Anholt Skole

Demontrationsprojekter efter vugge-til-vugge principper

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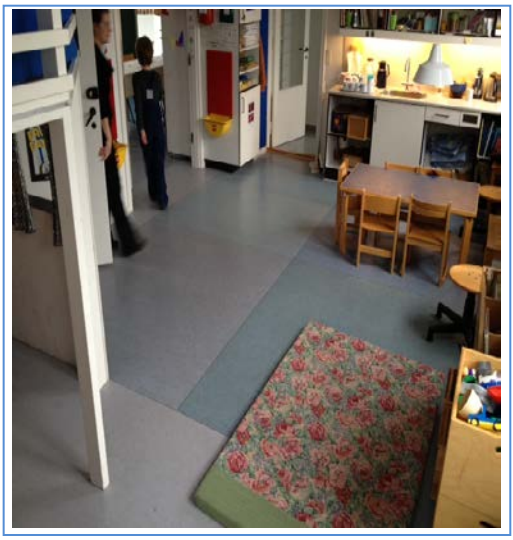
Publication date:
2012

Document Version
Tidlig version også kaldet pre-print



The Interreg IVB North Sea Region Programme

cradle to cradle islands

AALBORG UNIVERSITY

norddjurs kommune

European Union
European Regional Development Fund

ANHOLT SCHOOL

Demonstration projects according to Cradle-to-Cradle®-principles

Carla K. Smink and Søren Kerndrup (ed.)

Anholt School

Demonstration projects according to Cradle-to-Cradle®-principles

Carla K. Smink and Søren Kerndrup (Ed.), November 2012

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Printed by: Sæby Bogtryk, Tranåsvej 8A, 9300 Sæby, E-mail: sbo@sbo.dk, http://www.sbo.dk, CVR nr.: DK 19 49 78 79

Published by: Aalborg University, Department of Development and Planning, 2012

Translated from Danish to English by:
Carla K. Smink and Christina Grann Myrdal

Preface

This report has been written on the basis of the work Aalborg University (AAU) has carried out in the Cradle-to-Cradle Islands project (C2CI-project) (www.c2cislands.org) on Anholt. The C2CI-project is an Interreg IVB North Sea Region project with 22 partners from 6 countries around the North Sea. The project ran from January 2009 to summer 2012. The leading vision of the project was to see islands as innovative centres that implement Cradle-to-Cradle® solutions. The main goal was to develop innovative solutions in the field for energy, water and materials using Cradle-to-Cradle® (C2C) principles as a guide.

The focus of this report is on demonstration projects using C2C principles as a guide that can be implemented at Anholt School. Anholt is part of Norddjurs Municipality, project partner in the C2CI-project and owner of the school.

The report is aimed at people connected to the school (the school's principal, the manager of the nursery, teachers, and the parents' committee), Norddjurs Municipality and the other partners in C2CI-project. There is a Danish and an English version of this report.

The project at Anholt School is conducted in cooperation with Norddjurs Municipality (Kirsten Bjerg), Anholt School (Helene Henning and Kirsten Østergaard Rasmussen) and the parents' committee (Mia Nordby). To assess whether the project proposals fit with the purpose of the C2CI-project, we have received good input from EPEA[1] (Katja Hansen). We would like to thank Hanna Byskov Ovesen, who has worked on the project as a research assistant, and who has contributed to formulating demonstration projects. In addition, we would like to thank Annette Grunwald for good professional feedback and for the use of the handbook (2010) *"How to save energy at schools – an energy saving and educational development project"*. Finally, big thanks to Christina Grann Myrdal for the help with editing and translating the report.

Not all demonstration projects described in this report have been implemented at the school. However, discussing and planning the demonstration projects will be an important part of Anholt School's journey towards becoming a C2C-school. A journey that is not yet completed and, as

[1] http://www.epea-hamburg.org

with all journeys, there will be modifications to the projects along the way. This is an essential part of a learning process. At the moment, two demonstration projects are about to be implemented at Anholt School; one project is about a solar heating system and the other project is about insulation. Some of the other projects have served as inspiration for a number of activities in the new school year 2012/2013.

The C2CI-project is now completed, but Anholt School and Norddjurs Municipality can continue to work on C2C® projects at the school. Anholt School has already scheduled a workshop to continue the work – we wish Anholt School and Norddjurs Municipality success with their future work on C2C® projects.

Aalborg, November 2012

Carla K. Smink & Søren Kerndrup

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Part 1

The Cradle-to-Cradle Island Project

1 The Cradle-to-Cradle Island project

Carla K. Smink, Hanna Byskov Ovesen, Søren Kerndrup

This chapter introduces the Cradle-to-Cradle® (C2C) way of thinking as well as an introduction to the Cradle-to-Cradle Islands project (C2CI-project) (see for more information on http://c2cislands.org/). The various projects the partners in the C2CI-project have worked with will be described as well. This chapter has been written as part of introducing Anholt School and Norddjurs Municipality to the C2C® principles and to give the school and the municipality inspiration for choosing demonstration projects that could be implemented at the school.

1.1 What is Cradle-to-Cradle®?

The current way of thinking about the environment encourages us to "reduce, reuse and recycle". This way of thinking leads to a continuation of the traditional "cradle-to-grave" production model that creates enormous amounts of waste and pollution (www.epea.com). Figure 1 illustrates the ”cradle-to-grave” production form.

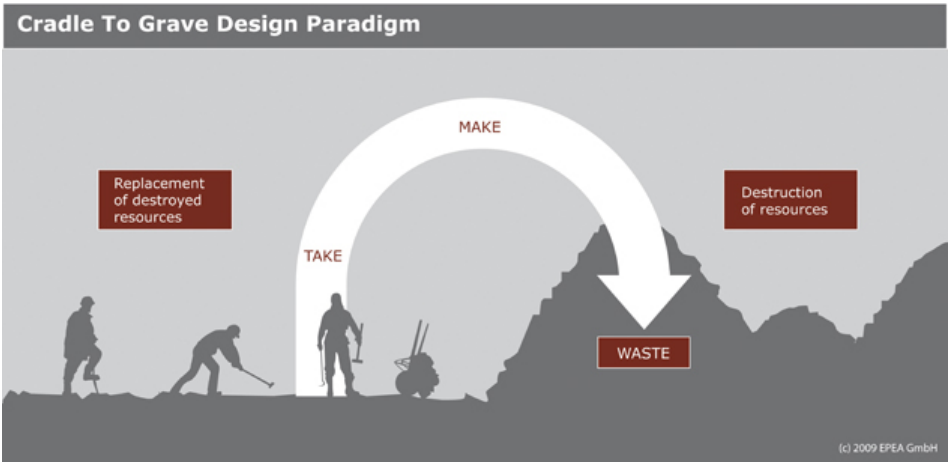


Figure 1. Cradle-to-grave production form (EPEA Hamburg 2012a)

The C2C® design concept offers an alternative to the present method of production whereby materials become nutrients that move within metabolic cycles and the concept of waste does not exist (www.epea-hamburg.org). In other words, in the C2C®-concept waste equals food: products are designed in such a way that they do not pollute and are part of a biological cycle or a technical cycle (see figure 2). Therefore we should stop doing bad things "less bad" and instead start doing the right things (www.epea-hamburg.org).

The three main C2C® principles are:

- **Waste equals food** – or to put it another way: waste does not exist. – there are nutrients that can be nutrients again
- **Use current solar income** – optimise the use of renewable energy (wind power, wave power, solar energy, geothermal, etc.)
- **Celebrate diversity** – support biodiversity, cultural diversity, conceptual diversity and innovation

The C2C® concept is an approach for designing products, processes and systems taking into account the entire life cycle of the product, optimising material health, recyclability, renewable energy use, water efficiency and quality, and social responsibility (McDonough and Braungart 2002)

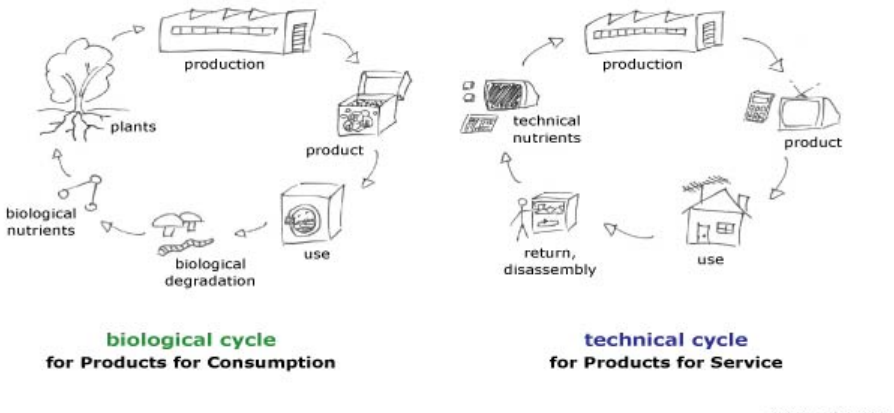


Figure 2. Two life cycles (EPEA Hamburg 2012b).

C2C® principles are most often applied by companies that already in the design phase of a (new) product must decide in which nutrient cycle the product is to be designed (the biological cycle or the technical cycle). The challenge in C2CI-project (see also section 1.2) is that the C2C®-principles are not being applied in relation to a product but to islands in the North Sea region. For many partners in the C2CI-project, it has been a challenge to define concrete projects where the C2C®-principles could be applied. EPEA[2] has played a central role in guiding the partners in the choice of projects so that the C2C®-principles are respected as much as possible.

1.2 Cradle-to-Cradle Islands project

The C2CI-project is an Interreg IVB North Sea Region project with 22 partners from 6 countries around the North Sea (map 1). The project ran from January 2009 to summer 2012 and had a total budget of € 3.5 million (50 % European funding, 50 % co-financing by the partners). The overall vision of the project was to see the islands as innovative centres that implement C2C® solutions. The main goal with the project was to develop innovative solutions in the field of energy, water and materials, using C2C® principles as a guide.

Water	**Energy**	**Materials**
Sustainable supply of drinking water by desalination of sea water	Testing and applying the concept of 'blue energy' (mixing salt water and fresh water in order to produce electricity)	Design of an Eternal Island Holiday House that is energy producing, made with local materials, easy transportable and degradable
Sanitation and separation of household water in several streams	Feasibility for increased use of solar, wind, wave and tidal energy	Local production with innovative materials (e.g. tourist products like custom tailored swim suits)
Purification and re-use of the effluent of waste water treatment plants	Designing and testing sustainable product services for island mobility	Develop data base on C2C® ideas, strategies, methods
Storage of rainwater underground during winter times to realise sustainable water supply in summer	Design of Eternal Island Holiday House	

Table 1. An overview of activities in the various themes (see c2cislands.org for all the activities)

[2] Environmental Protection Encouragement Agency, www.EPEA-hamburg.org

1.2.1 Why an island-project?

The islands in the North Sea Region are facing many common problems:

- Geographical isolation
- Lack of local resources (energy, materials, water)
- Declining population
- Many visitors in the summer and thus a high demand of water, energy, transport and goods (materials) in the high season
- Ambitions to become independent and self-sufficient in energy and water supply
- High visibility of sustainable activities
- Suitable sites for education in environmental innovation

However, the islands in the C2CI-project are also very different from each other; from the Shetland Islands (United Kingdom), which consists of 32 islands with an area of 1,466 km^2; to Runde (Norway) with an area 6.2 km^2 and 102 inhabitants. The degree of isolation, i.e. the distance measured in kilometres and time from the mainland, varies also for the participating islands. These differences between the participating islands create a good framework to develop and implement a variation of innovative projects on the islands.

An important objective of the C2CI-project is that the participating islands can learn from each other and share each other's experiences. In the course of time, it became clear that demonstration projects that had been successful implemented on one island could not be implemented on other islands, due to local circumstances (weather, geology, socio-cultural circumstances, etc.).

Map 1. Project partners in the C2CI-project.

1.2.2 Project examples

In this section, we provide an overview of the various demonstration projects the islands in the C2CI-project have chosen to work with. This description of the projects has been used to give Norddjurs municipality and Anholt inspiration for possible projects they could work on.

Ameland (The Netherlands)

The project is called: Cradle-to-Cradle ® holiday house Bambi

On the island of Ameland, the municipality works on a C2C® Holiday House. At this moment, they focus mainly on water and energy and how they can integrate C2C® aspects in an existing holiday house. They learn to see from a different point of view what the tourist wants and how they can use C2C® materials, new ways of thinking in an existing environment.

Recently, a vacuum-toilet and a recycle-shower have been installed. The vacuum-toilet will save 4.5 litres of water each flush, and the recycle-shower allows both water and heat to be recycled.

The targets of the project are as follows: The municipality of Ameland has signed an agreement for getting independence on water and energy in the year 2020. To realise this aim, Ameland has started several projects. One of these projects is the realisation of a sustainable or C2C® holiday house, with a main focus on water.

