A second life for school buildings by atelier PRO architects

Oorschot, L.M.

DOI
10.1088/1755-1315/1085/1/012004

Publication date
2022

Document Version
Final published version

Published in
IOP Conference Series: Earth and Environmental Science

IOP Conference Series: Earth and Environmental Science

PAPER • **OPEN ACCESS**

A second life for school buildings by atelier PRO architects

To cite this article: L M Oorschot 2022 *IOP Conf. Ser.: Earth Environ. Sci.* **1085** 012004

IOP Conf. Series: Earth and Environmental Science 1085 (2022) 012004 doi:10.1088/1755-1315/1085/1/012004

A second life for school buildings by atelier PRO architects

L M Oorschot[1]

[1] atelier PRO architekten, Kerkhoflaan 11a, 2585 JB Den Haag, Nederland

Abstract. Many educational buildings still do not have proper ventilation systems, are not sustainable in use, and contribute to the spread of Covid-19 viruses. The biggest challenge for the future is to provide attractive, useable, healthy, and sustainable educational buildings in the Netherlands. But is this challenge realistic? Old buildings are usually demolished and replaced by new ones because the government hardly gives any compensation for building renovation or transformation. This leads to the demolition of many school buildings even though the application of new raw materials is not circular and has an impact on our climate and environment. Furthermore, many pre-war buildings are heritage that have a positive impact on neighbourhoods. It is unclear who is responsible for educational buildings, renovation, and financing all the ambitions. The government, the municipality or the school foundation? Problems will soon be exacerbated. At this moment the environmental impact (MilieuPrestatieGebouwen MPG) has no legal base however, this will rapidly change in the age of a circular economy and the upcoming renovation wave. Atelier PRO architects designs many educational buildings and they noticed a change of attitude in conceptualizing educational buildings the last years in the forerunner municipality Amsterdam. Based on these cases and experiences atelier PRO learned their lessons about the ideal renovation towards attractive, healthy and sustainable educational buildings.

1. Introduction

Creating an educational building is a challenge in the Netherlands with its many stakeholders, interests, and daily users. Especially because most school buildings are old, obsolete, and well imbedded in the urban environment. There are demands for (1) school organisations to reduce operational costs such as energy, cleaning, and maintenance; (2) the municipality on the urban environment (urban space, traffic) and quality of the architecture; (3) limited construction costs by municipality and school organisations; (4) the users (teachers) to have space for their educational vision; (5) students for a healthy educational environment (ventilation, daylight, heat, cooling, and sound reduction); (6) the neighbourhood on noise reduction and car nuisance in the morning; (7) society on reducing the risk of contamination since the worldwide Covid-19 pandemic and (8) reducing the environmental impact of educational buildings in the near future. There is no other type of public building that is so directly intertwined with society. When an educational building is obsolete decisions have to be made by school foundations and municipalities between: (1) putting up a new building at a different location and leaving the old building empty, (2) replacing the school with a new one and demolishing the old school or (3) adapting and renovating the school. Because of lack of attractive plots in urban environments moving to another location is no option. The choice is usually between the last two. When environmental performance of an educational building has a legal base, the decision whether a building will be replaced or renovated is in the favour of the latter.

The European Commission adopted the renovation wave on October 14, 2020.[1] It points out that Europe's building stock is both unique and heterogeneous in its expression of cultural diversity and the history of our continent. But this stock is also outdated and changes very slowly. Of all the buildings 85% were built before 2001 and about 85-95% of those that exist today will still be standing in 2050. Most of them are not energy-efficient. Many rely on fossil fuels for heating and cooling and use old technologies and wasteful service systems. Overall, buildings are responsible for about 40% of the EU's total energy consumption and for 36% of its greenhouse gas emissions from energy, as was the case in three projects in Amsterdam for atelier PRO architects in the timespan 2015-2022, see Figures 1-3. This transitional period shows the difficulties with renovation and transformation of educational buildings. The word ‘circularity’ was already coined but had no significance in 2015, whereas it is on the tip of everyone’s tongue in 2022. The main challenges for architects are: how to convince users that old buildings can be renovated or transformed to attractive and functional educational landscapes and how to integrate new service systems into old buildings to provide a healthy indoor climate. The main question in this article is: what did architects at PRO learn about the ideal renovation towards attractive, healthy, and sustainable educational buildings?

