Strategy development and determination of barriers for thermal energy and electricity generation from agricultural biomass in Turkey

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Abstract

The present work deals with determining barriers for thermal energy and electricity generation from agricultural biomass in Turkey. Strategy development and determination of barriers were investigated in accordance with the work program requirements for the project entitled ''Exploitation of Agricultural Waste in Turkey'' under the European Life Third Countries Program. The study has been organized and presented according to the following three phases: (i) market barriers for electricity and thermal energy generation (ii) identification of barriers to the promotion of agricultural waste exploitation in Turkey, and (iii) conclusions for strategy development.

Keywords: Agricultural biomass, Turkey, Strategy development

1. INTRODUCTION

The agricultural sector has been Turkey's largest employer and a major contributor to the country's gross domestic product (GDP), exports and industrial growth. As the country develops, agriculture declines in importance, however it still accounts for a relatively large share of total output and employment compared to many other countries. Indicatively, the export of agricultural commodities (excluding agroindustry) for 2005 was about 2 billion USD, or 10% of total Turkish exports. Agriculture accounted for 16% of the country's GDP for the same year (Bascetincelik *et al*., 2006). Crops and livestock represent almost 90% of the agricultural sector in

Turkey, with forestry and aquaculture contributing the rest. The type and quantity of crops that form the basis of the agricultural sector in Turkey (wheat, barley, tobacco, cotton, rice, etc.) give rise to huge amounts of agricultural residues. These residues are treated in an uncontrolled manner either burned in open-air fires or disposed of and left to decay. In both cases, these management methods give rise to significant environmental impacts and, at the same time, waste useful energy resources that could reduce dependence on imported fuels (Kaya *et al*., 2008). Bascetincelik *et al*. (2006) found that the total calorific value of the field crop residues was around 228 PJ for the production period of 2002–2003 in Turkey. The major crops that take place in the ratio of the total calorific value are maize (33.4%), wheat (27.6%), and cotton (18.1%). The total calorific value of the fruit residue was 75 PJ. The major fruits are hazelnut (55.8%) and olive (25.9%) for the agricultural biomass. The total calorific values for cow, sheep and poultry wastes in Turkey were found to be approximately 47.8, 3.6 and 8.7 PJ/year, respectively. Thus, the total agricultural biomass potential was found to be approximately 363.1 PJ/year for the production period of 2002–2003 in Turkey (Bascetincelik *et al*., 2006).

Biomass available for energy can be converted to different types of final energy, e.g. power (electricity) and heat (charcoal and producer gas); of these, production of electricity appears to be particularly important. Use of agricultural biomass is a very sensitive matter because of the potential financial impact in Turkey where agricultural residues or wastes from agro-processing industries, could be used profitably in local boilers. Agricultural and municipal solid wastes, as energy sources are available economically in Turkey. The responsible authorities for solid waste management in Turkey are the Ministries of Environment, Industry and Trade, Interior Affairs, Public Works and Settlement, municipalities, the chambers of trade and industry; and the Turkish Standards Institute.

Comprehensive studies have been carried out concerning the present status, the technical potentials, the policies, and the regional distribution of energy resources in Turkey by many researchers (Demirbas and Bakıs, 2003; 2005; Balat, 2004; Balat, 2005a; 2005b; 2005c; 2005d; 2005e; Balat *et al*, 2005; Balat, 2006; Kaya, 2006; Kaya et al., 2008; Konak and Pamukcu, 2006; Kılıç, 2006; Kılıç and Kaya, 2007; Ozturk and Bascetincelik, 2006; Pamukcu and Konak, 2006; Yılmaz, 2006) and concluded that Turkey has extensive renewable energy resources that can be developed as a significant source of energy.

In 1992, electrical production from biomass, primarily wood, had a net impact of $ 1.7, billion and biomass electrical-generating capacity will have grown to approximately 22 GW in 2010. At this capacity level, the economic benefits are estimated to be $ 6.2 billion in personal and corporate income and 238000 jobs (Demirbas, 2002). At the micro-scale level, small gasifiers coupled to internal combustion engines and generators can produce up to 20 kWe of electricity for decentralized use. In the future, improvements should lead to more efficient arrangements with turbine generators or fuel cells (Balat, 2005e). Electricity produced by direct combustion of biomass and advanced gasification and pyrolysis technologies is almost ready for commercial scale use. Biomass power plants (BPPs) use technology that is very similar to that used in coal-fired power plants. For example, biomass plants

use similar steam-turbine generators and fuel delivery systems. Electricity costs are in the 6–8 c/kWh range. The average BPP was about 20 MW in size, with a few dedicated wood-fired plants in the 40–50 MW size range in 1983 (Sorensen, 1983).

