# WASTE-TO-ENERGY IN A POLISH PERSPECTIVE.

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## ABSTRACT

Energy recovery from waste becomes increasingly interesting both with respect to waste management and for the sustainable energy supply. The REMOWE (Regional Mobilizing of Sustainable Waste-to-Energy Production) project, seeks to facilitate the implementation of sustainable systems for waste-to-energy in the project regions. Based on investigations done within the REMOWE project this paper discusses increased waste-to-energy utilization in Poland with focus on a comparison with the current state in Sweden. There are big differences between Sweden and Poland, and between Lower Silesia Voivodship in Poland and Västmanland County in Sweden. The REMOWE project through its outputs and discussions during meetings support transfer of technology, knowledge and best practice. Procedural justice and early involvement of public can increase social acceptance and successful implementation of projects regarding incineration, biogas production and separate collection of biodegradable waste.

**Keywords:** waste-to-energy, REMOWE, social acceptance

## NONMENCLATURE

*Abbreviation*

| | |
|---|---|
| MBT | mechanical biological treatment |
| MSW | municipal solid waste |
| RES | renewable energy sources |
| RDF | refuse derived fuel |

## 1. INTRODUCTION

There is a growing interest in the waste-to-energy field, both with respect to waste management and the energy systems. The decisions on alternative uses of waste for energy are mainly influenced by different policies, waste management, energy supply and use, as well as technologies. The REMOWE (Regional Mobilizing of Sustainable Waste-to-Energy Production) project seeks to facilitate the implementation of sustainable systems for waste-to-energy in the project partner regions and in the Baltic Sea region. The project partnership consists of the Mälardalen University, with the School of Sustainable Development of Society and Technology coordinating the project, and The County Administrative Board of Västmanland in Sweden, Savonia University of Applied Sciences, Centre for Economic Development, Transport and the Environment for North Savo, and University of Eastern Finland (UEF) in Finland, Marshal Office of Lower Silesia in Poland, Ostfalia University of Applied Sciences, Fachhochschule Braunschweig / Wolfenbüttel in Germany, Klaipeda University in Lithuania, and Estonian Regional and Local Development Agency (ERKAS) in Estonia. The project activities are divided into 5 work packages. Work Package 1 concerns project management and Work Package 2 contains the project communication and information activities. In Work Package 3 the current status of the partner regions are explored, in Work Package 4 the possible future status is investigated and in Work Package 5 modelling of a sustainable regional waste-to-energy production will be studied.

The main purpose of this paper is to discuss increased waste-to-energy utilization in Poland with focus on a comparison with the situation in Sweden and based on investigations conducted in the REMOWE project.

### 1.1 Methodology

The study is based on an analysis of research publications, country, regional and municipality policy and strategy documents and statistics. The work has been done within the project REMOWE, Regional Mobilising of Sustainable Waste-to-Energy Production.

### 1.2 Waste to energy pathways

Waste is a heterogeneous energy source and different types of waste can be converted to different energy products in different conversion processes. Figure 1 shows an overview of possible pathways for waste-to-energy conversion. In biological processes microorganisms are used to convert a feedstock to energy rich products such as biogas and ethanol. Thermal processes like combustion, pyrolysis and gasification can convert the energy in waste to heat, electricity and gas. Municipal solid waste can be pre-treated prior to the thermal treatment. The high caloric fraction produced by pre-treatment is called Refuse Derived Fuel (RDF). RDF is produced from the fraction of the solid waste containing plastics, paper, wood, textiles and rubber. [1]

