SiEUGreen
Sino-European innovative green and smart cities

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Deliverable 5.6

Handbook for SiEUGreen Solutions Replication

Lead Partner: DRAXIS
Lead Authors: DRAXIS
Due Date: 30/10/2021
Version: 2.0

Co-funded by the Horizon 2020 Programme of the European Union

Co-funded by the Chinese Ministry of Science and Technology

The project has received funding from the European Union's Horizon 2020 Research and Innovation Programme,

under Grant Agreement N° 774233

SiEUGreen

Sino-European Innovative Green and Smart Cities

The project has received funding from the European Union's Horizon 2020 Research and Innovation Programme, under Grant Agreement Nº 77423 and from the Chinese Ministry of Science and Technology. Throughout **SiEU**Green's implementation, EU and China will share technologies and experiences, thus contributing to the future developments of urban agriculture and urban resilience in both continents.

SiEUGreen aspires to enhance the EU-China cooperation in promoting urban agriculture for food security, resource efficiency and smart, resilient cities. The project contributes to the preparation, deployment and evaluation of showcases in 5 selected European and Chinese urban and peri-urban areas. These areas are: a previous hospital site in Norway, community gardens in Denmark, previously unused municipal areas with dense refugee population in Turkey, big urban community farms in Beijing and new green urban developments in Changsha Central China.

Handbook Overview

This **Handbook** briefly describes how the Sino-European innovative green and smart cities (**SiEUGreen)** project contributes to overcoming major challenges related to land use, food security and social inclusion in urban areas. For that purpose, it uses environmentally friendly Urban Agriculture (UA) solutions that are implemented and demonstrated by various showcases. It also contributes directly to one of its main objectives to ensure ***the sustainability of the solutions and technologies***, as well as to foster ***expansion and adoption*** by interested parties.

The **purpose** of the Handbook is to bring together insights and lessons learned from the implementation of **SiEUGreen** showcases. More than a technical document, it aims to provide general guidance for public and private stakeholders replicating **SiEUGreen** showcases and smart and innovative UA solutions. Building on these, the experience gained and the knowledge acquired during the project in various locations and places, can be extended, thus making it easier to implement similar initiatives in other contexts.

This ensures that the project's results will not be confined to **SiEUGreen** demonstration sites and their beneficiaries alone – it is rather the case that the integrated UA solutions implemented in 5 showcases will serve as good examples and practices for other cities/municipalities and encourage them to learn from the **SiEUGreen** experience on their way to becoming green–smart–inclusive cities.

This handbook is directed at municipalities, smart city planners, private developers, NGOs and project developers, and focuses on the steps to be undertaken when seeking to replicate UA pilots and solutions. During the showcase deployment, valuable lessons and broad range of experiences have been captured by partners regarding the implementation process of **SiEUGreen** solutions. As a result, the Handbook will be a reference of work for stakeholders outside the project. More specifically it will be a reference for the various technologies of **SiEUGreen** project.

Setting the Scene

Rapid urbanization and **climate change** are expected to affect significantly agricultural production and promote urban agriculture practices around the world. It is estimated that by 2050, 68% of the world's population will be living in urban areas aggravating urban poverty and urban food insecurity (United Nations 2018). On top of this, the rapidly changing climate

(unpredictable seasons, droughts, floods, etc.) threatens not only food supply, but also the quality, access, tenuous transportation links and food security in general.

The outbreak of **COVID-19** pandemic made clear the importance of food security and self-sufficiency urging people to seek alternative methods for agricultural production. **Urban Agriculture (UA)** plays a **key role** in these global challenges of rapid urbanization and food security. It can provide an important contribution to sustainable, resilient urban development and the creation and maintenance of multifunctional urban landscapes.

More specifically, UA owing to lower transportation cost and supply of fresh nutritious products at competitive prices, can help us to meet future food demands while overcoming the aforementioned challenges in our current system. UA is multifunctional (e.g., social, ecological) indoor and outdoor multi-purpose (e.g., recreation, self-supply, profit) plant cultivation practice that serves local inhabitants and distributes food in urban and peri-urban areas (McEldowney, 2017). According to the Food and Agriculture Organization (FAO), more than 800 million people are engaged in UA and peri-urban agriculture worldwide.

Overall, UA has numerous advantages: **promotes sustainable development** by sequestering carbon, **reduces the poverty** and **food insecurity** resulting from urbanization by producing fresh and local produce, **improves the local economy** and the **health of the city residents** while also **preserving the environment**, **creates social ties**, **enhances the value of empty spaces**, **enriches the city's biodiversity**, and more (Clinton et al. 2018; McEldowney 2017).

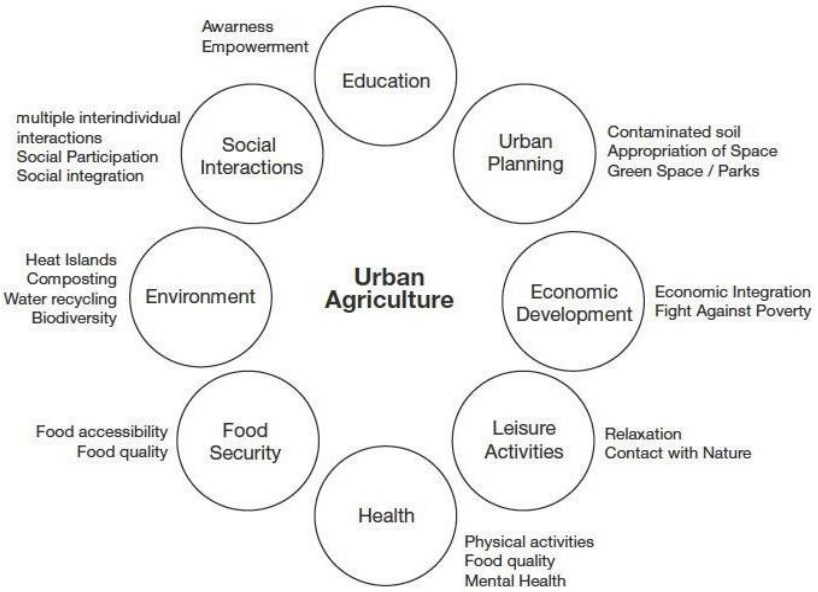

Figure 1 - Different areas of UA activity and assessment related to economic, social and environmental development. Source: Duchemine et al., (2008).

SiEUGreen Project

Figure 2 - SiEUGreen UA solution: Aquaponics system in Sanyuan farm, Beijing Showcase, China.

SiEUGreen project enhances the **EU-China** cooperation in **promoting UA for food security**, **resource efficiency**, and **smart** and **resilient cities**. In the general context of zero-waste circular economy, the **SiEUGreen** project **uses existing technological tools** and **develops innovative resource-efficient agricultural techniques** and **integrated concepts** to demonstrate how technological and societal innovation in UA can have a positive effect on economy, society and environment in China, Europe and elsewhere beyond the project period.

The **Consortium** of the **SiEUGreen** project is multi-disciplinary consisting of **European** and **Chinese researchers**, **technology providers**, **SMEs**, **financiers**, **local** and **regional authorities** and **resident communities**. By this, it covers all relevant themes concerned by UA: social & technological innovation, impact measurement, awareness and policies.

The project **prepares, deploys and evaluates five (5)** selected European and Chinese **urban** and **peri-urban areas**: students' residence at the **University Campus Ås**, **community gardens in Denmark**, previously **unused municipal areas with dense disadvantaged groups in Turkey**, big urban **community farms in Beijing** and **Central China**.

Project Information

Project Duration: **01/01/2018 – 31/12/2022**

Coordinated by: **Norwegian University of Life Sciences** (NMBU)

Project Coordinator: Professor **Dr. Sjur Baardsen**, Faculty of Environmental Sciences and Natural Resource Management (MINA-NMBU). P.O. Box 5003, N-1432 Ås, Norway, +4741515562 / +4767231740.

sjur.baardsen@nmbu.no

https://www.nmbu.no/ans/sjur.baardsen

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SiEUGreen Partners: Norwegian Institute of Bioeconomy Research (NIBIO), The Institute of Vegetables and Flowers, Chinese Academy of Agricultural Sciences (CAAS), NORDREGIO, EMETRIS SA, AARHUS KOMMUNE (AAKS), ViLabs LTD, OKYS LTD, Beijing Eco-Creative Agricultural Service Alliance (BAEISU), Beijing Green Valley Sprouts CO LTD (BGVS), Scandinavian Water Technology AS (ScanWater), Hatay Metropolitan Municipality (HATAY), Chinese Academy of Social Science (CASS), Sampas Bilisim Ve Iletisim Sistemleri Sanayi Ve Ticaret A.S. (SAMPAS), Hunan Hengkai Environmental Protection Science and Investment Group CO.LTD (HHEPSTI), SEECON INTERNATIONAL GMBH (SEECON), Leibniz Institute of Vegetable and Ornamental Sciences (IGZ), Beijing Photon Science & Technology Co, (PHOTON), DRAXIS Environmental SA (DRAXIS).

Replication Aspects

Certain aspects need to be taken into a systematic consideration when replicating solutions/showcases. Social, economic and financial aspects, as well as legal and regulatory frameworks that interact dynamically and need to be carefully analysed before proceeding with the replication of a particular showcase or solution.

Social Aspects

One significant element for a successful replication is the social acceptance of technologies by stakeholders. Showcases can be affected by stakeholders' behaviour and cultural aspects in the case of UA projects that are designed for social empowerment, participation and interaction among citizens of a municipality (i.e. Aarhus, Hatay). These can vary on location, local customs and preferences. The same is true, in the case of showcases that are highly dependent on technology (i.e., vacuum toilets will not 'work' if people do not accept and use them). Hence, what is considered a successful project in one location may not bear the same benefits in another. This risk is especially high in projects, where the stakeholders are not engaged in the process.

Regulatory & Legal factors

Another crucial aspect has to do with the main enablers and barriers for project implementation. For example, what is the regulatory environment that enables or restricts the development of a showcase. Before replication, a regulatory feasibility check must be conducted, as regulation and laws may differ significantly between different countries and even between different regions or cities of the same country. This step may be crucial for the implementation of the project.

Economic & Financial factors

Economic aspects of a project and any financial information are critical elements, which are necessary for a successful replication. The cost structure, financial risks, intangible and unforeseen costs and financial solutions constitute crucial information that need to be taken into consideration. The cost analysis should consider both fixed and operational costs to deploy and run a showcase. Fixed cost may include the cost of buying the land, where the showcase will be deployed, construction of the showcase (greenhouse, building retrofitting, etc.) and buying equipment. Operational costs include personnel salaries, current expenses to maintain and run the showcase, etc. The returns on the investment in UA projects are ensured through saving and recycling resources (i.e. water, energy, fertilizers, etc.) and not always an increase in revenues.

SiEUGreen Technologies

SiEUGreen implements a wide set of innovative technologies for UA (see also Torday Gulden 2022b), through the development and demonstration of 5 carefully selected showcases in European and Chinese urban and peri-urban areas. These UA technologies include:

- Green planting techniques (balcony gardening, aquaponics and hydroponics);
- Novel methodologies for social engagement and inclusion (UA typologies, urban farming for social inclusion and entertainment);
- Waste and wastewater management;
- Production of renewable energy, organic and bio-fertilizers;
- Digital communication platform.

Green technologies: concern soil-based traditional plant growing, water-based hydroponic culture (soilless) and aquaponics (fish and plant), paper-based plant growing and greenhouse technology.

Blue technologies: concern water and waste management, production of fertilizers and soil amendment from waste, resource recycling.

Yellow technologies: concern biogas production from waste resources, compost a fertilizer production, seasonal solar storage, combined heat and power, and photovoltaic generation of electricity.

Social Innovation: IT software application is used for more active social engagement and interactive platforms for raising awareness and sharing best practices.

SiEUGreen Fertilizers

Organic fertilizers and bio-fertilizers constitute a significant part of the circular economy. SiEUGreen solutions. produce organic fertilizers and bio-fertilizers by recycling and upgrading nutrients from urban waste and wastewater to enhance green cities and modern plant production.

