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ScienceDirect

Energy Procedia 72 (2015) 163 – 169

Energy Procedia

International Scientific Conference "Environmental and Climate Technologies – CONECT 2014"

SWOT analysis approach for advancement of waste-to-energy cluster in Latvia

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Abstract

It is important to improve the communication and collaboration of waste-to-energy stakeholders in Latvia to ensure sustainable economic and environmental development and promote innovation and local technology development. Therefore, implementation of a waste-to-energy cluster in Latvia has been proposed. The aim of this paper is to provide a comparative analysis of the organizational structure and SWOT analysis of five existing and one potential waste-to-energy cluster and develop suggestions for improved organization of the developing Latvian cluster. The analytical part includes SWOT analysis of the proposed Latvian waste-to-energy cluster and a comparison of its results with five SWOT analyses for existing European waste-to-energy clusters involved in the project COOLSWEEP.

Peer-review under responsibility of Riga Technical University, Institute of Energy Systems and Environment

Keywords: waste-to-energy; cluster development; SWOT analysis; Latvia

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Peer-review under responsibility of Riga Technical University, Institute of Energy Systems and Environment
doi:10.1016/j.egypro.2015.06.023

1. Introduction

Sustainable and interconnected development of energy and waste management sectors is significant to ensure global resilience to climate change. According to Moora et al. [1], due to the biodegradable part of municipal solid waste its use in energy production can contribute to achieving EU 20-20-20 energy goals, including the increase of renewable energy use and the reduction of CO_2 emissions. Energy and waste management industries are nationally significant in Latvia regarding energy independence and providing sustainable waste management and environmental management practices. Increased interconnectedness and collaboration between stakeholders in the waste-to-energy sector in Latvia is important for sustainable economic and environmental development. Improved communication can also encourage innovation and local technology development [2, 3].

To encourage these improvements the implementation of waste-to-energy cluster in Latvia has been proposed. Industrial clusters are collaboration networks between companies which are related to a similar industrial field or a similar value chain. Industrial clusters aim to improve skill and knowledge transfer between the cluster stakeholders, to promote innovation and smart specialization [4]. The importance of development of industrial clusters in Latvia has been recognized at the national level [5] and considered beneficial for transformation from current low-technology production to high-technology based industry.

Kulakova [6] performed a survey of Latvian cluster participants and identified that export and competitiveness increase as the most relevant aspects for current cluster emergence. The general driving forces of Latvian waste-to-energy sector have been investigated through technology-push and demand-pull perspective [4]. The analysis revealed that application of RDF and agricultural wastes for energy recovery purposes in Latvia is increasing; in addition, capital and technology availability, governmental regulations and available subsidies were identified as the most important driving forces of Latvian waste-to-energy sector so far.

On a global scale, strong clean technology and waste-to-energy industrial clusters have been developed, e.g., Copenhagen Cleantech Cluster in Denmark, Lombardy Energy Cluster in Italy, Oslo Renewable Energy and Environment Cluster in Norway, ECO WORLD STYRIA in Austria and Aclima in Spain. The mentioned clusters are also collaborating on a global scale to promote internationalization of their knowledge and abilities through the implementation of a FP7 project COOLSWEEP [7]. The COOLSWEEP project facilitates international collaboration between existing clusters and a developing waste-to-energy cluster in Latvia by providing mentoring, sharing experiences and best practice on cluster creation.

To elaborate the previous research, we identified the strengths, weaknesses, opportunities and threats (SWOT) of the potential waste-to-energy cluster in Latvia. Additionally, the comparison of SWOT analysis for waste-to-energy clusters involved in the project COOLSWEEP and the potential Latvian cluster would provide an understanding of the principal challenges and the future directions for implementation of Latvian cluster.

The aim of this paper is to provide a comparative analysis of the organizational structure and SWOT analysis of five existing and one potential waste-to-energy cluster and develop suggestions for improved organization of the developing Latvian cluster. To reach the aim of the study, the paper is organized as follows: first, the applied methodology is introduced, then the analysis results are presented, finally, the overall conclusions and discussion are introduced.

