Geothermal energy for circular food production – GEOFOOD

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The GEOFOOD project showcases the opportunities for direct use of low temperature geothermal energy to increase food production in highly productive circular systems. An aquaponics research plant was constructed at Wageningen University & Research (WUR) in Bleiswijk in the Netherlands and a demonstration plant was constructed by Samraekt in Reykjavik Iceland to validate mathematical models, provide a demonstration design for energy, nutrient and water recycling and provide educational material for disseminating and communicating the ideology to other geothermal areas in Europe and worldwide.

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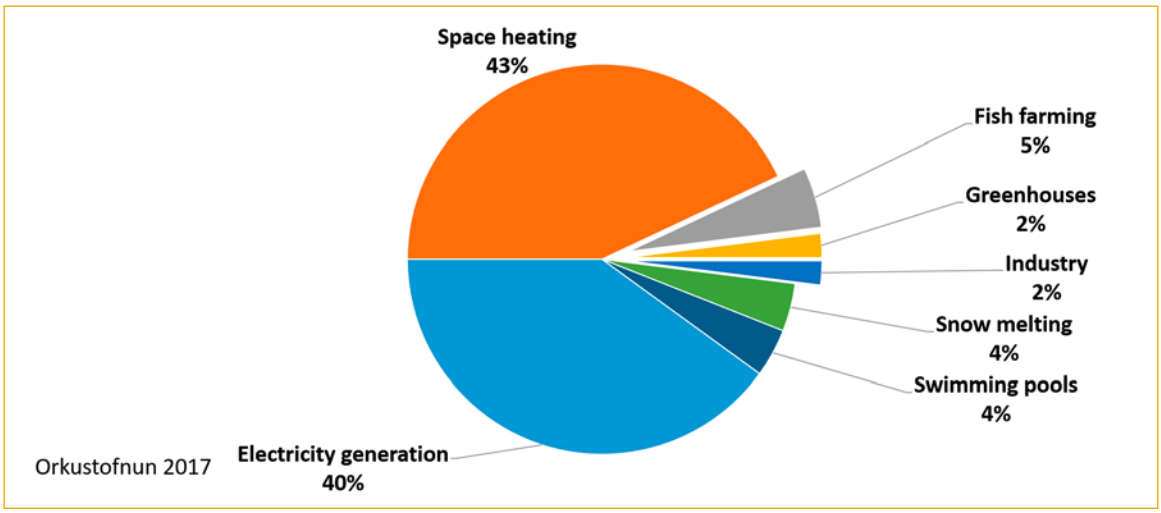
Expanding direct use of geothermal resources

New energy policies and environmental awareness of the general consumers have led to increased interest in renewable energy sources needed to replace fossil fuels. New alternatives include geothermal resources offering great potential in Europe and worldwide. According to Geothermal ERA-NET Europe produces 1.5 GWe of electricity from geothermal sources while the capacity is estimated to be 80-100 GWe. Moreover, low temperature geothermal fields exist throughout Europe and many places worldwide offering an enormous potential for new direct use applications.

Although geothermal resources are used in more than thirty European countries, except for Iceland, it is still only on a relatively small scale. Iceland has abundant geothermal energy, both high and low temperature fields. The installed electricity generation capacity from high temperature fields is 663 MWe providing approximately one third of the country´s total electricity production. Also, Iceland has a long history of efficient direct use of low temperature fields mainly for space heating, but also for swimming pools, snow melting, fish farming, greenhouses and industries, mainly for drying of fish, seaweed and salt. The direct use for food production and industries is estimated to 9 % of the current utilisation of geothermal energy in Iceland (Fig. 1), and there is a huge potential to expand this further. To support this a new collaborative initiative, Ork-idea, has been started. It is based on an agreement between the Agricultural University of Iceland, Landsvirkjun Power Company, the Association of Municipalities in South Iceland and the Ministry of Industries and Innovation in Iceland. The aim is to provide a strong base for



▶ *Fig. 1: Utilisation of geothermal energy in Iceland*

▶ Fig. 2: Design of the urban educational center in Reykjavik including a store (Samraekt)

sustainable agriculture and enhance innovation in the field of energy-dependent, advanced high value food production and processing.

