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A B S T R A C T

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D I S S E R T A T I O N   T H E S I S

For a scientific-educational degree "Doctor"

INFORMATION AND COMMUNICATION TECHNOLOGIES FOR SMART HOMES

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I. Overview, analysis and systematization of different types of information and communication systems for smart homes

1.1. Definition of smart homes

The concept of intelligent building has received increasing attention in the last two decades. Approaches to identifying smart buildings can be grouped into three categories, as listed below:

- performance- based definitions;
- A service-based approach that the building is able to offer;
- System based services;

A typical efficiency-based definition may be that of the European Intelligent Building Group. The EIBG defines intelligent buildings as those designed to provide its users the most efficient environment, while at the same time using and managing resources as efficiently as possible to minimize the cost of services.

Service-based definitions describe the intelligent building in terms of the services and / or quality of the buildings. The Japan Institute of Intelligent Buildings (JIBI) provides an example of a service-based definition: an intelligent building is a building with communication, office and building automation functions in the service of its occupants and is convenient for intelligent activities.

The definition of intelligent buildings is described by directly addressing the technologies and technological systems that buildings must include. A typical system-based solution is proposed by the Chinese Intelligent Building Standard (GB / T50314-2000), which states that intelligent buildings provide building and office automation systems and communication networks and optimally integrates structures, systems, services and management, providing the building with high efficiency, comfort, convenience and safety for its occupants.

However, in the context of the modern construction environment, it is obvious that intelligent buildings cannot exist without the inclusion of technological systems, especially information technology (IT).

Intelligent buildings are interdisciplinary and include multi-industrial engineering. They require the right combination of architecture, structure, environment, construction services, information technology, automation and facility management. In addition, smart homes and buildings are also strongly linked to economic and cultural aspects.

Single-family building, built according to current regulations

The building design features are typical and repetitive for each one and can be summarized below:

Roof - Regardless of the type of roof (flat or sloping) and its main structure (wooden or concrete), it must serve as the main heat-insulating part of the whole structure.

Walls - Walls must have certain characteristics to meet the standards of heat transfer, resistance and strength. Most widely used for wall insulation stone wool, suspended facades polystyrene foam.

Floor - It must also meet certain requirements and standards in order to prevent deterioration, heat resistance and prevent the ingress of water and moisture.

In Figure 1.1. a conceptual model of a single-family residential building is presented. It consists of a living room, two bedrooms, a bathroom, a technical room and an open veranda.

Figure 1.1. Conceptual model of a single-family residential building

The planned heating installation is able to satisfy the thermal needs of the building. There is a local water-pump heating installation with hot water heat carrier, produced by a pellet hot water boiler.

In Figure 1.2. the piping, the radiators and the boiler installed in the technical room of the house are shown. The heated water will be delivered to the boiler and the heating installation through a built-in circulating pump with electronic control, equipped with the necessary fittings.

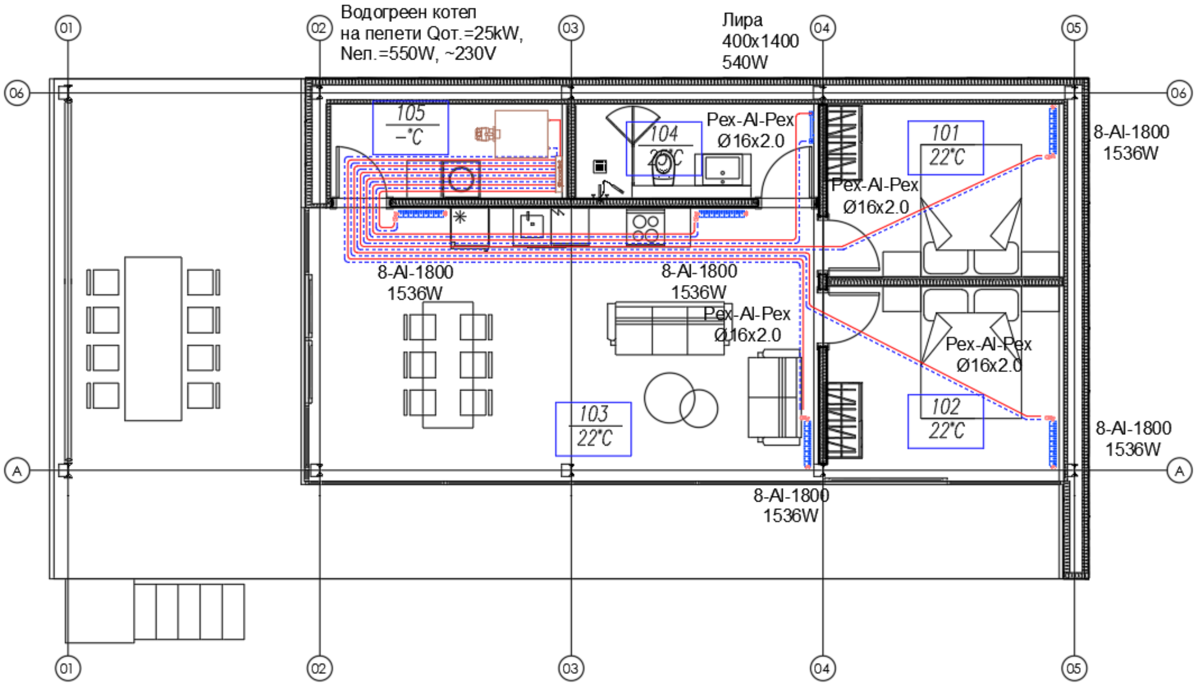


Figure 1.2. Piping and heat consumers

The installation, subject of the project, is schematically shown in Figure 1.3., For greater clarity, the control and shut-off valves are applied, as well as all the necessary diameters and additional information.

