Research projects 2008–2017

Environmental Technology Research Funded by Swedish Research Council Formas

Examples from a project catalogue

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Examples from a project catalogue

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Environmental technology projects are well represented in the research that Formas supports. Examples of these projects can be studies to develop new smart windows, new efficient energy technologies and improved systems for recycling, as well as governing policies for environmental technologies.

Environmental technology and cleantech innovations have had, and will come to have, an increasingly important global role in reducing environmental burdens and contributing to sustainable development. Sweden therefore needs a strong and internationally competitive environmental technology sector.

Formas defines environmental technology in broad terms: *"Environmental technology includes such products, systems, processes and services that provide distinct environmental advantages in relation to existing or alternative solutions when viewed from a lifecycle perspective."*

Research and development plays an important role. Trees and other plants, as well as their waste products, must be utilised more efficiently than they are today, for example in biorefineries – for the development of green materials and bioenergy. New technologies and new systems are needed for purifying water and sewage, decontaminating land, managing waste and recycling. There is an obvious potential for more efficient energy use within the built environment and agricultural sciences. New environmental technology initiatives are often characterised by a holistic approach, with a focus on system innovations and system solutions with major environmental relevance. The highest priority is placed on lifecycle considerations.

To apply a holistic approach also necessitates social science research, for example concerning needs, governance and regulatory policies.

This brochure is an extract from a catalogue which presents a selection of 160 environmental technology projects within the different research and responsibility areas of Formas. The entire catalogue can be found at www.formas.se/catalogue.

We hope that the projects can provide inspiration for new research, new systems, methods, policies, products and processes.

We also hope that the projects will encourage the formation of new contacts and networks.

We wish you an enjoyable read!

Conny Rolén
Senior Research Officer

Ingrid Petersson
Director General

External view

In 2015 two very important steps were taken towards transitioning to a sustainable society. The Paris Agreement highlighted how we can reduce climate emissions globally and concomitantly reduce the global rise in temperature to 1.5 to 2 degrees Celsius. In addition the UN 2030 Agenda for Sustainable Development was adopted, which highlights seventeen areas where ambitious goals must be fulfilled if we are to achieve a sustainable society.

The failings of linear economy models have become increasingly obvious and last year the EU adopted a circular economy model as its guiding principle. This means that we must utilise raw materials in a more efficient manner, use more renewable raw materials, design products that are more durable and can be recycled, build cities in a more sustainable way, process waste as part of a circulation cycle, transport people and goods using renewable energy and, most difficult of all, we must change our consumer habits.

Sweden aims to be part of the vanguard in all of these areas and this has led to the establishment and growth of companies that can deliver solutions to these challenges for an international market.

When I now look at the diversity of environmental technology projects that have been funded by Formas over the past decade I am struck by how many of these projects can contribute to solving the challenges described above and that also are aligned with the Swedish goverments areas for collaboration programs introduced in the spring of 2016. It should be emphasised, however, that I do not have the possibility to judge all of the effects many of the projects have had and will have, as some of these are still ongoing.

Examples of important areas included in the environmental technology projects funded by Formas are recycling and recovery of biological resources. In linear production strategies the products and the waste from production have previously been treated as waste. But to reach the long term goals we must find sustainable solutions for the recovery of plastics, textiles, solar cells, mining residues, sludge, batteries, used cars etc. The Formas projects provide good advice about what some of the solutions could be, but the projects also provide information about which solutions are not likely to work well.

A major challenge in fulfilling our climate commitments is the replacement of fossil raw materials as the source materials for product and fuel production. All forest source materials are not currently utilized to their full potential. The projects funded by Formas demonstrate a great wealth of inventiveness to enable better use of wood as a source material.

Östen Ekengren
Executive Vice president
IVL Swedish Environmental Research Institute

Contents

Introduction

Just over half of the funding awarded by Formas is allocated to support projects in the annual open call within the three responsibility areas of Formas; Environment, Agricultural Sciences and Building and Planning. The remaining research funding is allocated to targeted initiatives, which are calls announced within defined topic areas for which there is an urgent need for research and knowledge. Environmental technology projects exist within all of the responsibility areas of Formas.