The innovation and value of the project is as follows: Because they are using an existing holiday house they have to be inventive on how they can add new and innovative applications.

Lake Grevelingen, Zeeland (The Netherlands)

The project is called: Cradle-to-Cradle® Marina

On the dykes of the Delta Works (Dutch coastal sea defence system) near Lake Grevelingen the marina of the future is going to be realised. This new marina is built on new land and partially floating. Also a vacation resort will be integrated in the marina. In the design the focus will be on two different types of buildings, namely the harbour master office with small shops, café and sanitary

building and a small unit of vacation houses.

Elements that are incorporated in the design are:

- Floating construction.
- Renewable energy sources like wind and solar energy.
- Rainwater harvesting, etc.
- Optimal situation of the building, layout of the building, multi functionality of the building and the usage of materials.

The targets of the project are as follows: The aim of the project is to realise a C2C® marina in 2014/2015. To realise this aim, several design studies have been started, like the design of the harbour master offices, vacation houses, the design of the pontoons and a study to research possibilities to enhance biodiversity by means of artificial reefs. The master planning and design is the responsibility of the company Zeelenberg.

The innovation and value of the project is as follows: The marina of the future is built as a C2C® example, whereby the vision of C2C® is as much realised as possible. The vision of the marina is to show the cycles and to close the loops, to generate energy and to clean water, to enjoy the diversity under and above water and to enjoy the scenery, but also to give a secure and cosy feeling to the visitors and guests. Also its aim is to bring the local elements into this project, such as local grown food and fishery.

Region Uthlande, Insel- und Halligkonferenz Island Pellworm (Germany)

The project is called: Climate friendly holidays

The project "Climate friendly holidays" is established on the Pellworm as example for the other islands of the Region Uthlande: Sylt, Föhr, Amrum, Helgoland and the project partner in the C2CI-project.

The targets of the project are as follows: The basic of the

"Master plan Pellworm" is to lower CO_2 emissions and the target for Pellworm is to have a positive balance in 2020. One of the steps to reach this is to reduce energy consumption in regard of tourism and holiday houses/apartments.

The innovation and value of the project is as follows: Tourism is the main income on the islands in the Region Uthlande. This project is an example to show how both tourists and inhabitants can share reducing CO_2 emissions and use materials in the C2C® way.

The project is called: Promoting Föhrer Wasser

The Island Föhr has sufficient and good quality groundwater below the island. This is a good reason to drink "*Föhrer Wasser*" and not water transported in bottles from the mainland to the island. The project will develop a special bottle to be recognised as "*Föhrer Wasser*" and promote this idea to tourists and inhabitants.

The targets of the project are as follows: The target of the project is to develop models for a water cycle for the groundwater of the Island Föhr. Second target is to avoid CO_2 emissions from traffic caused by transport of water bottles from the mainland to the island.

The innovation and value of the project is as follows: The innovation is the use the own island resources, for the daily use of drinking water. This has to be filled in by the people themselves at home.

Lofoten (Norway)

The project is called: Lofoten Fisheries Heritage Centre

In Storvågan a new centre will be realised within 2014. In the centre there will, among other functions, be a museum, public areas, and facilities for scientists and showroom for sustainable development.

The targets of the project are as follows: Cooperation between the Municipality of Vågan, the regional Government of Nordland and the five National Departments, shall give a new standard of sustainable building methods, new energy supply from Tidal Power/Morild Technology and increased use of clean energy for transportation.

The innovation and value of the project is as follows: The Storvågan area, and surrounding areas, will be implemented with new infrastructure. New businesses and new areas for homes will be created. The project is to be regarded as an important part of the possible coming World Heritage Site of Lofoten (Culture and Nature). Eco-tourism will be developed as most important industry in the area.

Delft University of Technology (The Netherlands)

The project is called: RENOVA/RESEO-tool

RESEO stands for Renovation Strategy for Energy Optimization of holiday houses on the North Sea islands inspired by C2C®. It is a part of the RENOVA Decision Tool and can be used as a guide and a database on energy renovation. It provides six steps to the energy-renovation of a house. It includes a review of methods and technologies that can be implemented during each step. There are 74 energy related methods and technologies that can be used, including (dis)advantages, seasonal

potentials, efficiency, an indicator on the C2C® design principles, technology producers and an indicator on the level of potential for holiday houses.

The targets of the project are as follows: While the consequences of global warming are already present, the existing building stock is overly unsustainable and energy-inefficient. It contributes by large to CO_2 emissions and the depletion of natural resources. The implementation of clean and renewable energy is necessary to minimize their ecological footprint and transform them into beneficial elements of the environment. As a response to this problem, this energy tool is developed. It focuses on renovation of the existing houses and especially holiday houses in the North Sea Region.

The innovation and value of the project is as follows: decision makers can use the RENOVA-tool with technical knowledge involved in renovation projects, such as engineers, architects, building technologists and installers. Nevertheless, is can also be used by non-technical decision makers, such as house owners, managers or government officials.

Runde (Norway)

The project is called: Cradle-to-Cradle® and sustainability applications in the Runde Environmental Centre building; Promoting integrated Multi-Trophic Aquaculture; Development of wave power test centre

C2C® and sustainability applications in the building of Runde Environmental Centre (REC) include:

- Innovative sanitary technology (vacuum toilets with low water consumption and sewage collection for biogas production),

- Use of C2C® certified products in the building (e.g. carpet, furniture).

Information for visitors to the centre, as well as the promotion of similar projects on the island and in the region, is part of the centre's mandate.

Gathering relevant stakeholders from both public and private sectors of society and facilitating the development and testing C2C® technologies as a primary goal within the C2C® Islands-project. In this context, 'integrated aquaculture' represents a prime example of how 'waste' (from fish farms) becomes 'food' for other cultured species (mussels or seaweeds), based on fundamental principles of nature. Information about this technology will provide future development opportunities for Runde and the region.

The targets of the project are as follows:

- The REC acts as a test case for C2C® and innovative environmental technology, with the goal to document implementation and present it to a broad audience.
- The REC organises information seminars on relevant subjects and acts as a facilitator towards research and development institutions as well as the industry to collaborate on joint projects on the island (e.g. wave power test facilities)

The innovation and value of the project is as follows: 'Trying it out' – implementing sustainable and C2C® technology in the building of REC and documenting the entire process, including failures and problems, represents the main innovation value of this project. Involvement of the regional construction industry will have proliferation effects beyond the islands and beyond the project duration.

Samsø (Denmark)

The project is called: 1) Science and research dwellings and 2) Biogas/transport project.

Samsø is the official Danish energy island and the island has a long-term plan where a 100% self-supplied energy system already has been established. Samsø is today producing more energy than the island is consuming. Next phase is about implementation of smart grids and use of biomass in energy generation.

The targets of the project are as follows:

1. To establish 12 dwellings for scientists and researchers. Passive house standard and C2C® building materials.
2. Establishment of a central biogas plant to utilize biomass from all available resources such as waste, farm manure, bio energy crops.

The innovation and value of the project is as follows: The previous experiences of Samsø are so positive that this alone is a showcase. The next phase is therefore an even better chance for development of knowhow and demonstration. C2C® is part of this sustainable thinking and will be part of the planning of new buildings and installations as well as the use of resources on the island.

Shetland Islands (Scotland, UK)

The project is called: Valhalla Brewery

One of the local communities is home to the Shetland's only brewery. This brewery is relocating and wants to become more sustainable and needed to have a secure energy and water supply to protect the processes that they need to undertake on a daily basis. They have spent the last few months giving support to the brewery and have had input into an initial study into the energy requirements of the site and proposed solutions. Advice and help for this project is on-going.

The targets of the project are as follows: The project aims to reduce energy costs for the brewery along with significantly reducing the associated CO_2 emissions. It is anticipated that 36.6T of CO_2 can be saved annually along with up to 87MWh of electrical energy. The project will also redevelop an abandoned military building for use as an advanced energy efficient brewery.

The innovation and value of the project is as follows: The project will integrate wind turbine technology and heat pump technology to significantly reduce the demands for carbon based energies. This will not only reduce the operating overheads of the brewery, but will also significantly improve the sustainability of its end use products. In addition the project will see the redevelopment of an abandoned military base to accommodate increased brewing capacity with greatly enhanced sustainability both in terms of water use and energy use.

The project is called: Sustainable Spinning mill

A local community development organisation is developing a sustainable wool-processing mill to process local wool sources into sustainable and high value end products. The development is to incorporate a number of renewable and energy saving technologies to allow wool processing to be done in a low carbon way. It is also proposed to integrate rainwater collection to significantly reduce demands for piped mains water, further improving sustainability and reducing the carbon footprint of the process.

The targets of the project are as follows:

1. The project aims to develop a sustainable wool-processing mill to process local sheep's wool into end products. The project will redevelop an old industrial building to utilise a local natural product that is at present removed for disposal.
2. The spinning mill is to be developed with integrated renewable energy technologies (solar water heating and wind power) to enable wool processing to be complete in a low carbon manor.

The innovation and value of the project is as follows: The project will integrate wind turbine technology and solar water heating technology to significantly reduce the demands for carbon based energies. This will not only reduce the operating overheads of the proposed woollen mill, but will also significantly improve the sustainability of its end use products. In addition the project will see the re-development of a disused commercial building and the deployment of the first integration of rainwater recycling into a local community owned commercial project.

Spiekeroog (Germany)

The project is called: Energy and Climate Protection Concept

With this project the Municipality of Spiekeroog intends to outline a strategy for a self-sufficient supply of energy on the island. In regard to the special situation on the island many renewable energy techniques are not suited for use on Spiekeroog: Because of the status as a national park it is not allowed to build more wind turbines; the production of biological gas is not possible because there is no agriculture; to install solar cell panels on every suitable roof can detract the character from the historical townscape; geothermal heat systems can result in a collapse of the fresh water lens. This special situation on Spiekeroog requires particular strategies for using energy

on the island with a mixed concept of sustainable energy consumption, applying of renewable energy sources and possibilities for reducing CO2-emissions.

The targets of the project are as follows: The Municipality of Spiekeroog´s political goal is to preserve the special ecological and cultural features on the island. Therefore, one of the main targets of the Municipality in the C2CI-project is to develop a sustainable energy supply. Additional intentions of the Municipality are to initiate social-cultural sustainable initiatives and to strengthen the environmental education. Moreover, the Municipality works in cooperation with the project beneficiary Oldenburgisch- Ostfriesischer Wasserverband (OOWV) that has the goal to assure that the water supply on the island will be self-sufficient and independent from the mainland on a long-term basis. To realize these targets the Municipality started several projects. One of the projects is to develop an Energy and Climate Protection Concept.

The innovation and value of the project is as follows: The goal of the Energy and Climate Protection Concept for the Island of Spiekeroog is to carry out strategies for a sustainable use of energy in an area with special ecological and cultural features under the consideration of the C2C® concept. Also, it should be tried to integrate projects of other beneficiaries in the concept, e.g., the 'Energy SWOT Analyse Tool' elaborated by AAU or 'Design of an Energy Efficient Swimming Pool' elaborated by Delft University of Technology. With the concept it could be demonstrated that sustainable use of energy is also possible in areas with a high status of nature or culture protection. The results of the concept can be transferred to other islands or regions with a comparable sensitive landscape.

Texel (The Netherlands)

The project is called: LED Light Plan

The Light plan is the ambitious policy plan of the municipality of Texel for public lighting. It starts with an inventory of the current area. On the basis of road safety, social security and liveability a Texel's practical directive has been determined for the application of public lighting. This is translated into a plan with the main focus on sustainability and darkness. This plan provides LED lighting and generation of energy by means of solar panels.

The targets of the project are as follows: The local council of Texel has decided that in 2020 Texel should be self-sufficient with energy and should take darkness as a core quality of the island. The LED light is the interpretation on this vision for public lighting. It leads to a reduction of energy usage of 60 %, remaining energy is durably generated, none CO_2 emission, less light pollution, more nocturnal darkness and lower maintenance costs.

The innovation and value of the project is as follows:

- 100% LED-lighting
- 100% sustainable generated energy
- 100% reduction of CO_2 emission

With the implementation of an innovative and sustainable public lighting, Texel hopes to set an example and inspire the many tourists who visit the island and also stimulate other governments and organisations.

Tjörn (Sweden)

The project is called: Eco-friendly society: Cradle-to-Cradle®

The way of travelling should be eco-friendly, safe and comfortably. More travellers should choose to go by public transports. This project aims for a complete self-supporting water supply by taking better care of the available water on the island. By saving surface water the

amount of drinking water increases. Together with an infrastructure project the portal of Tjörn is developed. This portal will welcome visitors to the island and guide them from the start on how to be eco-friendly. A study will be done for a future design of minor ferry route.
A climate and energy plan for the municipality to work as a tool for continuous development in the energy field. The plan has also a purpose by describing the current environment; energy and climate work in the municipality.

