**Business Models for Small-scale Biomass Projects Development**

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**Abstract:** Biomass is recognized as the most promising renewable energy source in Serbia. The share of biomass in Serbian final energy consumption is over 10%, but mostly related to traditional use in stoves and ovens. One of the main obstacles for wider implementation of contemporary biomass facilities is the inexperience of consumers and stakeholders in the implementation of “innovative” business models, especially in the cases of small-scale projects. In this paper, three different business models (public utility company, energy cooperative and public-private partnership according to ESCO model) are considered for the development of small-scale biomass project in the village of Kostojevići (municipality of Bajina Bašta). Basic technical and financial characteristics of the project are presented, and all three business models are described in detail and discussed. . The possibilities of local citizens to be included in the biomass supply chain in each of the presented models are presented.

1. **Introduction**

The total technical potential of biomass was estimated in the Energy Sector Development Strategy of the Republic of Serbia to 3.448 million toe [1]. Energy balance of the Republic of Serbia for 2017 [2] shows that the share of wood fuels in final energy consumption is 11.9% or 1.04 million toe, with additional 0.008 million toe (0.09%) of biogas use. Biogas (9,506 toe) has also been used for electricity and/or heat production in autoproducers. Undoubtedly, the potential of biomass as an energy source in Serbia is recognized, but especially in the case of wood fuels, the use of this renewable energy source is based to traditional, inefficient methods of firewood use.

One of the main obstacles for the wider implementation of biomass project is inexperience in implementation of a different business model for startup, financing, and management of biomass projects. Especially for the small-scale projects that have the most significant potential in Serbia, there is no examples of good practice that could be replicated.

Into the framework of H2020 BioVill project [3] an attempt for development of small-scale biomass project in the village of Kostojevići (in the municipality of Bajina Bašta) was done. The project aim was the promotion of the concept of “bioenergy village”, that is an energy independent settlement. The village of Kostojevići was selected as the only village in Serbia with existing DH system (but fuelled by heavy fuel oil). Therefore, the experiences in Biovill project [procesna tehnika, Brisel] was used in this paper to propose three different business models (public utility company, energy cooperative and public-private partnership according to ESCO model) for development of the project in Kostojevići, but also to be used for a similar project in other Serbian settlements. In all models, the inclusion of local citizens in all phases of biomass supply and utilization chain are presented.

1. **Biomass project in Kostojevići**

The existing district heating system in Kostojevići uses heavy fuel oil for heat production to supply households and public buildings. The system has been operating since 2007 as a part of the Public Utility Company (PUC) “BB term” from Bajina Bašta. A boiler plant is located in the local schoolyard.

The biomass project is given in detail in [4 - 6] and it includes a fuel switch to biomass, i.e. wood chips. Based on an increased utilization of the existing DH grid by re-connection of former DH consumers and connection of new consumers, the installation of new biomass boilers instead of a refurbishment of the existing oil boilers is planned.

The total annual space heat demand was assumed to be around 8,842 MWh/a. The total connected consumer peak load is 1.4 MW. For the existing DH grid with a trench length of 2,900 m, losses of 25% of heat produced were assumed after reconnection. Considering the assumed grid losses and the simultaneity factor (60% of load is required at one time), the district heating plant needs to supply a peak load of approximately 1,120 kW at the boiler fringes. The capacity of the two new biomass boilers is planned with 500 kW and 200 kW(due to load management and cost optimization reasons), whereas the capacity of one of the two existing heavy fuel oil boilers accounts for further 750 kW (for peak load and back-up purposes). The latter boiler, due to sizing of the biomass boilers, will cover less than 10% of the total annual heat supply of the DH grid.

The total investment sum for the new biomass DH plants adds up to 280,000 EUR (excl. VAT). The new biomass DH system amortizes dynamically within 10.5 years. The internal rate of return of the biomass DH system reaches 8.66%, and the net present value is 56,000 EUR.

It was shown in [4] that a new biomass DH system is economically advantageous compared to a refurbishment of the existing fossil-fueled DH system. In addition, the new biomass DH system, compared to the refurbished fossil-fueled DH system, avoids the thermal utilization of 2.65 GWh/a of heavy fuel oil and the emission of 798 t/a of CO2 (equivalent).

