the ULg greenhouse has around 6,2 tCO2e/a and 47,9 kgCO2/m²*a higher GHG emissions. The following illustration shows the comparison with the reference scenarios.



Further potential to reduce the GHG emissions in the energy usage are available and described in previous reports. Depending on the feasibility and on the RTG heat management, a reduction of the GHG emissions in terms of heat energy could be possible. In addition, an integrated PV system in the greenhouse is a further option to reduce the GHG emissions. These options will be analysed in the future.

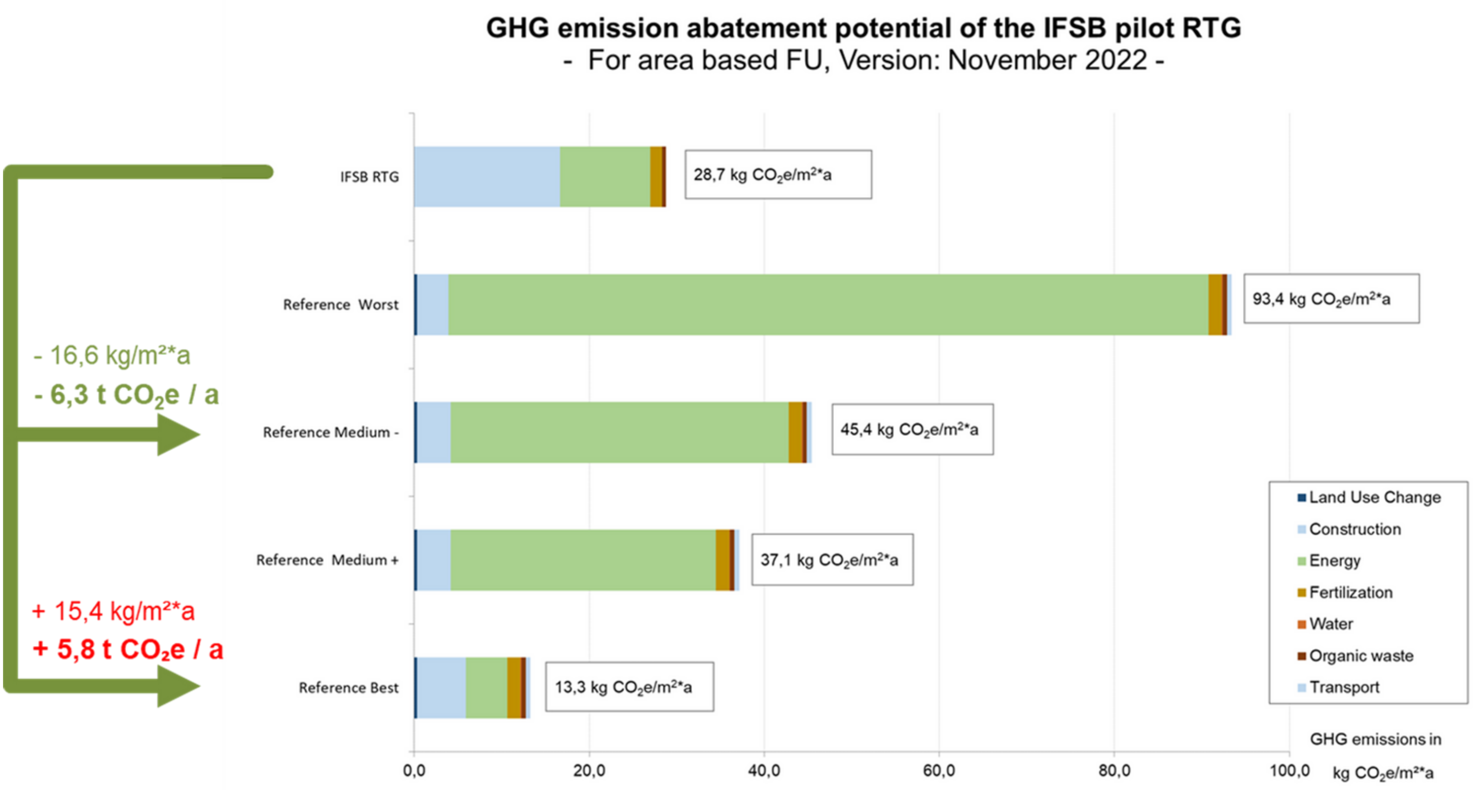
IFSB pilot

The IFSB rooftop greenhouse is built on an extension of the canteen, which is located on the southern side of the main building. This pilot is implemented as a high energy efficiency greenhouse with heat protecting glass. Energy efficiency is achieved by integrating energy saving glass panels and a thermal screen in the greenhouse.

The glazing will consist of a double glass with a heat coefficient of 1,1 Wm^2*K and a light transmission of 80%. Furthermore, it uses symbiosis between the building and the RTG, in terms of fertiliser potential inside the waste air streams of the ventilation system. The exhaust air from the ventilation system, which has a CO_2 content of up to 700 ppm during the day is used as fertiliser for the plants. Further energy mesurments are, the north wall of the greenhouse is integreted in the building as well as the canteen below RTG helps to heat up the greenhouse too. The renewable energy system (pellet boiler and solar thermal system) for the building and the greenhouse has also positive impacts in terms of GHG emission reduction.