Environmental technology in different Formas programmes and collaborations

In 2007 Formas and Vinnova, Sweden´s Innovation Agency, were commissioned by the Swedish Government to jointly develop a research strategy for the environmental technology area. Based on this research strategy Formas then introduced an Environmental Technology Program for the period 2007–2012. This program comprised four calls in collaboration with Vinnova and the Swedish Energy Agency, all with co-financing from the commercial sector. In total this program comprised around SEK 210 million, with half of the funding awarded co-financed by the commercial sector.

Over the period 2010–2014 Formas also participated in an ERA-Net (EU collaboration) for environmental technologies and environmental innovations, EcoInnovera. In this collaboration 25 organisations, research funding bodies and research administrators from 20 EU countries participated. Formas participated in the two calls launched by EcoInnovera.

Another program with a major environmental technology content was the program that was run in collaboration with the Swedish construction industry's innovations centre, BIC (a forerunner to the Swedish Centre for Innovation and Quality in the Built Environment, IQ Samhällsbyggnad). Formas and BIC jointly announced a large number of both national and international calls.

A number of the strong research environments that have received funding from Formas in recent years have also had an environmental technology focus.

This brochure is an extract from a catalogue which presents summaries of 160 projects that have received funding within Formas various programs and collaborations and in the Formas open call. The entire catalogue can be found at www.formas.se/catalogue. The project examples together reprecent all the six sections in the catalogue: Natural Resources in the Circulation Cycle, Biological Resources, Energy, New and Advanced Materials, Sustainable Building and Planning– Technologies and Processes, and Environmental Protection Technologies.

Formas also collaborates within the environmental technology area by having the task of providing state funding for research in collaboration with other various research organisations. Such financing for example is allocated to IVL, the Swedish Environmental Research Institute and the Swedish Institute of Agricultural and Environmental Engineering, JTI.

Natural Resources in the Circulation Cycle

Examine the recycling of materials – plastics, metals, rare earth elements, cotton, sewage, agricultural waste and other organic waste.

Project title
Laser induced breakdown spectroscopy in combination with automatic image analysis as a tool for fast sorting of mixed metallic flows

Project number
2011-549

Project duration
2011–2017

Funding awarded
SEK 4 720 000

Project leader
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Field trial of the instrument (the green box) that has been developed in the project.
Photograph: Jonas Gurell

Rapid sorting of mixed waste streams

Annually 1,500 million tonnes of steel are produced for infrastructure, consumer goods and other products. This annual production equates to five times the weight of the global human population, and is expected to almost double by 2050. Recycling of steel waste is important. The lifetime of a steel product is 25–30 years. This means that the 1,500 million tonnes of steel we produce in 2015 will be scrap by 2040. This material must be managed and the industries and societies that best succeed in doing this will gain great environmental and financial benefits.

This project develops techniques for the chemical analysis of recyclable steel scrap with the aim of making this a more attractive raw material. Rapid analysis will allow the waste material to be used as a source material, which will reduce the demand for virgin source material. A prototype has been developed based on laser technology. By illuminating the scrap with a laser pulse the chemical content can be determined within a fraction of a second at a distance of one metre. By positioning the instrument above a conveyor belt the composition of the scrap can be analysed and information can therefore be provided that increases the value of the material. The prototype has been evaluated by both the recycling and steel industries. Work is currently ongoing to achieve permanent industrial implementation. This work is being carried out by Swerea KIMAB in collaboration with Stena Recycling and Outokumpu Stainless. The project has also led to a collaboration with Acreo Swedish ICT in Sweden, Fraunhofer Institute for Laser Technology in Germany and Centro Sviluppo Materiali in Italy.

Recycling cotton fabric

The major environmental impact that our clothes and textiles represent has gained increased attention. The combination of the amount of clothing that is thrown away each year and the environmental problems associated with textile production constitute an enormous waste of resources. At the same time the population is increasing and also the use of new textiles. This project focusses on the electrochemical oxidation of cellulose in used cotton fibres in order to increase their reactivity and facilitate the use of recycling or further production of new material.