The GEOFOOD project

Food production in Europe requires further steps in reducing the carbon footprint. Major users of heat are the sectors of greenhouse horticulture and aquaculture. Integrating these two sectors in a circular zero waste production system and with direct use of geothermal energy can lead to better, more efficient use of heat, water and nutrients.

GEOFOOD with partners from Iceland, Slovenia and the Netherlands is communicating new circular food production systems to showcase the untapped potential of low temperature geothermal fields not only in Iceland but worldwide. The project aims for being a step toward increasing the deployment of low temperature geothermal resources for food production and processing, supporting the expansion of direct use of geothermal heat.

GEOFOOD provides innovative concepts illustrating how to increase the economic viability of geothermal heat infrastructure using circular food production systems. The production systems are based on optimized use of energy, water, nutrients and other resources to support viable agri-businesses which can help to cover the costs of running geothermal heat installations.

The GEOFOOD focus is on circular agricultural production processes, water treatment and waste recovery processes, operating in synergy as circular food production systems, which can be operated in series as a thermal treatment network which extracts as much heat as possible from geothermal well installations. Specifically, this thermal treatment train is comprised by sequence of horticultural greenhouses, fish farming systems based on recirculating aquaculture systems (RAS) acting as heat sinks and wastewater treatment and nutrient recovery systems which will have a variety of heating requirements through the year and that are able to use the waste heat from each previous step in the treatment train.

▲ Fig. 3: GEOFOOD research unit at WUR (Photo: Alexander Boedijn)

GEOFOOD demonstration units

A GEOFOOD research plant was designed and constructed at WUR in Bleiswijk in the Netherlands (Fig. 3). The plant has been running for one year and is used for validating a mathematical model for energy and water use. In the beginning of 2020, a demonstration system was built by Samraekt in Reykjavik in Iceland. The overall idea is designed as an urban unit for education and communication with local producers and consumers (Fig. 2).

The circular production units are based on combining the RAS with the horticulture production system. The wastewater from the aquaculture system is used as nutrient input for the plants as shown in Fig. 4. The water is running in two main circular units in a decoupled aquaponics system, as the water is not returned back to the fish again. This is done to keep optimal conditions in both subsystems. In addition, the sludge is used for valuable by-products. In this way the units are designed to use energy, nutrients and

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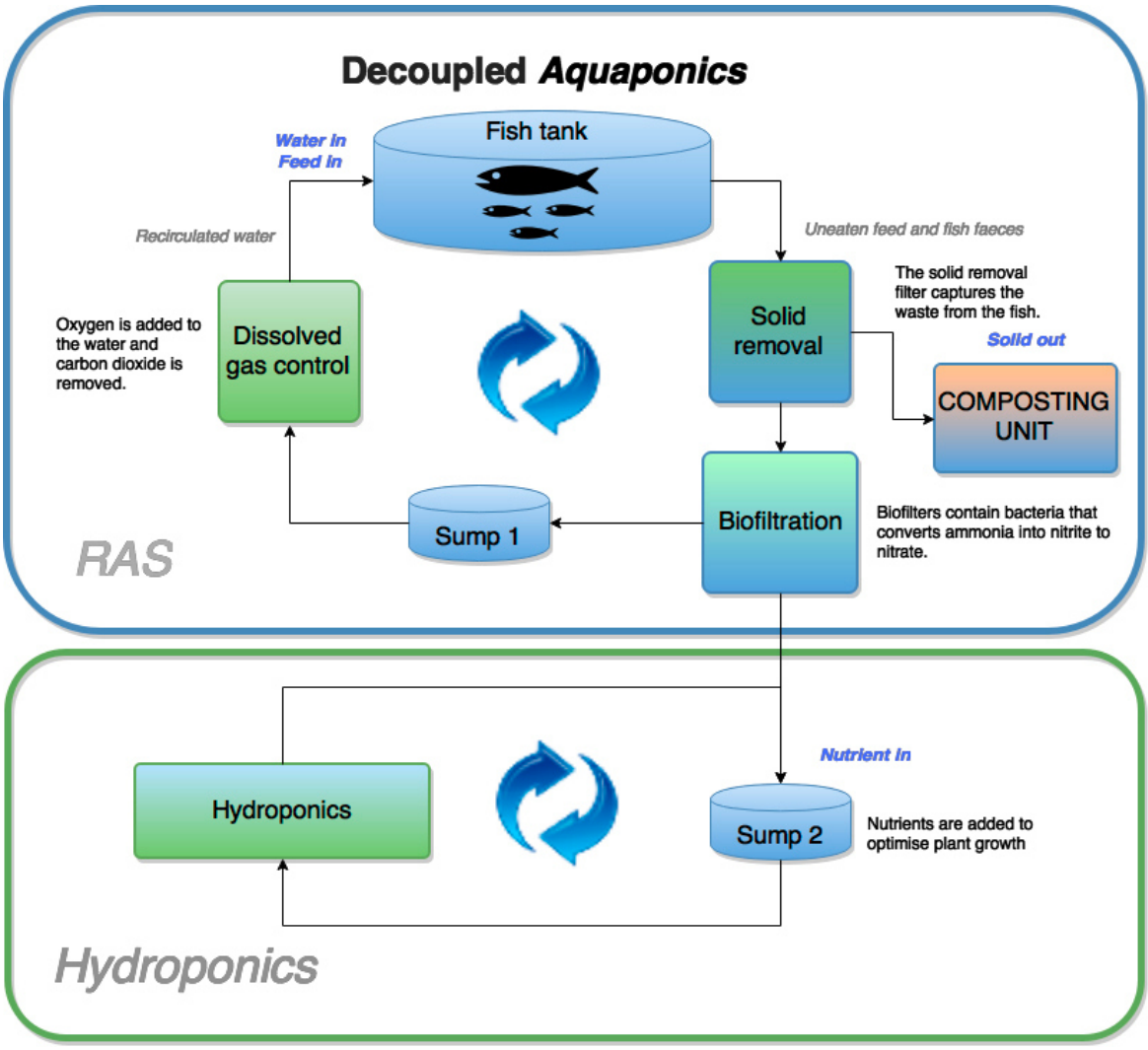

