Healthy Homes Design Competition: "reTHINK living"

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REHVA announced the Healthy Homes Design Competition 2022 with the aim to encourage students in different building disciplines to design a building with increased comfort quality while also tackling the problems of climate and demographic change. The team "re²THINK tank" convinced the international jury with both their space-efficient and user-focused proposal as well as their clean technical approach. The two master students from Augsburg, Germany were able to achieve the third prize.

Keywords: healthy homes, demographics, wellbeing, housing shortage, user-centric design, space-efficiency, communal space, synergies, comfort, daylight simulation, PV generation

The submission of the project "reTHINK living" depicts a radical answer to the question of how we will live together.

Before the implementation of any design idea, a healthy home was defined as a way of life that considers all kinds of wellbeing: social, physical, mental and eudaemonic health, hedonic and subjective well-being, productivity, as well as environmental quality and comfort. This groundwork formed the basis of a user-centric design of this building complex in Pernis.

An analysis of the demographics of the Netherlands, of Rotterdam and of Pernis in general gave an idea of the kind of future residents that could be expected. The fact that a household has to wait 5.5 years for an affordable flat on average is just one out of many issues that occur because of the increasing problem of the alarmingly high housing shortage in the Netherlands. Therefore, the huge gap between the number of needed accommodation and number of affordable and available ones is calling for new solutions regarding the complex question of how we will live tomorrow.

The concept of "reTHINK living"

The concept of reTHINK living questions the given apartment sizes and suggests a solution that is remarkably more space-efficient and results in a smaller per capita living space than in any form of conventional housing.

The left side of **Figure 1** depicts a conventional building organisation. The coloured area stands for the communal area inside every flat, usually the living room. The concept of "reTHINK living", as seen on the right side of **Figure 1**, removes this space and

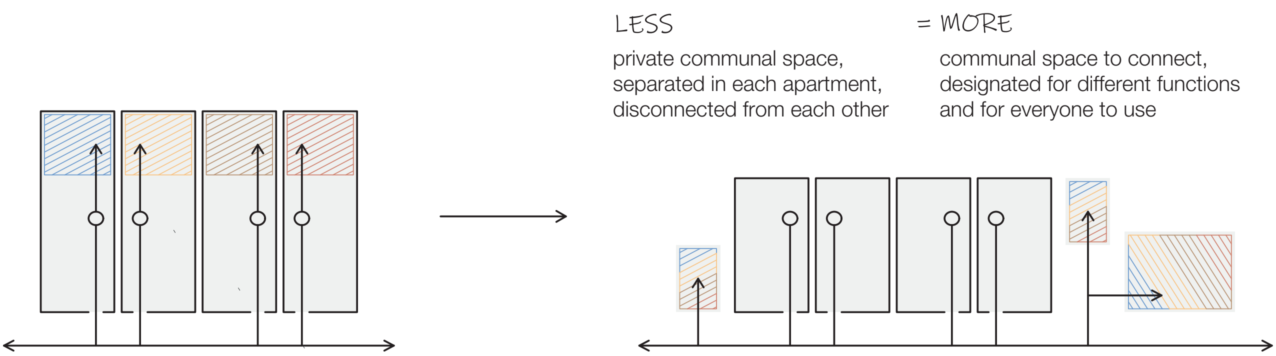

Figure 1. Conventional living becomes reTHINK living.

shares it with all the other residents of the building. The result of less private space and a reduced flat size is compensated by a maximised common area that can be used by every resident in a specific and meaningful way.

Synergies between the future residents

Coming from the demographics and the social infrastructure of Pernis, four different household types have been created: families, friends + couples, seniors, and singles. They all differ in their needs and desires, particularly when it comes to the kinds of communal areas that need to be close to them, be it a communal room for "sports + health" or "silence + rest", a room for childcare or some shared office spaces.

The organisation of the different kinds of common areas is depicted in **Figure 2**. It depends on the importance of the room for the household. Ultimately, this concept allows to build synergies among the residents throughout the building complex and strengthens the neighbourhood.

Urban design principles

The location of the competition at the Pernis waterfront presented an exciting but challenging site. The weaknesses include constant emissions from the nearby motorway in the west, a continuously present noise level coming from mainly the west as well, the smell of Diesel that is only partly shielded from the existing trees and lastly a poor social and functional mix.

