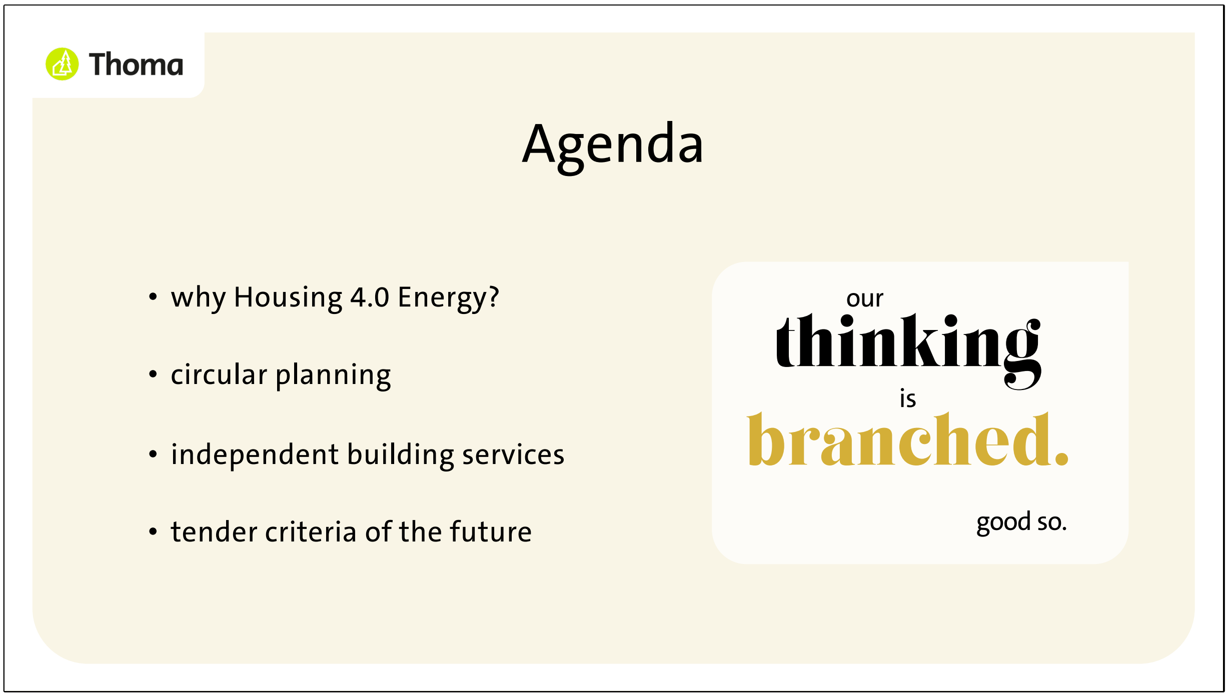
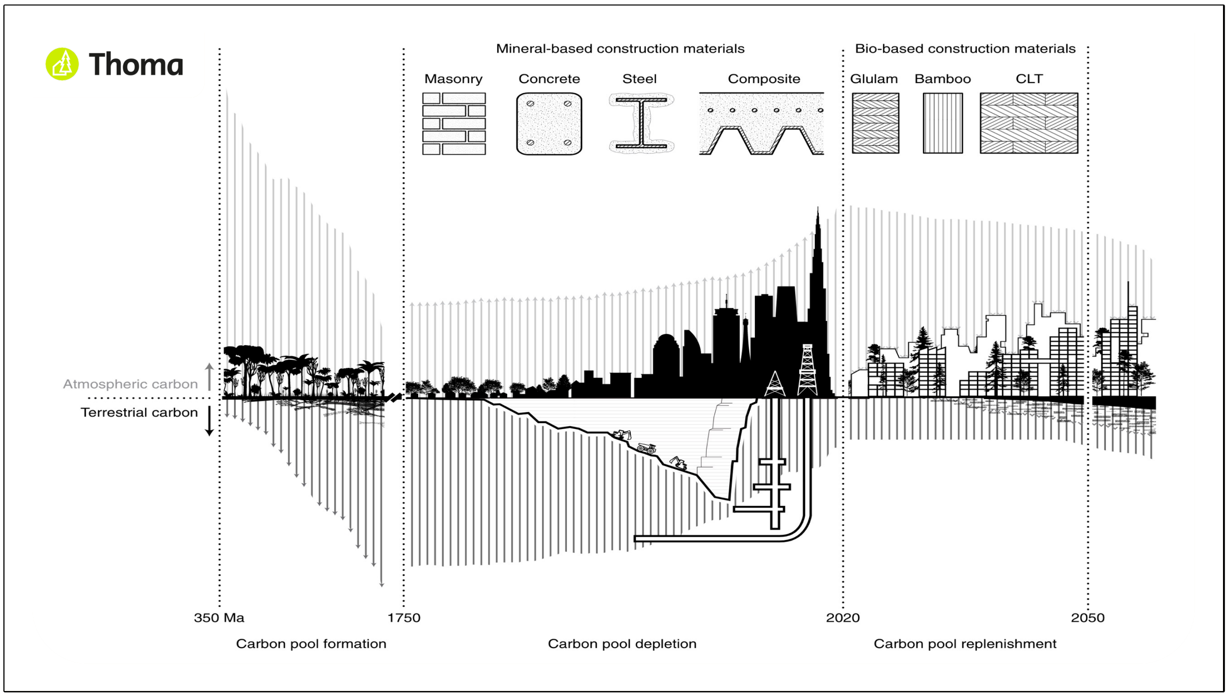
Presentation of the German prototype by Florian Thoma (head of the project)