Urban Composting Hub (IGZ)

Problem: The community of urban gardeners currently lacks access to affordable, locally produced, high-quality compost/soil amendments and organic fertilizers needed to accomplish a sustainable form of urban agriculture based on regional nutrient and carbon cycling. Moreover, citizens that have access to organic waste (e.g. garden, balcony or kitchen waste) often lack tools, space and skills to produce high quality compost for soil amendments and fertilizers.

Solution: Urban composting hub is a community-based initiative that addresses this problem by creating de-centralized collective local nutrient cycling system for valorising urban organic waste as precious source of plant nutrition and producing organic fertilizers from anaerobic digestion of organic waste streams (Halbert-Howard et al. 2021; Schröder et al. 2021). The urban composting hub offers composting as a service and compost as a product.

User engagement: The aim is to engage local communities (urban gardeners) and residents (home/balcony and allotment gardeners) in recycling their organic household waste and urban green waste to produce fertilizers/compost for their own or commercial use.

Garbage Processor (PHOTON)

Problem: Kitchen waste disposal in landfills creates an emergency in terms of GHG causing environmental, hygiene and safety problems especially in developing countries.

Solution: Garbage processor is a device that produces bio-organic fertilizers from household kitchen waste. This device utilizes microbial anaerobic fermentation, waste gas deodorization, as well as drying recovery technology to reduce the amount of food waste and produce organic fertilizers.

User engagement: Urban residents, balcony gardeners can use the garbage processor to process kitchen waste and produce bi-organic fertilizers to grow organic vegetables and flowers, trees at home/balcony.

Figure 4 Garbage processor

Nitrification of liquid waste streams (NMBU, NIBIO, IGZ)

Problem: Today's pressing environmental problems are associated with linear nutrient flows from rural agri-food production sites to human settlements. These open loops can be closed by using innovative, safe and resource-efficient technologies to recover essential plant nutrients from urban waste water promoting a circular economy. Source-separation of human urine can recycle nutrients more efficiently, providing direct access to a sustainable nutrient source as an alternative to synthetically produced mineral fertilizer for plant production.

Solution: The nitrification of liquid waste streams (GREENergy concept) demonstrates the value of circular economy, created from household organic waste and resulted in bio-based products and the reuse of waste and wastewater resources for the development of bio-fertilizers and organic fertilizers.

Figure 3 Lab biogas reactor at Campus Ås.

More specifically, the concept deals with converting and processing organic (human, food, etc.) waste into liquid or solid bio-fertilizer (sellable) using biogas reactors and post treatment facilities. These fertilizers can be used for a sustainable and high-quality organic food production saving costs on chemical fertilizers and the wastewater discharge and treatment. Moreover, this concept actively contributes minimize pollution risk (reduce waste and disposal) and optimize the usage of organic waste.

User engagement: Produced fertilizers can be by several end-users and prosumers, such as, small food producers (e.g. using fertilizers in their home/balcony gardens, urban community gardens), non-food producers (e.g., parks and green maintenance, flower companies, gardeners) and even large food production (conventional and urban farmers).

SiEUGreen Software & Social Innovation

Solutions for social inclusion and engagement of citizens, designed to empower the underprivileged members of urban communities and encourage the participation of urban population in UA practices.

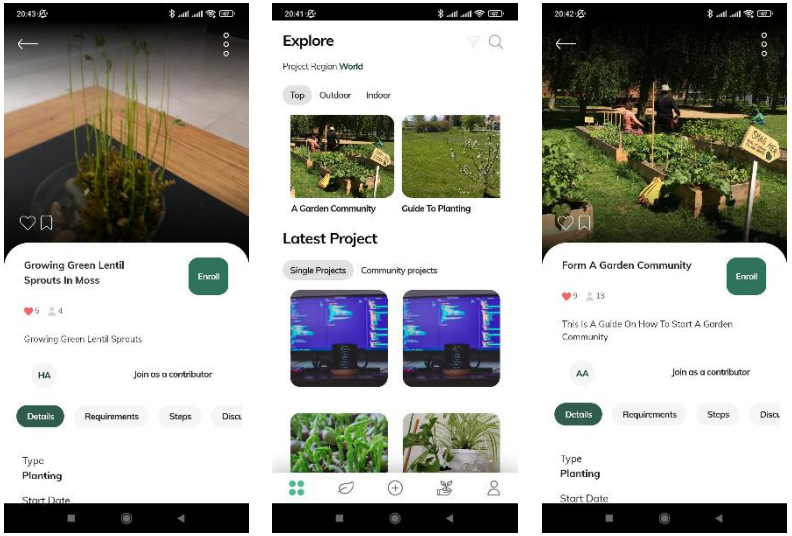


Figure 5 – commurban Application Interface

commurban app (DRAXIS S.A.)

Problem: General lack of awareness about UA in urban areas and hence low citizen engagement. Moreover, there is a limited (online and offline) access to methods, tools, training information and UA techniques.

Solution: commurban app software to facilitate residents' and community engagement and raise awareness about UA. commurban engages citizens in urban farming by maintaining and expanding a dynamic communication and knowledge/guidance exchanges among UA initiatives and practitioners. Moreover, it offers a simple way to explore new ideas and find inspiration in DIY projects.

User engagement: commurban provides users with urban farming techniques, training and consultancy on cultivation methods, supporting them in producing their own food and even generating income by selling raw materials, tools, etc. This tool can be used by health organizations and public authorities to engage patients/citizens or other end-users to improve citizens' mental and physical health, but also to contribute in small-scale food production.

UA for social empowerment (HATAY & SAMPAS)

Challenge: Mass influx of refugees to a province with high level of unemployment and families living on the brink of poverty. Ensure food security and self-sufficiency of refugees and socially disadvantaged members of local community.

Solution: Social empowerment model combining innovative UA systems (i.e., hydroponics, aquaponics) and renewable energy sources (photovoltaic panels) to enable disadvantaged communities ensure their food security and self-sufficiency.

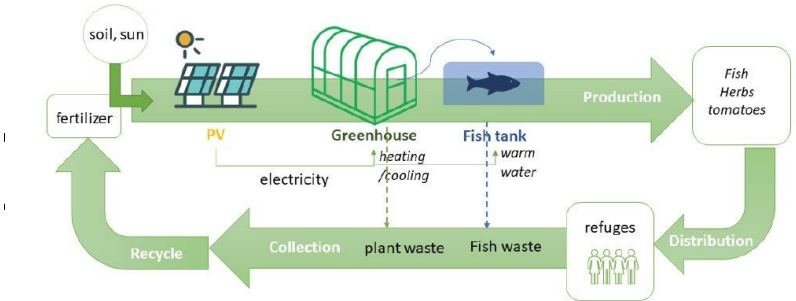


Figure 6 UA system applied in Hatay

User engagement: Refugees and disadvantaged groups are empowered to join the local and regional workforce by learning new greenhouse production methods and UA farming techniques to produce fresh, local, organic food. Additionally, they are also facilitated to adopt to the community.

UA Typologies (NORDREGIO)

Problem: Policymakers' lack of instruments to assess benefits and drawbacks of UA for the development of cities and integrated urban planning.

Solution: The integrated multiscale analysis framework on UA typologies enables urban planners and policymakers to understand the different types of UA in terms of location (intra-urban and peri-urban); governance (the different actors that manage the UA initiatives); land ownership (private or public) and the technology that is employed to grow food (e.g., pallets, greenhouses, polytunnels) (Tapia et al. 2021).

User engagement: Municipalities can use the analysis framework (on UA typologies) to enhance the role of UA in the city and develop a strategy for long-term urban planning that connects people and nature. More specifically, municipalities can strengthen urban planning, allowing for better assessment of inactive and under-utilized public spaces in applying UA (UA practitioners and associations), improving people' health (general public), enhance social inclusion, lessen maintenance costs of public areas, provide recreational services for citizens, boost local economy through production of local products (private sector developers).

Vertical Farming Solutions

Revolutionary practice that facilitates the production of food and medicinal plants without relying on high quality soil, high water consumption and fair weather conditions.

Paper-based Microgreen Technology (BGVS)

Problem: The loss of arable land, soil degradation, overuse of chemical fertilizers combined with more extreme and less reliable weather makes balcony gardening more relevant for food security and self-sufficiency than ever.

Solution: The paper-based microgreen system is a cultivation method, which is used to produce edible sprouts and vegetables on paper as an alternative to sowing seeds into the soil. The advantage of this system is that it can be used in different seasons, with short growing period, having a simple and easy operation and control of the temperature, humidity and light needed for growth.

User engagement: The idea is to engage residents to cultivate microgreens and vegetables using the paper based device at home (balcony gardening). Residents can consume their own produce or sell the produce to companies that will further process them into nutritious food or non-food products (soap) and later sell them to the market.

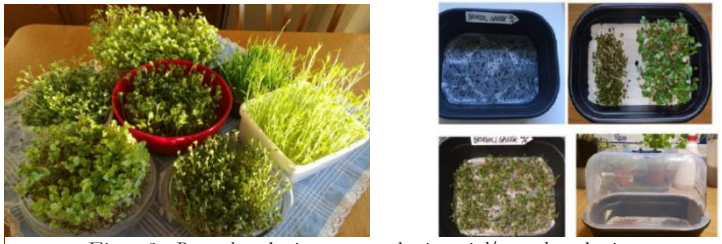


Figure 8 - Paper-based microgreen production trial/ actual production.

Fruit & Vegetable, Succulent Plants, Mushroom & Planters (PHOTON)

Problem: The shrinkage of natural spaces combined with the rapidly increasing population and modern urban lifestyle is pushing more and more people away from agriculture and agricultural related activities, despite the fact that a growing number of urban dwellers are yearning for greenness and freshness seeking to spent time away from tiresome urban lifestyle.

Figure 7 Fruit and vegetable, mushroom and succulent planter, from left to the right.

Solutions: Home growing devices that allows urban residents to produce balcony vegetables, fruits, succulent plants and mushrooms and consume their own organic produce.

A) **Fruit & vegetable planter** is a semi-enclosed matrix cultivation device with automatic environmental control function that adopts the design of the matrix automatic water absorption principle and the plant supplement light lamp.

B) **Mushroom planter** uses intelligent sensors to automatically collect environmental data, and is precisely controlled by a digital chip. It can simulate the natural growth environment of various edible mushrooms such as Oyster mushrooms (Pleurotus ostreatus), Shiitake mushrooms (Lentinus edodes), hericium edodes, and Enoki mushrooms (Flammulina velutipes).

C) **Succulent planter:** cultivation device with controllable environmental factors and home design elements that has the functions of automatic light replenishment and regular water replenishment (with micro drip irrigation used to replenish waster for small succulent plants.

User engagement: The idea is to reconnect urbanites with nature and agriculture activities. Using these devices, urban residents can have their own ecological vegetable garden and enjoy the pleasure of harvest without even leaving home. Users can experience the fun of farming, consume their produce, add fresh air and beautify home/balcony environment.

High Efficiency Aquaponics System (BAEISU & CAAS)

Problem: Due to the regional regulations against river and lake pollution, fish farming is not allowed in the Beijing region.

Solution: High efficiency aquaponics system for the integrated ecological fish-vegetable production in water shortage area or around megacities. Symbiosis can realize vegetables growing without fertilization, and fish without changing water, which not only ensures food safety, but also improves production efficiency. The entire growth process eliminates chemical fertilizers, pesticides, nutrient solutions, antibiotics and other substances, and the produced agricultural products can meet the standards of "zero chemical fertilizers, zero pesticides, and zero toxic substances".

User engagement: As the aquaponic system is quite new for most people in China it can serve as an attraction sight for visitors. Local restaurants can use the fresh vegetables and fish produced by the aquaponic system. Researchers can investigate the technical specificities of the system to identify the most efficient and market aligned combination of vegetable and fish species production.

Biomass yield estimation using machine learning (NIBIO)

Problem: As crop growth monitoring are heavily dependent on subjective human judgment the monitoring and control are prone to inaccuracy. Hence, for successful yield crops, intensive monitoring, control and automation are necessary**.** An efficient way of implementing this is the utilization of vision systems and machine learning algorithms to optimize the capabilities of farming techniques.