1. **Business Models for Development of Biomass Project in Kostojevići**

**Centralized model**

The centralized model represents the continuation of the existing practice, i.e. the financing of costs of heating in public buildings in Kostojevići from the budget of the City of Bajina Bašta. This model also means that the investment in the proposed solution and its operation costs would be financed from the city budget, and that the city administration would be responsible for the organization and management of plant operation. In addition, City of Bajina Bašta could apply for subsidy from the Public Investment Management Office of the Government of the Republic of Serbia within this model. This is certainly not an innovative solution, but it would have to be considered as a common practice in Serbia ("business as usual") during the selection a business model.

In the case of replacement of existing boiler in local school by woodchips boilers, technical staff of PUC “BB Term” would be in charge for operating and maintaining the new boilers.

In this model, the local population has the opportunity to participate, as a tenderer, in the process of public procurement of wood chips for utilization in boilers and/or cogeneration plants (depending on the selected solution). Certainly, local households, individually or jointly in a cooperative or other legal entity, should not have preferential treatment in the public procurement procedure. However, it is well known that transport costs have significant share in the price of biomass, and from that point of view, local biomass producers would be in a better position.

**Energy cooperative model**

Cooperative is a legal entity that represents a special form of organization, which by functioning based on cooperative principles, achieves its economic, social, cultural and other interests. In the concrete case, this model means association of Kostojevići’s citizens in energy cooperative. Energy cooperative could be an initiator, investor and project implementer, as well as biomass supplier and biomass plant operator. The scheme of functioning of this business model is shown in Figure 1. This concept is widely implemented in some of the most developed European countries [7].



Figure 1: Operating model for citizen cooperative [8]

Energy cooperative model is primarily interesting for development of district heating system in Kostojevići. Energy cooperative as legal entity would provide financial resource for boiler installation. Resources would be provided from cooperative fund. Cooperative would organize biomass collecting and woodchips production. Cooperative members and other forest owners in Kostojevići and surrounding settlements will provide biomass. In addition, cooperative would organize distribution and selling of heat.

Cooperative model is optimal framework for determination ideal ratio between fuel (wooden chips) price and heat price, and in that way for adjustment the profitability of whole system operation. This is the consequence of the fact that cooperative members are in the same time fuel sellers and heat consumers, but they are also stakeholders in cooperative fund.

The drawback of this concept is that cooperatives, as a rule, do not have enough experience and necessary knowledge for implementing this type of projects, which include the development of a complex techno-economic analysis, provision of funds, procurement of equipment, construction of facilities, organization of supply chains, financial monitoring and plant management. One of the solutions is that energy cooperative engages company to manage project in its name on behalf of cooperative – from design and construction of facility to operation period. However, for such solution, the cost-effectiveness parameters of the project should be somewhat more favorable.

**Public private partnership model - ESCO model**

In the cases when the local self-government unit recognizes the environmental significance, as well as the economic and social potential of the biomass project in some of the local communities, but lacks sufficient financial, technical and human capacities to implement such a project, local self-government unit could implement the procurement procedure to get private partner (ESCO company) for project implementation. Thereafter, the local self-government unit concludes a public-private partnership contract for project implementation with selected ESCO company. The selected ESCO company then implements a project under agreed and time-limited conditions for which it receives financial compensation, which is usually paid in equal instalments during the contract term. ESCO companies can launch the initiative by its own and contact the municipality or local community to promote the project and convince local decision makers that this is the best way of project implementation. After the expiry of the contract, it can be renewed, or the entire facility is transferred to public ownership, and the local self-government unit appoints a new plant manager. The main advantage of this approach is that ESCO companies are specialized in this type of projects, they know the market, have the knowledge and experience in drafting feasibility studies, have access to funding sources and know the organization of supply chains. On the other hand, the ESCO concept implies that a full financial benefit for the public sector and the local community comes only after the expiry of the initial contract period. The scheme of functioning of ESCO business model is shown in Figure 2.



