Building Concepts by Stora Enso

Schools

THE RENEWABLE MATERIALS COMPANY

storaenso

The renewable materials company

As a company working with renewable materials, we share a big responsibility in helping the world move away from its dependence on fossil fuels. Building on our heritage and know-how in forestry and trees, we develop and produce solutions based on wood and biomass for applications in the building industry.

Today we have wood-based products that are as strong as steel and with more design opportunities than ever before. The fact that wood is light means developers can also cut down on transportation costs.

And trees are renewable. They grow back. While they are growing they also absorb carbon and then store it during their lifetime improving the carbon footprint of the whole value chain. In fact, we can help cut carbon emissions in construction by up to 75% and create buildings that last for hundreds of years.

Welcome to the renewable materials company.

Table of contents

Creating a renewable future

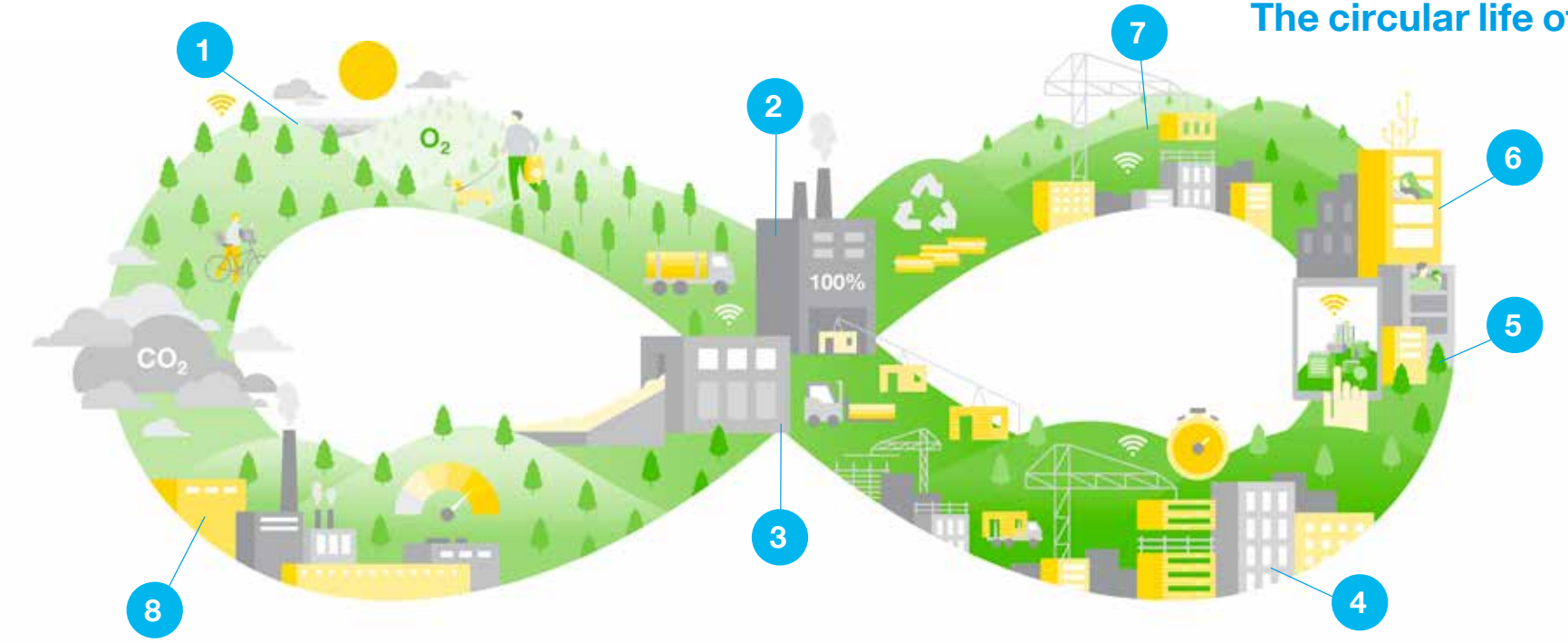
The global population is growing rapidly and moving into urban areas. This will result in the need to double the global housing stock by 2060. A consequence of this growth will be an increasing scarcity of natural resources in the coming decades.

In order to address material scarcity and avoid increasing greenhouse gas emissions from the building sector, the world needs low-carbon circular materials and building solutions. Since the energy supply to buildings in most countries is steadily being decarbonised, the building sector is now gradually moving its focus towards the selection of more sustainable and renewable building materials and solutions.

Stora Enso actively contributes to international, multi-stakeholder work for a better understanding of the sustainability attributes of buildings, the development of related metrics, and the life cycle sustainability assessment of buildings. In this work, we address the sustainability issues across the value chain, from sustainable management of forests, to resource efficient wood products manufacturing, to sustainable and safe products and all the way to the end-of-life options of products.

Our work is guided by the Stora Enso sustainability agenda, which is aligned with the Paris Agreement on Climate Change, and offers a balanced view to environmental, social and economic aspects of sustainability.

The circular life of wood



The building sector remains highly dependent on non-renewable and carbon-intensive materials but Stora Enso can provide the building sector with renewable and low-carbon wood products that contribute to a more sustainably built environment.

The above illustration reflects the circular life of wood – in an infinite loop that represents the renewable and carbon neutral nature of wood.

1. Sourcing renewable, sustainable and circular resources
Stora Enso's main raw material is renewable wood from sustainably-managed forests. Wood and biomass play an important role in combatting global warming, and the transition towards a circular economy.

2. Safe and efficient operations
Safe and efficient Stora Enso operations help combat global warming and resource scarcity, while promoting the welfare of our employees and wider workforce.

3. We make sustainable products that add value
Our products add societal value by addressing critically important global megatrends, such as growing population, global warming, and resource scarcity.

4. Our wood products and building solutions enable safe and low embodied carbon construction
Stora Enso's renewable and light-weight building solutions reduce embodied greenhouse gas emissions and promote safe, circular and low-carbon construction. Wood products also have significantly lower embodied greenhouse gas emissions associated with them compared with concrete and steel.

5. Sustainable wooden buildings store carbon and help reduce operational carbon emissions
Stora Enso's wood products and building solutions promote more sustainable green buildings. They help to improve energy efficiency and reduce operational carbon emissions. In addition, wood stores carbon during the building life time, while sustainable forest management guarantee the growth of new trees. Trees grow by absorbing carbon dioxide from the atmosphere and store it as biogenic carbon in the wood products. The longer the biogenic carbon is stored, the greater the environmental benefit as longer storage increases the sink for CO_2 emissions.

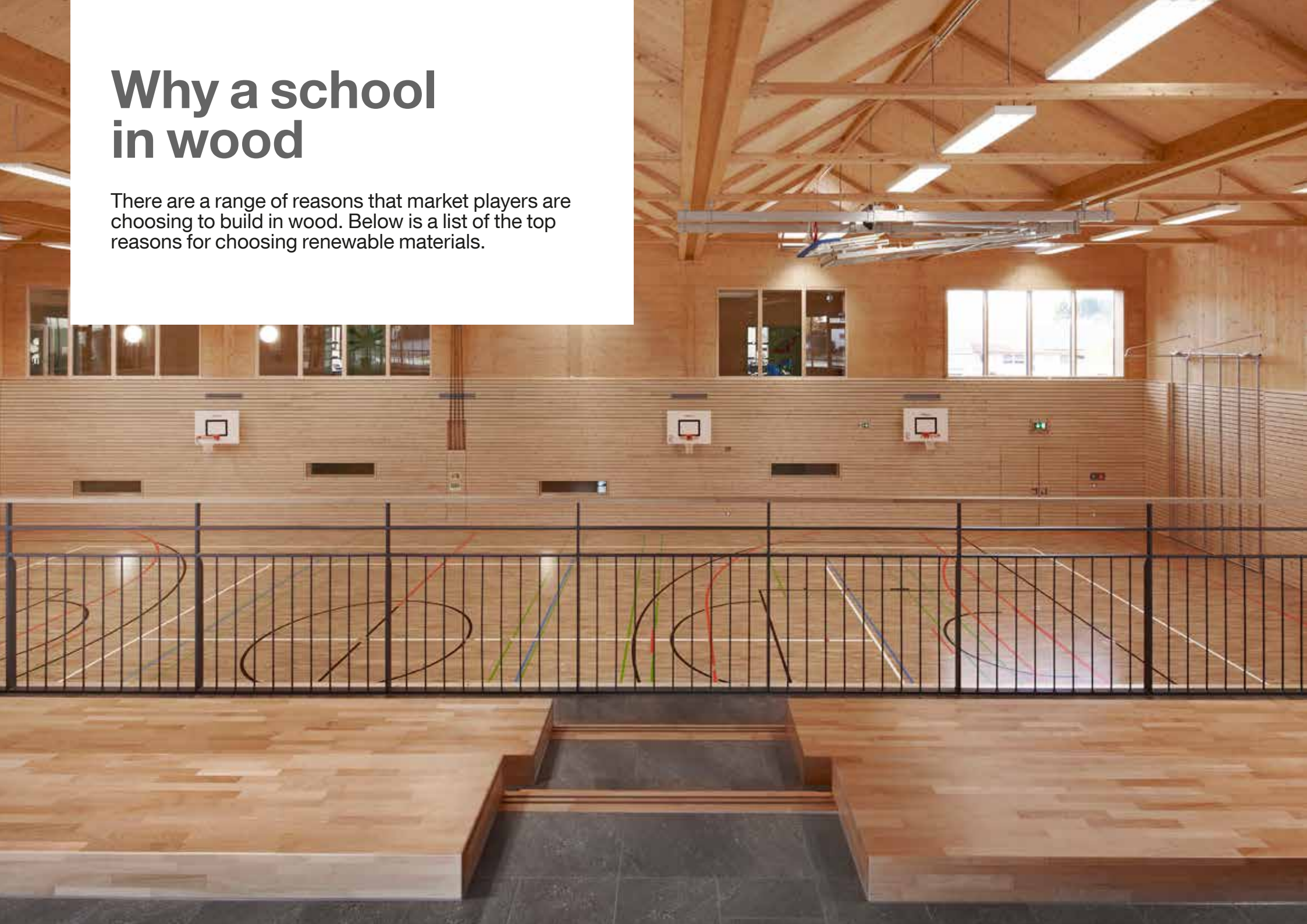
6. Comfortable and healthy spaces with wood
Biophilic building designs using wood enhance health and well-being in indoor environments and help avoid the chemicalisation of our environment.

7. Our designs and services give materials and buildings a longer life
Stora Enso's product designs and services can extend the lifespan of existing buildings and materials. Light-weight wood enables renovations or adding floors and ultimately helps avoid demolition and waste, while also promoting building energy efficiency.

8. Wood allows circularity even at end-of-life
When a wood product reaches its end-of-life and can no longer be re-used or recycled, it can be used for bioenergy generation – to ultimately avoid becoming waste and to substitute fossil fuels.

Why a school in wood

There are a range of reasons that market players are choosing to build in wood. Below is a list of the top reasons for choosing renewable materials.



Health and wellbeing

Time spent indoors is on the rise with basic education increasingly concentrating on new technology, laboratories and computers. Students are faced with specialised tasks that require high levels of concentration and creative thinking throughout the day.

These changes in curriculum and function place higher demands on the performance of indoor spaces of schools.