2. Methodology

The analytical part of this study includes the SWOT analysis of the proposed Latvian waste-to-energy cluster and its comparison with five SWOT analyses that have been developed within the project COOLSWEEP for existing European waste-to-energy clusters involved in this project. The SWOT's of five European clusters are analysed in detail to determine the specific challenges the planned cluster could face during further development. Particularly, the collaboration among industry, research and public institutions is examined to determine the preferential approach for the planning and organization of an effective Latvian waste-to-energy cluster.

The cluster organizational structure is analysed based on information about companies involved in the European clusters provided by the project COOLSWEEP. The considered partners for the proposed Latvian cluster are

stakeholders that expressed willingness to participate in a cluster during a seminar-type face-to-face meeting, during which the SWOT were also considered. The companies involved in each cluster are divided in six categories: engineering companies, local multi-utility companies, companies manufacturing other than waste to energy, R&D institutes and universities, waste management companies, companies manufacturing in the waste-to-energy field. The conversion technologies considered as corresponding to waste-to-energy sector within this study are: incineration, pyrolysis/gasification, co-incineration of refuse derived fuel, biogas production from wastes.

The applied framework includes SWOT analysis – a situation analysis for explaining the internal (strengths, weaknesses) and external (opportunities, threats) factors of business development and building a management strategy [8]. SWOT analysis is valuable for the evaluation of management procedures in companies, projects and plans [9].Though SWOT analysis emerged in the field of economic analysis, it has been extended to various research directions and increasingly applied in the context of environmental research. Nikolaou and Evangelinos [10] use SWOT analysis to develop policy recommendations to industry for adopting environmental management practices. In the waste-to-energy sector, Samolada and Zabaniotou [9] applied SWOT analysis for the comparison of two different applications of refuse derived fuel (RDF). Antonopoulos et al. [11] use SWOT analysis to evaluate application of new waste-to-energy technology. SWOT analysis has been applied for strategic evaluation of the whole industries as well. Lu and Lu [12] used SWOT analysis to evaluate the potential of green energy industry development in Taipei. Regarding the application to entire networks of companies, Zhao et al. [13] performed a qualitative SWOT analysis of an industrial cluster of the Dalian Software Park in China. They determined the strategic position of the industrial cluster and indicated approaches for strengthening its competitiveness. The widespread use and applications of SWOT analysis indicate its usefulness and clarity for identification of system improvements.

3. Results

The results of European cluster SWOT analyses confirm that the diversity of involved companies is one of the most important aspects for creating strong waste-to-energy clusters. Figure 1 presents the company distribution by specialization for the considered European waste-to-energy clusters and the proposed Latvian cluster. The total number of companies involved in each cluster varies in a wide range (from 15 partners in Latvia to 143 partners in Lombardy Energy cluster in Italy). Similarly, the share of each type of companies varies between the different clusters.

The share of research and development institutions and universities within the considered European clusters varies from 1–13 %. The highest absolute number is 7 research institutions per cluster, which is observed in Oslo Renewable Energy and Environment Cluster. Generally, universities and research institutions in European clusters are perceived as important elements in the overall waste-to-energy value chain due to their capabilities in technology development, demonstration and provision of waste-to-energy specialists. Nevertheless, clusters with both modest and large shares of research and development institutions are concerned with the lack of interest from university graduates for both working in the waste-to-energy field and for working on waste-to-energy research. Clusters that indicate good collaboration with research and development, stress that among the important weaknesses in this collaboration are the lack of interdisciplinary approach in universities and research centres as well as the difficulty to get products and solutions from research to market.

The major stakeholders driving the acknowledged European clusters are waste-to-energy operators and technology providers (see Fig. 2). In Latvian case the technology providers and operators are not dominant. We further investigate the background of waste-to-energy operators and technology providers in other clusters to define how dominance is caused and how it impacts cluster cooperation.

