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Energy Crops: Stakeholder Identification and Analysis

A Case of Belarus

Alesia Israilava

Supervisors

Philip Peck

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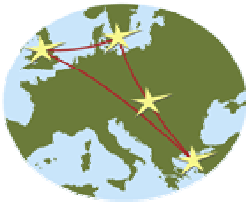

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Abstract

Belarus is subject to serious energy security issues due to limited domestic energy resources; a low diversity in the national energy profile, significant depreciation of capital assets in the Belarusian energy system, a high share of energy resources import, and a dominating dependence on one energy importer – The Russian Federation. In response to these issues the country is very interested in diversifying its energy profile, development of non-conventional renewable energy types and increasing the share of local energy resources. Introduction of short rotation willow crops is one strategy under examination. When willow is grown for energy purposes, it has the potential not only to contribute to the energy security enhancement, but also yield co-benefits in economic, environmental and social terms. Currently energy crops based energy is in the stage of early development.

Development of this energy option depends on a range of stakeholders, as well as economic and legislative settings. This work involves the identification of stakeholders in relation to short rotation willow crops (on any stage of their life cycle including cultivation and utilization of biomass), and then their interviewing in order to depict their interests, perception of other stakeholders, and existing coordination between them. All stakeholders identified are analyzed then in terms of attributes of power, legitimacy and urgency for defining those stakeholders that influence the development of short rotation willow crops most.

The research reveals the general interest in the development of this energy option on the side of the national government, but low current interest on the side of most stakeholders. Moreover, there is a weak interaction between stakeholders, a factor that is held in this work to be mainly attributed to limited knowledge and experience on this technology. However, the current economic and legislative settings do contain tools for stimulation of renewable energy development, inclusive of energy crops. Such items include reduced environmental tax and indexed tariffs for bioenergy that will provide financial incentives and the coming law on non-conventional and renewable energy that will provide for stimulation tools for renewable energy.

Executive summary

Energy security is regarded as "the availability of energy at all times in various forms, in sufficient quantities, and at affordable prices" and might be threatened by low diversity of energy profile and high import share, making energy system and, thus, national economy more vulnerable (UNDP, UNDESA and WEC 2004). Belarus, characterized in terms of energy by limited national energy resources, low energy profile, depreciation of capital assets in Belarusian energy system, by high imports of natural gas and oil as well as heavy dependence on neighbouring jurisdiction – main energy supplier The Russian Federation – makes Belarus subject to serious energy supply security issues. This situation makes it very important to increase the share of national energy resource in the energy profile, mainly by involvement of local energy resources and development of non-conventional renewable energy types.

Bioenergy seems to have high potentials for development in Belarus and contribution to the energy security enhancement strategies. Among various bioenergy options, the cultivation of short rotation willow crops with further combustion of harvested biomass in conversion facilities promises to be an attractive option, as it might not only contribute to the substitution of fossil fuels and, thus, energy security enhancement, but also provide for the involvement and reclamation of large areas of low quality and contaminated lands, reduction of GHG emissions, as well as respond to some social and economic issues. However, the development of SRWC based energy will depend on the stakeholders involved, current economical and legislative settings and some more factors. Thus, the research questions of this master thesis are:

What are potential benefits and co-benefits of the agro-biomass production system in the context of Belarus?

Who are the stakeholders and what are their interests, roles and power to influence the success of the system?

How feasible is it to establish agro-biomass production system in Belarus?

Methodology of the research is based on the definition of a *stakeholder* - *"a person or group who have a vested interest in a particular project, activity, or issue because they are involved in it or affected by it"*[1], and includes, firstly, investigation of benefits and co-benefits divided into four categories - energy security, economic, social and environmental dimensions – and then, in the main focus, identification and analysis of stakeholders within the framework of the theory of stakeholder identification and salience (Mitchell *et al.* (1995). Within this framework, stakeholders are analyzed in terms of possession of three attributes of *power*, *legitimacy* and *urgency*, and according to being attributed with the combination of these attributes are grouped into the categories of latent, expectant and definitive stakeholders, divided to more subcategories. According to the analysis as much as 8 stakeholders in relation to short rotation willow crops belong to the category of *Dominant Stakeholders* due to possession of *power* and *legitimacy* attributes: from these the Government, the Ministry of Energy and agricultural productive cooperatives are assumed to have the highest possibility to become *Decisive Stakeholders*, upon their current interests reaching some degree of urgency.

At the moment the interaction and cooperation between the stakeholders is rather weak, mutual understanding of the goals is absent or insufficient. As regards establishment of plantations, still there is no clear picture which sector has to be involved: agricultural or

[1] Dictionary of Environment and Conservation. Chris Park. Oxford University Press, 2007. Oxford Reference Online. Oxford University Press. Lunds universitet. 27 February 2008 http://www.oxfordreference.com/views/ENTRY.html?subview=Main&entry=t244.e2385

forestry. Insight in both sectors shows that, first of all, both have rather blurry perception of rationality of their own involvement, and, secondly, that the wider adoption of technology in the sector may develop in both directions – downstream from the Ministry to the production units, and upstream. In regards to conversion facilities, they are small-scale facilities that are deemed to be involved first of all, like newly established mini-cogeneration plants and re-equipped boiler-houses. Changes of interest and urgency may become possible due to various factors, including changes in policy and influence of economic and legislative settings, as well as production costs reduction. The current price of SRWC chips - 3.4 €/ GJ – is regarded high by stakeholders, however, in the light of rapidly increasing international as well as importing prices for Belarus for fossil fuels, this feedstock might soon become competitive.

The main conclusions, drawn upon the findings of the paper, are:

1. SRWC may potentially yield certain benefits and co-benefits; those that are expected by majority of stakeholders include substitution of fossil fuels by contribution to local renewable energy and decentralized distribution, involvement of low quality lands and reduction of GHG emissions. Meanwhile, financial co-benefits promised by bioenergy in the light of Kyoto Protocol, as well as social and economic co-benefits receive much less attention.

2. A list of stakeholders have been identified in relation to short rotation willow crops and analyzed in terms of influence on adoption and dissemination of this energy option. As a result, Government, Ministry of Energy, Ministry of Forestry, Ministry of Agriculture and Food, Energy generation sector, Housing and communal services, Agricultural productive cooperatives and Forestry associations have been identified as dominant stakeholder group who lacks only urgency of their interests that will transfer them to the most important group – decisive stakeholders. According to the collected information and author's assumption biggest interest is on the side of the Government, the Ministry of Energy and agricultural productive cooperatives.

3. A set of economic and legislative mechanisms has been identified in relation to the stimulation of renewable energy, inclusive of SRWC: reduced environmental tax, indexed prices for bioelectricity, Bioenergy Revolving Fund, however, they are rather immature to consider their effectiveness. Legislation on renewable energy that is to be enacted soon is expected to contribute to its dissemination and success; besides, benefits might accrue from Kyoto Protocol mechanisms as well.

4. Feasibility of dissemination of SRWC also depends on coordination and cooperation between various stakeholders, but those components are either insufficient or even absent at the moment. It is still unclear which sector will be involved in cultivation of the biomass, and actually none of them has urgent interest, while uncertainty also exists on the side of conversion facilities. Moreover, interaction between them in terms of supply-demand relationship creation is close to zero: plantations in the forestry sector are established while the consumer is still uncertain. One of the possible schemes is cultivation and conversion by agricultural productive cooperatives for their own energy needs.

5. The development will further be influenced by governmental policy and control, wider introduction of mini-cogeneration plants and re-equipment of boiler-houses to wood resources utilization, reduction of production costs, serving as drivers, while competition with another, cheaper bio-resources like forestry residues, as well as high production costs due to certain niche of lands used (the lowest quality), currently perceived by stakeholders as too high and unattractive, serving as barriers.

Upon the findings, the author drew recommendations on:

- The establishment of coordination between stakeholders at various levels;
- More efficient execution of power by the government at various levels (from national to local);
- More active involvement of the Ministry of Agriculture and Food;
- The development of pathways for short rotation crops to benefit from Kyoto Protocol upon its amendment ratification.

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1 Introduction

1.1 Background

The sustainability of development is regarded as having three dimensions: economic, environmental and social, with energy being an important aspect of each dimension of human development (IEA and OECD 2004). Energy sustainability, according to the World Energy Outlook is,

> *"Requires meeting our energy needs upon which economic development depends, while protecting the environment and improving social conditions* (IEA and OECD 2004)*".*

Thus, for sustainable energy future to become a reality, all those components have to be integrated into energy options considerations and among themselves.

The dependence of economy on energy supply security is obvious and is targeted by global, regional and national policies. For example, The European Union (European Commission Green Paper COM (2000) 769 final) defined its strategy for energy supply security: "[it] must be geared to ensuring, for the well-being of its citizens and the proper functioning of the economy, the uninterrupted physical availability of energy products on the market, at a price which is affordable for all consumers (private and industrial), while respecting environmental concerns and looking towards sustainable development"[2]. Thus, from the broad perspective of energy security as "the availability of energy at all times in various forms, in sufficient quantities, and at affordable prices" (IEA and OECD 2004/ UNDP, UNDESA and WEC 2004), the share of own and imported energy resources in energy balance, as well as diversity of energy profile in terms of energy carriers and importers are important features of national energy system. In the case of energy import, dependence on one main energy resource and on one main importer makes energy system and national economy more vulnerable.

Moreover, the issue of energy security is even of more importance for countries with economies in transition (EiT), which experience many reforms in terms of economy and legislation during the shift from centrally planned to market-based economy. These reforms undoubtedly affect energy systems. For example, Belarus – an EiT country – firstly experienced an economic decline when the reforms came into force in the 1990s, but later its economy revived owing to market-economy mechanisms and government policy, that were targeting cost- and energy-efficiency (MNREPRB 2006). However, Belarus has limited national energy resources, and energy statistics (IEA 2007) makes it obvious that the country is among most energy importing Europe's countries: its net imports in 2007 constitute 85% from TPES[3], moreover, its main supplier is one country - The Russian Federation. On the other hand, country's location between a major energy exporter - The Russian Federation - and a major energy importing region of The European Union has certain implications on economy and energy system, mainly reflected in negotiated prices which has been lower for Belarus then for other countries for a long time, however, recently this difference is decreasing fast. Energy indicators like total primary energy supply (TPES), energy production and net imports are organized in the Table 1-1.

[2] European Commission Green Paper COM(2000)769 final, p.11.

[3] total primary energy supply

Table 1-1 Selection on key energy statistics for countries in Europe and calculated share of energy import

Country	Net energy import, Mtoe	TPES, Mtoe	Share of energy import in TPES, calculated	Country	Net energy import, Mtoe	TPES, Mtoe	Share of energy import in TPES, calculated
Austria	24,76	34,36	0,72	Lithuania	4,87	8,59	0,57
Albania	1,23	2,40	0,51	Luxembourg	4,68	4,78	0,98
Belarus	22,71	26,59	0,85	the FYR of Macedonia	1,24	2,74	0,45
Belgium	50,89	56,65	0,90	Moldova	3,47	3,56	0,97
Bosnia and Herzegovina	1,56	4,96	0,31	Netherlands	37,86	81,85	0,46
Bulgaria	9,52	20,06	0,47	Norway	-200,44	32,12	-6,24
Croatia	5,20	8,89	0,58	Poland	16,68	92,97	0,18
Czech Republic	12,72	45,21	0,28	Portugal	24,55	27,17	0,90
Cyprus	2,86	2,55	1,12	Romania	10,21	38,34	0,27
Denmark	-10,52	19,61	-0,54	Serbia and Montenegro	5,25	16,66	0,32
Estonia	1,49	5,10	0,29	Slovak Republic	12,31	18,83	0,65
Finland	19,51	34,96	0,56	Slovenia	3,88	7,31	0,53
France	143,30	275,97	0,52	Spain	124,68	145,20	0,86
Germany	241,47	344,75	0,70	Sweden	20,11	52,17	0,39
Greece	23,13	30,98	0,75	Switzerland	16,43	27,15	0,61
Hungary	17,58	27,76	0,63	Turkey	61,89	85,21	0,73
Iceland	1,08	3,63	0,30	Ukraine	59,70	143,24	0,42
Ireland	13,80	15,29	0,90	United Kingdom	32,26	233,93	0,14
Italy	159,33	185,19	0,86				
Latvia	2,79	4,72	0,59				

Source: IEA (2007)

So, Belarus in terms of energy is characterized by high imports of natural gas (the major imported energy resource) and oil as well as by depreciation of capital assets in Belarusian energy system (CMRB 2004). This heavy dependence on neighbouring jurisdictions – main energy supplier (Russia) – makes Belarus subject to serious energy supply security issues. Moreover, there are fluctuations in price of energy carriers, increasing the economic vulnerability: recent rise in gas prices resulted in increased prices in general in Belarus.

An increase of local, renewable energy resources share contributes to the diversification of energy profile and enhancement of the security of supply. However, in many cases renewable and alternative energy resources remain more expensive then traditional fossil fuels, which is very much true for bioenergy. Nevertheless, some steps are being undertaken on international arena as well as by national governments to support development of bioenergy and make it more competitive. On one hand, mechanisms that discriminate fossil fuels are employed, for example, increase in prices of fossil fuels due to carbon charges (applied to the use of fossil fuels) and/ or energy taxes (from which biofuels are excluded), introduced in some countries, for example, Sweden as well as the rises in international prices (Swedish Energy Agency 2007). On the other hand, the mechanisms that support renewable energy are introduced, inclusive of funded research, feed-in tariffs, renewable energy certificates, etc. (Sims 2004b).

Among various types of renewable energy biomass seems to have some advantages as it can be stored and can be feedstock for energy demands like heat, electricity, transport fuels, and from The European Union's perspective is an important contributor to the renewable energy objective (Sims 2004a). According to World Energy Outlook projections, biomass will be used mainly for decentralized electricity and heat needs, as well as for co-firing with coal for GHG emissions reduction, but in small shares (IEA and OECD 2004).

However, biomass, like many other renewable energy sources, is competing with traditional fossil fuels like coal, gas and oil, and so far generally remains a more expensive option. Unfortunately, the trend might be the same as long as exploration costs for fossil fuels, as well as greenhouse gas emissions, are not taken into consideration in the supply costs calculations. Thus, if bioenergy is to become more competitive and successful in future, all the associated benefits in economic, social and environmental terms, like reduced emissions, development of local energy resources, and many other, should be taken into account when comparing this type of energy to the traditional fossil fuels (Sims 2004b). However, in the light of rising world prices for fossil fuels it might become more competitive. In fact, prices for crude oil have been increasing rapidly in last 3 years according to IEA statistics, the trend is depicted in the Figure 1-1.

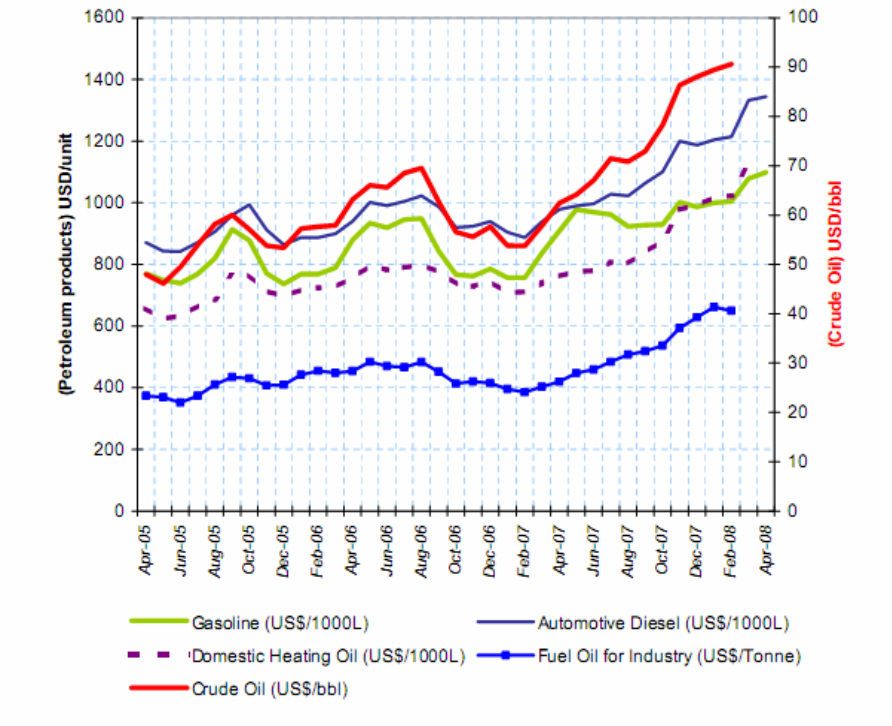

Figure 1-1 End-user petroleum product prices and average crude oil import costs

Source: International Energy Agency

CHP or co-generation is regarded as a highly efficient way of biomass conversion: electricity is generated in a steam or gas turbine driven by the biomass combustion, and while the heat is produced from the process "waste heat". Biomass feedstock ranges from energy crops like SRC willows to forestry residues, animal waste, etc. The main stages in the process are the cultivation of the trees, harvesting, transportation to the power plant, combustion and harnessing of the energy released (Feehan and Petersen 2004).

Willows belong to the range of short-rotation crops grown and further used for energy purposes. Such bioenergy systems can be found in Sweden, UK, Northern Ireland and some other European countries, as well as in the USA, providing knowledge and experience to other states. For example, in Sweden, research on possibilities of growing energy crops (mainly

willows) and further use as fuels started in 1970s and was introduced on the commercial scale in the beginning of 1990s (Rosenqvist *et al.* 2000). In OECD countries where agricultural and energy subsidies are minimal or do not exist, biomass produced from purpose-grown crops (rather than from waste organic products) competes better with coal and natural gas in the heat market rather than with traditional forms of generation in the electricity market (Sims 2004a).

Meanwhile, one of the main issues related to the expansion of biomass energy, and energy crops cultivation, is the competition with production of food and fiber in terms of land use. Set-aside lands seems to be a solution, but only partial, as there are environmental concerns about bringing this type of lands back to activities (Parris 2004). However, on the other hand, capability of such short rotation crops as willows to take up nutrients and absorb radionuclides and heavy metals also makes them suitable for water purification and reclamation of contaminated lands. The willows have been shown to be adaptable as vegetation filters in order to purify water and soils. The purification efficiency of willow vegetation filters has been demonstrated in several countries, such as Sweden, Poland, Denmark and Estonia (Feehan and Petersen 2004).

This might be of a potential interest for Belarus as cultivation of energy crops, such as willows, will allow for involvement of those lands that are not used at the moment: abandoned, of low productivity, degraded, post-mining, areas contaminated with heavy metals and radionuclides, unused forestry areas. In fact, according to various statistical data, as of January 2007, unused abandoned (mainly due to low productivity) lands constituted approximately 580 thousand ha (2.8 % of total available Belarusian lands), contaminated with radionuclides areas that are out of agricultural activities - 250 thousand ha (1.2 %) (MNREPRB 2007). As for post-mining soils, in 2004 the area of constituted 180 thousand ha (0.8 %) (CMRB 2004). Thus, energy crops grown on these lands will provide for significant amount of biomass feedstock, substituting use of fossil fuels.

Bioenergy is an attractive energy option to reduce greenhouse gas emissions under the Kyoto Protocol. The cultivation and use of biomass can have a neutral carbon dioxide balance. If grown sustainably, the amount of CO_2 extracted from the atmosphere during biomass growth is equal to the amount emitted in the process of biomass combustion (Hall *et al.* 1993, EREC 2004). Belarus is an Annex I Party to the United Nations Framework Convention on Climate Change (UNFCCC) and from 2005 is a full Party to Kyoto protocol. At the moment an amendment by which Belarus is included in Annex B with 95% obligation on GHG emissions reduction is pending on signing by the parties to the Protocol.

Besides the environmental benefits, biomass-based energy systems may yield economic and social gains: particularly, energy crops based systems are of special interest because they require involvement and, thus, utilization, development and diversification of agricultural sector as feedstock comes from this sector of economy (Parris 2004). This is another reason for Belarus to be interested in energy crops, as agriculture is a significant sector of state's economy: in 2004 its share in GDP constituted 9.7%, though reduced from 1997 level of 12.8% (EEC 2005). Also, renewable energy generally is regarded as more labor-intensive than traditional energy conversion technologies (Berndes and Hansson 2007), creating a range of job opportunities, which is of particular interest for the rural regions.

However, wide application of energy crop production is determined by roles of various stakeholders and mechanisms of support. For example, in Sweden these factors that influenced the increase of short rotation crops production were the following (Rosenqvist *et al.* 2000; Roos *et al.* 2000):

- Increased environmental taxes (on carbon dioxide and sulphur) for fossil fuels,

- Subsidies for the dedicated energy crops plantations,

- Previously established market for bioenergy.

The economic mechanism of environmental taxes has been introduced in Belarus recently, however, the latter two are absent at the moment.

1.2 Research Problem and Research Questions

As it was discussed above, energy crops like short rotation willows in addition to being a renewable energy resource, available locally, and thus contributing to energy security enhancement, yield various environmental, social and economic benefits. However, development of any energy type depends on the state's policy in terms of energy and those conditions that favour or impede its development, such as taxes or subsidies. There might be stakeholders that influence favour the development as they have certain interests and power (or no real power to exert) to development pathway in that or another way, but there might also be other stakeholders that may impede the development of that energy option if they have other objectives or energy priorities. Thus, the analysis of stakeholders can provide for the insight into current situation or the future possible pathway of development for particular energy type (in that case – short rotation willow crops).

As it has been mentioned above, Belarus has several issues that might be vital pre-conditions for considering the establishment of energy crops based system and their dissemination:

- Energy security issues, conditioned by high import of energy and a low energy profile, thus, the need for wider utilization of locally available energy resources,

- Big areas of land with low productivity or contaminated with radionuclides, that need to be decontaminated and reclaimed and are potentially available for crops cultivation,

- Opportunities for fossil fuels substitution and for reduction of greenhouse gases (GHG) emissions,

- Social and economic aspects that might potentially benefit from short rotation crops based energy.

However, whether such a system will be developing depends on various stakeholders, as they might have different interests and priorities as well as power to satisfy their interests via mechanisms of influence. That is why, for the author of the paper it is of interest to investigate the potential of such system in Belarus. This includes investigation on current environment for development represented by stakeholders, as well as policy, legal and economic settings.

So far, there have been few projects in this country related to the research on willow growing technologies. Nevertheless, the research in a broader context, like the role of such energy crops in the energy system of the republic and its possible future, as well as the insight to the stakeholders, their interests and ways they can influence its success was not established so far. As such, the research questions of this paper are:

What are potential benefits and co-benefits of the agro-biomass production system in the context of Belarus?

Who are the stakeholders and what are their interests, roles and power to influence the success of the system?

How feasible is it to establish agro-biomass production system in Belarus?

As there is explicit political interest in short rotation forestry in Belarus, this analysis should be of interest for Belarusian decision-makers in various spheres, including energy and agriculture, at the national, regional or local levels, as well as for all relevant stakeholders. It is also expected to be relevant for researchers and students working in the field.

Assumptions

Short rotation crop-based energy is in its early stage of development in Belarus and has the potential to develop and disseminate. The stakeholders involved have various interests, power and influence on the success of its development. However, it may happen, that short rotation crops will not develop after the loss of interest on stakeholders' side due to various reasons. These can include low or zero profitability, low competitiveness with traditional energy resources and more.

In the context of this paper the author assumes that the technology of energy crops cultivation and combustion will be able to disseminate, and that the main crop to spread will be willow[4]. The author also assumes that cultivation and utilization of these energy crops has high potential of yielding described benefits as energy security enhancement and support of sustainable development in its three dimensions. It is also assumed that decision-making can be affected by the co-benefits promised by cultivation short rotation willows and their utilization for energy purposes.

1.3 Methodology

The initial investigation of the research problem has started with the short research paper[5] on the ARPEA course. This paper aimed towards understanding the main principles of the agro-biomass production systems, which already exist in some European countries, as well as the benefits brought about by such systems. Firstly, these benefits are divided into several categories: energy security, economic, social and environmental benefits. Secondly, these are benefits that have already been proved to accrue from energy crops based systems (also when such systems are integrated with others like that of wastewater treatment) or are promised by their establishment and are being investigated by academia. Benefits identified for Belarus and described in the part of the thesis devoted to the context of Belarus were proposed in the following way: they reflect existing issues and problems in terms of energy security as well as economical, social and environmental terms, and introduction of short rotation energy crops is regarded as the means that **might potentially be a partial or a full** solution to those problems, taking into account existing experience of other countries and results in the field of research.

