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Energy policy and the role of bioenergy in Poland

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Abstract

Poland, as many other countries, has ambitions to increase the use of renewable energy sources. In this paper, we review the current status of bioenergy in Poland and make a critical assessment of the prospects for increasing the share of bioenergy in energy supply, including policy implications. Bioenergy use was about 4% (165 PJ) of primary energy use (3900 PJ) and 95% of renewable energy use (174 PJ) in 2003, mainly as firewood in the domestic sector. Targets have been set to increase the contribution of renewable energy to 7.5% in 2010, in accordance with the EU accession treaty, and to 14% in 2020. Bioenergy is expected to be the main contributor to reaching those targets. From a resource perspective, the use of bioenergy could at least double in the near term if straw, forestry residues, wood-waste, energy crops, biogas, and used wood were used for energy purposes. The long-term potential, assuming short rotation forestry on potentially available agricultural land is about one-third, or 1400 PJ, of current total primary energy use. However, in the near term, Poland is lacking fundamental driving forces for increasing the use of bioenergy (e.g., for meeting demand increases, improving supply security, or further reducing sulphur or greenhouse gas emissions). There is yet no coherent policy or strategy for supporting bioenergy. Co-firing with coal in large plants is an interesting option for creating demand and facilitating the development of a market for bioenergy. The renewable electricity quota obligation is likely to promote such co-firing but promising applications of bioenergy are also found in small- and medium-scale applications for heat production. Carbon taxes and, or, other financial support schemes targeted also at the heating sector are necessary in the near term in order to reach the 7.5% target. In addition, there is a need to support the development of supply infrastructure, change certain practices in forestry, coordinate RD&D efforts, and support general capacity building. The greatest challenge for the longer term lies in reforming and restructuring the agricultural sector.

Keywords: Bioenergy; Poland; Biomass

1. Introduction

Increased utilisation of renewable energy is a key strategy in the European Union in order to address environmental goals and supply security concerns. Sustained efforts to promote the development of renewable energy in several member states are now showing results through the increased use of wind energy (e.g., Denmark, Germany, and Spain) and bioenergy (e.g., Sweden, Finland, and Austria). However, renewable energy targets for EU-15 are not likely to be reached despite the extensive implementation of renewable energy policies in those Member States (Johansson and Turkenburg, 2004). The new member states were committed to similar targets when joining the EU but reaching them may prove to be an even bigger challenge here. Interest in renewable energy came

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relatively late in those countries and they are also in the process of fundamentally restructuring and reforming the whole economy, including the energy sector.

Relatively little has been written on renewable energy and energy policy in Eastern Europe given the importance of those countries for developing and increasing the use of renewable energy in the EU, and the implications for the EU Common Agricultural Policy (CAP). The first assessments of bioenergy and other renewable energy potentials were made in the TERES I (1994) and TERES II (1997) studies which formed part of the background for the EU White Paper on renewable energy. A later study surveyed background conditions, main actors, policy instruments, and prospects for future developments in, at that time, 13 accession states (Reiche, 2003). In the case of Poland, there are very few publications in the international literature. A recent example is an analysis of renewable energy policy in Poland, focusing on electricity generation and the implications of EU accession (Wohlgemuth and Wojtowska-Lodej, 2003).

Bioenergy has been identified as the most important and promising renewable source of energy for Poland (e.g., ESD, 1997; ESD and ECBREC, 2001). An overarching question in this paper is how the potential bioenergy supply can be matched with demand, and under what market and policy conditions, in order to reach the assumed targets? Our point of departure is that the use of bioenergy in Poland will develop in a broader context. The economy is in many ways still in a process of profound changes in the transition from a centrally planned economy to a market economy, faced with various economic and social development problems, including high unemployment—about 20% in 2004.

Important drivers for change in the energy sector follow from the membership in the EU with implications for several aspects of the organisation and development of this sector. Restructuring is unfolding as the energy markets are liberalised, and several companies from Western and Northern Europe are moving in as investors in the energy sector. Many countries are also looking to Poland as a source of carbon dioxide emission and as a host country for Joint Implementation (JI) projects. Environmental drivers for the energy sector thus include commitments under the Kyoto Protocol and resulting climate policy, but also compliance with the Convention of Long-Range Trans-boundary Air Pollution and various EC Directives.

We provide an in-depth assessment of the prospects and potential strategies for bioenergy expansion in Poland, integrating demand, supply, policy, and market aspects. The starting point is a review of the present Polish energy system, including the present use of bioenergy. The focus is mainly on bioenergy for heat and electricity production. The final objective of the analysis is to identify critical choices and decisions that must be made in Poland in order to develop the bioenergy market. For this purpose, the current market conditions and relevant policy are reviewed. The current and potential role of important actors in the development of the bioenergy market is also addressed. Different development options and strategic choices are discussed in the final section based on the review of present structures, policy, and actors.

2. Polish energy supply and demand

The prospects for expanding the modern use of bioenergy are partly determined by the current and future broader structure of the energy sector in Poland. Primary energy use in Poland has decreased slowly since the deep economic recession in 1989–1991. Primary energy use in 1990 was 4217 PJ, representing a 25% decrease from the 1988 level of use. Although the economy recovered during the rest of the 1990s, with typical annual GDP growth rates of about 4–6%, primary energy use continued to decrease slowly and was 3812 PJ in 2000. The industrial sector accounted for more than half of this decrease (Institute for Energy, 2003). Various projections and scenarios show that final energy use in Poland may be stable, or increase by as much as 19% by 2020 under different assumptions and macro-economic scenarios (Institute for Energy, 2003; Jankowski et al., 2002).

Hard coal and lignite account for a large, about 65%, but slowly decreasing share of primary energy use (Fig. 1). The index of self-sufficiency (the ratio of primary production to primary use) in 2000 was 87%, about twice as high as the EU average (Jankowski et al., 2002). Domestic coal reserves are sufficient for about 60 years at the current rate of extraction. The share of oil is increasing due to growing demand for transportation fuels. For example, gasoline consumption increased by about 90% between 1990 and 2000, driven largely by the near doubling in number of passenger cars from 5.3 to 10.0 million (GUS, 2002c). There is also a slight increase in the share of natural gas as households and industry slowly shifts to gas. In future projections, these trends are expected to continue.

2.1. Carbon and sulphur dioxide emissions

The strong reliance on coal makes carbon and sulphur dioxide emission reductions an important issue in Poland. Poland is a signatory to the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol committing itself to a 6% reduction of greenhouse gas emissions in the first commitment period of 2008–2012. Polands base

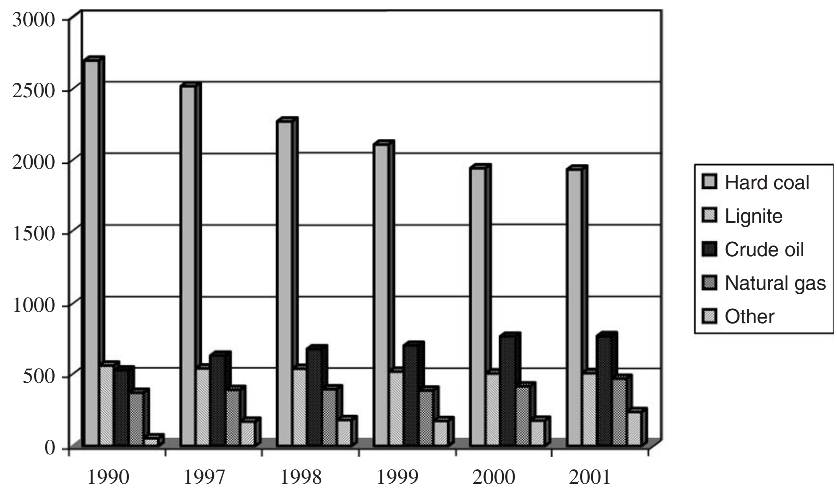

Fig. 1. Primary energy use [PJ] by fuel in Poland (GUS, 2002a).

year (1988) emissions were 478 Mton (Jankowski et al., 2002). Emissions in 2000 were 315 Mton (GUS, 2002c). Poland is a potential source of emissions permits equivalent to 50–130 Mton of carbon dioxide equivalents in the first commitment period.