Direct combustion of biomass in Turkey for many years has used fuelwood, animal wastes, agricultural crop residues and logging wastes. These sources are often called non-commercial energy sources, but in Turkey, fuelwood is a tradable commodity, since it is the primary fuel in rural and urban poor districts. One alternative for producing electricity from biomass in a gas turbine is direct combustion of biomass as a primary energy source. Biomass is burned directly to produce steam; the steam turns a turbine and the turbine drives a generator, producing electricity. Because of potential ash build-up (which fouls boilers, reduces efficiency and increases costs), only certain types of biomass materials are used for direct combustion. Direct combustion usually involves reducing the biomass into fine pieces for fueling a close-coupled turbine system. In a close-coupled system, biomass is burned in a combustion chamber separated from the turbine by a filter (Tasdemiroglu, 1986). Three main determinants of the costs of operating and constructing a biomass-fired power plant of a given size exist. They are: (1) the availability of the required fuel, (2) the delivered fuel prices and (3) the financing and construction of the desired power plant (Joutz, 1992).

The main objective of the present study was to develop strategy and to determine market barriers for thermal energy and electricity generation from agricultural biomass in Turkey.

2. DETERMINATION OF MARKET BARRIERS FOR UTILIZATION OF BIOMASS

2.1. Market Barriers for Biomass Electricity

Information

Outside of the Nordic Countries there is a lack of understanding of the use of biomass for power by decision makers at different levels-from planners and local authorities to politicians in national and the EU government.

There is also a lack of understanding of the benefits of biomass by decision makers and the general public. There is little political or public support to reflect the global, regional and local benefits of biomass, and therefore the level of financial support is low. In contrast with this, the fossil fuel lobby is very powerful, and the links between use of electricity and global impacts are not widely recognized by the general public.

Increased awareness will help to achieve consumer demand for green power, which is seen as one way in which financial problems may be addressed. There is a need for a very strong lobby to market green power, similar to those which promoted unleaded fuel or recycled paper

There is a need to make a strong case for biomass. Currently, there are few agreed facts. There is a need for a benchmark for the benefits of biomass, an agreed life cycle analysis for employment, carbon and energy balance, emissions etc. This must be done on national and European levels. These benefits should be costed in economic terms. This will be valuable for informing policy makers, and for marketing to the wider public (e.g. to achieve consumer demand for green power).

The biomass industry must continue to liaise with organizations whose activities will affect public opinion of the biomass industry. For example, during 1997 Friends

of the Earth campaigned on global warming issues and, in particular, sought to increase awareness of the link between electricity generation and CO_2. The biomass industry should ensure that it is seen as a favorable alternative. One important result of the lack of information on biomass energy is that, at the local level, there is opposition by the general public, and by planning authorities, to the perceived and actual local impacts of biomass power plants. Power generation is seen as a national concern, and only becomes a local community issue when a project proposal is made by a developer locally.

Risk

Financial barriers to the use of biomass for power generation are of great importance across the EU. A large part of the cost is associated with the risk, actual and perceived, of unproven fuel supply (e.g. short-rotation coppice) and a relatively unproven conversion technology (e.g. gasification, pyrolysis, co-firing). Modern conversion technologies (gasification and pyrolysis) offer great power generation efficiencies. However, these are relatively commercially unproven. The project risk finance is therefore high.

Biomass for heat and power is generally a familiar concept in the Nordic Countries. However, new technologies always have to overcome an initial barrier of mistrust and feeling of risk-especially on the part of decision-makers. Existing demonstration plants facilitate the process of building up the necessary trust in new technologies.

Most decision makers consider that the greatest risk is the uncertainty of future energy politics. The risk that taxes and fees will change before the investment has been paid off keeps them from investing unless the pay-off time is very short. State guarantees on long-term policies would give the investors a chance to survey the taxes and fees at least for the expected pay-off time, and would facilitate investments in renewable energy systems.

Environment

Use of biomass rather than coal or oil for electricity generation, may result in lower levels of local and regional pollutants including NOx and SOx. However, the use of appropriate, modern technology is critical. Wood combustion results in lower emissions of SO_2 than, for example, coal and would contribute to amelioration of acid rain. Research on co-utilization of biomass with coal has shown that, through dilution effects, emissions of SO_2 are reduced linearly with increasing percentage of wood used. In some circumstances, reduced NOx emissions occur because of a reaction between components of the wood and coal particles.

"Bio-energy" is not environmentally friendly by definition alone. With inappropriate technology, bio-energy use will result in both large damage to the local environment and to health. However, with modern and well designed technology the environmental and health gains are considerable. In areas where there is a surplus of nitrogen in the soil, the harvesting of bio-energy will result in a reduction of the nitrogen load in the soil as leaching of biomass after felling residues is avoided. Loss of nutrients in the forests can be compensated by wood ash recycling. When burning the fuel the emissions of nitrogen oxides will be much lower than the increase of nitrogen in the soil if the biomass was left on the ground as logging residues.