Recent studies[1] have investigated the use of wood in homes, classrooms and hospitals. The studies show lowered stress levels and blood pressure and improved concentration, instance, the number of mistakes made in mathematical tasks have been measured to decrease. Studies have also shown lower levels of aggression in interiors with wooden surfaces compared to ones with no wooden surfaces. Studies in Canada and Austria have also shown improved creativity and reduced pain perception.

Thermal comfort
Thermal 'sensation' is a parameter that reflects the thermal comfort in a building. Cold surfaces can cause the feeling of draught even though the building envelope is airtight, as the human body radiates heat towards colder surfaces of a room. Optimised thermal insulation guarantees suitable surface temperatures of walls and the roof of a building to mitigate uncomfortable indoor conditions.

Several studies indicate that the presence of wood in office buildings can have positive impacts on our physiology. Compared to other material types there are positive effects demonstrated, like lowering blood pressure and heart rate.

Air quality
Moisture damage in building structures is one of the critical causes of poor quality of indoor air and associated health problems such as asthma and respiratory disorders[2].
Highly insulated CLT-based structures contribute to indoor climate in various ways, for example:

- Good thermal insulation enables even temperatures in a room
- Natural wooden materials have low emissions during the use of a building
- Use of wood as an interior design element can contribute to a pleasant living and working environment

Comfort and indoor air quality are becoming increasingly important criteria. Building Concepts by Stora Enso promote a good and healthy indoor climate.

1 https://makeitwood.org/documents/doc-1624-pollinate-health-report---february-2018.pdf
2 European Respiratory Journal. 2007 March, 29(3):509-15

Sustainability

Sustainable schools aim to balance the needs of today and those of future generations; they are built without depleting natural resources and without other harmful environmental and social impacts. Today, sustainable buildings mostly aim at reducing carbon emissions, and at providing healthy and comfortable conditions for users, considering the whole building life cycle including the production of construction materials.

These aspects of sustainability are increasingly subject to tightening legislative requirements and voluntary third-party verification. Stora Enso building solutions help designers, contractors, owners and tenants achieve compliance and address their sustainability ambitions.

Additionally, from a social sustainability perspective, the functions of the school building have become broader, providing spaces for students and community members alike. In the future, it will be common to attend extracurricular activities in the same building and share it with members of the public. More use will be made of school buildings in the future beyond its specific role in the educational process.

Renewable wood and low carbon building solutions
Wood construction helps to reduce fossil carbon emissions. Sustainable, growing forests store carbon dioxide from the atmosphere. For example, according to our EPD, CLT stores 762 kilograms of carbon dioxide from the atmosphere. At the end of their life cycle, wood products can be reused, recycled or used for energy production. Additionally, sustainably managed, growing forests capture carbon dioxide from the atmosphere.

Wood for Stora Enso's wood products and building solutions originates from semi-natural, sustainably managed European forests, which grow by area and by volume. The European forests contribute to the social welfare and livelihood of local communities and regions with 16 million forest owners. Parallel multiple uses of these forests for recreation and nature conservation are integral parts of sustainable forestry practices.

Stora Enso promotes third-party certification of forest management, with demands that go beyond legal requirements. In 2019, 74% of all wood of all wood that was used by Stora Enso's mills originated from PEFC™ or FSC® (C125195) certified forests. For verification of the responsible and legal wood origin, Stora Enso applies PEFC and FSC Chain of Custody certified wood traceability systems[1].

In the production of wood based building solutions, Stora Enso's mills apply ISO based management systems to ensure responsible, efficient, clean, and safe working environments. Energy is mostly produced using biomass generated from sawmill residues, avoiding fossil carbon emissions. High yields and efficiencies in the use of wood ensure that no wood goes wasted.

Sustainability benefits in transport
Timber elements are transported onto site in pre-assembled, load-optimised panels. Additionally, wood is five times lighter than concrete. Lighter loads lower the total number of trucks, in turn lowering transportation costs and reducing transportation emissions.

Reduced building mass
Compared to concrete construction, the use of timber significantly reduces the building's weight resulting in reduced foundation requirements. Lighter wood elements can be installed with lighter cranes, instead of heavy and expensive tower cranes.

Life cycle design in CLT and LVL-buildings
Life cycle design aims to achieve building solutions that consider life cycle costs and contribute to higher construction quality, longer service times, good indoor environment, low energy demand as well as carbon emissions and other enviornmental impacts. New buildings are typically

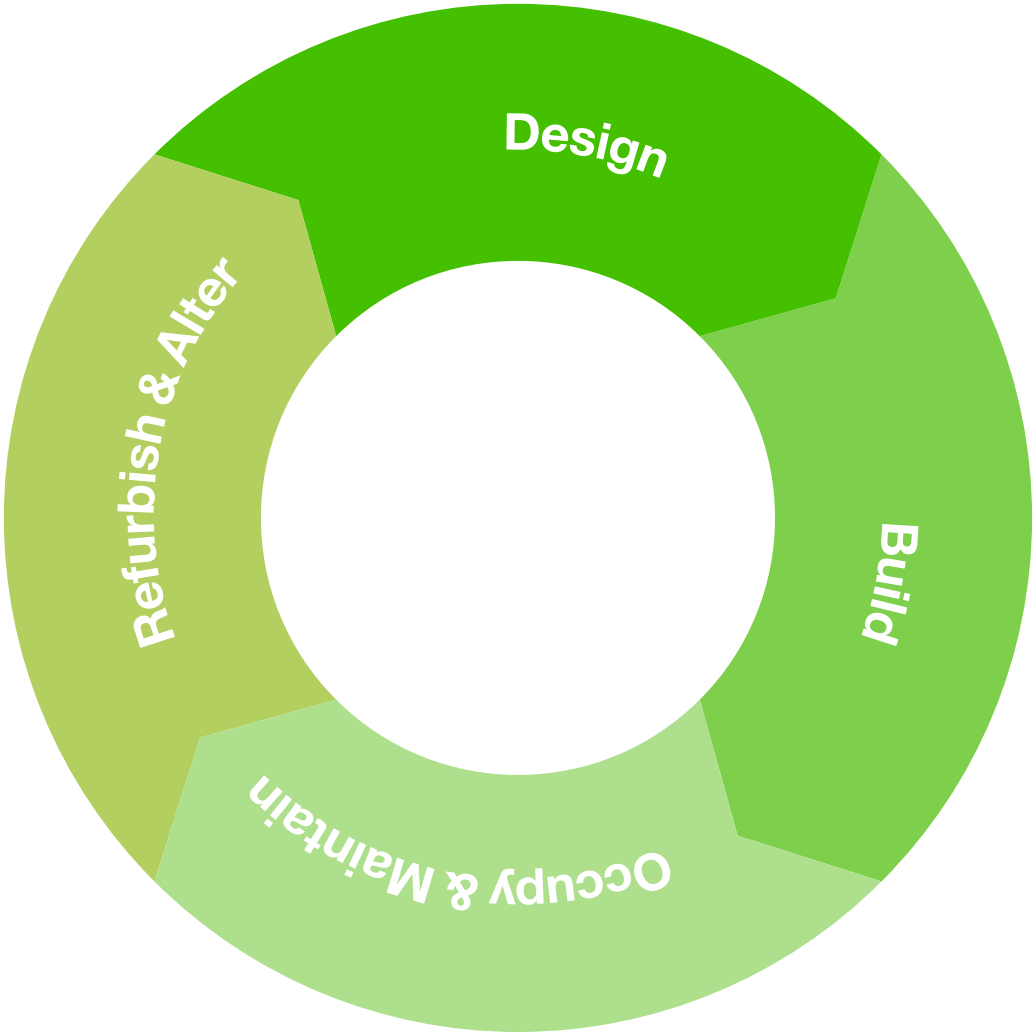
designed for a service life of 50–100 years. Longer service life using wood construction has been proven throughout history. Components such as fans, pumps, piping, surface coatings, waterproofing, façades, window frames, however, have a typical service life of 25–50 years. Therefore, a long service life requires a life cycle approach that addresses:

- Shorter life time components that are designed for replacement
- Long-term maintenance

  Maintenance, periodic condition surveys and timely repairs
- High quality construction of the building, building elements and components

Stora Enso building solutions are prefabricated building elements produced in tightly controlled factory conditions that improve the quality and ease of construction. High quality construction and the long service life of a building results in a reduced demand for renovation and refurbishment and reduces material use, waste generation, and energy use in the production of materials, transport and construction, further enhancing a building's sustainability performance.

1 Learn more about our sustainable wood sourcing https://www.storaenso.com/en/sustainability/environmental/forests-plantations-and-land-use



Certification
Stora Enso building solutions help designers, contractors, owners and tenants achieve compliance and address their sustainability ambitions.

The use of certification systems can provide good marketing and communication tools for customers, authorities and/or investors and may in some markets help increase market value. There are a number of different certification systems that provide third-party validation of building performance for sustainable homes, such as BREEAM, LEED, DGNB, HQE, Miljöbyggnad, and Minergie. These systems typically stress the energy efficiency and low carbon emissions, indoor climate and thermal comfort, low material emissions, life cycle design and assessment, and construction process procedures, etc. in grading for certification.

Green building rating tools increasingly promote lifecycle thinking by using life cycle analysis (LCA) and life cycle costing (LCC), which places great importance on material selection.

Stora Enso provides third party verified Environmental Product Declarations (EPDs) that offer transparent information about the environmental performance of our products throughout their life cycle. These EPDs can be used to help optimise sustainability performance using whole building Life Cycle Assessment (LCA) and to achieve green building certification.

Sustainability information on verification and certification:

Chain of Custody
Chain of Custody certificates (PEFC™ and FSC®) for responsibly sourced wood from sustainable and legal sources[1]

Sustainable forestry
For informtion on wood from sustainably managed certified forests, ask for our PEFC™ or FSC® (C125195) certified products[1]

Manufacturing processes
Certificates for responsible, efficient and safe manufacturing processes[1]

They include:
- ISO 9001 quality certificate
- ISO 14001 environmental certificate
- ISO 50001 energy efficiency certificate
- ISO 45001 occupational health and safety certificate

Carbon footprint and Life Cycle Assessment
Case-specific carbon footprint calculations are available upon request

Product environmental information and Life Cycle Assessment
Product specific Environmental Product Declarations (EPD)[1]

Sustainability
Product specific indoor air emission declarations are available upon request. Product-specific chemicals declarations, etc. are also available upon request.

1 https://www.storaenso.com/en/download-centre

Carbon footprint

Description
This study shows life cycle assessment calculations for a school building based on this concept, and a benchmarked to a standard mineral based method. Calculations are based on the EN 15798 standard, where building whole life cycle of 50 years is considered.

Basic assumptions
- School module of 1200 m² GIA.
- The energy performance class is estimated to be same in the both school building in accordance with regulations during the use stage.
- Service life is estimated to be 50 years, including maintenance and material replacement.