The main focus of the research is on the stakeholders. To define stakeholders, the author decided to use the following definition of a *stakeholder* -

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[4] This assumption is based on the knowledge of several facts. Firstly, there is ongoing research on that crops in Belarus, that has already resulted in certain knowledge and experience (projects are described in the Chapter 3). Secondly, natural conditions in terms of climate, landscape and soil are described as suitable for this crop in Belarus (ISEU 2005, Vandenhove *et al.* 2002). Then, the lowest production costs are reported for this crops (Rosenqvist *et al.*). And finally, current interest of the government in terms of short rotation forestry relates firstly to woody cultures like willows.

[5] *Bioenergy crops: potential co-benefits. Case of Belarus*. Paper on ARPEA course.

> *"a person or group who have a vested interest in a particular project, activity, or issue because they are involved in it or affected by it'*[6],

This matches other definitions suggested by researchers on stakeholder theory, however, most of them are in the field of business and are focused on organization, while this definition is focused on project/ activity. Thus, in this case, it is any ministry, agency, company, organization, person, etc., that have an interest in energy crops, because they are involved in the stages of cultivation of crops, their processing or end-product consumption (energy in the form of heat and/or electricity) or are affected by them.

To make this process more structured and in order to embrace the majority of relevant stakeholders, the author used the list of stakeholders identified by Bouille and McDade in their paper, as playing important roles in approaching sustainable energy, and compiled in the following categories: government; productive sector; civil society / academia / media. This approach was adjusted and applied to energy crops analysis in order to identify relevant stakeholders, understand their roles, needs and ability to influence the development and success of energy crops based system to contribute to sustainability (2002). Stakeholders are described with the questions *why*, *who*, *what* and *how* with the following objectives: under *why*-question energy crops (willows), as a renewable source of energy available locally, will be described in the perspective of benefits for country in social, economic and environmental terms. The questions "*Who? What? And How?"* are used for spotting relevant stakeholders, describing their interests and needs, as well as roles and ways of influencing the development of energy crops based system. Investigation of experiences in Sweden, UK and USA, have a long history of growing energy crops – mainly short rotation willows – and their use in the energy generation sector aims at identification of those stakeholders. Furthermore, this investigation provided for better understanding of roles of various stakeholders, their contribution to the dissemination of energy crops based systems, as well as various mechanisms (government support, regulation, economic incentives, etc.) that influenced the development of technology.

The main part of research is devoted to collection of data on the Belarusian context of the issue – identification of stakeholders and gathering information on their interests and ways to influence the way of dissemination of energy crops based systems. Collected data then was analyzed within the framework of stakeholder identification and salience theory (Mitchell *et al.* 1997): upon defining stakeholder attributes of power, legitimacy and urgency, they are grouped in three categories – latent, expectant and definitive stakeholders. This analysis aims at spotting most significant stakeholders in the development and dissemination of short rotation crops.

The data is gathered by several methods. The investigation started with the **literature review:** relevant EU documents, books and articles describe how energy crops were introduced in the USA and European countries, and how their cultivation and processing have been developing these last three decades. In Belarus, the system of cultivating short rotation crops like willows and their processing for energy purposes is in its early development stage. Preliminary literature review showed that the literature describing Belarusian experiences is limited, mainly because there is little experience in this field. In fact, it is limited to the following sources of literature:

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[6] Dictionary of Environment and Conservation. Chris Park. Oxford University Press, 2007. Oxford Reference Online. Oxford University Press. Lunds universitet. 27 February 2008 http://www.oxfordreference.com/views/ENTRY.html?subview=Main&entry=t244.e2385

- Articles describing experience of other countries and suggesting that this energy option might be interesting for Belarus,

- Governmental documents: state programs on energy related issues, which give general information on intentions to develop these types of energy resources,

- Reports on results of scientific and technological research made by Belarusian researchers,

- Legislation.

Thus, in order to draw a picture of current state of the issue, there was a need to obtain the information from the first-hand sources, i.e. stakeholders themselves. As such, the literature review helped to identify most of the stakeholders.

So, another method of data collection was performance of **interviews**. Additionally to the information on growing short rotation willows and their utilization for energy purposes in Sweden, UK and USA obtained from the literature few interviews were made with Swedish researchers on the issue. The interviews were designed to get answers to the questions the author came up with when going through the literature. In fact, the literature review of short rotation crops in Belarus provided the author with some information on roles, power and legitimacy of various stakeholders, existing economic and legislative mechanisms, affecting renewable energy, completed and ongoing research projects on short rotation willow crops, governmental interests and expectations of them, introduction of new conversion facilities, current state of plantations establishment. Upon this data, questions arose about the presence and urgency of existing interests, ways of influence exertion, perception of other stakeholders' roles.

However, the main focus of the research is the current and future situation with growing and utilizing short rotation crops in Belarus, and as it was mentioned the literature on the issues is rather limited. Mainly, the author is interested in stakeholders' perspective. Thus, the research aims to identify stakeholders and data collection via interviews with them. The stakeholders' identification was performed on the basis of the stakeholder definition, inclusive of the following steps:

- Ministry, agency, organization, company, a group of people, etc. is a stakeholder if it is mentioned in relation to one of the stages of short rotation crops life cycle in Belarus in the literature, mainly state programs. In fact, the stakeholder can be mentioned in program document as an actual or potential producer of crops or energy producer.

- Ministry, agency, organization, company, a group of people, etc. is regarded by the author as a **potential** stakeholder, if it was identified as a stakeholder during investigation of the experience of other countries. For example, farmers growing short rotation willows in Sweden were identified as stakeholders during the investigation of experience in other countries. Thus, the author identifies them as **potential** stakeholders in a Belarusian context and investigates their relation to the energy crops based system – whether they are growing or will be growing the willows (or even use it as a feedstock for energy generation) or no.

- The author also turns to the list of stakeholders identified by Bouille and McDade (2002) in their paper as playing important roles in approaching sustainable energy, to ensure that relevant stakeholders are not left out of analysis.

After the stakeholders were identified, interviews with people representing those stakeholders were planned and in some cases these were people who work on related projects and publish related articles. In addition, the questionnaires for semi-structured interviews were prepared. These questionnaires were adjusted in the consultation with the supervisor and the Belarusian researcher on short rotation willows. This researcher, as well as another academia representative whom the author had consulted, suggested more names and contact details of certain people to contact within the stakeholder organizations.

These were formal interviews performed in relevant offices in Minsk, Belarus, and interviews on the phone, all performed by the author in second half of April – beginning of May 2008. In addition to the information obtained from the stakeholder organization on its interests and roles, the author structured the interviews in the way to ask how stakeholders perceived roles of other stakeholders and what do they expect from them. Separate questionnaires were prepared in Russian language for all the stakeholders. Few questionnaires, translated into the English are represented as examples in the Annex II. As it is described in the limitations section, the author expected that some of the interviews would not be possible due to people's reluctance to talk and disclose information. However, most of the interviews did take place, and most interviewees were open to the discussion and shared important information. Although some of them preferred to keep their names and positions anonymous in the research reference. As such, only the author in the thesis mentions the name of the organization. And, finally, some of the interviews planned did not take place, as people refused to make an appointment for the author and communicate with her, thus, limiting relevant first-hand information.

1.4 Scope and Limitations

Scope. This research is aimed at woody short rotation energy crops, with the main focus on willows. Geographically, the scope of this thesis includes the Republic of Belarus, for which the analysis is performed. The scope embraces the issues related to all three stages of product life cycle – cultivation, processing and end-product consumption – mainly concerning their current implementation and potential development in Belarus. The research aims at all main stakeholder categories that are identified for all the stages mentioned. During the interviews some stakeholders were changing the focus of the conversation (short rotation willows): they were broadening the topic of discussion from willows to short rotation crops in general, were shifting to other short rotation crops or other types of bioenergy, mainly because it was according to the priorities and/ or they didn't have much to say about short rotation willows. The author collected all the data, however, decided not to broaden the scope. However, such information related to other renewable energy resources and renewable energy in general is regarded vital to the focus of this research paper.

Limitations. The research aims to get an insight to the interests and powers of various stakeholders. However, the author initially perceives some limitations. Firstly, relevant information on the current state of the issue in the literature is limited, and thus the author can obtain it mainly from stakeholders themselves. Secondly, limitations relate to possibility to get the first hand information that may be obtained from interviews with the relevant stakeholders. In fact, the author expected from the outset that some interviews will not be possible because of stakeholders' reluctance to meet the author and talk to her, particularly, stakeholders from the Government sector, who are important and sometimes the only source of information.

Then, in some cases identification of the person to talk to within the agency or organization is complicated as there is no information on names, positions and contacts of people on entry

points to the organizations such as web-sites. Finally, although the author has short rotation willows in the focus, during the conversations, interviewees sometimes changed the focus from short rotation willows to other types of bioenergy resources and technologies, or just broaden the focus to the category of bioenergy or even renewable energy in general. So, the author collected all the data but has had to analyze obtained information with the screening down to the issue in focus (short rotation willows), thus, the findings may have some degree of generalizations.

1.5 Definitions

The following definitions are important to this thesis.

Agricultural biomass - a subset of biomass produced directly from agricultural activities, including cereal grains; sugar crops; oilseeds; other arable crops and crop by-products such as straw; vegetative grasses; farm forestry (e.g. willow and poplar); and livestock by-products, for example, manure and animal fats (OECD 2004).

Benefit - an advantage or profit gained from something that constitutes the objective of performed activity[7], in the case of this research paper, for instance, stable energy supply from the introduction of short rotation willow crops into energy system.

Co-benefit – an advantage that accrues in complex with those benefits which constitute objectives of performed activity, in the case of this research paper, for instance, environmental gains as reduction of GHG emissions due to the introduction of short rotation willow crops into energy system.

Bioenergy - renewable energy produced from biomass when used to produce heat and/or power and transport fuels. Bioenergy produced from agricultural biomass includes *biofuels* such as bioethanol, mainly derived from cereal grains and sugar, and biodiesel from vegetable oils and animal fats; *biopower* in the form of electricity; and *bioheat* generated from processing mainly agro-forestry products (e.g. willow), crop and livestock by-products (e.g. straw and manure) and grasses (e.g. elephant grass) (OECD 2004).

Biomass - any organic material, of plant and animal origin, derived from agricultural and forestry production and resulting by-products, and industrial and urban wastes, used as feedstock for producing bioenergy and biomaterials (OECD 2004).

Economy in transition (EiT) or transitional economy - an economy in the process of major changes in its mode of economic organization. This may be from a centrally planned economy to a market-based economy, as in the former Soviet Union and many countries of Eastern Europe[8].

Energy security - a term that applies to the availability of energy at all times in various forms, in sufficient quantities, and at affordable prices, without unacceptable or irreversible impact on the environment. These conditions must prevail over the long term if energy is to contribute

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[7] "benefit *noun*" *The Oxford Dictionary of English* (revised edition). Ed. Catherine Soanes and Angus Stevenson. Oxford University Press, 2005. *Oxford Reference Online*. Oxford University Press. Lunds universitet. 27 May 2008 <http://www.oxfordreference.com.ludwig.lub.lu.se/views/ENTRY.html?subview=Main&entry=t140.e6748>

[8] Dictionary of Economics. John Black. Oxford University Press, 2002. Oxford Reference Online. Oxford University Press. Lunds universitet. 24 May 2008 http://www.oxfordreference.com.ludwig.lub.lu.se/views/ENTRY.html?subview=Main&entry=t19.e3186.

to sustainable development (UNDP, UNDESA and WEC 2004).

Short rotation crops (or short rotation crops, short rotation forestry) – consists of densely planted, high-yielding varieties of either willow or poplar, harvested on a 2-5 year cycle, although commonly every 3 years. It is a woody, perennial crop, the rootstock or stools remaining in the ground after harvest with new shoots emerging the following spring (DEFRA 2002).

Stakeholder - a person or group who have a vested interest in a particular project, activity, or issue because they are involved in it or affected by it[9].

[9] Dictionary of Environment and Conservation. Chris Park. Oxford University Press, 2007. Oxford Reference Online. Oxford University Press. Lunds universitet. 27 February 2008 http://www.oxfordreference.com/views/ENTRY.html?subview=Main&entry=t244.e2385.

2 Energy Crops: Why? Who? What? How?

In order to contribute to sustainable development of the country and the world as a whole, national energy systems have to be designed in a way they can enhance energy security and bring benefits in social, economic and environmental terms. As energy systems undergo institutional and regulatory reforms, it is important to develop and incorporate sustainable energy concepts in current energy and related policies in the context of existing capacities as well as develop new capacities (Bouille and McDade 2002). However, a sustainable energy system involves many stakeholders, also those who are not directly linked with the energy production, and each stakeholder is playing a different role, has different interests and needs, and different capacities. If the energy system is to contribute to sustainable development, all stakeholders have to be taken into account and brought together, their existing capacities are to be reinforced, and new roles and needs to be considered.

Bouille and McDade (2002) in their paper try to bring together concepts of capacity development and energy for sustainability, targeting stakeholders, their needs and roles, while using an approach of asking questions *why, who, what* and *how*. The *Why*-question reveals importance of energy for sustainable development, *who*-question describes the stakeholders of sustainable energy, *what*-question explains their needs and interests and, finally, the *how*-question aims to find out the ways to develop capacities for sustainable energy. They identified the following stakeholders as playing important roles in approaching sustainable energy:

• Government (the public sector, civil service, and representative officials);

• Productive sector (including the energy industry and other producers of non-energy goods and services);

• Civil society (including non-governmental organisations and representative groups);

• Academia/ research/ specialists/ scientists/consultant institutions;

• Media.

Thus, the investigation on energy crops based system in Belarus and possibility to accrue various benefits from it will be made in the frame of those questions. The preliminary research showed that this system is in its very early stage of development, so the research aims to see the current environment in which energy crops are to develop. For better understanding of the stakeholders in the energy crops based system, their interests and powers, it is interesting to look at the countries that have a longer history of cultivating those crops, like Sweden and UK. In fact, it will help to reveal how different stakeholders influenced the development of the system with time, see what were the effects of various policy instruments, and how barriers were (or were not) overcome.

Then, taking into account stakeholders identified in other countries relevant stakeholders will be identified for Belarus. In fact, these are stakeholders, who are directly related to the energy systems, like the government, energy suppliers, energy agency, etc., as well as those who might be indirectly linked to it. The author's interest to the latter is based on the preliminary research of the existing energy crops systems in other countries and, thus, knowing that they are stakeholders, for example, farmers.

2.1 Why: Energy Security and Triple Bottom Line

Development of local renewable energy resources by the country promises not only to provide for substitution of fossil fuels but also benefit it in three dimensions. The understanding of those benefits and inclusion in consideration is especially important for the government when discussing future development of energy policies (Sims 2004b). Moreover, assessment of multi-dimensional benefits seems to be of particular significance when making decision on introduction of new energy options in the national energy system:

- Will they enhance energy security?
- How can the economy benefit from it?
- What are benefits for society?
- How will this energy resource affect the environment?

2.1.1 Energy Security

Energy supply security has three key characteristics: availability – access (sufficiency) – affordability. In order to understand, how energy crops contribute to enhancement of energy security, they will be described in terms of these three characteristics.

Availability. Short rotation willows are harvested mainly during winter, between November and March. Due to their moisture content they are stored as short a time as possible (one month maximum), usually the biomass is transported from the field straight to the conversion facilities (for example, in Sweden to the district-heating plant) (Rosenqvist Personal comm.).

Sufficiency. Willows usually are not the main and only fuel type used in conversion facilities, it is combined with other energy resources. It is rather convenient to harvest this crop in winter: during this season energy needs are higher, thus the biomass of short rotation willows is combusted with other feedstock. During spring-summer period biomass comes from forests (Rosenqvist Personal comm.).

Affordability. Bioenergy as any other alternative energy source has to compete with cheaper fossil fuels, however, in certain circumstances some bioenergy option demonstrates high competitiveness with traditional fuel. This is the case of Sweden, where energy tax as well as carbon tax made short rotation willows biomass even more attractive option then fossil fuels. Moreover, among various biofuels, willow has the lowest cost profile (Rosenqvist *et al.*).

In fact, harvested biomass is a bulky organic resource with high moisture content (30-60% for fresh-cut woody biomass), and low calorific value compared to the fossil fuels; thus, it can be stored for a limited period of time, and its transportation for long distance is cost-inefficient (Hall *et al.* 1993; Volk *et al.* 2004). Thus, it is logical to conclude that the biomass resources like short-rotation crops should be produced and used in one region.

Biomass-based energy contributes to the shift from centralized towards decentralized distribution of energy. Distributed generation is the location of energy producers (usually small but dispersed) near to the point of energy consumption, and it is an alternative to the centrally planned energy system, where there are fewer energy generators but they are large. Such distributed system allows for reducing costs of fuel transportation (EREC 2004). Such distribution is of special significance for those areas in the country, where build-up areas like small villages are not connected to the gas supply system making the situation with the heating

rather complex. For such areas wood-fuel remains the most viable and cheap energy alternative. Another issue, also related to this situation, is the expenditures for energy supply, sometimes amounting for 10% of the family income (McKay 2006), and this may be even more for the developing countries.

As regards conversion options for short-rotation willows, combustion in **cogeneration facilities** is quite common. Cogeneration (or combined heat and power (CHP)) is a process of the combined production of heat and electricity. It is not only regarded as more efficient option in terms of conversion then independent heat and power generation, but also is contributing to the decentralization of electricity generation in the industrial and commercial systems (Swisher *et al.* 1997). As biomass supply from short rotation willows is not constant, and because of the quality of fuel itself, co-firing of biomass and coal, or combination of several biomass types is regarded beneficial for flexibility (EREC 2004).

2.1.2 Economic Dimension

Actually, economic benefits from biomass based energy appear as most tricky to describe: usually they would be regarded as some form of monetary savings accrued in case of substitution of fossil fuels with, for example, energy crops. In case of such comparison fossil fuels would probably be a cheaper option in terms of production costs just because some benefits from energy crops are not so evident, they fall out of the energy system, and negative effects associated with gas or oil are being externalized. Thus, the analysis of energy options should include other issues, related to land use, emissions, etc. in order to get a true cost (Sims 2004b). In fact, one should not look at the economic gains in the very narrow prospective of an energy price carrier. However, benefits that might accrue beyond the energy system itself have to be analyzed, and energy systems, that potentially might yield those benefits, have to be promoted – and this is where the government has to be active.

2.1.2.1 Regional and Rural Development

The issue of slow socio-economic development in rural areas is relevant for developing countries, meanwhile, developed and EiT countries experience socio-economic decline in those areas, related to other things in the state of agriculture. As a result, local schools, hospitals, shops, public transport, mail deliveries, etc. may be closed, and, after all, younger people are moving to towns and cities in pursuit of employment and better infrastructure (Sims 2004b). Advancements of energy systems are regarded among most important strategies for rural and regional development. Local renewable energy sources in most cases have distributed character, and so are more attractive for rural areas.

As it was already mentioned, biomass resources such as those from short rotation willows are produced and used in one region, and the product of energy generation is also consumed locally. Moreover, a significant proportion of the expenditures, associated with the bioenergy system, is being circulated within the region and, thus, remains in local economy (EREC 2004, McCormick and Kåberger 2005). This, in turn, provides for retention of money in the local community and further socio-economic benefits.

Establishment of a bioenergy system based on energy crops like willows helps bring together various stakeholders in the region, including governmental agencies, farmers, agricultural and forestry organizations, researchers, energy companies, wastewater facilities, providing opportunities for creation of co-operations and for uniting their efforts combating regional problems. This, in turn, provides for social cohesion within a community, and, thus, more integrated local development. Energy self-sufficiency not only contributes to the enhanced

existing capacities, but also attracts new businesses, and, finally, provides incentives for the population to stay in community (Sims 2004b).

2.1.2.2 Revival and Diversification of Agriculture

Biomass production can provide an alternative market for agricultural production, contributing to agricultural diversification and rural development (Feehan and Petersen 2004). Current EU agricultural policy recognizes the agricultural over-production and in order to reduce it sets aside some agricultural lands. This might soften potential *energy vs. food competition* debates that are rising in the EU and North America, as such lands can be used for SRC plantations.

2.1.3 Social Dimension

2.1.3.1 Employment Creation

Renewable energy generally is regarded as more labor-intensive than traditional energy conversion technologies (Berndes and Hansson 2007), creating a range of job opportunities, which is of interest for the rural regions. With the process of urbanization, increased rates of this process, small shares of a state's population living in the countryside, for example, in the UK, and decreasing rates of rural development income of rural population drops, as well as the level of job opportunities. Introduction of local energy resources such as cultivation and the utilization of energy crops potentially creates employment (McKay 2006): according to estimates by some researchers (Sims 2004b), around 42 personnel/ 100 GWh/ year are needed to provide sufficient amount of energy crops biomass feedstock for the plant, compared to 1-6 personnel/ 100 GWh/ year to operate and maintain conventional gas or coal-fired plants. Statistics for the project on short rotation willow crops with the gasification utilization in the UK provides for the figure of 98 employments per PJ of annual fuel consumption, including direct employment – 51, indirect – 11, induced (due to multiplier effect[10]) – 36 (EREC 2004).

When talking about energy crops' production system, there is direct and indirect jobs creation. Part of these jobs is created in the agricultural sphere, and part - in the energy conversion and generation sphere, also established in the rural area if the energy is to be used locally. Direct employment in the agricultural sector, for example, includes jobs at various stages of willows cultivation: preparation of soils on the sites assigned for plantations, preparation of cuttings (on specially designed sites), planting of cuttings, application of herbicides and fertilizers, other management practices on the field, then harvesting, packing, transportation, drying if needed (Abrahamson *et al.* 2002, DEFRA 2002). Further, jobs are provided in the conversion facilities like co-generation plant. Indirectly, such bioenergy system creates employment in the sphere of development and sale of machinery and equipment for farmers and conversion technologies for energy companies or boilers for those organizations that will use feedstock for their needs, for example, farms. In terms of employment qualification and specialization, it ranges from manual labor to highly specialized engineering and electronics (EREC 2004).

Compared to other renewable forms of energy bioenergy provides more employment: if for the former the main activities include construction and operation of conversion facility, the latter provide significant share of employment in terms of biomass feedstock supply (Sims 2004b). For energy crops this embraces cultivation, harvesting, transportation of woody

[10] An effect when money are spent within the region, stay there and contribute to further improvements in economy (EREC 2004)

biomass. As a result, bioenergy systems respond to the employment issue, however, becoming a more expensive energy option than traditional energy sources, and thus, less competitive. Besides, further developments in equipment and technologies, will probably decrease the workforce needs (Sims 2004b). However, in the light of rising energy prices competitiveness of bioenergy might increase: according to statistics by International Energy Agency crude oil prices almost doubled since 2005 (International Energy Agency).

However, Parris (2004) reminds that employment effect for the local or regional economy will depend on the degree of substitution by new biomass-based facilities of already involved resources. Another criticism he directs is related to the location of these installations: despite the need of their introduction to those areas that need development, such facilities would rather be located in the vicinity of industry and urban areas where both the demand for energy and labor supply is high. Labor issues may also include the lack of semi-skilled employment for cultivation and collection of biomass feedstock as well as plant operation.

2.1.4 Environmental Dimension

In environmental terms, energy crop biomass as an alternative energy resource is an attractive option due to the following reasons (Feehan and Petersen 2004): it is a renewable, locally available resource, resulting in much less emissions then fossil fuels; properly planned and managed energy crops plantations provide such ecological benefits as GHG emissions reduction, habitat and amenity value, the rehabilitation of degraded areas; wastewater treatment; heavy metals and radio-nuclides removal.

2.1.4.1 GHG Reduction and Kyoto Protocol

One of the drivers to promote utilization of biomass is the substitution of fossil fuels and reduction of GHG emissions (Parris 2004). The cultivation and use of biomass can have a neutral carbon dioxide balance, if grown sustainably: the amount of CO_2 extracted from the atmosphere during biomass growth is equal to the amount emitted in the process of biomass combustion (Hall *et al.* 1993, EREC 2004). Modern technologies for biomass conversion helped to reduce air emissions to very low values (Feehan and Petersen 2004). Utilization of co-firing technology contributes to the emissions reduction as well: carbon dioxide emissions are lower, and sulphur content of biomass fuels is much less then the one of coal, besides, biomass and coal interact in a special way, and sulphur remains in the ash (EREC 2004).