Solution: Machine learning based application for the evaluation of biomass development in lettuce and tomato production. Traditional approach with scores of several growth parameters requires much more time input with less accuracy. ML is effective for the quick estimation of the biomass/yield in a given growth period. A machine vision system implemented helps “see” the crops and analyse numerous essential

elements in crop growth effectively. The use of machine visions to acquire data from a smart agricultural setup is evidently capable of increasing the efficiency of food production (Zhao et al. 2020).

User engagement: The extracted features from the image processed are used for developing models from the processed dataset through an algorithm. The developed models can be utilized for further monitoring, analysis, and control by researchers, farmers, agricultural consultants.

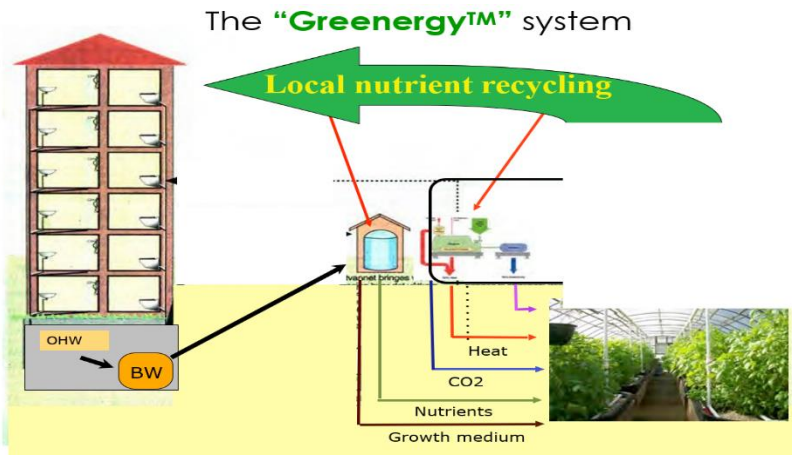


Figure 9 The GREENergy concept demonstrated at Showcase Showcase Campus Ås

GREENergy Concept

Problem: The current mishandling of organic household waste and toilets results in a massive loos of valuable resources (e.g. nutrient salts that are required in agriculture such as nitrogen, phosphorus and potassium) and in many cases leads to environmental pollution.

Solution: Smart integrated and decentralized solution for waste and wastewater management in cities and districts with climate resilient and environmentally friendly development. It optimizes well-being and minimizes the ecological footprint. It is elaborated by Scandinavian Water Technology, Norwegian Institute of Bioeconomy Research, Norwegian University of Life Sciences & HHEPSTI. The main innovative element is the combination of water saving household installations and local treatment of waste resources, in a way that facilitates reuse in urban agriculture, reduced greenhouse gas emission and minimal water pollution. The concept is decentralized and can be used independent of existing water and sanitation infrastructure.

User engagement: urban planners can use the concept in existing and new urban areas, along with production of energy, fertilizers and soil amendment, thus, minimizing pollution risk and optimizing the usage of organic waste Recycled waste and wastewater can be used for irrigation and fertilization of agricultural crops.

SiEUGreen Showcases

The development of **novel methodologies for social engagement** (UA typologies, IT software application), application of **innovative technologies for UA** (vertical farming, balcony gardening, aquaponics and hydroponics), **waste** and **wastewater treatments** (production of organic and bio-fertilizers) are taking place through the deployment and demonstration of 5 carefully selected showcases in European and Chinese urban and peri-urban locations.

- **Aarhus showcase:** UA for social bonding, environmental and health awareness of citizens, promoting the usage of unused city spaces, local food consumption and production.
- **Hatay showcase:** UA for social empowerment of unemployed women and refugees, promoting job opportunities and local food production.
- **Beijing showcase:** UA for recreation and educational purposes to promote a healthy and happy life style.
- **Campus Ås and Changsha showcases:** Green housing development projects based on the principles of circular economy, using waste recycling and wastewater management for UA.

Figure 10 - SiEUGreen Showcases Map

Aarhus Showcase - Community Gardens (Denmark)

Aarhus is an ethnically diverse city with 15% (about 50,000 people) of its population consisting of immigrants and direct descendants of immigrants who live in Denmark. Despite the fact that agriculture and fishery contributes only a small proportion to its GDP, the municipality of Aarhus (Aarhus Kommune) runs bottom-up initiatives, such as **"Taste of Aarhus"** involving urban agriculture since 2015.

Figure 11 – Aarhus, Central Denmark Region (Midtjylland).

Challenge: *How can cities create more socially inclusive places and communities, when focusing on edible nature and urban farming?*

SiEUGreen: The purpose of the showcase is to test **SiEUGreen** technologies in two gardens that are part of the "Taste of Aarhus" program. The municipality of Aarhus has great experience engaging different social groups in urban agriculture which can inspire other showcases). In addition, two gardens that are part of Taste Aarhus Program will test **SiEUGreen** technologies.

"Taste of Aarhus" Initiative

Project & Main Actors: The initiative adopts an inclusive approach to facilitate the engagement of different social groups in urban agriculture. The project supports the implementation of more than 250 gardens in the city. It has a cross-sectorial outreach within the public administration, and through urban agriculture involving urban planning, social and health care and educational sectors to address the challenges of segregated communities, obesity, lack of access to green areas and absence of physical activity.

Aim: Re-connect citizens to nature, activate the unused city areas and engage people in the practice of growing their own food. Underline the importance to consume locally and engage people in the practice of growing their food. Alleviate public spending in health and maintain public spaces, encourage social interaction and boost the local produce.

Funding: Self-funding of AAKS (€1 million) and through Nordea Bank funding (€1 million) for the period 2015-2018.

Aarhus Showcase Details

Value Proposition: The Aarhus showcase demonstrates how social empowerment through community based activities like UA can scale-up and change the city, establishing a circular economy, integrating refugees and migrants, providing access to fresh, organic and locally produced food, alleviating public spending in health and maintenance of public spaces, encouraging social interaction and boosting the local economy.

In the context of **SiEUGreen**, two gardens are testbeds for testing technologies: **Brabrand Fællesgartneriet** and **World Gardens**.

Partners & Stakeholders: Leading partners are the Municipality of Aarhus (Aarhus Kommune-AAKS) and NORDREGIO. The main stakeholders are the different departments within the municipality, residents and marginalized groups of society.

Tested SiEUGreen Technologies: UA typologies, COMMURBAN app, Polytunnels (Green technology) for production of various crops, solar-dry toilets with the photovoltaic panel and a solar collector (combination of Blue and Yellow technologies) to produce compost.

Showcase Implementation: 'Brabrand Fellesgartneriet'

Context

Brabrand Fællesgartneriet is one of the oldest gardens in Aarhus, established in 2014 in the peri-urban area of the city. The garden has an area of 11,000 m^2, which includes 6,000 m^2 of open cultivation land, 3,000 m^2 of greenhouses, and 2,000 m^2 of other built facilities, where 100 families grow food. As part of the **SiEUGreen** project, a solar-driven toilet was implemented in the site in September 2019. This toilet does not use water to flush the waste and, powered by the sun, transforms the waste into biochar, which is charcoal that can be used for soil additive and, as a fertilizer for growing food.

This technology aims to demonstrate alternative ways of dealing with human waste (faeces and urine) while addressing the scarcity of phosphorous, a non-renewable resource fundamental for growing food. This toilet is currently in use, and the compost made of the waste of the toilet (faeces and urine) is currently being tested by a laboratory. Depending on the quality of the compost, it will be used in two testbeds, one in the open field and another in a polytunnel.

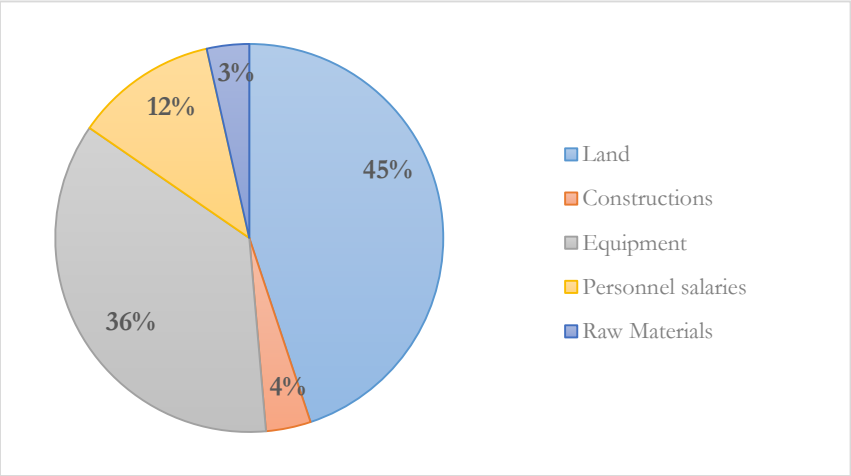
Main Outcomes

- The installation of a solar dry toilet added a useful service to the garden facilities;

- The establishment of four test beds to test different types of compost: from animal manure and from the waste of the toilet;
- Learning about social acceptance of this technology;
- Adjustment technology. Installation of a pump to the bin that collects the human waste to drain the urine to a container avoiding the soil's contamination;
- Test of compost done by a professional laboratory.

Total Financial Cost

Land: 8,068 €/year covers the lease of two greenhouses and the open field;
Constructions: 673 € for building the compost bin;
Equipment (solar dry toilet): 6,468 €;
Personnel: Monitoring and maintenance of toilet: 790€ and 1,345€ for installing the toilet;
Raw materials: 634.64 € (materials, toilet paper etc.);
EU contribution: 9,900€;
Own funding (Brabrand garden association): 8,070 €.



Enabling Conditions

- Excellent collaboration with the garden manager, who has mediated the interaction between the **SiEUGreen** researchers and the members of the garden;
- Willingness of the members of the garden in using the solar dry toilet and thus generating the primary material for the compost;
- Hiring of a student who monitors the toilet and has established the test beds;
- Collaboration with a laboratory that is testing the quality of the compost;

Main Barriers

- Fear of contamination from the alternative compost (e.g., new tools to be used in the test gardens). These must be stored separately from the other tools shared in the community;
- The smell and flies from the compost, that inadequate the location of the test gardens inside of the greenhouses;
- The new regulations from Aarhus Municipality that deliberates the land where the garden is located shall be developed for residential purposes.

Main Risks

- Possible lab analysis indicating that the compost is unsuitable to grow food;
- Closure of the garden association, which could be a consequence of the eviction from the land.

Challenges

- Overcome the resistance of accepting an alternative fertilizer from human waste;
- The threat of eviction, due to the new land-use regulations that incentivize the are to be developed for residential purposes;
- Smell and flies from the compost that do not allow to test it inside of the greenhouse.

Showcase Implementation: "World Gardens"

Context

World Gardens is an association that runs community gardens in the neighbourhoods of **Gellerupparken** and **Toveshøj**. Gellerup is located on the outskirts of Aarhus Municipality and is defined by the Danish Government as a ghetto. A "ghetto", in the Danish context, is defined based on the socioeconomic characteristics of the residents. Once an area is considered a ghetto, the municipality is responsible for taking actions to redirect its development to transform the area from being a disadvantaged urban area into an attractive urban district. In the case of Gellerup, such actions included the relocation of various municipal offices to this area, the refurbishment of residential units as well as the demolition of several buildings.

Figure 12 - Gardening in World Gardens. Photo source: NORDREGIO.

These interventions have changed the local environment substantially. As part of this process, some of the UA-plots that World Gardens has will disappear, as they are located on land in between buildings that will be demolished.

As part of the **SiEUGreen** project, World Gardens has been allocated funding to build polytunnels in three places in Gellerup. The polytunnels showcase new means for the residents to grow vegetables and prolong the growing season. They have been implemented in the open yards close to the homes of two members of World Gardens, and one set of polytunnels are located in the new City Park that is part of the redevelopment of Gellerup.

Figure 13 – Preparing the bin that collects the waste of the toilet, Brabrand. Photo Source: NORDREGIO.

