

NORDIC BEST PRACTICES

Relevant for UNEP 10YFP on
Sustainable Buildings and Construction
and Sustainable Food Systems



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Anna Kortesoja, Marika Bröckl, Håkan Jonsson, Venla Kontiokari and Mikko Halonen

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Preface

The working group on Sustainable Consumption and Production, under the Nordic Council of Ministers requested consultants from Gaia to identify, write out and publish this third report on Nordic best practice cases of sustainable consumption and production on the UNEP SCP Clearinghouse. Jointly the 50+ solutions presented in three different reports are directly linked to UNEP's 10-Year Framework Program and display a wide array of opportunities and actors of change for sustainability, covering sustainable lifestyles and education, sustainable public procurement, sustainable tourism and consumer information for SCP. The purpose of this report was more specifically to identify eight Nordic best practice examples of Sustainable Buildings and Construction and seven Nordic best practice examples of Sustainable Food Systems. These last 15 cases are all included in this report.

The work was supervised by the following Nordic focal points to the UNEP 10 Year Framework Program (10YFP); Marianne Gjørsv, Norwegian Ministry of Climate and Environment, Eva Ahlner, the Swedish Environmental Protection Agency, Taina Nikula, Finnish Ministry of the Environment and Kaj Juhl Madsen, Ministry of Environment and Food of Denmark. The lead consultant at Gaia was Anna Kortesoja.

The HKP group hereby wants to express its gratitude for their contribution to the project and the results we hope will be of inspiration for many others.

Stockholm 12/01/2018, on behalf of the NCM SCP working group (HKP gruppen)

Annica Carlsson,
Chair of the NCM SCP working group,
Senior Advisor, Swedish Environmental Protection Agency

Summary

There is an urgent need to transform global consumption and production patterns. The Nordic countries have a long tradition in advancing the goals of sustainable development. They have actively and successfully worked on various national and international fora to prevent re-source scarcity and unsustainable exploitation of natural resources. Also, the Nordic countries have been able to identify and put into practice a number of innovative partnerships that harness the expertise and business potential of the private sector actors for a shift toward more sustainable consumption and production (SCP) patterns.

However, while the Nordics generally fare well in sustainability comparisons, Nordic consumption overshoots considerably the ecological thresholds for sustainable and equitable consumption. By displaying practical and innovative examples of SCP, the Nordic Council of Ministers encourages accelerated action by all key stakeholders in Nordic countries, as well as sharing of lessons learned internationally.

This report is the third report in TemaNord series showcasing Nordic experiences in promoting SCP. Jointly the 50+ examples presented in the three reports¹ display a wide array of opportunities and actors that can deliver required change including public and private sector actors, research community, NGOs, city planners, and champions of change. The solutions presented in these reports are directly linked to UNEP's 10-Year Framework Programme², covering sustainable life-styles and education, sustainable public procurement, sustainable tourism, consumer information for SCP, sustainable buildings and construction, and sustainable food systems.

This report presents fifteen initiatives that cover two particular themes: 1) Sustainable Buildings and Construction and 2) Sustainable Food Systems. The cases were identified from a wide variety of Nordic cases together with the Nordic Council of Ministers working group on SCP. The cases are presented in a manner designed to facilitate a comparison of their respective strengths, key results, and novelty as well as to draw lessons learned of each particular case. The case descriptions are based on material made available to the consultant, including documents shared by the case representatives as well as information gathered through case interviews.

The eight cases in the theme Sustainable Buildings and Construction consist of different projects in the field of construction and land use, which aim to lower the environmental footprint of buildings. The case target groups range from land use planners to construction companies, as well as other parties from both public and private sectors.

¹ See also <http://norden.diva-portal.org/smash/record.jsf?pid=diva2%3A905930&dswid=1786> and <http://norden.diva-portal.org/smash/record.jsf?pid=diva2%3A1044854&dswid=-5478>

² UNEP 10YFP: <http://www.unep.org/10yfp>

The Sustainable Food System theme consists of seven cases, where the focus is on how to produce food sustainably and resource efficiently. The cases include cooperative initiatives in production, side stream utilisation, public sector efforts as well as a home restaurant concept.

All cases from the three Nordic studies have also been published in UNEP's 10-Year Framework Program (10YFP) information platform, the SCP Clearinghouse.³ It is a web-based information sharing tool, which can be used by different actors as an inspiration for putting SCP into action worldwide. SCP Clearinghouse also provides additional information and links for further information on the cases presented in this report.

³ SCP Clearinghouse: <http://www.spcclearinghouse.org>

Sustainable Buildings and Construction

1. Denmark

1.1 The Soul of Nørrebro

Figure 1: Hans Tavsens Park in autumn colors



Source: © SLA/Beauty & the Bit.

Case Description *

Implementation:	Denmark
Locally implemented:	Yes
Sustainability theme:	Climate Change, Ecosystems & Natural Resources, Education
Sector of activity:	Buildings and Construction
Type of Initiative:	Capacity Building & Implementation, Education & Awareness-Raising
Lead actor:	SLA Architects
Type of lead actor:	Business sector
Budget:	EUR 18 million
Partners:	Ramboll, Arki_Lab, Gadeidræt, Aydin Soei, Social Action, Saunders Architecture
Status:	Started in 2017. Ongoing, planned to be completed in 2022.
Contact person:	Kristoffer Holm Pedersen, Head of Communications & Business Development, khp@sla.dk

*Note: Case descriptions, e.g. with regards to geographic scope, theme, sector, type of initiative, and type of lead actor, follow the groupings used within UNEP's SCP Clearinghouse.

1.1.1 *Introduction*

The Soul of Nørrebro is an integrated urban design and climate adaptation project for Hans Tavsens Park and Korsgade in Nørrebro, Copenhagen. The project solves problems with extreme precipitation events (cloudbursts) and rainwater management, by collecting, diverting, and later cleansing rainwater by the city's nature biotopes. The project builds on the area's existing qualities and the unique local context, combining nature, local community and relevant cloudburst solutions to benefit the area.

1.1.2 *Objectives*

The objective is to promote interaction between the immediate natural and built environment in Nørrebro, and residents and visitors to Nørrebro. This neighbourhood is situated in Copenhagen's city centre, and draws on a profusion of cultural influences. Nørrebro has always been an initiator in the cultural exchange between Nørrebro and the rest of Copenhagen. Time and again Hans Tavsens Park and Korsgade have responded to and met the needs of the people of Copenhagen for recreation and an active urban life.

However, rainfall in Nørrebro, often combined with heavy cloudbursts – in particular in the areas of Hans Tavsens Park and Korsgade – may lead to negative impacts on Nørrebro over time diminishing its role and place in Copenhagen. The project will address the needs and diverse opportunities for urban life, biodiversity and peace of mind in an area – Nørrebro – that may need to accommodate 18,000 m³ of rainwater during extreme rainfall events.

In approaching the objective of increased interaction between people, nature and the built environment, this project applies lifecycle thinking that reflects the very special nature of Nørrebro. The project seeks to combine three complementary cycles: 1) the hydrological 2) the biological and 3) the social cycle. The aim is to create an internal synergy between these cycles, which will result in a holistic, unique urban nature – a cultivated microcosm – that creates tangible and measurable value, both for the local area and for all of Copenhagen.

The design for Hans Tavsens Park and Korsgade has been based on five main tools in the form of concept (see the Activities section). These tools will enable a good everyday life for all residents and visitors. This will be achieved by using the tools to increase the synergy between water, biotopes and the people of Nørrebro. Together, these tools will strengthen the unique quality of the area by creating an open framework that conveys the juxtaposition of the constructed and the cultivated.

1.1.3 Activities

The five tools are well aligned with the overall objective, and will secure a holistic project implementation. The tools, or concepts, cover:

- **Climate adaptation with city nature:** The entire project area will be climate-adapted, using the city's natural environment as the basis. Tanks to collect rainwater from roof surfaces will be located throughout the area. The collected rainwater can then be used – by residents for irrigation, by schools for learning and by the municipality for cleaning purposes or irrigation. The Hans Tavsens Park will be fitted with a retention volume of no less than 18,000 m³ at ground level, so that extreme rainfall water from upstream areas can be purified and held prior to controlled discharge.
- **Differences for all:** The residents of Nørrebro, its associations and visitors have very different expectations of, and dreams about, good urban life. Hence, community engagement will be a core activity throughout the project implementation.
- **Schools as drivers and Copenhagen's first Fablab for urban nature:** There is a huge potential for using the area's institutions and schools as drivers for the entire urban development of the district. From an early age, children from Nørrebro will learn to be active co-creators of the Nørrebro cycle and its city nature. The Blågård School, Nørrebro Park School, HTØ and HTV, Et Frie Gymnasium, Korsgadehallen and the manned playgrounds can all play an active role in that development. The FABLAB for City nature can use rainwater for the irrigation of plants. Rainwater can also be used to irrigate city nature biotopes, not only in urban spaces and in Hans Tavsens Park, but also on private balconies and in the backyards of buildings.
- **Links:** Both the physical and visual links between Hans Tavsens Park, Korsgade and their context will be improved so that the area is made more accessible, both physically and mentally. The project will be integrated as closely as possible with the environment so that the site will continue to be perceived as open and including.
- **Working with the urban landscape:** The Hellig Kors church is considered an architectural hinge to be integrated in the overall whole, rather than being considered a separate entity.

1.1.4 Key Results and Achievements

Success Factors

The project has gained significant attention in Denmark, the Nordics and beyond. The community engagement has started, with a tremendously positive response.

In 2016, the project was the final winner of the prestigious Nordic Built Cities Challenge, with the jury stating: "The proposal is of high aesthetic value, where the play and flow of water brings logic to the landscape. With a blue-green approach it creates a new and unique model for flood management. It leverages utility investment for more holistic, sustainable and resilient results that create both social and technological benefits. The proposal breaks new ground and has development and export potential though a smart application of technical, cultural and social values".

The project is also woven into the overall Copenhagen Climate Adaptation Plan that won the first prize on "Large-scale green networks and development concepts" in the 8th European Garden Award.

Novelty

The community engagement has taken the form of initial information meetings, workshops, city walks, and involving the nearby schools and school children. The project proponents consider it vital to trying to understand young people's needs and hopes in going forward, also considering that down the road these age cohorts are the ones who will live with the actual solutions. In later stages of the project, people will be engaged in the construction and maintenance phases as well.

Sustainability Impacts

The final impacts will be known only in years to come, but it remains clear that conceptualizing an innovative way to simultaneously build climate resilience and sustainable urban development has been a key impact so far.

1.1.5 Next Steps

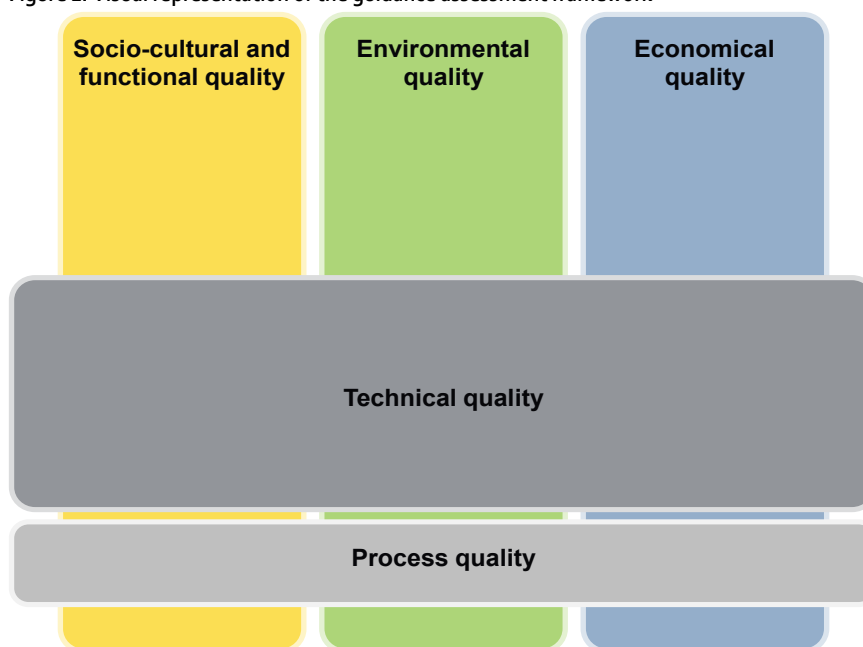
Both laypeople and professionals are invited to become involved by contacting SLA Architects. The needs and possible contributions may vary from time to time, but this project is designed to be based on collaboration and co-creation.

Challenges and potential for further development

The potential for further development lies in spreading the novel thinking and approach of the project, as well as challenging other cities and developers of urban environment to address and seek new yet relevant solutions to existing problems.

1.2 Guidance for city district development, “Miniguide til DGNB for byområder”

Figure 2: Visual representation of the guidance assessment framework



Source: © Danish Green Building Council.

Case description*

Implementation:	Denmark
Locally implemented:	Yes
Sustainability theme:	Climate Change, Ecosystems & Natural Resources
Sector of activity:	Buildings and Construction, Energy, Scientific research, development and innovation
Type of Initiative:	Capacity Building & Implementation, Education & Awareness Raising, Policy Frameworks & Tools
Lead actor:	Danish Green Building Council
Type of lead actor:	Civil society
Partners:	The guidance has been prepared based on work done by DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen). The Danish version has been adopted to Danish environmental, cultural and historical contexts, and has enjoyed the support of the Ministry of Environment and Food of Denmark. More than 60 national experts have contributed throughout the process in Denmark.
Status:	Started in 2012. Ongoing.
Contact person:	Mette Qvist, Managing Director, mette.qvist@dk-gbc.dk

*Note: Case descriptions, e.g. with regards to geographic scope, theme, sector, type of initiative, and type of lead actor, follow the groupings used within UNEP's SCP Clearinghouse.

1.2.1 *Introduction*

The “Miniguide til DGNB for byområder” is a comprehensive yet simple and practical guidance for all actors engaged in city area development. It embeds a holistic approach and centers around the three focus areas of sustainable development: economical, environmental and social. Danish industry supports it, and it is a fruitful example of advancing and promoting sustainability, catering to the full range of participants in area development. Apart from guidance, it is also a certification system.

1.2.2 *Objectives*

Area, district and city development means accommodating a wide range of often competing themes into a satisfactory solution for the actors engaged, whether actively or passively, in the process. Area, district and city development also involves the process – and journey – of verbalising and visualising a future state, that is both attainable and visionary.

The overall objective of the guidance is, and has been, to engage all actors with the Danish building industry towards practical action, within a sustainability framework, which is tailored specifically to the Danish context. The guidance also seeks to change the fundamental approach to area, district and city development, by focusing on integrated design, collaboration and co-creation.

The guidance has two primary functions: 1) the guidance can be used as a benchmark, to promote an area’s or city’s sustainability and 2) the guidance can be used as an active tool, in the planning and design phases, and for prioritising and scheduling activities across participants.

The term sustainability is open to misuse when interpreted in too many diverse ways. To combat this, the guidance couples the ideas and frameworks inherent in the notion of sustainability with practical and action oriented parameters and sets evaluation points. The guidance takes a holistic and process oriented approach, focusing on environmental, economic and sociocultural sustainability themes, which in turn are complemented with assessments related to technology and city area development processes. These themes are in turn weighted, and each theme contributes their weighted proportion to the overall assessment. Themes are weighted so that each theme contributes a certain percentage, in particular with environmental, economic, sociocultural and functional, and technical and process qualities are included as well.