However, dedicated production of energy crops also requires some energy inputs – machinery for cultivation and harvesting, transport for delivering the biomass feedstock, energy conversion facility operation – and this, in fact, is the fossil fuels input, resulting in increased air emissions. In order to minimize energy inputs and associated negative effects, the biomass production (in our case energy crops plantations) have to be located as reasonably close to the consumer of this feedstock as possible. Moreover, substitution of these fossil fuels' inputs with the renewable energy resources will make the whole system even more environmentally friendly (Sims 2004b).

2.1.4.2 Land Reclamation

Heavy metals removal. Field studies conducted by research institutions in different countries show that energy crops can be a convenient way of remediation of lands contaminated with heavy metals. Experiments in Czech University of Agriculture showed that Cd and Zn can be removed from soil with the help of willows (Vysloužilová et al. 2003). However, as it turned out, the level of soil decontamination was not very high in short, but in

the long-term, the remediation effect might be of interest, for example, the experiment in question showed 20% removal for Cd and 4% for Zn in an interval of two vegetation periods (so Zn is removed better then Cd). Nevertheless, this remediation effect negatively affects the willow plants – yield of biomass drops (Vysloužilová et al. 2003). Experiments on heavy metals removal after ash and wastewater sludge application have also been established by Swedish University of Agricultural Sciences, demonstrating an uptake of Cd by willow plants, varying depending on willow breeds (Dimitriou et al. 2005). These experiments show that there is a potential to utilize willows for remediation of land contaminated with heavy metals like Cd, Zn and others.

Radionuclides removal. In short, remediation of lands contaminated with radionuclides may be explained as uptake and accumulation of radionuclides by plants in the living tissues. First of all, it refers to caesium (137Cs) which is a chemical analogue of potassium (K) and is absorbed by plants as this nutrient and strontium 90Sr – analogue of calcium (Ca) (Goor et al. 2001; Grebenkov et al. 2002). Experiments on growing short rotation willows on lands contaminated with radio-nuclides, established by Belarusian researchers (Grebenkov et al. 2002), provided for the rates of radio-nuclides (137Cs and 90Sr) transfer in soil-plant system: those isotopes accumulate mostly in leaves similarly to heavy metals. These findings make willows a possible option for remediation of contaminated lands. However, it is important to monitor the content of radionuclides in soil (Goor et al. 2001, Grebenkov et al. 2002). Knowing contamination level and transfer factor it is possible to estimate expected content in wood, it is suggested that if this level is higher then particular figure (740 kBq/ m^2 in Belarus) such soil should not be used even for willows due to:

- Wood: the workers are affected;
- Emissions: process of combustion or gasification;
- Bottom-ash;
- Fly-ash: its capture must be conducted.

These aspects serve as limiting factors in the use of energy crops for land remediation.

In general, use of short-rotation willows for land remediation is attractive due to the following reasons:

- Firstly, the use of willows for remediation of land contaminated with radionuclides and heavy metals and in some cases of wastewater treatment means that these plants accumulate hazardous substances, thus removing them from soil and water. Of course, this cannot be applied to food crops as they end up in humans and animals; on the contrary, non-food crops such as willows or other energy crops are very suitable for the remediation purposes;

- secondly, such plantations can be established on contaminated lands that are not suitable and thus most probably have not been used for any purposes. This reflects the case of Belarus and Ukraine, where vast territories of lands are not used in agriculture after the Chernobyl disaster; after 20 years the level of radioactivity related mainly to caesium (^{137}Cs), makes it dangerous and even impossible to grow traditional crops there. SRWC plantations may provide for remediation effect and potential for employment creation. As such, here is a zero opportunity cost of land.

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2.1.4.3 Restoration of Degraded Lands and Post-mining Soils

For countries practicing peat extraction (peat-cutting), like Belarus and Finland, big areas of poor quality land left after the extraction are regarded as a problem that needs a solution. The main features of such post-mining soils are different thickness of peat layer and low pH, in terms of nutrients content the soil is rich in nitrogen N but poor in potassium K and phosphorus P (Hytönen and Kaunisto 1999). Thus, these areas cannot be used in agriculture, besides, they represent dull inhabited landscape (Figure 2-1); however, willows may grow there with additional fertilization. Experiments with planting willows on post-mining soils have been established in Belarus, they demonstrated that willows, although being demanding to natural conditions, were growing on that land. However, as Shamara (Personal comm.) explains, the yields were low, and for better yields application of herbicides and fertilizers was necessary as well as mechanical treatment, making the net cost of produced feedstock high (for more details on the project see Chapter 3).

Figure 2-1 Post-mining soils

Source: Kozulin[11]

2.1.4.4 Biodiversity

Plantations with short-rotation energy crops, such as willows, can serve the important function of biodiversity conservation, and much of this is due to the rotation period of this culture – approximately three years (Volk *et al.* 2004; DEFRA 2002). They serve as a shelter to butterflies, invertebrates, birds and small mammals, as well as providing for feed and microclimate. Not only the variety of wildlife in willow habitats is richer then in fields covered with traditional agricultural crops, but also particularly valuable species of birds can be found there (DEFRA 2002).

Moreover, some species found on these plantations consume organisms that damage plants, thus fulfilling function of pest control (DEFRA 2002). Generally, SRC sites serve a range of ecological services and positively affect biological diversity. However, Volk *et al.* (2004) suggest using different species of willows grown in blocks to provide for greater diversity, as well as reducing fragmentation of plantations, as the fragmentation might create so cold "ecological traps" for some bird species.

2.1.4.5 Wastewater Treatment

Some European countries, like Sweden and Poland, have been using willow plantations for wastewater treatment, as well as for energy production for a number of years. In Sweden, wastewater is applied to the plantations of short-rotation willow coppice: this water, rich in P and N, is redirected to the willow sites that are situated in the vicinity of WWT facility (Dimitriou and Aronsson 2004). In fact, this irrigation water is delivered to the farmers free of charge (McCormick and Kåberger 2005). In the end, water that returns to the environment has less nutrients content, contributing to the decrease of eutrophication. Wastewater treatment also results in sewage sludge, which also needs to be handled: usually it is dewatered

[11] Kozulin, A. *Restoration of peat-lands.* MS PP presentation on UNDP-GEF project

before any type of treatment, and this type of wastewater is nitrogen rich. In Sweden it is being applied to the willow plantations during the growing season – this is happening in Enköping (Dimitriou and Aronsson 2004).

Research in this field continues: effects on energy crops plantations after application of various types of wastewater like log-yard runoff and landfill leachate, sewage sludge, its mixture with the ash are being studied. As Dimitriou *et al.* explains, ash added to the sludge can provide for Potassium (K), which is also important nutrient for willows and is lacking in wastewater, and, thus, is being recycled (2005). However, some types of wastewater may contain hazardous components, their effects on willows are under studies, and thus monitoring with adjustments should be present to reduce damage to the plants (Dimitriou 2005).

However, it is important to consider important factors as distance to the field and associated costs for pipes, plantations area and wastewater properties (Rosenqvist and Dawson 2005b). Generally, when a SRWC system is combined with other vital functions, its cost-effectiveness increases, contributing to the competitiveness with fossil fuels based energy system and its overall importance for local development.

2.2 The Stakeholders: Who, What and How

To define stakeholders, the author used the following definition (Dictionary of Environment and Conservation):

> *"stakeholder is a person or group who have a vested interest in a particular project, activity, or issue because they are involved in it or affected by it"*[12].

Thus, for the terms of this work, it is any ministry, agency, company, organization, etc., that have interest in energy crops, because they are involved in the stages of cultivation of crops, their processing or end-product consumption (energy in the form of heat and/ or electricity) or are affected by them. Bouille and McDade (2002) came up with the long list of sustainable energy stakeholders grouped into five broad categories mentioned above. However, to make it applicable to energy crops we have to adjust it identifying those stakeholders more precisely according to the links they have to energy crops based system.

2.2.1 Government

This is a broad category that includes stakeholders whose functions are related to administration and regulation (Bouille and McDade 2002). According to World Energy Outlook projections (IEA and OECD 2004), most future growth of biomass energy resources will be a result of government policies to promote renewable energy or to increase the use of combined heat and power.

2.2.1.1 National and Local Government

The main functions of legislative authorities/elected officials listed by Bouille and McDade (2002) are:

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[12] Dictionary of Environment and Conservation. Chris Park. Oxford University Press, 2007. Oxford Reference Online. Oxford University Press. Lunds universitet. 27 February 2008 http://www.oxfordreference.com/views/ENTRY.html?subview=Main&entry=t244.e2385

- Setting of national political priorities;
- Social, economic, and environmental goals;
- Establishment of legal framework.

Thus, the government shapes the framework for development, and it is the productive sector that brings the development to life. All the stakeholders involved in an energy crops based system directly, or indirectly, have various interests and needs, though the extent to which they will involve in pursuing benefits promised by such system will differ. In fact, some benefits will be regarded as more vital for the country as a whole and, thus, will be more targeted by national government, while those benefiting the community locally will be of more interest for the local government. For example, development of local energy resources, like energy crops economically will benefit first of all local stakeholders, so this fact may be a driver for them for the adoption of the practices, as global environmental concerns for them are of less significance and thus cannot influence their interest that much (McCormick 2007).

When it comes to local government they can take their action. In Sweden some local governments decided to become Fossil Fuel Free, shifting from fossil fuels to renewable energy resources and increasing energy efficiency (McCormick 2007, Ericsson Personal communication 2008). However, whether the local government is able to exert influence on energy companies and contribute to wider energy crops adoption, is rather questionable. For example, although Swedish municipalities are theoretically able to influence success of renewable energy, they may not have enough power to do it. In spite of the law on municipal energy planning neither municipalities are obliged to behave in a particular way, nor they are empowered to force other relevant stakeholders to undertaken certain action. Besides, municipalities sold some energy companies to larger state or private companies and, thus, lost the control over them, with more power saved in district heating sector then in electricity sector (Khan 2004, Ericsson Personal communication 2008). Nevertheless, local government can influence its policy implementation by investing in renewable energy, as in the case of a co-generation plant in Kristianstad, on the Sweden's south-east coast (McCormick 2007).

We should not forget that for EU countries some issues are affected not only by national policies and stakeholders within the country, but also by EU wide policies. Regarding short rotation crops, there are several policy documents by EU directly, or indirectly, affecting this energy option, inclusive of the Common Agricultural Policy (CAP) and Biomass Action Plan (BAP).

2.2.1.2 Government Energy Authority or Ministry

The role of the Ministry of Energy or Energy agency usually includes development and implementation of energy policy by (Bouille and McDade 2002):

- Defining objectives for the energy sector;
- Shaping energy legislation and regulation;
- Design of relevant stimulating mechanisms.

Decisions on various energy options are made by this ministry/ agency as well, thus, it is important this stakeholder considers all economic, social and environmental aspects of various energy alternatives when making decisions. For example, in order to reduce the costs of renewable energy and make it competitive with traditional fossil fuels and nuclear energy,

Swedish National Energy Administration *Statens Energimyndigheten* developed research and development programs focusing among others on co-generation plants running on bioenergy feedstock (Körner 2002).

2.2.1.3 Non-energy Governmental Authorities/Ministries

Energy policy is managed by the energy administration. However, in the case of short rotation willows the energy sector is one of the sectors involved: energy facilities are the consumers of the feedstock, but the biomass feedstock is supplied by agricultural sector represented by farmers, who are involved in cultivation of energy crops. Thus, the SRC plantations are regulated by the agricultural policy, administrated by the national administration and by EU relevant agencies. Understanding and coordination of the policies, objectives and action plans in those sectors is vital for reaching common goals.

Swedish agricultural policy in the beginning of 1990s upon deregulation resulted in low prices for grain and compensation for set-aside land, thus, being the first to introduce measures, later provided by the EU Common Agricultural Policy, when Sweden has already had significant areas of willow plantations. However, CAP is criticized (Helby and Rosenqvist 2006) for the negative effects on energy crops, though it has intentions to drive their development, by:

- Providing farmers with the planting subsidies without distinguishing between traditional cereals and energy (thus, stimulating cereals cultivation),

- And by establishing obligations for setting aside certain area of land where energy crops may be cultivated, but farmers were setting aside the land of worst quality, thus, energy crops have been left with low productivity lands, where they unsurprisingly, did not yield good harvest.

2.2.2 Productive Sector

The stakeholders described here include suppliers of the feedstock (farmers involved in cultivation of short rotation willows), energy producers consuming the feedstock (conversion facilities like district heating plants), consumers of the final product – energy (businesses, enterprises, etc.), manufacturers of energy equipment and credit institutions.

2.2.2.1 Energy Supply Industry

This group includes several stakeholders involved in energy resources supply and conversion. In our case of short rotation willows, they are willow growers - agricultural organizations and farmers - that cultivate the biomass on plantations and supply it to conversion facilities. The main conversion technology for short rotation crops is combustion in co-generation plants with heat and electricity generation. Introduction of such system is based on two interdependent conditions (McCormick 2007): existence of stable market for energy crops biomass encourages farmers to establish plantations and grow dedicated crops, on the other hand, energy producers need stable supply of feedstock for running the facilities.

Farmers. For farmers to shift from traditional cultivation to energy crops, producing a high gross margin is essential (Sims 2004a). Expansion of bioenergy systems may be reached via formation of partnerships as in Sweden, within which farmers can share knowledge and skills as well as acquisition of machinery, for example, Swedish bioenergy company Agrobränsle AB that belongs to Swedish farmers cooperatives.

The Swedish experience shows that despite various stimulators and potential benefits, farmers' retreat from investing and growing willows, thus, energy companies have to lease these lands for plantations establishment. This reluctance happens because of several reasons (Roos *et al.* 2000, McCormick 2007):

- Farmers do not have enough knowledge and experience of establishing plantations and obtaining feedstock from it for energy purposes and thus are reluctant to shift from traditional to energy crops;

- If there is cattle or/ and other animals, crops production will be competing with the land for fodder and pasture, thus hindering farmer's desire to adopt such crops;

- There was a big interest due to subsidies, but later that interest decreased.

Cultivation of short rotation willows, as it was described in the section on benefits, may be coupled with **wastewater treatment**: apart from being a consumer of energy, wastewater facilities are suppliers of nutrients and irrigation for plantations. The interests of willow growers and wastewater treatment facilities are interrelated in the following way (Dimitriou and Aronsson 2004):

- Firstly, farmers growing SRWC benefit because there is a supply of irrigation water and reduced need for extra fertilizers: willows that need nutrients such as N and P, obtain them from the wastewater and what is very important they show high level of N and P uptake, N leaching is very low;

- Secondly, WWT facilities benefit as there is additional treatment for this wastewater at low cost;

- Environmental benefits – reduced eutrophication.

Moreover, in economic terms such collaboration provides for monetary saving for the stakeholders involved. Rosenqvist and Dawson (2005b) in their case study in Northern Ireland explain that:

- For farmers, such cooperation brings savings coming from the avoided use of fertilizers as well as increased productivity of willow plantations due to application of wastewater containing important nutrients,

- And for a WWT facility, using conventional treatment in winter and shifting to willow bio-filter during the growing season provides for savings associated with the avoided expensive secondary treatment stage.

Conversion facilities. Energy producers need stable supply of biomass feedstock for running facilities (McCormick 2007), and they want that feedstock be delivered as cheaply as possible to compete with low-priced fossil fuels; if both sides are able to understand benefits that might accrue for each of them, they will cooperate in reaching those goals (Sims 2004a). For wider dissemination of short rotation willow plantations stable demand for the feedstock on energy producer side is essential. In Sweden, where SRW plantations started to develop particularly successfully in the beginning of 1990s, certain demand has been created by district heating companies, that also has been developing in the direction of wider utilization of renewable energy and fossil fuels substitution (Helby and Rosenqvist 2006).

2.2.2.2 Entrepreneurs and Productive Industries

This group of stakeholders includes consumers of energy products and services. They consume energy as the final product, however, overall energy-efficiency will depend on their efficiency. If they consume energy produced from renewable energy resources they create demand for energy facilities. Stakeholders from that group are able to influence energy end-use efficiency, as well as contribute to the dissemination of knowledge and technology. Moreover, some of them are an important source of financing for the research and development.

2.2.2.3 Energy Equipment and End-Use Equipment Manufactures

These stakeholders represent developers, manufacturers and suppliers of equipment, machinery and vehicles. Domestic equipment and machinery manufacturers supply their products to both sides of energy industry (Bouille and McDade 2002):

- Supply side: equipment for power and heat generation (turbines, transmission units, etc.);

- Demand side: employed by industries capital goods and equipment consuming electricity and/or heat (motors, pumps, etc.).

There can also be a production of equipment for small scale users, as households, for example, production of pellet burners by Swedish companies (Helby et al. 2004).

With the development of new technologies they can diversify the products in order to meet the new demand. This expansion may include production and installation of ancillary equipment to energy technologies developed abroad, and this often requires the support of domestic industry (Bouille and McDade 2002), or development of domestically produced machinery as an alternative to imported. For energy crop cultivation there is a range of vehicles and equipment essential in the field, as well as equipment that is used for biomass in conversion facilities.

2.2.2.4 Credit Institutions

Credit institutions are also stakeholders in the energy systems as they (Bouille and McDade 2002):

- Finance options for large- and small-scale energy generation;

- Provide capital for energy using enterprises;

- Finance options for household energy consumers.

The role of the financing sector in the expansion of the environmentally sound and efficient energy options is important, as these technologies and programs are more expensive then traditional ones and often need significant capital investments in the early introduction phase. Reluctance of credit institutions and financial organizations to finance those technologies, as the investment risk is perceived by them as high, often becomes a barrier to energy-efficient, renewable and alternative energy options (Bouille and McDade 2002).

2.2.3 Civil Society, Academia and Media

This broad category of stakeholders is generally regarded as pursuing the interests of society for sustainable development (Bouille and McDade 2002).

2.2.3.1 Civil Society and Non-Governmental Organizations

The functions of those stakeholders include consumer participation and awareness; oversight and monitoring; environmental and social advocacy; equity considerations. These activities are important for sustainable energy penetrations, if the energy is about to contribute to sustainable development. Bouille and McDade (2002) emphasize the role of non-governmental organizations (NGOs) in the awareness and consciousness raising of citizens as energy consumers: consumers that have information on various energy options are able to make decisions and choices, and, thus, can make change in energy use patterns.

Eco-labels contribute to raising awareness among consumers about the products that cause less impact on various components of environment then other products in the same category, and influencing consumer choices. The Swedish Society for Nature Conservation developed an eco-label BRA MILJÖVAL (Good Environmental Choice) that can be used on products if they fulfil certain established criteria, and energy can also be eco-labelled. In fact, if the cultivation of energy crops complies with the biodiversity and air pollution requirements, energy obtained from this feedstock can be labelled with BRA MILJÖVAL eco-label (Körner 2002). Friends of the Earth have been active in the UK in support of biomass plants expansion: in fact, they contributed to the development of guidelines on production of energy from short rotation crops (Dinica 2002).

2.2.3.2 Energy Specialists and Consulting Firms

This group is generally important for the energy sector as it provides consultancy and analysis. Its role in promotion of renewable, alternative energy is of particular importance as they provide consumers of energy product and services with the information on *various energy options*. These stakeholders possess information on various energy issues and, actually, fulfil their functions by sharing information with other stakeholders. As a result, they are empowered to influence promotion of renewable and alternative energy options via consulting equipment and machinery manufacturers as well as conversion facilities and productive industry. Unfortunately, as Bouille and McDade (2002) remark, very often the link between the available expertise and policy- and decision-making is week. In transitional and developing countries, consultancy on renewable energy options may be lacking or even absent for some energy types.

2.2.3.3 Academia and Research Organizations

The importance of this group of stakeholders is obvious - they are a source of both knowledge and technology: their activity includes the knowledge and technology generation, adaptation and dissemination. These stakeholders can also be essential in developing new options to increase the energy supply to rural areas through the development and adaptation of new technologies (Bouille and McDade 2002). In Sweden, research on short rotation crops has been supported by the government via policies and financial support. There are several universities that have been involved in research on SRC willows in terms of the policy, economics, cultivation technology, application of wastewater, etc. and acquired a lot of knowledge and experience. They are the source of information and consultancy for farmers, as the Swedish University of Agricultural Sciences is (McCormick and Kåberger 2005).

2.2.3.4 Media

Media and public information channels (radio, television, newspapers and other print media, etc.) are important information channels. In fact, by disseminating information on energy efficiency and consumer choice, renewable energy options and success stories, and viable new energy technologies they can contribute to creating awareness in civil society regarding the role of energy in local and national sustainable development (Bouille and McDade 2002).

2.3 How: Mechanisms

Drivers influencing the development of energy crops at the national level are (Volk *et al.* 2004, Rosenqvist and Dawson 2005a):

- Reduction of energy resource imports, mainly oil and natural gas;

- Increase in the share of local, renewable energy sources;

- CO_2 emissions reduction strategy under the Kyoto Protocol scheme,

- Diversification of agriculture.

As this part of the study focuses on the experience of Sweden and the UK as the countries with longest history of willow cultivation, only their mechanisms are described. In Sweden among other reasons to shift to energy crops was also overproduction of agricultural products and subsidies for farmers (Hall et al. 1993). Development of biomass-based energy in Sweden has been supported also with the use of financial incentives, including the investment grants.

2.3.1 Investment Grants for Cultivation

In Sweden there have been a variety of subsidies, starting with one-time subsidy of 9,000 SEK per ha for shifting from traditional agricultural crops to other activities (Helby and Rosenqvist 2006). Short rotation crops were allowed to be cultivated on that land, thus, this is the first economic incentive. Then, subsidies for planting short rotation willows have been introduced in 1991 and till 1996 remained at the level of 10,000 SEK per hectare, leading to the increase in the area under willows plantations up to 15,000 ha by 2006. However, these subsidies had been reduced upon Sweden's EU accession and adoption of CAP, that required the subsidies to be not more then 50% of planting cost (Johansson 2002). This resulted in reduced interest to the SRC plantations, and in order to revive this interest subsidies have been increased again in 1999 to 5,000 SEK per ha. Under the CAP farmers can get 45 Euro per ha of set-aside land for production of energy crops.

A £100 million package for 3 years period was announced by the Prime Minister of the UK in March 2001 for supporting renewable energy development, and energy crops were among eligible types. Investments were directed mainly to the cultivation stage of energy crops and new technology demonstration (Dinica 2002).

2.3.2 Investment Grants for Conversion Facilities

For conversion facilities there are investment grants as well in Sweden (Körner 2002):

- 4, 000 SEK (approximately 400 euro) per kW of installed electrical capacity - for new facilities (cogeneration plants fired by biofuels);

- 25% of the investment costs (but not more then 4, 000 SEK per kW) for existing facilities like heating plant and cogeneration plants running on fossil fuels that are being upgraded for bio-fuels utilization.

In England and Wales energy crops have also been eligible for many renewable energy support schemes (Dinica 2002):

- Non-Fossil Fuel Obligation (NFFO, 1990-98), under which chosen projects could use two governmental guaranties: a purchase contract with regional electricity company for a particular period of time and indexed price per kWh;

- Renewable Obligation 2002 for suppliers;

- Climate Change Levy exemption for electricity used by business and industry;

- Utilities Bill 2000;

- EU 2001 Directive for renewable energy.

2.4 Stakeholders Analysis: theoretical framework

Identification of relevant stakeholders is an important task, however, this list does not give a full picture about energy crops. In fact, this can be described as "raw data" that needs to be refined and transformed to "information." The analysis of stakeholders within a certain framework can result in defining those stakeholders that are more important then other. In other words, they play various roles; some affect the issue in question more, some – less. In this research paper stakeholder analysis will be performed within the framework of stakeholder salience developed by Mitchell *et al.* (1997). The framework first of all applies to business and aims at defining those stakeholders managers have to pay attention to first of all. For the objectives of this paper the concept will be applied to the stakeholders identified for short rotation willows.

The author of this thesis decided to use a definition of *stakeholder* from the Dictionary of Environment and Conservation: stakeholder is a person or group who have a vested interest in a particular project, activity, or issue because they are involved in it or affected by it. In this research paper, stakeholder is deemed to be any ministry, agency, company, organization, etc., that have interest in energy crops, because they are involved in the stages of cultivation of crops, their processing or end-product consumption (energy in the form of heat and/ or electricity) or are affected by any of these stages (2007). When referring to the end product consumption the author does not imply particularly short rotation willows as they are usually not the only feedstock. Decision to include this stage into consideration can be described with the following example: if there is some demand or obligations for renewable energy in general, for instance, the energy consumers like industry can be obliged to use certain share of renewable energy, demand for renewable energy is created. The demand for short rotation willows as one of the feedstock types can increase, and thus this group that creates obligations (for instance, the Government) indirectly is a stakeholder.

