The Potential for Sustainable Biomass in the Romanian Energy Sector

Activity 8: Municipal Biomass Switch Assessment

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Description of the activity: Based on a combination between city density, economic parameters and data from ANRE regarding gas grid connections, a top of 20 high potential towns for introducing modern, biomass-based heating systems will be made. Data will be collected from local city halls based on questionnaires/ interviews (TBD) on the current means of heating in town, on status of plans for gas grid expansion (and whether alternative options are taken into account) and average bills people are paying for heating (assuming availability of data) - from ABF/ INS. As a methodology, we will collect statistical data and apply questionnaires in select municipalities.

Decarbonization Imperative

The European Union, in line with global sustainability imperatives, is steadfast in its commitment to drastically curtail carbon emissions. A targeted reduction of 40% by 2030 and an even more ambitious 80% to 95% reduction by 2050, compared to 1990 levels, are at the heart of this endeavor (EEA, 2020). Achieving these objectives hinges upon a pivotal shift toward renewable energy sources, a transition critical not only for decarbonization but also for the substantial employment opportunities it creates, outpacing the fossil fuel sector by threefold (United Nations, n.d.).

Policy Context

Within the realm of renewable energy, fuel switching initiatives within existing industrial processes emerge as viable short-to mid-term actions. Such approaches necessitate limited

systemic adaptations, capitalize on knowledge transfer from other sectors, and often yield additional co-benefits (Rehfeldt, 2020). A suite of technologies, primarily rooted in biomass and electricity, has been under discussion to facilitate these transitions in energy-intensive industries (Ausfelder, 2017).

Biomass Energy: A Key Enabler

"Biomass," an encompassing term referring to all living matter on Earth, constitutes a promising avenue in this transition. Derived from plants, trees, crops, and algae, biomass energy harnesses solar energy stored in these organic materials, which can be recovered through combustion. This renewable energy source stands poised to play a pivotal role in fulfilling future energy demands.

Strategic Significance of Biomass

Biomass, serving as the sole renewable liquid transportation fuel, holds the promise of diminishing reliance on foreign oil, thereby bolstering energy security (NREL, n.d.). Projections indicate a burgeoning global biomass power generation market, anticipated to reach $50.52 billion by 2025, underscoring its economic potential (Spherical Insights, 2023). Notably, biomass utilization for biofuels and textiles occupies a substantial 13% of global cropland (Muscat et al., 2020).

Categorization and Utilization

Biomass manifests in diverse forms based on its source, properties, content, and disposal methods (Chen et al., 2015). These categories encompass agricultural residues, forest remnants, animal waste, municipal solid waste, industrial by-products, aquatic vegetation, and algae. Within municipal biomass, key classifications include municipal solid waste, municipal sewage, and urban wood biomass (Li et al., 2017).

Strategic Imperatives

A nuanced understanding of municipal biomass potential is imperative for governments to devise effective energy policies and construct pertinent treatment facilities (Speirs et al., 2015). Concurrently, a comprehensive review and analysis of challenges and motivators leading to the adoption of biomass energy are indispensable. Such insights are foundational for crafting efficient and impactful policy frameworks, essential for the EU's pursuit of its carbon emissions reduction targets.

Municipal Role in Biomass Conversion: Policy Imperatives

Municipalities assume a pivotal role in both the evaluation and execution of biomass conversion initiatives. Transitioning to biomass energy presents an opportunity for municipalities to substantially diminish their carbon footprint while concurrently realizing significant energy cost savings[1]. The cost-effectiveness of biomass energy is contingent on the type of biomass utilized and the geographical location of the biomass plant[2].

Romanian Context: Challenges and Opportunities

Within the Romanian context, despite a 32% increase in biomass consumption between 2010-2019, the nation exhibits one of the lowest biomass consumption efficiencies in Europe (0.15) (Ramanauske et al., 2023). Presently, biomass constitutes a mere 0.6% of Romania's total electricity production, primarily reliant on traditional sources like firewood used by households, with more advanced forms such as pellets adopted by a limited segment (ANRE, 2023).