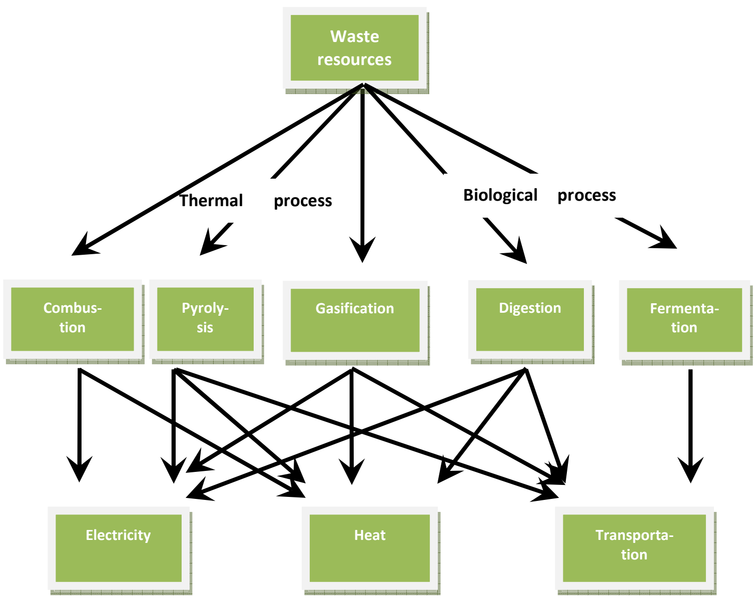


*Fig. 1 Waste to energy conversion pathways [1]*

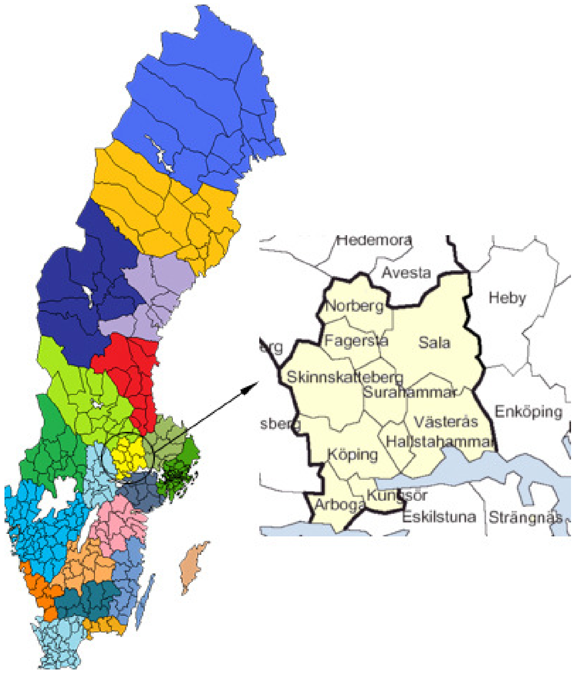


*Fig 2. The County of Västmanland. The figure on the left shows location of the county. The figure on the right shows the county and its 10 municipalities.*

## 2. BACKGROUND INFORMATION

### 2.1 Sweden and the County of Västmanland

The Swedish public sector has three levels of government: national, regional and local. At the local level, the entire territory of Sweden is divided into 290 municipalities, each with an elected assembly or council. The municipalities are organized in 21 counties. In a county there is the County Administration Board and the County Council which have different responsibilities. In addition, there is the European level which has acquired increasing importance following Sweden's entry into the European Union in 1995.

The County of Västmanland is a part of the Stockholm-Mälar region (Fig. 2) and is situated west of the capital Stockholm. 2.9 million people live in this region, about one third of the total population in Sweden. The county has about 250 000 inhabitants, which is about 3% of the total population in Sweden. The total area is 5 691 km$^2$ (1.3% of the total area in Sweden) with 5 145 km$^2$ of land, which means 48 inhabitants per km$^2$. This is significantly higher than the average population density in Sweden of 21.9 inhabitants per km$^2$. According to the prognoses for population growth made by the Administrative County Board, the population in 2030 will be between 257 000 and 283 000. Large parts of the land area are covered with forests (73%) and agricultural land (19%). [2]

### 2.2 Poland and Lower Silesia

Lower Silesia is a region (voivodship) located in the south-western part of Poland and geographically includes Lower Silesia and a part of Lusatia. The surface of Lower Silesia amounts to 19 947 km$^2$ (6.4% of the total area in Poland). Wrocław is the capital of the region, located at a similar distance from the capital of Poland and the capitals of neighbouring European countries (from Warsaw and Berlin, the distance is about 350 km, while the distance to Prague is only about 300 km).