• What is Housing 4.0 Energy? What are the **project objectives**? Why is it so important to create an awareness of the goals of H4.0E? What solutions are the project partners pursuing and what is the **approach of the German prototype** to achieve these goals?

• What is the material basis for establishing a **circular economy in construction**? How long does CO2 need to be stored in building materials to act as a real CO2 sink? What cascades of material-reuse are possible through planned deconstruction processes?

• What is the CO2 and cost balance of building a house compared to running it? What are the options for using independent and locally available renewable energy sources for heating and cooling buildings? What concepts do we need to evaluate the CO2 reduction and cost savings of building structures over their **entire life cycle**?



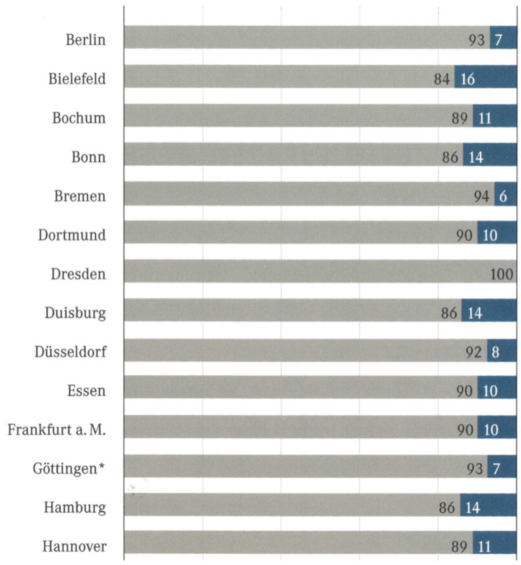
H4.0E Target 1: 60% CO_2 savings

Carbon pool formation (picture):
Evolution invents chlorophyll and wood-forming cells (trees). This enables the enormous capture of CO_2 from the atmosphere and our climate is created.

Carbon pool depletion:
40% of the total greenhouse gases are emitted during the construction and operation of houses and infrastructure.
50% of the total waste mass is generated during construction.
60% of the total energy and resource demand is accounted for by the construction sector.

Carbon pool replenishment:
We need to make our construction industry climate-friendly as soon as possible! This is a huge task, but we have the means.

Picture: Breakdown of subsidized (blue) and privately financed (gray) apartments in 2019 (bulwiengesa, 2021)



H4.0E Target 2: 40% cost savings

Between 2011 and 2019, the share of subsidised rental housing stock in Germany will fell by an average of 21 per cent, despite a tripling in the volume of new construction. This is due to expiring commitments and the sale of municipal stock.

There are many low-income households. Around 21% of households have a net income of €1,600 or less per month. Subsidised housing accounts for an average of 9.4% of the rental housing stock. The supply of social housing in the lower price segment cannot meet the demand.

The trend of **declining social housing** will continue over the next 10 years. This situation will further intensify the political debate on the housing market in the future!

Are our forests the new source of raw materials to continue our model of endless economic growth?

Is social housing in wood really always social for people and the environment (healthy, waste-free)?

How long will the buildings be used and can we reuse the materials?

How much energy will the buildings consume during their lifetime?

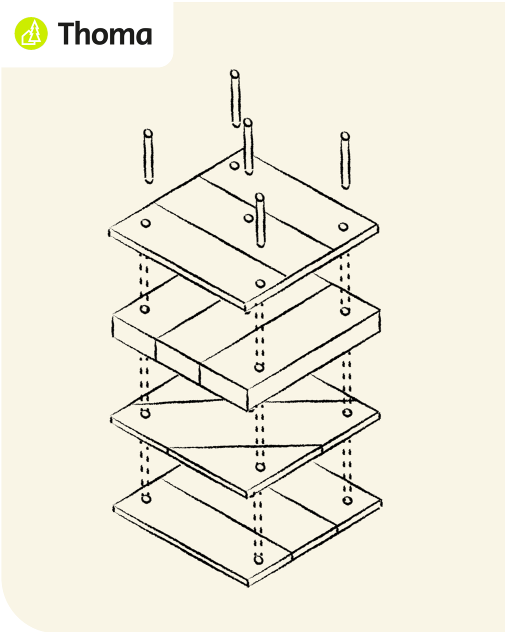
In order to have a positive answer to these questions, **3 principles are indispensable at the level of wood building materials**:

- The wood from the forest must be processed in its pure form, without chemicals.
- The operation of the buildings must be independent of fossil fuels.
- Buildings need deconstruction concepts and the ability to reuse their materials.