Preliminary results have demonstrated successful oxidation with the method, which is interesting as it is driven by electrical energy instead of the addition of chemicals. Through oxidation the cotton fibres gain improved fibrillation and cross-binding properties, as well as increased solubility. These are valuable properties for the recycling system and can give longer lifecycles. The project will also examine whether ionic solutions can function as electrolytes for the electrochemical oxidation of cellulose. Ionic solutions do not only have electrolytic properties but may also solubilize cellulose. These two properties mean that it should be possible to oxidise cellulose homogeneously, which can give both more efficient chemistry and newly regenerated material from used cotton.

Project title
Increased reactivity and applications for recycled cotton textiles by electrochemical oxidation techniques

Project number
2013-1680

Project duration
2014–2017

Funding awarded
SEK 3 459 000

Project leader
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An electrochemical workstation with cellulose oxidation ongoing.
Photograph: Hanna de la Motte

Fly larvae raised on organic waste become source material for feed production

This project has developed fly larvae composting for the treatment of organic waste and the production of a protein-rich animal feed and a concentrated ecological fertilizer from the resulting waste products. It is part of the EcoInnovera program and is a collaboration between SLU and two Swiss organisations, the Eawag research institute, and the food company Pacovis.

In an initial treatment stage the waste is decomposed and the fly larvae concomitantly become biomass. One tonne of waste can be converted into around 400 kg compost and between 100 and 150 kg of maggots. Per kilogram of dry matter the maggots comprise 40 percent raw protein and 30 percent fat. This makes them

Project title
Safe Protein from Unused Waste (SPROUT)

Project number
2013-2020
EcoInnovera

Project duration
2013–2014

Funding awarded
SEK 2 700 000

Project leader
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Prepuppae – the final larval stage before it leaves the material to find a dry, dark place to pupate.
Photograph: Sara Eriksson

an excellent source material for feed production, where they replace fish and soya proteins. This handling system offers a new value chain for waste management as safe feedstuff can be produced without the requirement for growing the source ingredients. This means that the results can be important for a sustainable society.

At the conclusion of the project a pilot facility for the treatment of organic household waste will be developed with a capacity to treat 2–3 tonnes of waste a day. This is the equivalent of waste from a community of around 10,000 inhabitants. The main research questions of the project, in addition to process technology development, are handling of the flies, eggs and maggots while at the same time maintaining the hygienic quality of the system.

Biological Resources

Deal with how renewable raw materials such as lipids, fatty acids, cellulose and lignin from oil crops, fungi, timber and algae can be used to produce such products as biofuels, chemicals, packaging materials, glue, paints, plastics and detergents. Biorefining processes play a key role.

Renewable raw materials become valuable chemicals

In a new biorefinery concept the researchers want to use microorganisms and enzymes to produce chemicals from renewable source materials. System studies will ensure that the biorefining is technologically viable and will identify the technology development that is essential to achieve an environmentally and economically sustainable concept. To achieve this processes will be modelled on an industrial scale and it will be possible to investigate the potential for integration of these processes with existing industry.

The researchers will use forestry waste and will evaluate the use of microalgaes as biological raw materials. In addition to producing biomass, algae can be used to produce high value products and to bind nutrients that can cause problems of eutrophication in the oceans.

In a biorefinery genetically modified yeast strains will manufacture adipic acid from the sugar in the biomass. Adipic acid is the starting material for the manufacture of nylon, but is also used as a plasticiser, lubricant and food additive. The lignin part of the raw material will be used to produce aromatic chemicals. By-product streams that are generated will be decomposed anaerobically for the production of biogas and treatment in bioelectrochemical systems for the recovery of nutrient substances.