While the regulatory landscape for promoting biomass in the electricity sector is relatively defined, issues persist in the heating industry due to jurisdictional overlaps among multiple

stakeholders. The coordination of strategies involving the National Energy Regulatory Authority, the Ministry of Energy, local public administration, and the government remains intricate[5]. Despite vast potential, the district heating sector faces challenges such as unfavorable market conditions, service quality concerns, and a lack of investments, leading to a decline in usage[6].

Methodological Approaches to Biomass Assessment

A critical precursor to effective biomass adoption lies in comprehensive municipal biomass potential assessments. Two methodologies—demand-driven and resource-focused—form the basis of these evaluations (Berndes et al, 2003). Factors including location, biomass quality, quantity, and available infrastructure profoundly influence biomass assessments for potential conversion. Studies emphasize the importance of proximity to biomass sources, energy policies, socio-economic factors, and public-private partnerships in successful biomass transitions (Hilma, 2020). Moreover, challenges such as corruption, resistance from utility companies, and unorganized biodiversity industry hamper biomass project development (Hilma et al, 2020). Researchers have endeavored to devise models incorporating economic, industrial, and environmental risks to facilitate informed decision-making processes regarding biomass investments (Izanloo et al. 2022).

In summary, the Romanian municipalities' strategic shift towards biomass energy demands a nuanced understanding of regulatory frameworks, proactive mitigation of challenges, and a meticulous assessment of biomass potential. These efforts, coupled with informed decision-making methodologies, are indispensable for fostering sustainable and efficient biomass conversion practices at the municipal level.

Research Methodology

Considering the complex landscape outlined in the Romanian context and the insights gleaned from extensive literature review on biomass adoption factors, our research adopted a quantitative approach. The methodology involved clustering all municipalities in Romania based on their size and subsequently selecting a representative sample from each cluster, considering economic development at the municipal level. A total of 40 municipalities were purposefully sampled for this research. These municipalities were approached through written questionnaires, incorporating a mix of multiple-choice and open-ended questions. The questionnaire, spanning 35 questions, required an estimated response time of approximately 20 minutes.

Questionnaire Overview

The questionnaire delved into multifaceted aspects, encompassing the annual expenditure budget at the municipal level, the nature of district heating services provision (delegated vs. direct), the number of customers connected to district heating, and the diverse array of fuels employed in the district heating systems. Additionally, qualitative assessments were sought, gauging the technological and economic state of the existing systems. Despite the scarcity of such data at the municipal level, inquiries extended to the number of households connected to individual gas boilers and other energy sources. This included probing into average household expenditures on heating and the existence of municipal-level policies aimed at supporting vulnerable households. The research also probed municipalities' inclinations toward expanding the gas grid or investing in alternative heating supply diversification methods. Moreover, efforts were made to comprehend the perceived hurdles at the municipal level hindering the widespread adoption of biomass-based energy.

Research Outcomes

Despite rigorous follow-ups, only seven out of the 40 municipalities responded to the questionnaire. Nevertheless, these responses provided valuable insights. The subsequent

table, derived from the statistical data analyzed, illuminates the availability of biomass sources at the municipal level.

Table 1: The availability of sources of biomass at municipal level

Administrative unit	Population	Biomass installed power in the county (MW)	Biomass used for centralized thermal energy	Exploited wood volume per county**	Production of cereals and seeds in 2018***
Bistrița	78,877.00	N/A	0%	615.4 TCM	203.171 t
Brașov	237,589.00	N/A	0%	760.1 TCM	150.898 t
Buzău	103,481.00	2.262	20%	467.2 TCM	982.891 t
Constanța	263,707.00	N/A	0%	63.4 TCM	1.825.187 t
Drobeta-Turnu Severin	79,865.00	N/A	0%	224.3 TCM	670.719 t
Galați	217,851.00	N/A	0%	57.7 TCM	883.130 t
Tulcea	65,624.00	0.527	0%	178.6 TCM	951.307 t

Source: Own research; *ANRE, 2022;**National Statistics Institute, 2022; ***Ziarul Financiar, 2019

These responses, while limited, serve as foundational data for understanding the current state of biomass availability in Romanian municipalities, shedding light on the challenges and potential opportunities in the quest for sustainable energy solutions at the local level. Further analysis of the gathered data will enable a more nuanced understanding of the feasibility and barriers to biomass adoption in these municipalities.