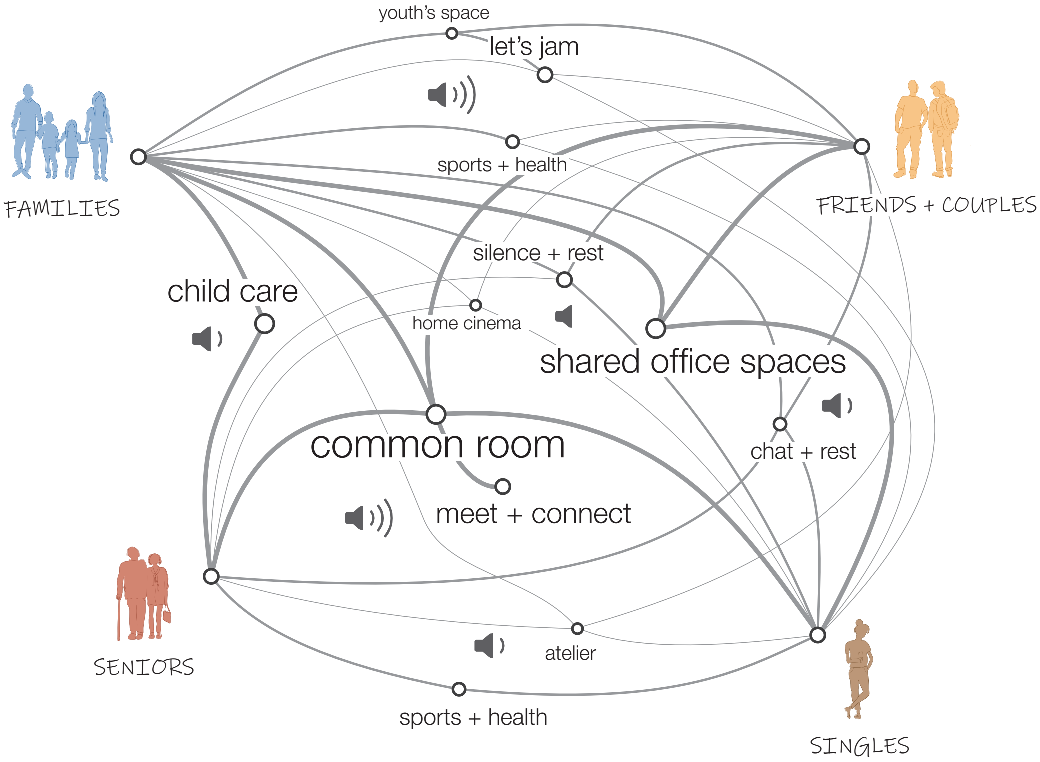

Figure 2. The four household types and the synergies among them.

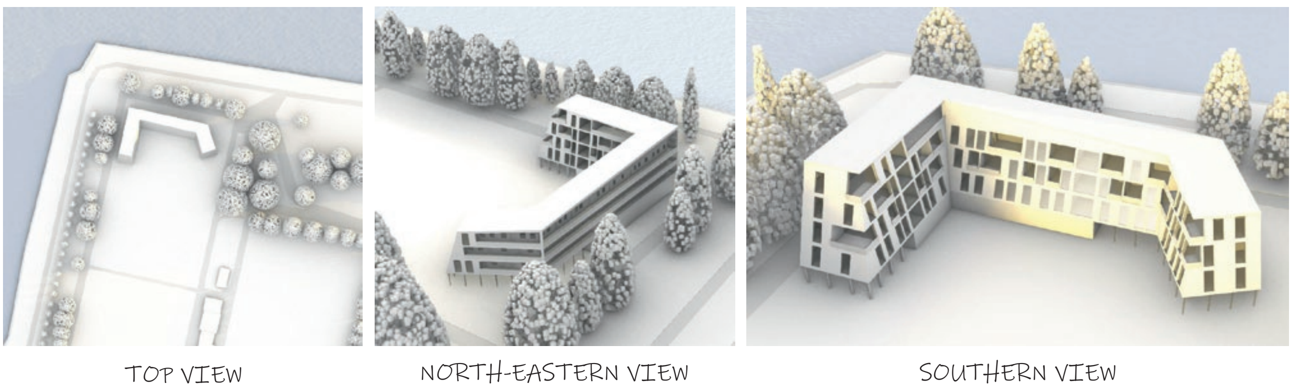

Figure 3. Perspective views.