Poland is a signatory to the Second Sulphur Protocol and the Gothenburg Protocol, and is thus committed to reducing sulphur dioxide emissions by 66% in 2010, from the 1980 level. Emissions have decreased from 4100 kton sulphur dioxide in 1980 to 1511 kton in 2000, and projections for 2010 are 1397 kton (UNECE, 2003) in accordance with the protocols. The EU membership, among many other things, also requires compliance with the Directive on the limitation of emissions of certain pollutants into the air from large combustion plants (EC, 2001). The professional producers, i.e., power plants and some large combined heat and power (CHP) plants, account for about half of the Polish SO_2 emissions, 805 kton of the total 1511 kton in 2000 (GUS, 2002c). SO_2 reduction programs in power production are near completion, and a greater challenge may be reducing NO_x emissions in plants above 500 MW-thermal (MW_{th}) by 2016 and further reductions thereafter (Kamiński, 2002).

The other half of the total sulphur dioxide emissions are caused by the mainly small- and medium-sized heat and CHP plants in the non-professional sector, and from individual boilers. Emission limits for SO_2, NO_x, CO, and particulates are defined for sources with an installed capacity above 1 MW_{th} (Ministry of Environment, 2003). CHP plants and smaller power plants can usually meet the requirements by burning low sulphur coal. Owners of small boilers, $<1\,MW_{th}$, pay an environmental fee per tonne of fuel used, depending on fuel characteristics. Households are exempt from environmental fees.

2.2. Electricity and heat

The structure and development of heat and electricity demand is relevant to the prospects for bioenergy in this sector. In the case of electricity, generation and consumption in Poland have remained relatively stable in the past 10 years. Gross generation in 2000 amounted to 145.2 TWh. The source of about 97% of electricity is hard coal and lignite. The remaining 3% is hydro power, biogas and landfill gas, wind energy and some biomass CHP. Current electricity consumption is about 3800 kWh/capita, much less than the 6–7000 kWh/capita which is typical of many Western European countries. In contrast to heat demand, Polish electricity demand is projected to grow. Total electricity production has been projected to increase to 233 TWh in 2020, on average 2.2% per year (Ministry of Economy, 2000). This corresponds to a per capita consumption of about 6000 KWh in 2020, assuming a relatively stable population below 40 million (GUS, 2000). Lower growth rates have also been projected, i.e., 1.2–1.3% per year (Ministry of Economy, 2002).

For the past few years, the annual production of industrial process heat and district heat (DH) in Poland is estimated to be 1100–1250 PJ (Table 1). In addition, an estimated 360–570 PJ are used for space heat and hot water production in small individual boilers for dwellings, hospitals, schools, etc. District heating systems cover nearly 70% of heat demand in urban areas, and about one-third of the dwellings in Poland (Energy Market Agency, 2003). In addition, there are about 8–9 million dwellings that have individual heating systems, roughly half of which have boilers with hydronic heat distribution systems (i.e., central heating) and half of which have stoves, using coal as the main fuel. Overall heat demand has been forecast to decrease by about

Table 1
District heat, heat in individual boilers for space heating, and industrial process and space heat production in Poland 2002

	Number of plants	Heat production (PJ)	%
Total district heating	8185	390	100
Professional CHP (incl. steam bleeding) and heat boilers	48	171	43.9
Own production in large DH companies (sales >100 TJ/a)	224	100	25.6
Own production in small DH companies (sales <100 TJ/a)	257	76	19.6
Industrial non-professional heat boilers and CHP plants sales to outside heat customers	7656	43	10.9
Authors' estimates:			
Heat for own use in industry and commercial buildings	—	720–870	
Individual boilers in housing	8–9 million	360–570	

Source: Energy Market Agency, 2003 and authors' own estimates.
Note: The winter of 2002 was cold. A mild winter may reduce heat demand by 25–30%.

15% in the next 20 years as a result of modernisations and efficiency improvements, including end-use efficiency (Kamrat, 2001; Renski, 2002). District heating systems have been designed according to Russian standards and are consequently oversized and not optimised for Polish conditions. A number of refurbishment plans and restructuring programs have been undertaken in recent years to remedy the situation with technical and financial problems in order to bring the systems up to Western European standards, including improved environmental performance.

2.3. Natural gas

Natural gas is a potentially important competing fuel to biomass, depending on gas-grid access and relative prices. Between 1967 and 2001, the natural gas consumption increased from 90 to 431 PJ. Most of the natural gas is used in industry (40%) and in the residential sector (34%). Relatively little (4%) is used for heat and power production. Poland's domestic gas production is relatively stable at about 140–150 PJ per year. Domestic reserves are limited and the expanded use of natural gas will depend on imports.

It may be noted that the modest growth in gas consumption does not match the near doubling of the length of gas transmission and distribution pipelines during the 1990s. However, natural gas consumption is expected to range between 650 and 1100 PJ in 2020, mainly at the expense of coal (Energy Market Agency, 1999, 2000; Ministry of Economy, 2000). Notably, natural gas is assumed to play an important role in meeting the projected increase in demand for electricity, and as a clean fuel for the domestic sector.

2.4. Waste-to-energy

The potential for energy from waste is another important factor that may influence the prospects for bioenergy in Poland. Poland is producing about 13 Mton of municipal solid waste (MSW) each year, 97% of which is currently dumped at over 900 landfills throughout the country. Methane is recovered and used for energy only at 28 landfills. There is one MSW incineration plant in Poland, in Warsaw, with a capacity of 60 kton per year. Sewage sludge production equals 360 kton dry matter per year, most of which is land-filled or dumped at waste water treatment plant sites.

Poland has plans to reduce the amount of land-filled waste, in accordance with ambitions within the rest of the European Union (EC, 1999). The "National Program for Waste Management" assumed strengthening of activities towards recycling of non-organic waste, composting and different high-temperature thermal utilisation of the organic fraction in MSW. It is expected that about 1.4 Mton of MSW organic fraction will be incinerated by 2010 (Ministry of Environment, 2002). This corresponds to about 14 PJ assuming that 10 GJ/ton can be recovered as energy. This is relatively small in comparison to the targets for bioenergy. It may also be noted that MSW incineration is meeting strong public resistance in Poland, resulting in long-lasting discussions at the scientific and governmental levels.