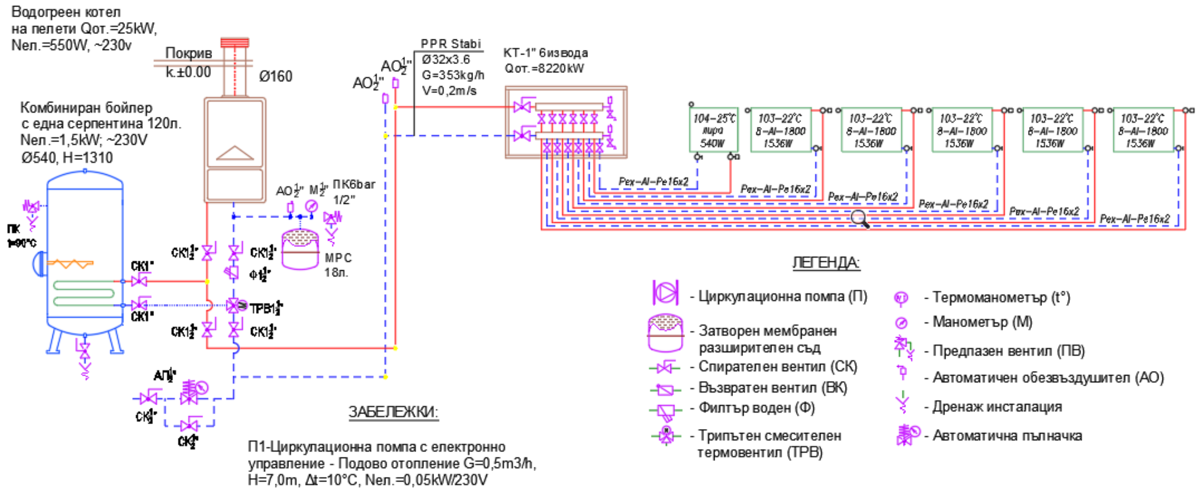


Figure 1.3. Pipe diagram of equipment, safety and control valves

1.2. European practices and perspectives

The policies of individual countries and the EU as a whole focus on striving to reduce the release of harmful gases into the atmosphere. The EU's goal is to reduce harmful emissions by 55% by 2030 and by 2050 to achieve a zero carbon footprint i.e. to achieve a carbon-neutral economy. The so-called "European Green Pact", also known informally as the "Green Deal", was signed.

The European Green Pact provides an action plan for
• increasing the efficient use of resources by moving to a clean, circular economy
• restoration of biodiversity and reduction of pollution.

Achieving this goal will require action in all sectors of the economy, such as:

• investing in environmentally friendly technologies
• support for industrial innovation
• introduction of cleaner, cheaper and healthier forms of private and public transport
• decarbonisation of the energy sector
• improving the energy efficiency of buildings
• work with international partners to improve environmental standards worldwide.

The European Green Pact provides a roadmap with actions to make more efficient use of resources by moving to a clean, circular economy and to halting climate change, reversing the trend towards biodiversity loss and reducing pollution. The pact sets out the necessary investments and available financial instruments and explains how to ensure a fair and inclusive transition.

1.3. Presentation of an intelligent building

Although the successful use of modern technologies, including IT, is a key feature of smart buildings, the introduction of technology should not be the only goal of smart buildings. When it comes to hardware, intelligent buildings cannot be separated from architectural design, facades and materials, which are among the main elements of the intelligent building.

Intelligent architecture refers to the creation of structures whose integrated systems are able to anticipate and respond to phenomenon, whether internal or external, that affect the operation of a building and occupants.

Smart architecture refers to three different areas:

- Intelligent design;

- Appropriate use of intelligent technologies;

- Intelligent use and maintenance of buildings.

The nature of the envelope / insulation and building cladding / of the building will be drastically influenced by the development of intelligent buildings. Facades designed to integrate emerging technologies will have inherent "intelligence" and will be able to respond automatically or through human intervention to contextual conditions and individual needs. Now smart facades can:

• be centrally controlled, while providing residents with the ability to manually control the system;

• change of their thermophysical properties such as thermal resistance, permeability, absorption, etc.;

• modify their internal and external color and / or texture;

• function as communication media facades with video and audio capabilities;

• changing the optical properties and allowing the creation of colored glasses, providing the possibility for dynamic shading and remote control of light.

1.4. Digital controllers

Building Automation Systems (BAS), also known as Building Management Systems (BMS), are primarily integrated processor systems. The building automation system is actually a digital controller that is connected to all subnets and nodes via a network.

Goals and objectives of the dissertation:

The aim of the dissertation is to study the progress and integration of new technologies in modern construction to reduce operating costs and improve the quality of life and to offer an innovative approach to creating a smart home.

To achieve this goal, the following tasks will be solved:

1. A detailed review, analysis and systematization of approaches and methods for integration of intelligent technologies in the creation of smart buildings will be made.

2. The existing problems concerning the construction of smart homes will be studied.

3. The impact of buildings on climate and the contribution of intelligent technologies to struggle with climate change will be studied.

4. An innovative model for creating a smart home equipped with intelligent technologies will be proposed and substantiated.

5. Experiments will be conducted to compare modern and innovative methods of building smart homes used to improve the quality of life of residents.

6. The obtained results will be analyzed.

II. Building automation systems – BAS

2.1. What is BAS

Building Automation System (BAS) is a general term (also known as Building Management System, BMS). It is used to denote a wide range of computerized building management systems, from dedicated controllers, through stand-alone remote stations, to larger systems, including a central computer, local stations and printers. BAS is one of the main intelligent building systems.

The main benefits of implementing the BAS are discussed below.

- Increased reliability of installed equipment and services
- Reduced operating costs
- Building management
- Increasing staff productivity
- Protection of people and equipment

2.2. Development of building automation systems (BAS)

The progress of the BAS can be divided into the following stages:

- centralized control and monitoring panel
- computerized centralized control and monitoring panel
- BAS with data acquisition panel (DAP) based on a minicomputer
- microprocessor-based BAS using LAN
- open BAS, compatible with Internet / intranet.

Figure 2.1. shows the progress of computing and building automation technologies and their relationship.

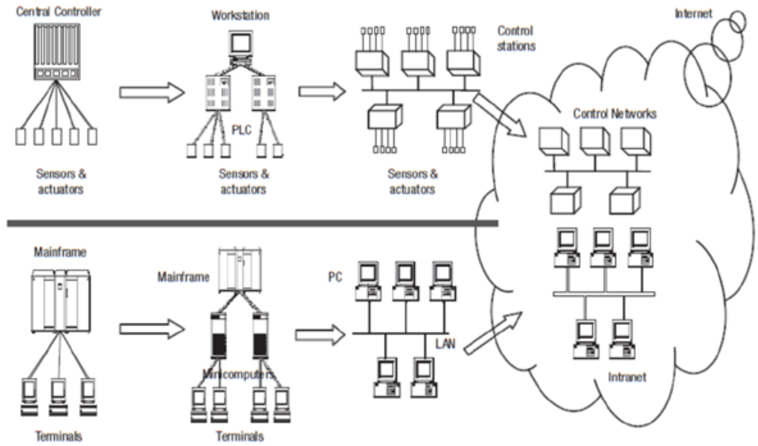


Figure 2.1. Progress of computerized automation systems

2.3. Programming and monitoring platforms and environment

Figure 2.2. shows an example of a typical network architecture of a building automation system.