Sulphur can be considered as a part of the ecological balance in nature. No additional sulphur comes from bio-energy. The effects of using wood biomass for energy on the level of emissions of acidifying compounds are small. Major improvements in heat and power production technology have already been achieved, regarding sulphur emissions. In agricultural land there may be a certain amount of sulphur from fertilizer which is recycled in the environment if short rotation forest or grass is used as a fuel.

Volatile Organic Compounds (VOCs) are a result of the process technology used. An appropriate technology does not result in measurable emissions of VOC. Biomass provides a number of local environmental gains. Energy forestry crops have a much greater diversity of wildlife and flora than the alternative land use, which is arable or pasture land. Energy crops may also offer a corridor for wildlife between woodland habitats. Energy crops that are carefully sited and designed will enhance local landscapes and provide a new habitat for recreation. Provision of recreation habitat is important near urban centers. It is important to underline here that the collection of fuel from European forestry and agriculture and the use of energy crops is a sustainable activity that does not deplete future resources. The reduction of CO_2 emissions applies for electricity production with biomass.

Financial

Financial barriers to the uptake of biomass for power generation are very important across Europe. There is currently a large difference in the cost of power generated from biomass and that from fossil fuels. European and national government support to bridge this difference is available through a wide range of initiatives, including grants, subsidies, taxation etc. Incentives are much greater in some countries than in others. Incentives are insufficient in the majority of countries. There are a range of incentives available in some countries, but in other countries there is only one scheme, and project developers have very limited opportunities to seek alternative funding. Incentives are not coordinated between countries and experience with problems and advantages are not readily transferred between countries. There is a widespread acceptance that fossil fuels do not pay the full environmental costs of their use and that the use of renewables would be greatly enhanced by recognizing this in some form of tax differential.

Market Characteristics

The biomass industry differs from many other renewables in that it encompasses both the farming and forestry communities and the power generation industry. This creates tensions and misunderstandings. There are often widely differing opinions on the merits of long term fuel contracts and the contractual liabilities that these place on, often quite small, fuel supply companies.

The industry is still finding forms of co-operation to deal with these differences that provide equitable returns for both sides of the industry. This situation has proved a major obstacle to the deployment of energy crops.

Regulations

Energy crops are not treated equitably under the Common Agricultural Policy, and this is one reason for the slow rate of uptake of these crops. Energy crops may be grown

on set-aside land under the Arable Area Payment Scheme. However, energy crops should be given the same level of stability as food crops and not be used, as part of set-aside, to counter cyclical surpluses in food production. Energy crops are not internationally tradable, and so should not have large implications for GATT. There is considerable uncertainty about future European standards for atmospheric emissions. In various countries, including Belgium and Italy, there are currently no standards for emissions from biomass power plants. There are indications that wood-fuelled plant is likely to be subject to European standards which are more stringent than those for e.g. coal. There are fears that biomass fuelled plants will be subject to emissions regulations for incineration plant; this would certainly result in heavy discrimination against biomass.

Critical Success

The greatest part of biomass to electricity schemes was developed in pulp and paper industries and forest industries, where significant synergies and the necessity of waste management were critical success factors. Beyond these applications biomass to electricity schemes have only been successfully deployed in Scandinavian countries where dedicated policies including tax and subsidy policies were implemented.

Strategic Issues

Renewable energy covers a wide range of issues which are dealt with by different Directorate Generals within the European Commission, but there is currently no integrated European policy for renewable energy. There is a need for a renewable energy policy which is integrated with environmental, employment, agricultural, rural development and transport policies.

Energy policy aims should be met alongside agriculture, environment, employment, rural development, and agriculture and transport policies. This would lead to recognition of all the benefits which individual biomass projects provide. Such a policy could be implemented via a range of support mechanisms. The role of local authorities in the field of energy-as representatives of energy consumers-should be given more recognition in national and community policy. This is particularly pertinent to biomass because it is consumed near its production area.

Local strategies, within the national framework, are important for the realization of biomass power projects. Denmark is advanced in their involvement of local communities in energy projects. There are a large number of biomass projects with an element of local ownership. In the recent action plan on energy (Energy 21), the government state, as one of their main principals, that they will engage the public in energy policy objectives, through active public debate on energy and inspiration for local work. This may also lead to novel ways of funding biomass projects e.g. through partnerships between private business, the government and local communities.

The deregulation of the electricity markets may have mixed effects on electricity production from biomass. It is too early to grasp the consequences in the long-term, but an initial trend is that electricity generated from renewable energy sources has a marketing value. Just as environmental labeling helps sell more traditional products, consumers are observant of the proportion of “green electricity” that power companies and utilities provide.