IFSB pilot

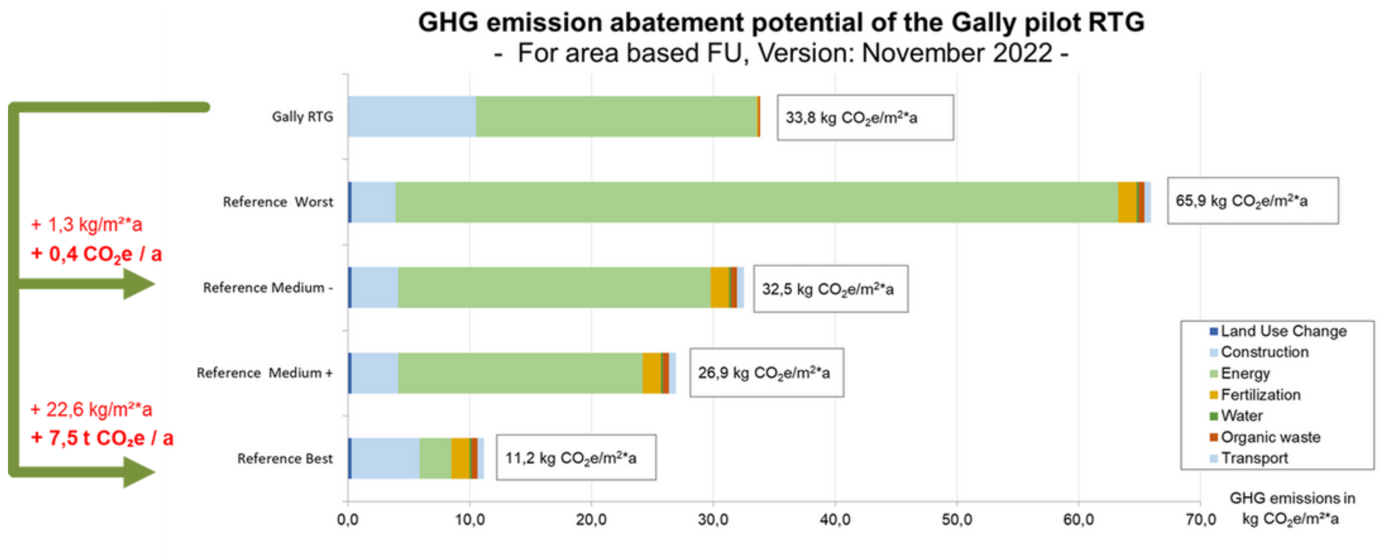
In the case of the IFSB pilot, the high energy efficiency standard of the greenhouse construction/design (e.g.: heat protecting glass panels etc.) leads to higher GHG emission in construction material, compared to the Reference scenarios. In terms of the renewable energy sources for heat production, the GHG emission savings are high compared to Reference medium and worst scenario. According to this greenhouse design, the monitoring period and the modelling method, a reduction of the GHG emissions of around -6,3 tCO2e/a compared to Reference Medium Minus scenario has been identified. Based on the area, a reduction of around -16,6 kgCO2e/m²*a has been calculated. In comparison with the Reference Best scenarios, the IFSB greenhouse has around 5,8 tCO2e/a and 15,4 kgCO2/m²*a higher GHG emissions. The following illustration shows the comparison with the reference scenarios. The monitoring is ongoing and the final results will be analysed in the near future.



Gally pilot

The Gally pilot is built on a redesigned building at St. Denis farm (area of 380 m2).
This redesigned building has a beneficial design and materials such as concrete slab and a concrete wall on the northern side, which leads to lower heat energy consumption in the greenhouse and in the building during the heating period because this massive wall is used as a solar collector.
This design leads to a 2˚C temperature increase inside the greenhouse during the wintertime. Furthermore, the given structure and cubature of the building is beneficial for the greenhouse because it results in an optimum ratio between the envelope and the surface area of the greenhouse.

As far as the production period is concerned, a summer production was chosen. This leads to a low temperature strategy between December to March and it reduces the energy demand. According to this method, the reference scenarios used the same operation time and production system. Based on this, no significant GHG emission savings can be achieved until October – November. Considering the monitoring period and the modelling of the energy demand, a GHG emission reduction prospect cannot be achieved until the end of the project. Final results will be available and published in the near future. According to this greenhouse design and the modelling method, no GHG emissions are present compared to Reference Medium Minus and the Reference Best scenario. The following illustration shows the comparison with the reference scenarios.



PARTNERS

Do not hesitate to visit GROOF website : www.groof.eu

Discover GROOF Guidelines : https://www.urbanfarming-greenhouse.eu/
This is a summary of GROOF's experience in designing and building an energy efficient rooftop greenhouse.

European Regional Development Fund