2. The Dutch school system and school buildings

The Dutch education system, type and location of educational building types. The Dutch school system is similar to most other European school systems. In the year 2020-21 there were 6,661 primary schools (PO) with 1,492,036 children in the age of four to eleven, with an average of 224 children per school. Neighbourhoods usually have their own PO’s that are often integrated with two or more schools, day-care and sport facilities. They frequently are two or three storeys high with a gross floor area up to 4,000-5,000 m^2. There were 648 secondary schools (VO) with 934,333 children in the age of twelve to eighteen, averaging 1,442 children or students per school. These schools are mostly located in districts. They generally have a gross floor area of 7,000-12,000m^2, three or more storeys high.[2] There are three different VO streams that represent different educational paths based on student academic levels and interests. The streams are: preparatory secondary vocational education (vmbo, four years), senior general secondary education (havo, five years), and university preparatory education (vwo, six years). After completing VO, students may respectively attend vocational education (mbo), university of applied sciences (hbo) or research university (wo). Often these schools are located on a campus or in clusters in regional areas nearby urban centres with excellent public transportation.

Ownership of educational buildings and perverse incentive to demolish buildings. The ownership of schools is fragmented. PO and VO are either private or public institutes. Sometimes buildings are owned by municipalities and sometimes by school foundations. The user of the building is responsible for operational costs. Private schools may have religious or social educational visions like Protestant, Hindu, Muslim, Roman Catholic, Montessori or Kunskapsskolan. These institutes have their own foundations, board of trustees, and students. Some public schools might follow a particular vision like Montessori. The client for an architect could be the school foundation, the municipality or a foundation of the municipality when it comes to creating, replacing or renovating educational buildings. The client is financially supported by the municipality and the federal government compensates it in part with a lump sum budget for brand new buildings. The lump sum is based on a normalised budget according to the number of inhabitants or children in relation to the kind and size of school to be built there. The government expects municipalities and foundations to contribute to the investment and co-financing is regulated accordingly.[3] If an educational building is obsolete and unused, legislation mandates governmental ownership so this is transferred to the municipality who pays for demolition, preparing a plot for new construction or for purchasing a new plot. Since 2015 school foundations have been reimbursed for operational costs such as maintenance, cleaning, energy, and small adjustments to schools. The lump sum does not cover renovation or transformation, so for this reason clients usually choose replacement.

The integral educational housing plan IHP. According to Dutch legislation each municipality must have an integral educational housing plan (*Integraal Huivestingsplan Onderwijs* IHP). The IHP is a collaboration between the municipality and local school foundations. The reason why there is no general IHP in the Netherlands is because circumstances vary. Some municipalities have a shrinking population and others are rapidly growing. The client often asks specialised educational real estate developers such as HEVO or ICS to create or renovate a school building. They select the architect, consultancies, and organise the development process. Some municipalities have their own developer such as Project-Management-Bureau PMB of Amsterdam and sometimes school foundations develop their own building projects.

3. Renovation between the Paris-agreement of 2016 and Covid-19

The definition of renovation is limited. Besides the matter of fragmented ownership, the Building Act is not clear about renovation. There is a difference between the terms 'deep renovation' and 'renovation'. Deep renovation has a legal status and meets the requirements for a new building. It is defined as 25 percent of the surface of the complete integrated skin whether renewed, changed or extended.[4] The skin is the sum of all facades, ground floor and roof. Integration refers to all building parts of the skin. The three educational buildings for this article are listed as heritage. Their façades, among other things, have architectural and cultural value and are protected. For this reason, a deep renovation according to the Building Act was not possible. The requirements that a listed building must meet are not clear and that has consequences for financing renovations and transformations. According to government guidelines about new regulations on the use of renewable energy there are exceptions mentioned for building with an architectural or cultural value, but in reality, no one chooses for deep renovation.[5]

Only a new educational building is financed. There is a debate about the negative incentives on the financing system of educational real estate. As pointed out, the municipality is only financially compensated for new buildings with a lump sum by the government. Even though the school's lifespan will extend 25 years, the building enlarged, the indoor air quality improved and becoming energy efficient, renovation is not compensated. It is up to each municipality to determine the investment cost of a school building. Some municipalities are partly financing the renovation cost to the school foundation for seventy percent, while others give a hundred percent (Utrecht) or even zero financing for the entire renovation cost of the building. It all depends on the IHP of the municipality.[6] In the case of Amsterdam, the compensation to school foundations was changed from €1,400 to €2,050 per square meter gross floor area from 19 July 2017. Lumion and Berlage were financed in this way and BSA by the British community of Amsterdam. This was just before the introduction of 'nearly zero-energy buildings' (NZEBs) as of 31 December 2020.[7] According to HEVO, new IHP legislation prepares for more possibilities for sustainability investments, total ownership costs and regional differences. HEVO described a few IHP-models and new style for school building renovation.[8] In this proposal renovation is the alternative to a new building if the life span of the building can be extended by twenty-five years and the renovated building meets the requirements of the Building Act.