Project title
Upgrading of renewable domestic raw materials to value-added bulk and fine chemicals for a bio-economy: technology development, systems integration and environmental impact assessment

Project number
2013-78
Strong research environment

Project duration
2013–2018

Funding awarded
SEK 24 975 000

Project leader
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BIOBUF

Project title
Seaweeds for a biobased society? Farming, biorefining and energy production (SEAFARM)

Project number
2013-92
Strong research environment

Project duration
2013–2017

Funding awarded
SEK 24 716 000

Project leader
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SEAFARM scientist Gunnar Cervin holding the first seaweed (sugar kelp) farmed in Sweden. The experimental farming facility for the project can be seen in the background.
Photograph: Henrik Pavia

Seaweeds for a biobased society

This project aims to farm sugar kelp (seaweed) on the west coast of Sweden to produce biomass that can be used as source materials for food and fodder production, and as chemicals for the manufacture of new biological materials, such as plastics, as well as energy production. This will take place in biorefineries. The project will also determine if this is sustainable or not and will discover if a new industry can be established along the Swedish west coast.

The project is subdivided into five focus areas:
1) Development of methods for algae farming at sea.
2) Storage and pre-treatment of the algae biomass.
3) Biorefinery development for the project, examining the opportunities for extracting food, fodder and chemicals for new materials, such as polymers for plastics.
4) Production of biogas from the waste products of the biorefining processes, as well as the possibilities to use waste material as an agricultural fertilizer, and
5) Evaluation of the entire process chain from a sustainability criteria perspective.

After eighteen months of the five year project the researchers have established two farming facilities and have learned how to grow kelp on ropes. Within the biorefinery part of the project new interesting materials have been developed and a deeper understanding has been gained of what the biomass contains. If this project is successful it will have laid the foundations for the establishment of a new industry on the Swedish west coast, a commercial activity that could generate economic development for coastal communities away from the major cities. For more information visit: www.seafarm.se

Biobased polyethylene – how will Swedish production be established?

Biobased "green" polyethylene will be in high market demand in order to reduce the amount of plastics manufactured from fossil-based sources. This project will determine and eliminate the factors hindering the establishment of polyethylene production in Sweden using green ethanol as a source material. The project is based on increasing the production of green ethanol by recirculating the streams in an ethanol production facility and using these streams to produce ethanol using a new microorganism.

As there is currently no production in Sweden the researchers want to determine where and how such production could be established. They also want to examine functional governance policies that can increase the risks for the companies involved in the value development chain from green ethanol, via green ethylene, to green polyethylene, as well as the products and end users.

Project title
Bioethanol, bioethylene och biopolyethylene

Project number
2014-181

Project duration
2014–2016

Funding awarded
SEK 4 052 000

Project leader
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Energy

Concern biogas and other biofuels, geothermal heating, fuel cells, batteries and how carbon dioxide can be converted into various fuels using hydrogen gas. Social science projects also address policies for governing technology dissemination and the management of local energy systems.

Project title
Synergies for improved environmental performance of first generation biofuels for transportation

Project number
2008-126
Environmental Technologies Program

Project duration
2008–2010

Funding awarded
SEK 3 289 000

Project leader
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Michael Martin and Mats Eklund in a biogas reactor that is not yet in operation.
Photograph: Tommy Hvitfeldt

Biofuels – synergies in production

The production of first generation biofuels was based on well-established techniques for the production of bio-ethanol, biodiesel and biogas. These are also relatively easy to use in existing vehicle and infrastructure technology systems. This has made it possible to increase their use. But biofuels are controversial, due to their alleged poor environmental and energy performance. Sometimes this can be explained by the analyses having focused on the conversion of the source materials into fuel without fully considering the by-products.

By developing efficient use of the by-products, energy and infrastructure through synergies between the various biofuel production systems, and also including other industrial activities, the environmental and economic performance of biofuels can be improved. This project has contributed to the development of knowledge to make such synergies possible. More than 60 potential production synergies were identified in the initial phase of the project, together with the project's industrial partners. These synergies were then categorised into a model. The industrial partners were Ageratec AB, Lantmännen Agroetanol AB, Svensk Biogas AB and Tekniska Verken AB.

Phase two addressed how to enable the potential synergies. The results have shown that pure by-product exchange is easy to evaluate for individual companies, but production synergies that involve a common infrastructure are more difficult to achieve.