Since 1994 we have been working to build wooden houses that do not pollute the environment and make us healthy again. The path we have taken has been to work with solid wood, strictly avoiding any kind of paint, glue or other synthetic treatments. We have always used mechanical joints.

"We always make our decisions when we know it will be good for the 7th generation after us" Haidi Chief from Haidai Gwaii

Buildings with a high potential for urban mining are our children's future.



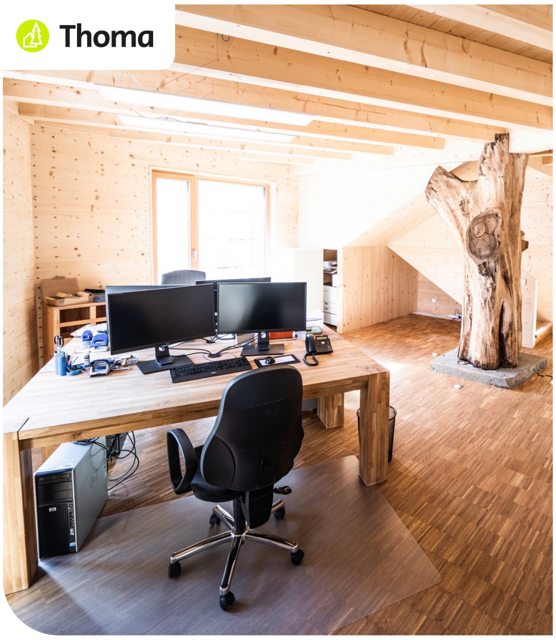
As a pioneer, we started with the worlds first mechanically joined cross laminated timber wall without glue (**Dowel Laminated Timber, DLT**). This construction method, which **we call Holz100**, is a model for a waste-free construction industry based on the circular principle of the forest.

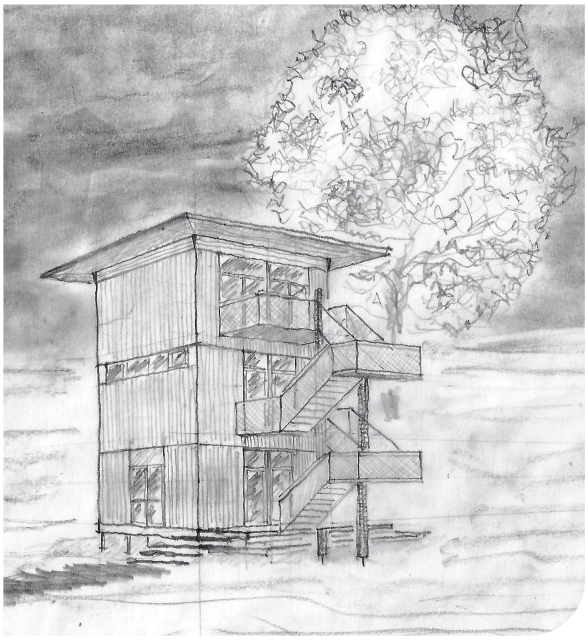
At the end of the journey, thermal recycling of wooden building materials? Even if only after having cascaded them for a long time! Material flow models in the LCA can show the use of "deconstructed" boards from Holz100 walls: 1 kg Holz100 VS 1 kg recyclate - 60% improvement. Most of the energy in the production process is used to make the boards. For the production of Holz100 walls, the PV systems on the roof of our factories are sufficient.

A board can be easily recovered from a dowelled cross laminated timber wall by **drilling out the dowel**. This is not possible with a glued wall.

Another challenge for a functioning circular economy is that deconstruction concepts need to be included in the development of projects. This makes it possible to reuse building materials at a high level without "downcycling" them.

A simple example for timber construction is the question of how to unscrew 30 cm long connecting screws after use without destroying the walls. A further cascade of use is possible if walls can be **reused as whole building components** before being disassembled into individual boards. The combination of these cascades means that the wood can be in the material cycle for several centuries prior to thermal utilisation.