The targets of the project are as follows: They want to find future green solutions in the areas of public transport, infrastructure and water.

The innovation and value of the project is as follows: Participating in this project gives them an opportunity to improve and speed up the work with eco-friendly solutions for the municipality.

Table 2. An overview of the various projects the islands in C2CI-project have worked on (factsheets, C2CI-project, www.c2cislands.org)

Some of these islands have been "frontrunners" and had worked on projects right from the beginning of the C2CI-project. These islands could typically build on existing experience because they had been involved in other (EU) projects and/or they had already well established relationships with other C2CI-project partners in advance. By contrast, some other islands had to define their local focus area first, based on an analysis of strengths and weaknesses in relation to the opportunities and threats that the islands were facing.

PART 2

ANHOLT SCHOOL AND CRADLE-TO-CRADLE

2 Anholt School and Cradle-to-Cradle®

Carla K. Smink, Søren Kerndrup, Hanna Byskov Ovesen

In part 1, we have introduced the C2C® way of thinking, the C2CI-project and the various projects that other islands in the C2CI-project work with. Based on this information, Anholt School and Norddjurs Municipality got a better understanding of how C2C® principles could be implemented at the school. In this chapter, originally written in the autumn of 2011, we will describe energy and environmental projects implemented at schools and where C2C® principles have been applied; the examples are both from Denmark and abroad.

Aalborg University (Department of Development and Planning), and Norddjurs Municipality are both partners in C2CI-project. Norddjurs Municipality had chosen Anholt school as focus area for testing C2C® principles (see also part 5), and has asked researchers at Aalborg University for help to come with suggestions for concrete project proposals that could be implemented at Anholt School. According to the municipality, it is obvious to use the C2CI-project to investigate the possibility of implementing sustainable projects on an island that is located so far away from the mainland (see also section 2.2). For Norddjurs Municipality, the C2CI-project on Anholt has to serve as a source of inspiration for other islands, like Anholt and Norddjurs Municipality can learn from other islands (personal communication, Kirsten Bjerg, Norddjurs Municipality, August 2012).

In a C2C® context, it has been instructive to work with Anholt School. The concrete C2C® demonstration projects, as presented in part 1, will hopefully give the school as well as the island itself unique opportunities to test and develop their own projects to meet future challenges. By implementing C2C® demonstration projects, Anholt School can contribute positively to the implementation of the Municipal Plan and the Energy Action Plan of Norddjurs Municipality (2009) and thus set an example for other schools in Norddjurs Municipality as well as for other municipalities.

2.1 Cradle-to-Cradle®: examples from Denmark and abroad

In this section, we will describe energy and environmental projects implemented at schools and where C2C® principles have been applied; the examples are both from Denmark and abroad.

2.1.1 Aalborghus, an upper secondary school – Aalborg

In the autumn of 2011, one of Denmark's largest solar cell panels was installed on top of Aalborghus' new multi-hall. The installation takes up 1,400 square meters and covers the entire roof of the hall. The expected electricity production will be around 90,000 kWh/year, which corresponds to the energy consumption of about 20 single-family houses. The new hall thus produces more electricity than the school itself uses.

The solar cell panels cost DKK 2.5 million (approximately € 335.366) and, according to the supplier – Midtfjord El in Løgstør[3], the payback time is 15 years. The performance guarantee of the installation is 25 years, and with longevity of around 50 years, it is expected to be a good business for the school, states Mads Andersen, project manager of Midtfjord El.

However, it is not only about money, the pedagogical aspect is also important for the school. The solar cell panels will be connect to measuring equipment, so that it can be used in teaching the pupils. The solar cell panels and the new multi-hall are part of a larger building project with a total budget of DKK 33 million (approximately € 4.4 million). The existing west wing of the school has been expanded, renovated and re-insulated. (Nordjyske 2011)

2.1.2 Green Solution House, Bornholm

On 27 September 2011, the Business Centre Bornholm presented an ambitious plan to build a sustainable conference centre (Green Solution House). The Green Solution House[4] is a key element in the Bornholm Bright Green Island strategy. The Green Solution House conference centre is designed and developed inspired by the C2C® principles (Regional Municipality of Bornholm 2012). The purpose is to:

- Be self-sufficient with energy; based on own solar cell panels, windmills and geothermal energy

[3] www.midtfjordel.dk/
[4] www.bornholm.dk/cms/site.aspx?p=1281

- Be in harmony with the natural surroundings (e.g. a roof with vegetation)
- Have its own waste management system
- Produce organic vegetables and fruit for the guest in a greenhouse
- Re-use water and rainwater should be collected
- Be a testing ground for new green technologies

With this green profile, Green Solution House will be an attraction in itself and it is expected to attract more "meeting tourists" to Bornholm than is the case today (Regional Municipality of Bornholm 2012). In that sense, the conference centre will also contribute to the local economy.

2.1.3 Schravenlant School, Schiedam (the Netherlands)[5]

Schravenlant School in Schiedam (the Netherlands) has gone through a major renovation. The school has been largely designed according to the C2C® principles, and is a national pilot for C2C® design. The students and teachers have had a say in the design from the outset; this is unique, at least in the Netherlands. The initiators of the project are Schiedam municipality, the Schravenlant School and the Foundation for Secondary Education in Schiedam. Schiedam Municipality has adopted the C2C® concept in its environmental policy. One result of this policy was a seminar bout C2C® entitled "Building on Sustainability". Teachers from the Schravenlant School took part in this seminar. Teachers and students have been interested in sustainability for years. They developed plans for the new school, which were presented to Schiedam council in 2008 and 2009. Some of these proposals have been included in the design. However, it is not about the school building, it is all about good education. Topics, which are important for the quality of teaching, good education (e.g. the educational environment should be inspiring and healthy; with too much CO_2 in the air, learning ability deteriorates) and being able to learn were the starting point for thinking what the school should be like. This is quite different from thinking about what a good building is. HEVO Consultancy arranged a brainstorming session with Schiedam Municipality, the Schravenlant School, architect, suppliers and third parties. The aim was to

[5] This section is based on http://www.youtube.com/watch?v=L4RqPFALhpg (Dutch movie with English subtitles). (Dubbelklik 2012)

gather knowledge about possible applications and involve parties who want to help to make the project feasible. The architect was asked to apply the C2C® idea where possible. This included using C2C® materials, and energy-neutral building methods. The school's initial aim was to build using the C2C® approach. But in order to succeed, various obstacles had to be taken. Education in the Netherlands is bound to various standard budgets for investment and these budgets are often quite limited. In order to be innovative, it was not asked for: what can we build for this budget? Instead, they gave a financial and economic interpretation to the things they invented, so they knew what it was going to yield. They did not see C2C® as being expensive. They took into account that the school will generate energy and "waste", which can be used elsewhere and the school can ask money for it. These are sources of revenue.

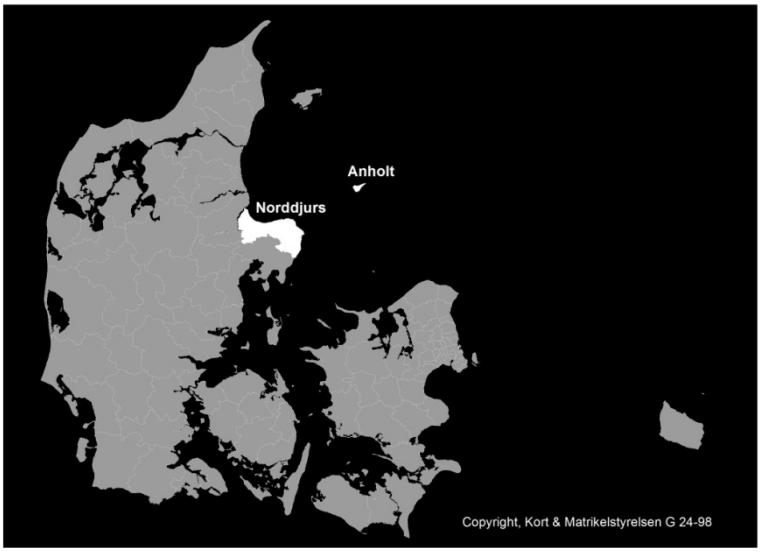
In theory, C2C® is understandable and many elements can be used, but reality can be inflexible. It has not yet been possible to construct an entire building according to the C2C® approach. That poses an enormous design challenge. The Schravenlant project has also been of great interest to the industry. That became apparent at a conference where companies that take a C2C® and low-energy approach were given a change to meet. The Schravenlant project partners were acting as a network node. Companies took the opportunity to enter into agreements and learn about each other's inventions. In due course it is hoped for that this project will become an example of that process. To extend the unique cooperation between the municipality and the school to include cooperation with the industry and to demonstrate the advantages and examples of C2C® and energy conservation is good. It is expected that students will start learning in the new building from August 2013.

2.2 Introduction to Anholt

In this section we will briefly introduce Anholt and Anholt School. The purpose of the section is to introduce the reader to the unique character of Anholt and Anholt School in a Danish context, as well as in the C2CI-project.

Geographical information about the island Anholt

Anholt is the most remote Danish island (see map 2); it takes around three hours to sail between the mainland and the island, which is located in the Kattegat circa 45 kilometres from Denmark and Sweden. There live around 154 people on the island. Due to the remoteness, inhabitants on the island cannot commute to work and to school at the mainland.



Map 2. Norddjurs Municipality and Anholt on the map of Denmark.

Therefore, many service facilities are on the island in the form of day care, school, elderly care, post office, grocery, doctor and priest. Most of the 22 km^2 island and the sea north of the island is designated as nature protection area (Nature 2000 area). This has made the island's unique nature preserved through the years. Wilderness, colloquially "the dessert", represents 85 % of the land area and consists of dunes on land upheaval. The dessert was previously covered by pine forest, but excessive logging created the dessert. Today, eliminating re-growth of pine and fir ensures preservation of the dessert. There are two paved roads on the island, from the harbour to the village. The other roads are gravel roads. All roads are pretty narrow, and as a tourist it is recommended not to bring your car to the island.

Anholt is one of the few Danish islands without an electricity connection to the mainland[6]. The power station on the island supplies the island with electricity using four diesel generators and there is a small windmill in the harbour. Annually, the diesel generators consume around 500,000 litres of diesel to cover the island's electricity consumption, which is rather stable with a load of 100-200 kW, but increases up to six times during the tourist season (Energinet.dk 2012). A consumer-owned energy company (NRGi) operates the power station. In order to ensure the same electricity price for consumers on Anholt compared to the rest of the country, Energinet.dk[7] covers the loss in operating costs on Anholt, which is around DKK 3 million/year (approximately € 402.440/year) (Energinet.dk 2012).

Anholt School

Anholt School was built in 1950 and rebuild and renovated several times, last in 2003. The school exist of three separate buildings that during the years have been built together; the total floor surface is 857 m^2. The school plays a central role in the local community; many people on the island are in one way or the other connected to the school, not only because their children go the school but also because the school is a gathering point for many people on the island.

The school has around 25 pupils, divided as follows (August 2012):

Nursery (0-2 years old)	5
Day Care (3-6 years old)	4
1-3 grade	4
4-6 grade	7
7-9 grade	5

11 people are employed at the school: the school's principal, a deputy manager (nursery/day care), 5 teachers, a pedagogue, a nursery nurse, a

[6] In 2008, the Danish Parliament has approved the erection of a 400 Megawatt offshore wind farm (111 wind mills) in the Kattegat, southwest of Anholt, on the condition that Anholt will be connected with the rest of the national grid. Therefore, from 2014, the approximately 154 inhabitants at Anholt will be supplied with electricity via a 28 km long submarine cable from the transformer platform to the island.

[7] Energinet.dk has the responsibility to provide Denmark with electricity and gas. The Danish ministry of Climate, Energy and Building owns Energinet.dk.

nursery assistant and a janitor. In addition, some teachers are employed for a shorter period of time.

2.3 Project proposals for Anholt School

As mentioned before, Norddjurs Municipality had asked researchers at Aalborg University for help to come with suggestions for concrete project proposals that could be implemented at Anholt School. AAU started to introduce Anholt School and Norddjurs Municipality to the C2C® way of thinking and presented the various projects that other islands in the C2CI-project work with (see also part 1). Next, AAU presented energy and environmental projects from Denmark and abroad that had been implemented at schools and where C2C® principles had been applied (see section 2.2). The purpose of giving all this information was to give inspiration to Anholt School and Norddjurs Municipality to think about projects that could be implemented at the school. This work was done in the fall of 2011.

All the time, researchers from AAU have stressed the importance of the involvement local stakeholders (e.g. the school's principal, the teachers, the pupils, the parents' committee etc.) in the whole process, i.e. from idea to implementation, in order to develop a local ownership of the project.