Main Outcomes

- Construction of several polytunnels with the use of recycled materials;
- Dissemination of knowledge on how-to-build polytunnels through workshops carried out in 2019 and 2020;
- Raise awareness about the possibility to extend the growing season with the use of polytunnels with Facebook posts;
- Empowerment of local community garden association via the involvement in an international research project and capacitation via the added poly tunnel technology.

Total Financial Cost

- **Land:** none, it is a public property;
- **Personnel:** all the people working in the garden are volunteers;
- **Constructions:** Polytunnels 4,570 €;
- **EU contribution**: 4,570 €.

Enabling Conditions

- Passionate volunteers, who have built the polytunnels with recycled material, responsible for the communication of the activities and carrying out workshops to other members of the community;
- Support from the local city administration and the local housing association;
- Low cost of the polytunnels, due to the use of recycled materials.

Main Barriers

- Potential eviction of some of the plots used by World Gardens due to the refurbishment of the whole residential area. However, the poly tunnels have been located mainly in places where no such threat exists;
- Without being a barrier, the location of the plots in a public area available to all have caused some cases of crops being taken from the gardens. This is not seen as a major challenge though, and is counteracted by the involvement of the community and children in the activities.

Main Risks

- Long-term restrictions on social encounter;
- Vandalism as the polytunnels are located in public areas.

Challenges

- Social distance restrictions due to Covid-19. This jeopardizes the replication of the technology (polytunnels) as it is not possible to conduct workshops on how to build polytunnels with a more significant number of participants.

Lessons Learned

- Social aspects play a fundamental role in the implementation of technologies;
- From a research perspective, it is of great value to begin a collaboration for testing technologies with people who show a lot of engagement already in the activity and in the community. This provides opportunities for integrating the technologies with the ongoing activity and in the community;
- For a local initiative, it can be empowering to be part of an international research project, bringing inspiration and extra legitimacy to their activities;
- Big EU projects applied to local community can serve as an international example later on;
- The polytunnels are an excellent way to create community engagement;
- It is more useful to count at the variety of crops that can be grown considering the season, rather than the kilograms;
- People of different cultural backgrounds may accept technology in different ways. The solar driven dry toilet demonstrates different acceptance levels of an alternative fertilizer from human waste.

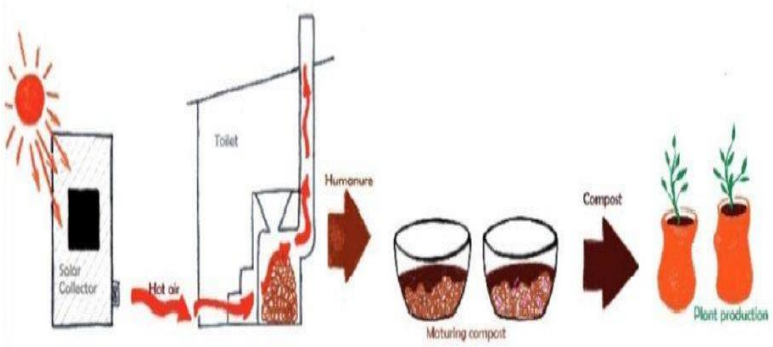


Figure 14 - Solar dry toilet: It contains both a photovoltaic panel and a solar collector for the heating. This toilet processes human excreta and extracts compost under urine.

Hatay Showcase – Community Garden (Turkey)

Hatay province is located in the Southern Turkey with urban population of 1.5 million people. Antakya is one of the most densely populated cities of this province. Due to its proximity to the Syrian border, Hatay has witnessed a large influx of refugees amounting to one third of the local population. The economic activity of this province is traditionally based in agriculture with many unemployed women and families living on the brink of poverty.

Challenge: *How can local authorities ensure food security and self-sufficiency for Syrian refugees and socially disadvantaged members of the Hatay community?*

SiEUGreen: The Hatay showcase was chosen to demonstrate how UA can be used for social empowerment of unemployed women and refugees, promoting job opportunities and local food production, aiming to improve food security and self-sufficiency. Within the scope of the SiEUGreen project showcase, the members of the Women's Cooperative were trained in innovative agricultural techniques (plant production with aquaponic system) and the Turunçlu.

Turunçlu Greenhouse

Project: Construction of 1,500 m^2 steel material greenhouse with a gothic roof, 3 tunnels with dimensions of 30 m in width, 50 m in length and 7.5 m in height, equipped with aquaponics system.

Figure 15 - Student visitors, Turunclu Greenhouse Hatay Showcase.

Partners: This construction is carried out by the Hatay Metropolitan Municipality and SAMPAS with financial support from the EU (**SiEUGreen**).

A**im:** Engage Syrian refugees and disadvantaged members of the local society in new UA production techniques.

E**xpected Outcomes:** Greenhouses were donated to cooperative member women by Hatay Municipality. To support and encourage these women, seedlings of vegetables and flowers to be grown in greenhouses were distributed.

Within the scope of the SiEUGreen project, workshops are organized for these women, where training on innovative

agricultural techniques other than traditional agriculture is provided. Many women participated in this initiative and continue to do so.

Women's Cooperative ("Ureten Eller") Initiative

Project: The local women cooperative "Ureten Eller" was established in 2017 and it is managed by an entrepreneur with the support of the Hatay municipality.

Figure 16 - The Women's Cooperative, Hatay Province.

Aim: Use urban farming to empower women with low-income to start their own businesses and provide local produce to the market.

Expected Outcomes: The cooperative provides advice and materials to support and encourage the women in building small greenhouses in their backyards to consume or sell the products (i.e., vegetables, flowers), resulting to a great number of women already involved in this initiative.

Hatay Showcase Details

Value Proposition

SiEUGreen provides UA-related technology and knowledge to support the Hatay showcase in the construction of the Turunçlu Greenhouse and supports the Women's Cooperative' (Ureten Eller) initiative. The aim for the **SiEUGreen** is to widen the usage of UA technologies, maintain the potential and encourage the replicability of this project around Turkey raising the awareness of municipalities and local communities in the social engagement to UA of economically disadvantaged citizens.

Use state-of-the-art UA technologies and practices to: produce fresh locally grown food and contribute to food security and self-sufficiency; employ unemployed women or empower low income women in creating their own small businesses; engage/employ refugees in UA activities: encourage the general public to participate in UA initiatives (internships for students, workshops and tours).

Partners & Stakeholders

Leading partners are the Hatay Metropolitan Municipality and SAMPAS. Main stakeholders are the public authorities, municipalities, refugees, unemployed women, general public, students.

Tested SiEUGreen technologies

commurban app to engage people in UA activities and increase the knowledge of urban farming and organic gardening practices.

Hatay Vitrin Greenhouse: 1,500m^2 steel construction with a gothic roof, 3 tunnels (30m width, 50 m length and 7.5m height).

Aquaponics: The aquaponic system includes 6 large tanks (5 tons each) where freshwater fish is cultivated. The waste from the fish comes to the collection tanks in the system through the water at the bottom. Then the water is filtered and the fertilized water is brought to the plant growing pipe system tubs with the help of pipe system. The incoming fertilized water circulates the entire system and after its circulation it is returned to the aquaponic tanks The aquaponic plant growing equipment covers 1,200 m^2 and consists of 16 plant growing pools (1.25 m x 6 m). 6,540 plant feeding beds through the NFT and plant feeding tubes.

Other innovative features – in the context of the local agriculture, such as biofilteration pool, photovoltaic panels, wind/humidity sensors and their control panels – were placed in the greenhouse to make it different from the traditional greenhouses.

Social innovation: through the UA model for social empowerment of disadvantaged community members.

Figure 17 Fish Tanks with biofilteration pools at the bottom.

Figure 18 Plant feeding testbedsbeds

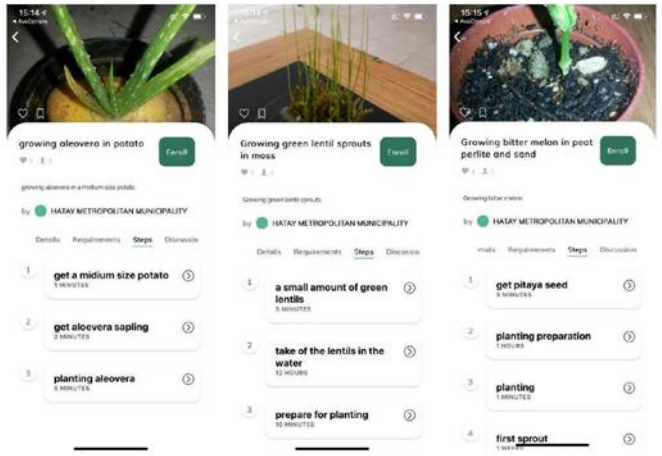
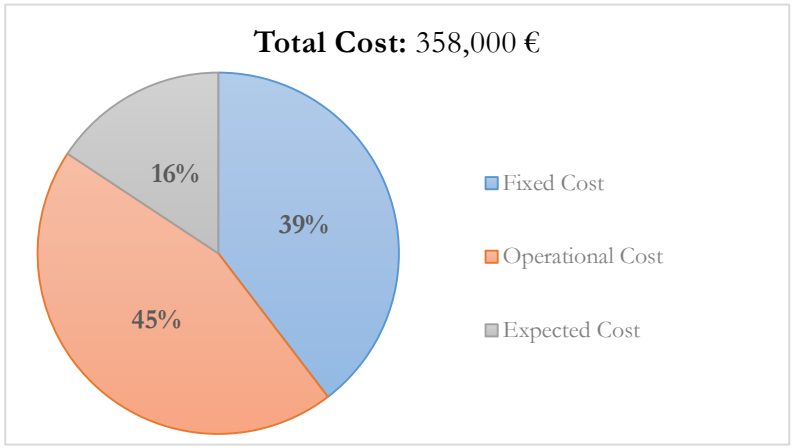
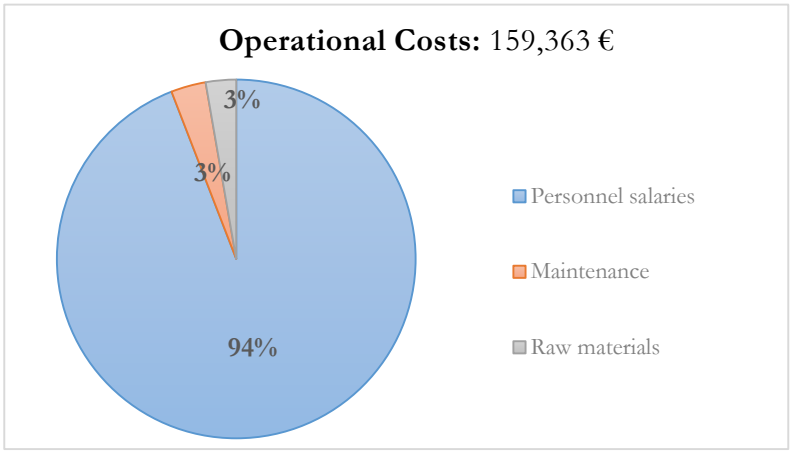
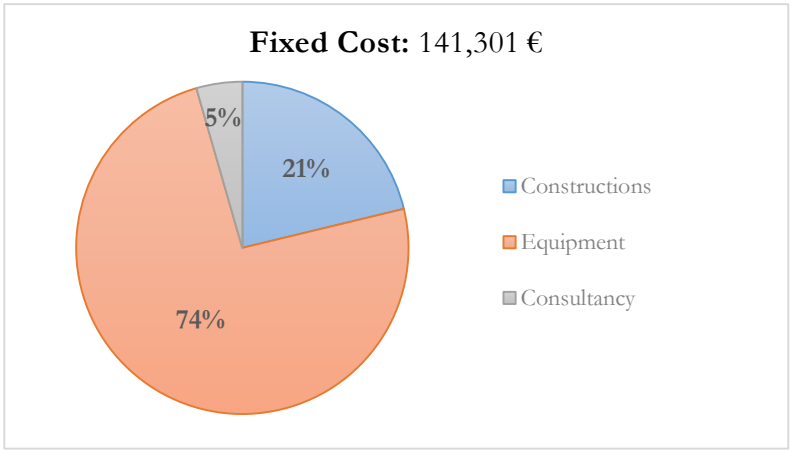