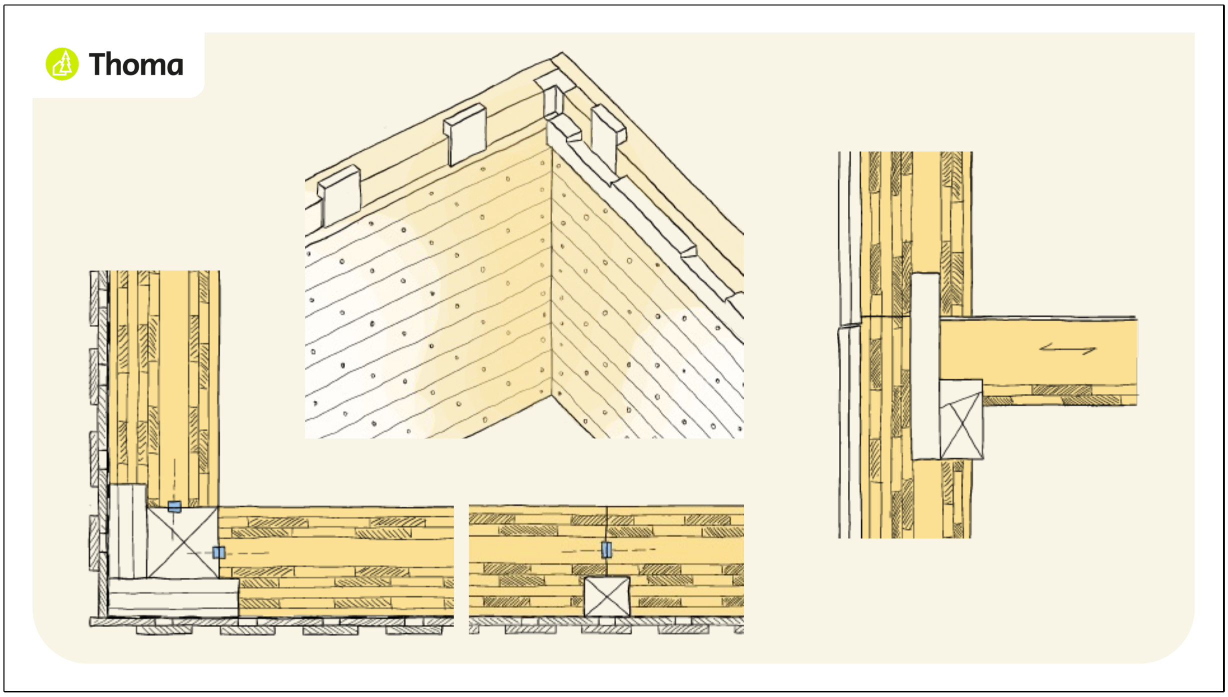




For the first time, the research tower will show new ways. With the planned deconstruction concept, **more than 80% of all materials used can be reused**. Never before has a 3-storey wooden building been developed in which all the wooden components are form-fitted and can be dismantled at any time.

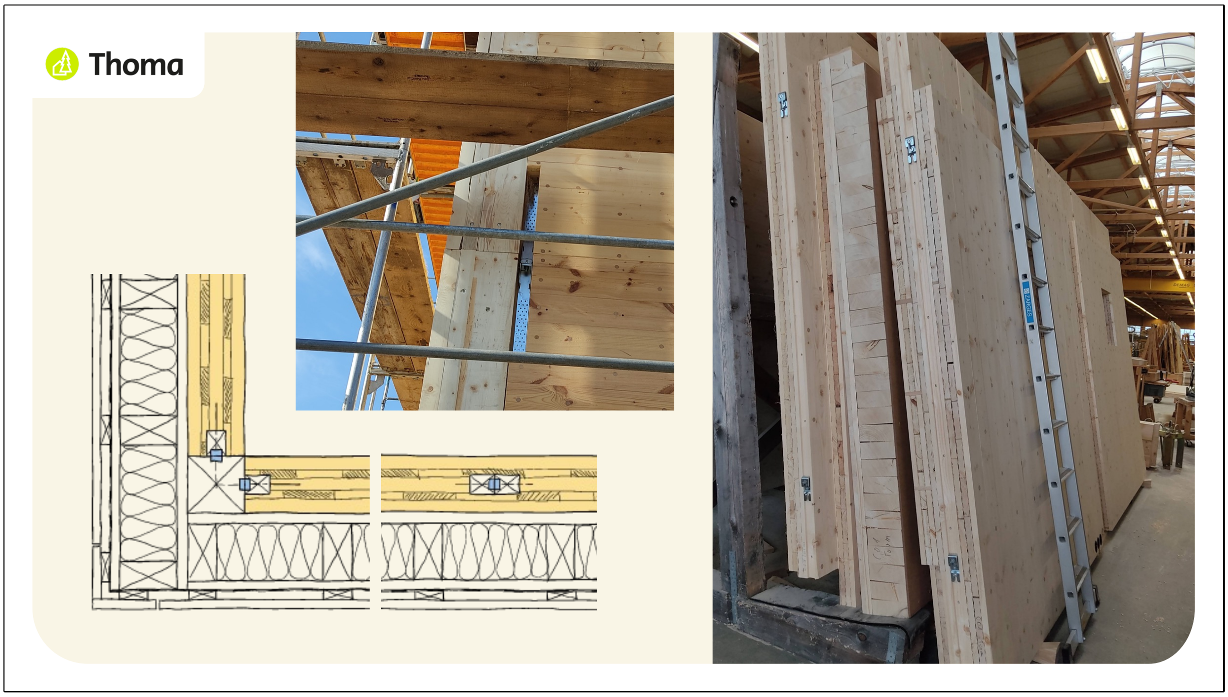
The tower has a net floor area (NFA) of 78 m2 and uses 110 m3 of wood. In LCA calculations, this results in a stored amount of **1000 kg CO_2/m^2 NFA**.