Figure 2: ESCO model [8]

From the point of ESCO model implementation, the project of replacement of existing boiler in local school by woodchips boiler has all desirable characteristics. Current energy consumption is too high and significant reduction is possible by implementation of energy efficiency measures. Fuel shift, from coal to woodchips, would additionally reduce fuel costs. All investment costs (energy efficiency measures, replacement of boiler, reconstruction of boiler house, etc.) are the responsibility of ESCO company. City of Bajina Bašta would be obliged to pay unvarying reimbursement to ESCO company for heating school.

Organization of biomass supply chain is the responsibility of ESCO company. Common practice is that ESCO company make long-term contract for biomass supply with local biomass (woodchips) producers. Another option for involvement of local community in this business model is that some local company or companies are responsible for heating system installation and maintenance.

**Conclusion**

The existing district heating system in Kostojevići uses heavy fuel oil for heat production to supply households and public buildings. Based on an increased utilization of the existing DH grid by re-connection of former DH consumers and connection of new consumers, the installation of new biomass boilers instead of a refurbishment of the existing oil boilers is planned. The significant potential for sustainable biomass utilization in Kostojevići exists. Existing school boiler is currently the largest single source of pollution in the village. If existing, dilapidated boiler would be replaced by modern woodchips boilers, state of environment during the winter period would be significantly better.

Three different business models for investments in the replacement of heat source has been investigated. The most conservative model is a continuation of current practice – financing from the municipality budget and managing of the plant by the local public utility company. This business model is not very attractive for the motivation of local people to connect or reconnect to the DH network. The price of distributed heat is determined by PUC, and biomass supply from local sources is not guaranteed.

For the realization of this project it is possible to get a subsidy from the Public Investment Management Office of the Government of the Republic of Serbia, the sustainability of the project after the investment period is questionable. The main reason is relatively small number of consumers in especially for the because

Regards to significant savings in operation costs due to investments in energy efficiency measures and replacement of heat source, this project is optimal for implementation of public private partnership - implementation of ESCO business model. In addition, for realization of this project it is possible to get a subsidy from the Public Investment Management Office of the Government of the Republic of Serbia. Relatively small additional investment in installation of PV panels on school, kindergarten and health center buildings provides their full energy independence. Bearing in mind that these buildings belong to educational and health institutions, and that almost all citizens of Ušće use their services, introduction of “energy independency” concept in the most important facilities in the settlement, besides financial savings and clear environment, has significant informative and educational effect regards to promotion of energy efficiency measures and renewable energy use.

However, for obtaining energy independent settlement of Ušće, more ambitious project of introduction of district heating system must be realized. District heating system would include all public buildings, all multi storey buildings for collective housing, and potentially it could include single-family houses. Realization of this project requires a high level of interest of the inhabitants of Ušće. They must invest in necessary inner HVAC installation (optimal solution would be implementation of energy efficiency measures in buildings’ envelopes in the same time) and they must pay for heat provided by centralized supply system. Therefore, energy cooperative business model is more appropriate for this case. Cooperative model assumes association of citizens in energy cooperative that would be initiator, investor and project realizer. In addition, energy cooperative would be biomass supplier and district heating system operator. Cooperative model is optimal framework for determination ideal ratio between fuel and heat prices, and adjustment of system profitability, because cooperative members are in the same time fuel sellers and heat energy consumers, and they also expect revenue due to share in cooperative fund.

Concept of energy independent settlement based to biomass use means using of locally available biomass (with or without the other renewables) for fulfillment of local demands primarily in heat and, if it is possible, in some extent, in electricity. The very active involvement of local people in organization and management of complete process of concept design and concept implementation is the common characteristic of all successful cases. However, the unique solution for involving of locals in the process does not exist.

Considering the proposed solution for more intensive biomass use in Ušće, it is noticed that each of proposed technical solutions has some specifics that define the business model for implementation and involvement of local community. Therefore, few different business models will be analyzed, as well as the ability of their implementation for each of proposed technical solution, with a special emphasis to ability of local community and citizens to be involved in biomass supply chain.

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