3. Bioenergy in Poland

From the review of energy in Poland, it appears that there are no strong fundamental driving forces for increasing the use of bioenergy in Poland in the near term. Poland is expected to meet environmental targets and commitments even without bioenergy. In the applications that are closest at hand in the near term, i.e., heat production and CHP production, demand for heat may decrease and biofuels are competing with natural gas as well as low-cost fuels such as coal- and waste-derived fuels. Coal prices can be expected to be relatively stable, slightly increasing (5–10%) or even decreasing (Ministry of Economy, 2002). Although the energy content in MSW is relatively limited, it may be a potentially important competitor to bioenergy in specific locations. Greater competition can perhaps be expected from natural gas, where prices, once the infrastructure is in place, have a tendency to adjust to competitive levels. In addition, heat demand is expected to decrease in Poland resulting in low levels of investment and further pressure on fuel prices.

3.1. Present use of bioenergy

The present use of bioenergy is difficult to quantify. As in many countries, estimates are uncertain and statistics are not coherent. For example, the major share of biofuels is used in rural areas and not included in the formal economy. Various official estimates put the contribution of renewable energy at between 3.3% and 4.5% of primary energy supply, equivalent to between 131 PJ in 1999 (Ministry of Economy, 2002) and 174 PJ in 2003 (ECBREC, 2004). ECBREC has made detailed estimates that the use of bioenergy was 165 PJ in 2003, equivalent to 95% of total renewable energy supply or about 4% of the total primary energy use of 3900 PJ (ECBREC, 2004). It is estimated that this bioenergy, after conversion losses, was used for producing 112 PJ of heat and 560 GWh of electricity (Table 2).

The use of firewood for heating purposes dominates the present use of bioenergy. It is estimated that almost 300,000 multi-fuel boilers, stoves and small wood-fired boilers (<500 kW), mainly in individual dwellings, is using about 98 PJ of firewood, wood waste and briquettes. Many farms and individual dwellings have switched from hard coal to firewood in the past 10 years, particularly in the northern part of Poland, due to the increasing price of coal. This fuel-switch may be temporary and induced mainly by the harsh economic conditions for the rural population. Nevertheless, modern wood-fired boilers are increasingly viewed as an interesting option for new investments in individual heating systems.

Briquettes and pellets production is estimated to about 100,000 and 20,000 ton per year respectively. Briquettes are sold in Poland and exported whereas all pellets are exported. In 2003, 5–10 companies produced pellets and exported to Germany, Denmark and Sweden. There are plans to increase the pellets production by 100,000 ton in the next few years (Bzowski, 2003a).

There is a growing interest in small- and medium-scale technologies: domestic sector (<100 kW), agricultural purposes (<500 kW), and district heating (0.5–20 MW). Roughly 100 biomass (mainly wood, biogas, and straw) district heating systems have been implemented since 1995, and 30–50 are being planned. The majority of projects in the district heating sector are refurbishment projects with coal to biomass fuel conversion and heating network refurbishment. Some of the district heating projects were developed under AIJ (Activities Implemented Jointly) and JI schemes as demonstration of technologies and with carbon-financing support (Secretariat for Joint Implementation, 2002).

The use of industrial woody by-products for energy is in the order of 3.3 Mm^3, equivalent to 20–25 PJ. The estimated installed capacity of wood-fired boilers in wood industry and district heating was about 450 MW in 2003 excluding large-scale CHP plants (ECBREC, 2004). The number includes about 20 district heating plants using wood-fuels in 0.5–15 MW boilers. The annual heat production based on biomass in district heating is estimated at about 1.2 PJ in 2003 (ECBREC, 2004). There were five large-scale wood-waste-fired CHP plants in the pulp and paper industry in 2003 producing 5 PJ of heat and 500 GWh of electricity. One additional

Table 2
Estimated biomass-based electricity and heat production in Poland in 2003 (ECBREC, 2004)

Biomass technologies/specification	No. of units	Power in MW thermal (th) or electric (el)	Energy production	
			Electricity (GWh/a)	Thermal (TJ/a)
CHP in Pulp & Paper and furniture industry	5[a]	450 (th)[a]	500[a]	5000[a]
Wood Industrial and DH (only heat) (>500 kW)	180	450 (th)	—	6750[a]
Wood small-scale heat plants and fire-wood domestic use (<500 kW)[a]	285000	5500 (th)	—	98800[a]
Straw district heating plants (>500 kW) [a]	65	90 (th)[a]	—	920[a]
Straw small-scale heat plants (<500 kW)[a]	150	23 (th)[a]	—	230[a]
Biogas CHP and DH systems	32	43 (th)/18 (el)	38	450
Landfill gas CHP and DH systems	17	19 (th)/7 (el)	22	200
Total:	560 GWh	112.3 PJ		

Notes: (a) Estimated data. Biomass-based heat-only production has not been covered in national statistics and ECBREC is currently monitoring this for the General Statistical Office (GUS).

CHP plant in the pulp and paper industry is planned. There are also a few examples of CHP units in other wood-processing industries. Several new biomass DH and coal-to-biomass conversion projects are in the planning phase (Bzowski, 2003b). Some district heating plants and CHP plants have started biomass co-firing in coal boilers on a trial basis. This has not yet led to any significant share of biomass in the fuel balance. Biomass co-firing with coal is estimated here to be about 130 TJ in 2003.

Poland has about 35 biogas systems in waste water treatment plants with an installed electric capacity of about 25 MW producing approximately 340 TJ heat and 24 GWh of electricity (EurObserv'ER, 2003). This equals about 500 TJ of primary energy from municipal biogas. In addition, about 10 biogas plants at agricultural farms have been installed in the past 20 years. However, the majority of them are not in operation mainly due to technical and economic reasons. These plants were mainly intended as demonstrations and were not based on commercially proven technologies.

The use of straw for energy has been estimated by ECBREC to be 65 kton in 2001, equal to about 800 TJ. There are now, in 2004, about 65 small- and medium-scale (0.5–7 MW) straw fired district heating plants, the first of which were implemented as demonstration projects in the early 1990s. In addition, there are perhaps 100 straw fired boilers in agricultural dwellings. There are probably 1000–1500 ha of willow (Salix Viminalis) plantations and the interest in energy crops is increasing. Most of the energy plantations were started for R&D purposes, some by own initiative for practical trials by farmers, and some for cuttings production. The main motivation for planting Salix has been for reclamation of industrial and contaminated soils, but it has also been promoted for production of road-boards, furniture, and as a bio-filter for water treatment.

Liquid biofuels, mainly ethanol and biodiesel, is attracting considerable interest in Poland. Surplus production of ethanol stimulated the first experiments with using ethanol as an additive to gasoline in 1991. Raw materials include molasses, and low-quality grain, potatoes or other agricultural products. Ethanol production reached 100 kton/year in 1997, then dropped to about 50 kton/year, and has remained stable until 2003. Poland also has about 100 kton/year of rape methyl ester (RME) production. The "*Biofuel Act*" was adopted in October 2003, setting targets for 5% of biodiesel and 4.5% of bio-ethanol in the transportation fuels market in 2005 (Ministry of Agriculture, 2003), but the targets were later removed by the Constitutional Tribunal. The targets correspond to 260.000 ton of bio-ethanol and 400.000 of bio-diesel production yearly. This corresponds to an additional production of ca. 0.8 Mton of rye and 2.4 Mton of potatoes, equivalent to 10–15% of current production. The biodiesel target implies additional production of 0.7 million ton of rape. Using biomass to produce transportation fuels is generally a less effective, more costly and technically challenging way of reducing carbon emissions (Gustavsson et al., 1995). In any case, the Polish Plans, whether or not adhering to the EC Biofuels Directive, are not likely to cause serious competition for solid biofuels in the heat and power sector in the near term.