The guidance’s target audience is the entire Danish building industry. It is intended to become a benchmark for meaningful daily praxis. The certification scheme criteria are weighed in relation with each other, so that an area is developed holistically, environmentally, economically, and socially, and so that not one aspect is given precedence over another.

The guidance aims to translate complicated themes, such as global climate change and the well-being of future generations, into meaningful, concrete and sensible actions in local settings, for example, for citizens, municipalities and developers.

1.2.3 Activities

The guidance was developed with wide support, both from private companies and public organisations. Prior to drafting the guidance, objective research was carried out in order to identify which existing assessment systems would make most sense in a Danish context, thus avoiding reinventing the wheel. The guidance was consequently built on the German DGNB system. This makes it a good example of knowledge transfer from one context to another. Other perceived advantages with the DGNB system included its open source philosophy and transparent nature, as well as alignment with EU standards, the latter which was highly appreciated by the building material industry. So far five city districts have been precertified: Nordhavn, Brygger Bakke (in Aarhus), Carlsbergbyen, Nørrestrand and Deltakvarteret Vinge at Frederikssund. At the end of 2017, the pipeline also contains four more districts. The five listed city districts are precertified, meaning that the master plan has been certified, and the consequent step includes to also certify the entire built area.

1.2.4 Key Results and Achievements

Success Factors

The guidance owns part of its success to the wide inclusion of, and buy-in from the Danish building industry actors. An extensive review process resulted in a guidance produced “bottom-up” and not “top-down”. Principles included in the overall selection of the guidance itself included:

- It being a “second-generation” certification system, that is, already tested elsewhere.
- Designed in Europe and for a European context.
- Inclusion of life cycle costing principles, while giving equal weights to economic, environmental and sociocultural themes.
- Suited for local adaptation and an inherent performance driven approach that allows for and encourages innovation.

Novelty

Each actor comes into an area development process with its own understanding. The guidance both allows and gives a framework for co-creation and participation across different areas of influence, in turn paving the way for new value creation. The guidance’s integrated approach increases the potential for innovation, and the fact that the guidance itself is also related to EU standards facilitates cooperation and active involvement between different actors, participants, and local inhabitants.

The guidance also enables investors and developers to clearly communicate on progress. It allows flexibility in going forward, by not establishing precise solutions but by providing a common framework. The guidance is also future orientated, meaning that the process does not end when the last brick is laid.

Sustainability Impacts

The guidance focuses on creating both healthy and safe environments, where the entire urban area is inviting and accessible, including for people with greater or lesser disabilities. The guidance also focuses on preserving the ties with existing qualities, such as unique existing structures, buildings or nature areas. In addition, maintenance and upkeep are seen as priorities already in the planning stages, so that an area will not degrade its inherent character and quality over time.

Cost-effectiveness

The guidance incorporates life cycle costing (LCC) in the overall assessment, and is consequently building in a long-term dimension in the financial planning and upkeep of the area. The LCC thinking also enables selecting solutions that are more advantageous when seen from a longer time line, keeping in mind that cheaper solutions may result in more expensive maintenance costs.

1.2.5 Next Steps

The embedded value of the guidance tool is vast, and it is an excellent example of how to elevate the least common denominators to more prominent and important places. It is also an example of how to make sustainability something measurable. The guidance also paves the way for a common language, and is a bridge from past learning to future challenges.

When fully implemented the guidance gives the opportunity to transform stakeholders from passive by-standers to active participants, intentionally engaging with others and future residents. As such, the guidance holds a promise to widen its influence across the Danish building and area development sectors.

Challenges and potential for further development

The guidance considers the entire process and life cycle of a city area, and contributes to bridging knowledge gaps, which for natural reasons exists in societal fabrics, for example, between political representatives and professional practitioners. A current challenge is to advocate the value of the tool, the benefits it gives, and to better argument and inform stakeholders of what better alternatives are from a sustainability point of view. A digital version is planned, something that is expected to further increase access and easy utilization.

2. Finland

2.1 E2ReBuild Oulu Demonstrator

Figure 3: Front view of building after retrofitting



Source: © Jaakko Kallio-Koski (M3 Architects).

Case Description*

Implementation:	Finland
Locally implemented:	Yes
Sustainability theme:	Ecosystems & Natural Resources
Sector of activity:	Buildings and Construction, Energy, Housing
Type of Initiative:	Research, Analysis, Assessment
Lead actors:	<ol style="list-style-type: none">1) E2ReBuild (a collaborative project between eight European countries. It received funding from the European Community's Seventh Framework Programme (FP7/2007–2013) under grant agreement n°260058, run during 2011–2014. The project had 20 partners from the eight European countries: architect bureaus and construction- and housing companies as well as universities and research institutes)2) Student Housing Foundation of Northern Finland, PSOAS (Pohjois-Suomen oppilasasuntolat Oy), a public student housing company (owner of the building project)3) Aalto University's Department of Architecture, Chair of Wood Construction (Demonstration leader, responsible for the collaboration between the partners and the Oulu Demonstration Project)

Type of lead actor:	1) Business Sector + Scientific and Technical 2) Business sector 3) Scientific and Technical
Budget:	EUR 1,4 million
Partners:	Main contractor: NCC Building Finland
Principal designers:	M3 Architects Several other partners: Optiplan, Suomen Rakennustuote, Insinööritoimisto Putkonen, Insinööritoimisto Taltekon, Oulun Sähkö-Aika, Fidelix
Status:	Started in 2012. Completed in 2014.
Contact person:	Simon Le Roux, Simon.LeRoux@ym.fi

*Note: Case descriptions, e.g. with regards to geographic scope, theme, sector, type of initiative, and type of lead actor, follow the groupings used within UNEP's SCP Clearinghouse.

2.1.1 Introduction

A student apartment building at Virkakatu 8, Oulu, Finland, built in 1985 using prefabricated concrete units, was in need of complete renovation. The renovation and refurbishment was a Demonstration Project in the EU project E2ReBuild. Timber based, prefabricated elements were used for the building envelope. The aim was to reach the energy efficiency level of a passive house. A lifecycle approach was used and material and energy efficiency analysed. The project was completed in March 2014.

2.1.2 Objectives

E2ReBuild was a European collaborative project aimed for industrial-scale energy efficient retrofitting of residential buildings in cold climates. The vision was to change the resource intensive construction sector to include innovative, energy efficient and modern practices, and to create added value to existing buildings. Europe has a large number of buildings built quickly and cost-effectively after World War II. Many of them are in need of substantial renovation. Energy efficiency is poor in many of these buildings, while demand for energy efficiency constantly grows.

The E2ReBuild Demonstration Projects utilized results from research on innovative and sustainable renovation solutions. Specifically, the focus was on industrialised manufacturing of facade elements and standardised retrofit measures with high replication potential. Existing structures, such as concrete frames, were mostly left in place. On the other hand, changes were more substantial than usual in renovations. The outcome and lessons-learned of these Demonstrations were used as bottom-up feedback for further research.

The Oulu Demonstrator aimed for the building to meet and exceed current standards for new buildings. The Demonstrator was a student apartment building consisting of 8 apartments. The building was originally completed in 1985. It had been built using the so-called "BES", a Finnish industrialized system using prefabricated concrete elements, developed in the 1970s for residential buildings. The apartment interiors had become outdated and a complete renovation was needed.

The Demonstrator aimed to meet the Passive House energy level. Targets for energy efficiency, insulation and airtightness were set based on the Finnish Passive House national recommendations. The aim was to reduce the building's energy use to 30kWh/m²/y, encompassing heating, ventilation and hot water.

A key objective was to apply modern industrialized wood construction techniques to retrofit existing buildings, using the TES (Timber-based Element System) Energy Facade. TES are large-scale, prefabricated, timber frame elements. The Oulu Demonstrator was a possibility to further develop the TES and monitor the results. Life cycle impacts were also considered, aiming for robust long-term solutions.

Another objective for the Oulu Demonstrator was to change the layout of the apartments to something more suitable for student families. Thus, property development with a strong social aspect was also involved.

2.1.3 Activities

The retrofit included a renewal of the facade with the TES elements and a comprehensive renovation of indoor spaces.

The ground floor slab was replaced with a well-insulated in-situ slab and new ground fill to reduce moisture risks. Detected air leaks in the existing concrete shell were grouted. The outer concrete layer of the existing facade elements, old insulation, doors and windows were removed. The inner concrete layer of the old elements was covered with TES elements, which contained a high degree of insulation - necessary in the very northern location. A total of 2,000 m² TES elements were assembled on-site. The building received a new roof with added insulation. Old balconies were replaced. Shade to the south side was provided to reduce risk of overheating in summer. The building volume was simplified to reduce thermal transmission. Building services were entirely replaced: district heating renewed, water saving fixtures added, heat recovery ventilation installed and additional HVAC ducts fitted under the roof.

Several different prefabricated structural materials were used, from timber-based facade elements to precast concrete and steel balconies, and modern doors and windows. The facade was clad with corrugated fibre cement cladding, usually used on roofs. This solution is robust, low-maintenance and protects the external thermal insulation from weather. Site drainage and ground frost insulation were improved. The interior was modified to house student families. This included adding saunas to the apartments and developing the layout of the apartments.

Building automation was installed to track energy performance, indoor air quality, outdoor conditions, and building physics. The latter was given extra attention, as the performance of the prefabricated facade needed to be verified. Airtightness tests and thermal surveys were done, both prior to construction and in winter prior to completion. Experimental radar survey was tested to investigate concrete structures. Aalto University interviewed the tenants before and after the retrofit, inspected off-site production, documented the project progress, assisted with quality control, and collected a year's worth of monitoring data (completed in March 2014).

Construction was started in August 2012 and initially completed in February 2013. However, further air leaks were detected at the ground slab perimeter and ground floor apartments were vacated for correctional work during December 2013 – March 2014.

2.1.4 Key Results and Achievements

Success Factors

Targets for energy retrofitted houses with passive house components (EnerPHit) were achieved.

The retrofit was one of eight nominees for the 2013 Wood Prize in Finland (Puupalkinto).

Novelty

The Demonstration was a broad-scale refurbishment. The focus was not solely on energy efficiency, but also included efficient retrofitting, collaboration, life cycle impacts, indoor air quality, tenant energy usage, building physics monitoring, combination of old and new components, and cost-effectiveness assessment. New ties and collaborations were created between universities and industry partners. The know-how of several parties was developed (the contractor, architects and planners, researchers and product development).

Sustainability Impacts

Occupant comfort levels were improved. The actual use of heat, electricity and warm water were analysed. Space heating demand and purchased district heat were both reduced by ~60%. Air tightness and the U-values (thermal transmittance) of exterior structures were all reduced significantly. However, the property's electricity use was only reduced by about 15%, due to the new efficient ventilation using electricity.

When well done, a similar refurbishment can reduce energy demand, enhance indoor comfort and rise property value of an existing building for several decades. Utilising existing structures and combining them with timber based components decreases the CO₂ footprint of the refurbishment.

Cost-effectiveness

Analysis revealed that the costs for the interior renovation and the balconies were half of the total refurbishment costs. The facade renovation itself represented 16% of the costs - half of this was due to facade cladding and separately assembled windows and doors. Design, survey, contract and site costs were another 16%. This could have been proportionally smaller, if the refurbishment would have been done to all five buildings on the property. Improved design coordination and cost-effective off-site prefabrication can reduce on-site delays. The rest, 19%, consisted of roof, ground slab and building services replacement as well as monitoring.

2.1.5 Next Steps

The results and lessons-learned have been used as teaching material, in further research and development, and in scientific publications and dissemination of research results.

The project supported product development. Other E2ReBuild Demonstrations utilising the TES system were Gröntenstraße in Augsburg, Germany; Sendling in Munich, Germany; Roosendaal in the Netherlands; and Thamesmead in UK. After the E2ReBuild-project ended, elements from the same local producer (Suomen Rakennustuote) have been used in new buildings. Similar TES elements have also been used in later projects in Germany, the Netherlands and Norway.

Challenges and potential for further development

The following topics or phases were identified:

- Exact measurements of existing buildings are important for design and prefabrication.
- Demolition of old structures requires care and expertise.
- Air tightness and indoor air quality when combining old and new structures.
- Moisture safety in assemblies and installations.
- Collect, analyse and report monitoring data efficiently with robust online interfaces.
- Monitor building performance for long enough to get results from normal living conditions.
- Pay attention to communication with tenants and minimise disturbance from construction work.
- Efficient and smooth implementation of retrofit projects (e.g. difference of interests and motivators of different parties).

2.2 PuuMera – large scale residential construction with wood

Figure 4: Architectural design of the building



Source: © Rakennusliike Reponen & Vuorelma Architects.

Case Description*

Implementation:	Finland
Locally implemented:	Yes
Sustainability theme:	Climate Change, Ecosystems & Natural Resources
Sector of activity:	Buildings and Construction, Housing, Energy
Type of Initiative:	Other
Lead actors:	
Builder:	Rakennusliike Reponen (Building Company Reponen)
Clients:	SATO (Suomen Vuokrakodit) and TA-Asumisoikeus
Architect:	Vuorelma Arkkitehdit
Type of lead actor:	Business sector
Budget:	Approximately EUR 30 million
Partners:	Structural design: Sweco Oy
Heating, ventilation and air conditioning design:	Optiplan
Fire safety design:	L2 Paloturvallisuus
Acoustic design:	Heliimäki Akustikot
Timber facade and wall elements:	Koskisen Oy
Timber floor elements and balconies:	VVR Wood
Sprinklers:	Marioff
Status:	Started in 2014. Completed in 2015.
Contact person:	Mika Airaksela, Managing Director, Building Company Reponen (Rakennusliike Reponen), mika.airaksela@rklreponen.com

*Note: Case descriptions, e.g. with regards to geographic scope, theme, sector, type of initiative, and type of lead actor, follow the groupings used within UNEP's SCP Clearinghouse.

2.2.1 Introduction

PuuMera is a construction concept that brought to life Europe's largest wooden apartment building in Vantaa, Finland. PuuMera makes efficient use of renewable energy sources and materials, e.g., laminated timber structures. The carbon footprint of the building is less than half of an average equivalent residential building. This was achieved via choosing recycled, environmentally-friendly materials, as well as by using recycled glass, hemp concrete and untreated wood in parts of the facade.

2.2.2 Objectives

The main objective of the PuuMera project was to develop an innovative yet profitable approach to build a large scale residential property in timber. This objective was met.

Over of a few centuries of new building material development, reinforced concrete became a cost-efficient option, indeed the new norm for building large scale structures. Not considered economically advantageous, wood did not become the material of choice for large scale apartment buildings. Building larger and taller buildings in wood has been something of the past, even though for example fire regulations today are adjusted to, and accommodate construction in wood on a larger scale than before. However, a considerable share of family residential buildings has remained, to a large extent, timber-based. This is true not only in Finland, but also seen in the landscape of many other countries.

In this context, the overall objective of the PuuMera project was 1) to build profitably in wood, and to challenge the common paradigm of using reinforced concrete, and 2) to construct a wood-based property that could be defined as a low energy building.

Realising these objectives required developing new ways of working. Hence, the PuuMera approach has also integrated co-creation as part of its concept, and has, for example, engaged future residents already in the design phase.

2.2.3 Activities

The PuuMera concept was developed by the Finnish construction company Reponen and its partners, and the concept has been realised through a series of three wood-based apartment blocks. The apartment building in Vantaa's Kivistö, completed in the autumn of 2015, utilises innovative laminated timber structure methods, which were developed in a previous project in 2011 in Vierumäki, Heinola. A third PuuMera building, sited in the area of Honkasuo in Helsinki, was completed in 2017.