In January 2012, Norddjurs Municipality and researchers from AAU visited Anholt School. The school's principal, two teachers and a member of the parents' committee represented Anholt School. During the three-days visit, various energy and environmental related challenges at Anholt School have been discussed. Discussions at the meeting were very fruitful and resulted in new proposals for demonstration projects that were tailored to other activities taking place at the school (see also part 5).

Initially, the researchers from AAU had formulated some general project proposals for the school. These proposals had been formulated in the fall of 2011, when researchers from AAU had not visited Anholt School yet. As mentioned before, these proposals were primarily designed to inspire and motivate the local stakeholders to think about the possibilities and challenges at Anholt School to implement C2C® inspired projects. The approach was to give concrete examples of what Anholt School *could* work with.

Norddjurs Municipality has adopted several plans (e.g. the Municipal Plan and an Energy Action Plan, see appendix 1) and strategies (e.g. Climate Strategy) that very well can form a framework for C2C® projects at Anholt School. Through its climate strategy, Norddjurs Municipality wishes to focus on what the municipality can do, to reduce greenhouse gas emissions. As it appears from the Municipal Plan (2009), economic growth should go hand in hand with less dependence on fossil fuels. The goal of Norddjurs council municipal council's is to:

- Ensure a quick introduction of climate-friendly technologies in agriculture, in manufacturing companies, and in industrial and commercial buildings and housing
- Reduce the energy consumption in municipal buildings
- Establish precautionary measures to ensure vulnerable areas against flooding

As owner of the municipal buildings, the municipality has a great potential to influence the buildings' energy consumption and hence the greenhouse gas emissions. The energy consumption can be reduced by modernising the building stock as well as by a behavioural change of the users. The Municipal Council has decided that by the construction of new municipal buildings climate-friendly technologies will be used in order to minimise the building's energy consumption as much as possible.

Norddjurs Municipality shows an interest in the C2C® way of thinking by participating in the C2CI project. The strength of C2CI-project is that all partners in the project can draw on the knowledge and experience from the other project partners, i.e., islands, municipalities and knowledge institutions (universities).

Researchers from AAU suggested Norddjurs Municipality to ask students from the Faculty of Industrial Design Engineering at Delft University (the Netherlands) to come up with proposals for a C2C® school; similar to the

project the students did at Ameland[8] (see part 1). These proposals could support the islanders and Norddjurs Municipality in developing ideas, concepts and images of how Anholt School could look like in the future.

2.3.1 Energy label Anholt School

In June 2009, the school was labelled with energy label G, which corresponds to a high energy consumption. Energy consultant Thomas Kristiansen from Brix & Kamp Ltd came up with a list of proposals for energy-savings and energy improvements for renovation. If all these proposals were implemented, the school could be labelled with energy label F; this is, in C2C® terms, being "less bad". It would cost DKK 423.828 (incl. VAT) (approximately € 56.855) to do all these investments. In our view, that is a lot of money for a rather small improvement. Besides, the proposals for improvement are “business as usual”, the use of renewable energy, which is a key element in the C2C® way of thinking, is not mentioned as a possibility.

Researchers from AAU suggested Norddjurs Municipality to:

- Ask the energy consultant to describe what it takes for Anholt School to be labelled energy label A
- Investigate what a new school, designed according to the C2C® principles, will cost
- Investigate the possibilities of using renewable energy sources at the school for heating and/or electricity

But we have to keep in mind, like in the example of the Schravenlant School and Aalborghus; it is all about good education. This should also be taken into account when designing demonstration projects for Anholt School.

Norddjurs Municipality and Anholt School have chosen to focus on the potentials for using renewable energy at the school for heating, see also part 4.

2.3.2 Anholt School as multi-house

As mentioned in part 1, "celebrate diversity" is one of the key principles of C2C®. In other words, biodiversity, cultural diversity, conceptual diversity and

[8]On Ameland, students from TU Delft designed 8 different C2C® holiday house concepts (“eternal holiday house”), see also part 1. To a different degree, the holiday houses live up to C2C® principles.

innovation must be supported. As stated before, Anholt School plays a central role in the local community. Therefore, the principle “celebrate diversity” is already supported at Anholt School today. For example, the school building is used for teaching purposes as well as for different kinds of meetings. However, there are several other multi-functional possibilities, e.g., in relation to the many tourists who annually visit the island.

Every year, approximately 50,000 tourists visit Anholt. The school can serve as a centre for information on C2C® projects. By doing so, the school can create an attraction value for both islanders and tourists. In relation to the C2CI-project, EPEA has prepared exhibition material as well as boxes with various C2C® products. This material can be exhibited in Anholt School.

2.4 Project proposals

In the C2CI-project, the partnership wishes, among other things, to achieve the following:

- Education for islanders, tourists, children and young people
- Positive results from pilot projects within energy, water and materials
- Transnational network of knowledge institutions, companies, authorities, and other relevant stakeholders, who work within clusters (energy, water and materials)
- Additional financial support from investors and funds to implement pilot projects

Anholt School can contribute to these objectives by implementing one or more demonstration projects. By taking point of departure in the projects carried out by other islands in the C2CI-project, as well as the examples mentioned in section 2.2, the researchers from AAU have identified four areas (themes) that can serve as inspiration to the demonstration projects to be developed at the school. As mentioned earlier, these projects were formulated before the researchers had visited Anholt School. In part 4, a description is provided about the demonstration projects, which the researchers have outlined in cooperation with Anholt School and Norddjurs Municipality, and that have been formulated after the visit to Anholt School.

As mentioned previously (see also section 1.2, table 1), the C2CI-project focuses on three themes: energy (including mobility), water and materials. By the description of possible demonstration projects to be implemented at Anholt School, AAU has taken these themes as starting point (theme written in brackets):

- Waste management (material)
- Water consumption and wastewater management (water)
- Lighting (energy)
- Interior and renovation of the school (material)

2.4.1 Waste management

Currently, a large part of the waste produced on Anholt is transported by ferry to the mainland. A demonstration project on waste management could focus on possibilities to use a part of the island's waste in local material cycles.

Possible demonstration projects in waste management could be to:

- Build a biogas plant
- Develop and build a system where waste (from the school) either is recycled or composted

On Samsø, another Danish island participating in the C2CI-project, they are in the process of designing and building a centralised biogas plant, which will be able to use various resources including waste. In order to design such a project on Anholt, they can obtain information and exchange knowledge with Samsø. Anholt can also obtain information and exchange experience from the Green Solution House (Bornholm, see Part 1), where they build their own waste management system.

2.4.2 Water consumption and wastewater management

Anholt School has its own seepage system. An objective for Anholt School may be that the school cleans its own wastewater and recycles the water (e.g. for toilet flush, watering the garden etc.). Thereby, the school can closed the water cycle.

Possible demonstration projects in water and wastewater management could be to:

- Collect wastewater and use it to produce biogas
- Clean the wastewater so that it can be recycled
- Install vacuum toilets on Anholt School
- Install cistern with washbasin (see picture 1) at Anholt School

Picture 1 Water cistern with washbasin. (Lawson 2010)

At Runde Environmental Centre (REC)[9], they have various C2C® and sustainability applications in the building of REC. For example, they have installed innovative sanitary technology (vacuum toilets with low water consumption and sewage collection for biogas production). Experiences with these applications can be used on Anholt.

2.4.3 Lighting

Another project focuses on energy and lighting at Anholt School. An objective for Anholt School may be that the school produces more energy than it consumes. A possible project could be to install solar cell panels and use the energy in LED lamps in the school. On Texel in Holland, the municipality has

[9] http://www.rundecentre.no/english/index.htm

composed a plan about lighting, the plan provides LED lighting and generation of energy by means of solar panels (LED Light Plan Texel, see part 1).

2.4.4 Interior and renovation of school building

As mentioned in section 2.3.1, the school is labelled with energy label G. The energy consultant came up with a list of proposals for energy-savings and energy improvements for renovation. As we stated, these proposals for improvement are all “business as usual”. However, these suggestions for improvement can be “translated” to have a C2C® focus:

- Use of C2C® certified products at the school (e.g., carpets, furniture, paint on the wall that cleans the air)
- C2C® certified insulation materials
- Windows

Anholt School can draw on the experiences from the Schravenlant School (see above). It is also possible to involve experts from the Danish Building Research Institute (SBI), which is part of AAU, as well as from students and researchers from the Department of Architecture and Design at AAU. Last but not least, Anholt School can discuss these issues with schools on other small islands in Denmark (Danish Small Islands Local Action Group) and develop a project about the interior and renovation of school buildings.

The demonstration projects are an important part of the C2CI-project, and the purpose of the demonstration projects is to show that the C2C® solutions do not only exists in theory but also can work in practice in different sectors and geographical areas. Therefore, it is important that the projects in this section are "translated" into concrete proposals that can be adapted and implemented in the local context of Anholt School.

Appendix 1: Energy Action Plan Norddjurs municipality - municipal buildings

In this appendix the efforts from Norddjurs Municipality with regard to municipal buildings[10] is described.

Municipal buildings	
Description	The action should contribute to creating good buildings to live and be in and at the same time achieve a good operating economy and a minimised energy consumption: • To implement energy management systems in all municipal buildings in order to provide an overview of the energy consumption, with the exception of rental buildings • New buildings are constructed with the use of climate-friendly materials. The building must be constructed optimally in relation to the energy consumption. It is of significance, that the operating costs are assessed in relation to the construction costs. A procedure is proposed that can ensure that new buildings are constructed by low-energy class 1 from 1st August 2010, and from 1st January 2015 after the standard for passive houses, unless exceptional circumstances apply • Existing buildings are optimised with regard to the energy consumption • There will continuingly be held meetings between service staff from the different institutions and the municipality; partly with concrete information, and partly for exchange of experience and dissemination of the good ideas • Regarding the preparation of the renovation plans for all the municipalities buildings, it must be ensured that the repair work carried out is done in a way that reduces the energy consumption as good as possible

[10] For a detailed description of the Energy Action Plan see: www.norddjurs.dk/ref.aspx?id=19190 (in Danish only).

Background	The municipality is a key actor in the efforts of reducing the energy consumption and the municipality can through their actions lead the way by showing good examples. As the owner of the municipal buildings, the municipality has good opportunities to influence the buildings' energy consumption and hence the emissions of greenhouse gases. By bringing energy consumption in focus, it is possible that energy consumption can be reduced, partly by modernisation of the building stock, and partly by a behavioural change of the users. In 2009 and 2010, all municipal buildings were labelled with an energy label. In connection with the review of the buildings' energy conditions, concrete energy-saving projects are created. Projects with a payback period of maximum 3 years should be initiated immediately.
Preconditions and barriers	It is a precondition that ownership is created for the project

PART 3

FOUR DEMONSTRATION PROJECTS AT ANHOLT SCHOOL

3 Four Demonstration Projects at Anholt School

Hanna Byskov Ovesen, Carla K. Smink, Søren Kerndrup

The intention with the discussion paper, as presented in part 1 and 2, was to introduce Anholt School and Norddjurs Municipality to the C2C® principles, this was in the fall of 2011. To a certain extent, the discussion paper has been useful, because the local stakeholders got an understanding of the various opportunities and challenges. However, it was still difficult for the local stakeholders to picture what kind of projects could be implemented at Anholt School. This written discussion paper was supplemented with an oral presentation via a videoconference (November 2011). In January 2012, Norddjurs Municipality and researchers from AAU visited Anholt School.

Based on the discussion paper, the videoconference and the visit to the school four demonstration projects were formulated, all based on C2C® principles, namely**:**

1. Installing **floor heating** that is based on solar power by connecting the floor heating system with solar panel on the roof. The floor in the nursery is very cold and therefore, the children cannot sit on the floor.
2. Installing a special floor that converts **kinetic energy** into electricity; when pupils go on tiles, these tiles convert kinetic energy into electricity. This project focuses on exploiting the learning potentials in "the power of play".
3. Reducing heat loss through **insulation**: there is a large heat loss in the building due to missing insulation in the ceiling.
4. A good **indoor air quality** is an important element in the educational environment. A challenge, which is amplified by the fact that one of the pupils in the school suffers from dust allergies. The indoor air quality can be improved by purchasing a special air filtering carpet.

3.1 Project 1: Floor heating

The primary objective of this project is to show how comfort, learning and well-being can be promoted by the use of renewable energy. The floor in the day care and nursery is very cold. The children cannot sit or crawl around on

the floor. It is not only uncomfortable, but a cold floor also increases the risk of children and teachers getting sick. One of the teachers at the school has stated the following:

"It's a stressful situation to have an ice-cold concrete floor for children that are crawling and lying on the floor, and we fear for injuries. At the moment, we (nursery nurses) use mattresses and pillows on the floor. Seen from the staff's point of view, it is a mental strain to work on such a cold floor where you stand and often sit to play with the children, combined with the thought/knowledge of how the cold influences on the children."

