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Eurbanlab
Accelerating urban innovations

Executive Assessment Report

Innovation Case: "Lyceum Schravenlant"

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Version 7.0 of the B4U-tool

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Project overview

The 40 year old building of Lyceum Schravenlant was in need of extensive upgrading. Like many old school buildings, the school struggled to keep the temperature and carbon dioxide levels in classrooms at acceptable levels. Providing students with good education starts with the provision of a good learning environment. In a participatory and integrated design process, the aim was to design and build a climate neutral school along the principles of the Cradle2Cradle philosophy.

The project performed well in terms of reduced energy consumption and climate resiliency, as well as the procedural aspects during its development. The Cradl2Cradle concept and BIM-method, as applied in this project, are interesting concepts that can be applied in different contexts, but they require significant time & effort from developing parties to be used and implemented correctly.

Location
- The Netherlands
- Schiedam

Urban Domain
- School for secondary education

Type of Innovation
- Energy
- Water management
- Organisational
- Material use

Size
- One school building
- 5712m^2 usable floor area
- 6040m^2 gross floor area

Investment value
- €10 million
- €1 million for added sustainabilty

Dates
- Design: 2010
- Completed: 2013

Client
- SOVOS (Stichting Openbaar Scholengroep Vlaardingen Schiedam)

Service provider(s)
- P. van Leeuwen construction
- LIAG architects
- HEVO projectmanagement

Other key words
- ATES system
- Cradle2Cradle
- Solar energy
- Green roof
- Greywater systems

Introduction

In many classrooms of Dutch old school-buildings, it is a struggle to keep indoor temperatures and carbon dioxide levels at acceptable levels[1]. Very few schools have ventilation systems other than natural ventilation and the simple opening of a window. A poor indoor climate affects the learning performance of students. Moreover, many schools are poorly insulated, resulting in high energy bills that affect the school's budget.
Unfortunately, the Dutch financing system for schools is a significant barrier for the implementation of sustainability measures (Hopman, et al., 2013). A combination of split incentives and fixed budgets that are insufficient for current standards, inhibit the build or renovation of more sustainable schools.

The 40 year old school building of Lyceum Schravenlant, located in the municipality of Schiedam, was in need of extensive upgrading to keep the temperature and carbon dioxide levels within classrooms at acceptable levels (HEVO, 2013). In 2009 the municipality and the school-board investigated the two scenarios; new build and renovation. Next to the provision of a healthy learning environment for its students, the school had the ambition to become climate-neutral (i.e. no CO_2-emissions) and to renew the school along the lines of the Cradle2Cradle philosophy. Given the state of the building and the ambitions, new build was preferred as the total cost of renovation would be significantly higher.

This pilot project was implemented to explore the possibilities for the built of sustainable and healthy schools, with the Cradle2Cradle concept as the leading principle. In short, the aims of the project were to:

- Built a CO_2-neutral school (i.e. no carbon dioxide emissions during its exploitation)
- Reuse of waste materials
- Use renewable energy sources
- Be energy efficient
- Have an EPC[2] <0,3
- Have a Greencal label A
- Have a GPR score of 8 on average

[1] http://www.rvo.nl/onderwerpen/duurzaam-ondernemen/gebouwen/frisse-scholen

[2] The Energy Performance Coefficient (EPC) is an index to express the energy efficiency of a building. A building with an EPC of 0,3 means that it uses 30% of the energy when compared to an average building that was built in the 1990s.

1 Description of the Innovation

The main aim of the new building was to replace the old school building with a more pleasant working environment for its students. A central aim therein was to increase the indoor air quality, combined with other aims to improve the comfort, such as acoustics and opportunities for social interaction. Because schools have an important societal purpose, and are mostly financed with public funds, the second important aim was to develop a sustainable school. Lyceum Schravenlant is designed to be a CO_2-neutral building and was fully developed along the principles of the Cradle2Cradle philosophy (LIAG, 2013).

Why is it innovative?
The Netherlands has been a pioneer in Cradle2Cradle (C2C) thinking for many years, but this is the first time that a school was designed with C2C as the leading principle, and has implemented a number of Cradle2Cradle certified materials (Bögl, 2014). Next to the technical aspects, the project is innovative because of the implemented Building Information Model (BIM), as well as the involvement of students, teachers and market parties during the design phase (a combination that makes the design process inherently integrated and participatory).