Reduction of energy use and supply of renewable energy and indoor air quality. Regulations on energy use and indoor air quality have developed rapidly in recent years. Since 1995 the energy efficiency of new educational buildings is calculated using an energy performance coefficient.

An energy performance certificate has been required since 2008 for buildings larger than 1,000 square meters. The *Energy Performance of Buildings Directive* 2010 (EPBD) requires all new buildings to meet 'nearly zero-energy buildings' (NZEBs) standards as of 31 December 2020, including energy use reduction of renewable energy.[9] According to the *Renewable Energy - Recast to 2030* (RED II), the sharing of renewable energy for all buildings will increase annually after February 1, 2022.[10] After decades of educational buildings lacking proper ventilation systems, the certificate Frisse Scholen (Fresh Air Schools) was introduced by Senter Novem in 2009. This is only required for new buildings or buildings with a deep renovation. Three classifications are defined: Frisse Scholen class A (very good), B (good) or C (satisfactory) and five themes are assessed: energy, air, temperature, light and sound.[11] The Frisse Scholen assessment was linked to energy performance as of 1 January 2021.[12]

Shortcomings of indoor air quality in school buildings. In the Netherlands ventilation systems are categorised according to the NPR 1088 in different systems. System A is a ventilation system with natural input and output (natural ventilation); B is mechanical input and output (uncommon); C is natural input and mechanical output (mechanical ventilation), and D is mechanical input and output (balanced ventilation). In recent years system E has been used, this is a hybrid ventilation system. Newly built houses in the Netherlands mostly have ventilation systems C or D. Of educations buildings 33 percent have system A, 16 percent System C, and 38 percent system D. There are nonetheless shortcomings of indoor air quality in school buildings. A dramatic conclusion was drawn in a report that recently appeared in 2021 after an assessment by the government on (PO and VO) educational buildings.[13] In all five categories 27.9 percent of PO and 26.4 percent of VO buildings were still not meeting the legal norms for ventilation. Especially category 2 PO stock went far under the norms by 34 percent and category 3 VO stock by 42 percent. The main reason for this dramatic result has to do with the ventilation system that was still in use. About 33 percent of educational buildings still rely on natural ventilation (system A), especially those built before 1992 (categories 1, 2, 3); built after 1992 (categories 4, 5) about 38 percent have balanced ventilation (system D). Furthermore, the assessment revealed that about 42 percent with natural ventilation and 12.5 percent with balanced ventilation are not meeting the ventilation requirements. Natural ventilation (system A) and ventilation with a natural input and mechanical output (system C) peak values are between 1,750 and 4,000 ppm CO_2 concentration with a negative effect on health.