Carbon dioxide and hydrogen provide third generation biogas

The researchers wanted to verify the possibilities of converting carbon dioxide into methane by allowing carbon dioxide to react with hydrogen via a reaction known as the Sabatier reaction: $CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$. Electricity from wind power can be used to generate hydrogen via the electrolysis of water. The reaction of this hydrogen with carbon dioxide produces methane that can then be used as a vehicle fuel. The hydrogen was produced in the project in collaboration with the wind power company Agrivind AB. It is of particular interest to be able to convert the carbon dioxide from the gas produced in a bioreactor when food waste is used as the substrate for the digester, as this gas already consists of around 60 percent methane, with the remainder being carbon dioxide. The process technology to upgrade this digester gas to pure methane should be relatively simple. The researchers have attempted to do this, in part using a "synthetic" biogas, or in other words a gas that they have artificially mixed together using bottled gas, and in part using real biogas from a digester, in a chemical reactor in the presence of various catalysts to promote the reaction. Promoting the reaction can mean that the majority of the carbon dioxide can be converted or that the reaction can proceed even at low reactor temperature and pressure. Conversion of carbon dioxide to methane in a biogas reactor has been shown to work well and it is not necessary to use particularly high pressure or temperature to achieve almost complete conversion to methane.

Project title
Third generation biogas from carbon dioxide and wind power-based hydrogen

Project number
2008–2164
Environmental Technologies Program
2010–937

Project duration
2009–2010
2011–2012

Funding awarded
SEK 1 350 000
SEK 1 486 000

Project leader
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Electricity from wind power can be used to generate hydrogen via the electrolysis of water. The reaction of this hydrogen with carbon dioxide produces methane that can then be used as a vehicle fuel.
Photograph: Thinkstock

Project title
Clean Technology, innovation and the role of public policy: conceptual issues and case studies

Project number
2009-2045
Environmental Technologies Program

Project duration
2010–2012

Funding awarded
SEK 450 000

Project leader
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Photograph: Thinkstock

Policies to encourage green technology use

This project examined how public policy can be developed to stimulate innovation and encourage more green technology use within industry and the energy sector. Above all the preconditions for a fit-for-purpose technology policy in the cases of wind power and transition in the pulp and paper industries were examined. This project contributes knowledge of how environmental policies should be supplemented with an active technology policy and also highlights the importance of this not being solely a matter of focussing on support for research and development but also on the learning effects in the production of new technologies.

The empirical aspects of the project have highlighted the importance of learning about the technologies, or in other words the fact that new technology cannot be developed by research and development (R&D) alone, but must be verified, scaled up and expanded in production. One of the studies has shown that innovation in the wind power sector is stimulated when the public funding for R&D is supplemented by production funding for wind power. The research focusing on wind power concomitantly illuminates the difficulties in measuring technology learning in a reliable manner. Another study examined how traditional environmental policies (for example individual limit values for emissions) can stimulate innovation in the area of the environment when these are implemented in a manner directed toward this purpose.

New and Advanced Materials

Investigate among other tings new cellulose-based materials for different application areas, foams, methods for preventing biofouling, hydrogen storage materials, composite bridges, thermoelectric textiles, bioactive silk for wound healing and membranes for purifying biogas and desalinating seawater.

CarboMat – consortium for advanced carbohydrate materials

Carbohydrates from plant cell walls are an underutilized natural resource with significant potential to meet the needs of society for renewable materials. Cellulose, the structurally most important polysaccharide in plant cell walls, is the most common biopolymer on Earth. In nature cellulose is linked to a number of other cell wall polysaccharides and forms unique composite materials, the properties of which are exceptionally well adapted to performing specific functions. These complex biomaterials are created by photosynthesis and they are biodegradable.

The CarboMat scientists use cell walls as a source of inspiration to design new biocomposites. Using enzyme techniques the sugar-based polymers such as cellulose are cleaved and reconstructed to create new materials with significantly improved strength and function. With their sights set on future societally beneficial products, the researchers are focussing on concepts for new materials. They are working on a number of focus areas, including new cellulose-based biomedical materials for wound healing and tissue regeneration and improved filters for water purification.