Picture 2. Day care centre/nursery at Anholt School.

A solution to this problem is to install solar panels on the roof and use the collected heat as floor heating in the day care/nursery (see an example in Figure 3). A solar heating system uses energy from the sun to heat the water. The hot water can be used as water for domestic use or – as we propose for Anholt School – for heating the floors and buildings. This means that this

demonstration project is based on the second principle of C2C® (see part 1): use current solar income.

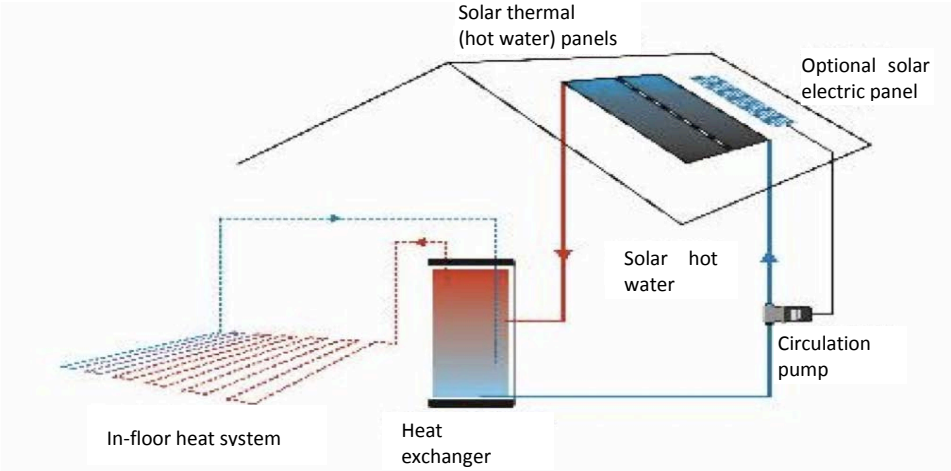


Figure 3. An example of floor heating with the use of a solar heating system (Aladdin solar 2008).

By choosing solar panels, the aim is to take into account the materials used in the production of solar panels so that the panels will meet C2C® as much as possible. If we were able to live up to this ambition, the project would also meet the first C2C® principle: waste equals food.

The value of the system as a demonstration project is to illustrate how alternative approaches for floor heating can promote children's and employees' comfort, learning and well-being in the day care/nursery without having an environmental impact.

3.2 Project 2: Kinetic energy

Teachers at Anholt School wish to teach the pupils how they can generate energy and how their own activities contribute to energy generation and consumption, as they stated:

"Anholt School and nursery have for many years been interested in contributing to children/pupils' environmental education. We are used to bring researchers, engineers and other professionals into the classroom as a part of teaching our

pupils. The C2C® way of thinking has a very good coherence with our community and everyday life in a small isolated community."

This wish has been translated into a project proposal. This project is about learning: how can pupils learn about energy and the way energy is created and used? The pupils learn about energy through converting their footprints into energy when they step on a tile (see also below).

This demonstration project combines the experiences from C2C® in order to create a learning process. The project takes point of departure in the second C2C® principle (use current solar income), since the energy is generated from kinetic energy. By choosing the materials for tiles, which are C2C® certified, they can be part of a "recycling system" whereby this project also meets the first C2C® principle (waste equals food).

There are different ways of creating a learning process. We have chosen to take point of departure in how energy is generated from playing children. One possibility is to install tiles that generate energy by walking or jumping on them. The idea of using these tiles is that each time the pupils walk on the tiles; electricity is generated, which can be used for lamps. In this way, renewable energy in the form of a footprint becomes a part of the pupils' daily routines. In figure 4, it is illustrated how this might look like. The example is from tiles at Simon Langton Grammar School in England.

Figure 4. On the left: The technology behind the Pavegen tile. To the right: Illustration of an exhibition of Pavegen tiles at Simon Langton Grammar School in England. (Pavegen Systems 2012)

The tile is designed to fit into an existing floor. Likewise, the tile is designed for outdoor use in areas with many pedestrians. The tiles are water resistant and thus function effectively both inside and outside. See Figure 5.

Figure 5. On the left: Illustration of how the tile can fit into the existing floor. To the right: Illustration of a Pavegen tile. (Pavegen Systems 2012)

3.3 Project 3: Insulating

The problem we would like to tackle is that the insulation in the nursery and in the ceiling of one of the classrooms is insufficient and leaks. Therefore, the primary objective of this project is to reduce heat loss through better insulation. The size of the roof, which needs insulation, is about 65 m^2 and includes three windows. The insulation materials to be used are C2C® certified.

According to the teachers, the poor insulation has serious negative consequences for the environment, the indoor air quality as well as the educational environment, which makes that insulation of the roof has high priority:

"The south-facing roof of the "old school" is not sealed and there no other form of insulation is used. With winds from the southeast, the wind goes right through the roof and it gets are very, very cold. Often so cold that we have to teach the pupils in the school's kitchen, which is obviously not optimal. When using the oil radiator, a lot of oil is used to no avail. From a working environmental point of view, this is completely unacceptable."

The idea with this demonstration project is to reduce the energy consumption of the school by better insulation. Better insulation means that less energy is used for heating, and that the indoor air quality in the classrooms is improved. At the same time, better insulation makes it possible to apply renewable energy more effectively. Since it is planned to use C2C® certified insulation materials, this project relates to the first C2C® principle (waste equals food). But, since better insulation optimising the use of renewable energy, the project also related to the second principle: use current solar income.

3.4 Project 4: Indoor air quality

Indoor air quality problems are deteriorating in Danish schools, due to the choice of materials and revised building standards. The requirements for insulation and sealing of buildings do also contribute to this. This manifests itself as asthmatic and allergic reactions by more and more pupils.

The primary objective of this project is to demonstrate how the choice of materials, i.e. C2C® certified materials, can help to improve comfort, indoor air quality and the educational environment for pupils and teachers. More specifically, we suggest to improve the indoor air quality by laying a C2C® certified carpet in one of the classrooms. This carpet can filter the air and thereby contribute to improve the air quality and the indoor air quality (see also figure 6). Some schools in the Netherlands have this kind of carpet, Anholt School could learn from their experiences.

The Dutch carpet company DESSO has produced a carpet called "Air Master"[11]. The "Air Master" carpet is designed to capture tiny dust particles without the use of chemical additives. The open structure of the carpet helps the regeneration of the carpet filter function, but also means that the dust is easily released during cleaning. The picture below (figure 6) shows how the "Air Master" carpet works.

[11] This section is based on DESSO (2012).

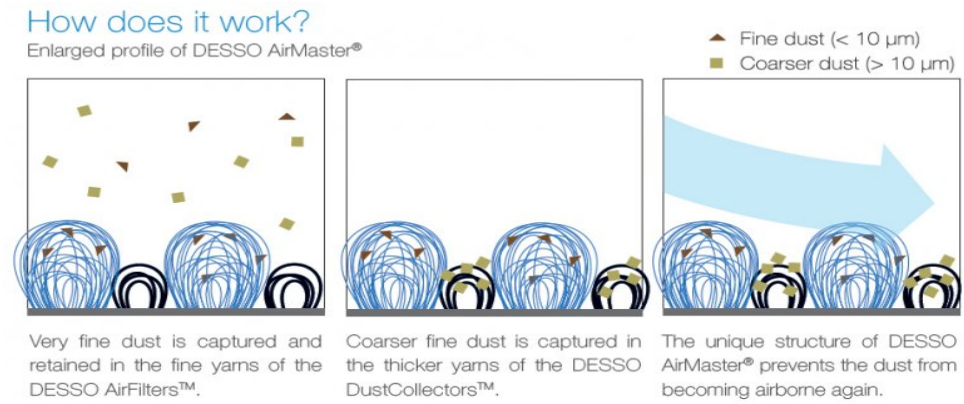


Figure 6. Illustration of how the DESSO "Air Master" carpet works. (DESSO 2012)

The materials of the carpet are produced in accordance with the C2C® principles, which means that the carpet is made from recyclable materials and thus re-enters the technical cycle (see figure 7).

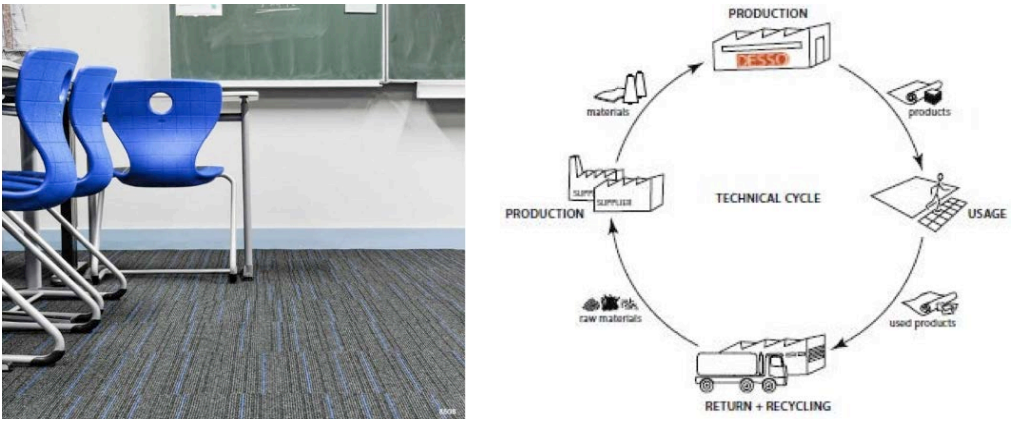


Figure 7. On the left: Illustration of a DESSO carpet. To the right: Illustration of the technical cycle for the DESSO carpet. (DESSO 2012)

PART 4

SKUB BOOKLET

4 SKUB Booklet

This booklet is based on Annette Grunwald's Handbook (2010): ***"How to save energy at schools – an energy-saving and educational development project"*** (translated from Danish by Christina Grann Myrdal).

The booklet is a summary of the handbook. The handbook can be downloaded at: *www.skub.aau.dk/digitalAssets/12/12492_handbog_100410.pdf*

Like the handbook, the booklet is addressed to teachers, technical service personnel, school managements and school boards. The booklet has been prepared to help and support schools that either contemplate carrying out energy-saving activities at the school or wishes to find inspiration for an already on-going project.

The booklet has also been used in the Interreg IVB project "Cradle-to-Cradle Islands" (www.c2cislands.org) with the purpose of achieving energy savings at Anholt School (Denmark).

Aalborg University
Department of Development and Planning

January 2012

Energy-saving activities in schools are often part of the curriculum and therefore have a limited time horizon. Examples are project days or weeks, field trips and so on. Topics such as energy and climate are also addressed in, e.g., the subjects of nature and technology, geography or physics.

To achieve more long-term effects of energy-saving activities, pupils and employees must adapt an energy efficient behaviour – and maintain this behaviour.

Creating energy savings through behavioural change can therefore be a renewable learning and action process at the school for those involved – pupils, teachers, school management and the technical department.

4.1 Why energy-saving projects at schools?

Why is it a good idea to implement an energy-saving project at schools?

Such a project can have many advantages:

- Students can be an active part of the project, and thus they can learn about the coupling of professional learning/theoretical knowledge and solutions.
- The pupils can learn about the connection between action and outcome.
- The money the school saves can, e.g., be used for other purposes.
- The school may serve as "the good example" and can make the surroundings save energy.

An energy-saving project is therefore not just a matter of saving electricity, water, and heat. It is also a project that includes plenty of learning (for both pupils and teachers) in particular attitudes, habits and the organisational culture at the school.

4.2 How is an energy-saving project conducted?

In the following, a description is given of what an energy-saving project can be about and entail if a school wants to carry out such a project.

Prior to project initiation

Before starting on an energy-saving project, it may be a good idea that the school board, management, and staff have discussed and decided on the broad organisational and pedagogical frameworks, as well as on the resources and goals of the project.

This discussion can, e.g., contain the following questions:

- What do we want with the project?
- How does the project fit in with the school's vision on running a school?
- Which professional, educational and social content do we want the project to have?
- Which results do we want to achieve?
- What is the time horizon?
- Which activities do we want to implement and when?
- With whom do we need to co-operate about the project?

Project initiation

When a project is initiated, it is important to focus on information and dialogue – e.g., remember to inform all employees and students about the project.

In order to ensure a good dialogue and information in the initiation of the project, it can be a good idea to keep track of the following:

- What is the purpose of the project?
- Which expectations do we have to the participants?
- Who is the co-ordinator and responsible for continuously following up on the project?
- Who can we address when we have questions and ideas?
- Who is responsible for what?
- Which activities will we implement?
- How do we ensure continuous information to everyone in the organisation?

