

# Thermal modules for apartments: an efficient solution for heating and domestic hot water

Module termice pentru apartamente: o soluție eficientă pentru încălzire și apă caldă menajeră

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**Abstract.** *In a residential building, the integration of thermal modules from the design phase can bring multiple benefits in terms of energy efficiency and thermal comfort. The article deals with a brief comparison between the traditional heating system and the decentralized system with apartment thermal modules by making the preparation of the thermal agent for heating and domestic hot water more efficient. The study was carried out following the new nZEB requirements regarding the obligation for all new buildings and those undergoing renovation to ensure a percentage of at least 30% from renewable sources.*

**Key words:** energy efficiency, thermal comfort, domestic hot water, heating

## 1. Introduction

In a world of climate change and the emphasis on sustainability, apartment owners and developers of residential buildings are starting to look for efficient and environmentally friendly solutions to provide heating and hot water in their homes. This is where the apartment modules come in, innovative technologies that bring with them a series of benefits for modern homes. They not only offer increased energy efficiency, but also individualized control, convenience, and adaptability to renewable energy sources.

In some countries, the thermal module concept is becoming a common way to achieve heating and domestic hot water (DHW) in residential buildings. A number of parameters can be addressed and evaluated to reveal the qualities and performance of the thermal module in relation to traditional concepts for heating and hot water installations. This paper aims to analyze the main parameters regarding the advantages and disadvantages, the quality (comfort) and the performance of the thermal mode, covering the distribution system and the equipment.

## 2. Component elements

Apartment modules, also known as individual heating plants, represent a significant change from traditional central heating systems. These compact and independent devices are designed to provide home heating and hot water in each apartment individually. Unlike centralized systems that require transporting hot water over long distances, apartment modules work directly in each housing unit, reducing energy losses and associated costs.

The apartment thermal module is completely thermally insulated, compact and easy to operate. Specially designed for two-pipe systems in residential buildings fed from a centralized heating source on the block (boiler or heating system)

The heat exchanger for preparing hot water with a special, innovative design, Micro Plate type, ensures a very good and uniform flow through the exchanger, thus ensuring a uniform and efficient coverage of the entire heat exchange surface, as well as a maximum flow turbulence for a increased heat transfer. The exchanger ensures minimum pressure losses, for minimum energy consumption required for pumping water in the entire system. All these characteristics of the exchanger must be ensured to guarantee a long life, increased reliability and a reduced impact on the environment.

The hydraulic part allows the flow from the primary and secondary circuits to pass through the heat exchanger only when the consumption of hot water is started and blocks the flow immediately after the consumption ceases.

The thermostatic part controls the temperature of domestic hot water. Due to the automatic hydraulic control of the heat exchanger, it is largely protected against limescale and bacteria formation.

Primary circuit:

- differential pressure regulator
- impurities filter
- immersion sheath for temperature sensor, for thermal energy meter
- ball valves.
- bypass loop for keeping the primary agent warm
- radiant floor pumping and mixing group

Secondary circuit:

- the heating circuit must be designed for direct heating
- the multifunctional controller type TPC-M

Domestic hot water is prepared instantly in the heat exchanger on the principle of countercurrent flow. The temperature is precisely regulated, without oscillations compared to the set temperature, the assurance of this regulation being achieved by the multifunctional controller with direct action and differential pressure regulator.

The multifunctional controller ensures an extremely fast operation to protect the exchanger from lime deposits as well as against the formation of bacteria. Also, the

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pressure regulator within the controller ensures taking over the temperature and flow variations on the primary side to ensure a constant temperature all the time, regardless of the desired domestic hot water flow rate [1].