4. Lumion College Amsterdam

The design-tender for the Caland 2 Lyceum (later renamed to Lumion) started in 2013. A new secondary school and sport facility for 1,300 students with a completely new vision on education in accordance with the principles of personalised learning of Kunskapsskolan. In this concept the school is divided into small clusters for 160 students, each with an individual entrance and eight classrooms around an indoor square. The existing plot in the neighbourhood Sloten was a controversy between the school foundation, which wanted a new school on a new plot, and the municipality. The original building was created in 1973 by the architect Joh. Bernhard Ingwersen in béton brut architecture and it was listed by the municipality in 2008, see Figure 1. The foundation did not carry out building archaeological research because the building did not match with their educational vision about personalised learning, so they wanted it demolished. In order to gain an advantage, they decided to wait for the March 2014 elections. After that the municipality and foundation came to an agreement about which part would be demolished and which preserved. The design-bid-phase started early 2015. The school organisations in Amsterdam were reorganised and the name changed to 'Stichting Openbaar Voortgezet Onderwijs Progreso' (SOVOP). In the preliminary concept design in April, the preserved part was radically separated from two new building parts. The first preliminary design was ready on October 26, 2015. The process management was transferred from the school foundation to the Projectmanagementbureau (PMB) of Amsterdam in April 2016 and a second preliminary design was produced 9 March 2016. Yet the conflict between the municipality and the foundation had not ended there. They still discussed how much of the building should be allowed to be demolished and what had to be preserved in the interior. After a presentation by the architect a positive advice was received on May 25, 2016 from the commission 'Welstand en Monumenten' for the new building part. Moreover, even though the school foundation was still not convinced it was necessary, a building archaeological research on the historic part was completed on August 26, 2016 under pressure by the municipality. In the final design, completed back in July 2016, there was still discussion about the interior and the amount of preservation and advice from the commission on September 28, 2016 was negative about the renovation of the interior of the existing building. Finally, though, they gave a positive advice under certain conditions on October 19, 2016. All the conditions were discussed in a meeting with PMB and members of the department of Monuments & Archaeology (M&A) on November 18, 2016 and an agreement was reached. In the construction documents and bid specifications for contractors on December 2, 2016, the starting point was agreed upon. The historic building was compact with a good Form Factor. It had an open building structure with a centre core of staircases, toilets and auxiliary spaces. There were corridors around the core and classrooms along the façade. The infill was more or less flexible. This smart layout inspired atelier PRO to do the same with the new addition creating a spiral staircase in the middle of a central hall. There was a debate about the infill of the existing building. The window frames between classrooms and corridors with an architectural value had to be maintained. The municipality and foundation reached a compromise whereby some would be restored and others removed and adapted to the principles of the Kunskapsskolan. The removed window frames were reused as wood panelling elsewhere in the building. A glass-appliqué designed by artist Joop van den Broek in 1972 was restored. Eventually the school board plans to hide this piece of modern art behind a wall because it is not in line with their vision.

Under pressure by the municipality the new wall was removed. Construction started in August 2017 and the building was completed in May 2019.

Figure 1. Lumion College Amsterdam after the renovation.
Source photos atelier PRO architects, photos by Jan Paul Mioulet

5. The British School of Amsterdam

In May of 2016 atelier PRO was invited to an architect selection for The British School of Amsterdam BSA that bought a nineteenth century prison at Havenstraat 6 in the Schinkelbuurt with support from the Amsterdam municipality, see Figure 2. The building was in a bad condition, brickwork was damaged and the roof was leaking. The prison was constructed in the period 1888 and 1891 and it was designed by government engineer W.C. Metzelaar. Many additions were added throughout the years. In fact, the ensemble was a chaos of buildings and additions. The BSA is a private school and foundation that wanted to incorporate three schools (primary, juniors, seniors) and amenities such as sport facilities, offices, and theatre. With the tender documents building archaeological research was already carried out by the department of M&A of Amsterdam on the possibilities for transformation of the prison. It was a challenge during the design process to convince users (teachers) that transformation could lead to a well-designed school. It was also going to be a challenge to integrate the balanced ventilation system into the existing structure. There were two important starting points. The old prison as an icon for the surrounding neighbourhoods had to be visible from the urban entrance road and secondly, the urban block around the prison had to be repaired. PRO helped BSA develop a program and used the building typology with circulation space of the prison and morphology of the building mass. The three cell blocks of the prison were transformed into schools with their own interiors and entrances. Every block was extended with a new building part for classrooms and the cells were transformed into an antechamber for more classrooms. Other cells were merged for additional and auxiliary spaces. The entrance and central hall with glass dome were renovated and became the heart of the building. The entrance wing with offices and church were transformed into a theatre and offices. Office space was added in a small extension at the back and a big extension on the front side was added for a sport hall and amenities. Inside the prison the paint on the brickwork was removed and a beautiful soft yellow stone appeared, so daylight from the glass dome above the space felt warm and intimate. Users of the BSA are calling this space The Globe, named after the Shakespeare theatre. The block of classrooms has a façade of brown red brickwork and a rhythm with vertical and horizontal bands and arches that refer to the cell structure. The two other new additions have a thin brick with thick joints. Close-up one experiences differences in the façade but from a distance the ensemble appears homogenous. In 2021 the building was delivered by the contractor. That year it was awarded best educational building of the year by Architectenweb and received the Geurst Brinkgreve Bokaal from the municipality of Amsterdam for best renovation or transformation of heritage. Users of the BSA are now convinced that transformation was the best way to have an iconic, attractive and functional educational building in the middle of the city.