The prefabricated wooden elements are produced indoors in order to ensure desired accuracy and quality of work, and to avoid moisture related problems. The work done at the building site is fast, as the wooden elements and parts arrive at the site ready for assembly.

With careful planning and design, as well as the use of new technologies, the fire safety levels may in fact be considered better than with traditional concrete building methods. Fire safety regulations are clearly addressed and accounted for, and

automated sprinkler systems installed. For example at the Kivistö site, each apartment has its own high pressure sprinkler system.

In terms of life cycle considerations, the PuuMera maintenance and service requirements are on par with concrete buildings. For example, the facades require repainting every 15 years, after which they are good as new, and do not require condition sampling and laboratory testing. The PuuMera building is built to the passive building standard; therefore ventilation is always kept at a suitable rate in order to avoid the accumulation of moisture.

And lastly, the PuuMera journey has so far shown that, in order to erect larger scale wooden buildings, new partnerships networks need to be forged in order to sustain and increase innovative solutions and ways of working.

2.2.4 Key Results and Achievements

Success Factors

The multi-storey wood-frame building won shared first place in a competition based on the carbon footprint of buildings, organised by the Confederation of Finnish Construction Industries RT and the Green Building Council Finland. Continuous resident surveys indicate a very high user satisfaction.

Novelty

The project is a good example of challenging traditional ways – in this case constructing a multi-storey building out of wood instead of concrete – with profitability in mind, in this case innovatively linking climate benefits with business profit.

Sustainability Impacts

The VTT Technical Research Centre of Finland has defined the building as passive in terms of energy. It has an air-leak factor of less than 0.6 l/h. The building uses solar panels for electricity generation. The U-value (thermal transmittance) of the walls is 0.12 W/m²K and of the roof 0.08 W/m²K.

The floors are constructed of wood, although, for thermal reasons, a concrete slab partitions the cold car parking level. The building's wooden frame has a stud construction in large prefabricated elements with composite intermediate slabs and beams. The partition elements are cross-framed, as are the lower and upper beams. The external walls are made from laminated timber. These are fitted with facade panels and boarding at the factory and delivered ready to the site. Windows and balcony doors are also installed in the factory. The intermediate floor elements consist of finished wooden elements, assembled on site. The sound insulation properties of the building have been excellent.

The carbon footprint of PuuMera, Europe's biggest wooden apartment building, is less than half of the carbon footprint of an average residential building due to the exploitation of renewable energy sources and its material choices. Overall, the carbon footprint is less than half of that of an average residential building. The carbon footprint of the building was successfully reduced through recycled, environmentally-friendly

material choices. Recycled glass, hemp concrete and untreated wood were used in some parts of the facade.

2.2.5 *Next Steps*

The building techniques will be developed further in coming projects, where a further aim will be to construct thinner walls.

Challenges and potential for further development

During the building process it became apparent that learning new skills is a prerequisite when seeking new and innovative ways of building. In this case, this entailed relearning skills almost lost during the overall transition towards concrete construction over the past 70–100 years.

3. Iceland

3.1 Urriðaholt (Urridaholt) sustainable neighbourhood

Figure 5: The Urridaholt master plan, Gardabaer, Iceland



Source: © Urridaholt Inc.

Case Description*

Implementation:	Iceland
Locally implemented:	Yes
Sustainability theme:	Climate Change, Ecosystems & Natural Resources
Sector of activity:	Buildings and Construction, Housing
Type of Initiative:	Capacity Building & Implementation, Policy Frameworks & Tools, Research, Analysis, Assessment
Lead actors:	1) Urridaholt Inc. 2) Gardabaer Municipality
Type of lead actor:	1) Business sector 2) Government/public sector
Partners:	Alta Consulting: project management, context analysis & planning, public participation & consultation, sustainability appraisal JTP: chief masterplanners & placemakers for residential and mixed use, public participation & consultation
Urban Engineering Studio:	Traffic & movement

Arrowstreet:	Planners of Business Street
Landslag:	Landscape design
COWI:	Strategy for SUDS
Status:	Started in 2003. Ongoing.
Contact person:	City planning officer in Gardabaer, Arinbjorn Vilhjalmsen, arinbjorn@gardabaer.is

*Note: Case descriptions, e.g. with regards to geographic scope, theme, sector, type of initiative, and type of lead actor, follow the groupings used within UNEP's SCP Clearinghouse.

3.1.1 Introduction

The Urriðaholt (Urridaholt) urban master plan in Garðabær, Iceland covers an environmentally sensitive area, with a pristine lake and panoramic views. It is a walkable neighborhood in a beautiful natural setting where emphasis is placed on high quality urban form. Community participation was a key element in the preparation of the master plan. Special attention was given to the relationship between the urban character and the natural environment. SUDS and BREEAM Communities certification were introduced here for the first time in Iceland.

3.1.2 Objectives

In Iceland, land is comparatively cheap and plentiful. This has fuelled urban sprawl and low-density residential suburbs where distances become too far to walk, pavements disappear, and bus routes become unviable.

One objective was to show how this trend could be reversed, using Urriðaholt as a model, and recalling the walkable character of the central core of downtown Reykjavík. The aim was to create a compact and diverse mixed-use, walkable neighborhood, with local amenities and opportunities to run good public transport. Integrated with sustainable urban design strategies, this will enhance the well-being of the people that will be living and working in Urriðaholt in the future.

The site encompasses a hill that rises some 50 m above a lava field, wetlands, and a portion of a pristine lake, in total 100 ha. The site is surrounded by a beautiful, unspoiled landscape and has spectacular views of mountains, volcanoes and the sea.

Another objective was to design a neighborhood that would fit into, and work with, the unspoiled surrounding landscape, and to integrate the built environment with nature. The pristine lake was also to be protected, both in terms of the cleanliness of the water and in terms of the water level. The aim was to use a Sustainable Urban Drainage System (SUDS) in the neighborhood, as traditional drainage solutions would result in a loss of water catchment area and shrinking of the lake itself. The SUDS maintains the natural hydrology of the site, and ensures that rain falling within the catchment area will feed the lake naturally.

The project serves as a bridge from the seaside community in Gardabaer to the inland nature preserve, providing new connections to the Green Scarf – a continuous natural landscape wrapping the Reykjavik capital area.

The master plan was created with respect for the environment and an emphasis on sustainability – aiming for a BREEAM assessment and certification.

When the planning process started, BREEAM communities' certification did not yet exist. To ensure the development met with the original sustainable vision, the planners therefore used existing guidelines and checklist. The master plan served as an excellent base for the BREEAM communities 2012 criteria and guidelines. The BREEAM community guidelines assisted the development of local plans in Urridaholt.

3.1.3 Activities

The project began with substantial collaborative activities, following Charrette methodology, with municipality council politicians and officers. This included a site visit, briefings, dialogue workshops and hands-on planning groups. The result was a Vision for a walkable, climatically responsive, mixed-use neighborhood, where the lake and the lava fields were protected as much as possible. After this, the local residents were invited to a Community Planning Weekend, where they were first introduced to the development concepts, and then invited to take part in workshops, walkabouts and hands-on planning sessions to consider challenges and opportunities for the site.

What emerged was the desire to create a highly sustainable community. This meant traffic-calmed streets and green links to the protected lake and the wider natural environment, and a detailed Vision for the site, incorporating ideas from the Winter Cities movement, SUDS, etc.

Urridaholt was designed to consist of a mixture of some 1,600 dwellings, 90,000 m² for office and retail, and 65,000 m² for public uses. Up to 9,000 people will be living and working in Urridaholt when fully built.

Mixed-use principles are utilised. The public buildings hosting most activities are sited to minimize walking distances – around the top of the hill at the geographic centre of Urridaholt. This hub is surrounded by a series of residential areas, each with their own identity. The hillside's own "Green Scarfs" lead through the landscape to surrounding natural areas. A range of housing types is planned to encourage development of a mixed community. Pedestrians are given priority: streets are designed to reduce traffic speed through changes in direction and use of landscaping. Solutions encouraging an active outdoor life throughout the year were incorporated to enhance the community's health and well-being during the dark winter months.

Urridaholt features the first Sustainable Urban Drainage System (SUDS), a large-scale Blue-Green drainage solution. Impervious materials are kept to a minimum and the area's design forms a network of swales, placed to collect water from roads and roofs.

Enabling walking, biking and use of public transports promotes resource efficiency. Guidance for the use of sustainable materials in the area also encourages sustainable building practices. Educational material on environmental practices is provided for residents and the elementary school has a special environmental focus.

3.1.4 Key Results and Achievements

Success Factors

Urridaholt has received international awards and certification:

- Recipient of the 2007 citation from the Urban Design Committee of the Boston Society of Architects.
- International Award for Livable Communities (LivCom), silver level, category "Environmentally Sustainable Projects".
- First international project to achieve a certification under BREEAM Communities 2012, and the first urban master plan in Iceland to receive a BREEAM Communities certification. The local plan for the North side phase 2 is the first phase to achieve a final certification – with a "Very Good" rating.

Novelty

Urridaholt is a pioneering development in Iceland – the first to introduce SUDS into a whole neighborhood – and the only known example of a hillside application of this technology in Europe at this high latitude.

Sustainability Impacts

Buildings are sited and designed to take advantage of daylight from the low-angled sun to reduce energy consumption. Sustainable design guidelines for designers promote the use of local and sustainable materials. Encouraging cycling and the use of public transport through safe streets and cycle paths reduces fossil fuel consumption. There are also bike parking at regular intervals in the streets and requirements to include shelters for bikes in all private houses and apartment buildings. Safe disposal of hazardous materials and is encouraged. Service stations for recycled material (glass, paper, plastics and metal) are provided within a walking distance.

Sustainable drainage systems are used in the area. This protects the lake and the surrounding environment. Permeable surfaces exist where possible, to get the water naturally into the ground. The rain from the roofs drain into the soil in raingardens and there are grassy water-channels, (swales) by the roadsides, into which storm water can drain. A network of swales collects water from the roads and allows infiltration, whilst the rainwater runs along the contours to the lake. The SUDS render the area a Low Impact Development, by the use of Blue-Green drainage solutions, which preserve the local hydrology and protect the environmental quality of lake Urridavatn.

Cost-effectiveness

The construction of the area and the buildings is somewhat more costly than traditional construction. However, it is expected that the buyers of the flats and houses will appreciate the area's environmental profile and the green solutions, and be willing to pay the somewhat higher price.

3.1.5 *Next Steps*

Today (2017) the area is about 60% built. It is estimated to be finished within the next five to ten years.

Challenges and potential for further development

Contractors had initial difficulties in understanding the new approach to planning. Education to the new thinking was thus an important part of the implementation of the SUDS, the new road layout, and the use of new design codes. To help in this task, brochures and videos were made, and books about building communities (placemaking) published. Step by step, the contractors and their consultants gained better insights into why certain solutions were required, what the purpose of these were and how to implement them.

One of the remaining challenges is to attract a mix of different age groups to move into the new area. At present, more elderly people are moving in – partly because there has been a shortage of apartment buildings for this age group. This may change with the opening of the school and the kindergarten, and with more building of smaller and cheaper apartment buildings.

The Urridaholt Vision dared to be different and is an example for implementing new sustainable urban solutions in Iceland, treading gently on the natural environment.

Key parties involved have emphasized that the consultation was successful and that the vision developed in the beginning of the project, by the large group, was both stimulating and useful. When reviewing the plan today, many feel that the emphasis put on environmental aspects and urban quality has stood the test of time and gives a sound base for a quality environment, which caters to the needs of the growing population in Iceland.

4. Norway

4.1 Østensjøveien 27, Oslo – Ø27

Figure 6: Façade of Ø27



Source: © NCC Group.

Case Description*

Implementation:	Norway
Locally implemented:	Yes
Sustainability theme:	Climate Change, Ecosystems & Natural Resources, Other
Sector of activity:	Buildings and Construction, Energy
Type of Initiative:	Capacity Building & Implementation, Education & Awareness-Raising, Research, Analysis, Assessment
Lead actor:	NCC Group
Type of lead actor:	Business sector
Partners:	Project developer: NCC Property Development
Architect:	Henning Larsen Architects
Landscape architect:	PK3 landskabsarkitekter
Status:	Started in 2011. Completed in 2013.
Contact person:	Manne Aronsson, manne.alexander.aronsson@ncc.no

*Note: Case descriptions, e.g. with regards to geographic scope, theme, sector, type of initiative, and type of lead actor, follow the groupings used within UNEP's SCP Clearinghouse.

4.1.1 Introduction

Østensjøveien 27 (Ø27) in Oslo, Norway is the Norwegian headquarters of NCC. It is a spearhead sustainability project, constructed as a Passive House. It emphasises the use of climate-friendly building materials and integrates good bicycle parking. The office area covers 17,000 m² over 6 floors. It has been certified "Excellent" by the BREEAM-NOR standard, the Norwegian adaption of the international sustainability assessment method for master planning projects, infrastructure and buildings.

4.1.2 Objectives

Well-being, efficiency and flexibility are the key principles for the Ø27 building, which meets the requirements for the modern workplace of the future. The floor plans comprise both open-plan and partitioned offices. The sustainable office building has been designed based on a holistic idea, taking into account, for example, daylight ratio spatiality, sustainable materials, and the location in the vicinity of public transport.

The office has been designed with flexibility in mind, and it will be possible to turn the office building into housing, i.e. apartments, should this become an objective in the future. The open-plan layout part of the office supports this ambition of flexibility. The facade may be adjusted to residential use, additional elevator and piping shafts are already installed, and the roofed atrium can be transformed as well.

In addition to the objectives set for the actual building, good siting was also an objective. Østensjøveien 27 is located centrally in Oslo, just a short distance from public transport hubs and close to the Ring 3 National Road. Bicycle access was also a priority when siting the building.

Energy efficiency, combined with a focus on Passive House criteria in line with Norwegian standards, remained a main goal throughout the planning. In line with NCC's certified environmental policy, all internally developed commercial buildings must, as a minimum, be certified as "Very Good", as defined by the scale used in the BREEAM-NOR standard.

4.1.3 Activities

The building was sited at Ø27, centrally located in Eastern Oslo, Norway, with due attention to convenient and appropriate access for both users and visitors. In line with the building's key objectives – well-being, efficiency and flexibility – the floors comprise both open-plan offices and partitioned offices. The office floors are built around a central, open atrium, with meeting rooms "extending out" over the open space, lending a sense of excitement and activity to the atrium. The atrium also serves as a meeting point and seating area for the staff restaurant. A well-equipped conference centre is located directly adjacent to the restaurant. The lobby houses a coffee bar open to the building's tenants and visitors.

The project started with an architectural competition with focus on:

- energy efficiency
- pleasant indoor environment
- good innovative office solutions. The accessibility of the location and good use of natural light were also identified as main aims.

The property contains a wide range of energy efficient solutions. The building is designed and built according to Passive House criteria. Building airtightness reaches a rate of 0.35 air changes per hour, and the insulated facades reduce challenges with cold bridges and air leakages. It should be noted that the superstructure is situated inside the facade. Ventilation, both near the outer core and further into the building, has been designed to take into account the outdoor air temperature. Many of the ventilation units have rotating heat exchanges, resulting in good heat recovery. Both ventilation and lighting levels can be adjusted with on-demand controls.