Main features of the Innovation:

- Cradle2Cradle philosophy incorporated in the design
- Aquifer Thermal Energy Storage system (ATES)
- Use of solar energy (for electricity and hot water)
- Green roof for rainwater infiltration and re-use
- Participatory design process
- Integrated design and construction process
- EPC 0,5 (60% better than the norm for schools in 2011; EPC 1.3)
- Frisse scholen A label (highest label for comfortable schools)

How does it work?
The following paragraphs provide a short outline of the sustainability measures and the BIM methodology.

<u>Sustainability measures</u>
The Cradle2Cradle design is based on the following principles:

- Material Health: Impact on humans and the environment. Value materials as nutrients for safe, continuous material flows.
- Material Reutilization: Maintain continuous flows of biological and technical nutrients (recycle)
- Renewable Energy: Power all operations with 100% renewable energy
- Water Stewardship: Regard water as a precious resource
- Social Fairness: Celebrate all people and natural systems, a positive impact on community

That the Cradle2Cradle concept served as an inspiration in the construction of the school means that much of the materials used in the building (except for the concrete) are re-usable. To reduce

the heating and cooling costs, the insulation of the building has improved significantly. In support of the sustainable energy principle, an Aquifer Thermal Energy Storage (ATES) system has been installed to supply in the school's heating and cooling demand. This entails that, unlike other school buildings, Lyceum Schravenlant is not connected to the natural-gas network, but gets its heat (and during summertime the cold) from groundwater-wells under the building. The showers in the gym are supplied with hot water from the solar collectors on the roof, and part of the building's electricity use is covered with the solar system, that comprises about 200m^2 or 120 individual panels (Peutz, 2013).
The basic heating in the building is provided for by "concrete activation", through heat pumps and thermal storage in the soil. Additionally, the ventilation-air is heated or cooled with a heat recovery unit or by using the cool air from an unused nearby classroom. A sophisticated climate system with CO_2 sensors continuously calculates what is more advantageous in terms of energy; using the electric pumps of the ATES-system or to reuse the heat or cold from the air already in the building. To support the water stewardship principle, all toilets are flushed rainwater that has been collected and purified by the green roof. The humidity in the atrium is partly controlled by a large wall of moss near the entrance.
The building is prepared for the future as it allows for new technologies to be implemented as soon as shorter payback periods allow for their implementation (e.g. a wind-turbine). Moreover, during construction, the team took into account any future growth or shrinkage of the building by implementing an installation set-up that is related to a standard grid size and by installing flexible walls. A good grid size that has been tailored to the use of a building leads to an optimal use of its layout and indoor spaces.

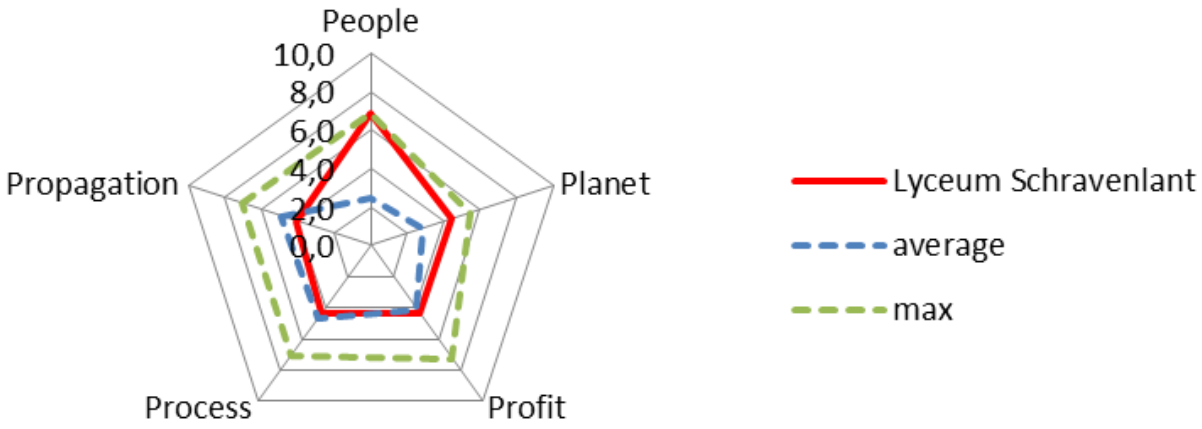
Building Information Model

The BIM methodology has been central in the design process of this project. BIM is a method to facilitate an integrated design process in which all parties work together at the same time, and reduces the costs of failure (SBRCURnet, 2014). One of the essential elements of BIM is communication. In contrast to the traditional design and construction process, all parties involved in the built of Lyceum Schravenlant (such as the client, architect, consultants, contractor and installer), have worked together in one model (and file), in which all the data that is needed for the design, construction and management of the building was linked/culminated. Where drawings and documentation of developing parties in the traditional design process are "thrown over the wall" to the next party in the chain, the BIM methodology stimulates an integrated approach. Often all parties sit together in sessions and work together on the model; inserting their data, adapting the design on the go. Changes to the design are quickly discussed, agreed upon and integrated into the model.