Some Definitions

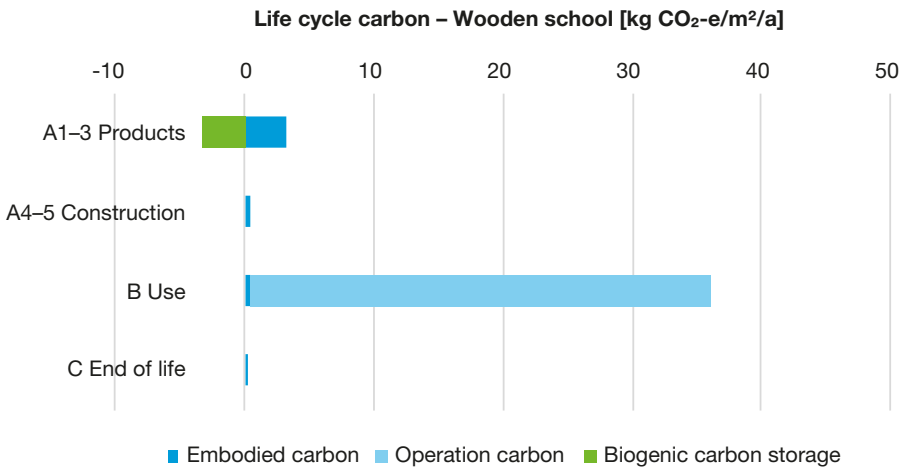
Embodied carbon is the greenhouse gas emissions associated with materials and construction processes throughout the whole life cycle of a building or infrastructure.

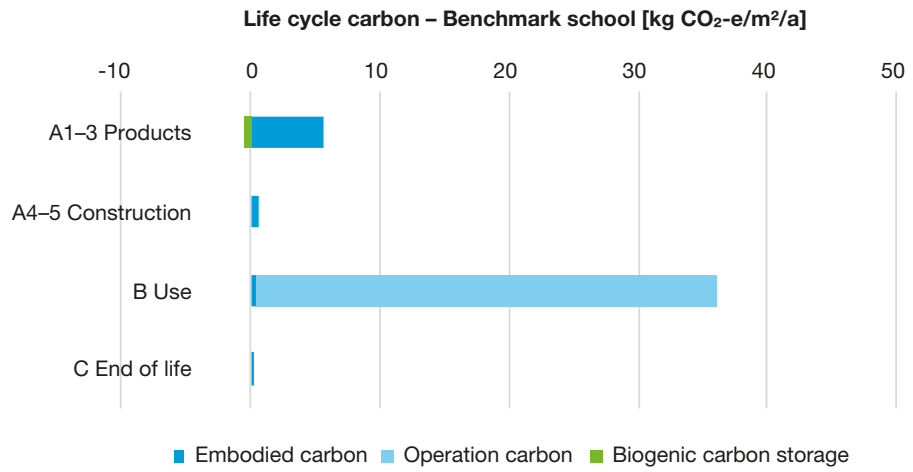
Operational carbon emissions are generated by the energy used to operate the building or infrastructure.

Biogenic carbon storage refers to carbon removed via sequestration from the atmosphere and stored as carbon in a product.

Net Zero Embodied Carbon – A net zero embodied carbon building (new or renovated) is highly resource efficient with embodied carbon minimised and all remaining embodied carbon reduced or offset in order to achieve net zero throughout its life cycle.

Materials included	Evaluation basis Wooden school	Evaluation basis Benchmark school
Foundations	Slab based light foundation	Slab based light foundation
Building main structures and envelope	Based on section drawings, element listing and BIM Suporting structure: LVL colums Intermediate floor: LVL Rib Panel Roof: Timber based structure and membrane. External wall: CLT, insulation, timber cladding, windows, doors	Intermediate floor: Hollow core concrete slab P320 structure Roof: Timber based structure and membrane. External wall: Concrete sandwich element incl. Insulation, windows, doors
Internal walls	Stud based internal walls (timber, insulation, gypsum plasterboard, paint)	Concrete based internal walls
Building systems and installations	Estimation based on building area (heating, electricity, ventilation, drainage, piping, fire alarm, communication cable, sanitary)	Estimation based on building area (heating, electricity, ventilation, drainage, piping, fire alarm, communication cable, sanitary)
Furniture	Excluded	Excluded
Material service life data	Normal/estimated service life	Mormal/estimated service life
Transportation	Based on One Click LCA average data	Based on One Click LCA average data
Use phase energy consumption	Estimated based on Finzeb	Estimated based on Finzeb
Operations and maintenance	Based on One Click LCA average data	Based on One Click LCA average data



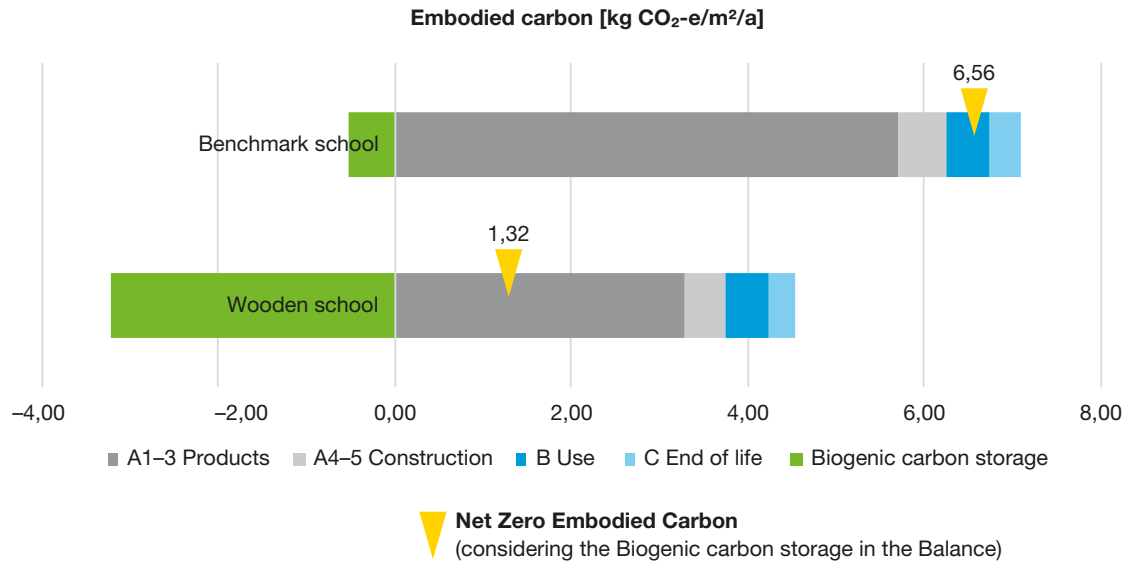


Main findings

The embodied carbon impact is 4.53 kg CO_2-e/m²/a when based on the School Concept by Stora Enso, and 7.09 kg CO_2-e/m²/a for the benchmark. This represents a saving of approximately 40%. Embodied carbon emissions can be reduced by using wood effectively along with other materials in a building.

Biogenic carbon storage in the timber structural frame offsets approximately 70% of the total embodied carbon emissions of the Building. Considering this, the overall impact of the timber school is in the range of 20% compared to the benchmark.

The wooden school stores 50 tons of carbon over the life cycle, which implies that 190 tons CO_2 are kept away from the atmosphere and stored in this building over its whole lifetime.



Innovation

The latest developments within wood construction allow for new opportunities for everyone in the construction sector to innovate, from architects looking to create new designs to structural engineers and developers looking for efficiencies in production. The opportunities include:

Life cycle design
BIM utilisation in design and production allows for a great deal of precision, less material waste and efficiency.

Customisable design
Modern CNC processing technology enables customisable panels to be produced, allowing for flexible, yet cost-efficient design and construction.

Service integration
Possibilities to integrate services in the structural zone can lead to reduction of floor-to-floor height and savings in cladding for instance.

Efficiencies

Energy efficiency
Buildings use approximately 40% of the EU's total energy consumption1. Reduction of energy use in buildings is one of the most economical ways to mitigate carbon emissions. The Energy Performance of the Buildings Directive (EPBD) is the main policy tool by the European Union to reduce energy use in buildings within the EU member states. There is also the Renewable Energy Directive (RED) that aims to increase the share of renewable energy in supply to buildings, further driving down carbon emissions from the use of buildings.

The EPBD is driving the constant improvement of energy performance in buildings, building elements and technical systems. The performance is defined and updated in national building regulations. According to the EPBD, as of the beginning of 2021, all new buildings will need to be nearly zero energy buildings (nZEB) in the EU member states. nZEBs are buildings with very high energy performance and their energy requirements are covered by renewable energy sources to a significant extent. In each EU member state energy performance levels and nZEB are defined differently using a methodology considering associated life cycle costs. Stora Enso wood-based building solutions offer a wide range of properties that fit the nZEB definition well in the Central and Northern European countries. CLT structures for use in the Nordic climates have been analysed for their physical and energy performance. Insulated CLT and other wooden structures can have U-values down to 0.1 W/m^{2}K and even below without any moisture risks and associated risks to the indoor climate.

With energy use in buildings heavily regulated and quickly approaching nZEB, efforts to lower the environmental impact of buildings are now focusing more and more on lowering energy consumption and carbon emissions associated with the production of building materials and the construction of buildings. The use of Stora Enso low carbon building solutions help lower environmental impacts relative to existing homes and construction practices.

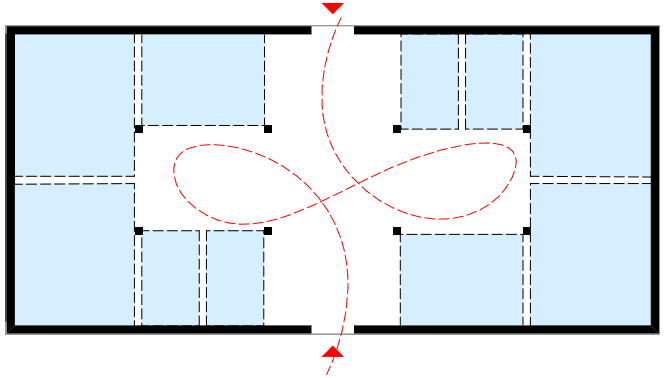
Cost efficiencies
Compared to conventional construction, building in timber reduces construction schedules, site overheads and financial holding costs.

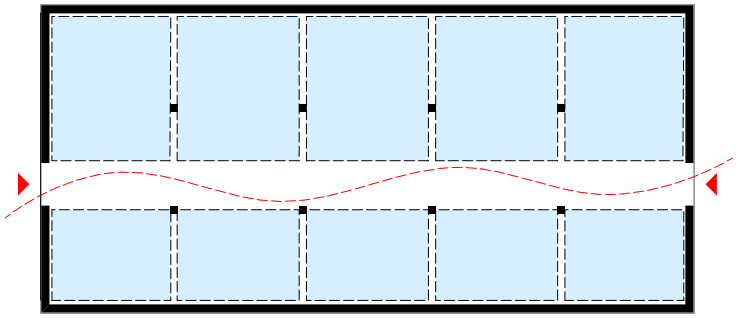
Project efficiencies
Reduced construction time in the production phase is one of the greatest incentives of timber in construction. Up to 30% faster construction time can be achieved compared to more site-intensive alternatives.