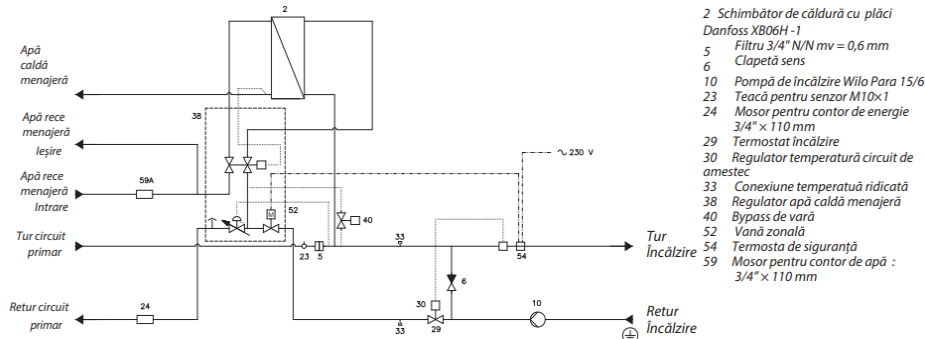


Fig. 1. Functional scheme of the thermal mode

### 3. Comparison between the traditional system and the one with thermal modules

Reference for the comparison of the traditional system without thermal modules and the one with thermal modules is based on a modern way of making distribution systems with fewer pipes for saving money and energy [2]. Pipeline distribution systems are shown in Fig. 2, where the main differences can be seen in the number of pipes installed. In the traditional system we have a route of 5 pipes (2 for heating, 1 for domestic hot water, 1 for domestic hot water recirculation and 1 for cold water) compared to the system with thermal modules with a route of 3 pipes (2 for heating and 1 for cold water). Since decentralized DHW is prepared in the apartments, the DHW distribution pipes and DHW recirculation on the columns are eliminated.

The system with thermal modules also comes with a major advantage by reducing the technical space by approximately 10-15 m<sup>2</sup>, due to the fact that domestic hot water storage will be eliminated [3].

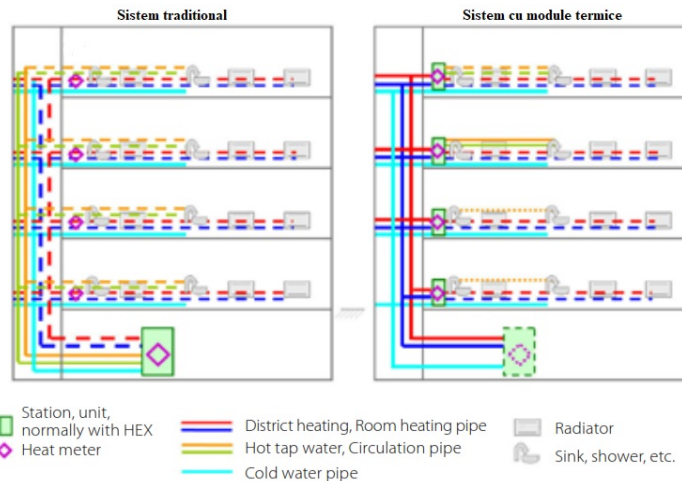


Fig. 5. Column distribution scheme for the traditional system and the system with thermal modules

According to the measurements made in Denmark, in over 2500 homes, an energy saving of 15-30% was obtained compared to the traditional system [4]. The analysis assumed the measurement of all thermal energy deliveries in the apartments. The main contribution to saving energy comes from the distribution of domestic hot water. It is assumed that half of the annual distribution energy loss is net loss (summer time), it does not contribute to heating the building. The winter temperature is identical for the two concepts, because for this period the heating system defines temperature levels.

This economy is also achieved by insulating the pipes, and the Danish standard [5] takes into account the heat loss constants (W/m), depending on the temperatures, the annual operating time and the diameter of the pipe.

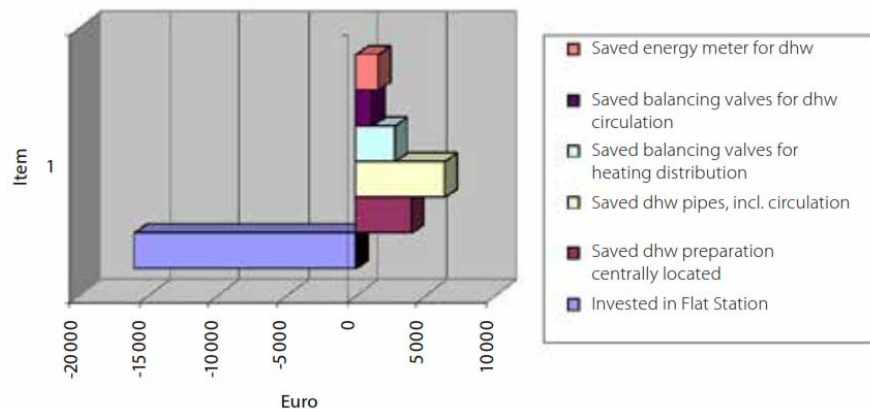


Fig. 3 The investment value of a block with 4 apartments

An example of investment comparing the traditional system with the one with thermal modules included in Fig. 3. This comparison is made of a block in Denmark, built with a basement and 4 levels, consisting of 24 houses, which has been modernized.