This design approach already plays an important role in short-lived buildings with a high number of changes of use! These include supermarkets, office buildings, event buildings, retirement homes, nurseries and schools.



Schematic illustration of the guiding details for **form-fitted wooden elements**

- Wall corner: with columns and the Knapp GIGANT (marked in blue). 30.6 cm solid wood without insulation.
- Wall longitudinal joint: The edge of the wooden elements can be used both as a corner element and as a longitudinal joint due to the constant milling.
- Floor transition: The ceiling panel does not run through to the outside but rests on a wooden bracket. This bracket absorbs the shear and tensile forces of the ceiling via a dovetail construction.
- Isometric view: The isometric view also shows the timbers that transfer the shear forces from the upper exterior wall to the lower exterior wall via a type of finger joint.



Alternative wall construction on the 3rd floor. Thinner solid wood wall with prefabricated cladding elements.

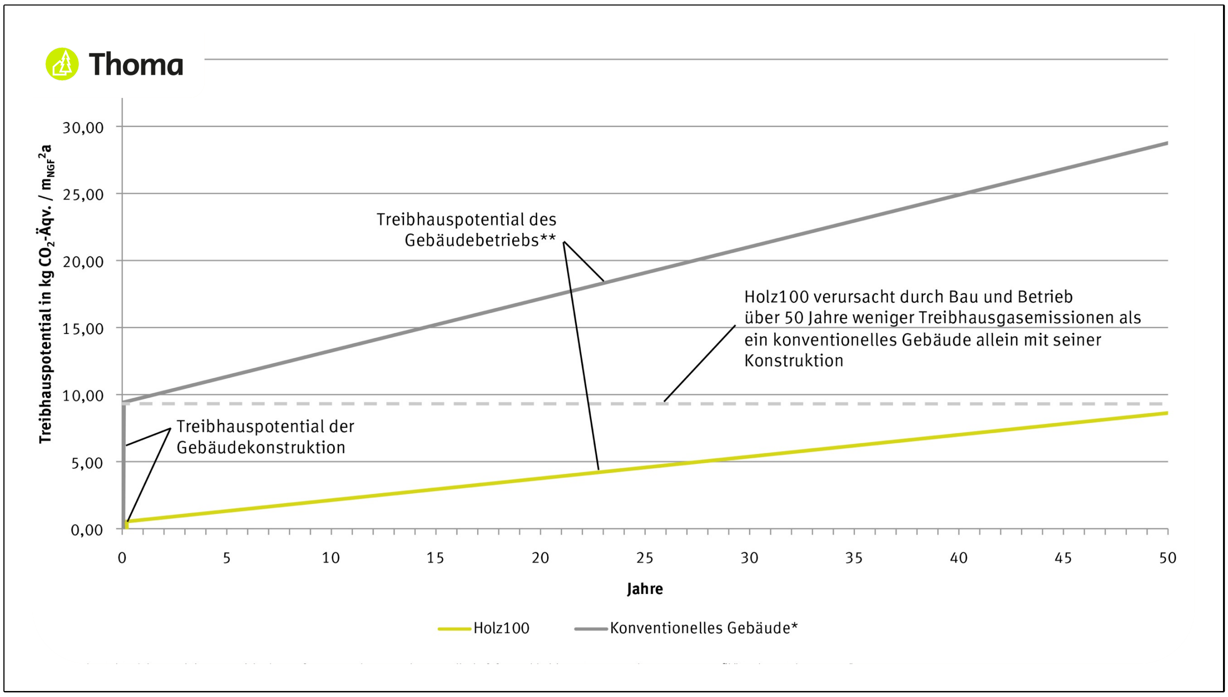
The picture on the right shows the Knapp GIGANT connectors used to connect the walls.