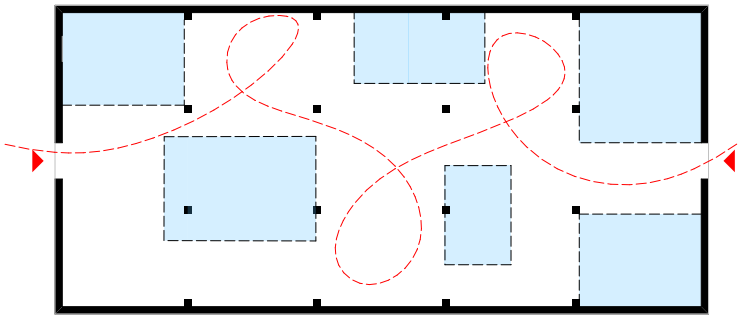
The concept

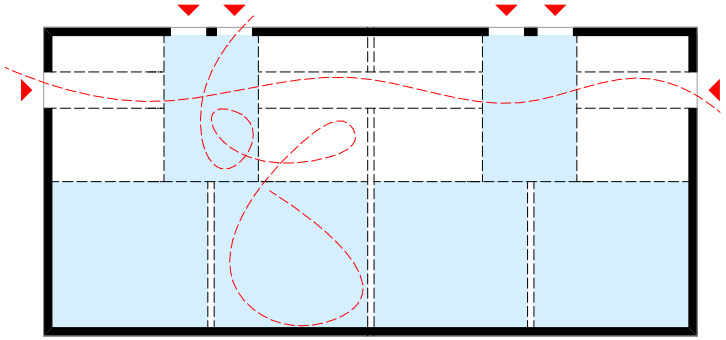
This manual is intended to show the possibilities for building schools with Stora Enso's massive wood products. It is intended for designers, contractors, building owners and developers to gain an understanding of how to create cost-competitive and innovative school buildings.

For structural calculations with our products visit:
www.calculatis.storaenso.com
To download our BIM Objects visit:
https://www.prodlib.com/library/suppliers/Supplier_Storaenso/









The eco school concept is based around a 600 m^2 school module with a capacity for about 100 to 150 students or five to eight classes. The module is designed according to the modern Finnish curriculum but is also very adaptable to different kind of educational needs. The generous size of the school module allows for simultaneous use by various age groups and classes with different learning needs. The open-plan layout facilitates open activities, communication and group teaching.

The module presented can be used on multiple scales, ranging from schools of 100 students to approximately 1,000. The example schools presented show a concept for a school of approximately 500 pupils and 1,000 pupils.

The eco school concept design is based on Stora Enso products; CLT (cross laminated timber), LVL (laminated veneer lumber), rib panels and glulam products such as beams and pilars. Floor height and room height are variable and not necessarily limited to the height of a single wooden wall element (2,95 meters). Roof form, central halls and individual room layouts are left open in the design and can be individually determined to suit the specific needs of the user or customer.

The following guidelines aim to illustrate the applications of the Stora Enso system in school buildings as well as help architects apply the Stora Enso system to the particular needs of each school typology.

Basic components: structural principles

Roof structure according to context and desired architecture

LVL rib panels

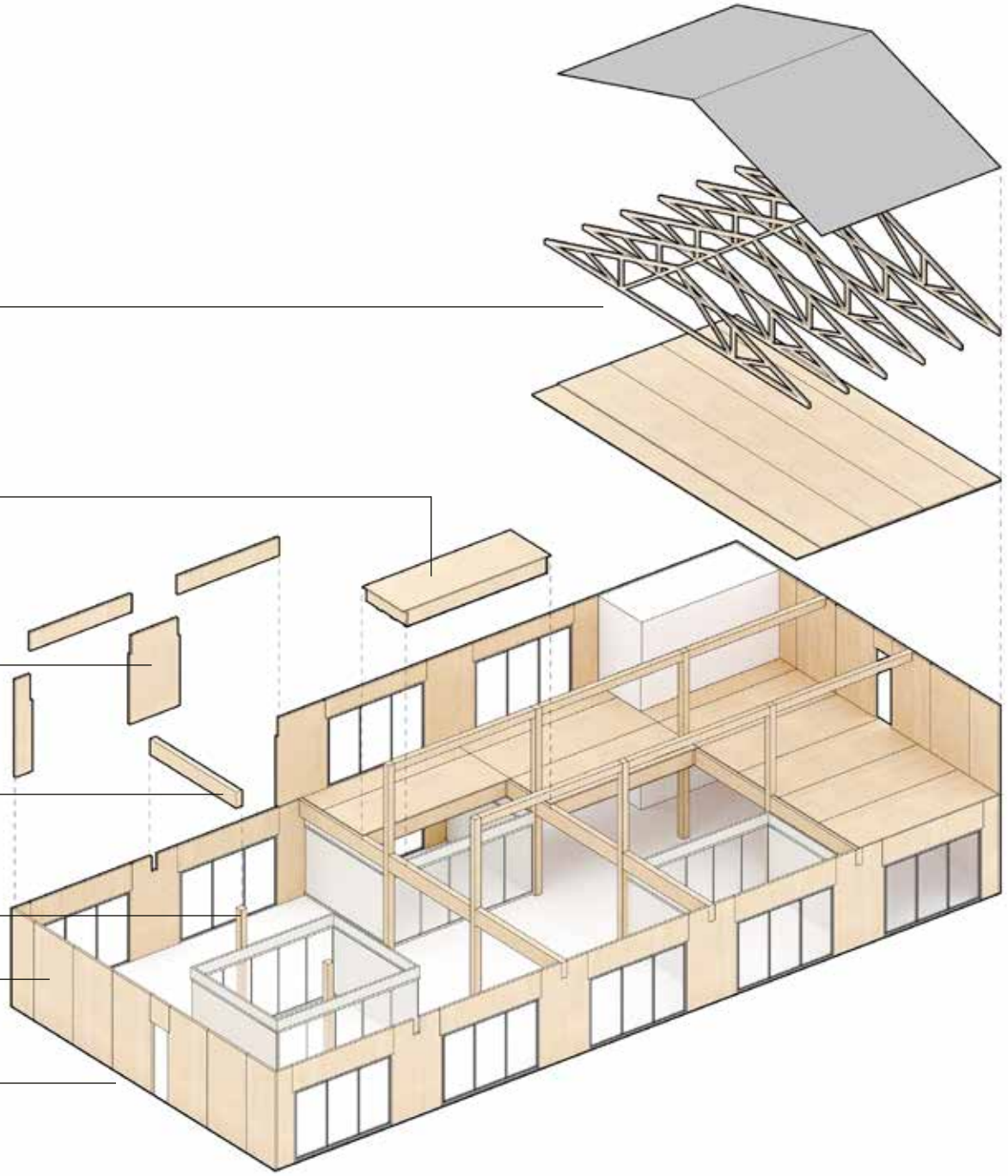
120 mm CLT wall panels.
Visual quality towards interior.
Four structurally stiffening 2450 mm wide CLT wall panels on each side.

Beams 300x700 LVL-S

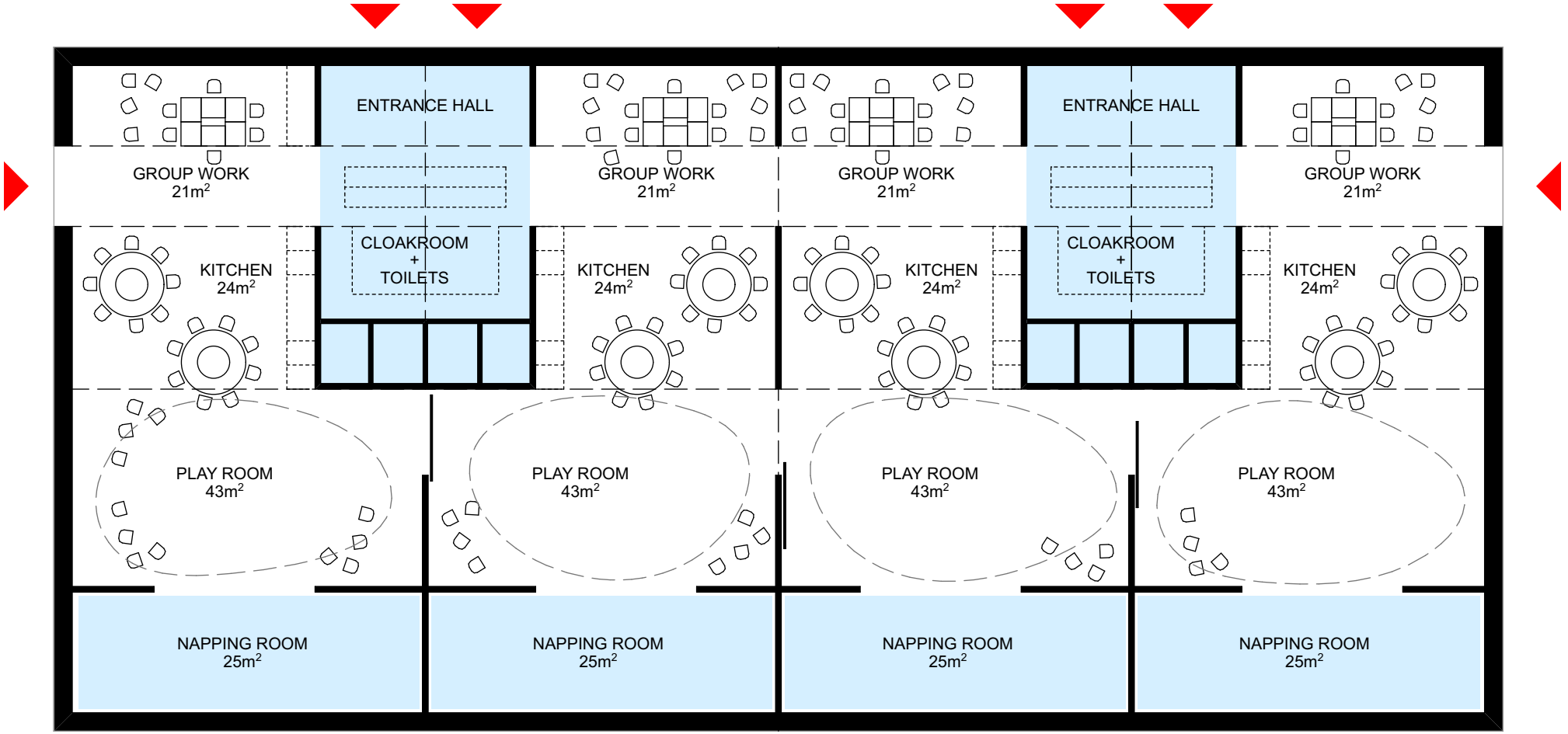
Columns 300x300 LVL-S

Shorter sides function as structural sitffening elements. openings up to 2 metres are possible.