Government support may be required for the development of green power. This is illustrated by experience of these schemes, in Holland, Sweden and Denmark, and in other industrial sectors. For example, the Dutch government supports green power by allowing domestic consumers of green power to pay a lower VAT rate. This compensates for the extra premium paid for green power, so that the net price is similar to the standard electricity supply.

Some form of regulation may be necessary for the initial development of green electricity. While domestic consumers may be persuaded to pay extra for environmentally benign power, they only account for a proportion of power consumption, and uptake will be much less by industrial and commercial users.

European industry has a very strong world market position in biomass electricity and is well placed to improve. This should be recognized and the effect on export performance given a heavy weighting in policy making. The income from exports will be a major contribution towards offsetting the cost of incentives and the RTD Program necessary to develop the home market.

2.2. Market Barriers for Thermal Energy Production from Biomass

Information

In a number of countries, for example Austria and Scandinavian countries, there is a long tradition of using wood for heating, and good information is available to industry, decision makers and the general public. However, in other countries, where the tradition of using wood for heating has been broken by almost completes reliance on fossil fuels, there is a lack of knowledge of wood fuel. Including:

- a lack of knowledge of the opportunities which exist,
- a lack of understanding of the benefits of biomass by decision makers and the general public
- little political or public support to reflect the global, regional and local benefits of biomass, and therefore the level of financial support is low.

Lack of understanding of the use of biomass for energy has, in the past, led to mis-information in the media, and this is an on-going threat to the industry. For example, there are concerns about perceived high use of pesticides and herbicides in short rotation coppice SRC. The environmental benefits and impacts of using biomass vary across Europe. Opinions on these may also vary widely between different interest groups within particular countries. SRC is one example. In some countries in northern Europe, there is some limited debate about the degree of benefit which may be gained from growing SRC. In some countries in southern Europe, there are strong anti-eucalyptus lobbies, based on perceptions that eucalyptus coppice has low wildlife value, is detrimental to the soil, has very high water consumption, and increases fire hazard.

Risk

The degree of risk varies according to the state of development of biomass for heating in the country concerned and on the particular technology being considered. For example, in Austria, where wood fired stoves and district heating are both widespread, there is very little risk associated with the installation of new stoves or development of

new projects. However, in the UK, where very little heat is produced from biomass, potential investors, home owners, wood product factory owners, financiers of larger projects, are faced with higher risks, both actual and perceived.

The security of fuel supply (e.g. pellets, wood chips) causes a risk, as infrastructures are considered to be weak and prices are not always stable. This risk could be met by long-term agreements on biomass prices between suppliers and plant operators and by measures to strengthen the infrastructure. In countries without subsidies or other administrative or governmental arrangements there is also reasonable financial risk. In countries where CO_2 taxes or subsidies exist, decision makers may consider the uncertainty of future energy politics as highest risk. State guarantees on long-term policies could lower the risk that fees change before the investment has been paid off.

Environmental

At present there is a great variation in the quality of wood burning equipment. While state of the art boilers produce extremely low emissions (less than 100mg/m^3 CO), standard equipment for domestic heating has unacceptably high emissions (typically 20,000 mg/m^3 CO). Thus policies to push technological performance of European equipment producers are a precondition for the successful growth of environmentally sound biomass use for heating applications. At the European level there is a need for standard regulations regarding emissions of domestic wood heating equipment, as well as for standard certification schemes for small scale combustion units.

Financial

In general the access to finance for biomass heat installations is comparable to fossil applications. However, where a plant type is new and not widely demonstrated, financiers see it as risky which results in high borrowing costs. In Europe, the cost of heat from biomass is, with a few exceptions, higher than that for heat generated from fossil fuels. One notable exception is the wood products industry, where the fuel is available at zero or no cost. A combination of widespread use of district heating, large timber industries and forest resources have also allowed wood chip markets to develop which are approximately competitive with fossil fuels. Where transport distances can be minimized, wood can be a cheaper fuel than the fossil fuel alternative. In general however, the capital investment costs are high compared to those for fossil fuel conversion systems. In countries with little development of the biomass heat industry (but with potential), the development of special financing schemes for biomass heat applications could increase deployment especially with larger plant.

Price Distortions

The European bio-fuel market is of course influenced by the prices of other fuels. The low price of fossil fuels is an important factor for their high share for heat production. Gas distributors can set their prices on the basis of marginal cost and not on the average cost. In some countries natural gas distributors are also supported through favorable regulations.

The liberalization of the European electricity and gas market will reduce the price for electricity in industry. This will also lower the cost effectiveness of biomass-CHP

and process heating. Furthermore within a liberalized market the prices for electricity may drop and the utilities may make more effort to replace domestic biomass heating. Through consideration of environmental or social issues these distortions could be corrected; however they hardly exist at present. Only some countries have CO2 or energy taxes, which try to take these issues into account. An EU wide regulation of these tax schemes would be desirable.