The BIM method allows information (such as drawings, calculations, building dimensions, reports) to be culminated and to be used efficiently by all parties. The advantage of working in one model is that all parties use the same data. This allows all parties to see where the bottlenecks of certain measures are (clash control) and if all requirements are met. In addition, it is possible to link the model to an energy efficiency calculation and to estimate the EPC-value that follows. This process requires different skills and mind-sets from parties involved. Identifying, resolving and communication of issues goes many times faster than current practice in the design process (ibid).

2 Impact overview

In the Eurbanlab assessment, the Cradle2Cradle inspired school building of Lyceum Schravenlant performed exceptionally well on the indicators in the People, Planet and Profits categories, and scores slightly below the Eurbanlab average in the Process & Propagation categories.



2.1 People

With many of the Eurbanlab indicators directed towards the evaluation of residential buildings, the assessment of Lyceum Schravenlant has had a particular focus on the social effects of the new building on its users.

▲ **Connection to the surroundings**

The school is part of the green ring around the city and has been situated and designed to provide a clear and inviting appearance towards the city. The distinctive colour has been chosen to form a sharp contrast with the surrounding dark brick buildings (Bögl, 2014). Although the school does not necessarily fit within the environment or connects with the existing cultural heritage, the design positively contributes to the appearance of the area. Given the socio-economic issues in the area, the bright and modern design can be seen as a positive influence that can add to the overall feeling of the neighbourhood.

▲ **Comfort & sense of place**

Similar to residential areas, 'sense of place' in schools refers to a feeling of safety, vitality, identity and other aspects that make the building comfortable and inviting for its users. With the comfortable schools programme of the Dutch government as a leading concept (AgentschapNL, 2012), a lot of attention has been directed towards increasing the thermal, visual and acoustic comfort of the building. The building is open, spacious, has a lot of natural light and large windows which increase the sense of place. The large central hall is inviting, stimulates social interaction and serves as a central point in the building.

▲ **Easily accessible by public transportation**

There is a small train station at 750m from the school and a tramline runs right in front of the building, with a stop at 350m. Together with dedicated bike lanes, the school is highly accessible for students and visitors.

▼ **Mixed-use building**

The new building functions as a modern and sustainable landmark in the area. Given its new appearance and sustainability profile, it is unfortunate that the building's sole function is of educational origin. The building's impact could be positively influenced by an increase in activities such as a centre for culture or the community. Given the socio-economic status of the area, the new and futuristic building could have a positive influence on users of the building.

2.2 Planet

In the Eurbanlab assessment methodology, the school has a significant effect on the energy performance and climate resiliency indicators. However, the school scores below average mainly because there has been little information available on sustainable construction materials, despite the prominent place of the Cradle2Cradle concept in the project.

▲ Adaptation to climate-change

Although climate adaptation has not been a central topic in the design of the school, there are a number of implemented adaptive measures (such as the green roof or the white façade), albeit for different reasons. The white façade for example was added mainly because of aesthetic reasons, but has the added benefit that it helps to reduce the build-up of heat inside the building (Bögl, 2014). Relatedly, insulation has received considerable attention in the design of the school, to retain the warmth from electric appliances, the people in the building and the added heat (or cooling) by the ATES-system. Special windows in the roof provide in natural lighting, but reflect the heat from the sun.
Lastly, the project site includes a significant share of green/pervious surface (47%) which adds to the infiltration capacity of rainwater during heavy rainfall. However, no additional research has been conducted to determine the possibilities for adaptive measures or the specific needs in the area. For example, no data has been gathered on a possible increase in rainfall over the coming years, including the current suitability of the grey water system or the green roof.

▲ Reduction in building-related energy consumption

The project has resulted in a significant improvement of the building's energy performance for heating, cooling and hot water provisioning. When compared to contemporary school buildings of similar size in the Netherlands, a reduction of 90% has been achieved in final energy consumption for building related energy. The building has a primary energy consumption of 25kWh/m^2 UFA, a significant improvement when compared to the primary energy performance of contemporary schools (103.6kWh/m^2 UFA).