The public administration in Poland encompasses government, local governments and state administration. The governmental administration units hold the control functions over the activities of local governments as well as representative functions. The local government encompasses three levels: municipality (gmina), county (powiat) and region (voivodship). Organs of each local administration unit fulfil public tasks within the area of their competence. Poland is divided into 16 voivodships, 379 powiats and 2 478 gminas. The administrative structure of Lower Silesia, shown in Figure 3, consists of 29 powiats and 169 gminas, including 36 urban ones, 55 urban-rural ones and 78 rural ones. [3]

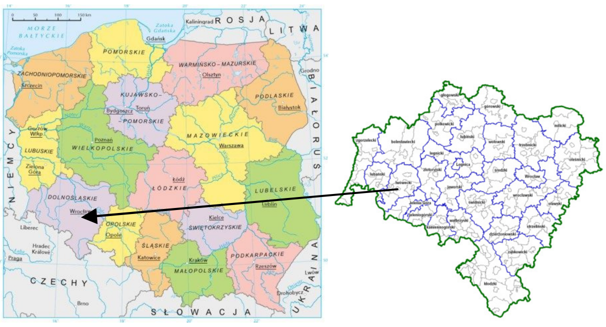


*Fig. 3 Lower Silesia. The figure on the left shows location of the voivodship. The figure on the right shows the voivodship and its 29 powiats.*

## 3. WASTE-TO-ENERGY RELATED POLICIES AND GOALS

Table 1 presents an overview of waste-to-energy related policies and goals at EU, national and regional levels in Poland and Sweden. In the following the main waste-to-energy policies and goals for Poland, identified in the report "Current status of the waste-to-energy chain in Lower Silesia, Poland" [3] will be briefly introduced.

**Polish energy policy until 2030** adopted by the Council of Ministers on the 20 November 2009 is a strategic document of the energy sector. One of the six main directions of development of the Polish energy sector is to develop the use of renewable energy sources (RES), including biofuels. The main objectives of the development of RES are: i) to increase of the share of RES in final energy consumption to the level of minimum 15% by 2020 and further increase in subsequent years, ii) to achieve by 2020 a 10% share of biofuels in transport fuel market, including the increased use of second generation biofuels and increasing the diversifying of energy supply and creating optimal conditions for the development of distributed energy based on locally available raw materials. An important support element for the implementation of energy policies are adopted at the voivodship, powiat and municipality levels development strategies of energy supply. They should ensure maximal use of local capacities of renewable energy to produce electricity, heat and cool especially in cogeneration, as well as for the production of liquid biofuels and biogas.

Element of the Polish Energy Policy until 2030 is a **Programme of enforcement of activities for 2009-2012**. It includes, among others, specific measures for biogas plants development and energy recovery of the biodegradable fraction of waste.

**Renewable energy development strategy** was adopted by the parliament in 2001. It appoints biomass and hydropower as the primary RES. The objective to increase the share of renewable energy from 2.5% in 2000 to 7.5% and 14%, respectively by 2010 and 2020, was stated. The strategy identified legal, financial, informational, educational and other barriers hindering the development of RES.

**Directions for agricultural biogas plants development in Poland in 2010-2020** were adopted by the Council of Ministers on 13 July 2010. It is assumed that by 2020 on average one agricultural biogas plant will be built in each municipality, using biomass from agricultural sources, assuming the right conditions for the mobilisation of these systems in the municipalities. The theoretical potential of raw materials from Polish agriculture is estimated to be able to provide app. 5 million $m^3$ of biogas per year. This potential includes the use of agricultural by-products, liquid and solid manure and by-products and residues of agro-food industry. The cultivation of crop plants, including the so-called energy plants, is also assumed (in parallel with usage of the waste-based substrates), to be used as a substrate for biogas plants. In the long-term, cultivation of crop plants is possible on the area of approximately 700 thousand ha, which would cover domestic consumption needs and raise additional resources for the production of biofuels and agricultural biogas. Realistically available substrate for biogas production is estimated to provide app. 1.7 million $m^3$ per year of biogas, which represents about 10% of the domestic demand for gas. Burning of this biogas in cogeneration can provide about 125 thousand MWh of electricity and about 200 thousand MWh of thermal energy.