Figure 2. The British School of Amsterdam after the transformation.
Source photos atelier PRO architects, photos by Eva Bloem

6. Berlage Lyceum Amsterdam

The Berlage Lyceum has two buildings, both listed by the government in 2004 as heritage, see Figure 3. The school is Unesco-listed and international issues are important subjects in the education program. It is a school that pays a lot of attention to languages, globalisation, and international orientation. All education is offered in Dutch and English. The vwo concludes with an IB-English degree, havo with a Cambridge certificate, and mavo with an Anglia certificate. The school is located on the Pieter Lodewijk Takstraat 33/34 along the Amstel canal on the edge of Amsterdam-South and the Diamantbuurt. Both neighbourhoods are beautiful urban ensembles of Berlage with many Amsterdam School Architecture apartment buildings. The two schools were constructed between 1921 and 1924 and the municipality architect Arend Jan Westerman (1884-1966) designed both. The school has several statues by Hildo Krop outside and wall paintings inside by Peter Alma and Joop Sjollema. The neighbourhood, buildings, and art all express the idea of *Gesamtkunst* and *Bildung* (*verheffing* in Dutch) for all users.[14,15] In the beginning the vice principal of the school Joost Schoots was in doubt about renovation and preferred a new building at another location.[16] After talks with the board of the school, the foundation 'Esprit Scholen' and the municipality of Amsterdam, Schoots was convinced that the school building and location were unique and that *Bildung* was a good argument for not moving away and respecting the existing structures. They decided that on the basis of pedagogic principle original qualities of the architecture of the buildings and art should be highlighted.

The old school was a corridor type building, long corridors lined with classrooms. This type of building has many possibilities to become very sustainable. A few years ago, the façades were renovated but inside it was outdated in many ways. It could not be adapted to the education vision and health was an issue. Architectural offices were asked to come up with some ideas and a tender was organised. In May 2016 PRO was invited for the tender by the foundation and a few months later selected. For every design phase there was a meeting with ICS, atelier PRO and the department of M&A from the municipality about the design, service systems, and materials. The walls of the buildings in circulation areas are plastered with pebbledash, which have been partially restored in the hall/staircase and in the corridor replaced by stucco. Wall tiles and terrazzo floors are being restored and after colour research and assessment, the original colours too. For example, the dark window frames in contrast to the light wall surfaces are brought back. Old Oregon pine and teak flooring (not original) in the classrooms removed to produce school furniture. The floor plan is changing to suit new education ideas. The circulation system in the central hall with its beautiful staircase split the building in left and right parts. On both sides of all the floors is a short corridor with classrooms on one side and small spaces (toilets) and rooms on the other. There are three staircases. A new elevator and three new shafts were created for all the new service systems. Separation walls between classrooms are being removed and replaced. The old ones had about 48 square meters and the new ones have about 62 square meters in order to adapt to the new educational landscape and to accommodate 30 students per class. Furthermore, some windows were added between the classrooms and the corridor. The buildings will be delivered in 2023.

Figure 3. Berlage College Amsterdam.
Source photos atelier PRO architects, photos by the architects

7. Integrated renovation is required

Reduce energy with an integrated box-in-box-renovation. Since educational buildings are crowded with people additional heating or cooling with ventilation air is unavoidable. Attractive educational buildings with a heritage value are found in dense urban environments, so a lot of noise sound reduction is necessary. Therefore, energy use reduction is realised with an integrated box-in-box renovation in combination with Low Temperature Central Heating for a basic temperature and a balanced ventilation (system D) with heat recovery HRV and demand control ventilation DCV for classrooms and other spaces when in use. Circularity is mainly achieved by not demolishing buildings and using minimalised raw materials for new parts. Both Lumion and BSA are built according to the Building Act of 2012. With Lumion there was a deep renovation of the historic building, but this was not the case for BSA and Berlage. Adhering to the Building Act, energy use was reduced by insulating the skin of the old and new building parts of Lumion and only the new parts of BSA. Energy performance coefficient ≤0.7 and facades $R_c \geq 4.5$ floors $R_c \geq 3.5$ roofs $R_c \geq 6$ m^2K/W window frames have a $U \leq 1.65$ W/m^2K with double insulated glass (HR++). The renovation strategy with Lumion was a box-in-box renovation of facades, floors, and roofs. Overhangs were insulated outside. Berlage's renovation did not comply with the Building Act. Energy use was reduced by insulating the skin as best possible. The cavity walls are filled with insulation; the roof is insulated above the ceiling ($R_c \geq 6 m^2K/W$), glass has been replaced by very thin monumental glass $U \leq 2.4$ W/m^2K, and air tightness of window frames improved to $q_{v,10} \leq 0.625$ dm^3/s per m^2. Furthermore, an integrated box-in-box-renovation was needed to meet de requirements for fire resistance and sound reduction between spaces of pre-war buildings like BSA.