Research Findings: Biomass Adoption Challenges and Municipal Dynamics

The outcomes of our research shed light on the current state of biomass adoption in the surveyed municipalities, revealing both challenges and notable dynamics within the context of decentralized heating systems.

Biomass Adoption Status

Among the participating municipalities, only one, Buzău, reported utilizing biomass energy, constituting 20% of its energy mix. Remarkably, all other municipalities affirmed non-utilization of biomass energy. This lack of uptake underscores a substantial gap in biomass adoption across these regions.

Heating Service Provision and System Condition

Six out of the seven municipalities have delegated their heating services to public operators, operating under local subordination. The lone exception arises from the absence of district heating infrastructure, necessitating households to rely on private heating systems. Overall, the centralized thermal energy supply systems were largely deemed satisfactory, with only one operator facing challenges due to financial constraints.

Decentralized Household Heating

In the absence of centralized district heating, decentralized households primarily rely on natural gas via individual gas boilers, followed by wood heating. This reliance on fossil fuels highlights the need for diversified, sustainable alternatives like biomass.

Challenges Impeding Biomass Transition

Respondents cited several hurdles hindering biomass transition, including inadequate, ambiguous, and unpredictable legislation. Such legal uncertainties pose significant obstacles, further compounded by concerns regarding weak efficiency and stability in biomass systems. These challenges create barriers to the widespread adoption of biomass energy.

Affordability Assessment and Support for Citizens

When evaluating the affordability of heating bills for citizens, responses varied. Only one municipality identified a low affordability among its population, while another reported high affordability. The remaining respondents either could not assess affordability or considered it average. Similarly, opinions on the burden of heating invoices for public institutions varied, with three out of four participants rating it as average.

Support Offered to Citizens

Table 2: Support offered to citizens for their heating bill

Administrative unit	Budget	Nr of served households	Nr of households which receive support for heating	Other forms of support for vulnerable consumers
Bistrița	416,005,910	0	1300	As per law 266/2021 compensation for gas/electricity bills; support with money for wood
Brașov	N/A	5384	1418	Supplementary heating energy
Buzău	569,941,500	3900	3900	None
Constanța	1,148,864,000	28630	28630	Heating subsidy from the state budget
Drobeta-Turnu Severin	427,589,330	24920	1055	As per law 266/2021
Galați	980,106,150	5933	14081	3000 lei through council decision
Tulcea	342,264,000	7355	903	None

Source: Own research

As Table 2 shows, it is crucial to underscore the importance of support mechanisms offered to citizens for their heating bills. Such support initiatives play a pivotal role in addressing energy affordability concerns, particularly in regions facing economic challenges.

In conclusion, the research findings illuminate the complexities surrounding biomass adoption in Romanian municipalities. Legal ambiguities, coupled with challenges in legislation and system stability, underscore the need for robust policy interventions. Additionally, the reliance on fossil fuels in decentralized heating systems highlights the urgency of transitioning to sustainable alternatives like biomass. Municipalities must navigate these challenges with strategic policies, aiming to enhance legal clarity, promote efficiency, and bolster support mechanisms for citizens.

Municipal Heating Dynamics and Budget Disparities

The heating landscape in Bistrița is unique, with no households connected to the local centralized heating system. Instead, residents in the Bistrița region rely on their private heating systems, reflecting a localized approach to heating solutions.

Interestingly, the size of a municipality's budget does not always correlate with the number of households connected to the centralized heating system. A case in point is Constanța, boasting a substantial budget of nearly 1,150,000 thousand lei, serving 28,630 households. In contrast, Drobeta-Turnu Severin, with a budget of 427,589 thousand lei, serves a slightly lower number of households at 24,920. Despite its larger budget, Constanța extends heating support to an equal number of households as those connected to the centralized heating system. Conversely, Drobeta-Turnu Severin supports a significantly smaller portion, providing aid to only 1,055 households.

Galați, possessing the second-largest budget, exhibits a distinct approach by offering heating support to a number of households 2.37 times greater than the number connected to the centralized heating system. This strategy indicates a proactive stance towards mitigating heating-related challenges for a larger segment of the population.