Switching from natural gas consumption to an increased electricity consumption for heating with an ATES-system, has a discernible impact on the energy performance and CO_2 emissions. The use of electricity for heating purposes becomes truly sustainable when it is sourced from renewable energy sources such as wind or sun. In this sense, Lyceum Schravenlant is future-ready and equipped to generate its own electricity in the future, boosting its sustainability performance even further.

▲ Sustainable materials

With the Cradle2Cradle principle as a leading concept, sustainable materials have received a more central role in the design and built of the school. Examples include the use of FSC-certified windowpanes, the re-use of materials (old lockers have been refurbished and reused), C2C certified materials such as marmoleum, and the facades of the school have a wooden skeleton that is FSC certified. Native wood was preferred because it reduces transportation and therefore reduces CO_2-emissions for the construction of the building. Unfortunately this was not available on the Dutch market. Initially the ambition was to use significant quantities of bamboo in the school, but this was not a viable option financially (van Huis, 2014).

▼ **Quantification of sustainable materials**

Although the previous point exemplifies the attention in the project for sustainable materials, there has been little attention for the documentation of these materials. As such, it has been impossible to quantify the amount of renewable or recycled materials in the building. Without exact figures in the share of recycled, renewable or recyclable materials it is impossible to determine or to communicate on the overall effect of sustainability concepts such as the Cradle2Cradle initiative. Hence the share of applied sustainable and Cradle2Cradle materials in the total building seems to be of minor significance.

▼ **Sustainable transportation**

To increase the sustainability footprint of the school, the premises could have been equipped with charging stations for electric vehicles, to be used by teachers or visitors.

▼ **Renewable energy**

In support of the renewable energy principle, an ATES-system has been installed to supply in the school's heating and cooling demand. This entails that, unlike other school buildings, Lyceum Schravenlant is not connected to the natural-gas network, but gets its heat (and during summertime the cold) from the ground-layers under the building. Moreover, the showers in the gym are supplied with water that is pre-heated with the solar collectors on the roof, and part of the building's electricity use is covered with the solar system, that comprises about 200m^2 or 120 individual panels (Peutz, 2013).
However, energy provided by ATES-systems is not considered to be a renewable source in the Eurbanlab assessment. The building is expected to produce about 15mWh of solar energy, which is little over 25% of the total energy consumption. The rest of the electricity has to be bought on the market and should have a renewable origin to make the school truly climate-neutral.

2.3 Profit

In the Netherlands, investment budgets for the construction of schools are standardized. This standard is based on a "lean and efficient" form of schools, which is related to the way of building in the early 90s of the last century. In order to meet the modern and widely anticipated "social quality" of schools, that are suitable to provide good education for the next decades, a supplementary effort (i.e. investment) is already required. To reach high ambitions in terms of sustainability, considerably more creativity and resources are needed (Adriaanssen, 2014).

▲ **Reduced energy bill**

Before the new built of Lyceum Schravenlant, the school had a significant energy bill due to the poor state of the building (mainly natural gas-consumption for space heating). In theory, the school can reduce its energy bill by 80%. Current numbers on electricity use, however, show a significant rise in consumption. This is to be expected because the systems are only running a couple a months, and need to be regulated.

▼ **Subsidies & Dependency on loans**

As described in previous sections, an inherent problem in the built of sustainable schools is the dependency on subsidies and loans from the government. At least 35% of the project costs in Lyceum Schravenlant were covered by subsidies. A loan from the municipality covered most of the remaining costs.

- **15 year payback period**

  Based on the above mentioned reduction in energy bills, a payback period between 10 to 15 years is possible. At the moment operational and maintenance costs are not yet know, but the real payback period will likely be around 15 years.

Description of the Business model

Often there is quite a price tag involved in becoming truly sustainable. In the development of Lyceum Schravenlant only measures with a maximum payback period of 15 years were selected. The application of Cradle2Cradle materials, however, were mostly uncertain during development of the project. Apart from two expectations, the team could realise the most sustainable measure against the lowest payback period.

Due to the fixed budgets in the context of schools in the Netherlands, it was impossible to achieve an A-label in the 'Comfrotable Schools' program. Also the ambition to build a climate-neutral school by applying an ATES-system and solar energy required an extra investment that could not be covered by the available budget.

Together with the municipality, the school established a financial construct with which the measures could be applied. The municipality of Schiedam offered the school a loan for the extra investment. With the energy costs that the school would otherwise have had to pay, the loan paid back to the municipality.