Project title
CarboMat – The KTH advanced carbohydrate materials consortium

Project number
2009-1687
Targeted call – Sustainable development

Project duration
2009–2013

Funding awarded
SEK 25 000 000

Project leader
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Project title
Foamed materials for packaging and absorbents based on forestry by-products

Project number
2013-64
Strong research environment

Project duration
2013–2017

Funding awarded
SEK 25 000 000

Project leader
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Extruding hemicellulose-based foamed material.
Photograph: Kerstin Jönsson

Foamed materials from forestry waste streams

Commercial foams, such as those used as packaging, absorbents and medical device products are currently produced primarily from fossil sources. In this strong research environment SmartFoam is developing new foam materials based on hemicellulose sources, a renewable by-product from forestry anwd agricultural production. The source material is available in huge quantities at potentially competitive prices, and increased use would provide added refining value for forestry and agricultural raw materials. But research is needed to develop new foam materials with bespoke functionality for packaging and medical device purposes.

Within SmartFoam the extraction and modification methods for the raw materials are being developed, both with regard to formulation and process technology, for the production of foamed material intended for large-scale production. SmartFoam will generate new knowledge, particularly in the following areas:

1) Extraction and chemical modification of hemicellulose for optimal foaming qualities.
2) Effects of the characteristics of the source material and mixed material on the water resistance, plasticising, foaming and function of the foam.
3) Effects of additives, such as nanocrystalline cellulose, on the structure of the foam material.

Bioactive-silk for healing infected wounds

New methods of treatment are needed to combat the increasing incidence of pathogenic resistant bacteria. Spider silk has been used for wound healing in traditional medicine. In this project bioactive-silk is being developed by coupling spider silk to molecules from the body's own immune defence system to develop a new strategy for the treatment of slow-healing wounds, independent of conventional antibiotics.

The unique proteins of spider silk are arranged in such an artful way that the material has both strength and elasticity. The scientists can now produce miniature variants of the proteins (spidroines) that the spider itself uses. When they have purified the mini-spidroines these spontaneously form fibres that resemble spider silk. As spider silk has good biocompatability the researchers are using this as a base to develop material for biomedical applications. By using modern molecular biotechnology they can also now couple other active molecules to the spider silk to develop an entirely new type of bioactive-silk intelligent biomaterial. In this project they are coupling the silk to molecules from the body's own defence mechanisms, bactericidal enzymes and antibacterial peptides. In addition, they are designing their bioactive-silk to promote the growth of skin cells necessary for wound healing.

Project title
Bioactive-silk – a novel material for healing infected wounds

Project number
2013-883

Project duration
2014–2016

Funding awarded
SEK 3 920 000

Project leader
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A fibre made from spider silk protein with incorporated antimicrobial peptides.

Sustainable Building and Planning – Technologies and Processes

Deal with energy-efficient systems for heating, cooling and ventilation, smart windows, concrete reinforcement, land decontamination, dehumidifying greenhouses, solar energy in urban planning, vertical growing and green roofing. Deal also with renovation, including risk assessment, governing policies, decision-making tools, energy efficiency and construction products.

Project title
Sustainable and cost-effective remediation of contaminated land in the built environment

Project number
2009-206
2009-781

Project duration
2009–2013
2010–2013

Funding awarded
SEK 5 601 150
SEK 6 075 000

Project leader
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Remediation of contaminated areas

Remediation of contaminated land is a very common part of construction projects in the built environment. The method most widely used is excavation and disposal, a method that is often very expensive and is not sustainable in the long-term.

The overall objective of these projects has been to develop a practical method that can be used for the assessment of sustainability and cost-efficiency for different remediation methods. Determining the effects of the remediation method on the different land functions for the ecological system after decontamination was of particular interest. The primary results of these projects have been the method SCORE (Sustainable Choice Of REmediation) and SF Box (Soil Function Box). SCORE allows different criteria for economic, social and environmental sustainability to be evaluated jointly to provide a measurement of total sustainability. SF Box allows indicators of land function for ecological systems to be evaluated and used to classify the effects of the remediation method on subsequent land function. The methods are integrated with each other and have been applied in four different case studies.

