Integration of sustainability solutions in sanitary installations: the example of the AveiroDOMUS "House of the Future"

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ABSTRACT: The University of Aveiro, in association with a group of interested companies, created an association called AveiroDOMUS, the main purpose of which is to design and build a "House of the Future". This house is developed under sustainable construction principles resorting to state-of-the-art and environmentally friendly technologies.
One of the major goals of the project is the optimization of the hydrologic cycle in the House, under sustainability principles such as water recycling, the use of rainwater, the incorporation of low flow fixtures and the use salt water, which is abundant in the area where the house is to be built – the Aveiro Salt Lagoon. This paper discusses the scheme of the water cycle and describes the solutions proposed for the several sanitary installations of this "House of the Future" in detail, pointing out, in each one of the steps, the measures that have been adopted towards the sustainability principles.

1 INTRODUCTION

The Portuguese city of Aveiro is 250 km from Lisbon, the capital, and 10 km from the Atlantic coast. It is surrounded by a saltwater lagoon system that occupies 110 km^2 of the River Vouga estuary (figure 1 and figure 2). The region of Aveiro is on the northern part of Portugal's coast and is regarded as a highly dynamic economic zone. A considerable number of industrial sectors are base there, involving all kinds of business activity, especially in the construction sector.

Figure 1. Location of Aveiro

The University of Aveiro was founded in 1973 and is now considered one of the most innovative and dynamic in Portugal. It is a university of international repute known for its academic

excellence, research, innovation, state-of-the-art technology and cultural input. It is the only Portuguese university that is a member of the ECICU – European Consortium of Innovative Universities, an organisation which has, over the years, been involved in countless activities in the spheres of Education, Research, Land use planning and Institutional development.

The House of the Future (figure 3) project is an interdisciplinary project involving 12 companies from the Aveiro region and various university departments. The House of the Future cooperation network that is known as AveiroDOMUS was created in 1999, with the University of Aveiro as its chief backer.

Figure 2. Aveiro Ria – Lagoon Área

2 AVEIRO'S HOUSE OF THE FUTURE PROJECT

The strategic goals of the House of the Future project are to develop new conceptions in the sphere of housing and to create conditions to build a potential futuristic house in the short term.

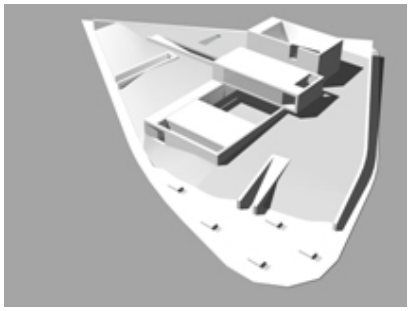

Figure 3. AveiroDOMUS House of the Future

The house must obviously be of an advanced design, but the main objective is to build it in accordance with sustainable building standards, ensuring proper interaction with local ecosystems and a good interior environment (air quality, absence of noise, comfortable temperature and humidity, light, etc.). Another pertinent aim is to reduce consumption of essential resources through the appropriate choice of materials and use of renewable energies and by optimising the water cycle.

The AveiroDOMUS House of the Future will be a permanent research and development laboratory, open to both industry and the public. In fact, one part of the house will be open to visitors, another part will be inhabited and a third part will be under study and evolving. These areas will be rotated from time to time.

3 THE WATER CYCLE IN THE HOUSE OF THE FUTURE PROJECT

The efficient use of water is an environmental priority today, and this is the main goal in terms of optimising the water cycle in the House of the Future.

It is general knowledge that water use in the home has different quality requirements, and this creates the chance to make use of different sources of supply, depending on the quality needed for the specific use. Rainwater can be used for flushing toilets, in washing machines, for cleaning the floor, washing cars, watering the garden, provided that it has been adequately pre-treated. A rainwater collection system can save 50% of treated water (from the mains system), with no loss of comfort or hygiene, within the consumption profile.

A system that includes the partial recycling of domestic wastewater has been planned for the House of the Future, with the aim of cutting the use of mains water to a minimum. At the same time, low-consumption devices will be used, linked to the use of alternative sources (rainwater). The House of the Future also has contemplated the use of saltwater and groundwater, and, since the land occupied by the House is very close to the area of influence of the Aveiro Ria's town canals, the groundwater is quite likely to have some salinity (figure 4).