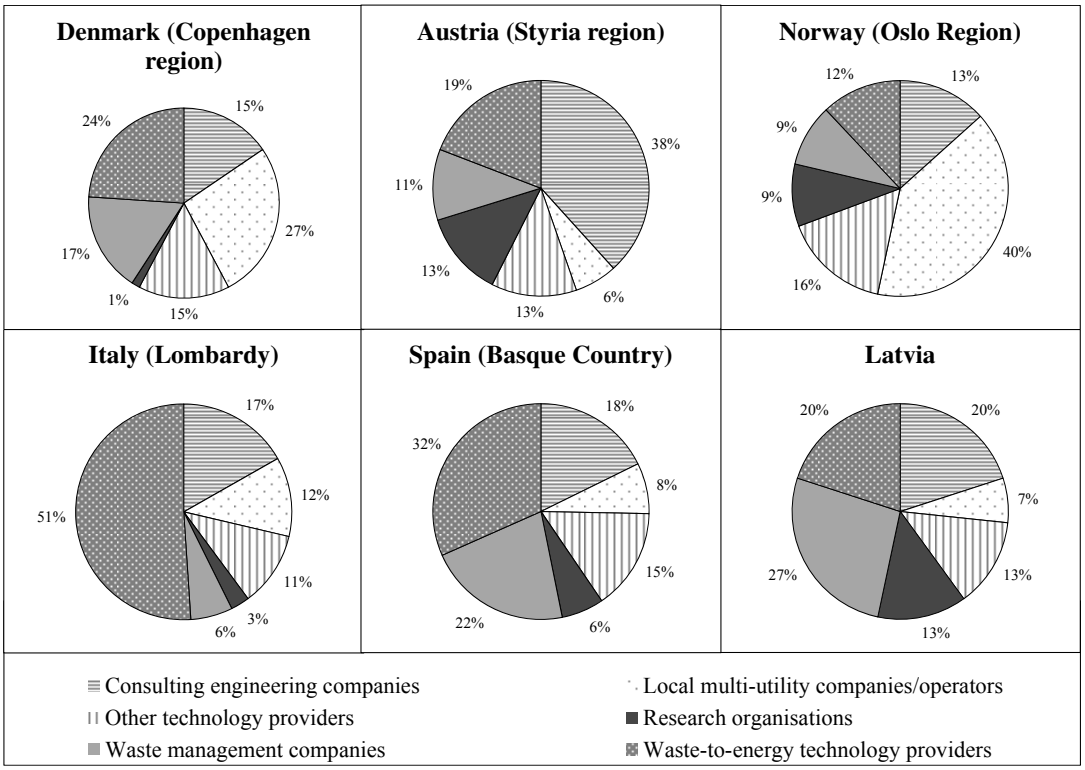

Fig. 1. Specialization of companies divided by region

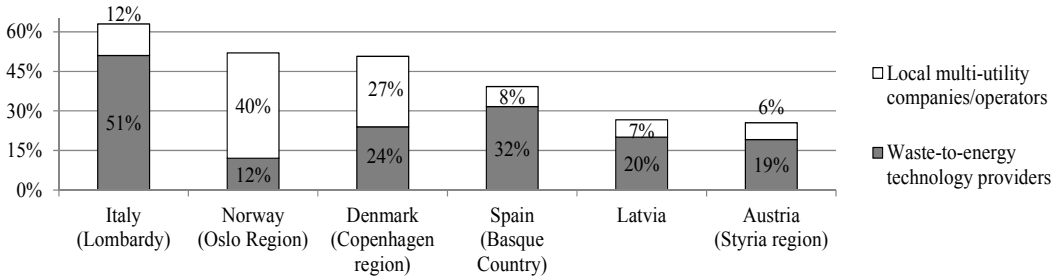

Fig. 2. Share of waste-to-energy technology providers and operators from total cluster participants