The work has been carried out in a collaboration between Chalmers, NCC Teknik, Statens geotekniska institut (SGI), Umeå University and SLU. Around 15 researchers have participated in the projects.

Sustainable remediation means that social, economic and environmental criteria are used in the choice and design of the clean-up method.
Photograph: Thomas Liljedahl

Support systems for sustainable entrepreneurship

SHIFT (Support Systems for Sustainable Entrepreneurs and Transformation) is a research project within the EU EcoInnovera programme. Eco-innovation and a green economy is high on the EU agenda, but support for small businesses that run sustainable operations is less developed at the EU level. Based on a combination of theories within the area of sustainability, innovation and entrepreneurship the researchers are studying aspects of the publicly funded support system for small eco-businesses in Finland, Germany and Sweden, for example by examining incubators, universities, regional business developers and financiers. Questionnaires, interviews and case studies are used to describe how such organisations support companies. The researchers provide good examples and propose genuine and realistic recommendations for how the support system can be developed to create more and more successful small eco-businesses.

SHIFT is a collaborative project jointly run by Sweden, Germany and Finland. In each country the respective research groups are working with national and regional stakeholders. In Sweden these are Vreta Kluster and Föreningen Cleantech Östergötland.

Project title
Support systems for sustainable entrepreneurship and transformation (SHIFT):

Project number
2011-2152
EcoInnovera

Project duration
2012–2015

Funding awarded
SEK 3 395 000

Project leader
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The SHIFT research team in 2013.

Project title
National Transdisciplinary Centre of Excellence for Integrated Sustainable Renovation

Project number
2013-1804
Strong research environment

Project duration
2013–2017

Funding awarded
SEK 22 985 000

Project leader
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Holistic approach for sustainable renovation

Within this strong research environment a collection of researchers and stakeholders from the building and planning sector will compile the existing research and results from previous renovation and research projects, develop methods and tools for carrying out sustainable, integrated renovation and will use these in some research projects that will be studied particularly thoroughly, followed up and evaluated. Approximately 30 scientists from higher education colleges and universities will participate in the project and 27 companies, government agencies and organisations have committed to the project as co-financiers and collaborative partners.

The project is transdisciplinary and concerns five research areas: 1) Administrative perspectives in the decision process and the role of the construction companies, 2) Integrated, holistic design and efficient renovation processes, 3) Economic challenges and opportunities when renovating, 4) Resident participation and democratic decision processes, and 5) Innovation and learning. The researchers are working with five work packages where they will establish a knowledge base, study previous renovation projects, introduce innovation and demonstration in new renovation projects through Living Labs (living laboratories where researchers, companies and residents interact) and action research, develop new or improve existing methods and tools for sustainable renovation, and work with communication, dialogue and dissemination of the results.

Kick-off for the strong research environment SIRen was held in May 2014 in Lund.

Environmental Protection Technology

Include water purification (drinking water, stormwater and sewage), phosphor recycling, energy efficient eradication of Legionella, binding toxins in bottom sediment, conversion of stored methane, recovery of metals from soil, stabilizing mining waste and new technologies to protect plants from insect pests.

Microelectrode arrays for drinking water quality monitoring

The aim of this project was to develop new sensors based on microelectrode arrays suitable for continuous monitoring of water quality at water purification plants, in water distribution pipes and in buildings. The work has primarily been carried out at Linköping University, but some sensor manufacturing has taken place at Printed Electronics Arena in Norrköping and at Electrum in Kista. The sensor method builds on a previous discovery known as the "electronic tongue". Further development of this electronic tongue into microelectrode arrays means that the sensors will function much better in drinking water and in sewage, where the low electronic conductivity otherwise limits monitoring measurements.

One type of microelectrode that has been studied builds on what is known as a microband, as well as arrays of these. Despite their simplicity these sensors have the characteristics expected of microsensors in terms of rapidity and detection limits. They can also be customized and have the potential to be mass produced at low costs. Another sensor type is manufactured from silicon and contains several hundred microelectrodes in the array. The microelectrodes are manufactured from different materials, including gold, platinum and rhodium. The results in this project have been so encouraging that the researchers are now involved in a Vinnova project to investigate the possibilities of founding a spin-off company to commercialize the research results.