Market Characteristics

The market characteristics for biomass heat are very different across the EU. In regions where there is already a culture of biomass use, the market is organized but outside these areas the market is often very disjointed with very mixed marketing messages being presented to potential customers. The lack of a main stream market also means that biomass for heating is rarely considered by plumbers or contractors who select and choose heating systems. This means that it is difficult for biomass to be used as heating. The market is not sufficiently organized to present the product to the potential customers. This results in a perception in the market place that systems are unreliable, inconvenient and have a high cost; also that there is no back-up or service available.

Furthermore, in regions without a tradition of using biomass, the market for the supply of fuel is poorly organized and there are no fuel standards. This makes it difficult for manufacturers and users as there is a risk that fuel will not be available or that the fuel that is available is inconsistent in quality leading to operational problems. Organization of the market for both fuel and conversion equipment is a key requirement but this can only take place once there is a genuine market created by arranging for biomass heating to be financially competitive with fossil fuels.

Regulations

A European wide regulation regarding norms and standards for biomass fuels (e.g. pellets)-similar to the European standards for liquid and gaseous fuels (directive 92/32EWG)-would support the wider uptake of biomass heat by creating transparent quality requirements for different wood fuels. On European level there is a also a need for standard regulations regarding emissions of domestic wood heating equipment, as well as for standard certification schemes for small scale combustion units, to ensure that environmental concerns do not become a major obstacle for biomass heating

Critical Success Factors

Several critical success factors can be identified across the EU. For large scale biomass district heating schemes and industrial applications the involvement of competent partners (industry or utilities) can increase deployment. The strong promotion of biomass heat by regional/national energy agencies is crucial for success. New products (e.g. micro grids) and services (e.g. guaranteed performance contracts) can open new markets. RTD activities should be carried out in close co-operation with the developers and with involvement of local manufacturers. This should reduce the production costs, stimulate the market and motivate industrial innovations.

Strategic Issues

RTD activities which increase the deployment of biomass for heat would initially favor countries which already have relevant products. The manufacturers are mostly within the EU so manufacture and employment would remain within the Union. Fuel would always be produced local to the site of use because of the cost of transport. Increasing deployment outside the existing areas for biomass heating would initially result in equipment being exported within the EU but if a sustainable market develops in a country for a product, local manufacturers would be likely to develop products to meet the demand.

Infrastructure Constraints

In general there is a serious danger for the biomass-heat market if a region has a well developed gas grid. In Denmark it is even forbidden to build biomass-fired plants in areas where there is a natural gas grid in order to protect the market for gas. Until now, there is no well established distribution system for wood chips, pellets etc. This is a major reason for biomass to be seen as a risky and uncertain source of energy.

The Carbon Trading Market in Central Europe

As global and European policies to limit emissions of greenhouse gases take shape, the emerging carbon market is focusing its attention on Central and Eastern Europe. Climate change is now recognized as one of the greatest challenges facing humanity in the 21st century, and the world's governments are moving to develop solutions. The Kyoto Protocol, signed in 1997 and likely to enter into force by the end of this year, commits industrialized countries to reduce their emissions of carbon dioxide and other greenhouse gases by 2012. Despite the withdrawal of the United States from this treaty in 2001, most other members of the OECD are pushing forward with its implementation.

The quest for solutions has focused on the market-based mechanisms established in the Kyoto Protocol to help countries meet their obligations at low cost. Their principle is simple: since climate change is a truly global problem, the precise location of emissions abatement efforts is irrelevant. As long as emissions are reduced somewhere, the benefit to the global atmosphere is the same. Emissions trading allow emitters to choose cost effective solutions, because governments or corporations can sponsor cheap emissions abatement projects outside their immediate vicinity and use the resulting carbon credits to meet climate regulations at home.

Buyers in the international emissions trading market are therefore seeking projects that reduce large quantities of emissions, at low cost, and in countries willing to part with their Kyoto-assigned quotas in exchange for foreign investment. One region in the world offers all these characteristics-Central and Eastern Europe (CEE).

Following a steep decline in emissions due to the closure of many inefficient Soviet-era industries since1990, the nations of CEE will meet their own Kyoto obligations, most with room to spare. However, the carbon intensity of the CEE economies, as measured in tons of carbon emitted per million dollars of GDP, is still many times higher than the European Union average. This signals the availability of low-cost and even cost-saving emissions reduction opportunities waiting funding through Kyoto's Joint Implementation (JI) mechanism.

Carbon credit buyers, including the Dutch government's ERUPT program and the World Bank's Prototype Carbon Fund, have begun to explore such opportunities. JI investments in this region have funded projects ranging from the construction of wind farms and biomass-fueled district heating systems to power plant renewal and forestry.