Concrete foundation and floor of the ground floor

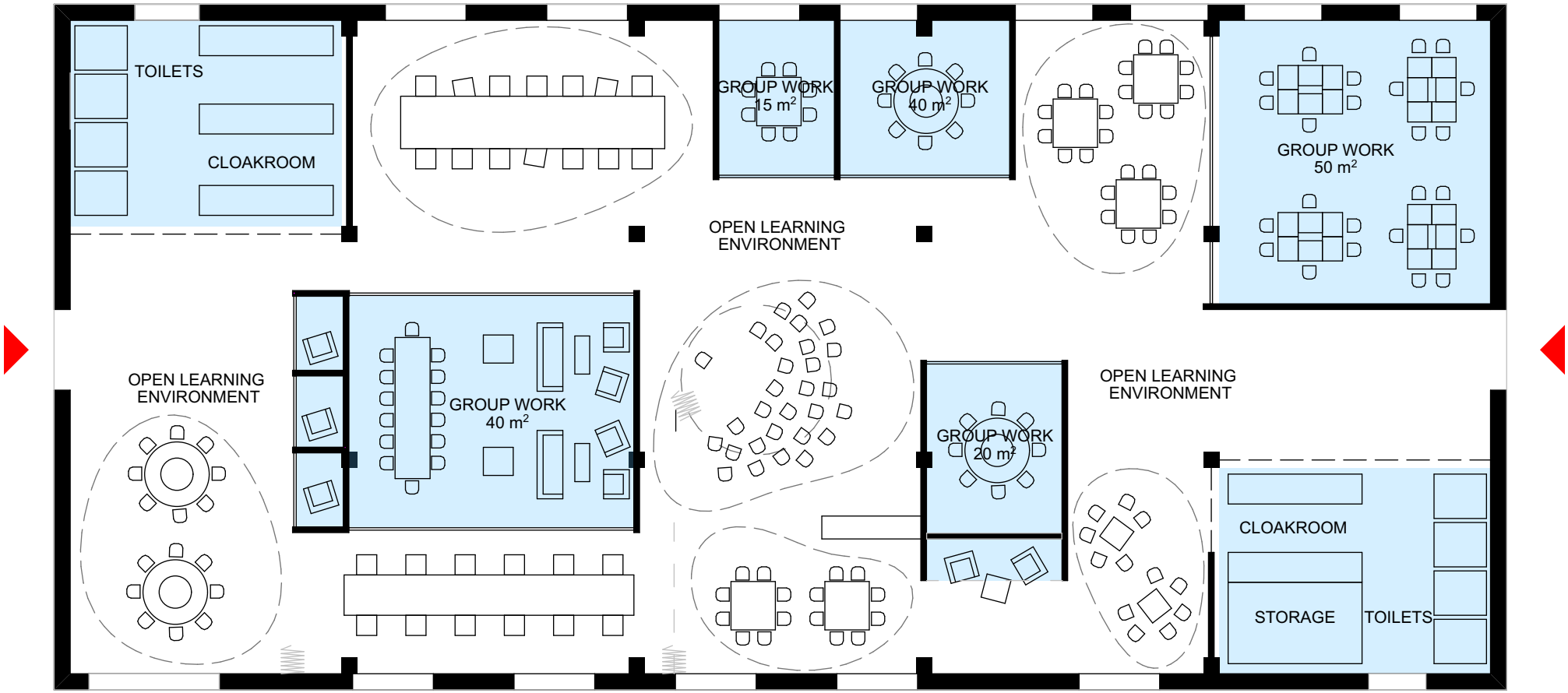


Basic components: kindergarten module



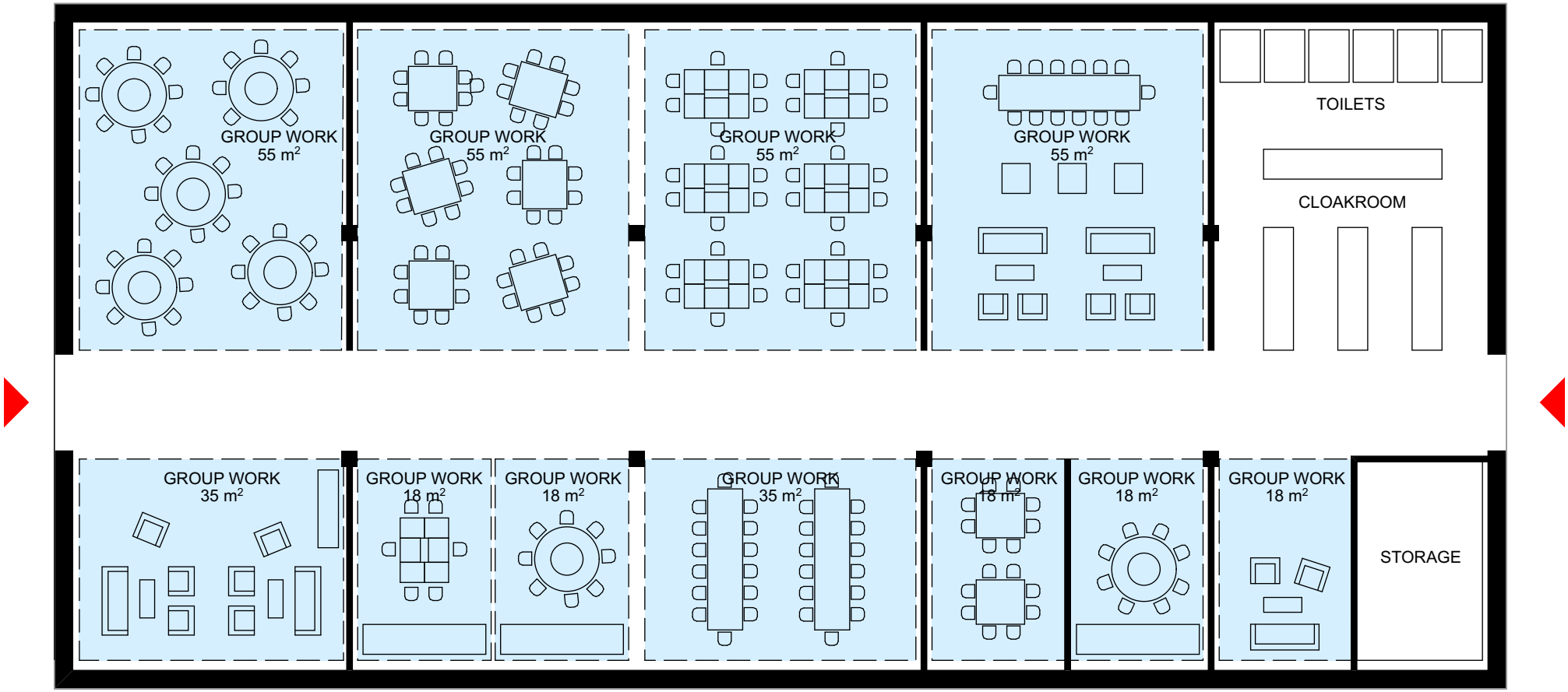
The kindergarten version of the school module can house four groups of children. Two groups share the entrance from the yard, cloakroom and toilets. Teachers and children can go from one module to other learning spaces via openings on the short sides of the module.

Basic components: open plan module



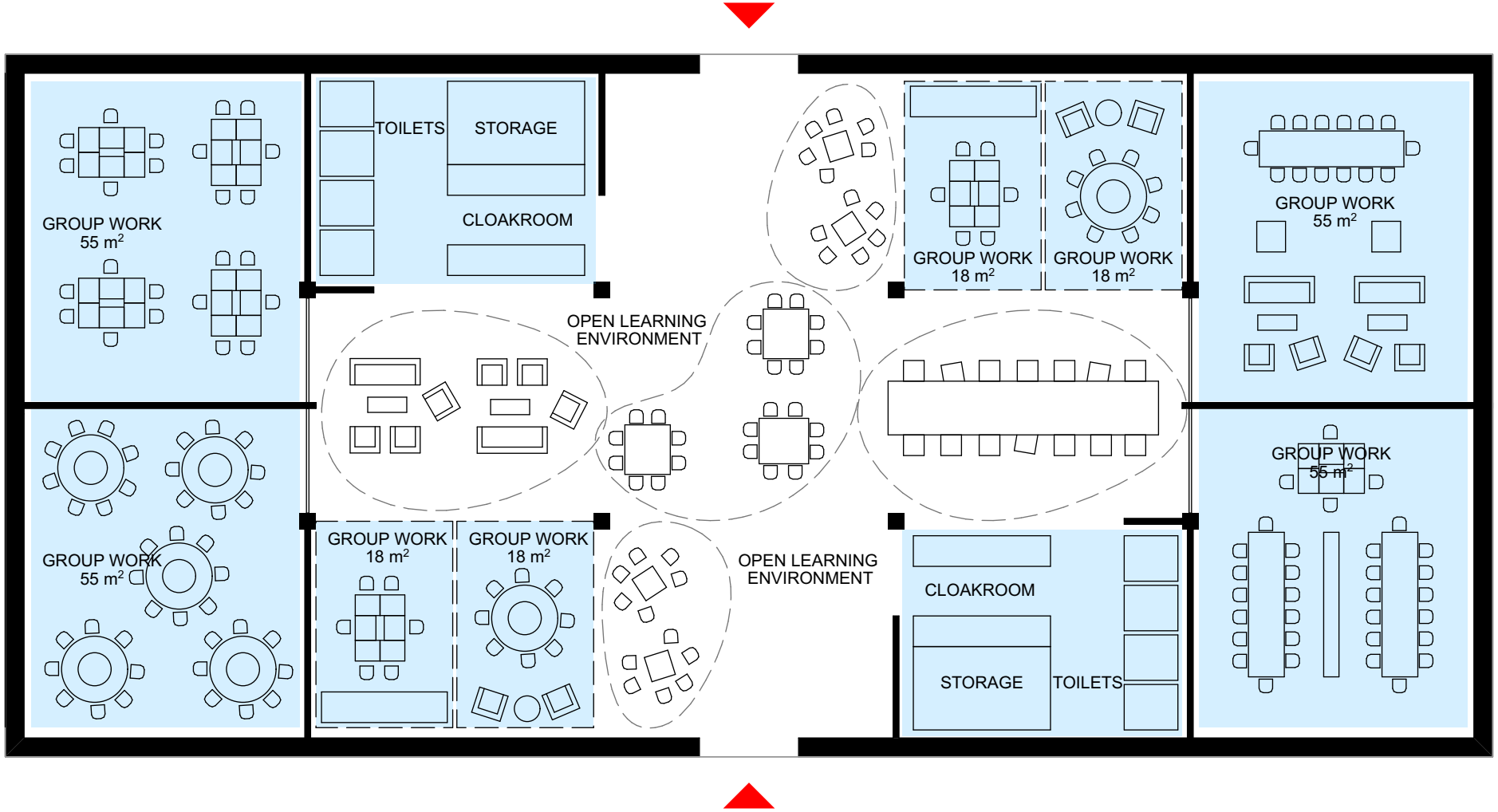
The open learning environment version has different sizes of open and closed learning spaces. By placing the more closed-group work spaces in the middle of the module, the space is divided to offer more options for different learning situations and different individuals.

Basic components: corridor module



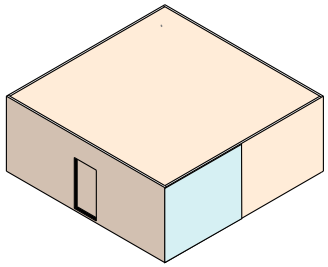
The corridor version of the school module can offer three different sizes of more traditional class rooms. These modules can be linked together with a corridor between modules or just placing modules next to each other.

Basic components: 50/50 module

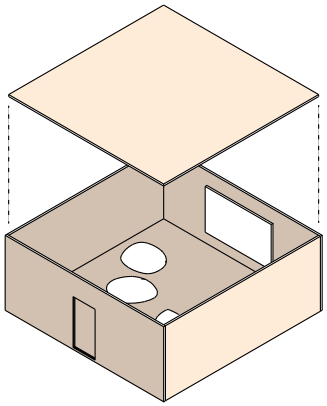


The 50/50 module has a centred, modern, open learning environment that also funtions as a lobby and as a traffic area inside the module. More private learning areas are located around the centre of the module and along the edges. Cloakrooms and toilets are located next to the entrances on the longer side of the module. These kind of modules can be linked together with a corridor or linked to the main entrance hall on one side while the other side can open to the yard.