3 Lessons learnt and further propagation

3.1 Context description

The context in which the urban innovation of Lyceum Schravenlant was implemented (in particular the sustainability measures and the Cradle2Cradle concept) can be characterised as highly supportive. The innovation benefitted from a specific demand and supportive regulatory frameworks for its implementation. The following paragraphs will outline the context in which Dutch schools have to operate, and the deviating context for Lyceum Schravenlant.

Split incentives
The financing of sustainability measures in schools is an important, if not the most important, barrier for implementation (Hopman, et al., 2013). Traditionally, the municipality is the principal financer for new school buildings. In accordance with the Law on secondary education, the educational institution becomes the owner of the buildings and the grounds in the legal sense of the word, but the municipality continues to bear the initial economic risks.
In this present system, the municipality is responsible for the initially high investment, whilst the school-board is responsible for the exploitation and profits from lower exploitation costs after new built or renovation. To cover the costs, municipalities receive an annual compensation from the Municipal Fund of which the amount depends on the number of enrolled students. In other words, municipalities and school-boards have a, more or less, fixed budget that is always present.

Within this system of fixed budgets and split incentives, schools have to be renovated and built more sustainably in the coming years. According to HEVO, becoming more sustainable – either to the level required by law, or going beyond that level – is always more expensive. Schools are not built to be very sustainable because of the related costs and split incentives. However, by focussing on TCO from the beginning, instead of total construction costs, and by setting a fixed payback period, individual sustainability measures become more transparent. Focussing on TCO and payback periods also allows for weighed decisions to be made for more sustainable measures with higher initial costs, but still can be covered with the exploitation costs. Lyceum Schravenlant has received several subsidies and loans from the municipality to increase the sustainability of the new school building (about 12% extra investment costs). The revenue that is generated during the exploitation phase should cover the additional costs of the sustainability measures (Adriaanssen, 2014).

Outdated norms & low budgets for sustainable schools
As mentioned in the previous section, the investment budgets for the construction of schools are standardized. This standard is based on a "lean and efficient" form of schools, which is related to the way of building in the early nineties of the last century. In order to meet the modern and widely anticipated "social quality" of schools, that are suitable to provide good education for the

next decades, a supplementary effort (i.e. investment) is already required. To reach high ambitions surrounding sustainability and comfortable schools, considerably more creativity and resources are needed (Adriaanssen, 2014). The budget for newly built schools allow for a label C to be built in the comfortable schools label. The budget is insufficient because the government has adopted outdated norms for, amongst others, indoor-climate.

Connection to market demands & Supportive government
Lyceum Schravenlant benefitted from a clear demand for sustainability, and in particular the adoption of the Cradle2Cradle philosophy. The municipality of Schiedam had adopted the Cradle2Cradle-principle in their climate-change policy since November 2007 (Gemeente Schiedam, 2010). Sustainability, and in particular the C2C-concept, was introduced long before planning of the new school began. The children at the school were introduced to the concept in class and by the local environmental organisation (government funded).

3.2 Process

Leadership in sustainability & Government support
Leadership appears to have been an important enabling factor in this urban innovation. Especially the ability of important actors at the government and in the project management agency to lobby and to connect important stakeholders, were determining factors for the success of the Lyceum Schravenlant concept.

The local centre for Nature, Environment and Education (NME) had already educated the students for several semesters about sustainability and Cracle2Cradle thinking in request of the municipality (van Huis, 2014). When the intention for the built of a new school were made public, the municipality organised a seminar on "Construction and Sustainability" in 2008 with students and lecturers from Lyceum Schravenlant. The aim of this exploratory workshop was to help adapt the school building to the educational philosophy of the school, and has helped to spark enthusiasm for sustainability; especially the Cradle2Cradle philosophy. Students and lecturers became so enticed by the idea that they actively started to lobby for a sustainable approach in the new school building (ibid). According to the municipality, this enticed the school-board to further investigate the possibilities for adopting the C2C-principle in the design for the new building.
In order to find interesting partners to work with in the built of the school, HEVO organised a unique meeting in the early stages of the design process. Suppliers, architects, teachers and constructors were brought together to brainstorm about materials and applications for C2C building (Dubbelklik, 2011). Not only did this provide an overview of the C2C-market itself, it also generated ideas for possible applications of Cradle2Cradle products.
The environmental officer of the municipality was enthusiastic and actively engaged in the project. This provided the opportunity to lobby at the government (e.g. the permit department) to speed things up or to make future changes to the school (e.g. expansion with wind energy) possible. Not only the environmental officer was very much engaged and remained active until the project was finished (which is normally not the case), other parties such as the construction company also showed persistency to make the school as sustainable as possible. The application of bamboo and

sufficient solar panels was uncertain because there was no financial room for their application, despite the subsidies. However, the team sat together and made sure that their application could be financed (van Huis, 2014).