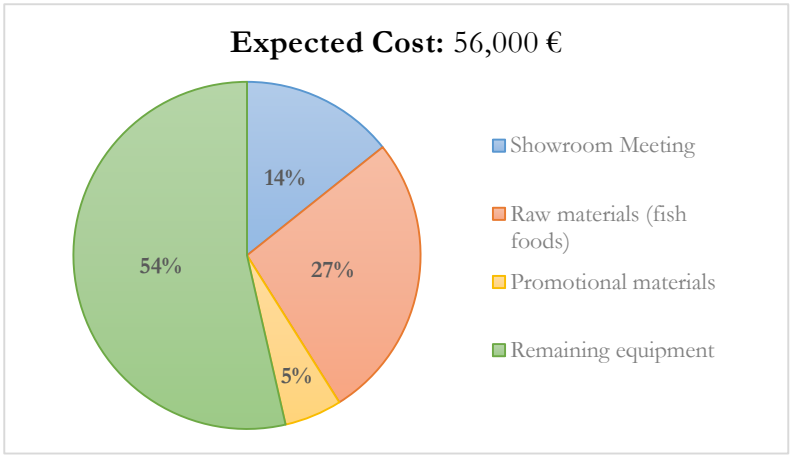
Figure 19 Commurban app in use of the showcase

Total Financial Cost









Showcase Implementation

Main barriers, risks and challenges

- Time consuming and complicated procedure or obtaining the necessary permission from the Ministry of Agriculture to produce fish with the aquaponic system. Water analysis and preliminary controls of the cultivation environment were carried out by the authorities, determining that there was no adverse situation and the permission was finally granted;
- Even though the Greenhouse was planned to be built in the Kisecik region of Hatay, it was determined that the construction of this greenhouse will bring difficulties in providing transportation and training for the Syrian refugees around this area. For avoiding the risk of jeopardizing **SiEUGreen**'s purpose, the greenhouse was moved close to the city centre where disadvantaged groups, local people and students will not face transportation problems;
- Lack of academics involved in aquaponics systems, making it a real challenge to implement a significant part of the project. In order to overcome the absence of knowledge and experience of how to set-up and operate the aquaponic system, consultancy services were received from Akdeniz University and any difficulties that could arise were prevented;
- There were disruptions in the supply of aquaponic equipment, as there was a small number of companies that sold these two separate systems together. However, a special research purchase was made by public authorities helping to overcome this challenge.

Enabling conditions

- In order to spread the social innovation part of the project and reach the targeted groups, local migration administration, international migration associations and NGOs in the province of Hatay served as the main facilitators in the project implementation.
- The procurement of the equipment necessary for the showcase was facilitated by the national manufacturers making the process of showcase deployment much faster.
- The fact that the Hatay Metropolitan Municipality owes the land where the Turunçlu Greenhouse is built has accelerated the speed of developing this project.
- Public authorities willing to make the difference and more specifically the Hatay Municipality in charge of deploying this showcase. Public administration supports UA bottom-up initiatives such as Women's cooperative.

Figure 20 - Hydroponics System, Hatay Showcase.

Main Outcomes

Social Impact

- Societal inclusion and integration of disadvantaged groups and disadvantaged members of local society through UA training and work;
- Better understanding of the social and economic potentials of Urban Agriculture and improved knowledge of organic gardening practices;
- Workshops organized by local NGOs and Hatay Municipality, engaging more people to practice UA and organic gardening;
- Efforts continue to create a concept model of a "continuous education centre" where Syrian refugee women, local people, university students and children will participate. Thanks to this model, it is planned to turn into a showcase where innovative social urban agricultural practices will be applied and learned.

Figure 21 - Aquaponic Workshop, Turunclu Hatay Showcase.

Economic impact

- All the fish and vegetables produced in the greenhouse are provided to disadvantaged groups for free. Economic and ecological costs are saved from purchasing food that travels long distances to reach the retail market, together with providing it for unemployed people;
- Turunclu Greenhouse (1,500m^2) equipped with aquaponics systems. Larger quantities of healthier and more fresh food like catfish and tilapia in the fish tanks, herbs and tomatoes;
- Large produce of seasonal flowers that can be sold on the regional market of Hatay municipality, offering jobs to unemployed and highly disadvantaged people.

Lessons Learned

- Region's resistance to produce with new technologies was met, as general public insists on traditional techniques. Moreover, there was limited interest from local people in social responsibility projects;
- Absence of technological infrastructure and readiness to implement the innovative UA techniques;
- Lack of a know-how to implement new UA technologies and low number of experts and academics with experience in innovative growing techniques;
- The contribution and support of local authorities to the project should be increased.

Changsha Showcase – New Green Urban Development (Hunan Province, China)

Challenge: Changsha is the capital of Hunan province and one of the most densely populated provinces in China. As such, it faces an enormous environmental issue, regarding the food supply with long transport distance. Changsha is also challenged by water shortage, as it has limited water resources. This can be solved by opening new water resource or by reusing the water from the domestic sewage and rainwater that can save a large amount of infrastructure and water conveyance costs. UA ameliorates the situation by producing food locally in an environmentally friendly manner with zero transport required.

SiEUGreen: The Changsha showcase was chosen to demonstrate how UA can contribute to producing food with zero transport, in an environmentally friendly manner. The showcase's purpose, is to realize the efficient recycling of urban water resources through the exchange of sustainable urban agricultural technologies and concepts between Europe and China. It supports the Futiancangjun real estate project by applying its Green, Blue and Yellow technologies for reusing and recycling waste and wastewater, replacing mineral with organic fertilizer, and utilizing solar energy.

Futiancangjun Real Estate Project

Project: The Futiancangjun housing development project was approved by Changsha Urban & Rural Planning Bureau in 2016. It covers an area of nearly 320,000 m^2 with a total construction area of nearly 740,000 m^2 and besides the residential area it includes schools, parks and a shopping mall.

Figure 22 - Futiancangjun, Changsha.

Aim: Housing development project for establishing green neighbourhoods and create circular systems, where waste recycling and wastewater management go hand in hand with resource-efficient, intelligent and sustainable urban farming, suppling secure food and effective utilization of solar energy.

Expected Outcomes: Build 3,500 apartments and install in some of them low-flashing toilets for wastewater treatment and recycling

into fertilizers that can be used for UA by the residence, some of whom will be equipped with 100 devices to grow crops in their balconies. **HHEPSTI** hopes to turn Changsha into an ecological city based on circular economy and sustainable development. Phase I to deliver 935 apartments and Phase II 1,200 apartments and Phase III 1,000 more apartments.

Changsha Showcase Details

Value Proposition

This showcase demonstrates a resource-efficient, intelligent and sustainable urban development with reduction, reuse and recycling of waste, local supply of secure food and effective utilization of solar energy. The project goes beyond traditional farming, highlighting green ecology, leisure environment and quality of life. The showcase includes 18 households for the demonstration to implement circular economy through the deployment of **SiEUGreen** Blue and Yellow technologies.

Partners & Stakeholders

Partner Hunan Hengkai Environmental Protection Science & Technology Investment (HHEPSTI) Co. Ltd. leads this project. Public authorities, residents, researchers, private developers and general public are the main stakeholders for this project.

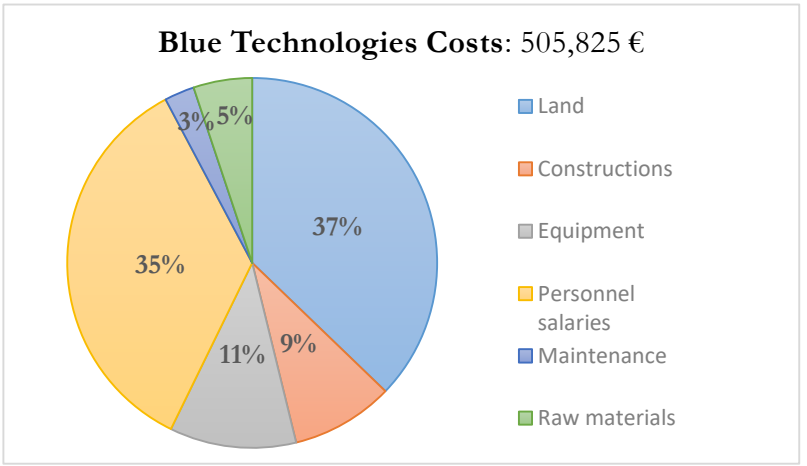
Tested SiEUGreen technologies

Green technologies: Traditional soil plant, hydroponic plant, paper growing, plant machine. Small balcony greenhouse (gardens) with soilless cultivation technology, automatic detection of greenhouse temperature and light environment and remote intelligent control technology.

Blue technologies: Composting technology of organic green garbage, struvite precipitation from black water (recovering nitrogen and phosphorus), recycled water reuse technology of greywater and rainwater (GREENergy concept). The latter is treated in constructed wetland to convert it to drinking water.

Yellow technologies: Windproof conductive technology, solar energy reuse technology.

Total Financial Cost



Note: *Black, Grey, Rainwater treatment costs*
Funding sources: 50% Chinese Government – 50% HHEPSTI

Showcase Implementation

Main barriers

China has a centralized system for wastewater treatment, as well as no policy to support urban decentralized domestic sewage treatment. The Changsha project is of a high technology content, so it is tough to transfer long-term management system beyond the scope of the project.

Main Challenges and Risks

- The Changsha showcase needs to be active to make sure that the future residents engage in the urban agriculture facilities and infrastructure. It is important to make sure that the dwellers actually accept these concepts and make use of the showcase's outputs. This challenge generates the need for a number of activities to take place, for making future residents feel ownership over the vision and be willing to contribute to it;
- Finding a long-term management system for Futiancangjun is also a crucial matter that needs to be solved. The solar and water systems, the balcony gardens and all the other new solutions that are demonstrated, need to be maintained properly. Except knowledge on how to manage the techniques, it is also important that the property management agency is well aware of, and agree to, the vision of the project. Hongyu property (brother company of HHEPSTI) will take care of the follow-up management of the whole system and Hengkai will be responsible for solving technical problems;
- Operating this urban agriculture model in future seems difficult. The idea of urban agriculture in China is still a rather avant-garde concept, as almost all agricultural products are produced in the countryside. The demonstrated infrastructure and applying technology is used inside the building. So residents and developers worry about the safety of the living environment, which will be an obstacle to the future development of this model.

Enabling Conditions

- Close cooperation with NMBU and ScanWater company;
- The parent company is a real estate development company, which can provide enough space for demonstration and facilitate subsequent commercial application;
- There are construction brother companies that can support the demonstration construction, as well as companies that can support the maintenance and management of the demonstration;
- Willingness of the resident in using the low-flush toilet and thus generating the struvite.

Main Outcomes

Blue technologies:

Struvite precipitation for soil conditioning

- Installed low-flush toilets and renovation of the inspection wells and pipelines;
- Obtained the optimal reaction conditions to do the nitrogen and phosphorus recovery experimental combining the crystallization of magnesium ammonium phosphate with an adsorbent;
- Formed a slow-release ecological fertilizer and a soil conditioner that has long-lasting fertilizer efficiency, high nutrient utilization, large yield increase, improved crop quality, and no impact on the environment;
- Applied for two (2) Patent Cooperation Treaty and two (2) Chinese invention patents.

Research on Recovery Technology of Grey water

- The renovation of the collection pipelines;
- The infrastructure construction and equipment installation of the grey water treatment room have been completed, and it is in the process of trial operation.

Research on Recovery Technology of Rainwater

- Lay 50m^2 of light-weight water-retaining materials and plant to form a green roof for the 18 households;
- The wetland had been constructed and the adsorption filler and the purified plants have been paved.

Yellow & Green technologies: Five solar photovoltaic panel street lights have been installed near the CO_2 demonstration building in Futiancangjun community and two sets of solar water heaters have been put into use on the roof. Completed a balcony garden promotion plan and a survey questionnaire.

Business Model Promotion: HHEPSTI fully integrates the entire set of **Sino-European** cooperation project urban agricultural concepts with the parent company's (Futianxingye) real estate development project. Covering 3 cities with more than 3,000 households.