Support for Vulnerable Populations

Five out of the seven municipalities surveyed extend additional support for heating to vulnerable populations. This inclusive approach signifies a commitment to addressing the heating needs of marginalized groups within their respective communities.

Table 3: Administrative and strategic planning capacity

Administrative unit	Is there an energy manager	Modernization / investment strategy
Bistrița	No	Develop a centralized heating/cooling strategy according to the Law no. 196/12.07.2021, i.e. to apply for non-reimbursable financing.
Brașov	Yes	Modernization of some heating points, i.e. central heating plants, rehabilitation of the transport network in the Florilor area and purchase of a heating pump, all with the help of the Municipality of Brasov
Buzău	No	Design solutions of housing plants with heat pumps and photovoltaic panels on the roof of the apartment buildings and on the roof of the thermal plant. In the insulated buildings, provide heat points equipped with heat pumps, panels and gas back-up boiler. Intending to apply for non-reimbursable financing for the modernisation of the heating service, by modernising the 5 functional heating plants with mixed solutions: heat pumps/photovoltaic panels/gas back-up boiler.
Constanța	No	Attract 50 Mil EUR from POIM AXIS 7.1
Drobeta-Turnu Severin	Yes	Intending to access non-reimbursable funds
Galați	Yes	System modernisation and energy efficiency improvement, renovation of heating points, installation of heat recovery units in chimneys
Tulcea	No	Not mentioned

Source: Own research

Table 3 underscores the importance of assessing administrative and strategic planning capacity in the context of municipal heating dynamics. Such evaluations are critical for gauging a municipality's readiness to address the complex challenges and opportunities associated with heating services.

In summary, the diverse approaches observed in the surveyed municipalities underscore the intricate nature of municipal heating dynamics. Budget disparities, strategies for supporting households, and inclusivity in assisting vulnerable populations all play a crucial role in shaping the provision of heating services at the local level. Municipalities must carefully consider their unique circumstances and resources when crafting policies and strategies to ensure equitable access to heating services for all residents.

Only three municipalities have an energy manager or a department responsible for the energy management, despite the legal obligations for all municipalities with over 50.000 inhabitants (as is the case with all respondents) to have one. Almost all respondents have a modernization strategy for the heating system, but some are in very infant stages, and three of them intend to apply for financing. In the case of Brașov municipality, the modernization will be performed with support from the local administration.

It is interesting to note, in Table 4 below, that the municipality owning the largest forestry fund does not consider biomass as an energy source. Six out of the seven municipalities wish to invest in solar energy, including Bistrița, which would have the possibility to invest in biomass, due to its access to wood supply.

Table 4: Interest in energy sources diversification

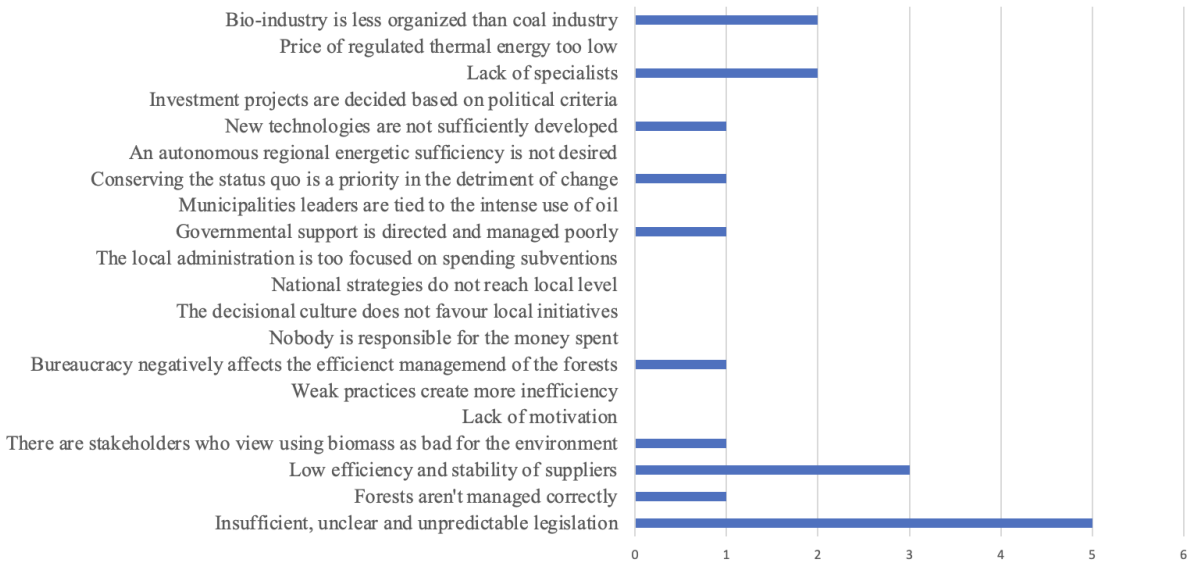
Administrative unit	Considered biomass for thermal energy	Other renewable energy sources used/ considering using?	Available nr of forest ha