Project title
Microelectrode arrays for drinking water quality monitoring

Project number
2010-1062

Project duration
2011–2014

Funding awarded
SEK 4 412 000

Project leader
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Project title
Using green liquor dregs from the paper industry for stabilisation of sulphide-bearing mine waste – solving two waste problems at the same – STABWASTE

Project number
2011-1146

Project duration
2012–2015

Funding awarded
SEK 3 830 000

Project leader
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Two waste problems – one solution

Mining generates large amounts of waste in the form of gangue and enriching sand. When sulphide-containing mined waste is oxidized in contact with air and moisture an acidic leachate is formed that can have high metal content, which can lead to negative environmental impacts. This can proceed for hundreds or thousands of tears in individual land-fill sites. Two common ways to manage the problem of acidic leaching are either to limit the amount of oxygen exposure of the waste or to add limestone the acidic liquid, which results in large amounts of potentially toxic sludge.

Use of other materials, such as industrial waste, to prevent the negative effects would solve two waste problems at once. This project has studied green liquor, and alkaline waste product from the paper industry. The goal was to develop methods for using green liquor to prevent the formation of acidic leachate using mixtures of the mining operation's own enriching sand or unclassified moraine to construct a covering layer for mining waste land-fill, or as an additive to gangue to create a coating for the reactive mineral surfaces. The project used laboratory trials in combination with full-scale trials in close collaboration with the mining company Boliden & Dragon Mining and with the forestry industry through its partnering organisation Processum.

Test surface at Brännkläppen outside Boden where a mixture of moraine and green liquor is spread out as a covering layer.
Photograph: Maria Mäkitalo

Nanotechnology for protection against insect pests

This project had the goal of developing new and powerful ways to augment the natural defence mechanisms of plants and increase their tolerance to stress, in the first hand from insect pests. This is of great importance in an increasingly warmer and damper climate in which insect pests flourish.

The researchers studied how nanoparticles could be used to provide the plants with specific microelements to prevent insect attack, or to "teach" the plants to produce odours to scare away the insects or, alternatively, to improve the ability of the plants consolidate contact and collaboration with plant-protecting microorganisms (biopesticides).

The researchers produced nanoparticles from common minerals, such as sand and limestone, and studied how these could be administered to plants together with microelements, biopesticides and repellents. They have shown that with the help of nanotechnology that it is possible to multiply the resistance of plants to drought and diseases several-fold. The researchers have even learned to produce surface-modified limestone particles that, if taken up by the plant, could hopefully prevent aphids from sucking the juices of the plant. It has been shown that mineral nanoparticles can significantly improve the collaboration between plant roots and biopesticide microorganisms.

Project title
Nanotechnology for innovative protection against insect pests

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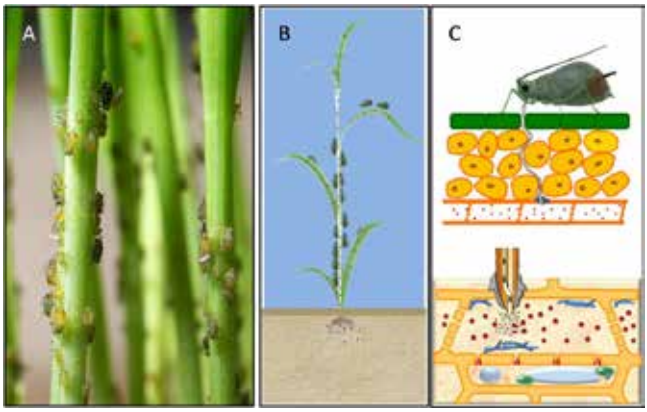

Aphids on a plant and a schematic representation of the project concept – to strengthen the resistance of a plant to aphids through the uptake of mineral nanoparticles.
Image: Velimir Ninkovic and Robert Glinwood

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