The largest share of technology providers and operators appears in the Lombardy energy cluster, particularly due to the important role of incineration plants within the waste-to-energy sector in Lombardy region. In the Oslo region cluster, multi-utility companies and waste-to-energy operators are predominant. They are generally concerned with waste collection, pre-treatment and operating incineration plants. In Denmark the overall situation is similar, but there is a more equal proportion between technology providers and operators; the focus is on incineration and co-incineration technologies as well as management of waste-to-energy by-products. The Basque region cluster is also dominated by technology providers and operators that are focused on incineration and waste collection and sorting. In Italy, Norway, Denmark and Spain clusters the other technologies (incl. pyrolysis, RDF production, biofuel production and biogas) are less advanced. The Eco World Styria cluster in Austria has a similar proportion of waste-

to-energy operators and technology providers as the developing Latvian cluster. The focus of Styrian waste-to-energy companies is on biogas, biomass thermal technologies, waste collection and production of RDF. The cluster is dominated by consultative engineering companies; therefore the focus of the cluster is on the development of new integrated solutions for waste-to-energy.

A summary of the developed SWOT analysis for the potential Latvian waste-to-energy cluster is presented in Table 1. We then compare it with the SWOT analysis for European clusters (see Table 2) to determine future challenges and development directions.

Almost all clusters identify a lack of cooperation between waste-to-energy stakeholders as an important weakness. In some of the existing clusters, the lack of communication between technology providers and research organizations is specifically underlined. Drawing on this experience, the evaluation of inter-firm connectedness should be introduced as an indicator for monitoring the development of the Latvian cluster.

In comparison to other European countries, the Latvian waste-to-energy sector is not as developed yet. The advancement of waste incineration and co-incineration plants is lower than in other countries studied. Overall, the applied waste management regulation is in accordance with Waste Framework Directive 2008/98/EC (i.e. reduction of the amount of disposed waste according to the hierarchal approach implementing higher reusing, recycling and energy recovery from waste). Nevertheless the stakeholders of the potential Latvian cluster who participated in the seminar indicated shortcomings in the application of the policy framework. To overcome this weakness and sequential threats, both industry and public stakeholders should be engaged in the development of those national definitions and policies for the waste-to-energy sector which are lacking.

Table 1.Summary SWOT analysis of potential waste-to-energy cluster in Latvia

	Strengths	Weakness
Internal factors	Possibility of direct stakeholder communication due to close geographic location. Stakeholders are responsive to innovation. High research capacity and flexibility. Globally recognized research institutions. Company stakeholders see technical colleges and universities as a source of specialists. New waste preparation and pre-treatment technologies have been installed. There are 53 agricultural biogas and landfill gas stations, large RDF consumer (cement factory). Local efforts on pyrolysis and gasification emerge. Government supports waste recycling and regeneration, including, RDF production and use for waste-to-energy.	Lack of collaboration among waste to energy stakeholders. Lack of integrated waste-to-energy value chain. Low experience in internationalization. Lack of specialized waste-to-energy education and knowledge integration between the two spheres. Research institutions and private companies are unwilling to cooperate due to varying aims. Underdeveloped local pyrolysis and gasification technologies. RDF quality improvements are needed, lack of local RDF consumers. Waste source sorting system is underdeveloped. Low local waste-to-energy technology development. Public awareness concerning biogas plant development (due to odours) and waste incineration plants.
	Opportunities	Threats
External factors	Stakeholders are interested in developing RDF value chain. Potential market for RDF and technological benefits in comparison with traditional technologies. High research capacity, especially due to increased EU funding for laboratories. National waste management policy was recently revised and improved. Government support for waste reduction and management. International funding is available. Local municipalities are interested to be the consumers of waste-to-energy outputs. Industry is in ongoing search for low-cost qualitative energy sources.	Ash reuse applications are underdeveloped. Companies lack reliable information about technologies. Lack of national strategy or incentives for development of new technologies. Lack of sectorial policies. Lack of legislative clarity (ash utilization, waste definitions, secondary wood separation from the total waste stream). Lack of company co-financing possibilities and company restraint to fund research activities. Local municipalities are not willing to install their own waste-to-energy plants. Communication problems and trust issues between companies, government, research institutions.