Lessons Learned

- Frequent communication with project personnel and reporting is crucial for successful deployment of the showcase;
- Actions to expand the scope of the **SiEUGreen** project concept are necessary to attract the interest of more urban residents and communicating with is important, so that they have more sense of participation;
- From the perspective of demonstration effect, the residents of Futiancangjun show great interest in urban agriculture, so it will have greater value and significance to make the demonstration technology more suitable for the

daily life of residents. For a local initiative, it can be empowering to be part of an international research project, bringing inspiration and extra legitimacy to their activities;

- Strengthen the communication with government departments to promote the concept through the government;
- Strengthen the communication with the design and construction companies, so as to present the demonstration technology content more completely;
- Although Changsha Showcase constitutes a great demonstration of decentralized sewage treatment, it is still a small one to generate policy changes in this department. Greater cooperation with other large enterprises and private sector developers is needed in order to create larger demonstration projects and gain greater social influence to obtain the support of the government and form policies towards the decentralization of wastewater treatment system.

Figure 23 - Appearance of Stereoscopic Ecological Innovation – Changsha, China.

Beijing Showcase - Big Urban Community Farms (China)

Challenge: Beijing hosts more than 20 million people, however the habitants of this megacity find it difficult to connect to the nature. The Sanyuan Farm within the Citizen Farm Project attempts to meet the urban residents' pursuit of green, natural and environmental protection, supporting the first step from traditional agriculture to UA as a leisure activity.

SiEUGreen: The project aims to develop and demonstrate aquaponics methods incorporating the hydroponic and aquaponic crop cultivation techniques, promoting high efficiency aquaponic system for the integrated ecological fish-vegetable production with zero pollution and zero emissions in water shortage area or around a big city. **SiEUGreen** partners aim to exploit the aquaponics system of the Beijing showcase as an attraction sight for visitors, as the system is quite new for most people in China.

Citizen Farm Project – Beijing Sanyuan Agricultural Science and Technology Park

About Sanyuan Farm: Founded in 1949, it is state-owned (Beijing Agricultural Group Co. Ltd.) and consists of a total area (West and East districts) of 667,000 m^2. The West district (of 333,500m^2 area) consists of greenhouses that produce vegetables

and flowers. The East district (another 333,500m^2) consists of cherry forest and flower field but also of a rented land area (since 2008) of 165,000m^2 that offers the opportunity to the residents of Beijing to rent small plots of land (50 to 80 m^2) from €250 to €500 per year to practice UA for leisure.

Aim: Demonstrate resource-efficient UA and a healthy happy life style and exploit this showcase of aquaponics system as an attraction sight for visitors & tourists.

Expected Outcomes:

- Total of more than 1,400 small plots have been rented;
- The farm's staff organizes workshops and exhibitions for the city's elementary schools and kindergartens;
- Demonstration of high efficiency aquaponics system and production of vegetables and fish.

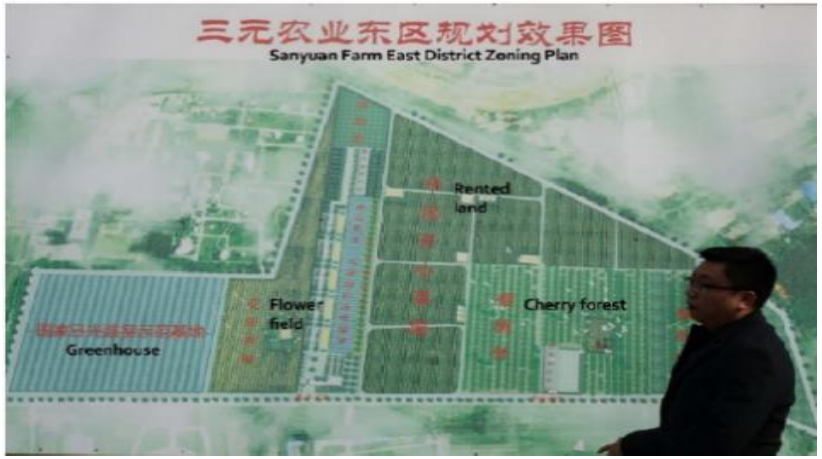


Figure 24 - Overall plan for Sanyuan Farm East District, Beijing, China.

Figure 25 - Urban small vegetable garden, Beijing Sanyuan Agricultural Science and Technology Park. Photo source: CAAS.

Figure 26 - Urban small vegetable garden, Beijing Sanyuan Agricultural Science and Technology Park. Photo source: CAAS.

Beijing Showcase Details

Value Proposition

To save energy and water resources, reduce waste and greenhouse gas emissions, and improve people's quality of life through:

- UA activities for entertainment and recreational purposes and production of vegetables and fish. Research and investigations on the aquaponics methods and development of systems to incorporate the hydroponic and aquaponics crop cultivation techniques;
- UA for educational purposes, promoting a healthy and happy life style while demonstrating the high efficiency aquaponics system;
- Alleviating agricultural pollution problems to a large extent, and better building an ecological environment.

Tested SiEUGreen technologies

- High efficiency aquaponics (symbiosis) system for the integrated ecological fish-vegetable production based on the principles of circular economy (no pollution and no emissions). Symbiosis can realize vegetable growing without fertilization, and fish without changing water, which not only ensures food safety, but also improves production efficiency;
- Kitchen waste project to turn kitchen waste into treasure, avoid wasting resources, realize harmless reduction of urban garbage, and improve the urban ecological environment;
- Use earthworm composting technology to reduce waste in the park and optimize the environment of the park. In addition, earthworm composting technology develops ecological recycling agriculture and improves soil quality.

Figure 27 - Urban small vegetable garden, Beijing Sanyuan Agricultural Science and Technology Park. Photo source: CAAS.

Partners & Stakeholders

This showcase is led by **SiEUGreen** partners' alliance of **Institute of Vegetables and Flowers (IVF)** at the **Chinese Academy of Agricultural Sciences (CAAS)** and the **Beijing Eco-Creative Agricultural Service Alliance (BAIESU)**. Among the stakeholders of this aquaponics system are researchers, students, citizens, SMEs and local restaurants. BAEISU and CAAS plan to continue their research and investigations on the technical specificities of the system to allow them to identify the most efficient and market aligned combination of vegetable and fish species production.

Showcase Implementation

Main challenges and risks:

- Operations during the general lockdown in China due to the COVID-19 pandemic;
- At the early stages of aquaponics (fish and vegetable symbiosis) system, the growth of the vegetables is not good, and the leaves are yellow and not lush. Thus, it is difficult to find fry;
- Low participation by neighbourhood committees during the implementation of the kitchen waste project.

Enabling conditions:

- Support of local government provided in Sanyuan Farm;
- Due to the regional regulations against river and lakes pollution, fish farming is not allowed in the region, and aquaponics could be considered for commercial fish production;
- Participation of many Chinese partners (46 persons from 8 organizations) and their effective cooperation both in research and showcase implementation.

Lessons Learned

- Strengthen the governmental communication and promote the concept through the government. Strengthen the communication with the design and construction companies, so as to present the demonstration technology content more completely;
- Communicate with residents more from the perspective of social participants, so that they have more sense of participation. Additionally, communicate with participating units, and suggest the project's team members' cooperation for completing the project, such as providing residents with small vegetable garden seeds and trash cans, for encouraging them to participate in the project;

- Allow people living in the city to feel the joy of farming; not only by eating healthy vegetables, but also exercising farming that will increase their quality of life.

Main Outcomes

- Urban agricultural technology integration and demonstration: The aquaponics demonstration covers an area of 80m^2, where each fish tank has a diameter of 4m and a height of 1.2m. The Sanyuan Farm aquaponics system will continue being used as an educational and research facility for CAAS;
- Currently, three circular agricultural technologies and two operating regulations have been completed, with two hundred comprehensive demonstrations of circular agriculture in urban small vegetable gardens and two aquaponics technologies;
- The **Urban Happy Garden** has been rent by more than one thousand households in the form of annual rent with providing high-quality seedlings and technical guidance.
- The social impact is that parents and children spent quality time together experiencing the pleasure of farming and eating fresh produce;
- Advance social engagement through an agricultural recycling program where three hundred households participate in exchange of organic fertilizers produced from kitchen waste for vegetable produce;
- Cycled System of Fish and Plants for entertainment that is able to keep higher temperature to make fish active and generates zero pollution to the environment due to the effective blend of microbes;
- Exploration of reduction and resource utilization modes of kitchen waste;
- The project is currently being demonstrated in Min'an District, Dongcheng District, Beijing. It has reached cooperation with 100 demonstration families to achieve a 50% reduction in waste and a 50% reuse rate;
- At present, we have completed three organic fertilizer treatment technologies for kitchen waste, two regulations and one local standard, two norms for community greening of kitchen waste, as well as two fertilizer recycling models for kitchen waste.

Figure 28 - Food waste treatment. Photo source: CAAS

Campus Ås – Showcase (Norway)

Campus Ås: Contingency plan was initiated in the spring of 2020 as an alternative to the Fredrikstad showcase by moving the activities to University Campus Ås, which already has some of the technologies that were to be established in Fredrikstad. Campus Ås will be using the waste streams from a student dormitory with 45 inhabitants that is featured with a source separating sanitary system using vacuum toilets for blackwater collection. The separated wastewater fractions are treated in the water and nutrient recovery system that are established in a lab building. Greywater is lead into a biofilter and further polished in a wetland or membrane filter as a tertiary step. Sludge from greywater is treated

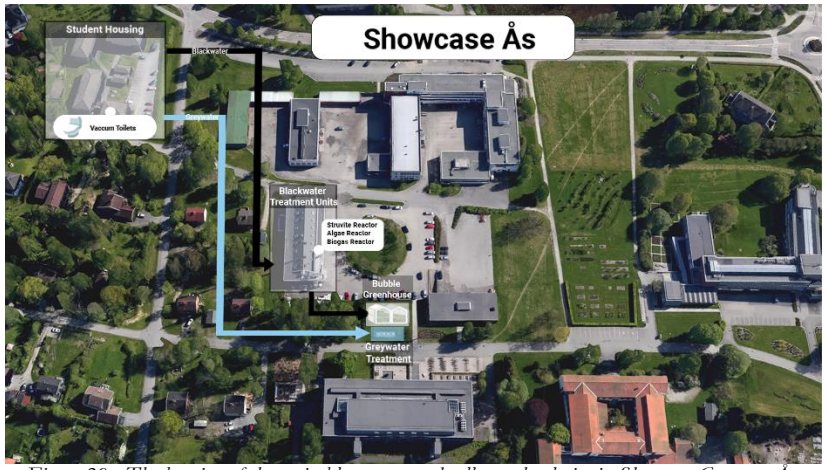


Figure 29 - The location of the main blue, green and yellow technologies in Showcase Campus Ås

The green systems are established in an adjacent greenhouse that features a novel type of innovative insulation system. The greenhouse receives water and nutrients as well as heat produced from biogas reactor form the water and nutrient recovery system. In addition to the recovery of water and nutrients from wastewater, organic soil and nutrients are recovered from domestic green wastes with help of a composting system.

Campus Ås Showcase Details

Value Proposition

The idea here is to combine societal and technological innovation, creating a zero waste and emissions neighbourhood. This is achieved by separating wastewater and waste streams at source and recycle nutrients and organic soil from blackwater and domestic green waste and reclaim irrigation water from greywater. Incorporated in building infrastructures it aims to increase resilience of cities and make of urban development more climate, environment and human-friendly. Use of different technical solutions for water, sanitation, storm water and energy; innovative greenhouse (special insulation); green roof

Partners & Stakeholders

This showcase is led by **the Norwegian University of Life Sciences (NMBU)** in partnership with NIBIO and Scandinavian

Water. The list of potential end-users of these consulting services includes residents, municipalities, urban planners, real estate developers, R&D project consortiums, architects, academics, municipalities and policymakers.