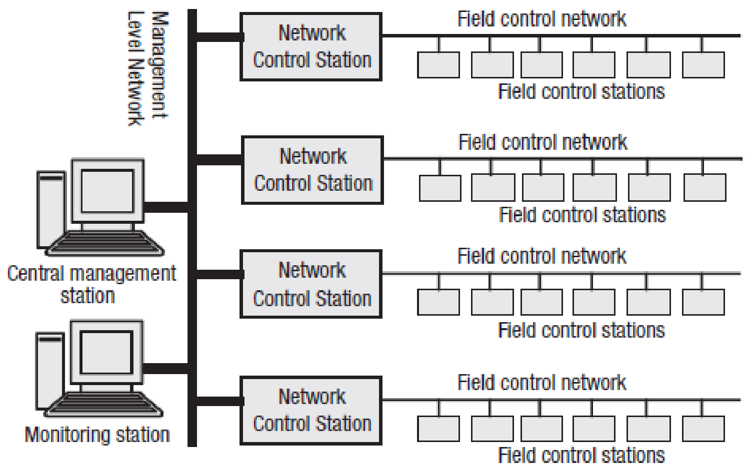


Figure 2.2. Typical BAS network architecture

The programming environments provided by the programming tools of different vendors are different and can be grouped into three categories:

1. Graphic / symbolic format;

2. Template or table format;

3. Text formats of high-level language programming;

Most modern automation systems provide a very user-friendly and powerful user or machine interface for setting up the BAS network, setting up the database and setting up the controller, and for monitoring and managing the system. Some systems share the same platform for both configuration and monitoring.

Typical functions in the presence of BAS are:

- functions for installation, management and control;

- energy management functions (supervisory control);

- risk management functions;

- information processing functions;

- equipment management functions;

- efficiency monitoring and diagnostics;

- maintenance management.

2.4. Principles and technologies of local networks

Integration is one of the main features of modern building automation systems. This integration is between digital stations or devices (system integration) and integration of control and management functions (integration of functions).

A modern building can have a large number of digital stations or devices, that could be integrated. Local area networks are the main choice for integrating such a large number of stations or devices in a building or in buildings located at close range (a few kilometers). LANs are used to transfer data between stations or devices on networks.

Examples of LAN technologies in applications

- Ethernet (IEEE 802.3)
- ARCnet (ANSI standard 878.1)
- LonTalk

Wireless technologies

- ZigBee technology
- Compatible with 802.11 (Wi-Fi) technologies
- Bluetooth technology
- Specific technologies.

2.5. Communication standards in building automation systems

As a practical example is shown in Figure 2.3. where the configuration of the system is illustrated, incl. building automation system, combining:

- HVAC system
- Fire alarm system
- Access control
- Security
- Lighting control
- Energy consumption

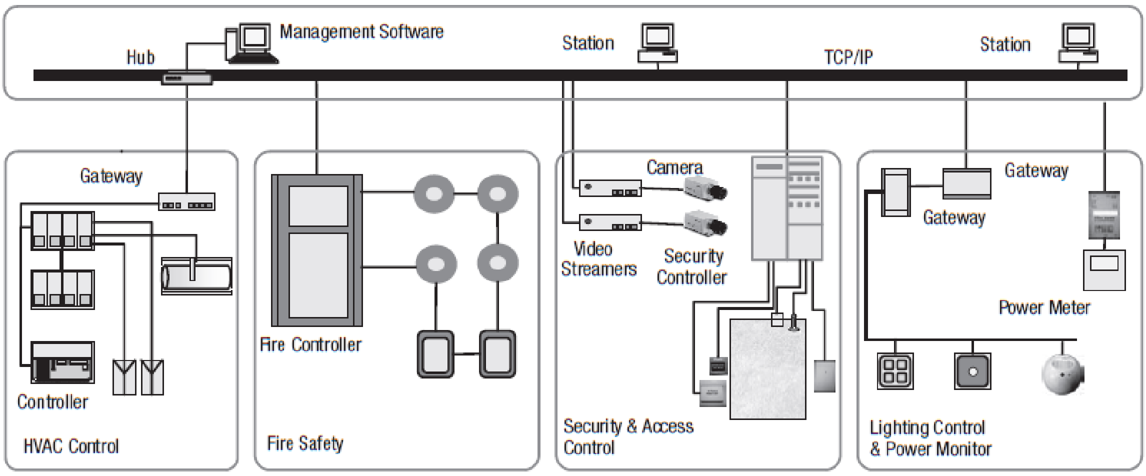


Figure 2.3. Integrated intelligent building system

III. Innovative solutions for improvement and integration of smart technologies for residential buildings

The intelligent building is an organic combination of different subsystems related to home life through modern technologies. It can both share resources and communicate at home, as well as exchange information between the local and external global network. Its main goal is to provide people with an efficient, comfortable, safe and favorable living environment, integrating service and management.

There are some basic features for a smart home as follows:

- The smart home can realize the interaction between the consumer and the enterprise of the electricity transmission network, receive information about the consumption and the price of electricity, set a plan for consumption, etc., directing scientific and rational use of electricity and creating awareness to the family of ourselves for saving energy and protecting the environment.

- Smart home can improve the comfort, safety, convenience and interactivity of our daily lives and optimize people's lifestyle.

The smart home can: support options such as remote payment, monitoring and interacting with the home via mobile phone and remote network, implementing the service for reporting and security of real-time metering devise cush as water meter, electricity meter and gas meter.

3.1. Technologies

Interactive electricity technologies

- Information on energy consumption. The service includes information on the operation and maintenance of the network, the price of electricity in real time, energy policy, publication of other information, energy consumption, balances and current accounts and responding to request of other information.

- Interactive control of household appliances. Depending on the needs of consumers, an analysis of the electricity load in households is made, development and optimization of the electrical program to direct the consumer to rational use of electricity in accordance with tariffs and personal preferences.