Mitchell *et al.* (1997) suggest that within the framework each stakeholder can be described in terms of three *attributes* - power, legitimacy and urgency. *Power* is defined by the authors of the concept in accordance with other researchers on stakeholder theory - Pfeffer and Weber –

> *"The ability of those who possess power to bring about the outcomes they desire (*Salanchik and

Pfeffer 1974)*"*,

and it may be exerted by "gain[ing] access to coercive, utilitarian, or normative means" (Mitchell *et al.* 1997). However, even if a stakeholder possesses power, he might not necessarily exert it. As regards stakeholders identified in this thesis, their power to influence short rotation willows will be investigated, i.e. influence exerted (or that potentially may be exerted) at any stage of SRW life cycle like cultivation or processing. As it comes from the experience in Sweden and UK, as well as assumed by the author of this research paper, that we can speak of utilitarian means like economic incentives (subsidies, establishment grants) or disincentives (taxes), and normative, for example, gaining "green image" by utilizing renewable energy.

The second attribute is *legitimacy* for which Mitchell *et al.* (1997) in their concept accept Suchman's definition:

> *"A generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions* (Suchman 1995)*"*.

Although sometimes the meaning of legitimacy is substituted by or coupled with the notion of power, Mitchell *et al.* (1997) suggests it as a separate attribute, though we can speak of legitimate or illegitimate exertion of power. In the analysis of attributes of stakeholders identified in the thesis, the author has chosen to operate with the legitimacy notion in the following way: the stakeholder has legitimacy to influence development and dissemination of short rotation crops (their cultivation, processing or consumption of energy product) when corresponding activity is in his area of responsibility or when other stakeholders regard this activity desirable and expect it from the stakeholder in question. For example, an NGO representing interests of society might have legitimacy to support dissemination of SRW biomass utilization as it contributes to fossil fuels substitution. Another example is energy producers' perception of potential suppliers of biomass feedstock – whom they perceive as a supplier.

The third attribute – the attribute of *urgency* – is suggested within the concept for adding dynamism to the stakeholder theory. It is defined (Mitchell *et al.* 1997) as:

> *"the degree to which stakeholder claims call for immediate attention*"

and consists of two components:

> *"(1) time sensitivity – the degree to which managerial delay in attending to the claim or relationship is unacceptable to the stakeholder, and (2) criticality – the importance of the claim or the relationship to the stakeholder".*

To operate with the attribute of urgency in the thesis, the author simplifies the analysis of this attribute to the investigation on stakeholders' current interests to short rotation willows. The focus will shift toward the interests of relevant stakeholders, to the establishment of SRW plantations and to the introduction of relevant conversion technologies. For example, are there an urgent interest on the Government side to this energy option and the interest of potential producers of the biomass (farmers) to the cultivation of short rotation willows?

Neville *et al.* (2003) agree with Mitchell *et al.* (1997) on dynamic nature of urgency, however, they further developed the relationship between the attributes and the way they contribute to the salience. In fact, the attributes are suggested to be placed on perpendicular axes, as it is

depicted in the Figure 2-2, thus demonstrating the concept of stakeholder salience more explicitly: salience increases with the increase of all the components. The figure also provides for understanding of power and legitimacy overlap that creates *authority* (Mitchell *et al.* 1997).

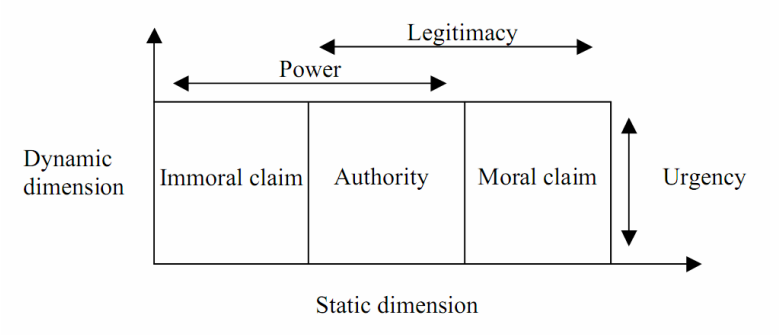

Figure 2-2 Stakeholder salience reconfigured

Source: Neville et al. (2003)

Upon investigation on these attributes stakeholder can be organized in several categories (Mitchell *et al.* 1997). However, attributes may vary: attributes can be gained as well as lost, thus, stakeholder may shift from one category to another. Stakeholders are grouped into categories of possessing one, two or all three attributes, what is depicted in the Figure 2-2.

Stakeholders that have only one attribute – legitimacy, power or urgency – belong to one group and are called *latent stakeholders*, as they have "low salience" (Mitchell *et al.* 1997). Actually, stakeholders with only one attribute have small potential to influence the development of short rotation crops. *Dormant stakeholders* (1) have power, but no legitimacy or urgency; their influence will probably be not exerted. However, as soon as another attribute is obtained, this group of stakeholder might gain much more importance. *Discretionary stakeholders* (2) have legitimacy, but no power or urgency, and, thus, also do not have much influence. *Demanding stakeholder* (3) possesses urgency but no power or legitimacy, so even if he has interests, without two other attributes these interests are not likely to be reached (Mitchell *et al.* 1997).

Possession of two attributes – power and legitimacy, power and urgency, legitimacy and urgency makes stakeholder to fall into the category of *expectant stakeholders*, who have much more potential to influence any stage of energy crops life cycle (Mitchell *et al.* 1997). *Dominant stakeholders* (4) are those that possess power and ability, i.e. they not only have ability to affect the activity but also legitimacy to do it. Nevertheless, if they do not have urgent interest, this power may be not exerted. Thus, upon obtaining the attribute of urgency these stakeholders become the most powerful. If stakeholder has urgent interests and legitimacy to pursue his interests, but does not have power to reach his goals, he belongs to *dependent stakeholder* (5) category. This happens due to his dependency on other stakeholders that have this power and may exert it, for example, the dominant one, so the dependent stakeholder becomes highly salient (Mitchell *et al.* 1997). The group of *dangerous stakeholders* (6) includes those who possess power and urgency, but lack legitimacy, thus, carry a risk of utilizing coercive means. However, within this research this kind of stakeholder is not expected to be identified.

Those stakeholders that have all three attributes of power, legitimacy and urgency belong to *definitive stakeholder* (7) group (Mitchell *et al.* 1997). However, within the concept the stress is

made on the fact of flexibility: some attributes are gained and lost, thus, there is possibility of migrating from one stakeholder group to another. This stakeholder has the highest potential to influence the activity: in fact, if the country is interested in adoption of technology on cultivation and utilization of short rotation willows, attention has to be paid first of all to that type of stakeholder.

This theory developed by (Mitchell *et al.* 1997) suggests looking at stakeholders from perspective of their salience to top management, and it has been used in a number of articles for stakeholder analysis, with the study by Agle *et al.* (2003). This theory was among the first to create profound research on the concept, and to prove its viability by interviewing top managers. Also, this study showed that the attribute of urgency deserves more attention as it contributes to the salience more then defined by Mitchell *et al.* (1997) However, in this thesis the author does not intend to define stakeholder salience in relation to some kind of management, for example, the government. On the contrary, the government is included by the author in the list of stakeholders, and is analyzed for possession of three attributes. However, any stakeholder, inclusive of the government, to see who the stakeholders, who most probably may affect the dissemination of energy crops in the Republic of Belarus, are, can use the findings of the thesis.

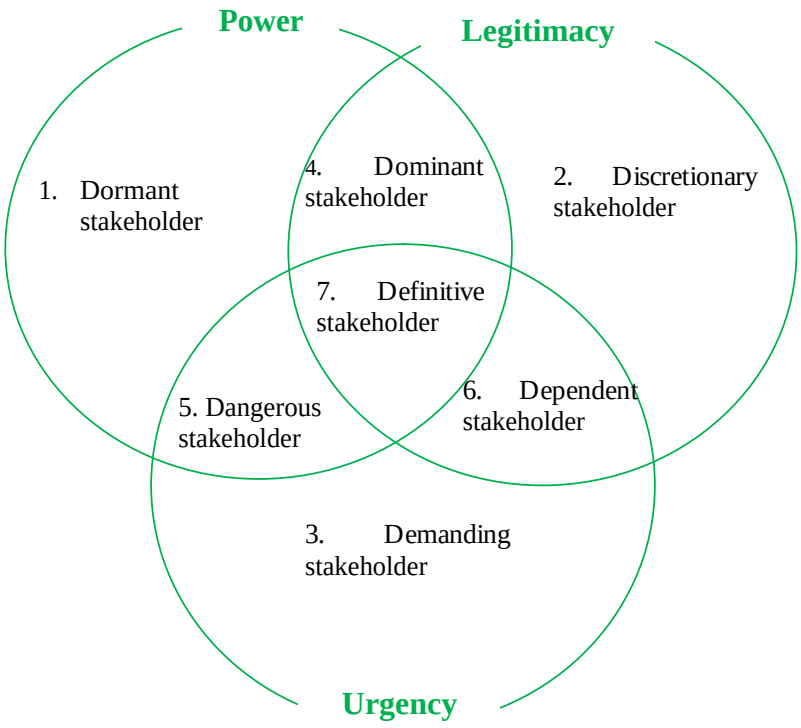

Figure 2-3 Stakeholder typology

Source: Mitchell et al. (1997)

3 Energy crops: Belarusian context

Belarus is a country with an economy in transition. The socio-economic settings are different from those of developed countries, and needs and interests of various stakeholders of energy system are different as well. Apparently, the conditions, mechanisms and pathways of renewable and alternative energy development will differ from those in developed countries, too.

3.1 Why: Energy Security and Triple Bottom Line

This section describes benefits that can potentially be brought about by the cultivation and utilization of short rotation crops for energy purposes. Firstly, the Belarusian energy system is described, including issues of energy security, as well as addressing the possible contribution from short rotation crops. Then, potential benefits in economic, social and environmental terms are discussed in the context of Belarus.

3.1.1 Energy Security

The energy situation in Belarus can be described with the following characteristics (CMRB 2004):

- Limited own energy resources,

- Low diversity of energy profile,

- Large share of one type of energy resource, which is imported,

- Depreciation of capital assets in Belarusian energy system,

- Heavy dependence on imported energy resources and consequent economic dependence on neighbouring jurisdictions, in particular, Russia, which is an important supplier of the main energy resources (natural gas and oil) of the republic of Belarus.

For example, in 2005 Russia supplied 83% of boiler fuels, with the share of 79.9% of natural gas in it (Decree # 575 2007). In that way, even turning to the two components of energy security – availability and access - within the national and international (transboundary) perspective the country addressed by this study is subject to serious energy supply security issues that threaten the regional economy, human development and are widely recognized as geopolitically important. In 2005 energy consumption amounted 30.05 million toe, in 2006 it increased to 31.2 and according to estimations in 2007 it totalled in 31.5, with the share of local energy resources 16.8%, 17% and 18.6% accordingly (Decree #575 2007).

The country's location between a major energy exporter, The Russian Federation and a major energy-importing region, The European Union, has implications on economy and energy system (OECD 1997). Russian gas is transported to western European countries via the territory of Belarus via "Druzhba" pipeline. This is one of the factors in the forming gas price at which gas is being sold by The Russian Federation to the Republic of Belarus, actually, due to that factor the price for Belarus so far has been lower then for other customers. In 2006 the price for natural gas was approximately 50 dollars, in 2007 – 100, and at the moment, the price is 120 dollars per 1 toe, however, it has been increasing quickly recently and is promised to grow further at high rates, threatening the third component of energy security – affordability

(Minenkov Personal communication 2008).

The development of non-conventional renewable energy and diversification of local energy resources[13], including biomass utilization, has considerable significance for Belarus both at the local and national levels (Decree # 575 2007, Directive # 3). There is an active work in the direction of introduction of mini co-generations plants and boiler-houses working on wood resources, mainly in small towns. In 2006 two such installations that consume local energy resources started to work amounting totally for 2.7 MW (Decree # 575 2007). Biomass, coming from plantations of short rotations crops like willows, is one of the renewable available locally energy resources. Its contribution to energy security can be described via its three components.

Availability. According to the experience of other countries like Sweden, UK, USA, as well as to the information from Belarusian interviewees (Shamara Personal communication 2008), biomass from short-rotation woody crops like willows will be harvested in winter and be available for some time during this season. However, Grebenkov (Personal communication 2008) says that the part of the feedstock can be utilized in the winter, and the rest can be stored. While stored the moisture content of the biomass drops, and it can be processed to wood chips; when the moisture decreases to 40%, the storage is possible.

Access. According to the views of all the interviewees and literature review, volumes of SRC biomass that can be realistically obtained in Belarus, will not be sufficient to become the feedstock for large energy objects. It might be consumed in mini-cogeneration plants, and in the boiler-houses of agricultural productive cooperatives. Also, as Shamara (Personal communication 2008) says, this biomass feedstock is not likely to be the main fuel for its consumers.

Affordability. This issue is rather unclear, although various stakeholders comment on it in different ways. Grebenkov (Personal communication 2008) says, that its price is already compatible with fossil fuels as natural gas, as the cost of willow wood chips is approximately 100 dollars (approximately 64 Euro) per toe, while the price of natural gas imported from Russia is 120 dollars (appr. 76 Euro). On the other hand, Shamara (Personal communication 2008) refers to the calculations made during their research[14]. The estimated cost of willow chips grown on post-mining soils constitutes 473.8 thousand Belarusian rubbles per 1 toe (approximately 143 Euro), though, the high price in that case is due to high expenditures related to the quality of land and, thus, required procedures. On the other hand, the value of land restoration has to be taken in to account.

The following calculations and comparison will assist in better understanding of the fossil fuel substitution with short rotation biomass: if we take an average amount of biomass that can be obtained from plantation – 10 tonnes per ha ($10*10^3$kg), and multiply it per calorific value of biomass 10 MJ/ kg: $10*10*10^3$ it will equal 10^5 MJ, 1 tonne provides for 10^4 MJ. 1 tonne of oil with the calorific value of 42 MJ/ kg provides $4.2*10^4$ MJ, thus 4.2 tonnes of biomass provide for the same energy volume as 1 tonne of oil, and 1 ha of plantations may potentially provide for energy equivalent to 2 tonnes of oil.

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[13] In the context of Belarusian energy policy, the following types among others can be included in the definition of "local energy resources": peat, lignite, wood resources (firewood, felling wastes), with required inclusion in this definition and established goals on introduction of other types like various by-products and wastes from forestry and wood-related industry (optimization of those activities is required), hydro- and wind-energy, secondary heat resources, municipal wastes, biomass, agricultural wastes (Decree #575 2007, Directive #3).

[14] The research on technology of cultivation short rotation crops on post-mining soils of energy purposes

3.1.2 Economic Dimension

The use of local energy resources and non-conventional renewable energy potentially provides for (CMRB 2004, Directive #3):

- Job opportunities on various stages: establishment, generation, transportation and utilization, as covered in earlier section;

- Increase in tax allocation to local and national budgets;

- Development of technology, equipment and machinery.

Researcher Grebenkov A. (NAS 2005), while analyzing possibilities of using existing forestry machinery for short-rotation crops cultivation, considers it viable to apply at several stages of the cycle particular equipment used in similar processes (ploughing, sprayers, transportation, etc.).

3.1.3 Social Dimension

Secure, stable and qualitative provision of energy to consumers in the form of heating and electricity, particularly for population in the heating season is very important factor of well-being and quality of life. That is why, this is a key point in the state's energy policy (Decree # 575 2007). This issue is, probably, even more important for small built-up areas like small towns and villages, here the use of local energy resources will be especially important. Secure supply is also important for functioning of industry.

Taking into account that a large share of agricultural production and forestry is concentrated in the countryside, the establishment of energy-crops production like willow plantations may first of all be interesting in these areas. In fact, biomass plantations can significantly contribute to the rural development, strengthening social self-sufficiency and security through utilizing existing infrastructure and provision of job opportunities, as well as making agricultural production less dependent on centralized energy resources supply. These opportunities are of special significance for countries like Belarus, looking at various strategies of development and increases in energy security of supply.

3.1.4 Environmental Dimension

3.1.4.1 GHG Reduction and Kyoto Protocol

Belarus is an Annex I Party to the United Nations Framework Convention on Climate Change (UNFCCC) and from 2005 is a full Party to Kyoto protocol, with the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus (MNREPRB) being a focal point. Belarus submitted its letter of proposal on including Belarus in Annex B list of countries with its reduction target of 95% from 1990 levels (MNREPRB 2006). Upon ratification of Amendment by member states, Belarus will get the access to the Kyoto Protocol mechanisms, obtaining possibilities for reduction GHG emission with the financial support.

Within the framework of the project, "Technical Assistance to Ukraine and Belarus with Respect to their Global Climate Change Commitments", financed by TACIS program, a preliminary list of 14 potential Joint Implementation (JI) projects was compiled and ranked according to a set of expert criteria. After the ranking, four projects were included for further

development and elaboration of project suggestions. The project for the construction of facilities for the combined generation of heat and electricity (co-generation plants) running on biomass feedstock is ranked first place (UNDP, GEF and EED 2007).

Agricultural land emits carbon dioxide and fallow lands emit less CO_2, but still are a source of emissions. When the plantations of short rotation crops like willows are established, compared to the scenario of growing nothing on that land, they represent the carbon stock. Furthermore, biomass substitutes the fossil fuels, further reducing CO_2 emissions (Grebenkov Personal communication 2008).

3.1.4.2 The Use of Low Value Lands and Areas Contaminated With Radio-Nuclides

The problem of growing short-rotation crops for energy purposes has one more important aspect for the Republic of Belarus: it is vital to involve in this process those lands that are not used at the moment: abandoned, low productivity, degraded lands, post-mining soils, areas contaminated with radio-nuclides, unused forestry areas. In fact, according to various statistical data we can speak about the following figures. As of January 2007, unused abandoned (mainly due to low productivity) lands constituted 580 thousand ha – 2.8 % of total available land (MNREPRB 2007).

The Chernobyl catastrophe that significantly damaged all the aspects of life in the Republic of Belarus, also resulted in vast territories of contaminated and abandoned land. As of January 2007 the area of as much as 250 thousand ha was out of agricultural activities due to contamination with radionuclides (with the ^{137}Cs and ^{90}Sr being the main problem). This constitutes 1.2% of Belarusian lands, including lands belonging to forestry organizations (40%), agricultural organizations (17.2%), and others (MNREPRB 2007). Remediation and involvement of these areas into agricultural activities is important for the republic. However, growing food crops due to the present level of radioactive contamination and thus potential damage to people's health is not recommended in these areas. Also, these categories may overlap: low quality land may also belong to contaminated category.

Figure 3-1 Willows growing on post-mining soils in Belarus

Source: ISEU (2005)

Post-mining soils constitute another big problem for Belarus, as the peat extraction industry is a vital part of the economy. The features of these soils are not suitable for agricultural crops and thus are not used in agriculture, and biodiversity of this landscape is rather poor. In 2004 the area of the lands was 180 ha (CMRB 2004). Research in the fields of SRC for energy purposes and land remediation started a decade ago and a few projects have been conducted by various institutions. The one, devoted to the development of technology of growing SRC on the post-mining soils, started in 2005 (ISEU 2005). Such projects are vitally important not only because they provide for knowledge and certain scientific and technological findings and conclusions, but also because they can be demonstrated to the relevant stakeholders and actors who may potentially use these skills, including government and productive industry. These demonstrations according to

researchers (NAS 2005, McCormick 2007) are very important to convince actors to adopt the practices. It should also be taken into account that low quality of the land results in low yields, thus, higher yields will always need application of more efforts and result in higher expenditures.

3.2 The Stakeholders: Who? What? How?

3.2.1 Government

3.2.1.1 Government (the President and the Council of Ministers)

In Sweden, the development of short rotations willows cultivation and utilization was very much due to the Government support that was pushing the development, for example, by significant support in the area of research (Ericsson Personal communication 2008). The Belarusian Government in the pursuit of the enhancement of national energy supply security and improvement of energy efficiency is looking for various pathways, driving the deployment of local energy resources and development of alternative and renewable energy sources. Also, similarly to other countries' policy, it is paying much attention to the research.

Realizing the socio-economic issues stemming from the energy supply dilemma and significance at the local and national levels to develop local, renewable energy sources, the Belarusian Government has formulated the country's policy for that energy development. In the hierarchy of regulation which forms the basis of this policy, Directive # 3 of the President of Belarus[15] (2007), concerning the problems of energy and material efficiency and economy, is a framework regulation, describing steps to be undertaken in order to enhance state's economic security. Measures, related to the use of local energy resources, are summarized in the Table 3-1. They are of qualitative nature, containing no certain quantitative objectives, and are addressed to the Council of Ministers and to ministries.

Table 3-1 Selection of measures, relevant for the use of local energy resources

Provision of	Measures (among others)
enhancement of the energy security and energy independence of the country	- control of rational use of fuel-energy resources by managers at various levels, - development of the Concept on energy security and increase of energy independence, that among other things should include steps for provision by the year of 2012 of electricity and heat production from local, secondary and alternative energy resources in the volume not less then 25% of the total, and development of biofuels production, establishment of wind energy facilities, biogas complexes, production of energy from municipal and other types of wastes;
economy in the spheres of production as well as housing and communal services	Use of local energy resources in : - boiler-houses in small built-up areas (up to 20 000 people) (re-equipment from fuel oil), - boilers and water heaters (re-equipment of corresponding electricity-based facilities), - water heating in small build-up areas in the period between heating seasons;
advancement of effectiveness of	- introduction of innovative projects in the field of alternative, renewable energy

[15] *Directive #3 by the President of the Republic of Belarus*. Economy and thrift are the main factors of state economic security

scientific and technical activity and innovation	sources; - optimization of various types of woody resources use. Starting from 2007 undertake measures to increase volumes of short-rotation woody biomass for energy needs;
stimulation of economy of fuel-energy resources	- introduction of dependence of the salary (directors of state agencies and other state organizations) on the indexes of economy and increase in local energy resources use

Source: Directive #3 (2007)

To follow up provisions made in the Directive, the Council of Ministers - the state executive authority - is developing and implementing measures on fulfilling the Directive, where among other measures, it also addresses involvement of local energy resources in its resolution. The Council of Ministers also enacts a list of other important state programs related to energy issues, which contain information on tasks (measures to undertake), responsible Ministries and other state agencies, as well as local governments, and schedule for fulfilment. In relation to short rotation willow crops, these are general goals of developing short rotation crops for energy purposes without certain quantitative objectives. Some programs are focused on conversion facilities, like introduction of mini-cogeneration plants running on wood feedstock and other local energy resources, and short rotation crops are perceived to be contributing to these energy resources.

3.2.1.2 Local Government

Provisions for energy efficiency and involvement of local energy resources as well as alternative renewable energy types mentioned above are considered in detail by six regional executive committees, with the particular activities being proposed with the assignment of responsibilities, ways and schedules of execution. For example, Minsk Regional Executive Committee (MREC 2007), among other activities for the Minsk region, plans to start the construction of mini-cogeneration plant, which will be working on local energy resources in one of the small towns and biogas facilities in some agricultural complexes. Also, it plans to increase volumes of short rotation woody crops, devoting up to 500 ha of land for this purpose by 2010 and recommending corresponding state agencies continuously supply executive committee with suggestions.

In the structure of various ministries, there are corresponding regional departments, which coordinate and implement the policy in the regions. The regional executive committee give tasks to the corresponding regional departments in terms of agriculture, energy, forestry, etc. Thus, regional departments get tasks from the executive committees and also coordinate with their own ministries.

However, reality is not necessarily following political plans, for example, the local government of Uzda district (district executive committee), where the plantation in the framework of the scientific research has been established, expressed their dissatisfaction with the current state of the issue (Shkel Personal communication 2008). In the beginning of the project they have been very enthusiastic about it, however, after the research finished, the plantation has stopped being maintained. Housing and communal services refused to harvest the biomass in the light of high expenditures. Agricultural productive cooperative has other resources to use (secondary wood resources from deconstruction).