The small picture shows tie rods on the outside. Instead of the usual nail plate, 2 L-profiles with a thread were used.

From floor slab to **finished 3-storey building in 2 days**! There was no screwing required during assembly.

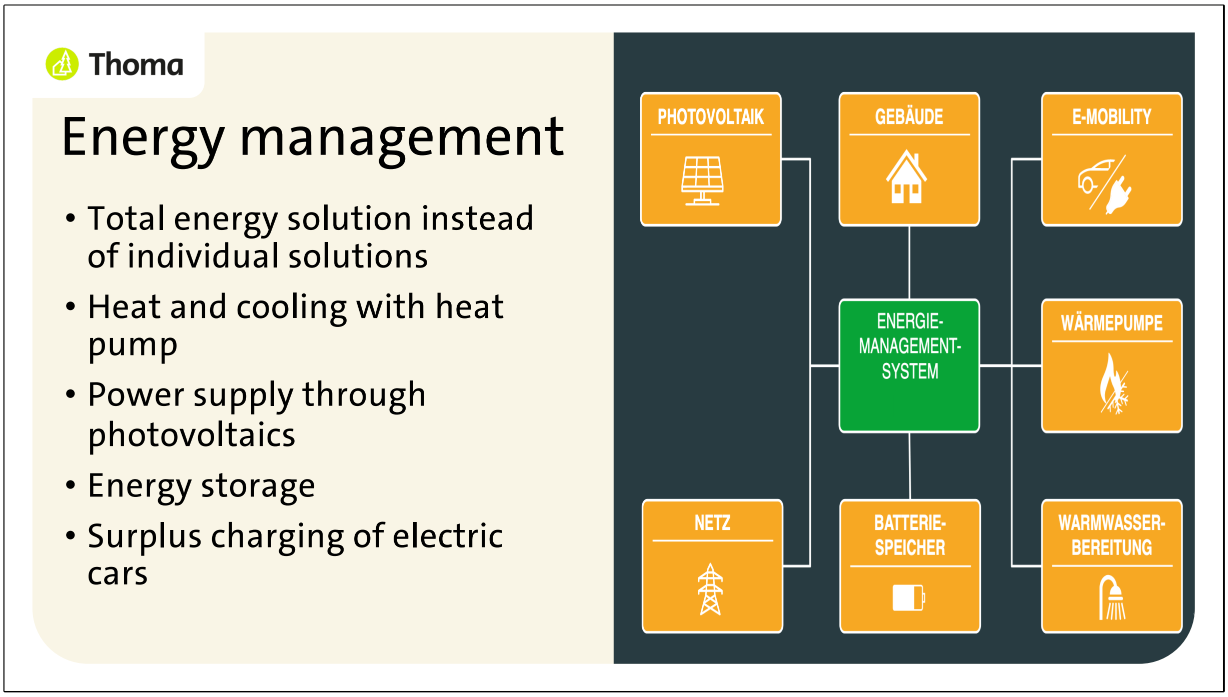
The picture shows a Holz100 hotel using biomass CHP technology with a wood gasifier. The wood gas drives diesel engines that produce about 1 part electricity to 3 parts heat (normal for CHP 1:5). The heat is used to heat the hotel and the neighbouring high school. The wood chips are readily available due to the large local forest areas. This is a good example of a **decentralised and independent solution** that is still networked!

What is the energy concept of the prototype?



First, we need to look at the ratio of CO2 emissions between the construction and operation of a building. This is normally 1:>3 over 50 years of use!

To estimate the impact of building operation on the overall CO2 balance, a 5-storey residential building (1000 m² NFA, 39.7 kWh/m² final energy demand heat) built with Holz100 was analysed by the TU Darmstadt. In addition to the almost CO2-neutral construction (the building has a lower wood content than the prototype), the operation over 50 years was compared with a conventional reference (ENEV, building 54.5 kWh/m² final energy demand heat). The result is **a 70% CO2 saving for the building during construction and operation.**



The centrepiece will be an energy management system that connects all energy producers (PV system) and consumers in the building via a router. It distributes the generated energy and maximises the self-consumption at the building level, as the building is not yet integrated into networks. The system can be managed via a web interface. The aim is to increase **the self-consumption up to 85% and the self-sufficiency up to 70-80%**. The energy flow will be documented and presented in time series. Characteristics such as energy production from the PV system, self-consumption, grid input and output will be shown.

Other advantages:
- The inverter is black start capable, i.e. the inverter does not require external power to start. With battery storage, the power supply can work as a stand-alone solution off the grid.
- The management system allows "peak shaving" to feed power back into the grid. Peaks are a major problem for renewable energy sources in terms of grid voltage stability.