Tested SiEUGreen Technologies

- **Bubble GH:** The pilot greenhouse consists of double walls of thin plastic that are stiffened by an aluminium skeleton. Between the walls, soap bubbles are used to insulate and create shade for the plants growing in the greenhouse. The soap bubble generator at the bottom uses ordinary washing-up liquid and it is controlled by sensors. The idea is that the soap bubble, which is a tight unit, insulates well both against heat and cold. When the sun is strong, the generator fills the walls with bubbles that prevent solar penetration and heating of the room.
- **Source separating sanitary system** with separate collection of blackwater with vacuum toilets. Highly efficient resource recovery from blackwater including anaerobic digestion (biogas reactor), filtration and struvite precipitation and reclamation of greywater with help of an innovative biofilter system.
- **Production of micro algae** with treated digestate liquid fraction as nutrient source.
- **Reuse of treated digestate liquid fraction** together with reclaimed greywater to grow vegetables and ornamental flowers in hydroponic systems.
- **Processing of domestic green waste and solid fraction of digestate** into a nutrient rich soil with an innovative composting system.

Figure 30 Bubble GH at Campus

The environmental, economic and health benefits arising from the implementation of the showcase can be used as a living example to inform the general public, draw political attention and raise the awareness of expected stakeholders for circular and sustainable smart city solutions and generate significant public and private investments by third parties interested in the concept. Additional information on how the SiEUGreen technologies are implemented at the Campus Ås showcase can be found on the NIBIO's website (see, Torday Gulden 2022).

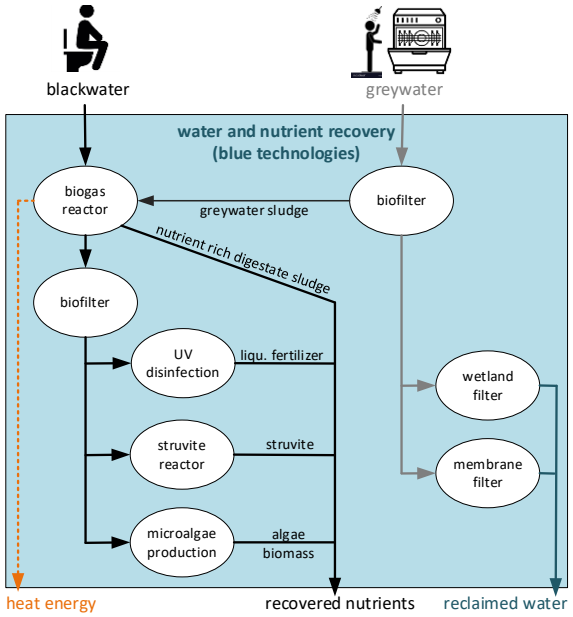


Figure 31 - Fertilizer production (biogas reactor process) implemented in SiEUGreen's Showcase in Campus Ås.

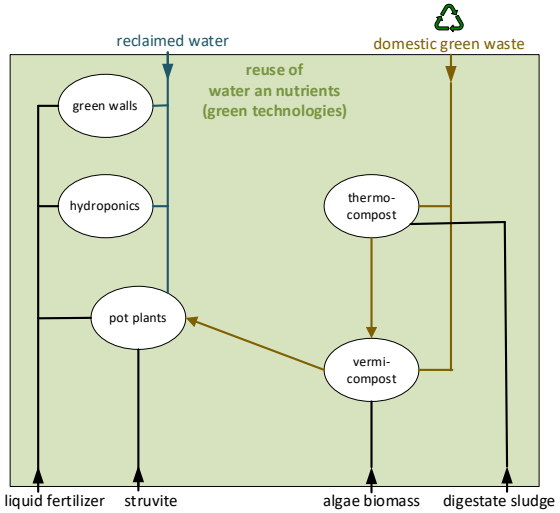


Figure 32 –Reuses of water and nutrients

Showcase Implementation

Main barriers

- Regulation and municipal approval of plans of apartments and reconstruction of old buildings area have taken longer time than anticipated (Fredrikstad showcase).
- Campus approval, municipal approval of the showcase greenhouse and tender process have taken longer than anticipated in addition to Covid-19 restrictions.
- Mini-showcase by NIBIO for a selection of technologies in existing buildings had few barriers, but Covid-19 put further restrictions on progress.

Challenges and Risks

- Without no doubt, the main challenge of this case was the cancelling of the showcase deployment at Fredrikstad**;**
  Measures: contingency plan and replacement of location from Fredrikstad to Campus Ås;
- Bureaucracy regarding approval of plans that include reconstruction of buildings and apartments;
  Measures: realistic plans that consider unforeseen delays.
- Bureaucracy regarding technology that deviates from traditional, especially on wastewater handling;

Measures: good information at an early stage involving decision makers.

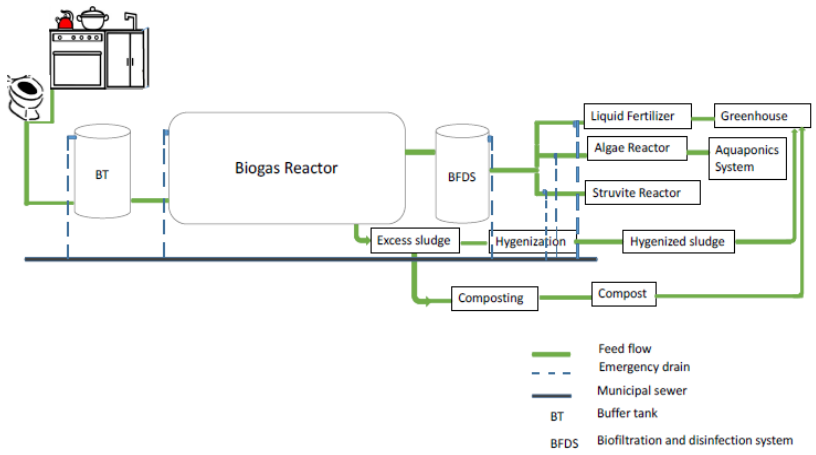


Figure 33 – reuse of water and nutrients at Campus Ås

- Law regulations such as infection control when reusing food waste in food production.
  Measures: Good dialogue with relevant authorities and infection-reducing measures (hygiene) and good training of involved people.
- Larger complexity by using integrated technology than assumed (e.g. small-scale biogas reactors).
  Measures: Some solutions need longer testing period and should be scaled up gradually.
- Negative residents' attitudes to new sewage systems and local waste-based fertilizers and soil production, e.g. treated urine as fertilizer.
  Measures: Good information for residents before they are moving in and good documentation of technology to avoid technical errors. Some techniques will have a narrow application.
- The COVID-19 pandemic prevents or reduces visits to the showcase.
  Measures: More online publications of show case technology.

Main Outcomes

Green technologies:

- Paper-based microgreen production technique;
- Aquaponics solution (microcosm demo scale).
- Vermicomposting, traditional warm composting and Bokashi treatment have been established for treatment of food waste. The compost can be used in production of tomato, cucumber and Chilly production using self-watering containers tested in the project. A test bioreactor is installed and there will be tests with in insect-production based on food waste.

Blue Technologies:

Socioeconomic:

- NIBIO's researchers using Norwegian Monitor database and interviews showed that 20 – 50% are motivated for UA using unconventional fertilizers. More men than women, younger than elder and personalities with openness to experience - were more open to these techniques.

Figure 34 - Aquaponics facility at NIBIO Landvik. Photo source: Jihong Lin Clarke.

Lessons Learned

- While developing the showcase plan the unforeseen scenario should have been considered.
- The risk identification and mitigation plans for showcase deployment were weak, instead a contingency plan should have been better formulated for the Fredrikstad showcase, which has to be developed from scratch.
- Many **SiEUGreen** technologies are very well suited for UA, such as paper-based growing of microgreen, hydroponic production, aquaponics production, traditional soil-based production based on food waste compost.
- It is important with training and motivation for homeowners and users in relation to technology and techniques to be used
- Large integrated showcases require good planning with clear contracts, which describe finances and responsibilities
- For new large UA showcases based on circular economy, it will probably be an advantage that the initiative is driven by motivated people who live in the apartments, in collaboration with research institutions.
- **Showcase Fredrikstad:** From this process, we have learned that it is important to have enough time for planning with precise agreements on responsibilities and finances and that both the developer, politicians and municipal administration are motivated to test/implement new solutions

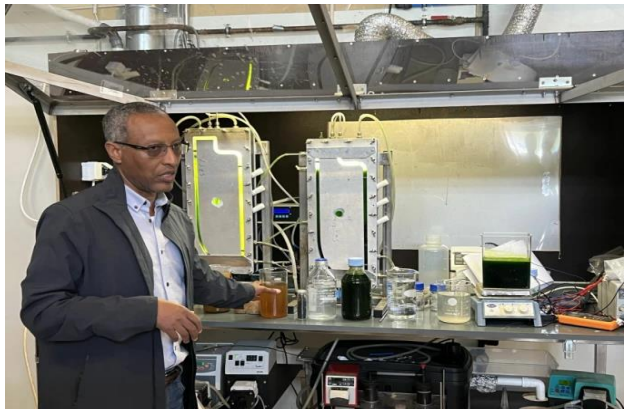


Figure 35 Presentation of microalgae reactor

International Knowledge Exchange

Green technology:

- Knowledge-sharing on hydroponics and aquaponics.
- Knowledge and experiences acquired among Chinese and European partners, especially NIBIO partner on these two plant cultivation techniques were frequently shared via various communication tools including necessary field visiting Norway (NIBIO's hydroponics and aquaponics facilities) and Beijing, China (Beijing Photon, CAAS's facility and Beijing Sanyuan showcase).
- Beijing Green Valley Sprout (BGVS) LTD's paper-based microgreen production technology was developed and largely adopted in China. In addition to that this technique was implemented in Beijing and Changsha showcases, it was introduced to Europe by NIBIO partner through knowledge sharing.
- NIBIO has verified and optimized the paper-based micro-green production protocol for European countries.

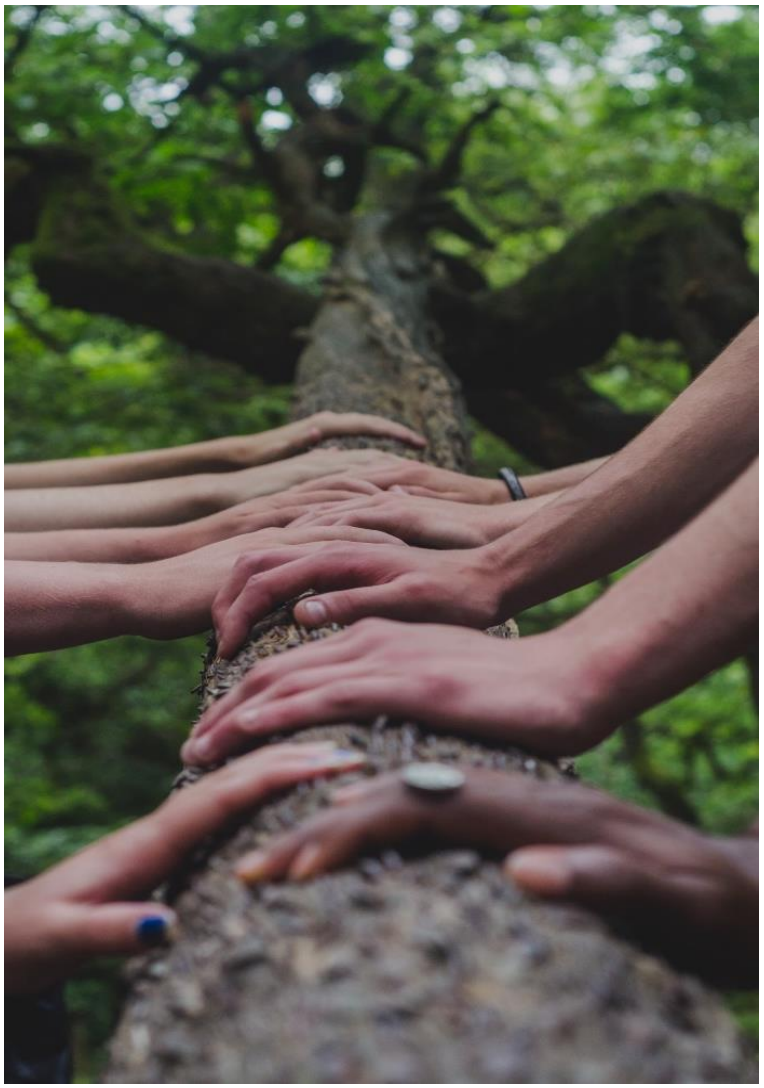
Blue water technology transfer:

- The wastewater treatment technology and water recycling technology were shared between HHEPSTI in China and, Scan Water and NMBU partners in Norway through the project period;
- Transnational Board meeting to exchange knowledge;
- Knowledge exchange between the Sino-European showcases regarding adaptation of technologies, social inclusion, environmental impact, sustainability, potential and challenges.