The committee complained (Shkel Personal communication 2008) that the results of the experiment have not been good (the yield is low). Besides, as they say, even if they harvest the

biomass now, they are not sure about the next harvest time, and they regard the calorific value obtained from current amount of the feedstock not enough for their needs. Thus, they are not willing to proceed with the plantations. However, in the executive committee they admit that in case of obtaining good results, they would be interested in further introduction of the plantations. The current state of things could result in the removal of this plantation.

3.2.1.3 Ministry of Energy of Republic of Belarus

There are two main governmental bodies that develop, shape and implement energy policy and regulate energy sector: The Ministry of Energy and Energy Efficiency Department. The Ministry of Energy is a republican body of public administration and is subordinated to the Council of Ministers. It is a departmental authority and its main role is to provide for secure, uninterrupted energy supply (Fedoseev Personal communication 2008). Its primary tasks include (CMRB 2001):

- The development and implementation of energy policy together with other republican bodies of public administration;

- implementation of scientific and technical, economic and social policy for effective work of Ministry's competent agencies in order to satisfy heat and electricity, gas and solid fuels needs of national economy and population as well as their rational use.

The Ministry of Energy among other functions participates in shaping and implementation of state policy for energy efficiency; develops normative acts for the regulation of relationship in fuel and energy complex and analyzes application of these acts; it participates in the formation of the state policy for energy and fuels prices (CMRB 2001). The main program[16] that the Ministry is coordinating at the moment, aims to result in modernization of energy equipment, first of all in the energy production sector:

- Upgrade of large co-generation plants,

- Transformation of boiler-houses into mini co-generation plants,

- Construction of new mini co-generation plants,

The objective allows the utilization of local energy resources and non-conventional energy sources (Decree # 575 2007). The accent is on the instalment of boilers for wood feedstock (firewood, wood residues) that seem to be among most promoted resources for energy generation. The State Complex Program (Decree # 575 2007) also contains measures, improving energy price forming policy and recognizes the essential importance of economic methods instead of established tariffs.

The program has objectives to adjust the existing legislation on energy production and consumption, as well as, develop a new one that will create favourable conditions for the wider dissemination of non-conventional, renewable types of energy, and consolidate governmental support for these energy resources. This legislation should also include provisions for financial stimulation for production and consumption of renewable and alternative energy:

[16] *State complex program on modernization of basic production assets of Belarusian energy system, energy savings and increase in the share of own fuel-energy resources in the republic for the period till 2011*, approved by decree by the President of Belarus #575 in 2007

- Energy price forming mechanism;
- Guaranteed connection of energy producers to the power grids and heat networks;
- Investment stimulation (Decree #575 2007).

One of the most important directions in the realization of state energy security policy is technical standardization and certification in energy and industrial sectors that might allow increasing not only efficiency of resource use but also the share of local, alternative and/ or renewable energy sources. The State complex program includes the goal of developing state standards for the qualitative features for fuel and energy resources including the ones for biomass of short-rotation crops (Decree # 575 2007). There already exist Technical Specifications on short-rotation willows that have been developed by Institute of Power Engineering Problems during their project on short rotation willows cultivation.

The interest of the Ministry of Energy in short rotation crops was initiated mainly by the deputy minister Shenetz who had been introduced to the experience of growing short rotation willows and utilization of that biomass for energy generation during his official visit to Sweden and became very enthusiastic about this process (Zaharevich Personal communication, Shamara Personal communication 2008). However, there was another reason for the Ministry to start the development in that direction. In practice, the energy sector management is divided between several big state-owned companies in line with their activity spheres: the Belarusian state energy concern "Belenergo" fulfils the functions of control of the Belarusian electric-power complex and Belarusian concern on fuels and gasification, "Beltopgaz" is in charge of safe and regular (uninterrupted) provision of consumers with gas and solid types of fuel. One of the activities of concern for "Beltopgaz" is the extraction and provision of peat from the peat-lands.

As Zaharevich and Shamaro (Personal communication 2008) explain, after the process of peat-extraction the territories of post-mining soils remain on the balance of Ministry of Energy before they will be transferred in some time to another agency's account - the Ministry of Forestry and the Ministry of Agriculture and Food). In order to get value from those lands, the Ministry of Energy decided to start the research on the technology of growing short-rotation willows on post-mining lands. This task was given by the Ministry of Energy to the concern "Beltopgaz" and performed by the research institute RUP "BelNIItopproject" within concern's structure. The task was to develop the technology and investigate its economic practicability (Shamara Personal communication 2008). However, another interviewee (Grebenkov Personal communication 2008) remarks that the reason for the research for post-mining soils is different: there is difficulty with new territories for peat extraction, thus, in order to prevent peat-extracting organizations of concern "Beltopgaz" from closing and the employees – from being left without job, it was decided to investigate various possibilities of utilizing areas after peat extraction that are still on the balance of the Ministry of Energy. Nevertheless, this reason has not been mentioned by any other interviewee.

Now, upon the reported by "Beltopgaz" results of the research, the Ministry of Energy perceives not much sense in further development of this topic. As Zaharevich (Personal communication 2008) explains, this energy resource becomes rather expensive, as the cultivation requires a lot of expenditures, mainly due to very poor quality of the land in question and, thus, required procedures of soil preparation, fertilizers, water delivery, etc. Without all these procedures the yields of crops are very low. Zaharevich (Personal communication 2008) says that if better results would have been obtained from the research, the Ministry might have been interested in further development and dissemination of the technology. Actually, he says, they could get better results if they would invest more money in

plantations, but it should be taken into account that the economic risk becomes higher and the cost of wood chips from these short rotation crops plantations increases.

At the same time, the interviewee adds, that the Ministry of Energy might be interested in utilization the biomass from short rotation crops, but they expect that it will be grown by the relevant sector or some organization that specializes on growing trees or crops. Actually, to the question which stakeholder the Ministry regards as the supplier of short rotation crops biomass, the answer is that the Ministry considers forestry sector as the most suitable for this purpose. However, they admit that this type of feedstock may turn out to be more expensive for them then the current one (natural gas) and the final product - energy - will have higher price for its consumers (Zaharevich Personal communication 2008).

3.2.1.4 Energy Efficiency Department

The Energy Efficiency Department (in the past - before 2006 – was known as the Committee on Energy Efficiency, subordinated to the Council of Ministers) is a Department under the State Committee on Standardization of the Republic of Belarus, fulfilling special (executive, control, regulatory and other) functions in the sphere of effective utilization of fuel and energy resources. Its main tasks are (CMRB 2006b):

- Implementation of state policy in the sphere of efficient use of fuel and energy resources;
- Technical normalization, standardization, compliance affirmation of energy-consuming goods and services, control of compliance of technical and economic indicators of energy-consuming and energy-generating equipment with the standards, norms and requirements in terms of efficient utilization of fuel and energy resources;
- Participation in the state expertise on energy efficiency of projects of new and reconstructed/ modernized objects in terms of efficient utilization of fuel and energy resources;
- Provision for state oversight on rational use of fuel and energy resources, and on implementation by energy-consumers and energy-generators of rational resource use measures as well as on compliance with norms of energy consumption.

The Energy Efficiency Department is coordinating another important program[17] within the context of energy policy. This program has objectives of implementation measures on (CNRB 2006a):

- Reduction of GDP energy intensity,
- Substitution of energy import with local energy resources,
- Creation of favourable conditions for energy security enhancement,
- Negative environmental impact abatement by means of GHG emissions reduction that are generated in the process of fuel combustion for energy needs.

[17] *the Republican program on energy-saving for 2006-2010*, approved by resolution # 137 of Council of Ministers of the Republic of Belarus, 02.02.2008

There are six regional, plus one Minsk-city departments under the Energy Efficiency Department, that fulfil functions on the regional management of the oversight of rational use of fuel and energy resources, and few more organizations (Energy Efficiency Department).

As Minenkov (Personal communication 2008) says, in the first place, for the economy, it is important to have cheap fuel, because with the use of cheap fuel the net cost of produced goods is decreasing. Thus, if natural gas has been sold to Belarus for low price, development of renewable energy would not get much attention. Vice versa, if those energy resources, which, for example, are supplied now by the forestry sector, become much cheaper then they are now, energy generating facilities will shift from natural gas to this wood fuel. However, at present the republic is characterized by:

- Small share of its own energy resources,

- Import of energy resources from one country (The Russian Federation),

- Fuel prices in the world, as well as, those, which, The Russian Federation exports, are rising,

This is why a list of decisions are being adopted in Belarus, inclusive of measures on:

- Provisions of not less then 25% of heat and electricity generation from local energy resources, including renewable energy,

- Diversification of energy supply,

- Diversification of energy profile.

To sum up, economics is always in the first place, and its coincidence with the issue of energy security and independence is beneficial (Minenkov Personal communication 2008).

As Minenkov (Personal communication 2008) explains, the role of Energy Efficiency Department is the coordination of measures on energy efficiency and on the increase of the share of own energy resources. This coordination consists of the following components:

1. Setting tasks on increase of the share of local energy resources to various agencies, including executive committees, various ministries, etc. However, these tasks do not have separate targets for various types of local energy resources: the agency gets one target for local energy resource share, and it is the agency itself that decides to which particular types of local energy resources this target will be reached. From this point the agency itself decides how it will distribute the task obligations within its area of responsibility: within sector and/ or regional and Minsk-city departments and committees; the agency itself plays coordinating and regulating role. For example, if a certain task is given to the Ministry of housing and communal services, and it decides on the division between 6 regions plus city of Minsk (thus giving different targets for regional and Minsk-city departments of housing and communal services): as Vitebsk region is more rich, say, in forestry resources, the increase of the share of local energy resources here might be planned with highest contribution of wood resources; let's say, in Minsk region agriculture is more developed then in other regions of the republic, thus here agricultural wastes will contribute most (Minenkov Personal communication 2008).

   The agency is given the freedom to decide which particular type of local energy resource to develop in the recognition of the fact that the agency has better knowledge and

understanding on the current situation in its corresponding sector. The program is usually made for several years, the basis and the final objective are defined, and then the objective is divided into annual targets. In the end of each year Energy Efficiency Department receives reports from the agencies, and if the targets for the year that passed are not fulfilled, they are added to the next year's targets (Minenkov Personal communication 2008). Thus, Department's influence on dissemination of certain renewable energy types is limited.

2. The task on increase of local energy resources share is one of the components of the common program of measures on energy efficiency in the republic, it means that each region and each sector develops an annual energy saving program – the list of measures that have to be financed and implemented. These are certain measures (like introduction of the boiler running on local energy resources, fuel switch from liquid fuel (mazut[18]) to local energy resources) with the described target volumes, expenditures, expected effects and time for execution. Besides, the volumes of financing are divided into several parts – various sources (funds) of financing. All these programs have to be coordinated with the Energy Efficiency Department, and after the deadline it verifies the results, if particular measures have not been fulfilled this usually points at under-financing (Minenkov Personal communication 2008).

In general, the policies of the Ministry of Energy and the Energy Efficiency Department to some extent disagree (Minenkov Personal communication 2008). On one side, energy producers (their interests are represented by the Ministry of Energy) would like to produce more energy and get more profit and, thus, are interested in the growth of energy use on energy consumers' side. On the other side, the Department's activity pursues the reduction of energy consumption, in order that the production becomes more efficient and results in less expenditures, as well as more rational energy use by consumers. The Energy Efficiency Department is interested in decentralization of energy supply, when consumers establish their own small-scale conversion facilities. The state's interest in energy consumption patterns is described by Minenkov (Personal communication 2008) in the following way: if less fuel is purchased, less money is spent by enterprises, and less is the net cost of goods. If the energy consumption is reduced, expenditures decrease too, leading to higher efficiency and cheaper production costs. However, European Economic Commission (EEC 2005) considers the division of responsibility between the Ministry of Energy and the Energy Efficiency Department as unclear.

The Energy Efficiency Department considers (Minenkov Personal communication 2008) that potential suppliers of short rotation crops biomass include forestry sector, entrepreneurs, or the sector of housing and communal services can grow the SCR and utilize the biomass themselves. Most probably agricultural sector will be involved, which main activity slows during the winter season, leaving space for occupation with crops harvesting, besides, it possesses the machinery and specialists. Possible sources of investment include national and local budgets, innovative fund, credits from banks, and hopefully in some time via flexibility mechanisms of Kyoto Protocol. However, potential suppliers must have economic incentives; in case they would work at a loss they might have government support in order to compensate this loss. What concerns provisions in various program documents; they are more like assessments or prognosis, not the real targets at the moment. Moreover, the interviewee (Minenkov Personal communication 2008) believes that for the time being the agencies mentioned would rather use other available resources: for example, forestry sector might

[18] Black oil

restore/ renew the forests, or burn the straw that remains in the fields. Usually the straw is burnt there in the fields, and the ash becomes a readily available fertilizer. Now it can be taken to the boilers for obtaining energy, however, fuel is spent for delivering straw to the boiler and the ash – to the field again, but at net energy wins.

As regards consumers of short rotation crops biomass, Minenkov (Personal communication 2008) considers, that it might be the sector of housing and communal services, which is most likely to use this biomass as a feedstock, as there are small boiler-houses in its area of responsibility. The Ministry of Energy has mainly large energy objects in the area of its responsibility, and it is very unlikely that it will be a consumer of this feedstock, as it needs large amounts of fuel. But woody fuel has low density and low calorific value, and it is hard to imagine the process of unloading the feedstock at the conversion facility.

Energy Efficiency Department (Committee on Energy Efficiency under the Council of Ministers of Belarus at the moment of the project beginning) together with United Nations Development Programme (UNDP) and the United Nations Economic Commission for Europe (UNECE) developed a GEF funded project "Biomass Energy for Heating and Hot Water Supply in Belarus"[19]. This project is being managed by one of the organizations under Energy Efficiency Department - RUE "Belinvestenergosberezhenie", which has been created in order to coordinate large investment projects in the sphere of energy efficiency. In the structure of that organization in the framework of the project the Bioenergy Revolving Fund has been created, that allows various organizations and enterprises to apply for repayable funding for implementing bioenergy projects as well as projects on energy saving and efficiency enhancement (Voitekhovich 2008). Wood residues have priority among all local renewable energy resources the increase in utilization of which is also being pursued.

Fedoseev (Personal communication 2008) from RUE "Belinvestenergosberezhenie," expressed the point of view that among various local energy resources wood and peat seem to have the priority in development. In this case wood resources may include:

- Refuse wood (felling debris like tops, branches and leaves, wood that is generated during sanitary and thinning felling, wood infected bugs),

- Raw waste lumber,

- Secondary wood (from demolition of various wood constructions).

The interviewee (Fedoseev Personal communication 2008) admitted that at present, natural gas is much cheaper then the wood, which is why the development of wider wood utilization is very slow, as it takes efforts and expenditures to get wood resources for energy purposes. However, with time utilization of wood is expected to develop and become more popular.

As to short rotation crops, like willows (Fedoseev Personal communication 2008), their priority as well as for any other type of fuel, is conditioned by the economic profitability. Their cultivation requires certain expenditures, especially for fertilizers. Their niche is perceived as it follows: cultivation on "neudobici"[20] (small areas of land that are not very suitable for utilization in traditional agriculture, usually due to the location, size and quality of soil), utilization of the biomass feedstock in small heating facilities. Maximum estimations for this

[19] Bioenergy project. Description http://www.bioenergy.by/en/about.html [last visited on 06.05.2008]

[20] Russian language

type of fuel to be obtained – 200-300 toe (Fedoseev Personal communication 2008). This interviewee lists the following needs for successful development:

- Particular organization has to be involved in establishment and maintenance of plantations of planting material, i.e. specializing on supply of planting material for short rotation crops like willows;

- Scientific support of such institutions as Academy of Sciences, agricultural academy,

- Involvement of Ministry of Agriculture and Food, Ministry of Housing and Communal Services, enterprises, regional executive committees;

- Demonstration of experience and its transfer in modules.

The housing and communal services sector can be involved in cultivation of short rotation crops, as well as, in their utilization in the boiler-houses of this sector, the same is true for agricultural productive cooperatives. Forestry sector is not regarded by the interviewee as a proper sector to be engaged in SRC cultivation, as this sector already possesses certain type of feedstock, which is available and utilization of which needs to be developed further – refuse wood. There has to be a strategic vision (Fedoseev Personal communication 2008). A few more issues to consider about energy crops include:

- Delivery distance has to be not very long,

- Processing of the wood feedstock into the form, which will be consumed at energy conversion facility (like, for example, pellet production), makes this fuel more expensive,

- Fuel is needed for running machinery used for cultivation and processing of the biomass.

Summing up, the price of the fuel product increases, however, Fedoseev (Personal communication 2008) mentions another opportunity – sale of this product abroad, however, this option is not in line with objectives of energy security enhancement.

Fedoseev (Personal communication 2008) points at the Ministry of Energy as a monopolist, having large energy objects within its structure, however, adds that the Ministry has technical, financial (innovation funds), institutional and human resources potentials. The Energy Efficiency Department and the Ministry of Natural Resources and Environmental Protection are the regulating authorities; their roles are inclusive of advice, demonstration objects, and approbation of technologies. They can influence adoption and further dissemination of short rotation crops by:

- Including such provisions into their programs,

- Acting as the customer via scientific and technical programs,

- Financing relevant projects.

Fedoseev (Personal communication 2008) lists the following measures that can contribute to the introduction of short rotation crops:

- Lax credits,

- Bioenergy Revolving Fund,

- Development of relevant legislative basis,

- State programs and scientific and technical programs,

- Economic mechanisms (including sanctions), ecological tax (Ministry of Natural Resources and Environmental Protection).

3.2.1.5 Non-energy Governmental Ministries/Authorities: the Ministry of Natural Resources and Environmental Protection of Belarus

Short rotation crops as it was mentioned above promise several environmental benefits, and GHG reduction may be regarded as the most important one: due to the cultivation stage they contribute to the carbon sink (land use change), and due to the utilization in conversion facilities the substitution of fossil fuels takes place. Thus, cultivation and utilization of energy crops might be promising in the light of Convention on Climate Change and Kyoto Protocol.

Belarus ratified both the Convention and the Protocol, the Ministry of Natural Resources and Environmental Protection was appointed as responsible agency for the implementation of state policy on climate change by the Decrees by the President of the Republic of Belarus (MNREPRB 2006). At the moment an amendment by which Belarus is included in Annex B with 95% obligation on GHG emissions reduction is pending on signing by the parties to the Protocol. This amendment will make it possible for Belarus to use Kyoto Protocol mechanisms like trading scheme (TS) and joint implementation (JI), obtaining possibilities and resources (Grebenkov Personal communication 2008). The Ministry assigned one of the organizations under its authority - RUP Belarus Research Centre ECOLOGY - to be the National GHG Inventory and Cadastre Centre (MNREPRB 2006).

As part of its commitments Belarus has to adjust its legal base to Protocol's requirements. Upon ratification of the amendment, Belarus will have an established amount of permitted emissions and will be able to trade the difference between this amount and the real emissions. As "hot air" cannot be sold, money obtained from the quota sale should be spent on further environmental improvements. At the moment there are around 100 JI projects, encompassing (Grebenkov Personal communication 2008):

- Biogas from wastewater;
- Landfill methane;
- Co-generation;
- Fuel-switch (from mazut to wood feedstock);
- Wind turbines;
- Gasification;

However, the state's interest in the opportunities promised by the Kyoto Protocol seems to be low. As Grebenkov (Personal communication 2008) explains, for JI projects, the economy plays a very important role: on one hand, monitoring of emissions reduction requires certain expenditures; on the other hand, the share of carbon funding constitutes 5%. Carbon funding might play different stimulating roles for various JI projects, which can be explained with the following examples. Two important components are variables – payback period and profitability. Three examples are organized into the Table 3-2, with the first example being an

abstract one.

Table 3-2 Examples of carbon funding potential profits

	Without carbon funding		With carbon funding		
	Payback period	Profitability	Payback period	Profitability	
Example 1 (abstract)	11 years	7.3%	11 years	7.4%	Insufficient stimulus
Example 2 Biogas facilities	11 years	7%	8 years	12%	Project definitely benefits from carbon funding
Example 3 Landfill methane	11 years	10%	2 years	37%	Project definitely benefits from carbon funding and is perceived as very stimulating

Source: Grebenkov (Personal communication 2008)

In regards short rotations crops, they can be grown on agricultural lands. Establishment of short rotation crops can become a JI projects, actually, it has been on the Belarusian list of JI projects and fell under the project[21], financed by TACIS program. However, later it has been left out of the list, as the applicant of the project usually has to be represented by the ministry. In the case of short rotation crops the applicant has not been identified, as it was unclear which ministry should be involved and responsible. Recently, research center "Ecology" received a proposal on collaboration from Lithuanian company, and the Ministry signed the resolution on cooperation (Grebenkov Personal communication 2008).

The Ministry of Natural Resources and Environmental Protection can support the development of short rotation crops by means of:

- Including this development in financing from environmental protection funds;
- Being the initiator of related legislative acts.

According to Yablonskaia (Personal communication 2008), these are usually private consulting firms that are involved in the joint implementation projects, as they have economic interests. They get in contact with the business (such as an enterprise), often the effects (benefits) will be more significant then, and develop a project concept for it at this business's expense (this is the firm's economic interest). They frequently take part in further implementation of the project. In Belarus state organizations have been created for the same purpose, and they function at the expense of state money, what is being criticized by Yablonskaia (Personal communication 2008) for creation no economic incentives for those organizations.

[21] TACIS project "Technical Assistance to Ukraine and Belarus with respect to their Global Climate Change Commitments"

3.2.1.6 Non-energy Governmental Ministries /Authorities: Ministry of Forestry

The Ministry of Forestry fulfils the following functions (CMRB 2006c):

- Development of forestry policy;
- Provision of various economy sectors with timber and other forestry products and services, taking decisions on quotas;
- State control on the state, rational use, protection and re-production of forest resources.

There are six regional forestry associations that carry out the control and implementation of programs on regional level, cooperation with regional government, marketing, interaction with consumers of forestry goods (like industries). Further, within those regional associations there are forestry enterprises that directly carry out forestry activity within the administrative regions (CMRB 2006c).

Introduction of plantations of short rotation wood cultivations in the forestry sector have been a target of governmental interest in the development of local renewable energy resources and the Ministry management's observation of the Swedish experience of growing short rotation crops (Ushkevich Personal communication 2008). The Deputy Minister of Forestry (Ushkevich Personal communication 2008) mentions, that he was observing the experience and saw that the crops are grown not for the energy purposes only, but also in the pursuit of environmental goals like remediation of lands contaminated with radionuclides and heavy metals. Nevertheless, he acknowledged the fact that cultivation of short rotation plantations is not a priority area for the Belarusian forestry sector. Moreover, it is unlikely to become one as there are other resources within the sector at the moment that may serve as the energy generation feedstock and the processing of which is being developed. These are forestry residues, generated during timber logging and storms, when trees are broken and thrown down by the wind (Ushkevich Personal communication 2008).

Those plantations of various cultures of short rotation forestry (including willows) that have been already introduced are expected to serve as the feedstock for several kinds of objects (Ushkevich Personal communication 2008):

- Energy objects being built within the framework of the UNDP/ GEF Bioenergy project, like mini-cogeneration plants working on local energy resources inclusive of wood,
- Boiler-houses within the sector of housing and communal services,
- Pellet production, probably for further sale of this fuel abroad at "good prices".

However, it is admitted by the interviewee (Ushkevich Personal communication 2008) that the demand for this biomass is very uncertain and there are no certain customers. Nevertheless, as he explains and regards it as a positive factor for further development of woody resources (SRC as well as forestry residues), in the sector of housing and communal services large share of boiler-houses are already running on wood resources.

As regards priorities of various forestry resources and their future, it is being recognized that many issues still need to be developed in relation to the cultivation of short rotation crops:

salary, technology, prices, quality, environmental and energy security. But other resources seem to have more relevance for the Ministry of Forestry:

- Refuse wood (felling debris like tops and branches),
- Raw waste lumber,
- Firewood (only as firewood).

Out of these options the first two are more expensive to produce, thus, their production cost is also higher. As regards of vision for future development, both forestry residues and short rotation crops are perceived to disseminate in light of increasing prices for oil and natural gas (Ushkevich Personal communication 2008).

3.2.1.7 Non-energy Governmental Ministries/Authorities: Ministry of Agriculture and Food

The Ministry of Agriculture and Food as well as any other ministry is formulating and implementing policy within its sector. As regards establishment of plantations of short rotation crops, there seems to be very low interest. It is admitted that for the successful development in this direction all relevant stakeholders have to participate. It is suggested that amelioration of channels may generate some woody feedstock: during the clearance of channels bushes are cut, this biomass should not be just burned but directed to the energy objects (MAF Personal communication 2008).