Establishing an energy-saving organisation

In many energy-saving projects at schools, there is often one or a few persons burning with enthusiasm for the project – but this enthusiasm may fade. Therefore, it is important, in the initiation of an energy-saving project, that an energy-saving organisation is formed who shall serve as the co-ordinator of the project.

This organisation will ensure commitment, learning effect, as well as the achievement of good project outcomes.

There are different models of energy-saving organisations. In the following, some examples of how to organise energy-saving projects are outlined:

- **Green Committee**
  This organisation consists of 2-3 teachers, a technical service manager, and a vice-principal as well as the head of the after-school centre.
  This is applied to Sønderbroskolen in Aalborg.

- **Working environment group**
  This organisation represents the management and the employee groups. The energy-saving project is integrated into the working environment group's work.
  This is applied to Filstedvejens Skole in Aalborg.

- **Environmental Committee**
  This committee consists of 3 permanent members which are the vice-principal as chairman, the head of the after-school centre and the technical service manager. In addition, 3 teachers, a child and youth worker and 3 pupils are part of the committee.
  This is used at Skolen på Duevej, Frederiksberg. Info can be found on http://www.duevej.skoleintra.dk.

- **Energy-Saving Team**
  This team consists of 2-3 teachers and pupils who volunteer for this task, as well as the technical service manager and the school management.
  This model is widely used in German schools.

In all the models, the management, the technical service manager and the teachers must participate in the energy-saving organisation.

If the pupils are not members of the organisation, it is important to determine how they can be involved and engaged in the project. This can, e.g., be through the pupils' council.

In addition, you should consider what management covers; important key persons, such as the manager of the after-school centre, should also be involved in the organisation.

The energy-saving organisation's responsibilities

The organisation's main responsibility is to be the co-ordinator of the energy-saving project. In addition, the organisation serves as:

- A co-operation partner for other interested teachers, pupils, administrative and cleaning staff.
- Liaison with the municipality and external co-operation partners.
- Planner and co-ordinator of the energy-saving project.

In addition, the organisation has some tasks, i.e., the organisation must:

- Make sure that an energy review is performed and an assessment is made of the school's energy consumption.
- Convene external actors for counselling, sparring, etc.
- Register shortages.
- Respond to deviations (sudden high electricity, heat or water consumption) and investigate the reasons for the deviations.
- Make sure that energy-saving activities are implemented.
- Provide information about energy consumption and energy costs.
- Provide continuous information about the project to colleagues and pupils.
- Collect ideas for savings from pupils and colleagues.

Offhand, the organisation seems to have many tasks – but the members do not have to do it all by themselves. They may choose to delegate some of the tasks.

The important issue is that the organisation has a unifying, co-ordinating and initiating function in relation to the energy-saving project.

The energy-saving organisation and the pupils' learning and participation

The organisation of an energy-saving project may have major implications for the learning motivation of the pupils and their long-term commitment to the project and process. Key questions are: which role do the pupils have in the project and which conditions are created for their professional, creative and social learning processes in the project?

In Figure 8, an attempt has been made to outline and describe three levels of the pupils' involvement.

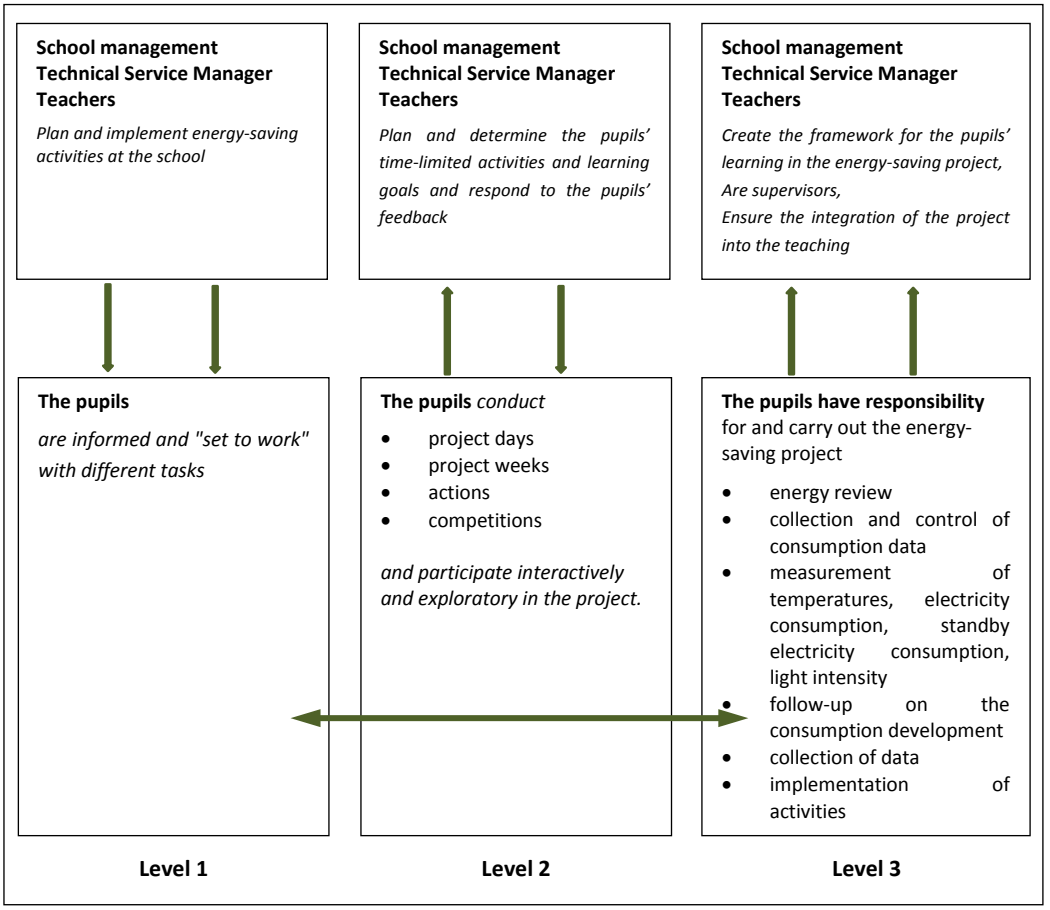


Figure 8. Illustration of three levels of pupils' involvement and learning in the energy savings process. (Grundwald 2010)

Level 1 will not have any lasting effect or any significant learning effect for the pupils.

The difference between the levels 2 and 3 is the degree to which the pupils are involved in the planning, the implementation, and the evaluation of the project – including which responsibilities they have.

Level 3 will be able to ensure a long-term process, which is required to implement behavioural changes. It gives the pupils a larger role in the project and it is coupled with the school's main goal: teaching. This will motivate both teachers and pupils.

Co-operation with others

An energy-saving project may have several possible co-operation partners:

- **The municipality**
  Collaboration with the municipality is an important part of the project. The municipality outlines the framework conditions for the school's work with energy savings, and also determines how the economy may serve as a motivation for the schools.

- **The local energy company**
  This is an important co-operation partner because the company possesses the technical expertise and has extensive experience in energy consulting. The energy company may, e.g., help with the energy review, find saving potentials and outline the potential for cost savings; put energy data at the school's disposal and also help to adjust the ventilation and heating system properly.
- **Others**
  Other key co-operation partners in an energy-saving project may include parents, local businesses, educational institutions, former pupils or teachers, and pupils from other schools.

Energy review of the school

An energy review of the school can provide an overview of the school's energy consumption (electricity, heat and water) and also the school's energy consumption pattern.

Therefore, the energy review provides information on potential problem areas, but also well-functioning measures.

The energy review is a "mapping" of the school and therefore serves as the "foundation" for the further work at the school.

For an energy review, various types of information must be collected, such as key figures for heat, electricity and water, as well as a statement of the school's electricity, heat and water consumption over a 3-5-year period.

An energy review can provide information about:

- **The use of unnecessary resources**
  (E.g., open windows, lights and operating appliances or turned on radiators in unused rooms, etc.).
- **Minor shortcomings which can be remedied with very little resources**
  (E.g., dripping taps, a draughty window, doors that do not close properly, unnecessary lights, etc.).
- **Problems with regulations**
  (E.g., adjustment of the ventilation or heating systems, a system stop when there is no need for it, etc.).
- **Potentials for better organisation**
  (E.g., merging events, changed planning, etc.).

Who should carry out an energy review?

There are different models for carrying out an energy review:

- External parties and participants from the school perform the energy review.
- The energy-saving team examines the school and uses checklists to facilitate the work.
- Pupils carry out the energy review together with a technical service manager. Different classes may divide the tasks among them.

No matter how the energy review is conducted, it is important that the pupils and teachers go through the school after the review and examine the energy use and the saving opportunities to achieve an understanding of these.

Results of the energy review

An energy review results in a description of the saving potentials for the school.

It is a good idea to prioritise the saving potentials, in order not to lose momentum. The prioritisation can be a subdivision in, e.g., short-term projects (problems that can be solved immediately), medium-term and long-term projects.

In the beginning, select an area in which the savings are easier to achieve, in order to have a successful experience. Subsequently, it is a good idea to make an action plan for the projects, which, e.g., may include the following:

- What have we decided to do and which goals will be achieved.
- Who does what and who is responsible for carrying it through.
- When should it be implemented.

An example of the content of an energy review

An energy review can include the following:

- The school's goal
- Basic information
- Consumption statement
    - Electricity consumption
    - Heat consumption
    - Water consumption
    - Key figures
- Already established routines at the school
- The organisation of the energy-saving initiative at the school
- Suggestions for energy savings
    - Electricity consumption
    - Heat
    - Water

The implementation – the energy-saving process at the school

In order to continue the motivation for the energy-saving project, it is important that everyone can follow the energy-saving activities and their results.

Therefore, it is an essential part of the project to make regular information on the energy-saving project available to pupils, staff, parents, and the public. This can be done, e.g., by the use of a board. In this way, the energy-saving project is visualised.

This board can, e.g., be used to display:

- How much energy the school uses.
- How much it costs.
- Which activities are initiated to save electricity, heat and water.
- This year's consumption compared to last year's consumption.

Pictures, examples, and graphics make the board more inviting, clear and informative.

It is important that the consumption data are coupled with the school's energy budget and the school's targets for the energy-saving project.

In order to implement the energy-saving project, it is important that there is an on-going dialogue and targeted communication in the organisation.

To ensure that the communication is good, the following questions can be asked:

- Do all participants feel that they have received timely information to the extent necessary?
- Have all objections been heard? And have they been taken seriously?
- Does everyone, even those not directly involved, have knowledge of the project?

It is important that positive results as well as problems are communicated – this gives a reliable picture of the project.

A way to support the motivation is to show the achieved results, recognise the positive results, and reward particularly dedicated pupils, classes or employees.

It is important that both employees and pupils think that it is exciting to be involved.

Economy as motivation

Savings achieved through behavioural changes are special, as a sustained effort is required to achieve and subsequently to maintain the savings level at the school.

Generally, the municipal schools' energy budget is established as an average of the last 3 years' consumption of electricity, heat and water.

This means that if the school is active in achieving savings, then it receives a lower award from the municipality the following year. The school that increases its consumption gets, on the other hand, a higher allocation. By saving energy in a shorter and limited period of time, the school will thus be penalised financially compared to other schools that are not doing anything. Therefore, the main principle ought to be that each school must receive the total profit created through the savings.

Aalborg Municipality's pilot scheme introduced at 5 municipal schools in 2010 is an example of a motivating incentive for schools. It has the following content:

- The point of departure for the statement of the savings were index year 2008

- The schools settled the actual consumption in kWh of electricity and in m^3 of water (cold / hot).
- The consumption was converted to kroner (DKK) at a current energy price.
- An "incentive pool" was arranged, where schools pay 1% of the total energy budget. The aim of the pool was to support schools in relation to unforeseen events and reward good examples of energy efficient behaviour.

From 2011, the scheme is extended to all schools in the municipality. If a school has used more energy than budgeted, the school must finance its extra cost; but if the school has used less than budgeted, it can keep the money and use it according to the school's own priorities, e.g., teaching, etc.

The scheme also includes a savings requirement of 2% per year in relation to the Municipality's sustainability and climate strategy. To achieve this over a longer period of time, it will be necessary to supplement behavioural savings with continuous investment in effective technological solutions. The scheme is continuously evaluated.

The cooperation between the municipality and the schools will generally be able to support the schools in their work and provide them with manageable framework conditions over a longer period of time. This can be done through a binding co-operation, e.g., as shown by examples from Germany. The municipality represented by the school administration commits itself to reimbursing funds saved for the schools. In return, the schools commit themselves to implementing various initiatives and to initiating a process that integrates the project into the organisation and into teaching. This process involves a series of steps, which means that the following must be made:

- A brief description of the school and the school's current activities within the environmental field.
- An overview of the planned precautionary measures and activities of the planned project.
- An assessment of the necessary funds.
- The school's consent to participation in the project.
- The designation of a contact person at the school.
- The declaration from the technical manager on participation in the project.