Selection procedure
Between March and May 2010, the school board, the staff and the municipality developed a "Statement of Requirements" in which the requests and wishes for the new building were drafted (Hevo, 2010). In parallel, the municipality of Schiedam asked Royal Haskoning - an independent, international engineering and project management consultancy firm – to determine the feasibility and options for sustainability and the Cradle2Cradle principle. This research preceded the definition phase in which the final Statement of Requirements is drawn up and the design phase is started. Moreover, the research laid the basis for the definition of criteria for the selection of designing parties such as the architect, constructor, installation consultant (Royal Haskoning, 2010; van Huis, 2014).

Assembling of a motivated project team
Based on this research the municipality and school-board selected the parties to be involved in the further development of the school. About 30% of the criteria were directed towards the sustainability of the parties to be selected, whilst another 30% of the criteria were financial. The environmental policy officer of the municipality had asked Royal Haskoning to pay special attention to economic feasibility and payback periods in the assessment and steered on sustainably oriented parties to be selected (van Huis, 2014).
Setting an ambitious goal and clear targets to reach that goal will attract like-minded actors. A political vision from the government is not enough to reach ambitious sustainability goals. The project team found that sustainability needs to be at the core of partners involved. There is also a need for willingness to take risks and invest themselves, both for the client and the contractor. With such a team, barriers become pieces of a puzzle, instead of limitations (Adriaanssen, 2014).

Different financial constructs & Clarity in the additional costs of sustainability
In order to build schools that go beyond the norm, innovative financing methods and willingness to invest are prerequisites. Lyceum Schravenlant has benefitted from a supportive government that provided a loan and subsidies to increase the sustainability of the new school building. With the revenue that is generated from energy savings, the loan is returned to the municipality.

But even with the additional financing, some measures such as the application of bamboo and solar energy were impossible. Because the architect and constructor were very much engaged in the project and wanted the project to be as sustainable as possible, ways were found to save money in certain aspects of the project to finance the sustainability measures. Moreover, by prioritising sustainability measures based on their payback period (everything < 15 years) a very clear picture is made that is different from the more normative way of communicating as can be seen in other innovative projects.

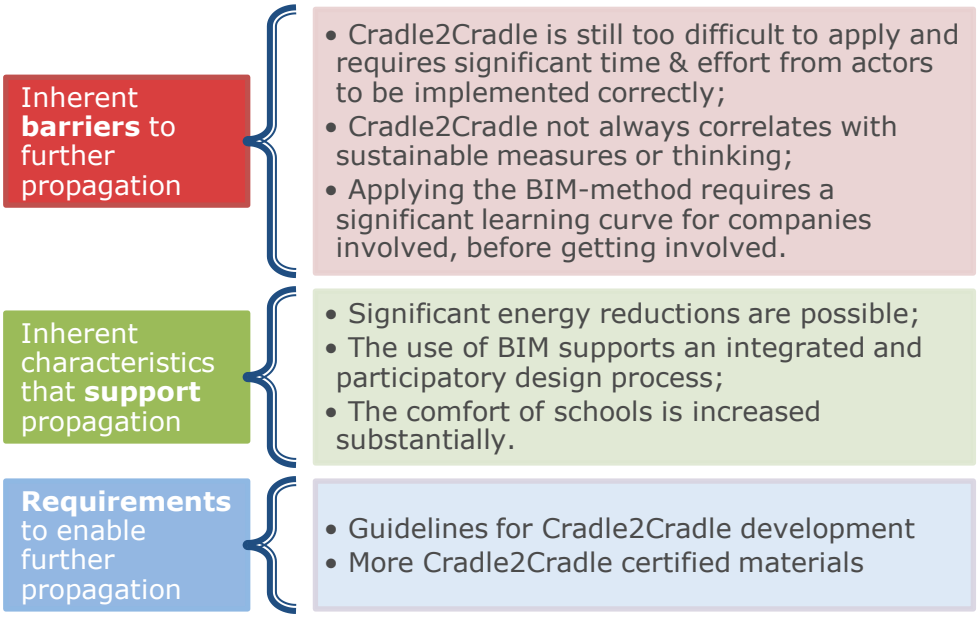
Participatory & Integrated design
The early involvement of stakeholders in the design and built of Lyceum Schravenlant is an often mentioned factor of success in its development. The before mentioned involvement of students, teachers and market parties lifted the status of the project and provided new opportunities.