The project planning included minimization of material use, selection of products with a low greenhouse gas footprint, and selecting the site so that it is accessible through a range of transport modes. In terms of architectural solutions, this has meant a compact building form and an indoor geometry that presents a continuous office landscape, with no corridors. Due attention has also been given to the materials used for the facade solutions.

The office is located near an Oslo metro station, and has easy access by bicycle. As part of the minimisation of greenhouse gas emissions, a focus was also to ensure the building facilitates non-combustion based modes of transport, hence the building also houses electrical charging stations for cars and safe bicycle parks.

4.1.4 Key Results and Achievements

Success Factors

The key success factors for Østensjøveien 27 were embracing the intentionally set priorities of well-being, efficiency and flexibility, and the team that has been working to make these principles a reality. The office building has been positively noted in a number of international arenas, and it has, for example, been:

- awarded the BREEAM-NOR rating of “Excellent”
- being a Passive House according to the Norwegian Passive House standard
- nominated among the 100 best sustainable solutions by the global environmental organization Sustainia100 at the Rio+20 UN Conference on Sustainable Development in 2012
- nominated in the “Best Innovative Green Building” category in the MIPIM Awards at the MIPIM international property exhibition in Cannes in March 2014.

Novelty

The building's environmental profile meets the Passive House standard; the property is also classified as Energy Class A by Norwegian standards. The central location and vicinity to the City of Oslo's planned "green street" gives both user and visitors easy access with a wide range of means of transport. The building has good access to the city bicycle network and has facilitated cycling through 100 lockers and 120 bicycle parking places. Out of the property's 72 parking places, 20 are equipped with electrical charging facilities. In addition to energy and access, building materials were selected based on greenhouse gas emission impact, and the architecture itself presents solutions that minimize overall material usage.

Sustainability Impacts

The building solutions included using low-carbon concrete and recycled steel for the load bearing structure. The facades were prefabricated in order to reduce waste and improve material use. The greenhouse gas emissions for the "as built" stage were reduced by 30% when compared to a reference building, and the reduction of greenhouse gas emissions from energy use is 61% and for material use 50%; the transport reduction amounts to 3%. An important climate initiative has been the compact building and simple building geometry. Natural light has been optimised in the office, and the facade solution has removed the need for cooling. The ventilation is regulated according to use. A circular economy feature includes utilising surplus heat energy from a neighbouring industrial plant as heating energy, which meets the building's heating needs.

4.1.5 Next Steps

By paying attention to the surrounding environments and aligning a single building with the ambitions and priorities of the city – in this case, Oslo – can create safer, peaceful environments for users and local inhabitants. Potential further developments may include using other building materials, for example wood, in office related construction, and to continue to anchor buildings better into the local environment and into the minds of local residents.

Challenges and potential for further development

The building serves as a good example of novel thinking and cooperation between different actors.

5. Sweden

5.1 Greenhouse Augustenborg

Figure 7: Birdseye view of the balconies and rooftop solar panels



Source: © NCC.

Case Description*

Implementation:	Sweden
Locally implemented:	Yes
Sustainability theme:	Climate Change, Ecosystems & Natural Resources
Sector of activity:	Buildings and Construction, Housing
Type of Initiative:	Capacity Building & Implementation, Education & Awareness-Raising
Lead actor:	NCC Sweden
Type of lead actor:	Business sector
Partners:	Owner: MKB Fastigheter, Malmö municipal housing company
Key political appointee	
project sponsor:	Katrin Stjernfeldt Jammeh
Status:	Started in 2014. Completed in 2016.
Contact person:	Madeilene Nobs, madeleine.nobs@ncc.se

*Note: Case descriptions, e.g. with regards to geographic scope, theme, sector, type of initiative, and type of lead actor, follow the groupings used within UNEP's SCP Clearinghouse.

5.1.1 Introduction

Greenhouse Augustenborg in Malmö, Sweden, is a showcase construction and refurbishment project within sustainable city development, and an integral step in the greening of the Augustenborg area itself. The holistic approach to the design aims to reduce the residents' ecological footprint. The building is, for example, equipped with greenhouses on the roof and large balconies with special cultivation areas. The building contains 56 apartments in total. The project was realised by NCC.

5.1.2 Objectives

Greenhouse Augustenborg's objective has been to develop sustainable housing, to promote housing that is innovative in terms of energy use, make use of various environmental techniques, relate to tenants' life styles, and support social cohesion.

Greenhouse Augustenborg is a project with a particular historical context. Augustenborg, a neighborhood of Malmö, is an area that was built in the early 1950s, during Sweden's post-war prosperity. At that time, it had its own coal-fueled central heating power plant. The area was designed in line with the Swedish standards and philosophy common in the 1950s – including an overall layout designed to ensure optimal conditions for sunlight. Construction started in 1948 by the housing company MKB. The underlying idea was that Augustenborg should not only consist of apartments, but also have schools, shops, work places and community centres. Later, however, the area entered a slow decline, but was then revitalized in 1998 by a government-funded program. Currently Augustenborg represents a leading example of an eco-city.

The process of developing the Green Augustenborg project – or Ekostaden Augustenborg in Swedish – started in 1997, and in 1998 the main targets were set together with local inhabitants. These were to: 1) Reduce the effects of flooding (an open storm water system); 2) Actively engage the local community in the improvement work; 3) Lower energy consumption, closely tied to the desire to lower the cost of living; 4) Introduce green roofs; and 5) Introduce a musical-themed playground. A main principle was that the residents should not move away, i.e., that the area should not undergo a transformation on the expense of changing the resident mix. The results from these actions, initiated in the late 1990s, have had positive effects on the neighbourhood, and the area has also reached a higher degree of climate resilience in managing heavy rainfall through the open storm water system.

The philosophy behind Greenhouse Augustenborg has been to add new urban space and qualities to the already existing neighbourhood, continuing to build on the actions and efforts already carried out. The project's key sustainable principles have been to focus on resource conservation, and create a climate smart building, which contributes to lower energy consumption and a healthy indoor climate, as well as engages users in the actual design and upkeep of the property.

5.1.3 Activities

The main part of the building is 14 storeys high and the refurbished part is 5 storeys high. The building houses 56 apartments in total. As the focus was on building a community, the building contains common areas, such as a rooftop greenhouse, available to all for growing light intensive plants and keeping other plants during winter. The rooftop also has a terrace for common use.

The project also approached how to influence behaviour by making use of smart technology. Each apartment is equipped with a wall mounted reading pane, giving data on energy, water and sun-produced electricity consumption, as well as other data, such as where bikes may be rented. The reading pane also, for example, facilitates turning off all appliances when leaving home. The owner of the building has also launched an educational and awareness effort. In this, the residents have received information on how to think smart in terms of energy efficiency, and for example on how to grow plants or food ecologically, and how to cook sustainably.

A key dilemma often faced in architecture is the zone that separates the outdoors from the indoors, and how this can be bridged. Each apartment is equipped with a 21 m² balcony, which is half open and half covered, thus creating unique outdoor/indoor spaces. In addition, towards the outside each balcony holds a planting area, measuring approximately 0.5 x 0.5 x 10–12 m. This means inhabitants have opportunities for urban gardening that are rarely available in the Nordic countries. Each apartment is also equipped with its own elevator door. This makes it possible to actually transport for example soil in a wheelbarrow, all the way from the basement to the balcony.

In the building phase, transparency was put into practical action, via the idea of partnering. This means an open common budget with alignment of interests through profit/loss sharing within agreed rules. The partnering approach enabled everyone involved to understand the overall business case, and to take into account each other's points of view. It should be noted that this meant that everyone – including the future owner, the main contractor, and the suppliers – shared the same office during the project. Sharing an office meant that information was shared more quickly, and that decision-making became more efficient.

The project indicates that to achieve success, all parties need to buy-in and collaborate: There is more to developing an area than building an individual house.

5.1.4 Key Results and Achievements

Success Factors

The building, a rental property completed in 2016, was rated Gold according to the Swedish Green Building Council rating system.

Novelty

Throughout the design phase, cooperation and collaboration between the client, the architect and the builder, resulted in novel solutions. This was, in particular, the case in

relation to how individual residents can have a sustainability impact on and through their daily lives.

Awareness is raised and sustainability impacts are communicated through tailored infographics. The unique approach in bringing the natural environment close in an urban setting also provides an opportunity for a more balanced life with lower stress.

Sustainability Impacts

Some key aspects include:

- Solar cells on the rooftop provide residents with green electricity.
- Smart building automation systems enable running equipment when the use of the electricity grid is at lowest.
- The building is a so called passive house, meaning heating is designed to come primarily from solar radiation, electrical appliances, lightning, and body heat.
- In order to encourage sustainable living, each apartment is equipped with a display that shows use of hot water, electricity and waste.
- Separate plugs provide only solar electricity.
- With one push in each apartment's entrance hall, residents can turn off all electricity that is not needed when away from home.
- In order to facilitate biking, the building has a bicycle garage with bike wagons, which are free to borrow, for example, for doing weekly shopping.

5.1.5 Next Steps

The project is a very good example of both area and property development, as well as the value added of close cooperation between different stakeholders. Greenhouses Augustenborg should be seen in a progression of a process that started about 20 years earlier, in the City of Malmö's desire to raise the overall quality of live in Augustenborg as a whole.

Challenges and potential for further development

The surrounding area houses socially vulnerable people, mostly with both lower education and income. The Spanish architect who was brought in, in a sense framed the project by saying: "You cannot only build a house, but must develop an area that is attractive long-term." This remained a leading principle throughout, as difficult questions were tackled, such as "what happens when a person with high income move in next door to someone with lower income," or "what really unites people from different socio-economic backgrounds." In the design and planning phases, a number of solutions were implemented.

5.2 Osmos

Figure 8: View from Gibraltargatan



Source: © CaseStudio.

Case Description*

Implementation:	Sweden
Locally implemented:	Yes
Sustainability theme:	Climate Change, Ecosystems & Natural Resources
Sector of activity:	Buildings and Construction, Housing, Energy
Type of Initiative:	Capacity Building & Implementation, Education & Awareness-Raising, Research, Analysis, Assessment
Lead actor:	HSB Göteborg
Type of lead actor:	Business sector
Budget:	Not yet available
Partners:	CaseStudio: Architecture Mareld
Landskapsarkitekter:	Landscape architecture, including rooftops
Bengt Dahlgren:	Building service system engineering
Limträteknik:	Wood construction engineering
Chalmers University of Technology:	Academic review and follow-up
Riksbyggen:	Builder at the neighboring plot; coordination of common grounds and parking areas.
Status:	Started in 2017. Ongoing, planned to be completed in 2022.
Contact person:	Helene Eriksson, Business Development with HSB Göteborg, helene.eriksson@hsb.se

*Note: Case descriptions, e.g. with regards to geographic scope, theme, sector, type of initiative, and type of lead actor, follow the groupings used within UNEP's SCP Clearinghouse.

5.2.1 Introduction

In 2016, the City of Gothenburg organised a competition for building tall wooden residential multi-storey houses. HSB Göteborg and Cas-eStudio jointly won the right to develop Osmos, a property at Gibraltarvallen, Johanneberg. In Osmos, the superstructure, facade and other significant parts are wooden. Osmos creates variation and common spaces between outdoors, indoors and the surrounding area. The project represents the versatility and flexibility of using wood in building and in aesthetics.

5.2.2 Objectives

The City of Gothenburg's aim for the competition was to inspire and stimulate the construction of good homes in energy effective houses. The city looked for new solutions in architecture, technology and sustainability that build on the known advantages of wooden houses, yet challenge current limitations and inspire others. Another aim was to take a step towards large-scale wooden buildings becoming a norm rather than an exception.

"Osmos" is a block of flats that strive to be a living organism, bustling with life and activities. Variety is seen to yield richness, and the buildings, the common spaces indoors as well as outdoors, provide opportunities to create varietal richness, and for it to flourish. Osmos forms a living, sustainable city block, which is in active exchange with its surrounding, and yet at the same time creates its own haven in the middle of Gothenburg city.

In demonstrating the viability and sustainability of designing and building a taller wooden multi-storey residential dwelling, the project draws on two intertwined traditional contexts: 1) the national context, as building in wood has been a dominant practice throughout Sweden for much of its history, and 2) the local historical context – Gothenburg was a main cradle for a specific type of wooden building, the "landshövdingehus".

Building in wood is part of a millennia long, continuous tradition in Sweden, and quality wood is a readily available raw material. Today, a large share of smaller residential building is still done in wood, but larger scale wood-based projects are very recent additions to the overall housing mix.

Some 100 years ago, a building type gained ground in Sweden, in particular in Gothenburg. This was the "landshövdingehus", or "governor house". It was a 3-storey house with a ground floor in stone or brick, and two wooden storeys. The first was built in 1875, the last in 1947. The practice stems from fire regulations: At that time, wooden houses could only be two storeys tall. Building the ground floor in stone circumvented this, making it easier to build the housing needed for the then growing working class.

Today, fire regulations no longer prevent building taller wooden houses. Whilst the Osmos project is deeply rooted historical contexts and traditions, Osmos in itself may be the first of its kind and start a new tradition.

5.2.3 Activities

The land use competition that was initiated in 2016 was finalised in April 2017. The jury reviewed 15 proposals, and awarded Osmos a winning place. The motivation included: "A tight building where the possibilities of wood as building material is made use of in clear ways. The emotion is leveraged by the fact that not only is the facade in wood but also the interior of the entrances and floor level common entrance areas. The yard, in combination with the common roof terrace, and a social hub at floor level, enables social activity and for people to simply meet. The common spaces are designed to support a sustainable daily living, for example, through sharing functions, bicycle maintenance space, and gardening."

In addition to design and practical solutions, the jury highlighted the level of innovation, and steps taken towards upscaling in general of wood building. Osmos addressed one key aspect when building larger houses out of wood: noise. Without adequate technical solutions, a large wooden building can act as a very large resonance box as sound can easily transverse throughout. This particular issue was solved by adding concrete in a hybrid construction together with wood as a way of getting enough heaviness and sturdiness in the construction to resorb vibrations and thereby act as sound traps.

In addition to its commercial partners, HSB Göteborg has also engaged the Chalmers University of Technology, as an academic partner and project innovation bouncing board. Chalmers will review the project from an academic point of view, as well as following up on progress. Through its participation in Johanneberg Science Park, HSB Göteborg is also seeking to advance and support cooperation between academic and different commercial market sectors.

5.2.4 Key Results and Achievements

Success Factors

The initiative has gained media attention. The number of partners and organisations engaged is a sign of credibility and the strength of the movement to build in wood. HSB Göteborg has developed a model for a wood building business strategy that intends to:

- leverage on the wood building strategies of Swedish cities Växjö and Skellefteå
- support cities in their wood building efforts
- participate in developing wood building programmes
- engage local networks and recognise industry associations, to inspire and promote further developments.

Novelty

Osmos combines the use of massive wood with a locally made prefabricated supporting structure, reducing transport needs. The vertical supporting structure is carried out in bearing walls in CLT wood (cross-laminated timber), and pillars in glulam (glued

laminated timber). Stairwells and elevator shafts are built in CLT. The horizontal supporting structures are built in a combination of CLT and 70–80 mm concrete joists, the latter to improve acoustics and comfort.

Architecturally, the project seeks to challenge the status quo, to build larger and more advanced wooden houses, combining traditional know-how with modern technologies. Work will continue to make wood even more visually present and part of the urban experience. Wood ages and e.g. the facade may add new aesthetic dimensions to both local environment and overall cityscape, creating a natural contact surface between residents, city people, and the built environment.