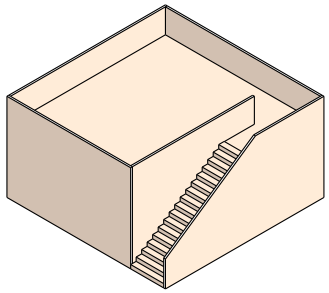
Basic components: mini module



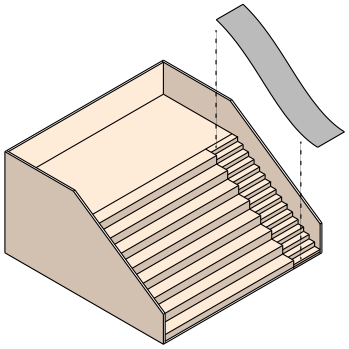
basic: transparency
height 2,95 m



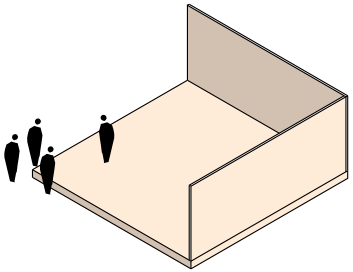
basic: insulation
height 2,95 m



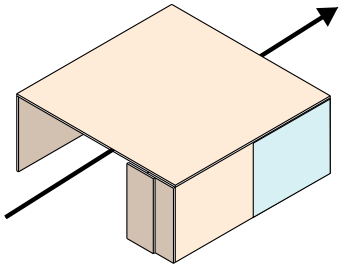
mezzanine
total height 4 m



step mezzanine & storage
total height 4 m

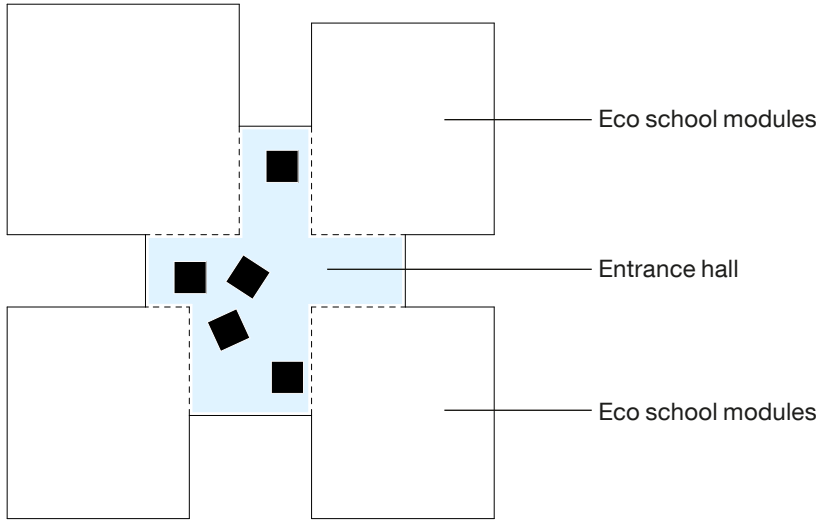


open: plinth/stage
height 2,95 m



open: sliding doors
height 2,95 m

In open-plan learning environments, it is important to provide acoustically and visually controlled spaces as well. Keeping ambient environmental noise out or containing a more noisy activity, freely placed mini modules provide enclosed areas for napping, silent study or listening to music, for example. The ‘mini modules’ are a way to define spaces outside of the main learning modules, for example in large entrance halls.



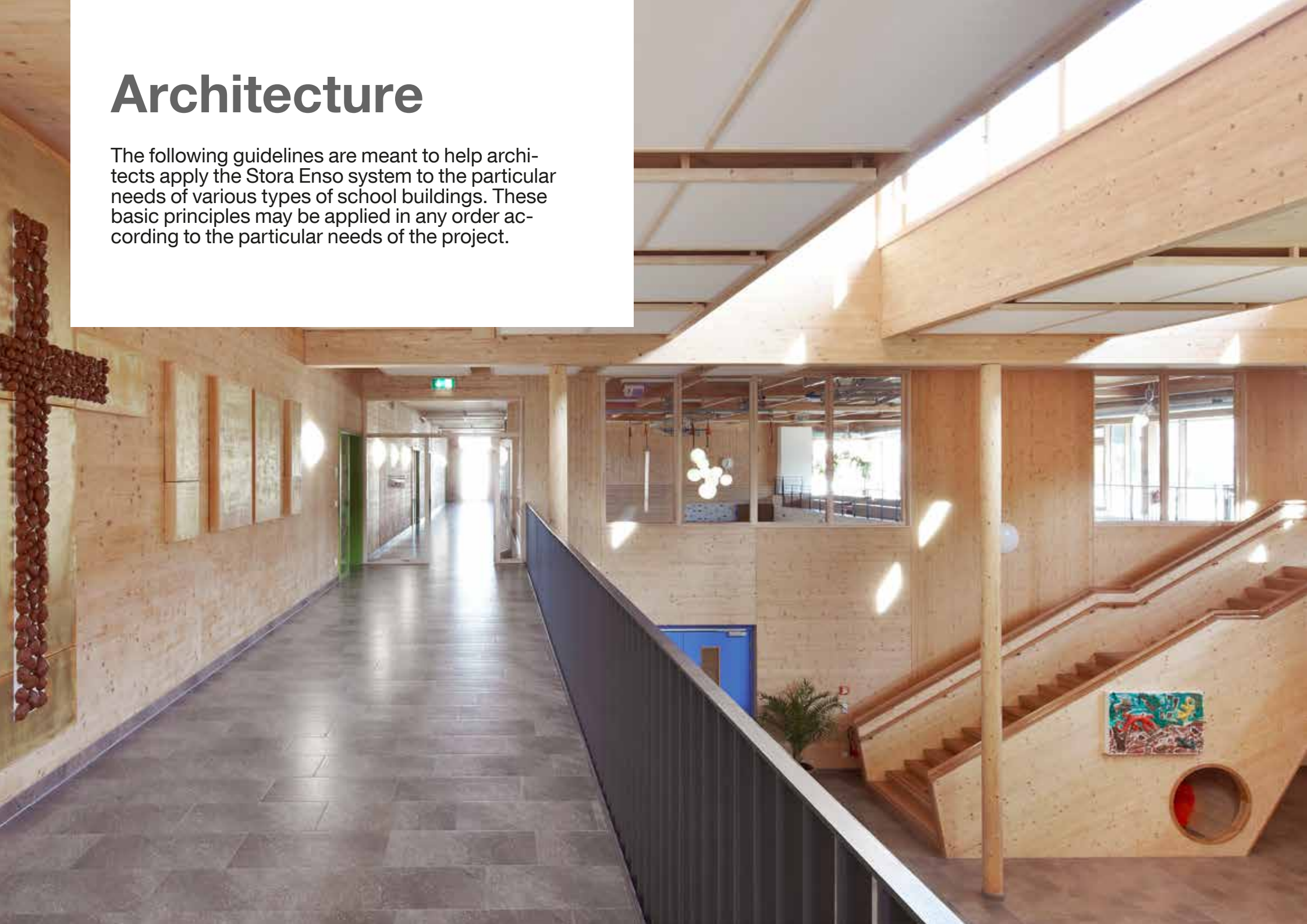
The construction system and sizes of the ‘mini modules’ are standardised, offering the benefits of more control when it comes to lighting, noise and visibility as well as changes in the height of space. They can also work as a spatial divider. They can be used as spaces for video and audio projection, silent reading, naptime, or as a stage/platform.

Safety/functionality concerns include: number of exits, access and banister height. The acoustic performance of the modules should be considered and will vary based on their uses. For instance, they can be insulated or non-insulated.

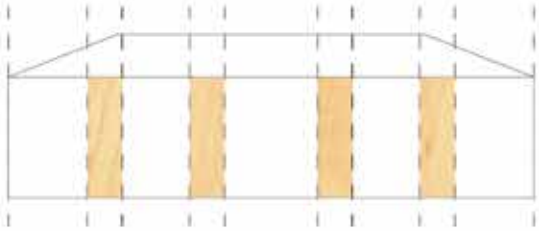
Structurally, they are designed as a non-load-bearing partition wall system, with the thickness of a single CLT element: 80 mm.

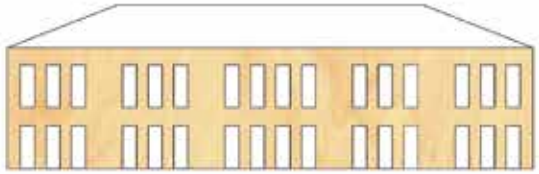
Architecture

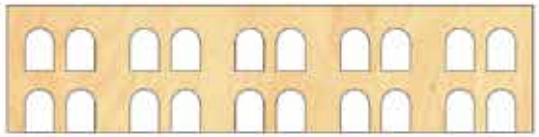
The following guidelines are meant to help architects apply the Stora Enso system to the particular needs of various types of school buildings. These basic principles may be applied in any order according to the particular needs of the project.

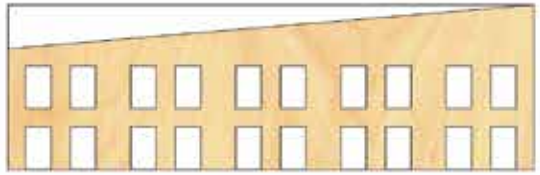


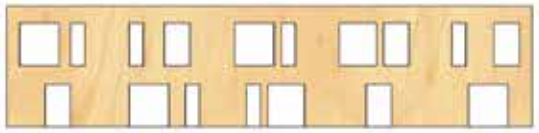
Buiding form: facade adaptability

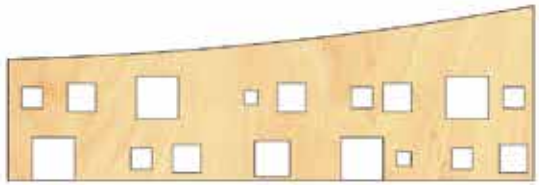










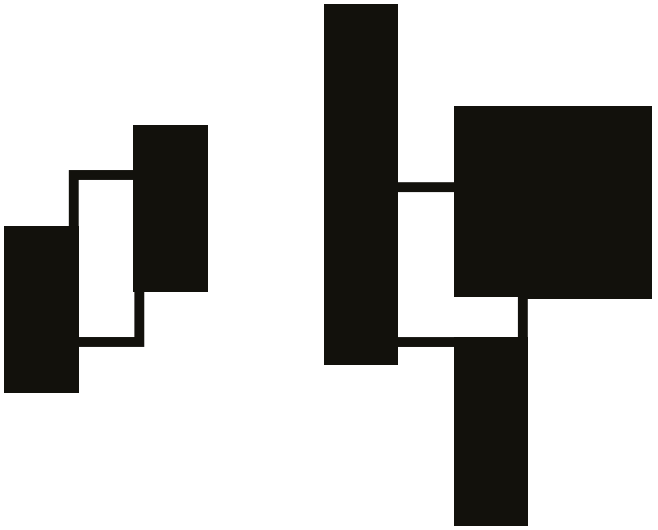


The school module façade can be modified according to architectural objectives, site and context. Façade material can also be anything from brick layer, metallic casettes or wooden boards.

Longer façades have four structural non-perforated stiffening CLT elements per side. This leaves a lot of different options for window openings in the façade.