3.2. Long- and short-term bioenergy potentials

Potential estimates are the result of various assumptions. For the purpose of indicating the order of magnitude for bioenergy potentials, some approximate numbers for the long- and short term are presented here and summarised in Table 3. The long-term potential is dependent on assumptions mainly concerning land availability. The near-term potential, i.e., in 5–10 years, is determined much more by the present land-use and the current generation of biomass and wood waste in agriculture and forestry.

Forests are covering 28.8% of the country area, equivalent to 8.9 Mha, with Pine as the most common species (68% of the forest composition). The energy stored annually in the 8.9 Mha of forests is in the order of 450 PJ (assuming 6 m^3/ha net growth, 500 kg dry substance per m^3, and 16 GJ/ton). The current harvest rate is about 26 Mm^3 per year, which corresponds to about half of the annual increment. Approximately 55–65 PJ may be available as forest residues in the long term. This is based on the simple assumption that 45 Mm^3, about 80% of the annual increment, can be harvested in a sustainable way in the future, and that 7–8 Mm^3 of forest residues can be extracted in addition to that. Similar or greater volumes could be available as wood waste from the wood industry.

The agricultural land area is about 18.5 Mha or 0.5 ha/capita. About 9 Mha could, in theory, be used for other purposes, assuming that about 0.25 ha/capita is sufficient for food production. Allocating this area for energy production and assuming an annual yield of 160 GJ/ha (10 ton/ha dry substance) would result in

Table 3
Indicative bioenergy potential estimates

Resources	Long-term potential (PJ/year)	Short-term potential (PJ/year)
Forestry residues	55–65	20–30
Wood waste	55–65	20–30
Used wood	?	20–30
Energy crops	650–1450	?
Straw	150	60–150
Biogas	30–40	30
Rough total	1000–1500	150–250

about 1450 PJ/year of bioenergy. Thus, the gross resource potential for forestry residues and short rotation energy forestry is about 1500 PJ. The long-term resource potential is smaller when various restrictions are imposed on land-use, forestry and agricultural practices, etc. Other potential estimates have been in the order of 650–750 PJ, assuming that less than 9 Mha will be available for energy crops (ECBREC, 2000, 2004).

Near-term potential estimates for forestry residues range from 6 to 20 PJ to 35 PJ depending on slightly different assumptions (State Forestry Holding, 2003b; Różanski and Jabłoński, 2003). The current use of industrial wood by-products for energy in industry is in the order of 3.3 Mm^3, equivalent to 20–25 PJ and corresponding to about 44% of the total wood waste production of 7.4 Mm^3 in 2001 (Wood Technology Institute, 2002). Most of the remaining part was used for particle board production. We make a rough estimate that an additional 20–30 PJ could be recovered from wood waste. It has been estimated that the potential of used wood (from furniture, building, railways, telecommunication, trade, etc.) is about 5 Mm^3/year, equal to about 35 PJ (Szostak and Ratajczak, 2003). However, much of this wood is contaminated and should be burned in appropriate plants.

Agriculture produces about 25.5 Mton of straw, of which 4–11 Mton (60–150 PJ) could be used for energy in the short term after subtracting for feed, litter and fertilising needs (Smagacz, 2003; Grzybek et al., 2001). In the short to medium term, it may also be relevant to consider short rotation forestry. There is 2.6 Mha of set-aside and fallow land and 0.6 Mha of contaminated agricultural land which may be withdrawn from agricultural use (GUS, 2002c). Using about 2 Mha of this land for short rotation forestry would result in 180–360 PJ assuming annual yields of 5–10 ton dry substance per hectare. Biogas from wet agricultural waste, sewage sludge, and landfill gas could add 34 PJ (Oniszk-Poplawska et al., 2003). In summary, not including energy crops or harvesting more of the annual increment in forests, the near potential is in the order of 150–250 PJ.

4. Energy policy and market issues in Poland

The general market and policy situation in Poland provides the background conditions for the development of bioenergy. In addition to general energy policy, we identify and discuss three important aspects in relation to bioenergy development: (i) fuel and electricity prices, (ii) renewable energy policy, and agricultural and forestry policy, and (iii) financing of projects.

The whole energy sector is going through restructuring, a process largely driven by the adjustment of Polish law to EU requirements. This includes adjustments of the heat, electricity and gas sector to EU directives. The basic elements of energy policy are outlined in *''Assumptions of Energy Policy to 2020''* based on an analysis of the present state and the expected future development of the energy sector (Ministry of Economy, 2000). This includes taking account of important trends such as globalisation, liberalisation of markets and decentralisation. The basic policy objectives are security of supply, enhanced competitiveness, and environmental protection.

The *''Energy Act''* from 1997 is the basic legal framework for the energy sector (Council of Ministers, 1997). It defines the Ministry of Economic Affairs as responsible for the energy sector in Poland. Important elements of the act include restructuring of the energy sector through unbundling, third party access (TPA), purchase obligations on electricity from CHP or renewable sources, a requirement for local energy plans, and the creation of a regulator. The *''Energy Act''* defines the responsibilities of the Energy Regulation Office (URE) which was founded in 1997 as the government executive body. URE's overall aim is to secure regulatory compliance as well as to protect consumer rights. The main tasks include licensing of energy production, transmission and trade, regulation of energy prices, and control of access to energy markets through TPA.

The electricity sector is planned to reach full market opening by 2005/06. The reforms include privatisations, with foreign investors as key participants, but progress has been slow so far (Pan Eurasian, 2004). The market is still dominated by state-owned companies. There are 27 electricity producers (excluding small-scale co-generation), one transmission company (PSE),[1] and 33 electricity distributors (ZE).[2] Only a handful of power plants and CHP plants have been privatised so far. Two distribution companies have been partly privatised.[3]

The gas sector is still dominated by the state-owned Polish Oil Mining and Gas Company (PGNiG) but market opening and introduction of TPA is scheduled to be implemented in 2005. TPA also applies to distribution of heat, although technical conditions make such connections possible only in a limited number of systems. Market opening proceeds gradually. There are about 3000 companies in heat production, distribution, and trade but more than 90% of the heat production is accounted for by the 911 companies with capacities above 1 MW that are licensed by URE. Ownership is dominated by local governments.

[1]PSE (Polskie Sieci Elektroenergetyczne S.A.)—Polish Power Grid Company, a joint-stock company since 1990 responsible for operating the national transmission system.

[2]ZE—regional electricity distribution companies and operators.

[3]VATTENFALL owns shares of GZE—Górnośląski Zakład Energetyczny (in the South) and RWE owns shares of STOEN—the regional electricity distribution company in Warsaw.