The BIM-method is praised for its ability to bring together different expertise in the early stages of development and to make the impact of decisions immediately visible.

Cradle2Cradle concept too vague to be practical for developing parties
The Cradl2Cradle concept still is too new and undefined to be practical in construction processes. In the built of Lyceum Schravenlant, many of the crucial and in-depth decisions with regards to C2C-materials, had to be taken during the development process. Moreover, due to the absence of guidelines, actors that normally are not engaged in this step of the process (installer and/or construction company), had to dive into the matter themselves to determine which material fits the concept best. It appears that there are too many considerations to deal with during the development process. To enhance the process, next projects should determine beforehand which materials to use for what purposes (windowpanes, the façade, floors etc.).

3.3 Propagation and its requirements

The possibilities for propagation of the concept as applied in Lyceum Schravenlant to increase the sustainability of buildings are moderate. Some of the most relevant factors that could enable further propagation are discussed below. There are however, also some barriers and requirements that should be addressed in order for the concept to be applied at different locations.
In general the concept is very interesting for further propagation, but it is dependent on motivated stakeholders with an extensive knowledge on sustainable construction materials, and the supply of more Cradle2Cradle certified materials and guidelines.



The applied concept in Lyceum Schravenlant, including the Cradle2Cradle philosophy, BIM-methodology and sustainability measures such as the ATES-system, provide significant benefits for users of the building. The evaluation has shown that large energy-reductions are possible and the comfort of the building has increased substantially.

Complexity of the Cradle2Cradle concept
The Cradle2Cradle concept as a leading principle in the design of sustainable buildings, appears to be too complex for stakeholders to work with effectively. Moreover, little certified materials are available on the market and there is no overview of available materials. The C2C-philiosophy does not always correlate with prevailing views on sustainable construction. The choice for building materials with the lowest possible environmental impact and recycling options do not necessarily fit with the Cradle2Cradle philosophy. Aluminum for example requires a lot of energy to produce, but is infinitely recyclable in the same quality; not sustainable, but does fit the Cradle2Cradle philosophy. Such considerations in the use of materials are prevalent in working with C2C as the leading principle and requires significant time & effort from developing parties.

The concept would therefore benefit from better tools, guidelines and certified materials to support the build of sustainable buildings by using the Cradle2Cradle philosophy. Future projects would also benefit from a definition stage in the design process in which decisions on materials to be used are clearly defined.

Clarification of the Cradle2Cradle concept and addressing split-incentives
The split incentives in the financing of sustainable renovation or new built of school buildings in the Netherlands, as explained in previous chapters, is a known barrier and initiatives are underway to change this system. As of January 1st 2015, municipalities will transfer some of their responsibilities to the school boards. The boards will now be more self-governing in the maintenance (indoors and outdoors) and in improvements of the buildings. However, extensive expansion and new built will remain the main responsibility of municipalities. If this legislative change will generate more initiatives at schools for the implementation of more sustainable technologies and measures remains to be seen.

Opportunities and Constraints of the BIM-method
The BIM-methodology has been an important element in the project development. According to the stakeholders in the project, the method is a tool that allows users to use a wide variety of information and data. Instead of 2D images, the model provides in 3D models of the plan and increases the transparency of measures in the design of the building. However, the learning curve of working with BIM is quite steep. Unlike, large companies who are working with the model for some time already, the model is mostly new to SMEs and requires some time to get used to.

Compilation of a motivated project team
As a last requirement for further application of the concept as applied in Lyceum Schravenlant, the stakeholders in the project mention the necessity of a highly motivated team with the expertise to implement the combination of measures.

Conclusion

The evaluation of Lyceum Schravenlant has shown that the applied concept, with main features the Cradle2Cradle philosophy, the ATES-system and the BIM-methodology, has resulted in significant improvements in terms of comfort and environmental sustainability.