Sustainability Impacts

Technically Osmos highlights the ambition to develop integrated energy systems. The plan is to combine and gain efficiency synergies between geothermal heating and roof top solar elements. This may increase the output yield of both systems. HSB Göteborg's energy consumption target (heating, cooling, operational electricity) is 60 kWh/m²/a. The planned solutions could reach an equivalent of 30 kWh/m²/a. The project will also look into finding synergies with nearby buildings and establish a local energy trading system.

Cost-effectiveness

A long-term target is to normalise wood building. The use of wood is expected to bring new value to the design solution and to the building and in-use phases. Current industrial processes are optimised to concrete, but with wood, for example the time to completion is expected to be cut by about 30%, as less concrete means less drying time. A wooden building has the potential for a long life cycle, with in-built flexibility enabling sustainable, economic modifications.

5.2.5 Next Steps

During 2017, the City of Gothenburg is preparing the detailed city plan, and the estimated time for construction to start could be somewhere in 2020. As part of its proposal, HSB Göteborg also prepared a strategic outline for increasing the amount of wood building in Gothenburg, to encompass all the city's activities and municipal companies. The detailed city planning is expected to be completed by the autumn of 2018, and the detailed planning of Osmos would then be ready by 2019.

Challenges and potential for further development

The potential for further development exists in advancing and showcasing wood building in the future.

Sustainable Food Systems

6. Denmark

6.1 The Danish Organic Action Plan

Figure 9: The red organic logo in a foodstore



Source: © Organic Denmark.

Case Description*

Implementation:	Denmark
Locally implemented:	Yes
Sustainability theme:	Ecosystems & Natural Resources, Food Systems, Agriculture and fishery
Sector of activity:	Food & Beverage, Scientific Research, Development and Innovation, Public Procurement
Type of Initiative:	Capacity Building & Implementation, Education & Awareness-Raising, Policy Frameworks & Tools
Lead actor:	Ministry of Environment and Food of Denmark
Type of lead actor:	Government / public sector
Status:	Started in 2011. Ongoing.
Contact person	Torben Berg, tokbe@mfvm.dk

*Note: Case descriptions, e.g. with regards to geographic scope, theme, sector, type of initiative, and type of lead actor, follow the groupings used within UNEP's SCP Clearinghouse.

6.1.1 Introduction

The Danish government presented an Organic Action Plan in January 2015. The main ambition was to double the organically cultivated area by 2020 from the 2007 level. The plan aimed for the public sector to lead the way by transitioning to organic production on publicly owned land and by supporting public sector kitchens to go organic. Denmark has achieved rapid growth in the production of organic produce and is globally in a leading position. Approximately 10% of consumption was organic in 2016.

6.1.2 Objectives

With the Organic Action Plan for Denmark, the Danish government (2011–2015) aimed to further develop and increase organic production, and to maintain Denmark's position as a leading country in producing and using organic produce. The aim was to increase sales of Danish organic products, both nationally and globally.

The overarching aim of the Action Plan was to double the organically cultivated area by 2020, measured from the 2007 level. To achieve this goal, engaging the relevant actors in Denmark was seen as an essential factor. The government wanted the public sector to lead the way and to accelerate the development. Therefore, one objective was to transition from conventional to organic production on publicly owned land, another was to continue efforts to support public sector kitchens to go organic. As a result, more than 800,000 people could potentially benefit from healthy, organic meals served every day in canteens, hospitals and nurseries.

A further aim was to strengthen the knowledge about organic food and organic production in primary schools and in agricultural education. Additionally, a research goal was to focus on new organic solutions and to create space for new experiments. The assumption was that organic production can strengthen Denmark's image as a green and sustainable country, also creating an understanding that Denmark as a country may have sustainable solutions to global challenges in a broader sense.

6.1.3 Activities

Denmark has a long-term goal of becoming a country with a green/sustainable profile. This includes being a major producer and consumer of organic produce.

One key activity in the Organic Action Plan 2011–2015 was to stimulate the demand of organic products by consumers and private and public kitchens. Some of the most important activities involved getting public kitchens e.g. schools and hospitals to start using more organic produce. This was, in part, done by seeking, and gaining a commitment to have more organic products on the menus at canteens, hospitals and nurseries. Another key action has been using the Organic Cuisine label to encourage the use of organic produce in both public and private kitchens.

To enable farms to convert to organic production, efforts were made to make the rules on how to become an organic producer easier to understand. This has been achieved partly through informing farmers via different channels about the requirements for becoming an organic farmer, partly through explaining how to

convert farming to organic production and partly by making the rules on how to become an organic producer clear and flexible enough to make the transition easier. To help develop good farming practices, research programs that aim to develop good organic production practices have also been initiated.

The current government has continued these two activities.

6.1.4 Key Results and Achievements

Success Factors

Today 97% of all Danes know the red national organic logo, which recently celebrated its 25th anniversary. Denmark has the highest consumption of organic products in the world. Of all food sold in Denmark 9.6% are organic and the share is rising. The area cultivated by organic farms in Denmark in 2016 was approximately 216,794 ha, equalling 8.1% of Denmark's total cultivated area. In 2016 there were already 3,173 farms producing organic produce. The dairy sector is the largest organic sector in Denmark.

The turnover of organic foods in the food sector has developed positively and was DKK 2 billion in 2016 (approximately USD 320 million). About 70% of the turnover came from retail sales in Denmark. Just under 2% of agricultural produce export was organic.

Sustainability Impacts

Organic food production methods have in many studies been shown to be more sustainable, as compared with conventional methods, when considering soil quality maintenance, water conservation, pest control and biodiversity improvements, along with limiting antibacterial regimen application, drug resistant bacteria, fossil based fertilizer use and pesticide contamination. In some cases, it is also possible to produce yields and to have economic returns per hectare of organic produce equal to that of conventional farming. Well thought out organic agricultural methods have been suggested as a solution to food insecurity and climate action (both mitigation and resilience building).

In terms of health, one main expected effect of increased organic public food procurement is a decrease in consumers' intake of chemical fertilizer and pesticide residues. Nutritional improvements when public kitchens convert to organic food are most likely the result of healthier and more sustainable meal compositions rather than from possible quality differences within individual food products. Kitchens using organic produce seem to develop menus more in line with national dietary guidelines for the general population, by being based on more fruits and vegetables.

Cost-effectiveness

On a five-year follow-up period, in average, the profitability of pork and milk produced using organic methods, has been higher than, or on the same level as, from using traditional methods. However, the profitability comparison evolves with market price fluctuations, and, e.g., in late 2017, the organic plant production profitability was below that of conventional production in Denmark.

6.1.5 *Next Steps*

The current government established an organic business development team, consisting of 16 representatives from the organic sector. The team delivered 25 recommendations to the minister in April 2017 that specifically aim to develop the organic production and consumption on market driven conditions.

Challenges and potential for further development

The main challenge today is to get enough produce to the market. The demand has grown rapidly and is now quite high, resulting in Denmark importing more organic produce than it exports. Some produce, such as certain fruits and vegetables, cannot be produced in Denmark because of the local climate. However, also produce that could be produced in Denmark is often imported. It takes two years to convert farming activities to organic farming, which means that production changes react to changes in demand with a certain delay.

6.2 Insects as sustainable food in Denmark

Figure 10: Edible insects as part of a future sustainable diet



Source: © Danish Technological Institute.

Case Description*

Implementation:	Denmark
Locally implemented:	No
Sustainability theme:	Consumer goods, Ecosystems & Natural Resources, Food systems
Sector of activity:	Food & Beverage, Scientific Research, Development and Innovation
Type of Initiative:	Capacity Building & Implementation, Education & Awareness-Raising, Research, Analysis, Assessment
Lead actor:	Danish Technological Institute
Type of lead actor:	Scientific and Technical
Budget:	EUR 1.5–2 million
Partners:	Syngja
Status:	Started in 2013. Ongoing.
Contact person:	Anne Louise Dannesboe Nielsen, aln@teknologisk.dk

*Note: Case descriptions, e.g. with regards to geographic scope, theme, sector, type of initiative, and type of lead actor, follow the groupings used within UNEP's SCP Clearinghouse.

6.2.1 Introduction

Insects are internationally recognised as a sustainable option for protein-rich food. Private sector interest and start-up companies specialised in insects have emerged lately in the Nordic. In Denmark, the Danish Technological Institute (DTI) has led active product development since 2013. While addressing the theme holistically, DTI's focus

has been on technological development, insect rearing practices, interaction with government offices, and raising consumer and media awareness.

6.2.2 Objectives

The objectives for the Insects as Sustainable Food theme are:

- Technological development of insect-based food products and ingredients
- Development of insect rearing practices
- Interaction with government offices and the value chain
- Raising consumer and media awareness

Individual projects under the theme aim at one or several of these objectives.

Technological development of insect-based food products and ingredients

Insects are a new source of food in Europe. Hence, in order to produce insect-based foods in commercial scale, both new process technologies and optimisation of known technologies are needed. Most companies bringing insect-based foods to the market are start-ups. For them, cooperation with researchers and knowledge institutions is vital. At the moment, certain whole insects are allowed to be used as food in some countries, but legalisation of insect-based ingredients is yet to come. However, to prepare for the future, research into such ingredients is already carried out.

Development of Insect rearing practices

Insects are also a new type of farm animal in Europe, and new rearing practices must be developed and implemented. To gain momentum, new industrial and automated rearing methods, adapted for the Northern climate, need to be developed for insect production. Some start-up insect farmers have previously farmed other animals such as pigs, and they already have facilities, which now need to be changed in order to be suitable for rearing insects. Others are new to farming, and start rearing insects without any previous background in farming.

Interaction with government offices and the value chain

The EU legislation on novel foods, and its interpretation in individual countries, has affected insect-based food business. Thus, acceptability of insects as a food source in EU countries has required extensive interaction from all parties involved, both within the government, and in the value chain.

Raising consumer and media awareness

In order to increase consumer awareness and acceptance of insect-based foods, it has been important to first gain media interest and exposure.

Activities

The theme “Insects as sustainable food” covers 10 ongoing or finished projects.

Technological development of insect-based food products and ingredients

Activities in technological development include optimisation of processes and sensory quality of the products as well as research on possible high value components (e.g. fats and proteins) in insects that may be used as functional food ingredients in the future. For example, the drying process of whole mealworms has been optimised to keep the worms intact, ensure highest possible quality, and provide a good shelf-life of mealworms as dried snacks. Another case is juice-like products where development includes working on stability, taste, appearance, and ingredients of the product.

Development of Insect rearing practices

Both laboratory and pilot-scale facilities for insect rearing have been developed to facilitate optimisation of the rearing process. The parameters tested include rearing conditions such as insect density, temperature, and humidity as well as feed composition and impact of these factors on growth, conversion rates, and composition of the insects.

Interaction with government offices and the value chain

There have been many meetings between DTI’s projects and Danish government offices to spread knowledge and acceptance of insect-based foods and finally to get the products on the market. To speed up the process DTI has also assisted in creating a community that interact, which includes knowledge institutions, universities and government offices. This work has aided legal acceptance of insects as food in Denmark by 2015.

Raising consumer and media awareness

Cooperation with media has produced 300+ articles in press/TV/internet. Visibility in the media is important for the whole theme of insect-based food, as it creates consumer awareness, acceptability, and interest in the products, which in turn supports the companies’ business. DTI has actively launched press releases and worked to get maximum attention for the use of insects as food and feed. It is also important that consumers feel safe with insect products. Hence, all consumer communication must be clear and the products must be correctly labelled indicating their content.

6.2.3 Key Results and Achievements

Success Factors

The DTI projects have successfully used active communication to affect consumer mindset. When the first projects started in 2013, Danish consumers were hesitant towards insect-based foods. The fact that insect-based food products are now on the shelves of Danish supermarkets is a clear success for the companies producing them,

and for the overall theme. In addition, these innovative forerunner companies themselves are internationally a success for Denmark. After all, more sustainable protein choices for consumers should eventually lead to a smaller environmental footprint.

Novelty

The major novelty in the DTI projects is the insects themselves. The whole production system is a new concept in Northern countries, starting from the insects farms. Globally, there is also limited scientific knowledge on industrial scale insect rearing and insect-based food ingredients. DTI has contributed knowledge on how to use insects in food products, processing methods and contributing factors to final product characteristics (e.g. taste, texture). Since 2015, certain whole insects are now classed as food in Denmark, and food products containing whole insects are sold in small specialty stores as well as in larger supermarket chains.

Sustainability Impacts

The main impact of insect-based food on sustainability is reducing the climate impact of protein through substitution – insects instead of beef, pork etc. Insects grow faster and have better conversion rates of feed than many other animal protein sources, and thus have a positive impact on the use of resources. Insects can also feed on certain types of side streams from the food industry, which helps to further reduce climate impacts.

Another main impact has been the guidance of consumers towards understanding that the amount of meat in their diet can be reduced without compromising nutritional value or taste. DTI has promoted this thought at events and seminars, and is monitoring the development through questionnaires. However, there is still some way to go.

Cost-effectiveness

At this early stage it is still difficult to estimate cost-effectiveness aspects, because production is limited. In the future, when economy of scale is achieved, production is expected to become cost-effective.

6.2.4 Next Steps

Production of insect-based foods is currently very work-intensive, and one direction in the development is to bring more automation to the production processes. In addition, many technological questions remain to be answered in order to enable production of different new insect-based products. It is expected that production of food ingredients (e.g. cricket oil, mealworm protein or grasshopper fibre) from insects will be legalised in the future. Utilising insects for production of high value food ingredients is a very interesting possibility that will further increase the value.

Challenges and potential for further development

A major challenge in development of insect-based foods is the EU legislation, which is very cautious in respect to the concept of novel foods, i.e. to foods and ingredients that have not been traditionally consumed in Europe. In the Nordic countries, whole insects

are approved as food in Denmark and Finland at the moment, and the approval of insect ingredients is expected by 2020. It is possible for companies to apply for a novel food status from the EU, which would then allow them to produce new products. However, a major obstacle is that the companies producing insect-based foods are generally very small, and they do not have resources to pursue the demanding and time-consuming process for the products to be classified as novel foods.

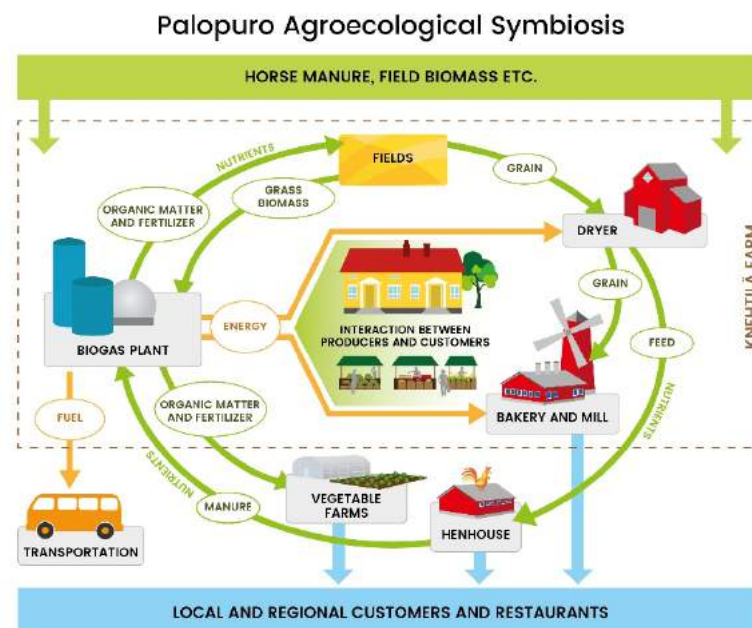
Rearing insects in a considerably colder climate than would be natural to them, can also lead to climate impacts through e.g. heating of the rearing facilities. Quite a lot of work is still needed in order to develop energy efficient insect farms.