For instance, the Hungarian government recently approved the country's first JI project, a coal-to- biomass fuel switch at the AES Borsod Power Plant. The prospective buyer, ERUPT, would contribute roughly 25% of the project's capital cost in exchange for the rights to the plant's future stream of emissions credits.

As interest in buying carbon credits in CEE grows worldwide, many hurdles remain to efficient, low- risk carbon commerce. Project developers are for the most part unaware of the opportunity to sell their carbon credits, governments have been slow to create the necessary regulatory environment, and there are few intermediaries who fully understand both the local market and the complex web of rules and conditions that govern carbon trading transactions. As the market develops it is expected that carbon commerce will become streamlined within a few years.

The lessons learned from this new market may open possibilities for Turkey through an increased use of biomass fuels and should be carefully considered as part of the overall strategy for increased agricultural waste utilization.

3. IDENTIFICATION OF BARRIERS FOR EXPLOITATION OF AGRICULTURAL BIOMASS IN TURKEY

3.1. Barriers in the Institutional, Legal, and Administrative Framework

A series of the most important barriers identified to date in the institutional, legal, and administrative framework for the exploitation of the agricultural waste in Turkey include the following:

- Definition of responsibilities structure and organization at the Institutional level requires a higher level of coordination and cooperation within and between institutions, agencies, institutes, and other stakeholders
- Limited authority at municipalities to obtain necessary data
- Insufficient available information about existing and possible future costs
- Insufficient detailed renewable energy resource assessments and data banks pertaining to Turkey
- Recovery of insufficient revenue from local taxes
- Insufficient local income sources and responsibility
- Insufficient credit facilities, particularly for small-scale projects
- Administrative and time-consuming obstacles for foreign investors
- Need for support for infrastructure and management know-how at local level
- Insufficient participation by the private sector
- Need for additional staff who have sufficient technical information
- Difficulties possibly encountered in planning, project feasibility, and project control activities
- Need for more efficient implementation of waste minimization policies
- Other insufficient policy and market tools (including available subsidies) in the environmental, agricultural, and energy sectors
- Need for higher level of dissemination and promotion
- Need for public acceptance and willingness

One important issue that is particularly evident from our survey is the need for detailed data. This raises a number of questions, particularly for investors. Reliable quantitative biomass resource data is scarce, especially for agricultural residues. This is coupled with (and due to) the informal nature of existing agro-industry residues available for energy purposes; that is, these resources are not always fully recognized and managed as true resources, and they are often unrecorded. Further, the picture that is presented to policymakers and energy industry investors is that the biomass market is small, not easily controlled, old fashioned, and financially unattractive. Better data would allow for more accurate observations to be made.

3.2. Real and Perceived Risks and Other Inherent Difficulties in Promoting Biomass Energy

In comparison to fossil fuels, biomass fuels are characterized by their low density, and sources of biomass are small, dispersed, disparate, and seasonal. Biomass fuels may be collected from, for example, individual farms covering a wide geographic area (Qin *et al*., 2008, 2009). Sources are relatively very small in comparison to fossil fuel extraction industries, with the possible exception of the largest pulp and paper or wood processing units. These issues all contribute to potentially elevated fuel costs – via logistics, contracting, transport, fuel preparation, storage, etc.

A unique aspect of many agricultural waste materials is their seasonality. The seasonality of agriculture is seen to be a key risk, for both establishing viable fuel supply businesses and for maintaining year-round fuel supplies to a potential energy plant.

The high capital cost of agricultural waste or biomass power plants is a major disincentive to investors. Further, the upper size limit of biomass plants is lower than fossil fuel fired plants, because long-distance transport of low-density biomass fuels is generally not considered feasible (for financial or environmental reasons). There are limited opportunities to achieve economies of scale with bio-energy. Thus, to achieve favorable power and heat generation costs, technology with high fuel conversion efficiency is selected. For example, gasification technologies enable higher electrical conversion efficiencies than conventional combustion boiler plants. There is also considerable interest in pyrolysis for the same reason.

Nonetheless, while improved technology may be able to battle some of the elevated investment costs of bio-energy, technology risks remain. Some relevant technology is proven, however a lot of technology remains in research, development, and demonstration phases. And this technology risk is considered unacceptable to most investors.

Another important consideration is that the core business for the wood or agro-industry plant owners and managers is not energy. If a capital sum is available for investment, improvements to their core business are likely to take precedence over any potential energy-related business expansion. However, entities that are market leaders in their field with a limited scope for further product/process improvement are perhaps more likely to examine diversification opportunities and view energy export as a new business opportunity.

In many countries, universities have also been noted to not sufficiently educate engineers about renewable energy technologies. Appropriate skilled staff will be necessary for future biomass and other renewable energy developments. Also, these individuals may in the future hold decision-making roles in energy plant investment. Giving students awareness and knowledge of successful renewable energy technologies is important for building acceptance and helping them to recognize the feasibility for renewable energy projects in the future.