- Selfpayment service. Multi-channel payment can be made by phone, SMS, website, self-service terminal and other means.

Support technologies

- Residential property security services. It is possible to provide different security models in order to achieve maximum control when an unexpected situation occurs at home according to the sensors for gas, smoke, movement and other alarm signals for remote monitoring. Emergency calls for help and notify the relevant department are possible.

- Information options for communal services (municipal, medical). Users have access to information for municipal, construction and repair activities, traffic and road information, health care and epidemic prevention. Meantime, according to the needs of the users, the system can also provide the users online medical services, health information platform for outpatient meetings, online consultations and other services.

- Business information services (personalization of information, information interaction, news subscription services, etc.). According to the user needs specific data could send, for example stocks, currency, various products and other information in real time, as well as reservation of products and other information.

3.2. Smart Home service system

The smart home service system is a support platform for monitoring, analysis and control of electricity consumption by household consumers and is also an important way to implement orderly electrical control and intelligent service of energy efficiency Figure 3.1. shows the power structure of the smart home and service system.

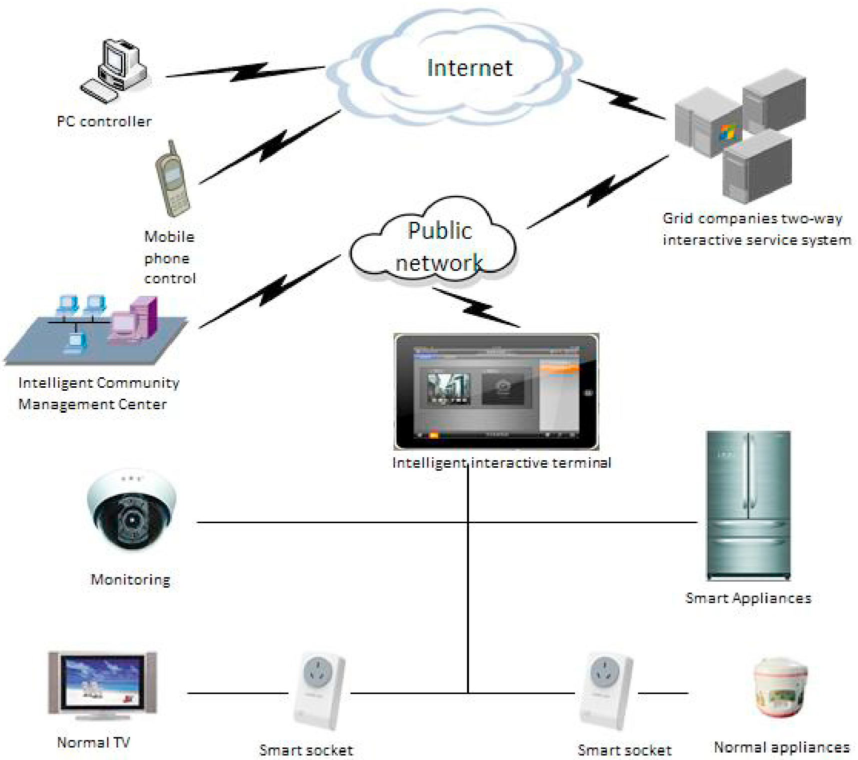


Figure 3.1. Structure of the system for electrical service of a smart home

The smart home electrical service system is mainly a main switchboard system, a communication channel, a home intelligent interactive terminal and a smart electrical device of 4 parts:

- The main system is a database server, application server, router, security equipment.
- A communication channel that divides a long-distance communication network and a local communication network. Remote communication using communications in a public network, selection of a local communication network from a composite fiber optic cable, broadband communications by power lines, wireless communications.
- Home intelligent interactive terminal, which is the main part of the smart home system, it is the central station and consumer contact center, also a smart center for control of electrical equipment.
- Intelligent electrical equipment includes intelligent appliances, security equipment and other devices and functions. Currently, due to the lack of promotion of smart appliances to meet the control of non smart appliances and the collection of electrical information, smart contacts can be used to control household appliances.

3.3. Key equipment for a smart home

- Basic control system - the main system includes servers, communication networks, workstations and internal connections. It also includes marketing applications, interactive website services and other interconnection applications.

- Family intelligent interactive terminal - the terminal is installed in a position convenient for users to work and establish communication and interaction with smart contacts, smart home appliances and home security devices.
- Intelligent electrical equipment - Intelligent contact
- Smart appliances
  - Robot vacuum cleaner
  - Smart washing machine
  - Air purifiers
  - Smart TVs
  - Smart lighting
  - Clever boiler
- Home security - the right place to install smoke sensors, infrared sensors, emergency buttons, gas leak sensors, cameras and more we can create an interactive communication terminal for a smart home.

3.4. Smart home appliance mode:

- Network device mode: (recommended built-in)
- The intelligent contact is connected by power control options to achieve the energy saving goal
- Control commands initiated by the intelligent interactive terminal are securely transmitted to the home appliance via the wireless module of the smart socket, and are used to start, set up and control household appliances
- Integrated network device mode, incl. data collection.

3.5. Network-friendly appliances

Network-friendly devices mainly use built-in technology to automatically disconnect the power supply from the main devices when their frequency signal is below the preset voltage threshold or in the event of disturbances in the mains frequency signal in real time. It is predictable that network-friendly appliances will respond to voltage or frequency signals, as well as signals from the control system, related to the current price of electricity.

3.6. Communication system for smart home

The external network can be cellular LAN, cable TV network, telephone network and internet, using mainly more secure technology, devices on each subnet should be able to communicate with each other, such as network for household appliances like refrigerators, air conditioners, TVs, microwave ovens, washing machines, lighting, etc..

Security: Including environmental protection, home video intercom, access control, alarm, fire, gas leak, water spill, etc.).

High speed access to information: Internet, videophones, cellular LAN access to the home.

Housing services: The community management center can monitor and manage equipment and the environment in the designated area.

The structure of the system is shown in Fig.3.2.