An urban analysis led to the following three urban design principles that define the cubature of the building:

1. Blocking the west side of the site to prevent the existing smell and noise.
2. Opening the complex to the east and south and alongside the solar path.
3. Strengthening the sightlines to Pernis as well as those to Rotterdam downtown.

Building organisation and flood concept

The building complex is vertically organised, which means the privacy increases with the floors of the building. The ground floor consists of a communal area for everyone to use, including the non-residents. The previously mentioned communal rooms are located on the first floor. The apartments can be found on the second to fourth floor. The reason why there are no rooms on the ground floor is the flooding concept of the building. As a maximum flooding of the site of one meter had to be considered (a number that is estimated to rise as a result of the climate crisis), the building was elevated by one floor level. This way, the ventilation of the courtyard can be increased, which counteracts the heat island effect. Small parts of the ground floor area are used for the technical equipment of the building.

Cubature

In order to improve the incidence of daylight, the southern facade is tilted by 70° and the eastern and western facades facing the inner courtyard are tilted by 80°.

The roof is tilted as well. There are five floors on the western side and four floors on the eastern side of the building to strengthen the urban principles.

Access and building organisation

The access to the flats and to the common areas is via a circumferential and completely glazed arcade and two staircases, each of them contains a lift. This makes the building completely barrier-free which marks the simplest way of inclusion. The plans in **Figure 5** also illustrate that each flat gets light from at least two directions, so there is no apartment with an insufficient exposure. In addition to that every flat has at least one loggia which allows each resident to enjoy their own private outdoor space. This creates a connection to the outside space and nature.

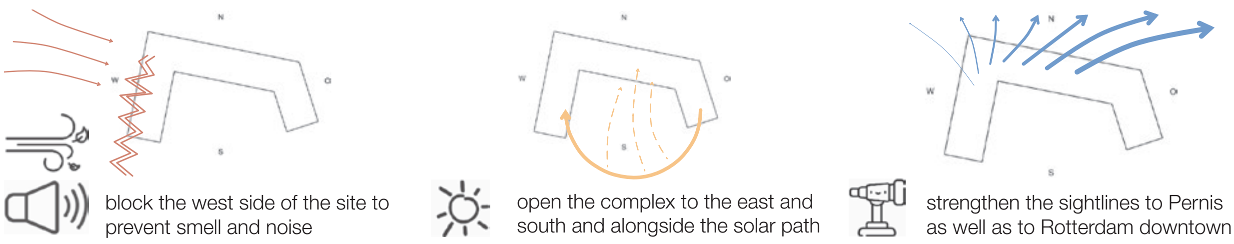

Figure 4. Three urban design principles.

Figure 5. Detailed floor plans of two out of the four household types (seniors and families).

Detailed floor plans

The differences of the four household types result in different floor plans. Two out of the four kinds of floor plans are depicted below.

The seniors' floor plans are primarily located close to staircases and elevators to shorten the access routes within the building. Each of their floor plans are designed to be extra-spacious to allow an independent life regardless of age or inability. Since the relative need for daylight increases with age, the south-facing window areas are relatively larger than in other floor plans.

The families enjoy a spacious entrance situation with the living room as the heart of the apartment referring to both the location and communication inside the apartment. Several loggias designated to different rooms maximise private outdoor areas.

The common features of the floor plans are that all circulation areas have been reduced to a minimum to keep the usable space as generous as possible. In addition, the bathroom is always located next to the entrance area facing the north in order to maximise the southern exposition of living and sleeping rooms in general.

Heating / cooling / ventilation concept

Passive cooling and heating of the building is provided by a water-water heat pump, which uses the heating and cooling energy from the river water. The heat pump delivers the correspondingly cooled or heated medium to a hot water tank and a heating water buffer tank. The hot water is then transferred from the hot water storage tank to all water points in the house. The cooled or heated medium is passed on from the heating water buffer tank to the underfloor heating with concrete core activation. Concrete core activation brings with it a high storage capacity as well as a high level of comfort due to a uniform heat radiation.