**Forecast pursuant to Article 4(3) of Directive 2009/28/EC of 23 April 2009 of the European Parliament and of the Council on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC** adopted by the Minister Of Economic Affairs in 2010 concludes that Poland would receive in 2020 a surplus of energy from renewable sources above the level indicated in the periodic trajectories (in accordance with Part B of Annex I to Directive 2009/28/EC) of almost 0.5%. In all the years of 2011-2020 there will be a surplus of energy from renewable sources, and the largest surplus values are provided for the years 2014, 2016 and 2018, each time by more than 1.6%. Forecasted values are based on the data currently available and may be subject to possible revision and updating of the reports under Directive 2009/28/EC. Poland is not expected until 2020 to use renewable energy from outside the country to meet obligations regarding the share of RES in final energy consumption (the own production potential is sufficient to achieve this purpose). The precision of forecasts is estimated currently at ± 0.5%.

**Ecological policy of Poland for years 2009-2012 with perspective up to year 2016** formulate among others the priorities of this policy including the reaching of requirements of the EU climate and energy package 3x20%. It points out the necessity of adopting a new Polish energy policy till year 2030 (it was already adopted), containing mechanisms stimulating energy savings and promoting the development of RES. These both mechanisms are considered as the most effective for reduction of emissions of pollutants to the environment, economically efficient and socially acceptable.

**Operational Program Infrastructure and Environment** belongs to the primary instruments aiming at achievement of given targets of environment and infrastructure development in Poland using finances of Cohasion Fund and Europeand Fund of Regional Development. One of the six main goals of the Programme is ensuring the long-term energy security of Poland by diversifying energy sources (including development of energy usage from RES), decreasing energy consumption by economy and development of RES. Realisation of these goals will support also the fulfillment of environment protection goals with special emphasis on climate policy. The activities relying on energy generation from RES showing the positive environmental impact are eligible to get support from the programme. The development of RES usage will be realized, among others, through investments in construction or modernization of installation for energy production using biomass, biogas, wind and water energy as well as through development of industries providing appliances for the production of fuels and energy from RES. These investments will contribute to the economic activation of the RES-rich regions.

**The Energy Law of April 10, 1997 (OJ 2006 No 89, item 625, as amended)** is the basic legal act regulating the energy market in Poland, including energy from renewable sources. The act defines such renewable source of energy as the energy of wind, solar, geothermal, maritime waves, currents and tides, rivers fall, energy derived from biomass, biogas, landfill and biogas generated in the processes of discharge or wastewater treatment or decomposition of plant and animal residues. The act also defines the term of agricultural biogas, which is gaseous fuel derived from agricultural raw materials, agricultural products, liquid or solid manure, by-products or residues of agro-food industry or forest biomass in methane fermentation process. Agricultural biogas is not, therefore, biogas produced from municipal and industrial waste other than from the agro-food industries, as well as municipal and industrial sludge. Therefore, the biogas from these renewable energy sources is not considered as a fuel. The Energy Law introduced certificates of energy origin. The green certificate confirms obtaining electricity from renewable sources, while the red certificate confirms generation of electricity in cogeneration. Certificates and revenues of their sale significantly promote the use of RES in Poland. Another significant support for the development of renewable sources of energy is the legal obligation to purchase electricity produced from renewable energy sources and to ensure priority access of this electricity to the grid.