While environmental protection is an important driver for agricultural waste exploitation and biomass energy, there can also be an opposing restricting effect in the eyes of some with respect to environmental protection. That is, in some countries, the general public does not always perceive bio-energy to be as "deep green" as other renewable energy technologies such as wind and solar. This is the case even for the "cleanest" sources of biomass. Uninformed people are simply unaware of the carbon neutrality of biomass, and some express the view that bio-energy is "burning the trees". And, as with all developments, there is potential for "Not-In-My-Backyard" (NIMBY) opposition to bio-energy plants, based on aesthetic appearance, increased traffic in the locality, and so on.

4. CONCLUSIONS FOR STRATEGY DEVELOPMENT

(1) Turkey is a developing country with rich biomass potential. Because Turkey is an energy important country, indigenous energy sources of Turkey are of strategic importance. Limited sources of petroleum-based fuel made the subject of producing quality energy and productive usage of it an important point for Turkey. Due to some technological and economical consequences, renewable energy resources have wide applications neither in the world nor in Turkey at present. Biomass can be used to meet a variety of energy needs, including generating electricity, heating homes, fueling vehicles and providing process heat for industrial facilities.

(2) The future of biomass electricity generation lies in biomass integrated gasification/gas turbine technology, which offers high-energy conversion efficiencies. The electricity produced by direct combustion of biomass, advanced gasification and pyrolysis technologies is almost ready for commercial scale use. A supplementary .ring of biomass in steam-electric power plants may, under certain circumstances, prove to be economically feasible.

(3) Use of agricultural waste already exists in some industries in Turkey on a small scale. However, because of the financial and technical barriers to biomass energy in Turkey, as discussed above, and insufficient policy/market instruments, the private sector is not yet seriously interested in biomass and waste-fuelled energy plants.

(4) In order to encourage investment by reducing technical barriers, a number of measures can be recommended. First of all, technology that is developed and/or transferred needs standardization and then replication. Applied biomass technologies should be evaluated in detail as a pre-condition for technology transfer. Cooperation with European Member States in related

technology areas should also be expanded. Improving data availability, quality, and completeness will also reduce technical barriers. Improved data should include residual or waste type, availability, quantities, and location. Additionally, the energy supply and demand should be closely monitored and the forecasts must be revised to take account of the progress of liberalization, energy efficiency improvements, structural changes in industry, and other major factors in order to better inform all players' investment decisions.

(5) To encourage investment by mitigating financial barriers, high initial capital costs, high operation and management costs, and risky fuel supply costs must be brought down or subsidized. Local production of renewable energy technology can reduce the investment costs significantly.

(6) Appropriate policy development can also help to mitigate cost issues. Appropriate financial mechanisms must be implemented by the public sector to mitigate the risks of project investment. Implementation of the potential market instruments can be summarized as follows:
   - Financial incentives (e.g., direct grants, loans, and/or subsidies) supporting the better use agricultural by-products;
   - Environmental taxes or penalties that would discourage land filling of agricultural waste or environmental unfriendly management of agricultural wastes;
   - Exemptions or reductions in the level of taxation for electricity, heat, and/or transport fuels produced with biomass sources; and
   - Energy investment-related financial support mechanisms such as special loans, start-up subsidies and/or grants.

(7) Market instruments considered to be of highest priority are the latter two energy-related instruments–tax exemptions or reductions and other energy investment-related financial support mechanisms. These are expected to provide the most immediate benefit for improving investor confidence.

(8) In addition to these market instruments are another growing type that is more tailored to the market than relatively straightforward capital grants or subsidies. For example, there is a rapidly growing market in the EU in greenhouse gas emission credits/trading and renewable energy certificates, which are backed respectively by emissions caps and mandatory obligations on utilities. Other broad mechanisms include carbon and energy taxes. These kinds of incentives have considerable value and can make otherwise financially unattractive installations viable. They also have wider effects on energy savings, energy efficiency, and renewable energy. Such market instruments could effectively promote biomass and other renewable energy forms in Turkey, as well. However, it should be noted that to date most incentives have focused on electricity, and heat has generally been excluded. The exclusion of heat is because of the dispersed and complex nature of heat (e.g., heat energy efficiencies and the heat market are much more difficult to measure) and its perceived unimportance. The heat market in Turkey should be considered vital and given additional attention.

