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THE USE OF SMART SYSTEMS IN HEATING SYSTEMS AS A WAY TO COST SAVINGS IN THE CONTEXT OF THE GREEN TRANSITION

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Abstract: This paper explores the importance and practical aspects of the application of smart systems in heating, with a special emphasis on the Tado smart thermostat. Digital transformation within the framework of the green economy contributes to the development of sustainable and energy-efficient solutions that reduce energy consumption, costs and emissions. The analysis of specific data on household energy consumption during the winter months has shown that the application of smart systems can bring savings of up to 31%, while at the same time increasing user comfort. The integration of smart technologies into heating systems is an important step towards digitalization, reducing the ecological footprint and developing new lifestyle habits aimed at more rational use of energy.

Key words: *Smart systems, smart thermostat, energy efficiency, digital transformation, energy saving, green economy.*

1. INTRODUCTION

Digital transformation in the context of the green economy represents the integration of digital technologies into business and social processes with the aim of creating more sustainable, efficient and environmentally friendly business and development models. This concept is also called the "twin transition"[1] because it combines digital transformation with green, i.e. the transition to models that reduce negative environmental impact (Bertoldi, 2022).

- The foundations of this transformation include:
- The application of digital tools and technologies (such as the Internet of Things, artificial intelligence, blockchain) to optimize energy consumption, manage resources and facilitate the transition to renewable energy sources.
- Support for the goals of sustainable development and climate neutrality through more efficient production, consumption and recycling.
- Changing business models towards a circular economy and waste reduction with simultaneous digital support in monitoring and control.
- The role of digitalization in increasing productivity and resilience to climate and economic challenges through automation and real-time analytics.
- Simultaneously achieving economic competitiveness and social responsibility through sustainable innovation and digital strategies.

Digital transformation enables faster and more efficient implementation of green policies and technologies, making the green economy more realistic and practical in different sectors of society and the economy (Brown, 2020).

2. SMART HEATING SYSTEMS – THEORETICAL FRAMEWORK

The use of smart heating systems, such as Tado and similar smart thermostats, brings significant advantages in controlling and optimizing energy consumption for heating in households and businesses (MacGill, 2019). Here are the main aspects:

Efficiency and energy savings

Smart systems use sensors, weather forecasts and data from smartphones to automatically adjust the heating operation according to the real needs of the user. This allows:

[1] The Twin Transition represents a paradigm shift that connects digital innovation with environmental demands, redefining the way companies, governments and societies organize work and development. Applying this concept enables more efficient use of resources, reduces negative environmental impacts and the creation of more competitive, resilient economies and communities.

- Automatic switching on and off of the heating when a person is present or absent (geofencing).
- Adaptation of the temperature to external conditions and previous usage patterns.
- Recognition of window openings and temporary switching off of the heating to reduce heat loss.

All these features contribute to significant savings, which can be up to 30% or more compared to classic thermostats or manual control (Löschel, 2022).

Comfort and ease of use

Smart heating systems allow:

- Remote control via applications from any location.
- Personalized heating schedules by day and hour.
- Connecting to other smart devices in the home (e.g. smart lights, security systems).

Sustainability and environmental aspects

Using a smart system:

- Reduces unnecessary energy consumption and greenhouse gas emissions.
- Supports the transition to sustainable practices and the use of renewable energy sources in heating systems.
- Helps reduce the overall ecological footprint of households.

Smart heating systems are easily integrated with different types of systems (boilers, underfloor heating, heat pumps) and enable zoned heating, which further increases efficiency and savings. In short, the use of smart systems in heating represents a step towards smarter, more economical and more environmentally friendly energy management, with direct benefits for users in the form of lower bills and greater living comfort (Sovacool, 2021). This is the reason for their increasingly widespread acceptance and implementation, among other things, on the Serbian market.

The Tado smart heating system (https://www.tado.com/en) is a smart thermostat and control system that enables efficient and automated heating management in households.

Key features of the system include:

- Saves up to 31% of heating energy through smart technologies such as geofencing (which turns the heating on when residents approach the house and off when everyone leaves) and weather adaptation (uses the weather forecast to optimize heating).

- Allows heating control in multiple rooms or zones separately, as well as hot water management if the system is compatible.
- It is particularly suitable for different types of heating systems, including boilers, underfloor heating (water and electric), heat pumps, as well as radiator valves via smart radiator thermostats.
- It has functions such as open window detection (temporarily turns off the heating to save energy) and alerts about problems with the heating system with advice and support.
- Allows heating control from anywhere via a mobile app, including manual adjustment, automatic scheduling and access to real-time consumption and temperature data.
- The system is compatible with a wide range of existing systems and valves, making it easy to integrate into existing installations.
- The new "Energy IQ" feature in the app helps users see accurate heating costs and adjust their behaviour for optimal savings.

Tado system is a smart, adaptable and energy-efficient solution for controlling heating in different types of homes, with a focus on saving energy and increasing the comfort of residents.