Building form: size adaptations

So far, the eco school concept has outlined the spatial and structural aspects of the single school module. The following pages outline applications of the standard module in schools of daifferent sizes. Two size options are presented. The examples are diagrammatic and aimed to give an overall idea of the number of modules and floor area needed for different student capacities and functions within the school. The various school functions are grouped into more broad categories for ease of representation. Specific, local requirements should of course always be consulted.



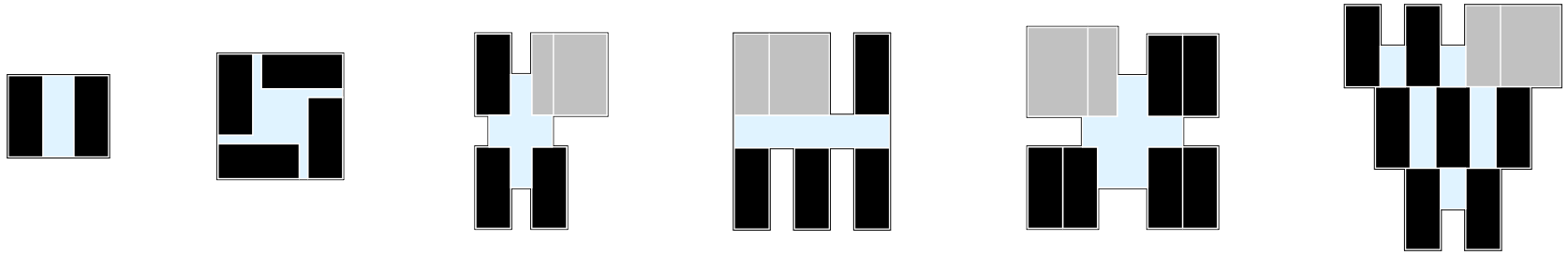
Building form: layout adaptability

SCHOOL MODULE

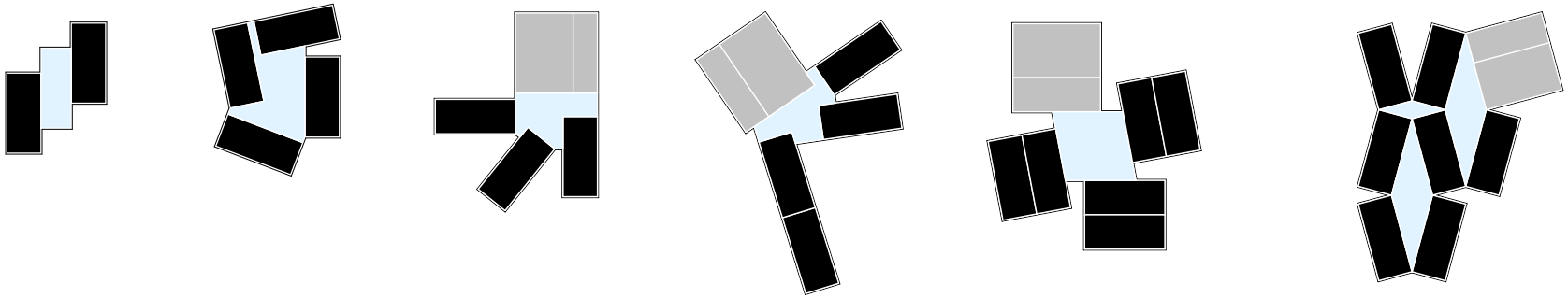
OTHER EDUCATIONAL SPACES

HALL

Different learning spaces layouts for different number of students.



Layouts can be adapted to the site and context by adjusting the modules around the main lobby.

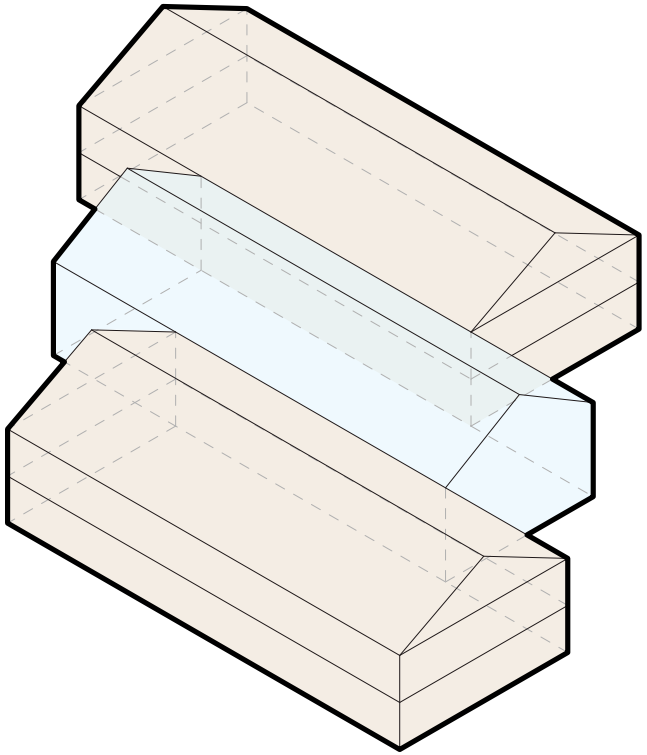


Eco School 300

The following outlines the spatial layout of a 300-student school using the eco school module as the building block.

The diagrams illustrate the approximate spatial requirements for each colour-coded function in a small-sized school.

The eco school modules are arranged around the entrance hall which is also the main circulation space and the dining hall. The ground floor includes the Kitchen / Personnel spaces and on the other side of entrance hall are the Arts & Science educational spaces. The second floor includes eco school modules on either side of the entrance hall bridge.



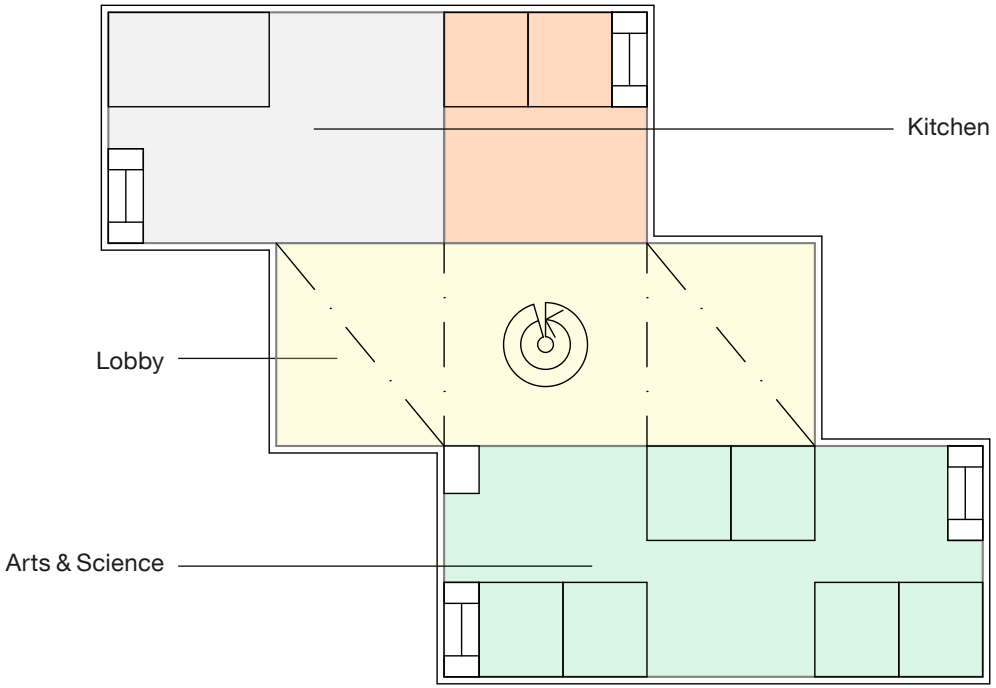
Eco school modules

Entrance hall

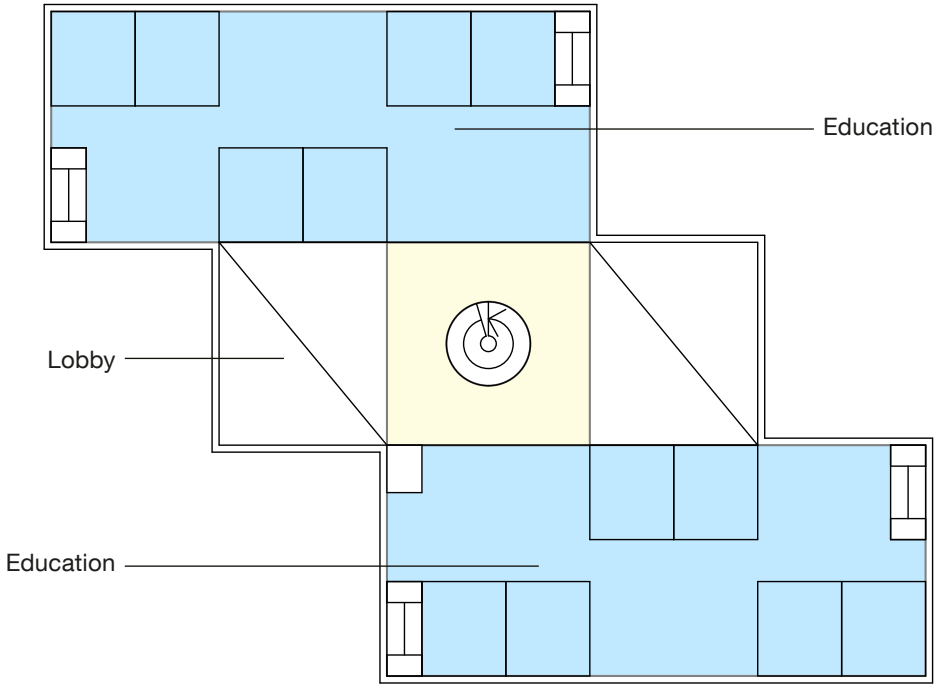
Eco school modules

Statistics

Approx. student capacity	300
Number of modules	7
Gross floor area	3 300 m^2
Approx. NIA/student	11 m^2