## 4. The advantages and disadvantages of using thermal modules

### 4.1. The advantages of the owners who use thermal modules

Homeowners who choose to use thermal modules in their homes can benefit from several advantages. Here are some of them:

- *Energy savings and low costs:* Thermal modules are designed to provide heating and hot water on demand, meaning that energy is only used when needed. This can lead to reduced energy consumption and, consequently, heating and hot water costs compared to traditional district heating systems.[6]
- *Individual control:* Owners using thermal modules have individual control over the temperature in their own apartments. This means they can adjust the

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temperature according to personal preference, which can increase comfort and energy efficiency.

- *Flexibility in installation:* Thermal modules can be installed near each apartment or housing unit, which means that there is no need for long pipes or complex distribution systems. This makes installation and maintenance easier and less expensive.
- *Reliability:* Typically, thermal modules are reliable and durable equipment that require less maintenance compared to other types of central heating systems.
- *Adaptability:* Thermal modules can be used with different energy sources, such as gas, electricity or renewable energy sources, depending on the preferences and local conditions of the owners.
- *Reduction of heat loss:* Being installed near housing units, thermal modules can reduce heat loss in long pipes and distribution systems, which contributes to energy efficiency.
- *Instant hot water:* Thermal modules can provide hot water instantly, meaning there is no need to wait for the water to heat up, which adds a level of comfort.
- *Reduction of dependence on fossil fuels:* If renewable energy sources are used to power the thermal modules, owners can reduce dependence on fossil fuels and help protect the environment.

#### **4.2. Disadvantages of owners who use thermal modules**

Here are some of the potential disadvantages of thermal modules, which owners should consider when deciding to use them:

- *Higher initial costs:* The initial cost of purchasing and installing thermal modules can be higher compared to traditional district heating systems. This can be a barrier for some owners.
- *Individual responsibility for maintenance:* Owners using thermal modules are usually responsible for the maintenance and repairs of their individual equipment. This can add additional costs and responsibilities.
- *Variability in quality:* The quality of thermal modules can vary by manufacturer and model. It is important to choose high-quality equipment to avoid problems and costs related to frequent repairs.
- *Electricity consumption:* Some thermal modules use electricity to operate, which can increase your electricity bills. However, there are thermal modules that work with renewable energy sources or with energy efficiency, which can reduce electricity consumption.
- *Vulnerability to individual failures:* If a thermal module fails in an apartment or housing unit, this can affect the comfort and hot water supply for that apartment specifically, while the rest of the building remains unaffected.
- *Limitations in cooling systems:* Thermal modules are usually designed for heating and hot water preparation, not for cooling. Owners who also want to

integrate cooling into the thermal modules may require additional solutions, such as the installation of additional cooling units.

- *Potential incompatibilities with existing systems:* In some cases, the installation of thermal modules may require modifications or upgrades to the existing building infrastructure, which may add additional costs.

## 5. Conclusions

In conclusion, apartment thermal modules represent a modern and efficient solution for heating and hot water in contemporary homes. They bring numerous advantages, from energy savings to individualized control and reduced environmental impact. With ever-developing technologies and increasing environmental concerns, the adoption of apartment modules can significantly contribute to achieving sustainability goals and increasing the quality of life in housing.

- *Outstanding energy efficiency:* Apartment thermal modules are an energy efficient solution for heating and hot water in homes. They provide heat and hot water on demand, eliminating energy losses associated with long-distance transport, resulting in significant energy savings and reduced costs.
- *Individual control:* One of the major advantages of apartment modules is individual control over temperature. Each owner can adjust the temperature according to their preferences, ensuring that they feel comfortable in their own home.
- *Flexibility in energy source:* Modules can run on different energy sources, including natural gas, electricity or renewable sources, giving owners options adapted to the environment and available resources.
- *Reducing dependence on fossil fuels:* By using renewable energy sources, the modules contribute to reducing the carbon footprint and protecting the environment.
- *Additional convenience and comfort:* The modules provide hot water instantly, eliminating the wait for the water to heat up, which adds a level of comfort to users.
- *Simplification of maintenance:* As the modules are installed in each individual apartment, maintenance and repairs become simpler and more cost-effective compared to centralized systems.
- *Potential for sustainability:* Integrating modules with renewable energy sources and building automation systems paves the way for a more sustainable and comfortable future for homes

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