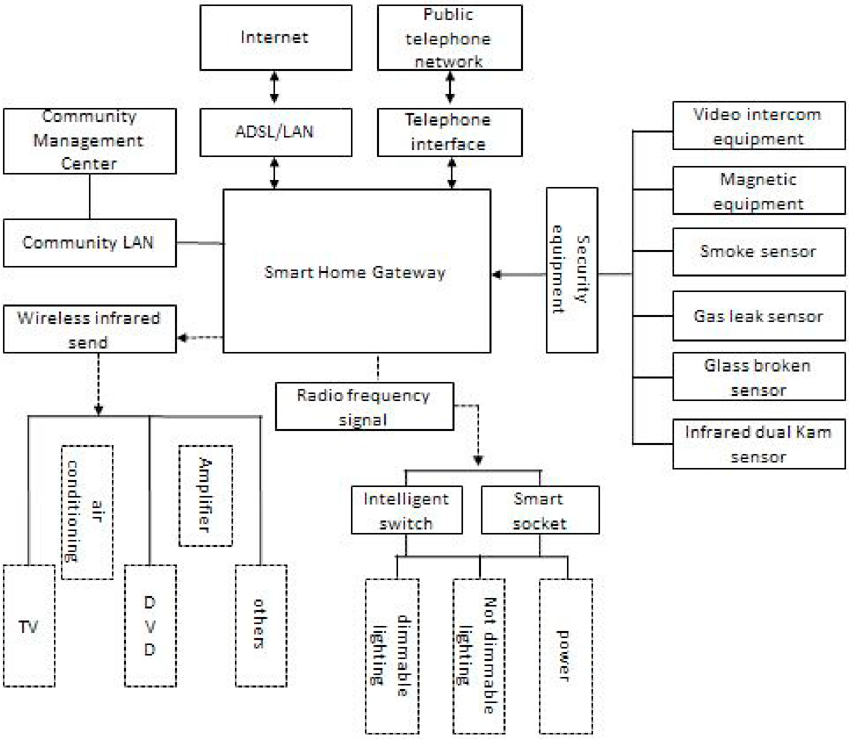


Figure 3.2. System structure

3.7. Exterior solutions

External walls

Modern manufacturers offer products that meet many criteria:

- Natural thermal insulation and air conditioning
- Sound insulation
- Microclimate

The roof

It is really important the use of insulating materials with increased characteristics, Ggeographical considerations are obligatory just like the geometry and the shape.

Garage doors

Garage doors can now be equipped with various smart enhancements that make them easier to use by allowing the owner and the car to be recognized as they approach.

External shades and screens

Exterior shades and screens are an important element of modern construction, in addition to the façade. Shades and screens perform an important function to reduce heating costs on days with high temperatures and high solar intensity.

Photovoltaic and solar panels

The energy needs of buildings represent 40% of the total primary energy needs in the EU. Therefore, the development of efficient energy alternatives for buildings used mainly for electricity, heating, cooling and hot water supply is imperative. One way to reduce dependence on fossil fuels is to use renewable energy systems (RES), which are usually environmentally friendly. The systems commonly used in buildings are photovoltaic solar thermal systems.

Utilization of rainwater

During rainfall, significant amounts of water fall into the ditch or into the soil. The quantities can reach 50-100 l / m2 within 24 hours. Instead of losing all this volume, it could be used for irrigation, washing or other various purposes. With proper treatment and filtration, rainwater could reach characteristics similar to those of distilled water.

Batteries for energy storage

Powered by photovoltaic panels or energy taken from the power distribution network the batteries can provide enough amount of energy for the whole household.

3.8. An innovative scheme of a "smart" home with intelligent appliances and systems

In Figure 3.3. diagram of a smart home is shown, combining various technologies integrated in order to support and facilitate the life of its inhabitants.

Figure 3.3. Schematic diagram of a smart home

The smart home can give us the option to manage the following basic systems:

Security

- setting of security and fire alarms using a code from the keyboard or magnetic card;

- access control at several levels (for children, friends, staff)

- streaming information about the state of the system (via internet, mobile phone, radio remote control)

- imitation of presence in the house

- management and monitoring of uninterruptible power supplies, generators and many other types of energy sources

- in case of malfunction, the system can automatically cut off the power supply eliminating the possibility of short circuits and fires;

- CCTV cameras and motion sensors are used to ensure security.

Economy

- control of individual heating circuits;

- determining the working hours of electrical appliances;

- heating control in different weather conditions

- switching off unused household appliances
- All this allows you to save energy.

Comfort

- remote control of the home, through touch panels, and mobile devices
- one control for all electrical appliances
- different scenarios for lighting and heating
- entry of various assistants who allow a variety of services and opportunities.

IV. Experimental part

Example model of a single family house with built-in intelligent control systems

The sample model is a detached house on one floor, which has two bedrooms, living room with kitchenette, bathroom, utility room and outdoor terrace. In the development process in order to achieve optimal results we focus in two directions:

- passive, which includes elements and parts of the building. Their orientation or nature help to reduce energy costs and increase the level of comfort. This direction includes the design, the materials and constructions used, various practical solutions and ideas such as wastewater treatment systems and energy production from photovoltaic panels.

- active, which unites all systems that can be driven (opened or closed, switched on or off). In this direction are all security systems, sensors, installations for maintaining the microclimate, lighting and all household equipment.

4.1. Intelligent design

Facade

The design considers various features of the geographical region, as well as construction techniques and technologies. The building has rich glazing and french windows, providing a view of its surroundings (Figure 4.1.)

Figure 4.1. Model of a building in harmony with the surrounding environment

The external walls are made of ceramic blocks with a thickness of 380 mm and have increased thermal insulation properties.

The facade is made of composite wood on the principle of the suspended facade.

In the air gap between the brick wall and the suspended facade is laid a layer of additional thermal insulation with a thickness of 50 mm. Because of that the heat transfer coefficient of the walls is U = 0.15 W / m2K at a standard of 0.28W / m2K, according to current standards.

Doors and windows

The doors and windows are made of triple glazed windows with different thickness and distance between the panes, the profile is multi-chamber, made of fibrocomposite material, which provides extremely good thermal insulation characteristics, reaching U = 0.60 W / m²K, thanks to the lack of metal implementation. At the same time, sensors are installed on all opening doors and windows to provide protection against unauthorized penetration.