A number of regulations have been issued with relation to the Energy Law, of which the most important in the context of this study is the Regulation of the Ministry of Economy dated at 14. August 2008 on a detailed scope of obligations to obtain and submit to the redemption of certificates of origin, to pay the replacement fee to purchase electricity and heat produced from renewable energy sources and the obligation to confirm the data on the amount of electricity generated from renewable energy sources (OJ 156, art. 969). This regulation defines, among others the term of biomass, which is solid or liquid substances of plant or animal, which are biodegradable, derived from products, wastes and residues from agriculture and forestry, and related industries, as well as parts of other wastes that are biodegradable. Energy crops are defined as plantations established for the use of biomass derived from them in the process of energy production, while the term of biogas means gas obtained from biomass, particularly from animal or plant waste treatment plant, wastewater treatment plants and landfills. Energy produced from renewable energy sources is defined, regardless of the power capacity of the source as: i) electricity or heat from, in particular: hydropower and wind power, ii) sources producing renewable energy from biomass and biogas, iii) solar photovoltaic cells and solar collectors for heat production, iv) geothermal sources, v) part of the energy recovered from incineration of municipal waste, in accordance with a separate regulation of Ministry of the Environment. In the case of biomass or biogas co-firing with other fuels Regulation lays down specific conditions for rating energy as energy from renewable sources for power generation units, depending on their capacity. The Regulation also defines the required share of electricity from RES in the total annual electricity sales to final customers, amounting min. 10.4% in 2010-2012, 10.9% in 2013 and 12.9% in 2017.

**Act of 27 April 2001 on waste (OJ 2007, No. 39, item 251, as amended)** was replaced by a new law in 2011, taking into account the requirements of the new Waste Framework Directive. Relevant provisions of the current Law on Waste, which may affect the growth of energy recovery from waste are: i) a ban on landfilling of combustible waste separately collected (from January 1, 2011), ii) a ban on landfilling of separately collected biodegradable waste (from January 1, 2013), iii) the possibility of allocating part of the energy from the incineration of municipal waste into energy from renewable energy sources; iv) inclusion of incineration of packaging waste and waste other than municipal and hazardous ones to energy recovery process R1, v) while the incineration of municipal waste and hazardous waste is considered in Poland, as the D10 process of disposal. This classification of municipal waste incineration will change with the entry into force of the new Act on Waste, according to which, thermal conversion of municipal waste in incineration plant reaching energy efficiency above 65% is considered as energy recovery process R1.

***Table 1 Overview of waste-to-energy related policies and goals at EU, national and regional levels in Poland and Sweden. Adopted from [4]***

| Energy | Waste |
|---|---|
| **EU (international level)** | **EU (international level)** |
| **COM** (2011) 112 'low-carbon roadmap' | **COM** (2011) 13 on the Thematic Strategy on the Prevention and Recycling of Waste |
| **COM(**2011) 144 'transport roadmap' | **Framework Waste Directive** (1975, 2008) |
| **Energy Policy** (2007) 20-20-20 goal | **Landfill Directive** |
| **Poland (national level)** | **Poland (national level)** |
| Polish energy policy (2009) | National Waste Management Plan 214 (2010) |
| Renewable energy development plan (2001) | Ban on landfilling of combustible waste separately collected (2011) |
| Directions for agricultural biogas plants development in Poland in 2010-2020 (2010) | Ban on landfilling of separately collected biodegradable waste (from January 1, 2013)<br>landfill tax |
| **Lower Silesia (regional level)** | **Lower Silesia (regional level)** |
| | Regional Waste Management Plan (2008) |
| **Sweden (national level)** | **Sweden(national level)** |
| The Swedish climate and energy policy (2009) | Ban on landfill of combustible waste (2002) |
| Biofuels strategy (2010) | Ban on landfill of organic material (2005) |
| | The Swedish waste policy (2005) |
| | The Swedish waste plan 2012-2017 (in progress) |
| | Environmental objectives |
| | 15. A Good built environment/ Waste |
| | Landfill tax (2000) |
| **Västmanland (regional level)** | **Västmanland (regional level)** |
| Climate and energy strategy for the Västmanland County (2008) | VafabMiljö AB Waste plan for 2009-2012 |
| Fossil free Västmanland 2015 | |