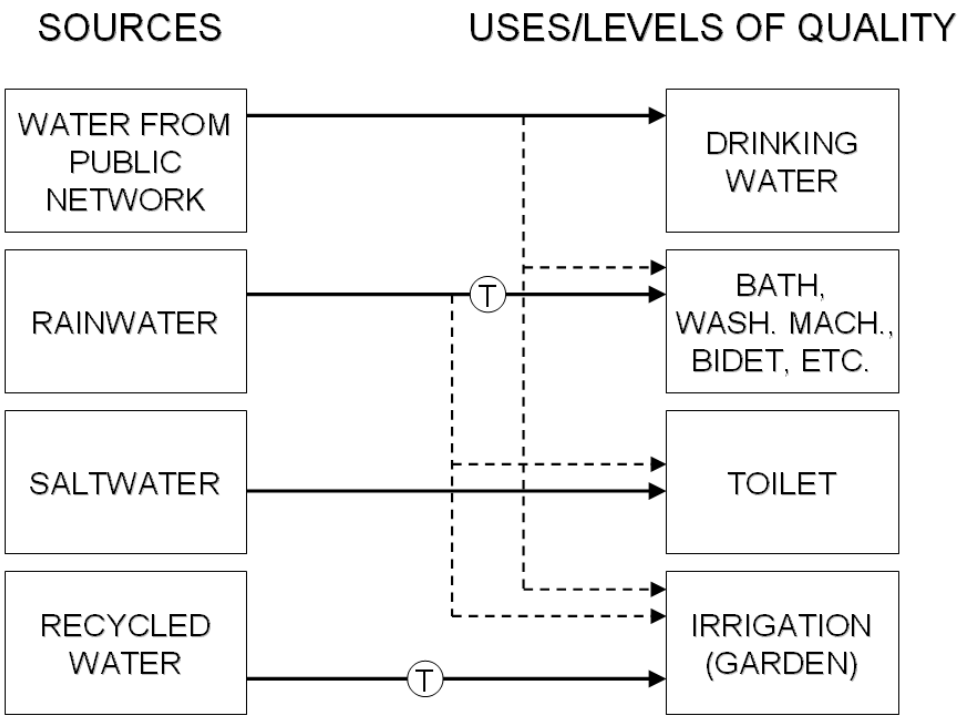

Figure 4. Water use scheme

The establishment of a non-desalinated saltwater supply line is one solution that could be a useful alternative when drinking water is in short supply, in coastal regions (like Aveiro), for purposes that do not need high quality water (toilet cisterns, for instance). The use of saltwater, though it may give rise to problems in terms of treatment, is currently used in many parts of the world, including Hong Kong etc. It can help to solve many drinking water shortage problems in those coastal regions and in Madeira and the Azores.

In terms of cutting consumption, the following were among solutions considered for the House of the Future: use of small volume cisterns; low-flow fixtures; timers and other automatic control devices; air emulsifiers; waterless (i.e. chemical) urinals, and low-consumption washing machines. Within this consumption-cutting goal, special attention will be given to cisterns, which can be waste a considerable amount of water (over 30% of total consumption in the residential sector, according to some authors). In the case of urinals, the use of chemical ones (with a liquid sealant) that do not consume any water is envisaged.

In terms of wastewater, several treatment systems will be looked at in this project, bearing in mind the proposed water cycle. The ultimate aim for non-reused water will be to achieve a quality that will allow the effluent resulting from the treatment process to used on the garden or to ensure a level of quality so that it can be discharged into the receiving environment.

There will be several steps in the treatment system, each with a specific purpose, including the removal of solids and other insoluble matter, the removal of biodegradable matter and the removal of chemical and microbiological contaminants. The reuse of solid material (sludge) produced in the treatment process will also be examined.