Installation of external shades is provided, which helps to ahieve healthy levels of internal temperature. They are able to provide sufficient visibility, perform the role of additional thermal and wind protection, as well as allow full use of daylight without unwanted glare and reflections. They have an option for electrical and remote control

Floor and roof

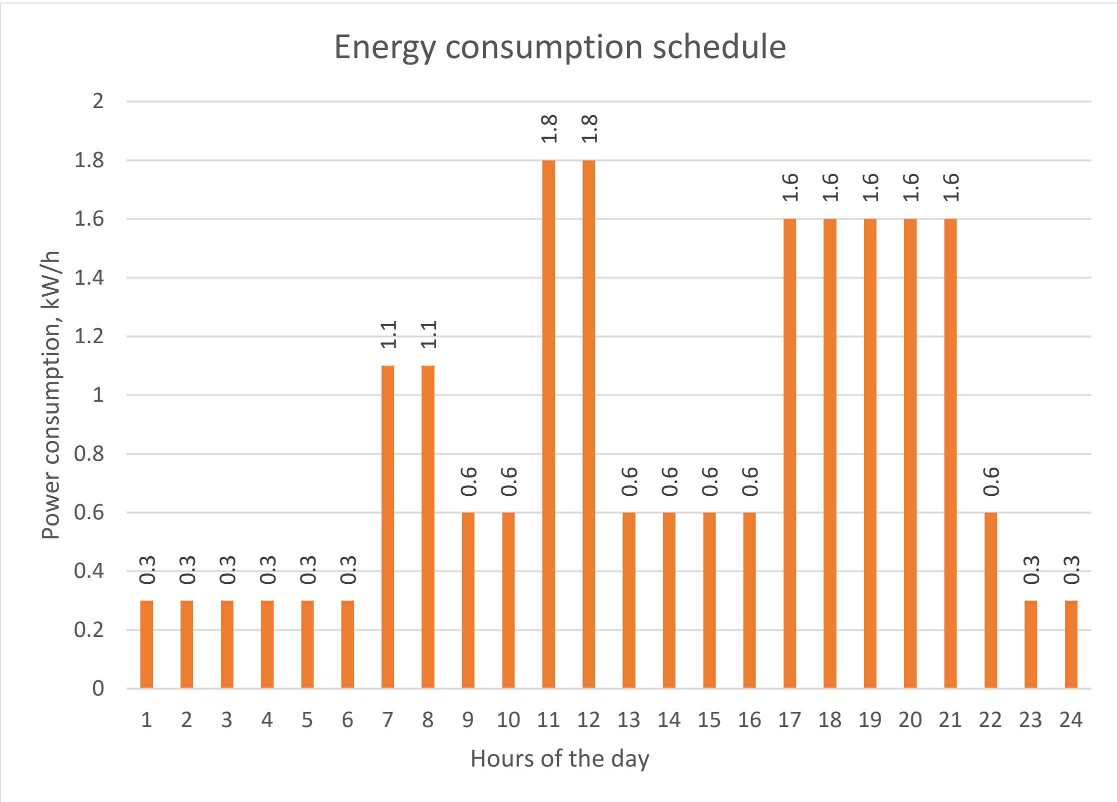
The floor and the roof are made according to all the requirements of the current regulations and laws. The structure of the materials is oriented to ensure sufficiently good thermal insulation characteristics. Both the floor and the ceiling are thermally insulated with extruded polystyrene XPS, which has a capillary microstructure and has a maximum closed cell structure, which makes it resistant to water and water vapor.

4.2. Intelligent technologies

Photovoltaic system

Photovoltaic panels are installed on the roof of the building, they are able to meet the energy needs of the occupants. They are mounted at a suitable angle for maximum absorption of sunlight, their orientation is south-southeast. The system has the ability to adjust the angle depending on seasonal characteristics. The choice of the number and type of panels is consistent with the average energy consumption on a daily basis.

Based on the reported estimated electricity consumption for the entire building, intended for year-round use, a schedule has been prepared with the energy consumed for full operation and ensuring the necessary level of comfort (Figure 4.2.).



As can be seen from the graph, it is clear that in certain time zones energy consumption is more intensive. These are the hours before work, the time for lunch and the hours after the end of the working day. In order to provide the necessary energy on the roof, 39 photovoltaic panels will be installed.

The panels have a single crystal structure 158x158mm, the number of cells is 144 (6x24), the dimensions are 2031x1008x30, the set power they are able to produce is 405W within one hour. The set efficiency of the photovoltaic panel is 19.78%.

In Bulgaria, there are data from long-term observations of the sunlight, with an average value of 2100 hours per year. In some areas it even reaches 2500 hours, which corresponds to 1400-1600kW / m2 on a horizontal surface.

The duration of sunlight is different for different parts of the country due to geographical features and differences. For the region of Sofia, it reaches 2020 hours per year.

Qh = 39 * 405 = 15795W / h

On a twenty-four-hour basis, using the efficiency of the solar panels we get:

Q = 15795 * 24 * 0.1978 = 74.9kW

To meet the energy needs of our building for 24 hours requires 21 kW of electricity, so the entire roof of the building is planned to install photovoltaic panels that are able for two hours of peak load to provide the energy needed for the whole day (Figure 4.3 .).

Figure 4.3. Roof with photovoltaic panels

Part of the energy produced by the panels, if necessary, is used directly for the needs of consuming appliances such as water heaters, refrigerators or air conditioners, and the rest is stored in a compact battery pack, which is able to provide enough energy for a family house with two bedrooms. The battery pack has a built-in inverter and a high level of autonomy.

The extra electricity is returned to the power supply grid and it should be purchased at preferential prices.

In Figure 4.4. a diagram of a single-family residential building with built-in intelligent technologies is shown.