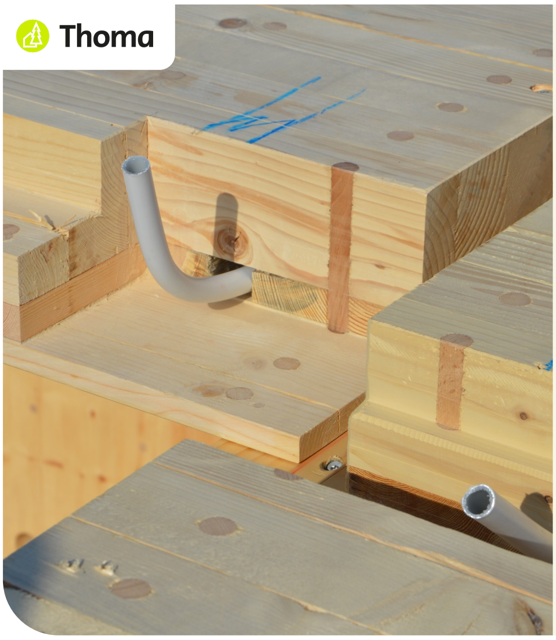
For relaxation between all this numbers and techniques. This house is heated exclusively by a central wood-burning stove. How does it work?

Massive wood constructions reduce the temperature amplitudes inside the building, thus **reducing the peak demand for heating and cooling**.

Massive wood lowers its moisture content by heating in winter, significantly reducing the wood's thermal conductivity. In addition to low thermal conductivity, wood has a high heat storage capacity.

Massive timber constructions have no thermal bridges and the homogeneous structures don't need vapour retarders and tapes. The construction remains free of condensation.

We observe in our projects that the energy demand of solid wood constructions is **30% lower** than the usual heat transfer calculations predict.



Building component activation

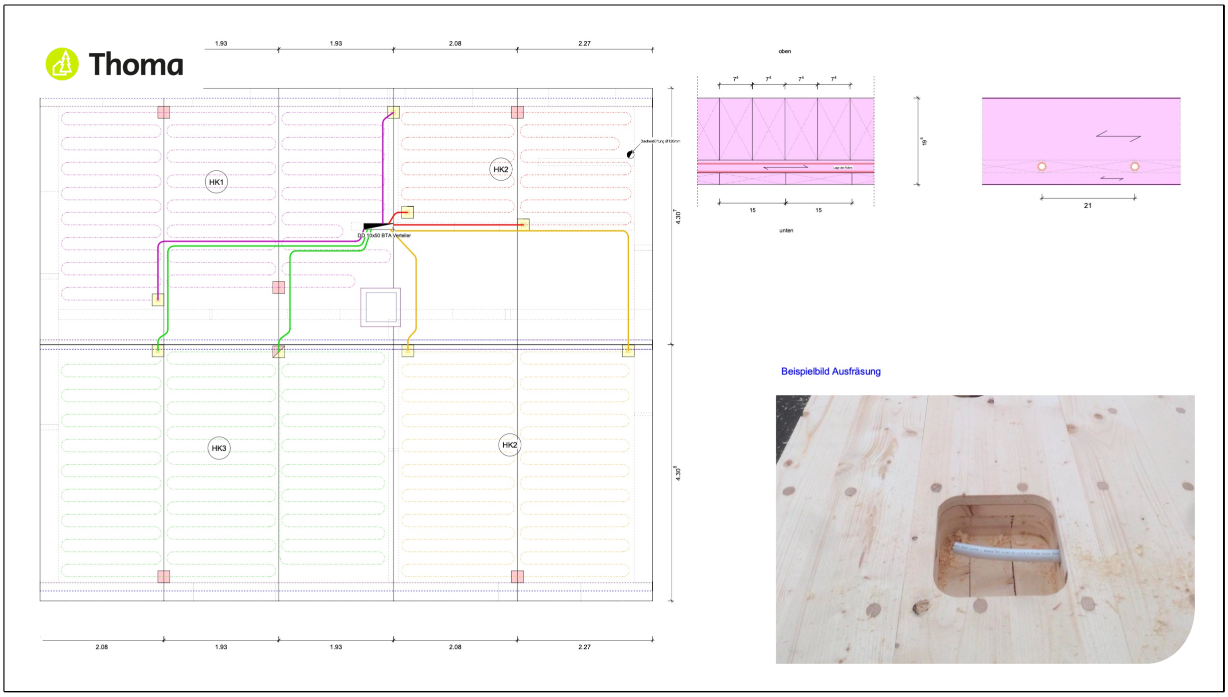
- Heating and cooling through the ceiling by means of heat pump
- Steady operating conditions
- High degree of prefabrication, no pipe laying on the construction site
- High self-regulating effect and balanced indoor climate.

Various types of heating systems are installed in the prototype for testing and demonstration purposes.