Tado claims to save up to 31% energy because it uses smart technologies that optimize heating according to user needs and outdoor conditions, thereby reducing unnecessary consumption. The main reasons are:

- Geofencing technology: the system recognizes when no one is home and automatically reduces or turns off the heating, and activates it when users approach, thus eliminating the heating of empty spaces.
- Weather adaptation: Tado takes into account the weather forecast and automatically adjusts the heating operation, preventing overheating and unnecessary consumption.
- Open window detection: when an open window is detected, the heating is temporarily turned off to avoid heat dissipation.
- Zone control: enables heating only in rooms that are in use, instead of the entire house.
- Timely warnings and advice: the system monitors the heating operation and advises the user on how to further reduce consumption and increase efficiency.

Figure 1. Example of different temperatures in rooms with the Tado smart system
Source: https://www.tado.com/en

All these functions combined result in a significant reduction in unnecessary energy consumption, which according to the manufacturer can be up to 31% savings compared to standard thermostats or manual heating control.

3. MATERIALS AND METHOD

The study utilised a cross-sectional research design to investigate the potential of smart heating systems. These data are from one meter and one Tado smart System that is controlled by that meter. It should be taken into account that January and February are the peak months with the lowest temperature during the year, that the building is thermally insulated, that the heating is by an electric boiler, and that the heating area is in the 70 m2 area. Considering that these are only two of the 6 months when the system is used intensively, but also the period in which the most electricity is consumed, the savings are impressive.

4. RESULTS AND DISCUSSION

Here is a summary table that summarizes data on consumption, average price in RSD/kWh, and calculated savings through the Tado system for January and February in the years 2023, 2024, and 2025:

Table1. Monthly consumption and savings values, expressed in electricity and money

Year	Month	Consumption (kWh)	Average price (RSD/kWh)	Savings (%)	Savings (kWh)	Savings (RSD)
2023	January	1146	8,51	17,7	202,6	1723,8
2024	January	1033	9,02	13,8	142,5	1285,3
2025	January	1269	10,42	17,1	216,9	2260,7
2023	February	680	8,51	21,1	143,5	1221,8
2024	February	1233	9,02	23,8	293,5	2647,3
2025	February	1192	10,42	15	178,8	1863,5

This table clearly shows the monthly consumption and savings values, expressed in electricity and money, for the specified period based on the data I provided through the calculations and savings percentages of the Tado system.

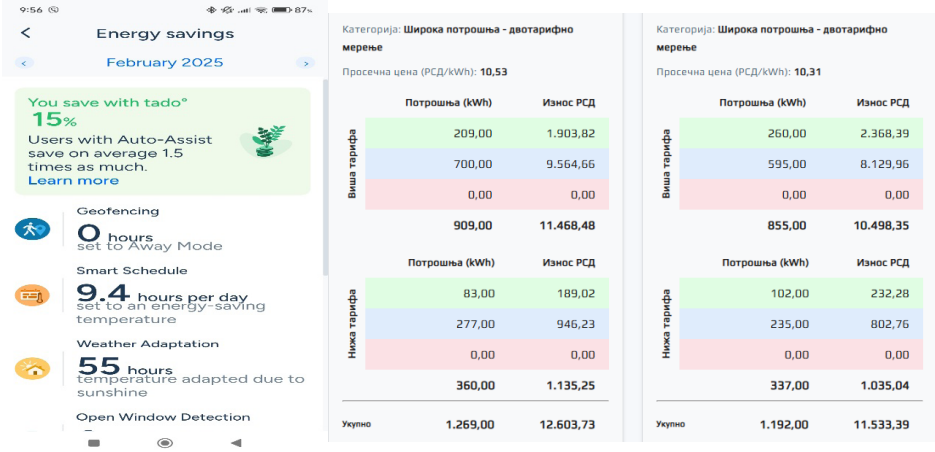

Figure 2. Example from the Tado app (for February 2025) and example from the application Introduction to the electricity bill of the Republic of Serbia (for February and January 2025)

If a study were to be conducted on the cost-effectiveness of integrating smart systems into a heating system, whether individual or central heating, as well as the payback period, but also the need for delivering thermal energy to the system/systems, we would clearly come to the conclusion that each percentage of savings on an annual basis is measurable in billions when it comes to large systems, as well as quick payback when it comes to an individual system, as well as showing how digitalization and the green economy together bring efficiency, energy savings and a reduction in the ecological footprint, which is clearly reflected in data on real consumption and savings in households (Lovell, 2021).

A special issue is the integration of smart heating systems with environmentally friendly electricity generation systems and their integration into existing systems, such as solar home power plants (Santarelli, 2023).

5. CONCLUSION

The application of smart heating systems, such as Tado, is an example of how digital technologies can contribute to achieving the goals of the green economy. Savings achieved through geofencing, time adaptation, zone heating and open window detection clearly show that energy consumption can be significantly reduced, while at the same time increasing user comfort.

Analysis of household consumption during the winter months confirms that the integration of such systems achieves measurable and long-term cost-effective savings. When the effects of the application of these technologies are viewed on a broader scale, in the context of central and large energy systems, it is clear that smart systems have the potential to contribute to reducing overall energy consumption at the national and global levels. This confirms that digitalization and the green economy together create sustainable models that combine economic efficiency, social responsibility and environmental protection.

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