Among various resources that are generated within agricultural sector, they may also serve as feedstock for energy production that the Ministry admits is livestock waste (MAF Personal communication 2008). As the interviewee describes, at the moment two biogas installations are working in starting conditions: one is running on poultry waste (manure) and its electrical power is 340 kW, another one – on pig manure, electrical power - 520 kW. Thus, the waste is processed with obtaining benefits in the form of energy: heat (warming up water) and electricity.

Moreover, it is being stressed that there is an environmental effect of reduction of GHG emissions, and it should never be omitted when the benefits of such installations are being analyzed. It is recognized that sometimes it is not easy to assess and calculate these environmental benefits but they definitely have to be assessed and added to other benefits' evaluation. The interest to these biogas facilities by the Ministry of natural resources and environmental protection is admitted: they have been taking part in all meetings on the issue and they have contributed financially to the introduction of these installations (MAF Personal communication 2008).

3.2.2 Productive sector

3.2.2.1 Energy Generation Sector

In practice, the energy sector management is divided between several big state-owned companies in line with their activity spheres. The Belarusian state energy concern "Belenergo" that was formed in 1995 to fulfil the functions of control of the Belarusian electric-power complex is under the authority of Ministry of Energy, and includes 36 organizations throughout Belarus (Belenergo). Its main activities include (Belenergo):

- Management of Belarusian energy system;

- Generation, transfer and distribution of electricity and heat;

- Maintenance of electric power stations as well as power grids and heat networks;

- Operative-dispatch control of technological process of electric power generation and delivery;

- Engineering supervision of the state of power stations and network (grid) objects in Belarusian energy system;

- Provision of measures for balanced development of energy system, including prognostication of energy demand; design, investment and construction of energy objects.

The company "Belenergo" is producing almost all needed electricity and a half of heat needs in the country. Industry is the main consumer of electrical energy (60%), while households consume about 60% of heat. In terms of energy the company is mainly directing large production complexes (EEC 2005). Another big state-owned company under the authority of Ministry of Energy is Belarusian concern on fuels and gasification "Beltopgaz" created in 1992. It is one of the major components within the national fuel-energy complex, which main task is safe and regular (uninterrupted) provision of consumers with gas and solid types of fuel.

In the area of responsibility of the Ministry of Energy there are large energy objects – heat stations (Zaharevich Personal communication 2008). They consume significant amounts of fuel, and the plantations of short rotation crops cannot create raw material base, for such large objects these plantations are just small things (Fedoseev Personal communication 2008). Meanwhile, there are also some boiler-houses and mini-cogenerations plants. On the other hand, there are boiler-houses within the sector of housing and communal services, and also many enterprises as well as agricultural productive cooperatives that have their own boiler-houses.

Mini-cogeneration plants have to be built where the reserves of fuel feedstock are available in sufficient amounts (Fedoseev Personal communication 2008). Minenkov (Personal communication 2008) also emphasizes the importance of having stable raw material base, bringing attention to some of the currently functioning mini-cogeneration plants: one of them (Vilejskaya) has a forestry enterprise as a supplier, which has sufficient reserves of wood, for another one (Pinskaya) supply of wood resources is insufficient, longer distance of delivery increases the net cost. Forestry sector (MRPFA Personal communication 2008) also admits that the success of those mini-cogeneration plants depends on how well the feedstock supply is organized: for example, in the town of Uzda the supply of the feedstock (forestry residues) for the mini-CHP is organized very well, however, other conversion facilities seem to have supply problems as within the distance of practicability the resources are not sufficient (MRPFA Personal communication 2008).

One the regional department of "Belenergo" company – "Brestenergo" – commented on their current interest in short rotation crops (Fedukovich Personal communication 2008). There was an assignment from the Council of Ministers for the energy sector to investigate the possibilities of cultivation and utilization of short rotation crops (willows) in the energy system. This issue is just in the discussion phase in "Brestenergo", there have been no quantifiable targets for this feedstock so far.

This feedstock is supposed to be used at mini-cogeneration plants. In Brest region there is already one mini-cogeneration plant, and second one will start functioning in 2010. By this moment "Brestenergo" expects to establish nursery willow plantations (for planting material). Biomass from short rotation crops will be a part of fuel loading, more energy resources will be delivered from the forestry sector (contracts are under discussion with forestry organizations) (Fedukovich Personal communication 2008).

"Brestenergo" is investigating both supply schemes: supply from other stakeholders, and by there own means - cultivation by the agricultural productive cooperative which is under the responsibility of the company and is in the vicinity of the mini-cogeneration plant that is under construction at the moment. Coordination with the regional government (executive committee) includes aspects of land, its exclusion from crop rotation, etc. In "Brestenergo" they also add, that they consult with the government on the issue of including some provisions in the legislative acts (Fedukovich Personal communication 2008).

3.2.2.2 Housing and Communal Services

In the sector of housing and communal services there are smaller energy objects like boiler-houses installed, for example, in schools, hospitals, also boiler-houses in some agricultural production cooperatives (those cooperatives that have been transferred into the area of responsibility of the Ministry of housing and communal services). They can be divided into several categories of installed capacity: up to 1 MW, up to 3 MW, 3-10 MW, over 10 MW. Part of them functions for the purposes of generation both hot water and heating (during heating season) and is running all the year round, others - only for the heating (Chirkovskij Personal communication 2008).

The regional administration of housing and communal services is tasked by the regional government (regional executive committee) in terms of volumes of fuel. Then the regional communal administration gives certain tasks for the boiler-houses in the area of its responsibility in terms of types and volumes of fuel to be utilized. In addition, administration performs the control on fulfilling the targets (Chirkovskij Personal communication 2008).

At present these are mazut, wood and natural gas that are used as a feedstock, with the net cost of 170 000 (approximately 55 euros), 145 000 and 90 000 Belarusian rubbles per 1 toe correspondingly, so natural gas is the most profitable resource to use (Chirkovskij Personal communication 2008). In terms of volume shares of these types of energy resources wood is mostly used feedstock, with sawdust utilized more then woodchips. The supply of wood feedstock is organized by forestry organizations or by the communal services themselves. Current goals in this sector are (Chirkovskij Personal communication 2008):

- Utilization of local energy resources,
- Maximum import substitution,
- Maximum loading of existing boilers,
- Fuel-switch from mazut to local energy resources.

In regards to short rotation crops (Chirkovskij Personal communication 2008), there are no tasks or targets within the sector. There has been a joint sitting for the Ministry of housing and communal services and the Ministry of forestry, where the last one was given the task to investigate the technology, however, the former one did not get any task. The point of view that has been expressed is that the sector of housing and communal services is not the proper

one to be involved in the stage of cultivation. However, if they will be delivered to the feedstock, they can use it, and there is no difference for them where the biomass comes from (Chirkovskij Personal communication 2008).

As for the wider utilization of local energy resources, it has been commented (Chirkovskij Personal communication 2008) that it depends on the type of boiler-house and economy. If the boiler-house is working only on one type of feedstock, for example, natural gas, obviously, it will continue running on the same fuel. If the boiler can be loaded with two kinds of energy resources, the one that is cheaper (net cost is lower) will be consumed. If it is possible to utilize natural gas, mazut and wood, wood should be used as much as possible, as this complies with the targets of import substitution.

3.2.2.3 Agricultural Productive Cooperatives

One of the limitations on collecting data from these stakeholders was the difficulty of identifying those agricultural productive cooperatives that have already established plantations of short rotation willows: there is no information (which of them, their contact information) in any literature or on the Internet, and thus it is impossible to contact them in order to have an interview. Only one contact was obtained from Belarusian researcher on SRW.

However, we can say that the work has started: several agricultural productive cooperatives that are usually located in villages established short rotation willows plantations for energy purposes recently, but there has been no harvesting of the biomass yet. The reasons to initiate the plantations establishment may include (Rodzkin Personal communication, Kuleshov Personal communication 2008):

- Introduction of the technology by researchers,

- Interest in new types of energy resources.

The area under the willows for one agricultural productive cooperative is usually just several hectares. The lands that are assigned for the plantations are mostly abandoned lots and so called “neudobici” – lots, wedges where it is not convenient to grow traditional crops – and such character of land allocation will probably remain in the near future (Rodzkin Personal communication, Kuleshov Personal communication 2008).

Willow plantations are being established by agricultural productive cooperatives to produce energy for their own needs: willows will be combusted on farms in their boiler-houses. These boiler-houses will be re-equipped or new boilers designed for wood will be purchased (Rodzkin Personal communication 2008). In some cooperatives the boilers running on wood resources are already present, thus the willow feedstock can be burned there with other wood feedstock, however, as the head of one of them mentions (Kuleshov Personal communication 2008), they are going to introduce news ones – with higher efficiency. Heat produced in this process will be used for the agricultural productive cooperatives for (Rodzkin Personal communication, Kuleshov Personal communication 2008):

- Heating of administrative buildings,
- Heating of other facilities (like animal husbandry facilities),
- Drying grain in assigned facilities,
- Heating of villages adjacent to the agricultural productive cooperatives.

So far, the agricultural productive cooperatives have not acquired any specialized machinery / equipment for willows planting, harvesting, etc., mainly because it is rather expensive and the scale of willow cultivation has been very low. And as Kuleshov (Personal communication 2008) mentions, it is unprofitable unless the territory under plantations reaches sufficiently large area, for example 10 ha. Probably, manual practices are more realistic for such agricultural productive cooperatives at the moment; it will be interesting to make a comparison of manual and mechanized technologies in terms of various aspects (economic, social, etc.) to find out what is more appropriate for such scope of energy crops production. Also, manual practices are more labor intensive and thus may potentially provide for more employment creation.

Thus, willow plantations are expected to benefit local communities in several ways, described above. They might potentially (Rodzkin Personal communication, Kuleshov Personal communication 2008):

- Become a renewable source of energy obtained locally,
- Substitute part of energy resources used at the moment,
- Create additional employment,
- Allow for optimization of land use.

As Kuleshov (Personal communication 2008) admits, further increase of the plantations area will depend on the yields: if reasonable results will be reached, there are strong intentions to increase the territory.

Grebenkov (Personal communication 2008) also expressed his point of view that agricultural sector is the right one to grow and utilize short rotation willows, because of the following reasons:

- Wood resources from the forestry are not an attractive option for agriculture – it does not have machinery for either cutting and transporting wood or transporting felling debris and forestry residues, and for the forestry organizations the supply of this resources to the agriculture is not profitable as the expenditure are rather high, thus, these residues as the resource becomes expensive;
- However, for the cultivation of short rotation willows agricultural machinery can be used, there are special choppers that can be attached right to combines;
- Biomass harvesting takes place during the winter when agricultural employees have less seasonal work, and thus are more free for SRC activities;
- Agriculture has wastelands where crop rotation shift takes place. An agricultural productive cooperative can find enough lands in order to supply its own conversion facility of 1 MW power with the feedstock;
- If there are boilers running on wood fuel, there should be a stable secure supply of the feedstock (as forestry residues) and developed delivery infrastructure. In that case, agriculture becomes dependent on its suppliers (forestry), but uninterrupted supply is questionable at the moment.

Grebenkov (Personal communication 2008) advocates for addition of other types of fuel, as

flexibility is very important for agricultural cooperative.

3.2.2.4 Forestry Associations

There are six regional forestry associations that carry out control, implementation of programs on regional level, cooperation with regional government, marketing, interaction with consumers of forestry goods (like industries). Further, within those regional associations there are forestry enterprises that directly carry out forestry activity within the administrative regions (CMRB 2006c). The term "forestry enterprise" refers not only to the enterprise but also to its area (territory) of responsibility, within each it is functioning. In order to provide facilities working on local energy resources with the feedstock 110 ha of short rotation crops plantations (called "energy plantations" in Belarus) were established in forestry enterprises and 310 ha (133% compared to the year 2007) are planned to be established in 2008 (Ministry of Forestry).

Interestingly, but the interview in one of these regional associations (MRPFA Personal communication 2008) started with the remark that "[they] are reading that there is a retreat from this activity [cultivation of short rotation forestry] in the world, but it is just being started in Belarus", but it is important to understand positive and negative attitudes. The establishment of the plantations was initiated within the Ministry of Forestry, which planned certain amount of hectares for the whole republic. During the year 2008, Minsk regional executive committee planned to establish 150 ha and gave this task to Minsk regional productive forestry association (hereinafter referred to as forestry association), and these plantations are in addition to the Forestry Plan for the planting of forestry cultures. Although particularly in Minsk region they have not planted willow crops (MRPFA Personal communication 2008).

Upon the coordination of this task by the forestry association with its Ministry – the Ministry of Forestry – it turned out that the Ministry regards this as a too big share for one region (compared to the plan for the whole republic). Moreover, the target has not been coordinated with the forestry association in terms of available lands for these plantations. Thus, the Ministry of Forestry and the regional government set targets (that is also providing for financing); however, the targets set by the executive committee have a priority over the Ministry's tasks (MRPFA Personal communication 2008).

Within the forestry association, forestry enterprises have various conditions in terms of area of land covered with the forest, quality of soil, etc., that is why this difference has to be taken into account when deciding on the size of the territory and the tree breed to be planted. Another important factor influencing decision on forestry enterprises to be chosen is the distance to the potential consumer of feedstock (energy producer). The distance should be not more then 50 km, otherwise it is not practicable (MRPFA Personal communication 2008).

The type of lands that will be devoted to the establishment of short rotation forestry plantations are:

- Glades (cleared places), without the requirements of clearing stumps,
- Low productivity lands, usually transferred from agricultural sector,
- Post-mining soils, transferred from agricultural sector (originated from the Ministry of Energy).

However, post-mining soils transferred from agricultural sector are being taken back for the

purposes of wetlands restoration. The tree breeds that most likely will be cultivated are pine and birch (MRPFA Personal communication 2008). Yields obtained from those lands will be low.

Interestingly, the question about fertilizer application was met with humour at the meeting. Also, there has been a point of view expressed (MRPFA Personal communication 2008) that there is no need to create plantations of short rotation forestry (and willows particularly) deliberately, as there are natural wild bushes of willows, and it was suggested that the harvesting of this biomass could be organized instead. There are complains on absence and/or insufficiency of the following components (MRPFA Personal communication 2008):

- The guidelines on cultivation of short rotation forestry are produced by the Institute of Forestry, however, it was described as "not of sufficient quality". They say they need something better;

- Machinery and equipment necessary for cultivation.

In the regional forestry association they also admitted (MRPFA Personal communication 2008), that at present moment there is no certain consumer for the short rotation biomass. But it is expected that it will be used by mini co-generation plants. Within the Minsk region particularly currently there is one mini-cogeneration plant in the town of Vilejka, and this is the one Minsk regional forestry association is expecting to provide with the feedstock. Also, the process of price formation is unclear at the moment, but definitely expenditures on collecting wood and its transportation from the plantation have to be taken into account, besides, profitability should constitute 5 % minimum (MRPFA Personal communication 2008).

3.2.3 Academia, Civil Society and Media

3.2.3.1 Academia and Research Organizations

Researchers play particularly important role in the development and dissemination of non-conventional and renewable energy as the source of theoretical and practical knowledge. The need for the knowledge as well as significance of scientific and technical research is recognized by the Government which is reflected in various government documents and state programs, starting with the Directive # 3 of the President of Belarus. Via these documents and programs, the Government gives tasks to research organizations on research in the field of renewable energy and local energy resources, like initiation of certain projects, also the Government supports those projects financially by funding them from various funds.

So far several projects on short rotation willows have been launched. One of them was performed by the Institute of Power Engineering Problems[22]. The main results reached in the research include (NAS 2005):

- The development of technological regulation and the guidelines on equipment and machinery for the cultivation and production of fuel from short rotation willows biomass in Belarus for small and middle-size boilers;

[22] Scientific research on the task "To develop technology of utilization short rotation willow as a source of renewable bioresources on the basis of establishment, cultivation and utilization of biomass from experimental-industrial plantations in Belarusian conditions" of the section "Scientific-technical support and provision" of scientific and technical program Republican program "Energy saving" for 2001-2005, approved by resolution of the Council of Ministers of Republic of Belarus, 16.01.01 №56

- Development of technical specifications for energy fuel from short-rotation willows;

- Technical and economic assessment of application of short rotation willows technology for production of local fuel for small and middle-size boilers.

Grebenkov (Personal communication 2008) who used to be the manager of the project that is already completed, explains that, in his mind, strict provisions in the state documents and programs for the short rotations forestry are not an appropriate approach (command-and-control), and that economic mechanisms are needed. The technology itself is not the best one and the payback period is not very short. The willow itself is a risky crop due to certain requirements to the temperature and moisture, but those conditions may vary annually. There should also be a process chart developed.

As to the roles of various stakeholders (Grebenkov Personal communication 2008), the Ministry of Energy should not be involved in this as it has large energy objects within the area of its responsibility. There should be special industry that will be engaged in short rotation crops production, inclusive of hybrids raising. Forestry should not be involved: they already have annual 2 million m^3 of wood increase. Then, forestry organizations do not have resources – human, machinery, monetary. Besides, there is no large enterprise that would be a constant customer of that amount of feedstock at the moment. And, finally, as he said "nowhere in the world forestry sector is involved in short rotation crops cultivation" (Grebenkov Personal communication 2008). Nevertheless, forestry can be involved in nursery gardens which supply cuttings and/or plantings.

From Grebenkov's (Personal communication 2008) point of view, agricultural productive cooperatives are the right stakeholders to be involved – they can be both producers of the feedstock and its consumers. Cooperatives demonstrate the interest in this activity, but they do not have stimuli at the moment. Although, these stimuli theoretically exist, no tax reductions will cover the expenditures for the plantations establishment. On the other hand, there is mazut and other types of fuel that are available in the sector of agriculture, and are rather cheap for agricultural cooperatives, thus, there is also a need for pressure to provide for the shift from these fuels to local alternative energy resources: if the Ministry is obliged it will pass the tasks to executive committees (agricultural departments within them), and they will pass it to managers of agricultural productive cooperatives. If there is an organization involved in feedstock supply, agricultural cooperatives could act as contractors, then, they can decrease their dependence on mazut.

Grebenkov (Personal communication 2008) perceives that soon stimulation might not be the necessity for dissemination of short rotation crops: with the current prices for natural gas (120 dollars per 1 toe) and the tendency for increase probably up to 200 dollars, the wood chips from short rotation crops at the cost of 100 dollars might become competitive, in fact, in the light of such an increase of fossil fuel price they will become. In regards to financing large energy objects (like co-generation plants providing cities and towns with heating), the area of responsibility of the Ministry of energy will be first finance the project, compared to small boiler-houses (in small towns and villages) in the sector of housing and communal services.

Remediation of lands contaminated with radionuclides face many challenges, some of these issues include:

- There is no standard regulating relevant fuel characteristics like temporally allowed level for the employees;

- Radioactivity level of emissions increases in 300 times, and of course such combustion

should not be allowed;

- No standards for the ash, no guidelines on its disposal.

Another project – by the task given by the Ministry of Energy to its concern "Beltopgaz" - has been performed by the research institute RUP "BelNIItopproject" within concern's structure in cooperation with the International Sakharov Environmental University. The results of the research showed (Shamara Personal communication 2008) that most post-mining soils are poor quality lands, not even categorized as soils. However, the willows still grew on this type of lands, though, the yields were not high. There are some more barriers to the cultivation of short rotation willows:

- Absence of necessary technology (meaning machinery and equipment),

- Impossibility to use suitable herbicides (destroying weed seeds): researchers saw that the ones used in Poland proved to be efficient, however, they are not allowed for use in Belarus.

Thus, some of the results reported by the research institute to concern "Beltopgaz", and further passed to the Ministry of Energy are:

- A Willow can grow in Belarusian conditions, and it grows on post-mining soils, however, the expenditures are rather high, especially for soil preparation (it is necessary that there was biologically active layer, in post-mining soils only the very top layer is biologically active, and under it there is almost nothing useful for the plants),

- There is no suitable machinery,

- Economic incentives are not sufficient.

The treatment of wastewater is not recommended on these plantations, as there are channels on the fields, and this water will drain there. The transportation distances have to be considered: Shamara (Personal communication 2008) mentions that plantations have to be situated in the proximity of the conversion facility, for example, mini-cogeneration plant. The delivery of wood chips is regarded as practical when it is realized in the radius of not more then 50-60 km. However, in fact it is rather large radius for short rotation crops delivery in terms of efficiency.

Thus, researchers possess the knowledge on technology of cultivation short rotation willow crops and also its conversion in facilities. But this is not their only function: those organizations, farmers or entrepreneurs that are interested in establishment of plantations or conversion technologies turn to researchers working on the issues in order to get information like guidelines and their participation with the knowledge contribution. For example, one of the agricultural productive cooperatives, that established a plantation of short rotation willows, made it with the participation of the International Sakharov Environmental University (its pro-rector whose research is in the field of growing these crops) (Rodzkin Personal communication 2008). Moreover, Grebenkov mentioned that he has been contacted by several organizations and entrepreneurs that are willing to establish plantations (Personal communication 2008).

3.2.3.2 Energy Specialists and Consulting Firms

There are organizations within the area of responsibility of the Ministry of Energy and Energy

Efficiency Department that can provide consultancy on energy related issues, including renewable and non-conventional energy. There are also other organizations that also have more focus on these types of energy and the questions of energy efficiency, as "Eneka" that works on energy projects in the pre-investment stage. Apart from the academic researchers and the research institute within the area of responsibility of concern "Beltopgas", no special energy specialists have been identified by the author as specialists on short rotation crops like willows that can provide consultancy or assistance.

Nevertheless, the interview about the specialist within the "Eneka" company, whose focus is on bioenergy, provided the author with relevant information in this regard. Korchinenko (Personal communication 2008) mentions the following barriers to the development and dissemination of bioenergy, as well as non-conventional and renewable energy:

- Lobbying by private companies for the use of natural gas: approximately 80% of companies, supplying energy equipment, are natural gas oriented, 15% - liquid fuel oriented, and only 5% supply equipment for non-conventional energy;

- Lack of understanding of possible profits;

- Improper utilization of imported technologies and absence of mechanisms of their adaptation to local conditions. As the interviewee explains, when some technology is imported from other country, there is a lack of understanding that feedstock which is used in this technology in the country-exporter may have characteristics different from its analogue in importing country, for example, waste composition burned in combustion facilities. Thus, there is a need to take into account the character of the feedstock at home and undertake adaptation process if needed;

- Economic reasons: introduction phase is usually rather expensive for biotechnologies;

- Technology developers – those who design and suggest the technology for development and dissemination – frequently have to look for potential customers of this technology and then convince them in its usefulness and profitability.

The list of drivers has been described as well (Korchinenko Personal communication 2008):

- "Green tariffs" (step-up co-efficient for the electricity produced from alternative and renewable energy);

- Certain enterprises and organizations act as a customer of technology;

- Certain enterprises and organizations that become interested in integrated ways of solving their economic, energy and environmental problems. For example, biogas facility at hydrolytic plant, which was prohibited to direct wastewater to the sewerage system.

3.2.3.3 Civil Society and Non-Governmental Organizations

There is a list of environmental NGOs registered in Belarus; some of them also deal with issues of renewable energy, energy efficiency and saving. However, no NGO was identified that could give information on short rotation crops or related questions. Nevertheless, the interview in one of the NGOs supplied the author with information that is useful. This NGO is active in the information dissemination on the issues of importance of:

- Energy efficiency and energy saving,
- Climate change,
- Local Agenda 21,
- Increasing utilization of non-conventional and renewable energy.

They are publishing brochures and organizing seminars with local government on abovementioned topics. This organization cooperates with the consultancy "Belenergosberezhenie" which is within the structure of Energy Efficiency Department (Yablonskaia Personal communication 2008).

As a public environmental organization, they have concerns about popularization of local energy resources utilization, particularly, of wood resources. In fact, they perceive the problem that it might cause massive forest cutting. And, representing public interests, they are interested in that threat not becoming a reality (Yablonskaia Personal communication 2008).

They expressed the viewpoint that, on one hand, the interest of various companies, enterprises, organizations, etc. in non-conventional and renewable energy, local energy resources development is frequently more a result of government pressure and necessity to follow tasks then of consciousness. On the other hand, as the state assists those organizations in the wider dissemination of renewable energy, for instance, via economic assistance in installation of boilers, running on local energy resources, they become more interested and involved in this shift (Yablonskaia Personal communication 2008).