- all solid **wood ceilings are component activated (unique patented system, picture)**
- Wooden floor heating on the ground floor
- Infrared
- Floor heating in dry screed
- Clay wall heating

Public access to the management system will allow interested parties to track data in real time and compare operating cases. It will:

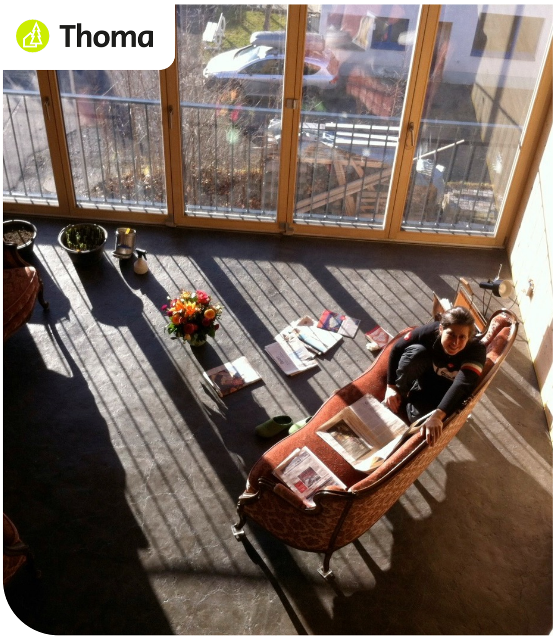
- transmit the indoor climate data from the rooms
- Operation of the heating circuits with room thermostats and servo drives at the heating circuit distributors
- Operating without room thermostats in "continuous operation".
- Heat meters and consumption data of the individual heating circuits or electric heating systems.



The illustration shows the **piping layout in the Holz100 ceiling panels**. Typically, 2 ceiling elements are connected to form a circuit and can supply one room. This is approximately 80-100 running metres per circuit.

In the second layer behind the ceiling, the pipes are drawn in at our factory.

Only the connection pipes need to be installed on site, either from below or from above.



The best solution is a house without technology. Situated at an altitude of 1600 metres in Switzerland, the entire building has no heating system. Thanks to the solid wooden shell, without insulation materials and storage masses (clay floors), the passive solar energy gain through the windows is sufficient to heat the building.

Through innovation & patents, we are the first to build energy self-sufficient timber houses, or at least houses with very low energy requirements - without polluting insulation materials and without complicated technology. Thoma homes that heat and cool themselves make nuclear power plants obsolete. They put an end to wars over fossil resources.

The **factory forest** creates wood from air and water. Totally waste-free and energy self-sufficient. The soil is improved and a valuable habitat is created. The forest can teach us to build our houses the same way. You just have to look.

Thoma

Tender criteria of the future

Verified minimum amount of CO_2 in the building structure.

- Up to 3 floors:
  400 kg CO_2/m^2_{NFA}
- 4-6 floors:
  200 kg CO_2/m^2_{NFA}
- >6 floors:
  150 kg CO_2/m^2_{NFA}

Long-term effect of the CO2 storage

- 50 years functional guarantee of the installed components
- 50 % reuse rate of the components on the same utilization cascade

Three ambitious proposals for **tender criteria** that will transform our construction industry.

1) According to the state of the art in solid wood construction by Thoma, an average of 0.8 cubic metres of wood is used per m2 of living space (for single-family houses). This results in approximately 700 kg of stored CO2 per m2 of living space. In multi-storey residential buildings, this amount is reduced by about half due to the proportionally smaller wall and roof areas. This is based on an environmental declaration with balanced CO2 values for the products, which already takes into account the CO2 emissions of the production process.

2) Wood that has to be disposed of as special construction waste after 5 to 20 years, for example, is ultimately not a CO2 sink in a climate-positive sense, but an environmental burden that does not fulfil this function.

Best bidder principle

- Construction costs
- Operating and maintenance costs for the first 20 years
- Disposal costs (price according to the valid prices at the time of installation)

3) Life cycle costs are used instead of the lowest bidder principle.

Our buildings must last, run on green energy, have low maintenance and running costs, and leave the world without a trace.

Further Links:

Project Homepage:
www.housingforzeroenergy.eu

EU Homepage:
www.nweurope.eu/projects/project-search/h40e-housing-40-energy/

Training Material:
https://rise.articulate.com/share/4Bj8nnRXruCsDhtYaOV6qGr2RtY0jOMk#/

Thoma

Thoma Holz GmbH

more than wood.

Forschungszentrum
Hasling 35
5622 Goldegg
Österreich

Tel.: +43 64158910
Mail: info@thoma.at
Web: www.thoma.at

Please contact us any time:
www.thoma.at/kontakt/kontakt-formular/

Or sign up for our (german) newsletter:
www.thoma.at/kontakt/newsletter-anmeldung/