▲ *Fig. 4: Schematic diagram of a decoupled aquaponic system (Samraekt)*

water resources in a sustainable way leading to economically competitive solutions and a cleaner environment.

Education and promoting direct use of geothermal energy

A zero-waste food production including 100% renewable energy and innovative by-products, will underpin a new concept addressing EU-wide challenges and will strengthen the competitiveness of Europe. It is certain that aquaculture, horticulture and other food production and processing will have to develop towards closing the nutrient loop, improving energy efficiency and saving water. The connection to experience and educational tourism provides a new pillar to the business opportunity. Education and training related to sustainable and healthy food products, direct use of renewable energy and other climate and nature issues is becoming of increased interest globally. Thus, an education and training center linked to the commercial production showcase using natural resources in a sustainable way is believed to have a high potential for year-round attraction.

Geothermal resources and their potential and benefits have to be made better known. Direct use of geothermal energy is now part of the European agenda and GEOFOOD is taking one step to promote its potential and support increased applications and innovative concepts for geothermal energy use in horticulture, aquaculture and industrial drying processes.

In 2019 a total of 21 geothermal doublets were operational in the Netherlands that supplied 5,600 TJ of heat, mostly for commercial greenhouse production. An established greenhouse horticulture sector in combination with a steady increase in geothermal projects offers an interesting opportunity for other companies within the food sector looking to contribute to the ongoing transitions towards sustainable energy use and a circular economy.

The GEOFOOD project aims for distribution of knowledge from the systems set up in the Netherlands and Iceland to Slovenia. It focuses around the vision to reignite geothermal food production in the Brežice area. The challenges, however, are numerous. The most pertinent issue at the moment regarding geothermal food production in

Slovenia is the public debate regarding the reinjection and related costs of investment, together with the transnational character of this debate. Recent recognitions of geothermal food production as a future vision of Slovenian food production policy have started to shift this debate and it is precisely in projects like GEOFOOD that the necessary knowledge and the collective willpower can be gathered towards the future innovation in the geothermal food production.

The GEOFOOD model is well presented in close collaboration between the multidisciplinary consortium members, with published scientific and industry articles, presentations, study tours showing the pilot units and developing learning programs. Workshops have been held in Slovenia and the Netherlands with participants from the horticulture and aquaculture industries, geothermal specialists, researchers, stakeholders from municipalities and governmental institutes. It is noticeable how the interest for direct use of geothermal energy is increasing from all stakeholders supported by the growing geothermal networks worldwide and the increased focus on geothermal resources from policy makers.

Further information can be found on www.geofoodproject.eu. ◆

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