(9) Overall, relative to the current status of policy and legislation in the EU that

promotes agricultural waste exploitation, Turkey has many gaps to fill. Priority market instruments to address costs were given above. Recommended priority policy instruments include:

- A policy or program to encourage alternative, beneficial uses of agricultural residues and wastes, in particular for biomass energy production, and potentially to encourage planting of energy crops;
- Modifications or additions to existing landfill regulations or establishment of a separate policy that sets a target for the reduction of biodegradable waste, or specifically agricultural crop wastes and residues, sent to landfills;
- Policy or legislation establishing a target for the penetration of renewable energy sources into the gross domestic energy consumption, potentially with interim targets to ensure the country stays on track with the goal and potentially with separate but integrated targets for RES-heat, RES-electricity, and/or biomass sources; and
- Policy or legislation establishing a target for the penetration of biofuels into the gasoline and diesel transport fuel market, potentially with interim targets to ensure the country stays on track with the goal.

(10) The recommended market and policy instruments are not only energy sector-specific, but agricultural and environmental, as well. These three areas are interrelated and individually and collectively must be considered.

(11) Three other specific recommendations remain with significant environmental implications. These are related to use of wood and wood residue usage, co-generation of biomass and coal, and biomass plant emission limits. First, it was recognized that market demand for biomass fuels already exists in Turkey, including in rural areas, where a large number of people generate income through trade of wood and wood residues, primarily for cooking purposes. However, with regard to both the demand and supply sides of wood fuels from both forest and non-forest sources, technologies and methodologies need to be modernized. Existing approaches are inefficient, uneconomical, and environmentally undesirable since it is essentially open burning. Technological standards and incentives supporting advancement in technology are recommended for implementation. Second, co-generation of biomass with coal could be encouraged where coal is currently used; this will reduce the emissions of those existing power generation systems and make a considerable contribution to greenhouse gas emission reductions. Third, with the exception of dust, it appears Turkish biomass-related air emission limits are generally compliant with EU limits in the Large Combustion Plants Directive. Dust emission limits could be reduced significantly. If the limits that can be specified in Turkey are not sufficiently protective, technological standards can also be developed.

(12) The role of the government in formulating and implementing favorable policies for agricultural waste exploitation is vital. While specific policies and regulations are recommended, it is also important for efficiency and effectiveness that communication and mechanisms for coordination/cooperation between

ministries (i.e. energy, agricultural, and environmental) be improved. Successful policymaking and implementation can lead to an ultimately important outcome: The private sector, which has the capacity to mobilize needed funds, must be motivated to participate in biomass and other renewable energy development.

(13) The process of liberalization, restructuring, and privatization in the energy sector is also vital. It should be continued without any delays in the introduction of competition. This will assist in creating a favorable environment for investment.

(14) While biomass fuel supply is an area fraught with difficulties, experience has shown that biomass fuel supply can integrate well with existing wood and agricultural production activities, providing additional revenue opportunities for existing forestry and agricultural operators/contractors and potential opportunities for new specialized biomass fuel supply specialists to be established. Advancements and technical developments take place with increasing scales of activities, which further leads to reduced prices, improved quality (i.e. conformance to specific standards), and improved reliability in supplies. In combination with appropriate policy and market instruments, plus R&D support, needed investments can be mobilized and agricultural waste exploitation in the form of biomass energy can be successfully promoted and implemented on a wider basis in Turkey.

(15) CHP production could also be utilized for production of process heat and steam for industry in Turkey. Industry needs heat for drying and many kind of processing, which enables efficient CHP production even without district heating network. In addition, heat production of smaller CHP plants can be used for heating of public or industrial sites. In large scale the highest interest seems to be focused on power production, i.e. production of electricity.

(16) The most favorable conditions for power production based on thermal conversion are in medium or large scale, which enables utilization of an efficient steam cycle. However, most of agro-biomass is distributed to large areas and missing logistics limits size of potential power plants. Industrial agro-biomass, like residues from olive oil or cottonseed oil production, is an exception because residue is usually available in relatively large volumes on one site. These industrial sites offer very attractive locations for biomass fuelled energy plants.

(17) The most potential applications to utilize agro-bio-fuels in energy production in Turkey seem to be relatively small-scale applications. The most interesting size of the plant is below 10–20 MW. Technically size of CHP or power plant is not limited but investment and operation cost of very small power plant is usually very high compared to large-scale power production. In most cases this results directly in conclusion that in small scales the most feasible way to utilize agro-biomass is heat production replacing some more valuable fossil fuels. However, this expects that there has to be a local need for heat. Need for power is more or less similar around Turkey because national grid can be used for distribution of electricity but need for heat is always local. Heat can not be transported long distances but it has to be utilized in the neighborhood

of the plant. In practice, this means that actual need for heat has to be specified case by case.

(18) Although there are sufficient quantities of agricultural biomass potential in the country, certain parameters should be taken into account before making a strategy for their energy exploitation.
- Small farming size depends on the region.
- Environmental risks caused by the removal of the residues from the field.
- Opportunity cost of the residue.
- Lack of commercial harvesting machinery for certain residue types.

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