Table 2. Summary SWOT analysis of European waste-to-energy clusters [7]

	Strengths	Weakness
Internal factors	Development of waste-to-energy plants and recycling go hand in hand to divert waste from landfilling. Strong specialization in incineration and co-incineration technologies. High calorific value of waste allows achieving high combustion and results in higher energy efficiency. Industry know-how, ability to produce cutting-edge machinery already exported all over the world. Good presence of consulting engineering companies. Good internationalization experience of big companies.	Companies complain of shortage of waste for incineration and co – incineration capacity. In Oslo region, waste is imported from abroad. Anaerobic digestion of biowaste and biofuel is still emerging and the market is underdeveloped. Due to limited market size in each country, most cluster companies seek support for internationalization and market opportunities abroad. Over consolidated use of only trusted local suppliers.
	Opportunities	**Threats**
External factors	Good investments in research in waste-to-energy. Public authorities play an important role through regulative initiatives, taxes and subsidies. All analysed areas have landfill bans. Good implementation of EU legislation at national level and good presence of unified European environmental laws and technical standards. Waste management and separate collection is generally a good tradition among people in the areas considered by the report. Opening of the market could develop new intra-European trade and business opportunities. Incinerators are quite accepted by the public in Denmark and Norway.	Current lack of stable policy framework and elaborate national strategy on waste treatment in Italy and Spain. Need more investment on RDT. Waste management and treatment infrastructure is dependent on people sorting their waste. It takes time to change people's habits. There is a "not in my backyard" (NIMBY) philosophy regarding waste management mainly in Italy and Spain. People do not want to have waste management facilities (including biogas plants, incinerators) next to their living area.

4. Conclusions

The analysis of the organizational structure and SWOT of existing European waste-to-energy clusters provides suggestions for the development of the potential Latvian cluster. These suggestions will be used during development of the Cluster Action Plan for the Latvian waste-to-energy cluster.

Four out of five considered European clusters are dominated by technology providers and operators, most of which are related to incineration and co-incineration technologies. The cluster in Austria is dominated by consultative engineering companies and focuses on development of integrated solutions for waste-to-energy. Though different in structure, each cluster can prevail if effective communication is ensured between actors. Based on the analysed European experience, the organization of the potential Latvian cluster should ensure that industrial partners are supported by capable and collaboration-oriented research institutions. Moreover, genuine (not formal) communication and collaboration between stakeholders is required to promote innovation and interdisciplinary capabilities of research institutions. This would in turn, promote industry and research spin-offs as important drivers for new locally developed waste-to-energy technologies and applications. The implementation of inter-firm connectedness indicators would aid monitoring of the development of Latvian cluster.

SWOT analysis of the Norwegian waste-to-energy cluster indicates that university graduates are not interested to work in waste-to-energy field and on waste-to-energy research. Initiatives to avoid such situation should be implemented in Latvia, e.g., internships for students could be provided to increase their understanding and practical knowledge of waste-to-energy applications.

In comparison with the situation in the studied European regions, the Latvian waste-to-energy sector is smaller and the cluster involves fewer companies, therefore it is important to balance the interests of competitors. The most important future challenge in the Latvian case would be to ensure a balance between cluster and individual company needs.

To strengthen the "triple helix" nature of the cluster, the communication between institution and industrial partners must be improved. This would also aid improving the application on national waste-to-energy policy framework. The cluster should have a central role in aiding groups of stakeholders to acquire research and development funding that is not easily accessible or implementable to each entity on its own. As well, the cluster should help stakeholders to develop collective product and service packages that can be exported, thus aiding internationalization of cluster activities.

Acknowledgements

The work was supported by European Union 7th Framework Programme project 'Coordinating and Leveraging regional knowledge for initiating a Sustainable and optimised EU Waste to Energy Programme (COOLSWEEP)' Grant agreement no: 319893.

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