Bistrița	No	Solar energy	3,134.01
Brașov	Yes	Solar energy	0
Buzău	Yes	Mix: solar and hydro power	177
Constanța	Yes	Solar energy	0
Drobeta-Turnu Severin	No	Solar energy	0
Galați	No	Solar energy	0
Tulcea	Yes	Wind energy	2.8

Source: Own research

The main challenges for adopting energy solutions based on biomass, as the Questionnare evidenced in Figure 1, according to the answers given by municipalities, is insufficient, unclear and unpredictable legislation, followed by low efficiency and stability of suppliers.

Figure 1 4: Declared challenges for biomass adoption



Source: Own research

Interpretation and Conclusions: Challenges and Missed Opportunities in Municipal Heating

The findings of this research point to a series of critical challenges and missed opportunities in the realm of municipal heating in Romania. Despite the conducive conditions for widespread biomass adoption in the country and the mounting European pressure to decarbonize, the responses indicate a surprising lack of interest and preparedness at the municipal level.

1. Lack of Municipal Engagement:

- The low response rate reveals that energy-related issues are not receiving adequate attention at the municipal level. This lack of engagement is concerning given the urgency of decarbonization efforts and the potential of biomass as an alternative energy source.

2. Absence of Energy Managers:

- Alarmingly, almost half of the respondents do not have an energy manager appointed at the municipal level, despite the legal obligation. This absence points to a lack of organizational preparedness to tackle energy-related challenges.

3. Energy Poverty and Financial Strain:

- The research highlights significant issues such as high subsidies to households, substantial energy bills for public institutions, and energy poverty among many households. The financial burden on both households and municipal budgets is substantial, underscoring the urgency for sustainable, cost-effective solutions.

4. Limited Interest in Biomass:

- Despite the availability and proximity of biomass, respondents showed limited interest in biomass as an alternative heating source. This lack of enthusiasm, coupled with the low

penetration of district heating, reflects a broader misconception about the municipal responsibility in the heating sector.

5. Inadequate Project Formulation:

- Projects aimed at addressing heating sector challenges were found to be poorly formulated, lacking maturity and precision. This lack of strategic planning suggests a need for capacity-building efforts and more focused initiatives.

Policy Recommendations:

1. **Capacity Building:** Municipalities should invest in capacity-building efforts to enhance understanding and awareness of alternative energy sources, emphasizing the benefits of biomass adoption.
2. **Legislative Clarity:** The government should provide clear, predictable legislation regarding biomass adoption. Removing ambiguities can encourage municipalities to explore biomass options.
3. **Financial Support:** Financial incentives and support mechanisms from the government can encourage municipalities to invest in renewable energy projects, including biomass-based solutions.
4. **Collaborative Initiatives:** Encouraging collaboration between municipalities, industry experts, and research institutions can foster knowledge-sharing and best practices, promoting effective solutions.
5. **Public Awareness:** Initiatives to raise public awareness about the benefits of biomass adoption should be conducted. Informed communities can exert pressure on municipalities to explore sustainable heating solutions.

In conclusion, addressing the challenges in municipal heating requires a multifaceted approach involving policy changes, capacity building, and enhanced collaboration. Only through concerted efforts at various levels can Romania harness the full potential of biomass

and other renewable sources, ensuring sustainable, affordable, and environmentally friendly heating solutions for its communities.