- The implementation of a pedagogical day within the first six months of the project with the topic "Climate protection and energy savings".
- A declaration from the teachers expressing that they will consistently support and apply the project's learning goals in their teaching, at events outside teaching, and in interdisciplinary work at the school.
- A declaration from the school which confirms that the school will assist in the further development of the project by providing help in terms of documenting of the results.

The above points can serve as inspiration for the co-operation between the schools and the municipality, but may also be an inspiration for the development process at the individual school.

How much is it possible to save?

Through the so-called SkoleDuel competition (School Duel), the schools have on average reduced their electricity consumption by approx. 13 % and their heat consumption by 15 % (info can be found on www.seas-nve.dk)

SEAS-NVE assesses that many schools can save up to 25 % of their current total energy consumption through behavioural changes.

How much can be saved depends a lot on the school's initial situation; if there has already been a focus on energy savings or not, and whether there is a continued focus on behavioural savings.

Potential problems and barriers in the Process

Problems and barriers can be found in many different parts. If a project is not working properly, it may be a good idea to examine the reason for this and identify what can be done to solve the problems.

Barriers may be found in one of the participating groups: pupils, teachers, management, technical staff, and parents. But it can also be based on a conflict between the participating groups.

Causes of barriers or problems can, e.g., be:

- Lack of time
- Lack of resources
- Lack of commitment

- Lack of support from the management or other groups
- Lack of involvement of one or more groups at the school
- Lack of understanding of the value of the project
- Lacking or late information about the project and the project process
- Conflict of interests
- Different levels of ambition

Important experiences from other Schools

The following is a list of important experiences that other schools have defined as important to the energy-saving project:

- On-going information by the school board and the school board's definition of the energy-saving project as a focus area for the school.
- Subsequent planning and implementation of the energy-saving project at the school's pedagogical council meeting.
- The project tasks must be distributed among many people in order not to overload the individual too much.
- A clear division of responsibilities must be made at the beginning of the project by the energy-saving team or project manager.
- The work in the energy-saving team must be continuous.
- External partners must be involved from the beginning.
- Focus must be kept on selected activities.
- Small steps must be taken – expectations must not be too high at the beginning.
- Activities with the greatest potential for savings must be selected as a first choice.
- The project must be characterised by persistence and continuity (successes, such as the achievement of financial savings, do often not appear right away).
- The internal acceptance and support of the project of the groups involved must be promoted through targeted information
- The people involved must not be frustrated by structural or technical shortcomings at the school which have an impact on energy technologies and savings

PART 5

DEVELOPMENT AND IMPLEMENTATION OF THE DEMONSTRATION PROJECTS

5 Development and implementation of demonstration projects

Søren Kerndrup and Carla K. Smink

In this chapter, we will describe the development and implementation of demonstration projects at Anholt School. The chapter can be read as a separate chapter, but more information is available in the other parts of this report.

It has been important for the participating islands in the C2CI-project to develop and implement demonstration projects that contribute to capacity building at the local level, as well as contributing to improving the local economy. Development and implementation should preferably also contribute to improve the islands' development potential. Implementation of demonstration projects, networking with other islands and actors, as well as connecting different (environmental and energy) projects can create such a potential.

In the C2CI-project, participants did not have a "recipe" of how to use C2C® principles best. An important part of the C2CI-project was to develop and implement demonstration projects that took the local situation at the island as point of departure. As mentioned in part 1, some islands in the C2CI-project have been so-called "frontrunners", i.e., these islands have been working on demonstration projects right from the beginning. Other islands had to define their focus area first. The situation on Anholt was quite different from the other islands in the C2CI-project, since Norddjurs Municipality, located on the mainland (see also map 2, page 35), had taken the initiative to participate in the C2CI-project. In the beginning, the project on Anholt did not have well-defined objectives and goals; on Anholt there was no group of stakeholders that took ownership for the project.

Therefore, the first task on Anholt was to identify a focus area and to identify stakeholders that would take ownership for the project. Norddjurs Municipality asked researchers from AAU to help to identify a focus area on Anholt. After several meetings between Norddjurs Municipality and researchers from AAU, it was agreed upon to focus at Anholt School. It was

evaluated that the school was a good focus area for developing and implementing C2C® demonstration projects; the municipality is the owner of the school and has an interest in improving the environmental performance of the school. The school has many environmental challenges, and many people on the island are in one way or the other connected to the school, not only because their children go the school but also because the school is a gathering point for many people on the island. Since Anholt is a very small island, the school plays a central role in the local community – it was expected that activities in the C2CI-project relatively easy could achieve a broader anchoring in the development of the island.

As described in the first three parts of this report, researchers from AAU have introduced Anholt School and Norddjurs Municipality to the C2C® principles (part 1). Besides, researchers from AAU have introduced the school and the municipality to demonstration projects developed and implemented on the other islands participating in the C2CI-project. These projects could serve as inspiration for the school and the municipality when choosing demonstration projects that could be implemented at the school (part 2 and 3). Both the school and Norddjurs Municipality have been involved in the whole process in order to ensure ownership.

PlanEnergy[12] has been chosen to provide assistance to the technical details for the demonstration projects as well as by helping implementing the demonstration projects. PlanEnergy is a consultancy company and is experienced in implementing energy projects in a local context. Besides, PlanEnergy has previously been working on projects on Anholt and in Norddjurs Municipality.

The main challenge in implementing the demonstration projects was to "translate" the project ideas so they matched the specific technical, social and economic conditions at the school. It was important for the municipality to integrate the project proposals in the existing school buildings; this "translation process" happened as much as possible with the school's stakeholders and local workmen. In this process, it was also important for the municipality to ensure that the local competences on the island would be strengthened and developed. This has created a number of challenges for

[12] http://www.planenergi.eu/

PlanEnergy. In collaboration with the local stakeholders, PlanEnergy experimented with different possible solutions in order to create as much value for money as possible.

5.1 Planning and implementation processes

In this section, we will describe in four steps how the demonstration projects have been planned and implemented. These four steps are:

1. Identification of one or more focus areas
2. Identification and development of a common project/problem understanding amongst the actors involved
3. Specification and description of demonstration projects based on local priorities
4. The practical implementation of the demonstration projects

Step 1: Identification of one or more focus areas

As mentioned in part 1, the C2CI-project ran from January 2009 until summer 2012. In August 2011, Anholt School was chosen as a focus area to implement C2C® demonstration projects. Norddjurs Municipality had until then participated in partner meetings organised under the auspices of the C2CI-project. Various previous attempts to start projects on Anholt had not been successful. There was a very limited knowledge of and interest in the C2CI-project on Anholt. This was partly due to the fact that there had been controversies between the islanders and Norddjurs Municipality and among the islanders themselves.

As mentioned before, the school was an obvious choice to implement C2C® demonstration projects because: 1) the school has some environmental challenges; 2) the school has well-defined stakeholders; and 3) Norddjurs Municipality (as project partner in the C2CI-project) owns the school building.

Once the school was chosen as a focus area, Norddjurs Municipality asked researchers from AAU to inform the school's main stakeholders (the school's principal, staff representatives and members of the parents' committee) about: 1) the C2CI-project; 2) demonstration projects developed and implemented on other islands; and 3) possible demonstration projects that could be implemented at the school (see also part 1 and 2). Researchers from AAU chose to write a discussion paper that accounted for these aspects. This written discussion paper was supplemented with an oral presentation via a

videoconference. The participants in the videoconference had quite different backgrounds, which made it difficult to "understand" each other. The intention with the discussion paper and the oral presentation (videoconference) was to create a dialogue, to exchange ideas as well as to minimise the "language" barrier between the participants in the conference. However, it was difficult to create a common language in this setting. The discussion paper and the videoconference only partly facilitated a dialogue between the various participants; but it had the positive side effect that the local stakeholders continued the discussion and had a brainstorm after the videoconference. It was chosen to organise a videoconference, because Anholt is a very remote island (see also part 1), and it had not been possible for researchers from AAU and Norddjurs Municipality to visit Anholt at that time. It was assessed afterwards, that it had been better to organise a face-to-face meeting.

Nevertheless, the discussion paper and the presentation helped to develop new project ideas. As said before, the local stakeholders continued the discussion and had a brainstorm after the videoconference. The brainstorm resulted in a very concrete project proposal; it was suggested to find a replacement for the oil-fired boiler and the two oil tanks (current heating system at the school). Furthermore, three people (two teachers and a member of the parents' committee) decided that they would like to participate in a working group to identify, develop and implement demonstration projects at the school. By this, the school was formally approved as focus area in the C2CI-project.

Even though there had been various obstacles on the way, it had been possible to establish a working group of local actors, who took ownership for the project and who were willing to spend time on identifying possible demonstration projects at Anholt School. The working group, together with researchers from AAU, would explore opportunities to use C2C® inspired demonstration projects to improve the school's environmental performance.

Step 2: Identification and development of a common project/problem understanding amongst the actors involved

As mentioned under step 1, there had been controversies between the islanders and Norddjurs Municipality and among the islanders themselves. These controversies had to do with previous activities and projects on the island; projects and activities were understood and interpreted differently by the islanders and by Norddjurs Municipality. As a result, the people on Anholt

had been very sceptical whether the C2CI-project would be different from these previous activities and projects, and whether the C2CI-project would create value on the island. Taking this into consideration, taking the school – and not the island as a whole – as a focus area has been an obvious choice.

Step 1 has been an important step in creating interest and support amongst the stakeholders at the school in getting them involved in the C2CI-project. As mentioned before, the brainstorm amongst the local stakeholders on Anholt resulted in a very concrete project proposal; it was suggested to find a replacement for the oil-fired boiler and the two oil tanks. But still, it was difficult for the local stakeholders to imagine how the project could create value for them, how they could contribute to the project and what exactly was expected from them. It was therefore decided to organise a meeting on Anholt, where researchers from AAU, Norddjurs Municipality and the working group from Anholt School – together with the school's principal would participate in. The aim of the meeting was to elaborate upon the content of the C2C® principles and the possibilities to implement these principles at Anholt School.

In January 2012, Norddjurs Municipality and researchers from AAU visited Anholt School. During the three-day visit, various energy and environmental related challenges at Anholt School have been discussed. The visit has been important for developing a common problem understanding as well as creating a mutual trust amongst all participants. Both these aspects have been crucial for identifying and developing proposals for demonstration projects. Discussions at the meeting were very fruitful and resulted in new proposals for demonstration projects that were tailored to other activities taking place at the school.

Based on the discussions at the meeting in January, it was decided to investigate the possibility of developing projects that helped to improve and support activities at the school within four areas, namely (see also part 4):

1. Installing **floor heating** which is based on solar power by connecting the floor heating system with solar cell panels on the roof.
2. Installing a special floor that converts **kinetic energy** into electricity; when pupils go on tiles, these tiles convert kinetic energy into electricity.
3. Reducing heat loss through **insulation**: there is a large heat loss due to missing insulation in the roof.

4. A good **indoor air quality** is an important element in the educational environment.

By formulating these demonstration projects, it was taken into account that only a relatively small budget was available; DKK 135.000 (approximately €18.000) was available for implementing demonstration projects and DKK 245.000 (approximately €33.000) was available for consultancy support.

Researchers from AAU have investigated various possible demonstration projects and have consulted Katja Hansen from EPEA to ensure that the projects would comply with C2C® principles as much as possible. With regards to demonstration project 1 (floor heating), we had to consider the pros and cons of using respectively solar cell panels and solar heating. By choosing one option rather than the other option, we could have taken into account the materials used in the production of solar cell panels and solar heating; for various reasons (e.g., limited resources, time and budget). However, we have chosen not to take these material requirements into consideration. In relation to demonstration project 3 (reducing heat loss through insulation), it was possible to use C2C® certified insulation materials. With regard to demonstration projects 2 and 4 (kinetic energy and improving indoor air quality), the connection to C2C® was directly through cooperation with EPEA. Both demonstration projects take point of departure in products that are developed and/or approved by EPEA.

Based on all this information, a new paper (see also part 4) was written. In the paper, four concrete demonstration projects were presented. It was now up to the local stakeholders on Anholt to discuss the pros and cons of the proposed demonstration projects as well as to prioritise the demonstration projects. Prioritising the four demonstration projects was important due to the limited funds available to implement all four demonstration projects.

Prioritising demonstration projects

Anholt School's principal prioritised the four demonstration projects. She gave first priority to installing floor heating based on solar power. The school's principal had given this project first priority for two reasons. In the first place, this demonstration project would improve the functionality of the nursery to a high degree. In the second place, the demonstration project has a high "demonstration value". This demonstration value is ensured in two ways: 1) it

is a good way to profile the school's energy efforts, and 2) it is a good way to show all islanders and visitors possibilities for renewable energy projects.