Energy use and supply, temperature and fresh air. All three school buildings have a Low Temperature that use the old and renovated Central Heating System for a base temperature inside in combination with ventilation air when classrooms are in use. Lumion is connected to the District Heating and Cooling network of Amsterdam. BSA has two new Natural Gas Boilers and an old one was renovated. Berlage is connected to the local seasonal thermal energy storage STES. Both Lumion and Berlage are all electric and have solar-panels using the sun as renewable energy source. BSA uses fossil fuel. Electricity in Berlage is provided by 620 solar-panels (330 Wp/st) on each flat roof. In the new buildings of BSA and Lumion are floor heating or convectors. Besides improving the air quality, energy use is further reduced by new ventilation service systems in all three schools. The natural ventilation (system A) in Lumion, BSA and Berlage were replaced by decentral balanced ventilation (system D) using heat recovery HRV and demand control ventilation DCV in classrooms and other spaces. This was necessary to meet the requirements of energy performance and indoor quality. Only Frisse Scholen class B for ventilation ($8.5dm^3$/s per person) was achieved. Every building part has its own decentral ventilation service system, which is recommended for either renovation or transformation.[17] Since temperature exceedance during summertime is problematic all buildings have outside sunscreens. Classrooms have LED lighting with presence detection and daylight control. Balanced ventilation is necessary. Why? (A) A water-based central heating system gives a stable temperature throughout the year inside the building but cools off too slowly when there is a sudden temperature exceedance in summertime and warms up too slowly with variable use of classrooms in wintertime. Therefore, it is better to invest in active cooling and heating systems using fresh air and Frisse Scholen class B instead of class A and underfloor heating.[18] (B) Outdoor noise disturbance in urban areas requires closed windows. Ventilation system A, B, and C are used less because of noise disturbance of playing children in the classroom and outside traffic in busy places where schools are usually located. (C) A lot of fresh ventilation air is needed because thirty children or students in a room produce much CO2, moisture and heat. Furthermore, energy efficiency with heat recovery is required.

Fire safety and sound reduction in pre-war educational building. In pre-war buildings such as Berlage special attention is given to renovation. Sound reduction from other classrooms and fire safety of wooden floors between different levels are important issues. In each building of Berlage there are two ventilation units on de ground floor and in the basement. New vertical ducts were installed to supply fresh air and the corridors are used as horizontal ducts for air exhaustion. The ceiling in the corridors was lowered to make space for ventilation ducts and other service systems. Because of the box-in-box-renovation the air tightness of window frames was improved, implying that sound from neighbouring classrooms was more present than sound from outside. The old ceilings in classrooms and corridors were replaced by new Rockfon Mono Acoustic ceilings without joints. The pipes, ventilation system channels and all the sensors above the ceiling are hidden.

8. What did atelier PRO learn?

If someone's asks why the Covid-19 virus is spreading under children up to 18 years, the indoor air quality of educational buildings is one of the causes.[19] Probably we are going to have to learn to live with zoonotic viruses in the future. Replacing all obsolete educational buildings is a waste of raw materials and financially not optional. As pointed out, the Dutch educational system and educational buildings are characterised by decentralisation and defragmentation in almost everything. As shown, renovation is held back by barriers at different points and interests of stakeholders throughout the value chain. There is no incentive to maintain buildings because school foundations always hope for a brand-new building. What atelier PRO learned is:

- Firstly, an integrated renovation is needed. A balance must be found between the urban environment; energy performance; environmental performance (circularity); health (covid requirements routing, air quality, materials); sound reduction in classrooms; functionality (educational visions); indoor climate (temperature exceedance, daylight, air quality), and architectural heritage value. The ideal formula is different for every location and organisation. The best option is to use ventilation air with decentral balanced ventilation (system D) with heat recovery HRV and demand control ventilation DCV in classrooms, heating/cooling of fresh air, and heat pump with air or soil as source or district heating. Solar panels provide electricity for general use and service systems in schools.
- Secondly, definitions about the levels of 'deep renovation' must be revised and the concept integrated renovation and circularity must be anchored in this new definition.
- Thirdly, it must be clear who is responsible for the indoor (air) quality in educational buildings, especially when it comes to financing renovations and transformations.
- Fourthly, taking into consideration Covid-19 measures and budget, there has to be a better-defined relation between ambitions and requirements.