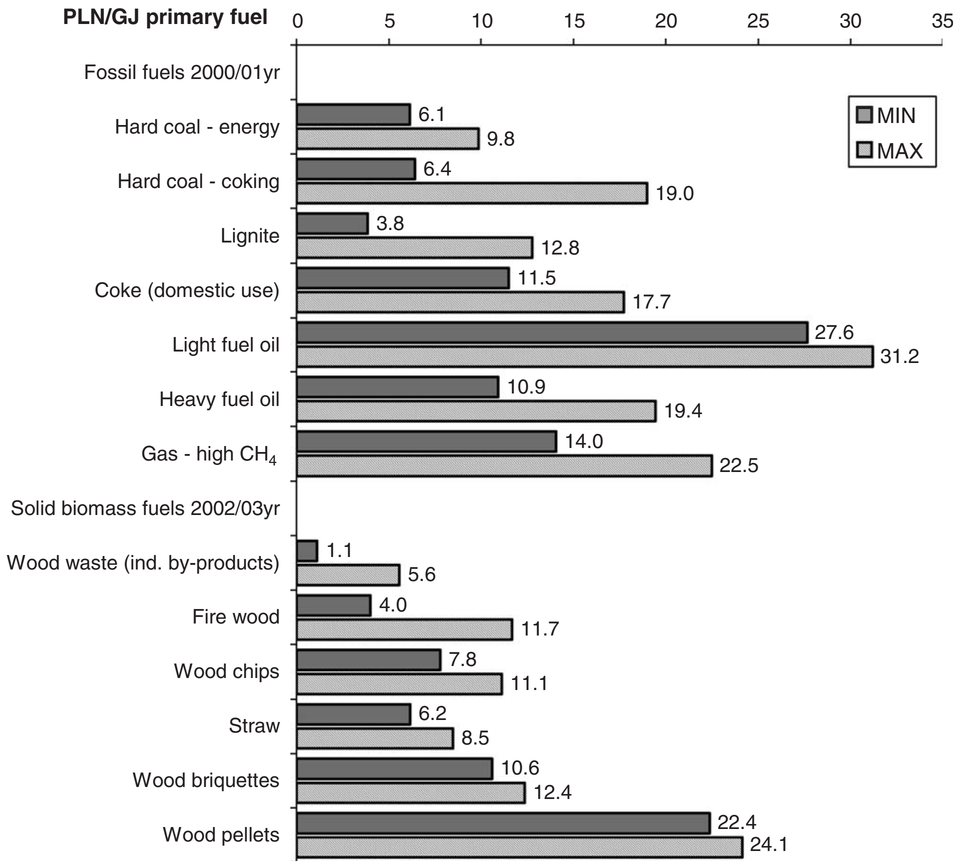

Fig. 2. Fuel prices (PLN/GJ) in Poland 2001/2002. It should be noted that markets for biomass are local and not well developed. Based on GUS, 2002a and estimates for biomass fuels made by ECBREC.

4.1. Fuel and electricity prices in Poland

Energy prices have increased considerably since 1990. Electricity prices increased from 0.02 to 0.3 PLN/kWh in 2000, a 15-fold increase over 10 years (GUS, 2002b).[4] Heat prices for central heating increased from about 1 PLN/GJ in 1990 to 47 PLN/GJ in 1998, as a result of removing subsidies, reforming the energy sector, and improving environmental performance (Bodych-Wasilewska and Cherubin, 2002). For comparison, the price index for consumer goods and services increased about 9 times during the same period (GUS, 2002b). Electricity and heat prices are presently at similar levels as in Western Europe but energy represents a much larger fraction of total household expenditures due to lower income levels.

Domestic as well as imported fine coal and lignite have been the least-expensive fuels. Waste wood, firewood and straw compete with coke, oil and gas in the domestic sector. Biomass also competes in district heating except in southern Poland where the coal mines are located and coal prices are on the low end. Light fuel-oil and gas have been the most-expensive fuels (See Fig. 2). Prices paid for bioenergy are about 10 PLN/GJ except for pellets. This is the same level at which production of Salix would be profitable under Polish conditions (Ericsson et al., 2004).

So far, biomass has been competitive to fossil fuels only in limited applications, and locally, for example as waste wood in the wood-processing industry or as firewood for domestic heat. Fine coal accounts for about 90% of the heat production. Prices of heat from district heating differ widely depending on fuel costs, transport distances and investment programmes which support energy efficiency improvements in district heating. The rapid increase in heat prices has motivated energy efficiency measures leading to decreases in heat demand. Energy suppliers, as a result, have a strong pressure to reduce production costs and biomass has been regarded as an option especially for small-scale district heating applications. In 2001, the DH prices varied between 20 and 55 PLN/GJ. In general, district heating system using fine coal have the lowest heat prices, and those using light fuel oil and natural gas have the highest prices.

The final price of electricity varies regionally and by type of consumer. Most of the power plants are located

[4] The Polish Zloty (PLN) is rather volatile but the exchange rate in 2003 was about 4 PLN/EUR.

in the southern industrialised part of Poland, and electricity is more expensive in the north. Average prices in 2000 were 248.5 PLN/MWh for the domestic sector and between 147 and 224 PLN/MWh in industry. Electricity prices have increased faster in rural areas than urban areas since the the process of liberalisation and regionalisation of energy prices started in 1996. Poland does not have any fuel, heat or electricity taxes at present, except for a 0.02 PLN/kWh temporary excise tax on electricity motivated by the government budget deficit. There is also a value added tax of 22%. Introducing taxes on top of the energy price increases in the past 10–15 years has not been a political option. However, energy and carbon taxes are likely to increase in the future, as in other Member States, and thus enhance the competitiveness of bioenergy.

4.2. The policy context for bioenergy

Energy policy has focused mainly on restructuring, developing the natural gas infrastructure, and improving the energy efficiency of the economy. Renewable energy has been considered only in the long-term perspective. For example, *''Assumptions of the Energy Policy''* (Ministry of Economy, 2000) described renewable energy sources as having low technical potential and assumed that the utilisation would not be very significant before 2020. In the 2002 revisions to this policy document, renewable energy is more explicitly recognised and its share in the energy balance is predicted to grow from an estimated level of 131 PJ (3.3% of primary energy) in 1999 to 157 PJ (4.0%) in 2005 (Ministry of Economy, 2002). Energy policy in Poland is developing rapidly since 1997, and it is no surprise that various documents are not coherent concerning the role and future development of renewable energy and bioenergy. In general, the importance of bioenergy is increasingly recognised.

4.2.1. Renewable energy policy

The late 1990s marks the start of political interest in creating conditions for renewable energy development. The ''*Resolution on Increase of Renewable Energy Sources Utilisation,''* approved by the Parliament in 1999, was a milestone (Parliament Resolution, 1999). Subsequently, the Parliament called on the Council of Ministers to prepare the development strategy of the renewable energy sector in Poland and its harmonisation with the energy- and environmental policies. The Ministry of Environment took over the task of preparing the strategy on behalf of the Council of Ministers. In parallel with this strategy development, the government worked on related policy documents (Ministry of Economy, 2000; Ministry of Environment, 2000c, 2000b).

The resulting strategy, *''Development Strategy of Renewable Energy Sector''* adopted by Parliament in 2001, is the key document supporting renewable energy in Poland (Ministry of Environment, 2000a). The strategy elaborates short-, mid- and long-term objectives for renewable energy. The objective is to increase the share of renewable energy in Poland's primary energy balance to 7.5% in 2010 and to 14% in 2020. Biomass energy is recognised as the most promising and most important renewable energy source in the 10–20 year time-frame (Fig. 3). However, it is also noted that in order to increase utilisation of biomass as well as other renewable sources of energy, the state must create the necessary market conditions and support systems. The objectives are expected to be met through the implementation of support programmes for particular renewable sources and technologies. The first step in this direction was the ''*Wind Energy Development Programme 2002–2005*'' which was completed in 2002 but has not been adopted due to political reasons—allegedly the policy would mainly support foreign manufacturers.