Table 2 presents country average shares of renewable energy in the final consumption in 2005 along with targets for 2020. Sweden is leading with 39.8 % of renewable energy in 2005 while Poland had clearly the lowest share of renewable energy and the relatively lowest target of 15 % in 2020. This target of 15 % is stated in the Polish energy policy; the target differs a little in different policies and acts, as shown in Table 3

***Table 2 Share of renewable energy in 2005 and targets for 2020 [5]***

| | Sweden | Finland | Estonia | Lithuania | Poland |
|---|---|---|---|---|---|
| Share of renewable energy | 39.8 | 28.5 | 18 | 15 | 7.2 |
| Targets of renewable energy | 49 | 30% | 25 | 23 | 15 |

***Table 3 The Polish targets for renewable energy in different policy and legislation regulations [3]***

| | **2011-2012** | **2014** | **2020** |
|---|---|---|---|
| Energy policy | | | 15 %<br>10% share of biofuels in transport fuel market |
| Renewable energy development strategy | | 7.5% | 14%, |
| The Energy Law of April 10, 1997 (OJ 2006 No 89, item 625, as amended) | min. 10,4% | 10.9% in 2013 | 12.9% in 2017 |

## 4. WASTE MANAGEMENT

Poland has tight deadlines for meeting the requirements of the EU law, such as meeting the aims of reducing the biodegradable waste destined for landfilling. Landfill directive requirements for Poland are as follows: 25 % reduction of biodegradable MSW landfilled by 2010, 50 % reduction of biodegradable MSW landfilled by 2013, and 65 % reduction of biodegradable MSW landfilled, in respect to data from 1995 [10]. From January 1, 2013 the ban on landfilling of separately collected biodegradable waste will be in effect in Poland [3].

The ban on landfilling of separately collected organic waste was introduced in Sweden 2005 and according to the environmental objective 35 percent of waste should be recovered through biological treatment by 2010. This environmental goal has not been achieved completely, but the systems for the collection of food waste are used in more than half of the 290 municipalities in Sweden, 60 others are working with developing or implementing systems for food waste sorting. In 2009, about 21 % of the food waste from households, restaurant and shops were recovered by biological treatment in Sweden. [11] The corresponding figure for the county of Västmanland was 60 %. [12]

## 5. PROGNOSES OF WASTE AMOUNTS AND FUTURE WASTE MANAGEMENT

The prognoses in the Polish waste management plan NWMP 2014 about future waste amounts indicate 329 kg/person in 2013 and 377kg/person 2020 [13]. In the outlook for waste management in 2020 according to the Department of Waste Management of the Polish Ministry of Environment [8] 50% of generated waste will be recycled, 25 % will be treated in mechanical biological treatment plant and 25 % waste will be treated thermal in incineration plant [MS GDP]. Furthermore, 25 % of the waste that will be treated through mechanical biological treatment will be RDF.

## 6. WASTE-TO ENERGY PLANTS

There are about 390 incineration plants across Europe, with big differences between countries, from 129 in France to 1 in Poland and Hungary [9], see Table 5. In Sweden waste-to-energy is a well established source of energy, 30 incineration plants operate here. One of heating plants in Västmanland use waste as fuel today but Mälarenergi in Västerås is planning to build a new boiler using waste as energy source [2].

***Table 5 Waste-to-energy Plants operating and the amounts of waste thermally treated [9, 11]***

| | Waste-to energy plants | Waste treated in million tones |
|---|---|---|
| Europe | About 390 | 69 |
| Poland | 1 | 0.04 |
| Lower Silesia | 0 | 0 |
| Sweden | 30 | 4.6 |
| Västmanland | 1 | 0.01 |

There are 9 waste incineration plant construction projects in Poland, with total planned capacity 2 022 00 Mg/year, see table 6. Zusok in Warsaw is the only waste incineration plant in Poland; no incineration plant projects are planned in Lower Silesia. [8]