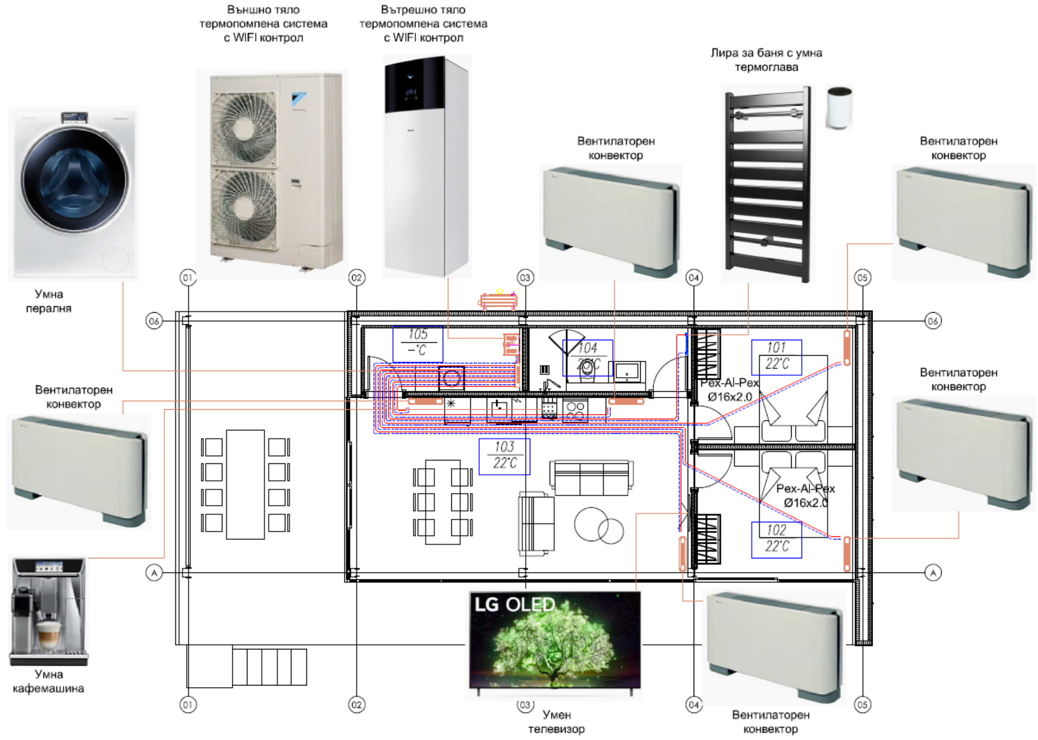


Figure 4.4. Smart appliances

To ensure a suitable microclimate - heating and cooling, a heat pump system is provided. The heat pump is a separate type with outdoor and indoor unit. The outdoor unit is an air-to-water type and will be mounted on a separate foundation to stop transmiting noise and vibration to the residential building. The indoor unit is equipped with heat exchangers, an electronically controlled circulation pump, a built-in stainless-steel boiler with an electric heater. The connection between the indoor and outdoor unit is through a pipe bundle of copper pipes for liquid and gaseous phase, power and communication cable.

Thanks to the built-in heat exchanger, the indoor unit or hydraulic module provides hot or cold water that supplies the air conditioning system. The heating of the living room and the bedrooms is carried out with fan coil units for sub-wall installation for the bathroom towel dryer is provided.

The heated water is transported by a beam scheme from a distribution collector, made by a water distributor, automatic deaerators, shut-off and control valves. The pipes are polyethylene with an aluminum layer, insulated with thermal insulation of microporous rubber. The connection between the collector and the indoor unit is made with copper heat-insulated pipes.

The heat pump system is equipped with a wireless module, the fan coil units have a controller with an option for remote control, and the towel dryer has a thermostatic head with electric actuator.

The air conditioning system is equipped with temperature sensors and a communication module that can be controlled manually or with automatic settings depending on our location.

Whenever we are on our way home, the system knows that and changes its settings so when we return, the optimal characteristics of the microclimate are reached.

The power from the photovoltaic panels mounted on the roof of the building is used to heat the hot water in the boiler. For this purpose, the energy is directed to the heater during the time when we have the most intense flow of sunlight, usually in the early afternoon. The boiler is also equipped with functions for remote control and monitoring, and if necessary, its parameters can be turned off or changed.

In the technical room, in addition to the indoor unit of the heat pump are installed distribution manifold and the washing machine, which is the latest generation and has smart technology that allows us to adjust the washing time, analyze common problems and give options for solving them (specific programs and washing cycles). The washing machine connects to the home network via an application that allows us to control it remotely via the Internet, it is also possible to connect with smart assistants.

The kitchen is fully equipped with an option for control via the Internet. The coffee machine can prepare coffee just before getting up, the refrigerator has a touch screen that gives different information it has the option of a built-in internal camera, is compatible with home internet assistants.

The TV is equipped with an operating system and has both a wireless connection option and Bluetooth technology and a cable option.

A smart vacuum cleaner with an option for wet cleaning is provided.

For all other devices which do not have the option to be controled over the Internet, smart electrical outlets are provided which can remotely start or stop the products on demand.

The lighting is entirely based on LED technology, which guarantees high reliability, long operation and low energy consumption. Each section is part of the local management and control system.

The management of all installed devices and systems are integrated and easily managed by means of specialized software. One of the most commonly used is a product is of the company "Apple" called “Apple home”.

With its help we are able to monitor and control any system compatible with this software, such as monitoring the air purity, the temperature in the premises, whether certain appliances are turned on, the garage door and security systems.

The Home app groups accessories into rooms so you can easily control devices in any part of the home with a touch or click. We can even tell the Siri voice assistant things like "Turn off my bedroom light" or "Start heating upstairs." We can tap an icon to perform more complex tasks such as dimming the lights or adjusting the thermostat. "Apple home" allows us to set configurations that allows work with multiple accessories in a certain combination - all with one command. We can create a mode called "Leaving Home", which turns off the lights, locks doors and lowers the temperature of the thermostat. The voice assistant integrated in any mobile device allows us to set commands and modes from anywhere in the world.

The system also has the option to take care of our home by itself, for example, depending on our location, it can turn on the lights, increase the heating before we get up, using motion sensors to individually control the lighting in the rooms, and turn off anywhere we have left the building.

A local treatment plant is provided for the utilization of the wastewater. It is compact in size, does not emit odors and allows purified water to be used for irrigation purposes. In addition to the treatment plant, a separate plastic tank made by fiberglass is installed where the rainwater is stored.

The domestic wastewater treatment plant does not need electricity. It has a volume of 2200 liters. and is designed for buildings with four permanent residents. It consists of a tank, filter shaft - filter bucket, tank cover leveling ring (Figure 4.5.).

Figure. 4.5. Wastewater treatment plant for a household of four people

4.3. Intelligent use and maintenance of buildings

The entire volume of incoming information is received in the building automation system, which communicates on the one hand with the installed appliances and systems, and on the other hand with the users. There is processed information about the produced and consumed electricity in the household. The system sets the schedules for the use of various appliances in order to maximize the optimization of energy consumption.

The building is not completely independent and in any case the building is connected to the national power grid. An energy management system has been implemented in the building automation system.