Key achievements and results:

- The water management technologies developed in the EU can be installed at apartments to save water at Chinese sites.
- The novelty method, developed in China, of how to grow plants by replacing soil with paper may be successfully applied to European sites.
- The Chinese technology that uses biological kitchen waste disposal to produce useful resources may be adopted by the European communities as well.
- The social inclusion across the EU and China is useful both for European and Chinese sites. The project strategies to engage communities into urban agriculture are efficient.
- The business models developed within the project are aiming to take the EU-China cooperation to the next level: from scientific and technological exchange to the exchange of business models.

Figure 36 - Paper-based microgreen technology (green technology). Photo source: NIBIO.



Key Targets & Achievements

Land Use Target

Unused land reused: 200.000 m2 (20ha)

Balcony gardens: 90,

Organic rooftops: 2

Greenhouses: 7

Food Security Target

Amount of secure food produced in relation to the amount of food produced without the project.

Target: >50% increase 12.000kg.

Societal Inclusion Target

Engagement and behaviour change workshops: 2 in each showcase.

Disadvantaged individuals participated: 500

Total Individuals involved: 5.000

Households involved in showcases: 750

Targets	Showcases	Beijing	Changsha	Hatay	Aarhus	Target Achieved
Land Use	**Land Use** **Balcony Gardens** **Organic Rooftops** **Greenhouses** **Unused Land Reused (68ha in total)**	333,500 m² - - 1 (6,000 m²)	1,250 m² 100 1 (50 m²)	2,300 m2 N/A - 1 (1,500 m2) Aquaponic Greenhouse	N/A N/A - -	✓ ✓ - - -
Food Security	**Food Security (total 20%)**: **Polytunnels, Soil-based traditional plant growing, aquaponics, buckets with drip irrigation system for balconies**	12,000kg (seveal leaf vegetables varieties & fishes)	2,000kg leaf & vegetables	*Fish Production* • Number of fish tanks = 6 Pieces •1 fish tank max water amount = 5000 lt. *Plant Production* Total Plant beds in NFT and plant feeding tube=6,540 plant beds.	100kg crops in polytunnels & 2,797.5kg crops (20% increase)	✓
Societal Inclusion	**Engagement & behaviour change workshops** **Disadvantaged individuals (589)** **Total individuals involved (2,335 indv.)** **Households Involved (631)**	2 40 (unemployed) 1,200 100	2 379 (unemployed) 415 117	3 120 (Syrian refugees) 370 N/A	2 50 (low-income citizens) 250 314	✓ ✓ - -

Notes: The above presented data is with regards to the mid-term showcase implementation, hence it is excluding any data related to Campus Ås/Fredrikstad. The showcase deployment activities are grouped into four UA categories/pillars. Land use, Resource Efficiency (data N/A yet), Food Security and Societal Inclusion. Land use: Includes different types of land that has been set up for SiEUGreen urban agriculture activities. Resource efficiency: Includes the activities for the adoption of SiEUGreen blue, green, yellow technologies that contribute to resource efficiency. Food security: Includes the activities to cultivate food using SiEUGreen technologies. Societal inclusion: Includes activities targeted to engage the stakeholders/communities. Data Source: Sino-European Innovative Green and Smart Cities Deliverable 3.3 Mid-term Showcase deployment report.

Socioeconomic Benefits

The implementation of **SiEUGreen** solutions, concepts, technologies in UA has a lot of social and economic benefits for various social groups, refugees, disadvantaged women, urban residents across the **SiEUGreen** showcases.

Potential Social Benefits

- Stronger sense of community among residents through participation in UA activities. Urban residents in Hatay and Aarhus can cultivate on public and private land producing food for themselves, their relatives, friends or neighbours, something that can generally support and empower social integration and bonding;
- Stronger sense of belonging and identification with the project, especially in the case of residence in new buildings in Changsha and in Campus Ås, families and students, respectively;
- Feeling of empowerment due to the active participation management of the different types of green and blue infrastructures on the site;
- The greenhouse in Hatay is expected to empower the disadvantaged groups such as refugees and unemployed women promoting the social inclusion in the particular municipality that can serve as a good practice to be adopted by other cities/municipalities around the region of Antakya but also elsewhere.

Potential Economic Benefits

- Affordable access to private, semi-private or public spaces for recreation and horticultural activity;
- In-kind rewards such as auto-produced fruit and vegetables;
- Expected reduction of cost for water sanitation and waste management due to recycling and reuse of resources;
- Local jobs related to the maintenance and governance of the green and blue infrastructure;
- Expected economic empowerment of poor communities, refugees and unemployed women through creation of jobs related to UA;
- Utilization of unfused urban spaces that can improve the economic situation in these areas through creation of greenhouses and UA activities.

Project Sustainability

This Handbook contributes directly to the sustainability of the **SiEUGreen** project in order to support the continuation of the delivery of benefits to the project beneficiaries and perhaps other constituencies for an extended period after the financial assistance has been terminated.

Partners have elaborated different ways to empower **SiEUGreen** sustainability and more specifically have considered different approaches that can empower them either individually or

collectively to sustain and expand the use and practice of **SiEUGreen** legacy outcomes.

The developed sustainability strategy is rested upon three main pillars:

- **Strengthening the engagement of showcase participants:**
  Engagement activities such as educational workshops and training sessions (Hatay), residents' participation in UA community gardens (Aarhus, Beijing), women and refugee association meetings (Hatay), as well many other activities that strive to promote and establish **SiEUGreen** practices, concepts and technologies beyond the end of the project.
- **Continuous development and evolution of the SiEUGreen outputs (concepts technology, methodology, etc.):**
  Iteration cycles for further development/adaptation of the technological advancements of the project, will aim at ensuring that a continuous improvement is established and leads closer to tailored products and services towards targeted stakeholders.
- **Targeted and continuous dissemination to secure high interest and boost the awareness about SiEUGreen solutions:**
  The dissemination of **SiEUGreen** outcomes can also include scientific publications and policy recommendations.

Figure 37 - Aquaponics System (Beijing, China).

Figure 38 - Balcony Gardening Devices (Beijing, China).

Replicability Assessment

Showcase	Financial Cost	Enabling Conditions	Barriers	Risks & Challenges	Assessments
Aarhus	Low	High	Medium	Med-Low	Easy
Hatay	Med-High	Med-High	Med-High	Med-Low	Normal
Changsha*	Med-High	High	Low	Med-High	Normal
Beijing	N/A	High	Medium	Low	Easy
Campus Ås**	High	Med-Low	High	High	Hard

Notes:

*Funding sources: 50% Chinese government & 50% own funding (HHEPSTI).

** This showcase was initially planned to take place in another location in Fredrikstad. However, the showcase Fredrikstad (Norway) faced delays and switched to plan B (Campus Ås). The showcases of Aarhus and Hatay faced delays to implement their activities according to the initial plan set, due to the COVID19 lockdown.

Supporting Document – Handbook Input

In order to select more detailed information on the implementation of showcases we sent to showcase leaders and collaborating partners a supporting document with a set of questions presented below.

Instructions

Please answer as extensively as possible the questions below.

Please note that your answers will be used to draft the Handbook for SiEUGreen Solutions Replication (Deliverable 5.6). If applicable, please provide us with pictures of the showcase featuring any recent developments.

Questions

Q_1: Why this showcase was selected to demonstrate SiEUGreen solutions?

Q_2: What are the main outcomes (tangible and intangible) of your showcase so far and what is yet to be achieved? If applicable, please share any recent photos from the showcase (copy them into the last page below)?

Q_3: What resources were used in order to deploy the showcase? What were the initial capital expenditures (i.e., land, construction, etc.) necessary for the realization of the project, and operational expenditures (employees' salaries, maintenance, etc.) essential for a smooth development of the pilot?

Q_4: What are the main enablers and barriers (regulation, laws, local authorities) for project implementation?

Q_5: What are the main challenges and risks in the showcase development? How have you overcome these challenges and how have you managed the risk?

Q_6: What are the main lessons learned from the implementation of the showcase.

Figure 39 – Questionnaire for replication of solutions

SiEUGreen
Sino-European innovative green and smart cities

Sino-European Innovative Green and Smart Cities

Deliverable 5.6

Replication Handbook-Questions

Lead Partner: DRAXIS
Lead Authors:
Due date: 20/03/2021
Version: 1.0

Co-funded by the Horizon 2020 programme of the European Union

Co-funded by the Chinese Ministry of Science and Technology

The project has received funding from the European Union's Horizon 2020 Research, and Innovation Programme, under grant Agreement Nº 774233

About Handbook

More than a technical document, the replication handbook aims to provide general guidance for public and private stakeholders considering replicating SiEUGreen showcases and smart and innovative UA solutions. Building on the SiEUGreen activities, the aim of replication is to extend the experience gained and lessons learned during the project to other locations and places, making it easier for them to implement similar smart UA initiatives successfully in other contexts. This ensures that the project results will not be confined to the SiEUGreen demonstration sites and their benefit alone – it is rather the case that the integrated UA solutions implemented in 5 showcases will serve as good examples and practices for other cities and encourage them to learn from the SiEUGreen experience on their way to becoming green–smart–inclusive cities.

Questions

Q_1: Why this showcase was selected to demonstrate SiEUGreen solutions?

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Q_5: What are the main challenges and risks in the showcase development? How have you overcome these challenges and how have you managed the risk?

Q_6: What are the main lessons learned from the implementation of the showcase?

Instructions

Please answer as extensively as possible the questions below.

Please note that your answers will be used to draft the Handbook for SiEUGreen Solutions Replication (Deliverable 5.6). If applicable, please provide us with pictures of the showcase featuring any recent developments.

If you have any doubts or questions please do not hesitate to contact us at gmichailidis@agroapps.gr

Thank you in advance!

Glossary

AI: Artificial Intelligence

Care Farming: is a method that uses agricultural practices to provide social, or educational care services to socially excluded people, people with disabilities and vulnerable groups of people.

EU: European Union

GDP: Gross Domestic Product

GHG: Greenhouse Gases

GH: Greenhouse

IoT: Internet of Things

IT: Information Technology

ML: Machine Learning or educational care services to socially excluded people,

people with disabilities and vulnerable groups of people.

NFT: Nutrient Film Technique

NGOs: Non-Governmental Organisations

R&D: Research and Development

UA: Urban Agriculture

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Afterword

Hopefully, this handbook is inspiring and useful for practitioners and policy makers responsible for the implementation of UA projects.

The showcases and solutions presented here are integrated part of the SiEUGreen project that strives to support EU-Chinese cooperation through scientific and technological exchange and the exchange of business models.

The handbook aims to guide you through the SiEUGreen Project and provide information on the showcases that maybe helpful in similar contexts.

SiEUGreen
Sino-European innovative green and smart cities

Partners

Norwegian University of Life Sciences (NMBU)

Norwegian Institute of Bioeconomy Research (NIBIO)

The Institute of Vegetables and Flowers, Chinese Academy of Agricultural Sciences (CAAS)

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Scandinavian Water Technology AS (ScanWater)

Hatay Metropolitan Municipality

Chinese Academy of Social Science (CASS)

Sampas Bilism Ve Iletisim Sistemleri Sanayi Ve Ticaret A.S. (SAMPAS)

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SEECON International GMBH

Leibniz Photon Science & Technology Co, PHOTON

Beijing Green Valley Spouts CO LTD (BGVS)

DRAXIS Environmental S.A.