***Table 6 Waste incineration plants projects in Poland [8]***

| Location | Planned Capacity Mg/year (number of lines) | Planned Power $MW_{el}/MW_{th}$ | Time frame |
|---|---|---|---|
| Szczecin | 150 000 (2) | 8.1/27 | 2014 |
| Koszalin | 92 000 (1) | 3.0/16 | 2014 |
| Bialystok | 120 000(2) | 3.0/20 | 2015 |
| Bydgoszcz & Torun | 180 000(2) | 9.2/27,5 | 2014 |
| Poznan | 240 000(2) | 10/40 | 2014 |
| Lodz | 200 000(2) | 7.3/35 | 2014 |
| GZM Katowice | 500 000(2) | 27/82 | 2014 |
| Krakow | 220 000(2) | 8.7/35 | 2014 |
| Warszawa* | 320 000 (2) | 18/30 | 2015 |
| Total | 2 022 000 | | |

## 7. ENERGY SCENARIOS

The Bellona Environment CCS Team, BEST [14] presented possible futures for the polish energy sector in three power sector mix and demand trajectories: PEP, gas expansion and Energy Efficiency, EE. For each of the three trajectories two scenarios are developed; one with widespread CCS application, and one without any application. A countrywide rollout of CCS in Poland is in line with EU policy, which sets out to make CCS commercial by 2020 and widely deployed thereafter. Assumed application of CCS to coal and lignite plants in the central and southern regions of Poland beginning in 2020, and gas plants in 2025. Total deployment in all regions will be achieved soon after 2035.

***Table 7 Three possible futures of energy sector in Poland PEP, Gas Expansion and EE [14]***

| | |
|---|---|
| PEP, national energy policy | Follows the government predictions contained in the polish energy policy 2009 ( until 2030. Annual electricity demand growth of close 2 % and energy mix depending on coal and lignite. |
| Gas expansion | The same growth in electricity demands as the PEP, but a greater representation of gas-fired generation, as suggested by recently increased investments in gas CHP and with thoughts of discovery of significant domestic gas resources. Coal and lignite continue to play a dominant role. Natural gas assumed to play a larger part, providing more that 15 % of Poland's electricity in 2020 and over 20 % after 2030, nuclear and renewable capacity same as in the PEP; additional gas capacity replace coal. |
| Energy efficiency | Energy efficiency assumes a significantly lower 1 % annual growth rate for electricity demand, due to the adaptation of significant energy measures in Poland Renewable and nuclear capacity the same as in the PEP and GE: The fossil capacity decrease as the demand decreased; the fossil energy mix the same as in the Gas Expansion. Energy mix solar, wind, biomas, hydro, oli, natural gas, hard coal, lignite and nuclear. |

## 8. INCREASED WASTE-TO-ENERGY UTILIZATION IN POLAND

Waste incineration plant projects in Poland are important and a real step towards implementation of the new Waste Framework Directive, the Landfall directive and the development of modern municipal waste treatment systems. By 2020, Poland needs extension of separate waste collection and new waste treatment plants, sorting plants in particular, MBT plants, waste incinerations plants, RDF power plants and landfill sites for treated waste [8].

The current generation of incinerators, combined with more efficient sorting and recycling procedures is far less polluting and more energy efficient than earlier types. Nevertheless, incineration is still controversial and raises people's concerns [15]. As one of the main challenges for waste management development in Poland a World Bank report "Solid waste management in Bulgaria, Croatia, Poland and Romania". A cross-country analysis of sector challenges towards EU harmonization [7] states that Poland's policy to develop waste-to-energy leap forward disposal and waste minimization targets encounters strong opposition from public and NGOs in Poland. The lack of social acceptance is the most important hindrance for the implementation of waste incineration plant projects in Poland [8]. Furthermore, only 8 % of the surveyed Warsaw residents are aware that the Waste Incineration Plant ZUSOK exists and operates. The problem of social acceptance has also been mentioned during meetings within the project REMOWE by the Polish part. The issue of social acceptance must be given a attention.