The *''Energy Act''* contains two elements of particular importance for the development of bioenergy and renewable energy in general. One is the *''Electricity Feed-In Ordinance''* and the other is the obligation on municipalities to prepare local energy plans. The *''Electricity Feed-In Ordinance''* obliges electricity suppliers to provide an increasing share of electricity from renewable sources in their supply mix, increasing from 3.1% in 2001 to 9.0% in 2010. The ordinance, however, has failed so far to produce the stable market conditions sought by investors. Prices have been negotiated on a case-by-case basis, in principle based on avoided costs, and have been on average 175 PLN/MWh. Up until 2004, there was no mechanism to enforce compliance and no scheme for renewable electricity certificates trading. Since 2004/2005, such mechanisms have been introduced and future compliance is expected. The local energy plans should include an account of possible ways of utilising local energy sources but the experiences so far have been mixed. Many local governments do not have the capacity to prepare good plans and the *''Energy Act''* does not specify any deadline for the preparation of plans. Only about 10% of the municipalities have prepared energy plans so far.

Bioenergy R&D is another important component of a coherent policy and a strategy to develop bioenergy. There has not been any coordinated bioenergy research programme in Poland so far. The current fragmentation is partly due to lack of coherence in energy, environmental, agricultural and research policies, and partly due to the lack of coordination and planning of government R&D funding in general. Various projects are financed through state funds (i.e., The State Committee for Scientific Research), and the EU programmes. A recent estimate is that the yearly budget

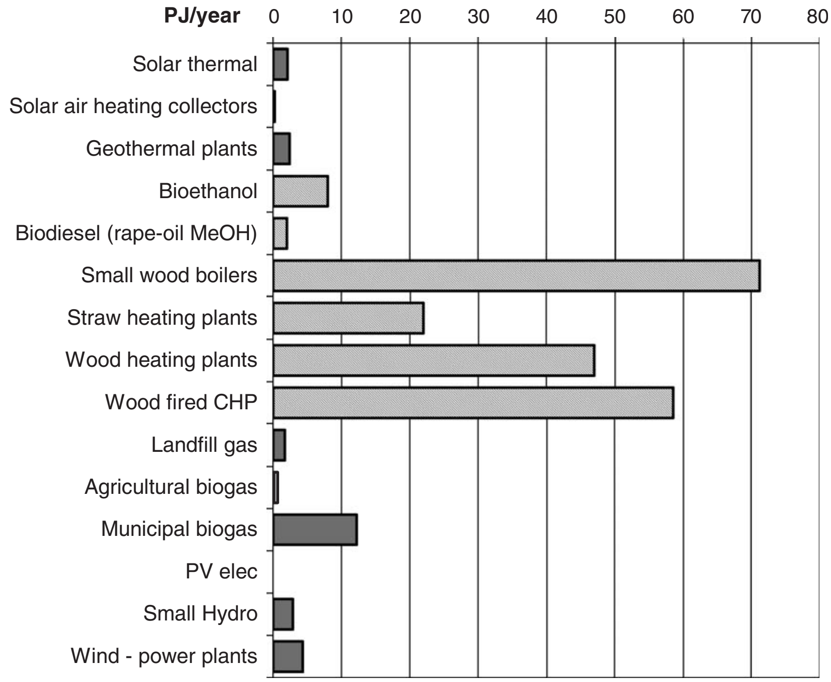

Fig. 3. Targets of renewable energy production in 2010 assumed in the Development Strategy of Renewable Energy Sector (Ministry of Environment, 2000a).

for bioenergy was about 10 MPLN in 2002 involving about 160 people at about 40 institutions (ECBREC, 2003). Since 2002, a joint research group, supported by the State Scientific Committee, is under development which aims for bioenergy R&D coordination.

4.2.2. Forestry and agricultural policy

The utilisation of logging residues for fuels has so far not received much attention in forestry policy or forestry management recommendations. The recommendation from forestry experts has been to leave the residues at the felling site as they are, or after chipping, rather than producing wood chips for energy (Muszyński, 2001). Another common method is to burn them at the felling site. Logging residues are generally considered a problem because of fire risks, or as a source of various wood diseases, and burning them solves these problems. However, the practice of utilising logging residues for wood chips production is expected to grow based on the experience from the Nordic countries and due to the ambitions to increase renewable energy (Rzadkowski, 2000). One forestry policy objective is to increase the forested area through the "*National Programme for Augmentation of Forest Cover from 1995*" (Puchniarski, 2000). The increase of the forestry area is driven by the environmental policy goals in Poland aimed at the afforestation of 0.7 Mha poor and marginal agriculture areas by 2020 and 1.5 Mha by 2050.

The agricultural sector is facing considerable restructuring, most likely resulting in larger farms and fewer jobs. Roughly 18% of the employed in Poland work in agriculture. This is about four times higher levels than the EU average, and the share of agriculture in GDP is twice the EU average (Kuik and Oosterhuis, 2001). In addition, there are large regional disparities in income, and unemployment rates go as high as 40% in some rural areas. The average size of private farms is small, less than 8 ha nationally and about 4 ha in Southern Poland, although farms above 20 ha account for more than 40% of the agricultural production. Without subsidies to preserve the current structure, modernising agriculture will lead to larger farms, less employment, higher yields and surplus agricultural land. The development of rural energy infrastructure is one objective of the agricultural policy (Ministry of Agriculture, 1998). However, it does not express any special role for renewable energy. As in many other countries, the focus is mainly on supporting the production of bio-ethanol and bio-diesel which would motivate continued cultivation of conventional crops.

4.3. Financing bioenergy

Bioenergy in Poland has been supported mainly through grants and soft loans, typically made available through bilateral financing. Environmental taxes, or tax exemptions, have been of less importance. Essentially, all investments in industrial and district heating applications have been made with 30–50% investment subsidies. The main sources of support include the National Fund for Environmental Protection and Water

Management (NFEP), Voivodship Funds for Environmental Protection, the Ecofund Foundation (EF, capitalised through debt-for-nature swaps), Bank of Environmental Protection (BOŚ), Agricultural Property Agency (APA), and the Global Environment Facility (GEF). Although these funds have a broader environmental mandate, support for bioenergy projects, notably in district heating applications, has been an important part of the project portfolios (Fig. 4).