The choice of ventilation concept is a hybrid ventilation. This allows the building to be naturally ventilated in summer, in our case by cross-ventilation. In winter, the mechanical ventilation system with heat recovery is used to ventilate the building sufficiently while only a negligible amount of thermal energy is released into the outside air. The choice of a hybrid ventilation system that draws in air through an air tower in the south with a fine filter also gives the chance to optimise the indoor air quality. Thus, the residents can decide for themselves whether to ventilate via natural ventilation by means of cross-ventilation, which is made possible by the arcade in which the upper part of the glazing can be opened at any time, or whether to use the mechanical ventilation system to ventilate the room.

Winter and summer comfort policy

To improve the thermal comfort in winter on one hand, the building is heated by a water-water heat pump. An underfloor heating system using concrete core activation serves as a radiator which allows the heat to be kept in the building as efficiently as possible. Hybrid ventilation, which ventilates the building mainly in winter, releases as little thermal energy as possible to the outside air, improving thermal comfort in the building in winter.

To avoid overheating in summer on the other hand, the external blinds, which are attached to each exterior window facing south and the inner courtyard, were controlled with a sun sensor. In addition, it is possible to override the control of the external blinds by means of the sun sensor, so that the user can also control the external blinds individually. The building is equipped with

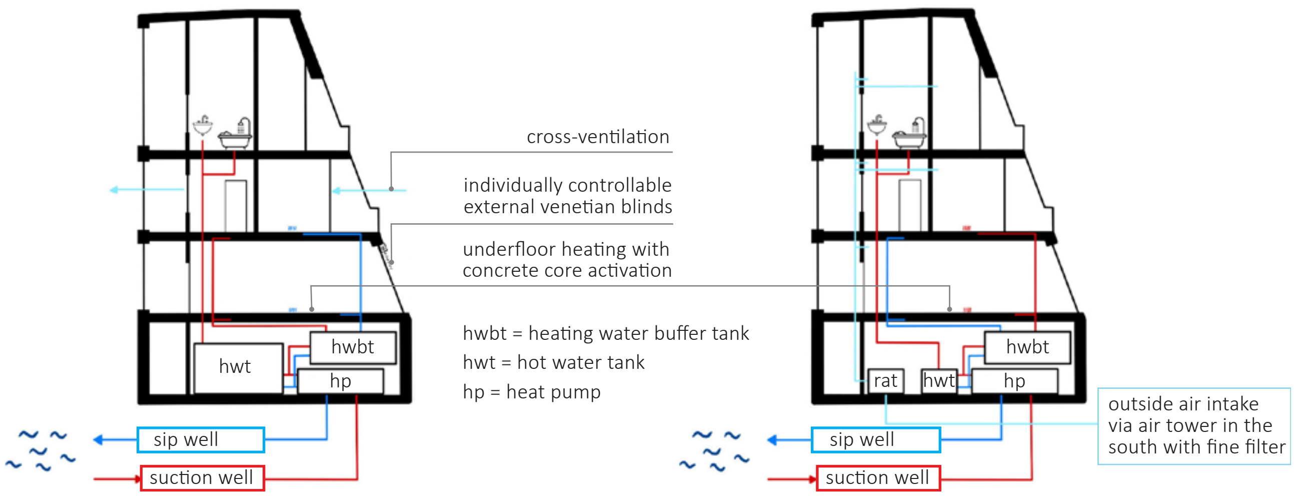

Figure 6. Heating / cooling / ventilation: summer (left) and winter (right) situation.

a water-water heat pump, which extracts the heat or cold from the adjacent river, so that overheating of the building can be avoided by cooling through the underfloor heating with concrete core activation. The river has an average temperature of 18°C in the warm months, which makes it ideal for cooling the building with a water-water heat pump and thus optimising comfort in the summer.

Integrated water systems

In terms of water use, all the rainwater from the roof of the building is collected in a rainwater storage tank. The water is then filtered and transported to the toilets or washing machines via domestic waterworks or a pump, so that the rainwater can be used for these purposes.