4 AVEIRODOMUS HOUSE OF THE FUTURE: SUB-PROJECTS RELATED TO THE WATER CYCLE

The water cycle in the House of the Future (figure 5) project will be studied under two Sub-projects: Indoor Water and Specific Rooms. The Specific Rooms Water Cycle sub-project starts at the point of entry of water into the bathrooms and ends at the discharge point of the wastewater produced there, and is a transit point in the water cycle of this futuristic house, which is also linked to architecture.

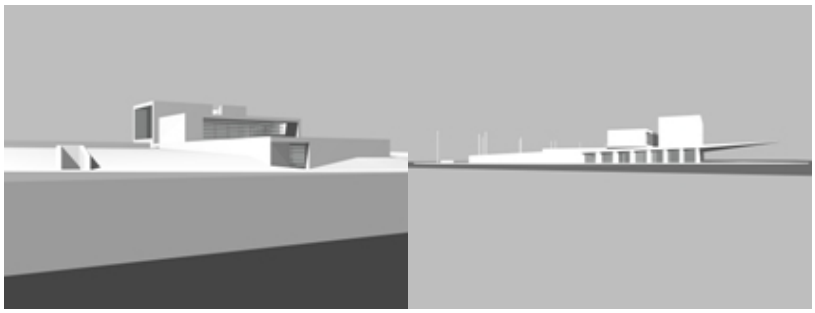

Figure 5. AveiroDOMUS House of the Future

This work lays particular emphasis on the use of water from alternative sources and the possibilities of reusing it, along with fixtures, treatment plants, sanitary equipment, use devices and accessories that help to cut water consumption, while maintaining comfort and satisfaction for the house's occupants.

5 TYPES OF BATHROOM

The characteristics envisaged for the House of the Future's bathrooms will chime with the basic concepts of this futuristic house, which aim to endow the AveiroDOMUS's House of the Future (figure 6) with mobility, adaptability and ability to change.

Different features will typify the bathrooms for the House of the Future, and these are related to the applicability of new products in different solutions under development within the Sub-projects.

In one case, the bathroom's cistern will be supplied by a salt or brackish water line, and will have system that separates and collects solid and liquid waste matter. Both types of waste will be treated, and the possibility of the end products yielded by the composting of the solid phase being reused on the garden is being studied.

A single-unit bathroom that can be moved around inside the house is also planned. It will have runners so that the sanitary fixtures and fittings can be easily rearranged inside it. This bathroom will have independent water storage and wastewater collection systems.

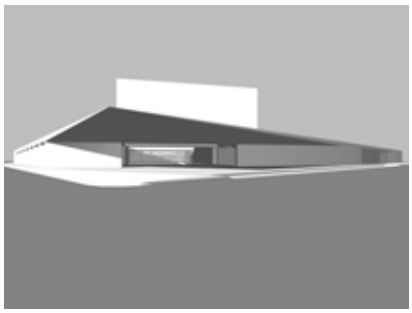

Figure 6. AveiroDOMUS House of the Future

In relation to the choice of sanitary fixtures, there is a vast range of options from a panoply of solutions with every kind of aesthetic theme. The criterion for choice should be based on minimising water consumption (even though it should still be possible to regulate consumption and pressure requirements of the fixtures by fitting accessories).

Besides meeting the aesthetic requirements of bathrooms, aspects related to comfort and hygiene have not been ignored, and it was imperative to fit accessories with devices that meant they could not be touched, especially in bathrooms used by the general public. It is intended that in these bathrooms, from the time the visitor enters until they leave, it will be impossible to touch any kind of object (door, soap dispenser, taps, automatic rubbish bins, etc.).

6 CONCLUSIONS

Besides developing various solutions for the future that are linked to the concept of increasing ease and flexibility of use, the Indoor Water and Specific Rooms Sub-projects of the Aveiro-Domus House of the Future's Water Cycle will provide an opportunity to study the possibility of optimising the water cycle in homes. It will also help to gear all the technical requirements to the needs of the occupants of the futuristic house, improving the comfort and adaptability of bathrooms.

Studies currently underway are showing the usefulness and feasibility of incorporating devices to cut consumption, adopting measures for reusing water and making use of other sources of water (rainwater, non-desalinated saltwater, groundwater, etc.).

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