Now many products are costly, because the ingredients are produced in small amounts, and hence are expensive. Further development and automation of rearing facilities will speed up the process of making the insects cost-effective.

7. Finland

7.1 Agroecological Symbiosis in Palopuro

Figure 11: Diagram illustrating the symbiosis model and its nutrient, energy and material flows



Source: © University of Helsinki.

Case Description*

Implementation:	Finland
Locally implemented:	Yes
Sustainability theme:	Ecosystems & Natural Resources, Food Systems, Agriculture and fishery
Sector of activity:	Energy, Food & Beverage, Scientific Research, Development and Innovation
Type of Initiative:	Capacity Building & Implementation, Financial Instruments & Investments, Research, Analysis, Assessment
Lead actor:	1) Actual and possible AES members/parties: Knehtilä farm, Mäntymäki henhouse, Lehtokumpu vegetable farm, Samsara bakery, Palopuron Biokaasu Oy (owned by Knehtilä and Lehtokumpu farms, Nivos Oy (energy producer) and Metener Oy (biogas technology producer) 2) Palopuro Agroecological Symbiosis project
Type of lead actors:	1) Business sector, 2) Scientific & Technical
Budget:	EUR 150,000 (AES project 2015–2017)

Partners:	University of Helsinki. LUKE Natural Resources Institute Finland Ministry of Environment's nutrient recycling programme RAKI (funding)
Status:	Started in 2014. Development of the symbiosis is ongoing.
Contact person:	Kari Koppelmäki, vegetable farmer & PhD at University of Helsinki, kari.koppelmaki@helsinki.fi Markus Eerola, Knehtilä farm, markus.eerola@mtk.fi

*Note: Case descriptions, e.g. with regards to geographic scope, theme, sector, type of initiative, and type of lead actor, follow the groupings used within UNEP's SCP Clearinghouse.

7.1.1 Introduction

The agroecological symbiosis (later "AES") in Palopuro (Hyvinkää, Finland) is a model for a multi-enterprise community producing local organic food while recycling nutrients and being a net energy producer. Palopuro is a pioneering model of symbiotic cooperation between different producers (cereal farm, henhouse, vegetable farm), food processing (bakery) and a biogas plant generating both fuel and fertiliser. A farm market and other events build on the communality of the cooperation model.

7.1.2 Objectives

Palopuro AES is a pilot model for sustainable food and energy production, answering the globally accelerating demand for sustainable nutrition and energy. It is a producer and processor community aiming for energy and nutrient self-sufficiency. Each partner of the AES gains benefits they would not achieve alone. It creates and maintains environmentally friendly but economically feasible production, using local solutions to tackle global challenges, in particular population growth and climate change. Closing the biomass and nutrient cycles makes the production sustainable, while organic farming prevents pesticide residues from accumulating. Future goals are to create interest in replicating the AES, and to support continued rural vitality, communal connectivity and social capital.

Conventional farming interrupts natural nutrient cycles, which leads to resource degradation and nutrient depletion of arable land, while causing eutrophication and pollution elsewhere, e.g., in surface waters. AES's represent one solution to restructuring the food system and solving problems that the currently prevailing linear resource flow and globalisation of markets have caused. One central goal is to enhance the nutrient use efficiency of farms without cattle. This integrated food system is based on the concepts of industrial ecology (= energy and material flows resemble natural ecosystem cycles) and industrial symbiosis (= industrial partners are located close to each other and mutually benefit from each other), applied to food production, processing and consumption.

The AES reconnects farmers and customers, integrating food production back into the local community. It enhances transparency of food production, as consumers will

be able to see the whole production chain. The AES also boosts job opportunities in rural areas, in particular linked to energy production and food processing.

Research investigates changes from cultural, social, political, ecological and spatial points of view. The material and energy flows of the AES are quantified: produced, used and sold products, biomasses and energy, plus any flows from outside the AES. Research also covers studying the interests of villagers, customers, visitors, and participants; social acceptance and support from the wider community; issues such as funding, legislation, certification and administration; product demand; business and industry partners with shared interest; distribution channels and many more.

7.1.3 Activities

The centre of the AES is the Knehtilä organic cereal farm, winner of the 2015 WWF Baltic Sea Farmer of the Year Award. Knehtilä farm (385 ha of fields) combined their ideology and business by collaborating with other local organic producers (5500 hen Mäntymäki henhouse, 3 ha Lehtokumpu vegetable farm) and processors (Samsara organic bakery). A biogas company has been created to bring together the abovementioned parties, an energy company (Nivos) and a technology provider (Metener). The AES model was developed during 2015–2017, in a project funded by the Ministry of Environment's nutrient recycling programme (RAKI), led by the University of Helsinki and supported by LUKE Natural Resources Institute Finland, the farms and the bakery.

The AES utilises and recycles local resources. Organic farming uses green manure fallows for fertilisation and soil conditioning. Leguminous plants bind nitrogen from the atmosphere. In stockless farming the biomass is not needed as fodder and is normally worked into the soil. In the AES, the biomass, together with hen and horse manure, is fed into the biogas plant, which will be in use for the growth season 2018. Knehtilä and Lehtokumpu farms can use the digestate as organic fertiliser and soil conditioner. Samsara bakery plans to invest in local facilities, which would use flour from Knehtilä. The henhouse can utilise losses from milling (and in the future from baking) as feed. Biogas will be used to dry and mill grain, run farm machinery and vehicles, and for the bakery's ovens. More than half of the gas is to be sold as fuel for passenger cars. Hence, the AES is more than energy self-sufficient, it is a net producer of renewable energy.

The selected biogas technology is dry anaerobic digestion that runs in batches (3–4 batches a year). Establishing a new biogas company together with Nivos was a financially feasible solution to build a plant. This was a way to access starting capital and multiply the possibilities to sell biogas as car fuel.

Interaction between producers and customers is enhanced via direct sales by all three farms (and Samsara in the future). Additionally, products from other producers and handcrafts are sold at Knehtilä's farm shop and on market days. The market days have become a central part of the village's social life, bringing together producers, the village association, local hunters, artisans and customers. Also Icelandic horses, restaurant Salonkiravintola Neilikka and a hostel enliven the village.

7.1.4 Key Results and Achievements

Success Factors

Over 10,000 visitors visit the farms, market days and other events annually. This is significant in comparison to the 600 inhabitants of Palopuro village, and the visitor numbers are increasing.

Novelty

The Palopuro AES is, worldwide, the first known full application of industrial symbiosis to farming & food production. Neither food processing at farms, nor farm-scale biogas production are new ideas. The novelty of AES is in combining both concepts with several farms, creating a mutually beneficial, locally integrated, agro-food industrial complex that minimises waste and emissions, relies on renewable energy, maintains fertility of the soils and recycles nutrients.

An energy company participating in biogas production from only agricultural biomasses is new in Finland. Decentralised production of biogas car fuel also remains rare. The biogas plant is a pioneer in utilising the selected technology and being based on such a collaboration.

Sustainability Impacts

In green manuring, nutrients may either leach during winter or not be available to next season's crop at right times. The digestate can be used as fertiliser more precisely: in right amounts, at the right time, where needed. This reduces leaching of nutrients and tackles lack of available nitrogen in spring. Fermentation destroys seeds of unwanted plants, helping organic farming to keep weeds away. Biogas production also helps to utilise the not-easily-usable chicken and horse manure. The amount of horse manure fed into the biogas plant is not large, but significant to the stable owner.

Wider cultivation of nitrogen fixing fallows in crop rotation increases soil quality (structure and organic matter), and increases diversity in cultivated species, farmland wildlife (including beneficials such as pollinators), and habitats at landscape level.

Gross energy production of Palopuro AES is ~2,500 MWh/a, of which roughly half will be used locally, and ~1,500 MWh/a can be sold as car fuel (corresponding annually to the consumption of 120 cars, each driving 20,000 km/a). Utilising biogas instead of fossil energy (at Palopuro and as car fuel) replaces 770 t CO₂-equivalent/a of fossil carbon emissions. Net energy production is ~1,300 MWh/a, whereas ~600 MWh/a is bought from outside.

Cost-effectiveness

The AES is profitable to its members. Organic crop farms can significantly increase yields through improved fertilization. The AES boosts job opportunities in rural areas (energy production, food processing).

7.1.5 Next Steps

The AES members continue the development of the AES from concept towards actual implementation. The biogas plant is being built and starts operating in 2018. The AES members are going to found a real estate company to build the facilities for the bakery. There are options to introduce more horticultural production, such as strawberry farming.

Challenges and potential for further development

Further co-development and research is needed. Research on AES continues, with a new project focusing on building AES networks for localised, sustainable food procurement at regional level. Regional ecological potential, social sustainability, regional economy and local biogas use will be assessed. Municipal food services participate as public stakeholders. SME sized food processors' interest and potential to join in the AESs is mapped.

Business models may need further consideration, e.g., a real estate company owning the bakery building makes it easier to change ownership. As a bakery is seen as industry, not agricultural activity, it causes dilemmas when applying for financial support and building permits, among other bureaucracy.

The costs of use and maintenance, the actual output and long-term feasibility of the biogas plant are still unknown. A similar plant at another location could utilise e.g. gardening waste or industrial side streams. The best way to utilise the produced biogas depends on the surroundings and circumstances. If there would be, e.g., an industrial facility with a large need for electricity and warmth, combined heat and power production might be feasible. In this case, utilisation as car fuel could be the most feasible use purpose. As biogas plant investments are not possible for farmers acting alone, a crucial challenge is to get energy companies and similar larger parties to invest. The bakery's logistics costs might need to be shared with other processors in order for the bakery to be profitable. Generally, an active local spirit and engagement is needed for an AES to form and exist.

The digestate of a biogas plant has to be applied to fields in a specific way and has to be covered when stored, which also needs some investments. Ecological impacts (including reduction in GHG emissions and nutrient load to waters, increase in soil carbon storage and biodiversity) deserve further assessment and monitoring.

8. Faeroe Islands

8.1 “Heimablídni – dine in the homes of the Faroese” home hospitality concept

Figure 12: Heimablídni – Dine in the home of the Faroese



Source: © Anna Valeur/visitfaroeislands.com.

Case Description*

Implementation:	Faeroe Islands
Locally implemented:	Yes
Sustainability theme:	Food systems
Sector of activity:	Culture and recreation, Food & Beverage, Tourism
Type of Initiative:	Capacity Building & Implementation
Lead actor:	Local households
Type of lead actor:	Other
Partners:	Local tourist offices, Visit Faroe Islands
Status:	Started in 2010. Ongoing.
Contact person:	Visit Faroe Islands, info@visitfaroeislands.com

*Note: Case descriptions, e.g. with regards to geographic scope, theme, sector, type of initiative, and type of lead actor, follow the groupings used within UNEP’s SCP Clearinghouse.

8.1.1 Introduction

Heimabíldni, or home hospitality, is a concept where local, often traditional, Faroese food is served in a home. Home restaurants offer the opportunity to get to know locally produced food, different from the food usually served in restaurants. One can also learn interesting stories related to that particular part of the country or village. Heimabíldni is one of the reasons why the distinctive Faroese cuisine, including traditional preparation techniques such as fermentation, is having a renaissance and winning a broader audience.

8.1.2 Objectives

Heimabíldni, or home hospitality, aims to make it possible for the local families and farms everywhere on the Faroe Islands to gain some additional income from providing hospitality services to visitors to the Faeroes. The aim is to both offer the possibility to dine in remote areas, where few or no restaurant services exist, and to provide an alternative to restaurants in other areas, for instance near the capital. Another objective of the home hospitality concept is to introduce visitors as well as Faroese to the distinct traditional Faroese cuisine, based on mainly locally sourced produce and prepared using traditional methods, such as “ræst” (fermentation). The aim is also to familiarize the diners with Faroese culture and traditions. This will, at the same time, help to preserve culinary traditions, by transferring knowledge to both visitors and Faroese. Additionally, serving food in a home connects the diners from near and far with their hosts and locals. Integration with local people and traditions leads to an enhanced travel experience.

Faroese cuisine has some distinct elements. Living in an isolated North Atlantic archipelago, the Faroese had to rely on eating what the local environment provided. Resources were used efficiently: every bit of fish caught, every part of animals slaughtered, and every bird caught were used. The Faroese learned to store and preserve as much as possible for tougher times and through the winter months. These preservation methods are still used today, and produce food that has distinct and unique flavors, even without added spices, drawing on the climate and elements from which it is produced and how it has been preserved and stored.

One of the distinctive flavors is a result of what the Faroese call “ræst” or fermentation. This is the process of drying meat and fish outdoors, allowing an aging process to occur. The resulting flavor that is acquired depends on the climate and weather; warmer temperatures will spoil it, too cool a temperature will prevent fermentation and too much wind will result in a lack of flavor. The distinctive taste created by the unique storage and preparation processes together with the philosophy of using what nature provides, creates some unique gastronomic elements which are a part of old Nordic food culture. Heimabíldni serves as an inspiration for modern restaurant food.

8.1.3 Activities

Heimablídni is available on most of the islands in the Faroes. In practice, this means that families open their homes to serve lunch, afternoon tea or dinner to visitors. The arrangements for Heimablídni visits are usually made directly with the family that provides the food. In some cases, the local tourist office can help to arrange the experience. Today, there are between five and ten families providing home hospitality food in the Faroe Islands on a more or less regular basis, some additional families may occasionally open their doors to visitors to provide these services.

The dinner or lunch offered is usually a traditional Faroese cuisine meal, but there are no specific requirements for what can be served. Instead, the host family decides what they serve and when. However, the food is always prepared in the house where it is served. The food may be based on traditional family recipes, either served in the traditional way, or with a modern twist. Whilst the menus vary, the food is often based on ingredients that are locally sourced – or even grown on the farm where it is served.

The food regulations that apply to mainstream restaurants do not apply to these “home restaurants”, and a family may simply establish a Heimablídni in a village or on a tiny island in response to demand. The special guidance for Heimablídni issued in 2012 by the Faroese Food and Veterinary Agency specifies that food served under the Heimablídni concept is not part of the normal regulations of the Food and Veterinary Agency, and states that the food shall be prepared in the home of the host and served in that same home. The purpose is to let the visitor know that the food is prepared in a private kitchen.

8.1.4 Key Results and Achievements

Success Factors

As representatives for Heimablídni home hospitality, Anna and Óli Rubeksen from Velbastaður have received the Nordic Council of Ministers’ Embla award for best food tourism destination for the service in 2017. They have been pioneers of the concept and central for its development.

The families providing these services, such as Óli and Anna Rubeksen, also feel that there is a greater purpose than only providing meals to visitors. Serving dinners in your own home helps to preserve a family heritage that otherwise could easily be lost. It also serves to bring different people together around a meal at the same table, thus bringing people together also in a greater sense.

Novelty

Developing the home hospitality concept formally started in 2010, when the need was identified to provide tourism services in remote areas, where no restaurant services exist. The concept was also applied to other areas where demand and an interest to provide these services existed. The idea was to serve traditional Faroese food to visitors, often based on old family recipes and using in some cases old preparation methods, which had mainly been reserved for local’s and families own consumption.