Ground floor



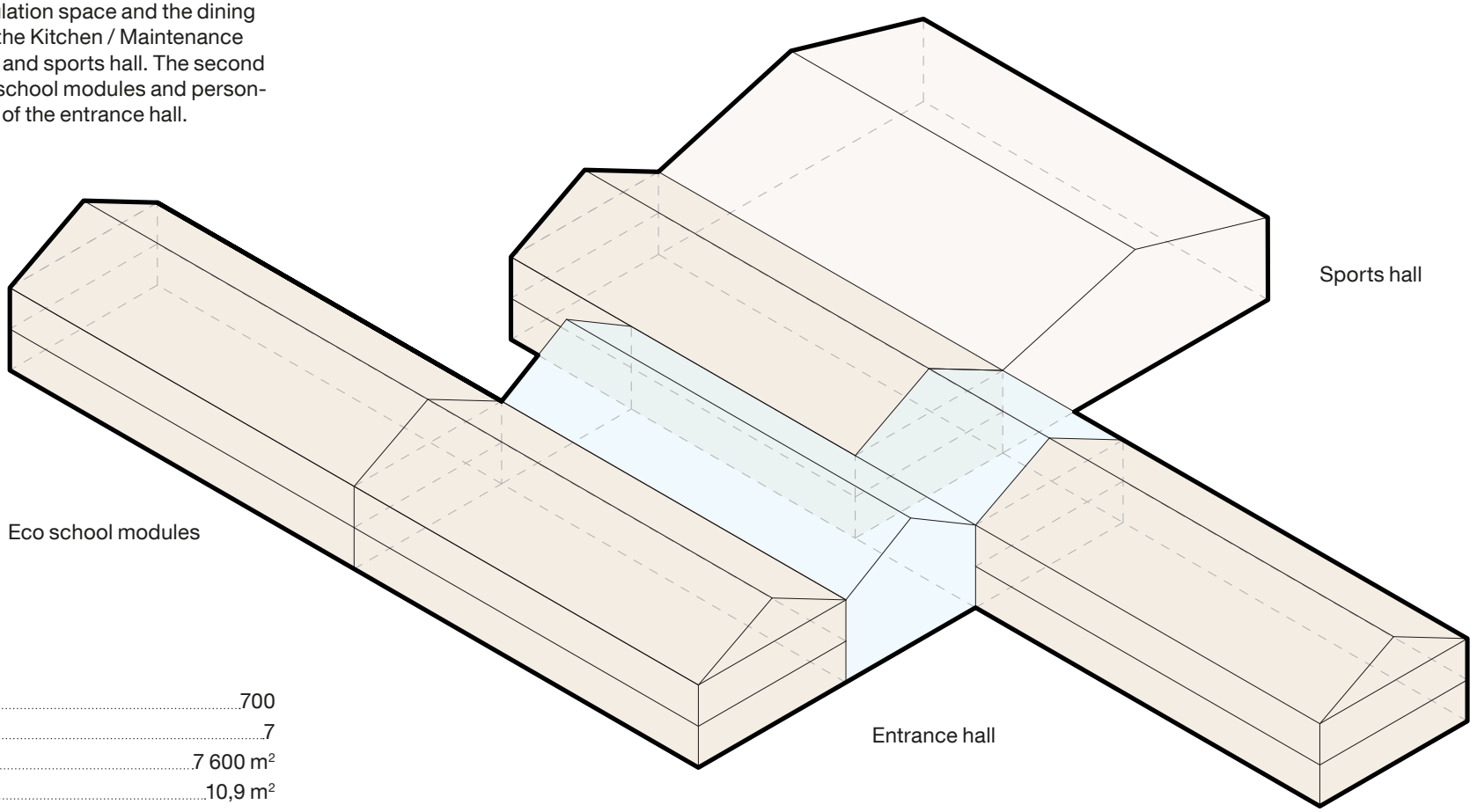
1st floor

Eco School 700

The following outlines the spatial layout of a 700-student school using the eco school module as the building block.

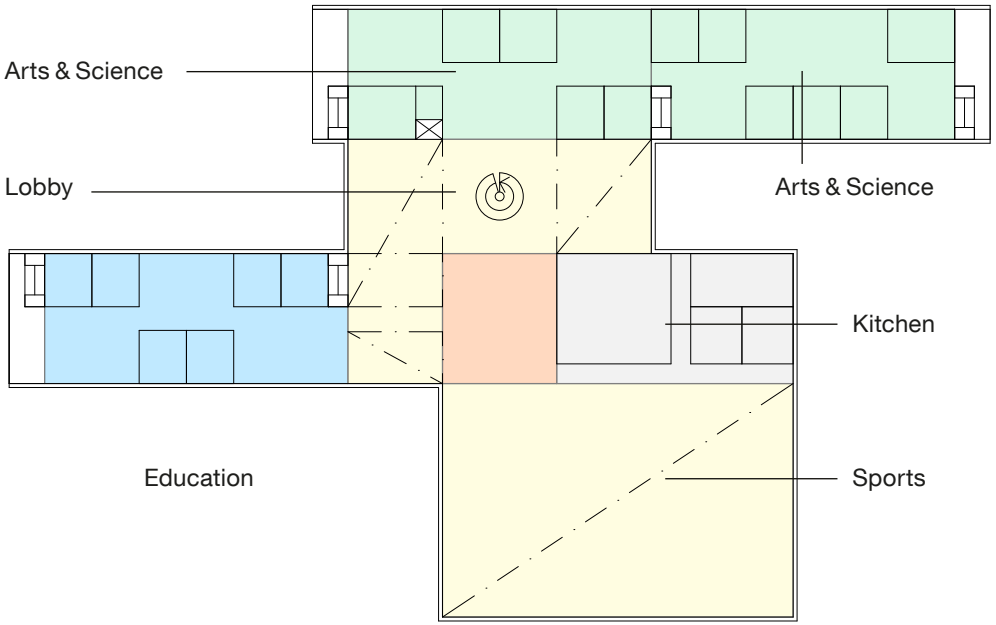
The diagrams illustrate the approximate spatial requirements for each colour-coded function in a medium-sized school.

The eco school modules are arranged around the entrance hall which is also the main circulation space and the dining hall. The ground floor includes the Kitchen / Maintenance spaces, Arts & Science spaces and sports hall. The second floor includes educational eco school modules and personnel office spaces on either side of the entrance hall.

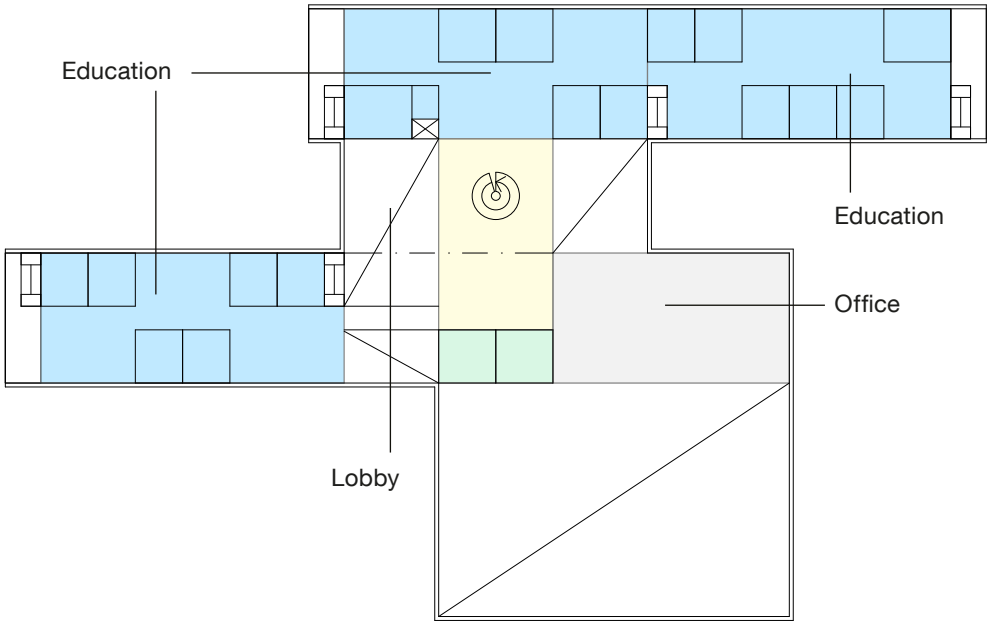


Statistics

Approx. student capacity	700
Number of modules	7
Gross floor area	7 600 m^2
Approx. NIA/student	10,9 m^2

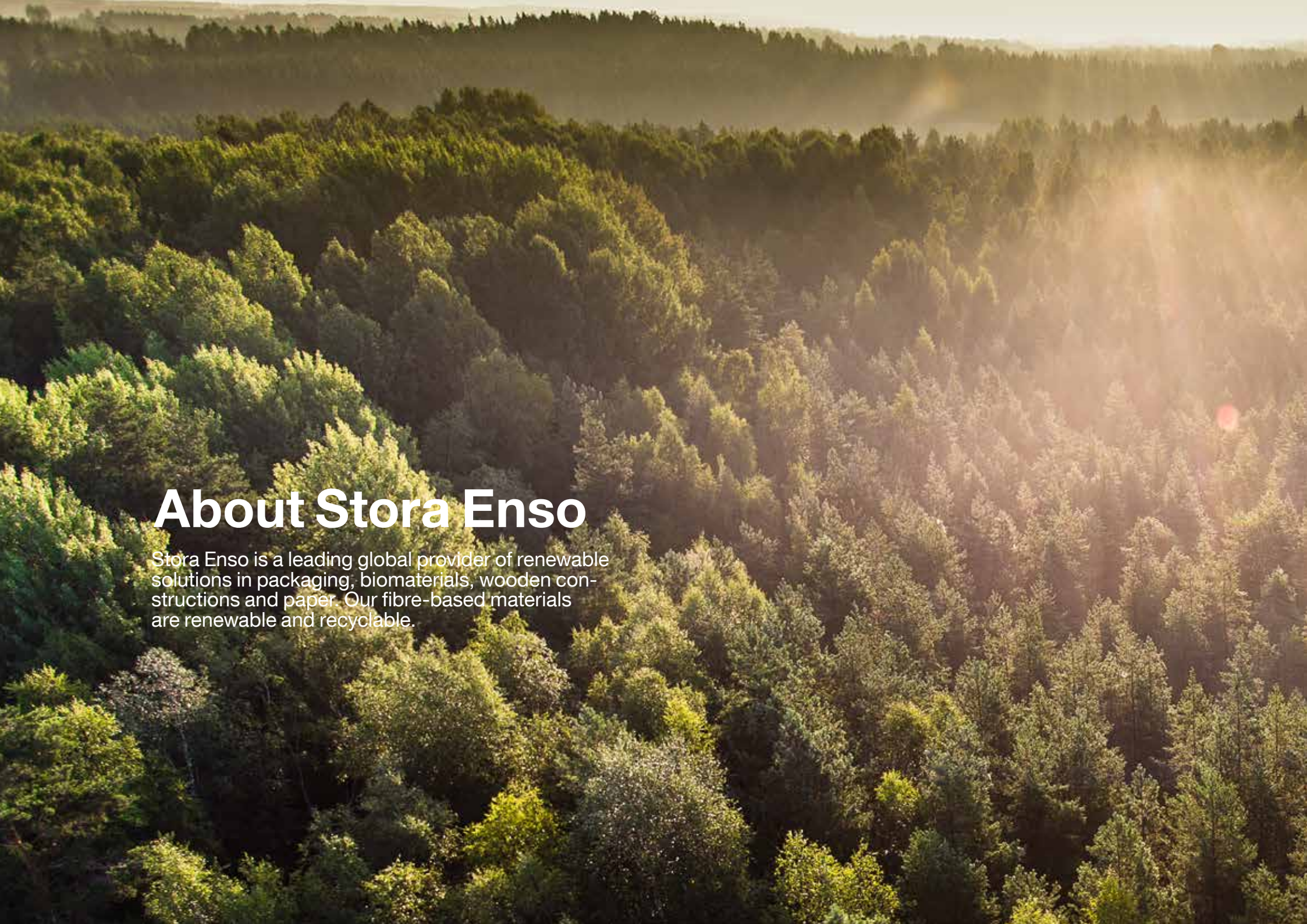


Ground floor



1st floor

Concept renderings



About Stora Enso

Stora Enso is a leading global provider of renewable solutions in packaging, biomaterials, wooden constructions and paper. Our fibre-based materials are renewable and recyclable.

Disclaimer

This brochure is intended to show what possibilities exist when it comes to constructing school buildings from wood. This information should be treated as an overall concept for the preliminary design of buildings and structures.

It does not replace the need for final design and calculations by repsonsible designers, including but not limited to structural, acoustic, fire or building physical design.

Stora Enso
Division Wood Products

Building Solutions

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