3.2.3.4 Media

Media, inclusive of TV, newspapers and Internet resources, plays role of the information distributor. The national TV channels introduce new research institutes involved in the development of various types of non-conventional energy, or companies and organizations utilizing these technologies. Several interviewees mentioned in the conversation on short rotation crops that they saw it in the news, and are interested to look deeper to the experience. They also seem to be more interested when they learn about Belarusian experience in relevant issues.

There is also the utilization of Internet resources: which refers to a site[23] that provides readers with information on various types of alternative renewable energy. It contains data on technologies, experience abroad and for some energy types – on Belarusian experience. In regards short rotation energy crops, there is a general description of this energy option, however there is no information about Belarussian experience, current state or future possibilities.

3.3 Current Legislative and Economic Settings for Bioenergy

3.3.1 State Program Documents

There are several programs that are relevant in one or another way for the development of short rotation willow crops:

[23] www.reenergy.by

- Directive # 3 by the President of the Republic of Belarus "Economy and thrift are the main factors of state economic security",
- Special program on provision of not less then 25% of the total electricity and heat production from local and alternative energy resources for the period till 2012,
- State complex program on modernization of basic production assets of Belarusian energy system, energy savings and increase in the share of its own fuel-energy resources in the republic for the period till 2011,
- Republican Program of Energy Saving for 2006-2010,
- Program on measures of economy of energy resources and monetary funds.

3.3.2 Energy Legislation

There is a Law "On energy saving" and a list of other legislative acts on rational energy use in industry and households. The European Economic Commission's recommendation (2005) to the Council of Ministers was to develop a common law on energy that will cover all the aspects of energy sector inclusive of generation, transfer, delivery and consumption, with the existing energy legislation being a part of it. Actually, provisions on elaboration and development of legislative base to facilitate and support renewable energy development are found in many state program documents reflecting government's understanding of the problem and intention to work in that direction.

There is a project of the Law on non-conventional and renewable energy in the phase of harmonization that might be adopted soon. According to the description (MAF Personal communication 2008), it will contain provisions for governmental stimulation, energy producers and consumers. This law is perceived as very important, because it will probably initiate interest for renewable energy in more organizations. Although at present the development of these types of energy is understood to be beneficial for the environment, frequently it is not profitable (when compared to traditional fuel types) (MAF Personal communication 2008). The law will probably encourage the expansion of the energy that is not profitable at the moment but beneficial for the environment in terms of ecosystems conservation and reduction of negative effect on the environment. Ministry of Economy is responsible for the design of the law, as it has been given the task to work on the issue of stimulation. This is going to be a basic law with different supporting legislative acts (appendices) (MAF Personal communication 2008).

3.3.3 Energy Prices

Energy prices play an important role in balancing energy supply and demand, energy-efficiency and energy investment, energy accessibility. That is why price policy is regarded as a key factor in influencing consumer behaviour. However, Belarus has not yet developed market mechanisms for energy price forming, and energy prices are developed by the Government: prices for industrial consumers are being set by the Ministry of Economy, while for households – by the Council of Ministers. Thus, neither energy producer, nor energy consumer do not have any influence on final decisions. Also, the process of prices formation is not transparent (EEC 2005).

There used to be a significant difference between energy prices for these two categories of consumers: for the former category it was rather high while for the later one – rather low. Recent energy tariffs policy was pursuing the goal to gradually reduce that gap (EEC 2005, Belenergo). However, as of the first half of 2008, households pay half as much then industrial

consumers (Minenkov Personal communication 2008). As European Economic Commission (2005) points out, absence of market mechanisms and limited financial independence of state energy companies cannot stimulate competition and cannot facilitate reduction of energy generation and transfer expenditures.

However, in order to stimulate development of local and alternative energy resource utilization, economic mechanisms are essential. In fact, some steps in terms of economic stimulation are undertaken in Belarus in order to enable implementation, development and dissemination of utilization of these energy resources. One type of support is reduced environmental taxes: for the emissions from combustion of biogas and bio-fuels (peat, various wood resources including biomass of short-rotation crops, agricultural wastes) for heating and electricity purposes, a coefficient 0.5 is applied to the tax rate (*Dacree # 215* 2007). According to this Decree, current tax rate for 1 tonne of the emissions varies from 170,000 to 33,663,800 Belarusian rubbles (approximately 50 and 1000 euro correspondingly) depending on "danger class"[24]. Depending on substance and volumes of emissions as well as the size of emitter (large objects or small) the cost of emissions will be different, and reductions will have various significance. Some of the interviewees (Shamara Personal communication 2008) perceive such reduction as insufficient incentives.

To support the generation of electricity from renewable energy (including bio-electricity), compensation mechanisms have been introduced in Belarus in 2006 by the Ministry of Economy Resolution (UNDP, GEF, and EED 2007). By the resolution[25] the Ministry "with the objective to stimulate generation of electricity from alternative and renewable energy resources (including biomass) as well as on the small energy objects" establishes indexation[26] of electricity prices produced from alternative energy types (MERB 2006).

This can be explained through the following example (Minenkov Personal communication 2008): an organization installs its own small-scale energy conversion facility – steam boiler/ steam turbine running on biomass. The energy generation is allocated in the following way, the heat is sold to the households at established rates. Produced electricity is partly used for the organization's need, and partly for the conversion facility maintenance. The meters show the data on energy produced and consumed, the difference is sold to the concern "Belenergo" with the electricity rates set for industrial consumers and with the application of the index 1.3. Usually taking into account the expenditures on the fuel feedstock and low rates for the households the heat is produced at a loss for the organization, however, profits gained from the indexed electricity sale should be enough not only to cover these losses but produce net income as well, which can partly be used for further improvements in terms of energy saving and efficiency. If this scheme functions and net benefits are obvious for the organization in question, this represents a good stimulus for shifting to renewable energy types.

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[24] Pollutants belong to four classes of danger (I, II, III, IV with the substances belonging to class I being the most dangerous) and also there are those pollutants that do not have class of danger

[25] *Resolution (solution, decree) # 91 on tariffs for electricity, generated in the Republic of Belarus by legal entities, not being part of Belarusian state energy concern, and by individual entrepreneurs, and sold to energy supplying organizations of this concern* by the Ministry of Economy of the Republic of Belarus in 2006.

[26] Electricity, generated in the Republic of Belarus by legal entities, not being part of Belarusian state energy concern "Belenergo", and by individual entrepreneurs, and sold to energy supplying organizations of this concern will be bought by these organizations (actually by the concern "Belenergo") with prices indices of 1.3 (first 5 years from the moment of operation start), 0.85 (next 5 years of operation) and 0.7 (after 10 years of operation). Expenditures for this electricity acquisition are to be included by the organizations of concern "Belenergo" into primary price of electricity production (MERB 2006).

Thus, this can be an effective mechanism of economic stimulation, however, it is criticized as being imperfect (Minenkov Personal communication 2008): in fact, the same step-up coefficient applies to all types of alternative, renewable types of energy. Nevertheless, the capital per unit expenditures differ for these various types as well as payback periods, thus, it would be more logical to apply various indices. Thereby, the mechanism stimulates the development of alternative renewable types of energy in general, but for particular types it is imperfect, for example, biogas. Minenkov (Personal communication 2008) adds that "Belenergo" might be reluctant to purchasing generated electricity at increased by index rates.

The prices for the wood chips from short rotation willows were calculated within the framework of the research on the topic "Development of technology on cultivation of short rotation crops on the post-mining soils". It turned out that the cost of 1 toe of these wood chips constitutes 473.8 thousand Belarusian rubbles, which is approximately 143 Euro. In fact, it is three times more expensive then wood chips from forestry residues (Shamara Personal communication 2008). The following calculations can be performed for this calculated price:

1 toe of this biomass feedstock is 143 euro;

1 toe provides for: 42 MJ/kg (calorific value)*10^3 kg=42 GJ

42 GJ cost 143 euro => 3.4 €/ GJ

Rosenqvist *et al.* made estimations for production costs for various energy crops in different regions of Europe under present conditions and projections for 2020 (large scale). According to these estimations, currently willow has the lowest production costs among various energy crops, besides, the lowest costs for Eastern Europe (we assume, it may be applied to Belarus), which constitute approximately 3.7-5.2 €/ GJ, thus, our calculations show that the cost is already lower. Moreover, Rosenqvist *et al.* assume, that for less developed crops a potential for larger production costs reduction exists due to the possibilities of further investigation on more suitable breeds of the culture, as well as increase of scale from smaller to larger. According to the same estimations, by 2020 the costs for willows for Eastern Europe may reduce to 3.3-3.4 €/ GJ. Short rotation willow crops have been introduced in Belarus recently, and currently are at small scale of cultivation, thus, there is potential for further improvement of the technology and shift to larger scale, resulting in reduction of production costs, hence, making this feedstock more attractive option.

3.3.4 Bioenergy Revolving Fund

The Bioenergy Revolving Fund has been created within the framework of the project "Biomass Energy for Heating and Hot Water Supply in Belarus": the total sum available is 3 million dollars, GEF's contribution is 1.54 million dollars as gratuitous grant, and Belarus' contribution (including resources from innovation fund of the Ministry of Energy) is equivalent to 1.54 million dollars and is also available to be increased from other sources (Voitekhovich 2008). All entities and organizations can apply for repayable funding from this fund in order to use it for projects on bioenergy and energy efficiency enhancement. It is aimed at shifting from fossil fuels to alternative and renewable energy, reduction of GHG emissions and wider utilization of local energy resources (with the highest priority for wood residues). However, it is being criticized that there is too little money within the fund (MAF Personal communication 2008)

4 Energy Crops in Belarus: Stakeholder Analysis

In this chapter stakeholders, described in Chapter 3, are analyzed within the framework of the stakeholder identification and salience theory, described in Chapter 2. In fact, the stakeholder's attributes – power, legitimacy and urgency – are investigated. In the end, according to the possession of certain attributes stakeholders are grouped in several categories.

4.1 Government

4.1.1 The Government

The national government (represented by the President and the Council of Ministers) forms the national policy for various issues, including energy policy. It formulates the main provisions in terms of energy profile, energy efficiency and savings and enacts them in corresponding decrees. Provisions in most cases are addressed to certain ministries and agencies, thus making them responsible for particular tasks within defined time period. However, for short rotation willows (as well as for short rotation crops in general) there are no established goals, except for the suggestions to develop this energy option and provisions for research by research institutes. At the same time, the option of cultivation short rotation crops and their utilization in the conversion facilities is suggested in most state programs among other types of renewable energy that are regarded to have some potential development in Belarus.

The local government, in the light of national government provisions, addresses the issue of deployment of renewable energy and local energy resources. The regional executive committees give tasks to the corresponding regional departments of Ministries and agencies in terms of agriculture, energy, forestry, communal services, etc. The tasks established by local government are of a more quantitative character, with better-specified goals, responsibilities and schedules. In the case of Minsk regional executive committee, it was certain area (in ha) under plantations. Thus, the government at any level of administration is attributed with *legitimacy* to influence short rotation crops at any stage.

The government potentially possesses *power* as well, as it is setting tasks for the relevant sectors, and the regional government has more power in the sense that it gives more specific provisions, as well as makes decisions on local budget. Nevertheless, some inconsistencies are present: sometimes there is a lack of understanding and coordination of the tasks, for example, as it was admitted by regional forestry organization, when the regional executive committee gave the task for how many ha of short rotation energy crops has to be established without considering how much land is available and suitable for this within the area of responsibility of this particular regional forestry organization. At the same time, if such a task is performed by the local government, it is logical to expect similar task for the energy generation sector (its regional department), i.e. setting requirements on utilizing the biomass and thus making them consumers of the biomass feedstock. Also, identification of the executor of the task can be vague, like giving task on establishment of SRC plantations to the forestry and agriculture, when the actual responsible agency is unclear.

The author concludes that in the case of short rotation willows, as well as, for short rotation crops, there is no *urgency* for the government to shift. In fact, biomass coming from plantations is regarded as potential energy resource; however, it hardly has any development priorities within bioenergy types or within renewable energy in Belarus. Thus, the government as a complex stakeholder (including governments at all levels) is attributed with power and

legitimacy, thus, has *authority* but lacks urgency. As such, the author places the Government bodies assessed into the category *Dominant stakeholders*.

4.1.2 Ministry of Energy

The Ministry of Energy is involved in design and implementation of the policy in the energy sector fulfilling functions of legislation development and participation in fuel price formation. It has *power* to affect energy producing sector represented by state-owned energy companies within the Ministry's area of responsibility, as well as *legitimacy* to do this, for example, by financing from innovation fund. As regards short rotation crops, demand for this feedstock on the side of energy producing sector has to be created and this is the area where the Ministry of Energy can exert its power. In fact, the Ministry has already exerted his legitimate power to some extent when it established the task to perform the research on short rotation willows that has been fulfilled by the research institute of one of the companies under the Ministry's responsibility. However, some stakeholders (like Energy Efficiency Department) consider that Ministry of Energy is not a right stakeholder to be involved in energy crops schemes, as it has only large energy objects within its area of responsibility.

However, the third attribute – *urgency* – again becomes crucial in that case. There has been an interest in cultivation and utilization of short rotation crops (mainly willows) initiated by the deputy minister, based on the need to have additional energy resource and to utilize post-mining soils. However, the research results reported to the Ministry reduced its interest to deal with the SRWC biomass almost to zero. Even thought they still express interest to be consumer of the biomass supplied by other sectors, the factor of the possible price (apparently not attractive compared to other resources at that time (and in the static context)) has negative effect on this interest. So, at the moment neither time sensitivity nor criticality component of urgency can be attributed to the stakeholder in question. To sum up, the Ministry of Energy has attributes of power and legitimacy but no urgency, thus, belongs to *Dominant stakeholders* group. Renewal of the interest with some degree of urgency could place that stakeholder to *Definitive stakeholder* category.

4.1.3 Energy Efficiency Department

The Energy Efficiency Department is another important agency designing energy policy with the focus on energy efficiency, import substitution and increase of renewable local energy resources, and implementing it via coordination of ministries and other agencies of public administration in their energy consumption. Thus, this stakeholder possesses the attribute of *legitimacy* to influence the dissemination of renewable energy inclusive of short rotation willows. However, the character of its functions in relation to agencies (ministries and other agencies of public administration) makes its *power* to affect the energy option in question rather vague. In fact, the Department establishes tasks for those agencies in terms of renewable energy, and is coordinating the fulfilment of those tasks but there are no specifications on particular energy resources to be utilized, thus, the possibilities to influence the development of any particular energy resource are limited.

There is a possibility for the Energy Efficiency Department to contribute to the dissemination of certain energy option by including relevant provisions into its program, acting as the technology customer via scientific and technical programs, or financing relevant projects. However, the Energy Efficiency Department does not have urgent interest (in fact, hardly any interest has been admitted) in relation to short rotation willows or short rotation crops in general. In the end, this stakeholder is regarded as attributed with *legitimacy* but not *power* and *urgency*, so, it is ascribed to the Discretionary stakeholder group.

4.1.4 Non-energy Governmental Ministries/Authorities: Ministry of Natural Resources and Environmental Protection

The *power* of the Ministry of Natural Resources and Environmental Protection in relation to short rotation crops is not easy to describe. In fact, the Ministry can support the development of this energy option by means of being the initiator of related legislative acts that can stimulate cultivation or utilization of the biomass in conversion facilities. The Ministry can also include it in financing from environmental protection funds: for example, according to the Ministry of Agriculture and Food (MAF Personal communication 2008), Ministry of Natural Resources and Environmental Protection has contributed a lot to the introduction of biogas facilities by participating in all the meetings on the issues and provision of significant funding. So, Environmental Ministry can successfully use some mechanisms to exert influence, however, if we define power as ability to reach goals, the author considers that the Ministry cannot reach the goals only by its own effort, as it is not involved itself in the cultivation or conversion of biomass. That is why it is concluded that Ministry of Natural Resources and Environmental Protection is not attributed with the power.

The Ministry possesses *legitimacy*, mainly due to the environmental benefits promised by this renewable energy resource. Although short rotation crops like willows can bring benefits in terms of GHG emissions reduction (at cultivation and utilization stages) and could be potentially of interest for the Ministry especially in the light of Convention of Climate Change and Kyoto Protocol, such interest has not been identified by the author at the time of research. Thus, the Ministry of Natural Resources and Environmental Protection can be described as possessing legitimacy, but lacking power and urgency attributes, and so also can be categorized as belonging to the *Discretionary stakeholder* group.

4.1.5 Non-energy Governmental Ministries /Authorities: Ministry of Forestry

The Ministry of Forestry is developing and implementing policy for the forestry sector, it has been an initiator of introduction of short rotation crops plantations for cultivation of biomass for energy purposes within the forestry sector. Even though plantations have been established, there are no particular consumers of that feedstock. The Ministry expects that certain conversion facilities (like mini-cogeneration plants and boiler-houses within housing and communal services) will become customers, but these are only expectations. So, in relation to short rotation crops (in general, not only willows) the Ministry possess *legitimacy* and *power*, but these attributes are related only to the cultivation stage.

As regards third attribute – *urgency* – it is not present in the Ministry at the moment and is unlikely to appear in the nearest future. In fact, the Ministry of Forestry has – logically and reasonably - a much larger interest in supplying forestry residues as energy resource to energy facilities. To sum up, the Ministry is ascribed to *Dominant stakeholder* group upon possession of two attributes – legitimacy and power. As the theory suggests, those stakeholders that acquire or loose some attributes, are moving from one stakeholder category to another. So, if the interest obtains certain degree of urgency in the light of increasing price of fossil fuels and need for local energy resources and thus higher attractiveness of short rotation crops biomass to energy producers, this stakeholder does have the power to move to the *Definitive stakeholder* category.

4.1.6 Non-energy Governmental Ministries/Authorities: Ministry of Agriculture and Food

Within the agriculture sector there are several agricultural productive cooperatives that either established plantations of short rotation willows, or are willing to do this. However, the interest to this energy option within the sector is not present at the level of the Ministry, thus, the attribute of *urgency* is absent. Nevertheless, if there is interest on the Ministry's side, it has *power* and *legitimacy* to initiate and support the development of short rotation willows cultivation and utilization of biomass in boiler-houses. This can be achieved via inclusion of this energy option in the sector policy, the establishment of corresponding tasks for the regions and then coordination of execution, as well as financing from funds. The introduction of two biogas facilities in agricultural productive cooperatives involved in animal husbandry is an example of policy implementation. Thus, the Ministry possesses the attributes of power and legitimacy, but lacks urgency, so it again belongs to *Dominant stakeholder* group.

4.2 Productive Sector

This sector is represented by energy generation sector, housing and communal services, agricultural productive cooperatives and forestry associations.

4.2.1 Energy Generation Sector

The energy generating sector is managed by two big state-owned companies and includes large energy objects like heat stations, large boiler-houses and recently introduced mini-cogeneration plants. These conversion facilities consume various types of feedstock, mainly oil and natural gas. By consuming certain type of energy resource they are creating demand for it and thus influence the dissemination of this resource utilization. As regards short rotation willow crops, conversion facilities possess *legitimacy*, and they can exert *power* via creating demand for SRWC biomass. Although, most of these energy objects are large and the need for this energy feedstock is rather high, and it would require establishment of plantations at huge areas of land, on the other hand, they can start the substitution of the traditional fossil fuels with a small share and gradually increase it to 10-15%.

Meanwhile, most mini-cogeneration plants are running on wood resources and are potential consumers of this feedstock. Moreover, wider introduction of these mini-cogeneration plants running on wood resources might potentially create bigger demand for various types of wood feedstock, including biomass of short rotation crops. However, at present the energy generation sector has no urgent interest in SRC biomass and does not create any demand for this feedstock, thus, is not attributed with *urgency*. As such, the stakeholder also belongs to the category of *Dominant stakeholders*. Emergence of the interest with some degree of urgency will place that stakeholder to *Definitive stakeholder* category.

4.2.2 Housing and Communal Services

There are small scale conversion facilities like boiler-houses within the sector of housing and communal services. They are boiler-houses in hospitals, schools and other public facilities, however, these are housing and communal services that decide on the feedstock to be utilized, thus they have *legitimate power* to introduce SRWC biomass as a feedstock. Certain share of these conversion facilities is running on wood resources, and more facilities are re-equipped with new wood-based boilers, besides, low energy resources needs make it even more suitable potential consumer of the biomass.

The attribute of legitimacy can also be described by other stakeholders' (like the Energy Efficiency Department) perception that housing and communal services are the right stakeholder to be involved in utilization of SRWC biomass. Besides, the Energy Efficiency Department and the Ministry of Forestry perceive that this sector can also be engaged in the cultivation of energy crops, similar to current partial supply of resources from forests by own efforts. At the same time, interest to this energy option is very low, as it is considered that the priority belongs to forestry resources and housing and communal services do not have difficulties with their supply, hence *urgency* is absent. That is why housing and communal services fall into *Dominant stakeholder* category due to possession of power and legitimacy attributes and lack of urgency.

4.2.3 Agricultural Productive Cooperatives

Some agricultural cooperatives started introducing plantations of short rotation willows on their lands in order to produce feedstock for their own conversion facilities (boiler-houses). They make this decision on their own; cultivation is performed by cooperative's employees and at the expenses of cooperative, the biomass obtained from plantations will be utilized in cooperative's boiler-house. So this stakeholder group possesses *power* and *legitimacy*. In addition, other stakeholders (like the Energy Efficiency Department, researchers on SRWC) perceive agricultural cooperatives as legitimate stakeholder to be involved in cultivation of short rotation crops and consumption of the produced biomass.

There is definitely an interest on this stakeholder's side to energy crops like SRWC, however, only a very small share demonstrates this interest. Besides, even this interest emerges very much due to academia proposing this energy option and as such it is clearly not considered to be an urgent situation. Evolution of interest is most likely to be conditioned by the degree of satisfaction with the biomass yields and associated expenditures. In this light, a few inconsistencies can be noted here: firstly, the lands used for energy crops are of low quality/ productivity (common for all stakeholders who has established plantations) lands and they are very likely to demonstrate low yields or high expenditures for obtaining better yields; this may result in diminishing interest on stakeholder's side. Then, the issue of machinery and equipment available in agricultural sector for cultivation and processing of willow crops: some interviewed stakeholders say that agricultural machinery is suitable, other say that it is not suitable and that forestry sector possesses proper machinery. This brings the author to the conclusion that there is no understanding which machinery/ equipment is needed and suitable for cultivation and processing of the biomass. So, at the moment existing interest cannot be described by the author as urgent, thus, *urgency* attribute is perceived as lacking. To sum up, this stakeholder group, upon possessing power and legitimacy, falls into *Dominant stakeholder* category. Nevertheless, upon increase of importance of this energy option for agricultural sector in the light of increasing cost for conventional fossil fuels, reduced production costs for SRWC, demonstration of good experience of cultivation or combustion of this biomass might place that stakeholder to *Definitive stakeholder* category.

4.2.4 Forestry Associations

In Belarus, the forestry sector might become the one that will be producing short rotation forestry for energy needs. Plantations on various short rotation crops including willows have been established in some forestry enterprises throughout the territory of the republic. Although rationality of forestry sector involvement in short rotation crops cultivation is criticized by some stakeholders (for example, by researchers on SRWC), there are stakeholders that perceive forestry sector as a legitimate stakeholder to be involved, for example, the Ministry of Energy and the Energy Efficiency Department. Though the establishment of

plantations is coordinated by the local government in terms of goals for certain area under plantations, forestry associations and forestry enterprises have *power* and *legitimacy* to contribute to the development of the cultivation stage of short rotation crops life cycle. In fact, they take decisions on location of plantations, technology employed and other factors that will affect the yields, and in the end, the success of these plantations.

They create supply of biomass feedstock, however, even they, similar to the Ministry of Forestry, and have only expectations of potential consumers to purchase this feedstock. For example, the Minsk regional forestry association expects that mini-cogeneration plant in Minsk region will be the customer, but at the moment this mini-CHP has enough resources coming from forestry residues. When both types of feedstock are equally available for conversion facility it will purchase the cheaper one, as both of them are wood resources.