Whilst local families wanted to open their homes to visitors in order to provide a different type of service, this was not initially possible because of food, veterinary and other regulations that apply to restaurants, the legislation first had to be changed. The route taken was to regulate home dining in a manner similar to the Faroese regulation of direct sales of farm produce and e.g. home slaughtered meat.

Sustainability Impacts

The traditional methods for preparing food in the Faroes have not been part of mainstream restaurant food, and both the tradition and the methods have been slowly disappearing. Heimablíðni is playing a key part in preserving local food culture and presenting it for a broader audience, at the same time enabling locals to make a supplementary income. The concept helps to preserve traditional family recipes and methods of preparation whilst at the same time contributing to new food adaptations that further develop local and Nordic food culture. This serves to foster pride in the local cuisine, now seen as an integral part of Nordic cuisine. Using local produce also can lower CO₂ emissions as transport needs are minimized.

8.1.5 Next Steps

There seems to be a good potential for providing and developing these types of services. Even visitors that usually do not want to spend a lot of money on other types of services, such as hotels, often value highly unique food experiences and are willing to pay more for better quality. Gastronomy is increasingly an integral part of the tourist experience.

Challenges and potential for further development

When the need for home hospitality services was first identified in 2010, there were many rules and regulations that made this type of activity impossible. Representatives from the Ministry of Trade & Industry, The Farmers Association, the Tourism Association, the Outer Islands Association, the Food and Veterinary Agency, the local tourist offices and the Tourist Board, together with local farmers had to work together to find a solution that would allow homes, also outside urban areas and the remoter areas, to become part of the increasing tourism industry. Working together they found solutions that meet the needs of farmers and local families and made providing home hospitality services possible.

9. Iceland

9.1 Auðlindatorgið – Resource square, a web-based marketplace for biodegradable resources

Figure 13: The Resource Square marketplace promotes the efficient use of biodegradable resources



Source: © Environmental Agency of Iceland.

Case Description*

Implementation:	Iceland
Locally implemented:	Yes
Sustainability theme:	Ecosystems & Natural Resources, Agriculture and fishery, Waste
Sector of activity:	Energy, Food & Beverage
Type of Initiative:	Capacity Building & Implementation
Lead actor:	Environmental Agency of Iceland
Type of lead actor:	Government / public sector
Partners:	Ministry for the Environment and Natural Resources. Nordic Council of Ministers
Status:	Started in 2016. Ongoing.
Contact person:	Hildur Hardardottir, advisor at the Environment Agency of Iceland, hildurh@ust.is

*Note: Case descriptions, e.g. with regards to geographic scope, theme, sector, type of initiative, and type of lead actor, follow the groupings used within UNEP's SCP Clearinghouse.

9.1.1 Introduction

The Resource Square (in Icelandic it is called Auðlindatorgið) is a web-based market place for connecting Icelandic industries, companies or individuals in need of certain biodegradable resources and by-products with those who can offer these resources. It was set up by the Environmental Agency of Iceland to address the missing connection between parties generating certain biodegradable waste and by-products and those who can use it. On the marketplace by-products can be advertised and innovators can ask for specific materials they need. The marketplace promotes more sustainable use of natural resources, thereby reducing waste and CO₂ emissions.

9.1.2 Objectives

The objective of the Resource Square is to promote sustainable use of resources by keeping the resources in use for longer in the circular economy. This is done by connecting buyers and sellers of biodegradable resources, and by doing so, reducing the amount of biodegradable resources and sidestreams being wasted and going to landfills. Biodegradable resources that today end up in a landfill can become higher value products, when appropriated by someone that uses the material as raw material for their products, thus creating value, reducing costs for landfills and also reducing CO₂ emissions.

9.1.3 Activities

When the sources and uses of wasted by-products in Iceland were researched, the results showed that about a third of the biodegradable waste was still being sent to landfill. Thus, the web-based marketplace for biodegradable waste and by-products was developed by the Environment Agency of Iceland in 2016 in order to create a connection between the industries and actors generating biodegradable waste and those who can utilise it.

In the web-based marketplace anyone, both industries and private citizens, can advertise their by-products and innovators can ask for specific materials they need. Each advertisement must provide contact details, so that the person interested can get in contact with the buyer or seller. This means that no communication is actually happening on the site, only the contact details are provided. This way the marketplace creates the missing link between industries and potential users, while also promoting increased utilisation of natural resources and reducing waste going to a landfill.

The site is divided into five categories, which are: manure and sludge, fisheries, slaughterhouses, agriculture and forestry, and kitchens and cafeterias. There is also a possibility to search for by-products in specific geographic areas, in case transports and logistics costs are a restriction.

The transaction between the seller and buyer is bilateral and the Resource Square is not involved in the transaction other than being the matchmaker that connects the buyer and seller. The legal agreements and payments take place between the buyer and seller.

Although the website is fully functional at this stage, the marketing of the marketplace has not yet started other than at conferences and by informing key stakeholders such as slaughterhouses or relevant industries and organisations by direct contact. An active marketing campaign is planned to start at the end of 2017 or beginning of 2018.

9.1.4 Key Results and Achievements

Success Factors

Studies indicate that biodegradable waste in Iceland is an underutilized resource and approximately a third of all biodegradable waste generated annually is either landfilled or incinerated. Currently, more than half of all landfilled waste is of a biodegradable nature. Studies show that 8% of carbon emissions in Iceland come from waste treatment, which mainly consists of landfill waste.

There are many opportunities to increase the utilisation of this resource, and thereby reduce waste generation and promote a more sustainable economy.

Novelty

A main challenge associated with increasing the reuse of biodegradable resources is the difficulty in obtaining the resource. To connect providers and potential users it is vital to provide information on where, when, and by whom the biodegradable waste is disposed of or made available. The Resource Square creates this vital connection. Industries can advertise their by-products and innovators can call for specific material on the marketplace. This type of service has previously not existed in Iceland.

Sustainability Impacts

Increased utilisation of resources has both economic and environmental benefits as it reduces the generation of waste, creates value, and promotes a more sustainable and circular economy. A side product in one sector can be the main ingredient in another. In a world with limited resources, it is important to maximise the utilisation, which also at the same time reduces greenhouse gas emissions. The Resource Square plays a part in this.

Iceland has a lot of innovation going on in the business sector. Therefore, there is a large potential to use the current biowaste more efficiently and to produce higher value products. Some examples of how this is already done in Iceland:

- Donating or distributing food leftovers from restaurants, food stores and big kitchens at a reduced price.
- Producing health supplements from shrimp or other crustacean shells.
- Producing health supplements from sheep hearts and liver.
- Producing food supplement from fish protein, for healthy weight and joints, and increased endurance and energy.
- Using intact fish skin for human tissue transplants.

- Using coffee grounds to produce cosmetics.
- Using sludge for soil improvement in heavily eroded areas in Iceland.

Cost-effectiveness

Resource efficiency leads to savings in the form of less waste and as a result lower waste handling costs, as well as additional revenue for by-products that would otherwise have to be disposed of.

9.1.5 Next Steps

The immediate future of the marketplace includes increasing the number of users by running a marketing campaign aimed at potential users. The planned marketing campaign is intended to get user traffic onto the web-marketplace so it becomes more active.

Other plans include expanding the marketplace to include non-biodegradable waste such as plastics and metals. Furthermore, there is an interest to explore the possibility of adding a “sharing economy” function that creates connections between individuals who are willing to borrow or rent assets owned by someone else, such as tools and sports equipment.

The Environment Agency of Iceland is currently looking for a party that would be interested in running the service, which has so far been an agency project within a limited time frame.

Challenges and potential for further development

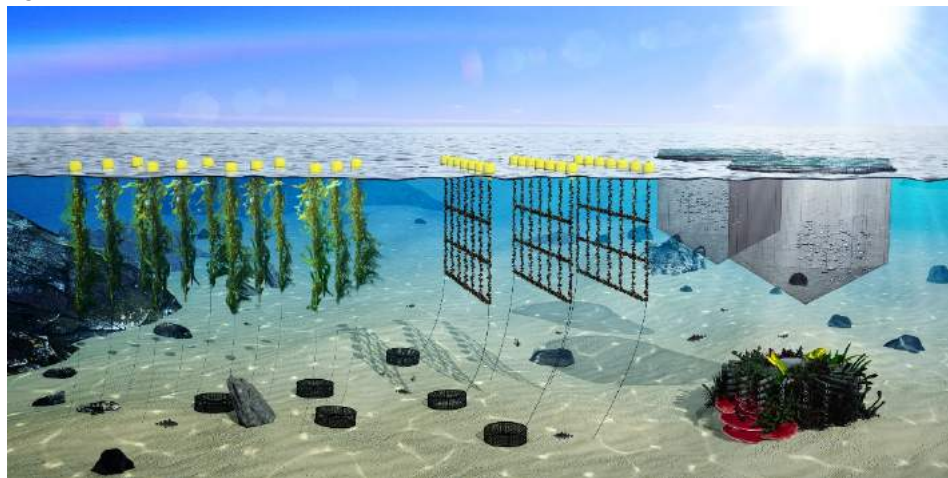
It is possible that Iceland is such a small market area that the buyers and sellers in Iceland can find each other relatively easily even without the web-marketplace. A bigger market area or country could perhaps better profit from this type of web marketplace and there is thus interest to expand the platform to other geographic areas.

Marketing the service is a key element of the operations, i.e. targeting the right user groups. Until now, marketing efforts have consisted of conferences and directly contacting some key stakeholders. The planned marketing campaign will answer to this challenge.

10. Norway

10.1 Ocean Forest

Figure 14: An illustration of Ocean Forest's aquaculture concept



Source: © Ocean Forest.

Case Description*

Implementation:	Norway
Locally implemented:	Yes
Sustainability theme:	Climate Change, Ecosystems & Natural Resources, Agriculture and fishery
Sector of activity:	Food & Beverage, Scientific Research, Development and Innovation, Industrial Sector
Type of Initiative:	Research, Analysis, Assessment
Lead actors:	1) Lerøy Seafood Group 2) Bellona Foundation (50/50 ownership)
Type of lead actor:	1) Business sector 2) Civil society
Status:	Started in 2014. Ongoing.
Contact person:	Harald Sveier, manager of Ocean Forest, harald.sveier@leroy.no

*Note: Case descriptions, e.g. with regards to geographic scope, theme, sector, type of initiative, and type of lead actor, follow the groupings used within UNEP's SCP Clearinghouse.

10.1.1 Introduction

Lerøy Seafood Group and the Bellona Foundation have started Ocean Forest, a collaborative company to develop more sustainable seafood production and to reduce the environmental footprint of aquaculture. Ocean Forest combines research and development, innovation and implementation of new forms of biomass production in the sea. The goal is to develop products for food, feed, energy and raw materials for industry and agriculture. Ocean Forest cooperates with research and technology communities.

10.1.2 Objectives

The driver behind Ocean Forest is the current deteriorating state of environment, linked to climate change, ocean acidification, population growth, food and water scarcity, constantly rising standards of living and energy demand. There is need to transform food production from resource depleting farming to methods sustainably utilising natural processes and cycles. The motto: to recycle what the earth has plenty of, in order to produce what it needs more of.

Ocean Forest has three principal objectives: to reduce the environmental footprint of fish farming, to establish self-sufficient aquaculture that produces animal and human nutrition products, and to study which new species would be suitable for the aquaculture industry.

Algae and shellfish farming only utilises nutrients that are either already present in the ocean or are emissions from human activities, such as agriculture, cities or fish farming. Seaweeds (i.e. macroalgae) and mussels are cultivated along conventional fish farming, thus utilising nutrient emissions from fish production and lowering the impact of fish farms. Oceans absorb more than 20 million tons of CO₂ each day, leading to acidification. CO₂ is bound to algae and shellfish (via growth of their calcium carbonate shell). Ocean Forest aims to develop aquaculture facilities that via large-scale algae and shellfish farming remove more CO₂ than the production of biomass at the facility generates.

The vision is to innovate, research, develop and implement new forms of more sustainable seafood production. Ocean Forest aims to be world-leading in research on integrated solutions and synergies between biology and technology. The target is to establish sustainable large-scale production of biomass by aquaculture along the Norwegian coast. The end products will be food, feed, and raw materials for, e.g., dietary supplements, medicine, fertilisers and biofuels. The company aims for both a smaller environmental footprint from production as well as higher output and lower costs of biomass production at sea. Production should be feasible at industrial scale and profitable.

Other goals are to study CO₂ and nutrient removal, how cultivation affects biodiversity, as well as synergies between the cultivated species and wild populations. Possible negative effects from integrated aquaculture are also assessed. As wild seaweed populations are essential to biodiversity, harvesting them could lead to biodiversity depletion. Aquaculture is thus a better option.

10.1.3 Activities

Ocean Forest needed to create a functioning R&D system for sustainable, integrated multitrophic aquaculture. The R&D process is continuously developing research results and experiences into new business concepts for commercial aquaculture, which utilises new solutions for biomass production on a large scale. Ocean Forest was established in 2014 in Bergen. The first mussels and seaweed plantation was launched in September 2014 at the first farm in Sotra, off the Hordaland coast.

Ocean Forest addresses the environmental challenges of aquaculture, helps to remove CO₂ from the ocean – and indirectly from the atmosphere – and creates economic value. It integrates a range of technological solutions, ecological cycles and natural interactions between species. Only native species are used so that no invasive species problems arise.

Research is also done in cooperation with third parties. The Institute of Marine Research in Norway is looking into the environmental impacts of seaweed production. So far no negative impacts have been detected, but research is still ongoing. There are indications that seaweed farming can help to preserve marine biodiversity. Norwegian kelp forests provide shelter for approximately 3 million tons of fish fry (young fish). Among the beneficiaries are cleaner fish that naturally eat salmon lice. Large-scale cultivated macroalgae can thus provide shelter and support wild fish populations, while indirectly alleviating salmon lice problems.

Sugar kelp (*Saccharina latissima*) is the first seaweed grown by Ocean Forest. It is used as a taste enhancer and flavouring. It could also be used like lettuce, but it has a very distinct taste. Seaweed is developed mainly into products for human nutrition. As a standalone case it is not profitable to use seaweed as biofuel. However, after extraction of wanted components, the rest of seaweed biomass can be used for biogas production.

With the assistance of Pelagia Karmsund Fiskemel, Ocean Forest produces mussel meal, primarily from the soft mussel parts. Fish feed pellets, where a share of fishmeal is replaced by mussel meal, have been produced by the company EWOS. As especially blue mussels gather naturally occurring algal toxins, Ocean Forest collaborates with the National Institute of Nutrition and Seafood Research (NIFES) in studying whether these algal toxins could have a negative impact on cultivated fish or fish consumers, when fish is fed with mussel meal.

10.1.4 Key Results and Achievements

As the R&D is still ongoing, most of the results are preliminary or estimations of expected impacts.

Success Factors

Reliable methods to cultivate and utilise seaweed have already been found. A commercial seaweed facility is going to start operating in autumn 2018 – one year prior to the original target.

Tests with fish feed containing mussel meal have measured fish appetite, growth and survival. Results are promising: mussel meal has a high protein content and is suitable for replacing some of the fishmeal currently being used in fish feed. No negative reactions to algal toxins have been detected. Thus, the use of fish meal, which is often produced from wild fish, can be reduced in feed.

The amount of CO₂ and nutrients removed will be another key success indicator.