9. References

[1] A Renovation Wave for Europe - greening our buildings, creating jobs, improving lives https://eur-lex.europa.eu/resource.html?uri=cellar:0638aa1d-0f02-11eb-bc07-01aa75ed71a1.0003.02/DOC_1&format=PDF
[2] CBS Stateline https://opendata.cbs.nl/statline/
[3] VNG Modelverordening voorzieningen huisvesting onderwijs https://vng.nl/nieuws/update-model-verordening-voorzieningen-huisvesting-onderwijs
[4] Building Act, chapter 3, article 3.2 https://www.bouwbesluitonline.nl/docs/wet/bb2012_reg/hoofdstuk-3/artikel-3.2
[5] Rijksdienst voor Ondernemend Nederland 2021 Leidraad eis hernieuwbare energie bij ingrijpende renovatie https://www.rijksoverheid.nl/documenten/richtlijnen/2021/12/02/leidraad-eis-hernieuwbare-energie-bij-ingrijpende-renovatie
[6] Bouwstenen https://bouwstenen.nl/onderwijs-huisvestingsplannen
[7] Gemeente Amsterdam 2015 Actualisatie IHP's 2016-2020. Resultaten 2016-2017 en opgaven 2018-2022+
[8] HEVO 2021 Financiering en uitvoering van een duurzaam IHP
[9] Energy Performance of Buildings Directive 2010/31/EU & Energy Efficiency Directive 2012/27/EU https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/energy-performance-buildings-directive_en
[10] Renewable Energy - Recast to 2030 (RED II) https://ec.europa.eu/jrc/en/jec/renewable-energy-recast-2030-red-ii
[11] Requirements of class A is a CO2 concentration in the classroom in use of maximum 800ppm, a ventilation flow of minimal 12dm3/s per person and a height of space of 3.2 meters. Class B is 950ppm, minimal 8.5dm3/s per person and 2.8 meters. Class C is 1.200ppm, minimal 6dm3/s per person and 2.6 meters.
[12] Rijksdienst voor Ondernemend Nederland May 2021 Programma van Eisen Frisse Scholen 2021 – In opdracht van het Ministerie van Binnenlandse Zaken en Koninkrijksrelaties https://www.rvo.nl/sites/default/files/2021/06/PvE-Frisse-Scholen-2021.pdf
[13] Ruimte OK kenniscentrum 2021 Verdiepend onderzoek gebouwtypen en ventilatiesystemen https://www.rijksoverheid.nl/documenten/rapporten/2021/08/19/verdiepend-onderzoek-gebouwtypen-en-ventilatiesystemen
[14] Berlo G van, Engering H and Hunderman G 1999 Een Amsterdamse School Stichting Mr. Dr. M. Spaanders-Fonds Amsterdam
[15] Niël M P C (BBM) 2017 Bouwhistorische verkenning Berlage Lyceum Pieter Lodewijk Takstraat 33 en 34 te Amsterdam
[16] Arbeek S 2021 Het monument als gesprekspartner – Renovatie Berlage geleegd uitgevoerd (Schooldomein Year 34 October 2021 No 1 pp 53-55)
[17] Arbeek S 2021 Decentraal ventileren, beter leren (Schooldomein Year 33 May 2021 No 5 pp 72-73)
[18] bbn adviseurs 2019 Frisse scholen, is 'uitmuntend' noodzakelijk (Schooldomein Year 32 October 2019 No 1 pp 34-35)
[19] Ding E, Zhang D and Bluyssen P 2022 Ventilation regimes of school classrooms against aiborne transmission of infectious respiratory droplets Building and Environment 207 https://repository.tudelft.nl/islandora/object/uuid:54515fe1-4b56-4403-b28c-0f506509b578?collection=research