Energy concept and on-site energy use

Regarding to the on-site energy use concept, a 370 m² photovoltaic system will be installed on the roof of the building. This photovoltaic system generates a total of roughly 78 430 kWh/a, so that theoretically the entire electricity demand of 61 914 kWh/a (including the electricity demand to supply the heat pump) can be covered by the photovoltaic system through the integration of an electricity storage unit – this creates a plus-energy building.

The electricity generated by the photovoltaic system is first used to cover the current electricity demand in the building (washing machine, PCs, TVs, kitchen, e-mobile charging stations). If the photovoltaic system generates more electricity than is needed in the building, it is stored in an electricity storage unit for use at a later time. If there is still surplus electricity, it is fed into the power grid.

Overall lighting concept

Floor-to-ceiling windows maximise the visual axes to the south and the inner courtyard. The view to the north and thus towards the water is also improved by a completely glazed arcade which means that depending on preferences the occupants can enjoy the view towards the water or towards nature and neighbourhood.

Strategy to minimize overall energy use

In order to minimize overall energy use of the concept, passive cooling by using a water-water heat pump was applied on the one hand, and the 3E-strategy was purposed on the other hand:

1. **Sufficiency = energy saving**
→ less floor space by removing and reducing the common area from the flats
2. **Efficiency = energy efficiency**
→ use of a heat pump, a hybrid ventilation system and clever energy management throughout the building
3. **Consistency = renewable energy**
→ availability of the required energy as efficiently as possible. In this case, all the energy required on the site is produced on the roof of the building and partly stored in an electricity storage system to be available for use at any time. ■

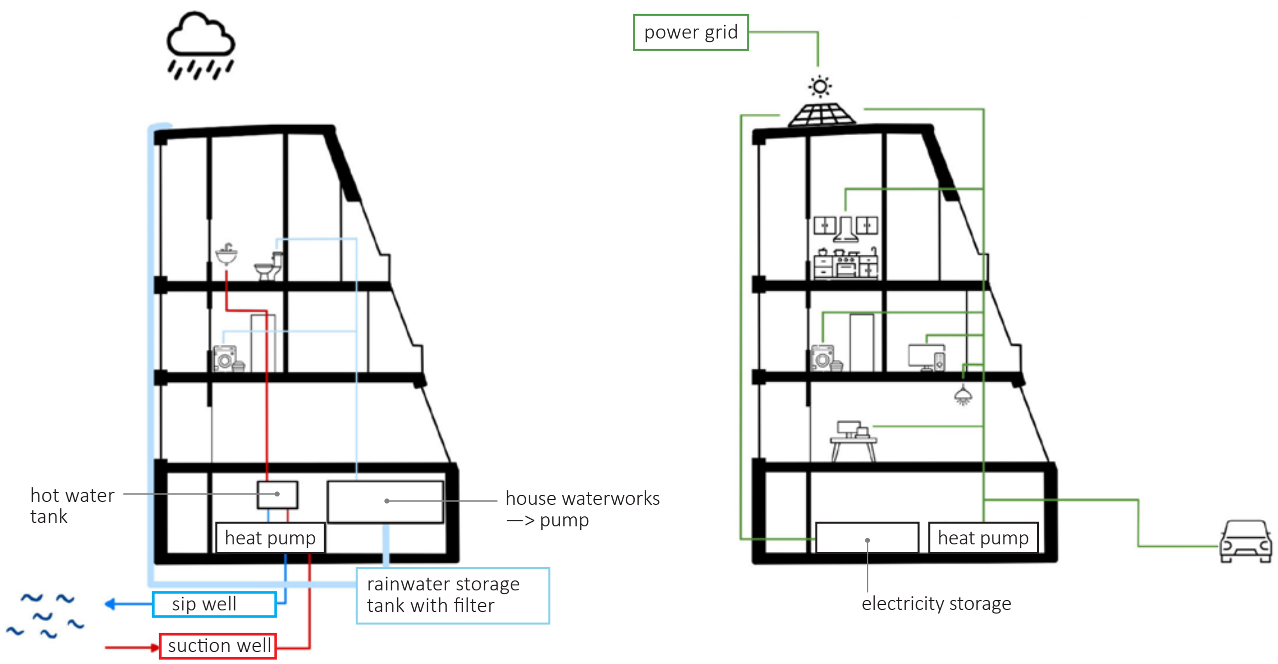

Figure 7. Integrated water systems and energy concept.