

Titlul tezei de doctorat:

Sustainability and performance of district heating systems by addressing the challenges posed by the imperative of climate neutrality

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SUMMARY

Keywords: *sustainability, innovative technologies, public-private partnership, energy efficiency, integrated system, district heating, energy policies, thermal energy, management, monitoring*

From the perspective of the sustainability of district heating systems within the context of the imperative for climate neutrality, several intervention directions subject to research in this paper can be outlined:

1. Encouraging Investments in Innovative Technologies: Proposals for fiscal incentives and financing to help develop and implement innovative technologies that enable the integration of energy sources, such as biomass heating plants, heat pumps, other renewable energy sources, and energy storage systems.
2. Creating Public-Private Partnerships: Local and regional authorities should establish partnerships with private companies or state-owned enterprises (national or European) to develop integrated district heating solutions that enhance energy efficiency, thereby reducing consumer costs, all under the imperative of climate neutrality established by European directives.
3. Promoting Energy Efficiency: Promotion programs by authorities to raise awareness of energy efficiency, continuously informing consumers about the benefits of integrated district heating systems and the efficient use of energy. By applying the VUCA matrix and the methodology of our survey, defining elements of the service emerged, which are necessary for improving the understanding of heating behaviors, the technologies used, and the levels of awareness regarding efficient heating practices. Understanding consumer preferences and behaviors related to thermal energy supply systems is important for a wide range of objectives, including optimizing thermal energy supply services, aligning thermal energy supply services with consumer needs, and supporting policy-making for centralized heating systems (SACET). Through the empirical research conducted as part of the thesis, we aimed to explore consumer preferences regarding centralized thermal energy supply compared to other heating options. As a component of the applied research, the VUCA matrix for centralized thermal energy supply systems was developed, considering that the purpose and role of using the VUCA matrix is to better steer the service in the context of challenges and changes in this sector.

4. **Adopting Coherent Energy Policies:** To encourage the transition to sustainable integrated district heating systems focused on the imperative of climate neutrality, governments should adopt and include pricing policies that reflect the true costs of energy, as well as subsidies to support innovative technologies.
5. **Developing the Necessary Infrastructure:** Investments in integrated district heating systems and in energy transport, supply, and storage systems by authorities. Development of heating/cooling/storage systems. The centralized heating system is considered a prosumer that can produce and consume electricity while also providing backup capacity (storage).
6. **Community Involvement:** Encouraging community involvement in the development and implementation of sustainable integrated district heating systems to truly align with citizen needs by establishing energy communities in well-defined areas and stimulating the role of the thermal prosumer in the energy community. The thermal prosumer: the blockchain-based source of the energy community.

Our research defined the evaluation of district heating service performance based on the following criteria: effectiveness, accessibility, quality, efficiency, process performance, best practices, and transparency. Effectiveness refers to the service's ability to meet user requirements, while accessibility evaluates the extent of network coverage and equitable user access to the service. Service quality involves ensuring a constant and reliable flow of thermal energy, and efficiency refers to the optimal use of resources to maximize benefits and minimize costs.

Process performance involves monitoring and optimizing all stages of the thermal energy supply cycle, and the adoption of best practices contributes to improving performance and efficiency. Transparency in service management and communication with users are essential for effective governance and participatory decision-making.

Assessing the environmental impact of district heating systems and identifying measures necessary to reduce emissions and promote sustainability are important aspects addressed in this research. We analyzed the development prospects of the service, considering technological trends and environmental requirements to face the challenges posed by climate neutrality promotion policies. The need for clear and hierarchically defined decision-making relationships between centralized heating regulation, national policy, and local policy is emphasized.

Proposals for improving the efficiency and performance of the district heating service include modernizing infrastructure, adopting innovative technologies, and implementing smart public policies. Additionally, addressing topics such as thermal energy recycling management through the reuse of residual energy from buildings, new business concepts for operators (equipment versus service), thermal prosumers, and energy communities, empowering users, and surveys reflect the current socio-economic dynamism in the effort to achieve climate neutrality by 2050. The general conclusions emphasize the importance of implementing research results and innovative elements in integrated district heating systems and the need to ensure an efficient, sustainable, and accessible service for all users under the conditions of climate neutrality.