We estimate that over 60 MPLN (40 MPLN as investment grants and 20 MPLN soft loans) have been directed to bioenergy projects since 1990, not including support from Voivodship Funds (ECBREC, 2003). Some of the projects were funded through bilateral co-operation with Sweden (Sida—the development co-operation agency), Denmark (Danish Energy Agency), Finland and The Netherlands (AIJ and JI programmes). For the next 5 years, we estimate that the annual allocation of grants and loans for bioenergy may be in the range of 10–20 MPLN (2.5–5 MEUR). The number may double or triple if larger bioenergy projects, notably biomass CHP, are implemented. Currently, a few such projects are discussed and feasibility analyses are being undertaken. Future funding may also be available through European Union structural funds

There are expectations that JI will become a significant source of funding. Poland has been engaged in this activity since 1995 and several AIJ and JI pilot projects have been implemented, notably together with Norway, Canada, Finland and The Netherlands. The most important JI funds so far are PCF and the Dutch ERUPT programme. Both have short-listed various renewable energy projects including biomass CHP, landfill-gas and biomass district heating projects. PCF has planned to contribute investments support of 10 MUSD until 2008. However, these projects have been hampered by the fact that Poland is still missing a clear climate policy and a proper regulatory framework. National priorities for JI are renewable energy (especially small- and medium-scale biomass district heating, wind, geothermal), coal-to-gas, CHP, energy efficiency, and forestry activities. Coal-to-gas and energy efficiency projects have dominated so far. CO_2-eq reduction cost estimates vary widely. According to some recent studies, the reduction costs for coal-to-gas CHP projects were 26–33 USD/tCO_2-eq and 54 USD/tCO_2-eq for biomass CHP projects (PSE, 2002). ECBREC analyses show costs of 5–50 EUR/tCO_2-eq for small coal-to-biomass conversion projects in district heating.

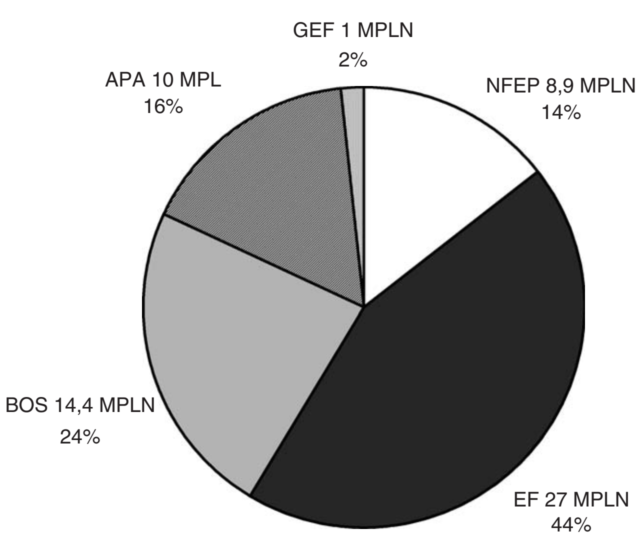

Fig. 4. Financial support for bioenergy in Poland 1990–2002 estimated by ECBREC (not including the support from 16 Voivodship Funds). Sources include Ecofund, 2002; Bzowski, 2003b; Kasprzak, 2002.

5. Actors

Several different actors may be involved in the development of bioenergy systems. The most important ones on the supply side include forest owners, wood industries, and farmers. Potential users of bioenergy range from individual households to large CHP and power plants. Policies and measures to stimulate the growth of bioenergy should be sensitive to the characteristics and context of different actors in order to be effective.

The National Forestry Holding manages 7.5 Mha which equals 78% of all forested areas. The State Forest Holding employed 32,300 people in 2001 and the yearly turnover reached 3709 MPLN in which wood sales income accounted for 79% (State Forestry Holding, 2003a). Developing bioenergy supply is contingent on acceptance for the extraction of forestry residues and the introduction of new management practices and harvesting schemes. Whether the centralised character of forestry in Poland can facilitate or hinder the utilisation of forestry residues is not clear. Extensive testing and field trials, monitoring, for example, environmental effects, will be needed in order to build capacity and acceptance in the National Forestry Holding. The forestry sector is currently not as developed as in other member states in terms of harvesting schemes, machinery, logistics and wood fuels production but it is well organised in terms of administration,[5] wood production schemes, environmental protection and cooperation with the wood industry.

Wood industries are currently the most important suppliers of bioenergy. Poland is also a large

[5] State Forestry Holding administration is structured with 17 regional directorates (which make independent forestry management plans, wood production and forestation). Regional directories manage 439 forestry districts and 26 service departments (e.g., transport and forwarding, storage, forest services, fisheries holdings, and training centers).

particle- and fibre-board producer with an annual production that reached 3.7 Mm^3 in 1999 (Ratajczak, 2001). There is now a growing competition for raw material between the production of board and pellets. In all, this may create incentives for the forestry sector to increase the production of wood chips and extraction of residues. The forestry industry developed the technical capacity and know-how for virgin wood chips production in the early 1990s when particle- and fibre-board production increased. This provides a good basis for the development of forestry fuels production with the use of existing infrastructure, engineering know-how and logistics. A growing demand for pellets and briquettes provides an opportunity for wood industries to diversify and improve the utilisation of by-products.

Farmers play a less important role in bioenergy supply so far. However, agriculture presents a large potential for straw, including the technical, organisational and engineering capacity for straw harvesting, pressing and supply for energy. Demonstration projects and information efforts would stimulate an increased production of straw for energy if there is market demand. It is a greater challenge to develop the large potential for energy crops cultivation. For this purpose, a stronger effort is needed in capacity-building and creating incentives through coherent agricultural and energy policy and targeted support schemes. However, as in other Member States, this sector is now mainly focused on conventional crops for bio-ethanol and RME production. A first step towards perennial energy crops could be extensive demonstration activities in first phase of implementing the CAP. Energy crops may not create more jobs but it can cushion the effects on employment of the restructuring of agriculture.

Small- and medium-scale CHP and heat boilers in district heating, as well as individual boilers in dwellings and other buildings, appear to be the most promising applications for bioenergy, in particular because sulphur emissions from coal-firing are reduced. The interest in using bioenergy is still relatively weak, but it is increasing. Various demonstration projects in small-scale district heating show both positive and negative results in terms of project development, technological problems and biomass supply. In the short term, development is expected to continue in district heating below 20–30 MW on the basis of partial financing from NFEP, Ecofund Foundation and Voivodship Funds. In the domestic sector, some users have switched to firewood in response to the higher coal prices in northern Poland. Firewood, as well as pellets, may become an important option in new small-scale installations if there is a relative price advantage. However, fossil fuel taxes may be needed to promote domestic demand and avoid that pellets, as presently, are mainly exported.

Since 1989, district heating plants have been controlled and mainly owned by local government at the municipal, or gmina,[6] level. The Energy Act of 1997 (which requires development of local energy plans by each gmina or powiat) gives local authorities an important decision-making role in energy supply planning, including liquid and gaseous fuels supply, energy efficiency programmes, and implementation of renewable energy technologies. Thus, local decision-makers play an important role for the bioenergy development especially in the district heating sector as most of the district heating systems are still municipally owned. Owners of district heating systems are likely to respond to economic policy instruments promoting bioenergy since the fuel-flexibility in currently coal-fired boilers is relatively high.

Large CHP and power plants have the option of co-firing with coal. This can be an important component in a strategy to develop the fuel market and bioenergy logistics. Larger-scale CHP plants and power plants have not been interested in bioenergy due to the uncertain system of renewable electricity purchases, the yet early stage of wood fuels market development, and relatively low costs of heat and electricity production based on fine coal combustion. However, interest is growing rapidly as compliance with the renewable electricity quota obligation is increasingly enforced. Under the quota obligation, somewhat increased electricity production costs from co-firing can easily be passed on to the consumers. These professional actors can respond quickly to this policy instrument through minor technical modifications and installations of new burners in existing plants. In principle, all of the near-term wood fuel potential of 5–7.5 Mm^3 (residues and fuel wood) could be absorbed by co-firing 10–15% biomass in electricity production (Ljunggren and Berggren, 2004). The draw-back of co-firing is lower environmental benefits compared to small-scale fuel conversions, and that ash-recirculation is not possible.