The literature provides some insights into the field. Many authors referred to the importance of perceived justice in the acceptability of hazardous technologies. Different dimensions of perceived justice have been identified. The concept of distributive justice [16] and procedural justice are relevant for waste incineration [15]. The distributive justice refers to the balance between distribution of costs and benefits of a project. The perception of fair distribution of benefits and costs will be associated with more positive attitudes towards incineration technology. Procedural justice has to do with the decision process itself. A facility project can be considered unacceptable by a population simply because the decision was made without proper consultation with the local authorities, because the population claims to have been ignored during the decisions process or because the decision process was not clear [15]. One of the ways to prevent this specific kind of perceived justice and the rejection of the project is to increase public participation it the project from the early stages [15]. For waste management technologies “early and often citizen involvement” is important [17]. Additionally, emissions of air pollutants and resulting public health issue seem to play most critical role towards the social acceptance [18] and therefore air pollution abatement measures need to be carefully designed and implemented, while also the plant’s operations’ to be thoroughly monitored and controlled.

Within the REMOWE project the problems with acceptance for biogas plants as well as separate collection of biodegradable fraction by household are also raised. In these respects Sweden and Västmanland constitute a good example. One of the outputs from the REMOWE project is a “Manual for sorting of waste for waste-to-energy systems” [19]. This manual describes systems for sorting of waste with the purpose to utilize its content for energy recovery with examples from Sweden. Experiences from Västmanland suggest that the psychological aspects, people’s behavior and motivation should be given priority in the beginning of the process of implementing a sorting system for food waste [19]. The direct contact with the affected residents and the close interaction with the customers were considered important. The goal of reaching 80 % of households with verbal information was implemented in four steps: 1) large meetings (about 500 households were invited per session; about 10 % of those invited came to these assemblies); 2) arranged meeting places in schools and in supermarkets 3) knock on doors 4) phone calls.

There are different initiatives in Sweden to encourage municipalities to take care of food waste. One of them is a report by Biogas East (Biogas Öst), a regional organisation promoting biogas in mid-eastern Sweden since 2008, ”Food waste became biogas. Five good examples” [12] and a report published by the branch association Swedish Waste Management (Avfall Sverige) “Help for introduction of system for collecting sorted food waste” [20]. The latter report contains a description of possible collection systems with technical descriptions and examples of appropriate collection vehicles, common collection intervals, increased cost for containers, information, and more. It also contains a guide which specifies what the municipality should consider when establishing a scheme for the collection of food waste to be introduced. The guide is also published separately “Manual for implementing collection of sorted food waste” [21]. According to the manual success factors for the introduction of collection of source-separated food waste are mainly of "soft" character. It is planning, adequate human resources, information and monitoring and control, i.e. factors that are not really related to a specific design of the collection system. One conclusion to be drawn from this is that the way in which work with the system is conducted, both the introduction and operation, is more important than any collection system chosen. Different collection systems have their pros and cons. The most important thing is that the systems are well adapted to the current municipality.

## 8.1 CONCLUSIONS

This study, based on investigations made in the REMOWE project (Regional Mobilizing of Sustainable Waste-to-energy Production), discusses increased waste-to-energy utilization in Poland, with focus on a comparison with the current state in Sweden. There are big differences in the field of waste-to-energy between these two countries. For example, roughly 87 % of municipal waste is landfilled in Poland compared to 3 % in Västmanland County of Sweden.

A project like REMOWE, with partners far developed in the field as well as partners with low level utilization of waste, support transnational transfer of technology and knowledge. Due to the dissemination of projects outcomes the project partners as well as all EU regions are able to benefit from solutions and best practice discovered. The manual for sorting of waste is one good example here.

The Polish region as well as Poland is characterized by low level waste management and utilization of waste. Poland needs an extension of separate waste collection and new waste treatment plants. Waste incineration plant projects are important for the development of modern municipal waste treatment systems. As the lack of social acceptance of incineration technology is regarded as a main hindrance in this respect special attention should be given to procedural justice. Public participation in the project from the early stages is also crucial for the successful implementation of a system for selection of biodegradable fraction.

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