Novelty

Industrial seaweed cultivation in Europe is in the very early developmental phase and utilises only a few species. In Norway, brown kelp species like *Laminaria hyperborea*, Norwegian kelp (*Ascophyllum nodosum*) and in particular sugar kelp are already being harvested. In spring 2017 Ocean Forest harvested 40 000 kg of sugar kelp. Making use of the findings, Lerøy Seafood Group is pioneering new approaches and process to reduce their food's footprint. It has launched new products, including four different seasonings based on seaweed and dried seaweed for chefs who wish to make their own seasonings. Seaweed-seasoned salmon has also been brought to the market.

Sustainability Impacts

The main impact is the lower environmental footprint of aquaculture. Research has shown that kelp can remove 30–100% of dissolved nitrogen produced by fish farming. Ocean Forest has done chemical analyses showing that each wet ton of sugar kelp binds 2.4 kg nitrogen, 340 g phosphorus, and 26 kg of carbon, equalling 100 kg CO₂. No other crop binds this much CO₂. There is no data yet available on mussels.

As algae and mussels are not fed but grown on resources already in the seawater, farming them does not use any additional chemicals (biocides or antibiotics).

Traditional agriculture is often linked to water scarcity, nutrient leaching, soil erosion, and land use disputes. Crop-based biofuels compete with food production. Seaweed and shellfish farming is a sustainable alternative: space-efficient, not requiring fresh water, removing excess nutrients from waters, and not competing for land area.

Cost-effectiveness

Calculations are hard to upscale, but the costs are largest for seaweed processing and storing.

10.1.5 Next Steps

A commercial seaweed facility will start operating in autumn 2018. In the next years, Ocean Forest will focus on establishing stable and predictable industrial production of seaweed. The production volume will be increased significantly, and the sales and marketing focus will be increased.

Challenges and potential for further development

Seaweed has to be processed rapidly after harvesting – in less than 24 h. This means that distances from farming facilities to processing plants have to be short and the supply chain has to be effective. Product development and market research are also still needed, in order to understand the type of seaweed products people are actually interested in buying.

The chemical composition of seaweed varies with the season. For example, the amounts of nitrogen bound to the protein part of the algae depends on the time of year. Today, harvesting is done based on maximum biomass, but in the future, some seaweed farms may want to extract certain compounds from the seaweed, in which case the harvesting has to be researched, and timed specifically based on those compounds.

Growing blue mussels is straightforward, but separating the soft and hard parts and processing the mussel meat into dry powder requires further development. Ocean Forest is researching different solutions to the challenge.

Suitable water currents and clean water are required – the Norwegian fish farming industry has the necessary know-how for facility siting. Biomass production in the oceans has to be developed so that it does not cause similar problems as agriculture, e.g. biodiversity loss, social injustice, or arguments about water area ownership. It also has to be taken into account that harvesting has local impacts on, e.g., nutrient competition with phytoplankton and other species of the ecosystem.

The main challenges to profitable usage of seaweed as biofuel are commercial and political: high costs of cultivation, preserving and refining the seaweed; inadequate demand; bioenergy policies with unclear sustainability criteria and unmoving industry actors.

10.2 Norilia AS – Sustainable food value chain in the meat industry

Figure 15: Resource efficient production by Norilia



Source: © Øivind Haug.

Case Description*

Implementation:	Norway
Locally implemented:	Yes
Sustainability theme:	Consumer goods, Ecosystems & Natural Resources, Food Systems
Sector of activity:	Food & Beverage, Scientific Research, Development and Innovation, Industrial Sector
Type of Initiative:	Capacity Building & Implementation
Lead actor:	Norilia AS
Type of lead actor:	Business sector
Partners:	Norilia has partnered up with stakeholders in the scientific community. Partners include universities and research institutes as well as start-up companies with the high-end technological know-how needed in the development of the production processes. A key partner is Felleskjøpet Agri, a cooperative owned by Norwegian farmers that e.g. produces feed for livestock and pet food.
Status:	Started in 2007. Ongoing.
Contact person:	Heidi Alvestrand, Development manager, heidi.alvestrand@norilia.no

*Note: Case descriptions, e.g. with regards to geographic scope, theme, sector, type of initiative, and type of lead actor, follow the groupings used within UNEP's SCP Clearinghouse.

10.2.1 Introduction

Norilia creates growth and profitability through sustainable utilization of side streams from the meat industry. The aim is to use all the parts of slaughtered animals in the most high-value and sustainable way, preferably for human consumption. Norilia is responsible for production and sales of products such as hides, casings and animal feed, but also for high-end products based on technological innovations, e.g. proteins and amino acids produced through enzymatic hydrolysis or new innovative products produced from eggshells.

10.2.2 Objectives

Norilia aims to create growth and profitability through sustainable utilisation of side streams from the meat industry. When animals are slaughtered, depending on the animal, up to half of the weight of the animal is not sold either to the consumer market or to meat processors. The obvious, traditional uses of side streams of the meat industry include, e.g. using the hides, producing casings for sausages and animal feed or pet food. Norilia company tries to ensure the greatest possible value creation for the side streams. Norilia aims to be a contributor to a green transition through improved utilisation of resources. It leads, or is a partner in, several research and innovation projects.

The company is also responsible for sales of new ingredients based on the processing of so called Plus Products. Plus Products are all the products from the animal that are not sold to the Norwegian consumer market or industrial markets as meat or processed meat. The aim is to produce higher value products from meat by-products, preferably using the processed by-products for human consumption instead of the current situation, where a large part of Plus Products are used for animal feed, fertilizer or energy. Norilia is currently working on several projects linked to the development of protein, fats and minerals.

10.2.3 Activities

Norilia is a company with about 45 employees and a turnover of approximately NOK 500 million, of which 70% comes from export. Norilia aims to create growth and profitability through sustainable utilization of renewable biological resources from the meat industry. It heads up several research and innovation projects and is responsible for sales of new ingredients based on the processing of Plus Products. Most of the raw materials come from its owner company, Nortura AS, the biggest meat producer and slaughterhouse owner in Norway, but also from other slaughterhouses in Norway and Sweden.

Norilia has the following operations and activities:

- Hides & Skins Department – sales of hides and skins
- Casings Domestic Market – import of casings for the Norwegian meat industry
- Norwegian Casings Export – export sales of casings
- Wool Department – sales of Norwegian wool
- Nutri – sales of meat by-products (entrails and bones) for animal food and selected products for human consumption
- Department for business-development: Run research and innovation-projects to add value to the plusproducts and to develop new business
- Development and coordination of the associated companies in international trade of by-products, and development and coordination of activities to increase value-added on by-products.

Nortura, the owner company, has identified Plus Products as one of three strategic areas for investment in growth. Norilia has increased its investment in business development in recent years, and is also working closely with researchers and other industry players. In 2016, a decision was made to build a new processing plant for enzymatic hydrolysis of cut bones from poultry. The plant is being built adjacent to Nortura Hærland, Norway's largest poultry slaughterhouse and processing plant, and will be completed in 2018. The plant will contribute to increased value creation and resource utilization and will also form the basis for the development of new business areas. Norilia will also produce hydrolysates (proteins), fat and sediment (solids). Hydrolysates from the factory are short peptides with great bioavailability and taste that can be used in different applications for human use.

A new production facility for the separation of shell (calcium) and membrane from eggshells has also been built at Nortura Revetal in 2017. The plant is based on newly developed technology. Work is currently ongoing to develop new and innovative products from calcium and membrane, such as the use of membrane in wound treatment and calcium in supplements and human food.

10.2.4 Key Results and Achievements

Success Factors

The success of the enzymatic hydrolysis activities is highly dependent on developing a process that produces a stable, high-quality product, and on the ability to find a market for the product. To achieve this, a high level of cooperation with different stakeholders, especially in the research and start-up community, has been necessary. Some of the technologies being developed have previously been used in the fish industry. Hence creating a functioning process for other raw materials requires cutting edge knowledge of process parameters and enzymes.

A key success factor has been the availability of funding from Nortura and from Innovation Norway, which has provided 15% of the financing. Nortura is a cooperative

owned by the farmers and therefore has strong relations and control of the whole value chain.

Norilia is, through its owner, involved in the whole value chain, from procurement of raw materials to sales. This makes it possible to better control the quality of the raw materials as well as to seek a market for the end products, while staying attuned to customer requirements and needs.

Novelty

Norilia focuses on finding the highest value products from co-streams from slaughtering beef, pork, sheep, chicken and turkey. This is done by using innovative new processes, such as producing high quality proteins and amino acids by complex enzymatic hydrolysis, or by producing high added value products from egg shells. One project was nominated for the Norwegian agricultural cooperative 2016 innovation prize.

Sustainability Impacts

Animal protein is valuable and in the future, there will be protein deficiency that needs to be addressed globally.

Sustainability is using resources efficiently, a key aim for Plus Products. The ambition is that nothing should go to waste, but used as efficiently as possible, preferably for human consumption. This requires processing. Therefore, one of Nortura's focus areas has lately been to develop a process where proteins and amino acids are extracted from chicken bones by enzymatic hydrolysis, and at a later stage also from other animal products, leading to more sustainable use of the animal.

Cost-effectiveness

Resource efficiency leads to savings in the form of lower waste handling costs. Additional revenue is created from products that have a much higher economic value than traditional uses such as animal feed, energy or fertiliser.

10.2.5 Next Steps

The company sees great potential for growth and development of new business areas based on the processing of Plus Products from the meat industry.

Challenges and potential for further development

Developing a completely new process, such as the enzymatic hydrolysis for protein production, involves extensive development work and also involves some risks. One challenge is to ensure that the production processes work as they should technically. Another challenge is to find a new market for the new products, as the products are new and innovative. Further marketing and sales efforts are needed to ensure that the products find the right customers and target groups. Possibilities are seen in, e.g., protein supplements for the sports industry or for the elderly who may have protein deficiency.

Sammanfattning

De globala målen och Agenda 2030 syftar till att utrota fattigdom och hunger, förverkliga de mänskliga rättigheterna för alla, uppnå jämställdhet och egenmakt för alla kvinnor och flickor samt säkerställa ett varaktigt skydd för planeten och dess naturresurser. Uppnåendet av målen förutsätter en omfattande transformation av hur vi producerar och konsumerar varor, tjänster samt naturresurser i våra samhällen – i Norden såväl som globalt.

Även om de nordiska länderna har arbetet aktivt i både nationella och internationella fora för att befrämja mer hållbar konsumtion och produktion (SCP), överskrider vårt ekologiska fotavtryck i Norden betydligt jordens förmåga att förnya naturresurserna. Genom att presentera praktiska och innovativa SCP exempel, vill Nordiska ministerrådet hjälpa accelerera transformationen i de nordiska länderna samt inspirera aktörer internationellt att befrämja SCP.

Den här rapporten är den tredje i en TemaNord serie som presenterar ett antal nordiska initiativ och projekt för att konkret och aktivt befrämja hållbar konsumtion och produktion. Tillsammans beskriver dessa tre rapporter med över 50 exempel,⁴ hur kommuner, städer, företag, skolor, forskare, ideella organisationer och vanliga medborgare konkret och framgångsrikt kan bli del av transformationen. Exempelen är direkt förknippade med ramprogrammet för hållbar produktion och konsumtion under FN:s miljöprogram UNEP (UNEP's 10-Year Framework Programme).⁵ De omfattar Hållbar turism, Hållbar konsumentinformation, Hållbara livsstilar & utbildning, Hållbara offentliga upphandlingar samt Hållbara livsmedelssystem och Hållbara byggnader & byggande.

Initiativen som presenteras i den tredje rapporten omhandlar två tema: Hållbara livsmedelssystem och Hållbara byggnader & byggande. Initiativen identifierades tillsammans med Nordiska ministerrådets arbetsgrupp för hållbar konsumtion och produktion. Initiativen som presenteras valdes från ett brett utbud av nordiska projekt och har som mål att sprida lärdomar om effektiva, framgångsrika och hållbara sätt att befrämja SCP. Initiativen är sammanställda och presenterade på ett sätt som underlättar en jämförelse av centrala resultat och succékriterier och som kan hjälpa att sprida och kopiera goda SCP lösningar. Beskrivningarna bygger på befintligt material som gjorts tillgängligt för konsulten, inklusive dokumentation samt intervjuer med representanter för de respektive initiativen.

De åtta initiativen inom temat Hållbara byggnader & byggande omfattar inspirerande exempel bland annat på byggnadslösningar med minskat ekologiskt

⁴See also <http://norden.diva-portal.org/smash/record.jsf?pid=diva2%3A905930&dswid=1786> and <http://norden.diva-portal.org/smash/record.jsf?pid=diva2%3A1044854&dswid=-5478>

⁵ UNEP 10YFP: <http://www.unep.org/10yfp>

fotavtryck (förknippat med byggnadsprocesser, val av byggmaterial samt byggnadens livscykel), planeringsprocesser och markanvändning som i högre grad beaktar ekosystemtjänster och framtidens behov av ökad klimatesiliens i byggd miljö.

Temat Hållbara livsmedelssystem omfattar sju initiativ med fokus på ökad hållbarhet och resurseffektivitet i produktion och konsumtion av livsmedel. Exempelen beskriver bland annat innovativa sätt att utnyttja sidoströmmar och insekter i livsmedelsproduktion samt initiativ för att främja organiskt jordbruk och autentiska restaurangtjänster i hemmen.

I linje med det övergripande målet att påskynda transformationen och inspirera nordiska och internationella aktörer, har initiativen även publicerats i den s.k. SCP Clearinghouse⁶ webbportalen, som fungerar som informationsplattform för UNEP:s 10 åriga ramprogram för hållbar produktion och konsumtion. SCP Clearinghouse är ett webbaserat verktyg för informationsutbyte som kan användas som inspiration för olika sätt att befrämja mer hållbar konsumtion och produktion av olika aktörer och överallt i världen. På SCP Clearinghouse finner man också ytterligare material och länkar till mer detaljerad information om initiativen som presenteras i de tre rapporterna.

⁶ <http://www.scpclearinghouse.org/>

Appendix: Categories in UNEP's SCP Clearinghouse⁷

Sustainability Themes

- Climate Change
- Consumer goods
- Ecosystems & Natural Resources
- Food Systems
- Human Rights
- Agriculture & fishery
- Education
- Poverty eradication
- Waste

Sectors of Activity

- Agriculture & Fishery
- Buildings & Construction
- Consumer Goods
- Culture & Recreation
- Education
- Forestry
- Housing
- Waste, incl. Chemicals
- Energy
- Financial Sector
- Food & Beverage
- Scientific Research, Development And Innovation
- Mass Media
- Public Procurement

⁷ <http://www.scpclearinghouse.org/>

- Industrial Sector
- Tourism
- Transport

Types of Initiative

- Capacity Building & Implementation
- Education & Awareness Raising
- Financial Instruments & Investments
- Policy Frameworks & Tools
- Research, Analysis, Assessment



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NORDIC BEST PRACTICES

The working group on Sustainable Consumption and Production, under the Nordic Council of Ministers requested consultants from Gaia to identify and write out best Nordic practice cases of sustainable consumption and production to be shared internationally within the UNEP SCP Clearinghouse. This report is the third part of three reports and covers 15 examples of two particular themes on:

- 1) Sustainable Buildings and Constructions
- 2) Sustainable Food Systems

The cases have also been added into the UNEP's 10 Year Framework Program (10YFP) information platform, the SCP Clearinghouse. The objective is to enhance international cooperation in order to accelerate a shift towards sustainable consumption and production in developed and developing countries. The SCP Clearinghouse is a web-based information sharing tool, which can be used as an inspiration for advancing SCP worldwide.



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