Another important factor for the development of bioenergy may be the presence of *international energy companies* (such as, French EdF, German MVV and RWE, and Swedish Vattenfall and Sydkraft) that have been active in Poland since the early 1990s. For example, MVV and Sydkraft have invested in district heating companies and MVV owns a 30 MW biomass-based CHP system supplying heat to a wood joinery factory. Vattenfall and RWE own CHP plants and distribution grids. Many of these companies bring with them experience of bioenergy from other countries. They also generally claim an interest in the development of bioenergy applications in Poland but no broader strategy or major investments have been presented or undertaken yet.

[6]Gmina—is the lowest administrative level. Poland has 16 voivodships (regions), 373 powiats (counties and larger towns with powiat status), and 2489 gminas (local municipal administrative level).

6. Discussion and conclusions

Poland has a large potential for bioenergy but fundamental driving forces, in terms of demand growth for heat and electricity, energy security, or environmental protection, for increasing the use of bioenergy in the short term are lacking. The high level of self-sufficiency through domestic coal resources and associated infrastructure has slowed the diversification of energy supply. Energy policy in the 1990s was largely focused on increasing the supply of liquid and gaseous fuels, and reforming the energy markets. The *''Development Strategy of Renewable Energy Sector''* adopted in 2000 essentially marks the start of renewable energy policy development in Poland. The main driver for renewable energy is the 7.5% target assumed when joining the European Union. However, except for the renewable electricity quota obligation, energy policy instruments for promoting bioenergy are undeveloped. In addition, forestry and agricultural policy and practices are not coherent with the assumptions for bioenergy development in the renewable energy policy. The experience from other countries is that it takes time to develop bioenergy markets, partly due to the complexity of bioenergy systems and the involvement of many actors.

The bioenergy market in Poland is still at an early stage of development. Some investments, supported through various funds, have been made in the past few years, for example, in modern biomass fired boilers and pellets production, but the main use of bioenergy is still as firewood in the domestic sector, typically in old boilers or furnaces. Biomass energy in Poland competes with fossil fuels in small-scale district heating applications and for individual boilers depending on local availability of fuels and the geographical location. Bioenergy is generally less expensive than fuel oil and natural gas. It also competes with coal in some of the northern voivodships where long transportation distances are adding to the price of coal. However, economic incentives would be needed to tip the scale in favour of bioenergy in small-scale district heating and the domestic sector. Overall, we expect that continued support through investment grants and JI projects will result in steady but low growth in small- and medium-scale applications.

Relatively high fuel flexibility in the production of heat and electricity means that many actors in this sector can respond quickly to relative fuel price changes or quota obligations. From this perspective, it is a strategic near-term choice whether bioenergy should be supported to be used as a neat fuel in smaller plants or for co-firing in larger plants where the environmental benefits are likely to be smaller (at least for clean biomass fuels). In principle, Poland has already made this choice through implementing a quota obligation that can be expected to increase co-firing for electricity production considerably in the near future, as enforcement has now become stricter. EU emissions trading will provide additional incentive for plants covered by the scheme.

The quota obligation which marginally increases electricity production costs is probably politically more palatable than introducing general fossil fuel taxes that impose a greater economic burden on all consumers. High carbon taxes on fuels for heating, the main driver behind the rapid expansion of bioenergy in Sweden during the 1990s, are probably not a political option in Poland in the near future. Co-firing is a low-risk strategy in a nascent biofuel market since the impact on the plant of a fuel shortage is limited. Flexible demand through co-firing could also be a strategy to facilitate the development of Salix cultivation. However, it would be unfortunate if the biomass resources are exclusively used for co-firing since this strategy does not fully realise the advantages of bioenergy when it is used as a neat fuel in smaller applications. We therefore recommend that the development is closely monitored and additional measures considered so that a balance can be struck between demand in small- and medium-scale heating applications, and demand for renewable electricity production through co-firing. Stimulating demand in heating applications is also necessary for reaching the overall 7.5% target.

In the near term, the expanded use of bioenergy for heat and electricity does not conflict with the ambitions to increase the use of biomass-based transportation fuels. In the longer run, strategic choices must also be made concerning the use of surplus agricultural land—whether for starch-rich crops for ethanol production, or for cellulose-rich crops for the production of liquid and gaseous fuels, or for cellulose-rich crops to be used for heat and electricity production. Many other countries are faced with the same choice.

On the supply side, the forestry sector is highly centralised in Poland through the State Forestry Holding. Forestry policy needs the development of guidelines and regulation for logging residue management as well as ash re-circulation for nutrient recirculation, and other environmental measures. Research, demonstration and information dissemination and other forms of capacity building is needed to support acceptance and increased forestry fuels production. It also requires an openness to change in this centralised sector. The potential for forestry residues is somewhat uncertain. In some areas it is common that people collect firewood from the residues. The Nordic experience, mainly based on spruce, cannot be directly transferred since the main species in Poland is pine. A learning-by-doing approach is needed to explore the specific barriers and opportunities in Poland.

One of the biggest challenges in Poland, as well as the rest of the EU, lies in restructuring the agricultural sector. Poland will develop the inventory systems for production subsidies under CAP rules within the next few years. Producing biofuels from starch- or oil-rich plants is seen as the main option in this sector, as in many other European countries, although the environmental and economic rationale is weak. The development of energy crops in Poland will depend strongly on CAP and resulting domestic policies. The Swedish company Agrobransle, specialised in Salix cultivation, has established a branch in Poland. The Ecofund Foundation and some of the Voivodships funds have shown interest in supporting Salix cultivation for energy but no large demonstration projects have been implemented yet. Better integration of energy and agricultural policy is probably a necessary condition for an expansion. In addition, support for energy crops is best administrated by the agricultural sector. As in forestry, there is a strong need for learning-by-doing and other forms of capacity building, in addition to economic incentives. However, under the accession treaty, Poland was getting only 25% of the level of agricultural subsidies under CAP during 2004, increasing to 100% until 2014. Poland is not eligible for the 45 EUR per hectare support for energy crops and a significant expansion under current conditions is unlikely.

In summary, the continued development and direction of bioenergy will depend on the political will and determination to pursue different options through financial incentives, including (i) continued investment support and priority in future JI projects, (ii) fossil fuel taxes, production subsidies, and feed-in or quota systems, as well as (iii) co-ordinated and expanded RD&D efforts, and (iv) building capacity, consensus and acceptance among key actors and policy-makers in different sectors. In response to the lack of policy coherence in the area of renewable energy, the development of a *"National Renewable Energy Act"* has been proposed. This would serve as more stable legal basis for renewable energy and bioenergy investments (Oniszk-Poplawska, 2003). There have been several attempts to develop a renewable energy act in the last few years. Recently, some specific components relating to the quota obligation and its enforcement were included in the amendments to the "*Energy Act*" and further work on a renewable energy act was then suspended, hence putting an end to the ambitions for a stable and coherent framework, at least temporarily.

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