4.4. Analysis

Based on the model presented in the previous chapters, we can analyze the direct benefits of integrating IT to create a smart home.

The amount of money we spend for electricity for the normal living of our conceptual home is a factor. The reporting is made on an annual basis. A coefficient of simultaneity of home equipment is used. Equipment includes air conditioning, washing machine, stove, boiler, lighting and other appliances such as TVs and computers with lower power consumption. For this purpose, two cases are considered: when we do not have and when we have a system for energy management and building automation. The results show that in normal operation it is possible to achieve savings of up to 40% (Figure 4.6).

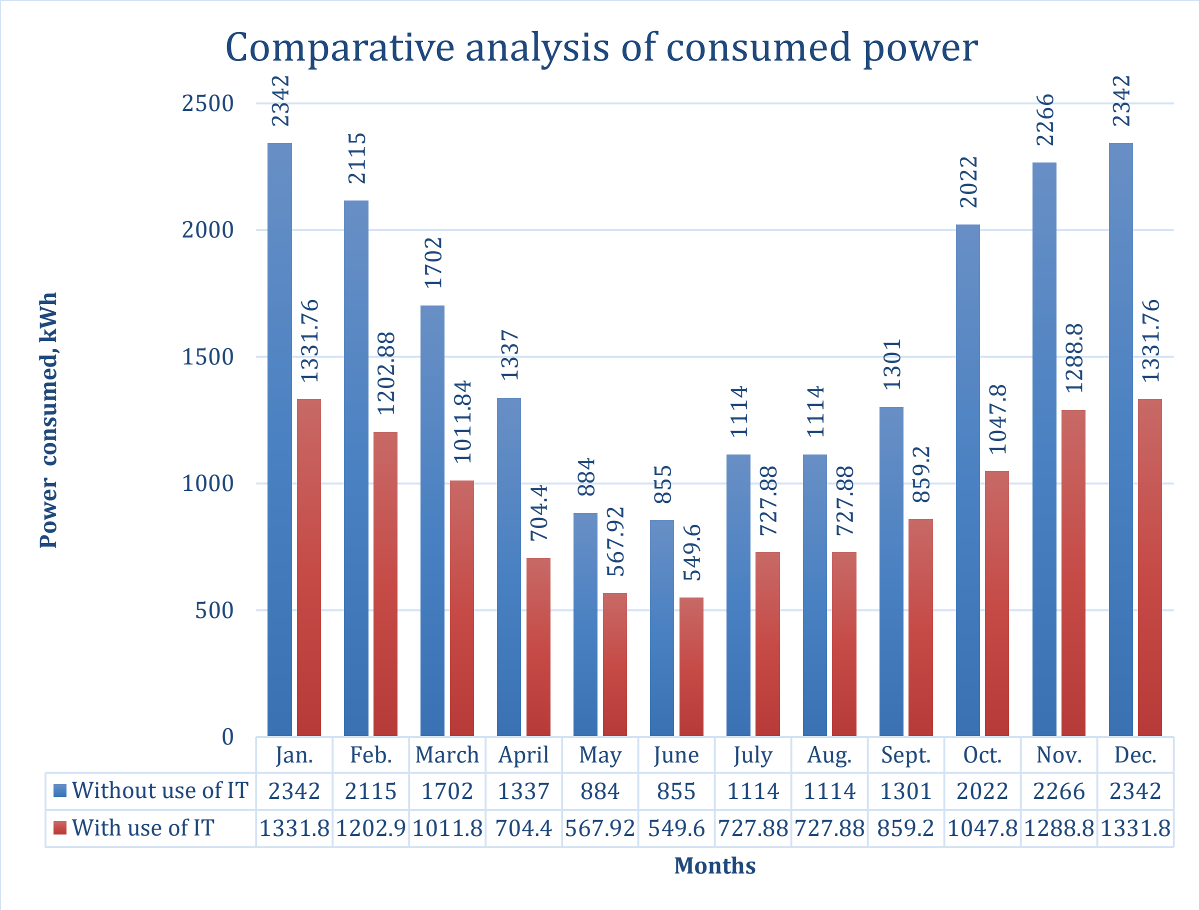


Figure 4.6. Comparative analysis of consumed electricity

We also must mention the main benefits:

- The production of electricity from the photovoltaic system varies depending on the season, the weather, and the location of the sun depending on the daytime. For the gaps when the consumption is not intensive and the battery is charged, we are able to supply national power grid thanks to a two-way meter.

- Reducing the water consumption for communal needs - through the built local treatment plant the water for watering and washing can be supplied by the treated water.

- Ensuring autonomy through security systems, analysis of parameters to ensure the necessary microclimate

- Complete independence from central utility providers.

CONCLUSION

In recent decades, as a result of active human activity, regardless of our desires, the earth's climate is changing at a faster rate than expected.

Despite the higher costs for the initial construction of a smart home, with more careful planning and in-depth analysis we are able to achieve high results, both in terms of care for nature and in the long run to recoup the investment.

The integration of a whole set of IT creates the opportunity to live with less stress without disturbing our rhythm, while at the same time being in harmony with nature, and taking care of its good condition, reducing the carbon footprint.

CONTRIBUTIONS

The contributions in the dissertation have mainly scientific-applied character and are as follows:

1. After a detailed review, a critical analysis and systematization of methods and tools for integrating intelligent technologies in the creation of smart buildings.

2. Existing problems and solutions concerning the construction of smart homes are discussed.

3. The impact of buildings on the climate and the contribution of intelligent technologies to combating climate change are studied.

4. An innovative model for creating a smart home equipped with intelligent technologies has been proposed.

5. An experimental development of a single-family house with built-in intelligent control systems has been made.

6. Innovative solutions for energy efficiency and multifunctional intelligent information and communication technologies have been invested in the experimental development.

7. The results are analyzed and tested in the company "MARTMAX" Ltd.

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ДЕКЛАРАЦИЯ

Фирма "МАРТМАКС" ООД декларира, че разработеният от маг. инж. Росен Симеонов Петров иновативен модел за " Информационно-комуникационни технологии за интелигентни домове " представлява интерес за нашата фирма и ние ще го използваме в нашата практика за проектиране и изпълнение на едно- и многофамилни жилищни сгради.

11.2021г.

Мартин Сариев ....
/управител/