The third attribute – *urgency* – it seems to be absent as well as for all previous stakeholders. The current involvement in cultivation activity is probably conditioned mainly by the Ministry's interest and government's tasks. There are other resources generated within the forestry sector that are utilized as energy feedstock for conversion facilities and have priorities, for example, forestry residues. Further development might depend on yields obtained at currently established plantations and demand formed on the side of feedstock consumers. Thus, this stakeholder attributed with power and legitimacy is ascribed to the *Dominant stakeholder* and upon emerging urgency that might be conditioned by certain demand on energy producers' side has a high potential to move to the group of *Definitive stakeholder*.

4.3 Academia, Civil Society and Media

This stakeholder category constitutes of academia and research organizations, energy specialists, NGOs and media.

4.3.1 Academia and Research Organizations

Research organizations working on short rotation willow crops projects as well as bioenergy and renewable energy in general are relevant stakeholders for the development of these energy types, as they are involved in knowledge and experience generation, adoption of technologies utilized abroad and their adjustment to local settings. Besides, they are the source of knowledge and consultancy for those stakeholders that would like to introduce the technology at commercial scale, for example, agricultural productive cooperatives. However, even though academia has government support and plays a role of consultant for other stakeholders, its *power* to influence the dissemination of short rotation willow crops as well as renewable energy is limited. Nevertheless, the *legitimacy* of academic involvement is obvious and is enhanced by the perception of other stakeholders on the relevance of academia in the investigation of cultivation processes and design of guidelines, as well as development of processing and conversion technologies. Though they are not *legitimate actors*, as they do not have access to the land for cultivation or combustion of biomass, they possess legitimacy of their interests which we recognise here.

The urgency attribute is rather tricky to define for this stakeholder group. Actually, two projects on short rotation willows are completed by now and there is almost no activity on the issue. In one of them – on the technology of cultivation willows on post-mining soils – the obtained findings resulted in the loss of interest in the technology by the research institute and initiator of the project – the Ministry of Energy. Thus, this group of stakeholders is dependent on those stakeholders that are funding the research.

However, one of the institutions that have been involved in the project – International Sakharov Environmental University - proceeds working on the cultivation processes, though the focus shifted to the aspect of cultivation on the lands contaminated with radio-nuclides. This university as well as some other universities is also working on other renewable types of energy. The work is rather active in the light of emerging interest on other stakeholders' side to renewable energy and its certain types and expected increase of this interest. Government policy on wider adoption and dissemination of new energy resources and government support of the research constitute more drivers for academia. In the end, the author ascribes this stakeholder with some *urgency*, as existence of demand for technology might provide for further funding of the current research, which is perceived by academia worth developing and able to bring about described benefits and co-benefits. Thus, this stakeholder is categorized as *Dependent stakeholder*.

4.3.2 Energy Specialists and Consultants Firms

From rather limited information on the role of energy consultancy in the development of short rotation crops gathered the author concludes that there is no consultancy of that energy option besides academia sector. In fact, this stakeholder can be described as *potential stakeholder*. However, consultancy on bioenergy and renewable energy in general is available in some organizations within the Ministry of Energy and the Energy Efficiency Department, also consulting companies that are involved in renewable energy and energy efficiency particularly start to appear. Thus, in relation to short rotation crops the author concludes that this stakeholder does not possess *urgency* (mere absence of interest), however, in the case the interest emerges *legitimacy* is recognized, but the *power* is limited, thus the stakeholder belongs to *Discretionary Stakeholder* group.

4.3.3 Civil Society and Non-Governmental Organizations

There are several environmental NGOs functioning in Belarus, some of them are dealing with the issues of renewable energy, energy efficiency and climate change, however, nothing has been identified in relation to short rotation crops. These environmental NGOs are involved in dissemination of relevant information, however, their *legitimacy* in relation to short rotation is limited: in fact, they have to represent public opinion, but current public knowledge on that energy option is still low or absent, and there are no public claims for or against it. Moreover, their power is limited as well: in the government might not pay any attention to their claims. No urgency in relation to SRWC is admitted: neither negative nor positive issues have been raised so far. Thus, this stakeholder does not possess any of this attributes and so stays outside the graph. This means, that at present moment within the decided definition of the research NGOs are not a stakeholder at all.

4.3.4 Media

Media also fulfils functions of information dissemination and awareness raising, and in the case of short rotation crops it has been admitted as really raising awareness and interest from relevant stakeholders to look at this technology. However, the media is run by the state and hence will be driven by states interests. So, media is attributed only with legitimacy and belongs to the *Discretionary Stakeholder* group.

4.4 Stakeholder Salience: Graphical Representation and Discussion

Now, when all the stakeholders have been identified, described and analyzed in terms of possession of three attributes – power, legitimacy and urgency – they can be depicted in the figure (Figure 4-1). Stakeholders in the box are ranked in the order of their assumed importance, decreasing from the top to the bottom.

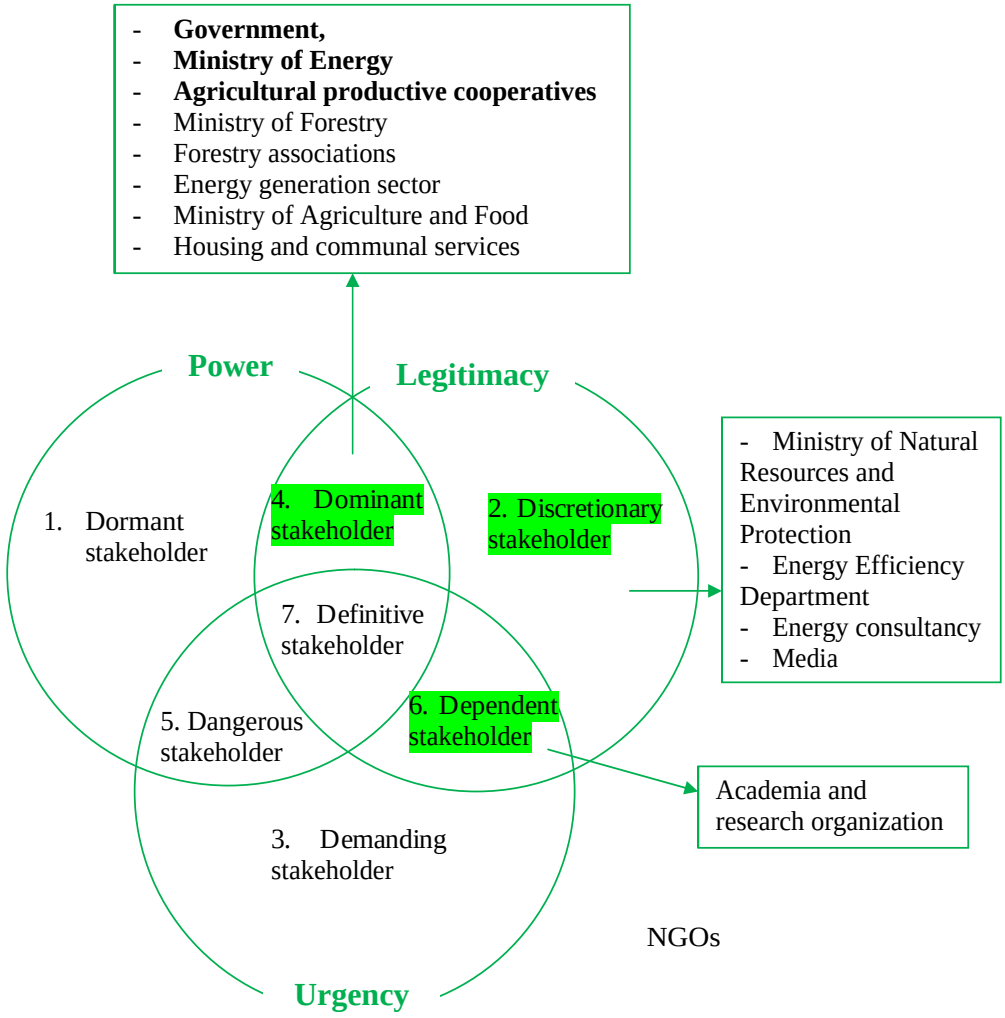

Figure 4-1 Stakeholder salience and grouping

The findings of analysis and grouping show that as much as 8 stakeholders in relation to short rotation willow crops belong to the category of *Dominant Stakeholders* due to possession of *power* and *legitimacy* attributes. Almost all of these dominant stakeholders have some interest in willow crops for energy purposes: either at the cultivation stage (like agricultural cooperatives or forestry associations), or conversion stage (energy producing sector), or all the life cycle (government). Interest gaining importance for the stakeholder as well as time sensitivity results in appearance of urgency attribute, which in turn allows for the shift of those stakeholders from the dominant to *Decisive Stakeholder* group. The author assumes that the Government, the Ministry of Energy and agricultural productive cooperatives have the highest possibility to become those decisive stakeholders, as their current interest is bigger then on other

stakeholders' sides. Moreover, although this is quite a big number of dominant stakeholders that might be able to influence the development of short rotation crops, the power that they possess differs.

Academia and research organizations belong to another category characterized by possession of two attributes of legitimacy and urgency – *Dependent Stakeholders*, and they are unlikely to gain the third attribute of power and move to another category. It is also possible that their interests lose urgency in the light of lacking interest on other stakeholders' side, and they will move to the *Discretionary Stakeholders* category. At the moment the remaining four stakeholders are within this category, attributed with only one attribute – *legitimacy*. Although they belong to the same category and are not attributed with power or interest they still differ in roles. In fact Energy Efficiency Department as well as Ministry of Natural Resources and Environmental Protection have certain power to influence the development of short rotation crops but this power is limited. Moreover, they possess certain interest, which can increase and become more explicit with time, and the urgency attribute is possible to appear in the near future. In that way, these two stakeholders may easily shift to the *Dependent Stakeholder* category. As to the two remaining - energy consultancy and media – they belong to *Discretionary Stakeholder* category and are not likely to leave it. Currently, NGOs were defined as lacking any attributes and thus remaining outside the stakeholder graph.

Changes of interest and urgency in relation to short rotation willow crops with the following category shift may become possible due to various factors, including changes in policy and influence of economic and legislative settings, as well as production costs reduction. Enactment of the Law on unconventional and renewable energy is expected to improve stimulation mechanisms for renewable energy and lead to its wider adoption and dissemination. Changes in the process of energy prices formation might contribute to this as well. Effectiveness of such tools as reduced environmental tax for emissions upon utilization of bioenergy resources as well as indexation of bioelectricity is not very clear at the moment as the tools are rather "immature". Price calculations for chips from short rotation willow crops made by various researchers differ, however, in any case they still are more expensive then traditional fossil fuels or even chips from forestry residues, thus, their competitiveness is still weak. However, as it was discussed in the previous chapter 3, current price of 3.4 €/ GJ, in fact, is not very high and has significant potential for production costs reduction. Moreover, in the light of rapidly increasing international as well as importing prices for Belarus for fossil fuels, this feedstock might become competitive in the future. As to Bioenergy Revolving Fund, it is being admitted that the amount of money is not very big.

The feasibility of development of SRC based energy will depend on these legislative and economic settings, as well as on various stakeholders – their current and future interaction. At the moment this interaction seems to be rather low, in many cases the mutual understanding of the goals and of interaction itself is absent or insufficient. For example, energy sector assumes that forestry sector might be the supplier of the biomass feedstock, and the forestry sector expects energy sector to consume the feedstock, however, this mutual interests are not put into any documents, no contractual relationship exists between them so far, as well as strong motivation.

The need for having certain organization involved in nursery gardens establishment and maintenance in order to produce willow cuttings has been admitted by almost all stakeholders, including selection of clones and hybrids development activity. It has been suggested that it is forestry sector that may be involved in this. As regards establishment of plantations themselves, still there is no clear picture which sector has to be involved in this: some stakeholders perceive it should be agricultural sector, other – that forestry sector, and some –

that it should be sector of housing and communal services. However, those sectors not always perceive themselves as the right stakeholders to be involved in cultivation. Interestingly, but when forestry and agricultural sector are compared, in the former one the interest in short rotation energy crops seems to come downright from the Ministry to the forestry associations and further to forestry enterprises; in the case of latter one the situation is opposite – interest seems to emerge at the level of particular agricultural cooperatives, while the Ministry is almost unaware of these beginnings. From this it can be concluded, that the development also can be from the bottom to the top, if the actors downstream could draw the attention of the management and get it interested in the issue.

As regards conversion facilities, it is admitted by all the stakeholders that they are small scale facilities that will be involved, like newly established mini-cogeneration plants and re-equipped boiler-houses. However, the author makes a remark that according to the information on the Bioenergy project web-page, some mini-cogeneration plants or re-equipped boiler-houses are introduced where there already exists available feedstock base – for example at the big enterprise producing some kind of waste – as furniture factory that is producing woodworking waste. Thus, the feedstock base has to be analyzed when the new facility is planned; in some cases it has already been admitted, that, available resources are not sufficient. The same concerns plantations of short rotation willow crops – upon their establishment it should be considered who will be the consumer, which conversion facility needs additional feedstock and how its seasonal availability affects the work of the facility. However, the option of utilization of this biomass by large energy objects with other energy resources (co-firing) could be investigated, as it is regarded as very effective. Also, possibilities of co-firing biomass with peat could be developed.

During the analysis of the data gathered the author always kept in mind that the option of short rotation willow crops has been introduced recently. Some stakeholders still have limited knowledge and even less experience, and thus their perception and attitude is affected by this insufficiency of knowledge. Knowledge build-up and successful demonstration is still low at the moment, and it is highly possible that the development will become more rapid in the near future, however, there is the same possibility that this energy option will experience decline.

The future development of short rotation crops will be affected by one more factor: in fact, current preferences of the stakeholders and research priorities defined certain niche for the land to be used under plantations – low quality. Actually, involvement of this type of lands is regarded as a benefit, as there are large territories of this land in Belarus. However, the first experiences provide us with the information that yields are rather low at these lands, and efforts to increase the yields result in high expenditures and, thus, higher cost of biomass feedstock for the conversion facilities. Such results are making this feedstock unattractive and can influence further adoption of the technology at commercial scale. Successful cultivation of short rotation willow crops requires following the technology guidelines and application of all the techniques, utilization of low quality lands, for example, post-mining soils, will require even more efforts to reach the same or better results and, thus, more expenditures, and such situation have to be fully understood by the stakeholders.

Moreover, apart from competition with conventional fossil fuel energy resources, short rotation crops have to compete with other types of bioenergy. In fact, within the bioenergy woody resources seem to have the highest priorities in Belarus, with the resources coming from forestry sector being the most attractive option. These are various types of forestry residues, and most stakeholders expressed the viewpoint that these energy resources are most appealing renewable resources to them in terms of price, which is less then for short rotation crops biomass.

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5 Conclusions and Recommendations

For Belarus, being subject to energy security issues due to a heavy dependence of the present energy system on the import from one large supplier and low diversity of energy profile, it is vitally important to increase the share of locally available renewable resources in the total energy consumption and break the dependence on fossil fuels. Introduction of short rotation willow crops plantations for energy purposes is one of the renewable energy options that have a potential to contribute to domestic energy resources and yield certain co-benefits in economic, social and environmental terms. However, possible pathways for adoption and dissemination of this energy option, which is in its early development stage in Belarus, is assumed to depend on and be influenced by various actors (defined as stakeholders), as well as current policy, economic and legislative settings and mechanisms. This research paper aimed to get insight into these issues on the benefits and co-benefits, as well as analysis of stakeholders and current settings with the implications for future development feasibility.

5.1 Conclusions

Here are the main conclusions drawn upon the findings of the paper.

1. Short rotation willow crops have a potential to yield certain benefits and co-benefits on various stages of their life cycle, and some of them are rather explicit, understood and expected by most stakeholders. It concerns, first of all, contribution to renewable energy resources available locally and decentralised distribution, substitution of fossil fuels, and involvement of low quality lands and reduction of greenhouse gases emissions. However, less attention and interest exists in relation to financial benefits promised by bioenergy in the light of Kyoto Protocol, as well as social and economic co-benefits.

2. A list of stakeholders have been identified in relation to short rotation willow crops and analyzed in terms of influence of adoption and dissemination of this energy option. As a result, Government, Ministry of Energy, Ministry of Forestry, Ministry of Agriculture and Food, Energy generation sector, Housing and communal services, Agricultural productive cooperatives and Forestry associations have been identified as dominant stakeholder group who lacks only the urgency of their interests that will transfer them to the most important group – decisive stakeholders. According to the collected information and author's assumption biggest interest is on the side of the Government, the Ministry of Energy and agricultural productive cooperatives.

3. A set of economic and legislative mechanisms has been identified in relation to stimulation of renewable energy, inclusive of short rotation willow crops: reduced environmental tax, indexed prices for bioelectricity, bioenergy revolving fund. These tools have been introduced just recently and they still need changes to raise their effectiveness. Legislation on renewable energy is expected to be enacted very soon and contribute to its dissemination and success, besides, renewable energy might benefit from Kyoto Protocol mechanisms upon ratification of amendment to Kyoto Protocol on inclusion of the Republic of Belarus in Annex B with the reduction target.

4. Feasibility of dissemination of short rotation willow crops also depends on coordination and cooperation between various stakeholders, and coherence of their activity, those components are either insufficient or even absent. It is still unclear which sector is the proper one to be involved in cultivation of the biomass, and actually none of them has urgent interest to be engaged in this activity, while uncertainty also exists on the side of conversion facilities.

Moreover, interaction between them in terms of supply-demand relationship creation is close to zero: plantations in the forestry sector are established while the consumer is still uncertain. One of the possible schemes is cultivation of those crops by agricultural productive cooperatives and consumption of the biomass by themselves for their own energy needs.

5. Several factors are identified to influence the development: governmental policy and control; wider introduction of mini-cogeneration plants and re-equipment of boiler-houses to the mode when they can use wood resources that might serve as drivers, while high production costs of biomass related a lot to certain niche of lands used (the lowest quality) and competition with another, cheaper, bio-resource - forestry residues – may serve as barriers.

5.2 Recommendations

Upon the findings, the list of the following recommendations is formed:

- Coordination between stakeholders has to be established, first of all, between potential providers and consumers of short rotation crops feedstock. This can include joint sitting of relevant ministries: of energy, agriculture and food, forestry, probably ministry of housing and communal services, as well as interaction of relevant departments at local level – regional, production units themselves;

- As government has power to coordinate and control other stakeholders, this power has to be used efficiently: corresponding targets can be developed for various sectors. If a certain task is given to the sector involved in cultivation of short rotation crops, relevant tasks can be designed for conversion facilities, like inclusion of this feedstock into energy balance. This concerns involvement of government at various levels: national and local (regional, provincial, municipalities, etc.);

- The Ministry of Agriculture and Food can pay more attention to the possibilities of cultivating short rotation crops in the light of interest to this activity in production units within its area of responsibility – agricultural productive cooperatives;

- Inclusion of short rotation crops into the list of joint implementation (JI) projects for benefiting from The Kyoto Protocol upon its amendment ratification; for that the coordination and cooperation has to be enhanced between the stakeholders and the responsible ministry has to be defined in the iterative process.

5.3 Implications for Further Research

Some research areas have been identified as relevant for further investigation, inclusive of:

- The Dilemma of low quality lands involvement and resulting high production costs;

- Involvement of large conversion facilities: co-firing of biomass, for, instance with peat;

- Emerging interests from entrepreneurs to the establishment of SRWC plantations, mainly as nursery gardens for cutting production;

- Involvement of the sector of housing and communal services in consumption of short rotation willow crops biomass as managing small scale conversion facilities.

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Shamara, Nikolai Semenovich. Research institute "BelNIItopproject". Formal interview. Minsk, 16 April 2008.

Shkel, Tereza Evgenievna. Deputy manager. Uzda district executive committee. Interview on the phone. 2 May 2008.

Ushkevich, Nikolai Tarasovich. Deputy Minister, Ministry of Forestry. Formal interview. Minsk 21 April 2008.

Yablonskaia, Yulia. Executive director, International public organization "Ecoproject partnership". Formal interview. Minsk, 29 April 2008.

Zaharevich, Aleksandr Nikolaevich. Head of Investment Department, Ministry of Energy of Republic of Belarus. Interview on the phone. Minsk, 18 April 2008.

Abbreviations

CHP	combined heat and power
EiT	economy in transition
GHG	greenhouse gas
JI	joint implementation
SRC	short rotation coppice (or short rotation crops)
SRF	short rotation forestry
SRWC	short rotation willow coppice (or crops)
TPES	total primary energy supply

Appendix I

Organizations and people interviewed

Stakeholder group	Stakeholder/organization	Person
Government	Uzda district executive committee	Shkel, Tereza Evgenievna, Deputy manager
	Ministry of Energy of Republic of Belarus.	Zaharevich, Aleksandr Nikolaevich, Head of Investment Department
	Energy Efficiency Department	Minenkov, Andrei Vladimirovich, Head of Section, Section of Scientific and Technical Policy and External Economic Links,
	RUE "BELINVESTENERGOSBEREZHENIE"	Fedoseev, Viktor Georgievich
	Ministry of Natural Resources and Environmental Protection of the Republic of Belarus	Grebenkov, Alexandre, PhD Project Manager, Project "Capacity Building for Implementation of Flexible Mechanisms of Kyoto Protocol in Belarus"
	Ministry of Agriculture and Food (MAF)	
	Ministry of Forestry	Ushkevich, Nikolai Tarasovich, Deputy Minister
Productive sector	"Brestenergo".	Fedukovich, Mihail Korneevich, Deputy head of the section, Section on social development
	Minsk Regional Administration of Housing and Communal Services	Chirkovskij, Sergej Vladimirovich, Deputy chief engineer
	Suvorov agricultural productive cooperative	Kuleshov, Valerii Egorovich, Head
	Minsk regional productive forestry association (MRPFA)	
Academia, consultancy, NGOs and media	Energy engineering and consulting company "Eneka"	Korchinenko, Sergej Vitaljevich, Section manager, section of bioenergy
	International Sakharov Environmental University	Rodzkin, Aleg, Pro-rector
	Research institute "BelNIItopproject"	Shamara, Nikolai Semenovich
	International public organization "Ecoproject partnership"	Yablonskaia, Yulia, Executive director

Appendix II

Examples of questionnaire interviews

Ministry of Energy

1. Which renewable energy types are in the focus of your agency at the moment?
2. What are the interests in bioenergy? Biomass? Short rotation crops? Willows?
3. Can you please comment on provisions for SRC development in the state program which is on your agenda now? There has been a project in development of technology of SRWC on post-mining soils initiated by the Ministry of Energy. What is the current state of the research and results?
4. The role of your agency in relation to short rotation crops?
5. Which stakeholder, to your mind, is important for their development? Which stakeholder do you perceive to be involved in cultivation?
6. Is the Ministry of energy interested in utilization of SRWC on energy objects in its area of responsibility?
7. How the Ministry of energy may influence suppliers of feedstock?
8. Which stakeholder will be a consumer of the feedstock?
9. How do you think introduction of mini-cogeneration plants and re-equipment of boiler houses will affect SRWC? Will SRWC become the feedstock for the energy objects in the area of your responsibility?
10. In your mind, which mechanisms may influence the development of SRWC?
11. Which benefits and co-benefits can short rotation crops yield?
12. How do you perceive future development of SRWC?

Ministry of Forestry and Regional Forestry Association

1. What were the reasons for establishment of short rotation crops plantations?
2. Is there a certain demand for this feedstock from particular customers? Volumes?
3. Whom do you perceive as potential consumer of the biomass feedstock?
4. What is the process of defining areas of plantations to be established? Where do the goals come from?

5. How are the certain forestry enterprises chosen? How do you make decisions on category of lands devoted to the plantations establishment and particular tree breeds?

6. How was the price for the SRC feedstock will be formed?

7. What can affect your future plans for expansion of those plantations?

8. Which stakeholders do you perceive as able to affect the dissemination of short rotation crops?

9. Which benefits and co-benefits can short rotation crops yield?

10. How do you perceive the future development of SRWC?

Agricultural productive cooperative

1. Why did you decide to establish plantations? Which tree culture did you introduce in your plantations?

2. What are going to do with the produced biomass?

3. What is the territory under the plantations currently?

4. How many people are involved? Will it create additional employment?

5. What is the situation with the machinery and equipment?

6. Do you apply fertilizers?

7. Are you going to increase the area of plantations? What can influence you decision for expansion of the area?

8. What land is used currently and will be involved in the future in case of expansion?

9. Who (which stakeholders) can influence you plans and decisions for short rotations crops?

10. How much substitution you expert to obtain from this energy resource?

11. What do you think about future developments for SRC plantations? Are there any plans to introduce plantations at larger scale for supplying conversion facilities with the feedstock?