Lyceum Schravenlant makes use of technologies that are rather well-established in current practice. Increased insulation, together with the use of solar energy, ATES-systems and smart ventilation systems are relatively easy to implemented. As a guiding principle the Cradle2Cradle philosophy works well. To be truly sustainable, however, application of the concept needs significant ambition, expertise and insight into the effects of construction materials or sustainability measures on the overall environmental footprint. Actors willing to work with the Cradle2Cradle philosophy, have to operate in the absence of clear guidelines and a limited amount of certified materials.
By working with the Building Information Model (BIM), some of the effects will become more apparent. However, BIM requires a development process that deviates significantly from current practice as explained in previous chapters. The steep learning curve of BIM can be an important barrier for further application of the methodology, but more stakeholders are learning to use the method every year.

The school's environmental performance can be further improved by increasing the share of renewable energy in the total consumption. In future Cradle2Cradle inspired projects, the developing parties would do well to pay special attention to the share of recycled and renewable materials in the building. By quantifying and reporting on such figures, the environmental performance of ambitious projects becomes more apparent and easier to communicate. However, within the constricting financing context of fixed budgets and split-incentives in the current Dutch system, the development team of Lyceum Schravenlant has achieved a remarkable result in terms of sustainable building.

Data sources and Assessment quality

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Background information on the Eurbanlab assessment methodology

What is the aim of the Eurbanlab assessment (B4U)
Eurbanlab aims to accelerate the transition towards low-carbon climate resilient cities. To do so, the "Benchmark for You" (B4U) was designed to identify those urban innovations that substantially contribute to the sustainability of the urban environment, and have the potential to be widely applied in other locations. "Urban Innovations" are identified as urban development projects that incorporate systemic innovations, in which new or modified concepts, systems, products and/or techniques are used, which contribute to low-carbon, climate resilient development on the scale of a neighborhood or upwards.

What is the B4U?
The B4U is a comprehensive indicator-based assessment methodology that has its basis in the environmental & social sciences. Comprising over 60 indicators, the method uses a combination of qualitative and quantitative indicators that were developed together with actors in the public, private and academic sector. Because not all aspects of a project can be caputured in indicators, the B4U also includes a rigourous descriptive assessment. Finally, by comparing the project's sustainability impact and transferability with other Eurbanlab assessed projects, the B4U provides an overview of effective sustainable solutions that are currently available on the market.

Measuring impact on People, Planet & Profit aspects
Following the Triple-P approach, the indicators under "People" determine a project's contribution towards the long term attractiveness and liveability of urban developments. The "Planet" category revolves around two core aims of Eurbanlab; *'low-carbon'* (less consumption of fossil fuels and additional generation/use of renewable energy), and *'climate resiliency'* (the capability to cope with impacts of climate change). "Profit" stands for economic viability of the concept and the value of a project for a neighbourhood, for its users and its stakeholders. This category includes the "business case" description, which is more complicated than a number of financial analysis indicators – such as Payback Period, IRR or NPV – as it also deals with e.g. distribution of costs and investments.

Analytical indicators under Process and Propagation
Path-dependencies, lock-ins to certain technologies, construction or land-use regulations, and the various other factors that govern urban development, present innovative developers with increased complexity and risk in the Urban Innovation's development process. Influencing the obstacles in this Process, is essential for a successful outcome. The B4U therefore extends the Triple-P approach to evaluate *how* projects have been developed, and how innovations have been implemented. These indicators typically determine the context of the project, such as the political climate, governance issues, and quality of the development process as a means of determining the factors of success in development.
Finally, under Propagation, indicators such as market demand and compatibility determine the possibilities for up-scaling and transferability of new concepts or technologies that were applied. If innovations possess certain inherent characteristics, or require specific contexts for further implementation, these innovative projects will remain small-scale implementations and will not contribute to a wider transition.

Data collection & Type of data
The assessments are carried out by Eurbanlab certified assessors who base their assessments on experience and inputs from stakeholders in the project such as the architect, construction company, municipality and/or tenants, as well as project reports and site-visits. The indicators typically require data such as energy use in kWh, tonnes of CO_2 emissions, percentage of sustainable materials used, and qualitative expert scores. Assessors also analyse the planning context (financial, governance, socio-economic), the development process and the business case, to determine specific barriers or opportunities due to the context and characteristics of the innovation itself, that can support or inhibit further propagation of the innovation.

Eurbanlab Accelerating the transition towards low-carbon, climate resilient cities.

Eurbanlab – An initiative co-funded by Climate-KIC
Climate-KIC is a European partnership that brings together private, public and academic partners to jointly develop innovative technologies and services that counteract the adverse effects of climate change and facilitate climate adaptation – on national and global scales.

Climate-KIC creates a strong and vibrant network of committed partners that share the same concerns: to solve today's grand challenges and at the same time boost innovations and economic growth.