Reducing heat loss through insulation was given second priority. This project also improves the functionality of the school, i.e., the educational environment for the pupils at the school. Furthermore, the project has an important demonstration value, due to the fact that C2C® insulation materials will be used.

The project "kinetic energy" was given third priority. The project was considered to be important, as it direct links to a school's core business: education and learning. The project was, however, given a lower priority because it is easier to implement such a project with other funding. The project "improving indoor air quality" focussed too much on a single product (carpet). The local stakeholders were uncertain of the effect of a carpet cleaning the air. Besides, this demonstration project did not have a clear energy focus; focus was too much on materials. This project was therefore given the lowest priority.

Step 3: Specification and description of demonstration projects based on local priorities

Due to the limited budget in the project, Norddjurs Municipality and Anholt School decided to start investigating the possibilities for implementing demonstration project 1 (floor heating) and 3 (reducing heat loss through insulation). Norddjurs Municipality asked PlanEnergy to investigate the potentials in these two projects and implement these projects to the extent possible within the available budget. Hereby, the importance of involving local stakeholders (e.g. subcontractors, workmen) in the design and installation of the demonstration projects was emphasised.

PlanEnergy has faced various challenges in the implementation process. These challenges can be divided into three categories:

- *Conceptual challenges*. Challenges related to how a project is put into practice,
- *Contextual challenges*. Challenges related to the constellation of existing facilities, buildings, actors and practices,
- *Economic challenges*. Challenges related to the available budget.

Demonstration project 1: ”Floor heating”

The *conceptual challenges* in relation to the demonstration project “floor heating” have been significant with regard to fulfilling one or more of the C2C® principles. The aim with this demonstration project was to install floor heating, which was based on solar power by connecting the floor heating system with solar cell panels on the roof; pumps based on solar cells would activate the floor heating. Unfortunately, this concept had some limitations in relation to the specific context in which solar energy would be used. According to PlanEnergy’s assessment, this design would have some limitations for heat production; the pumps would stop if there was no direct sun, why it was not possible to utilise the heat of the panels.

The second challenge concerned the *contextual challenges*. There was no simultaneity of production of energy in the solar cell panels and the need for heating; when the need for heat was high (winter) solar heating output was relatively low. PlanEnergy recommended making some changes in this demonstration project (see also below). Cooperation with the school’s janitor has been crucial in the deliberation on the design of the system (see also below); the janitor has given good information about the existing energy system, and the specific conditions at the school (e.g. energy consumption). Therefore, the system was designed in such a way, that it was possible for the janitor to install the system and thus reduce costs for sales and installation.

The third challenge was an *economic challenge*, which was closely related to the contextual challenges. A visit to the school revealed that the floor in the nursery was from 1958. This meant that a new floor with improved insulation had to be installed before it would be sensible to install floor heating, both from an energy-saving and an economic point of view. Replacing the floor and installing insulation was not possible within the available budget for the project.

As briefly touched upon, PlanEnergy proposed a number of changes in the demonstration project. One of the changes was to connect the solar cell panels to the heating system. This made an improved utilisation of the energy production possible. Anholt School and the local stakeholders perceived this change in the demonstration project as a disappointment. Floor heating had played an important role in the motivation and commitment to the project by the working group and the school’s principal. The “floor-heating project” was

not just about reducing energy consumption and to get a more comfortable room to be in, the project was also about "new" learning opportunities (e.g., teaching pupils about how energy is produced). However, there are good opportunities to implement the original demonstration project in the future. It was therefore proposed to connect the solar heating system to the energy system and actively work on the future financing of insulating the floor (e.g., through a pool of municipal money for renovation and improvements). It was estimated that once the solar heating system was in place, Norddjurs Municipality would be interested and willing to start renovating the old floor; the solar heating system and the floor heating system could then easily be connected.

In this project, stakeholder involvement has been essential to make decisions on how to redefine this demonstration project. Even though it was difficult for the local stakeholders to contribute to the conceptual challenges, they have done a good job. They have been active and constructive in developing new solutions that make a potential future connection of solar energy with the floor heating system possible. Besides, they have been active and constructive in thinking about options of how to find funding for renovation and investments.

Demonstration project 2: "Insulation"

There were no immediate *conceptual challenges* in relation to the choice of materials, which all comply with one or more of the C2C® principles; C2C® insulation materials are available on the market. The challenges in this project were of a *contextual* and *economic* nature; and these two challenges were closely related. A visual inspection of the school showed that the insulation in the nursery and in the ceiling of one of the classrooms was insufficient and leaked. There was therefore a need to seal the construction in order to reduce the draught and loss of heat in these rooms. In collaboration with local workmen, it was assessed that the best solution would be to seal the space under the eaves in the classroom, to fix insulation and to establish vapour barriers. Basically, this solution involved improvements of existing insulation, and not insulation of new surfaces. It was therefore assessed to use the same materials as already used in order to avoid that the materials could not work together.

The *economic challenge* for this demonstration project was that it had been decided that the solar heating project had first priority. There was allocated DKK 100.000 (approximately € 13.400) to the solar heating project, while the remaining DKK 35.000 (approximately € 4.700) could be used for the insulation project. Consequently, the insulation project had lost its value as an independent demonstration project. However, the project has indirectly been important to profile the school in relation to the use of renewable energy. The use of renewable energy requires that the school reduces energy losses and thus improves the possibility that renewable energy sources can cover a larger part of the total energy consumption of the school.

For all of these challenges, both in relation to demonstration project 1 and 2, interaction and cooperation with local stakeholders has been important. PlanEnergy has benefited from local knowledge, experience and core values on the island. This has been crucial for the way the technical solutions could interact with the specific socio-cultural values on Anholt.

In the next section (step 4) it will be described how the need for capacity building and use of local resources have played a role in the way the procurement and installation of the demonstration projects was organised.

Step 4: The practical implementation of the demonstration projects

The practical implementation of the demonstration projects on Anholt has created new challenges. There were, among other things, a series of "practical" problems. These problems could impossibly be predicted and/or taken into account beforehand in the project descriptions. Since the implementation of the demonstration projects is not yet complete, we will in this section focus on the challenges that arose in the first phase of the implementation process.

The first challenge was that all four demonstration projects had a strong focus on local capacity building through the use of the local stakeholders' competences. This prioritisation had consequences for the conceptual development of the projects. The demonstration projects were put out to tender based on the conceptual development of the projects. This meant that focus was put on identifying and assessing the stakeholders' potentials and possibilities through dialogue, so that it was possible to implement demonstration projects within the C2CI-project's limited budget.

The second challenge was that with only two till three months left in the C2CI-project, time was a limiting factor in implementing the demonstration projects. This short deadline limited to a high degree the kind of capacity building that could be realised. The short deadline also meant that it was only possible to use already existing competences, skills and organisations, while long-term capacity building measures were eliminated.

The third challenge was related to the limited budget for the demonstration projects. The limited budget influenced the choice of technologies and suppliers and also forced the project to focus on the cheapest possible alternatives. If there had been a larger budget and more time, C2C® principles could have been utilised to their full potential in the demonstration projects.

The limited scope (time and money wise) of the practical implementation of the demonstration projects meant that there quickly arose situations where we had to improvise and develop alternative solutions regarding outlining the plans; e.g., when one of the key local stakeholders in the project changed job and moved from the island. Consequently, PlanEnergy, researchers from AAU and the school's principal had to "invent" new ways to organise and configure the work, in order to ensure that the key elements of the project were implemented. The project partners managed to make use of local resources and knowledge; this has been an important and vital resource for the implementation of the demonstration projects at Anholt School.

In the following, it will be described how the implementation of the projects was challenged by the emergence of some unforeseen practical problems, and how these were resolved through creative improvisation. The solutions were based on the involved stakeholders' expertise and experience in implementing and developing locally based energy and environmental projects, as well as mutual trust between all participants in the project.

Demonstration project 1: "Floor heating"

As described above, the solar cell panels and the installation procedure was designed in such a way that it could be installed and set up by the school's janitor, who was a trained plumber. This way of organising the work had various advantages: 1) it was possible to use local skills; 2) it was relatively cheap; 3) the project could be implemented relatively fast. However, this all changed when the school's janitor shortly before the solar cell panels had to

be ordered and installed, announced that he could not install the system because he changed job and would move to the mainland in the near future. This meant that implementation of the demonstration project came under pressure. The immediate alternative was to let the installation company from the mainland, who was supposed to cooperate with the janitor, make an offer to install the solar cell panels. Unfortunately, this proved not to be a sustainable option. The offer made by the installation company was too expensive; it would not be possible to implement the demonstration project within the available budget. It has not been possible to find another installation company to take over the job, partly because the Danish market for installation of solar cell panels is booming at the moment due to upcoming changes in transfer energy prices for consumers. Consequently, it is a big challenge for the project partners to find local workmen that are able and willing to take over the job within the steadily shorter time. It is especially a challenge, because none of the local workmen on Anholt is active in this line of business. In cooperation with each other, PlanEnergy, researchers from AAU and the school's principal are exploring how to implement the project. Three possible business models have been suggested:

1. *Locally based business model (1)*. In this model, one local workman takes ownership for the project. But since none of the local workmen on Anholt has all the skills necessary to carry out the project, other local workmen with supplementary skills have to be involved as well.
2. *Locally based business model (2)*. In this model, local workmen take ownership for the project, but PlanEnergy is involved in the project as consultant, since they have experience with installing solar heating systems.
3. *A mainland based model (3)*. A business model where an installation company from the mainland, supplemented with local competences and a local workforce, will carry out the project.

At the moment, project partners are working on the first model. This model is favoured above the other two models because it does not only contribute to capacity building on Anholt; the model also contributes to improving the local economy.

Demonstration project 2: ”Insulation”

As described above, the insulation project is implemented in close cooperation with a local workman, which means that business development is an integrated part of capacity building. Considerations about how to carry out the project, is done through an active dialogue between PlanEnergy and the local workman.

The involvement of local competences in designing the project has been crucial to implement the project within the planned framework. Since the project mainly consisted of making improvements in the existing building, the challenge was primarily to use existing craft skills. As a result of this strategy, there have not been requirements for the development of knowledge about new environmentally friendly materials, which are C2C® certified. The close cooperation with the local workman allowed great flexibility in the organisation of the work. It was therefore possible to initiate and carry out the work within the limited resources available, both economic and time wise.

The insulation project has helped to emphasise the potentials of using local competences within a project with limited resources. Prioritisation of the floor-heating project meant that the insulation project’s primary task was to improve the existing building through repairs to the existing leaks and missing insulation. This meant that the demonstration project primarily consisted of the use of traditional materials and competences, so the project no longer qualifies as a demonstration project. Nevertheless, the project offers a significant contribution to the school’s overall energy and environmental performance. Therefore, the project can be seen as a necessary and important part of creating a better school, both energy and environmentally wise.

The local stakeholders and workmen have been introduced to C2C® methods, and these methods have been included in PlanEnergy’s discussions with the local workmen about how the demonstration projects can be implemented and developed. Besides, these discussions have helped to develop an understanding of what is required to use the methods if they were to be used in the future.

PART 6

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This report has been written on the basis of the work Aalborg University (AAU) has carried out in the Cradle-to-Cradle Islands project (C2CI-project) (www.c2cislands.org) on Anholt. The C2CI-project is an Interreg IVB North Sea Region project with 22 partners from 6 countries around the North Sea. The project ran from January 2009 to summer 2012. The leading vision of the project was to see islands as innovative centres that implement Cradle-to-Cradle® solutions. The main goal was to develop innovative solutions in the field for energy, water and materials using Cradle-to-Cradle® (C2C) principles as a guide.

The focus of this report is on demonstration projects using C2C principles as a guide that can be implemented at Anholt School. Anholt is part of Norddjurs Municipality, who is a project partner in the C2CI-project and owner of the school. The project at Anholt School is conducted in cooperation with Norddjurs Municipality, Anholt School and the parents' committee. To assess whether the project proposals fit with the purpose of the C2CI-project, we have received good input from EPEA (www.epea-hamburg.org).

Not all demonstration projects described in this report have been implemented at the school. However, discussing and planning the demonstration projects will be an important part of Anholt School's journey towards becoming a C2C-school. A journey that is not yet completed and, as with all journeys, there will be modifications to the projects along the way. This is an essential part of a learning process. At the moment, two demonstration projects are about to be implemented at Anholt School; one project is about a solar heating system and the other project is about insulation.

According to the municipality, it is obvious to use the C2CI-project to investigate the possibility of implementing sustainable projects on an island that is located so far away from the mainland. For Norddjurs Municipality, the C2CI-project on Anholt has to serve as a source of inspiration for other islands, like Anholt and Norddjurs Municipality can learn from other islands.

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